Outgoing Longwave Radiation Derived from AIRS Radiance Observations

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Goal

- Produce CERES-like OLR from AIRS radiances.
- Extend to IASI and other future hyperspectral sounders.
- Traceable to CERES, later to CLARREO.
- Simplicity with accuracy.
  - Understandable, repeatable, with high confidence!

Method

AIRS OLR – least-squares regression between CERES OLR and AIRS radiance principal component scores.

- The first 35 PCs and 1707 pristine channels.
- Four year AIRS gridded radiances from AIRS near-real-time system.

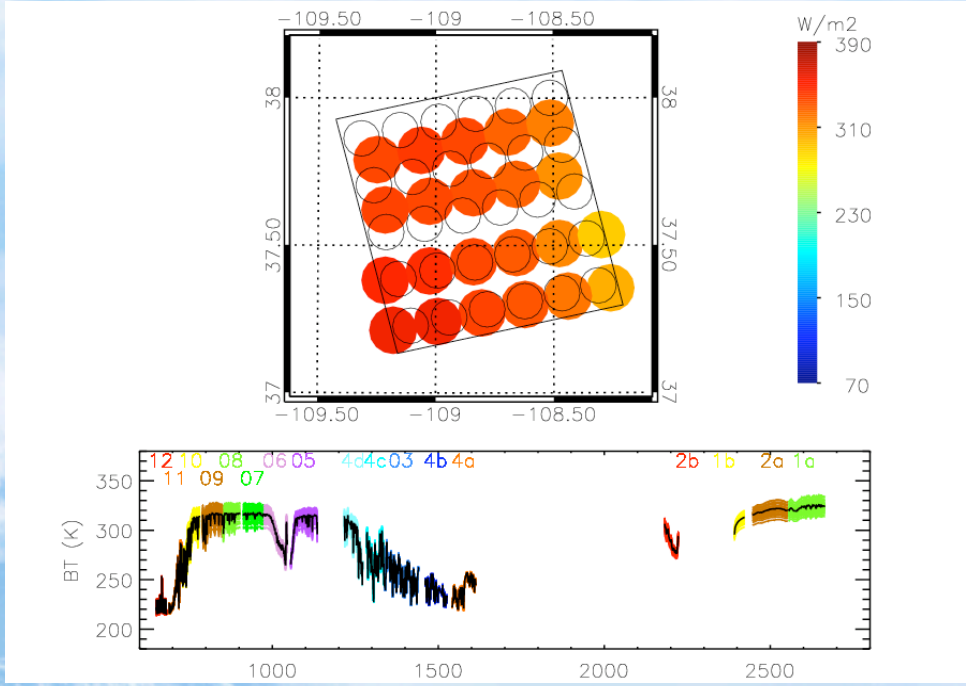
Sun, F., M. D. Goldberg, X. Liu, and J. J. Bates, Estimation of outgoing longwave radiation from Atmospheric Infrared Sounder radiance measurements, J. Geophys. Res., Vol. 115, D09103, doi:10.1029/2009JD012799, 2010.

Upgrade AIRS OLR

- NEW AIRS radiance eigenvectors of 1567 pristine channels:
  - Seven year AIRS level1b granule radiances.
  - Will be used in AIRS version 6 regression retrievals of T(p) and q(p).

- Compared with CERES OLR as a function of cloud fraction (MODIS), atmospheric precipitable water (GMAO) and surface skin temperature (MODIS).

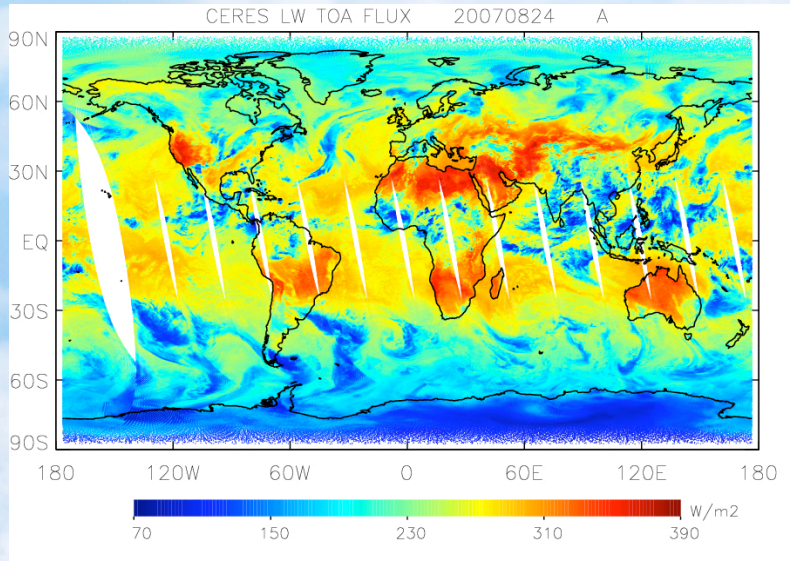
Collocation of AIRS Radiances and CERES OLR

