U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE
NATIONAL METEOROLOGICAL CENTER

OFFICE NOTE 214

A Simple Technique for Providing Backup HUFGES Coefficients to the NMC Operational Cycle

Edward A. O'Lenic
Development Division

JUNE 1980

1. Introduction

When the NMC Data Assimilation Cycle (or FINAL) fails to run to completion, some other means must be found to supply guess coefficients to the subsequent Operational (OPNL) Cycle so that the Hough Analysis may proceed. In the past, the 12- or 24-hour old coefficients from a previous Hough Analysis were used for this purpose. While the analysis always ran successfully from these coefficients, the analyses often contained substantial errors, which were, in turn, passed on to the forecasts.

In hopes of providing a better set of backup coefficients, a technique was developed to create guess coefficients using the 7-layer primitive equation model (7L PE) 12-hour forecast fields available from the previous Operational (large scale) Cycle. The appropriate 7L PE 12-hour forecast fields are converted to 2.5 degree longitude-latitude (LOLA) fields. The 70- and 50-mb height and temperature fields are extrapolated from the 100-mb fields using a linear regression technique (Finger, et al, 1965). Finally, the LOLA fields are converted to spectral coefficients using program SPDGES. These coefficients may then be used, if necessary, directly by the Hough Analysis. Note, however, that this technique produces timely coefficients in the northern hemisphere only, while 12-hour old HUFANL coefficients are used in the southern hemisphere. The operational version of this backup code (called the "F12 backup") requires about 5 minutes of wall time and 680K of core on the IBM 360/195 computer.

The development of the F12 backup coincided with the testing of 7- and 11-layer versions of a spectral model. The spectral models were installed in the operational run stream for testing purposes, and run immediately after the 7L PE if sufficient time is available in the operational job schedule (nearly every day). The global nature of the spectral models makes them ideal candidates to provide backup coefficients. Therefore it was decided to evaluate the spectral model forecast coefficients along with those of the F12 backup. The spectral 7-layer model requires 8 minutes of CPU time and 600-700K bytes of core, while the 11-layer version runs in about 35 minutes of CPU time and 1000K of core. Figure 1 schematically illustrates the three backup techniques mentioned thus far.

2. Comparisons of the Spectral Models and F12 Backup

This section examines the performance of both versions of the spectral model, and the F12 backup, by comparing backup Hough height analyses with those generated from the legitimate guess coefficients (HUFGES), valid at 00Z 1 August 1979. The RMS height and vector wind errors from each of the nine iterations performed in the Hough Analysis (Figures 2-5) provide a gross measure of the agreement between the guess coefficients and the observations at selected levels.

Technically, the RMS errors for iteration 1 correspond to the error involved in fitting the guess coefficients to the observations. The coefficients resulting from the first iteration, and all later iterations are considered to be "analysis" coefficients, and the RMS errors for iterations 2 through 9 reflect the error in fitting those analysis coefficients to the observations. Figures 2-5 clearly show that the errors in the guess coefficients persist in the subsequent analysis coefficients.

The 500-mb RMS height deviations (Figure 2) are very similar for all three backup candidates, with the spectral models out performing the F12 backup during early iterations. Large differences appear at 100 mb (Figure 3), where the spectral 11-layer model and the F12 backup give a good showing compared to the spectral 7-layer model. The largest errors for all the backup candidates occur at 50 mb (Figures 4, 5), where errors from the 7-layer spectral forecast are far larger than those from the other two candidates. After nine iterations, however, all three sets of analysis height and wind fields have similar error characteristics, a fact which, unfortunately, does not assure similarity among the resulting analyses, as we shall see.

The guess-minus-legitimate (or guess minus OPNL) height difference fields (Figures 6-11) clarify comparisons of the various backup systems by giving details not discernable from the RMS errors statistics, such as relative maxima and minima, and the horizontal and vertical distribution of the height differences. Because the guess-minus-OPNL height differences for all three candidates are very small and reasonable below 100 mb, they are not included in this discussion. We begin instead with the 100-mb level.

