Shortwave Reflected Energy from NISTAR and EPIC onboard the DSCOVR Spacecraft

Clark Weaver[1,2] Jay Herman[1,2] Alexander Marshak[3] Steven R Lorentz[4] Yinan Yu[4] Allan W Smith[4]

1 Atmospheric Chemistry and Dynamics Branch, NASA Goddard Space Flight Center
2 Earth System Science Interdisciplinary Center (ESSIC), U. Maryland.
3 Climate and Radiation Laboratory, NASA Goddard Space flight Center
4 L-1 Standards and Technology, Inc., Manassas, VA US

A36D-05 McCormick Place Hall A. South, Level 3
Friday, 16 December 2022 10:00 - 13:30pm
A52J-1096 - Deep Space Earth Observations II Poster

Introduction We produce a one-year record of Shortwave reflected energy from the Earth Polychromatic Imaging Camera. Additional hyperspectral information is provided by the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) and the SCIAMACHY instrument. We spatially integrate our SW reflected energy for an entire EPIC disk and compare with the reflected energy from the SW Band B filtered NISTAR instrument (Electrical substitution radiometer). We also compare with the Single Scanner Footprint CERES observations.

EPIC radiance Wm^{-2} str^{-1} nm^{-1}

$$I_\lambda = \text{EPIC counts} * K_\lambda \text{ (calib factor)} * S_\lambda \text{ (solar flux)} / \pi$$

λ = 340, 388, 443, 551, 680, 780 (nm)

High Spectral Resolution information

224 channels between .365 and 2.5 microns

SCIAMACHY

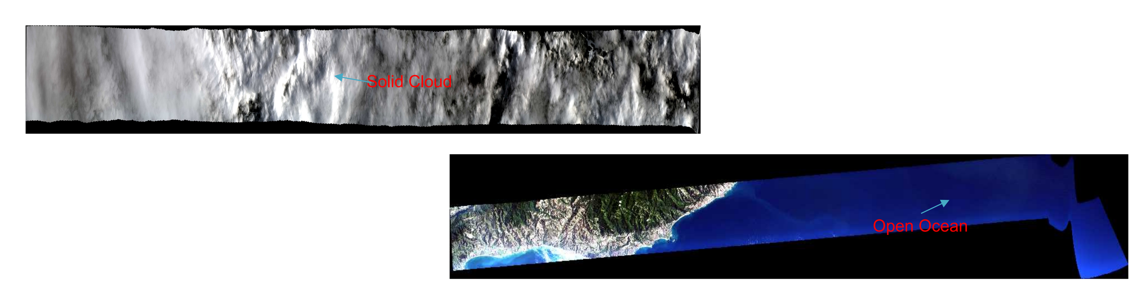
between .275 - .365 microns

Selecting AVIRIS spectra

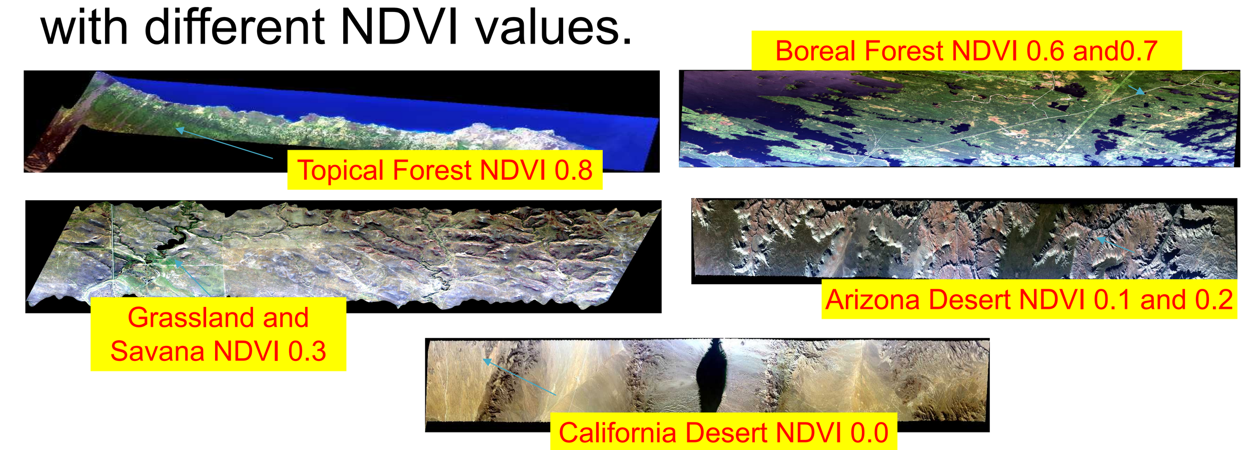
We sifted through many AVIRIS flights and selected nadir viewed spectra from nine homogeneous scenes. Our method assumes that the spectra from a given EPIC pixel is a weighted combination spectra from a solid cloud scene and one of the homogeneous scenes. Note these spectra are used generically; e.g., the spectra from the same cloud-free ocean scene is used for all EPIC pixels over ocean.

