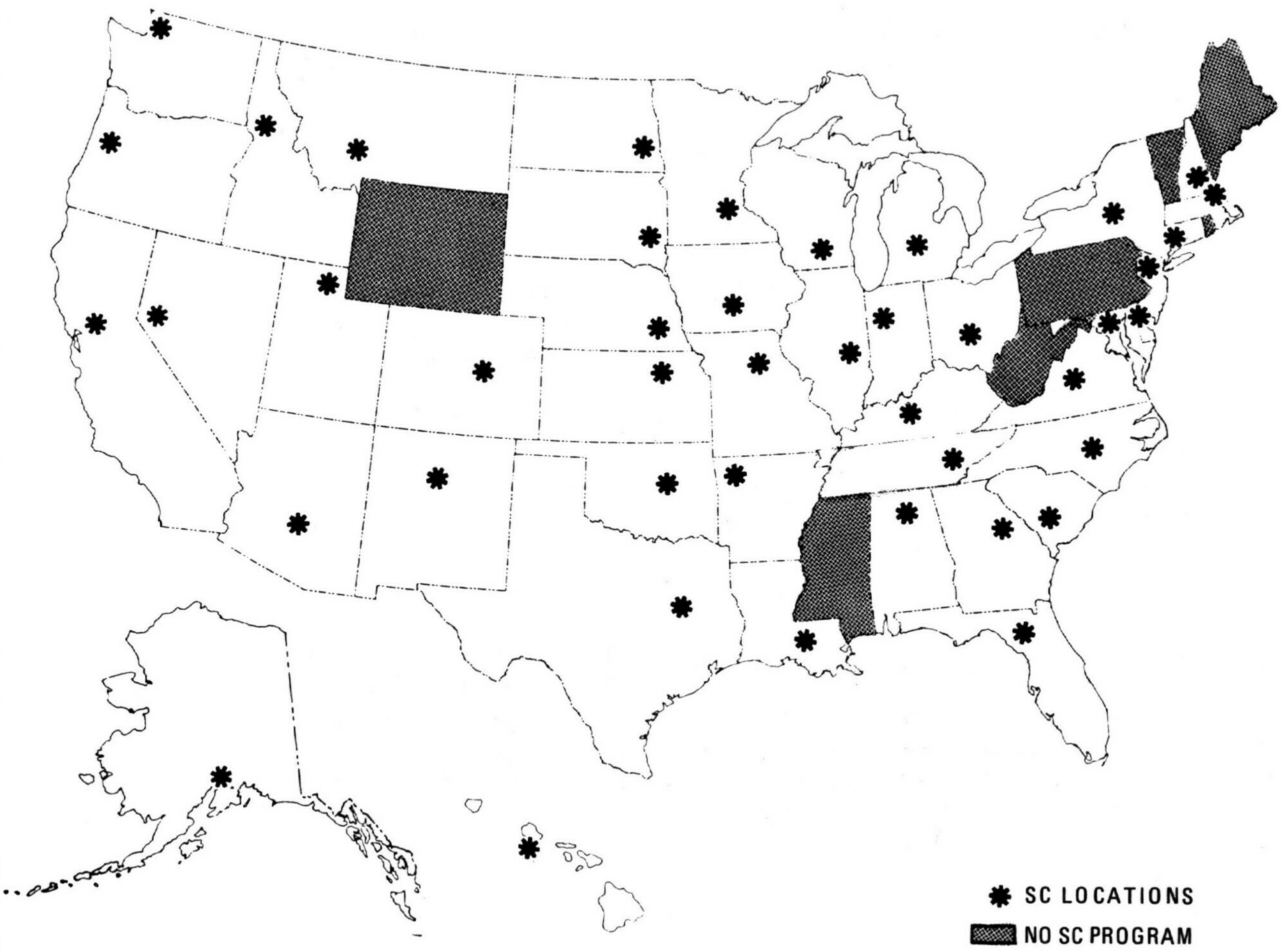
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
ENVIRONMENTAL DATA AND INFORMATION SERVICE
NATIONAL CLIMATIC CENTER

THE STATE CLIMATOLOGIST

IN COOPERATION WITH THE
AMERICAN ASSOCIATION OF STATE CLIMATOLOGISTS



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NCC BRIEFS

A Memorandum of Agreement has been signed with the Tennessee Valley Authority to furnish State Climatologist support to the State of Tennessee. The State Climatologist will be Robert C. Beebe. Mr. Beebe's address is Tennessee Valley Authority, 524 Union Avenue, 310 Evans Building, Knoxville, TN 37901.

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The NCC and AASC are pleased to welcome Mr. John C. Purvis as the new State Climatologist for South Carolina. Mr. Purvis replaces Mr. Mark W. Perry. Mr. Purvis' address is South Carolina Division of Research and Statistical Services, 1028 Sumter Street, Suite 201, Columbia, SC 29201.

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Thunderstorm Report. The Nuclear Regulatory Commission has published "National Thunderstorm Frequencies for the Contiguous United States (NUREG/CR-2252)." This report, authored by Michael Changery of the National Climatic Center's Applied Climatology Branch, presents month and annual analyses of mean thunderstorm frequencies utilizing 30 years of data extracted for a 450-station network. Results will be used by the NRC in site standards development for nuclear plant siting. This report is available for $4.50 from GPO Sales Program, Division of Technical Information and Document Control, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

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Navy Atlas. The U.S. Navy Marine Climatic Atlas of the World, Volume IX, "World-Wide Means and Standard Deviation, NAVAIR 50-1C-65," has been printed. The atlas contains analyses of surface wind, surface air temperature, sea surface temperature, air-sea temperature difference, dew point temperature, sea-level pressure, and wave height. This publication can be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 for a cost of $31.00.

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Hurricane Tracks. The revised and updated edition of Tropical Cyclones of the North Atlantic Ocean, 1871 - 1980 has been printed and distributed in a cooperative effort among ESIC/NHC/NHRL and NCC. Copies are available from NCC for $5.00. The earlier version of the publication (covering 1871 - 1977) has been out-of-print for about two years.