The guess-minus legitimate height differences for the spectral 11-layer and the F12 backup systems (Figures 6-8) are quite acceptable, the maximum differences being about $\pm$ 60 meters. The spectral 7-layer heights, however, differ from the legitimate analysis by as much as 198 meters, a difference nearly four times greater than the other methods. Such large differences are readily explained by the low vertical resolution of the spectral 7-layer model. The top layer of the model extends from 145 mb to zero pressure. Low vertical resolution also explains the relatively large RMS errors seen earlier (Figures 2-5). Thus, the spectral 7-layer model is not as suitable a source of backup guess coefficents as are the spectral 11-layer model, and the F12 backup. In fairness, it should be noted that at 250 mb, the spectral 7-layer model performed nearly as well as the 11-layer version, and better than the F12 backup (Figures 9-11).

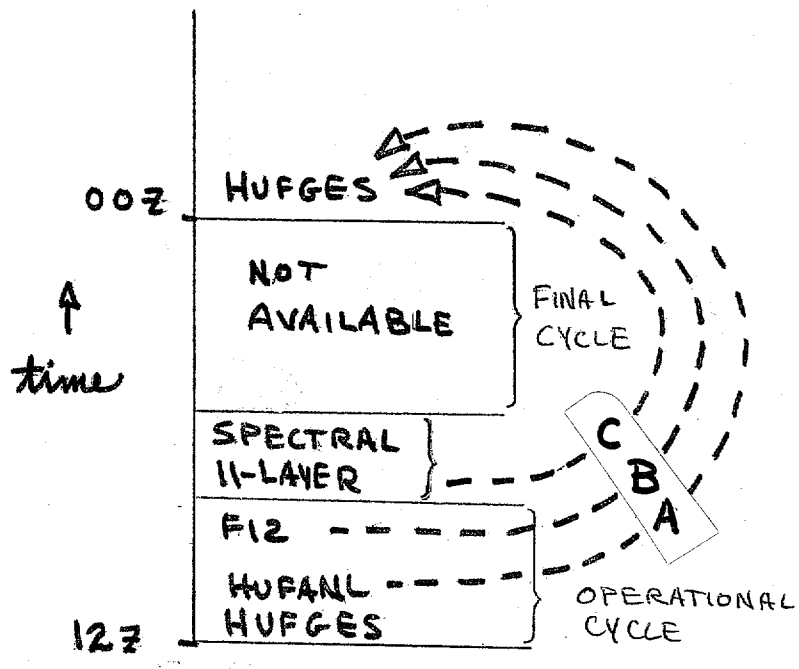

Figure 1. Three methods to create guess coefficients (HUFGES) when the FINAL is not available:

