Initial Results of CERES-Like ERBE Data Processing

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CERES Science Team Meeting

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Project Overview

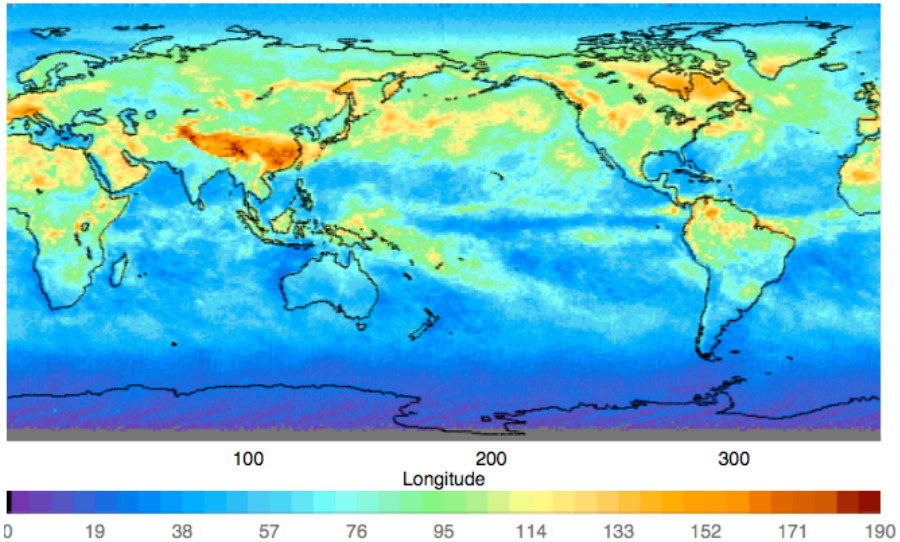
- Funded by NOAA Climate Data Record (CDR) .
  - Produce "CERES-Like" data products from NOAA-9/10 ERBE Scanner measurements
    - Collocate retrieved cloud properties from AVHRR (P. Minnis PI in a separate CDR project)
    - Reprocess NOAA-9/10 ERBE data using CERES angular distribution models (ADMs)
    - Compute surface irradiances
    - Combine GEO to cover diurnal sample
  - So far have processed NOAA-9 Apr, Jul, Oct, Dec, 1986 into SSF and SSF-1Deg Month products.

ERBE and CERES Processing

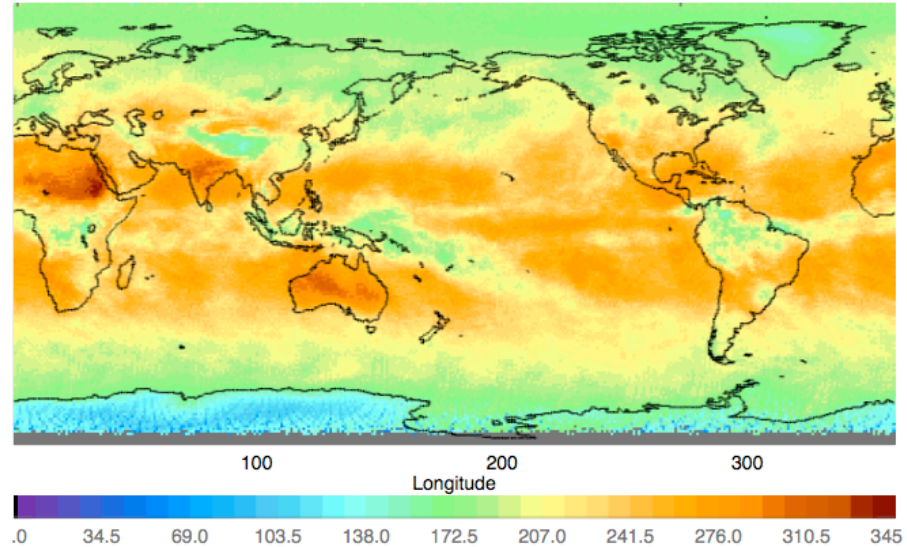
- **Scene Identification**
  - ERBE algorithm used Maximum Likelihood Estimate (MLE) method to identify the scene type.
  - CERES uses Imager measurements to identify the scene types.
- **Unfiltering**
  - Process of removing instrument spectral response on observed radiance
  - Unfiltering algorithm in ERBE and CERES are different and use different spectral databases.
- **Inversion** (Convert radiance to irradiance)
  - ERBE ADMs are developed based on Nimbus-7 ERB data for 12 broad scene types
  - CERES-AQUA ADMs are used to reprocess the ERBE NOAA-9 scanner data.
  - **Spatial Gridding**
  - ERBE is 2.5 degree, while CERES is 1 degree.

