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JP2.2 CLOUD/HYDROMETEOR INITIALIZATION FOR THE 20-KM RUC USING SATELLITE AND RADAR DATA

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1. INTRODUCTION

The cloud-top pressure data assimilation technique (Kim and Benjamin 2000) developed for the Rapid Update Cycle has been implemented in an updated version with the 20-km version of the RUC (Benjamin et al. 2001). The GOES sounder-based cloud-top data remains the same as that used in 40-km RUC testing, but is now applied to the finer 20-km grid. In this paper, we report on the 20-km application of the RUC cloud analysis and also look ahead to the next step of assimilation of radar reflectivity. As described below, intercomparison of satellite and radar data will be necessary for quality control.

2. 20 KM CLOUD ANALYSIS

The 20-km version of RUC uses bulk mixed-phase cloud microphysics scheme from the NCAR/Penn State MM5 model, with 5 hydrometeor types explicitly forecast (Brown et al. 2000). An upgraded version of this scheme is being implemented along with the rest of the 20-km RUC at NCEP.

The RUC 1-h predicted hydrometeor mixing ratios provide background fields to be modified using the GOES sounder-based cloud-top pressure data (Menzel and et al. 1998). A threshold value (10^{-8} g g^{-1}) of hydrometeor mixing ratio determines predicted cloud-top pressures at each grid point. Then, the GOES cloud-top data are used to determine whether hydrometeors have to be added or cleared. Since the cloud-top pressure does not include cloud thickness, we use a conservative cloud thickness of 50 hPa for cloud building. For cloud clearing, hydrometeor mixing ratios are set to zero, and the water vapor profile is adjusted such that it does not exceed 50% in relative humidity in the cleared part of the column. Routine monitoring of the RUC 20-km cloud analysis in testing shows that the number of grid points at which there is cloud clearing is almost the same as that for cloud building. Due to concern about accuracy of low clouds from the GOES cloud-top product, no cloud building is done at pressures greater than 700 hPa.

An example of cloud top pressure from the 20-km RUC in Fig. 1 shows evidence of details introduced by the assimilation of NESDIS cloud-top pressure data. Figure 2 is the 3-h forecast of the same field from the 20km RUC. A visual comparison shows some accuracy in the cloud forecast and less fine-scale structure. The actual NESDIS cloud product, composited from GOES-8 and 10, is shown in Fig. 3. An experimental single field-of-view cloud product is available from NESDIS, but has not yet been tested in the RUC cloud analysis.

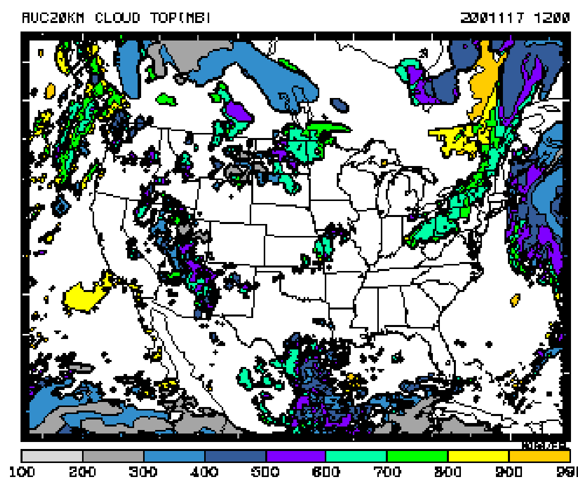

Fig. 1. Cloud-top pressure - 20-km RUC analysis - 1200 UTC 27 Apr 2001 including GOES cloud-top assimilation. Analysis is performed within GOES sounder scan coverage (Fig. 3).

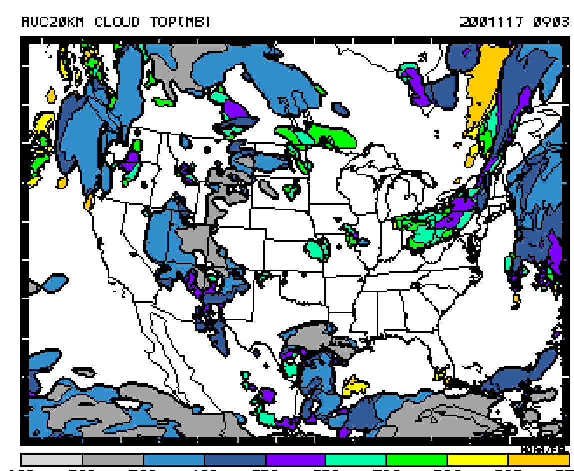

Figure 2. Same as Fig. 1, but from 3-h forecast from 20-km RUC valid at 1200 UTC 27 April 2001.

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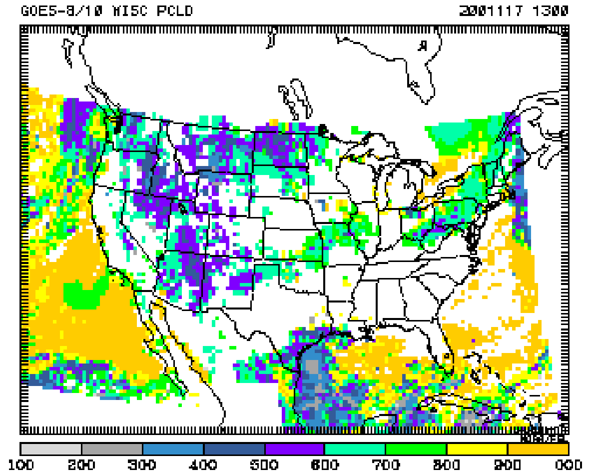

Figure 3. NESDIS cloud-top pressure data valid at 1300 UTC 27 April 2001. The data are processed on the 40-km RUC grid using nearest neighbor selection.

