WEATHER AND CIRCULATION OF MARCH 1981
Drought Worsens in the East and Northern Plains

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1. Mean circulation

For the second straight month the character of the upper air circulation changed dramatically. A complete reversal in the mean pattern over much of the hemisphere took place from February (Dickson, 1981) to March that opposed the normal trend. March further deviated from its usual behavior with a circulation that was far more steady in a day-to-day sense than February's very transient one.[1]

[1] This is based on pattern correlations over North America between monthly mean and daily 700 mb height charts.

At 700 mb (Fig. 1) progression of the North American trough to well out over the Atlantic and the appearance of several ridges and highs to the north are readily discernable as adjuncts of the reversal from February in the height anomaly pattern over the Atlantic and Arctic basins (Fig. 2). This reversal, as well as the progression and deepening of the Aleutian low and the development of the low to the east of Novaya Zemlya, can be tied more firmly to the several blocking high episodes during the month. These surges kept high latitudes of North America and the Arctic Ocean relatively warm while moving

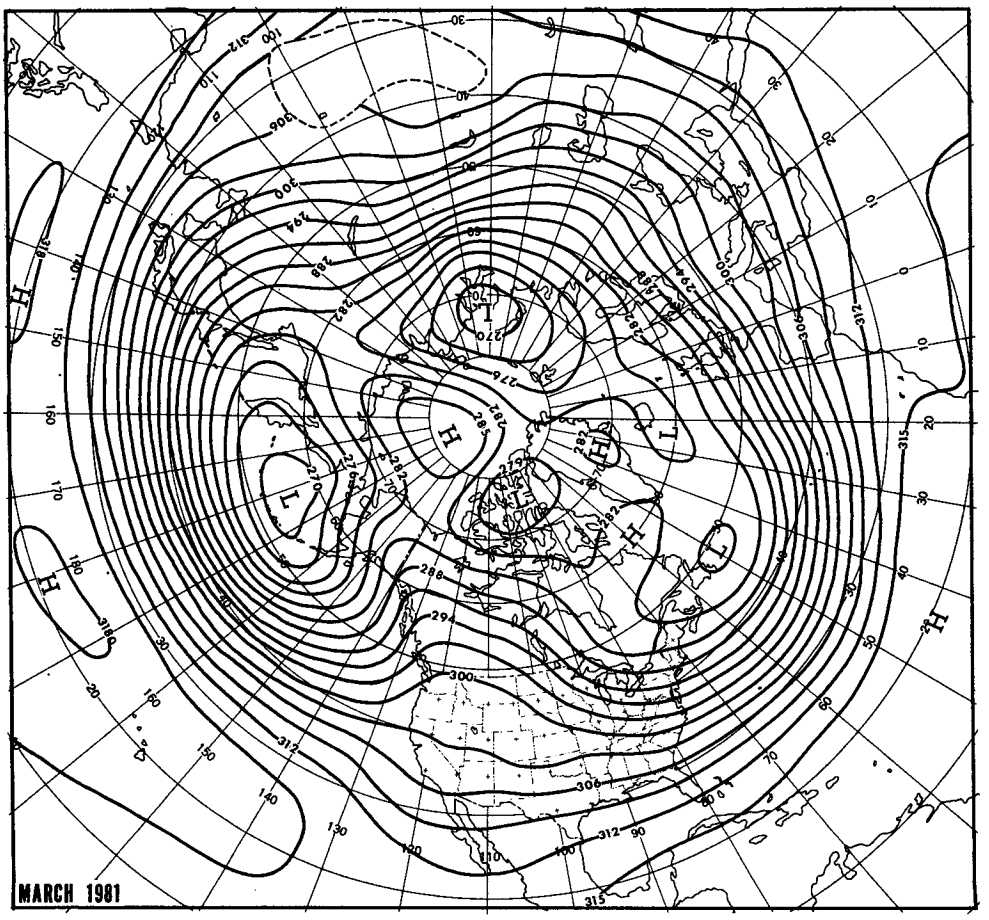


FIG. 1. Mean 700 mb height contours (dam) for March 1981.

