



CLIMATE  CENTRAL

# THE AGE OF ALASKAN WILDFIRES

Todd Sanford, PhD, Regina Wang, and Alyson Kenward, PhD

2015

# THE AGE OF ALASKAN WILDFIRES

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Princeton: One Palmer Square, Suite 330 Princeton, NJ 08542

Phone: +1 609 924-3800

Toll Free: +1 877 4-CLI-SCI / +1 (877 425-4724)

[www.climatecentral.org](http://www.climatecentral.org)

## SUMMARY

Alaska, the great northern frontier of America, is being reshaped by climate change. While rising temperatures are altering its character and landscape, they are also bringing the ravages of wildfires.

In the past 60 years, Alaska has warmed more than twice as fast as the rest of the country, with average temperatures up by nearly 3°F. By 2050, temperatures are projected to climb an additional 2-4 degrees, with the Arctic region seeing the most dramatic increases. These rising temperatures are expected to increase wildfire risks in Alaska, just as they have in the rest of the western U.S.

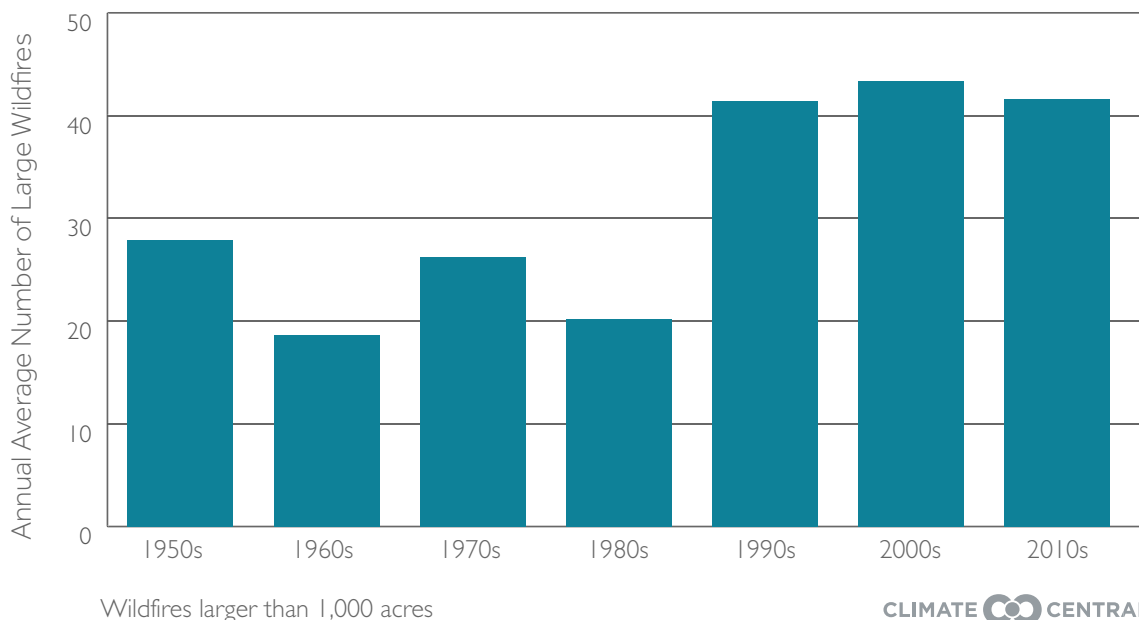
Wildfires have been on the rise across the western U.S. since the 1970s, at the same time that spring and summer temperatures have increased dramatically, and average spring snowpack has declined substantially.

Fires in Alaska don't often make news in the lower 48, but they threaten vast expanses of forest, parkland, and tundra that store immense quantities of carbon. The state's growing number of large wildfires have the potential to damage these ecosystems, and the people and wildlife that depend on them, while releasing a significant amount of carbon into the atmosphere, further contributing to global warming. Wildfire emissions over these vast areas also threaten air quality in Alaska and beyond.

Our analysis of 65 years of Alaska wildfire data shows:

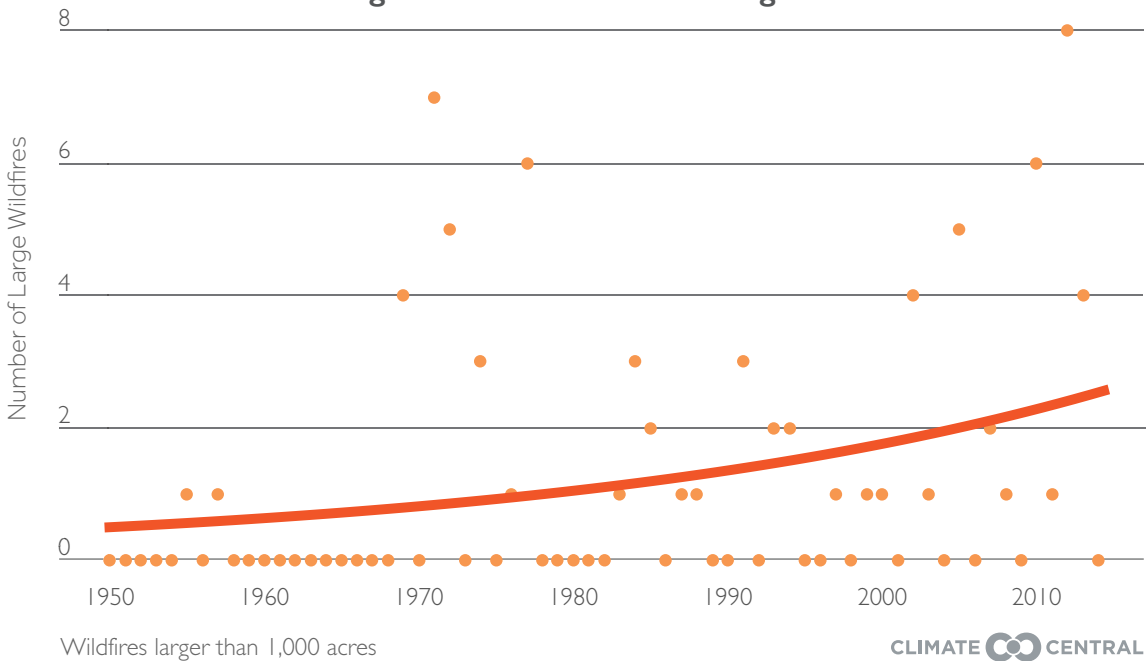
- The number of large wildfires (larger than 1,000 acres) suddenly increased in the 1990s, and the 2000s saw nearly twice as many large wildfires as the 1950s and 60s.

### Alaska Wildfires Have Increased Dramatically Since 1990



- In the Arctic region, the number of large wildfires increased nearly tenfold in the 2000s compared to the 1950s and 60s. Only three years in the 1950s and 1960s saw large wildfires; there have been 33 large wildfires in the Arctic since 2000.
- The area burned in large wildfires each year is increasing. In just two years, 2004 and 2005, wildfires burned a larger area than in the 15 years from 1950-1964 combined. In particular, there has been a dramatic increase in wildfires larger than 10,000 acres but smaller than 50,000 acres.
- Alaska's wildfire season is about 40 percent longer now than it was in the 1950s. The first wildfires start earlier in the year, and the last wildfires are burning longer into the fall. Overall, the wildfire season has increased more than 35 days and is now more than three months long, running from May through early August.
- Rising temperatures across Alaska have been concurrent with the rise in the number and size of Alaskan wildfires. Years with the hottest May-July temperatures also tend to be years with the most fires, and the greatest area burned.
- According to the National Climate Assessment, the amount of area burned in Alaskan wildfires is projected to double by 2050 and triple by 2100 under continued emissions and further warming.

### Large Arctic Wildfires No Longer Rare



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# 01. INTRODUCTION

The number of large western wildfires burning every year, on average, across the western U.S. has been on the rise since the 1970s. In a 42-year analysis of large wildfires (larger than 1,000 acres) on U.S. Forest Service land, Climate Central found that the number of wildfires burning now is at least double what it was in the 1970s, on average, and some states have seen an even more dramatic increase (Climate Central, 2012). Also since the 1970s, the total area burning has risen and the length of the wildfire season has increased dramatically. Over this same period of time, average annual temperatures, as well as spring and summer temperatures specifically, have also increased across the West, while average spring snowpack has decreased. While there are several factors that influence wildfire activity, it is clear that typical wildfire years and the climate drivers behind them, are changing.

How wildfires have changed across Alaska is also of growing interest. In the past 60 years, Alaska has warmed more than twice as fast as the rest of the country, and temperatures are projected to rise by 2-4°F more by 2050 (with the most dramatic rates of warming projected for the far north) (Chapin et. al., 2014). The vast majority of Alaska's interior is boreal forest, and this area is susceptible to wildfires, with an average of about 1 million acres burning every year (Alaska Division of Forestry, 2010).

While wildfires can be devastating locally, the impacts of Alaskan wildfires are also widespread. Immense quantities of carbon are stored in the state's boreal forests and tundra regions. As these areas burn, they release carbon emissions into the atmosphere, helping drive global temperatures even higher. In a self-feeding cycle, this hotter climate is expected to raise wildfire risks even further.

To better understand recent trends in wildfire activity across Alaska, Climate Central set out to analyze wildfires according to similar methods used in our previous analysis of 11 western states, [The Age of Western Wildfires](#).

## 02. OVERALL INCREASE IN ALASKA WILDFIRES

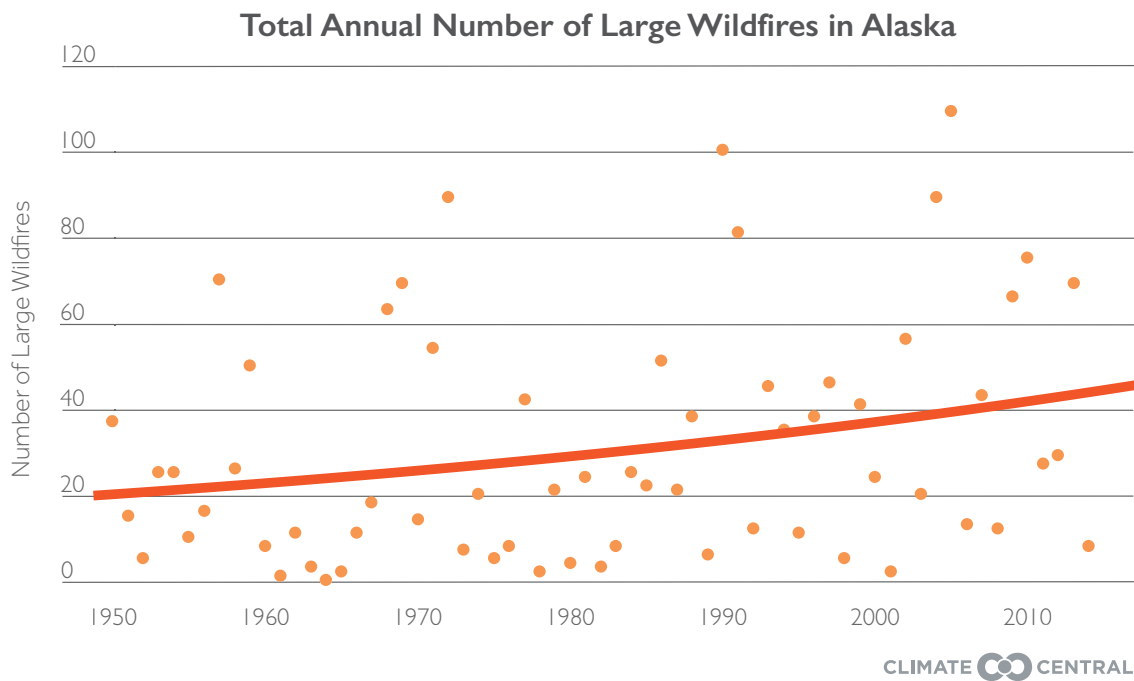
To study trends in wildfire activity across Alaska, we analyzed more than 60 years of wildfire data from the Bureau of Land Management (BLM) Alaska Fire Services (see Methodology section for details). Our analysis focuses on changes in wildfire frequency and area burned rather than measures of severity or intensity. Using BLM records of wildfires larger than 1,000 acres in size from 1950-2014, we plotted changes in the annual number of large wildfires and the total area burned from these in 6 regions, distinguished by vegetation and climate: Arctic, Interior, Bering, South-Central, Southeast, and Aleutians (see Figure 1).

This analysis focuses on changes in large wildfire numbers and sizes, and the potential associations of these trends with climate factors. However, it is also important to acknowledge that management practices can factor into wildfire activity. In particular, in 1986, fire suppression policy was instituted in Alaska with a focus on critical areas, such as near cities and towns (Calef 2015). However, this imperative to suppress so-called “high-priority” wildfires meant that managed fires tended to remain small in size. Consequently, most of these actively suppressed fires have been excluded from this study because they never grew to be more than 1,000 acres.



**Figure 1.** The state of Alaska is separated into six broad regions based on vegetation types and climate. See Methodology for full description. Figure based on Vose et al. 2012.

