TISA Working Group Update

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GEO and MODIS/VIIRS Imager calibration: P. Khakurel, C. Haney
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Spring 2026 CERES science team meeting
May 12-14, 2026
NASA-Langley, Hampton, VA

Legend
Completed
In progress
Pending

TISA Ed5 improvements

- Incorporate GEO cloud retrieval and gridding PGEs into catalyst so that it can be run on AMI-P
- SSF1deg and SYN1deg products to include nighttime-only clouds, along with daytime, and 24-hour
- SYN1deg 3x3 pc-tau cloud types
- SYN1deg CERES/GEO SW flux normalization
- Improved regional GMT hourly solar incoming computations
- MODIS and VIIRS stability assessment using DCC, Dome-C, Libya-4 invariant targets
- NOAA20-VIIRS, SNPP-VIIRS, and Terra-MODIS to Aqua-MODIS C7 scaling factors
- GEO to Aqua-MODIS scaling factors
- Use AIRS and CrIS as a transfer radiometer between MODIS/VIIRS and GEO/MODIS
  - CWG uniquely computes the TOA predicted IR channel BT using the imager or GEO (need only cal, not SBAF)
  - The TISA GEO WV and WN to LW broadband are based on imager/CERES, requires an imager equivalent GEO radiance
- Improved GEO narrowband to SW broadband relationships
- FBCT, cloudtype narrowband to broadband with more channels using ML, and improved footprint scaling
  - The Ed5 SSF has 12 imager channels for total, clear and the 2 cloudlayers, Ed4 only 5 channels for cloudlayers

SYN1deg 3x3 pc-tau clouds

SYN1deg 3x3 pc-tau cloudtypes

- The Ed4 SYN1deg provided 4-pressure layer cloud properties
- The Ed5 SYN1deg will provide 3x3 pc-tau cloudtypes
  - The 3x3 pc-tau clouds will provide the SARB group more accurate Fu-Liou flux computations
  - Ed4 layer optical depth distribution was estimated using a gamma function based on the log and linear averaged optical depth
- The Ed4 CldTypHist product
  - Contains the Terra/Aqua/N20/GEO sampling strategy similar to SYN1deg
  - The number of 2025 users that ordered SYN1deg and CldTypHist products is 1299 and 124
  - For Ed5, discontinue CldTypHist product, since SYN1deg will contain 3x3 clouds, now duplicitous
- The TISA temporally interpolates each cloud type individually and spatially averages all the cloud-types to compute the total cloud for the hourbox
  - There are very few GEO datagaps and the 3x3 and 4-layer total cloud properties should be similar
  - However, for polar regions SYN1deg uses N20-only twice daily observations, the individual cloud-type interpolated based total cloud properties may slightly differ between the 3x3 and 4-layer clouds

4-layer minus 3x3 cloudtype total cloud comparison

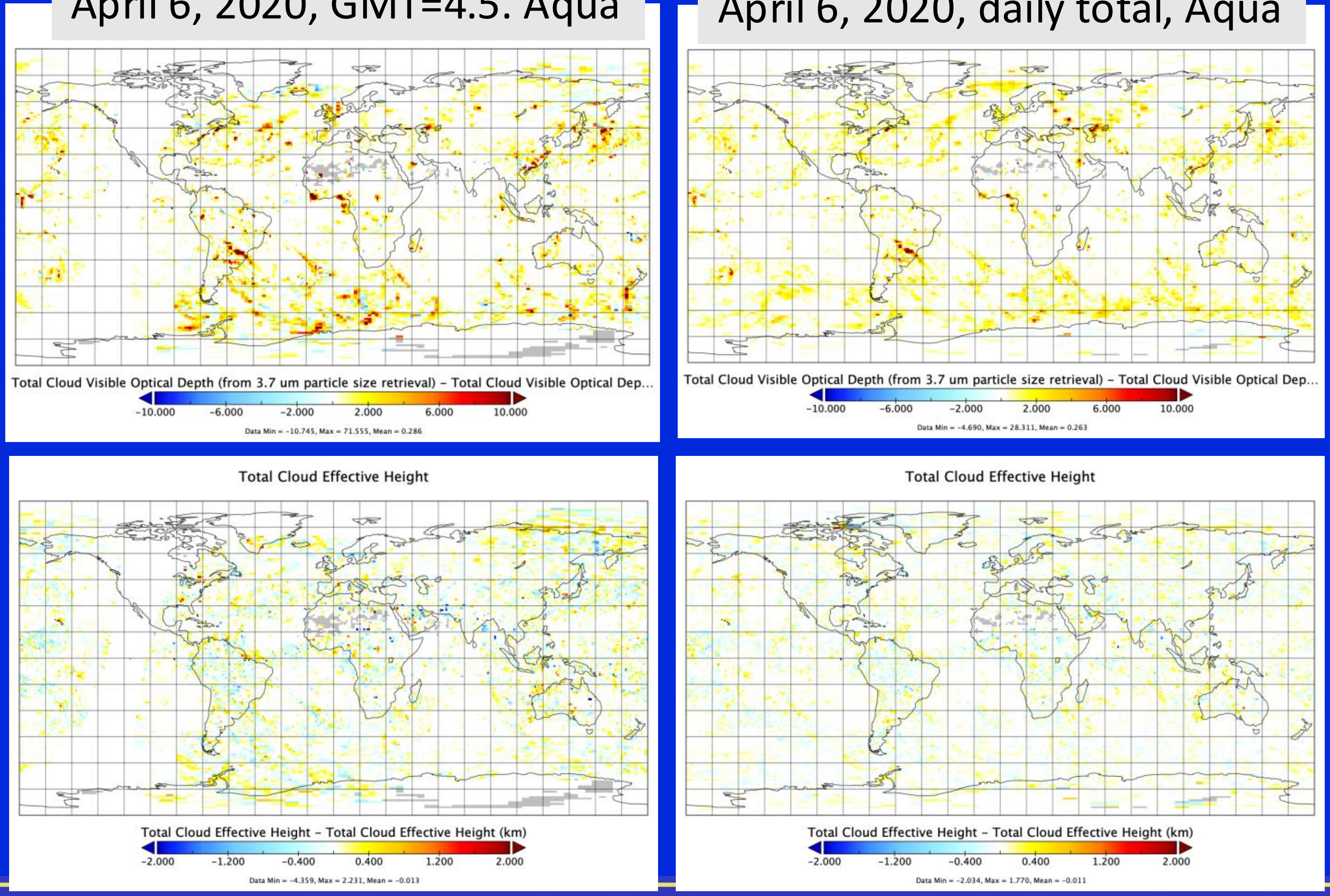
4-layer minus 3x3 total cloud properties

April 6, 2020, GMT=4.5. Aqua

April 6, 2020, daily total, Aqua

Optical depth

Cloud Effective Hiegth



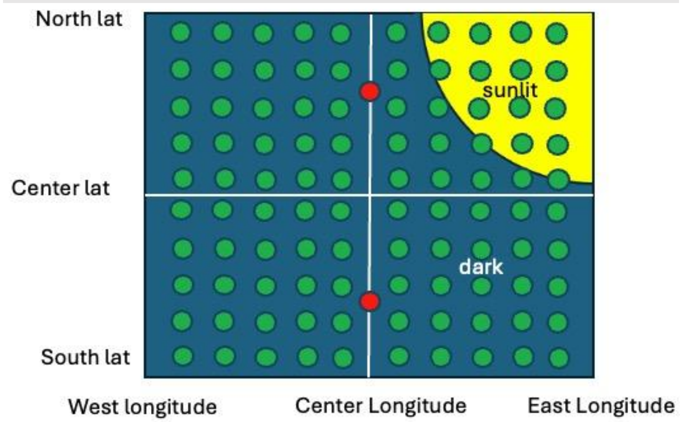
- For Aqua-only twice daily observations, the total cloud properties may slightly differ between the 3x3 and 4-layer cloud properties
- The cloud fraction is linearly interpolated between successive observations
- The cloud property is linearly interpolated between successive valid individual cloud-type observations
- if one of the observations is clear-sky or does not contain the cloud-type, the valid cloud property is replicated
- The total cloud property is the weighted cloud fraction sum
- The total cloud properties are the weighted cloud fraction cloud-type properties

- The regional hourly and daily total cloud property differences are small

Solar Incoming

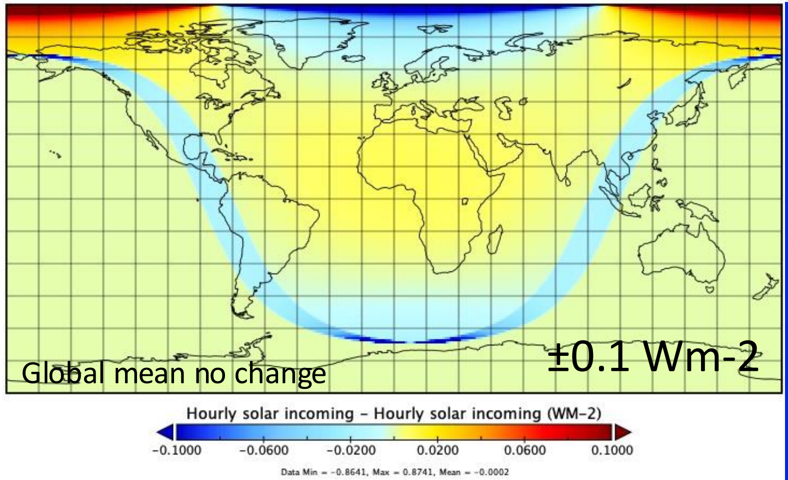
Ed5 solar incoming computations

1° region computation locations

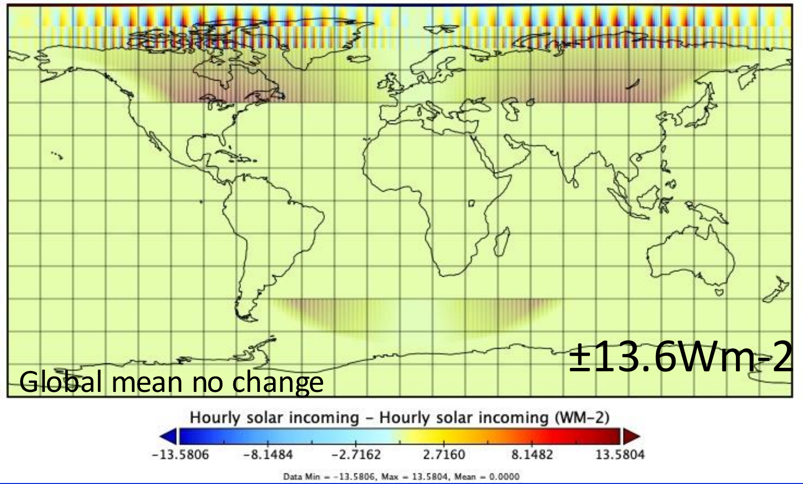


Edition4 integration   Edition5 integration

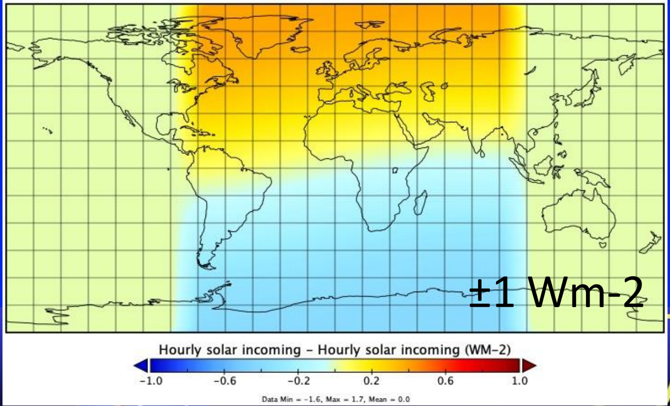
Ed4 – Ed5 June 23, GMT=11.5, solstice
Equal angle grid



Ed4 – Ed5 June 23, GMT=11.5, solstice
nested grid



Ephemeris off by 1 hour, Equinox



- The hour-angle is integrated over the GMT to compute the integrated cos(SZA) (int_csza)
- The Ed5 int_csza is the average of a 0.1° latitude and longitude grid over a 1° region
- The nested int_csza can either be averaged over the equal angle grid or averaged using the 0.1° grid within the nested region
- Solar incoming = int_csza* E_{sun}(TSIS)* $Dis_{E\text{-}S}^2$
- Must update the ephemeris hourly

