

TISA Working Group Report

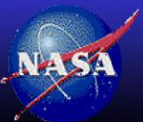
CERES TISA Sublead: D. Doelling

TISA: A. Gopalan, E. Kizer, C. Nguyen, M. Nordeen, M. Sun, J. Wilkins, F. Wrenn, (Raju retired)

GEO calibration: R. Bhatt, C. Haney, B. Scarino

Sub-setter: C. Mitrescu, P. Mlynczak, C. Chu, E. Heckert

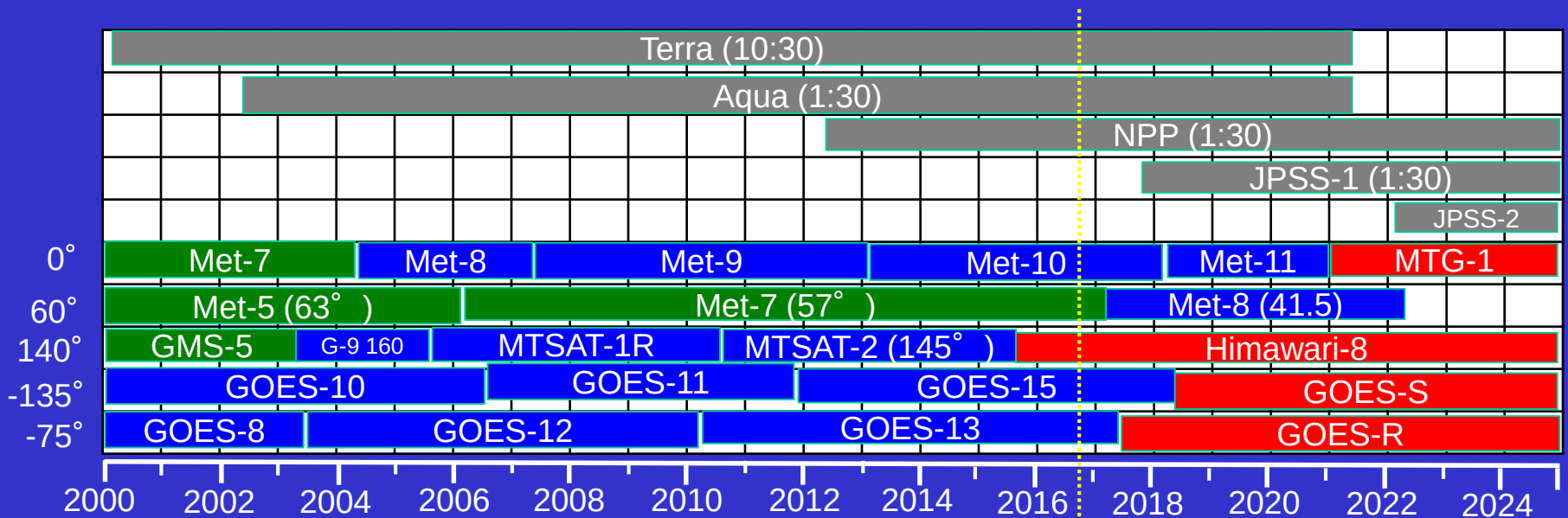
27th CERES-II Science Team Meeting
16-18 May, 2017, LaRC, Hampton, VA, 23681



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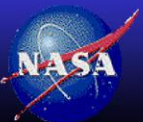


CERES record Geostationary Time Series

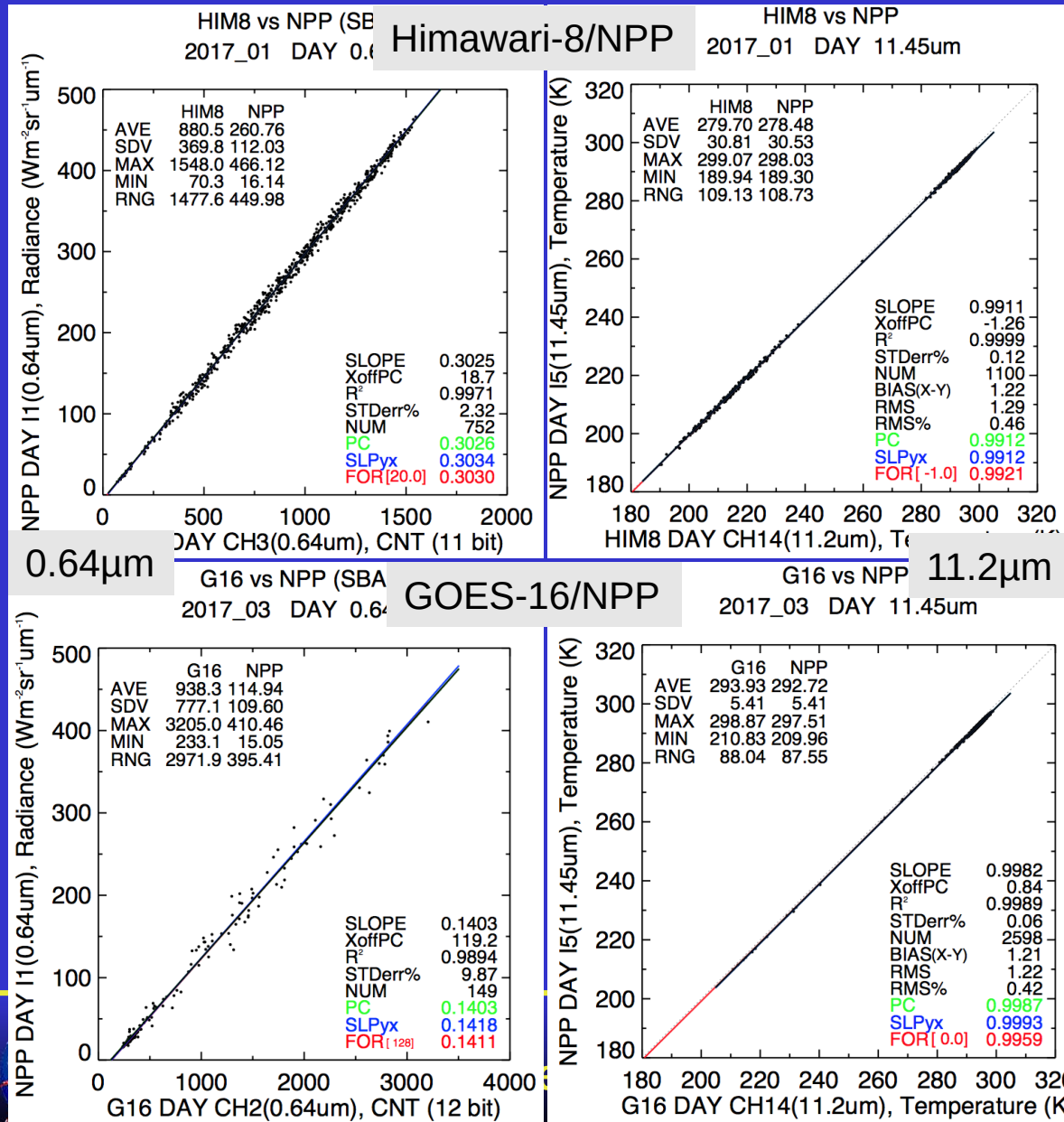


1st generation
2nd generation
3rd generation
MODIS/VIIRS

- INSAT-3DR (74E) launched Sept 8 , 2016, INSAT-3D (82E)
- Himawari-9 (140E) launched Nov 1, 2016, standby Him-8
- GOES-R launched Nov 19, 2016, GOES-S launch in 2018
- FY-4A (100E) launched Dec 10, 2016 (2nd generation Chinese)
- Met-7 (57E) decommissioned March 31, 2017
- Met-8 (41.5E) operational Oct 21, 2016
- JPSS-1 to launch in 4th quarter 2017, JPSS-2 in 1st quarter 2022
- Met-11 (0E) to replace Met-10 in March 2018

