Surface Atmosphere Radiation Budget (SARB) working group update

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Outline

- Accomplishments since the last science team meeting
- SYN Ed4 plan
- Ed4 MOA
- CRS Ed4 plan
- NPP plan

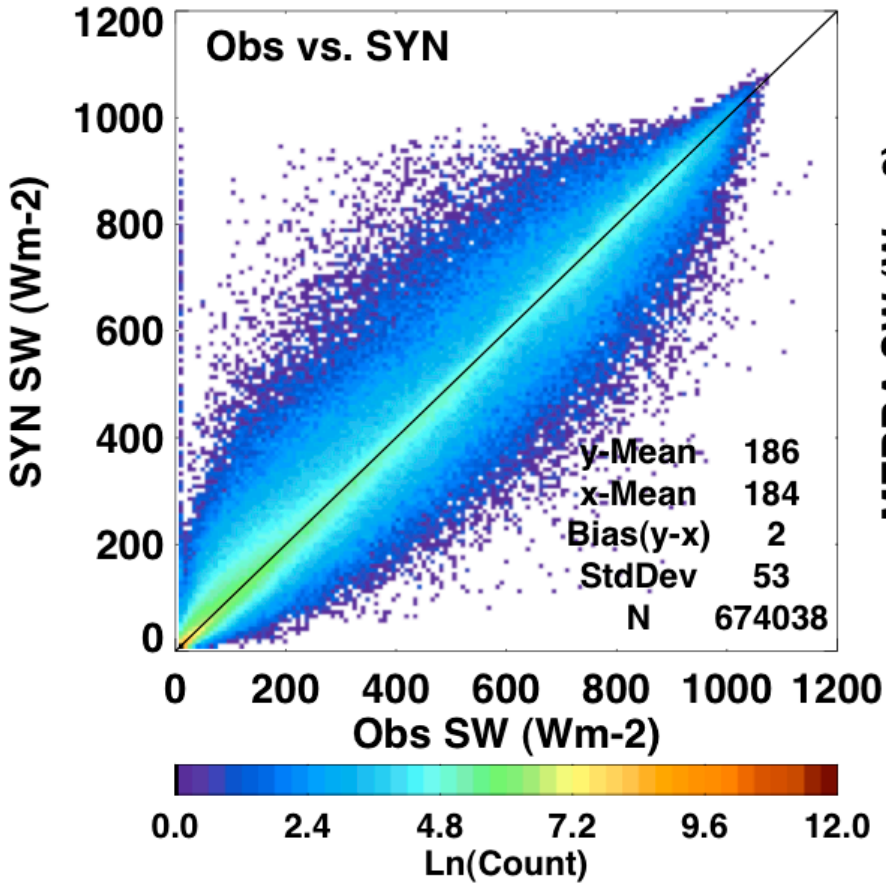
Accomplishment since the last CERES science team meeting

- Produced EBAF-surface ed2.7 from March 2000 through March 2012 (F. Rose's presentation)
- Evaluated EBAF-surface ed-2.7 with surface observations
- Evaluated SYN diurnal cycle with surface observations
- Evaluated GEOS temperature and humidity with surface observations and AIRS (D. Rutan's presentation)
- Compared CRS- and MODIS derived surface albedo (A. Radkevich's presentation)
- Revised surface and atmospheric irradiance uncertainty estimate