A. use 12-hour old HUFANL coefficients,

B. convert 7LPE 12-hour forecast fields to HUFGES coefficients,

C. use spectral 11-layer 12- or 24-hour forecast coefficients.

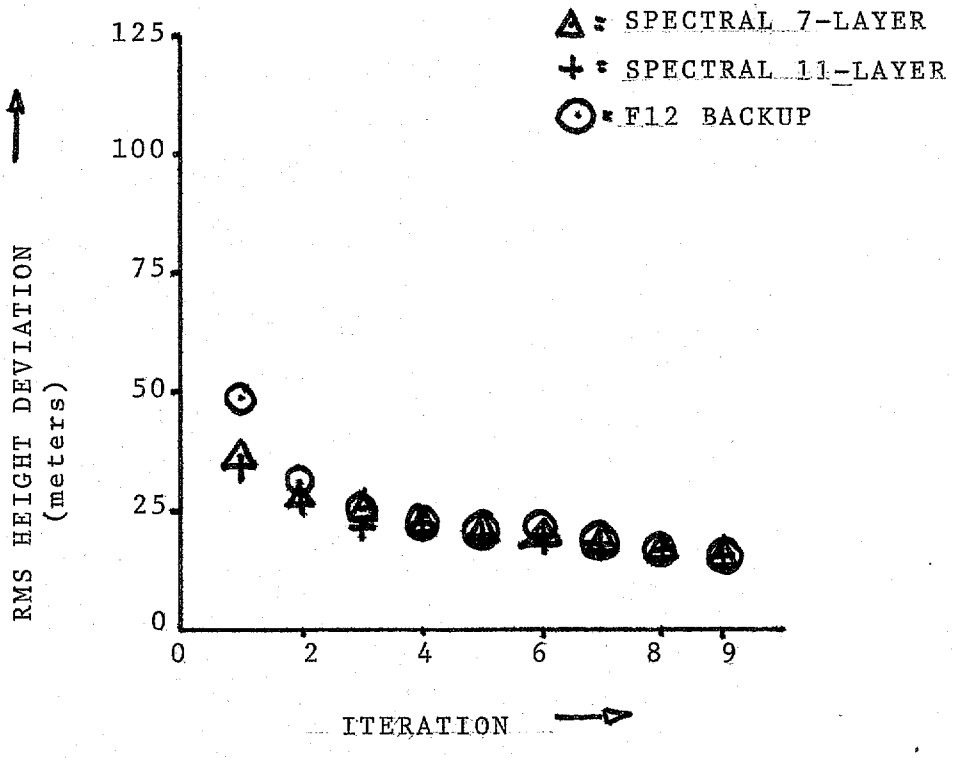

Figure 2. 500 mb RMS height deviation in fitting guess coefficients (iteration 1), and subsequent analysis coefficients (iterations 2-9) to observations in the Hough Analysis.

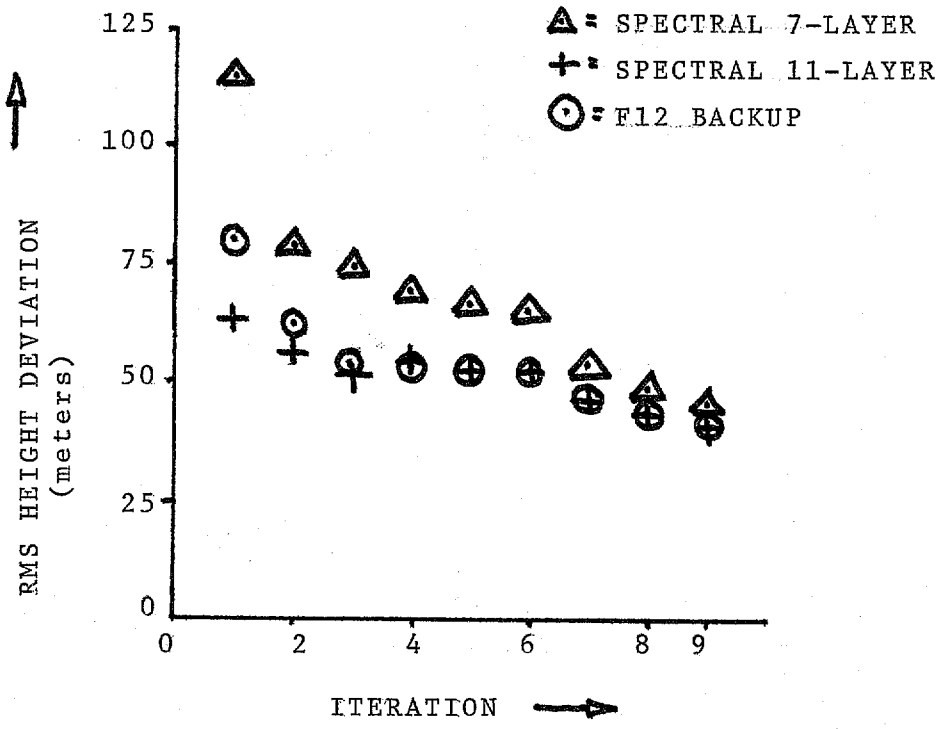

Figure 3. 100 mb RMS height deviation in fitting guess coefficients (iteration 1), and subsequent analysis coefficients (iterations 2-9) to observations in the Hough Analysis.

