

THE WEATHER AND CIRCULATION OF FEBRUARY 1965

Strong Atlantic Blocking

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1. SUMMARY

Blocking in the Atlantic was the outstanding feature of the circulation in February 1965 and it was persistent enough to contribute significantly to the weather far upstream. Cyclonic systems were retarded such that 700-mb. heights were below normal over most of North America, with resultant lower than normal surface temperatures. Without positive height departures from normal in Canada or the Gulf of Alaska there were no sustained Polar air outbreaks and no extreme average temperatures in the United States during the month.

There were also few precipitation records in February. Maximum total precipitation was two to three times normal in parts of Texas and the Northern Plains. Record February snowfall was noted in Nebraska (Omaha, 25 in. and Lincoln 26 in.) and Michigan (Sault Ste. Marie, 33 in.). New monthly records were also established in Alaska with 86 in. at Juneau and 87 in. at Yakutat.

2. MONTHLY MEAN CIRCULATION

Blocking was one of the dominant aspects of the 700-mb. circulation in February 1965 (figs. 1 and 2). There was one center in the East Siberian Sea where heights were 520 ft. above normal. But the largest and most intense center of blocking was located south of Iceland where 700-mb. heights were 870 ft. above normal. This is the largest positive height anomaly recorded in the North Atlantic between the United Kingdom and Greenland in the history of available monthly mean charts (since 1933).

Downstream from this blocking, heights were lower than normal in Russia along the trough that extended from the Arctic to the Mediterranean. There were large height falls in the northern portion of this trough where blocking had been located in January [1]. Over central and northern Asia the flow was anticyclonic with above normal heights, while cyclonic flow and negative heights prevailed in the extreme east, partially as a result of blocking at higher latitudes. Although this blocking was rather strong, it was so far north that the mean 700-mb. jet (fig. 3) was not displaced southward. A principal effect upon the circulation, however, was the speed-up of

the westerlies which were 12 m.p.s. stronger than normal in mid-Pacific south of the Aleutians.

Low-latitude activity northeast of Hawaii probably contributed to the ridging in the eastern Pacific, but the Asiatic blocking also tended to carve out lower heights in the Gulf of Alaska. The two processes were acting contrarily and neither the Low in Alaska nor the ridge in the eastern Pacific was able to become unquestionably dominant. Their combined effect however, was to strengthen the westerlies, with a strong jet near 50° N. from the eastern Pacific to the Northern Plains. The mean 700-mb. wind axis then extended southeastward to a maximum value of 20 m.p.s. off the eastern coast of the United States.

In the Atlantic the extensive blocking was accompanied by a split in the westerly flow, a characteristic of blocking. The southerly branch of the westerlies supported a principal sea level cyclone track from the western Atlantic to Europe near 40° N. In this area there is normally not even a secondary storm track [2].

3. AVERAGE MONTHLY WEATHER

TEMPERATURE

Temperature anomalies in February 1965 (fig. 4) were rather persistent from January. Eighty out of one hundred cities across the Nation changed temperature category by not more than one class (out of five) and there were no extreme changes from much above to much below normal or vice versa. Largest changes occurred in the area from Texas to Wyoming where general cooling to 2°–4° F. below normal in February replaced temperatures that had been 4°–10° F. above normal in January. Cooling also occurred in the Great Basin, an influence of the northerly anomalous flow.

In the Midwest temperatures were generally 2°–4° F. below normal where heights were negative but with rather weak anomalous flow. Since height changes were small warming along the Atlantic Coast States was closely related to the change of anomalous flow to southerly.

The 1000–700-mb. thickness (fig. 5) and the temperature anomaly (fig. 4) were very similar, with below normal surface temperatures generally in areas where the thickness was below normal. There was a very

