

WEATHER AND CIRCULATION OF APRIL 1977

Generally Mild and Wet but Continued Drought in the West

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1. Mean circulation

Deepening of a strong mean low over the Arctic Ocean led to markedly faster than normal polar westerlies over most of the Northern Hemisphere. The remnants of the high-latitude blocking which had characterized the circulation since late December 1976 were manifested as weak ridges and positive anomalies north of the Sea of Okhotsk and over Greenland (Figs. 1 and 2).

The principal Pacific trough persisted in its March position near Japan (Taubensee, 1977). Weakening of

the strong ridge which had been over the eastern Pacific, along with the normal seasonal decline of the westerlies, favored retrogression and a southward extension of the weak mean trough which had been just west of the British Columbia coast. As a consequence, the 700 mb ridge over the Canadian Rocky Mountains rebuilt to stronger than normal values, but was not as extremely amplified in a meridional configuration as it had been during much of the past fall and winter.

Although the mean 700 mb wind maximum associated

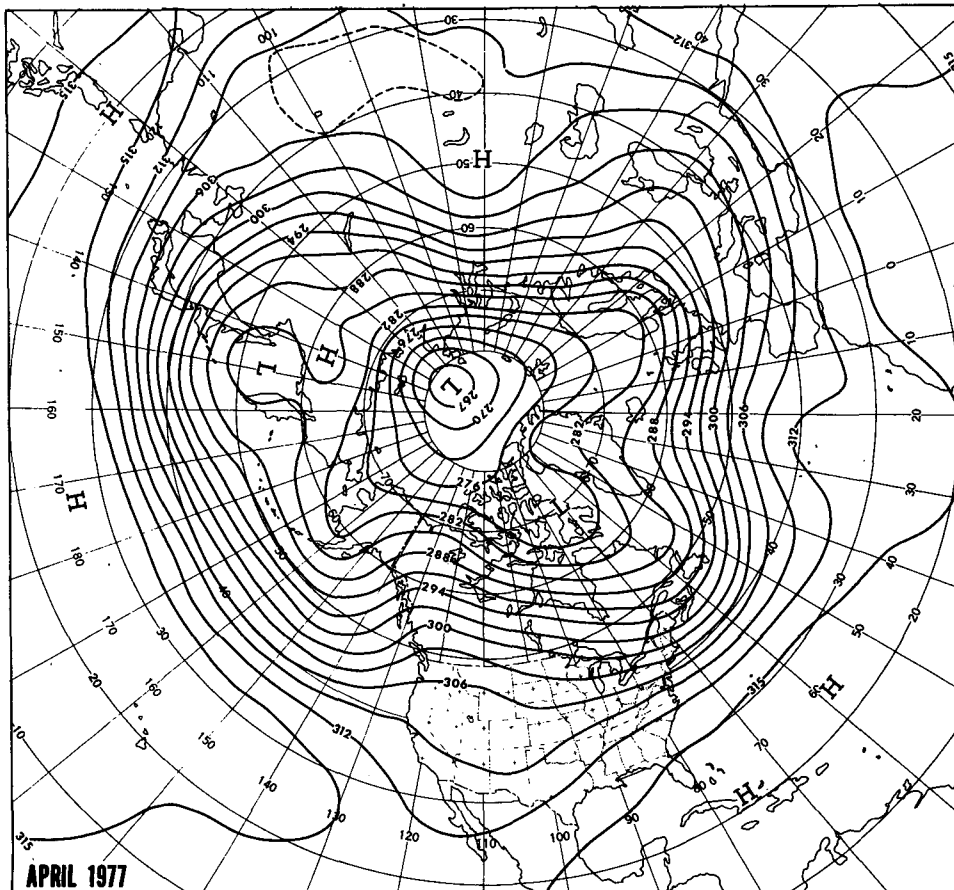


FIG. 1. Mean 700 mb height contours (dekameters) for April 1977.

