SEASONAL CLIMATE SUMMARY

The Climate of Spring 1983—A Season with Persistent Global Anomalies Associated with El Niño

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1. Summary

Large climate anomalies associated with the 1982–83 Pacific Warm Episode continued during spring (March, April and May). This warming event has been documented in detail by a series of Special Climate Diagnostic Bulletins issued by the Climate Analysis Center. Previous seasonal climate reviews (Wagner, 1983; Krueger, 1983; Quiroz, 1983) have also described the developments of this extraordinary episode and its related anomalous circulations in the atmosphere and hydrosphere.

Intense El Niño conditions persisted in the eastern equatorial Pacific. However, by the end of the season the pattern of global atmospheric anomalies gave some indication that this event was starting to weaken. The Southern Oscillation index (Tahiti–Darwin pressure) rose sharply from its extreme low in February, reaching a small positive value in May. Also, the domain of anomalous equatorial low-level westerly winds (which elongated from the dateline eastward to about 100°W) diminished in intensity and size. In the meantime, easterly winds of normal to above normal strength prevailed west of the dateline.

At 700 mb, the extraordinarily large negative height anomalies over the North Pacific continued from winter to early spring, but weakened as the spring season progressed. In contrast, both the negative height anomalies over the southern United States and the positive height anomalies over the North Atlantic gained strength.

For the United States, it was a cool and wet spring. In fact, the country *as a whole* experienced its second coldest spring in the past 53 years. Meanwhile, precipitation totals were much above normal for most of the country.

2. Southern Oscillation index and sea surface temperature anomalies (SSTAs)

The Tahiti-minus-Darwin Index (Fig. 1), which is a measure of the Southern Oscillation (Rasmusson and Carpenter, 1982; Chen, 1982), has risen sharply from its extreme low in winter, reaching a small positive value in May. It indicates that the extraordinarily large negative/positive surface pressure anomalies in the southeast Pacific High/Indonesian Low area was rapidly returning to its normal state during late spring (March, April and May).

The monthly averaged SSTA indices for five areas in the eastern equatorial Pacific are shown in Fig. 2. The spring SSTA and SST maps for the Pacific are shown in Figs. 3 and 4, respectively.

The SST analyses were carried out by Dr. Richard Reynolds of CAC, using merchant ship data transmitted in real time on the Global Telecommunications System (GTS). His analyses do not exhibit the tendency for underestimation of the larger anomalies which was characteristic of the earlier operational analyses prepared at the National Meteorological Center.

After reaching a large maximum during late autumn and early winter, the SSTAs showed a decrease in all five Niño areas (Fig. 2). However, those near the South American coast increased again to new peaks during March–May. Anomalies as large as 6°C could be found along the coast of Ecuador and northern Peru. The substantial increase was explained by Reynolds (personal communication, 1983) to be due to the persistence of the anomalous values while the mean seasonal cycle declined rapidly from its maximum.

In the North Pacific, the negative SSTAs continued to intensify during spring (Fig. 3). A vast pool of below −2°C anomalies were observed centered at 35°N, 155°W. On the other hand, the negative SSTAs in the South Pacific that were observed during December–February were restored to near normal values.

Figure 4 shows the mean spring SST field. The 29°C isotherm continued to migrate eastward, reaching the west coast of Central and South America during spring. Note that the equatorial pattern by this time had become approximately zonal without the normally observed cold tongue in the eastern Pacific.

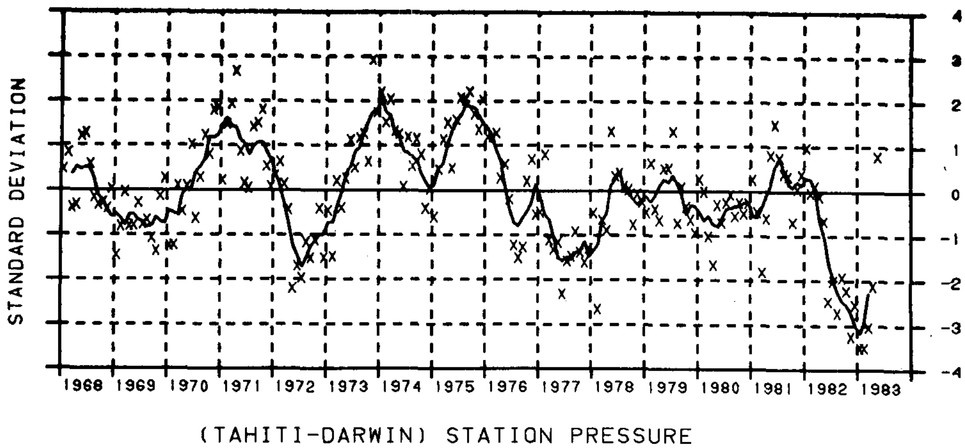

FIG. 1. Normalized anomalies of index of the Southern Oscillation (Tahiti-Darwin sea level pressure). Crosses represent individual monthly mean values and the solid curve shows the smoothed variations using 5-month running means.

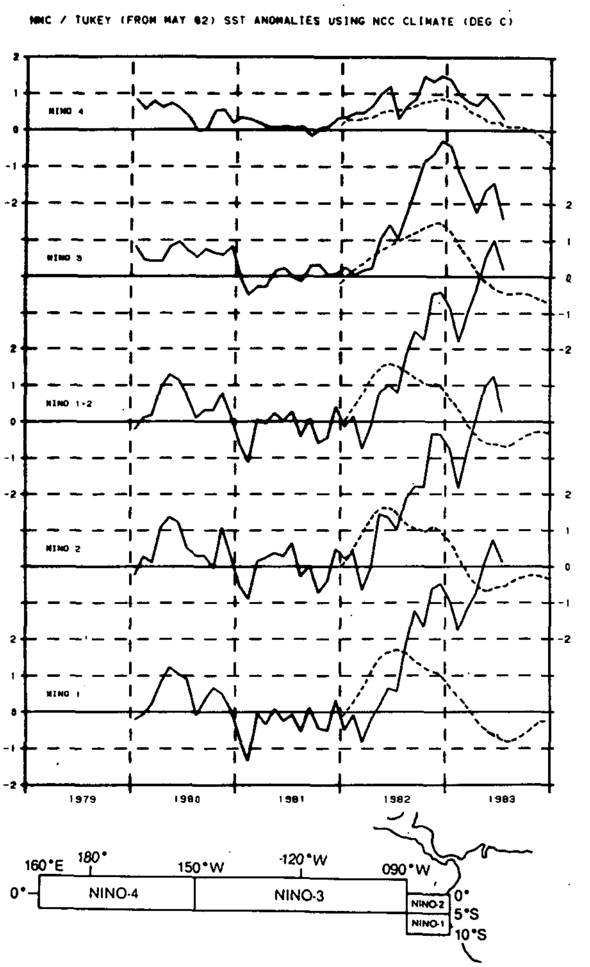

FIG. 2. Indices of monthly mean sea surface temperature anomaly (°C) in areas of the tropical Pacific (see map at bottom). The dashed lines show the composite sea surface temperature anomalies for the six El Niño events centered in 1951, 1953, 1957, 1965, 1969 and 1972. The composite is plotted so that the central year of the El Niño events corresponds to 1982.

3. Anomalies over the tropical Pacific

a. 850 mb wind field

The main feature of the low-level wind field has been the strong westerly anomalies that accompanied the SST warming in the eastern equatorial Pacific (Fig. 5). A major decline in the southeasterly trade winds and appearance of westerly anomalous flow first occurred over the Indonesian region in June 1982 (Fig. 6). The westerly anomalies progressively migrated eastward. By December, the center of the anomalies was well east of the dateline and the domain of the westerly anomalies had expanded to the South American coast. During spring, the intensity of the anomalies has decreased from the winter peaks and, west of the dateline, easterlies of normal to above normal strength were observed (Figs. 5 and 6).

