UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL WEATHER SERVICE
Silver Spring, Md. 20910

OA:W111x1:RER

January 22, 1979

TO: Recipients of Technical Procedures Bulletin Series

FROM: Duane S. Cooley
Chief, Technical Procedures Branch
Meteorological Services Division, NWS

SUBJECT: Technical Procedures Bulletin No. 255: THE SEVEN-LAYER LFM MODEL

This bulletin describes some recent changes in the operational LFM model. Changes have been made in the vertical structure of the model, its initialization, and post-processing. One significant outcome of these changes is to improve the forecasts in the stratosphere. This material was provided by John E. Newell, Atmospheric Modeling Branch, NMC.

THE SEVEN-LAYER LFM MODEL

1. INTRODUCTION

In order to make the LFM and the seven-layer hemispheric model more similar, the vertical structure of the LFM has been changed to make it a seven-layer model also. In this way an improvement which is developed in one of the two models may more easily be incorporated in the other.

The top of the model is located at 50 mb at all gridpoints and this value does not change with time. The model stratosphere is bounded by the 50-mb surface at the top and by the tropopause surface at the bottom. The stratosphere is divided into three layers of equal pressure thickness. The structure of the LFM below the tropopause is unchanged.

With the improved vertical resolution in the seven-layer LFM, it is possible that the model's 100-mb forecasts will be superior to persistence. At present, this is not known to be the case. After the seven-layer LFM is running operationally in place of the current one, the 100-mb forecasts will be evaluated.

2. CHANGES IN THE LFM INITIALIZATION PROCEDURE

The initialization scheme for the seven-layer model requires analyses of heights, winds, and temperatures at 70 and 50 mb. The highest level at which the present LFM analysis is performed is 100 mb. Since the second transmission of the raobs, containing data above 100 mb, is received too

late for anlaysis, the needed fields at 70 and 50 mb are generated using a statistical procedure developed by the Upper Air Branch at NMC.

The height and temperature at 70 mb are computed as functions of the 100-mb height and temperature, using regression equations whose coefficients are functions of latitude. The height and temperature at 50 mb are computed as functions of the 70-mb height and temperature, using another pair of regression equations whose coefficients are functions of latitude. The wind components at 70 and 50 mb are computed geostrophically from the respective height fields.

The new initialization procedure divides the stratosphere into three layers, rather than two, using the methods described by Gerrity (1977). Winds, heights, and temperatures in the sigma coordinate system used by the model are computed from the analyses, including the statistically generated 70 and 50-mb levels.

3. CHANGES IN THE MODEL'S FORECAST PROCEDURE

The addition of the third stratospheric layer was accomplished by eliminating the layer of constant potential temperature (the "quiet cap" or "thetasphere") that previously rested on top of the six meteorological layers. Where the six-layer LFM had two layers between the tropopause and approximately 80 mb, the new seven-layer LFM has three layers between the tropopause and 50 mb. Experiments have shown that the extra layer and the placing of the top of the model at a higher altitude produces beneficial effects on forecasts in the stratosphere. The addition of the seventh layer has no significant effect on forecasts in the troposphere.

In the post-processing section of the model, the method of vertical interpolation from the sigma surface to present surfaces has been changed. In using the hydrostatic equation the new procedure is to assume that absolute temperature varies linearly with the natural logarithm of pressure, rather than assuming that potential temperature varies linearly with the Exner function. This change is designed to improve the stratospheric forecasts and its impact in the troposphere is negligible. The major effect of the change in the stratosphere is to reduce substantially an apparent warm bias in the high level temperature forecasts and a corresponding bias in the geopotential heights. This bias was not in the forecast itself, but was introduced by the θ linear-with-π assumption used in the six-layer LFM (Gerrity, 1977).

In summary, the seven-layer LFM contains four sigma layers in the troposphere (the bottom one being the 50-mb thick boundary layer) as in the six-layer LFM. The principal difference is that a third layer has been added to the stratosphere and the computational cap has been removed. In addition, the vertical interpolation from sigma to pressure has been modified.

4. REFERENCES

Gerrity, J.P., 1977: The LFM Model - 1976: A Documentation. NOAA Technical Memorandum NWS NMC-60.

Technical Procedures Bulletin No. 218: The 7L PE Model, Sept. 30, 1977.