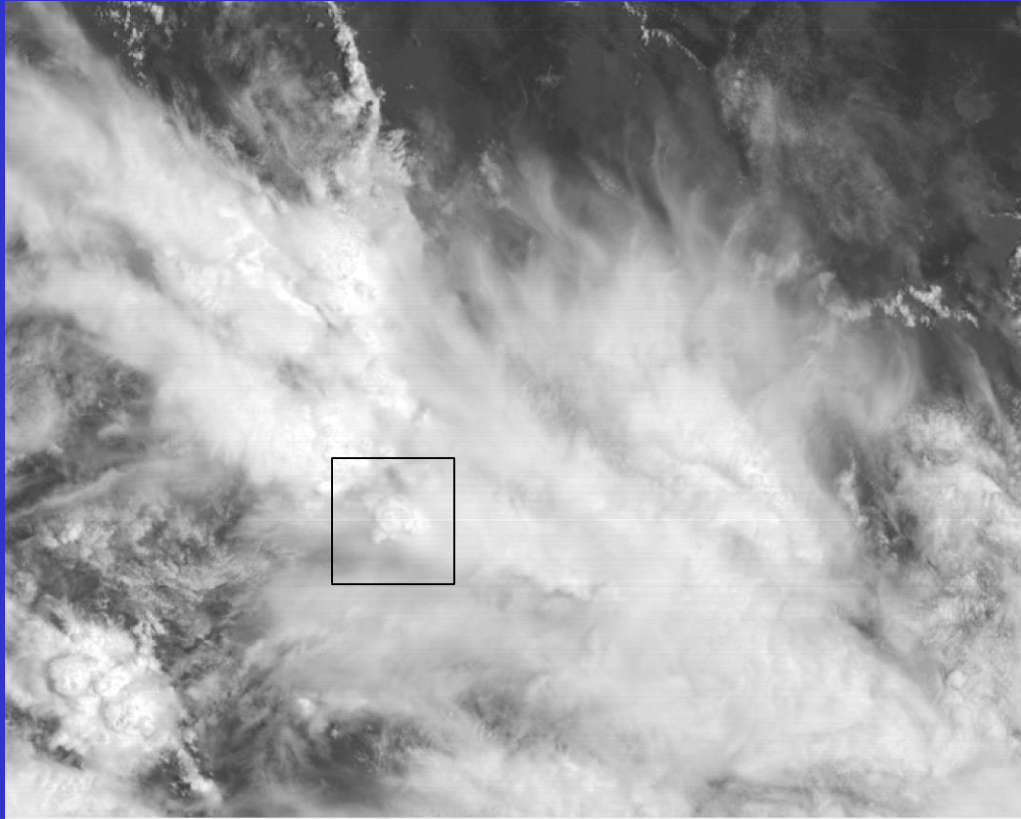


GOES-16 March 2017 NPP calibration checkout

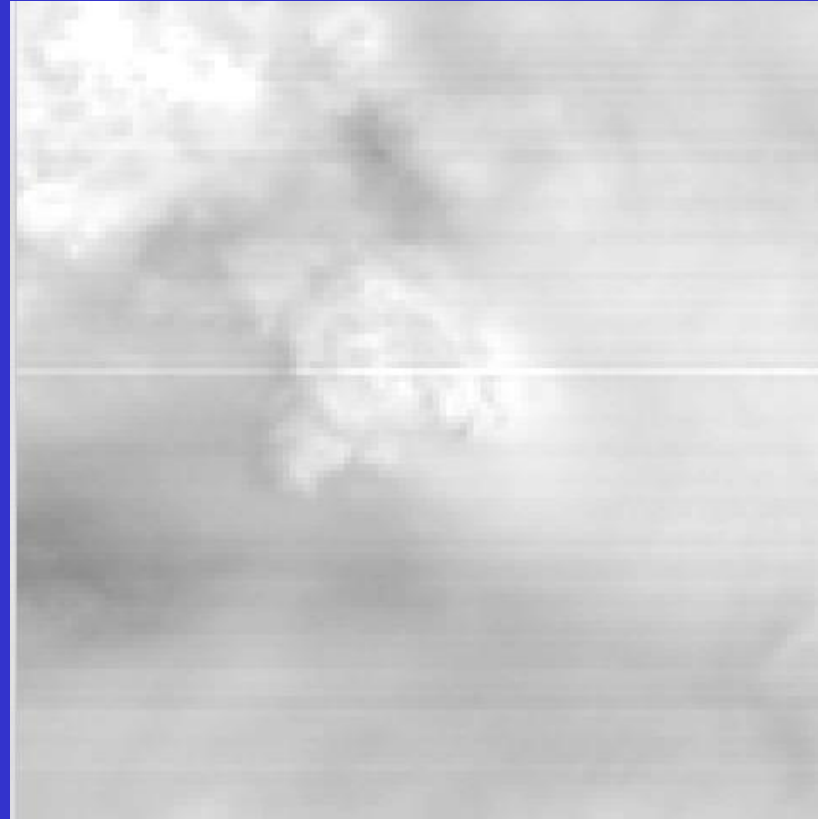


- GOES-16 has 4X more visible noise than Him-8
- GOES-16/NPP IR calibration uncertainty is similar to Him-8
- The GOES-16 is available for testing. Still in commissioning phase
- We will re-calibrate when the instrument team

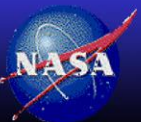
GOES-16 visible imager detector noise



GOES-16 has 0.5km resolution in the 0.64 μ m band
Twice the resolution of GOES-15



GOES-16 has 1000 detectors per scan
GOES-15 has 8 detectors per scan

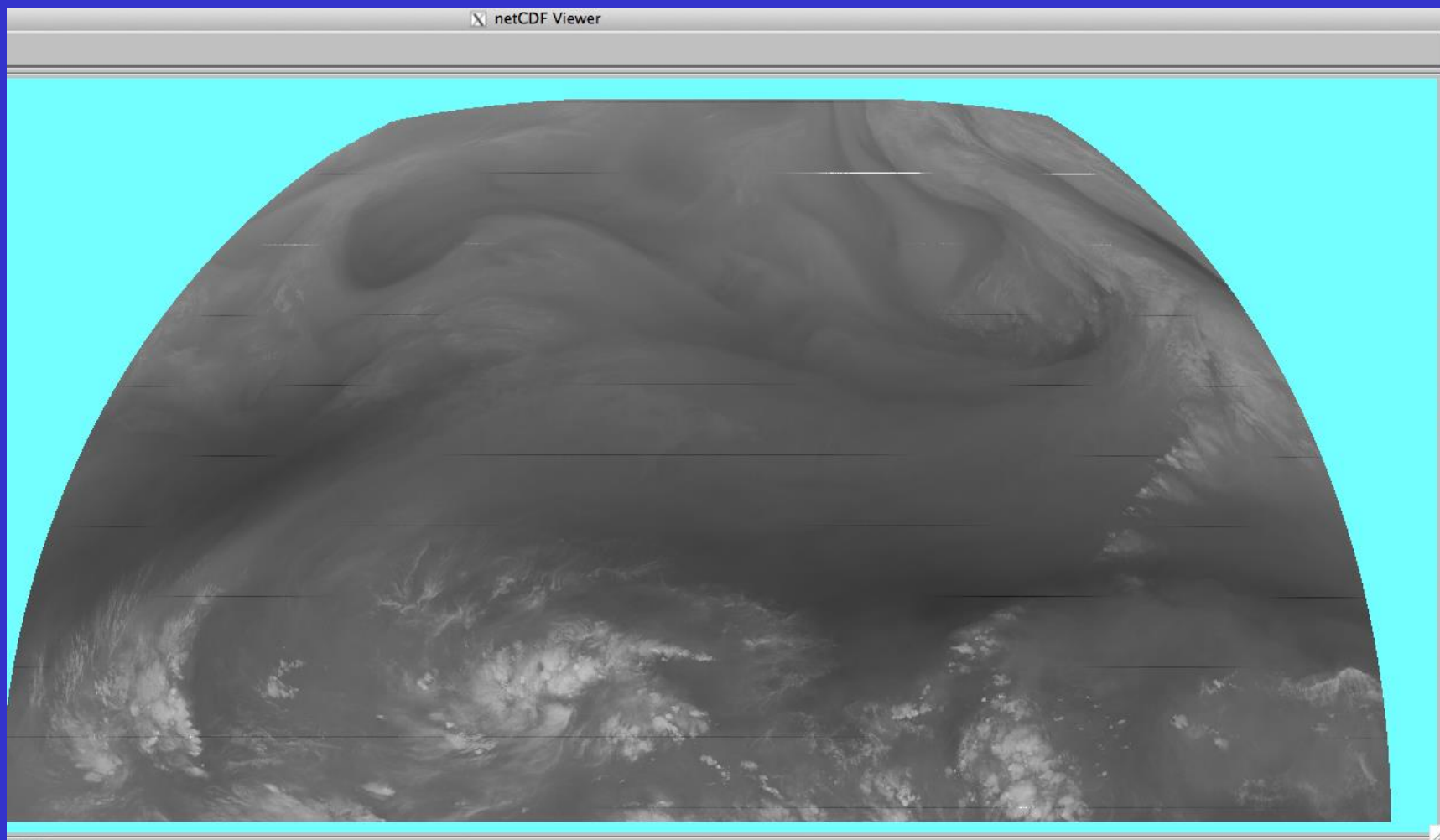


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Himawari-8 WV (6.7 μ m) image

Jan 6, 2017 19:30 GMT



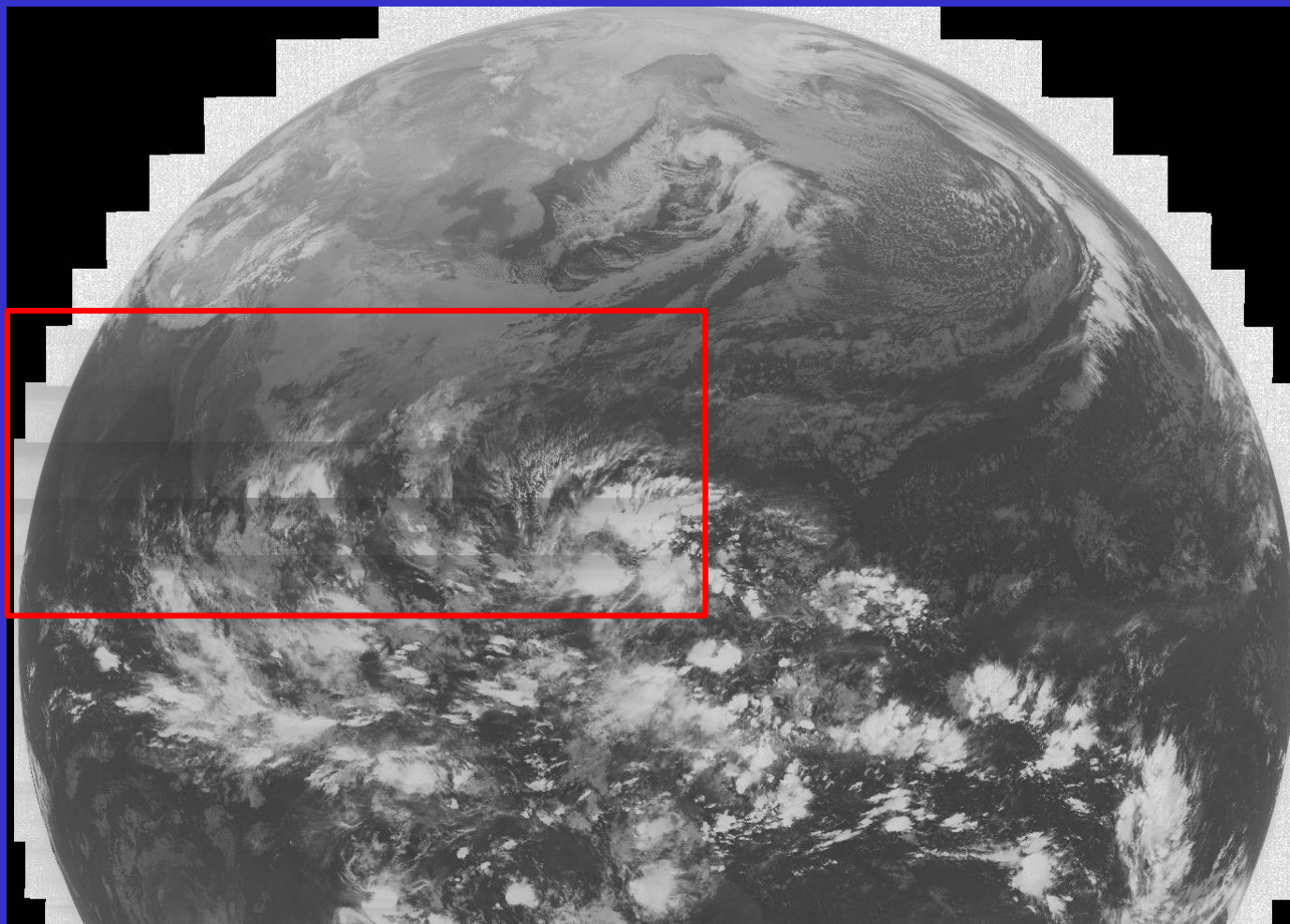
Even with the 3rd generation GEOs detector striping will still be a concern



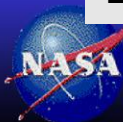
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Him-8, WV, Feb. 1, 2017 14:30 GMT

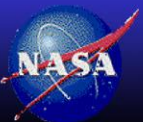


Even with the 3rd generation GEOs, stray light artifacts still present



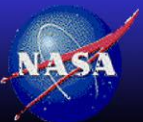
Met-7 to Met-8 transition

- Met-8 successfully moved to 41.5E and became operational on Oct 21, 2016
- Met-8 first 2nd generation satellite in the Indian Ocean
 - 16 channels, Met-5/7 only had a visible, WV and IR channel
- Met-8 has been routinely calibrated monthly against Aqua-MODIS since November 2016
- Met-8 had a de-icing event that resulted in a data gap in Jan 17-22, 2017
- Met-7 had a de-icing event Mar 10-13, 2017
- Cloud group working on cloud retrieval code
 - Focusing on land snow regions using the 1.6 μ m channel
- Begin Met-8 processing Mar 2017 for Ed4A



