A WINTER STORM AT LOS ANGELES, CALIFORNIA

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INTRODUCTION

The first 3 weeks of January 1952 were notable because of the large amount of storminess over the eastern Pacific Ocean. During these weeks, nearly every Low in the northern Pacific moved east along the southern coast of Alaska and then southeastward off the west coast of Canada (Chart X).

On January 12, one such storm was noted near Kodiak, Alaska. In the following 5 days it moved southward toward the coast of California, where, on the morning of the 17th, it seemed about to dissipate. However, on this date, one of the minor vortices associated with this area of cyclonic circulation apparently deepened and began moving toward California. Early on the morning of the 18th, it moved inland between Los Angeles and San Diego.

This storm brought damage and disaster to the region of Los Angeles, while depositing 7.37 in. (Jan. 15–18) of rain on the city proper. The rainfall on the 15th to 16th (3.39 in.) was related to the passage of a cold front which moved down the coastline as a low pressure moved into northern Nevada. The fall of 3.98 in. on the 17th to 18th was directly related to the storm which moved inland near Los Angeles.

Considerable property damage resulted from earth slides and some flooding in the Los Angeles River District.

PRECIPITATION FACTORS

The Hydrometeorological Section of the U. S. Weather Bureau [1, 2] found certain definite factors were involved in the production of rainfall over southern California. One report [1] states, "Cyclonic systems which result in gradient winds from the southwest quadrant over southern California produce precipitation, and the intensity of precipitation varies directly with the wind velocity and dewpoint but inversely with the distance of the cyclonic system from the area." This report emphasizes the importance of an orographic barrier by reporting it as the main controlling feature for the production and distribution of rainfall, and concludes that in major general storms orographic lifting of stable air is sufficient to account for the precipitation intensities in the Los Angeles area. For maximum storm amounts the optimum gradient wind direction at Los Angeles should be from 210° [2].

In summation, moisture supply, its rate of inflow from a critical direction and orography are keys to the production of rainfall over California.

THE CIRCULATION PATTERN

The southwesterly air flow aloft during the rain period, at Los Angeles, is illustrated by figure 1. Incidentally, the Low off northern California moved northeastward over southeastern Oregon during the following 24 hours in connection with the Low entering the Gulf of Alaska. This related movement, of the two Lows, is in agreement with the findings of Henry [3].

The trough over the Gulf of Alaska, like the others before it, filled as it moved along the north end of the ocean ridge, but later, deepened as it traveled southeastward in the main trough off the west coast of North America (see the preceding article by Winston). The moving trough over the Gulf was the upper air counterpart of the surface storm which moved to a point west of San Francisco by the 17th.

Figures 2 and 3 indicate the day to day changes in the deep flow of southwesterly winds which supplied consider-

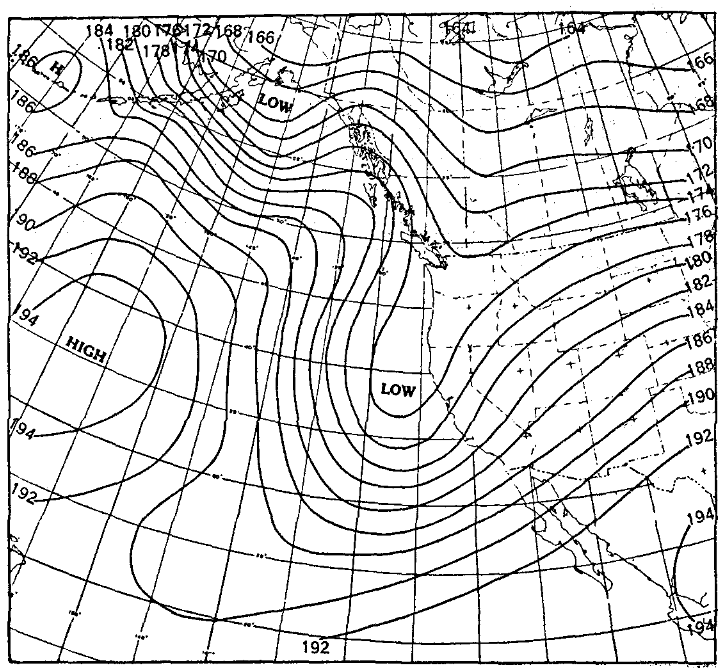

Figure 1.—500 mb. chart, 1500 GMT, January 12, 1952. Contour lines at intervals of 200 geopotential feet.

