

## TRADING POST

Since our last issue, the following Technical Procedures Bulletins have been issued.

No.	Title
178	Changes in Positioning the LFM Precipitation Forecasts.
179	Six Hour Cycle in Final.
180	The Use of Model Output Statistics for Predicting Ceiling, Visibility, and Cloud Amount.
181	72-hour Maximum Temperature Forecasts Based on Model Output Statistics.
182	Correction of LFM Error.
183	Revisions to NMC/QPB Heavy Snow Guidance Program.
184	Hourly National Weather/Temperature Bulletins on Request/Reply.
185	The Teletype Radar Intensity Plot.
186	Storm Surge Forecast for Essexville and Lakeport, Michigan.
187	LFM FOUS Freezing Levels and Relative Humidity.
188	Updated Facsimile Schedule NAFAX and FOFAX (supersedes TPB #175).
189	Updated Facsimile Schedule NAMFAX.
190	Wind Wave Forecasts for the Gulf of Mexico.
191	Use of Model Output Statistics for Predicting Surface Wind.
192	Alaska Maximum/Minimum Temperature and Surface Wind Forecasts FMAK 1 Bulletin.
193	The Use of Model Output Statistics For Predicting Ceiling, Visibility, and Cloud Amount.

Persons interested in obtaining copies of these Bulletins can write directly to Dr. Duane Cooley, Chief, Technical Procedures Branch, Meteorological Services Division, NWS W111, Gramax Bldg., Rm 1302, Rockville, Md. 20852.

## BACKGROUND INFORMATION FOR DISCUSSING DROUGHT

This year's unusual winter weather has made front-page news. It has also raised a deluge of questions as to why there has been such extreme weather over the Nation and will the drought continue in the West through spring and summer. This Technical Attachment tries to give you some answers to these questions.

One of the first things that comes up when discussing the drought is cycles in weather regimes, and the relationship of the drought cycle to sunspot cycles. There is no question that cycles in past weather data have existed, but they are mostly random in character with no known physical basis and not persistent enough to be projected into the future. The cycles of substantial climatic change with periods of 96,000; 41,000 and 21,000 years do have a good physical basis. They have been related to known changes of the earth's orbital elements (i.e., eccentricity, obliquity, and precession, respectively. However, sunspot cycles or other possible cyclic changes in the sun's radiation have not yet been related to weather cycles by sound physical theory. There may be a relationship but reliable solar data cover too short a time span and are not detailed enough to establish conclusive physical or statistical proof that the relationship exists. For example, there appears to be a relationship between the western United States drought cycle and the sunspot cycle. However, climatologists have not found this same relationship in past centuries. Therefore, it is very risky to talk about future changes of climate using such cycles.

Assigning reasons for climatic change is a very complicated problem. Figure 1 gives a graphical presentation of the factors involved. A plausible theory linking climatic changes to any one of the indicated factors can be and has been developed. Currently, the most controversial factors involve changes of climate due to air pollution. There are good theoretical arguments to show that the earth will warm up due to increasing carbon dioxide (CO<sub>2</sub>) in the atmosphere (greenhouse effect), and there

## Climatic Events And Processes

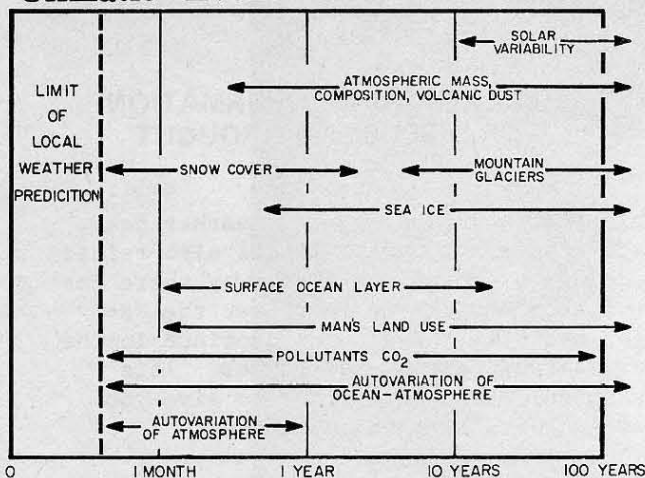


Figure 1. Characteristic climatic events and processes in the atmosphere, hydrosphere, and biosphere and possible causative factors of global climatic changes. (From *Understanding Climatic Change*.)

are equally good physical reasons to support a cooling of our planet because of the  $\text{CO}_2$  increase. The true state of affairs is that we don't know the reasons for most climate changes.

