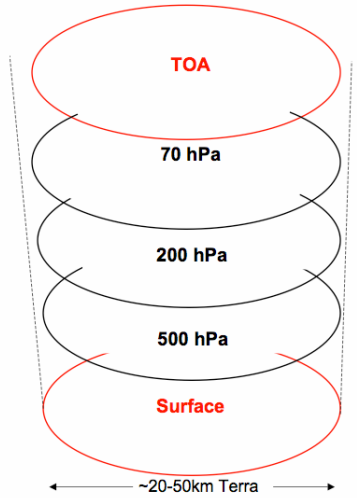
CERES Surface and Atmosphere Radiation Budget (SARB): Calculated fluxes, forcings, and comparison with observations

T. P. Charlock (NASA Langley)
Fred G. Rose (AS&M) algorithm development
David A. Rutan (AS&M) CAVE validation
Zhonghai Jin (AS&M) coupled air-sea radiative transfer
Seiji Kato (Hampton U.) - changes to SW code



www-cave.larc.nasa.gov/cave/ or goggle "CERES CAVE"

For easy-to-download subsets of CERES SARB
and independent ground data for validation

Graphs and tables of results and checks

"Point and click" radiative transfer

Accurate ocean surface spectral albedo tool

Ungridded SARB vertical profile at ~2,000,000 CRS footprints/day

Langley Fu-Liou radiative transfer: Kato 2005 SW upgrade, retains Kratz-Rose window

NCEP O3(z)
Mostly from SBUV/2

70 hPa (altitude ~18 km)

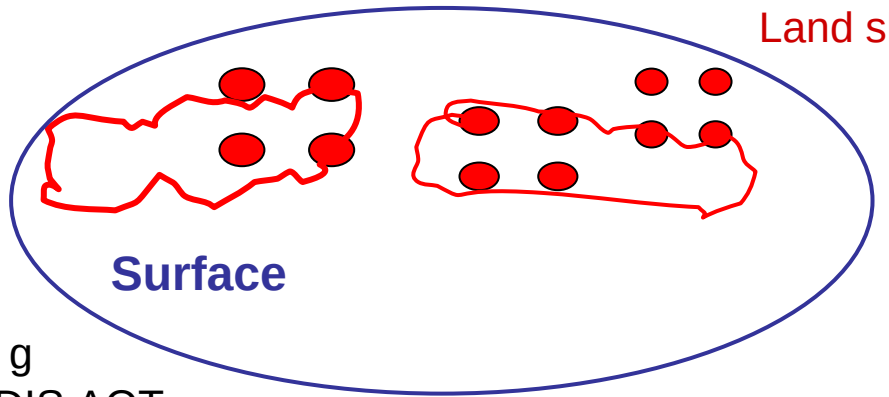
MINNIS modis

GSFC NWP

Modis Atmosphere Team

GEOS4 T(z), q(z), surface wind
Wind speed affects ocean surface albedo

MODIS ~1km pixels provide
Cloud properties (almost always)
Aerosol AOT (sometimes)
Land skin temperature (if clear)



