TISA (Time-Space Averaging) Update

D. Doelling
NASA LaRC

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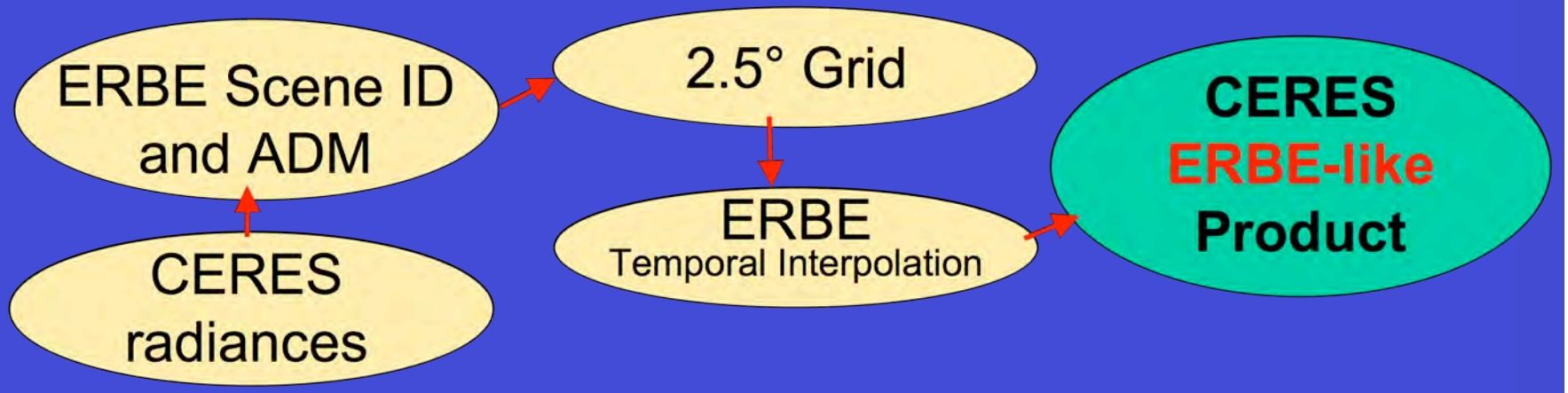
C. Nguyen, R. Raju, M. Sun
SSAI

10th CERES-II Science Team Meeting
NASA GISS, New York City, NY, Oct 27-29, 2008

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)



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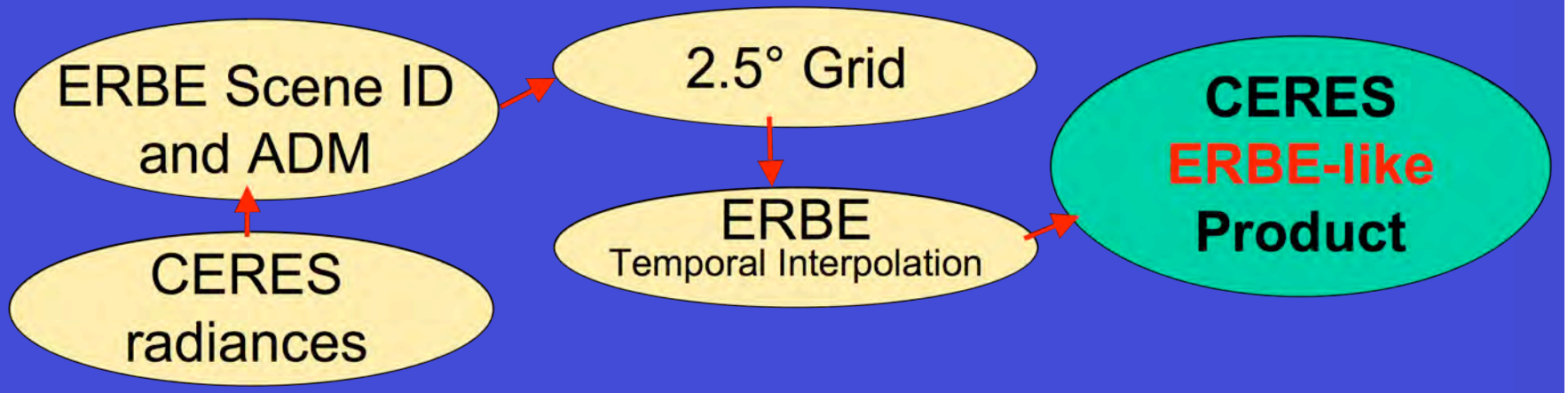
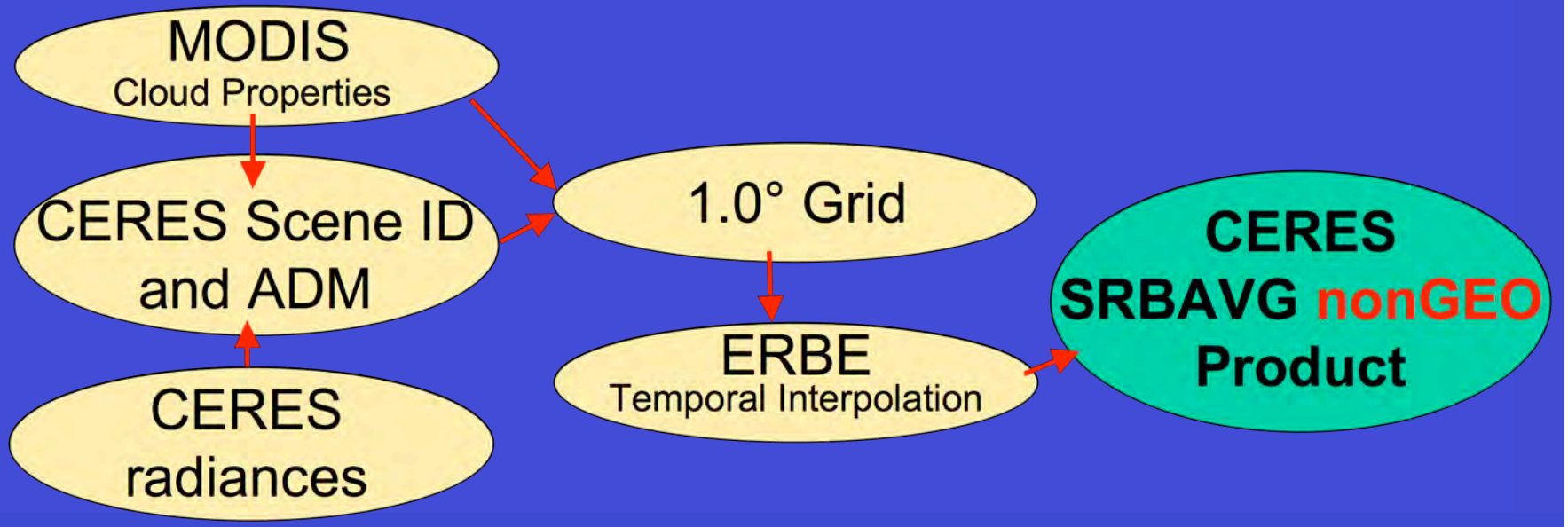


- Appropriate Usage:
  - To compare with historical ERBE (1985-1989) fluxes to ensure that flux differences are not associated with CERES algorithm improvements

SRBAVG nonGEO Product

- Product Features:
  - TOA fluxes and MODIS cloud properties



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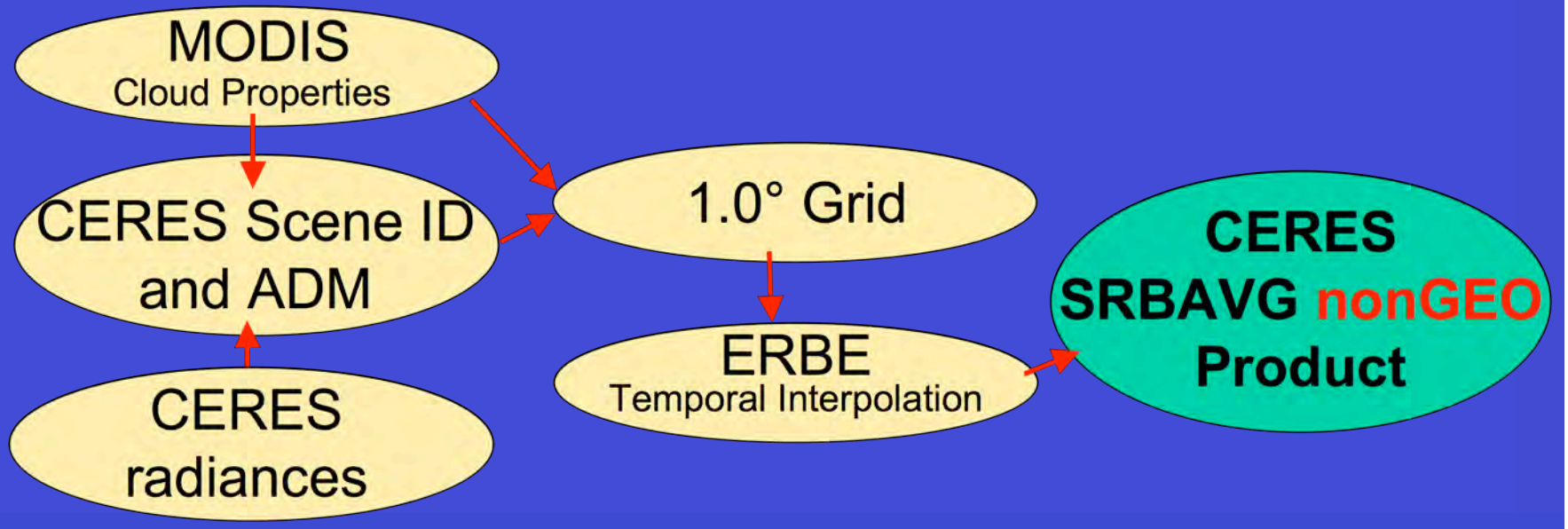
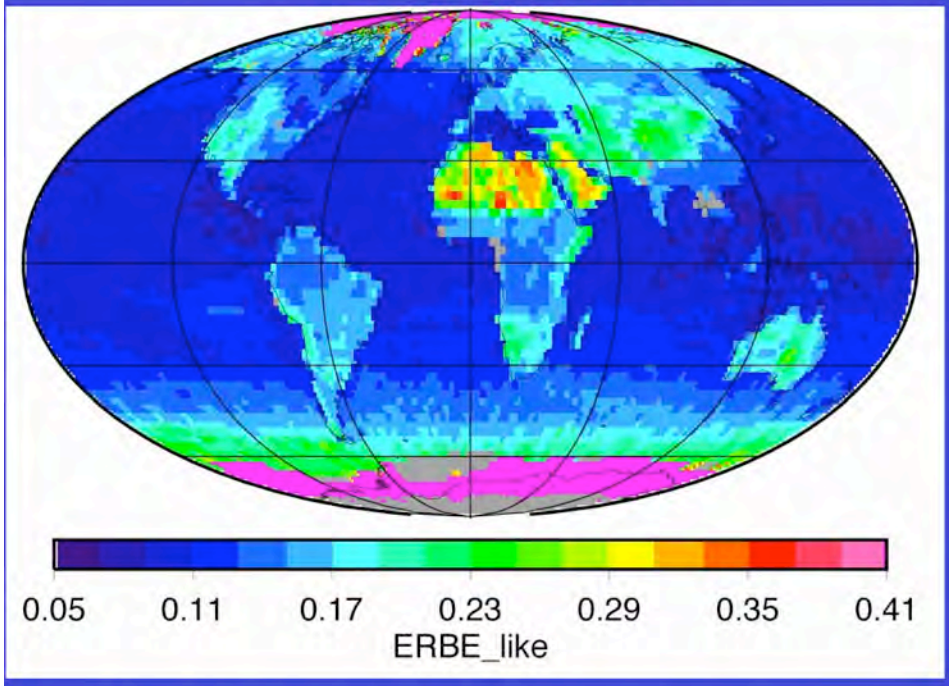