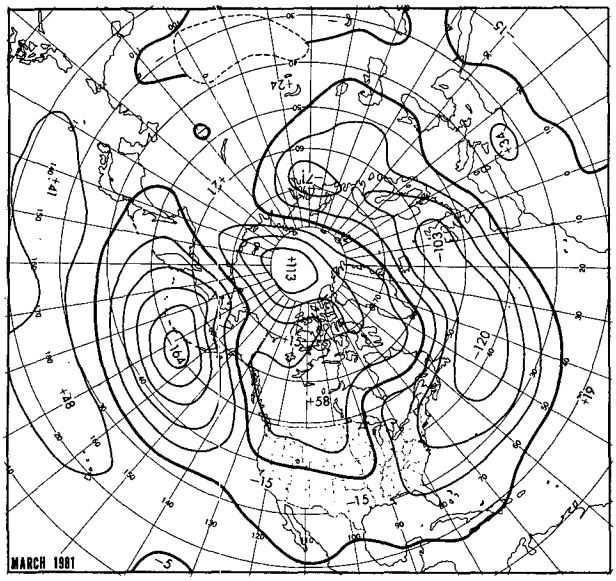


FIG. 2. Departure from normal of mean 700 mb height (m) for March 1981.

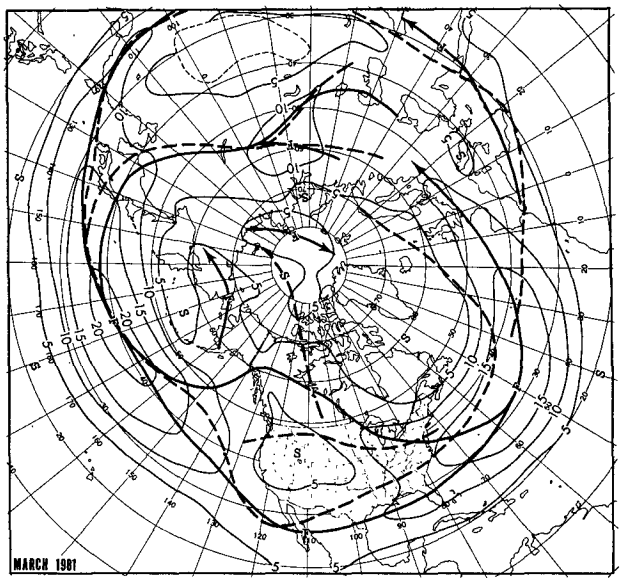


FIG. 4. Mean 700 mb geostrophic wind speed (m s^{-1}) for March 1981. Solid arrows indicate observed axes of maximum wind speed and dashed lines, the normal.

colder air south (Fig. 3) and promoting troughing and cyclogenesis over the central Pacific, the western Atlantic and northern Europe.

The resulting ringlike height anomaly and baroclinic patterns in Figs. 2 and 3, respectively, are further reflected in an unbroken fast westerly current from Southeast Asia to central Europe (Fig. 4) that is far south of its normal position over much of its course. The strength of this current and its acceleration from February are graphically illustrated in Fig. 5 where mean zonal wind speeds for the Western Hemisphere are plotted. At a time of normal decline this speed increased from near 9 to almost 15 ms^{-1} between 30 and 35° latitude! The fact that this is unusual is further developed in Fig. 6, where estimates of monthly means of hemispheric zonal kinetic energy are plotted for March 1974 to

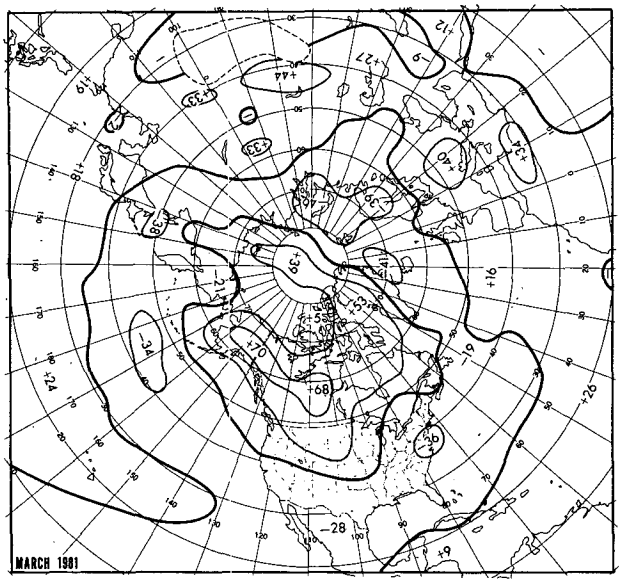


FIG. 3. Departure from normal of mean 1000–700 mb thickness (m) for March 1981.

