WEATHER AND CIRCULATION OF NOVEMBER 1981
Widespread Warmth with Storminess in the Far West

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1. Mean circulation

General progression of planetary waves in mid-latitudes, and a substantial decrease in heights in high latitudes at 70 kPa, led to a broad and well-organized westerly wind current around the Northern Hemisphere in November (Fig. 1). Its formation from the western Pacific to the western Atlantic was expedited by phasing of mid-latitude wave features with their counterparts at higher latitudes. The subsequent pattern exhibits a strong wavenumber 4 character with prominent ridges near the dateline, over North America, near the Greenwich meridian, and over central Eurasia.

In an anomaly sense these ridges represent a shift of blocking, or higher than normal 70 kPa heights, from high latitudes and dominant planetary wave 3 in October (Erickson, 1982) to middle latitudes and wave 4 in November (Fig. 2). In addition, a negative height anomaly reemerged in the Gulf of Alaska after a temporary absence in October.

Many of these changes seem to have been related to the southeastward push of domes of cold air into Manchuria and south central Europe (Fig. 3). The wavetrain downstream from northeastern Asia is often associated with strong baroclinity and fast westerlies (Fig. 1) in the western Pacific, while the progression and maintenance of the central Asian ridge is consistent with cold air moving into the Balkan peninsula. Whatever the case, warm air (Fig. 3) and a split westerly current (Fig. 4) characterized the lower troposphere over the center of both continental masses.

2. Temperature

After a mostly cool October (Erickson, 1982) the United States enjoyed higher than normal temperatures almost everywhere within its borders in November (Fig. 5). Above normal heights at 70 kPa over much of the interior of the nation with anomalous southerly and maritime flow aloft over the Far West were responsible for the relatively warm conditions. While the greatest mean departures from normal occurred in the north central United States, the majority of highest daily, highest so late, or highest for November temperature records were set to the south and west of this region (cf. Table 1). For example, Phoenix, AZ had its warmest November on record.

Only the southeast Atlantic coast and the highlands of the middle Atlantic states experienced cooler-than-normal air in the mean. Frequent cloudiness and precipitation were important contributing factors in the first area. In the second the fact that much of the month's precipitation was in the form of snow was probably decisive, as evidenced by the regional definition of the anomalies in Fig. 5.

3. Precipitation

Precipitation amounts for November were generally light to adequate for the southeastern third of the United States from southern Texas to Maine as well as around the Great Lakes (Fig. 6). Two locations in the lee of the central Appalachians (Richmond, VA and Asheville, NC) observed their fourth straight month with subnormal rainfall, continuing an extended recent history of drought for that area.

In contrast, the western United States was mostly wet in November, mainly as a result of frequent incidence of intensifying Pacific storms. With a deeper-than-normal trough just off the west coast of the United States (Figs. 1 and 2) and fast Pacific westerlies (Figs. 1 and 4), northern California, the Pacific Northwest, and the mountains to the east were particularly vulnerable. In mid-month these areas were hit several times by high winds, torrential rains, and in higher elevations heavy snows. The rain shadows over the Great Basin and immediately to the lee of the Rockies suggest the weakening of these Pacific systems as they propagated eastward. Regeneration of some of these storms over the central Great Plains contributed to the large precipitation excesses there, although most can be attributed to an early-month cutoff low.

