TISA (Time-Space Averaging) Update

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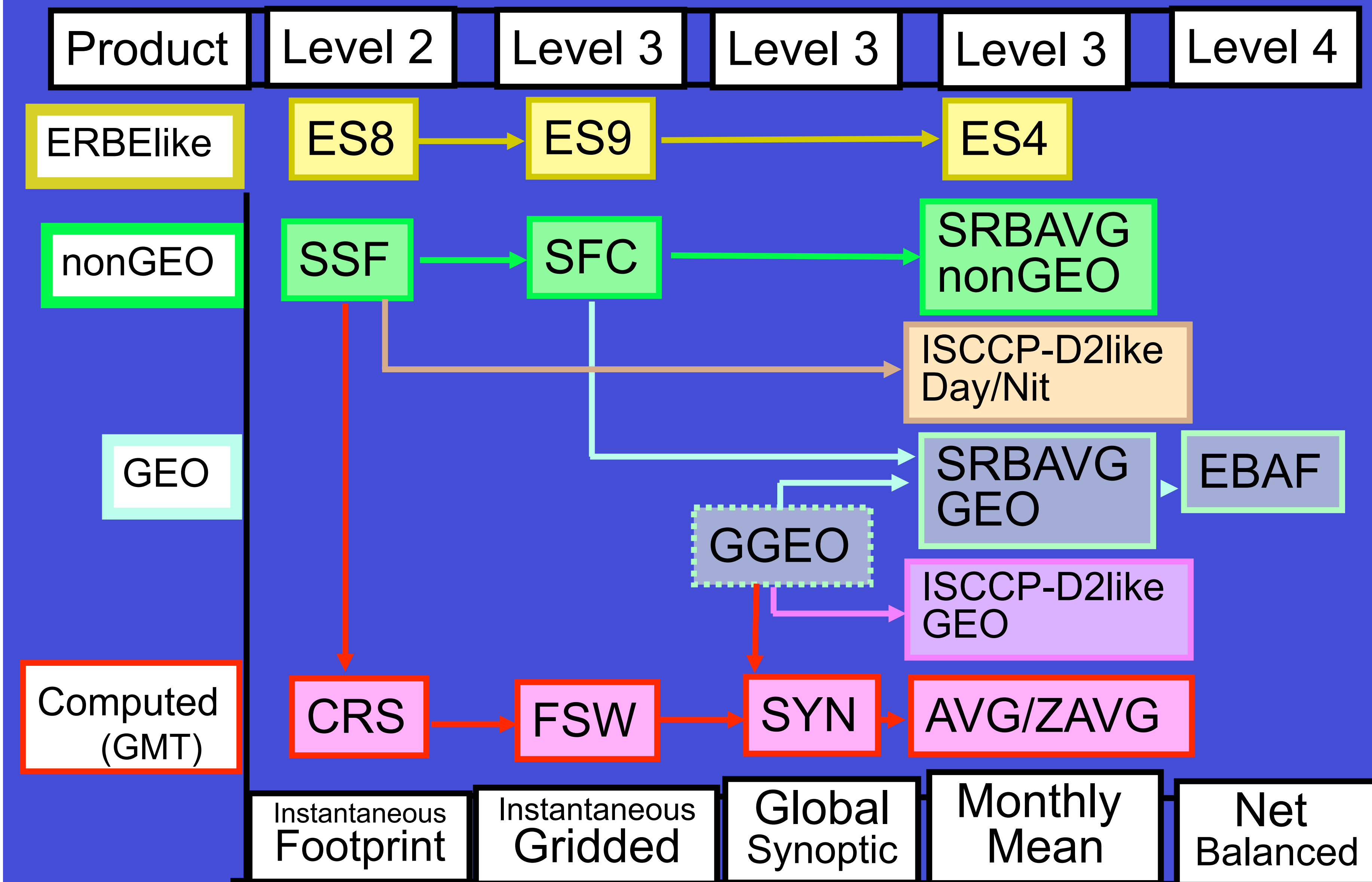
11th CERES-II Science Team Meeting
Ciy Center at Oyster Point, Newport News, VA, April 28-30, 2009

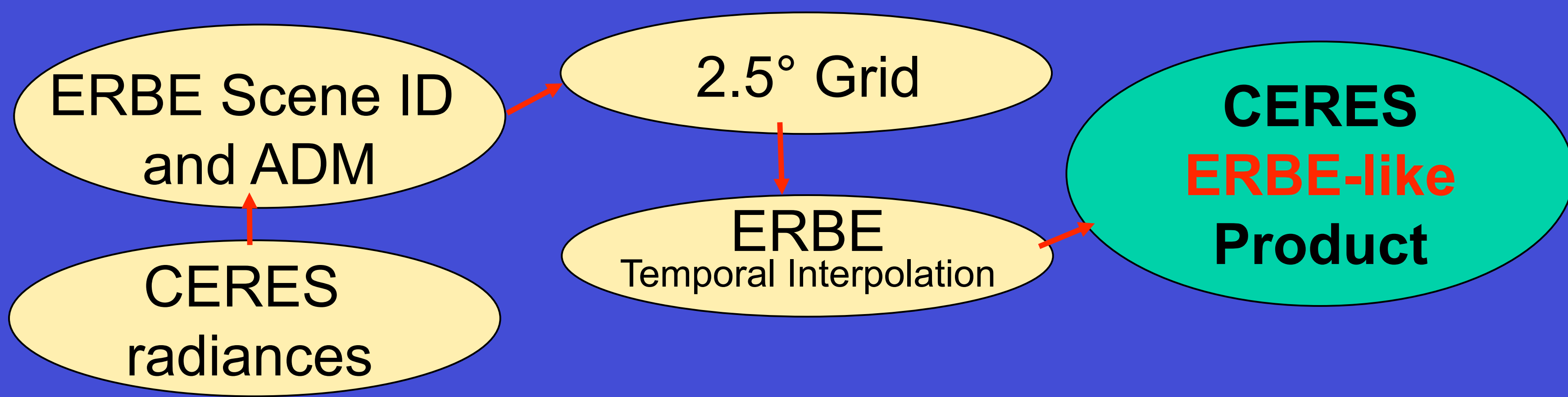
Outline

- Introduction to CERES monthly averaged products
  - Public release of the SYN/AVG/ZAVG Edition2 product
  - TOA and Surface flux comparison of CERES products
  - Product status
- Surface flux validation of SYN/AVG/ZAVG product
- MTSAT calibration update
- Diurnal EOF analysis of GEO derived BB fluxes to ensure added value
  - Compare with nonGEO and GERB
- GEO cloud property normalization with MODIS for the ISCCP-D2like merge product
  - Moguo Sun presentation


Product
Level 2
Level 3
Level 3
Level 3
Level 4
ERBElike
ES8
ES9
ES4
nonGEO
SSF
SFC
SRBAVG nonGEO
ISCCP-D2like Day/Nit
GEO
SRBAVG GEO
EBAF
GGEO
ISCCP-D2like GEO
Computed (GMT)
CRS
FSW
SYN
AVG/ZAVG
Instantaneous Footprint
Instantaneous Gridded
Global Synoptic
Monthly Mean
Net Balanced

ERBE-like Product

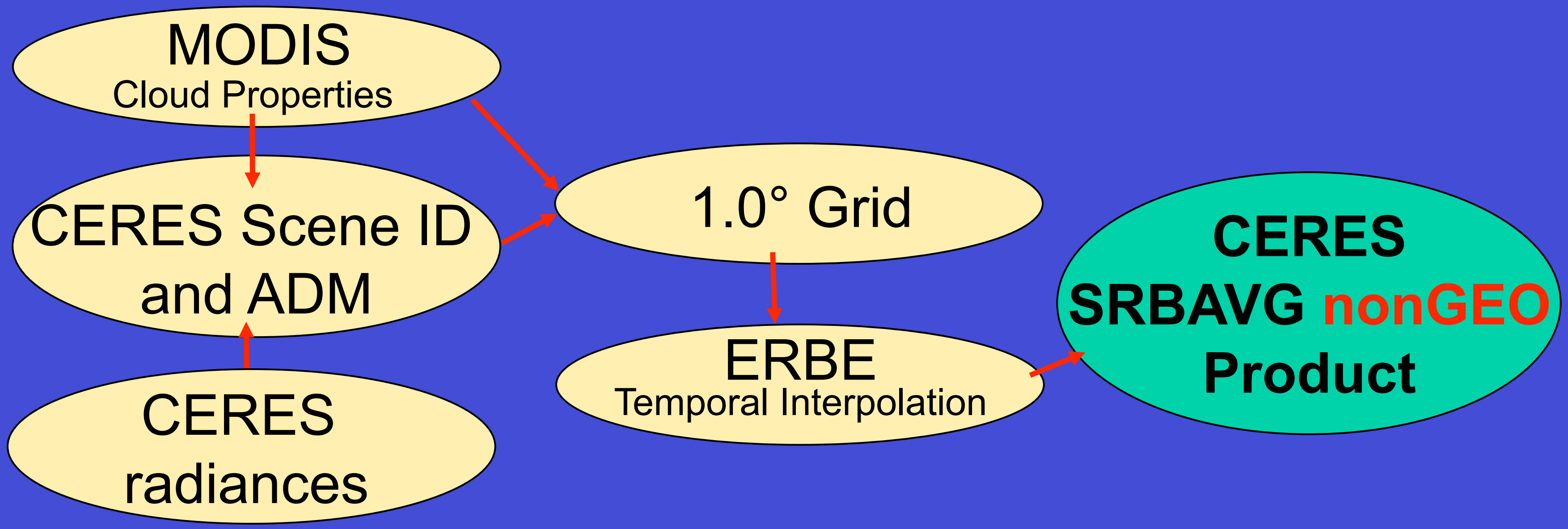
- Product Features:
  - – Based on ERBE algorithms and in the same format (ES-4 & ES-9) as the original ERBE scanner dataset (1985-1989)



- Appropriate Usage:
  - – To compare with historical ERBE (1985-1989) fluxes to ensure that flux differences are not associated with CERES algorithm improvements

SRBAVG nonGEO Product

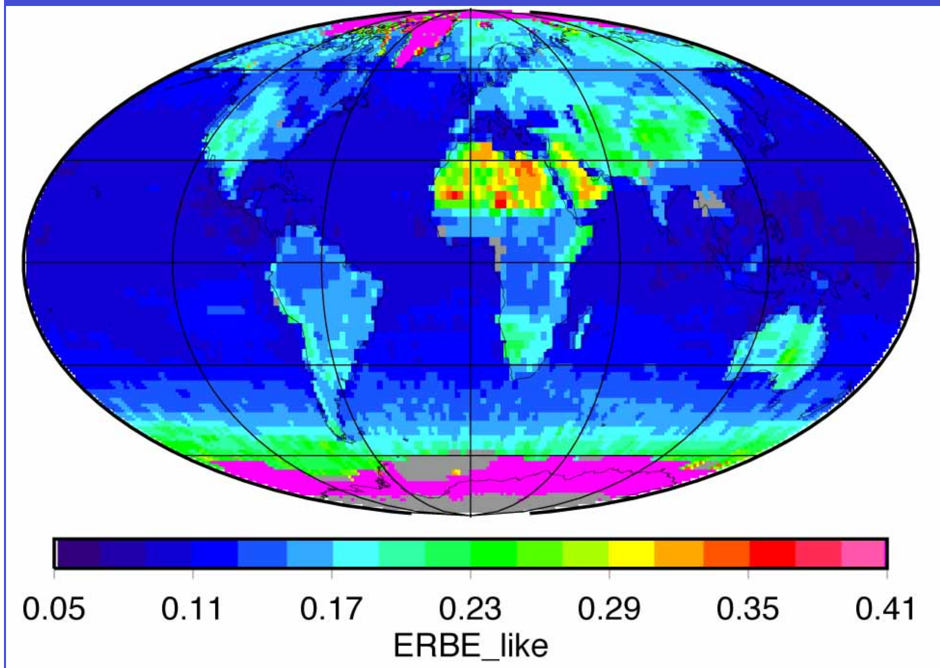
- Product Features:
  - CERES TOA fluxes and MODIS cloud properties



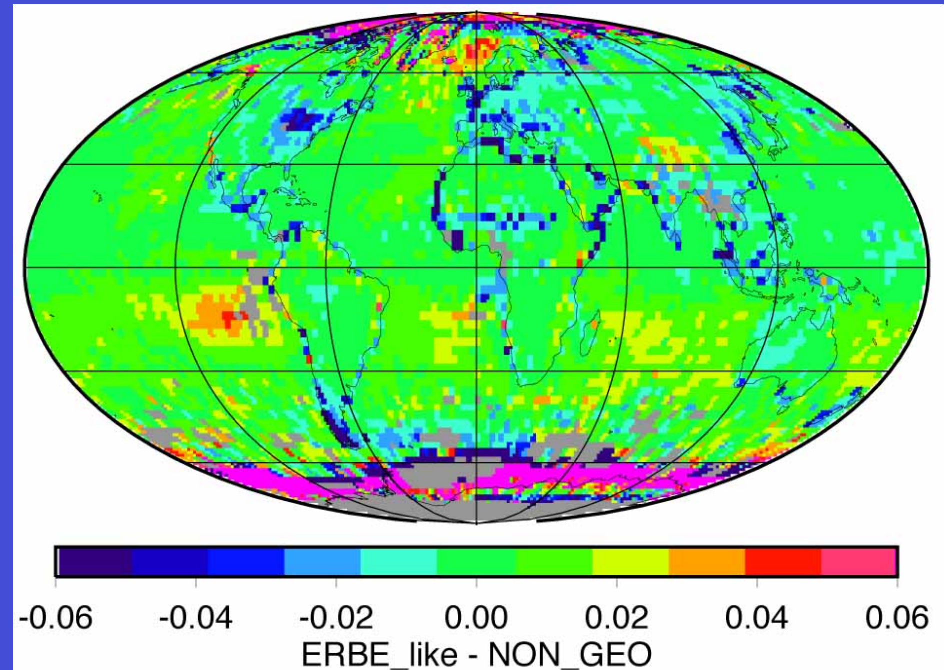
- Appropriate Usage:
  - **SSF/SFC** products provide the instantaneous fluxes
  - Fluxes and cloud properties are sampled only during Terra overpasses

Aug 2002 Clear-sky Albedo

ERBE like mean



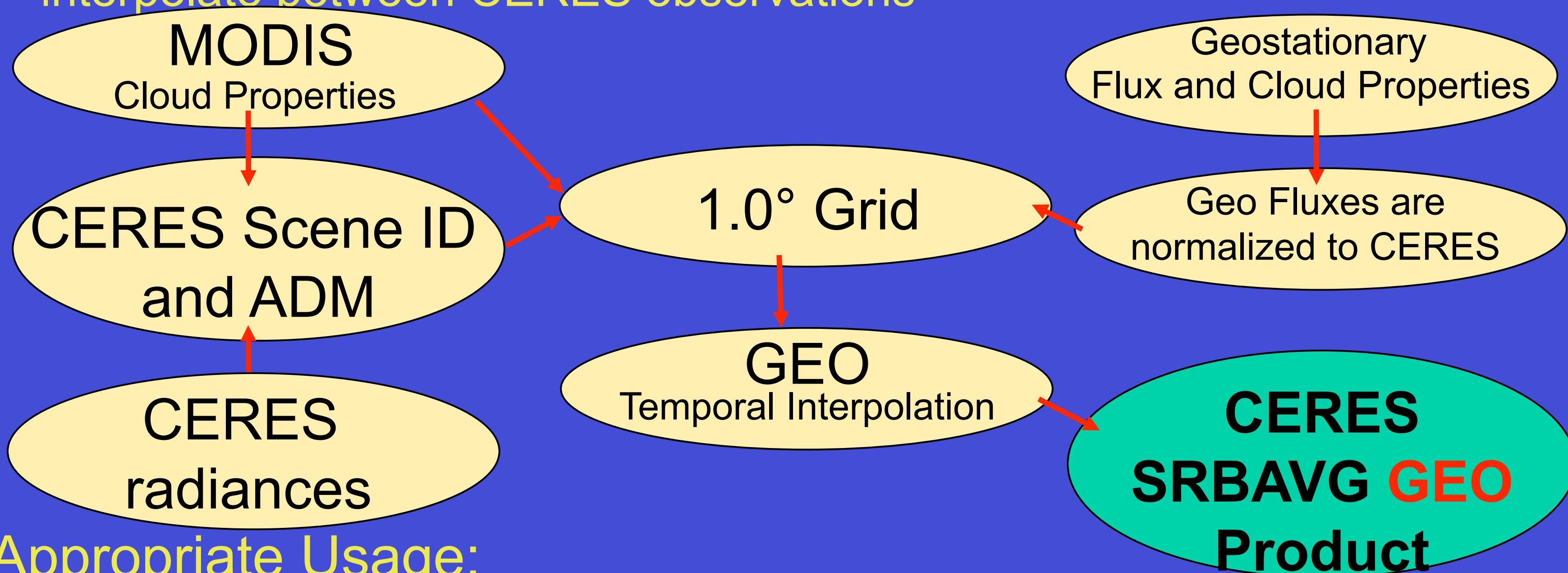
ERBE like - nonGEO



- The CERES ADMs and scene identification is an improvement over ERBE-like
  - especially clear-sky scene identification, and polar cloud retrievals
- CERES ADMs show no dependencies with cloud properties or regionally

SRBAVG GEO Product

- Product Features:
  - TOA and surface fluxes and MODIS/GEO cloud properties
  - Uses 3-hourly geostationary derived fluxes and cloud properties to interpolate between CERES observations