Collins NCAR

Wielicki
Loeb
Priestley

MATCH aerosols
Always used for SSA & g
Used for AOT if no MODIS AOT

~20-50 km

Large CERES footprint for TOA flux

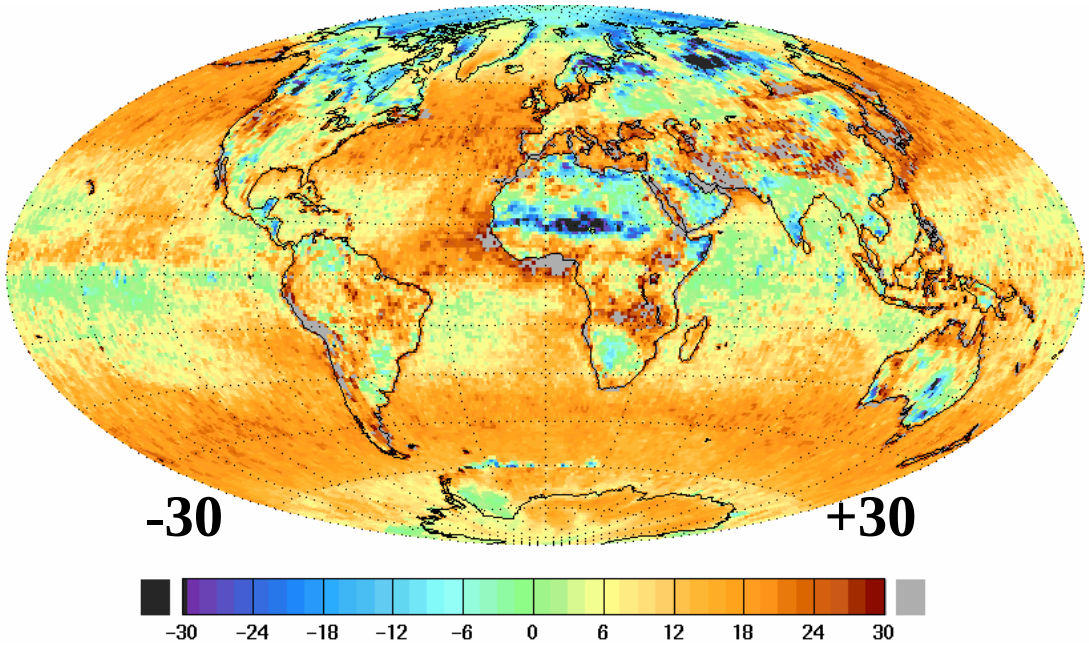
Monthly maps from CAVE home page

Reflected SW at TOA

Observed = 241.5 Wm-2

Bias = 11.0 Wm-2

day overpass



Bias = Untuned - Observed

CERES Terra FM1 FSW Ed2C

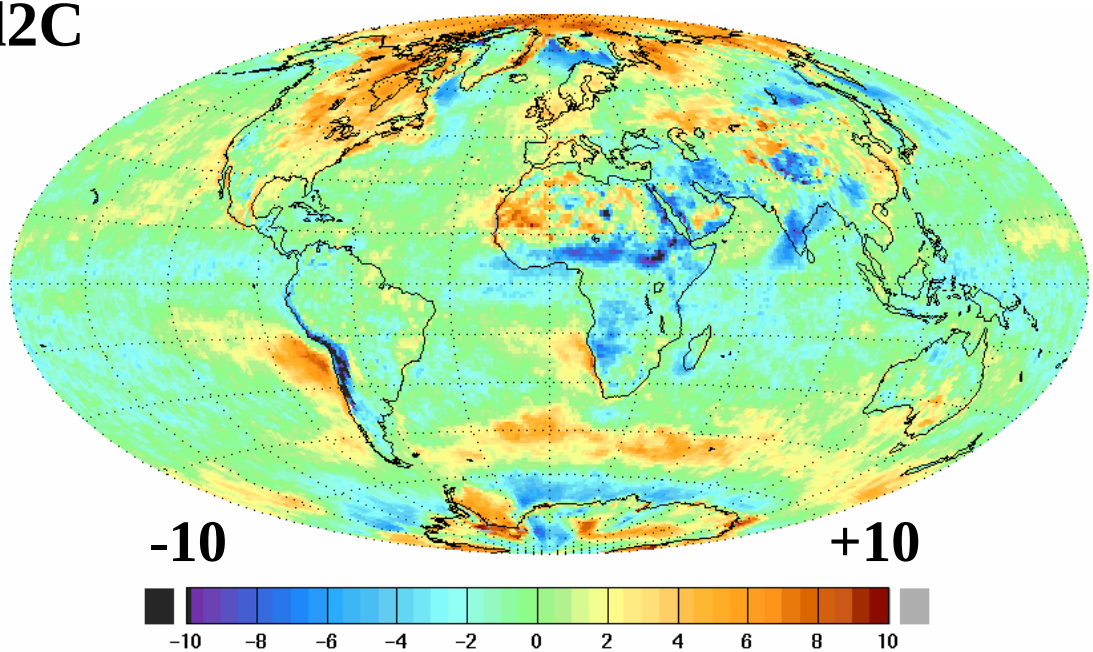
March 2003

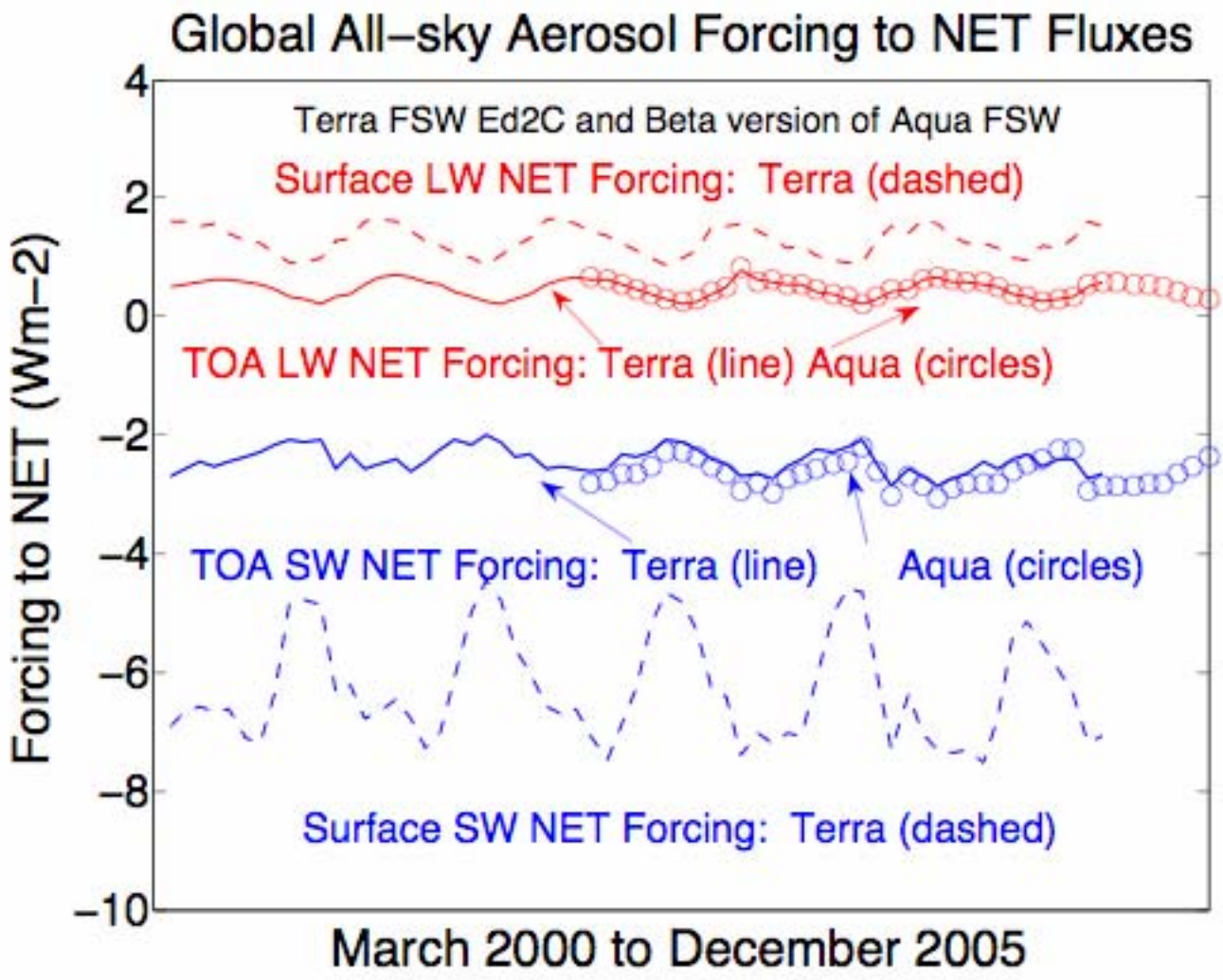
OLR

Observed = 237.2 Wm-2

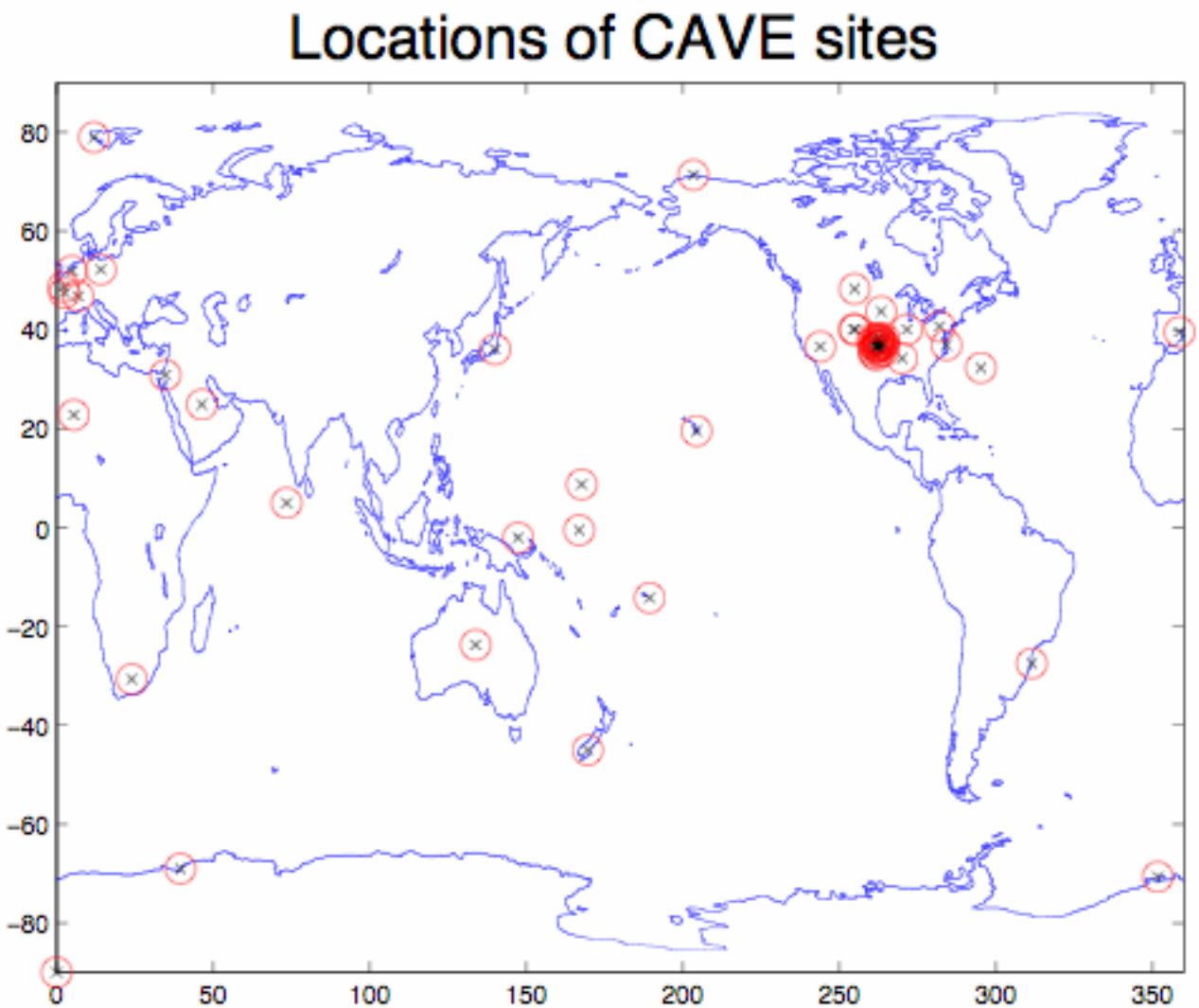
Bias = 0.0 Wm-2

day + nite




Global All–sky Aerosol Forcing to NET Fluxes
Terra FSW Ed2C and Beta version of Aqua FSW
Surface LW NET Forcing: Terra (dashed)
TOA LW NET Forcing: Terra (line) Aqua (circles)
TOA SW NET Forcing: Terra (line)
Aqua (circles)
Surface SW NET Forcing: Terra (dashed)
Forcing to NET (Wm–2)
4
2
0
–2
–4
–6
–8
–10
March 2000 to December 2005

