CERES TOA and Surface Radiative Flux Error Analysis

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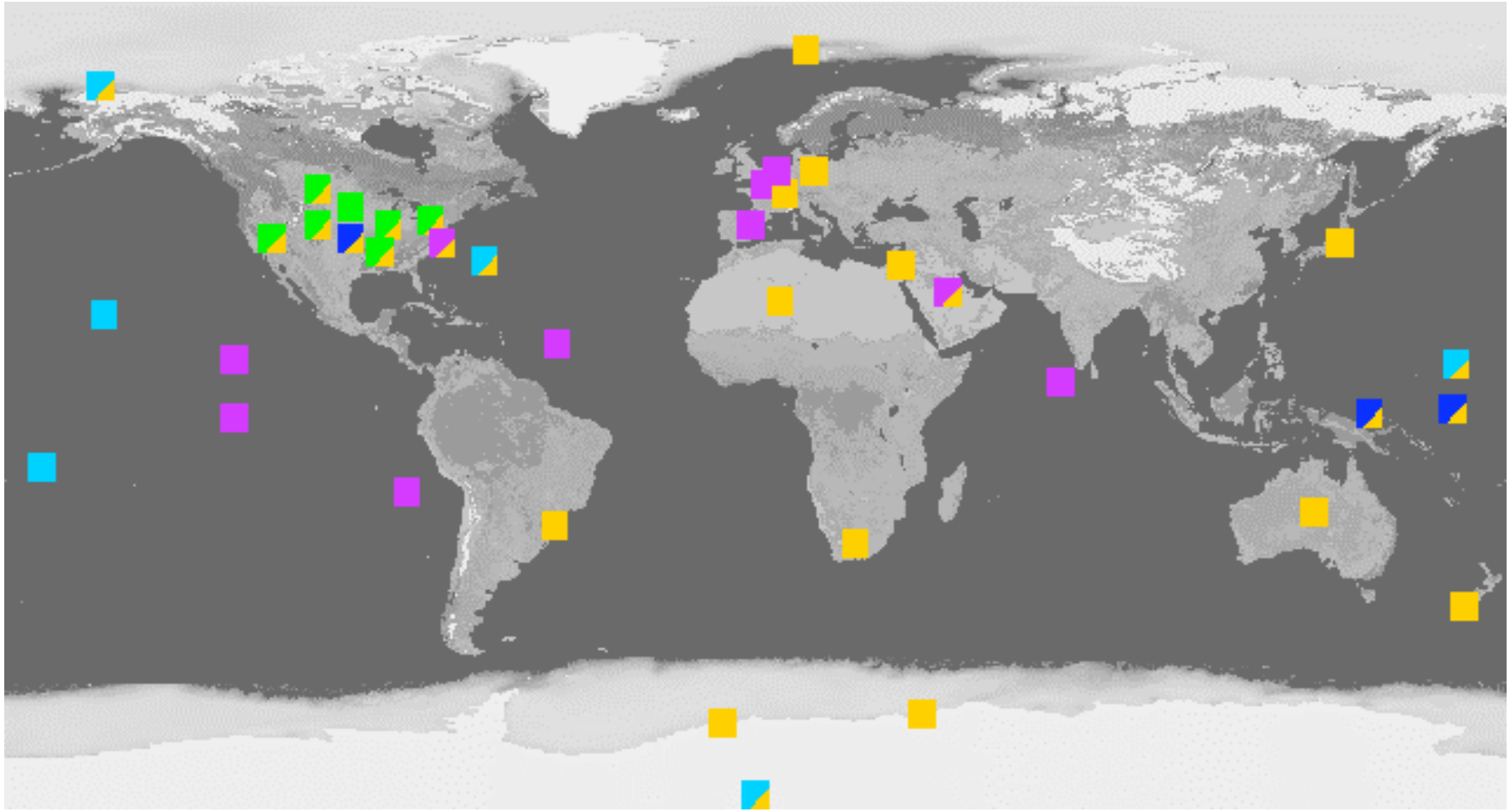
TOA Flux Errors