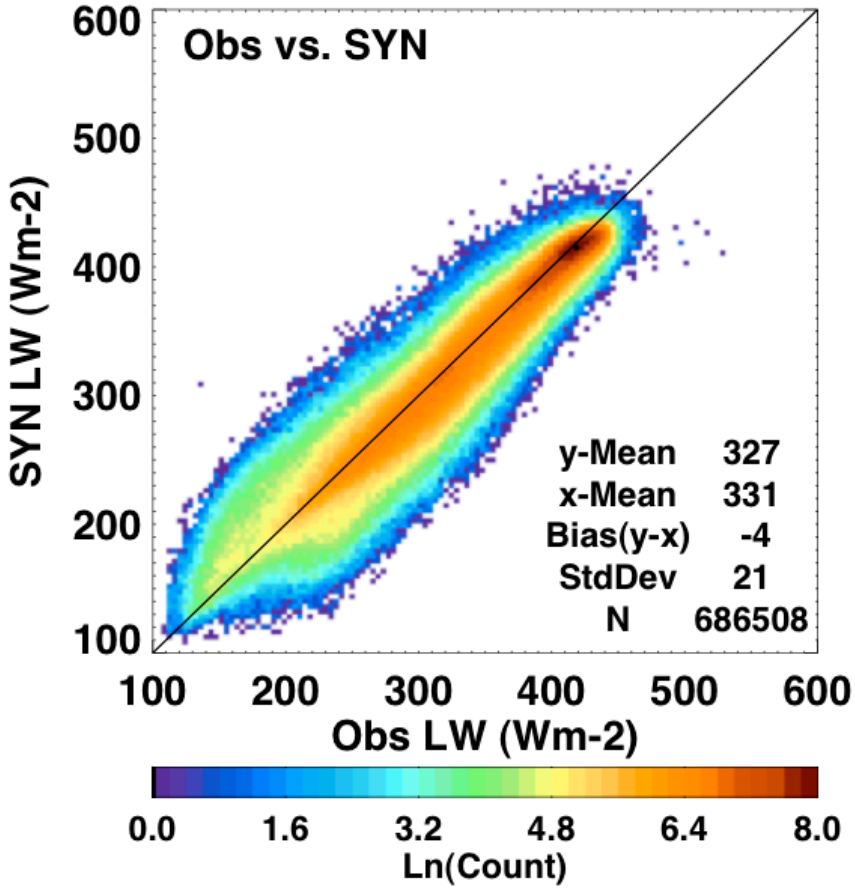
Diurnal cycle evaluation

3 hourly irradiance evaluation with surface observations at 35 sites

Shortwave down

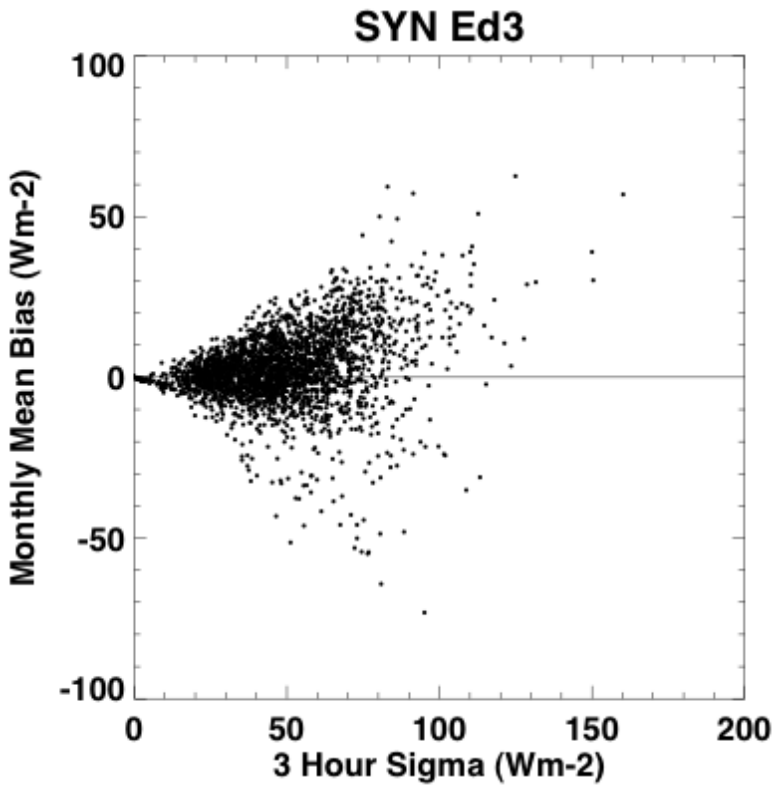


Longwave down

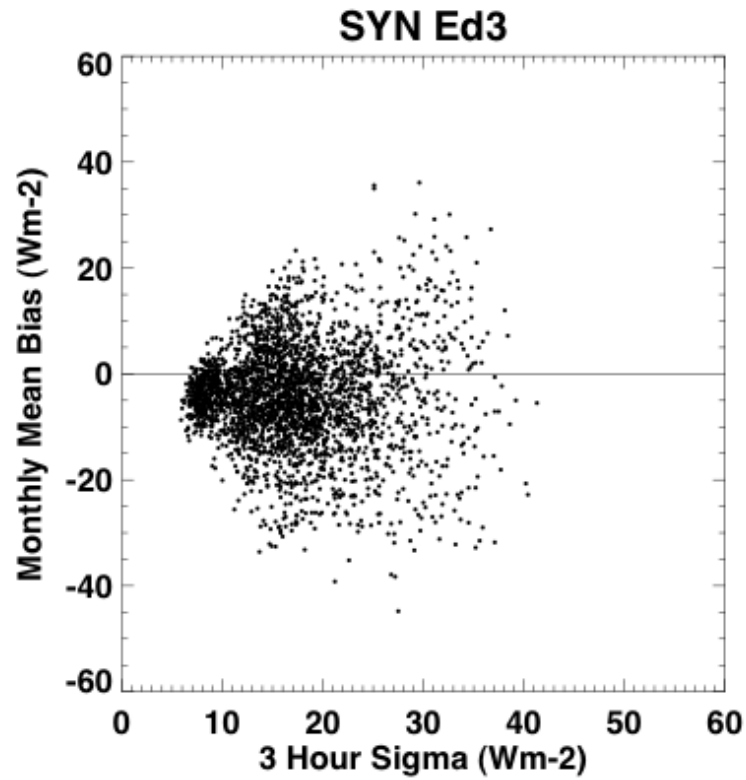


Diurnal cycle

Shortwave



Longwave



SW monthly mean bias error increases with 3-hourly errors

Summary of evaluation of diurnal cycle with surface observations

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)

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)

March 2000 to Dec 2007 (35 locations)