CERES ARM Validation Experiment (CAVE) includes BSRN, SURFRAD



www-cave.larc.nasa.gov/cave/ or goggle “CERES CAVE”

Surface Flux Validation

Instantaneous Footprint Results
Terra, 70 Months of CRS Ed2B, (“clear” –

Downward Untuned Surface Flux Biases (Model-Obs)(W/m2)					SFC Aerosol Forcing		
	All Sky		Clear Sky		Clear-Pristine		SW
	LW	SW	LW	SW	LW	SW	CNA*
ARM/SGP	-7	+8	-8	+3	+1	-16	-16
Island Sites	-3	+25	0	+14	+1	-9	-7
Polar Sites	-4	+11	-7	-3	+0	-4	-3
SURFRAD	-8	+11	-9	-0	+1	-17	-16
European	-6	+21	-3	+0	+2	-27	-19
Validation Sites	-6 (23)	+13 (94)	-9 (15)	+2 (29)	+3	-16	-10

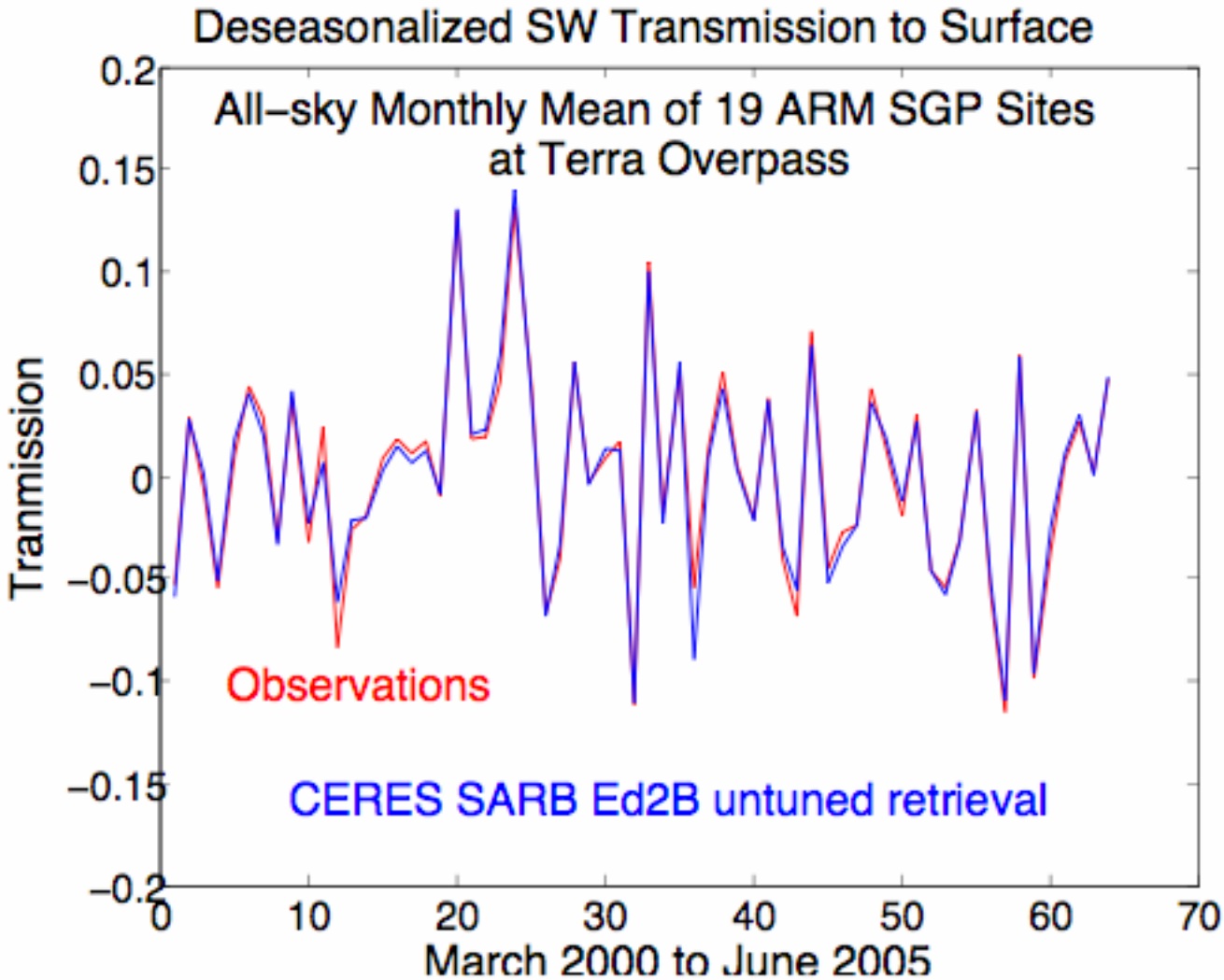
ARM SGP for 64 months **Mean (RMS) of Bias for All-sky SW insolation**

4 (89) for E13 site (Central Facility)