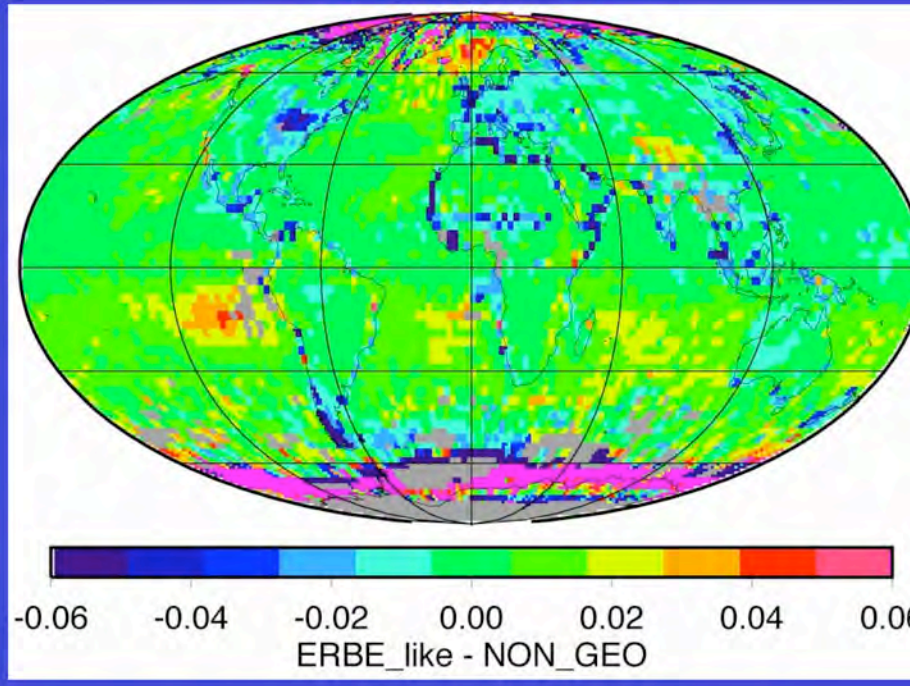
- Appropriate Usage:
  - To evaluate CERES ADM improvements
  - Fluxes and cloud properties are sampled only during Terra overpasses

Aug 2002 Clear-sky Albedo

ERBE like mean



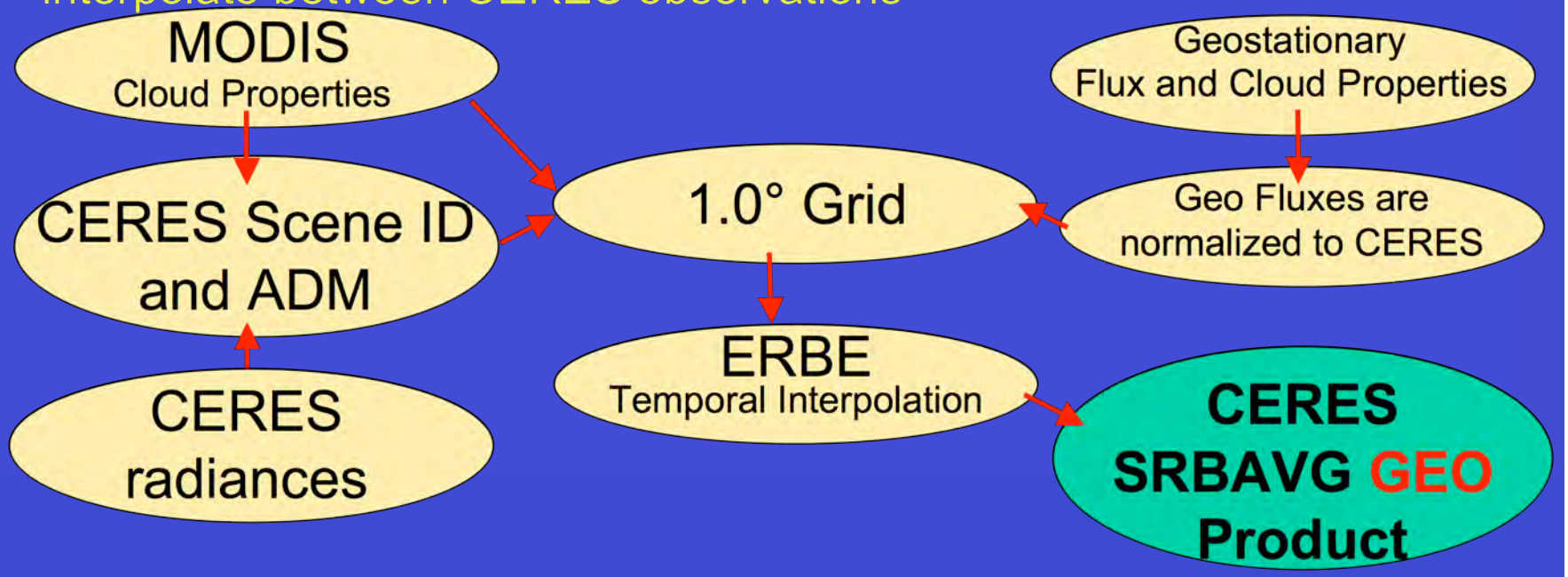
ERBE like - nonGEO



- The CERES ADMs and scene identification is an improvement over ERBE-like
  - most notable in clear-sky identification
- This will effect cloud forcing fluxes

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



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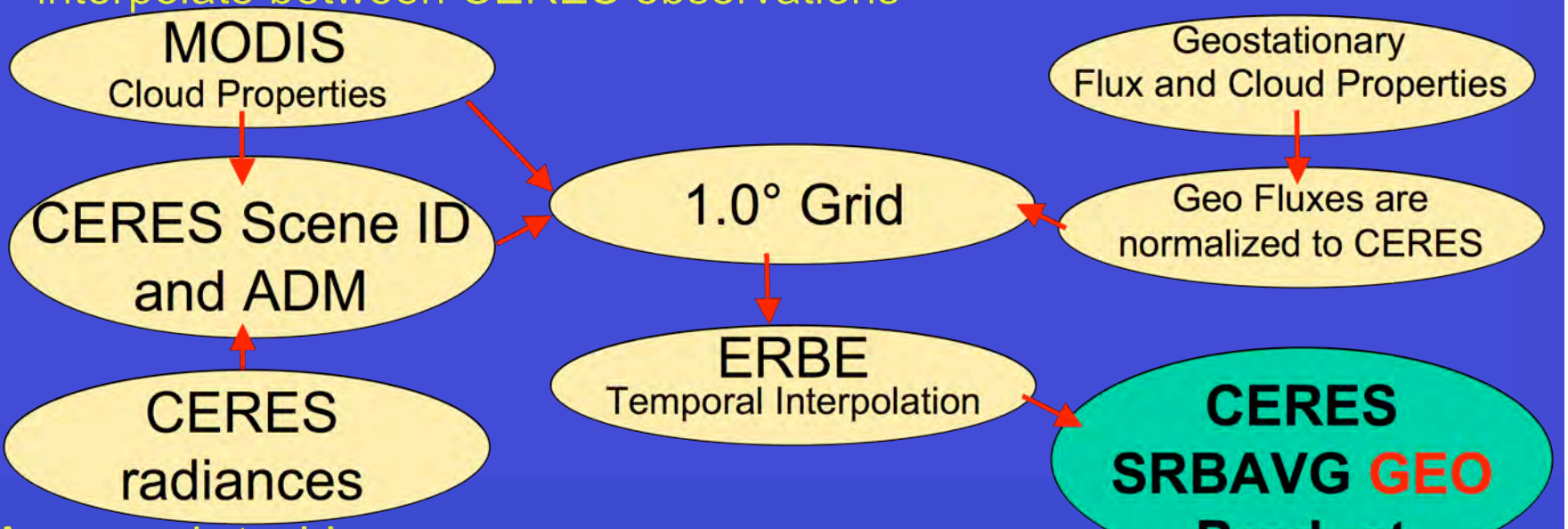
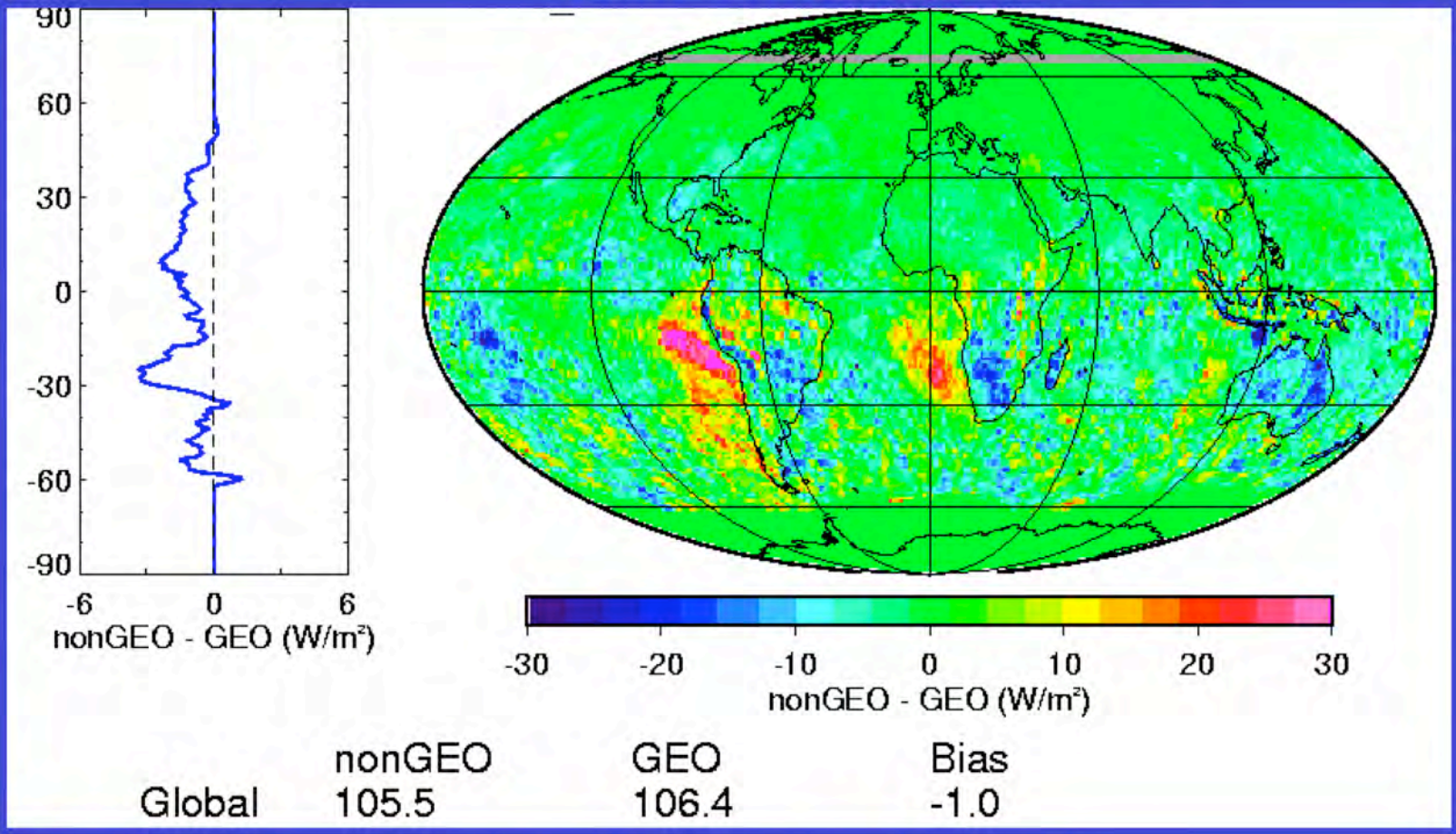