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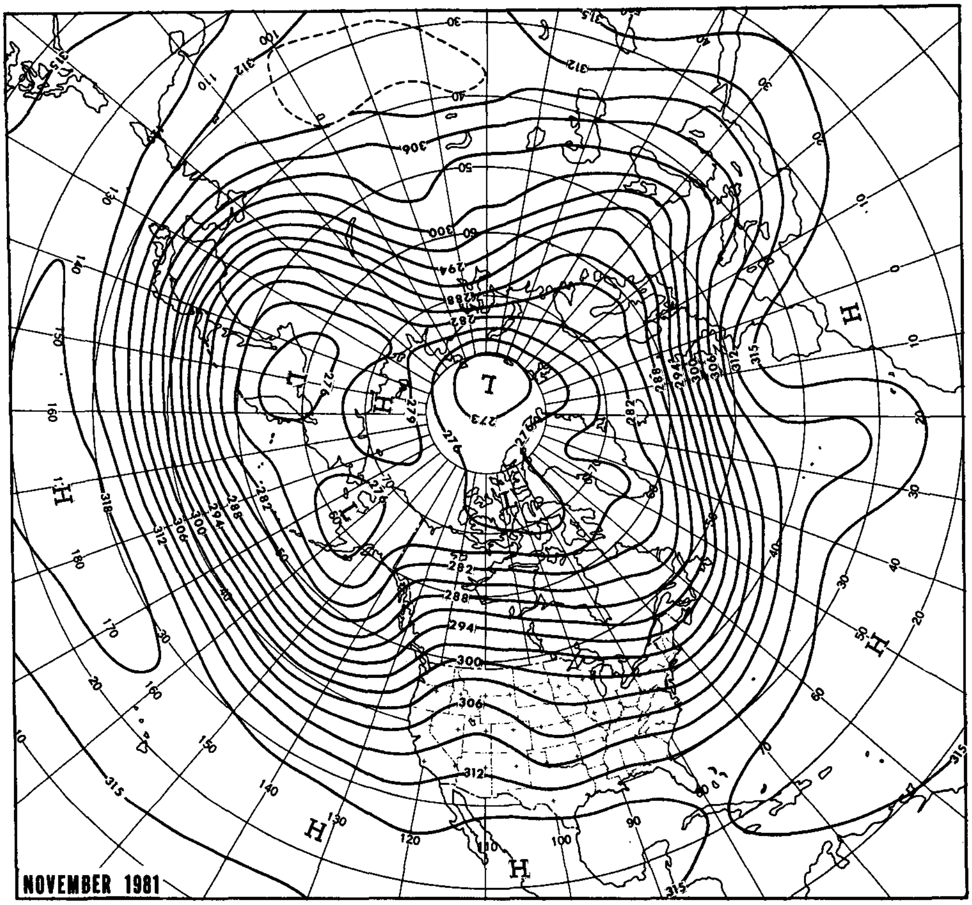

FIG. 1. Mean 70 kPa height contours (dam) for November 1981.

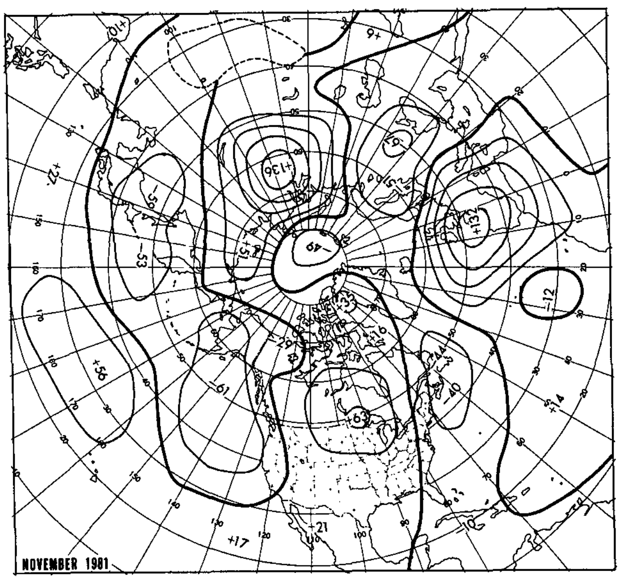

FIG. 2. Departure from normal of mean 70 kPa height (m) for November 1981.

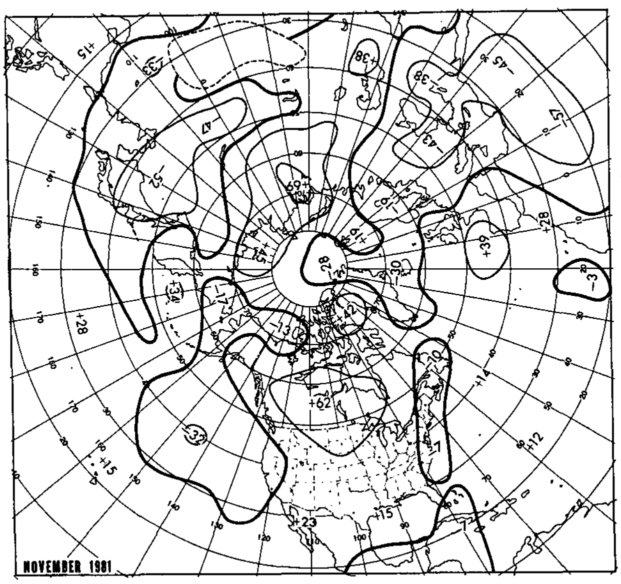

FIG. 3. Departure from normal of mean 100–70 kPa thickness (m) for November 1981.