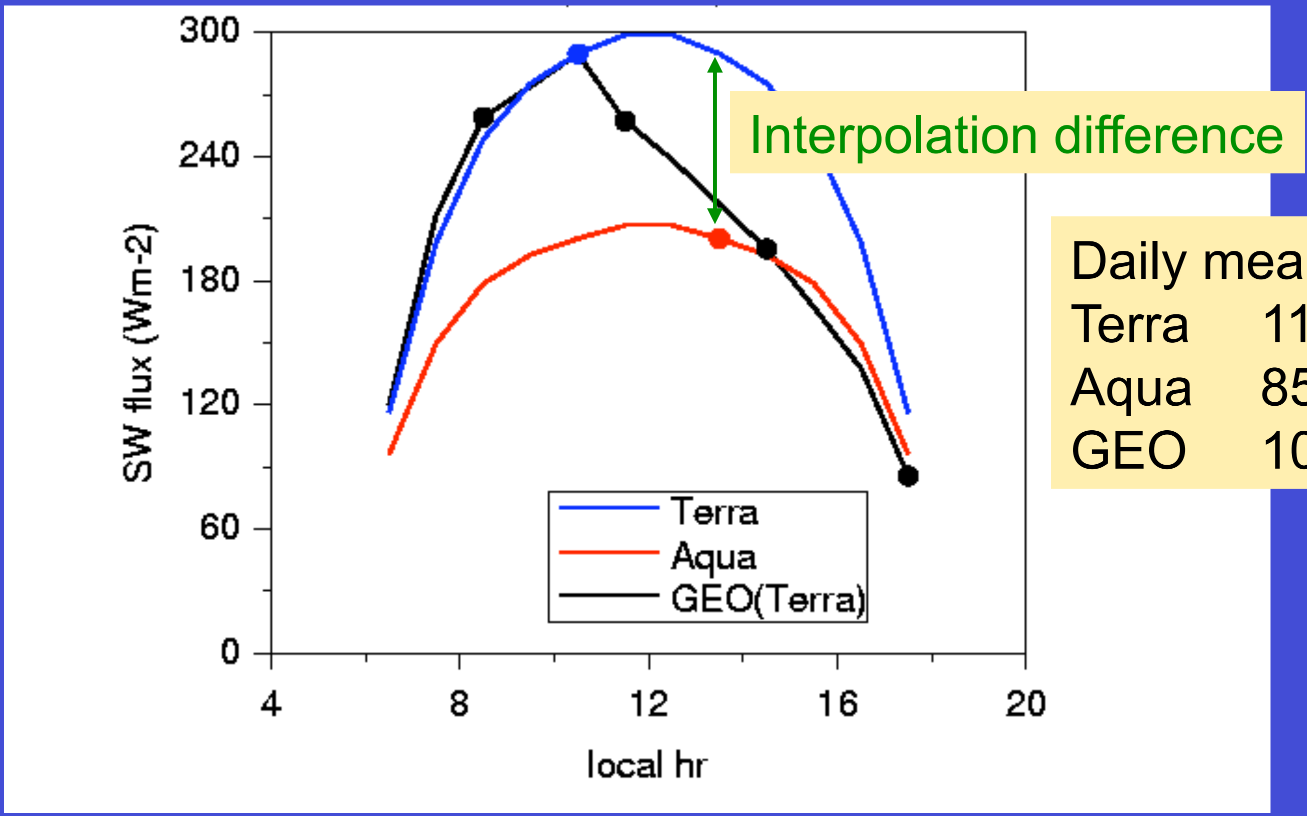


- Appropriate Usage:
  - The SRBAVG GEO product is the most robust diurnally averaged CERES TOA monthly mean flux product and of climate quality

SW Diurnal Averaging

Convert instantaneous measured flux to daily mean flux

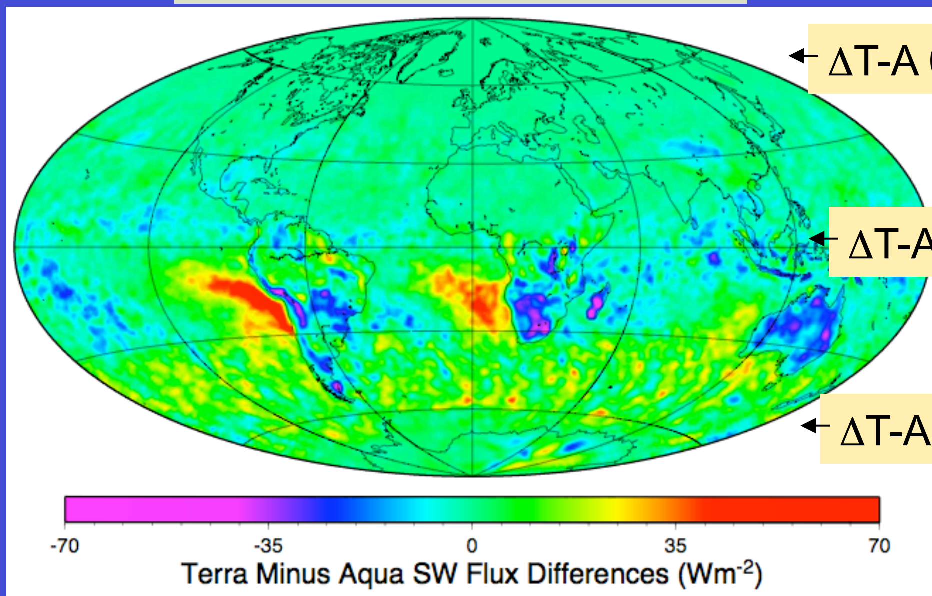
Example: Peruvian stratus region



Daily mean (Wm-2)	
Terra	119.0
Aqua	85.4
GEO	102.3

Terra (10:30 LT) - Aqua (1:30 LT) monthly CERES SW flux differences Dec 2002

CERES only fluxes

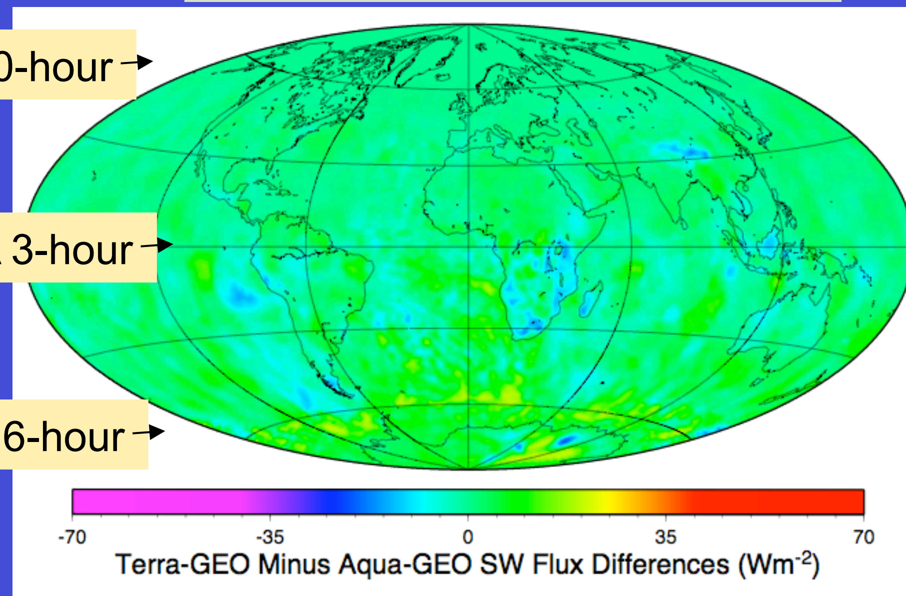


ΔT-A 0-hour

ΔT-A 3-hour

ΔT-A 6-hour

CERES & GEO fluxes



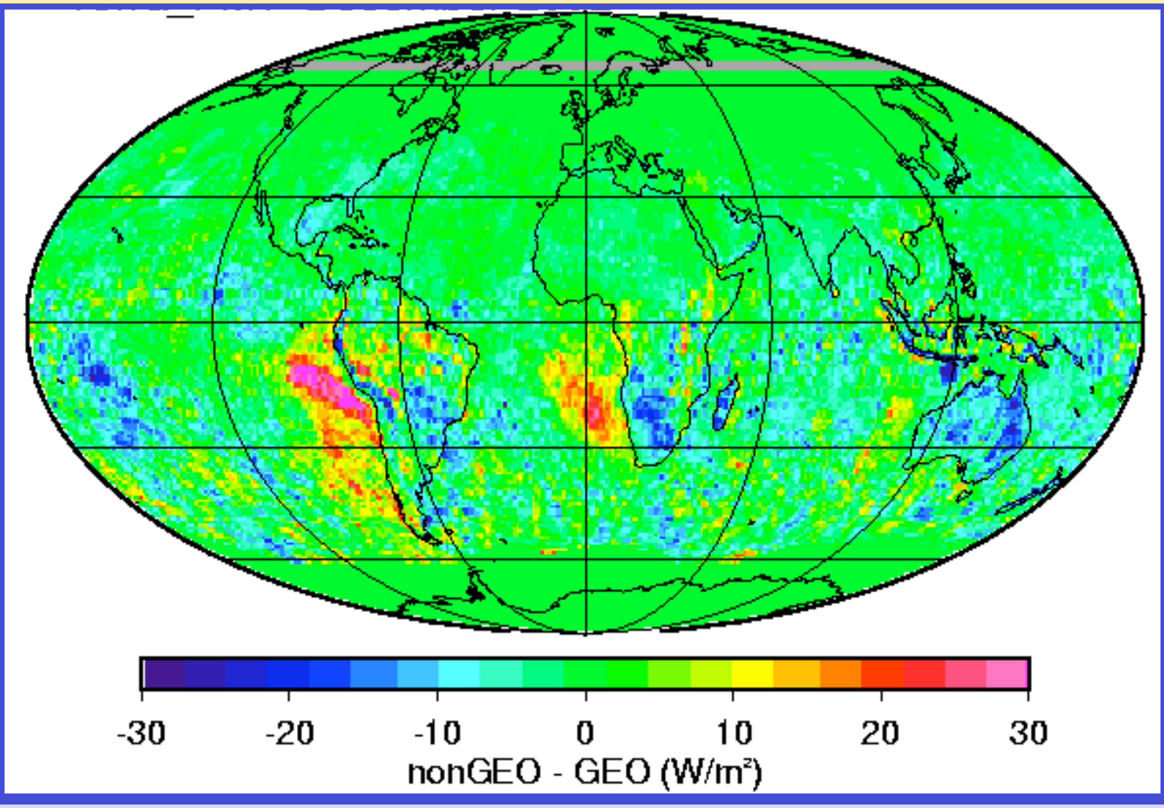
Regional rms=11.7 Wm^{-2} (11.1%)

Regional rms=4.6 Wm^{-2} (4.3%)

- Terra fluxes > Aqua fluxes over marine stratus regions (morning clouds)
- Aqua fluxes > Terra fluxes over land afternoon convection regions
- The merged GEO fluxes have removed the CERES sampling bias of the diurnal cycle

Terra nonGEO - GEO SW monthly mean Dec 2002

- nonGEO = CERES fluxes and ERBE (constant meteorology) temporal averaging
- GEO = CERES fluxes utilizing GEO fluxes for temporal interpolation



- Regional monthly differences can be > 20 Wm^{-2}
- Global bias is - 1.0 Wm^{-2}

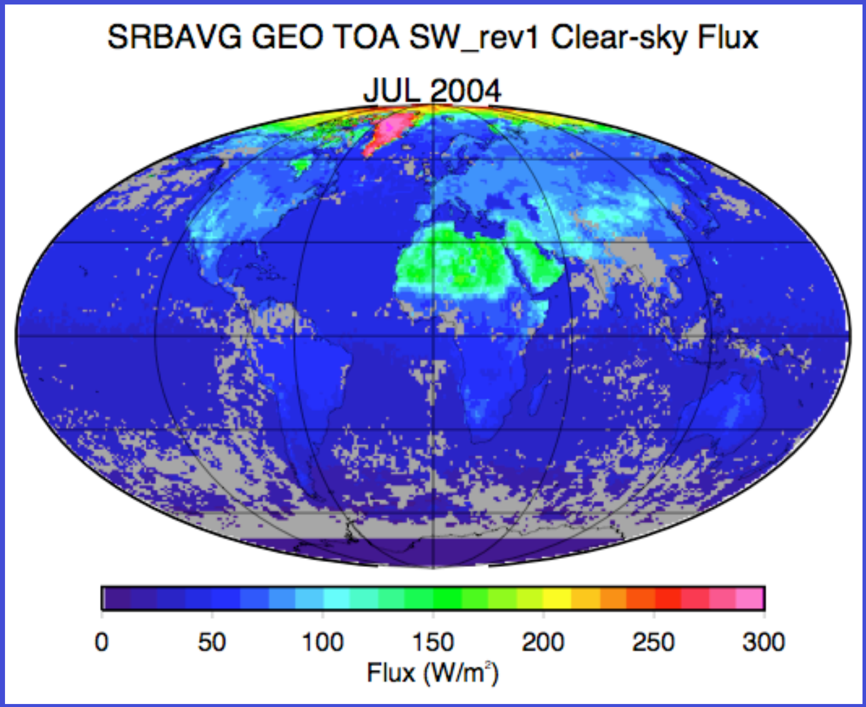
EBAF Product

- Energy Balanced and Filled (EBAF) Product Features:
  - TOA fluxes where the global net is constrained to the ocean heat storage (~0.9 Wm^{-2}) in the Earth-atmosphere system, taking into the CERES calibration and algorithm uncertainties
  - Spatially interpolates (fills) fluxes for all non observed (mainly clear-sky) regions
  - netCDF product that is Climate and Forecast (CF) compliant

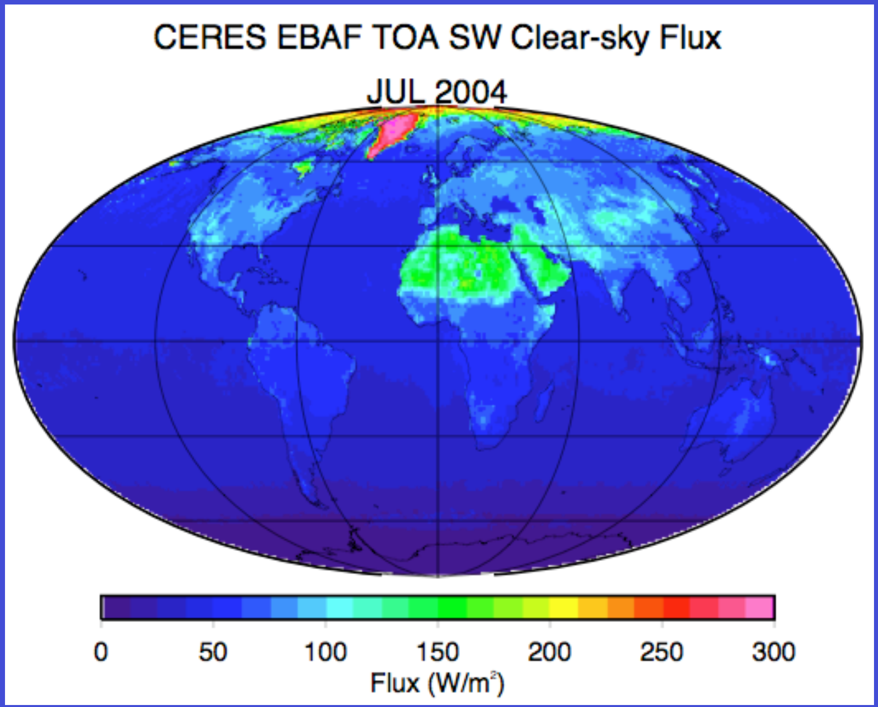
- Appropriate Usage:
  - The EBAF is for climate model evaluation
  - Estimating the Earth's annual global mean energy budget
  - Studies that infer meridianal heat transports

July 2004 Clear-sky SW

SRBAVG-GEO



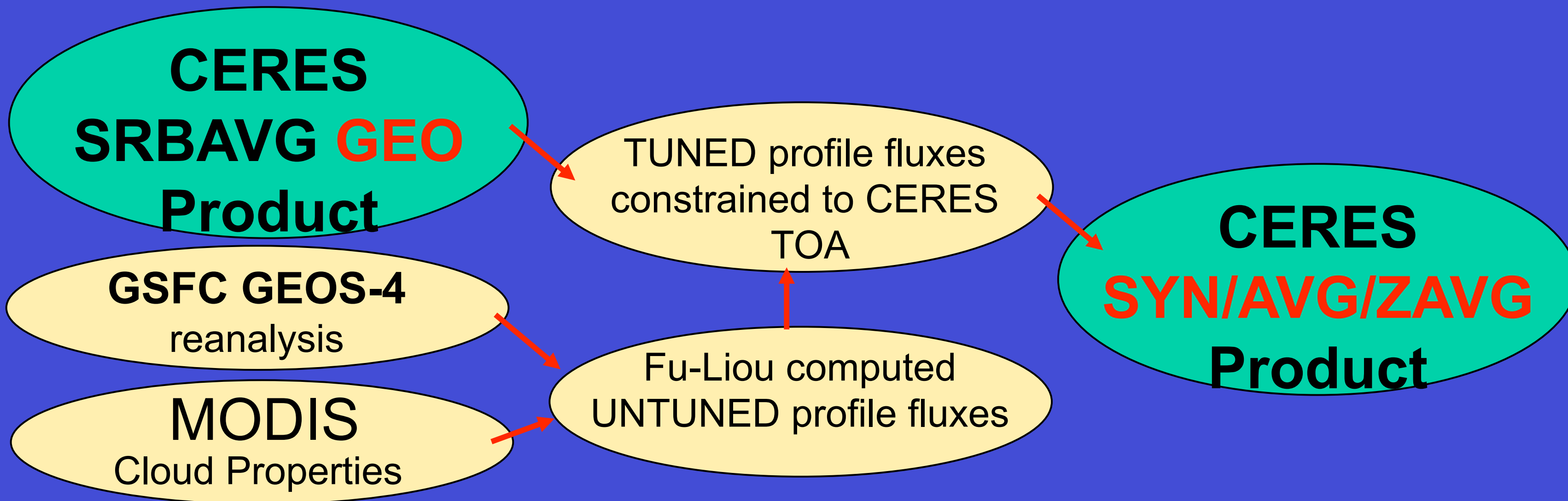
EBAF



- Note the amount of missing clear-sky SW regional fluxes
- CERES requires that 99% of the MODIS pixels within a CERES footprint are clear to be classified as clear-sky
- Missing clear-sky fluxes are based on MODIS derived broadband clear-sky pixel radiances

SYN/AVG/ZAVG Product

- Product Features:
  - –Surface and atmosphere Fu-Liou radiative transfer modeled fluxes consistent with CERES observed TOA fluxes



- Appropriate Usage:
  - – SYN fluxes and cloud properties can be compared directly with climate model results at the 3-hourly or monthly level
  - – Fluxes at the surface, 500mb, 200mb, 70mb and TOA levels
  - – Fluxes under pristine, clear-sky, all-sky (no aerosol), and all-sky conditions
  - – Best surface and profile fluxes available