	Global Interannual Cld Rad Fcing Trend/decade	Zonal Eqtr - Pole Gradient Monthly	1 deg region Monthly (1 σ)	20km fov Instantaneous (1 σ) (S_o = 1000)
Dominant Error Sources	Calibration Stability	Angle Sampling Twilight	Calibration Time Sampling	Angle Sampling
TOA SW Flux	0.3 Wm^{-2} Terra Rev1	3.5 Wm^{-2}	3.0 Wm^{-2}	10 Wm^{-2}
TOA LW Flux	0.5 Wm^{-2} Terra Rev1	2.0 Wm^{-2}	1.5 Wm^{-2}	5 Wm^{-2}
TOA Net Flux	0.6 Wm^{-2} Terra Rev1	4.0 Wm^{-2}	3.5 Wm^{-2}	11 Wm^{-2}
Science Rqmt	0.15 Wm^{-2} 25% feedback	1 - 3 Wm^{-2}	2 - 5 Wm^{-2}	10 Wm^{-2}

ARM/BSRN/CMDL/Surfrad Surface Radiation Sites



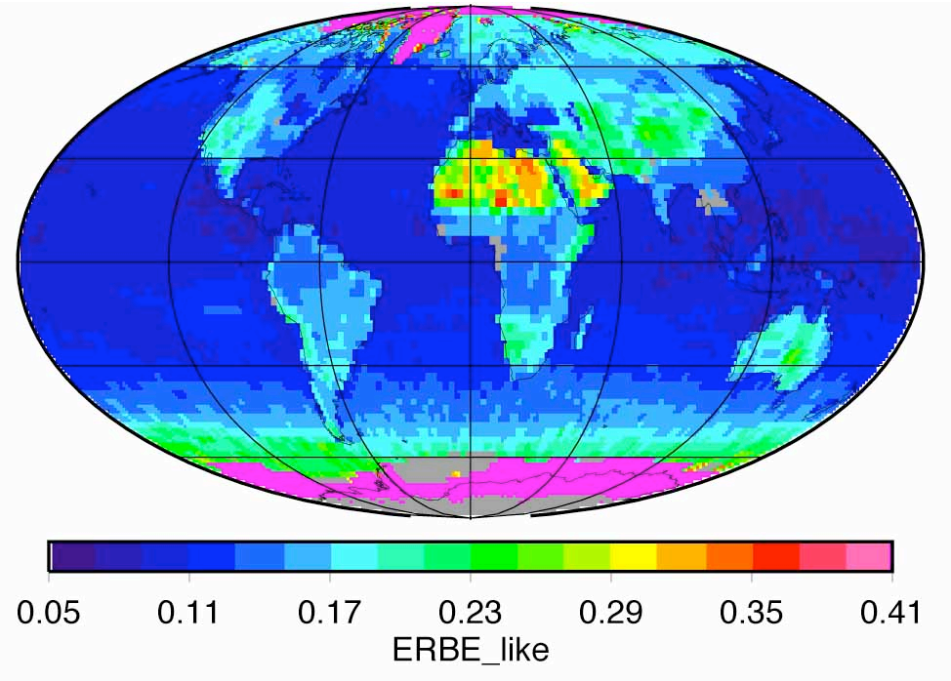
Surface Downward Flux Errors: 20 - 40 Surface Sites

	Global Interannual Cld Rad Fcing Variability	SYN/AVG (est) Month, 1-deg Bias, Clr/All (1 σ)	SRBAVG Month, 1-deg Bias All (1σ)	CRS 20km fov Instantaneous 1 σ, Clr/All Sky (S_o = 900)
Dominant Error Sources	TBD	Aerosol, Tair, Polar sfc/cld Site Inhom.	Aerosol, Tair, Param. Site Inhom.	Angle Samp, Water Vapor Aerosol, Tair
Surface Down SW Flux	0.5 Wm^{-2} (40 sites)	0 / +5 Wm^{-2} (σ = 6)	3 Wm^{-2} (σ = 20)	23 / 20 Wm^{-2}
Surface Down LW Flux	1.0 Wm^{-2} (40 Sites)	-7 / -6 Wm^{-2} (σ = 8)	< 1 Wm^{-2} (σ = 10)	12 / 17 Wm^{-2}
Surface Down Total Net Flux	1.1 Wm^{-2} (40 Sites)	-7 / -1 Wm^{-2} (σ = 9)	4 Wm^{-2} (σ = 22)	26 / 26 Wm^{-2}
Science Rqmt	TBD	< 5-10 Wm^{-2}	< 5-10 Wm^{-2}	< 25 Wm^{-2}
BSRN Acc.	TBD	5 SW?, 10 LW?	5 SW, 10 LW	15 SW, 10 LW