CERES Like ERBE - NOAA-9 SSF

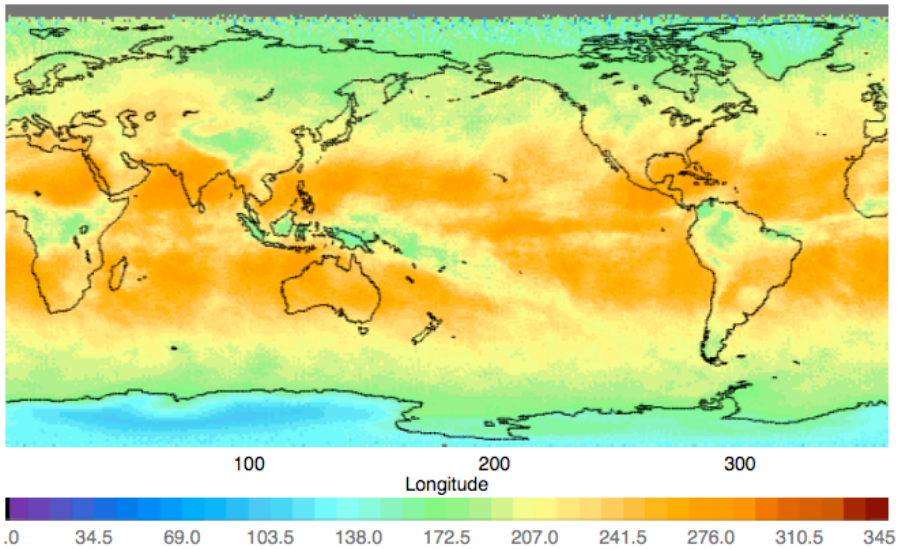
Instantaneous – Monthly Gridded (April – 1986)



Shortwave Daytime TOA Flux



Longwave Daytime TOA Flux



Longwave Nighttime TOA Flux

Month (1986)	TOA Flux Monthly Global Mean (W/m^2)		
	SWDT	LWDT	LWNT
APR	228.9	223.1	220.8
JUL	212.1	233.1	228.4
OCT	214.9	226.4	225.7
DEC	223.8	222.0	220.6

