TISA Working Group Report

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28th CERES-II Science Team Meeting

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CERES ED4A LEVEL 3 PRODUCTS

CERES Ed4A level 3 products

- SSF1deg, is the gridded SSF product
  - Single satellite product
  - Gridded 1-hour instantaneous, daily and monthly average
  - The temporal stability is based on the well-calibrated CERES fluxes
  - Use constant meteorology based on the satellite local equator crossing time to account for the regional diurnal cycle
  - Observed clouds and TOA fluxes, and hourly-only (no daily or monthly) parameterized surface fluxes
- SYN1deg, is the gridded synoptic product
  - Terra+Aqua Ed4A, and a Terra+NPP Ed1A product (Oct 2017)
  - Gridded hourly, 3-hourly, daily, monthly hourly, and monthly
  - Use 1-hourly GEO radiances and clouds to account for the regional diurnal cycle (residual GEO cloud and flux artifacts)
  - Observed clouds and TOA fluxes, and hourly regional computed Fu-Liou surface, TOA and profile fluxes (all temporal resolutions)

CERES Ed4A level 3 products

- EBAF, combines the temporal stability of the SSF1deg product and the regional diurnal fluxes of the SYN1deg product
  - Monthly and climatological averages
  - Clear-sky fluxes have been spatially filled, by using sub-footprint imager clear-sky fluxes.
  - The TOA fluxes have been net balanced
  - The GEO artifacts have been mitigated
  - The surface fluxes have been tuned to remove known anomalies
  - Ed4A has included cloud properties

New CERES product selection page

The previous page was organized by level

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. Data Quality Summaries				Browse & Subset
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. Data Quality Summaries				Browse & Subset

Synoptic TOA and surface fluxes and clouds (SYN)

Hourly gridded observed TOA and Fu-Liou 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/VIIRS and GEO cloud properties, MODIS/VIIRS aerosols, and Fu-Liou RT, surface and in-atmospheric (profile) fluxes consistent with the CERES observed TOA fluxes. Data Quality Summaries				Browse & Subset
CldTypHist	CERES-MODIS/VIIRS and GEO cloud properties stratified by cloud optical depth and pressure. Data Quality Summary				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/VIIRS clouds and aerosols, and parameterized surface fluxes by instrument. Data Quality Summaries		FOV*		Browse & Subset
SSF1deg	Gridded daily and monthly averages of the SSF product by instrument. Data Quality Summary				Browse & Subset
CCCM (C3M)	Nadir view CERES-SSF/MODIS/CALIPSO/CloudSat collocated parameters. Data Quality Summary Variable Descriptions Data Product Catalog		FOV*		Order via ASDC

Fast Longwave and Shortwave Flux (FLASHFlux)

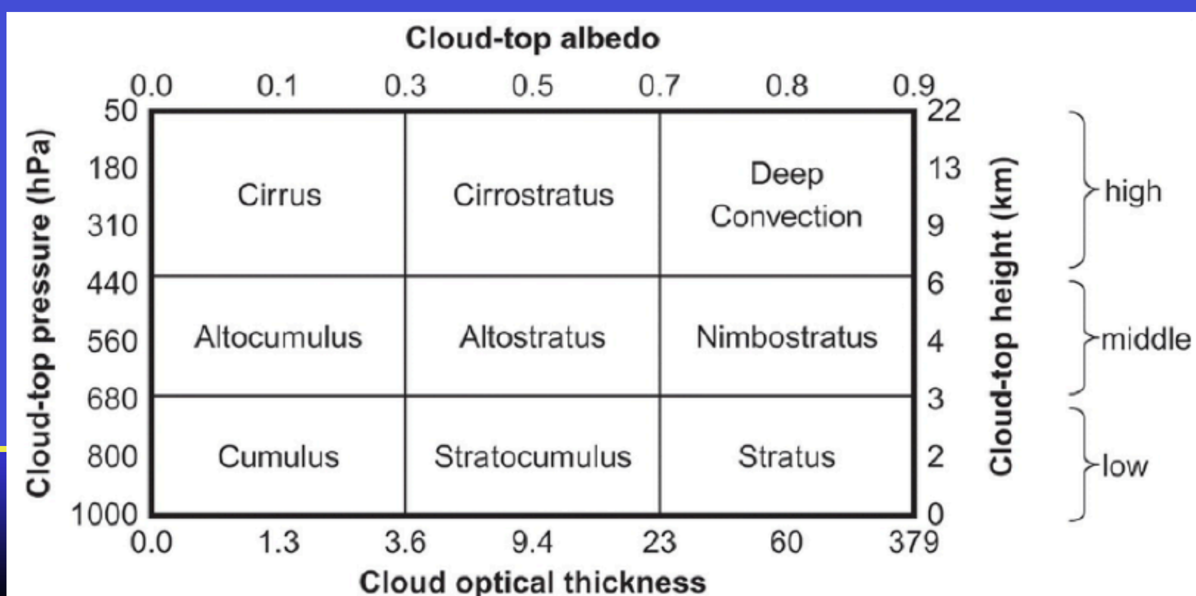
Near real-time, CERES scanner footprint TOA and parameterized surface fluxes and clouds by instrument.

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. Data Quality Summary		FOV*		Browse & Subset
FLASH1deg	Gridded daily averages of the FLASH_SSF product. Data Quality Summary				Browse & Subset

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

CERES Ed4A level 3 products

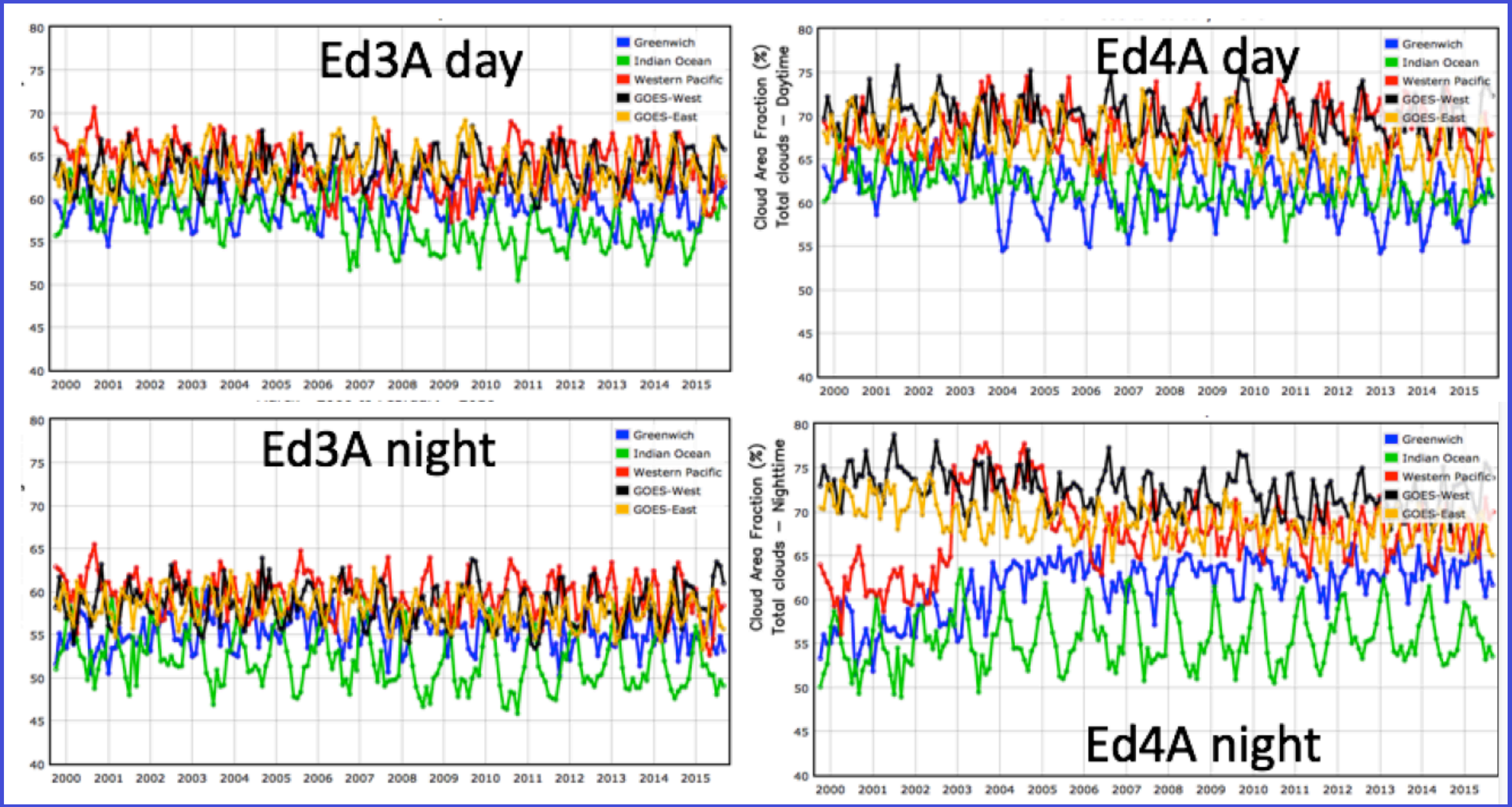
- CldTypHist, stratifies the instantaneous SYN1deg MODIS and 1-hourly GEO clouds into pressure and optical depth bins
  - Monthly 1-hourly, and monthly products
  - Replaces the Ed3A ISCCP-D2like products
  - CldTypHist does not temporally interpolate, whereas SYN1deg interpolates within 4-cloud layers
  - CldTypHist contains cloud fraction; effective and top pressure, height and temperature; particle size, IWP/LWP, and IR emissivity



Changes between Ed3A ISCCP-D2like and Ed4A CldTypHist

- ISCCP-D2like consists of 3 products
  - Daytime and nighttime single satellite monthly mean clouds and daytime 7 layer by 6 optical depth cloud amount array
  - GEO monthly mean
  - Merge of Terra and Aqua and GEO clouds
- CldTypHist consists of 1 product
  - Merge of Terra and Aqua and GEO clouds
  - No daytime 7 layer by 6 optical depth cloud amount array
- ISCCP-D2like based on 3-hourly GEO 2-channel (visible and IR) cloud retrievals
- CldTypHist based on hourly multi-channel GEO cloud retrievals that are more similar to MODIS
  - The retrieval quality depends on the number channels available
  - Most of the improvement was at night. ISCCP-D2like maintained an IR emissivity of unity at night

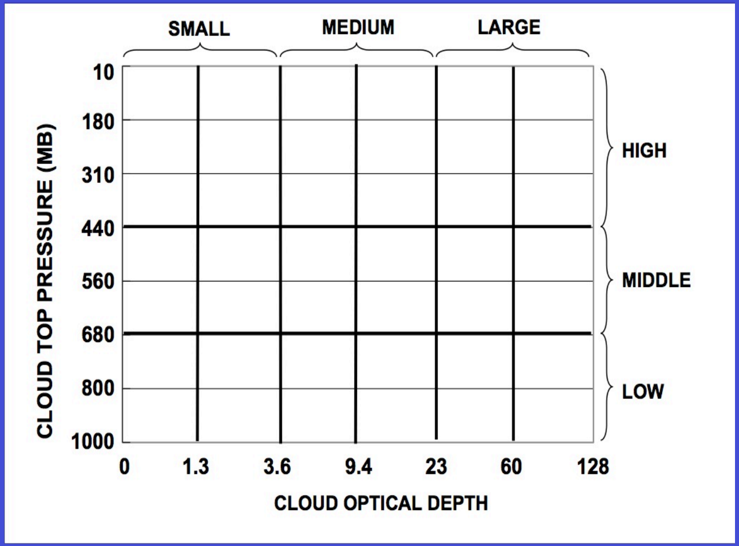
Monthly CldTypHist Cloud fraction (%) comparison



- The Ed3A there is a difference between day and night cloud fraction and the cloud fractions are less dependent on GEO satellite
- The Ed4A has a more similar day and night cloud fraction, however the cloud fractions depend more on GEO satellite

FLUX BY CLOUD TYPE

Flux by Cloud Type (FluxByCloudTyp) Data



- A dataset that stratifies instantaneously matched and spatially gridded CERES fluxes and MODIS cloud properties into the ISCCP-D1 cloud types based on 6 cloud optical depth and 7 cloud top effective pressure.

Note: MODIS cloud data here are from the NASA Langley cloud working group. It is NOT GSFC MODIS cloud product.

Motivation

Cloud and radiative fluxes are fundamental atmospheric variables essential for any climate studies, both observational and modeling.

Cloud properties and associated radiative fluxes stratified into different types provide more stringent constrains to models and also reveal more insights into how cloud-climate interacts. Recent studies investigate cloud-climate feedbacks in cloud types, typically ISCCP cloud types (in many studies like Zhang et al, 2005; Zelinka et al, 2011, 2016). But they still rely on RT model for fluxes.

The community has ISCCP-D1 for many years but yet to have observed fluxes matched to each cloud type. The CERES group has the natural position to provide such a product.