Figure 7 shows the mean 850 mb streamfunction anomalies for MAM (Spring). Note the intensive cyclonic circulation over French Polynesia. (Remember that cyclonic streamfunction circulations are shown as highs in the Southern Hemisphere). Several devastating storms and typhoons were reported to have crossed this area since last December. The number of cyclones east of 180° during January to April (5) is unprecedented in modern time. Carl Erickson of CAC is writing on these unusual features and their relations with the 1982–83 Warm Episode.

b. Outgoing long wave radiation (OLR)

Accompanying the huge SST and low-level wind anomalies in the eastern equatorial Pacific were also the huge negative outgoing longwave radiation (OLR) anomalies (Figs. 8 and 9). The OLR data are good indicators of cloudiness and precipitation in the tropics: lower than normal values are associated with enhanced precipitation and vice versa.

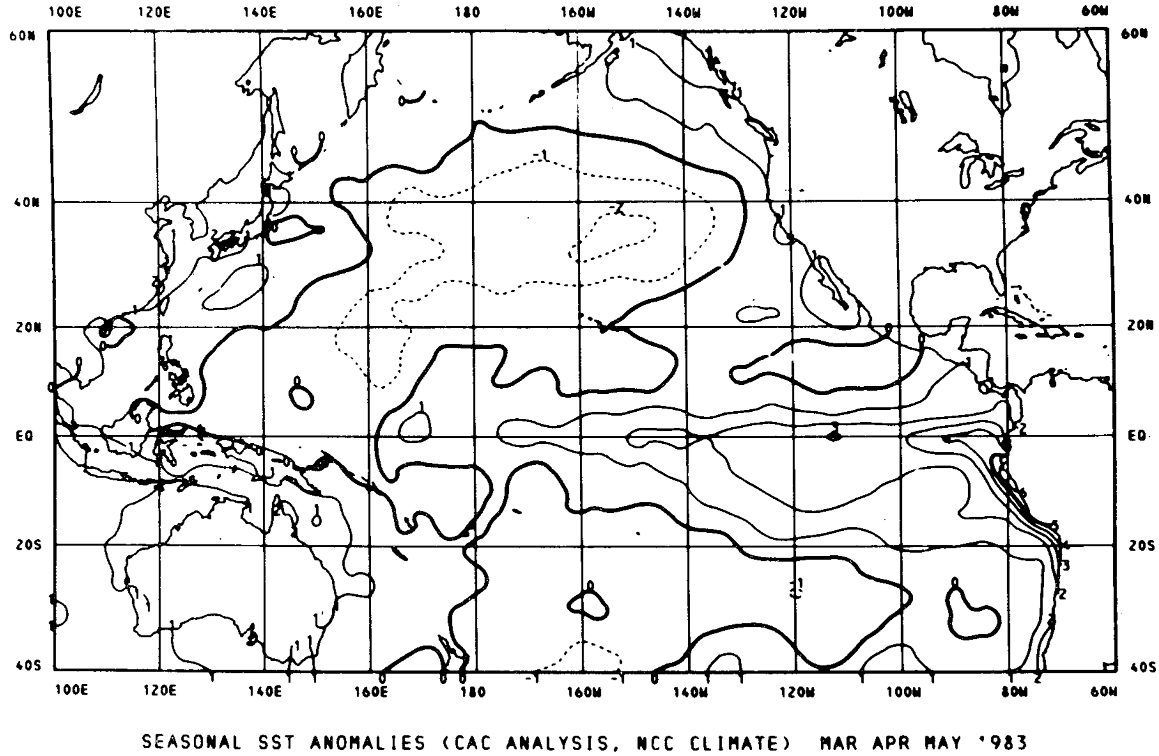

FIG. 3. Sea surface temperature anomaly (°C) for spring 1983 over the Pacific Ocean. Dashed lines portray negative anomalies, thin solid lines indicate positive anomalies, and the heavy solid line is the zero line. Anomalous isotherms are at 1°C intervals except for 0.5°C between +1 and −1°C.

Similar to the low-level wind field, the enhanced precipitation had been migrating steadily eastward since last June. By spring it extended from west of the dateline all the way to the South American coast (Fig. 9). The eastward shift temporarily eliminated the climatological dry zone along and south of the equator

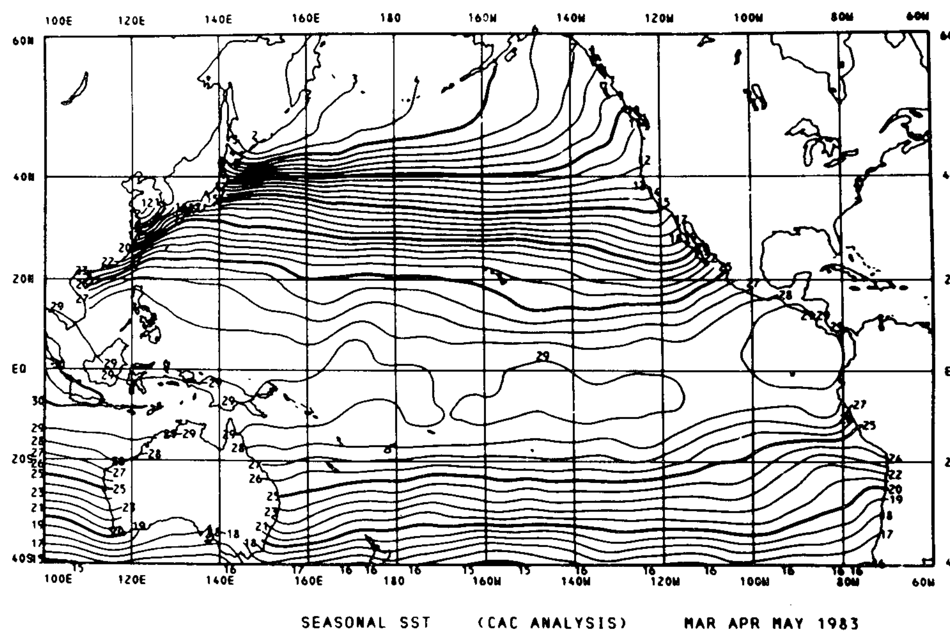

FIG. 4. Sea surface temperature (°C) for spring 1983 over the Pacific Ocean.

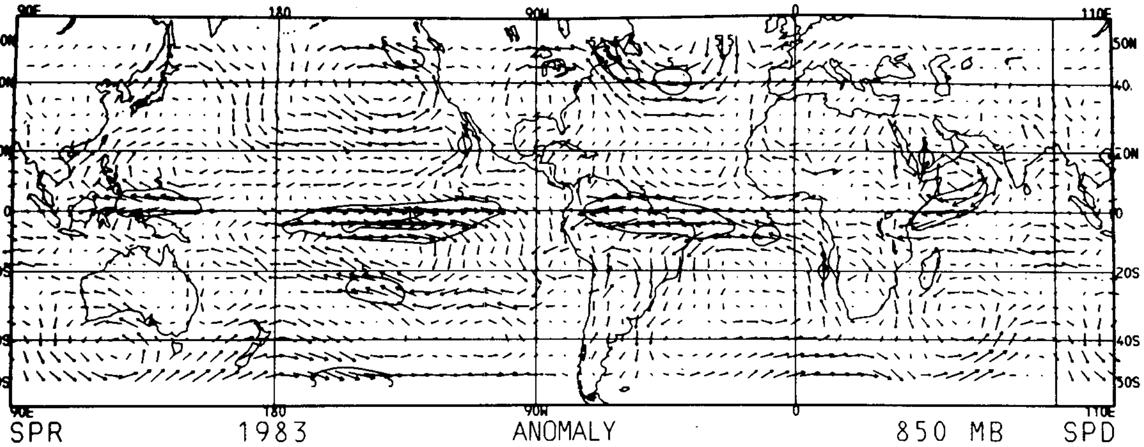

FIG. 5. Mean 850 mb speed anomaly for spring 1983. Contour interval is 5 m s^{-1}.

in the eastern Pacific. Note the extremely large negative OLR anomalies over the French Polynesian region, another indication of abnormal, intensive cyclonic activity in that area during MAM.

