Discussion on (SYN/AVG/ZAVG) Beta-to-Edition Strategy

T. Charlock, D. Doelling, N. Loeb
NASA LaRC

T. Caldwell, D. Keyes, M. Nordeen,C. Nguyen,
F. Rose, D. Rutan
SSAI

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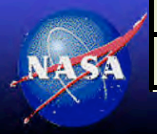
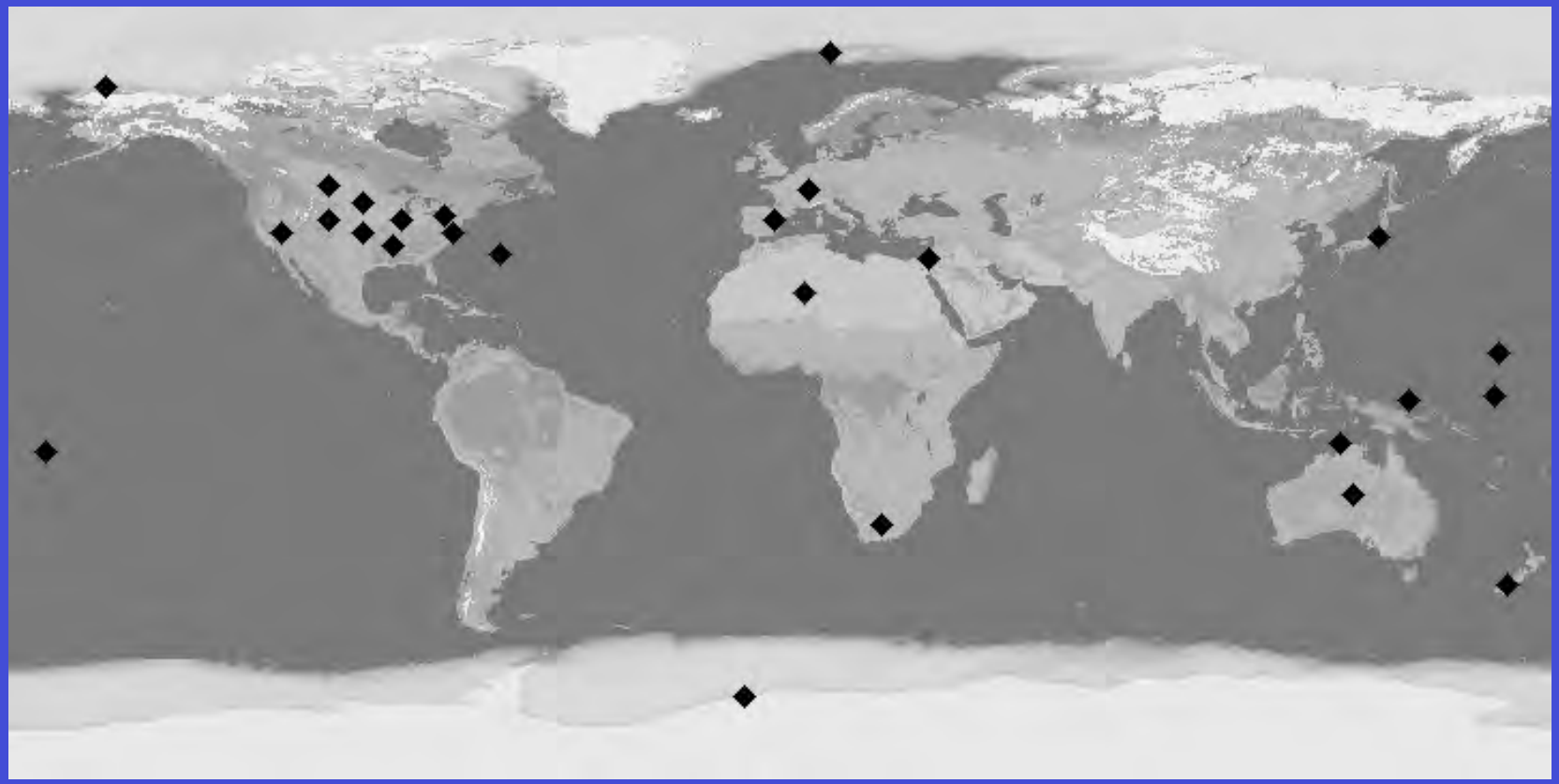
SYN/AVG/ZAVG Validation Summary

Truth dataset	Validation	SW	LW
Cave surface flux comparisons	Comparison with other datasets ISCCP, SRB, ModelB		
	Deseasonalized trends, GEO artifacts		
	Tuning at TOA improvement		
	GEO clouds computed flux improvement over MODIS interpolated		
	Improvement of Tuned fluxes with GEO flux using MODIS-only clouds		
	Increased GEO computed flux improvement near sunrise/sunset flux		
	UV index and PAR comparison		
Terra-based fluxes compared with Aqua TOA 1:30 PM observed	GEO cloud computed fluxes similar to TOA temporal interpolated fluxes		
	GEO clouds computed SFC flux improvement over MODIS interpolated compared with Aqua clouds		
Beta4	TOA Untuned – Observed flux consistency Clouds and fluxes are consistent		
SeaWifs PAR	Compare untuned PAR flux		
NCAR/NCEP	Net atmosphere flux comparison		
EOF	Any GEO artificacts		
GERB diurnal	Computed TOA fluxes diurnally consistent		

Validation Outcome	
Improvement	
Neutral	
Caution - DQS	
Show Stopper	



The 26 CAVE Sites Used in Surface Comparisons



- Ground based radiometer fluxes are used as “truth”
- Mostly located over land regions

Surface Flux Dataset Comparison

Surface Fluxes	Time	Clouds	Sounding	SW flux	LW flux
ECMWF ERA40	2000-2001	Modeled	ECMWF	Computed	Computed
ISCCP FD	2000-2004	AVHRR/ GEO	TOVS	Computed	Computed
GEWEX SRB 3.0	2000-2005	AVHRR/ GEO	GEOS4	Computed	Computed
CERES ModelB	Terra 2000-2005 Aqua 2002-2005	MODIS/ GEO	GEOS4	Parameterized	Parameterized
CERES AVG		MODIS/ GEO	GEOS4	Computed	Computed

- Compared at the following time scales
  - Monthly means for the seasonal months April 2000 - October 2005
  - Instantaneous hourly July 2004

Surface Flux Dataset Comparison

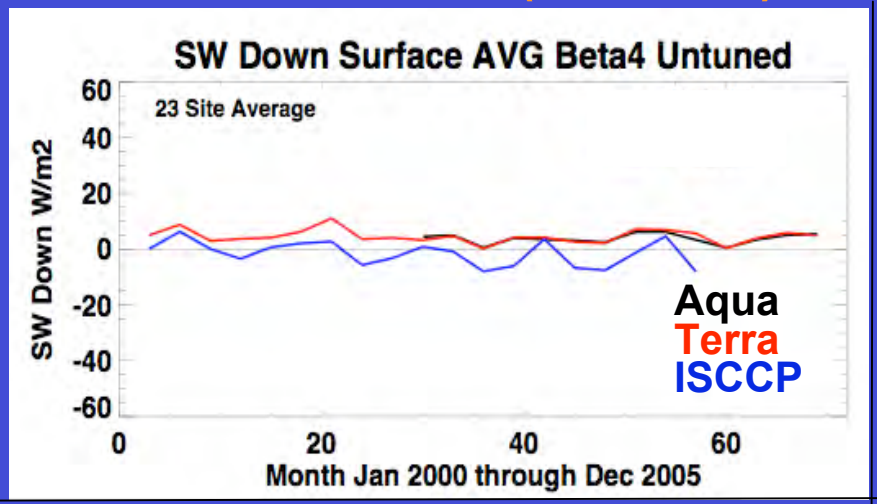
(seasonal) monthly means

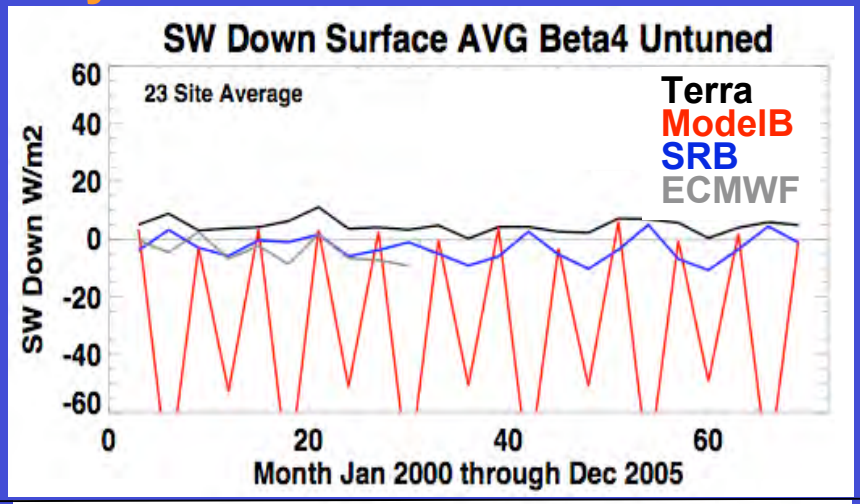
Dataset	SW Surface Down (Wm^{-2})					LW Surface Down (Wm^{-2})				
	Mean	Bias	RMS	σ	RMS (%)	Mean	Bias	RMS	σ	RMS (%)
ECMWF	196	1	23		9	334	-1	12		4
ISCCP-FD	192	1	18		9	334	6	20	19	6
SRB	192	-2	18		9	334	-2	10		3
ModelB	195	1	20		10	334	-2	9		3
AVG-Terra	193	4	12	11	6	334	-6	11	9	3
AVG-Aqua	191	4	10	9	5	338	-6	11	9	3

- AVG SW down rms is reduced by half from other datasets
  - Improved cloud property retrievals
- AVG LW down is similar to other datasets
  - More dependent on GEOS4 skin temperature and lower atmosphere