We use the VLIDORT (Vector LInearized Discrete Ordinate Radiative Transfer package) to account for different viewing and illumination geometry of the EPIC, AVIRIS, SCIAMCHY sensors.

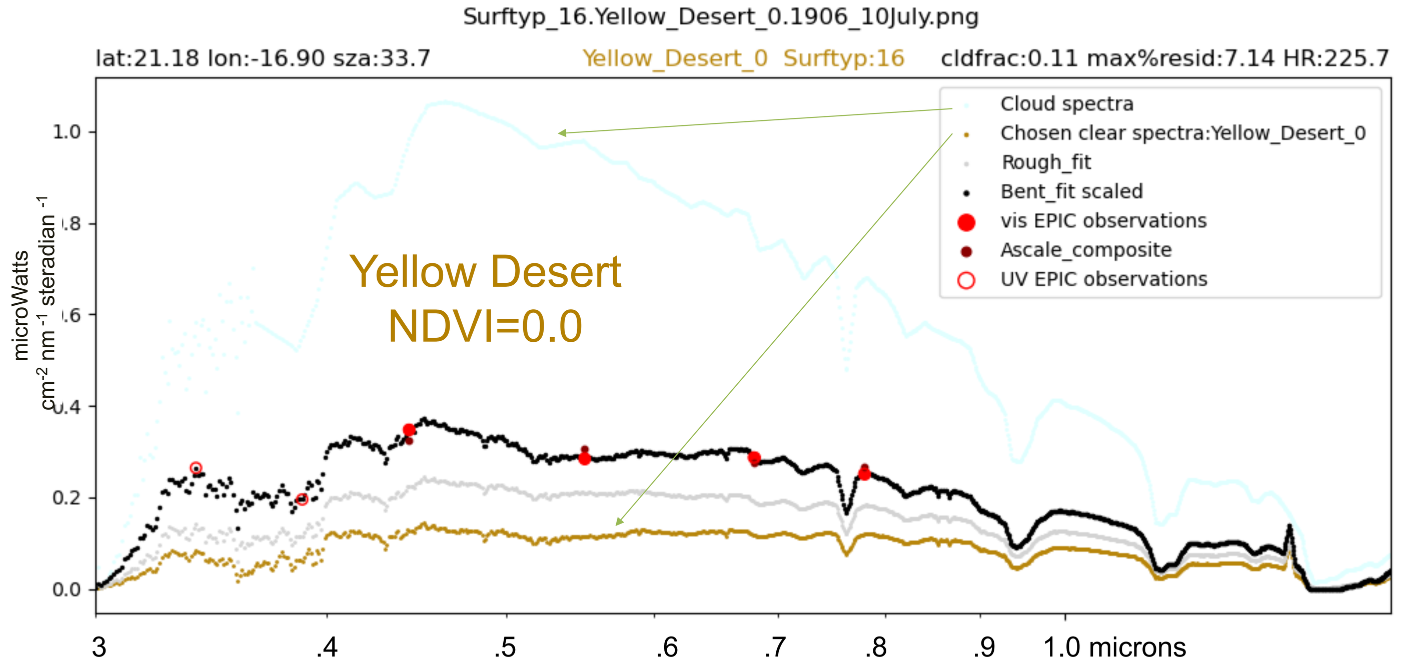
Over **Ocean** we use single solid cloud scene with 100% cloud fraction and scene of cloud-free ocean



Over **Land** we use cloud-free spectra from 7 scenes with different NDVI values.

