

# THE STATE CLIMATOLOGIST

2014/15 Annual Summary

Volume 33, Issue 1

**The *State Climatologist* is a publication of the  
American Association of State Climatologists**

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May, 2015

Dear AASC Members, Partners, and Friends:

The variability of the earth's climate system continues to impact society and garner increasing attention from the general public and decision makers alike. As the awareness of the influence of climate grows, the work of the members of the American Association of State Climatologists (AASC) becomes increasingly important and relevant within our society. With these facts in mind, it is a pleasure to share with you the 2015 edition of "The State Climatologist", a summary of the accomplishments of members of the AASC during the past year. This publication highlights the work of state climate offices, regional climate centers, and our federal partners in providing reliable climate data, services and expertise to the citizens of the United States.

The AASC continues to advance in numerous areas. Many of our membership have taken advantage of our new institutional membership structure becoming either "Institutional Leader" or "Institutional Associate" members of our Association. The increased revenue stream has allowed us to move forward in choosing Asheville, NC as the location of our national office, and to proceed toward the hiring of our first full-time Executive Director. In addition, the Association has recently launched a new web site that details the rich diversity of state offices and offers a location for members to share climate tools, data and research and to conduct the business of the Association. A full-time Director, a permanent national office presence and new web site will enhance our efforts to effectively serve the membership of the AASC as we move through a time of change and opportunity in the fields of climate services and climate research.

All of the advances we have made in the last year have been a result of the tireless efforts of AASC members who have volunteered time and talents to move the Association forward. Thanks to all of you that have worked so diligently to make plans and proposals a reality. A personal thanks to all that have offered advice and wisdom during my first year as President. It is truly an honor to serve such an outstanding group of individuals and such a wonderful Association.

Sincerely,

A handwritten signature in black ink that reads 'Daniel J. Leathers'.

Daniel J. Leathers

President of the American Association of State Climatologists  
Delaware State Climatologist



### ***About the American Association of State Climatologists***

The American Association of State Climatologists (AASC) is a professional scientific organization composed of state climatologists (one per state), directors of the six Regional Climate Centers and associate members who are persons interested in the goals and activities of the Association. State Climatologists are individuals who have been identified by a state entity as the state's climatologist and who are also recognized by the Director of the National Climatic Data Center of the National Oceanic and Atmospheric Administration as the state climatologist of a particular state.

State Climatologists currently exist in 48 states and Puerto Rico. They are typically either employees of state agencies or are staff members of state-supported universities. Associate members may be assistant state climatologists or other climatologists under the employment of the state climatologist, representatives of federal climate agencies, retired state climatologists, or others interested in climate services. For more info, see

<http://lwf.ncdc.noaa.gov/oa/climate/stateclimatologists.html>

### ***ARSCO***

A state climate office may gain status as the AASC-Recognized State Climate Office (ARSCO) by providing:

1. A document detailing current and planned activities meeting ARSCO requirements;
2. A letter of support from the state's Regional Climate Center Director;
3. A letter of support from at least one National Weather Service Forecast Office serving the state.

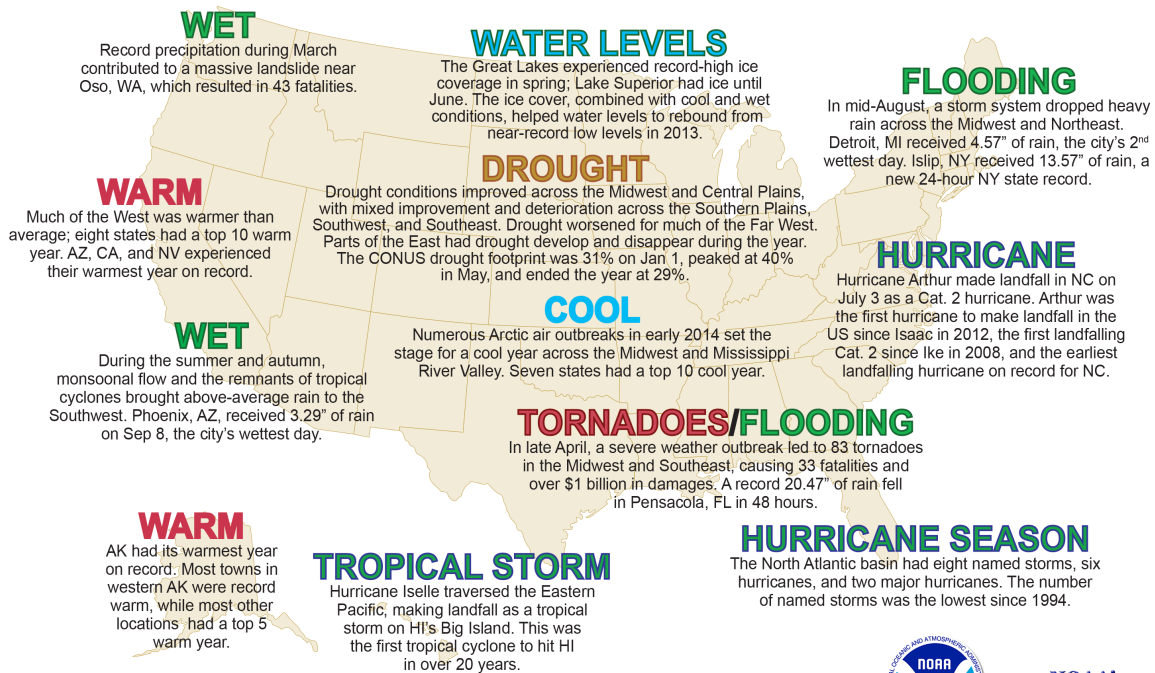
Candidate offices must demonstrate the following capabilities:

- Communication capabilities – the office must be able to communicate with its clientele via multiple media, including telephone, Internet, mail, E- mail, and fax;
- Information services – the office must be capable of providing a range of data and information;
- Research – the office must conduct research on climate and human activities;
- Outreach – the office should design products and services for education, climate information, awareness, and the media;
- Monitoring and assessments – monitoring climate conditions, evaluating future impacts, and providing historical context to events are activities conducted by ARSCOs.

Upon receipt of the materials and approval of the AASC Executive Board, a Memorandum of Agreement (MOA) with the National Climatic Data Center shall be issued. Currently, 38 states have received ARSCO status

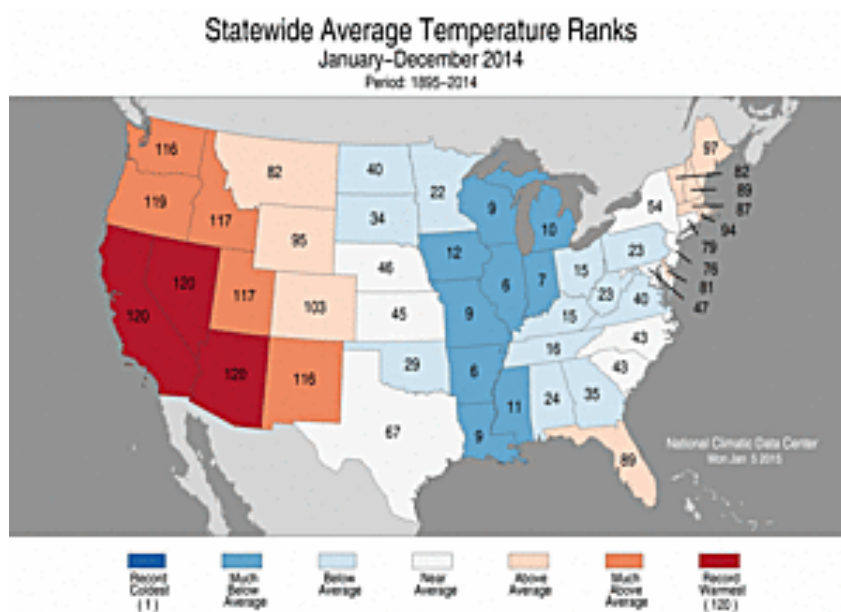
# NATIONAL OVERVIEW: STATE OF THE CLIMATE 2014

## Preliminary Significant U.S. Weather and Climate Events for 2014

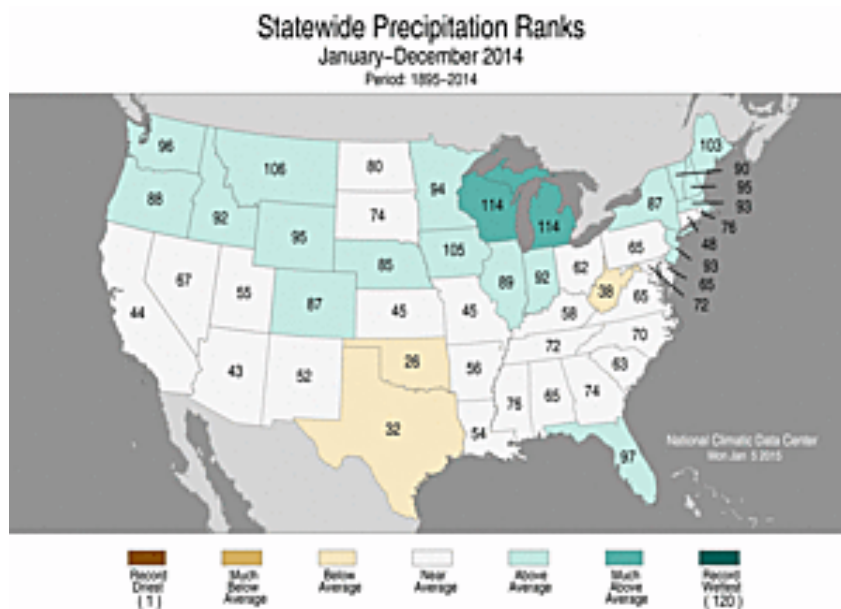


NOAA's  
National Climatic Data Center

# National Temperature and Precipitation Analysis



2014 National Temperature Rank Map



2014 National Precipitation Rank Map

In 2014, the contiguous United States (CONUS) average temperature was 52.6°F, 0.5°F above the 20<sup>th</sup> century average, and tied with 1977 as the 34<sup>th</sup> warmest year in the 120-year period of record. 2014 was slightly warmer than 2013 for the CONUS when the annual average temperature was 52.4°F. This marks the 18<sup>th</sup> consecutive year with an annual average temperature above the 20<sup>th</sup> century average for the CONUS. The last year with a below-average

CONUS temperature was 1996. Since 1895, when national temperature records began, the CONUS has observed an average temperature increase of 0.13°F per decade. Precipitation averaged across the CONUS in 2014 was 30.76 inches, 0.82 inch above the 20<sup>th</sup> century average. This was the 40<sup>th</sup> wettest year on record for the CONUS. Over the 120-year period of record, precipitation across the CONUS has increased at an average rate of 0.14 inch per decade.

On a statewide and seasonal level, 2014 was a year of temperature extremes, with precipitation extremes more muted. Above-average temperatures during 2014 were observed across much of the West, Northeast, and Florida. In the West, eight states had one of their 10 warmest years on record. Arizona, California, and Nevada were each record warm, in addition to Alaska.

The Arizona average temperature was 62.3°F, 2.9°F above the 20<sup>th</sup> century, besting the previous record set in 2012 by 0.2°F. The California average temperature was 61.5°F, 4.1°F above the 20<sup>th</sup> century average, besting the previous record set in 1934 by 1.8°F. The Nevada average temperature was 53.1°F, 3.6°F above the 20<sup>th</sup> century average, besting the previous record set in 1934 by 0.1°F. Below-average temperatures were observed for most locations east of the Rockies, with the coolest temperatures stretching from the Midwest to the Lower Mississippi River Valley. Seven states had an annual temperature that ranked among their 10 coolest on record. Despite several months being record and near-record cold in the region, no state had an annual temperature that was record cold, or even ranked among their five coolest years. Several cities in the western U.S. had a record, or near-record, warm year, while several cities in the central U.S. had a record, or near-record, cool year (a map of those cities is available here). Based on NOAA's Residential Energy Demand Temperature Index (REDTI), the contiguous U.S. temperature-related energy demand during 2014 was 3 percent above average and ranked as the 60<sup>th</sup> highest in the 1895-2014 period of record. On a local level during 2014, approximately 39,527 daily warm temperature records were tied or broken (14,122 warm daily maximum records and 25,405 warm daily minimum records); while approximately 49,459 daily cool temperature records were tied or broken (28,522 cool daily maximum records and 20,937 cool daily minimum records).

Overall, much of the CONUS had near-average precipitation for the year. Above-average precipitation stretched across the northern tier, from the Pacific Northwest to the Upper Midwest, and into the Northeast. Michigan and Wisconsin each had their seventh wettest year on record with precipitation totals 117 percent and 118 percent of average, respectively. Below-average precipitation was observed across the Southern Plains and parts of the Central Appalachians, but no state was top 10 dry. Despite near-average annual precipitation for California, long-term precipitation deficits (dating back over 3-years) in the state, combined with a record warm year in 2014, were associated with the exacerbation of drought conditions across the state. Several stations across the nation had either their wettest or driest calendar year, despite much of the nation having near-average precipitation (a map of those cities is available here). In terms of drought, according to the U.S. Drought Monitor, drought conditions improved across the Midwest and Central Plains, with both drought improvement and deterioration intermittent across parts of the Southern Plains, Southwest, and Southeast. Drought worsened for much of the Far West. Parts of the East had drought develop and disappear during the year. The CONUS drought footprint was 31.0 percent on Jan 1<sup>st</sup>, peaked at 40.1 percent in May, and ended the year at 28.7 percent, the smallest footprint at any point in 2014.

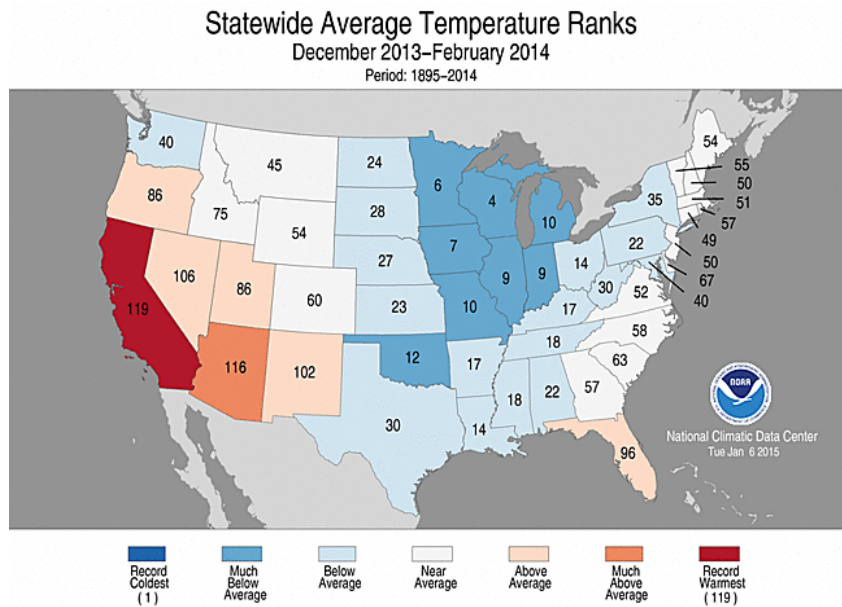
## Seasonal highlights in 2014 included:

- The CONUS had its 33<sup>rd</sup> coolest winter on record, with much of the country east of the Rockies being cooler than average, mainly due to several Arctic cold-air outbreaks. Many states had their coldest winter since the 1970s. Seven states were top 10 cold, but no state was record cold. The cold winter in the Midwest resulted in the second largest Great Lakes ice cover in the 1973-2014 record. The western U.S. was warm during winter. Arizona had its fourth warmest winter, while California was record warm. The winter was dry for the CONUS, with a precipitation total 0.97 inch below average, the 17<sup>th</sup> driest on record. Below-average precipitation was observed in the West and Southern Plains where three states had a top 10 dry winter. The dry winter exacerbated drought conditions in California, where winter is the wet season, as well as in the Southwest and Southern Plains. The winter snow cover extent was the 10<sup>th</sup> largest on record.
- The CONUS spring temperature was near-average, which masked regional extremes. The West was warm, with California tying its fifth warmest spring on record. Cool conditions in the East continued, particularly in the Midwest and Lower Mississippi River Valley. The cool spring in the Upper Midwest allowed ice to remain in parts of Lake Superior into June, the latest observed date of such an occurrence. Other than California, no state had a spring temperature that ranked among the 10 warmest or coolest on record. The CONUS spring precipitation total was also near average, with above-average precipitation across the Northwest, Midwest, Northeast, and Southeast. Florida tied its tenth wettest spring, while Washington had its fourth wettest. Below-average precipitation was observed across the Southwest, Central and Southern Plains, and into parts of the Ohio Valley. Kansas had its third driest spring on record. The spring snow cover extent was slightly larger than average.
- The contiguous U.S. had a near-average summer temperature that was the coolest since 2009. As with much of 2014, the West was particularly warm during summer, while the East was cooler than average. California, Oregon, and Washington each had a top 10 warm summer, while Florida tied its ninth warmest. July was particularly cool in the central U.S., when three states —Arkansas, Illinois, and Indiana — were record cool during the typically hottest month of the year. The summer precipitation total for the CONUS was 9.43 inches, 1.11 inches above average, and the ninth wettest summer on record. A majority of the summer precipitation occurred in June and August. Six states across the northern tier had a top 10 wet summer. Dry conditions were observed in the Southeast, where Georgia had its 10<sup>th</sup> driest summer on record. In the Upper Midwest, Minnesota observed 8.07 inches of precipitation during June, marking the wettest month of any month for the state. During summer, the CONUS drought footprint shrank from 37.3 percent to 32.8 percent.
- Autumn was the 40<sup>th</sup> warmest on record for the CONUS, with a warmer than average September, the fourth warmest October, and the 15<sup>th</sup> coolest November. California had its warmest autumn on record, in addition to five additional states in the West that were top 10 warm. Below-average seasonal temperatures were observed in the Midwest and Southeast. Illinois and Indiana each had one of their 10 coldest autumns. The CONUS autumn precipitation total was near-average with regional and monthly extremes. A wet and cool year across the Midwest allowed water levels in the Great Lakes to rebound to above-average levels for the first time in 15 years.

- December ended the year on a warm note. The CONUS December temperature was 4.5°F above the 20<sup>th</sup> century average, the second warmest December on record, behind only 1939. Each state had above-average December temperatures. Nine states across the West, Southern Plains, and Northeast had a top 10 warm December. No state was record warm. The monthly precipitation was near average, with above-average precipitation observed across the West, Central Plains, Southeast, and Northeast. Maine had its seventh wettest December on record. Below-average precipitation was observed across the Southern Plains and Northern Plains. North had its ninth driest December. No state had its wettest or driest December on record.

## Seasonal Analysis

### Winter



*Winter 2013/2014 Statewide Temperature Rank Map*

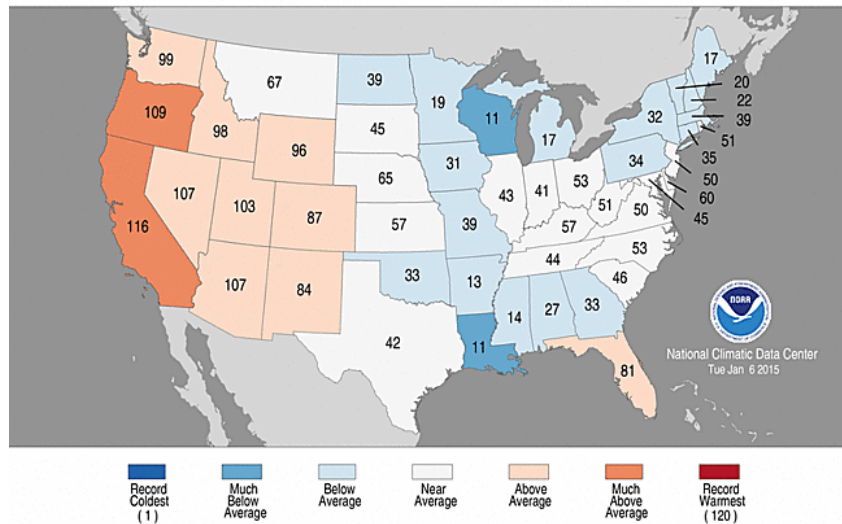




California's annual precipitation comes during the winter season. Above-average precipitation was observed across the northern tier of the country, stretching from the Northern Plains, through the Midwest, and into the Northeast. No state had a top 10 wet winter season. The cool and somewhat wet conditions across the central United States contributed to the 10<sup>th</sup> largest winter snow cover extent for the winter season and the largest since 2010/11. By the end of the winter season, 35.9 percent of the contiguous U.S. was in drought, up from 31.0 percent at the beginning of the season. During winter, drought conditions improved in parts the Midwest, but worsened in the Southern Plains and West.

## Spring

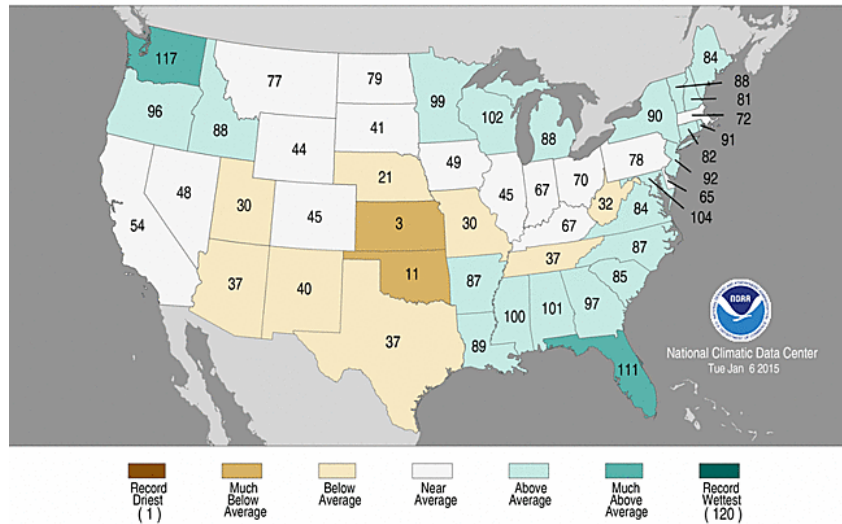
Statewide Average Temperature Ranks  
 March–May 2014  
 Period: 1895–2014



Spring 2014 Statewide Temperature Rank Map



Statewide Precipitation Ranks  
 March–May 2014  
 Period: 1895–2014

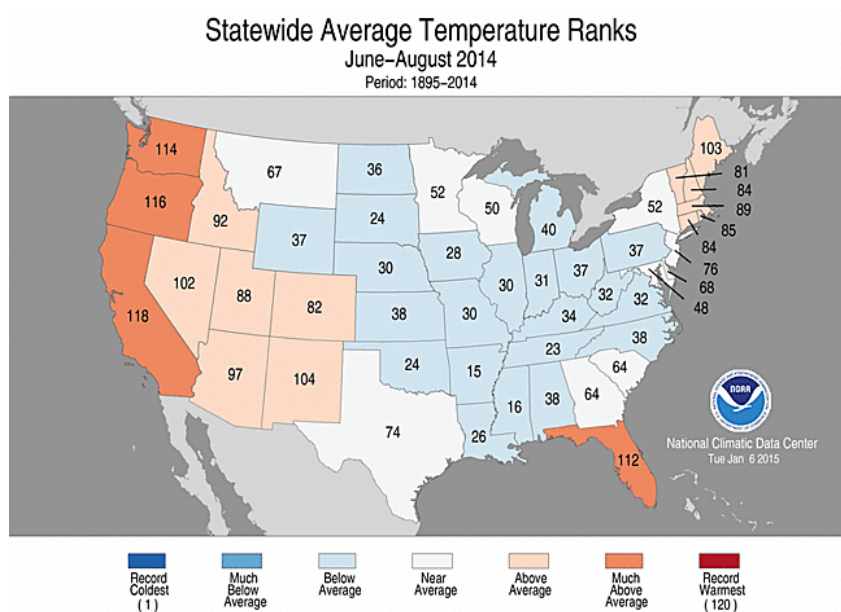


*Spring 2014 Statewide Precipitation Rank Map*

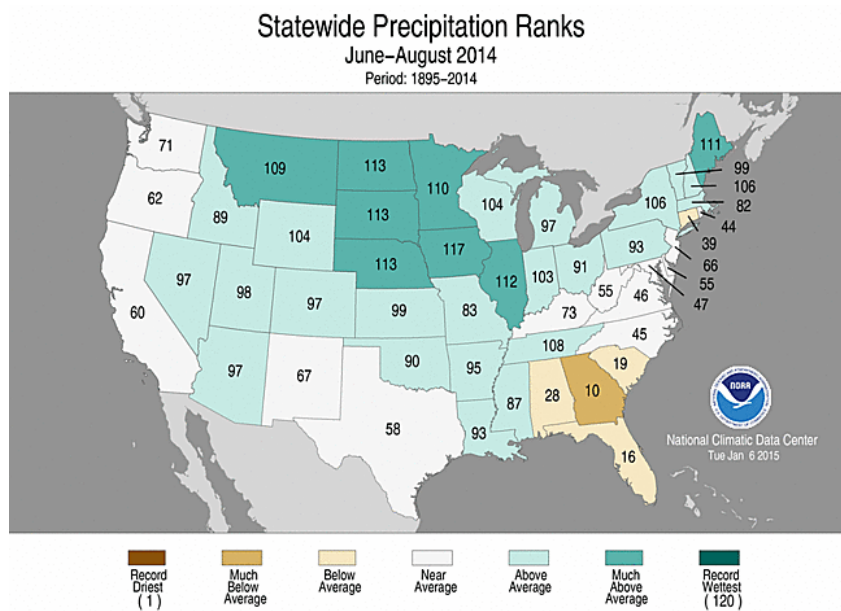
The national spring temperature of 51.1°F was 0.2°F above the 20<sup>th</sup> century average and ranked near the median value in the 120-year period of record. Each month had near-average temperatures during spring, but some regional extremes were observed. The West continued to be much warmer than average. California had its fifth warmest spring on record. Below-average temperatures persisted in the East, particularly the Upper Midwest and the Lower Mississippi River Valley. The cool conditions in the Great Lakes region allowed ice cover to remain on the lakes much later than the average ice-out date. Ice was observed into June on parts of Lake Superior. Other than California, no state had a spring temperature that ranked among the 10 warmest or coolest on record.

The March–May precipitation total was 8.06 inches, 0.12 inch above average and ranked near the median value. March and May had near-average precipitation for the CONUS, while April was wetter than average. Above-average spring precipitation was observed across the Northwest, Midwest, Northeast, and Southeast. Florida tied its tenth wettest spring, while Washington had its fourth wettest. Below-average precipitation was observed across the Southwest, Central and Southern Plains, and into parts of the Ohio Valley. Kansas had its third driest spring on record. The spring snow cover extent was slightly larger than average. March was particularly wet across the Northwest. Washington's climate division 3 (Puget Sound Lowlands) had its wettest March on record, with 8.82 inches of precipitation, 4.67 inches above average. The record-breaking precipitation contributed to a massive landslide near Oso, Washington that resulted in 43 fatalities. In late April, a strong storm system moving through the central part of the country spawned over 80 tornadoes in the Midwest and Southeast causing 33 fatalities and over \$1 billion U.S. dollars in damage; this was the deadliest tornado outbreak of 2014. The storm system also dropped 20.47 inches of precipitation in Pensacola, Florida, shattering the city's 48-hour precipitation record. Despite localized heavy precipitation events, during the spring season, the CONUS drought footprint expanded from 35.9 percent to 37.3. Drought intensified in the West, Southwest, and the Central and Southern Plains. Drought conditions improved across the Midwest.

# Summer



*Summer 2014 Statewide Temperature Rank Map*



*Summer 2014 Statewide Precipitation Rank Map*

The contiguous U.S. summer temperature was 71.7°F, 0.3°F above the 20<sup>th</sup> century average, ranking near the 120-year median value. This was the coolest summer for the Lower 48 since 2009. June was warmer than average while July and August had near-average temperatures. As with the previous two seasons, summer was generally marked by warm temperatures west of the Rockies and cool temperatures east of the Rockies. The near-average contiguous U.S. temperatures masked these regional extremes. The West Coast was particularly warm, where California, Oregon, and Washington each had a top 10 warm summer. New England was

also warmer than average, as was Florida, which had its ninth warmest summer. Below-average temperatures were observed from Great Plains, through the Midwest, and into the Southeast. Summer had a late arrival in the Northeast, where Central Park in New York City didn't reach 90°F until July 2<sup>nd</sup>, the fourth latest occurrence on record. July was particularly cool in the central U.S. where three states were record (or tied the record) cold — Arkansas, Illinois, and Indiana.

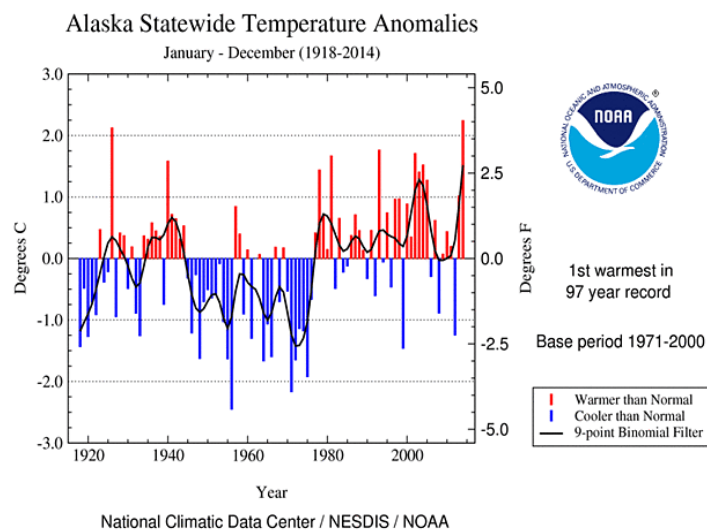
The contiguous U.S. average precipitation during June-August was 9.43 inches, 1.11 inches above the 20<sup>th</sup> century average. This was the ninth wettest summer on record for the CONUS and the wettest since 2004. June was the fifth wettest on record and the wettest since 1989. August was the 10<sup>th</sup> wettest on record and wettest since 1977. July was slightly drier than average. Much of the country was wetter than average during summer, with the largest departures from average across the Northern Plains, Midwest, Northeast, and Southwest. Six states across the northern tier had a top 10 wet summer. Dry conditions were observed in the Southeast, where Georgia had its 10<sup>th</sup> driest summer on record. In the upper Midwest, Minnesota observed 8.07 inches of precipitation during June, marking the wettest month of any month for the state. The Minnesota June average precipitation is 4.11 inches. The cool and wet summer across the Midwest created ideal corn growing conditions during 2014, boosting crop yields. In the East, Hurricane Arthur made landfall near Beaufort, North Carolina on July 3<sup>rd</sup> with winds of 100 mph. Arthur brought flooding rains and high storm surge to coastal North Carolina, causing significant erosion. Arthur was the first hurricane to make landfall in the U.S. since Isaac in 2012, the first landfalling Category 2 since Ike in 2008, and the earliest landfalling hurricane on record for North Carolina. During summer, the CONUS drought footprint shrank from 37.3 percent to 32.8 percent. Drought conditions across the Southwest improved greatly where enhanced monsoonal flow and the remnants of several tropical systems from the East Pacific brought beneficial rainfall. Drought also improved across the Central Plains. Despite the beneficial rainfall to the west, drought conditions deteriorated across parts of the Southern Plains during the summer. Drought conditions also continued to intensify across the West, particularly California.



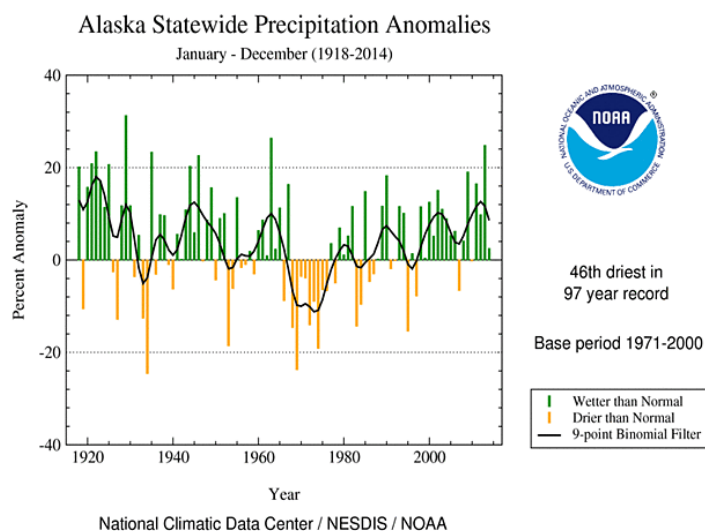
Illinois and Indiana each had one of their 10 coldest autumns. In parts of the northern Upper Midwest, the cool and wet summer, followed by a cool autumn caused corn crops to mature slowly. Despite early-season concerns, most of the region's corn was successfully harvested by the end of the season, with bumper crops reported in most states.

The autumn precipitation total for the CONUS was near average at 7.15 inches, with each month having near-average monthly precipitation. Above-average precipitation was observed across parts of the Northwest, Northern and Southern Rockies, the Midwest, and Southeast. Below-average precipitation was observed across the Northern Plains and the Northeast. No state had seasonal precipitation totals that ranked among the ten wettest or driest. The Southwest was particularly wet early in the autumn due to enhanced monsoonal flow and the remnants of several tropical cyclones entering the region from the East Pacific, while the Northeast was particularly dry early in the season. An early-season snow storm in the Northern Plains dropped heavy snowfall in Wyoming and parts of the Dakotas in September, marking the earliest snowfall on record for several cities. In November, the cool and wet conditions across much of the country were associated with the largest November snow cover extent on record for the CONUS. The cool and wet year across most of the Midwest during 2014, combined with the near-record ice cover in spring, allowed Great Lakes water to rebound to above average levels. This was the first time in nearly 15 years that all five of the Great Lakes had water levels above average. This is in contrast to early 2013 when the lakes had record and near-record low water levels.

## *Alaska Annual Summary*



*Jan-Dec 2014 Alaska Temperature Time Series*



*Jan-Dec 2014 Alaska Precipitation Time Series*

The average statewide temperature for Alaska during 2014 was 4.0°F above the 1971-2000 average. This ranked as the warmest year on record for Alaska in a period of record that dates back to 1918. The previous warmest year on record occurred in 1926 and 2014 was 0.2°F warmer. Locally, several towns in western Alaska had their warmest year on record including Nome, Bethel, McGrath, King Salmon, Homer, and Cold Bay. Anchorage had its second warmest year while Barrow had its third warmest year. In Anchorage, the temperature never dropped below 0°F during 2014, marking the first year that has occurred in a 101-year period of record. The year started off warm in Alaska with the seventh warmest winter and eighth spring on record, with temperatures 6.7°F and 3.1°F above average, respectively. Things weren't quite as warm during the summer, but were still warmer than average. June-August ranked as the 16<sup>th</sup> warmest, with much of the warmth occurring in August, which was the fourth warmest for the state. The summer average temperature was 0.9°F above average. Autumn ranked as the 10<sup>th</sup> warmest on record, with the year ending on a warm note with the fifth warmest December. The autumn average temperature was 3.6°F above average, while December was 8.1°F warmer than average.

The area-averaged annual precipitation for Alaska was slightly above the 1971-2010 average and ranked as the 52<sup>nd</sup> wettest on record for the state. The year started off slightly wetter than average with the 27<sup>th</sup> wettest winter on record with precipitation 21.2 percent above average. Spring was the 29<sup>th</sup> driest, with precipitation 10.3 percent below average. Summer was the third wettest on record for Alaska with precipitation 31.5 percent above average. Several towns including Juneau, Fairbanks, and Haines had their wettest summer on record. Autumn was the 29<sup>th</sup> driest for the state with precipitation 10.4 percent below average. December was also drier than average with a monthly precipitation total 19.2 percent below average.

## *Very Warm/Cold and Wet/Dry Percentages*

One way to assess the magnitude of warm/cold and wet/dry episodes is to compute the percent area of the contiguous United States that was "very warm/very cold" and that was "very wet/very dry". The figures above depict these values for each month in the past 30 years. These percentages are computed based on the climate division data set. Those climate divisions having a monthly average temperature/precipitation in the top ten percent (> 90<sup>th</sup> percentile) of their historical distribution are considered "very warm/very wet" and those in the bottom ten percent (< 10<sup>th</sup> percentile) are "very cold/very dry". The "very warm" categories translate to the "much above average" while the "very cold" categories translate to the "much below average" in terms of the NCDC ranking methods. This is similar for the "very wet" and "very dry" categories and the NCDC ranking methods of precipitation totals.

*The table below shows the percent area of the nation "very warm" and "very cold" for each month of 2014 as well as the annual averaged values*

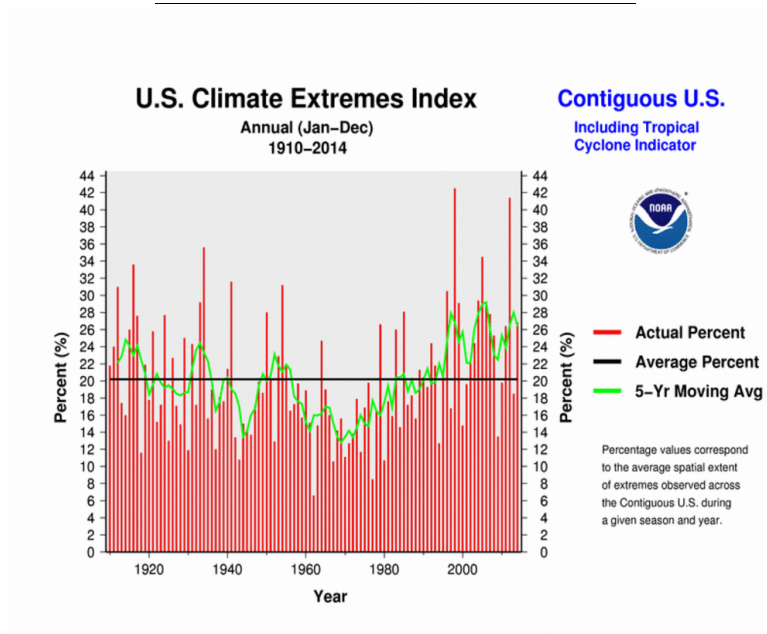
MONTH	PERCENT AREA OF CONUS "VERY WARM"	PERCENT AREA OF CONUS "VERY COLD"
January	16.31	8.59
February	11.00	14.04
March	16.11	9.52
April	1.61	0.32
May	5.18	0.35
June	12.60	0.00
July	25.85	30.27
August	8.60	4.71
September	13.88	0.00
October	41.17	0.00
November	5.31	36.50
December	26.05	0.00
2014	15.31	8.69



The table below shows the percent area of the nation "very wet" and "very dry" for each month of 2014 as well as the annual averaged values.

MONTH	PERCENT AREA OF CONUS "VERY WET"	PERCENT AREA OF CONUS "VERY DRY"
January	0.79	26.82
February	9.07	11.90
March	8.10	7.24
April	13.10	5.57
May	0.75	4.35
June	17.15	12.17
July	7.02	6.77
August	26.09	2.30
September	11.49	3.93
October	8.66	7.10
November	6.00	4.15
December	4.32	0.99
2014	9.38	7.77

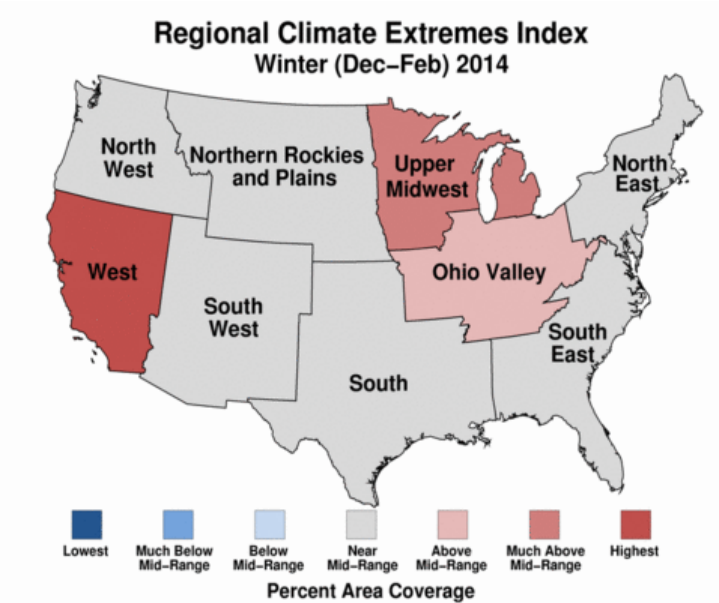
## *Climate Extremes Index*



*USCEI Annual Time Series*

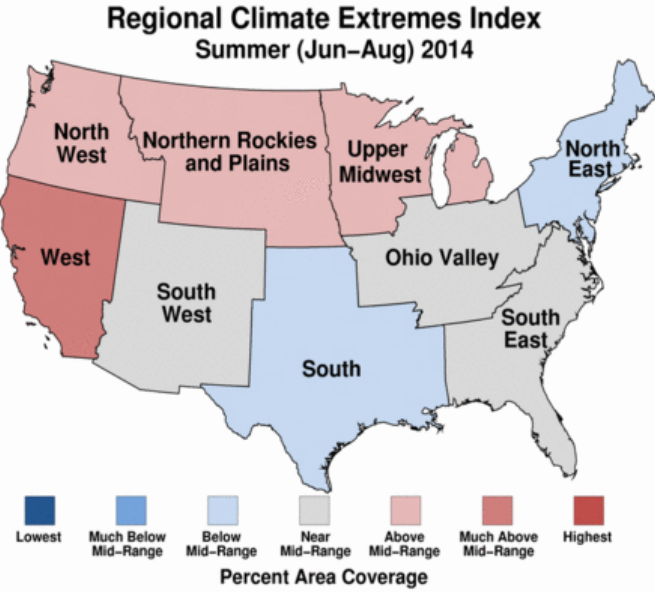


The annual USCEI was 27 percent, which is above the average of 20 percent, and the 19<sup>th</sup> highest value in the 105-year period of record. When excluding the tropical cyclone component, the USCEI was even higher at 31 percent, the ninth highest value on record. Extremes in warm night time temperatures, 1-day precipitation totals, and days with precipitation were the largest drivers of the above average USCEI. For some regions, the Climate Extremes Index was much above average. The West had its highest regional CEI on record at 63 percent, driven largely by warm nighttime and daytime temperatures and the spatial extent of drought. The Southwest had its fifth highest regional CEI driven by warm nighttime and daytime temperatures, 1-day precipitation totals, and days with precipitation. The Upper Midwest had its sixth largest regional CEI driven by extremes in cold nighttime and daytime temperatures, the spatial extent of wet conditions, 1-day precipitation totals, and days with precipitation.



*Regional CEI values for winter 2013/14*

For winter (Dec-Feb), the USCEI was 25 percent, above the average of 20 percent, the 25<sup>th</sup> highest value in the 105-year record. Elements that contributed to the above average USCEI included the spatial extent of cold maximum and minimum temperatures and days with precipitation. The West region had its largest regional CEI on record for the winter season driven largely by warm nighttime and daytime temperatures and the spatial extent of drought. In the spring (Mar-May), the USCEI was 20 percent, right at average. On the national-scale, the spatial extent of one-day precipitation extremes ranked as the third highest spring value on record at 60 percent above average, behind only 2011 and 2013. On the regional scale, the elements that track the spatial extent of cold daily highs and lows were elevated across the central U.S., one-day precipitation extremes were record and near-record high in much of the eastern CONUS, while the spatial extent of drought was record high in the West.



*Regional CEI values for summer 2014*

During the summer (Jun-Aug), the USCEI was 20 percent, also right at average. When excluding the tropical cyclone component, the USCEI was still 20 percent. Despite the near-average national USCEI, the West region had its second highest CEI on record mostly due to warm nighttime temperatures and the spatial extent of drought.

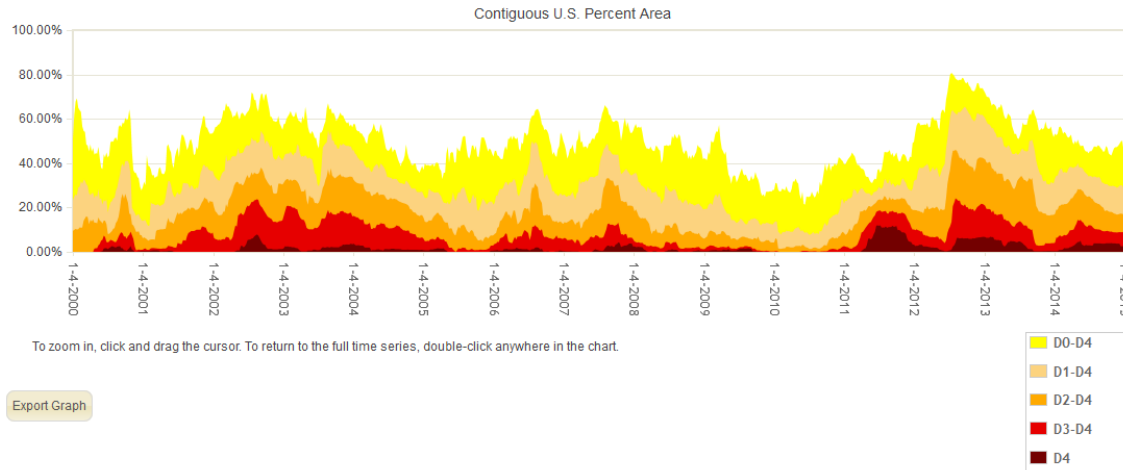
For fall (Sep-Nov) the USCEI was 15 percent, below the average of 20 percent, ranking as the 33<sup>rd</sup> smallest autumn USCEI on record. When excluding the tropical cyclone component, the USCEI was closer to average at 18 percent. The component that examines extremes in warm nighttime temperatures was above average and ranked as the 11<sup>th</sup> highest value on record. On the regional scale, the West had its sixth highest CEI on record, driven largely by warm daytime and nighttime temperatures and the spatial extent of drought.

## *National Drought Overview*

The U.S. experienced a significant recovery from the major 2012 drought on a national scale during 2013, while a notable feature of 2014 was a resurgence of drought at the start of the year. The national drought area expanded during spring 2014, but was followed by a contraction later in the year. In the bigger picture, 2014 follows a trend of national recovery from the major drought of 2012.

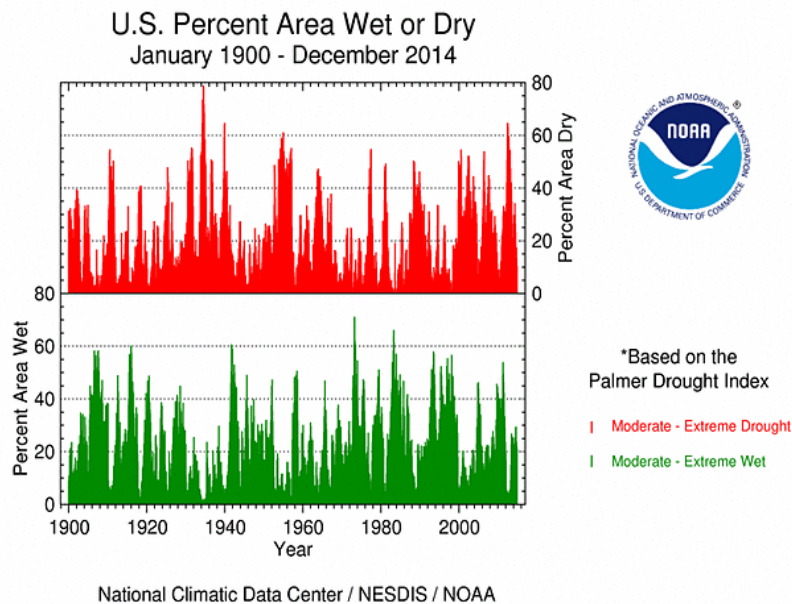
The year started out with 31.0 percent of the contiguous U.S. (CONUS) in moderate to exceptional drought (based on the U.S. Drought Monitor [USDM]) manifested in four drought epicenters — two large areas of moderate to exceptional drought stretching across the Far West and in the Central to Southern Plains, an area of moderate to severe drought in the Midwest, and areas of moderate drought in the Northeast. Moderate to extreme drought continued across parts of Hawaii. As the year progressed, drought expanded to encompass 40.1 percent of the CONUS by May 6<sup>th</sup> and was mainly limited to the West and the Central to Southern Plains. A steady contraction of the national drought area occurred beginning in the summer. By year's end, the

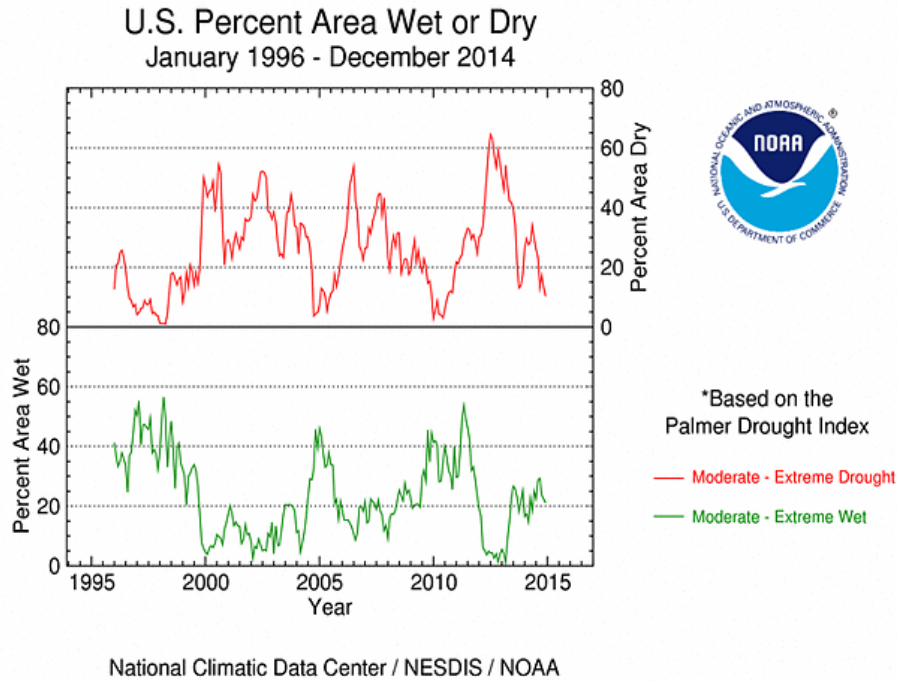
drought area had fallen to 28.7 percent of the CONUS, which is the smallest extent since December 2011.



