GOES-R AWG Radiation Budget Team: Upward Longwave Radiation - TOA (OLR)

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Outline

- Executive Summary
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- ADEB and IV&V Response Summary
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Executive Summary

- The ABI ***Upward Longwave Radiation TOA*** algorithm generates the total thermal emission radiative flux from the earth-atmosphere system at the top of the atmosphere, commonly known as the ***outgoing longwave radiation (OLR)***. It is an Option 2 product, but follows Baseline schedule.
- ATBD (100%) is on track for a September 2010 delivery.
- Version 3, destined for 100% deliver, is a multi-spectral algorithm modified from the heritage HIRS OLR algorithm. Version 4 employs a new band-by-band estimation approach that is still under evaluation.
- Validation tools have been developed and applied to 2 weeks offline runs of SEVIRI-based OLR data with the reference CERES SSF OLR product.
- Validation results indicate spec compliance for F&PS requirements.

Requirements

Name	User & Priority	Geographic Coverage (G, H, C, M)	Vertical Resolution	Horizontal Resolution	Mapping Accuracy	Measurement Range	Measurement Accuracy	Product Measurement Precision	Refresh Rate/Coverage Time Option (Mode 3)	Refresh Rate Option (Mode 4)	Vendor Allocated Ground Latency
Upward Longwave Radiation : TOA	GOES-R	C	N/A	25 km	5 km	50 - 450 W/m^2	**20 W/m^2**	**5 W/m^2**	60 min	5 min	3236 sec
Upward Longwave Radiation : TOA	GOES-R	FD	N/A	25 km	5 km	50 - 450 W/m^2	**20 W/m^2**	**5 W/m^2**	60 min	5 min	3236 sec

C – CONUS FD – Full Disk

Qualifiers

Theses are made with the following qualifiers.

- Day and night
- All sky conditions
- Quantitative out to Local zenith angle 65 degrees (was 62 degrees) and qualitative at larger LZA

Algorithm Description

Algorithm Summary

- ABI Upward Longwave Radiation TOA algorithm generates the total thermal emission radiative flux from the earth-atmosphere system at the top of the atmosphere, hereafter, the outgoing longwave radiation (OLR).
- Heritage: HIRS multi-spectral OLR algorithm, currently operational for POES/MetOp.
- OLR regression model is determined with theoretical RTM simulations of 3200 cases (Phillips soundings).
- Revision: Higher order radiance predictors are added to account for nonlinear effect of water vapor that reduces limb and scene-dependent systematic errors.
- SEVIRI is the primary surrogate development/evaluation system.