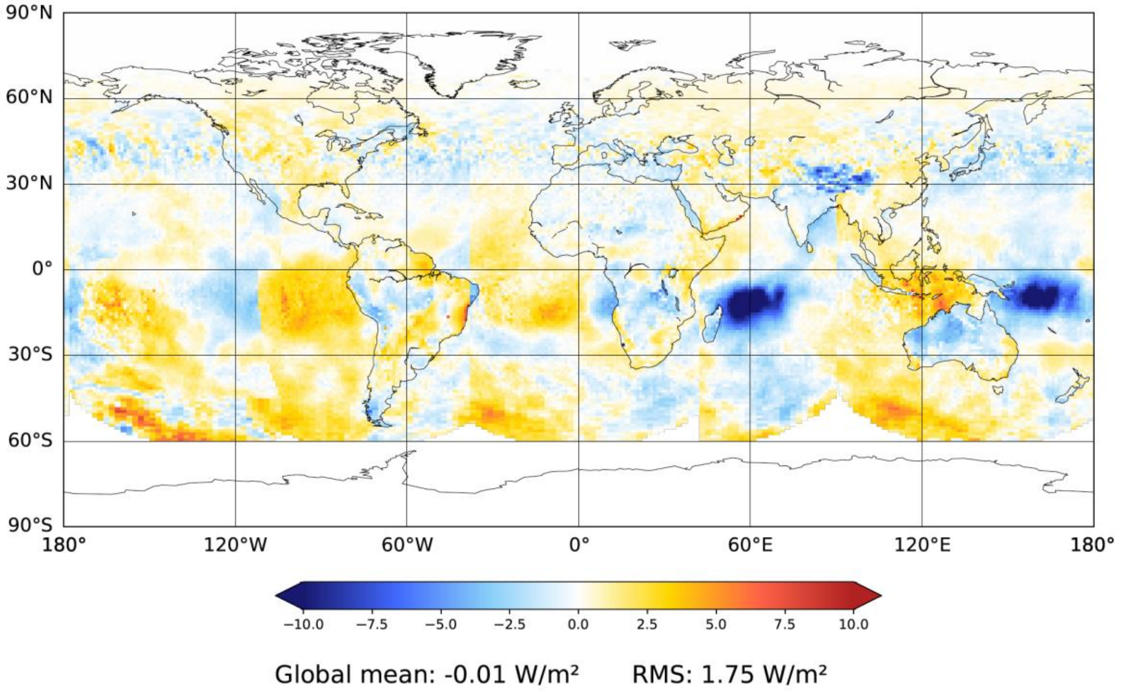
CERES/GEO SW normalization

SYN1deg CERES/GEO all-sky SW Regional Normalization

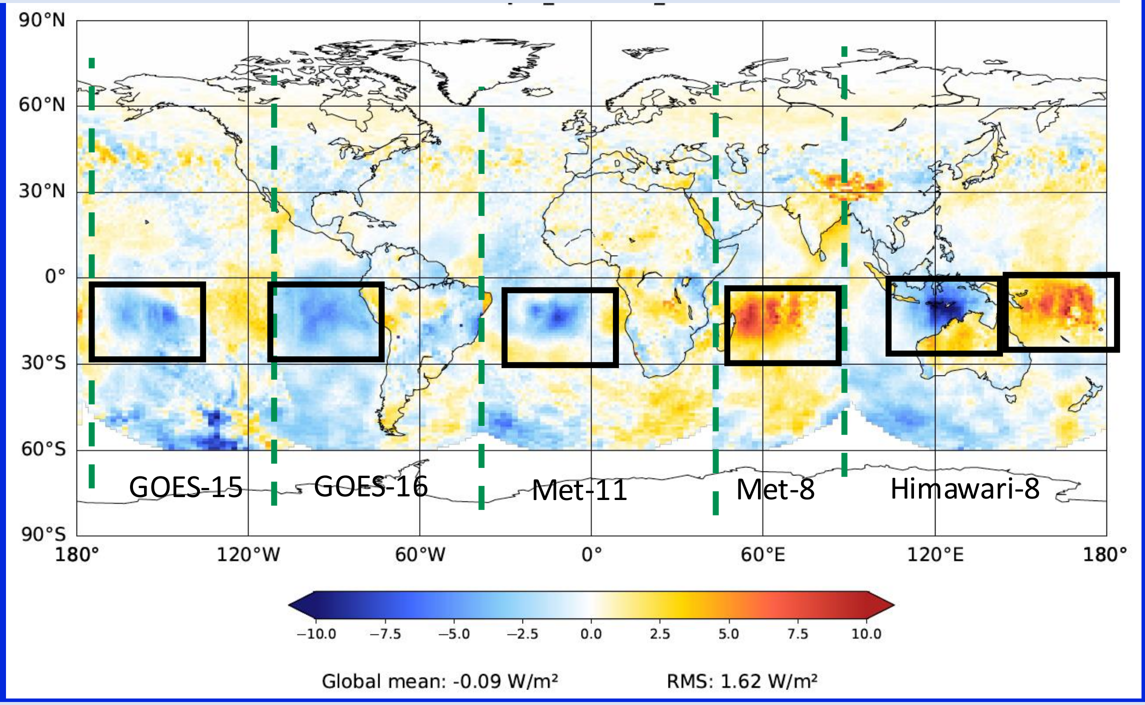
- The GEO imager narrowband to broadband derived instantaneous gridded fluxes are normalized with the CERES observed fluxes
  - To maintain the CERES instrument calibration in the 26-year SYN1deg flux record and spatially across the 5 contiguous GEOs
- Regress monthly the coincident within 30-minute instantaneous and collocated regional GEO and CERES flux pairs to compute the normalization coefficients
  - For a region, use the surrounding 5x5 regional flux pairs from the same GEO and surface type
- The CERES/GEO normalization coefficients are applied to all GEO hourboxes
  - Unless the GEO regional hour has a glint probability < 20%, rely on temporal interpolation
- Edition4 methodology was based on having both Terra+Aqua observations
  - Exclude glint flux pairs, since the other satellite overpass provided sufficient non-glint pairs
- Edition 5 methodology needs to be seamless between Terra+Aqua and N20-only
  - Mitigate the regional monthly flux difference between Terra+Aqua and N20 normalizations
  - Need to use regional hourly glint pairs

SYN1deg Ed4 monthly all-sky Δ SW flux Terra-only or Aqua-only minus Terra+Aqua

Ed4 Terra-only minus Terra+Aqua SW, Jan 2019



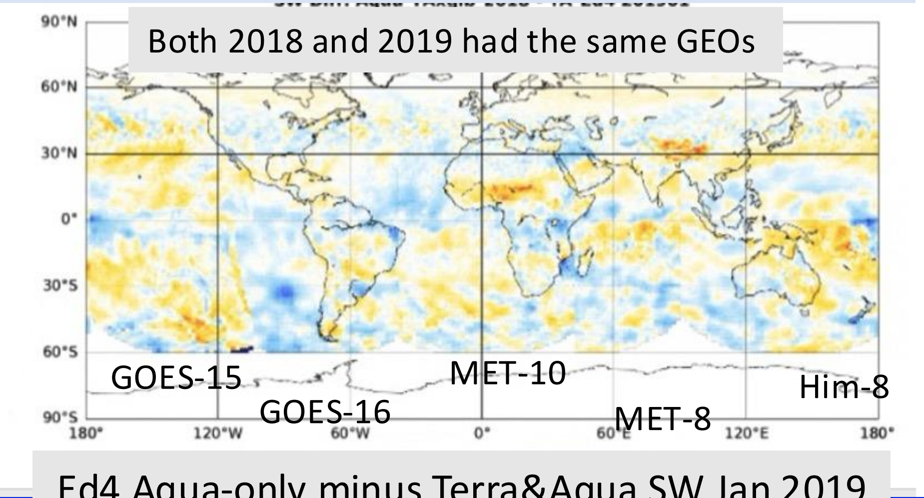
Ed4 Aqua-only minus Terra+Aqua SW, Jan 2019



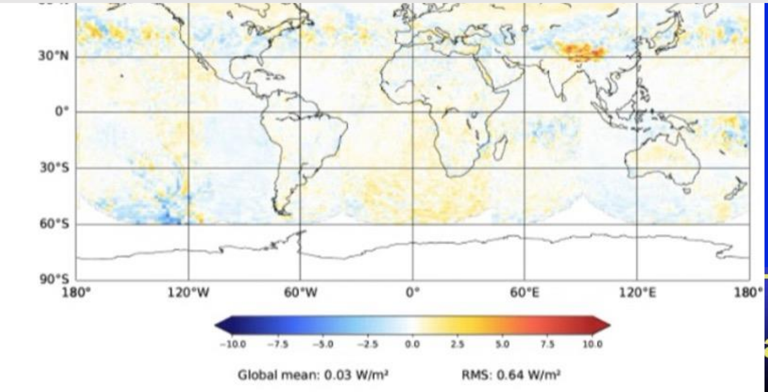
- The goal is to reduce the Terra-only or Aqua-only minus Terra+Aqua SYN1deg regional monthly means
    - Each satellite combination applies its own CERES/GEO normalization
- The greatest regional monthly inconsistency is over GEO glint regions
- The CERES/GEO normalization mitigates the imperfect GEO narrowband to broadband and GEO to Aqua-MODIS scaling

Can we use "Terra and Aqua climatology" CERES/GEO normalization for Ed4?

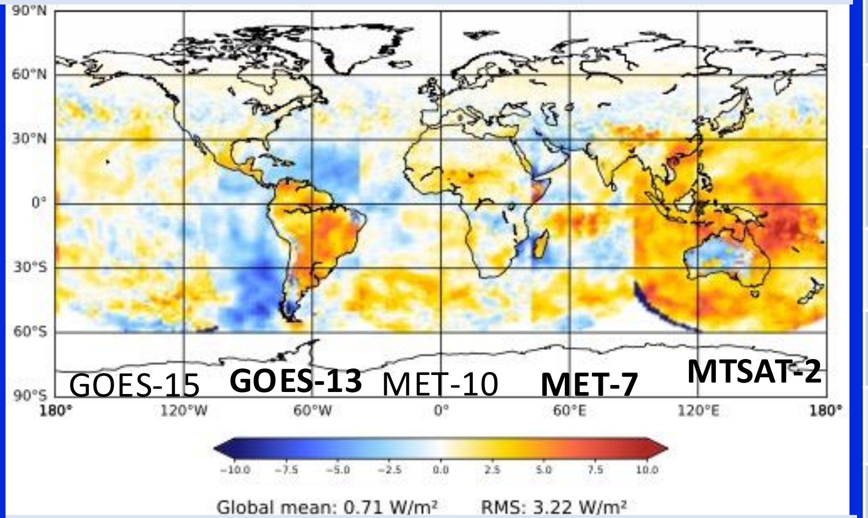
Ed4 Aqua-only minus Terra&Aqua SW Jan 2019
Using 2018 Terra&Aqua coefficients
applied to both Aqua-only and Terra&Aqua 2019



Ed4 Aqua-only minus Terra&Aqua SW Jan 2019
Using 2019 Terra&Aqua coefficients
applied to both Aqua-only and Terra&Aqua 2019



Ed4 Terra-only minus Terra&Aqua SW Jan 2019
Using 2015 Terra&Aqua coefficients
applied to both Aqua-only and Terra&Aqua 2019



Only 2 GEOs were the same between 2015 and 2019
GEOs that differ are in bold text

- Narrowband to broadband biases are GEO dependent
- Thus climatology normalization will not work

Year	Bias (W/m²)	RMS (W/m²)
2019 Ed4	**-0.09**	**1.62**
2012	+0.63	3.20
2013	+0.74	3.22
2014	+0.61	3.23
2015	+0.71	3.22
2016	+0.09	1.95
2017	+0.20	1.90
2018	+0.06	1.31
2019	+0.03	0.64
2020	-0.16	1.29
2021	-0.18	1.49
Dec&Jan 19	-0.04	1.66

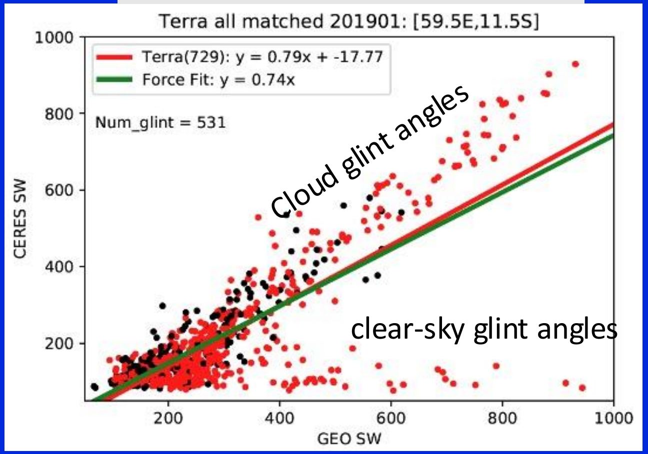
Jan 2019, Glint region scatter plot

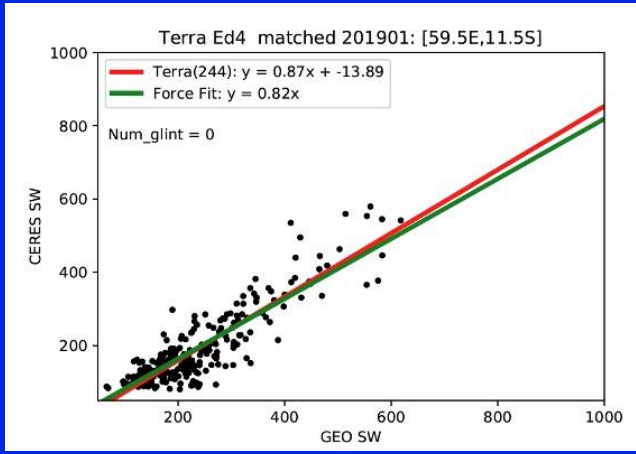
All matches, red=glint

Ed4, With glint filter

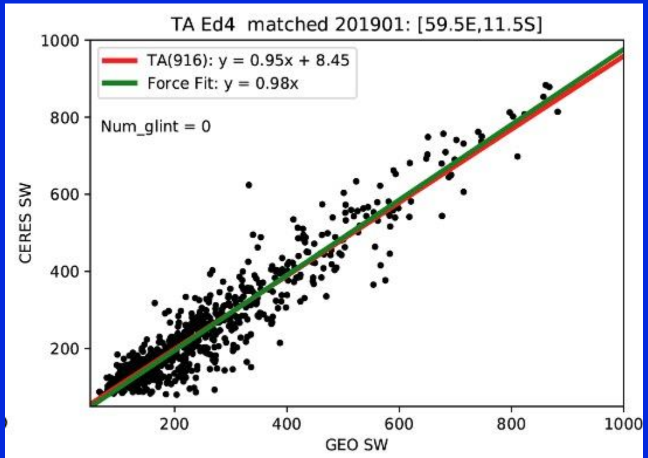
Ed4 regression

Terra-only



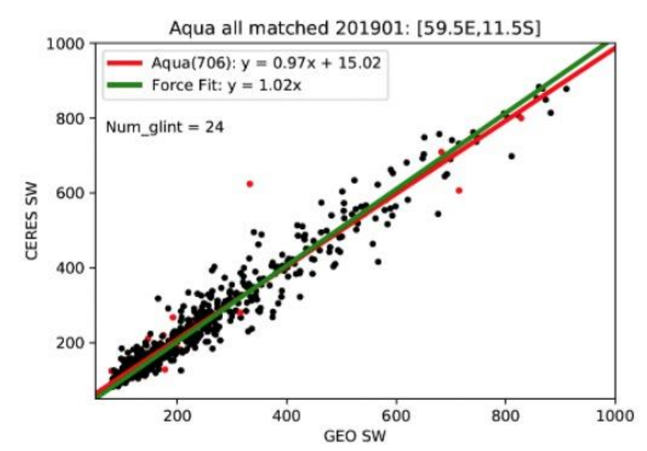


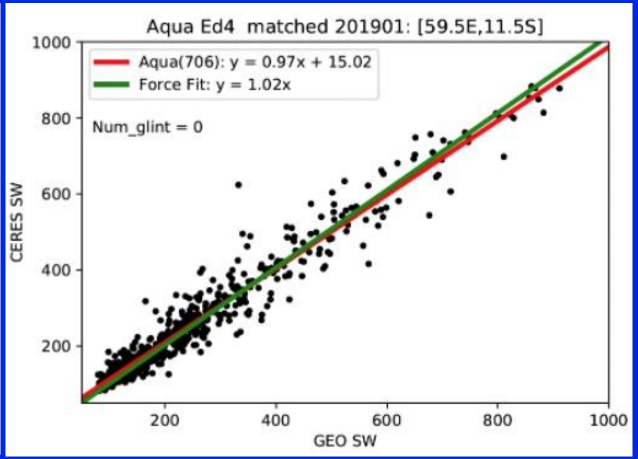
Terra+Aqua



With glint filter

Aqua-only





- The Ed4 CERES/GEO normalization relies on the non-glint CERES overpass
- Not an option for Ed5