- Appropriate Usage:
  - The SRBAVG GEO product is the most robust CERES TOA monthly mean flux product and of climate quality

nonGEO - GEO SW monthly mean
Dec 2002

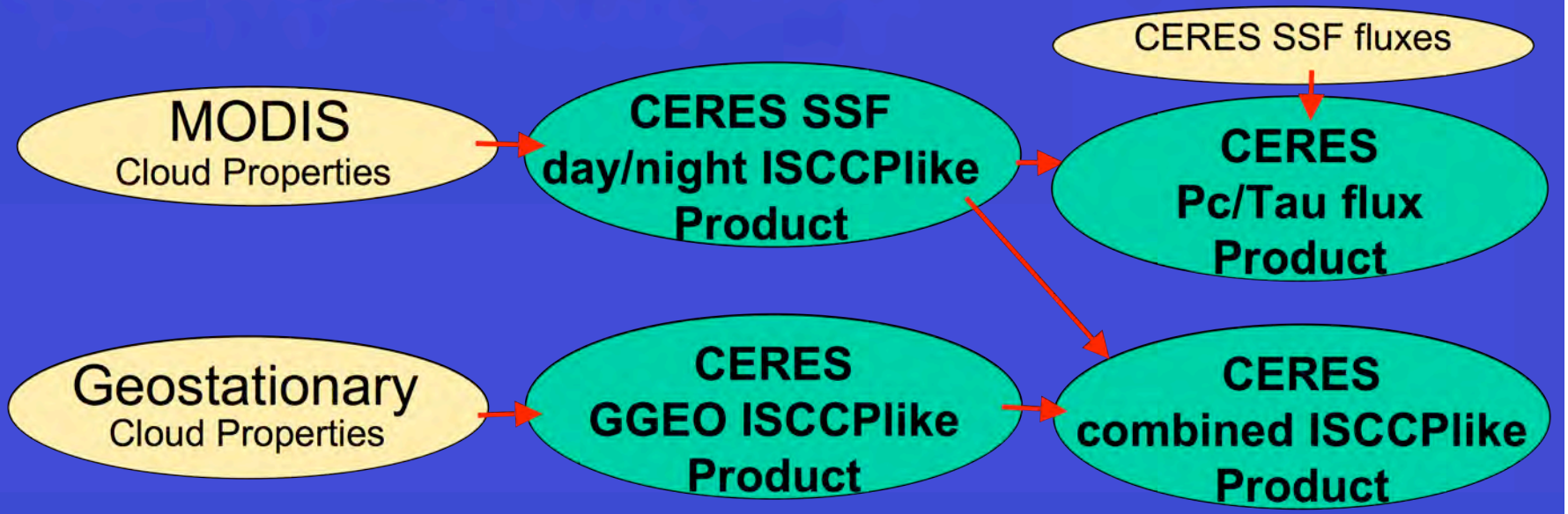


	nonGEO	GEO	Bias
Global	105.5	106.4	-1.0

- Blue afternoon convection, Red afternoon cloud clearing
- Regional monthly differences can be ~ 20 Wm^{-2}

ISCCP-D2like Products

- Product Features:
  - CERES cloud properties classified into pressure and optical bins that emulate the (GISS) ISCCP D2 product



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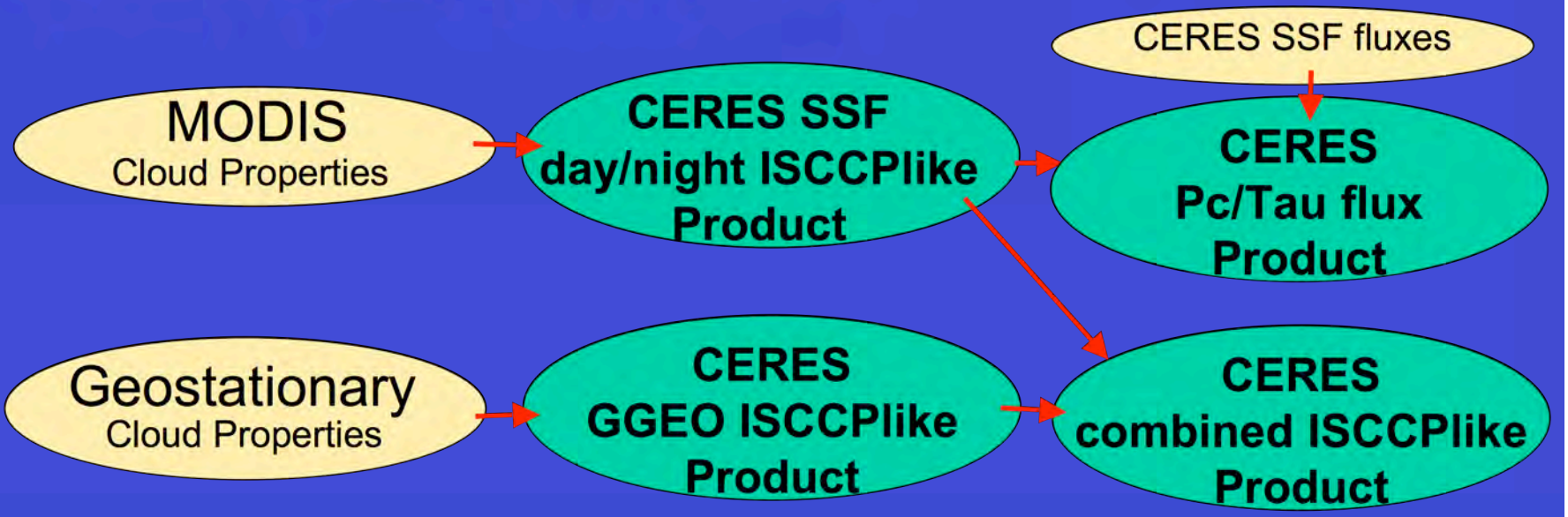

- Appropriate Usage:
  - GCM and climate studies that require Pc/Tau cloud properties to improve cloud parameterizations, ISCCP simulators, etc.

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

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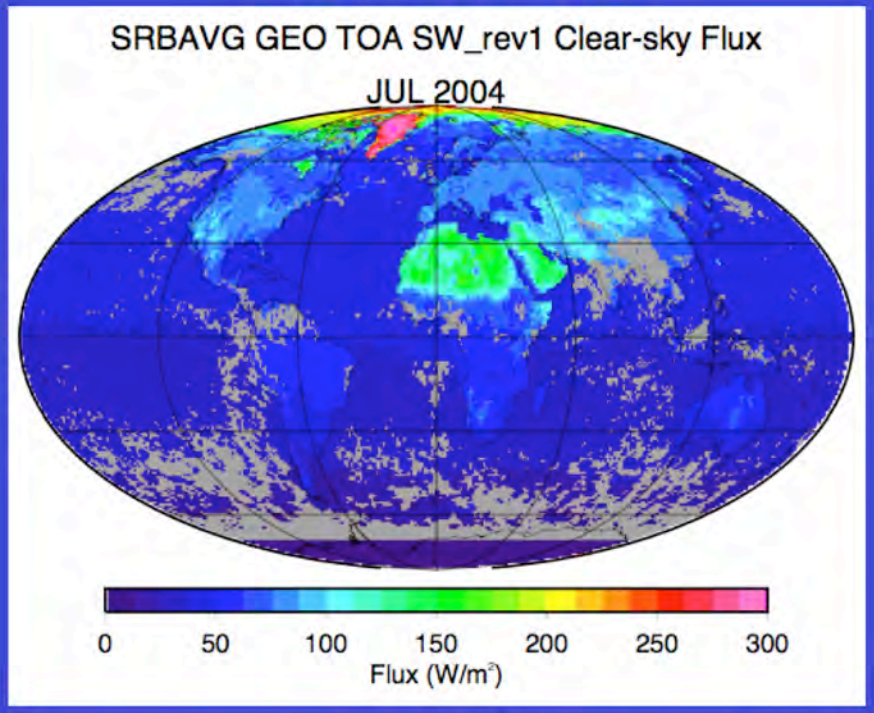
  - netCDF product that is Climate and Forecast (CF) compliant

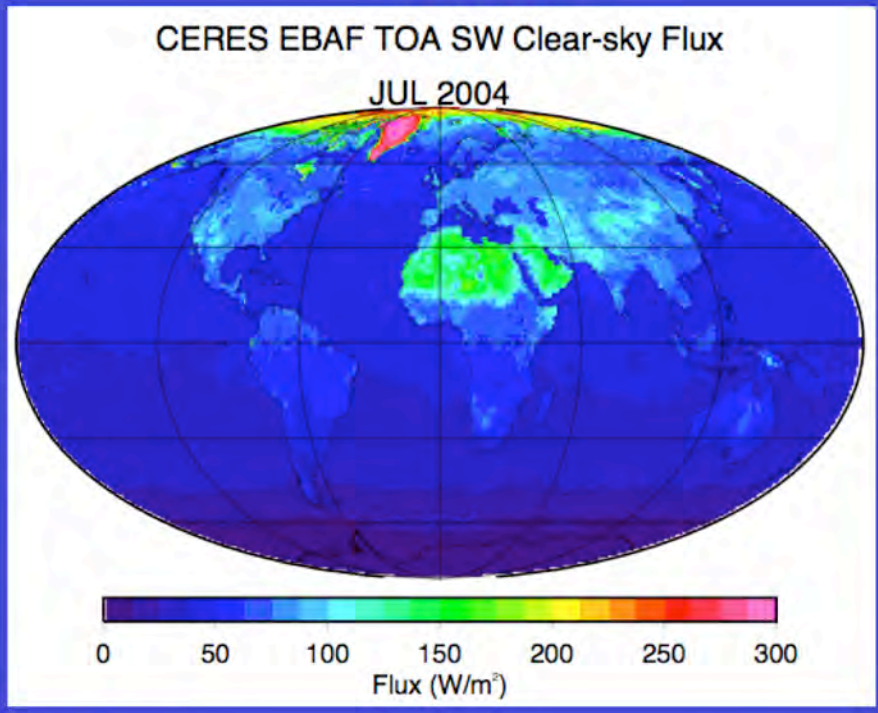
- Appropriate Usage:
  - The EBAF is for climate model evaluation
  - Estimating the Earth's annual global mean energy budget
  - Studies that infer meridianal heat transports

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

5 Year Global Mean TOA Fluxes

Mission	ERBE	CERES			
Product Name	ES-4	ES-4 Ed2B rev1	SRBAVG nonGEO Ed2D rev1	SRBAVG GEO Ed2D rev1	EBAF Ed1A
Time Period	02/85 – 01/89	03/00 – 02/2005			
Solar Irradiance	341.3	341.3	341.3	341.3	340.0
LW (All-sky)	235.2	239.0	237.7	237.1	239.6
SW (All-Sky)	101.2	98.3	96.6	97.7	99.5
Net (All-Sky)	4.9	4.0	7.0	6.5	0.85
LW (Clear-Sky)	264.9	266.6	266.4	264.1	269.1
SW (Clear-Sky)	53.6	49.3	51.2	51.1	52.9
Net (Clear-Sky)	22.8	25.4	23.7	26.2	18.0
LW CRE	29.7	27.6	28.7	27.0	29.5
SW CRE	-47.6	-49.0	-45.4	-46.6	-46.6
NET CRE	-17.9	-21.4	-16.7	-19.7	-17.1