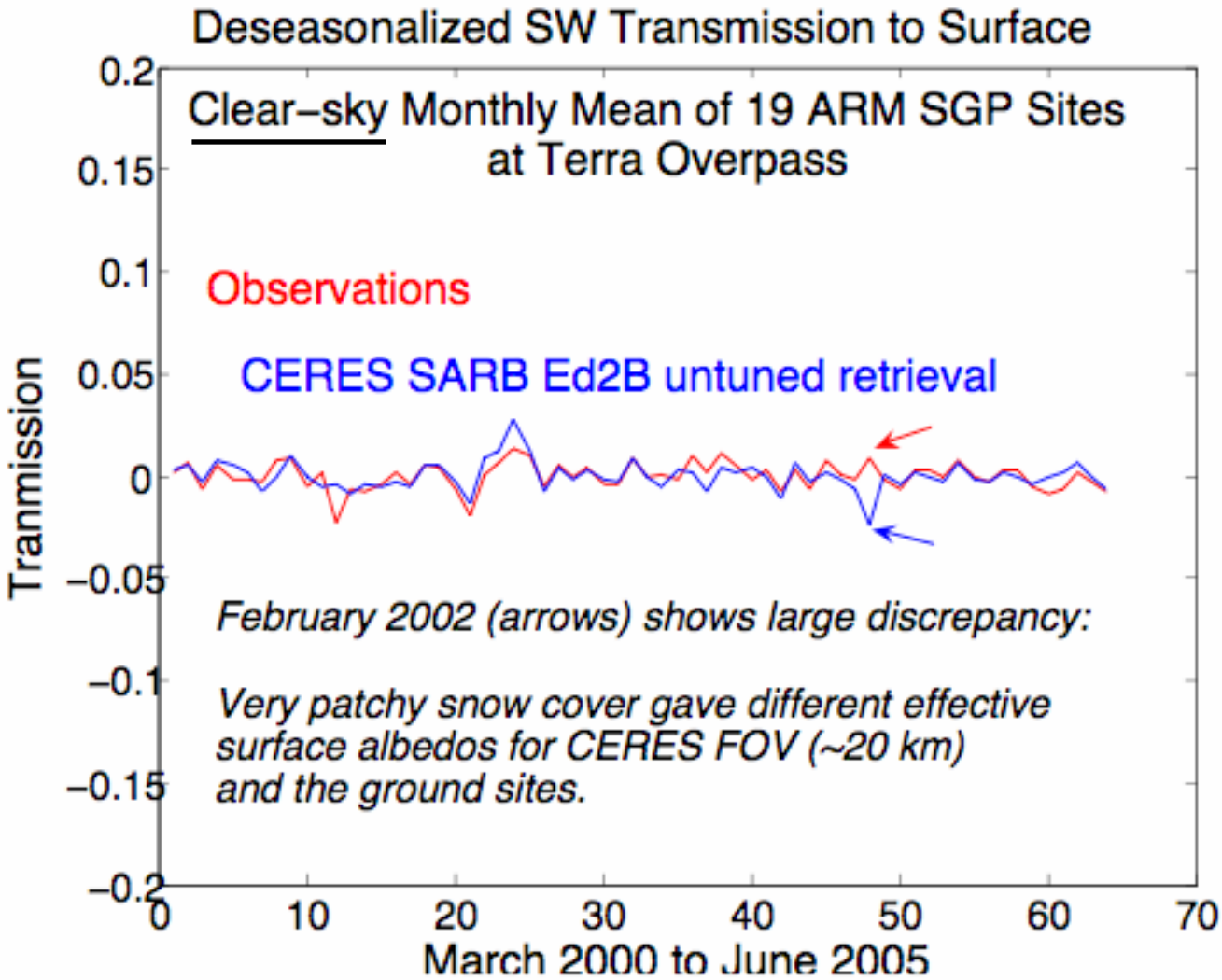
10 (87) for 19 SGP sites

10 (30) for 19 sites as a virtual daily “grand” site

10 (13) for 19 sites as a virtual monthly “grand” site



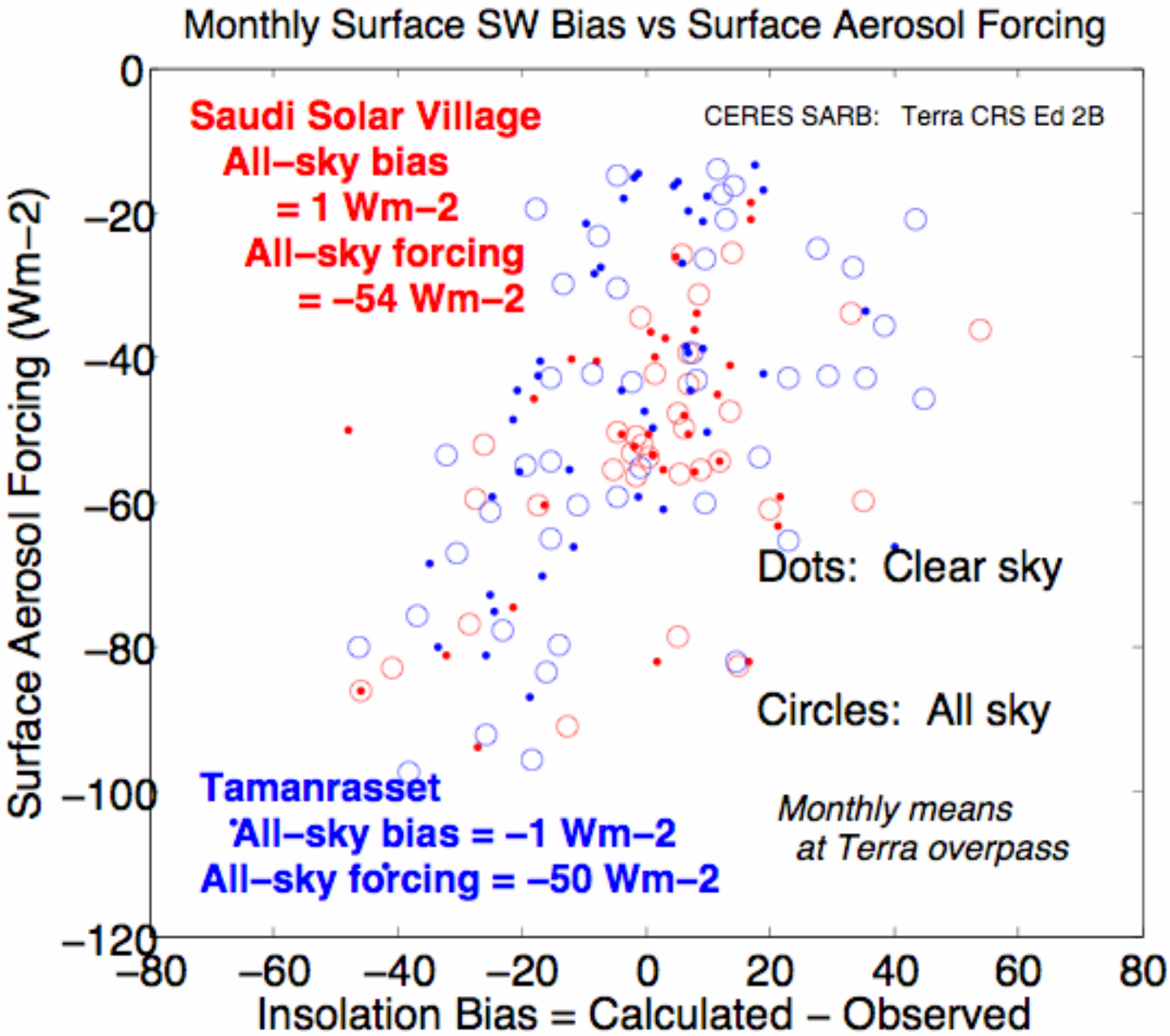
Using all 19 SGP sites as a virtual monthly "grand" site, CERES SARB retrieval captures the interannual variability of all sky insolation.

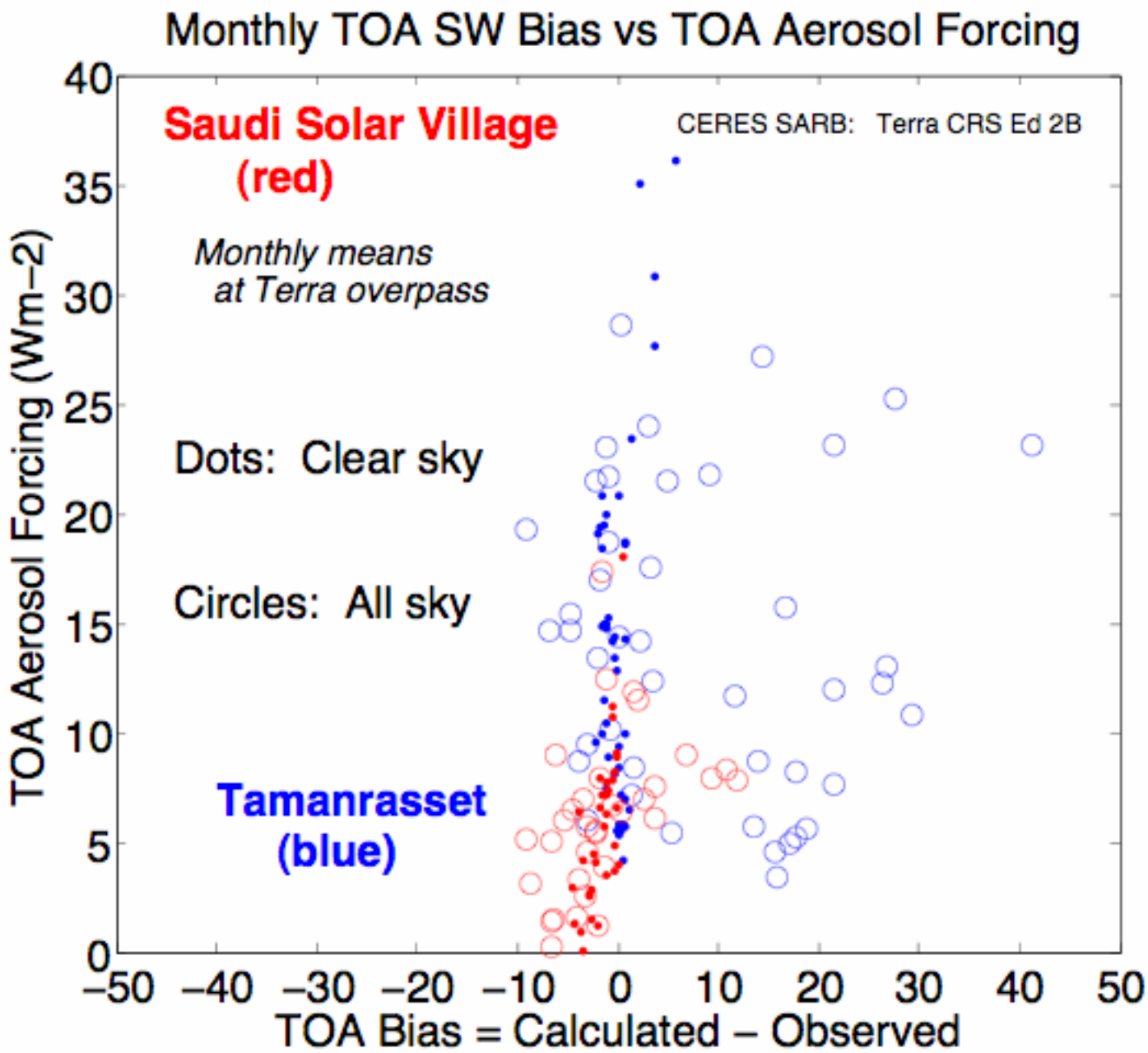


Retrieval does not capture interannual variability in clear-sky transmission well.

