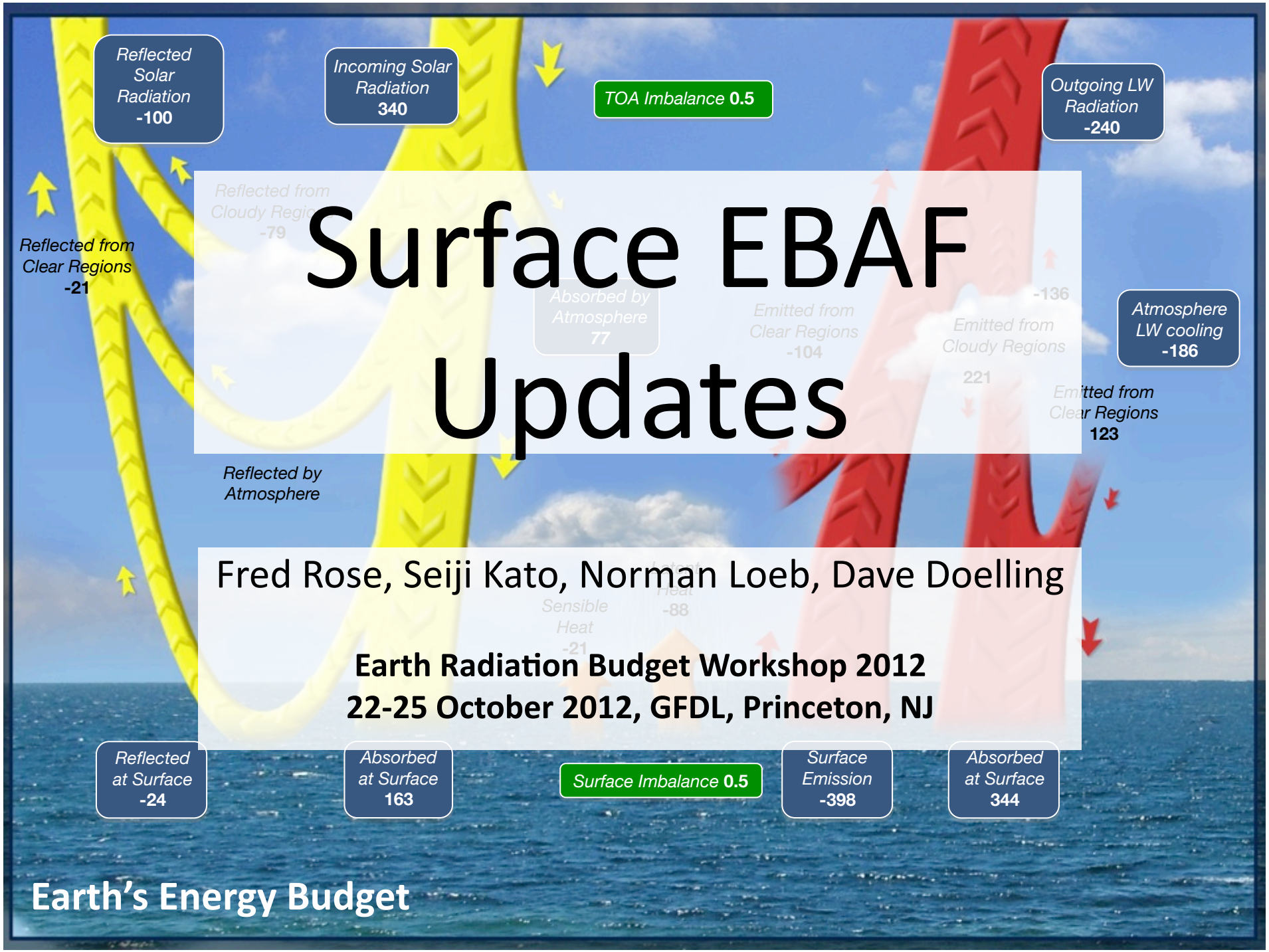


Surface EBAF Updates

Fred Rose, Seiji Kato, Norman Loeb, Dave Doelling

Earth Radiation Budget Workshop 2012
22-25 October 2012, GFDL, Princeton, NJ

Outline

- SFC EBAF Product Description
  - Method (how It's done)
- Ed26rV2h
  - Basic results
  - Validation plot
- Ed3_Develop :Differences from Ed26rV2h
  - Extend record (2010_02 -> 2011_11)
  - Fix issues
    - Geos4,Geos5.2 → Geos5.4 to 200812
    - Ed3 SYN1Deg_Month was Ed3-lite
    - Clean up 'dirty' Jacobian
    - 1 degree Grid shift
    - Solar Constant variability extended to surface fluxes

SFC EBAF Inputs

- Monthly Gridded
  - SYN1deg_Month (Ed3-lite) to (Ed3)
    - GMAO (Geos4 and Geos5.2) T(z),Q(z) (NO AIRS assimilation)
    - MODIS [Terra&Aqua](4x daily) and GEO(3hourly clouds)
    - Hourly Fu-Liou Broadband Radiation Transfer
      - » TOA and SFC , Longwave and Shortwave fluxes
  - TOA EBAF (Ed2.6r)
    - TOA Broadband Shortwave & Longwave
  - AIRS (AIRX3STM.005) UTRH(200:500hpa)
    - Used for OLR bias correction
- Zonal (Land Ocean) / Seasonal
  - C3M – CRS
    - Sfc Longwave bias correction Calipso/Cldsat cloud base
  - Uncertainty estimates of RT Inputs and outputs.
    - Cloud (Frac,Tau,Height) , Tskin , Tair , SfcAlb, PW, AOT
    - TOA (SW,LW) , Surface (SWDN, SWUP, LWDN, LWUP)

SFC_EBAF Process

- Compute sets of partial derivative computations "Jacobian" for each monthly mean gridbox (SW high &low sun CosSZA pdf)
  - Dx ::Cloud (Frac,Tau,Height) , Tskin , Tair , SfcAlb, UTRH, PW, AOT
  - DF::TOA (SW,LW) , Surface (SWDN, SWUP, LWDN, LWUP)
- Direct adjustment of OLR from GMOA to AIRS UTRH values
  - OLR' = OLR + (dOLR/dUTRH) * $UTRH_{Airs}$-$UTRH_{Gmao}$
- Use Lagrange multiplier method, "a balancing act"
  - TOA_EBAF:: ΔTOALW↑ , ΔSWTOA↑
  - C3M-CRS:: ΔSFC LW↓
  - While minimizing changes to
    - SFC (LW↑ , SW↓ , SW↑)
    - Cloud (Frac,Tau,Height) , Tskin , Tair , SfcAlb, UTRH, PW, AOT
  - Relative to assigned uncertainties for all inputs and fluxes

SFC EBAF Jacobian

dF/dX DIRECT METHOD	TOA LW↑	TOA SW↑	SFC LW↓	SFC LW↑	SFC SW↓	SFC SW↑
AIRS UTRH(200:500)hPa	Strong					
G5.4.1 *Boundary Layer T(z),Q(z)*			Strong			

dF/dX Lagrange Multiplier Method	TOA LW↑	TOA SW↑	SFC LW↓	SFC LW↑	SFC SW↓	SFC SW↑
PW	Moderate		Moderate		Moderate	
T Skin	Moderate			Strong		
T Air	Moderate		Strong			
SfcAlb		Moderate				Strong
AOT		Moderate			Moderate	
Cloud Frac	Strong	Strong	Moderate		Strong	
Cloud Top	Strong					
Cloud Bot			Strong			

Ed26rV2h SFC EBAF

- Time
  - Monthly: March 2000 – February 2010
  - 1deg Eq. Angle (360x180) from Eq. Area
- Issues
  - GEOS4 based Surface Longwave Flux
    - Mix of Geos4(2000-2007) and Geos5.2 (2008+)
    - “Correct” to all Geos.5.4.1 in future
  - Grid shifted 1 grid box to east
  - Some locations(<1%) have ‘dirty’ Jacobian values

Global Decade Mean Ed2.6rV2h Toa and Surface Flux Results

Global Decade Mean Total Sky (Wm-2)	Unadjusted CERES SARB	Adjusted CERES SURFACE EBAF	Adjusted - Unadjusted
TOA SW UP	**98.5**	**99.6**	**1.1**
TOA LW UP	**237.3**	**239.6**	**2.30**
SFC SW Down	187.2	186.7	-0.46
SFC SW Up	23.3	24.1	0.81
SFC LW Down	**341.8**	**343.7**	**1.87**
SFC LW UP	397.6	398.1	0.46

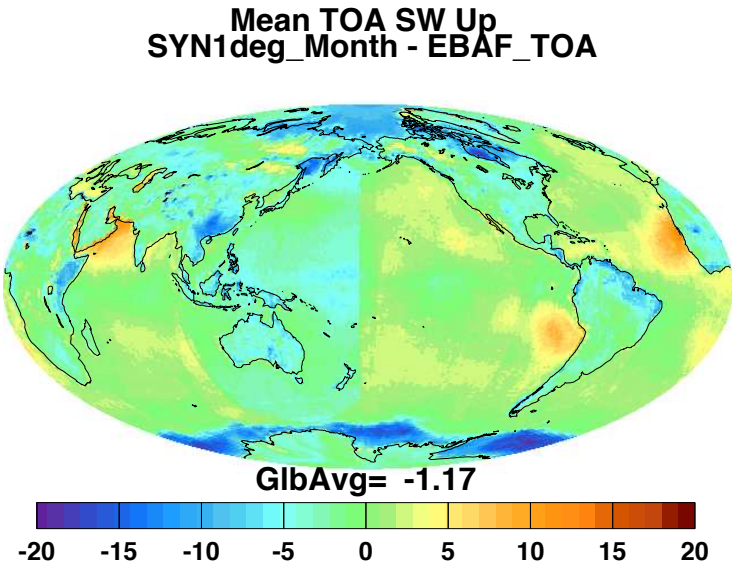
Closure of TOA in SFC_EBAF to TOA_EBAF Ed2.6r product to within -0.05 SW / -0.008 LW