ADM improvement

Diurnal improvement

Net balanced

New CERES Product Browse Page

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION | + Visit NASA.gov

CERES Browse Products

CERES Browse Products Homepage

Home

Home | EBAF | SRBAVG | SYN/AVG/ZAVG | ERBE-like

Related Activities

- CERES-Terra 5-year TOA global product means
- View CERES Data Product Summaries
- Order CERES Data via the Langley Web Ordering Tool

CERES Browse Monthly Mean Gridded Products

CERES Product	TOA Flux	Surface Flux	Cloud Properties
EBAF	X		
SYNAVG	X	X	X
SRBAVG	X	X	X
ERBE-like ES-4	X		
ERBE-like ES-8 (instantaneous)	X		

+ Freedom of Information Act
+ Budgets, Strategic Plans and Accountability Reports
+ The President's Management Agenda

Curator: Joanne H. Saunders
NASA Official: Takmeng Wong
Last updated: 08/07/2008

+ USA.gov
+ ExpectMore.gov

- http://lposun.larc.nasa.gov/cgi-bin/cgiwrap/ceresdm/browse/browse.pl or link from CERES homepage (also redesigned)

SRBAVG Surface flux Browse Products Page

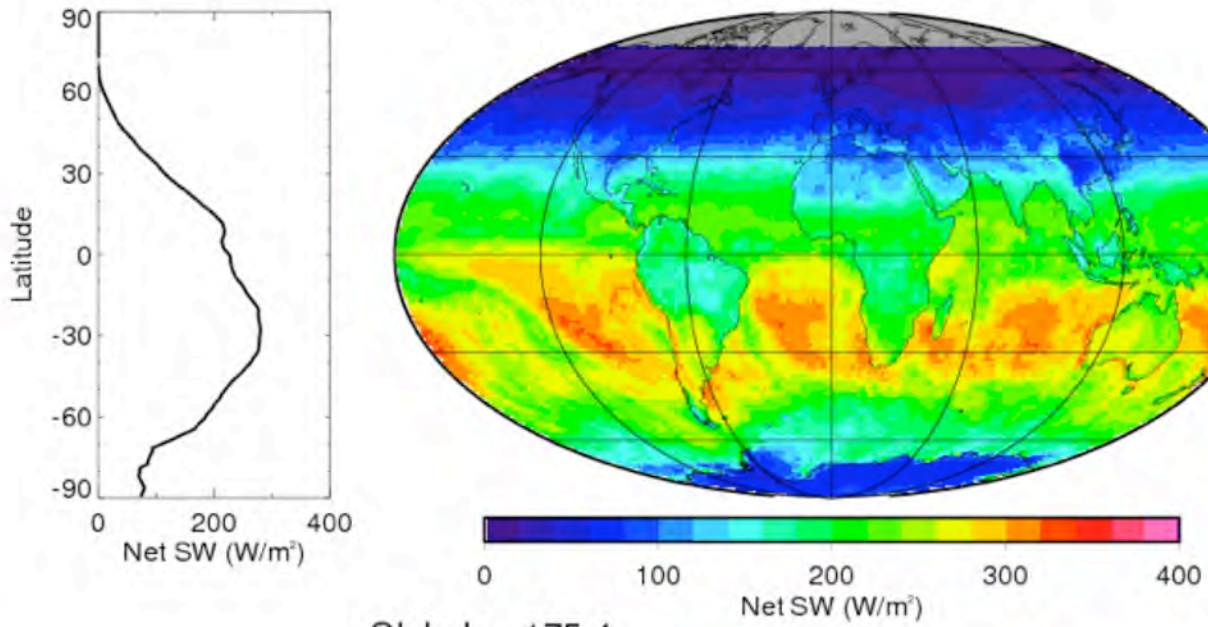
CERES SRBAVG Ed2D ModelB Surface SWnet flux (Terra Jan 2004)

Home -> SRBAVG -> SRBAVG Surface Fluxes

Home | EBAF | SRBAVG | SYN/AVG/ZAVG | ERBE-like

CERES SRBAVG Ed2D Model B All-sky SFC Net SW Rev1 Flux

Terra-FM1 January 2004

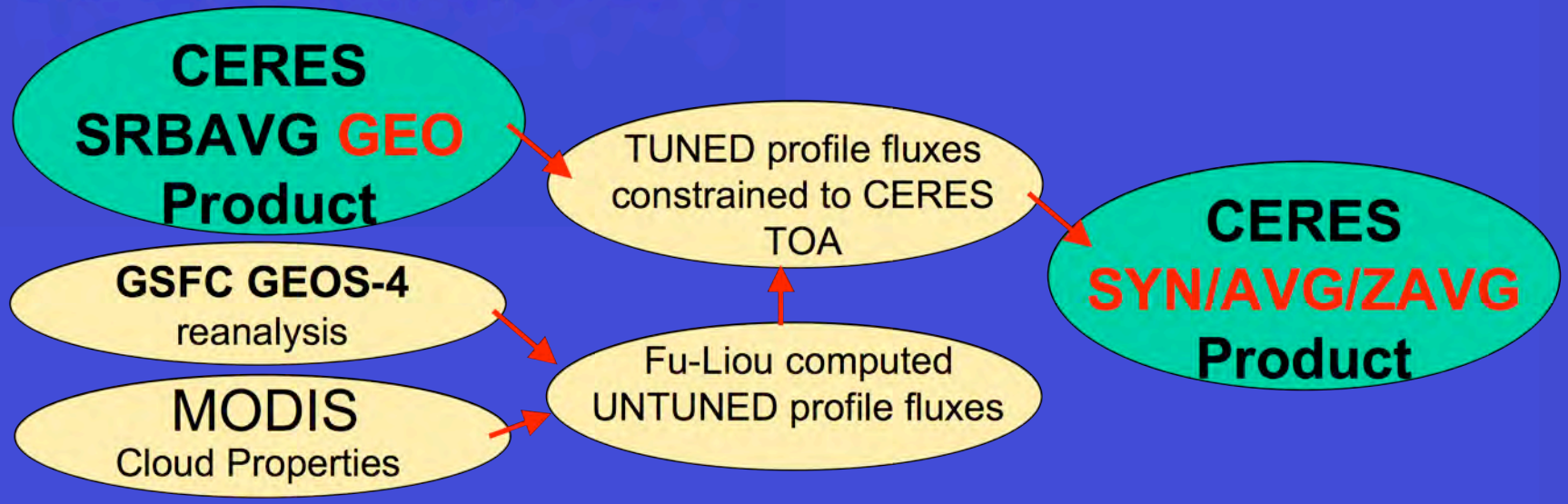


Global	175.4
60N-60S	191.6
30N-30S	221.4

Filename: CER_SRBAVG1_Terra-FM1-MODIS_Edition2D_016028.200401

SYN/AVG/ZAVG Product

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



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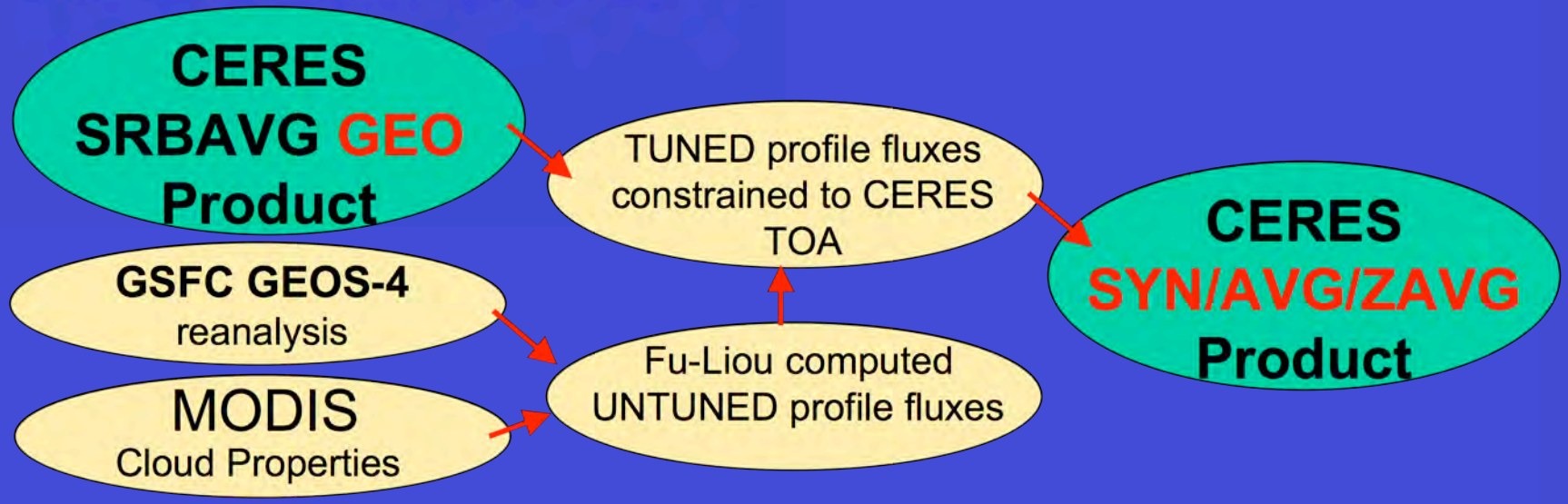
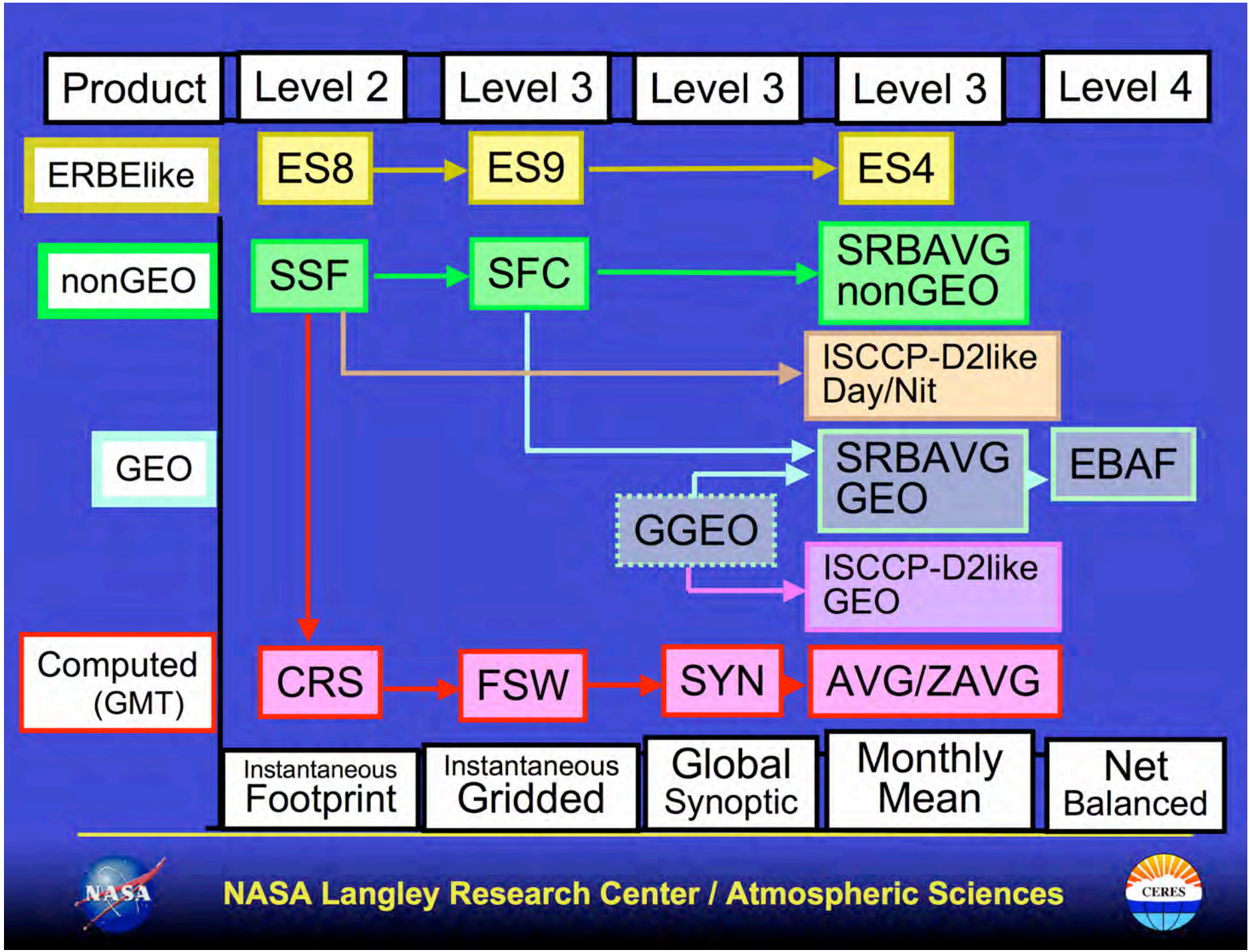