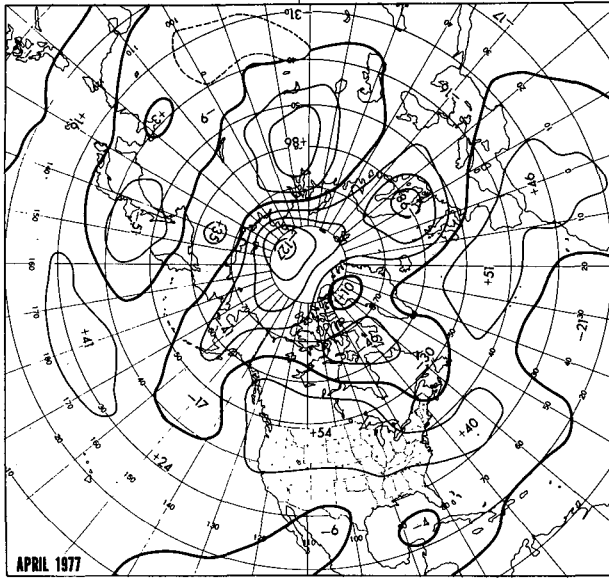


FIG. 2. Departure from normal of mean 700 mb height (m) for April 1977.

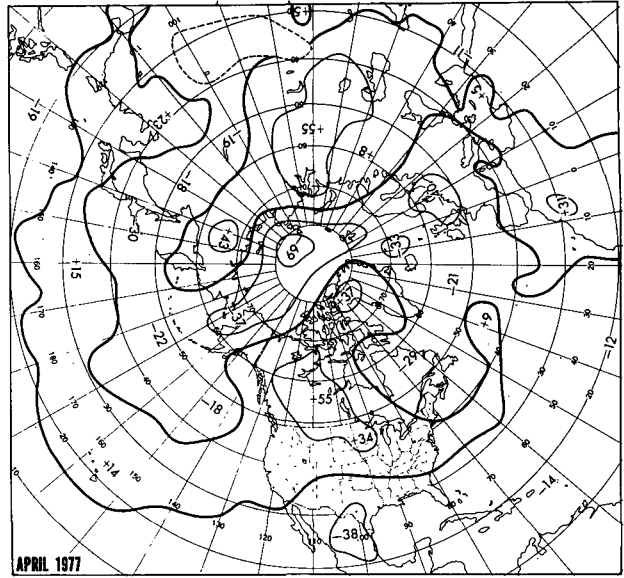


FIG. 4. Departure from normal of mean 1000-700 mb thickness (m) for April 1977.

with enhanced thermal contrast was slightly south of normal and somewhat stronger than normal over most of the Pacific (Figs. 3 and 4), the southern branch of the normally split flow over southwestern North America was so weak as to be indiscernible. The northern branch was located in central Canada, far north of its normal position near the United States border. The southern part of the trough which had been over the Great Plains during March (Taubensee, 1977) weakened and retrograded to the southern Rocky Mountains in the generally weak flow at low latitudes,

while the remains of the northern part sheared and joined with the Hudson Bay trough and advanced to the Atlantic Coast of North America in the strengthened mean flow at high latitudes (Figs. 1 and 3).

The low which had been south of Greenland crossed the Atlantic and extended southward into Europe as a deep trough, joining with a pre-existing low-latitude trough which retrograded slightly from the Black Sea to the eastern Mediterranean. A strong 700 mb ridge in central Asia remained approximately stationary while amplifying; its associated height and thickness anomalies strengthened somewhat and moved north-eastward (Figs. 1, 2 and 4).

2. Temperature

Temperatures averaged above normal over most of the Nation for the second consecutive month (Tau-

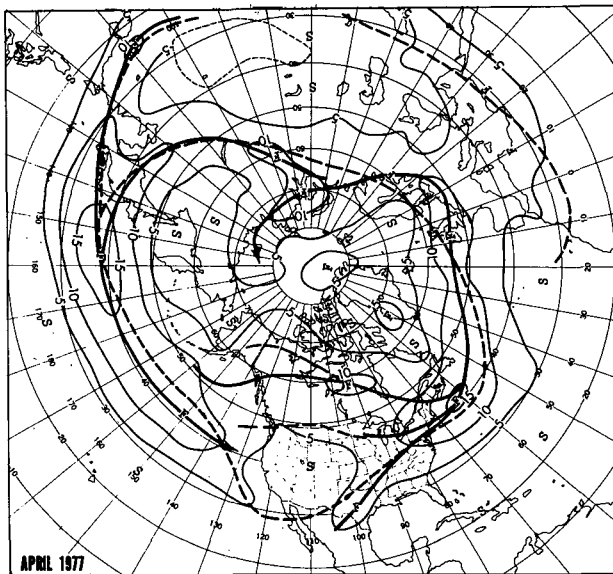


FIG. 3. Mean 700 mb geostrophic wind speed ($m s^{-1}$) for April 1977. Solid arrows indicate observed axes of maximum wind speed; dashed lines show the normal.

