14C.6 Hurricane Model Initialization with AMSU Measurements

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1. INTRODUCTION

Currently, numerical simulations of hurricanes normally require bogusing of a vortex into the large-scale analysis field as an initialization procedure. A scheme was developed to produce hurricane vortices using the Advanced Microwave Sounding Unit (AMSU) data (Zhu et al. 2002). Recently, several major improvements were made to the scheme. The new scheme is applied in Hurricane Isabel (2003) case study to test the effectiveness and impact of this scheme.

2. RETRIEVING TEMPERATURE

Previously, the temperature retrievals were made by a statistic regression algorithm. There were 15 sets of regression coefficients derived separately for each scanning angle. In the new scheme, an entirely physically based one-dimension variation method (1DVAR) is used to retrieve atmospheric temperature profiles. It is found that the new retrieval scheme can obtain a horizontally smoother temperature field without discontinuity between each scanning angle. In addition, the new 1DVAR retrieval system includes a radiative transfer model, which contains emission and scattering components of surface and atmosphere. Figure 1 shows a vertical cross section of atmospheric temperature anomalies for Hurricane Isabel. The areas of cold anomalies are significantly reduced as compared with that from emission-based retrieval (not shown). We think this is a major improvement because the brightness temperature depression in strong rainfall areas is due partially to precipitation scattering. The melting and evaporation processes associated with cloud/raindrops below 500 hPa can also result in a cooling to the atmospheric temperature which further depresses brightness temperature at the AMSU sounding channels. Our new retrieval is able to identify this physical cold anomaly.

This AMSU derived temperature fields are then assimilated into the NCEP GFS data assimilation system (GDAS) to produce a best analysis of three-dimension atmospheric temperature field within the storm and its environment. Assimilation of the AMSU derived temperatures into NWP analysis fields are generalized by using AMSU derived temperature anomaly field, rather than the temperature itself. This will make our scheme applicable for any NWP model outputs. Figure 2 compares the 200-hPa temperatures from GDAS analysis and the re-analysis after the assimilation of AMSU temperatures. Note that a warm-core is added to Hurricane Isabel center (Fig.2b), which cannot be found in the original GDAS analysis field (Fig.2a). We can also see that the areas with the assimilated AMSU temperatures can be smoothly connected to the background regions with GDAS analysis.

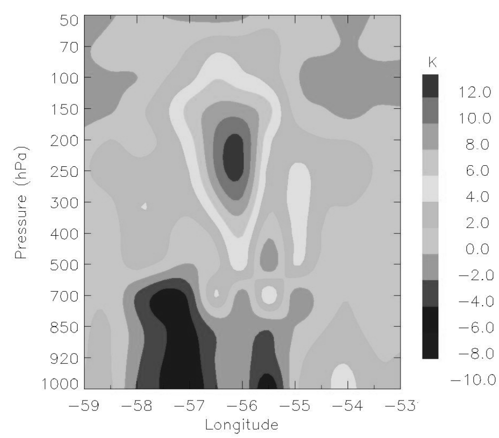

Figure 1. AMSU 1DVAR retrieval of atmospheric temperature anomalies for Hurricane Isabel at 0600 UTC 12 Sep 2003.

3. INVERTING WIND FIELD

The rotational and divergent winds are obtained by solving the nonlinear balance and omega equations using the GDAS analysis as the lateral boundary conditions. We found that the present scheme significantly improve the GDAS analysis by adding obvious vortex features. These features are mostly needed when the hurricanes are simulated at higher spatial resolutions. The retrieved wind filed at surface can be validated using the NOAA/AOML/HRD surface wind analysis (see Fig. 3). Both wind fields show strong

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asymmetric structures with maximum wind located at the east side of the storm; and the maximum winds are around 90 Knots. Because the time for HRD surface wind analysis is 1.5 hours later than that of AMSU derived winds, the center of the maximum wind is shifted cyclonically to northwestward. The AMSU derived radius of maximum wind (about 100 km) and the vortex central location are also in good agreement with that of HRD surface wind analysis. A big difference between these two wind fields is that the strong winds region for AMSU retrieved winds is broad than that of HRD analysis.