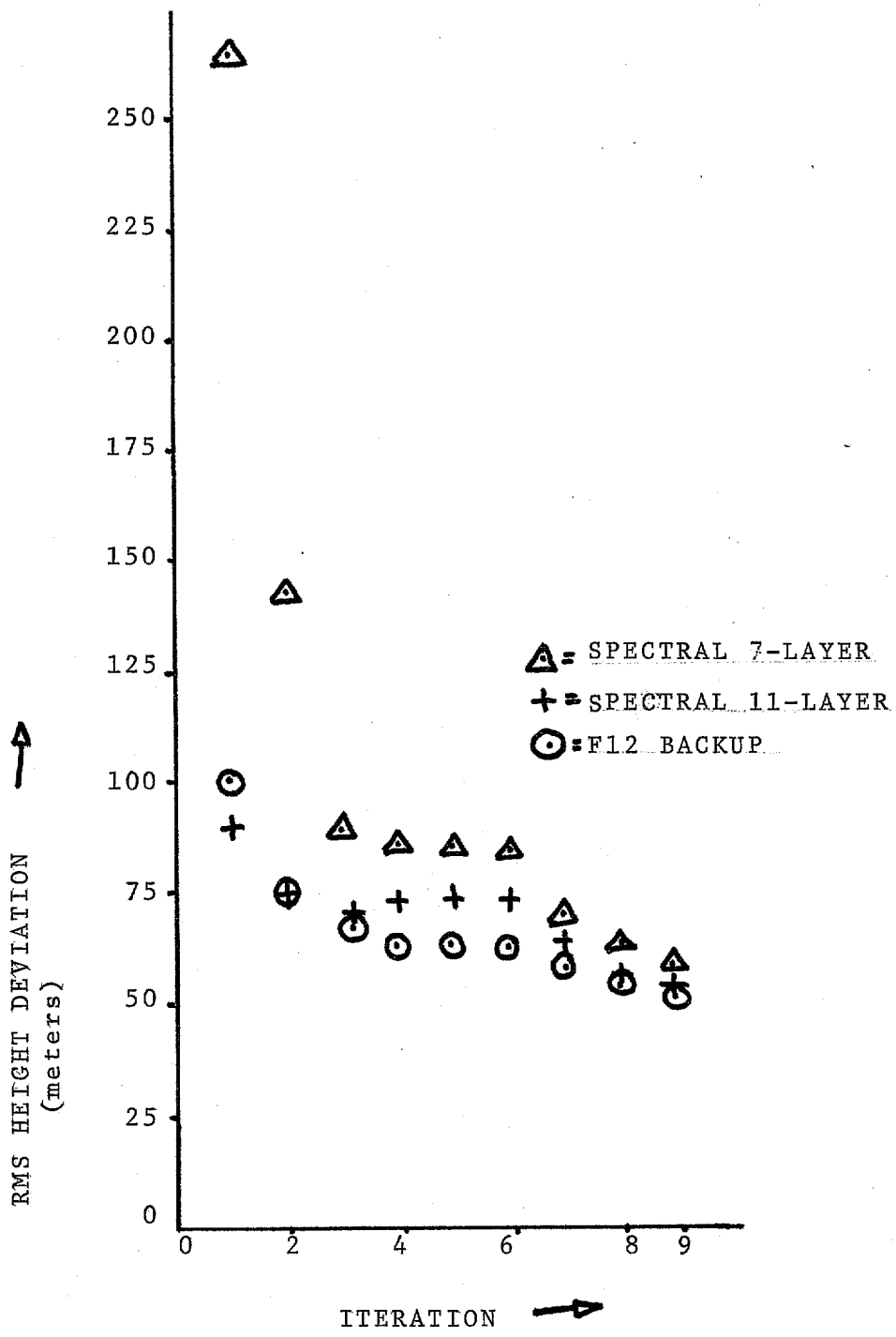

Figure 4. 50 mb RMS height deviation in fitting guess coefficients (iteration 1), and subsequent analysis coefficients (iterations 2-9) to observations in the Hough Analysis.