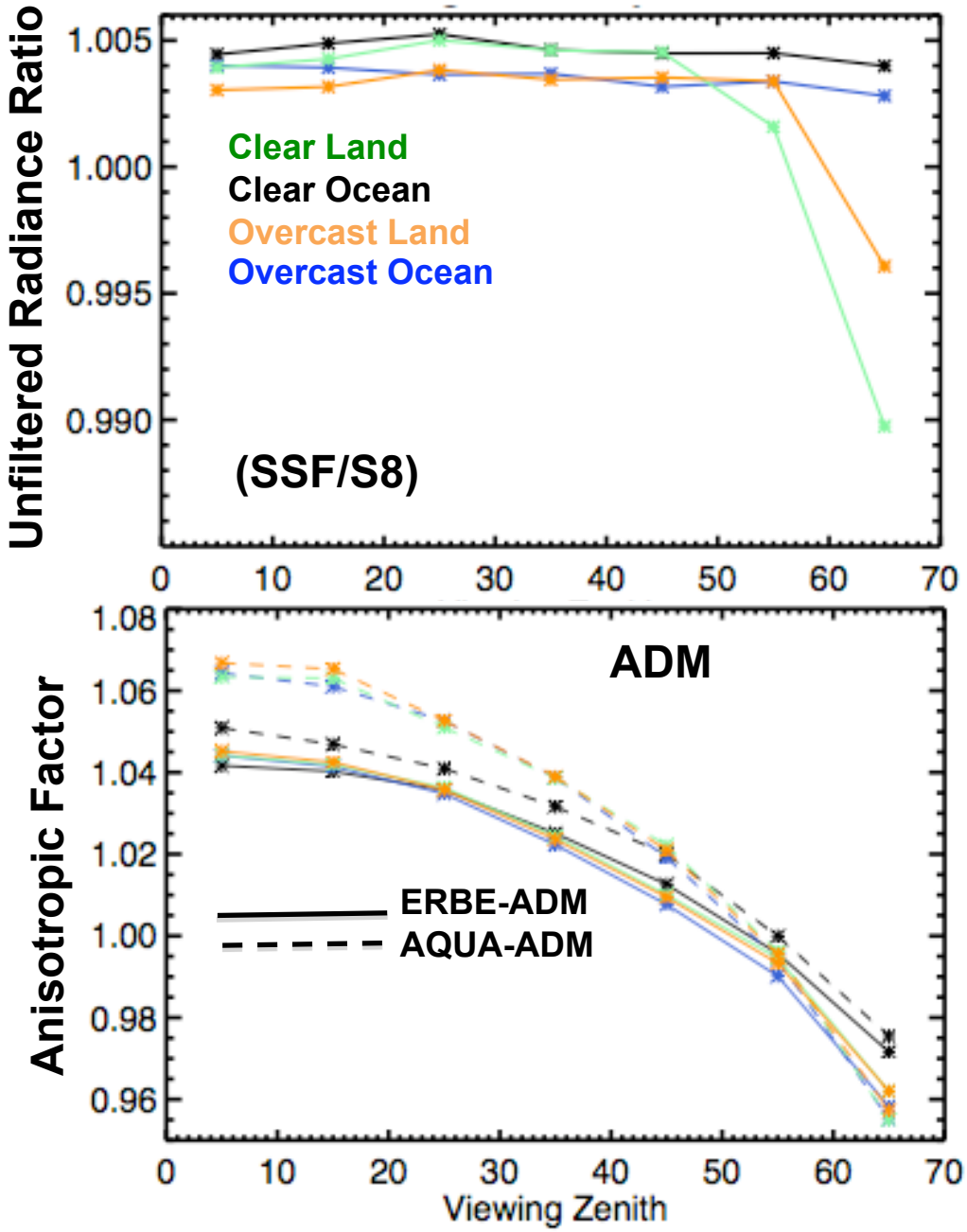
NOAA-9 SSF & NOAA-9 S8 Products

Instantaneous – Monthly Gridded (Matched* Footprints)

Month	Data Products	Shortwave Daytime	Longwave Daytime	Longwave Nighttime	SWDT % DIFF	LWDT % DIFF	LWNT % DIFF
Apr-86	ERBE-S8	226.8	232.2	229.9	4.4	-0.8	-0.9
	ERBE-SSF	236.8	230.2	227.9			
Jul-86	ERBE-S8	209.9	242.6	237.6	4.4	-0.9	-0.9
	ERBE-SSF	219.1	240.4	235.3			
Oct-86	ERBE-S8	212.0	235.5	234.0	4.6	-1.0	-0.9
	ERBE-SSF	221.7	233.2	231.9			
Dec-86	ERBE-S8	220.2	230.7	229.4	4.7	-1.0	-0.9
	ERBE-SSF	230.5	228.3	227.3			

(*Match footprints in S8 and SSF, then compute global monthly means.)

Viewing Angle Dependence (LWDT)