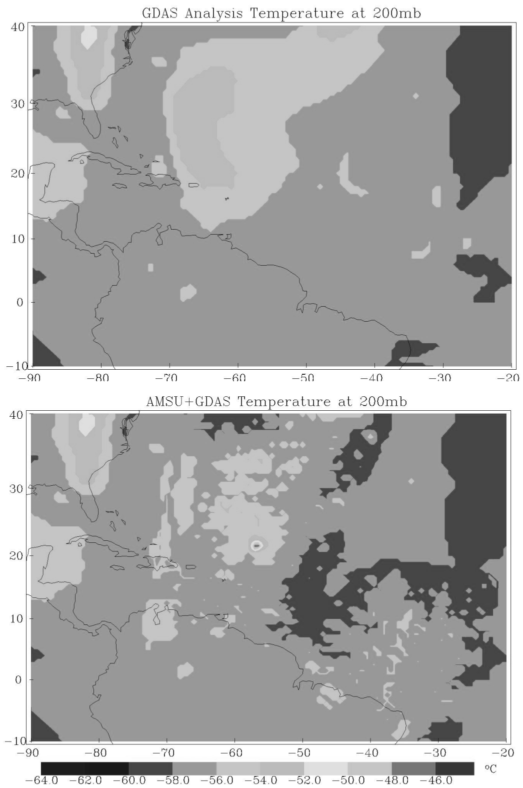

Fig. 2. Atmospheric temperatures at 200 hPa at 0600 UTC 12 Sep 2003 from (a) GDAS analysis (b) AMSU 1DVAR retrieval.

4. CONCLUDING REMARKS

After testing the improved hurricane vortices construction scheme, we find that the new 1DVAR temperature retrieval scheme can produce better atmospheric temperature field without discontinuity between each scanning angle. The lower level cold anomalies are reduced because of the use of a scattering radiative transfer model. The AMSU retrieved temperatures are assimilated into GDAS analysis field by using the retrieved temperature anomalies. As a result, the regions with assimilated AMSU data can smoother transfer to background field.

In general, the AMSU derived surface wind field is in reasonable agreement with that of HRD surface wind analysis in the following four aspects: the asymmetric structure, the magnitude of maximum wind, the radius of maximum wind and the vortex central location. Using the above derived hurricane vortex fields as model initial conditions, impact studies are undergoing with a mesoscale model such as Weather Research and Forecasting (WRF) model. More results will be presented in the conference.

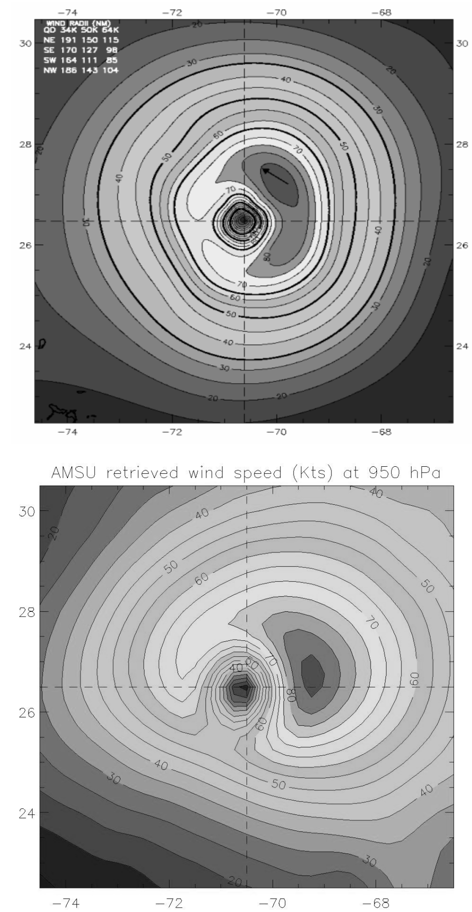

Fig. 3. (a) NOAA/AOML/HRD surface wind analysis for Hurricane Isabel at 0730 UTC 16 Sep and (b) AMSU derived wind speed (Knots) at 950 hPa at 0600 UTC 16 Sep 2003.

5. ACKNOWLEDGMENTS

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6. REFERENCES

Zhu, T., D.-L. Zhang, and F. Weng, 2002: Impact of the advanced microwave sounding unit measurements on hurricane prediction. *Mon. Wea. Rev.* **130**, 2416-2432.