TISA Working Group Update

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GEO and MODIS/VIIRS Imager calibration: P. Khakurel, C. Haney
INTERNS comparison and orbital tool: B. Hoang, J. Patel
DMT and subsetter team: K. Dejwakh, W. Miller & subsetter team

Fall 2026 CERES science team meeting
October 27-29, 2026
NASA-Langley, Hampton, VA

Outline

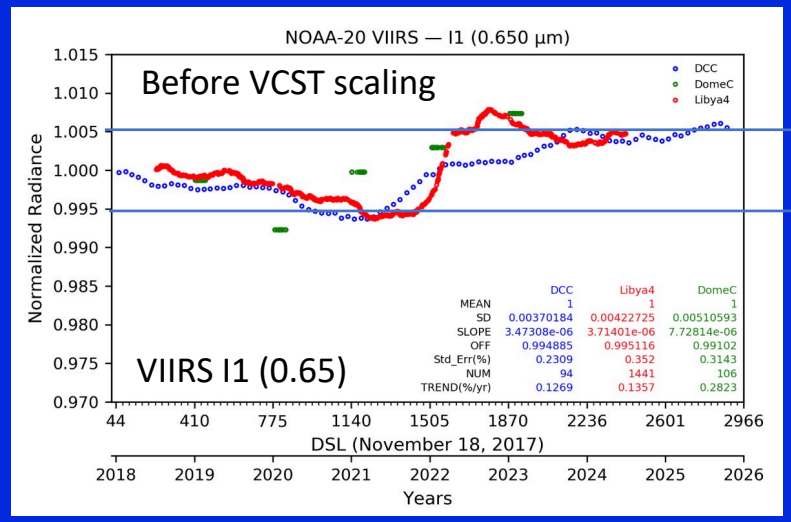
- SNPP and NOAA20 VIIRS scaling with Aqua-MODIS C7
  - Stability improvement with the VCST N20-VIIRS daily calibration corrections
- GEO calibration and navigation
  - IR calibration with AIRS and CrIS
  - GEO subsatellite point and angles recomputed hourly
- Cloud property spatial gridding and temporal interpolation
  - The processing is now hourly driven rather than zonal monthly
  - 3x3 and 4-layer cloud capability and validation
- GEO narrowband to broadband (NB to BB) and CERES normalization
  - Ed5 clouds impact on the SW NB to BB
  - Ed5 normalization improvements over glint and large solar zenith angles
- FluxByCloudType
  - Ed5 clouds and additional channel narrowband to broadband
- Ed5 Framework status and GEO processing in production environment

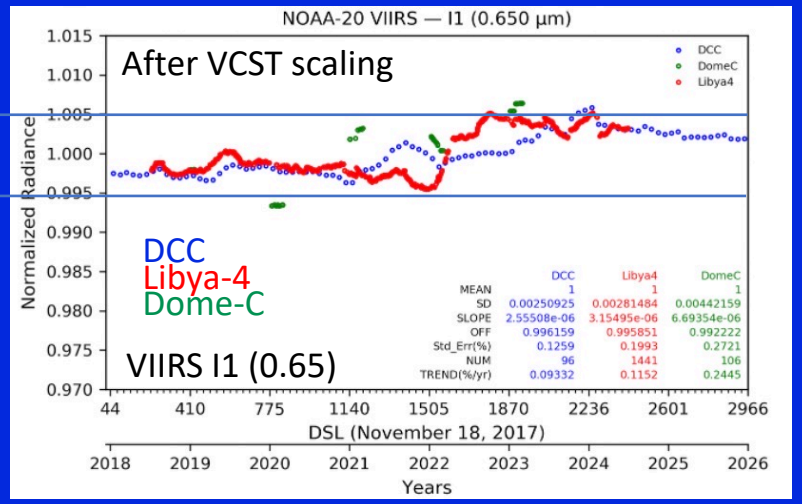
SNPP and NOAA20 VIIRS scaling with Aqua-MODIS C7

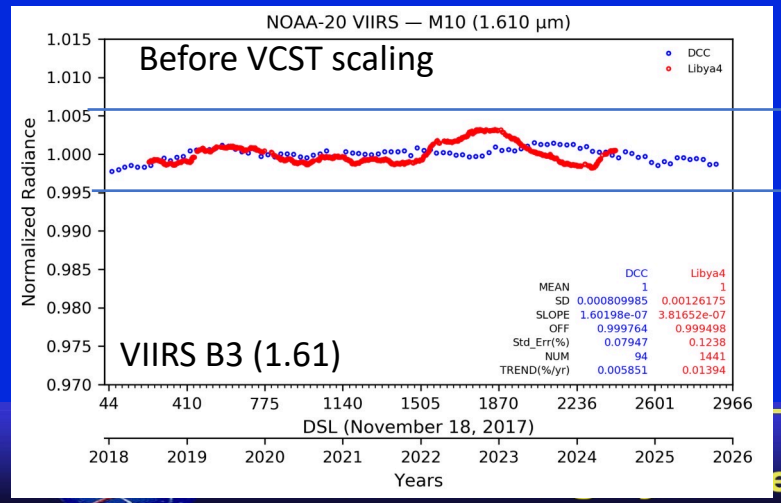
NOAA-20 VIIRS VCST daily scaling factors

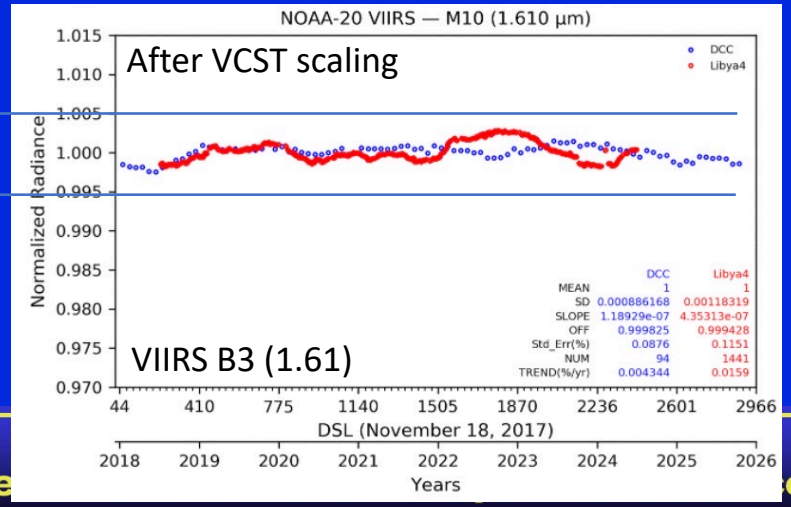
- For the first 3-years, the on-orbit stability is based on the solar diffuser.
  - The solar diffuser-based calibration was found to be degrading when compared with lunar looks
- After the first 3-years, the on-orbit stability is obtained from lunar observations.
  - The lunar looks are noisy and require 3-years before they are useful
- The VIIRS visible channel L1B radiances were trending downward until the more reliable lunar looks were used to maintain stability (~2021)
- There are no plans to reprocess the NASA N20-VIIRS dataset.
- The NASA Goddard VIIRS characterization support team (VCST) provided daily scaling factors to mitigate the forward processing degradation drift
- The VCST daily scaling factors will be applied in the CERES processing
  - Will impact cloud retrievals and FBCT narrowband to broadband fluxes

N20-VIIRS VCST daily scaling validation









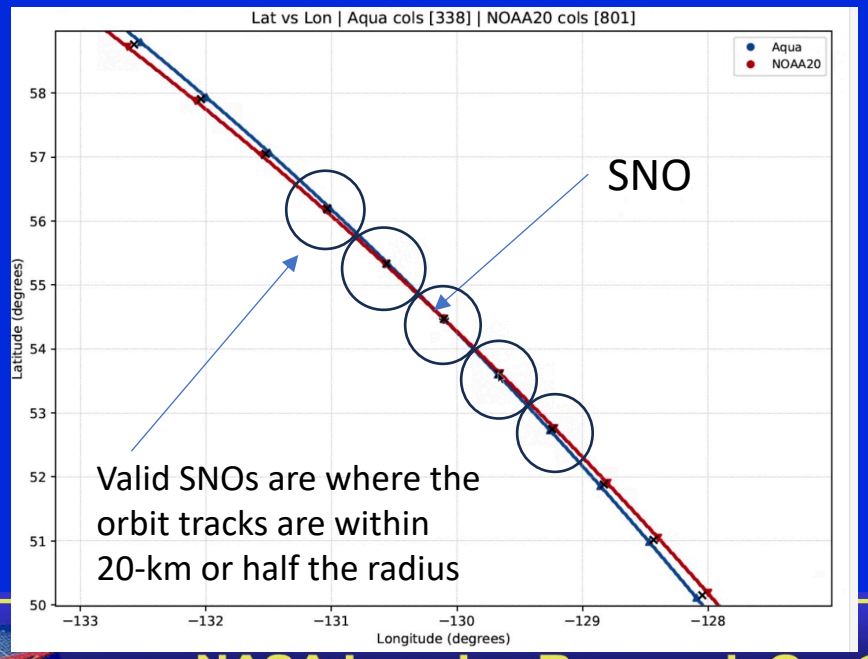
- The VCST daily scaling mainly mitigated the shorter wavelength L1B degradation trends before 2022
- For most VIIRS channels the stability was within ±0.5% based on deep convective cloud (DCC), Libya-4, and Dome-C stable earth targets
- It seems that the VCST daily scalings did somewhat correct for the early record degradation

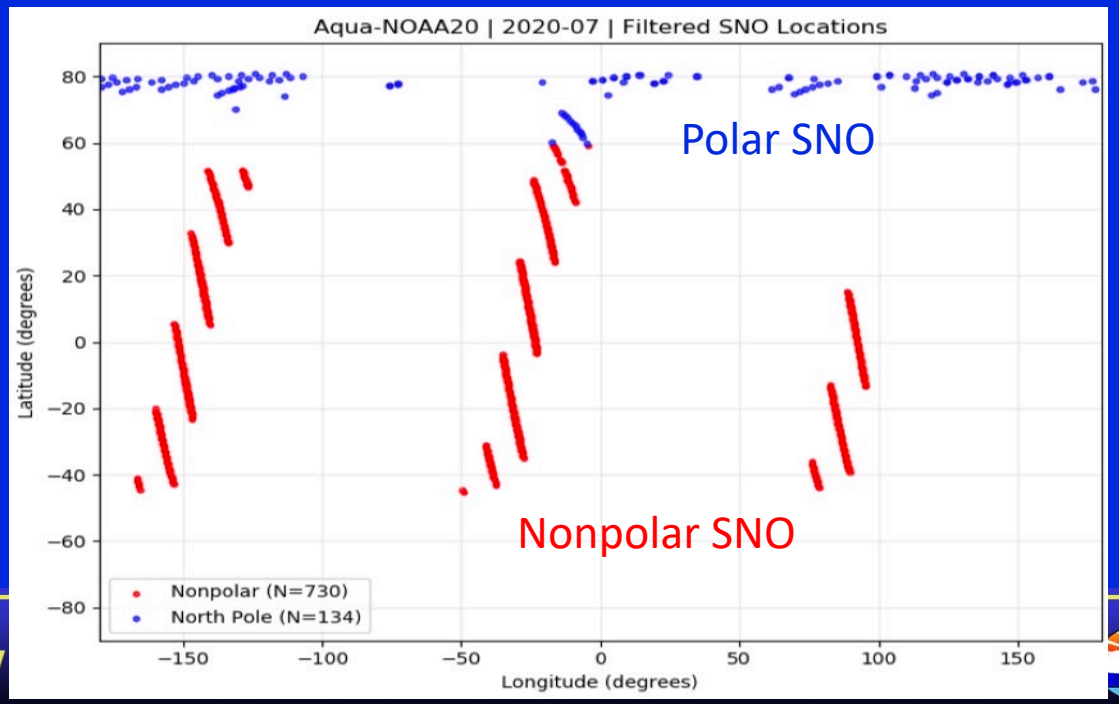
SNPP and NOAA-20 VIIRS with Aqua-MODIS scaling strategy

- Aqua, SNPP and NOAA-20 are in the same 1:30PM LT orbit
  - SNPP and NOAA-20 are in the same 16-day repeat cycle orbit but spaced 8 days apart during 2012 to 2022 scaling period
- Aqua (720km) altitude differs from SNPP and NOAA-20 (824km) altitude allowing orbital intersects every 64 hours over both the poles and nonpolar domains
  - Divide the calibration domain into non-polar all-sky ocean and polar all-sky
  - The polar SNOs are only available near solstice over the Arctic
- Compare the polar and nonpolar Spectral Band Adjusted Factor (SBAF) corrected VIIRS to MODIS scaling factors
  - Similar scaling factors validates the Simultaneous Nadir Overpass (SNO) strategy
  - Each domain has a unique SBAF, reflected Earth spectra, and solar conditions

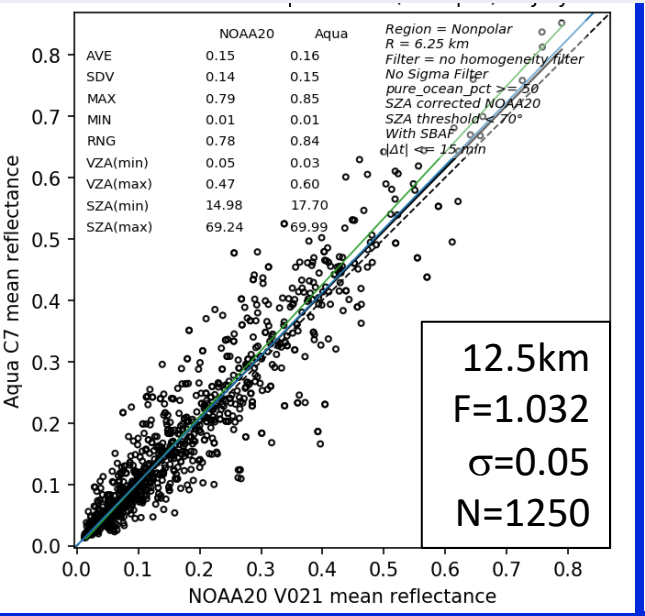
VIIRS scaling with Aqua-MODIS strategy

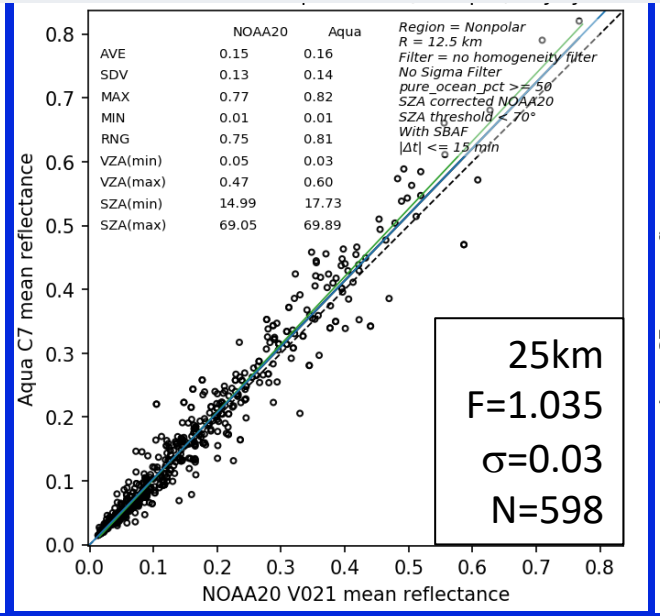
- The scaling factor is the linear regression of the MODIS and VIIRS instantaneous SNO radiances
- Larger SNO footprints reduces the instantaneous matching noise but may reduce number of SNOs and the radiance dynamic range