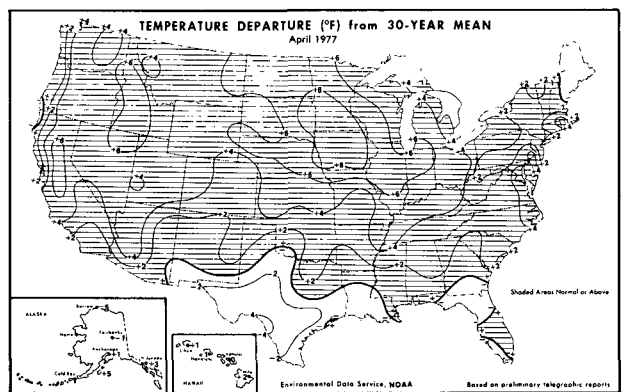


FIG. 5. Departure from normal of average surface temperature ($^{\circ}F$) for April 1977 (from National Oceanic and Atmospheric Administration and Statistical Reporting Service, 1977).

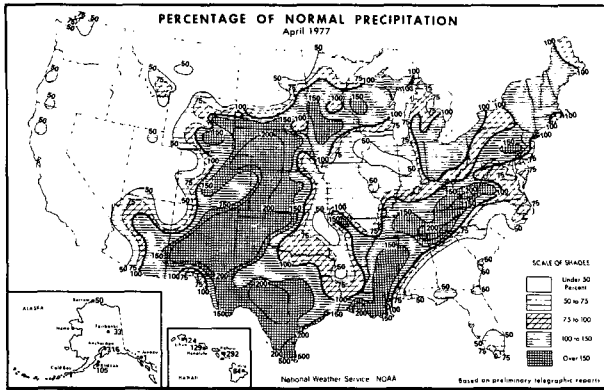


FIG. 6. Percentage of normal precipitation for April 1977 (from National Oceanic and Atmospheric Administration and Statistical Reporting Service, 1977).

bensee, 1977) in excellent agreement with the monthly mean thickness anomaly pattern (Figs. 4 and 5). The only area which was substantially cooler than normal was southern Texas and the Rio Grande Valley, where temperatures averaged as much as 4°F below normal.

The greatest warm anomalies were located over the Intermountain Region and northern Mississippi Valley, where temperatures averaged 6° to 8°F above normal. A number of stations in these areas reported one of the warmest Aprils on record (Table 1).

Cold air circulating around the strong Arctic low kept temperatures along the north coast of Alaska below normal, but advection of maritime air ahead of Pacific storms continued the relatively mild weather along the south coast and Alaskan panhandle. Temperatures remained near to above normal in Hawaii, which continued under the influence of a stronger than normal subtropical ridge (Figs. 1 and 2).

TABLE 1. Record and near-record warm monthly mean temperatures observed during April 1977.

Station	Temperature (°F)	Anomaly (°F)	Remarks
Wilmington, N. C.	65.9	+2.6	3rd warmest April
Detroit, Mich.	52.4	+4.7	6th warmest April
Muskegon, Mich.	50.3	+5.0	Warmest April since 1955
Evansville, Ind.	61.5	+4.8	Tied for 3rd warmest April
Fort Wayne, Ind.	55.4	+6.1	2nd warmest April
Des Moines, Iowa	58.5	+9.0	Warmest April
Waterloo, Iowa	51.7	+4.3	Warmest April since 1955
Sioux City, Iowa	55.6	+6.2	5th warmest April
Rochester, Minn.	53.0	+8.5	2nd warmest April
Minneapolis, Minn.	53.0	+7.9	3rd warmest April
Duluth, Minn.	44.4	+5.8	Tied for 6th warmest April
Grand Island, Neb.	56.2	+6.3	Warmest April since 1955
Fargo, N. D.	49.5	+7.2	5th warmest April
Williston, N. D.	49.1	+6.7	Warmest April since 1952
Missoula, Mont.	46.9	+3.0	Warmest April since 1952
Walla Walla, Wash.	57.3	+4.5	5th warmest April
Phoenix, Ariz.	73.5	+5.8	Tied for 2nd warmest April

TABLE 2. Record and near-record monthly and seasonal precipitation totals established in April 1977.