Glint probability <25° pairs in red

Ed4 Terra-only and Aqua-only regressions differ

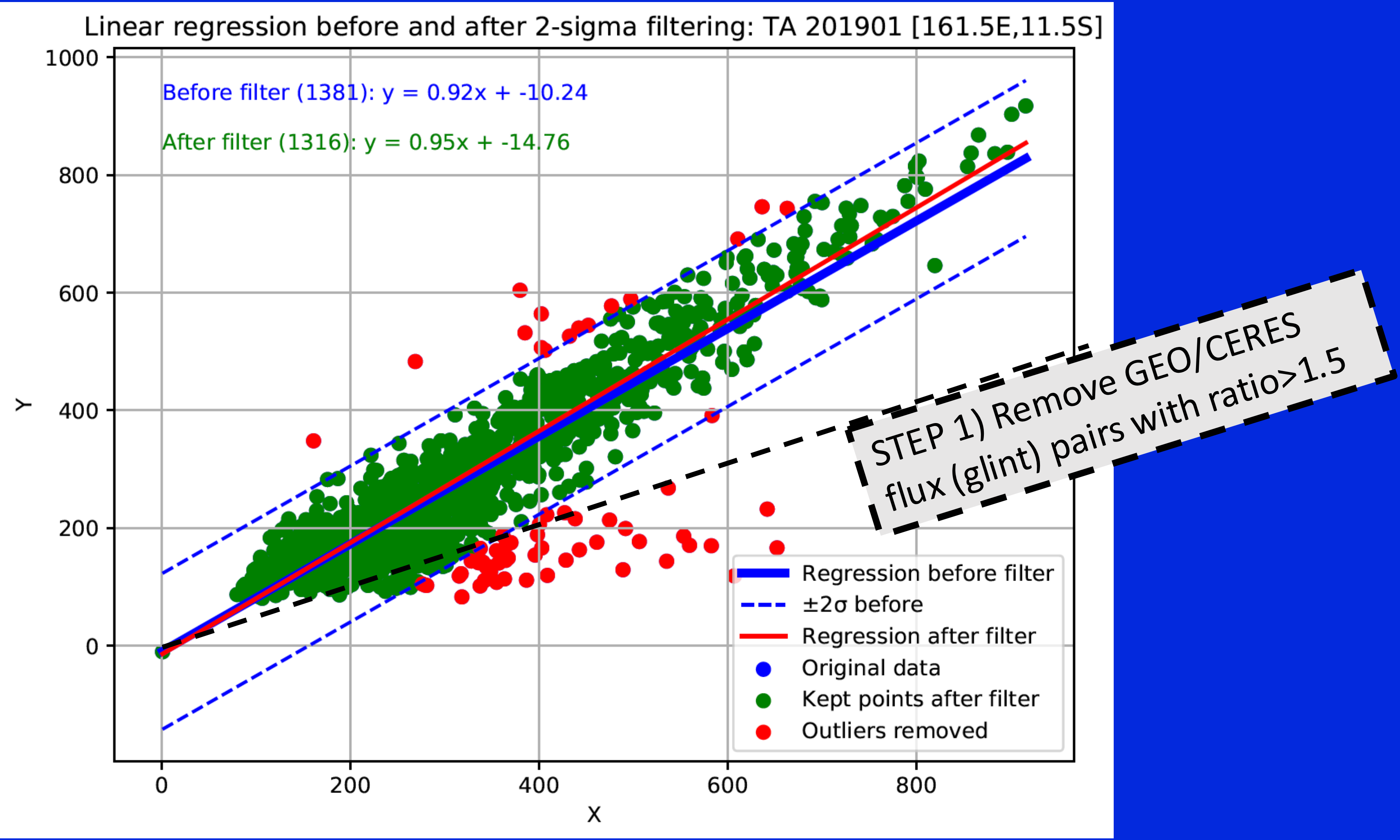
Ed5 CERES/GEO normalization methdology

STEP 2) Apply a force (through the origin) slope linear regression only with pairs where the GEO/CERES flux < 1.5

STEP 3) Apply a 2-sigma filter to remove outliers

Outliers are due to regional 30-minute cloud advection changes, for example where CERES is clear and GEO is overcast and any residual clear-sky glint pairs

STEP 4 Recompute the force slope

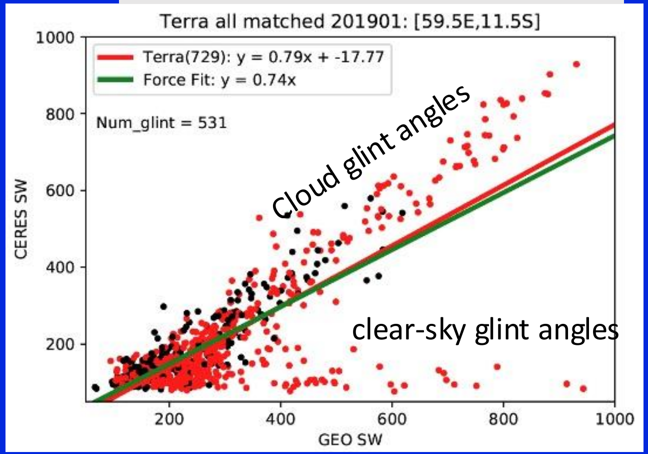


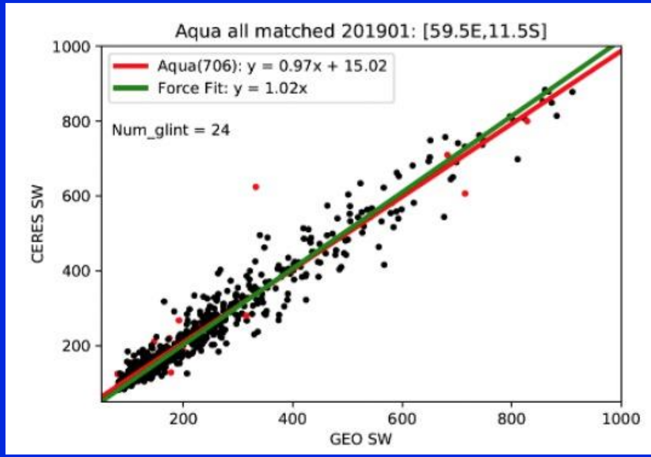
Jan 2019, Glint region scatter plot

Terra-only

Aqua-only

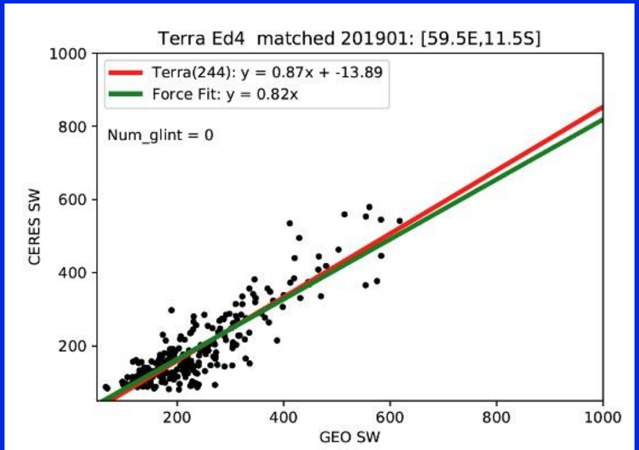
All matches

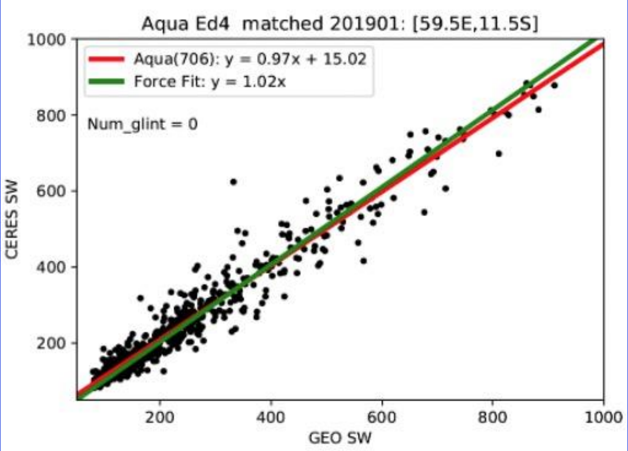




Glint probability <25° pairs in red

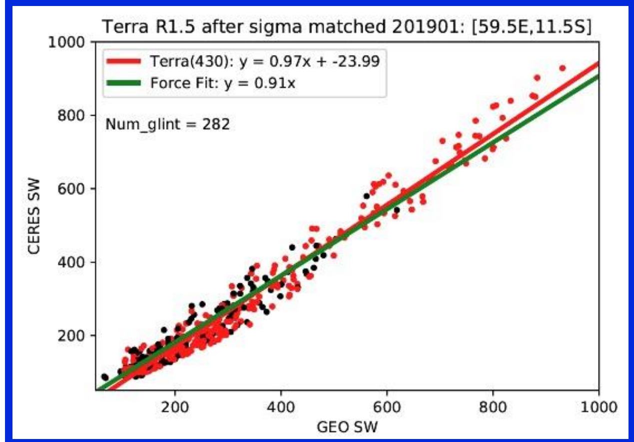
Ed4, With glint filter

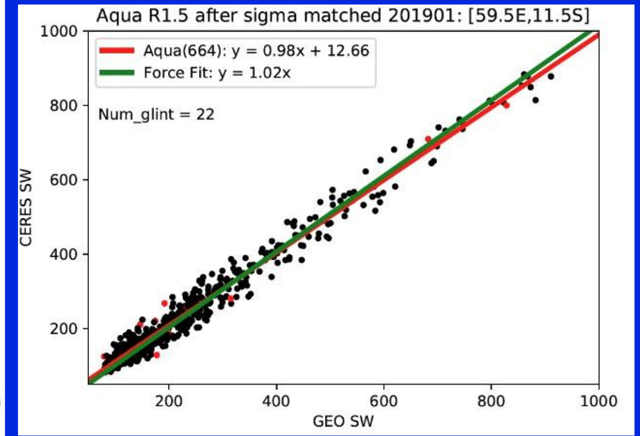




Ed4 Terra-only and Aqua-only regressions differ

Ed5, With 1.5 ratio, 2*sigma filter

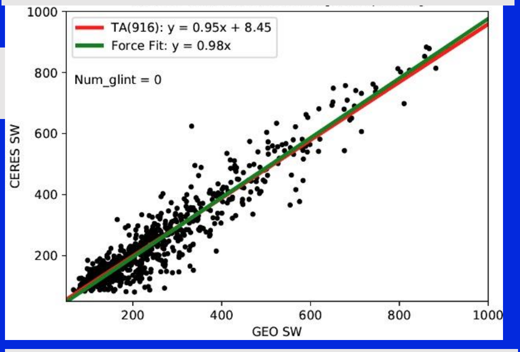




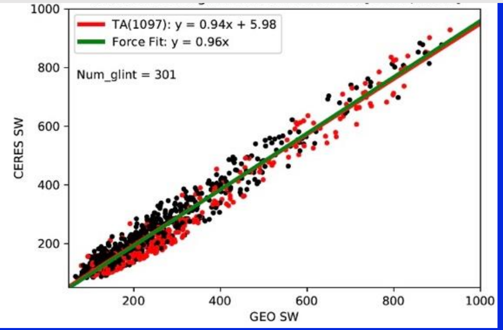
Ed5 Terra-only and Aqua-only regressions are closer

Terra&Aqua

Ed4, With glint filter



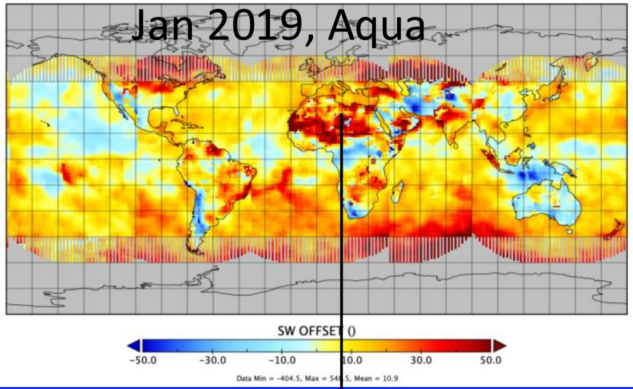
Ed5, With 1.5 ratio, 2*sigma filter

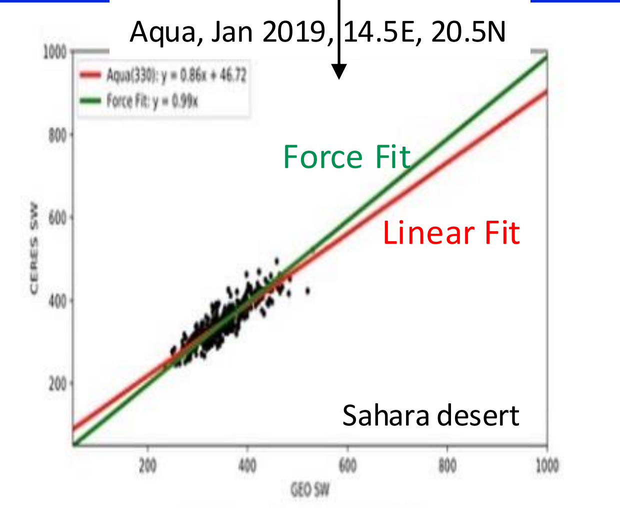


Slope	Ed4 Force	Ed5 force
Terra (glint)	0.82	0.91
Aqua (nonglint)	1.02	1.02
T+A	0.95	0.96