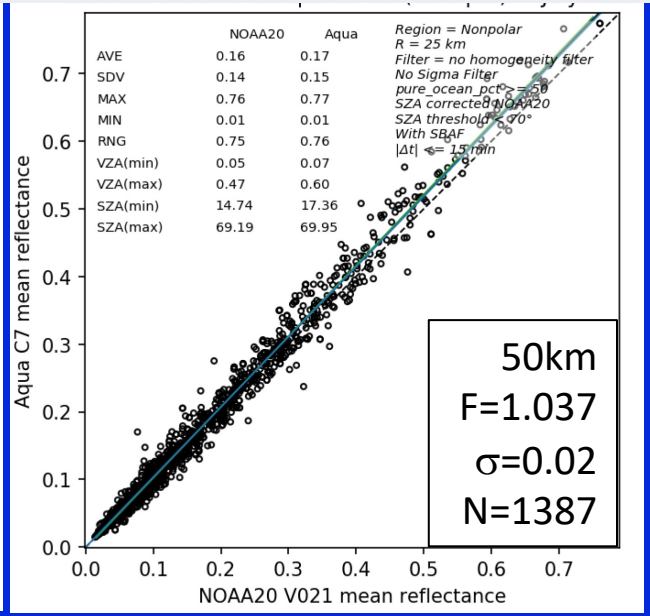


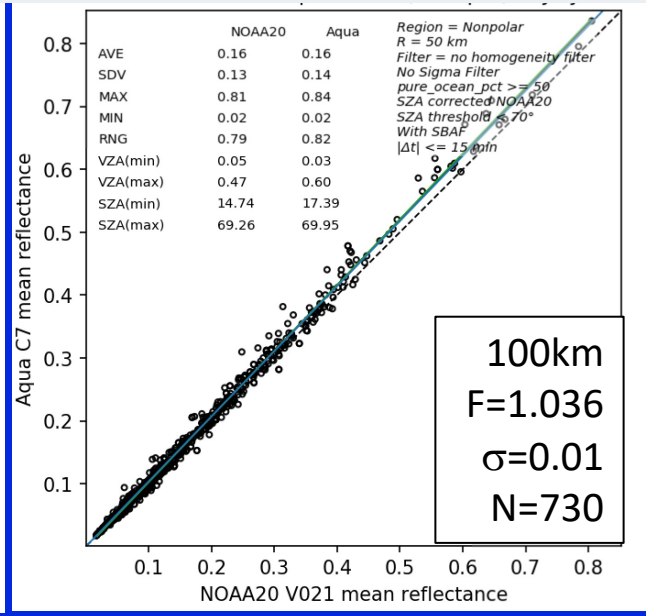


N20-VIIRS I1 and Aqua-MODIS B1, 0.65µm, July 2020, nonpolar all-sky ocean reflectance pair regression plots by SNO size

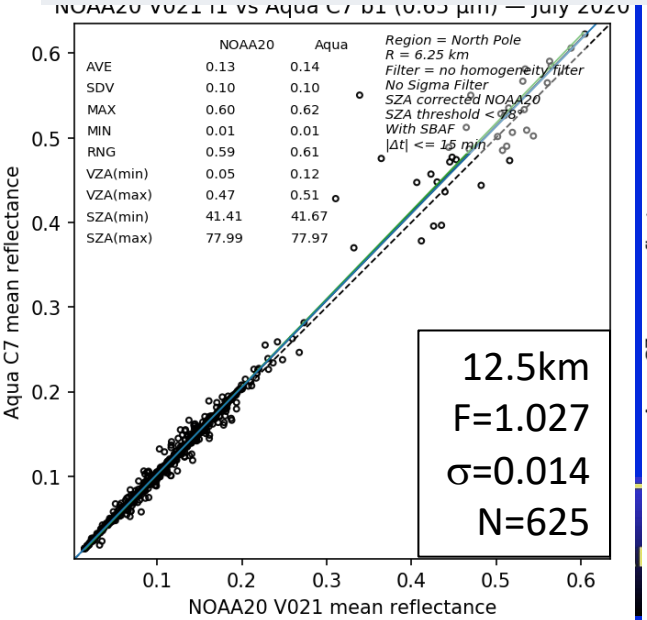


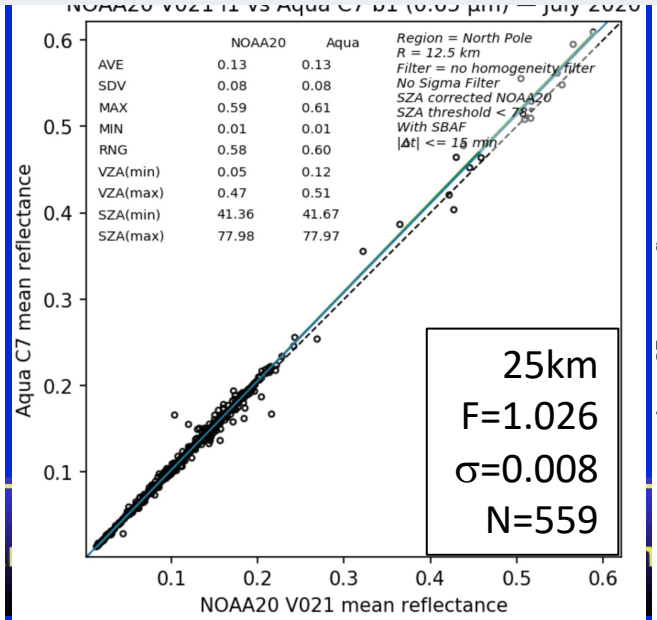


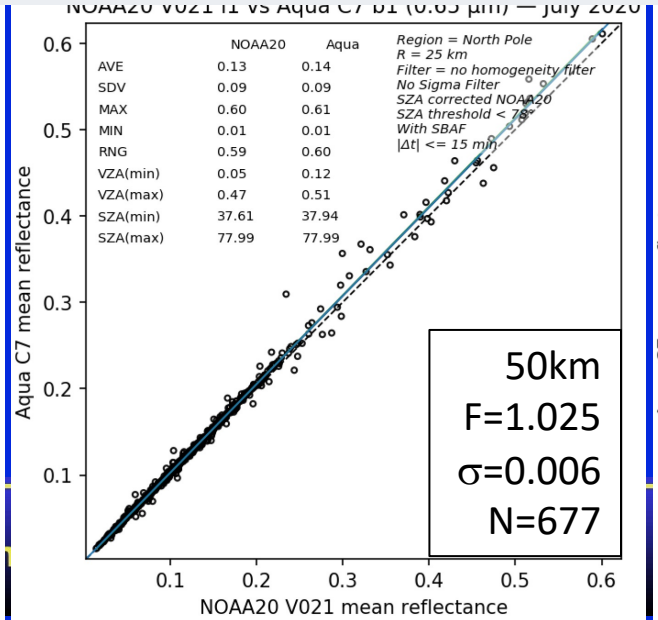


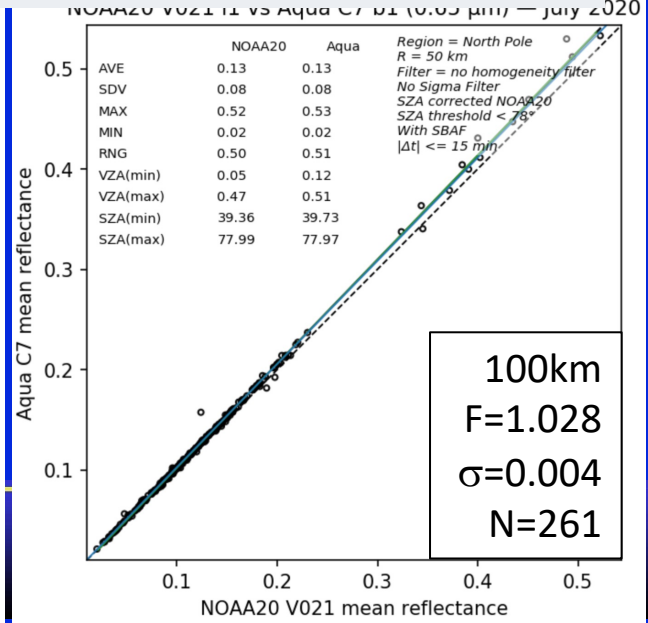


N20-VIIRS I1 and Aqua-MODIS B1, 0.65µm, July 2020, polar all-sky reflectance pair regression plots by SNO size









July 2020 NPP and N20 VIIRS nonpolar scaling factors by SNO diameter

NPP	12.5km	25km	50km	100km	Δfactor
M5/B1	0.9387	0.9613	0.9650	0.9662	Δ2.8%
M7/B2	0.9327	0.9552	0.9641	0.9676	Δ3.6%
M3/B3	0.9490	0.9660	0.9661	0.9670	Δ1.9%
M4/B4	0.9473	0.9679	0.9700	0.9704	Δ2.4%
M8/B5	0.9357	0.9590	0.9640	0.9638	Δ2.9%
M10/B6	0.9202	0.9477	0.9574	0.9579	Δ3.9%
M9/B26	0.9461	0.9716	0.9411	0.9492	Δ3.1%
I1/B1	0.9614	0.9836	0.9865	0.9872	Δ2.6%
I3/B6	0.9120	0.9392	0.9492	0.9498	Δ4.0%

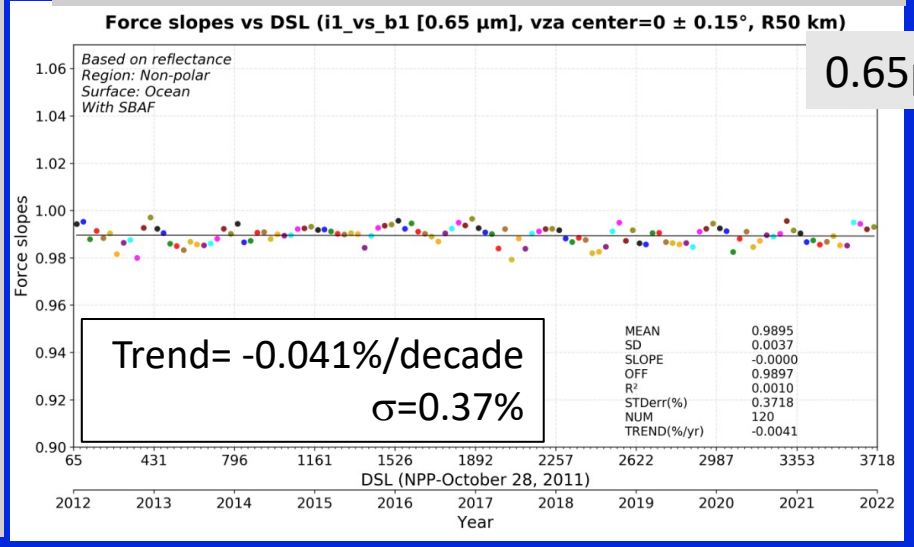
NOAA20	12.5km	25km	50km	100km	Δfactor
M5/B1	1.0206	1.0231	1.0200	1.0219	Δ0.3%
M7/B2	1.0037	1.0053	1.0155	1.0133	Δ1.2%
M3/B3	1.0225	1.0223	1.0191	1.0198	Δ0.3%
M4/B4	1.0254	1.0265	1.0278	1.0266	Δ0.2%
M8/B5	0.9793	0.9845	0.9874	0.9882	Δ0.9%
M10/B6	0.9650	0.9725	0.9778	0.9785	Δ1.4%
M9/B26	1.0013	1.0177	1.0323	0.9968	Δ3.4%
I1/B1	1.0324	1.0347	1.0366	1.0356	Δ0.4%
I3/B6	0.9755	0.9828	0.9885	0.9884	Δ1.3%

- For N20-VIIRS, the SNO scaling factors are consistent within 1.4%, except for band 26 (1.38μm)
- For NPP-VIIRS, the 12.5km and 25km SNOs have smaller scaling factors than the 50km and 100km SNOs
- For both the N20 and NPP VIIRS, the 50-km and 100-km SNOs have very consistent scaling factors
- Use the 100km SNOs to derive the scaling factors

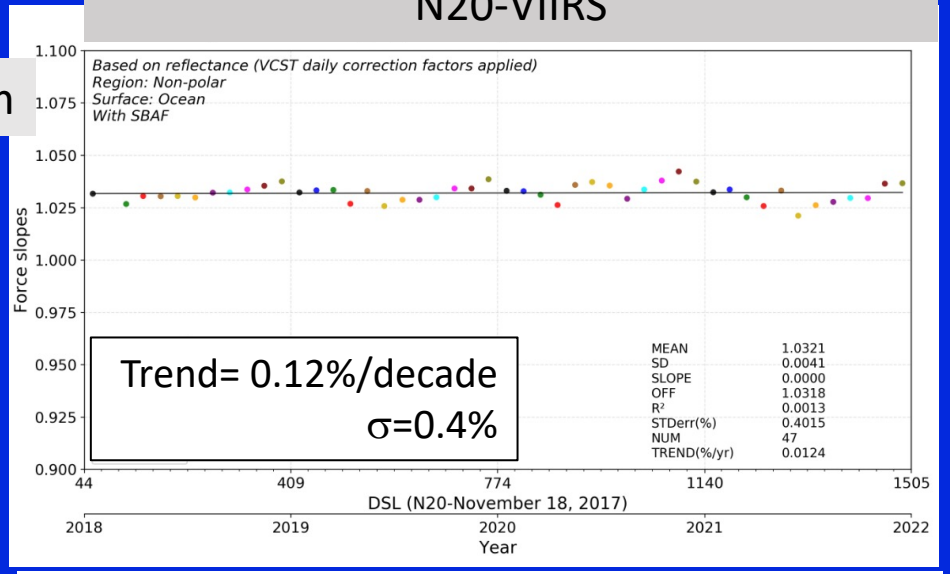
NPP and N20 VIIRS-I1 with Aqua-MODIS scaling trends

Nonpolar all-sky ocean

NPP-VIIRS

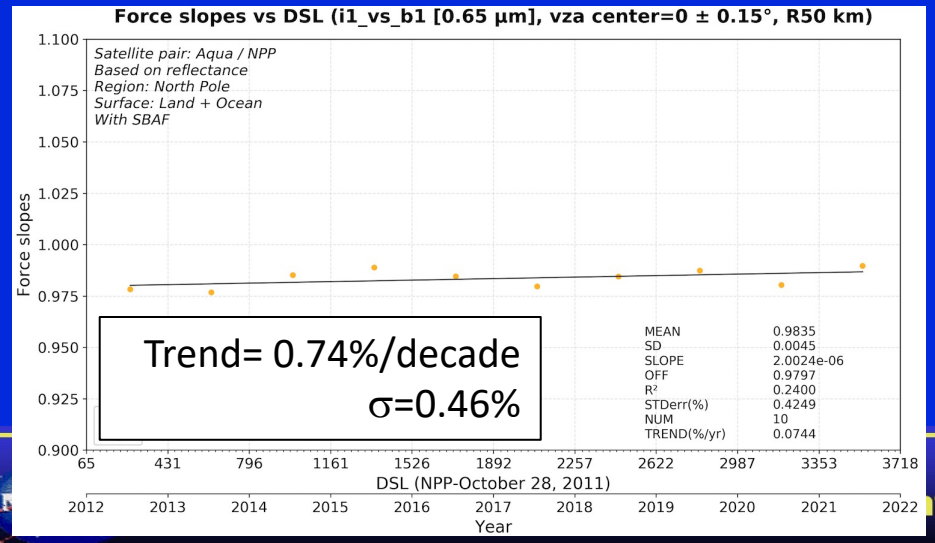


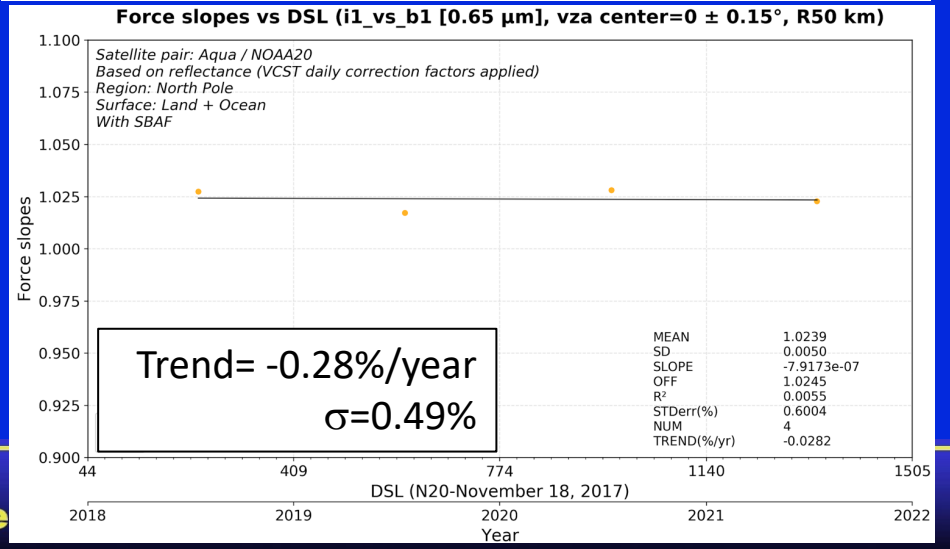
N20-VIIRS



- Due to the excellent stability of Aqua-MODIS C7 and VIIRS sensor the scaling factor trends are insignificant