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NATIONAL CLIMATIC CENTER (NCC)

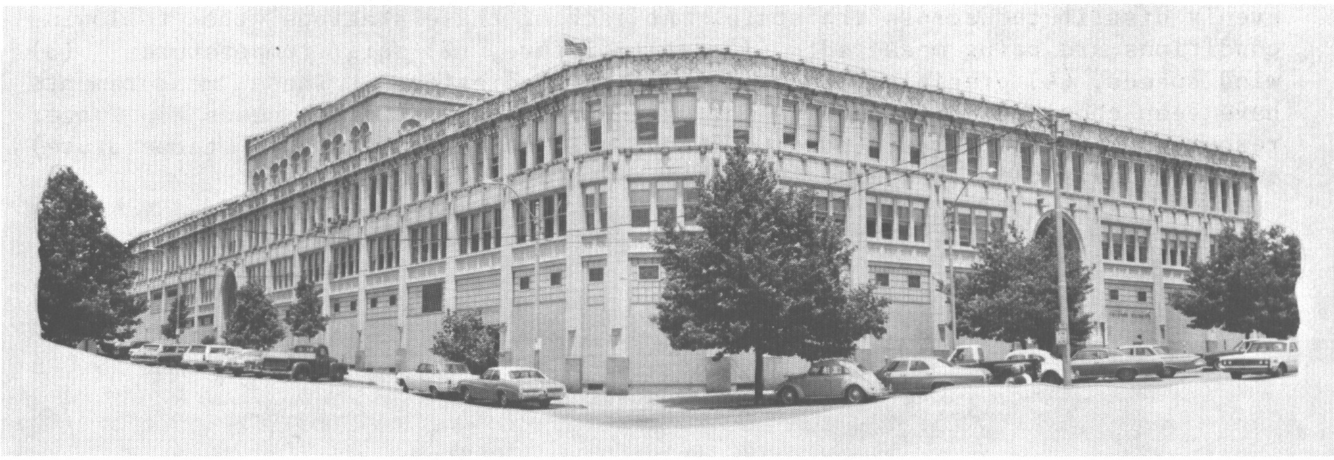
"NCC" -- we often hear this name, but do you ever wonder what it is? The National Climatic Center is located in the Federal Building, formerly known as the Grove Arcade Building, in downtown Asheville, North Carolina.

The Grove Arcade Building was conceived, planned, and started by Dr. E. W. Grove in 1926. The building was to be a 22 story monument to Dr. Grove's beloved Asheville.

Dr. Grove died in 1927 and the work was suspended. The property was purchased and the building completed (at only 4 stories) by Walter P. Taylor in 1928-29.

The Grove Arcade Building was purchased by the Federal Government in 1942. It has been owned and occupied by the Government ever since. It is now on the register of National Historic Places.

It is within this building that valuable original weather records are laid to rest. The National Climatic Center at Asheville is the largest of its type in the world. It is an operating division of the Environmental Data and Information Service (EDIS), a major component of NOAA under the Department of Commerce.



NATIONAL CLIMATIC CENTER, ASHEVILLE, NORTH CAROLINA

KENTUCKY STATE CLIMATOLOGIST APPOINTED TO ADVISORY COUNCIL

Glen Connor, State Climatologist for Kentucky, has been appointed by Governor Brown of Kentucky to the Alternate Energy Advisory Council. The Council is chaired by the Commissioner of the Bureau of Energy Production and Utilization, Kentucky Department of Energy.

The Council will provide advice to the Division of Alternate Energy on programs which stimulate development of alternate energy sources. Four areas of specific development will be addressed: solar, low head hydro, wood, and wind.

Conner has been appointed chairman of the committee on wind. The Department of Energy has purchased ten anemometers which will be loaned to citizens interested in wind power production. The data collected through this effort will be maintained by the Kentucky Climate Center as part of its data base. Over 100 people have signed up for the anemometer loan program.

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NEW NETWORK OF WEATHER STATIONS

The Illinois State Water Survey has just opened a new network of weather stations in Illinois. Stanley A. Changnon, Chief of the survey, announced that it addresses one of the major missions of the survey: to monitor the water and atmospheric resources of Illinois. This new network includes seven stations evenly distributed across the state. At each of these stations the following conditions are being measured: (1) soil moisture, (2) soil temperatures, (3) wind speeds, (4) precipitation, and (5) solar radiation. These measurements have been chosen to provide data for design and operational needs in water resources and agriculture (precipitation, soil moisture, and soil temperature) and for wind and solar energy applications.

THE CLIMATE PROGRAM AT THE ILLINOIS STATE WATER SURVEY

The Illinois State Water Survey, a Division of the Illinois Department of Energy and Natural Resources, has been involved in climatology data gathering, services, and research for several decades. Since part of our charge is to survey, record and predict, where possible, the water resources for the state, it was logical that atmospheric moisture was included as a major concern of the Water Survey. Since advection and dynamic processes play such an important role in the distribution of atmospheric moisture and precipitation, the Survey's staff expanded during the 1950-1980 period to include cloud physicists, dynamic meteorologists, statisticians, and atmospheric chemists, as well as climatologists. The group of professional atmospheric scientists now number about 45 persons.

Two years ago, under the direction of the then newly appointed Water Survey Chief, Stanley Changnon, the Climatology Section was created. This group consists of 15 persons: Five Ph.D.'s (or equivalent research), 5 holders of master's degrees, two persons with bachelor degrees, two technical support, plus a secretary. About half of these individuals are supported by state funds, and the remainder being supported by research funds obtained from sources other than the State of Illinois.

(L to R): John Vogel, Edna Anderson Stanley Changnon, Wayne Wendland

PAST HIGHLIGHTS

Climatology at the Illinois State Water Survey has enjoyed a relatively long and productive life. Many reports and bulletins have appeared over the years identifying and demarcating the climates of Illinois, showing and discussing changes to the distribution of certain climatic parameters in both space and time. Hydrometeorological research also has been a major effort at the Survey. The meso-scale raingage networks, operated by the Survey for many years in Illinois and other states, have provided the data base and thereby the means to answer many questions on precipitation intensity-duration relationship, and the areal extent of various precipitation rates. Both parameters significantly impact engineering and construction interests.

Another area of great research has been the study of inadvertent climate modification by power plants, cities, and other man-made influences. This culminated in the 5-year field study of the modification to the environment in and around St. Louis (METROMEX) and yielded a new dimension of information on the temporal and spatial extent of the impact of a large metropolitan area on the distribution of various climatological conditions. Similar research has been pursued in the Chicago Metropolitan area, to determine the urban as well as the Lake Michigan influences on weather conditions and climate. This area of research also now incorporates studies of jet contrails.