SYNI Ed4 plan

- Cloud
  - Use 4 significant cloud vertical profiles (combination of 4 cloud types)
  - Include cloud overlap (random overlap)
  - Incorporate cloud group's lapse rate and consistent phase function.
- Aerosols
  - Hourly MATCH (file size ~700 Mb/day)
  - Include tropospheric SO4, stratospheric SO4, Ammonium sulfate, and volcanic ash in addition to small dust, large dust, sulfate, sea salt, black carbon, soluble, and insoluble.
  - MODIS aerosols (collection 5)
- Surface albedo
  - Ed4 surface history map (include partly clear-sky albedo derived from MODIS radiances)
  - new spectral shape (using MODIS MCD43C product) over land and snow
  - Solar zenith angle dependent surface albedo look-up table
- Radiative transfer code
  - 18 SW bands
  - SW, GWTSA (inhomogeneous scenes) /4-stream (homogeneous scenes) hybrid
- Tuning
  - Regional, seasonal, scene (cloud/clear) and surface type (land and ocean) dependent tuning
- TSI
  - 5-channel GEO cloud properties
  - Including MODIS and GEO retrieved skin temperature
  - Improved NB-BB LW irradiance (See M. Sun's talk on Thursday)
  - Include lapse rate retrieved by the cloud group (at least two heights of temperature and pressure)
- Snow/Ice map
  - Use 1/16 mesh of EICE and ESNOW maps.
- New variables
  - Aerosol radiative effect product from SYN pristine, clear-sky, all-sky, and all-sky no aerosol fluxes (proposed)
  - Entropy computations

Ed4 MOA

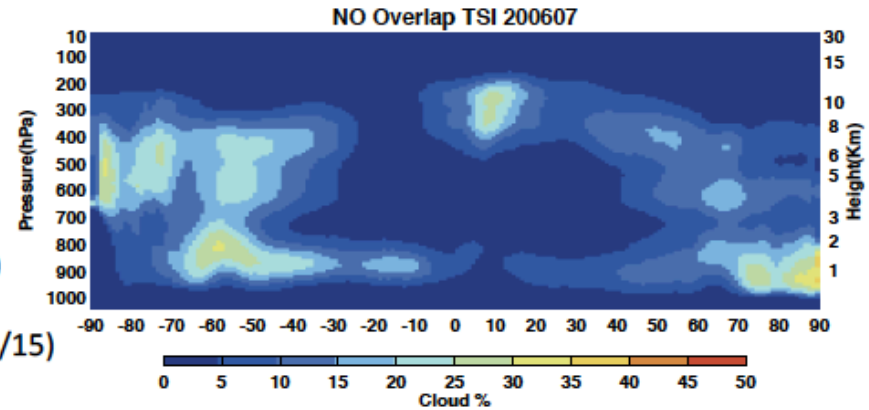
	Edition 2	Edition 4
GEOS	4.1 and 5.2	5.4.1
Grid size	1°×1°	1°×1°
T and Q vertical resolution	58 levels	58 levels
Bottom 3 levels	Sfc, sfc-10 hPa, sfc-20hPa	2m, 2m, (duplicate two layers) and 10m
T and Q temporal resolution	6 hourly	6 hourly
Near surface T and Q	6 hourly	Hourly
Skin temperature	3 hourly	Hourly
Ozone vertical resolution	58 levels	58 levels
Ozone temporal resolution	Daily	Daily (GEOS)