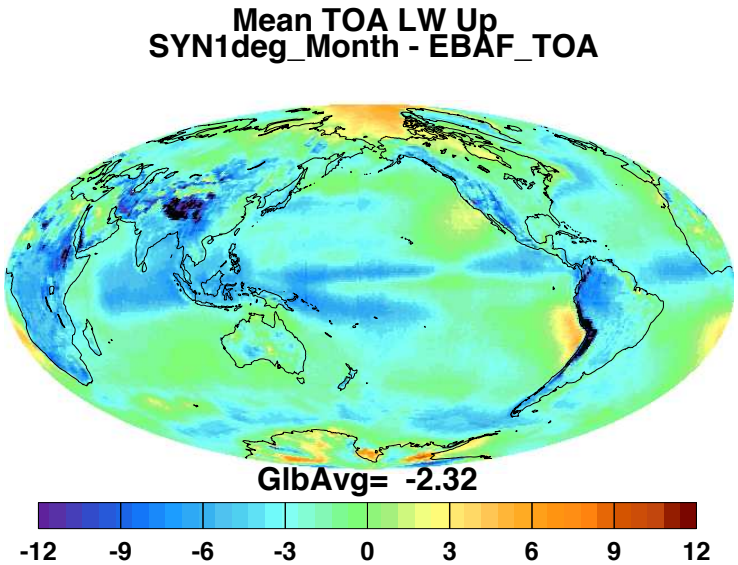
Global Decade Mean Ed26rV2h Input Adjustment Results

Global Decadal Mean Model Inputs	Unadjusted CERES SARB	Adjusted CERES SURFACE EBAF	Adjusted - Unadjusted
Skin Temperature(K)	288.4	288.4	0.0
Sfc Air Temperature(K)	287.4	287.8	0.4
Upper Trop RH(%)	**44.7**	**37.4**	**-7.3**
Precip. Water (cm)	2.33	2.34	0.01
Aerosol Opt. Depth	0.167	0.169	0.002
Surface Albedo	0.136	0.143	0.007
Cloud Fraction	0.613	0.614	0.001
Cloud Top Pres. (hPa)	581.7	588.4	6.7
Cloud Base Pres. (hPa)	677.1	701.7	24.6
ln(Cloud Opt. Depth)	1.27	1.32	0.05

Ed2 SFC EBAF Decade Mean @TOA

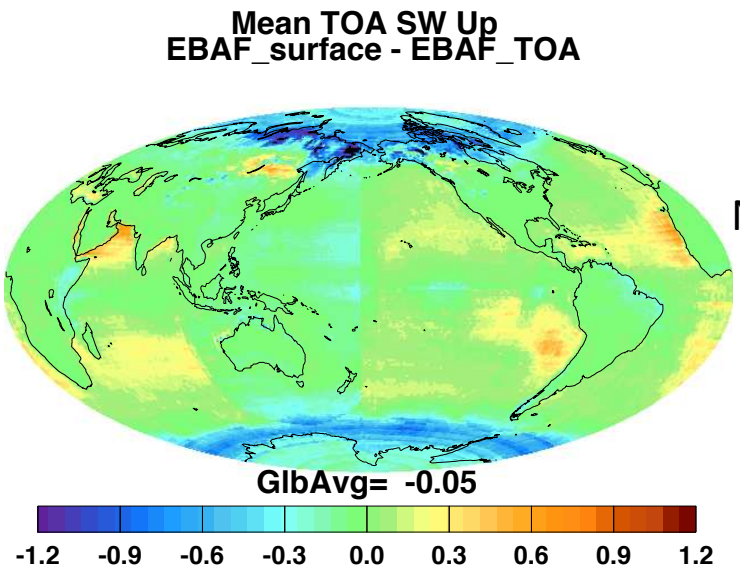
Before

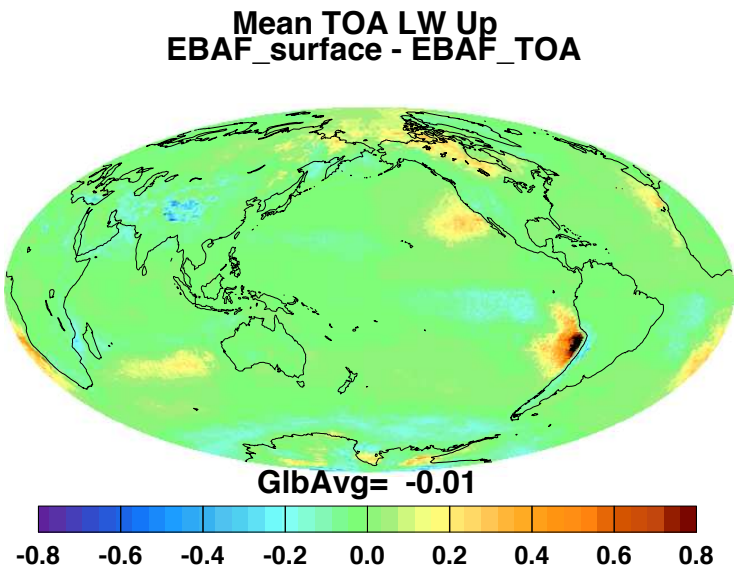




After

Notice Scale Change



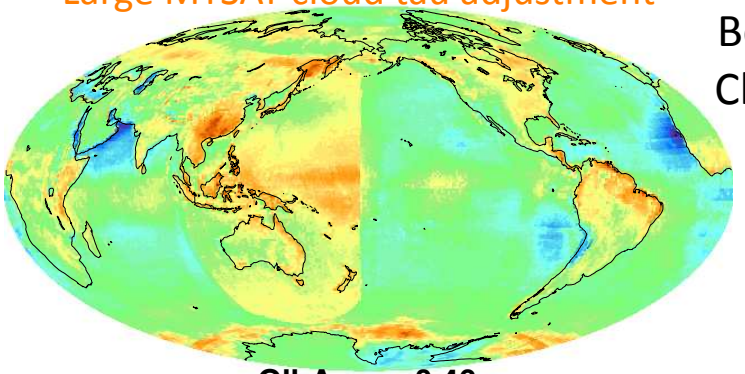


Units Wm^{-2}

Ed2 SFC EBAF Decade Mean @SFC

Mean Surface SW Down
SYN1deg_Month -EBAF_surface

Large MTSAT cloud tau adjustment

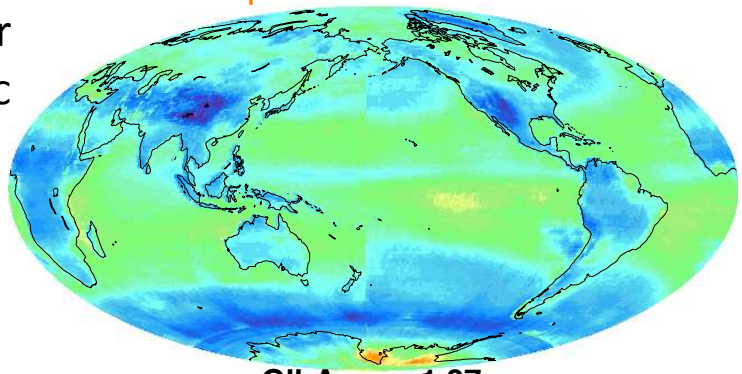


GlbAvg= 0.46

-12 -9 -6 -3 0 3 6 9 12

Mean Surface LW Down
SYN1deg_Month -EBAF_surface

Land T2m Temperature & Ocean Cloud Base



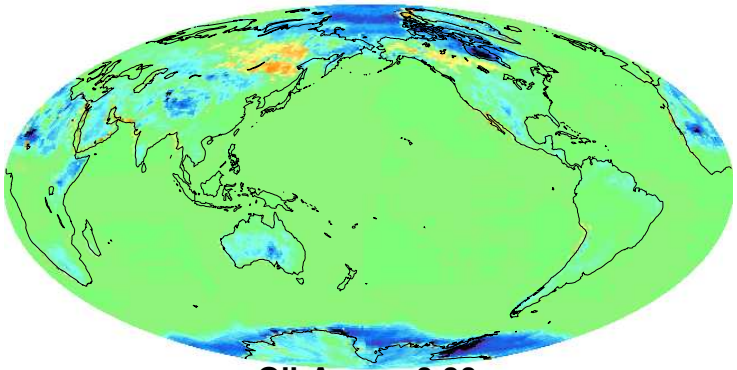
GlbAvg= -1.87

-8 -6 -4 -2 0 2 4 6 8

Before –After
Change to Sfc
Fluxes

Mean Surface SW Up
SYN1deg_Month -EBAF_surface

Sea Ice Albedo Increase



GlbAvg= -0.80

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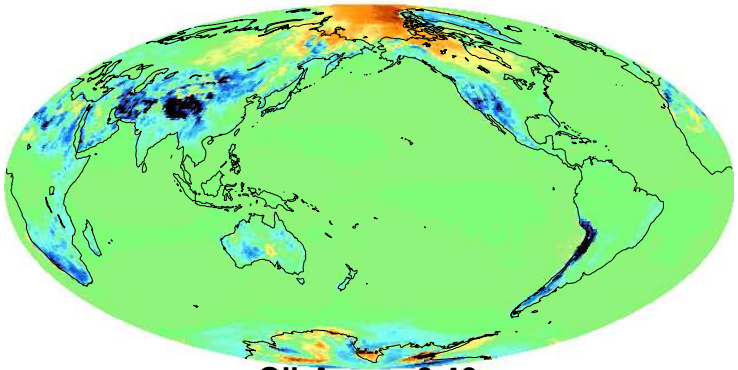
Mean Surface LW Up
SYN1deg_Month -EBAF_surface