SYN/AVG/ZAVG released as Edition2

Available at the Langley DAAC under CERES Data Products

http://eosweb.larc.nasa.gov/PRODOCS/ceres/level3_syn-avg-zavg_table.html

Monthly Regional Radiative Fluxes and Clouds (AVG): Monthly and monthly hourly (3-hour) averages of the SYN product.				
Select Parameters: Clear-sky and All-sky TOA Fluxes, Surface Radiative Fluxes, OLR, Clear-sky and All-sky Albedo, Cloud Properties, Surface Types, Radiative Flux Profiles				
Documents: Description/Abstract				
Spacecraft	**Data Set Name** (Select name to order)	**Data Products Catalog (PDF)**	**Sample Software**	**Temporal Coverage (Monthly)**
Aqua (covers opened 06/18/2002)	CER_AVG_Aqua-FM3-MODIS_Edition2B. CER_AVG_Aqua-FM4-MODIS_Edition2B. Quality Summary Edition2 - Terra 2C and Aqua 2B.	DPC_AVG_R5V1	Readme R5-691 | Read Package R5-691.	07/2002 - 07/2003 (sequential dates may require both FM3 and FM4)
Terra (covers opened 02/25/2000)	CER_AVG_Terra-FM1-MODIS_Edition2C. CER_AVG_Terra-FM2-MODIS_Edition2C. Quality Summary Edition2 - Terra 2C and Aqua 2B.			03/2000 - 03/2001 (sequential months may require both FM1 and FM2)

- The Terra record is complete to October 2005 and there is one year of Aqua
- The Data Quality Summary has been updated and demonstrates that the GEO cloud properties add value to the computed surface fluxes

Global mean TOA flux comparison

Mar00-Feb04			CERES						SRB	ISCCP	NCEP
TOA		ERBE-like	SRBAVG		EBAF	SYN/AVG/ZAVG				FD	reanalysis
			Non-GEO	GEO		Obs	untuned	tuned			
SWdn		341.3	341.3	341.3	340.0	341.3	341.3	341.3	341.8	341.3	344.2
All-sky	OLR	239.0	237.7	237.2	239.7	238.8	237.8	238.1	240.5	235.6	238.5
	SW	98.3	96.6	97.7	99.5	98.0	98.3	97.8	101.8	105.2	117.3
	NET	3.9	7.0	6.5	0.85	4.6	5.2	5.4	-0.4	1.0	-11.6
Clear-sky	OLR	266.7	266.4	264.1	269.5	265.9	262.4	262.7	268.0	262.0	270.3
	SW	49.3	51.2	51.1	52.5	51.0	52.2	52.3	53.7	54.6	54.8
	NET	25.3	23.8	26.2	18.1	24.3	26.7	26.3	20.1	25.3	19.1
Cloud Forcing	OLR	27.6	28.6	26.9	29.8	27.3	24.6	24.6	27.4	26.4	31.7
	SW	-49.0	-45.4	-46.6	-47.1	-47.0	-46.1	-45.5	-47.5	-50.9	-62.5
	NET	-21.4	-16.8	-19.7	-17.3	-19.7	-21.5	-20.9	-20.0	-24.5	-30.7

ADM improvement

Diurnal improvement

Net balanced

LW Ed3β

Computed

Tune to CERES (Obs)

ISCCP clouds

Modeled

Global mean surface flux comparison

Mar00-Feb0 4		CERES SRBAVG-GEO		CERES SYN/AVG/ZAVG		SRB		ISCCP	NCEP
SURFACE		ModelA	ModelB	untuned	tuned	SRB	QC	FD	renalysis
All-sky	SWup		24.2	23.1	23.2	21.9	22.6	22.9	26.8
	SWdn		194.9	189.0	189.8	188.7	181.8	188.7	188.0
	SWnet		170.7	165.9	166.6	166.8	159.2	165.8	161.2
	LWup		392.0	397.9	398.1	397.1	399.1	393.7	397.4
	LWdn		344.1	342.2	342.1	342.9	346.7	345.4	340.4
	LWnet		-47.9	-55.7	-56.0	-54.2	-52.4	-48.3	-57.0
	Net		123.7	110.2	110.6	112.6	106.9	117.5	104.2
Clear-sky	SWup	30.2	30.9	28.5	28.5	28.6		28.7	
	SWdn	242.7	245.3	243.8	243.8	248.0	243.1	248.3	280.1
	SWnet	212.5	214.4	215.3	215.3	219.4		219.6	
	LWup	397.6	391.4	397.2	397.5	396.6		392.2	
	LWdn	313.1	313.5	315.3	315.2	308.3	313.3	313.9	312.7
	LWnet	-84.5	-77.9	-81.9	-82.3	-88.3		-78.3	
	Net	128.0	136.5	133.4	133.0	131.1		141.3	

CERES Monthly Gridded Averaged Data Products

CERES PRODUCT	TRMM Jan98-Aug98 & Mar00	Terra Mar00-present	Aqua Jul02-present
ERBE-like (ERBElike Monthly TOA Flux Averages)	**Ed2**	**Ed1-CV** (to Mar09) **Ed2** (Mar00-Aug07)	**Ed1-CV** (to Mar09) **Ed2** (Jul02-Aug07)
SRBAVG (Monthly TOA/Surface Flux and Cloud Averages) Contains both nonGEO and GEO	**Ed2B**	**Ed2D**(Mar00-Oct05) (Nov05-Aug07) Fall 09	**Ed2D**(Jul02-Oct05) (Nov05-Aug07) Fall 09
SRBAVG Include daily parameters		**Ed2E/F** (Mar00-Aug07) Fall 09	**Ed2E/F** (Jul02-Aug07) Fall 09
ISCCP-D2like Pc/Tau cloud properties similar to ISCCP-D2 **GGEO Beta1**(Mar00-Aug07) GGEO Ed1 Fall 09 Merged Ed1 Fall 09		**Beta1**(Mar00-Aug07) Day/Nit Ed1 Fall 09 Pc/Tau flux Beta Dec09	**Beta1**(Jul02-Aug07) Day/Nit Ed1 Fall09 Merged Ed1 Fall09 Pc/Tau fluxBetaDec09
EBAF Energy Balanced and filled		**Ed1A**(Mar00-Oct05)	
AVG/ZAVG (Synoptic Monthly TOA/Surface/Profile Flux and Cloud Averages)		**Ed2C/F** (Mar00-Oct04) (to-Oct05) May 09	**Ed2C/F** (Jul02-Jun03) (to-Oct05) Jul 09

- Future products
- SSF, SFC, CRS, FSW products current to Aug07

TISA Data Product Catalogues (DPC) have been updated

- When the CERES project lead can't read your data based on the DPC, major revisions were needed
  - All TISA dimensions were based on the assumption the user had read the entire DQS and most CERES documents

BEFORE

SDS Name	Units	Range	Dimen-sions	DataType
Tuned Total-Sky SW Up	W m^{-2}	0 .. 1400	18 x 5	32-bit real
Tuned Total-Sky SW Down	W m^{-2}	0 .. 1400	18 x 5	32-bit real
Tuned Total-Sky LW Up	W m^{-2}	0 .. 850	18 x 5	32-bit real
Tuned Total-Sky LW Down	W m^{-2}	0 .. 700	18 x 5	32-bit real
Tuned Total-Sky WN Up	W m^{-2}	0 .. 370	18 x 5	32-bit real
Tuned Total-Sky WN Down	W m^{-2}	0 .. 370	18 x 5	32-bit real

AFTER

SDS Name	DataType	Units	Range	No of Elements
Tuned Total-Sky SW Up	32-bit real	W m^{-2}	0 .. 1400	Nlon*Nlat*Ngmt*Ns*Nlev
Tuned Total-Sky SW Down	32-bit real	W m^{-2}	0 .. 1400	Nlon*Nlat*Ngmt*Ns*Nlev
Tuned Total-Sky LW Up	32-bit real	W m^{-2}	0 .. 850	Nlon*Nlat*Ngmt*Ns*Nlev
Tuned Total-Sky LW Down	32-bit real	W m^{-2}	0 .. 700	Nlon*Nlat*Ngmt*Ns*Nlev
Tuned Total-Sky WN Up	32-bit real	W m^{-2}	0 .. 370	Nlon*Nlat*Ngmt*Ns*Nlev
Tuned Total-Sky WN Down	32-bit real	W m^{-2}	0 .. 370	Nlon*Nlat*Ngmt*Ns*Nlev

- Obviously the AVG Tuned Total-sky SW Up dimension 18x5 was meaningless to most users
- All dimensions are now clearly defined so that you could write your read code from the DPC
- All the level 3 TISA products, SYN/AVG/ZAVG, SRBAVG, and ISCCP-like have been updated

ZAVG DPC dimensions defined

Table 2.12-5(a). Nlat, Nlon dimensions that define the CERES equal angle 1° latitude by longitude grid. Nlon is always 1 for zonal and global parameters. Nlat is 1 for global parameters.

Dimension	No of Indices		Definition
	Zonal	Global	
Nlat	180	1	Index #1 is defined at 89.5°N and #180 is at 89.5°S
Nlon	1	1	Index #1 is defined at 179.5°W and #360 is at 179.5°E

Table 2.12-5(b). Ngmt dimension that defines the 8 Monthly 3-hourly GMT time increments. For the Monthly Ngmt only has one index.

Ngmt Index	Monthly 3-hourly	Monthly
1	00-03 GMT	00-24 GMT Monthly
2	03-06 GMT	-
3	06-09 GMT	-
4	09-12 GMT	-
5	12-15 GMT	-
6	15-18 GMT	-
7	18-21 GMT	-
8	21-24 GMT	-

Table 2.12-5(c). NS dimension that define the parameter statistics for individual grid cell.

Ns	Statistic
1	Mean
2	Standard deviation

Table 2.12-5(d). Nlev dimension that define the atmospheric profile levels.

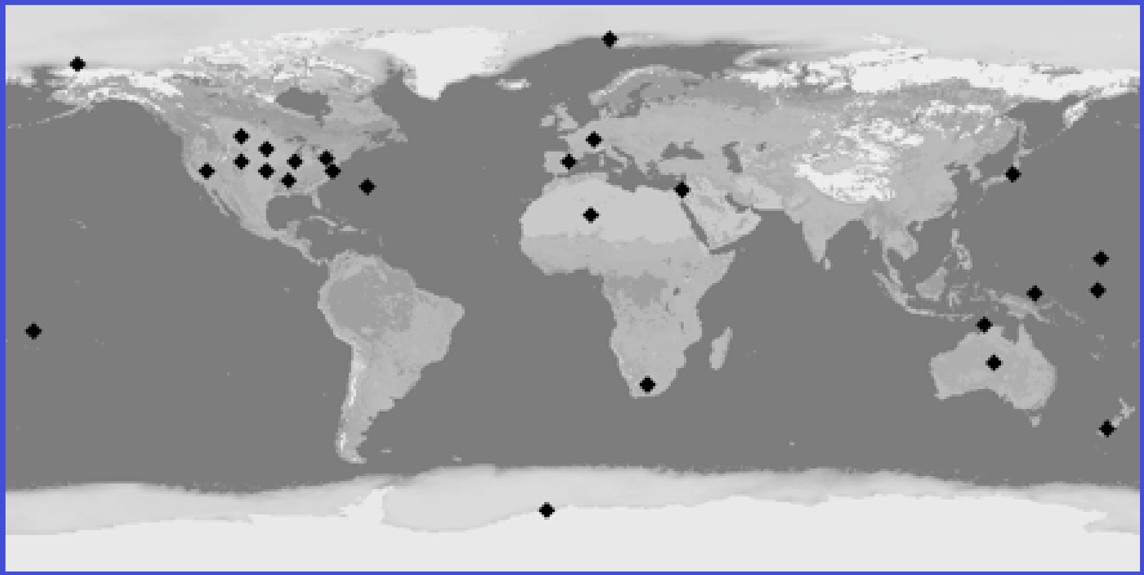
Nlev	Atmospheric level
1	TOA (30 km)
2	70mb
3	200mb
4	500mb
5	Surface

SDS Name	No of Elements
Tuned Total-Sky SW Up	Nlon*Nlat*Ngmt*Ns*Nlev
Tuned Total-Sky SW Down	Nlon*Nlat*Ngmt*Ns*Nlev
Tuned Total-Sky LW Up	Nlon*Nlat*Ngmt*Ns*Nlev
Tuned Total-Sky LW Down	Nlon*Nlat*Ngmt*Ns*Nlev
Tuned Total-Sky WN Up	Nlon*Nlat*Ngmt*Ns*Nlev
Tuned Total-Sky WN Down	Nlon*Nlat*Ngmt*Ns*Nlev

- The monthly mean regional AVG Tuned Total-sky SW Up dataset parameter dimension can easily be attained
360(Nlon)•180(nlat)•1(Ngmt)•2(Ns)•5(Nlev)

Surface flux validation of SYN/AVG/ZAVG product

Comparison of SYN/AVG/ZAVG surface fluxes with 23 surface site radiometers



- Prove that the SYN/AVG/ZAVG surface fluxes are the best product available
- Surface radiometers provide independent flux measurements for validation
  - Surface sites had complete records and of BSRN standard
  - One ARM SGP site was used to keep the global distribution uniform
- Compare monthly means from CERES and other datasets to the surface fluxes
- Next slides are taken from the SYN/AVG/ZAVG DQS

Comparison of Surface flux datasets with surface radiometer fluxes

Dataset	ISCCP-FD	SRB	Model-B	CERES
Clouds	ISCCP	ISCCP	MODIS/GEO	MODIS/GEO
Profile	TOVS	GEOS-4	GEOS-4	GEOS-4

Apr00 to Oct05 seasonal monthly means

Surface Mean (Wm^{-2})	SWdown 195		SWup 44		LWdown 334		LWup 385	
	Bias	Sigma	Bias	Sigma	Bias	Sigma	Bias	Sigma
ECMWF	-4.9	23.8	-9.5	21.8	-0.4	14.3	-0.9	13.9
ISCCP-FD	-1.0	20.6	-15.6	20.5	7.1	20.6	0.3	22.5
SRB	-2.9	22.4	-18.4	29.9	-0.9	11.2	-2.7	13.9
Model B	0.5	24.0	-15.7	32.4	-0.5	10.3	-7.6	15.4
Terra untuned	4.4	12.3	-13.1	21.8	-5.2	10.4	-5.6	16.4
Aqua untuned	3.3	9.8	-14.7	21.6	-5.6	10.4	-5.3	16.4
Terra tuned	4.6	12.4	-13.1	21.6	-5.2	10.3	-5.0	15.9
Aqua tuned	3.7	9.9	-14.5	21.6	-5.5	10.4	-4.8	15.9

Impact of GEO clouds between MODIS measurement time on the computed surface fluxes

- Compute two surface flux dataset using SARB algorithm (Fu-Liou radiative transfer)
- “Merge” the standard product uses 8 3-hourly GEO and 2 MODIS cloud obs daily
- “MODIS-only” uses only the 2 Terra-MODIS cloud observation daily

Hour+:30	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Merge	G	I	I	G	I	I	G	I	I	G	M	I	G	I	I	G	I	I	G	I	I	G	M	I
MODIS	I	I	I	I	I	I	I	I	I	I	M	I	I	I	I	I	I	I	I	I	I	I	M	I

- The MODIS cloud properties are superior to the 2 channel GEO cloud retrievals
- However the GEO clouds are diurnally complete

Terra Surface (%)	SWdown (surface-untuned)		LWdown (surface-untuned)	
	Bias	RMS	Bias	RMS
MODIS	3.1	22	-0.9	7.0
GEO	2.2	31	-1.6	5.5
Interp-CERES	2.2	37	-2.0	6.3
Interp-merge	2.9	32	-1.4	5.7

- The MODIS clouds have a smaller RMS error than GEO clouds with surface obs
- But the interpolated clouds between MODIS-only obs have a > RMS then the merged MODIS and GEO interpolated clouds

Impact of GEO clouds between MODIS measurement time on the computed surface fluxes

- Can GEO clouds improve the computed surface fluxes in a region with diurnally varying clouds?
- The ARM SGP site in summer July 2004 should have clear mornings and afternoon convection
- Determine if GEO clouds improve the computed surface fluxes in the early morning and late evening, hours away from the last MODIS obs

RMS error (%)

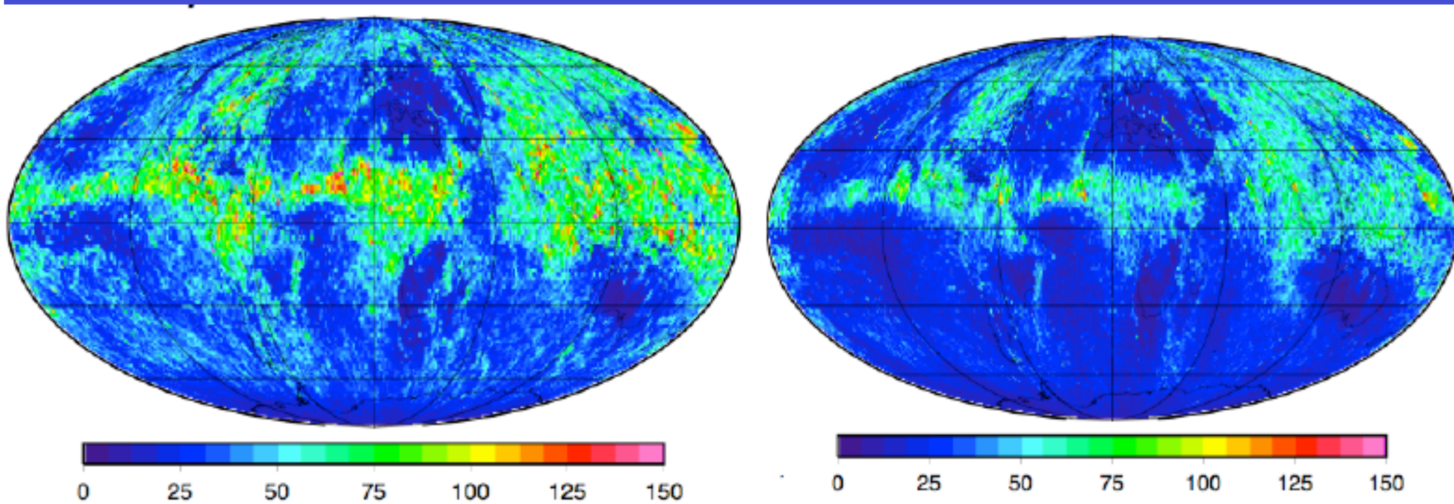
SWdown (%)	Terra (10:30)		Aqua (13:30)	
Local Time	**MODIS**	**merged**	**MODIS**	**merged**
3-9	34	26	39	27
6-12	21	19	25	19
12-18	22	18	19	18
15-21	35	25	33	26

- As predicted the merged GEO clouds have reduced the RMS over MODIS clouds in the early morning and evening hours
- There is even some improvement for all local time increments

Impact of Aqua merged clouds to predict the 10:30AM Terra-MODIS computed TOA flux

- Below are the results instantaneously of Aqua interpolated TOA fluxes versus Terra observed

MODIS-only 56 Wm-2 RMS



Merged 29 Wm-2 RMS

Aqua Interpolated Dataset - Terra measured @10:30
SW RMS error (Wm^{-2}) for July 2004

	SW		LW	
	Untuned	Tuned	Untuned	Tuned
MODIS	55	39	18	14
Merged	31	29	11	10

Impact of Aqua merged clouds to predict the 10:30AM Terra-MODIS computed surface flux

• Are the computed surface flux from the merged clouds from Aqua more consistent with the Terra overpass computed fluxes than from Aqua interpolated for July 2004?