But ensemble mean aerosol forcing (-17 Wm^{-2} from entire raw time series) is okay,

as insolation bias of raw time series is only 3 Wm^{-2} for clear skies.


Monthly Surface SW Bias vs Surface Aerosol Forcing
Saudi Solar Village
All–sky bias
= 1 Wm–2
All–sky forcing
= –54 Wm–2
CERES SARB: Terra CRS Ed 2B
Dots: Clear sky
Circles: All sky
Tamanrasset
All–sky bias = –1 Wm–2
All–sky forcing = –50 Wm–2
Monthly means
at Terra overpass
Surface Aerosol Forcing (Wm–2)
Insolation Bias = Calculated – Observed
0
–20
–40
–60
–80
–100
–120
–80
–60
–40
–20
0
20
40
60
80


Monthly TOA SW Bias vs TOA Aerosol Forcing
Saudi Solar Village
(red)
CERES SARB: Terra CRS Ed 2B
Monthly means
at Terra overpass
Dots: Clear sky
Circles: All sky
Tamanrasset
(blue)
TOA Aerosol Forcing (Wm−2)
TOA Bias = Calculated – Observed
40
35
30
25
20
15
10
5
0
−50
−40
−30
−20
−10
0
10
20
30
40
50

SARB footprint (FOV) calculations are noisy (compared with data) and they:

- reflect more SW at TOA than observed by CERES (~3-5%) --- ocean

- transmit more SW to surface for all-sky (~2%) & clear-sky (0-1%) --- land

  Interannual variability for all-sky SW is quite good.

  Interannual variability of snow albedo effect is good.

  Aerosol forcing has some credibility as seasonal mean

  but not for heavy dust sites, where

  aerosols spoil cloudy calculations.

- have less surface LW down than PIR (~10 Wm-2) --- land

- emit more daytime OLR than CERES (0-2 Wm-2)

  And hint at possible drift in observed daytime OLR record

Gridded 24-hour SYNI now under testing

www-cave.larc.nasa.gov/cave/ or goggle "CERES CAVE"