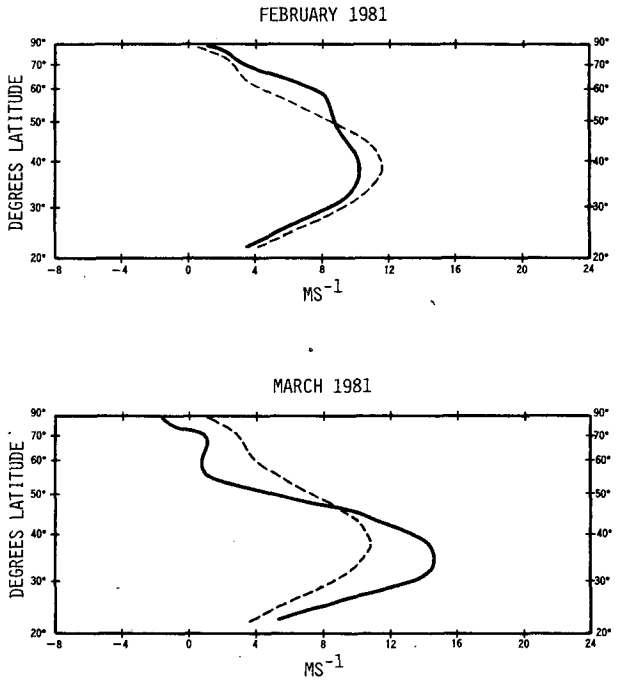


FIG. 5. Mean observed (solid lines) and normal (dashed lines) 700 mb zonal wind speed profiles for the western half of the Northern Hemisphere for (a) February 1981 and (b) March 1981.

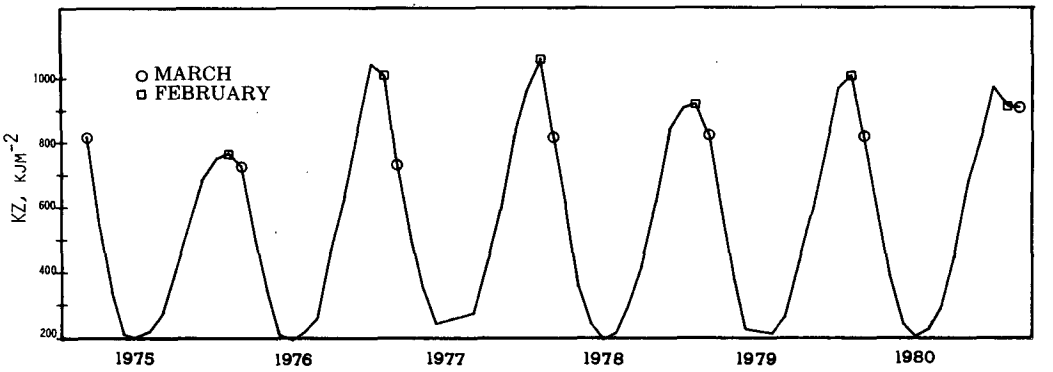


FIG. 6. Monthly means of Northern Hemisphere (100–10 kpa) zonal kinetic energy at 0000 GMT.

the present.[2] Note that in March 1981 the usual (for this period of record) sharp decline from February was temporarily forestalled. The observation earlier that the March pattern was relatively stable seems even more noteworthy in this context.

Other possible consequences of the enhanced zonal flow are the general progression of midlatitude long waves over Eurasia, and the appearance of a trough in the southwest of the United States along with maintenance of negative height anomalies across the southern part of the country (further enhancing the impression of zonal symmetry in Fig. 2).

2. Temperature

Even though the upper air circulation differed considerably from that in the previous month, most of the United States again enjoyed warmer than normal temperatures (Fig. 7). Only along the middle Atlantic Coast and in the central Appalachians did temperatures average substantially below the 30-year mean. This was the case despite strong anomalous northerly flow over most of the eastern half of the nation (Fig. 2). Unlike January (Wagner, 1981) a direct link to the Arctic didn't exist (Fig. 1) and the air over Canada wasn't particularly cold (Fig. 3), perhaps partly a result of a depleted snow cover.

Clear skies, the aforementioned lack of snow, and warm air associated with the large positive height anomaly over south central Canada well account for the large temperature excesses in the northern Great Plains. The strong west Canadian ridge and the deep low near 180°W longitude placed Alaska under a deep persistent current of warm maritime air.

3. Precipitation

During March the southern half of the United States was frequently traversed by rain-producing systems from the Pacific that had easy access to the country via the mean trough in the Southwest (Fig. 1). Many areas, particularly the Southwest, received considerable drought relief (Fig. 8).