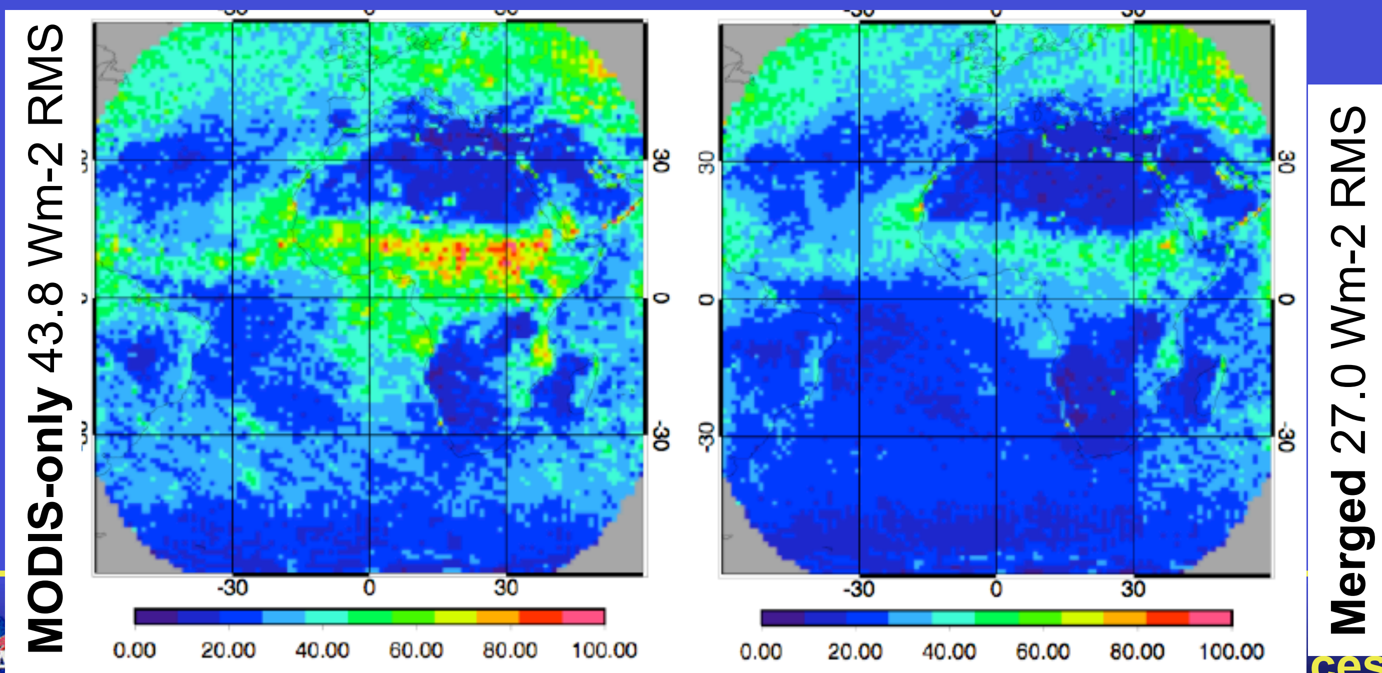
RMS (Wm-^{2}) Aqua interpolated		SWdown	SWup	LWdown	LWup
Model B	MODIS	61	11	13	0.3
	merged	30	9	9	0.2
Untuned	MODIS	45	5	11	0.6
	merged	26	4	10	0.6
Tuned	MODIS	33	5	10	2.3
	merged	24	4	10	2.3

• The merged computed surface fluxes have predicted the Terra-MODIS computed flux better than the Aqua-only interpolated clouds, especially for the SW

• Tuning has a greater impact on CERES-only, since the clouds are not consistent with the fluxes

Impact of Terra merged computed TOA fluxes to predict GERB diurnal fluxes

- GERB TOA measured broadband fluxes are observed every 15 minutes offering an excellent opportunity to compare the merged and CERES-only datasets
- GERB-2 Edition 1 level 2 product TOA fluxes onboard Meteosat-8 during July 2004 have been normalized to the CERES-Terra calibration
  - The normalization adjusts the GERB absolute calibration but leaves the diurnal dynamic range intact
- Compare the computed TOA fluxes derived from the Terra merged and CERES-only dataset with the GERB instantaneous hourly fluxes



Dataset - GERB SW RMS error (Wm^{-2}) for July 2004

Impact of Terra merged computed TOA fluxes to predict GERB diurnal fluxes

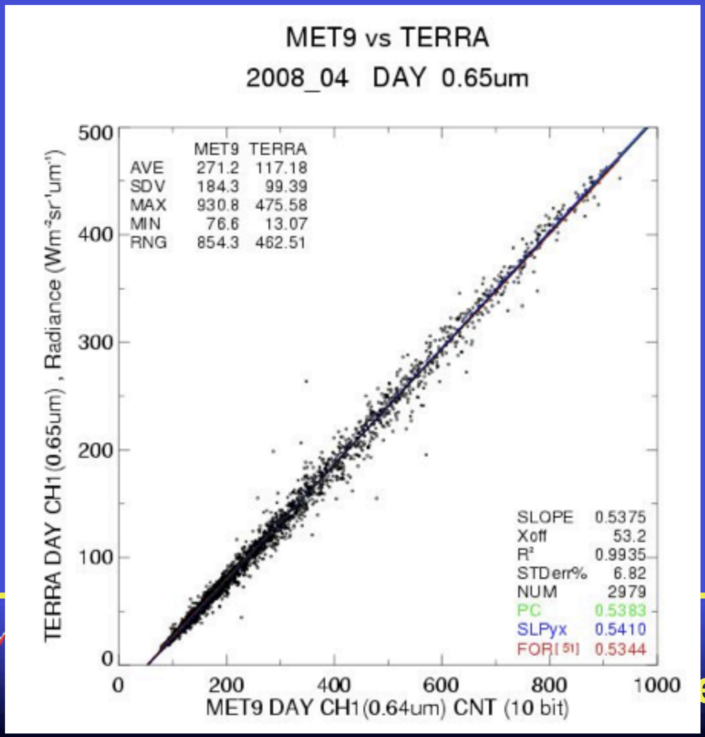
Terra TOA (Wm^{-2})		RMS (CERES-GERB)		
		observed	untuned	tuned
SW	MODIS	43.8	33.2	32.9
	merged	27.0	27.3	26.9
LW day	MODIS	14.3	14.7	12.8
	merged	10.9	11.1	10.5
LW night	MODIS	12.8	13.3	12.2
	merged	9.0	10.9	10.2

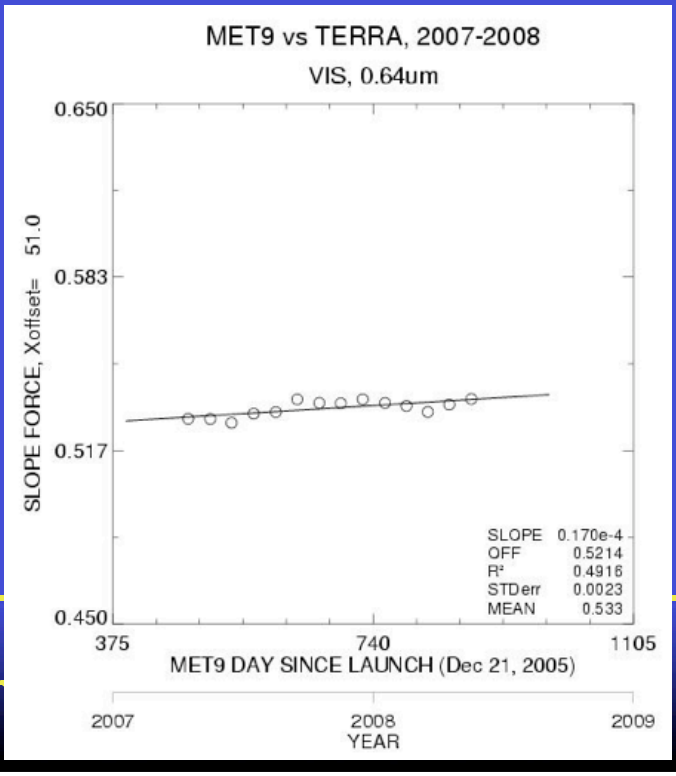
- The merged computed TOA fluxes are an improvement over MODIS-only
- The merged computed TOA fluxes are very close in quality to the measured

MTSAT calibration update

GEO to MODIS Cross-Calibration Method

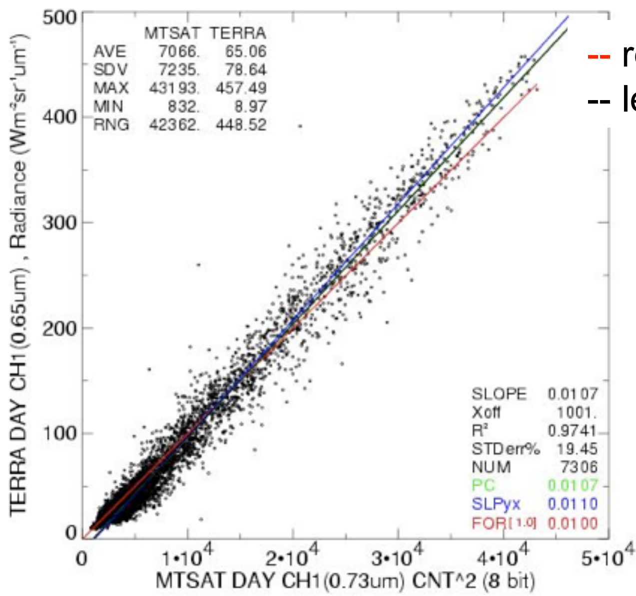
- None of the GEO visible sensors have onboard calibration
- Ray-match coincident GEO counts (proportional to radiance) and MODIS radiances averaged over a 0.5° latitude by longitude ocean region near the sub-satellite point
- Perform monthly regressions to derive monthly gains
- Compute timeline trends from monthly gains



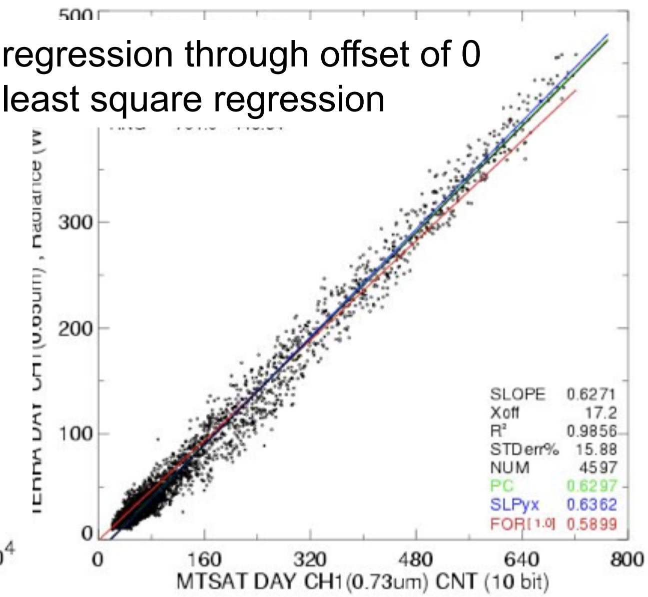


MTSAT-1R/MODIS VIS cross-calibration

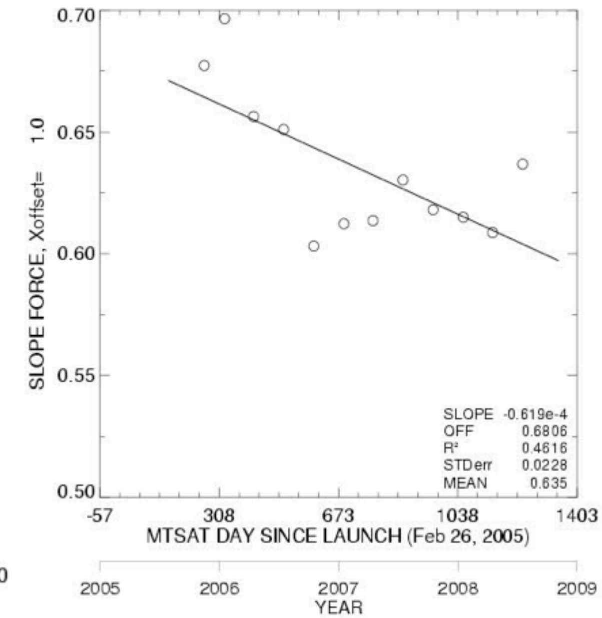
MTSAT/Terra
April 2006, 8-bit



MTSAT/Terra
April 2008, 10-bit



MTSAT/Terra
2005-2008



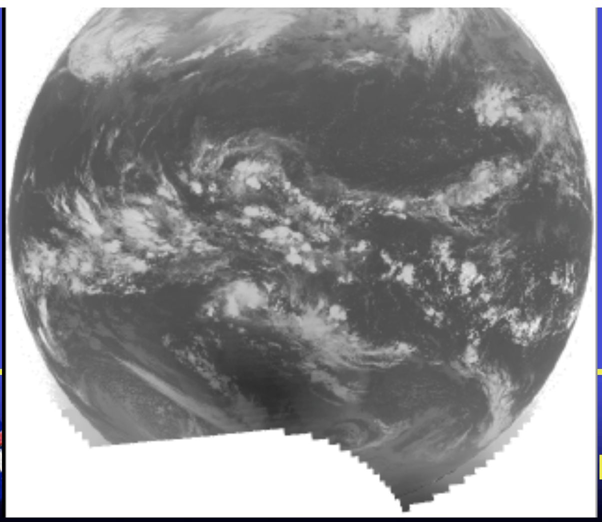
- Same ray-matching technique as the other satellites
- Note the departure from linearity in the low part of the dynamic range
- Whether 8bit count^2 HiRAD or 10bit linear HRIT images show nonlinear behavior
- Similar behavior for Aqua-MODIS, GOES-11 and VIRS
- MTSAT IR cross-calibration is typical of other GEOs, implying good navigation

MTSAT characteristics

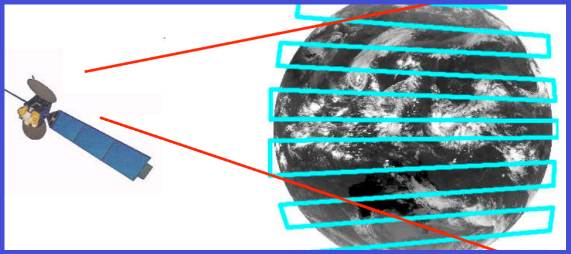
- MTSAT blew up during launch Nov 15, 1999
- GMS-5 launched on June 21 1995 continues operating until May 2003
- GOES-9 was moved to the GMS-5 location until MTSAT-1R becomes operational

Characteristic	MTSAT-1R	MTSAT-2
# of VIS/IR detectors	336/84	8/2
VIS/IR Spatial resolution (satellite)	0.5/2 km	1.0/4 km
VIS/IR spatial resolution (transmitted)	1.0/4 km	1.0/4 km
Launch Date	Feb 26, 2005	Feb 18, 2006
Operational Date	Nov 2005	mid 2010

IR, Feb 24, 2008 14:30 GMT



- MTSAT-1R scan pattern is most unique



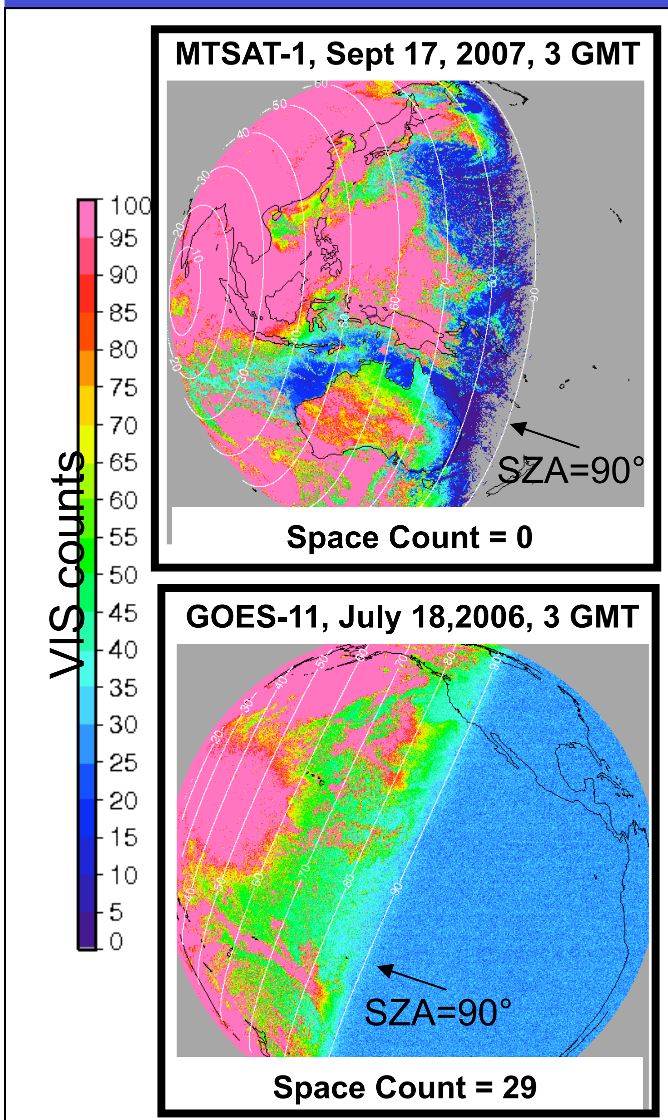
- Most geostationary imagers scan horizontally

