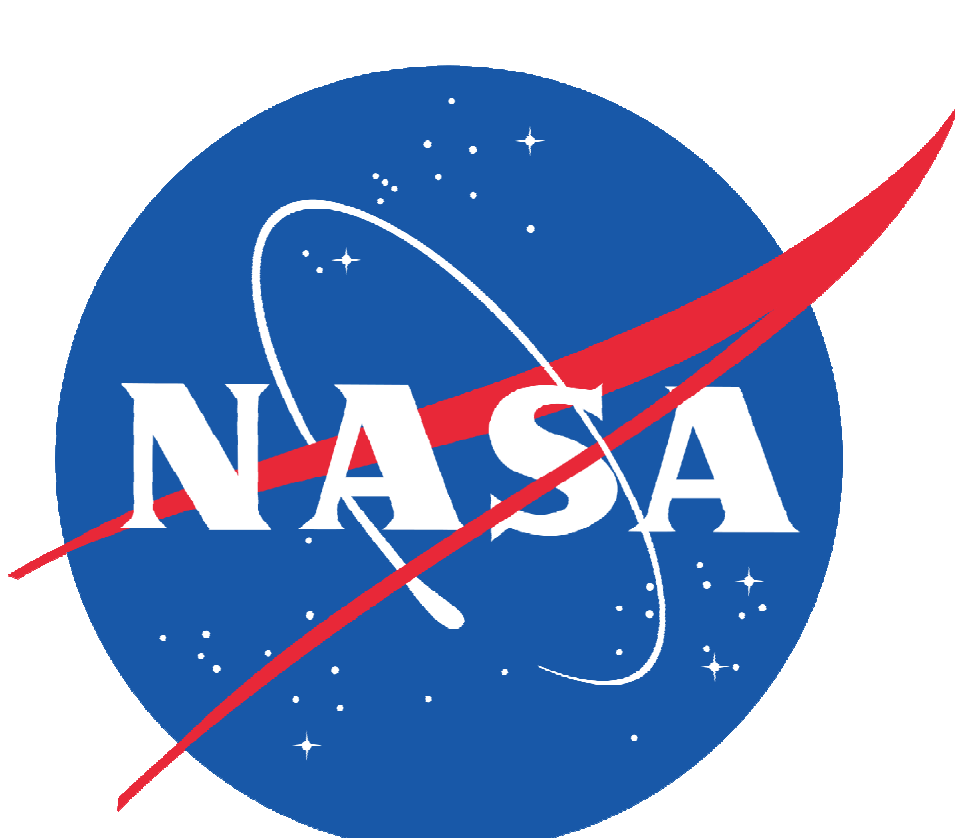




Improving the Derivation of GEO-derived Fluxes in the SYN1deg Product

Wrenn, F.[†], Doelling^{††}, D.R., Liang, L.[†], Moguo, S.[†], Nguyen, L.T.C.[†]

[†]Science Systems and Applications, Inc., Hampton, VA ^{††}NASA Langley Research Center, Hampton, VA



CERES Mission

The Clouds and Earth's Radiant Energy System (CERES) satellites are part of NASA's Earth Observing System (EOS). It's goal is to provide long-term global estimates of the shortwave and longwave radiative fluxes at TOA and the surface.

CERES is currently operational on three platforms:

- **TRMM**: precessionary satellite $\pm 30^\circ$, 46 day repeat cycle, (instrument failed in April 2000)
- **Terra**: 10:30 Sun-synch Local Equatorial Crossing Time (LECT)
- **Aqua**: 13:30 LECT
- **NPP**: 13:30 LECT
- **JPSS-1**: 13:30 LECT, (Launched on March 2017)

CERES Products

Energy Balanced and Filled (EBAF)					
Climate Data Record (CDR) of monthly TOA fluxes and consistent computed surface fluxes and clouds suitable for analysis of variability at the intra-seasonal, inter-annual, and longer time scales.					
Data Product Information	Description	Parameter	Resolution	Version/Availability	Order Data
EBAF-TOA	Monthly and climatological averages of TOA clear-sky (spatially complete) fluxes, all-sky fluxes and clouds, and cloud radiative effect (CRE), where the TOA net flux is constrained to the ocean heat storage.		1°	1°	1°
EBAF-Surface	Monthly and climatological averages of computed surface clear-sky fluxes, all-sky fluxes, and cloud radiative effect (CRE), consistent with the CERES EBAF-TOA fluxes.		1°	1°	1°
	Data Quality Summaries				Browse & Subset

