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DEVELOPMENT OF A NEW OREGON ANNUAL PRECIPITATION MAP USING THE PRISM MODEL

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Dr. Kenneth Hadeen
Director, NCDC

Dr. Charles Wax
President, AASC

John P. Hughes
Editor, The State Climatologist

Introduction

Development of precipitation maps (also known as isohyetal analyses) is a lengthy and difficult process, particularly in areas with significant terrain features. In the western United States, the problem of complex terrain is compounded by lack of precipitation stations in many areas. Increasingly, however, scientific needs demand more accurate precipitation information. Ecological and hydrological information are becoming increasingly linked with spatial representations, and the need for high quality digital data is increasing.

The latest isohyetal analysis for the state of Oregon was published in 1964. It was hand-drawn by scientists using data from existing stations, and represented the period 1930-1957. In recent years, several attempts have been made to procure funding for a new analysis, but the labor-intensive nature of typical isohyetal analyses has made such an effort prohibitively expensive.

Many methods exist for interpolating precipitation from monitoring stations to grid points. Some provide estimates of acceptable accuracy in flat terrain, but none have been able to adequately explain the extreme, complex variations in precipitation that occur in mountainous regions. Inadequacies in these methods typically must be overcome by adding numerous estimated "pseudo-stations" to the data set and tediously modifying the resulting output by hand. Even then, there is no provision for easily updating the precipitation maps with new data or developing maps for other years or months.

Significant progress in this area has recently been achieved through the development of PRISM (Precipitation--elevation Regressions on Independent Slopes Model). PRISM is an analytical model that uses point data and a digital elevation model (DEM) to generate gridded estimates of monthly and annual precipitation. PRISM is

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NATIONAL CLIMATIC DATA CENTER IN COOPERATION WITH
AMERICAN ASSOCIATION OF STATE CLIMATOLOGISTS

uniquely suited to regions with mountainous terrain, because it incorporates a conceptual framework that addresses the spatial scale and pattern of orographic precipitation.

Overview of PRISM

In general, on a given mountain slope face, precipitation increases with increasing elevation. However, orographic effects typically respond to smoothed topographic features rather than detailed variations in terrain (Burns, 1953; Henry, 1919; Schermerhorn, 1967; Spreen, 1947). Relationships between measured precipitation and elevation are generally strengthened when the elevation of each data point is given in terms of its height on a smoothed terrain, termed its "orographic" elevation. The relationship between precipitation and orographic elevation varies from one slope face to another, depending on location and orientation. Thus, a mountainous landscape can be thought of as a mosaic of smoothed topographic faces, or "facets," each experiencing a different orographic regime.

In operation, PRISM performs the following:

(1) uses a Digital Elevation Model (DEM) to estimate the "orographic" elevations of precipitation stations;

(2) uses the DEM and a windowing technique to group stations onto individual topographic facets;

(3) estimates precipitation at a DEM grid cell through a regression of precipitation vs. DEM elevation developed from stations on the cell's topographic facet; and,

(4)when possible, calculates a prediction interval for the estimate, which is an approximation of the uncertainty involved.

Evaluation of PRISM

PRISM has been compared to kriging, detrended kriging, and cokriging in the Willamette River Basin, Oregon. In a jackknife cross-validation exercise, PRISM exhibited lower overall bias and mean absolute error (Daly and Neilson, 1992; Phillips, et al, 1992; Daly, et al, 1993). PRISM was also applied to northern Oregon and to the entire western United States. Detrended kriging and cokriging could not be used in these regions because there was no overall relationship between elevation and precipitation. PRISM's cross-validation bias and absolute error in northern Oregon increased a small to moderate amount compared to those in the Willamette River Basin; errors in the western United States showed little further increase. PRISM has recently been applied to the entire United States in three separate runs (western, central, and eastern) with excellent results, even in regions where orographic processes do not dominate precipitation patterns.

By relying on many localized, facet-specific precipitation/DEM-elevation relationships rather than a single domain-wide relationship, PRISM continually adjusts its frame of reference to accommodate local and regional changes in orographic regime with minimal loss of predictive capability.

Development of a new Oregon isohyetal model

Development of the updated analysis for Oregon began with collection of precipitation data from Oregon locations and nearby stations within

contiguous states (Washington, Idaho, Nevada, and California). This included two primary data sets: National Climatic Data Center (NCDC) cooperative stations and Soil Conservation Service (SCS) SNOTEL stations. The period 1961-90 was used for the analysis. Mean monthly values for stations which had at least 27 years of data were used without modification. Data sets for those with at least 15 but less than 27 years of data were modified by applying a least-squares fit to data from a representative nearby station, yielding a 30-year average.