Polar all-sky





- The polar and nonpolar scaling trends are within 0.8% for NPP and 0.4% for N20 across all visible channels

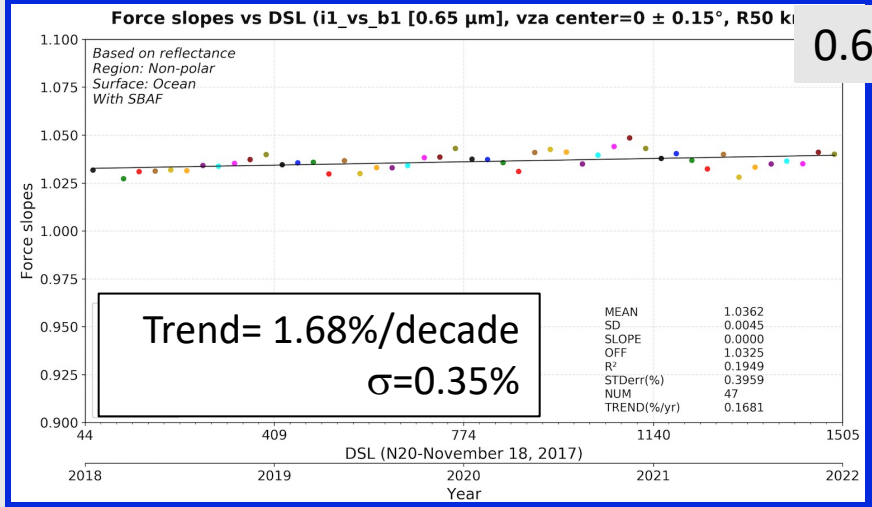
Impact of VCST N20-VIIRS daily adjustments

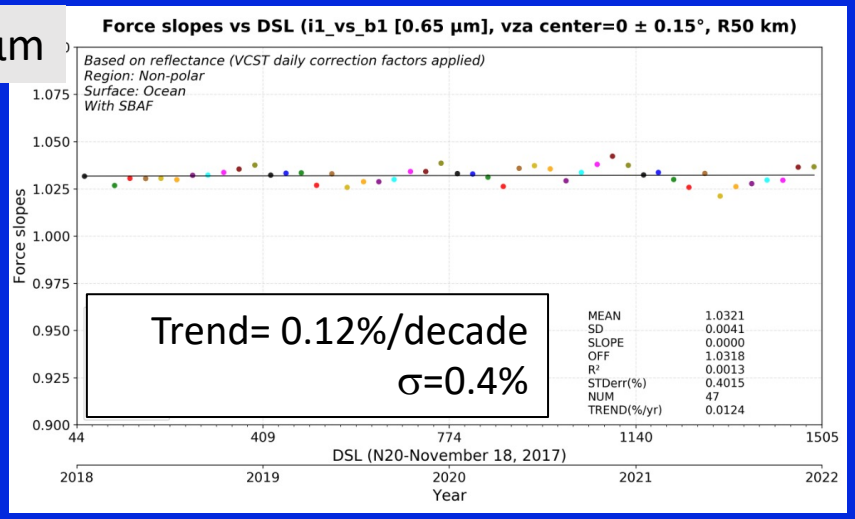
Without VCST daily adjustments

With VCST daily adjustments

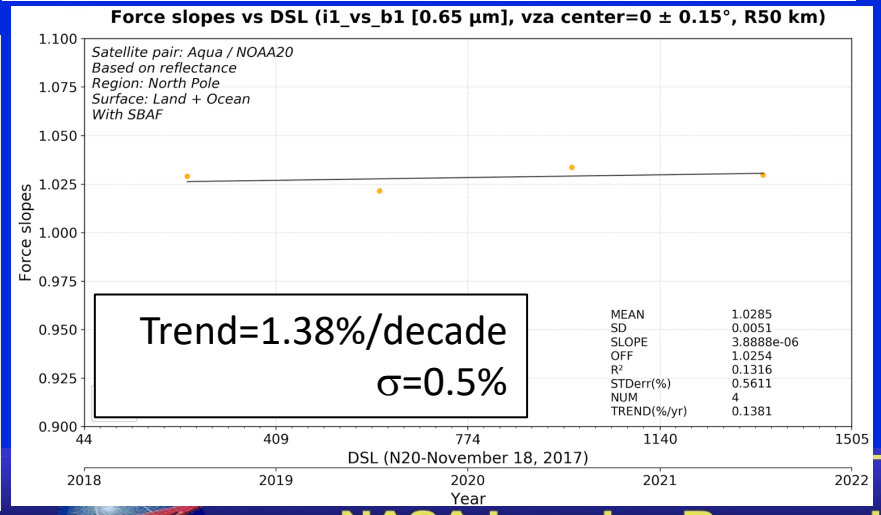
Nonpolar all-sky ocean

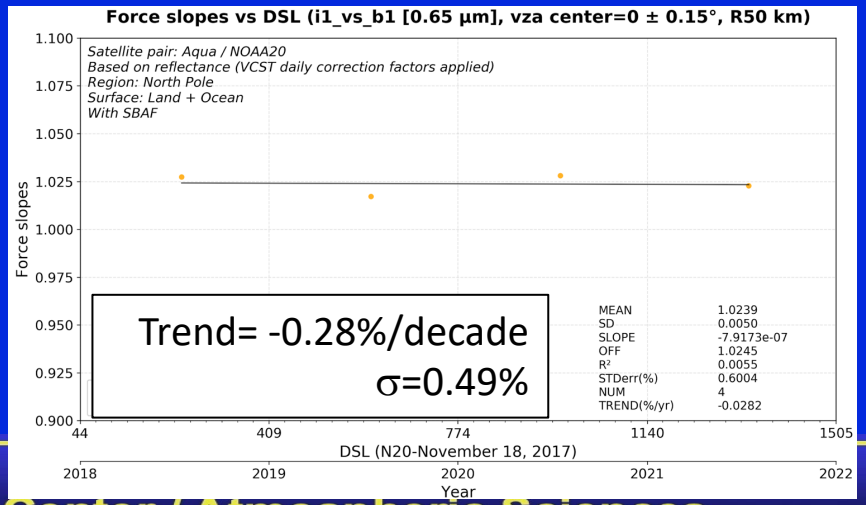
0.65µm





Polar all-sky





N20 VIIRS nonpolar trends, before and after VCST daily adjustments

N20-VIIRS	Trend %/decade	
nonpolar	None	With
M3/B3	+1.73	+0.54
M4/B4	+2.67	+1.43
M5/B1	+1.04	+0.46
M7/B2	+1.63	+1.47
M8/B5	-0.40	-0.50
M9/B26	+0.94	+0.78
M10/B6	-0.28	-0.46
I1/B1	+1.68	+0.12
I3/B6	+0.24	+0.07

- Note the reduced trends after applying the VCST daily stability adjustments

NPP-VIIRS/Aqua-MODIS scaling factors

Timeline nonpolar	µm	Sigma %	Trend decade %
M3/B3	0.48	0.43	+0.99
M4/B4	0.51	0.40	-0.55
M5/B1	0.65	0.42	-0.37
M7/B2	0.86	0.49	+0.20
M8/B5	1.24	0.34	+0.24
M9/B26	1.38	1.02	+0.10
M10/B6	1.61	0.65	-0.05
I1/B1	0.64	0.37	-0.04
I3/B6	1.61	0.67	+0.08

Bands	Non-Polar		Polar		Diff	
	No SBAF	SBAF	No SBAF	SBAF	No SBAF	SBAF
M3/B3	0.9967	0.9698	0.9852	0.9644	Δ1.2%	Δ0.6%
M4/B4	0.9684	0.9731	0.9678	0.9751	Δ0.1%	Δ0.2%
M5/B1	0.9494	0.9695	0.9350	0.9718	Δ1.5%	Δ0.2%
M7/B2	0.9635	0.9717	0.9703	0.9735	Δ0.7%	Δ0.2%
M8/B5	0.9646	0.9625	0.9631	0.9646	Δ0.2%	Δ0.2%
M9/B26	0.9912	0.9581	1.0948	0.9233	Δ9.5%	Δ3.8%
M10/B6	1.0251	0.9646	1.0331	0.9553	Δ0.8%	Δ1.0%
I1/B1	0.9898	0.9895	0.9918	0.9835	Δ0.2%	Δ0.6%
I3/B6	1.0188	0.9564	1.0272	0.9478	Δ0.8%	Δ0.9%

- Note that for most channels the nonpolar and polar SBAF corrected scaling factors are within 1%

N20-VIIRS/Aqua-MODIS scaling factors

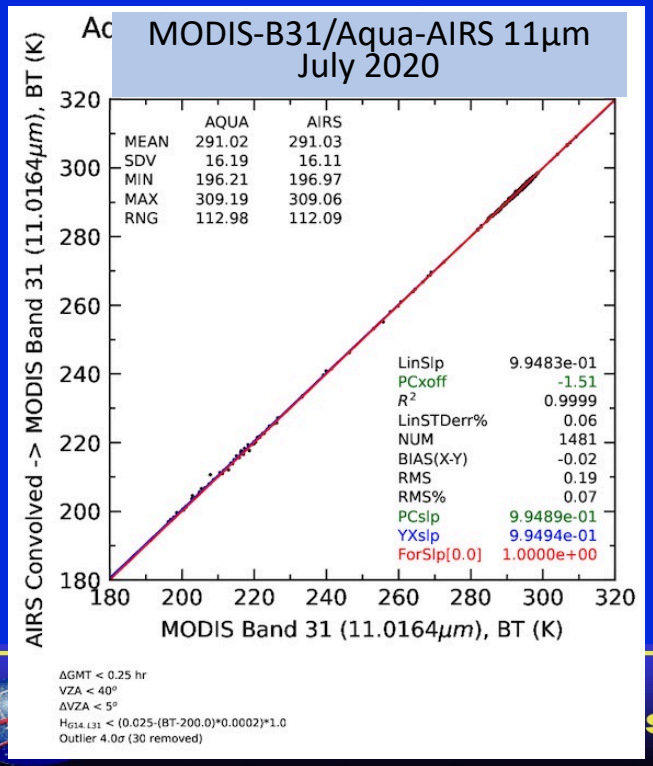
Timeline nonpolar	µm	Sigma %	Trend decade %
M3/B3	0.48	0.30	+0.54
M4/B4	0.51	0.36	+1.43
M5/B1	0.65	0.41	+0.05
M7/B2	0.86	0.61	+1.48
M8/B5	1.24	0.35	- 0.50
M9/B26	1.38	1.20	+0.78
M10/B6	1.61	0.68	- 0.50
I1/B1	0.64	0.40	+0.12
I3/B6	1.61	0.70	+0.07

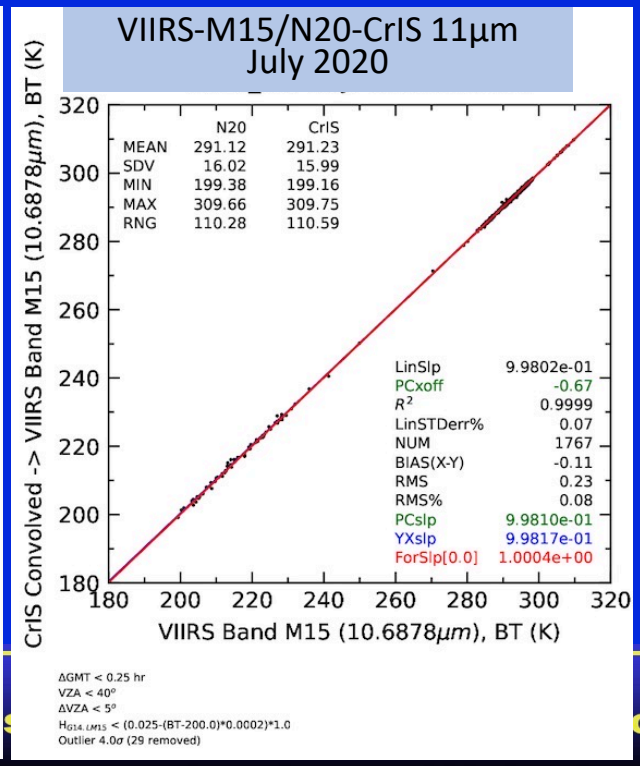
Bands	Non-Polar		Polar		Diff	
	No SBAF	SBAF	No SBAF	SBAF	No SBAF	SBAF
M3/B3	1.0483	1.0154	1.0336	1.0090	1.4%	0.6%
M4/B4	1.0270	1.0230	1.0276	1.0210	0.1%	0.2%
M5/B1	0.9975	1.0190	0.9767	1.0167	2.1%	0.2%
M7/B2	1.0018	1.0152	1.0119	1.0166	1.0%	0.1%
M8/B5	0.9886	0.9866	0.9904	0.9932	0.2%	0.7%
M9/B26	1.0151	0.9841	1.1745	0.9795	13.6%	0.5%
M10/B6	1.0449	0.9907	1.0597	0.9873	1.4%	0.3%
I1/B1	1.0292	1.0321	1.0265	1.0239	0.3%	0.8%
I3/B6	1.0567	1.0006	1.0688	0.9933	1.1%	0.7%

- For all channels the nonpolar and polar SBAF corrected scaling factors are within 0.8%

MODIS/VIIRS IR intercalibration with AIRS/CrIS

- Grid the MODIS and VIIRS 11µm channel pixel L1B radiances over the TWP (Himawari-8 GEO domain)
- Convolve the AIRS hyperspectral radiances with MODIS spectral response function (SRF),
  - MODIS(AIRS)rad = [ΣAIRS$_\lambda$ • SRF(MODIS)$_\lambda$•Δ_λ]/ [Σ SRF(MODIS)$_\lambda$•Δ_λ]
- The MODIS or VIIRS 3.7µm, water vapor and 8.6µm channel SRFs are not contained in the AIRS or CrIS spectral range





11µm	@290	@220
$MODIS_{obs}$ - $Aqua_{AIRS}$	-0.02	-0.38
$VIIRS_{obs}$ – $N20_{AIRS}$	-0.12	-0.25

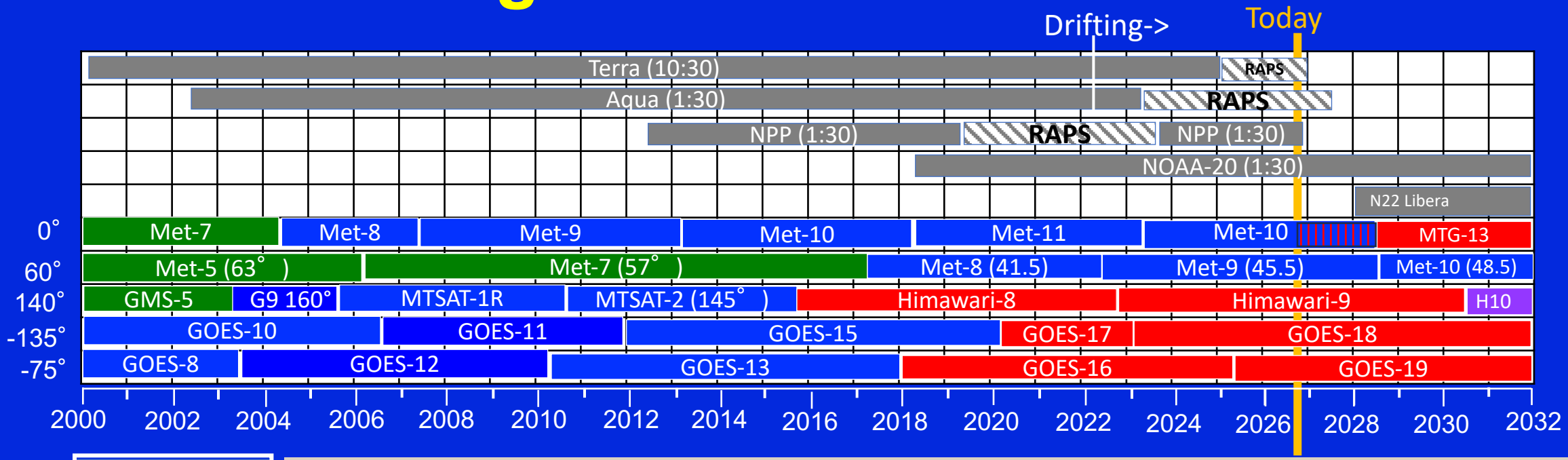
- VIIRS is more consistent across the dynamic range than MODIS
- MODIS and VIIRS are within ~0.1K over the dynamic range