## 02. OVERALL INCREASE IN ALASKA WILDFIRES



**Figure 2.** Annual number of large wildfires (larger than 1,000 acres) across all regions of Alaska between 1950-2014. The fit to the data is a Poisson regression and the p-value is  $<2e^{-16}$  (see Methodology for a note on statistical regressions and measures of statistical significance).

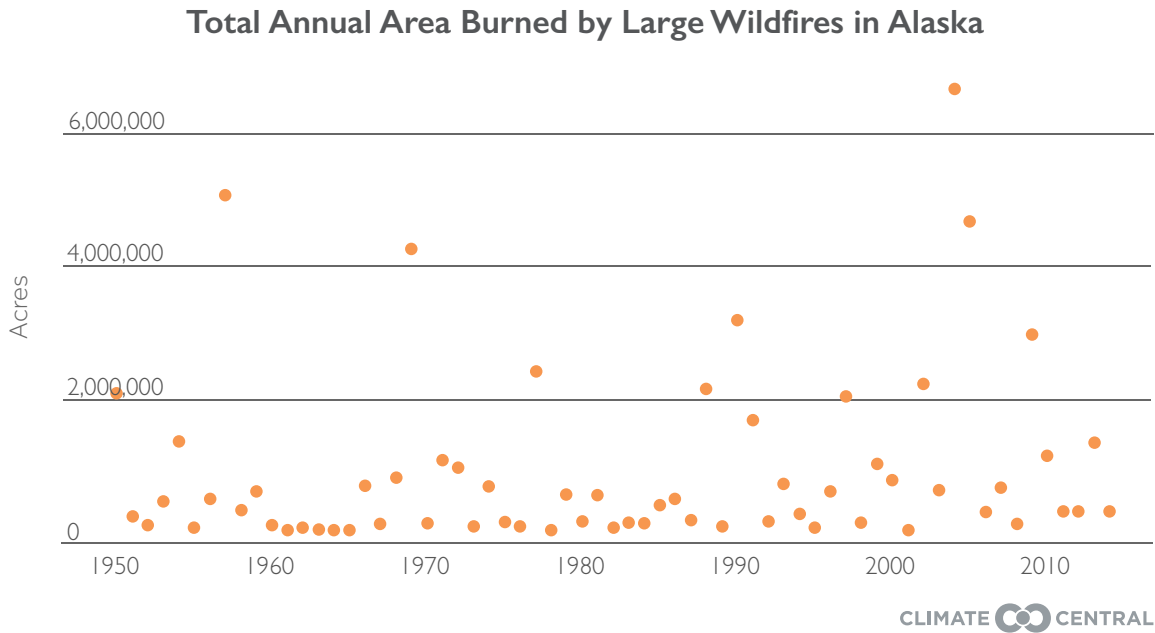
As illustrated in Figure 2, the frequency of large Alaskan wildfires has increased statewide in the past few decades. This overall increase contains large inter-annual variability. The beginning of the period saw roughly 20 large wildfires in an average year, whereas now Alaska has over 40 large wildfires each year, on average. Since 1950 about a quarter of all years have seen fewer than 10 wildfires, but there has only been one year since 2002 with fewer than 10 fires (2014). Four of the five years with more than 80 fires have occurred since 1990.

The area burned in these large wildfires has likewise increased, as shown in Figure 3. Notably, the combined fires of 2004 and 2005 burned more acres than all the fires in the first 15 years of the study period. Similar to the trend in large wildfire frequency, there is an overall upward trend in the area burning each year, though there is high inter-annual variability. The megafires (those larger than 50,000 acres) obscure the trends of the other large wildfires in Figure 3 to some degree. The wildfires burning between 1,000 and 50,000 acres are shown in Figure 4. The upward trend for these large wildfires now is clearer when the less frequent megafires are removed.

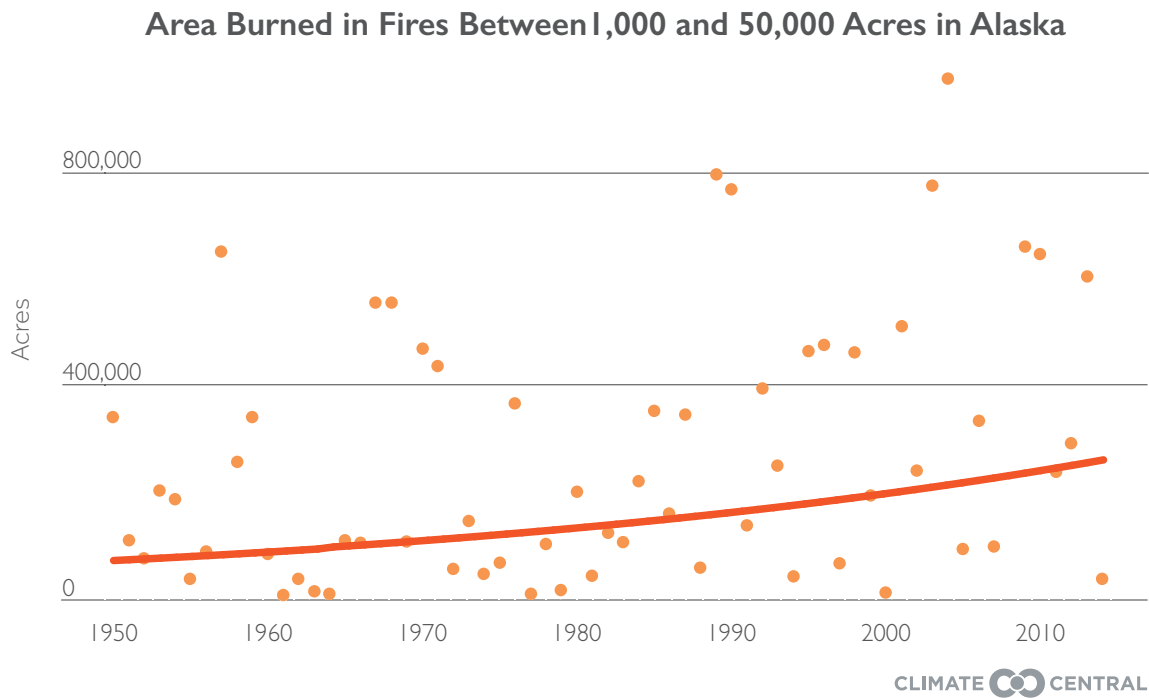
Examining these trends as decadal averages reveals a pronounced change. Figure 5 shows the average number of large wildfires each year by decade and indicates a marked increase in fire activity in the 1990s. While the first four decades of the study period averaged fewer than 24 fires per year each decade, the next three decades, including the currently incomplete 2010s decade, averaged 42 fires per year.



## 02. OVERALL INCREASE IN ALASKA WILDFIRES

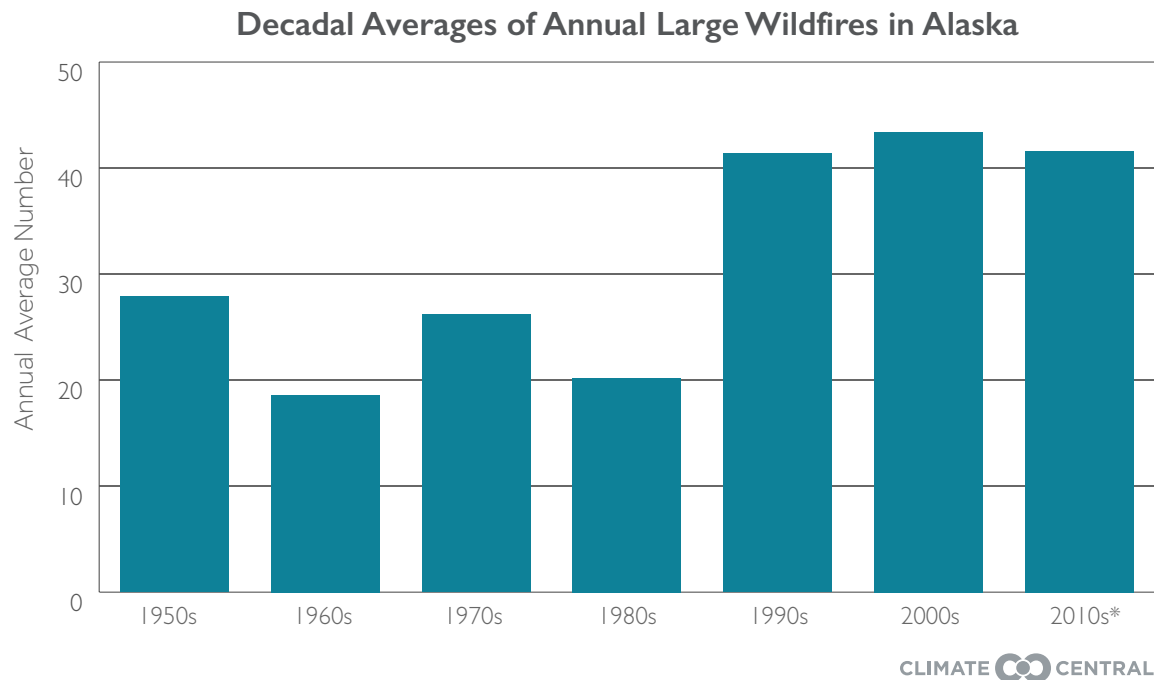


**Figure 3.** Annual area burned in large wildfires across all regions of Alaska between 1950-2014.



**Figure 4.** Annual area burned in large wildfires between 1,000 and 50,000 acres across all regions of Alaska. An exponential fit to the data is shown. The period of record is 1950-2014 and the data used is the same as in Figure 3.

## 02. OVERALL INCREASE IN ALASKA WILDFIRES

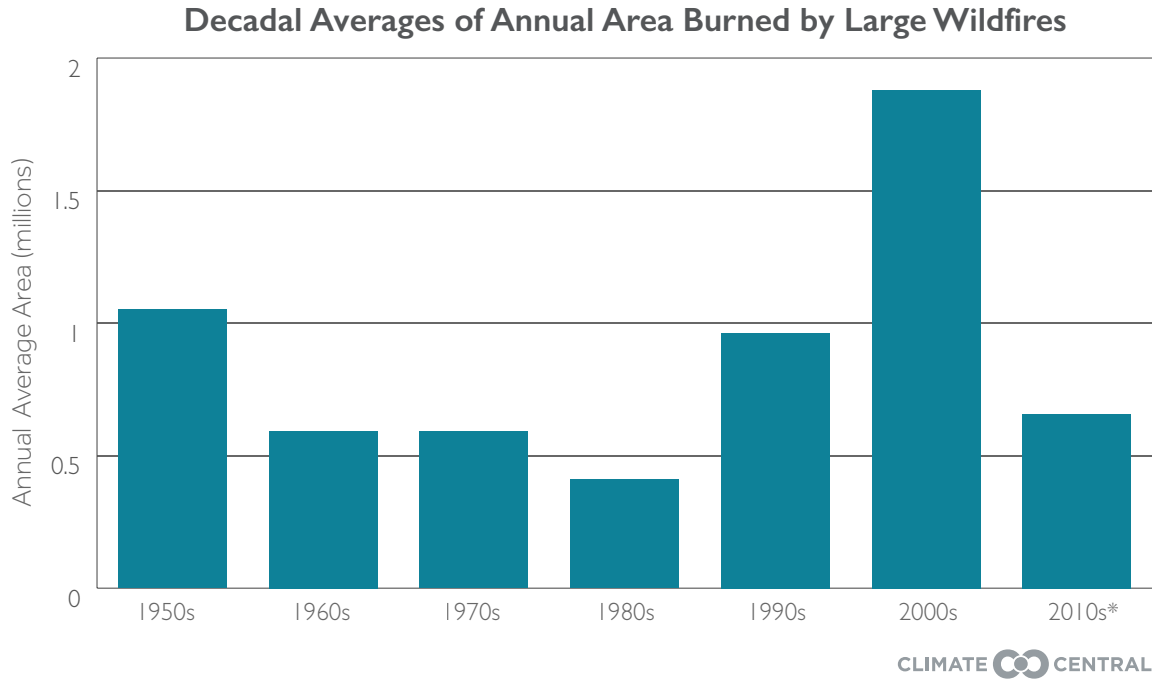


**Figure 5.** Decadal averages of annual number of large wildfires across all regions of Alaska.  
\*The value for the 2010s decade is derived from the average number of fires between 2010-2014 (not the full decade).