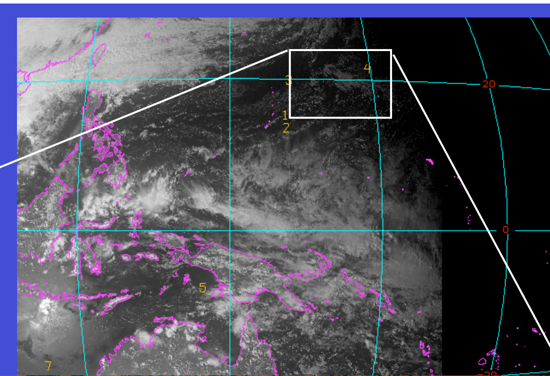
McIDAS vs B1U MTSAT-1R format

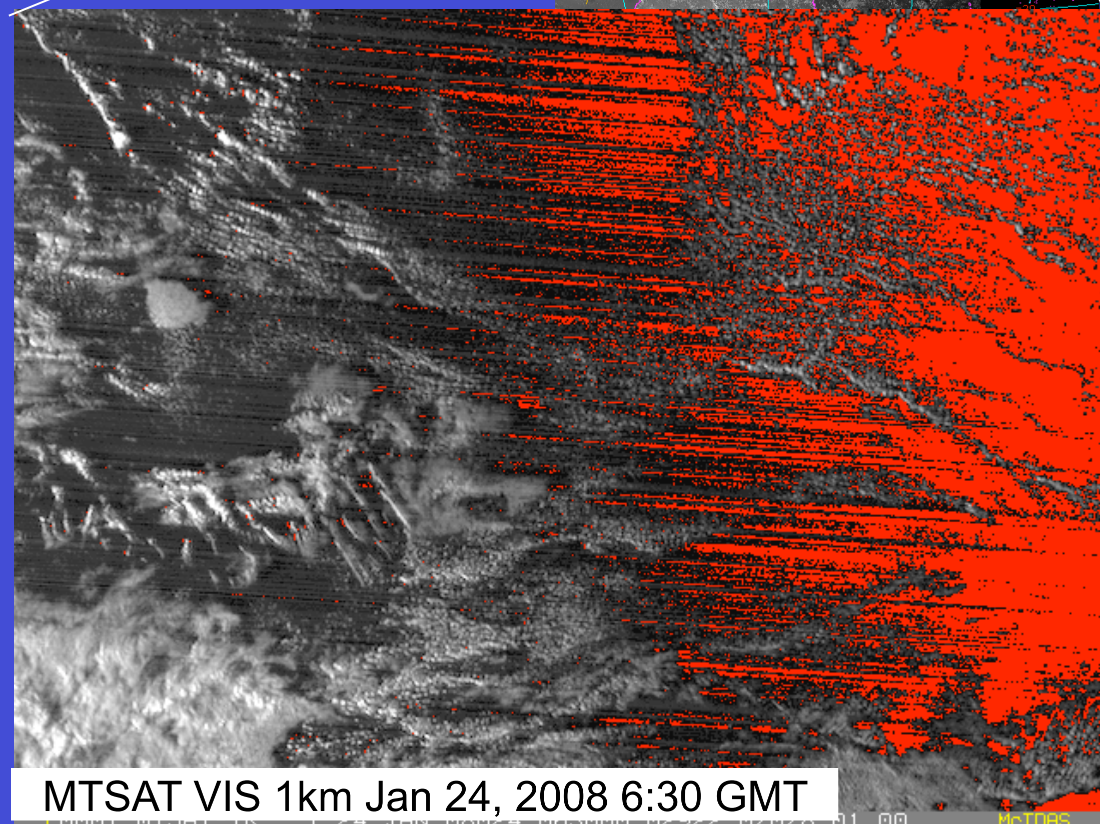
- Currently SRBAVG GEO record is from Mar00 to Oct05, when MTSAT-1R was put into service replacing GOES-9
- McIDAS original transmitter (HiRAD) was similar to GMS-5
  - Degraded both the spatial and radiance resolution
  - Upgraded transmitter in July 2007 to HRIT
- Tried to get HRIT from Australians (record not complete), JMA did not archive
- ISCCP project did receive the HiRES dataset, free distribution from NCDC

Parameter	McIDAS	B1U
Accessibility	Real-time ingestion	One time NCDC (Ken Knapp)
Visible nominal resolution	8 bit squared	10 bit linear
Temporal resolution	1-hourly	3-hourly
Temperature coefficients	good	Too warm compared with MODIS
Navigation	Up to 20 km off	Good
Data drop outs		fewer
Spatial resolution	1.25km JPEG compression 1100x1148 pixels	1.0km original 1375x1375 pixels

MTSAT/GMS-5 all have visible count offset of 0

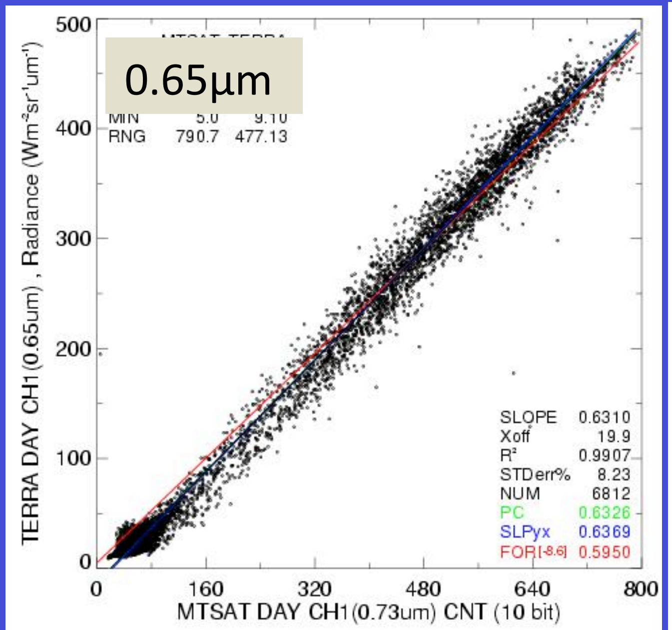


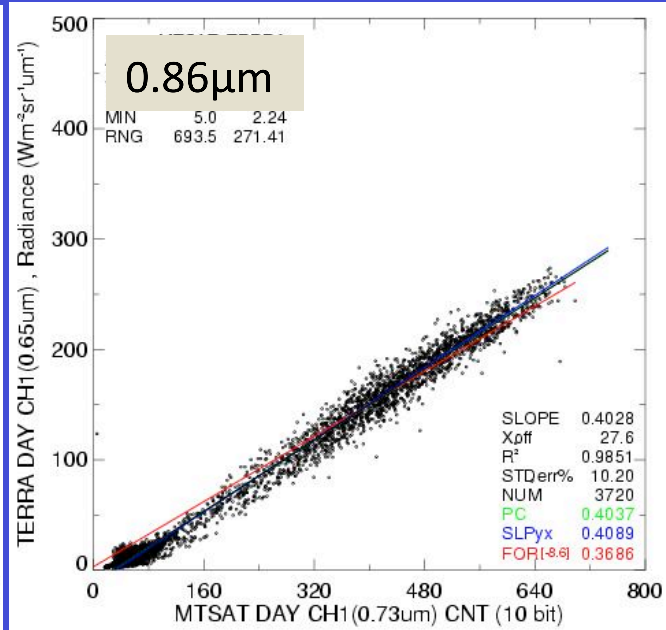




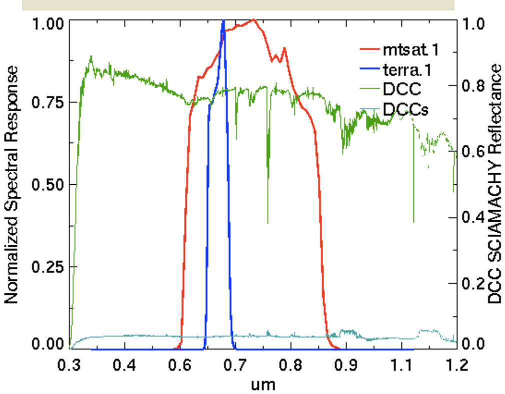
- Lots of shadows where the VIS count 0, artificially reducing the mean radiance
- Note striping of scan pattern

MTSAT/Terra SEP07

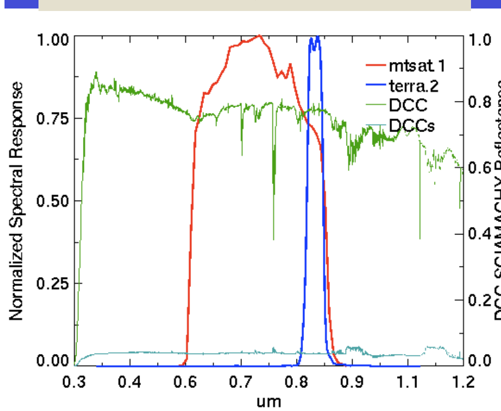




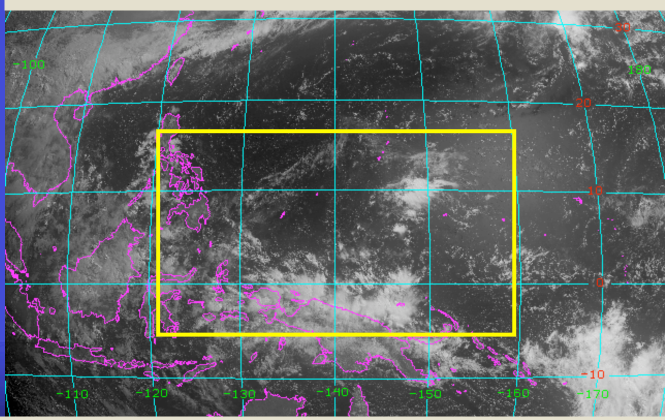
Terra 0.65µm SRF



Terra 0.86µm SRF



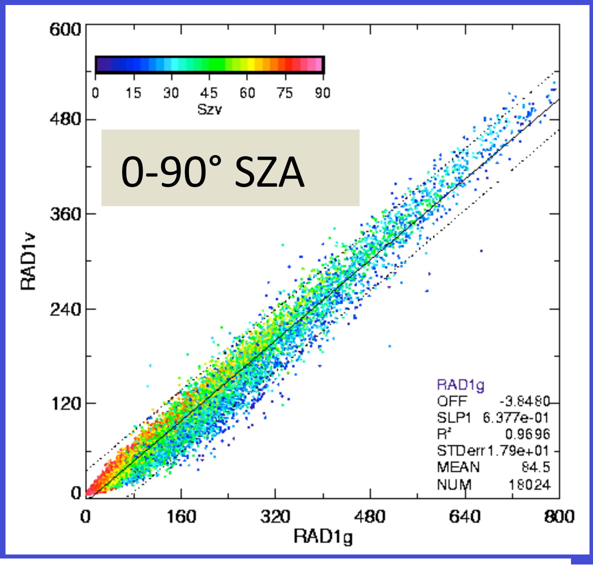
MTSAT VIS, June 11, 2008 23:30



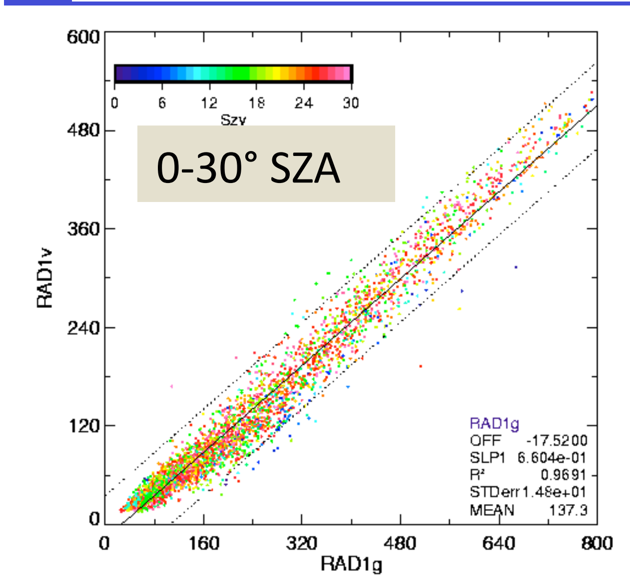
Yellow box grid domain, bright spot glint

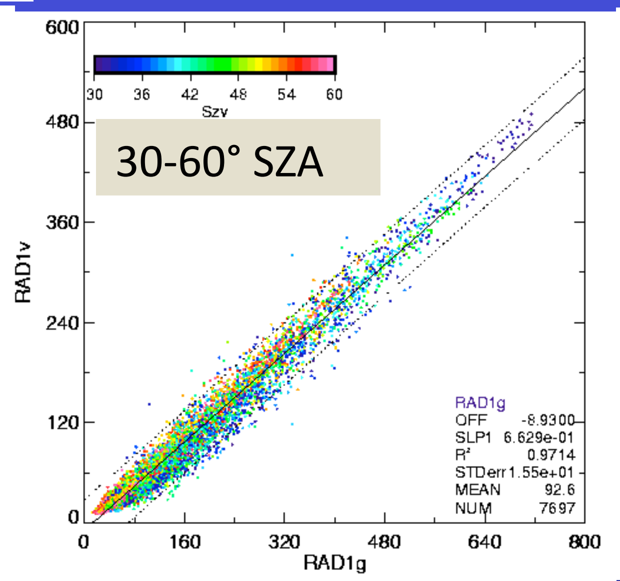
- Perhaps the large MTSAT VIS spectral band is a factor
- Regress both MODIS 0.65µm and 0.86µm channels
- The nonlinear regression appears to be both in the 0.65 and 0.86µm channels, which removes spectral response as a factor

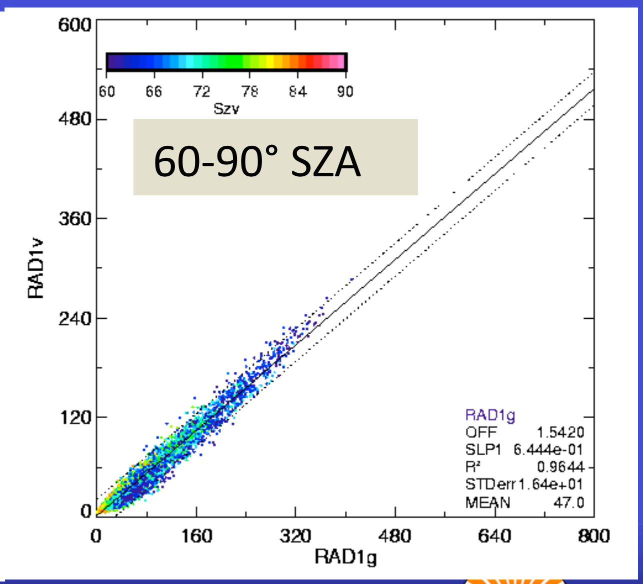
MTSAT/VIRS SEP07-MAR08



- VIRS is in a 47 day precessionary cycle observing all SZAs every 23 days
- There is a functionality with SZA in the MTSAT/VIRS visible regressions for the domain within ± 15° latitude and ± 20° longitude from the sub-satellite point

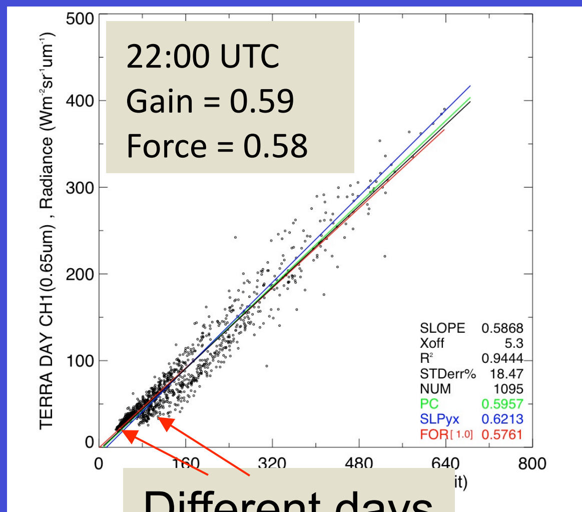


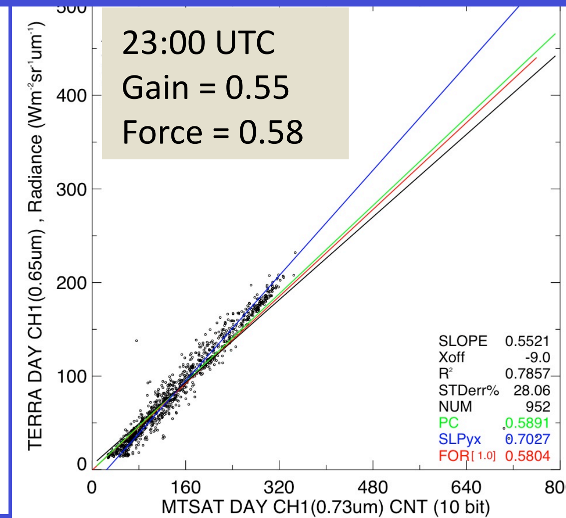




January 2008 MTSAT/Terra

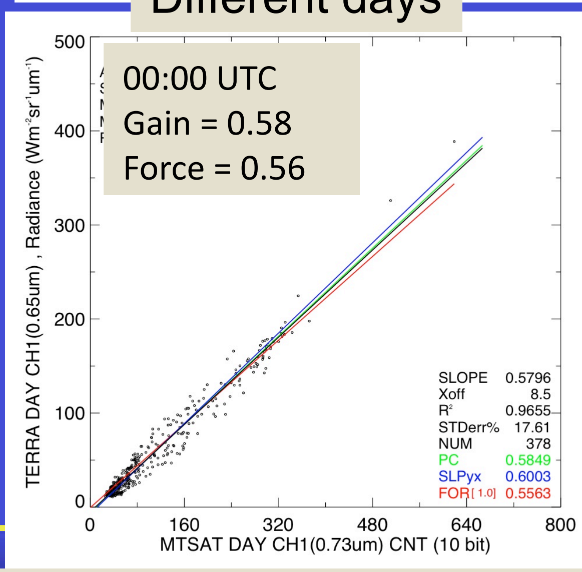
Increase Domain: ± 45° lat x lat from sub-satellite point, to avoid glint, polarization,spectral issues