For much of the month, however, water deficits continued to accumulate over the northern mountains, intermountain and plains regions under the

[2] This information was produced by Mr. A. J. Miller, Climate Analysis Center, from NMC "final" analyses with the same global energy program used by Hauser and Miller (1978).

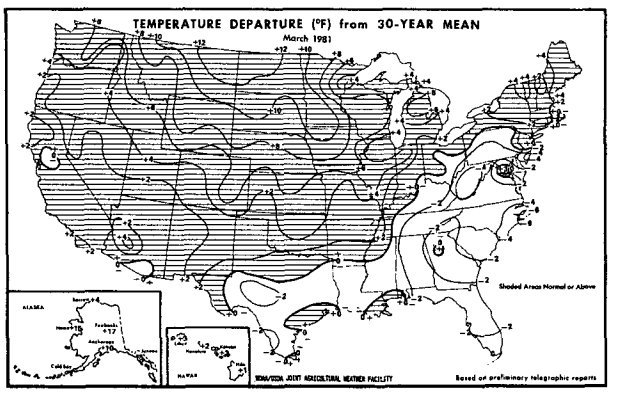


FIG. 7. Departure from normal of average surface air temperature (°F) for March 1981 (from National Oceanic and Atmospheric Administration and Economics and Statistics Service, 1981).

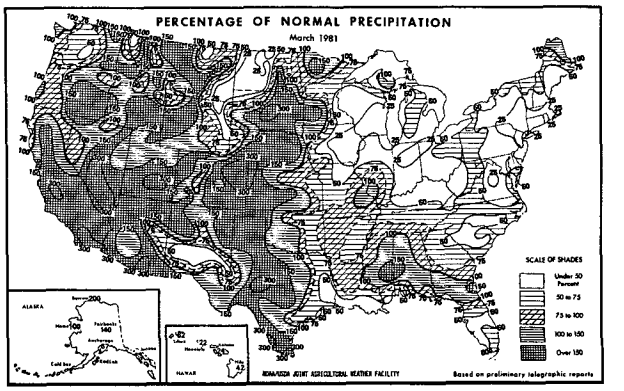


FIG. 8. Percentage of normal precipitation for March 1981 (from National Oceanic and Atmospheric Administration and Economics and Statistics Service, 1981).

TABLE 1. Monthly precipitation total records and near-records at selected stations in the Northeast since December 1980.*

Station	March amount (inches)	March anomaly (inches)	March	February	January	December
Albany	0.26	−2.32	2nd driest	2nd wettest	3rd driest	
Bridgeport, CT	0.69	−2.80	driest			
Concord, NH	0.86	−1.91	5th driest	wettest	3rd driest	2nd driest
Hartford, CT	0.27	−3.55	driest		driest	
Wilkes Barre/Scranton, PA.	0.49	−2.01	driest	wettest		
Wilmington, DE	1.26	−2.48	2nd driest		driest	
Worcester, MA	0.74	−3.11	2nd driest	wettest		

* December, January and February information from Taubensee (1981), Wagner (1981) and Dickson (1981), respectively.

control of the strong positive height anomaly aloft (Fig. 2). Much of the relief implied in Fig. 8 for the former two areas did not arrive until the second half of the month, and in the case of the latter not until the final days of March after the circulation pattern embodied in Fig. 1 completely broke down. Along with the abnormally high air temperatures little snow fell in this region to replace an already large snow-cover deficit; Minneapolis, MN had its least snowiest March of record (0.1 inch) while Waterloo, IA had its second driest (0.25 inch with normal of 2.25 inches) and equalled its second least snowiest (trace).

Additionally, little precipitation fell at any time during the month over virtually the entire northeast quadrant of the United States. Strong disturbances were few in the cold, dry flow downstream from the Canadian ridge reminiscent of early winter. Drought, as measured by the Palmer Index (not shown), spread and intensified over the Tennessee and Ohio Valleys, the southern Appalachians, and the East Coast from Georgia to southern New England.

In the Northeast, record or near-record dryness at several locations continued the remarkable seesaw of precipitation extremes the region had been undergoing over the last several months (Table 1). Its origin is apparent in Fig. 9 where the phase-locking from December to March of the 700 mb Northern Hemisphere ridge, the stable December–January wavelength, and the large swings in the trough position from January to March are all indicated. February brought positive upper level temperature and vorticity advection and frequent eddies to the Northeast in stark opposition to adjacent months.