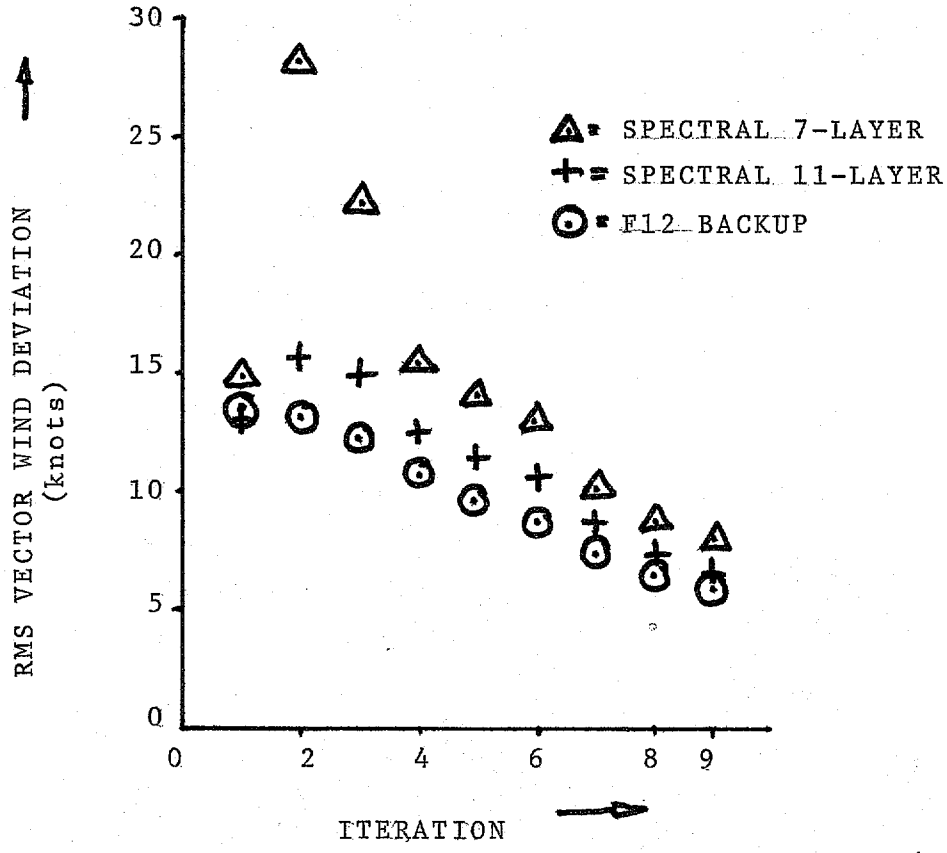

Figure 5. 50 mb RMS vector wind deviation in fitting guess coefficients (iteration 1), and subsequent analysis coefficients (iterations 2-9) to observations in the Hough Analysis.