- Appropriate Usage:
  - – SYN fluxes and cloud properties can be compared directly with climate model results at the 3-hourly or monthly level
  - – Fluxes at the surface, 500mb, 200mb, 70mb and TOA levels
  - – Fluxes under pristine, clear-sky, all-sky (no aerosol), and all-sky conditions


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
NASA Langley Research Center / Atmospheric Sciences

CERES Monthly Gridded Average Data Products

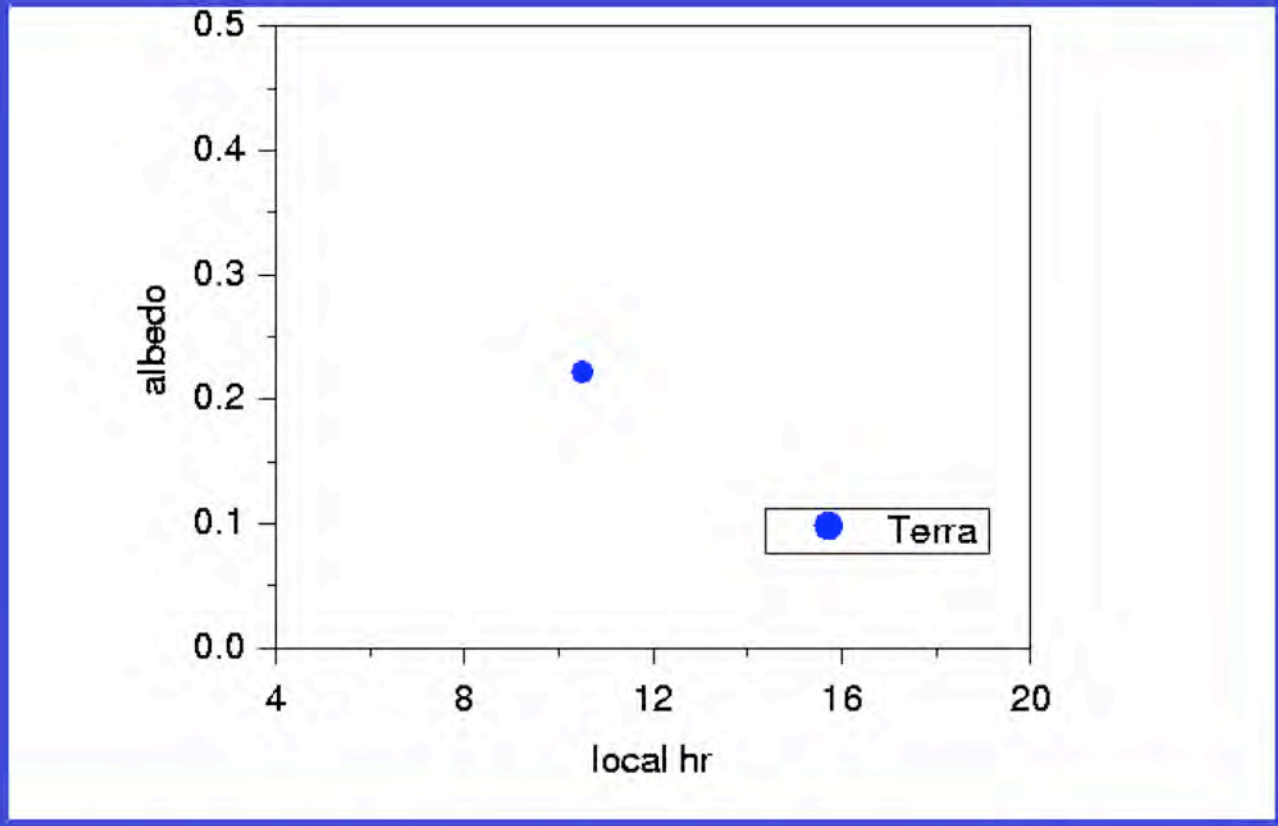
CERES PRODUCT	TRMM Jan98-Aug98 & Mar00	Terra Mar00-present	Aqua Jul02-present
ERBE-like (ERBElike Monthly TOA Flux Averages)	**Ed2**	**Ed1** **Ed2** (Mar00-Dec05)	**Ed1** **Ed2** (Jul02-Jul07)
SRBAVG (Monthly TOA/Surface Flux and Cloud Averages) Contains both nonGEO and GEO	**Ed2B**	**Ed2D**(Mar00-Oct05) (Nov05-Dec06) Spring 09	**Ed2D**(Jul02-Oct05) (Nov05-Dec06) Spring 09
SRBAVG Improvements, daily parameters, forward processing		**Ed2E/F** (Mar00-Dec06) Spring 09	**Ed2E/F** (Jul02-Dec06) Spring09
ISCCP-D2like		**Beta1**(Mar00-Dec06) Jan09	**Beta1**(Jul02-Dec06) Jan09
EBAF (Energy Balanced and filled)		**Ed1A**(Mar00-Oct05)	
AVG/ZAVG (Synoptic Monthly TOA/Surface/Profile Flux and Cloud Averages)		**Beta3**(Mar00-Oct04) **Ed2C/F** (Mar00-Oct05) Apr09	**Ed2C/F** (Jul02-Oct05) Apr09

– * Future products

Temporal Averaging

Convert instantaneous measured flux to daily mean flux

Example: Peruvian stratus region



- Terra equatorial crossing time is 10:30AM
- Plot Terra albedo measurement

Temporal Averaging

Convert instantaneous measured flux to daily mean flux

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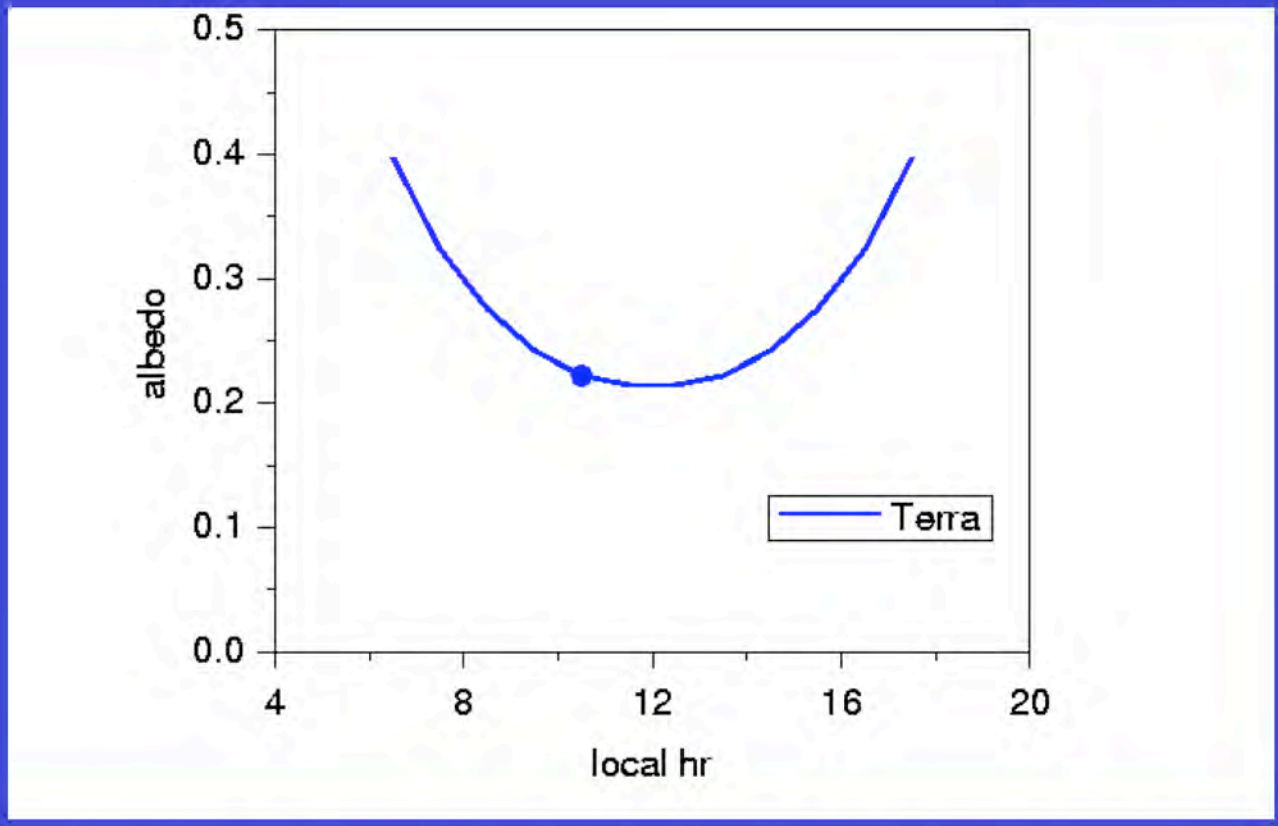
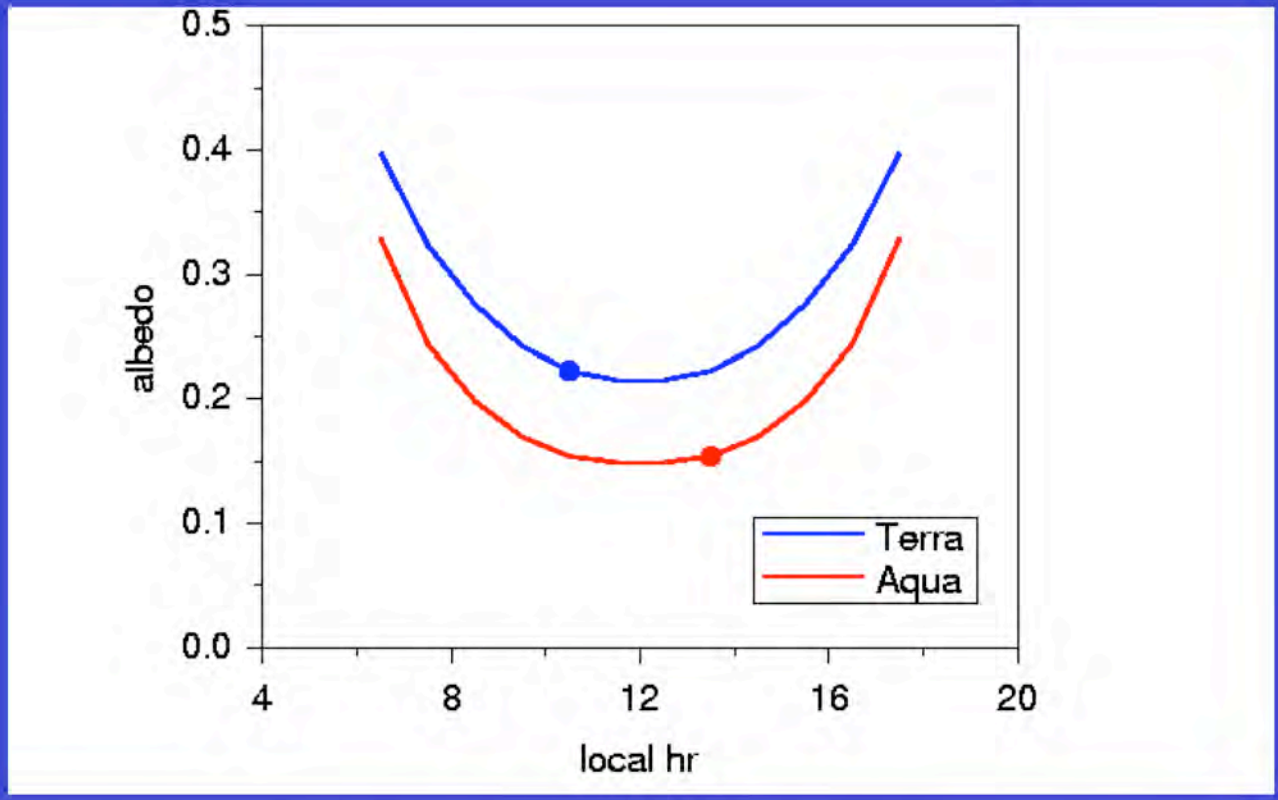


