Long Range Forecast

A LONG RANGE FORECAST FOR THIS WINTER (DECEMBER 1982 TO FEBRUARY 1983), AND HOW IT WAS PREPARED

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ABSTRACT

An attempt was made by the author to make a subjective long range forecast for the winter of 1982 to 1983 by using sea surface temperature anomalies. He keyed in on the water temperature anomalies in the equatorial Eastern Pacific, the northern Pacific Ocean, and the northern Atlantic Ocean. From these anomalies the author made a subjective forecast of the winter 700 mb height anomalies and height field over the United States and both oceans. From that pattern he derived a temperature and precipitation forecast for the United States.

Numerous articles have been written on the subject of long range forecasting. Many authors, such as Namias and Henricksen, have keyed in on ocean sea surface temperature anomalies in determining a winter outlook, and this concept is utilized in this study. There is no attempt in this article to present an objective method of long range forecasting, but rather to show that at least a subjective long range forecast is feasible if sea surface temperature anomalies are known.

A few meteorologists including Namias (2) propose that warm equatorial waters in the eastern Pacific Ocean strengthen the Aleutian low, which in turn produces negative height anomalies (at 700 mbs) in the eastern United States. They also propose that cold equatorial waters in the Eastern Pacific Ocean relate to positive height anomalies in the eastern United States. This is factor number one considered in the forecasts.

Henricksen (3) attempted to show a relationship between North Atlantic Ocean sea surface temperature anomalies and the height anomalies upstream in the United States. He was able to obtain the water temperature records from the various stationary weather ships in the North Atlantic. He found a large correlation between the water temperature anomalies measured at ship Charlie (53N 35W), and the winter surface temperatures and height anomalies in the eastern United States. Unusually cold water at ship Charlie related to negative height anomalies in the eastern United States and vice versa. According to Henricksen such cold water might well lead to below normal heights in that area and to above normal heights west of Greenland. The above normal heights west of Greenland (blocking) would tend to depress the westerlies in the eastern United States. This was factor number two considered in the forecasts.

Factor number three that is incorporated in the forecast was anomalous water temperature patterns in the Northern Pacific Ocean. Examination of the Northern Pacific Ocean water temperature patterns for 1947 to 1978 (4) showed that, in most cases, the major negative height anomaly was about 5 degrees north northeast of the center of the major cold water anomaly. Through teleconnections (5) a reasonable estimate of the location of negative height anomalies in the United States could be made.

Cold water anomalies between 30N and 45N seemed to work best. The center of such an anomaly between 160E and 180W related to negative height anomalies over the central United States; cold water anomalies centered between 180W and 160W related to negative height anomalies over the eastern United States; cold water anomalies centered between 160° west and 140° west related to negative height anomalies off both coasts; cold water anomalies centered between 140W and the west coast seemed to relate to negative height anomalies in the western United States. Table 1 summarizes these correlations.

There also seems to be a good relationship between warm water anomalies off Baja California and negative height anomalies in the southeast United States. Elsewhere in the Northern Pacific Ocean the relationship between warm water anomalies and the position of the negative height anomalies in the United States is only tenuous. There does seem to be a weak correlation between unusually warm water east of 140W and low height anomalies in the eastern United States; also between unusually warm water west of 140W and low height anomalies in the western United States.

TABLE 1.

LONGITUDE OF THE COLD WATER ANOMALY CENTER IN THE NORTHERN PACIFIC OCEAN	RESULTANT POSITION OF THE NEGATIVE HEIGHT ANOMALIES IN THE UNITED STATES
160 EAST TO 180 WEST	CENTRAL UNITED STATES
180 WEST TO 160 WEST	EASTERN UNITED STATES
160 WEST TO 140 WEST	OFF BOTH COASTS
140 WEST TO WEST COAST	WESTERN UNITED STATES

Several forecasters in the National Weather Service Forecast Office at Washington, D.C. made forecasts on the position of the negative height anomaly in the United States for the years 1947 to 1978. This was based only on the relationships just discussed concerning water temperature anomalies in the northern Pacific Ocean. It was discovered that, in some of those cases, there was considerable disagreement where the cold water anomaly center in the Pacific Ocean was actually located.

