CGMS-34, NOAA-WP-34
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Agenda Item: II/3
Discussed in WG2

PRIORITIES FOR FUTURE SATELLITE PRODUCT DEVELOPMENTS RELATED TO THE USE OF CLOUDY RADIANCE IN NWP

In response to CGMS Action 33.16

NOAA Response to CGMS XXXIII Action 33.16

Priorities for Future Satellite Product Developments Related to the Use of Cloudy Radiance in NWP

1 Introduction

CGMS Action 33.16: The ITWG should also help to formulate priorities for future satellite product developments related to the use of cloudy radiance in NWP. The ITWG Rapporteur should inform the ITWG co-chairs of this new action (Rapporteur: F. Weng)

2 NOAA Response to CGMS XXXIII Action 33.16

In the US Joint Center for Satellite Data Assimilation, the following actions have been taken

1. Develop a community radiative transfer model (CRTM) that includes forwarding and tangent linear/adjoints (or jacobians) simulations of clouds and precipitation (Han, et. Al, 2006). Initially, the CRTM clouds and precipitation simulations are achieved in thermal wavelengths from infrared and microwave regions. These adjoint models must be validated for their intended applications, not just in the limit of infinitesimal perturbations.
2. Construct sets of high-quality satellite and associated in-situ observations, the latter including condensate sizes and shapes, to fully assess the CRTM performance. The US Cloudsat program will collocate the observations with NWP model outputs and other satellite measurements (AMSR-E, AIRS, AMSU, SSMIS), and ARM sites. The biases and standard deviations of simulated radiances under cloudy conditions are being fully characterized.
3. Improve modeling of moist physical processes in cloud resolving models, especially convection (which will inherently be influenced by the dynamics in the model). Such advances would lead to satellite-based precipitation structure retrievals that better represent the underlying cloud state.
4. Exploit millimeter-wave sounding channels (e.g., Advanced Microwave Sounding Unit-B, Special Sensor Microwave Imager Sounder (SSMIS)) with improved sensitivity to snow and drizzle to retrieve these variables..
5. Standardize 1dvar processing capability that retrieves all hydrometeors profiles in addition to temperature and water vapor profiles. Such software (microwave integrated retrieval system, MIRS) is being developed at NESDIS and other NWP centers
6. Alternative experiments called cloud-cleared radiance process have been demonstrated successfully for improved uses of infrared sounding data in NWP models. The experiments will lead to standardization of cloud-cleared processing software and to directly assimilate cloud-cleared radiances by current 3dvar and 4dvar systems that do not include moisture physics.

Several experiments have been conducted at the JCSDA, including WRF-GSI analysis for Hurricane Katrina (Liu and Weng, 2006) and Hybrid Variational (HVAR) Analysis Approach (Weng et al, 2006). A study used Gridpoint Statistical

Interpolation (GSI) scheme from National Center for Environmental Prediction (NCEP) and Weather Research and Forecasting (WRF) model for hurricane studies. The in June 2006 released GSI included the newly developed Community Radiative Transfer Model (CRTM) for both clear and cloudy radiance assimilation. We utilized conventional observations and satellite radiances that are currently used in the operational data assimilation. In addition, the Special Sensor Microwave Imager Sounder (SSMIS) radiance is at the first time assimilated in GSI for hurricane studies. A “control-run” using NCEP analysis field and a “test-run” using the new data assimilation are compared in this study. It is shown that “test-run” with SSMIS cloudy radiance assimilation improved the surface minimum pressure forecasting and the initial temperature field contained the important features associated with clouds in hurricanes (Figure 1). Both “control-run” and “test-run” can predict the central location of Hurricane Katrina within 60 km for the first 30 hours. The error in forecasting the central location after 30-hour grew up dramatically for the “control-run” while the error for “test-run” is stable for the entire 48-hour forecasting. The forecasting surface minimum pressure and maximum wind speed from “test-run” in general agree with observations better. Results for the “test-run” also showed that the warm core at 200 hPa is strengthened and extended as Hurricane Katrina was developing toward its mature stage, which consisted with SSMIS observations.