Figure 10 is the mean MAM OLR chart. The intertropical convergence zone (ITCZ) in the eastern equatorial Pacific remained well south of its normal position, and resulted in a continuation of abnormally

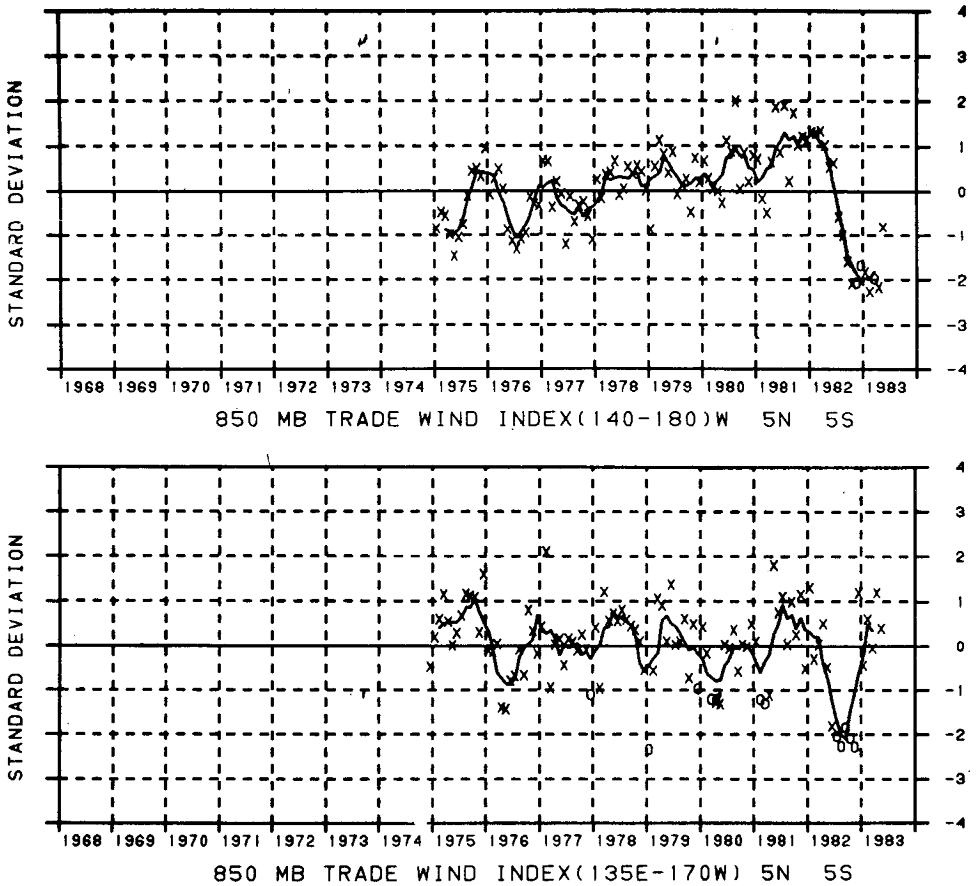

FIG. 6. Normalized anomalies of indices of the 850 mb zonal wind within 5° of the equator over the west central Pacific and the east central Pacific. Individual monthly mean values are shown by crosses and the solid curves show the smoothed variations using 5-month running means. The departures, which are taken with respect to monthly means of the complete record of each quantity through 1983 are divided by the appropriate monthly standard deviations.

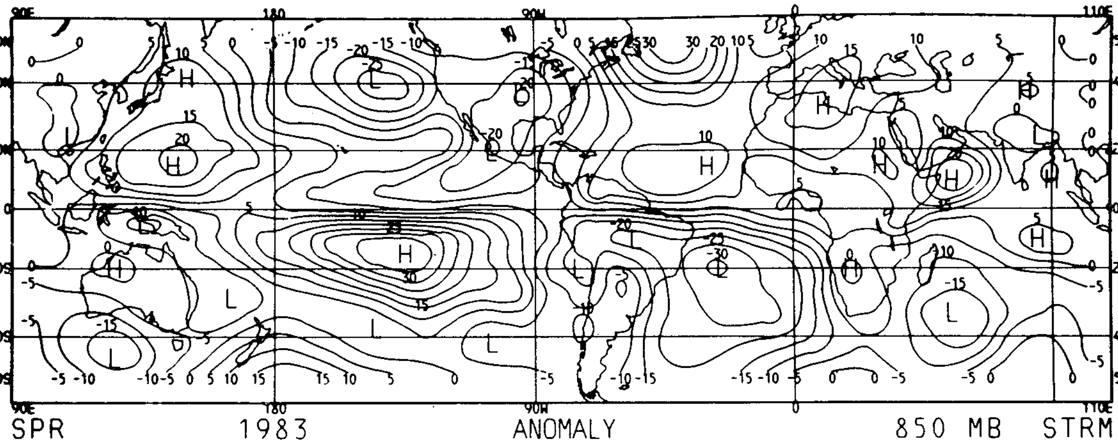

FIG. 7. Mean 850 mb streamfunction anomaly (10^5 m^2 s^{-1}) for spring 1983. These anomalies represent departures from mean values for the 5-year period 1976–80. High (H) and low (L) values of streamfunction anomaly represent centers of clockwise and counterclockwise circulations, respectively. Thus H(L) signifies anticyclonic (cyclonic) circulation in the Northern Hemisphere and cyclonic (anticyclonic) circulation in the Southern Hemisphere. A streamfunction gradient of 30×10^5 m^2 s^{-1} per 10° of latitude corresponds to an anomalous wind of 2.7 m s^{-1}.

heavy precipitation over Ecuador and northern Peru. At Guayaquil, for example, a total of 622 mm of rainfall was reported during May, compared to a normal value of 42 mm.

4. Upper tropospheric flow anomalies

The pattern of 200 mb circulation anomalies in MAM (Fig. 11) was similar to that during winter (DJF) but with reduced intensity. The huge anticyclonic dipole over the Pacific, a characteristic of a warm episode (Arkin, 1982), continued to dominate the flows with easterly anomalies greater than 15 m s^{-1} found near 140°W at the equator (Fig. 12). Like the other parameters mentioned earlier, the dipole has also migrated eastward from near the dateline in late summer, to about 140°W during MAM. During May the dipole moved further eastward and decreased in strength very rapidly. The 200 mb zonal wind index over the eastern equatorial Pacific is shown in Fig. 13, a decreasing yet strong easterly wind anomaly can easily be seen.

Another major feature of the 200 mb circulations were bands of strong westerly anomalies in the subtropical latitudes in both hemispheres (Fig. 12). In the Northern Hemisphere, the anomalies extended from near the dateline to about 70°W, exceeding 20 m s^{-1} at 30°N, 140°W and 15 m s^{-1} over the Gulf of Mexico. The subtropical jetstream in the Southern Hemisphere was also stronger than normal over the east Pacific. Anomalous westerly winds extended across the Andes into eastern Argentina, resulted in frequent storminess to that region.

The upper tropospheric circulation anomalies over the tropical Atlantic differed radically from those over

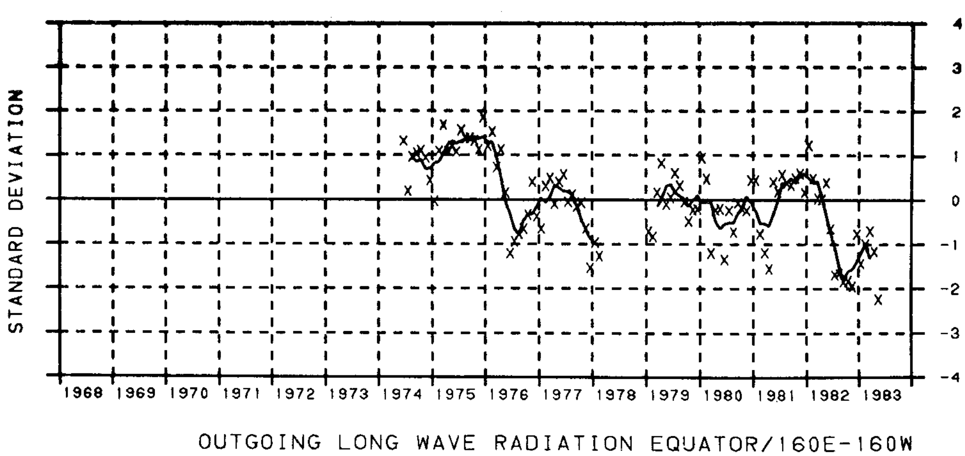

FIG. 8. Normalized anomalies of index of the outgoing longwave radiation over the central equatorial Pacific. See Fig. 6 for further details.