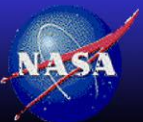
Planned GEO visible to SW flux studies

- GEO derived SW flux
 - Calibrate GEO visible channels with MODIS C6
 - Theoretical GEO visible to MODIS band 1 (0.65 μ m) radiance conversion
 - Empirical (SSF) GEO-MODISlike to BB radiance conversion
 - Convert BB radiance to flux using CERES TRMM ADMs
 - Normalize GEO fluxes with CERES using coincident data
- 1-hourly GEO from 3-hour reduced the Aqua-based GEO minus Terra observed fluxes RMS error from 13.6 to 9.0 Wm⁻²
- ADM studies
 - Footprint vs regional, MODIS vs GEO clouds, TRMM vs Ed4 ADM
- SSF and Himawari-8 multiple visible channel to BB radiance studies
 - Adding 11 μ m improves SSF based NB2BB from 10.3 Wm⁻² to 8.6 Wm⁻²
 - Use SSF derived multi-channel NB to BB coefficients with Him-8
- Test theoretical GEO NB to BB radiance models designed for each GEO
 - Use ScaRaB BB radiance to evaluate improvement
 - Use Aqua based models and compare with Terra observations



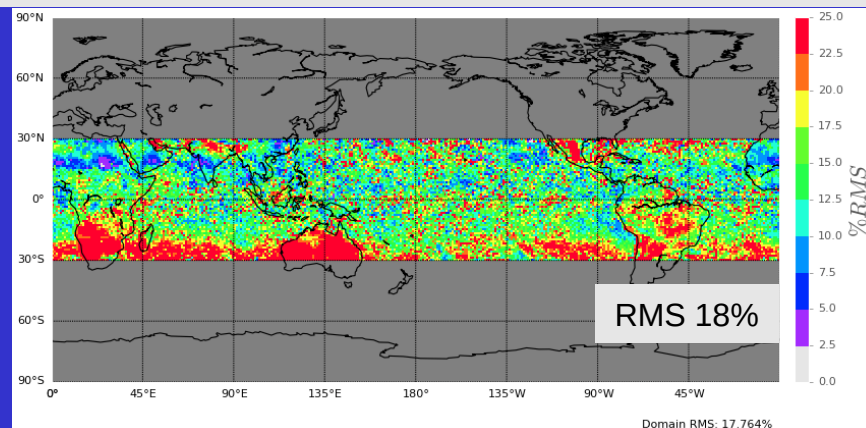
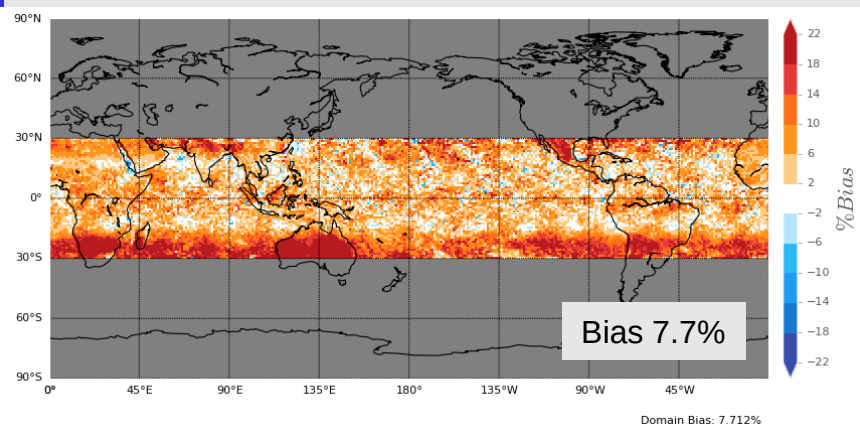
Megha-Tropique (MT) and Aqua SW flux comparison

- Motivation: The GEO derived SW fluxes were very dependent on cloud properties for $\text{SZA} > 60$.
 - The SYN1deg Ed4A uses hourly GEO derived fluxes for $\text{SZA} < 60$ and directional models for $\text{SZA} > 60$
- MT is in a tropical precessionary orbit and is very suitable to validate the GEO derived broadband fluxes for large SZA
- Validate the MT with Aqua-CERES radiances and fluxes
 - Coincident GEO and CERES fluxes have a $\sim 15\%$ RMS error
 - Coincident MT and CERES fluxes must have lower RMS

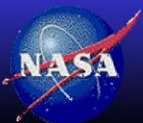


MT and CERES hourbox matched SW fluxes March-August 2013

MT SANN and CERES Ed4 flux

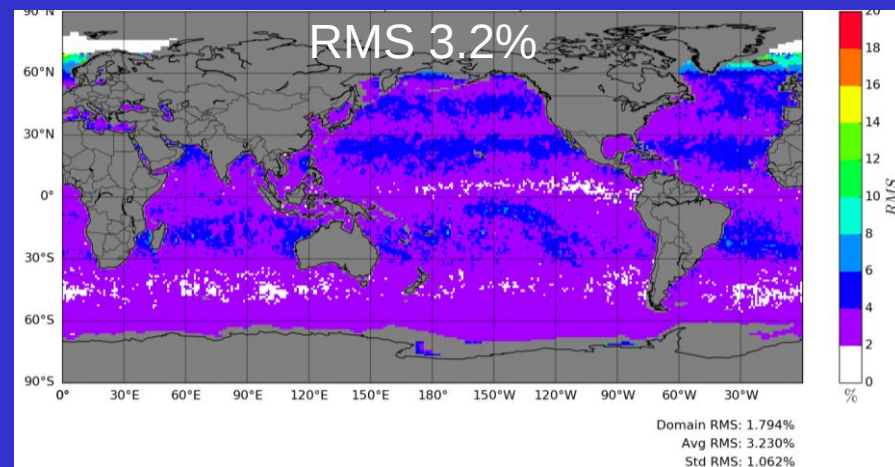
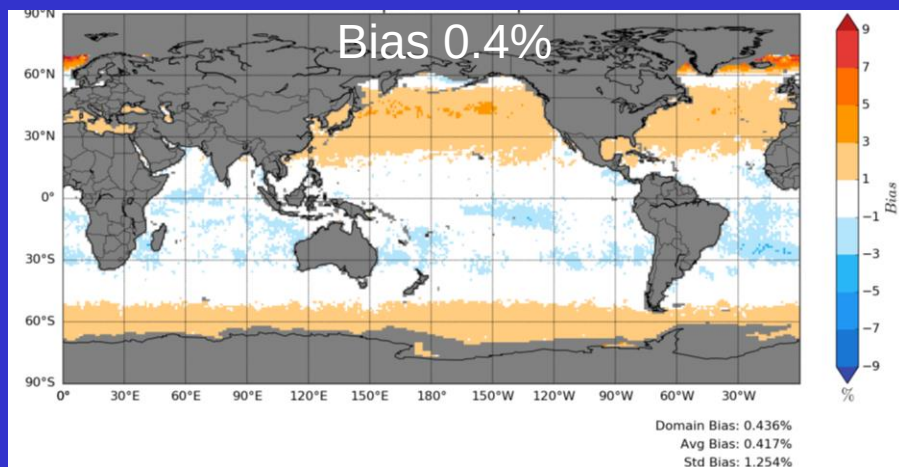


- The MT SANN fluxes do not seem to work well over land and large VZA
- Can MT radiances be converted using the TRMM ADM to flux?
- How close are the MT TRMM ADM fluxes to the CERES fluxes?

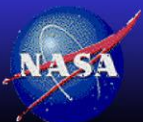


CERES-Aqua (TRMM ADM MODIS clouds) minus CERES (Ed4 ADM) SW flux

Using Aqua CERES footprint radiiances and MODIS clouds, March 2013



- SZA (zonal) dependent TRMM vs Ed4 SW ADM bias
- TRMM orbit within $\pm 35^\circ$ latitude
- The TRMM ADM with MODIS clouds can be used within the MeghaTropique domain, since the CERES TRMM ADM SW fluxes are close to the Ed4 ADM fluxes

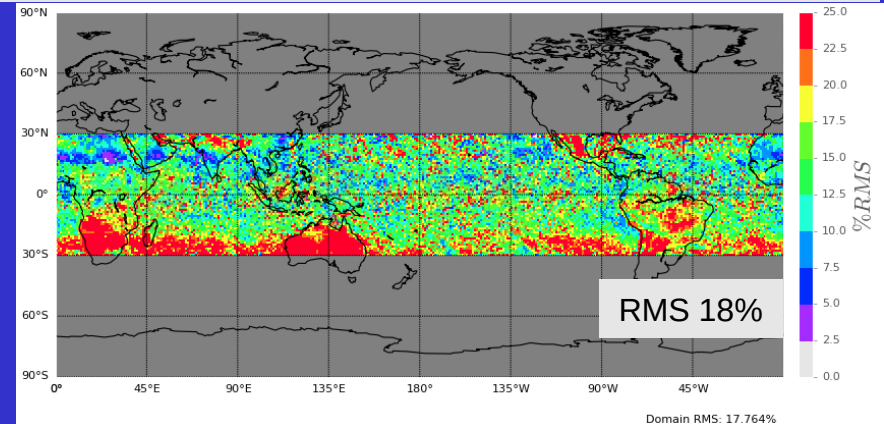
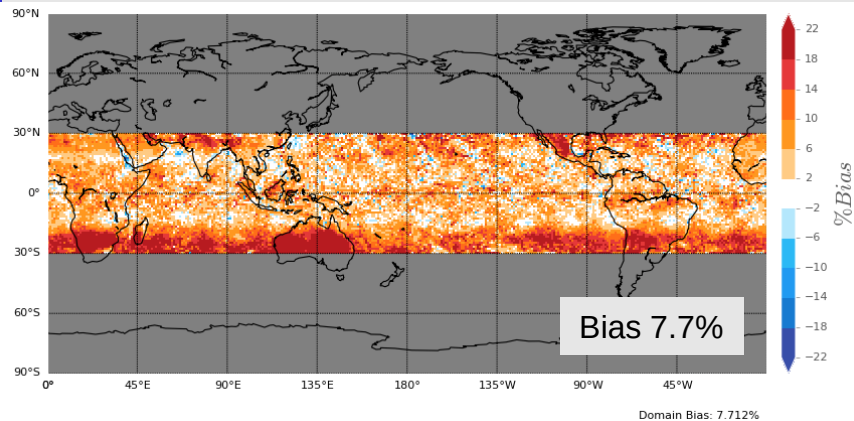