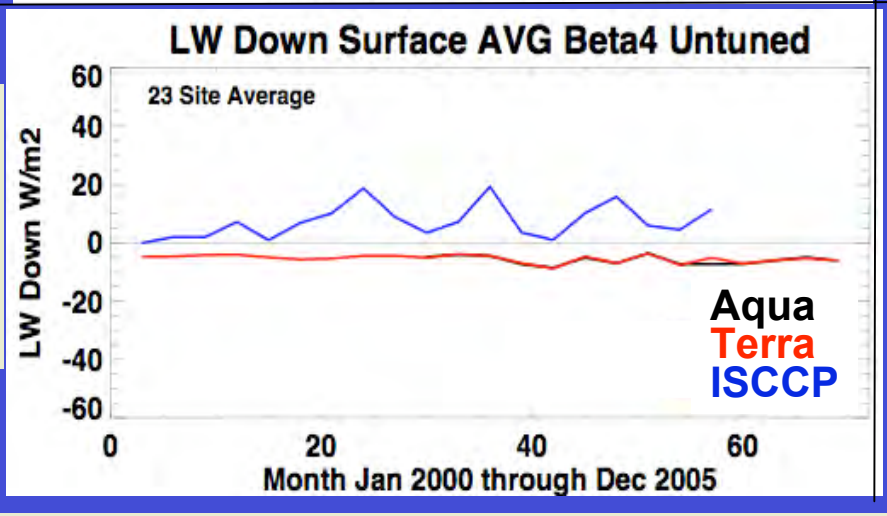
Surface Flux Trend Comparison
Product - CAVE flux monthly mean differences
(seasonal) monthly means

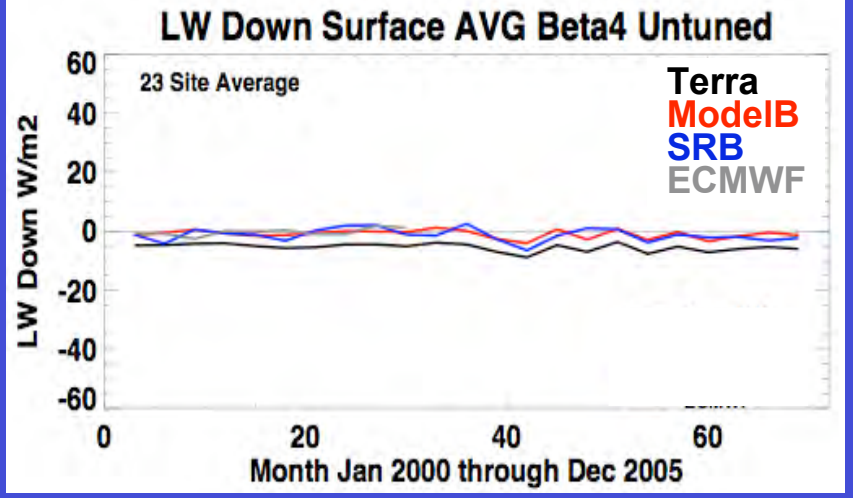
SWdown





LWdown

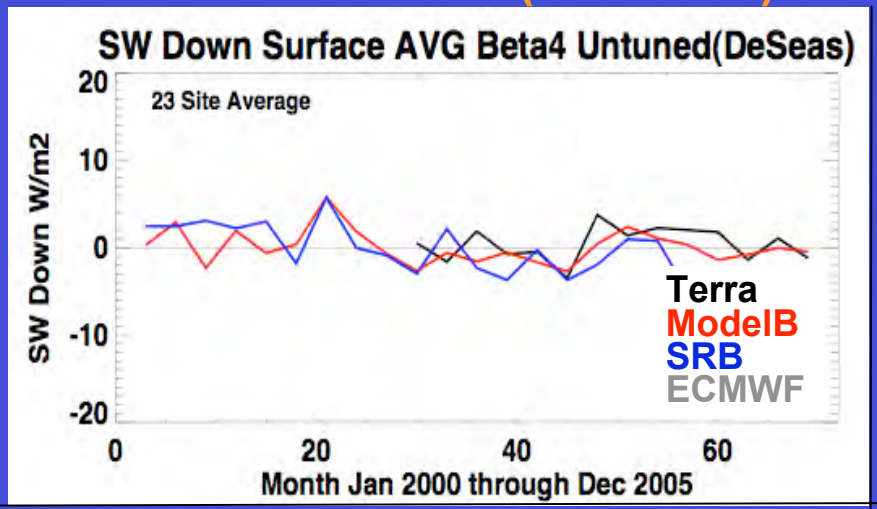


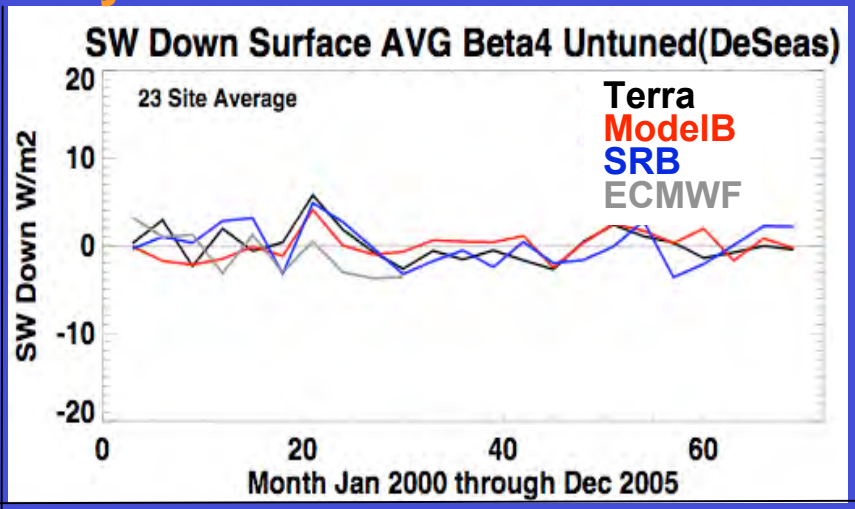


- AVG surface fluxes have minimized seasonal noise
- AVG greatest improvement is over polar regions compared with other datasets
- Terra and Aqua consistency

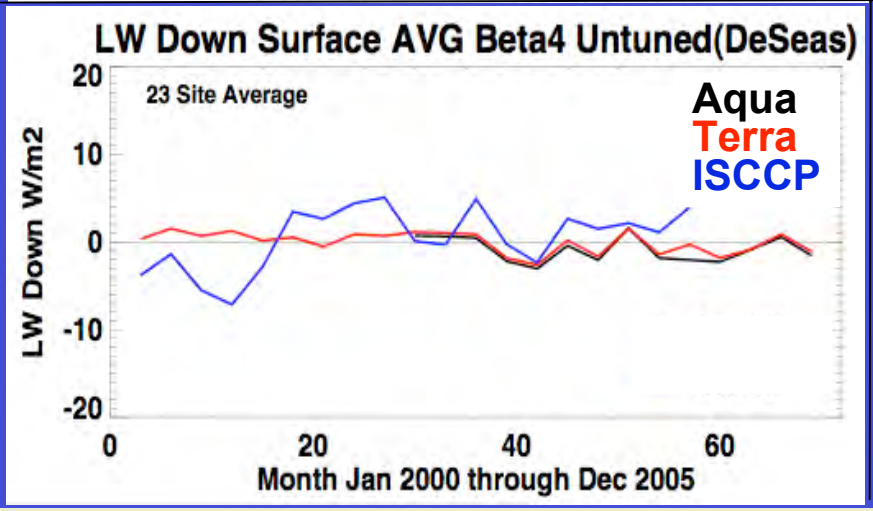
Surface Flux Trend Comparison
Product - CAVE flux deseasonalized differences
(seasonal) monthly means

