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AN EVALUATION OF THE THUNDERSTORM PROBABILITY FORECASTS - 1986 SEASON

Until 1986, all the operational thunderstorm forecast equations were derived by applying screening regression techniques to relate manual digitized radar (MDR) data to large scale meteorological predictors obtained from numerical forecast models. However, since radar coverage in the West is poor, this Model Output Statistics (MOS) approach has been at a distinct disadvantage here.

In an effort to more accurately delineate convective activity over the western U.S., TDL investigated the use of BLM lightning data as a predictor. The use of these data has important advantages.

1. The presence of lightning, by definition, indicates an active thunderstorm.

2. Lightning detection is not significantly affected by mountainous terrain.

3. The temporal and spatial resolution of the lightning strike data make it an ideal data set.

Ron Reap (TDL) (1986) found a high correlation between terrain elevation and the hour of maximum lightning frequency. At high elevations, maximum frequency occurs in the early to mid afternoon. At lower elevations, the hour of maximum lightning frequency occurs during the evening or night. Additionally, Reap found a pronounced increase in the magnitude of lightning activity with increasing terrain elevation. Therefore, the topographic features in the West appear to exert a strong influence on the timing and frequency of lightning activity.

Using the collective 1983-85 lightning strike data sets, TDL combined lightning frequencies with large scale predictors from the models to produce a new set of interactive predictors. As a result, the final thunderstorm probabilities not only reflect synoptic scale characteristics, but also the influence of small scale topographic effects. The thunderstorm probability data for the western U.S. was distributed via AFOS to the operational sites in gridded format in the summer of 1986. An application program was written to transform the data into contoured probabilities (WR Programming Note 58).

Reap has done a preliminary analysis on the effectiveness of the thunderstorm probability forecasts, as shown in Figures 1 and 2. These figures represent the 18-24 UTC forecasts from June 13 to September 15, 1986. The scores shown in Figure 1 represent the best scores TDL has obtained for any of their thunderstorm forecast products, in either the eastern or western U.S. For example, if the 20% probability threshold is selected to delineate an area of general thunderstorm activity, the Probability of Detection (POD) is 84%, the Critical Success Index (CSI) is 0.45, and the False Alarm Ratio (FAR) is 50%. What this means is that 84% of all the lightning strikes occurred within the 20% and greater contour and that 50% of the MDR blocks (47.6 km on a side) registered 2 or more lightning strikes. As the probability threshold increases, the POD decreases, but so does the area encircled by the probability contour. For example, within a contour probability threshold of 50%, the POD is 30%. However, the area within the 50% probability contour may only be a small fraction of the Western Region. The

reliability diagram in Figure 2 shows that the equations underforecast thunderstorm activity when the observed lightning frequencies were above 30%; however, the degree of underforecasting is relatively constant (8-10%).

In addition to the operations forecasts, Reap also developed experimental 6-h forecast equations for several categories of lightning density, i.e., ≥ 2, ≥ 20..., ≥ 100 strikes per grid block. Verification results for the 1985 data season revealed that the predictability of high lightning densities is very low. Although the forecast equations are quite successful in identifying general areas of lightning activity, they are not successful in identifying localized regions of high density strikes. Storms with high strike rates apparently respond to small scale features in the temperature, moisture and wind fields that are not resolved by existing numerical models.

TDL has just prepared a more complete report which includes daily maps of probability forecasts with actual lightning observations superimposed. In addition, the coefficients for the thunderstorm probability equations are being recomputed using the 2.3 million strikes collected during the 1986 season. Thus, guidance for 1987 should be better than 1986. The lightning data set for the West now contains over 6 million reported cloud-to-ground strikes for the 4 summer seasons (1983-1986). Two significant changes are being incorporated into the new development effort. They include replacement of the 0-6 h forecast projection by the 24-30 hr projection and the development of probability equations for the 1200 GMT forecast cycle. Replacement of the 0-6 h projection by the 24-30 h projection will extend forecast coverage into the important 1700-2300 MST early evening period. Addition of the forecasts for the 1200 GMT cycle will obviously provide more timely coverage throughout the day.

Reference:

Reap, R. M., 1986: Evaluation of Cloud-to-Ground Lightning Data from the Western United States for the 1983-84 Summer Seasons. Journal of Climate and Applied Meteorology, 25, 785-799.