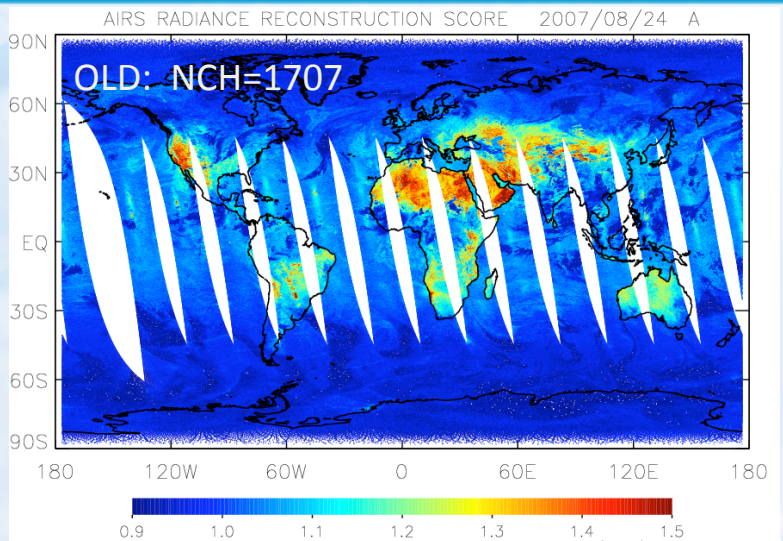


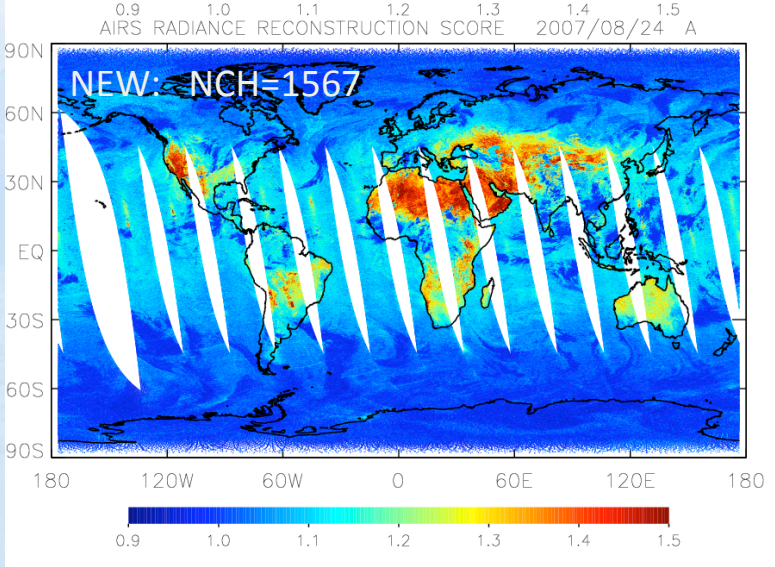
"big box" – 6x5 AIRS FOVs

- Average CERES OLR in "big box".
- Average AIRS spectra in "big box", then do principle component decomposition.

Radiance Reconstruction Scores



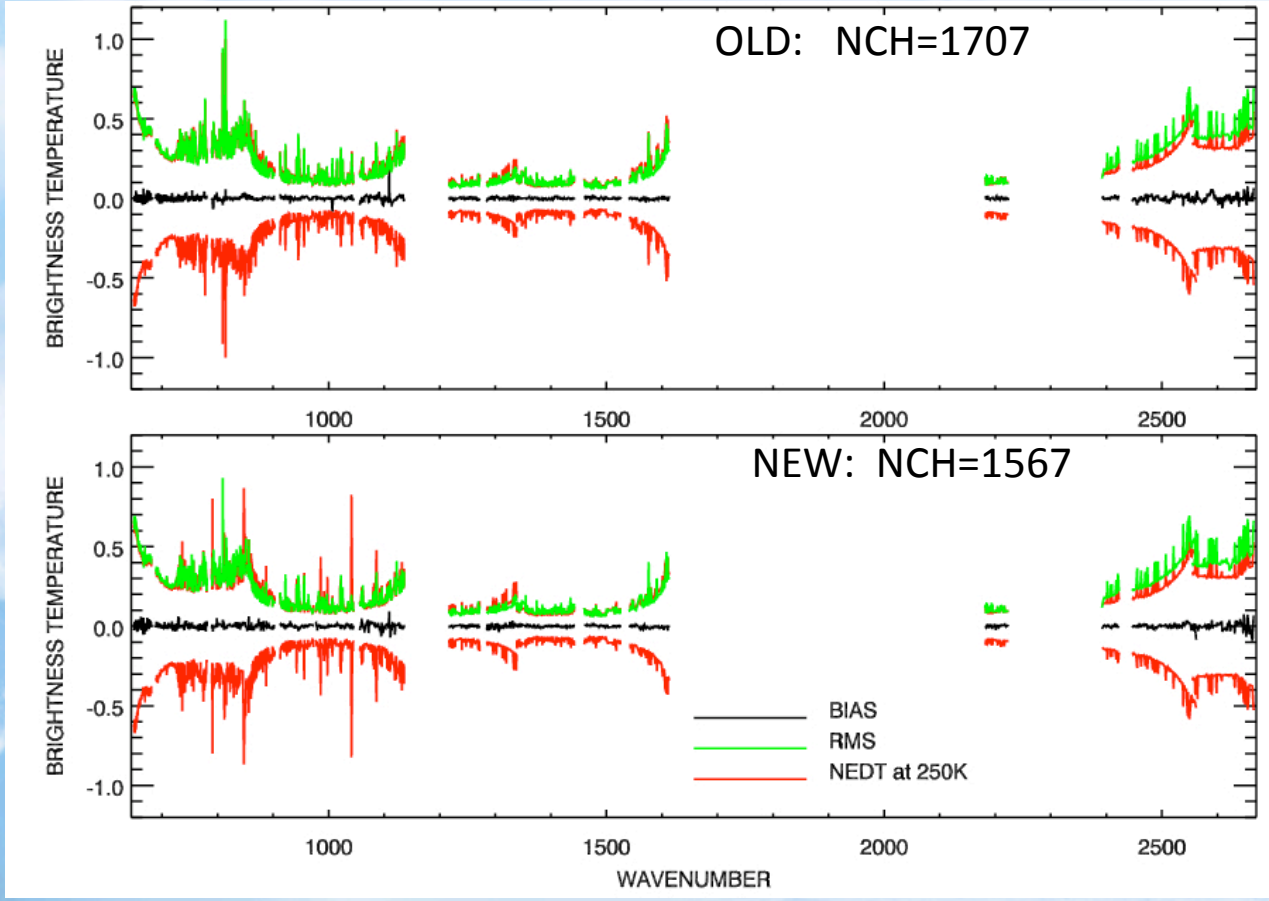




RCs of 1567 channels is slightly higher than RCs of 1707 channels.

Some scene temperature dependence.