Methodology

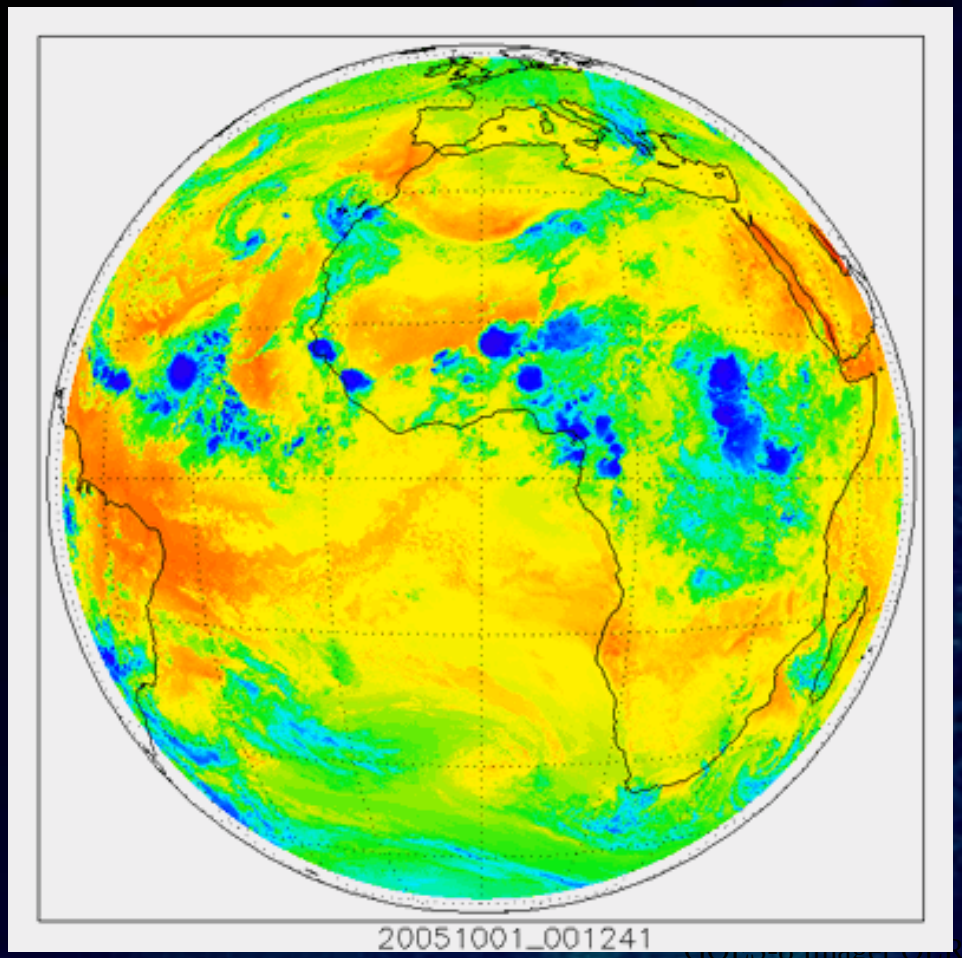
- The ABI OLR is estimated with a linear combination of the transformed radiances (*N*), observed at local zenith angle θ. The predictor variables X_i are composed of the linear and higher order terms of the ABI radiances.

$$OLR = a_0(\theta) + \sum_{i=1}^{10} a_i(\theta) X_i(\theta)$$

$$X = \left\{ N_5, N_6, N_7, N_{11}, N_5^2, N_6^2, N_6^3, N_9, N_{11}^2, N_{11}^3 \right\}$$

- The regression coefficients a_0*'s* and a_i*'s* were derived at 19 local zenith angles and, for computational efficiency, were interpolated to every 0.01 degrees from nadir to 65 degrees that formed the 11x6500 coefficient LUT.

Example OLR Output



"ABI OLR" Product derived with SEVIRI-based proxy ABI radiances on Oct. 1, 2005

Native resolution: 2km, 15 minutes

Algorithm Changes from 80% to 100%

- Investigation of OLR retrieval errors led to new band-by-band estimation approaches that help to decouple the temperature and water vapor inter-dependencies. Scene separation is strongly desired (cirrus in particular).
- Metadata (standardized statistics) defined.
- Quality flags defined and added.

ADEB and IV&V Response Summary

- No feedback required for Option 2 products at this stage.