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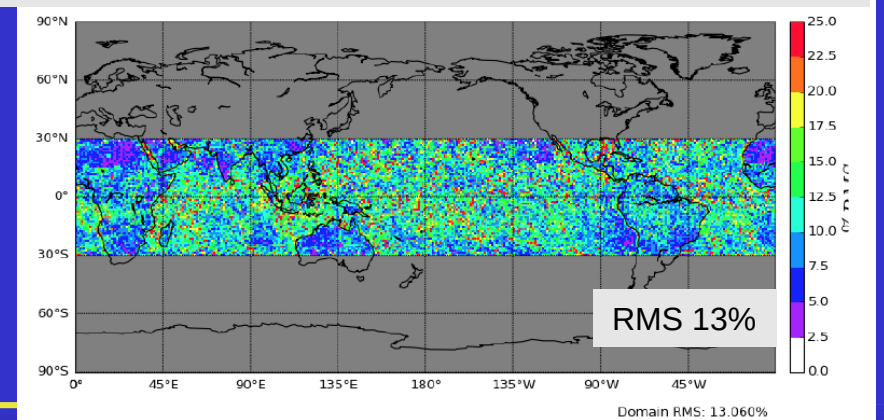
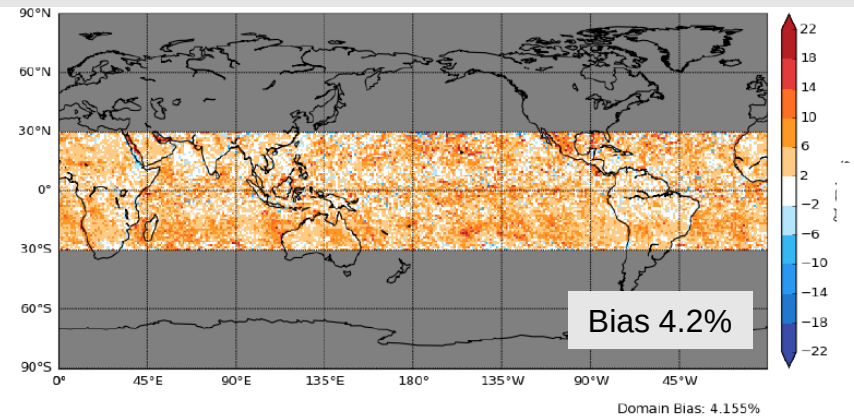


MT and CERES hourbox matched SW fluxes March-August 2013

MT SANN and CERES Ed4 flux



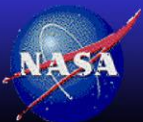
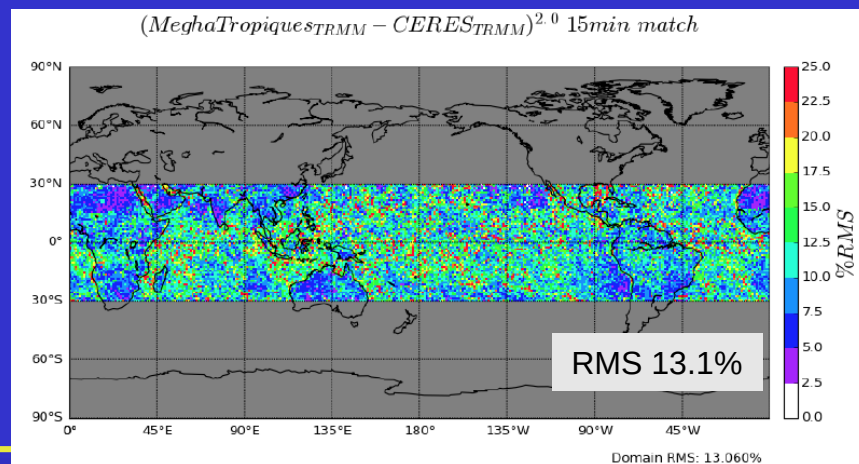
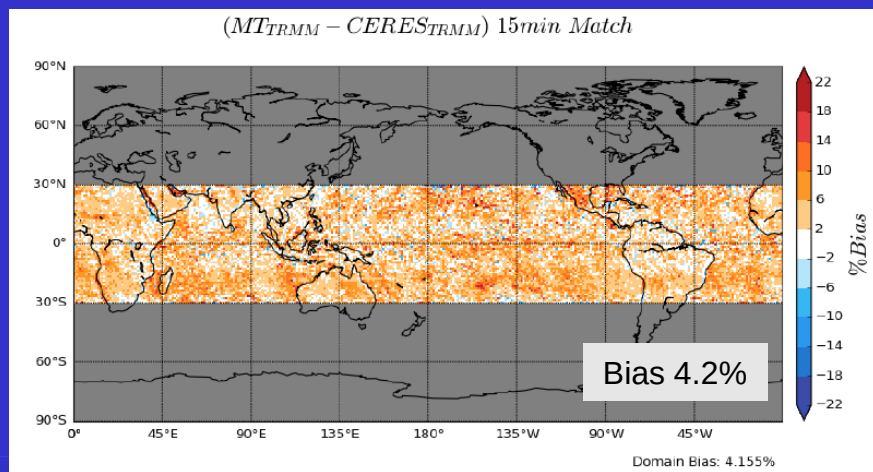
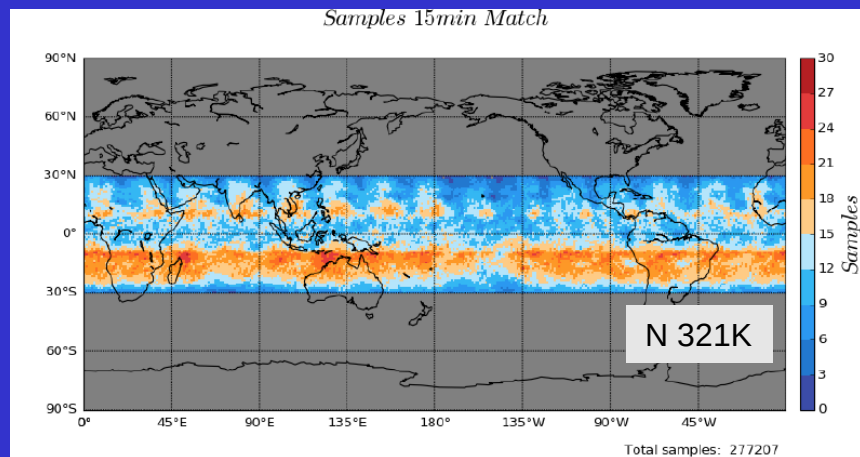
MT (TRMM ADM based on MODIS) and CERES (TRMM ADM) flux



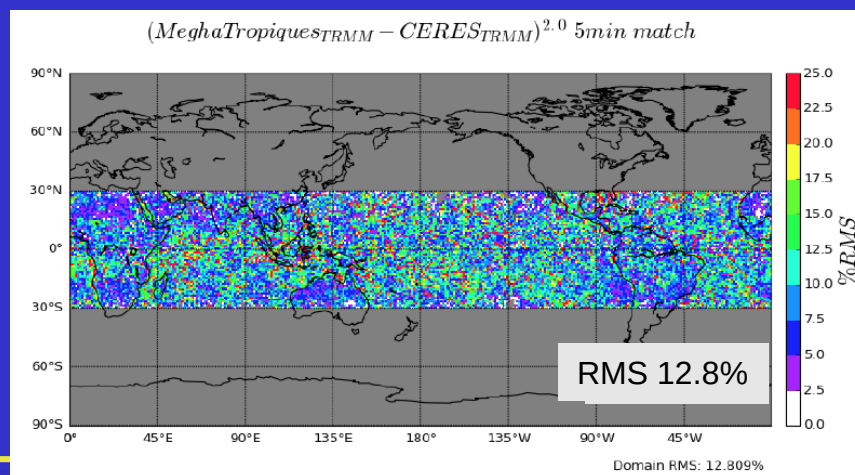
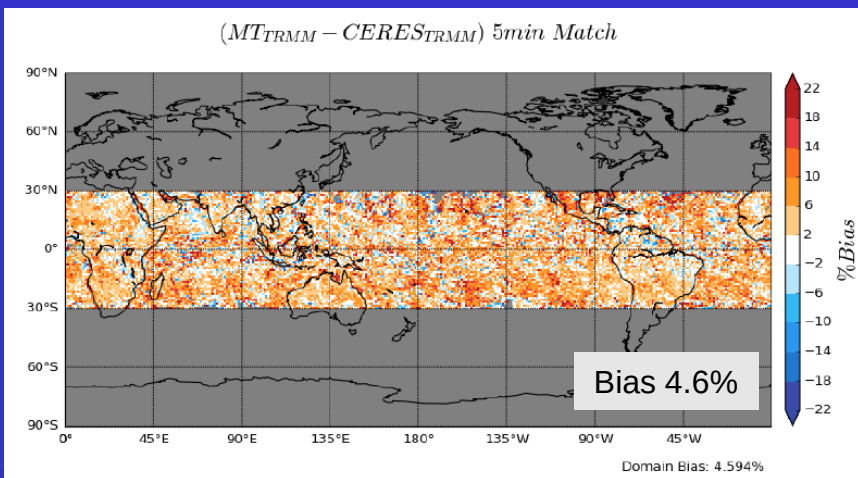
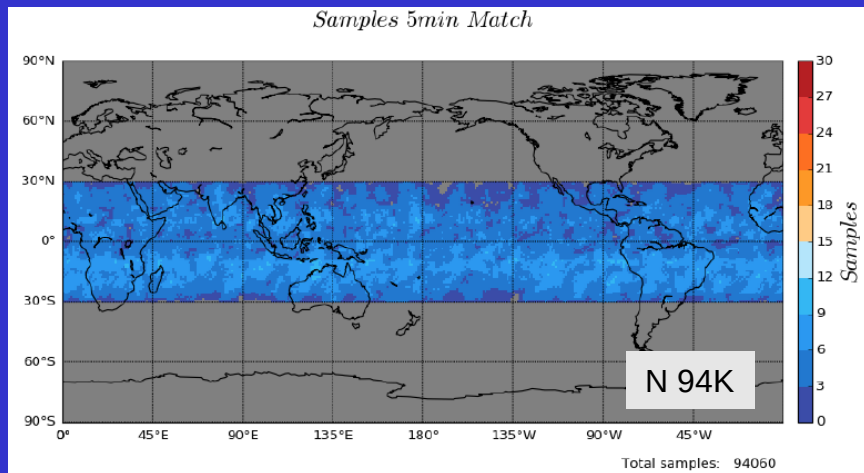
- The MT SANN fluxes do not seem to work well over land and large VZA
- The MT TRMM ADM fluxes have improved the VZA dependency but not over land