Nevertheless, the results were very encouraging. Of the 32 cases between 1947 to 1978 the average number of times of the negative height anomaly was correctly positioned by the forecasters was 50 percent. Random guessing would produce 25 percent correct choices. This is because the forecasters had four choices: the western United States, the central United States, the eastern United States, and off both coasts. The result was especially good considering that there were several cases where the center location of the water temperature anomalies and/or the center location of the negative height anomalies in the United States were next to impossible to determine, as seen in Figure 1. If only the good cases were considered the results would be much better (see Figures 2 and 3).

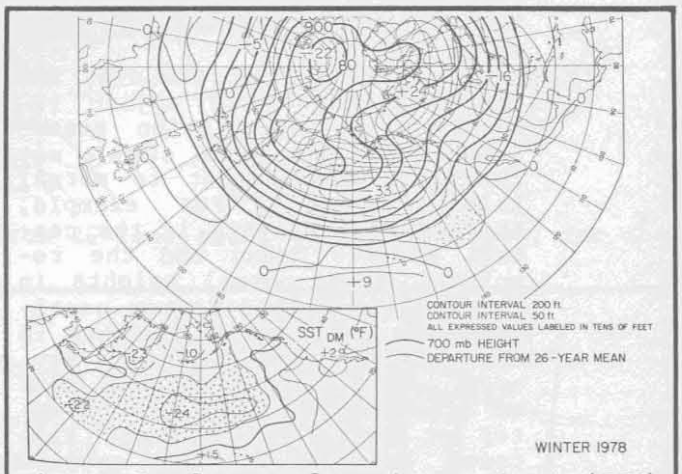

Figure 2. Sea surface temperature (SST) departure from 26-Year mean, expressed in degrees Fahrenheit, over the northern Pacific Ocean, Winter 1978.

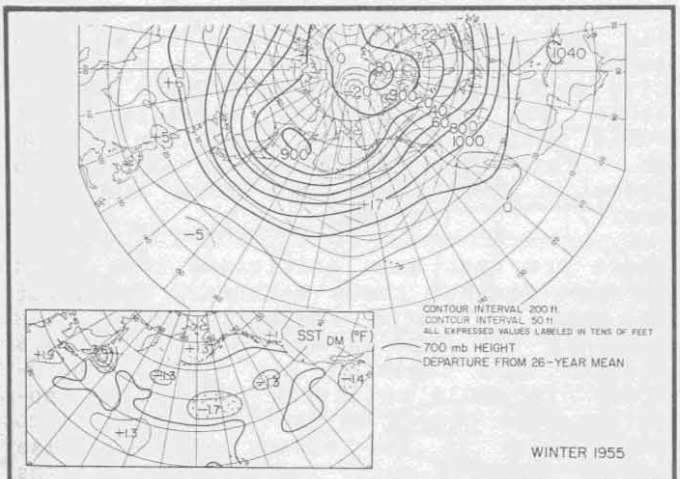

Figure 1. Sea surface temperature (SST) departure from 26-Year mean, expressed in degrees Fahrenheit, over the northern Pacific Ocean, Winter 1955.

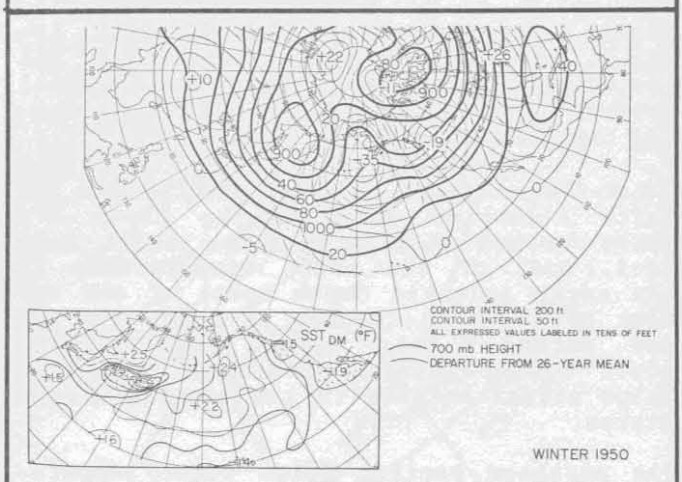

Figure 3. Sea surface temperature (SST) departure from 26-Year mean, expressed in degrees Fahrenheit, over the northern Pacific Ocean, Winter 1950.