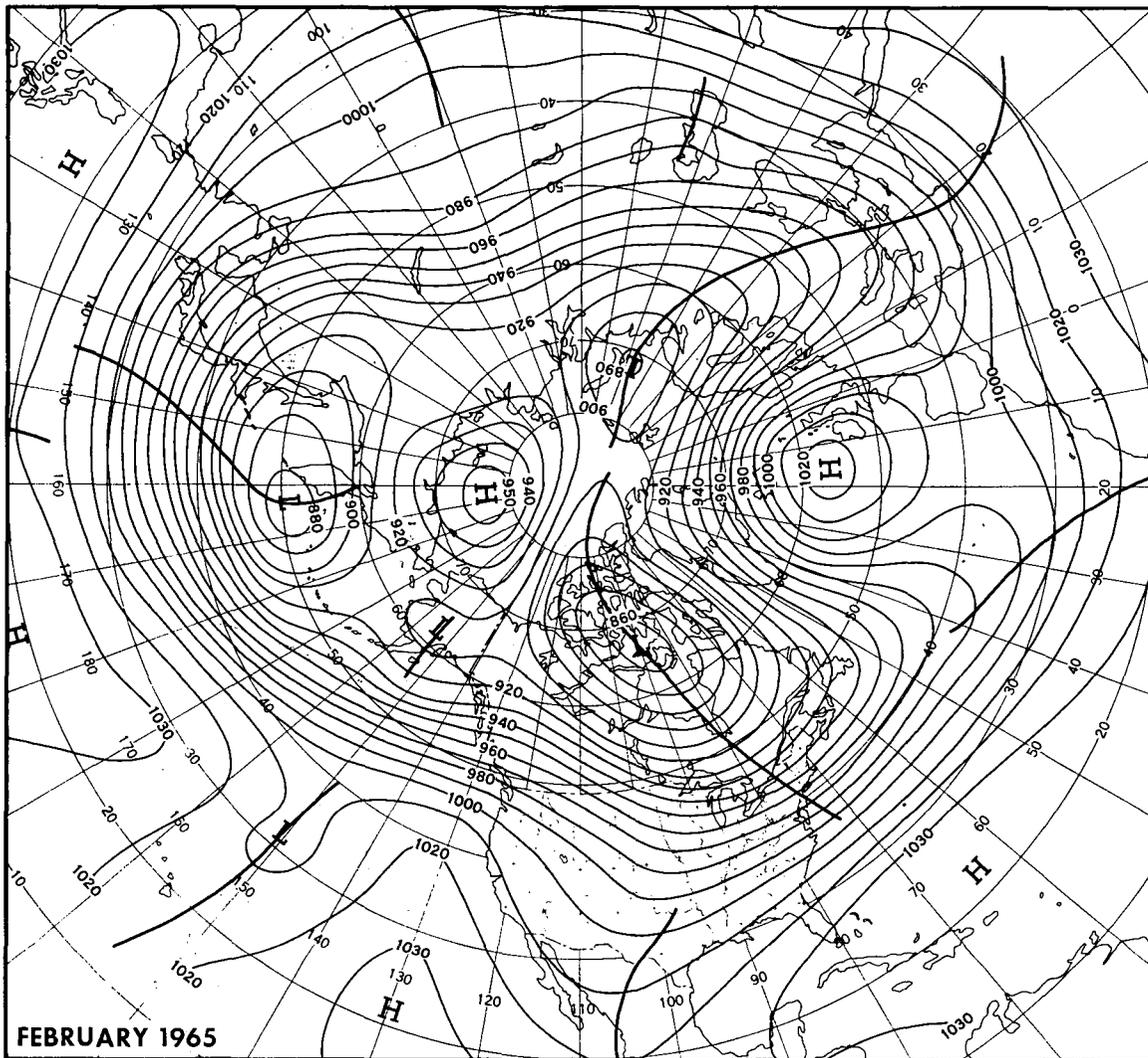


FIGURE 1.—Mean 700-mb. contours (tens of feet) for February 1965. Blocking in the Atlantic and eastern Siberia were notable features of the circulation.