In the subtropical Pacific a stronger-than-normal ridge restricted precipitation amounts over the Hawaiian Islands throughout the month.

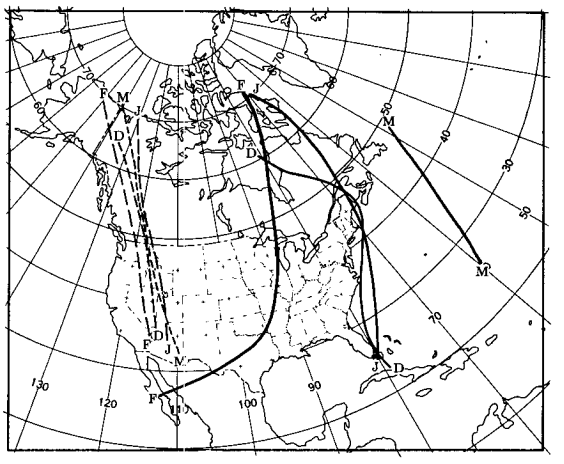


FIG. 9. Monthly mean 700 mb trough (solid) and ridge (dashed) line positions in the vicinity of North America since December 1980. Lines are labeled with the month's initial.

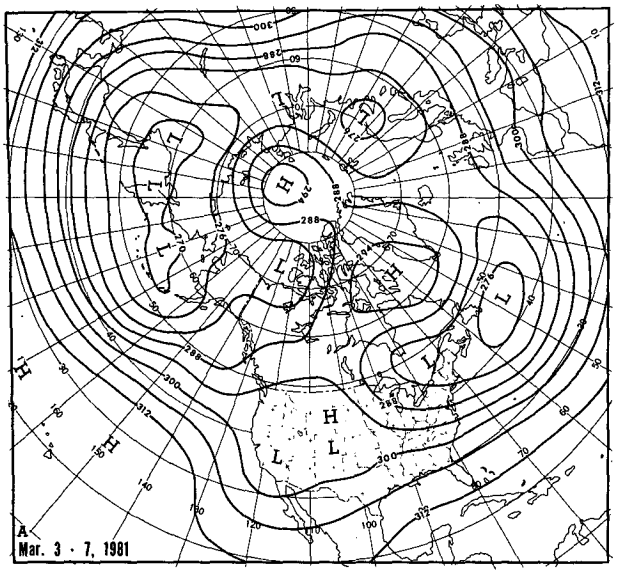
4. Variability within the month

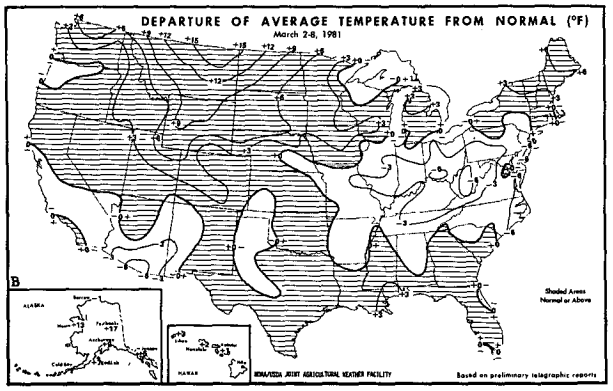
a. 2–8 March

The transition of the 700 mb circulation (Fig. 10A) to a state much like the monthly mean that began in late February (Dickson, 1980) was largely complete by the first week in March. Rapid and general progression (and deepening over the Atlantic) of midlatitude troughs accompanied the erosion of midlatitude ridges and the retrogression and amalgamation of high heights at high latitudes into two blocking centers.

With the advancement of the mean trough to the Southwest and a low from Hudson Bay to Quebec, only a remnant of the previous week's ridge in the central United States remained in the northern Great Plains. This was still enough to keep that area unseasonably warm (Fig. 10B) and dry (Fig. 10C). This dryness extended eastward to New England through an area influenced by mainly northwesterly flow aloft and north of the track of the week's main disturbance. To the south most areas received at least moderate precipitation from two storms that moved east from California in the advance of the mean trough.

Away from the northern plains ridge, storminess and low heights moderated temperatures from the previous week. In the case of a zone from southern Illinois to the sea persistent cold advection, interrupted only once in the week ahead of the first storm, depressed temperatures considerably below normal.