FluxByCldType Overview

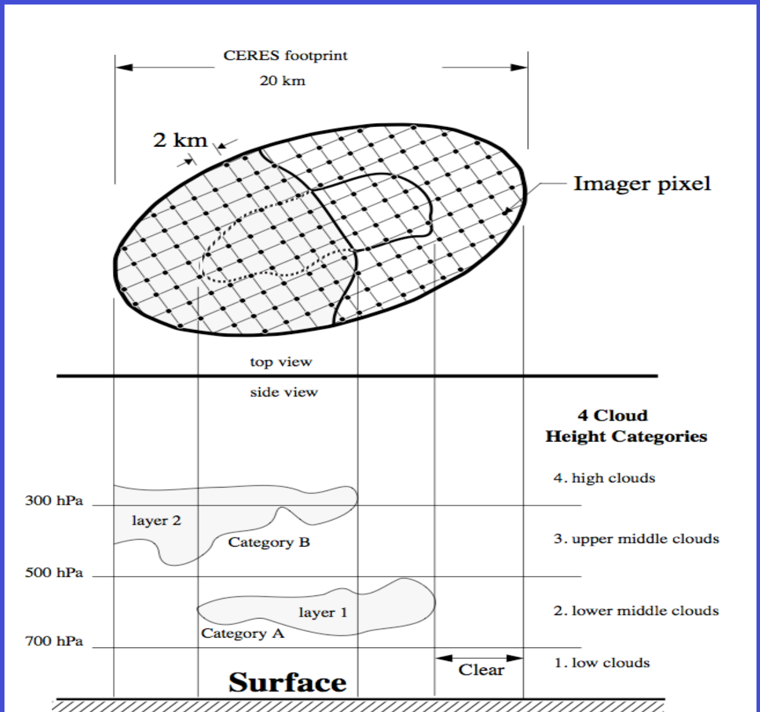
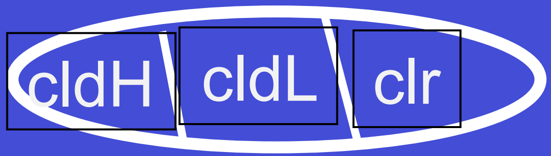


Figure 8-1. CERES Cloud Geometry



- Only ~10% of all CERES 20-km footprints are of one scene type.
- Convert the imager pixel level narrowband radiance to broadband for the multi-scene footprints
- Use the CERES Ed4A ADMs to convert the broadband radiance into flux, which are dependent on the cloud, profile, surface type, angular, and aerosol properties
- Normalize the 3 sub-footprint fluxes with the footprint flux
- The FluxByCldType should provide the same gridded instantaneous fluxes as the SSF1deg-hour

Flux Algorithm

SSF Footprints → Single scene footprints

Single scene footprints → NB2BB coefficients

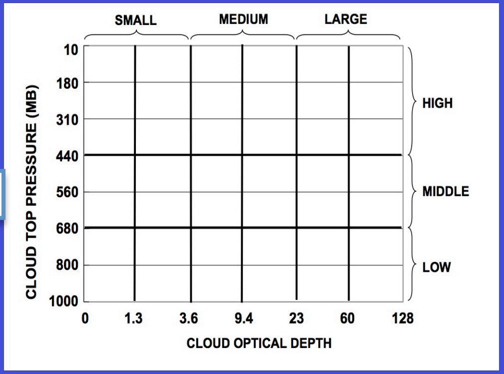
NB2BB coefficients → NB2BB: clear/cld1/cld2

NB2BB: clear/cld1/cld2

BB2Flx: clear/cld1/cld2 ← ADM

Normalize sub-footprint fluxes to footprint flux

Sort clouds/flux into cloud types



Grid into $1^0 \times 1^0$

Validate with SSF1deg-hour

Narrow-Band radiance to Broad-Band Radiance (NB2BB)

SSF footprints

↓

sort single scene SSFs into bins

↓

NB rad. vs. TOA flux

↓

Obtain coefficients from multi-linear regression

↓

SW: A(9,7,9,6,2)
LW: A(7,4,6,2)

All MODIS NB Channels on both SSF cloud layers are used:

- SW: 0.47, 0.65, 0.86, 11, 12 (um)
- LW: 0.47, 0.65, 0.86, 11, 12 (um)

Define bin (category):

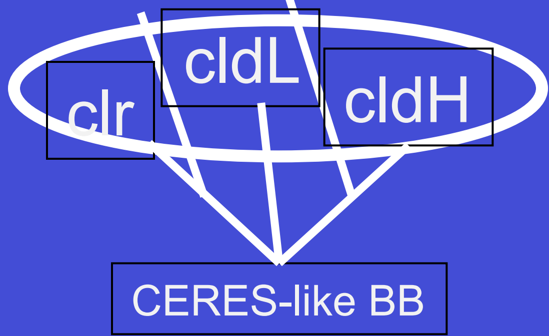
- Flux: SW, LW
- Surface: Ocean, Land (Forests, Savannas, Grass/Crop, Dark Deserts, Bright Deserts, snow/ice)
- Cloud: clear, overcast
- SW
  - SZA (9): 0-90, every 10
  - VZA(7): 0-70, every 10
  - RAZ(9): 0-180, every 20
- LW
  - VZA(7): 0-70, every 10
  - PW(4) : (0,1,3,5,10)

SSF must be 100% clear or 100% cloudy.

BB Radiance to BB Flux by ADM

SW BB Rad = a0 + a1*Rad1 + a2*Rad2 + a3*Rad3 + a4*Rad4 + a5*Rad5

LW BB Rad = a0 + a1*Rad1 + a2*Rad2 + a3*Rad3 + a4*Rad4 + a5*Rad5



BB Radiance

↓

CERES ADM

↓

BB Flux

ADM (Angular Distribution Model)

$$F(\theta_o) = \frac{\pi I(\theta_o,\theta,\phi)}{R(\theta_o,\theta,\phi)}$$

$F(\theta_o)$: flux

I : BB Radiance

R : anisotropic factor

Loeb et al, 2005, JAOT

R is derived based on angles, cloud amount, optical depth, phase, surface types, etc.

Validation: Footprint Level

For each footprint: calculated flux vs. observed flux

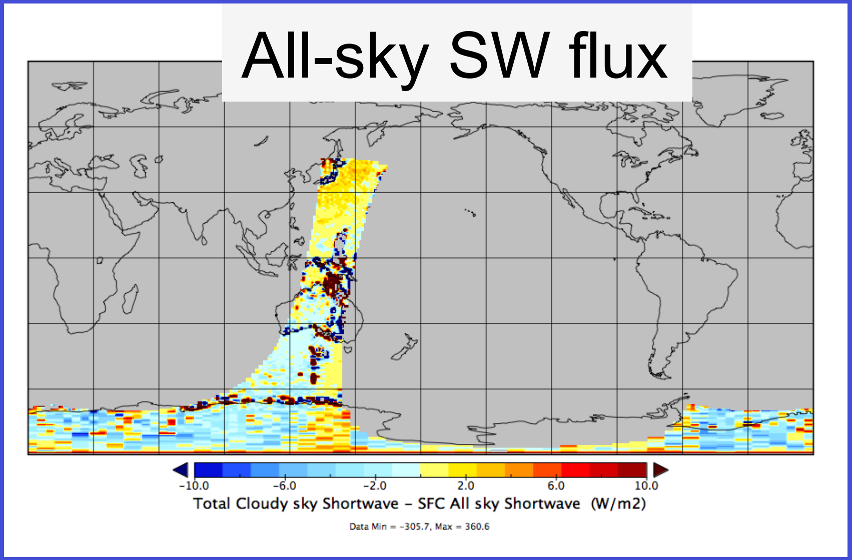
$$flux_{fp} = f_{clr} * F_{clr} + f_{cld1} * F_{cld1} + f_{cld2} * F_{cld2}$$

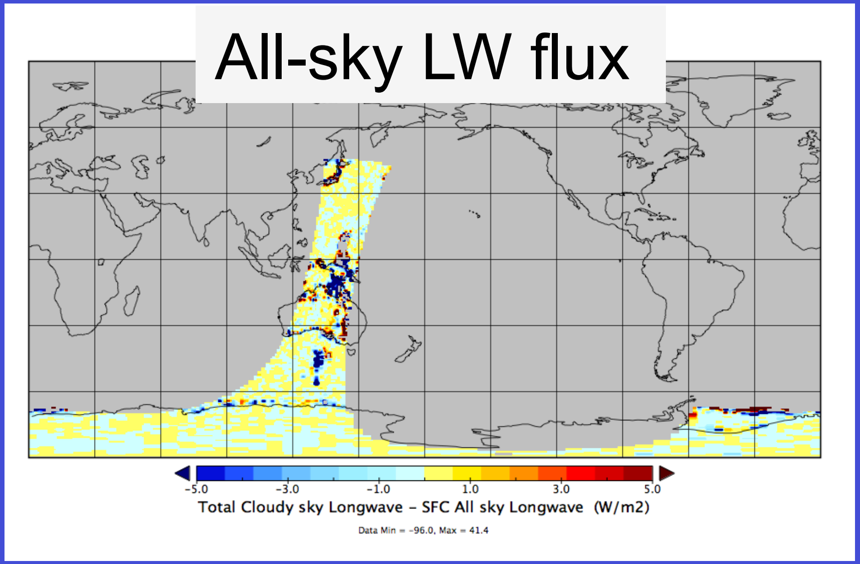
f : cloud fraction

F : Flux

Perfectly, calculated flux should equal observed flux

FluxByCldType Ed4A gridded instantaneous comparison with SSF1deg, April 1, 2006





- Before normalization with the footprint flux

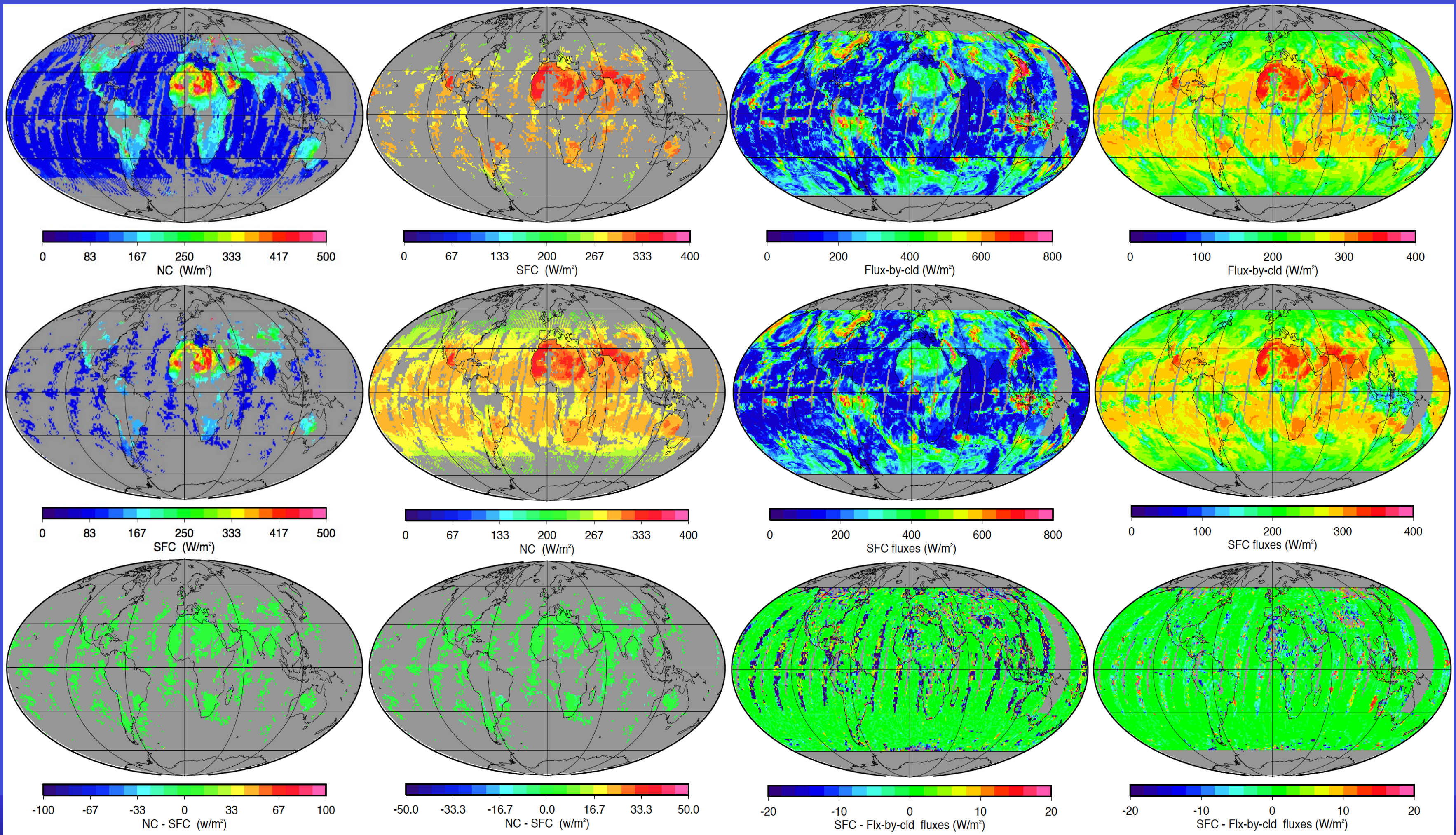
Validation Ed3A: Grid Level, FluxByCloudTyp, April 1, 2006

SW clear-sky | LW clear-sky | SW All-sky | LW All-sky

FluxByCloudTyp

SSF1Deg

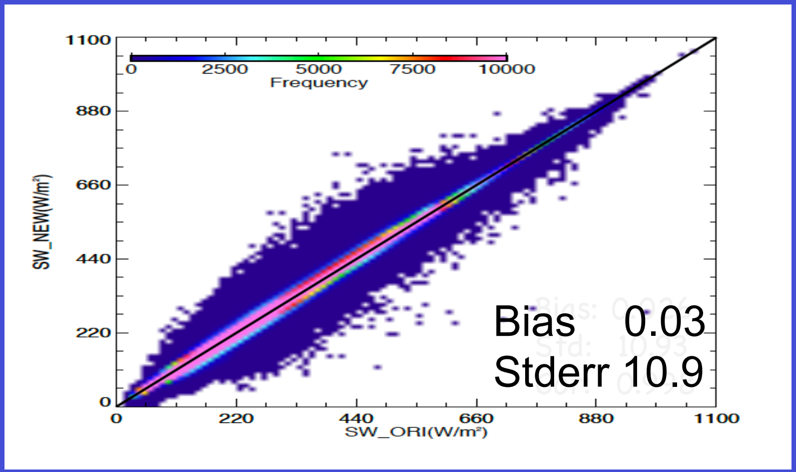
Difference



Validation Ed3A: Footprint Level, Jan 2010

SW

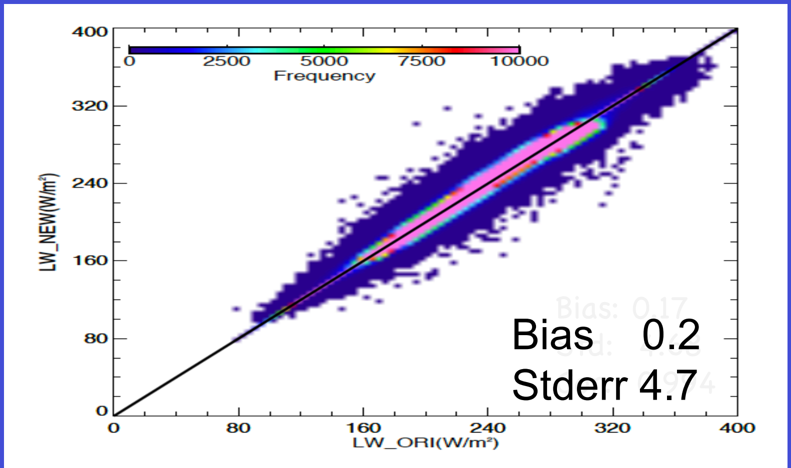
Derived Flux (W/m²)



