Adaptations of Gridpoint Statistical Interpolation for the Rapid Refresh System

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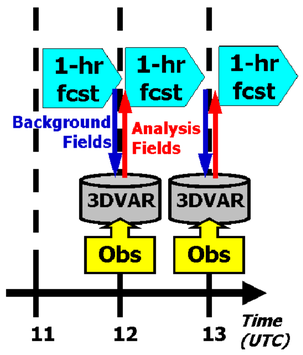
Overview

The Rapid Update Cycle (RUC) is a regional data assimilation and forecasting system that has been running at the National Centers for Environmental Prediction (NCEP) since 1994. Producing analyses of atmospheric conditions and short-range forecasts every hour, it serves the needs of air and ground transportation, hazardous weather prediction, and routine forecasting for the general public.

A new, more advanced version for rapid updating called Rapid Refresh (RR) is under development at ESRL/GSD. In RR, NCEP's Gridpoint Statistical Interpolation (GSI) scheme will be adapted for regional data assimilation.

GSI is capable of assimilating a large variety of atmospheric observations, especially those from satellites—a major attraction. NCEP is still refining GSI, with contributions from several institutions, including NASA and NOAA/ESRL. Some recent results of GSI adaptation are presented below.

The RUC One Hour Cycle



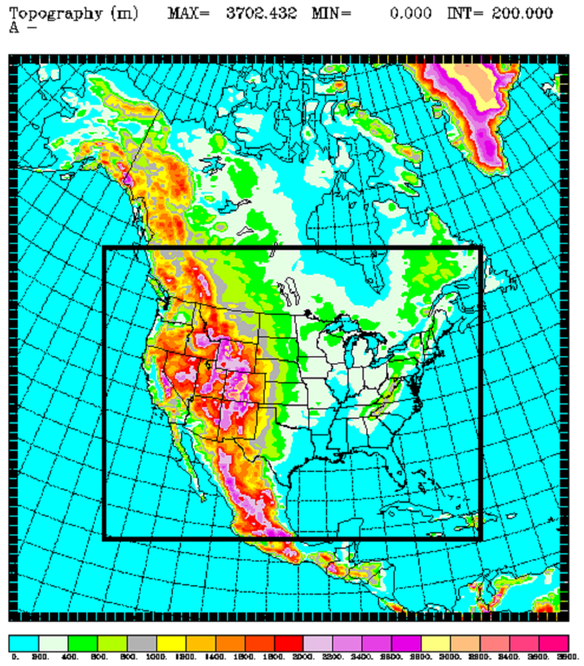
The 1-h RUC data assimilation cycle. The RUC generates a new 12-h forecast every third hour and 9-h forecasts at all other hours. For documentation, operational and experimental real-time forecasts from RUC, see http://ruc.noaa.gov.

RR will be a new system

> New analysis method based on GSI
> New dynamical core based on WRF
> New, enlarged domain

RR will retain RUC features

> One hour assimilation cycle
> Analysis of hydrometeors/clouds
> Good balancing of mass and wind fields
> Observation quality control



The RUC (smaller inner rectangle) CONUS domain and planned RR (larger outer rectangle) domain.

Recent Experiments with GSI in Rapid Refresh Framework

1) Satellite radiance assimilation experiment - RR domain is much larger than RUC domain and data coverage is uneven. Over oceans and sparely populated land, satellite data are important.

2) Application of anisotropic background error term in order to take into account situation dependence. Especially important in the planetary boundary layer to restrict appropriately obs influence at higher levels.

3) Surface-layer data assimilation - the NCEP code, based on similarity theory, is only partly exercised. It has many empirical and a few ad hoc features that are poorly tied to theory. We mostly ignore for now.

4) Real time cycling - at present, we run a 12-hour cycle over the RR domain.

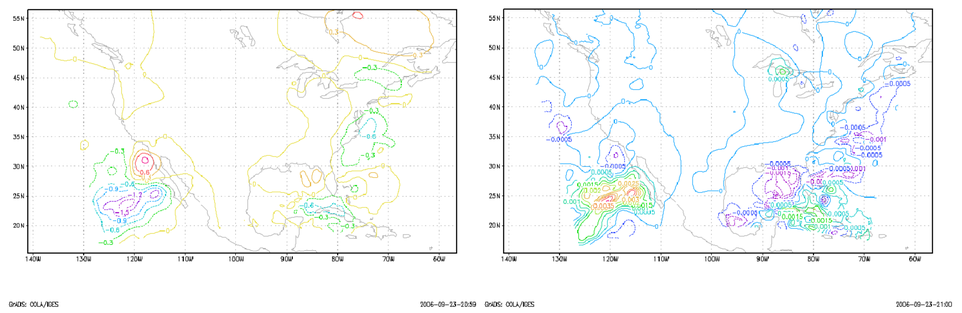
Satellite Data Experiments for Rapid Refresh

Both HIRS and MSU

Use of Community Radiative Transfer Model (CRTM)

Preliminary experiments with satellite files from the North American Model (NAM) over CONUS domain using RUC background fields

Case of 1200 UTC 11 April 2006

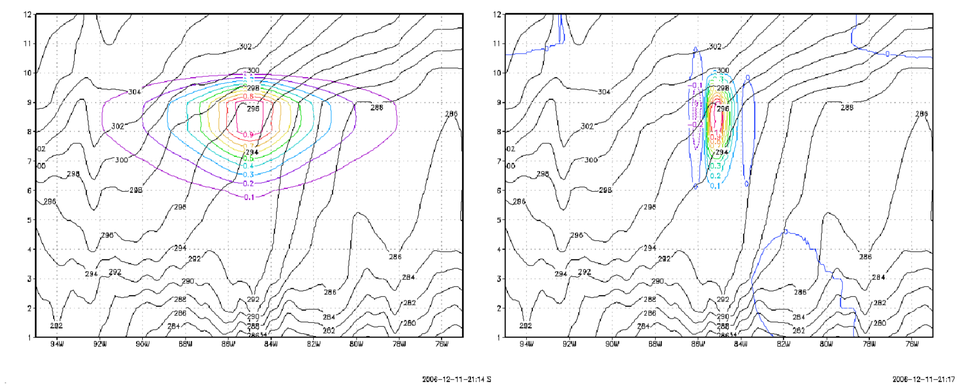


Difference between satellite and no satellite data for analysis

Left: potential temperature (K)
Right: specific humidity (g/g). In satellite case, all available satellite radiance information is used. Model level = 10 (~825 hPa).

Anisotropic Background Term Experiments

Spread of impact from observations might be influenced by using information from the forecasted potential temperature and/or application of a specially selected weight function.



Spread of impact from 1C temperature perturbation at 850 hPa level

Left: original isotropic structure function.
Right: modified spread using forecasted potential temperature (black curves) and linear weighting function. Background is 1-h RUC forecast valid at 15 July 2006, 00 UTC. Vertical cross section is along 46N.

Summary

Preliminary experiments to assimilate satellite radiance data into the Rapid Refresh have produced reasonable analysis increments. Further real-time experiments are in progress. Anisotropic background term experiments are promising. Approach will be part of future operational system. Surface-layer data assimilation is rather primitive but adequate for now. Real time cycling shows stable behaviour. Cycle frequency of six hours will begin very soon. Final target is one-hour cycle.