NPP and N20 scaling factor summary

- The N20-VIIRS VCST daily scaling adjustment provided improved stability and trends for the visible bands
  - The NPP-VIIRS VCST daily scaling adjustments are anticipated mid November
- The large 100-km SNOs provided the lowest monthly linear regression standard errors compared with the smaller SNO
- Applying the scene specific SBAFs provided more consistent nonpolar and polar scaling factors and were within 1% for most bands
- The MODIS and VIIRS 11µm band BT are consistent within 0.1K
- The NPP and N20 scaling factors have been delivered to the CWG this summer

GEO calibration

CERES imager and GEO time series



1st generation
2nd generation
3rd generation
4th generation
MODIS/VIIRS

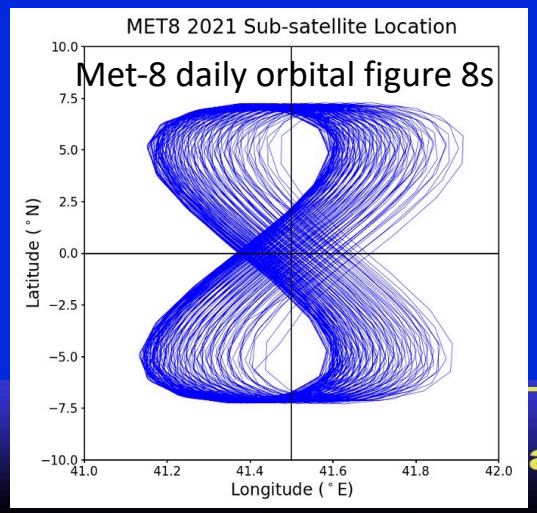
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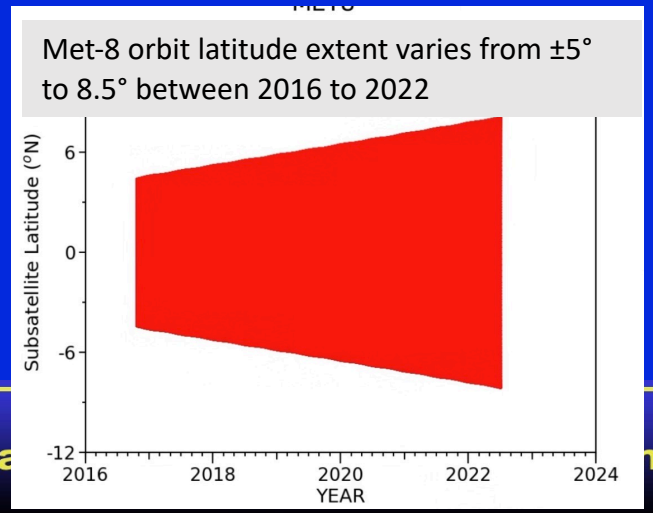
- Terra decommissioned December 2026
- Aqua decommissioned June 2027
- NPP decommissioned early November 2026, CrIS and ATMS degraded performance
- Meteosat-10 currently at 0° to move to Indian Ocean mid-2028
- Meteosat-12 is the 0° operational satellite, but has no onboard calibration
- Meteosat-13 launched in August 28, 2026 (CERES to transition from Met-10 to Met-13 when operational)
- Himawari-10 in late 2030
- GOES-XO (GOES-20) launch no earlier than 2032
- CLARREO launched May 15, 2026 and soon to be operational, Mission refocused to calibrate land imagers
- NOAA-22 Libera to launch late 2027

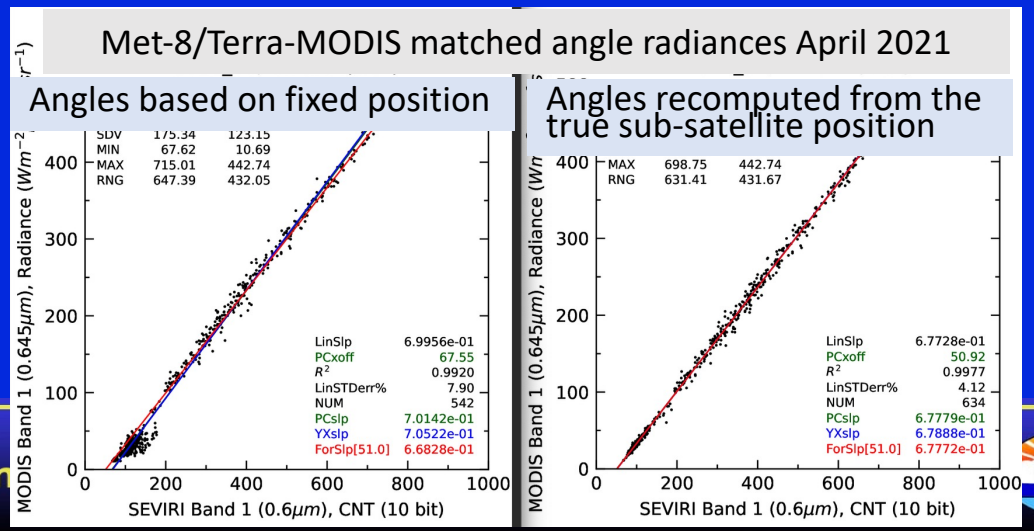
GEO subsatellite position

- The McIDAS area file format does not provide the subsatellite latitude and longitude position needed to compute the proper view and azimuthal angles
  - For Ed4, the GEO subsatellite position was assumed to be located at the equator at a fixed longitude
  - For GEOs with well maintained orbits, the orbit control box was within several tenths of a degree and did impact the angular computations
- For Meteosats over the Indian Ocean, the orbit is not maintained and can oscillate as much as ±10° in latitude over a day
  - The longitude variation is minimal
  - The near subsatellite view angle can differ by 1° for every 1° in latitude shift in the sub-satellite location
  - Proper view angles are necessary for GEO/MODIS angle matching, glint retrievals, GEO ADM and narrowband to broadband LUTs

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°

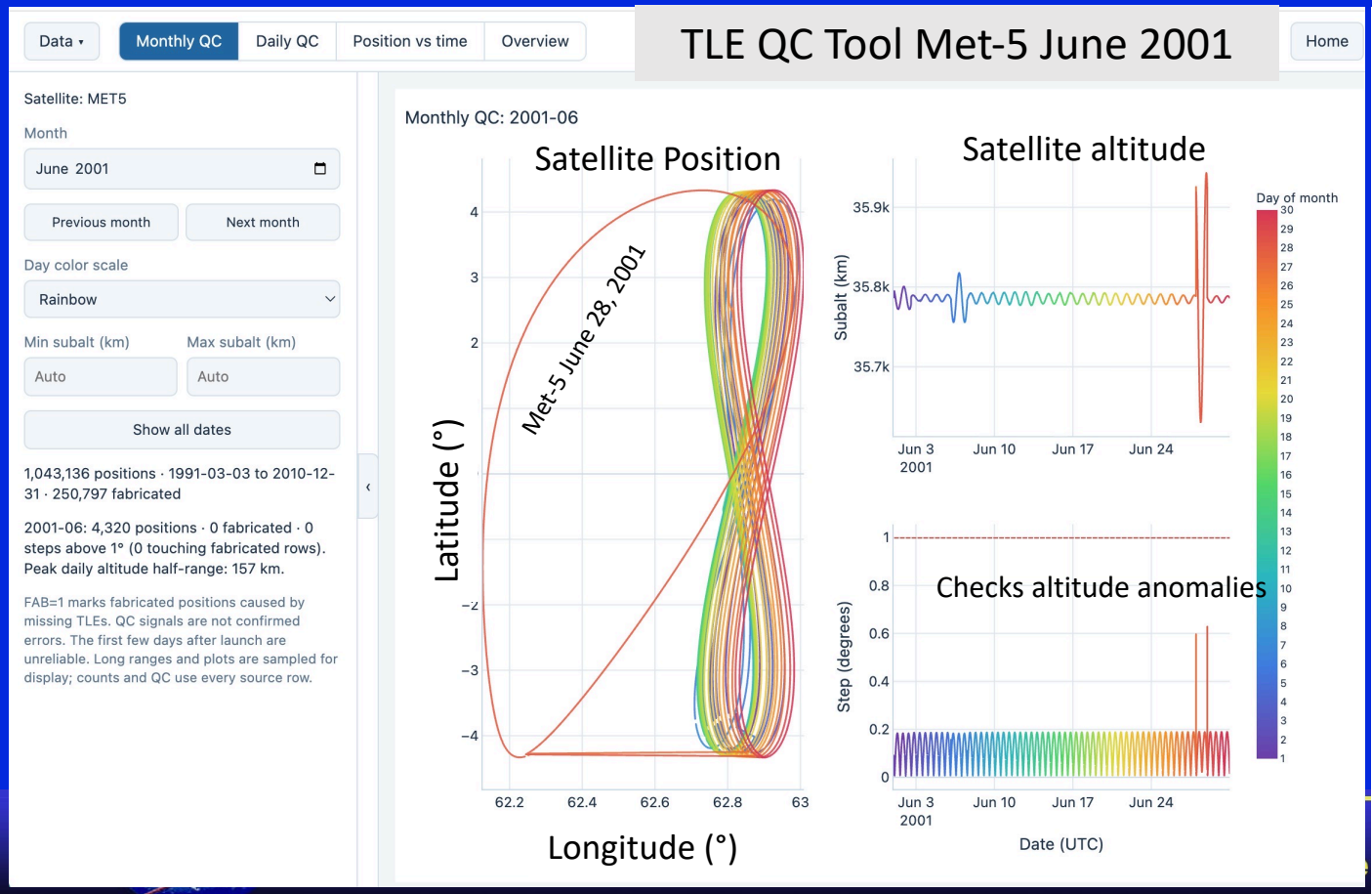


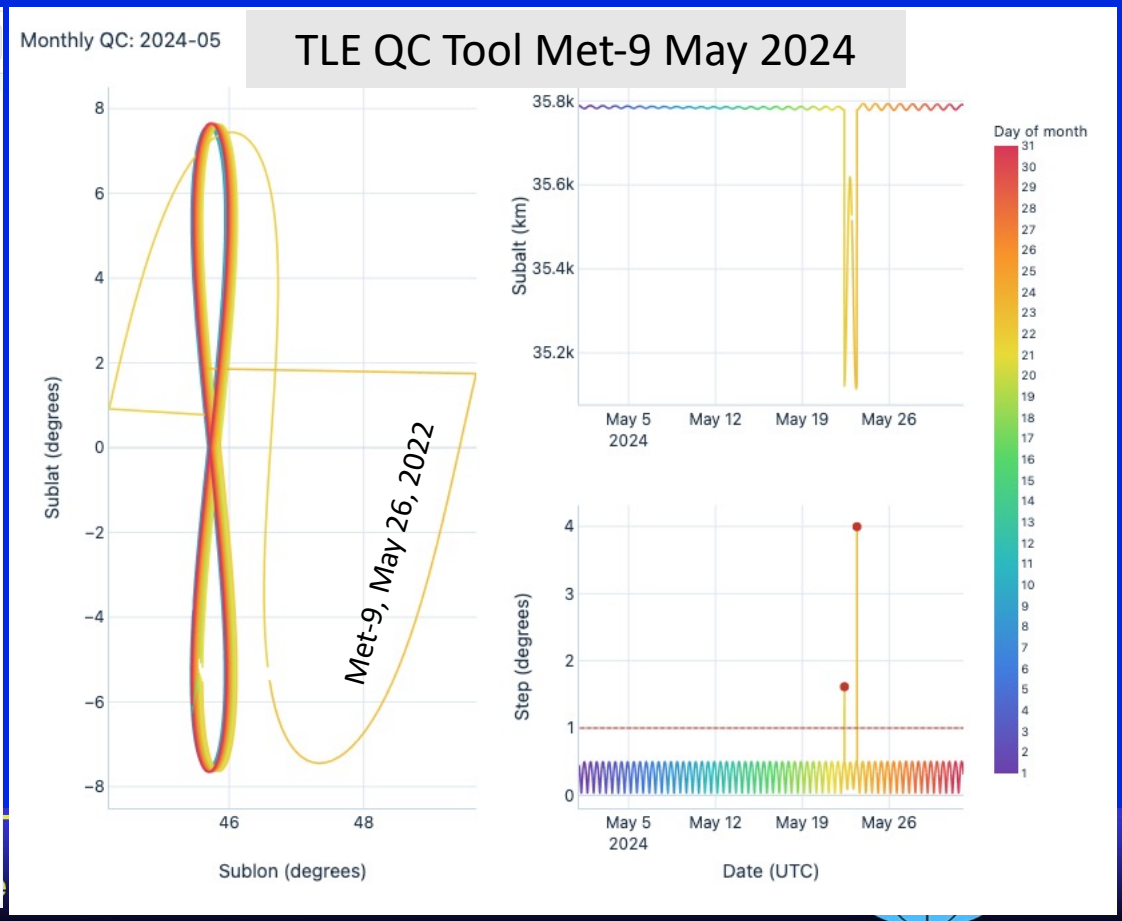




GEO orbital location from TLEs

- Daily TLE files are used to predict the GEO orbit (**CELES**TRAK)
  - Orbital propagation code from python library
- However, a few daily TLEs are spurious. A TLE QC tool was developed to quickly identify spurious TLEs
- A spurious daily TLE is replaced with the previous day TLE and propagated into the following day



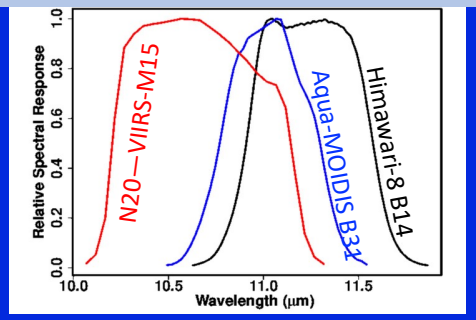


Ed5 Him-8 IR intercal with MODIS and VIIRS

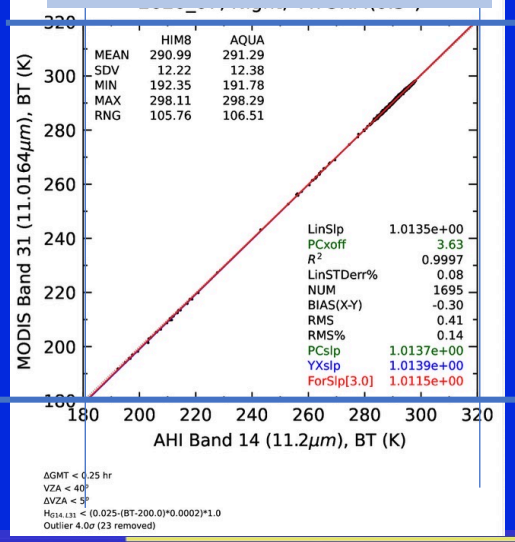
IR	GEO cloud retrievals	GEO NB to BB
Ed4	• Multi-channel retrieval • No IR scaling	• Calibrate GEO water vapor and window IR bands with MODIS analogous bands • GEO LW NB to BB coefficients based on MODIS
Ed5	• 3-channel retrieval • 11μm calibrated with Aqua-AIRS & N20-CrIS • No 3.7μm scaling	

- The GEO water vapor and window channel to LW coefficients are based on MODIS/CERES regressions
- The GEO to Aqua MODIS BT scaling coefficients convert the GEO BT to a MODIS equivalent BT (no spectral difference adjustment)