Biases and Variations of Observed minus Reconstructed AIRS Radiances on August 24, 2007



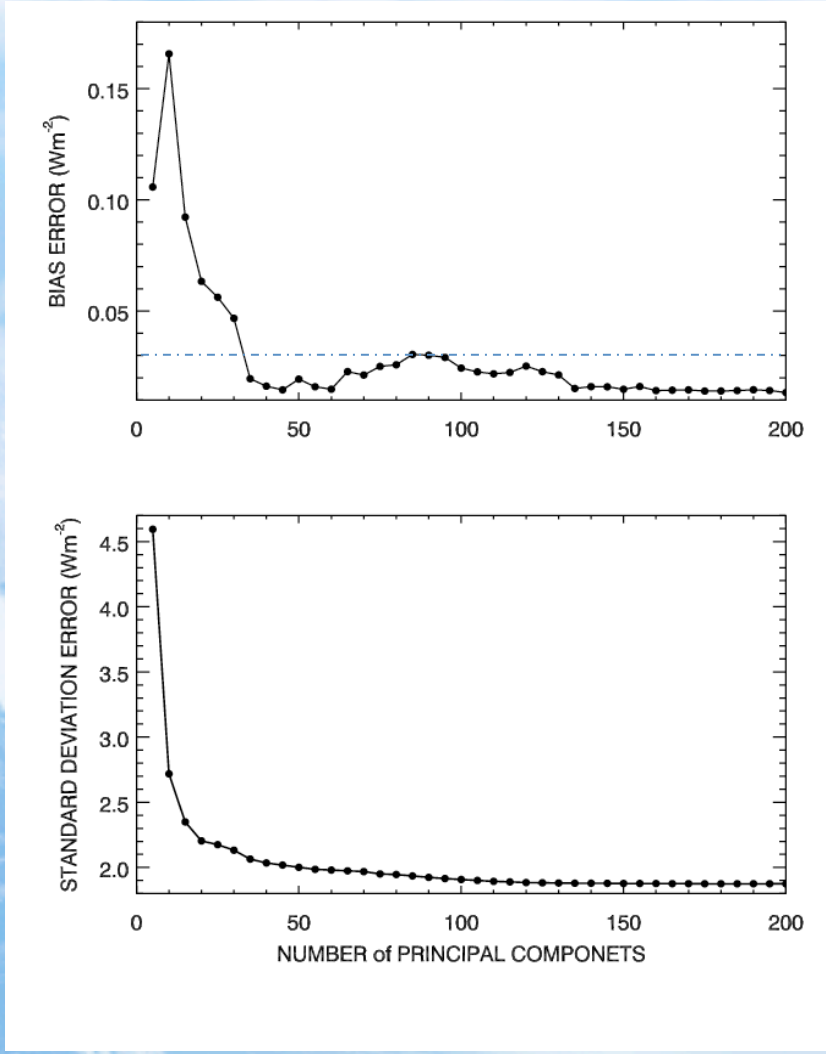
There is no significant difference between new and old sets of AIRS radiance eigenvectors.

Training and Test Ensembles

Training ensemble		Test ensemble
Nov. 25, 2003	Nov. 12, 2005	Jun 6, 2004
Jan. 20, 2004	Mar. 6, 2006	Nov. 23, 2004
Apr. 13, 2004	Jun. 3, 2006	Mar 15, 2005
Jul. 6, 2004	Sept. 6, 2006	Sept. 8, 2005
Oct. 26, 2004	Dec. 6, 2006	May 20, 2006
Feb. 15, 2005	Feb. 26, 2007	Jul. 12, 2006
May 12, 2005	May 12, 2007	Jan. 1, 2007
Aug. 11, 2005	Jul. 26, 2007	Aug. 24, 2007
Total:1,521,993 pairs		Total: 759,669 pairs

- Uniform scenes: ratio of SDV and MEAN of CERES OLR < 5%.

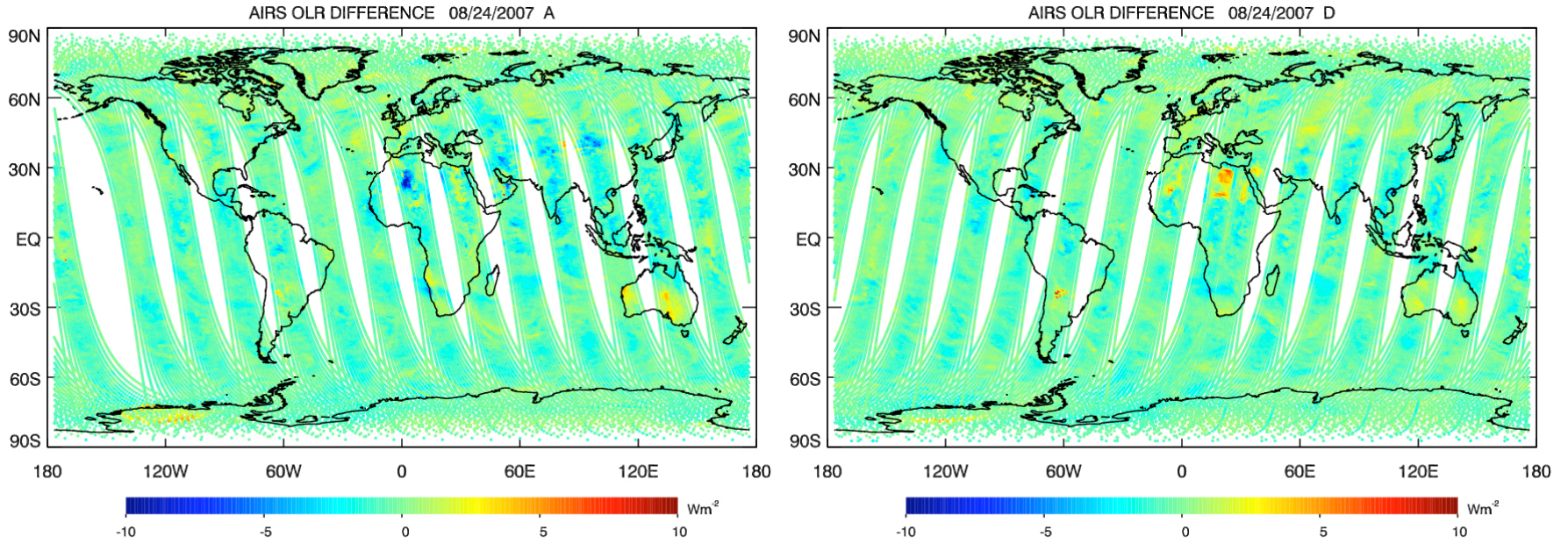
Regression Fitting Errors versus the Number of AIRS Radiance Eigenvectors



Biases and standard deviations decrease rapidly when NPC ≤ 35 and then slightly vary.