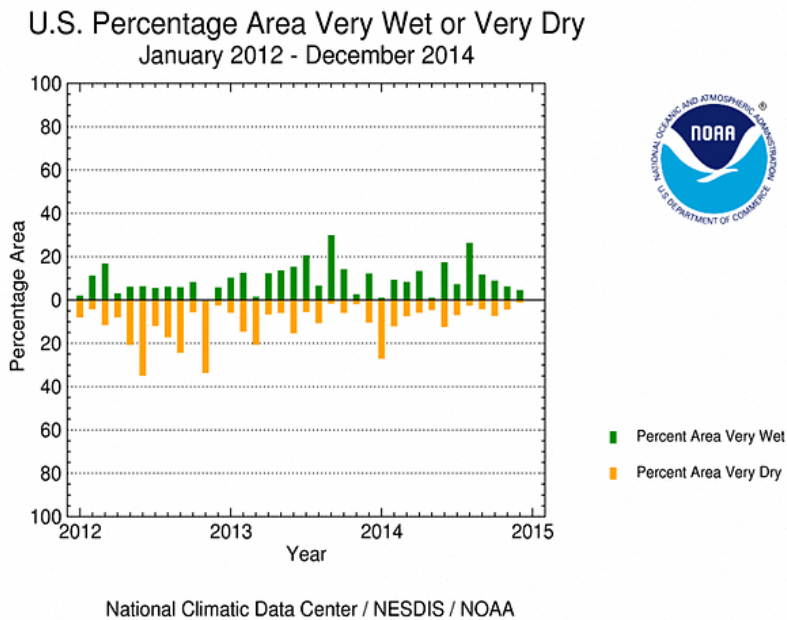
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*The percent area\* of the contiguous U.S. experiencing moderate to extreme drought (based on the Palmer Drought Index) started the year at about 17.5 percent, expanded to 34.1 percent by the end of May, then shrank again to end the year at about 10.3 percent. The Palmer Drought Index data go back 115 years*





*\*This drought statistic is based on the Palmer Drought Index, a widely used measure of drought. The Palmer Drought Index uses numerical values derived from weather and climate data to classify moisture conditions throughout the contiguous United States and includes drought categories on a scale from mild to moderate, severe and extreme.*



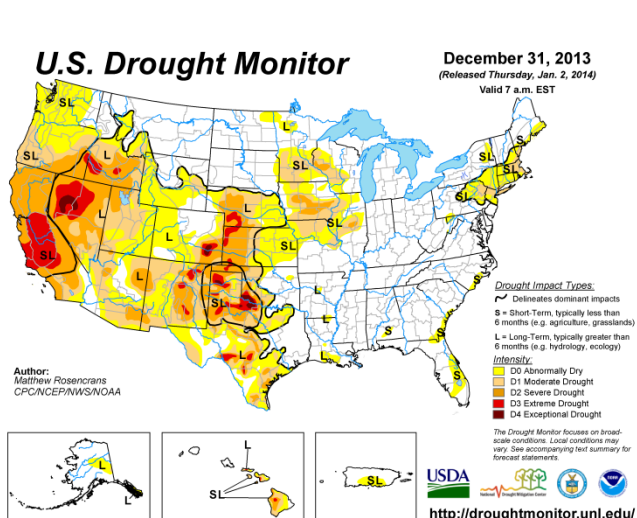
On a month-by-month basis, 2014 was characterized by large areas of dry weather which were more than counterbalanced by large areas of wet weather. Three months (January, February, and

June) had ten percent or more of the country experiencing very dry precipitation anomalies (at the tenth percentile of the historical record or drier), while four (April, June, August, and September) had ten percent or more of the country experiencing very wet anomalies (monthly precipitation totals at the 90<sup>th</sup> percentile of the historical record or wetter). One month (January) had more than a fourth (25 percent) of the country very dry, while one (August) had more than a fourth of the country very wet. When averaged together, the wet and dry anomalies resulted in the fifth driest January, nationally, in the 1895-2014 record, fifth wettest June, and tenth wettest August.

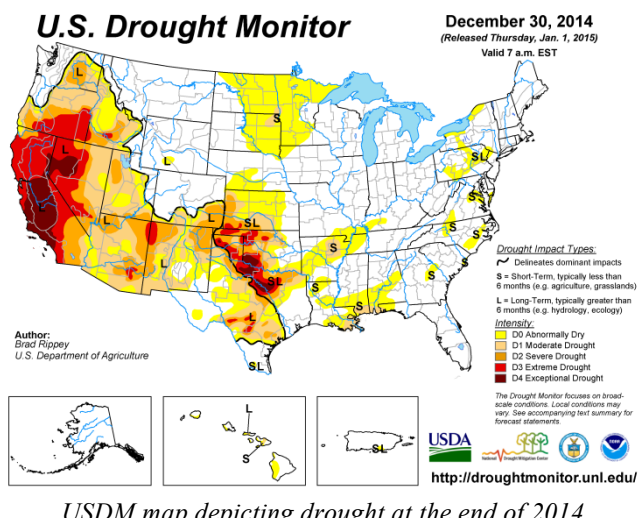
Unusual warmth characterized the months of 2014, but unusually cold temperatures were also widespread. Eight months (January, February, March, June, July, September, October, and December) had ten percent or more of the country experiencing very warm temperature anomalies (at the 90<sup>th</sup> percentile of the historical record or warmer), while three (February, July, and November) had ten percent or more of the country experiencing very cold temperature anomalies (at the tenth percentile of the historical record or colder). Two months (July and December) had more than a fourth of the country very warm, while over 40 percent of the country was very warm during October. Two months (July and November) had more than 30 percent of the country very cold. Not only did the temperature anomalies go from one extreme to the other from month to month, but the extremes occurred across space as well. For example, July had 26 percent of the country very warm *and* 30 percent very cold. This was due to the high amplitude meridional circulation pattern that occurred during the month. This pattern of a long-wave ridge over the western CONUS and trough over the east occurred frequently throughout the year, resulting in statewide annual temperature ranks that were very warm in the West and very cold along the Mississippi River Valley. When averaged across the country, the cold and warm temperature anomalies tended to cancel each other out, except for the last three months — October 2014 ranked as the fourth warmest October in the 1895-2014 record, November 2014 as the 15<sup>th</sup> coldest November, and December 2014 as the second warmest December.

Drought is an imbalance between water supply (precipitation) and water demand. In nature, water demand is primarily evapotranspiration, which is easily measured by temperature. Warmer temperatures are associated with more evapotranspiration, which can exacerbate drought conditions. The Palmer Z Index integrates these water supply and water demand components. On a national scale, the Palmer Z Index started the year alternating between dry (January, March, May) and wet (February, April) conditions, then wet conditions dominated during the summer (especially June and August), with the last four months averaging out to near neutral conditions nationally. But on a regional basis, drought persisted for several months, especially in the Far West.

# Regional Drought Overview



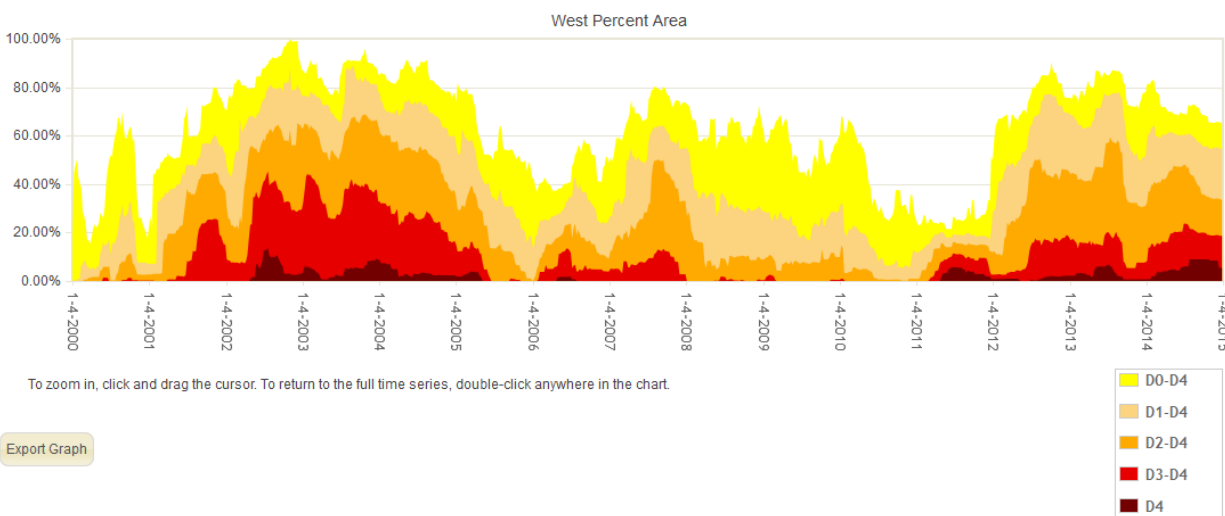
USDM map depicting drought at the beginning of 2014



USDM map depicting drought at the end of 2014

In summary, there was a resurgence of drought during the spring, mainly in the Great Plains states; development of drought in the Northeast and Southeast, including Puerto Rico, during the second half of the year; and persistence of drought in the West throughout the year. Beneficial rains countered the expansion of drought as the year progressed — in the Midwest and Hawaii during the spring; in the Central and Northern Great Plains during the summer and fall; and in the Northeast, Southeast, and Puerto Rico near the end of the year.

## West:

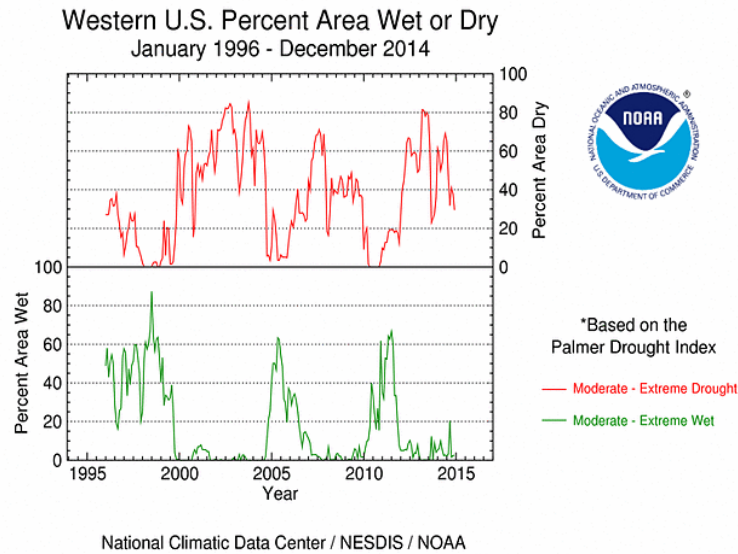


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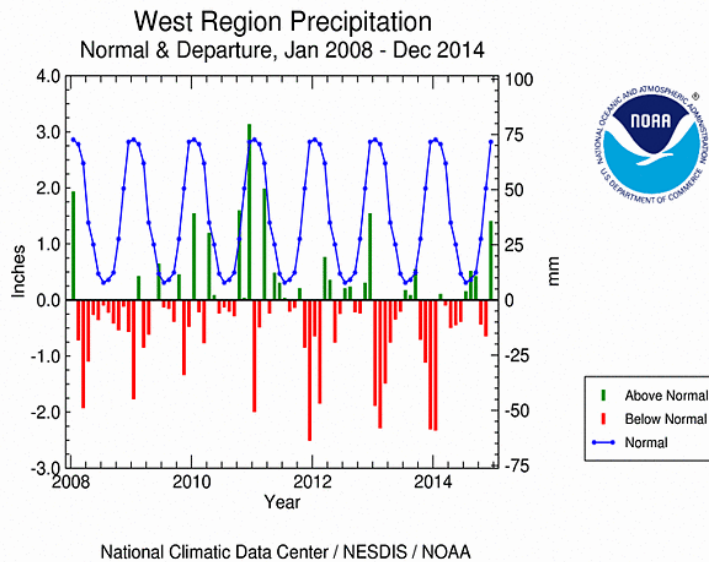
Percent Area of Western US in Moderate to Exceptional Drought since 2000 (based on USDM).





*Percent area of the West in moderate to extreme drought since 1996 (based on the Palmer Drought Index).*

The 2014 calendar year began with 51.4 percent of the West in moderate to exceptional drought (according to weekly USDM statistics). The percent area expanded to 64.5 percent by mid-February, hovered around 60 percent during spring to late summer, and ended the year at 54.5 percent. A similar variation in the percent area over time is seen in monthly statistics based on the Palmer Drought Index. The year began with 35.7 percent of the West in moderate to extreme drought, with the area expanding to 69.2 percent by the end of June, and shrinking to 29.5 percent by the end of the year.

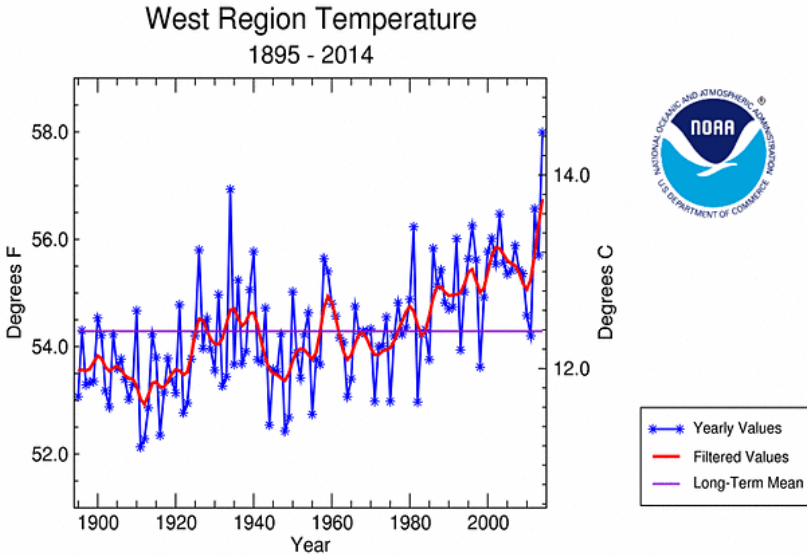


*West region precipitation, normal and departure, January 2008-December 2014.*

The early drought expansion occurred because the West started the 2013-2014 hydrologic year (water year, October 2013-September 2014) on a very dry note, with the dryness centered in California to southern Oregon and extending across the Pacific Northwest and into northern Nevada. The West region (California-Nevada) had the 22<sup>nd</sup> driest October, 29<sup>th</sup> driest November, sixth driest December, and third driest January in the 1895-2014 record. With two of the normally wettest months sixth and third driest, the water year through January 2014 ranked as the driest October-January on record for the West region. The Northwest region (Idaho, Oregon, and Washington) had the ninth driest October, 24<sup>th</sup> driest November, eighth driest December, and 19<sup>th</sup> driest January, resulting in the third driest October-January on record. The Southwest region (Arizona, New Mexico, Colorado, and Utah) was drier than normal for most months from December 2013 through June 2014, with December 2013-April 2014 and December 2013-June 2014 both ranking sixth driest on record.

Recovery from the drought began during late winter and spring for some parts of the West, but by late spring the normal wet season is over for the Far West. Precipitation for February and March 2014 was near normal for the West region and well above normal for the Northwest region. Nevertheless, by the end of the wet season, the West region still had the third driest October-May and the Northwest region the 24<sup>th</sup> driest October-May, and by the end of the 2013-2014 water year, the West region had the fourth driest October-September.

Summer is the normal wet season for the Southwest. Rainfall from summer monsoon showers and remnants of tropical systems gave the Southwest region its second wettest July-September on record. The 2014-2015 water year started dry, but beneficial rain in December 2014 gave the West region the 46<sup>th</sup> wettest October-December and the 44<sup>th</sup> driest January-December for 2014.

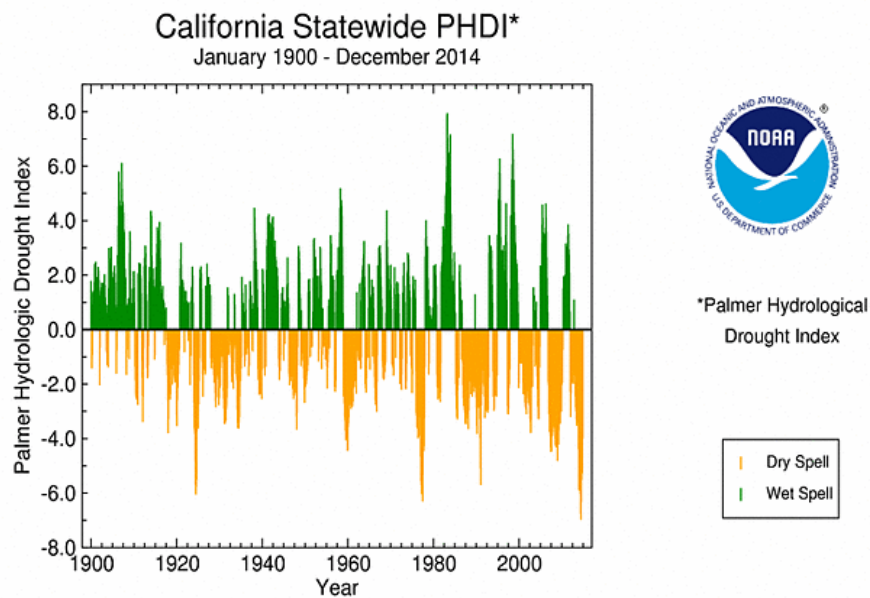


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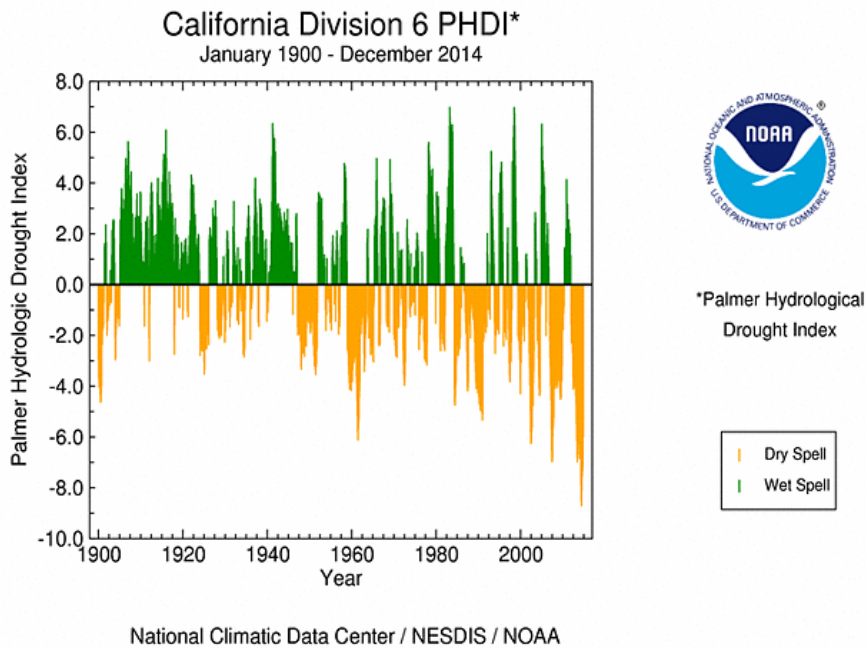
*West region temperature, January-December, 1895-2014.*



Persistent and unusually warm temperatures occurred in the West during 2014, with the West region having the warmest year in the 120-year record. Three states (Arizona, California, and Nevada) logged the warmest year on record, while five others (New Mexico, Utah, Idaho, Oregon, and Washington) ranked in the top ten warmest category. By increasing evapotranspiration, the hot temperatures intensified the drought conditions. This was especially true for California, which has suffered through three consecutive hydrologic years with drier than normal conditions. Indeed, six of the last eight hydrologic years have been drier than normal for California. The Standardized Precipitation Evapotranspiration Index (SPEI) integrates the effects of both drier and warmer than normal conditions. When the unusual warmth in California during the last three decades is combined with the excessive dryness of the last several years, the statewide SPEI reaches record low levels, both for the 12-month time scale (August 2013-July 2014) and the 36-month time scale (August 2011-July 2014).



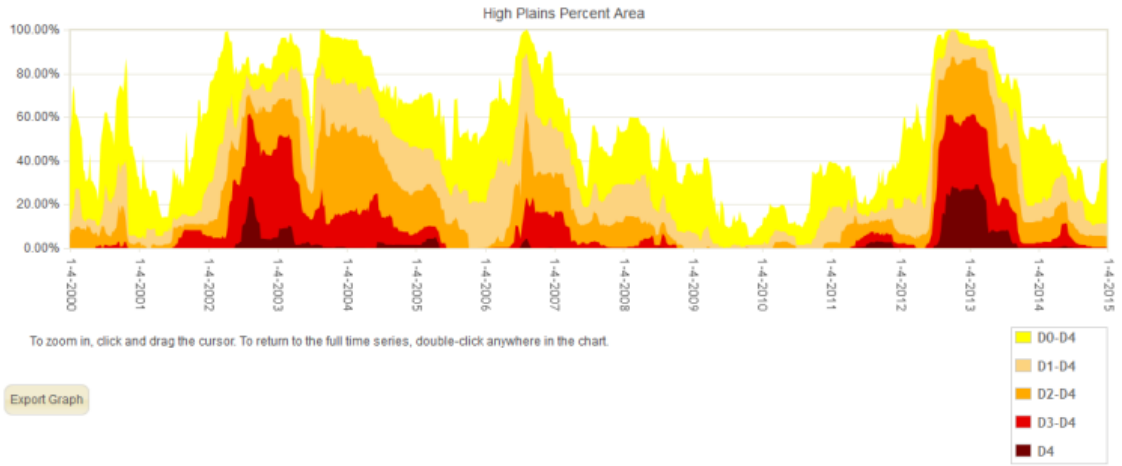
*California statewide PHDI, January 1900-December 2014*



*California climate division 6 PHDI, January 1900-December 2014.*

Like the SPEI, the Palmer Hydrological Drought Index (PHDI) is another drought index that integrates both moisture supply and moisture demand. The very dry and record hot conditions during 2014 drove the PHDI to record low levels for many parts of California, including the Central Coast Drainage (climate division 4), the San Joaquin Drainage (climate division 5), and the South Coast Drainage (climate division 6), as well as statewide. Some of these analyses show a disturbing trend toward more extreme droughts over the last 40 years in California. Impacts from the severity of the 2014 dryness, and the prolonged multi-year drought in California, included diminished reservoirs, low streamflows, dried out wells, and ravaged crop and rangeland.

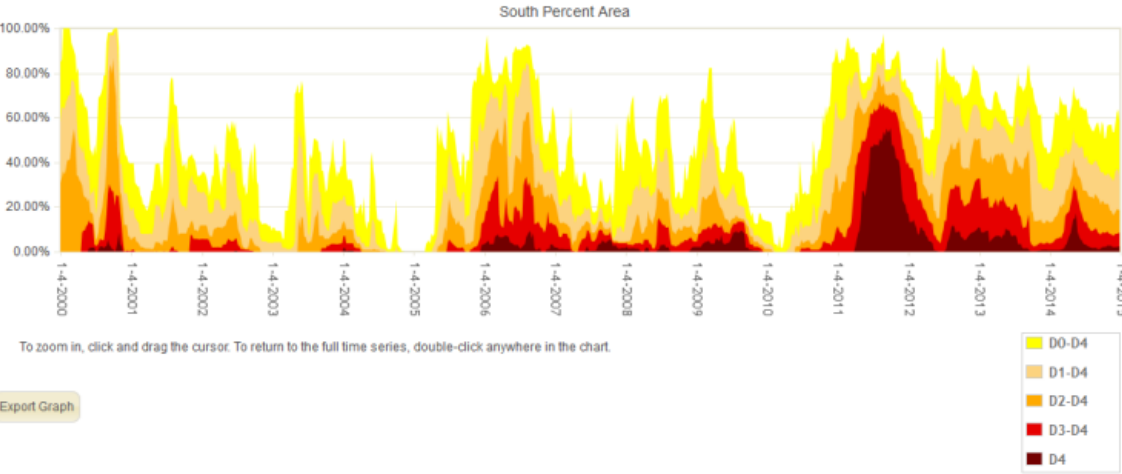
# Great Plains:



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USDA

Percent area of the High Plains in moderate to exceptional drought, 2000-2014, based on the USDM.



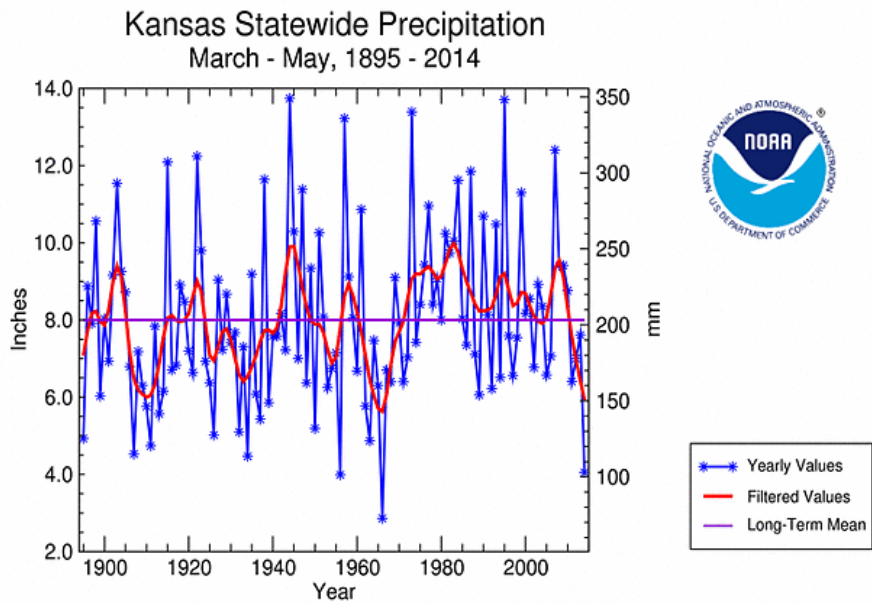
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USDA

Percent area of the Southern Plains in moderate to exceptional drought, 2000-2014, based on the USDM.

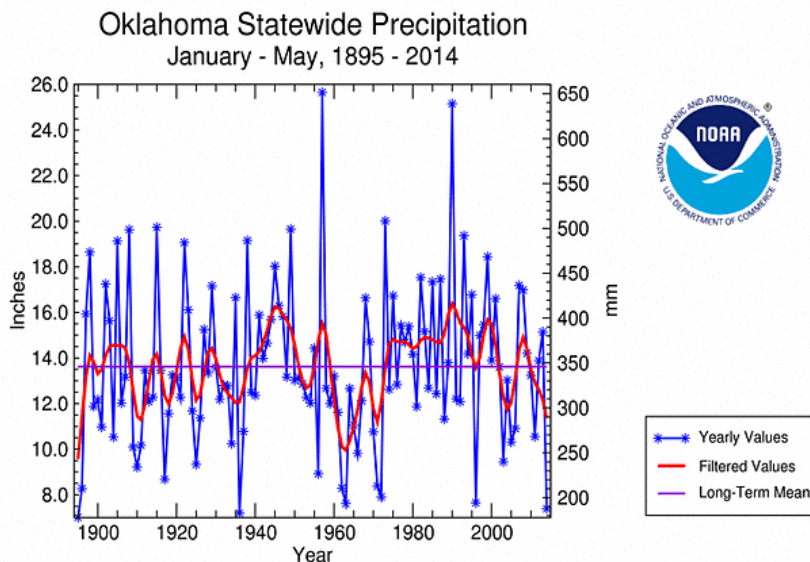
Drought expanded in the Great Plains during spring 2014 but above-normal rainfall during the summer caused it to contract. At its peak, 35.9 percent of the High Plains (Central to Northern Plains) and 54.4 percent of the Southern Plains were in moderate to exceptional drought in early May. Kansas had the third driest and Oklahoma the eleventh driest March-May during 2014. The first five months of 2014 were each drier than normal for Oklahoma, with the state ranking third driest for January-May. Texas had the fifth driest January-April. By late fall, abnormal dryness and drought began redeveloping in the Northern Plains. In spite of some wetter-than-normal months during 2014, the year still ended up drier than normal for Oklahoma and Texas. It marked the fourth consecutive drier-than-normal year for Texas, while four of the last five years

have been drier than normal for Oklahoma. By the end of the year, 33.9 percent of the Southern Plains was still in moderate to exceptional drought.



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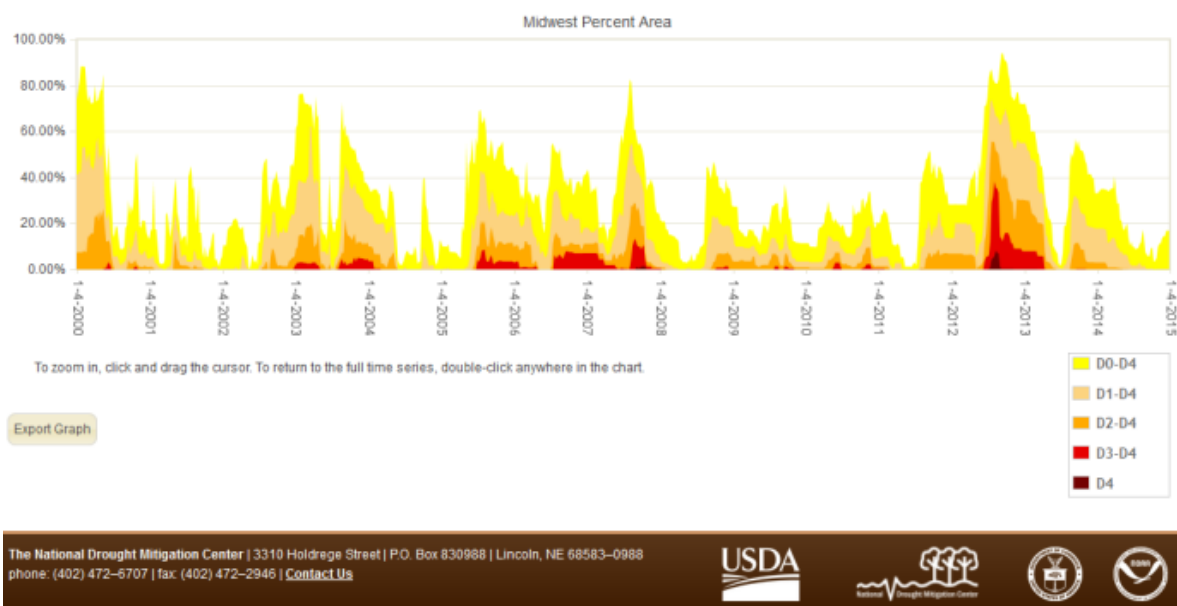
*Kansas statewide precipitation, March-May, 1895-2014.*



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*Oklahoma statewide precipitation, January-May, 1895-2014.*

## Midwest, Southeast, and Northeast:



*Percent area of the Midwest in moderate to exceptional drought, 2000-2014, based on the USDM.*

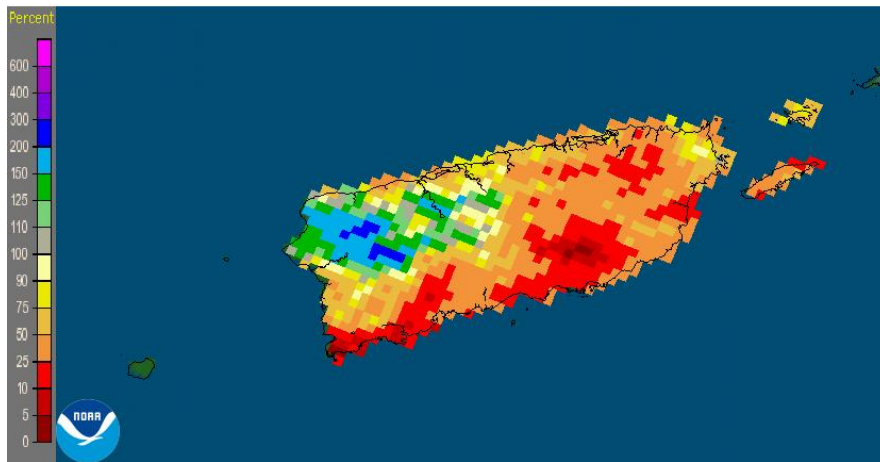
The Midwest began 2014 with 17.7 percent of the region in moderate to severe drought, according to the USDM. Spring and summer precipitation reduced the drought area to less than 1 percent by September.

Dry conditions beginning in the late summer caused drought to appear over parts of the Southeast, mostly in Alabama and Georgia, with 9.5 percent of the region in moderate to severe drought by mid-November.

Precipitation the first weeks of 2014 eliminated vestiges of leftover 2013 drought in the Northeast region, but dry conditions during the fall of 2014 caused moderate drought to return, expanding to about 3.8 percent of the region by mid-October. Heavy rain late in the year greatly reduced the Southeast and Northeast drought areas.

## Hawaii and Puerto Rico:

Puerto Rico: Current 60-Day Percent of Normal Precipitation  
Valid at 7/31/2014 1200 UTC- Created 7/31/14 20:21 UTC



*Puerto Rico percent of normal precipitation, July-August 2014.*

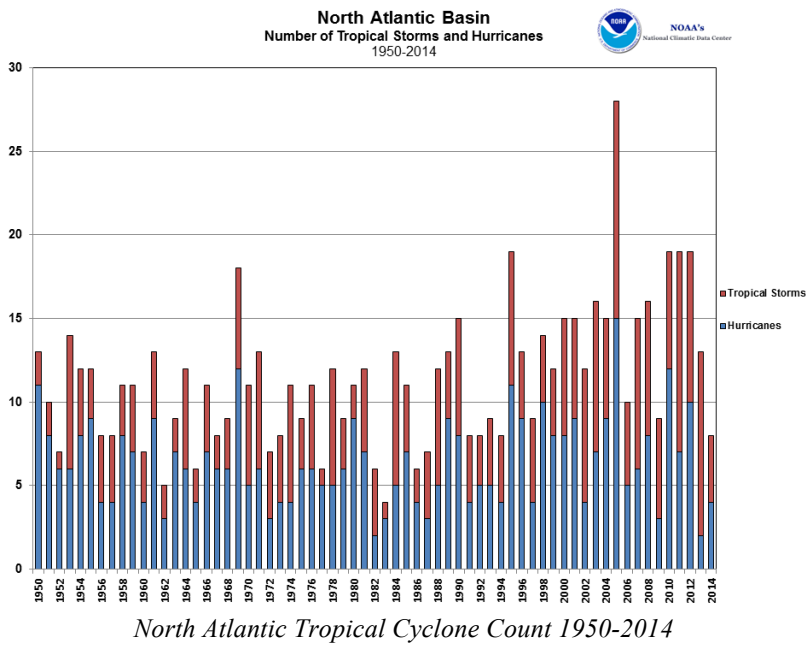
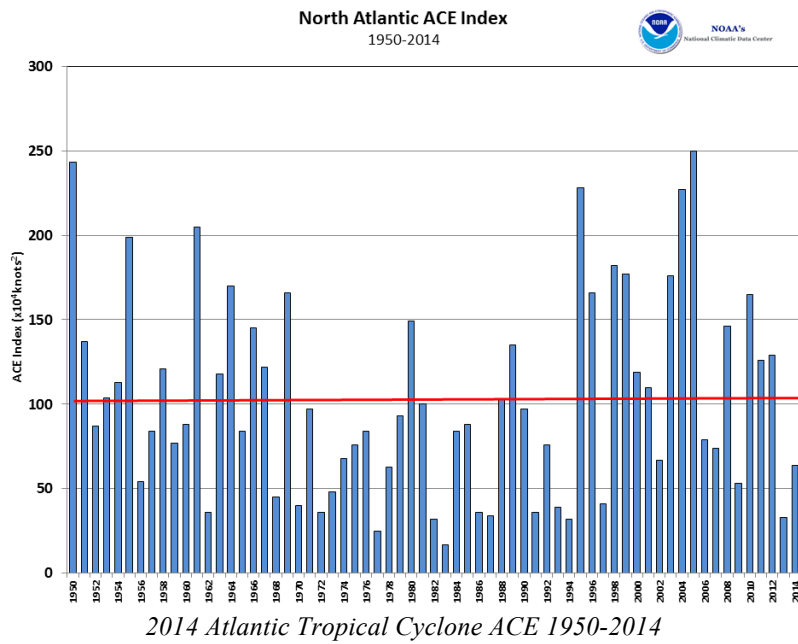
Puerto Rico began 2014 with abnormally dry conditions on the USDM map. Very dry weather during the summer of 2014 over the southern and eastern portions of the island resulted in the introduction of moderate drought conditions in July, with a peak coverage of 17.7 percent of the island by July 29<sup>th</sup>. Subsequent above-normal rainfall eliminated the drought area and greatly reduced the abnormally dry area by late fall.

The year began with 49.6 percent of Hawaii in moderate to extreme drought, according to USDM statistics. Beneficial rains steadily shrank the drought area to below 1 percent by early April. Dryness in late fall to early winter expanded the drought area slightly, with 2.8 percent of the Hawaiian Islands in moderate drought by year's end.

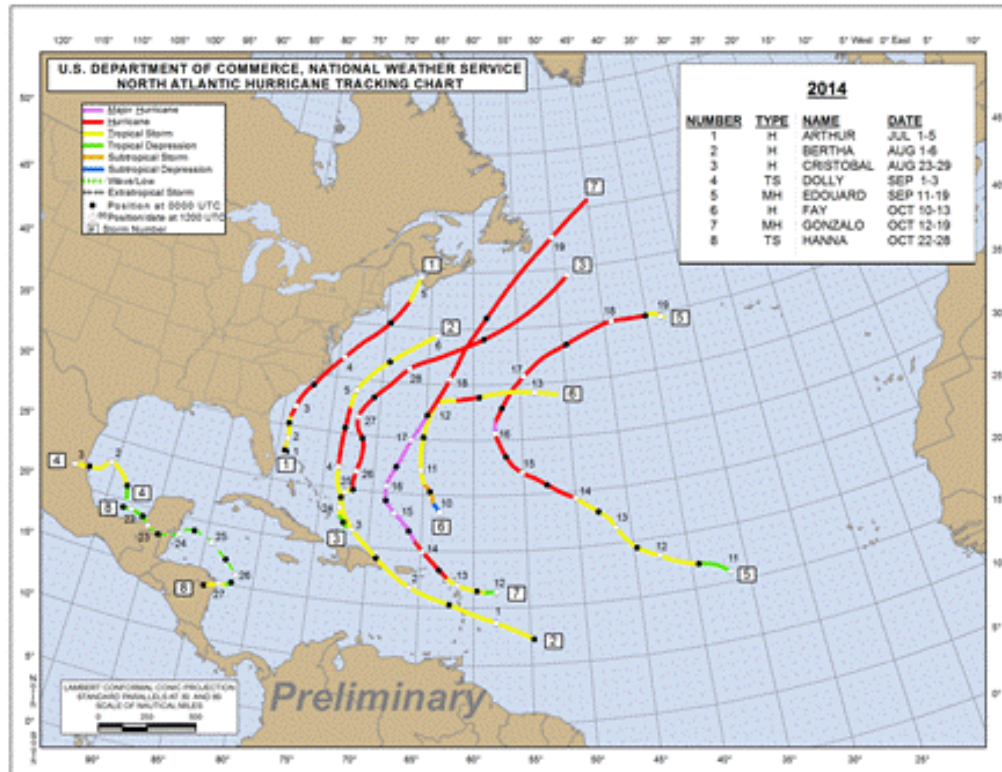
## *Wildfires*

NCDC no longer maintains monthly and annual summaries of wildfires in the United States. A comprehensive 2014 wildfire summary issued Jan 12, 2015 by the Department of the Interior can be found here: [http://www.doi.gov/pmb/owf/upload/2016\\_01\\_12\\_FY-2014-WFM-Annual-Rpt\\_Final2.pdf](http://www.doi.gov/pmb/owf/upload/2016_01_12_FY-2014-WFM-Annual-Rpt_Final2.pdf)).

# Hurricanes & Tropical Storms







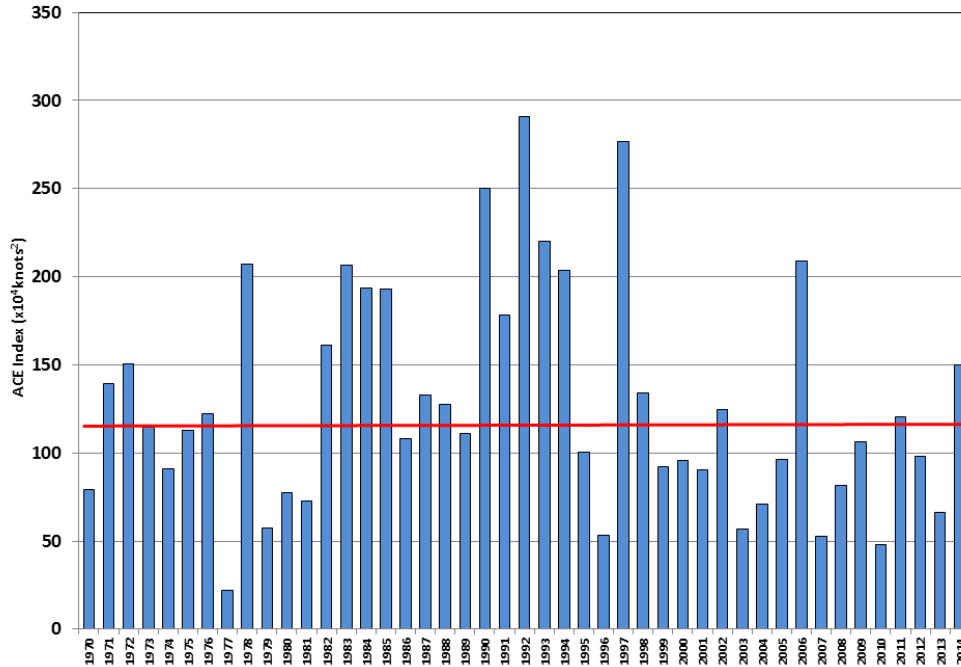
2014 Atlantic Tropical Cyclone Track. Source: NOAA's National Hurricane Center

The 2014 North Atlantic hurricane season had eight tropical storms, four hurricanes, and two major hurricanes. The number of tropical storms was below the 1981-2010 average of 12.1, the number of hurricanes was below the 1981-2010 average of 6.4, and the number of major hurricanes was near the 1981-2010 average of 2.7. In terms of the total number of named storms, this was the least since 1994 when eight named storms were observed. One hurricane, Arthur, made landfall in the U.S. during the 2014 season, marking the first landfalling hurricane in the contiguous U.S. since Isaac in August 2012. No other tropical cyclones directly impacted the contiguous U.S. during 2014. The first major hurricane of the season was Edouard, which never made landfall. Edouard had maximum sustained winds of 115 mph and a central minimum pressure of 955 mb. Edouard was the first major hurricane in the North Atlantic basin since Hurricane Sandy in 2012. Gonzalo was the second major hurricane in the North Atlantic during 2014 and had maximum sustained winds of 145 mph and a central minimum pressure of 940 mb. This was the first Category 4 hurricane in the North Atlantic since Ophelia in 2011 and the strongest since Igor in 2010. Gonzalo caused significant damage as it passed over Bermuda. The Accumulated Cyclone Energy (ACE) index of tropical cyclone activity also indicated a below-average season in the North Atlantic. The ACE index is used to calculate the intensity of the hurricane season and is a function of the wind speed and duration of each tropical cyclone. The 2014 Atlantic hurricane season had an approximate ACE of  $64 (x10^4 \text{ knots}^2)$  which was below the 1981-2010 average value of  $104 (x10^4 \text{ knots}^2)$ . Despite the below-average number of named storms, the ACE was higher than last year (2013), which had more storms, because of the two major hurricanes that occurred in 2014.



# East Pacific Basin 2014 Season Summary:

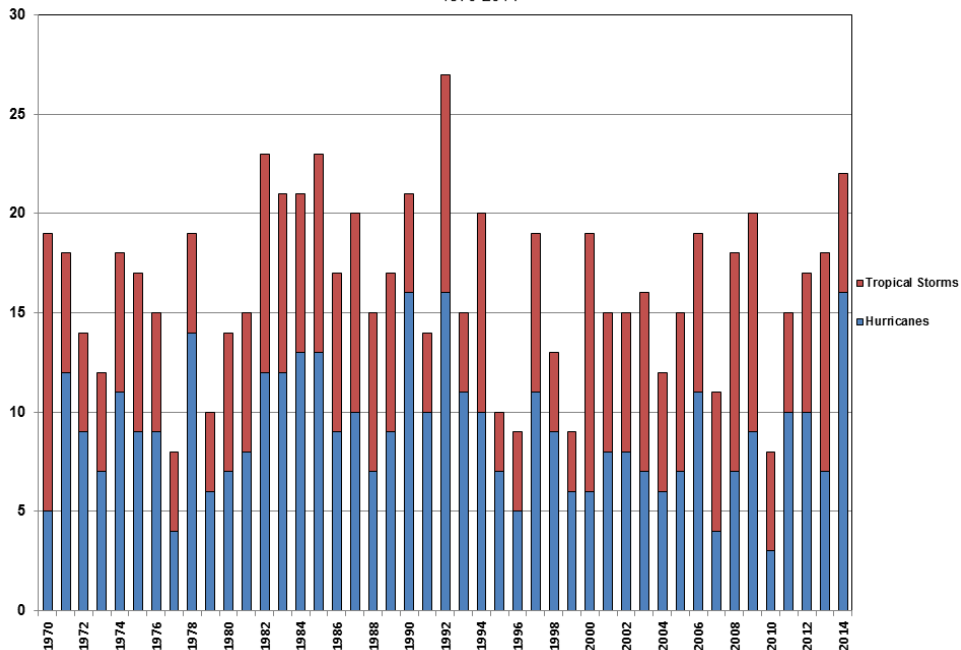
East North Pacific ACE Index  
1970-2014



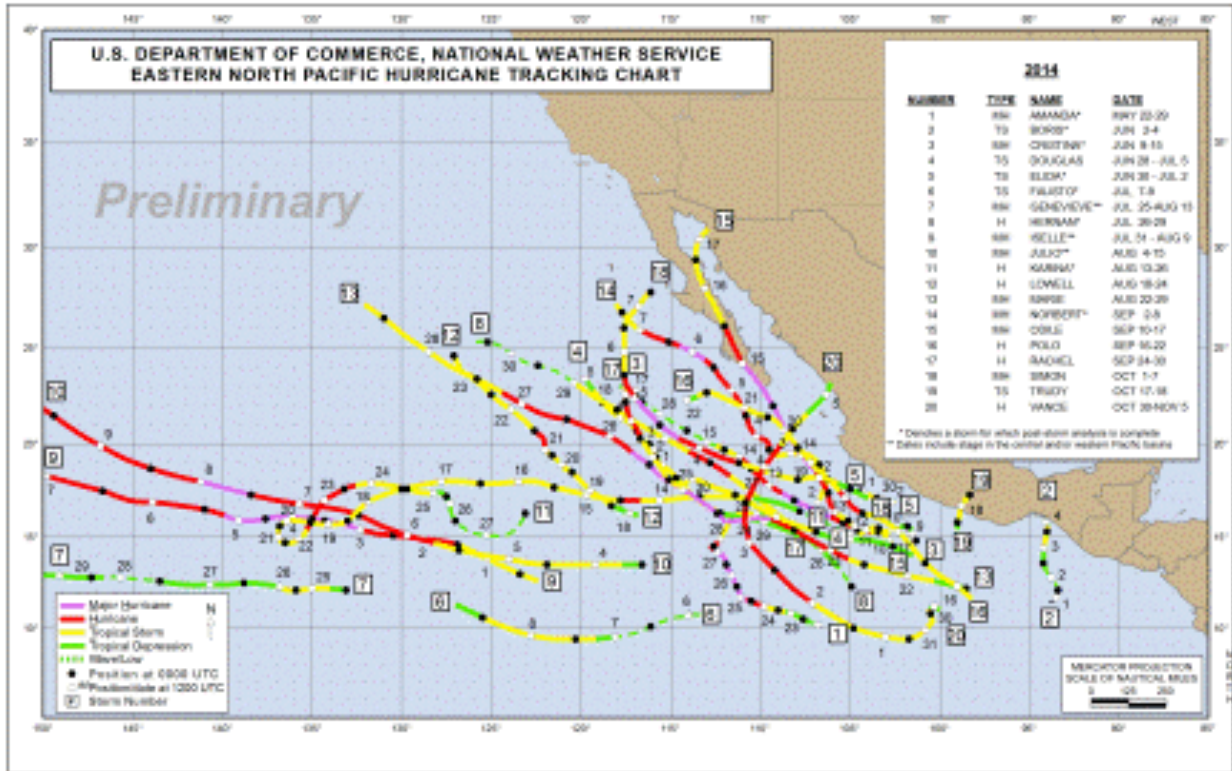
2014 East Pacific Tropical Cyclone ACE 1970-2014



Eastern Pacific Basin  
Number of Tropical Storms and Hurricanes  
1970-2014



East Pacific Tropical Cyclone Count 1970-2014

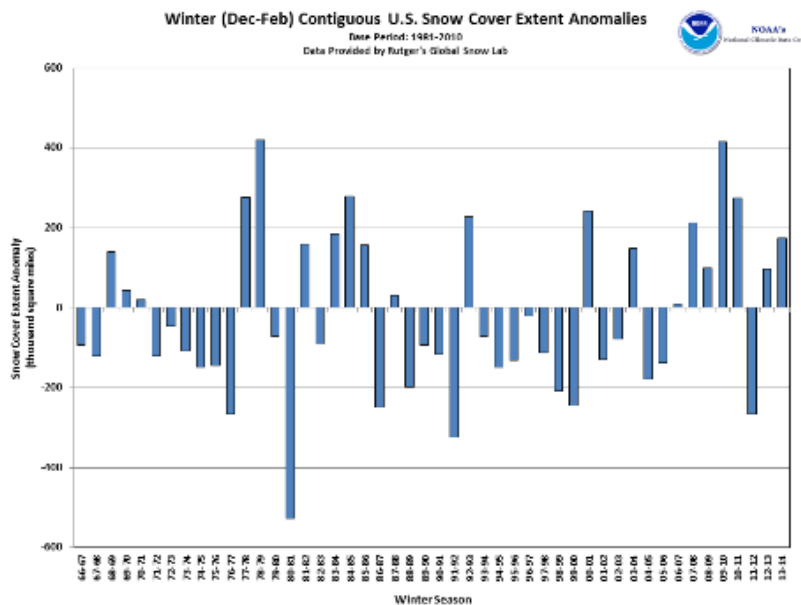


2014 Atlantic Tropical Cyclone Tracks. Source: NOAA's National Hurricane Center

The 2014 East Pacific Hurricane Season had 22 named storms, of which 16 were hurricanes, and of these nine were major hurricanes. The 1981-2010 average number of named storms in the East Pacific is 16.5, with 8.9 hurricanes, and 4.3 major hurricanes. The number of named storms was the highest since 1992 and the third highest since reliable records began. The number of hurricanes tied with 1990 and 1992 as the most on record for the basin. Several of the storms impacted Mexico and the Hawaiian Islands causing significant damage and over 40 fatalities. Several remnant low pressures from the active East Pacific tropical cyclone season brought heavy rain into the Southwest and Southern Plains regions of the United States, causing record flooding and bringing some drought relief. The ACE index for the season was  $150 (x10^4 \text{ knots}^2)$ , which is above the 1981-2010 average of  $132 (x10^4 \text{ knots}^2)$  and the most since 2006. Several noteworthy storms occurred including Hurricane Amanda in May which had maximum sustained winds of 155 mph and a central minimum pressure of 932mb — the strongest May hurricane on record for the basin. Hurricane Iselle, which formed in the East Pacific basin and moved into the central Pacific made landfall on the Big Island of Hawaii as a tropical storm, marking the first landfall of a tropical cyclone in Hawaii since Hurricane Iniki in 1992 and only the second tropical cyclone to make landfall on the Big Island.