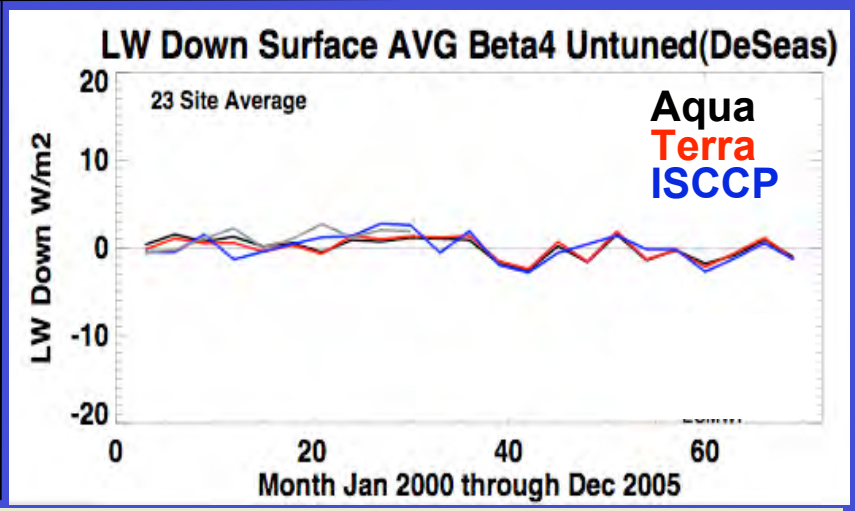
SWdown





LWdown

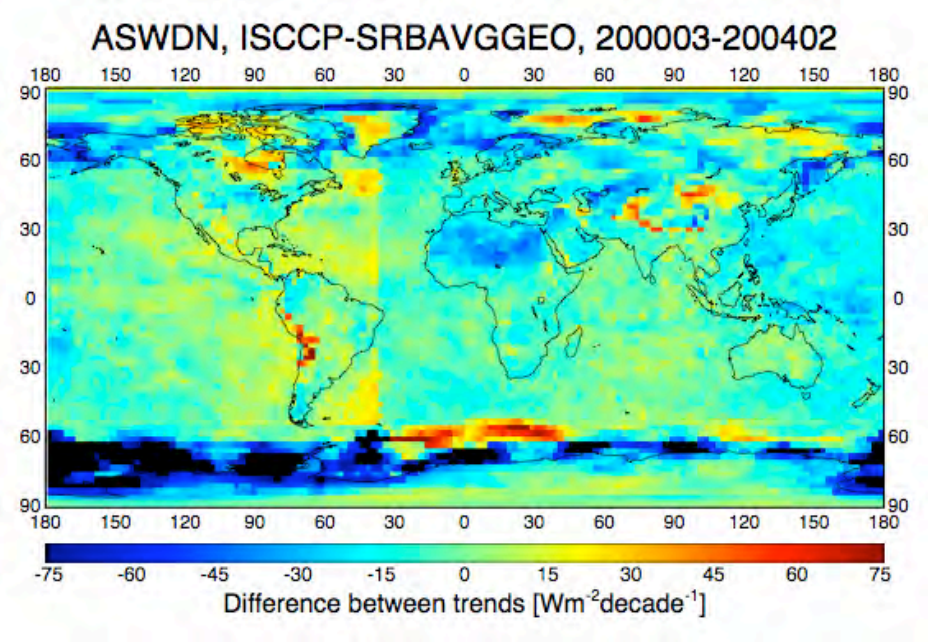




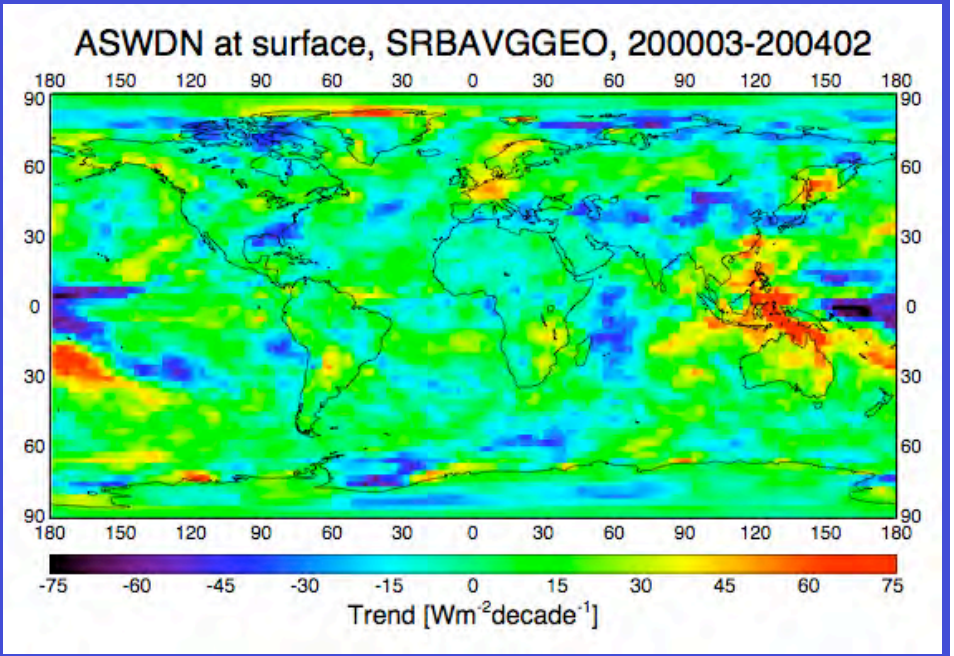
- Terra and Aqua based AVG surface fluxes trend consistently
- AVG does not have any apparent trends
- GEO clouds are not tied to MODIS, only GEO calibration is tied to MODIS

Surface SW down Deseasonalized Trend
March 2000 - February 2004

ISCCP - ModelB



ModelB



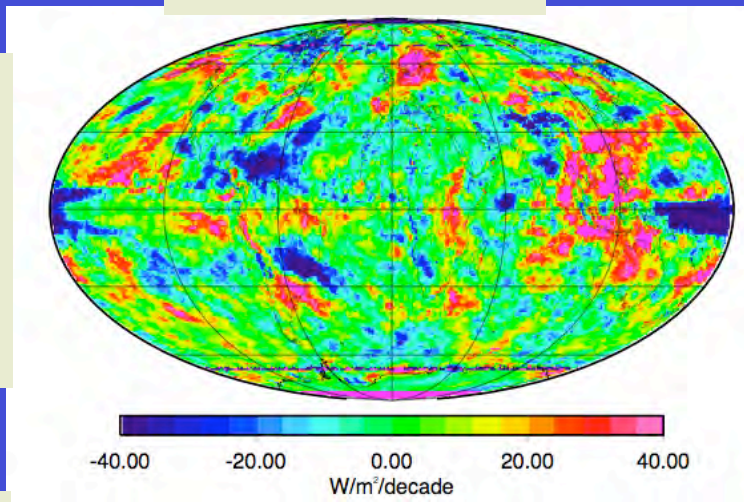
- Unlike ISCCP, GEO fluxes are tied to the CERES TOA fluxes
- No geostationary artifacts are imbedded in the GEO product
- AVG and ModelB fluxes are similar (previous slides)

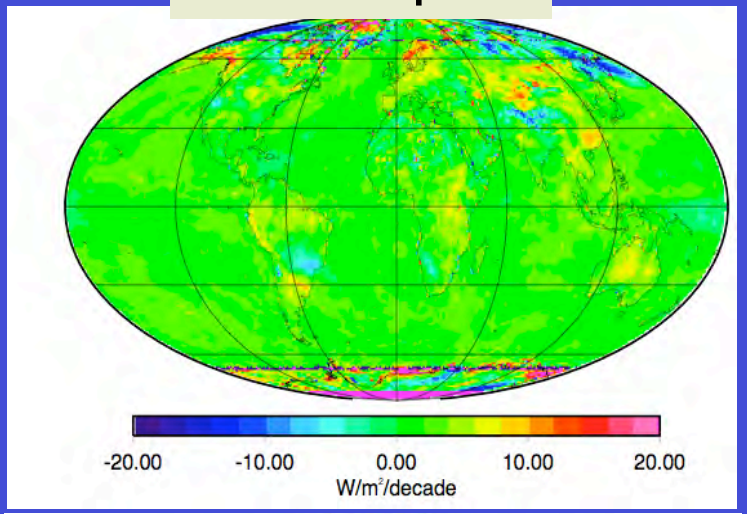
Deseasonalized Surface Flux Trends

Terra (seasonal) monthly means (Apr00-Oct05)