Validation Strategy

Validation Approach

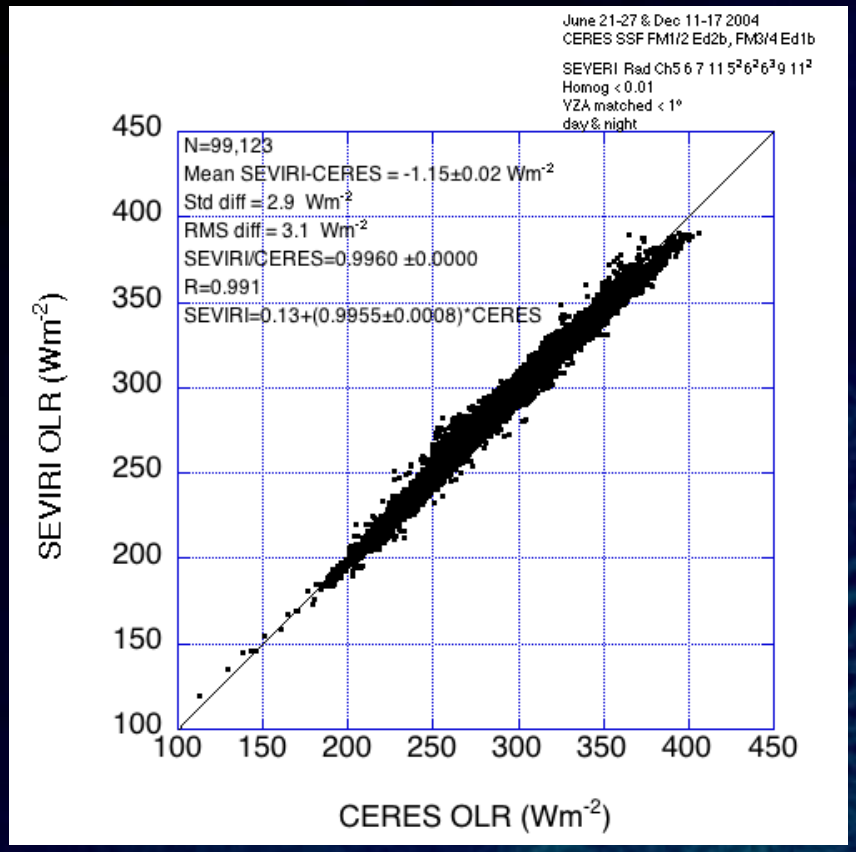
- There is no absolute “Ground Truth” TOA radiative flux measurement.
- The best reference product today is from the Cloud and the Earth’s Radiation Energy System (CERES)
- The flux measurement from broadband instrument still requires spectral un-filtering, angular models for solid angle integration, calibration method to handle instrument degradation, temporal integration, ….
- Collocation constraint set for time, geo-location, and local zenith angle. (leaving out azimuth angle)
- Scene homogeneity consideration to reduce spatial sampling errors

Validation Data

- Offline evaluation (2 weeks)
  - » June 21-27, Dec 11-17, 2004
  - » SEVIRI radiance data from Meteosat-8 Full Disk
  - » CERES SSF OLR product: FM-1/2 (Ed-2B) and FM-3/4 (Ed-1B), onboard NASA EOS Terra and Aqua, respectively.
  - » Collocation at 3x3 FOVs, within 15 minutes window, local zenith angle matched.

Validation Results

Offline Validation (1)



Validation Results:

No. of cases = 99,123

Mean diff = -1.15±0.02 Wm^{-2}

STD of diff = 2.9 Wm^{-2}

RMS diff = 3.1 Wm^{-2}

For:

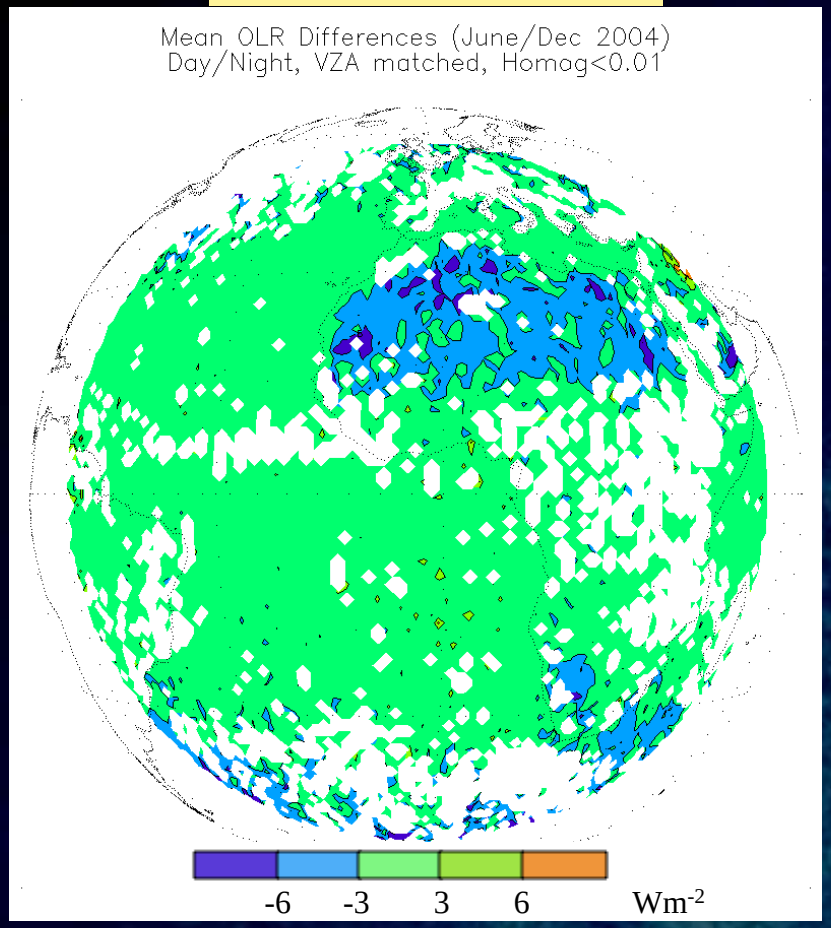
Homogeneous scenes

CERES FM-1/2/3/4

Offline Validation (2)

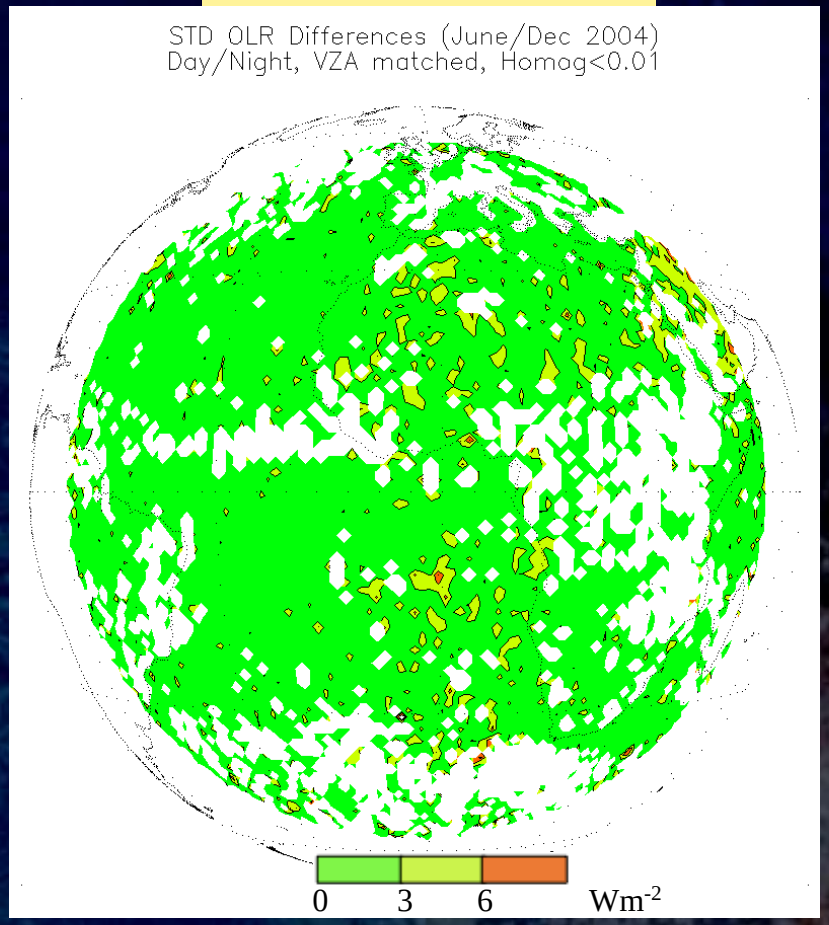
Mean OLR Error

June 21-27, Dec 11-17, 2004



STD OLR Error

June 21-27, Dec 11-17, 2004



Validation Results Summary

	F&PS			Algorithm Evaluation		
	Accuracy	Precision	Range	Accuracy	Precision	
OLR (Wm^{-2})	20	5	50-450	2	4	Offline

Summary

- The ABI OLR algorithm provides the thermal infrared component for the TOA earth radiation budget.
- Version 3 is destined for the 100% ATBD, compliant to F&PS requirements. Version 4 is still under refinement and evaluation.
- Version 4 to fix the underestimation over desert areas and overestimation for the very low OLR (<120 Wm^{-2}) is expected.