## *National Snow & Ice*

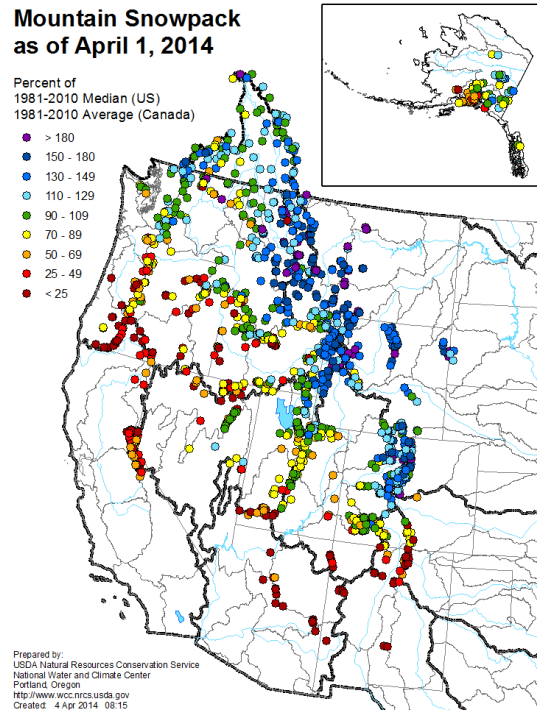
The 2013/14 winter season (December 2013–February 2014) was cooler and drier than average for the contiguous United States and ranked as the 33<sup>rd</sup> coldest and 17<sup>th</sup> driest winter on record. For the December-February period, below-average temperatures were observed in the eastern U.S., with much-below average temperatures in the Midwest. The West, especially the Southwest, was warmer than average. California had its warmest winter on record. Much of the northern U.S., stretching from the Northern Rockies, through the Upper Midwest, Ohio Valley, and into the Northeast was wetter than average. Below-average precipitation was observed from the West, through the Southwest, and into the Central and Southern Plains. Arizona, California, and New Mexico each had a top 10 dry winter season. Several winter storms in the East during the season contributed to the cool and wet season, while the lack of precipitation and the warm temperatures in the West contributed to the much below-average snow pack in mountain locations, exacerbating long-term drought conditions.



*Contiguous U.S. Winter Snow Cover Extent Anomalies. Data Source: Rutgers Global Snow Lab*

According to the Rutgers Global Snow Lab, for the winter season (December 2013–February 2014), the snow cover extent (SCE) for the contiguous U.S. was 1.42 million square miles, which was 170,000 square miles above the 1981–2010 average. This marked the 10<sup>th</sup> largest seasonal SCE in the 1966–present period of record, and the largest since the winter of 2010/11. The above-average seasonal SCE consisted of the eighth largest December SCE, 16<sup>th</sup> smallest January SCE, and ninth largest February SCE. For the spring season (March–May), the contiguous U.S. snow cover extent was 28,000 square miles above the 1981–2010 average, ranking as the 21<sup>st</sup> largest (28<sup>th</sup> smallest) spring snow cover extent on record. Each of the spring months had near-average SCE. Later in the year, in November, much cooler than average conditions across the eastern two-thirds of the nation were associated with a record large snow cover extent for the month. The monthly snow cover extent across the lower-48 during November was 876,000 square miles, 400,000 square miles above the 1981–2010 average.

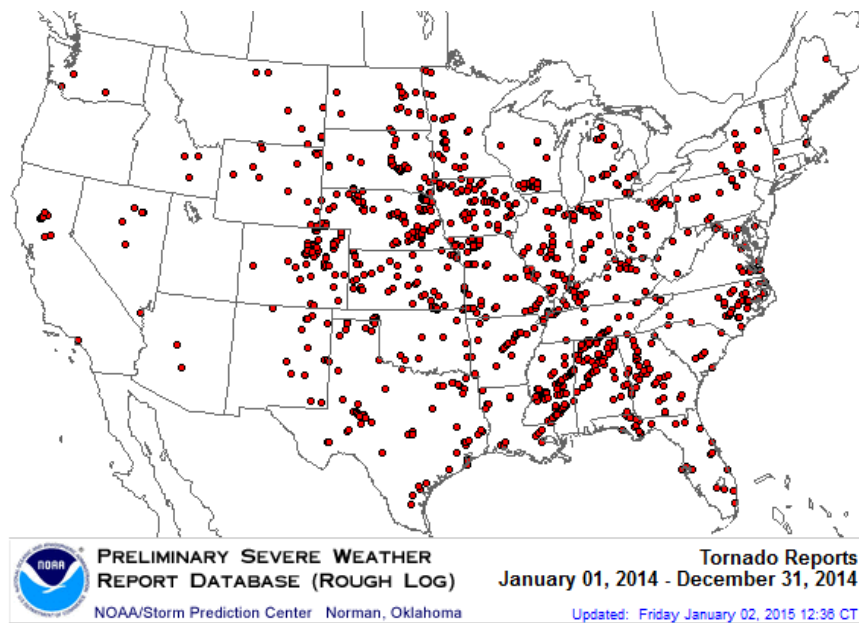
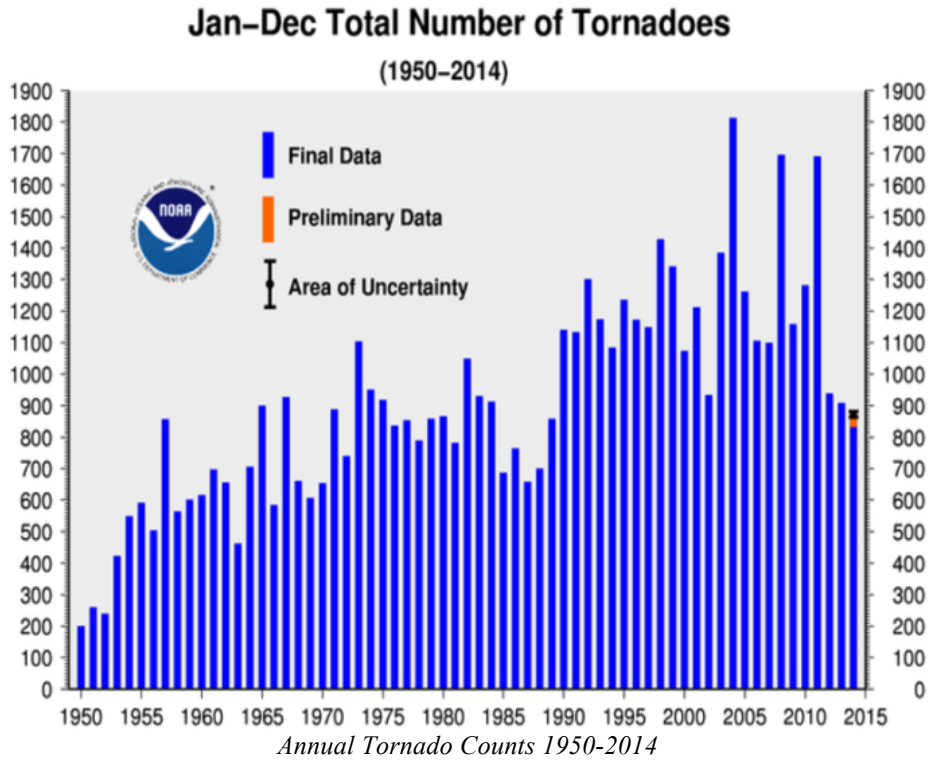
Conversely, Alaska was much warmer than average, resulting in the 5<sup>th</sup> smallest November snow cover extent.



*Western U.S. Snowpack. April 1, 2014. Source: USDA*

Winter and spring mountain snowpack provide a crucial water source across much of the western United States. The total annual water budget for agriculture and human use in the mountainous West is highly dependent on the amount of snow melt that will occur in spring and is proportional to the amount of snow on the ground. The annual snowpack typically reaches its maximum value at the end of March. According to data from the USDA, on April 1<sup>st</sup>, above-average snow pack was observed across the Northern and Central Rockies. Some locations across Montana, Wyoming, and Colorado had snow pack totals greater than 180 percent of average. Near-average snow pack was observed in the northern Cascades and parts of the Great Basin. Below-average snow pack was observed across the Southern Cascades, the Sierra Nevada Mountains, and into the Southern Rockies. Many locations across these regions had snowpack totals less than 25 percent of average. In Alaska, near-average snow pack was observed across central parts of the state with below-average snowpack in southern areas.

# Tornadoes



2014 Tornado Occurrences. Source: SPC

Similar to the past two years, tornado activity across the U.S. during 2014 was below average. During 2014, there were 831 confirmed tornadoes during the January-October period with 50

tornado reports still pending for November-December. This gives 2014 a preliminary tornado count of 881. The 1991-2010 annual average number of tornadoes for the U.S. is 1,253. Depending on the final confirmation rate this could be the slowest tornado year since 1988 when there were 702 confirmed tornadoes. 2014 marks the third consecutive year with less than 1,000 tornadoes impacting the United States. This hasn't occurred since 1987-1989, which was before the deployment of NEXRAD (coincident with the deployment of NEXRAD, the number of weak tornadoes observed annually increased due to better detection). As with most years, there were several large and destructive tornado outbreaks during 2014. There were 47 tornado-related fatalities, most of which occurred in April. There were at least five severe weather outbreaks that caused damages exceeding one billion U.S. dollars.

Most months of 2014 had a below-average number of tornadoes. April had a near-average number of confirmed tornadoes, 128, with a multi-day tornado outbreak late in the month associated with most of the tornadoes. April was also the deadliest month in terms of tornado-related fatalities, 35. An above-average number of tornadoes was reported during June, 284, the most active tornado month of the year. June was also the most active tornado month for any month since May 2011 when 326 tornadoes were confirmed. Two tornado-related fatalities were reported in June. The rest of the year had below-average tornado activity, but four tornado-related fatalities were reported in July, one was reported in October, and five occurred in December. The 47 tornado-related fatalities was the lowest number since 2009, when there were 22.

## **2014 National and Regional Center Summaries**

## High Plains Regional Climate Center

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3310 Holdrege Street  
Lincoln, NE 68583  
ph. 402.472.6706 | fx. 402.472.2946  
<http://hprcc.unl.edu>  
Director, Martha Shulski, Ph.D.



The High Plains Regional Climate Center (HPRCC) was established in 1987 and represents one of the six federally-funded Regional Climate Centers in the United States, operating within a three-tiered system of climate services (state, regional, national). HPRCC encompasses a six-state area of North Dakota, South Dakota, Nebraska, Kansas, Colorado, and Wyoming. The Center is part of the School of Natural Resources at the University of Nebraska-Lincoln. The mission of the Center is to increase the use and availability of climate data with long-term objectives to 1) provide climate services in the High Plains region, 2) develop climate information products, and 3) carry out applied climate studies. The Center serves clientele across a broad spectrum, however, agriculture is the dominant economic influence in the region and many products and services are tailored to this sector. HPRCC personnel work closely with scientists from other regional and federal climate centers on services and programs to *provide a regional structure for climate applications*. There are currently 9 full time employees at the Center, 1 undergraduate intern, and 3 graduate students (Ph.D.).

### Climate Services and Products

Representatives from a variety of sectors have contacted the HPRCC to seek expert advice on the data available and how it can be summarized. Each month, the center receives hundreds of customer contacts. These contacts include applications such as engineering, legal, insurance, media, education, transportation, agricultural and other decision-makers. Key service activities include:

- a collection of a *quality set of near-real time data* for decision making situations
- development of a *framework for climate data distribution and management (ACIS)*, in conjunction with other Regional Climate Center staff ([rcc-acis.org](http://rcc-acis.org))
- maintenance of web-based sites and interfaces for *user-defined climate information requests* relevant to recent and historical climate data (> 450,000 web hits per year)
- generation of *graphical climate monitoring products* at the local, regional, and national level
- development of a framework to *evaluate the impacts associated with climate events* ([cir-exp.unl.edu](http://cir-exp.unl.edu)).

HPRCC leads in the development of a quarterly climate summary and outlook focused on the Missouri River Basin. We solicit input from local and regional climatologists, hydrologists, and others working in the region for up-to-date information on the climate conditions and relevant impacts to generate these summaries.



## **Regional Mesonet**

Through collaboration with state partners, the HPRCC collects data from state mesonets across the region through the Automated Weather Data Network (AWDN). North Dakota (NDAWN), Nebraska, Wyoming, Kansas (Kansas Mesonet), Colorado (CoAgMet), and Iowa (IEM) all share data with the HPRCC. The Center offers automated and manual quality control techniques on the data streams, develops regional products, and delivers the data to the Applied Climate Information System (ACIS) framework. These mesonet data are the *basis for real-time decisions* in various sectors like agriculture and water management. In agriculture, decisions on planting, fertilizing, disease treatment, irrigation, insect scouting and harvesting are supported by this information. In water management, the data have been used for drought monitoring and assessment and to meet the water accounting requirements regarding waters of the North Platte and Republican Rivers. Several crop decision aids utilize the AWDN data and irrigation-scheduling tools have been developed. The Center maintains hundreds of subscribers accessing AWDN information online in customized reports of raw and/or summarized weather data. HPRCC continues to work with Agronomists at the University of Nebraska-Lincoln for corn and soybean water use web tools (CornSoyWater).

## **Climate Applications**

The Center is part of a large research team in the North Central U.S. investigating the influence of a variable and changing climate on regional corn production – termed *Useful to Usable: Transforming Climate Variability and Change Information for Cereal Crop Producers* (agclimate4u.org). The USDA funds are being utilized to develop decision support tools based on user need. A total of six tools have been developed to date and each tool combines climatological and agricultural information with the goal of enhancing on-farm decision-making capacity. HPRCC has a long-standing collaboration with the National Drought Mitigation Center (NDMC). The two centers are engaged in the EPA-funded *Climate Masters of Nebraska* project. Similar in nature to the Master Gardener program, it is an adult education program developed to teach participants about climate change and understanding their carbon footprint (climatemasters.unl.edu). Three 10-week courses have been held to date in Lincoln, NE.

HPRCC is involved in a climate adaptation project involving sustainability staff from municipalities in a 5-state region (IA, NE, KS, MO, OK). Staff at HPRCC is working with the Urban Sustainability Directors Network to summarize and assess historical climate change and future climate projections at the local level. HPRCC is collaborating with the Mayor's Office of Lincoln, NE to understand changes for the city of Lincoln

Staff at HPRCC have authored or co-authored a total of 27 peer-reviewed journal articles and reports since 2010. Topics for these papers are wide ranging, and include: data quality control techniques, climate variability, soil moisture, evapotranspiration, and land use influence on climate trends. More about our research can be found at: <http://www.hprcc.unl.edu/research.php>. There are currently three Ph.D. students studying under the direction of Dr. Shulski with topics including agriculture and recent climate trends in the U.S. Corn Belt, assessing climate capacity in the Missouri River Basin, and a lightning climatology for the High Plains.

## **Outreach and Engagement**

HPRCC remains actively engaged in various types of outreach activities across the region. Staff provides classroom visits to schools around the area, as requested, with our mobile weather station to teach students about weather and climate monitoring. Hands-on guides have been developed for students to learn how to build weather instruments and observe the weather. Additionally, HPRCC attends and presents at local and regional hands-on public educational events.

The Center continues to work in Indian Country and is involved in several activities with tribes based in Kansas, Nebraska, and Wyoming. HPRCC provides educational outreach at the K-12, college, and community level for tribes based in Nebraska. A series of workshops have taken place with four Kansas-based tribes with the goal of increasing resiliency to climate extremes and improving capacity for understanding current climate conditions. Similar work has taken place with two Wyoming-based tribes over the last year in which HPRCC is helping increase capacity of local climate assessments.

## Midwestern Regional Climate Center

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Champaign, IL 61820  
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<http://mrcc.isws.illinois.edu>



### ***Beth Hall, Director***

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#### **Administration**

Olivia Kellner joined the MRCC staff as a full-time climatologist. She earned her PhD in Atmospheric Sciences from Purdue University in 2015 and has worked in the Indiana State Climate Office and the National Weather Service before joining the MRCC. She will be assisting in a variety of roles at the MRCC from climate monitoring, to outreach, to applied climate research.

Bryan Peake joined the MRCC staff as a full-time service climatologist. His responsibilities will be divided among the MRCC Service Office and assisting with MRCC research projects. He earned his undergraduate degree in Atmospheric and Oceanic Sciences at the University of Wisconsin-Madison.

During summer 2014, the MRCC hosted 4 summer interns. Justin Malandrucolo was an undergraduate from the University of Illinois who built an iOS app for the MRCC (“WxAlmanc”) that would tell users what weather conditions were like on a particular day and location of their choosing. Tyler Smith was an undergraduate student from Western Kentucky University and he helped support the MRCC Service Office by filling historical climate data requests from the public. Alex Carne, from Valparaiso University, was jointly supported by the MRCC and Illinois-Indiana Sea grant to help identify historical flooding events from the Chicago / Cook County region. Finally, Alan Marinaro was a graduate student at Northern Illinois University. He performed statistical analysis on historical Chicago floods and collaborated on a climatological analysis of the 2013-2014 Midwest winter. The MRCC is looking forward to continuing the summer internship program for at least 2 more students in summer 2015.

#### **Climate Services and Products**

Over the past year, representatives from several sectors (i.e. legal, consultants, and engineers) contacted the MRCC service office regularly for climate data and special products, with over 1020 offline contacts since July 2014. Including access to the MRCC online data system, *cli-MATE*, there have been over 100,000 page views (almost 10 million web hits) since July 2014.

Several new tools have been added to *cli-MATE*, including a Freezing Degree-Day calculator that several National Weather Service offices across our region had requested. This parameter can be used to learn more about ice damming and possibly frozen soils. The maps and tools section has also expanded, providing users great flexibility for displaying specific variables and time periods. The Missouri State Climate Office has been testing an MRCC beta tool for *cli-MATE* that allows a user to plot station data from selected data networks, including their own

state mesonet. This is a big advancement above the other mapping tools via cli-MATE that is only based upon data from the Cooperative Observation network, and pre-gridded before the user selects which variables and time period to plot.

The MRCC also did a full website redesign in 2014. Several of the new features and layouts include a social media (e.g., Facebook and Twitter) feed on the home page, fast-link buttons on the home page to our most popular resources (e.g., cli-MATE, Midwest Climate Watch, Vegetation Impact Program (VIP)), and a re-designed Midwest Climate Watch site. This site has broadened the display window and offered tabs so users can see more in sections such as “Highlights & Reports”, “Maps & Images” and “Special Topics”. Under “Special Topics”, users can now find climate monitoring tools in sectors such as drought, agriculture and horticulture, and the Great Lakes.

*The Climate Observer*, the MRCCs bi-monthly electronic newsletter, continues to expand in terms of the number of subscribers (over 3500 as of March 2015). Each issue offers two climate-relevant articles where at least one article is written by non-MRCC climate enthusiast. Often these articles are written by a state climatologist or a NWS forecaster, but have also included articles by other stakeholders and agencies such as the National Park Service and the private sector. There is also a MRCC climate tool and a non-MRCC climate tool highlighted so readers can learn more about the various climate monitoring tools, data, and resources that are available online.

Future plans for the MRCC over the next year include:

- Better organize historical hourly climate information so that a wider variety of operational and customized tools can be provided such as a wind chill and a heat index climatology, a dew point temperature climatology, and chilling hour accumulations.
- Develop additional climatological tools for agriculture and other vegetation foci including products related to disease and pest impacts driven by climatology
- Expand value-added climate monitoring products from operational mesonet data around the region to provide online tools and resources based upon that data.

### **Collaboration Efforts and Outreach**

The MRCC continues to work closely with Illinois-Indiana Sea Grant to foster the relationship between climate and Great Lakes issues. A funded project that examines changing trends in heavy rainfall events in the Cook County and Chicago area continues with anticipated completion by January 2016. This project will also result in a vulnerability assessment that emergency managers and facility managers of critical infrastructure and key resources can use to become more resilient to extreme rainfall events and flooding.

The MRCC has been actively involved in the Useful To Usable (U2U) project, which is led by Purdue University, with nine other universities and the HPRCC also collaborating. *Useful to Usable (U2U): Transforming Climate Variability and Change Information for Cereal Crop Producers*, is an integrated research and extension project that seeks to improve the resilience and profitability of farms in the North Central Region. Starting summer 2015, the MRCC will begin the transition process for the 5 decision-support tools that U2U has developed for the

agricultural community. The MRCC and High Plains Regional Climate Center (HPRCC) will be the new hosts of these climate-monitoring tools.

The MRCC engaged in 3 regional road trips in 2014 that brought the opportunity for MRCC personnel to go to many NWS offices, state climatologist universities and state offices, NOAA labs, private companies, state forests, and individual farmers and vineyard operators. This helped spread the word about who the MRCC is and what our mission includes.

## National Climatic Data Center

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### **Transition to the National Centers for Environmental Information**

In 2015, NOAA’s existing three National Data Centers—the National Climatic Data Center, the National Geophysical Data Center, and the National Oceanographic Data Center, which includes the National Coastal Data Development Center—merged into the National Centers for Environmental Information (NCEI). Two Science Centers—the Center for Weather and Climate and the Center for Coasts, Oceans, and Geophysics—as well as integrated services for support and data stewardship make up NCEI.

Overall, NCEI is responsible for hosting and providing access to one of the most significant archives on Earth, with comprehensive oceanic, atmospheric, and geophysical data. From the depths of the ocean to the surface of the sun and from million-year-old sediment records to near real-time satellite images, NCEI is the Nation’s leading authority for environmental information. NCEI continues the tradition of excellence, unmatched expertise, and trusted, authoritative data that the previous three Data Centers established. The top priority during the near future is to build on the full spectrum of atmospheric, oceanographic, coastal, and geophysical products and services that the Data Centers delivered. While NCEI’s product portfolio will evolve as current products and services are assessed, no products or services are currently slated to be cut or reduced. By using consistent data stewardship tools and practices across all of our science disciplines and by forging an improved data management paradigm, we expect to provide users with improved access to environmental data and information archive products. For more information, please visit [www.ncei.noaa.gov](http://www.ncei.noaa.gov).

### **Assembling the “State of the Climate in 2013” Report**

The “State of the Climate” series has provided a detailed update on global climate indicators, notable weather events, and data collected by environmental monitoring stations and instruments since the report’s inception in 1990. For the 14th consecutive year, scientists from NCEI’s Center for Weather and Climate (formerly known as the National Climatic Data Center or NCDC) served as lead editors of the report, which was compiled by 425 scientists from 57 countries across the globe and published as a supplement to the *Bulletin of the American Meteorological Society*.

The report used dozens of internationally recognized climate indicators to track and identify changes and trends in the global climate system. Each indicator includes thousands of measurements from multiple independent datasets. The diverse array of international authors helped consolidate this wide range of data, using their expertise to more fully understand and communicate the state of the complex climate system. The report provides a valuable reference for the increasing number of professionals and consultants who use climate conditions and trends in their work.

### **Explaining Extreme Events of 2013 from a Climate Perspective**

For the third year, scientists from NCEI’s Center for Weather and Climate collaborated with their colleagues across the globe to examine the causes of certain extreme events. Published by the *Bulletin of the American Meteorological Society*, “Explaining Extreme Events of 2013 from a Climate Perspective” addressed the causes of 16 individual extreme events that occurred on four continents in 2013. In addition to investigating the causes of these extreme events, the multiple analyses of some of the events allowed the scientists to compare and contrast the strengths and

weaknesses of their various analytic methods. Despite the different strategies, there was considerable agreement between the assessments of the same events. By further developing the ability to put extreme weather and climate events into the longer-term context of climate change, NCEI is helping provide the public with the information needed to make decisions about effectively minimizing and preparing for the impacts of these events.

### **Sustaining Over 20 Climate Data Records in Operations**

In 2014, NCEI expanded its national inventory of operational Climate Data Records (CDRs) to over 20 by transitioning five new CDRs from research into operations, which included cloud properties, vegetation, and precipitation records. The CDR Program is responsible for generating and archiving operational climate data records for the atmosphere, oceans, and land. These CDRs provide authoritative, observation-based information on how, where, and to what extent the land, oceans, atmosphere, and ice sheets are changing.

All of the operational CDRs provide input to emerging climate prediction modeling as well as capture and maintain the Nation's record of climate history, including the severity and frequency of drought, floods, and hurricanes. Produced from decades of satellite data and used by industry, government, and research communities to detect, assess, model, and predict climate change, decision makers value these long-term records for devising effective strategies to respond to, adapt to, and mitigate the impacts of climate variability and change.

### **Expanding the U.S. Climate Reference Network in Alaska**

The U.S. Climate Reference Network (USCRN) program, managed by NCEI, has been working to expand the network in Alaska since 2009. At the end of 2014, a total of 16 stations had been installed and are operating across Alaska. During the summer of 2015, two new sites will be installed. One will be in the Denali National Park and Preserve and other in the Selawik National Wildlife Refuge. The plan is to install a total of 29 USCRN stations in Alaska by the end of 2022. Data from these stations in Alaska, as well as the 114 stations in the 48 contiguous states and two in Hawaii, are available on the USCRN website.

### **Releasing the U.S. Climate Resiliency Toolkit**

In November 2014, a NOAA-led partnership of federal agencies and organizations, including NCEI, developed and launched the U.S. Climate Resilience Toolkit called for in President Obama's Climate Action Plan. The Toolkit enables decision makers to take action to boost their climate resilience using data-driven tools, information, and subject-matter expertise to make smarter decisions. It also offers information from across the Federal Government in one easy-to-use location so that Americans are better able to understand the climate-related risks and opportunities impacting their communities and take steps to improve their resilience.

The Toolkit's initial focus is on helping the nation address challenges in the areas of coastal flood risk and food resilience. This site is also being expanded to address additional areas such as water, ecosystems, transportation, and health. The Toolkit's collection and functions will connect citizens to the vast open federal data now available through the Climate Data Initiative as well as relevant information from the National Climate Assessment and other sources of best-available science. The site is designed to serve interested citizens, communities, businesses, resource managers, planners, and policy leaders at all levels of government.

# **State Climate Office Summaries, 2014**



## **Alabama Office of the State Climatologist (AOSC)**

**John Christy, PhD, Alabama State Climatologist**

Bob Clymer, MS, Assistant State Climatologist

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It is the role of the Alabama Office of the State Climatologist to provide weather and climate information to public and private interests to improve decision-making activities that affect environmental quality and the economic efficiency of the State. Activities include providing specific weather data for the state and for the world, developing plans to mitigate the economic impacts of weather and climate variability and providing consultation on the use, interpretation and availability of weather and climate information. The Alabama Office of the State Climatologist also directly engages in important societal debates such as global warming through workshops, congressional testimony and educational activities.

### **2014 Conditions**

Since October 2010, the AOSC has been posting a monthly summary of climate information which includes information from many sources such as NCDC, CoCoRAHS, AOSC and news reports. <http://nsstc.uah.edu/alclimatereport/>. Responses from stakeholders have been universally positive. We now have done so for a fourth entire year of 2014 and this has increased our exposure, particularly with the in-state media as many stories have followed from these postings.

Of key interest are the stories that are included about specific events or features from the past. Also popular is the listing of all record events (though this is a little misleading as we note because some of the NOAA period-of-records are shorter than is actually the case, so “records” tend to occur more frequently than in reality.)

For the third year in a row, severe weather (tornadoes and hurricanes) was scarce. Drought conditions were not severe either. The most unusual feature of the climate of 2014 was the very cool and wet summer – the second in a row. For the state as a whole, only a handful of stations recorded a high of 100°F.

### **Drought Monitor**

While there had been an informal collaboration-of-opportunity when preparing the Alabama drought level lines of the Drought Monitor each week, but in 2012 we continued to formalize a state-wide process, and in 2013 a bill was introduced to the state legislature to codify the procedure (did not make it through the session this year). This bill is being reconsidered this year. On Monday a.m., the SC emails all entities involved in drought monitoring and impacts at the four NWS offices, the State Office of Water Resources, other state agencies, industry and municipal users with a preliminary assessment. Through the day on Monday and morning of Tuesday, information is passed among the players and by Tuesday afternoon the SC sends to the DM our consensus recommendations. This centrally-planned process has helped greatly in

expressing the best recommendations we can generate. A bill is being considered in the state legislature this year that will codify the Drought Monitor procedure and identify the State Climatologist as a formal position in State Government.

**Historical Climate Network upgrades**

Due to NOAA budget cuts, there is considerable uncertainty about the continued funding of the operation and maintenance of the 17 Regional Climate Reference Network stations in Alabama. One (Guntersville) was removed in 2013 as the owner sold the land to a development. The AOSC is in the process of collection new site license agreements with the 16 USRCRN stations that will be handed over to the State Climatologist.

**CoCoRaHS**

On 1 November 2007, Alabama became an official member of the CoCoRaHS network. As of 12 Mar 2009 there were 670 stations registered, as of 2 March 2015 there were 926, an increase of 19 over last year. The AOSC is the state coordinator with each NWS WFO serving as Regional Coordinators for their appropriate counties. Again, the cooperation with the NWS WFO’s and Southern Region HQ has been superb in promoting this very public service activity.

**AWEP Program 2015**

With efforts from the AOSC and the Alabama Universities Irrigation Initiative, the USDA budgeted over \$60M for farmers to develop better water resources in the last Farm Bill. A new Farm Bill will continue the program with language designed to encourage irrigation in moist regions such as the Southeast.



**Results in for Economic Development**

The AOSC was again contacted by several industries wanting climate information necessary to make decisions about locating in Alabama and what their facilities might expect from various weather events. The AOSC continues heavily involved in the agricultural community by assessing water resources and the potential for irrigation expansion. In 2012 and 2013 bills initiated by our efforts to enhance irrigation opportunities with tax credits was passed by the state legislature and signed by the governor. Dr. Richard T. McNider of UAH, who was the lead scientist on the project and former State Climatologist, is pictured below to the right of the Governor with the current State Climatologist



looking over his shoulder at the signing ceremony.

In 2014 an analysis was performed of the first two years of the program and



was given in this report last year. We are awaiting the results for 2014, but we anticipate continued growth in revenues as farmers take advantage of the tax credit to install economically and environmentally sustainable irrigation systems.

Various economic interests contacted the AOSC in 2014 for information and speaking engagements related to climate change legislation. The SC has appeared before the U.S. Congress at hearings on energy and climate (photo at right before the U.S. House Science Committee, 11 Dec 2013.) The SC also appeared before state legal hearings (in and out of Alabama) on various climate issues as states struggle with legislation on carbon emissions. Because Alabama is a manufacturing and industrial state, the prospect of paying higher prices for energy (fuel, electricity, etc.) has caused considerable concern among those who have established our economic base. Alabama is one of the few states that produces more electricity than it consumes, exporting over 67 million MW-hrs (30%) out of state in 2012. Contrast this export activity versus a state such as California which is dependent on imports of 60 million MW-hrs of electrical power. This export “product” is in jeopardy if rates are forced to rise. As a result of research on climate-change issues and impacts of legislation, the AOSC was able to provide hard metrics for business and congressional leaders, including congressional and state testimony in 2014, for the development of policy.

As a result of the basic science on global climate that the SC has performed, he became a target of a congressional investigation initiated by the White House, and promulgated by a congressman from Arizona. As of this writing, the issue is being addressed by UAH.

[http://www.al.com/news/huntsville/index.ssf/2015/02/arizona\\_congressman\\_asking\\_que.html](http://www.al.com/news/huntsville/index.ssf/2015/02/arizona_congressman_asking_que.html)

The State Climatologist will not be intimidated by such tactics and will continue to report on the observational record of climate variables and continue to assess climate model output in light of the observations.

<http://vortex.nsstc.uah.edu/aosc>

## **Alaska Climate Research Center** **Geophysical Institute, University of Alaska** **Annual Report for 2014**

The Alaska Climate Research Center (ACRC) is part of the Geophysical Institute, University of Alaska, Fairbanks. It was established by the State of Alaska via Title 14, Chapter 40, Section 085. Specific information can be found in this statute. Originally we were supported by the State with our own specific budget, but later on this was added to the allocation by the State to the Geophysical Institute, which supports us now.

### **KEY PERSONNEL:**

Gerd Wendler, Director, Professor Emeritus  
Martin Stuefer, Assistant Director, Associate Professor  
Kevin Galloway, Webmaster  
Blake Moore, Programmer

### **PURPOSE:**

The purpose of the center is threefold:

- Dissemination of climatological data (free of charge)
- Research on climate variability and climate change in Alaska and Polar Regions, and
- Education

### **Dissemination:**

For nearly three decades we have made climatological data available to the public, research organizations and interested industries. Today this is mostly accomplished via our website (<http://akclimate.org/>) which received in 2014 over 180,000 unique visitors. On a daily basis we receive on average 5000 visits. Analyzing by domain, “net” is the most frequent source of visitors, followed by “edu”. From the international realm Great Britain was the country most interested in our data (2.28% of our visitors), followed by Canada (1.73%) and Germany (1.71%). Over the course of a year, winter is the busiest season, probably due to the fact that very cold temperatures (down to -40°F and colder) can occur paired with ice fog, which makes driving difficult, if not dangerous, and in winter there also exists a high pollution potential due to the strong surface inversion

The ACRC website contains many summaries, products, meteorological and climatological information. Furthermore, from our home page, users can select any number of links: Fairbanks weather and climate, our popular webcam and on-campus weather station, climatological data, up-to-date summaries, Alaska weather, information for tourists, seasonal and other weather and climate links, and a ‘spotlight on climate’ section giving a list of the latest features posted.

Specific request of data, normally received online, by telephone, and sometimes by walk-ins, are filled free of charge. It should be noted that we do not make predictions on future climate change, nor assess the socio-economic and biophysical impacts of such predicted climate projections. Our focus is on observations.

On our website we publish monthly and annual reviews both, for selected cities (Barrow, Fairbanks, Anchorage, Nome, King Salmon, Juneau, Ketchikan) as well as for Alaska as the State, the latter one based on the 19 first order stations of Alaska. Further, in conjunction with ACCAP (<https://accap.uaf.edu/>), we supply seasonal climate reviews. As an example we discuss here shortly a summary of the climate of 2014 for Alaska; more details can be seen from our website.

The mean average annual temperature in 2014 for the 19 first order stations was 35.6°F, a substantial positive departure of 3.0°F from the 30-year normal of 32.6°F. This is different to the previous years: 2013 Alaska was slightly too warm with a deviation of +0.7°F, while in 2012 Alaska was substantially below normal with a deviation of -2.9°F. A deviation of 3.0°F as observed last year is very substantial for an area as large as Alaska and a time period as long as a year. The value surpasses the amount of warming to be expected by climate change over a century. According to the National Weather Service it was the warmest year ever recorded in Alaska, surpassing 1926, which held the previous record. All 19 stations had a positive deviation. Kotzebue (+5.5°F), King Salmon (+5.2°F) and Homer (+5.0°F) showed the highest deviations. The smallest, but still positive deviations were found in Annette (+0.3°F), Yakutat and Gulkana (both 0.8°F) and Juneau (+0.9°F). For more details, an isopleth temperature presentation of Alaska is presented in Figure 1.

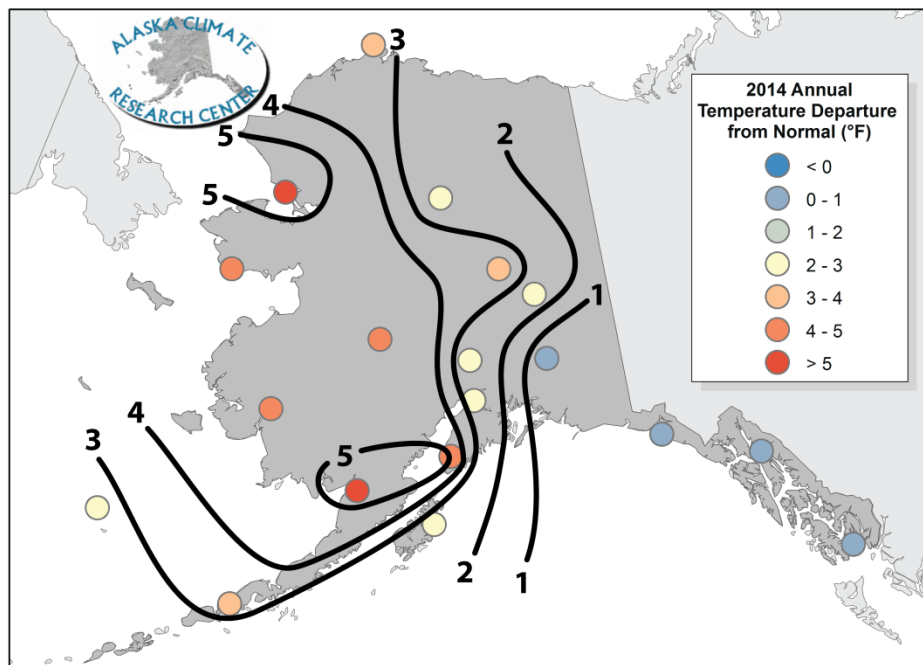


Figure 1: Isopleth presentation of the temperatures deviations from the normal (1981-2010) for 2014 based on all first order Alaskan meteorological stations.

The magnitude of the observed high temperature 2014 can be judged easier from Figure 2, which gives the deviation from the mean annual temperature since 1949, and it clearly demonstrates the exceptional warmth of last year. Further, the 1975 regime change in the PDO on Alaskan's temperatures, going from dominantly negative to positive values, is well documented in this graph.

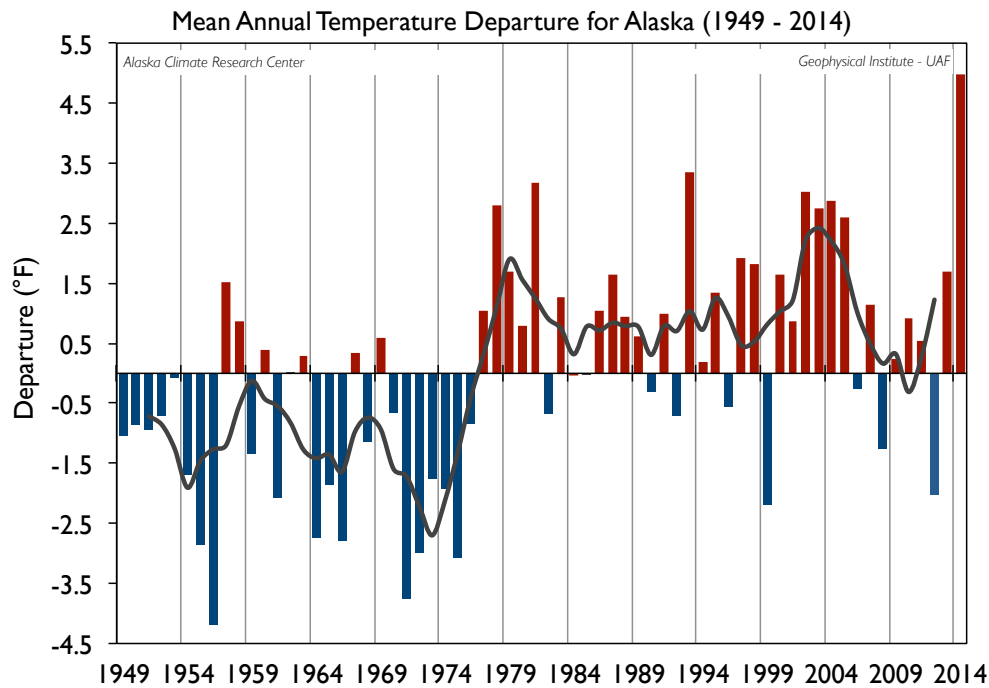


Fig. 2: Mean temperature departure for Alaska based on all first order stations

**RESEARCH:**

A substantial number of publications on the climate of Alaska and Polar Regions have been produced over the years. In 2014 we published one new journal article (open access), which can be downloaded from our website.

Open Access

Strong Temperature Increase and Shrinking Sea Ice in Arctic Alaska

by Gerd Wendler, Blake Moore and Kevin Galloway

The Open Atmospheric Science Journal, 2014, 8, p.7-15

1874-2823/14 2014 Bentham Open

A very strong temperature increase in Barrow of 2.7°C over the last 34 years for which we have high resolution microwave satellite observations being able to look through clouds and darkness and a strong decrease in sea ice were observed. The substantial observed warming when compared with the global value is in agreement with the polar amplification of this warming; however, the generally accepted explanation (warmer temperature -> earlier snow melt -> lower albedo -> more solar radiation absorption -> enhanced warming) seems to be in our case not the most important contributor. In October, when the temperatures are far below the freezing point, Barrow observed a temperature increase of 7.2°C, a very substantial value for a time period of 34 years. It was the highest monthly value. As the adjacent Arctic Ocean was less ice covered, advection of relatively warm air is the main cause, as the wind direction in October has northerly component, advecting relatively warm air. Solar radiation is very weak in October, as the solar elevation angles are very low.

**EDUCATION:**

We have been giving talks and seminars on the climate and observed climate change in Alaska and Polar Regions. We also provided educators and community groups with charts and data for use in educating their classes and communities, as well as answering a variety of queries from the community regarding issues such as the lake effect, Alaska's warming, and abnormal weather events in Alaska, etc.



## **Office of the Arizona State Climatologist**

*Nancy J. Selover, PhD. State  
Climatologist*

State Climate Office

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## **ARIZONA STATE CLIMATE OFFICE**

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<http://azclimate.asu.edu/>

The Arizona State Climate Office (ASCO) is located within the Office of Climatology of the School of Geographical Sciences & Urban Planning (SGSUP) at Arizona State University (ASU) in Tempe, AZ. The office includes the State Climatologist, Dr. Nancy J. Selover and two affiliated faculty in SGSUP (Drs. Anthony Brazel and Randall Cerveny). The office is affiliated with the new Center for Urban Climate Research at ASU. Our mission is still to: (1) manage and disseminate climatological information about the State of Arizona, (2) monitor the climate of Arizona and the Southwest, (3) collaborate with state agencies in need of climate data and advisement, and (4) conduct research aimed at an improved understanding of the spatial and temporal variability of the climate of Arizona.

The Arizona State Climate Office is a designated ARSCO, committed to supporting the objectives of the AASC. Below is a brief description of the activities of the Office over the past year that addresses each of the ARSCO qualifications:

### **Communication Capabilities**

- We maintain an ASCO web page (<http://azclimate.asu.edu/>) to provide real-time weather data with a climate context, and provide climate products online. The website includes general climate and real-time weather information, the monthly Arizona Climate Summary, daily rainfall and evaporation tables for the Phoenix area, daily North American Monsoon updates (in summer), and links to climate education and safety information and other climate data resources.
- Maintain a voicemail system to take data and information requests when the office is not physically staffed. Calls are answered or returned within 24 hours whenever possible. Most data requests come through the phone or e-mail, generated by the forms available on the website, or from the State Climatologist contact information available through numerous links on the University website. The data are served back through the Internet, phone, e-mail, and the U.S. postal service as we have some stakeholders without computer access.

### **Information Services**

- In 2014 we continued to receive most of our data requests through the e-mail resulting from the State Climate contact information available through the University or re-direct from the webpage. I have no statistics for the web hits as those data disappeared when the website was taken down after being hacked. It came back online in the fall. Data users, other than web downloads, include university researchers, state and local government agencies, the public, private industry, the media, and an increasing number of requests from the legal community. We did 33 media interviews on drought,

monsoon, dust storms, extreme weather, climate change, extreme heat, AZ climate, water resources, urban heat island, wildfire, extreme cold, and the climate outlook, of which 16 were TV, 7 radio, 8 newspaper, 2 University projects, and 2 Internet articles, and we were involved in 23 legal cases as consultants or expert witnesses. The trend this year is an increase in e-mail and fewer phone data requests. This year we generated monthly summary products for temperature and precipitation records, and continued updating the Climate of Phoenix with current data. We produced monthly reports on drought for the Arizona Department of Water Resources webpage, climate summaries for State Climate Office website, provided input to the CLIMAS monthly summary and outlook publication (Southwest Climate Outlook), heating and cooling degree days for AZ Commerce Department, daily climate data for the Kingman, AZ newspaper and daily evaporation and weather data for the local Water/Power Utility Salt River Project..

### **Research**

DOC-NOAA – Co-PI on Evaluation of Drought Risks and its Impact on Agricultural Land and Water use to Support Adaptive Decision-making. PI - Soe Myint \$300,000

NASA – co-PI on Using Remote-Sensing to Understand the Impacts of Droughts on Agricultural Land Use and Water Consumption to Support Adaptive Decision-making in Arid Environments. PI - Soe Myint \$199,953

NOAA SARP – Informing Emergency and Risk Management Climate Knowledge in Arid Regions. Co-PI with Nalini Chhetri. \$98,443.

ASU Lightworks and Strategic Solar Energy LLC. Microclimate Impacts of Photovoltaic (PV) Structures. Co-PI, \$15,000/

CDC through Arizona Department of Health Services, Arizona BRACE. Co-PI. \$100,000.

National Park Service – Monitoring Microclimates in the Petrified Forest National Park. \$20,000.

### **Outreach & Service**

- Co-Chair of Technical Monitoring Committee of State Drought Task Force
- Recording Secretary of Arizona Flood Warning Multi-Agency Task Force
- State Coordinator – CoCoRaHS – Community Collaborative Rain, Hail & Snow Network, citizen scientist precipitation observers.
- Member of State Hazard Mitigation Plan Update team starting 2014-2015 State and County plan updates to incorporate climate change.
- Co-President Central Arizona Chapter of American Meteorological Society
- Mentoring four K-12 teachers in the Earth Climate System in the AMS Datastream program
- Member of American Meteorological Society Applied Climatology Committee – planning of January 2014 Applied Climatology Conference
- Member of American Meteorological Society Local Organizing Committee – planning of January 2015 Annual AMS meeting in Phoenix
- Member of WERA1012 – a planning committee within the Western Association of Agricultural Experiment Station Directors, with the task of Managing and Utilizing Precipitation Observations from Volunteer Networks
- Marcus Fund for Physical Geography Award Committee – Association of American Geographers – field research award for graduate/undergraduate students in hostile environments

Reviewer of papers, chapters, reports for the:

- Climate Literacy and Energy Awareness Network – 2 reports, one on carbon sequestration and one on global climate change and engineering
- Reviewed proposals for EPA's National Center for Environmental Research National Priorities Strategies to Improve the Nation's ability to plan and respond to water scarcity and drought due to climate change.

24 Presentations to Community (14) and Education (10) Groups on drought, climate change, monsoon, UHI, water resources.

- Western Governors Association – Drought Forum – Sectoral Impacts - Mining & industry October 2014
- AZ Dept of Emergency Management quarterly training – Drought Impacts - Mar 2014, Weather & Climate Outlook - Aug 2014
- Interagency Coordinating Group – State Drought Task Force Updates - Apr & Nov 2014
- Decision Center for a Desert City – Climate Change & Water Resources - Oct 2014
- Drexel University Climate Change & Urban Desert Cities – Mar 2014
- Arizona Geographic Alliance – Urban Heat Island - Jun 2014
- School of Sustainability – Guest Lecturer Stakeholder Engagement - Sept & Nov 2014
- AMS Southeast Arizona Chapter – Measuring Precipitation & Arizona Climate - Jan 2014
- Association of Hospital Engineers – Climate Change & Drought in Arizona - May 2014
- Hassayampa River Preserve– Arizona Weather & Climate - Jan 2014
- Colorado River Plateau Futures Forum - Drought and Water in the Southwest – Sep 2014

### **Monitoring and Impact Assessments**

- Monitoring temperature and precipitation in the Petrified Forest National Park to inform park archaeologist as to weathering conditions for petroglyphs and other historical cultural assets.
- Prepare monthly statewide temperature and precipitation updates and calculation of watershed SPI for drought monitoring for the Governor's Drought Task Force.
- Publish monthly newsletter summary of Arizona climate, and contribute monthly temperature and precipitation summaries to the Arizona-New Mexico – CLIMAS publication "Southwest Climate Outlook".
- Archive data from the PRISMS network for Phoenix, Flood Control District of Maricopa County, and the Phoenix first-order weather station, and the AZMet network for Arizona.
- Statewide coordinator for CoCoRaHS precipitation monitoring in Arizona (906 observers).
- Maintenance of Arizona USRCRN climate stations to fill in for NOAA maintenance budget shortfall
- Translating and disseminating climate variability and urban heat island research for policy-makers in the cities and tribes in the Phoenix metropolitan area.
- Coordinated the transfer of 14 of 18 USRCRN climate stations from NOAA to in-situ ownership, with the NPS Inventory & Monitoring Group, USGS Grand Canyon Research & Monitoring Group, Arizona State University, Salt River Project, and the White Mountain Apache Tribe. Data are being ingested by the Western Region Climate Center and pushed out to MADIS.

## Office of the California State Climatologist

Dr. Michael Anderson-

Over the past year the California State Climate Office has been involved in a variety of projects and collaborations. The efforts are in the areas of design hydrology, volunteer observing networks, extreme precipitation monitoring, and drought. Data services are provided via phone, fax, email, and web services.

