CERES CRS Edition 2B and FSW Edition 2C Surface and Atmosphere Radiation Budget (SARB)

Clouds and the Earth's Radiant Energy System (CERES)
Science Team Meeting at Hampton, Virginia (1-3 November 2005)

T. P. Charlock (NASA LaRC)
Fred G. Rose (AS&M) algorithm development
David A. Rutan (AS&M) CAVE validation
Zhonghai Jin (AS&M) coupled ocean atmosphere radiative transfer
.

Lisa H. Coleman, Thomas E. Caldwell, Scott Zentz (SAIC) - Data Management
Seiji Kato (H.U.) - modification of LaRC Fu-Liou code
David Fillmore and Bill Collins (NCAR) - MATCH morphing to CAM3.0(?)
Wenying Su (H.U.) - surface UV and PAR algorithms

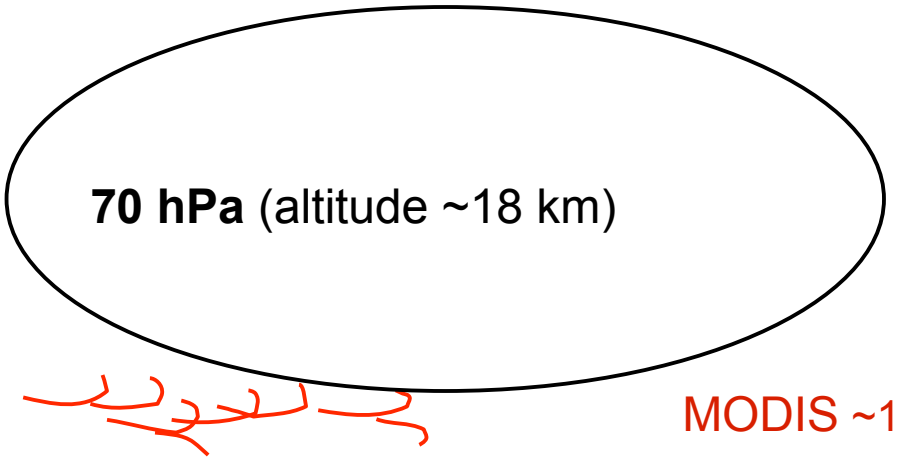
SARB/SOFA Working Group tomorrow: Zhonghai Jin, Ells Dutton, Wenying Su

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

Input data for computing SARB vertical profile at ~2,000,000 footprints/day

Absolutely no ground-based radiometric data are used for input

NCEP O3(z)
Mostly from SBUV/2



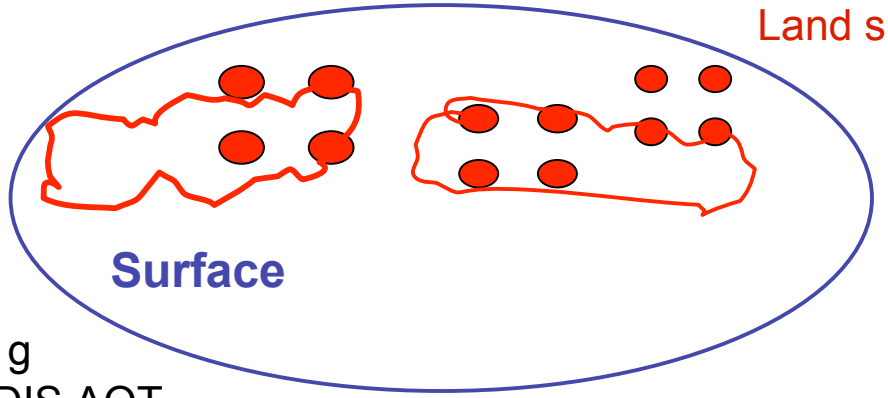
MODIS ~1km pixels provide

Cloud properties (almost always)

Aerosol AOT (sometimes)

Land skin temperature (if clear)

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



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

~20-50 km

Large CERES footprint for TOA flux

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

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

NASA Langley CERES ARM Validation Experiment CAVE

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

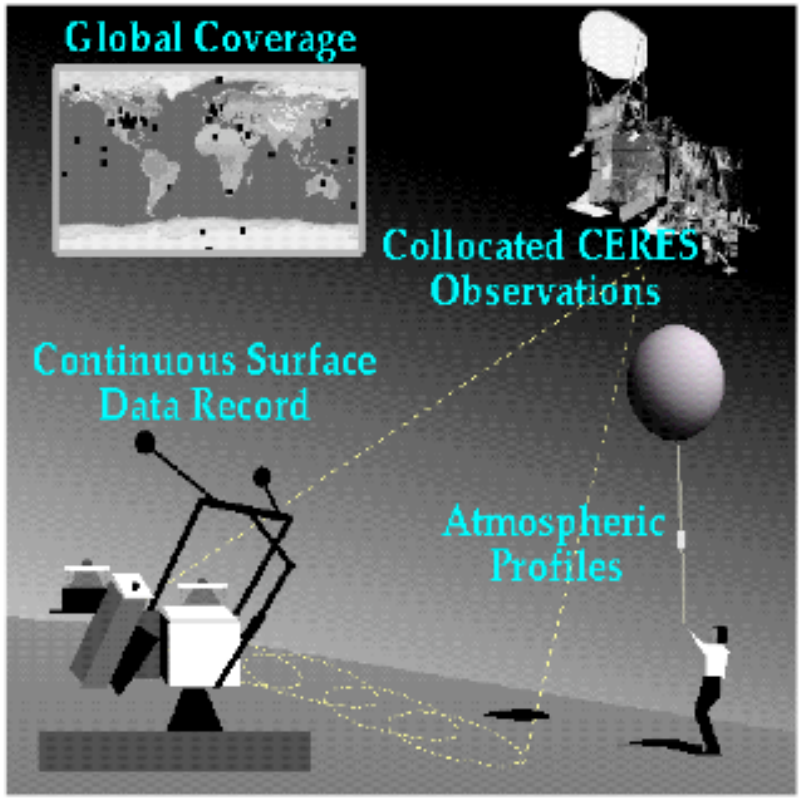
Publications

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

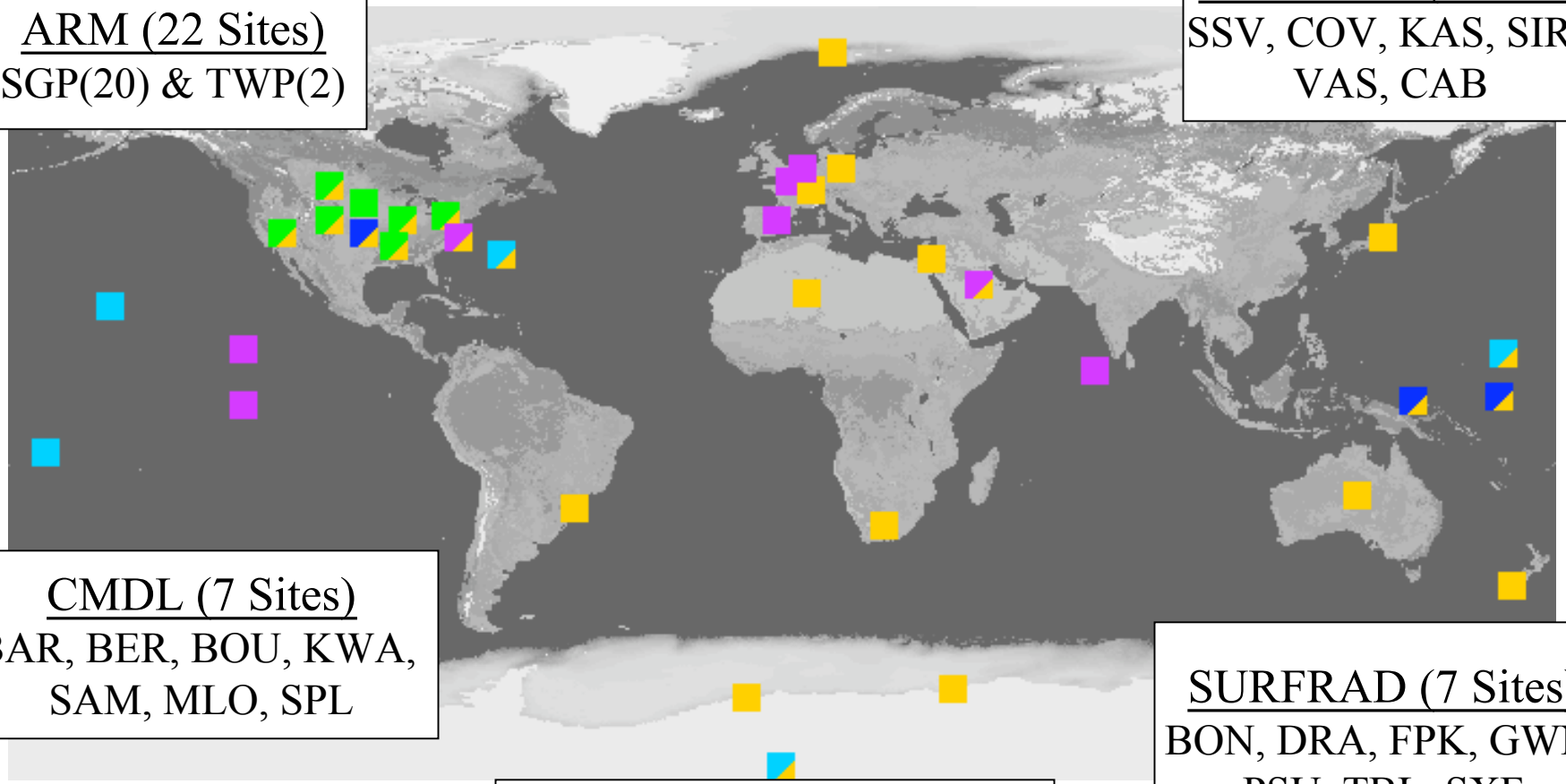
CRS Advice

CLAMS

ULDB Balloon Observations

Site Map

Surface sites in CAVE validation program



ARM (22 Sites)
SGP(20) & TWP(2)

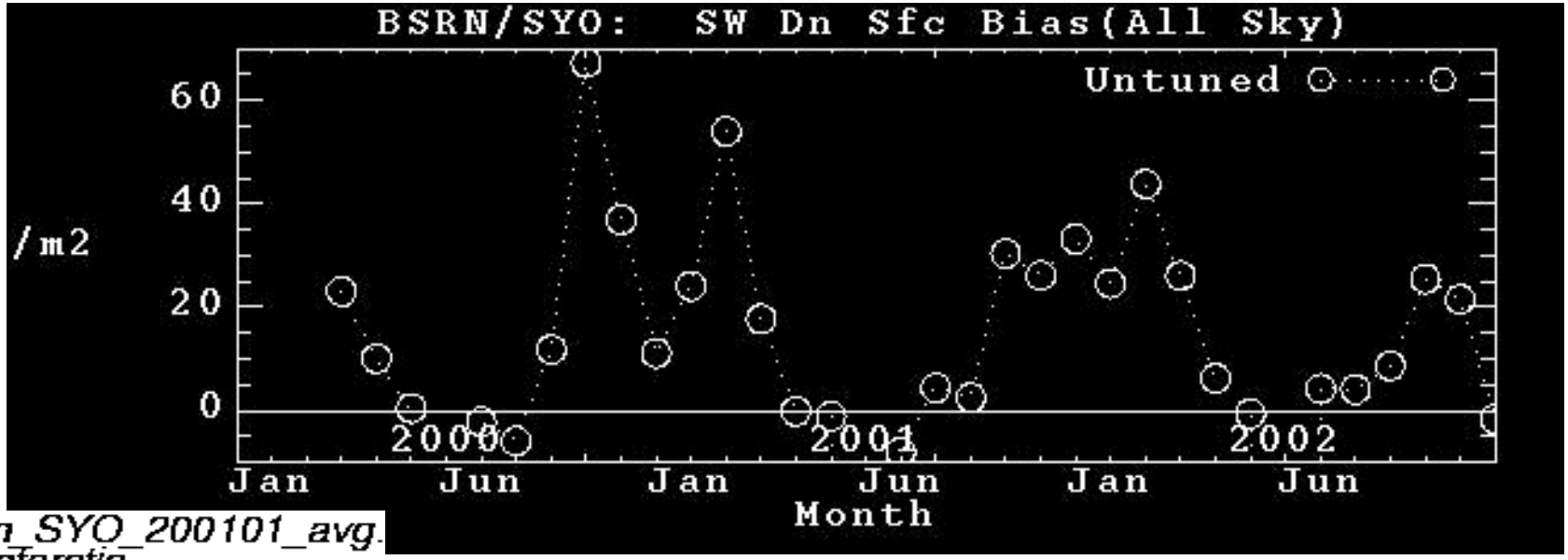
Other Sites (6 Sites)
SSV, COV, KAS, SIR, VAS, CAB