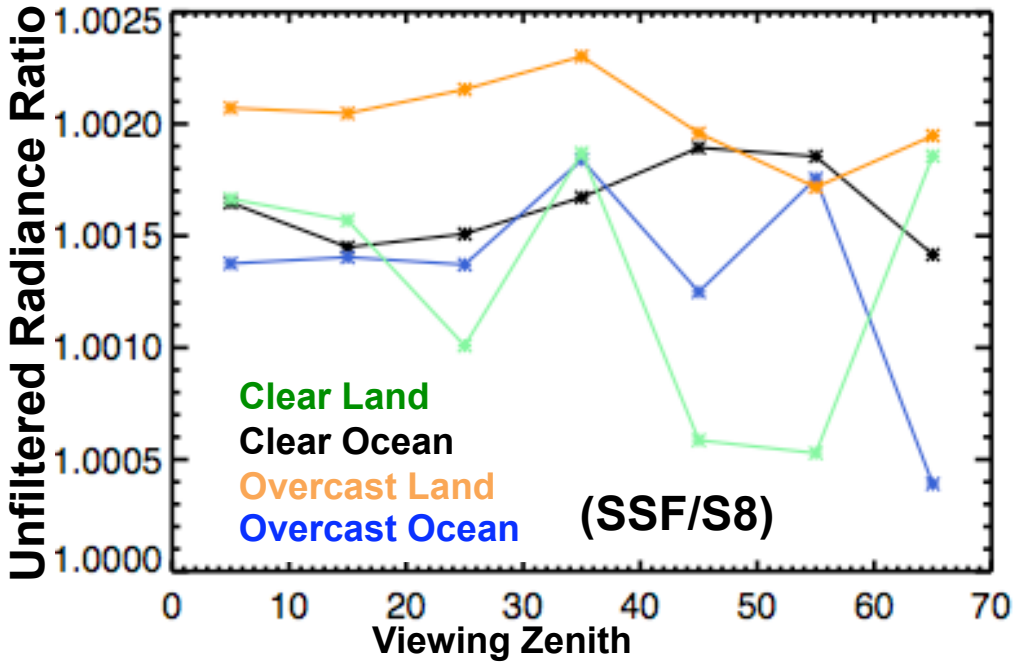


- On average, Unfiltered radiance in SSF is higher by 0.4%.
- Except at the last bin, the unfiltered radiance ratio appears to be less dependent on the viewing zenith.

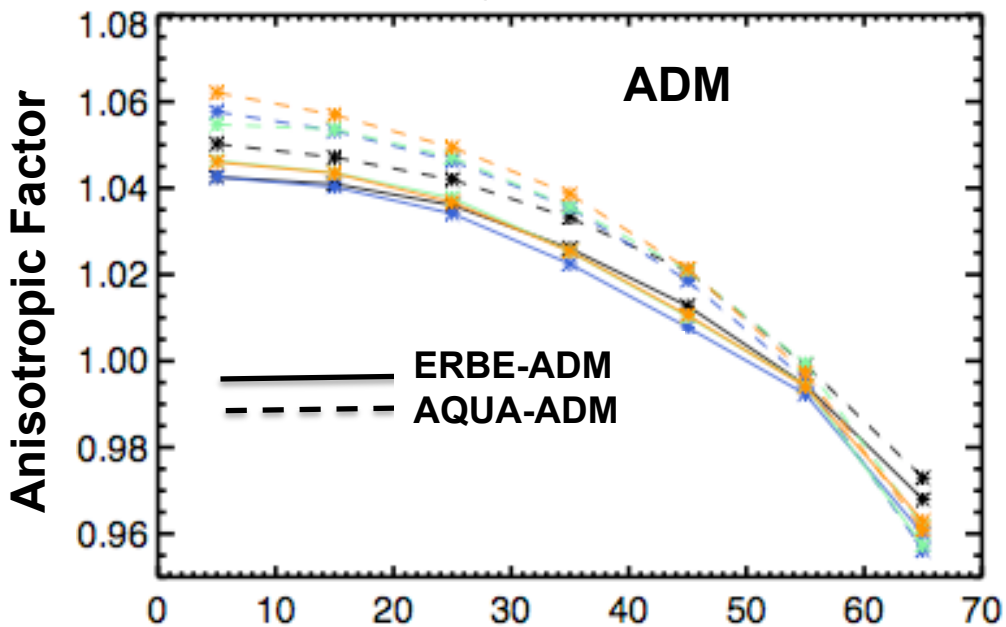
- On average, 10% variation is observed in LWDT ADM.

- ADM variation is higher in AQUA compared to ERBE suggesting AQUA-ADM more anisotropic than ERBE-ADM.

Viewing Angle Dependence (LWNT)