A project was launched in 2008 to begin the deployment of weather monitoring equipment to assist in the forecasting and monitoring of extreme precipitation conditions in California. The project is a partnership effort between DWR, Scripps Institution of Oceanography, and NOAA's Earth Systems Research Laboratory (ESRL). Three types of instrumentation are to be deployed in this project: GPS-Met (water vapor), soil moisture, and vertically pointing radar (freezing level). Deployment of the instruments is finishing up and new storm diagnostics from the new data streams are being developed. Data transfer into the California Data Exchange Center is still being pursued. The partnership now includes the new Center for Western Weather and Water Extremes housed at Scripps Institution of Oceanography. Dr. F. Martin Ralph heads the new center after a career at NOAA's ESRL.

Calendar year 2013 set a new record for dryness at the state level. Winter 2014 and 2015 set new records for warmth. The April 1 snow pack of 2015 is on pace to be the smallest since 1950 at about half of the previous low set in 2014 and 1977. The ongoing drought is providing many opportunities to evaluate drought impacts and water management from the perspective of a changing climate. There are many speaking opportunities and interview requests as a result including some international interest from Brazil, Japan, Denmark and the Netherlands.

The drought has also elevated interest in the NIDIS pilot projects going on in California. These pilot projects have supported collaboration with the NIDIS federal agencies as well as the California Nevada Applications Program RISA and the Western Region Climate Center. A recent product is a two-pager on California Precipitation developed in collaboration with the California Nevada Applications RISA and the Center for Western Weather and Water Extremes. The product can be found on the State Climatologist web page and the CNAP RISA page at: [http://cnap.ucsd.edu/pdf/CA\\_Precip\\_final.pdf](http://cnap.ucsd.edu/pdf/CA_Precip_final.pdf).

As part of the State's Climate Action Team, the Research working group developed a five year research plan to help guide the State's investment in climate change research. The plan is being finalized and is expected to be released in the spring of 2015. The plan can be viewed at: [http://www.climatechange.ca.gov/climate\\_action\\_team/reports/CAT\\_research\\_plan\\_2015.pdf](http://www.climatechange.ca.gov/climate_action_team/reports/CAT_research_plan_2015.pdf).

Additional work is going into a research development and deployment plan for the Hydrology and Flood Operations Office within the Department of Water Resources where the Office of the State Climatologist sits.

In its sixth year of operation, the CoCoRaHS California effort has signed up more than 1,200 volunteers covering 55 of California's 58 counties. Over 10,000 daily precipitation reports are entered each month. The program provides an opportunity for the State Climatologist to interact with the multiple weather forecast offices that serve the state and is providing insight into the

spatial variability of rainfall at the event scale. The National Weather Service State Coordinator at the San Diego Weather Forecast Office is leading the effort to produce a quarterly newsletter. Work continues on developing information to inform flood planning efforts in a changing climate. Vulnerabilities in the flood management system have been identified and potential impacts from climate change have been described along the lines of impact to system vulnerabilities. Further research and development will be pursued to assist the State's flood planning efforts. This work includes working with the California Nevada Applications Program RISA and the Western Region Climate Center.

The State Climatologist has been involved in related work at the regional level in examining the benefits of advanced monitoring for extreme precipitation in the San Francisco Bay region and exploring the benefits of forecast informed reservoir operations. Work to date has involved participation in work groups and speaking engagements.

Collaboration continues with the Western Region Climate Center, the National Oceanographic Atmospheric Administration Regional Integrated Science Assessment California Nevada Applications Program, the Department of the Interior Southwest Climate Science Center, and the United States Department of Agriculture Southwest Climate Science Hub. Collaborative efforts with the United States Bureau of Reclamation and United States Geological Survey also continue. Collaboration and funding of climate services task orders with the University of California also continues. Work is wrapping up on the United States Forest Service Sierra Nevada Adaptive Management Program, a collaborative state-federal effort to examine the watershed impacts of different fire-treatment methods.

# Colorado ARSCO Annual Report for Calendar Year 2014

Prepared for AASC May 2015

## Colorado Climate Center

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Wendy Ryan, Asst. State Climatologist  
Noah Newman, Zach Schwalbe,  
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### Introduction and background:

The Colorado Climate Center (CCC) was established by the State in 1974, through the Colorado State University Agricultural Experiment Station, to provide information and expertise on Colorado's complex climate. Through its threefold program of Climate Monitoring (data acquisition, analysis, and archiving), Climate Research, and Climate Services, the Center responds to many climate-related questions and challenges. The Center monitors climatic conditions on both broad, regional scales and very local scales using data gathered by public sources (National Weather Service, USDA, USDI etc.) but also by monitoring networks deployed by the Center. Data resources are combined to provide higher granularity and as much local detail as possible in a state with great topographic and climatic diversity. By documenting climate variations in time and space, the relationships between climate, water supplies, other natural resources, agriculture and societal responses can be better understood and applied to support appropriate planning and decision making.

### Priorities and accomplishments of the Colorado Climate Center in 2014 were:

Climate Monitoring is a core function of our organization and is the bulk of what we do. 2014 saw continuation of long-term drought conditions over southern Colorado where some areas have been in at least moderate to severe drought for 4 years. Conditions moderated, though, with near average growing season temperatures, fairly generous summer rains, and below average evaporative stress. While rangeland productivity was still significantly reduced due to prolonged drought, both dryland and irrigated drops had a good year.

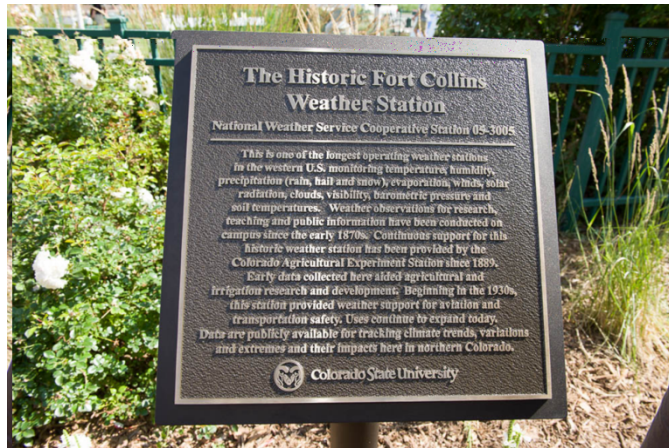
Here are several specific activities and accomplishments:

- 1) Provide comprehensive climate monitoring for the Fort Collins campus weather station.  
<http://ccc.atmos.colostate.edu/~autowx/>



*Wendy Ryan, Colorado Assistant State Climatologist, shows off a new CoAgMet station in eastern Colorado. Wendy has worked hard for several years to improve the quality of CoAgMet data.*

2014 marked the 126<sup>th</sup> year of continuous uninterrupted weather observations and climate monitoring on the campus of Colorado State University. Wendy Ryan produced a timely and popular monthly report tracking local climate anomalies and extremes affecting the university and the Fort Collins community. We hosted a special weather station celebration including the unveiling of a plaque commemorating the role of the weather station in Fort Collins and CSU history. It was followed two weeks later with a public seminar and a webinar <https://youtu.be/c-Za8TPTvIc>



- 2) Manage, maintain and enhance the Colorado Agricultural Meteorological Network (COAGMET) to provide timely local weather and climate information to support the Colorado agricultural industry <http://climate.colostate.edu/~coagmet/>  
<http://coagmet.colostate.edu>

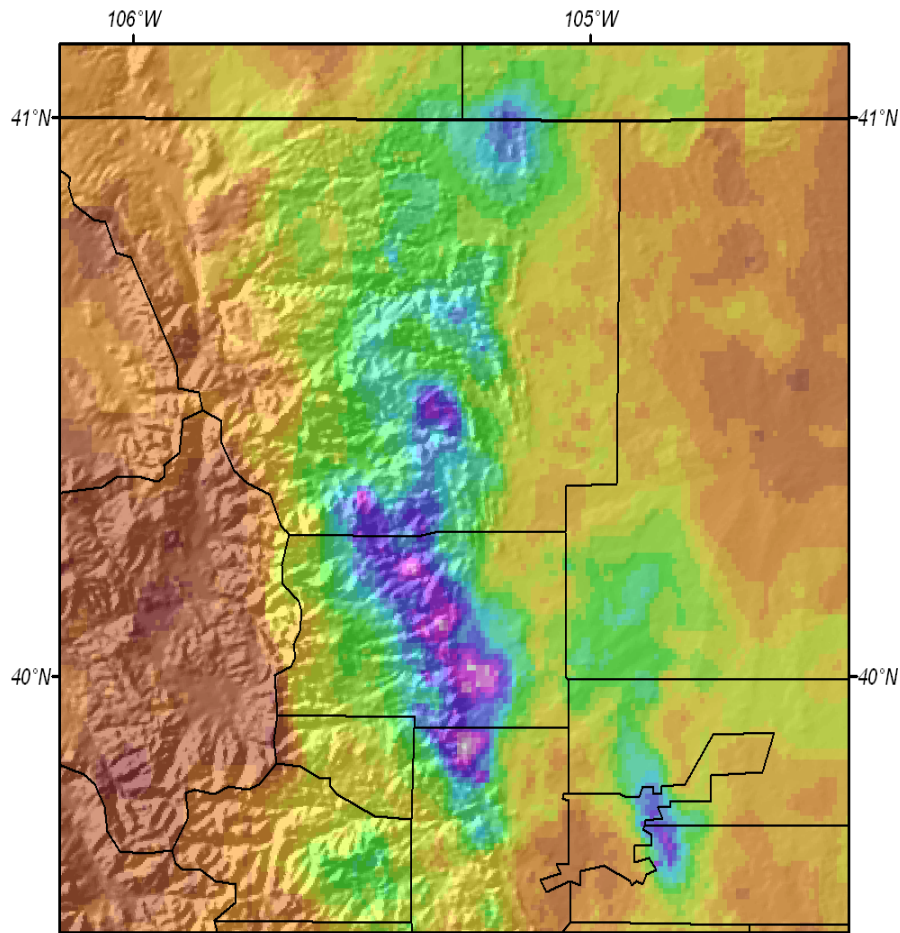
We operated and slightly expanded our statewide network of automated weather stations to serve the needs of Colorado agriculture.

We have been actively involved now for over 20 years and have been the primary caretakers for the past several years. One additional station was added in July 2014 (Cherokee Park, CO) bringing the total to 69 stations. Working with several CSU partners in other departments as well as with CSU Extension, we promoted use of a new irrigation water use tool (WISE on eRAMS) that utilizes field-specific soil information along with local precipitation and regional meteorological conditions from CoAgMET, NOAA and Northern Colorado Water Conservation District. We expanded our outreach of the WISE irrigation scheduling tool. CoAgMet webservicees were implemented to support easy access to raw data by diverse users. This network is underfunded but we continue to perform station maintenance and calibration annually to assure data quality. The CoAgMet network is becoming increasingly visible, and more stations are communicating in near-real time. CoAgMet is now a well-recognized data source for



water management, water administration, and long-term planning in addition to agriculture. A relatively new use of CoAgMet is now in support of new "Water Banks" for managing limited water resources in Colorado.

- 3) Coordinate climate monitoring, drought tracking and early warning: We continued our weekly Tuesday morning Climate, Water and Drought assessment reports [http://ccc.atmos.colostate.edu/drought\\_webinar.php](http://ccc.atmos.colostate.edu/drought_webinar.php) and expanded the e-mail list to routinely disseminate these updates to users and media. This work is done in collaboration with the National Integrated Drought Information System (NIDIS). Our ongoing efforts with the NIDIS Upper Colorado River Basin Drought Early Warning System and the Colorado Water Availability Task Force provide a continuous opportunity for improving climate and drought monitoring products and services to benefit diverse stakeholders. We are currently working to develop and implement soil moisture monitoring products.
- 4) Track the pulse of long-term climate trends and variations for key climatic elements such as temperature, precipitation, snow accumulation and evapotranspiration and provide this information to the citizens of Colorado to help address concerns over climate change and public response. The Colorado Climate Trends website continues to serve this information in graphical and tabular formats for the best long-term observing sites in Colorado.
- 5) Document rainfall patterns associated with September 2013 flooding. We completed, in collaboration with other groups, high resolution rainfall maps from the storms of September 2013. These maps have been shared with many organizations and have appeared in a variety of reports and presentations. As more infrastructure damage and repairs have been assessed and completed, this storm is in the top three most expensive (in 2014 dollars) for the State of Colorado in the past 100 years exceeding the Pueblo floods of 1921 and approaching the great floods of June 1965 that ravaged parts of Denver and several other counties.



*Total accumulated precipitation (inches) for period September 8 – 15, 2013. Map created with the Storm Precipitation Analysis System (SPAS) through a collaborative effort by Applied Weather Associates, LLC, MetStat, Inc. and the CSU Colorado Climate Center. Radar data supplied by Weather Decision Technologies, Inc.*

A "Climate Extremes" committee was convened to evaluate a reported new record one-day rainfall amount near Colorado Springs from the September 2013 storms. A new record of 11.85" was confirmed for a USGS gauge on the grounds of the Rod and Gun club at Fort Carson for September 12, 2013. The maximum consecutive 24-hour amount was 12.46"; however 11.85" was chosen as the record for the midnight to midnight period in order to be consistent with daily summaries from the station. The National Climatic Data Center accepted this as the new state record, and the first such record from a non-NOAA gauge.

- 6) Engage the citizens of Colorado, as well as all of the US and parts of Canada, in backyard climate monitoring through the Community Collaborative Rain, Hail and Snow network (CoCoRaHS) and related activities. <http://www.cocorahs.org>

During 2014 we added Puerto Rico plus several provinces of Canada. Several thousand new volunteers were recruited but total numbers of active volunteers only grew by a few hundred this year as we saw a fairly large attrition rate for our older volunteers who had been with the project for several years. Many users continue to make use of CoCoRaHS

data including the NWS, the National Climatic Data Center and the PRISM climate group at Oregon State University. CoCoRaHS also improved data export capabilities making it easier for a variety of users to extract raw data to then integrate into their specific products and services including some in the private sector. CoCoRaHS is the single largest source for readily accessible and GIS compatible daily manual precipitation data in the U.S. It is helping improve the quality of daily precipitation products used for USDA crop insurance claims documentation as well as for flood documentation and drought assessment. The National Climatic Data Center incorporates CoCoRaHS daily precipitation reports as a part of the Global Historical Climate Network (GHCN). CoCoRaHS data are nationally available through NOAA's Applied Climate Information System (ACIS) to serve a broad range of climate monitoring applications

- 7) Broadly disseminate climatic information, expertise and applications, and assist others in applied climate research. The staff of the Colorado Climate Center continues to provide climate services – generally at no cost to any users requesting climate data and/or expertise. Weekly climate, water and drought assessments were conducted year-round. Climate Center staff participated in youth water festivals in all parts of the state, and participated in many meetings and conferences. Nearly 100 invited talks and presentations were given.

***Publications:***

Recent publications are available from the CCC's web site at (<http://ccc.atmos.colostate.edu/publications.php>)

***ARSCO Qualifications:***

The Colorado Climate Center is designated by the AASC as the official state climate office for Colorado. The following section describes ways in which CCC addressed the ARSCO qualification requirements during the past year:

***Communication Capabilities:***

Communication and outreach are very high priorities for the Colorado Climate Center. The CCC website and links are a critical part but not our only communications capability. We are currently in the middle of a long and arduous effort to upgrade our website. Hopefully, this will be completed soon. We continue to use webinars as a means of reaching distributed audiences. YouTube, Facebook and Twitter are all employed to broaden our communications portfolio.

***Information Services:***

Our staff responds quickly to requests for climatic data and expertise – at no cost for most customers. The bulk of information services are managed through the CCC website <http://ccc.atmos.colostate.edu> which serves tens of thousands of users and provides access to both real-time data, historic data, products, narrative climate descriptions and publications. The four primary data sources provided are 1) The National Weather Service's COOPERATIVE network, 2) The CSU Campus Weather Station, 3) The Colorado Agricultural Meteorological Network (CoAgMet) and 4) the Community Collaborative Rain, Hail and Snow network (CoCoRaHS). But other data sources are integrated as needed, such as the USDA Natural Resources Conservation Services Snow Survey data. In 2014 NOAA terminated funding for the

Regional Climate Reference Network (RCRN). We are in the process of taking over ownership of this important observing network in our region. The NOAA Regional Climate Reference Network (RCRN) was defunded at the national level this year. In an effort to retain these important climate monitoring stations, we took over responsibility for the stations so that NOAA would not remove them from Colorado. In order for this to occur, we have been working all year to secure site license agreements with each of the 17 locations as well as continue routine maintenance of the stations. We partner with NOAA and other State Climate Offices to effectively deliver regional climate services. We periodically present current climate conditions as a part of the monthly Great Plains and Midwest Climate and Drought Update Webinar series.

***Research:***

Current and ongoing research at the Colorado Climate Center is focused in these areas.

- 1) Detection, interpretation and communication of the variability and trends observed in climate time series. This is ongoing work serving the mission of the Center and the needs of Colorado.
- 2) Drought monitoring and drought early warning. Supported through the National Integrated Drought Information System (NIDIS) we continue to develop new tools for drought detection and early warning and continue to make new efforts to reach and satisfy the information needs of a variety of stakeholders. We have begun exploring ways of combining soil moisture observations with more readily available climate information to track soil drying and drought onset.
- 3) Improving the estimation of crop water use using ground based CoAgMet weather data.
- 4) Precipitation characteristics and statistical properties. The CoCoRaHS network continues to provide a gold mine of high spatial resolution precipitation data for studying spatial patterns, frequency, intensity and extreme events. We are supporting efforts at other institutions for integrating ground based observations with remote sensing to improve overall monitoring.
- 5) Weather Instrument intercomparisons. Thanks to the historic facilities available at the Fort Collins campus weather station, we maintain a number of ongoing studies instrument intercomparisons including snow sensors, rain gauges, and temperature measurement systems including comparisons of precipitation and temperature between NWS COOP stations and NOAA Climate Reference network stations. We are beginning soil moisture measurement intercomparisons as well.
- 6) We have beginning a small project to identify desirable climates in SW Colorado for grape vineyards. The intent of this work is to potentially expand the areas where grapes are grown around the Grand Valley and Four Corners area to support the wine making industry in Western Colorado by identifying climates that may support production soon or, if warming continues, in the future.

***Outreach:***

To the extent possible, we continue to utilize face-to-face climate information delivery. From school programs to guest lectures and professional conferences, we directly reached thousands with climate and water information this past year. Some examples of meetings that we now participate in every year: American Meteorological Society annual meeting, Colorado Water Congress, the Colorado Foundation for Water Education, the Colorado Farm Show, the

Governors Ag. Forum, the South Platte Forum, the Arkansas Basin Water Forum, the Upper Colorado River Water Forum plus a variety of other occasional venues.

Nationally, the Community Collaborative Rain, Hail and Snow network (CoCoRaHS) <http://www.cocorahs.org> continues to provide outreach opportunities almost every day. We continue to add new training and informational content via the CoCoRaHS YouTube channel: <http://www.youtube.com/cocorahs/> but we also stay in touch with thousands of participants and data users via e-mail, web access and social media.

# **ARSCO Annual Report for 2014-2015**

## **Connecticut State Climate Center**

Xiusheng (Harrison) Yang  
Professor and State Climatologist  
Richard Anyah  
Associate Professor and Associate State Climatologist  
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### **1. Staff**

Director: Xiusheng (Harrison) Yang  
Associate Director: Richard Anyah  
Web Master: Nickolas Hanna  
Student volunteer: Jessica August

### **2. The advisory board**

Dr. Michael Willig, Center for Environmental Sciences and Engineering,  
Dr. John Volin, Department of Natural Resources and the Environment,  
Dr. Glenn Warner, Department of Natural Resources and the Environment,  
Dr. Anji Seth, Department of Geography, and  
Dr. Guiling Wang, Department of Civil and Environmental Engineering

### **3. Support**

The CSCC has been running with support to satisfy the minimum NCDC requirement for the program. The Department of Natural Resources and the Environment has provided secretarial support to the Center for day-to-day needs. The College of Agriculture, Health and Natural Resources has supported the Center with web upgrade and maintenance. Due to budget issues, CSCC was unable to obtain any travel funds for the annual AASC meeting and other activities.

### **4. Past and current CSCC activities**

During the past year, CSCC has committed a substantial amount of time and effort in making the Center a valuable asset to the research, education and outreach communities at University of Connecticut, state and local government agencies, and the general public in the State of Connecticut.

#### **4.1 Research**

- CSCC has supported 6 researchers (6 from UCONN, 1 from Yale, 1 from WCSU) by providing NCDC quality-insured data, in the fields of climate change, air pollution, environmental engineering, and agriculture.
- CSCC has actively participated in the USDA Northeast Climate Hub initiatives
- CSCC has discussed with University Corporation for Atmospheric Research (UCAR) for possible collaborations in research.

- CSCC has submitted a proposal to the Connecticut DEEP for analyzing the Connecticut climate data for the past 100 years and rewriting the climate reference book for the State.

#### 4.2 Education

- CSCC has provided up-to-date climatic data and live images for several courses taught at the University of Connecticut, including NRE 3115 Air Pollution, NRE 3145 Meteorology, NRE 3146 Climatology, and NRE 4170 Climate-Human-Ecosystem Interaction.
- CSCC is working with other faculty members to develop more structured educational and training programs at the University of Connecticut.

#### 4.3 Outreach

- CSCC has updated its website data pages for public to access climatic data for the State of Connecticut. The web site now provides processed climatic data for more stations across the State. The climatic data have been updated to 2010, with normal computed for the most recent past 30 years (1981-2010). For the majority stations, data includes statistics for the past 100 years, 30 years, and 10 years for various purposes.
- In addition to the website, CSCC also delivers climate information via the joint web page with Connecticut IWR <http://www.ctiwr.uconn.edu>, feature articles in various local media, traditional ways through our cooperative extension system, posters and demonstrations at university and college organized events (such as Cornucopia), and peer-reviewed publications.
- CSCC has delivered dozens of services in the past year to university research community, governmental agencies and general public by providing processed and certified climatic data sets in various formats through email, telephone, fax, and mail.
- CSCC has provided a few of impact analyses to various media (newspapers, magazines, and radio talks), local governments and schools, and state government agencies on climate change, El Niño, drought, and abnormal wintry weather. Recommended by the Dean of CANR and the NRE Department Head, CSCC also has served on the Governor's working group on climate change. A poster has been displayed at the College's Cornucopia event.

## Office of the Delaware State Climatologist

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**Daniel J. Leathers, State Climatologist**

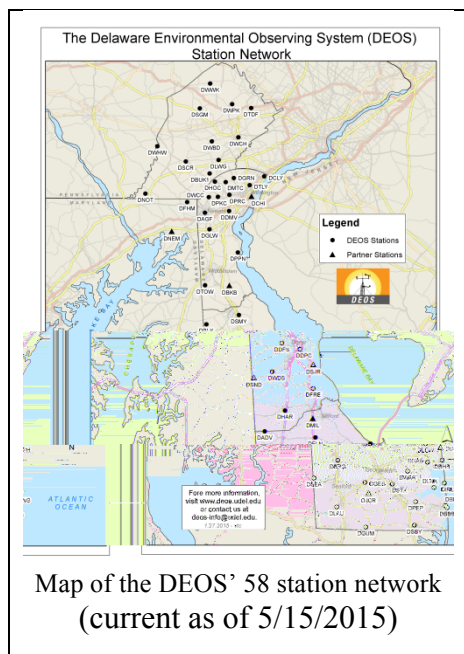
**Kevin R. Brinson, Associate State Climatologist**



The Office of the Delaware State Climatologist (ODSC) is located within the College of Earth, Ocean, and Environment at the University of Delaware. The ODSC works in conjunction with the Delaware Environmental Observing System (DEOS), and the Delaware Environmental Monitoring and Analysis Center (DEMAC) to provide environmental data services to Delaware and the surrounding region.

The ODSC is an AASC Recognized State Climate Office (ARSCO) and partners with the National Center for Environmental Information, the Northeast Regional Climate Center, and the National Weather Service in Mt. Holly, NJ to provide data and climate services to the citizens of the State of Delaware. As with most State Climate Offices, we provide climate data and expertise to the public and private sector via our web page ([climate.udel.edu](http://climate.udel.edu)), as well as conduct newspaper, radio, and television interviews and give many public lectures. The ODSC also serves in the Technical Assistance Center of the Delaware Emergency Management Agency during critical weather events. The State Climatologist is also a statutory member of the Water Supply Coordinating Council (WSCC), and presents water related climate information at quarterly meetings. The following represent current initiatives of the ODSC.

### *The Delaware Environmental Observing System (DEOS)*



The ODSC and DEOS continue to work together to develop real-time weather, climate and environmental data systems to meet the needs of a growing constituency. For over 10 years, DEOS has provided real-time environmental observations for Delaware and the surrounding region. Today, DEOS operates its own environmental monitoring platforms and aggregates and disseminates data from over 175 additional environmental sensing systems throughout our region in real-time. These data are used for a number of purposes including forecast model initialization, emergency management, coastal flood monitoring and irrigation scheduling to name just a few. DEOS monitoring and data services are utilized across many sectors throughout the Mid-Atlantic Region. (<http://www.deos.udel.edu>).

Our core meteorological network has now grown to a total of 58 stations (50 installed and maintained by DEOS) located in the three counties of Delaware, Chester County in



Pennsylvania (in cooperation with Chester County Emergency Management), and Cecil County in Maryland. Data from the core network and additional environmental observing platforms is collected, visualized, disseminated in real-time and archived by DEOS. The data collected by the core meteorological stations include air temperature, relative humidity, wind speed and direction, total solar radiation, atmospheric pressure, precipitation, and in many cases soil temperature and soil moisture. More than 36 of the core stations also measure snow depth (described more below). The additional 184 observing platforms observe various environmental parameters including meteorological conditions, stream flow, tidal water level, water quality, groundwater well level, and ocean and bay characteristics (from buoy data).

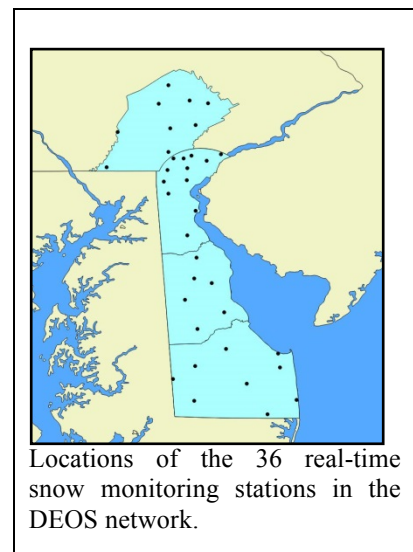
### ***The Delaware Coastal Flood Monitoring Project***

Surrounded by the Delaware Bay, the Delaware River, and the Chesapeake Bay, the Delmarva Peninsula is very vulnerable to coastal storms. Much of the damage during tropical and extra-tropical weather events is associated with severe coastal flooding. The Delaware coastline is extremely susceptible to such events, examples being the great March, 1962 storm and post-tropical cyclone Sandy. The Delaware Coastal Flood Monitoring System (CFMS) extends along the Delaware coastline from Lewes, DE to New Castle, DE and was used during several nor'easters in 2013 and 2014 ([www.coastal-flood.udel.edu](http://www.coastal-flood.udel.edu)). The system sends a warning of forecast tidal levels to users via the DEOS Alerts System, directs them to the CFMS web site where all information on the coming event is available. The CFMS website provides the user with a map showing the potential coastal inundation for the upcoming storm for 15 communities along the Delaware Bay shoreline, as well as road elevation profiles of key evacuation routes relative to the predicted inundation level. In 2015, a project funded by the Delaware Department of Natural Resources and Environmental Control Coastal Programs and NOAA allowed a mobile version of the CFMS to be developed and deployed. The mobile CFMS website now makes it easier for first responders to demonstrate the potential danger of coastal flooding to the public during weather emergencies and makes it easier for coastal resource managers and emergency managers too coordinate efforts from the field during coastal storm events.

### ***The DEOS Snow Monitoring Network***

DEOS supports the Delaware Department of Transportation (DelDOT) Snow Removal Reimbursement Program with at least one snow depth measurement in each of the 12 transportation maintenance areas statewide. The three northernmost areas include three snow depth monitoring systems and the southern districts have varying numbers resulting in 26 operational snow monitoring stations across the State. Ten additional snow sensors are operated in Chester County, PA as well as a few research sites, but are not monitored for use in real-time applications. In total 36 snow depth monitoring stations exist within the DEOS network (see figure). Sonic ranging depth sensors are installed at each location from October to April and brought in each summer for maintenance. Storm total snowfall is available in real-time and archived on the DEOS snow monitoring website.

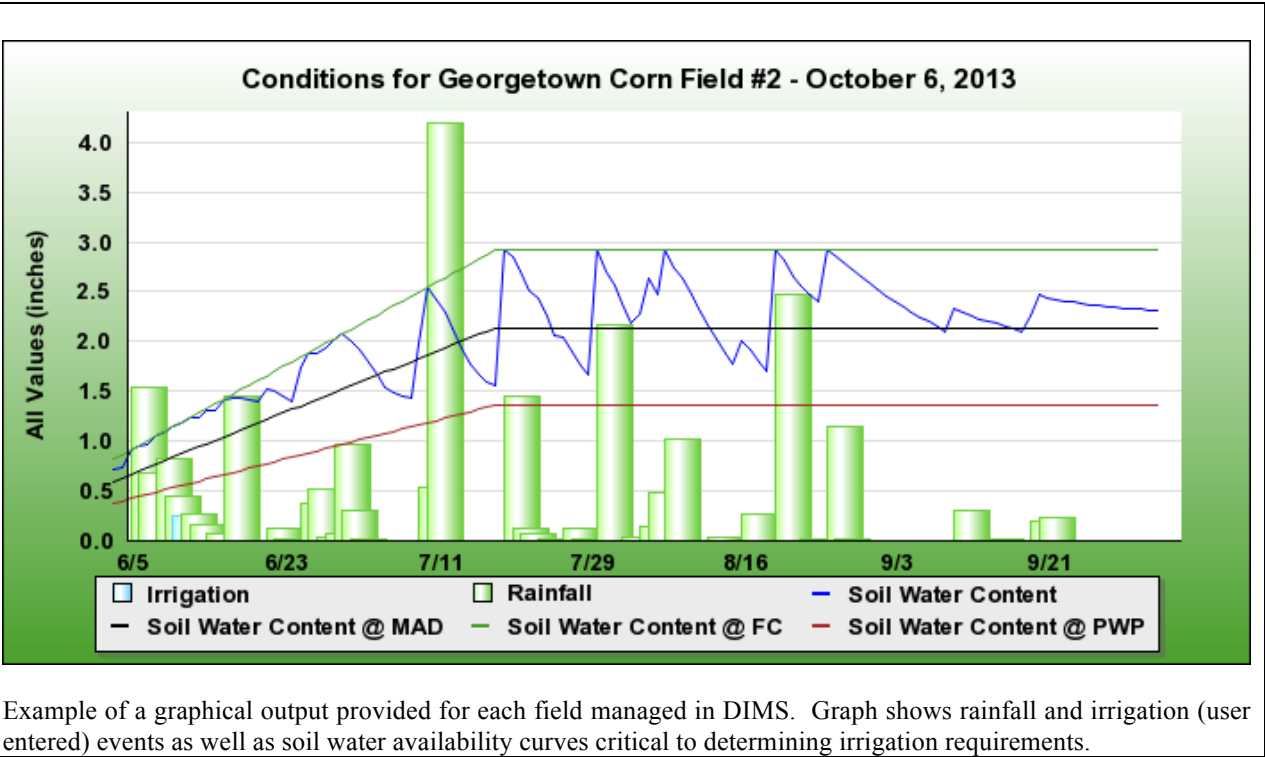
The 2014-2015 snow season resulted in over \$1 million being reimbursed to civic associations throughout Delaware. This money helps defray snow removal costs of neighborhoods and



developments and expedites the snow removal process, particularly during major snowstorms. In addition, the snow monitoring network’s data are used operationally by DelDOT to deploy snow plows and other snow removal equipment within each maintenance area during an event. Thus the DEOS snow monitoring network is an extremely valuable resource for the state.

***The Delaware Irrigation Management System (DIMS)***

DIMS serves as an irrigation scheduling tool for the agricultural community of Delaware. It uses daily meteorological data from the DEOS network to obtain reference evapotranspiration and rainfall that are used to calculate crop water requirements for user-defined farm fields. DIMS provides a user interface where growers can enter their field specific information (i.e., crop type, field location, planting date, etc.) and using that information, DIMS automatically determines the NRCS soil texture classification and nearest DEOS meteorological station for each field. Crop water requirements are updated daily and allow users to enter their own irrigation and rainfall data to make the system provide more accurate results. DIMS was launched in spring 2012 for use with corn, soybean, and several vegetable crops and is currently used for over 100 irrigation systems statewide.



Example of a graphical output provided for each field managed in DIMS. Graph shows rainfall and irrigation (user entered) events as well as soil water availability curves critical to determining irrigation requirements.

***The Delaware Community Collaborative Rain, Hail, and Snow (CoCoRaHS) Network***

Delaware joined CoCoRaHS on September 1, 2009. Kevin Brinson, Associate State Climatologist, serves as the CoCoRaHS coordinator for the state. Presently, the state is homogeneously covered by about 37 active observers, 20 of which have joined CoCoRaHS since October of 2014. Many of these new observers are participating in a program to verify satellite precipitation measurements measured by NASA. For more information, go here.

***Outreach Highlight: Delaware Coast Day 2014 (Lewes, DE)***

ODSC, DEOS, and DEMAC helped coordinate and participated in the primary theme of the 2014 Delaware Coast Day (Weather and Climate: On Our Radar) held in Lewes, DE on October



State climate office staff explains how visitors to Coast Day can volunteer to join CoCoRaHS.

5, 2014. Displays and booths included information about global climate variability, local climate extremes, a fully functional DEOS weather station with live weather information, and maps of climate change projections for Delaware. Other participants demonstrated how weather and climate professionals respond during weather emergencies, the effects of sea level rise and coastal storms on Delaware’s coastal communities, as well as how climate change impacts the Arctic and tropical reefs.

***Additional State Sponsored Research Projects***

The ODSC is currently involved in State funded research projects to develop a new Coastal Storm Severity Index for the Mid-Atlantic region, to compile a high water mark database and reporting system for coastal flooding events in Delaware, to develop a strategic hydrologic and meteorological monitoring plan for transportation systems in Delaware, and to develop a web portal to disseminate climate change projections and climate data for Delaware.

## **Florida Climate Center**

Center for Ocean-Atmospheric Prediction  
Studies

Florida State University  
Tallahassee, FL 32306-2840  
Phone: (850) 644-3417



**FloridaClimateCenter**  
Office of the State Climatologist

### **David Zierden, State Climatologist**

James J. O'Brien, Emeritus State Climatologist  
Melissa Griffin, Assistant State Climatologist

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### **About the Florida Climate Center**

The Florida Climate Center is housed at the Center for Ocean-Atmospheric Prediction Studies (COAPS) in the Research Complex at Tallahassee's Innovation Park. Though physically located off-campus, COAPS and the Florida Climate Center are part of the Department of Earth, Oceans, and Atmospheric Sciences at the Florida State University (FSU). The Florida Climate Center is a public service center sponsored by the Institute of Science and Public Affairs. The office space, facilities, and equipment are provided by COAPS, but the Climate Center receives ongoing state financial support that covers the salaries of 1.5 full-time employees in addition to many other grants. The Florida Climate Center staff currently consists of David F. Zierden, State Climatologist and Melissa Griffin, Assistant State Climatologist. Dr. Mort Winsberg, author of *Florida's Weather* and professor emeritus of geography at FSU, collaborates with the Florida Climate Center staff on relevant projects; and Dr. James J. O'Brien, former State Climatologist and Professor Emeritus, remains actively involved and provide welcome leadership to the Florida Climate Center.

The Florida Climate Center is an American Association of State Climatologists (AASC) Recognized State Climate Office (ARSCO) and works in partnership with the National Climatic Data Center (NCDC), Southeast Regional Climate Center, and National Weather Service to provide data and climate services to the citizens of the State of Florida. We have a standing memorandum of understanding with NCDC and letters of support from the National Weather Service Forecast Offices.

### **Climate Services**

The State Climatologists duties and the purpose of the Florida Climate Center are to provide "climate services" for the State of Florida. Climate services can be broken down into four broad categories, all of which are critical in meeting these needs.

Taking an active role in listening and understanding customer needs, then responding quickly and effectively in providing or directing them to the information that fills those needs. Some aspects of the service provided routinely are:

- Answering routine questions and data requests
- Certifying climate data for use in legal matters
- Providing expert testimony

- Participate in working groups where climate matters are involved including:
  - Coordinator, U.S. Drought Monitor, Florida Monitoring Group
  - NIDIS Southeast Pilot
  - Public Water Supply Utilities, Climate Impact Working Group
  - Tri-State Row Crop Working Group
  - University of Florida Extension Climate Variability and Change Focus group
  - National Climate Assessment
  - Florida Climate Institute – Climate Information and Agriculture/Forestry working groups
  - FDOH Building Resilience Against Climate Effect TAC

### **Research and Applications**

The Florida Climate Center is a key partner with the Southeast Climate Consortium, one of the Regional Integrated Science and Assessment (RISA) teams funded by NOAA’s Climate Program Office. The Southeast Climate Consortium now receives additional funding through USDA National Institute of Food and Agriculture. Through this involvement, we conduct research into downscaled and localized climate forecasts and their application to the sectors of agriculture, forestry, and water resources. The Climate Center also directs research aimed at a better understanding of regional interannual climate variability in the Southeast U.S. This research is of an applied nature with the ultimate goal of providing climate forecast information and products to the different user groups.

### **Community Outreach and Education**

In October 2007 Florida became the 23rd state to join the Community Collaborative Rain Hail and Snow (CoCoRaHS) program and now boasts over 500 active observers across the State of Florida. The CoCoRaHS program started in Colorado in 1998 and has expanded to 27 states where more than 7,500 observers take daily measurements of rain, hail and snow. Melissa Griffin, Florida’s Assistant State Climatologist, is the State Coordinator for CoCoRaHS in Florida and provided the momentum to initiate the program in this state. As a non-profit organization, CoCoRaHS stresses training and education and welcomes volunteers from all walks of life to take part in monitoring precipitation.

In addition to the CoCoRaHS activities, members of the climate office staff have taken part in numerous outreach events across portions of the state, including weather and climate classrooms at elementary and middle schools, university open houses, and summer camps. Through our involvement in the USDA NIFA Climate Extension Project, Melissa Griffin works closely with Four-H and has developed a climate and weather education program called “Weather and Climate Toolkit”. Education modules in this toolkit are taught by Melissa and others to students and Four-H leaders at summer camps across the Southeast.

David Zierden has participated in dozens of Extension-sponsored workshops, commodity meetings, in-service training in the last year and will continue to provide training and climate forecast information. The Florida Climate Center staff is also active in the community and is a frequent participant with displays and activities at such events as NWS Weatherfest, Mag Lab open house, Earth Day at FSU and FSU Marine Lab open house.

## **Communication**

The Florida Climate Center issues monthly climate summaries and newsletters that highlight new climate products, people in or connected to the Florida Climate Center, recent and scheduled outreach activities, and example of climate services.

The Florida Climate Center serves as a platform for the communication of climate information and science to the State of Florida. In addition to traditional media, websites, and email lists, the Florida Climate Center is also active on social media to expand our reach and audience. The following avenues are used to reach a broader audience:

- Traditional Media – dozens of interviews with State and National newspapers and radio, availability to answer questions
- Web page – maintain an extensive and current website loaded with data and product resources: [climatecenter.fsu.edu](http://climatecenter.fsu.edu)
- Monthly Climate Summary – sent out to a wide subscriber list and posted to our website. Also sent to SERCC for inclusion in regional and national summaries
- Newsletter – release a monthly newsletter highlighting recent activities and climate issues
- Social Media – active presence on Facebook (272 followers), Twitter (390) followers
- Blogs – frequent contributor to climate blogs (our own website along with Georgia's climate and agriculture blog and the Tri-State SIFTAG.org)

## **State and Regional Climate Issues**

The Florida Climate Center had teamed up with the University of Florida and other State Universities and plays an important and active role in the formation and development of the Florida Climate Institute (<http://www.floridacclimateinstitute.org>). Through this partnership, top biological, social and agricultural scientists work with climatologists in order to bring together the best science expertise in the state to address the complex issues associated with climate change and societal response. In addition to providing expert knowledge and understand of the climate of Florida, the center has been tasked with providing high-quality datasets for a variety of climate scenarios for the institute.

The Florida Climate Center is actively involved in the National Integrated Drought Information System (NIDIS) pilot project in the Southeast U.S. The NIDIS pilot project is concentrating on drought issues in the ACF basin and has hosted a series of stakeholder workshops since 2009. The pilot presents a bi-weekly webinar on current drought status and the drought outlook for the basin, where David Zierden is the climate lead.

The State Climatologist has organized a group of National Weather Service personnel, Water Management District, and other interested parties in providing input to the weekly *U.S. Drought Monitor*. Each week there is a free exchange of emails and phone calls assessing the severity and impacts of drought across the state, then providing input to the *U.S. Drought Monitor* in a unified voice.

## Publications

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Williams, M. A., M. A. Bourassa, D. F. Zierden, M. Griffin (2013), Characterizing multidecadal temperature variability in the southeastern United States, *J. Climate*, (submitted).

Stefanova, L., P. Sura and M. Griffin (2013), Quantifying the non-Gaussianity of observed wintertime daily minimum and maximum temperatures in the Southeast United States, *J. Climate*, 26(3), 838-850, doi:10.1175/JCLI-D-12-00161.1.

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Ingram, K.T., J. W. Jones, J. J. O'Brien, M. C. Roncoli, C. Fraisse, N. E. Breuer, W L. Bartels, D. F. Zierden, and D. Letson (2013), Vulnerability and Adaptability of Agricultural Systems in the Southeast United States to Climate Variability and Climate Change, *Climate Change in the Midwest*, S. C. Pryor, 48-58, Indiana University Press

Roncoli, C; Breuer, N; Zierden, D; Fraisse, C; Broad, K; Hoogenboom, G (2012), The art of the science: climate forecasts for wildfire management in the southeastern United States, *Climatic Change*, 113(3-4), 1113-1121, doi:10.1007/s10584-012-0526-1.

## **Georgia Office of the State Climatologist**

Georgia Environmental Protection Division  
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Atlanta, Georgia 30354  
<http://epd.georgia.gov/office-state-climatologist>

### ***Bill Murphey, State Climatologist***

Nyasha Dunkley, Deputy State Climatologist  
Lauren Lindsey, Service Climatologist



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### ***Role***

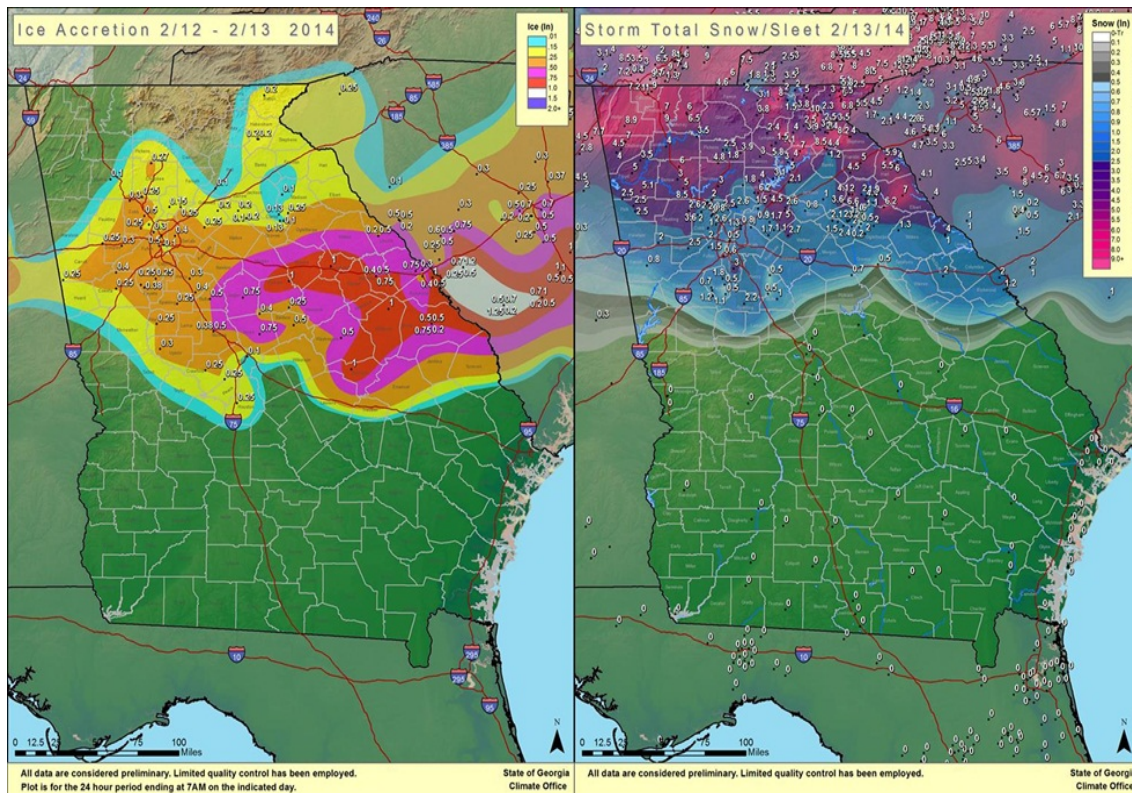
The State of Georgia Climate Office (SCO) within the Environmental Protection Division functions to collect, disseminate, and interpret climatological and meteorological data. It daily serves the State in responding to public and private entities on issues related to Georgia's climate, as well as offering correspondence with educational institutions as it relates to atmospheric science. An important role of the SCO is to stay apprised of current atmospheric conditions as it relates to (but not limited to) droughts, the ENSO (El Nino-Southern Oscillation) forecast, and the short, middle, and long-term seasonal outlooks. In addition, it internally produces composite maps containing climatological information, such as precipitation and temperature.

### ***Information Services***

The GA EPD climate website contains monthly summaries, meteorological and climatological data resources, and other useful links for public dissemination of information. Specific requests for climatological information and data are received frequently from media, private and public sources and addressed on an ongoing basis. The SCO monitors climate conditions within the state and provides input on drought and their impacts to the U.S. Drought Monitor. Climate details for 2014 were available through the monthly summaries, highlights of which will be provided here. The year began with a significant winter storm affecting much of the state on January 28<sup>th</sup> and 29<sup>th</sup>, with accumulating snow and freezing rain. Snowfalls totals exceeded 2" in northern and central parts of the state. Ice accretions exceeding one half inch were reported northwest of Savannah, with numerous trees and power lines down. The combination of very cold temperatures, accumulating snowfall, and workday-hours onset resulted in abysmal travel conditions in and around Atlanta, where some commuters were stuck in their vehicles on icy roadways for over 24 hours. Overall, January experienced near record cold temperatures with Macon, Columbus, and Athens experiencing their 3<sup>rd</sup>, 4<sup>th</sup>, and 5<sup>th</sup> coolest January average temperatures on record (respectively).

Another significant winter event occurred at the beginning of February. A powerful storm brought heavy snow and record levels of ice to north and central Georgia on February 11-13, 2014. Two waves of precipitation occurred with this system, with the second round moving in on Wednesday and proving to be the more significant of the two. Areas along and just south of the Interstate 20 corridor of East Central Georgia received historic ice totals from the system.





The summer months were primarily slightly cooler and drier than normal for much of the state. Macon experienced the 2<sup>nd</sup> driest August on record, while Columbus reached their 6<sup>th</sup> driest August on record. The warm September and October months were followed by an unusually cold November. Macon set a record for the coldest November on record, while Athens and Columbus both experienced their 4<sup>th</sup> coolest.

### ***Outreach***

The SCO upholds an outreach focus. It maintains very open communication with news media outlets across the entire state. Data and analyses are disseminated via the internet, email, telephone, regular mail and in person through interviews and presentations. Staff participates, to the extent possible within staffing and budget limits, in as many outreach efforts as possible. These outreach efforts range from elementary school presentations, children 4-H programs, guest lectures at various Georgia universities and participation on climate-related discussion panels. As an example, the climate office staff participated at the American Meteorological Society's 13th Annual WeatherFest held in Atlanta in February 2014. The SCO booth had a three-pronged focus of displaying climate instrumentation, air quality forecasting, and providing climate education.



The SCO also seeks to take advantage of social media and thus has established, and maintains, an active Facebook page.

## **HAWAII AASC REPORT for 2014-2015**

**Dr. Pao-Shin Chu, Chris Holloway,  
Kristine Tofte and Xiaoyu Bai  
Hawaii State Climate Office  
Department of Atmospheric Science  
School of Ocean and Earth Science and Technology  
University of Hawaii  
Honolulu, HI 96822**

April 30, 2015

The Hawaii State Climate Office (HSCO) has been dedicated to completing several projects and handling climate data requests throughout 2014.

One primary goal we strive to fulfill at the HSCO is to support others who have needs of climate and weather data requests. The requests came from a wide scope of fields: state government agencies, military, local and mainland professionals and students. This year the most frequent data we provided include temperature, precipitation, and wind. Furthermore, as in the past 10 years, we continued to assist the State Department of Business, Economic Development and Tourism (DBEDT) in updating their annual “Data Book,” containing the climatological data for the State of Hawaii. In 2014, we found that the return-level threshold values for heavy rainfall change with time considerably based on a non-stationary generalized extreme value (GEV) model (Chen and Chu, 2014). For instance, a rare rain storm with daily rainfall of 300 mm (20-yr return period) in 1960 has become a rather common storm (3-5 yr return period) in 2009 on the Island of Hawaii (Big Island). In the engineering design (e.g., urban drainage, dam) and environmental regulation, return-period rainfall amounts are assumed to be constant at a given threshold value (e.g., 100-yr return period). However, because climate is changing, this assumption of stationary precipitation climatology should be revisited and need to modify existing facilities as heavy rainfall and flooding have become more common in a changing climate.

This year the HSCO has experienced a change in personnel. Andre Marquez and Chris O'Connor have both left the climate office to continue pursuing careers in Physical Sciences. Andre Marquez has received his Ph.D. from INPE (National Space Research Institute) in Brazil in 2014, and is now home helping INPE with the upcoming CMIP6 project. Chris O'Connor had completed his M.S. degree in August of 2014, and is now teaching oceanography at Schofield Barracks on Oahu. Xiaoyu Bai came aboard in August 2014 and is currently working towards a M.S. in Atmospheric Sciences, focusing on Bayesian change-point inference and dynamical downscaling. Chris Holloway, who leads the dynamical downscaling project, is currently working towards an M.S. in Atmospheric Sciences. Kristine Tofte from Norway, who also works towards a M.S. in Atmospheric Sciences, is presently completing her research on Kona winds and VOG in Hawaii. Vog is smog or haze containing volcanic dust and gases.

