

Radiance Data Assimilation for WRF model : Overview and Results

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Introduction

A general framework of satellite radiance assimilation in Weather and Research Forecast Variational Assimilation (WRF-Var) system was implemented in the past three years (Liu and Barker, 2006). The system incorporates both CRTM and RTTOV into WRF-Var system. This poster summarizes current status of radiance assimilation in WRF-Var with some demonstrations for basic components. The results from some case study and extended tests are also shown.

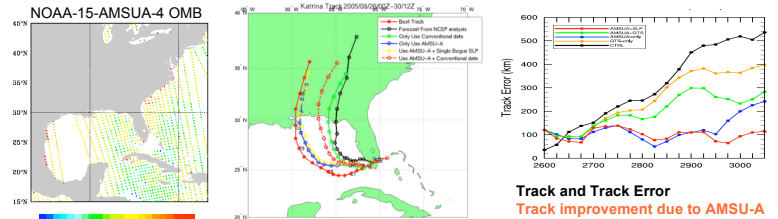
Radiance Assimilation Status

- Data Ingestion**
 - NCEP radiance BUFR data, including AMSU-A/B, MHS, HIRS, AIRS
 - SSMIS from AFWA/NRL, UPP produced
- Radiative Transfer Model**
 - Both CRTM_1.1 and RTTOV8_7 are incorporated into WRF-Var
- Bias Correction**
 - Scan bias and air-mass bias (Harris and Kelly, 2001)
 - Variational Bias Correction (Derber and Wu, 1998)
- Quality Control:**
 - AMSU, MHS, SSMIS: Scatter Index and Background CLWP for precipitation check
 - AIRS: Multivariate Minimum Residual (MMR) scheme for cloud detection
- Thinning**
 - Pick one pixel closest to the center of the box for AMSU, MHS, SSMIS
 - Pick the warmest pixel for AIRS
- Load Balancing (only for RTTOV currently)**
- Observation error tuning (Desroziers & Ivanov, 2001)**
- Monitoring tool: useful for research and operational implementation**
- Work for 3DVAR/FGAT/4DVAR**
- Initial Cloudy Radiance Assimilation Capability with CRTM**
 - CRTM Forward, TL and AD modules for cloudy radiance implemented in WRF-Var.

Katrina Case at 00Z 26th Aug. 2005

Model: WRF-ARW with 12km*51L, (not nested), model top at 10hPa, WSM3 Assimilation Experiments: WRF 6h forecast as the background, 4 exps.

- (1) **GTS** (only conventional data);
- (2) **AMSU** (only AMSU-A data, channels 1-4 over sea, channels 5-10 over land and sea);
- (3) **GTS+AMSU**
- (4) **AMSU+SLP** (AMSU-A plus a single sea level pressure obs)

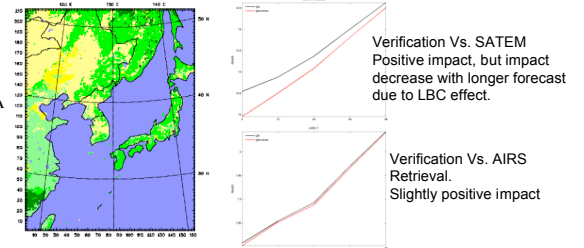


DATC Extended Testbeds

DATC: Data Assimilation Testbed centers, extended tests for pre-operational implementation
Testbeds: East Asia, Atlantic, Antarctic etc., full cycling experiments for radiance impact evaluation

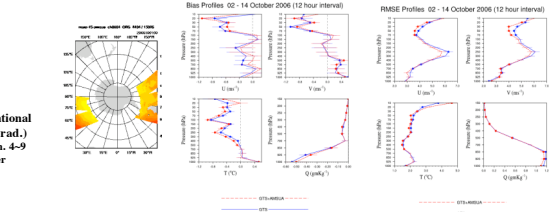
East Asia Testbed:

- 162°212°42L, 15km
- model top: 50mb
- Full cycling exp. for a month
- 1 ~ 30 July 2007
- GTS+AMSU
 - NOAA-15/16, AMSU-A/B from AFWA
 - AMSU-A: channels 5-9 (T sensitive)
 - AMSU-B: channels 3-5 (Q sensitive)
 - Radiance used only over water
 - thinned to 120km
 - +2h time window
 - Bias Correction (H&K, 2001)
- Compare to GTS exp.
- Only use GTS data from AFWA
- 48h forecast, 4 times each day
- 00Z, 06Z, 12Z, 18Z