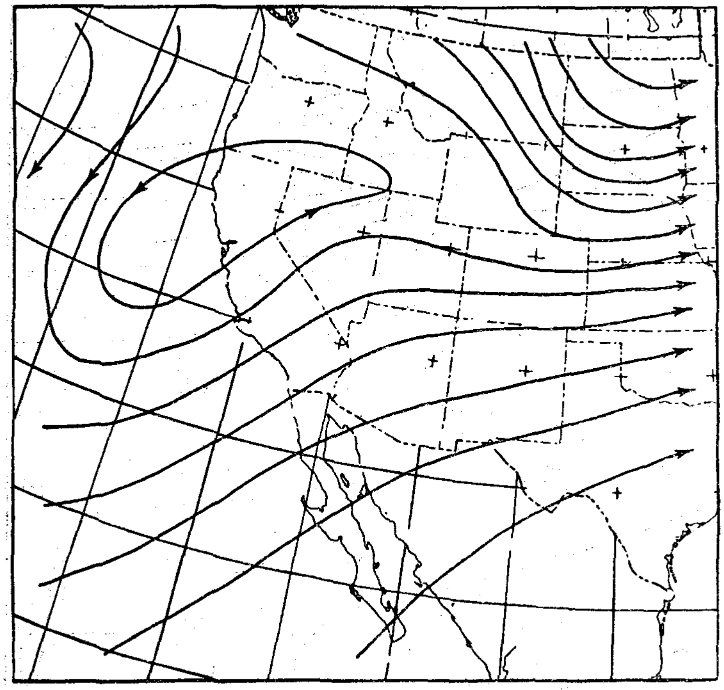

Figure 2.—Airflow chart, 1500 GMT, January 17, 1952. Solid lines represent the airflow parallel to the contour lines at the 500-mb. surface.

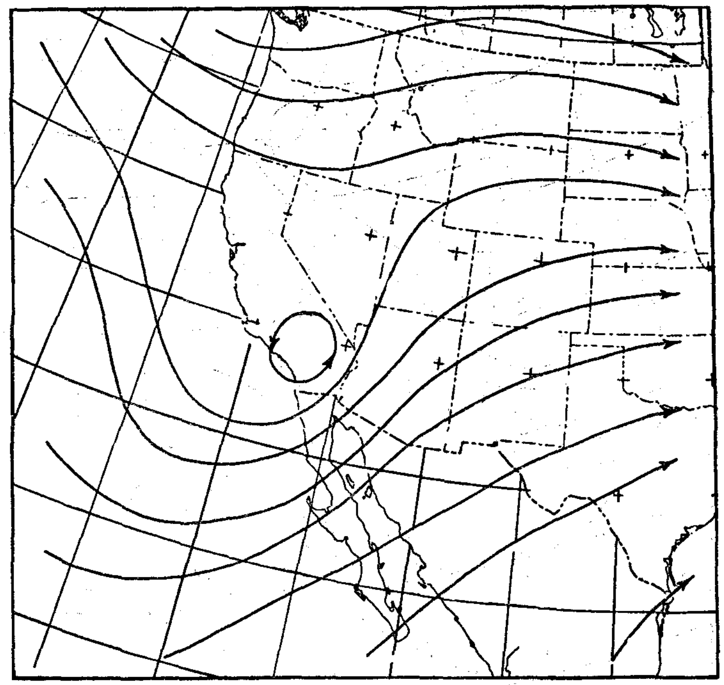

Figure 3.—Airflow chart, 1500 GMT, January 18, 1952.

able moisture, from a favorable direction, to southern California. From an inspection of the first 3 figures an important observation is suggested by the flow patterns, that considerable horizontal convergence was taking place at the southern end of the upper trough. Plotted winds on the original charts support this observation. That this activity was discernible to very high levels can be inferred from a comparison of the *jet stream* position in figure 4 with the flow patterns of figures 2 and 3.