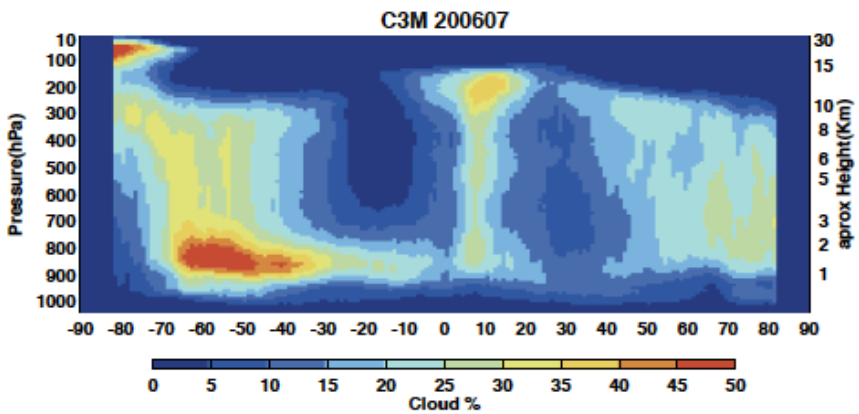
cloud overlap in ed4 SYN

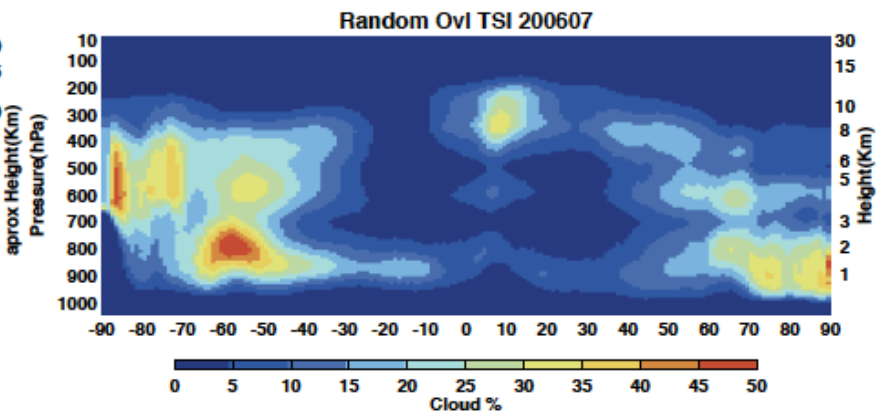
Monthly Mean Zonal /Pressure
Cloud Percentage July 2006

Left: C3M VFM Calipso/Cloudsat active sensor

Right Top: Ed3a TSI (Modis/Geo) space viewed (No Overlap)
Right Middle: TSI (Modis/Geo) w/Random Overlap (15case)
Right Bottom: TSI (Modis/Geo) w/Most probable overlap (4/15)

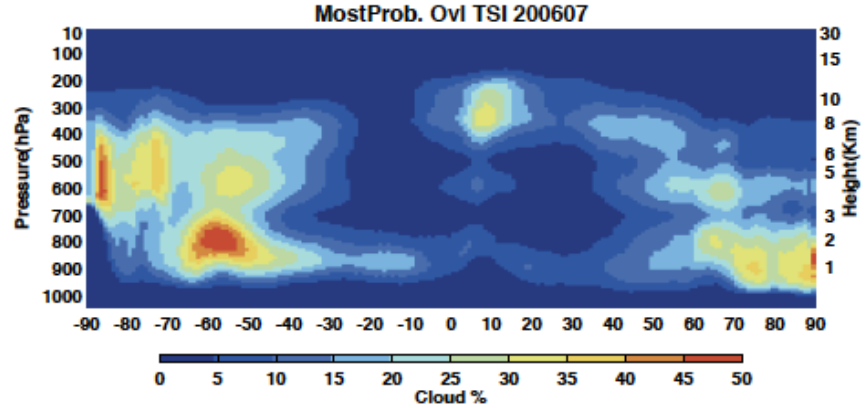






Fifteen(15) possible cloud overlap conditions
using TSI four (4) layer height information

C	h1	h2	h3	h4	h5	h6	h7	h8	u1	u2	u3	u4	m1	m2	low
F	T	T	T	T	T	T	T	T	F	F	F	F	F	F	F
F	T	T	T	T	F	F	F	F	T	T	T	T	F	F	F
F	T	T	F	F	T	T	F	F	T	T	F	F	T	T	F
F	T	F	T	F	T	F	T	F	T	F	T	F	T	F	T



Ed4 validation plan

- Surface irradiance
  - Land (7 SURFRAD, 14 ARM/SGP, and 8 BSRN sites including 5 polar, 5 desert, and 8 tropical sites)
  - Ocean (17 Atlantic, 10 Indian Ocean, 19 Pacific ocean buoy arrays and 3 Woods Hole buoys)
- Ship data (e.g. MAGIC)
- Temperature and humidity comparisons
  - ARM sites
  - AIRS
- MATCH aerosol versus CALIPSO-derived profiles
- Antarctic snow albedo

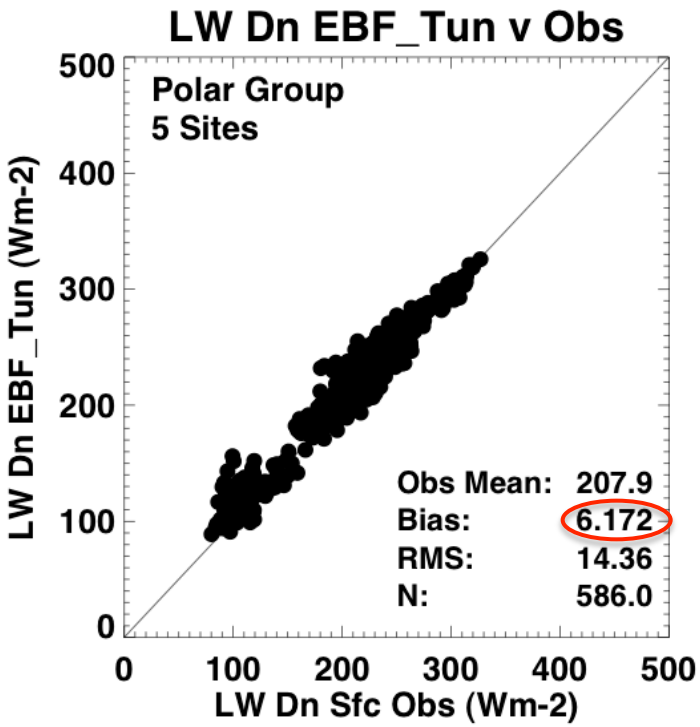
Ed4 CRS

- 18 band SW code
- New ice cloud properties (consistent with cloud group)
- Time varying CO2, CH4, N2O
- Boundary layer temperature profile consistent with cloud group
- Surface albedo history map including retrieval from partly cloudy CERES footprints
- Snow spectral albedo is modeled by snow grain size as a parameter
- Use MODIS derived surface albedo spectral shape
- Solar zenith angle dependent all-sky surface albedo
- Revised tuning algorithm