GlbAvg= -0.46

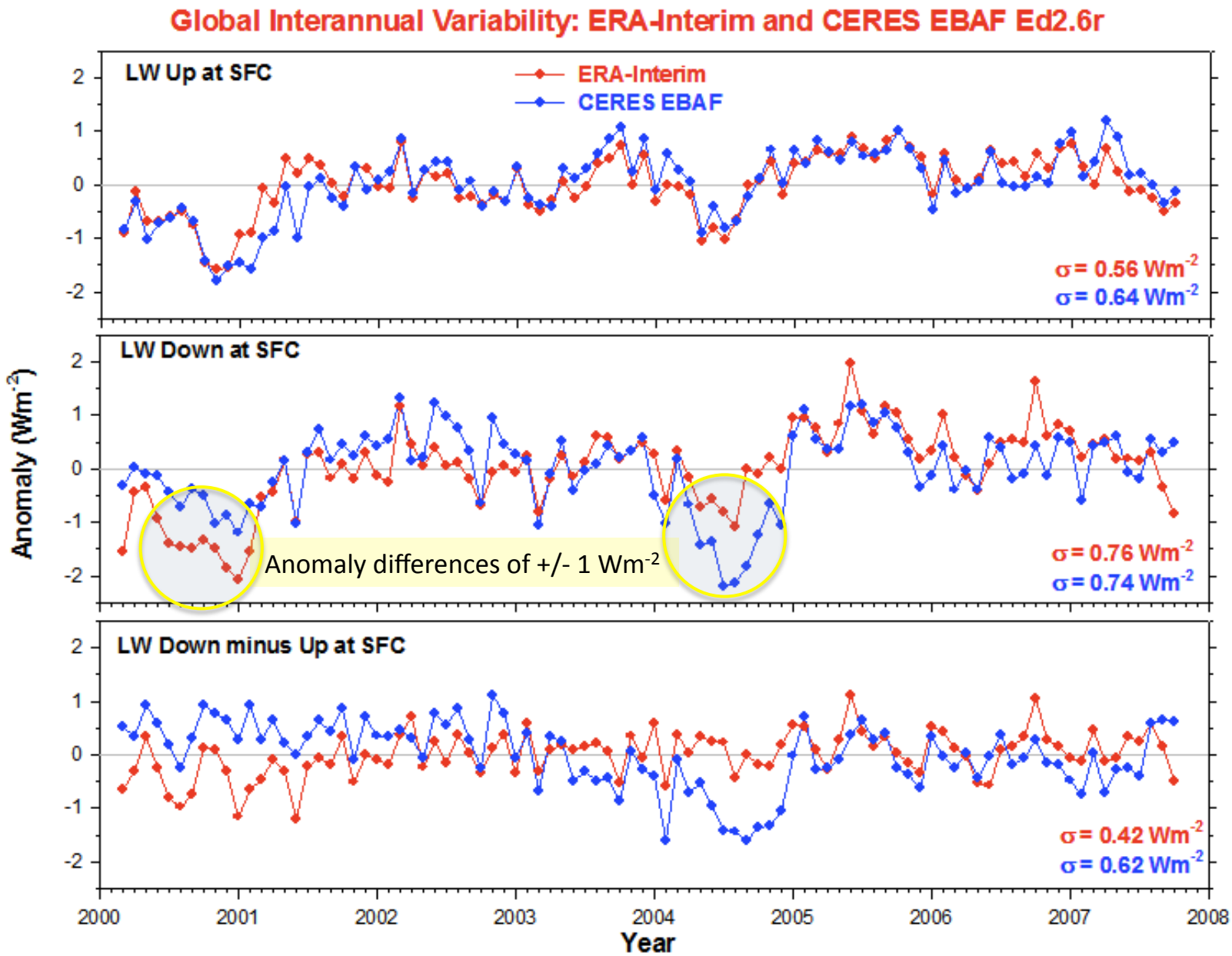
-12 -9 -6 -3 0 3 6 9 12

Units
Wm^{-2}

Identification of an Issue

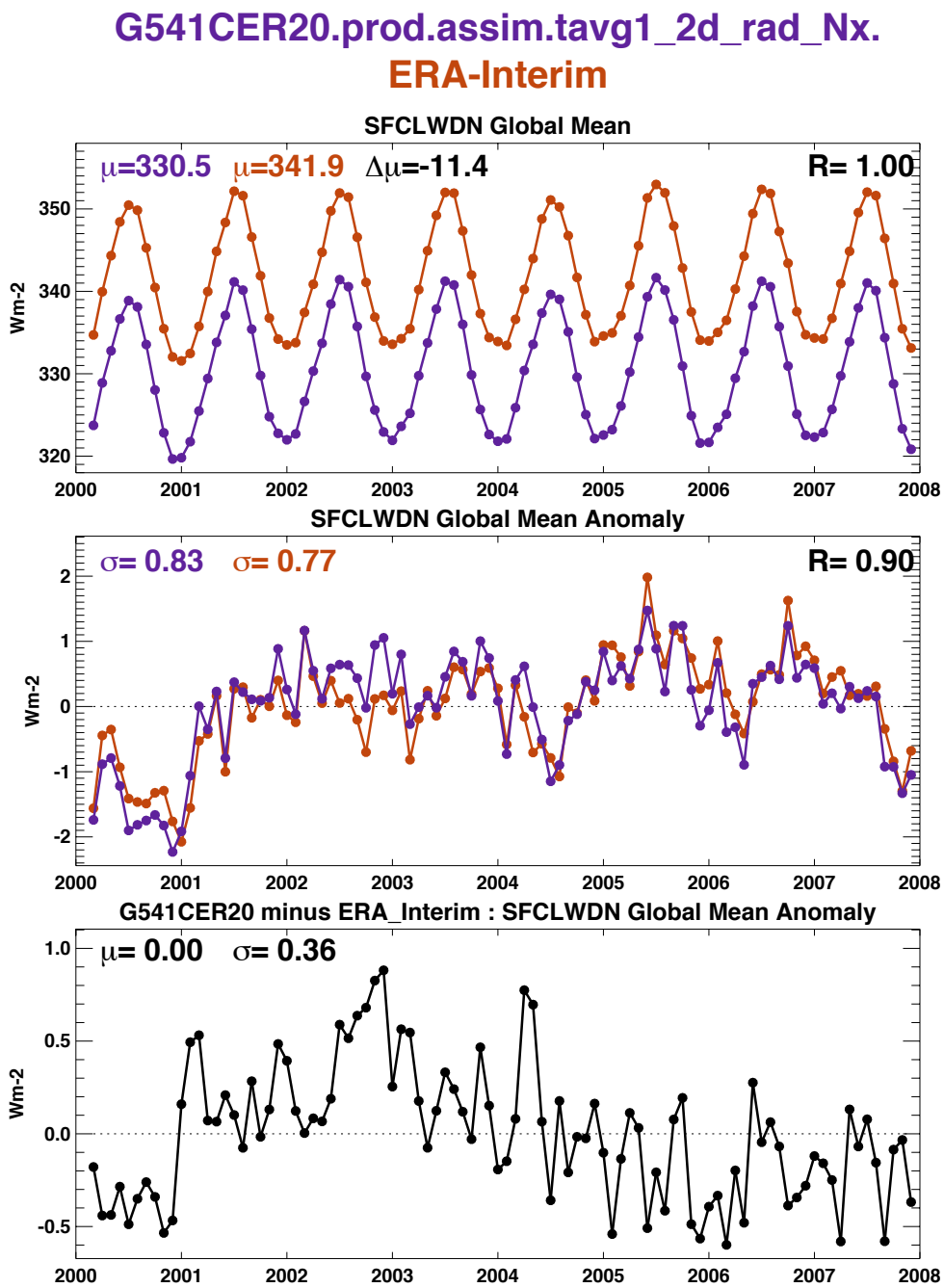
- Surface Longwave Down
  - SFC_EBAF
  - ERA-Interim
- Surface Temperature and Humidity
  - Geos4
  - G5.4.1