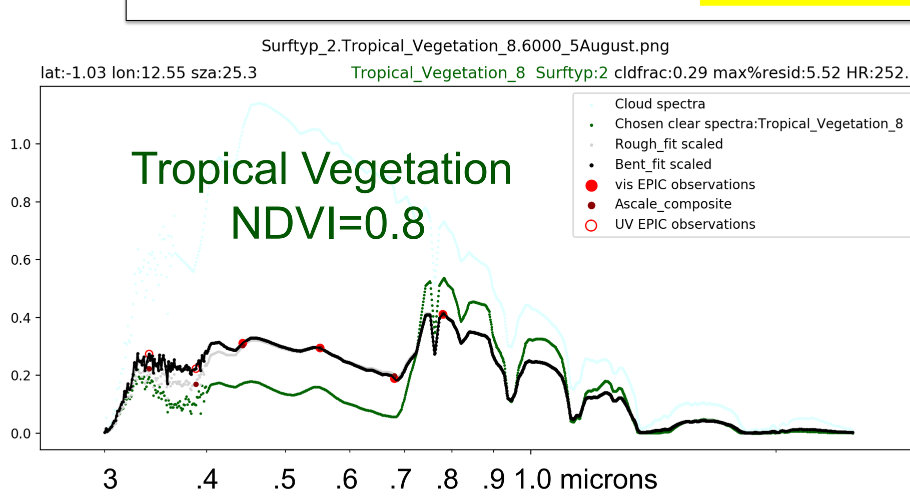


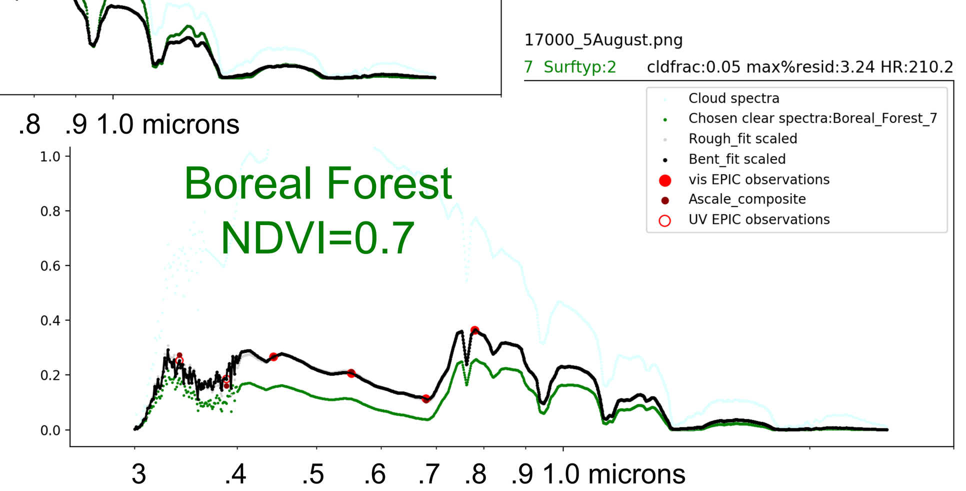
Composite spectra are constructed for each EPIC pixel: over land a weighted combination of the spectra from the solid cloud scene and one of the 7 land scenes is used. Over ocean the solid cloud scene is used with the clear-ocean scene.