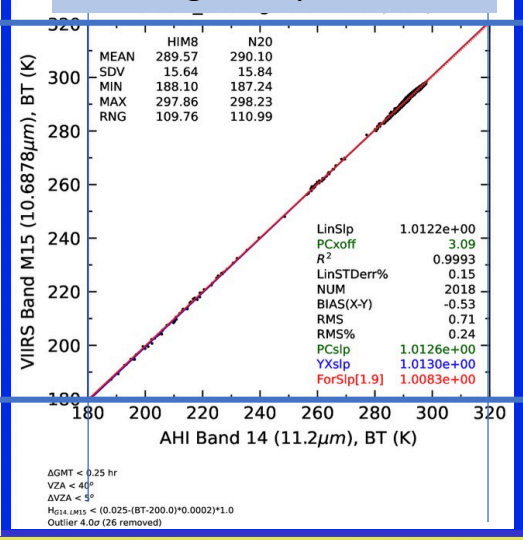
11μm Spectral Response Functions



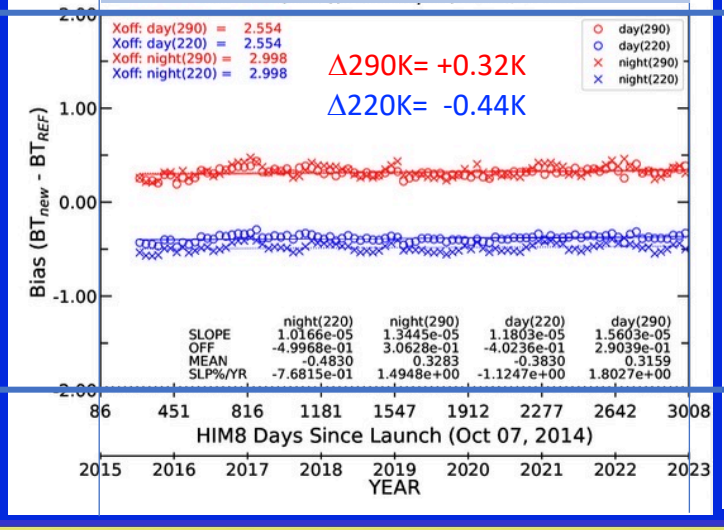
Him-8/Aqua-MODIS 11μm Night, July 2020



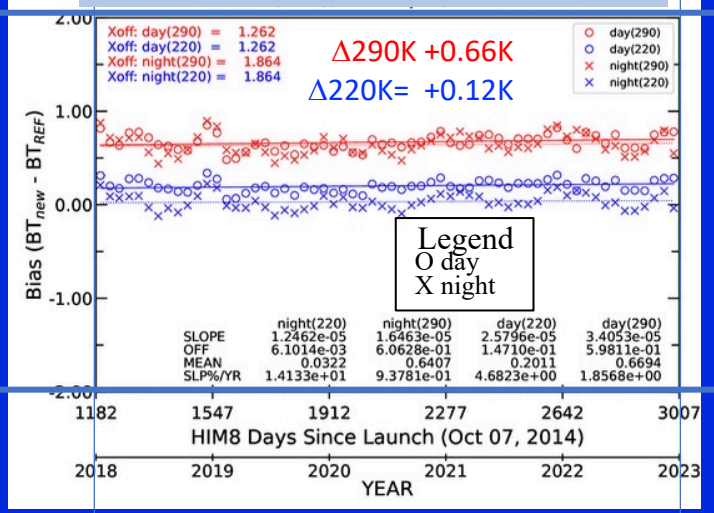
Him-8/N20-VIIRS 11μm Night, July 2020



Him-8 minus Aqua-MODIS 11μm



Him-8 minus N20-VIIRS 11μm



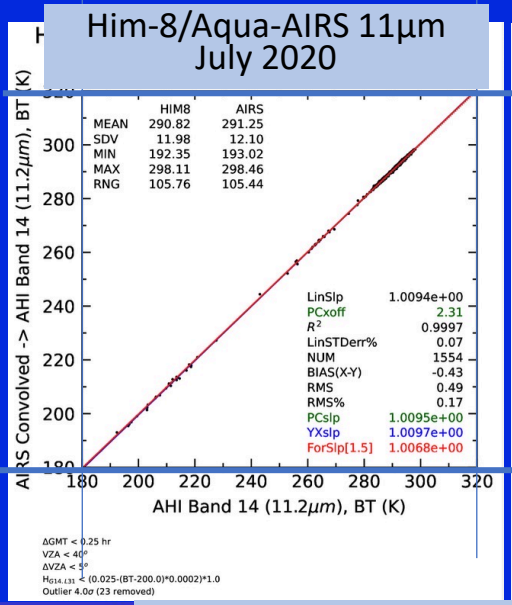
- Note the GEO-MODIS BT difference is due to both a spectral and calibration difference
- Here the day/night BT bias is similar, but the BT bias is a function of BT

Ed5 GEO IR calibration with AIRS and CrIS

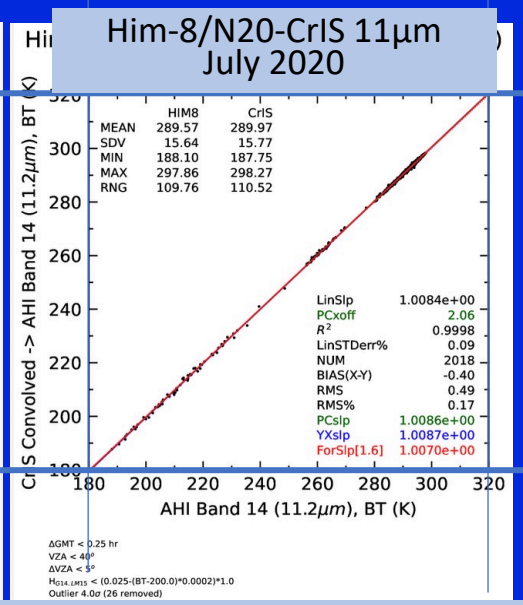
IR	GEO cloud retrievals	GEO NB to BB
Ed4	• Multi-channel retrieval • No IR scaling	• Calibrate GEO water vapor and window IR bands with MODIS analogous bands • GEO LW NB to BB coefficients based on MODIS
Ed5	• 3-channel retrieval • 11µm calibrated with Aqua-AIRS & N20-CrIS • No 3.7µm scaling	

- First make sure that Aqua-AIRS and N20-CrIS have similar calibration
  - Aqua and N20 intersect every 64 hours over tropical regions
  - Use GEOs as a transfer radiometer
  - Convolve the AIRS hyperspectral radiances with GEO spectral response function, GEO(AIRS)rad = [$\Sigma AIRS_\lambda \bullet SRF(GEO)_\lambda \bullet \Delta_\lambda$]/ [$\Sigma SRF(GEO)_\lambda \bullet \Delta_\lambda$]
  - AIRS and CrIS do not have the spectral range to inter-calibrate the 3.7µm, water vapor and 8.6µm channels
- Processing is set up to inter-calibrate all 22-GEOs with AIRS and CrIS from 2002

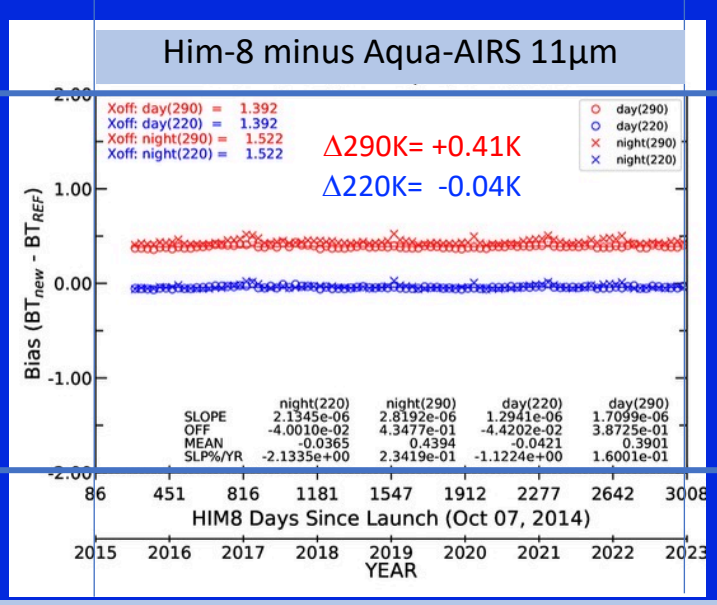
Him-8/Aqua-AIRS 11µm July 2020



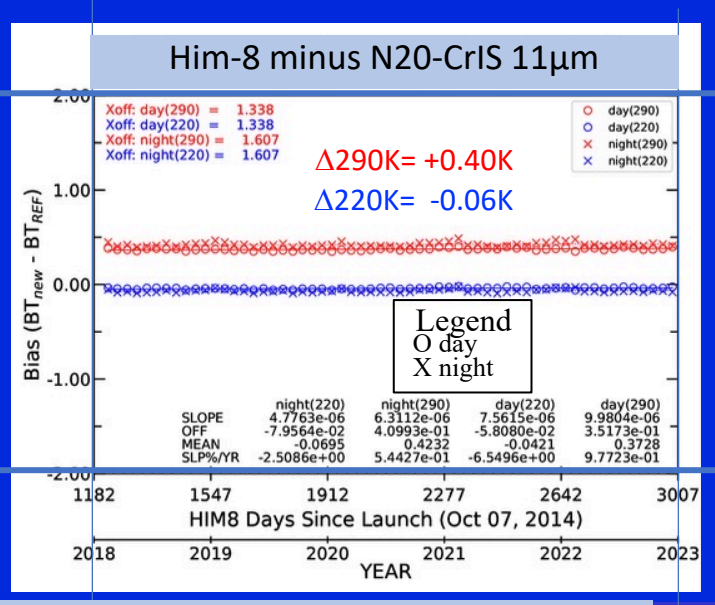
Him-8/N20-CrIS 11µm July 2020



Him-8 minus Aqua-AIRS 11µm



Him-8 minus N20-CrIS 11µm

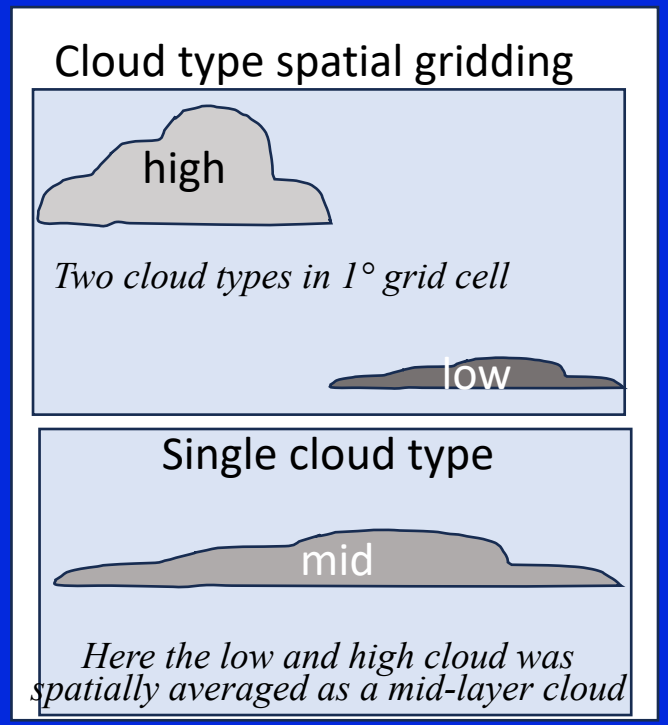


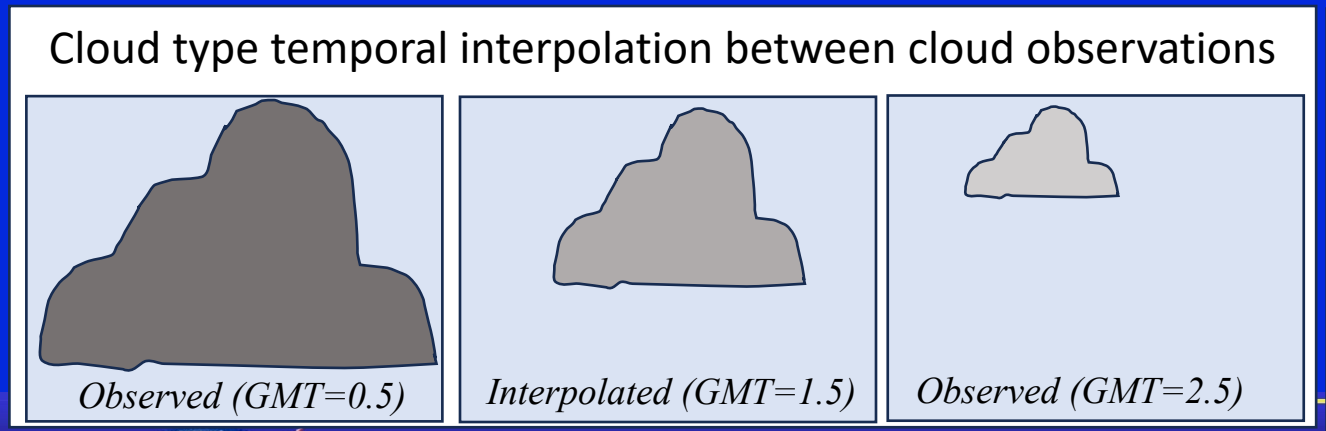
- The GEO-AIRS BT difference is strictly a calibration difference
- Note the GEO-AIRS and GEO-CrIS similar BT difference indicating that the calibration consistency of AIRS and CrIS

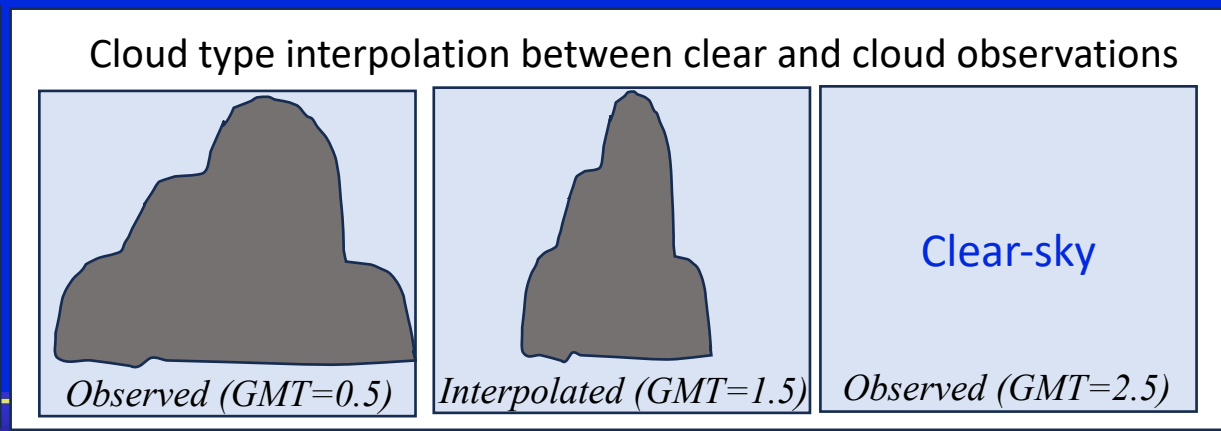
Cloud property spatial gridding and temporal interpolation

Cloud property interpolation

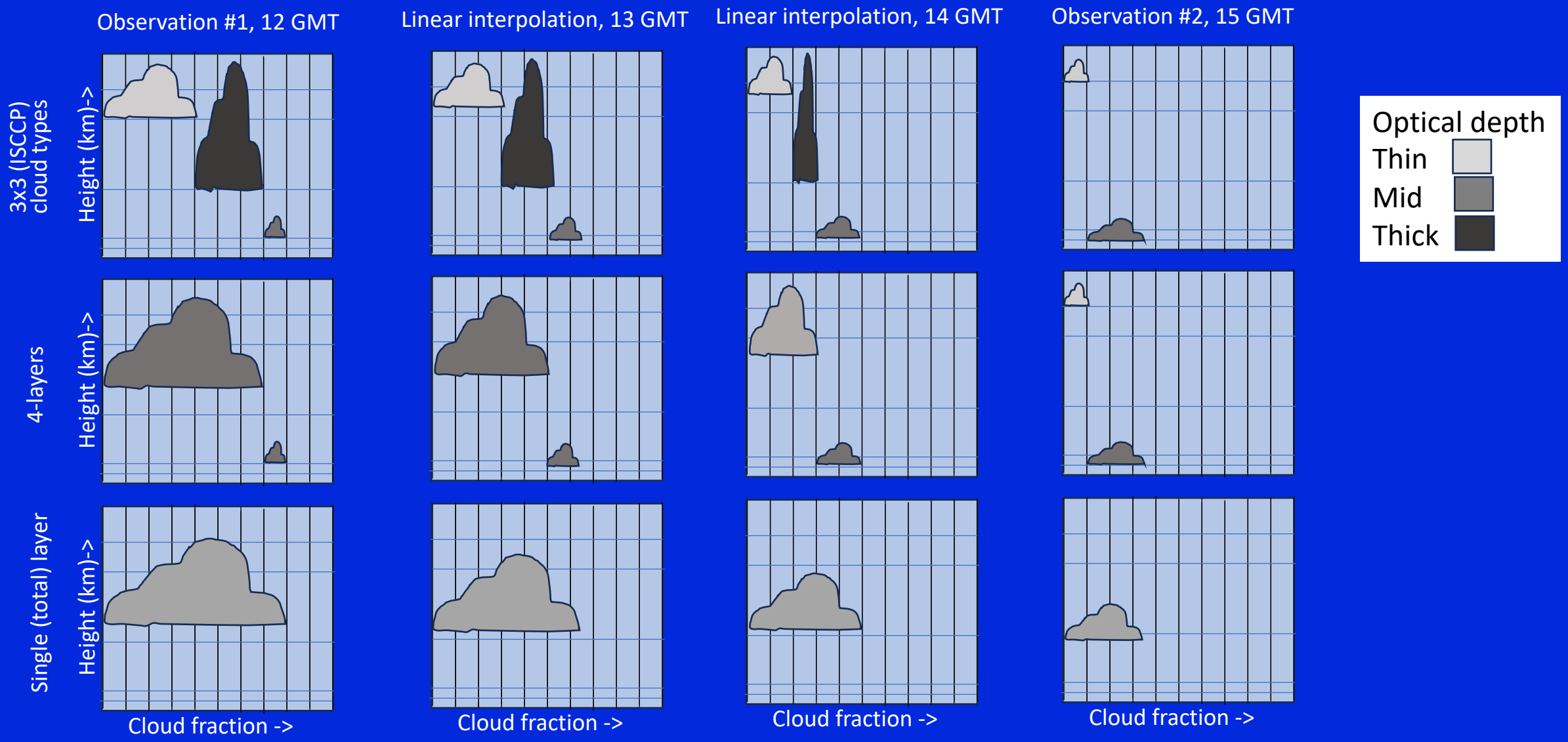
- The instantaneous pixel cloud properties are gridded by cloud type
  - The more cloud types the better the representation of the cloud distribution within a region
  - If a high (cirrus) and low (stratus) cloud parameter values are gridded into a single mid-layer cloud the values
  - If an optically thin (cirrus) and thick (DCC) cloud parameter values are gridded into a single mid optical depth bin
- For each cloud cloud type, the observed cloud parameter values are linearly interpolated to fill in unobserved hourboxes
  - Between cloud and clear observations, the cloud fraction is linearly interpolated but the cloud property is replicated towards the clear-sky observed







Cloud Property 1-layer, 4-layer, 3x3 cloud-type Interpolation



- Do the monthly total cloud properties vary based on number of cloud types?