In summary, the three predictors used to determine the height anomalies in the United States were the water temperature anomalies in the a) eastern Pacific equatorial waters, b) the northern Pacific Ocean, and c) in the northern Atlantic Ocean.

What would happen if the three predictors each positioned the negative height anomalies in a different location in the United States? There are these three possibilities:

1) One water temperature anomaly, especially if it was strong, could produce an atmospheric circulation that would overwhelm the potential circulations that would be produced by other water temperature anomalies.
2) The upper air pattern could change back and forth between circulations favoring one water temperature anomaly and circulations favoring another such anomaly.
3) The circulation pattern over the United States could adjust itself to the circulation anomalies in the oceans in such a way that was inconsistent to normal teleconnections. For example, above normal heights in the central Pacific Ocean and the resultant below normal heights in the western United States usually favor above normal heights in the eastern United States. However, above normal heights west of Greenland caused by cold water at Ship Charlie might also cause heights in the eastern United States to be below normal.

As of late November 1982, temperatures of the eastern Pacific equatorial waters were running 2° to 4° F above normal. This would imply a stronger than normal Aleutian low, above normal heights in the western United States, and below normal heights in the eastern United States during this winter.

Water temperatures at Ship Charlie (in the North Atlantic) were running about 4°F below normal in late November 1982. In fact, most of the water temperatures in the north Atlantic Ocean north of 45N and west of 20W were running at least 4°F below normal. This would imply heights above normal west of Greenland and thus below normal heights in the eastern United States.

The northern Pacific Ocean water temperature anomalies are shown in Figure 4. It is somewhat a difficult pattern to work with. However the warm water off Baja California suggests lower than normal heights in the southeast United States. The center of the broad cold water anomaly is about 167W; this implies heights above normal in the western United States and below normal heights in the eastern United States.

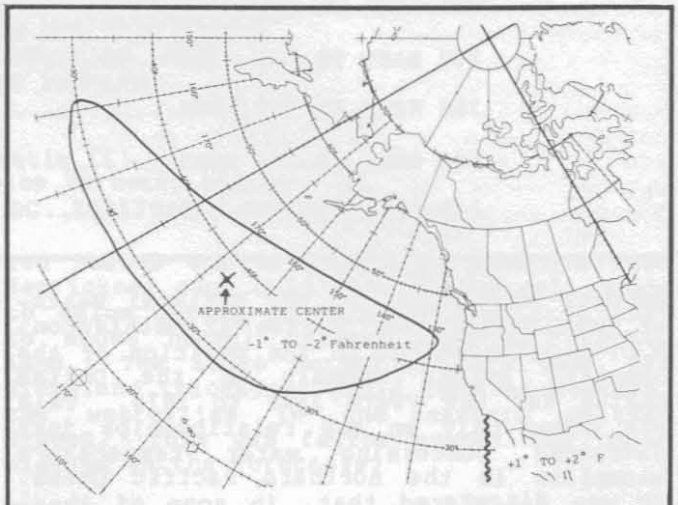

Figure 4. Northern Pacific Ocean sea surface temperature anomalies in degrees Fahrenheit, as of late November, 1982. Approximate center is near 38N 167W.

For the winter of 1982-83, the water temperature anomaly patterns all seem to indicate the same thing: negative height anomalies in the east and southeast portions of the United States, and positive height anomalies in the western United States! There does seem to be a vague correlation between the intensity of the water temperature anomalies and the intensity of the corresponding height departures in that area. Keeping that in mind, the author made a subjective forecast of the placement and intensity of the height anomalies for this coming winter (Figure 5); this would lead to the 700 mb flow seen in Figure 6. Figure 7 is a subjective interpretation of the surface temperature and precipitation anomalies that would follow from such a pattern at 700 mb. This forecast is very similar to those of some other long range forecasters.