SFC_EBAF vs ERA-Interim



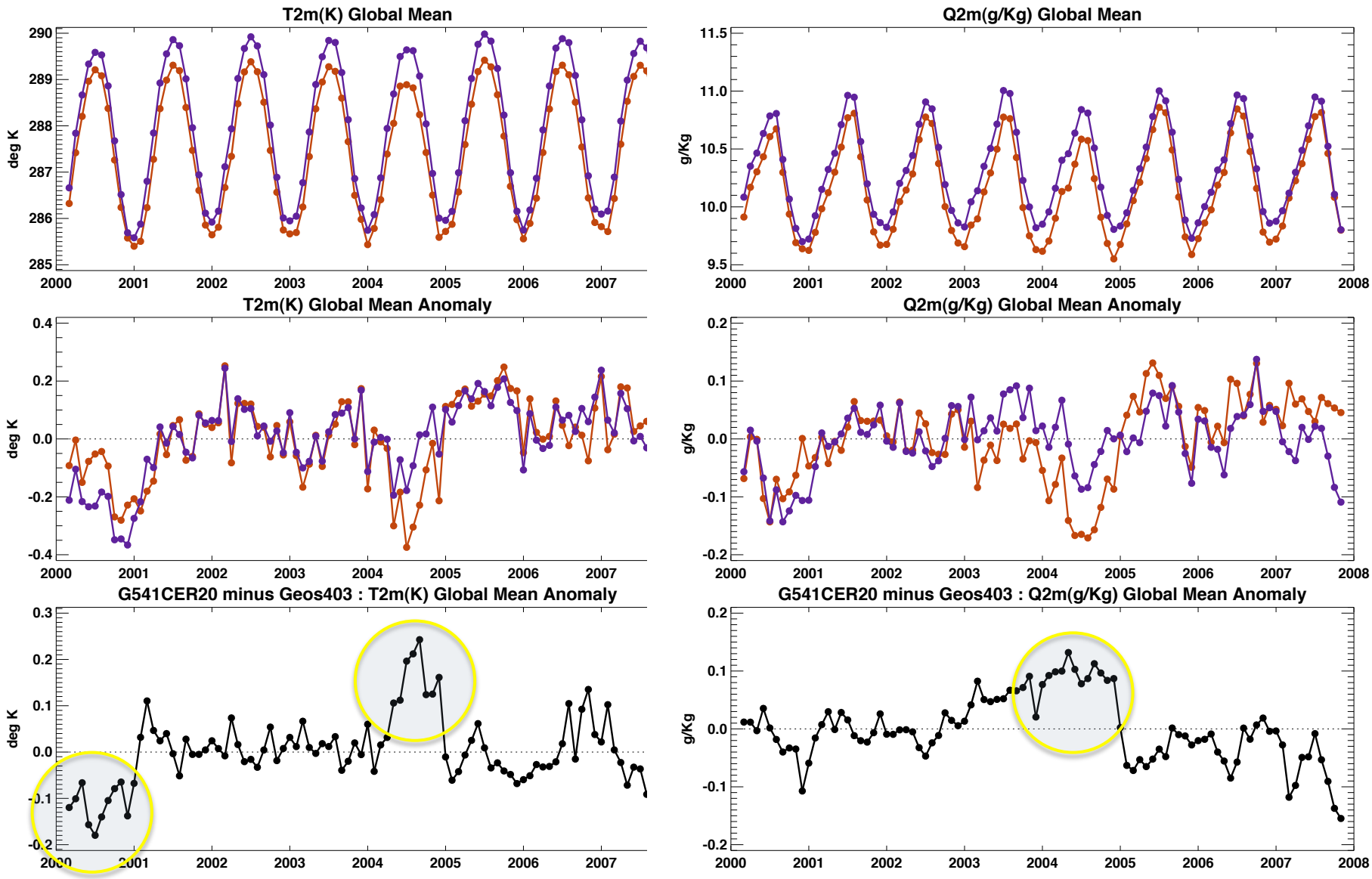
ERA-Interim & Geos5.4.1 SFC_LW_Down

- Large Bias 11 Wm^{-2}
- Anomalies agree to ~ 0.5 Wm^{-2}



G5.4.1 & Geos4: Temperature and Humidity @Sfc+2m

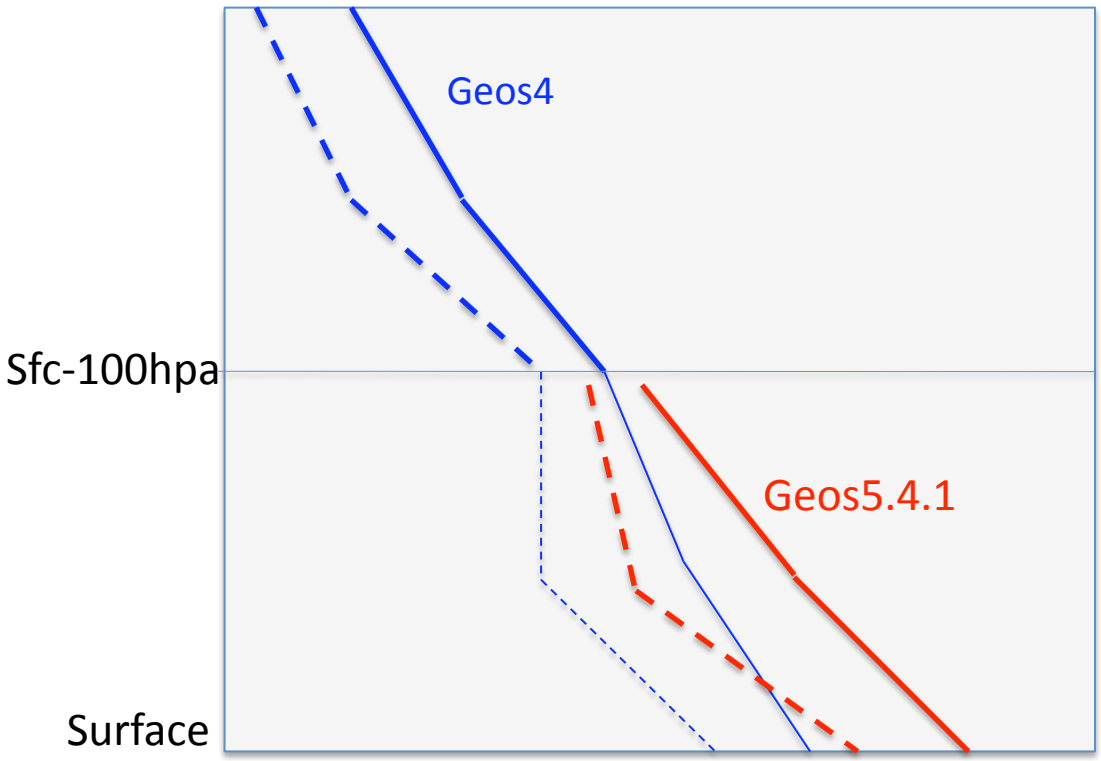
G541CER20.prod.assim.tavg1_2d_slv_Nx.
DAS.cer.asm.tsyn2d_mis_x.GEOS403.



Near Surface replacement with G5.4.1

Above SFC-100hpa: no change to T(z) Q(z) profiles

Below Sfc-100hPa: G5.4.1 T(z) Q(z) are used in Fu-Liou computation to compute partial derivative



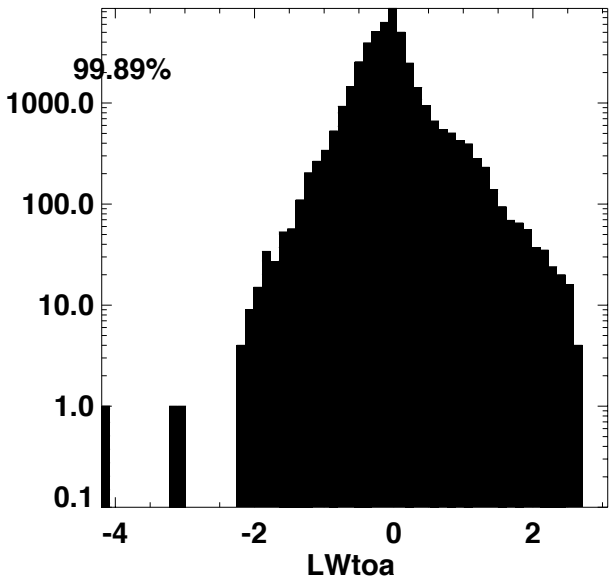
Temperature(Solid) & Dewpoint(Dashed)

G5.4.1 – Geos4
Partial Derivative Spatial Variability Histograms
(March 2000)

Little change to OLR while impact to Sfc LW Down is significant

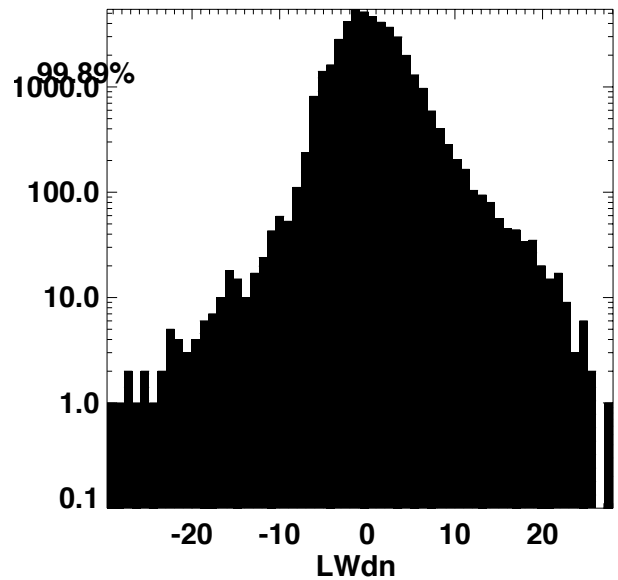
TOA LW [Wm^{-2}]

μ=-0.064 σ= 0.46



SFC LW Down [Wm^{-2}]

μ= 0.49 σ= 3.9



Clean up of Derivative Fields

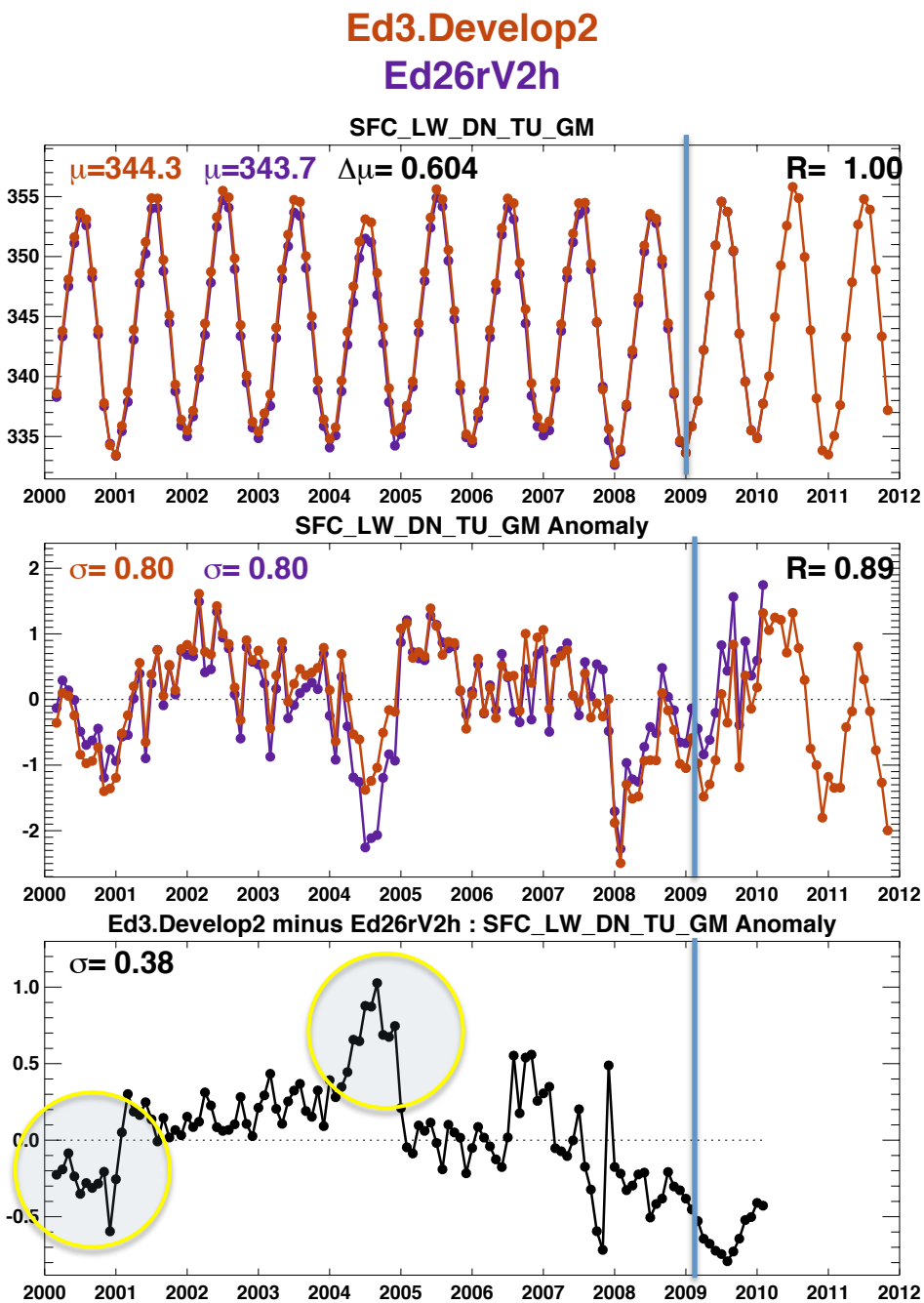
99.89% (44964) are within +/- 10σ

0.11% (49) reset to μ value

Updates toward Ed3 SFC_EBAF

- Use difference of G5.4.1 boundary layer T(z) & Q(z) from earlier Geos4 and G5.2 products as part of direct method Jacobian correction to alter primarily SFC LW Down.
  - DLF' = DLF + [DLF<G5.4.1> - DLF<Geos4>]
- Clean up Jacobian where partial derivatives are greater than +/- 10σ of the spatial variability for a given flux component.
- Solar constant variability from SOURCE extended to surface fluxes.
- Extend temporal record.
- Fixed grid shift.

