TISA (Time-Space Averaging) Update

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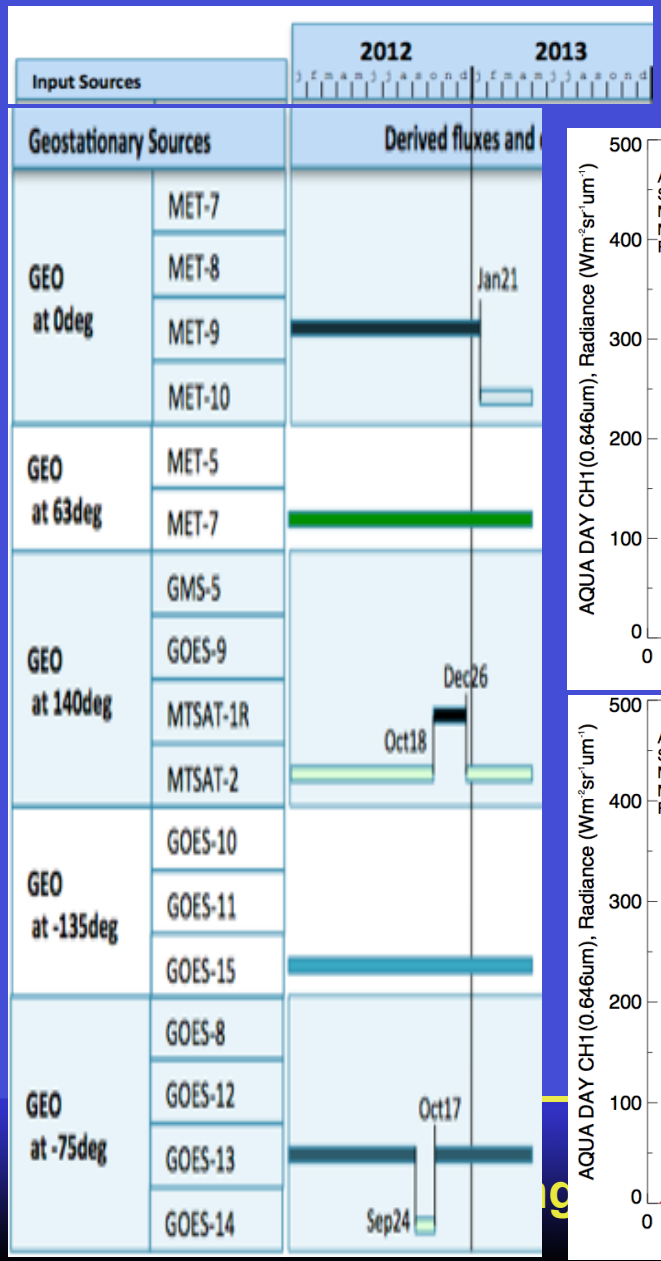
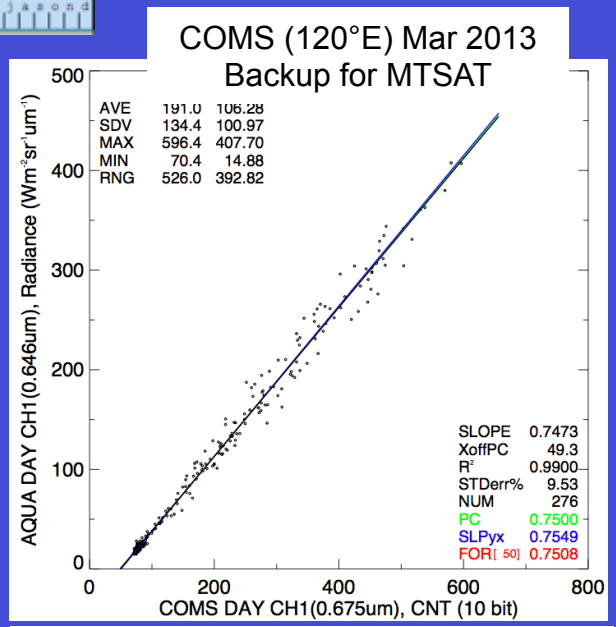
19th CERES Science Team Meeting
NASA-Langley, Hampton, VA, May 7-9, 2013

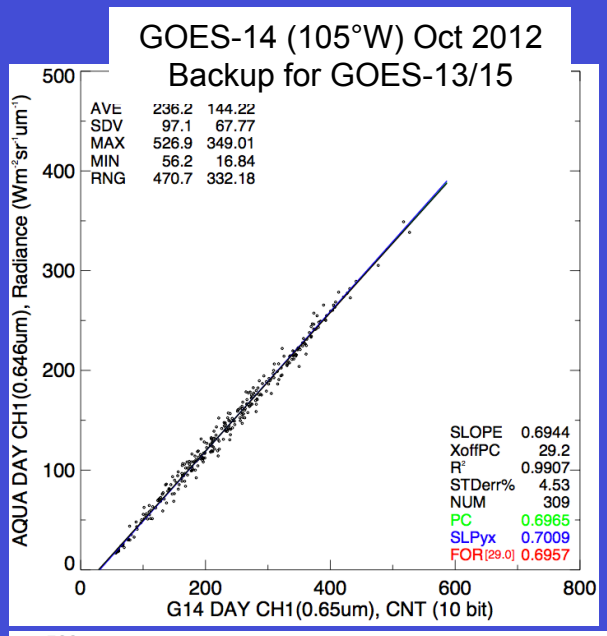
TISA SYN1deg Edition 4 improvements

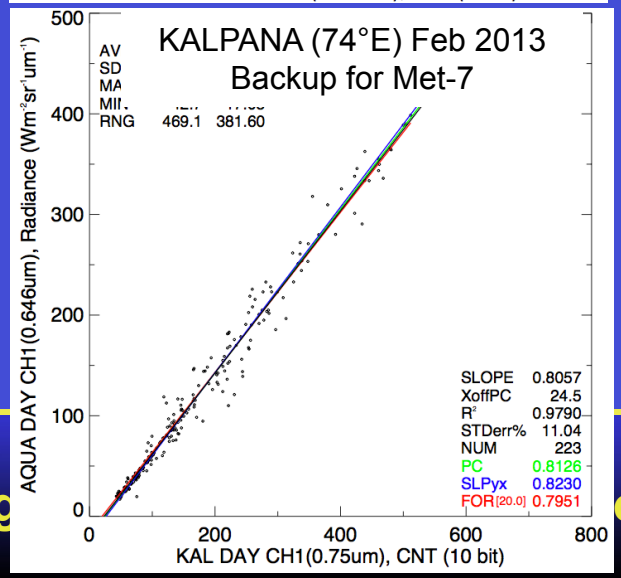
	Ed2	Ed4
GEO calibration	Terra-MODIS Collection 5 reference Terra-MODIS/GEO ray-matching	Aqua-MODIS Collection 6 reference Terra-scaled-to and Aqua-MODIS/GEO ray-matching Deep convective cloud and desert SCIAMACHY based spectral band adjustment MTSAT-1R adjusted point spread function (Doelling Thursday presentation)
GEO clouds	Visible and 11μm cloud retrievals Assumed particles size Assume night time emissivity = 1 MODIS clear-sky albedo maps Phase, 253°K threshold	Visible and 3.7,11, and 12μm cloud retrievals/mask 3.7μm channel retrieved particle sizes Emissivity based on 3.7,11 and 12 (good for thin clouds) GEO specific clear-sky maps Multiple IR channel threshold (MODIS lapse rate?)
GEO LW flux	Simple global parameterization based on WN radiance column weighted RH Instantaneous normalization	WN and WV to BB (M. Sun Thursday presentation) LW ADM 5° by 5° LW regional normalization
GEO SW flux	GEO visible->MODIS 0.65μm->BB CERES SW TRMM ADM 5° by 5° SW regional normalization	Investigate visible to BB conversion Investigate GEO derived clear-sky TOA flux accuracy
Temporal interpolation	TRMM SW directional models LW linear interpolation 3-hourly GEO	GEO 1-hourly observations (no temporal interpolation)
Surface fluxes	GEOS and MODIS skin temperatures GEOS 4.0/5.2 merged dataset Untuned surface fluxes	Include GEO derived skin temperatures GEO 5-channel clouds (test normalized to MODIS) Surface fluxes tuned to TOA using cloud overlap 2000 to present GEOS 5.4 dataset Spectral & SZA dependent surface albedo
Validation	Terra/Aqua-CERES & GERB TOA fluxes ground site fluxes	Include Megha-Tropique

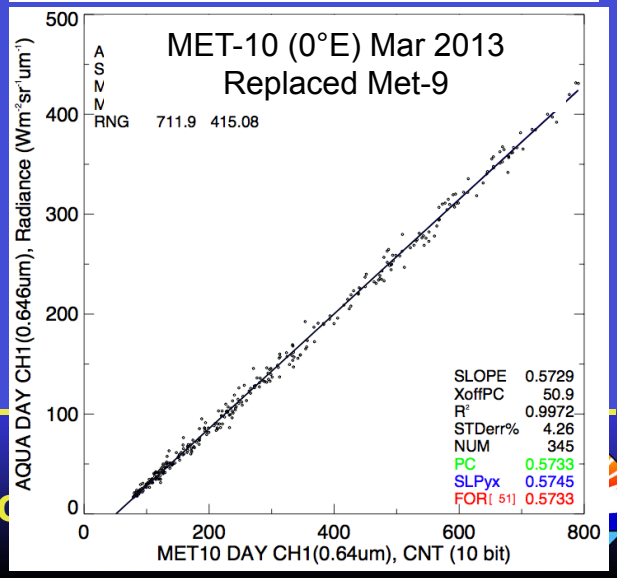
New GEO satellites calibrated with MODIS