Station	Amount (inches)	Anomaly (inches)	Remarks
San Francisco, Calif.	T	-1.59	Tied with 1949 for driest April
Mount Shasta, Calif.	1.18	-1.20	8th consecutive dry month
Elko, Nev.	10.85	-23.69	Seasonal total since 1 July 1976
Pendleton, Oreg.	0.18	-0.64	7th consecutive dry month
Walla Walla, Wash.	0.20	-1.23	5th driest April
Pocatello, Idaho	0.06	-1.00	Driest April
Helena, Mont.	0.10	-0.83	2nd driest April
Missoula, Mont.	0.08	-0.93	Driest April since 1952
Grand Junction, Colo.	0.54	-0.25	11th consecutive dry month
Williston, N. D.	0.53	-0.71	Driest April since 1952
Brownsville, Tex.	6.62	+5.34	Wettest April
Winslow, Ariz.	4.8	—	Snowiest April
Valdez, Alaska	71.4	—	Snowiest April
Sault Ste. Marie, Mich.	11.3	—	Brought seasonal total snowfall to new record high
Buffalo, N. Y.	2.2	—	Added to already record seasonal total snowfall
	175.6	—	
	198.9	—	

3. Precipitation

The trough in the southern Great Plains (Fig. 1) favored heavier than normal precipitation over most of the important agricultural areas of the Nation's middle third (Fig. 6). Rains of 2-5 inches were beneficial to the winter wheat areas of the central Great Plains which had been dry previously, and also continued a good supply of moisture to sections where ample rains had occurred in March (Taubensee, 1977). Heavy rains fell along the southwest Gulf Coast, where Brownsville had the wettest April on record (Table 2). Excessive rains in the southern Appalachians were associated with damaging floods, but the Southeast remained dry near the subtropical ridge.

In the absence of the normal 700 mb wind maximum and its associated storms near the United States-Canadian border (Fig. 3), precipitation was less than half normal over the northwestern third of the country (Fig. 6), where the severe drought continued with little relief (Table 2). Wells and streams were reported to be drying up in some areas.

Precipitation was generally above normal over Hawaii, and along the south coast of Alaska. Anchorage had over three times the normal total, and Valdez reported its snowiest April on record (Table 2). Winslow, Ariz., also reported its snowiest April, although accumulations were insignificant there and melted quickly.

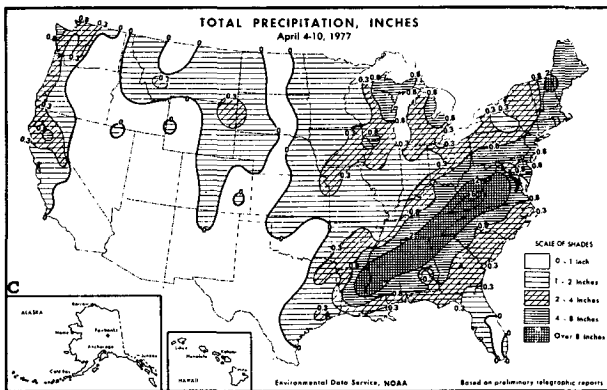
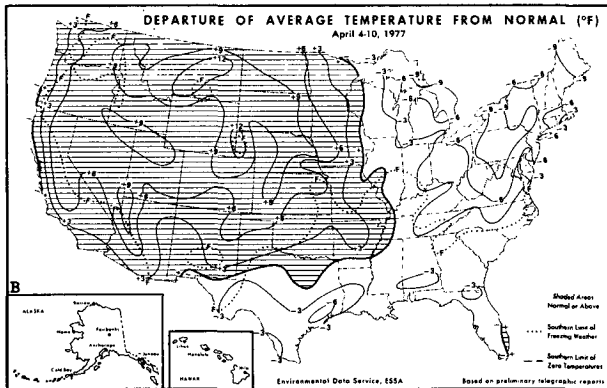
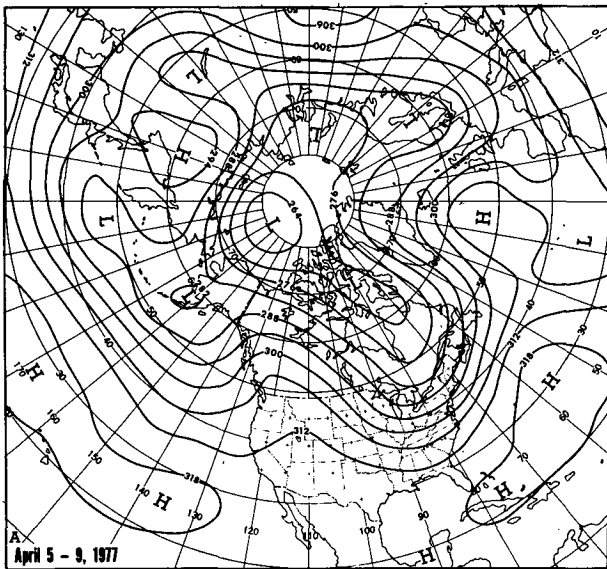