CURRENT CLIMATE SECTION GOALS

With the 1980 establishment of the Climatology Section, objectives and interests were refocused from the rather broad scope that the former Atmospheric Sciences Section had attained. The program objectives of the Climatology Section include:

1. studies to develop a better understanding of the dynamics, causes and distribution of climatic parameters and features, particularly in Illinois;

2. research to better explain past climatic changes as well as to increase skills in predicting future climate;

3. research to quantitatively define the impact of climate on human endeavors and the biosphere;

4. collection and maintenance of climatological data from the Illinois cooperative weather stations as well as our own specialized studies and new climate networks;

5. dissemination of findings to appropriate user communities;

6. cooperate with other states and federal agencies to increase use of climate data and information.

Our research, data collection and service activities may be divided into three categories: (1) the climate systems, (2) climate impact assessment and (3) the Illinois Climate Center.

MAJOR CURRENT PROJECTS

P. J. Lamb recently initiated a study (NSF funded) of the atmospheric dynamics associated with summer precipitation anomalies in eastern North America. He is assisted in this project by Diane Portis and Michael Richman, both Master's level researchers.

Douglas M. A. Jones and A. L. Sims are investigating the statistics of instantaneous rainfall rates. They will study the spatial coherency of short-term precipitation rates over a meso-scale network. It is funded by the Air Force.

Although some work has been done to specify the probability that certain environmental conditions follow a given set of antecedent conditions, we are studying the quality of conditional probability forecasts for various sectors of Illinois and the Upper Midwest. Future study will investigate the probability (based on about 100 years of climatic data) that a given condition will follow a set of antecedent conditions by weeks, months or seasons.

(L to R): Diane Portis, Peter Lamb, Michael Richman

S. A. Changnon, R. G. Semonin and W. M. Wendland have been pursuing a study (funded by NSF) of the effect of aircraft produced contrail cirrus on surface weather. This research has identified changes in time trends of certain standard meteorological parameters measure at NWS first order stations, which are coincident with the advent and increase in the frequency of jet traffic since the mid 1950s. These coincident changes are most clearly found in the observations of stations located within the area of most frequent jet traffic of the Upper Midwest. Conditions such as the amount of high cloud cover, the number of clear days, the number of cloudy days, etc. exhibit strong spatial coherence both within and outside the areas of frequent jet traffic.

(L to R): Richard Semonin, Keith Hendrie, Douglas Jones

(L to R): Peter Vinzani, Alice Wallner, Greg Dzurisin (front) Rebecca Runge

S. A. Changnon in cooperation with G. Dzurisin, is conducting a project (funded by NSF) to identify the climatology of precipitation detected by radar over northern Illinois and southern Lake Michigan. This study is using 3 years of data gathered by the ISWS CHILL and HOT radars. It is attempting to discern urban and lake effects on summer rainfall.

S. A. Changnon, G. L. Achtemeier, and P. G. Vinzani are also doing climatological investigations of two recent notable events in Illinois. The 1980-81 drought in southern Illinois, and the record incidence of blowing dust conditions in central Illinois in the spring of 1981. These are classic assessments to determine the validity and causes of two events. Other research is focusing on the climatology of heavy rainstorms in the populous northeastern Illinois. Recent increases in urban flooding in the Chicago Metropolitan area are being investigated as to causes.

Applications of long-range predictions of future weather (months and seasons) are another research topic. Lamb and Changnon are working with Steven Sonka, an agricultural economist, in pursuing and planning research in this area. Particular attention is being given to the needs and applications of predictions in agriculture.

P. G. Vinzani is the Weather Observer for the ISWS maintained Morrow Plots site, located on the campus of the University of Illinois. These data are maintained by the Illinois Climate Center, with those of about 80 other cooperative stations within the state. These records typically extend to 1901 and are maintained on computer disk for easy access. The Weather Observer prepares responses to many climatological inquiries directed to the Illinois Climate Center. The Illinois Climate Center houses the Illinois State Climatologist, S. A. Changnon, Jr.

The State of Illinois has provided funds for the 1981 installation of 6 climatological stations where continuous readings of temperature, humidity, insolation, wind direction and speed are integrated and recorded, and soil moisture is measured monthly with a neutron probe. An additional six sites will be installed within the next six months. The data are currently recorded on analog or digital paper tape and sent to the Survey on a weekly basis for data reduction. The wind and solar data will provide a data base from which the potential of alternative energy sources will be estimated. We expect to maintain these sites for future decades to provide a denser network of quality climatological observations than have been available in the past. L. K. Hendrie with Semonin, Jones and Wendland, have been responsible for the development and installation of the Illinois Climate Network. The synoptic nature of soil moisture observations made at regular intervals about the state offer a potential for monitoring the water budget more completely, as well as provide advisory services to the strong agricultural interests of the state.

J. L. Vogel is the Director of the recently initiated Regional Climate Coordinating Office, a facility sponsored by NSF which will coordinate climatological services and research projects of the 10 states in the north-central-94 region. Climatological personnel, facilities, and services within this ten state area are varied in size and funding. One purpose of the Regional Climate Coordinating Office is to assess the climatological efforts of each state, as well as advocate a stronger position in those states which currently enjoy little state support for climatological efforts, as well as coordinate research programs of interest to two or more states.

Our technical staff includes E. Breischke, E. Anderson and P. Stone. Secretarial services are provided by A. Wallner and B. Runge.

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A PRACTICAL METHOD OF CORRECTING MONTHLY AVERAGE TEMPERATURE BIASES CAUSED SOLELY BY DIFFERING TIMES OF OBSERVATION AS A MEANS OF IMPROVING CLIMATIC RECORD AND CROP MODELING ACCURACIES

Tom Blackburn
National Weather Service

1. THE PROBLEM AND ITS CONSEQUENCES

While the majority of substation weather observers record their maximum and minimum temperatures for the previous 24 hours around dawn, a substantial minority record their readings in the afternoon or evening, and the official "first order" weather offices (usually at airports) take theirs at midnight. The effects of these differences are often overlooked, even though they can wreak havoc on models and forecasts that relate average temperatures and various degree day bases to seed germination, plant growth, insect emergence and fungi growth. When a substation changes its time of observation, a fictitious climate change will result.

This article proposes a computer programmable method of determining and correcting on a month to month basis, the biases in monthly average temperatures attributable to differences in times of observation. Observations taken at midnight are defined as having zero error. Adjustments for non-midnight averages may then be applied each month to "correct" readings to the equivalent midnight values. All times are local standard times (LST).