Application of the Ed4 linear fit near the terminator

SW linear regression offset scaling coefficient



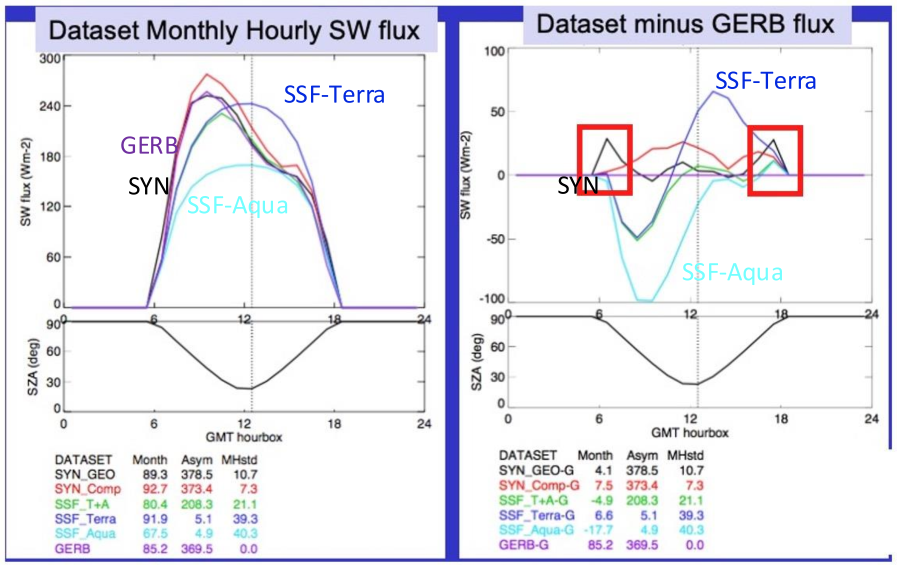


GEO narrowband to broadband biases are SZA dependent

Ed4 linear fit comparison with GERB

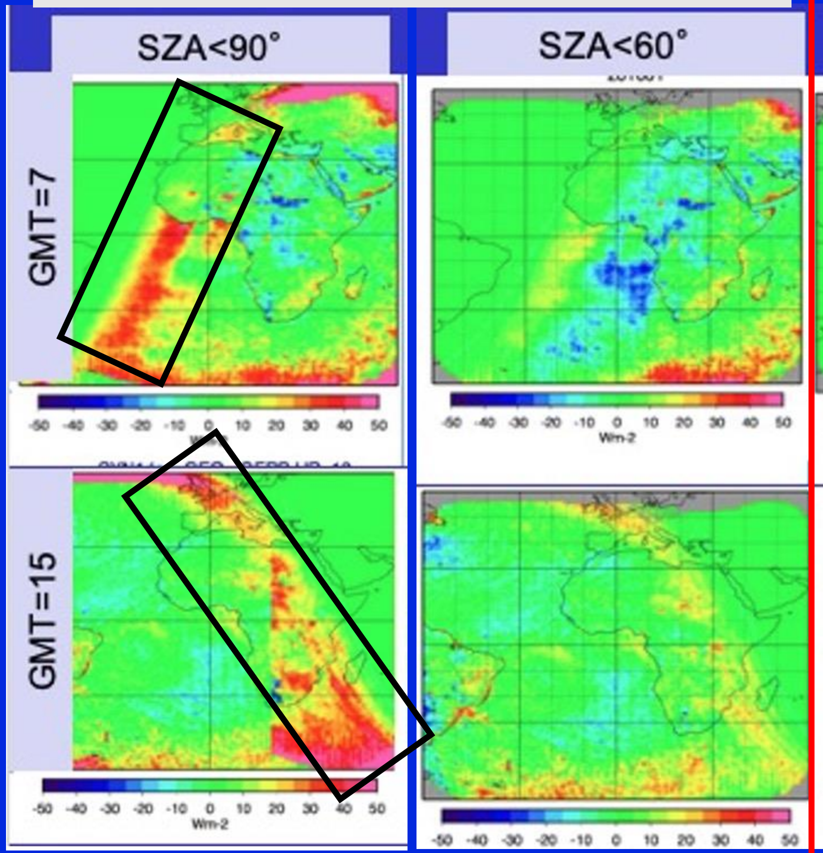
Monthly hourly SSF, SYN, GERB July 2010 fluxes

Monthly Hourly Flux, 0°E, 0°N, July 2010



Ed4 uses directional models for hourboxes>60° SZA

SYN1deg – GERB monthly hour, July 2002



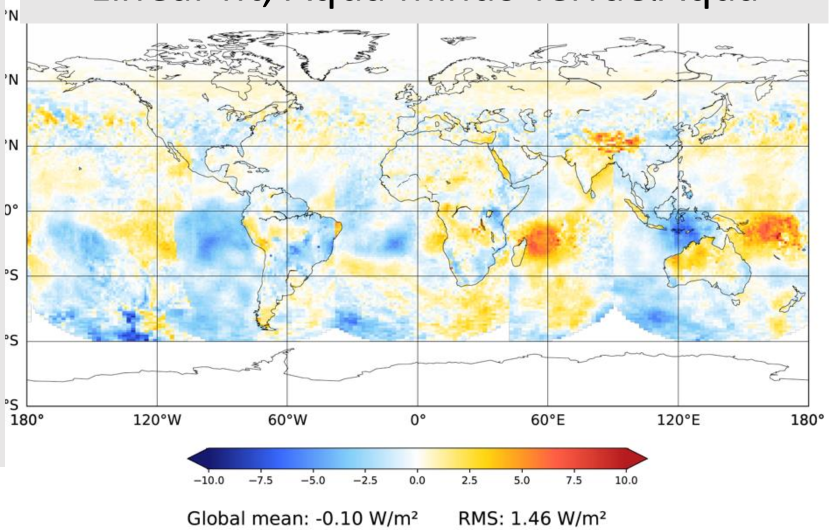
October 2016 CERES STM

Force fit allows terminator hourboxes to be normalized

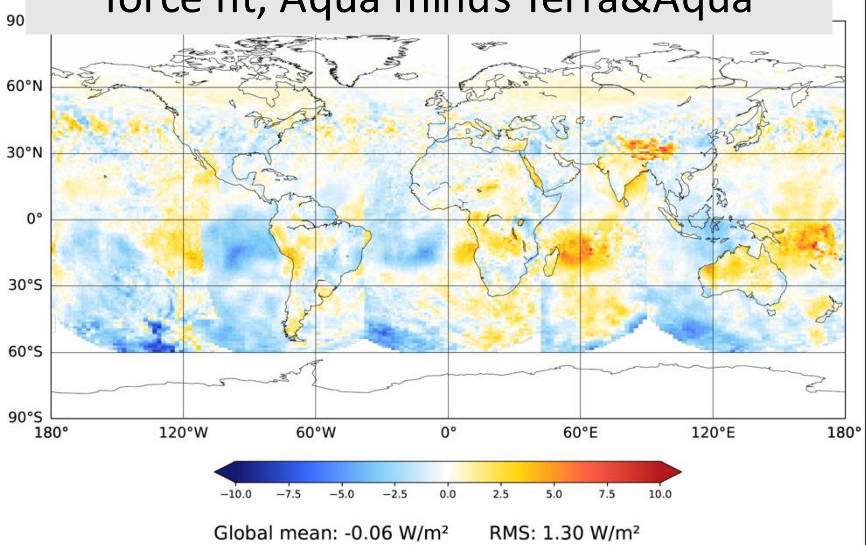
- Ed4 temporally interpolated daytime hourboxes with SZA>60°
- Ed5 will use all daytime GEO SZA<90° observed fluxes

Daytime hourboxes <60°

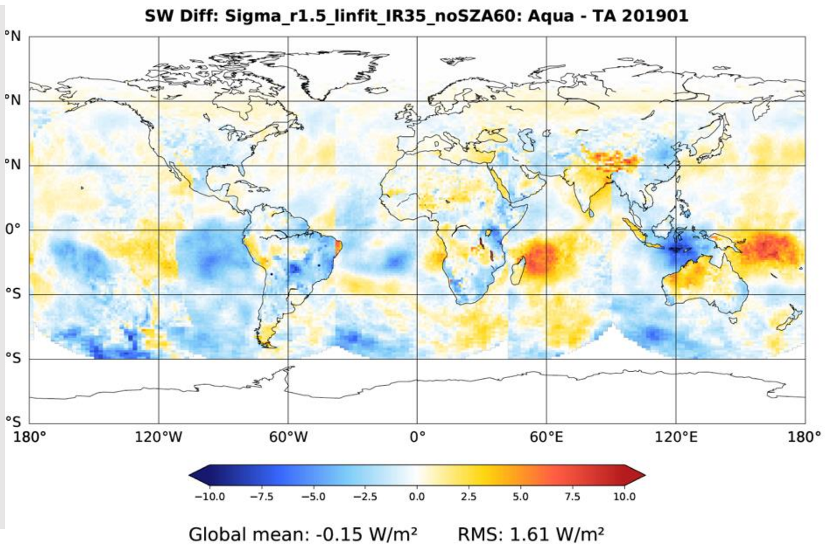
Linear fit, Aqua minus Terra&Aqua

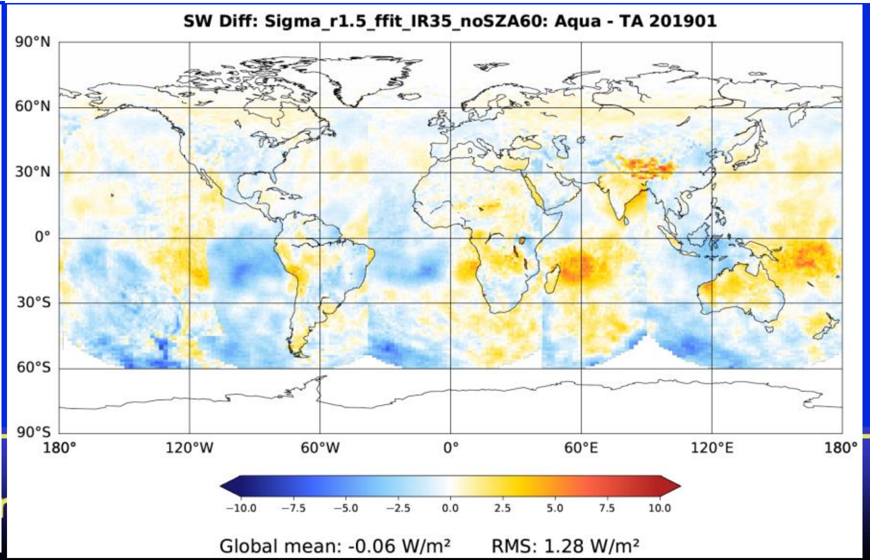


force fit, Aqua minus Terra&Aqua



All daytime hourboxes





Aqua	Bias (W/m^2)	RMS (W/m^2)
Ed4	**-0.09**	**1.62**
Linear (SZA<60)	-0.10	1.46
Force (SZA<60)	-0.06	1.30
Linear (SZA<90)	-0.15	1.61
Force (SZA<90)	-0.06	1.28

Terra	Bias (W/m^2)	RMS (W/m^2)
Ed4	**-0.01**	**1.75**
Linear (SZA<60)	+0.04	1.53
Force (SZA<60)	-0.05	1.30
Linear (SZA<90)	-0.15	1.68
Force (SZA<90)	-0.02	1.28

Meteosat normalization with GERB to validate the diurnal impact

- Construct local time GERB and Meteosat derived 1° regional instantaneous SW flux maps by appending 15° longitude GMT strips over the month
  - Both the hourly GERB and Meteosat data are observed between :00 to :15, are time matched within 5 minutes, minimizing cloud advection differences
- Perform GERB/Meteosat normalization at Terra (10LT) and Aqua (13LT) overpass times
  - Did not use the CERES SSF1deg sampling pattern, where the observations at the 60°N, 0°, and 60°S are at 12:00, 13:30 and 14:30 local time
  - GERB SW fluxes are not scaled to CERES, assume that GERB fluxes are robust diurnally
- Perform both Ed4 and Ed5 normalization algorithm
  - Compare the monthly hourly flux differences between 6-18 LT
  - Terminator hourboxes included