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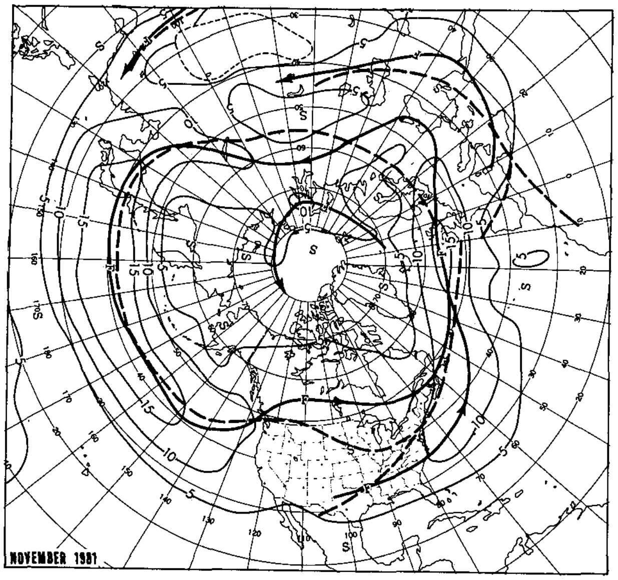

FIG. 4. Mean 70 kPa geostrophic wind speed (m s^{-1}) for November 1981. Solid arrows indicate observed axes of maximum wind speed and dashed lines, the normal.

TABLE 1. Temperature records equaled or exceeded in November 1981.

Station	Date	Temperature (°C)/(°F)	Remarks
Midland, TX	18	28.9/84	Highest for November
Montgomery, AL	27	28.3/83	Equaled highest so late
Phoenix, AZ*	17	28.3/83	Highest so late
Jackson, MS	30	27.8/82	Highest so late
Las Vegas, NV	15	27.8/82	Highest so late
Albuquerque, NM	16	22.8/73	Highest so late
Williston, ND	03	22.8/73	Highest for November
Casper, WY	16	18.9/66	Highest so late

* Warmest November.

On the eastern side of the Atlantic basin grossly different precipitation regimes prevailed to the south and to the northeast of the strong ridge. Drought continued to worsen in Spain and Morocco, but northern Europe, from the North Sea and Baltic coasts south to the Alps, was hit by gale force winds, flooding and snow in a manner reminiscent of the west coast of the United States.

4. Variability within the month

a. 2–8 November

The major circulation changes that took place at 70 kPa from October to November were already well-advanced by the first week in November. A comparison of Fig. 7a to the previous one in the sequence (Fig. 12a, Erickson, 1982) reveals an abrupt drop in heights near the pole and a rapid shift in wave energy in midlatitudes toward shorter wavelengths (specifically from wavenumber 3 to 4). This was brought about by general retrogression of waves from the western Atlantic to the western Pacific and progression over Eurasia. At the same time, zonal flow over the Atlantic buckled dramatically allowing insertion of a new wave and providing fuel for downstream amplification over Eurasia. The week's most dramatic weather event was associated with these latter changes; as cyclonic vorticity was driven into European Russia the Baltic coast was flooded and swept by gale-force winds.

Over the United States conditions were more benign as almost the entire country had above normal temperatures for the second straight week (Fig. 7b). This isn't surprising in view of the broad ridge aloft that kept the westerlies well north of most of the country during the week.