➔ K=85 PCs. Will be used for regression retrievals of T(p) and q(p).

AIRS OLR Difference — NEW vs. OLD



Statistics for Uniform Scenes of the Test Ensemble

AIRS vs. CERES

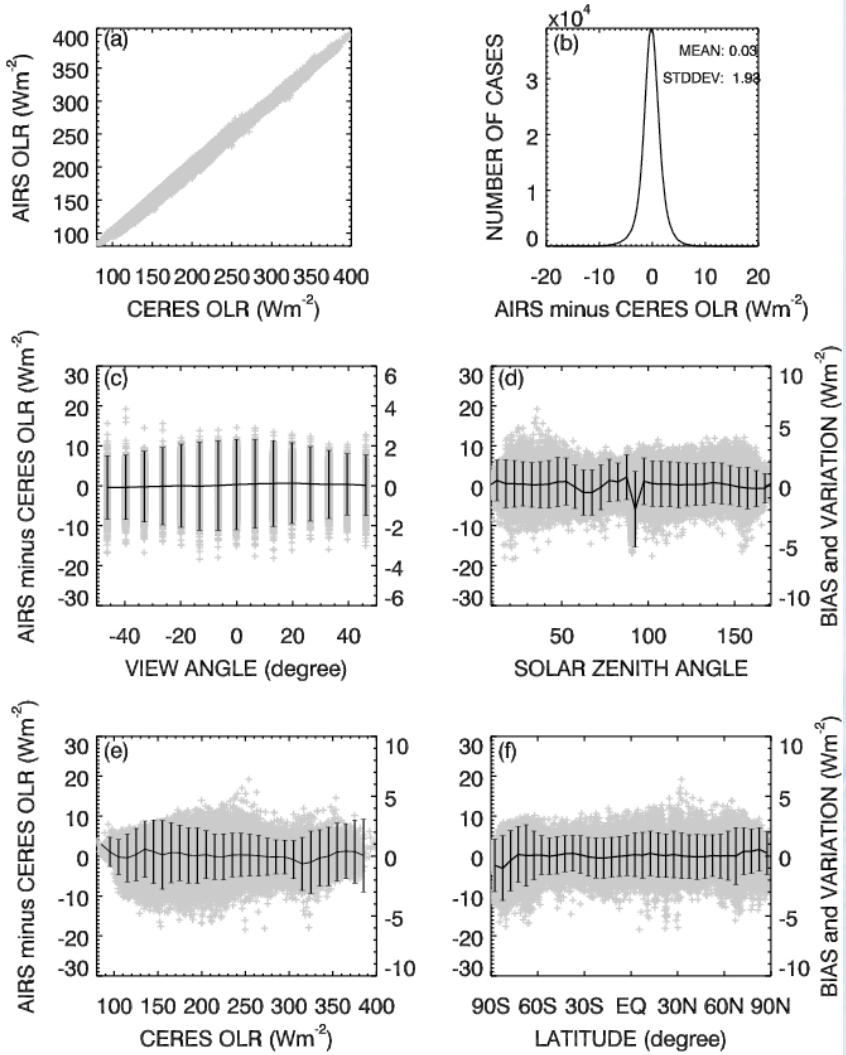
OLR Difference

AIRS View Angle