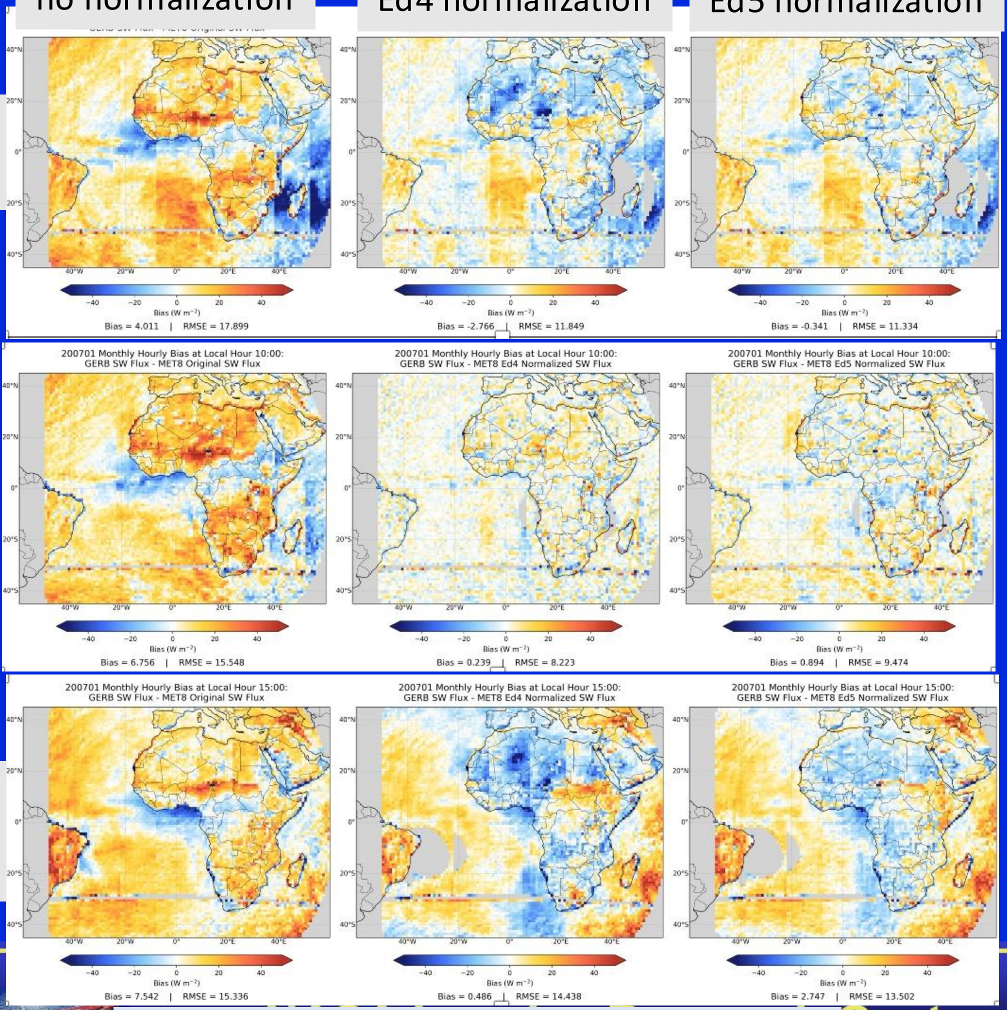
Met9-GERB Monthly Hourly SW comparison

Terra, Jan 2007 | no normalization | Ed4 normalization | Ed5 normalization

9 LT

Normalization hour 10 LT

15 LT

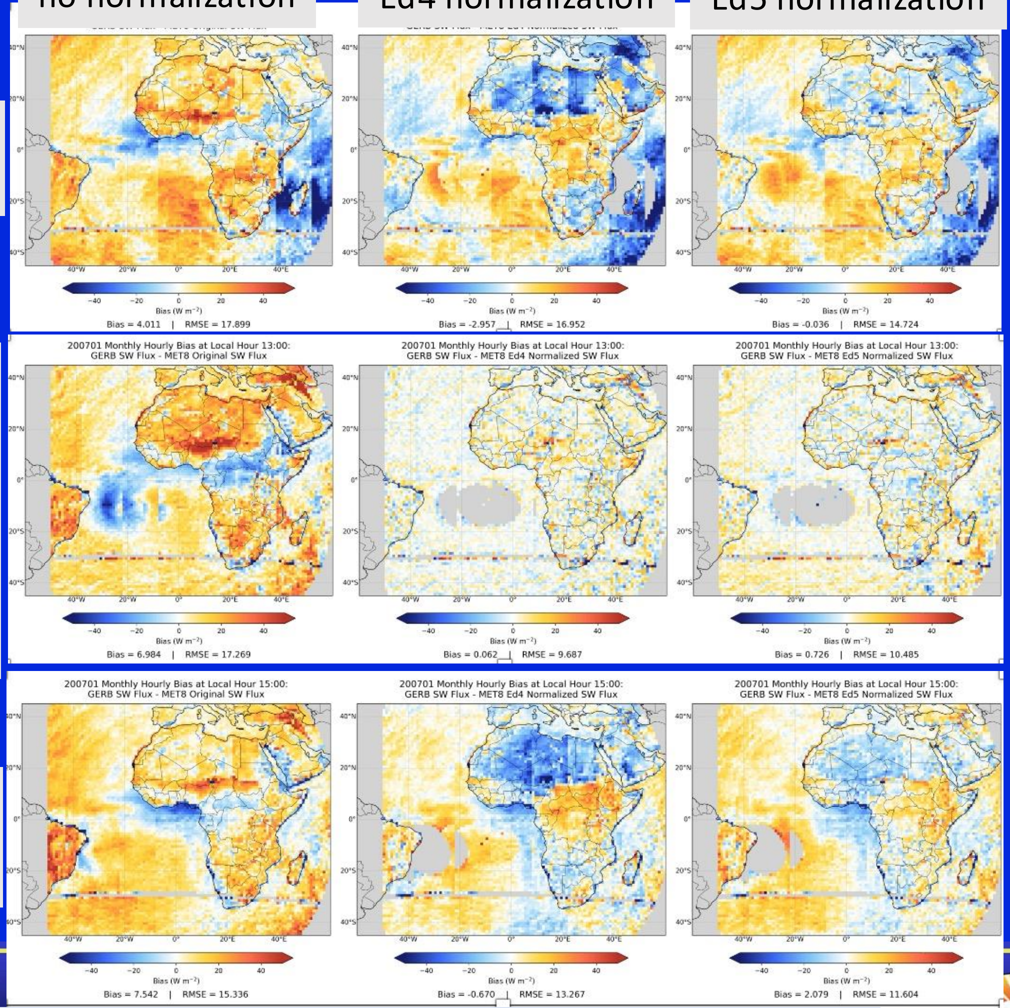


Aqua, Jan 2007 | no normalization | Ed4 normalization | Ed5 normalization

9 LT

Normalization hour 13 LT

15 LT



For this Study, Glint hourboxes are defaulted

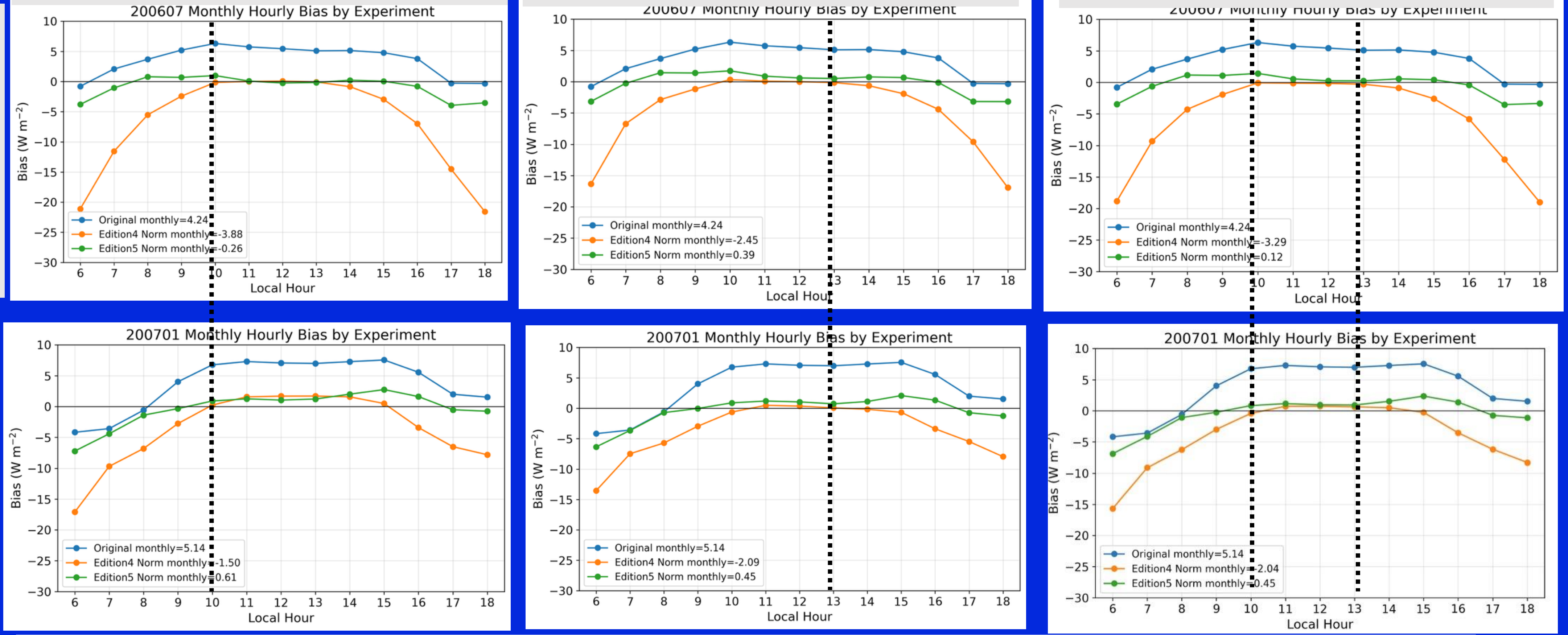
For this study, Ed4 terminator hourboxes are normalized

Monthly Hourly Domain Met9-GERB Bias

Terra-only (10 LT) | Aqua-only (13 LT) | Terra/Aqua (10&13 LT)

July 2006

January 2007

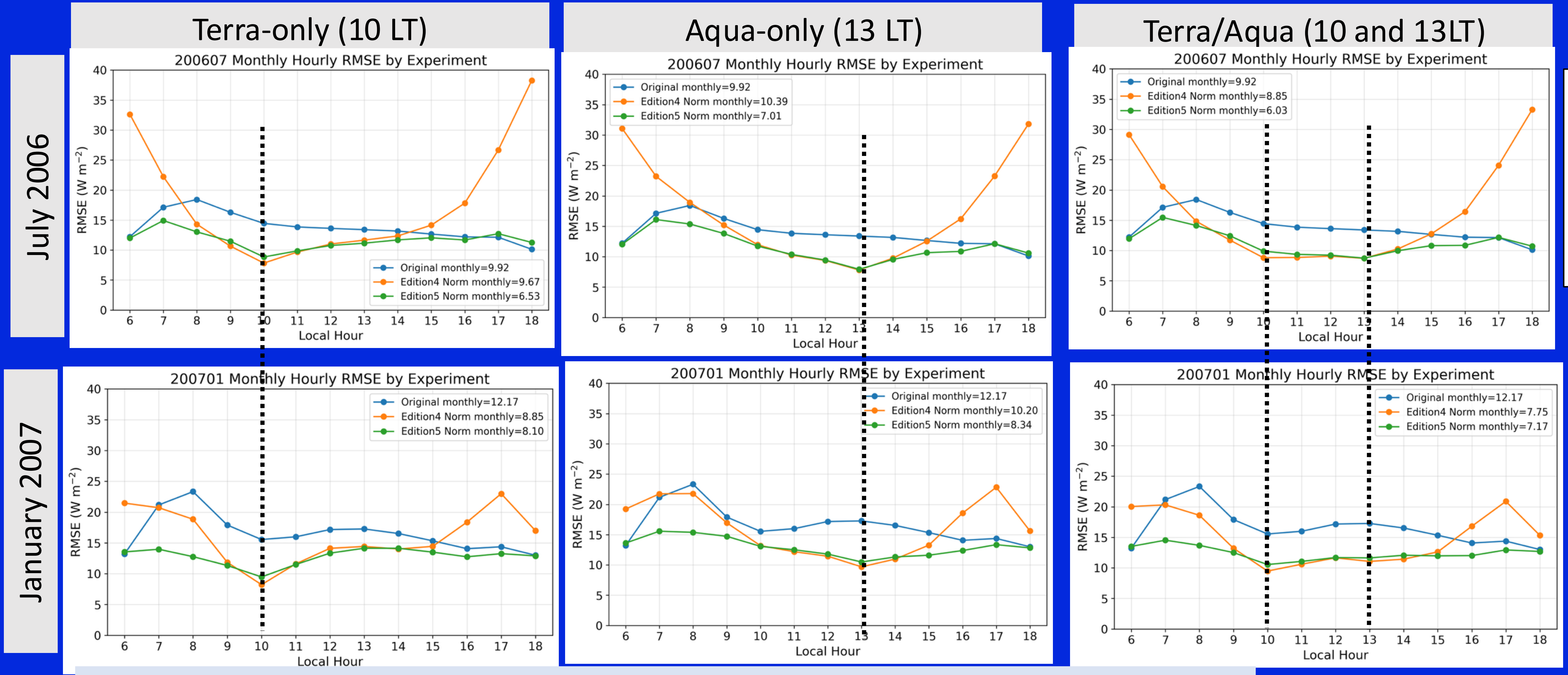


Legend
Met-9
Ed4
Ed5
.... Norm LT

- Between 10 and 14 LT the Ed4 and Ed5 biases are close to 0
- The Ed5 normalization is reduces the bias for morning and afternoon hourboxes
- GEO narrowband to broadband fluxes have a SZA bias, where high SZA fluxes are smaller and low SZA are larger

CERES

Monthly Hourly Regional Met9-GERB RMS



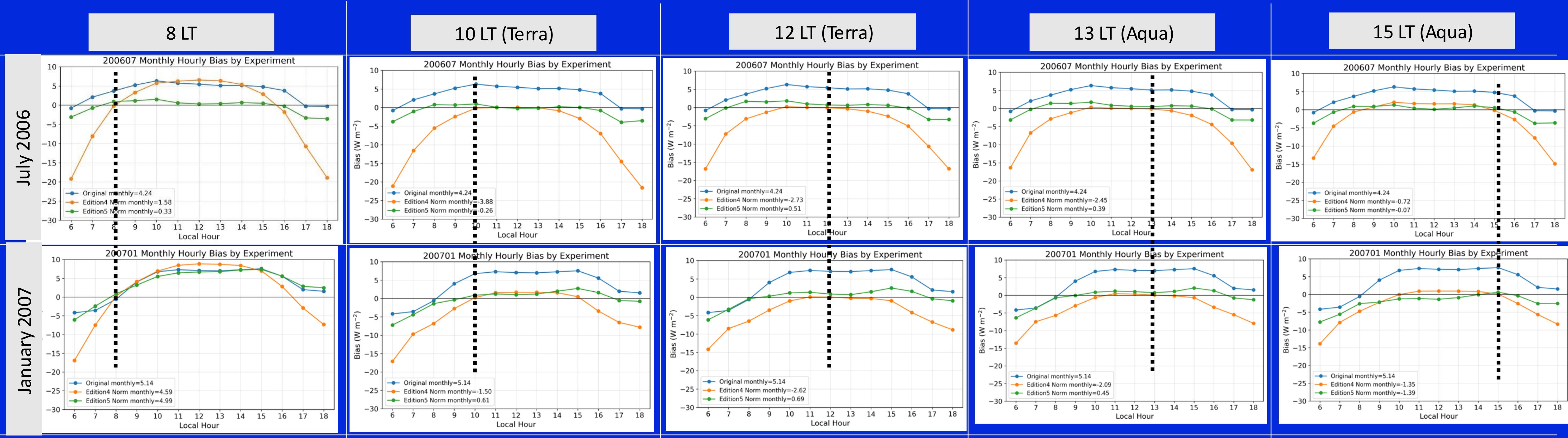
Legend
Met-9
Ed4
Ed5
…. Norm LT

- Between 9 and 15 LT the Ed4 and Ed5 RMS are similar
- The Ed5 normalization provides regional RMS errors less than or equal to the non-normalized
- The Ed4 terminator fluxes have regional RMS errors much greater than the non-normalized

Monthly Hourly Domain Met9-GERB Bias

Legend
Met-9
Ed4
Ed5
.... Norm LT

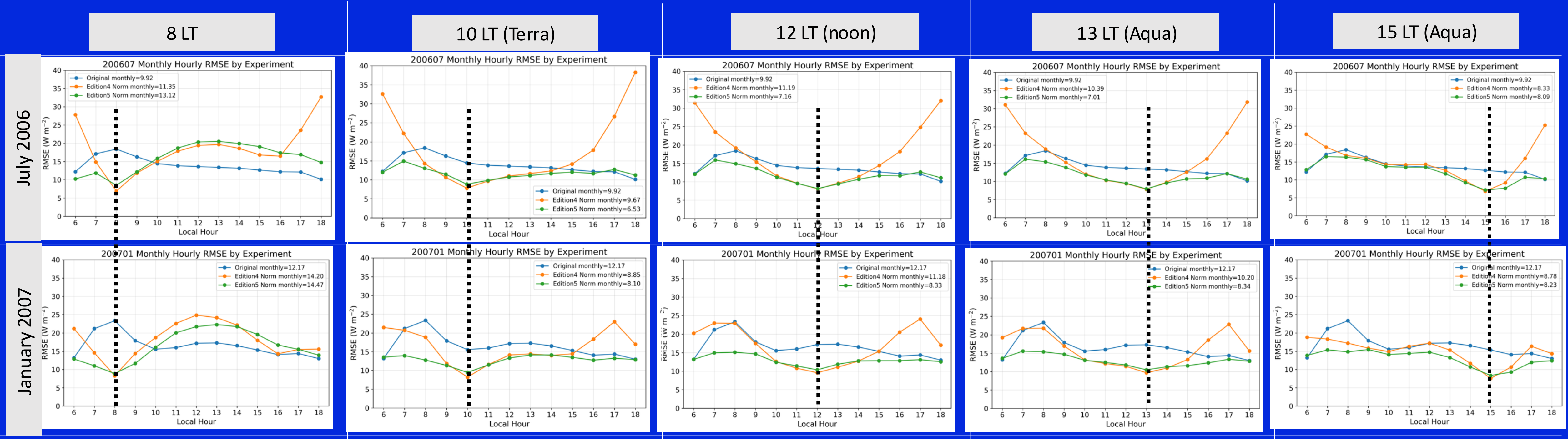
- What is the local time limit for GERB/GEO normalization?



- Since the Met-9 narrowband to broadband derived flux biases are SZA dependent, the Ed5 normalization can be applied between 9-15 LT
- If the GEO narrowband to broadband fluxes are not SZA dependent more LT can be considered.