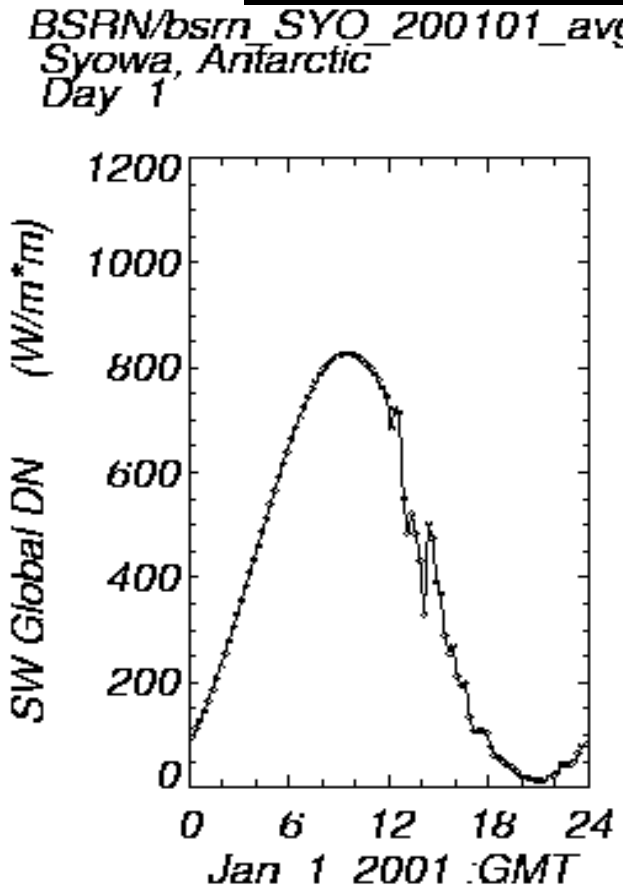
CMDL (7 Sites)
BAR, BER, BOU, KWA, SAM, MLO, SPL

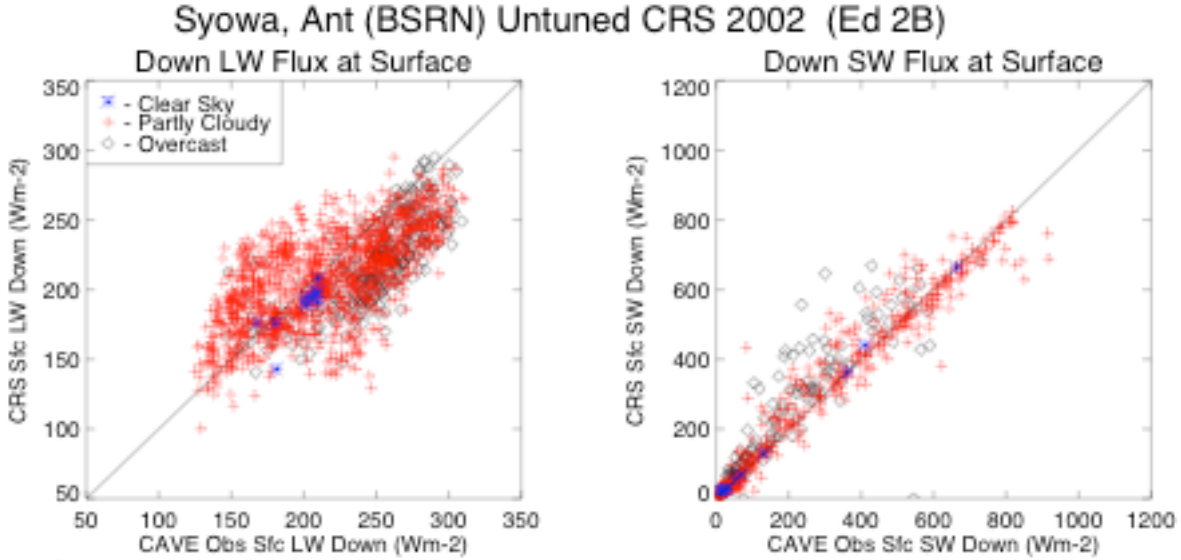
SURFRAD (7 Sites)
BON, DRA, FPK, GWN, PSU, TBL, SXF

BSRN (12 Sites)
ASP, DAA, FLO, GVN, LAU, LIN, NYA, PAY, SBO, SYO, TAM, TAT

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







All Sky

	Obs Mean	N	Bias CRS-Obs	Std Dev	RMS	Mod Frc All-Clr	Forcing All-CNA
LW Dn Sfc	219.3	1437	-10.4	33.2	34.8	38.6	0.1
LW Up Sfc	--------	--------	--------	--------	--------	--------	--------
SW Dn Sfc	263.0	612	16.3	66.0	67.9	-41.6	-1.2
SW Up Sfc	--------	--------	--------	--------	--------	--------	--------
LW Up TOA	183.5	1535	0.7	7.8	7.9	-17.6	-0.0
SW Up TOA	311.7	508	12.0	15.2	19.4	14.3	0.3

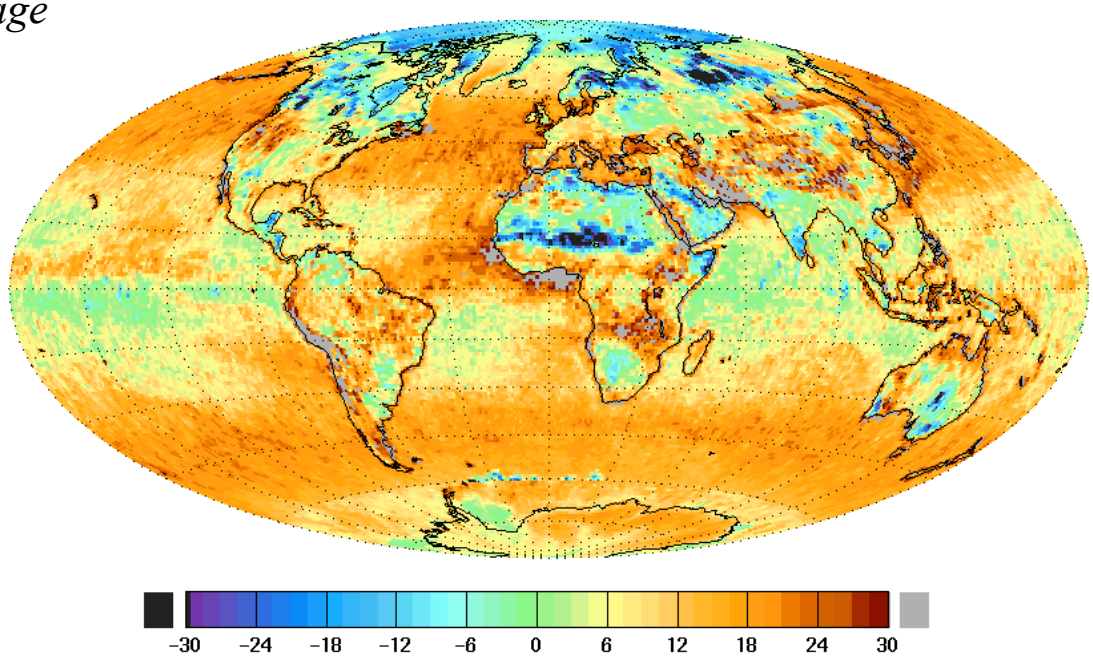
Gridded monthly maps from CAVE home page

Reflected SW at TOA

Observed = 241.5 Wm-2

Bias = 11.0 Wm-2

day overpass



Bias = Untuned - Observed

CERES Terra FM1 FSW Ed2C

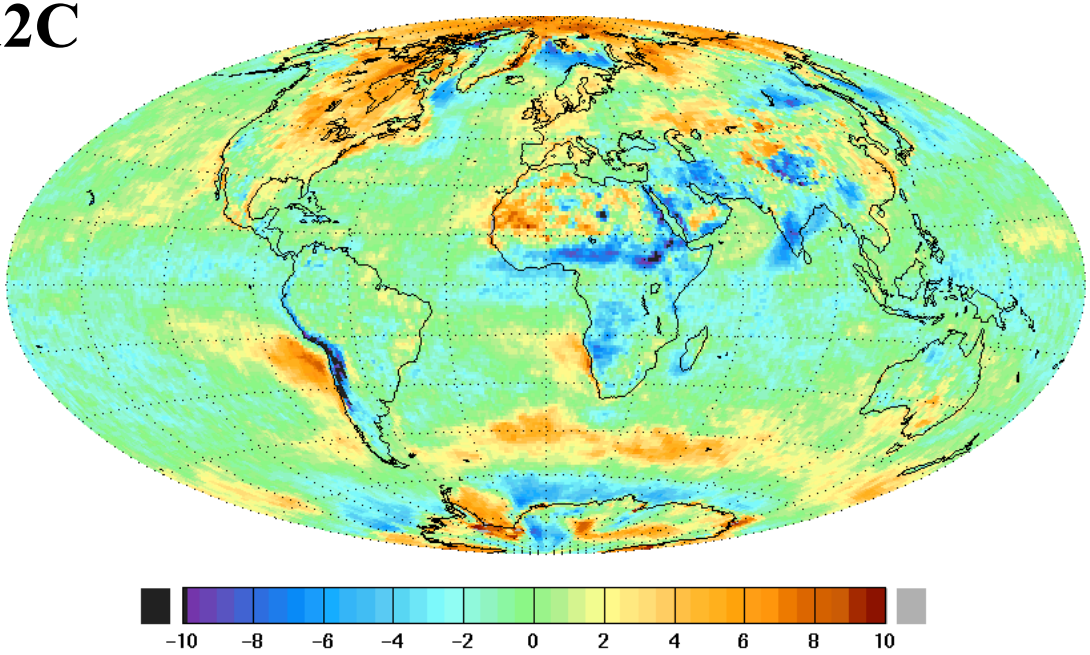
March 2003

OLR

Observed = 237.2 Wm-2

Bias = 0.0 Wm-2

day + nite



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

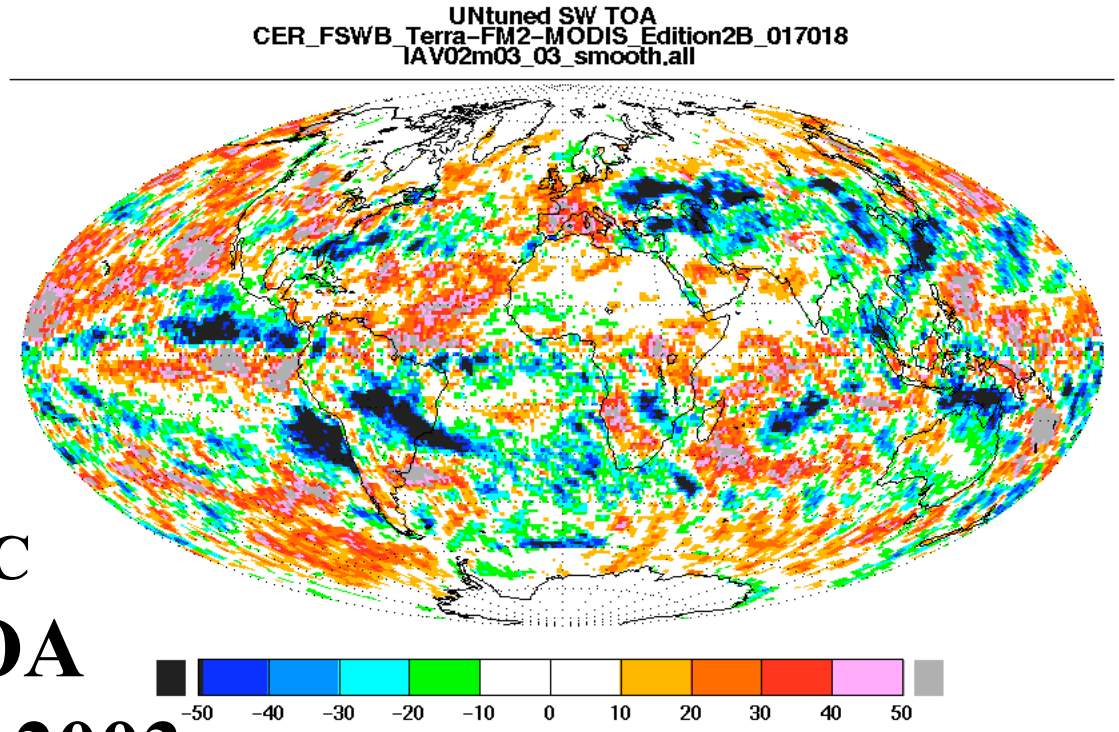
Both months normalized to have same sampled TOA insolation in each gridbox