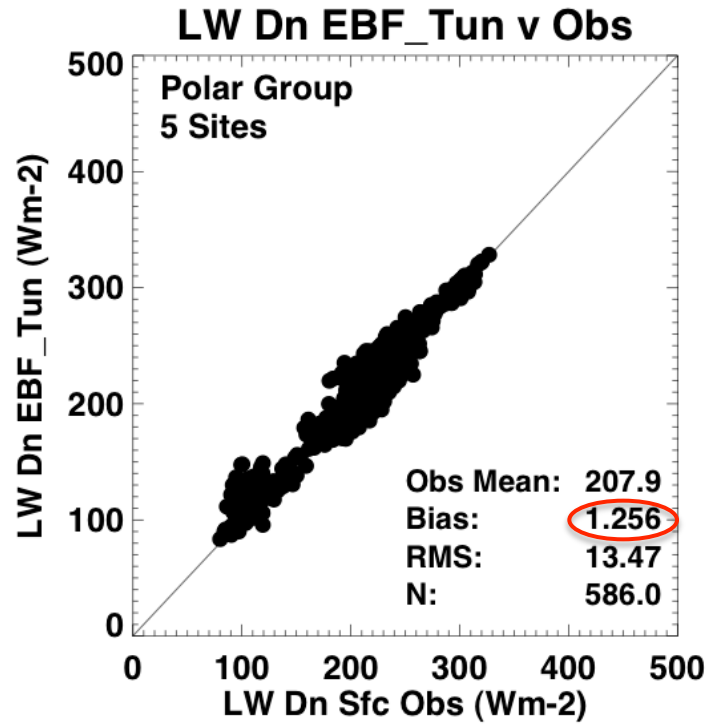
EBAF-surface Ed2.7 issues

Downward longwave with and without GEOS-5.4.1 correction

With GEOS-5.4-1 correction



Without GEOS-5.4.1 correction