Cloud property interpolation validation

Total Cloud Base Height (km)	12 GMT obs	13 GMT interp	14 GMT interp	15 GMT interp
3x3 total cloud	6.65	6.53	5.86	3.92
4 lay total cloud	6.65	6.53	5.83	3.92
Single total cloud	6.65	5.74	4.83	3.92

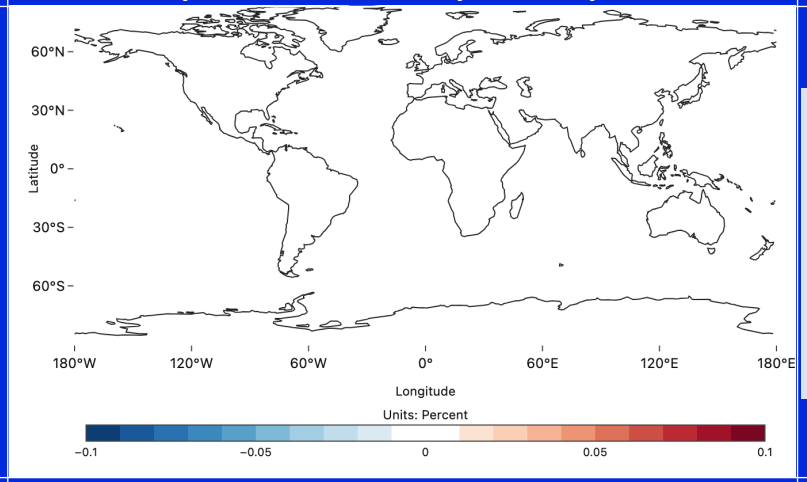
- The total cloud fraction is the sum of all cloud-type cloud fractions
$Frac_{TOT} = \Sigma(Frac_{LAY1} + Frac_{LAY2} * Base_{LAY2} + \ldots)$
- The total cloud base height is the sum of the individual base heights weighted by the cloud fraction
$Base_{TOT} = \Sigma(Frac_{LAY1} * Base_{LAY1} + Frac_{LAY2} * Base_{LAY2} + \ldots)/Frac_{TOT}$

- The spatial gridding and temporal interpolation routines are validated by comparing the monthly total cloud property values from the 3x3 and 4-layer, and a single 1-layer
- The cloud fraction should be identical
- The cloud properties should be identical if all hourboxes are observed (no temporal interpolation) – SYN1deg (hourly GEO and 12-hourly Aqua-MODIS)
- The cloud properties may differ depending if most hourboxes are unobserved– (hourboxes mostly temporal interpolation) – SSF1deg (12-hourly Aqua-MODIS)

July 2020 Cloud Fraction (%) interpolation comparison

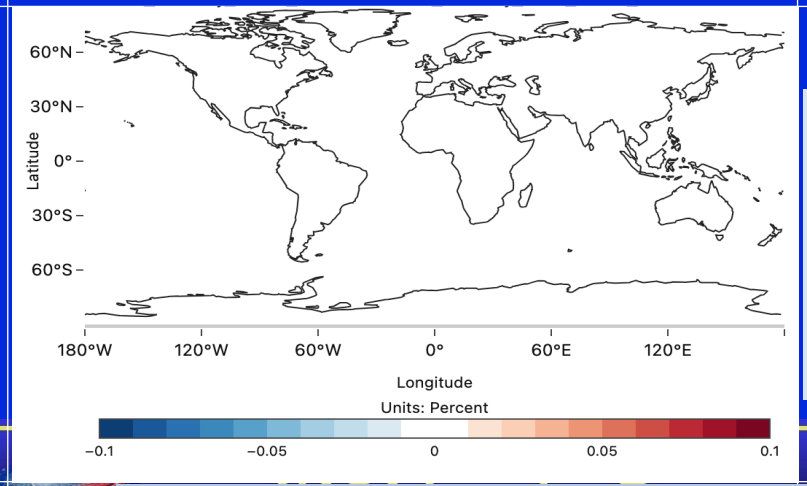
SYN1deg, Aqua+GEO

9-layer minus 4-layer, July 2020



Global Means
9-layer = 66.35
4-layer = 66.35
Δ = 0.00
Reg σ = 0.0

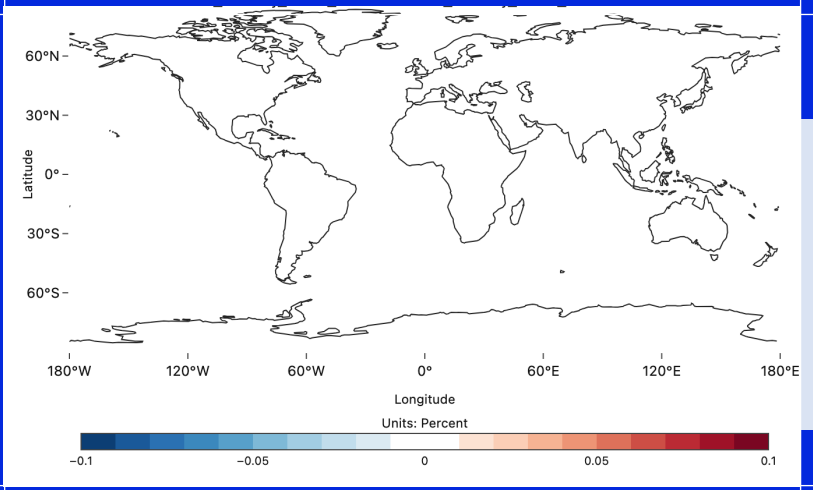
4-layer minus 1-layer, July 2020



Global Means
4-layer = 66.35
1-layer = 66.35
Δ = 0.00
Reg σ = 0.0

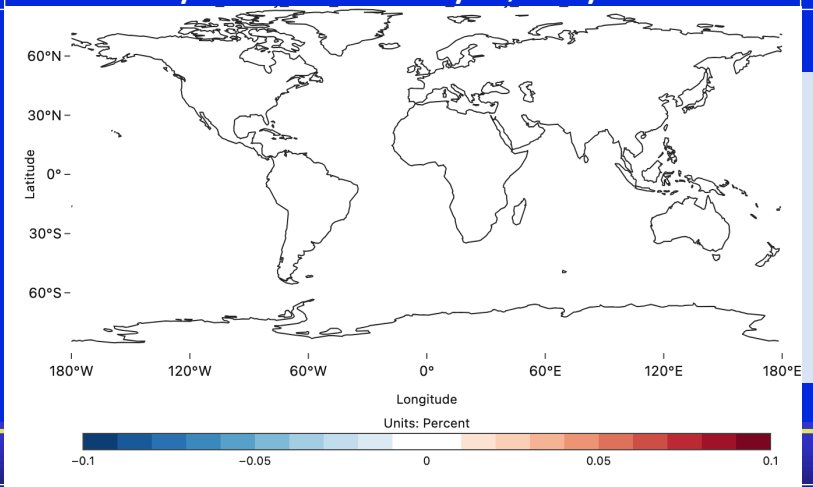
SSF1deg, Aqua-only

9-layer minus 4-layer, July 2020



Global Means
9-layer = 67.51
4-layer = 67.51
Δ = 0.00
Reg σ = 0.0

4-layer minus 1-layer, July 2020



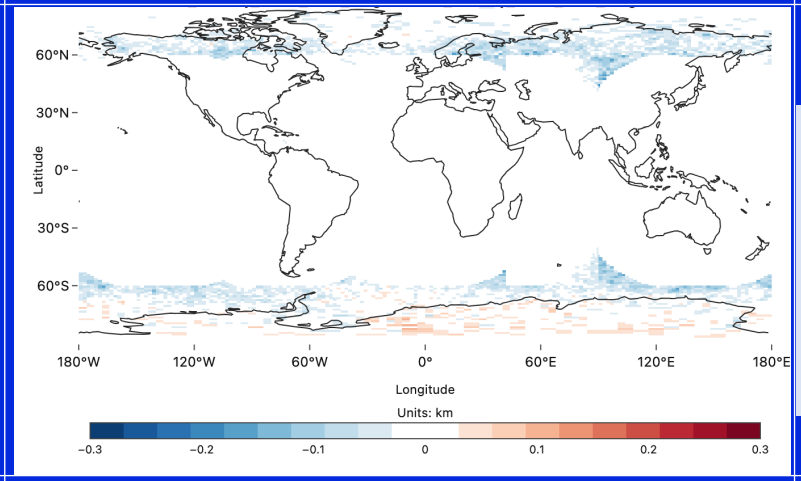
Global Means
9-layer = 67.51
4-layer = 67.51
Δ = 0.00
Reg σ = 0.0

- The total cloud fraction is the same whether interpolated or observed or number of layers

July 2020 Cloud Base (k) interpolation comparison

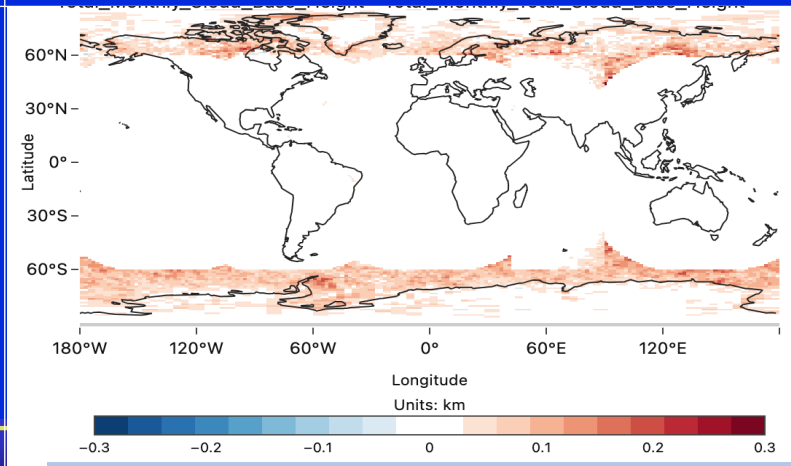
SYN1deg, Aqua+GEO

9-layer minus 4-layer, July 2020



Global Means
9-layer = 3.16
4-layer = 3.17
Δ = -0.004
Reg σ = 0.02

4-layer minus 1-layer, July 2020

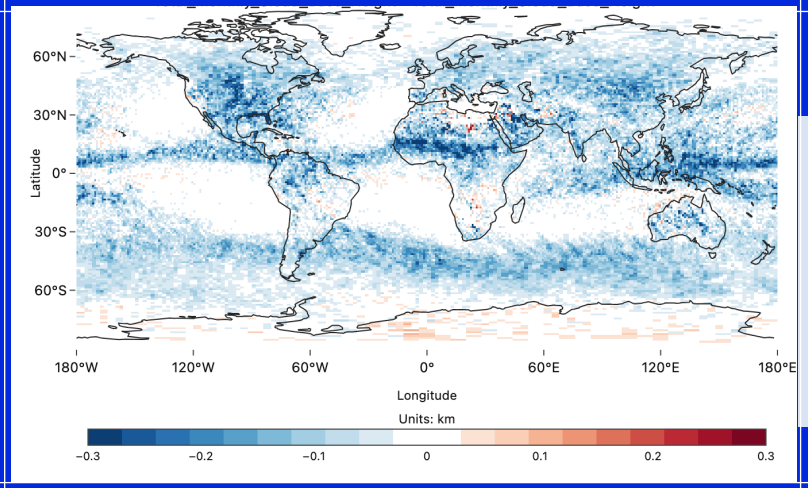


Global Means
4-layer = 3.17
1-layer = 3.16
Δ = +0.01
Reg σ = 0.03

- for regions with all observations the total cloud properties are identical

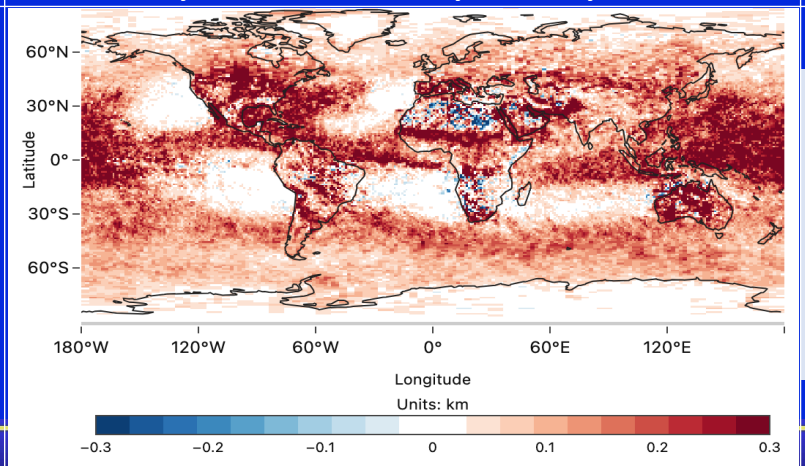
SSF1deg, Aqua-only

9-layer minus 4-layer, July 2020



Global Means
9-layer =3.50
4-layer = 3.56
Δ = -0.06
Reg σ = 0.06

4-layer minus 1-layer, July 2020



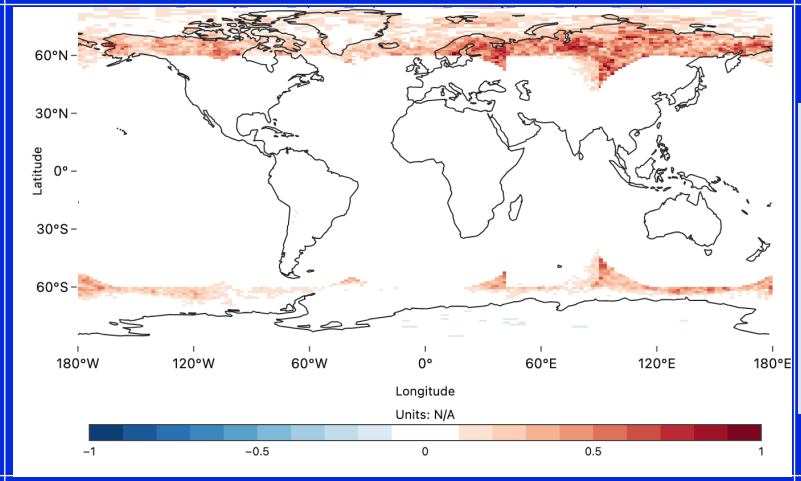
Global Means
4-layer = 3.56
1-layer = 3.43
Δ = +0.13
Reg σ = 0.12