PRISM was run for each monthly data set as well as for the annual

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2. Application of the model to short-term extreme events, including updating of precipitation frequency-duration information;

3. Use in stream flow forecasts;

4. Use in conjunction with water balance and ecological models to provide predictions of the effects of future climate change scenarios on native vegetation;

5. Comparison of distribution of precipitation during different climatic regimes (e.g., ENSO events) with those during normal years;

6. Research into rainfall and snowfall undercatch, especially for high elevation stations; and,

7. Studying the optimal placement of sensors for temperature and precipitation measurement.

Conclusions and Future Work

The updated isohyetal analysis is thought to be of quality and accuracy comparable to that of traditional labor-intensive isohyetal methods at a fraction of the cost.

Currently PRISM is being studied for use in predicting distribution of other meteorological parameters, such as temperature, snowfall, evapotranspiration, and degree day totals. Other current research topics include the following:

1. Investigation of optimal grid resolution for precipitation modeling;

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Daly, C., R.P. Neilson, and D.L. Phillips, 1993: A Digital Topographic Model For Distributing Precipitation Over Mountainous Terrain. In review for publication in the Journal of Applied Meteorology.

Henry, A.J., 1919: Increase of precipitation with altitude. Mon. Wea. Rev. 47, 33-41.

Phillips, D. L., J. Dolph, and D. Marks, 1992: A comparison of geostatistical procedures for spatial analysis of precipitation in mountainous terrain. Agric. For. Meteorol., 58:119-141.

Schermerhorn, V. P., 1967: Relations between topography and annual precipitation in western Oregon and Washington. Wat. Res. Res., 3, 707-711.

Spreen, W. C., 1947: A determination on the effect of topography upon precipitation. Trans. Amer. Geophys. Union, 28, 285-290.

George H. Taylor
Oregon State Climatologist
Christopher Daly
PRISM Services/Oregon State Univ
Wayne P. Gibson
College of Oceanic & Atmospheric Sciences, Oregon State University

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king group (under the Office of
ter Data Coordination) which
ussed water data issues in federal,
e, and local agencies. Their pri-
y focus is water quality, but water
ntity issues are also a concern of
group. The AASC is a new
nber on the committee, and was
resented by Pam Naber Knox, the
consin SC. She also represented
SC at the last meeting of this
mittee in Minneapolis in 1991 as
unofficial participant.

h ACWDPU meeting has a specif-
neme concentrating on one aspect
water resources data. The previ-
meeting in Minnesota looked at
lands issues; the most recent
eting in July 1993 was on water
standards. The first day of the
eting was devoted to briefings on
history and purpose of the com-
tee (which was rechartered after a
-year break), reports on new data
ection activities by various organi-
ons, and a panel discussion on
ups that are trying to organize
collection standards.

major reports presented were on
/S modernization and the new
ional Water Quality Assessment
AWQA) program. Gene Stallings
the NWS Office of Hydrology
cribed the modernization program
discussed the hydrologic capabili-
of the NEXRAD system. Pat
hy of USGS described the
WQA program and the 20 field
jects which are currently taking
ce. A total of 60 projects is
nned over the duration of the
WQA program. Some of these

ACWDPU Meeting, July 14-15, 1993

The Advisory Committee on Water Data for Public Use (ACWDPU) met in Washington, DC, on July 14-15, 1993. This committee is a USGS-sponsored intergovernmental agency

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projects concentrate on surface water quality, while others are looking at groundwater contamination in agricultural areas. Each project is designed independently to look at regionally important water quality issues, and consists of a planning phase, field observations, and post-collection analysis. Ultimately, the intent of NAWQA is to build up the base "climate" of water quality across the entire U.S.

The panel discussion focused on ways that various organizations are trying to get scientists to agree on "standards" for data collection. The intent of these groups is not to impose regulatory thresholds, but to describe acceptable data collection methods for each variable. For example, the nitrate concentration of streams can be measured in several ways; these groups are working to define appropriate techniques for each method and to determine the accuracy that can be expected with each approach. Ideally, the use of standard techniques would allow data to be more easily shared between agencies, encouraging wider use of the gathered information.

On the second day, the committee broke into working groups that looked at how to promote comparability of water data between federal and state agencies. They concluded that:

a. The intent of the committee is to encourage standard methods of analysis, NOT to regulate pollutants;

b. The use of compatible water data records will encourage the sharing of information between groups (both measurement techniques used and data base storage methods are important);

c. Collection of metadata must be included in the data accumulation process;

d. Groups should communicate their standard techniques to others so that compatible data can be collected;

e. A national council should be established to lead the coordinating effort, with federal agencies taking the major role;

f. Comparability of records between federal agencies should be promoted in laws like the Clean Air Act, since many states base their methods on the requirements imposed by federal regulatory agencies; and,

g. We need to recognize that not all regions and users have the same set of water data needs.