Monthly Hourly Domain Met9-GERB RMS

Legend
Met-9
Ed4
Ed5
…. Norm LT



- The Ed5 normalization is not effective outside 9-15LT, since the dynamic range is limited, the regression is noisy, and the narrowband to broadband errors are greater for large SZAs

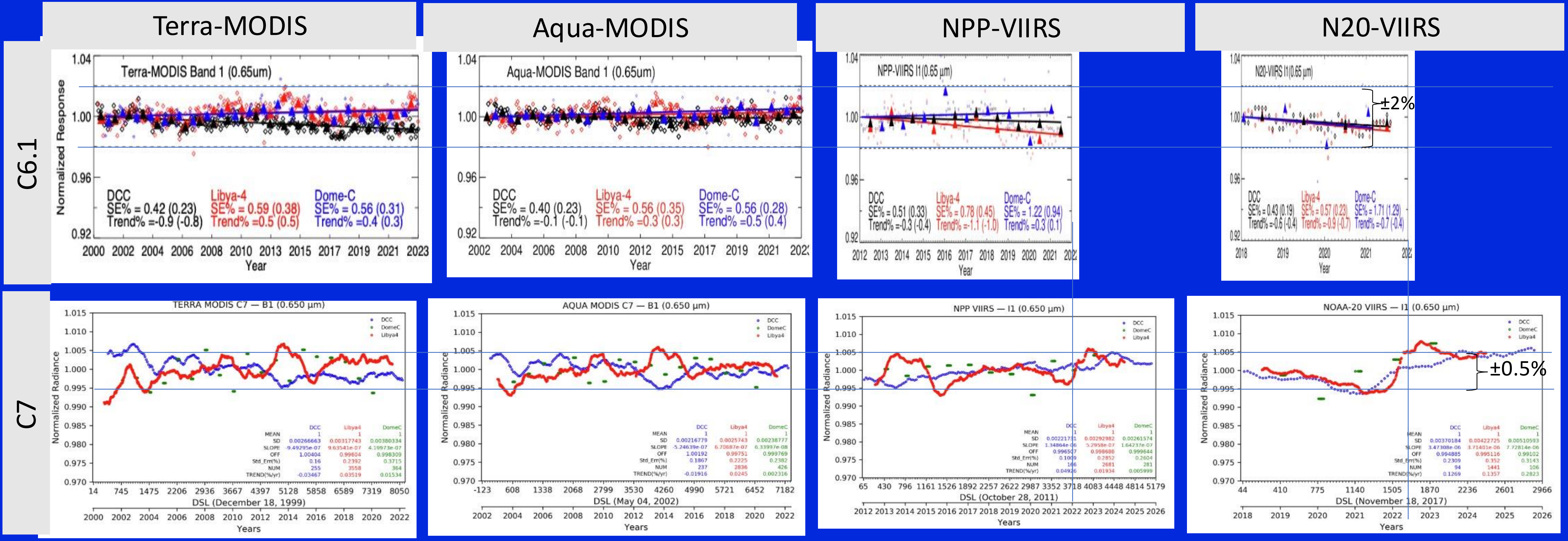
SYN1deg Ed5 CERES/GEO SW Normalization Conclusions

- The linear regression through zero or force fit allows all terminator hourboxes to be normalized
- The Ed5 regression criteria successfully removes glint impacted CERES/GEO flux pairs
- The Ed5 normalization provides more consistent SYN1deg-Terra&Aqua and SYN1deg-single-satellite monthly SW fluxes
- The Ed5 normalization is effective between 9 to 15 local time
  - The GEO narrowband to broadband SW flux biases seem to be SZA dependent when compared with GERB

Imager Calibration

MODIS and VIIRS 0.65µm stability over DCC, Libya-4, Dome-C

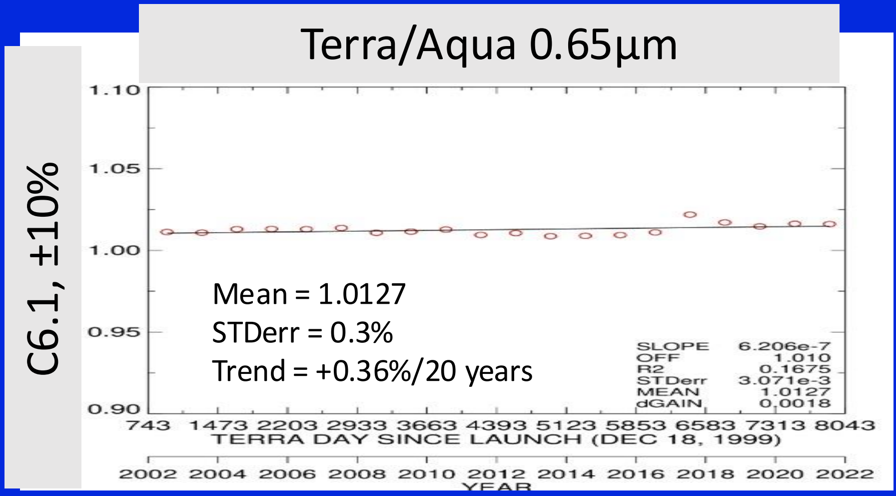
Legend
DCC
Libya-4
Dome-C

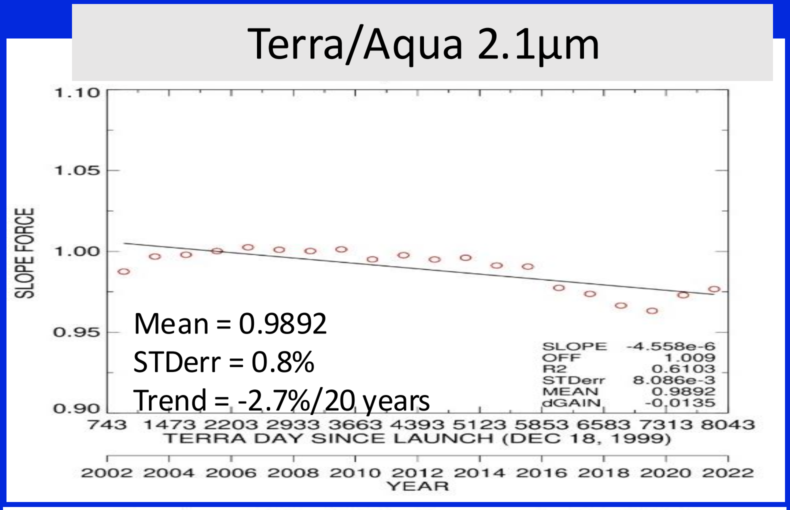


- Main Ed5 stability algorithm improvement is including aerosols, water vapor and ozone to account for the atmospheric column
- The invariant Earth target natural variability is at best ±0.5%, MODIS and VIIRS are stable within 0.5%
- MODIS C7 calibration stability is an improvement over C6.1, especially for Terra

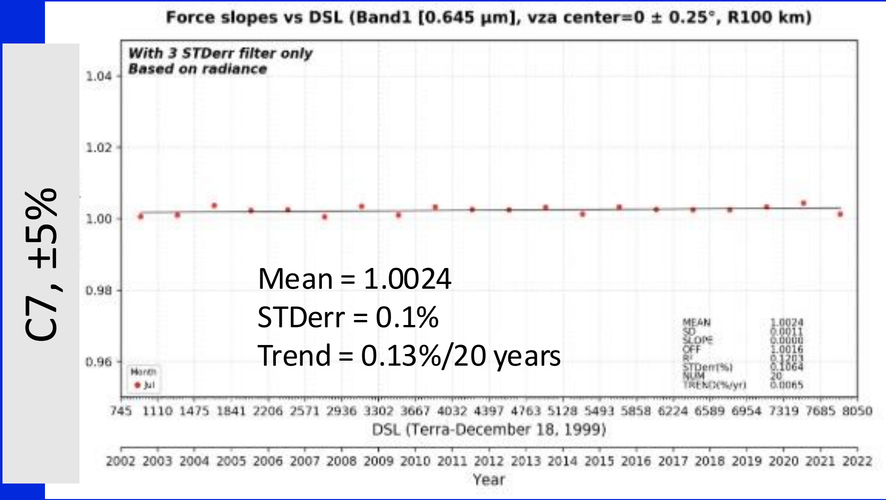
Terra to Aqua MODIS scaling

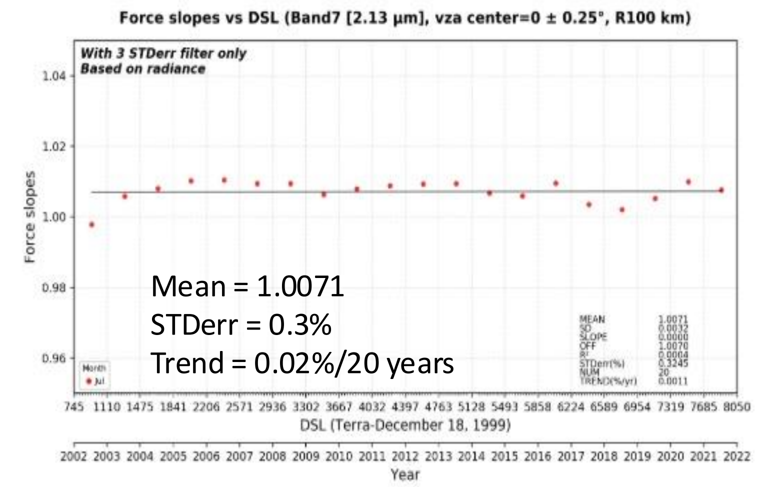
C6.1, ±10%





C7, ±5%





- Polar 100-km simultaneous nadir overpass (SNO) Terra/Aqua pairs are regressed monthly and compared with Lyapustin MAIAC inter-calibration

Terra/ Aqua Scaling	SNO Stderr (%)	SNO	MAIAC	MAIAC /SNO (%)
0.65µm	0.11	1.0024	1.0013	-0.11
0.86µm	0.23	0.9903	0.9961	+0.59
0.47µm	0.22	0.9861	0.9882	+0.21
0.55µm	0.15	1.0013	1.0003	-0.10
1.24µm	0.35	0.9783	0.9929	+1.50
1.64µm	0.42	0.9887	0.9982	+1.16
2.13µm	0.32	1.0071	1.0006	-0.65

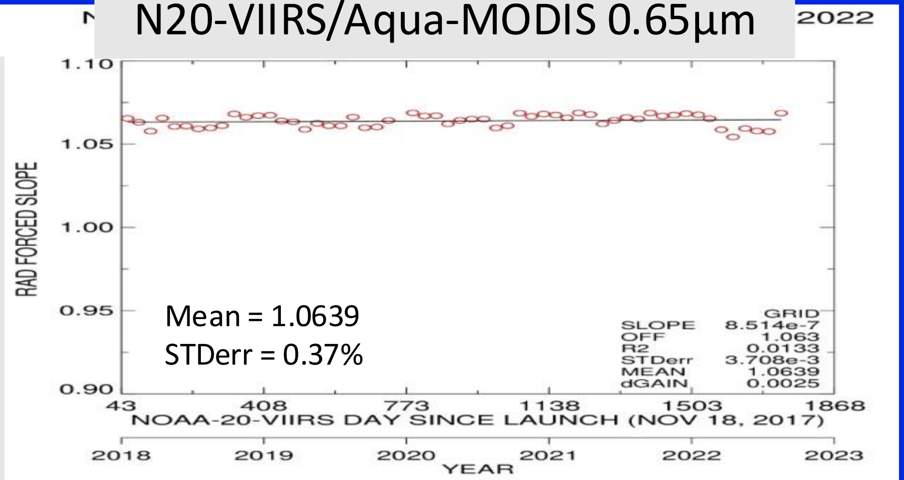
C6.1 scalings used 0.5° grid angular matched data including off nadir, C7 used 100-km SNOs-only

- The Terra/Aqua MODIS C7 non-scaled calibration are near 1.0 and very stable over time

N20 to Aqua tropical scaling

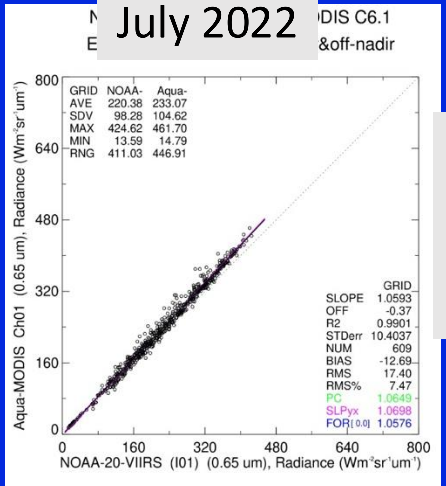
C6.1, ±10%

N20-VIIRS/Aqua-MODIS 0.65µm



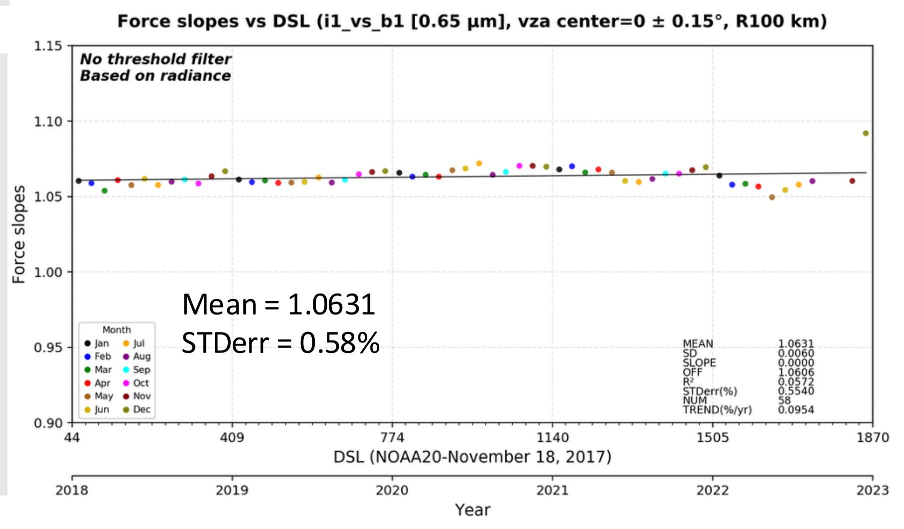
Mean = 1.0639
STDerr = 0.37%

July 2022



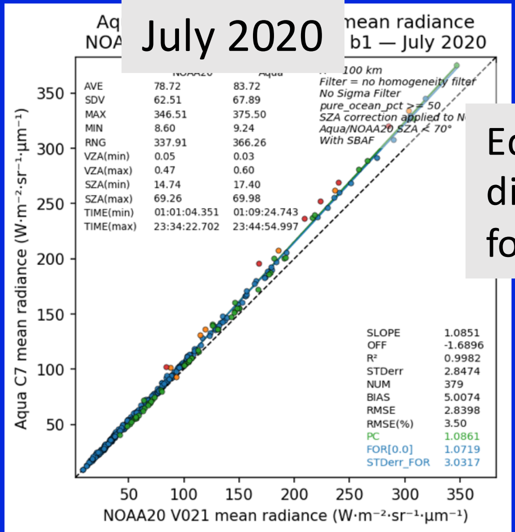
Ed4 uses gridded angle-matched 50-km gridded pairs including off-nadir