FIG. 7. (A) Mean 700 mb contours (dam) for 5-9 April 1977; (B) departure from normal of average surface air temperature (°F); and (C) total precipitation (inches) for week of 4-10 April 1977 (from National Oceanic and Atmospheric Administration and Statistical Reporting Service, 1977).

4. Weekly variability

a. 4-10 April

The strong ridge over the eastern Pacific at the end of March (Taubensee, 1977) moved eastward as strong

westerly flow over the Pacific broke down into a highly amplified pattern from North America to Europe. Strong ridges were located over the Rocky Mountains and the central Atlantic, while deep troughs were found over eastern North America and central Europe (Fig. 7A).

Temperatures averaged above normal everywhere west of the Mississippi River with the exception of Louisiana and southern Texas (Fig. 7B). Under the influence of the mean ridge, temperatures reached record highs for so early in the season at numerous cities from Washington to Minnesota (Table 3) and averaged as much as 12°F above normal in some places. The strong trough steered cold air from Canada into the East, where averages were 6-9°F below normal and frost occurred as far south as the southern Appalachians.

A vigorous short wave early in the week triggered a storm which produced snow in the Great Lakes, tornadoes in the Southeast, and torrential rains leading to flooding over much of the southern Appalachian area (Fig. 7C). Heavy rains had fallen in much of the same area the previous week (Taubensee, 1977) so runoff was substantial due to saturated soils.

TABLE 3. Stations reporting record early season warmth during April 1977.

Station	Temperature (°F)	Date	Remarks*
Spokane, Wash.	81	7	
Medford, Oreg.	87, 90	23, 24	Equaled highest on 23rd
Pendleton, Oreg.	83	7	Equaled highest so early
	87	7	
	91	24	
Kalispell, Mont.	74	7	
	82, 84	23, 24	
Missoula, Mont.	82	8	
Helena, Mont.	79	8	
Glasgow, Mont.	82	8	
Havre, Mont.	83	8	
Casper, Wyo.	78	9	
Grand Junction, Colo.	83, 84	9, 10	
Bismark, N. D.	87	9	
Rapid City, S. D.	88	9	
Huron, S. D.	91	9	
Sioux Falls, S. D.	88	9	
Duluth, Minn.	84	10	
St. Cloud, Minn.	87	10	
Minneapolis, Minn.	88	10	
Rochester, Minn.	85	10	
Grand Rapids, Mich.	80	10	Equaled highest so early
	86	18	
Detroit, Mich.	86, 87, 89	10, 11, 12	
Allentown, Pa.	87	12	
Philadelphia, Pa.	92	12	
Bridgeport, Conn.	86	12	
Madison, Wisc.	86, 87	17, 18	
Toledo, Ohio	88	18	
Burns, Oreg.	80, 84	23, 24	
Stampede Pass, Wash.	76	24	Highest for month
Yakima, Wash.	92	24	
Lewiston, Idaho	94, 97	23, 24	
Boise, Idaho	91	24	
Pocatello, Idaho	85	24	
Winnemucca, Nev.	89	24	Highest for month

* All are highest so early in the season except as otherwise noted.

b. 11-17 April

The strong mean ridge and its associated warm air moved eastward from the Rocky Mountains to the Great Lakes area, while the trough which had been over eastern North America progressed to the western Atlantic (Fig. 8A). Fast westerly flow over the eastern Pacific between a deep trough in the Gulf of Alaska and