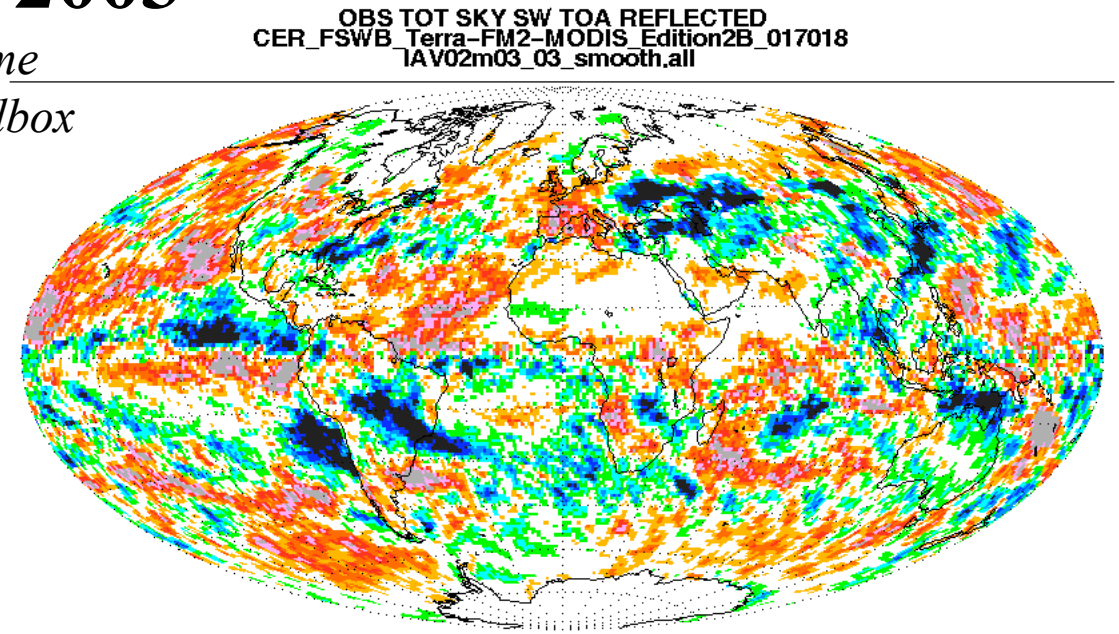
OBSERVED

mean=0.8 stddev=23.5 Wm-2

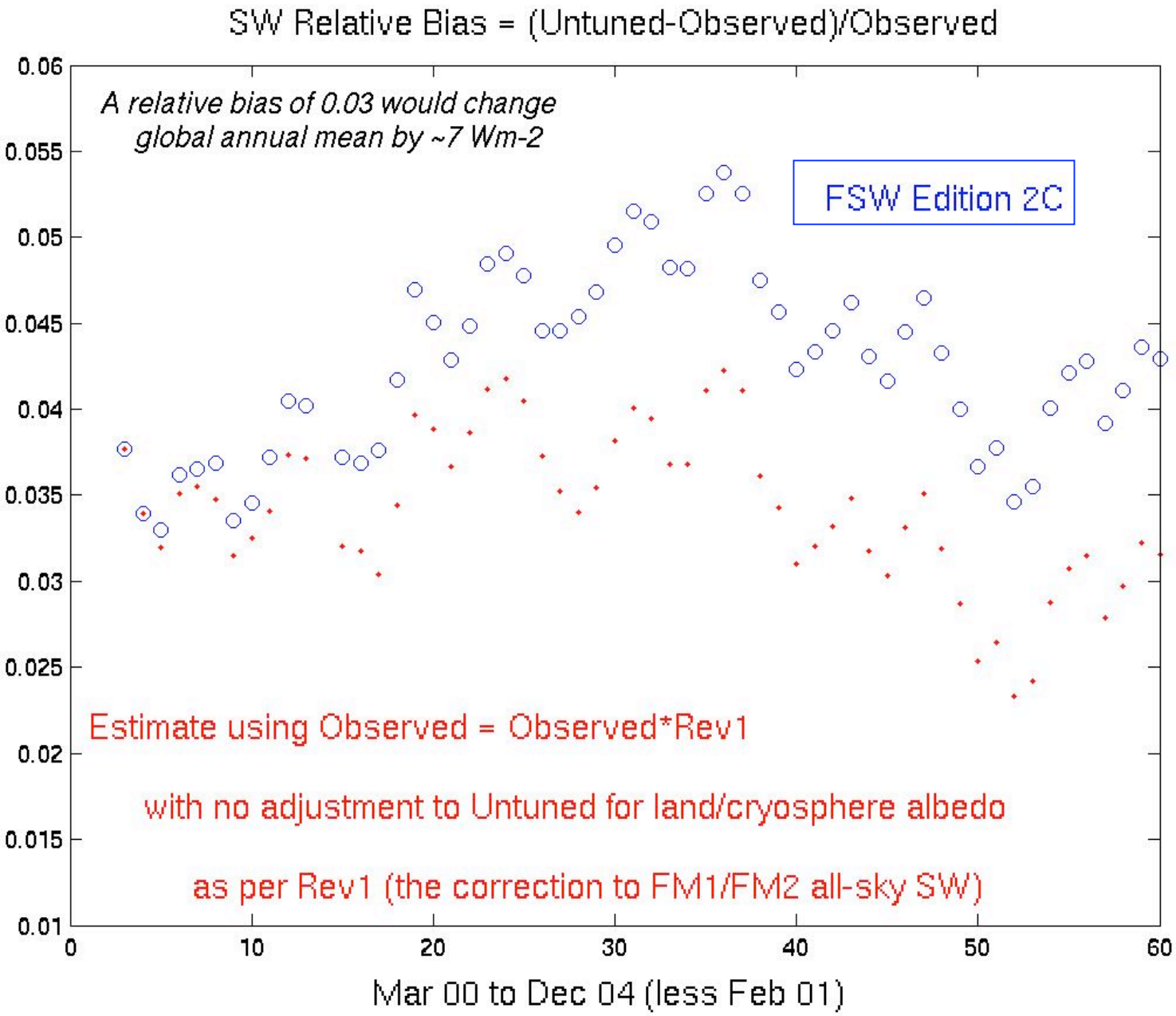
CERES instrument

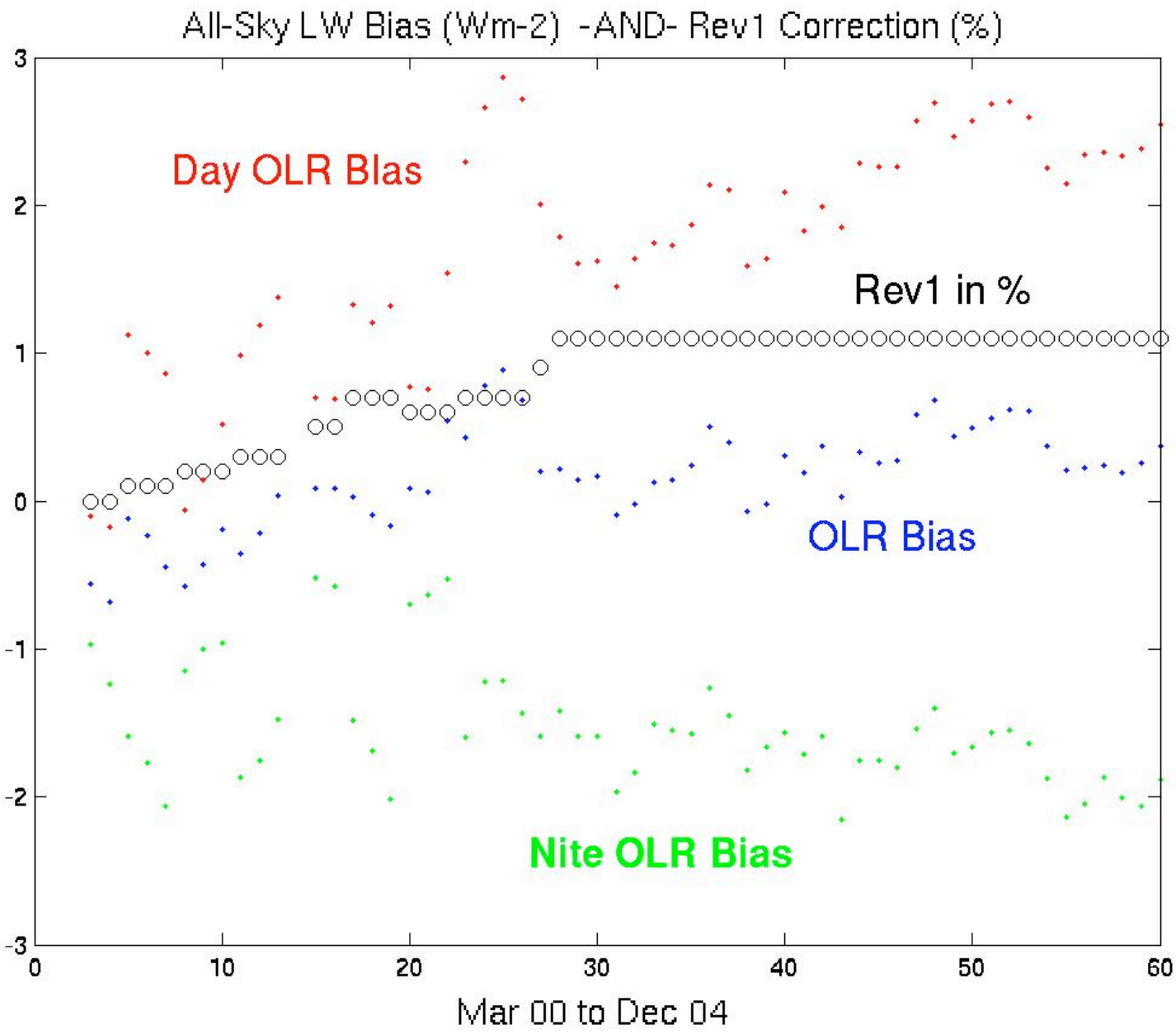
inverted to flux



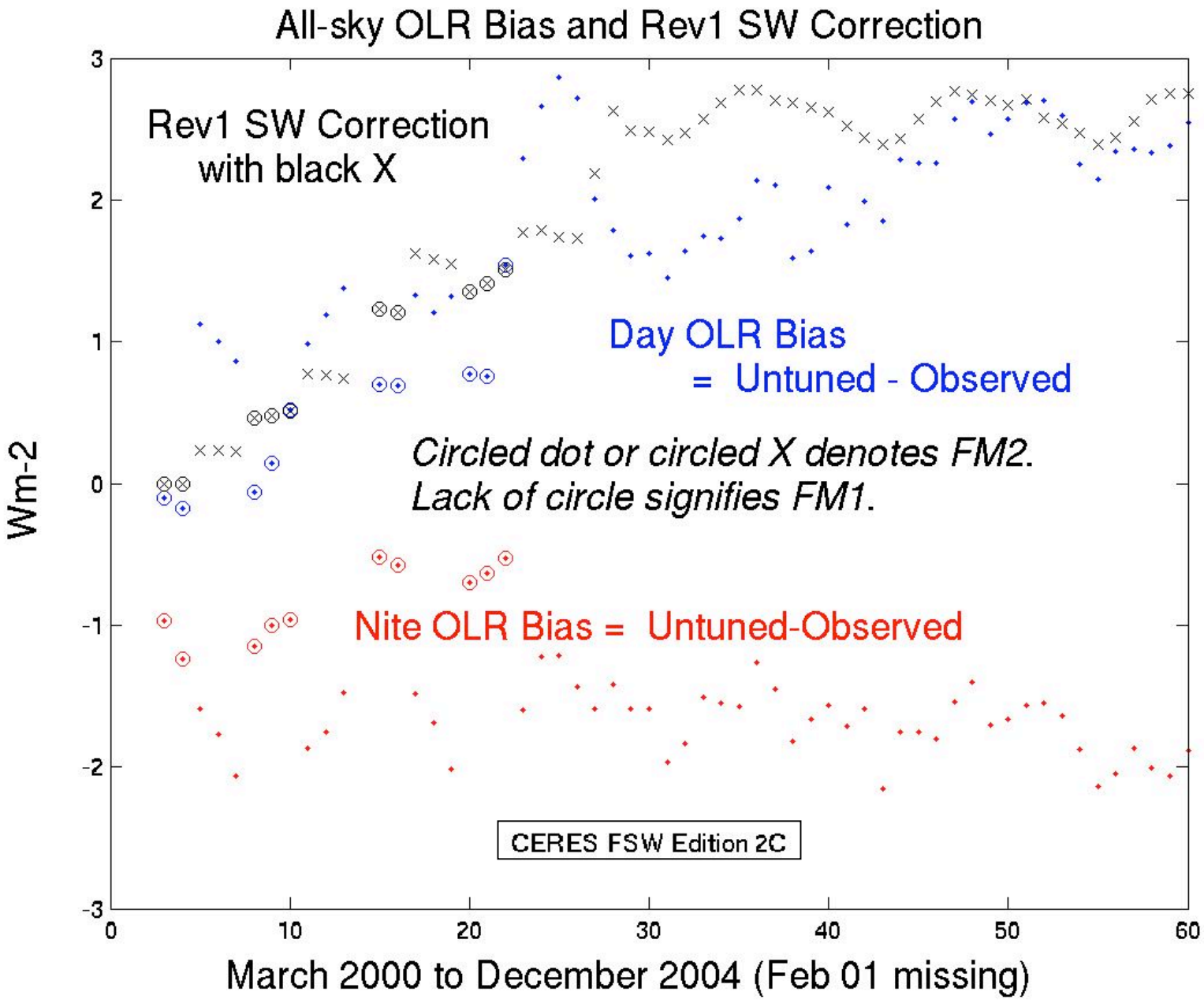


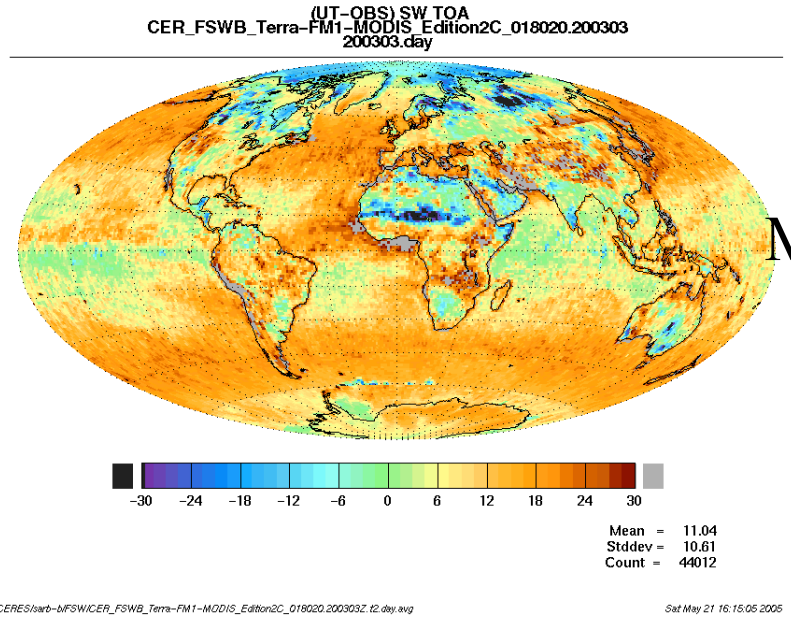
ASCII global mean time series from CAVE web page



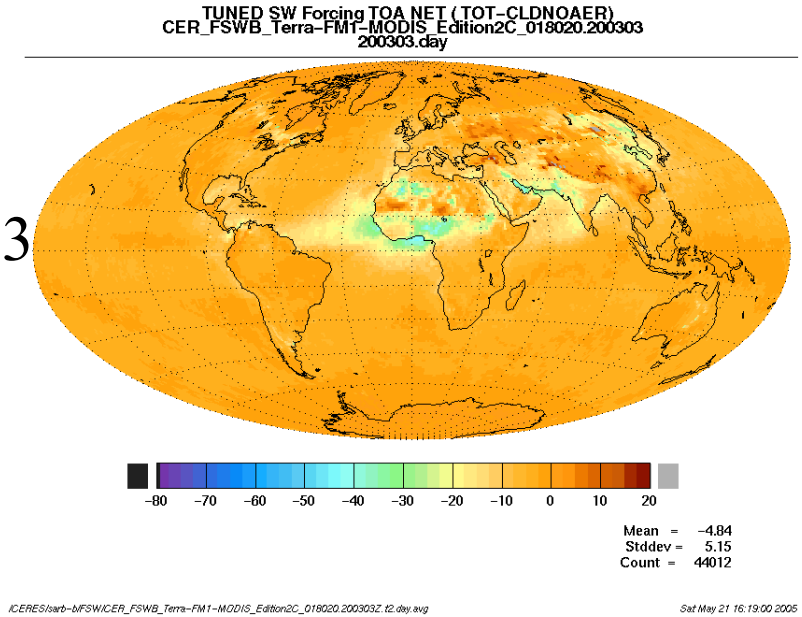

