MONTHLY WEATHER REVIEW

Editor, EDGAR W. WOOLARD

VOL. 67, No. 2
W. B. No. 1260

FEBRUARY 1939

CLOSED APRIL 3, 1939
ISSUED MAY 12, 1939

AN OBSERVATION OF VARIABLE WATER-VAPOR CONTENT IN RAPIDLY-MOVING AIR MASSES

By ARTHUR ADEL and C. O. LAMPLAND

[Lowell Observatory, Flagstaff, Ariz., March 1939]

In the course of systematic measurements, at the Lowell Observatory, of the water-vapor content of the entire depth of the atmospheric column, an effort is being made to secure observations under varied conditions that should be fairly representative of the weather for the different seasons, including extreme as well as average conditions.

The present note deals with one of the rather unusual records. In the Southwest, in late autumn or winter, there occasionally blows a strong, cold, and dry wind from the northeast. This peculiar wind, which may continue for from 1 to 3 days, is accompanied by characteristic conditions, in that rarely is there any appreciable precipitation; the barometer is generally at maximum height; there is little or no cloudiness; and the surface humidity is low. The transparency of the atmosphere is excellent, as shown by the deep blue of the daytime sky and the sparkling brilliance of the stars at night. These strong winds from the northeast are, in general, accompanied by low temperatures, but there are exceptions to this condition.

The observations here to be described were made during such a wind.

As already mentioned, under these conditions humidity measurements by dry- and wet-bulb readings near the surface indicate a low water content for the air. This property was long ago found to be true for the entire atmospheric column as determined spectrographically in connection with the Observatory's planetary spectroscopic investigations. At that time, however, it was not feasible to determine quantitatively the absolute amount of water vapor in the atmospheric column. With the installation of a recording infrared spectrometer in 1937, such quantitative determinations have become a part of an Observatory program of atmospheric research. The spectroradiometer installation occupies the northeast corner of the main building of the Observatory, the building itself being located on the northeast promontory of the Observatory mesa. It may also be mentioned that on this high plateau and the mountainous regions to the northeast, there are no extended bodies of water.

The 23d of November 1938, offered a favorable opportunity to measure the water-vapor content of rapidly-moving air masses during a strong wind from the northeast. Fowle's spectroscopic method for determining the water-vapor content of the entire atmospheric column was employed, with the sun as the source of radiation; and the percentage absorption in the water vapor band Phi, center at 1.14 mu, was the specific item utilized on this date.

Three independent spectroscopic measures of water vapor were made respectively at 10:28 a. m., 10:34 a. m., and 10:47 a. m., M. S. T., surface temperature 25° F. The measures were accordingly made through very nearly air mass 2. Reduction to unit air mass, which may not be significant in view of such variability, yielded in millimeters of an equivalent layer of liquid water: 0.3, 0.8, and 0.5, given in order to correspond to the times of observations listed above.

It is worth mentioning that probably the reason for the fluctuation being of the order of the vapor content itself is in great measure the smallness of the latter. In other words, had this fluctuation of a fraction of a millimeter occurred during the wettest part of our summer rainy season when the water-vapor content of the air averages about 18 millimeters it would have passed unnoticed.

UNUSUAL FLUCTUATIONS IN THE DEW-POINT ALONG THE SOUTHERN CALIFORNIA COAST

By DEAN BLAKE

[Weather Bureau Office, San Diego, Calif., June 1938]

San Diego was one of the first Weather Bureau stations to use hygrometrical data in predicting minimum temperatures. In 1917, Henry F. Alciatore, then in charge, experimented with formulas for the citrus belt of San Diego County, the basis being the dry-bulb and dew-point temperatures, and the relative humidity at the regular 5 p. m. observations (P. S. T.). Besides developing hygrometrical formulas, various of the other methods then being tested, such as the "least square" and "median temperature," were carefully studied and applied.

It was early discovered that there was a sufficiently constant relation between the dew-point at San Diego and minimum temperatures the next morning at back-country stations to justify the issuance of forecasts. This was particularly gratifying as the observations were taken 62 feet above ground on the roof of the Post Office and Custom House Building, and the elevations of the stations, for which the predictions were made, were from 110 to 657 feet above sea level, and their distances from San Diego ranged from 8 to 32 miles.