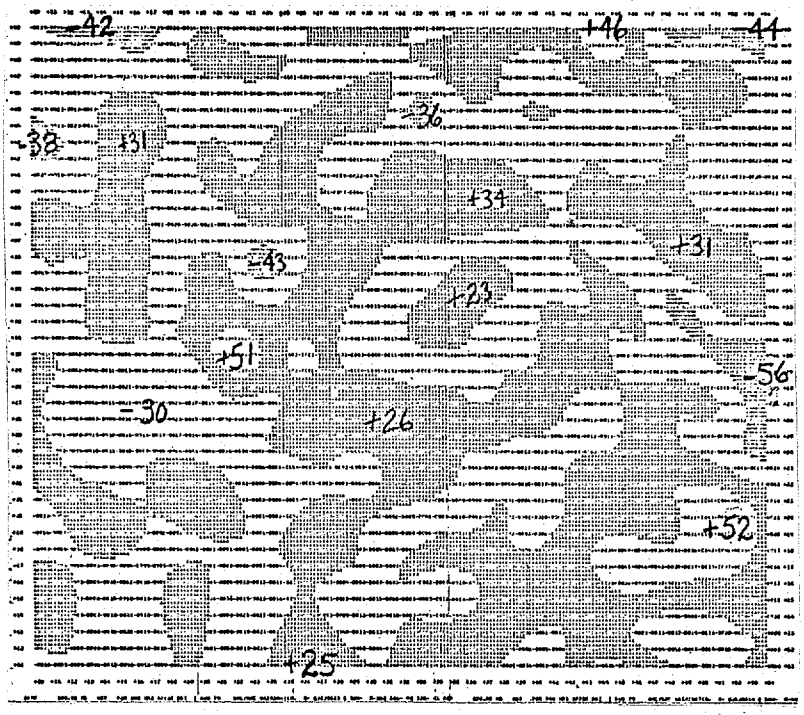

Figure 6. 100 mb height differences, spectral 11-layer minus legitimate (OPNL) analysis, valid 00Z 1 August 1979, northern hemisphere.

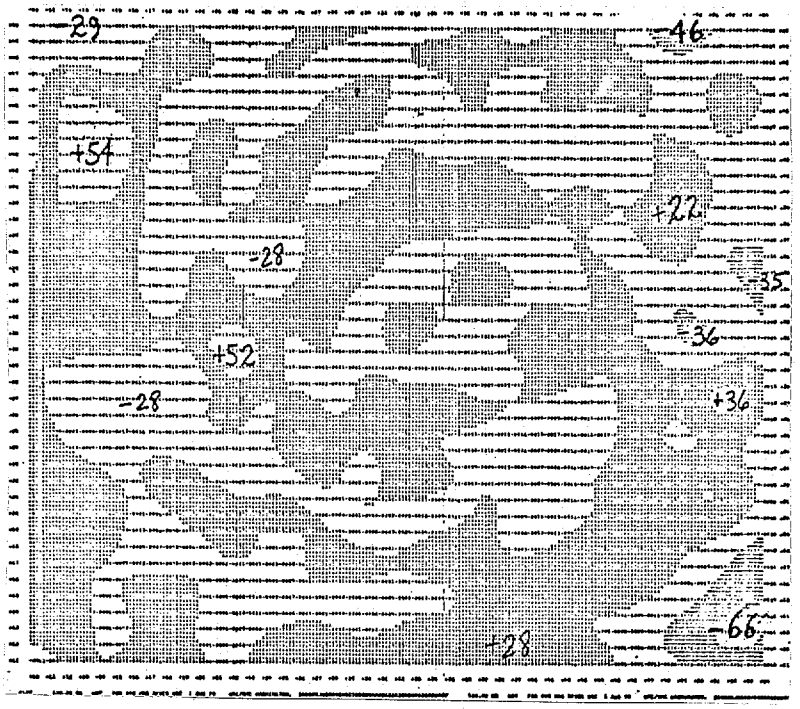

Figure 7. Same as figure 6, but for F12 backup minus legitimate (OPNL) analysis.

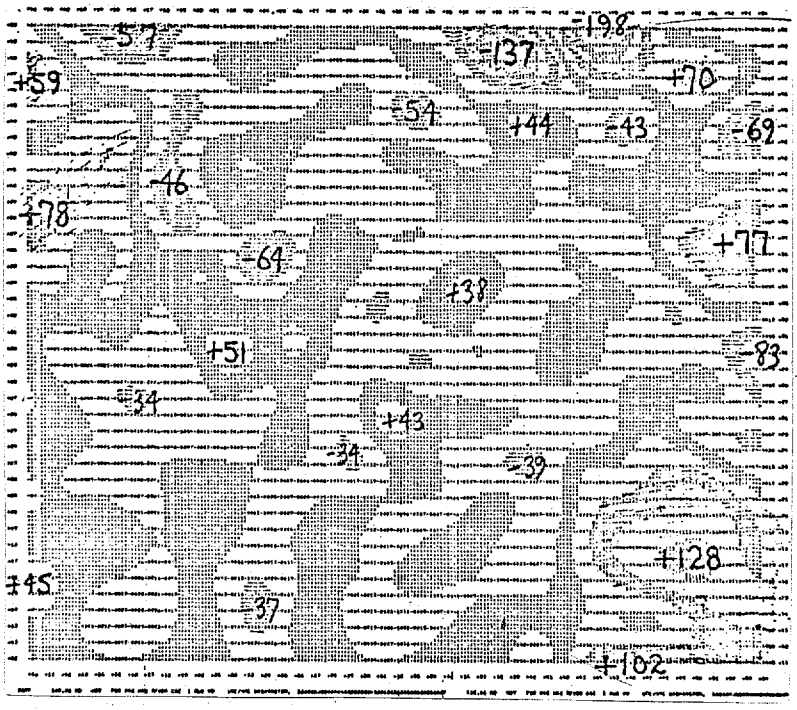

Figure 8. Same as figure 6, but for spectral 7-layer minus legitimate (OPNL) analysis.