MT and CERES 15 minute matched SW fluxes

March-August 2013



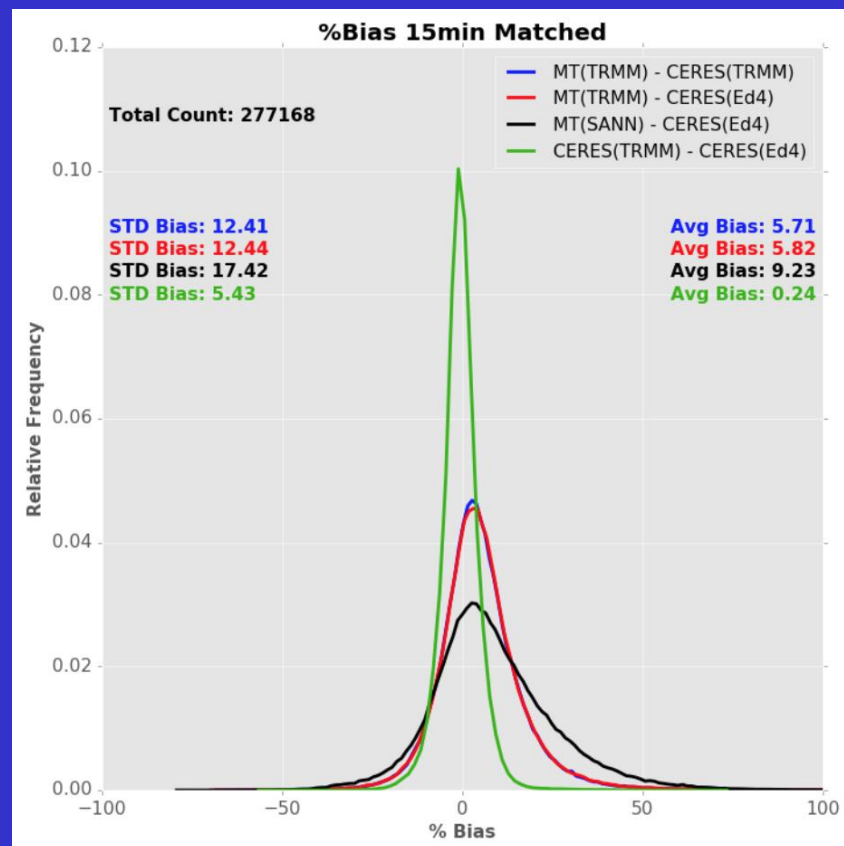
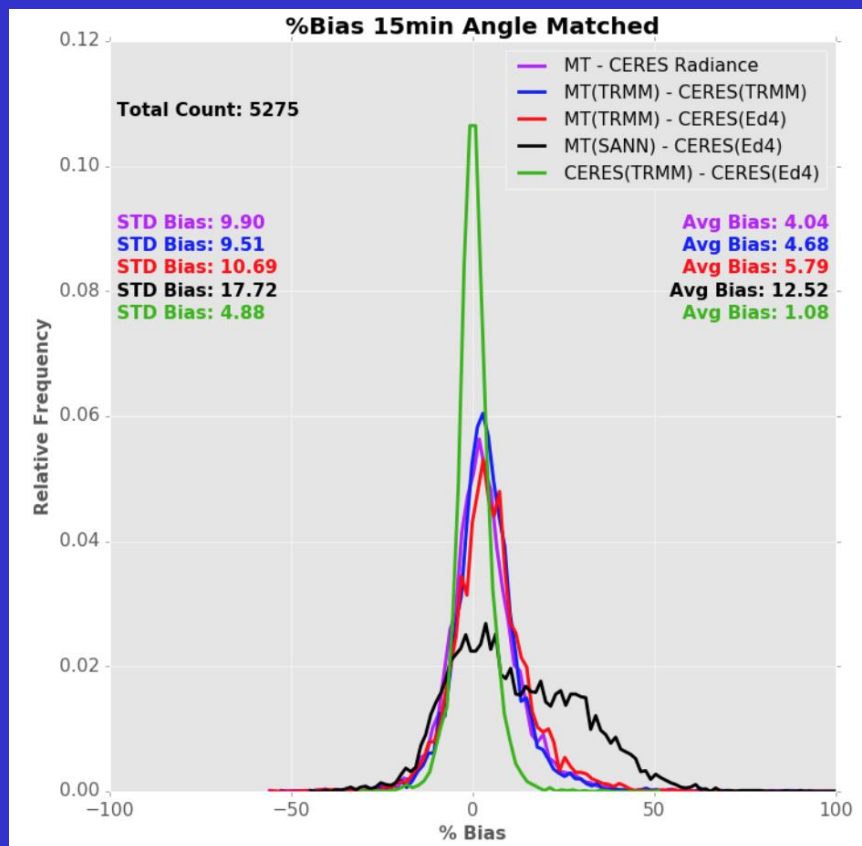
MT and CERES 5 minute matched SW fluxes March-August 2013



- The regional SW flux RMS is reduced with shorter time matches
- There are some regions that have very large residual biases and RMS errors



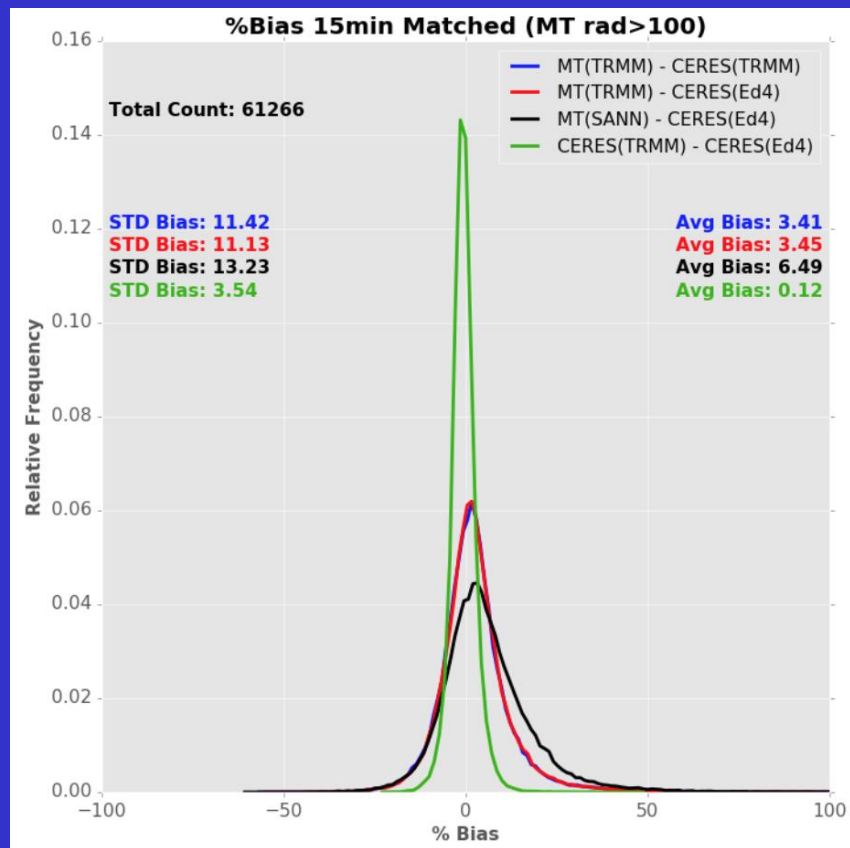
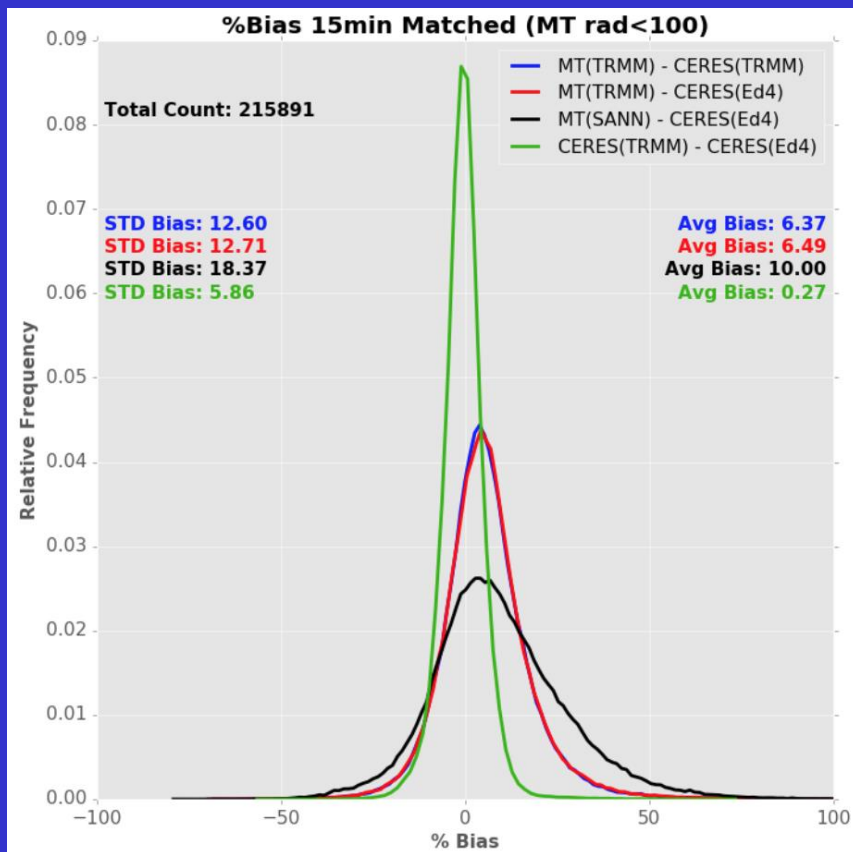
MT and CERES 15 minute matched SW fluxes March-August 2013



- The angle matched MT and CERES radiances and fluxes have similar bias and RMS error
- The angle matched and non-angle matched have similar MT and CERES flux statistics
- The MT-SANN fluxes have a large positive bias compared with MT-TRMM