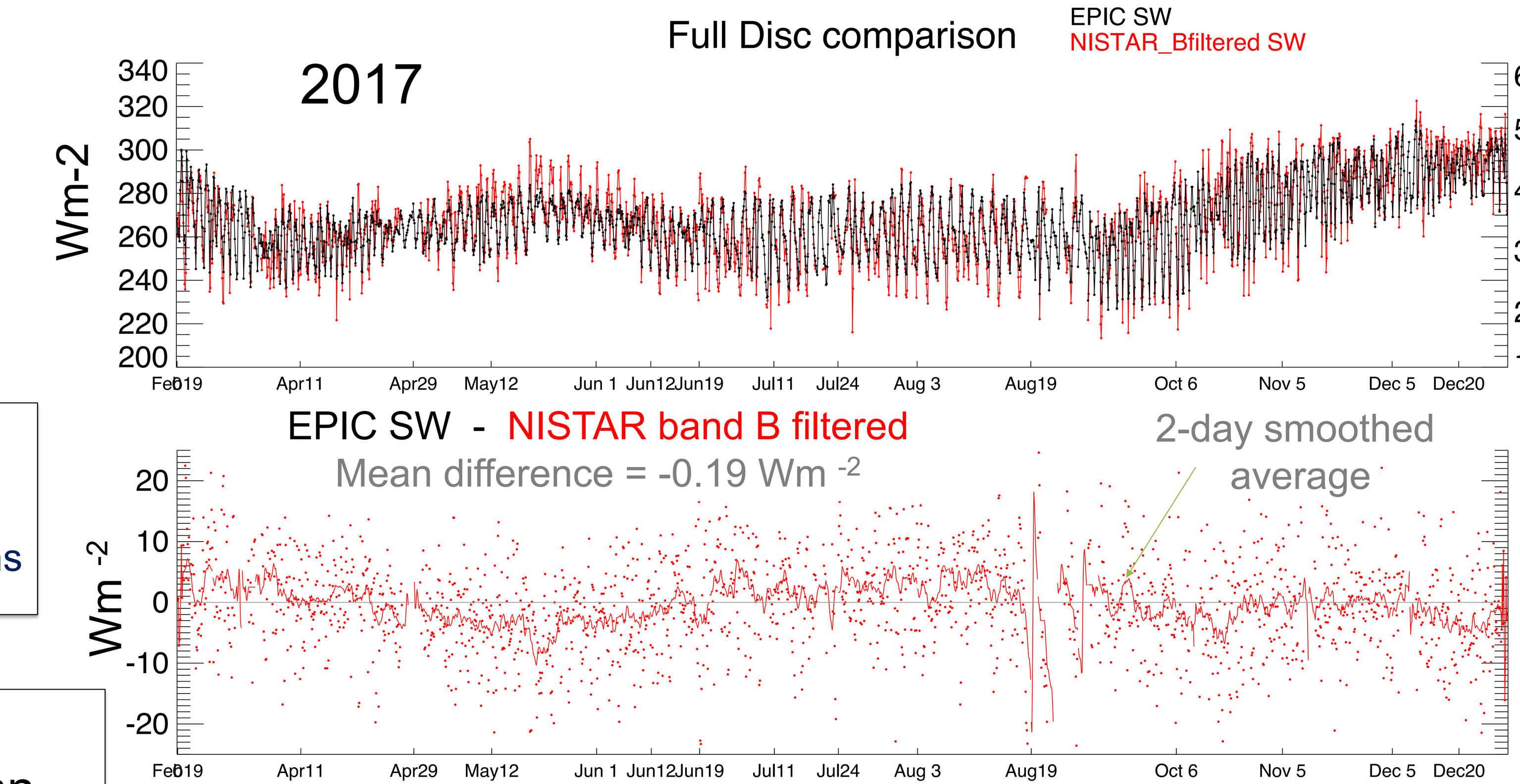
Shown above is spectra from a single EPIC pixel over the western Sahara. Our algorithm constructs a composite spectra (grey trace) that best fits the spectral shape of the observed EPIC radiances (red circles). The underlying surface scene with the lowest residual error compared with EPIC is chosen. In the example above, the algorithm chose a desert spectra, consistent with known underlying surface over the Sahara.