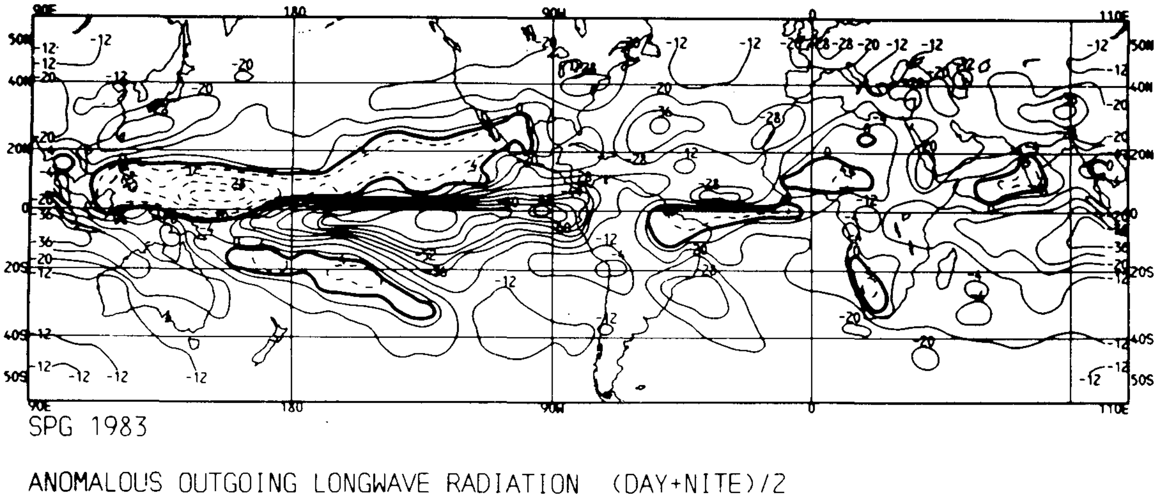

FIG. 9. Anomaly of outgoing longwave radiation (W m^{-2}). Departures are taken relative to the mean spring values of the years 1975–77. Isopleths are drawn at intervals of 8 W m^{-2}. (See Winston, 1982, for further details.)

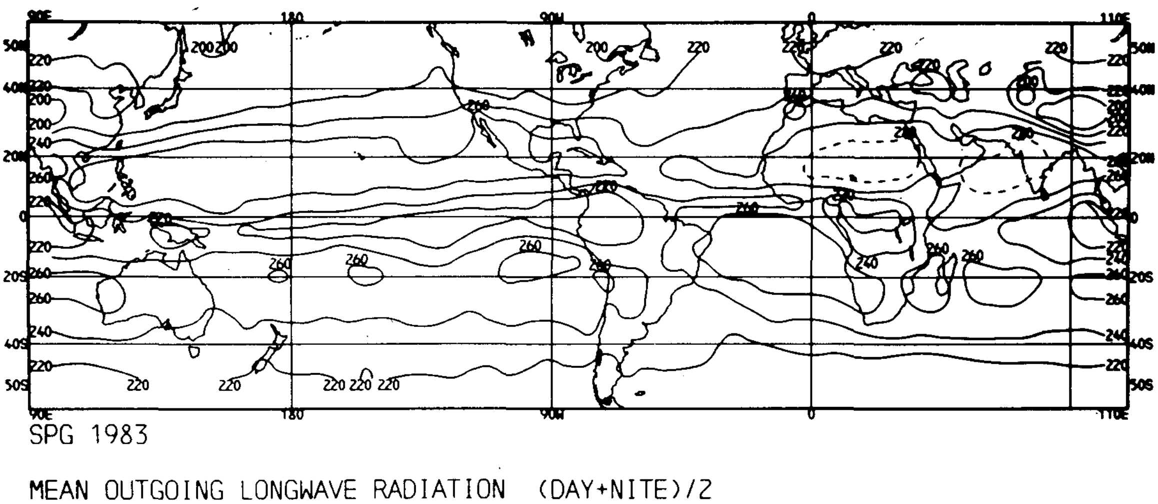

FIG. 10. Mean outgoing longwave radiation (W m^{-2}) for spring 1983. (See Winston, 1982, for further details.)

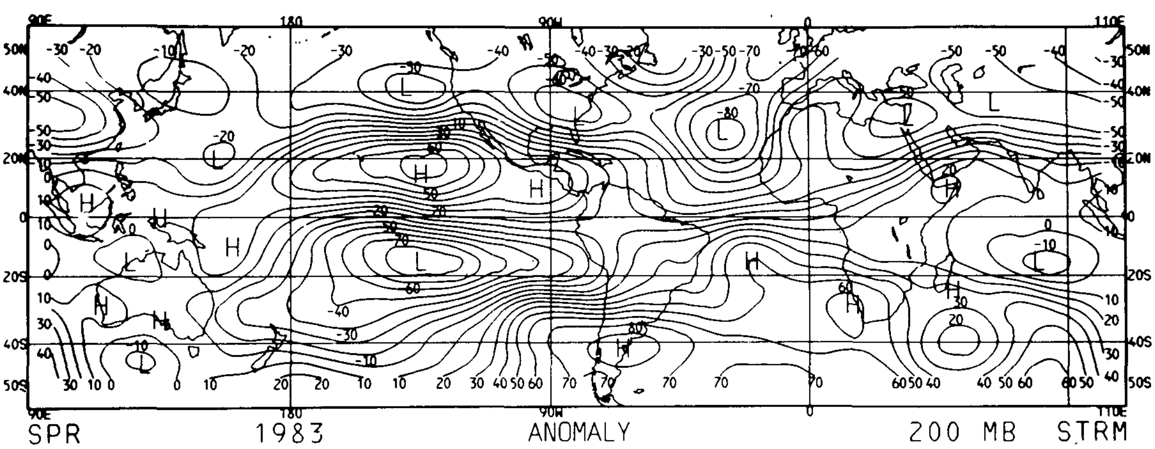

FIG. 11. Mean 200 mb streamfunction anomaly (10^5 m^2 s^{-1}) for spring 1983 (see legend to Fig. 7). These anomalies represent departures from the mean values for the 10-year period 1968–77.

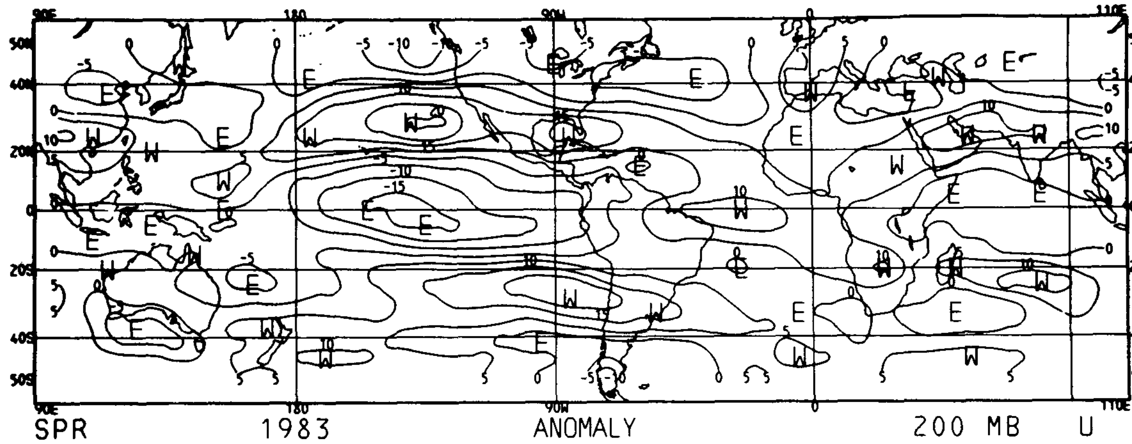

FIG. 12. Mean 200 mb zonal wind anomaly for spring 1983, contour interval is 5 m s^{-1}.

the tropical Pacific. A pair of strong cyclonic anomalies straddled the equator (Fig. 11) resulting in greater than 10 m s^{-1} westerly anomalies over the equator (Fig. 12).

