

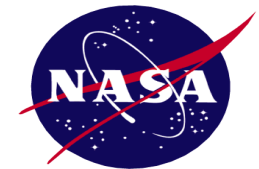


Improvements to the Inter-calibration Methodology of the EPIC Instrument's Visible Channels using VIIRS as a Reference

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Introduction

- EPIC onboard the DSCOVR satellite at L1 lacks onboard calibration
- Filter wheels radiometrically calibrated against the moon to monitor stability
- EPIC's constant view of the sunlit-disk of Earth provides unique opportunity for inter-calibration of EPIC channels using well-calibrated instruments on low Earth orbit (LEO) satellites
- Inter-calibration is performed by ray-matching with VIIRS on NPP-Suomi
- EPIC bands 1-4 are in the ultraviolet wavelengths and have no VIIRS channel counterparts, and therefore are not considered here

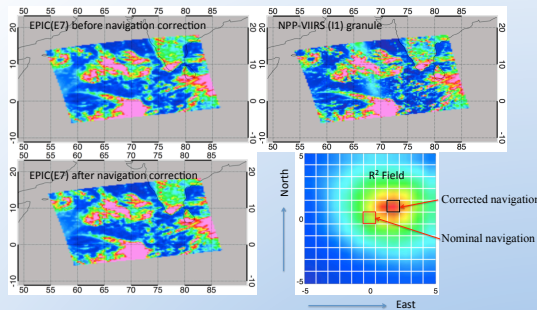
Data

- EPIC L1B, bands 5-10
 - Version 02 is used for most of this study
 - Version 01 is briefly used for navigation analysis
- NPP-VIIRS LAM PEATE L1B version 001
 - M-bands at 750-m resolution
 - I-bands nominally at 350-m but subsampled to 750-m

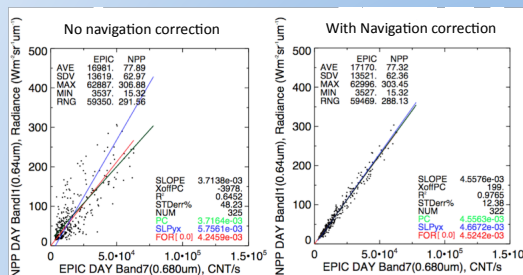
EPIC		VIIRS	
Band ID	λ (nm)	Band ID	λ (nm)
E5	443	M3	488
E6	551	M4	555
E7	680	I1	672
E8	688	M5	640
E9	764	M7	865
E10	780		

Table listing the different band and wavelengths used among the different instruments in this analysis

EPIC Navigation Correction using VIIRS Imagers

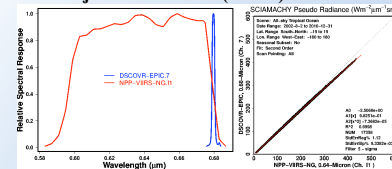


- Spatially average the EPIC (E7) and VIIRS (I1) imager pixels into the $0.25^\circ \times 0.25^\circ$ latitude by longitude grid for images within 15 minutes
- Linearly regress the corresponding grid location and compute R^2
- Shift the EPIC grid ± 5 gridded regions in both the latitude and longitude directions to find the highest R^2

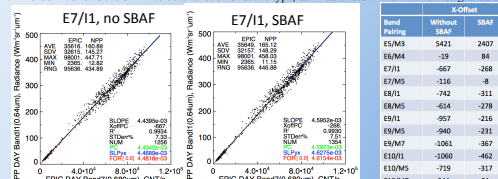


VIIRS-based navigation correction improves the navigation dramatically

Spectral Band Adjustment Factor (SBAF)



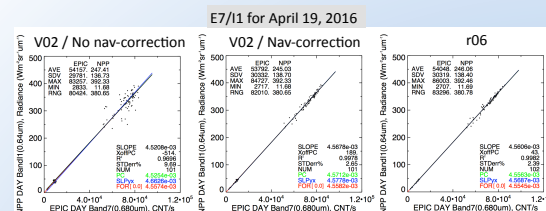
- Spectral band differences must be taken into account when inter-calibrating EPIC with VIIRS bands
- Use SCIAMACHY hyper-spectral footprint convolved with spectral response function pseudo radiance pairs and apply a 2nd order fit to estimate the SBAF over the all-sky ocean domain
- The 2nd order fit allows the SBAF to be a function of scene type, dark radiances will differ from bright radiances