Baker (1), using a carefully calibrated three-year study of the effects of the time of observation on average temperatures at St. Paul, MN, found an annual average difference of 2.5 degrees Fahrenheit between a sunrise and a 3-4 p.m. LST time of observation. This translated into a difference of 320 in the seasonal growing degree days (base 50) and over 700 in the annual heating degree days. The average difference was the largest (3.0°) February through May, and smallest (1.6°) in December.

Schaal and Dale (2) noted a gradual, but significant apparent cooling of Indiana's climate between 1935 and 1975, due in part to a gradual change in the predominant time of observation. In 1935, there were only 8 morning, but 58 afternoon temperature observers, while in 1975, there were 51 morning and only 29 afternoon observers. Schaal and Dale stated "The climate has "cooled" 1.2° F in the past 40 years, solely because of a change in the time of observations" (2). This cooling may have been overlooked in part, because it paralleled a similar fictitious cooling occurring at the first order sites as they were gradually moved from city offices to the cooler airports, and then in many cases, from second floor roof airport locations to the still cooler center-field sites.

2. AN EXAMPLE OF THE PROBLEM

Assume that maximum temperatures of 45, 75 and 55 occurred on April 30, May 1 and 2, respectively. Assume further that each maximum occurred at 4 p.m. An observer taking his/her readings at 4 p.m. on these dates would record maxima (the highest temperatures to have occurred during the previous 24 hours) of 75 on both the 1st and 2nd. A 7 a.m. observer would record maxima of 45 and 75 on the first and second (with these values actually having occurred on the previous calendar day), and the midnight observer would record maxima of 75 and 55, respectively. Now let's assume that the midnight observer is the "correct" one (i.e., with readings having no "errors") and compare the results.

	Reported Max Temps		Sum of Maxes	Difference from Midnight Obs	
Time of Ob	May 1	May 2	May 1 + 2	Total	Total divided by 31
Midnight	75	55	130	0	0 (by definition)
7 a.m.	45	75	120	-10	-0.3
4 p.m.	75	75	150	+20	+0.6

The total divided by 31 (right column) indicates the effects of the time of observation of the May 1 and 2 maxima alone, on the monthly average May temperature. The 30° difference between the 7 a.m. and 4 p.m. sums (150 minus 120) thus creates a difference in the monthly average of 0.97° (30 divided by 31 days).

By the same reasoning, if yesterday's <u>minimum</u> were 30, occurring at 7 a.m., and today's low were 50, a 7 a.m. observer would show minima of 30 both dates, while the 4 p.m. and midnight readers would show 30 and 50.

3. EFFECTS OF MONTH-END TEMPERATURES ON AVERAGES

Note in the previous section that the 7 a.m. observer recorded a maximum on May 1 that actually occurred on April 30th (45°). Nearly all maxima recorded by the midnight observer will also be recorded by the 7 a.m. reader, except on the following day by the latter. Thus, the month's average maximum usually won't be biased by the one-day difference, except for the maximum on the last day of each month, which the 7 a.m. observer will record in the following month.

Suppose in the above sample month, the May 31st maximum were 85. The midnight and 4 p.m. observers will record this, but not the 45 on April 30th, while the morning observer will pick up the 45, but miss the 85° reading. This creates a 40° bias in the monthly total maximum column, causing the morning observer to have a 1.3° lower average maximum for the month.

The minimum may also be biased, but usually only when the minimum on the final day of the month (i.e., April 30th) is colder than on the first (May 1st). The maximum temperature bias will commonly make averages too high in the autumn (when successive end-of-month temperatures are usually cooler) and too low in the spring. Biases in the minimum will be almost random.

4. AVERAGE ADJUSTMENTS FOR WASHINGTON, DC

In the Washington, DC metropolitan area, we have over 200 volunteer temperature observers who take their readings anywhere between 6 and 10 a.m. and between 4 p.m. and midnight. Each month for the past eight years, we have computed deviations in the monthly averages caused by differing times of observation. Figure 1 graphs a 7-year average of adjustments that were applied to monthly average maximum and minimum temperatures.

5. SOME CHARACTERISTICS OF ADJUSTMENTS

Note in Figure 1 that upward adjustments in the 6 a.m. minima are largest in the spring. This coincides with the season when variations in minima from one day to the next are the largest.

From March through October, the sun rises soon after 6 a.m., causing a rapid temperature rise, thus greatly reducing the upward temperature adjustment required thereafter. By 8 a.m., negative adjustments are needed, since monthly averages for these observers are higher than for midnight observers.

For afternoon readers, small downward corrections are needed in the minima, which occasionally occur after their observations have been made (usually at midnight). Since midnight minima are the most frequent and coldest (relative to morning minima) during the winter, the correction factor is much larger in the cold season (1.4° in January vs. 0.5° in July for 4 p.m. observers. Maximum temperatures for morning observers, when averaged over seven years, had to be raised during the months when temperatures were normally increasing (spring) and lowered (or raised less) when temperatures are falling, for reasons explained in paragraph 3.

6. INADEQUACY OF ABOVE ADJUSTMENTS USED ALONE

Table 1 combines the separate Figure 1 maximum and minimum adjustments into an adjustment of the monthly mean temperature. While this may be accurate for the