- Directional model relates albedo with solar zenith angle
- Assumes constant meteorology throughout the day

Temporal Averaging

Convert instantaneous measured flux to daily mean flux

Example: Peruvian stratus region

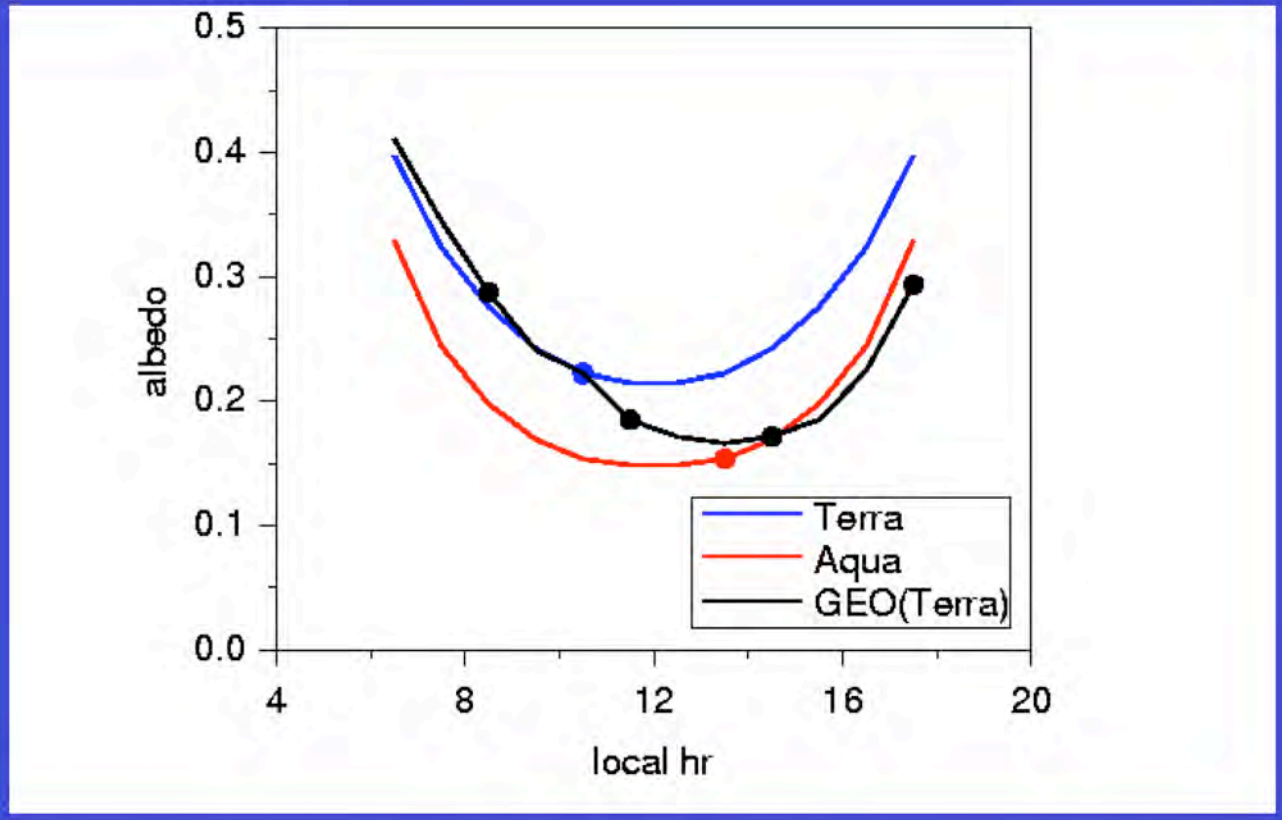


- Aqua equatorial crossing time is 1:30PM
- Cloud cover has decreased between Terra and Aqua measurement

Temporal Averaging

Convert instantaneous measured flux to daily mean flux

Example: Peruvian stratus region

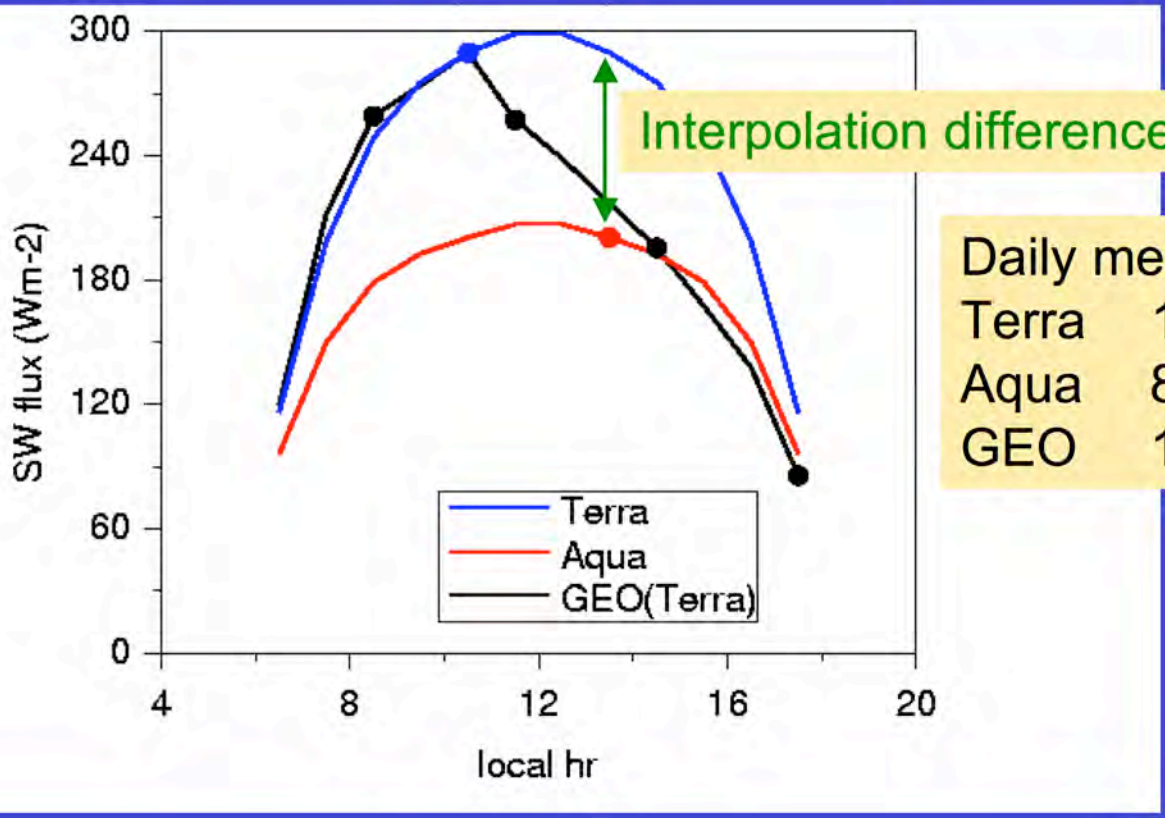


- Use geostationary 3-hourly derived albedos to resolve diurnal cycle

Temporal Averaging

Convert instantaneous measured flux to daily mean flux

Example: Peruvian stratus region



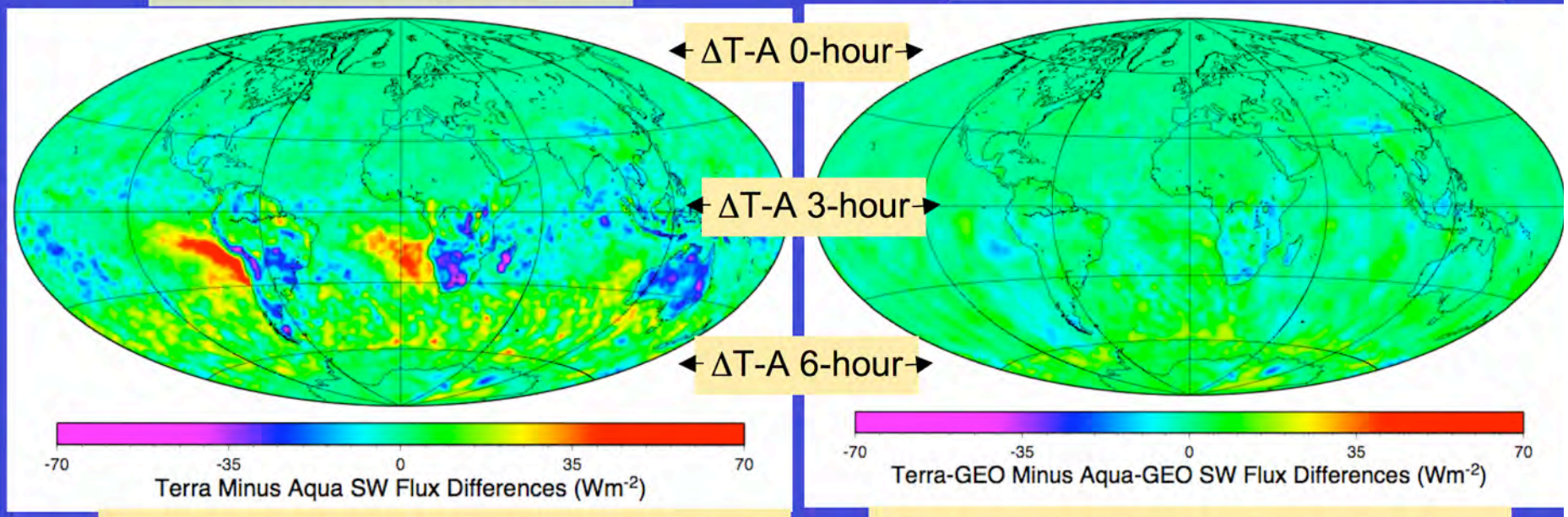
Daily mean (Wm-2)