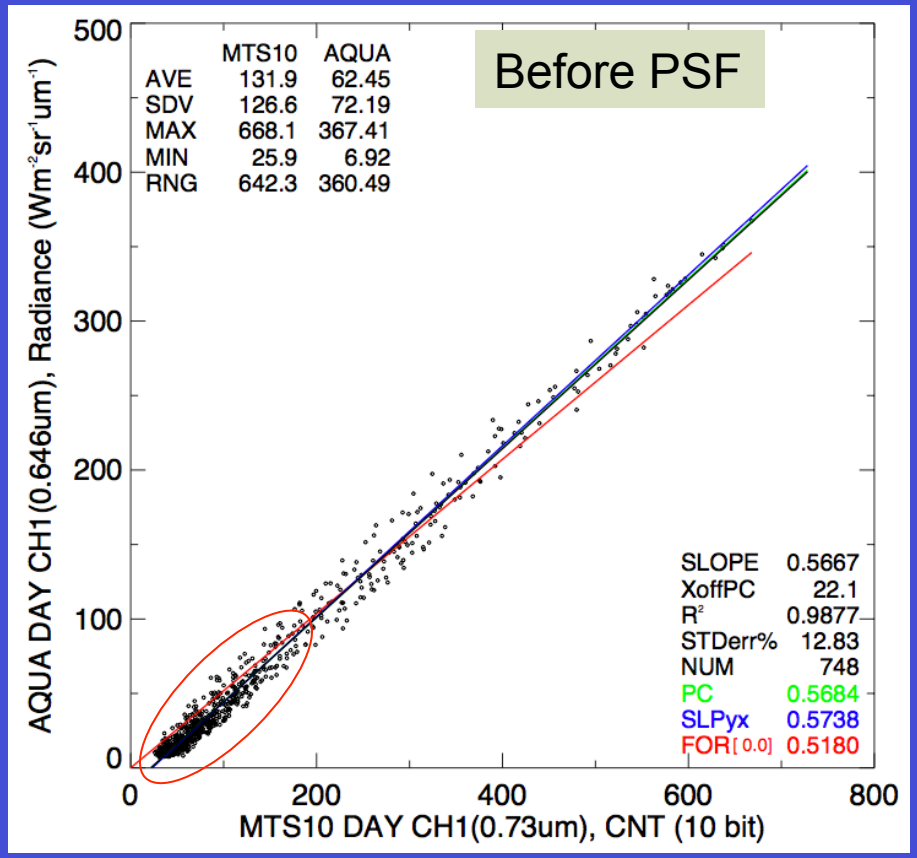


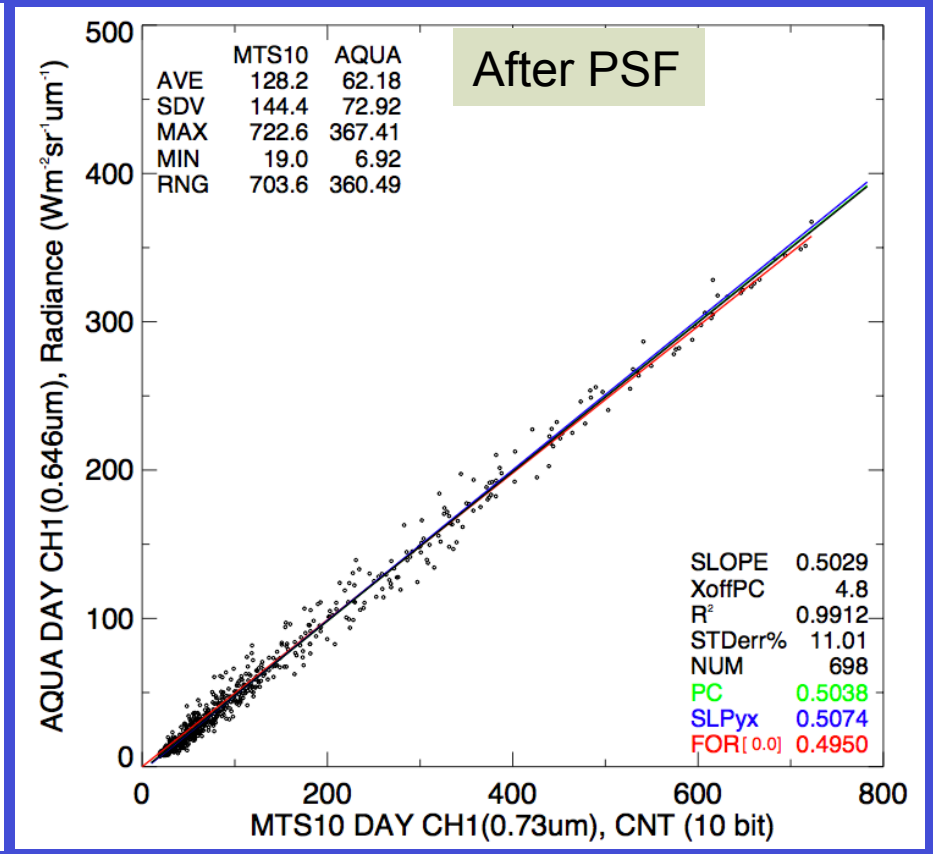




MTSAT-1R/Aqua-MODIS ray-match inter-calibration Dec 2012

- Konstantin developed a MTSAT1 point spread function, which included radiance contributions of 200 km for a given 1-km pixel.



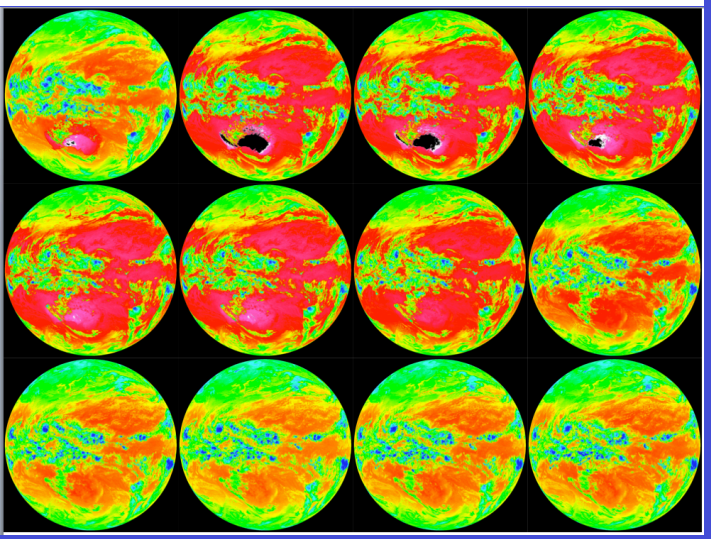


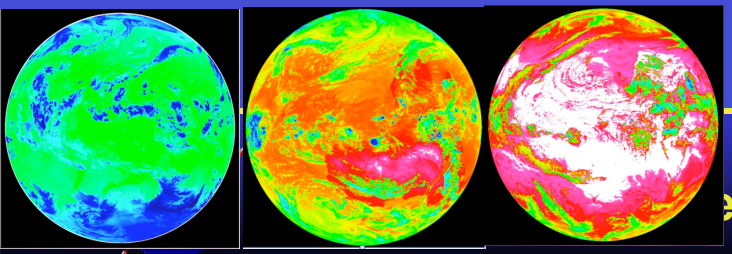
- After PSF correction, the MTSAT-1R counts are now proportional to radiance and all linear regressions intersect the space count = 0

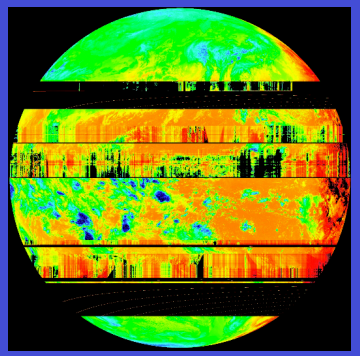
Monthly GEO image cleaning

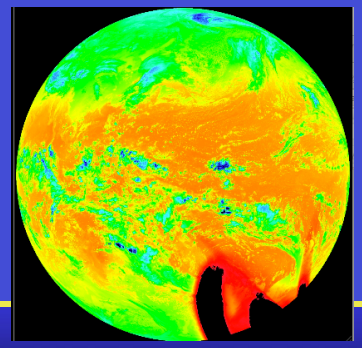
- TISA team cleaning bad scan lines monthly from GEO images, 3rd week of month clean previous month
  - Images that are cleaned are resubmitted to the ASDC archive

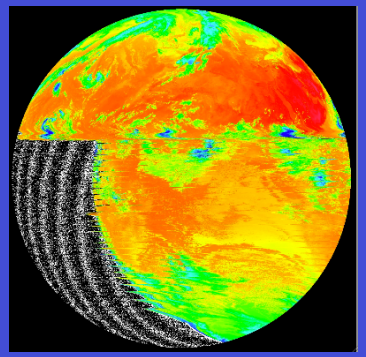
MTSAT-2 IR hourly warming event

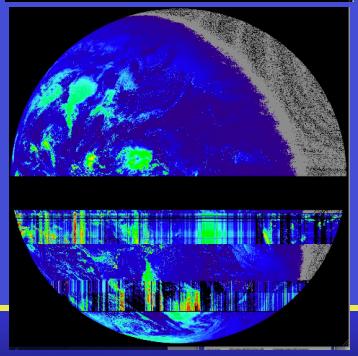


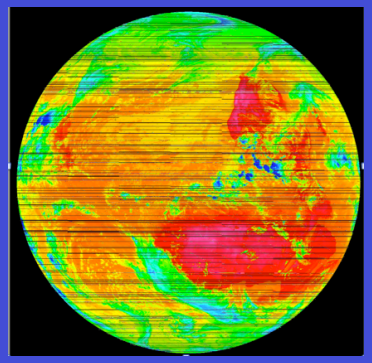


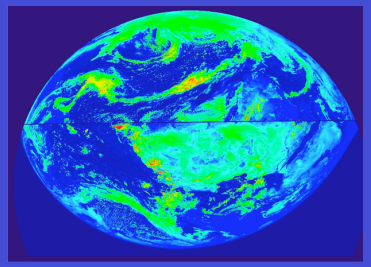












GEO 5-channel cloud retrievals

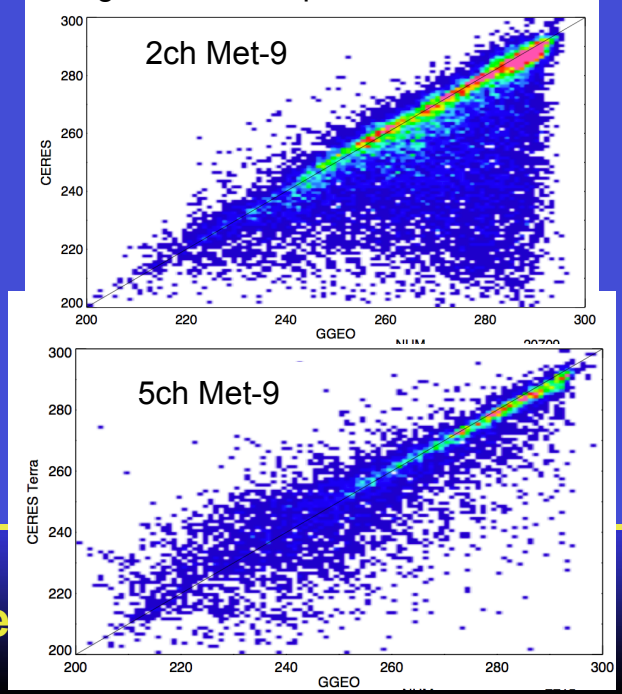
- Cloud WG to process 12 years of 1-hourly GEO 5-channel cloud retrievals and be saved at 8-km resolution in netCDF
  - Uncompressed estimated at 85TB/10years compressed 17TB/10years
  - Display in subsetter
  - Perform GEO comparisons with MODIS at coincident matched angles for QC
- Finalize GEO cloud retrieval code for 15 satellites before Oct 2013 based on 4 seasonal months/satellite