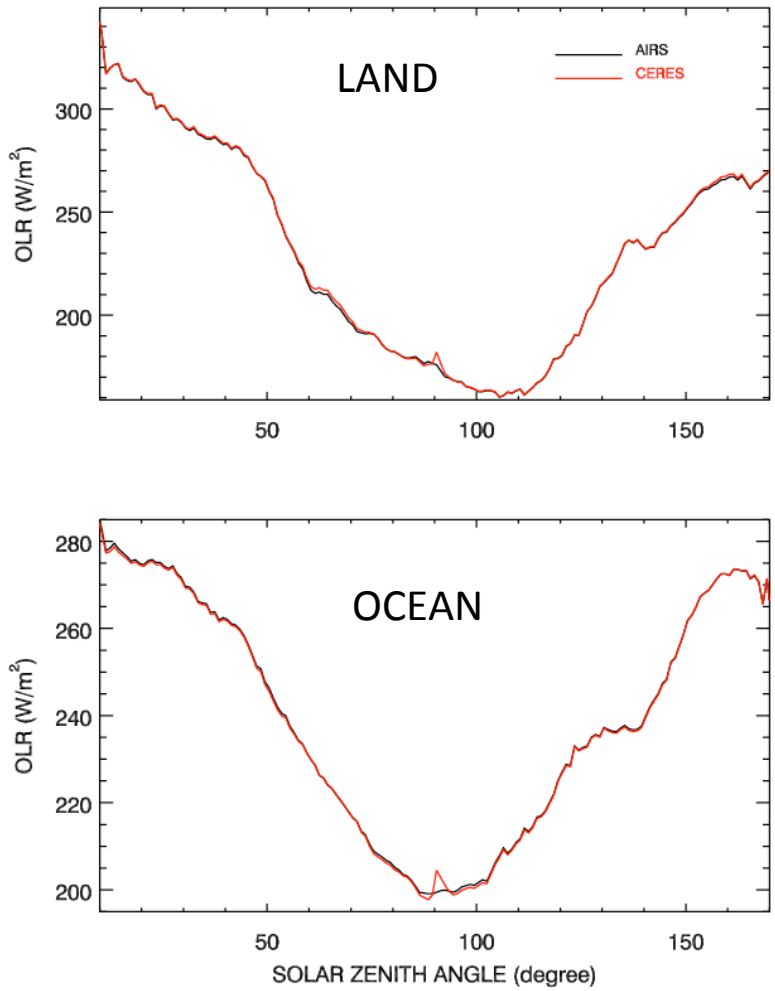
Solar Zenith Angle

CERES OLR

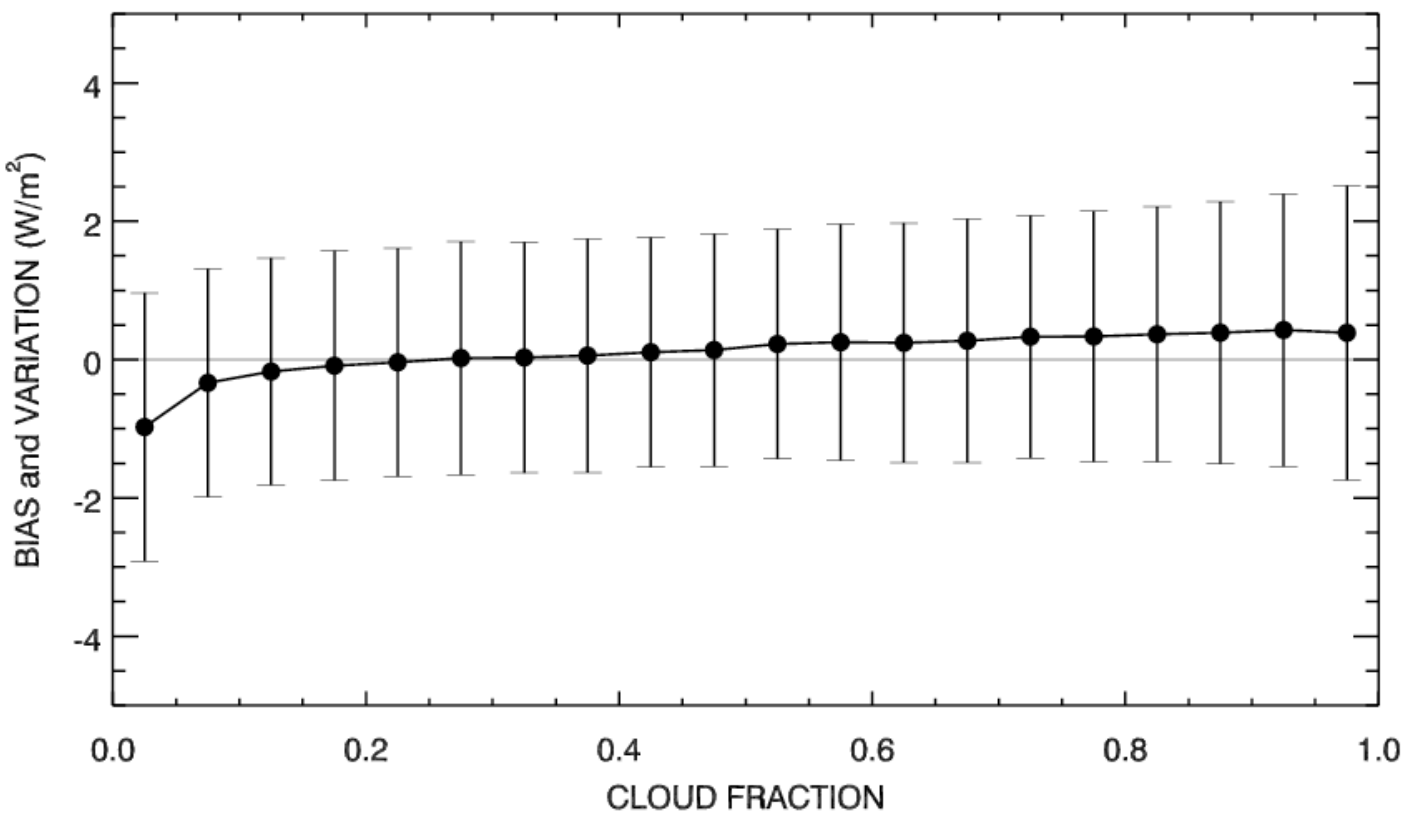
Latitude



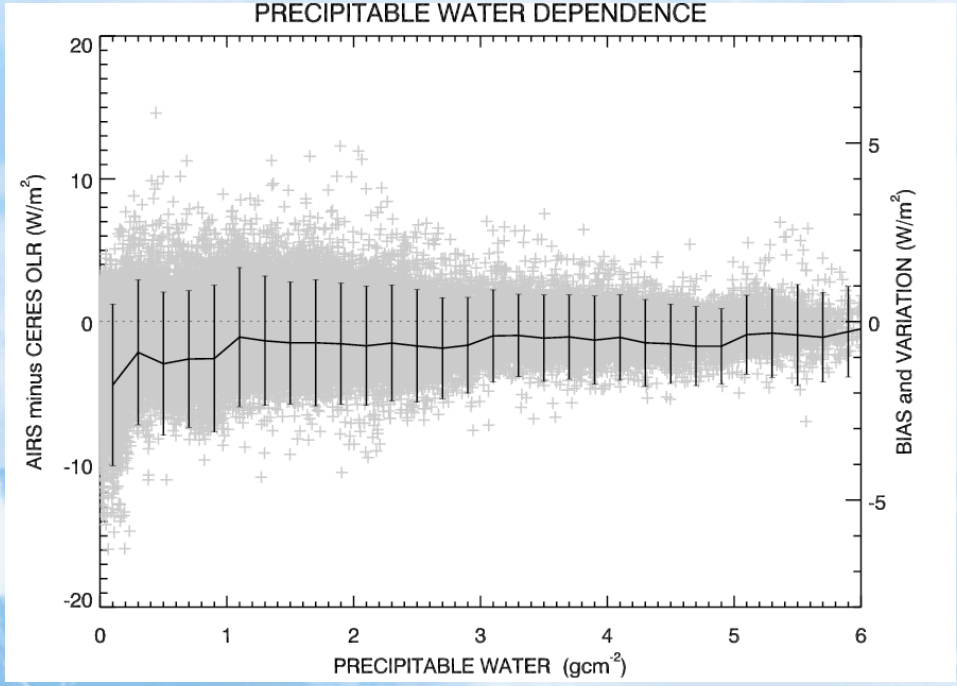
MEAN AIRS and CERES OLR:
CERES OLR has a jump in the twilight region