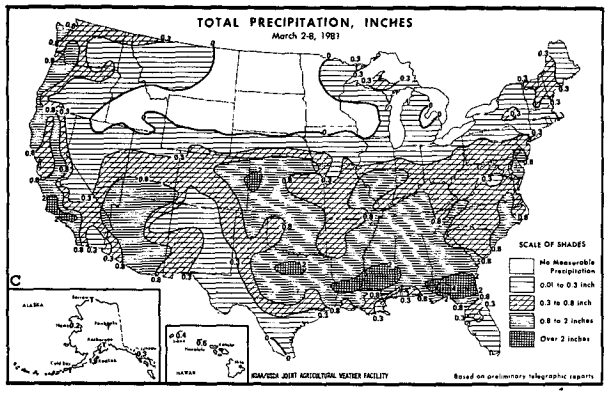
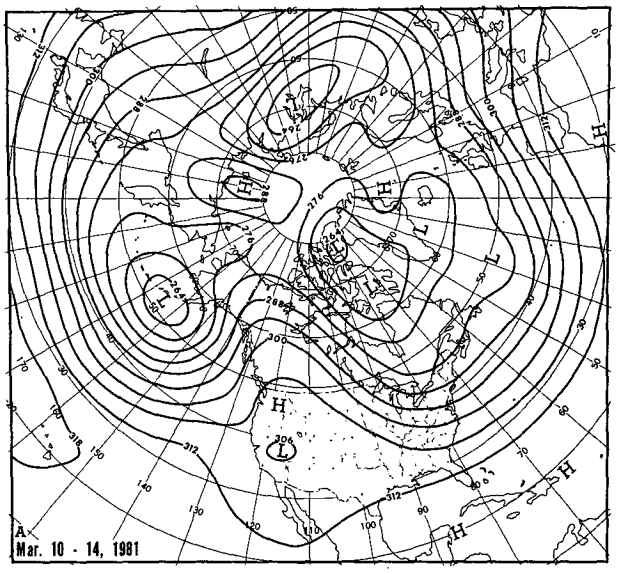
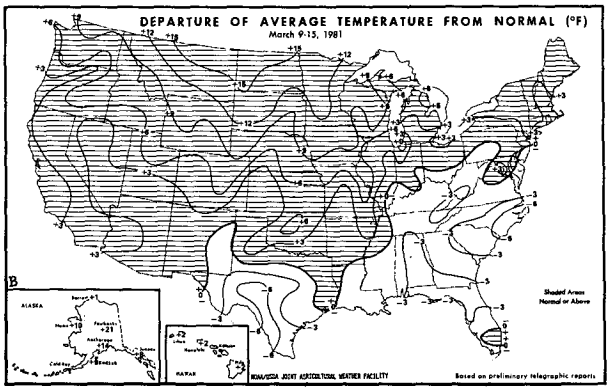


FIG. 10. (A) Mean 700 mb contours (dam) for 3–7 March 1981, (B) departure from normal of average surface air temperature (°F) and (C) total precipitation (inches) for week of 2–8 March 1981 (from National Oceanic and Atmospheric Administration and Economics and Statistics Service, 1981).





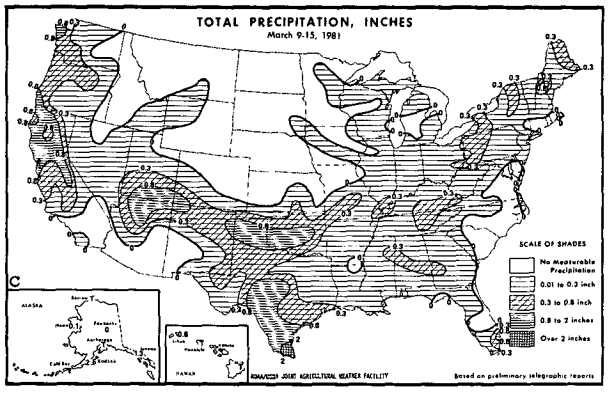
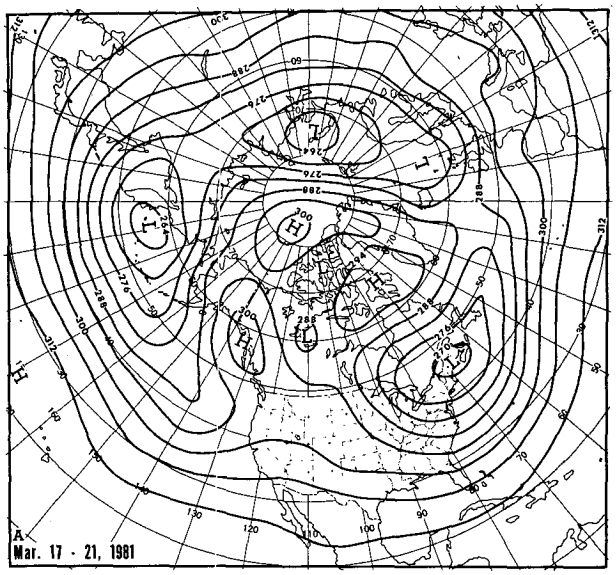
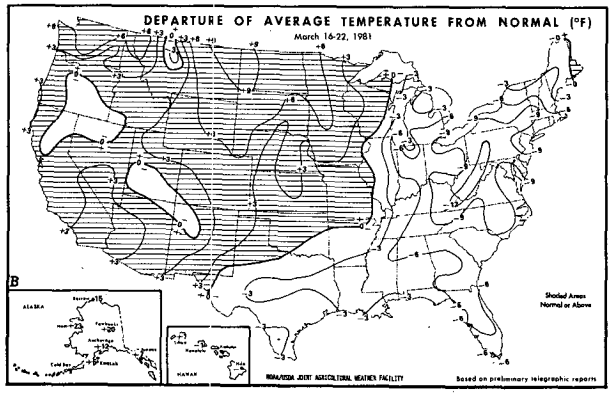