One of our main focuses this year was completing the dynamical downscaling of future projected rainfall for the Kauai Department of Water Supply. This research, supervised by Dr. Chu, concluded that in future total accumulated precipitation for the wet season, which runs from

November to March, is following a pattern in which already dry areas are becoming drier and the wet regions are becoming wetter. These results still contain a significant amount of uncertainty, inherent to all future projections by GCMs, but are consistent with the IPCC Fifth Assessment Report. The Climate Office is still continuing its efforts in reducing the uncertainties in these future projections, through the use of state of the art statistical models based on Artificial Neural Networks and machine learning. The dynamical downscaling project funded by Oahu's Board Water Supply will take advantage of these new statistical tools to reduce some of these inherent uncertainties for future rainfall projections.

Another project we have been focusing a lot of our efforts on is understanding long-term trends of VOG from the Big Island reaching and affecting, the most densely populated island of Oahu. Kristine Tofte is the lead researcher on the project under Dr. Chu, and has spent the past year mastering the necessary tools to complete their work. These skills include using WRF, which is an advanced high resolution numerical weather prediction model, to perform dynamical downscaling that acts to control an independent aerosol dispersion model. Through this experimental method we can now simulate high resolution VOG concentrations and trajectories that can afflict the individual islands. Future work includes using a regression analysis to extend our understanding of the atmospheric conditions that bring VOG to the islands.

The 2014 Central Pacific Hurricane season extending from June 1<sup>st</sup> to November 30<sup>th</sup>, was a particularly active year in terms of tropical cyclone strength and numbers. The Central Pacific Hurricane Center of the NWS observed four hurricanes and one tropical storm, with three storms coming within 1000km of the Hawaiian Islands. Before making landfall, Hurricane Iselle reached category 4 strength with maximum sustained wind speeds of at least 130 mph, and the storm was also classified as a rarely observed annular tropical cyclone. Hurricane Iselle impacted the windward side on Big Island as strong Tropical Storm; it is the most intense tropical cyclone to make landfall on the Big Island. The impacts from the storm were felt hardest by the agricultural economy. Damage was heaviest to the papaya crop, with the cost of the lost harvest and regrowing estimated at \$53 million (2014 USD) (Burnette, Tribune 2014).

According to the Hawaii Drought Monitor provided by the Hawaii's Commission on Water Resource Management, the last area of severe drought (D2) was finally eased to moderate drought (D1) which means severe drought was finally eliminated in the State of Hawaii. This severe drought has been present continuously in various locations in the State of Hawaii since June 2008. Fortunately, there are no other drought areas in the state.

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## **Idaho State Climate Services**

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Ayodeji Arogundade (Post-Doc) and Yohannes G/Eyesus Getahun (Graduate Student)

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Climatic information is essential to every citizen of Idaho. To help people obtain the climatic and water data and information necessary to planning and every day work, the State Climatologist Program strives to acquire, archive, process and disseminate, in the most cost effect manner possible, climate and weather information which is or could be of value to policy and decision makers in the state and to provide climatic services which are important to the people of Idaho. The functions of the State Climatologist and State Climate Services are to:

- Collaborate with state and federal agencies responsible for monitoring and forecasting water availability for Idaho
- Assist Idaho weather information users to obtain historical Idaho weather data from the National Climatic Data Center
- Maintain a data bank of climatological and hydrological research data and information
- Assist data users by formatting climate data into usable forms.
- Perform requested climate analyses or refer requests to other appropriate persons, agencies or consulting firms
- Maintain contact with users of climatic and hydrological data in order to ascertain their needs for data and analyses
- Maintain a bibliography of publication pertinent to Idaho and Pacific Northwest climate

In May, 1978, an agreement was concluded among the National Climatic Data Center, the National Weather Service and the University of Idaho to provide climate services which had been provided by a former National Weather Service program. ISCS became the AASC Recognized State Climate Office (ARSCO) for the State of Idaho in 2001.

Idaho State Climate Services is housed in the Department of Biological and Agricultural Engineering and is directed by the Idaho State Climatologist. It is supported by the Idaho Agricultural Experiment Station and the Idaho Cooperative Extension System in cooperation with the Idaho Water Resources Research Institute.

**ARSCO Qualifications:** ISCS is designated by the AASC as the official state climate office for Idaho. The following describes the ways in which ISCS addresses each of the ARSCO qualifications:

***Communication Capabilities:***

- ISCS maintains a website and internet, email, telephone, and fax communication links.

***Information Services:***

- Idaho joined CoCoRaHS in January 2009; the Idaho SC serves as the statewide coordinator of the precipitation network, which now has 202 observers.
- Responded to numerous e-mail/phone requests for climate data/information/services.
- Interviewed by local, state and national newspapers, radio stations, and other media outlets.
- Maintain three automated weather stations, a Cooperative Observer Station with over 110 years of data, a CoCoRaHS non-recording precipitation gage, and a recording precipitation gage, and partially fund a Sno-Tel site.
- ISCS provides numerous reports including Intensity-Duration-Frequency spreadsheets for many cities in Idaho.

***Research:***

- Develop hybrid remote sensing-ground sensor method to quantify watershed snow-covered area.
- Use remote sensing to simulate snowmelt runoff from the Upper Snake River.
- Examine the effect of climate change scenarios on snowpack and runoff volumes and timing for the eastern Snake River Plain, the principal water supply for southern Idaho.
- Evaluate the impact of current water rights on distribution of irrigation water under changing supplies associated with various climate change scenarios.
- Evaluate the impact of climate change scenarios to evapotranspiration on irrigation water demand and the resulting economic impact on agricultural revenues.
- Analyzing historical temperature trends at climate stations across Idaho
- Developing algorithms and models to assimilate remotely sensed data for use in spatially distributed land surface-atmosphere exchange models
- Maintain a 130 foot tall eddy covariance forest research tower to study water and carbon exchange in complex mountainous, forested topography.
- Conducting studies for the Idaho Transportation Department on the interaction of inclement weather and road slope and curvature on the frequency of accident occurrences.



**Outreach:** Participation and collaboration of the following outreach activities:

- Interact with federal and state stakeholders regarding annual climate, and water resources conditions.
- Presentations to Idaho State Legislative committees on climate and climate change issues in the state.
- Climate products made available through ISCS website, and the printed volume, *Climates of Idaho* (Abramovich, R., M. Molnau, and K. Craine, University of Idaho, College of Agricultural and Life Sciences).
- Climate Presentations to local schools.
- Interviewed by print, radio and television media contacts.
- Serve as a climate expert on Idaho Public Television talk shows.

**Monitoring and Impact Assessment:**

- ISCS helps monitor current and historical precipitation through the CoCoRaHS network (<http://www.cocorahs.org/>) and QA/QC analyses of the Idaho network.
- ISCS is conducting studies of the impact of climate scenarios on state climate, water supply, agricultural water demand, and agricultural revenue for the Snake River Plain of southern Idaho. These are related to historical observations from the Cooperative Observer Network, SnoTel (<http://www.wcc.nrcs.usda.gov/snow/>), and an agricultural meteorology network (AgriMet, <http://www.usbr.gov/pn/agrimet/>)

**Research Publications:**

- Qualls, R.J., R.G. Taylor, J. Hamilton, and A.B. Arogundade, Climate change opportunities for Idaho's Irrigation supply and deliveries, Chapter 3 in *Climate Variability and Water Dependent Sectors: Impacts and Potential Adaptations*, D.E. Peck and J.M. Peterson (eds.), Routledge, Taylor and Francis Group, Abingdon Oxon, UK, 132 pp, 2014.
- Crago, R. D. and R.J. Qualls, Use of land surface temperature to estimate surface energy fluxes: Contributions of Wilfried Brutsaert and collaborators, *Water Resources Research*, 50 (4), 3396-3408, doi:10.1002/2013WR015223, 2014.
- Crago, R.D. and R.J. Qualls, The value of intuitive concepts in evaporation research, *Water Resources Research*, 49(9):6100-6104, doi:10.1002/wrcr.20420, 2013.
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- Hydrologic Remote Sensing: Perspectives and Applications*, ed. Ni-Bin Chang, CRC Press Taylor & Francis Group, New York, 568 pp., 2012; (<http://www.crcpress.com/product/isbn/9781439877456>)
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- Zhao, W. , and R. J. Qualls, Modeling of long-wave and net radiation energy distribution within a homogeneous plant canopy via multiple scattering processes, *Water Resources Research*, 42:1-13, W08436, doi:10.1029/ 2005WR004581, 2006.
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- Qualls, R.J., J. M. Scott, and W. B. DeOreo, Soil moisture sensors for urban landscape irrigation: effectiveness and reliability, *J. Am. Water Resources Assoc.*, 37(3):547-559, 2001.

## **Illinois State Climatologist Office**

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Dr. Jim Angel, State Climatologist for Illinois

The State Climatologist Office (SCO) for Illinois is located at the Illinois State Water Survey (ISWS) in Champaign, Illinois, at the Prairie Research Institute, University of Illinois. The office also operates the NWS coop site for Champaign-Urbana. The office is co-located with the Midwestern Regional Climate Center. Jim Angel has been the State Climatologist (SC) since 1997.

### **Climate Services**

The SC maintains a web site, a blog, and Twitter account devoted to climate data and information on a wide variety of climate topics. The web site covers standard products such as climate maps and datasets. Meanwhile, the blog and Twitter accounts provide a means for reporting climate conditions as they develop. In 2014, the blog had 92 posts and 117k views. The Twitter account had 266 followers and 280 tweets in 2014.

The SC is actively engaged in providing information services within Illinois. In the past year, the media contacted the office over 120 times. Each month the SC prepares a press release on conditions around the state. The SC does a weekly radio recording of current agriculture weather conditions that gets distributed around the state. The SC gave 30 public talks in the last year. In addition, the SC was the presenter on three NWS Central Region Climate Outlook webinars (March and September 2014, and January 2015).

The SC writes regular contributions to the monthly ISWS Water and Climate Summary. The SC provides both data and information for the following agencies in Illinois: the Water Supply Task Force, the Drought Response Task Force, the Department of Natural Resources, the Department of Transportation, the Attorney General's office, and the Illinois Emergency Management Agency.

The SC has worked closely with University of Illinois Extension on a number of issues that included: a) training of CoCoRaHS weather observers, b) teaching a section on climate to Master Naturalists in Champaign and Madison Counties, c) speaking at University of Illinois Extension Seminars around the state, and d) occasional guest on the Illinois Gardener program on WILL-TV.

The Illinois SC has worked closely with the National Weather Service on a variety of issues that included: a) supporting the cooperative weather observer network through contributions to newsletters, letters of appreciation, attending award ceremonies, etc., b) training of CoCoRaHS weather observers, and c) coordinating climate services needs in Illinois amongst the five NWS offices that serve Illinois.

The SCO works closely with the American Association of State Climatologist (AASC) on a variety of climate issues in conjunction with other state climatologists, Regional Climate Centers, the National Center for Environmental Information, and the National Weather Service.

The SC, Jim Angel, is a member of the American Association of State Climatologists and an editor for the Journal of Service Climatology. He is a member of the American Meteorological Society and is the chair of the AMS Applied Climate Committee. He is a member of the American Geophysical Union.

He is on the advisory panel for the Midwest Climate Hub of the U.S. Department of Agriculture and is a member of the NC-1179 committee (supported by the U.S. Ag Experiment Stations) on Food, Feed, Fuel, and Fiber: Security under a Changing Climate. He is the co-chair of the education and outreach committee of the National Integrated Drought Information System (NIDIS).

### **Research**

The Illinois SCO maintains an active research program, with applied research focused on Illinois and the Midwest. Three articles and one report chapter were published in the past year (below).

#### *Professional Presentations and Posters:*

- Angel, J., Todey, D.P., Massey, R., Widhalm, M., Biehl, L.L., Andresen, J., Niyogi, D., Song, C., and B. Raub. 2014. "The U2U Decision Support Tool for Corn Growing Degree Days." 21st Conference on Applied Climatology. Denver, CO.
- Angel, J., Todey, D.P., Massey, R., Widhalm, M., Biehl, L.L., Andresen. 2014. "Dealing with Climate Change and Variability in the Growing Season: A U2U Decision Support Tool for Central United States Corn Producers Based on Corn Growing Degree Days." Poster Session. 2014 American Geophysical Union Fall Meeting. San Francisco, CA.

#### *Publications:*

- Prokopy, L.S., J.S. Carlton, J.G. Arbuckle, T. Haigh, M.C. Lemos, A.S. Mase, N. Babin, M. Dunn, J. Andresen, J. Angel, C. Hart, and R. Power. 2015. "Extension's Role in Disseminating Information about Climate Change to Agricultural Stakeholders in the United States." Climatic Change, DOI 10.1007/s10584-015-1339-9.
- Haigh, T., E. Takle, J. Andresen, M. Widhalm, J.S. Carlton, and J. Angel, 2015. "Mapping the Decision Points and Climate Information use of Agricultural Producers across the U.S. Corn Belt." Climate Risk Management, 7, 20-30.  
<http://dx.doi.org/10.1016/j.crm.2015.01.004>
- Haigh, T., L. Morton, M. Lemos, C. Knutson, L. Prokopy, Y. Lo, and J. Angel, 2015. Agricultural Advisors as Climate Information Intermediaries: Exploring Differences in Capacity to Communicate Climate. Weather, Climate, and Society, 7, 83-93.  
<http://dx.doi.org/10.1175/WCAS-D-14-00015.1>
- Fuchs, B. (editor), 2015. How the 2012 central U.S. drought evolved from the floods of 2011: A state by state assessment. Chapter on Illinois written by Jim Angel. National Drought Mitigation Center.  
<http://drought.unl.edu/Portals/0/docs/CentralUSDroughtAssessment2012.pdf>

## Indiana State Climate Office

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### ***Dr. Dev Niyogi, State Climatologist***

Ken Scheeringa, Associate State Climatologist

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*IClimate* is an American Association of State Climatologists (AASC) Recognized State Climate Office (ARSCO). In addition to permanent staff the office provides work opportunities to graduate and undergraduate students in research projects and customer service interactions.

### **Research**

Research at *IClimate* continues to focus on developing agroclimatic products, crop modeling, analysis of extremes, and decision tools. The office has active involvement in research related to a regional USDA/ NIFA signature project on developing climate resiliency for corn producers in the Midwest. This project, titled “Making Climate Information Useful to Usable (U2U)”, is working to transform climate variability and change information into tools for cereal crop producers. *IClimate* research findings were presented at several major conferences across the United States and internationally.

Additionally *IClimate* continues to be involved in several research projects primarily supported through NSF, NIFA, and NASA, and other federal agencies. An assessment of the role of land use and land cover including urbanization on the regional hydro-climatology continues.

The development of a regional drought information portal and an environmental cyber-infrastructure prototype for heterogeneous data access and processing is ongoing. *IClimate* continues to work on drought characterization, explore cyber-infrastructure for data collection, and share visualization methods leading to improved practical applications.

Other *IClimate* projects involve developing multidecadal soil moisture / temperature climatology for the US Corn belt. These data are being processed and made available to the broader community.

Projects are underway related to the design framework of land use planning as a tool for climate change adaptation in greener cities with particular focus on Indianapolis, Indiana. A series of projects are also underway related to climate literacy and education for middle schools and informal educators. Details regarding these projects and resulting publications can be found at <http://landsurface.org>

## **Outreach**

*IClimate* receives requests to speak to conferences, professional organizations, and trade shows. A talk given to the 100<sup>th</sup> Purdue Road School in 2014 energized follow up meetings of the Indiana Climate Services Team. Attendees included state agencies, NWS, MRCC, and *IClimate* staff. Discussions continued about agency data needs, expansion of auto station networks, what products can be provided, and future collaborations.

Ken Scheeringa continues as the *IClimate* state co-manager of CoCoRaHS Indiana. Weekly and monthly Indiana total precipitation GIS maps based on CoCoRaHS observations continue to be posted to our web site: <http://www.iclimate.org/precip/images/precip.asp>.

*IClimate* joined Twitter in May 2014. Monthly Indiana temperature statements and precipitation maps are distributed along with weekly maps during the growing season. Links to climate topics and current extremes are released as they occur.

*IClimate* volunteered to collate and publish the AASC 2013 Annual Newsletter. A special thanks is due Olivia Kellner for her extensive editing and publishing efforts to assemble the organization's annual newsletter. The 2014 newsletter preparation will travel with Olivia in her new position at the MRCC.

## **Monitoring and Impact assessment**

*IClimate* continues to provide a highlights version of the monthly weather summary to MRCC at the end of each month. The full monthly report is posted to our *IClimate* web site: <http://www.iclimate.org/summary.asp> and to the AASC web site: [http://www.stateclimate.org/state.php?state\\_id=IN](http://www.stateclimate.org/state.php?state_id=IN).

Reference evapotranspiration monitoring using ETgages continued during the 2014 growing season at 7 Purdue research farm automated weather stations and at 2 non-automated farm stations. One of the non-automated sites will become an automated station in 2015. The automated measurements are updated hourly into the *IClimate* web database. The NWS offices in Indianapolis (IND) and Northern Indiana (IWX) continued onsite daily manual collection of ETgage data in 2014. Their data are posted to the CoCoRaHS RefET web page. Private ETgage monitoring sites in Indiana expanded greatly in 2014. The CoCoRaHS ET page carried as many as 18 Indiana ET daily measurement sites, more than any other state.

Ken Scheeringa was recognized by the Purdue Agronomy Dept for 25 years' service as observer at the IN41 station of the National Atmospheric Deposition Program (NADP), which monitors precipitation chemistry at over 200 locations nationwide. Ken was also recognized for completion of 40 years of service to the department in 2014.

## **Education**

*IClimate* continues working with a network of teachers and educators in developing and delivering a curriculum and professional development material on climate science with a focus on the Midwest. The website <http://iclimate.org/cc> continues to be used by teachers to access climate change curriculum modules that can be integrated into middle school activities.

### **Representative products/ publications**

Kellner O. , D. Niyogi 2014: Assessing drought vulnerability of agricultural production systems in context of the 2012 drought, *Journal of Animal Science*, *J. Animal. Sci.* 2013-7496.

Shepardson D., A. Roychoudhury, A. Hirsch, D. Niyogi, S.M. Top, 2014: When the atmosphere warms it rains and ice melts: Seventh grade students' conceptions of a climate system, *Environmental Education Research*, 20, 333-353.

Kellner O., and D. Niyogi, 2014: Land-surface Heterogeneity Signature in Tornado Climatology? An Illustrative Analysis over Indiana 1950-2012, *Earth Interactions*, 18, 1-32.

Smith N.G., V. L. Rodgers, E. R. Brzostek, A. Kulmatiski, M. L. Avolio, D. L. Hoover, S. E. Koerner, K. Grant, A. Jentsch, S. Fatichi, D. Niyogi, 2014: Toward a better integration of biological data from precipitation manipulation experiments into Earth system models, *Reviews of Geophysics*, 52, 412 – 434.

Takle E. S., Christopher J. Anderson, Jeffrey Andresen, James Angel, Roger W. Elmore, Benjamin M. Gramig, Patrick Guinan, Steven Hilberg, Doug Kluck, Raymond Massey, Dev Niyogi, Jeanne M. Schneider, Martha D. Shulski, Dennis Todey, and Melissa Widhalm, 2014: Climate Forecasts for Corn Producer Decision Making. *Earth Interactions*, 18, 1–8.

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Harry J. Hillaker, State Climatologist



The State Climatologist Office (Iowa SC) is a bureau of the Iowa Dept. of Agriculture & Land Stewardship. The State Climatologist is appointed by the Iowa Secretary of Agriculture (an elected state official). The Iowa SC office was founded in Iowa City at the University of Iowa on October 1, 1875 and was initially known as the Iowa Weather Service. In 1890 the Iowa Weather Service operations were moved to Des Moines and came under the supervision of the Iowa Weather & Crop Service. The Iowa SC was co-located with the National Weather Service from 1890 until 2003 and has worked very closely with that agency since its inception. Finally, the Iowa SC was made a division of the newly created Iowa Department of Agriculture in 1923.

#### **Information Services:**

The Iowa SC office maintains archives of NWS co-op and first order station data back to the beginning of records. This would include the regular NCDC reports such as *Storm Data*, *Iowa Climatological Data* and *Local Climatological Data*, as well as the original observations. Access to a multitude of federal and state weather and climate data archives are also maintained. With 140 years of continuous operation the Iowa SC Office has an unusually large archive of original federal and state books, reports and manuscripts from the 19<sup>th</sup> and early 20<sup>th</sup> Century.

#### **Research:**

The Iowa SC office primarily is involved with the acquisition, processing, dissemination and archiving of weather and climate data. However, research activities are performed as funding permits and have been conducted in cooperation with agencies such as the National Climatic Data Center (NWS co-op network metadata), the Midwestern Regional Climate Center (pre-1948 data keying project), the National Science Foundation (crop-hail climatology), U. S. Army Corps of Engineers (evaporation, snow, short-duration precipitation studies) and the Iowa Dept. of Natural Resources (development of more timely temperature data resources).

Work has continued in developing a monthly data base of historical Iowa precipitation records with over 20,000 station-years compiled. Preliminary work in developing statewide averages of various weather statistics beyond average monthly temperature, precipitation and snowfall is also in progress. These new averages include the number of days per year reaching or exceeding maximum temperatures of 90°F or 100° and minimum temperatures at or below 0°F, dates of last spring and first fall freeze, as well as extreme annual maximum and minimum temperature and maximum daily precipitation amount. The first version of these historical metrics has been completed with plans for expanding the number of locations used in these statistics continuing in 2015.

**Outreach:**

The office maintains very open communication with the news media with several hundred media contacts each year. This, combined with preparation of Public Information Statements issued in cooperation with the National Weather Service, and weekly and monthly crop-weather summaries prepared for the USDA provides very wide dissemination of climate products and information. Over two thousand specific climate data information inquiries are answered in a typical year. Most inquiries are received from government agencies, the news media, attorneys and insurance, in that order. Virtually every major branch of State government utilizes the Iowa SC Office data on a regular basis.

The office also prepares regular monthly climate reports, the *Preliminary Iowa Monthly Weather Summary* and the *Iowa Climate Review*. The Preliminary Monthly Weather Summary is issued within the first few work days of each month and provides a brief summary of Iowa's weather conditions for the previous month. This report is available on-line and is also sent free of charge via regular mail. The Iowa Climate Review is a monthly report containing daily data for all official Iowa weather stations and is available by subscription. The Climate Review report is not currently on-line; however, the raw data are provided to Iowa State University's Iowa Environmental Mesonet web page and made available at that site. As part of the AASC/NCDC exchange program work began in providing monthly weather summaries to the Midwestern Regional Climate Center (MRCC), via the AASC web page, beginning with the November 2008 summary and continuing to the present. Occasional special storm event summaries have also been prepared for the MRCC as part of these grants.

The Iowa State Climate Office works closely with the National Weather Service in monitoring the co-op and ASOS data networks so as to improve the quantity, quality and timeliness of Iowa climate observations. The State Climatologist has served on several NWS regional and national committees involved with climate and data issues. In January 2012 the Iowa SC became co-chair of the NOAA Data Stewardship Team and in July 2013 became the co-coordinator for the Community, Collaborative Rain, Hail and Snow Network in Iowa. The Iowa SC made 13 climate presentations during 2014 to various agricultural groups, community service organizations and government agency meetings.

**Monitoring and Impact Assessments:**

The Iowa State Climate Office is a member of the Governor's Drought Task Force and Flood Task Force and the State of Iowa Hydrology Working Group. The office provides regular updates of monthly temperature and precipitation data to the USDA Farm Service Agency for their use in evaluating county-by-county eligibility for disaster relief programs. The office also assists the Iowa Homeland Security and Emergency Management Division in their operations and occasionally provides guidance for county and regional emergency response offices. Special weather summaries and analyses are also prepared for the USDA and U.S. Geological Survey and the office is a regular contributor to the U.S. Drought Monitor. The office also contributed to a regional assessment of the 2012 drought and provided weather summaries for sixteen issues of the Iowa DNR's Water Summary Update in 2014.

As always, there were many notable extremes of the weather in Iowa in 2014. The year began with unseasonably cold weather for the first three months, resulting in the coldest first quarter



year since 1979. Drought concerns, which were renewed during a very dry late growing season in 2013, continued well into 2014. The combination of persistent low temperatures and relatively dry soils allowed frost penetration to exceed five feet and resulted in hundreds of water main breaks across the state during the early months of the year. The last of the frozen soils across northern Iowa finally thawed about April 22. A period of widespread heavy rainfall began in mid-June 2014, quickly erasing drought issues and replacing them with record flooding over portions of far northwest Iowa. Drier weather returned in July in some areas, along with unseasonably low temperatures. February, July and November all ranked among the top ten coolest for those months among 142 years of statewide statistics. Not until December did a calendar month average more than one degree above normal during 2014. Meanwhile, very wet weather resumed over much of southwestern and central Iowa from August through mid-October. This greatly slowed harvest activities, however, an extended period of much drier weather in late October into November allowed harvest to be completed prior to the onset of widespread winter weather. 2014 was the wettest year on record at Denison and Greenfield while there were a few locations scattered across east central and northern Iowa with slightly below normal annual precipitation. Soil moisture reserves at the conclusion of the harvest season were the highest for that time of year since the end of the 2010 season and were much greater than normal over much of central and southwest Iowa.

## **Kansas Climate Center**

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Mary Knapp, Assistant State Climatologist

The Kansas Weather Data Library, which serves as the Kansas Climate Center, observed its 38<sup>th</sup> year of operation in 2014. As a part of the Department of Agronomy, the office receives funding to support both undergraduate and graduate students and provide opportunities for them to participate in a variety of research and service activities, including participating statewide, regional, and national meetings.

We currently support three graduate students and a post-doctoral, and a visiting scientist, in addition to full time positions in Kansas Mesonet network management, programming/web development, and weather station maintenance. The Kansas Climate Center has developed strong relationships with the seven National Weather Service Offices that serve Kansas. These include Pleasant Hill, MO, Topeka, KS, Springfield, Mo, Wichita, KS, Hastings, NE, Goodland, KS, and Dodge City, KS. This has included coordination with the CoCoRaHS program, support for Cooperative Observer Network awards, and other activities. The Weather Data Library also conducts a collaborative working relationship with the High Plains Regional Climate Center. This has included participation in regional workshops, submission of monthly climate reports for KS, and transfer of data from our Mesonet for use by the Regional Climate center.

The Kansas Mesonet is a network of automated weather stations. K-State Research & Extension weather stations are at the root of the Kansas Mesonet. These stations were established in 1986 at KSRE research centers and experiment facilities around the state. Most were co-located with National Weather Service Cooperative Observing Stations.

### **Information Services**

The Weather Data Library provides weather and climate information through a variety of means. Communication by way of telephone, fax and email are common, but our primary delivery of information is by way of the web. Last year, we launched a new website to our Mesonet (<http://mesonet.k-state.edu>) which provides a link to near real-time data, as well as historical summaries, and various products for various end users.

### **Research**

Faculty and students associated with the Kansas Climate Center are involved in various applied research projects. Current projects include the evapotranspiration estimation uncertainty under advective conditions in Kansas semi-arid climate region and climate change impacts on agricultural productivity. In addition, our research also includes studies on the impact of climate on native prairies, historical drought patterns, and Kansas drought assessment. Kansas Climate Center presented research talks at annual meetings of American Society of Agronomy and the Ogallala Aquifer Research Workshop, as well as annual AGU meeting. We also presented papers at number of state and regional professional meetings and workshops. In addition, faculty also

made invited presentations nationally and internationally. Our publications include:

- [1] Lin, X., K.G. Hubbard, R. Mahmood and G. Sassenrath. Assessing satellite-based start-of-season trends in the US High Plains. *Environ. Res. Lett.* 2014, doi:10.1088/1748/326/9/10/104016
- [2] Zhang T., X. Lin, and G. Sassenrath. Current irrigation practices in the central United States reduce drought and extreme heat impacts for maize and soybean, but not for wheat. *Science of The Total Environment.* 2014. 508:331-342.
- [3] Xu, L. X. Lin, J. Amen, K. Welding, and D. McDermitt, 2014: Impact of changes in barometric pressure on landfill methane emission. *Global Biogeochemical Cycles.* 20:7 doi:10.1002/2013GB004571
- [4] Liu, Z. K.G. Hubbard, X. Lin, and X. Yang. Negative effects of climate warming on maize yield are reversed by changing of sowing date and cultivar selection in Northeast China. *Global Change Biology.* 2013 August. doi: 10.1111/gcb.12324.

### **Outreach**

The Weather Data Library provides outreach in a variety of ways. Media outlets are a major component. In addition to frequent interviews for radio, TV and newspapers on various weather and climate topics, we produce 3 weekly audio clips on weather and climate phenomena. These air on the local radio station, are distributed to 75 other stations, and are accessible on the website at <http://www.ksre.ksu.edu/News/>. Other regular feature is participation in a weekly agricultural weather program, broadcast across the state, which covers current conditions and developing situations of interest to the agricultural community.

Additional outreach activities include presenting at various workshops, and events including the Governor's Water Conference, Regional Drought Conferences, Farm Profit Seminars, and historical society events. Outreach to K-12 has included teacher workshops, participation in the STEM program, and an annual Kids Field Day.

### **Network Monitoring and Impacts**

Expansion of the Kansas Mesonet continues. The latest stations added included collaborations with the KSU Horticulture Department, Highland Community College, and Rock Springs 4H Camp. Increased focus is being put into the future growth of the Mesonet, as well as enhanced data analysis for quality control. During the recent years, we have provided weekly updates on drought conditions to the Kansas Water Office for use in their reports. We also actively participate in the Drought Monitor discussions, and provided information for the NWS Central Regional Headquarters climate assessment products.

## **Kentucky Climate Center**

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***Dr. Stuart A. Foster, State Climatologist and Director***

Dr. Rezaul Mahmood, Associate Director



The Kentucky Climate Center (KCC) observed its 37<sup>th</sup> year of operation in 2014-15. Restructuring of research functions at Western Kentucky University has placed the Kentucky Climate Center back within the Department of Geography and Geology, where it originated in 1978. The KCC received funding to support both undergraduate and graduate students and provide opportunities for them to participate in a variety of research and service activities. The KCC currently supports students from programs in geoscience, meteorology, and computer science.

The KCC is recognized by the AASC as the State Climate Office for Kentucky and has developed working relationships with the five National Weather Service forecast offices that serve portions of Kentucky, which include Jackson, KY, Louisville, KY, Paducah, KY, Wilmington, OH, and Charleston, WV. The KCC also enjoys supportive relationships with the Midwestern Regional Climate Center and the National Centers for Environmental Information.

In addition to housing the Office of the State Climatologist, the Kentucky Climate Center is home to the Kentucky Mesonet and the Climate Research Laboratory. The Kentucky Mesonet is a statewide network of automated weather and climate stations that is recognized as the official source of climatological observations for the Commonwealth of Kentucky. The Climate Research Laboratory supports the WRF and WRF-Chem models for atmospheric and atmospheric chemistry modeling focusing on impacts of land use and land cover change and air quality.

### **Information Services**

The KCC provides weather and climate data and information through a variety of channels. These include communication via telephone, fax, and e-mail. Our primary sources of service delivery are via the Kentucky Climate Center website, (<http://www.kyclimate.org/>), which includes a variety of narratives, tables, maps, and graphs summarizing Kentucky's historical climate, and the Kentucky Mesonet website (<http://www.kymesonet.org/>). New servers were recently acquired that will enable upgrades of content and efficient delivery of information via these websites.

## **Research**

Faculty and students associated with the KCC are involved in a variety of applied research projects. Efforts focus on the analysis of meso-scale land-atmosphere interactions using data from the Kentucky Mesonet. Papers on these topics were published in the Journal of Geophysical Research-Atmospheres, Ambio, Climatic Change, Bulletin of the American Meteorological Society, Environmental Research Letters, International Journal of Geosciences, and Journal of Environmental Science and Technology.

## **Outreach**

The KCC provides outreach via the media, including interviews through the television, radio, and newspaper media addressing significant weather events, climate change, and the Kentucky Mesonet. A new outreach opportunity this year involved participation in local programming by a National Public Radio affiliate that hosted a live talk show to discuss risks and outlooks for winter weather. Two major snowstorms and record cold weather in Kentucky this past winter produced media requests from around the state.

The state climatologist plays an active role on the Kentucky Drought Mitigation Team organized through the Kentucky Division of Water within the Kentucky Cabinet for Energy and Environment and the Mammoth Cave Biosphere Reserve Advisory Council. The KCC is also represented on the South Central Kentucky Innovation and Technology Council.

Representatives of the KCC were featured speakers at various events held throughout the state, including events held by the Kentucky County Judge Executive Association, selected Area Development Districts, the Association of American State Geologists, the Kentucky Farm Bureau, and the University of Kentucky/Kentucky State University Cooperative Extension Service.

The KCC received funding through the American Geophysical Union to produce interactive web-based tools (<http://www.kymesonet.org/bradd/>) to support local water managers. This work was carried out and involved engagement with the Barren River Area Development District and local water managers within the region.

## **Monitoring and Impact Assessments**

Expansion of the Kentucky Mesonet (KM) continued. Sixty-five research-grade automated weather and climate monitoring stations are currently operational throughout the state. One of the mesonet stations also serves as an eddy-covariance flux measuring site. Five mesonet stations include probes for monitoring soil moisture and temperature. During the past year, an agreement was reached with a local consortium to fund the addition of a new station to be located in Butler County, Kentucky.



**LOUISIANA OFFICE of STATE CLIMATOLOGY**  
**2014 Annual Report**  
*Department of Geography and Anthropology*  
*Louisiana State University*

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Amanda Billiot, Research Associate  
Josh Gilliland, Graduate Student  
Rudy Bartles, Graduate Student

#### **Mission**

The mission of the Louisiana Office of State Climatology (LOSC) and the Louisiana State Climatologist is to serve as the State focal point for activities pertaining to the climate of Louisiana. Responsibilities include:

- to collect, archive, and make available climate data for the state of Louisiana
- to provide climate education and information to the citizens of the region through various outreach programs including the media
- to maintain an active research program pertaining to the climate of Louisiana and the region.
- 

To achieve these goals, the LOSC cooperates with LSU, the National Weather Service (NWS), Southern Regional Headquarters of the NWS, the Southern Regional Climate Center (SRCC), and the National Climatic Data Center (NCDC).

#### **Need and Relevance**

A primary role of the LOSC is to collect and archive high quality climate data for Louisiana and then make these data available to the general public, often with some interpretation or forensic application. Users of these data include researchers, attorneys, construction companies, federal and state planning agencies, private consultants, power companies, insurance companies, teachers and students, among others. Hundreds of requests are still handled annually. We also collaborate with the Louisiana Office of USDA's National Agricultural Statistics Service, where data are shared.

The LOSC has taken on the responsibility of producing a weekly summary of the State's weather and climate in the form of the *Louisiana Weekly Weather Highlights* available on the LOSC website at the following URL: <[www.losc.lsu.edu](http://www.losc.lsu.edu)>. The Office also provides a weekly

summary of Louisiana Climate Data to the National Agricultural Statistics Service (NASS) that is published weekly in the *Louisiana Crop Weather Summary*. In addition to these weekly products, the LOSC also produces monthly summaries of the State's Climate data, which is also available on the LOSC website. The office also produces event-based summaries for significant weather events that impact Louisiana. The LOSC is also active on the ad hoc committee of the *U.S. Drought Monitor*. We cooperate and coordinate efforts closely with the NWS Offices in the region. We also remain primed and ready to work with Governor's Office of Homeland Security and Emergency Preparedness (GOHSEP) when needed.

### **Outreach**

The LOSC conducts frequent interviews with radio, newspaper, and magazine media.

The State Climatologist authored 52 weeks of the *Louisiana Weekly Weather Highlights* available on the Louisiana Office of State Climatology website at <[www.losc.lsu.edu](http://www.losc.lsu.edu)>.

The Louisiana Office of State Climatology (LOSC) handles hundreds of data requests annually from the public, including researchers, lawyers, students, insurance adjusters, construction companies, local/state/federal offices, and more. In 2014 alone, the LOSC has had 18,819 Facebook Posts, 8,281 Twitter Views, 611 Direct Data Requests, and 347,625 Website hits demonstrating an effectiveness in reaching the public through multiple means.

The LOSC provides a weekly summary of Louisiana Climate Data to the National Agricultural Statistics Service that is published weekly in the *Louisiana Crop Weather Summary*.

Serve on the U.S. Drought Monitor - Weekly Ad Hoc Advisory Committee.

### ***Newspaper, Magazine, Radio, and Television Interviews and Stories***

I am a contributing writer to the *St. Bernard Parish Post*. I contributed 51 articles (weekly) in 2014. The LOSC was consulted for stories in each of the following Newspapers and Magazines in 2014: *The Advocate* – 16 (Baton Rouge), *Times-Picayune* - 5, *The Reveille* – 1, *Daily News Bogalusa* -1, *NOLA Defender* – 1. The State Climatologist gave at least **53** radio interviews to *Louisiana Network* on a variety of weather topics involving Louisiana. LA Network has 75 radio station affiliates in Louisiana. Interviewed by the History Channel's "One in a Million" for story on a women in southeastern Louisiana who lost houses in 5 separate hurricanes. Interviewed by WVLA-TV (33) on SURGEDAT and opening of hurricane season, by Jeff Palermo on Tiger Rag Radio Show on icing of roads in south Louisiana. Was a Guest on *Sunday Journal* with John Pastorek WBRZ, Channel 2 – May 27, 2014 for the opening of the 2014 hurricane season. Interviewed by KMAR Radio 17 times, by WJBO Radio 3 times, by Talk Radio-Baton Rouge (107.3 FM) twice, and by KEEL News Radio, AM 710, Shreveport, LA once.

### **Research**

Needham, H.F., and B.D. Keim. 2014. Correlating Storm Surge Heights with Tropical Cyclone Winds at and before Landfall. *Earth Interactions* 18:1-26. DOI: <http://dx.doi.org/10.1175/2013EI000527.1>.

Needham, H.F., and B.D. Keim. 2014. An Empirical Analysis on the Relationship between Tropical Cyclone Size and Storm Surge Heights along the U.S. Gulf Coast. *Earth Interactions* 18:1-15. DOI: <http://dx.doi.org/10.1175/2013EI000528.1>.

Shao, W., B.D. Keim, J.C. Garand, and L.C. Hamilton. 2014. Weather, Climate, and the Economy: Explaining Risk Perceptions of Global Warming. *Weather, Climate and Society* 6(1):119-134.

#### **Invited Lectures**

“Hurricane History of the Gulf and East Coast of the United States.” Presented to the Southeast Climate Consortium Fall Planning Meeting 2014, Auburn University, Auburn, AL, November 19, 2014.

“Hurricanes of the Gulf of Mexico.” Presented to the Poydras House Retirement Community, New Orleans, LA, November 18, 2014.

“Spatial and Temporal Analysis of Hurricane Strikes along the Gulf and Atlantic Coasts.” Presented to the NWS-Shreveport Louisiana Regional Climate Conference, Shreveport, LA, August 26, 2014.

“Dangers of Heat Stress and Lightning to Athletes.” Presented to the Louisiana High School Officials Association Annual Meeting, Thibodaux, LA, August 15, 2014.

“Temporal and Spatial Patterns of U.S. Hurricane Activity,” Presented at the LSU Science Café, Baton Rouge, LA, May 27, 2014.

“Hurricanes in a Changing Climate,” Presented to the local chapter of the International Facilities Managers Association Monthly Meeting, Baton Rouge, LA, May 20, 2014.



## **Michigan State Climatological Resources Program: 2014 AASC Annual State Climate Office Report**

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*Submitted by Jeff Andresen, State Climatologist*  
Email: [andresen@msu.edu](mailto:andresen@msu.edu)

The Michigan Climatological Resources Program (MRCRP), home of the Office of the Michigan State Climatologist within MSU's Dept. of Geography, is the archival and service center for climatological data and related information for Michigan. Leadership of MCRP is the responsibility of the State Climatologist, who supervises operational and research activities under the direction of the Chair of the Geography Department. Operational and research support in the program are provided by Aaron Pollyea and Mike Kiefer.

### **ARSCO Qualifications**

The MRCRP is an American Association of State Climatologists (AASC) Recognized State Climate Office (ARSCO) and fulfills a number of qualifications as outlined below. Major objectives of the MCRP are consistent with the AASC-defined role of a state partner in provision of climate services, including: 1) Collection of observations for the purpose of climate monitoring, summarization and dissemination of weather and climate information to the user community; 2) Demonstration of the utility of climate information in the decision making process and assessment of climate impacts; 3) Development of an active research program addressing climate-related issues in the state and region; and 4) Development of an educational element of the program which allows and encourages students to participate in climatological research, gain operational job experience on internships, and provide training in applied use of climatological information.

### **Communication Capabilities**

The majority of public requests for climate data and information are placed via telephone and email exchanges. While a fraction of requests are still filled through conventional mail service, a growing proportion of responses are through email. MCRP also provides information through dedicated worldwide web sites (see below). Climate data are collected operationally in the program via internet (Unidata's Internet Data Distribution system) and dedicated satellite receiver connections, and via internet and telephone through the program's Enviro-Weather information access system.

### **Information Services**

The number of requests for climate information, interviews, and speaking engagements remained at a relatively high level in 2014. The total number of formal public requests for climate-related data and information during the year was 103, which was down slightly from 104 in 2013 but

still above the five year average. Most of the requests were received via phone or email. The majority of the requests were from law firms, the insurance industry, and other researchers. The average amount of payment received per billable request was \$59.02, which was up from \$48.23 in 2013 and the second straight yearly increase in this category. These numbers continue to suggest at least a temporary leveling off of a long term declines in the number of formal data requests. In contrast, use and data access from our internet sites, [climate.geo.msu.edu](http://climate.geo.msu.edu), [www.agweather.geo.msu.edu/mawn](http://www.agweather.geo.msu.edu/mawn) and [www.enviro-weather.msu.edu](http://www.enviro-weather.msu.edu) continued at high levels with an average of 20,930 hits per day, which is a new record high (just surpassing the 20,882 hits per day in 2012) and 1222 hits greater than in 2013.

### **Outreach Activities**

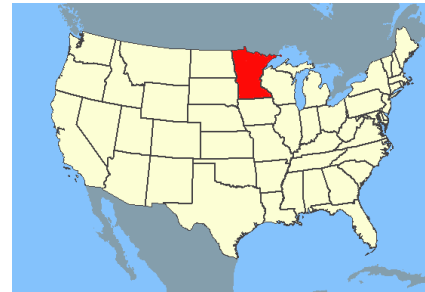
The MCRP in conjunction with MSUE (through the SC's formal appointment) also maintains an active outreach program through traditional venues, providing climate-related information in formats ranging from public speaking engagements to regular columns in the popular press. During 2014, the MCRP staff provided 28 interviews to print, radio, and television media (including 1 TV and 6 radios) and 37 talks or seminars to the public. The SC and some MCRP staff also write weather- and climate-related columns on a daily (MSUE Crop Advisory Team, see <http://msue.anr.msu.edu/news/>) and bimonthly (Michigan Farm Bureau) basis. During 2014, 22 columns were written. MCRP continues to serve as state-level coordinator of Michigan's Community Collaborative Rain, Hail, and Snow (CoCoRaHS) network.

### **Research**

MCRP maintains an active research program addressing climate-related issues in the state and region. Current projects involve investigation of past and projected future climate changes in the region and potential impacts of weather and climate on regional agriculture. We also continued work on the Enviro-Weather project, the primary objective of which is the development and implementation of www-based techniques and tools that address weather- and climate-related processes in agricultural and natural resource management in Michigan. During 2014, staff at MCRP authored or co-authored 6 refereed articles, 2 book chapters, and 4 non-refereed articles and technical reports. MCRP was associated with 8 new external grants totaling \$5,403,956., 6 grants in force from previous years, and 21 new grant proposals submitted.

## Minnesota State Climatology Office

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The Minnesota State Climatology Office (MN\_SCO) exists to manage, analyze, and disseminate climate information in service to the citizens of Minnesota. The MN\_SCO is funded by the State of Minnesota Department of Natural Resources - Division of Ecological and Water Resources, and housed at the University of Minnesota - Department of Soil, Water, and Climate. This partnership was formed in 1973.

The MN\_SCO assists its customers in their investigations of the climate's impact on various components of the natural environment, and on socioeconomic activities. The MN\_SCO uses its climate monitoring resources to quantify weather conditions and to place these conditions within historical and geographical context. The MN\_SCO also provides quantitative summaries of historical climate conditions, allowing users to make informed decisions about future activities.

In order to provide its services, the MN\_SCO requires an extensive historical climate data set. The climate database managed by the MN\_SCO consists of millions of data points. The database features data collected by Minnesota's high spatial density precipitation monitoring program, formed in the early 1970s. This "network of networks" utilizes the efforts of water-oriented state and local agencies to assemble precipitation data from approximately 1500 observers each year. Additionally, the National Weather Service (formerly the U.S. Weather Bureau) has maintained a large scale, volunteer-based climate monitoring network in Minnesota since 1890. Other, smaller scale climate monitoring efforts extend the historical record earlier into the 19th century. The MN\_SCO also archives multi-element hourly weather data gathered at Minnesota's airports.

The MN\_SCO provides customers with free access to a comprehensive electronic climate database. The MN\_SCO also serves its customers by offering a variety of value-added analyses of climate data in the form of narratives, maps, graphs, and tables. Customers access MN\_SCO products and services via a Web site, email, telephone, office visits, meetings, and public appearances.

The customers of the MN\_SCO are many and varied. Customers can be grouped in the following categories:

- Minnesota Department of Natural Resources (sponsoring agency)
- State, Federal, and Local Governmental Agencies
- Private Sector Professionals (including the media)
- Academic Community
- General Public

**ARSCO Qualifications:** the MN\_SCO is designated by the AASC as the official state climate office for Minnesota. The following describes the ways in which the MN\_SCO addresses each of the ARSCO qualifications:

***Communication Capabilities:***

- full-featured Web site
- fully staffed information line
- near-immediate response to email inquiries

***Information Services:***

- Web site – the MN\_SCO Web site hosts approximately 3000 users per day. The Web site offers free access to nearly all of Minnesota’s digitized climate data, as well as a number of value-added products such as narratives, maps, and tabular summaries.
- The Web site offers on-line daily data entry and data maintenance capability to volunteer precipitation observers. These near real-time data are automatically transferred to the National Weather Service North Central River Forecast Center.
- Phone and email – the MN\_SCO answers dozens of phone calls and emails per week from customers with climate questions.

***Research:***

- In 2014, the MN\_SCO was called upon to provide data sets and counsel to numerous researchers investigating topics involving atmospheric science.
- The MN\_SCO participates in three advisory committees tasked to provide guidance concerning climate change adaptation research and outreach.

***Outreach:***

- Staff give frequent interviews to electronic and print media.
- Staff are commonly requested to attend multi-agency, multi-disciplinary meetings where a climatological perspective is required.
- Staff make public appearances addressing matters of weather and climate.

***Monitoring and Impact Assessments:***

- The MN\_SCO works with the National Weather Service to coordinate Minnesota’s role in the *CoCoRaHS* program.
- Web site offers a variety of routinely prepared summaries of weekly and monthly temperature, degree day, precipitation, and snow depth data.
- Web site offers a chronological journal of significant weather events, providing a description of the event, impacts, and historical context.
- The MN\_SCO utilizes a list server to deliver a monthly electronic newsletter summarizing climate conditions observed during the previous month and the resulting impact on water resources.
- The MN\_SCO is in frequent communication with authors of the U.S. Drought Monitor.

## Mississippi State Climatologist Annual Report for 2014-15

Effective August 16, 2014, Dr. Chris Fuhrmann was named Assistant State Climatologist for Mississippi. Chris was the service climatologist for the Southeast Regional Climate Center, prior to coming to MSU.

**Service activities** of the SC this past year included the routine handling of daily requests for data or information, and provision of data analyses for more complex requests. The same sort of climate data consumers are found in Mississippi as elsewhere—lawyers, engineers, professors, researchers of all types, businessmen, housewives, farmers, teachers, students with science fair projects, and every other imaginable user. Much time is spent providing weather summaries to other government agencies upon request, but no routine publication of this sort is attempted. The SC also serves as a member of Mississippi State University's Crisis Action Team with the responsibility of providing weather updates and advisories for potential severe weather events and school closings.

This past year the SC and Assistant SC have been working with a group of other MSU faculty on the submission of multiple funded projects to increase awareness of the Geosciences, specifically Climate and Weather among under-represented groups and provide these groups instrumentation in the climate sciences.

**Outreach activities** have focused on helping the public gain a general understanding of Climate vs. Weather and to clear-up common misconceptions related to each. The SC office continues to be overwhelmed with requests for information and for presentations about potentially changing weather characteristics to groups throughout the state and region. Agricultural interests, who are quite diverse in Mississippi, still command the greatest interest in terms of the number of speaking engagements. A concerted effort is underway to provide a more complete education program to 4-H, boy scouts, girl scouts, FFA, and other youth organizations in the region.

**Research activities** this past year continued to include the understanding of vegetation changes on the local weather and climate of Mississippi and the testing of wind measurement equipment which may better help MDOT with the application of herbicide spraying.

### **The following specific outreach activities and public educational presentations on weather and climate were conducted this year:**

Climate trends and future scenarios for the Southeast United States: Results from the 2014 National Climate Assessment. Presented at a meeting on climate change sponsored by the EPA, Federal Highway Administration, and MS Department of Transportation, March 2015, Jackson, MS

Climate Service and Agriculture in Mississippi. Presented at the Annual Convention of the Mississippi Seedsmen's Association, February 2015, Tunica, MS

Climate trends and future scenarios for the Southeast United States: Results from the 2014 National Climate Assessment. Presented at the spring 2015 Graduate Student Seminar Series, College of Veterinary Medicine, Mississippi State University, January 2015, Mississippi State, MS

Climate trends and future scenarios for the Southeast United States: Results from the 2014 National Climate Assessment. Presented at the fall 2014 Brown Bag Seminar Series, Department of Geosciences, Mississippi State University, October 2014, Mississippi State, MS

Presented a guest lecture to the Broadcast Meteorology Program Summer Workshop at Mississippi State University

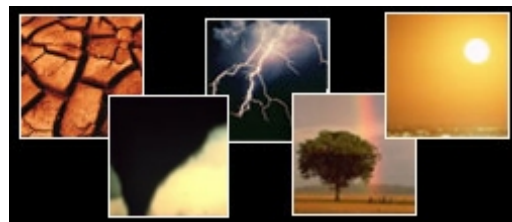
Presentation to Campus – Community Emergency Response Team (C-CERT) on a Disaster Resistant University.

