Progress and plans for the use of radiance data in the NCEP global and regional data assimilation systems

John Derber[1] ,Andrew Collard[2], Li Bi[2], Paul van Delst[2], Dave Groff[2], Jim Jung[5], Xu Li[2], Emily H. C. Liu[3], Haixia Liu[2], Rahul Mahajan[2], Cathy Thomas[2], Russ Treadon[1], Xiaoyan Zhang[4], Yanqiu Zhu[2]

[1]NOAA/NCEP/EMC [2]IMSG@NOAA/NCEP/EMC [3]SRG@NOAA/NCEP/EMC [4]ESSIC,University of Maryland
[5]University of Wisconsin

Satellite Data Usage at NCEP

Global and Regional Models:

- GOES-15 Sounder
  - Channels 1-15
- SEVIRI
  - Meteosat-10 Channels 5-6
- AMSU-A
  - NOAA-15 Channels 1-5, 7-10, 12-13, 15
  - NOAA-18 Channels 1-7, 10-13, 15
  - NOAA-19 Channels 1-6, 9-13, 15
  - Metop-A Channels 1-6, 9-13, 15
  - Metop-B Channels 1-13, 15
  - Aqua Channels 6, 8-13
- AMSU-B/MHS
  - NOAA-18 Channels 1-5
  - NOAA-19 Channels 1,2,4,5
  - Metop-A Channels 1-5
  - Metop-B Channels 1-5
- ATMS
  - SNPP Channels 1-14, 16-22
- HIRS
  - Metop-A Channels 2-15 (regional does not use 9)
- AIRS
  - Aqua 93 Channels
- IASI
  - Metop-A 120 Channels
  - Metop-B 120 Channels
- CrIS
  - SNPP 84 Channels
- SSMIS
  - DMSP-17 Channels 1-3, 5-7, 24

Added at 14th January 2015 global model upgrade

14th January 2015 Global Model Upgrade

- Forecast model changed from Eulerian at T574 (approx. resolution 27km) to Semi-Lagrangian T1534 (~13km).
- Analysis resolution remains on a linear grid corresponding to T574 (1152x576 grid boxes)
- A hybrid EnKF-3DVar data assimilation system is used with 75% of the solution prescribed by the ensemble and 25% from the static background error covariance.
- The resolution of the 80 member ensemble has increased from T254 to match the analysis resolution at T574.
  - The ensemble members also benefit from the addition of stochastic physics to help address systematic uncertainties in the forecast model.
- Observation innovations are still computed at the analysis rather than forecast model resolution.

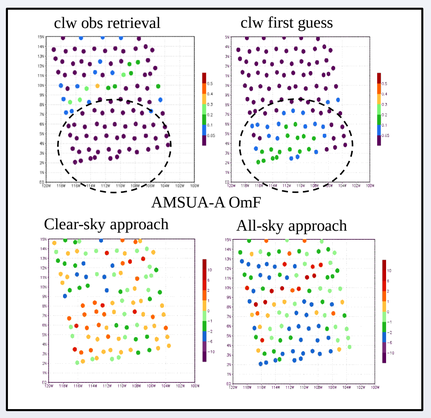
- Microwave radiance assimilation has benefitted from the upgrade to FASTEM-5, resulting in a 2K improvement to the first guess departures in window channels.
- The radiance bias correction scheme has been extended to bring scan-dependent bias correction inside the variational framework in addition to improved preconditioning and the ability to correct passive data. (Zhu et al., 2014)
- The bias correction scheme was also extended to correct biases in the SSMIS sounding channels that depend on the position of the satellite within its orbit.

References

Zhu, Y., Derber, J., Collard, A., Dee, D., Treadon, R., Gayno, G. and Jung, J. A. (2014), Enhanced radiance bias correction in the National Centers for Environmental Prediction's Gridpoint Statistical Interpolation data assimilation system. Q.J.R. Meteorol. Soc., 140: 1479–1492. doi: 10.1002/qj.2233

Upcoming changes for the Spring 2016 Global Model Upgrade

Assimilation of Cloudy Microwave Observations

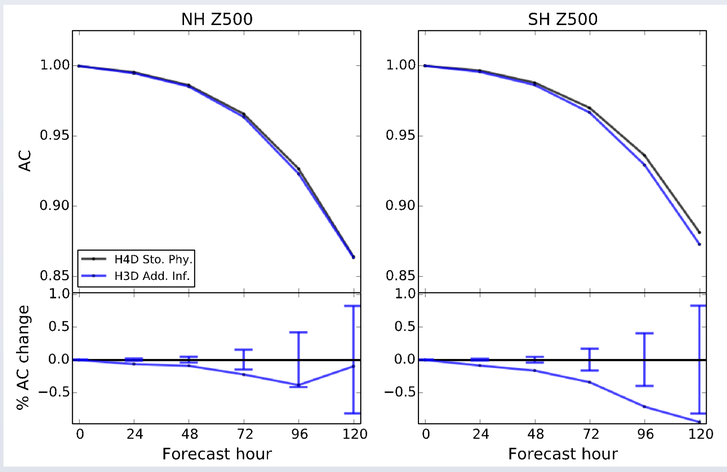


Assimilate cloudy microwave radiances from AMSU-A in non-precipitating conditions.

See presentation by Yanqiu Zhu.

4DEnsVar

- Upgrade from 3DEnsVar hybrid to 4DEnsVar hybrid, i.e., the time variability of the ensemble spread through the assimilation window is now used.
- The relative weighting of ensemble and static background terms is 87.5:12.5 – changed from 75:25.

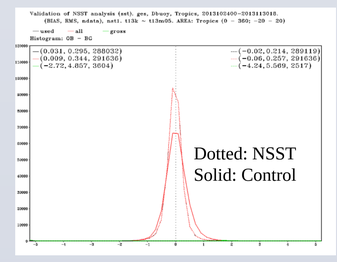


Also

- CRTM v2.2 including the FASTEM-6 microwave surface emissivity model. Better specification of azimuthal dependence of emissivity.
- Temporal thinning: allow observations in the same location but at different times to both be assimilated (to take advantage of the time component of the 4DEnsVar system).
- Assimilation of AVHRR and VIIRS AMVs
- Bias correction of aircraft temperature observations.

Future Development

- Near-Sea Surface Temperature. Analyse ocean foundation temperature through assimilation of conventional and satellite observations within the GSI, explicitly accounting for sea surface cooling and diurnal warming effects. The improved fit to tropical drifting buoys is shown:



- Cloud-cleared radiances for infrared observations (see talk by Haixia Liu)
- Infrared Cloudy Radiance Assimilation (e.g., poster 8P.03 by Xiaoyan Zhang)
- Further extension of usage of hyperspectral infrared radiances (Talk by Andrew Collard and Poster 9P.01 by Jim Jung)
- Further development of CRTM, particularly with cloudy radiance simulation (Poster 2P.03 by Paul van Delst and Poster 8P.01 by Emily Liu).