COMPUTED

mean=0.6 stddev=24.2 Wm-2

CERES MODIS clouds

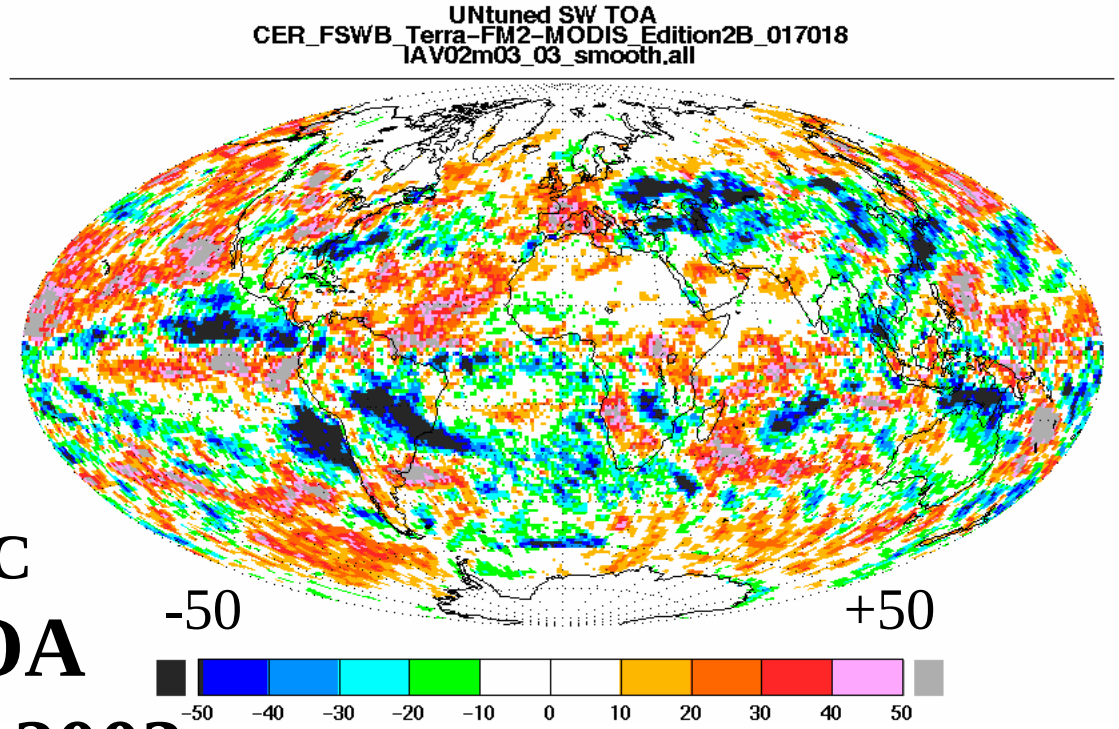
Langley Fu-Liou code

CERES Terra FSW Ed2C

Reflected SW at TOA

March 2002 - March 2003

Both months normalized to have same sampled TOA insolation in each gridbox

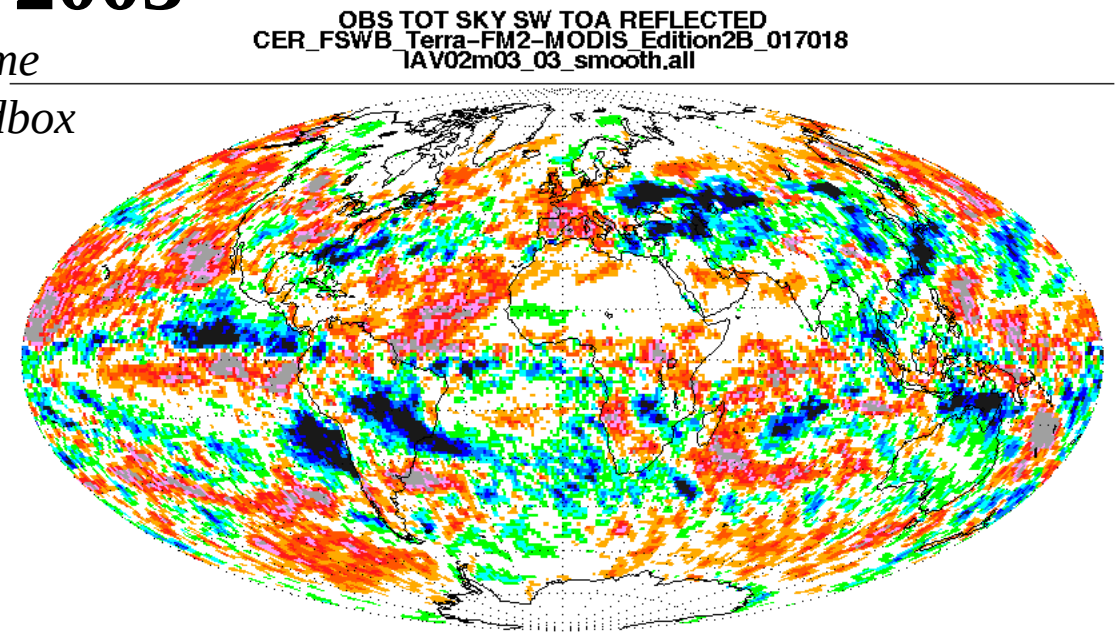


OBSERVED

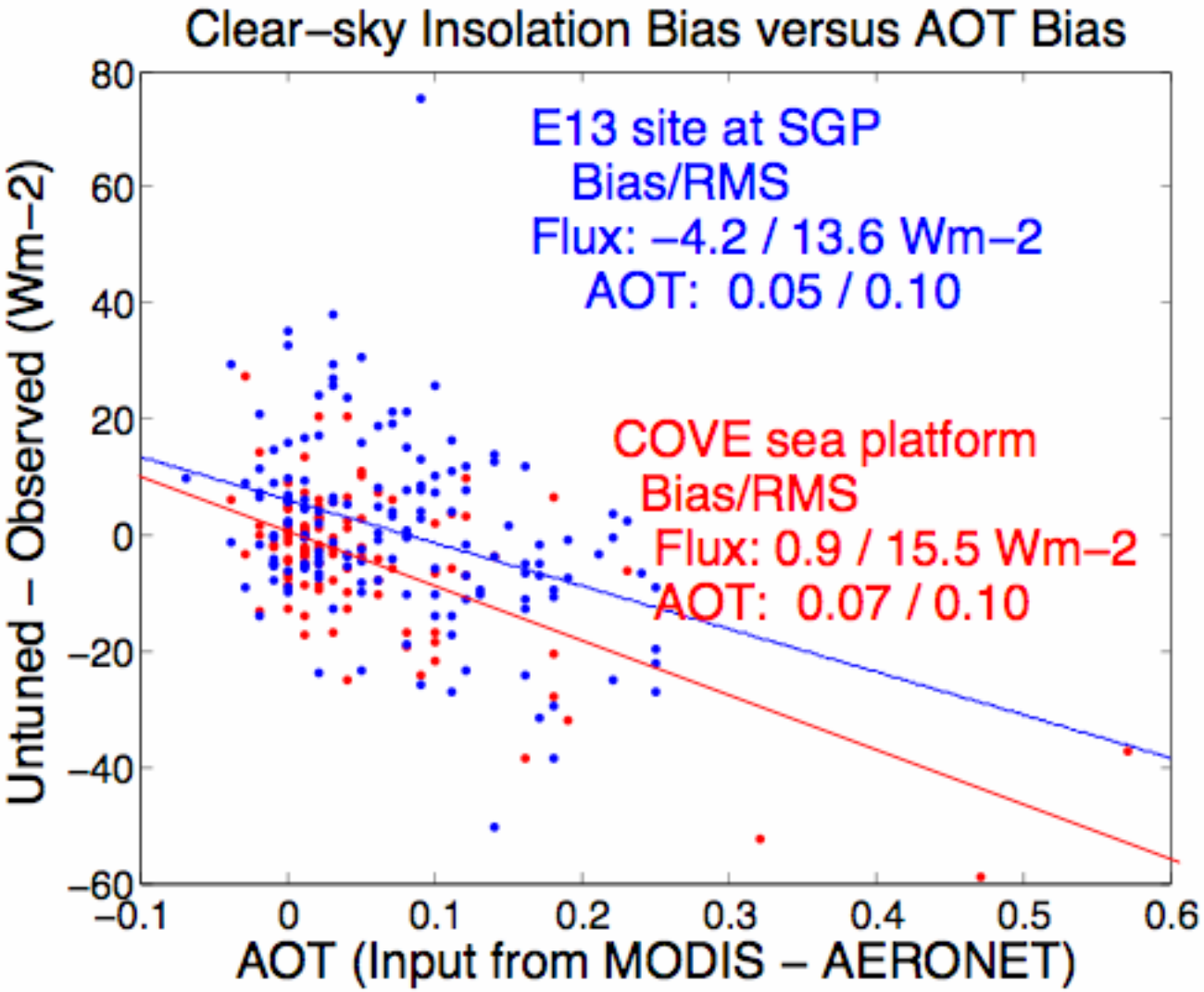
mean=0.8 stddev=23.5 Wm-2

CERES instrument

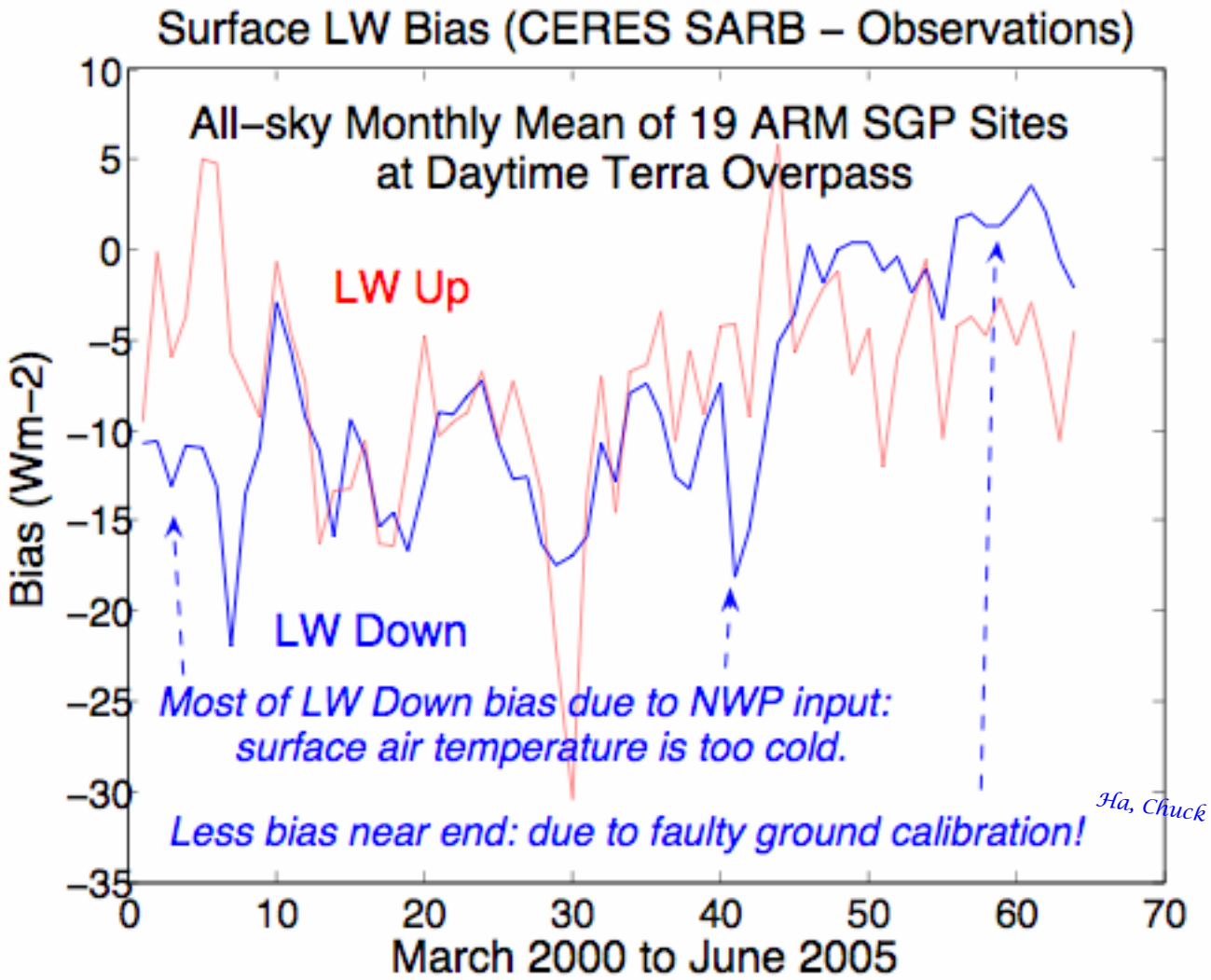
inverted to flux

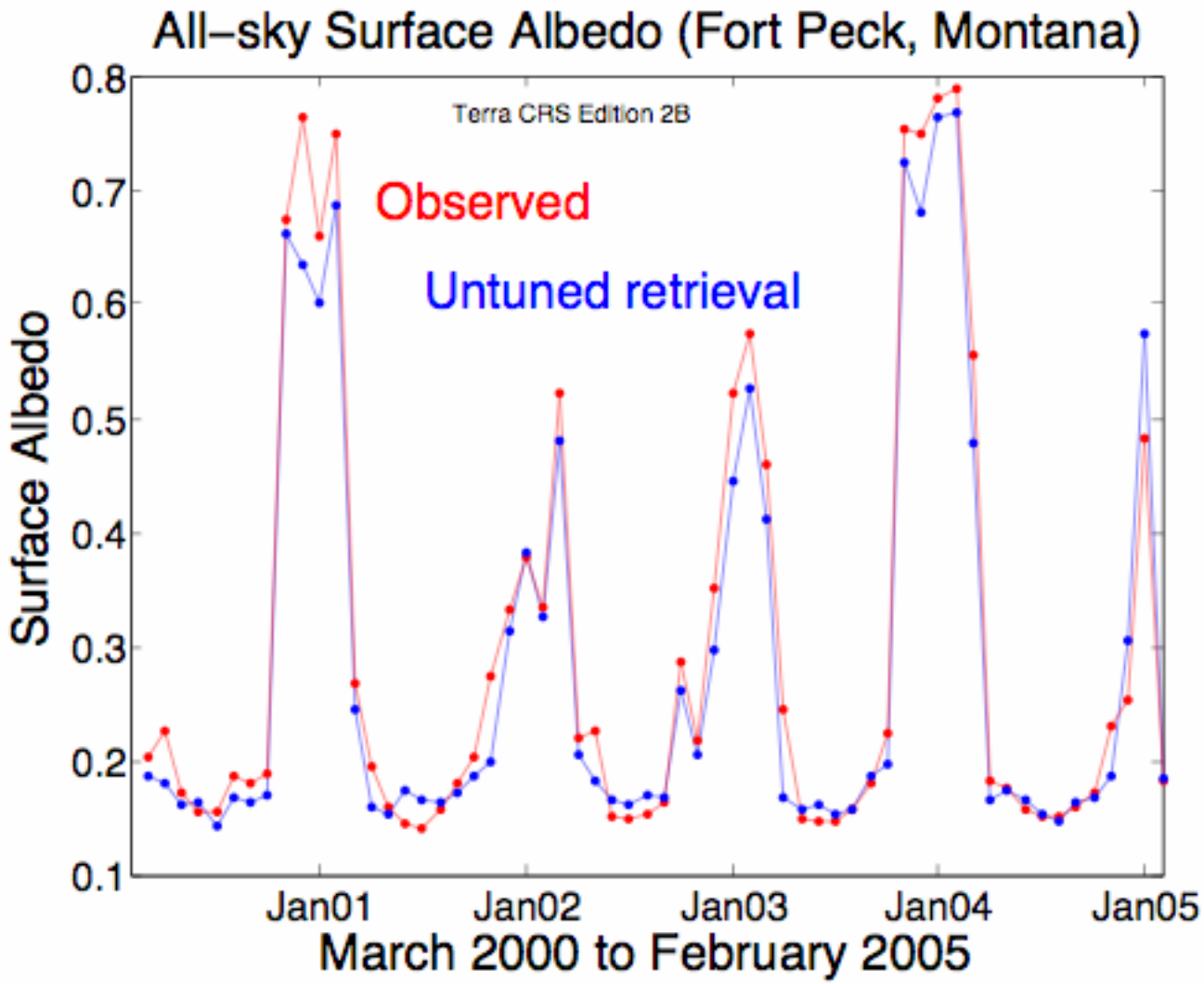