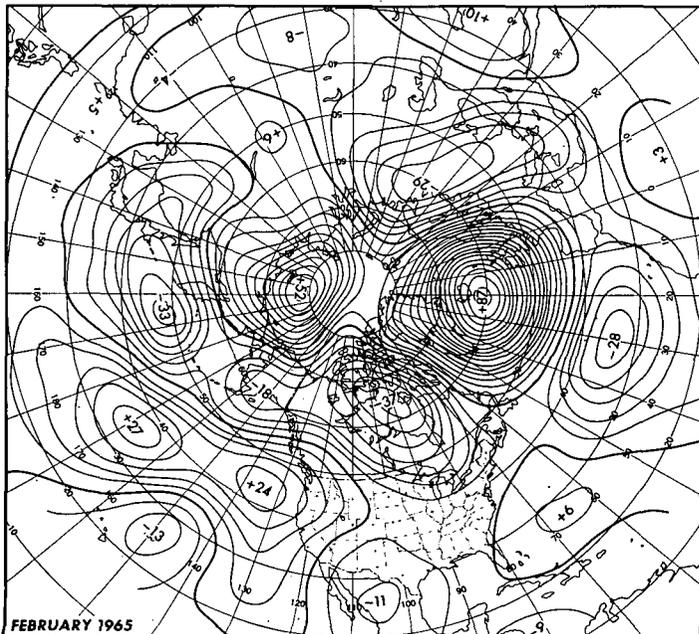


FIGURE 2.—Departure of mean 700-mb. heights from normal (tens of feet) for February 1965. Size of area of below normal heights over North America was unusual.

cold pool of air over much of Canada this month but on the average the flow from this source was confined mostly to the Great Lakes area because of the mean zonal flow over the area from the Rockies westward to the Pacific. Thus, even though there were occasional very cold outbreaks during February, there was rapid modification as mild Pacific air dominated the flow. This is further indicated in figure 3 which shows the mean jet stream at 700 mb.

From the Great Lakes to the British Columbia coast the westerlies were 5-8 m.p.s. stronger than normal for the month, a condition unfavorable for extreme average cold in the United States. Note also the weakness of the jet that is normally observed from the Northwest Territories southward through Saskatchewan to the Central Plains States. Almost parallel to this track in February is usually found a principal track of anticyclones [2]. However a count of Highs this month shows only a secondary track here with another secondary track from the Pacific source.

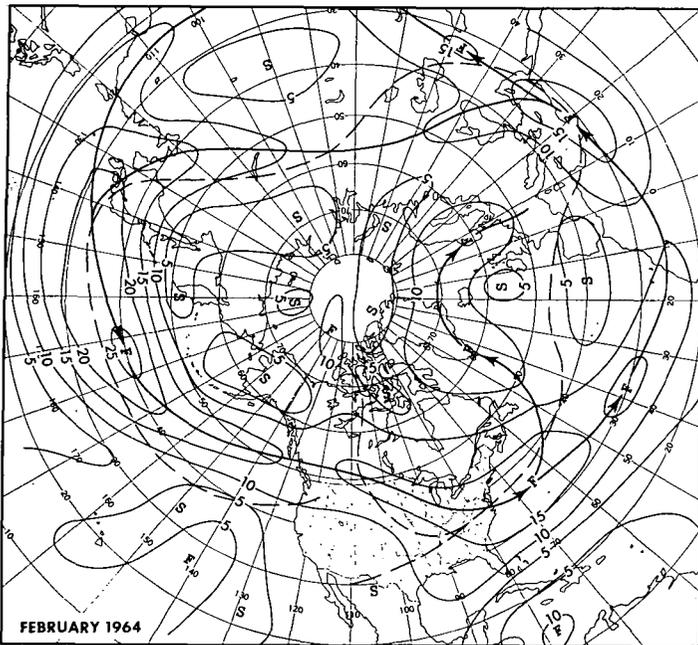


FIGURE 3.—Mean 700-mb. isotachs (meters per second) for February 1965. Solid arrows indicate principal axes of maximum wind speed and dashed lines the normal. Westerlies were north of normal in the Pacific and North America but were displaced southward in the Atlantic.

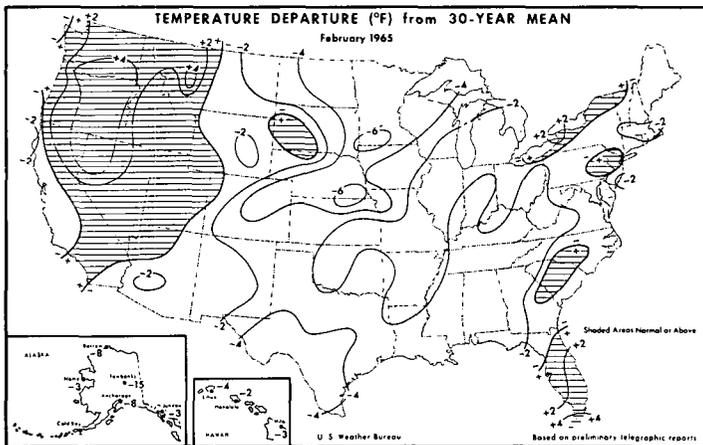


FIGURE 4.—Surface temperature departure from normal (°F.) for February 1965 (from [4]). Extreme values were few as a result of the weekly variability.