All-Sky LW Bias (Wm-2) -AND- Rev1 Correction (%)
Day OLR Bias
Rev1 in %
OLR Bias
Nite OLR Bias
3
2
1
0
-1
-2
-3
0
10
20
30
40
50
60
Mar 00 to Dec 04

The OLR observation is made by subtraction: OLR = (SW+LW) - (SW)

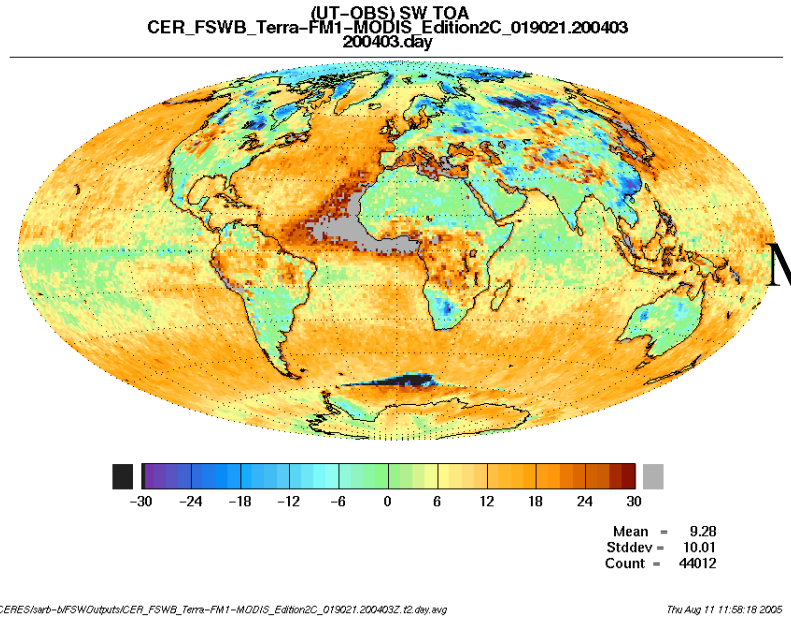




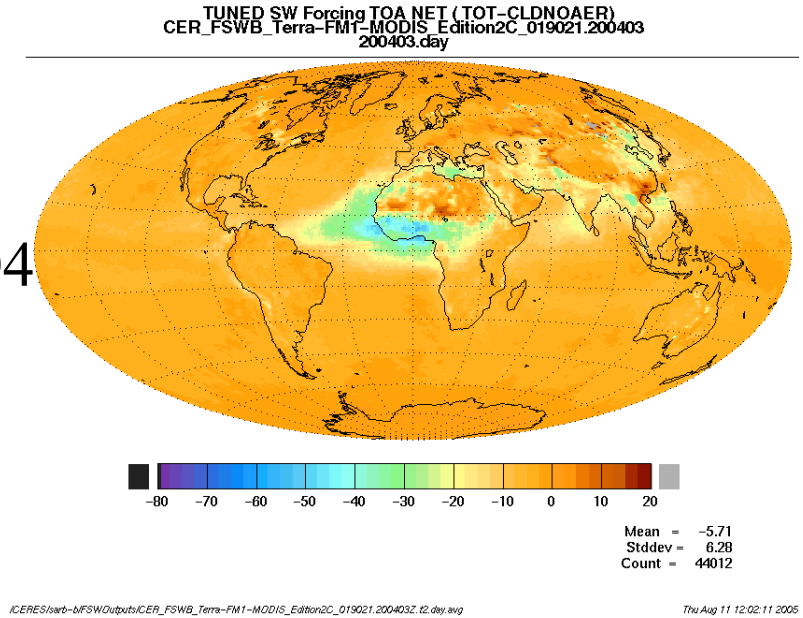
March 2003



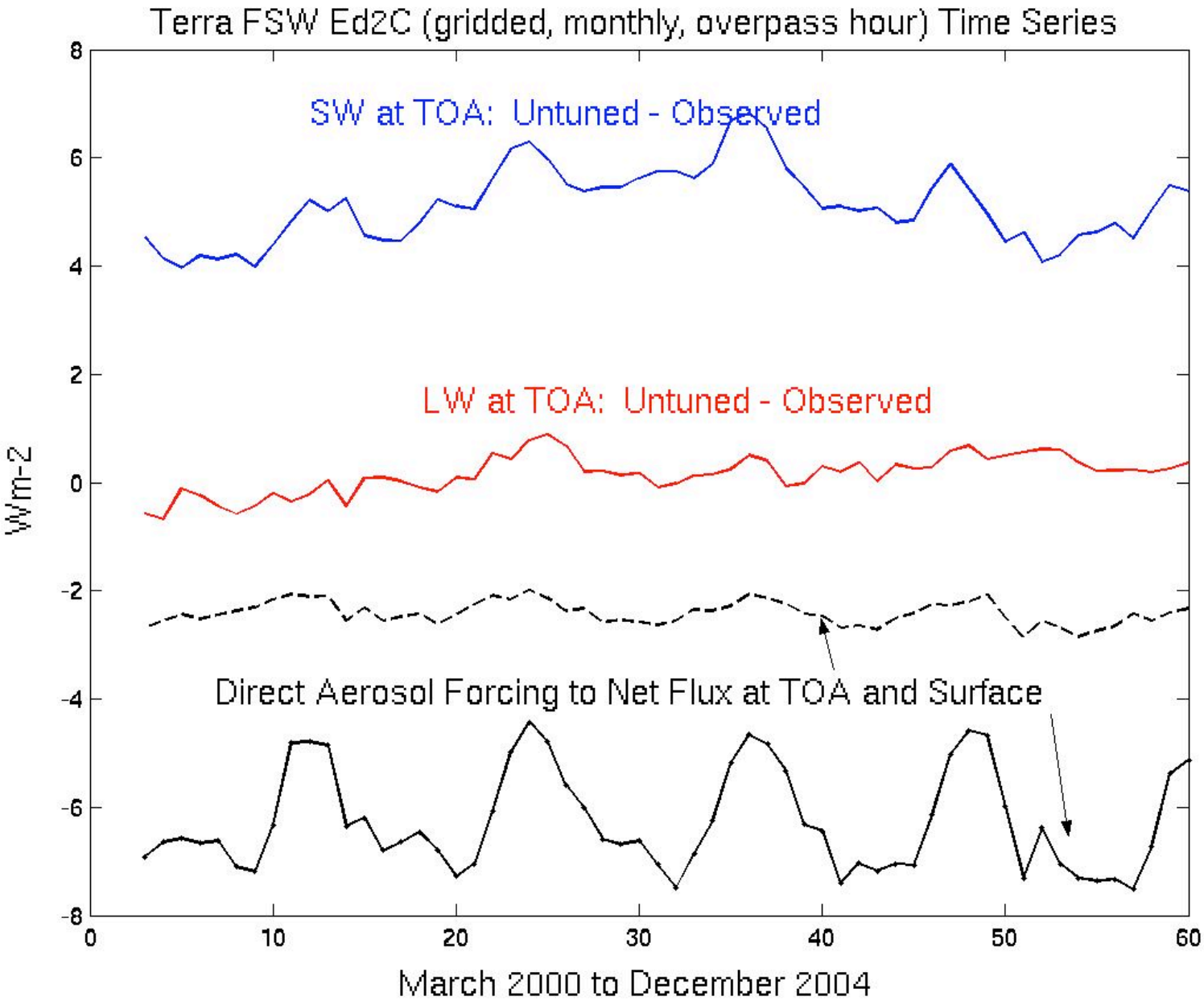
SW TOA: Untuned-Observed **DAY ONLY** Aerosol Forcing to SW Net