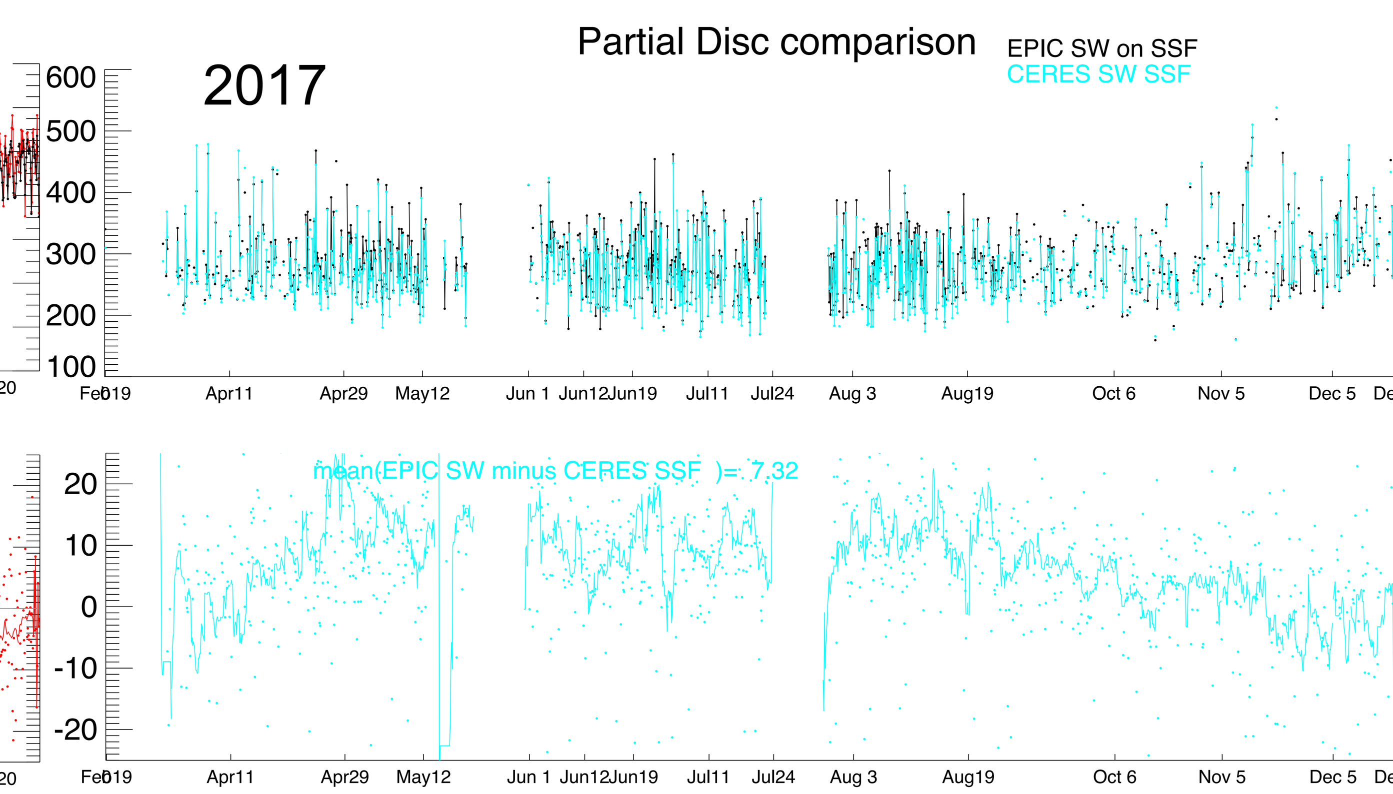
Finally, the composite spectra is scaled and bent (small adjustment) to exactly match the 4 visible EPIC channels over land and 6 channels (UV and visible) over ocean. The resulting scaled composite spectra (black trace) is spectrally integrated yielding an estimate of the SW reflected energy for the EPIC pixel.





Active vegetation scenes with high **NDVI** values have relatively more energy in wavelengths above 680nm. EPIC can identify these scenes when the radiance for 780nm is greater than 680nm. Compare the two vegetation scenes above with the desert scene, where the 780nm radiance is less than the 680nm value. The SW reflected energy in the longer infrared wavelengths is determined by the chosen AVIRIS spectra which is largely driven by the EPIC radiances at 780 and 680nm wavelength. Any SW broadband reflected energy estimate from EPIC **needs to include both the 680 and 780nm wavelengths**.