PRECIPITATION

Heavy precipitation in the Southeast and the Gulf Coast States and as far north as the Tennessee Valley ranged from 4 in. over most of the area to a maximum of 10 in. at Tallahassee, Fla. (fig 6). Several inter-related factors favored heavier than normal precipitation in this area. The trough in the Southwest was strong and persistent (figs. 1 and 2) and from this trough short-

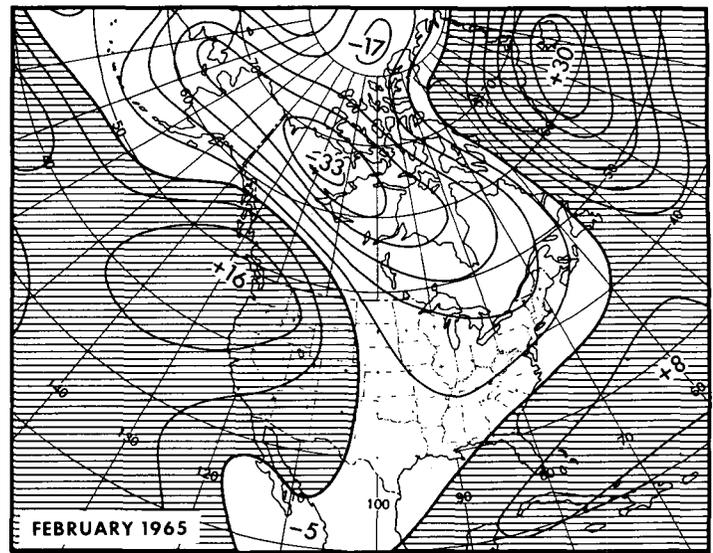


FIGURE 5.—Departure of mean 1000-700-mb. thickness from normal (tens of feet) for February 1965. Strength of the Atlantic blocking is indicated by the large area of above normal thickness.

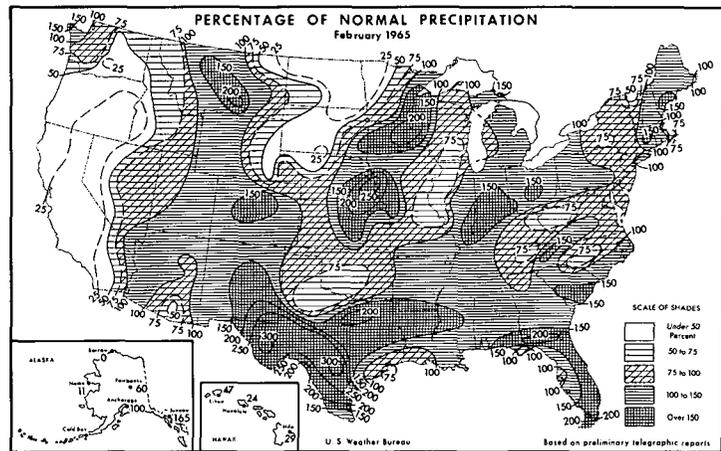


FIGURE 6.—Percentage of normal precipitation (in.) for February 1965 (from [4]). Heavy precipitation in the Gulf Coast States was closely related to the active trough in the Southwest.

wave perturbations moved on a path toward the Northeast. The thermal field (fig. 5) encouraged development of these waves, and moisture from the Gulf of Mexico was available at low levels and aloft. Conditions were conducive to over-running far in advance of perturbations emanating from the Southwest trough and also to occasional heavy showers along the fronts.