SSF Observed Flux (W/m²)

LW

Derived Flux (W/m²)



SSF Observed Flux (W/m²)

Total Samples : 10,000,000

- Before normalization with the footprint flux

Validation Ed3A: Footprint Level, Bias Dependence

SW ±500 Wm-2 LW ±200Wm-2

Cld%

Tcld

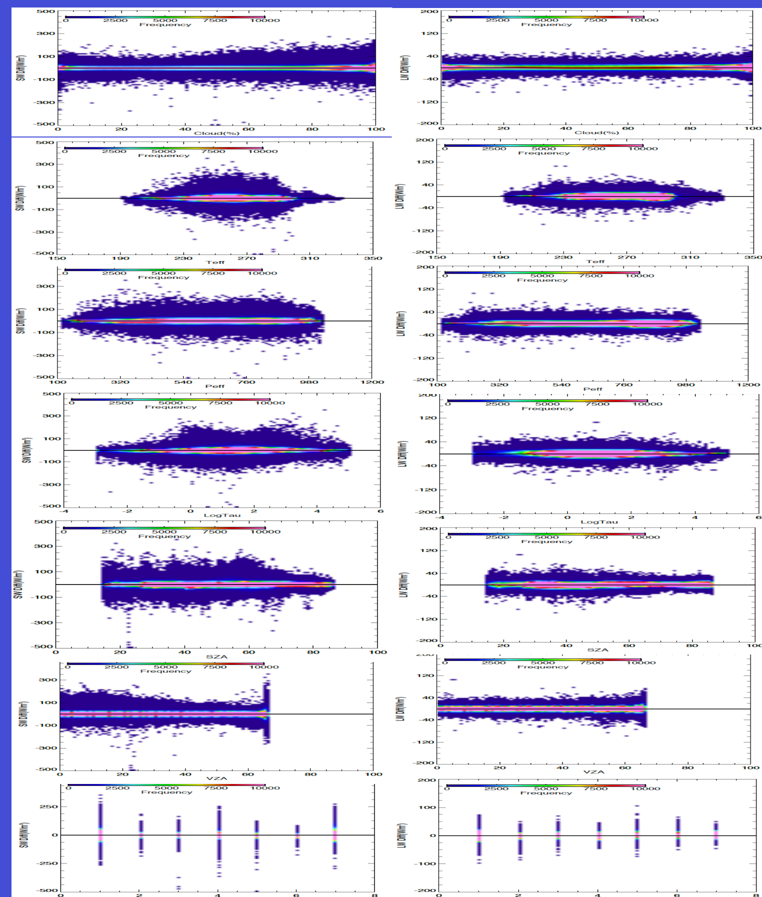
Pcld

Log(τ)

SZA

VZA

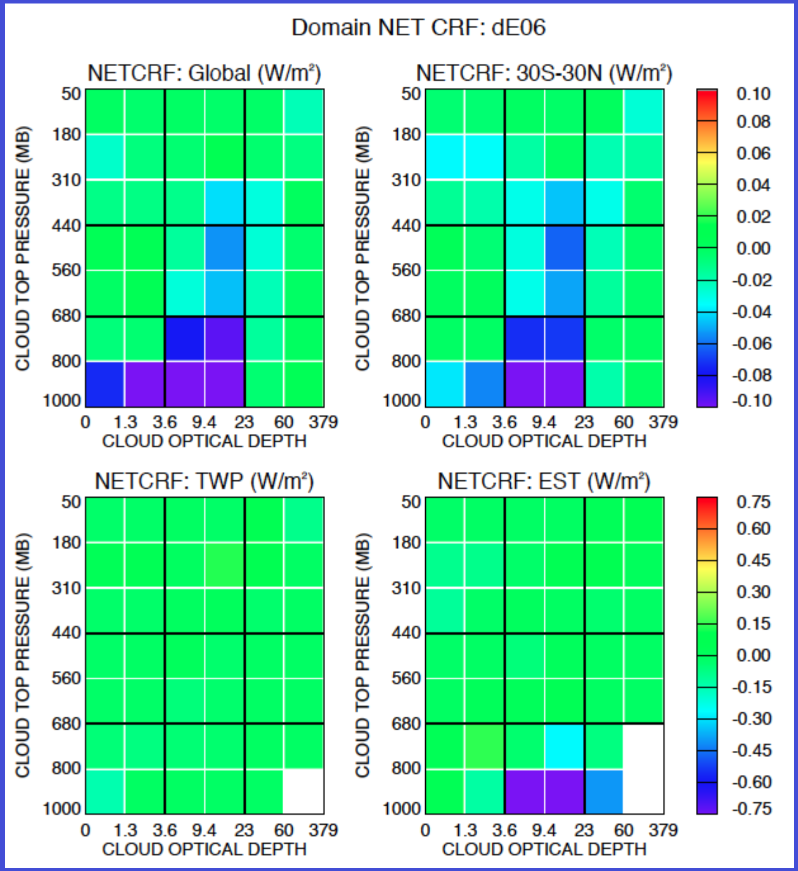
Srf. Type

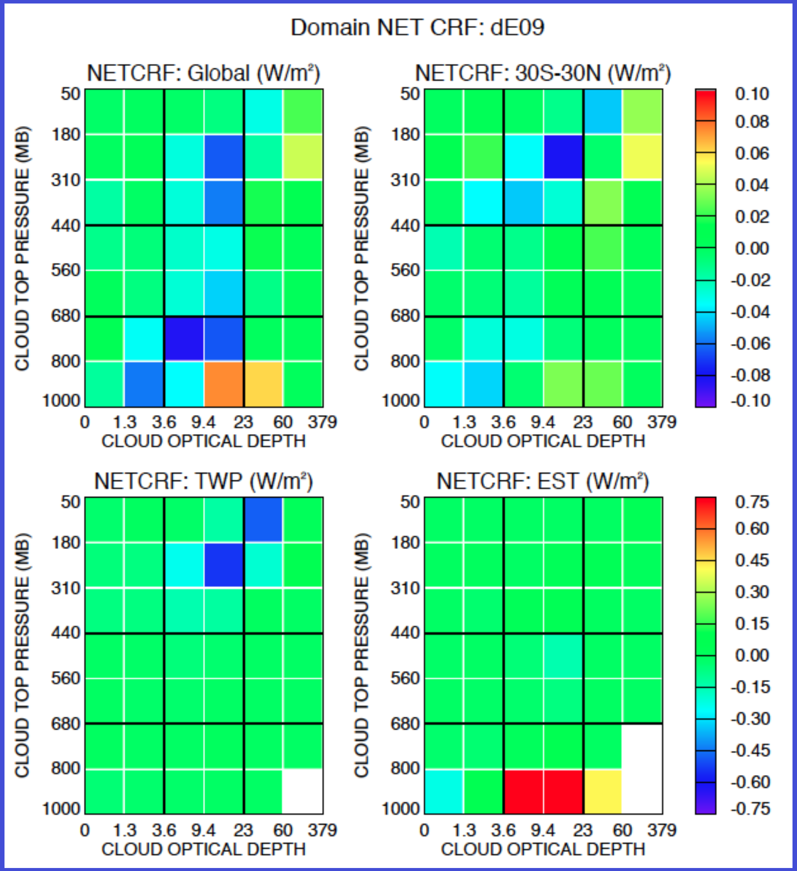


Jan 2010

- The algorithm is free from dependencies on SZA, VZA, cloud fraction, optical and other parameters.

Example Ed3A: 2006/07 vs. 2009/10 El Nino
NET CRF





2006/07 El Nino

2009/10 El Nino

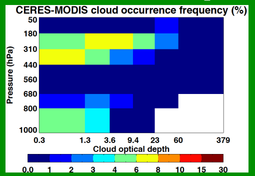
CERES FluxByCloudTyp Product

CERES Flux-by-cloud Type Simulator

CERES FluxbyCldTyp Simulator by Eitzen et al.

MODIS imager radiances → **MODIS cloud retrievals** → **Cloud freq**

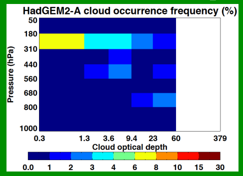
p_c



τ

CFMIP 3-hourly gridded output → **Generate subcolumn clouds at overpass time** → **Cloud freq**

p_c



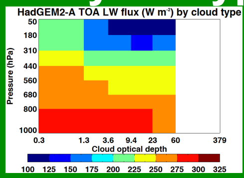
τ

Evaluate (Cloud freq ↔ Cloud freq)

Grid box sfc alb, T, qv, O_3 profiles → **Get Langley Fu-Liou radiative transfer model fluxes**

Cloud freq → **Get Langley Fu-Liou radiative transfer model fluxes** → **OLR by cld typ**

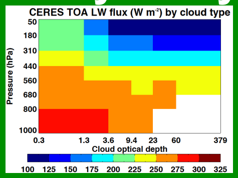
p_c



τ

CERES SSF clouds, fluxes → **OLR by cld typ** (also from MODIS Cloud freq)

p_c



τ

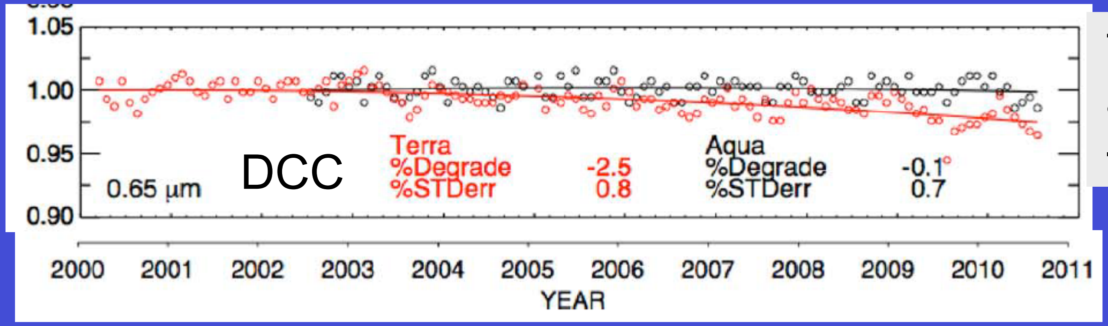
Evaluate (OLR by cld typ ↔ OLR by cld typ)

CERES Ed4A level 3 products

- All of the CERES Ed4A level 3 products were delivered to the ASDC this year and processing is current to January 2017.
- FluxByCloudTyp is the remaining CERES Ed4A level 3 product that has not been delivered.
  - Moguo, Cathy and Josh are still working on the code
  - The incorporation of the Ed4a ADMs and increased number of narrowband channels used to convert broadband was more complicated than originally thought
  - Still need to validate
  - A November or early December delivery likely
- The Ed3A FluxByCloudTyp will shortly be placed on the subsetter
  - To coincide with the Flux by cloud type simulator paper by Eitzen et al., accepted
  - It has the Edition 2 MODIS clouds