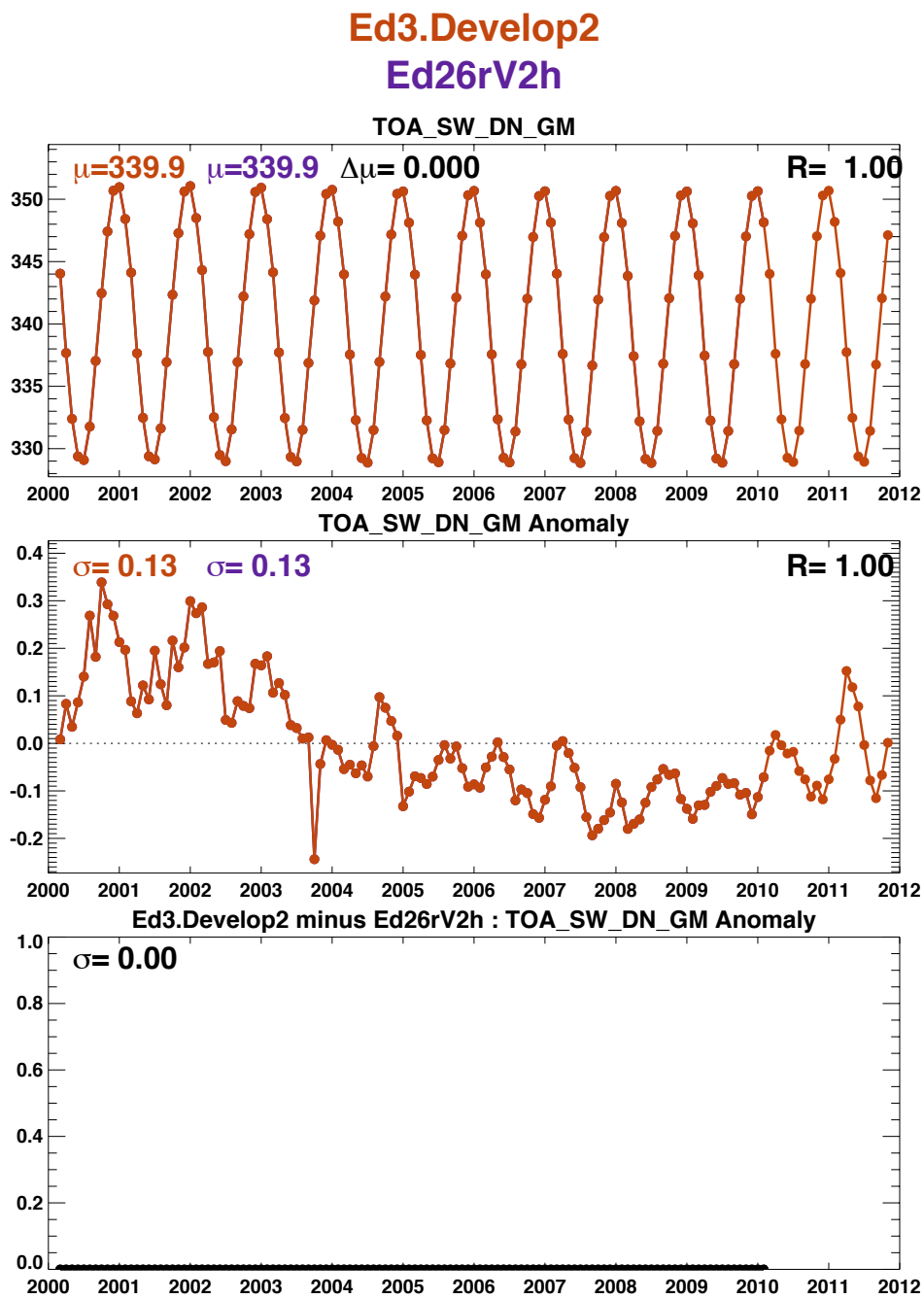
Surface Longwave Down



- Ed3.Develop2 SFC LW Down contains the G5.4.1 Boundary Layer T(z)&Q(z) correction thru 2008.
- Result is an increase the negative anomaly in 2000 and reduce the negative anomaly in 2004.
- This is now more consistent with the ERA-Interim and G5.4.1 Sfc LW Down anomalies over these periods.

TOA Insolation

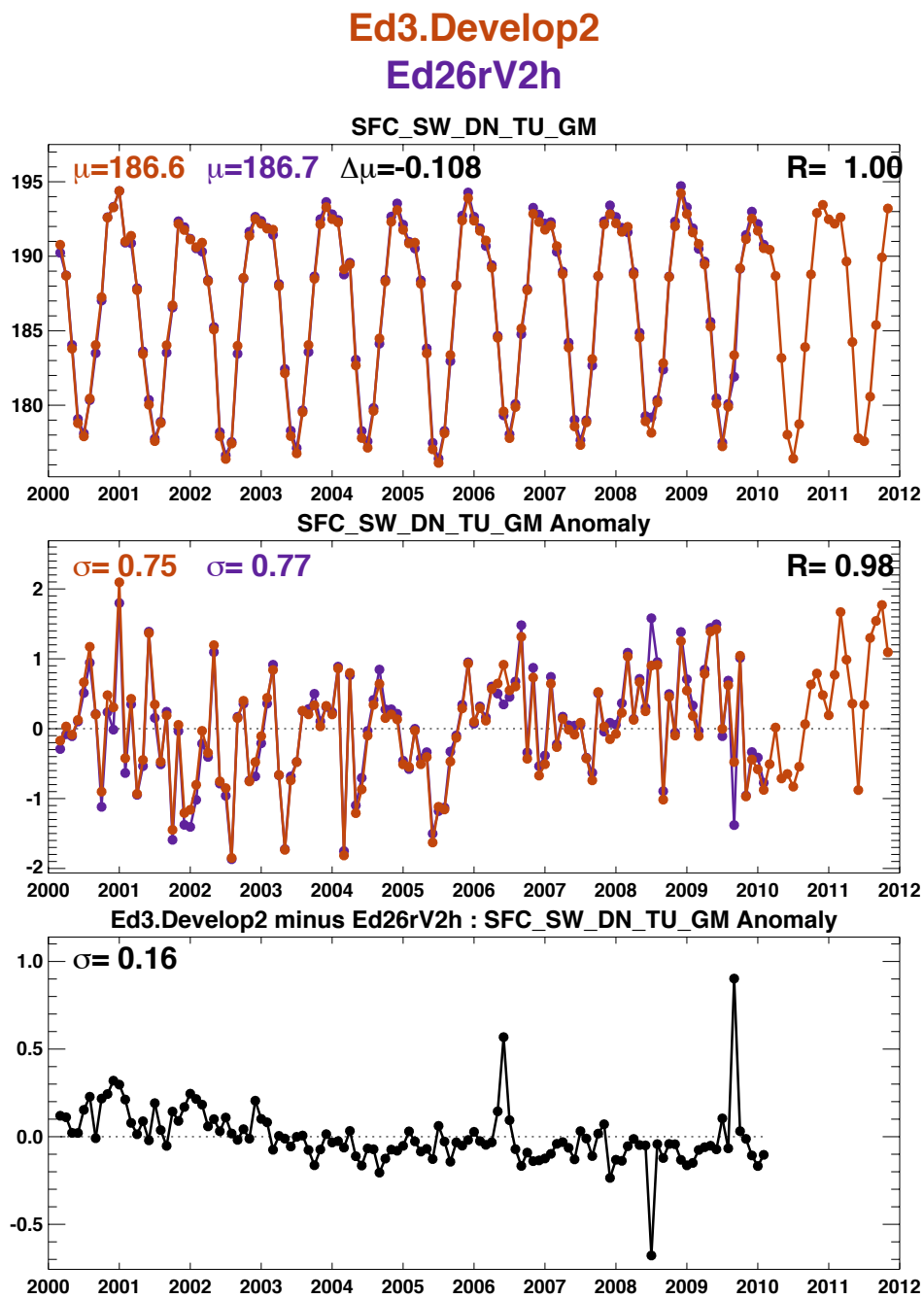
•No Change between versions
SOURCE variability present