There are four main criticisms that could be made against these methods. The first is that the water temperature anomalies used for the studies of the 1947 to 1978 winters were those of the winter considered. It could be argued that those anomalies were caused by the anomalous 700 mb circulation in the oceans and not visa versa. However water temperature patterns change slowly most of the time from the late fall (the time the forecast would normally be made) to the winter. So most of the time I believe this approach would still be valid.

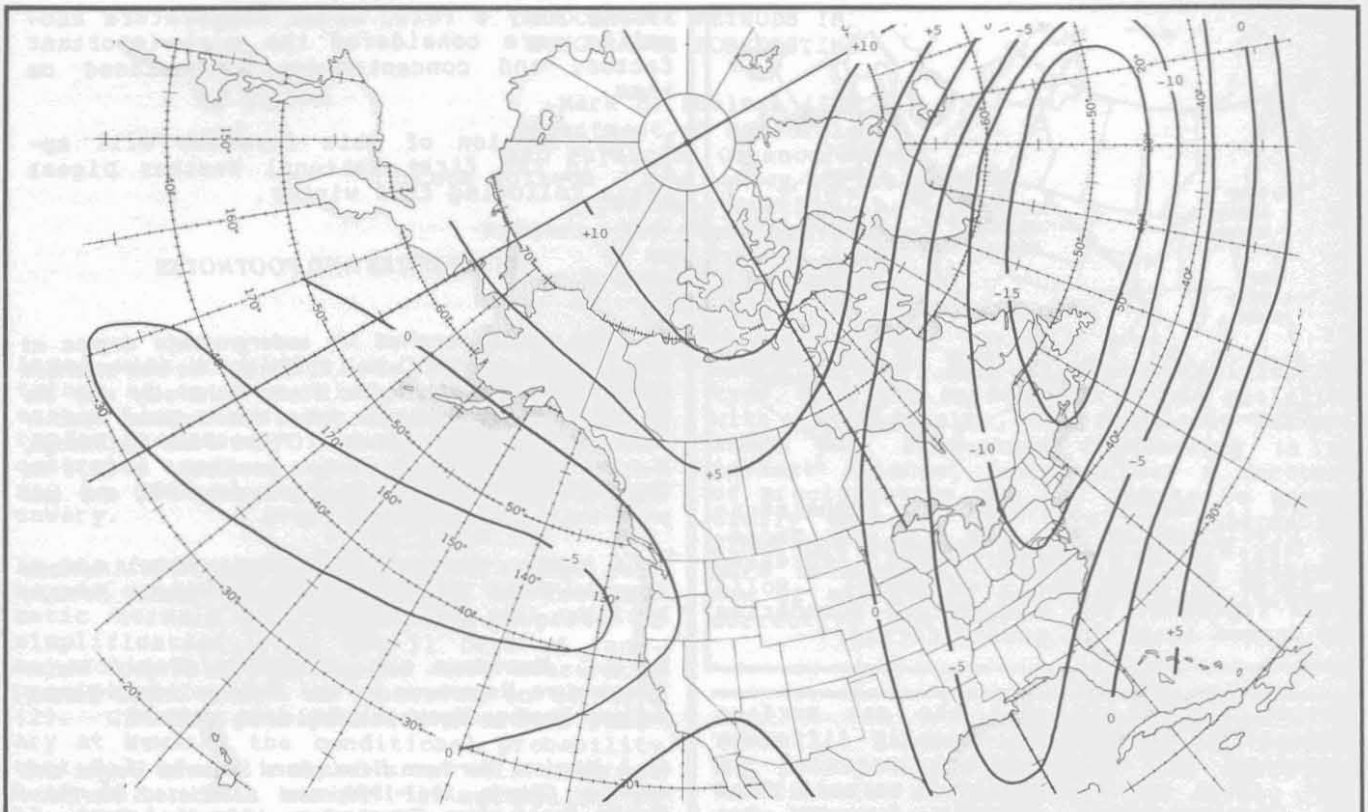

Figure 5. Forecast 700 mb height departure from 26-Year mean, in tens of feet, for the winter 1982-83.