Synoptic TOA and surface fluxes and clouds (SYN)					
Hourly gridded observed TOA and Fu-Liout RT surface fluxes and clouds. Suitable for regional diurnal and process studies.					
Data Product Information	Description	Parameter	Resolution	Version/Availability	Order Data
SYN1deg	Hourly CERES and geostationary (GEO) TOA fluxes, MODIS/VIRS and GEO cloud properties, MODIS/VIRS aerosols, and Earth Radiation Budget (ERB) surface and in-atmospheric (profile) fluxes consistent with the CERES observed TOA fluxes.		1°	1°	1°
ClerfVizMap	CERES-MODIS/VIRS and GEO cloud properties stratified by cloud optical depth and pressure.		1°	1°	1°
	Data Quality Summaries				Browse & Subset

Single Scanner Footprint (SSF)					
Individual CERES scanner footprint TOA and parameterized surface fluxes and clouds. For comparison with other same orbit sensors, for example, A-train datasets.					
Data Product Information	Description	Parameter	Resolution	Version/Availability	Order Data
SSF	CERES footprint observed TOA fluxes, MODIS/VIRS clouds and aerosols, and parameterized surface fluxes by instrument.		FOV*	1°	1°
SSF1deg	Gridded daily and monthly averages of the SSF product by instrument.		1°	1°	1°
CCCM (CCM)	Nadir view CERES-SSF/MODIS/CALIPSO/CloudSat collocated parameters.		FOV*	1°	1°
	Data Quality Summaries				Browse & Subset

Fast Longwave and Shortwave Flux (FLASHFlux)					
Near real-time, CERES scanner footprint TOA and parameterized surface fluxes and clouds by instrument.					
Data Product Information	Description	Parameter	Resolution	Version/Availability	Order Data
FLASH_SSF	Near real-time CERES fluxes and clouds in the SSF format. Not of climate quality or to be appended with any other CERES dataset.		FOV*	1°	1°
FLASH1deg	Gridded daily averages of the FLASH_SSF product.		1°	1°	1°
	Data Quality Summaries				Browse & Subset

*FOV: Field-of-View instantaneous footprint data.

Order CERES Data

http://ceres.larc.nasa.gov/order_data.php

The Level-2 and Level-3 CERES data products are available to visualize and order on the CERES Subsetter website. Users can sub-set by parameter, temporal range, and spatial ranges.

Motivation

The SYN1deg geostationary satellite measurements to more accurately capture the diurnal cycle.