Numerous civic organization presentations related to our climate and climate change.

# MISSOURI CLIMATE CENTER

**Dr. Patrick Guinan, Extension/State Climatologist**  
**Brian Hirsch, undergraduate assistant**  
**Riley Fannon, undergraduate assistant**

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The Missouri Climate Center is designated by the AASC as the official state climate office for Missouri. As State Climatologist for Missouri and Director of the Missouri Climate Center, I serve as resource for weather and climate information. The State Climatologist collects and maintains an extensive historical climate database of Missouri weather records for monitoring and dissemination to the citizens of the state and beyond. This includes performing and assisting in the primary functions of the center whose mission is to advance the use of climate information for the economic and environmental benefit of Missouri and the public safety of its citizens through climate monitoring, research, education, and extension and information services. In 2014 we fulfilled hundreds of climate data requests and gave educational presentations in dozens of venues around Missouri. The following information provides information over the past year of how the Missouri Climate Center addressed each of its ARSCO qualifications.

### ***Communication Capabilities:***

- The MCC web site provides easy access to weather and climate information including links to specialized web sites for real-time and historical weather in Missouri. The Missouri Climate Center posts timely monthly weather and climate impact reports for the state of Missouri;
- Over 4000 lines of data arrays are collected daily from a network of 31 automated weather stations associated with the Missouri Mesonet. The daily and hourly arrays are posted on a server for free access.
- The Meteorological Assimilation Data Ingest System (MADIS) incorporates 5-minute weather conditions from the Missouri Mesonet (21 real-time stations).
- Continued development and recruitment for an e-mail delivery agricultural weather product called Horizon Point. Horizon Point is a custom weather analysis system for farmers and provides an opportunity to have specific weather reports sent directly to their e-mail address. Over 600 Missouri clients are enrolled.
- Added mobile links to all the real-time web sites.

### ***Information Services:***

- Submitted 20 press releases in 2014 to the Extension news service related to weather, climate and the environment;
- Serve as an information source for the media including national, state, and local mediums;
- Fulfilled hundreds of requests for climate information and provided climatological expertise to numerous individuals, groups and agencies;
- Submit soil temperature information published in a national bulletin *Weekly Weather and Crop Bulletin*: <http://www.usda.gov/oce/weather/pubs/Weekly/Wwcb/>
- Submit soil temperature data to the Midwestern Regional Climate Center for generating daily and weekly 2” and 4” soil temperature maps:  
<http://mrcc.isws.illinois.edu/cliwatch/mesonets/soilTemp.html>
- Run the rice model program to predict rice growth stages:  
<http://agebb.missouri.edu/weather/reports/ricedds.asp>
- Provide weather data from the automated network to be used in a risk assessment tool for wheat scab prediction: <http://www.wheatscab.psu.edu/>
- Provide a weekly climate summary table for the *Integrated Pest and Crop Management* Newsletter: <http://ppp.missouri.edu/newsletters/ipcmindex.htm>;
- Provide a 2-inch and 6-inch soil temperature table for the Agricultural Electronic Bulletin Board (AgEBB): <http://agebb.missouri.edu/weather/reports/soilTemp2.asp>  
<http://agebb.missouri.edu/weather/reports/soysoil6.asp>;
- Campus weather station and forecast linked to College of Agriculture web site:  
<http://cafnr.missouri.edu/>;
- The real-time stations are providing 5-minute weather conditions to the Meteorological Assimilation Data Ingest System (MADIS);
- Installed a new real-time automated weather station at the Southwest Research Center near Mount Vernon, MO: <http://agebb.missouri.edu/weather/realtime/mtvernon.asp>

### ***Research:***

- The Missouri Mesonet has provided opportunities for educational programs, teaching, research, innovation, discovery and service to communities. It has led to the development of state-of-the-art information delivery systems, including transitioning 21 weather stations to wireless telecommunication and real-time weather data dissemination for local, state, and national outlets as well as public, private and federal entities. In 2014, the average number of actual internet visits made to our 21 real-time weather web sites was over 337,000 per station, or, over 6,000,000 visits.
- Providing real-time weather status to 21 weather stations in the Missouri Mesonet for Integrated Pest Management;
- Provide climate data for graduate students and faculty research projects
- Continued participation in a multi-state 5-year USDA/NIFA grant awarded in 2010. Grant title: Useful to Usable (U2U): Transforming Climate Variability and Change Information for Cereal Crop Producers.
- In 2014, the National Science Foundation awarded a 5-year collaborative grant involving several universities and others in Missouri. Specifically, it is an Experimental Program to



Stimulate Competitive Research grant (EPSCoR). The title of the grant is “Missouri Transect: Climate, Plants and Community”. Strong components of the grant are science education, research, technology and community outreach. I will be installing 3 real-time weather stations on K-12 property, which will provide opportunities to share this new science technology with educational institutions, students, teachers, administrators and others. I am a co-PI on the Climate team.

**Outreach:** Education, Awareness, and Contact Activities

- Guest lecturer for *ASM-4460* class, Irrigation and Drainage. Dr. Allen Thompson, Instructor. University of Missouri, Columbia. Topic: Evapotranspiration Methods and Drought Update.
- Presented at field trip to Sanborn Field for Dr. Allen Thompson's *ASM-4460* class, Irrigation and Drainage. Topic: Weather instrumentation and application.
- Presented at field trip for Dr. Jason Hubbard's Climate Measuring Lab at Sanborn Field. Topic: Automated weather monitoring and how it works and application.
- Presented at field trip to Sanborn Field for Dr. Ben Knapp's 2160 Natural Resource class. Topic: Weather instrumentation, observation and application.
- Gave numerous weather presentations to extension field day events across the state;
- MU’s Annual Crop Management Conference; Topic: Using Weather Related Tools for Decision Management
- Gave several presentations to various groups across the state on several climate topics including “Automated Weather Monitoring”, “Drought”, “Historical Climate Trends in Missouri”, and “Climate Change”.
- Weather updates for MU Extension Quarterly Ag-Marketing Teleconferences;
- Weekly growing season weather updates for MU’s IPM Agronomy and Horticulture Teleconferences (April-August);
- State Co-Coordinator of the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) in Missouri;
- Member of the Missouri Drought Assessment Committee;
- Member of the North Central 1179 Regional Climate Committee: Food, Feed, Fuel and Fiber: Security Under a Changing Climate ;
- Member of the WERA 1012 Regional Coordinating Committee: Managing and Utilizing Precipitation Observations from Volunteer Networks
- Information resource for media outlets including Missouri Net, Brownfield Network, Cooperative Media Group, and local TV, radio, and newspaper outlets.

## Nevada State Climate Office

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Douglas P. Boyle, Nevada State Climatologist



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The Nevada State Climate Office (NSCO) was established under Nevada Revised Statute 396.595. Our mission statement is:

The Nevada State Climate Office serves the people of Nevada by maintaining descriptions of, reporting on, and providing access to information on the climate in the state, including atmospheric conditions and levels of precipitation. The Office collaborates with, advises, and promotes climate data collection, interpretation, and research in conjunction with local, state, and federal agencies and the governor's office and is responsible for drought planning in the state. The Office participates within and serves as a member of the national and regional network of state climatologists.

**ARSCO Qualifications:** The NSCO is the AASC-designated state climate office for Nevada. The following activities during 2014 address each of the Office's ARSCO qualifications.

### *Communications*

- A completely new website (<http://www.unr.edu/climate>) was developed for the NSCO provides basic information related to the current drought conditions, seasonal forecast information, weather conditions and the activities of the NSCO. The new format for presenting this information is was developed around a few frequently asked questions from an audience that does not have a great deal of climate science background but is concerned with the current state (and future forecasts) of the climate and its impacts. The new format allows for a great deal of flexibility and growth in the organization and content of the website by members of the NSCO (i.e., we don't need to rely on others to update content and/or make improvements to the way in which we convey information to our audience).
- New software was purchased to enhance the utility of the NSCO 65" monitor and video software system in the Departmental "glass case" outside the NSCO. A wide range of different climate and weather related information is currently displayed on the monitor and updated regularly. The monitor seems to be very effective at capturing the attention of the hundreds of students, faculty and others that walk through the lobby of Mackay Science every day.
- The NSCO continues its state mandated responsibility of providing a quarterly state climate summary. The entire report format, content, and scope are currently being redesigned with the goal of providing a much timelier product on the current climate conditions. We expect the new format to become operational July 2015. Ultimately, we

would like to move from quarterly to monthly reporting in the future with improved coverage of eastern and southern Nevada.

### ***Professional Presentations and Meetings***

In 2014 the Nevada State Climatologist made professional presentations at and/or attended the following meetings:

- Southern Nevada Association of Environmental and Engineering Geologists, “Climate change and Lake Mead water levels” Las Vegas, NV, 11 February 2014.
- Trout Unlimited, Sagebrush Chapter, “Status of the drought conditions and streamflow in NV,” Sparks, NV, 13 March 2014.
- Great Basin Climate Forum, Desert Research Institute, Reno, NV, 10 April 2014.
- American Society of State Climatologists, Stevenson, WA, 8-11 July 2014.
- WERA-102 Annual Meeting on Climate Data and Analyses for Applications in Agriculture and Natural Resources (attended by phone), Monterey, CA, 1-3 October, 2014.
- Western Governors’ Drought Forum, Las Vegas, NV, 8-9 December 2014.

### ***Media Interviews***

In 2014 the Nevada State Climatologist performed numerous interviews with journalists from newspapers, magazines, radio, television, and journalism schools including (but not limited to) the following:

- Bloomberg News, Brian K Sullivan, 22 September 2014
- Capital Public Radio, the NPR station for Sacramento, Stockton, Tahoe and Reno, daily interview show Insight, longevity of drought in Nevada, 4 February 2014.
- CBS News 8, Las Vegas, 9 December 2014
- International Business Times, Maria Gallucci,
- Impacts of Tesla factory on local water resources, 4 September 2014.
- Fox News 11, Reno, Drought & Truckee River, 1 July 2014
- Nevada Today, Drought Experts at UNR, 28 March 2014
- Medill School of Journalism, Katherine Depsey, Ancient shorelines map lake levels to help predict future droughts, 13 November 2014
- Reno Gazette-Journal, Drought, Deepening Drought threatens Nevada’s way of life, 22 June 2014
- Reno Gazette-Journal, Drought threatens region’s way of life, 14 July 2014,
- Reno Gazette-Journal, Drought, Nevadans can deal with drought on new website, 27 May 2014.
- Reno Gazette-Journal, Chances for El Nino this winter sputtering, 8 August 2014.
- Reno Gazette-Journal, Bummer: January starts out dry, pattern similar to 2014, 14 August 2015
- Reno Gazette-Journal, 2014 warmest year on record for Reno and Nevada, 12 January 2015
- Others including Fox News, Las Vegas Sun, Clear Sky Group, and Ruby Radio.

### ***Operational Meetings and Activities***

In 2014, the NSCO participated in a significant number of operational meetings related to flood, drought, and other climate related issues.

- As the State Climatologist, I am a member of the Nevada Drought Response Committee (DRC). On 16 January 2014, the committee met with members of the Governor's staff and the Nevada Attorney General's office. One outcome of this meeting was to suspend our operational bi-weekly operational meetings at the emergency operations center in Carson City and, instead, focus on the development of a strategic plan for drought in Nevada. The DRC worked for the next six months to develop, based on a one-day drought-planning workshop for the agriculture community, the draft "Nevada Drought Strategic Plan; A map for a more drought resilient Nevada." This document was completed in July 2014. Throughout 2014, the DRC produced brief reports to inform the Nevada Governor and his staff regarding the current drought status, a summary of known impacts to agriculture, residential and industrial areas, and the environment. We also provide him with a drought and climate forecast and an update on all official drought declarations by the Federal Government.
- The Nevada State Climatologist is an active participant in the biweekly CA - NV Drought Monitor and Water Conditions Discussion. These meetings are coordinated by the NWS to provide an opportunity for all of the CA and NV NWS office representatives and the California, Oregon, and Nevada State Climatologists to discuss the current drought situation and provide a coordinated drought conditions message to the U.S. Drought Monitor authors, other agencies, and the media. This has developed into a very important discussion and is well attended (usually at least 50 participants) on the phone and web.
- The Nevada State Climatologist is an active participant in the NWS Reno Hydro Partners – discussions with agencies, stakeholders and the media regarding current weather and climate conditions. Meetings occurred in 2014 on the following dates: 18 December 2014, 10 December 2014, 9 December 2014, 12 November 2014, 15 April 2014, 13 March 2014, 6 February 2014, 7 January 2014.

### ***Research***

- In 2014, I continued to build a new research program in paleoclimate modeling here at UNR and completed the development of a new climate lab in rooms MS 132 and MS 133 to provide our office with the space we need to continue to grow our research program. We will be adding a new Ph.D. student in 2015 and anticipate the new position of Deputy Nevada State Climatologist to be filled in July 2015.
- The NSCO has a number of research projects aimed at developing a better understanding of the frequency and magnitude of previous short- and long-term droughts, why they occurred, and how our modern water resource infrastructure would respond to some of the longer-term megadrought conditions that we know happened in the past. It is really important to us that we conduct high caliber research that can be used to help answer practical and relevant questions related to our current water resources and climate change related issues in the state.
- I have continued to collaborate with research scientists affiliated with the Comer Science and Education Foundation (CSEF). I remain a very active member of Dr. Wallace Broecker's paleohydrology group within the CSEF Abrupt Climate Change Initiative. In

2014, I was again invited to present and attended the annual CSEF Abrupt Climate Change Conference and was able to continue my collaborative relationships with several other members of this group. Together, along with Scott Bassett, we are carrying out a new collaboration in the Great Basin that involves comparing the paleoclimate estimates from our paleolake modeling with the University of Maine group's paleoclimate estimates from paleoglacier modeling. We are working to integrate the two efforts to develop a new loosely-coupled glacier and watershed hydrology model to investigate glacial moraines and paleolake levels at Lake Russell, the Tarim basin in China, and a to be determined basin in Mongolia.

### ***Publications***

Since 2013, our research group has published, submitted, or is preparing the following manuscripts for review in professional journals:

#### *Published or In Press*

**Boyle, D.P.**, C. Garner, J.S. Tilley, S. Bassett, A. Huggins, and C. Barth, "Application of hydrologic models to assess the effects of cloud seeding on agriculture in the Walker River Basin of Nevada," *Journal of Weather Modification*, **In Press (expected June 2015)**.

**Boyle, D.P.**, C. Barth, S. Bassett, "Towards Improved Hydrologic Model Predictions in Ungauged Snow-Dominated Watersheds Utilizing a Multi-Criteria Approach and SNODAS Estimates of SWE," in *Putting PUB [Predictions in Ungauged Basins] into Practice*, edited by J. Pomeroy, C. Spence, and P. Whitfield, Red Book monograph published by the International Association of Hydrological Sciences and the Canadian Water Resources Association, **2014**.

#### *In Review*

Putnam, A., D. Putnam, W. Broecker, G. Denton, C. Wang, C., E. Cook, L. Andreu-Hayles, J. Palmer, E. Clark, I. Hajdas, J. Southon, **D.P. Boyle**, S. Bassett, S. Birkel, J. Martin, F. Quesada, H. Wolcott, "Asian mid-latitude deserts wetter than today for most of the past eight centuries," *Quaternary Science Reviews*, **In Review** (previously submitted to Science, Nature, Nature Geoscience, and Nature Communications).

Hatchett, B.J., **D.P. Boyle**, C.B. Garner, M.L. Kaplan, S.D. Bassett, and A.E. Putnam, "Evidence for the sensitivity of a Great Basin terminal lake to storm track position," *Journal of Climate*, **In Review**.

#### *In Preparation*

Barth, C., **D.P. Boyle**, B.J. Hatchett, S. Bassett, and C. Garner, "Late Pleistocene Climate Inferences from a Modern Hydrologic Water-Balance Model of Jakes Valley, NV," *Target journal - Frontiers in Quaternary Science, Geomorphology and Paleoenvironments*.

Hatchett, B.J., and **D.P. Boyle**, "Investigating the Response of a Great Basin Terminal Lake to Abrupt Climate Change," *Target Journal - Nature Geoscience*.

## New Hampshire State Climate Office

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The New Hampshire State Climate Office (NHSCO) resides within the Department of Geography at the University of New Hampshire (UNH) – Durham, a land-, sea-, and space-grant institution. In concert with the UNH mission, the goal of the NHSCO is to:

- provide New Hampshire citizens and other constituents with climate information at the local, county, and state levels.
- conduct research on climate-related issues relevant to the state of New Hampshire and its residents.
- be a resource in climate science for educational and outreach purposes.

In keeping with this mission, the NHSCO has focused on providing the public with quality and timely information on weather and climate through research, outreach activities, production of online materials, regular media interviews and dissemination of data and analyses to the user community.

### **ARSCO Qualifications**

The following activities address the NHSCO's qualifications as an ARSCO:

#### *Communication Capabilities:*

The NHSCO disseminated information on weather and climate to a wide variety of users by email, telephone, regular mail, and social media as well as through outreach and academic publications and in person through interviews and presentations. State and regional climate summaries, datasets, state agency reports, and significant event summaries are available to the public online.

- Maintained a website ([www.unh.edu/stateclimatologist/](http://www.unh.edu/stateclimatologist/)) that allows users, with various interests and skill levels, direct access to climate data.
- Hosted a Twitter page (@nh\_sco) followed by national and state government offices and officials, news and nonprofit organizations, educators, and students.
- Worked with UNH Media Services to provide expertise to the media covering significant weather and climate events.

### *Information Services:*

The NHSCO regularly provides information on weather and climate to a wide variety of users including state agencies, local businesses, law enforcement, concerned citizens, K-12 and university faculty and students. Record snowfall and winter cold were of particular interest to the media and the public in 2014/15.

- Produced winter snowfall summaries for state agencies and the media and distributed winter weather and climate information online in real time.
- Responded to over 20 citizen data requests and dozens of data inquiries by the media.
- Interviewed for print media (*EARTH Magazine*), made appearances on NHPR's *Morning Edition* and WMUR-TV and NECN news broadcasts.

### *Research*

The NH State Climatologist collaborated with university faculty and state agencies on climate science research in support of state climate change assessment and impact studies.

- Co-author on the sea-level rise assessment for the NH Coastal Hazards Commission and the final report on state drought for the Department of Environmental Services.
- Participant in the science and outreach sectors of the NH-EPSCoR project "Interactions among Climate, Land Use and Ecology Services."
- Co-authored article on the influence of politics and weather on public perceptions of climate change in NH submitted for peer-review publication.
- Co-author on the successful proposal establishing the UNH Center for Infrastructure Resilience to Climate (UCIRC).

### *Outreach:*

The NHSCO is involved a variety of outreach programs and activities and regularly engages with schools, organizations, businesses and academic institutions.

- Two public presentations on winter climate change and impacts on winter recreation.
- Collaborated with the UNH Leitzel Center to recruit and train K-12 teachers to participate in CoCoRaHS with their students.
- Mentor for the Leitzel Center Research Experience for Teachers (RET) program.
- Served on the Mount Washington Observatory (MWObs) Board of Trustees holding positions on both the Scientific and Technology Advisory Committees. Member of the Education Task Force created to review MWObs distance learning program.

### *Monitoring and Impact Assessment:*

The NHSCO continues to work closely with the NWS Forecast Offices in Gray, ME and Taunton, MA, NOAA as well as the Mount Washington Observatory to maintain state weather observing networks.

- NH CoCoRaHS network Co-coordinator with the NWS Forecast Office in Gray.
- NWS COOP observer for the USHCN station in Durham, NH.

- Maintain the Durham, NH NOAA Climate Reference Network (CRN) stations.

The NHSCO also collaborated with state agencies, providing climate data and analyses for state environmental management and planning activities.

- Member of the NH Drought Management Team and worked with NH Department of Environmental Services and UNH faculty to complete revisions the state drought management plan.
- Member of the Scientific Advisory Panel for the NH Coastal Hazards Commission and Department of Health and Human Services Climate and Health Working Group.
- Steering committee member, UNH Center for Infrastructure Resilience to Climate.





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**ARSCO Annual Report: June 2014 - May 2015**

Dr. David A. Robinson, NJ State Climatologist  
Mathieu Gerbush, Assistant State Climatologist/Climate Services  
Keith Arnesen, Assistant State Climatologist/Agriculture  
Chad Shmukler, Technical Director  
John Read, Technical Assistant  
David Fittante, Field Technician  
Missy Holzer, Educational Advisor  
Erik Namendorf, Assistant Field Technician  
Christina Speciale, Part Time Research Assistant  
Megan Martin, Undergraduate Research Assistant  
Colleen McHugh, Undergraduate Research Assistant  
Jack McCarty, Undergraduate Research Assistant

The Office of the New Jersey State Climatologist (ONJSC) has experienced another successful year of providing climate services to meet the ever-growing needs of the close to 9 million Garden State residents, stakeholders and decision makers. As we serve all within the NJ community and, on occasion beyond, we continue to be mindful of our mission to: 1) gather and archive NJ weather and climate observations, 2) conduct and foster research associated with NJ's weather and climate, and 3) provide critical climate services to all seeking assistance. Our website is <<http://njclimate.org>>.

The ONJSC operates the New Jersey Weather and Climate Network, or NJWxNet. This unique network of 58 weather stations <http://njweather.org> serves as a one-stop Internet resource for New Jersey weather and climate data. The NJWxNet includes 34 NJ Mesonet sites, monitoring a rich suite of atmospheric and surface variables, and 24 NJ SafetyNet stations, monitoring a subset of important variables primarily at public safety agencies. Our new NJWxNet website, launched in April 2014 continues to operate well, and includes five-minute observations (previously hourly) collected and displayed in real time as colorful maps and tables on the NJWxNet web site. We also access data from NWS, USGS, NJDOT and other networks to augment our observations. We continue to improve metadata and network quality control. Ten

additional Mesonet sites are either being installed or locations for them are being determined. Most, if not all, should be functioning by the end of 2015.

Over the past year, support for general ONJSC and NJWxNet activities has come from the NJ Department of Environmental Protection, NJ Office of Emergency Management, US Forest Service, and Global Science and Technology Inc (via a National Weather Service grant). Using NJWxNet data, we continue working with NJ agriculture extension colleagues to develop indices for blueberries and apples and with these individuals and others at Cornell on a grape growth index. We continue to partner with the US Forest Service on data gathering and display associated with fire danger monitoring. Considerable attention has been paid to the quality control of NWS Cooperative Station observations at critical stations with lengthy records.

New Jersey's seventh year in the Community Collaborative Rain, Hail and Snow Network saw close to 300 observers actively participating and submitting vital observations. Our color-filled state and regional maps of precipitation, snowfall, snow cover and snow water equivalent continue to be popular. In addition to the NJWxNet and NJ CoCoRaHS, the ONJSC maintains a comprehensive archive of historical data, metadata and climatologies from NWS primary and cooperative stations. This is supplemented with data submitted by ONJSC volunteer observers. This information is manually processed and displayed in event, weekly and monthly maps and tables. One of the most popular pages includes snowfall observations for any event depositing 2" or more snow at any location in the state. This included 19 events this past winter, a number only surpassed in the past decade by the 20 in the 2013-14 winter. Since late in 2014, this snow page has been accessed over 40,000 times, often being used to resolve snowplowing contracts that are based on increments of snowfall.

Research endeavors within the ONJSC range from student projects on topics such as climatologies of nighttime summer heat in the urban NY-NJ metropolitan area, statewide excessive heat episodes, tropical rainfall and snow cover duration. A number of collaborative efforts with Rutgers colleagues and state and federal agencies continued throughout the past year. For instance, the ONJSC made significant contributions to the recently released NJ Office of Emergency Management (NJOEM) Hazard Mitigation Plan.

The ONJSC continued our monthly reports of NJ weather and climate highlights, including societal impacts. Reports are shared with the Northeast Regional Climate Center, posted on the AASC national website and on the ONJSC website, and published in the "Weather Shelter" newsletter of the North Jersey Weather Observers. Examples of ONJSC outreach activities include the creation of online weather training materials for NJ public safety officials, and a wealth of interviews and presentations. The ONJSC gave approximately 300 interviews to the media between May 2014-April 2015.

**ARSCO Qualifications:** The ONJSC is an American Association of State Climatologists (AASC) Recognized State Climate Office (ARSCO). As such, the office fulfills a number of qualifications outlined below.

### **Communication capabilities**

- Ingest, process, archive and disseminate historic and real-time climate data.
- Maintain numerous web sites related to the ONJSC mission  
<<http://climate.rutgers.edu/stateclim>>.

### **Information Services**

- More than 500 specific requests for data and products each year.
- More than 500 unique visits to ONJSC web sites each day.
- Weekly and monthly climate summaries in map and tabular form.

### **Research**

- Collaborate with Rutgers colleagues, as well as state and federal agencies on projects associated with issues such as forest fire management, pest management, agriculture, transportation, water resources, public safety, homeland security.
- Student research on topics such as urban heat islands, state snow cover variability, ocean influences on state weather and climate.

### **Outreach**

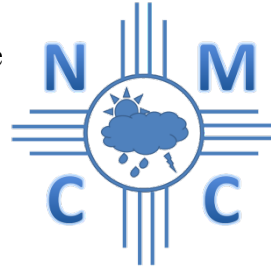
- Over 300 hundred media interviews each year.
- Presentations to numerous schools, civic organizations, senior centers, etc.
- Conference presentations in the past year to groups such as the China National Meteorological Bureau Modern Meteorology Management Delegation, the New Jersey Emergency Preparedness Conference, the New Jersey Utilities Association, the Northern NJ-Newark/Jersey City Urban Area Security Initiative meeting, and the Madison Public Library (far from an inclusive list).
- The NJ State Climatologist is a member of the National Academy of Sciences Board of Atmospheric Sciences and Climate, the NWS StormReady Community Program advisory board, and the Sustainable Jersey climate, forestry and urban heat committees.

### **Monitoring and impact assessment**

- Operation of the NJWxNet. <<http://njweather.org>>
- State operation of NJ CoCoRaHS
- Web site updates for significant winter events.
- The NJ State Climatologist is a member of the NJ Drought advisory committee.

## New Mexico Climate Center

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David DuBois, State Climatologist  
Stan Engle, Database Administrator  
Elizabeth Smith, Research Assistant  
Antonio Arredondo, Graduate Assistant

Rebecca Armenta, Graduate Assistant  
Yizhi Zhao, Graduate Assistant  
Cristina Gonzales, student intern from Puerto Rico

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### General Information

The New Mexico Climate Center (NMCC) resides within the Department of Plant and Environmental Sciences at New Mexico State University in Las Cruces, New Mexico. The climate center is operated by the State Climatologist, one technician, and several student assistants. By law, the duties of the NMCC are to (1) assess the effect of climate on the natural environment, agricultural production, land and natural resources and human health, (2) coordinate climate impact studies and programs, (3) consult and coordinate with the federal and state agencies government in climate related activities, and (4) disseminate climate data, information, advice and assessments to state and local agencies and the general public.

### Climate Information Services

The NMCC collects, archives, and disseminates climate data and information from official U.S. government, state, and private observing stations throughout New Mexico. Our Center maintains a website, <http://weather.nmsu.edu> to house climate information and data at no cost to the public. Additionally, the NMCC maintains a network of automated weather stations throughout the state that are used primarily for agricultural decision making. In 2014 we began the transfer of the former US RCRN weather stations in New Mexico from NOAA to local entities. Many requests for data and information were also answered by phone and email. In addition, the NMCC provided a variety of web based tools for decision support in the areas of drought, air quality, agriculture, hydrology, construction, and economic development. The Center also supported the Drought Task Force's Drought Monitoring Workgroup during monthly conference calls.

### Research

Our research activities in 2014 consisted of applied climate research in which climatic information was used for studies involving drought, flooding, crop improvement, irrigation/water management, and air quality studies. The Climate Center continued to be funded with a contract with the Department of Health for operation of an air quality and health program covering southern New Mexico. We completed a wind erosion study in 2014 for the NM Environment

Department where we quantified the emission rates of several wind-blown dust source areas in the region. The Climate Center continued to work closely with the NOAA RISA Climate Assessment of the Southwest (CLIMAS) to continue work in the area of climate services, and seasonal predictions of air quality. We started working with the NM Department of Transportation in 2014 on their dust mitigation investigations after a multi-vehicle pile-up resulting in seven fatalities on interstate 10 in New Mexico due to zero visibility and dust. A new area of research was started this year with inexpensive sensor networks to collect meteorological and air quality conditions. Our first application of this was to deploy a small particulate monitor aboard a hot air balloon during the Albuquerque Balloon Fiesta. Plans are underway for continuing this experiment and extending it to dust monitoring along the ground.

### **Outreach**

Much of our outreach focused on drought impacts to NM and climate change. We continued our outreach using Twitter (@nmclimate), Facebook (/nmclimate), and YouTube (/nmclimate) for providing climate information to the public. We maintained two blogs focusing on air quality and climate blog for our Center. We participated in numerous outreach activities in public schools and community events including the Master Gardener program promoting climate awareness and CoCoRaHS. The Center also participated in the annual Las Cruces Water Festival that attracted about 1,500 elementary school students and educated them on water conservation and awareness. In 2014 we provided climate tours and education to more than 100 K-12 students at our office. Our program helped run a dust workshop for the City of Las Cruces in 2014 where we promoted the health aspects of dust and mitigation options for those living within the city. We also continued our involvement in the Joint Advisory Committee for the Improvement of Air Quality in the Ciudad Juárez, Chihuahua, El Paso, Texas and Doña Ana County, New México Air Basin. Our office fielded numerous media interviews from local as well as state-wide and national organizations.



### **Peer Reviewed Publications**

- Vargas, V., Chalbot, M.-C., O'Brien, R., Nikolich, G., DuBois, D. W. (2014). The effect of anthropogenic volatile organic compound sources on ozone in Boise, Idaho. *Environmental Chemistry*, 11(4), 445-458. [dx.doi.org/10.1071/EN13150](https://doi.org/10.1071/EN13150)
- Rodopoulou, S., Chalbot, M.-C., Samoli, E., Dubois, D. W. (2014). Air pollution and hospital emergency room and admissions for cardiovascular and respiratory diseases in Dona Ana County, New Mexico. *Environmental Research*, 129(2), 39-46. [www.sciencedirect.com/science/journal/00139351/129](http://www.sciencedirect.com/science/journal/00139351/129)



# NORTH CAROLINA CLIMATE OFFICE

*Dr. Ryan Boyles, Director and State Climatologist*    *Mr. Ameenulla Syed, Assoc. Director & ECONet Manager*  
*Mr. Aaron Sims, Associate State Climatologist*    *Ms. Ashley Hiatt, Environmental Meteorologist*  
*Mr. Sean Heuser, Instrumentation Meteorologist*    *Mr. John McGuire, Meteorologist & Developer*  
*Ms. Heather Dinon Aldridge, Applied Climatologist*    *Ms. Rebecca Cumbie, Extension Climatologist*  
*Mr. Corey Davis, Applied Climatologist*    *Mr. Greg Deleruyelle, Administrative Support Specialist*  
*Mr. Nathan Parker, Technology Support Specialist*

A comprehensive annual report is available at

[http://www.nc-climate.ncsu.edu/PDFs/office/reports/SCO\\_Annual\\_Report\\_2015.pdf](http://www.nc-climate.ncsu.edu/PDFs/office/reports/SCO_Annual_Report_2015.pdf)

## Climate Information Services

**Requests for Services:** Direct requests from clients via email and phone during 2014-2015 resulted in a **19% decrease** in time spent directly responding to requests for services from clients as compared with the previous year.

**Website Usage:** The volume of visits (sessions) **increased by 55%** over the previous year. Overall, the SCO website has received nearly 1.5 million page views over this period and has seen 500% growth in usage over the past 5 years.

**Climate Database Usage:** Users requested more than 2.5 million data queries through the CRONOS interface. With the development of more sophisticated SCO applications and products, end users now have access to more value-added information and services. In addition, the SCO is also providing terabytes of gridded data to partners and end users. The SCO continues to average about 2.3TB of internal climate data transfer each month with about 1.38 billion data records selected, updated, or inserted each month. Our CRONOS API handled 19.94 million queries, which represents an increase in 574% over the previous year's value of 2.96 million queries.

**New Tools for Climate Data Exploration:** New tools were developed to help clients explore and synthesize climate data:

- Fog, visibility, and present weather climatology tool focused on aviation
- Severe weather mapping and analysis
- Drought history and monitoring
- Fire weather monitoring

## Climate Support for Agriculture and Water Resource Management

<http://www.nc-climate.ncsu.edu/products/ag>

<http://www.nc-climate.ncsu.edu/products/water>

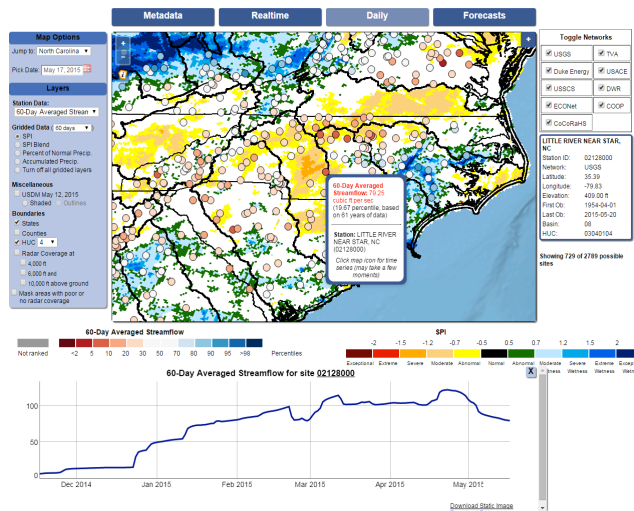
We continued our support for operational agriculture products, including:

- Peanut Disease Advisories
- Thrips Risk assessments
- statewide turfgrass irrigation guidance
- Late Blight monitoring in potatoes and tomatoes
- dispersion and technology support for the national ipmPIPE for Cucurbit Downy Mildew.

Each of these projects are in collaboration with partners in NCSU College of Agriculture and Life Sciences. We also continued our weekly drought monitoring to support water and agricultural management.

**Integrated Water Portal: SCO** developed an integrated portal that will bring together water data from several different agencies into a map-driven data exploration and visualization tool. This tool allows users to quickly explore regional and local water conditions, focused mainly on surface and near surface supplies. This portal incorporates current and historical station-based water and precipitation data with high-resolution gridded products, such as precipitation estimates from NWS, that incorporate radar-estimates of precipitation and drought indices produced by the SCO.

In addition to this, point-based streamflow and reservoir forecasts have been added to the portal. In the future, gridded output from NASA Land Information System (LIS) will be added supply gridded forecast information as well as streamflow and reservoir forecasts for more sites. The integrated water portal is especially designed to support drought monitoring and forecasting needs and is targeted toward an audience of water supply and natural resource managers at municipal, state, basin, and ecosystem scales. <http://www.nc-climate.ncsu.edu/water/map>



*Streamflow and gridded drought severity (SPI) in the new Integrated Water Portal*

## Climate Support for Forest and Natural Resource Management

<http://www.nc-climate.ncsu.edu/products/forestry>

**Fire Weather:** With support from NC Forest Service, we provide a Fire Weather Intelligence Portal that includes map-based web tools to visualize fire risk using the National Fire Danger Rating System and inputs from all CRONOS observations. <http://www.nc-climate.ncsu.edu/fwip/>



**Defense Coastal / Estuarine Research Program (DCERP):** We are assessing the impact climate change may have on ecosystems using Marine Corp Base Camp Lejeune as the study domain. Our role in this large SERDP project is to assess the climate sensitivities of each ecosystem of focus and produce fine resolution climate change projections and historical climate conditions over the base for these modeling efforts. More information is available at <http://dcerp.rti.org>.

**PINEMAP:** Climate Support for Southern Conifer Management: In collaboration with 42 other investigators from across NC State University and the southern US, we successfully proposed in 2010 a 5-year project to USDA for research, extension, and educational activities to improve the management of pine trees in the southern US. We serve as the conduit to the other State Climatologists, developers for a decision support system, and the climate extension resource for all partners. <http://www.pinemap.org>

### **Climate Monitoring: Environment and Climate Observing Network (ECONet) - the NC Mesonet**

**Station Maintenance: 115 site trips** were made throughout the past year to perform routine or emergency maintenance covering almost 17,000 vehicle miles.

- Six wind monitors were replaced due to damages and upgrades.
- 22 integrated wind / temperature / humidity / pressure probes were repaired or replaced.
- 30 radiation sensors were recalibrated or replaced for annual maintenance.
- Five soil temperature sensors were replaced due to sensor failures.
- 14 soil moisture sensors were replaced with a newer model.
- Two stations were upgraded from traditional phone lines to internet and cell communications.
- Two telephone modems were replaced due to damage.
- 16 enhanced temperature and humidity probes were installed.
- One rain gauge was replaced due to sensor failure.
- Two leaf wetness sensors were replaced.
- Data met the highest quality control standard 97% of the time.



*Staff and students at the Spindale tower installation*



## **Educational Outreach**

### **Undergraduate & Graduate Student Training**

- SCO supported 7 undergraduate and 2 graduate students over the past year.

### **Outreach Highlights**

- Total direct educational outreach contact hours: 6,861
- SCO staff provided 40 presentations by invitation
- SCO provided tours and programs for 16 visitor groups, which is slightly above the 6-year average
- 12<sup>th</sup> year of hosting Centennial Campus Magnet Middle School interns
- Helped NC win the CoCoRaHS Cup by recruiting >150 new CoCoRaHS volunteers for citizen science precipitation and drought monitoring.
- Development of new climate science videos and climate communication training for undergraduate student interns

**SCO Climate Blog:** The State Climate Office has continued to routinely communicate news and scientific information via its Climate Blog (<http://nc-climate.ncsu.edu/climateblog>). In FY2015, this included 56 short blog pieces with >56,000 views and >500 direct email subscribers. The blog is posted via Twitter, which had more than 150,000 views

### **Research Activity, Presentations and Publications**

4 manuscripts were successfully published in peer-reviewed journals or reports

5 manuscripts are in development or currently in submission

18 presentations were given at 10 scientific conferences

5 staff and students attended 12 scientific meetings and conferences

## North Dakota State Climate Office

**Adnan Akyüz, Ph.D.**

**State Climatologist, North Dakota**

**Professor of Climatological Practices**

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**Mission Statement:** The mission of the North Dakota State Climate Office is to advance the use of climate information for the economic and environmental benefit of North Dakota and the public safety of its citizens, through climate monitoring, research, education, and extension and information services.

**ARSCO Qualifications:** NDSCO has been recognized by the AASC as the official state climate office for North Dakota since March 2007. NDSCO also enjoys the support from local National Weather Service Forecast office in Fargo-Grand Forks, High Plains Regional Climate Center and holds a Memorandum of Agreement between NCDC and the State Representative. In addition, the following describes the ways in which NDSCO addresses each of the ARSCO qualifications:

**Observation Capabilities:** The State Climate Office operates an Automated Weather Monitoring Network called The North Dakota Agricultural Weather Network (NDAWN) which consists of nearly 80 stations distributed across North Dakota, the Red River Valley, and border regions of surrounding states.

**Communication Capabilities:** The North Dakota State Climate Office oversees the operation of the NDAWN Center. The access information to NDAWN Center and the services are listed below:

- North Dakota Agricultural Weather (NDAWN): <http://ndawn.ndsu.nodak.edu/>
- NDAWN Weather Data
  - Tables and Maps (Hourly, Daily, Weekly, Monthly, Annual, Normals, Departure from Normals)
  - <http://ndawn.ndsu.nodak.edu/hourly-table-form.html>
- NDAWN Agricultural Applications
  - Barley, Canola, Corn, Potato, Sugar beet, Sunflower, Wheat, Small Grains, Crop Water Use, Irrigation Scheduling, Insect Development, Degree day for the energy use.
- Answers requests for climate information or asking climate related questions.
- Frequent media contacts

**Conference Proceedings:**

1. Ryberg, K. R., F. A. Akyuz, A. V. Vecchia, W. Lin. Changes in Seasonality and Timing of Peak Streamflow in Snow and Semi-Arid Climates of the North-Central United States, 1910-2012. *Journal Hydrological Processes*. (Submitted)
2. Steele, D.D., T.F. Scherer, F.A. Akyuz, A. Wamono, T.M. DeSutter, and S.R. Tuscherer. 2014. Evaluation of a Low-Cost Optical Rain Sensor. ASABE Paper No. SD14-063. St. Joseph, Michigan: ASABE
3. Akyuz, F.A., B. Mullins, D. Morlock, N. Bart, and D. Ritchison. 2014: Services of the North Dakota Agricultural Weather Network to the Agricultural Sector. 21st Conference on Applied Climatology. 9-13 June 2014, Westminster, CO.

**Other Popular Publication:**

1. Akyüz, F. A., and B. Mullins, 2014: North Dakota Quarterly Climate Bulletin. Winter 2013-2014. V.8, No. 1. Electronic: <http://www.ndsu.edu/fileadmin/ndsco/ndsco/bulletin/winter14.pdf>
2. Akyüz, F. A., and B. Mullins, 2013: North Dakota Quarterly Climate Bulletin. Spring 2014. V.8, No. 2. Electronic: <http://www.ndsu.edu/fileadmin/ndsco/ndsco/bulletin/spring14.pdf>
3. Akyüz, F. A., and B. Mullins, 2013: North Dakota Quarterly Climate Bulletin. Summer 2014. V.8, No. 3. Electronic: <http://www.ndsu.edu/fileadmin/ndsco/ndsco/bulletin/summer14.pdf>
4. Akyüz, F. A., and B. Mullins, 2012: North Dakota Quarterly Climate Bulletin. Fall 2014. V.8, No. 4. Electronic: <http://www.ndsu.edu/fileadmin/ndsco/ndsco/bulletin/fall14.pdf>
5. Akyuz, F. A.: Weekly Weather. Crop and Pest Report. Weekly from May 7, 2014 through September 10, 2014.

**Professional/Invited Presentations (Total=17):**

1. "Causes and Effects of the Dust Bowl and the Current Impact of Soil Erosion". Dust Bowl Panel Discussion. NDSU Main Library. Dec 4, 2014.
2. "Services of the NDAWN Center". Northern Ag Expo. Dec 2, 2014.
3. "How weather affects gardening in North Dakota?" Master Gardener Course. Nov 14, 2014.
4. "Misconceptions in Weather and Climate" ND Department of Health Seminar. Oct 22, 2014. Bismarck, ND.
5. "Climate Change Impact on Agricultural Sector in the Northern Plains". Climate Change Vulnerability Assessment and Adaptation Workshop. Bismarck. Oct 15, 2014.
6. "NDAWN Update". 2014 REC Fall Conference. Oct 1, 2014.
7. "Utilizing the NDAWN Weather Data for Better Gardening". 2014 ND State Horticultural Society Meeting, Aug 9, 2014.
8. "North Dakota Beautiful: Climate Perspective". Fargo Public Library. Jul 12, 2014.
9. "Impact of North Dakota Agricultural Weather Network in North Dakota's Agricultural Sector". 39th Annual AASC Meeting, Stevenson, WA. Jul 8-11, 2014.
10. "Services of the North Dakota Agricultural Weather Network to the Agricultural Sector". 21st Conference on Applied Climatology. Jun 6, 2014. Westminster, CO. <https://ams.confex.com/ams/21Applied17SMOI/webprogram/Paper247673.html>
11. "Weather Data for Successful Gardening in ND". Gardening Saturday. Alerus Center. Apr 5, 2014.

12. "Climate Change and ND Agriculture and NDAWN". Spring Research Extension Center Conference. Mar 12, 2014.
13. "Misconceptions in Meteorology". Bethany Assisted Living, Fargo. Feb 20, 2014.
14. "What's new in NDAWN and a prediction on 2014's weather". Best-of-the-Best in Wheat and Soybean Research. Moorhead, MN. Feb 6, 2014.
15. "What's new in NDAWN and a prediction on 2014's weather". Best-of-the-Best in Wheat and Soybean Research. Alerus Center, ND. Feb 5, 2014.
16. "North Dakota Beautiful: Climate Perspective". NDSU Library. January 17, 2014.
17. "Weather in 2013 and the outlook into 2014". Winter Ag Expo, Jamestown, ND. Jan 14, 2014.

**K-12 Contribution (Total= 10):**

1. K-12: 8th grade Earth Science Lab. Nov 18, 2014.  
<http://www.ndsu.edu/news/view/detail/16122/>
2. K-12: Kennedy Elementary PTA Day. "Clouds for Kids". Nov 17, 2014.
3. K-12: 8th grade Earth Science Guest Lecture. Nov 17, 2014. Climatology faculty member teaches middle school students about weather <http://www.ndsu.edu/news/view/detail/16122/>
4. K-12: Severe Weather Safety. Ellen Hopkins Elementary School in Moorhead, MN. Jun 18, 2014.
5. K-12: Science All Around Us. Fargo School District ELL Program. Jun 16, 2014.
6. K-12: Weather Camp at Summer Program for the K-2 at St. Joseph's School in Moorhead. June 3, 2014.
7. K-12: Kennedy Elementary Severe Weather Day-Tornadoes. Apr 28, 2014.
8. K-12: ND Science Olympiads. Meteorology Event Organizer. Apr 26, 2014.
9. K-12: "Creating Tornadoes". Expanding your Horizons. Mar 12, 2014.
10. K-12: Tsunami 4 Kids. NDSU. Mar 19, 2014.

**Media Interaction:** Total Documented = 39 (List available upon request)



# OKLAHOMA CLIMATOLOGICAL SURVEY

The weather of 2014 would probably be considered boring by most, and rightfully so. After all, there were no EF-5 twisters ravaging the countryside, nor was there a never ending onslaught of days with triple-digit heat. The blizzards of the last few years never materialized, nor did that other unwelcome winter visitor, the ice storm. What we did have, however, was drought, the most boring – if not most damaging – of Oklahoma's weather

hazards. That particular guest has been plaguing Oklahoma's ecosystem, agriculture and economy since its beginning in late fall 2010 to the tune of several billion dollars in damage. The spring rainy season was mostly a bust, although a return of moisture in late May paved the way for more rain during June and July. That uncharacteristically timed relief delayed the re-intensification of drought that started during May, but more dry stretches from August forward left over 60 percent of the state in drought at year's end. The year ended with a dark, dank and dreary December in which the sun was mostly a no-show at only 35.4 percent of possible sunshine, according to the Oklahoma Mesonet's solar radiation sensors.

In the end, 2014 left us with memories of a (mostly) cold and (mostly) dry year, with a few bursts of excitement to satisfy most weather enthusiasts. Here are a few of the more notable weather highlights (or lowlights) from 2014, as well as the top extremes as measured by the Oklahoma Mesonet.

## 2104 Oklahoma Weather Highlights

- 2014 ended up with a total of 16 tornadoes, the lowest count since accurate records began in 1950. That bests the previous minimum annual twister count of 17 back in 1988.
- The 2014 statewide average precipitation total for the year was 28.87 inches, 7.63 inches below normal, to rank as the 26<sup>th</sup> driest year since 1895.
- A no-show summer and a frigid first few months of the year guaranteed a cool 2014, and the statistics back that up. The statewide average temperature for 2014 was 58.9 degrees, about a degree below normal, to rank as the 29<sup>th</sup> coolest on record.

<b>Dr. Kevin Kloesel</b>	Director
<b>Dr. Chris Fiebrich</b>	Associate Director
<b>Gary McManus</b>	State Climatologist
<b>Dr. Mark Shafer</b>	Associate State Climatologist & Director of SCIPP
<b>Monica Deming</b>	Service Climatologist

**Oklahoma Climatological Survey**  
 120 David L. Boren Blvd., Suite 2900  
 Norman, OK 73072  
 Ph: 405-325-2541 Fax: 405-325-2550  
 E-mail: [ocs@ou.edu](mailto:ocs@ou.edu) <http://climate.ok.gov>

## **Mesonet 20<sup>th</sup> Anniversary**

The anniversary was celebrated at the National Weather Festival (NWF) in Norman on November 1, 2014. The Mesonet marketing team met every two weeks leading up to the event. Mesonet logo flags were designed and ordered for the event. The outreach banners were assembled by the Mesonet techs. A guest book for VIPs was designed and ordered to sign in and write comments. The guest book is now stored in the Mesonet library. There were nine partners for the Mesonet booth at NWF including: Oklahoma Cattlemen's Association, Oklahoma Wheat Commission, Oklahoma Soybean Board, Oklahoma Emergency Management, Oklahoma Prescribed Fire Association, Oklahoma Department of Forestry, USDA ARS, OCS, and SCIPP. The celebration was held at the Mesonet tower in the parking lot of the National Weather Center. Approximately 4,000 visitors came to National Weather Festival. The Mesonet sold 390 t-shirts at the event, and 74 people signed the Mesonet guest book.

OU is creating a historical marker to be placed at the NWC tower. The plaque has been installed at the podium by the tower.

## **Outreach**

OCS' public safety outreach program, OK-First, provided training to 340 public safety officials, the highest annual total ever, including 106 new participants. OK-First's online re-certification classes drew 81 students, accounting for 23.8% of the annual training total. OK-First began training emergency management personnel on the use of dual-pol radar products. Also new in 2014 was a new OK-First website in January to which all users were migrated throughout the year, and late in 2014 users began beta testing of a new OK-First Weather Briefing page.

K-12 outreach participated in dozens of activities attended by thousands of students and adults. K-12 also held the 4<sup>th</sup> Annual Mesonet Weather Camp, attended by 23 participants from 13 states. Campers were able to visit the Phased Array Radar installation and the OU Flight Academy. The Mesonet Camp Alumni count is at 87 representing 19 states and 16 Oklahoma counties. Forty-four of the eighty-seven participants were from Oklahoma. K-12 also hosted their 2nd annual "Meteorology from Atmosphere to Zulu" camp for 9th and 10th graders. The camp was funded by the Oklahoma Regents for Higher Education. With support from staff at OU's Precollegiate Programs, we welcomed 29 participants from 14 Oklahoma counties. Two participants are alumni of Mesonet Camp. As part of the career and college awareness component of Regents Academies, campers met with campus staff, meteorology faculty, private sector meteorologists, and meteorology students. Our Regents Meteorology Camp Alumni count is at 57, representing 21 Oklahoma counties. Five Mesonet Camp alumni have attended our Regents camp. The Regents provide funding so students can attend free-of-charge.