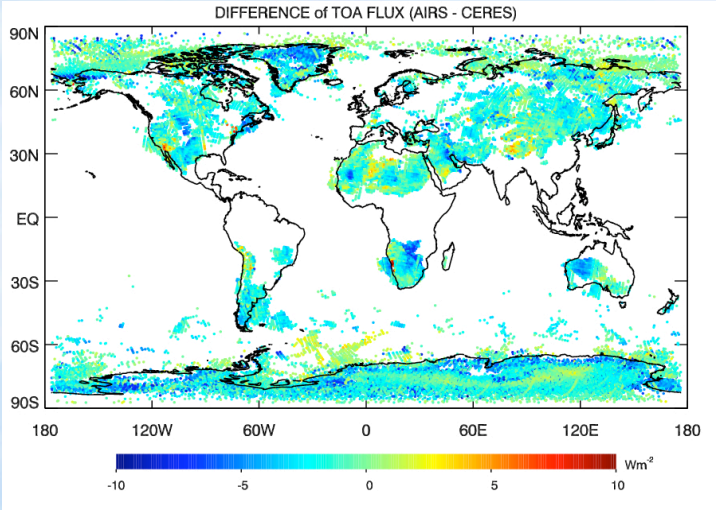
Cloud Fraction Dependence for Uniform Scenes of the Test Ensemble



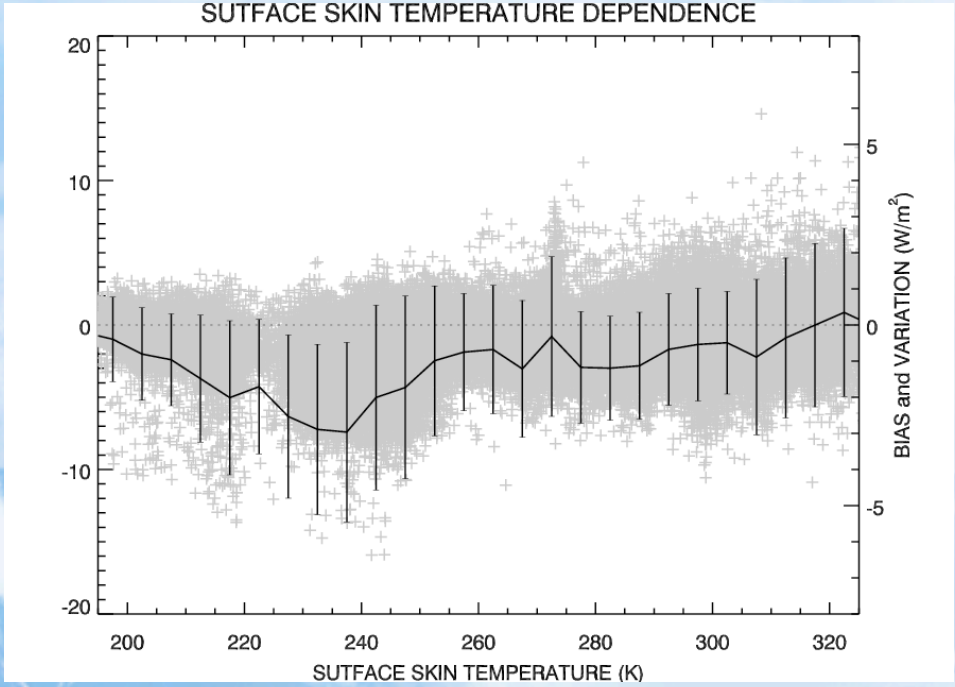
Precipitable Water Dependence for Clear Uniform Scenes of the Test Ensemble



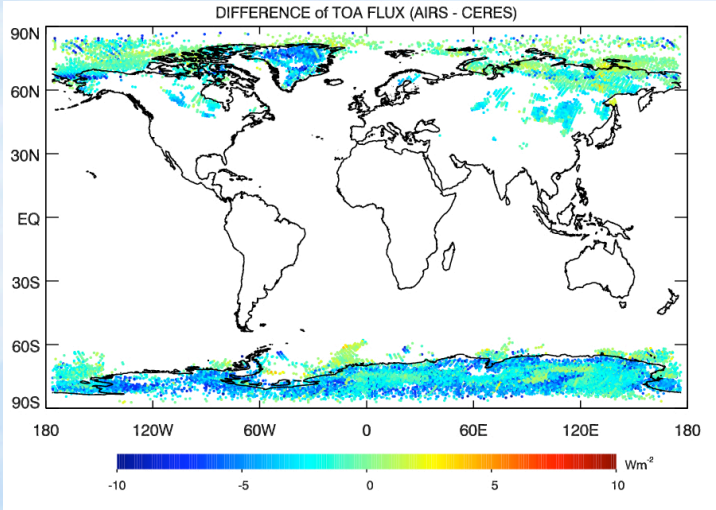
TPW ≤ 1 g/cm²



Surface Skin Temperature Dependence for Clear Uniform Scenes of the Test Ensemble