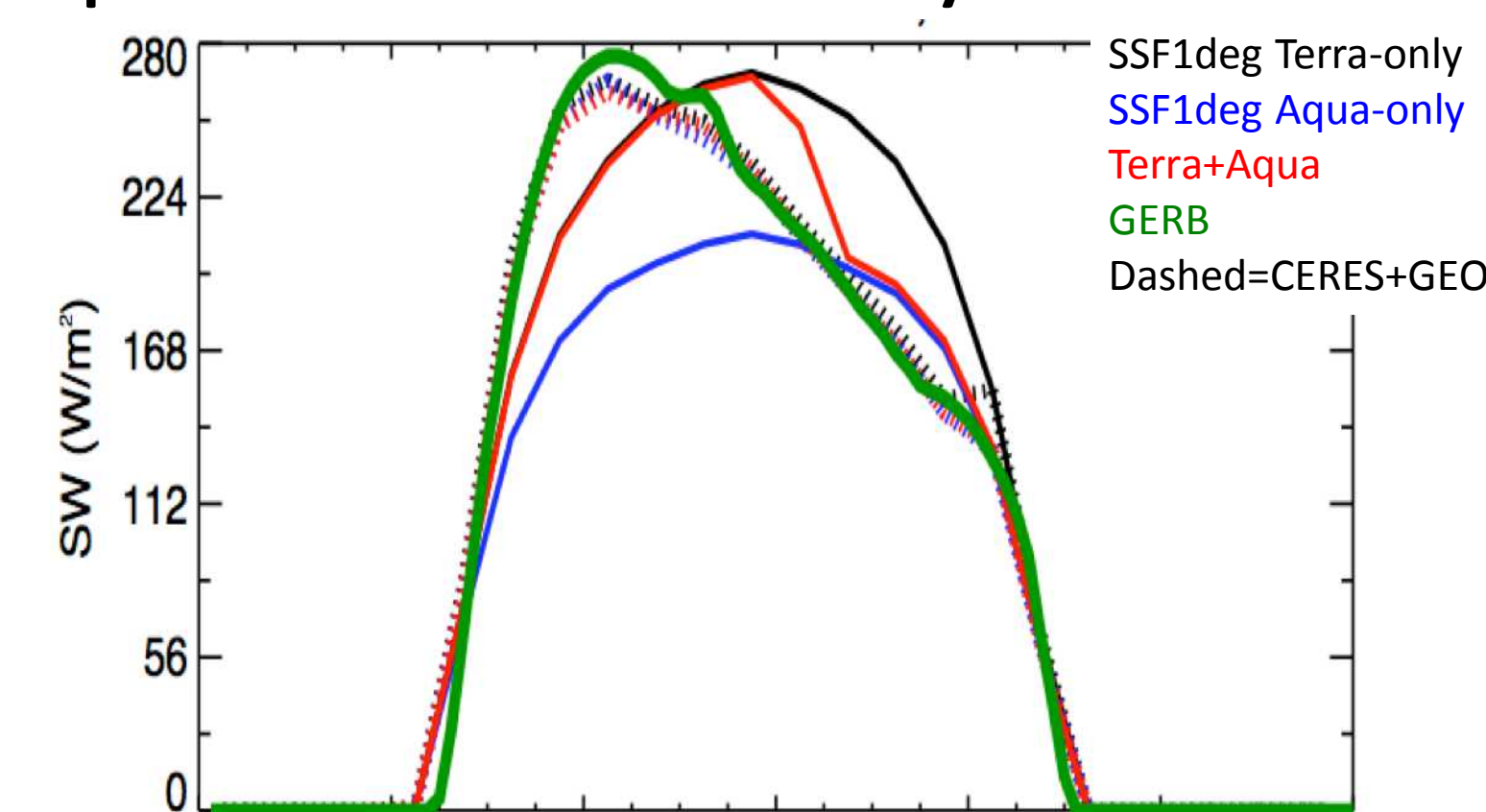


Figure 1: Status region off the coast of Namibia. Using GERB (green) as truth, Terra-only and Aqua-only measurements over/under estimate the GERB measurements, respectively. When GEO is added (dashed) the CERES measurements more closely resemble GERB.