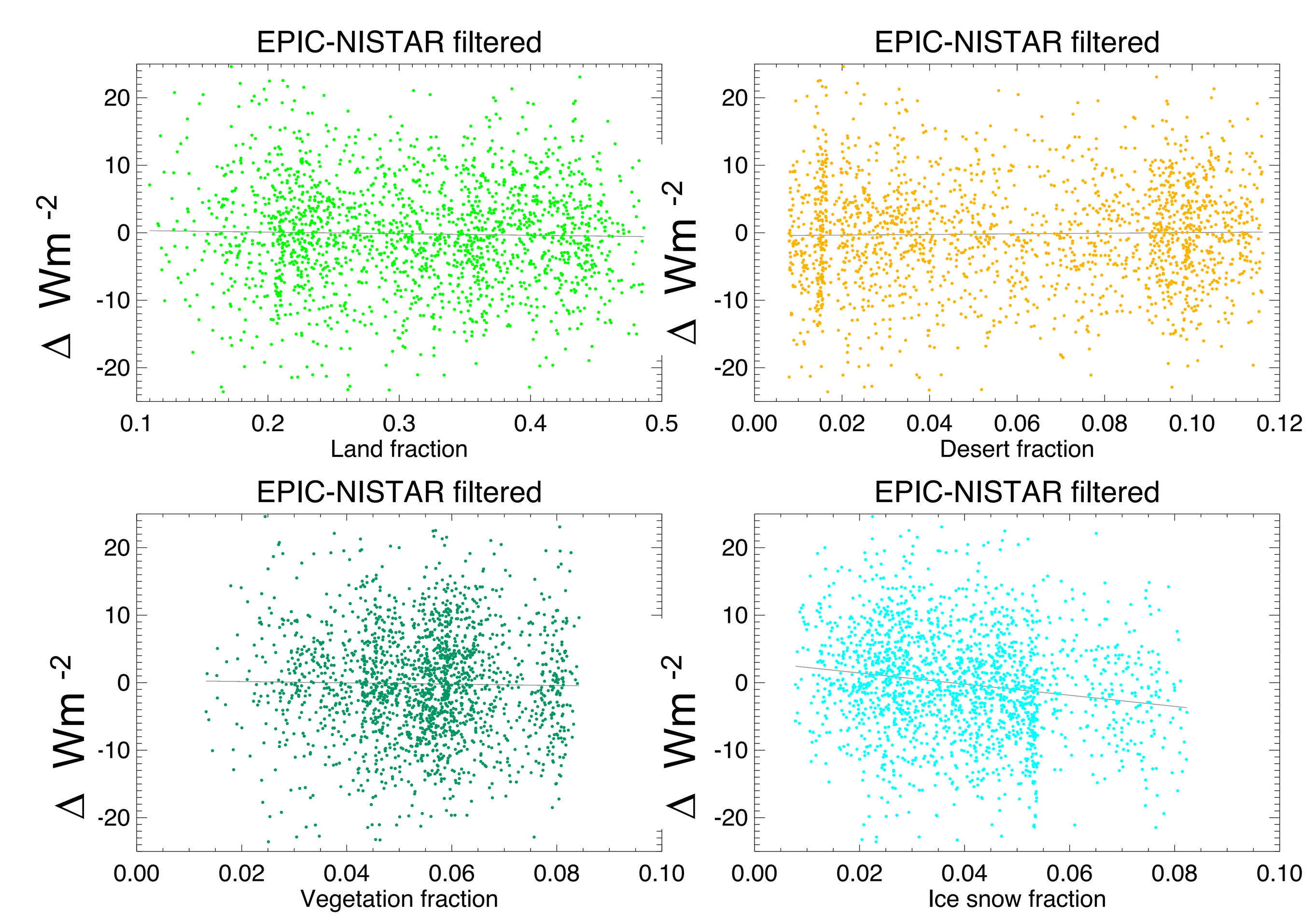




NISTAR Band-B filtered energy comparison

We processed all EPIC images for 2017, spatially integrated the energy from all EPIC pixels for each image and compared the total energy with the NISTAR Band-B filtered reflected energy. On average the EPIC estimate is only **0.19 Wm^{-2}** below the NISTAR observations.

Cause of time dependent difference? The smoothed average of the EPIC SW minus NISTAR energy varies $\pm$5 Wm^{-2} (red trace in difference time series above). To diagnose the cause for this the differences are plotted against the fraction of Land, Desert, Vegetation and Snow+Ice for an EPIC image. On average differences are not sensitive to the amount of Land, Desert, or Vegetation, But differences are sensitive the amount of **Ice and Snow** in the EPIC image. This suggests that treatment of these scenes need further improvement.