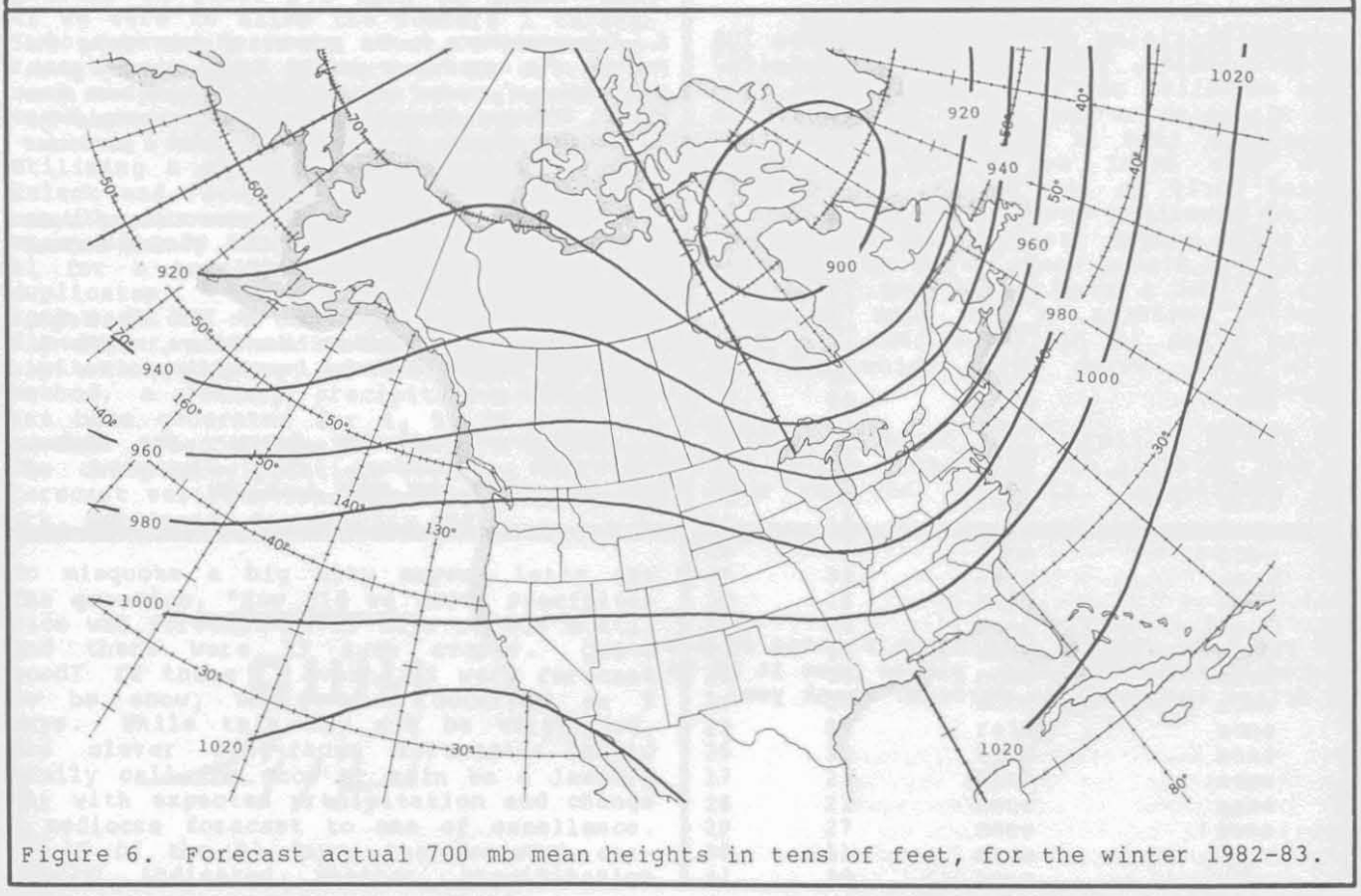

Figure 6. Forecast actual 700 mb mean heights in tens of feet, for the winter 1982-83.