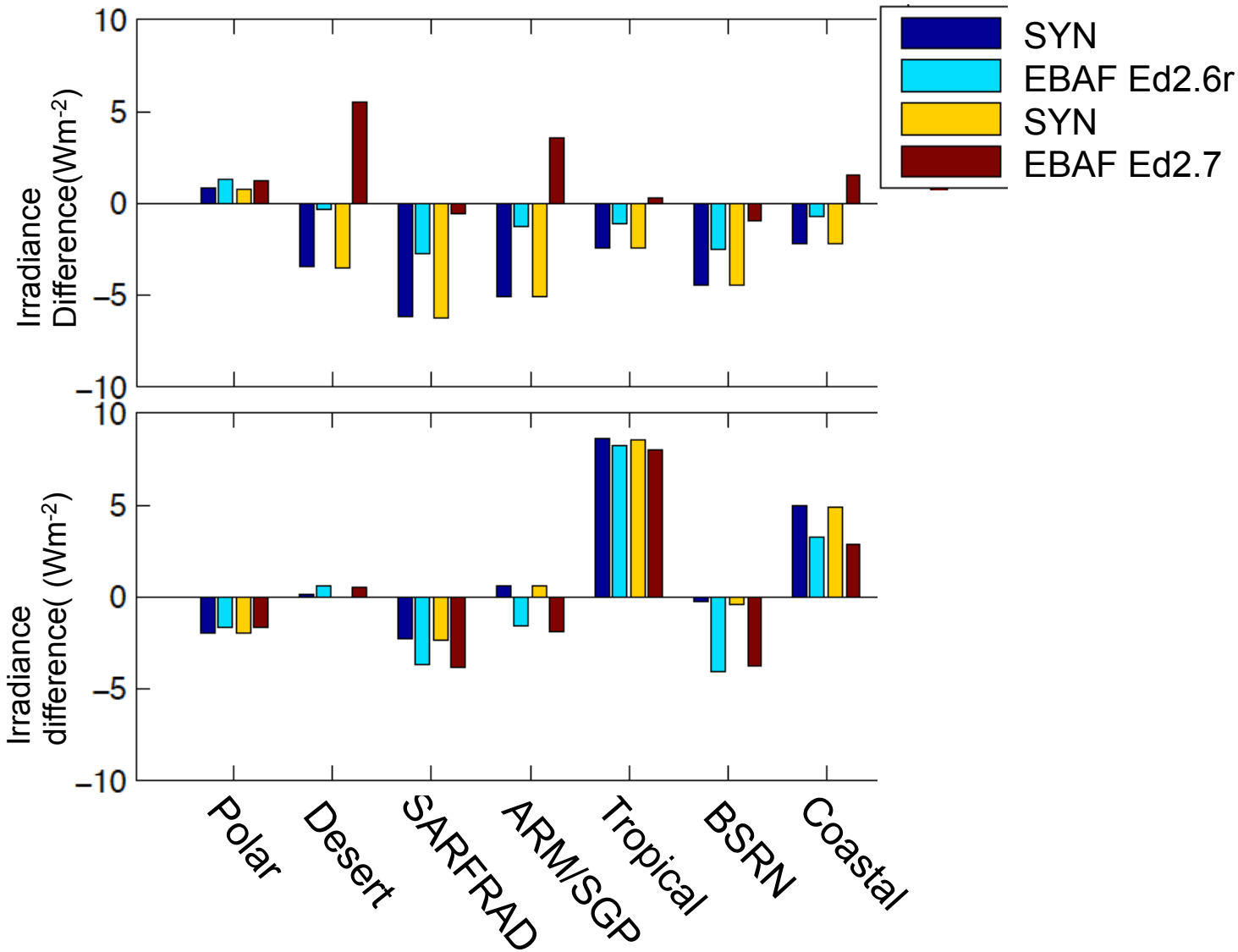


Is polar region boundary layer from GEOS-5.4.1 too warm?

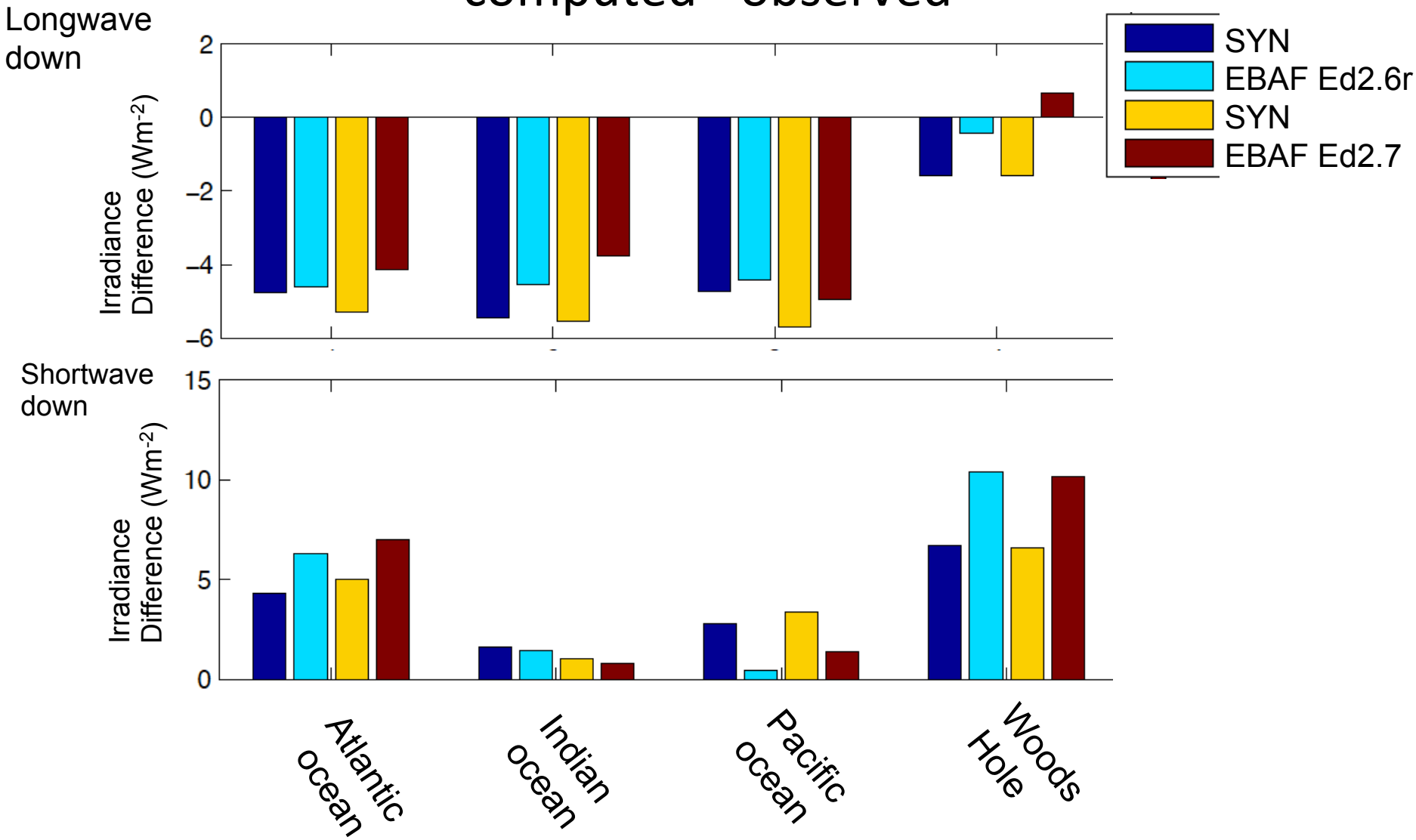
Bias error comparisons (land)
computed - observed