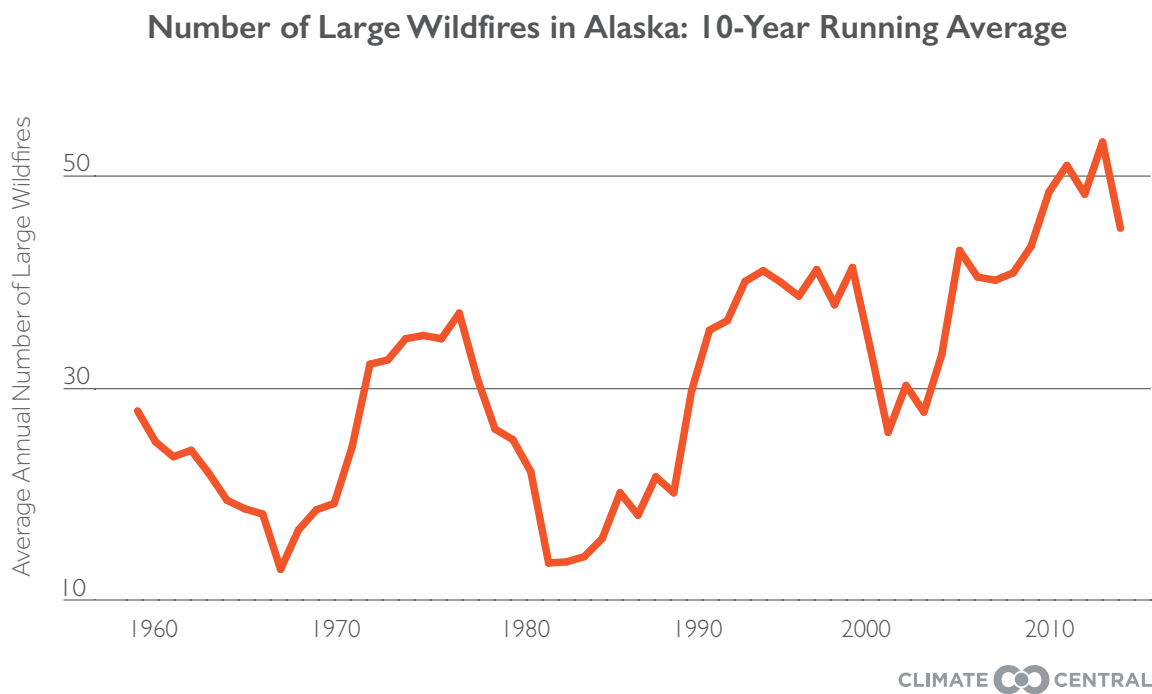
Decadal trends in area burned are less clear, but Figure 6 shows a dramatic spike in total burned during the last full decade. From 1980 to 2009, the average area burned each year approximately doubled each decade, with at least 8 million more acres burned in the 2000s than in any other decade. While the current decades has not yet seen comparable areas burned, the historical patterns of inter-annual variability in any given decade suggest that this decade could still change significantly with large wildfire activity in the final five years.

Studying the 10-year running average of Alaska wildfire data also helps illustrate the large inter-annual variability in Alaskan wildfires (Figure 7). This view shows oscillations in the data on roughly decadal scales, but an overall upward trend over the record towards more large wildfires each year. Figure 8 shows the 10-year running average for total area burned by large wildfires in Alaska. It shows a similar decadal-oscillation, and a large increase beginning after 2000.

## 02. OVERALL INCREASE IN ALASKA WILDFIRES

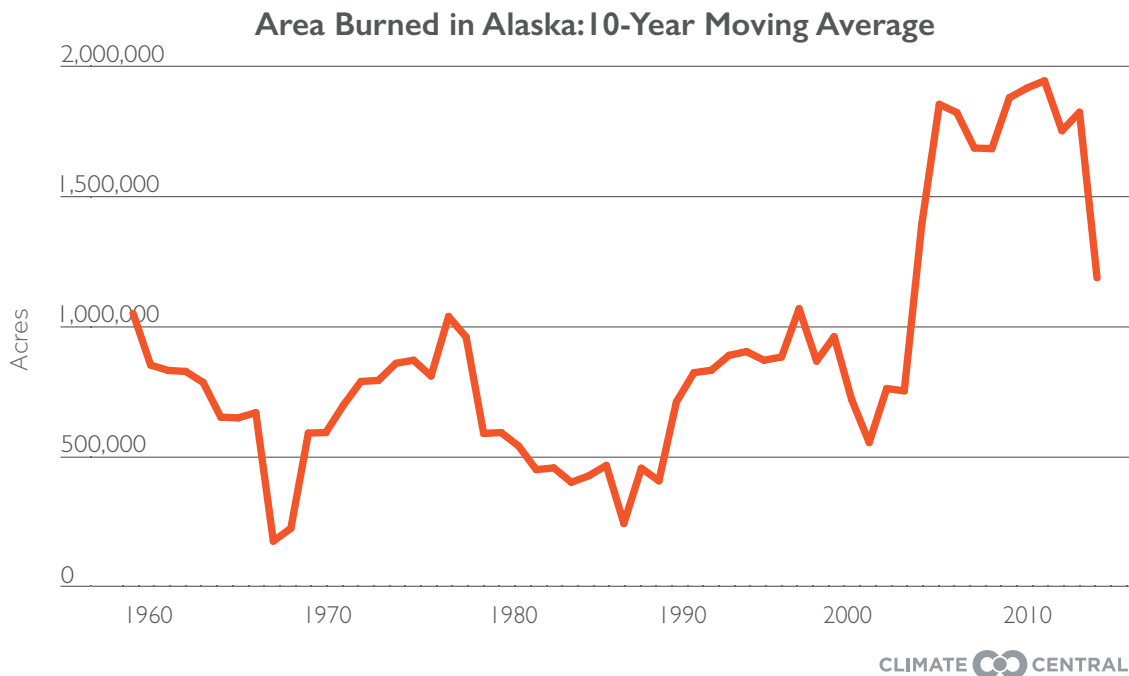


**Figure 6.** Decadal averages of annual area burned by large wildfires across all regions of Alaska. \*The value for the 2010s decade is derived from the average number of fires between 2010-2014 (not the full decade).



**Figure 7.** Ten-year running averages of annual number of large wildfires across all regions of Alaska.

## 02. OVERALL INCREASE IN ALASKA WILDFIRES



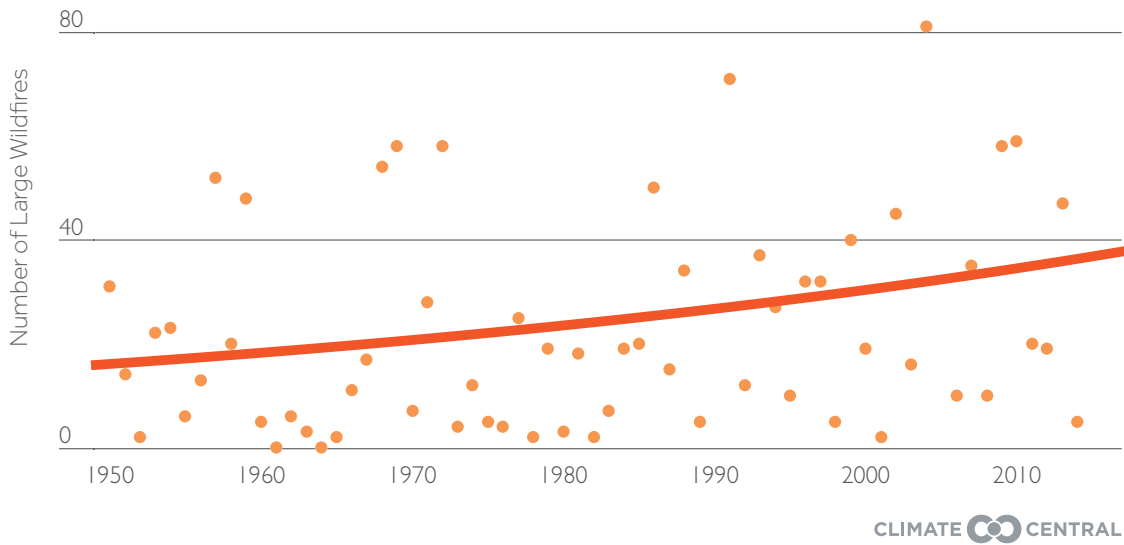
**Figure 8.** Ten-year running averages of area burned by large wildfires across all regions of Alaska.

The statewide wildfire trends are largely driven by changing wildfires in the boreal forest, primarily located in the Interior and South-Central regions. The boreal forest comprises 90 percent of the forested area in Alaska (Vose et al 2012). Figure 9 shows the time series for the number of large wildfires each year for the Interior region of Alaska and because most of the state's wildfire activity falls within this region, the data and trends are very similar to that of the entire state. Similarly, there is a great deal of inter-annual variability. Despite this variability, there is a statistically significant increase in the number of large wildfires burning each year in Alaska's Interior region. Figure 10 shows the time series for annual area burned by large wildfires in the Interior. It follows a very similar trajectory as for the state-wide numbers in that there is a slight upward trend over the past sixty-five years.

The decadal average of number of large wildfires each year shows a marked increase beginning in the 1990s, much like that for the entire state (Figure 11). The first four decades averaged about 18 large wildfires in a given year. The last 24 years have experienced an average of around 34 large wildfires each year; almost a doubling in the past two and a half decades compared to the beginning four decades in the time period of the study. The decadal behavior for annual area burned (Figure 12) shows a sharp increase beginning in the 1990s, but a slight drop over the past five years; similar to the behavior of the state-wide numbers for annual area burned.

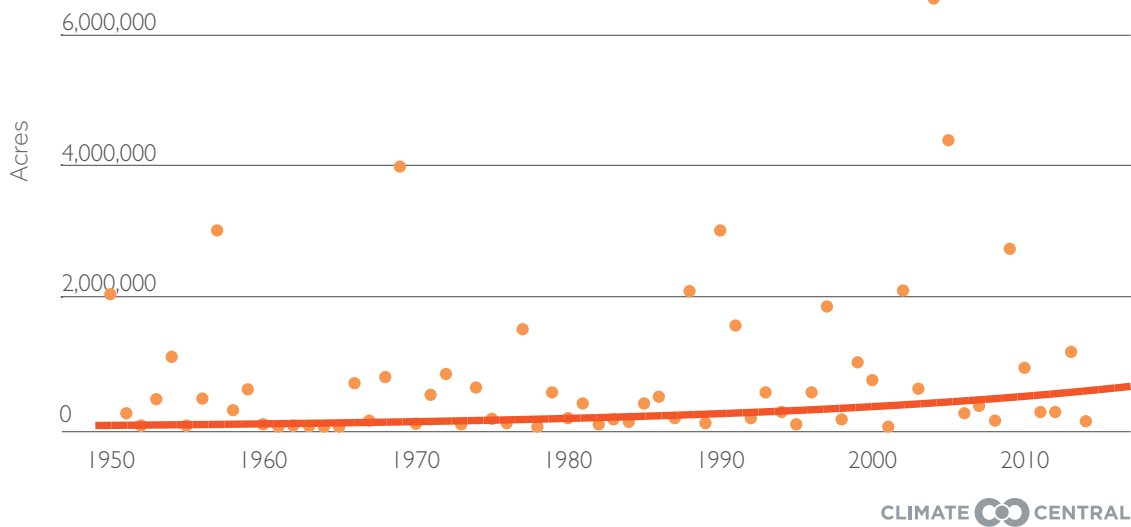
## 02. OVERALL INCREASE IN ALASKA WILDFIRES

### Total Annual Number of Large Wildfires in Interior Alaska



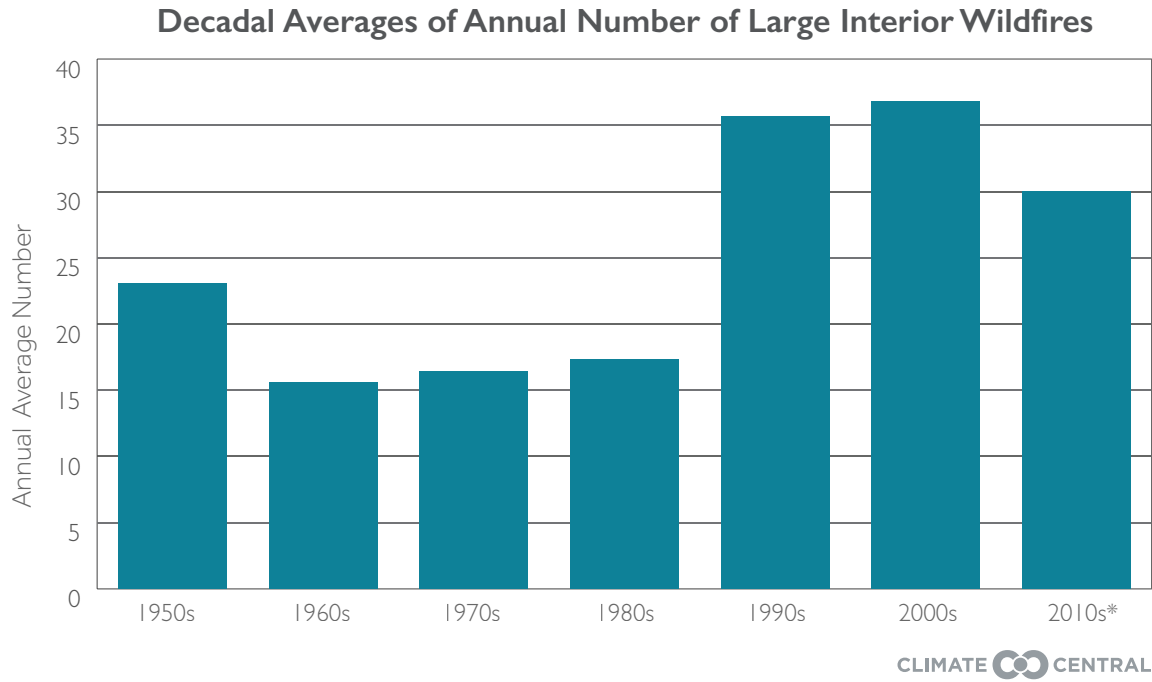
**Figure 9.** Annual number of large wildfires across all regions of Alaska from 1950-2014. The fit to the data is a Poisson regression and the p-value is  $<2e^{-16}$ .