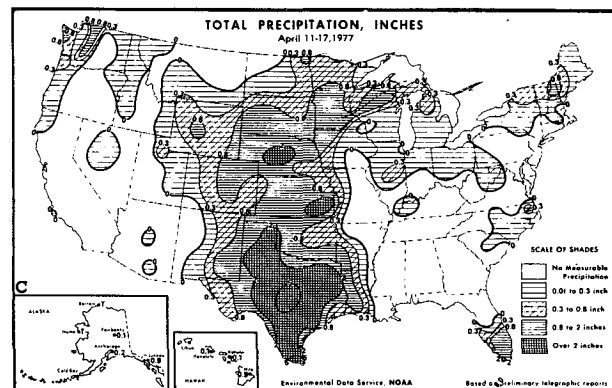
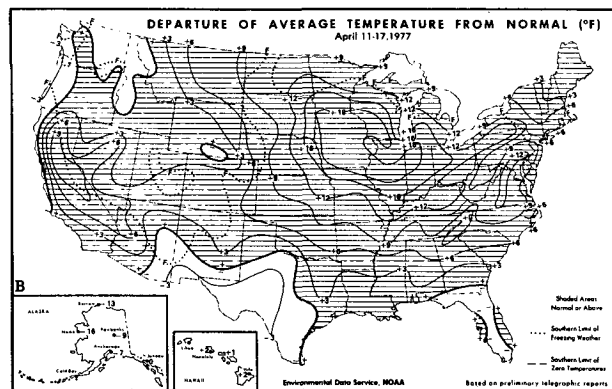
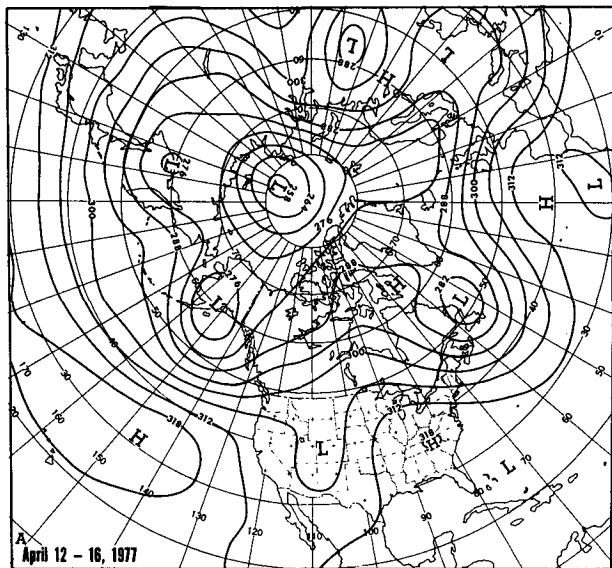


FIG. 8. As in Fig. 7 except for (A) 12-16 April 1977 and (B) and (C) week of 11-17 April 1977.

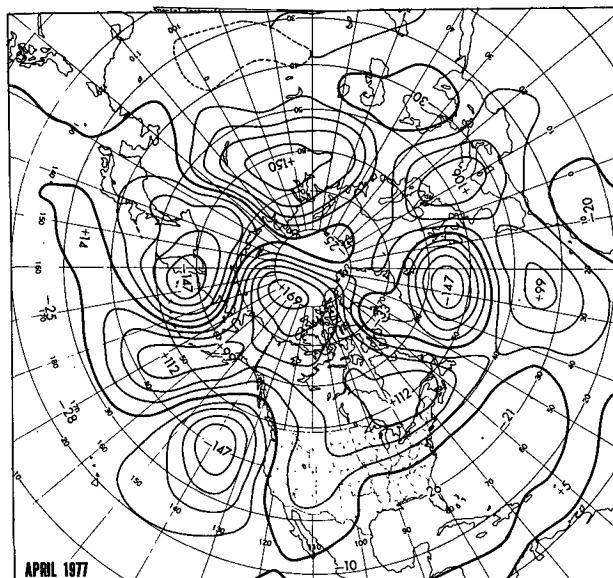


FIG. 9. Mean 700 mb height change (m) from first half to second half of April 1977.

a strong subtropical ridge to the south pushed a weak trough into the southern Rocky Mountains.

Temperatures averaged above normal over practically the entire country, where 700 mb heights were above normal and a strong ridge extending from the Southeast to the Great Lakes kept out Arctic air. The weekly mean temperature was more than 18°F above normal over part of the northern Mississippi Valley and adjacent areas (Fig. 8B). Additional records for early season warmth were set in the Northeast (Table 3). Indianapolis, Ind., had nine consecutive days with maximum temperatures above 80°F from 10 to 18 April, the longest such April heat wave on record. Chicago's Midway Airport reported a total of eight days with maxima above 80°F, the greatest April total on record.