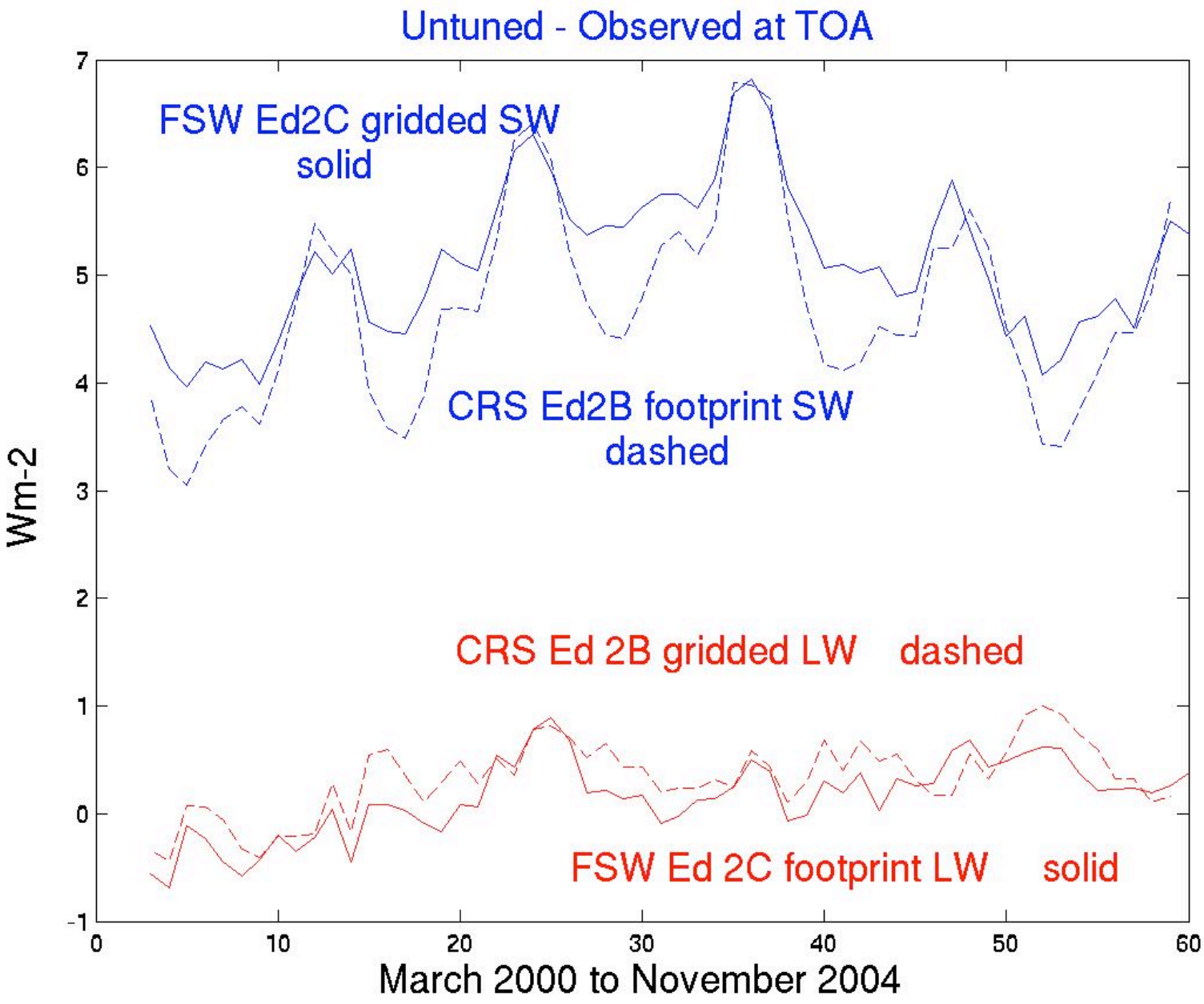
March 2004



ASCII global mean time series from CAVE web page



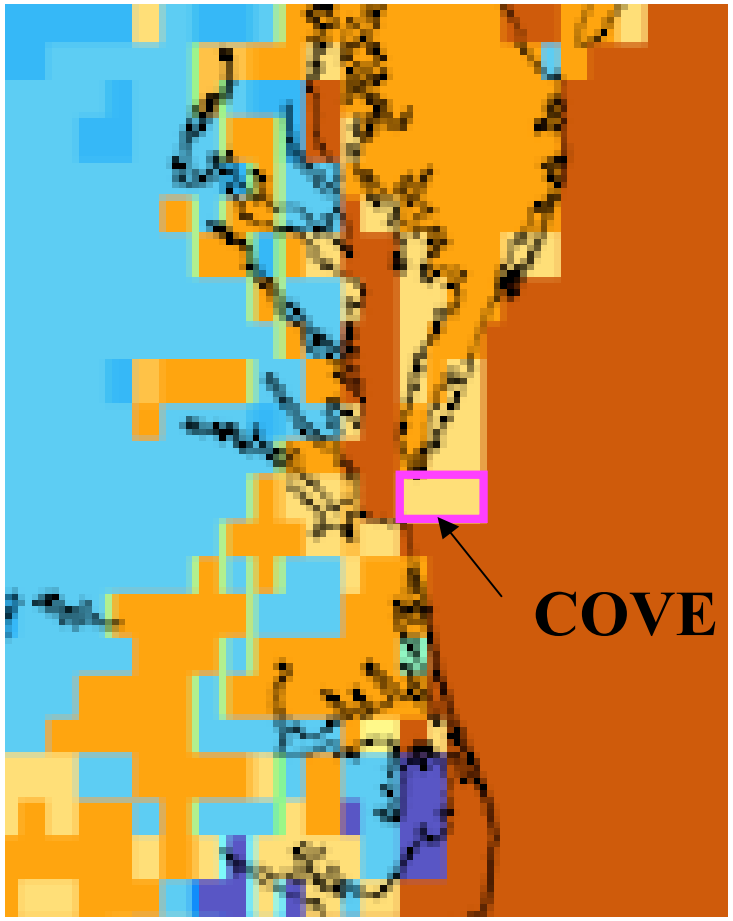
Rev1 is not used here


Untuned - Observed at TOA
FSW Ed2C gridded SW
solid
CRS Ed2B footprint SW
dashed
CRS Ed 2B gridded LW dashed
FSW Ed 2C footprint LW solid
Wm-2
March 2000 to November 2004
7
6
5
4
3
2
1
0
-1
0
10
20
30
40
50
60

Misplaced IGBP map vexes validation at COVE CRS Ed2B in 2002

Observed TOA SW = 222.6 Wm-2 Bias = 51.5 Wm-2

Observed Insolation = 552.7 Wm-2 Bias = 3.1 Wm-2



This is a CERES map of IGBP types near Tidewater, Virginia. A map with the degree scale is on the next page. The area within the magenta rectangle appears to contain 3 tiles (with each tile 10 minutes by 10 minute) of IGBP type 12 (cropland). **This wrecks CERES validation at COVE, which is the sole site with surface radiometers deployed over water.**

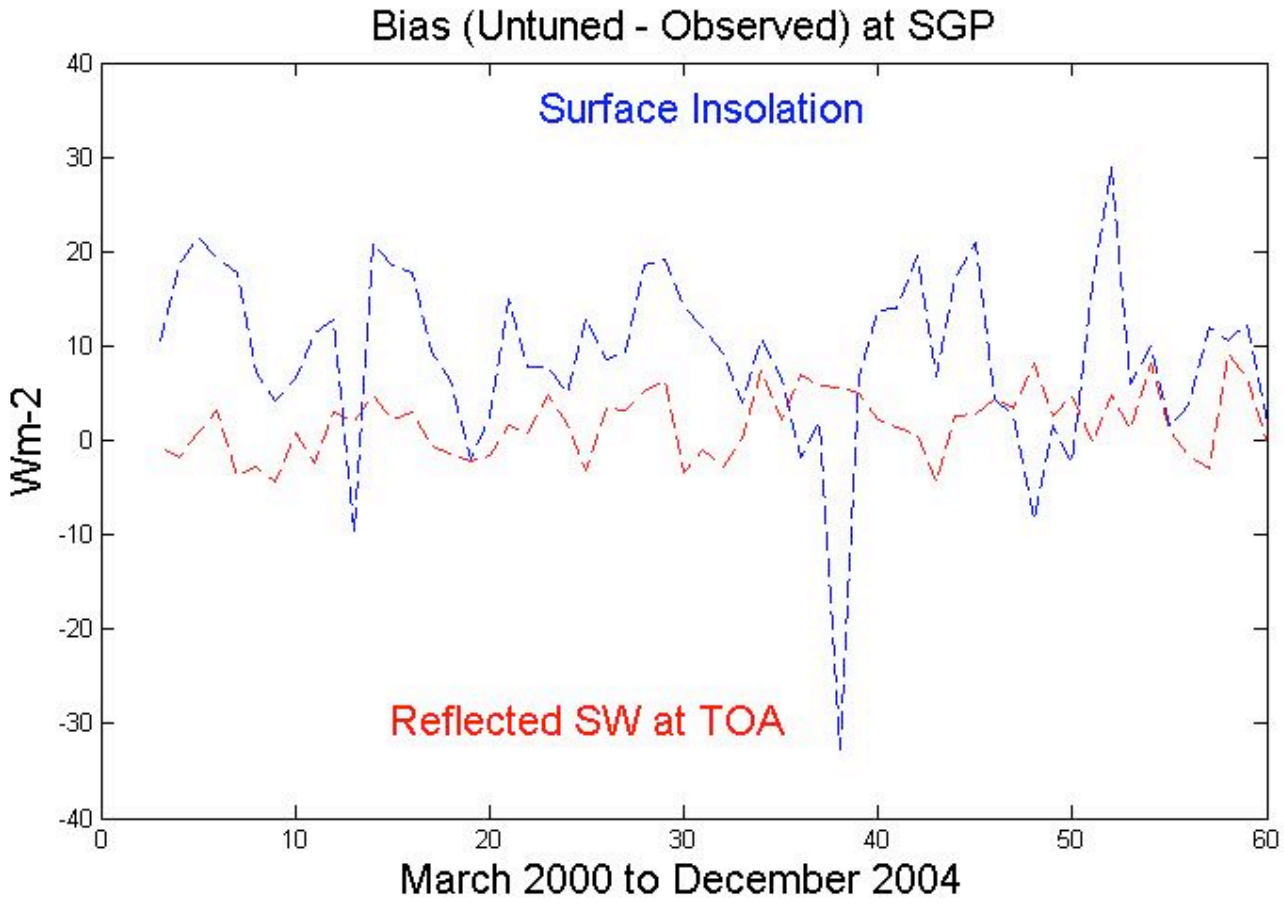
The magenta rectangle causes SARB to assign the wrong surface albedo for about half of the FOVs over COVE, making a mess of Terra CRS Edition 2B at the site. SARB has a surface albedo fix for a "validation subset re-run code", but this does not help the Terra CRS Edition 2B archive. The Cloud WG has confirmed that the same rectangle botches their retrievals (the SARB subset re-run does NOT fix this). It's possible that the magenta rectangle adversely affects the Inversion for TOA fluxes, too.