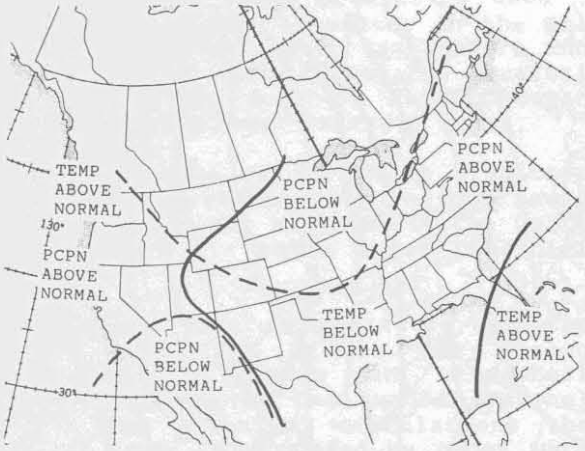

Figure 7. Winter forecast for temperature and precipitation over the U.S. for December 1982 through February 1983, expressed in terms of departure from normal. Solid lines represent the temperature boundaries and dashed lines are precipitation.

Another problem is that the sea surface temperature normals are slightly different depending on which source material is used. This article utilizes normals from the "Oceanographic Monthly Summary Sea Surface Temperature Climatology, April 1982" (8).

A third criticism is that with a given 700 mb circulation, temperature and precipitation anomalies can be quite different from one situation to the next. This would be especially true if an anomalously extensive snow cover set up in the United States early in the season, or if there was an anomalous lack of snow cover. Also, total winter precipitation in much of the United States tends to be mainly a result of just a couple of storms. The circulation patterns at the time of those storms often is different than the mean circulation, which would throw off the forecast.

The fourth criticism that could be leveled is that volcanic ash or sunspot cycles are not considered. Although they may certainly play a role, water temperature anomalies were considered the most important factor, and concentration was placed on them.

A verification of this forecast will appear in the first National Weather Digest issue following this winter.

REFERENCES AND FOOTNOTES

1. Dave Gustin received his undergraduate degree at Shimer College in Mt. Carroll in Illinois. He also attended graduate schools at Florida State University and the University of Michigan. He joined the National Weather Service in 1967 as an intern at O'Hare Field in Chicago, IL, where he worked in various positions. In 1976 he transferred to the WSFO in Washington, DC, and was promoted to Lead Forecaster in 1979.

2. J. Namias. Multiple Causes of the North American Abnormal Winter 1976 to 1977, Monthly Weather Review, 106:3, Mar. 1978, pp 279-295.

3. G.C. Henricksen. An Attempt to Project Winter Temperature Departures for the Eastern United States, National Weather Digest, 4:1, Feb. 1979, pp 27-37.

4. J. Namias. Northern Hemisphere Seasonal Height and Anomaly Charts, 1947-1978, and Associated Northern Pacific Sea Surface Temperature Anomalies, California Cooperative Oceanic Fisheries Investigations, Atlas no. 27, June 1979.

5. Teleconnections is the process of determining the position of a negative or positive height anomaly given the location of another such anomaly. This has been done by J.F. O'Connor (6) and Namias (7) who averaged the hemispheric patterns of many cases in which a particular anomaly was centered in a certain location.

6. J.F. O'Connor. Hemisphere Teleconnections of Mean Circulation Anomalies at 700 mbs, U.S. Weather Bureau, Technical Report WB10, February 1969.

7. J. Namias. Teleconnections of 700 MB Height Anomalies for the Northern Hemisphere, California Cooperative Oceanic Fisheries Investigations, Atlas no. 29, Aug. 1981.

8. Oceanographic Monthly Summary Sea Surface Temperature Climatology, U.S. Department of Commerce, NOAA, NWS, NESS, April 1982.

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