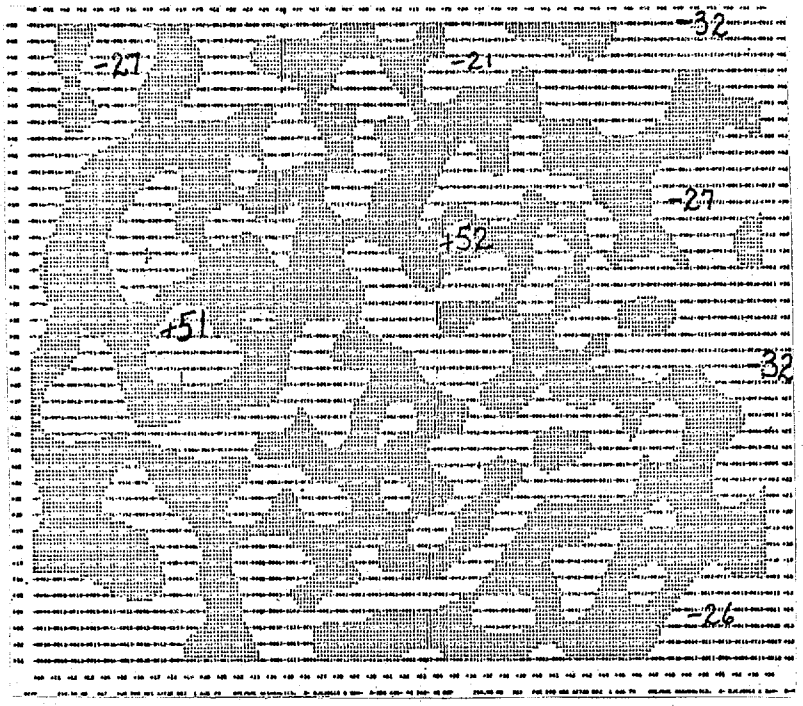

Figure 9. 250 mb height differences, spectral 11-layer minus legitimate (OPNL) analysis, valid 00Z 1 August 1979, northern hemisphere.

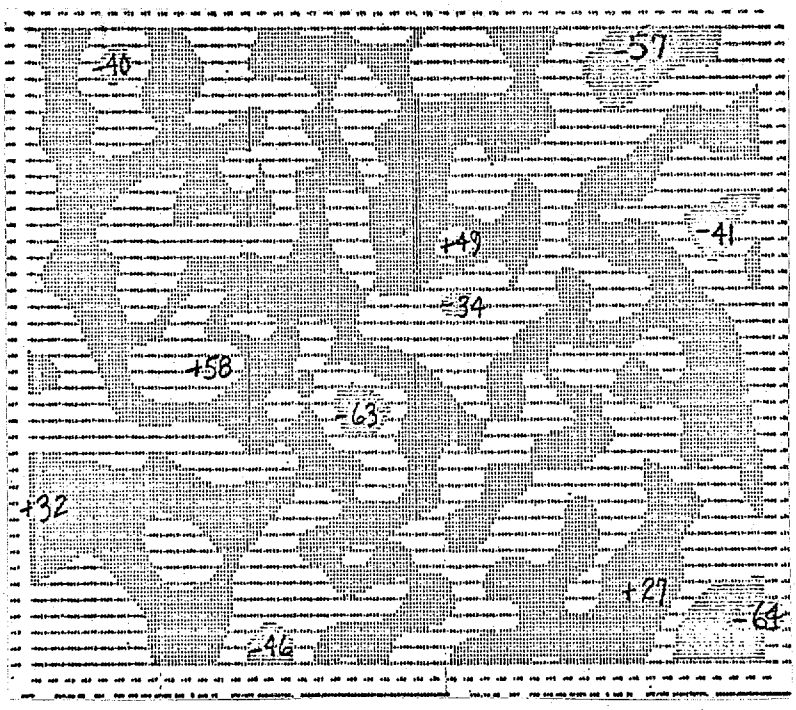

Figure 10. Same as figure 9, but for F12 backup minus legitimate (OPNL) analysis.