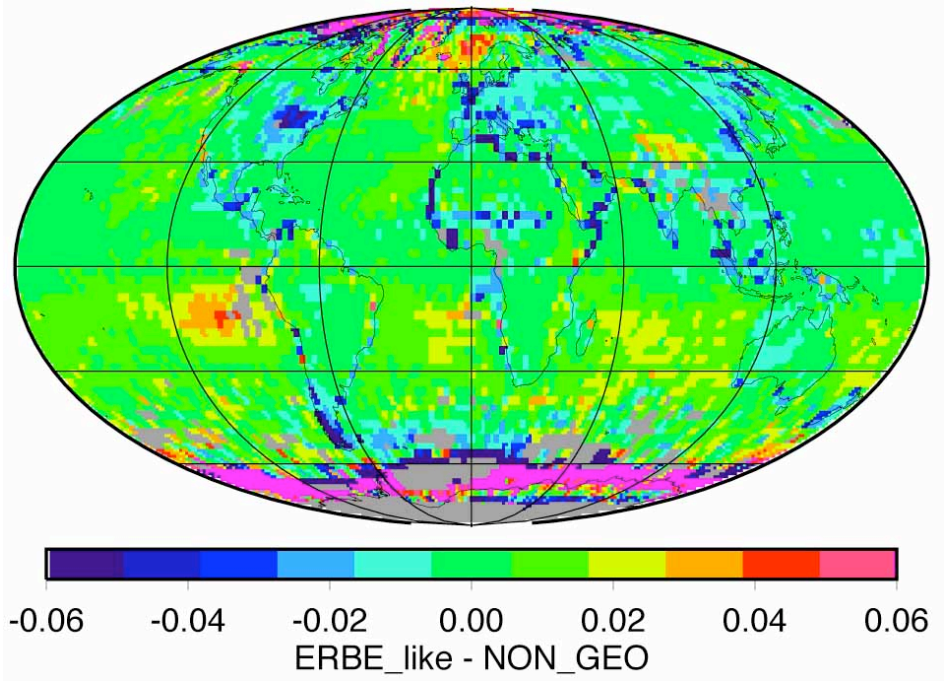
Comparisons with ERBE-Like

Aug 2002 Clear-sky Albedo

ERBE-like mean



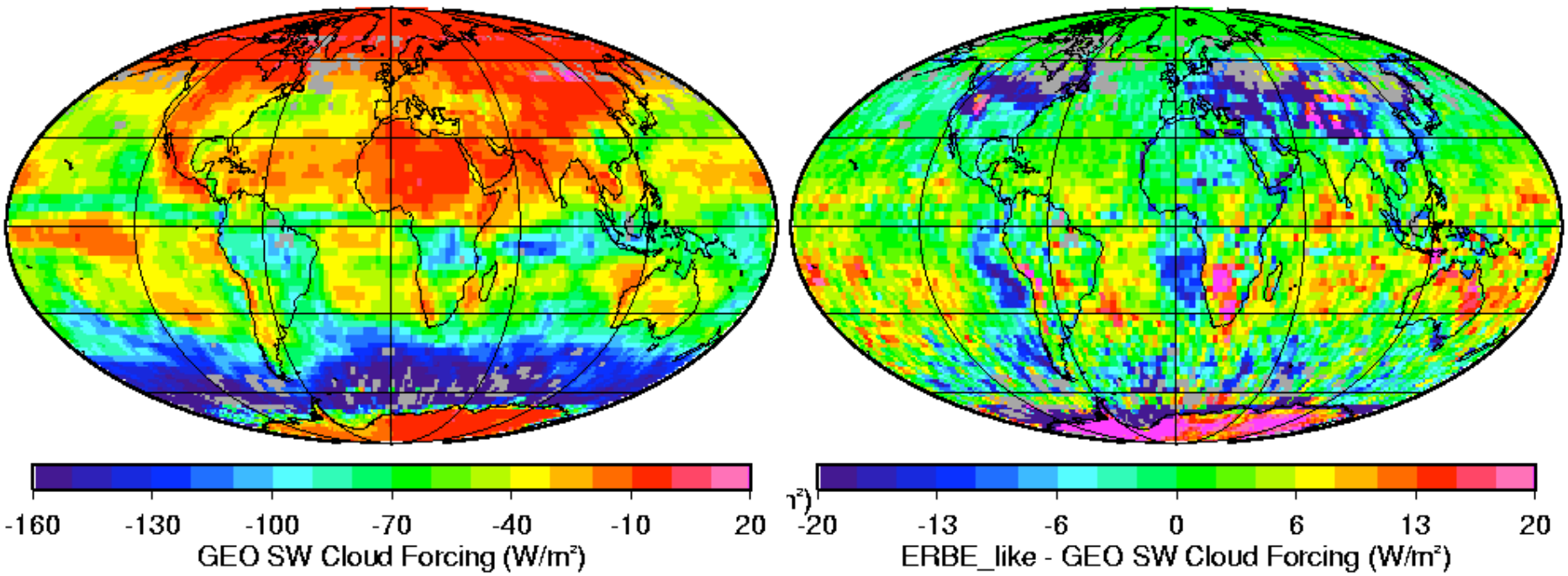
ERBE-like – SRBAVG_nonGEO



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