Monitor Progress on web site

http://cloudsgate2.larc.nasa.gov/cgi-bin/site/showdoc?docid=214&c=home

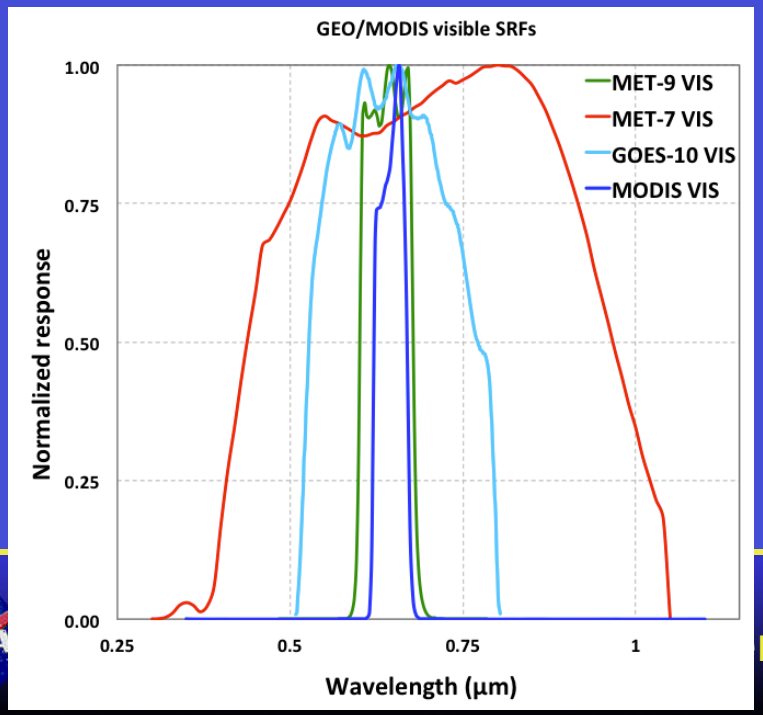
Satellite	January		April		July		October	
GOES-8								
GOES-9								
GOES-10								
GOES-11								
GOES-12								
GOES-13								
Meteosat-8 (MSG-1)								
Meteosat-9/Terra (MSG-2)	2ch	5ch	2ch	5ch	2ch	5ch	2ch	5ch
Meteosat-9/Aqua (MSG-2)		5ch		5ch		5ch		5ch
MTSAT-1R								
MTSAT-2								

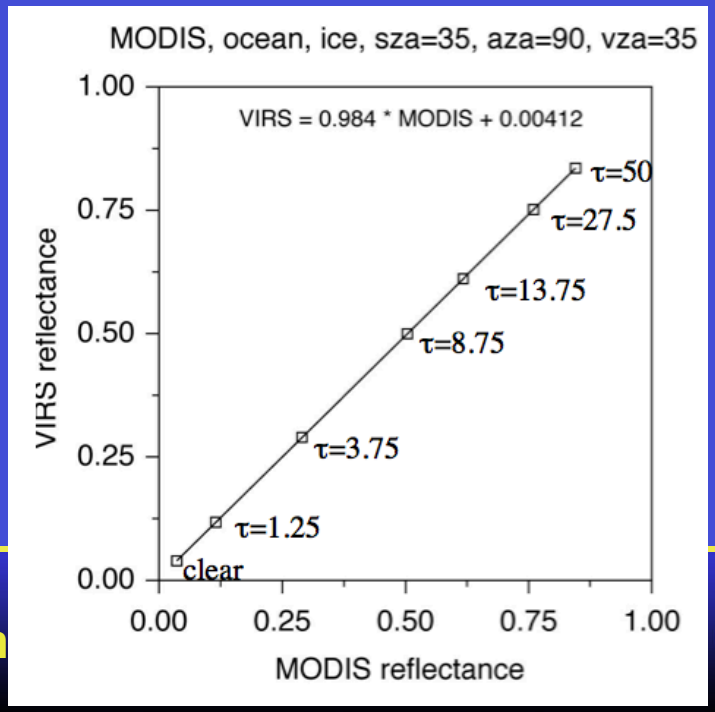
Night Cloud Temperature Jan 2010



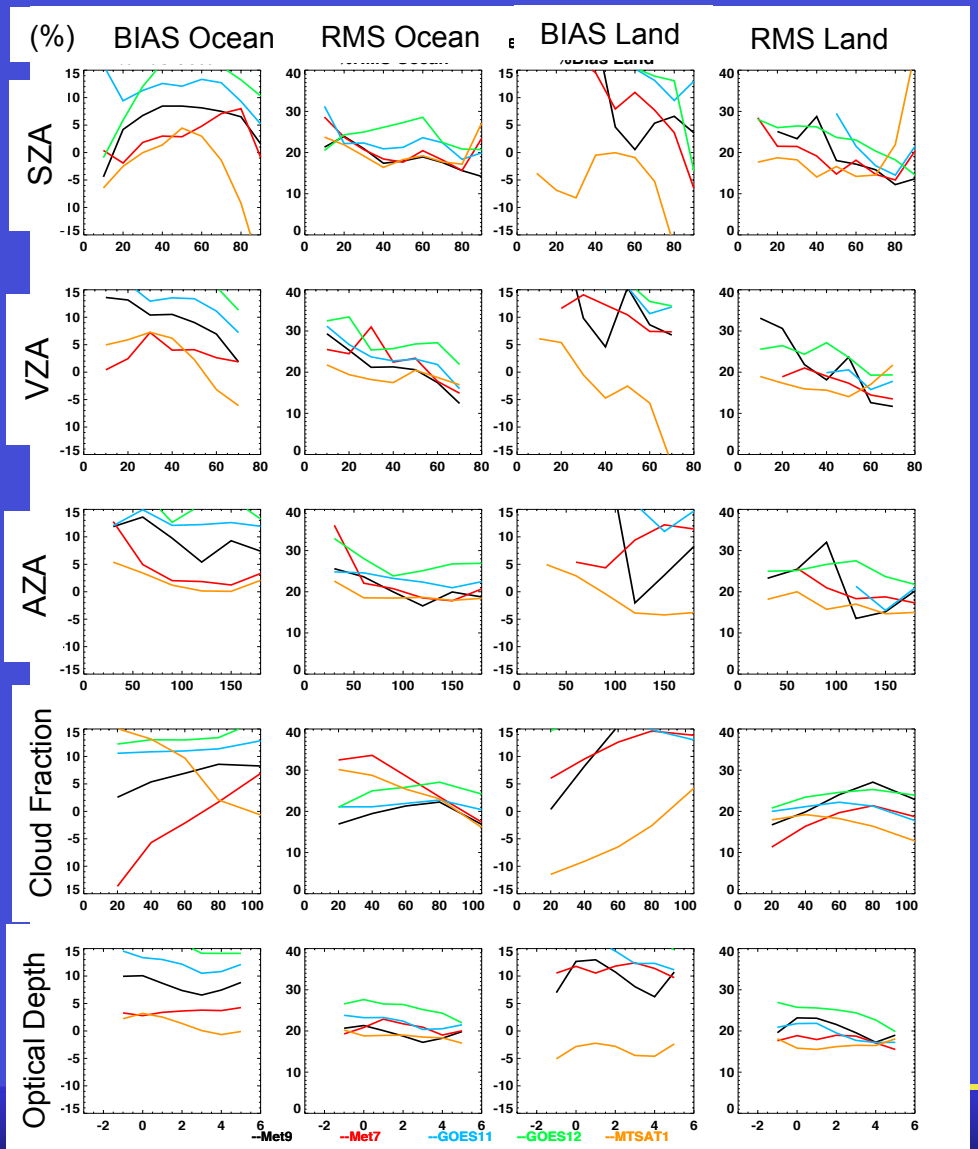
SW NB to BB

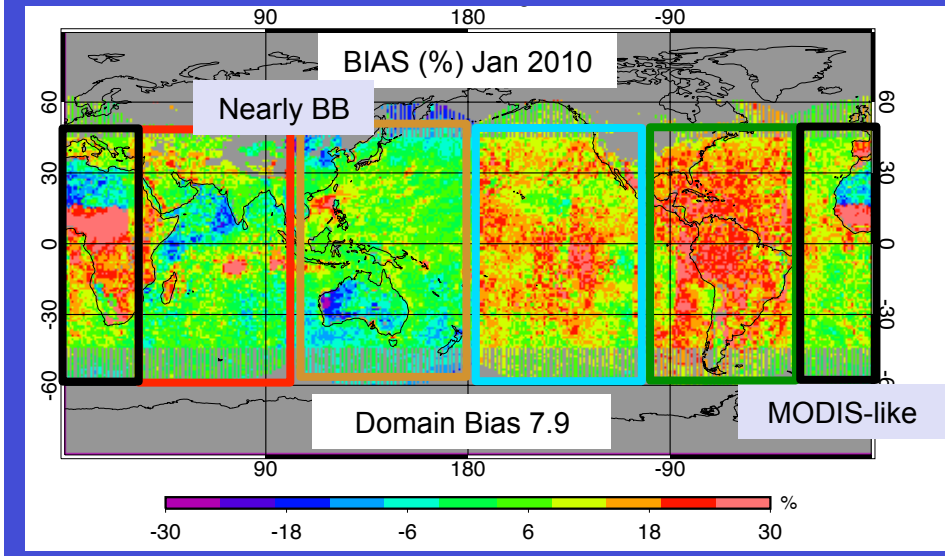
- Edition2 GEO->(theoretical)->MODIS->(SSF empirical)->BB radiance
- Some GEO spectral response functions (SRF) are nearly broadband, does it make sense to convert to the MODIS SRF?
- Quantify improvement of using optical depth regressions rather than bins
- Quantify improvement over assuming NB = BB reflectance

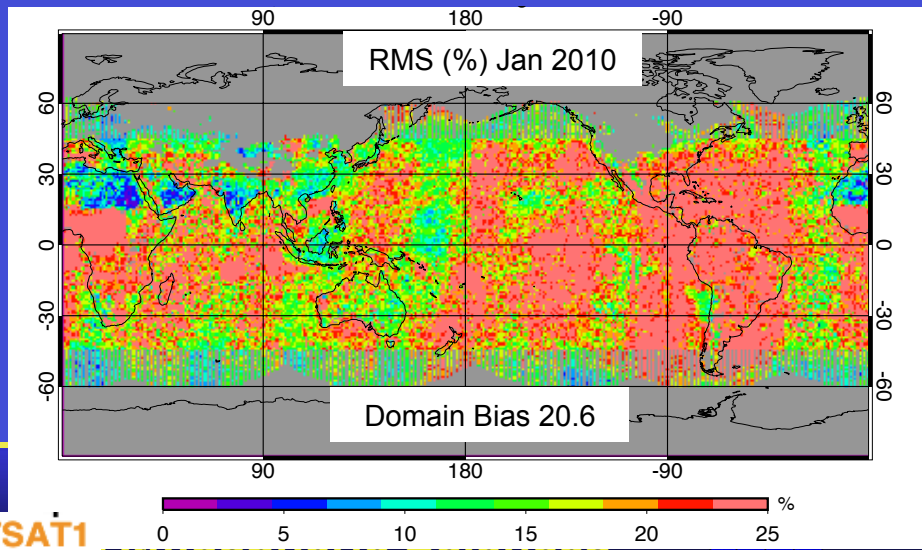




GEO->BB SW Model (regional normalization)