### Total Annual Area Burned by Large Wildfires in Interior Alaska

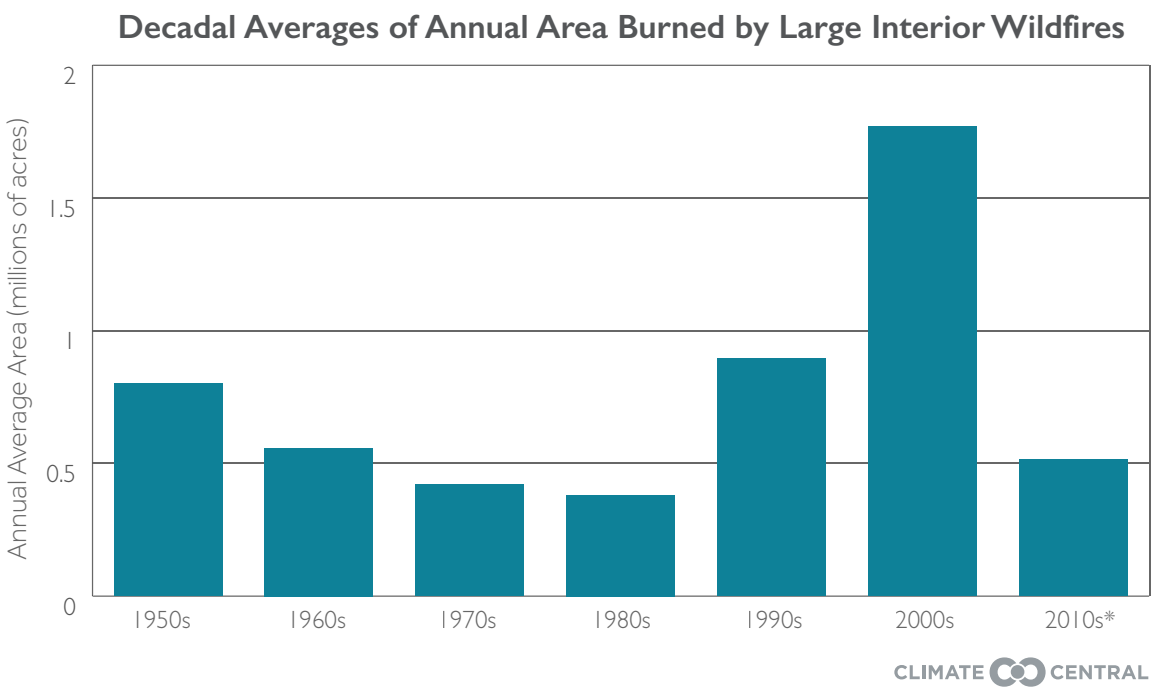


**Figure 10.** Annual area burned in large wildfires in Interior Alaska from 1950-2014. The fit to the data is an exponential regression and the p-value is  $<2e^{-16}$ .

## 02. OVERALL INCREASE IN ALASKA WILDFIRES



**Figure 11.** Decadal averages of annual number of large wildfires for Interior region of Alaska from 1950-2014. \*The value for the 2010s decade is derived from the average number of fires between 2010-2014 (not the full decade).

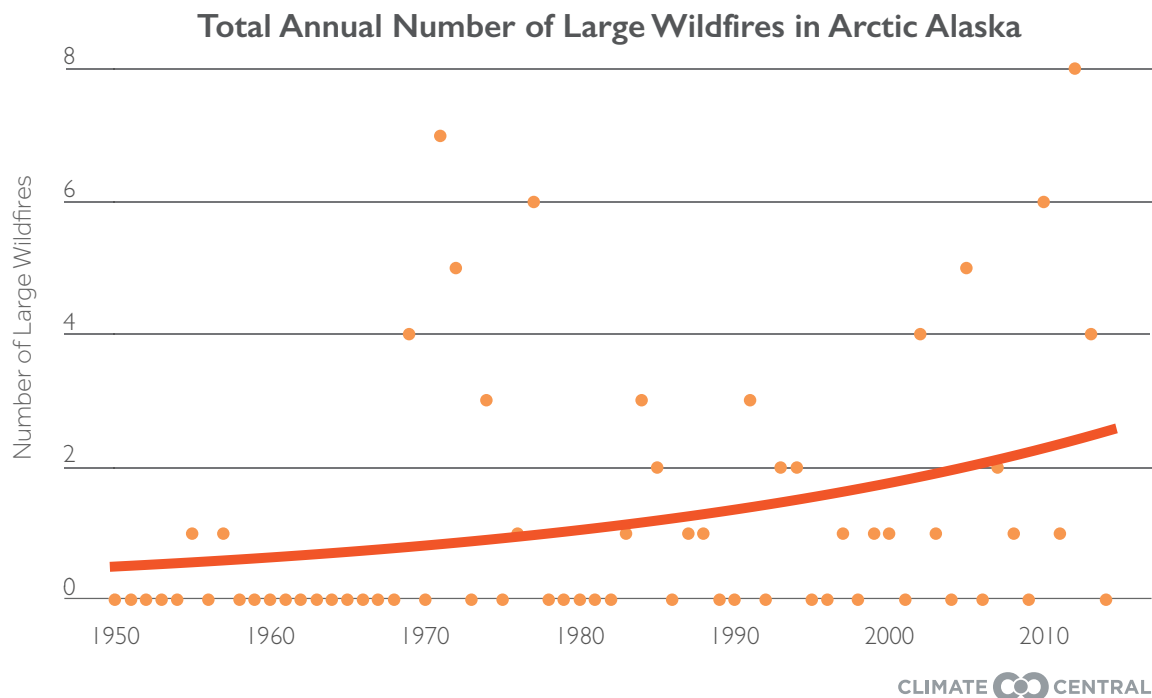


**Figure 12.** Decadal averages of annual area burned by large wildfires for Interior region of Alaska from 1950-2014. \*The value for the 2010s decade is derived from the average number of fires between 2010-2014 (not the full decade).

## 02. OVERALL INCREASE IN ALASKA WILDFIRES

Wildfire trends in other regions of Alaska show variable behavior. The Aleutians (islands running off the southwest coast of Alaska, towards Russia), for instance, had only had two wildfires larger than 1,000 acres over the entire 65-year period. The temperate, coastal forests of the Southeast region saw relatively few wildfires, and decreasing trends overall (though insignificant) in both numbers and area burned by large wildfires (see Appendix, Figure A1). On the other hand, the forests of the relatively small area of South-Central Alaska have seen increasing trends in both area burned and number of large wildfires. The area burned has seen a pronounced uptick in recent decades (see Appendix, Figure A2).

The Arctic region consists of large areas of permafrost and relatively little above-ground biomass (trees, shrubs, etc.) compared to other regions, such as in the Interior region. However, there are vast stores of carbon in this tundra region and changes in Arctic wildfire regimes threaten this vital carbon storage system. Though the numbers of large wildfires in the Arctic are smaller in comparison to the Interior and state-wide numbers, Figure 13 shows that the number of large wildfires appears to be increasing (Figure 14 shows there is not a clear increase Arctic area burned). The decadal-averaged annual number of large wildfires show an upward increase after an active 1970s with the 2010s, so far, being the most active over the period of study (Figure 15). Likewise, the past 24 years have shown more activity in decadal area burned than the first four decades of the record (Figure 16).



**Figure 13.** Annual number of large wildfires in Arctic Alaska region from 1950-2014. The fit to the data is a Poisson regression and the p-value is  $3.00e^{-5}$ .

## 02. OVERALL INCREASE IN ALASKA WILDFIRES

### Total Annual Area Burned by Large Wildfires in Arctic Alaska

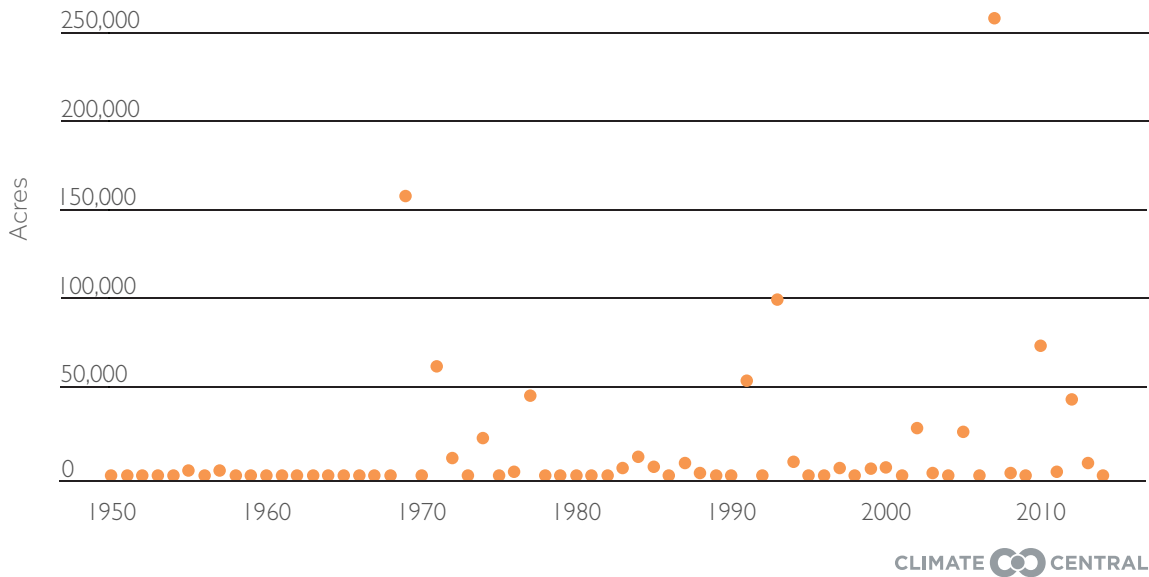


Figure 14. Annual area burned by large wildfires in Arctic Alaska region from 1950-2014.

### Decadal Averages of Annual Number of Large Arctic Wildfires

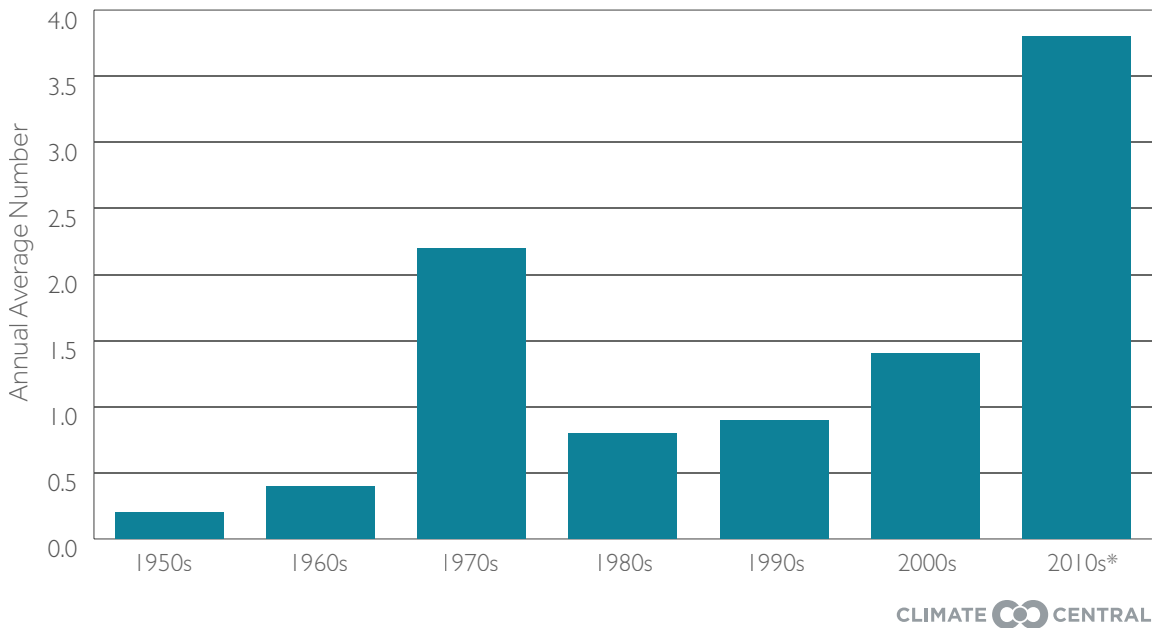
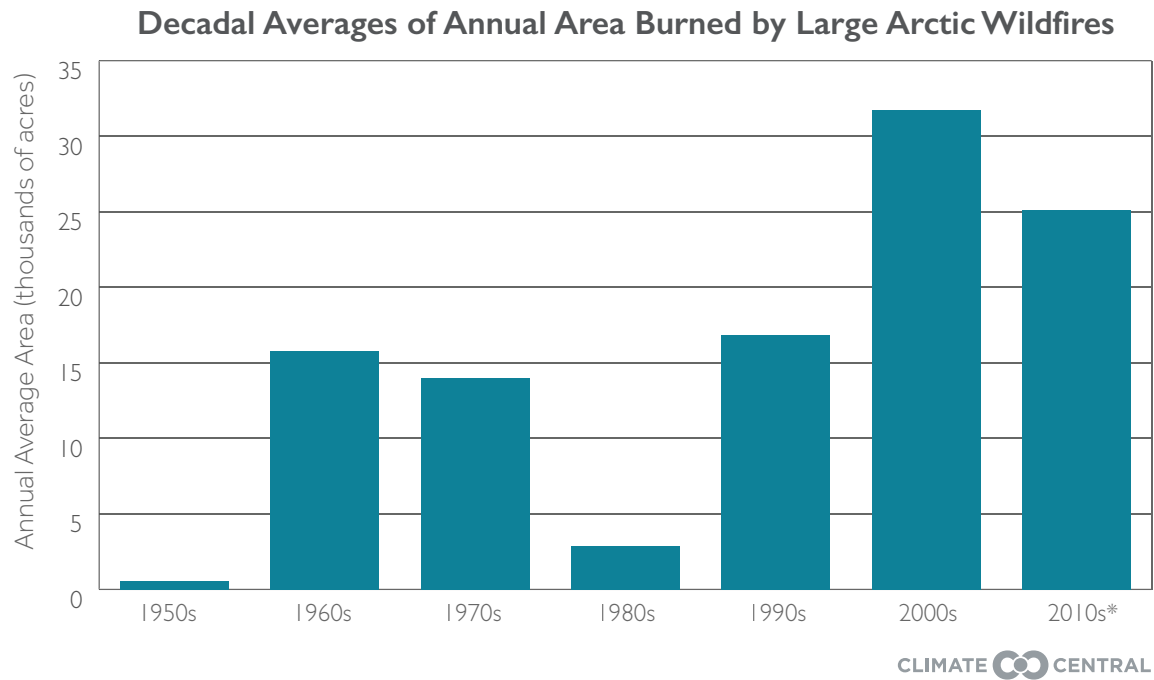