Checking aerosol effects at two special sites with AERONET

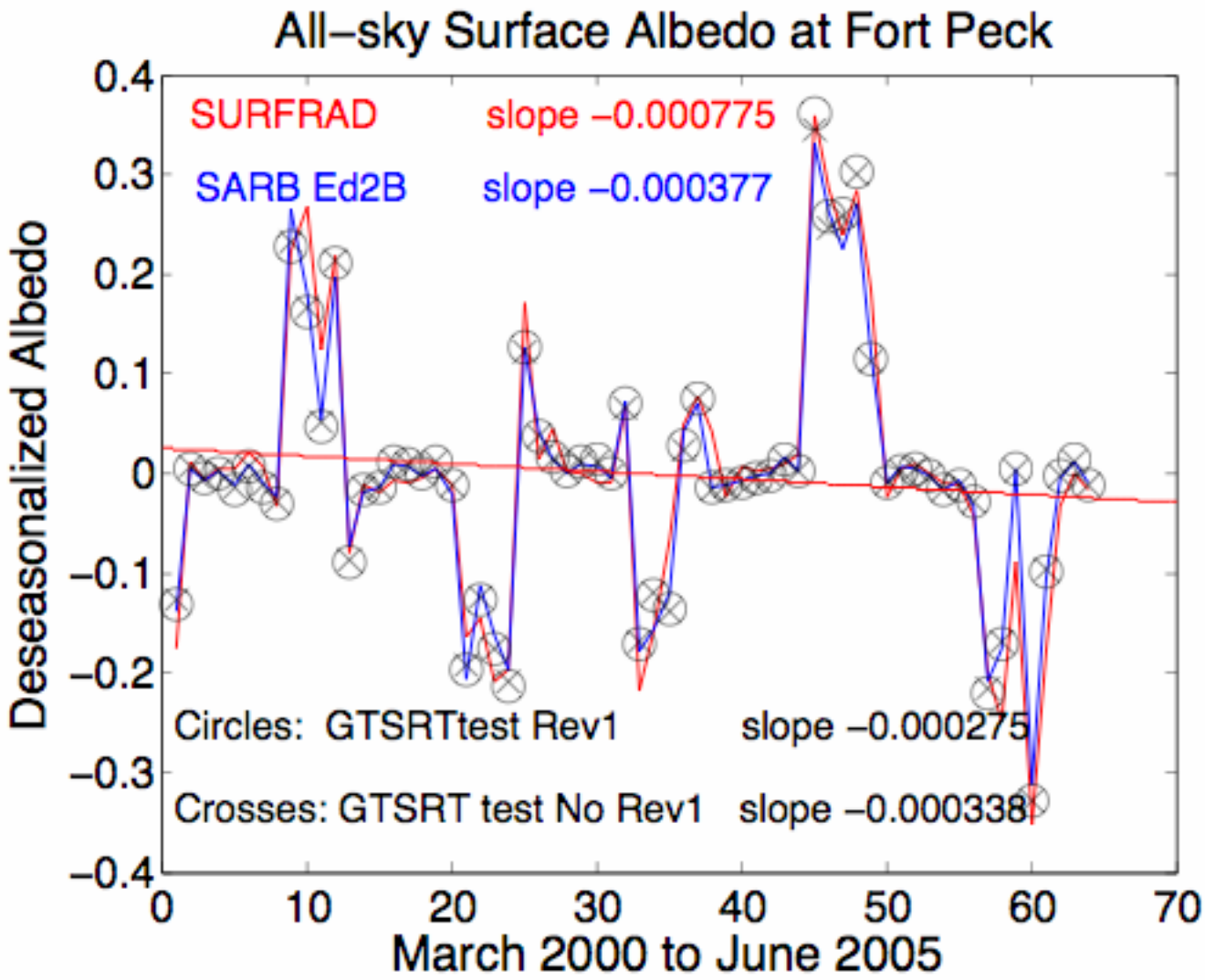


Remer, Inc. *Holben, Inc.*


Surface LW Bias (CERES SARB – Observations)
All–sky Monthly Mean of 19 ARM SGP Sites
at Daytime Terra Overpass
LW Up
LW Down
Most of LW Down bias due to NWP input:
surface air temperature is too cold.
Less bias near end: due to faulty ground calibration!
Ha, Chuck
Bias (Wm–2)
March 2000 to June 2005
10
5
0
–5
–10
–15
–20
–25
–30
–35
0
10
20
30
40
50
60
70