After further investigation a statistical method employing combinations of the dry-bulb temperature, dew-point, and relative humidity at 5 p. m. was adopted as the most practical and accurate. In view of the lack of psychrometric readings at the stations for which the predictions were made, the percentage of verification was unexpectedly high.

In the main, Alciatore's method is still in use at San Diego, and the dew-point, because of its relative conservatism, continues the basis for the predictions. It is true,

however, that there has been a steady improvement in the forecasts; the reasons for this are that the psychrometric data are available from all of the key stations, and that the evening weather map is now employed for estimating the influences of wind and cloudiness and for estimating the movements of the air masses involved.

When the teletypewriter was installed some years ago, the airway sequences became available to the city office. From them it was discovered that at the stations near the ocean there were wide and rapid fluctuations in the dew-point under certain pressure situations. In some cases the changes were so large from hour to hour that verification of the reports was requested. The remarkable variation of 20° to 30° occasionally took place between the sequences. In fact, the fluctuations were greater than those of the temperature at some of the stations, and, after some study, the conclusion was reached that the observations at coastal stations were not dependable air-mass indicators, and that one sequence of reports alone was of little value in our predictions.

It has been known for some time that, under certain pressure conditions over the Far West, dew-points are far from constant. Floyd Young has discussed nocturnal changes in the dew-point at Medford [1] and later emphasized that their use in minimum temperature predictions was limited because of these changes,[2] However, as hygrometrical data are still used in the frost work in San Diego, any material change in the moisture content of the air during the night must be foreseen if the forecasts are to be of value to the growers.

Our citrus districts frequently are the last to experience the change in air mass with the passage of cold or occluded fronts, and it is not at all unusual for firing to take place in the areas around Pomona and Redlands, while showers are still falling in San Diego County. In such situations reports from the north are invaluable, and, since the airway sequences have been received every hour, they have proven extremely helpful.

In the accompanying figure the temperature and dew-point readings at the sequences, 41 minutes past the hour, are shown on January 6 and 7, 1938, for the airway stations at Laguna Beach and Oceanside, and the airport stations at Burbank and San Diego. The weather map on both of these dates showed a large anticyclone over western United States with the center over southern British Columbia. Winds aloft were from the north or northeast, but as the high area was in the process of breaking down velocities were light.

Hourly and diurnal changes in the dew-point at the coastal stations of southern California are normally very small, and the unusual fluctuations shown in the figure occur only when dry descending wind or *S* air prevails. These abnormal variations are found on the border line between the moist ocean air and the dry land air, and it is the seesawing back and forth of the widely differing masses that causes the sudden changes.

This is further exemplified by a brief description of the location of each of the stations.

The station at Laguna Beach is about one-half mile from the ocean, and is situated on the slope of a hill which rises several hundred feet to the east and northeast. During the early evening the air flows down this incline, especially when the gradient winds are in that general direction. When it reaches the station, the humidity and dew-point both drop rapidly, but the temperature fall is slight as the air is heated somewhat in descent. The breeze usually diminishes after the early evening hours, and fluctuations in moisture content take place as the front between the maritime and land air masses moves back and forth.

At Oceanside, the situation is somewhat different. It, too, is about one-half mile from the ocean, but here the airway station is in a shallow valley running in an east-west direction, and the wind is usually stronger and the dynamical effects less pronounced than at Laguna Beach. As a result, there is a gradual fall in both dew-point and temperature when the cooler, drier land breeze prevails, and a rise when the moist, ocean air sweeps by during the day.

The assertion that the fluctuations are due to the proximity to the ocean is borne out by the sequence reports. These show that the dew-point at both Laguna Beach and Oceanside rises materially with the arrival of the sea breeze, usually about 10 or 11 a. m., and falls shortly after sunset with the advent of the land breeze.