- for regions with mostly interpolated cloud properties the total cloud properties differ slightly

July 2020 optical depth interpolation comparison

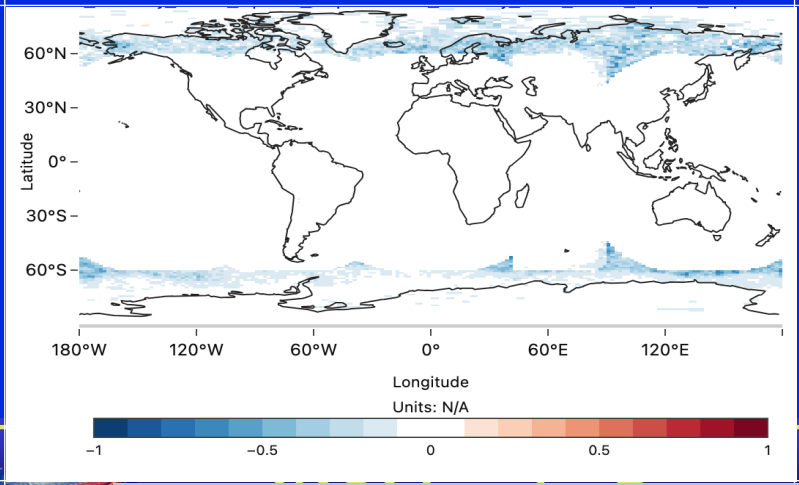
SYN1deg, Aqua+GEO

9-layer minus 4-layer, July 2020



Global Means
9-layer = 3.89
4-layer = 3.86
Δ = +0.03
Reg σ = 0.09

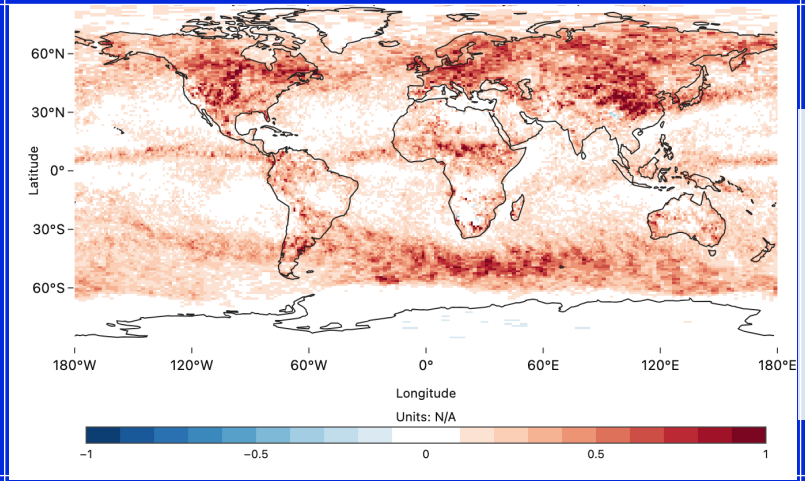
4-layer minus 1-layer, July 2020



Global Means
4-layer = 3.86
1-layer = 3.89
Δ = -0.02
Reg σ = 0.07

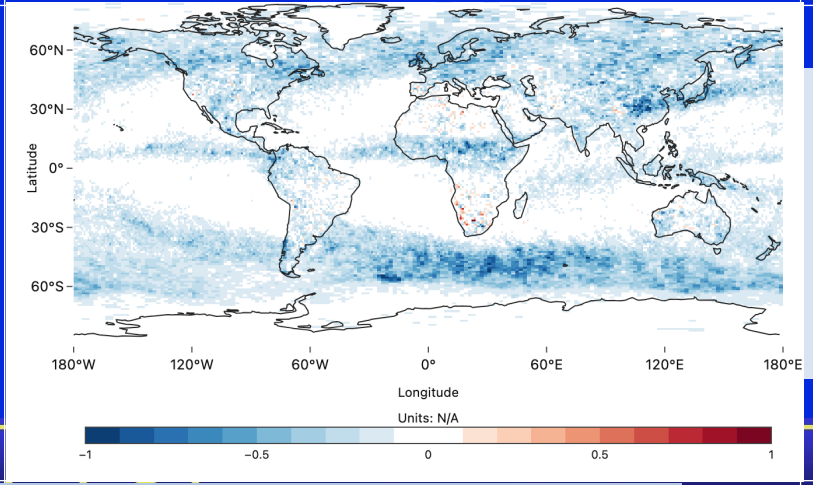
SSF1deg, Aqua-only

9-layer minus 4-layer, July 2020



Global Means
9-layer = 3.42
4-layer = 3.23
Δ = +0.21
Reg σ = 0.19

4-layer minus 1-layer, July 2020



Global Means
4-layer = 3.23
1-layer = 3.38
Δ = -0.15
Reg σ = 0.15

- The global total cloud properties are only slightly dependent on number of cloud types

GEO NB to BB

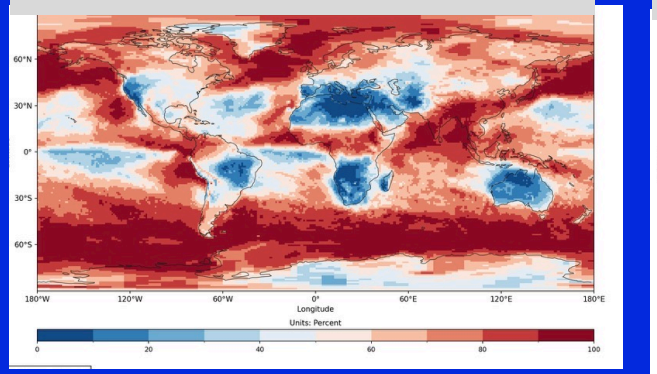
Ed5 – Ed4 24-hour Cloud Properties

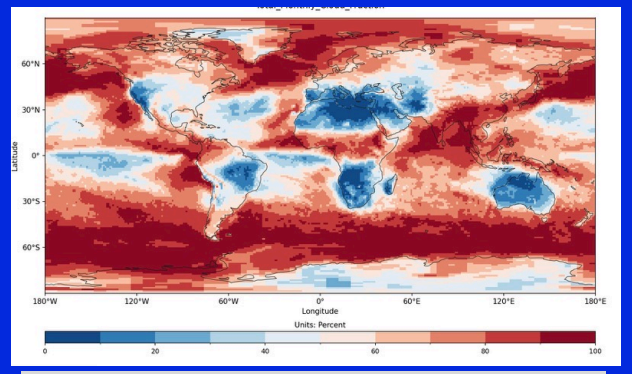
Edition 5

Edition 4

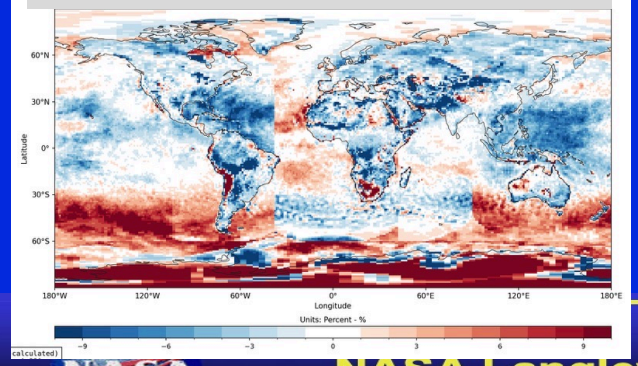
Ed5 - Ed4

cloud fraction 0-100%

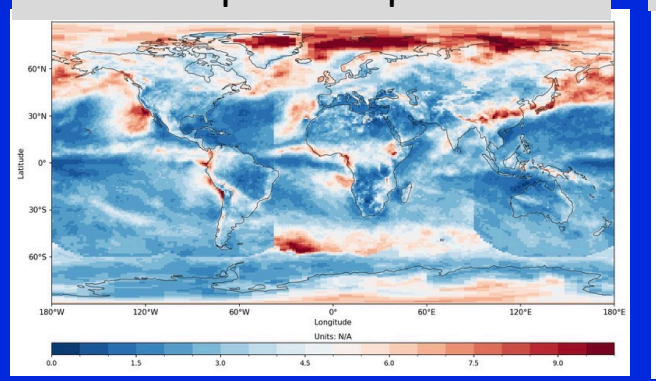


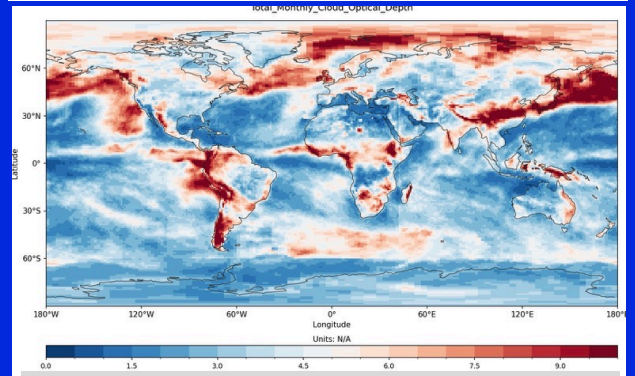


cloud fraction ±10%

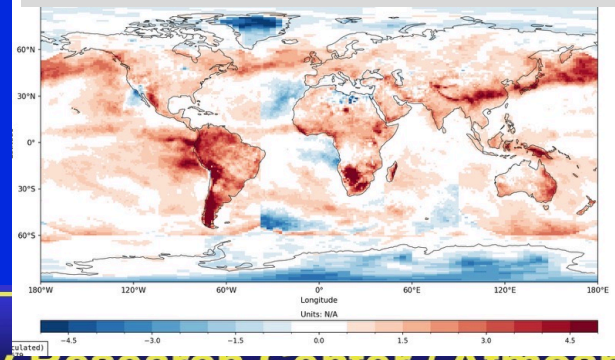


Cloud optical depth 0-10

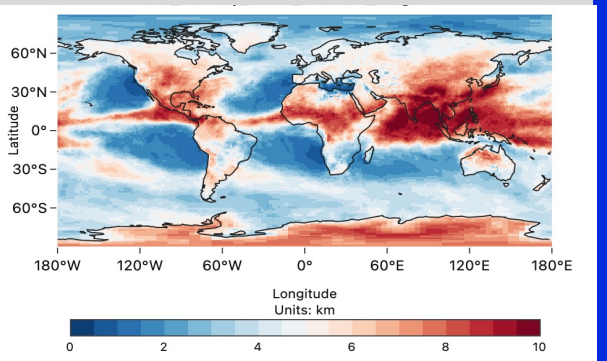


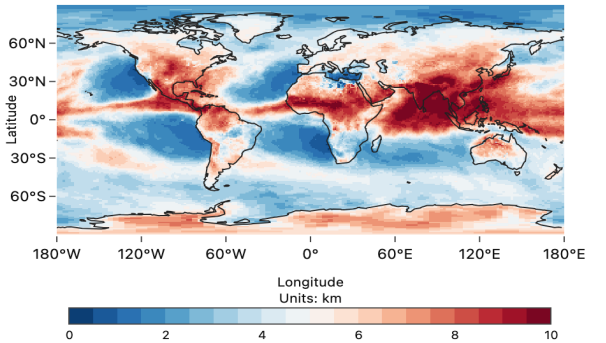


Cloud optical depth ±5

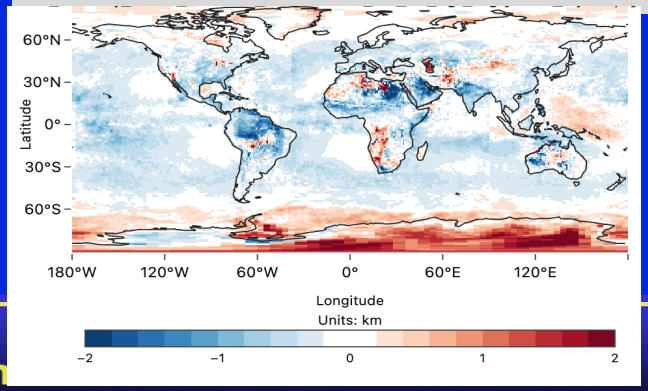


Cloud effective Height 0-10 km





Cloud effective Height ±2km



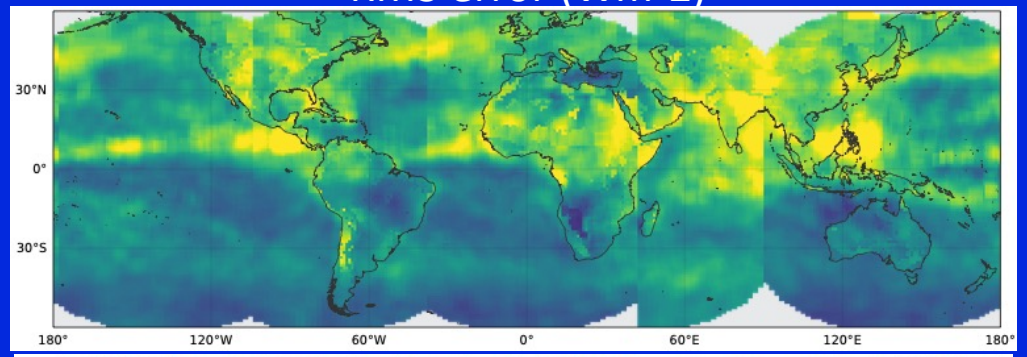
- Ed5 clouds are optically thicker at night with lower cloud base heights
- Do the Ed5 clouds improve the SW narrowband to broadband (NB to BB) fluxes due to improved LUT scene selection?
- Ed5 is using the same SW Ed4 SW NB to BB LUTs

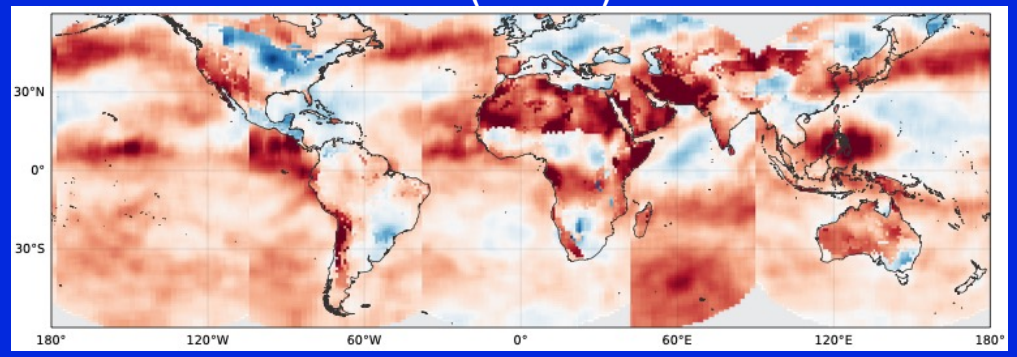
GEO – N20 CERES within 30-minute matched SW fluxes, July 2020

RMS error (Wm-2)

Bias (Wm-2)