FIG. 11. As in Fig. 10 except for (A) 10–14 March 1981, and (B) and (C) week of 9–15 March 1981.

b. 9–15 March

Continued eastward movement of long waves at 700 mb over Eurasia and the Pacific and continued westward translation at high latitudes led to full-latitude phasing and the emergence of a strong wave-three pattern in the second week of the month (Fig. 11A). The most prominent branch consisted of a deepened Pacific low and the downstream growth of the ridge in the west of North America. The widespread warmth over most of the western two-thirds of the United States (Fig. 11B), the relatively low





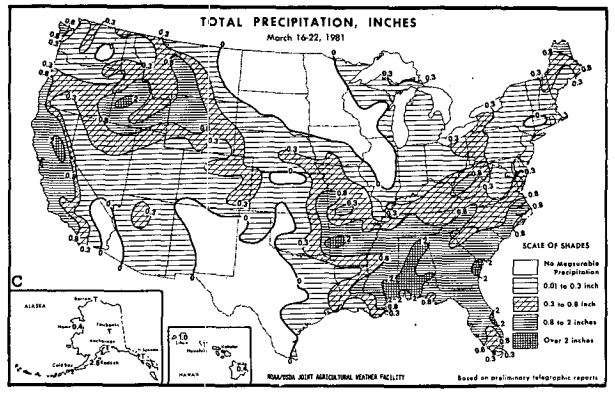
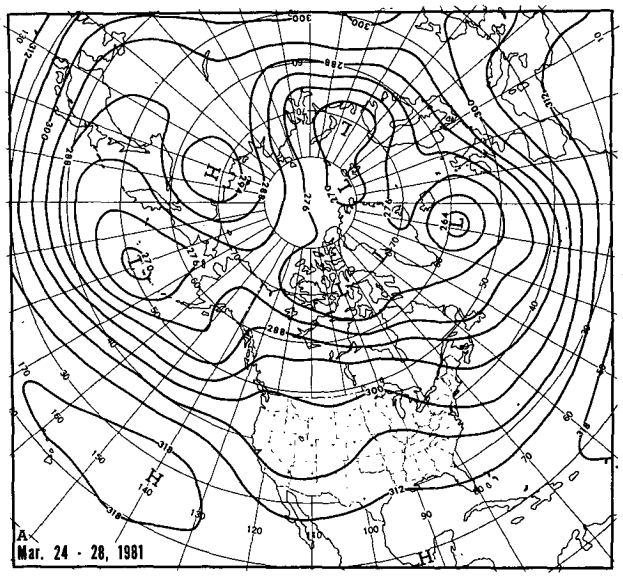
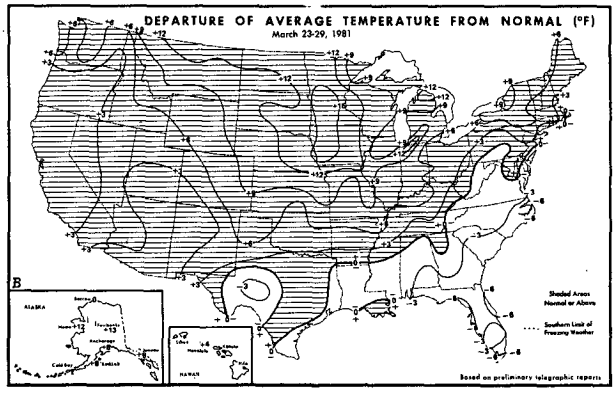


FIG. 12. As in Fig. 10 except for (A) 17–21 March 1981, and (B) and (C) week of 16–22 March 1981.