Figure 15. Decadal averages of annual number of large wildfires for Arctic region of Alaska from 1950-2014. \*The value for the 2010s decade is through 2014.



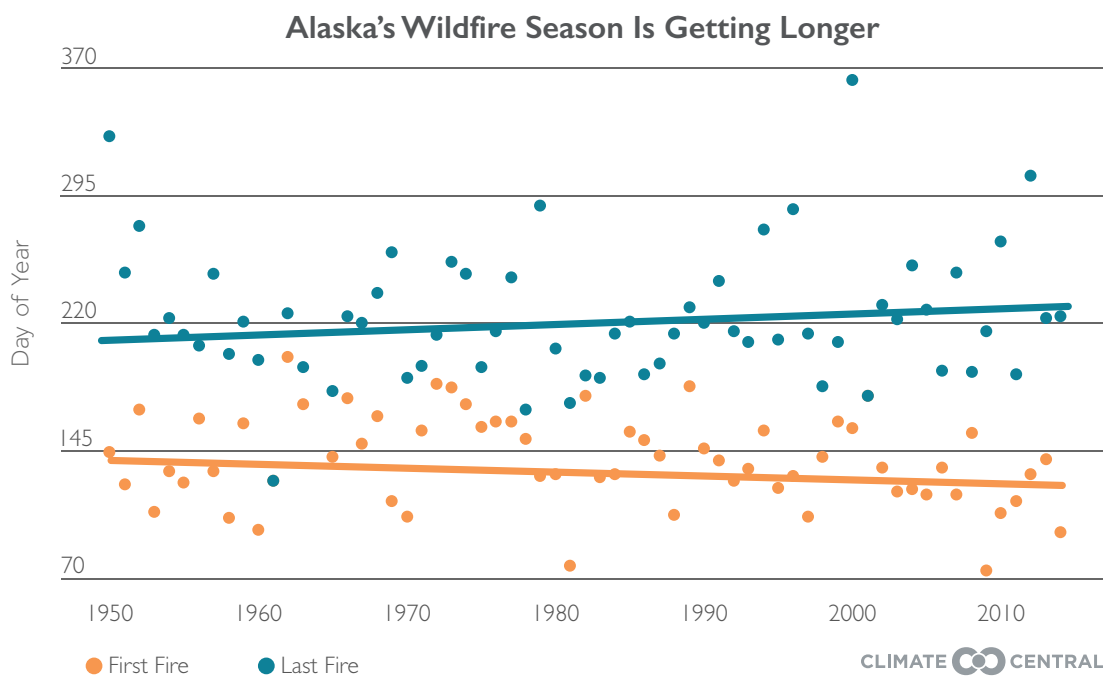
## 02. OVERALL INCREASE IN ALASKA WILDFIRES



**Figure 16.** Decadal averages of annual area burned from large wildfires for Arctic region of Alaska from 1950-2014. \*The value for the 2010s decade is through 2014.

# 03. FIRE SEASON IS GETTING LONGER

The length of the fire season in Alaska, defined as the length of time from the first fires each year to the last fires, is much shorter than in the American West, where the fire season has increased by 75 days since 1970 to an average length of more than 200 days/6 months (Climate Central, 2012). In Alaska, the average fire season statewide was shorter than 70 days, on average, in the 1950s. Presently, the overall season has lengthened by nearly 35 days, on average, over the 65-year-period, as shown in Figure 17. This longer wildfire season results both from fires starting earlier each year, which on average came 14 days earlier, *and* also wildfires starting later in the year, which on average now start 20 days later than in the 1950s. The more dramatic shift in how much later Alaskan wildfires start each year in August is distinct from changes in the lower western states (where season lengthening was largely attributed to earlier starts to the wildfire season).



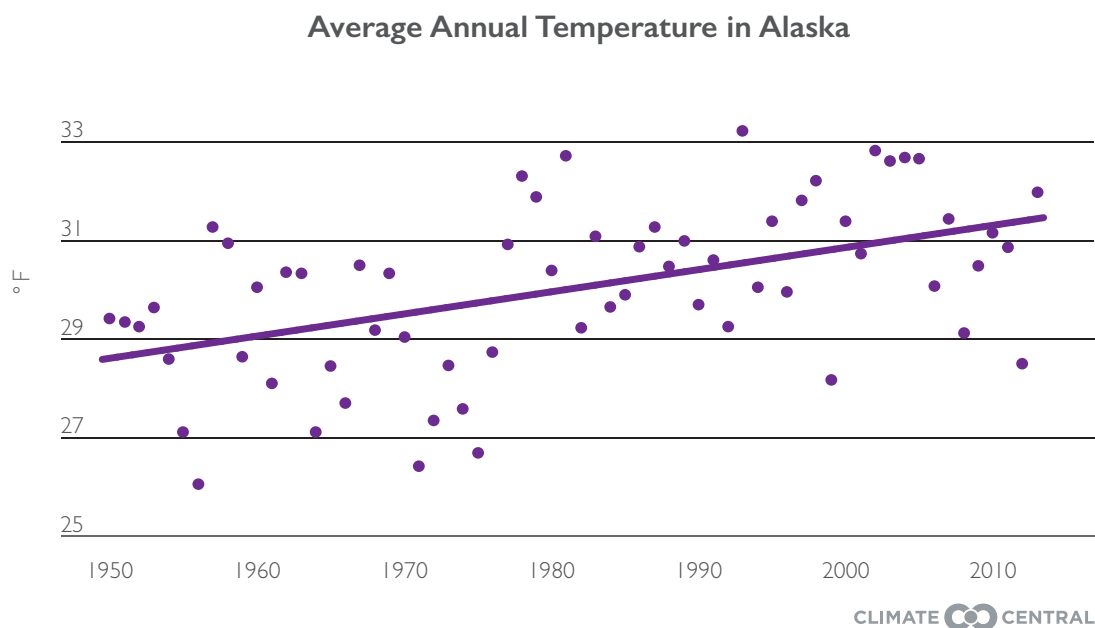
**Figure 17.** Annual start dates of first and last wildfires each season in Alaska. The trends show first wildfires each year occurring earlier and last wildfires occurring later. As a result, the average wildfire season in Alaska is now longer than in the 1950s.

# 04. CLIMATE FACTORS IN ALASKAN WILDFIRE TRENDS

## 4.1 INCREASING TEMPERATURES

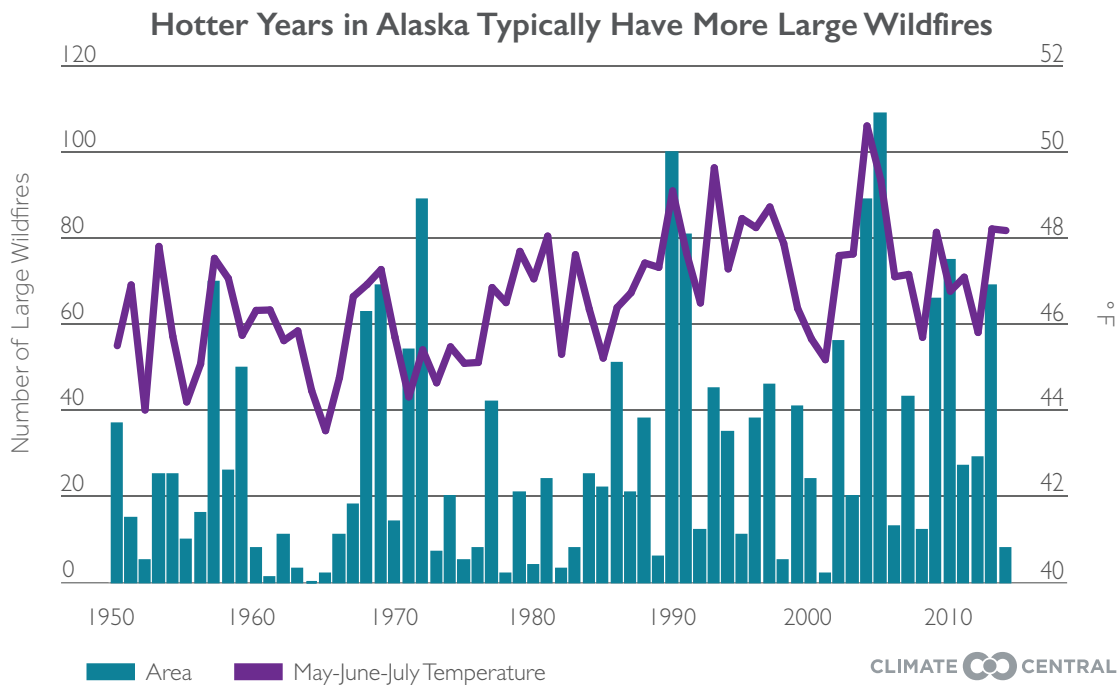
Elevated temperatures have been associated with increased wildfire activity by providing conditions conducive for the ignition and spread of wildfire. Previous analysis in the western U.S. has shown specifically that the numbers of large wildfires has generally been increasing at the same time that spring and summer temperatures have been getting hotter (Climate Central 2012, Westerling 2006).

Alaska has warmed by almost 3°F, on average since 1950, across all seasons, with statistically significant trends (Figure 18). Previous work that has carried out a thorough correlation analysis between active wildfire years and climatic conditions found a strong positive association between area burned and temperatures in May, June, and July (Duffy 2005). These temperatures have also shown a strong linear trend and a warming of over 2.4 degrees Fahrenheit (see Figure AX).



**Figure 18.** Mean annual temperatures across all regions of Alaska. A linear regression fit is also shown with a p-value of  $2.8e^{-05}$  (see Methodology).

## 04. CLIMATE FACTORS IN ALASKAN WILDFIRE TRENDS



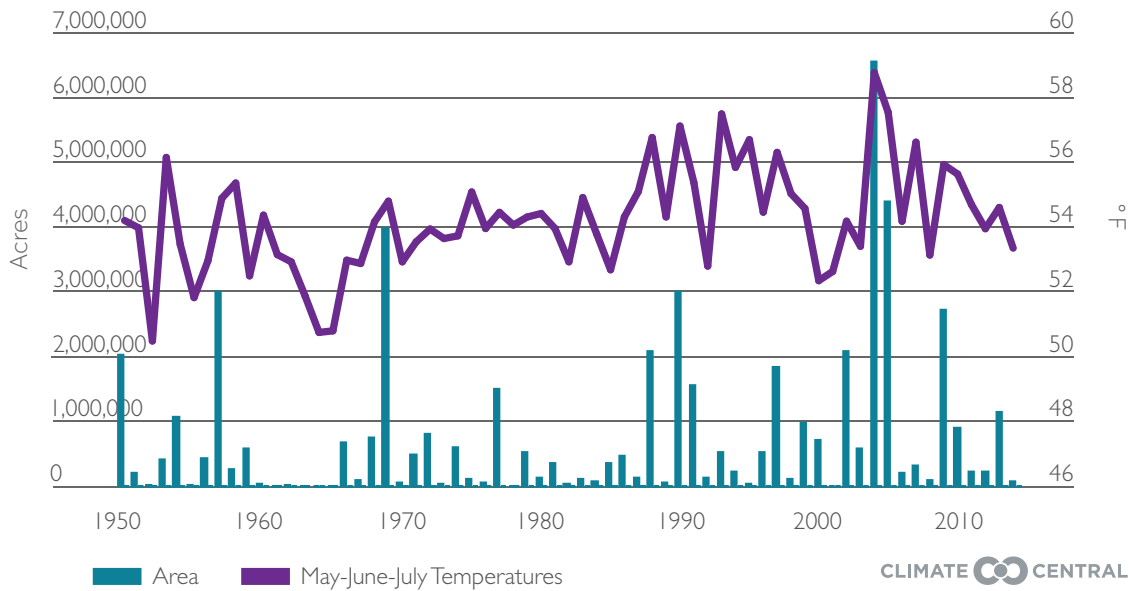
**Figure 19.** The number of large wildfires each year across all Alaskan regions and average annual May-June-July (MJJ) temperatures.

