Numerical prediction of the movement of Bay depressions

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ABSTRACT. The 24-hour displacement of two monsoon depressions in the Bay of Bengal was computed on the basis of the non-divergent barotropic model of Charney and Estoqse's baroclinic model. Relaxation methods were used for the barotropic model, and Fjortoft's graphical technique was employed for Estoqse's model. The difficulties experienced with the data available, and effect of errors caused by inadequate data are discussed. Finally, the predicted contours of the 1000 and 500-mb surfaces are compared with the observed patterns and suggested lines for improvement are indicated.

1. Introduction

The numerical prediction of large scale pressure systems may be said to have its beginning in the classical work of Richardson (1922). The subject was revived in more recent years by Charney (1949) and collaborators (Blackburn and Gates 1956, Thompson and Gates 1956); but perhaps the biggest factor contributing to this renewed interest was the advent of electronic computing devices. A rough estimate revealed that these computers were about $10^6$ times faster than conventional desk computers, and could perform the couple of million multiplications and divisions needed for a 24-hour forecast in an hour.

Progress in this branch of Meteorology in the tropics has been understandably slow because there has been no opportunity to use high-speed computers for numerical prediction, and graphical methods (Fjortoft 1952) are to a large extent subjective because of the sparse network of stations reporting upper winds and temperatures. Despite this limitation, the present study was undertaken to gain experience with the different models in use, and to have greater insight into the type of difficulties likely to be encountered when high-speed computers become available.

As a beginning, the displacement of two monsoon depressions in the Bay of Bengal was computed with the non-divergent barotropic model of Charney (1949), and with Estoqse's model (1956, 1957), based on a variation of Fjortoft's earlier work. We used relaxation methods (Southwell 1946), and Fjortoft's graphical technique to obtain the predicted contours of the 1000 and 500-mb surfaces for a period 24 hours ahead. The theoretical implications of both these models are by now fairly well known; we shall, therefore, only briefly indicate the theory for continuity and then proceed to discuss the results.

2. Theoretical aspects

(a) The non-divergent barotropic model—This model is built around a simplified form of the equation for conservation of vertical vorticity (hereafter referred to as vorticity for simplicity). The main assumptions in deriving the model are as follows —

(1) The wind field is quasi-geostrophic,
(2) There exists a level in the mid-troposphere, generally associated with 500 mb, where there is no divergence,
(3) The generation of vorticity by such factors as the rotation or stretching of vortex tubes, horizontal gradients of the vertical velocity or the existence of isobaric—iso-steric sole-noids is negligible and

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