TEMPERATURE ADJUSTMENTS VS. TIME OF OBSERVATION, MAX AND MIN SHOWN SEPARATELY
WASHINGTON, D.C. AREA

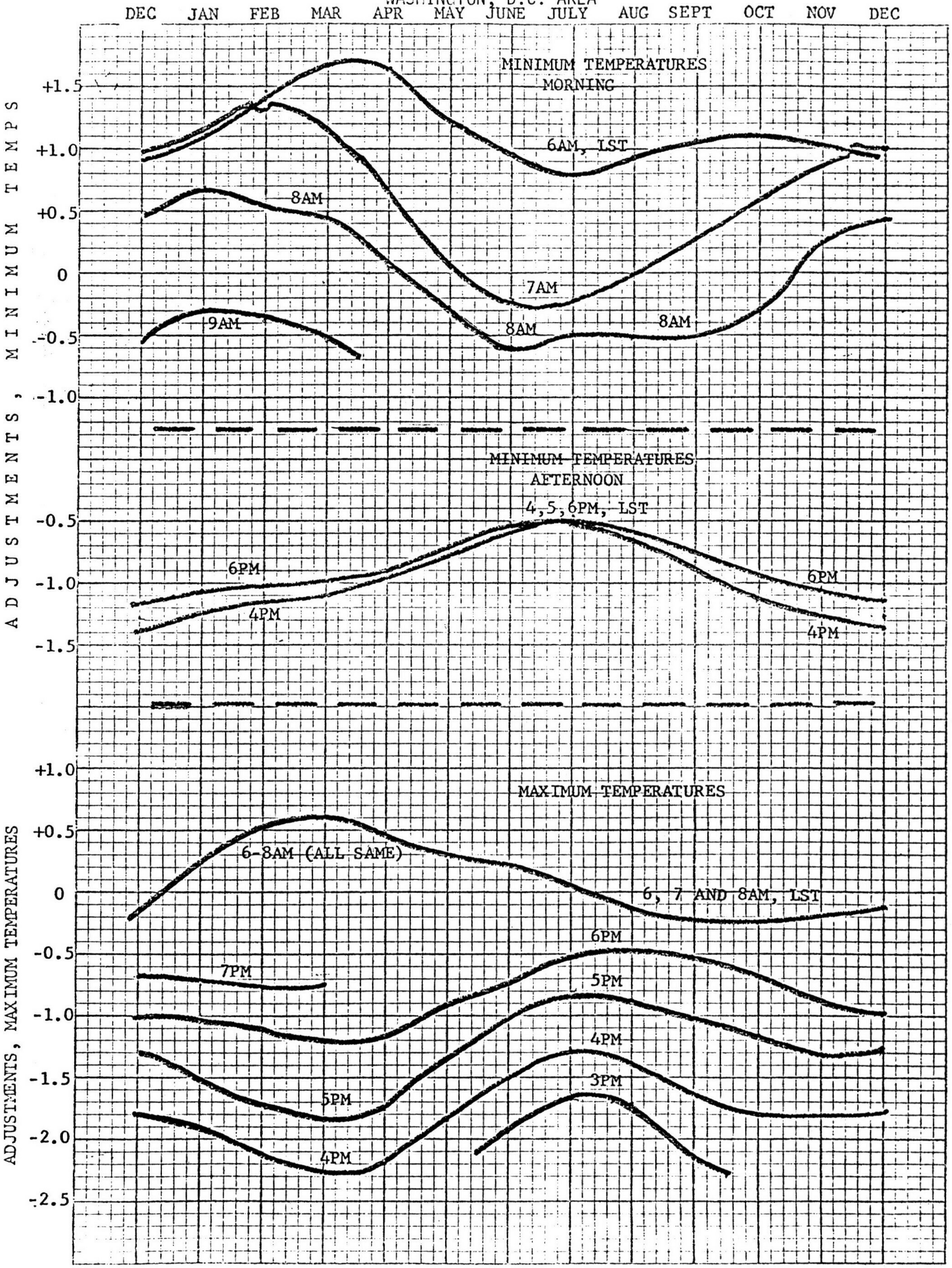

FIGURE 1.

TABLE 1

AVERAGE MONTHLY ADJUSTMENTS °F AS A FUNCTION OF LOCAL STANDARD TIME OF OBSERVATION, WASHINGTON, DC AREA

	M O N T H											
TIME	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
6 AM	0.65	1.02	1.15	1.08	0.77	0.63	0.45	0.42	0.42	0.43	0.42	0.42
7 AM	0.65	0.97	0.93	0.58	0.18	0.03	-0.05	-0.07	0.03	0.20	0.33	0.42
8 AM	0.45	0.53	0.53	0.22	0.00	-0.20	-0.22	-0.33	-0.32	-0.27	-0.03	0.17
4 PM	-1.57	-1.60	-1.65	-1.58	-1.32	-1.05	-0.90	-1.02	-1.23	-1.50	-1.62	-1.62
5 PM	-1.43	-1.40	-1.45	-1.35	-1.05	-0.78	-0.63	-0.72	-0.88	-1.08	-1.23	-1.28
6 PM	-1.02	-1.08	-1.08	-1.03	-0.82	-0.65	-0.50	-0.52	-0.62	-0.82	-0.85	-0.83

TABLE 2

AVERAGE DAY TO DAY TEMPERATURE VARIABILITY, °F

(Table 1 column headings apply in Tables 2 through 4)

	5.71	5.72	5.97	5.95	5.50	4.69	3.56	3.63	4.05	4.56	5.07	5.55

TABLE 3

ADJUSTMENTS EXPRESSED AS A FRACTION OF VARIABILITY

6 AM	.11	.18	.19	.18	.14	.13	.13	.12	.10	.09	.08	.08
7 AM	.11	.17	.16	.10	.03	.01	-.01	-.01	.01	.04	.06	.08
8 AM	.08	.09	.09	.04	.00	-.04	-.06	-.09	-.08	-.06	-.01	.03
4 PM	-.28	-.28	-.28	-.27	-.24	-.22	-.25	-.28	-.30	-.33	-.32	-.29
5 PM	-.25	-.24	-.24	-.23	-.19	-.17	-.18	-.20	-.22	-.24	-.24	-.23
6 PM	-.18	-.19	-.18	-.17	-.15	-.14	-.14	-.14	-.15	-.18	-.19	-.18

TABLE 4

SAME AS TABLE 3 AFTER DELETING EFFECTS OF SEASONAL CHANGES

6 AM	.15	.16	.14	.14	.10	.12	.15	.16	.16	.14	.15	.15
7 AM	.14	.15	.12	.09	.03	.03	.05	.06	.10	.12	.15	.15
8 AM	.13	.08	.05	.01	-.04	-.03	-.02	-.01	-.01	-.00	.07	.10
4 PM	-.28	-.30	-.32	-.28	-.26	-.22	-.24	-.25	-.26	-.27	-.27	-.27
5 PM	-.23	-.27	-.28	-.24	-.20	-.16	-.17	-.19	-.19	-.21	-.21	-.21
6 PM	-.18	-.22	-.23	-.19	-.15	-.12	-.12	-.13	-.13	-.14	-.15	-.16
7 PM	-.14	-.16	-.16	-.13	-.10	-.08	-.07	-.07	-.08	-.11	-.12	-.13

Washington, DC area, the magnitudes of temperature adjustments will vary greatly, not only in different parts of the country, but between heat islands and nearby rural valleys as well. Because of these differences, values in Table 1 and Figure 1 should only be viewed as representative of the general characteristics of the correlation of adjustments with the observation time. Further refinements, described below, are needed to apply these principles to other areas.