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

CERES & GEO fluxes



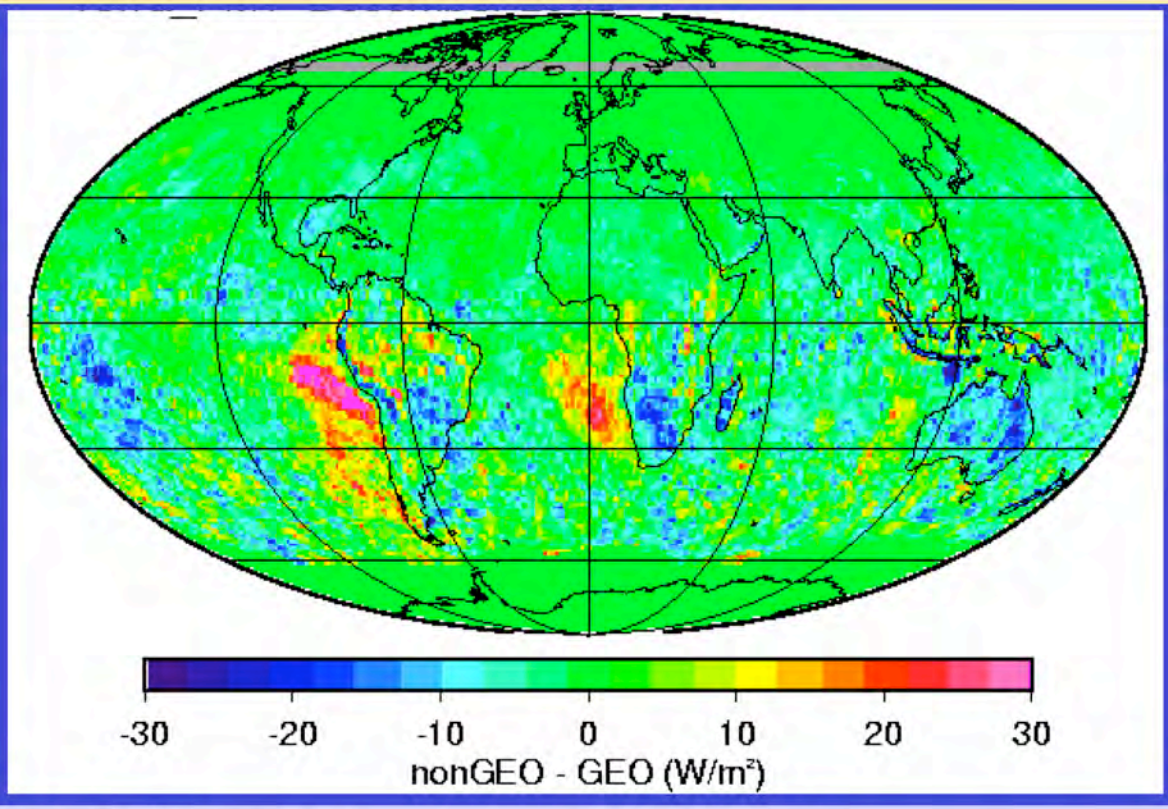
Regional rms=11.7 Wm^{-2} (11.1%)

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

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

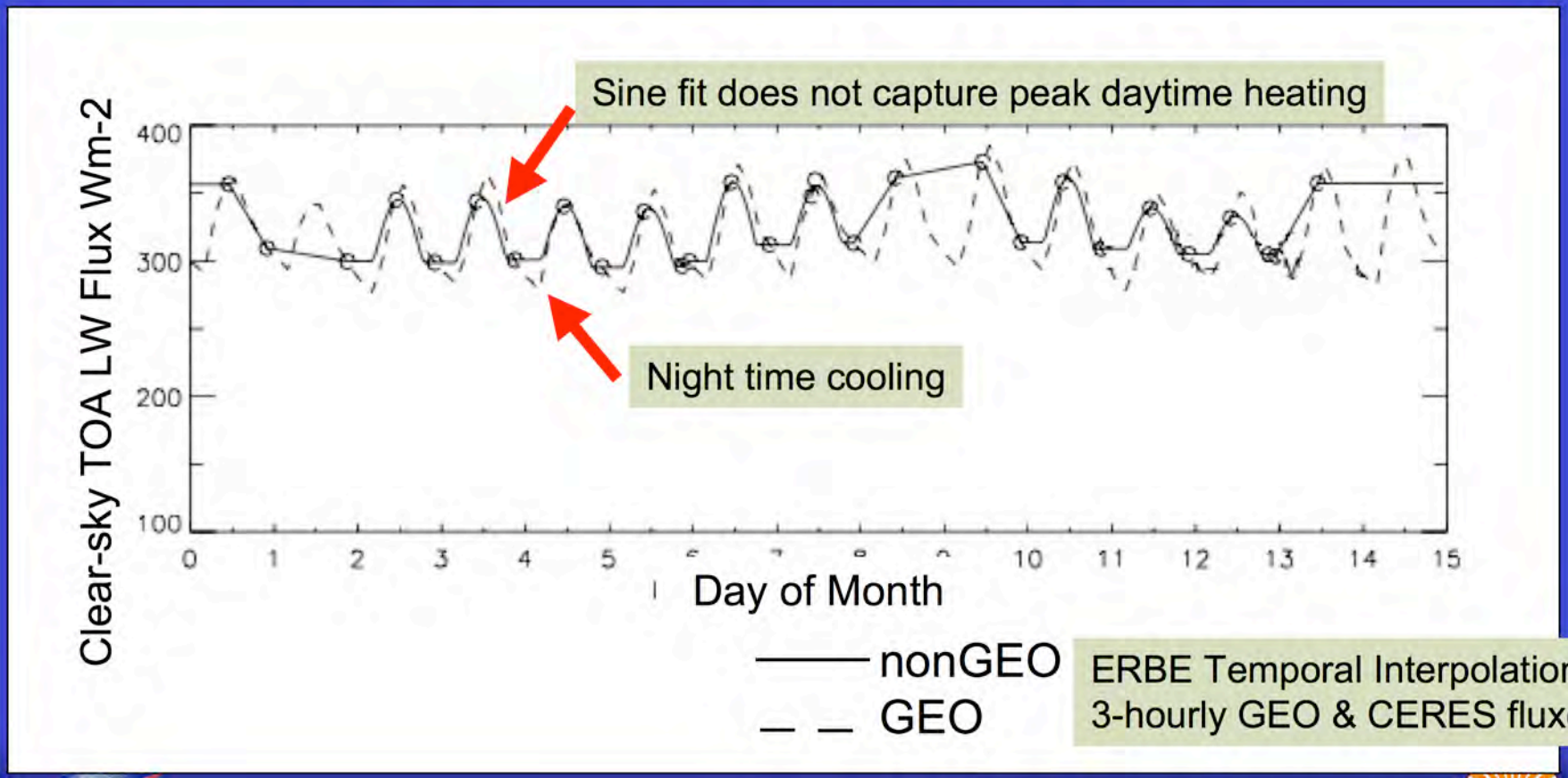


- Regional monthly differences can be > 20 Wm^{-2}
- Global bias is - 1.0 Wm^{-2}

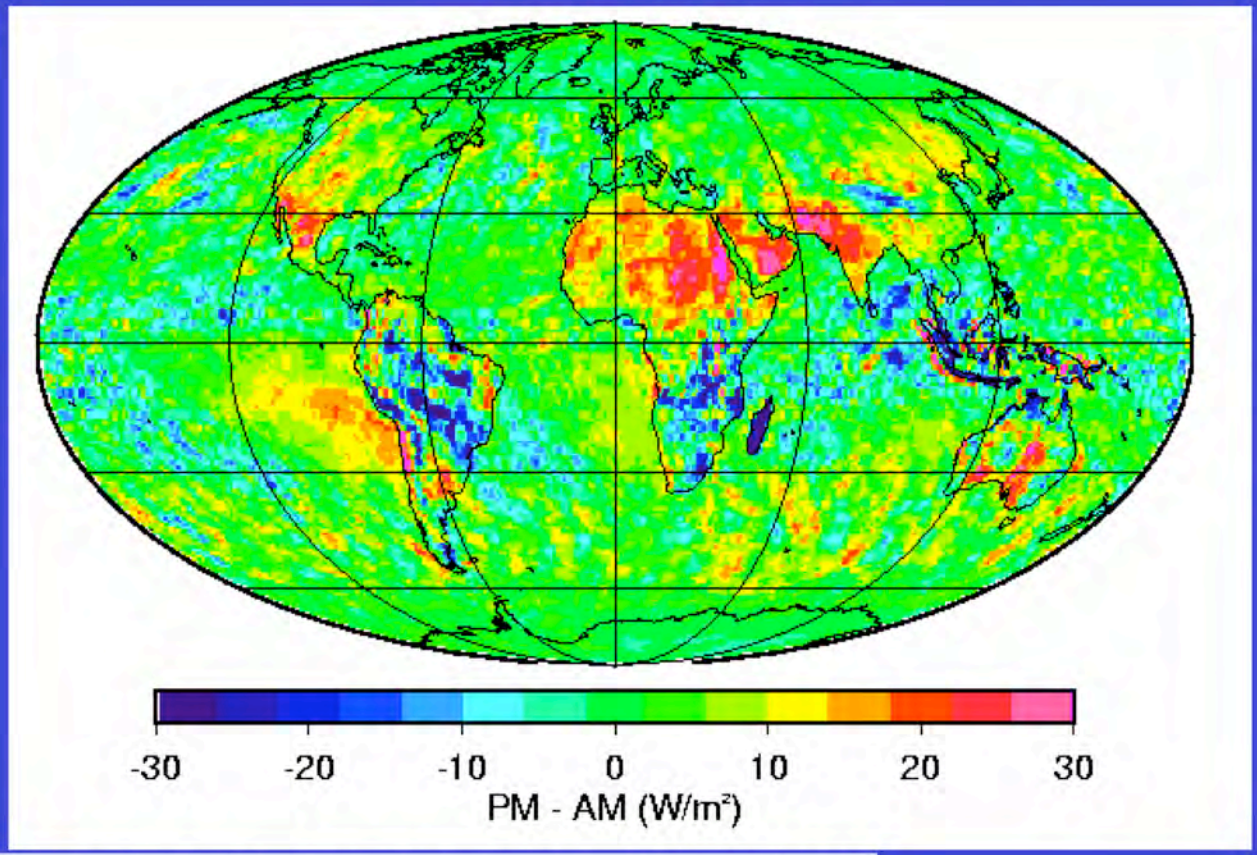
Clear-sky TOA LW Flux

June 2001, Terra FM-1, Arizona Desert

- ERBE temporal interpolation linearly interpolates between measurements over oceans
- Over land a half-sine fit is used to model diurnal heating if night time observations exist