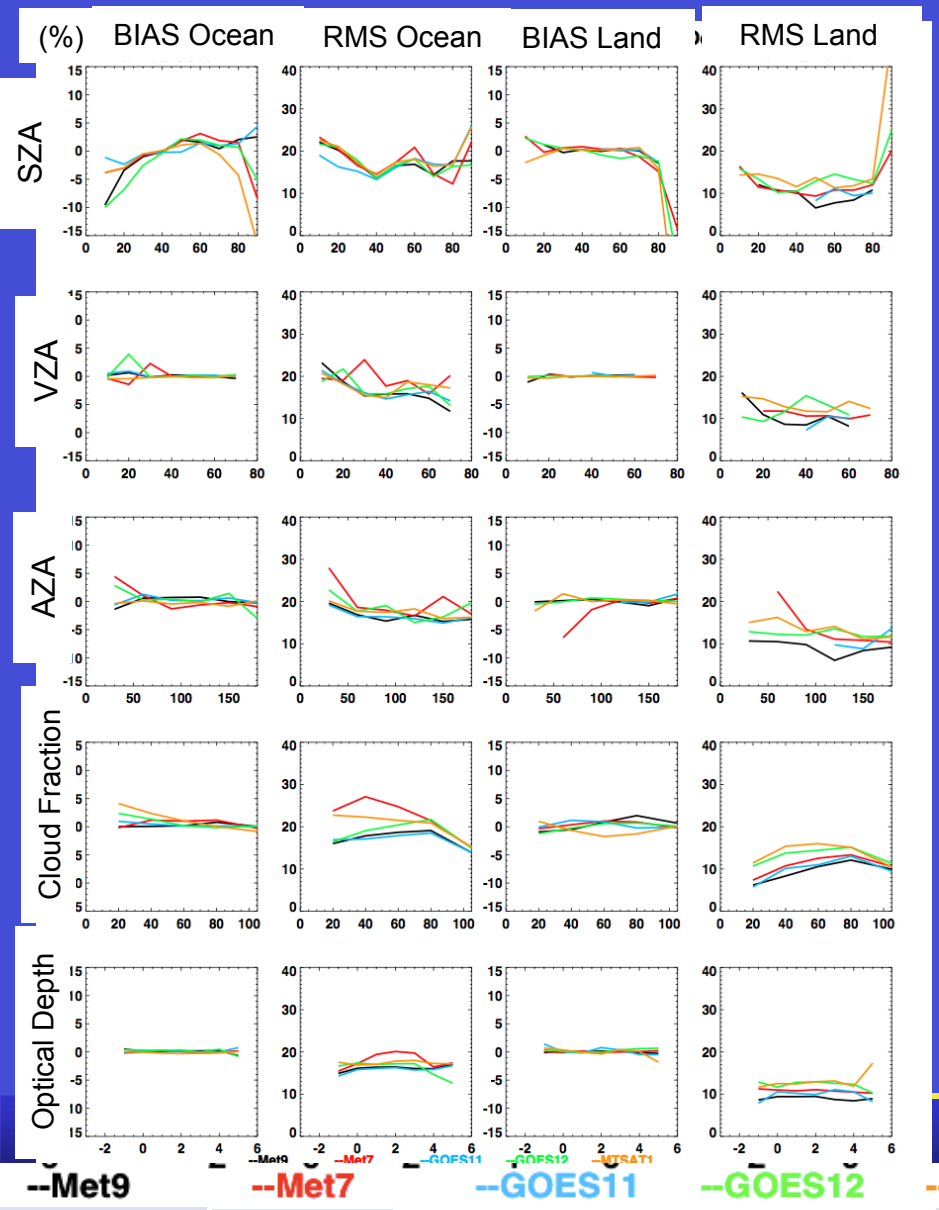


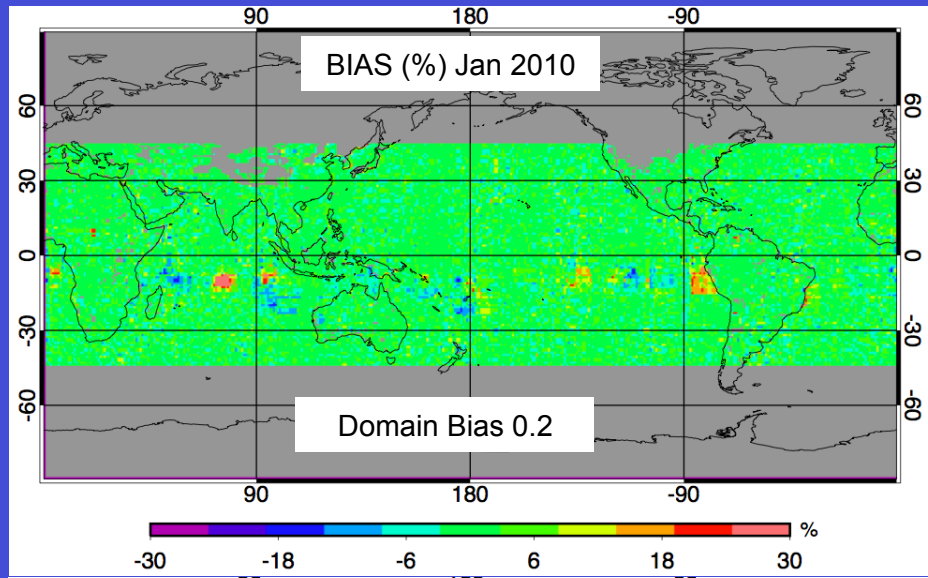


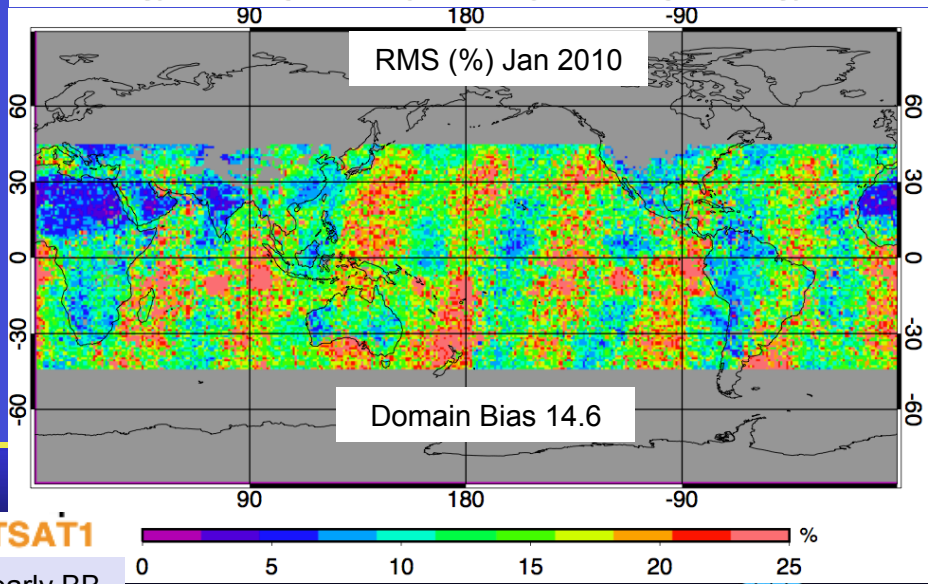
--Met9 --Met7 --GOES11 --GOES12 --MTSAT1

MODIS-like | Nearly BB | Nearly BB

GEO->BB SW Model (regional normalization)







MODIS-like | Nearly BB | Nearly BB

SW NB to BB summary

MODEL	Bias	RMS
GEO = BB	11.4	28.3
GEO/BB opt bin	9.4	23.1
GEO/BB opt regress	7.9	20.6
GEO/MODIS/BB Ed2	2.3	17.8
Regional normalization	0.3	14.5

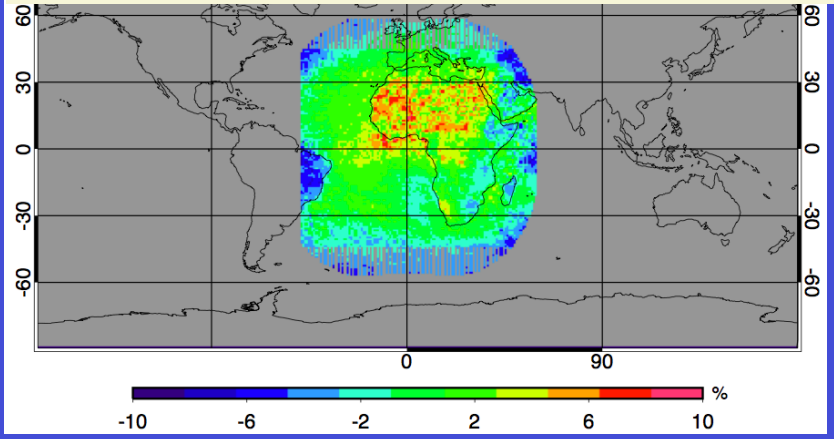
- Evaluate each of the 15 GEO satellites individually to select the appropriate NB to BB model
- Reevaluate the NB to BB models using the GEO Edition 4 clouds
- Test using GEO/CERES NB to BB coefficients based on 10-years of data, by classifying the GEO satellites by SRF extent
- Also test with GERB fluxes for time periods outside of Terra and Aqua overpass times

LW NB to BB

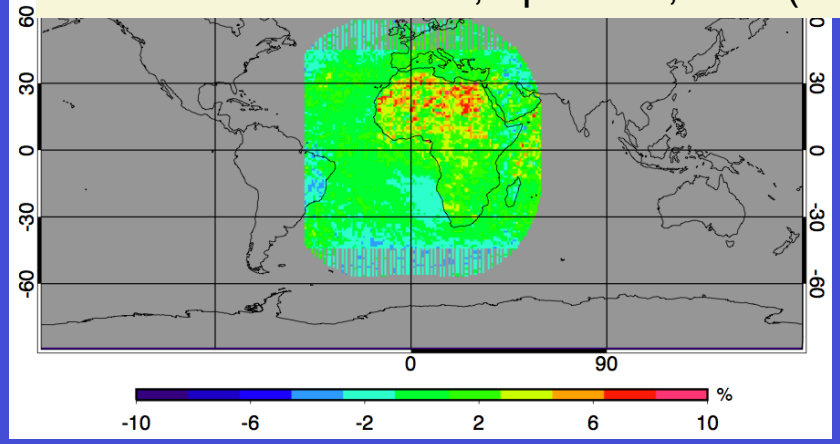
Edition 2/3	Edition 4
Simple global parameterization based on WN radiance column weighted RH Instantaneous normalization	WN and WV to BB (M. Sun Thursday presentation) LW ADM 5° by 5° LW regional normalization

- Use SSF MODIS WN&WV radiances and CERES fluxes as a function of LW ADM types
- Apply Edition2 CERES LW ADM based on GEO clouds

Ed2 no normalization, Apr 2010, Bias (%)