Longwave down

Showrtwave down



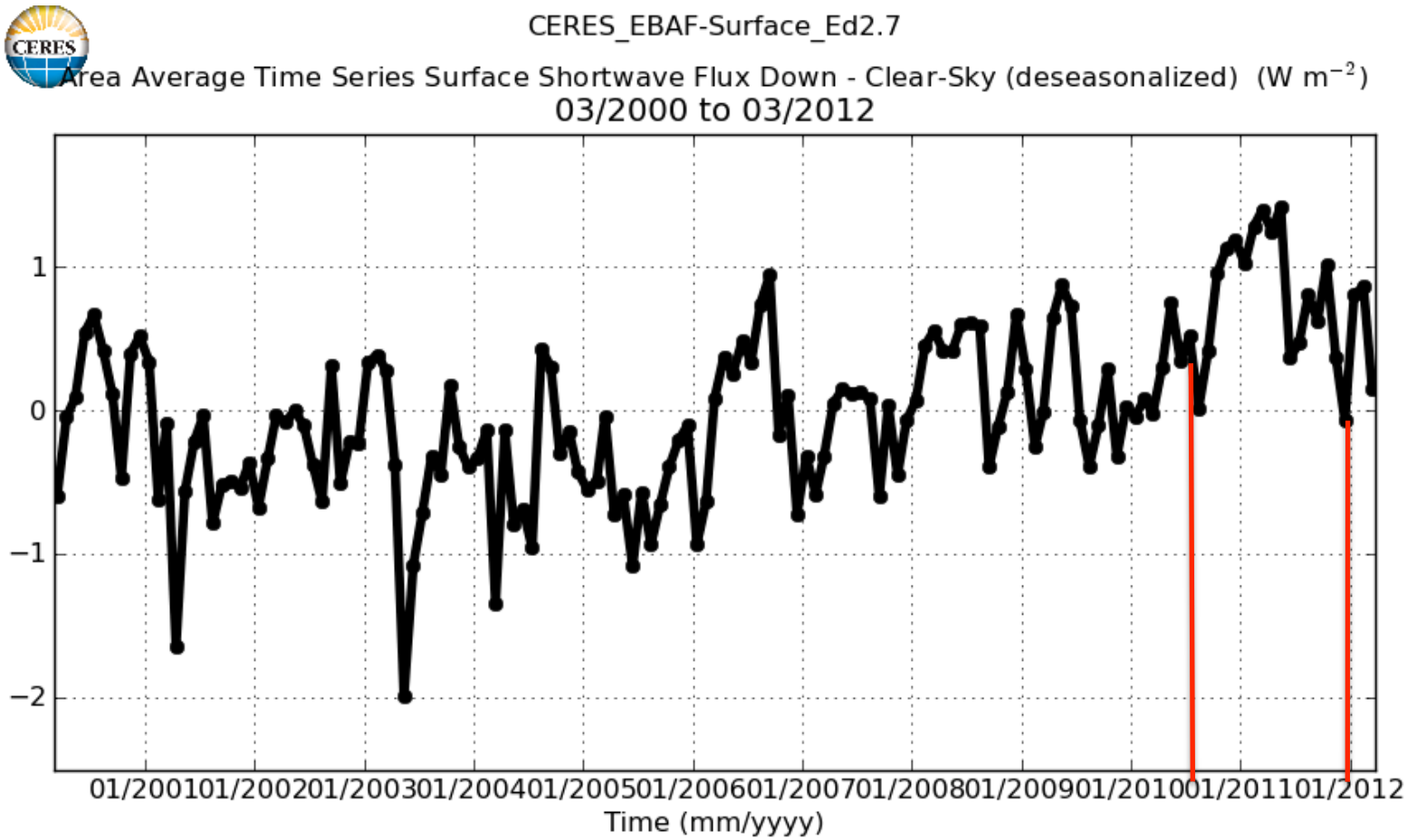
Bias error comparisons (ocean)
computed - observed



EBAF-surface Ed2.7 problem

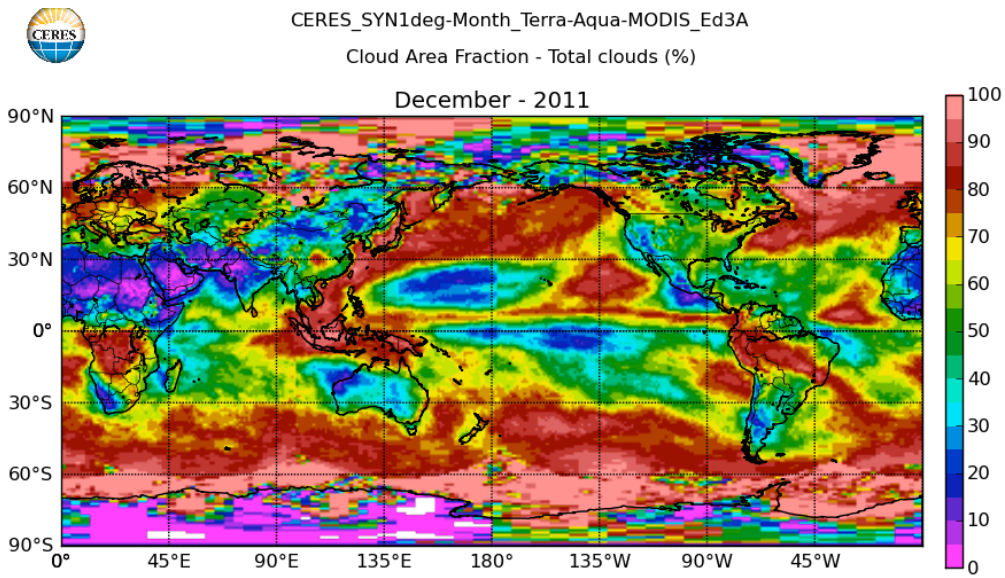
- Aerosol geolocation problem (July 2010 through December 2011).
  - Affects SSFa (1st hour and might be other hours)
- Cloud fraction problem December 2011
  - Affects SYN
- Process one month (December 2011? after cloud problem is corrected) off line to evaluate the impact of the aerosol problem