### **About OCS**

The Oklahoma Climatological Survey, a research unit of the College of Atmospheric & Geographic Sciences at the University of Oklahoma, was established in 1980 to provide climatological services to the people of Oklahoma, conduct research on the impacts of climate on human activities, and serve as a support facility for the State Climatologist. OCS has a legislative mandate to acquire, process, and disseminate climate and weather data and information for use by the state's citizens. The Survey maintains an extensive array of climatological information, operates the Oklahoma Mesonet, and hosts a wide variety of educational outreach and scientific research projects.

OCS co-hosted the second Science of Climate Change and Variability workshop at the Biological Station at Lake Texoma attended by teachers from Texas and Oklahoma. Oklahomans for Excellence in Science Education (OESE) invited OCS to provide speakers to help teachers better understand what scientists know about climate change and discuss how to teach these topics in their classrooms.

More than 30 presentations were made by the Climate and Data Services team across the state during 2014 over diverse topics, from drought to climate change, the Dust Bowl and tree ring science. Gary McManus was an invited to speak at the Western Governors Association Drought Forum and also the Governor's Water Conference. OCS sent 156 "Mesonet Ticker" e-mails and 15 press releases detailing Oklahoma weather and climate themes. OCS and the Mesonet were mentioned hundreds of times in the state's two largest newspapers. OCS personnel were featured in numerous print, television and radio pieces from local to national scale. Team members also helped the Oklahoma Film and Music Office locate a potential site for a feature film to be shot in Oklahoma, located in "Dust Bowl" conditions.

Agricultural outreach produced 12 Mesonet Connection publications exploring relevant issues surrounding climate and weather. Al Sutherland and Gary McManus produced weekly Mesonet Weather segments for OETA's SUNUP-TV program, airing most Saturday mornings. Agricultural outreach also staffed Mesonet booths at numerous meetings and conferences across the state, as well as providing informational talks concerning climate, weather and Mesonet products. A new Cattle Comfort video tutorial that combines expert interviews with an overview of Cattle Comfort science was produced and made available on the okmesonet Youtube channel. The first ever Oklahoma Ag Weather Symposium was held at the National Weather Center. Gary McManus and Al Sutherland were included as speakers along with leaders from the Ag community, including Oklahoma Secretary of Ag, Jim Reese, and OSU researchers and extension specialists. Al Sutherland has begun a blog titled Weather and Agriculture: A Plains Perspective that addresses weather and climate tools and science of value to agriculture. This blog is another output of the Grazing CAP grant extension component.

Cindy Luttrell organized and was the main person staffing a Mesonet exhibit at the Oklahoma Outdoor Expo held at the Lazy E Arena in Guthrie on Sept 26, 27, & 28. The attendance for the three days was estimated at 45,083, with 18,116 attending school day on Friday.

## **Research**

Mesonet personnel continue to perform research and provide information on the soil moisture data collected by the Oklahoma Mesonet. Research was performed on possible methodologies for determining soil coefficients at the new 10 cm soil moisture depth using existing coefficients from the Mesonet's 5 cm and 25 cm coefficients. These new coefficients are now being utilized to provide estimates of 10 cm soil moisture. To assist in the continuation of researching the use of plant available water (PAW) as an operational product to the public, an update of the extremes of PAW for each Mesonet station to allow linearized comparisons of PAW in a similar fashion to how Fractional Water Index (FWI) is calculated.

**OCS Staff had the following publications in 2014:**

Basara, J. B., M. Rowell, B. G. Illston, and G. McManus, 2014: Flash Recovery Across the Southern Great Plains During the 2013 Warm Season. *26th Conference on Climate Variability and Change*, Atlanta, GA.

Corbett, M. K., S. L. Stalker, K. A. Kloesel, C. A. Fiebrich, J. Hocker, A. Melvin, 2014: Weather ready schools and weather education: what are our students being taught? *23<sup>rd</sup> Symposium on Education*. Atlanta, GA, Amer. Meteor. Soc., February 2014.

Duchon, C., C. Fiebrich, and D. Grimsley, 2014: Using high-speed photography to study undercatch in tipping-bucket rain gauges. *J. Atmos. Ocean. Tech.*, **31**,1330-1336.

Glenn, J. C., K. S. Pennington, J. B. Basara, J. Liu, G. B. Senay, and B. G. Illston, 2014: Actual Evapotranspiration Estimates from In Situ Oklahoma Mesonet Observations and MODIS Satellite Data. *28th Conference on Hydrology*, Atlanta, GA.

Guzman, J. A., M.L. Chu, P.J. Starks, D.N. Moriasi, J.L. Steiner, C.A. Fiebrich, and A.G. McCombs, 2014: Upper Washita River experimental watersheds: Data screening procedure for data quality assurance. *J. Environ. Qual.*, **43**, 1250-1261.

Liu, J., J. Basara, B. G. Illston, J. C. Glenn, K. S. Pennington, and G. B. Senay, 2014: A Methodology for Estimating Actual Evapotranspiration at Oklahoma Mesonet sites with Applications to Drought Monitoring, *21st Conference on Applied Climatology*, Westminster, CO.

Liu, J., J. B. Basara, K. S. Pennington, J. C. Glenn, and B. G. Illston, 2014: Seasonal to Interannual Variability of Evapotranspiration across Oklahoma during Drought Periods. *28th Conference on Hydrology*, Atlanta, GA.

McCombs, A. G., A. J. Ilk, and C. A. Fiebrich, 2014: Effects of nearby irrigation on Oklahoma Mesonet observations. *18<sup>th</sup> Conf. on Integrated Observing and Assimilation Systems for the Atmosphere, Oceans, and Land Surface*. Atlanta, GA, Amer. Meteor. Soc., February 2014.

Melvin, A. D., K. A. Kloesel, M. K. Corbett, J. E. Hocker, D. E. Mattox, S. L. Stalker, G. Kitch, and R. Smith, 2014: Weather ready schools: Should school hallways as storm shelters be the next weather safety recommendation to be retired? *23<sup>rd</sup> Symposium on Education*, Atlanta, GA, Amer. Meteor. Soc., February 2014.

Morrissey, M., P., Masale, C. Fiebrich, J. S. Greene, and S. Postawko, 2014: Pacific climate services capacity building in cooperation with Pacific Island Country Meteorological Offices and NOAA, a case study in the country of Vanuatu. *26<sup>th</sup> Conf. on Climate Variability and Change*. Atlanta, GA, Amer. Meteor. Soc., February 2014.



Sallee, B.M., T.E. Ochsner, C. Fiebrich and C. Neel, 2014: Estimating Groundwater Recharge Using the Oklahoma Mesonet. *ASA-CSSA-SSSA International Annual Meeting*, Long Beach, California. November 2014.

Stalker, S. L., M. K. Corbett, K. A. Kloesel, C. A. Fiebrich, J. Hocker, A. Melvin, and D. Mattox, 2014: How weather decisions are made in schools: the first step in weather ready schools. *23<sup>rd</sup> Symposium on Education*, Atlanta, GA, Amer. Meteor. Soc., February 2014.

Starks, P.J., C.A. Fiebrich, D.L. Grimsley, J.D. Garbrecht, J.L. Steiner, J.A. Guzman, and D.N. Moriasi, 2014: Upper Washita River experimental watersheds: Meteorologic and soil climate measurement networks. *J. Environ. Qual.*, **43**, 1239-1249.

Additionally, we worked with the National Weather Service Forecast Office in Tulsa, Oklahoma on using Oklahoma Mesonet data to estimate black globe temperature and wet bulb globe temperature. Wet bulb globe temperature (which is similar to heat index) is used frequently by athletes and the military to estimate the effect of temperature, radiation, humidity, and wind speed on humans. These new variables are now part of the WeatherScope software, being implemented into WeatherMapper, and will be run operationally every 5 minutes on the Mesonet website.

### **Monitoring and Assessments**

During 2014, the Mesonet Calibration Lab and Sensor Development team completed 3272 laboratory calibrations of sensors. Field Technicians made a total of 1,497 site visits to Oklahoma Mesonet stations, Little Washita and Fort Cobb ARS stations, repeaters and bases. The Field team resolved 283 problem trouble tickets and 1460 total rotation tickets during 2014 in the three networks.

## **Oregon Climate Service**

Oregon State University  
College of Earth, Ocean, and Atmospheric Sciences  
104 CEOAS Admin  
Corvallis, OR 97331

Staff:

Philip Mote, Director  
Kathie Dello, Deputy Director

Performance period: 5/1/2014-4/30/2015

The Oregon Climate Service (OCS) is the official AASC Recognized state climate office (ARSCO) for the state of Oregon. OCS staff are also a part of the Oregon Climate Change Research Institute (OCCRI) and participate in the NOAA-funded PNW Climate Impacts Research Consortium (CIRC).

The focus of the past year has largely been on communicating about the evolving drought conditions and supporting state agencies and others as they cope with the drought. As of April 2015, ten Oregon counties have official drought declarations with more on the way. As a result of the second warmest year on record statewide, snowpack in Oregon Cascades was at near record or record lows. This looks to be Oregon's worst drought since 1976-1977. The drought has been an opportunity to have a conversation about climate change adaptation across the state, and to ask the question: what are we learning from this year?

### **Routine activities**

Staff answer about 10-15 requests per week by phone, e-mail, and personal meeting. Requests often increase in periods of active weather, or at end of season/year. Staff monitor and weigh in on US drought monitor activity. OCS staff are sometimes asked to review climate pieces of documents produced by state and federal agencies.

### **Highlights**

#### *Drought*

- Ongoing: Media requests are at an all-time high after increasing in volume during last year's drought. Kathie Dello and Phil Mote have been featured by a number of state and national outlets including the Associated Press, New York Times, Time, Circle of Blue, Climate Central, High Country News, National Geographic, Wired Magazine, the Oregonian, Bend Bulletin, Oregon Public Broadcasting, local TV and radio, and the Corvallis Gazette-Times.
- Kathie Dello serves on the Oregon Interagency Public Information Officers Drought committee, which was tasked with developing a high-level communications strategy.

- In partnership with the Climate Impacts Research Consortium, Office of the Washington State Climatologist, NOAA, NIDIS, and the Climate Impacts Group, we helped to organize a PNW Drought Outlook meeting in Boise as a preliminary scoping event to a region-wide NIDIS Drought Early Warning System.
- March 2015: With Oregon State University Extension and the Oregon Water Resources Department, we held two climate and drought meetings in eastern Oregon. The first meeting was in La Grande; the second in Ontario.
- Ongoing: With drought conditions developing in Oregon, OCS hosts a weekly drought coordination call for the purpose of distilling and submitting input to the US Drought Monitor. OCS has bi-weekly calls with Washington to coordinate border issues and occasionally joins the California/Nevada bi-weekly call to coordinate issues to the south.
- Ongoing: Kathie Dello is a member of the state Water Availability Committee, and observes the state Oregon Drought Council.

#### *Oregon Hazard Mitigation Plan 2015 update*

Kathie Dello assisted the Oregon Department of Land Conservation and Development (and other agencies) with an update to the Oregon Hazard Mitigation Plan by writing portions of the windstorms and climate change chapters. FEMA noted, “In particular, I appreciated the way Oregon addressed climate change in their plan. Of course, the separate efforts with their Climate Change report and subsequent Climate Adaptation plan helped, but they did a great job translating the impacts of climate changes into hazard probability as well as mitigation actions. This demonstrates value-added integration of planning initiatives across the state.”

#### *CoCoRaHS*

Kathie Dello continues to coordinate the CoCoRaHS network for Oregon, including enhanced partnerships with Oregon State University Forestry Extension.

#### *2014 AASC Annual Meeting*

OCS co-hosted a highly successful annual meeting with the Office of the Washington State Climatologist. Attendees appreciated the educational and fun time at Skamania Lodge in the beautiful Columbia River Gorge.

#### **Outreach**

Outreach is a major component of OCS activity. We typically use the following platforms:

- **Twitter:** The microblogging service has been an effective way of getting quick bits of timely climate and weather information out to interested parties. These people include

local media, the general weather/climate-interested. There are 562 followers, and local media outlets pull directly from the feed. Contextual tweets are among the most retweeted/favorited by other users.

- **K-12:** Kathie Dello spoke to the second graders at Wilson Elementary School and judged the Middle School Meteorology Challenge at the State Science Olympiad at Oregon State University. Kathie also presented at a teacher workshop.
- **Public presentation:** Staff is asked to give presentations on Oregon climate. This can include historical climate, events of interest, current conditions, and the science and impacts of regional climate change. The audiences range from general public to decision-makers and included the National Tribal Forum, the Bend City Club, several OSU classes and the annual Cascadia field trip for new graduate students in our College, OSU Extension annual conference, an international Water for Food conference, the corporate board of Portland General Electric, a forum with US Rep. Peter deFazio, a conference on climate change and electric utilities, American Institute of Architects, Idaho Environmental Forum, Deschutes National Forest, Oregon Sustainable Bar, Salem City Club, USDA Round Table, Multnomah Athletic Club, Hatfield Marine Science Center, Lewis and Clark Law School, and Oregon Water Resources Department.
- **Media:** Staff gave many interviews to print, TV and radio media over the past year beyond drought. Weather and climate stories featuring OCS leadership are often cited in the daily OSU media digest. These interviews are either requested by media (direct phone call) or follow a press release. Press releases are crafted in partnership with the Oregon State University News and Communications office.

### **Service**

Kathie Dello participated on the AASC IT team, tasked with helping to build the new AASC website.

### **Other**

For the first time in many decades, OCS operated out of Weniger Hall on the Oregon State University Campus. This is the temporary home while Strand Ag Hall undergoes a renovation. We had to move many years of climate records and a 19<sup>th</sup> century precipitation map carefully into storage for the year.



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**2014 ARSCO Summary**

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The Pennsylvania State Climate Office database continues to incorporate observations from more than a half dozen separate networks within the Commonwealth. During the last year, the web interface has been placed on a virtual machine which will allow for long-term network reliability and support. In addition, the office has added several new networks through work on the National Mesonet Program (described in detail later). The CoCoRaHS network continues to expand across Pennsylvania under the auspices of the state climate office and with the name FROST. By the end of 2014, over 800 volunteer observers had enrolled and typically, about 300 faithfully report each day.

***Information Technology Capabilities:***

- About a dozen web data requests were logged each month (besides those by phone and the occasional US mail)
- Primary users are commercial, educational and government organizations
- The entire North American Regional Reanalysis data set (approximately 4.7 terabytes) is updated routinely so that the data have been completed through 12/31/14. This constitutes a 36-year data set. We have added select fields from the CFSv2 global analysis (1979-2014) (approximately 2.5 terabytes).

***Communication Capabilities:***

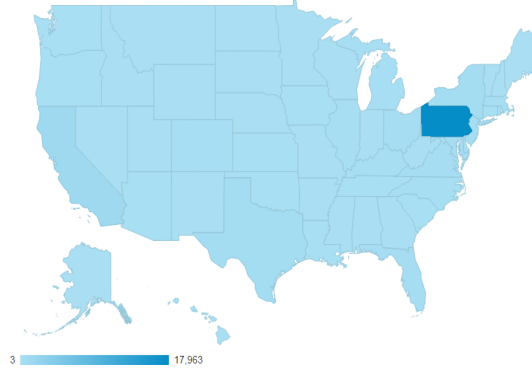
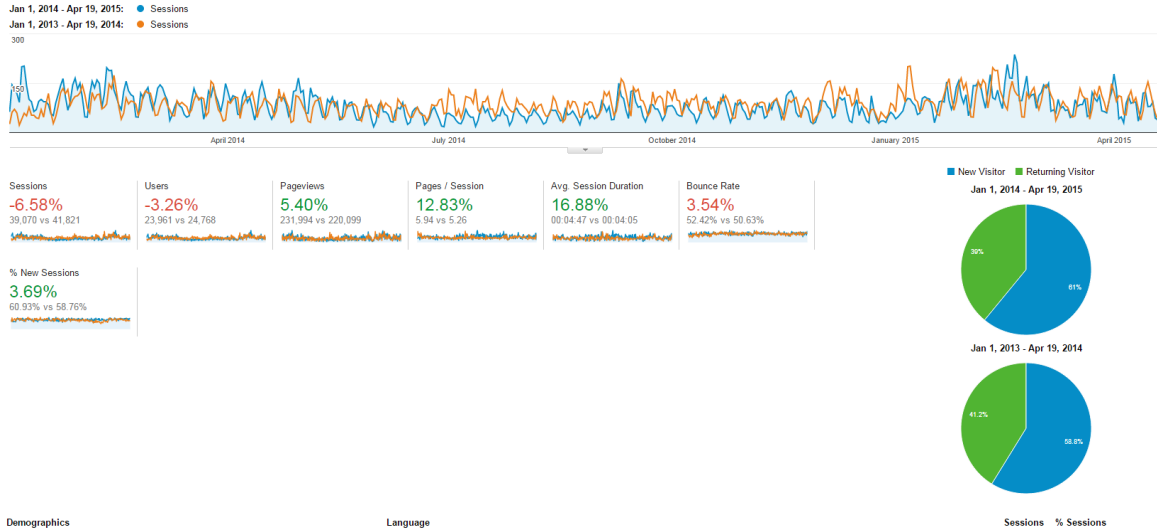
- Development of new products has mainly focused on grant-related items, such as those connected with a data inventory and display. Our web server has been secure since January 2013 after a serious breach into our database during the previous year and has been placed on a virtual machine for added reliability and support services.

***Information Services:***

- The Interactive Data Archive continues to provide data which include data queries for specific dates and strings of dates. An archive of high-impact weather events in the Mid-Atlantic region is currently being updated by some of our undergraduate students.

### User Base Assessment:

- The number of visitors to the site/usage statistics have remained relatively constant this past year as compared to 2013. The largest changes are ~13% increases in pages visited per session and ~17% increase in average session duration. Over two-thirds of site visits originated in the state of Pennsylvania. The following charts show the 2014 session counts and their respective statistics and demographics information:



Region	Acquisition			Behavior			Conversions		
	Sessions	% New Sessions	New Users	Bounce Rate	Pages / Session	Avg. Session Duration	Goal Conversion Rate	Goal Completions	Goal Value
	26,517 <small>% of Total: 93.69% (28,395)</small>	57.68% <small>Avg for View: 59.69% (-3.36%)</small>	15,294 <small>% of Total: 90.53% (16,893)</small>	50.03% <small>Avg for View: 52.00% (-3.78%)</small>	6.16 <small>Avg for View: 5.88 (4.67%)</small>	00:05:00 <small>Avg for View: 00:04:44 (3.72%)</small>	0.00% <small>Avg for View: 0.00% (0.00%)</small>	0 <small>% of Total: 0.00% (0)</small>	\$0.00 <small>% of Total: 0.00% (\$0.00)</small>
1. Pennsylvania	17,963 (67.74%)	52.02%	9,345 (61.90%)	42.31%	7.46	00:06:30	0.00%	0 (0.00%)	\$0.00 (0.00%)
2. California	1,282 (4.83%)	47.89%	614 (4.01%)	83.39%	1.69	00:00:44	0.00%	0 (0.00%)	\$0.00 (0.00%)
3. Texas	673 (2.54%)	55.87%	376 (2.46%)	78.45%	3.19	00:01:22	0.00%	0 (0.00%)	\$0.00 (0.00%)
4. New York	616 (2.32%)	80.68%	497 (3.25%)	60.23%	3.72	00:01:42	0.00%	0 (0.00%)	\$0.00 (0.00%)
5. New Jersey	517 (1.95%)	73.50%	380 (2.48%)	56.29%	5.81	00:02:41	0.00%	0 (0.00%)	\$0.00 (0.00%)

***Data Quality Control/Assurance:***

- The PA Climate office takes advantage of the sophisticated DQ control routines provided by MADIS on CWOP. Other data is manually QA with student support. A trend comparison of surface temperature and dew point (comparing FAA sites and NARR grid point data) has assured us of the quality of both data sets for long-term trends.

***Climate Office Projects:***

- In collaboration with the National Park Service, a climate data inventory project is now in its tenth year. Annual and seasonal summaries have been designed which will have applicability to Pennsylvania climate stations (and DCNR) that are not part of this project. For 2014, information regarding the long-term trends in temperature and precipitation for a selection of stations within the parks have been included in the most recent annual summary documents.

***Special Projects:***

- Collaboration with experts at Kansas State University continues with the refinement of environmental data monitoring systems for a Wheat Scab project.
- A project with Pennsylvania DOT and the top forecasters from the forecasting practicum course continued to provide an early alert for hazardous winter weather for surface transportation in Pennsylvania. An additional project has continued which investigates the F.A.S.T. bridge sprayer by Boschung with Dual-Pol radar data.
- Collaboration continued between ZedX, Inc. and the state climate office in providing forecast charts and commentary for the Soy Bean Rust and other rust spores (corn and wheat stem) with USDA.
- Work has begun on a project with USDA-ARS and the Dept. of Soil Sciences to develop a fertilizer-forecasting tool for the Pennsylvania region so that nutrient run-off can be minimized and the efficacy of the nutrient can be maximized. This project has added 4 weather stations to the sub-hourly network.
- GS&T has collaborated with the climate office regarding the National Mesonet Program by contributing metadata from the COPAMS (DEP's air quality network) as well as sub-hourly data sets. In addition, new data streams will be established in collaboration with the Pennsylvania Turnpike Commission and the Allegheny County Health Department. These datasets will be sent to MADIS in real-time, as well.
- Contributions were made to the 2014 update of the Pennsylvania Climate Assessment, a multidisciplinary study of climate change impacts on the state of Pennsylvania.

***SCEP:***

- The Pennsylvania State Climate Office contributed monthly state weather summaries including its societal impacts to the Northeast Regional Climate Center during all of 2014 as per Task 2.1 of the 2013-2014 NCDC-SCEP agreement.

## South Carolina Office of Climatology

Hope Mizzell, State Climatologist  
Wes Tyler, Assistant State Climatologist for Service  
Mark Malsick, Severe Weather Program Liaison  
Administrative Assistant (Vacant)  
Jennifer Simmons (Intern)



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Created in 1986, the Office of State Climatology (SCO), as mandated by the South Carolina General Assembly (Section 49-25-10 et seq., Code of Laws of South Carolina, 1976), represents the State in all climate and meteorology matters. The SCO resides within the South Carolina Department of Natural Resources (SCDNR). The SCO serves as liaison between the National Weather Service and State agencies, such as the Governor's Office, SCDNR, SC Department of Public Safety, and the SC Emergency Management Division. The SCO assists other State and Federal agencies in data acquisition and interpretation before, during, and after periods of severe weather.

The SCO provides a unique service to the state by archiving and distributing climate and meteorological data, reports, and research that date back to the late 1800s. The SCO administers the *South Carolina Drought Response Act*, which requires the office to formulate, coordinate, and execute a comprehensive drought response program for the State of South Carolina.

**ARSCO Qualifications:** The following describes the ways in which the SCO addressed each of the ARSCO qualifications during 2014:

### Communication Capabilities:

- The office expanded the SCO website (<http://www.dnr.sc.gov/climate/sco>). Products and links were updated as needed. Special product updates included the SC County Weather Atlas's severe weather events and the Snowfall Climatology GIS Maps.
- The office expanded the email notification system focused on severe weather notification and tropical advisories. The address list increased from 1,794 in 2013 to 1,973 in 2014. The breakdown of subscribers is Agriculture 2%, Commercial 10%, Education 5%, Government 50%, Health 2%, Medical 1%, Personal Interest 29%, and Utility 1%.

### Information Services:

- The SCO averaged 44 monthly phone and email requests for climate data and 32,000 information retrievals from the SCO web site.



- Staff assisted SCDNR Law Enforcement, SC Highway Patrol, and County Solicitor Offices with 30 watercraft, vehicle, and criminal investigations. Staff distributed findings for Ice Safety and Cold Water Immersion to DNR Law Enforcement.
- Media inquiries averaged 10 per month.
- The office issued weekly and annual summaries of the State's weather and climate in the *South Carolina Weekly Weather and Climate Report* and the *South Carolina Year in Review*, both of which are available on the SCO website. The SCO also provided a weekly summary of South Carolina Weather and Climate Data to the National Agricultural Statistics Service (NASS) that is published weekly in the *South Carolina Crop Weather Summary*.
- SCO provided 24 special weather event summaries during 2014. Examples include the late freeze of April 16-17, May 5 high temperatures, July 29 temperature evaluation, flooding rains of September 7-8, heavy rains of October 14, and record snow on November 1. Historical documentation was provided to NWS Offices for their special anniversary reports on the 1924 Horrell Hill Tornado and the 1989 Hurricane Hugo.
- The Drought Response Program requires regular correspondence with 48 Drought Response Committee Members, four major power companies, and over 500 water utilities. Correspondence during drought events includes drought projections, official declarations, and suggested response. During 2014, the SC Drought Response Committee was convened twice via a teleconference.
- The office worked with hydroelectric dam operators and other resource agencies to enhance drought mitigation efforts as a part of the implementation of their Federal Energy Regulatory Commission's (FERC) hydro-power dam license. Staff served as a member on the Catawba-Wateree, Yadkin Pee Dee, and Keowee-Toxaway Drought Management Advisory Committees participating in conference calls and providing a Climate Update at the Catawba-Wateree Drought Management Group Annual Meeting.

**Research:**

- South Carolina's Climate Report Card was published in the inaugural edition of the Journal of South Carolina Water Resources, [http://www.clemson.edu/restoration/events/past\\_events/sc\\_water\\_resources/journal\\_scwr.html](http://www.clemson.edu/restoration/events/past_events/sc_water_resources/journal_scwr.html).
- The office is a cooperating institution in the Carolinas Integrated Sciences and Assessments (CISA) project focused on integrating climate science and water management in North and South Carolina.
- Staff continued the project focused on documenting historical weather events that shaped SC history.

**Outreach:**

- The SCO provided approximately 40 annual presentations to various governmental, private sector, and civic organizations.

- Staff were speakers or participants at many state and national conferences such as the Southeast Regional Climate Center's Technical Advisory Committee's Annual Meeting, the American Association of State Climatologists Annual Meeting, the Palmetto Chapter of the American Meteorological Society, NIDIS Coastal Drought Monitoring Knowledge Assessment Workshop, Carolinas Resilience Conference, Columbia Downtown Optimist Club, Katawba Valley Land Trust, Joint Water Resources Committee, SC Chamber of Commerce's Environmental Technical Committee, SC Water Resources Conference, and the Interstate Council on Water Policy.
- The Assistant State Climatologist serves as commissioned law enforcement officer to assist SCDNR during weather emergencies.
- The Severe Weather Liaison served on the State Employee Code of Conduct Task Force.
- The State Climatologist serves on the American Meteorological Society's Climate Services Committee, the Carolina's Integrated Science and Assessment Steering Committee, the
- Coastal Climate Extension Specialist Advisory Committee, and the Selection Committee for the SC Flood Map Modernization Mapping Initiative. She also administered two exams for the National Weather Association's Seal for Broadcast Meteorologists.
- The Carolinas Integrated Science and Assessment program worked with the SCO to produce a YouTube video about the office mission and responsibility.  
[https://www.youtube.com/watch?v=AADbT\\_pFwMQ](https://www.youtube.com/watch?v=AADbT_pFwMQ)

#### **Monitoring and Impact Assessment:**

- The SCO added its first automated weather station on the State's highest peak, Sassafras Mountain. The office partnered with the NC State Climate Office on station installation and the online data is made available via their Environmental and Climate Observing Network.
- The SCO produced and mailed certificates of recognition for CoCoRaHS observers reporting for 5 years. (39 observers were recognized).
- Through a Harry Hampton grant the office distributed 44 complimentary rain gauges to new CoCoRaHS observers.
- Staff worked closely with the National Weather Service to monitor the COOP and ASOS data networks to maintain the quality of SC climate observations.
- Staff completed an Open-File Report on the February 12-13 Ice and Snow Event, the November 1, 2014 Snow Event and an Event Summary on Hurricane Arthur.
- As a member of the State's Emergency Operations Team, SCO staff participated in quarterly hurricane task force meetings, the annual full scale state hurricane exercise, the Governor's Hurricane Roundtable Exercise, the Hurricane Season After Action/Lessons Learned Review Conference, the Governor's Winter Storm Review meeting, the SCEMD/SC National Guard 2015 Full Scale Exercise (Vigilant Guard-15) initial planning meeting, and the SC Department of Public Safety Winter Weather Table Top Exercise. Staff issued 9 weather outlooks, 7

strong thunderstorm/tornado advisories, 39 tropical advisories/updates, and 7 winter weather advisories.

- Customized forecast information was issued for the DNR Governor's Cup Billfish Tournaments, the SC Forestry Commission, SC Department of Transportation, SC Department of Public Safety, the University of South Carolina's Event Planning Department and the Citadel Medal of Honor Bowl. Staff provided the primary weather brief for 29 County, SC Department of Public Safety and State Executive Group conference calls for the February 11-13 Winter Storm event and 13 weather briefs for the January 28-29 winter event.



**South Dakota Office of Climate and Weather  
South Dakota Mesonet**

**Dr. Dennis Todey – State Climatologist/Associate Professor**  
**Colin McKellar – Assistant State Climatologist**  
**Laura Edwards – Extension Climate Field Specialist – SDSU Extension**  
**Nathan Edwards – Network Engineer**  
**Ryan Vanderleest – Data Management**

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The South Dakota Office of Climate and Weather is part of the South Dakota State University Extension in the Department of Agriculture and Biosystems Engineering. The mission of the state climate office overlaps well with the mission of extension to provide science-based data and information and education to the people of the state to support the economy, livelihood and wellbeing of people in the state and to help provide information for decision-making throughout the state. As part of the SDSU Extension, the state climate office has connections across the state to communicate with people of the state providing for a direct set of users as well as contacts to transfer information back to the on state impacts and needs. The South Dakota Office of Weather and Climate (SDOCW) was granted ARSCO status in 2005. Nathan Edwards and Laura Edwards are located remotely in the Aberdeen Regional Office of SDSU Extension.

**Personnel**

Dr. Dennis Todey continued as state climatologist and director of the climate office completing his 11th year in this position. Dr. Todey has served as the president of the American Association of State Climatologist and is the current ARSCO representative on the executive board.

Mr. Colin McKellar joined the climate office in the last year as a grant funded state climatologist. He has brought skill in mapping and data analysis. His primary emphasis has been working on climate education via a grant funded position.

Laura Edwards is the extension climate field specialist in the Aberdeen Regional Office. She helps coordinate SDSU extension climate activities and reporting with the state climate office particularly with the agricultural community. She is also become co-state coordinator for CoCoRaHS. Many educational and news releases are coordinated between the climate office and SDSU Extension.

Nathan Edwards is the network engineer overseeing the South Dakota Mesonet network maintenance, data collection, and developing station support. He has also taken some responsibility in revamping data management in the office.

Ryan Vanderleest is the database manager and programmer leading data processing for the office helping transition to new data transfer streams and helping redeveloping the climate web site along with mobile data applications.

### **Reporting - Events**

South Dakota continues its string of major records. Wet conditions in eastern South Dakota in June of 2014 produced many daily records and a run at the state 24 hour record when Canton SD recorded 8.43 inches just short of the 8.75 inch record. The 24 hour amount did contribute to the all-time monthly record of 19.75 inches.

Working as part of SDSU Extension Laura Edwards and Dennis Todey cooperated on several weekly reporting efforts during the 2014 growing season including:

- Weekly Outlooks to SDSU extension Agronomy

- Weekly radio spots as part of IGrow Radio – SDSU Extension

- Bi-weekly news releases on crop conditions and updated climate outlooks

The SCO also reported on climate information weekly during the summer fire season. In cooperation with the South Dakota School of Mines and Technology (state fire meteorologist) and South Dakota Wildland Fire Suppression, we published a weekly discussion of fire conditions, weather and climate impacts on potential fire issues. Early 2015 required some additional fire work as the dry winter and dry early spring enhanced fire activity throughout the state.

Early 2015 started as the dries on record for the state of South Dakota for January – April. This increased media traffic and interest on early season dryness in the state and surrounding areas because of the impact on rangeland and winter wheat.

### **South Dakota Mesonet**

The state climate office manages, archives and supplies data from a 36 station automated weather station network across the state. Nathan Edwards continued work on the

network in 2012. In 2013 the main activities continued trouble-shooting to stabilize poor-reporting stations and beginning work longer-term station management planning.

Currently about half of the stations have local sponsorship. Sponsors include:

- East Dakota Water Development District
- Several cities and counties
- Private agricultural firms
- Ag and electrical cooperatives
- Private individuals
- Pesticide applicators

Recent changes included refurbishing of sites on SDSU experiment stations and adding soil moisture two stations. Several station moves are in progress to accommodate soil issues or because of encroachment on station locations.

The SD Mesonet was also able to be the basis for a small grains disease model in collaboration with the SDSU Plant Science Department and North Dakota State University. The model is being rolled out in 2014.

### **Federal Interaction**

Dennis Todey is regularly requested by the US Army Corps of Engineers to part of their monthly run-off forecast and water management calls during the run-off season. I am the lead speaker setting the stage with the current conditions and outlooks in the Missouri Basin. I am the only non-federal presenter. Attendees are mostly governmental, press and tribes. I have also been requested to present at their regional tour of face to face meetings throughout the basin as a trusted local source of information. The USACE has funded additional travel as necessary. Local entities have indicated trust in hearing from a non-federal source of information regarding USACE activities and Missouri River management.

Dennis has also worked in cooperation with regional NOAA personnel and other climate services personnel on developing regional climate services to coordinate climate activities, information delivery and publications of regional use. In these cases we show collaboration across multiple states and agencies and deliver more climate information to South Dakota and region. A NOAA Report on the webinars was released in late 2014 summarizing the findings of the surveys.

We have been involved with the evolving NIDIS pilot in the Missouri Basin through initial meetings, follow-up conference calls and the NIDIS sponsored tribal meeting in Rapid City on observations, climate and information delivery to tribes in South Dakota.

### **Traditional and Social Media**

The South Dakota State Climate Office and SDSU Extension have expanded their traditional media presence with social media. Dennis Todey and Laura Edwards shared

work on SDSU Climate on Facebook posting over 100 events throughout the year. Both Laura Edwards and Dennis Todey manage Twitter accounts for SD Climate information.

Dennis also created several blog posts for the combined U2U/Sustainable Corn Blog, which were also shared via Facebook. Laura Edwards and Dennis Todey did numerous radio and TV interviews and well as creating weekly press releases. Many were part of the SDSU extension created a network called iGROW radio to deliver daily information via radio across the state. Dennis Todey and Laura Edwards collaborated on weekly weather/climate updates for iGROW radio.

The SCO overall did over 100 media interviews ranging from record precipitation to winter conditions and usual outlooks for farmer/producers in state and regional print, radio, TV and other media. Dennis was twice a host on South Dakota Public TV's South Dakota Focus and on KELO's Inside KELOLand dealing with climate change and drought issues.

### **Research**

Dr. Todey was part of two other ongoing USDA-funded projects during 2014-5. These were funded to do work on climate change issues and the corn system across the Midwest. The Corn CAP through Iowa State ([www.sustainablecorn.org](http://www.sustainablecorn.org)) will collect data on greenhouse gas emissions from crops, assess people's understanding of climate and climate needs for their operations, develop tools to help producers use climate information and do climate education at multiple levels. The 2<sup>nd</sup> project (U2U – Useful to Usable) through Purdue ([www.agclimate4u.org](http://www.agclimate4u.org)) is working on surveying of climate attitudes, tool development for agricultural producers and also some climate education. The U2U project through Purdue included four other state climatologists (IN, MI, IL, and MO) and two regional center directors (MRCC and HPRCC). Laura Edwards worked on the extension portion of the Corn CAP conducting farmer interviews for the project.

Two new tools were released from the U2U project this year including the Ag Climate Viewer and the GDD Module. Both can be found at the U2U web site.

Initial research on precipitation extremes has determined interesting changes in South Dakota where there seem to be limited changes in summer extremes (24 hour), but are significant changes in spring and fall at certain locations. More will be published during this year.

### **Outreach**

Dr. Todey has been very active in collaborating with NOAA Central Region on regional climate activities including continued work on regional drought webinars. Documenting impacts and conducting several of the webinars were activities during the year. Monthly webinars were conducted throughout the year for the Great Plains and Central Region. Average attendance was 50-60. A review of the webinars was published with NOAA in

late 2014. Additional coordination with federal and state agencies occurred because of the wet fall across the northern plains watching for potential flooding.

Working with several other SCs, RCCs the NDMC and federal agencies we have developed 2 page drought impact and outlook publications for decision-makers in the Great Plains and Midwest.

The state climate web site has maintained its central access point for various data in the state including federal and non-federal data. The site serves the general public, other researchers and a variety of clientele across the state. Various issues with campus IT have delayed development and deployment of a new version of the web site. The state climate office has developed a new mobile page for display of the SD Mesonet Data. This page is available at <http://climate.sdstate.edu/mobile>. During 2014 the page received over 328,000 page views largely from South Dakota and surrounding states (with an interesting set from Washington).

The web site and individual responses continue to supply data for various users in the state and outside the state. Over 50 individual data request and several legal data requests have been supplied by the SCO during the last year. Dr. Todey was called to testify for two legal cases.

Dr. Todey continues to be a source for climate information locally, regionally and nationally. Planting conditions, outlooks and reports on records continue to be a popular media need. He has been invited to over 50 talks in the state and region including talks in MN, IA, and ND during the year with a total attendee list of 2900 in-state and 1500 out of state during 2014.

The SCO continues as the state co-coordinator for Cocorahs along with Laura Edwards from SDSU Extension. The three National Weather Service Offices are regional coordinators. During the recent wet period South Dakota has had over 270 reports on various days, over half the “active” reporters. Despite a lack of coordinated efforts to add CoCoRaHS volunteers at the state level, local and individual efforts continue to add people with approximately 60 new observers added from 1 April 2014 – 1 April 2015.

### **Education**

As part of the Sustainable Corn Project Dr. Todey is working on developing educational modules talking about climate and agriculture and potential changing climate issues.

In conjunction with the South Dakota Discovery Center, GLOBE, and the USDA Sustainable Corn Project planning is occurring for a teacher education course on climate and climate interactions this summer. Colin McKellar is largely involved in making this happen.



Dr. Todey does several in-class talks about climate, agriculture and impacts affecting changing climate on their interaction.

**AASC Executive Council**

Dr. Todey served as past-AASC president in 2012-13. Dr. Todey took over the ARSCO coordinator position on the executive council and has continued outreach efforts for new state climatologists in missing states. During the past year Rhode Island has named a new SC. Maine has transitioned as well as Pennsylvania. Discussions in Massachusetts came to an unfortunate halt due to some state budget issues. Candidates for the SC position were in hand.

Dr. Todey has also cooperated extensively on the executive director search and is currently serving on the ED search committee.



## Texas Annual Report, 2014

### Highlights

The Office of the State Climatologist received a research grant from the National Oceanic and Atmospheric Administration, and the office continued its vigorous outreach activities as the 2011-2015 drought continued.

### Physical Location and Funding:

The Office of the State Climatologist (OSC) is housed in the Department of Atmospheric Sciences, Texas A&M University. During 2013, the OSC team included:

John Nielsen-Gammon	Texas State Climatologist
David Coates	Graduate Research Assistant
Brent McRoberts	Research Associate
Andrew Cook	Undergraduate Assistant
Cameron Batiste	Undergraduate Assistant
Emily Lewis	Undergraduate Assistant

Operating funds are provided by Texas A&M University, with additional external grant funding for particular research projects. Cost recovery is available for large data requests.

### Communication and Information Services:

The OSC maintains a web site (<http://climatexas.tamu.edu>) and a Facebook page (ClimaTexas). We populate these web sites with weekly and monthly climate reports, drought monitoring information, and other newsworthy or educational items.

### Research:

During the past year we completed two externally-funded research projects and commenced a third.

The first completed project, funded by the USDA, was designed to improve and expand our high-resolution SPI products for use throughout the central and eastern United States. Teaming up on this project with us were state climatologists R. Boyles (North Carolina) and D. Niyogi (Indiana). The SPI products are now available in real time through the NCSU web site and are heavily utilized for drought monitoring purposes, including drought monitoring. Four manuscripts are in preparation for submission.

The second completed project, funded by the USDA, was designed to produce probabilistic soil moisture and streamflow forecasts for agricultural planning purposes,

and included collaborators in the College of AgriLife Sciences. The focus of our efforts was on an important river basin in west-central Texas. Three manuscripts are in preparation for submission.

The new project is a followup to the first project above. We are improving the accuracy of the high-resolution SPI and will be testing its utility as input for a high-resolution version of the National Land Data Assimilation System (NLDAS). This work is funded by and in collaboration with NOAA.

Nielsen-Gammon gave five presentations at research conferences, including two invited presentations.

Nielsen-Gammon also served as lead author of a chapter in *Science, Education, and Outreach Roadmap for Natural Resources*, published by the Association of Public and Land-grant Universities, Board on Natural Resources and Board on Oceans, Atmosphere, and Climate. The chapter was entitled Grand Challenge 3: Climate Change. <http://hdl.handle.net/1957/47169>.

**Outreach:**

In addition to the regular reports posted on the OSC web site, and responses to requests for climate data, the OSC conducts outreach through speaking engagements, press interviews, and blogging. The OSC fulfilled approximately 50 data requests during the year.

The ongoing drought conditions in Texas have led to widespread interest in location-specific weather and climate information. The number of fulfilled invitations for speaking engagements remains high. The State Climatologist gave 33 invited outreach presentations to audiences in Texas and elsewhere in 2013, visited six senator and representative offices on Capitol Hill, and gave testimony at a Texas Legislature committee hearing.

The OSC provided numerous interviews to newspapers, news radio, and other media outlets. During 2013, Nielsen-Gammon gave over 100 news interviews. His work was also the subject of a Texas A&M University press release and a Texas A&M Agrilife Crop and Weather report.

**Monitoring and Impact Assessments:**

The State Climatologist is an appointed member of the Texas Drought Preparedness Council, a statewide interagency committee created by the Texas Legislature in 1998 to monitor drought conditions and coordinate drought mitigation activities. The Council meets monthly in Austin.

Beginning in 2012, the OSC has served as host and organizer for weekly Texas Drought Monitor Coordination Conference Calls. These calls, held every Monday afternoon at

2:00 PM CT, are attended by National Weather Service personnel, extension agents, agency representatives, and drought monitor authors. The State Climatologist prepares a draft of suggested changes to the Texas portion of the weekly US Drought Monitor, and those changes are then discussed and amended. A summary of changes is sent to the Drought Monitor author and a copy is posted on the OSC web site.

Since December 2008, with occasional assistance from SCEP funding from NOAA, the Office has produced a monthly climate impacts report that documents the print media coverage of weather and climate effects on the general public and is posted on both the OSC and AASC websites. Because of the diversity of climate impacts in Texas, reports include more than a hundred impact reports. Reports are gathered from newspapers and other sources throughout the state with links to the original source material. The reports are posted on our own web site at <http://climatexas.tamu.edu/> as well as on <http://www.stateclimate.org>.

# Utah Climate Center Annual State Climate Office Report

## Research

### Article (Refereed Journal)

2014

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#### Global eastward propagation signals associated with the 4-5-year ENSO cycle.

2014



**Full Title:** Global eastward propagation signals associated with the 4-5-year ENSO cycle.

**Publication:** Climate Dynamics

**Link:** <http://link.springer.com/article/10.1007/s00382-014-2422-z>

**Full Citation:**

Wang, S.-Y., X. Jiang, and B. Fosu, 2014: Global eastward propagation signals associated with the 4-5-year ENSO cycle. Climate Dynamics (in press / DOI:10.1007/s00382-014-2422-z)

#### Significant impacts of radiation physics in the WRF model on the precipitation and dynamics of the West African Monsoon.

2014



**Full Title:** Significant impacts of radiation physics in the WRF model on the precipitation and dynamics of the West African Monsoon.

**Publication:** Climate Dynamics

**Link:** <http://link.springer.com/article/10.1007/s00382-014-2294-2>

**Full Citation:**

Li, R., J. Jin, S.-Y. Wang, and R. R. Gillies, 2014: Significant impacts of radiation physics in the WRF model on the precipitation and dynamics of the West African Monsoon. Climate Dynamics, DOI: 10.1007/s00382-014-2294-2

#### Bay of Bengal: Coupling of pre-monsoon tropical cyclones with the monsoon onset in Myanmar.

2014



**Full Title:** Bay of Bengal: Coupling of pre-monsoon tropical cyclones with the monsoon onset in Myanmar.

**Publication:** Climate Dynamics

**Link:** <http://link.springer.com/article/10.1007/s00382-014-2289-z>

**Full Citation:**

Fosu, B. O., and S.-Y. Wang, 2014: Bay of Bengal: Coupling of pre-monsoon tropical cyclones with the monsoon onset in Myanmar. Climate Dynamics, DOI: 10.1007/s00382-014-2289-z

## Could the 2012 drought in central U.S. have been anticipated?

2014



**Full Title:** Could the 2012 drought in central U.S. have been anticipated?

**Publication:** Journal of Earth Science and Engineering

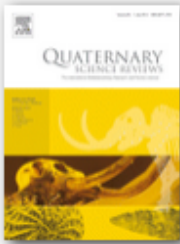
**Link:** <http://davidpublishing.org/Download/?id=17591>

**Full Citation:**

Wang, S.-Y., D. Barandiaran, K. Hilburn, P. Houser, et al., 2014: Could the 2012 drought in central U.S. have been anticipated? - A review of NASA working group research. J. Earth Sci. Engineering, 4, 428-437

## Monsoon extremes and society over the past millennium on mainland Southeast Asia.

2014



**Full Title:** Monsoon extremes and society over the past millennium on mainland Southeast Asia.

**Publication:** Quaternary Science Reviews

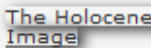
**Link:** <http://www.sciencedirect.com/science/article/pii/S0277379114001462>

**Full Citation:**

Buckley, B. M., R. Fletcher, S.-Y. Wang, B. Zottoli, and C. Pottier, 2014: Monsoon extremes and society over the past millennium on mainland Southeast Asia. Quaternary Science Reviews, 95, 1-19.

## Tree-ring reconstruction of the Great Salt Lake level

2014



**Full Title:** Tree-ring reconstruction of the Great Salt Lake level

**Publication:** The Holocene

**Link:** <http://hol.sagepub.com/content/24/7/805>

**Full Citation:**

DeRose, J. R., S.-Y. Wang, B. M. Buckley, and M. Bekker, 2014: Tree-ring reconstruction of the Great Salt Lake level. The Holocene. DOI: 10.1177/0959683614530441

## On the yearly phase delay of winter intraseasonal mode in the western United States

2014



**Full Title:** On the yearly phase delay of winter intraseasonal mode in the western United States

**Publication:** Climate Dynamics

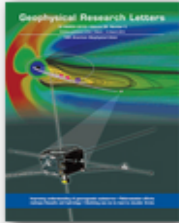
**Link:** [http://cliserv.jql.usu.edu/paper/Inversion\\_Phase\\_Delay.pdf](http://cliserv.jql.usu.edu/paper/Inversion_Phase_Delay.pdf)

**Full Citation:**

Wang, S.-Y., R. R. Gillies, and H. van den Dool, 2014: On the yearly phase delay of winter intraseasonal mode in the western United States. Climate Dynamics, (in press) DOI: 10.1007/s00382-013-1784-y

## Probable causes of the abnormal ridge accompanying the 2013-14 California drought: ENSO precursor and anthropogenic warming footprint

2014



**Full Title:** Probable causes of the abnormal ridge accompanying the 2013-14 California drought: ENSO precursor and anthropogenic warming footprint

**Publication:** Geophysical Research Letters

**Link:** <http://onlinelibrary.wiley.com/doi/10.1002/2014GL059748/abstract>

**Full Citation:**

Wang, S.-Y., L. Hipps, R. R. Gillies, and J.-H. Yoon, 2014: Probable causes of the abnormal ridge accompanying the 2013-14 California drought: ENSO precursor and anthropogenic warming footprint. Geophysical Research Letters. DOI: 10.1002/2014GL059748 [open access]

## Impact of Land-Sea Breezes at Different Scales on the Diurnal Rainfall in Taiwan.

2014



**Full Title:** Impact of Land-Sea Breezes at Different Scales on the Diurnal Rainfall in Taiwan.

**Publication:** Climate Dynamics

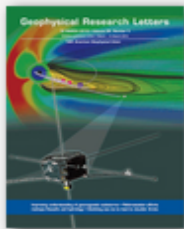
**Link:** [http://cliserv.jql.usu.edu/paper/TW\\_Diurnal\\_MERRA.pdf](http://cliserv.jql.usu.edu/paper/TW_Diurnal_MERRA.pdf)

**Full Citation:**

Huang, W.-R., S.-Y. Wang, 2014: Impact of Land-Sea Breezes at Different Scales on the Diurnal Rainfall in Taiwan. Climate Dynamics (in press) DOI: 10.1007/s00382-013-2018-7

## The Pacific Quasi-Decadal Oscillation (QDO) - An important precursor towards anticipating major flood events in the Missouri River Basin?

2014



**Full Title:** The Pacific Quasi-Decadal Oscillation (QDO) - An important precursor towards anticipating major flood events in the Missouri River Basin?

**Publication:** Geophysical Research Letters

**Link:** [http://cliserv.jql.usu.edu/paper/Missouri\\_River\\_Flood.pdf](http://cliserv.jql.usu.edu/paper/Missouri_River_Flood.pdf)

**Full Citation:**

Wang, S.-Y., K. Hakala, R. R. Gillies, and W. J. Capehart, 2014: The Pacific Quasi-Decadal Oscillation (QDO) - An important precursor towards anticipating major flood events in the Missouri River Basin? Geophysical Research Letters, in press.

## Weather Research and Forecasting model simulations of a rare springtime bow echo near the Great Salt Lake.

2014



**Full Title:** Weather Research and Forecasting model simulations of a rare springtime bow echo near the Great Salt Lake.

**Publication:** Meteorological Applications

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Zhao, L., Wang, S.-Y., J. Jin and A. J. Clark, 2014: Weather Research and Forecasting model simulations of a rare springtime bow echo near the Great Salt Lake. Meteorological Applications (Royal Met. Soc.), in press.