TOA SW Cloud Forcing, Jan 2002

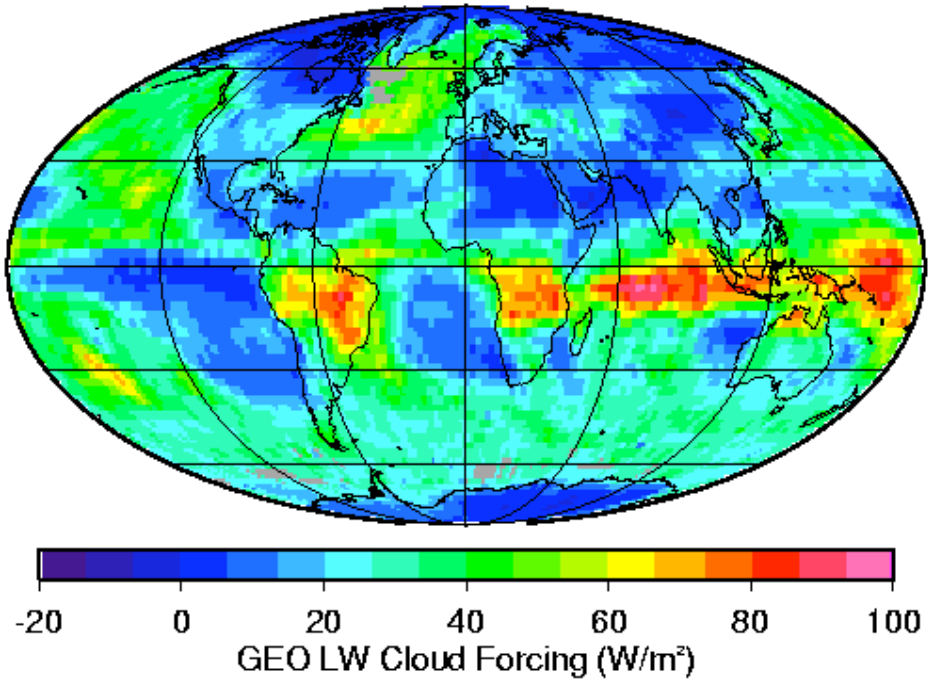
SRBAVG_GEO **ERBE-like – SRBAVG_GEO**



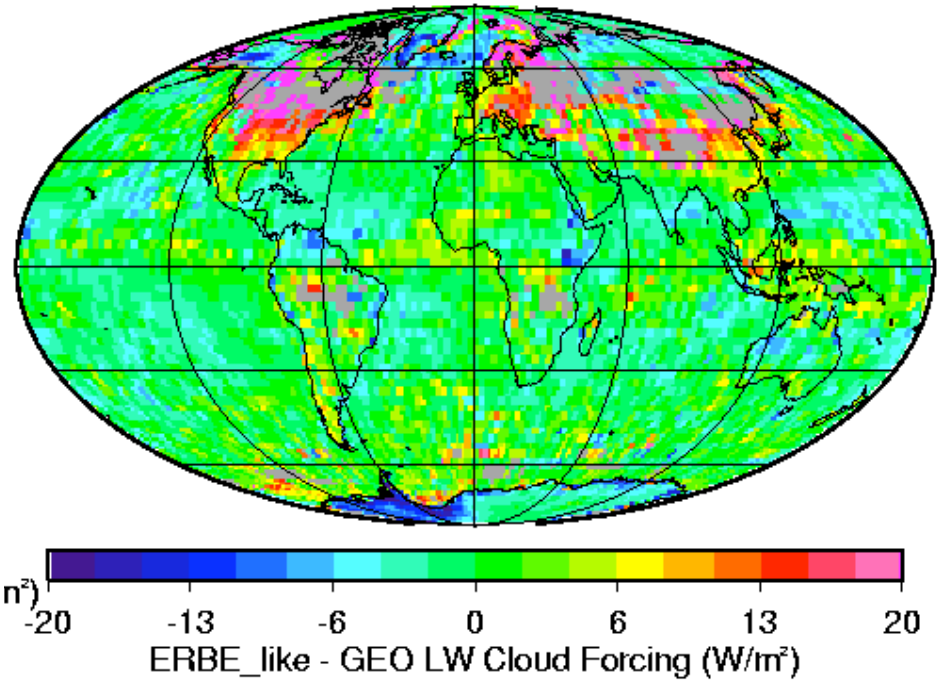
- $SW_{CF} = SW_{clear\text{-}sky} - SW_{all\text{-}sky}$ Blue is cooling, Red is warming