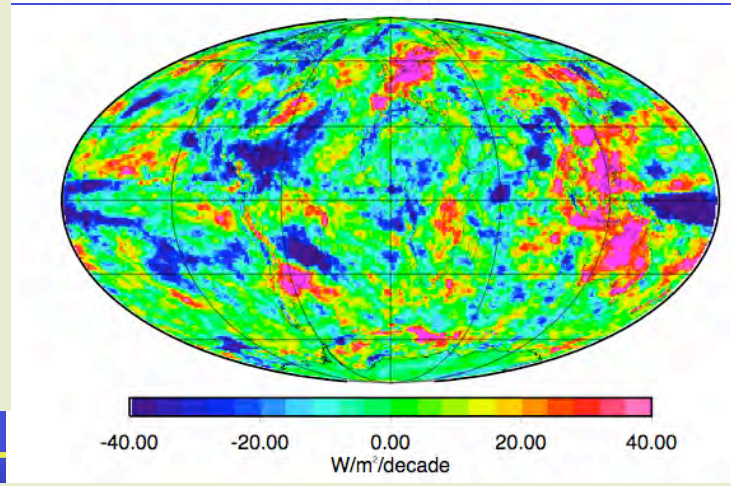
SWdown | SWup

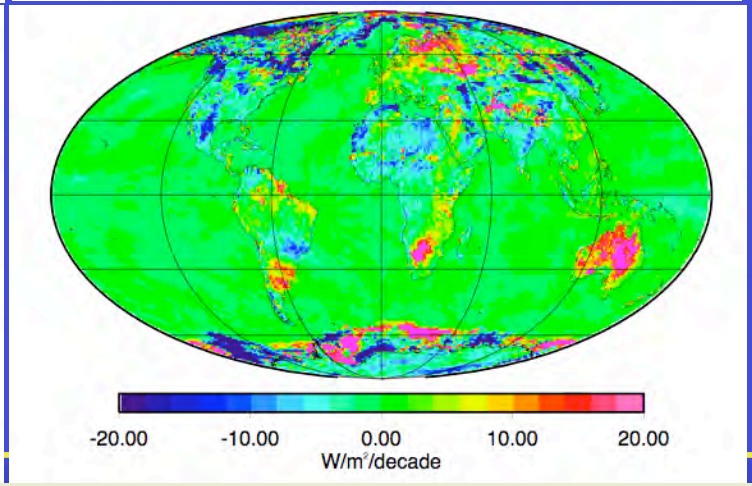
ModelB





AVG untuned

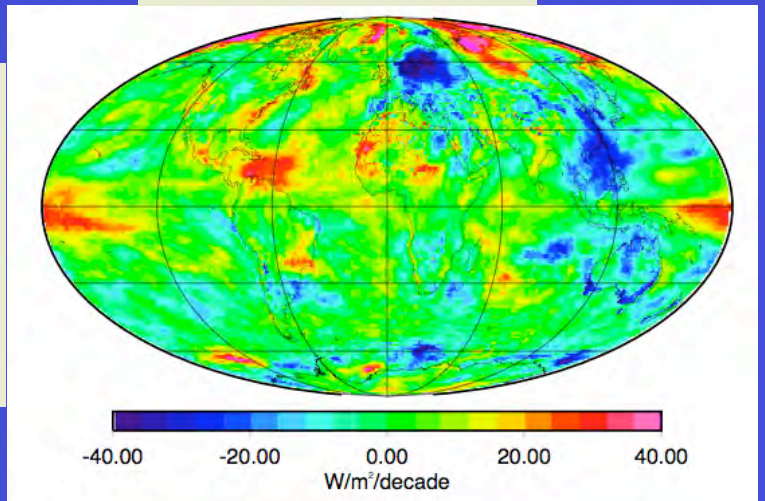
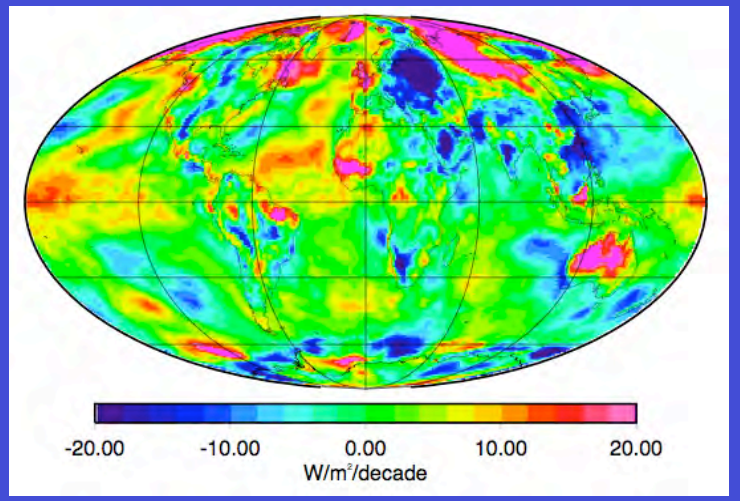
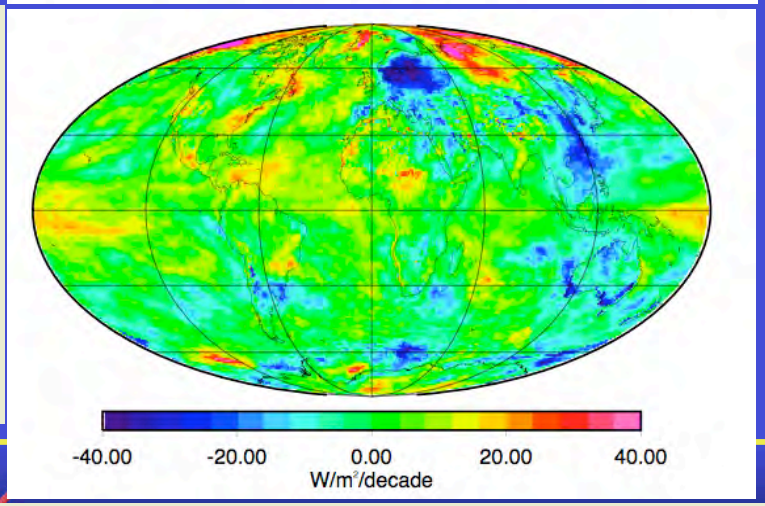
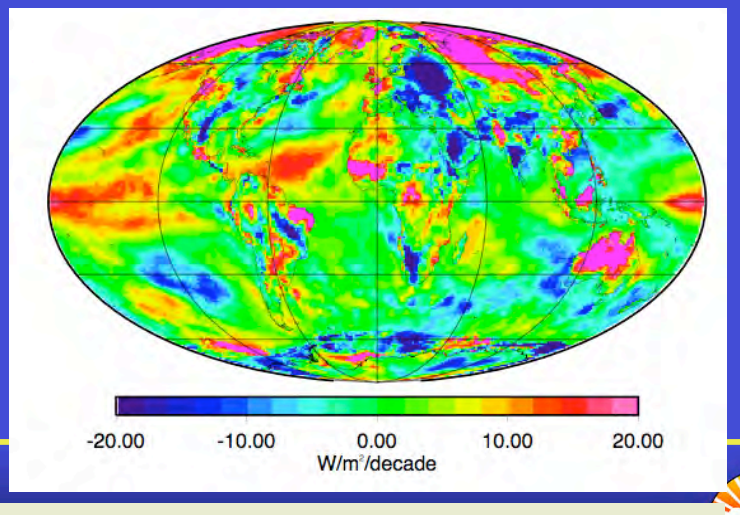




- No discernable GEO artifacts are detected
- GEO clouds are not tied to MODIS, GEO radiances are calibrated against MODIS

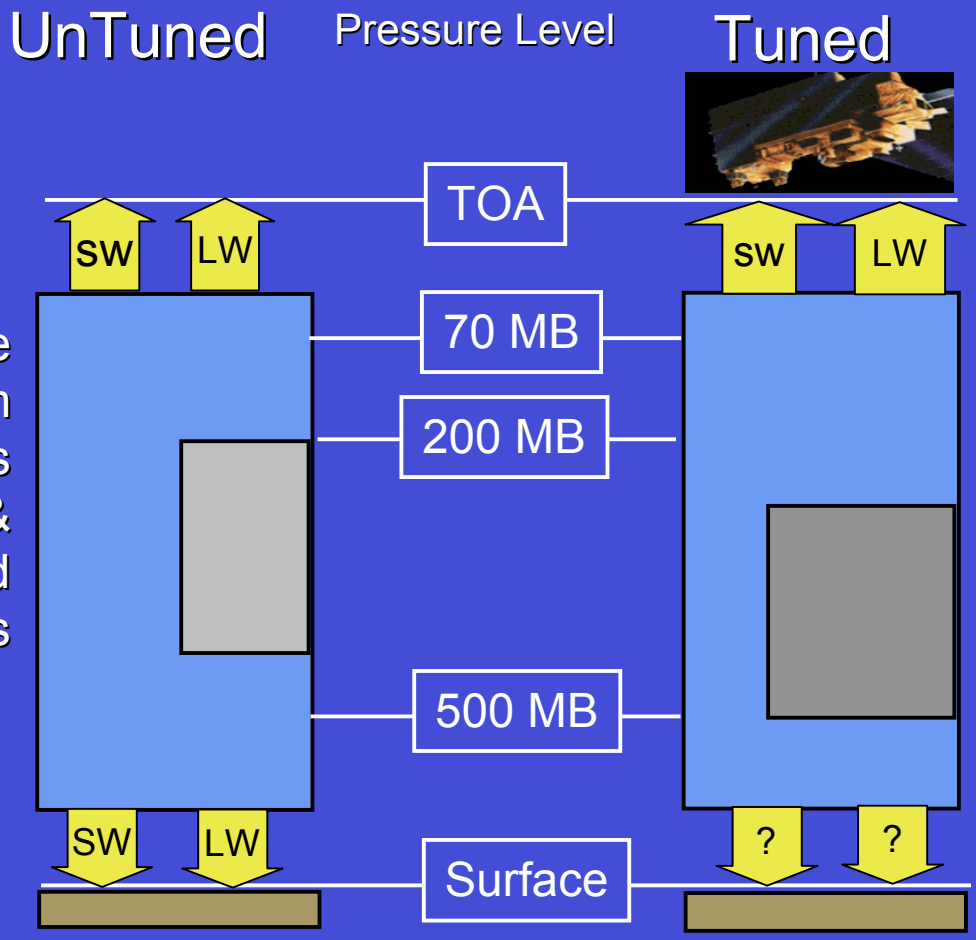
Deseasonalized Surface Flux Trends

Terra (seasonal) monthly means (Apr00-Oct05)

	LWdown	LWup
ModelB		
AVG untuned		

- No discernable GEO artifacts are detected

Untuned/Tuned Concept



Fluxes are computed from GEOS4 profiles and MODIS & GEO cloud properties

Adjust Cloud
- Top Height
- Optical Depth
- Amount

Within given uncertainties to match CERES TOA fluxes

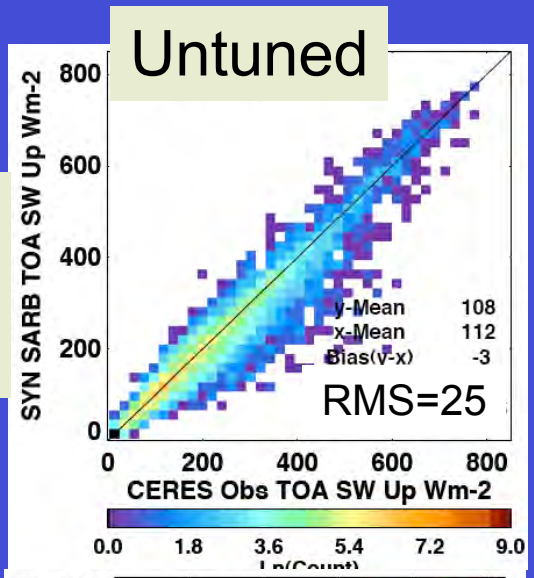
- Minimum cloud property adjustment to achieve maximum flux difference
- Non iterative linear tuning approach to attain consistent clouds and fluxes

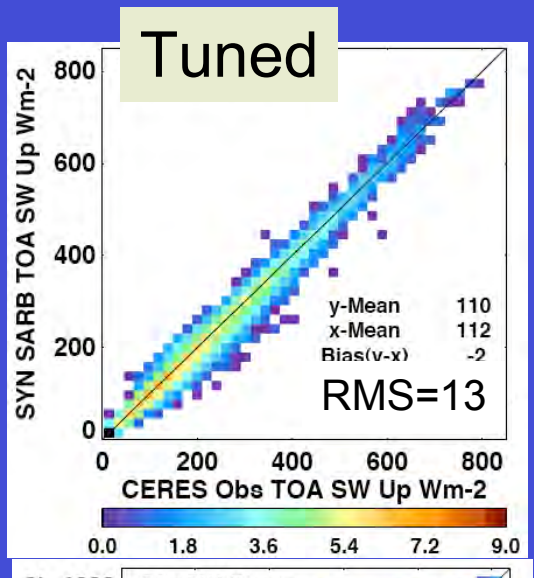
AVG and Cave SWdn Surface flux comparison