The consequences of very small and apparently insignificant mean temperature changes over a hemisphere or the globe can be very great. Figure 2 is a smoothed graph of the mean annual temperature of the Northern Hemisphere over the last 100 years. There was a very definite but small warming from the 1880s to 1940s and a cooling (greatest in the Arctic) from the 1940s to the present. While the magnitude of the changes of the

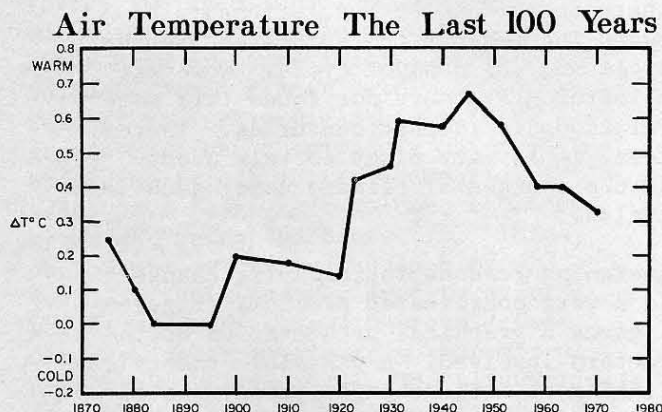


Figure 2. Changes in the 5-year surface temperatures over the region  $0-80^\circ\text{N}$ , during last 100 years. Note, the zero origin for indicating temperature change is taken as the temperatures in the 1880s and 1890s. (From *Understanding Climatic Change*.)

mean temperature involved have been less than one degree Celsius, the related changes in the weather have been very significant. Since temperatures in the Arctic and sub-Arctic have cooled more than the average, the hemispheric thermal gradient between high and low latitudes has increased. This resulted in the gradual development of stronger meridional flow and slower west-to-east motion of weather than a decade ago. The consequence of this is the occurrence of more extreme weather events than in the three previous decades, i.e., weather more reminiscent of the late 1880s than the 1940s and '50s. This certainly has been the case over the past 5 years and should continue to be so. It is important to keep in mind that the past two decades have been abnormally favorable to agriculture, actually a rare period if you look at climatological conditions over thousands of years. Thus, some climatologists consider that this benevolent period of the past 20 to 30 years is ending.

Two of the big questions regarding the character of the weather over the next several years are:

- 1) is the cooling trend going to continue? and
- 2) where and when will the weather extremes occur?

The answer to question 1) is not clear. Using the cycle idea and just the data given in Figure 2, which is not a good scientific procedure, you would expect the cooling to continue into the 1990s. Yet, almost as risky is the prediction by some climatologists that a warming will take place by the 1980s due to increasing air pollution. In any case the Northern Hemisphere should stay cool enough in the 1970s to continue the relatively frequent occurrence of extreme weather conditions such as droughts; abnormally cold, snowy winters, etc.

The answer to question 2) is not available now, but leading research meteorologists speculate that within 10 years more reliable seasonal forecasts of general weather conditions for the United States may be feasible. One of the factors being studied in trying to improve seasonal forecasting techniques is the sea-surface temperature field. The major problem here is the lack of good sea-temperature