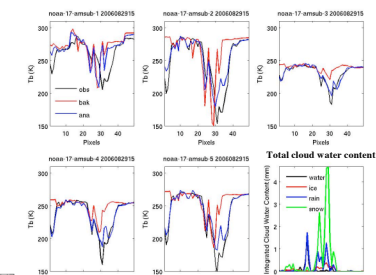
Antarctic Testbed:

- 57L, 60km
- model top: 10mb
- Full cycling exp. for 14 days
- 1 ~ 14 October 2006
- GTS: assimilate NCAR conventional
- GTS+AMSU-A (NCEP BUFR rad.)
 - NOAA-15/16/18, AMSU-A, ch. 4-9
 - Radiance used only over water
 - +2h time window
 - Bias Correction (H&K, 2001)



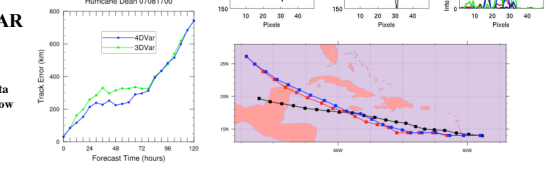
Initial Cloudy Radiance Capability

- CRTM cloudy radiance Forward/TL/AD calculation interface implemented
- Particle size is diagnosed from cloud water content
- No hydrometeor control variables available in WRF-3DVAR, instead Total Water (Qt) as control variable, and a warm-rain process' TL/AD is used to partition Qt into cloud water and rain (Xiao et al., 2007) in 3DVA (Warm-rain process limits the application)
- Initial test with WSM3 microphysics scheme for hydrometeors forecast with a 4km resolution
 - Include cloud water/ice, rain/snow, no mixture phase



4DVAR Vs. 3DVAR

- 45km resolution
- 4DVAR is still very slow
- 57L levels, model top = 10mb
- Only assimilate radiance data (AMSU/MHS), 6h time window
- Use CRTM and a static bias correction

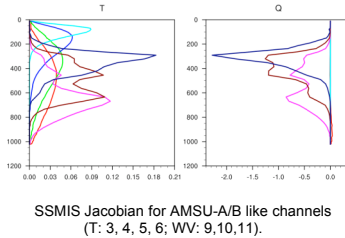
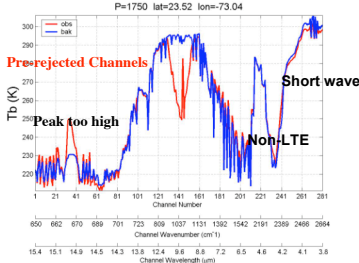
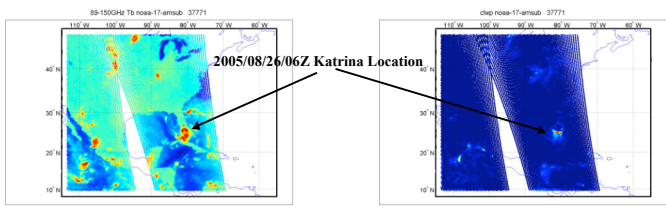
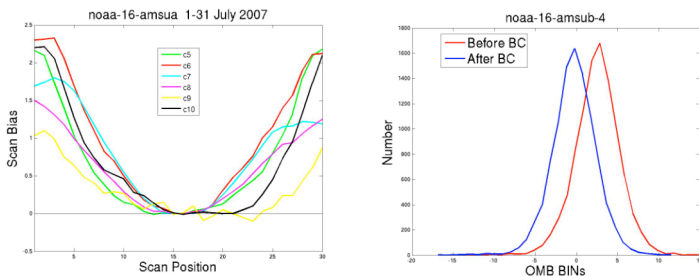


Future Plans

- Add more instruments, IASI, GOES platforms etc.
- Tune the system for various testbeds
- Further developments for cloudy radiance assimilation and 4DVAR+radiance
- Explore ensemble-based radiance assimilation

Reference

Liu, Z.-Q. and Barker, D. M., 2006. Radiance Assimilation in WRF-Var: Implementation and Initial Results. 7th WRF users' workshop, Boulder, Colorado, 19-22 June 2006.
http://www.mmm.ucar.edu/wrf/users/workshops/WS2006/abstracts/Session04/4_2_Liu.pdf



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Madison, WI, University of Wisconsin-Madison, Space Science and Engineering Center,
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