TOA LW Cloud Forcing, Jan 2002

SRBAVG-GEO

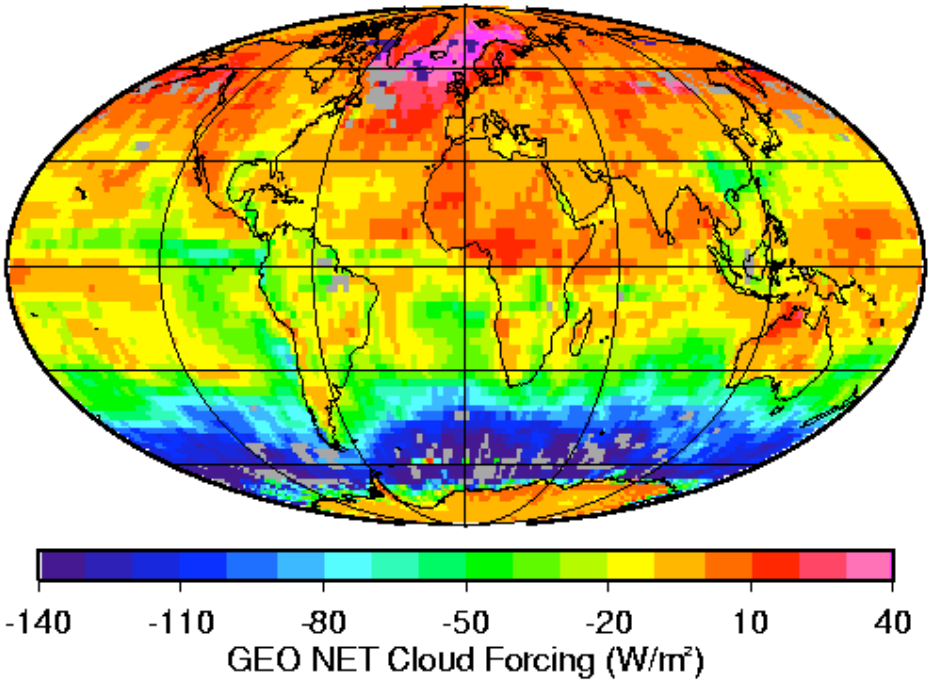


ERBE-like – SRBAVG_GEO