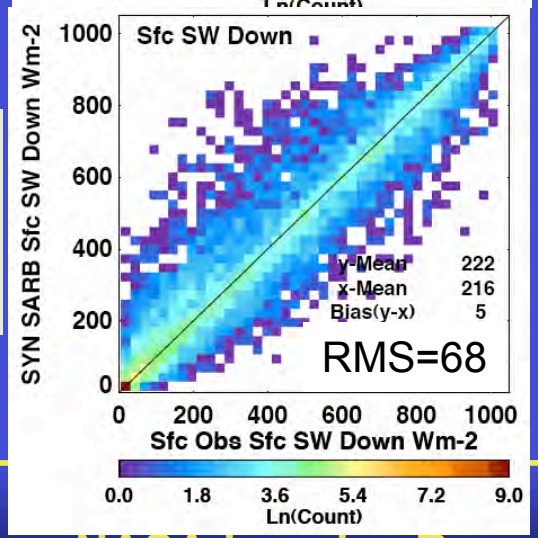
Instantaneous hourly, July 2004

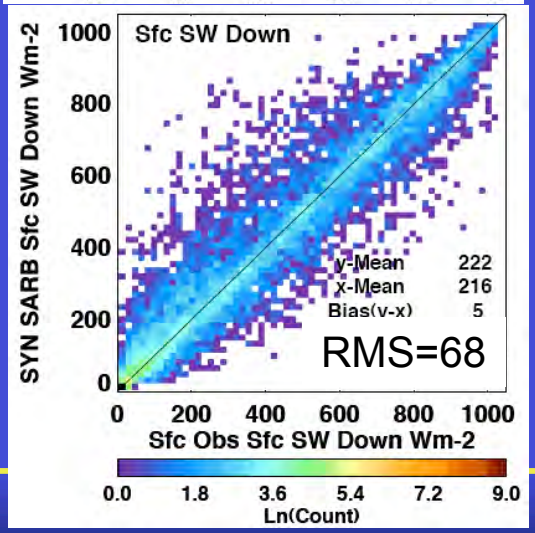
TOA

Surface









- Tuning matches the CERES flux as expected at the TOA

- Tuning does not seem effect surface fluxes

AVG - Cave Surface flux comparison

(seasonal) monthly means

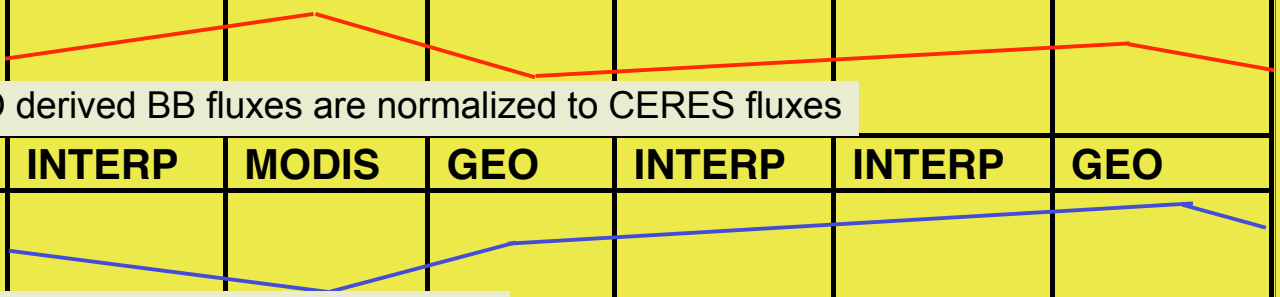
Surface Fluxes			Untuned			Tuned		
	Satel-lite	Mean Wm-2	Bias Wm-2	RMS Wm-2	RMS %	Bias Wm-2	RMS Wm-2	RMS %
SWdn	Terra	191	4	12	6.3	4	12	6.3
	Aqua	193	3	10	5.2	4	10	5.2
SWup	Terra	44	-11	20	45	-11	20	45
	Aqua	44	-12	21	48	-12	21	48
LWdn	Terra	334	-6	11	3.3	-6	11	3.3
	Aqua	338	-6	11	3.3	-6	11	3.3
LWup	Terra	385	-5	15	3.9	-3	14	3.6
	Aqua	385	-5	15	3.9	-4	14	3.6

- Slightly reduced RMS errors from Aqua
- Surface flux similar after tuning to TOA flux

Terra CERES-only & Beta4 Inputs

Merged (Beta4) GEO & CERES

Local Time	9:30	10:30	11:30	12:30	1:30	2:30
Fluxes	INTERP	CERES	GEO	INTERP	INTERP	GEO
Clouds	INTERP	MODIS	GEO	INTERP	INTERP	GEO

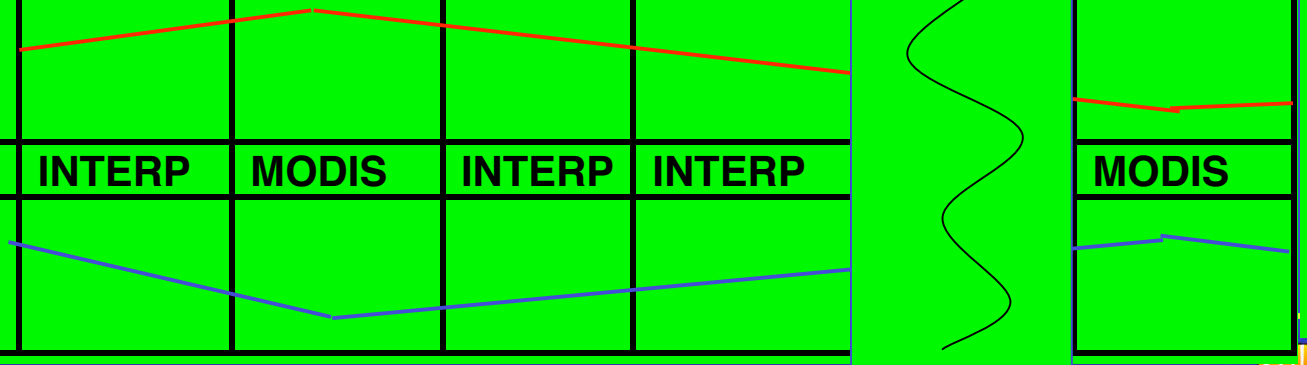


- 3-hourly GEO derived BB fluxes are normalized to CERES fluxes
- 3-hourly GEO clouds are not tied to MODIS

Diurnally complete

CERES-only

Local Time	9:30	10:30	11:30	12:30	22:30
Fluxes	INTERP	CERES	INTERP	INTERP	CERES
Clouds	INTERP	MODIS	INTERP	INTERP	MODIS



10:30 sunsynchronous

AVG and Cave SWdn Surface flux comparison

Instantaneous hourly, July 2004

SW Down			MODIS-only			GEO (Beta4)		
	Satel-lite	Mean Wm-2	Bias Wm-2	RMS Wm-2	RMS %	Bias Wm-2	RMS Wm-2	RMS %
ModelB	Terra	218	7	89	41	4	78	36
	Aqua	220	5	88	40	5	79	36
Untuned	Terra	216	7	79	37	6	69	32
	Aqua	216	5	79	37	5	69	32

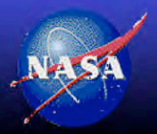
- GEO clouds improve RMS errors by ~10%
- GEO clouds improves the bias
- Computed fluxes are an improvement over parameterized

AVG and Cave LWdn Surface flux comparison

Instantaneous hourly, July 2004

LW Down			MODIS-only			GEO (Beta4)		
	Satel-lite	Mean Wm-2	Bias Wm-2	RMS Wm-2	RMS %	Bias Wm-2	RMS Wm-2	RMS %
ModelB	Terra	358	-2	22	6.1	0	22	6.1
	Aqua	358	-2	21	5.9	0	22	6.1
Untuned	Terra	358	-7	22	6.1	-5	21	5.9
	Aqua	358	-6	21	5.9	-5	21	5.9

- Only cloud base heights effect LWdn, no TOA component
- There for little change between MODIS and GEO clouds and before and after tuning
- GEO clouds does improve the bias



AVG and Cave Surface flux comparison

Instantaneous hourly, July 2004

Terra untuned Beta4 (%)	SW down		LW down	
	bias	RMS	Bias	RMS
CERES	3.2	22	-0.9	6.9
GEO	2.3	32	-1.6	5.4
Interpolated	3.0	33	-1.4	5.6
All	2.8	32	-1.3	5.9

- Similar results for Aqua and tuned (not shown)
- GEO cloud computed SW improves bias but increases RMS
- GEO cloud computed LW improves RMS but increases bias

AVG and Cave SWdn Surface flux comparison

SGP sites only, Instantaneous hourly, July 2004

Swdn(%)	Aqua (13:30)		Terra (10:30)	
Local time	MODIS-only	GEO Beta4	MODIS-only	GEO Beta4
3-9	39	27	34	26
6-12	25	20	21	19
12-18	19	17	22	18
15-21	33	26	35	26

- GEO clouds greatest impact is in the early morning and late afternoon away from the CERES measurement
- LWdn is similar for computed GEO or MODIS-only (not shown)

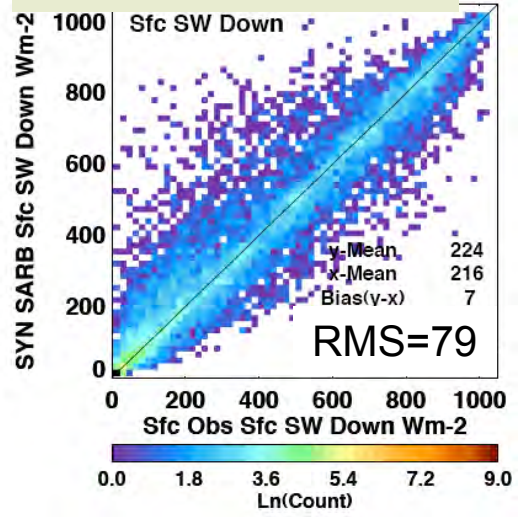
AVG and Cave SWdn Surface flux comparison