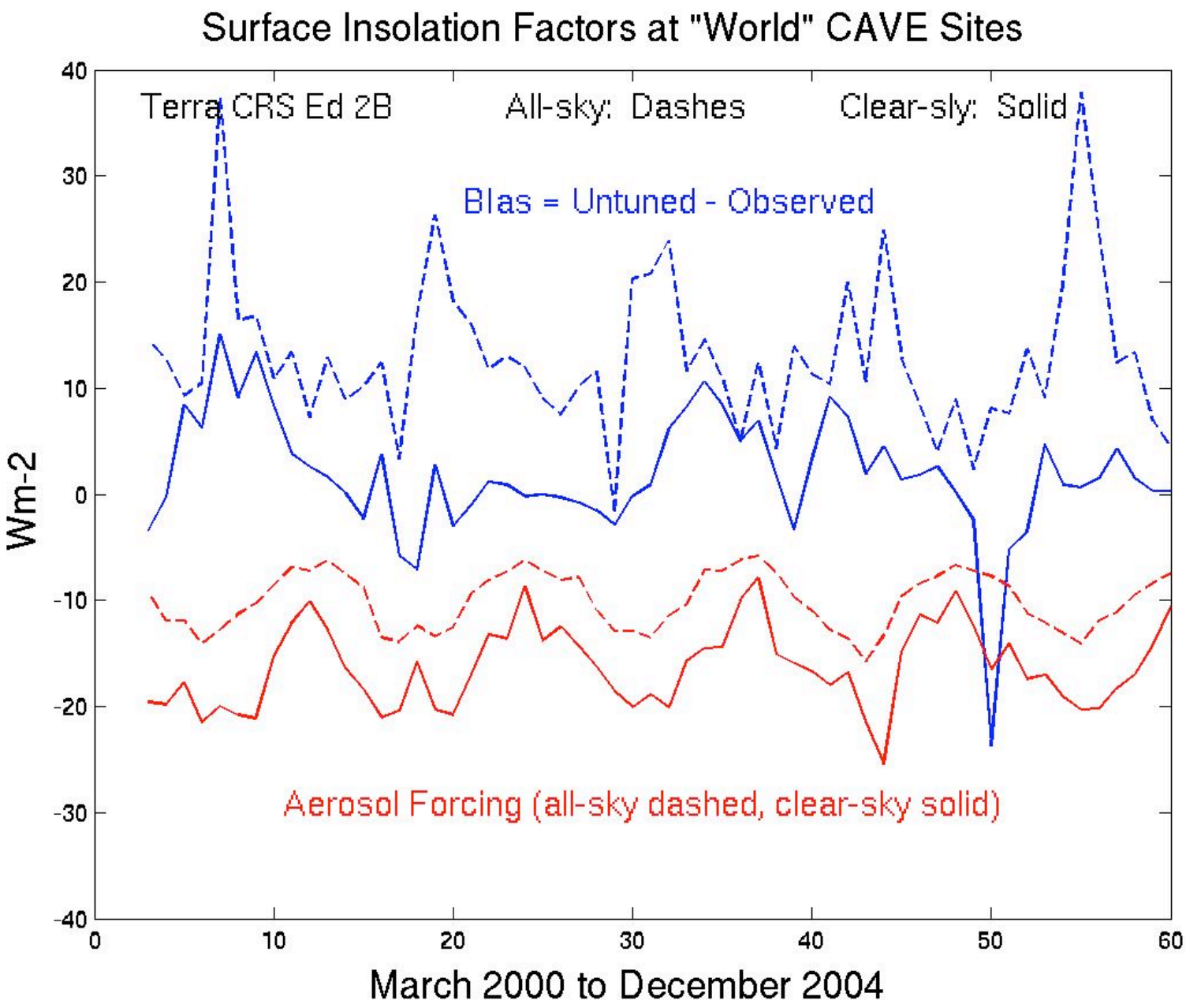
CERES TOA to Surface Closure at 20 ARM SGP Sites

SW snapshots ~1030 LST (LW ~1030 & 2230 LST).
CERES Terra CRS Edition 2B over ARM SGP in 2002.

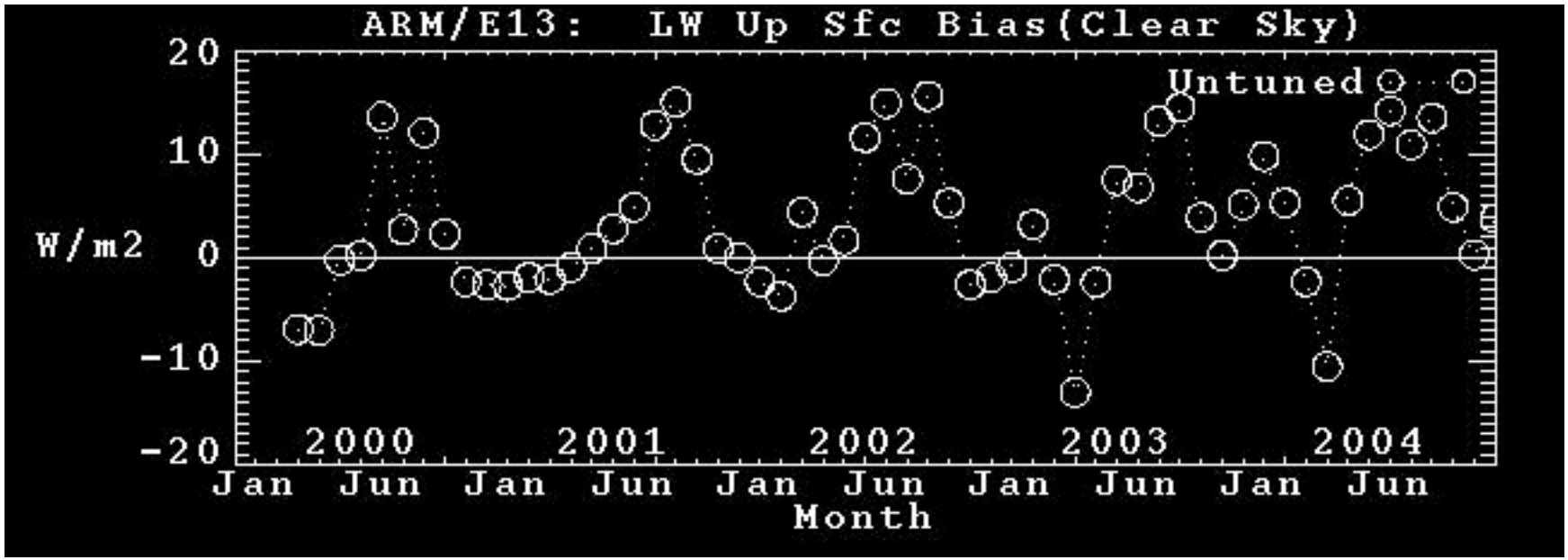
	Observed	#	**Bias** as (Untuned - Observed)	RMS	Aerosol Forcing
	Wm^{-2}	N	Wm^{-2}	Wm^{-2}	Wm^{-2}
All sky					
Surface LW ↓	327.6	8749	-10.4	18.3	0.7
TOA LW ↑	239.2	9449	2.1	7.8	-0.3
Surface SW ↓	583.5	4392	10.3	84.2	-15.9
TOA SW ↑	285.1	4717	2.1	24.4	4.6
Clear sky					
Surface SW ↓	723.1	1329	3.3	18.9	-14.0
TOA SW ↑	169.3	1404	-0.9	2.9	5.0

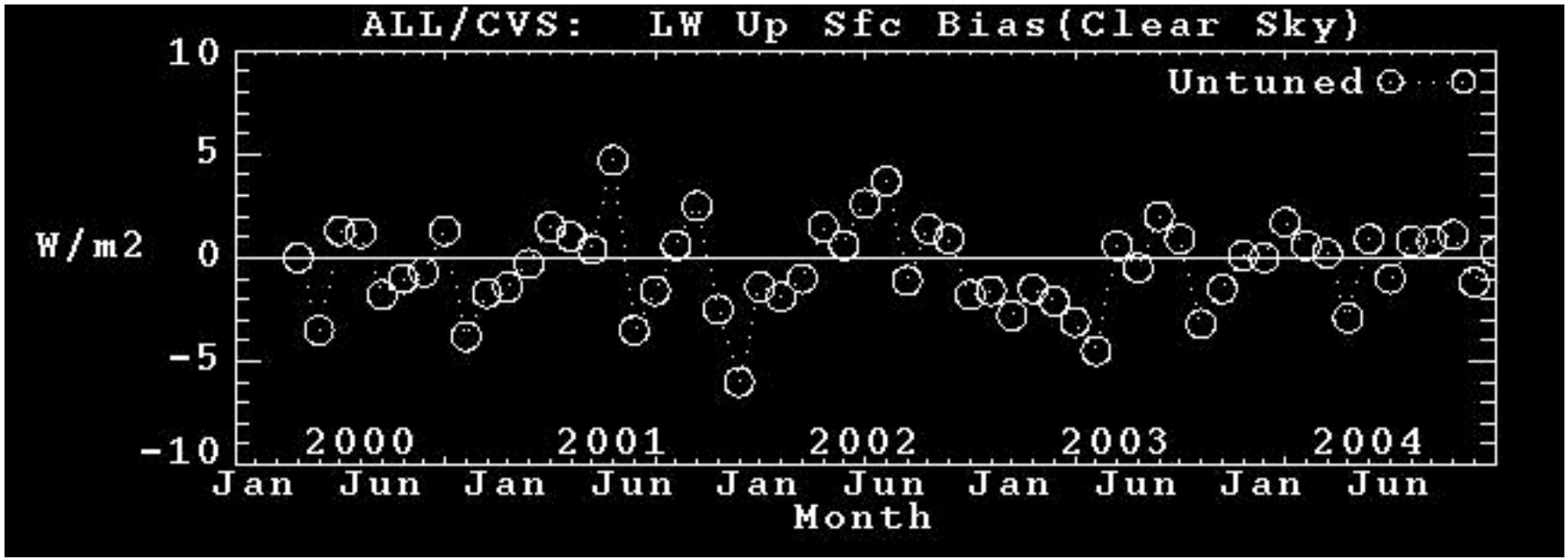
All-sky Bias for Terra CRS Ed2B (footprint scale)