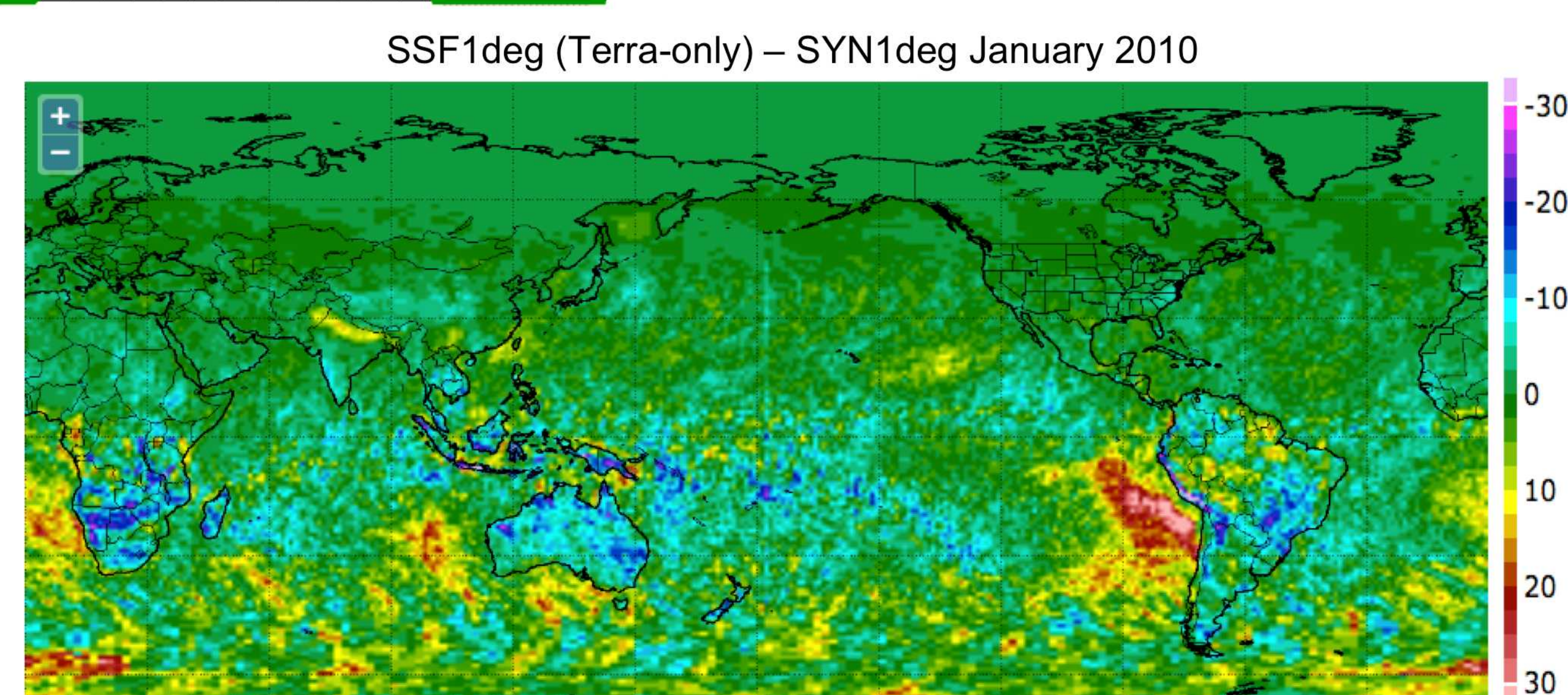


Figure 2: Difference between SSF1deg (Terra only) and SYN1deg. Regions with marine stratus show overestimation while land afternoon convection show an underestimation. This is consistent with Figure1 when considering the Terra-only line and dashed CERES+GEO lines.

Geostationary Radiance to Flux

CERES is testing another geostationary narrowband to shortwave radiance approach. The radiances are then converted to flux using the CERES TRMM ADM. (TRMM was in a precessionary orbit)

Current Ed4 approach: Use a theoretical narrowband to MODIS visible channel and then a empirical MODIS to broadband radiance conversion

Proposed approach: Use a theoretical hyperspectral (2500 wavelengths) radiative transfer model radiances to construct unique GEO narrowband to broadband models as a function cloud properties.