Clear-sky SW down anomalies

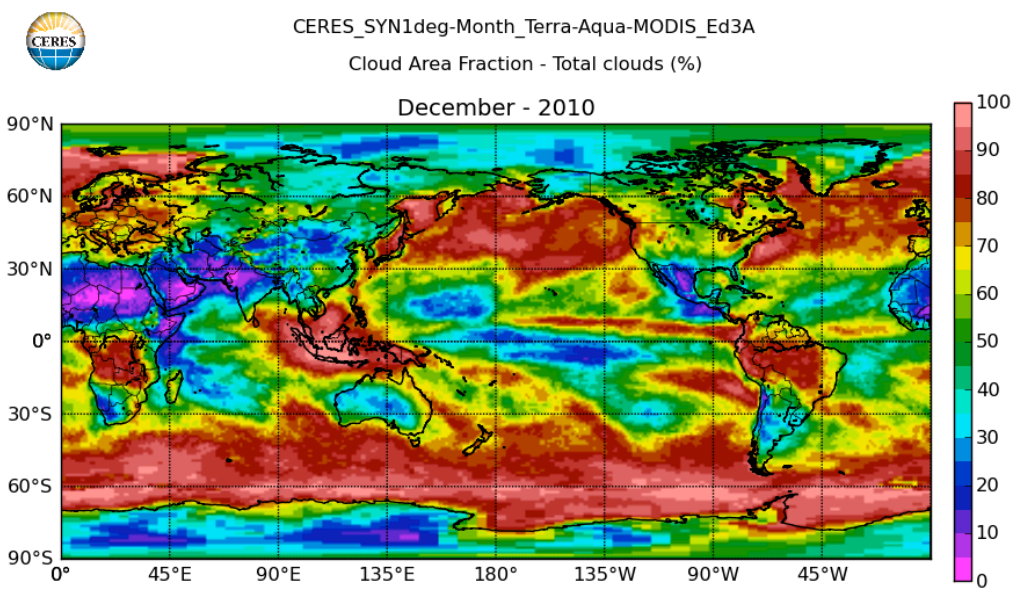


Selected Region: [-90,0 to 90,360]

SYN cloud problem



Only 1 day of SSF was used for Dec. 2011 process



Schedule

- Ed2.7 EBAF-surface public release (May 2013)
- Deliver SYNI Ed4 code by the Feb./March 2014 (testing the code with Ed4 ADM module after Sep. 2013).
- Deliver CRS Ed4 code in summer 2014

Publications and documentations

- Published
  - Kato, S., N. G. Loeb, F. G. Rose, D. R. Doelling, D. A. Rutan, T. E. Caldwell, L. Yu, and R. Weller, 2012, Surface irradiances consistent with CERES-derived top-of-atmosphere shortwave and longwave irradiances
- Accepted
  - Rose, F., D. A. Rutan, T. P. Charlock, G. L. Smith, and S. Kato, 2012; An algorithm for the constraining of radiative transfer calculations to CERES observed broadband top of atmosphere irradiance, submitted to *J. Ocean. Atmos. Technol.* In press.
  - Radkevich, A., K. Khlopenkov, D. Rutan, S. Kato, 2012, A Supplementary Clear-Sky Snow and Ice Recognition Technique for CERES Level 2 Products, *J. Atmos. Oceanic Technol.* In press.

- Submitted

  Diurnal Variations of Albedo", Rutan, D., G. L. Smith, and T. Wong,submitted to J. of App Met. Clim.

  Analysis of cloud type dependent shortwave 3D effects on TOA radiance, atmospheric absorption and surface irradiance, Ham, S. H., S. Kato, H. Barker, F. G. Rose, S. Sun-Mack, in preparation.

Documentation

- Ed2 CRS collection guide (in progress)

SARB:NPP

- Analyze CRS with ed1 clouds (after Ed1 SSF delivery in June 2013, no revision of CRS code)
- Deliver Ed1 CRS (Ed2 CRS Terra/Aqua code) in Sep. 2013 (ed1 SSF will be produced after June 2013).
- Deliver SYNI Ed1 code in Spring 2014 (with TISA WG).