The meeting concluded by asking the members whether their organizations would like to be represented on the newly formed advisory committee for the NAWQA program. Based on discussion with AASC members at the AASC meeting in Idaho, it was determined that representation of AASC is probably not needed.

The ACWDPU met in November in the Delmarva Peninsula to look at problems with groundwater contamination, and will meet again in April 1994 in Orange County, California, to look at water conservation issues. If you have any questions or comments about this committee, please feel free to contact Pam Naber Knox (1225 W. Dayton Street, Madison WI 53706, 608-263-2374, email: naber-@macc.wisc.edu).

Pam Naber Knox
Wisconsin State Climatologist

Acceptance Speech for the American Association of State Climatologists' Helmut Landsberg Award

First, I want to thank the Association for the honor it has given to me. I will value this award because it comes from a group of climatologists whom I admire, both professionally and personally, and the award is in honor of a remarkable man both as a scientist and as a person.

Second, I want to apologize for not being able to personally receive this award, but I am sure to see many of you at future meetings.

I would like to convey a few thoughts I have about the role of the Association in the field of climatology and the atmospheric sciences.

- It is clear that the need for SCs is now greater than ever. Perhaps we have come full circle from the time when the Weather Bureau decided it could no long support the SC program. We have an active SC program in virtually every state. Nonetheless, there are many areas in which the Program can and should make its presence more strongly felt.

- The SCs in many ways can be regarded as the practicing family physician. As such, they are frequently relied upon to provide a diagnosis or prognosis on an immense variety of practical problems related to some aspect of climate. Much information is gained through these hands-on practical encounters. Because of this the SC is in a unique position to understand the climate information needs and the capability of users to benefit from this information. The users know this, but I fear that too often the knowledge of the SCs does not make its way back to the specialists in the field. As a result, many applied programs constantly struggle with inadequate funds to accomplish this important work, which too often is the weakest link in the chain of translating our knowledge about climate to the users.

- The challenge to us is clear. We must be more articulate in the value of our work to our colleagues as well as policy/decision makers in government and in business. More Journal articles and committee work must be combined with our normal business.

Finally, I want to thank all of you again, and wish you the best of success in your Annual Meeting.

Thomas R. Karl
Senior Scientist
National Climatic Data Center

NCDC CD-ROM PRODUCTS CURRENTLY AVAILABLE

ISMCS Version 2.0 ($50.00)

National Climate Information Disk Vol. 1 ($50.00)

Marine Climatic Atlas Version 1.0 ($50.00)

Global Upper Air Climatic Atlas (GUACA) Version 1.0 ($200.00)

Historical U.S. Climate Data (CLIVUE/CLISNOOP) Version 1.0 ($50.00)

Solar and Meteorological Surface Observational Network (SAMSON) Version 1.0

Individual Regions (specify Eastern, Central, or Western) ($100.00)
Complete Set ($300.00)

Add $11.00 service and handling charge to each order.

JUST ISSUED

Radiosonde Data of North America 1946-1992. Contains all available radiosonde data for North America (U.S., Canada, Mexico, and Caribbean Islands) through the 100-mb level on four disks. Disk periods are 1946-1965, 1966-1979, 1980-1989, and 1990-1992. Data include significant, mandatory, and special wind levels for all observation times and include geopotential height, temperature, dew point, wind direction, and scalar speed. The user can select for output to printer, screen, or file, a single station or multiple stations for a defined time period, or all stations within a specified geographic region in either synoptic or station sort. The CD also contains available station metadata. (4 disks, $100.00 per disk)

time, position, storm stage (and maximum wind, central pressure when available). The user will have the capability to display tracks and track data for any basin or user-selected geographic area. The user will also be able to select storm tracks passing within a user-defined radius of any point. Narratives for all tropical storms for the 1980-1992 period will be included as well as basin-wide tropical storm climatological statistics. (Available December 1993)

Global Daily Data. This CD-ROM will provide access to a 10,000-station set of daily maximum/minimum temperature, daily precipitation, and 3-hourly present weather for the 1977-1991 period of record. Data can be selected for viewing or output to file for geographic areas or by a predefined user-selected list of stations. Each data record includes element flags for suspected erroneous data. A data inventory contains station name, latitude/longitude, elevation, period of record, and the number of observations of available data. (Available December 1993)