5. Mean Spring circulation and weather for the Northern Hemisphere

Figure 14 shows the mean 700 mb heights and anomalies for spring 1983. The intense and widespread below normal heights over the North Pacific stand out as one of the major anomalies in the Northern Hemisphere. Earlier in winter, the negative anomaly in that area set a historic record (Quiroz, 1983) in association with the 1982–83 Warm Episode. Although much reduced in strength during spring, the North Pacific cyclonic anomaly, coupled with the large subtropical anticyclonic anomaly (Figs. 7 and 11), continued to produce a tremendous westerly jet with 20 m s^{-1} or wind speed greater than normal at the 200 mb level (Fig. 12). The very strong jetstream extended eastward as far east as the Gulf of Mexico. Accompanying this extraordinary westerly jet were the widespread, large negative height anomalies and 1000–700 mb thickness anomalies over most of the United States (US) (Figs. 14 and 15). The ridge over western Canada assisted in directing cold air into the US from the north. The northwesterly flows and the prolonged cloudiness over most of the US combined to produce one of the coldest springs in recent history (Fig. 16). Guided by the extraordinary westerlies, several severe Pacific storms struck the west coast of the US, bringing high winds and heavy rain and caused flooding, erosion and washouts. Much heavier than normal snowpack was also recorded in the western mountains. The southward displaced jet stream and the associated large negative anomalous heights over the southern tier of the US resulted in heavy downpours of rain in the eastern two-fifths of the nation. For the country as a whole,

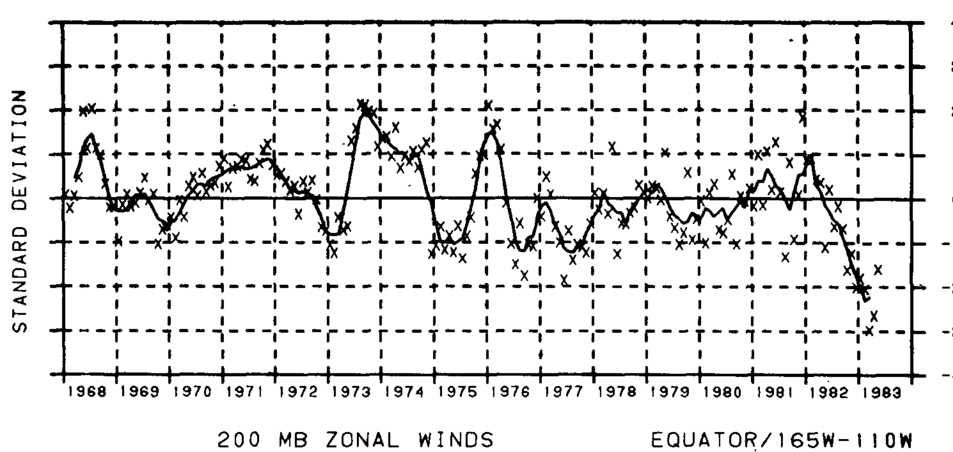

FIG. 13. Normalized anomalies of index of the 200 mb zonal wind over the eastern equatorial Pacific. See Fig. 6 for further details.

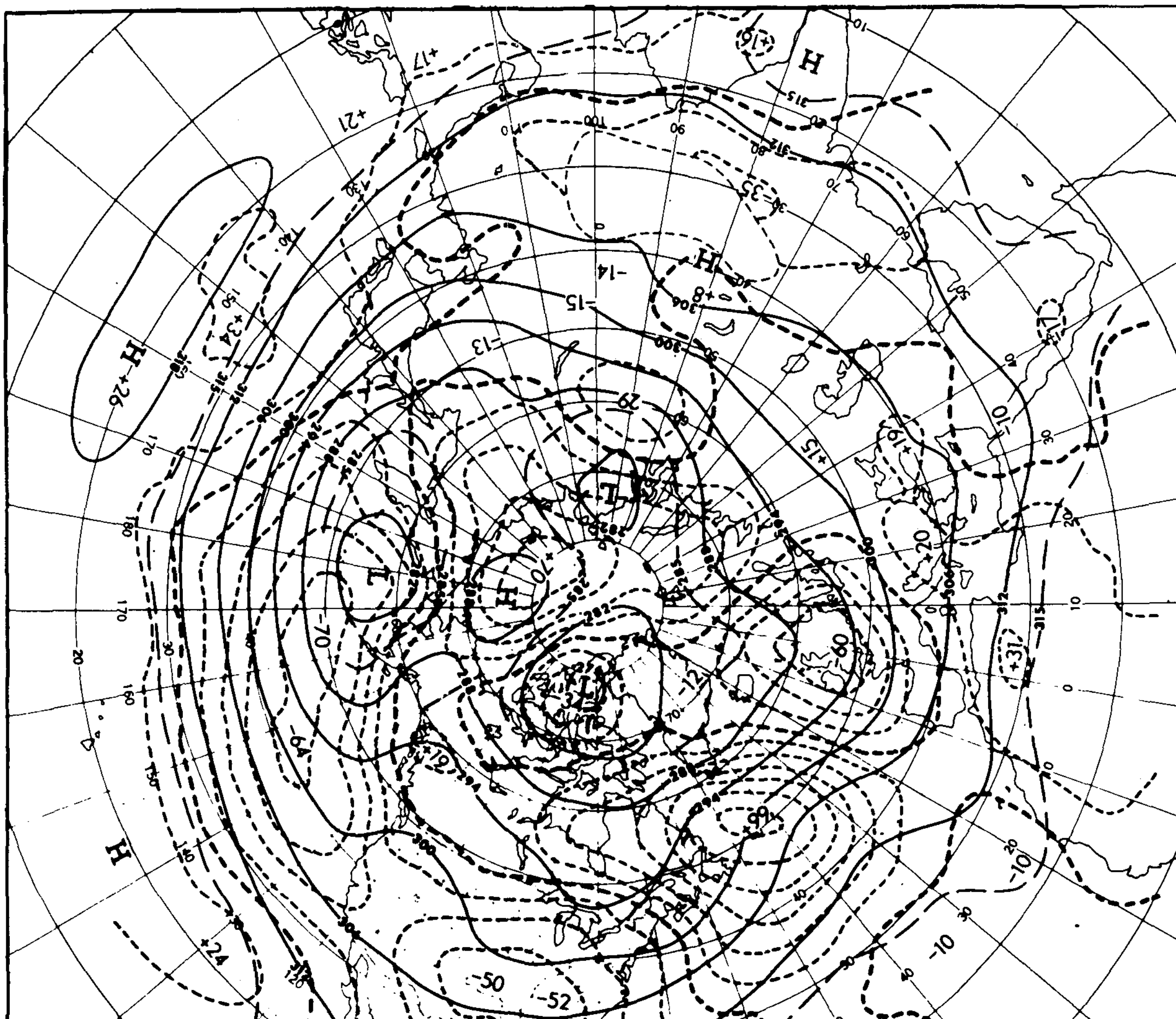

FIG. 14. Mean 700 mb height (solid) and height anomaly (dashed) for spring 1983. Absolute height field is portrayed by solid lines at intervals of 6 dam. Anomaly field is indicated by dashed lines at intervals of 15 m with maximum and minimum anomalies labeled.

this spring was one of the wettest seasons in the past 53 years (Fig. 17).

It is interesting to note that the spring circulation anomalies mentioned above are similar to the prominent Pacific–North American pattern described by Wallace and Gutzler (1982) for the winter seasons. Perhaps the extreme nature of the anomalies caused the actual values of some of the atmospheric parameters to be more like winter than spring.

