NOTES AND CORRESPONDENCE

An Error Estimate for Numerical Prediction of Hurricane Trajectories¹AKIRA KASAHARA² AND GEORGE W. PLATZMAN*The University of Chicago*

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Errors inherent in the dynamical prediction of hurricane trajectories by numerical process may be classified into the following three types: a) physical modeling errors imposed by the assumptions employed for developing a feasible prediction model; b) mathematical approximation errors arising from the use of finite-difference schemes and the specification of boundary conditions; c) errors of analysis for initial conditions, especially those due to sparsity of observational data in and around hurricanes.

In connection with errors of type (c), we made the following experiment to assess empirically the forecasting error due to uncertainty in establishing the initial position of the hurricane center. In this experiment we employed a numerical prediction model of hurricane movement in which the hurricane is defined as an axially symmetric vortex that moves without changing its shape and intensity (Kasahara and Platzman, 1963). As a consequence of this definition, interaction terms appear in the prediction equation for the steering flow, defined as the residual after subtraction of the vortex. The movement velocity of the vortex is then calculated in such a way as to minimize interaction terms between vortex and steering flow. For a more detailed discussion of this model, the reader should consult the reference cited.

Numerical computations were made from 500-mb data for hurricane Betsy in the period 0300 13 August to 1500 17 August (twice a day). For each of the ten sets of initial data for hurricane Betsy, five separate forecasts were made (to 48 hours) from five different initial positions of the vortex center. As shown in Fig. 1, the arrangement is such that initially there is a central, "true" position surrounded by four "virtual" positions symmetrically located at a distance of 50 nautical miles from the "true" position. Since the trajectories of these five points are slightly different, their relative positions will change as the forecast proceeds. At 12-hour intervals

FIG. 1. Inset: initial configuration of "true" vortex center and four "virtual" centers at a distance of 50 n mi from the true center. Upper and lower curves: maximum and minimum dispersion of "virtual" centers in any of ten forecasts with 500-mb data of hurricane Betsy 1956. Middle curve: mean dispersion for the ten forecasts.

the distance of each "virtual" position from the "true" position was determined, and the four distances averaged. This "dispersion" naturally increases with time. The upper and lower curves in the figure show the maximum and minimum dispersion found at a particular time on any of the ten forecasts. The middle curve shows the mean dispersion, that is, the dispersion (at a particular time) averaged arithmetically over the ten forecasts.

After 24 hours the mean dispersion had increased from 50 to 90 n mi; the range on individual cases was between 40 and 150 n mi. At 48 hours the mean was 190 n mi, and the range was from 50 to 400 n mi. These

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results show very clearly that there is an appreciable uncertainty in predictability of hurricane trajectories owing only to uncertainties in locating the vortex center relative to the steering flow in the initial-data analysis.

REFERENCE

- Kasahara, A., and G. W. Platzman, 1963: Interaction of a hurricane with the steering flow and its effect upon the hurricane trajectory. *Tellus*, **15**, in press.