On the morning of the 18th (fig. 3) it was evident that the upper cold Low was filling as, concurrently, a westerly to northwesterly wind had begun to invade the length of the Pacific Coast. As a consequence, the moisture supply was cut off and the rainfall at Los Angeles ceased approximately 2 hours after the time represented by figure 3.

It is of passing interest to note the position and strength of the *jet streams* (figs. 4 and 5) before the rain stopped at Los Angeles. In this storm, it appears that a relationship might exist between the location of the upper *jet* and surface areas of precipitation. As pointed out by Starrett [4], for cases of *jet streams* associated with troughs, the maximum of precipitation occurs to be north of the *jet* and east of the trough.

THE DEEPENING IMPULSE

Intimately connected with the upper trough over the Gulf of Alaska was the down-wind pressure surge with its characteristic of super-geostrophic winds moving southward. Presumably, a similar surge supplied the impulse for the apparent development (or regeneration) of the surface vortex on the 17th. Necessarily implied is a strong cross-isobar flow, which also represents considerable horizontal divergence. Such divergence works to produce pressure falls and, normally, could be expected to accentuate a tendency toward falling pressure in a surface Low beneath it. Of course the relationship is not so simple and straightforward, but at least its contribution is in that direction. In this case it appears that the moving area of divergence effectively removed mass from the region above the small surface vortex and the result was deepening. The movement of the surface Low after the 17th was guided by the movement of the upper trough.

SURFACE ANALYSIS

With the paucity of reports from the ocean area it is difficult to determine whether the storm, indicated in figure 6, was active before or became more active after the first hint of its existence at 33° N. and 127° W. at 0630 GMT on the 17th.

However, the analysis for 0030 GMT (18th) showed the circulation apparently had deepened some 5 mb. and was moving toward Los Angeles and San Diego where the sea level pressure had dropped about 5 mb. during the preceding 6 hours. The possible cause of this development was described in a previous paragraph.

Coincident with the drop in coastal pressures, rain began to fall along the coast from San Diego north, to just beyond Burbank and Los Angeles. In the following hours rain overspread all of southern California and Arizona.

From the standpoint of analysis and forecasting this storm presented some difficulties. The cold front depicted in the surface illustrations was not drawn on the original

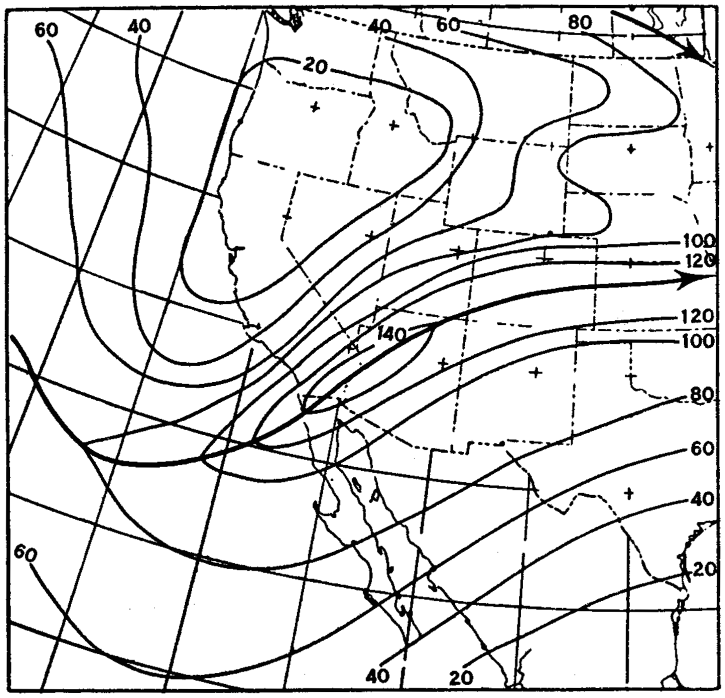

Figure 4.—200-mb. isotach chart, 0300 GMT, January 18, 1952. Solid lines are drawn at intervals of 20 knots, heavy solid line indicates the *jet stream* axis.

