

# WARM CONTINENTAL ANTICYCLONE WITH PERIPHERAL MOIST TONGUES

## A Recent Example Illustrated by Satellite Photographs

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Weather events over the central third of the United States during the first week of August 1970 provide an excellent example of an upper level summer continental warm anticyclone accompanied by well-defined moist tongues. This type of situation, in which significant amounts of convective precipitation can occur with anticyclonic northwesterly flow aloft, was discovered originally with the help of isentropic analysis and described by Namias (1938) and Wexler and Namias (1938). Since the advent of weather satellites, many cases of the cyclonic cloud vortex have been illustrated in the literature, but to our knowledge, none of the large-scale anticyclonic eddy.

As shown by Stark (1970, fig. 7), a narrow band of precipitation in southern Texas was associated with the passage of hurricane Celia in early August, and a broader band of quite heavy convective activity extended from southern Minnesota to the Ohio and Tennessee Valleys.

Over northern Texas and eastern Oklahoma, no rain at all fell during the week beginning August 3. The 500-mb map for 1200 GMT on Aug. 6, 1970, is representative of the upper level circulation during the week (fig. 1).

Selected satellite photographs show spectacularly the daily evolution of the cloud and precipitation areas. On August 3, Celia (fig. 2A) was crossing the southwest Texas coast while scattered convective activity appeared over the southern and central Rockies and the northern plains. On the next day, the remains of Celia (fig. 2B) were over the Big Bend country near the Rio Grande while convective activity had become better organized and moved southeastward to Iowa, Illinois, and eastern Missouri. On the 5th, the remains of Celia were still detectable over New Mexico while the convective activity in the central Mississippi Valley showed little change (photo not shown). The showers associated with Celia's moisture (fig. 2C) seemed to have become absorbed in the

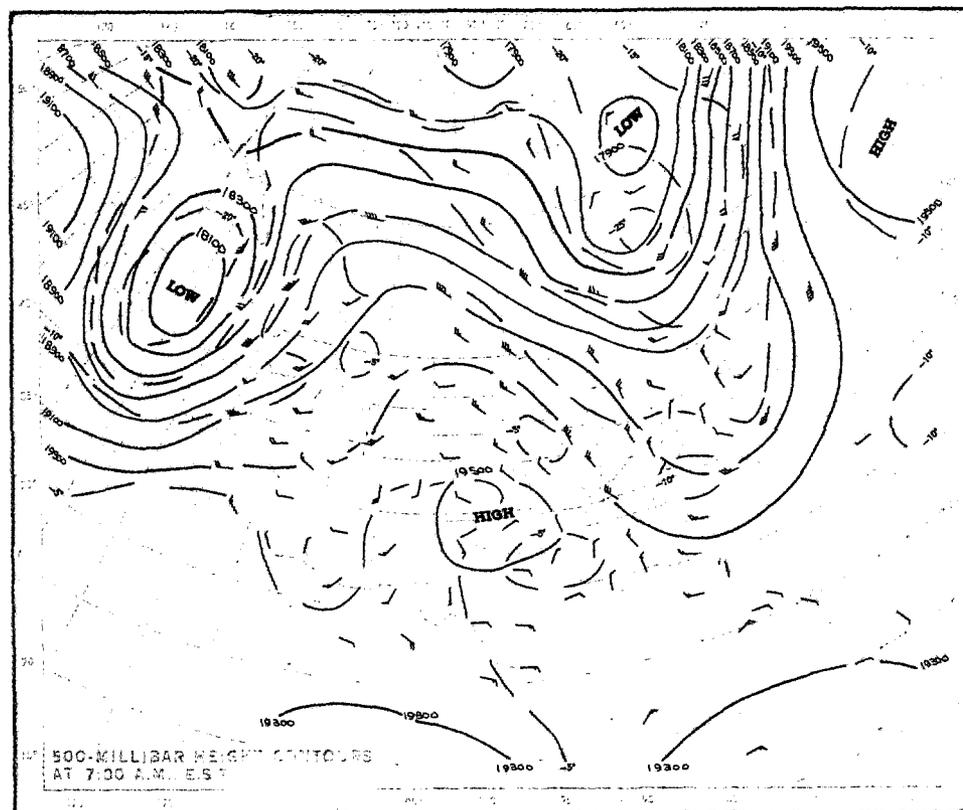


FIGURE 1.—The 500-mb circulation over North America at 1200 GMT on Aug. 6, 1970 (from Environmental Data Service 1970).