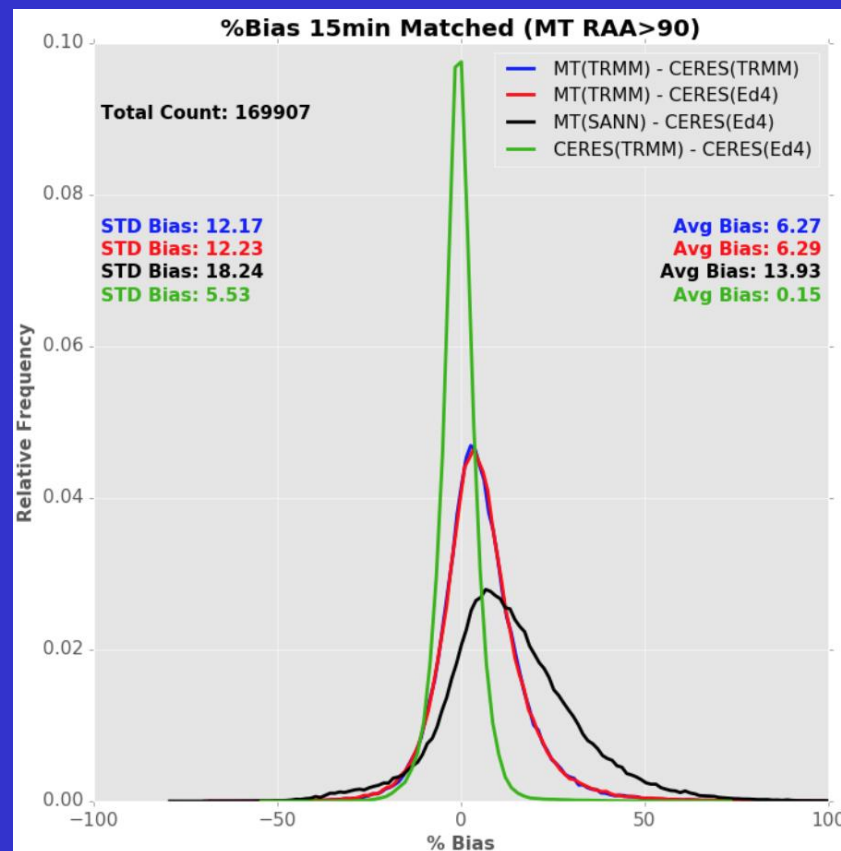
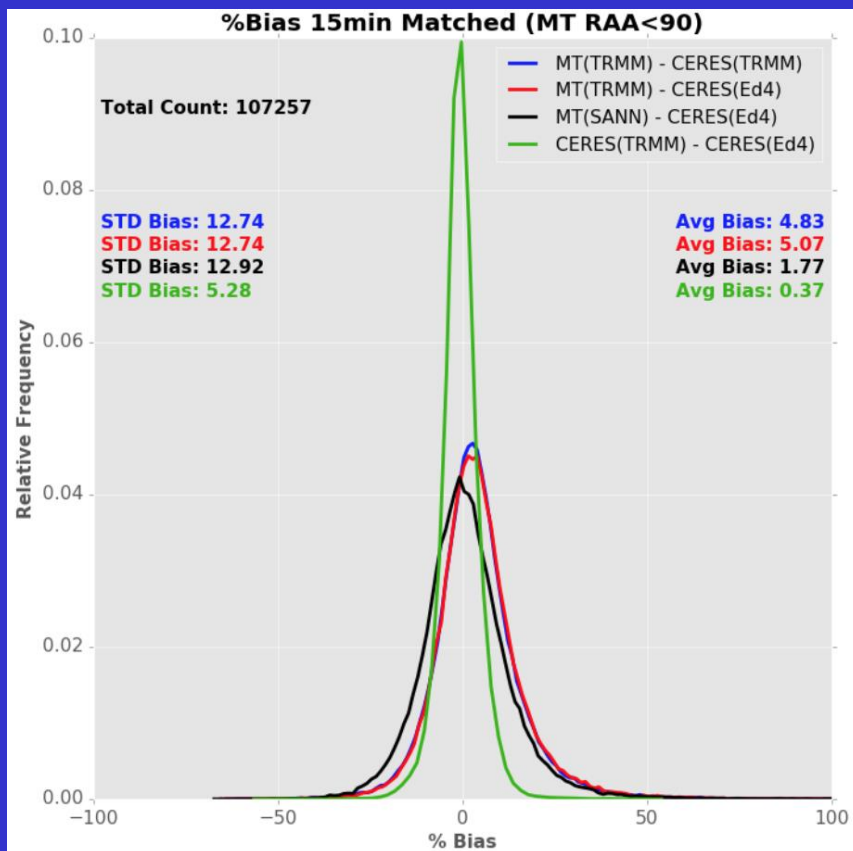
MT and CERES 15 minute matched SW fluxes March-August 2013



- Bright MT-SANN fluxes have lower bias and RMS error compared with CERES
- Most of the TRMM ADM error compared to Ed4 is for low flux conditions, because brighter scene conditions are more Lambertian



MT and CERES 15 minute matched SW fluxes March-August 2013



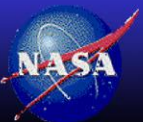
- MT-SANN fluxes are biased with respect to relative azimuth angle (RAA)
- The MT1_L2-FLUX-SCAOL1A2-1.06_2013-03-09T00-34-14_V2-00.hdf RAA seem to be reversed (0° is backscatter), We reversed the RAA for this study, much worse if we did not



Megha-Tropique Conclusions

	Footprint vs 1° region ADM	TRMM adm MODIS cld	TRMM adm GEO cld	MT vs CERES rad ang match	MT-SANN CERES flux	MT- TRMM CERES flux	GERB CERES flux	GERB CERES rad ang match
bias	-0.1%	0.4%	-1.0%	4%	7%	5.8%	0.6%	
RMS	1.8%	3.2%	7.6%	9%	18%	12.5%	10.7%	

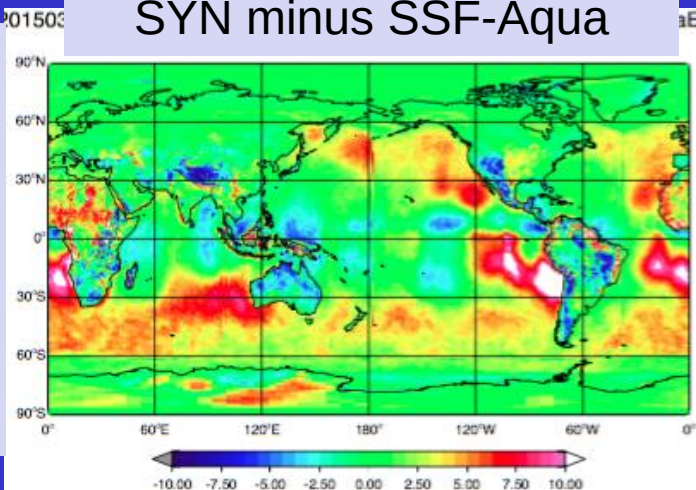
- Megha-Tropique SANN flux seems to have relative azimuth angle dependency
- Megha-Tropique radiances can be used to check GEO NB to BB derived radiances and possibly fluxes using TRMM ADM in a similar fashion to GERB



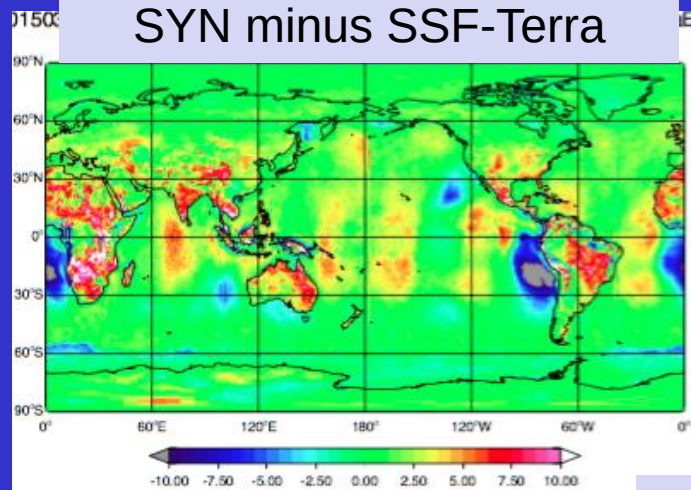
SYN – SSF 12-year SW flux difference

Edition 3

SYN minus SSF-Aqua



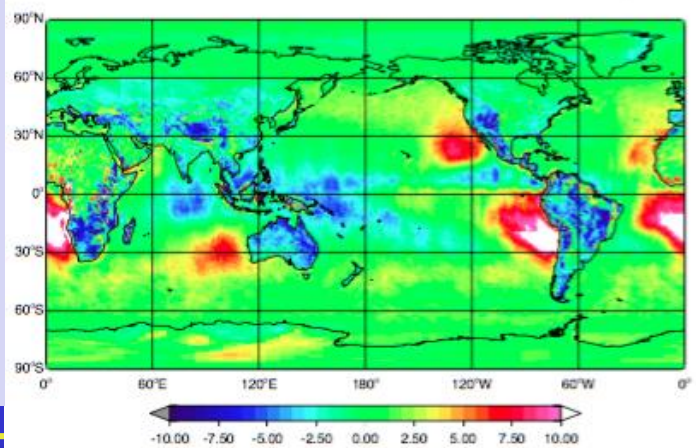
SYN minus SSF-Terra



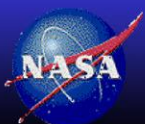
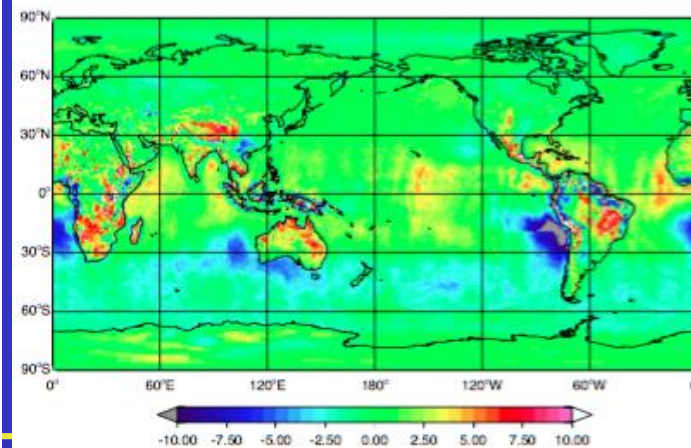
Units: Wm⁻²

Edition 4

503 SW(W/m²) Mean Diff: SYN1degDARTerra-AquaEd4 - SSF1degDARAq



503 SW(W/m²) Mean Diff: SYN1degDARTerra-AquaEd4 - SSF1degDARAq



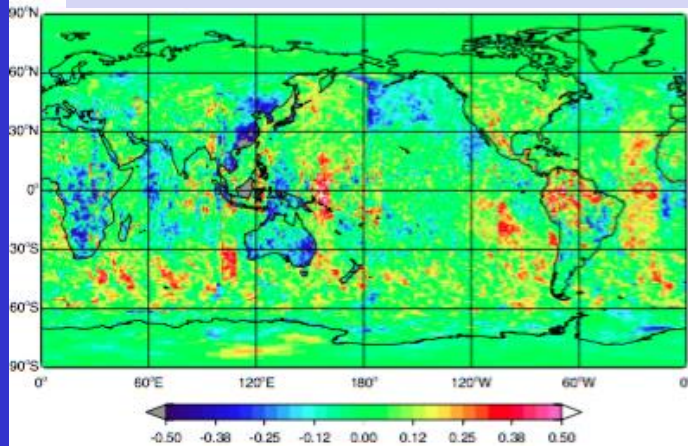
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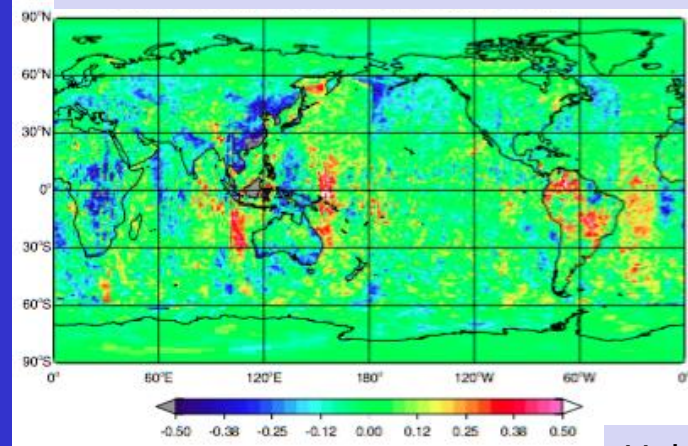
SYN – SSF SW regional trend anomalies