Precipitation in the Northern Plains States and the Rocky Mountain States was 0.5-1 in., about normal except for areas west of the Divide. The Far West was very dry with less than half the normal precipitation over most of the area which was under the influence of the upper-level ridge and north to northeast anomalous

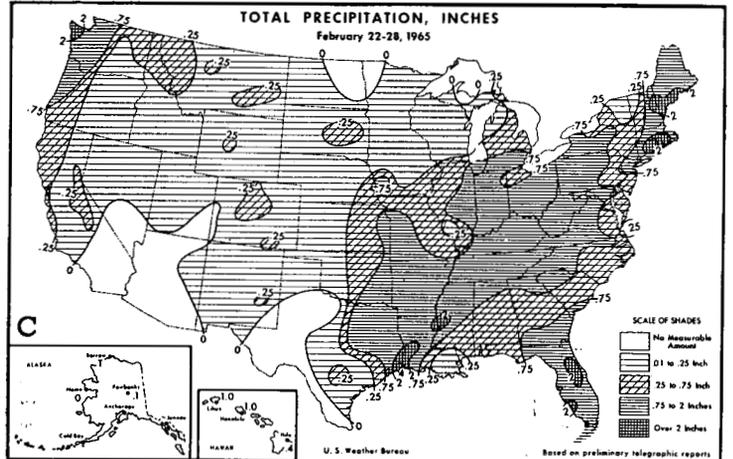
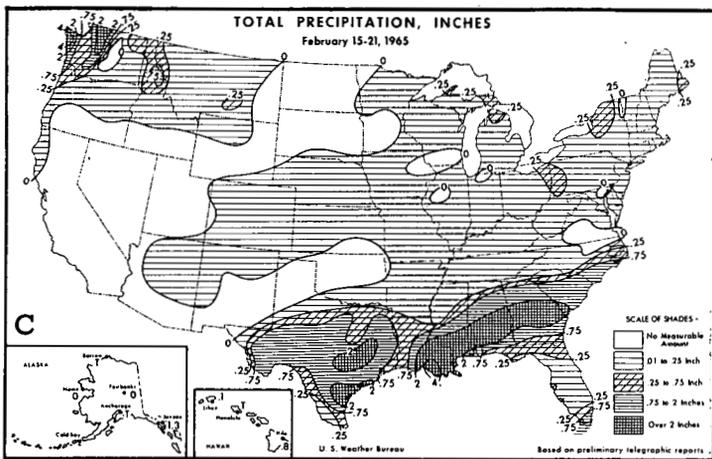
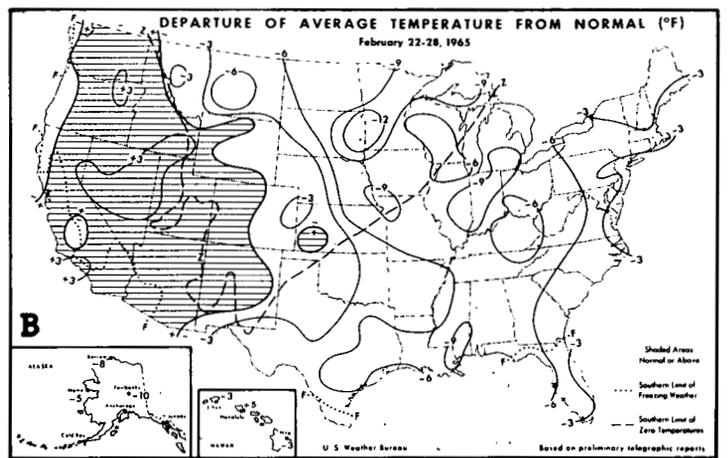
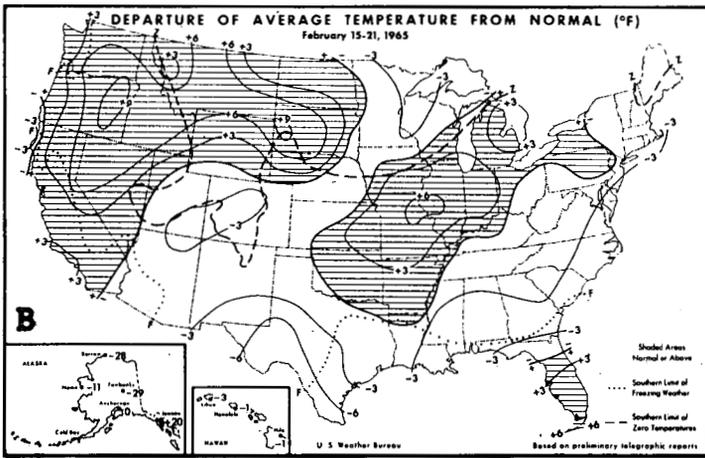
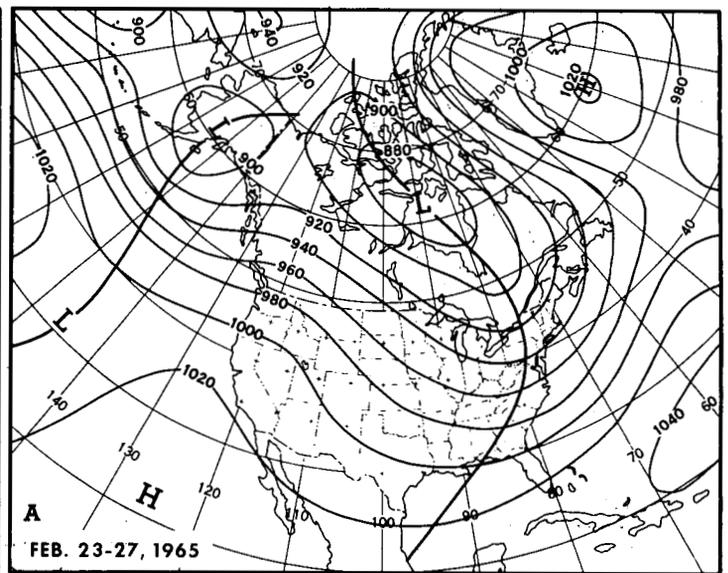
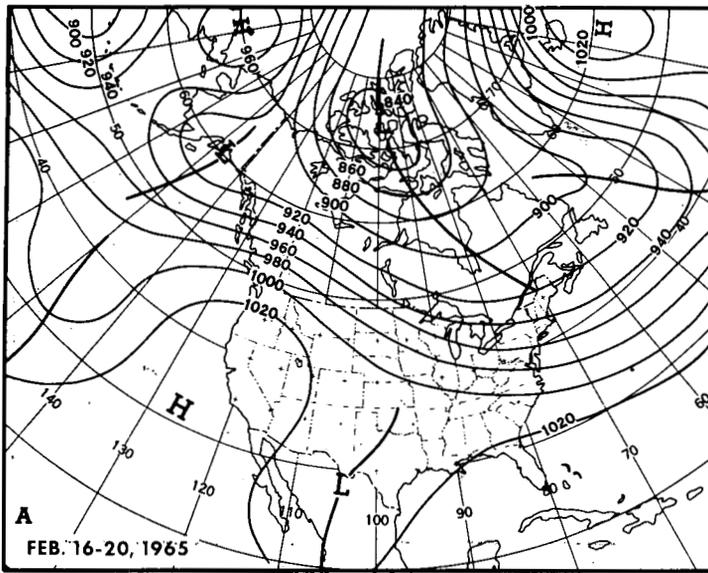