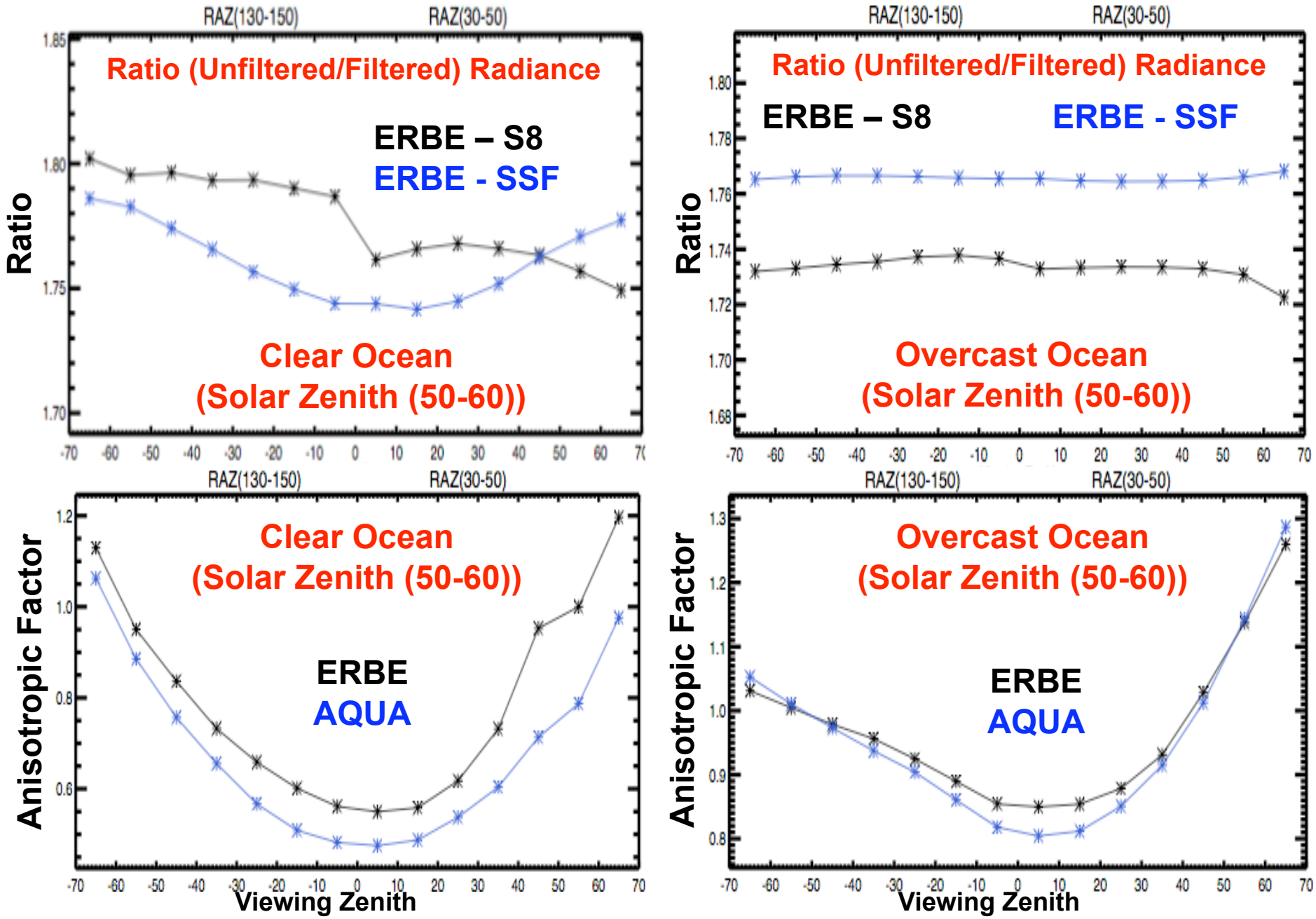


- On average, Unfiltered radiance in SSF is higher by 0.2%.



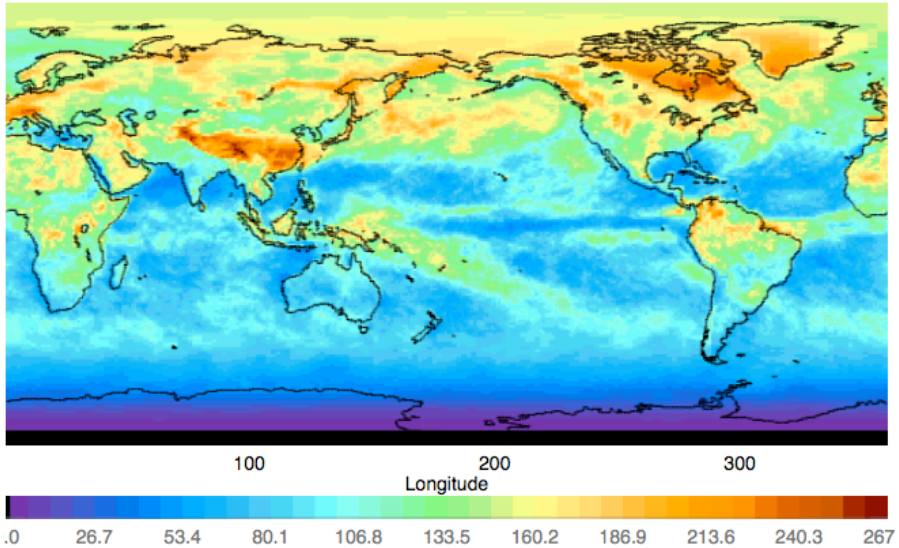
- On average, 10% variation is observed in LWDT ADM.
- ADM variation is higher in AQUA compared to ERBE suggesting AQUA-ADM more anisotropic than ERBE-ADM.