Another major feature of the Northern Hemisphere circulation anomalies was found in the North Atlantic (Fig. 14). The enormous blocking ridge south of Greenland, together with the deep lows over the US and British Isles jointly produced heavy precipitation and above normal temperatures over eastern Canada and heavy precipitation and below normal temperatures over extreme western Europe (Fig. 15).

The thickness anomalies in Fig. 15 show that, in general, western Eurasia was milder than normal while eastern Eurasia was cooler than normal.

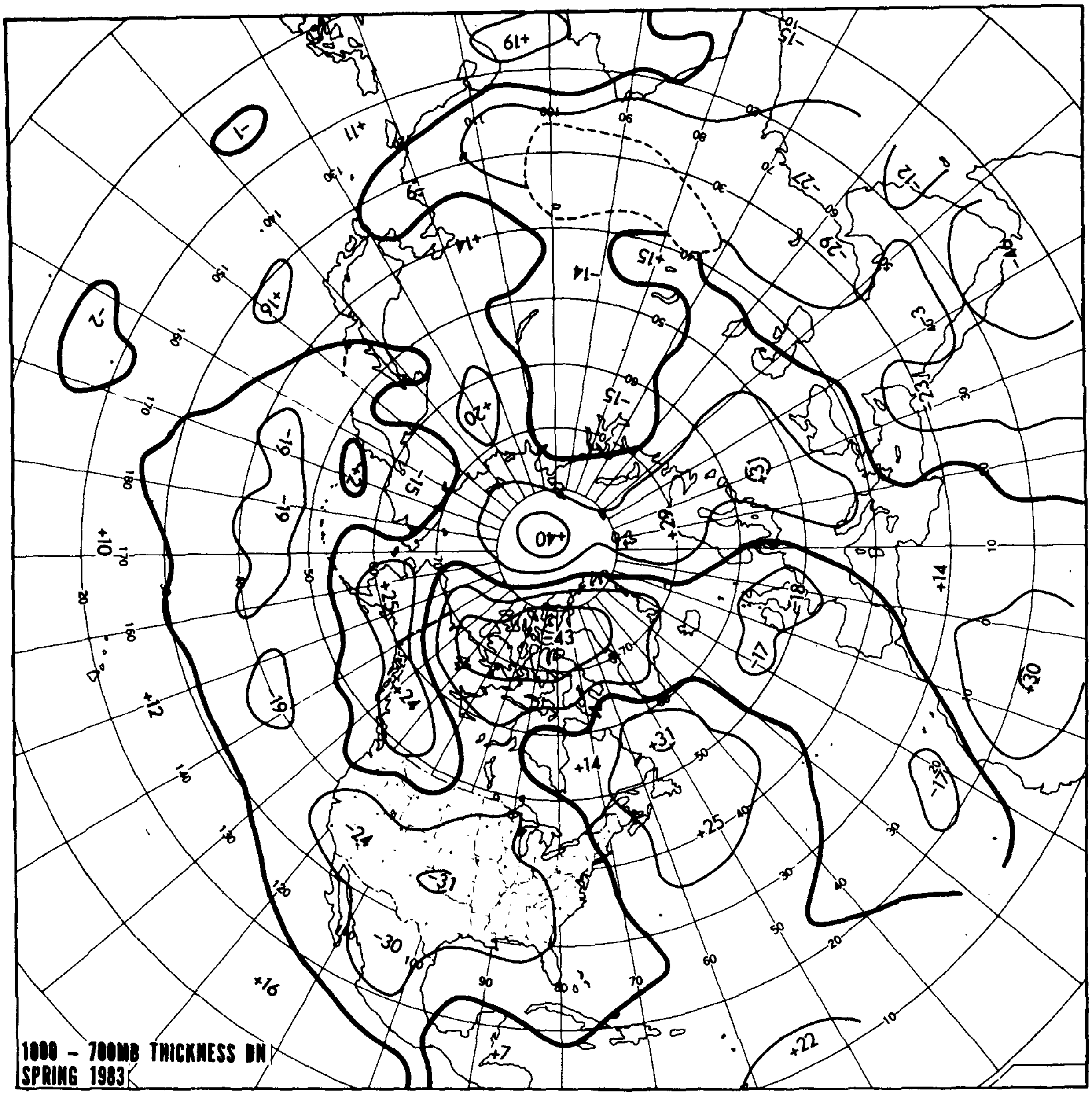

FIG. 15. Anomaly of mean 1000–700 mb thickness (m) for spring 1983.

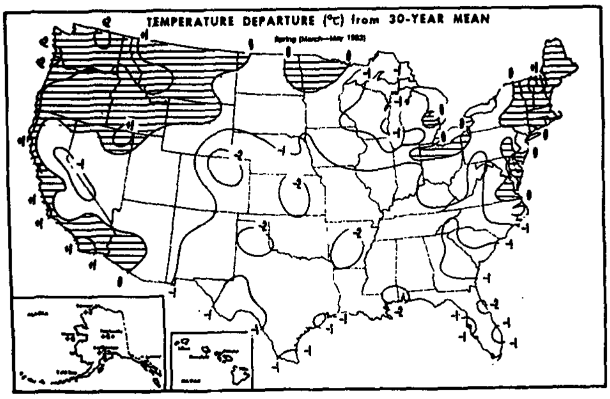

FIG. 16. Anomaly of mean surface air temperature (°C) for spring 1983 (from National Oceanic and Atmospheric Administration, Statistical Reporting Service, and World Agricultural Outlook Board, 1983). Anomalous isotherms originally drawn at 2°F intervals have been relabeled to nearest full °C. Printed station values in Alaska and Hawaii are also relabeled to nearest °C.

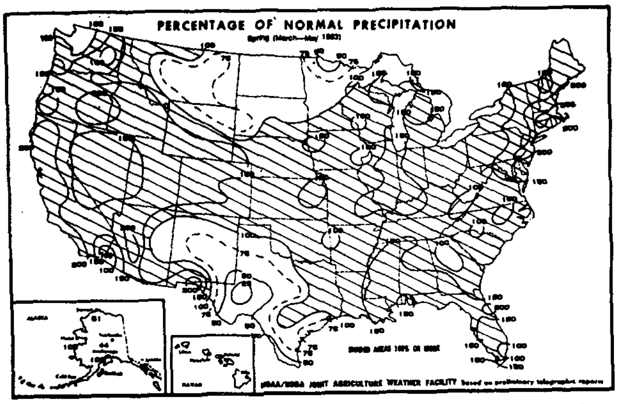

FIG. 17. Percentage of normal precipitation for spring 1983 (from National Oceanic and Atmospheric Administration, Statistical Reporting Service, and World Agricultural Outlook Board, 1983).