7. CORRELATION BETWEEN ADJUSTMENTS AND DAILY TEMPERATURE VARIABILITY

The magnitude of required temperature adjustment is highly correlated to the average magnitude of day to day changes in maximum (and minimum) temperatures; that is, the variability. For example, if the maxima on three successive days were the same, occurring at 4 p.m., the variability and hence the adjustment for these dates for 4 p.m. observers would be zero. Table 2 shows the average variability at the stations used in this study (note that Tables 1 to 4 all appear on the same page). In the Washington area, the largest variabilities usually occur in the spring, and smallest in July. Table 3 shows the size of the adjustments required as a percentage of this variability. This table should be more applicable than Table 1 to other parts of the country where the times of sunrise and sunset are very similar to Washington's. This will be dealt with later.

8. IMPORTANCE OF APPLYING ADJUSTMENTS FOR MONTH-END TEMPERATURES

Table 3 (like Figure 1) shows the impact on morning observations, of differences in temperatures between the last day of last month and the final day of this month. In the absence of actual knowledge of these differences each month, this table could be used for temperature corrections. However, it is important that we actually know the differences between the maxima and minima for these dates, since in any given month, they can be far different from the long term averages. Table 4 has deleted these average month-end effects, and can be used with the help of Table 5 to apply corrections for the final days of last month and this month, based on actual values. It should be self-explanatory. A computer program can be written to obtain adjustments from Table 4 values and Table 5 entries.

9. CORRECTIONS FOR LOCAL SUNRISE AND SUNSET TIMES

Tables 4 and 5 will provide good results if the local standard times of sunrise (and perhaps sunset to some extent) coincide with Washington's. If not, Figure 2 can be used, which shows adjustments relative to the time of sunrise, and Figure 3, of sunset. The latter figure indicates that adjustments have much more closely approached zero by sunset in summer than winter. This has little significance, however, because the adjustment appears to be more closely related to the number of hours before midnight than to the time of sunset.

Because of this, it may be that Table 4 adjustment values would be nearly as representative across the United States as Figure 3, suggesting that trying to adjust values as a function of the time of sunset will show little advantage. Adjusting morning values, however, will usually show a significant improvement over Table 4, since sunrise determines the time the temperature usually begins to rise.

10. TEMPERATURE ADJUSTMENTS, RURAL VS. URBAN AREAS

A comparison of adjustments required in a rural valley vs. an urban setting, showed both the variability and adjustments to be up to 20% higher in the valley. The overall adjustments as a function of variability, however, were about the same. The percentage adjustment approaches zero considerably faster in the first 90 minutes after sunrise at the valley site, probably because the more intense nighttime inversion found there in clear, windless nights is more rapidly broken. There is also a more rapid decrease in the adjustment around sunset (as rural temperatures fall more rapidly), but this difference is not as large as that in the morning.

In the Washington area, we determine adjustments for both a rural and urban site, then apply an average of these two corrections to our observers' monthly average temperatures.

11. CONCLUSIONS

Significant biases in monthly average temperatures, caused solely by the time at which observations are taken, can cause serious problems with crop modeling and "errors" in climatological average temperatures and degree days. These biases can be largely eliminated. The most accurate adjustments can be made using Table 6 in conjunction with the appendix for morning observers, and either Table 6, or Table 4 with the appendix for evening observers. If the very important month-end corrections aren't obtainable, Table 3 may be used in place of Tables 4 and 6 and the appendix (with a possible large loss in accuracy). If it isn't practical to determine average day-to-day variabilities by computer for each station whose values are to be adjusted (or at least for the station used in the appendix) nor to determine month-end corrections, then Table 1 corrections should still be better than no adjustments at all.

TABLE 6

TEMPERATURE ADJUSTMENT AS A PERCENTAGE OF VARIABILITY VS. HOURS BEFORE AND AFTER SUNRISE AND SUNSET

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
HRS BEFORE/ AFTER SUN-RISE												
1:00 before	+15	+16									+15	+15
0:30 before	+14	+15									+15	+15
SUNRISE	+14	+15	+14							+14	+15	+15
0:30 after	+13	+12	+12	+13					+15	+13	+11	+12
1:00 after	+10	+ 8	+10	+12	+10		+15	+13	+11	+ 8	+ 7	+ 8
1:30 after	+ 4	+ 5	+ 6	+ 9	+ 7	+10	+10	+ 8	+ 6	+ 2	+ 2	+ 5
2:00 after		+ 2	+ 2	+ 5	+ 3	+ 6	+ 5	+ 4	+ 1	- 3	- 2	
2:30 after			- 2	+ 1	0	+ 2	+ 1	0	- 3	- 7		
3:00 after				- 3	- 4	- 1	- 2	- 3	- 6			
3:30 after				- 7	- 6	- 4	- 4	- 5				
4:00 after					- 8	- 6	- 5					
SUNSET												
3:30 before						-22	-24					
3:00 before					-24	-19	-20	-25				
2:30 before				-27	-21	-16	-17	-22				
2:00 before			-31	-25	-19	-14	-14	-19	-24			
1:30 before			-29	-23	-16	-12	-12	-16	-20	-27		
1:00 before	-27	-27	-26	-20	-14	-10	-10	-13	-17	-24	-26	-27
0:30 before	-25	-25	-24	-18	-12	- 8	- 8	-10	-14	-21	-24	-24
SUNSET	-23	-22	-21	-15	-10			- 8	-12	-18	-21	-22
0:30 after	-20	-20	-18						- 7	-15	-18	-19
1:00 after	-18	-17								-13	-16	-17
1:30 after	-16									-11	-14	-15
2:00 after	-13										-12	-13

APPENDIX

DETERMINING ADJUSTMENTS TO MONTHLY AVERAGE TEMPERATURES NOT TAKEN AT MIDNIGHT

1.a. If each substation's daily maxima and minima are entered in a computer data base, determine the average daily variability of maxima and minima by computer for each station not taking readings at midnight. To do this, have the computer sum the daily differences between successive maxima for each day of the month, including, if possible, the difference between the maxima on the last day of last month and first day of this month. Have the computer do the same for the minima. Add these together and divide by twice the number of days in the month.

1.b. If daily values are not entered into the computer data base, select a reliable station assumed to have an average variability (avoiding intensely urban or rural valley stations) and determine the variability manually as in 1.a. Assume that all stations have the same variability.

2. Find the sunrise and sunset (LST) for the midpoint of the month.

3. For each station, determine the number of hours (to the closest 30 minutes) before or after sunrise (morning observers) or sunset (evening observers) that the observations are taken. Enter these in the computer data base for all months for all stations, so steps 2 and 3 need not be repeated each month.

4. Enter Table 6 to find the percentage temperature adjustment to apply, as a function of the hours before or after sunrise or sunset. This should also be done for all stations and all months, as per steps 2 and 3.