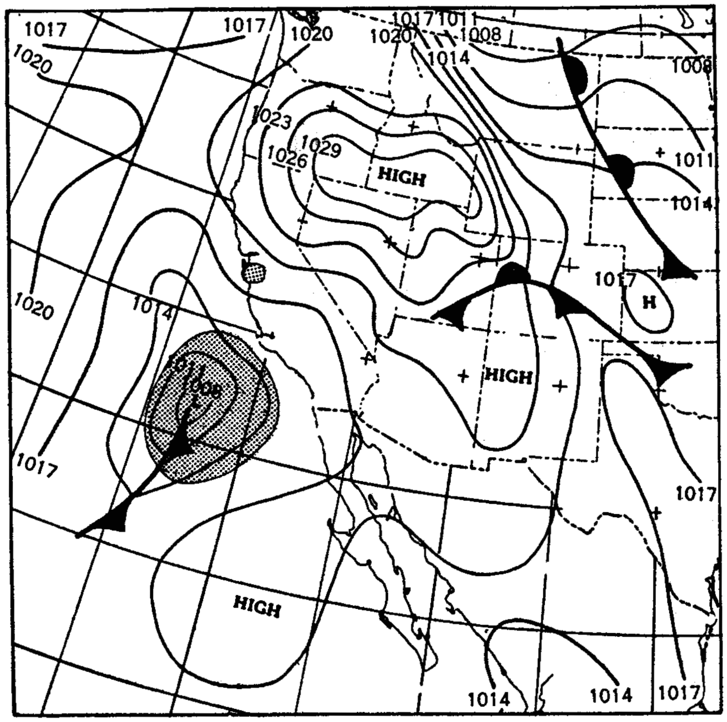

Figure 6.—Surface chart, 1830 GMT, January 17, 1952. Shaded area indicates precipitation in progress.

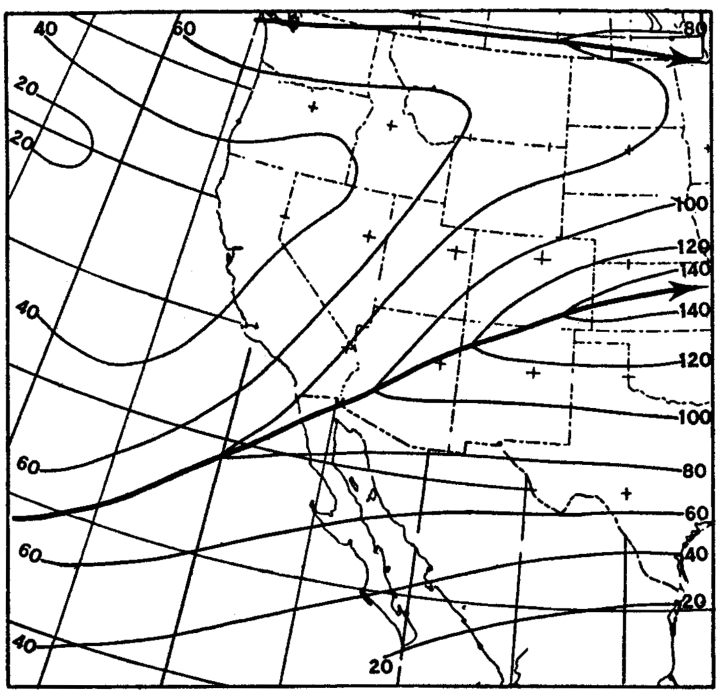

Figure 5.—200-mb. isotach chart, 1500 GMT, January 18, 1952.