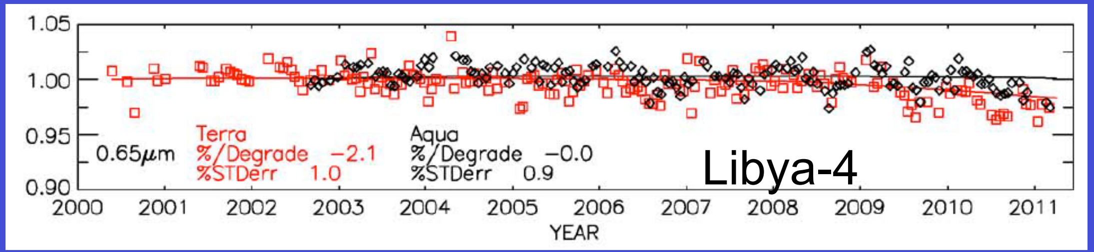
MODIS C6 TO C6.1 SCALING FACTORS

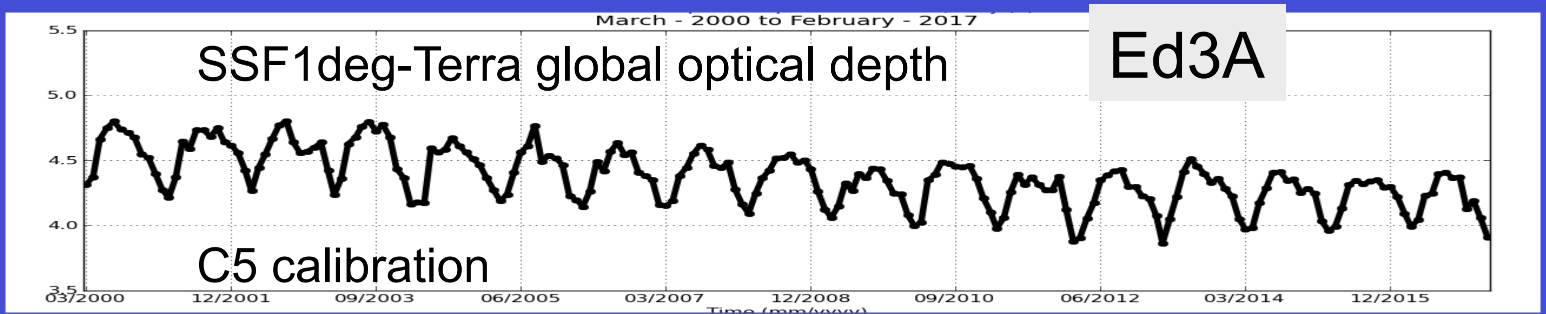
MODIS C5 stability

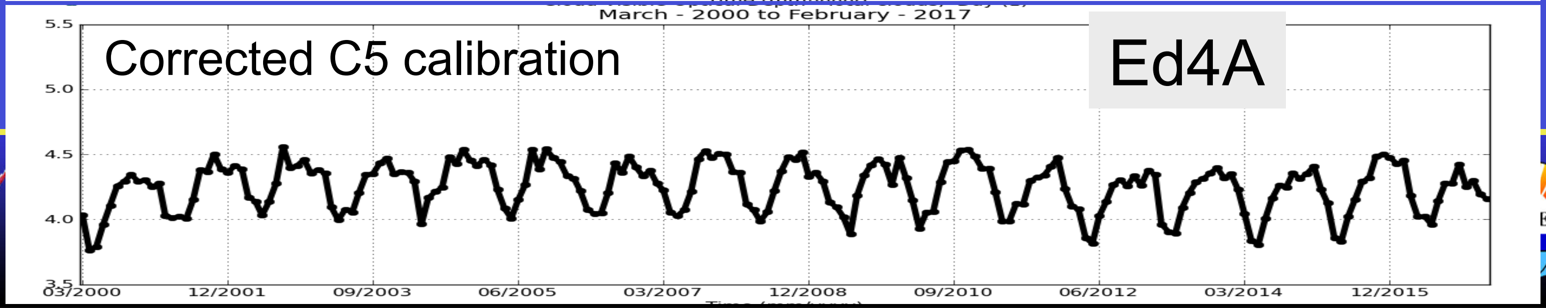


Terra-MODIS C5 had a -1% anomaly in late 2003 and a -1.5% anomaly in early 2009

Wu et al 2013







Terra and Aqua stability analysis till 2013

Trend in %

MODIS Band		Terra						Aqua					
		Deserts		Dome C		DCC		Deserts		Dome C		DCC	
µm	#	C5	C6	C5	C6	C5	C6	C5	C6	C5	C6	C5	C6
0.44	9	-8.8	1.0					0.0	-1.3				
0.47	3	-6.3	0.0	-4.6	1.9	-3.5	0.2	0.7	-0.8	0.0	0.7	0.4	0.0
0.55	4	-1.2	0.1	-0.3	-0.2	-0.4	-0.3	0.5	-0.9	1.1	0.7	0.8	-0.1
0.65	1	-2.1	0.9	-1.6	0.8	-2.5	-0.1	0.0	-1.4	0.5	-0.0	-0.1	-0.9
0.86	2	-1.9	0.9	-2.9	2.0			0.0	-1.8	0.0	0.6		
1.24	5	0.4	0.5			2.6	1.6	-0.3	-0.7			1.3	0.8
1.38	26					1.4	0.8					0.6	0.9
2.12	7	-0.8	-0.3			0.5	1.7	0.1	-0.9			2.2	1.6

- MODIS C5 solar diffuser anomaly in early 2009 caused the negative trend
- MODIS C6 is more stable than C5
- The Earth invariant targets also have some natural variability

Doelling et al 2015

MODIS C6.1

- MODIS C6.1 reprocessing corrected the Terra 6.7µm and 8.6µm detector striping problem, due to cross-talk issues after the Terra spacecraft anomaly in late February 2016
  - Both Terra and Aqua MODIS C6.1 is forward processing beginning in Aug 22, 2017
  - Terra is forward processing from the beginning of record (March 1, 2000) and is now at Dec 31, 2003
  - Once Terra has finished processing, Aqua will start from beginning of mission
  - CERES will reprocess all products starting in March 2016, once the Terra and Aqua C6.1 data is available (Hopefully early 2018)
  - There should be less of a discontinuity between Feb. and March 2016 due to water vapor channel impact using C6.1 on the MODIS cloud properties and polar LW down surface fluxes
  - The CERES Ed4 data products are processed until Jan 2017

MODIS C6.1

- Are there any MODIS channel calibration differences between C6 and C6.1?
  - Channel calibration differences could also cause discontinuities in the cloud retrievals, which can impact the computed surface fluxes
- Regress the C6 and C6.1 pixel level radiances to determine the one time scaling factor
  - Compare C6 and C6.1 granule over ocean equatorial region that contains deep convective clouds, in order to obtain the entire range of earth viewed radiances
- Estimate the predicted C6 and C6.1 scaling factors using Sept 15, 2017 granule
  - MOD02SS1.S2017258.2110.061.2017261190903.hdf
  - MYD02SS1.S2017255.2335.061.2017260224742.hdf
  - The actual scaling factors will be performed using the month before the C6 to C6.1 transition

CERES GEO calibration group web site

https://satcorps.larc.nasa.gov/cgi-bin/site/showdoc?mnemonic=SAT_CALIB_USER

NASA Fact

Cumulonimbus clouds, or rain producing clouds, may stretch from their base near the Earth's surface to an altitude of 10 kilometers (33,000 feet) or higher.

+ More NASA facts...

Satellite Calibration Page

Calibration Coefficients

- AVHRR Calibration Coefficients
- GEO Calibration Coefficients
  - Pre-CERES_1.0 Link
  - Pre-CERES_2.0 Link
  - CERES-Ed4
- Terra to Aqua MODIS Scaling Factors (VIS/NIR/SWIR)
- Terra to Aqua MODIS Scaling Factors (IR)
- Terra MODIS C6 to C5 Scaling Factors
- Aqua MODIS C6 to C5 Scaling Factors
- Terra MODIS C6 to C6.1 Scaling Factors
- Aqua MODIS C6 to C6.1 Scaling Factors

Spectral Band Adjustment Factors (SBAF)

- SCIAMACHY
- HYPERION
- GOME-2 (In development)
- IASI
- AIRS (Coming soon)

Spectral Plotting Tools

- SCIAMACHY
- HYPERION (Coming soon)
- GOME-2 (Coming soon)

Tools

- Satellite Spectral Response Function (SRF) comparison to
- Satellite Visible Band Solar Constant Comparison Tool
- IR Brightness Temperature Correction Coefficients for Con

Publications

C6.1 to C6 scaling factors

Aqua MODIS Collection 6 to Collection 6.1 scaling factors, last update September 2017

Calibration Home

- DR Doelling, A Wu, X. Xiong, BR Scarino, R. Bhatt, C.O. Haney, D. Morstad, A. Gopalan, 2015, The Radiometric Stability and Scaling of Collection 6 Terra- and Aqua MODIS VIS, NIR, a 53, NO. 8
- Granules used for VISIBLE and IR Aqua-MODIS bands:
  - 2018 forward-processing: **MYD02SS1.S2017255.2335.061.2017260224742.hdf**

Channel:

✓ 0.65 Micron (1)
0.85 Micron (2)
0.46 Micron (3)
0.55 Micron (4)
1.24 Micron (5)
1.62 Micron (6)
2.11 Micron (7)
0.90 Micron (17)
3.84 Micron (20)
4.05 Micron (23)
1.38 Micron (26)
6.78 Micron (27)
8.62 Micron (29)
11.0 Micron (31)
11.8 Micron (32)
13.2 Micron (33)
13.64 Micron (34)
13.94 Micron (35)
14.24 Micron (36)

Slope=1.0019, C6.1/C6=+0.19%

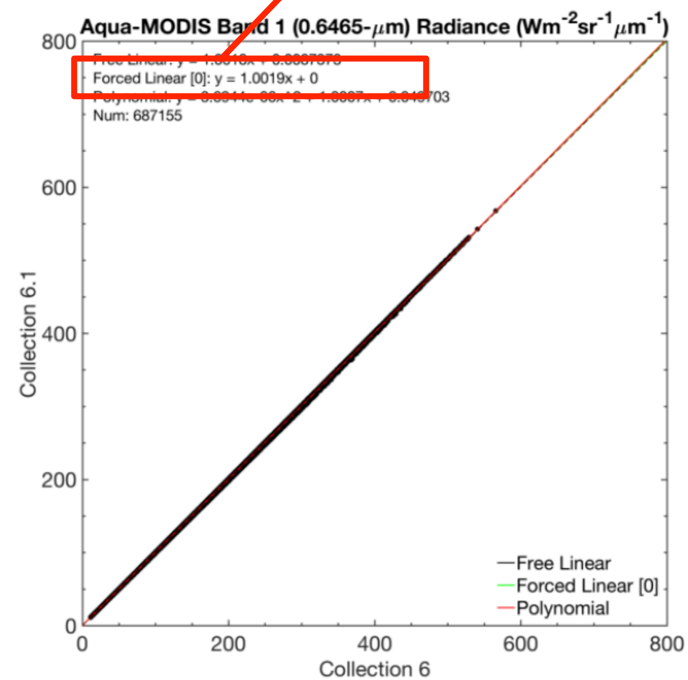


Table of C6.1/C6 scaling factors (2017)

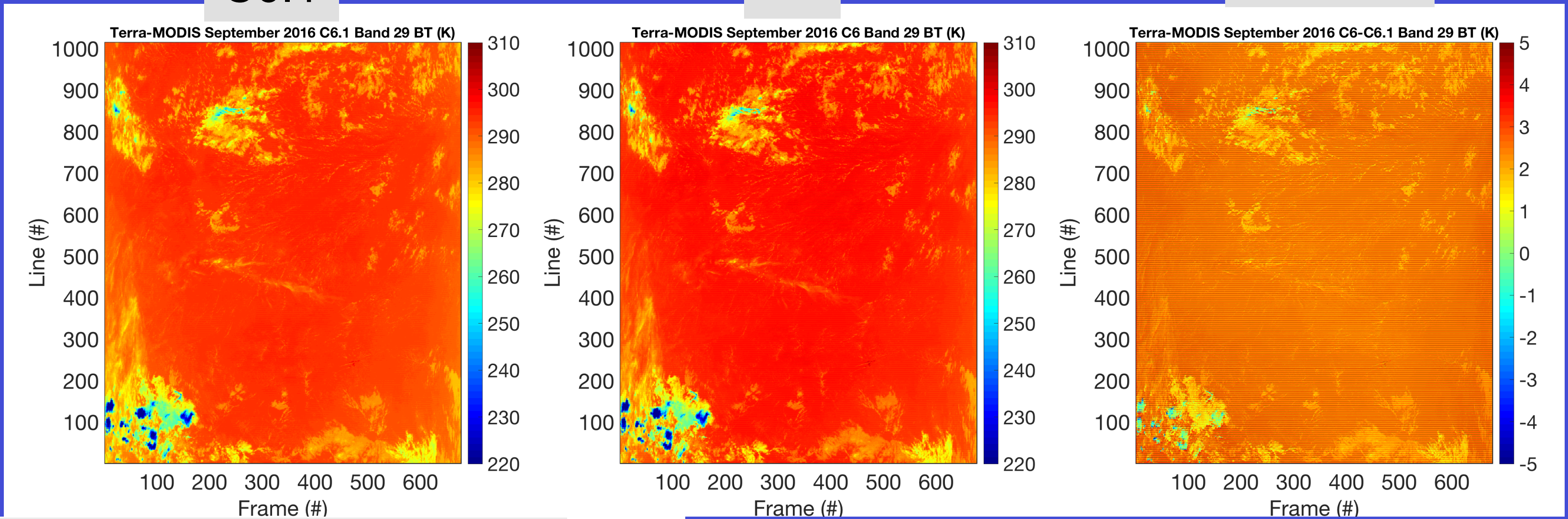
Channel	Terra	Aqua
Band 1 (0.65μm)	0.0	+0.19
Band 2 (0.86μm)	0.0	+0.21
Band 3 (0.47μm)	0.0	+0.27
Band 4 0.56μm)	0.0	+0.25
Band 5 (1.24μm)	0.0	0.0
Band 6 (1.6μm)	0.0	0.0
Band 7 (2.13μm)	0.0	0.0
Band 17 (0.91μm)	0.0	0.0
Band 20 (3.74μm)	0.0	0.0
Band 23 (4.05μm)	0.0	0.0
Band 26 (1.38μm)	0.0	0.0
Band 27 (6.72μm)	striping	0.0
Band 29 (8.6μm)	striping	0.0
Band 31 (11.0μm)	0.0	0.0
Band 32 (12.0μm)	0.0	0.0
Band 33-36 (CO_2)	0.0	0.0