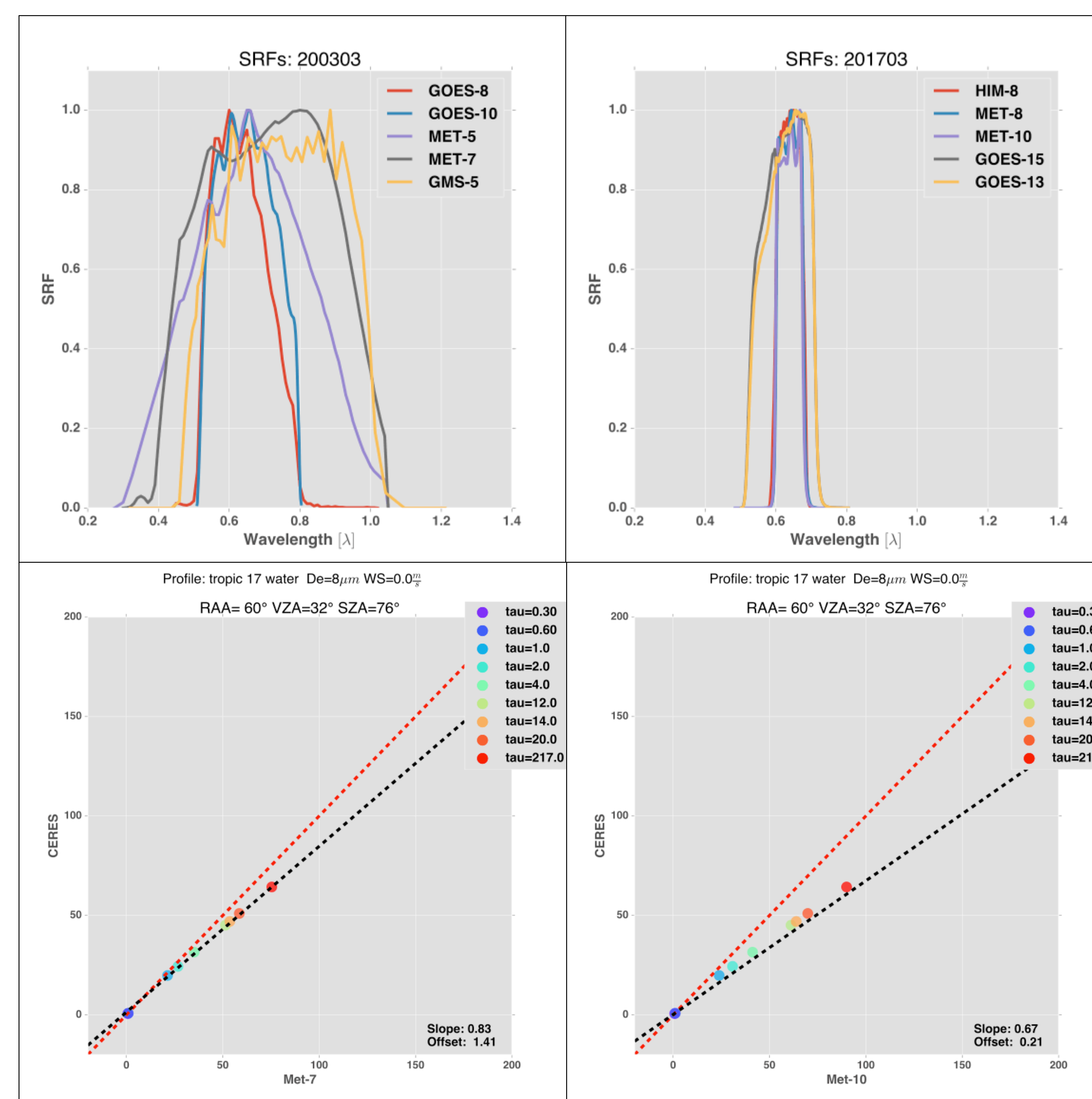
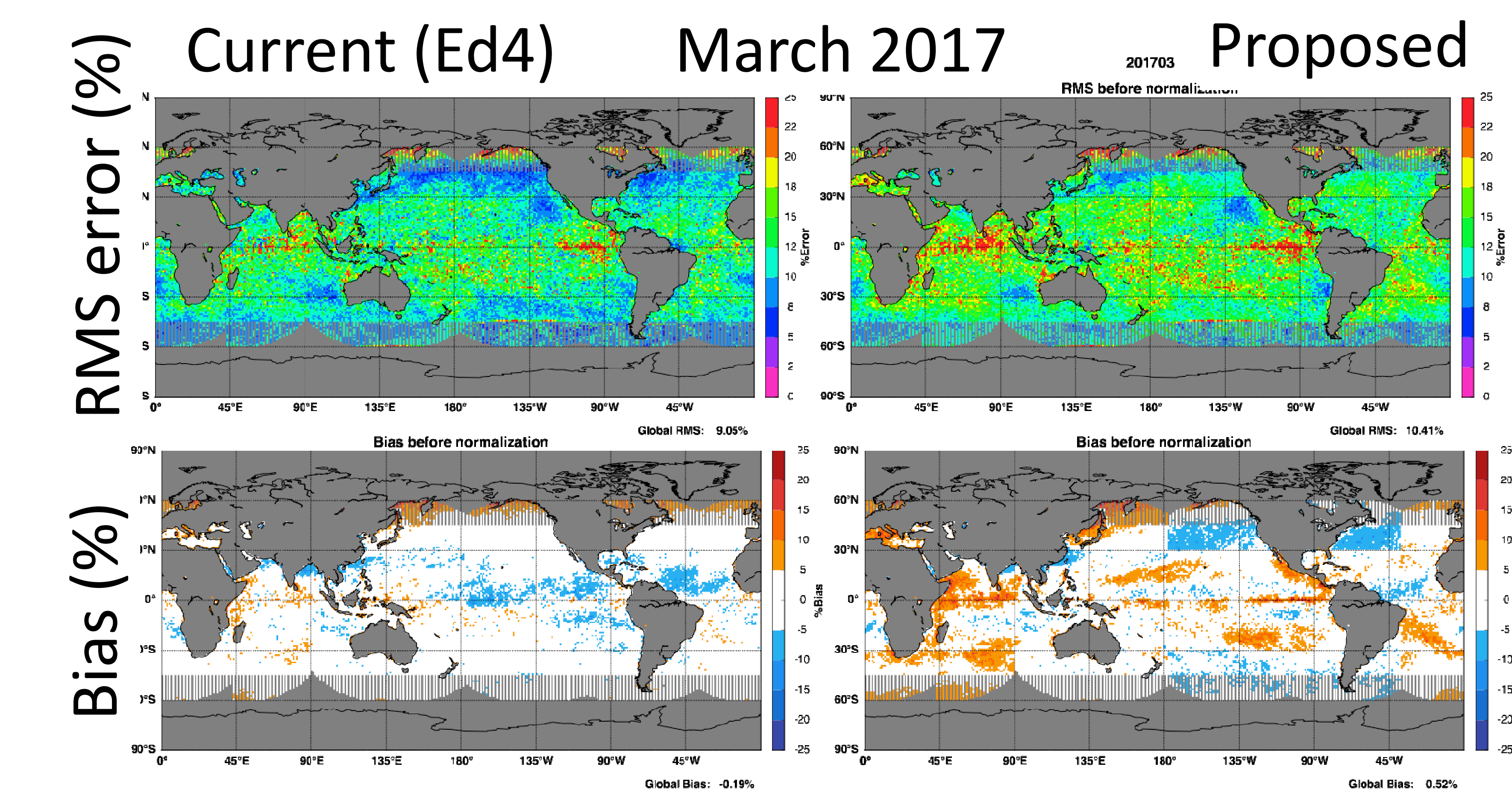