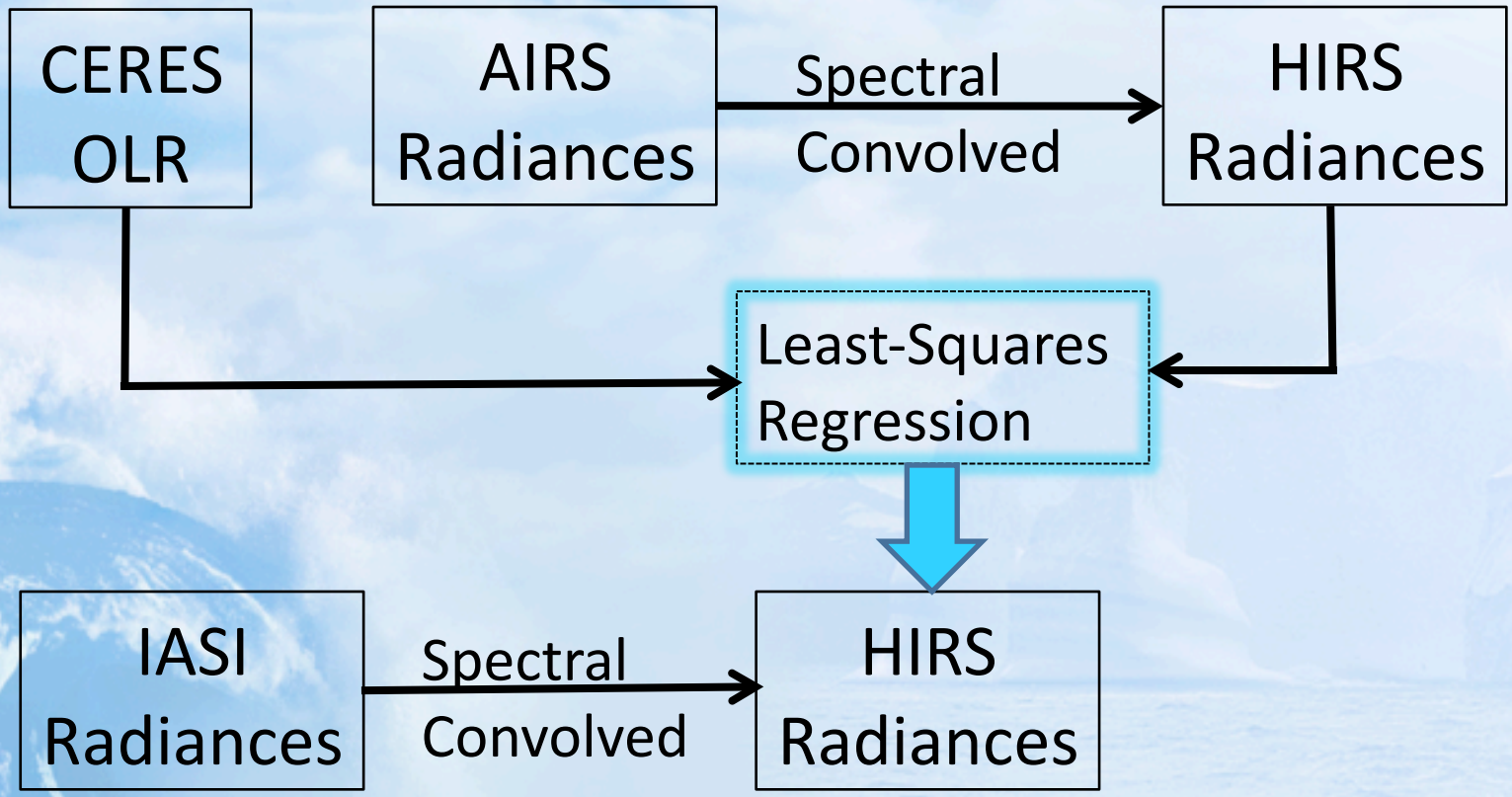
$210 \leq T_{skin} \leq 250$



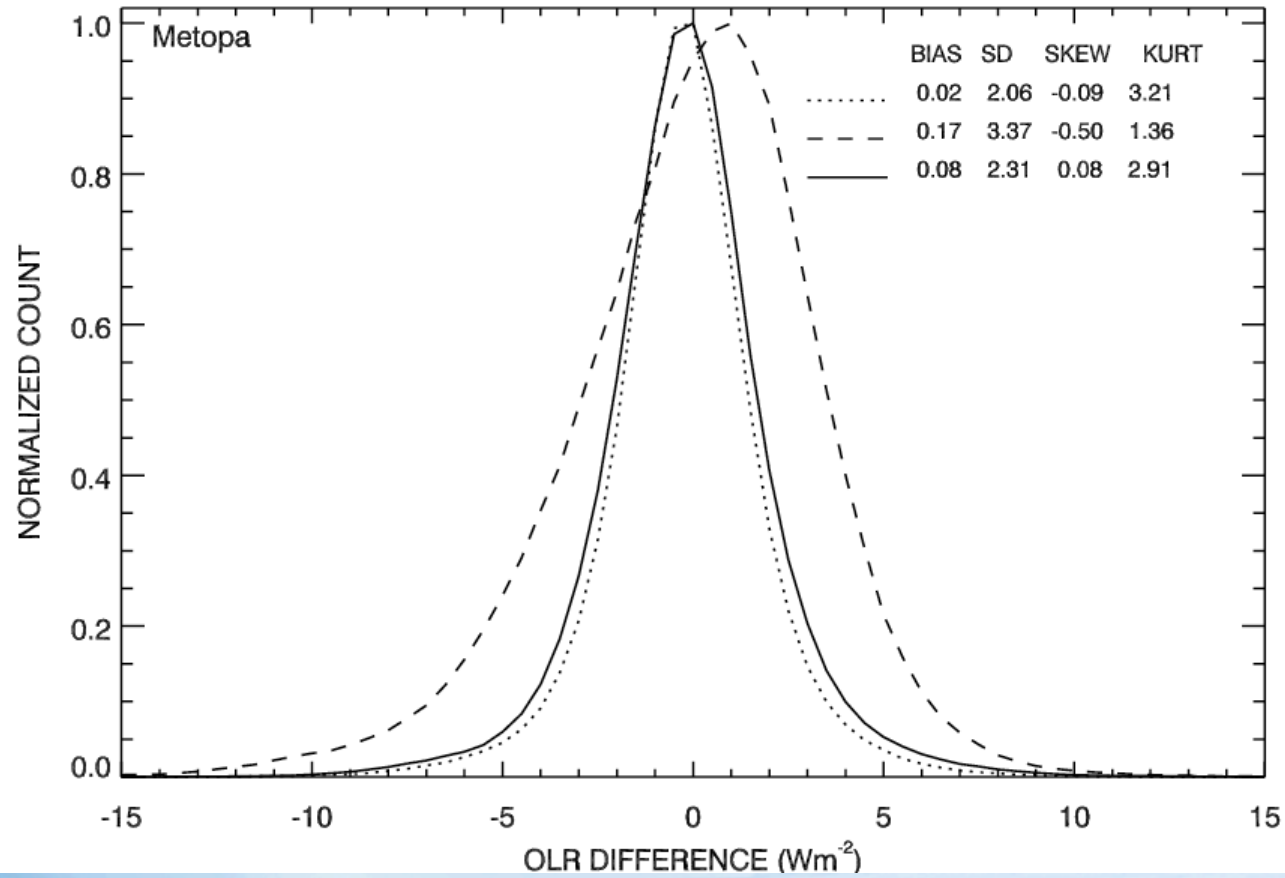
Summary

- AIRS OLR is a principle component regression with CERES TOA OLR. Re-trained with new set of 1567 pristine channels.
- AIRS OLR is in a good agreement with CERES OLR. Bias and variation are 0.03 Wm^{-2} and 1.93 Wm^{-2}, respectively.
- Large OLR differences ($\geq$ 1 Wm^{-2}) mainly occur in the twilight regions, in the South Polar regions, and over mid- and high latitude dry land.