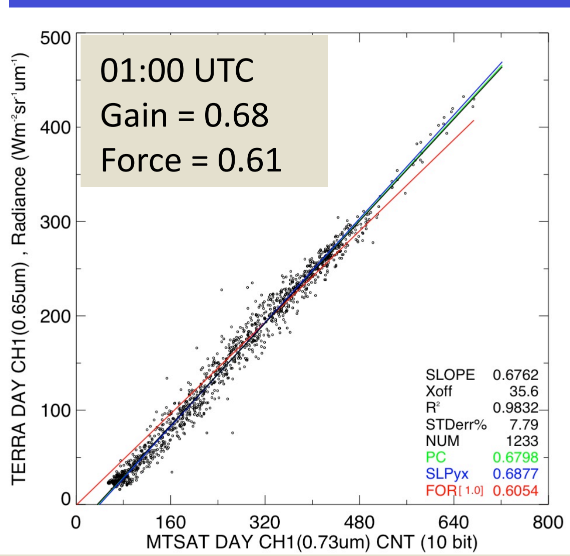


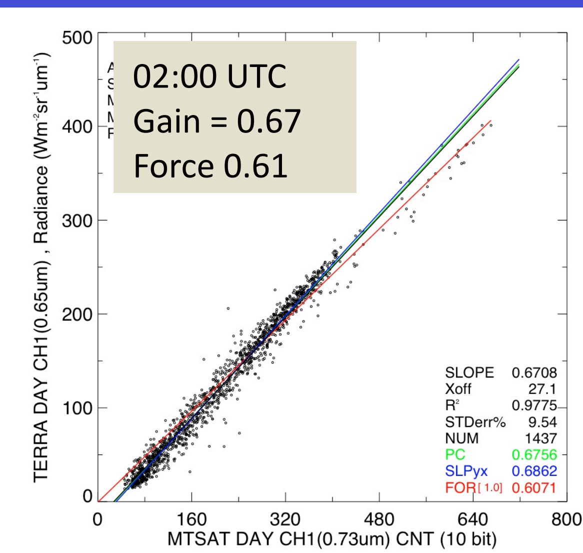


-- regression through offset of 0
-- least square regression

- I threw up my hands at this point and after attending a conference at JMA, where they could not provide me any further help



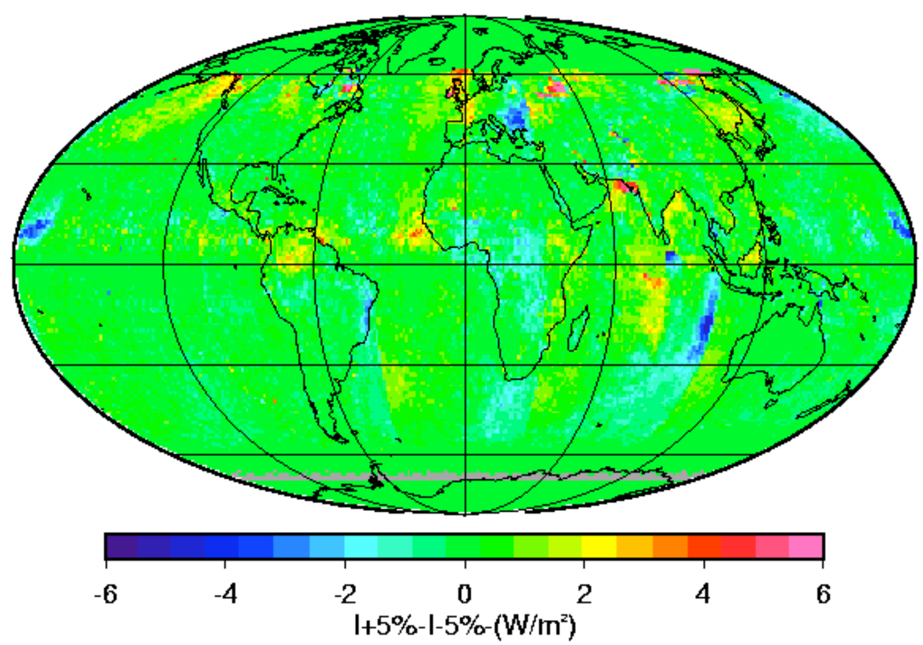




- Each GMT has differing MTSAT/Terra gains, gain dependent on location of matches

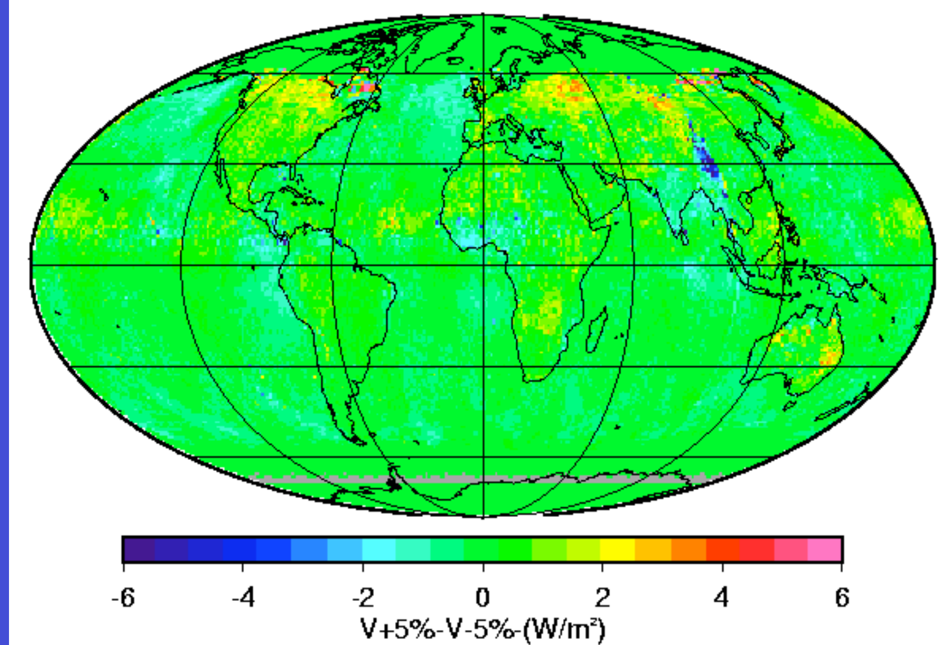
Change in Total-Sky TOA SW Flux due to artificial GEO calibration adjustments, July 2002

(IR+5%) - (IR-5%)



Bias=0.10%,rms=0.9%

(VIS+5%) - (VIS-5%)



Bias=0.01%,rms=0.8%

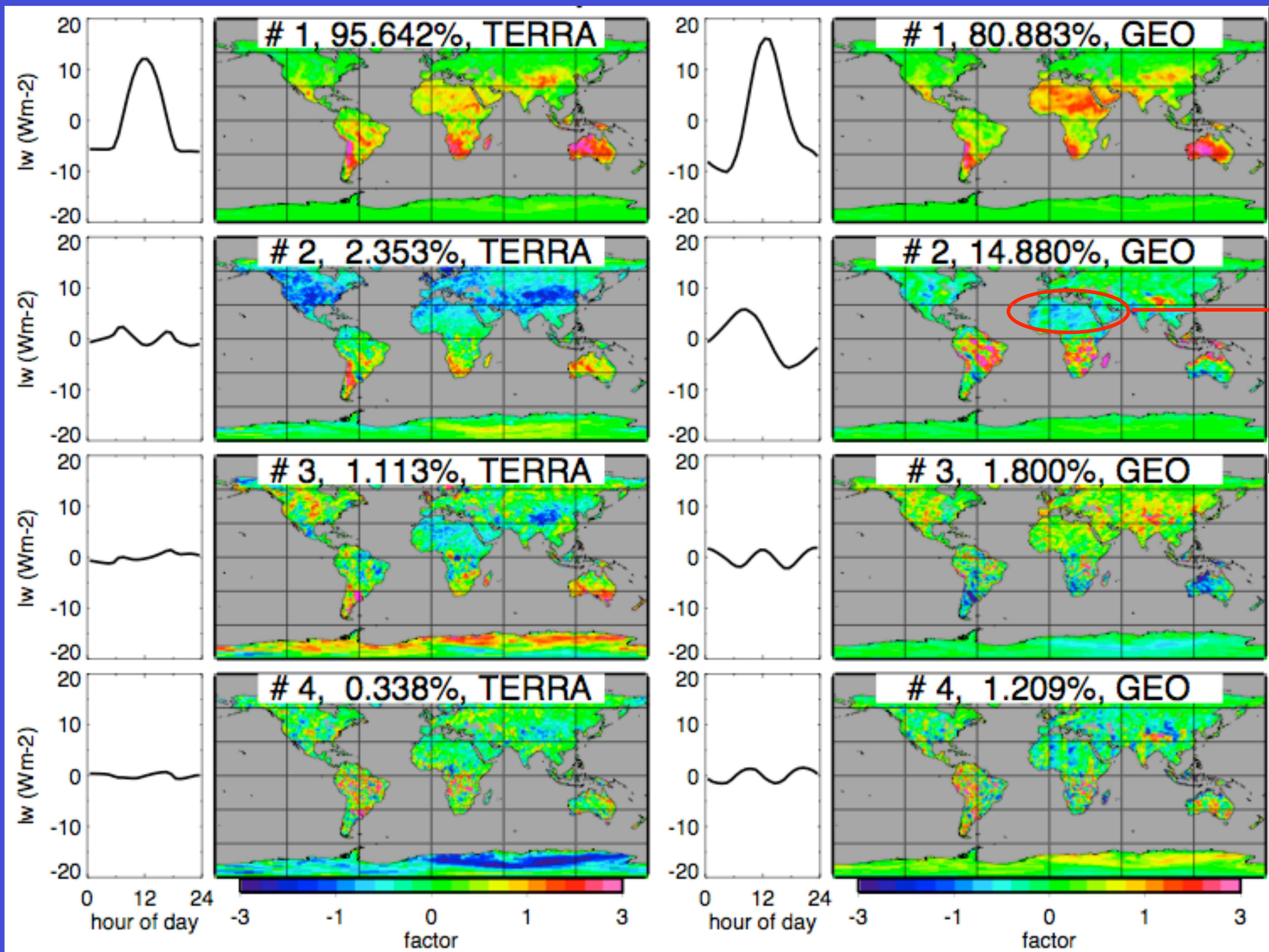
- Plotted differences are for 10% calibration change
- Actual GEO SW calibration uncertainty is 3-5% and LW is 1-2%
- GEO flux constraint to CERES removes sensitivity to GEO calibration
- Even though MTSAT VIS is not well calibrated, it will not alter CERES calibration

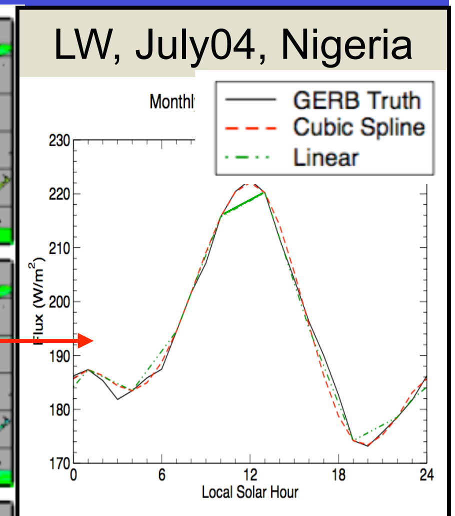
Diurnal EOF analysis of GEO derived BB fluxes

Diurnal EOF analysis of GEO derived BB fluxes

- EOF analysis can deconvolve the diurnal signal into diurnal and semi-diurnal cycles
  - Perform EOF analysis on Jan 2005 1° gridded monthly SW and LW hourly fluxes
- How much diurnal value is the SRBAVG GEO product adding?
  - The 25 GB/month of 3-hourly 5-satellite GEO dataset needs to be ingested, calibrated, processed for cloud retrievals and converted to BB and normalized to the CERES calibration
  - Is the GEO product providing more diurnal components than the nonGEO product?
  - Is the GEO product free of diurnal GEO artifacts?
  - Compare GEWEX SRB fluxes with GEO to determine if SRBAVG is an improvement over existing diurnal datasets
- Compare the SRBAVG-GEO product with GERB fluxes
  - GERB Edition1 data available
  - Are the GEO diurnal components similar to GERB?

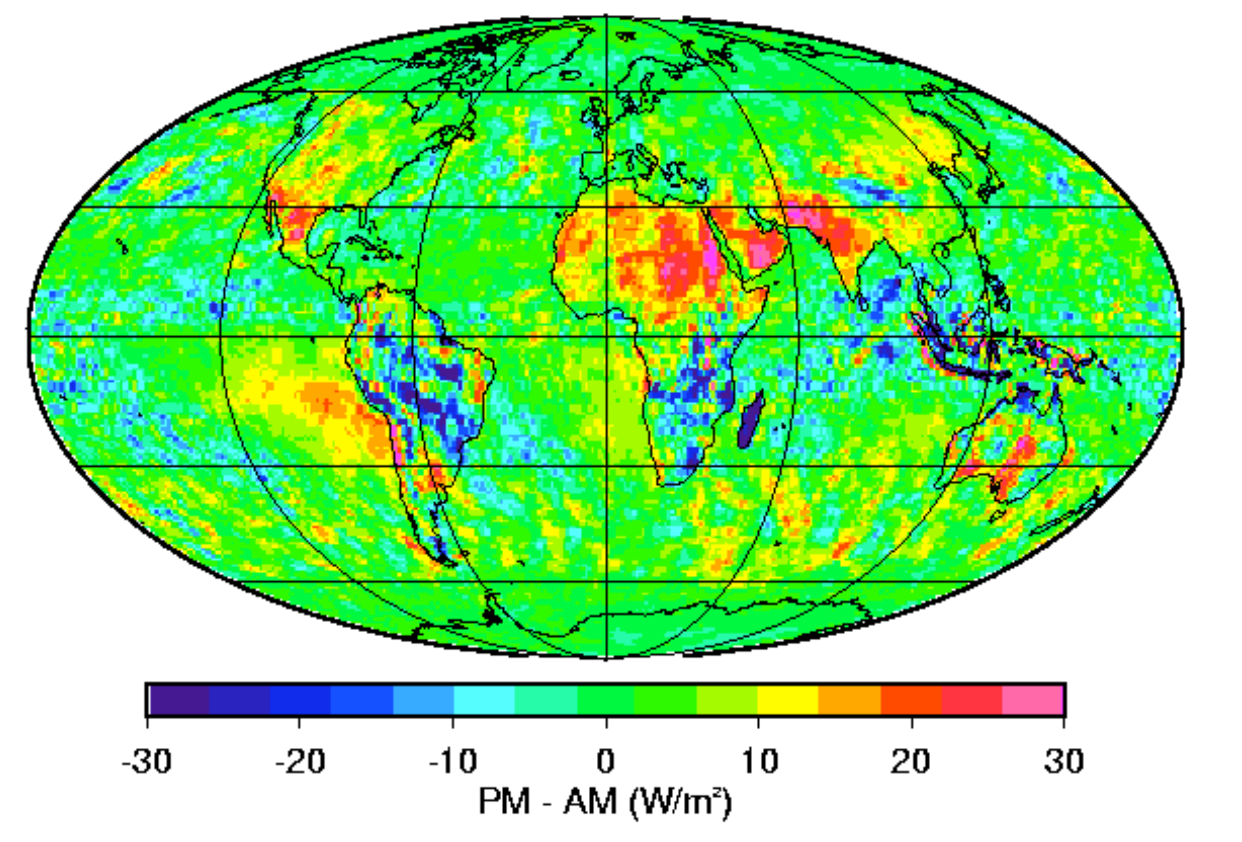
EOF analysis, LW, Jan 2005, Land





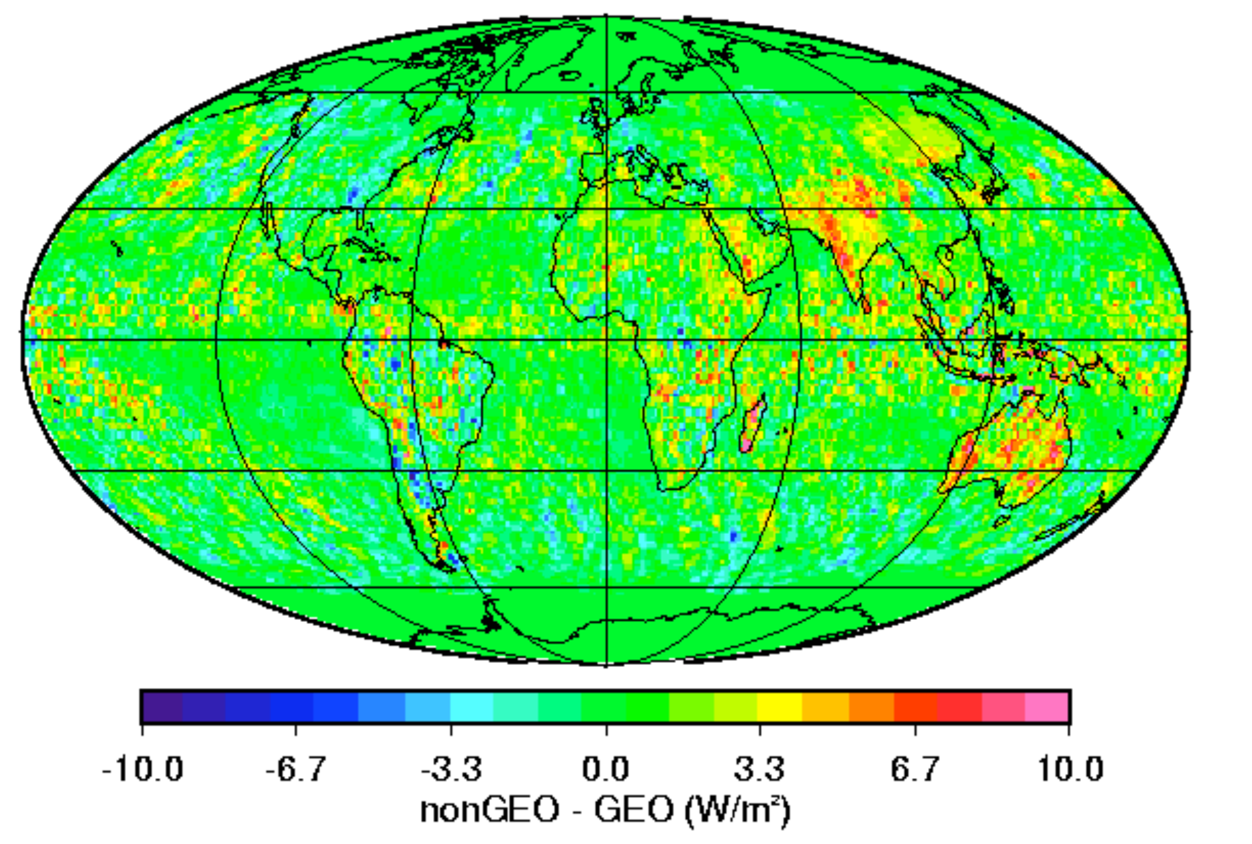
• nonGEO LW half-sine fit is fairly close to the observed diurnal cycle
• Second EOF shows that GEO captures the afternoon convection