## *Scholarly Paper Presentations*

2014

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1. Gillies, R. R. (Presenter & Author), Wang, S.-Y. (Presenter Only), 2010 AGU Fall Meeting, "Evaluation of precipitation in the Intermountain Region simulated by the NARCCAP regional climate models," American Geophysical Union, MOs cone Convention Center, San Francisco.
2. Gillies, R. R. (Presenter & Author), Wang, S.-Y. (Presenter & Author), Booth, M. R. (Author Only), 2010 AGU Fall Meeting, "Observed and Projected Changes in Precipitation Regime over Utah," American Geophysical Union, Moscone Convention Center, San Francisco.
3. Gillies, R. R., Wang, S.-Y., National Weather Association 39th Annual Meeting, "A Forecast of Prolonged Inversion Episodes in the Intermountain West out to One Month," National Weather Association, Sheraton Hotel, Salt Lake City, UT. (October 22, 2014 - Present).
4. Gillies, R. R., Wang, S.-Y., National Weather Association 39th Annual Meeting, "Decadal Climate Research Leading to Longer-term Prediction for the Great Salt Lake Hydrological Cycle," National Weather Association, Sheraton Hotel, Salt Lake City, UT. (October 21, 2014 - Present).
5. Schroder, M., Wang, S.-Y., Gillies, R. R., National Weather Association 39th Annual Meeting, "Development of Springtime Climate Forecasting for the Intermountain West," National Weather Association, Sheraton Hotel, Salt Lake City, UT. (October 21, 2014 - Present).
6. Wang, S.-Y., Gillies, R. R., National Weather Association 39th Annual Meeting, "Utah Freeze Date Prediction Utilizing Weather Station Climatology and the Climate Forecast System Model," National Weather Association, Sheraton Hotel, Salt Lake City, UT. (October 21, 2014 - Present).
7. Gillies, R. R., Wang, S.-Y., Davies, R. (Other), Kakala, K., Capehart, W. (Other), Atmospheric Sciences Seminar Series, "Mapping extreme precipitation 'hotspots'," University of Utah, Dept. Atmospheric Science. (February 27, 2014 - Present).
8. Gillies, R. R. (Presenter & Author), Wang, S.-Y. (Author Only), Chung, O.-Y. (Author Only), Huang, Y.-C. (Author Only), 16th Conference on Mountain Meteorology, "Pace maker of drought in the Loess Plateau, China," San Diego, California. (August 18, 2014 - August 22, 2014).



9. Wang, S.-Y. (Presenter & Author), Gillies, R. R. (Author Only), Yoon, J.-H. (Author Only), 16th Conference on Mountain Meteorology, "What caused the winter drought in Nepal?," San Diego, California. (August 18, 2014 - August 22, 2014).
10. Wang, S.-Y. (Presenter & Author), Davies, R. (Author Only), Gillies, R. R. (Author Only), World Weather Open Science Conference, "Mapping extreme precipitation 'hotspots' across the midlatitudes.," Montreal, Canada. (August 16, 2014 - August 21, 2014).
11. Wang, S.-Y. (Presenter & Author), Hakala, K. (Author Only), Gillies, R. R. (Author Only), World Weather Open Science Conference, "The water storage buildup leading to the 2011 Missouri River flooding," Montreal, Canada. (August 16, 2014 - August 21, 2014).
12. Yoon, J.-H. (Presenter & Author), Wang, S.-Y. (Author Only), Gillies, R. R. (Author Only), Hipps, L. E. (Author Only), 19th Annual CESM Workshop, "What caused the extreme drought in California?," Breckenridge. (June 16, 2014 - June 19, 2014).
13. Wang, S.-Y. (Presenter & Author), Davies, R. (Author Only), Gillies, R. R. (Author Only), 21st Conference on Applied Climatology, "Mapping extreme precipitation 'hotspots' across the midlatitudes.," Westminster, Colorado. (June 9, 2014 - June 13, 2014).
14. Wang, S.-Y. (Presenter & Author), Hakala, K. (Author Only), Gillies, R. R. (Author Only), 21st Conference on Applied Climatology, "Teleconnection and the buildup of water storage leading to the 2011 Missouri River flooding," Westminster, Colorado. (June 9, 2014 - June 13, 2014).
15. Wang, S.-Y. (Presenter & Author), Hipps, L. E. (Author Only), Gillies, R. R. (Author Only), Yoon, J.-H. (Author Only), 21st Conference on Applied Climatology, "What caused the extreme drought in California?," Westminster, Colorado. (June 9, 2014 - June 13, 2014).
16. Wang, S.-Y. (Presenter & Author), Hipps, L. E. (Author Only), Gillies, R. R. (Author Only), Climate Prediction Applications Science Workshop, "Diagnosing the 2013-14 California drought," Fairfax, Virginia. (May 6, 2014 - May 8, 2014).
17. Wang, S.-Y. (Presenter & Author), Davies, R. (Author Only), Gillies, R. R. (Author Only), Climate Prediction Applications Science Workshop, "Identification of extreme precipitation threats.," Fairfax, Virginia. (May 6, 2014).

18. Li, R. (Presenter & Author), Wang, S.-Y. (Author Only), Gillies, R. R. (Author Only), Jin, J. (Author Only), Spring Runoff Conference, "An effective downscaling technique for winter precipitation and snowpack in the western United States," Utah State University, Logan, UT. (April 1, 2014 - April 2, 2014).

## Vermont State Climate Office

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The Vermont State Climate Office (VTSCO) received its ARSCO recognition in June 2005. The office is housed within the Department of Geography at the University of Vermont (UVM) & State Agricultural College, a land-grant institution that emphasizes outreach as one of its core missions. The VTSCO is located in a laboratory setting donated by the Geography department. National Science Foundation (NSF) and NOAA Climate Database Modernization Program (CDMP)-funded equipment, archival publications and documents are housed there, with adequate facilities for the undergraduate and graduate assistants.

The core mission of the VTSCO is to provide climate research and services to Vermonters and other constituents (university researchers, policy makers, state agencies, legal firms or school children) in a timely and efficient manner. This is facilitated via a dedicated website and e-mail address.

With the loss of the VTSCO graduate research assistant in AY 2010, undergraduate interns provided the primary assistance in AY2014-2015. A NOAA PACE (Postdocs Applying Climate Expertise) postdoctoral fellow, Dr. Evan Oswald, was also affiliated with the VSCO for the period 2013-2015.

**ARSCO Qualifications:** The VTSCO is the AASC-designated state climate office for Vermont. The following activities address each of the Office's ARSCO qualifications.

### ***Communications capabilities:***

- The VTSCO website (<http://www.uvm.edu/~vtstclim>) served as the portal for disseminating information and research. An unfunded EPA grant was submitted in August 2015 to work with Dr. Michael Brewer and team at the Climate Monitoring branch of NCDC (initiated during a SCEP funded visit in February 2011) on the creation of a seamless geospatial data portal for this site.
- AMS (American Meteorological Society) Applied Climatology Committee member – national liaison to the NOAA Regional Climate Centers and the American Association of State Climatologists

- provided free data, expert opinions and recommendations via the telephone, facsimile, electronic mail and regular mail

**Information services:**

- Provided 6 media interviews about flooding and science communication.
- Handled 15 email requests. These were a combination of undergraduate and graduate students seeking specific weather information for class projects; NASA DEVELOP interns working in Lake Champlain flooding; Vermonters seeking snowfall information as well as future climate projections data.

**Research:**

- NOAA PACE (Postdocs Applying Climate Expertise) Postdoctoral Fellow (Dr. Evan Oswald) spearheaded the submission of 3 journal articles, which were the direct result of his work with colleagues at the Vermont Department of Health and the Vermont Agency of Natural Resources on climate change research related to forest health, air quality and human health.
  - Oswald, E. M., Dupigny-Giroux, L.-A., Leibensperger, E., Poirot, R. and Merrell, J. (2015) "Climate controls on air quality in the Northeastern U.S.: An examination of ozone statistics during 1993-2012," *Atmospheric Environment*, doi:10.1016/j.atmosenv.2015.04.019. Available at <<http://www.sciencedirect.com/science/article/pii/S1352231015300200>>
- Co-authored a Bulletin of the American Meteorological Society with colleagues from the Climate Services Division at the National Weather Service, on the deployment of the Local Climate Analysis Tool (LCAT).
  - Timofeyeva, M., Horsfall, F. Holligshead, A., Meyers, J. and Dupigny-Giroux, L.-A., (2015) "NOAA Local Climate Analysis Tool (LCAT): Data, Methods, and Usability," *Bulletin of the American Meteorological Society*, accepted October 2014, doi:10.1175/BAMS-D-13-00187.1. (in press for April 2015 issue) Available at <<http://journals.ametsoc.org/doi/abs/10.1175/BAMS-D-13-00187.1>>

**Presentations included:**

- "Developing a Climate and Health Profile in Vermont," Hales, H., Fogl, M., Grass, D., Oswald, E. and Dupigny-Giroux, L.-A., American Public Health Association Meeting, New Orleans, LA, 19 November, 2014.
- "Exploring severe weather hazards, climate and science communication: Through the lens of the Vermont State Climatologist," **invited speaker & participant**, Developing Sustainable Networks of Women Scientists for Addressing Issues of Disasters Related to Weather and Changing Climate Montego Bay, Jamaica, 20-22 October, 2014.
- "Challenges and lessons learned in implementing climate and geospatial understanding in the K-16 curriculum and among diverse students," **Keynote**

**luncheon speaker**, Vermont EPSCoR Annual Meeting, Burlington VT, 5 August, 2014.

- “Challenges and lessons learned in implementing climate and geospatial understanding in the K-16 curriculum and among diverse students,” **invited speaker & participant**, Diversity in the Computational Geosciences Workshop, NCAR, Boulder, Colorado, 23-25 June, 2014.
- <“Air Quality Management: perspectives from Northeast States: Vermont,” Poirot, R., Oswald, E. and Dupigny-Giroux, L-A., NASA Air Quality Applied Sciences Team (AQAAT) 7<sup>th</sup> Semiannual Meeting, Harvard University, 17-19 June, 2014.

**Outreach:**

- 10 public presentations on climate change in Vermont and the impacts on specific sectors such as gardening.
  - “2015 Leahy Center Environmental Summit: Climate Change Resilient, Floodwater Smart,” Invited speaker, ECHO Lake Aquarium and Science Center at the Leahy Center for Lake Champlain, Burlington, VT, 21 March 2015.
  - “Nimble and active: Using technology to respond to real world events in a changing climate,” **Keynote speaker**, Teaching PLACE: Using technology and professional wisdom to uncover the interrelationships between natural and built systems, Champlain Basin Education Initiative, 24 January 2015.
  - “Communicating science: Reflections on being the VT State Climatologist,” Middlebury College, Environmental Studies Colloquium Series, 4 December 2014.
  - “A systems view of climate change in Vermont,” UVM Legislative Summit on Climate Change, 18 November 2014.
- my advanced seminar class (Climatology and Natural Hazards) was a Service-Learning format 1/in support of the State-Federal Roundtable that was co-organized with Northeast Regional Climate Services Director, Ellen Mecray and colleagues from the EPA and VT Agency of Natural Resources and 2/ to meet State and USGS identified needs around Critical Infrastructure, inundation flood modeling on Lake Champlain and updating FEMA Flood Insurance Rate Maps (FIRMs).
- Continued the activities of the Vermont Weather and Climate Research group, including participation in the aforementioned Vermont Climate Roundtable on 31 March 2015 in Montpelier, VT.

# University of Virginia Climatology Office

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Philip J. Stenger, Director and State Climatologist

The University of Virginia Climatology Office is a Research and Public Service Center in the Department of Environmental Sciences. The office is also an integral member of the Southeast Regional Climate Center and the director part of the center's Technical Advisory Committee.

The office provides information and conducts research on the atmospheric environment and the impacts of weather and climate on economic and ecologic systems to government, education, industry, the media and individuals. Its on-line, *Climate Advisories* feature climate research and/or educational material, and its web site offers an extensive array of climatic information and guidance to a broad spectrum of climatic data users.

**ARSCO Qualifications:** The AASC has designated the Climatology Office at the University of Virginia as the state climate office for Virginia. The following describes the ways in which the office addresses each of the ARSCO qualifications:

## **Communication Capabilities**

The University of Virginia Climatology Office has phone, fax, email and videoconferencing capabilities with high-speed Internet service for the rapid transfer of data. The office maintains a web site devoted to a variety of its educational, informational, data provision and outreach goals.

The office has enhanced real-time lightning detection and storm development monitoring capabilities, through the Telvent System.

## **Information Services**

The University of Virginia Climatology Office serves as the official repository and provider of climatic records within Virginia. It handles thousands of requests for information annually, and provides general guidance on climate issues of all spatial and temporal scales. Its web-based information services are accessed tens of thousands of times a year, with an estimated total download of information in the hundreds of

thousands of pages. These inquiries come from individuals, industry, the media and dozens of governmental and educational entities, worldwide.

The office's monthly video production *Climate Advisory*, a brief discussion of relevant topics regarding the climate of Virginia, was televised statewide on Public Television, public access channels and agricultural information networks. This collection is made available through the YouTube website.

The office frequently provides interviews to print, radio, television and web-based media. This includes taped and live broadcasts and regular radio call-in shows. Occasionally, the University will make informational webcasts and general news releases.

In addition, the office has been involved in a number of legal cases, some of which involved direct expert witness testimony, including a precedent-setting case slated for adjudication before the Virginia Supreme Court.

### **Research**

The office was a long-term integral participant in the Shinar Institute Research Program, which focused on the Shenandoah Valley of Virginia. Under this program, the office was involved with air quality climatology, development of an asthma alert system and demographic relationships to respiratory health. After the formal conclusion of the contract period, the office is continuing follow-up discussions, publications and impact planning based on this work.

This office is continuing a program of research into relationships between crime and weather conditions, including influences from geographical location, demographics and other factors. This office has been training and involving students in this work. Though in the preliminary phase, useful results have already been developed.

### **Additional significant research efforts of the office include:**

- Examination of the relationships between climatic regimes and exacerbation of respiratory distress in collaboration with researchers at the U.Va. Health Science Center.
- Investigation of the relationships between large-scale atmospheric teleconnections and tropical cyclone impacts in the Mid-Atlantic region.
- Investigation into a number of objective definitions of seasons and the timing of seasonal transitions.
- Analyses of objectively derived seasonal definitions to look for secular changes in warm and cold season onset and intensity.
- Investigation of factors linking human perception with objective measures of the intensity of seasonal conditions.
- Drought and drought impact research and monitoring.
- Analyses regarding thunderstorm precipitation distributions and relationships to major flash flooding events in Virginia.

## **Outreach**

- Provides data and expertise to dozens of state, federal and local government entities, and educational institutions each year.
- The office distributes information via hundreds of contacts with the print, radio, on-line and television media.
- The office serves as a lead scientific contributor to the Virginia Drought Monitoring Task Force with periodic conferences, drought reports, and analyses.
- A series of Video Climate Advisories regarding aspects of Virginia climate, produced for television and web-based distribution, including PBS and Farm Bureau networks are archived and available through the office website and YouTube.
- The office has been increasing emphasis on its web site as a vehicle for making information available to potential users. This has succeeded in reaching larger numbers of individuals and organizations in a more cost-effective fashion. The estimated amount of information accessed continues to increase substantially each year.
- Presentation of education and training lectures for the Virginia Master Naturalist Program at numerous locations around the state on an ongoing basis. This includes core instruction requirements for the program's many chapters around the state.
- Invited presentations to the Virginia Native Plant Society and Master Gardeners Organizations.
- Informational presentations before local government and advisory groups regarding climate-related topics of community concern.
- Involvement with school (K-12) and community groups regarding climate science.
- Work with graduate students at the University of Virginia and other institutions on degree research and class-related projects.
- The office has been recognized by the National Weather Association as an approved institution for seal holders to receive recertification education and experience. As such, it provides this service to local television weather forecasters.

## **Monitoring and Impact Assessment**

- Continuing work and publication regarding human health impacts in relation to changing weather conditions.
- Provision of data and impact assessment for and service as a member of the Virginia Drought Monitoring Task Force as lead climatologist.
- Participation as a member of the Virginia Hazard Mitigation Steering Committee, including development of climatic hazards analyses. The Virginia Hazard Mitigation Plan is accepted by FEMA, and now provides the guidelines for planning across the state. Assessment work continues for ongoing updates to the plan and review of proposed projects.
- Investigation into perceived severity of winter/summer conditions in Virginia, with specific emphasis on potential secular changes.



**2014 Papers in Preparation / Review:**

Hondula D.M., D.B. Knight, R.E. Davis, L. Marr, L.J. Sitka, S.D. Gawtry, K. Enfield, P.J. Stenger. Respiratory Hospital Admissions, Population Demographics and Air Quality Controls in the Shenandoah Valley of Virginia, *Health and Place*.

Heymann P., A.P. McLaughlin, J.A. Wisniewski, P.J. Stenger, J. Patrie, M.A. Brown, J.M. El-Dahr, T.A. Platts-Mills, N.J. Byrd. Seasonal Variations in Asthma Exacerbations Among U.S. Children Living in Different Geographic Locations, *Journal of Pediatrics*.

Stenger, P.J., J.M. Rawley. Secular Changes in the Relationship of ENSO with Atlantic Tropical Cyclones Impacting the Mid-Atlantic Region.



## Office of the Washington State Climatologist

[www.climate.washington.edu](http://www.climate.washington.edu)

### 2015 Annual AASC Report May 2015

This report summarizes the Office of the Washington State Climatologist (OWSC) activities during the last 12 months (May 2014 through April 2015). The objectives of OWSC continue to be as follows: (1) to provide climate data for Washington for users ranging from the public to state agencies to professional scientists, (2) to be a resource in the analysis and interpretation of the past, present, and future climate of the state, and (3) to conduct outreach and educational activities on behalf of the residents of Washington State. The office is affiliated with the Joint Institute for the Study of the Atmosphere and Ocean (JISAO) of the University of Washington and receives the majority of its financial support from the State of Washington. It seeks additional support from federal agencies to conduct research on issues related to regional climate.

#### Personnel

Nicholas Bond  
PhD, State Climatologist

Karin Bumbaco  
MS, Assistant SC

Luke Chang  
Student Assistant,  
Computer Science

Alexandra Caruthers  
Undergraduate Summer  
Intern

#### **Outreach and Support**

One of our main support activities in the last 12 months has been to support the WA State Department of Ecology in monitoring drought. This was the second consecutive winter that the Water Supply Availability Committee (WSAC) was activated to monitor conditions, and we were actively involved in monthly meetings again this year. The winter of 2014-15 was extremely warm causing our typical mountain snow to fall as rain, resulting in a great deal of concern about a snowpack/water supply drought. Unlike last year, during which a period of cold and wet weather in spring eased any drought concerns, state drought declarations were made this time around – nearly half of the state is in a declaration at the time of this writing. With drought declarations in WA, OWSC has been fielding more calls from state agencies and the media. We have also been writing a weekly drought monitoring report at the request of the WA State Department of Ecology (<http://www.climate.washington.edu/events/2015drought/>). This is representing a significant new effort, and additional funding is being sought to continue it.

In addition to supporting state agencies, OWSC has continued additional outreach and support activities in the last 12 months. One of our most popular products, the monthly climate newsletter that summarizes the previous month's weather events and puts them into a climatic context, has reached 55 new subscribers in the last year with a total of over 375 subscribers. OWSC has maintained the website ([www.climate.washington.edu](http://www.climate.washington.edu)) with links to climate and weather information, and has updated one of our most-popular tools – the trend analysis tool – with data through 2014. Our student assistant, Luke Chang, has continued to work on backend coding issues for some of the OWSC-developed tools. We have remained a reputable source for climate data and information requests that require more detail than our website provides (over 120 in the last 12 months). Many of these requests pertain to the developing drought. Another subject of great interest is the abnormally warm water that has developed off the coast of western North America (termed “the blob” by the WA State Climatologist). Aside from these requests, OWSC has continued to be retained as expert witnesses for an hourly fee on a number of court cases.

Increasingly, OWSC has been communicating with the public through social media. We currently have 145 followers on Twitter (@WAStateClimate) and 245 “likes” on Facebook. There is much larger following for the weekly guest segment of the State Climatologist on KUOW – the Seattle affiliate of National Public Radio.

Numerous appearances have been made by OWSC in the last 12 months, including scientific presentations at conferences and state agencies, guest lectures at the University of Washington, outreach demonstrations, and talks to the general public. An abbreviated list follows:

- PNW Climate Science Conference, NWS Emergency Management Workshop, Conference on Horsekeeping and Climate Change, PNW Weather Workshop, AASC Annual Meeting, Whidbey Island Gardening Workshop, Puget Sound Marine Waters Workshop, Paws-on-Science at Pacific Science Center, etc.

### **Research: Potential Evapotranspiration in Eastern WA, “The Blob”, Optimal Network Design, and Strong Wind Events**

As described in last year's annual report, recent OWSC research efforts have focused on daily records of potential evapotranspiration (pET) in the Columbia Basin of eastern WA and a journal manuscript is currently in press with the Journal of Applied Meteorology and Climatology (Bond and Bumbaco 2015). Findings include an increase in summer mean pET since the late 1980's that resulted from an increase in solar irradiance. Part of this increase is due to increase in clear-sky fluxes (“global brightening” as manifested regionally), part is due to a modest increase in temperatures, and part is due to a decrease in boundary layer humidity; whether these trends are likely to continue is beyond the scope of the study. Synoptic patterns associated with high and low pET summers are also examined.

OWSC, specifically Nick Bond, has also been involved with research to quantify just how unusual the warm waters off the west coast of WA State – termed “the blob” – were during the winter of the 2013-14. OWSC took the lead on a journal article (Bond et al. 2015) to describe the cause of the warm anomalies, as well as its extent and impacts on fisheries and regional weather.

A journal article evaluating weather station coverage over Antarctica (Bumbaco et al. 2014) with OWSC involvement was published within the last year. This seemingly should have nothing to do with OWSC, except that research on designing optimal observing networks that the office carried out in previous years is what led to our participation in the recent publication.

We also hosted a summer intern through the Joint Institute for the Study of Atmosphere and Ocean (JISAO) summer intern program – Alexandra Caruthers. With our guidance, Alex gathered hourly wind speed and direction records from around WA State and began preliminary analysis of the relationship between strong and moderate wind storms and ENSO in the region. Seasonality and general statistics for each of the 12 sites were also computed. We are actively looking for additional support to continue the work.

### **Publications**

Bond, N.A., M.F. Cronin, H. Freeland, and N. Mantua, 2015: Causes and impacts of the 2014 warm anomaly in the NE Pacific. *Geophys. Res. Lett.*, **42**, doi: 10.1002/2015GL063306

Bond, N.A. and K.A. Bumbaco, 2015: Summertime Potential Evapotranspiration in Eastern Washington State. *J. Applied Met. Clim.*, in press.

Bumbaco, K.A., G.J. Hakim, G.S. Mauger, N. Hryniw, and E.J. Steig, 2014: Evaluating the Antarctic Observational Network with the Antarctic Mesoscale Prediction System. *Mon. Wea. Rev.*, **142**, 3847-3859.

### **AASC Activities**

OWSC jointly hosted the 2014 AASC Annual Meeting with the Oregon Climate Service (OCS) at Skamania Lodge in Stevenson, WA in July 2014. OWSC and OCS ran the meeting successfully, and worked with the AASC executive committee to finalize meeting plans. OWSC was able to bring a student intern to the meeting – through sponsorship from the Western Regional Climate Center – to help run the technical aspects of the meeting. We have also been in contact with the 2015 meeting hosts to share meeting insights.

**West Virginia State Climate Office (WVSCO)  
2015 Annual Report for Calendar Year 2014**

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***Dr. Kevin Law, State Climatologist***

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The West Virginia State Climate Office (WVSCO) continues to deliver weather and climate information to the public while providing professional consultation. In the past year, the WVSCO has been contacted by various stakeholders including engineers, researchers, and government agencies while providing legal counsel and drafting reports to be used in trials where weather and climate expertise is essential.

In addition to consultation, the WVSCO assists in climatic education. One such opportunity was last summer at the Friends of Blackwater Symposium where a talk was given explaining the increased variability of our climate and the possible future climate scenarios for the region. The office also took the opportunity to speak with media outlets and other educational institutions. Last spring, the office in cooperation with the National Weather Service office in Charleston, WV held a StormReady and a Storm Spotter Training demonstration at Marshall University. The WVSCO continues to remain active with the CoCoRaHS network and participated in new recruiting activities such as visiting the WV Farm Bureau and local schools around the state to help increase the visibility of the program.

Already this year, the WVSCO has been invited to speak at the National Thoroughbred Racing Association Track Superintendents' Field Day and attend a workshop in Washington D.C. dedicated to teaching science through literature. The office has also agreed to help sponsor a local organization for a NOAA Environmental Literacy Grant proposal.

**2014 Weather and Climate in Review**

Very few major weather events occurred in West Virginia during 2014 but overall it was known for its below normal temperatures. Precipitation values for the year were near normal and balanced geographically and temporally even though there were areas that were seasonally drier and wetter. During the winter, southwestern WV was slightly above normal, while the rest of the state was below normal (Fig. 1). This shifted through the spring, as the southern part of the state became much drier and gradually became wetter moving northward (Fig. 2). The summer was much drier over much of the state with a few exceptions along the southern border and the northern panhandle (Fig. 3). By late fall, the precipitation reverted back to a wet pattern over much of the state (Fig. 4).

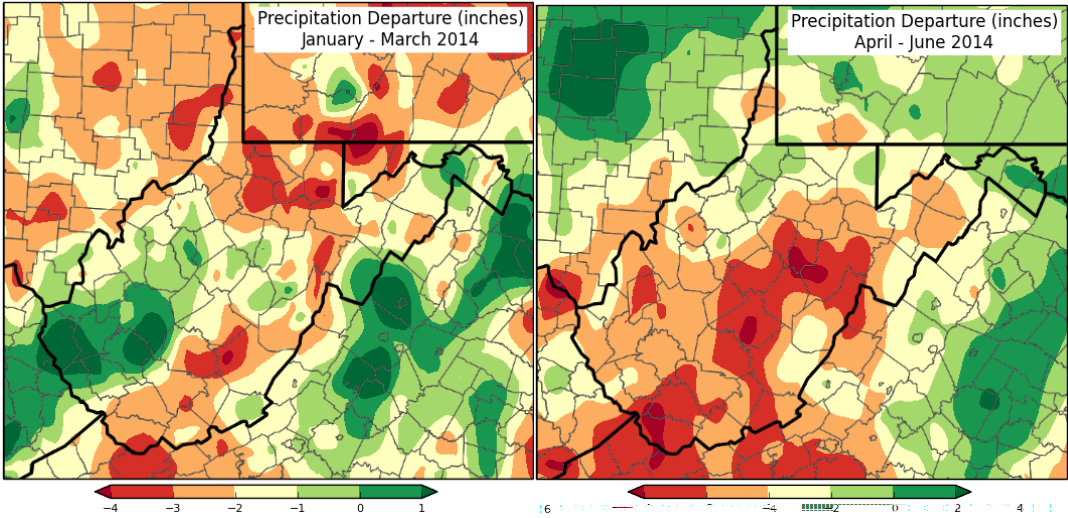


Figure 1: Jan. – Mar. Precip. Departure (in)      Figure 2: Apr. – June Precip. Departure (in)

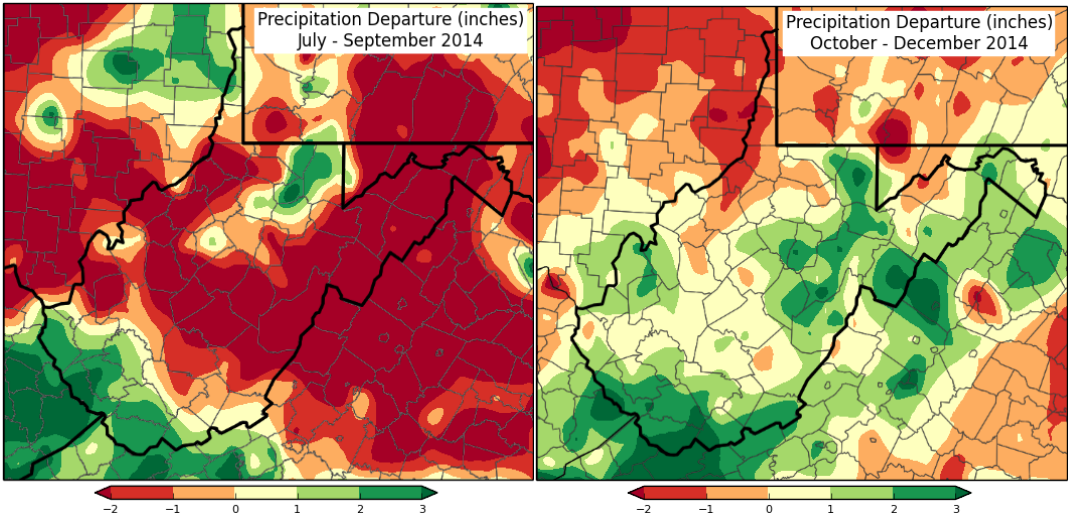


Figure 3: July. – Sept. Precip. Departure (in )      Figure 4: Oct. – Dec. Precip. Departure (in)

The 2014 temperatures were the most noticeable climate anomalies. Wintertime temperatures were well below normal with temperatures more than 6 degrees below normal in January (Fig. 5). Below normal temperatures continued through March although it was not quite as harsh as

January. In fact, January was the 8<sup>th</sup> coldest in state history. Despite the very cold temperatures, precipitation values were not that high, therefore overall snowfall totals were not that impressive.

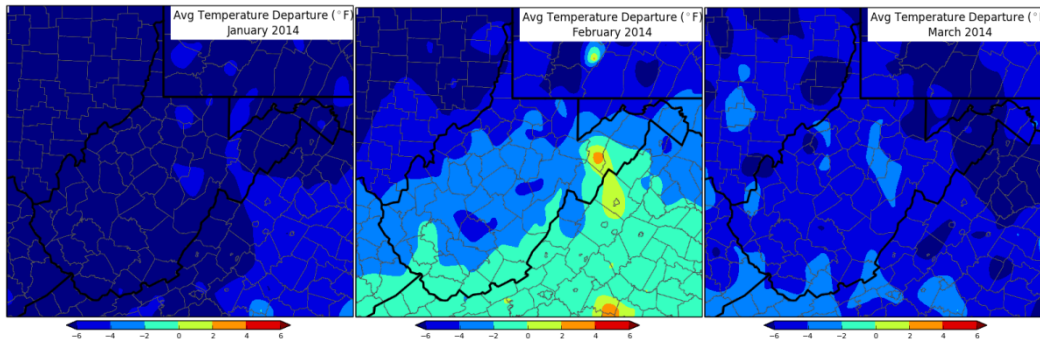


Figure 5: Jan., Feb., and March Temperature Departure (°F)

By springtime, temperatures started to increase near normal to slightly above normal conditions over much of the state (Fig. 6). The warmest temperatures of the year occurred in June. However, the warmer temperatures did not last long as July and August (Fig. 7) quickly reverted to below normal temperatures. West Virginia had its 15<sup>th</sup> coldest July and its 26<sup>th</sup> coldest August in 2014. It definitely had residents asking the question, “Where is summer?”

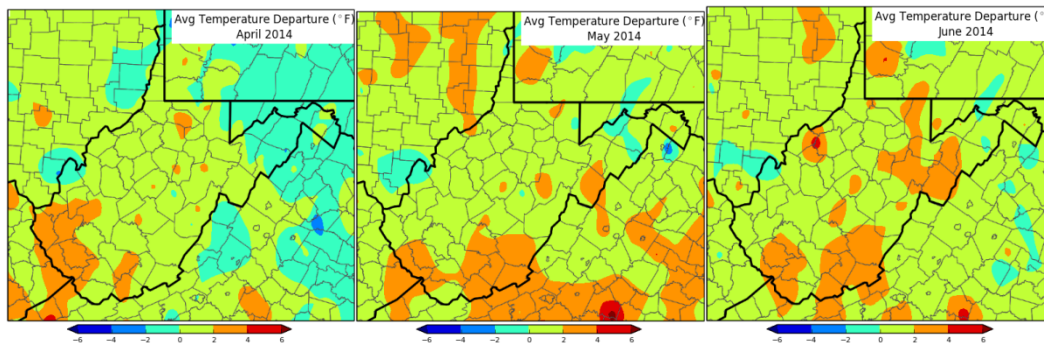


Figure 6: April, May, and June Temperature Departure (°F)

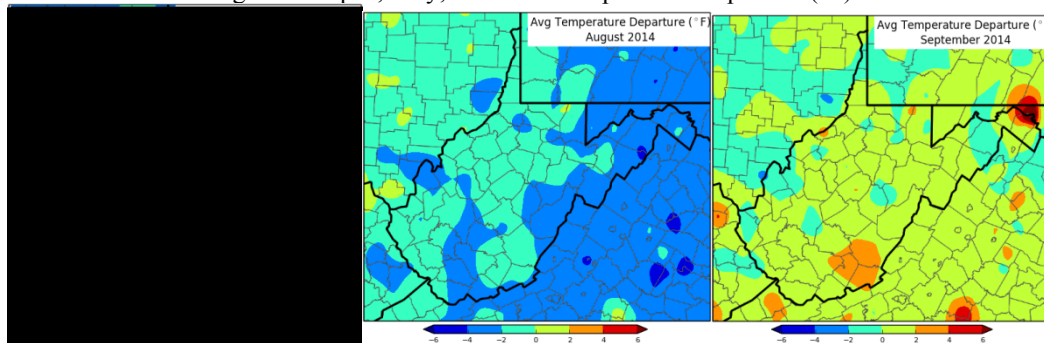


Figure 7: July, August, and September Temperature Departure (°F)



By September, temperatures finally came back to normal. But the end of the year produced temperatures all over the spectrum as October was near normal, November was extremely cold, while December was unusually warm (Fig. 8). To show the extremes, it was the 7<sup>th</sup> coldest November and the 18<sup>th</sup> warmest December in recorded state history.

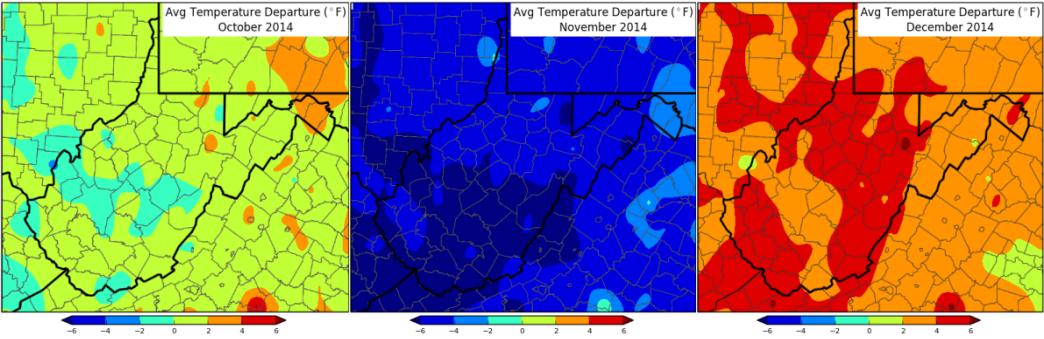
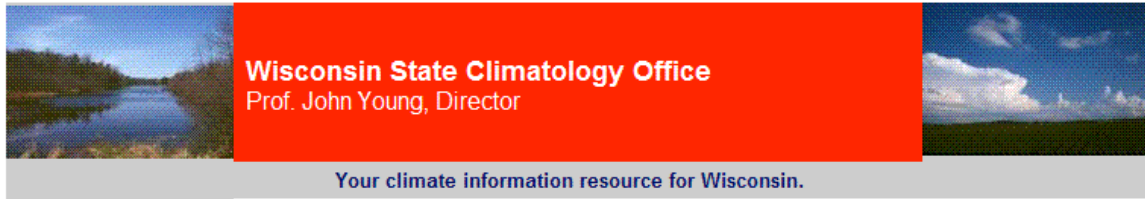


Figure 8: October, November, and December Temperature Departure (°F).





The Wisconsin State Climatology Office (SCO) is affiliated with the Department of Atmospheric and Oceanic Sciences at the University of Wisconsin-Madison and is a partner with the Midwestern Regional Climate Center. The SCO distributes and analyzes data for climate monitoring, provides climate information and interpretation to residents of Wisconsin, develops “value –added” climate for a wide user community, and conducts applied climate research with University and State collaborators. The part-time office staff consists of Lyle Anderson (office manager, data management), Dr. Edward Hopkins (data access and analyses, website graphical products), and Emeritus Professor John Young (Director, scientific analyses and liaison to University researchers).

### **INFORMATION SERVICES**

**Website:** The SCO maintains its website <http://www.aos.wisc.edu/~sco> that provides an expanding variety of graphical climate information, data, and links for citizens, scientists and clients in the government and private sector. Continuing progress on climate products includes:

- Climate History: Graphics that demonstrate observed climate variability by year, season, and locations through the state are routinely updated.
- Extensive data for seven cities illustrate interannual, interdecadal fluctuations and recent climate trends. Seasonal variations of trends and variability are pronounced.
- Probabilities of temperature, precipitation and extreme events are being expanded. Tables of “normal” probabilities of temperature, precipitation, and snow (plus derived variables for applications) are being linked to Wisconsin city pages.
- Climate Watch: month-to-month climate anomalies for recent year-long intervals demonstrate strong intra-seasonal variations that disrupt seasonal forecasts.
- Applications sections on Water, Energy, and Agriculture continue to expand. Risk probabilities are being investigated, especially for heavy rains.

**Data Services:** The SCO staff answers questions and fills data requests made by telephone, fax, email and office visits. Advice is also provided on web links to climate data and maps from regional and national centers. Nearly 460,000 contacts are made annually from the public, media, private sector (e.g., legal, insurance) and governmental agencies. These consisted of more than 450,000 website visits, 440 email requests, and 160 telephone inquiries in 2014. Most requests made by the public are routine and answered without charge. A minimal service charge is assessed for data and interpretation analyses that require significant time or scientific effort.

## **OUTREACH**

The SCO continues to make its presence known to University colleagues and residents of Wisconsin. In addition to interviews with the electronic and print media in the state, the staff gives lectures to service groups, universities and business conferences.

**University of Wisconsin-** John Young continues to be liaison with staff and students in the Department of Atmospheric & Oceanic Sciences (AOS), and campus physical science groups. In addition to AOS, he participates in the weekly Physics Department's Chaos and Complexity Seminar and Applied Mathematics Seminar, is now an invited member of the "4<sup>th</sup> Tuesday" dinner group of senior campus scientists, and interacts with climate-related research faculty in other academic departments. He is an Affiliate Member of the Center for Climate Research. He usually speaks at AOS research seminars and graduating AOS seniors (topics such as "Exploring the Intersections of Weather, Climate, and Impacts" and "Views of Climate Chaos"). His latest Physics talk in 2014 was "Variability, Uncertainty and Vulnerability in our Chaotic Climate". Ed Hopkins' role as "Dr. Data" has expanded to include assistance to student researchers from several departments, and consultation on data issues with the Center for Climate Research.

**Climate Change and Variability-** Young occasionally speaks on themes of regional change, variability, extremes, and impacts to public and university groups. In addition to some television and newspaper interviews, the News page of the University web site published some interviews with him and Hopkins on specific Wisconsin climate events. Recent attention has been on (a) disrupted trends in lake ice cover and winter temperatures in Wisconsin, (b) dry to drought conditions in 2014 following an exceptionally wet spring of 2013, and (c) record cold winter months due to the "polar vortex." Young interacted with University Extension affiliates on the drought issue, including assessment of both short-term and long-term aspects and the impact of frozen soil. He spoke at a special Climate Change Extension lecture series in Iowa County on "Understanding Wisconsin Impacts in a Changing Climate." Hopkins has given talks on Wisconsin climate and extreme weather to public groups in southern Wisconsin, including a keynote address at a statewide conference of golf course turf managers.

**Climate Change and Adaptation-** In 2008, the SCO was recognized as a collaborator within the developing Wisconsin Initiative on Climate Change Impacts (WICCI), a multidisciplinary program involving university and state government scientists that issued a major report in 2012. Young currently is a member of the WICCI Outreach Committee. This collaboration is a basis for a hoped-for expanded SCO mission in Wisconsin climate change science applications in the future, and collaborations with colleagues in the Center for Climate Research. The development of this program has recently been delayed by state political opposition to climate science funding. On a regional basis, Young participated in the March 2014 "Midwest Climate Collaboration Meeting" hosted by MRCC in Illinois.

**USDA Interactions-** Hopkins gives regular input to the Wisconsin Ag Statistics Service, the Wisconsin Department of Natural Resources and the U.S. Geological Survey. The SCO has regularly served as ex-officio member of the State Emergency Board for the Farm Services Administration, which reviews specific weather/climate events contributing to crop damage.

**National Weather Service-** SCO regularly interacts with staff members in three NWS offices regarding weather/climate extremes and climate issues. Ed Hopkins continues to analyze weather

extremes reported at individual stations throughout the state and is a member of the State Climate Extremes Committee.

**National Publications-** Hopkins coauthored an article for the Nov/Dec 2014 issue of the periodical *Weatherwise* entitled “The Weather and Climate of Wisconsin: It’s More than Frozen Tundra.” This article updates aspects of the 2002 book “Wisconsin’s Weather and Climate” (University of Wisconsin Press) by J.M.Moran and E.J. Hopkins.

## RESEARCH

Young continues to explore the basis for developing probabilistic content of our data analyses, which will provide a clearer starting point for analysis of climate extremes and their trend. Interactions with other campus colleagues on the recurrence probabilities for heavy multi-day rains are one focus. Continuing related work is done on campus with Physics Professor J.C. Sprott regarding power laws in chaotic precipitation records. Young’s one-year collaboration with NCDC scientists K. Kunkel, T. Karl, and K. Redmond of WRCC on future changes in Probable Maximum Precipitation resulted in an article published in *Geophysical Research Letters*.

The SCO continues to intermittently collaborate with WICCI scientists from across the campus.

## STATUS OF PROJECTS AT END OF 2014

- Maintain the spectrum of SCO services and factual data despite state cuts to University funding and current political opposition to climate science.
- Continue to establish a probability basis for analysis of extremes and impacts.
- Eventually establish state funding for science staff and achieve ARSCO status.
- Partner with local, state and federal government agencies on matters relating to climate services and long-term climate change.
- Continue expansion of website information, smoothed graphics and probabilities.
- Expand collaborative research with campus and state in WICCI.

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Meteorology and Space Science Building, on UW-Madison campus,  
home of Wisconsin State Climatology Office (photo by Hopkins)



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Tony Bergantino	Deputy Director
Barbara Muller	Librarian and Archivist
Michelle Ogden	Data Services/Research Associate
Kira Olson	Office Administrator and Data Manager

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The Wyoming State Climate Office (SCO; [http://www.wrds.uwyo.edu/sco/climate\\_office.html](http://www.wrds.uwyo.edu/sco/climate_office.html)) is a part of the Wyoming Water Resources Data System (WRDS; <http://www.wrds.uwyo.edu>) and together are the single largest providers of water- and climate-related data in the state. Established in 1967 and housed within the Department of Civil and Architectural Engineering at the University of Wyoming, WRDS and the SCO are funded primarily through contracts with the Wyoming Water Development Commission.

The WRDS/SCO staff provides a variety of services, ranging from the development of enhanced drought-monitoring products to the online dissemination of water and climate data. WRDS and the SCO also support a wide range of groups by assisting in the development of the State Water Plan and helping to coordinate climate- and hydrologic-monitoring efforts throughout Wyoming.

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### **Activities Related to the ARSCO Mission**

#### ***Providing Support for Resource Management in the State and Region***

- Digitization of daily and spot Diversion records for Water Division II. These data are made available to resource managers for determining available flow during various hydrologic conditions and the digitization expands upon previous years' work. This is an ongoing effort with the State Engineer's Office and the intent is to digitize these records throughout the entire state and to make them available via map- and text-based interfaces.
- Continued CoCoRaHS participation is helping us provide precipitation data for parts of the state where there is otherwise only modeled information. We have also used CoCoRaHS as a means of connecting with various stakeholder groups to let them know of our capabilities and what sorts of information we can provide to them that they may not have otherwise been aware of.
- Assistance with Probable Maximum Precipitation update for the State of Wyoming. This study provides Probable Maximum Precipitation (PMP) values for any drainage basin within Wyoming, including regions adjacent to the State that provide runoff into drainage

basins within Wyoming. The PMP values are valid for June 15 through September 15, which is the time of the year when the most intense rainfall could occur. A seasonality adjustment is provided to derive PMP values for dates outside of this time period. PMP values may be used in the computation of the Probable Maximum Flood (PMF). PMP values provided in this study supersede PMP values in the four Hydrometeorological Reports (HMRs) for locations in Wyoming, including HMR 49 (Hansen et al., 1977), HMR 51 (Schreiner and Riedel, 1978), HMR 55A (Hansen et al., 1988), and HMR 57 (Hansen et al., 1994).

### ***Coordinating and supporting the collection of weather and climate data***

Over the past year, WRDS/SCO has continued to be involved in supporting and enhancing weather/climate data collection platforms in the state. WRDS/SCO is expanding a cooperative effort with the Department of Civil & Architectural Engineering, the City of Laramie, and the National Weather Service to monitor and report real-time precipitation and streamflow around Laramie to assist with flood warning and modeling. This effort also involves two graduate students who are gaining experience relevant to their studies. Phase one of this project has just been completed and consisted of the installation of a streamflow station in cooperation with National Weather Service office in Riverton. The station is transmitting 15-minute stream stage, air temperature, water temperature, and precipitation.

WRDS/SCO continues to maintain and enhance the NWS COOP station (485435, Laramie 2NW) which it has done now for almost 50 years.

CoCoRaHS continues to play an important part in operations at the WRDS/SCO. Observation numbers and participant involvement was on par with the previous year and remains high. Emphasis has continued on invigorating observers and trying to get observers who have gone inactive back reporting.

Our Social Media presence has increased in the last year with as we explore this venue as a means of getting our products out to a wider range of users.

### ***Weather and climate research, assessments, and data dissemination***

- Continued to offer ready access to a large suite of water and climate-related data via the World Wide Web. These web products continue to serve an increasing audience with the number of visitors increasing about 20% compared to the previous timeframe.
- New equipment was purchased late in 2014 with an eye toward updating our aging ArcIMS platform. The new mapserver, based upon ArcGIS Server will allow for a much broader and efficient access to water and climate data, both graphical, textual, and in document form for the state of Wyoming. Development and enhancement of this new tool is ongoing.
- The number of traditional (phone, email, mail, walk-in) requests has decreased again and was lower again compared to the same time period the year before. This decline is attributed to the continued increase in the amount of products being placed online. While the numbers of traditional or simple requests are going down, the continued trend of an increase in specialized requests is still ongoing. These specialized requests are for data that require some extra packaging or data processing to produce the end product that the

requestor is interested in and go beyond simply a temperature or precipitation amount for a particular set of days.

- WRDS/SCO maintains a circulating Library containing over 21,000 documents on water and climate. The Library has weekly visits by students, faculty, and consultants. Digitization of historical Water Development Project Reports has been completed with the exception of a few documents that will require special effort to digitize. We are now working to lessen the turnaround time between when a report is completed and when it is available online.
  - <http://library.wrds.uwyo.edu>
- Numerous interviews with media (radio and newspaper) related to drought conditions as well as snowpack and temperature extremes.
- Although CoCoRaHS promotion was much more subdued than previous years, there was still a spin-off enhancing the overall visibility of the WRDS/SCO operations and has resulted in invitations to speak to multiple groups and organizations such as Master Gardeners, etc.
- Heavy involvement in QC operations for the CoCoRaHS network development of new routines for error checking. These new methods are being used (in conjunction with the current tests) by several states with hopes that nationwide usage will follow.

## **Representative Publications**

### ***Service/Outreach Publications***

- Nicholson, C. 2014. *Drought Impacts and the Security of Wyoming's Future Water Resources: Online Decision Making Tools for Multiple Water Use Sectors*. Presented at the International Water Association Water, Energy and Climate Conference, Mexico City, Mexico.
- Nicholson, C. 2014. *What's New with Water and Climate in Wyoming?* Presented at the Wyoming Association of Rural Water Systems, Spring Training Expo. Casper, WY.

*Compiled by Tony Bergantino*

**AASC Current State Climatologists/Office Directors:**

<b>State</b>	<b>State Climatologist/Office Director</b>	<b>ARSCO</b>
Alabama	John Christy	Yes
Alaska	Peter Olsson (SC), Gerd Wendler (Director)	Yes
Arizona	Nancy J. Selover	Yes
Arkansas	Michael J. Borengasser	No
California	Michael Anderson	Yes
Colorado	Nolan Doesken	Yes
Connecticut	X. Harrison Yang	Yes
Delaware	Daniel J. Leathers	Yes
Florida	David Zierden	Yes
Georgia	Bill Murphey	No
Hawaii	Pao- Shin Chu	Yes
Idaho	Russell Qualls	Yes
Illinois	Jim Angel	Yes
Indiana	Dev Niyogi	Yes
Iowa	Harry Hillaker	Yes
Kansas	Xiaomao Lin	Yes
Kentucky	Stuart Foster	Yes
Louisiana	Barry Keim	Yes
Maine	George L. Jacobson	No
Maryland	Konstantin Vinnikov	No
Massachusetts	David Taylor	No
Michigan	Jeff Andresen	Yes
Minnesota	Greg Spoden	Yes
Mississippi	Michael Brown	Yes
Missouri	Patrick Guinan	Yes
Montana	Kelsey Jencso	No
Nebraska	Allen Dutcher	Yes
Nevada	Douglas P. Boyle	No
New Hampshire	Mary Stampone	Yes
New Jersey	David Robinson	Yes
New Mexico	David DuBois	Yes
New York	Mark Wysocki	No
North Carolina	Ryan Boyles	Yes
North Dakota	Adnan Akyuz	Yes
Ohio	Jeffrey C. Rogers	No
Oklahoma	Renee McPherson	Yes
Oregon	Philip Mote	Yes
Pennsylvania	Paul Knight	Yes
Puerto Rico	Amos Winter	No
Rhode Island	VACANT	No
South Carolina	Hope Mizzell	Yes
South Dakota	Dennis Todey	Yes

Tennessee	VACANT	No
Texas	John Nielsen-Gammon	Yes
Utah	Robert Gillies	Yes
Vermont	Lesley-Ann Dupigny-Giroux	Yes
Virginia	Philip Stenger	Yes
Washington	Nick Bond	Yes
West Virginia	Kevin Law	Yes
Wisconsin	John Young	Yes
Wyoming	Tony Bergantino	Yes