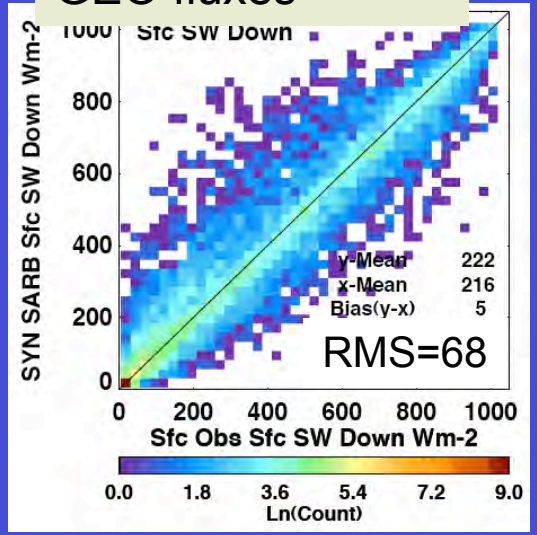
Instantaneous hourly, July 2004

MODIS-only clouds
GEO fluxes

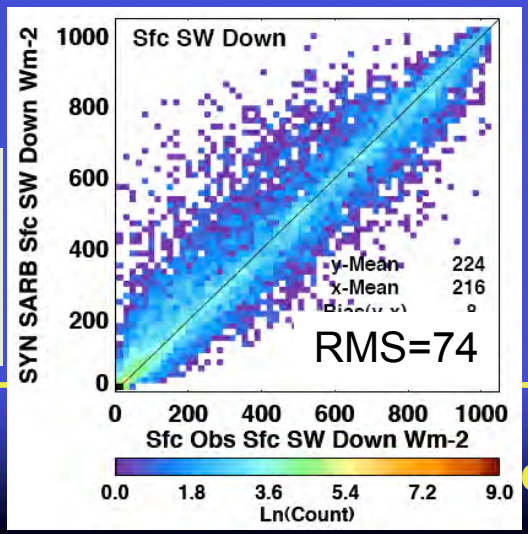
GEO(Beta4 clouds
GEO fluxes

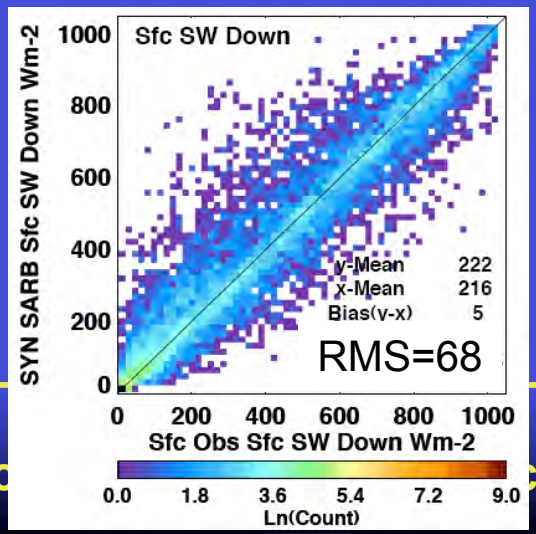
Untuned





Tuned





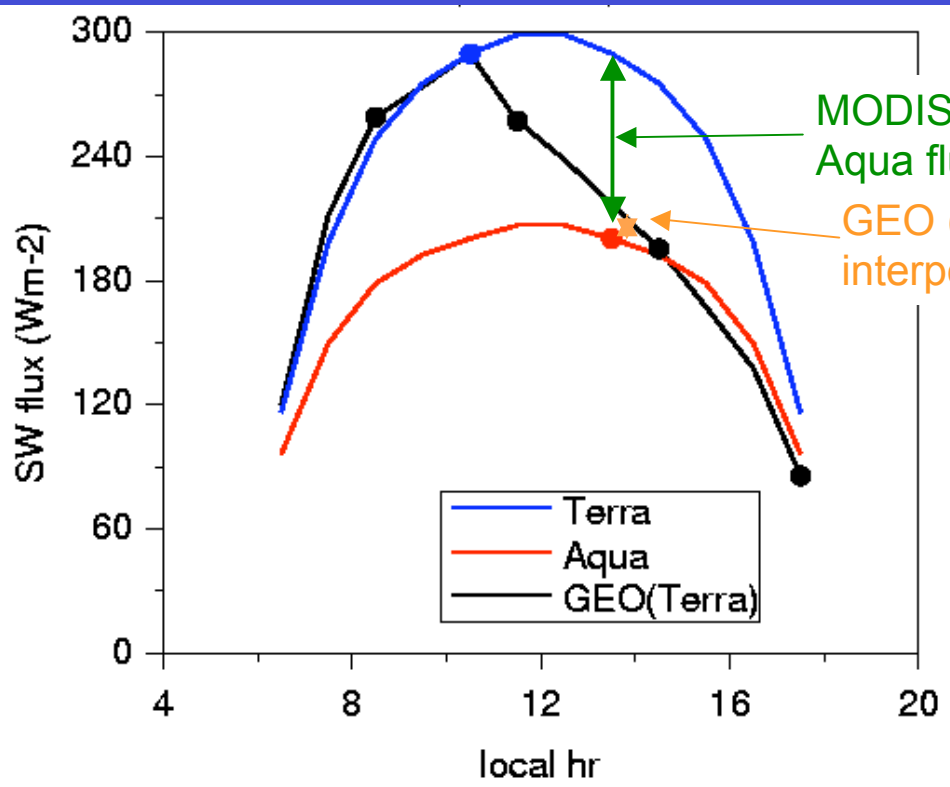
- If the clouds and TOA fluxes are inconsistent then tuning adjust clouds to minimize TOA flux and improves the surface flux

- If the clouds and fluxes are consistent to begin with then tuning has little impact on surface fluxes

Terra - Aqua flux difference studies

- Compare Terra interpolated or computed 1-hourly fluxes with Aqua observed fluxes - July 2004
  - Terra (10:30AM) and Aqua (1:30PM) local equator sampling
    - Both at noon at 70° N and 6 hours apart at 60° S
    - GEO limit is ±60°
  - Compare both surface and TOA fluxes
  - Are the Terra/GEO couds based computed fluxes closer to Aqua observed fluxes than using Terra only clouds

Temporal SW Flux Averaging
Example: Peruvian stratus region



MODIS clouds interpolation - Aqua flux error

GEO (Beta4) clouds interpolation - Aqua flux error

- The flux difference between Terra interpolated at Aqua (1:30PM) observation time
- Terra-MODIS only interpolation assumes constant clouds

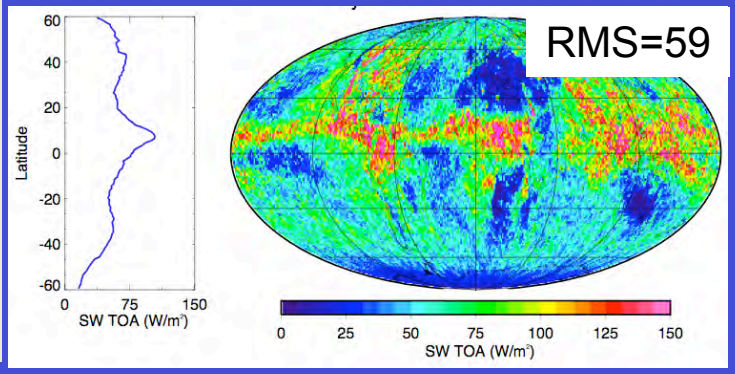
Terra_based - Aqua (1:30PM) observed comparison

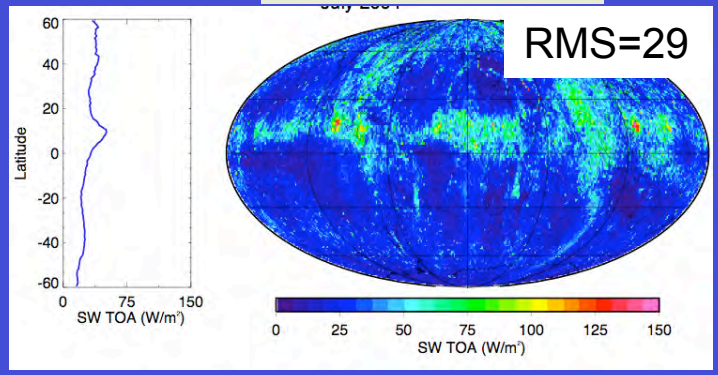
SW TOA, instantaneous hourly, July 2004

MODIS clouds

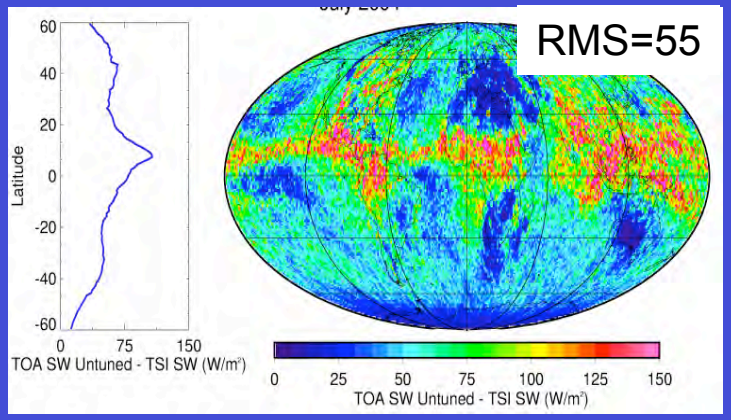
GEO (Beta4)