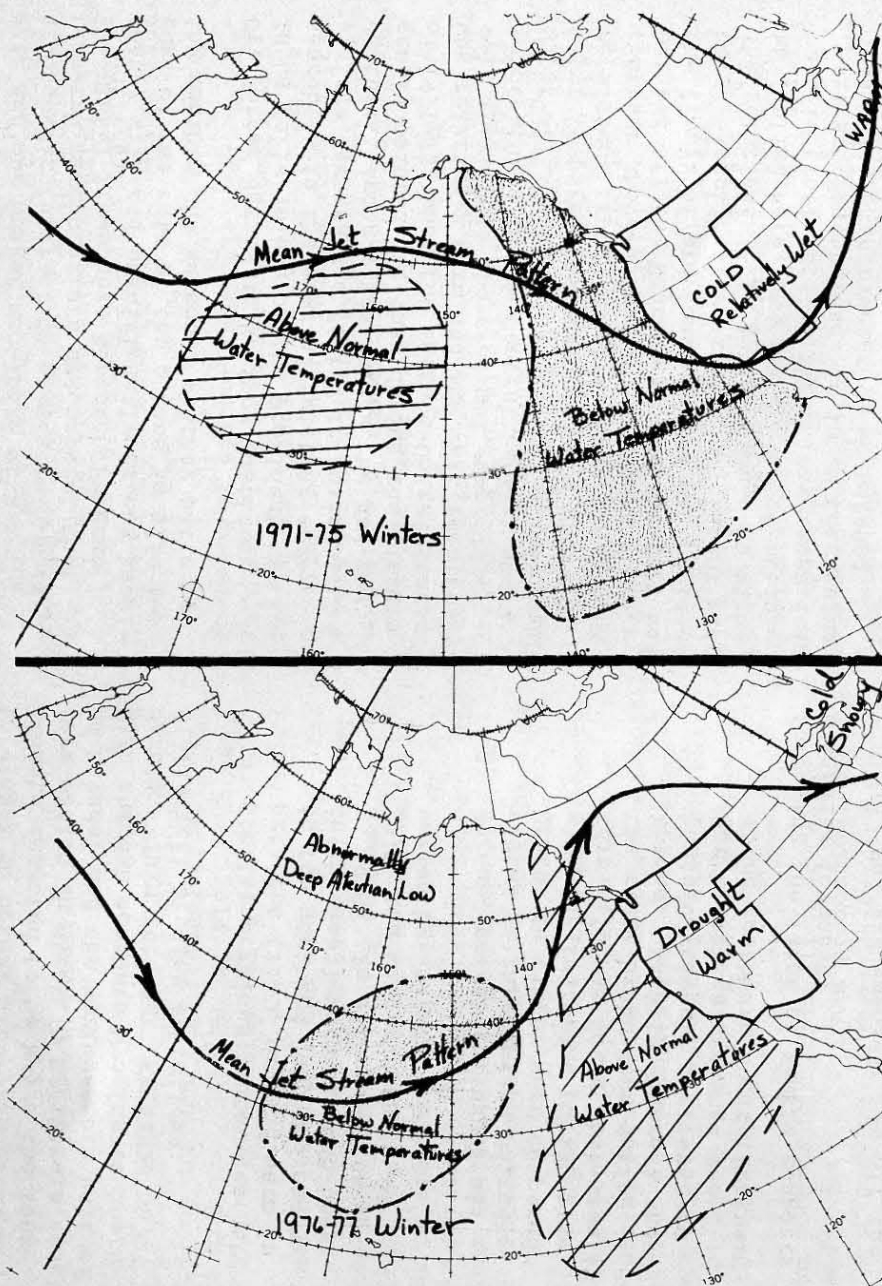
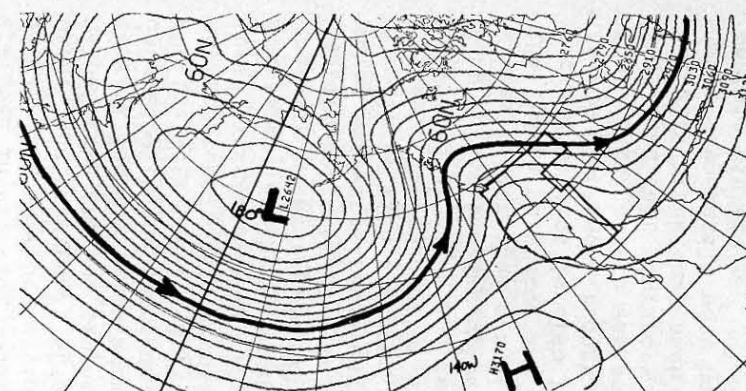
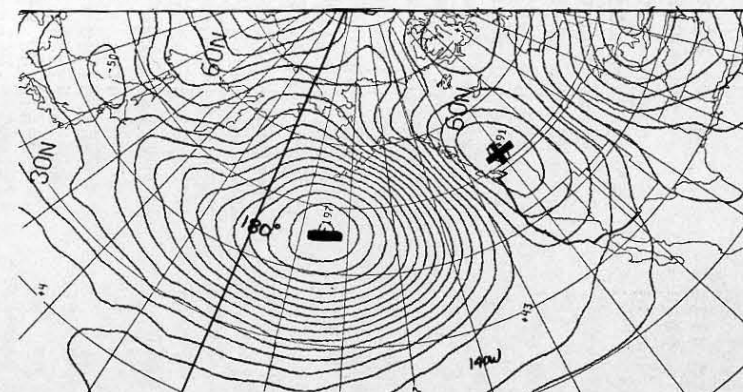