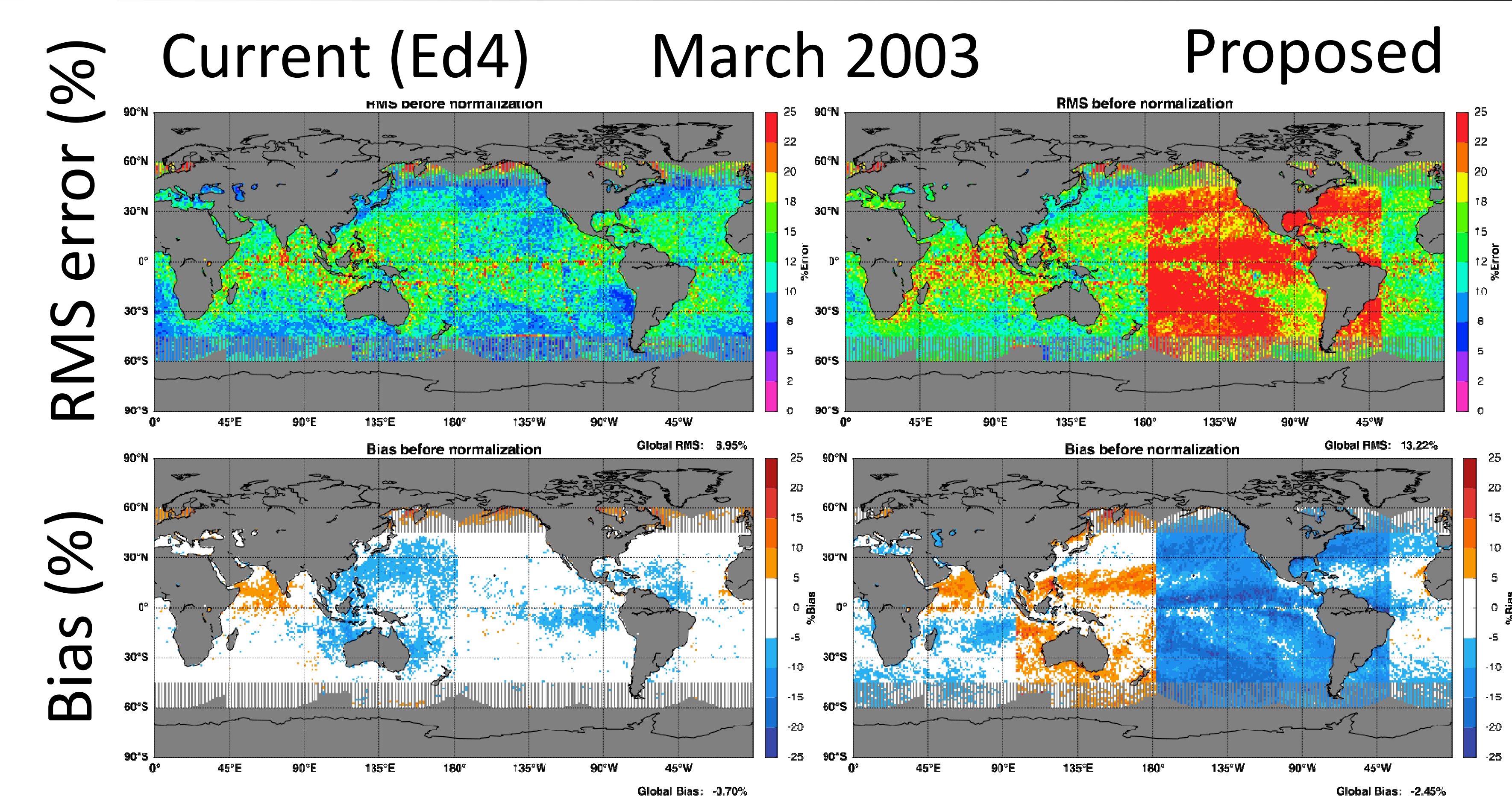