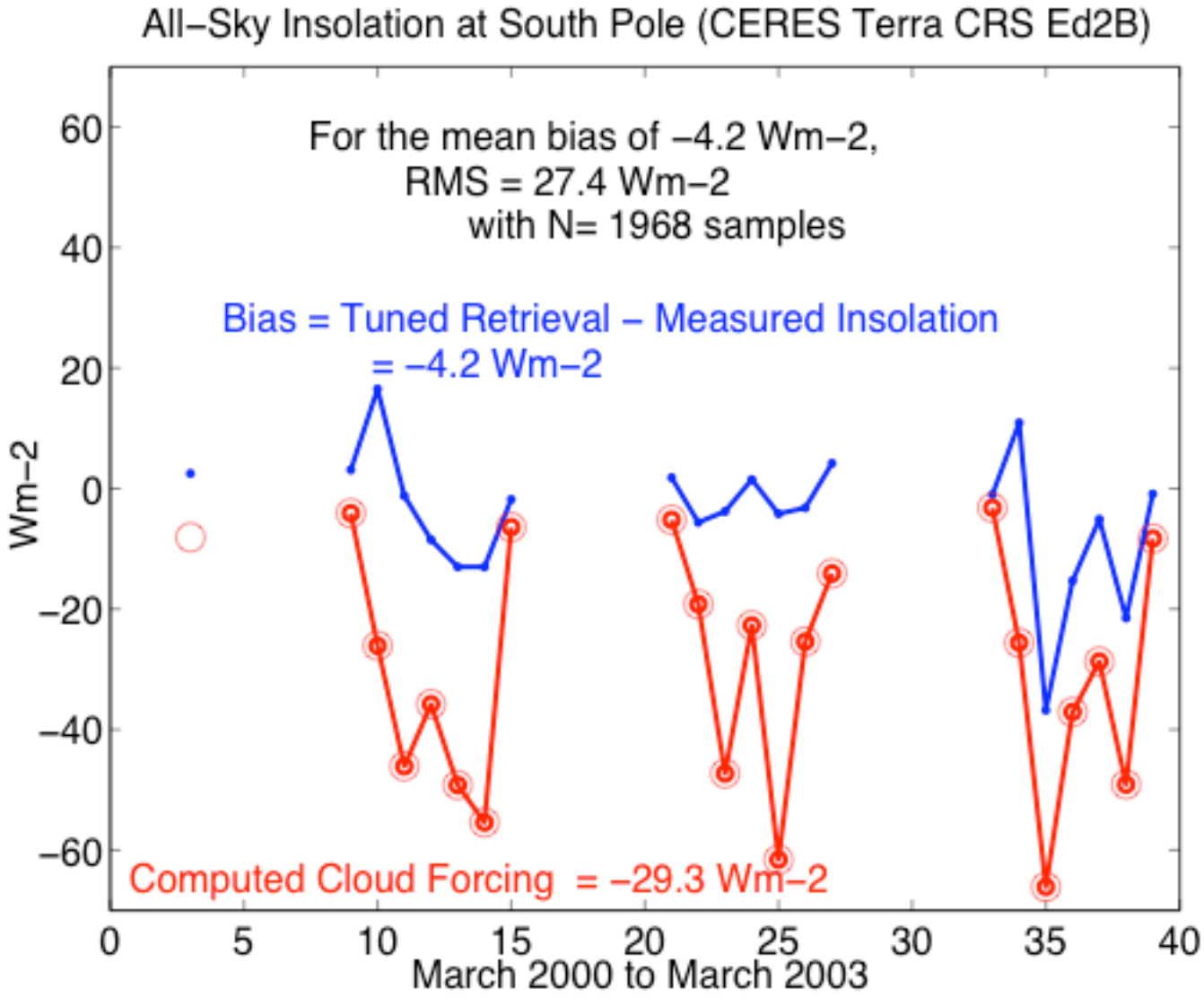



Surface Insolation Factors at "World" CAVE Sites
Terra CRS Ed 2B
All-sky: Dashes
Clear-sly: Solid
Bias = Untuned - Observed
Aerosol Forcing (all-sky dashed, clear-sky solid)
Wm-2
March 2000 to December 2004
40
30
20
10
0
-10
-20
-30
-40
0
10
20
30
40
50
60

Bias for Terra CRS Ed2B shows accurate skin T from SSF

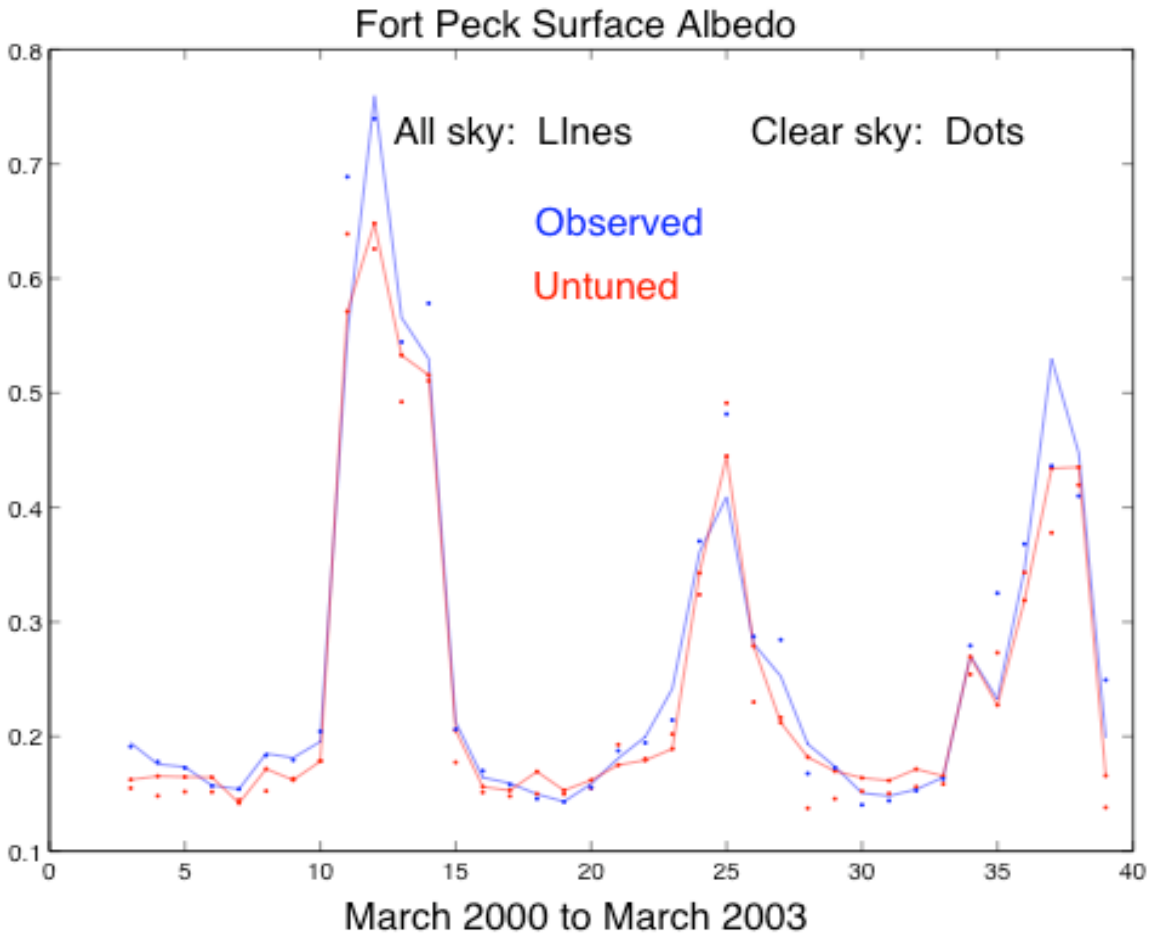





All−Sky Insolation at South Pole (CERES Terra CRS Ed2B)
For the mean bias of −4.2 Wm−2,
RMS = 27.4 Wm−2
with N= 1968 samples
Bias = Tuned Retrieval − Measured Insolation
= −4.2 Wm−2
Computed Cloud Forcing = −29.3 Wm−2
Wm−2
60
40
20
0
−20
−40
−60
0
5
10
15
20
25
30
35
40
March 2000 to March 2003

Comparison of CERES Terra CRS Edition 2B with surface measurements.

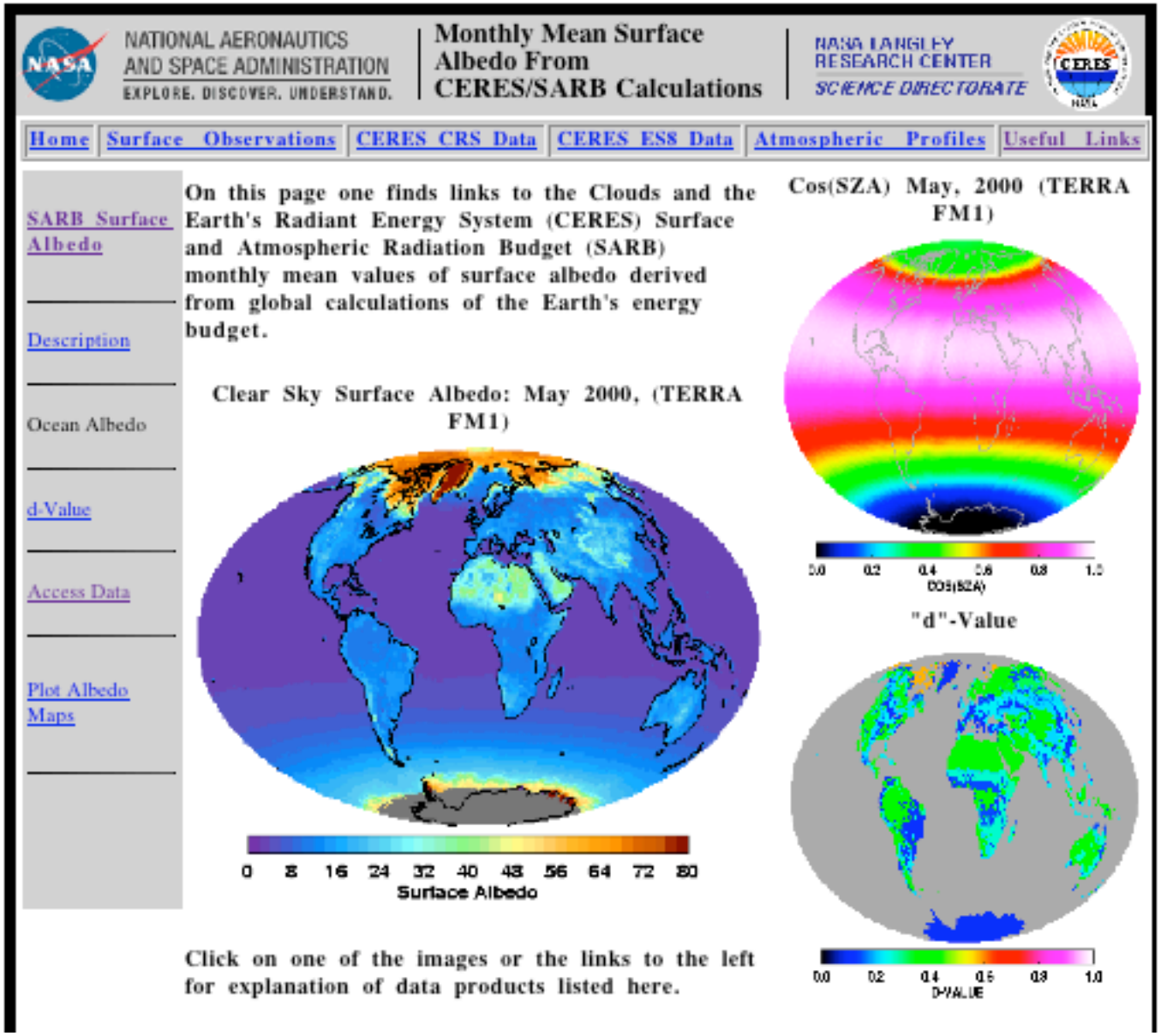
Each data entry represents the mean surface albedo, at the time of Terra overpass, for an entire month. "Observed" data are from a ground-based radiometers. "Untuned" retrievals are from CERES SARB using no ground radiometric data.