Terra C6 and C6.1 Band 29 8.6μm channel

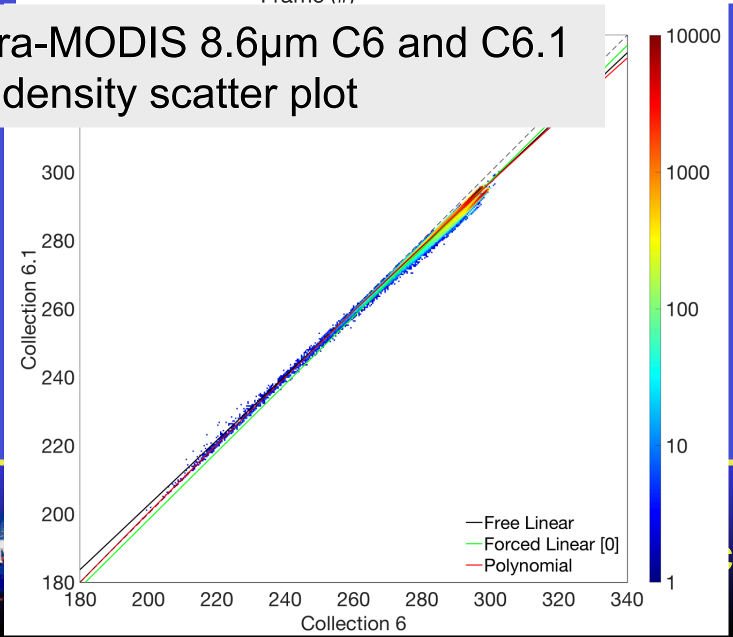
C6.1

C6

C6-C6.1

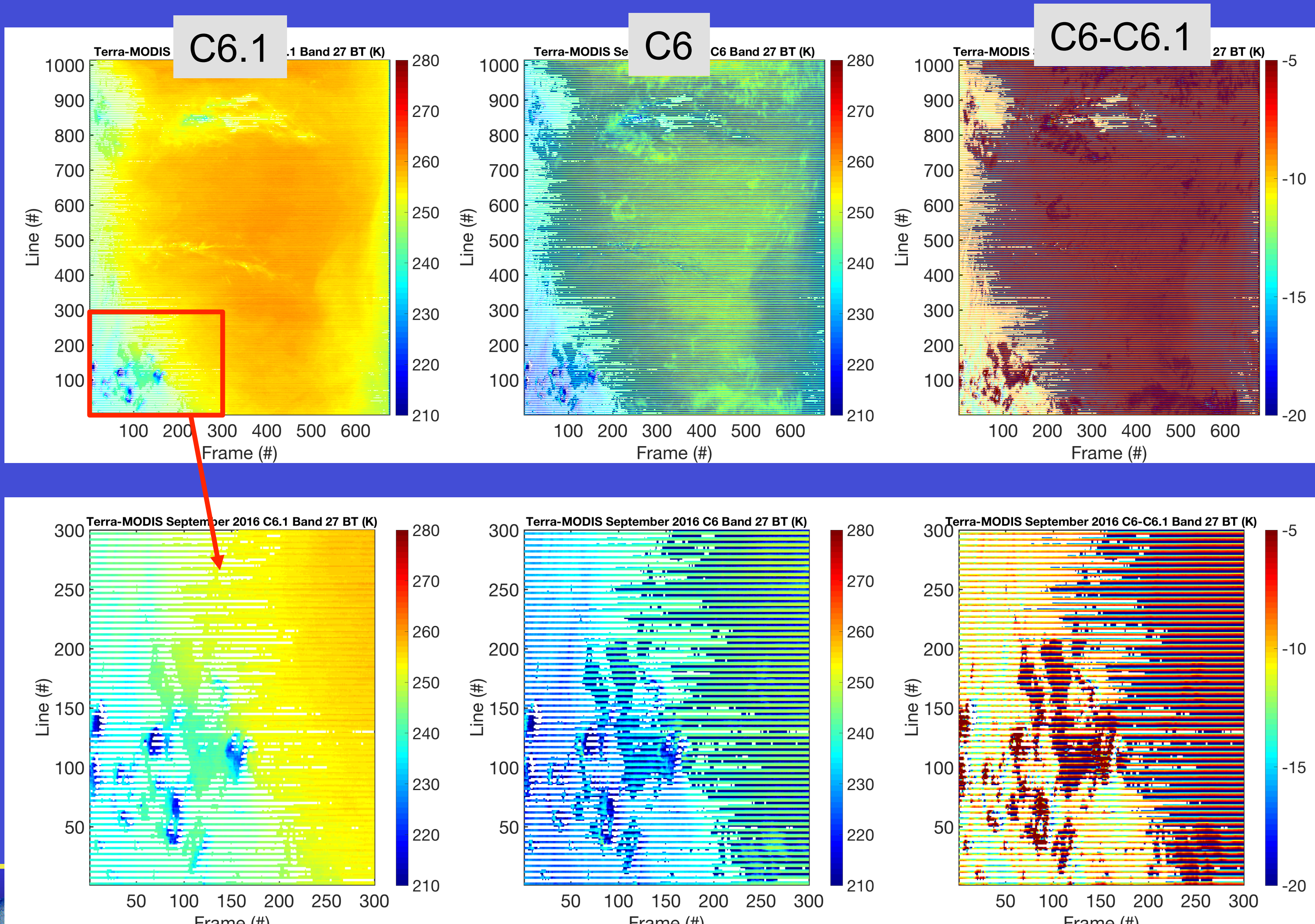


Terra-MODIS 8.6μm C6 and C6.1 BT density scatter plot



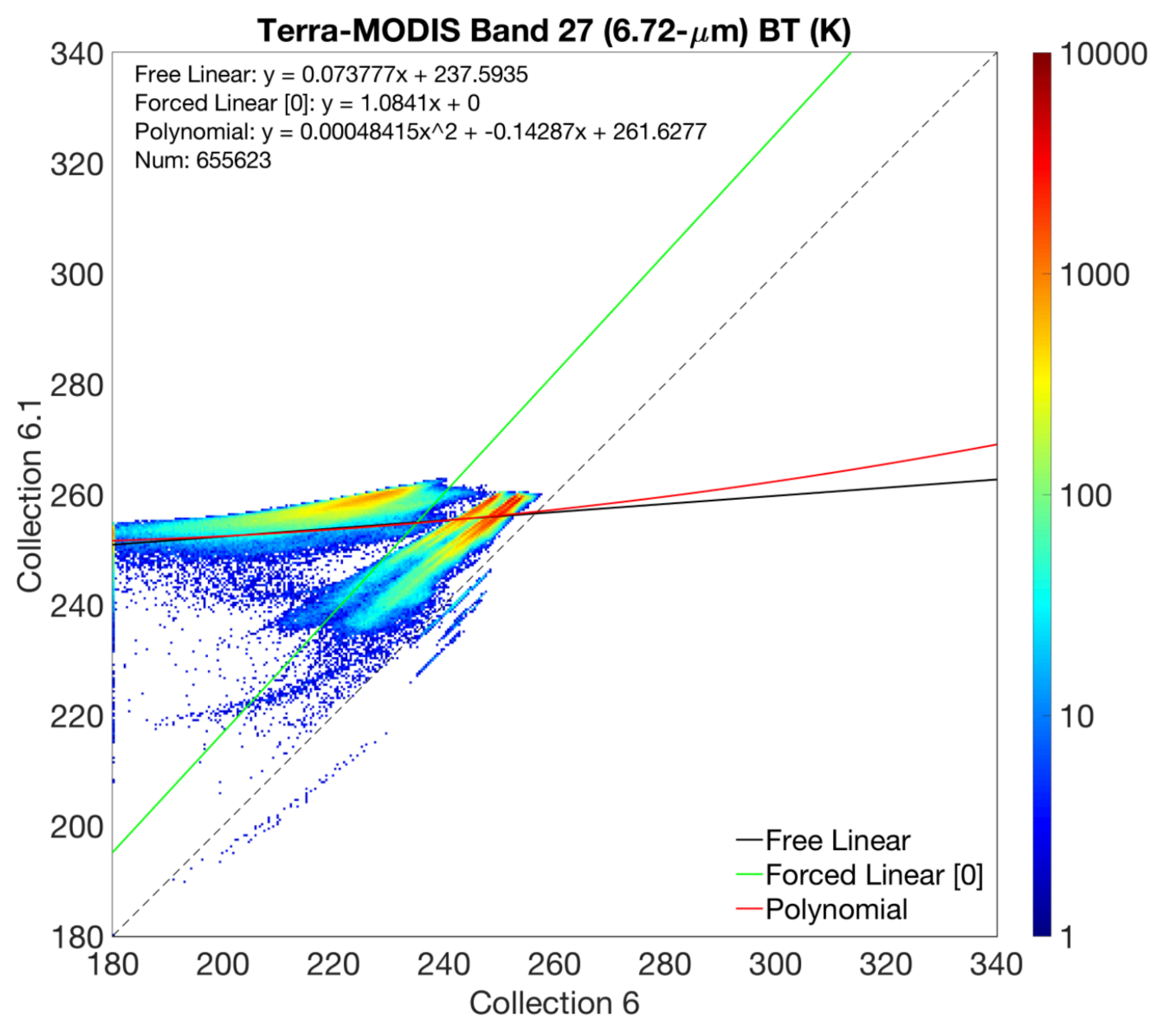
MOD02SS1.S2017258.2110.061.2017261190903.hdf

Terra C6 and C6.1 Band 27 WV 6.7µm channel



• An example cross talk detector to detector striping

Terra-MODIS WV 6.7µm C6 and C6.1 BT density scatter plot



MODIS C6 TO C5 SCALING FACTORS

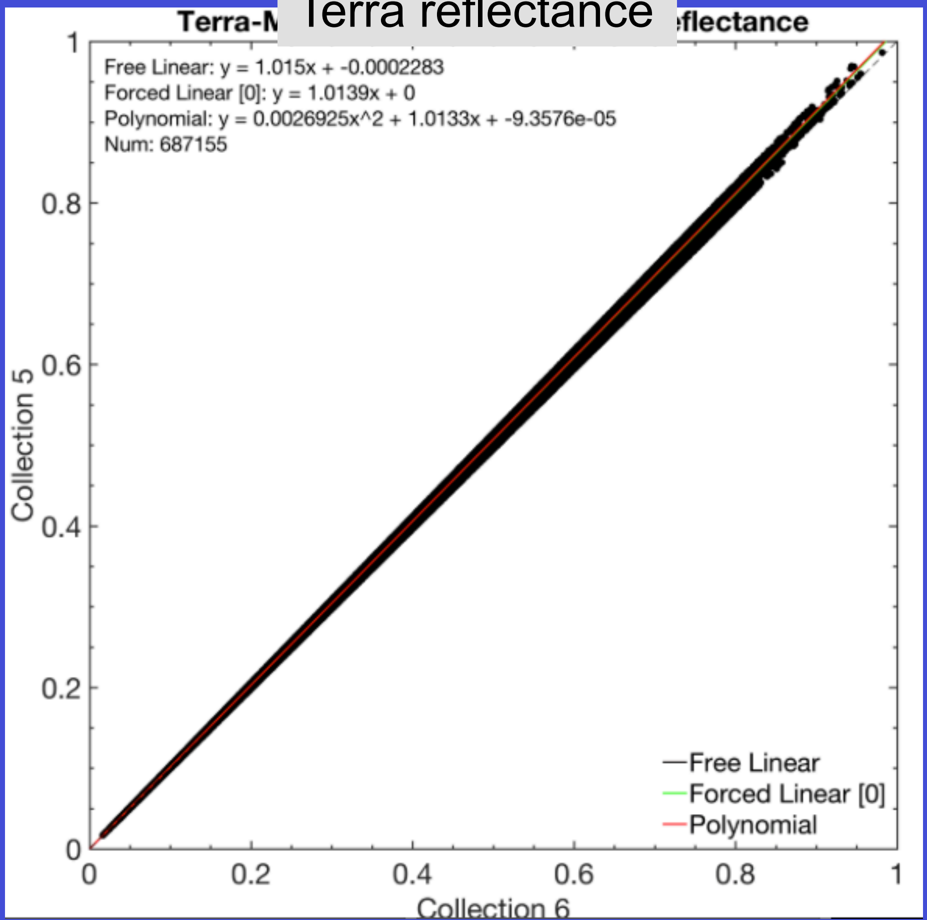
Table of C5/C6 scaling factors (2007, 2017)

Channel (%)	Terra	Aqua
Band 1 (0.65µm)	+1.62, +1.39 RVS	+0.30, -0.37 RVS
Band 2 (0.86µm)	+0.06, -1.46 RVS	+0.14, -0.68 RVS
Band 3 (0.47µm)	+1.03, +1.20 RVS	+0.31, -0.85 RVS
Band 4 0.56µm)	+0.69, +0.44 RVS	+0.34, -0.61 RVS
Band 5 (1.24µm)	-3.18, -1.65	-0.09, 0.0
Band 6 (1.6µm)	-0.26, 0.0	-0.03, 0.0
Band 7 (2.13µm)	-0.75, -0.05	-0.04, 0.0
Band 17 (0.91µm)	+0.89, -0.11	+0.23, -0.02
Band 20 (3.74µm)	low rad saturation	0.0, 0.0
Band 23 (4.05µm)	low rad saturation	0.0, 0.0
Band 26 (1.38µm)	+3.94, +4.97	0.0, 0.0
Band 27 (6.72µm)	striping	0.0, +0.23 striping
Band 29 (8.6µm)	low rad saturation	0.0, +0.04
Band 31 (11.0µm)	+0.0, +0.04	0.0, +0.08
Band 32 (12.0µm)	+0.0, +0.03	0.0, +0.07
Band 33-36 (CO_2)	>0.1, >0.1	