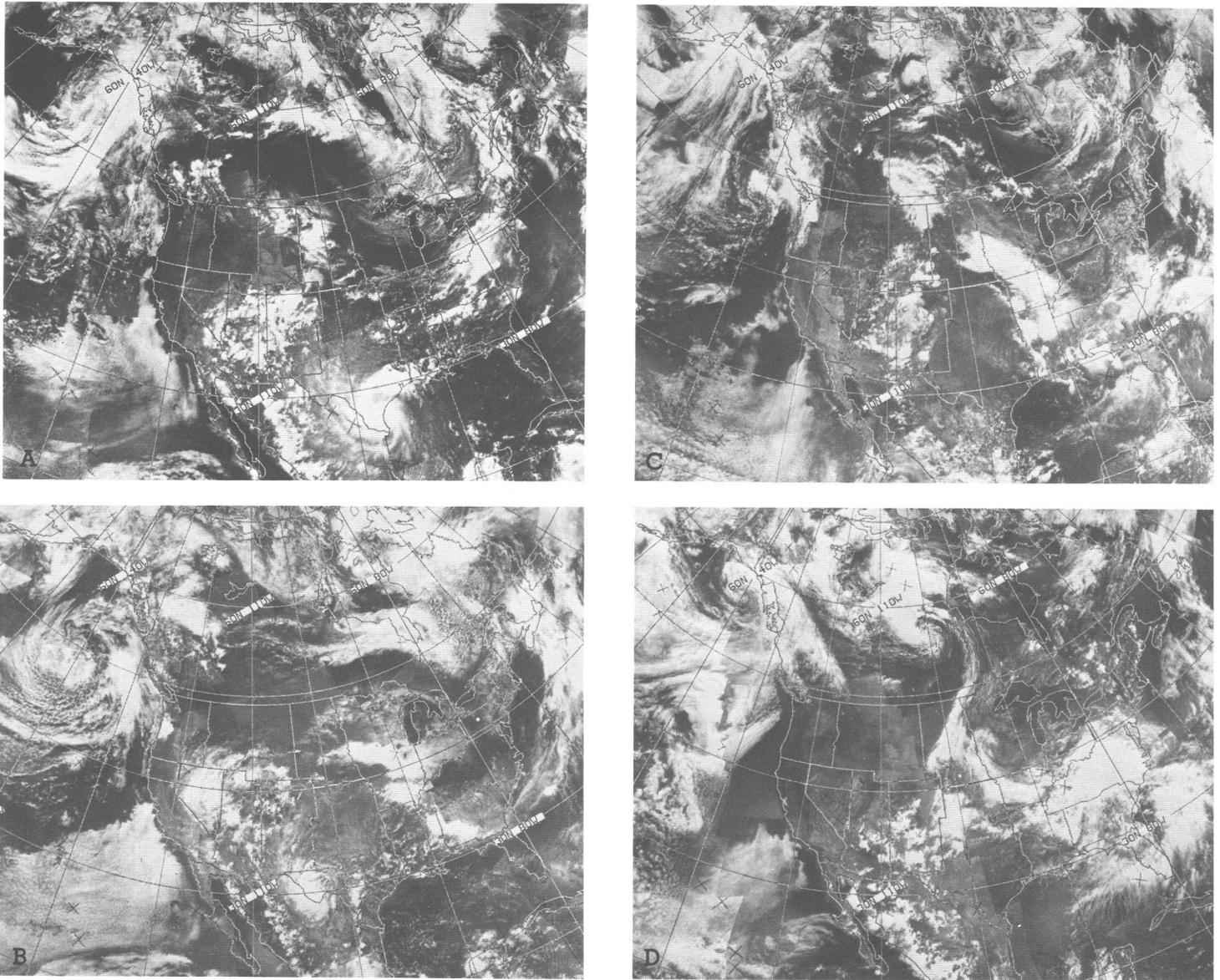


FIGURE 2.—Photographs taken by the ITOS 1 satellite for (A) Aug. 3, (B) Aug. 4, (C) Aug. 6, and (D) Aug. 9, 1970.

ordinary mountain convective activity on the 6th while the other area of heavy rain and thunderstorms extended from eastern Nebraska down to Arkansas and northern Mississippi, following the northwest branch of peripheral circulation around the High.

Precipitation was heaviest in Iowa where the northern moist tongue encountered a stationary front with consequent forced lifting and convergence. The area of convective activity moved southeast and even southward following the upper circulation, directly opposite the low-level winds which were southerly and southeasterly, in the manner pointed out in earlier studies involving isentropic analysis (Namias 1938).

By August 9, a weak cutoff Low (fig. 2D) had formed over Indiana in the northwesterly current, and the area of heavy convective activity was moving eastward to the

Appalachians where up to 10 in. of rain over western North Carolina in 48 hr on the 9th and 10th caused flash floods.

The heavy rains associated with the northwesterly flow aloft during the week of Aug. 3–9, 1970, made a strong impact on the surface moisture condition as seen in figure 3. There had already been fairly wet conditions in parts of the Midwest, but the persistent thundershowers of the first week of August raised the crop moisture index to the “excessively wet” category in southeastern Iowa and northeastern Missouri. At the same time, an extensive area of northeast Texas and adjacent Oklahoma was still in the “extreme drought” category.