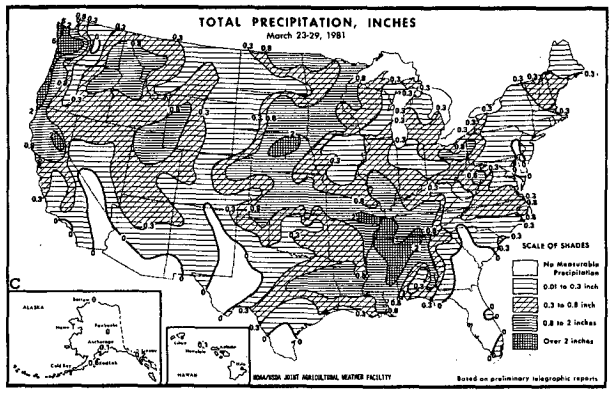


FIG. 13. As in Fig. 10 except for (A) 24–28 March 1981, and (B) and (C) week of 23–29 March 1981.

temperatures in the Southeast, and the extensive dryness (Fig. 11C) can be attributed to this wave feature and the trough off the Atlantic Coast.

The fact that heights remained low in the Southwest permitted two weak disturbances to move across the region accounting for the bands of precipitation extending into Oklahoma and Texas. Continual cloudiness and frequent rain lowered mean temperatures over the latter while maritime air moderated those in New England. Except for along its south coast, Alaska was dry during the week under diffluent flow aloft.

c. 16–22 March

The conversion from a two-cell to three-cell blocking pattern at high latitudes was completed as the Atlantic 700 mb trough deepened near the coast of North America and the retrograding high near Baffin Island swelled prominently (Fig. 12A). Lower latitudes again were dominated by broad oceanic troughs and strong zonal westerlies as the other two blocking highs and the Pacific trough retreated westward. A lobe of the latter, however, extended eastward to the California coast, again eroding the North American ridge over the United States.

Most of the country experienced its coolest week of the month (in a departure from normal sense), especially the eastern third of the nation where cold outbreaks, cloudiness and moderate precipitation (including snow) kept the central Appalachians 10°F or more below normal. Conversely, maritime air over the Southwest and anticyclonic circulation and clear skies aloft over the Northwest and northern plains kept temperatures in those areas well above normal.

Greatly reduced 700 mb heights in the West reflected the passage of more vigorous short waves from the Pacific this week that drove storms across the country along paths suggested by the axis of maximum precipitation in Fig. 12C. It was dry downstream from the weak ridge in the Southwest and in the vicinity of upper air ridging in the Washington interior and the northern Great Plains. Most of Alaska continued very dry beneath diffluent flow.

d. 23–29 March

The decline of high-latitude 700 mb ridging and fast subtropical westerlies that had dominated most of the month was well advanced during this period (Fig. 13A). All three high centers continued retrograding rapidly but only the one that moved from western Canada to northeast Siberia retained its strength. Attendant with this, both oceanic troughs again advanced to mid-ocean to the west of reemerging subtropical ridges at the eastern ends of the respective basins.

Over North America the main westerly current was displaced far to the north over Canada as the eastern lobe of the Pacific trough moved into the American Southwest behind an amplifying mid-continental ridge. Consequently, the familiar pattern of widespread warmth reappeared but with its focus shifted into the lower plains west of the upper Mississippi River (Fig. 13B). The Southeast coast and the Florida peninsula remained cool and dry in the face of an anomalous northeasterly flow component. By the end of the month, however, temperature records were being set from Wisconsin to Maine and as far south as Georgia. At least 19 stations reported record daily high temperatures on 31 March with four locations around southern Lake Michigan and one in southern Illinois noting record monthly or so early in Spring high temperatures.

Precipitation was perhaps more plentiful over the nation than at any other time in the month (Fig. 13C) as a deep Pacific trough moved across the country. Its associated surface feature moved onto the California coast on 24 March, and slowly to mid-continent by week's end. On 24 and 25 March precipitation intensity records were set at Red Bluff, CA. Along the Mexican-United States border and to the east of the ridge line (except in the deep South) conditions were mostly dry.

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