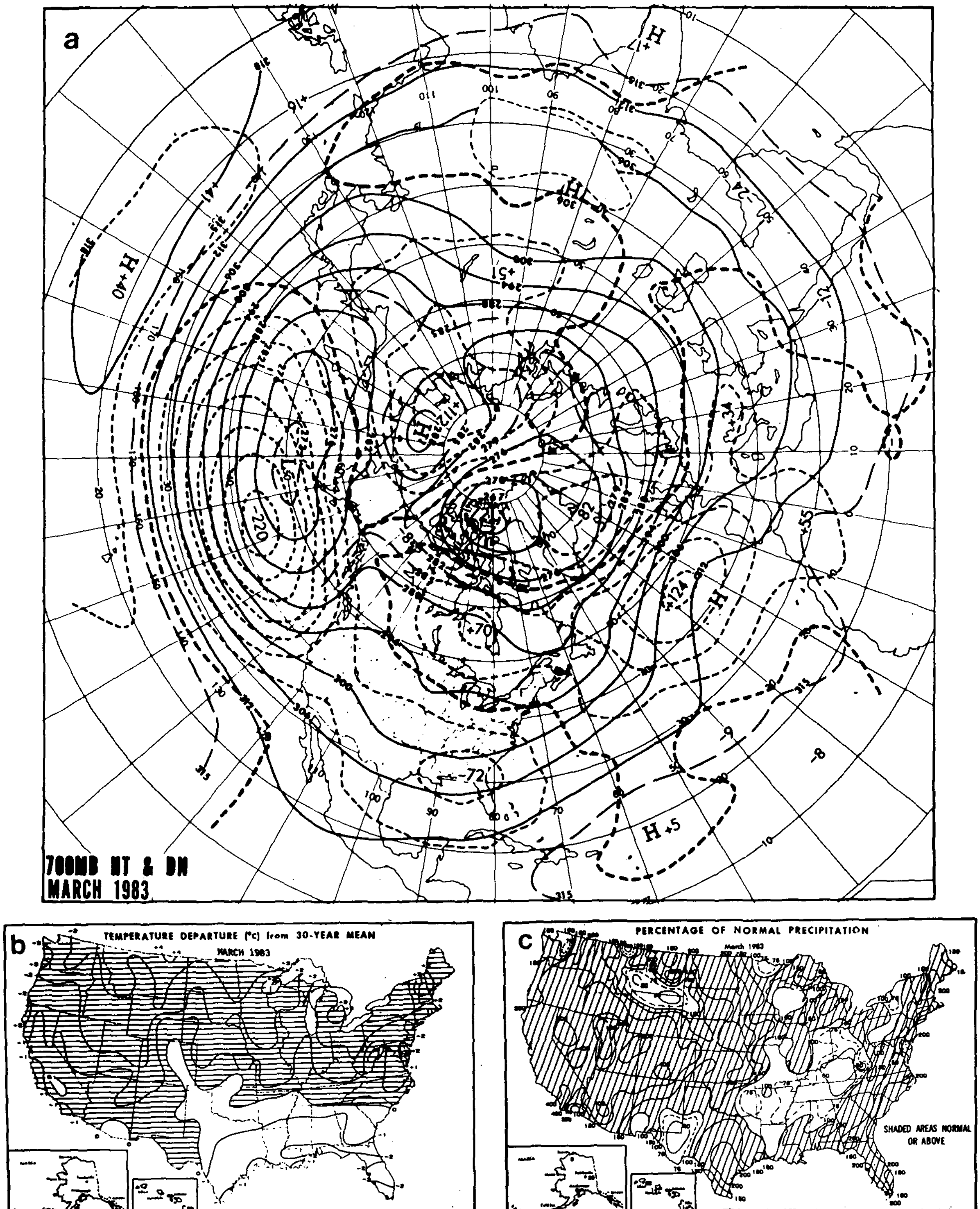

FIG. 18. (a) Mean 700 mb height (solid) and height anomaly (dashed) for March 1983. Absolute height field is portrayed by solid lines at intervals of 6 dam. Anomaly field is indicated by dashed lines at intervals of 30 m with maximum and minimum anomalies labeled. (b) Anomaly of mean surface air temperature (°C) for March 1983 (see Legend to Fig. 16). (c) Percentage of normal precipitation for March 1983. (Figs. 18b and 18c are from National Oceanic and Atmospheric Administration, Statistical Reporting Service, and World Agricultural Outlook Board, 1983.)

6. Monthly circulation and weather anomalies

a. March 1983

The 700 mb circulation this month was most anomalous over the Western Hemisphere (Fig. 18a). The extremely low heights in the eastern North Pacific stand out as an important feature of the circulation. The anomalous low was quite extensive as was the area of large positive height departures in the subtropical North Pacific. The associated strong westerly flow became almost zonal and penetrated as far as the western Atlantic.

In the North Atlantic the flow was also dominated by a very strong, very extensive westerly flow, but at much higher latitudes. There the westerlies extended from Hudson Bay all the way to the Black Sea flanked by the anomalously deep and extensive subpolar vortex to the north and the strong ridge in the North Atlantic to the south.

Most of southern Eurasia was dominated by negative height anomalies while positive anomalies prevailed over north Asia.

The ridge over western Canada and the extensive area of above normal height over the rest of Canada blocked cold air advection to the south and contributed to widespread warmth over the contiguous United States (Fig. 18b). Below normal temperatures were confined to the southeastern regions where more cyclonic activity and cloudiness were observed.

March was one of the wettest for most of the nation (Fig. 18c). Deep cyclonic circulations off the west coast guided by the very strong westerly jet led to frequent onslaughts of intense storms and extremely heavy precipitation. Severe Pacific storms brought in high winds, heavy rains, and damaging surf to most of the west coast, spread rain and snow at higher elevations and across the Plateau to the Rockies and into the Plains. California, most of the Plateau and the central Rockies had two to four times the normal amount. Heavy snow piled up in the Cascades, the Sierras and in other high mountain ranges. Storm systems associated with the deep upper level trough in the Southeast spread heavy rains from the Gulf Coast States to New England.

b. April 1983

The intense cyclonic circulation anomaly in the eastern North Pacific of March broke down rapidly during April as above normal heights developed over the central and western North Pacific and the Gulf of Alaska (Fig. 19a). Despite changes over the central Pacific, intense cyclonic circulation anomalies persisted off California and in the southeastern United States.

Strong Atlantic westerlies of March also broke down as the mean flow became more wavelike with a strong ridge building northward to Greenland and a deep trough extending southward over the British Isles. Rearrangement of the large scale circulation patterns extended to Eurasia where a strong ridge was observed near the Ural Mountains and a deep trough formed inland from the east coast of Asia.

The vast area of lower than normal heights over the US was associated with an anomalously strong upper level subtropical jet that stretched from central Pacific through most of the Atlantic. The prominent circulation anomalies, with an amplified ridge over western Canada and a deep trough over the southeastern US brought in abnormally cold weather to most of the nation (Fig. 19b). Temperatures were normal or slightly warmer along the northwest border and in New England.

The eastward extension of the westerly jet across the Gulf of Mexico was accompanied by wet spells and storminess over most of the area east of the Mississippi River (Fig. 19c). The northern Plains, parts of the Rockies, and the southern Plains were drier than normal. Low pressure systems which developed off the west coast during the second half of the month ended a short dry spell that had persisted in the West and brought total precipitation to well above normal along the coast and on the central Plateau. The central Rockies and much of the central Plains also had above normal precipitation.

c. May 1983

The major Northern Hemisphere 700 mb height anomalies in May (Fig. 20a) were similar to those in April (Fig. 19a). In the North Pacific there was a stronger than normal westerly flow near 40°N with zonally oriented lower than normal heights north of it and higher than normal heights south of it. Near the dateline, however, there was a weak ridge at 40°N during May instead of the weak trough observed in April. In the North Atlantic, the positive height anomalies south of Greenland weakened from April while the negative height anomalies over the British Isles deepened.

The area of below normal heights over the contiguous United States diminished in zonal domain from April but extended northward with another major cyclonic center northwest of Hudson Bay. The ridge over western Canada persisted from April and had extended southwestward into the eastern North Pacific, replacing the negative height anomalies found there in April.