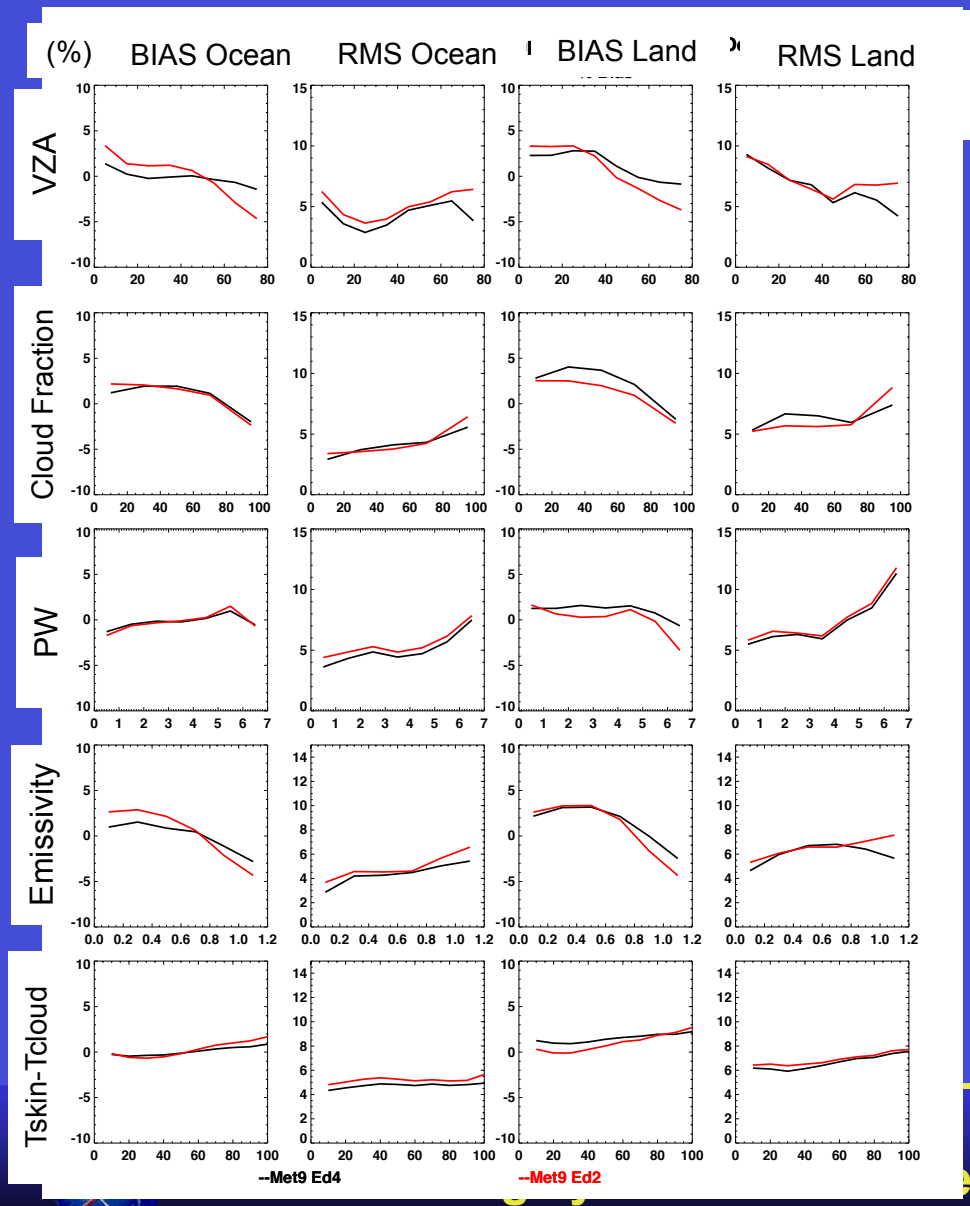


Ed4 no normalization, Apr 2010, Bias (%)



- Improvements over land/desert and over large view angles
- Comparisons are for Terra CERES and GEO derived LW fluxes coincident within 1.5 hours
- Still have large residual bias over deserts, perhaps the difference between GEO and MODIS cloud properties over deserts

Met-9 LW NB to BB



Met9 Ed2

Met9 Ed4

- The Edition 4 improvement over Edition 2 is the reduction of view angle and cloud emissivity dependencies
- Will redo comparisons with hourly GEO and Terra/Aqua coincident fluxes within 15 minutes
- Also compare with GERB fluxes to evaluate the diurnal consistency LW to BB

Flux-by-cloud-type product

Product

- MODIS cloud properties and CERES fluxes stratified by cloud pressure layer and cloud optical depth similar to the ISCCP-D2like 42 cloud types

Algorithm

- CERES footprint clear, and layer fluxes are derived from MODIS multiple band radiance to CERES radiance coefficients derived from clear and overcast CERES footprints
- Footprints with snow fraction > 10%, ocean glint, sparse MODIS to BB bin sampling, nighttime, and poleward of 60° are not considered
- The clear and layer radiances are converted to flux using CERES ADM (clear and overcast models)
- The clear and layer fluxes are then normalized to the footprint flux
- The footprint clear and layer fluxes are then sorted into 1° by 1° regions and by D2like cloud types (6 optical depths, 7 pressure levels, and clear)

Application

- Modelers may then compare computed individual cloud property fluxes with CERES during Aqua or Terra overpasses

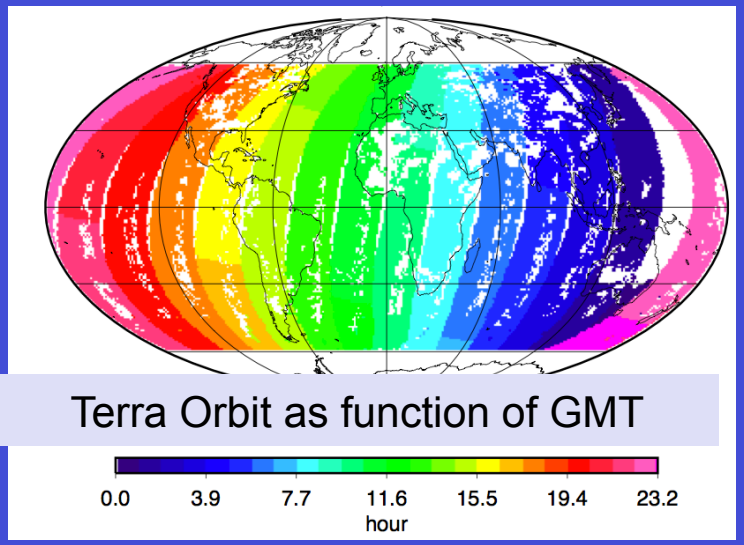
Validation

- Validate by comparing the total cloud properties and fluxes with the SSF1deg

Delivery

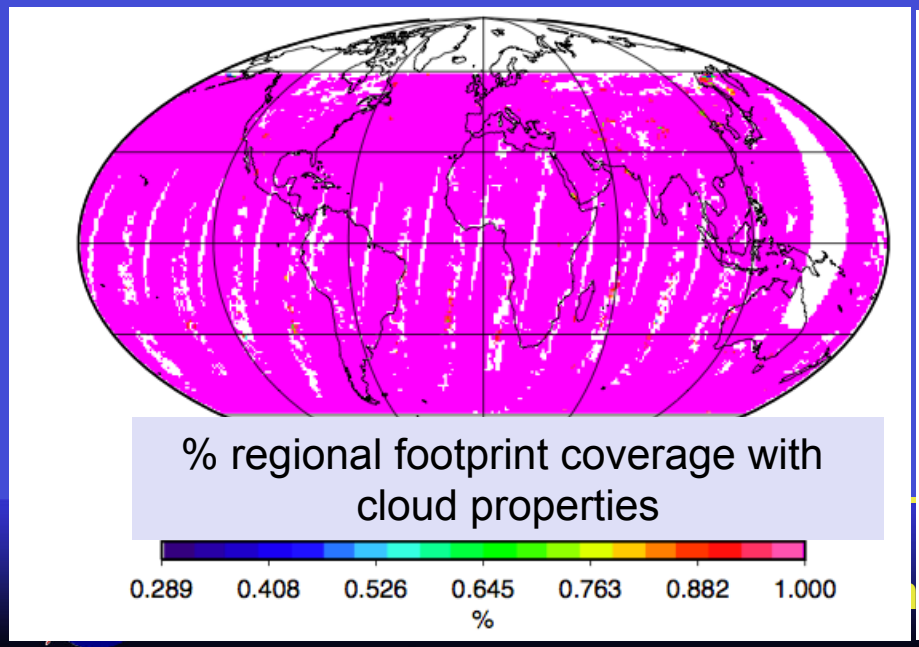
- Deliver the code this month

Flux-by-cloud-type_Daily Product, IDL display tool, Jan 1, 2008

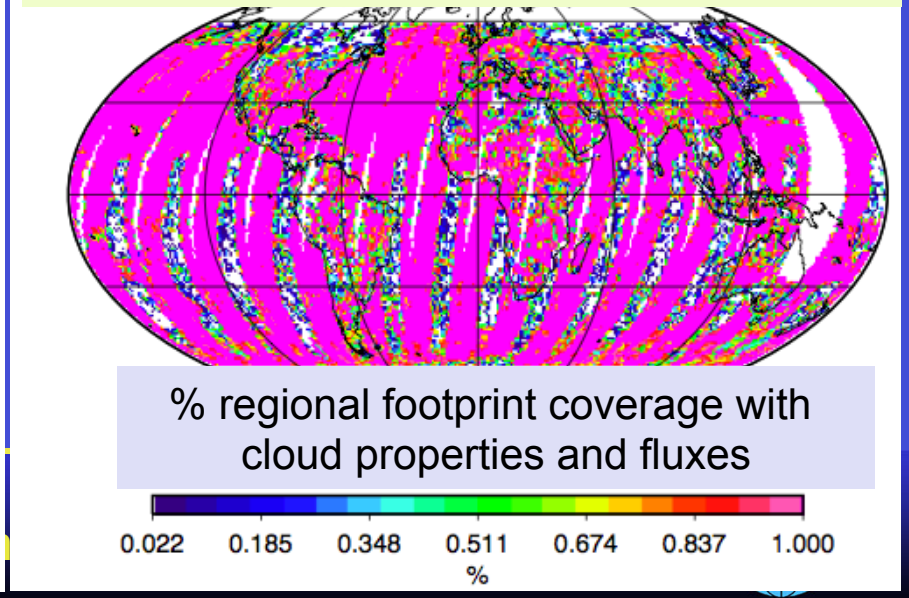


Terra Orbit as function of GMT

ocean glint, sparse MODIS to BB bin sampling, nighttime, and poleward of 60° reduces the number of footprints with estimated BB fluxes in a region



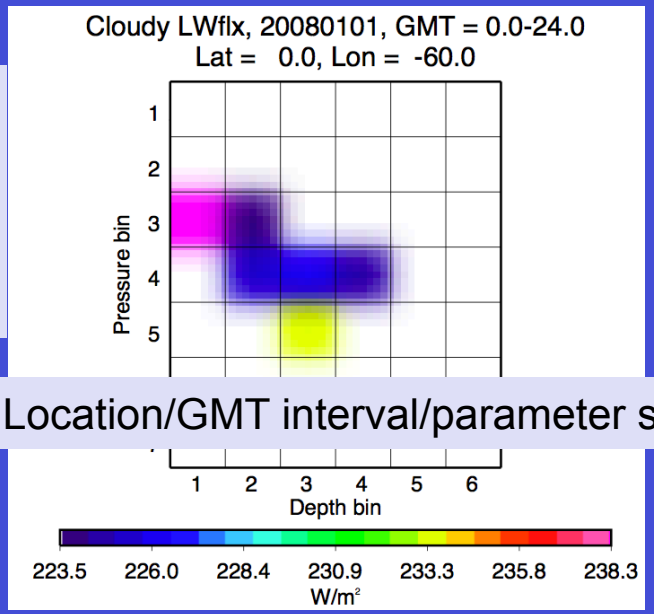
% regional footprint coverage with cloud properties