FUTURE PRODUCTS

Global Tropical and Extratropical Cyclone Climatic Atlas (GTECCA). This single volume CD-ROM will contain all global historic tropical storm track data available for five tropical storm basins. Periods of record vary for each basin, with the beginning as early as the 1870s and 1992 as the latest year. Northern hemispheric extratropical storm track data will be included from 1965 to 1992. Tropical track data include

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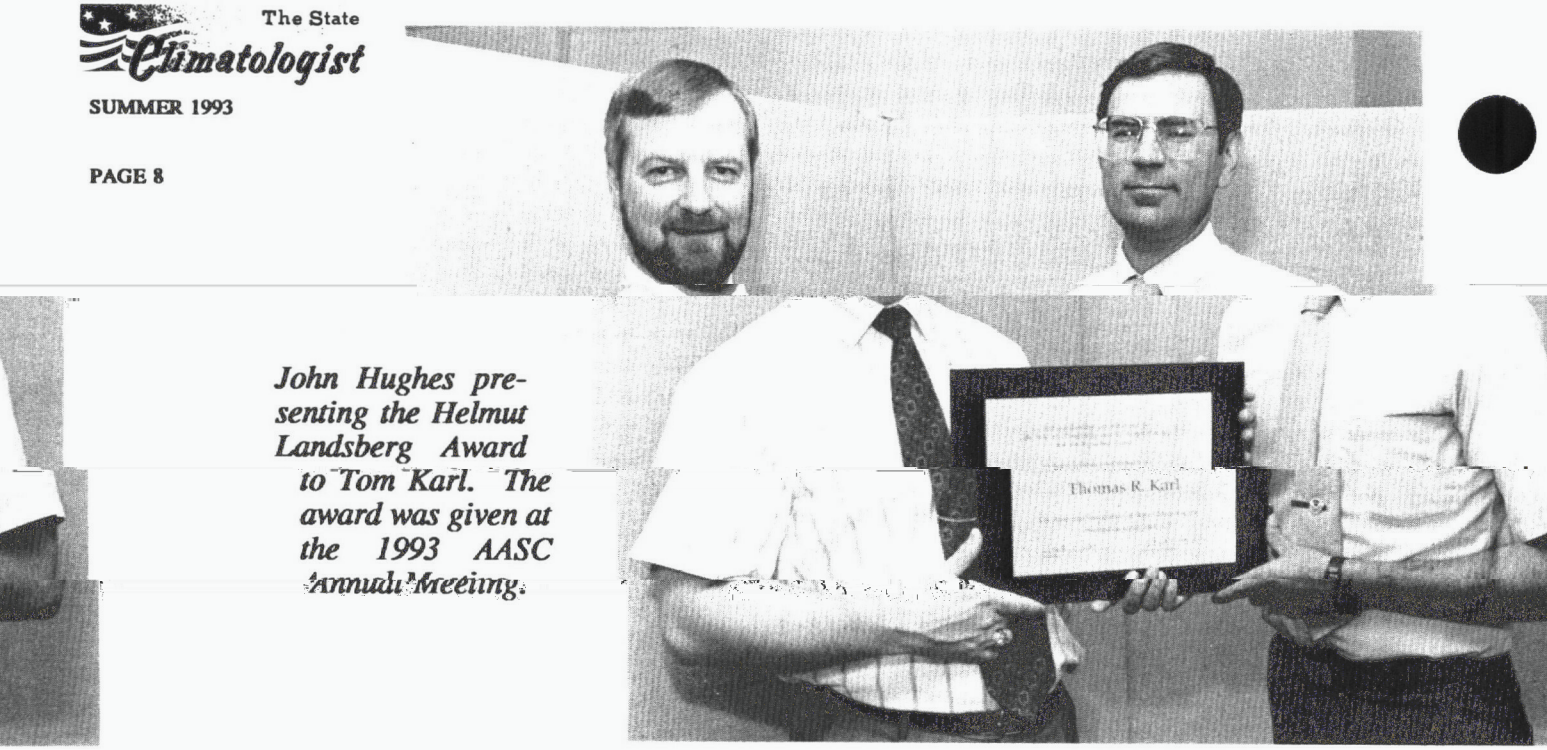

John Hughes presenting the Helmut Landsberg Award to Tom Karl. The award was given at the 1993 AASC Annual Meeting.

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NATIONAL CLIMATIC DATA CENTER
FEDERAL BUILDING
37 BATTERY PARK AVENUE
ASHEVILLE, NORTH CAROLINA 28801-2733