FIGURE 9.—Week of February 15–21, 1965: (A) 700-mb. contours (tens of feet) for February 16–20; (B) surface temperature departure from normal (°F.) (from [4]); (C) total precipitation (in.) (from [4]). Expanding wavelength and increased westerly flow were responsible for widespread warming.

FIGURE 10.—Week of February 22–28, 1965: (A) 700-mb. contours (tens of feet) for February 23–27; (B) surface temperature departure from normal (°F.) (from [4]) (C) total precipitation (in.) (from [4]). The trough in the East encouraged severe snowstorms and cold weather in the eastern half of the United States.

flow. In northwestern Washington 8 to 12 in. of precipitation fell; this was normal to slightly above for February.

4. WEEKLY FEATURES

FEBRUARY 1-7

Average 700-mb. flow during the first week (fig. 7A) was generally westerly and northwesterly over the United States but the anomalous height component was somewhat meridional in the northeastern quarter and along the west coast. The deep Low over Hudson Bay and the strong blocking over the Atlantic, where heights were 1190 ft. above normal south of Iceland, were inter-related, and probably were mutually perpetuated to some degree.

Temperatures were lower than normal from the Rockies eastward (fig. 7B), with departures of 9°-15° F. below normal in the Ohio and Tennessee Valleys. The previous week had been cold and another Arctic air mass entered the country at mid-week. Daily minimum temperatures were below 0° F. from the Ohio Valley to the Northern Plains States. On the average, however, warming occurred across the northern part of the Nation from the eastern Great Lakes to Montana. The western third was warmer with temperatures 6°-9° F. above normal over the Great Basin. In this area heights were above normal and the flow was anticyclonic.