C7, ±15%



Mean = 1.0631
STDerr = 0.58%

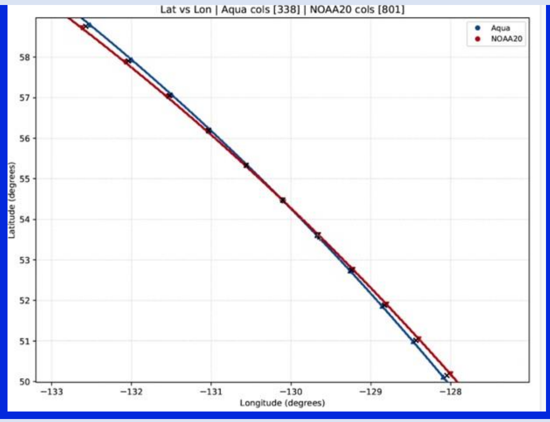
July 2020



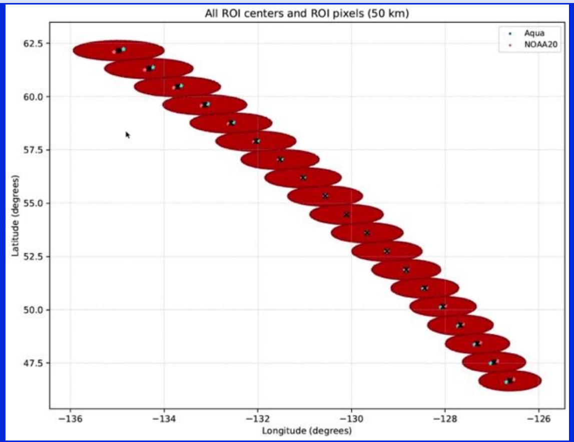
Ed5 uses 100-km diameter SNO cal footoprints

Ed5 utilizes 100-km intercal footprints

Aqua and N20 ground track intersect



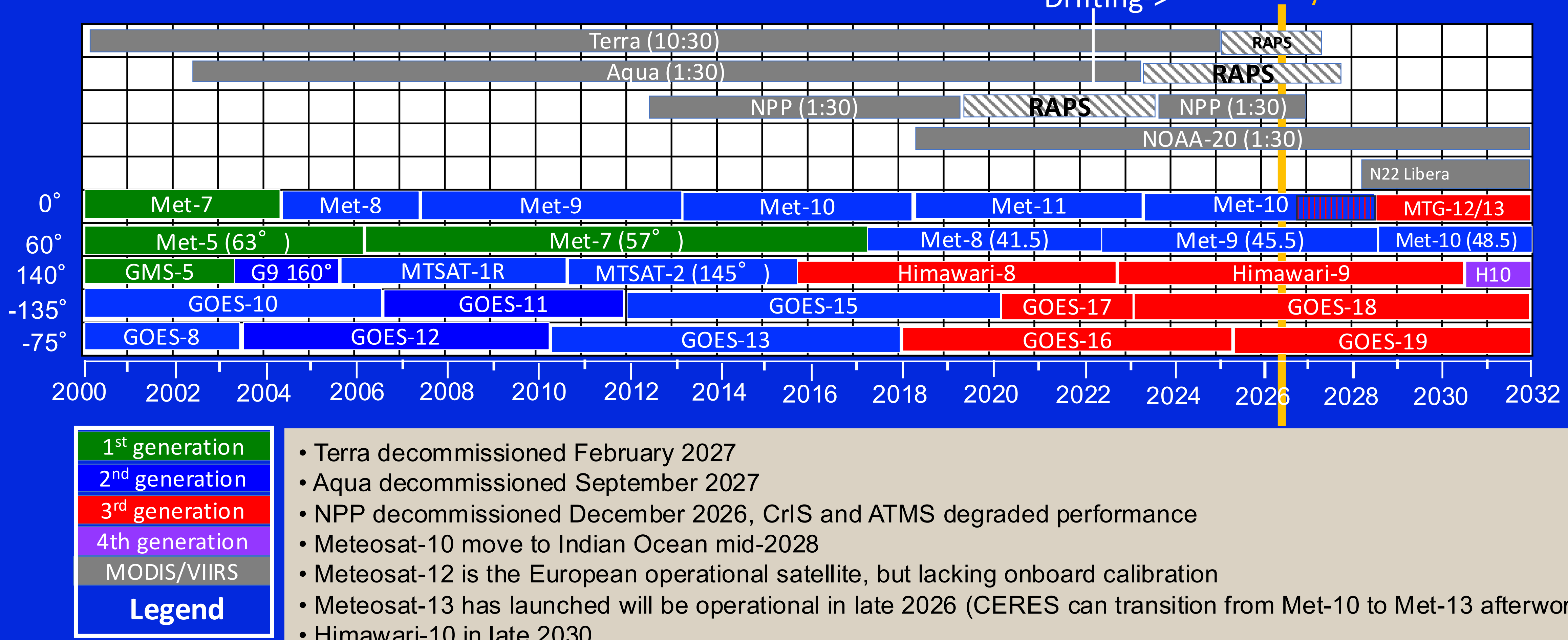
Aqua and N20 100-km calibration footprints



- N20 is ahead of Aqua by 10-15 minutes when the tropical ground tracks intersects
- Aqua visible channel calibration did not change much between C7 and C6.1

GEO calibration

CERES imager and GEO time series



- Terra decommissioned February 2027
- Aqua decommissioned September 2027
- NPP decommissioned December 2026, CrIS and ATMS degraded performance
- Meteosat-10 move to Indian Ocean mid-2028
- Meteosat-12 is the European operational satellite, but lacking onboard calibration
- Meteosat-13 has launched will be operational in late 2026 (CERES can transition from Met-10 to Met-13 afterwords)
- Himawari-10 in late 2030
- GOES-XO (GOES-20) launch no earlier than 2032
- CLARREO launch May 2026 (today)
- NOAA-22 Libera to launch end of 2027

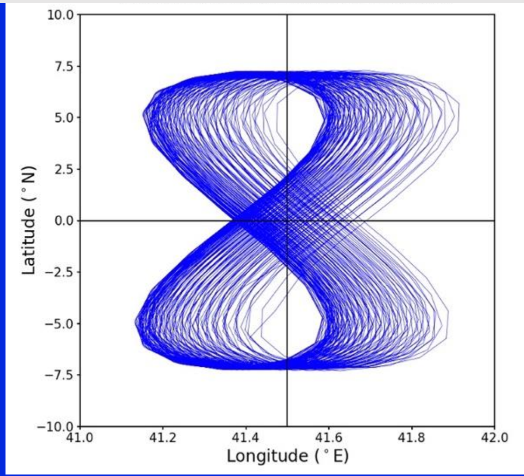
GEO Ed5 scaling factors

- For the visible, replace the MODIS C6.1 instantaneous 0.5° gridded radiances with C7, then time and angle match pairs are regressed monthly
  - For the GEOs with large daily latitude migrations, recompute angles with updated TLE navigation
  - Use the single scene type dependent SCIAMACHY spectral band adjustment factors
  - The proposed Ed5 (low priority): Use of high-resolution single scene type GEO/imager radiance pairs focusing on clear-sky, DCC, etc., requires downloading GEO images, which is time consuming
- For the IR, include AIRS and CrIS instantaneous 0.5° gridded convolved with GEO and MODIS spectral response functions as transfer radiometers
  - The CWG GEO imager channel TOA predicted BT takes into account the GEO spectral response function, The CWG needs the GEO/imager calibration difference
    - However, the spectral band BT induced differences are much larger than calibration and dependent on the water vapor and cannot be resolved with apriori SBAFs
  - The TISA group requires the Aqua equivalent 11µm and 6.7 µm radiances, no SBAF applied
    - The TISA LW uses Aqua-MODIS WV and WN channel to CERES broadband relationships
    - A 11µm homogeneity factor applied to all IR bands reduces the BT GEO/imager monthly scatter

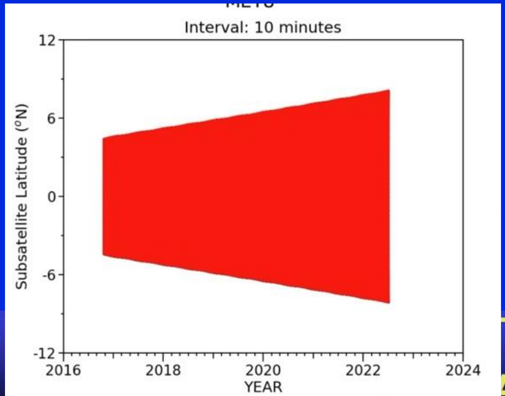
Met-8 (Indian Ocean) daily figure 8 in latitude

The Met L1b pixels are on a rectified (fixed grid) centered at the Equator
The Met subsatellite location over the day is not retrievable
The Ed4 VZA is based on the Equator, where as Ed5 will use updated navigated sub-sat using daily TLEs

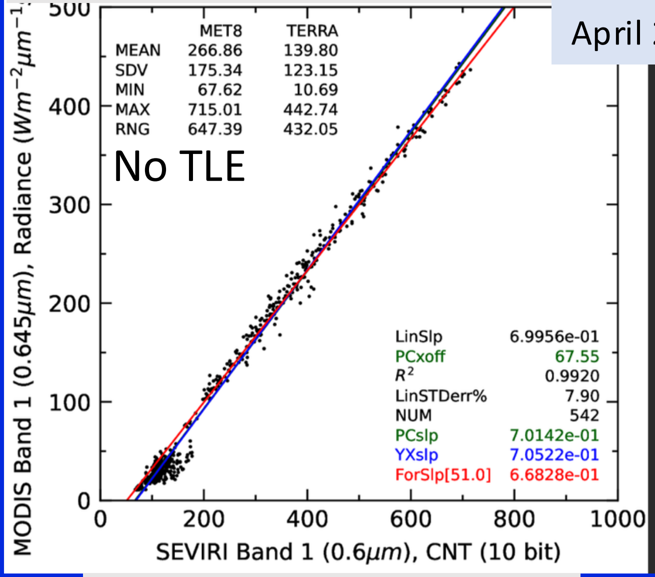
Met-8 Daily Latitude = ±7.0° in 2021

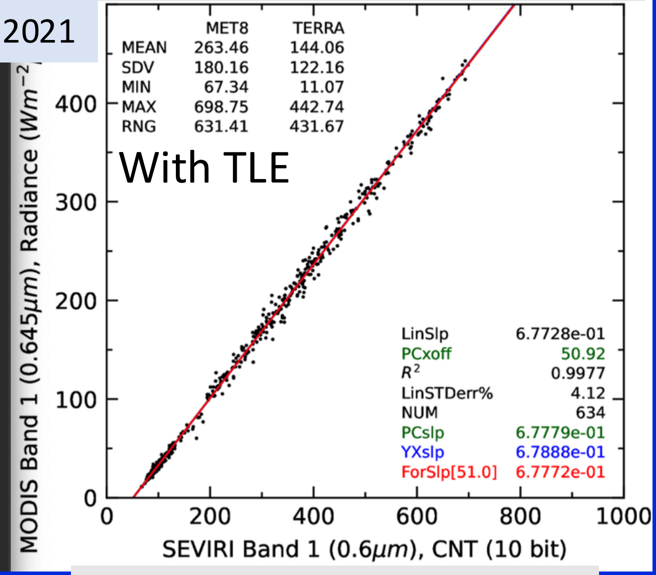


Met-8 (CERES record) Daily Latitude increase from ±5° to 8.5° between 2016 to 2022

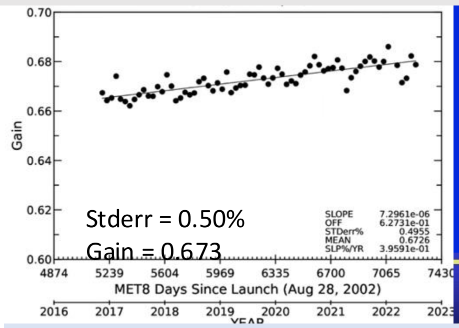


April 2021

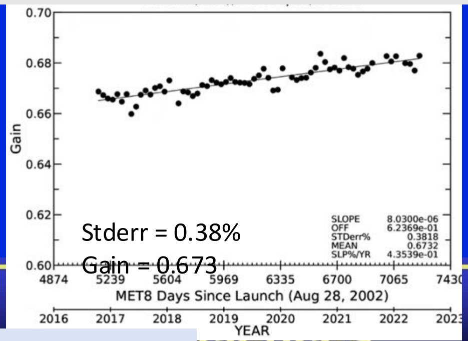




No TLE Met-8 gains with Aqua



With TLE Met-8 gains with Aqua

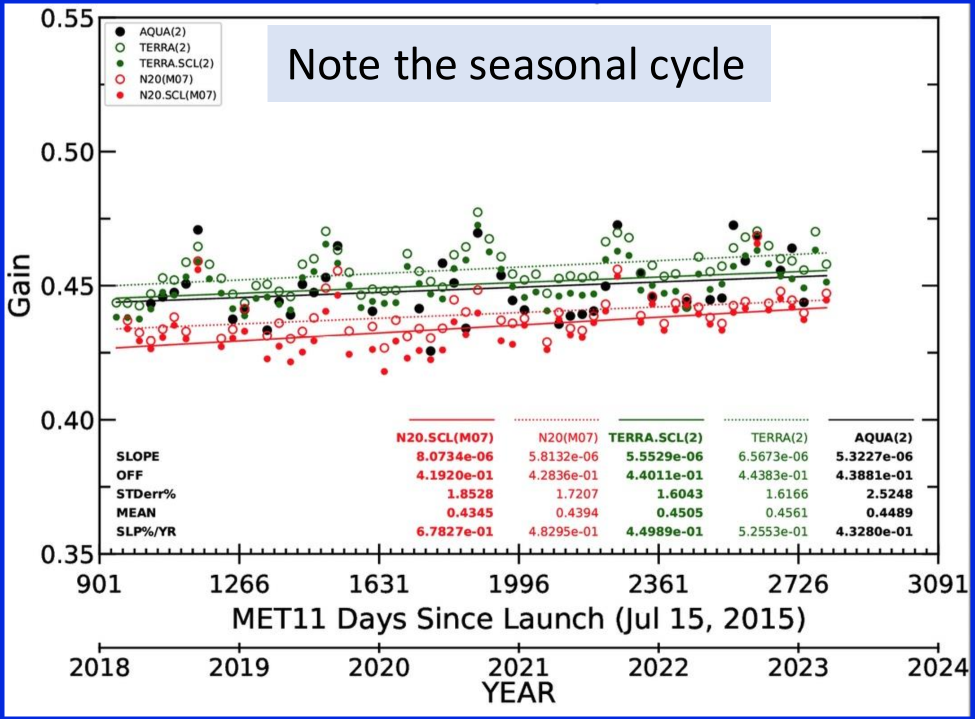


Mostly impacts the equinox months with equatorial GEO glint

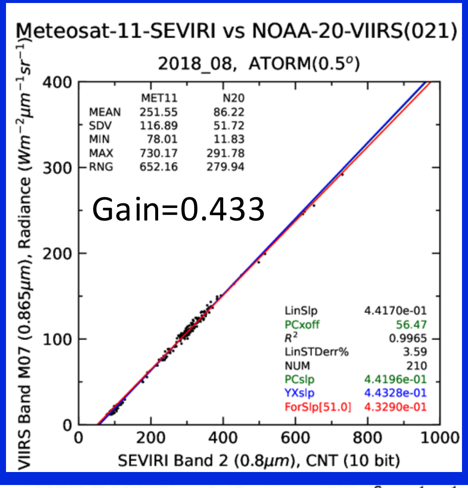
GEO	±Lat
GOES-08	<0.5°
GOES-09	<2.0°
GOES10-15	<0.5°
GOES16-17	<0.1°
GOES-18	<0.05°
GMS-05	<2.0°
Him08-09	<0.05°
Met-05 IO	**3-8.5°**
Met7/11	<1.0°
Met-07 IO	**3-10°**
Met-08 IO	**5-7.5°**
Met-09 IO	**5.5-9°**
Met10 <2023	2-4°
Met12	<0.7°
MTSAT-1/2	<1.0°