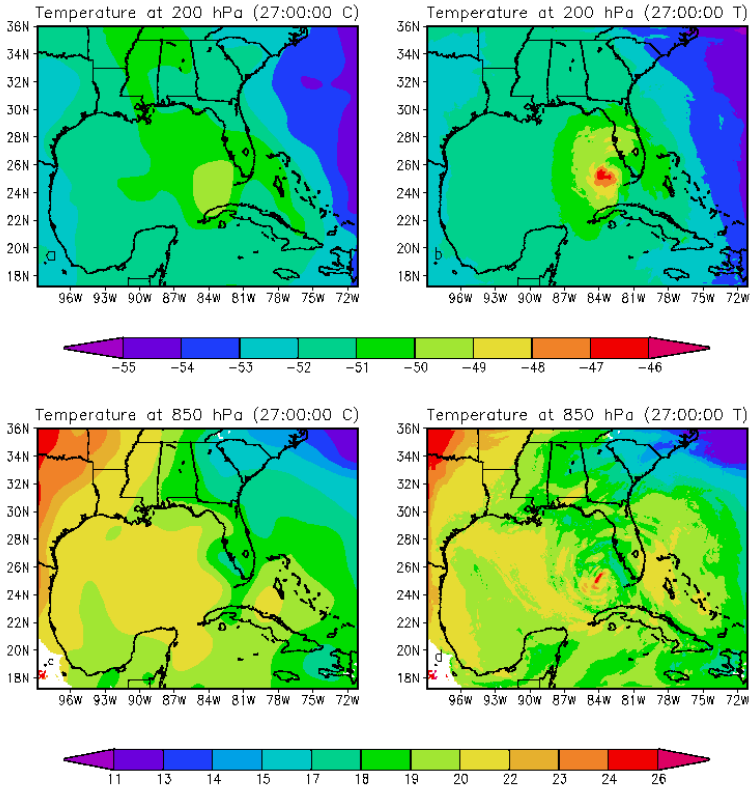

Figure 1. The initial temperature field at 200 hPa for the “control-run” (a), “test-run” (b), and at 850 hPa for the “control-run” (c), “test-run” (d).

In the hybrid variational scheme (HVAR), we produced the vortex analysis associated with tropical storms through direct assimilation of atmospheric temperature and surface parameters retrieved from a one-dimension variational (1DVAR) scheme through use of 4DVAR. The atmospheric temperature information under precipitation

conditions are primarily obtained from Advanced Microwave Sounding Unit (AMSU) and the surface parameters from Advanced Microwave Scanning Radiometer (AMSR-E). In the 2005 hurricane season, the HVAR was applied for two hurricane cases, resulting in improved analyses of their three dimension structures of temperature and wind fields than operational forecast model outputs. It is found that HVAR reproduces detailed structures for hurricane warm core at upper troposphere within rainfall bands (Figure 2). Both lower-level wind speed and upper-level divergence are also enhanced with reasonable asymmetric structure.

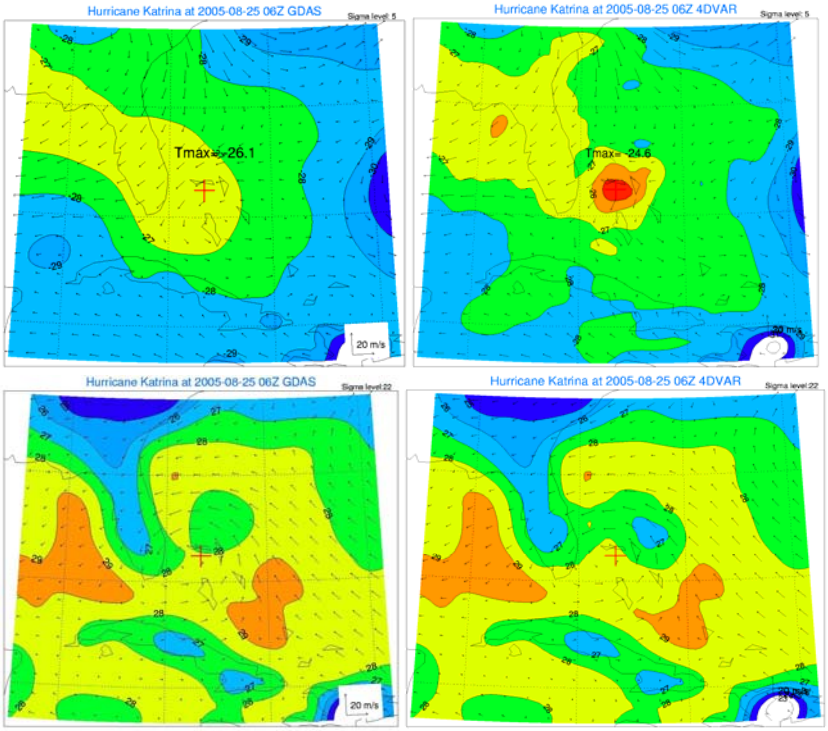

Figure 2. The temperature and wind fields at 250 hPa from (a) GDAS analysis, (b) hybrid variational (HVAR) scheme, and the temperature and wind fields at surface level from (c) GDAS analysis, and (d) HVAR variational scheme for Hurricane Katrina at 0600 UTC 25 August.

References

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