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STUDIES WITH SATELLITE RADIOMETER DATA

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Our work with satellite radiometer data has been concentrated on preparing for the data we expect to receive from ITOS D next spring and Nimbus E next fall. The vertical temperature profile radiometer (VTPR) on ITOS D will provide temperature data with sufficient coverage to test the results of the simulation studies that were carried out earlier. These studies indicated that global winds could be derived from the temperature data with sufficient accuracy to allow forecasts of improved quality. We are preparing to experiment with the ITOS speed data on a near realtime basis through a data link to Suitland. In preparing for the ITOS D data, we have obtained two important results which we would like to report on today.

The main limitation in our earlier work was the crudeness of the Mintz-Arakawa model which GISS borrowed from UCLA to use in these earlier simulation studies. The model was especially poor in its use of only two vertical levels for determining the entire vertical structure of the atmosphere. We have therefore rebuilt the model with an arbitrary number of vertical levels. We have also rebuilt the physics in the areas of radiative transfer and cloud effects.

We thought that the five-level model would be sufficient, but we recently discovered at the meeting of the Joint Organizing Committee – which is the scientific body for planning at the international level under the Global Atmospheric Research Program – that five levels may not be adequate and nine levels appear to be required. We now have our model working with both five and nine levels and have tested it and have proved that it works well under the shocks of inserted temperature data and as a model for generating forecasts. Although we are not in the forecasting business, we need to run forecasts on occasion because accuracy is our principal means of judging the quality of the winds that we obtain from the temperature data.

Figure 1 shows the comparison between the old UCLA two-level model, the improved GISS five-level model, and the observations obtained from the National Meteorological Center (NMC) for the period of July 1 to 3, 1970. Both models were started from NMC observations for the Northern Hemisphere for July 1 as the initial states. The figure shows that after 48 hr, the agreement between the GISS five-level model and the observations are appreciably better than the UCLA two-level model.

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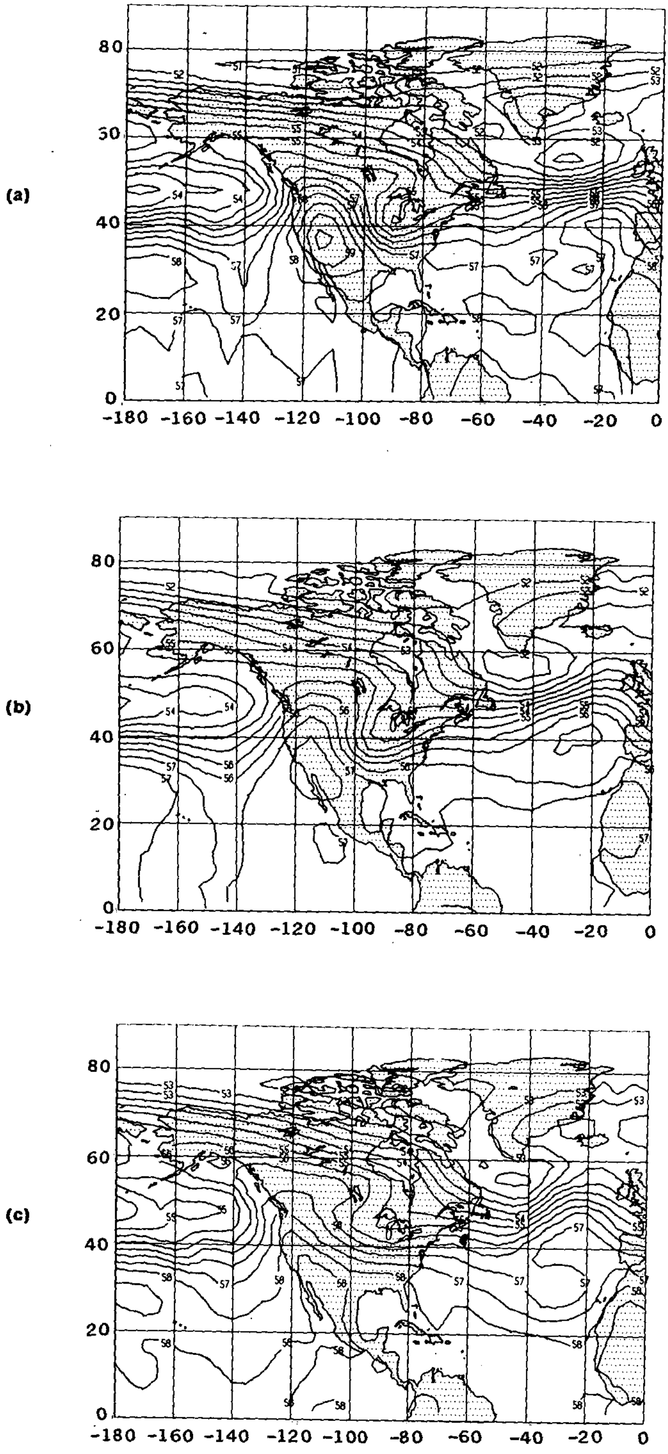

Figure 1–Comparison of 50-kN-m^{-2} (500-mbar) geopotential height analyses: (a) NMC observation; (b) Five-level GISS model; (c) Two-level UCLA model.

I would like to draw your attention in particular to the intensity and axis of the trough centered below the Great Lakes and to the high centered off the coast of California. Figure 1(a) represents the actual NMC 50-kN-m^{-2} (500-mbar) geopotential height analysis for the same period 2 days after the initial study. Figure 1(*c*) indicates what we obtained from the two-level UCLA model. The axis of this trough did not change sufficiently in two days, nor did the high develop in the California region.