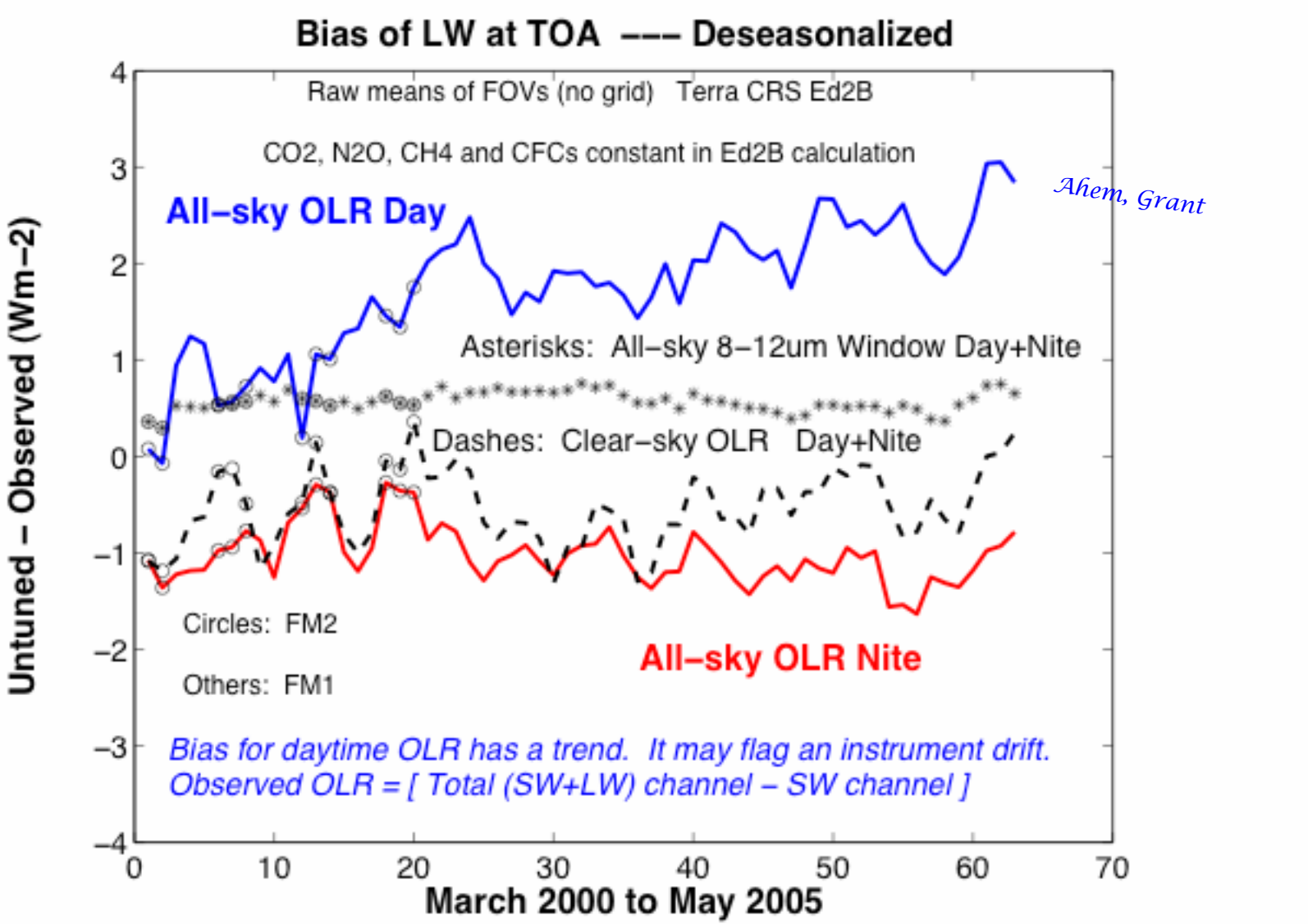


Observations by SURFRAD



Rutan poster shows comparable melt signal for NH latitude belts with snow cover. The signal is much weaker in SH.

Changes in global bias for computed OLR during day and nite



Ahem, Grant

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NASA Langley CERES ARM Validation Experiment CAVE

Home | Surface Observations | CERES CRS Data | CERES ES8 Data | Atmospheric Profiles | Useful Links

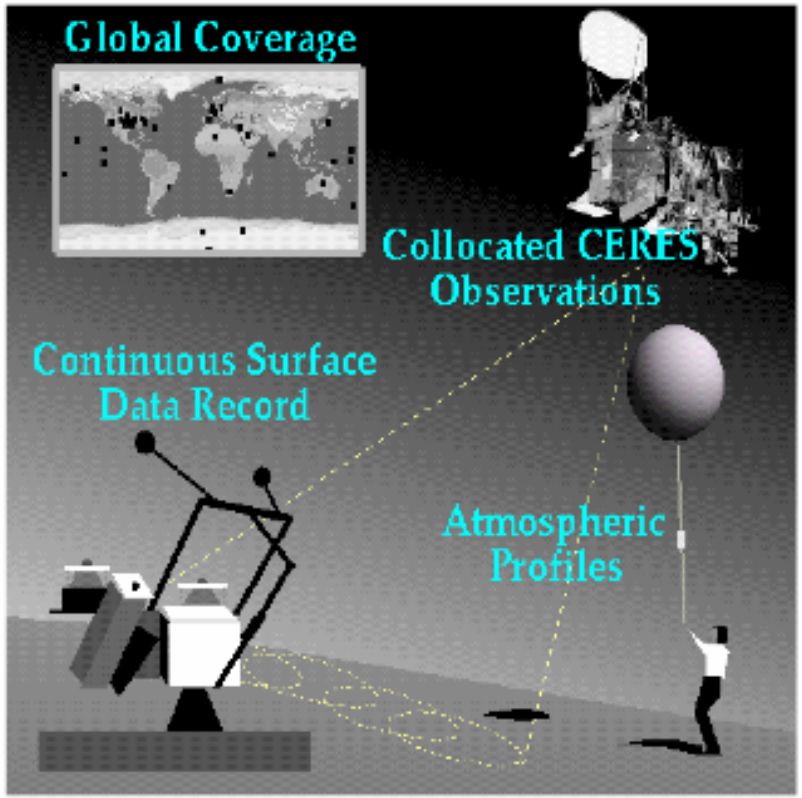
Welcome to the CAVE web site. Data collected in this effort are meant for use in validation studies of Clouds & The Earths Radiant Energy System (CERES) instruments operating on the Tropical Rainfall Measurement Mission (TRMM) and Earth Observing Systems(EOS) Terra (soon Aqua) satellites.

Important Change to CAVE Surface flux, Aerosol, Meteorology (SAM) Files

Please Read for Details

CAVE Data Info & Validation Results

- Overview and Site Map
- Plot CAVE Data On Line
- Validation Plots & Statistics
- Publications
- Cloud Fraction In CAVE
- Aerosols In CAVE
- Updates Mar 23, 2005
- The Group



Referencing CAVE data

Radiation Transfer & Related Links

- COART Coupled Ocean-Atmos RT Model
- Ocean Albedo Look-up Table
- Point & Click Fu & Liou
- CRS Advice
- CLAMS
- ULDB Balloon Observations
- Site Map

www-cave.larc.nasa.gov/cave/ or goggle "CERES CAVE"

TOA Flux Validation

Instantaneous Footprint Results

Terra, 64 Months of CRS Ed2B, "clear" - imager

Upward Untuned TOA Flux Biases (Model-Obs)(W/m2)					TOA Aerosol Forcing		
	All Sky		Clear Sky		Clear-Pristine		SW
	LW	SW	LW	SW	LW	SW	CNA*
ARM/SGP	+2	+2	+0	-1	-0	+5	+5
Island Sites	-2	+17	-4	+7	-1	+10	+4
Polar Sites	+3	+16	-2	+6	-0	+1	+1
SURFRAD	-1	-1	-1	+0	-0	+6	+5
European	+2	+8	-0	-2	-0	+9	+4
Validation Sites	+1(8)	+11 (27)	-1(5)	-0(6)	-1	+6	+4

*Difference model run with clouds and aerosols and model run with clouds, no aerosols. (SW is daytime only, LW is day and night.)

"+11 (27)" denotes bias of 11 Wm^{-2} and RMS of 27 Wm^{-2}

Changes in GLOBAL mean SW for calculations vs. observations
Dashed lines show Terra CRS Editon 2B official results