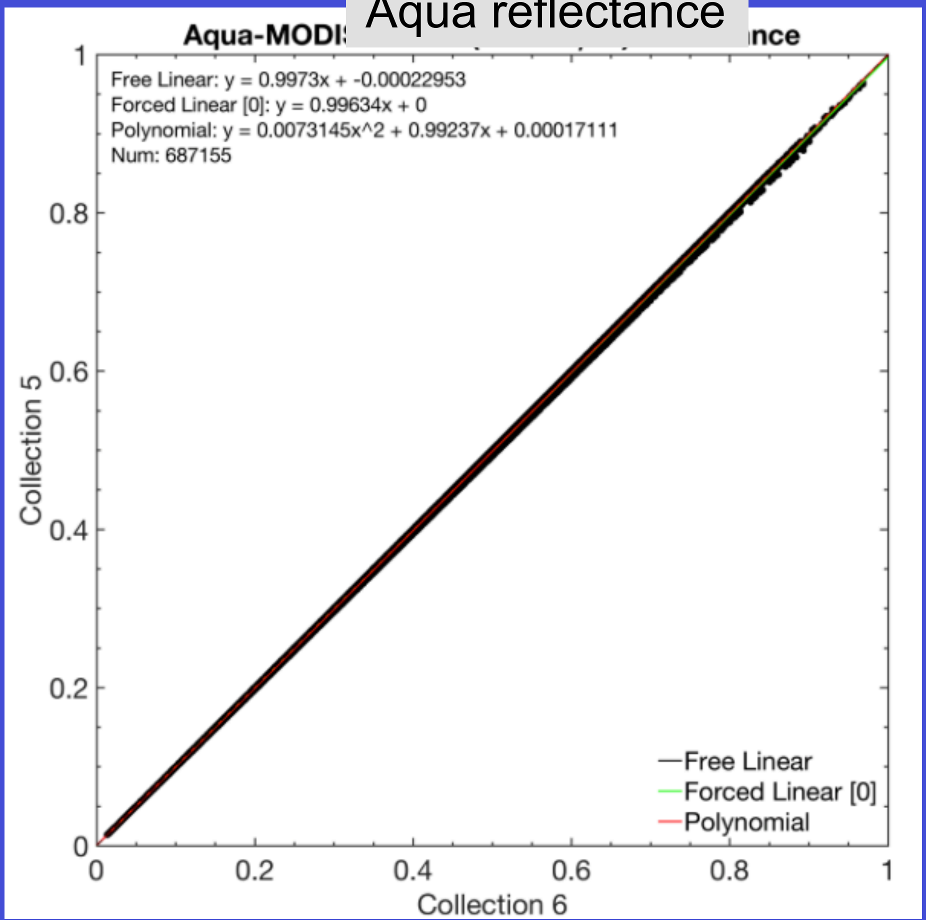
Solar diffuser anomaly in 2009

MODIS Band 1 (0.65μm) C6 to C5 comparison

Terra reflectance



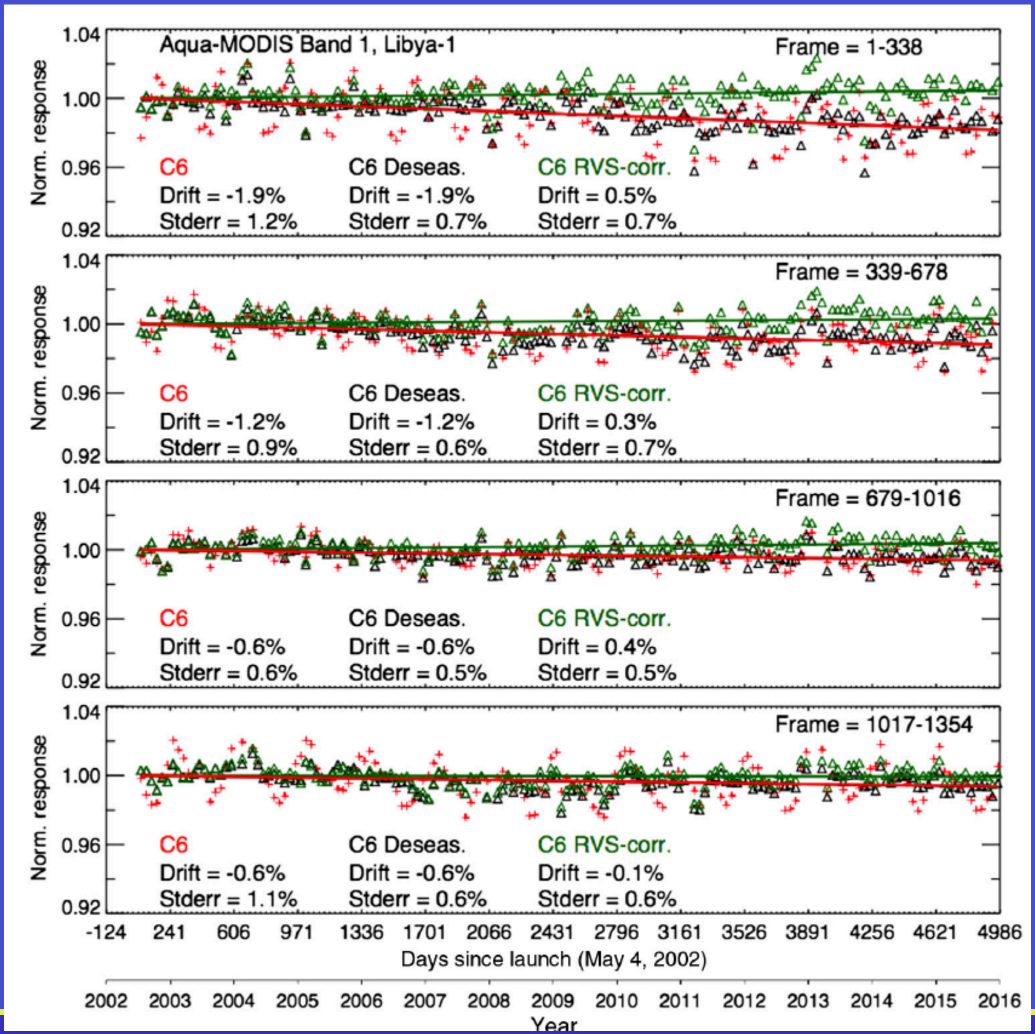
Aqua reflectance



- An example of response versus scan angle (RVS) correction in C6

MOD02SS1.S2016307.0010.006.2016307143521.hdf

MODIS B1 0.65µm scan angle dependency over Libya-4

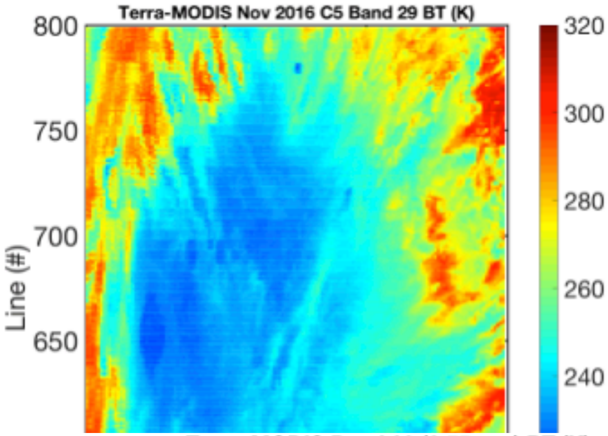


Bhatt et al. 2017

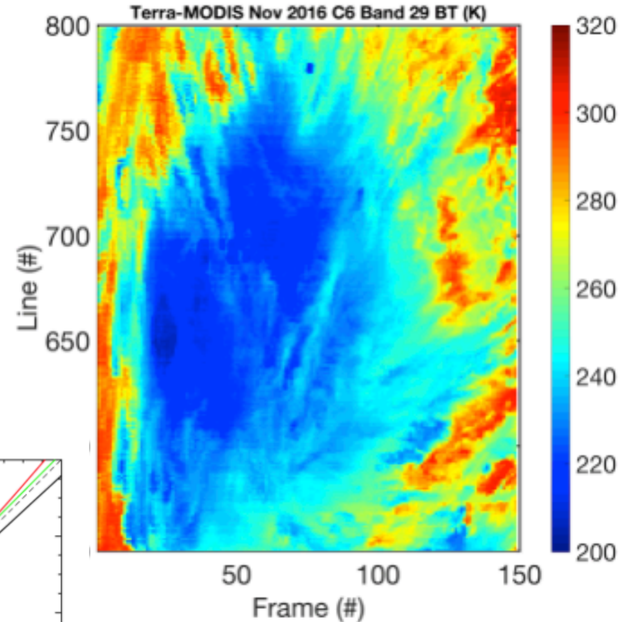
- The azimuthal scan angle dependency between left and right of nadir is 0.5 to 1.0% based on ray-matching
- This is confirmed using the Libya-4 invariant target, C6 • RVS corrections were based on the DCC mode method

Terra-MODIS Band 29 (8.6μm) C6 to C5 comparison

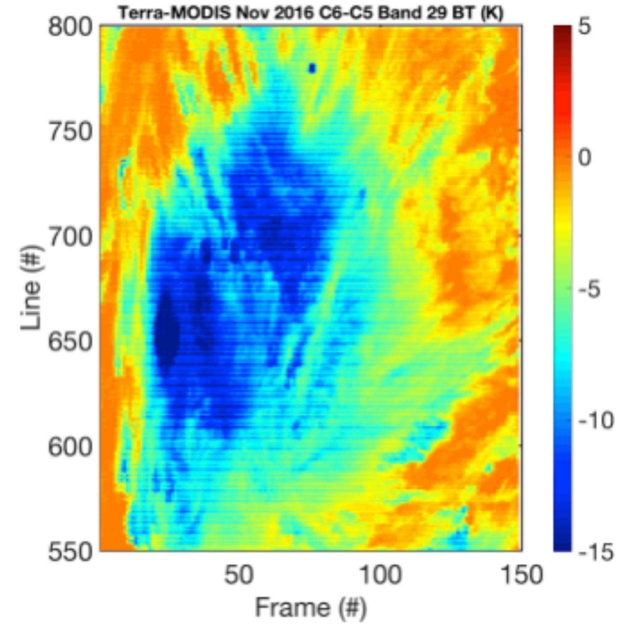
C5

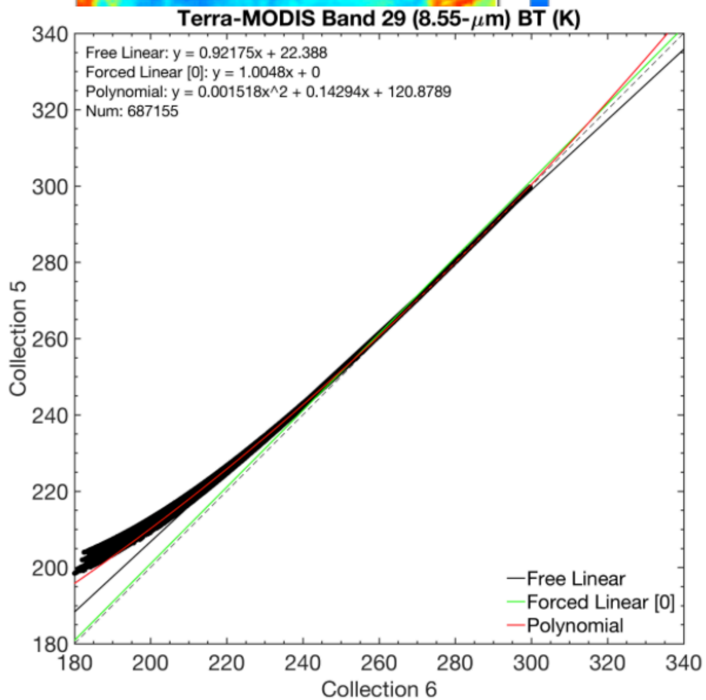


C6



C6-C5





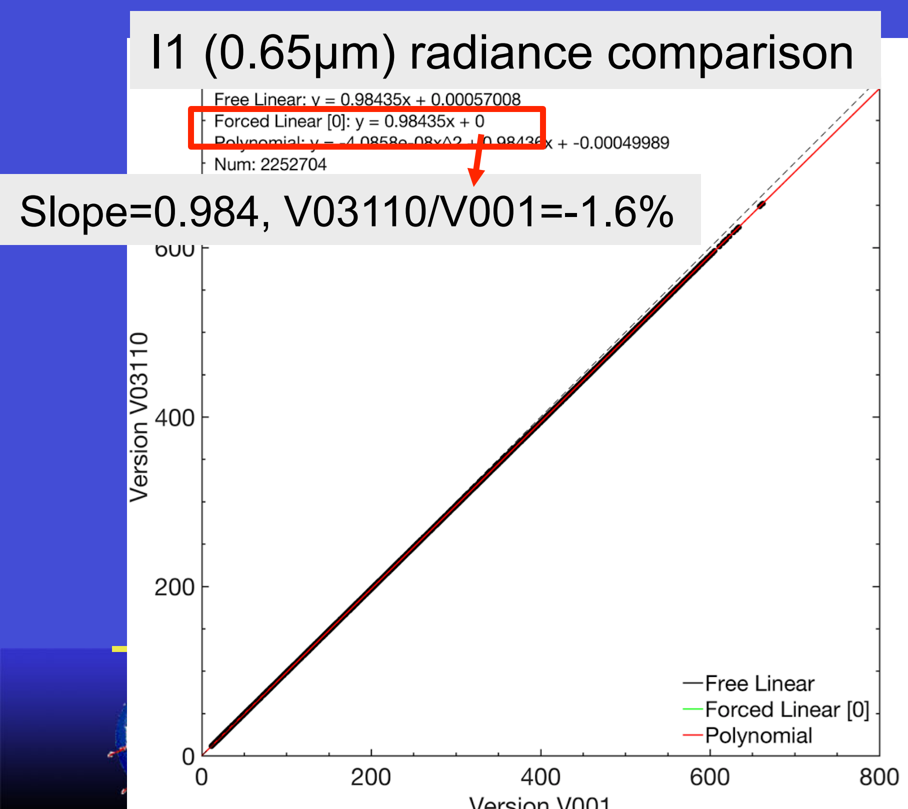
- An example of low radiance saturation in C5

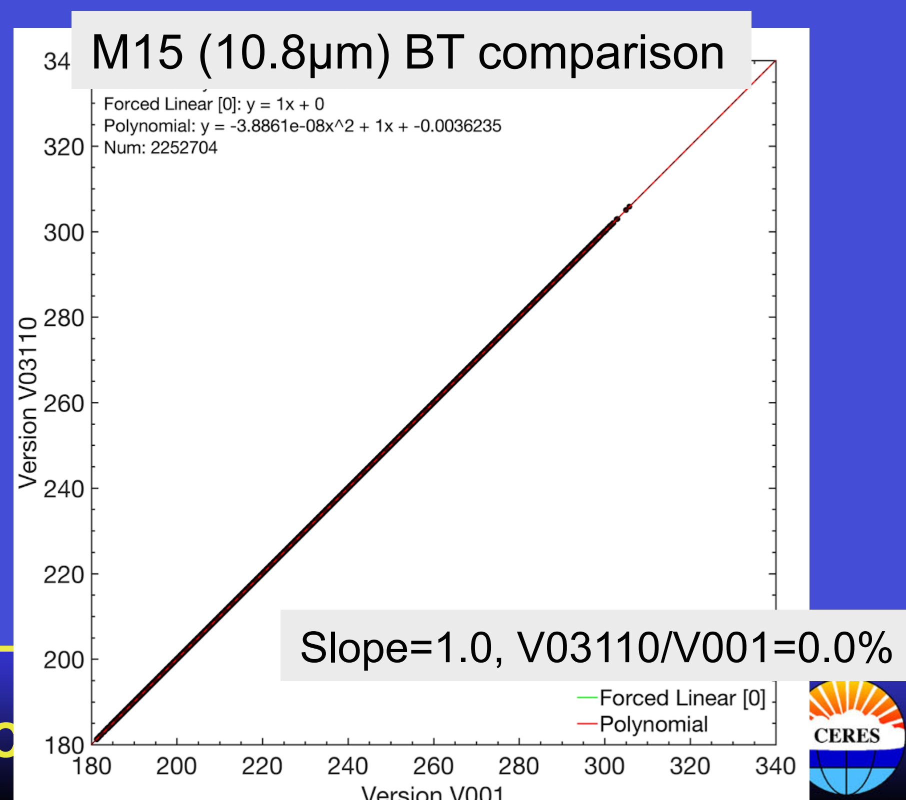
MOD02SS1.S2016307.0010.006.2016307143521.hdf

VIIRS V03110 TO V001 SCALING FACTORS

NPP-VIIRS versions

- For Ed1
  - NPP-VIIRS V03100 was processed from Jan. 27 2012 to Dec 31, 2015, V001 has been processed from Jan. 1 2016.
- For Ed2
  - Process the whole record using V001
  - Apply Aqua-MODIS C5 to NPP-VIIRS V001 scaling factors