The rapidity of the transition from the cold weather earlier in April to the warm spell was rather remarkable, and quite similar to events almost exactly one year previous (Wagner, 1976). As the warm air moved eastward from the Great Plains, temperatures rose from 13° on the 9th to 81°F on the 10th at Lansing, Mich. Other two-day temperature changes from the 10th to the 11th were 27° to 90°F at Richmond, Va., and 20° to 87°F at Dulles International Airport west of the Nation's Capital. At the latter location, these were the lowest and tied for highest temperatures observed in the whole month. Between the 11th and 12th the temperature went from 13° to 79°F at Concord, N.H.; 25° to 84°F at Albany, N.Y.; and 36° to 90°F at Kennedy International Airport in New York City. Before the warm spell was over, temperatures soared to daily record values of over 90°F at some cities in the middle Atlantic States, although failing to surpass the heat wave of April 1976 in most localities.

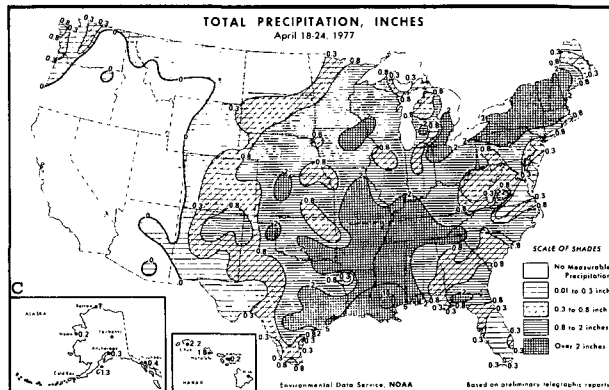
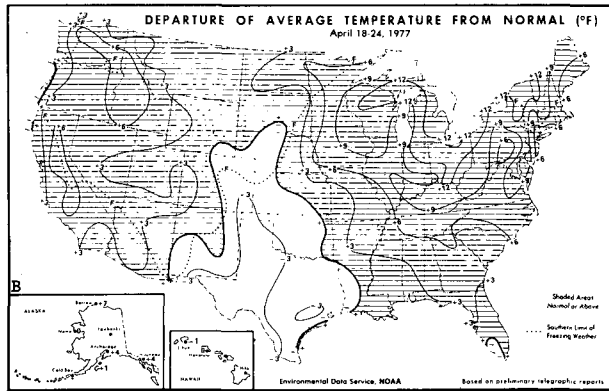
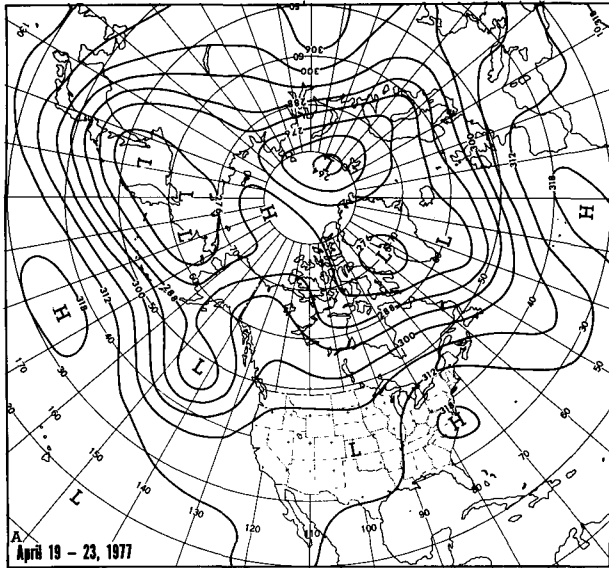


FIG. 10. As in Fig. 7 except for (A) 19-23 April and (B) and (C) week of 18-24 April 1977.

Strong southerly flow between the trough in the southern Rocky Mountains and the eastern ridge brought generous quantities of moisture northward from the western Gulf Coast to the northern Mississippi Valley. Rains were beneficial in most areas, except in Texas where severe weather, hail, and tornadoes with up to 5 inches of rain contributed to flooding (Fig. 8C).