- There is 1° Lat to ~1° VZA relationship
- The Indian Ocean (IO) Meteosats will be renavigated to update the VZA and RAZ for clouds and NB to BB

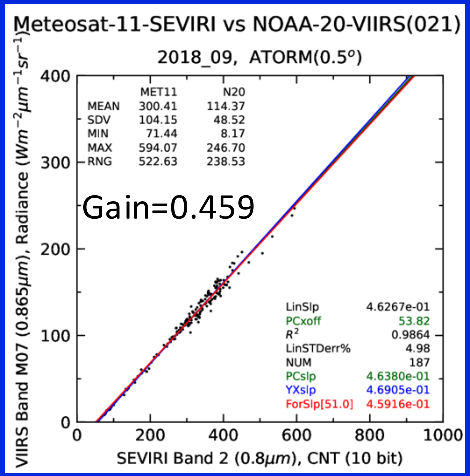
Met-11 0.86µm with imager scaling



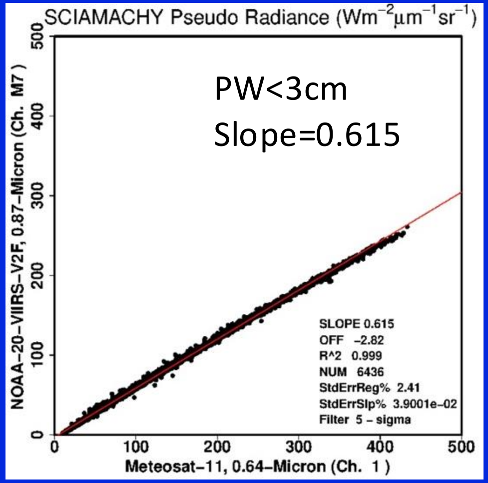
Met-8 more WV absorption

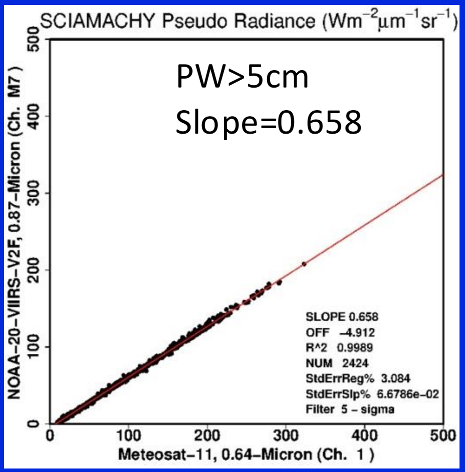


Met-8 less WV absorption

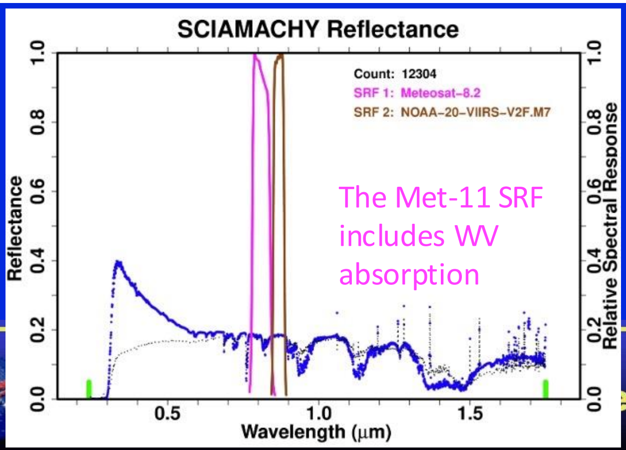


0.433/0.459 = 0.943





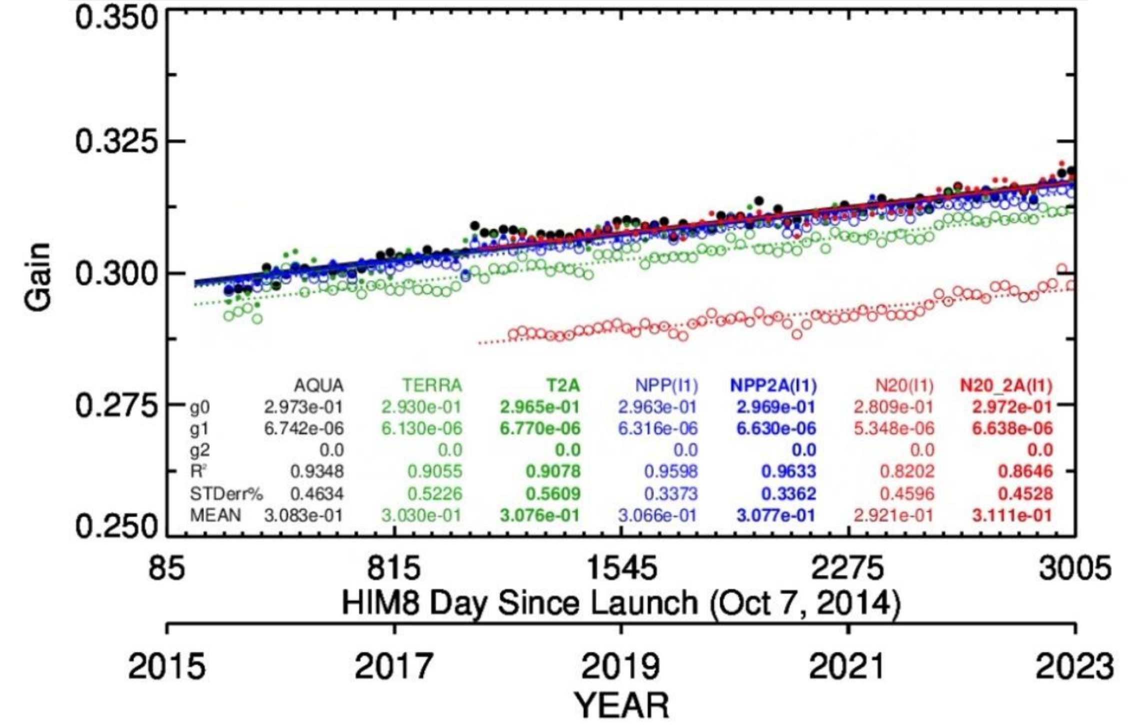
0.615/0.658 = 0.935



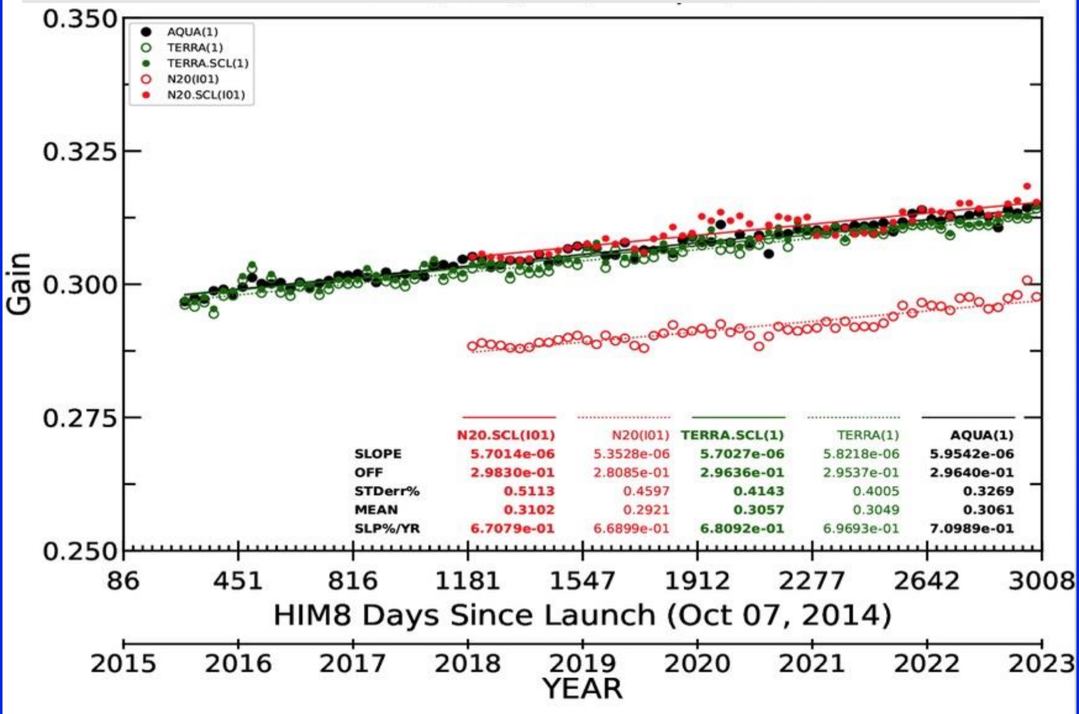
- To properly scale the Met-11 0.86 band to MODIS or VIIRS the SBAF must be a function of PW
- Need to correlate the monthly Met/MODIS match PW with the proper SBAF

Ed4 vs Ed5 Him-8 0.65μm scaling

Ed4 Him-8 0.65μm



Ed5 Him8 0.65µm



- For each GEO, the GEO is intercalibrated with Terra, Aqua, NPP and N20 using unique SBAFs with and without imager scaling to Aqua-MODIS
- The GEO intercalibration with Aqua-MODIS is the Ed5 GEO scaling
- Using GEO as a transfer radiometer is a great way to validate the imager scalings with Aqua-MODIS

- The Terra and Aqua-MODIS C7 calibration is more similar than C6.1

GEO validation of Aqua C7 scaling factors (2018-2022)

Terra unscaled

Band	µm	G15	G16	G17	HIM8	MET8	MET11	Mean (%)
B3/B3	0.48		1.0104	1.0115	1.0107			+1.1±0.1
B4/B4	0.51				0.9953			-0.5
B1/B1	0.65	0.9999	1.0012	0.9949	0.9958	0.9978	0.9940	-0.3±0.3
B2/B2	0.87		1.0205	1.0207	1.0165	1.0297	1.0172	+2.1±0.5
B26/B26	1.38		0.9928	0.9800				-1.4
B6/B6	1.61		1.0142	0.9969	1.0187	1.0118	1.0117	+1.1±0.8

N20 unscaled

Band	µm	G15	G16	G17	HIM8	MET8	MET11	Mean (%)
M03/B3	0.48		0.9577	0.9590	0.9588			-4.2±0.1
M04/B4	0.51				0.9559			-4.4
I01/B1	0.65	0.9526	0.9477	0.9481	0.9448	0.9487	0.9464	-5.2±0.3
M05/B1	0.65	0.9594	0.9596	0.9563	0.9497	0.9533	0.9549	-4.4±0.4
M07/B2	0.87		0.9844	0.9850	0.9764	0.9892	0.9796	-1.7±0.5
M09/B26	1.38		?	1.0273				+2.7
I03/B6	1.61		1.0011	0.9967	0.9808	0.9818	1.0041	-0.7±1.1
M10/B6	1.61		1.0137	1.0089	0.9923	0.9933	1.0161	-0.5±1.1

Terra scaled to Aqua

Band	µm	G15	G16	G17	HIM8	MET8	MET11	Mean (%)
B3/B3	0.48		0.9957	0.9968	0.9962			-0.4±0.1
B4/B4	0.51				0.9978			-0.1
B1/B1	0.65	1.0030	1.0037	0.9974	0.9984	1.0006	0.9967	0.0±0.3
B2/B2	0.87		1.0082	1.0082	1.0038	1.0173	1.0054	+0.9±0.5
B26/B26	1.38		1.0720	1.0644				+6.8
B6/B6	1.61		1.0047	0.9883	1.0092	1.0020	0.9922	+0.7±0.9

N20 scaled to Aqua

Band	µm	G15	G16	G17	HIM8	MET8	MET11	Mean (%)
M03/B3	0.48		0.9926	0.9945	0.9936			-0.6±0.1
M04/B4	0.51				0.9986			-0.2
I01/B1	0.65	1.011	1.0087	1.0095	1.0042	1.0083	1.0060	+0.8±0.3
M05/B1	0.65	1.000	1.0024	0.9994	0.9916	0.9951	0.9971	-0.2±0.4
M07/B2	0.87		0.9735	0.9744	0.9649	0.9769	0.9685	-2.8±0.5
M09/B26	1.38		?	1.0200				+2.0
I03/B6	1.61		0.9893	0.9847	0.9693	0.9700	0.9923	-1.9±1.1
M10/B6	1.61		0.9916	0.9864	0.9707	0.9714	0.9941	-1.8±1.1

- All Aqua scaling factors within 1.0%, except in orange
- Verify the N20 tropical scaling factors using polar intersects, especially for SWIR bands

Calibration Conclusions and Future Work

- Terra and Aqua MODIS and NPP and N20 VIIRS are stable within 0.5%
- MODIS C7 calibration stability is an improvement over C6.1, especially for Terra
- The Terra/Aqua MODIS visible channel calibration is mostly within 1.5% - without scaling
- Need to reexamine the N20-VIIRS SWIR band scalings, the SBAF is very scene type dependent
  - Working on polar N20 with Aqua SNOs for scalings
  - The 1.6µm channel is used to determine optical depth over polar regions
- Cloud mask and cloud retrievals rely on differing parts of the dynamic range.
  - The N20 and Aqua inter-calibration factor is reflectance dependent and the SBAF for clear-sky and cloudy skies differ
- Working on NPP/Aqua scaling factors
- The GEO to Aqua-MODIS visible scalings are completed for 2020
  - Working on 2008 and the rest of the record
- The GEO to Aqua IR scalings are dependent on the non-shared SRF induced radiances from water vapor absorption
  - Use CrIS as a transfer radiometer between GEO and Aqua-MODIS, by convolving CrIS hyper-spectral radiances with the GEO and MODIS SRFs