The weak trough over Oklahoma in Fig. 7a is a

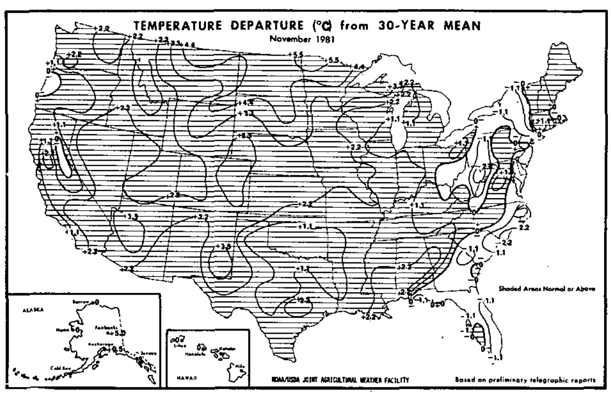

FIG. 5. Departure from normal of average surface air temperature (°F) for November 1981 (from National Oceanic and Atmospheric Administration and Statistical Reporting Service and World Agricultural Outlook Board, 1981).

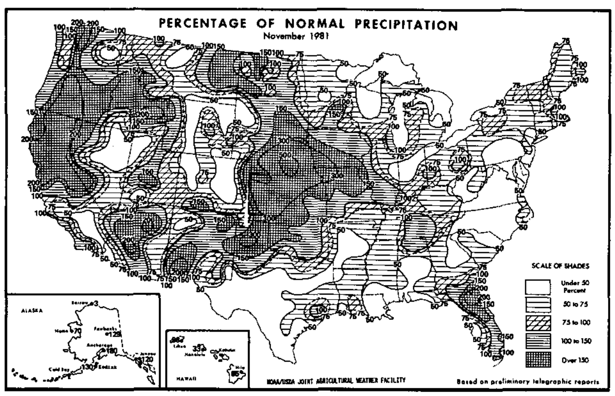

FIG. 6. Percentage of normal precipitation for November 1981 (from National Oceanic and Atmospheric Administration and Statistical Reporting Service and World Agricultural Outlook Board, 1981).

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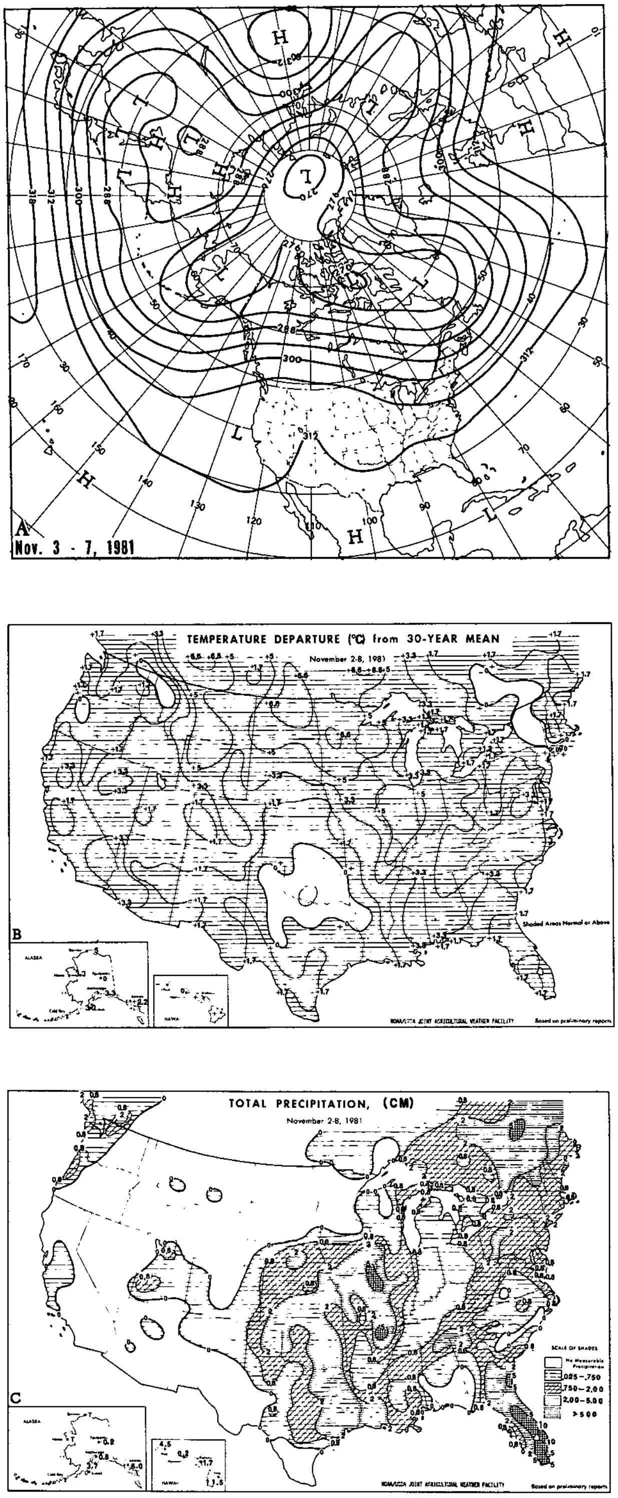