- All-sky tropical ocean (ATO) gridded ($0.5^\circ \times 0.5^\circ$) ray-matching, linearly regresses the E7/I1 radiance pairs over tropical oceans
- The SBAF correction brings the offset of the linear regression closer to zero
- SBAFs are available on the NASA LARC SBAF Webtool (<https://satcorps.larc.nasa.gov/SBAF>)

Comparison V02 and r06 ATO Raymatched Calibration

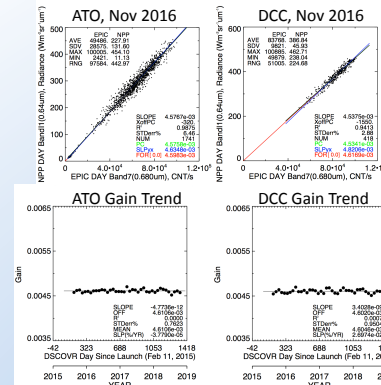
The EPIC team recently released two days of test data (09/05/15 and 04/19/16) with new navigation, labeled as r06. We can compare how our navigation-corrected V02 data performs against the new r06 data.



2015248		2015248		2015248	
Band Pairing	Without SBAF	Without SBAF	Without SBAF	Without SBAF	Without SBAF
E5/M3	5421	5421	5421	5421	5421
E6/M4	-39	-39	-39	-39	-39
E7/I1	-467	-467	-467	-467	-467
E8/M5	-116	-116	-116	-116	-116
E9/M7	-742	-742	-742	-742	-742
E10/M5	-654	-654	-654	-654	-654
E10/M7	-1060	-1060	-1060	-1060	-1060
E10/M5	-719	-719	-719	-719	-719
E10/M7	-244	-244	-244	-244	-244

- In most cases, the EPIC V02 navigation-corrected data has standard error and x-offsets much closer to that of the r06 data.
- Ratios of the gains of the V02 navigation-corrected against the gains from the r06 data are typically very small or close to zero.
- This implies that the navigation of the new r06 test dataset is a major improvement over the prior V02 dataset.

Comparison of V02 ATO and DCC Raymatched Calibration



- All-sky tropical ocean (ATO) gridded ($0.5^\circ \times 0.5^\circ$) ray-matching, linearly regressed E7/I1 radiance pairs over tropical oceans
- Deep convective cloud (DCC) ($0.25^\circ \times 0.25^\circ$) ray-matching, linearly regressed E7/I1 radiance pairs that have BT < 220K
- The DCC and ATO have their own unique SBAFs

VIIRS	DCC-RM			ATO-RM			Gain
EPIC/ VIIRS	Mean Gain	σ (%)	Trend %/yr	Mean Gain	σ (%)	Trend %/yr	DCC/ ATO (%)
E5/M3	5.292e-3	0.8	+0.39	5.275e-3	0.5	+0.42	+0.3
E6/M4	4.111e-3	1.0	+0.25	4.107e-3	0.6	+0.26	+0.1
E7/I1	4.605e-3	1.0	+2.7e-2	4.611e-3	0.7	-3.8e-5	-0.1
E7/M5	4.665e-3	0.9	+9.8e-3	4.679e-3	0.7	-2.5e-2	-0.3
E10/I1	5.331e-3	1.2	-5.6e-2	5.319e-3	1.1	-2.1e-2	+0.2
E10/M5	5.402e-3	1.2	-6.9e-2	5.397e-3	1.0	-3.5e-2	+0.1
E10/M7	5.334e-3	1.2	-0.12	5.335e-3	1.0	-9.4e-2	-0.02

- The DCC and ATO temporal trends for all non-absorption band pairings are very similar, with their mean gains within 0.3%
- Most bands appear to be stable or have a near-zero trend%/year
- The absorption in bands E8 and E9 make more difficult to calibrate, and therefore further study is required for confidence in the results for those bands

Conclusions

- SBAF accounts for spectral differences and brings the x-offsets closer to zero
- New test dataset r06 shows exceptional improvement in navigation over V02. Hopefully this navigation will make it into the next publicly released dataset
- ATO and DCC temporal trends for non-absorption band pairings are within 0.3% of each other
- Most bands show only small or near-zero trend%/year

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