These results encourage us to continue the numerical modeling research in which the efforts will now be concentrated on the physics of the moist convection and the treatment of the planetary boundary layer.

As our second point of preparation for ITOS D, we developed methods for the four-dimensional assimilation of satellite radiometer data and tested these schemes with the currently available satellite infrared spectrometer (SIRS) radiance data. The results are shown in Figure 2.

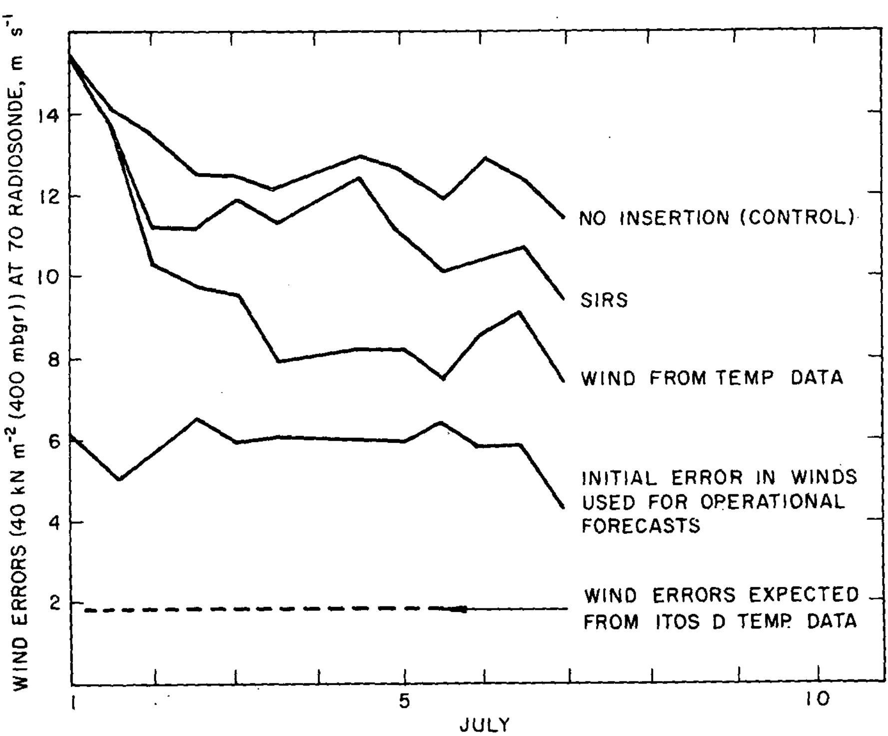

Figure 2–July 1970 experiment.

The average wind error plotted on the vertical axis is the difference between the observed winds obtained at 70 radiosonde stations in the Northern Hemisphere and the winds calculated from the model and interpolated to these stations. At the start of the experiment, the model was evolving along lines completely unrelated to the actual stage of the atmosphere on July 1, 1970. Our aim was to see whether the repeated insertion of the temperatures derived from satellite radiometer data would drive the winds into better agreement with the observations, as the simulation studies had indicated. The temperature inversion program was supplied by the Smith group at the National Environmental Satellite Service and was directly coupled to the atmospheric equations of the model; that is, the radiances were inserted as inputs and the temperatures were calculated internally.

The second graph from the top shows the effect of the SIRS temperature data. The effect is immediate, starting out at about 14 m s^{-1}, which is the normal value for two completely unrelated flows, dropping steadily to about 9 or 8 m s^{-1}. However, these wind errors are only about as good as the wind errors NMC obtains at the end of a 24-hr forecast. The third graph shows the effect of inserting real temperature data as obtained from NMC analysis, that is, a mass of ground-based data as well as SIRS satellite data. The temperatures were inserted at intervals corresponding to the amount of temperature data available for a single polar-orbiting satellite. The mean wind error for these data is about 6 m s^{-1}. At this level of wind errors, most of the major pressure features found in the Northern Hemisphere are correctly given. The bottom graph shows the expected wind errors from the VTPR obtained by performing simulation studies for this instrument. Serving as initial states, these should generate very good forecasts.

We have also completed major programs for imbedded grids designed to be used in conjunction with GATE and for high-resolution short-range forecast experiments utilizing dense data from geostationary sounders. We have completed modification of Dr. Shuman's six-level operational model to run on the GISS 360/95 computer. We will test the model dependence of our results by running the experiments on these two different models, GISS and NMC.

CHAIRMAN:

Are there any questions for Dr. Halem?

MEMBER OF THE AUDIENCE:

I would like to ask whether the improvement in error in going from the Nimbus SIRS radiometer to the future VTPR radiometer on ITOS is due to the improved field of the instrument or to the scanning of the instrument or due to the accuracies. Do you know what the source of the improvement is?

DR. HALEM:

The source is precisely all three of the factors you mentioned. The SIRS has a field of resolution of about 250 km. The VTPR is expected to have a field of resolution of about 60 km. The SIRS did not have what we call true side-scan coverage, having what was really a side stepping along the vertical path. The VTPR will provide us with the side-scanning coverage so that we will have almost contiguous coverage of the Earth in 12 hr. And, finally, with this improved vertical resolution, we do expect to get better accuracy in the retrievals, mainly because we expect to see through more clouds.