Precipitation was light over most of the Plains and the Basin this week (fig. 7C) beneath the ridge aloft and northwesterly flow east of the ridge. Heavy amounts for this time of year (to 0.75 in.) fell in California, Arizona (including 15 in. of snow at Flagstaff), and Utah as an upper-level perturbation moved in from the Pacific. Meanwhile an upper Low that had been just west of Baja California was forced eastward where a sea level wave was induced over the western Gulf of Mexico. Up to 2 in. of precipitation fell in southern Texas and 1 to 2 in. in the Southeast as Gulf air overran the associated front.

FEBRUARY 8-14

Large changes in the circulation this week produced a reversal in the temperature pattern across the Nation. Strong ridging in the Gulf of Alaska (fig. 8A) was a critical factor as heights increased by as much as 600 ft. off the west coast. A consequence of this ridging was deepening downstream as the flow changed to meridional over much of the United States. While deepening occurred over the Southwest there was strong ridging in the East where heights increased by 600 ft. along the New England coast. At the same time there was a marked weakening of the Hudson Bay Low as it moved northward. Blocking in the Atlantic strengthened and moved northward somewhat and was probably related to the east coast ridge.

Temperatures in the Mississippi Valley and westward lowered substantially the second week of February (fig. 8B) as cold air was transported far into the West and Southwest. In the Great Basin average weekly tempera-

tures fell 12°-18° F. There were some areas of warmth left in the Pacific Northwest where heights were well above normal. In the eastern third of the Nation warming was widespread from the Gulf Coast to the Lakes; average temperatures increased some 15°-20° F. over a large portion of this area. This warming can be attributed to the strong southwesterly flow aloft and to above normal 700-mb. heights.

Precipitation this week (fig. 8C) averaged 2-6 in. over much of the South. This precipitation fell east of the upper trough and occurred mostly as warm Gulf air overran cold air. Two wave disturbances from the mean trough in the Southwest deepened in the central Mississippi Valley along the zone of maximum thermal contrast shown in figure 8B. Both released heavy snow in the North Central States as they moved from Texas across the western Lakes to northern Quebec. Traces of snow were reported in Louisiana but heavy snow fell from Tennessee to the Canadian border. Marquette, Mich., had 15 in. with the second storm.

FEBRUARY 15-21

Changes in the flow that affected the United States were considerable this week. At 700 mb. (fig. 9A) there was general progression of the principal features and a marked increase in the westerlies as a zonal flow replaced the meridional flow of the previous week. This change was characterized by shearing of the trough formerly over the mid-continent, the disappearance of the ridge along the east coast, and an expanding wavelength.

In reaction to this circulation a general warming trend took place over the western two-thirds of the Nation as the ridge moved into the West and heights increased (fig. 9B). Some residual coolness was noted from the Great Basin to Texas. There was pronounced cooling over the eastern third of the United States where mean temperatures decreased 10° F. or more over a large area. The strong ridge of the previous week was replaced by cyclonic flow.

Drier than normal conditions prevailed over most of the United States except in the Gulf Coast States and the Southeast (fig. 9C). Amounts here ranged from 0.5 to 2 in. during the passage of a wave from the Southwest trough.

FEBRUARY 22-28

Reversal of the flow during the last week of February (fig. 10A) appears to have been related to the formation of a new trough in the East to compensate for the very long wave spacing of the previous week. Meanwhile blocking in the Atlantic showed a tendency to move westward for the first time this month as heights in Davis Strait and western Greenland were 700 ft. higher than they had been in the previous week.

An unusual feature of the circulation was the weakening of the ridge in the West while the Low northeast of Hawaii intensified. Ordinarily barotropic processes would be expected to build the downstream ridge. In this instance,