Next Work: IASI OLR



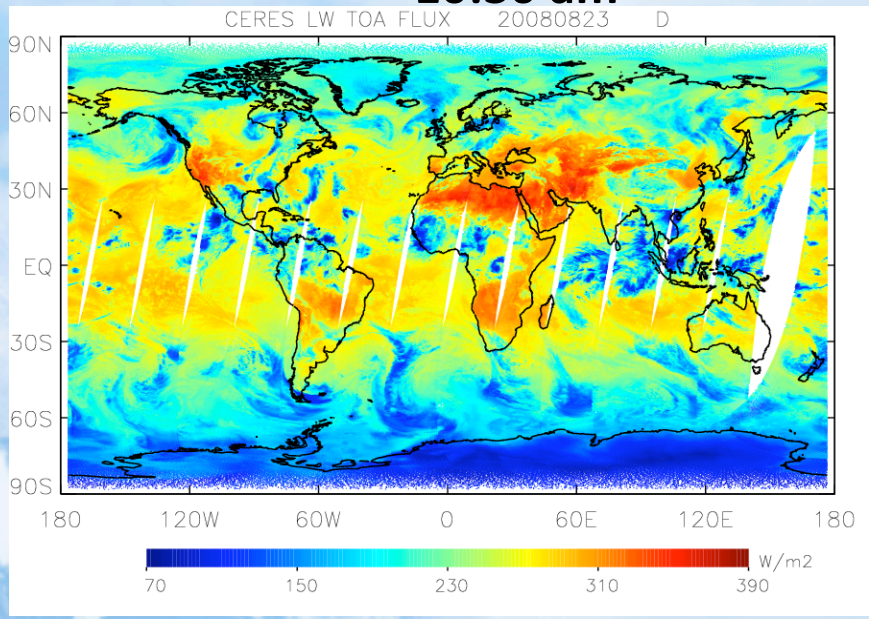
Histogram of OLR Differences (AIRS minus CERES)



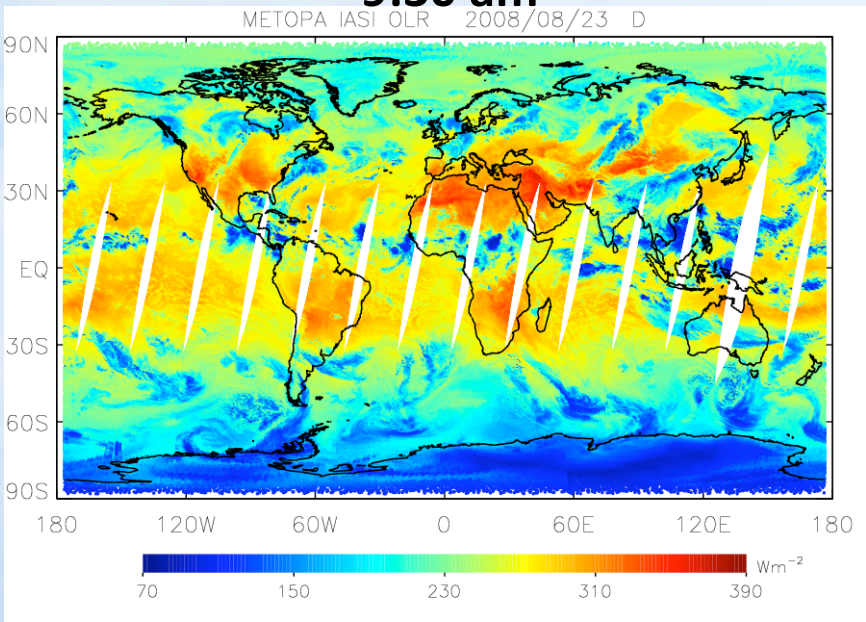
Dotted – (AIRS – CERES) **Solid** – (HIRS 19CH– CERES) **Dashed** – (HIRS 4CH– CERES)

CERES (Terra) and IASI OLR (Descending)

10:30 am



9:30 am



Next year, NOAA operational IASI OLR will delivered through IASI near-real-time system