FIG. 7. (A) Mean 70 kPa contours (dam) for 3–7 November 1981, (B) departure from normal of average surface air temperature (°F), and (C) total precipitation (inches) for week of 2–8 November 1981 (from National Oceanic and Atmospheric Administration and Statistical Reporting Service and World Agricultural Outlook Board, 1981).

reflection of the stationary system that accounted for the one notable exception to the overall warmth and virtually all of the precipitation that fell in the central Plains (Fig. 7c). The precipitation to the windward of the Appalachians and in the Northeast is associated with the perturbation in the westerlies that finally dislodged this cutoff low after mid-week.

The low center shown near Cuba is the 5-day mean signature of Tropical Storm Katrina. This disturbance reached tropical storm strength southwest of Cuba on 5 November, crossed the island nation's midsection early on 6 November, and finally lost itself in a cold front to the northeast on 8 November. The exceptional rainfall amounts over the Florida Peninsula are associated with Katrina's circulation.

Unlike the lower 48 states, Alaska had temperatures significantly below normal along its coasts, except for the panhandle.

b. 9–15 November

As 70 kPa heights continued to fall near the pole, progression and amplification of mid-latitude upper-air waves proceeded downstream from Eurasia to the Pacific and the central United States (Fig. 8a). In contrast to the previous week the trough-ridge complex over the western and central Soviet Union lost much of its amplitude, the former beginning to cut off from the main westerly stream. However over North America, the main current moved south in response to the tremendous upper-air trough deepening southeastward from the Gulf of Alaska, thereby transferring the hemisphere's focus of severe weather from Europe to the west coast of the United States.

Maritime flow from the Pacific kept the Far West quite warm (Fig. 8b) and wet (Fig. 8c) during the week. Unfortunately, the northwest coast was lashed almost continuously by high winds and flooding, which reached their peak with the appearance offshore of a deep low on 14 November. This storm ultimately was blamed for nine deaths.

Over most of the rest of the United States temperatures were above normal and precipitation light or absent, largely because of a general increase of 70 kPa heights as the continental ridge moved eastward. In the East, however, temperatures fell below normal mainly as a consequence of the retrogression and deepening of a high-latitude trough that allowed offshore storm development to tap colder air masses to the north. A low that played a role in this process (after moving along the Gulf coast across Florida into the Atlantic) also was the source of much of the coastal precipitation shown in Fig. 8c. The interesting precipitation maxima oriented along the upper Ohio and Mississippi Valleys seem to be related principally to showers that occurred in unstable air behind an early week cold frontal passage. Finally note the dramatic reversal in Alaskan temperature anomalies from the previous week.

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c. 16–22 November

Midlatitude wave amplification, first over Eurasia two weeks before and then over the Pacific, shows up in Fig. 9a over North America, most prominently in the ridge over Canada and in the trough on the east coast of the United States. In the case of higher latitudes a general westward movement of waves has occurred. In particular the low near Baffin Island has split; part has retrograded as a trough to the western Archipelago while part has amalgamated with the southwestward plunging Arctic low. This last feature moved to a position directly to the north of the ridge over the western Mediterranean. Downstream the westerly current has split, part flowing north around the retrograding Eurasian high and part south around the almost completely cutoff trough over Asia Minor.

Temperatures for the week were again above normal over most of the United States, but large positive departures were mostly confined to the high plains, mountain and intermountain regions in the West beneath the 70 kPa ridge (Fig. 9b). Two frontal passages channeling cooler, drier Canadian air were responsible for the negative temperature anomalies east of the Mississippi River.