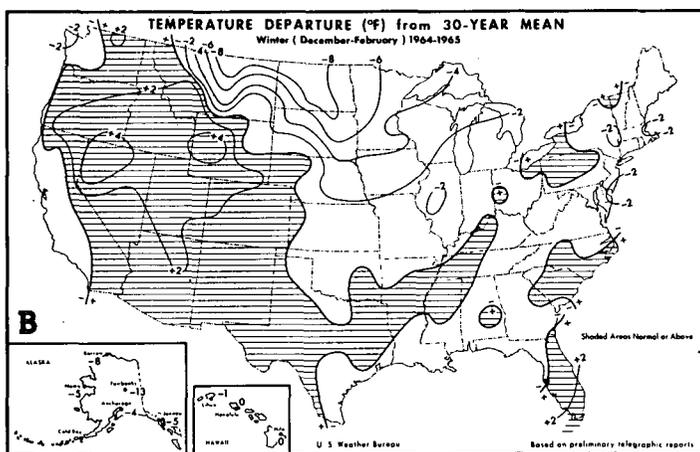
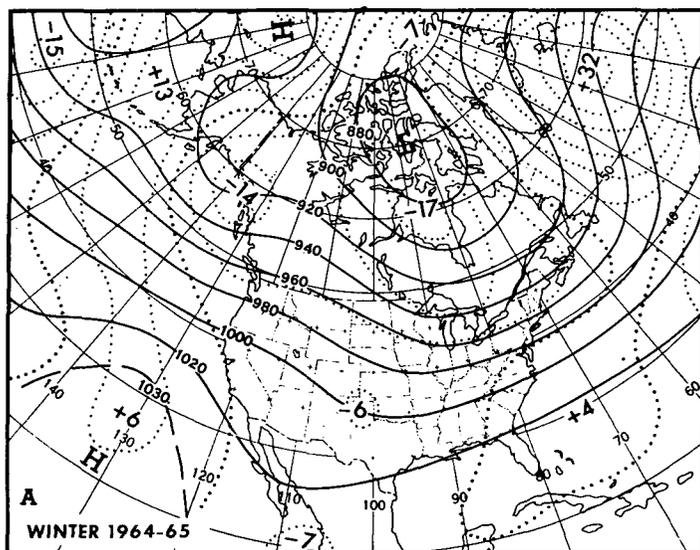


FIGURE 11.—Winter, December 1964–February 1965. (A) 700-mb. contours (solid) and height departure from normal (dotted) (both in tens of feet); (B) departure of surface temperature from normal (°F.) (from [4]). This was a mild winter compared with the previous two winters during which the ridge in western Canada was considerably stronger than normal.

however, deepening in the Gulf of Alaska suggests that baroclinic processes dominated and the redistribution of anticyclonic vorticity was minimized.

Cooling was widespread this week (fig. 10B) as 700-mb. heights decreased from coast to coast. Temperatures in the West were lowered by 6° F. over a wide area with only slight warming in the Great Basin. Average temperatures decreased as much as 15° F. in the Northern and Central Plains and fell 3°–6° F. in the East.

Precipitation this fourth week of February (fig. 10C) was generally near 1 in. from eastern Texas to the eastern

Lakes along the mean trough. Most of this occurred as heavy snow associated with one storm that took 4 days to move from the northern Rockies to central Texas to southern Quebec. With the passage of this storm El Paso, Tex., had its first measurable snow of the winter and Austin, Tex., had a 5-in. snowfall. At Springfield, Ill., the 14-in. snowfall was the heaviest since 1900; Chicago, Ill., had 7-ft. drifts. Michigan also received heavy snow that ranged to 11 in. in several areas. Light precipitation again was reported west of the Mississippi Valley where the 700-mb. flow was northwest and the anomalous flow was northerly.

5. WINTER 1964–65

Blocking was a recurrent feature of the North Atlantic circulation during the 1964–65 winter (fig. 11A). Rather strong blocking occurred in December [3] when a large positive height anomaly was located just southeast of Greenland. In January [1] blocking was much weaker as, during the first half of the month, it apparently retrograded into an Arctic High. In February blocking returned in strength as discussed earlier in this report.

Another notable feature of the winter circulation was the below normal 700-mb. heights over most of North America, except for a small area in western Alaska and in coastal States in the Southeast. Note also that the circulation relative to normal was very weak over most of the United States. Consequently, temperature departures from normal were also rather small (fig. 11B) since there was no sustained flow from either cold or warm sources.

Positive heights west of Alaska favored transport of cold air into the Gulf of Alaska with resulting cyclogenesis. But the deep Low near Baffin Island was very extensive and probably restrained ridging of any consequence in western Canada. Thus the Arctic source of air normally found in Canada and Alaska in winter was too far removed to produce extreme cold in the United States this year, except in the Northern Plains where temperatures were 8° F. below normal.

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