Surface Shortwave Down

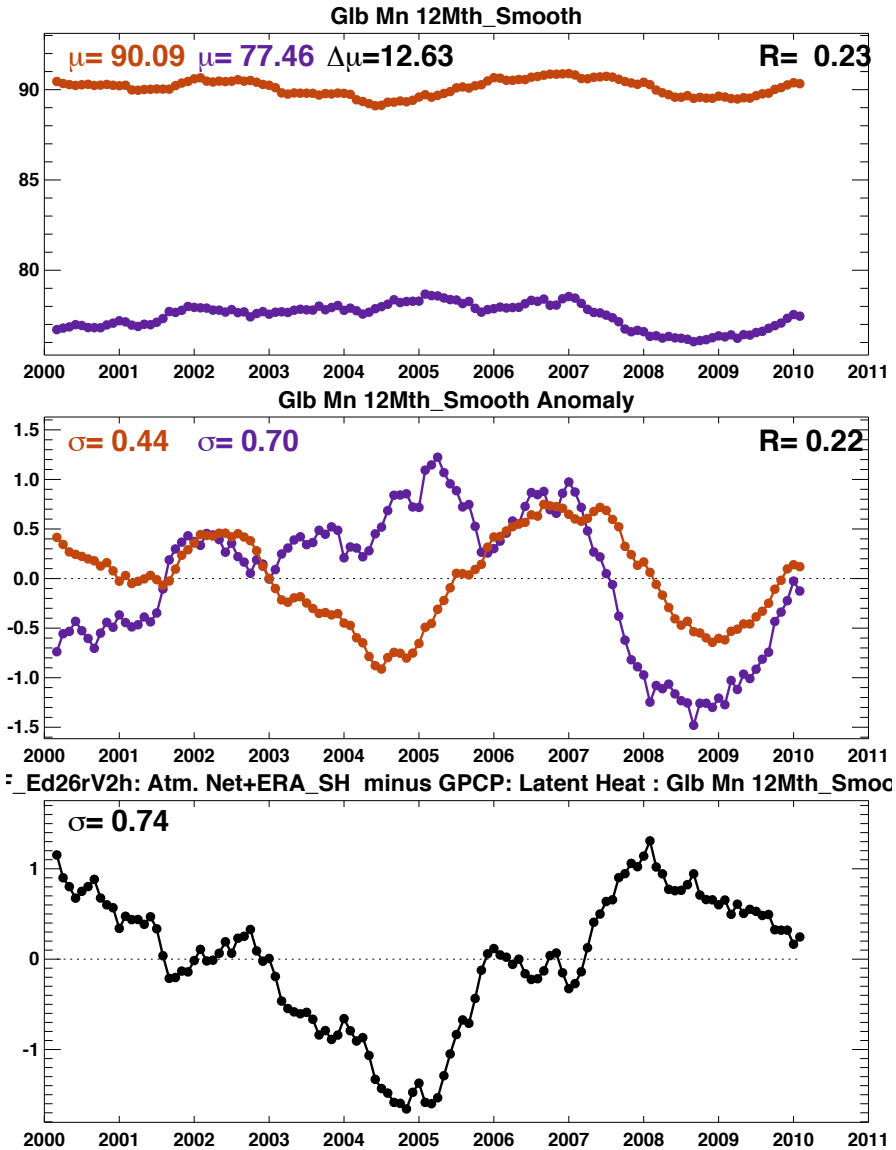
- Ed3.Develop2 SFC SW Down contains a scaled correction for SOURCE TOA insolation variability.

- Formal processing at DAAC of Ed3 cleaned up a few months with outliers

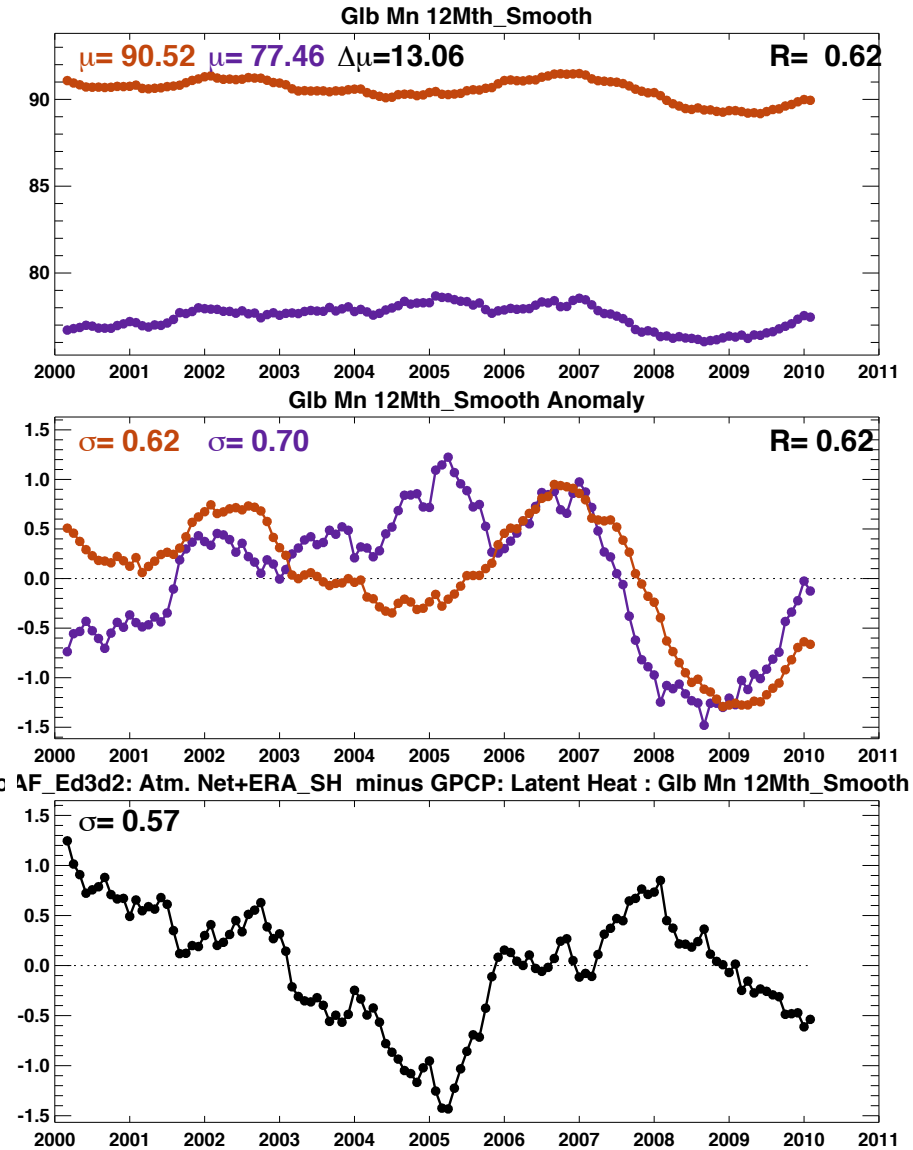


GPCP Precipitation based Latent Heat Vs. SFC_EBAF
(Before & After G5.4.1 Corr.) using ERA-I Sensible Heat

SFC_EBAF_Ed26rV2h: Atm. Net+ERA_SH
GPCP: Latent Heat



SFC_EBAF_Ed3d2: Atm. Net+ERA_SH
GPCP: Latent Heat

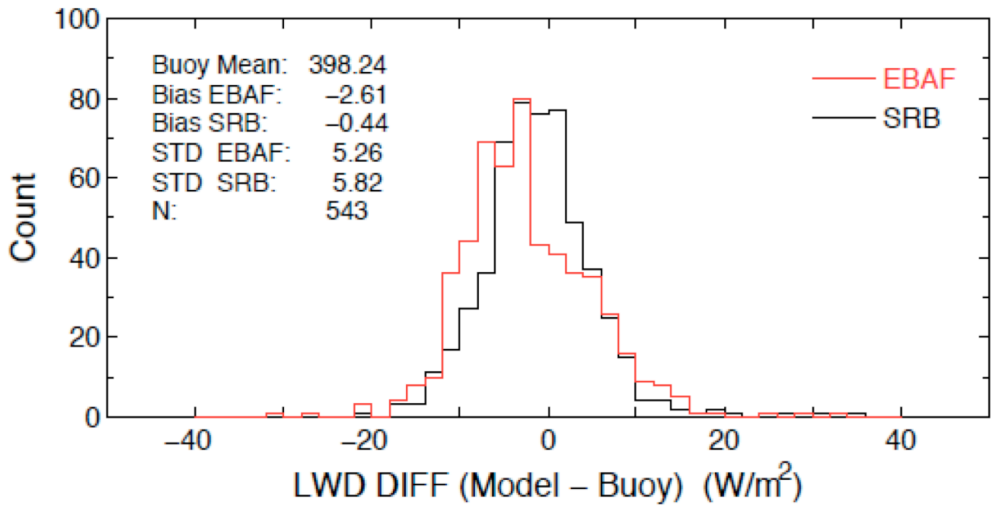


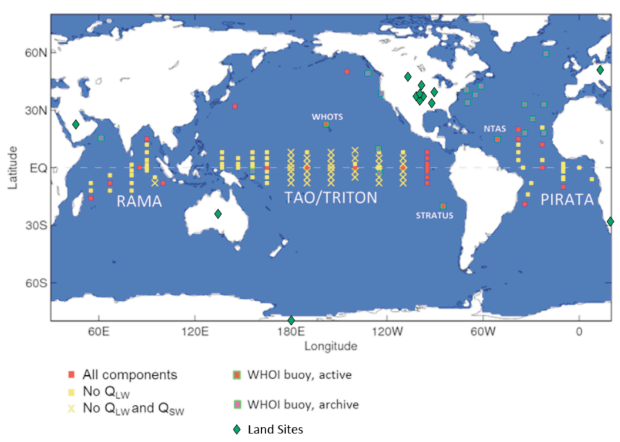
Summary

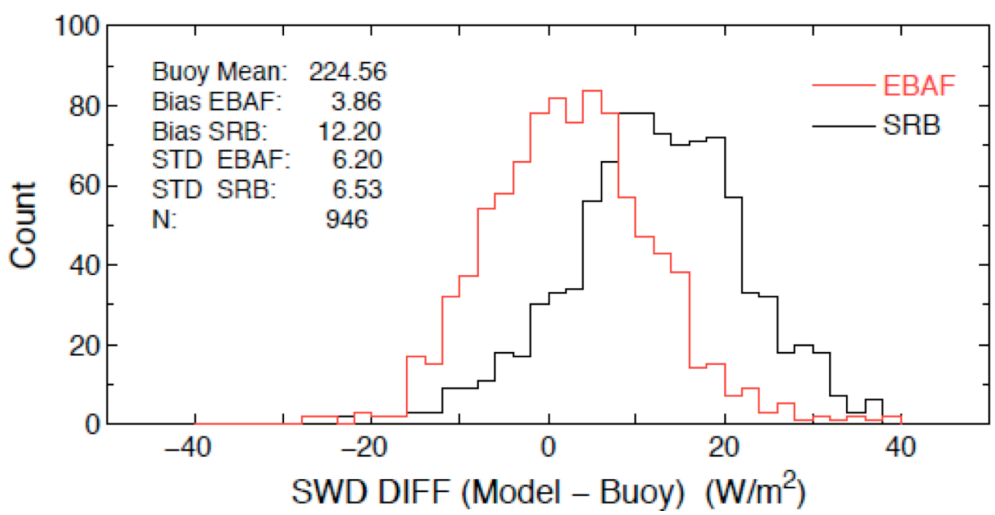
- SFC_EBAF Updates in progress to:
  - Extend record
  - Correct for near surface T,Q deficiencies in especially the GEOS4 time period
  - Fix grid shift found in initial release
  - Reduce effect of “dirty Jacobian”
- Next formal release beyond what was shown here is to use:
  - Full time-series of G5.4.1 correction.
  - A revised TOA_EBAF version as input ?