The second of these frontal events was driven by a storm that first developed in the lee of the Rockies in midweek and then moved across the Great Lakes region to New England (Fig. 9c). In its wake this low left snow from the northern Plains eastward. Houghton Lake, MI, for example, had 36.6 cm (14.4 inches) on 20 November. Weather conditions in the Pacific Northwest were somewhat similar to the week before (compare precipitation amounts in Figs. 8c and 9c), but less severe as the Gulf of Alaska low filled considerably. Early in the week, however, Eureka, CA had a record 63.5 mm (2.54 inches) in one day.

d. 23–29 November

Unlike previous weeks almost the entire mid-latitude westerly wavetrain advanced eastward and amplified (Fig. 10a). The western Mediterranean high was the only feature that didn't progress (because of the loss of a wave in the Atlantic) while the Canadian high was the only feature that didn't grow. In addition, continuous trough and ridge links to the Arctic were completed as the progressing, intensifying midlatitude wave couplet in eastern Eurasia was able to connect up with the couplet retrograding from the North American side of the Arctic.

The key to this major distortion in the general circulation may have been the simultaneous digging of troughs deep into central Europe and the eastern Pacific. The stage was set for these movements in preceding weeks when a deep Arctic low first developed and then bifurcated, throwing its energy and vorticity southward into existing sub-Arctic troughs. The consequences for at least Europe were great and closely resembled the events associated with the cyclonic thrust in the first week of the month (Section

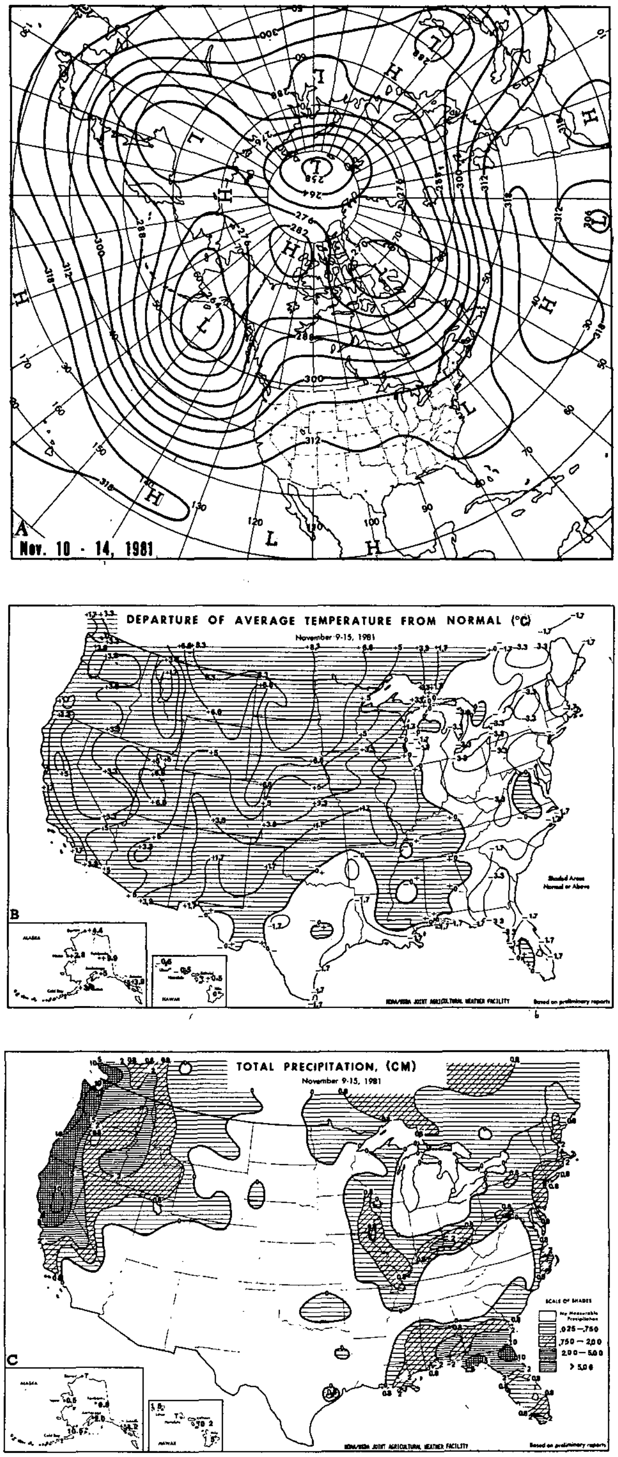

FIG. 8. As in Fig. 7 except for (A) 10–14 November 1981, and (B) and (C) week of 9–15 November 1981.