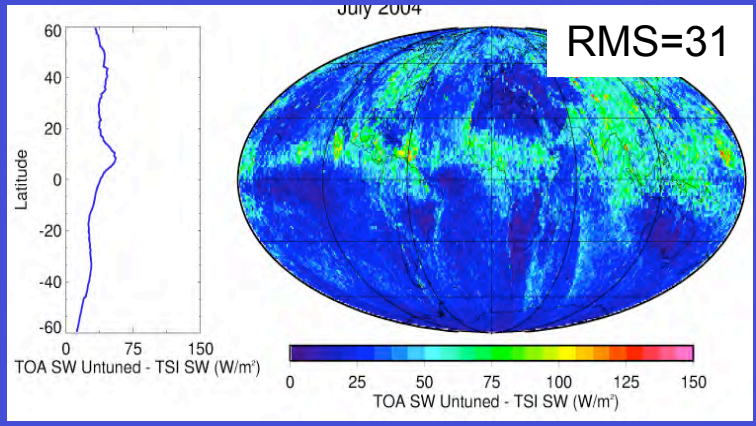
Interpolated - Aqua





Untuned - Aqua





- Terra interpolated and Untuned fluxes using Beta4 clouds are similar compared with Aqua observed and are an improvement over MODIS clouds

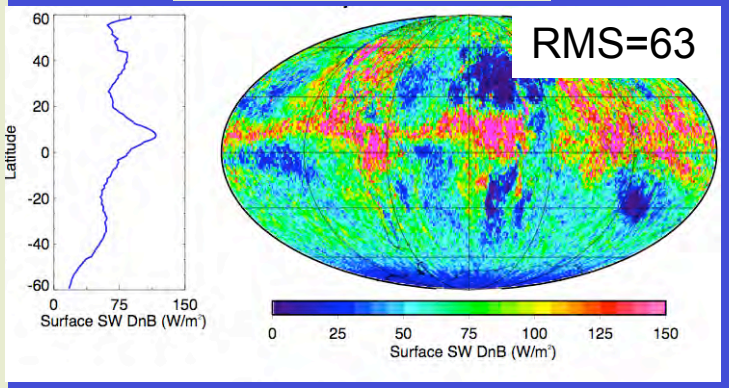
Terra_based - Aqua (1:30PM) observed comparison

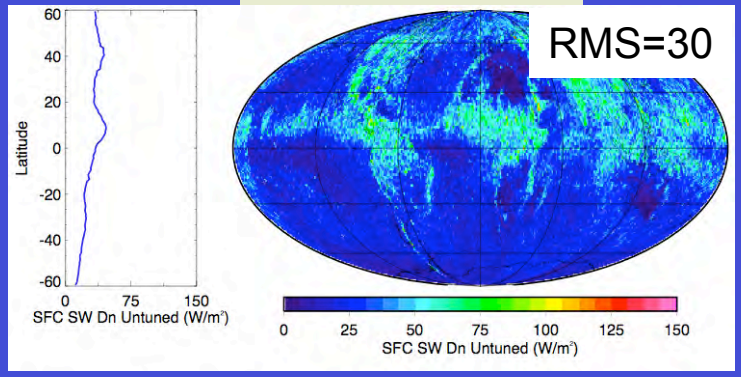
SW down, instantaneous hourly, July 2004

MODIS clouds

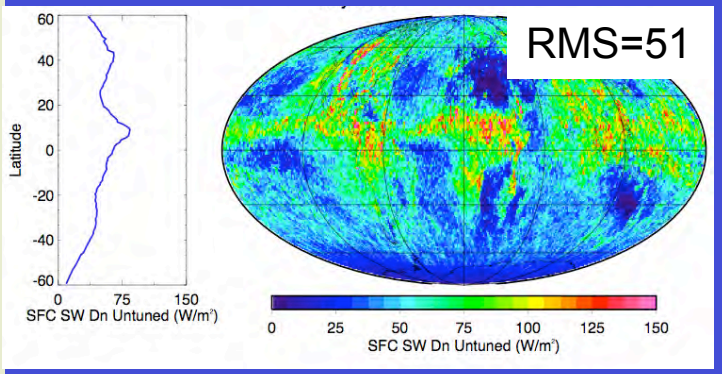
GEO (Beta4)

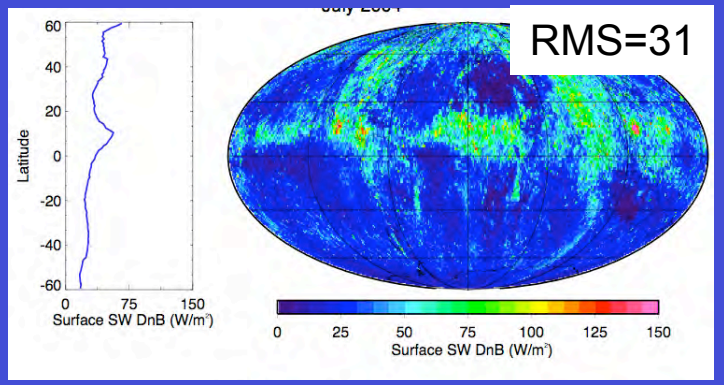
ModelB - Aqua(modelB)





Untuned - Aqua (Untuned)





• Beta4 clouds an improvement over MODIS interpolated clouds in computing surface fluxes consistent with Aqua MODIS cloud computed flux

Computed or interpolated Terra based flux - Aqua observed flux (1:30pm) comparison

instantaneous hourly, July 2004

RMS (Wm^{-2})	@Aqua observed (1:30 PM)	MODIS-only	GEO (Beta4)
SW TOA	Terra_Interpolated	59	29
	Untuned	55	31
	Tuned to GEO flux	41	29
LW TOA	Terra_Interpolated	17	11
	Untuned	17	11
	Tuned to GEO flux	15	10

• Terra interpolated and Untuned fluxes using Beta4 clouds are similar compared with Aqua observed and are an improvement over MODIS clouds

Computed Terra based flux - Aqua observed surface flux (1:30pm) comparison

instantaneous hourly, July 2004

RMS (Wm^{-2})	Clouds	SWdn	SWup	LWdn	LWup
ModelB	MODIS-only	63	13	12	0.2
	GEO Beta4	30	11	10	0.2
Untuned	MODIS-only	52	6	10	0.7
	GEO Beta4	31	5	10	0.7
Tuned to GEO flux	MODIS-only	38	6	9	2.3
	GEO Beta4	28	5	10	2.3

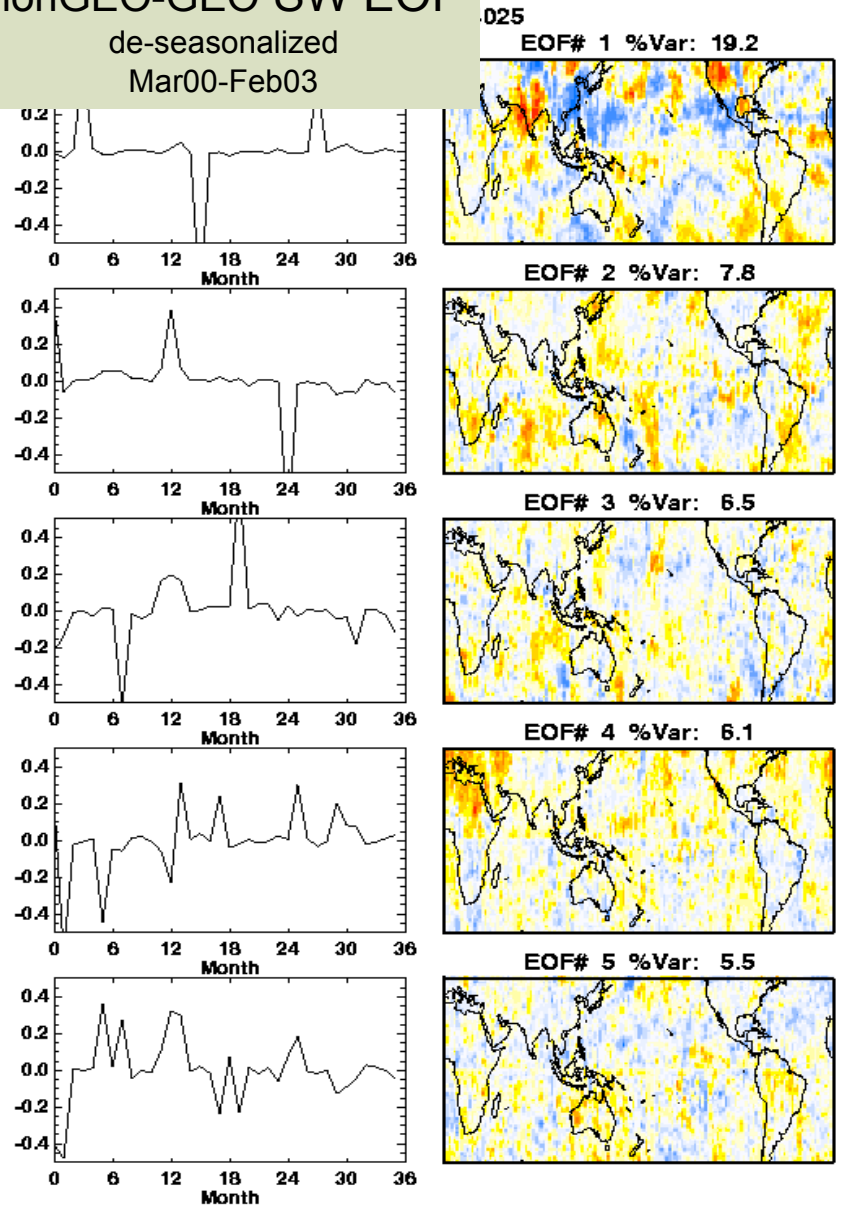
• Beta4 clouds an improvement over MODIS interpolated clouds in computing surface fluxes consistent with Aqua MODIS cloud computed flux