The association between higher May-June-July (MJJ) temperatures and the number of large wildfires is shown in Figure 19. As can be seen, years with the most large wildfires also generally coincide with higher MJJ temperatures, though there are also years with elevated temperatures but lower wildfire activity. Similarly, years with higher MJJ temperatures also tended to have more area burned overall. The most distinct year in the record, in terms of both temperature and wildfire burn area, was 2004. That year, Alaska's MJJ average temperature was the highest on record since 1950 and that year also saw more than 6 million acres burned in large wildfires across Alaska (an area equivalent to size of the Denali National Park and Reserve).

The correlation between years with higher than average MJJ temperatures and greater large wildfire frequency is also evident in specific regions of Alaska. Similar to the statewide results, Figure 20 shows that years with large area burned typically coincide with elevated MJJ temperatures in the Interior region. In the South-Central region, almost all years with large area burned also typically had higher than average temperatures (see Appendix, Figure A3). However, the hottest year on record, 2004, was not a particularly large burn year in the South-Central region demonstrating MJJ temperature is not the sole control on wildfire activity. Overall for the South-Central region, there is an increasing trend in MJJ temperatures and the number of large wildfires has increased though with a weaker trend. Both the Interior and South-Central regions show similar behavior between numbers of large wildfires and MJJ temperatures.

## 04. CLIMATE FACTORS IN ALASKAN WILDFIRE TRENDS

### Hotter Years Typically Have More Area Burning in Large Interior Wildfires



**Figure 20.** Area burned by large wildfires each year in Interior region of Alaska and average annual May-June-July (MJJ) temperatures.

Finally, the Arctic region has seen increases in average May-June-July temperatures of over 4 degrees F, since 1950 (Figure 21). Though the Arctic has seen more limited wildfire activity since 1950 than some other regions, the more recent uptick in activity comes as MJJ temperatures have marched upwards. However, unlike the statewide and other regional pictures, there is not a clear association between area burned by large wildfires and MJJ temperatures for individual years (see Appendix, Figure A4). One explanation is that the peak fire season in the high northern latitudes of the Arctic may come later in the year and, thus, MJJ conditions are not the best indicator of wildfire activity there. The same is true for number of large wildfires in the regions, as well.

## 04. CLIMATE FACTORS IN ALASKAN WILDFIRE TRENDS

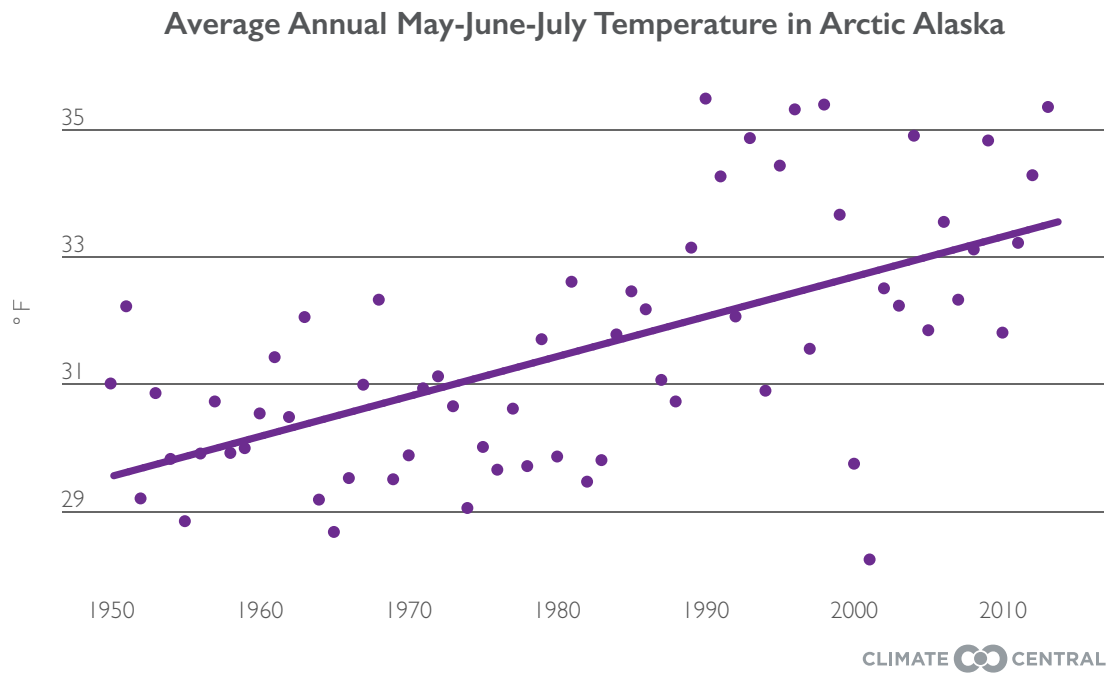


Figure 21. Annual May-June-July temperatures for the Arctic region of Alaska. A linear regression fit is shown and the p-value is  $7.5e^{-08}$ .

## 04. CLIMATE FACTORS IN ALASKAN WILDFIRE TRENDS

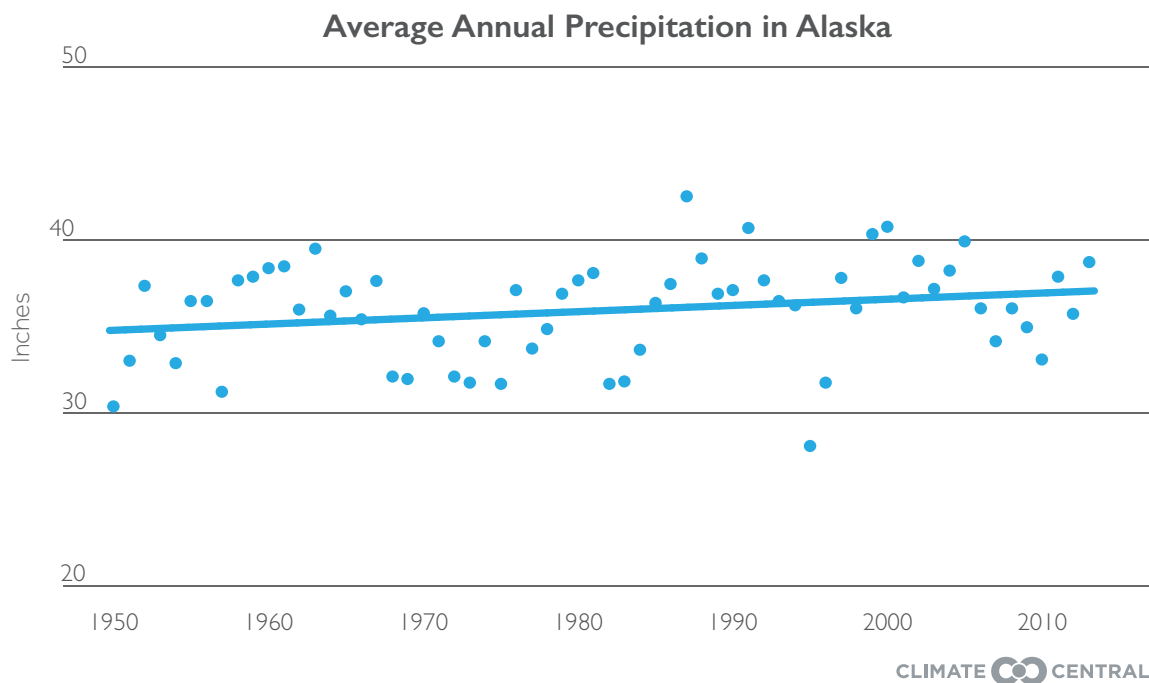
### 4.2 PRECIPITATION

Annual average precipitation in Alaska has increased by about 2.3 inches since 1950, though the trend is not as strong as that for temperature (Figure 22).

Duffy et al. (2005) found a negative association between area burned and June precipitation, such that years with reduced rainfall tended to be years with more large wildfires. Overall, June precipitation shows virtually no trend (increasing or decreasing) since 1950, compared to generally wetter conditions throughout the year (Figure 23).

Statewide, years with lower June precipitation are generally years with more area burned by large wildfires (see Appendix, Figure A5). In particular, the very large burn years of 1957, 1969, 2004, and 2005 (in terms of area burned) coincided with some of the lowest June precipitation amounts over the record. This relationship is generally also true in other regions of Alaska, although in some cases for the Interior and South-Central regions a very dry year did not always lead to a large areas burned by wildfires.

The Arctic is another region where the largest wildfires have generally occurred in years with average-to-below average June precipitation (see Appendix, Figure A6). Whereas the Arctic showed a weaker relationship between MJJ temperatures and wildfires than other regions, it appears that wildfire activity in the Arctic is more tightly coupled to June precipitation than it is



**Figure 22.** Annual average precipitation for all regions of Alaska. A linear regression fit line is shown with a p-value of 0.062.

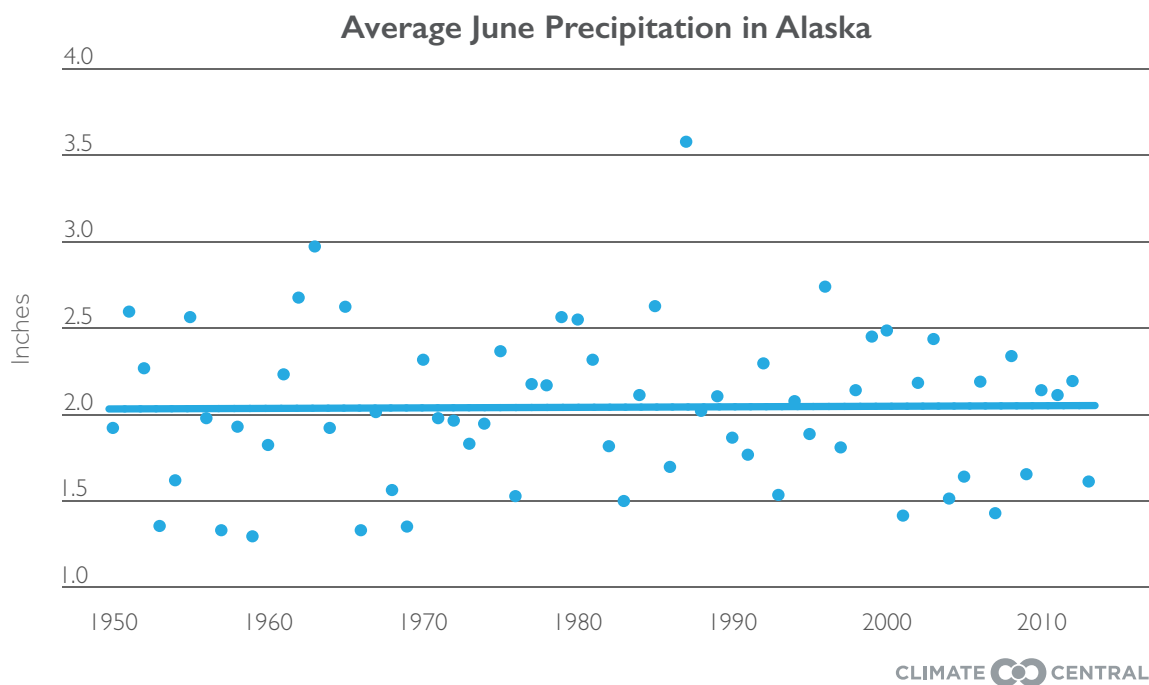
## 04. CLIMATE FACTORS IN ALASKAN WILDFIRE TRENDS

elsewhere in Alaska. However, the wildfire activity in the Arctic has been lower than other regions of Alaska since 1950 making trends and associations more difficult to discern.

Unlike the clear increase in temperatures over the study period, precipitation has shown large inter-annual variability with either no clear trend (June precipitation) or weak increasing trends (annual precipitation). These precipitation fluctuations may reflect the natural oscillations of the Pacific Decadal Oscillation (PDO), which is known to significantly impact seasonal climate across some Alaskan regions. Figure 26 depicts the PDO index since 1950, which indicates the changing phases of the PDO over several decades.