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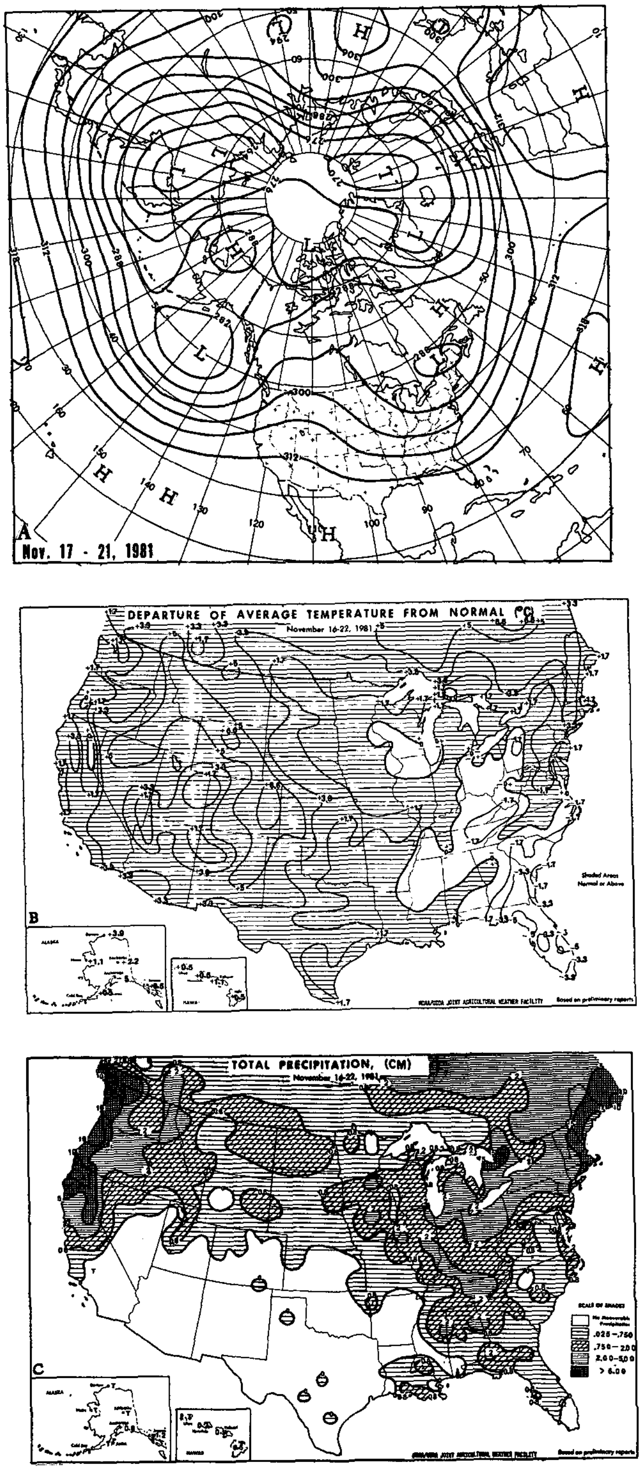

FIG. 9. As in Fig. 7 except for (A) 17–21 November 1981, and (B) and (C) week of 16–22 November 1981.