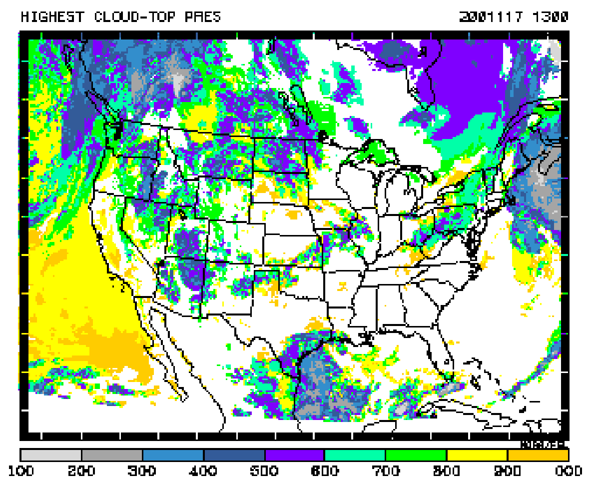

Figure 4. Hourly cloud product GOES imager data and 20-km RUC forecast. The highest cloud-top pressure is plotted in case of multilevel clouds.

3. GOES IMAGER AND RADAR DATA

An imager-based GOES cloud product on the 20-km RUC grid is also produced every hour (Fig. 4). A description of this product is given in Kim and Benjamin (2000). Comparison of the GOES sounder-based cloud product (Fig. 3) and the GOES imager-based cloud product (Fig. 4) shows strong resemblance. Advantages of using imager data include better spatial coverage in the RUC domain, ingest frequency (15 min.) and higher resolution (4 km). The higher ingest frequency helps in reducing temporal sampling error, and higher spatial resolution refine spatial variability of clouds.

While we are developing methods of combining imager and sounder data for better description of the cloud field, we also envision this product as a screening tool for national-scale radar reflectivity data, which are prone to problems such as ground clutter and freezing-level bright bands. Any nonzero reflectivity reported by radar can be checked against the imager-based cloud product. For example, low level echoes in western Iowa in Fig. 6 do not show consistency with clouds in Fig. 3.

We use a simple forward model to compute reflectivity (dBz) from model-predicted hydrometeors (rain, ice, snow, and graupel) and compare with WSI's national reflectivity data. The highest pressure level of reflectivity greater than 5 dBZ using this forward model is the estimated echo-top (Fig. 5, 3-h forecast from 20-km RUC valid 1200 UTC 27 April). This can be compared with the WSI echo-top product (Fig. 6). Preliminary investigation shows that intercomparison between satellite and radar products for consistency will be critical for effective assimilation of these data. Unlike cloud-top pressure, radar data may be assimilated through deeper layers by use of both echo-top and vertically integrated liquid water content data.

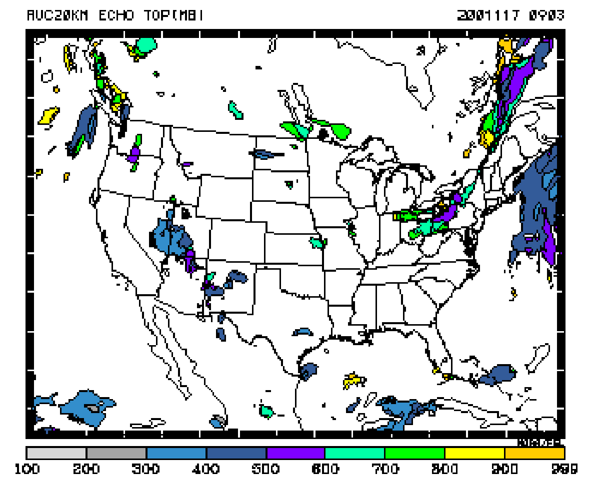

Figure 5. 20-km RUC predicted echo-top valid as 12 UTC 27 April 2001. This field will serve as a first guess to be modified by radar echo-top field.

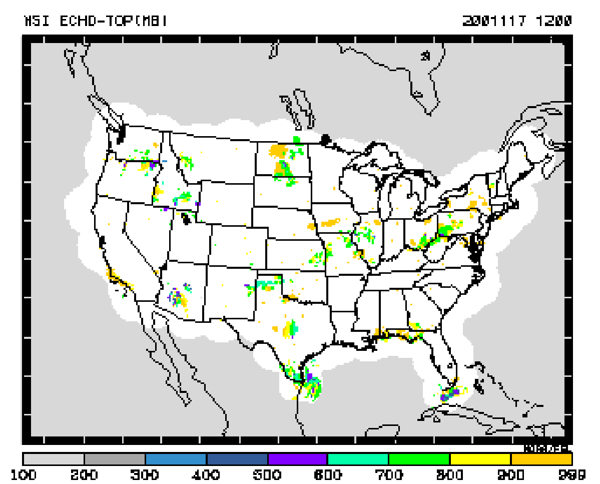

Figure 6. National scale WSI's echo-top product converted into pressure level. Shaded area are outside of NEXRAD coverage.

4. ACKNOWLEDGMENTS

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