The persistence of these soil conditions and their effect on the overlying atmosphere is illustrated by the surface temperature and dew-point analyses for 1800 GMT (around

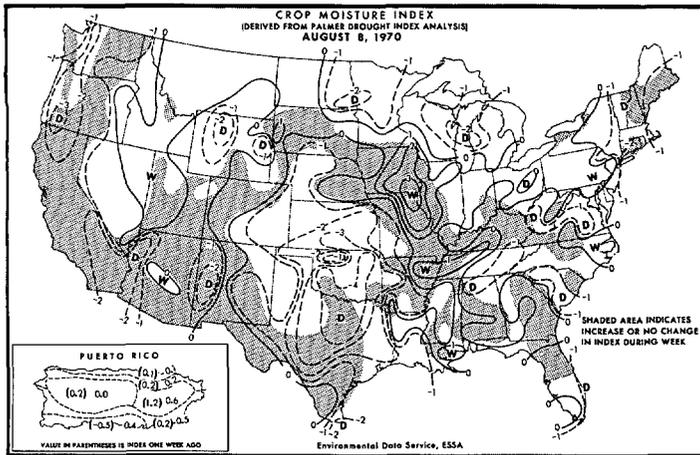


FIGURE 3.—Crop moisture index map for the period ending Aug. 8, 1970 (from Environmental Data Service and Statistical Reporting Service 1970).

midday local time) on August 13. It can be seen that bands of relatively low temperatures and high dew points extended from southern Minnesota and Wisconsin generally south or southeastward to northern Arkansas and Tennessee (figs. 4A and 4B). Both areas corresponded with the area of maximum soil moisture surplus (fig. 3) contributed to by thunderstorms in the anticyclonic moist tongue of the previous week. Note also the excellent agreement between the highest temperatures centered in north-eastern Texas and the area of greatest moisture deficiency.

At 1800 GMT on August 13, most of Kansas, Nebraska, South Dakota, Iowa, and Missouri were under clear skies with at most scattered clouds—no fronts were in the vicinity. Some showers were observed within 24 hr of that time over extreme western Kansas and North Dakota; but otherwise, no precipitation occurred. Since the principal area of relatively low temperatures and relatively high dew points was not associated with concurrent cloudiness, it is probable that the amount of moisture in the soil surface, and available for direct evaporation and transpiration by plants, had a marked effect on daytime surface temperatures. A larger proportion of the incoming solar energy may have been used to evaporate moisture, and less was available for sensible heating of the moist ground.

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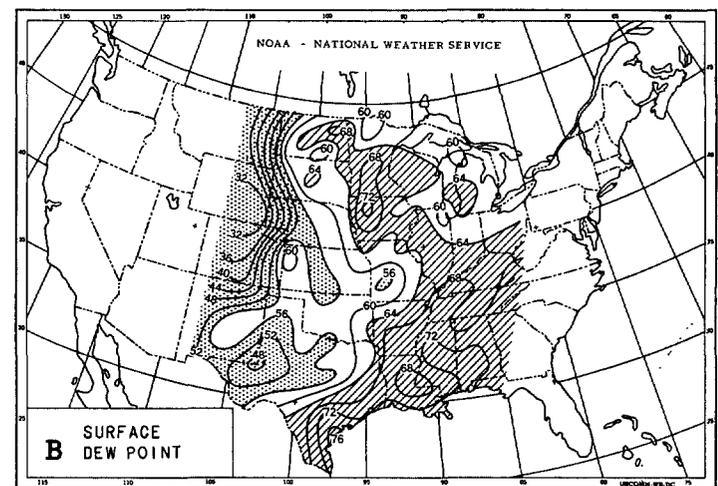
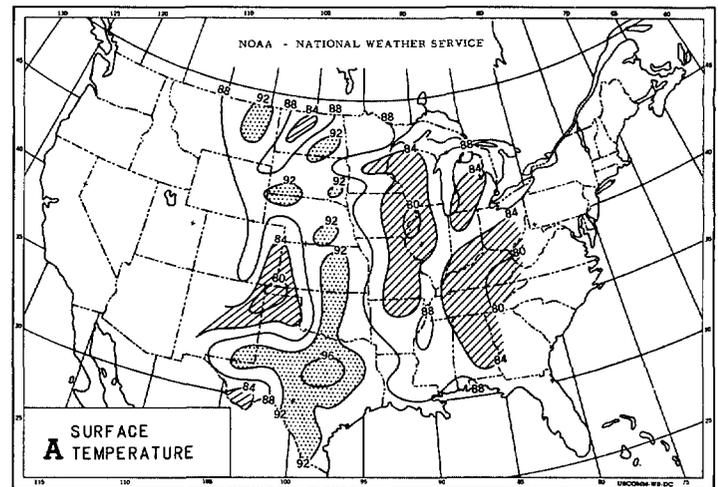


FIGURE 4.—(A) surface temperature ( $^{\circ}\text{F}$ ) at 1800 GMT on Aug. 13, 1970, and (B) surface dew point ( $^{\circ}\text{F}$ ) at 1800 GMT on Aug. 13, 1970, over the central United States. The analysis is at intervals of  $4^{\circ}\text{F}$ . The relatively cool and moist areas (temperature less than  $84^{\circ}\text{F}$  and dew point greater than  $64^{\circ}\text{F}$ ) are hatched; the relatively warm and dry areas (temperature greater than  $92^{\circ}\text{F}$  and dew point less than  $56^{\circ}\text{F}$ ) are stippled.

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