GEO LW 16:30 (PM) - 7:30 (AM) monthly hourly mean Dec 2002



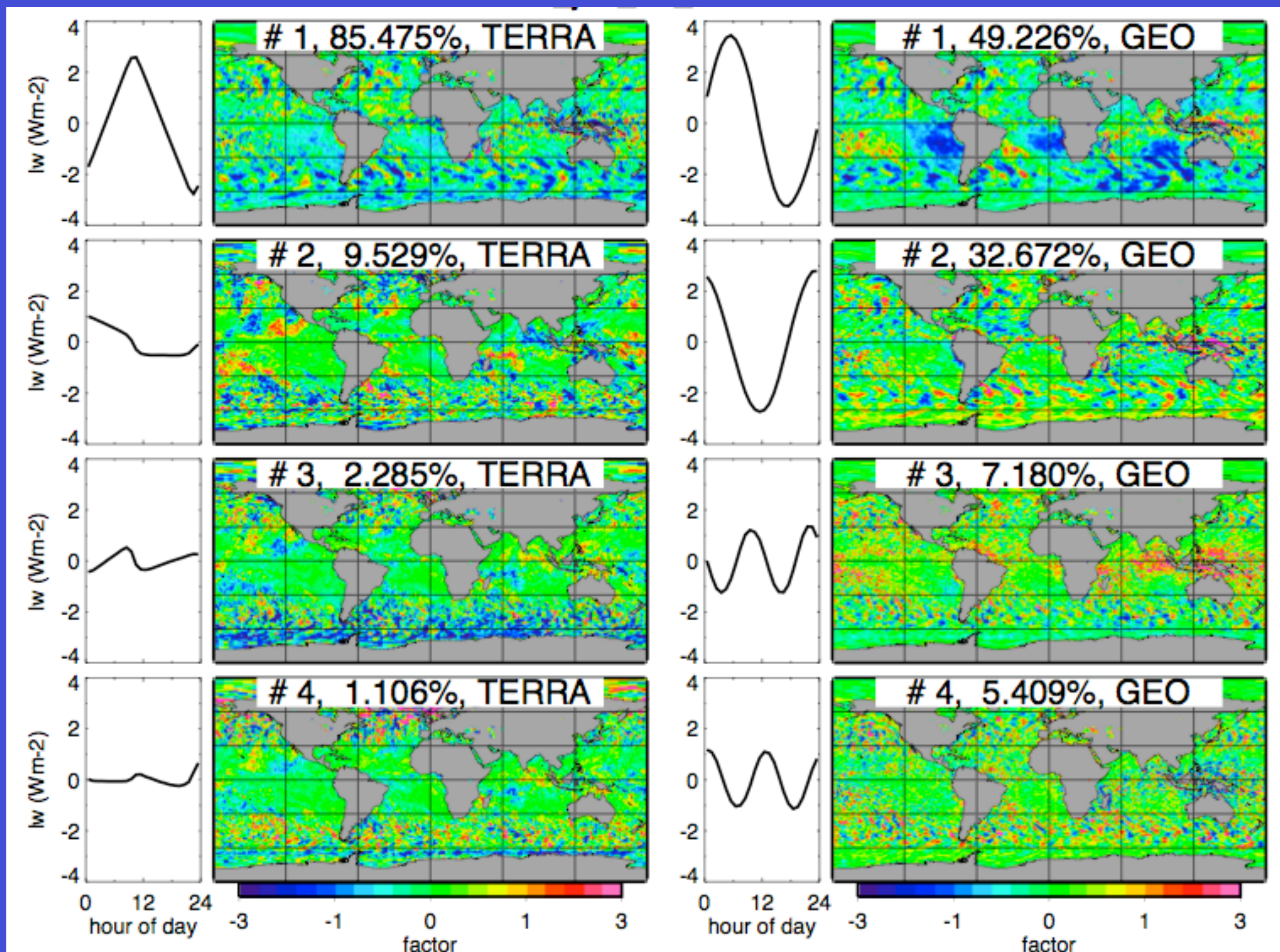
- For land: blue afternoon convection, red thermal lag
- PM-AM differences can be ~ 30 Wm^{-2}

nonGEO - GEO LW monthly mean
Dec 2002

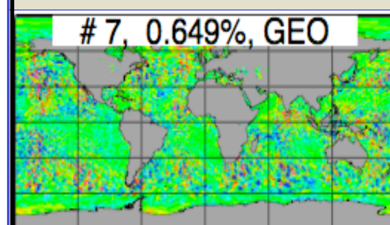


• Global bias = 0.5 Wm-2

EOF analysis, LW, Jan 2005, Ocean



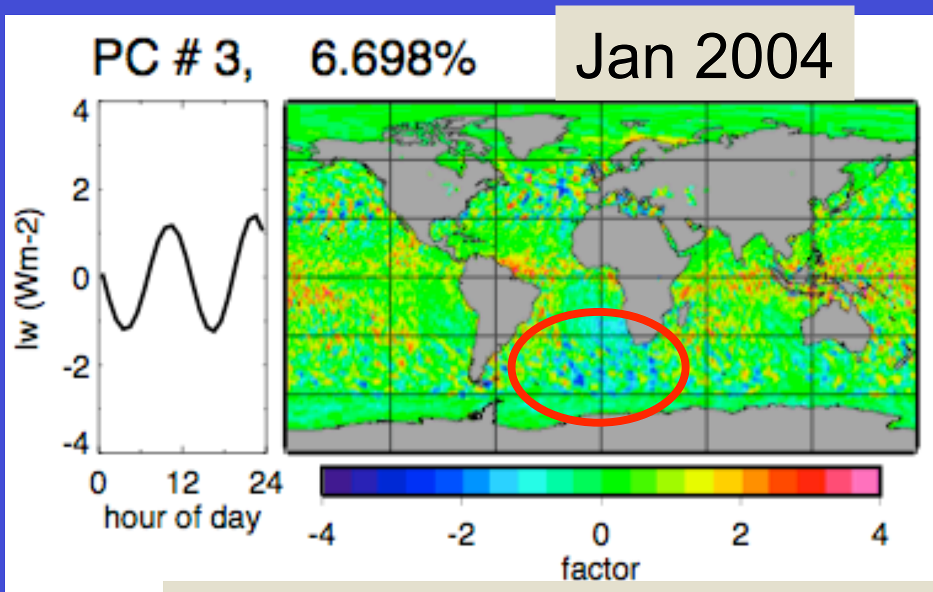
GEO artifacts

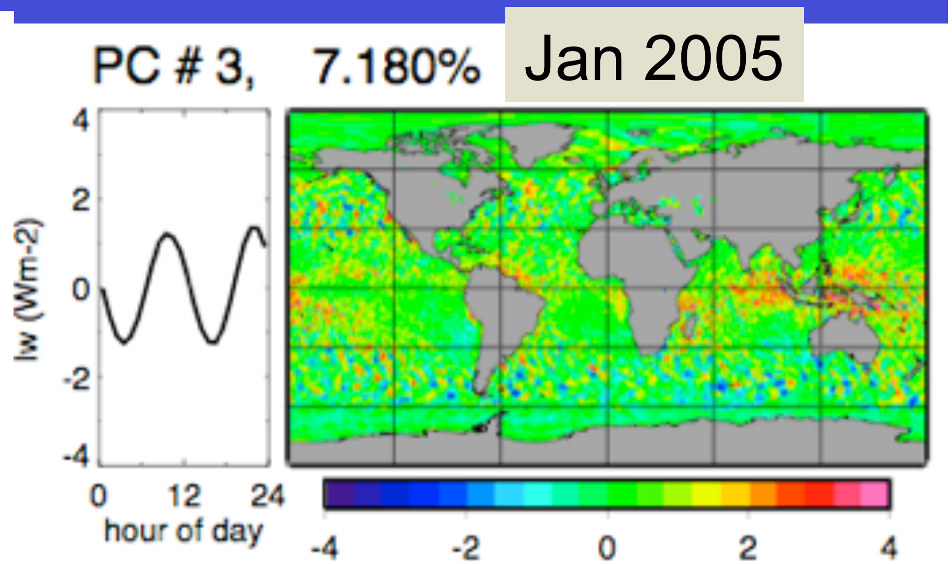


- nonGEO LW linear interpolation is working well
- First GEO EOF shows stratus regions, whereas Terra does not

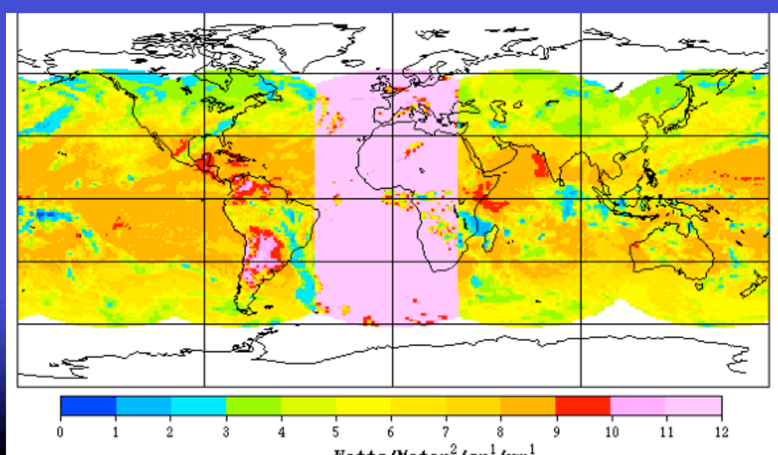
ences

EOF analysis, LW, Ocean



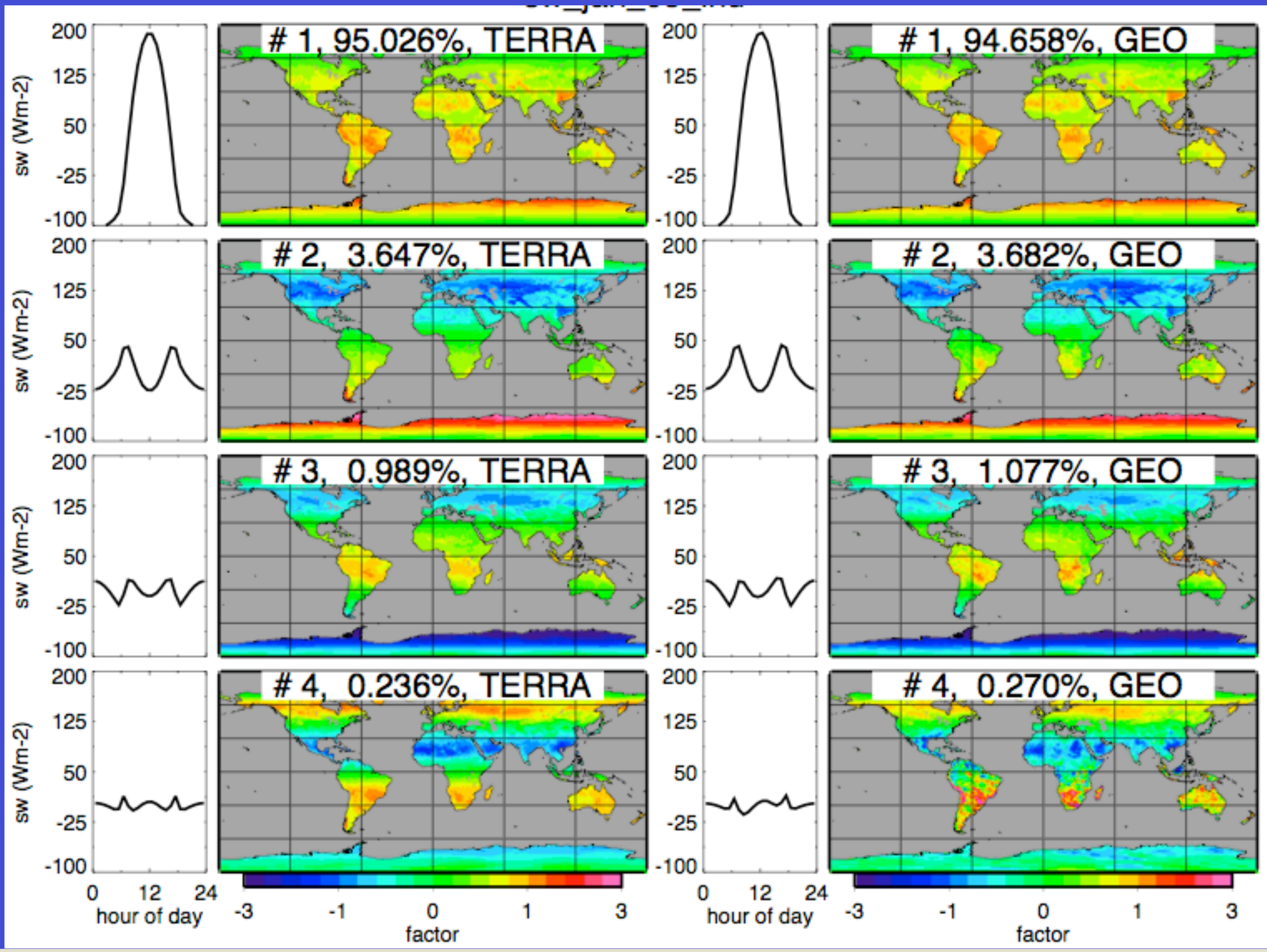


- Note the Meteosat-7 region is different than the rest of the southern ocean
- What GEO artifact could cause this, calibration,etc?



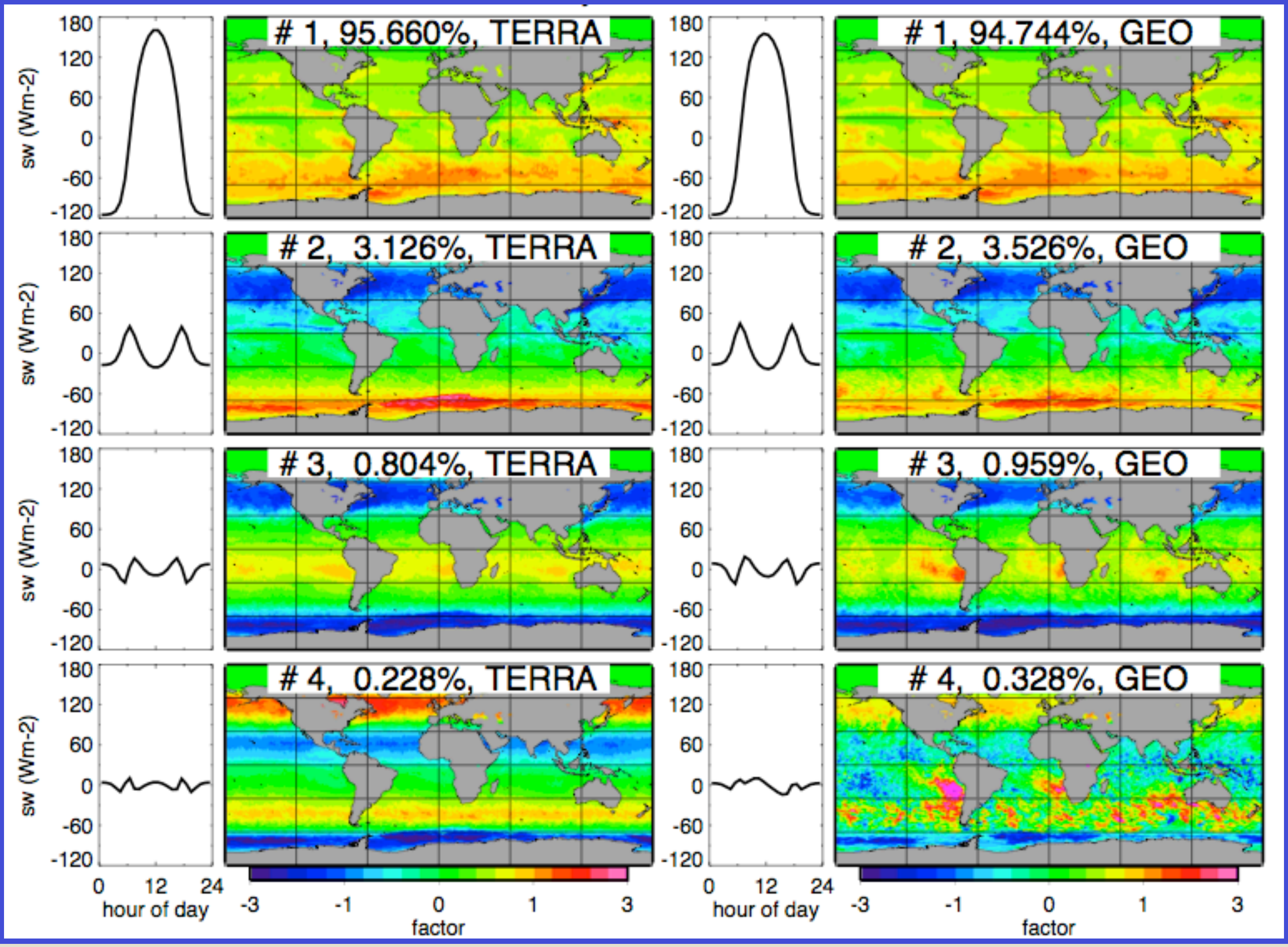
- IR radiance from Jan 26, 2004 at 18 GMT
- 8 bad consecutive IR Met-7 images