Edition 3

SYN minus SSF-Aqua



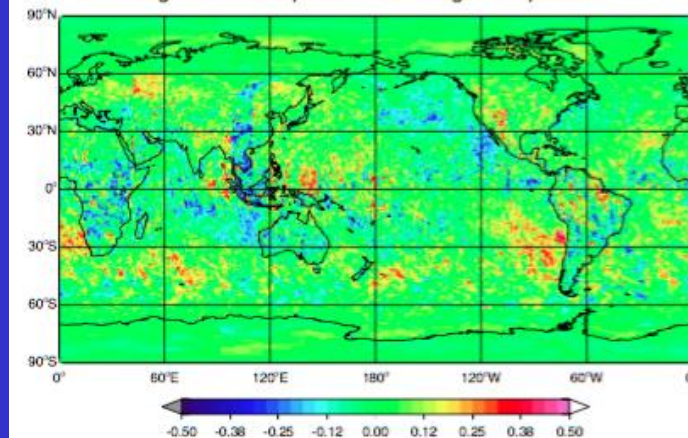
SYN minus SSF-Terra



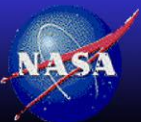
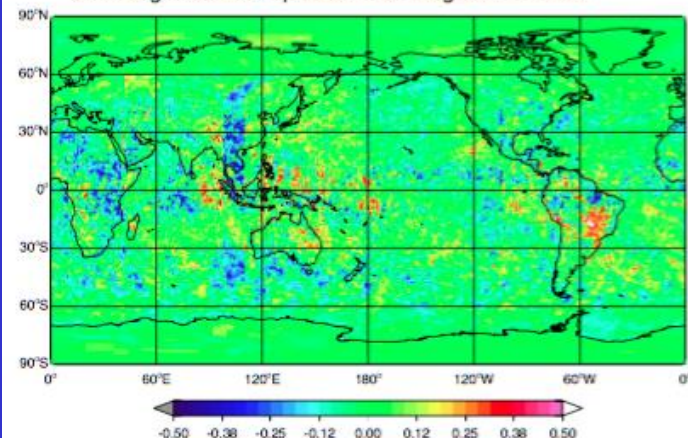
Units: $\text{Wm}^{-2}\text{yr}^{-1}$

Edition 4

200304-201305 SW Wm²yr⁻¹ Trend Dmr.
SYN1degDARTerra-AquaEd4 - SSF1degDARAquaEd4



200304-201305 SW Wm²yr⁻¹ Trend Dmr.
SYN1degDARTerra-AquaEd4 - SSF1degDARTerraEd4



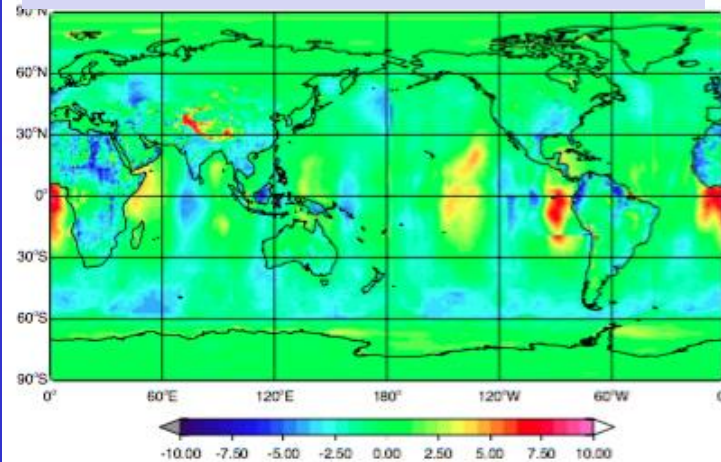
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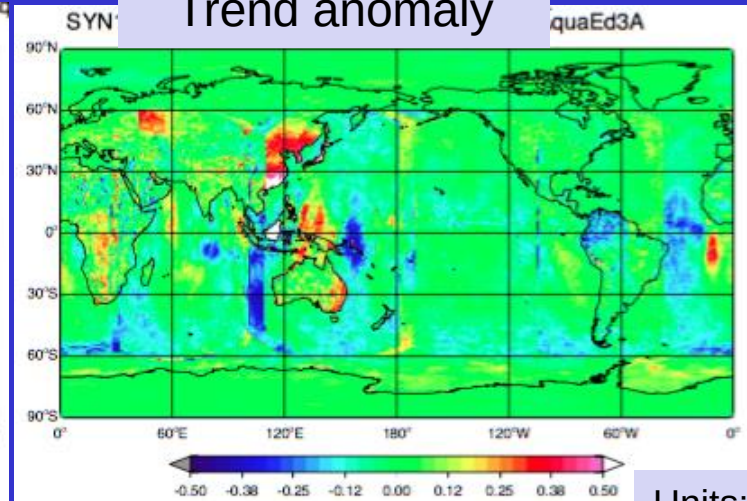
SYN Ed4 SW flux comparisons

SYN Ed4 minus Ed3

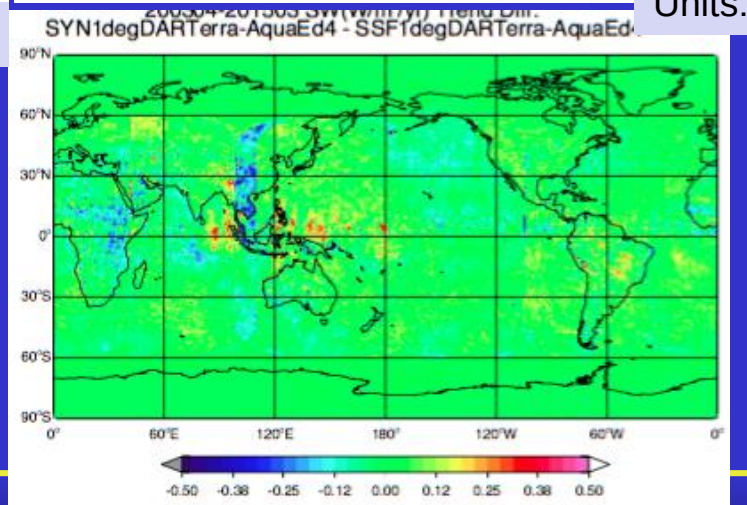
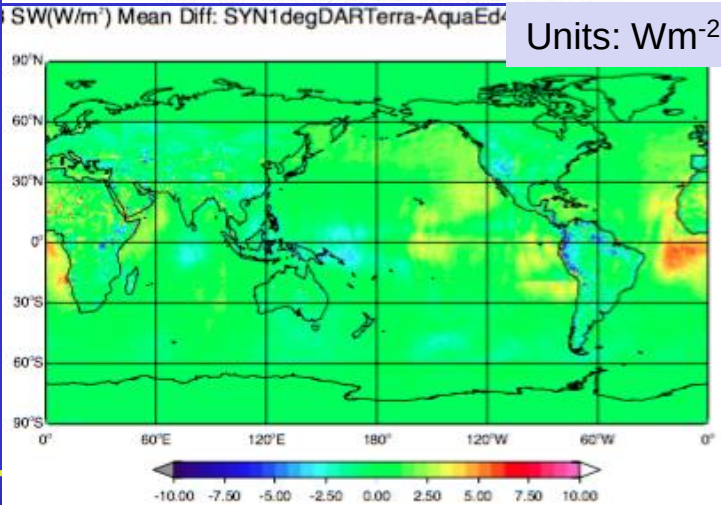
Mean difference



Trend anomaly



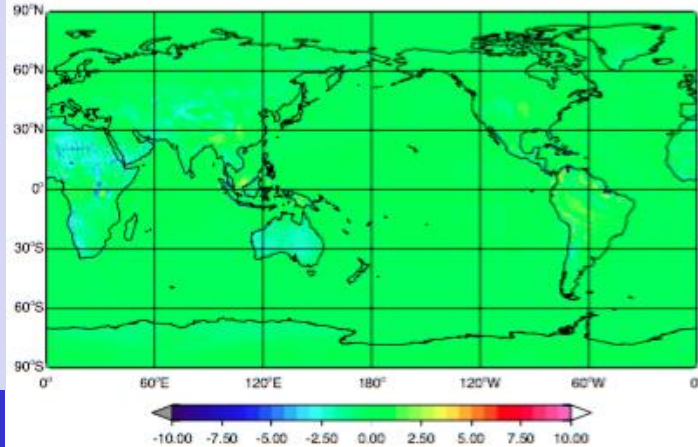
SYN Ed4 minus SSF-Terra+Aqua



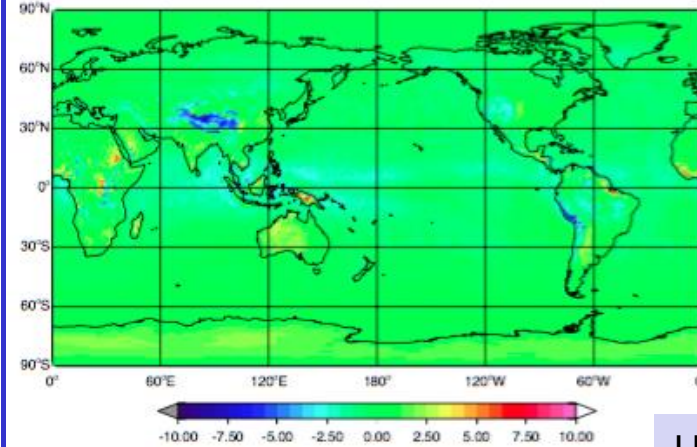
SYN – SSF 12-year LW flux difference

Edition 3

SYN minus SSF-Aqua

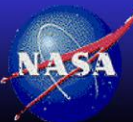
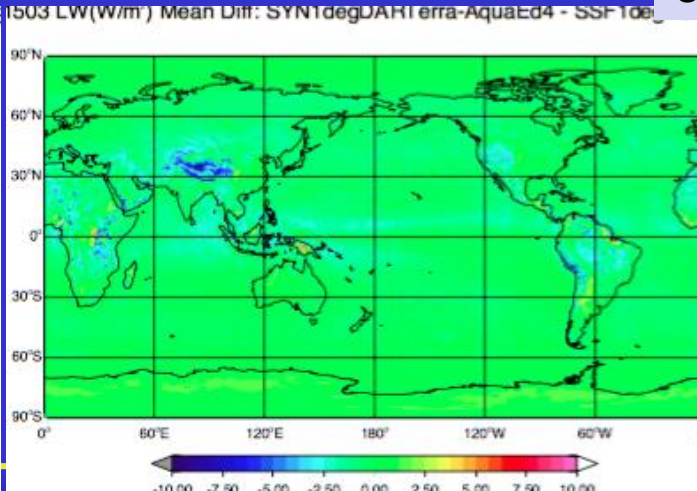
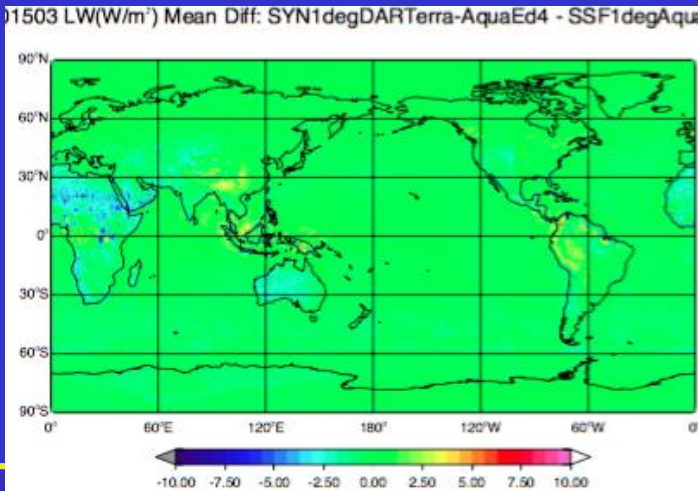


