Update of radiance assimilation in NCAR/AFWA

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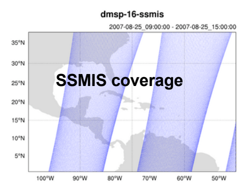
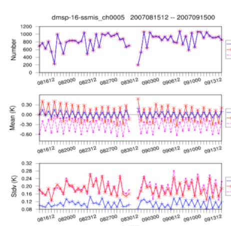
Introduction

A general radiance assimilation capability has been developed in WRF variational data assimilation system during the last few years and was made publicly available with the WRF 3.1 release in April 2009 for research community and operational applications. The results for assessing the impact of SSMIS and AIRS radiances are presented here. Recent developments and preliminary results on assimilation of cloud and precipitation affected radiances are also shown.

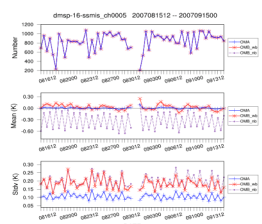
SSMIS/AIRS impact

- Horizontal resolution is 15 km
- Model top is 10 hPa
- 6 hourly full cycling assimilation/forecast experiments from 15 August to 15 September 2007, i.e., the background field is a 6h WRF-ARW forecast initialized from the previous analysis cycle. LBC is from GFS forecasts.
- 3 Experiments:
  - GTS (only assimilate conventional obs)
  - GTS+SSMIS (assimilate conventional obs plus SSMIS channels 3~6 and 9~11 only over sea)
  - GTS+SSMIS+AIRS (add more AIRS T sounding channels).
- Radiances assimilation configurations
  - use CRTM1.1, 90km thinning, VarBC
  - F16 SSMIS covers 00Z/12Z; AIRS covers 06Z/18Z

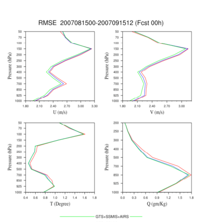


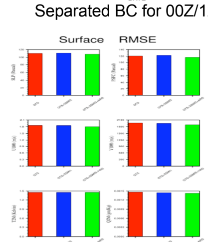


Non-separated BC for 00Z/12Z



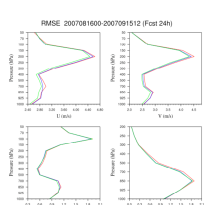
Separated BC for 00Z/12Z

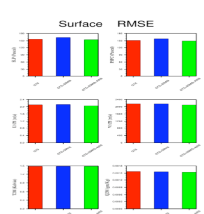




RMS of analysis error vs. ECMWF analysis

Upper-air Surface





RMS of 24h forecast error vs. ECMWF analysis

Upper-air Surface

Positive impact for upper air U, V, T and Q when adding SSMIS and AIRS radiances

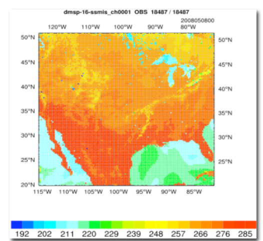
Assimilation of cloud/precipitation affected radiances: with simulated observations

With a 3DVAR:

–Use total water Qtotal=Qvapor+Qrain as control variable

–Use a warm-rain physics as well as it AD for partitioning Qt increment into Q and Rain.

–Simulated SSMIS Tbs (Channels 1~6, 8~18)

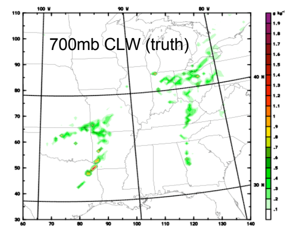


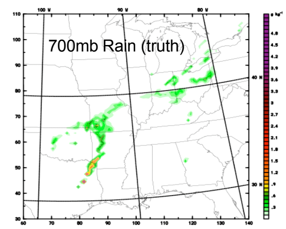
Simulated Tbs in each grid point by applying cloudy CRTM. The case is taken from a 9km convective forecast valid at 2008050800.

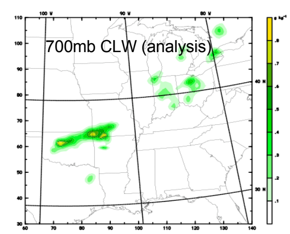
Resolution is thinned to 27km.

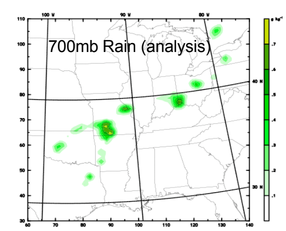
Cloud liquid water and rain are only Hydrometeors considered for meeting assumption of assimilation scheme.

Analysis starts from a cloud-free background









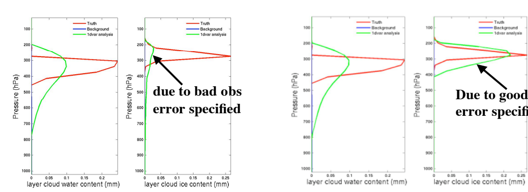
With a 1DVAR: non-precipitating case

Simulated radiances from a cloudy profile (cloud water and clo ud ice) taken from the same convective case as 3DVAR:

HIRS channels 4~8 (sensitive to ice cloud)

AMSU-A channels 1~6 (affected by water cloud)

1DVAR iterations start from a cloud-free background profile

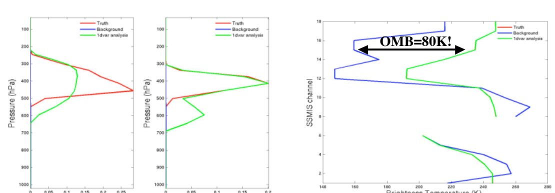


With a 1DVAR : precipitating case

Simulated radiances from a precipitating profile (cloud water a nd rain) taken from the same convective case as 3DVAR:

SSMIS channels 1~6, 8~18 (similar to that 3DVAR condition)

1DVAR iterations start from a cloud-free background profile



1DVAR did good job for retrieving cloud and precip. information.
NOTE: Our 1DVAR is a non-incremental implementation with a quasi-Newton algorithm. More appropriate for non-linear problem.