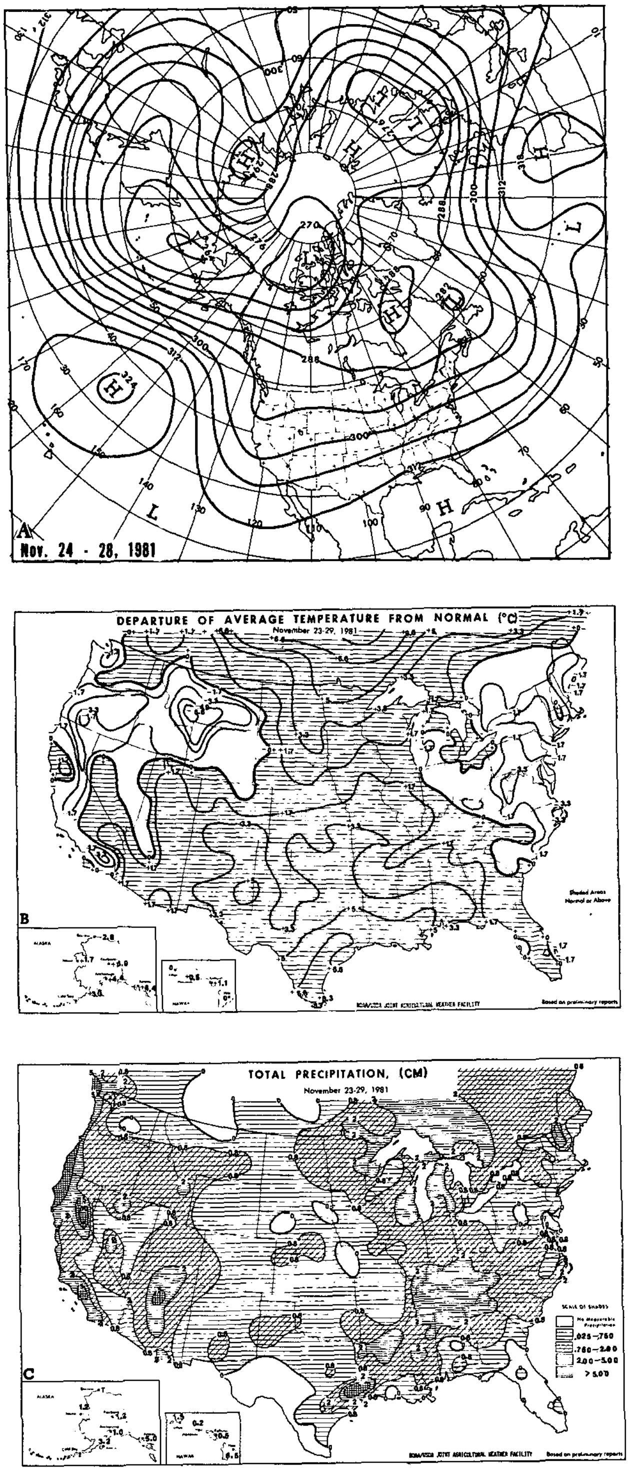

FIG. 10. As in Fig. 7 except for (A) 24–28 November 1981, and (B) and (C) week of 23–29 November 1981.

4a). Again coastal flooding and high winds with snow over the mountains were the results, the only difference being a shift in the focus of the worst weather from the Baltic coast west to the Channel and North Sea coasts.

Almost coincident with the gale in western Europe

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was Typhoon Irma's transit over the northern islands of the Philippines on 23–24 November. Wind speeds up to 70 m s^{-1}, 3–5 m waves, flooding and mudslides reportedly accounted for 273 fatalities and a quarter of a million homeless. Irma had developed well to the east four days earlier, reaching typhoon strength on 21 November just before its track dipped to the southwest. As it slammed into the islands it veered northwest, then sharply northeast after reaching the South China Sea, finally being caught up in the westerlies east of Taiwan.

Over the continental United States the pattern of weekly weather changed in several respects, largely as a result of the movement onshore of the eastern Pacific trough combined with only a weak ridge over the interior. First, the center of relatively high temperatures shifted to the plains as low 70 kPa heights and trapped cold air cooled off much of the mountainous Far West (Fig. 10b). More importantly, storms from the Pacific were able to freely and rapidly traverse the country, causing widespread but mostly light precipitation. The principal exception was along the length of the Pacific Coast. To the north substantial amounts fell for the third straight week but to the far south the rain was the first to fall in a long time (reportedly since April).

5. Tropical activity

Aside from Tropical Storm Katrina in the Atlantic (see Section 4a) and Typhoon Irma (see Section 4d) only two additional tropical storms in the western Pacific will be noted here. Typhoon Hazen early in its history followed a track similar to Irma's, but unlike Irma skirted the southern end of Luzon on 19–20 November before weakening in the South China Sea. Tropical Storm Jeff began its life by emulating Hazen and Irma but, fortunately for Luzon, veered to the northwest. By 25 November it had decayed considerably.

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