SYN/AVG/ZAVG EOF analysis

- EOF deseasonalized trend analysis for computed TOA and surface fluxes
  - To test for GEO artifacts and trends in the GEO cloud retrievals
  - TOA untuned - SRBAVG_nonGEO EOF
    - No trend observed with SRBAVG_nonGEO relative to SeaWifs
  - GEO radiances are calibrated against MODIS, and GEO derived fluxes are normalized to CERES, however GEO cloud properties are not normalized to MODIS

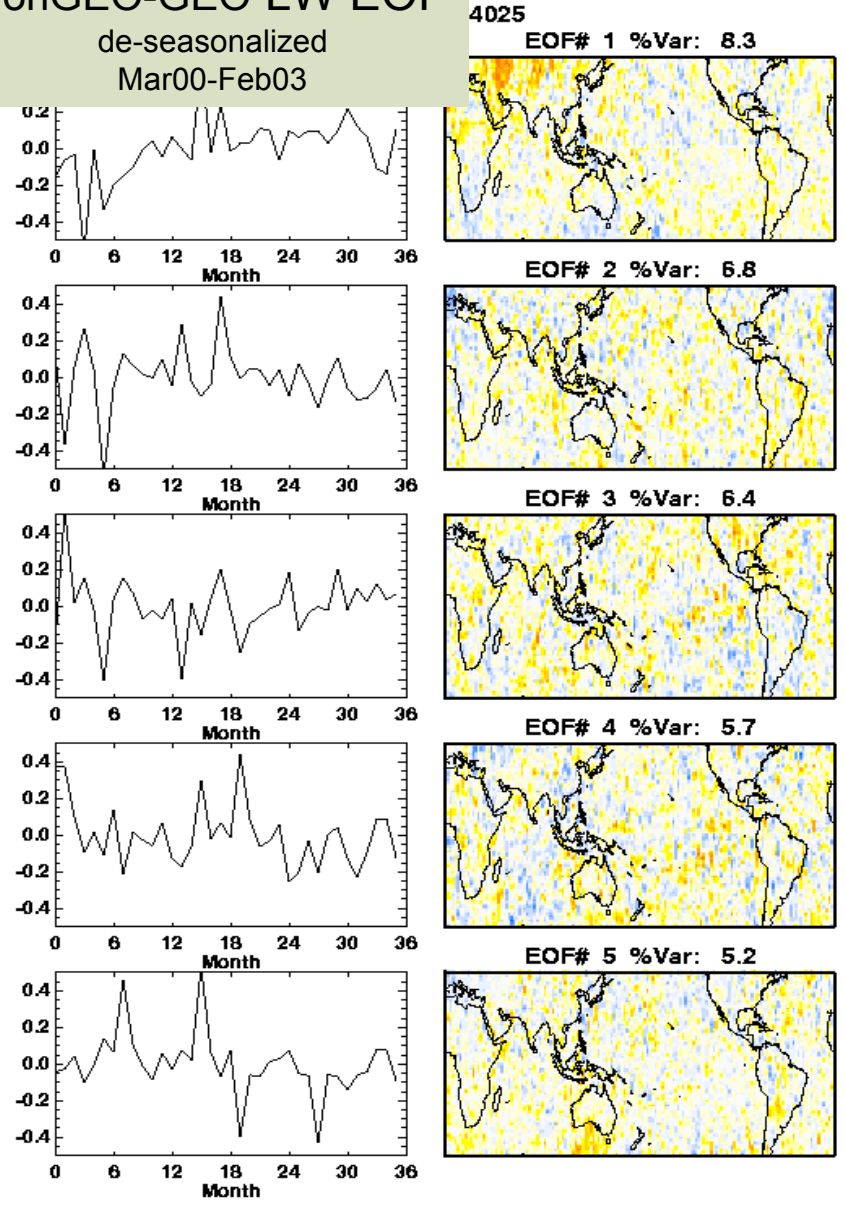
nonGEO-GEO SW EOF

de-seasonalized
Mar00-Feb03



nonGEO-GEO LW EOF

de-seasonalized
Mar00-Feb03



- No GEO artifacts observed in the SRBAVG-GEO fluxes
- De-seasonalized flux EOFs tend to bring out the GEO viewing artifacts

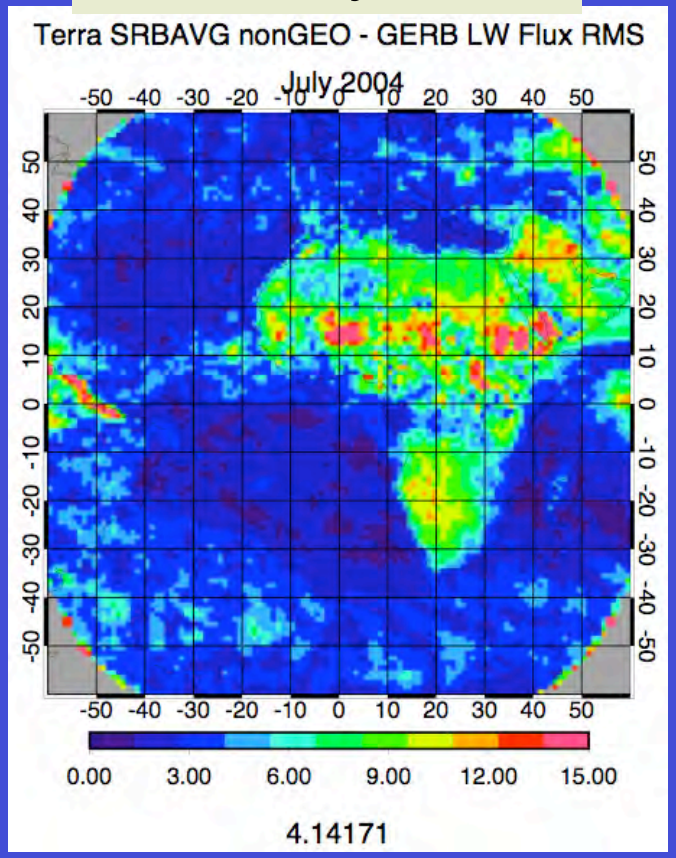
es

CERES

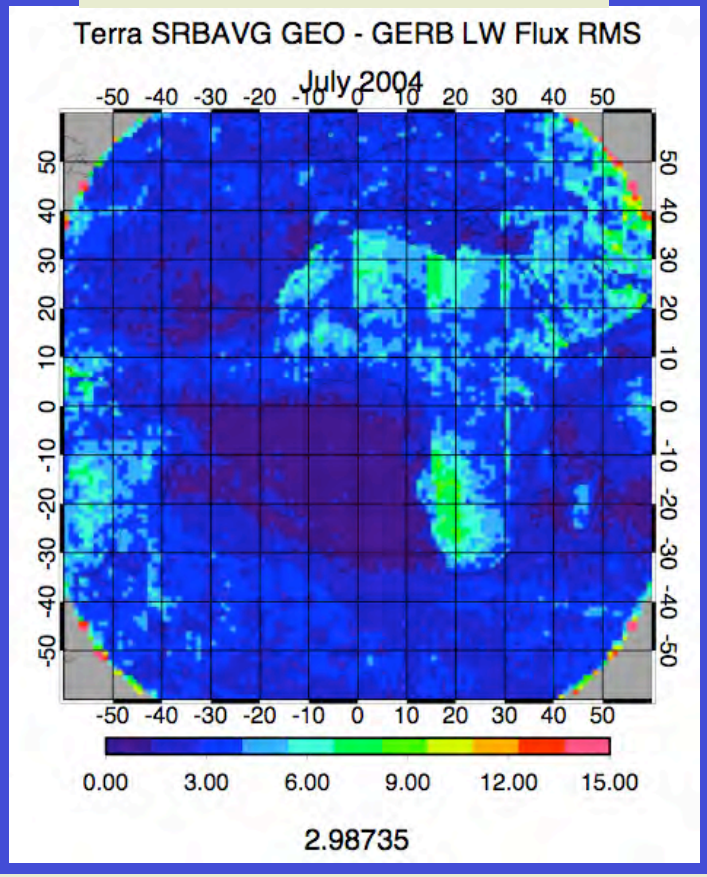
Comparison of SRBAVG - GERB LW flux differences

monthly hourly RMS, July 2004

Terra-only fluxes



Terra/GEO fluxes

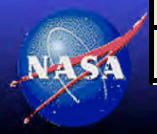


- GERB fluxes are measured every 15 minutes
- Compare untuned with GERB relative fluxes after removing calibration bias

SYN/AVG/ZAVG Validation Summary

Truth dataset	Validation	SW	LW
Cave surface flux comparisons	Comparison with other datasets ISCCP, SRB, ModelB		
	Deseasonalized trends, GEO artifacts		
	Tuning at TOA improvement		
	GEO clouds computed flux improvement over MODIS interpolated		
	Improvement of Tuned fluxes with GEO flux using MODIS-only clouds		
	Increased GEO computed flux improvement near sunrise/sunset flux		
	UV index and PAR comparison		
Terra-based fluxes compared with Aqua TOA 1:30 PM observed	GEO cloud computed fluxes similar to TOA temporal interpolated fluxes		
	GEO clouds computed SFC flux improvement over MODIS interpolated compared with Aqua clouds		
Beta4	TOA Untuned – Observed flux consistency Clouds and fluxes are consistent		
SeaWifs PAR	Compare untuned PAR flux		
NCAR/NCEP	Net atmosphere flux comparison		
EOF	Any GEO artificacts		
GERB diurnal	Computed TOA fluxes diurnally consistent		

Validation Outcome	
Improvement	
Neutral	
Caution - DQS	
Show Stopper	



SYN/AVG/AVG validation discussion