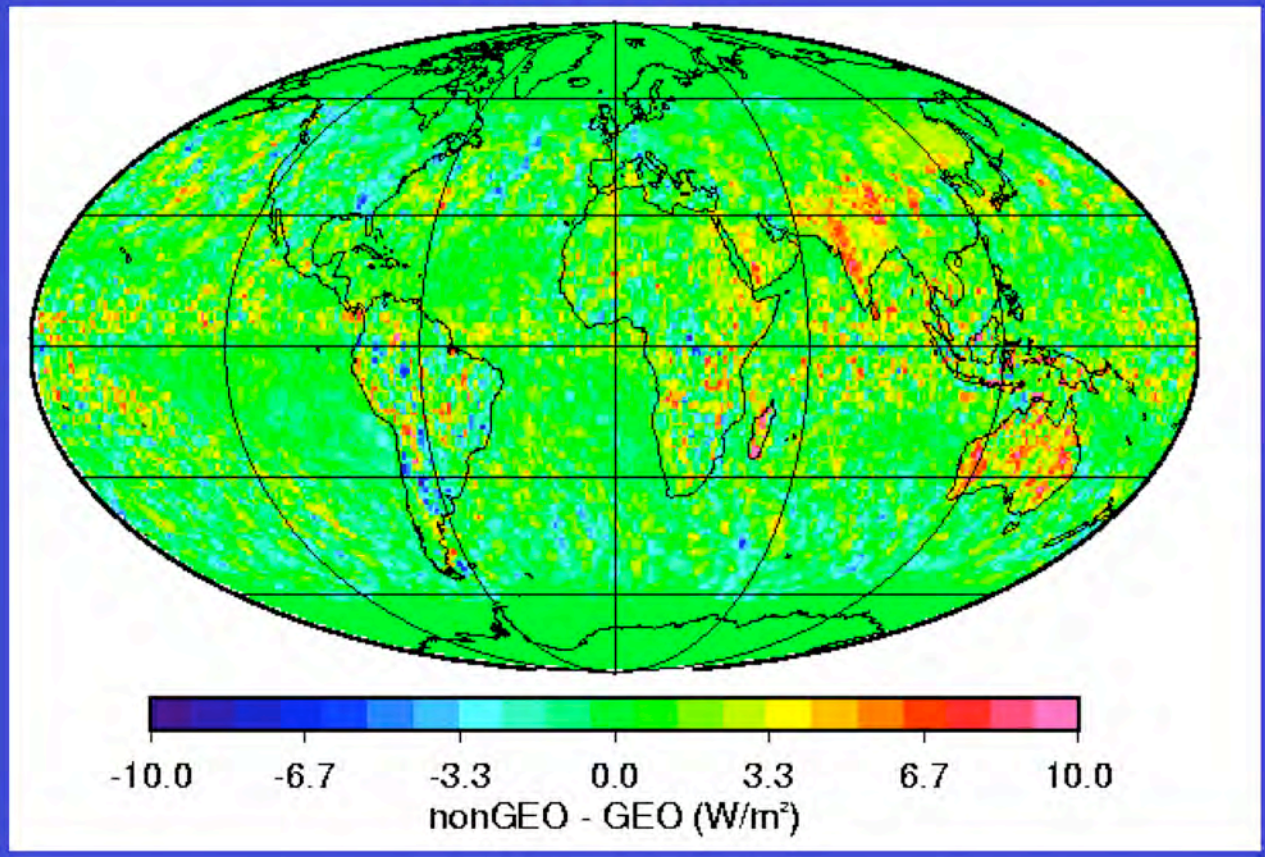


GEO LW 16:30 (PM) - 7:30 (AM) monthly hourly mean
Dec 2002



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

nonGEO - GEO LW monthly mean Dec 2002



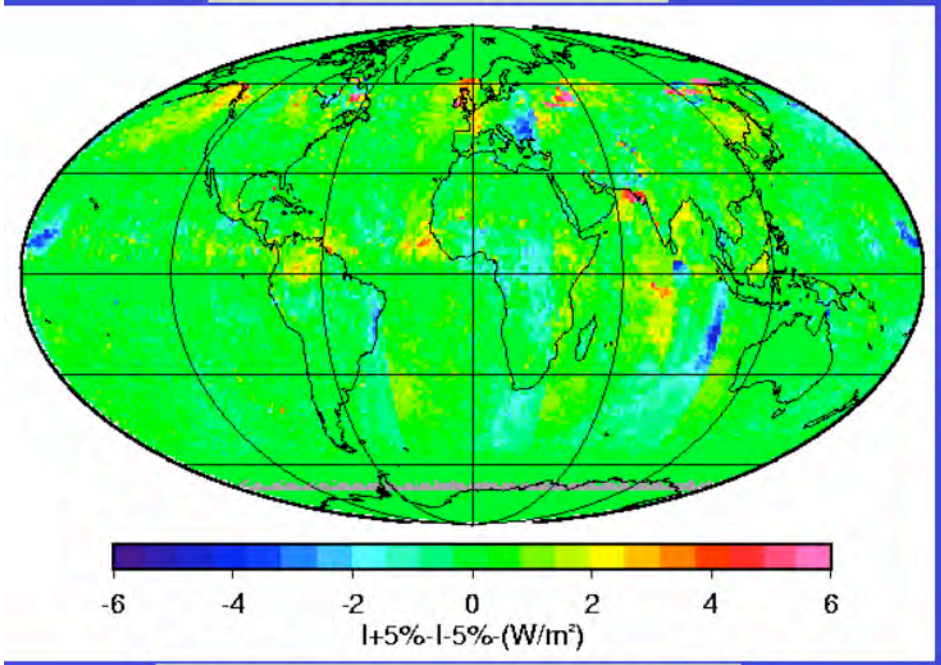
- Global bias = 0.5 Wm-2

Using Geostationary Data for Temporal Interpolation of TOA Fluxes

- 3-hourly imager data from geostationary satellites is used to define diurnal variations between CERES observations
  - Terra and Aqua sun-synchronous orbits limit diurnal sampling
- Calibration is critical
  - GEO imagers calibration tied to MODIS, which is well calibrated
- Cloud retrieval is a subset of CERES MODIS algorithm
  - Consistency between CERES and GEO clouds properties
- GEO narrowband to broadband relationships use the same scene identification as the CERES ADMs
- Final fluxes are regionally constrained to CERES observations
  - Maintain the CERES instrument calibration
  - No dependency with region, cloud amount, solar or view angle
  - No GEO artifacts or GEO induced trends over time

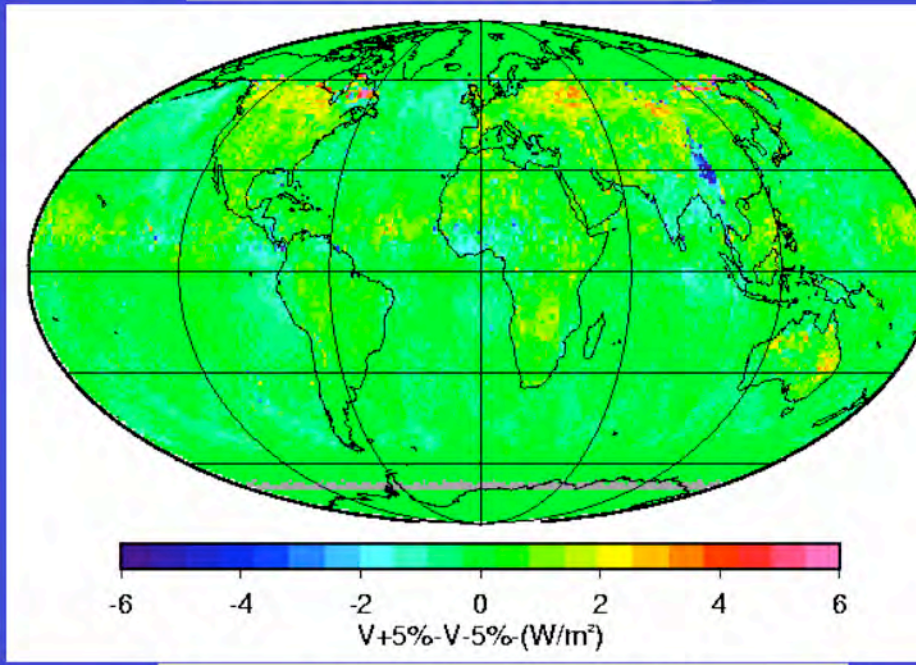
Change in Total-Sky TOA SW Flux due to artificial GEO calibration adjustments, July 2002

(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 constrainment to CERES removes sensitivity to GEO calibration

ISCCP-D2like Beta datasets are public

ATMOSPHERIC SCIENCE DATA CENTER

CERES ISCCP-D2like Data Sets

CERES

CERES Data Products | Clouds and TOA/SFC Flux Processing | Processing Level Details

The CERES data products are written in HDF format. (Information on HDF)

For convenience in ordering a specific CERES data product, select the Data Set Name in the table below.

Monthly Cloud Averages (ISCCP-D2like):
3-hourly (GMT based) monthly and monthly 1° gridded regional mean cloud properties as a function of 18 cloud types, similar to the NASA-GISS "ISCCP D2" product.

Select Parameters: Cloud fraction, Effective Pressure, Temperature, optical depth, IWP/LWP, particle size, IR Emissivity in PC/Tau bins similar to ISCCP-D2 product

Documents: Day/Nit Description/Abstract | GGEO Description/Abstract

Spacecraft	Data Set Name (Select name to order)	Data Products Catalog (PDF)	Sample Software	Temporal Coverage (Monthly)
GGEO	CER_ISCCP-D2like_GEO_Composite_Beta1. Quality Summary ISCCP-D2like Beta1.	DPC_ISCCP-D2like-GEO_R5V1.pdf	Readme GEO_R5-682 | Read Package GEO_R5-682	03/2000 - 10/2005
Terra (covers opened 02/25/2000)	CER_ISCCP-D2like-Day_Terra-FM1-MODIS_Beta1. CER_ISCCP-D2like-Day_Terra-FM2-MODIS_Beta1. CER_ISCCP-D2like-Nit_Terra-FM1-MODIS_Beta1. CER_ISCCP-D2like-Nit_Terra-FM2-MODIS_Beta1. Quality Summary ISCCP-D2like Beta1.	DPC_ISCCP-D2like_R5V1.pdf	Readme R5-682 | Read Package R5-682	03/2000 - 10/2005
Aqua (covers opened 06/18/2002)	CER_ISCCP-D2like-Day_Aqua-FM3-MODIS_Beta1. CER_ISCCP-D2like-Day_Aqua-FM4-MODIS_Beta1. CER_ISCCP-D2like-Nit_Aqua-FM3-MODIS_Beta1. CER_ISCCP-D2like-Nit_Aqua-FM4-MODIS_Beta1. Quality Summary ISCCP-D2like Beta1.			07/2002 - 10/2005

A Portable Document Format (PDF) reader (such as Adobe Acrobat Reader) is required to open and view PDF documents.

CERES Data Products | ASDC Home Page | Access Data | Questions/Feedback

NASA

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CERES ISCCP-D2like Datasets

GMT	00-03	03-06	06-09	09-12	12-15	15-18	18-21	21-24
Terra day				T				
Terra nit								T
Aqua day					A			
Aqua nit	A							
GEO	G	G	G	G	G	G	G	G
Merged	A	G	G	T	A	G	G	T

- ISCCP-D2like is GMT 3-hourly
- Example given for region at 0° Longitude
- Merged will adjust GEO cloud retrievals to MODIS

Extending the SRBAVG GEO record

- Currently SRBAVG GEO record is from Mar00 to Oct05
- The switch from GMS-5 to MTSAT in Nov05
  - First noted that MTSAT spectral response is weighted towards the near IR, little Rayleigh scattering and large glint component
- MTSAT (10 bit, 1.0 km) was first transmitted as a GMS-5 like (8 bit, 1.25 km) image using JPEG compression
  - Calibration against MODIS is very noisy
- McIDAS receiving MTSAT 10 bit since Oct07
  - Have developed 8 bit to 10 bit conversion
- MTSAT/Terra matches have been recollected
  - Calibration strategy using large match grid (±45° from sub satellite) completed
  - Need to evaluate how near sub satellite radiances effect cloud retrievals, will GEO flux normalization with CERES be sufficient

Extending the SRBAVG GEO record

- 100% GEO to MODIS cross calibration matched data and software lost in SAN disk failure
  - total loss of ~ 2 TB
  - First concentrated on MTSAT calibration
  - Real time monthly calibration begin ramp up for all pairs
  - DAAC helping with collecting MODIS historical matches
  - Begin retrieving McIDAS historical matches from 2006
  - Rely on web based and paper regression plots
  - Started processing GGEO from Nov05 to Dec07 to match GGEO and MODIS cloud properties
  - Deliver GGEO coefficients in Dec07

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