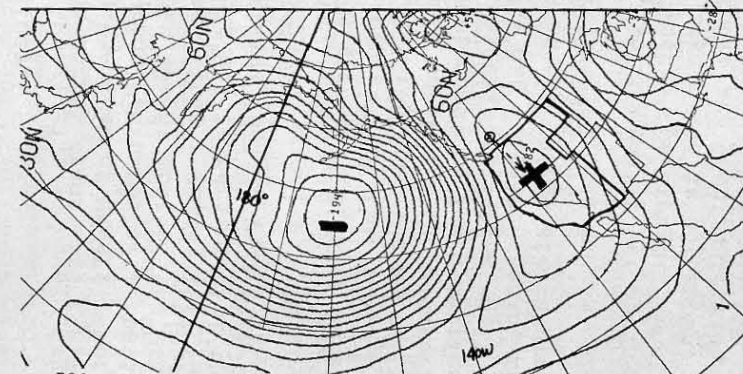
Figure 3. A schematic representation of the jet stream wave pattern as related to sea-surface temperature fields.



a. 700mb 30-day mean height field Jan. 25-Feb. 24, 1977.



b. Associated 700mb 30-day mean departure from normal.



c. 700mb 15-day mean departure from normal, Feb. 9 to 24, 1977.

Figure 4. 700-mb mean and departure from normal charts for February 1977. (Courtesy of Dr. Gilman, NMC).

data and our meager knowledge of sea-atmospheric interaction processes. Most research meteorologists are hopeful that the Global Atmosphere Research Program (GARP) will add significantly to our knowledge of the role of the oceans in affecting monthly and seasonal weather patterns.

Dr. Jerome Namias at Scripps Institute in La Jolla is one of the prominent researchers in the area of relating sea-surface temperature fields to seasonal weather. Among other things, he had recently pointed out that during the winters of 1971-75, when the eastern United States was relatively warm and the west relatively wet, there were above-normal sea-surface temperatures in the Central Pacific where an upper-air ridge persisted, and below-normal water temperatures east of 140°W where a persistent trough existed. (See Fig. 3) In contrast above-normal water temperatures existed off the West Coast this winter, and the trough of previous winters was replaced by an exceptionally strong, persistent ridge. The relationship is not as simple as might be implied here, and its degree of usefulness is controversial among long-range forecasters. Nonetheless, it is an intriguing idea and one that needs to be pursued.

The reasons for this winter's pattern being so persistent are not evident. However, if you follow Namias' ideas, there are some interesting associations. The pattern was self-preserving in several ways. The abnormally strong Aleutian Low helped keep the sea temperatures in the central Pacific below normal. This coupled with the abnormally warm water off the West Coast resulted in a sea-surface temperature gradient that fostered cyclogenesis around 145°W. The persistent southerly winds helped maintain the warm water regime off the coast. In eastern North America an extreme snow cover was established early in the winter associated with a strong upper-air trough. The abnormally high radiation heat loss at night and reflected heat loss during the day helped keep temperatures colder than normal which helped the trough persist. The effect of the Rocky Mountains is also to have a ridge in the west and a trough in the east. Thus, this pattern was so strongly established that migratory storms which normally break down such regimes at least temporarily were not able to do so this winter.

The official NWS outlook for this spring is for the upper-flow pattern to return

to closer to normal with precipitation amounts expected to be above the long-term median in northern California, most of Nevada, and the northwestern half of Utah through northern Wyoming to South Dakota. This forecast was based on statistical studies as follows:

- 1) Similar previous winter weather patterns (i.e., dry and warm in the west and cold and snowy in the east) were studied back to 1900. In all cases, except 1970, the winter pattern reversed by spring.
- 2) Strong, persistent upper-air ridges in the western United States in winter were compared with the following spring pattern. It was found that usually the ridge broke down during spring. Note in Figure 4 the positive anomaly over western North America weakened and moved southward during February.