Most of the western and eastern thirds of the country had little or no precipitation, under the influence of ridges.

c. 18-24 April

During the second half of April, 700 mb heights increased markedly over the Arctic, Canada, Alaska,

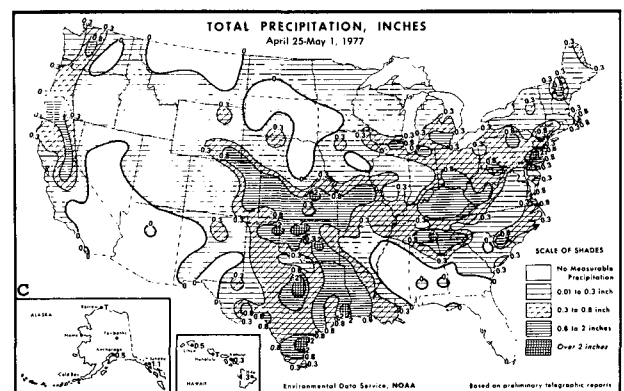
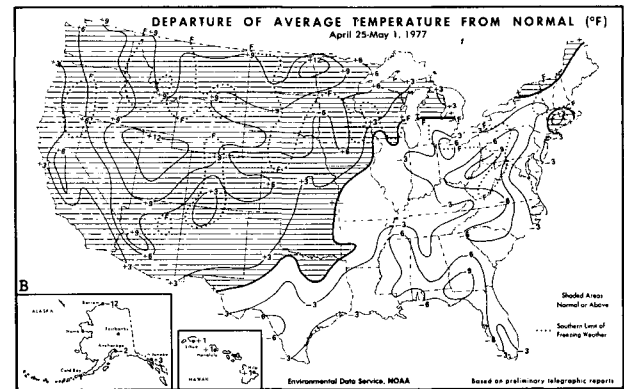
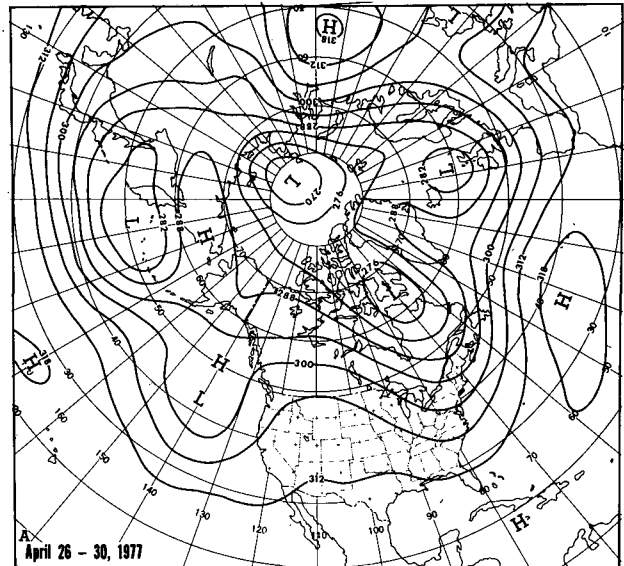


FIG. 11. As in Fig. 7 except for (A) 26-30 April and (B) and (C) week of 25 April-1 May 1977.

and the northern tier of states as the flow became more blocked (Fig. 9). Vigorous troughs became established near Kamchatka, over the eastern Pacific, and in the Icelandic area.

The warm ridge progressed only slightly from its previous week's position to the east coast of the United States, while the mean trough moved from the Rocky Mountains to the Great Plains and weakened. A strong low west of Vancouver Island contributed to renewed ridging over western North America (Fig. 10A).

Temperatures were again above normal over most of the country, although departures were not so extreme as during the previous week. Greatest anomalous warmth was over the Great Lakes area, where the week averaged as much as 12°F above normal (Fig. 10B). It was cool at the beginning of the week in the Northwest, but the strongly amplifying ridge brought record high temperatures for so early in the season for the second time this month to parts of the Northwest interior (Table 3).

The trough in the southern Great Plains brought heavy rains to the lower Mississippi Valley, where up to 10 inches in Louisiana caused floods (Fig. 10C). Phasing of a high-latitude trough from Canada with the southern trough over the Ohio Valley at the end of the week brought rains of over 2 inches to parts of the

Northeast, where it had previously been rather dry. Most of the West was again rainless.

d. 25 April-1 May

Broadening eastward of the western ridge and deepening of the phased troughs into a full-latitude trough near the East Coast gave a circulation pattern similar to that of the first week of the month (cf. Figs. 7A and 11A). The temperature anomaly distributions of the two weeks were also quite similar, the main difference being less extreme cold in the Great Lakes area and New England at the end of the month (Figs. 7B and 11B).

Precipitation was distributed over most of the country and no excessive amounts fell anywhere (Fig. 11C). The best rains of the month fell in parts of California but did little to end the long-standing drought.

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