5. Multiply the adjustments (step 4) by the average variabilities (1.a or 1.b) and convert them into hourly adjustments: 6am ____ 7am ____ 8am ____ 9am ____ 5pm ____ 6pm ____ 7pm ____ 8pm ____ LST.

ADJUSTMENTS FOR MORNING OBSERVATIONS (computer should be programmed to do the steps below)

6. Min temp first of this month ____ minus min last day of last month ____ = ____ (enter 0 if negative). This difference remains constant for obs taken before sunrise. Have it then decrease linearly to 0 during the next three hours.

7. With this modification, the min temp adjustments are: 6am ____ 7am ____ 8am ____ 9am ____ LST (all must be positive or 0).

8. Max temp last day of this month ____ minus max last day last month ____ = ____ (may be + or −) (the max temp difference is constant for all hours 6 thru 9 am).

9. Total the difference (steps 7 + 8) 6am ____ 7am ____ 8am ____ 9am ____.

10. Divide the step 9 values by twice the number of days in the month: 6am ____ 7am ____ 8am ____ 9am ____.

11. Add or subtract these from the monthly adjustment determined in step 5.

ADJUSTMENTS FOR EVENING OBSERVATIONS

12. Max temp first of this month ____ minus max last day of last month ____ = ____ (enter 0 if positive). This correction decreases from its full value at about 5 pm LST to 0 for an 11 pm ob time.

13. Assuming this decrease is linear, the adjustments are thus: 5pm ____ 6pm ____ 7pm ____ 8pm ____ (all must be negative).

14. Divide the above values by twice the number of days in the month: 5pm ____ 6pm ____ 7pm ____ 8pm ____.

15. Subtract these from the step 5 adjustments. 5pm ____ 6pm ____ 7pm ____ 8pm ____.

16. Additional adjustment (if programmable): If the max (min) temp on the last day of the month occurs after the time of observation (pm observers only), add (subtract) 1/60th of the difference between the time-of-ob max (min) and the midnight max (min) to (from) the afternoon stations' monthly average max (min). Difference between time-of-ob and midnight max (min): 5pm ____ 6pm ____ 7pm ____ 8pm ____.

17. Add this adjustment to those determined previously (steps 11 or 15): 5 pm ____ 6pm ____ 7pm ____ 8pm ____.

REFERENCES

(1) Baker, Donald G., 1975, Effect of Observation Time on Mean Temperature Estimation. Journal of applied Meteorology, 14, 471-76.

(2) Schaal, Lawrence A., and Robert F. Dale, 1977: Time of Observation Bias and "Climatic Change." Journal of Applied Meteorology, 16, 215-222.

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THE LONG RANGE FORECAST
by
E. Arlo Richardson

Nearly every civilization that has existed upon the earth has felt the need for information on the future course of the weather. The lore of all civilizations is replete with statements relating the behavior of characteristics of plants, animals and insects to expected future weather conditions. Some of these weather proverbs were found as far back as 4000 BC on clay tablets of Babylonia. A very few of these statements are based upon facts, but most are of little or no value as predictors of future weather.

Many proverbs relate the phases of the moon to future weather conditions. A few of these proverbs have been put together in rhyme supposedly by Dr. Jenner, the discover of the vaccination.

"Last night the Sun went pale to bed,
The Moon in halos hid her head,
The boding shepherd heaves a sigh,
For see! a rainbow spans the sky;
Hark how the chairs and tables crack!
Old Betty's joints are on the rack;
Her corns with shooting pains torment her,
And to her bed untimely send her;
Loud quack the ducks, the peacocks cry,
The distant hills are looking nigh;
How restless are the snorting swine!
The busy flies disturb the kine,
Low o'er the grass the swallow wings;
The cricket, too, how sharp he sings!
In fiery red the sun doth rise,
Then wades through clouds to mount the skies.
'twill surely rain,--I see with sorrow,
Our jaunt must be put off tomorrow."

The above illustrates a large group of commonly used weather proverbs. A few are based on reality. Others are not. I will leave it up to you to decide which are scientifically based.

The American Indians had a very gruesome proverb: "When the locks turn damp in the scalp house, surely it will rain." This was a valid application of scientific knowledge since the high humidity that caused the scalp locks to become damp also favored rain. This may have been a forerunner of our hair hygrometer that has been used for generations.

We could spend considerable time discussing these proverbs, but let us look at more modern approaches to making long term predictions of the weather. As the science of mathematics and statistics developed, many researchers began to look for cycles in the weather patterns of the past which could be used to predict the future. In all of these studies the assumption was made that the weather would behave in the future in the same manner that it had behaved in the past. Some students of cycles looked for periodicities such as 10, 20, 30 or 100 year cycles. Others looked for cycles related to physical phenomena such as the annual cycle related to the movement of the earth about the sun, lunar cycles, sunspot cycles, cycles related to the position of the planets with relation to their alignment with the sun and the earth and many others.

The search for weather cycles became a mania for many people who spent years in trying to find that elusive period that they felt would control the weather patterns. A search for cycles is a lot of fun and with modern computers more exhaustive tests of multiple cycles is being studied. These modern studies, however, are not based on random numbers but are being based upon physical principles which are a little more sound than those made in centuries past.

Besides the cycle hunters, a more modern mathematical approach to climate analysis is that of statistically studying trends in the weather and following more short term directed indications of the past weather. These trends are then related to extremes of the past and the assumptions are made that the weather will find it very difficult to establish a new extreme condition. It will, therefore, tend to revert back towards more normal behavior the nearer a value approaches an extreme value of a particular weather variable. These types of studies show some of the better results as long as care is taken by the researcher to limit the "climatological outlook" so described to the accuracy of the data available. In expressing outlooks based on this type of climatic analysis, some people tend to go beyond the limits of the technique in order to appear more accurate or more specific. This is always a danger when there is such an urgent need for knowledge of the course of future weather as it will affect the well being of agriculture, industry and even life itself.

Another approach which is closely related to the information used by the Weather Forecaster to make the regular weather forecasts is to use the computer to calculate prognostic charts 5 to 10 days up to 30 days in the future based upon the computer's use of mathematical models of the atmosphere to predict the movement, weakening and intensifying of high pressure, low pressure troughs and ridges on the weather map. This approach is really just in its infancy and will improve as our understanding of the physical processes in the atmosphere increase.

Another relatively recent approach to long term prediction is that of statistically studying the relation between sea surface temperatures and other physical observations which are less variable than atmospheric conditions.