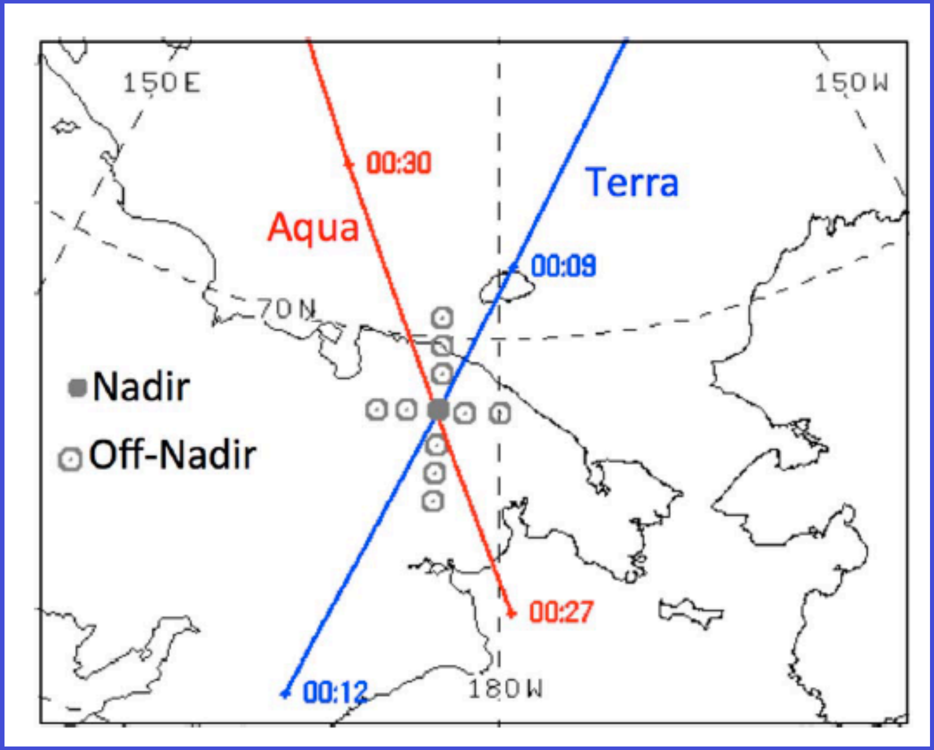
VIIRS V001 to 03100 scaling factors

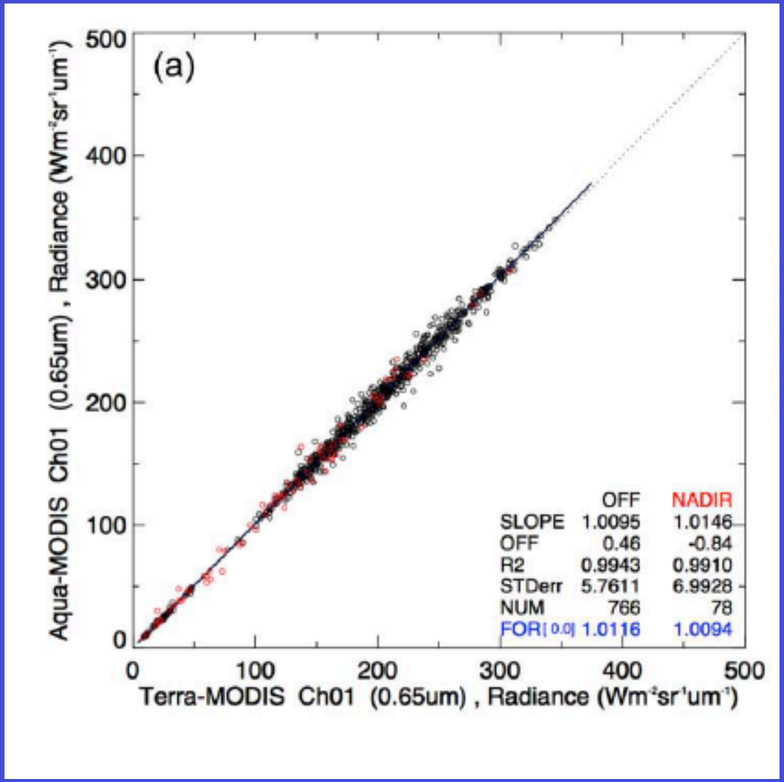
Channel (%)	Sept 2017
I1 0.65μm	-1.6
M7 0.86μm	-0.4
M3 0.47μm	-2.6
M 1.24μm	+0.4
M11 1.64μm	+0.1
I4 3.7μm (BT)	0.0
M14 8.6μm	0.0
M15 10.8μm	0.0
M16 12.0μm	0.0

- These were performed this morning
- The rest of channels will be updated shortly on the web site

TERRA TO AQUA MODIS C6 SCALING FACTORS

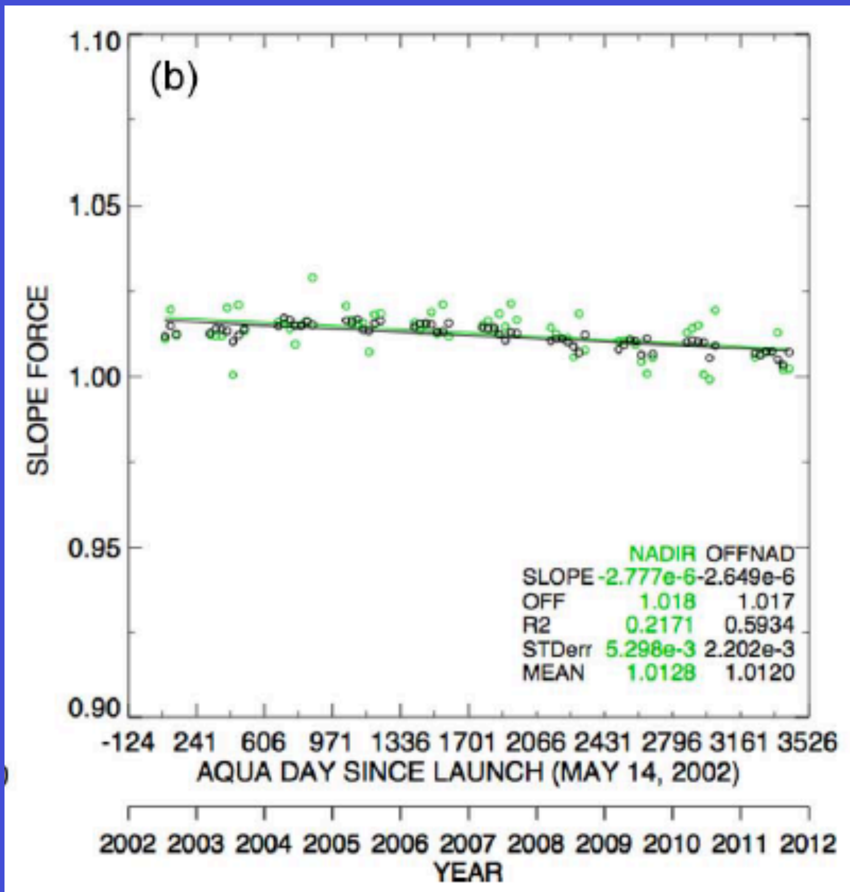
Terra to Aqua C6, July 2002, B1 (0.65µm), Polar SNOs

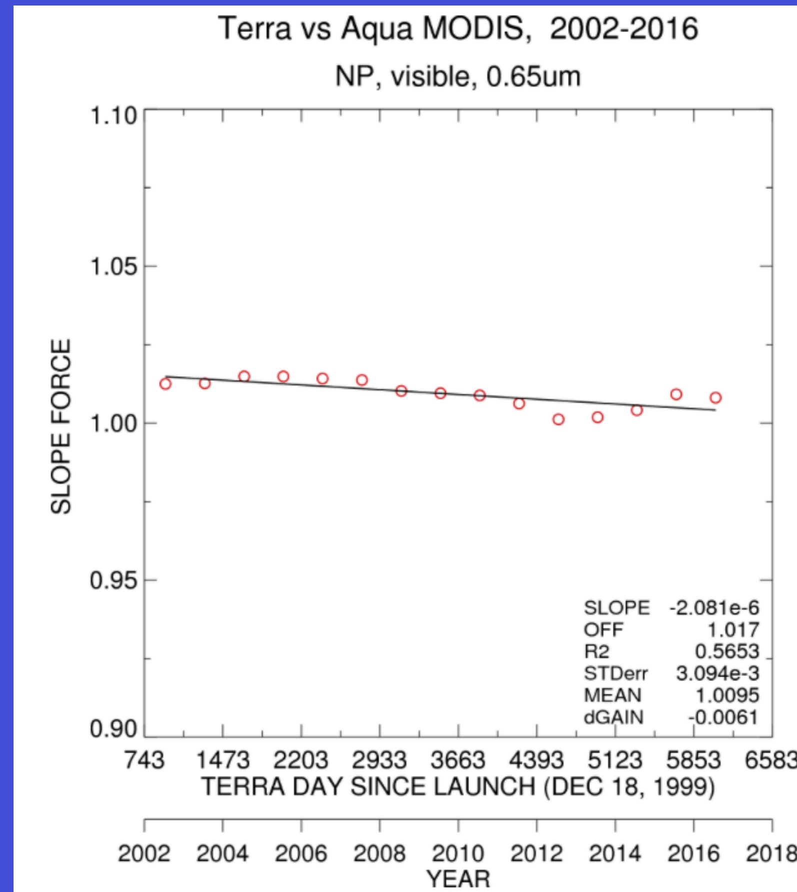




- All Terra and Aqua simultaneous nadir overpass (SNO) are between 10 and 15 minutes apart
- Use both nadir and off-nadir radiance pairs, 10x more points
- SNO occur during local noon so that the azimuthal angle are symetric

Terra to Aqua C6 scaling factors, B1 (0.65µm)





- Only 6 months out of the year are illuminated
- Off–nadir monthly gains have a smaller trend standard error
- The scaling factor trend is unpredictable, use annual gains

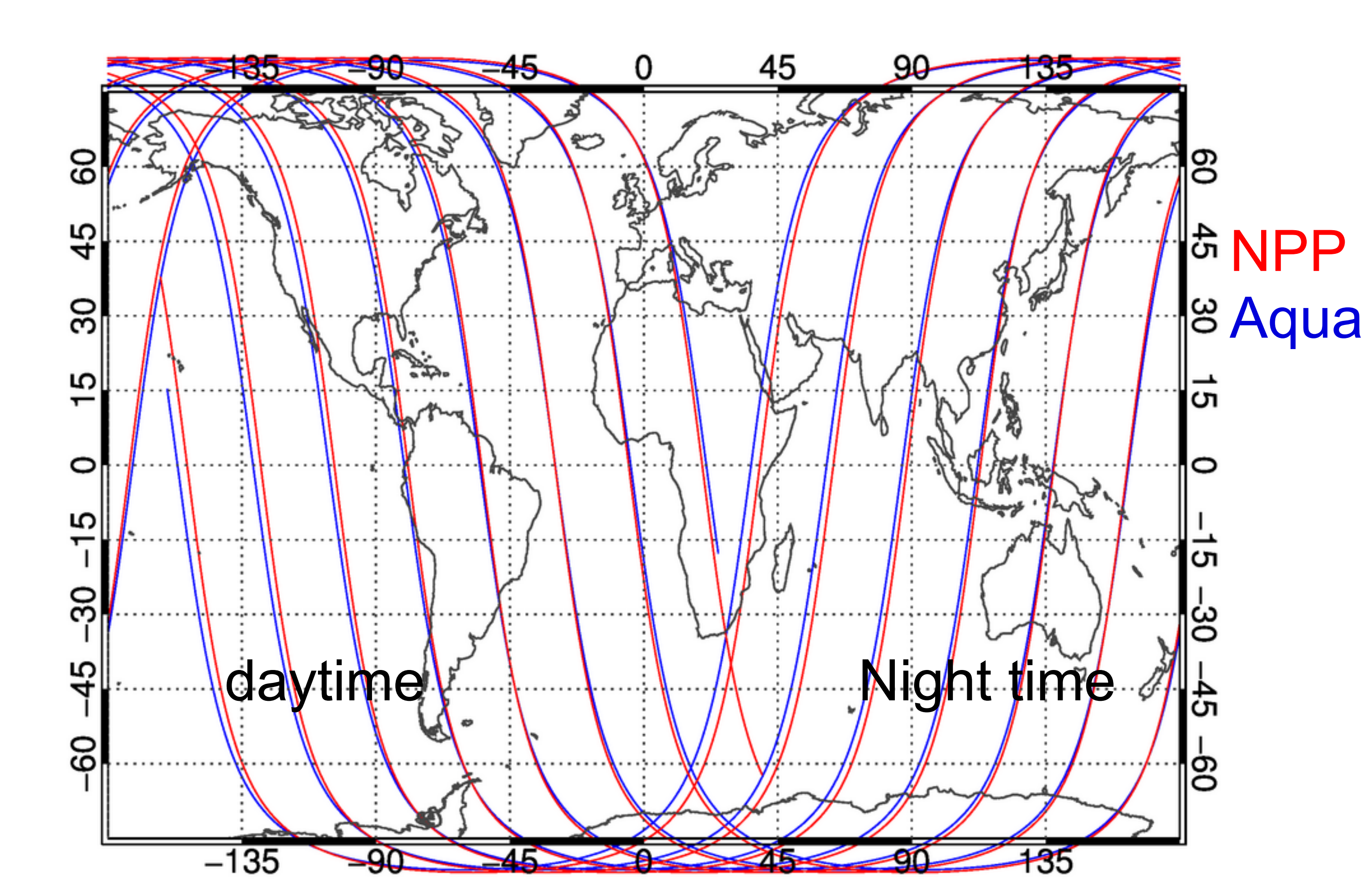
Terra/Aqua MODIS C6 scaling factors

Band (%)	15 year mean	15-year range
Band 1 (0.65µm)	+0.95	+0.28 to +1.65
Band 2 (0.86µm)	-0.83	-2.22 to -0.11
Band 3 (0.47µm)	-1.10	-1.55 to -0.53
Band 4 0.56µm)	+0.27	-0.23 to +0.84
Band 5 (1.24µm)	-6.93	-7.38 to -6.23
Band 7 (2.13µm)	-0.48	-2.25 to + 0.1
Band 26 (1.38µm)	+3.60	+2.4 to +4.6