Backup Slides

Validation at Ocean Buoy Sites 2001-2007





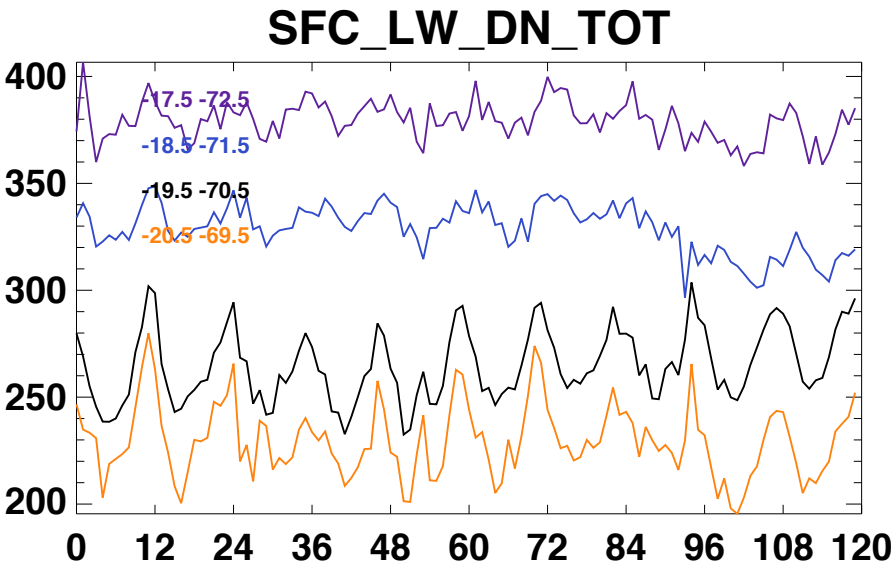


Lisan Yu, WHOI

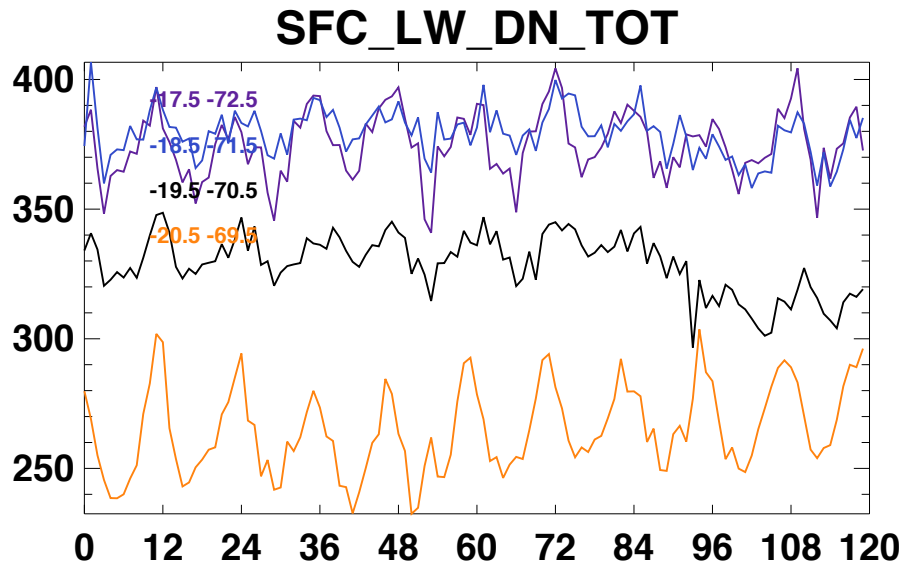
SFC_EBAF Grid shift problem

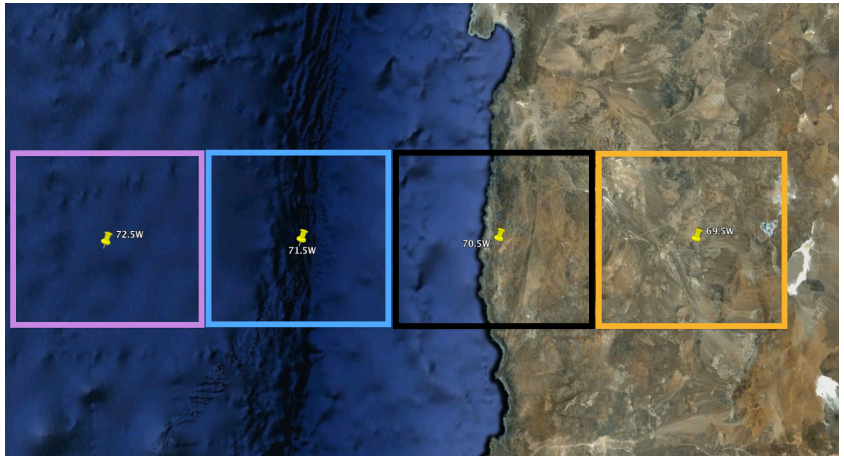
- Shashi Gupta and Anne Wilber discovered a one degree shift to the west of SFC_EBAF data Ed26rV2h in the final 360x 180 deg product
- The shift was **not** in the intermediate(44012)eqArea grid product
- Tracked it to the grid replication process in the production of the final HDF file Fred Rose creates gives to Cristian Mitrescu. I traced it to one line where I had made a mistake but, where 'IDL 7.1 let me down' I don't understand why the code did not "bomb" when it hit the line with the mistake??

Ed26rV2h (Incorrectly shifted 1deg EAST)

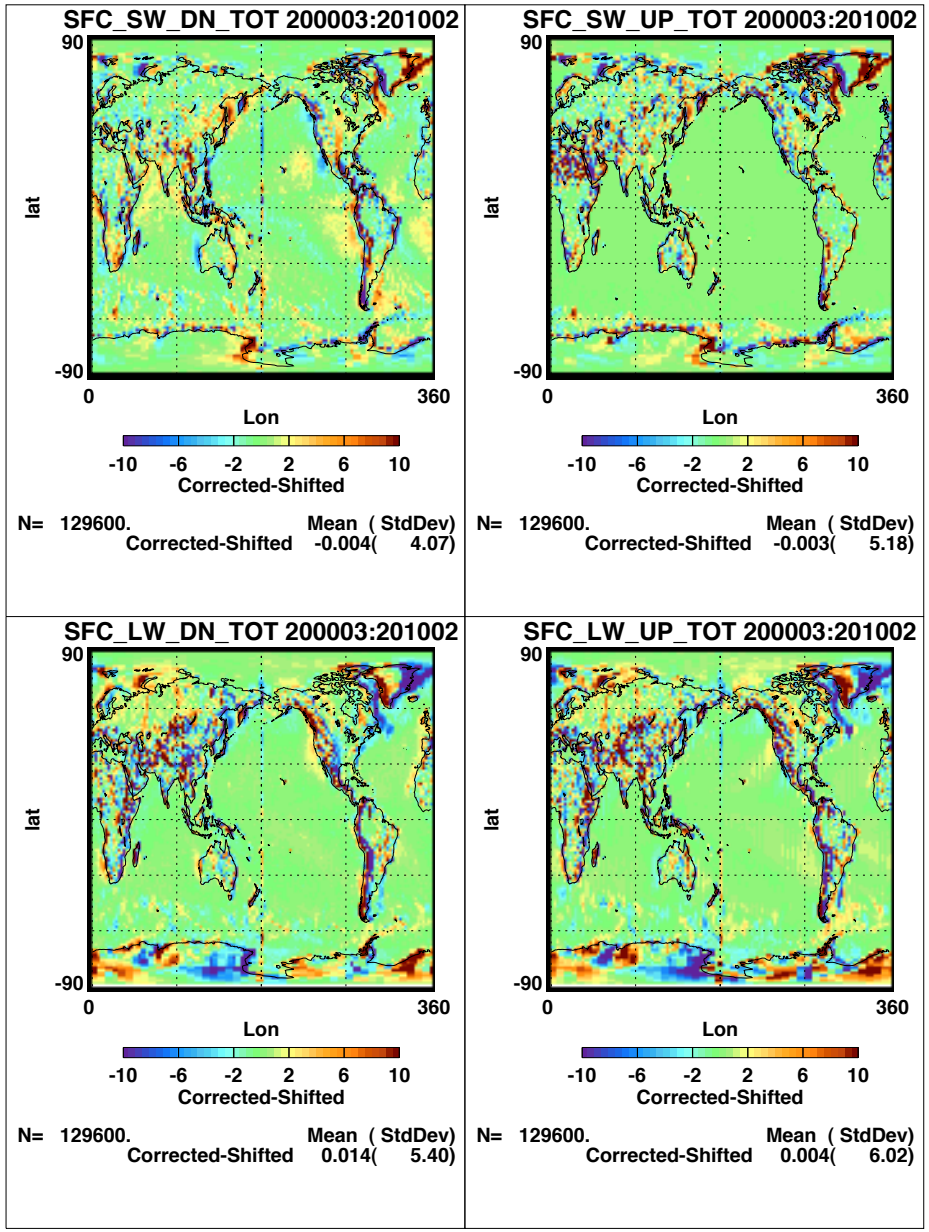


(Corrected)