Previous studies have investigated a potential influence of the PDO phase on wildfire activity in Alaska. Duffy and workers (2005) found that the negative (cool) phase of the PDO (recognized as bringing cooler-than-average temperatures to Alaska) can cause drier-than-average summer conditions across the state that may be more conducive for wildfires. A more recent study (Calef 2015), however, that the overall increase in large Alaskan wildfires in recent decades was timed with the shift of the PDO to the positive (warm) phase in the late 1970s.

In general, the effects of large-scale climate patterns, such as the PDO, likely play a role in wildfire activity through both temperature and precipitation variations. However, precipitation trends across Alaska have either not changed over the period of study or even seen a trend toward wetter

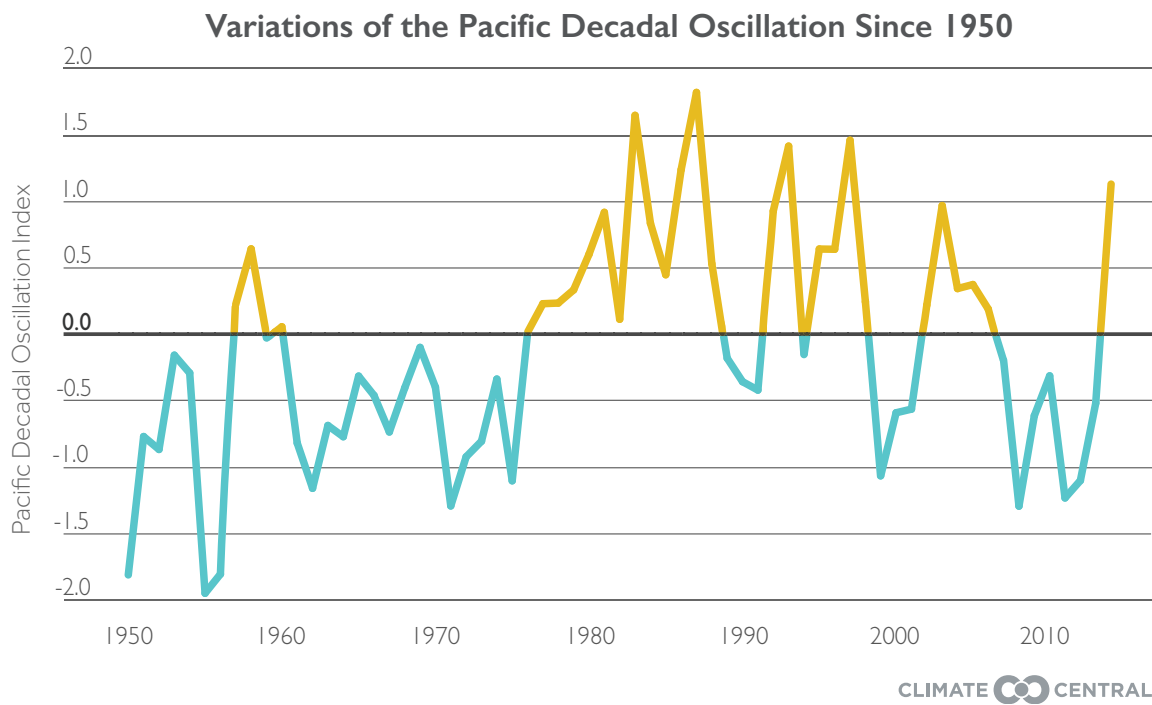


**Figure 23.** Average June precipitation for all regions of Alaska. A linear regression fit is shown with no statistically significant trend present.



## 04. CLIMATE FACTORS IN ALASKAN WILDFIRE TRENDS

conditions. On the other hand, the increased wildfire activity in the last few decades show a strong association with temperatures, which have consistently risen while precipitation amounts have fluctuated. This points to warmer temperatures in Alaska now being the primary driver in wildfire behavior and future projections under continued greenhouse-gas emission scenarios show this increasing temperature trend will continue.



**Figure 24.** Annual Pacific Decadal Oscillation (PDO) Index. Positive values indicate generally warmer and potentially wetter conditions across much of Alaska.

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# 05. METHODOLOGY

Since Alaska experiences great climatic and vegetative diversity across its vast latitudinal and longitudinal extent, the state was divided into six regions (and statewide numbers were also analyzed and considered). The state was delineated based on the [Unified Ecoregions of Alaska 2001](#), a United States Geological Services map accessed through the Alaska Geospatial Data Committee. This study used the following regions, with the composite USGS level 2 designations shown in parentheses: Arctic (Arctic Tundra), Interior (Inter-montane Boreal), Bering (Bering Tundra and Bering Taiga), South-Central (Alaska Range Transition and Coast Mountains Transition), Southeast (Coastal Rainforests), and Aleutians (Aleutians Meadows).

Wildfire data from the Bureau of Land Management Alaska Fire Services was accessed via the [Alaska Interagency Coordination Center](#) (AICC). AICC provides wildfire data extending back to 1950, with additional fire information including discovery date, approximate fire size, and latitude and longitude coordinates. This study analyzed all fires larger than 1,000 acres from 1950 to 2014, both at the state level and at the regional level. Since Alaska experiences relatively few fires compared to regions like the American West, decadal averages were also calculated. Only regions that averaged greater than one fire per year were included in this analysis.

Temperature and precipitation data from the Global Historical Climatology Network was obtained through the [Alaska Climate Research Center](#). All stations with at least 90% complete data from 1950-2013 were included in this analysis. The 33 stations used for temperature analysis and 31 stations used for precipitation are shown on a map and grouped by region in the Appendix (Figure A7, Table A1). Within each region, each station was weighted equally in order to calculate the average annual, spring and summer, and May through July temperatures and precipitation. To calculate the statewide averages, the regional data was aggregated with equal weighting of each station.

Data on the Pacific Decadal Oscillation was obtained from the [Joint Institute for the Study for the Atmosphere and Ocean](#) at the University of Washington, and the average January and February value was calculated since this value has shown a negative association with area burned (Duffy et al., 2005).

The linear, exponential, and Poisson regression fits for the wildfire and climate data were calculated using the R software package (R Core Team, 2014). Poisson fits were carried out for large wildfire frequency. Area burned was analyzed using an exponential regression, where appropriate. Linear fits were performed on the temperature and precipitation data. Where trendlines have been shown, we have also included a p-value to indicate the statistical significance of the trendline.

*We gratefully acknowledge Michael Flannigan and Xianli Wang (University of Alberta) for reviewing this analysis and providing helpful feedback on an earlier version of this report.*

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# 06. REFERENCES

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# 07. APPENDIX: REGIONAL TRENDS AND GRAPHICS

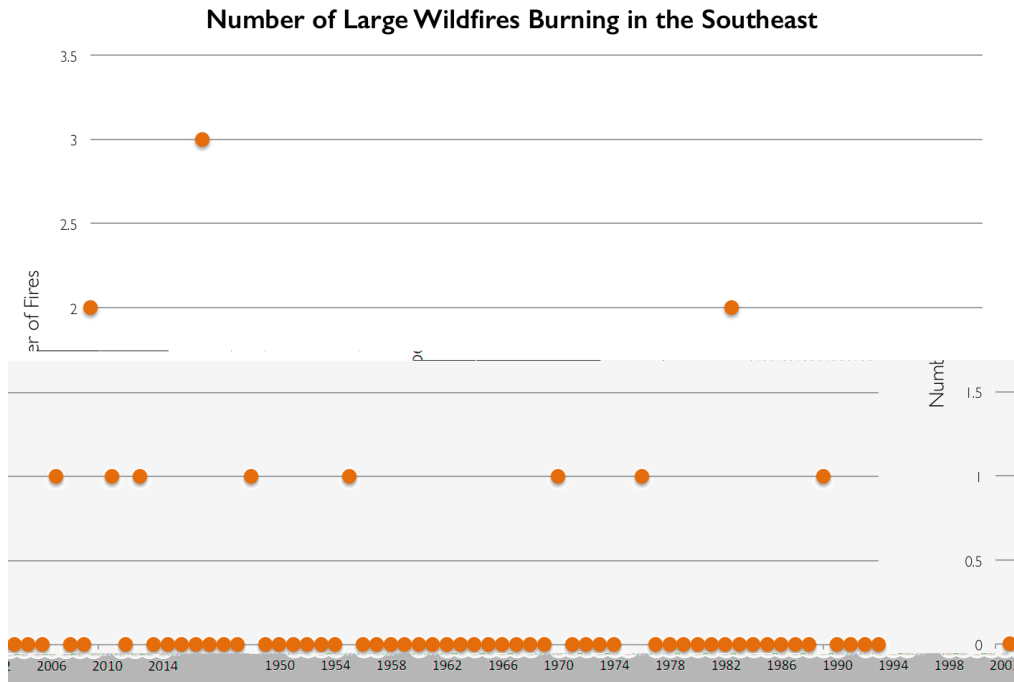


Figure A1. Annual number of large wildfires burning in the Southeast region.

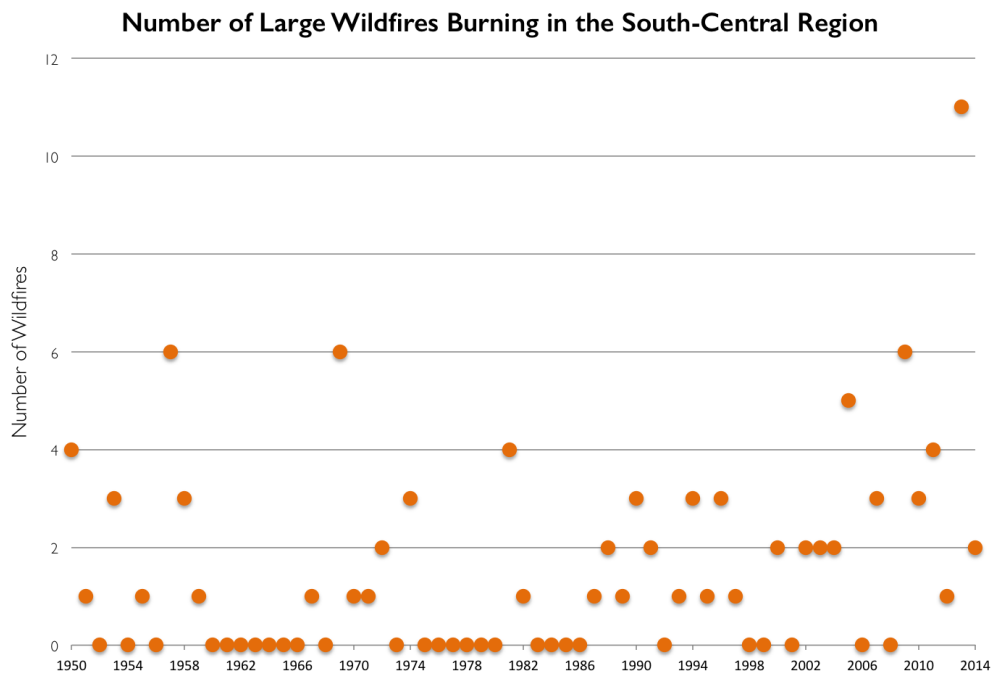


Figure A2. Annual number of large wildfires burning in the South-Central region.

## 07. APPENDIX: REGIONAL TRENDS AND GRAPHICS

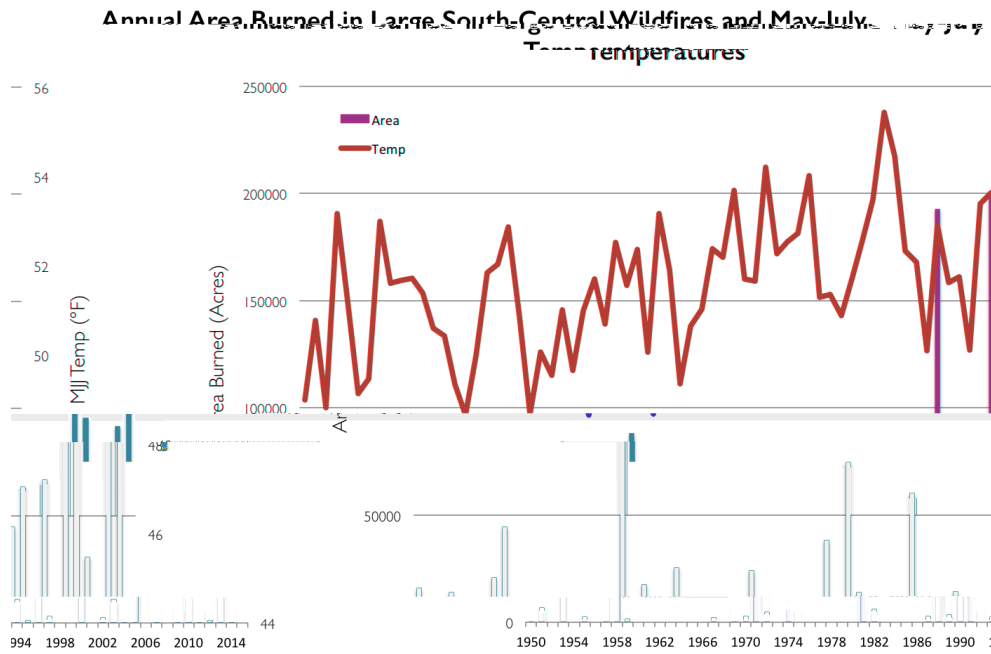


Figure A3. Area burned by large wildfires each year in South-Central region of Alaska and average annual May-June-July (MJJ) temperatures.