EOF analysis, SW, Jan 2005, Land

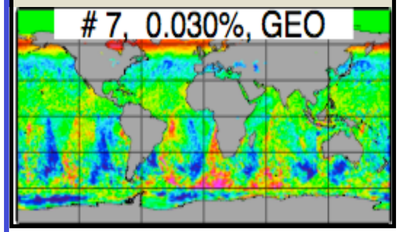


- 1st and 2nd EOF shows the diurnal SWinc cycle and zonal change in day length
- 3rd and 4th GEO EOF reveals afternoon convection, 4th EOF shows artifacts

EOF analysis, SW, Jan 2005, Ocean

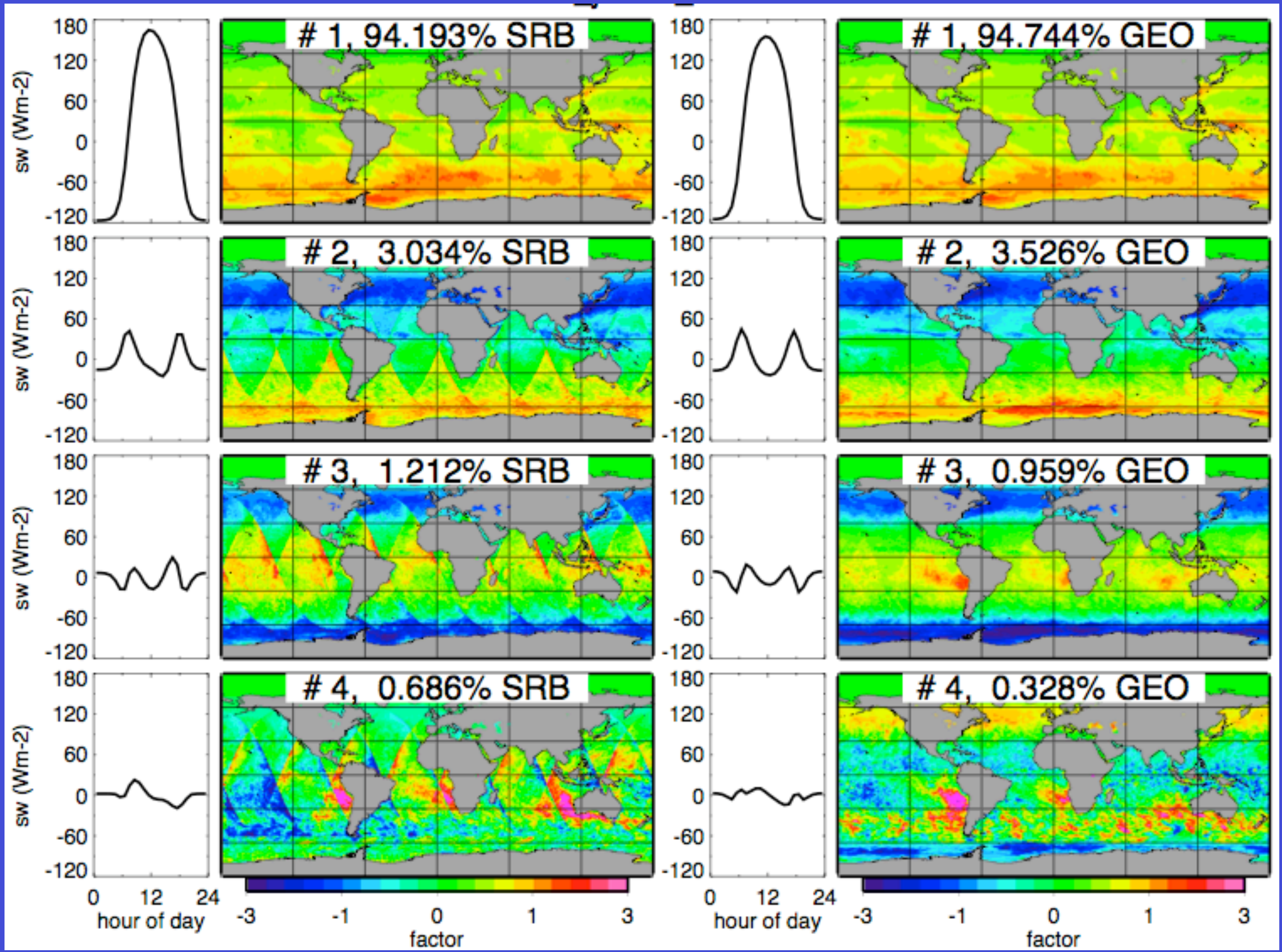


GEO artifacts



- SW directional models are working well
- 3rd and 4th GEO EOF reveals stratus regions, 7th EOF shows artifacts

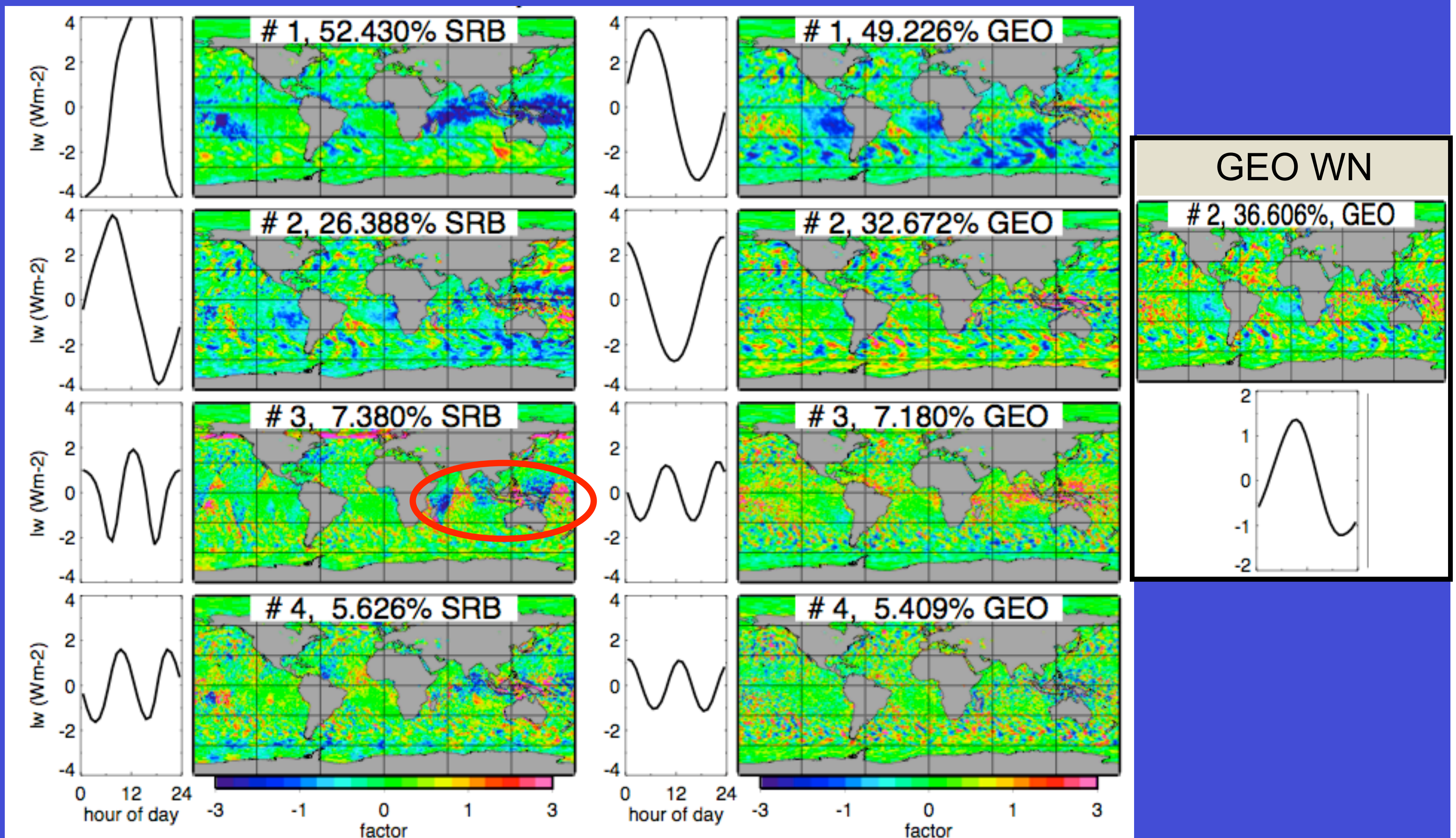
EOF analysis, LW, Jan 2005, Ocean, SRB



- 2nd EOF SRB artifact reveals GEO day/night boundaries
- 3rd EOF SRB artifact shows AVHRR orbits

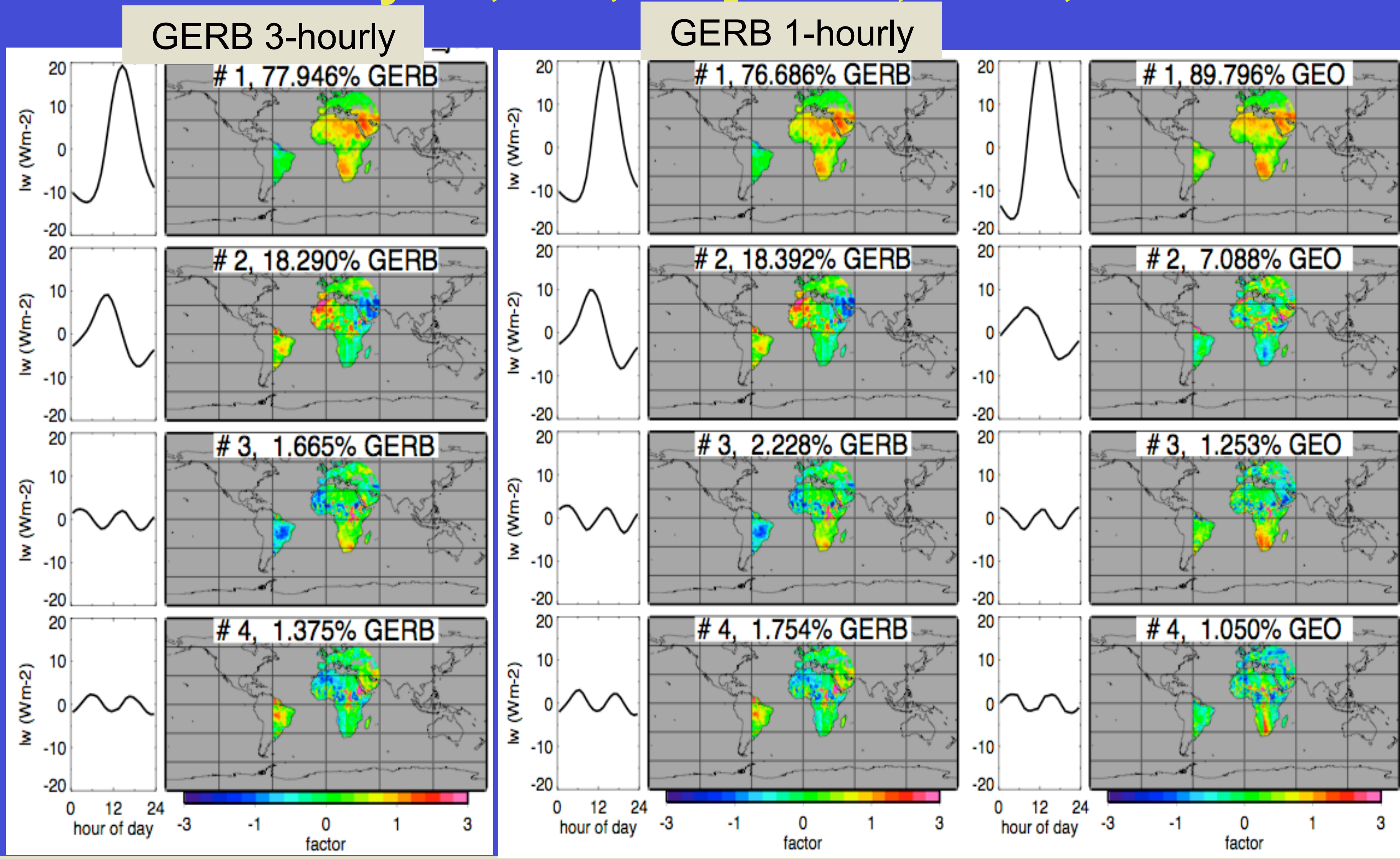
Sciences

EOF analysis, LW, Jan 2005, Ocean, SRB



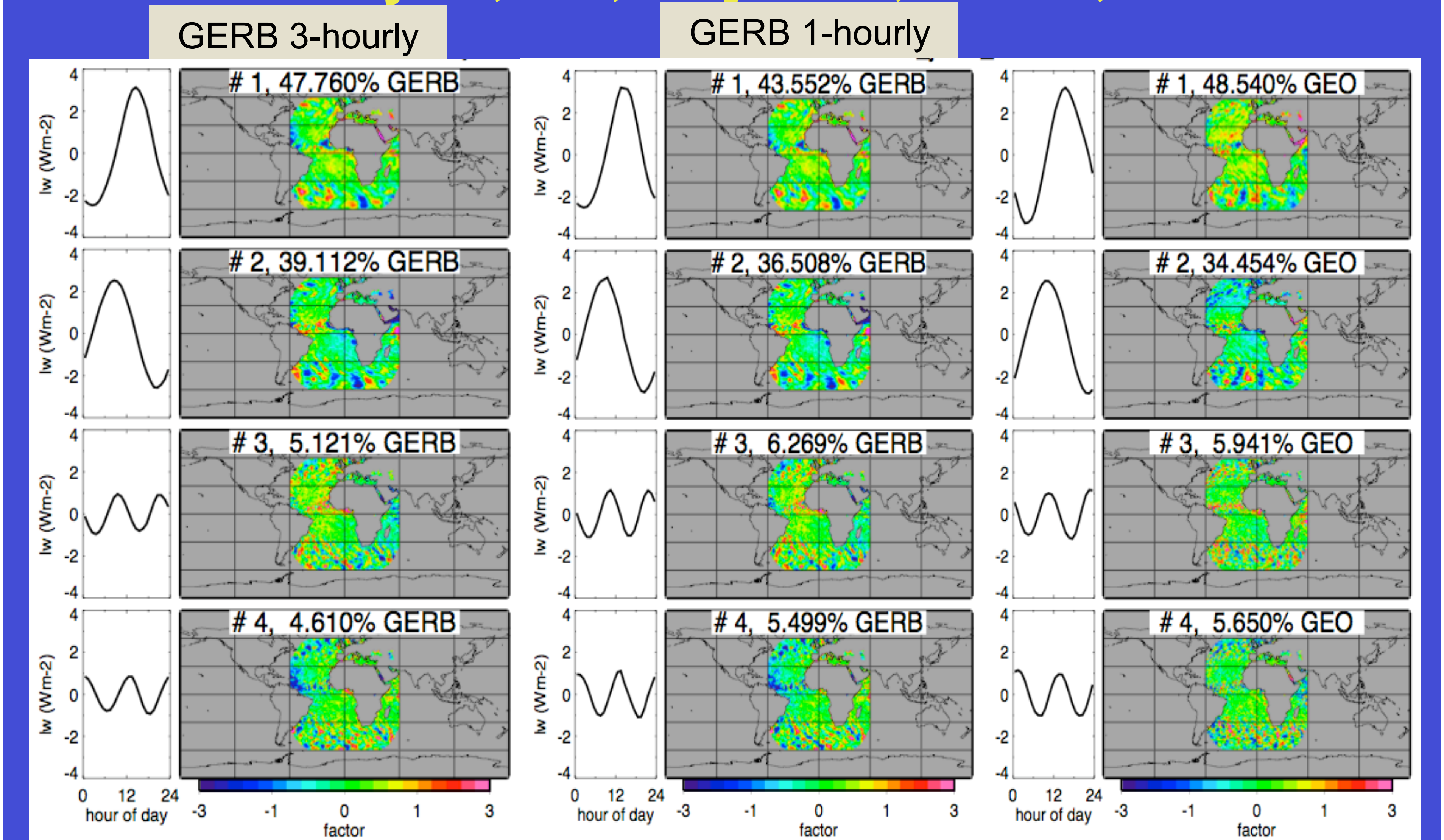
- 1st SRB EOF reveals a ITCZ diurnal cycle, the GEO WN has same pattern
- 2nd SRB EOF is similar to 1st GEO EOF
- 3rd SRB EOF shows some peculiar striping, GEO day/night boundaries

EOF analysis, LW, July 2004, Land, GERB



- There seems to be no added diurnal value going to 1-hourly LW
- Assume GERB dynamic range to be valid, transfer CERES calibration using coincident fluxes
- 1st EOF is very consistent between GERB and GEO

EOF analysis, LW, July 2004, Ocean, GERB



- There seems to be no added diurnal value going to 1-hourly LW
- GEO is getting the general shapes and explained variances, seems to be some shift in phase

Edition 3 improvements

- GEO based clear-sky maps for cloud retrievals
  - Currently relying MODIS maps
- Recalibrate all 11 GEO sensor to MODIS using their entire records
  - Currently updated in ~ 2 year chunks
- LW narrowband to broadband improvement
  - Currently simple global parameterization with column weighted RH
  - Use angular LW ADM strategy as was done in the SW
- Combined Terra and Aqua SRBAVG products
  - Agree on radiometric scaling between CERES instruments
- Split the nonGEO and GEO datasets
- Provide netCDF and HDF formatted datasets

TISA 6 month (production) goals

- Calibrate the GGEO record from Nov 2005 to Aug 2007 (inline with the SSF processing)
  - Code and calibration coefficient delivery
  - Process SRBAVG, SYN/AVG/ZAVG record
- Deliver SRBAVG ED2E code
  - Remove error in the RAPS SW normalization code
  - Include daily means
  - Improved Model B surface fluxes and temporal averaging
  - Process in SRBAVG from beginning of record, coordinate with GGEO delivery after Nov 2005
- Deliver ISCCP-D2like Edition2 day/nit/merged code
- Deliver SFC/SRBAVG-nonGEO Edition3 code
- Document TISA CERES products in publications

GEO cloud property normalization with MODIS for the ISCCP-D2like merge product

M. Sun