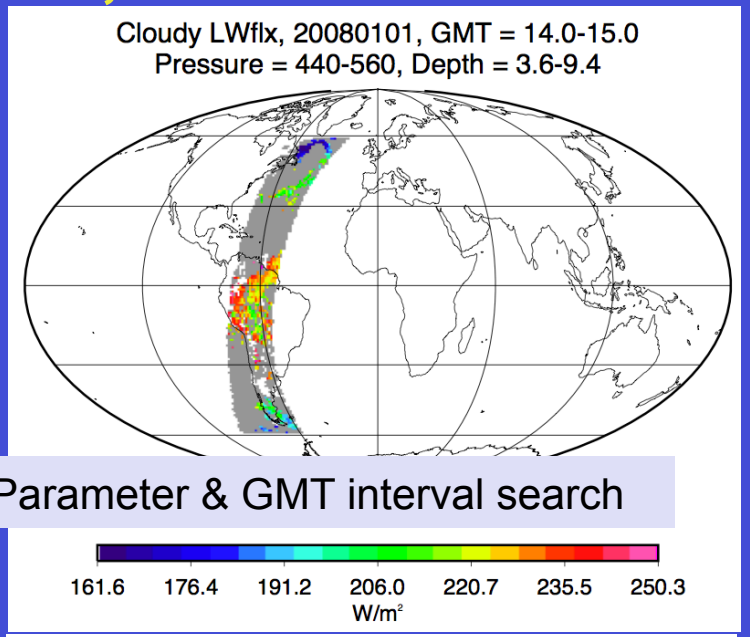
% regional footprint coverage with cloud properties and fluxes