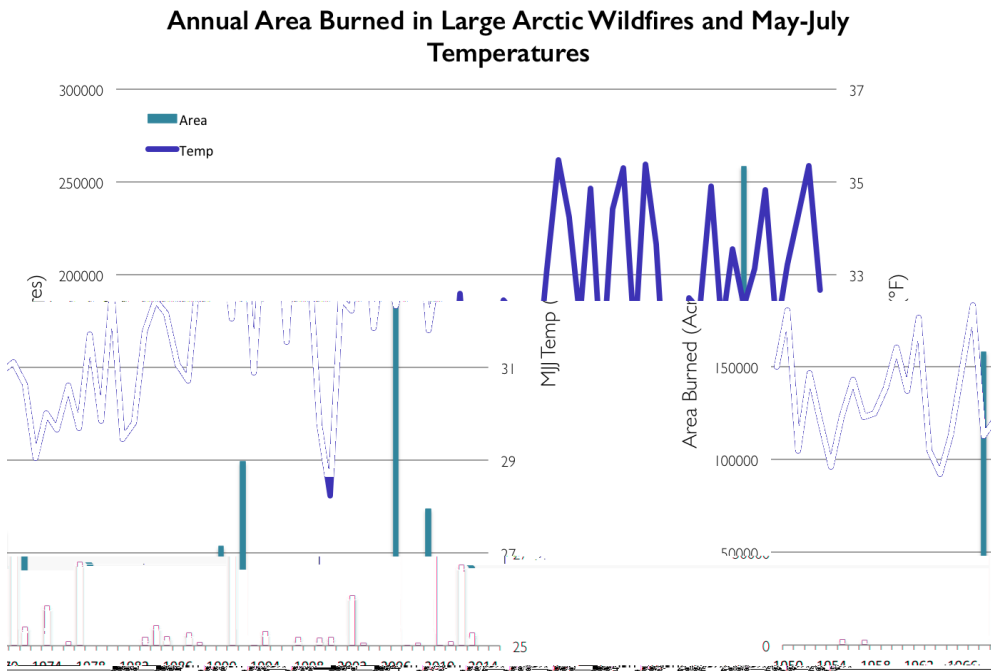


Figure A4. Area burned by large wildfires each year in Arctic region of Alaska and average annual May-June-July (MJJ) temperatures.

# 07. APPENDIX: REGIONAL TRENDS AND GRAPHICS

**Annual Area Burned in Large Alaskan Wildfires and June Precipitation Trends**

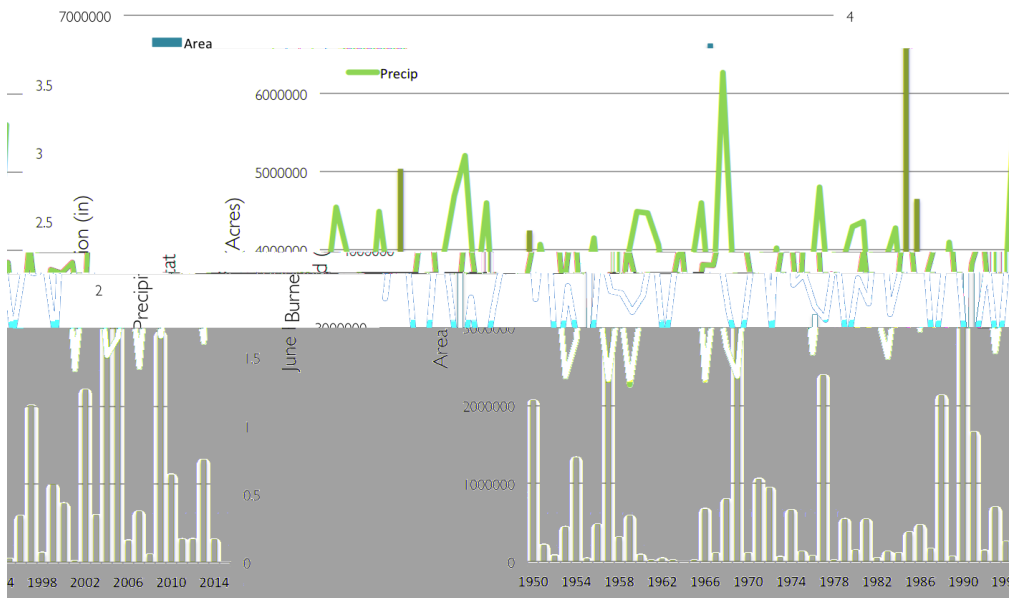


Figure A5. Area burned by large wildfires each year across all regions in Alaska and average June precipitation.

**Annual Area Burned in Large Arctic Wildfires and June Precipitation Trends**

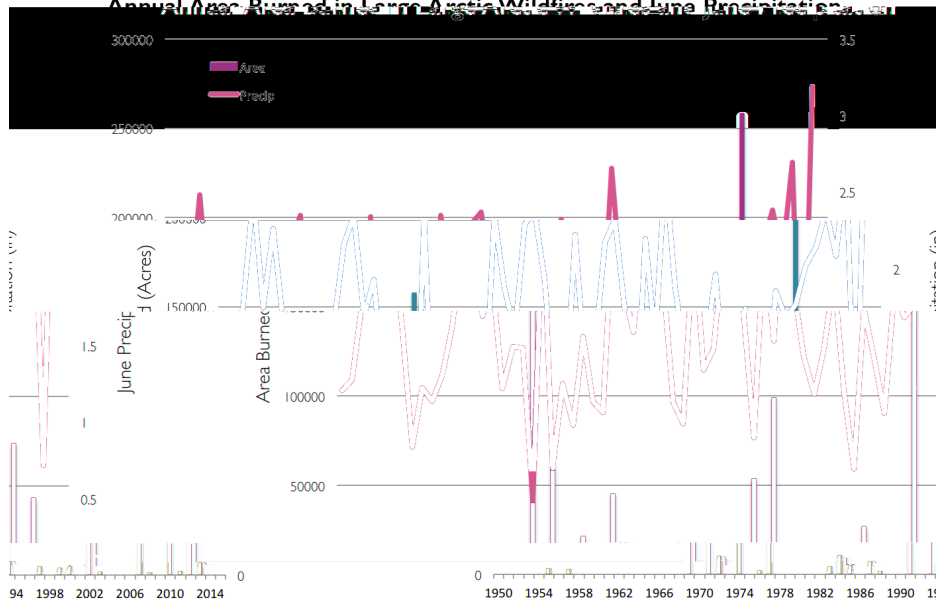


Figure A6. Area burned by large wildfires each year across the Arctic region of Alaska and average June precipitation.

## 07. APPENDIX: REGIONAL TRENDS AND GRAPHICS

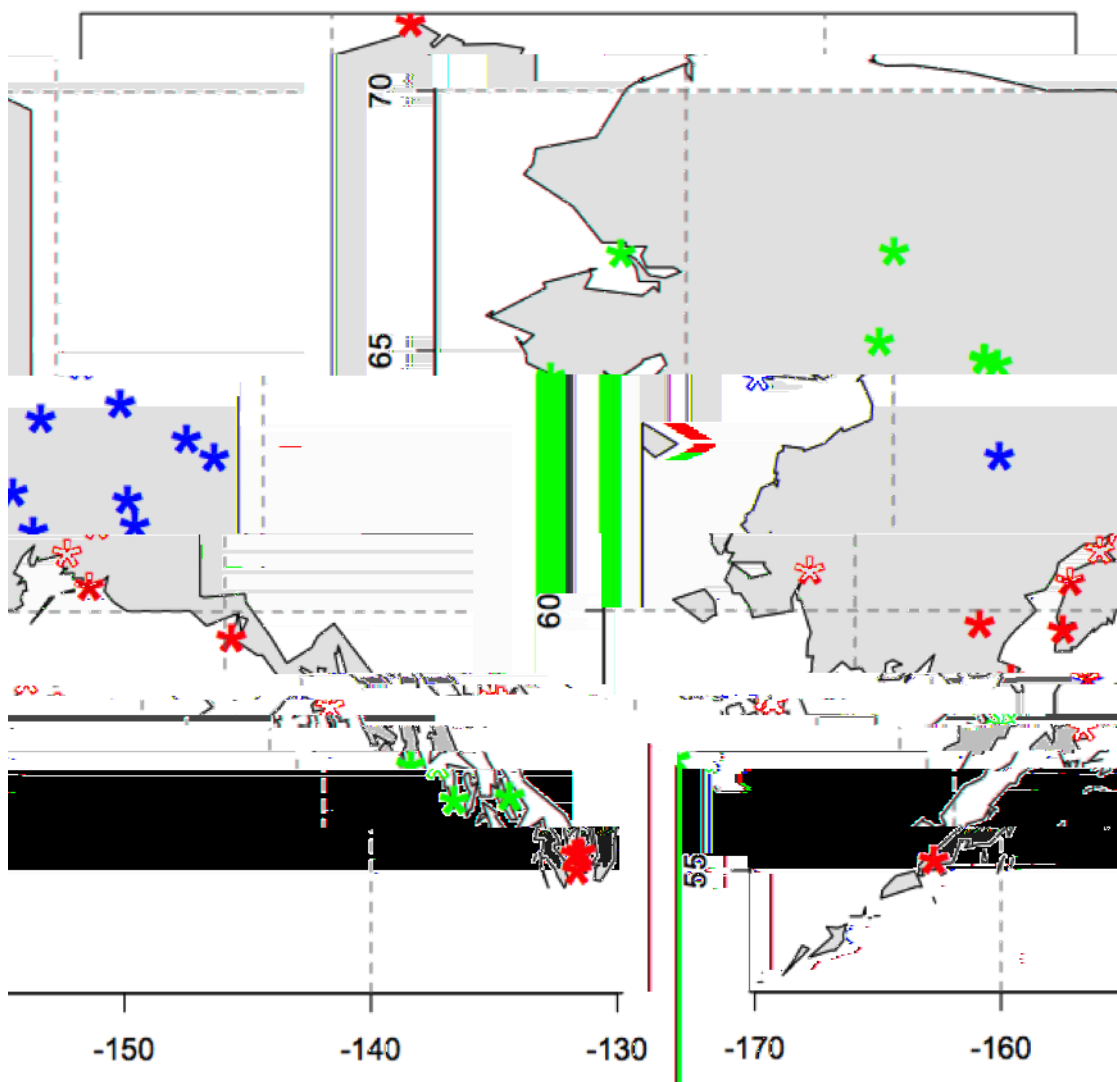


Figure A7. Stations with at least 90% complete data from 1950-2013 used in this analysis (33 for temperature and 31 for precipitation). All stations are part of the Global Historical Climatology Network.

## 07. APPENDIX

Table A1. Stations with at least 90% complete data from 1950-2013 used in this analysis (33 for temperature and 31 for precipitation). All stations are part of the Global Historical Climatology Network.

Station	Region	Climate Variables
Barrow**	Arctic	Temperature, precipitation
Annette**	Southeast	Temperature, precipitation
Beaver Falls	Southeast	Temperature, precipitation
Cordova AO	Southeast	Temperature, precipitation
Juneau**	Southeast	Temperature, precipitation
Ketchikan	Southeast	Temperature, precipitation
Little Port Walter	Southeast	Temperature, precipitation
Sitka Japonski	Southeast	Temperature, precipitation
Wrangell	Southeast	Temperature
Yakutat**	Southeast	Temperature, precipitation
Cold Bay**	Aleutians	Temperature, precipitation
St. Pauls**	Aleutians	Temperature, precipitation
Bethel**	Bering	Temperature, precipitation
Kotzebue**	Bering	Temperature, precipitation
King Salmon**	Bering	Temperature, precipitation
Illiamna AP	Bering	Temperature, precipitation
Nome**	Bering	Temperature, precipitation
Anchorage**	Southcentral	Temperature, precipitation
Gulkana**	Southcentral	Temperature, precipitation
Homer**	Southcentral	Temperature, precipitation
Kenai AP	Southcentral	Temperature, precipitation
Kodiak**	Southcentral	Temperature, precipitation
Matanuska Ag Exp Stn	Southcentral	Temperature, precipitation
Talkeetna**	Southcentral	Temperature, precipitation
Bettles**	Interior	Temperature, precipitation
Big Delta**	Interior	Temperature
College Obsv	Interior	Temperature, precipitation
Fairbanks**	Interior	Temperature, precipitation
McGrath**	Interior	Temperature, precipitation
MicKinley Park	Interior	Temperature, precipitation
Northway	Interior	Temperature, precipitation
Tanana AP	Interior	Temperature, precipitation
University Exp Stn	Interior	Temperature, precipitation

Stations used in analysis. \*\* First-order stations.