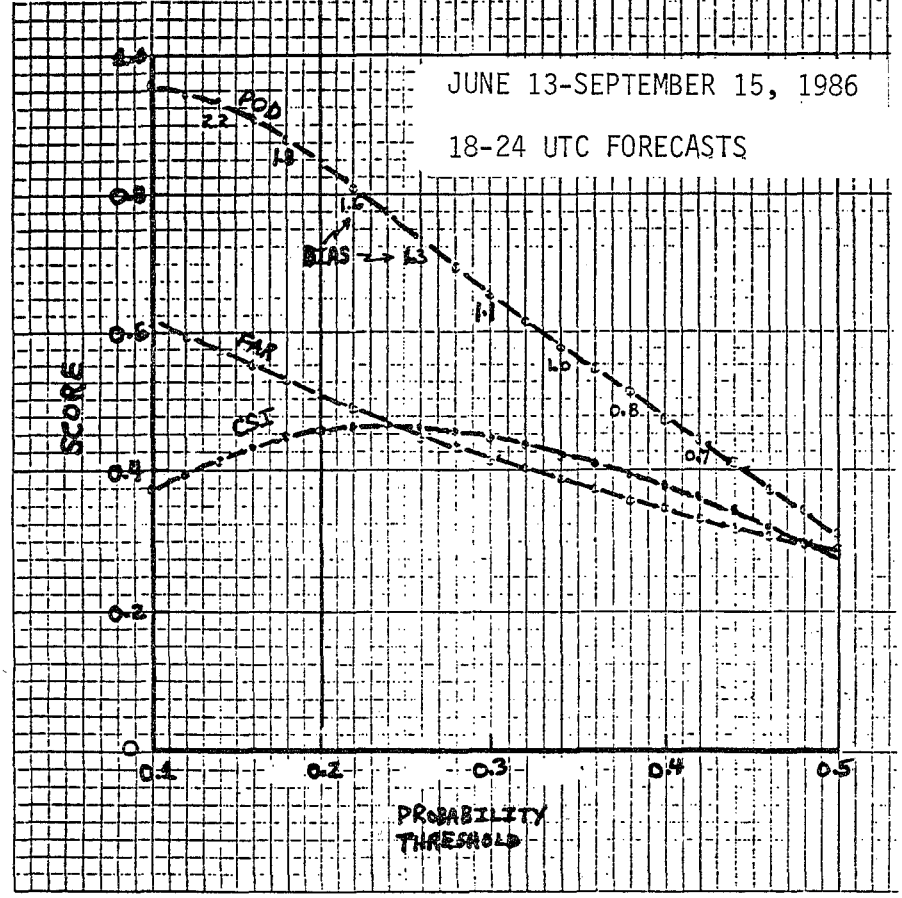

FIGURE 1.

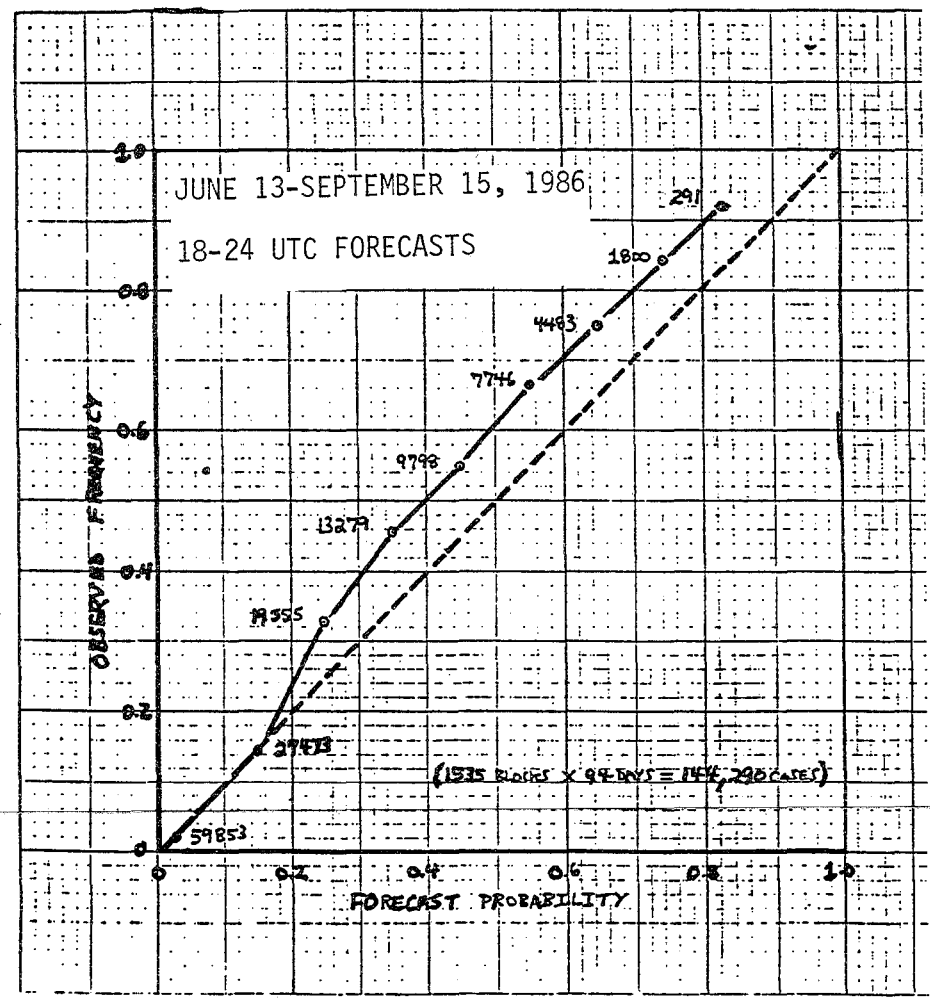

FIGURE 2.