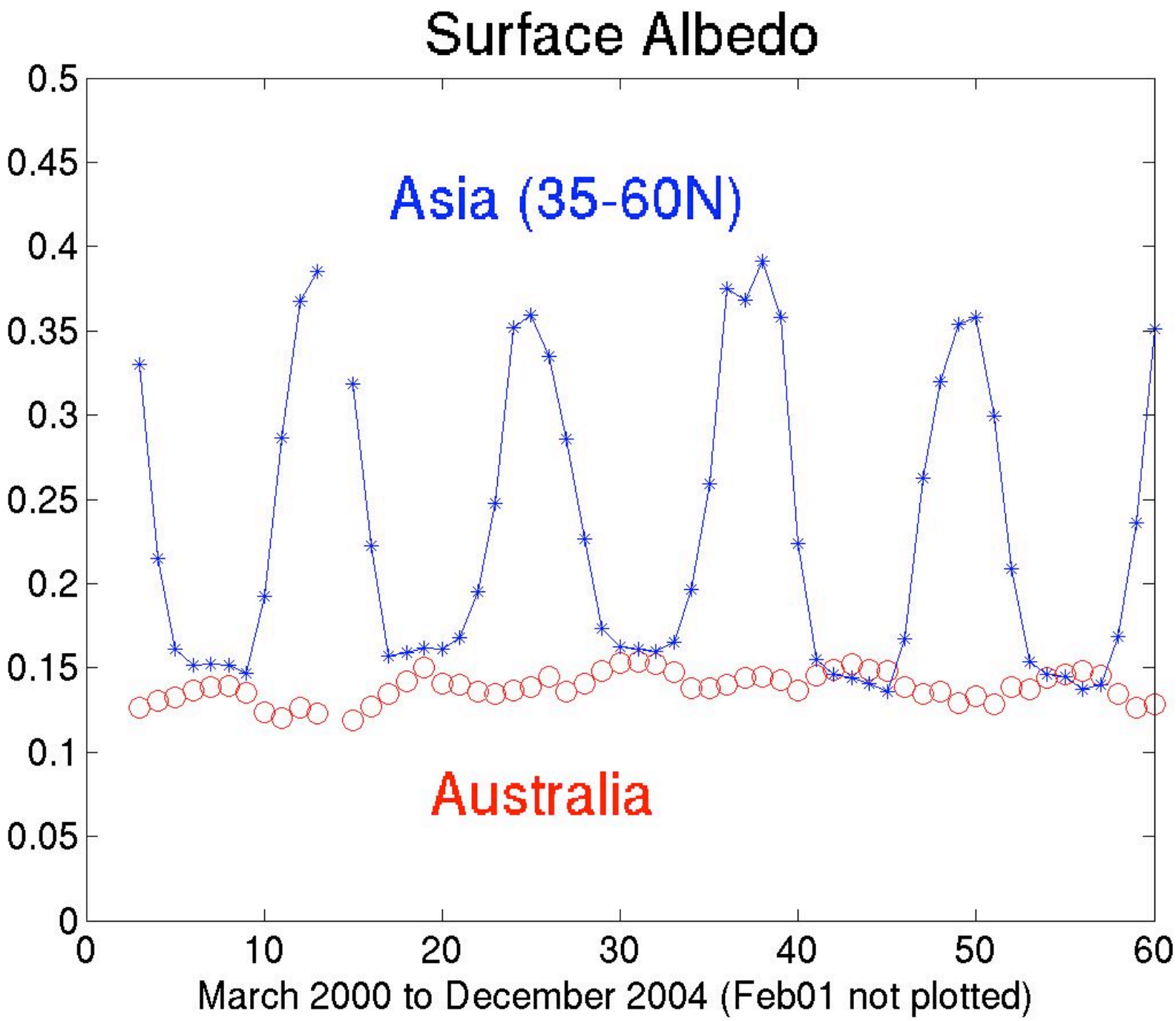


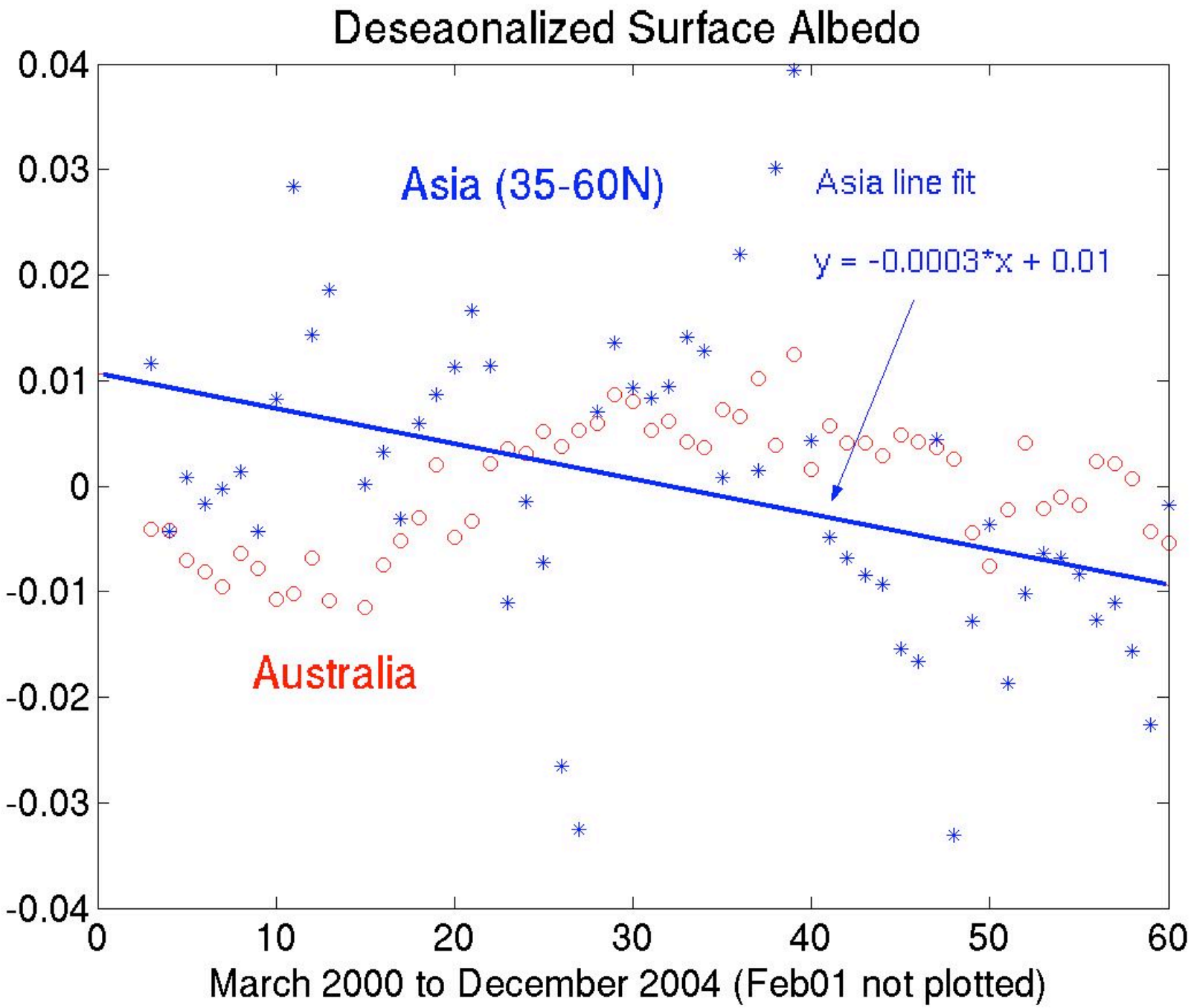
Retrieval captures both annual and interannual variations in surface albedo

Release of Gridded, Monthly Clear-sky Surface Albedo for CAVE google "CERES CAVE" and seek Home page

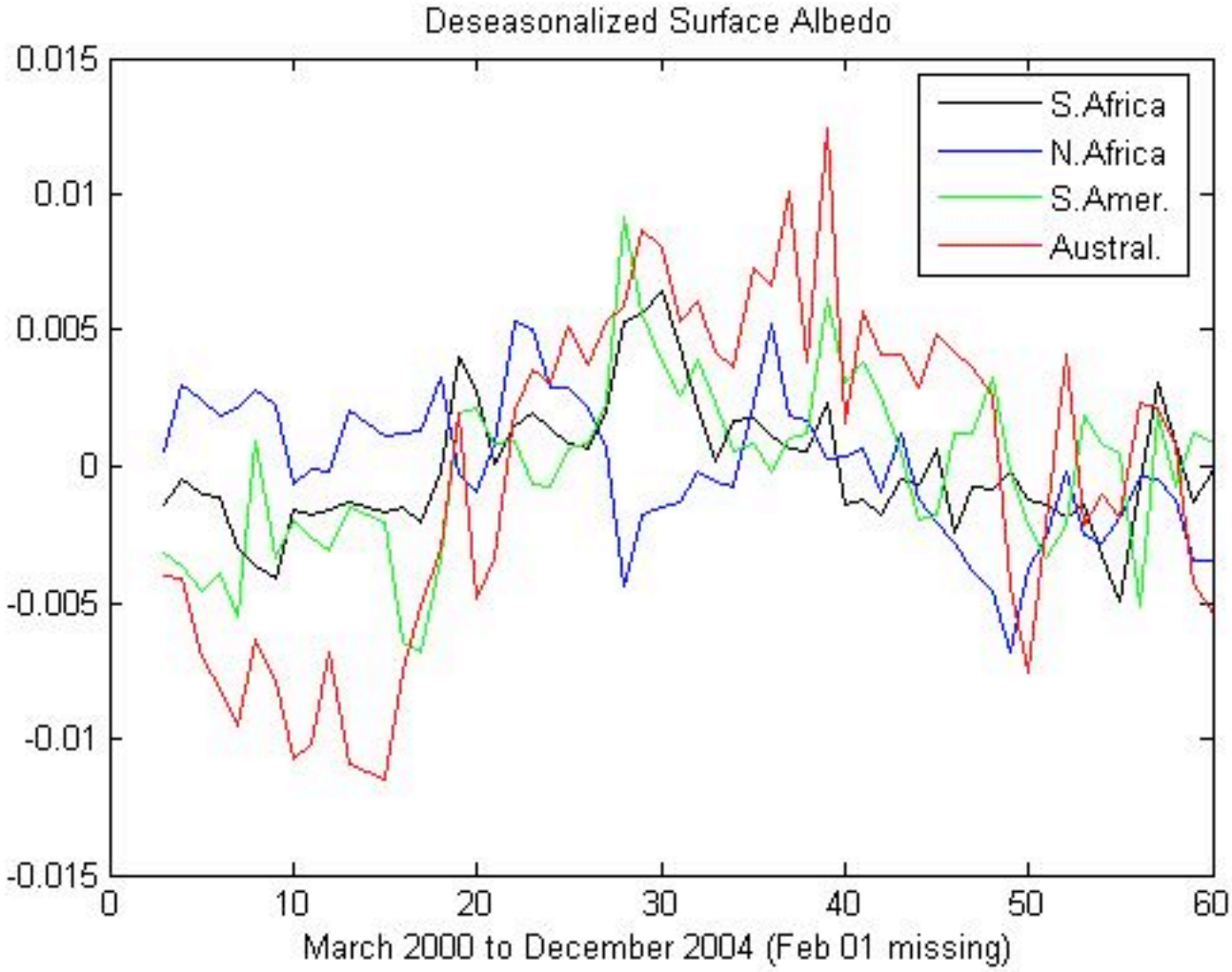
CAVE Surface Albedo Page http://www-cave.larc.nasa.gov/cave/sfc_albedo.html




Surface Albedo
Asia (35-60N)
Australia
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
10
20
30
40
50
60
March 2000 to December 2004 (Feb01 not plotted)


Deseaonalized Surface Albedo
Asia (35-60N)
Asia line fit
y = -0.0003*x + 0.01
Australia
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
0
10
20
30
40
50
60
March 2000 to December 2004 (Feb01 not plotted)

Is the decrease in surface albedo over Asia (35-60N) due to snow melt (ice albedo feedback of global warming)? Surface albedos are not decreasing in the regions shown below.



Surface and Atmosphere Radiation Budget (SARB)

ASDC has official records -- CAVE has easy to use subsets

CRS "Edition": TRMM (1998) and Terra (2000-2005…)

Beta1: Aqua (...2002-2004) at ASDC, but not yet on CAVE

FSW Edition 2C: Terra (2000-2004…)

plus web based surface albedo for GCMs…

SYN: future global production of 3-hourly, gridded fluxes (plus UV, PAR)

Extensive surface and TOA validation, access to "point and click" codes, etc.

SARB 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

Aerosol forcing has some credibility

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

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

More work on aerosols, clouds, and surface optics underway for Edition 3