Angle Dependence (SWDT)

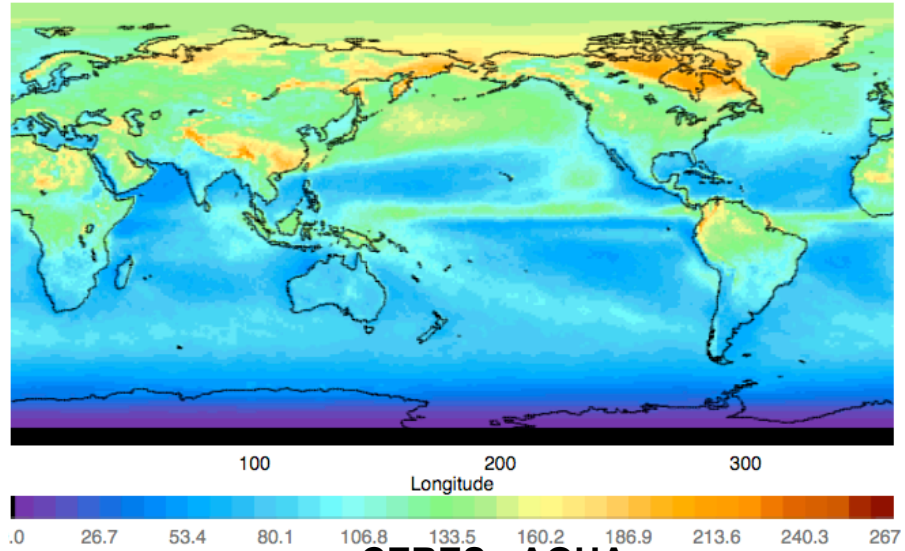


CERES-Like ERBE - NOAA-9 SSF1-deg

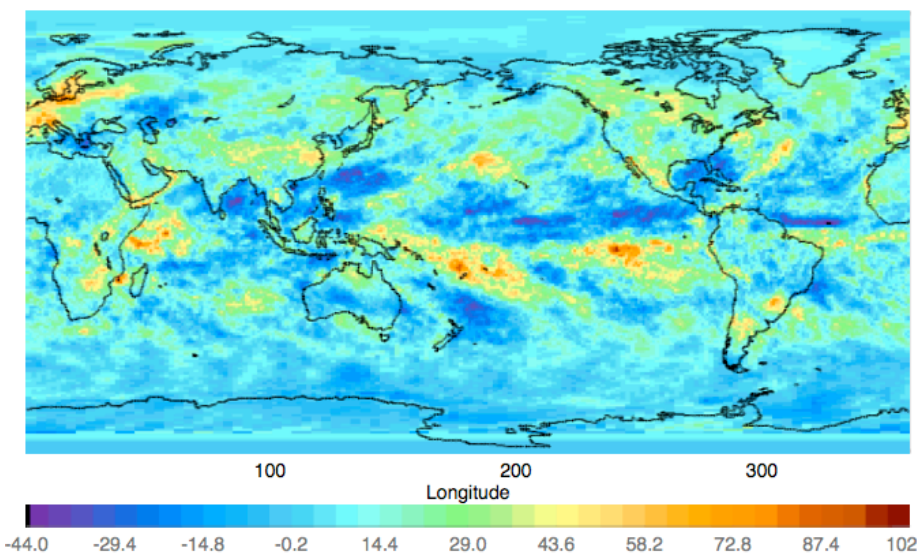
Monthly Product (April – 1986) – All Sky Shortwave