Flux-by-cloud-type_Daily Product, IDL display tool, Jan 1, 2008, 14-15 GMT

LW flux

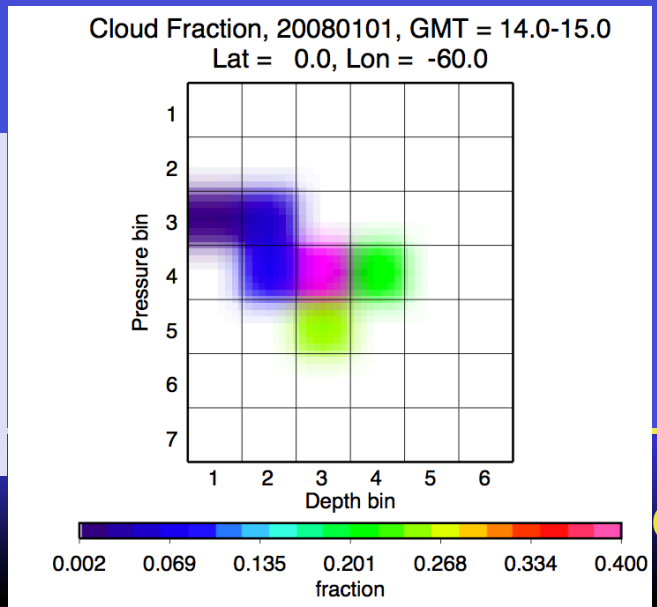


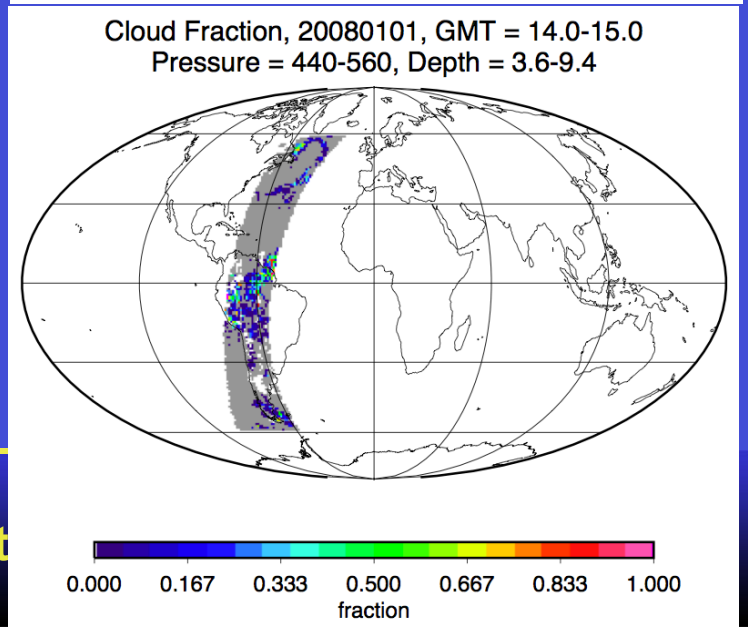
Location/GMT interval/parameter search



Parameter & GMT interval search

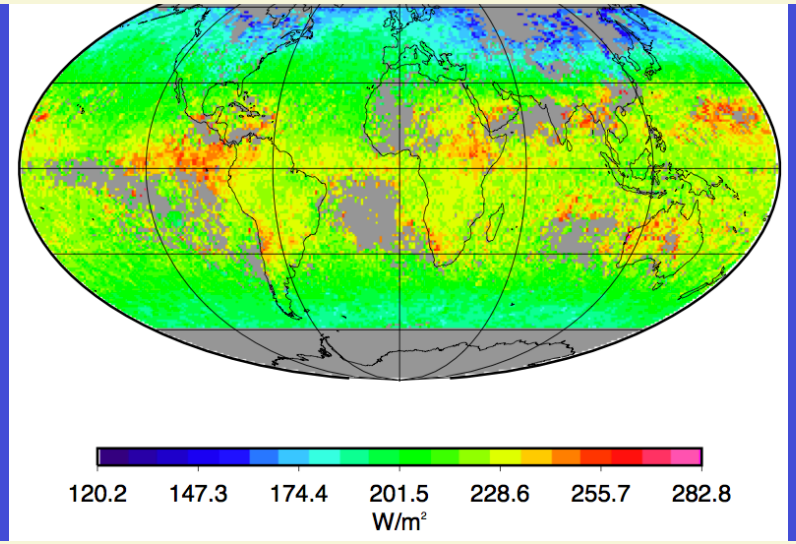
Cloud Fraction



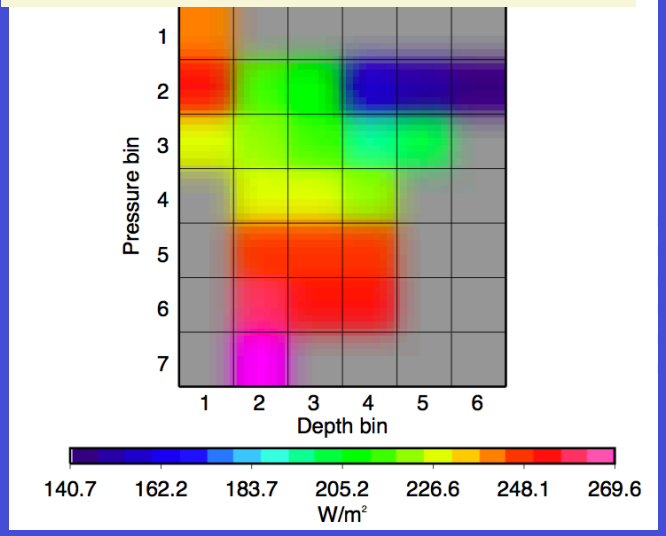


Flux-by-cloud-type_Monthly, IDL display tool, Jan 2008

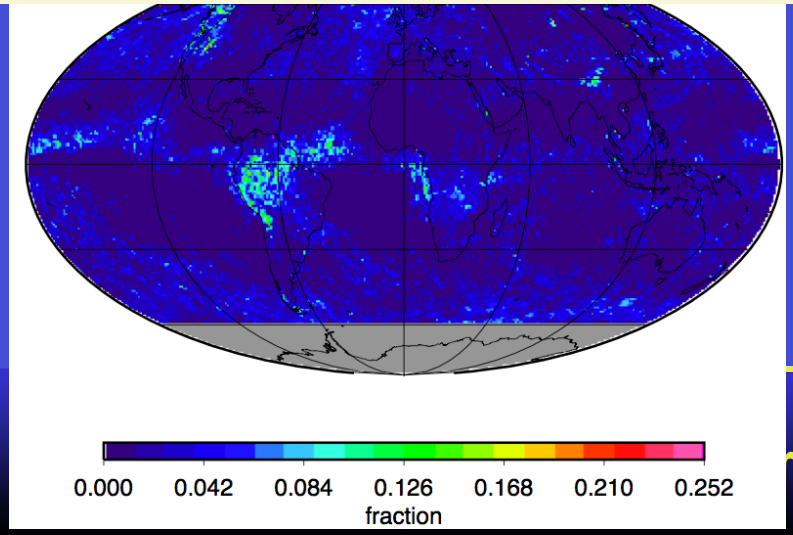
LW Flux, 440-560mb, 3.6-9.4 COD



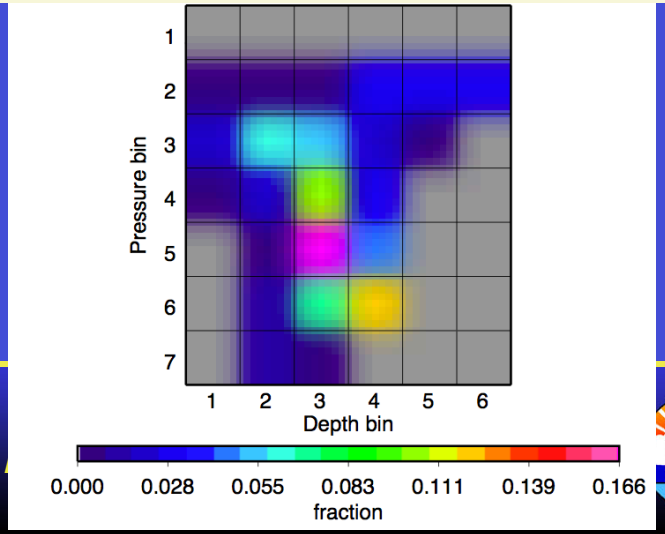
LW Flux, lat=0°, lon=60°W



Cloud Fraction, 440-560mb, 3.6-9.4 COD



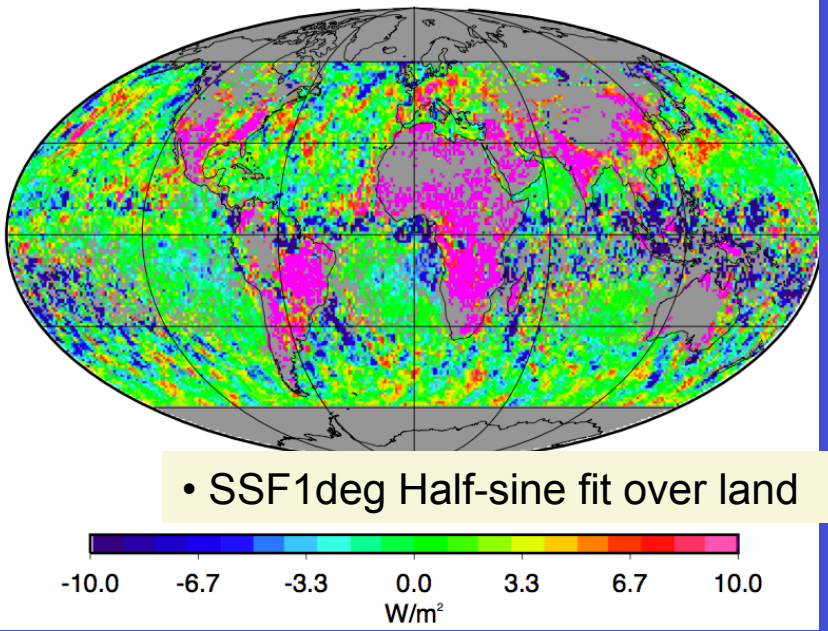
Cloud Fraction, lat=0°, lon=60°W



Monthly Flux-by-cloud-type minus SSF1deg,

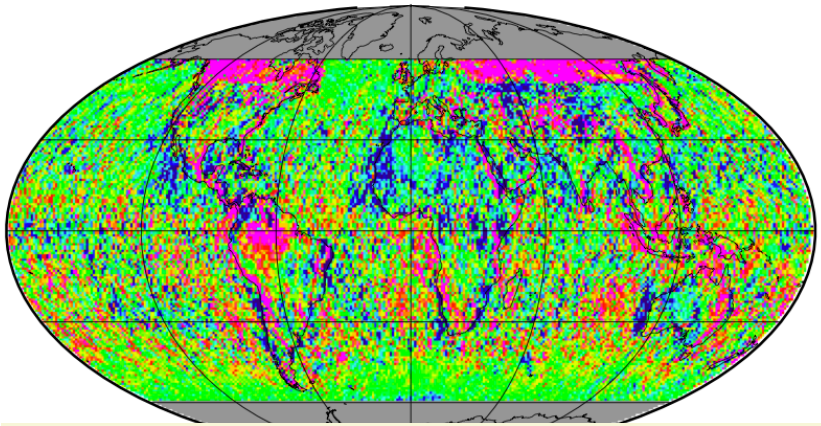
QC plots to monitor monthly processing only,
Monthly Flux-by-cloud-type cannot replicate SSF1deg-Month

LW Flux, 440-560mb, 3.6-9.4 COD



• SSF1deg Half-sine fit over land

Cloud Fraction, 440-560mb, 3.6-9.4 COD



• No FluxByCloudTyp flux over snow > 10%

- Flux-by-cloud-type averages overpass observations

  The SW overpass flux is the daily flux from measurement albedo

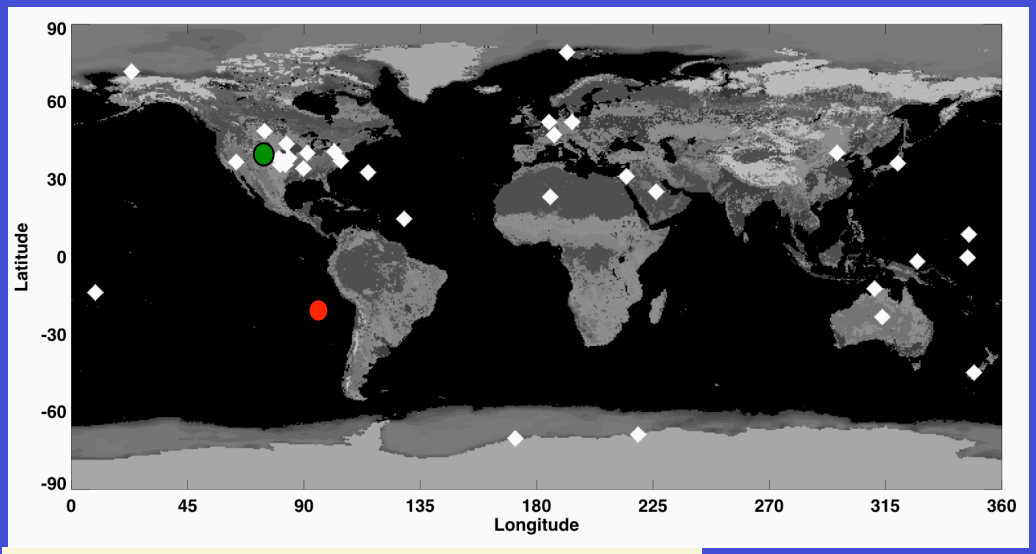
  The LW assumes the measurement flux equals the daily flux

- SSF1deg assumes constant meteorology between overpass observations, (LW linear interpolation over ocean, half sine over land)

SYN1deg surface fluxes

- Fill in the daily 24-hourboxes with MODIS and 3-hourly GEO cloud properties
  - GEO cloud properties are not normalized to MODIS
  - GEO IR and visible radiances are first calibrated against MODIS
- Linearly interpolate the cloud and profile properties to fill in the remaining hourboxes
- Use Fu-Liou radiative transfer model to compute the surface flux hourly
  - SYN1deg Ed3a surface fluxes are untuned
  - EBAF 2.7 surface are tuned to the TOA
  - Use GEOS atmosphere and GEOS/MODIS skin temperature
  - Use MODIS and MATCH aerosols

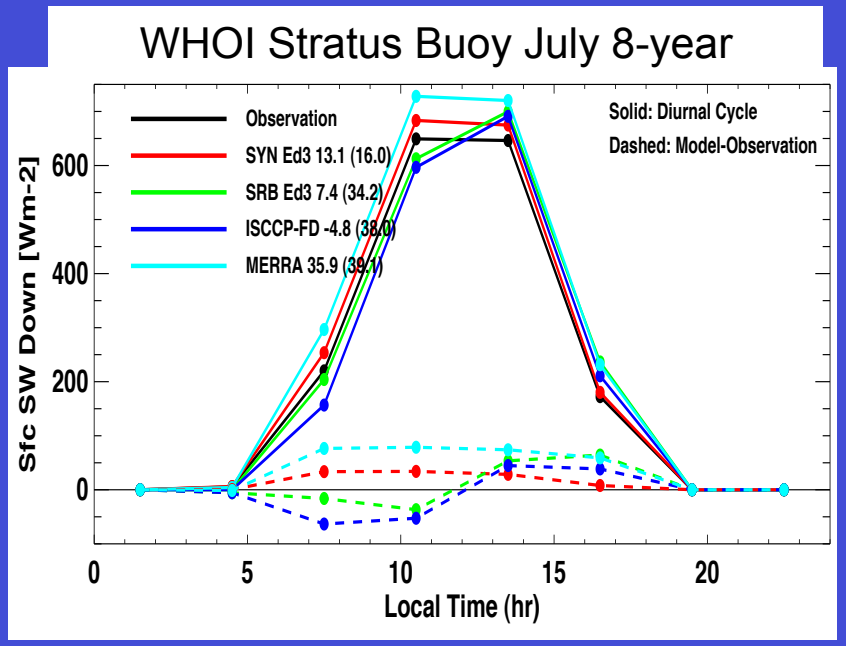
Comparison of surface flux datasets with ground sites

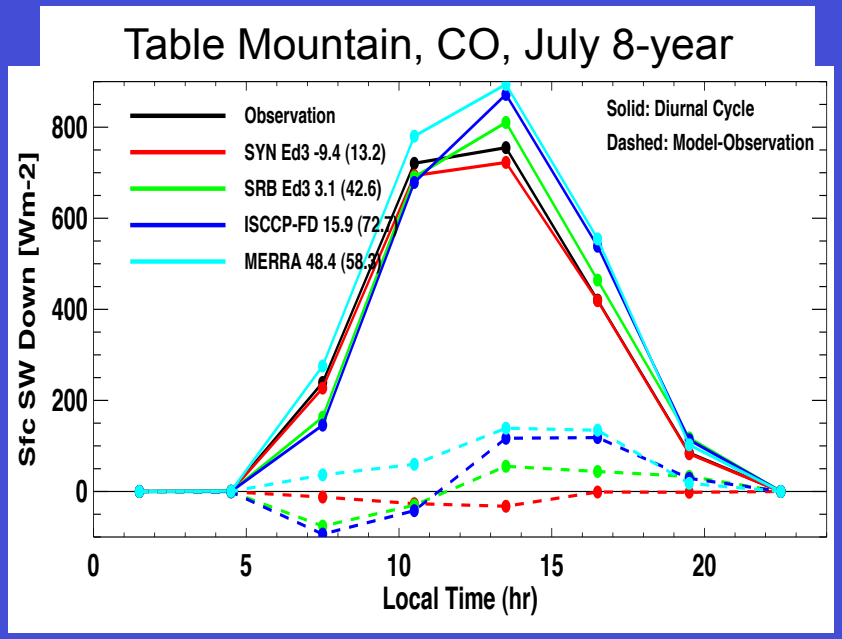


- 35 ground sites used in study
- WHOI stratus buoy
- Table Mountain, CO, USA

Dataset	clouds	profile
SYN1deg Ed3a	CERES (MODIS/GEO)	MERRA
ISCCP-FD	ISCCP (AVHRR/GEO)	TOVS
MERRA	Assimilated	MERRA
SRB Ed3.1	ISCCP	MERRA