SYN minus SSF-Terra



Units: Wm⁻²

Edition 4



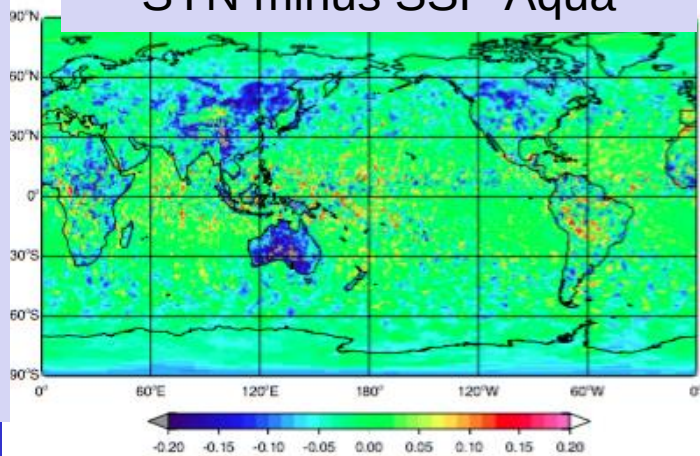
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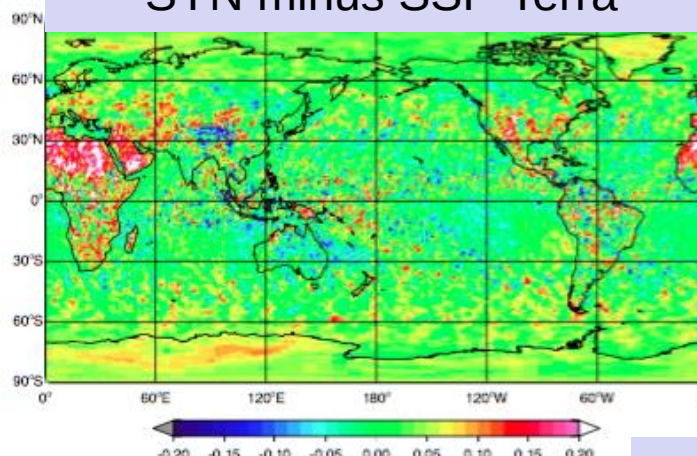
SYN – SSF LW regional trend anomalies

Edition 3

SYN minus SSF-Aqua



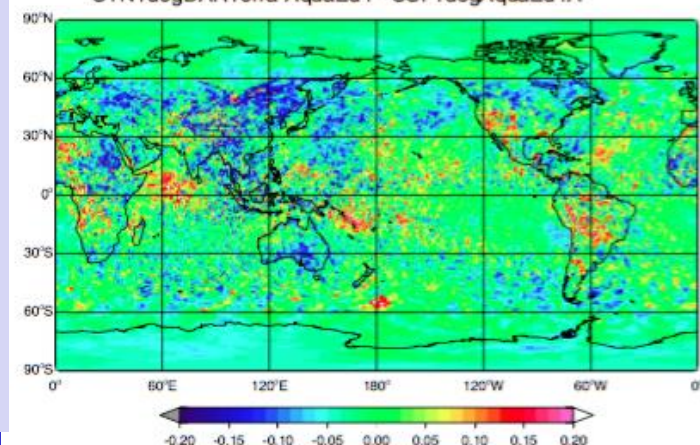
SYN minus SSF-Terra



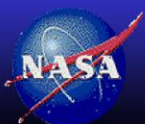
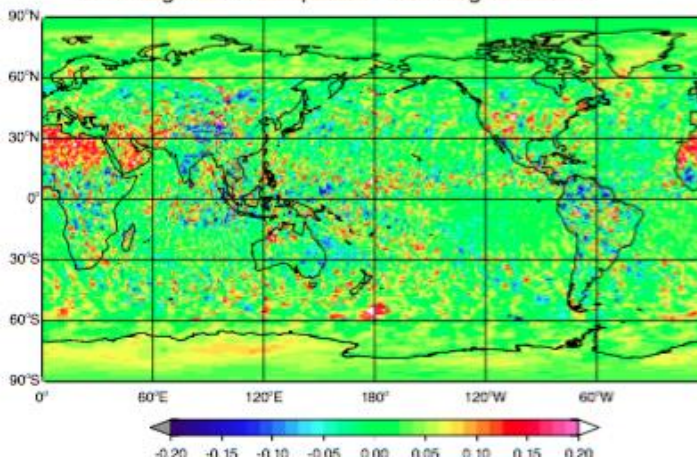
Units: Wm⁻²yr⁻¹

Edition 4

200304-201303 LW(W/m²/yr) trend Dm.
SYN1degDARTerra-AquaEd4 - SSF1degAquaEd4A



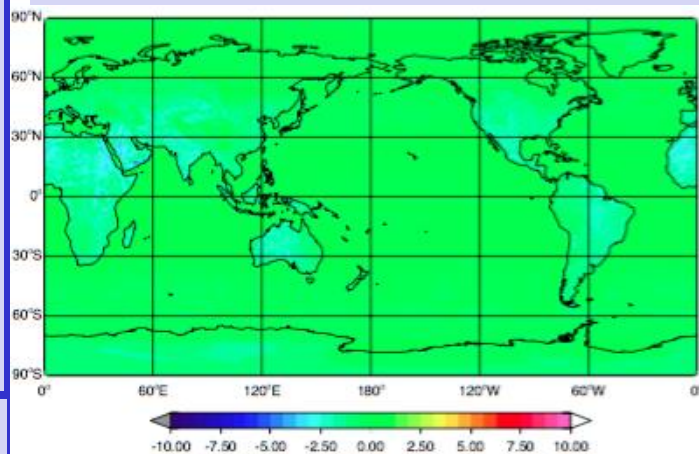
200304-201303 LW(W/m²/yr) trend Dm.
SYN1degDARTerra-AquaEd4 - SSF1degTerraEd4A



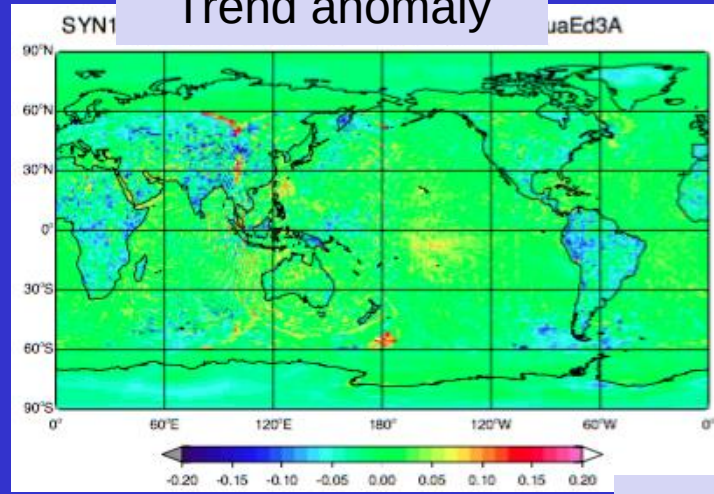
SYN Ed4 LW flux comparisons

SYN Ed4 minus Ed3

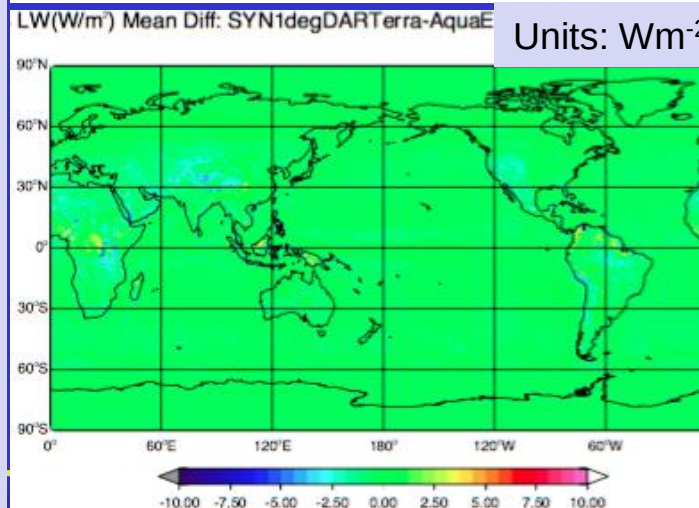
Mean difference



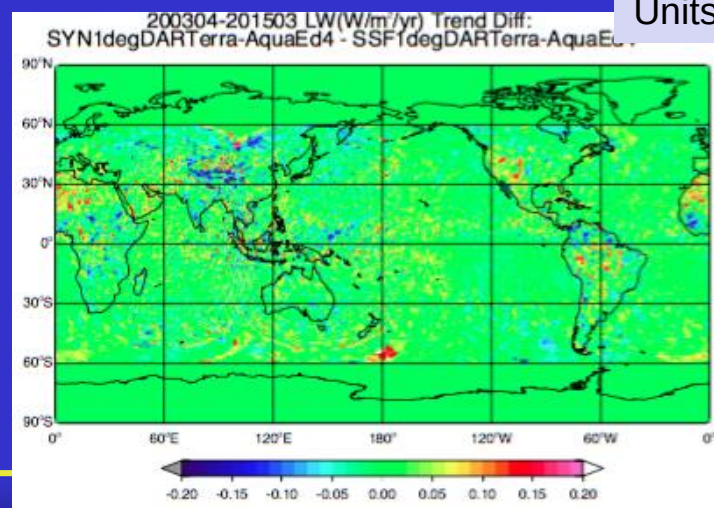
Trend anomaly



SYN Ed4 minus SSF-Terra+Aqua



Units: Wm^{-2}



Units: $\text{Wm}^{-2}\text{yr}^{-1}$

SYN Ed4 trend anomaly conclusion

	Ed3 SW	Ed3 LW	Ed4 SW	Ed4 LW
SSF-Terra	96.27	239.21	96.79	239.21
SSF-Aqua	96.06	238.96	96.60	238.79
SYN	97.56	238.79	96.87	238.57

- The SYN Ed4 minus SSF1deg-Terra&Aqua have smaller regional SW and LW flux differences than Ed3
- The relative SYN Ed4 regional SW and LW flux trends are smaller compared to SSF1deg than Ed3
- The SYN1deg Ed4 global mean SW flux is 0.77 Wm^{-2} less than Ed3, for LW -0.22 Wm^{-2}
 - SSF1deg Ed4 – Ed3 SW $\sim 0.5 \text{ Wm}^{-2}$