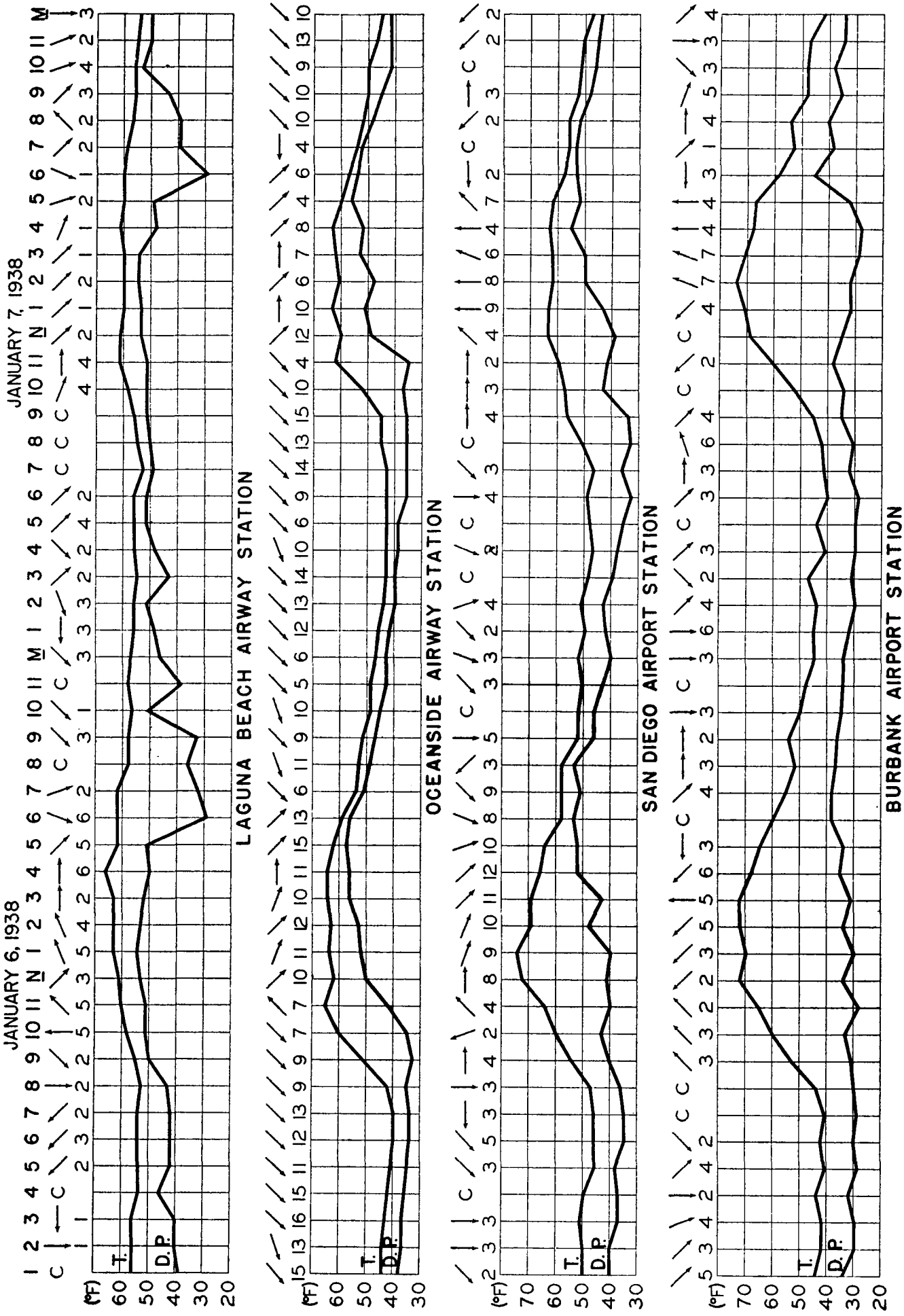
At the San Diego airport station, which is located several miles from the ocean, but on the shore of San Diego Bay at the base of a hill about 200 feet high, the dew-point fluctuates more than at Oceanside but less than at Laguna Beach. This is what one would expect. It is a matter of observation that even the distance of a mile or two may affect the readings when the land and sea breeze prevails, and simultaneous readings at the city office and the airport often show considerable difference.

On the other hand, the Burbank airport station is located so far inland that the moisture content of the air remains relatively constant, and the temperature extremes are effected without much change in the dew-point.

---

[1] Forecasting Minimum Temperatures in Oregon and California, by Floyd D. Young. MONTHLY WEATHER REVIEW, Supplement No. 16, pp. 53-55. 1920.

[2] Predicting Minimum Temperature Especially as a Function of Preceding Temperature. E. S. Nichols, with discussion by Floyd D. Young. MONTHLY WEATHER REVIEW, 58: 179-189. 1930.


JANUARY 6, 1938
JANUARY 7, 1938
LAGUNA BEACH AIRWAY STATION
OCEANSIDE AIRWAY STATION
SAN DIEGO AIRPORT STATION
BURBANK AIRPORT STATION
T.
D.P.
(°F)