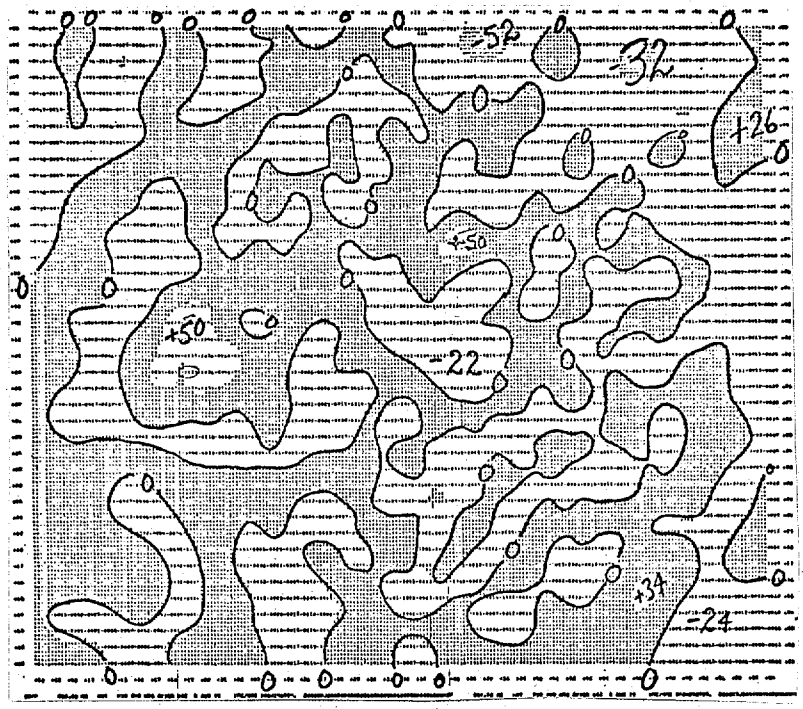

Figure 11. Same as figure 9, but for spectral 7-layer minus legitimate (OPNL) analysis.

3. Results and Conclusions

The spectral 11-layer model and the F12 backup produce fields which are acceptable as backups for the HUFGES coefficients, the former system being somewhat more accurate. While the spectral 7-layer model also performed well below 100 mb, its low vertical resolution creates large errors in its forecast height and wind fields at and above this level. Therefore, use of the 7-layer version of the spectral model to provide backup HUFGES coefficients was not recommended.

4. Epilogue

The 11-layer spectral model was installed for testing in the operational run-stream in September 1979, and serves as the primary backup system. However, the F12 system, implemented in August 1979 as the primary backup system, now serves as a backup for the 11-layer spectral model (a second order backup). The spectral model is normally run once each day immediately after the 12Z Operational Cycle (Figure 1). Should the 12Z FINAL be unavailable, the 12 hour spectral forecast provides backup coefficients. Should the 00Z FINAL fail, the 24-hour spectral forecast provides the backup coefficients. Should the appropriate spectral forecast be unavailable, the F12 backup comes into play, causing the 7L PE forecast to become the first guess.

A 12-layer version of the spectral model is scheduled to supplant the 7L PE during the summer of 1980. After that time, the FINAL backup will come, not from a special run of the spectral model, but from the Operational Cycle.

REFERENCE

A Method for Objective Analysis of Stratospheric Constant Pressure Charts
by F. G. Finger, H. M. Woolf, and C. F. Anderson; Monthly Weather Review
October 1965, pp. 619-637.