Such measurements from satellites are being studied by lag techniques to try to predict seasonal changes in the weather. In addition to these seasonal studies, other researchers are looking at longer term influences of the increase in carbon dioxide due to our increased use of fossil fuel and the impact of manmade pollutants such as the aerosols used in hairsprays, etc. on the physical processes of the atmosphere.

Since many of the modern approaches to long term forecasting are still in their infancy, it is too early to judge which are valid and which will follow the paths of early random cycle hunters to oblivion.

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Washington, D.C. 20230

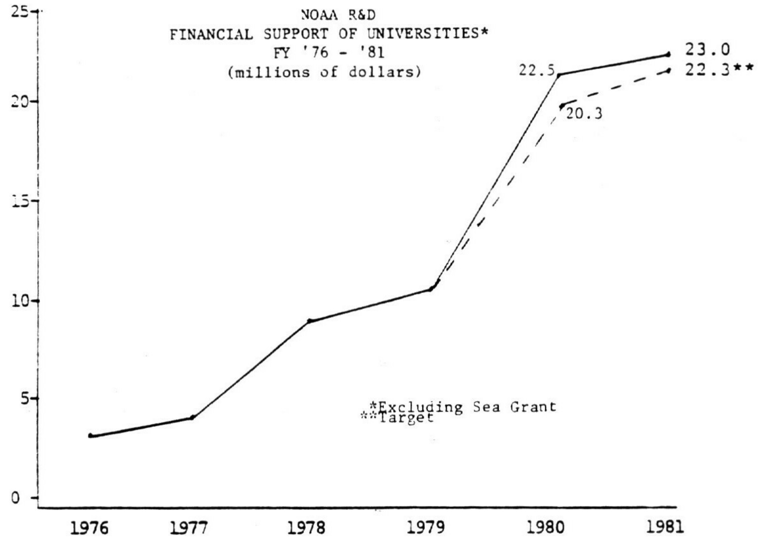
OFFICE OF THE ADMINISTRATOR

UNIVERSITY AFFAIRS LETTER
Washington, DC, November/December 1981

Dear Colleague,

NOAA's budget for FY 1982. . . which year began October 1, 1981. . . has been provided by Congress in the form of a continuing resolution, instead of an annual appropriation that NOAA usually receives. Total funds available may be clarified by December 15, when further action is necessary on the resolution. The general outlook remains: three lean budget years in planning for any additional NOAA financial support of university R&D.

On September 30, 1981. . . the books were closed on FY 1981. . . ending another solid year of NOAA/University cooperation. A few highlights of this effort are noted below: . . . 526 students were hired as summer employees, 40 were graduate students. . . 43 university faculty members received IPA/term appointments in NOAA research laboratories. . . 249 faculty members and students from over 75 universities used the ships of the NOAA fleet for marine research.



The good news. . . reflected in the above graph. . . is that NOAA exceeded its target goals for FY 1980 and FY 1981. . . for university R&D grants, cooperative agreements and contracts almost equally divided among atmospheric, oceanic and fisheries sciences.

It should be noted. . . that NOAA's Sea Grant Program. . . supported an additional $19.5 million R&D effort at selected universities during FY 1980 and $22 million in FY 1981.

Target figures for FY 1982. . . are now being developed by NOAA Administrator John V. Byrne.

Sincerely yours,

Earl G. Droessler
Director of University Affairs

GRANTS FOR SECOND YEAR OF NOAA RECENT POSTDOCTORAL RESEARCH SUPPORT PROGRAM, 1981

Postdoctoral	University Receiving Grant	Research Title	Award Amount	Term	NOAA Sponsor
BOHNSACK, JAMES A. Ph.D., Biology 1979 Univ. of Miami	Univ. of Miami	Resiliency of Coral Reef Fish Community Structure in Response to Reduced Harvesting Pressure	$45,700	12 mos. beginning 9/1/81	Dr. William Richards Miami Laboratory NMFS, Miami, Fla.
CHEN, ELLEN Y. Ph.D., Fruit Crops, 1979 Univ. of Florida	Univ. of Florida	The Application of Geostationary Satellite Surface Infrared Radiance Temperatures to Provide Mesoscale Climate Information.	$37,866	12 mos. beginning 9/1/81	Mr. Dan Tarpley Applications Lab NESS, Camp Springs, Md.
GORDON, GEOFFREY A. Ph.D., Atmospheric Science, 1979 Univ. of Missouri	Univ. of Maine	Climate-Yield Models	$28,900	12 mos. beginning 9/1/81	Dr. Sharon LeDuc Center for Environmental Assessment Columbia, MO
LEWIS, LONZY J. Ph.D., Atmospheric Science, 1980 St. U. of N.Y. at Albany	Georgia Institute of Technology	Solar Radiation Studies	$33,700	12 mos. beginning 9/1/81	Dr. Lester Machta ERL-Air Resources Lab Silver Spring, Md.
MOSLEY-THOMPSON, ELLEN Ph.D., Geography Climatology, 1979 Ohio State Univ.	Ohio State Univ.	Analysis of the Quelccaya Ice Cap Climate Record	$30,000	12 mos. beginning 9/1/81	Dr. Joseph O. Fletcher Climate Research Program ERL, Boulder, Colorado
RICE, DONALD L. Ph.D., Marine Chemistry, 1979 Georgia Institute of Technology	State Univ. of N.Y. at Binghamton	Biogeochemical Partitioning of Trace Metals in the Benthic Boundary Layer - The Role of Macroinfauna	$25,000	12 mos. beginning 9/1/81	Dr. William G. Conner Office of Marine Minerals CZM, Washington, DC

When the six grants . . .to the universities noted above were awarded by NOAA in September, the second round of a modest new NOAA research grants program was completed. The grants will support the on-campus research of these few recent postdoctorals who have built outstanding records and have exceptional promise in academic research, in front-line scientific work on atmospheric, fisheries, and ocean sciences, and related fields that undergird the mission of NOAA.

From across the country . . .more than two dozen proposals were received by NOAA from recent postdoctorals. These were reviewed internally and then ranked by a NOAA review board, resulting in the six grants listed above. Each grantee will establish a visiting relationship with a NOAA laboratory or facility and the NOAA sponsor will help the grantee to feel at home in NOAA.

The next round . . .of recent postdoctoral research support grants is expected to be announced through the University Affairs Letter and Federal Register in January 1982. Watch for it.

USCOMM-NOAA-ASHEVILLE, N.C. 2/82/450

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