- Scaling factors need to updated annually

AQUA MODIS C5 OR C6 TO VIIRS V001 SCALING FACTORS

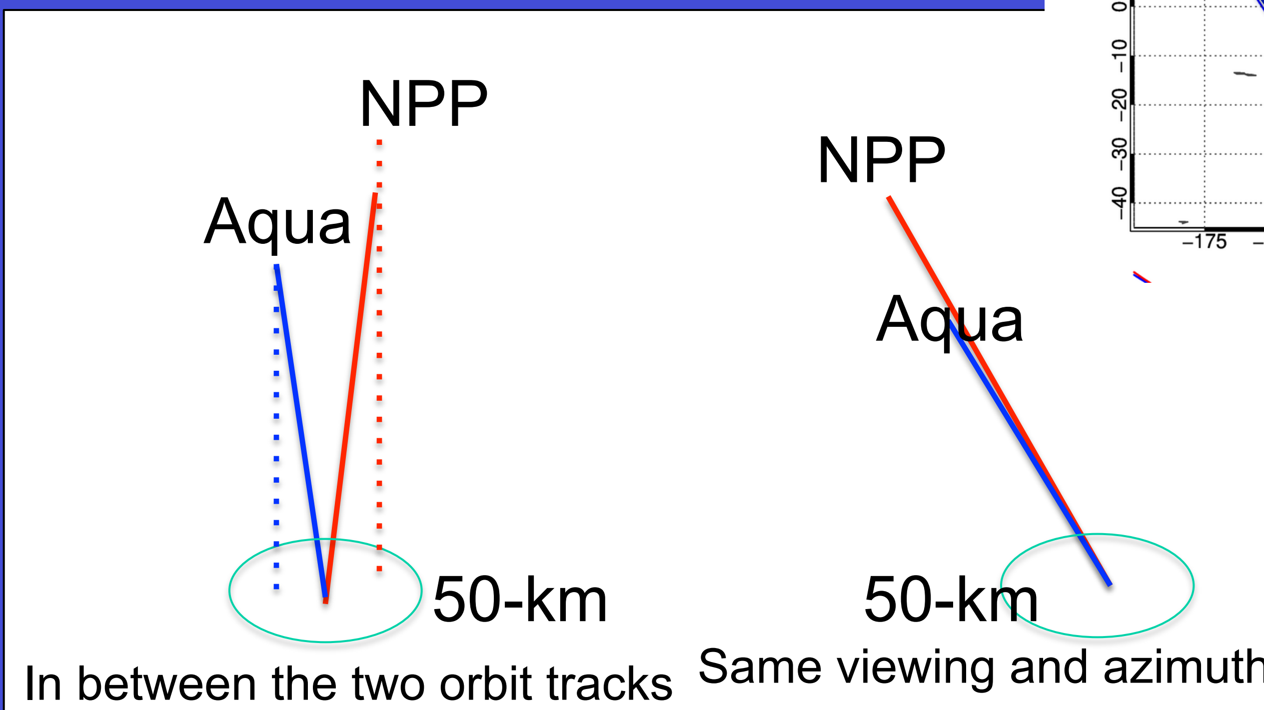
Aqua and NPP ground track intersects July 19, 2015

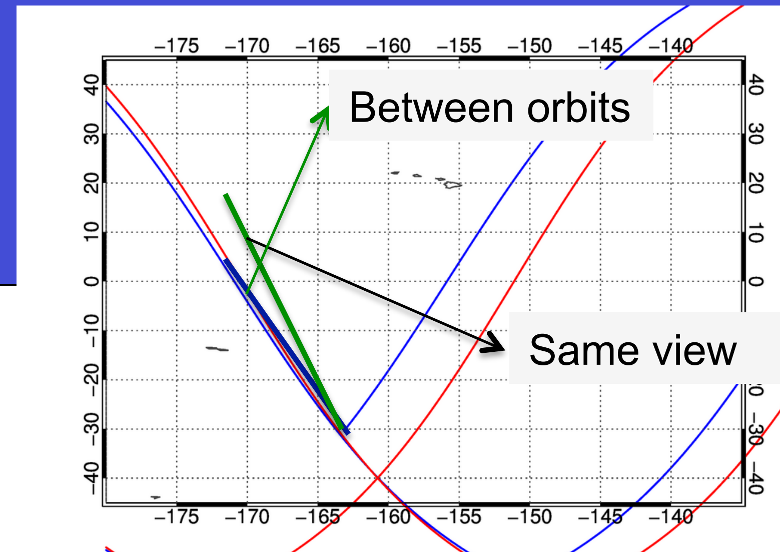


• Tropical intersects provide greater dynamic range and are illuminated for all 12 months of the year.

• Polar intersects provide half of the dynamic range and are only illuminated 6 months out of the year

Aqua and NPP ground track intersects

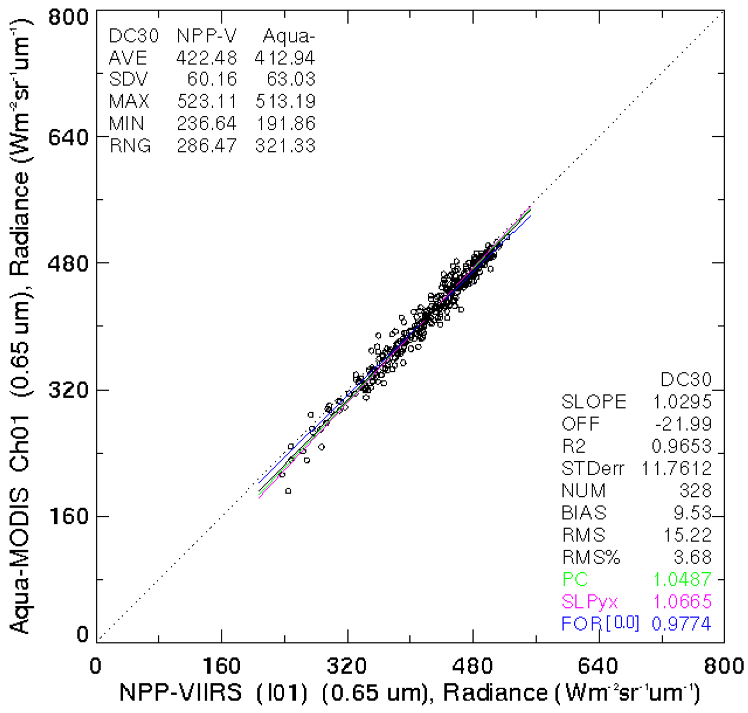




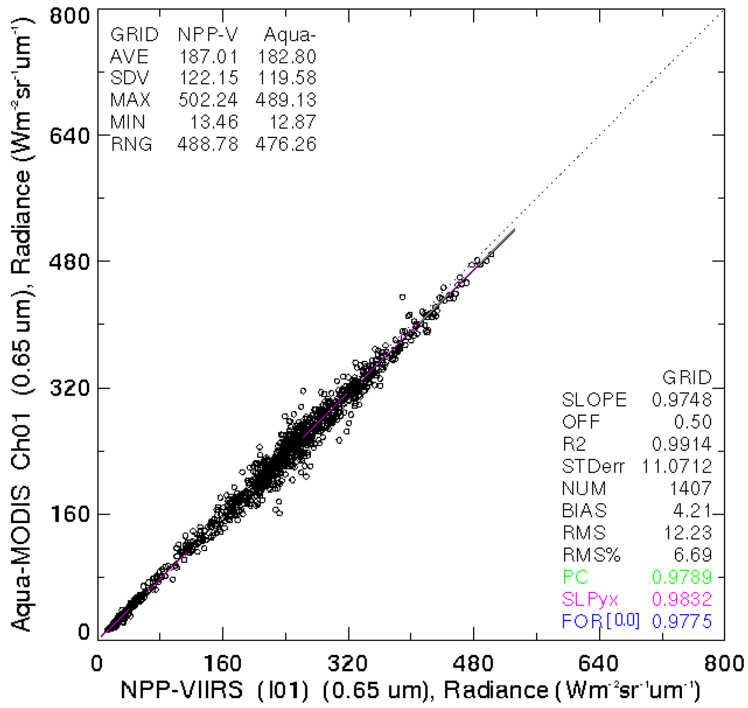
- The Aqua satellite altitude is ~705 km, whereas the NPP is at 824
- NPP leaves no scan gaps at the equator

Feb. 2012 Aqua-MODIS C6 B1 and NPP-VIIRS V001 I1 (0.65µm) ray-matched pairs

Deep Convective Cloud (DCC) 30-km ray-matched

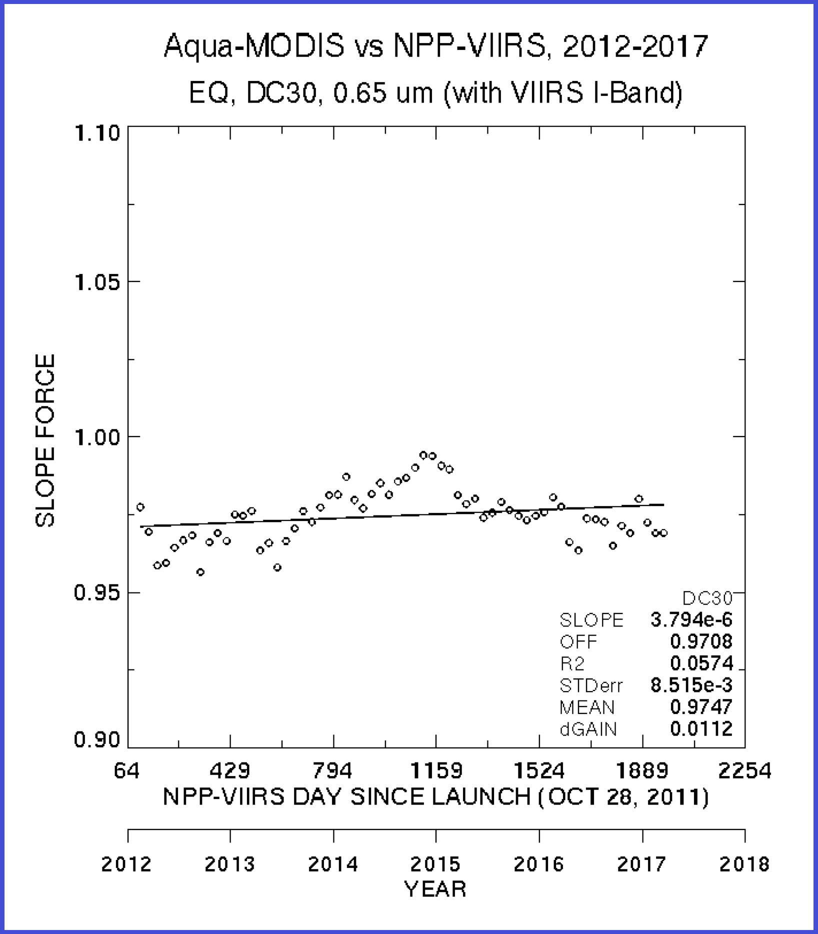


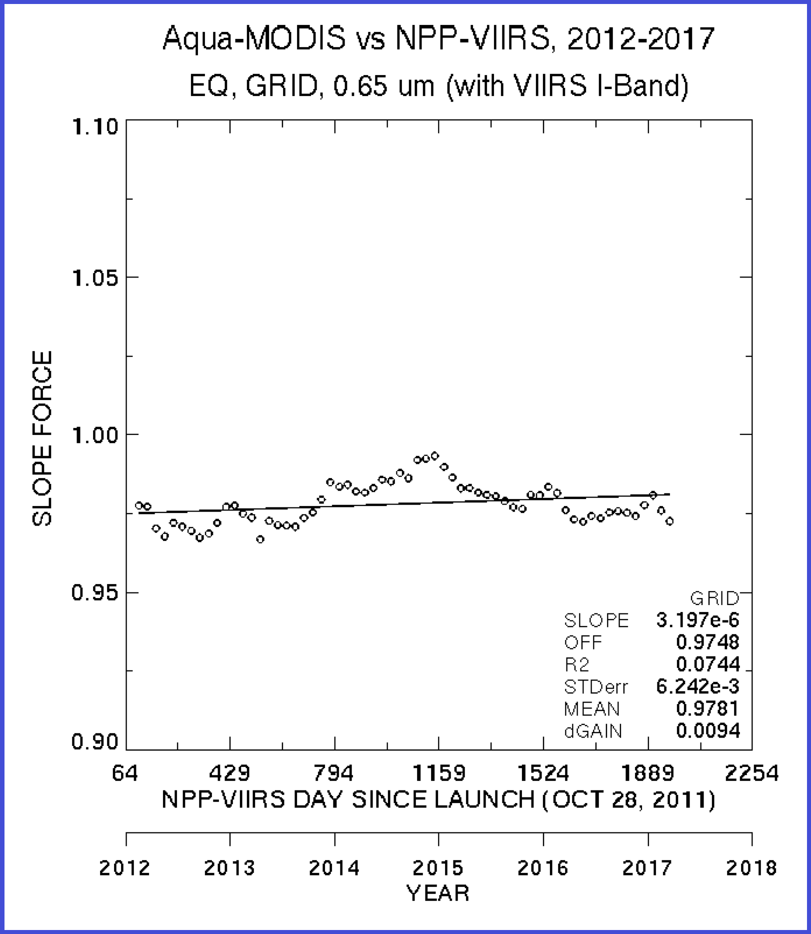
0.5°gridded all-sky ocean (ATO) ray-matched



- The DCC-ray and ATO-ray Feb. 2012 gains are almost identical for this month
- Each method has a differing spectral band adjustment

Aqua-MODIS C6 B1 and NPP-VIIRS V001 I1 (0.65µm) monthly gains





- The DCC-ray and ATO-ray timeline gain means are within 0.35%
- There is a relative gain drift in early 2015 with respect to Aqua-MODIS

Aqua-MODIS C5/C6 and NPP-VIIRS V001 scaling

Channel	C5 DCC	C6 DCC
I1 0.65μm	-2.46%	-2.48%
M5 0.65μm	-3.83	-3.84
M7 0.86μm	-6.74	-6.75
M3 0.47μm	-2.73	-2.65
M4 0.55μm	-3.41	-3.37
M 1.24μm	-0.75	-0.79
I3 1.64	-3.75	-3.79
M11 1.64μm	-2.17	-2.20
M 2.11μm	-60.59	-60.66

Channel	C5 ATO	C6 ATO
I 3.7μm	-0.42K	-0.40K
M 3.7μm	+0.06	+0.08
M 8.6 μm	-0.21	-0.22
I 11.0μm	+0.52	+0.56
M 11μm	-0.13	-0.07
I 12.0μm	-0.11	-0.06
M 12.0μm	+0.10	+0.14

- There is only a slight difference between C5 and C6 in the later Aqua-MODIS record
- All MODIS and VIIRS bands are independently calibrated

How to scale and maintain stability

- When a new imager version is available, the newer version will be scaled to the older version during the transition month
- The stability will be reexamined yearly. If there are significant imager calibration drifts the LUT will be updated
  - If there is a significant calibration anomaly during the year, the LUT tables can be updated with a delta delivery