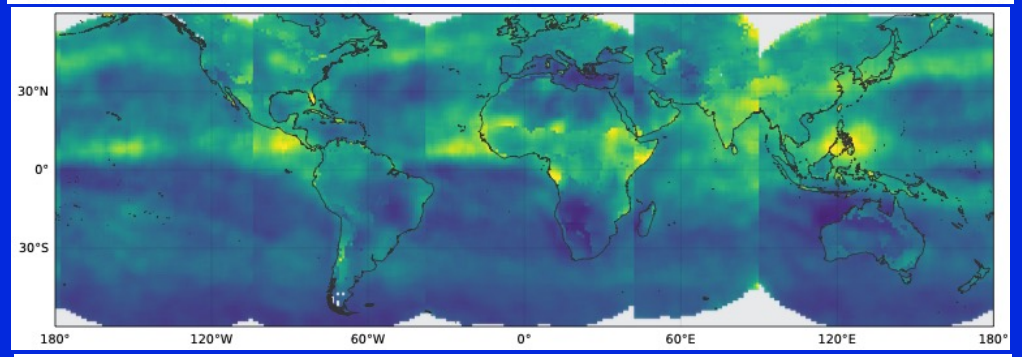
Edition 4

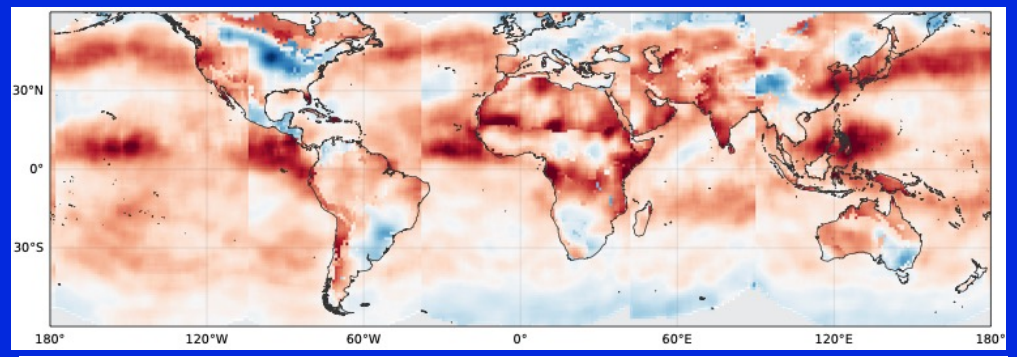


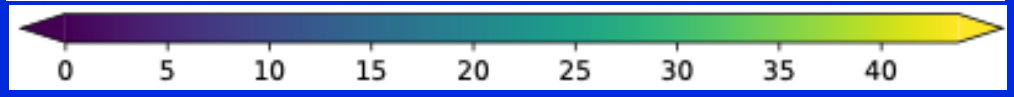


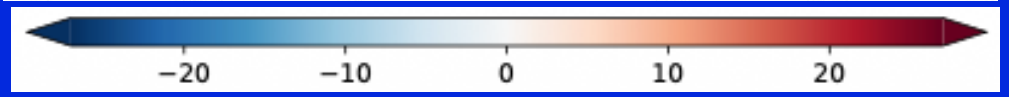
Ed4 (Wm-2)
RMS=25.7
Bias = 7.07

Edition 5



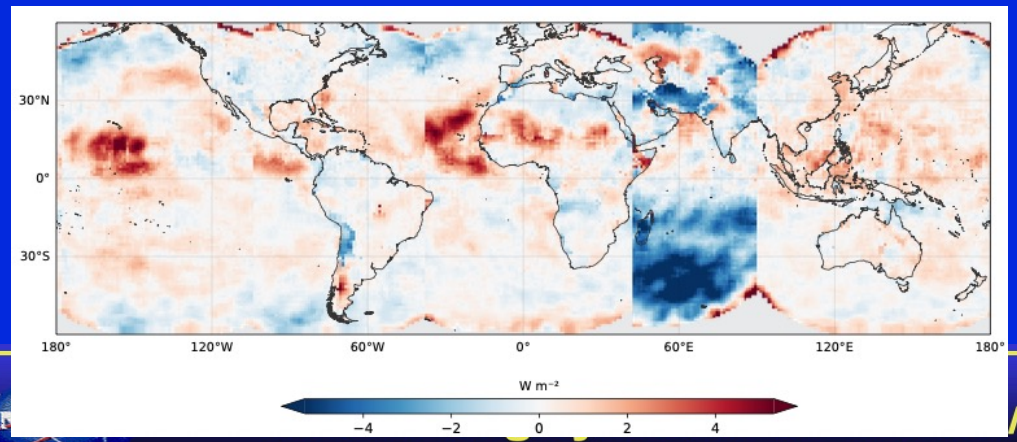


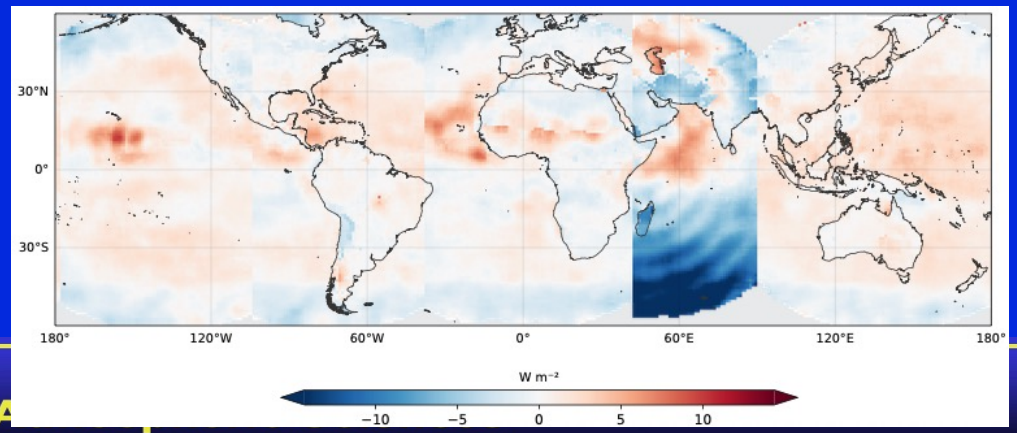




Ed5 (Wm-2)
RMS=18.8
Bias = 5.87

Ed4 – Ed5





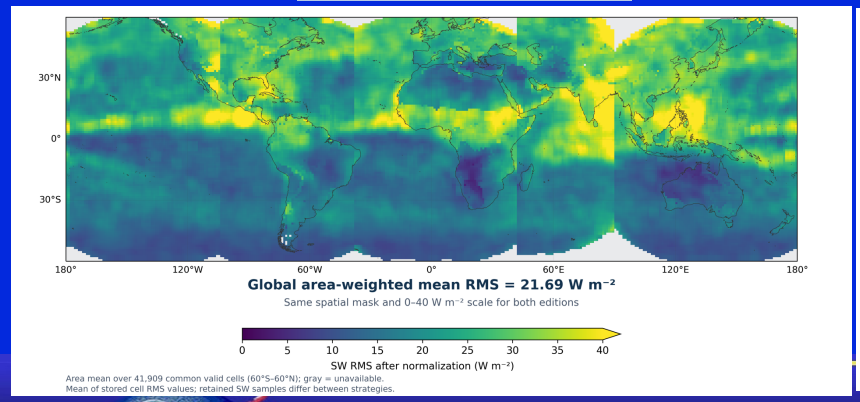
GEO/CERES normalization

- For Ed4, the within 30-minute CERES and GEO SW fluxes are regressed linearly over a running 5x5 regional domain
- For Ed5, the within 30-minute CERES and GEO SW fluxes are regressed through the offset after applying a 2xsigma filter over a running 5x5 regional domain
- Ed5 normalization significantly improved over glint and large solar zenith angles

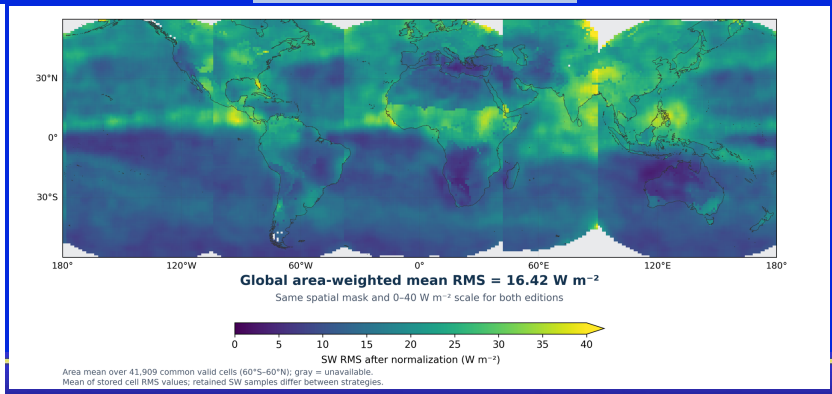
Ed5 (Wm-2)
before normalization
RMS=18.8
Bias = 5.87

Ed5 (Wm-2)
after normalization
RMS=16.4
Bias = 0.0

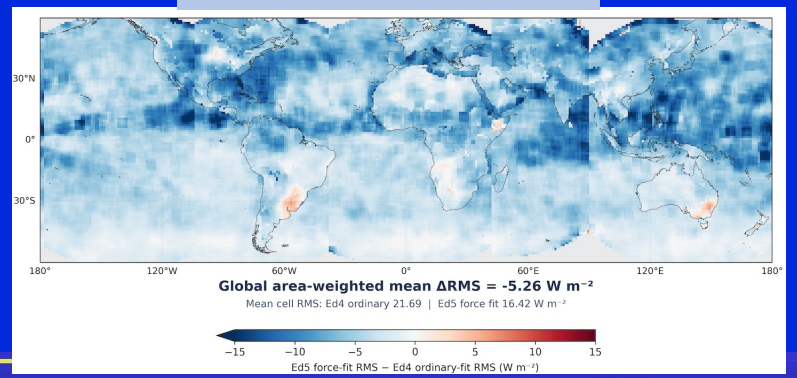
Ed4 RMS error



Ed5 RMS error



Ed5-Ed4 RMS error

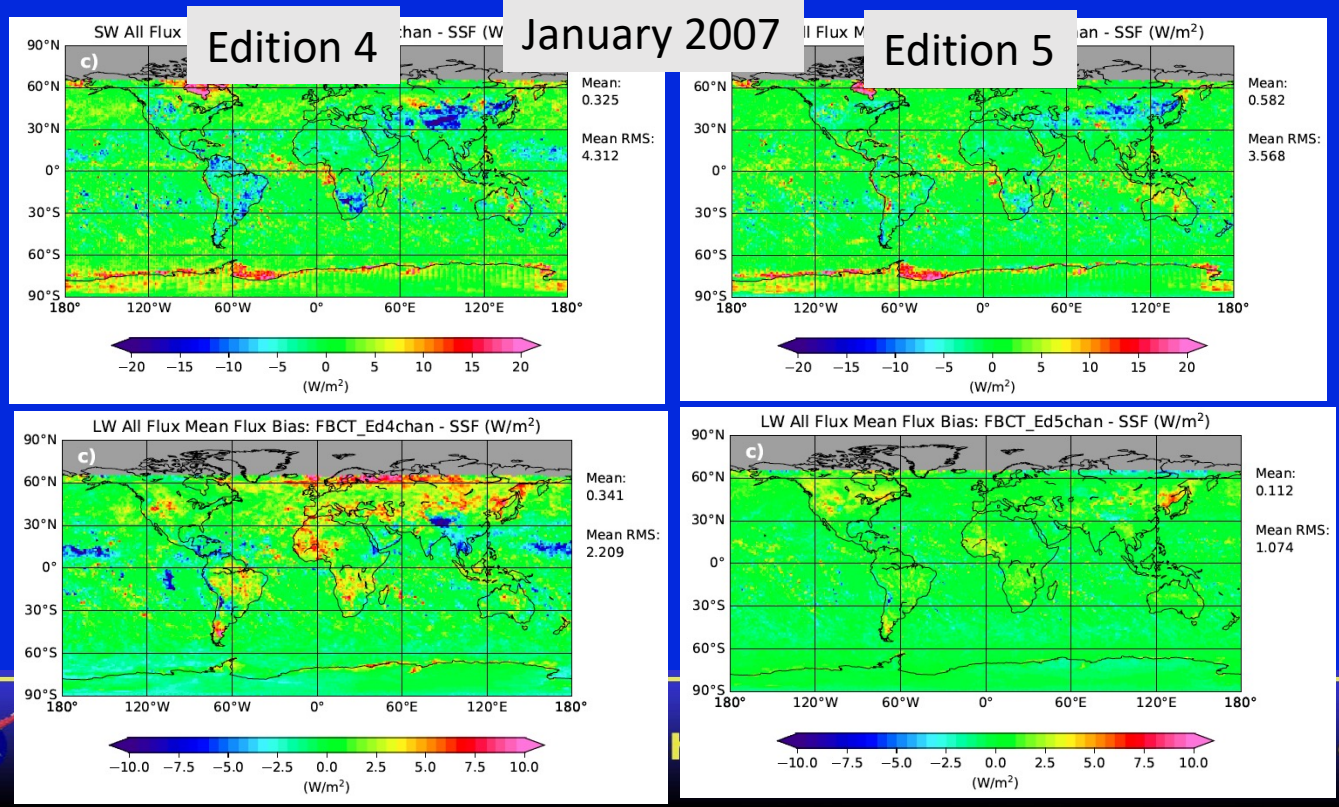


FBCT

Ed5 FluxByCloudType

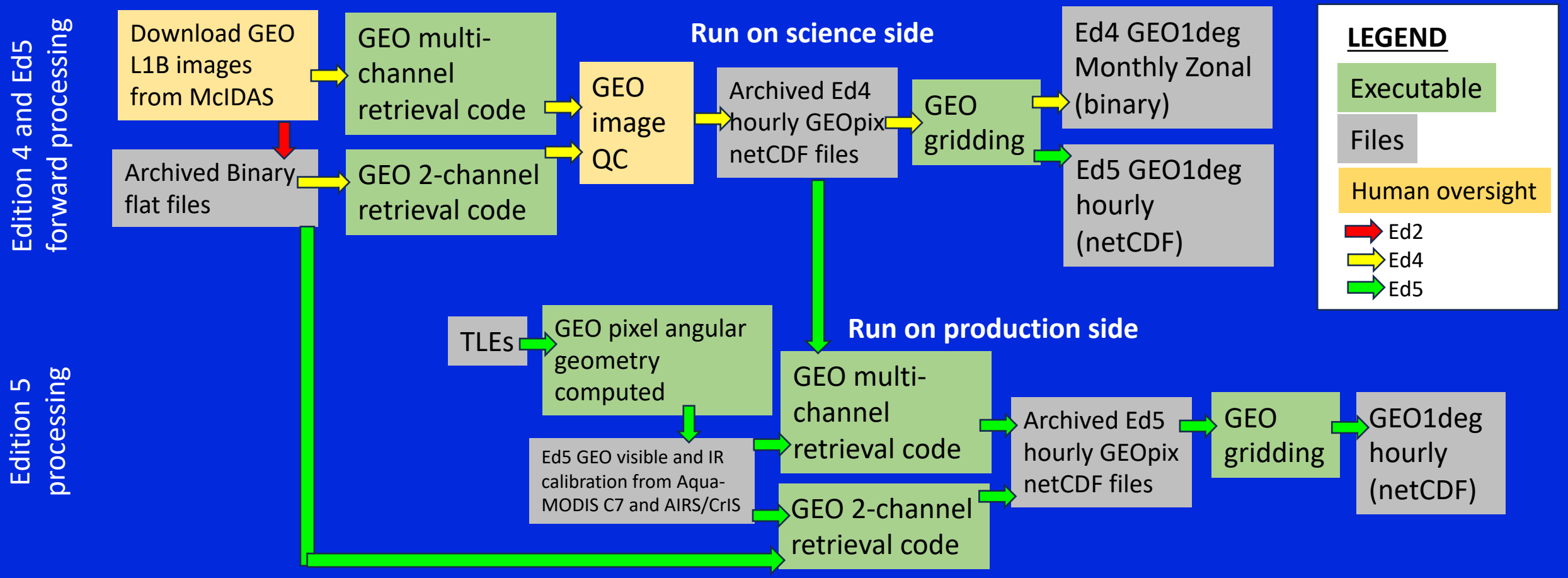
NB to BB					
Ed5 SW	0.47µm	0.65µm	0.86µm	1.24µm	1.38µm
Ed 5 LW	6.7µm	8.6µm	11µm	12µm	14.2µm
ED4 SW & LW	0.47µm	0.65µm	0.86µm	11µm	12µm

- The main FBCT improvement is from using MODIS additional channels in the narrowband to broadband (NB to BB) radiance conversion
  - The NB to BB coefficients are based on overcast footprint, LUT Januarys 2006-2009
  - Especially the water vapor channel for the LW
- Apply to the sub-footprint MODIS radiances and compare to footprint CERES observed flux



TISA FRAMEWORK

GEO cloud retrieval processing strategy



- For Ed4, the TISA group downloaded the entire GEO record of McIDAS images, retrieved clouds and performed quality control – The download time and human supervised quality control took well over a year and is not feasible for Ed5
- For Ed4 run on science side, for Ed5 able to run in the production environment

Ed5 SYN1deg framework accomplishments

LEGEND

Completed

In progress

Initiated

- SSF1deg-hour and GEO1deg-hour spatial gridding
- Process GEO clouds and gridding in production environment
- Container hourly processing libraries
- MOA, IGBP-altitude, ephemeris (SZA) container
- Cloud container,
  - Hourly temporal interpolation with daily, monthly and regional, zonal, and global averaging
  - Working on Monthly hourly
  - Working on Day and night cloud interpolation and averaging
- Working on GEO narrowband to broadband and CERES/GEO normalization
- Working on FBCT
- Observed flux container
- Computed flux container