ERBE-NOAA-9



CERES - AQUA



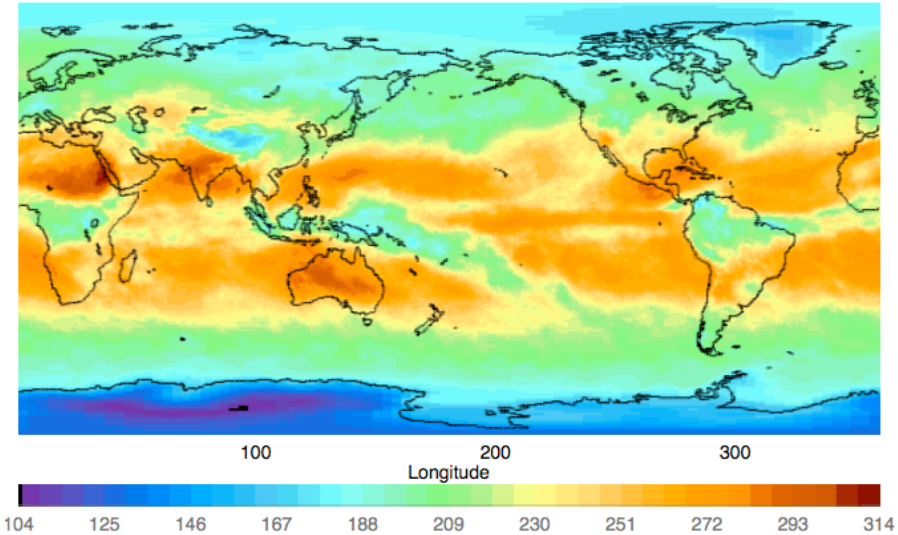
[(NOAA9 - AQUA)/(AQUA)] * 100

TOA Flux Monthly Mean (W/m^2)		
CERES-AQUA	ERBE-NOAA9	NOAA9 - AQUA
94.9 ± 0.34	105.1	10.2

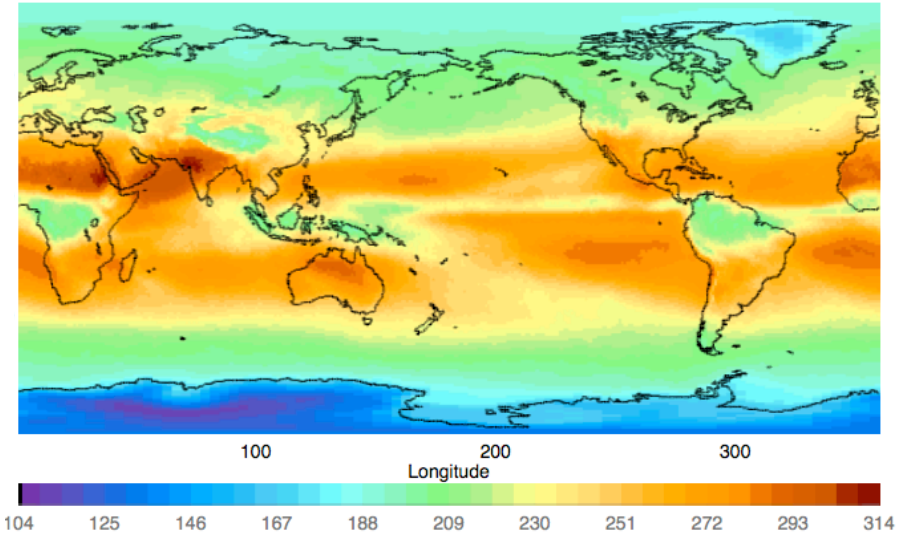
- **NOAA9 is brighter compared to AQUA in shortwave**

CERES-Like ERBE - NOAA-9 SSF1-deg

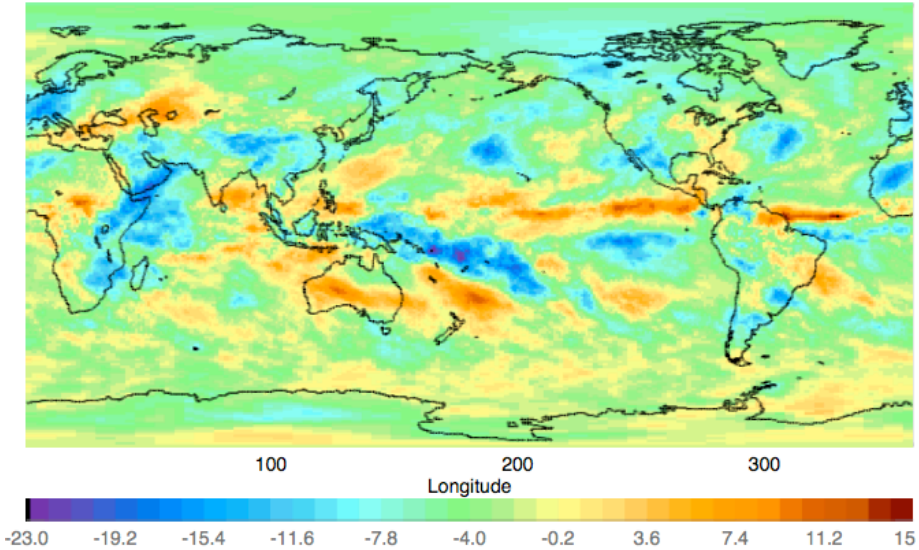
Monthly Product (April – 1986) – All Sky Longwave