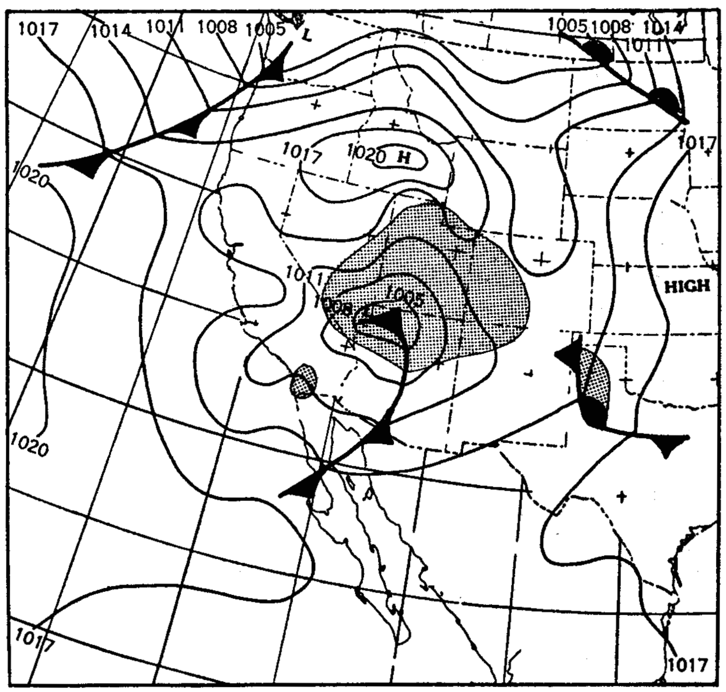

Figure 7.—Surface chart, 1830 GMT, January 18, 1952.

analysis. Only after determining the position of the cold front over Arizona (on the 18th) and redrawing the preceding maps was it possible to include the cold front in figure 6.

Actually this cold front was identifiable out over the ocean upon the basis of incomplete reports from Guadaloupe, Mexico. Prior to its arrival, Guadaloupe reported (0300 GMT on the 18th) a SSE wind, rain and a 3-hr. pressure change of −3.2 mb. Judging by ship reports, in the vicinity, the cold front passed the island after 0630 GMT (18th) and by 1230 GMT winds were WSW as far east as San Diego. The next report from Guadaloupe, (at 1830 GMT) on the 18th, showed a brisk NW wind, Partly Cloudy, and a 3-hr. pressure rise of 3.9 mb. So, this was a cold frontal passage at a low latitude station but without data to the west, it is difficult to ascertain its earlier history.

Normally, one would expect to find a warm front associated with the extensive alto-stratus cloud sheet and steady rain which was reported on the 17th to 18th. Some field stations at the time suggested a surface warm front through southern California and northern Mexico, but the Analysis Center could find only inconclusive support from the soundings.

In retrospect, it appears that the steady rain was related to the strong horizontal convergence represented by the air flow over the west coast. Therefore considerable vertical stretching must have been taking place at the same time, so that widespread lifting of the moist air could produce the cloud sheet and rainfall without a discernible warm front. Considering the nature of the terrain and the distance between contrasting cold and warm sources it appears the horizontal thermal gradient was so weak as to make the identification of a warm front an uncertain process. Therefore, it was omitted from the analysis.

Early in the morning of the 18th the storm reached the coast where it split into 2 centers as the rainfall came to an end over the southern end of the State. By midmorning (local time) the storm had moved to Arizona (fig. 7).

STORM DAMAGE

Following the storm period the total amount of rainfall at Los Angeles during the balance of the month was 0.65 in. The total for the month was 10.03 in. which is the third highest total for January in the history of the station. It was also the highest January total since the record 13.30 in., set in 1916. Such a monthly total represents a considerable percentage of the annual rainfall which, in the mean, is slightly over 15 in.

In the mountainous country such heavy falls of rain are, usually, not without serious consequences. Although little overflow occurred on the major streams, there was considerable flooding from the hillside canyons and in the valleys where flood control projects have not been completed. According to a letter from the Los Angeles Forecast Center, "The major cause of flooding in some streams was the collection of debris, shrubbery and trees which had been allowed to accumulate during the years of little or no flow since the last flood year of 1943." The same letter stated, "Many communities have been built on natural flood plains, and where sufficient flood control works had not been completed flooding occurred and numerous families were evacuated."

As of the middle of February incomplete estimates placed the storm damage in the Los Angeles Area at near $5,000,000 with 21 deaths directly or indirectly influenced by the storm.

REFERENCES

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4. L. G. Starrett, "The Relation of Precipitation Patterns in North America to Certain Types of Jet Streams at the 300 millibar level," *Journal of Meteorology*, vol. 6, No. 5, October 1949, pp. 347–352.

U. S. GOVERNMENT PRINTING OFFICE: 1951