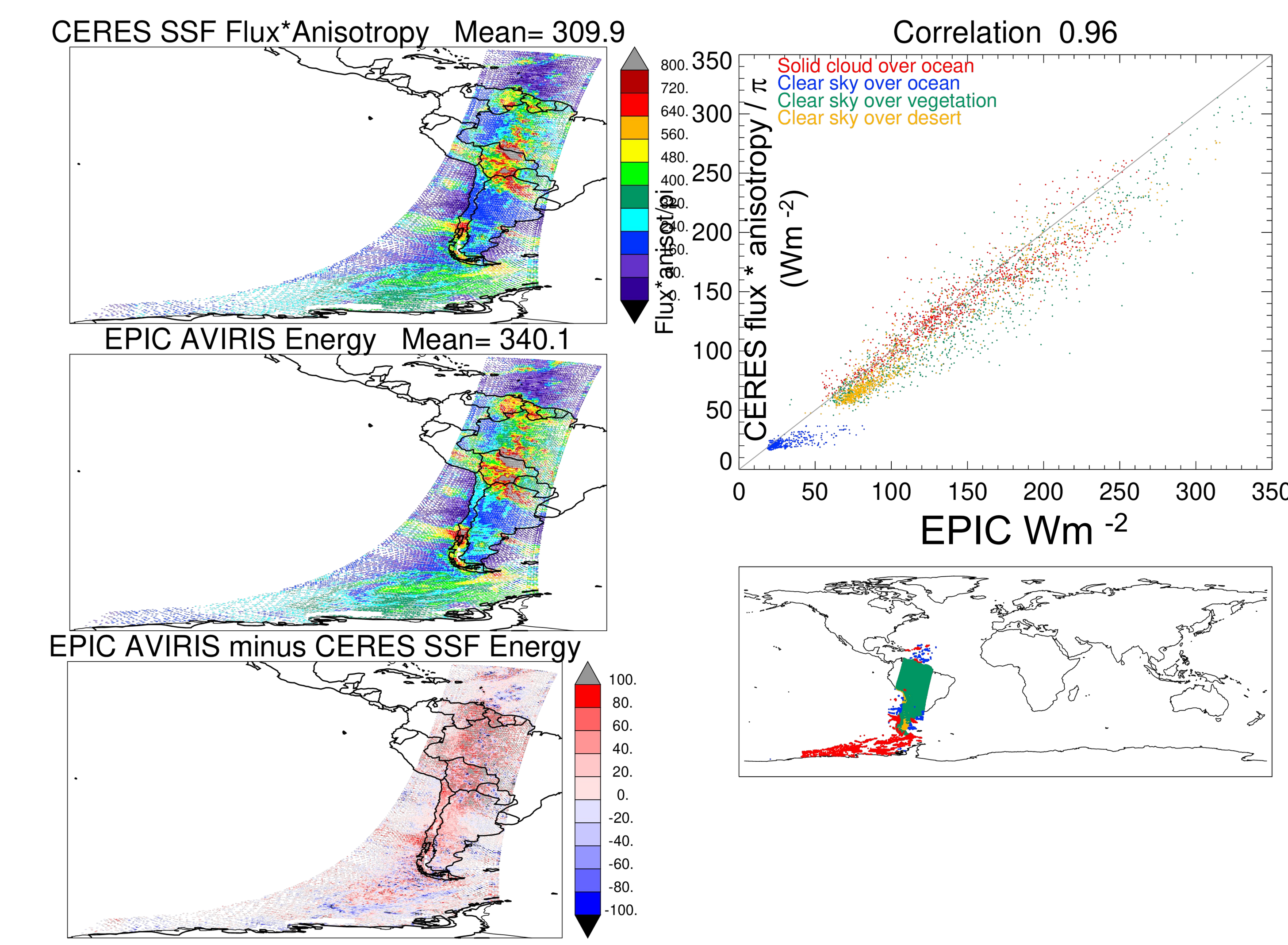
CERES Single Scanner Footprint Edition4A

We can also compare our EPIC SW product with CERES reflected SW energy. Instead of doing a full disc comparison, we only use CERES SSF pixels that are within 30 minutes of the EPIC imaging time. We use the Edition 2 Angular Distribution Models to convert the CERES flux to the energy that EPIC would observe.

On average the EPIC estimate is **7 Wm^{-2}** above the CERES

Pixel comparison for 19 Feb 2017 hour 13

While CERS and EPIC energies show same synoptic features, difference maps show they occur over all scene types (LHS). This is also confirmed by the scatter plot of pixel energies color coded by scene type.



Conclusion We construct a record of Shortwave reflected energy from EPIC radiances along with AVIRIS high resolution spectral for 2017. While total reflected energy from a single EPIC image may be 15Wm^{-2} different than the NISTAR observation, on average, there is negligible offset bias compared with NISTAR observations for 2017.