Comparison of 3-hourly SW Down with other surface datasets July 8-year average

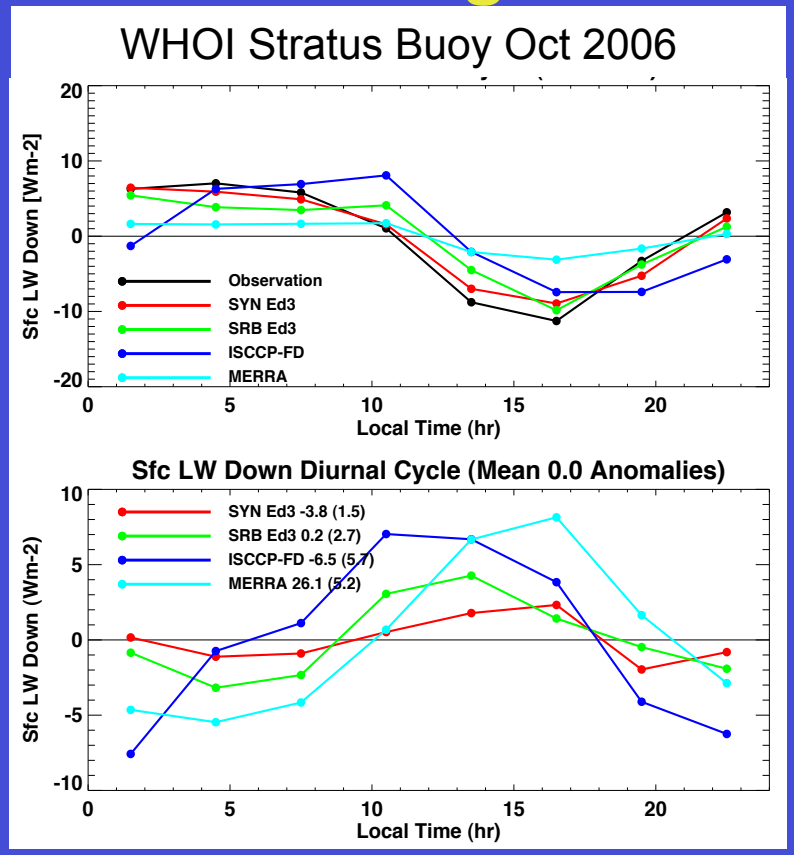


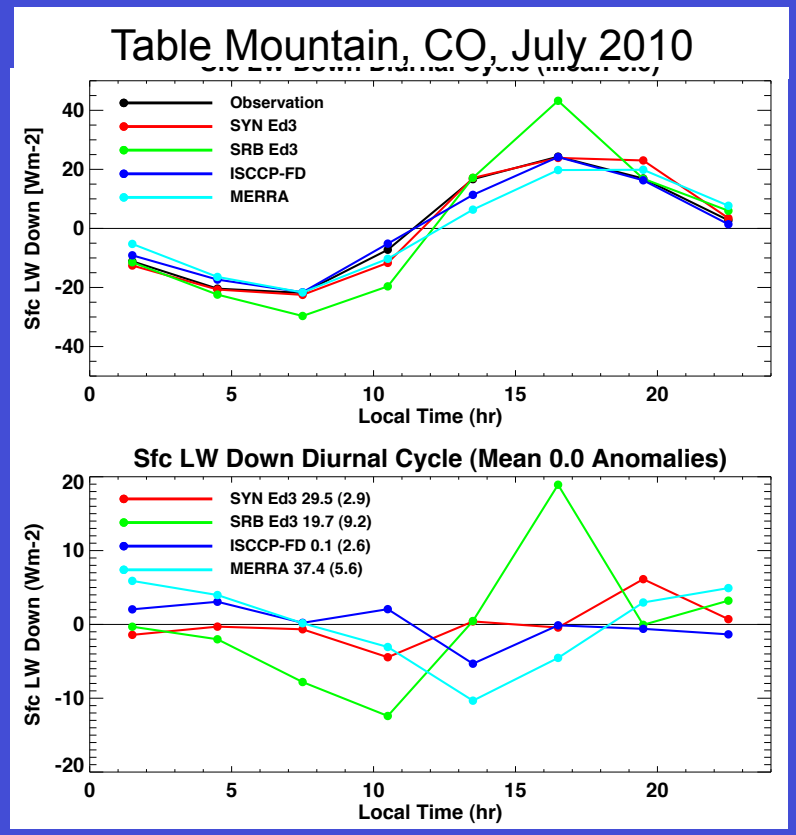


BIAS (σ) (Wm^{-2})	SYN Ed3a	ISCCP-FD	MERRA	SRB Ed3.1
Stratus Buoy	13.1 (16)	-4.8 (38)	35.9 (38)	7.4 (34)
Table Mt, CO	-9.4 (13)	15.9 (73)	48 (58)	3.1 (43)

- The SYN1deg has the smallest diurnal sigma and captures the shape of the diurnal cycle

Comparison of 3-hourly LW Down with ground observations





BIAS (σ) (Wm^{-2})	SYN Ed3a	ISCCP-FD	MERRA	SRB Ed3.1
Stratus Buoy	-3.8 (1.5)	-6.5 (5.7)	26.1 (5.2)	0.2 (2.7)
Table Mt, CO	29.5 (2.9)	0.1 (2.6)	37.4 (5.6)	19.7 (9.2)

- The SYN1deg has the smallest diurnal sigma

SW down dataset comparison

Surface Shortwave Irradiance (Observed Mean 185Wm^{-2})				
Model	Monthly Mean Bias Wm^{-2}(%)	Standard Deviation Wm^{-2}(%)		
		3-hr	Day	Month
SYN	2.2 (1.2)	53.2 (28.9)	30.0 (16.3)	11.5 (6.1)
ISCCP	-10.0 (-5.3)	79.4 (43.1)	39.9 (21.7)	19.0 (10.1)
MERRA	14.0 (7.4)	84.5 (45.9)	45.6 (24.8)	19.5 (10.4)
SRB	-10.9 (5.8)	80.0 (43.4)	39.2 (21.3)	20.6 (10.9)
ERA-interim	9.7 (5.2)			15.6 (8.3)
EBAF	-0.1 (0.1)			11.8 (6.3)

- As with TOA, the advantage of 3-hourly GEO in the SYN1deg product is improving the daily and 3-hourly surface fluxes

LW down dataset comparison

Surface Longwave Irradiance (Observed Mean 331Wm^{-2})				
Model	Monthly Mean Bias Wm^{-2}(%)	Standard Deviation Wm^{-2}(%)		
		3-hr	Day	Month
SYN	-4.2 (-1.3)	20.9 (6.3)	15.6 (4.7)	9.7 (2.9)
ISCCP	8.4 (2.5)	35.5 (10.7)	29.7 (9.0)	19.0 (5.7)
MERRA	-17.8 (-5.4)	22.5 (6.8)	16.9 (5.1)	11.0 (3.3)
SRB	0.0 (0.0)	30.4 (9.2)	20.9 (6.3)	10.8 (3.3)
ERA-interim	-6.3 (-1.9)			10.1 (3.1)
EBAF	0.7 (0.0)			9.8 (3.0)

- As with TOA, the advantage of 3-hourly GEO in the SYN1deg product is improving the daily and 3-hourly surface fluxes

CERES Subsetting Ordering Tool

Ordering Tool: C. Chu, C. Mitrescu, P. Mlynczak

Ordering Statistics: P Mlynczak, E. Heckert

Web Pages: P. Mlynczak, E. Kizer, E. Heckert

ASDC SSF Level2 subsetting: W. Baskins, P. Piatko

http://ceres.larc.nasa.gov/index.php
Google: CERES NASA

SYN1deg level 3 order page

New products

Parameters

Observed TOA Fluxes

- [x] Observed TOA Fluxes — Selected Fields: Click to View

Computed TOA, Surface, and In-Atmosphere Fluxes

- [ ] Computed TOA Fluxes — Click to select individual parameters
- [ ] Computed Surface Fluxes — Click to select individual parameters
- [ ] Computed All-Sky In-Atmosphere Fluxes — Click to select individual parameters
- [ ] Computed Clear-Sky In-Atmosphere Fluxes — Click to select individual parameters

Cloud Parameters, MODIS Aerosols, and Auxiliary Data

- [x] Cloud Parameters — Selected Fields: Click to View
- [ ] MODIS Aerosols — Click to select individual parameters
- [ ] Auxiliary Data — Click to select individual parameters

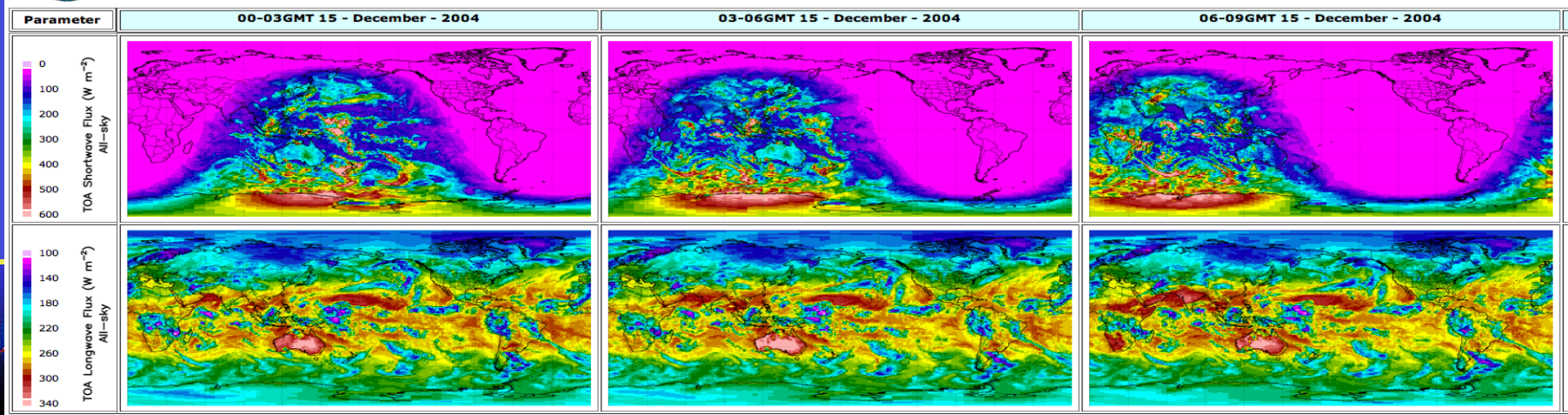
Temporal Resolution

SYN1deg now has Monthly 3-hourly, and 3-hourly

- ( ) Monthly
- ( ) Monthly 3-Hourly: all hours GMT
- ( ) Daily: every 1 days
- (•) Daily 3-Hourly

CERES_SYN1deg-3H_Terra-Aqua-MODIS_Ed3A - Regional Data Plots

Selection Page | Help



CERES User Activity

Total Users 2010-2013 816

Number of Users (Unique by Product and Time Period)

FY (Oct-Sep)

Products	FY10	FY11	FY12	FY13 Sep-Apr
EBAF-TOA	21	126	191	176
EBAF-Surface			79	100
SYN1deg				141
SYN1deg-lite	25	115	149	15
SSF1deg-lite	29	102	96	80
ISCCP-D2like			25	34
SSFlevel2			60	63
Total	53	242	358	373

Number of Visualizers (Unique by Email)

- Half of the users are visualizing

FY10	FY11	FY12	FY13	Total
33	136	179	190	432

Number of Visualizations

- On average 12 visualization events per user

FY10	FY11	FY12	FY13	Total
641	1,711	2,338	2,296	6986

CERES by product ordering

Number of Data Months

Products	FY10	FY11	FY12	FY13	Sep-Apr	Total
EBAF-TOA	1,388	30,833	27,043		31,365	90,629
EBAF-Surface			13,829		19,511	33,340
SYN1deg					28,967	28,967
SYN1deg-lite	5,745	27,502	16,344		2,224	51,815
SSF1deg-lite	9,874	43,284	11,621		16,202	80,981
ISCCP-D2like			4,084		4,192	8,276
SSFlevel2			2,238		923	3,161
Total	17,007	101,619	75,159		103,384	297,169

Number of Orders

Products	FY10	FY11	FY12	FY13	Total
EBAF-TOA	42	380	571	325	1,318
EBAF-Surface			158	222	380
SYN1deg				493	493
SYN1deg-lite	62	483	608	50	1,203
SSF1deg-lite	103	518	584	225	1,430
ISCCP-D2like			42	61	103
SSFlevel2			406	126	532
Total	207	1,381	2,369	1,502	5,459

CERES subsetter statistics to be incorporated into the NASA ESDIS Metric System database

- This requires valid email and affiliations

CERES Ordering Tool Summary

- New subsetted products:
  - EBAF-TOA Ed2.7 (Mar00 to Oct12) (postponed)
  - EBAF-Surface Ed2.7 (Mar00 to Mar12) (postponed)
  - SYN1deg Monthly 3-hour and 3-hour now available
  - Projected: SSF1deg Ed3a (full parameter), ISCCP-D2like Ed3a
  - Projected Internal: GEO 1-hourly 8-km clouds
- New features:
  - Incorporate the CERES subsetter ordering statistics into NASA ESDIS Metric System database. (User needs to register to validate email address, along with country and affiliation)
- CERES internal subsetter available for validation of products before delivery of code
  - Cross and within product parameter comparison internal-tool
  - http://ceres-subset8.larc.nasa.gov/ord-tool/
  - Available to other subsystems to help with QC
- Working with ASDC on their new ordering pages
  - Please provide me any suggestions