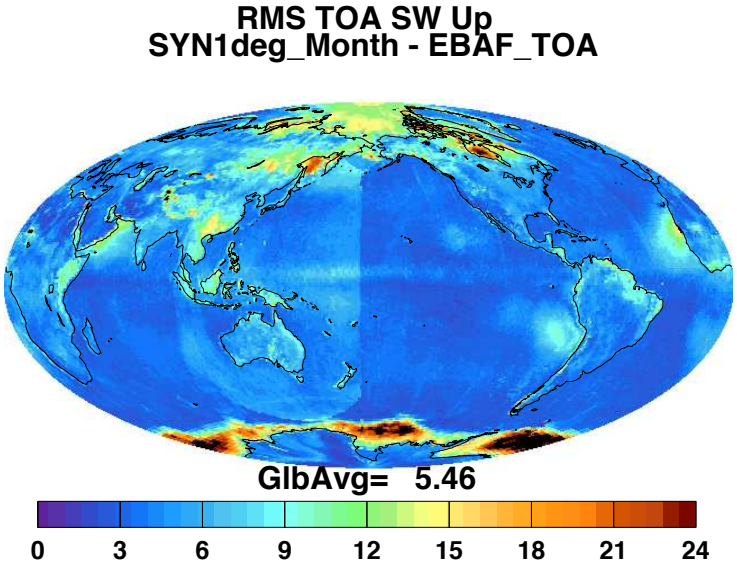


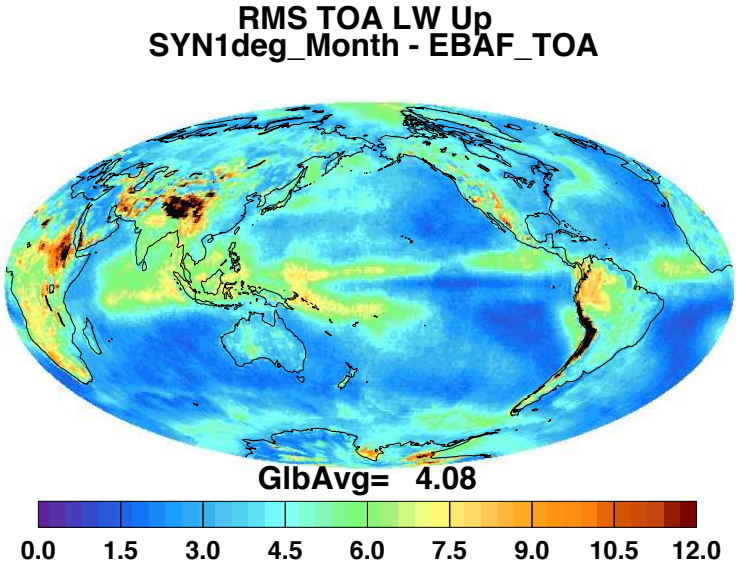
Grid Shift Mean Effect



Ed2 SFC EBAF Decade RMS @TOA

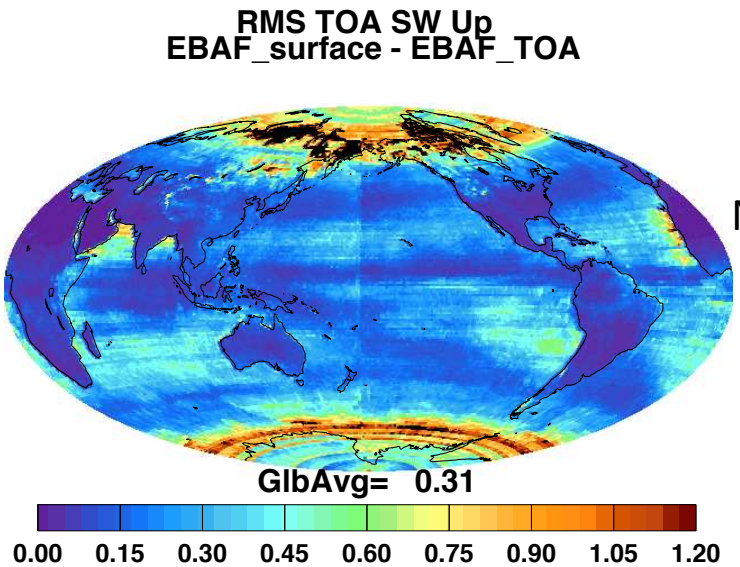
Before

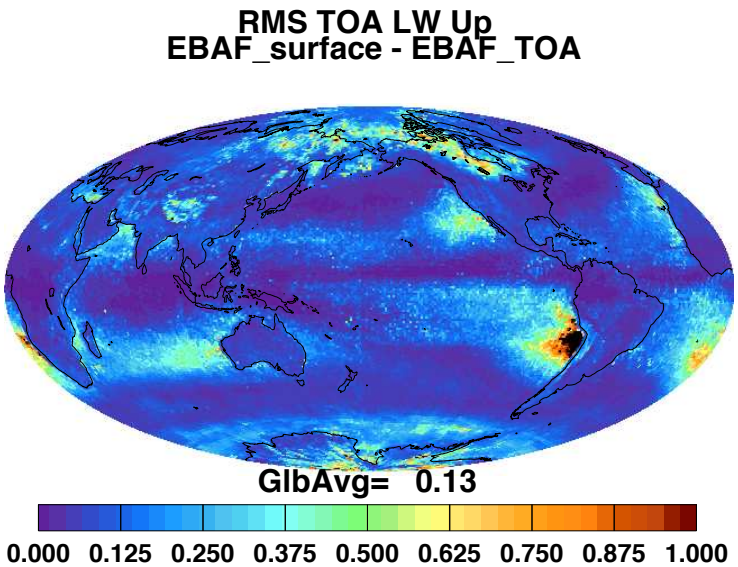




After

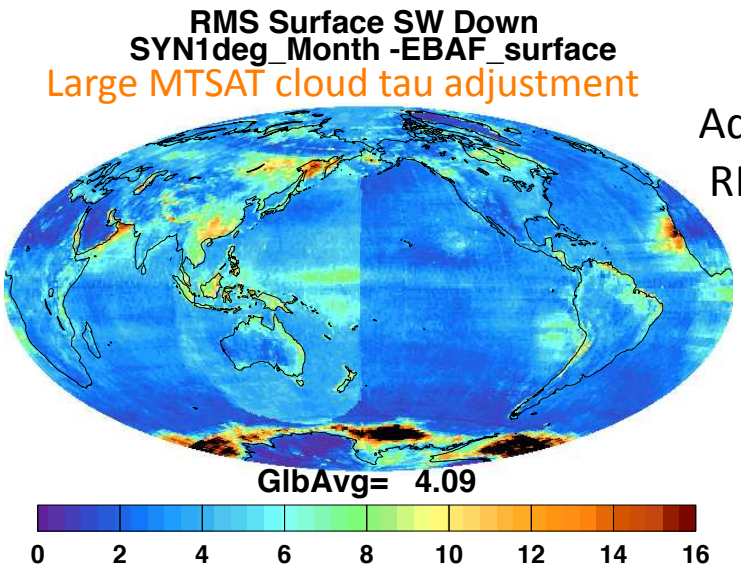
Notice Scale Change



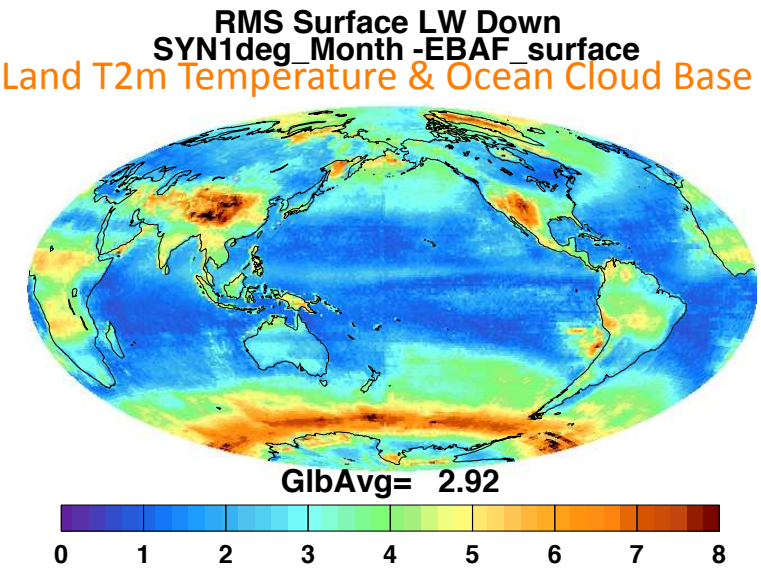


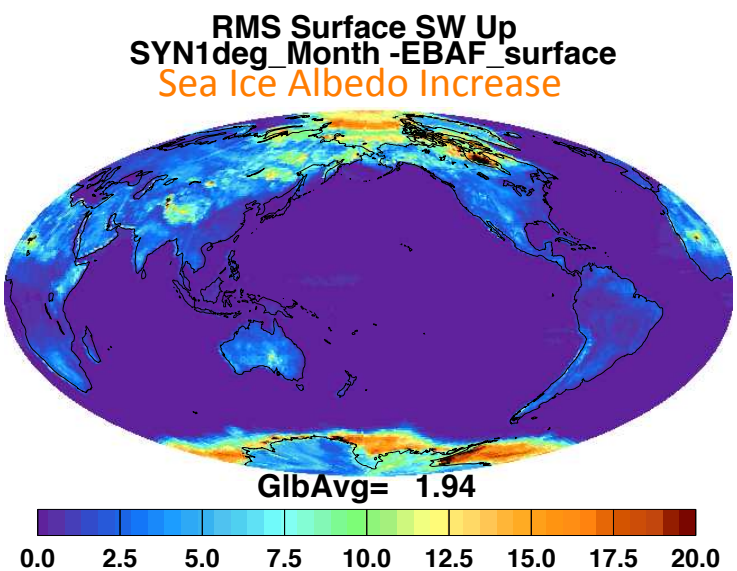
Units Wm^{-2}

Ed2 SFC EBAF Decade RMS @SFC



Adjustment RMS to Sfc Fluxes





Units Wm^{-2}