Following the ideas of Namias supports a similar forecast:

- 1) The sea temperatures off the West Coast changed during February for the first time in 3 months. By March 1st they had cooled to near-normal values.
- 2) The normal trade-wind regime in the area of Hawaii returned during February, after having been absent most of the winter. This suggests that the cold sea temperatures of the central Pacific were also moderating.
- 3) The strong El Nino (a warm ocean current that periodically replaces the normally cold water off the equatorial west coast of South America) that existed during early winter has receded. Again, this suggests things are returning to normal.

Of course, an abnormally wet spring is needed to weaken the drought. Whether this will take place is not known, but at least there are good indications that the past persistent, dry regime is ending.

(cont'd on pg. 47.)



adjustments and forecasts must be pursued. The forecast must be the man's product, and his alone, based upon his decision making process--- considering computer output. The public should be served by a good forecaster and not snowed by an impressive, but unreasoning computer.

We are not competing against the computer and automation, for it is incapable of competition. We are competing with our own assumptions and goals and defeating our main purpose--- that of making a better forecast.

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To the Editor:

I request that you correct a statement attributed to me in your February 1977 issue under the "Summary of the Panel Discussion on: The Effects of Automation on Operational Meteorology". The incorrect statement is "... that since 1961, at Salt Lake City, automation has produced a leveling off in the goodness of the forecasting". Nothing could be further from the truth. The 1961 could have been an inadvertent typographical error for 1969, but even this would not have been correct. At Omaha I attempted to point out that without proper motivation of forecasters by management to use their meteorological skills to modify automated guidance, rather than accept it blindly, the final operational product will deteriorate. This deterioration was referred to as "Meteorological Cancer". Possible signs of Meteorological Cancer were found in the verification data of NMC 30-hour (Man-Machine) Surface Prognostic Charts, Fig. 1, Chicago Weather Forecasts, Fig. 2, and Western Region FP (man-machine mix) PoP forecasts, Fig. 3. Note that in Fig. 1, there is a leveling off of the quality of the progs since 1969 and in Fig. 2 there is a decrease from 1968 through 1974. In Fig. 3 the FP forecast verification shows a decrease from the winter of 1973-74 to 1974-75, while the MOS guidance was improving. The sharp increase of improvement of the FP forecasts for 1975-76 is attributed to the Western Region Man/MOS program (Western Region Technical Memorandum No. 112) which is designed to motivate and assist our forecasters in putting out better operational PoP and Aviation terminal forecasts. Of interest is the continued improvement of the automated (MOS) PoP guidance for our stations from 1972 to present. You can see that having used these charts in my Omaha talk the statement attributed to me must be wrong.

## NMC 30-Hour Surface Prognostic Charts 1948~1974

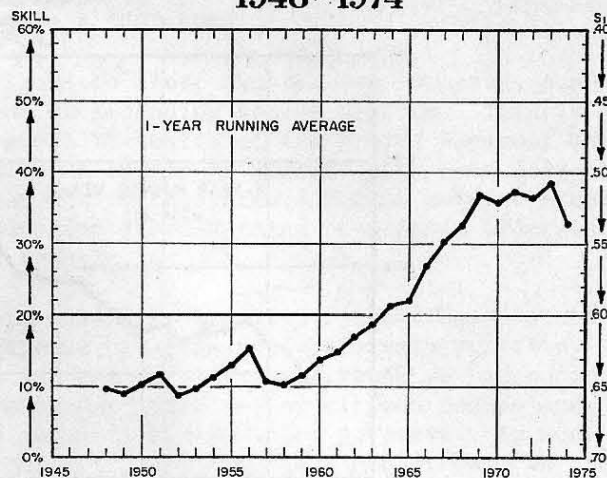


Figure 1. Graph of  $S_1$  Verification Scores.

Incidentally, subsequent to giving my Omaha talk, verification of the National Weather Service maximum temperature forecasts for tomorrow for Salt Lake City was completed through December 1976. (See Fig. 4.) You can see from these data that the temperature forecasts have improved steadily, except for a short period around 1969, over the past 15 years. Some of this improvement must be attributed to the improving automated graphical and numerical guidance transmitted by the National Meteorological Center. (See pg 48)

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*I believe that this was a matter of interpretation by the participant as the paper that you authored was not read or formally presented at the meeting. Ed.*

Drought - from page 42

There are two excellent references that give more information than we are able to present here. One is *Understanding Climate Change* published by the National Academy of Science in 1975. Another easily available publication is Dr. J. Murray Mitchell's answers to climate questions printed in the April 1975 issue of *NOAA*.

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