ERBE-NOAA-9



CERES - AQUA



[(NOAA9 – AQUA)/(AQUA)] * 100

TOA Flux Monthly Mean (W/m^2)		
CERES-AQUA	ERBE-NOAA9	NOAA9 - AQUA
237.4 ± 0.36	228.8	-8.6

- NOAA9 is colder compared to AQUA in longwave

CERES Like ERBE - NOAA-9 SSF1deg

Monthly Product – All Sky

SSF1deg All Sky Monthly Mean (W/m^2)						
Month (Year – 1986)	Shortwave TOA Flux			Longwave TOA Flux		
	ERBE NOAA9-S4	CERES NOAA9	CERES AQUA	ERBE NOAA9-S4	CERES NOAA9	CERES AQUA
Apr	100.1	105.1	94.9 ± 0.34	229.8	228.8	237.4 ± 0.36
Jul	98.3	101.6	91.4 ± 0.59	237.3	236.0	242.8 ±0.34
Oct	100.7	104.4	96.8 ± 0.42	233.8	232.6	238.9 ± 0.35
Dec	109.3	112.2	103.7 ± 0.64	227.0	225.5	235.7 ± 0.34

NET Flux (W/m^2)			
Month (Year – 1986)	NOAA-9		CERES
	S4	SSF	AQUA
Apr	9.8	5.8	7.4
Jul	-1.4	-3.4	0.0
Oct	9.1	6.6	7.9
Dec	18.5	17.1	15.4

- **For these months, ERBE-NOAA9 estimates for shortwave (longwave) flux are always brighter (colder) than those from CERES-AQUA.**
- **On average shortwave TOA flux estimates from NOAA-9 are 8.5 W/m^2 brighter than AQUA, while it is 8.1 W/m^2 colder in longwave.**
- **However, NOAA-9 net flux compares favorably to CERES-Aqua values.**

ERBE_NOAA-9 Scanner and WFOV

Instantaneous Measurement Comparison

Month	Shortwave Daytime					
	Slope	Intercept	WFOV Mean	Scanner Mean	Scanner - WFOV	% DIFF
Apr-86	1.0441	-2.3656	229.0	236.7	7.7	3.4
Jul-86	1.0205	3.6939	281.7	291.1	9.4	3.3
Oct-86	1.0402	-0.0990	200.5	208.4	7.9	3.9
Dec-86	1.0219	5.3566	269.1	280.4	11.3	4.2

Month	Longwave Nighttime					
	Slope	Intercept	WFOV Mean	Scanner Mean	Scanner - WFOV	% DIFF
Apr-86	0.9815	1.5913	241.3	238.4	-2.9	1.2
Jul-86	0.9874	1.4898	221.0	219.7	-1.3	0.6
Oct-86	0.9866	2.0551	254.5	253.1	-1.4	0.6
Dec-86	0.9997	-2.0237	201.6	199.6	-2.0	1.0

Month	Longwave Daytime					
	Slope	Intercept	WFOV Mean	Scanner Mean	Scanner - WFOV	% DIFF
Apr-86	0.9854	3.5480	242.8	242.8	0.0	0
Jul-86	1.0105	-2.5118	240.3	240.3	0.0	0
Oct-86	1.0134	-3.5352	263.3	263.3	0.0	0
Dec-86	1.0596	-14.1150	236.6	236.6	0.0	0

Summary

- The comparison of instantaneous monthly global mean of TOA flux in ERBE-S8 and ERBE-SSF suggests
  - ERBE-SSF brighter (~4.5%) than ERBE-S8 in shortwave, while
  - ERBE-SSF colder (~0.9%) than ERBE-S8 in longwave (both daytime and nighttime)
- Similarly, monthly SSF-1deg monthly product comparison of ERBE-NOAA9 and CERES-AQUA suggest
  - Brighter shortwave flux in ERBE-NOAA9, while
  - Colder longwave flux in ERBE-NOAA9.
- For four months of data, shortwave flux estimate from NOAA-9 are 8.5 W/m^2 brighter, while it is 8.1 W/m^2 colder in longwave flux estimates.
- NOAA-9 Scanner and Non-Scanner instantaneous measurement suggests
  - Scanner measurement brighter (3.7% in an average) for daytime shortwave channel.
  - Colder scanner measurements (0.8% in an average) in nighttime longwave channel.

Future Work

- **Reprocess other months of data for NOAA-9 and NOAA-10**
- **Compare scanner and Nonscanner measurements on NOAA-10**
- **Compare Nonscanner measurements on ERBE Satellites**