Very prominent wave patterns were observed in the 700 mb height field in May (Fig. 20a). Across Eurasia the wave pattern was particularly evident. Besides the center of negative anomalies found over the British Isles, two more centers associated with strong troughs were observed over western Siberia and southwest of Kamchatka. While a prominent ridge was found from north of the Black Sea extending northward through

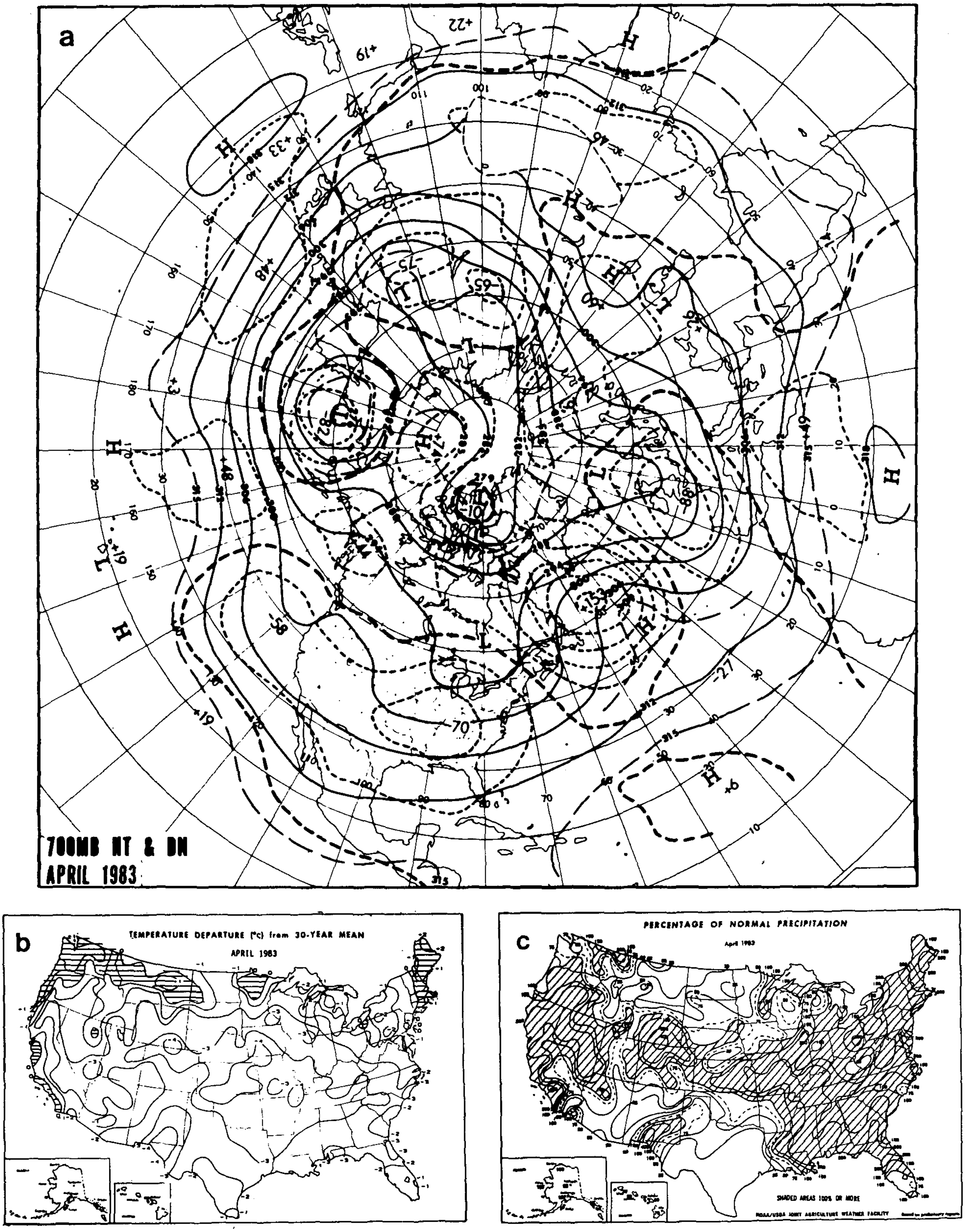

FIG. 19. As in Fig. 18, except for April 1983.

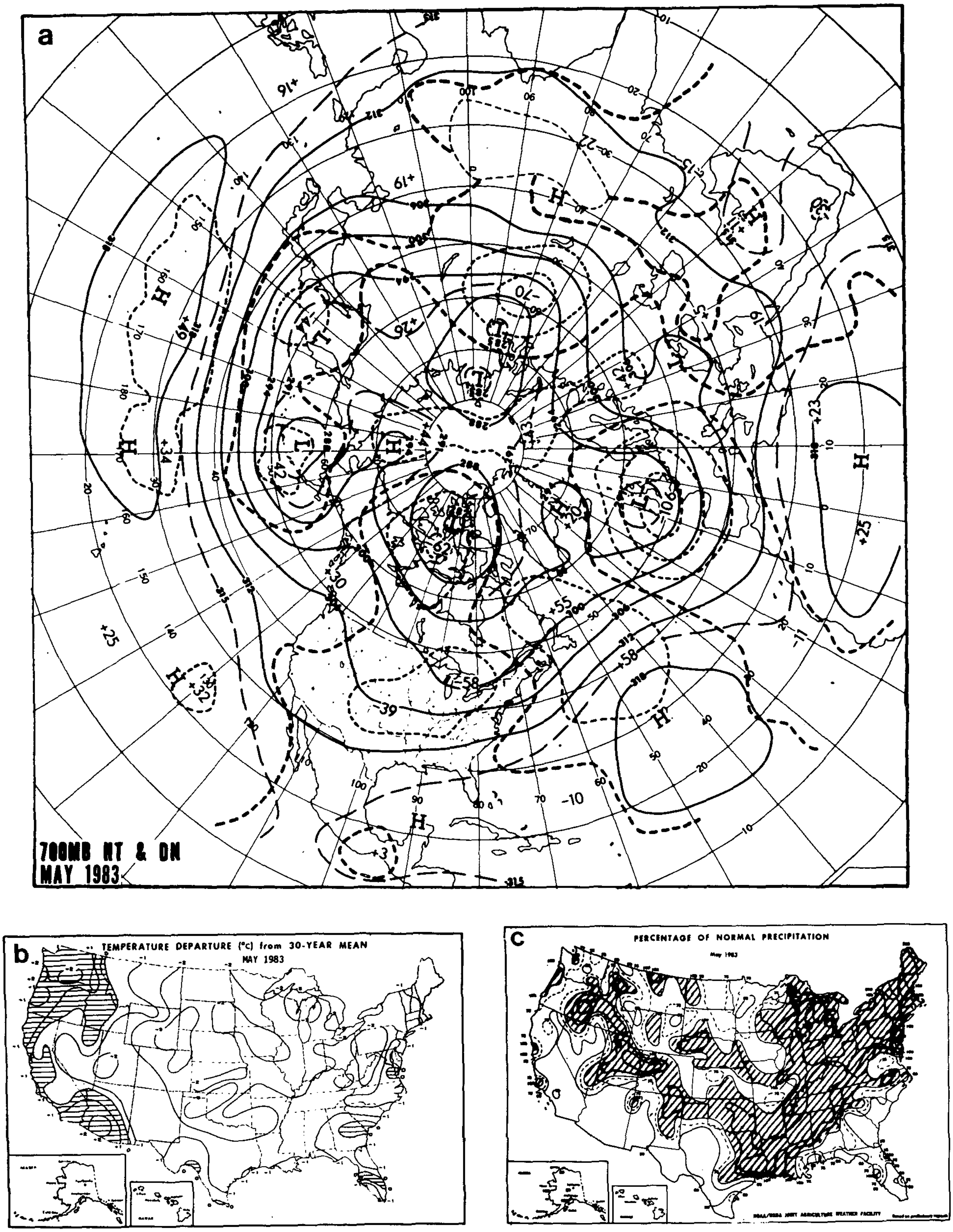

FIG. 20. As in Fig. 18, except for May 1983.

Finland, another weaker ridge was also located over central and eastern Siberia.

Most of the United States experienced much below normal temperatures in association with the ridge over western Canada and deep troughs over most of the contiguous US (Fig. 20b). The greatest departure occurred on the northern and central Plains as a result of stronger than normal northerly flows from Canada. In late May, a rare surge of cold air brought frost down to the upper Mississippi Valley. Temperature anomalies over the West were warmer than normal in association with the ridge aloft near the west coast.

The precipitation pattern in May was most notable for the heavy amounts through a very large region from eastern Texas to the central Ohio Valley, and over the northeastern United States and western region of the Great Lakes (Fig. 20c). The pattern fitted well with the deep trough over the central United States and also with the anomalous trough over the Great Lakes and the blocking ridge north and east of Newfoundland which combined to produce pronounced anomalous southerly and southeasterly flows over the northeastern United States and southeastern Canada. Showers and thunderstorms were frequent in these areas and resulted in much heavier than normal precipitation. The Rockies and Plateau also received heavier than normal precipitation in association with cold outbreaks from western Canada and cyclonic flow aloft, which resulted in cold rain and heavy snowfalls.

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