Figure 3: Spectral response functions (SRFs) for 10 geostationary satellites. On the left: March 2003 GEOs with notably larger and more variable SRFs. On the right: March 2017 with the current suite of GEOs display a less variance narrower filter in the shortwave.

Figure 4: Both approaches use cloud fraction, optical depth, cloud phase, angular dependent narrowband to broadband factors. Instead of using optical depth directly, the optical depth RTM radiances are linearly regressed to better account for calibration errors

SW Narrowband to Broadband Validation

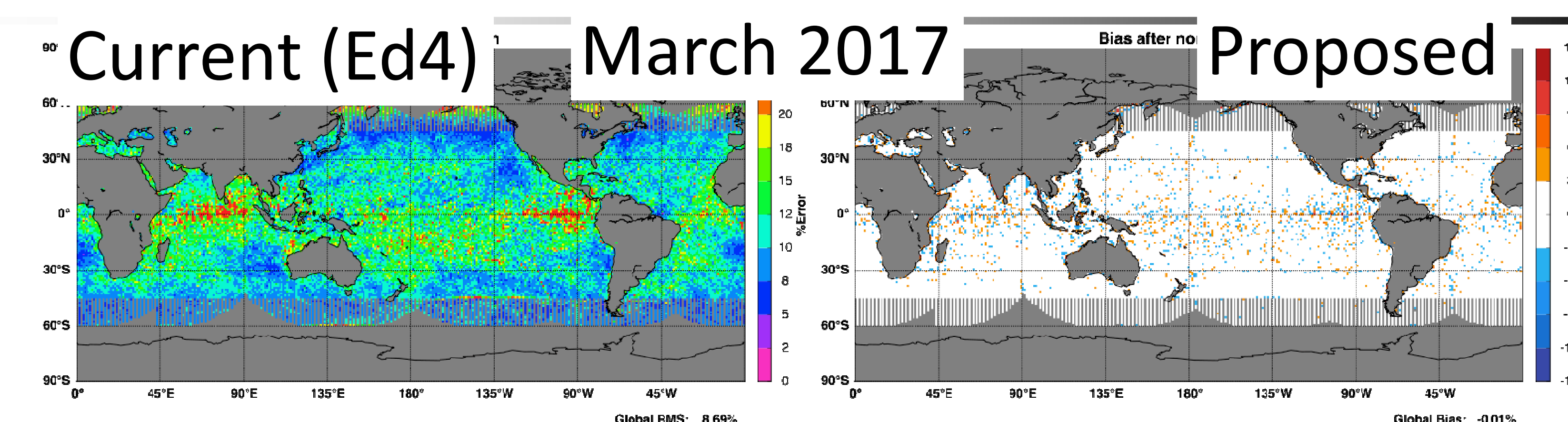
GEO and CERES (Terra and Aqua) time-matched within 15 minutes derived fluxes are analyzed for both methods



The proposed approach works well with narrow visible sensors. The two GOES sensors in March 2003 need to be reexamined for correctness.

SW regional Normalization

Finally, GEO fluxes are normalized using $5^\circ \times 5^\circ$ regions to CERES to remove geostationary artifacts. Note **both approaches** have the same RMS error after normalization.



Conclusions

The proposed approach has the advantage of allowing all future GEOs to have optimized NB to BB LUTs and possible multi-channel NB to BB. The initial RTM LUTs need to be updated with more scene dependent models