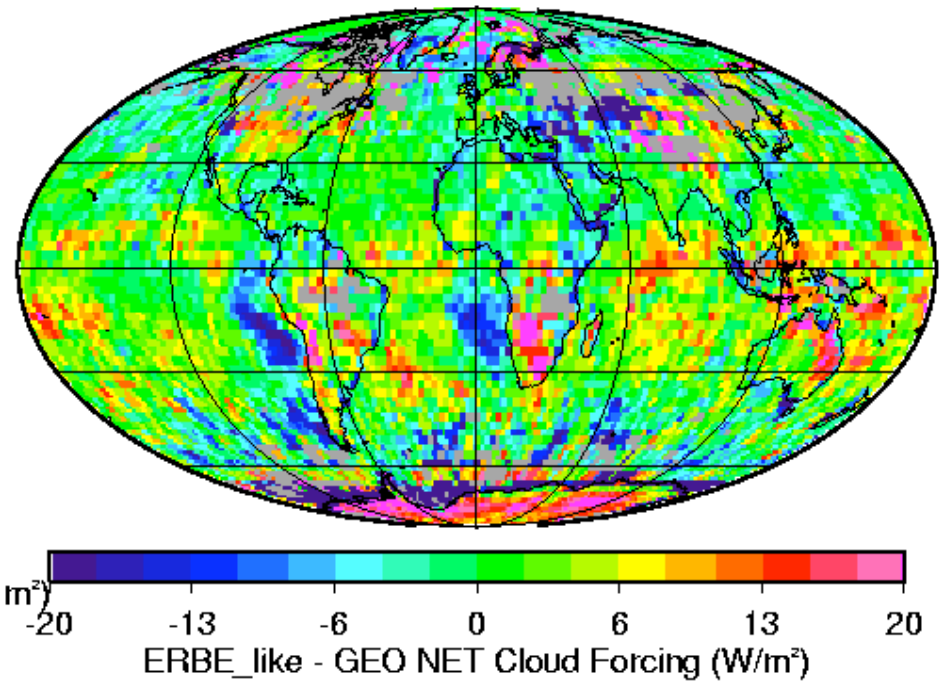


TOA NET Cloud Forcing, Jan 2002

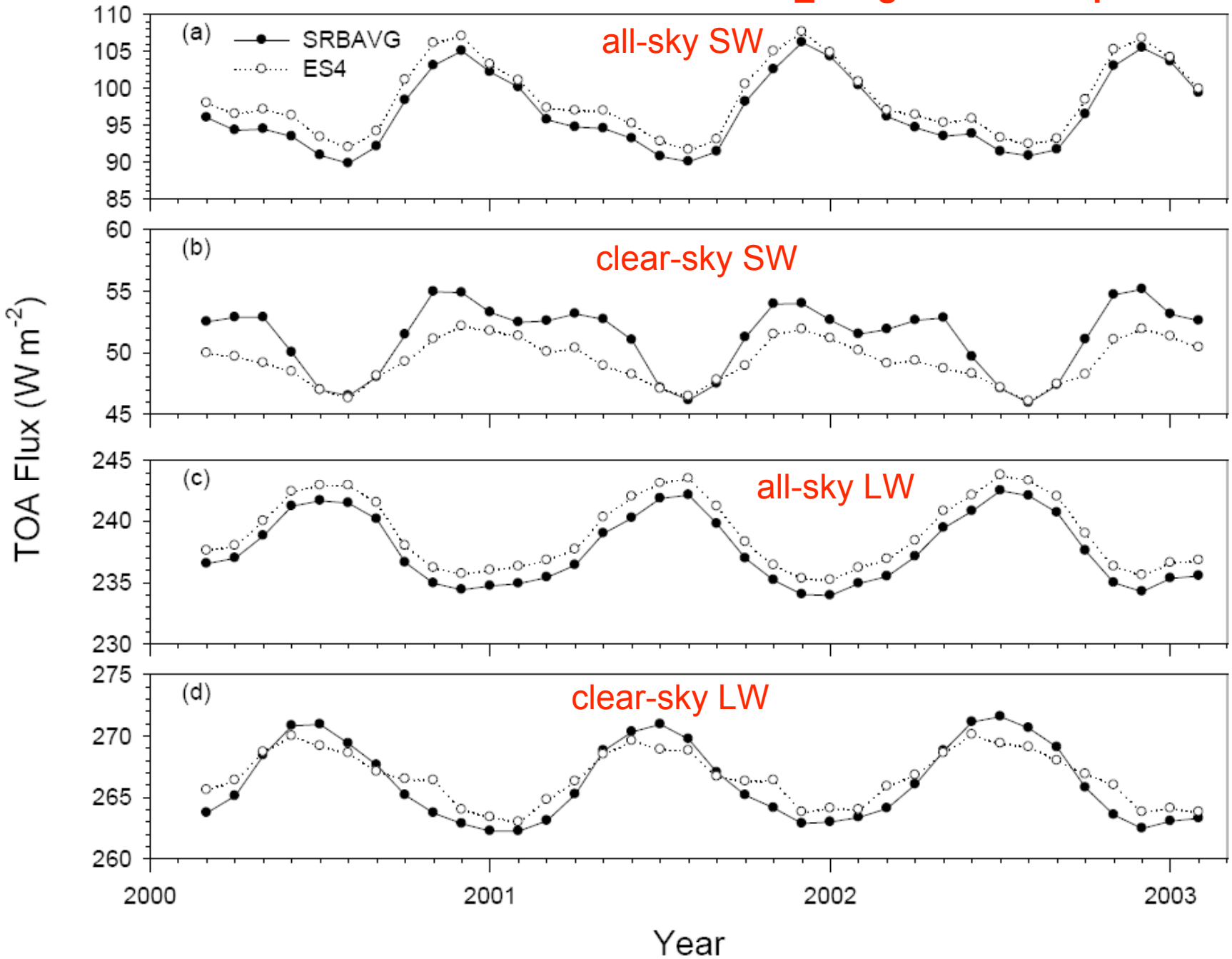
SRBAVG_GEO



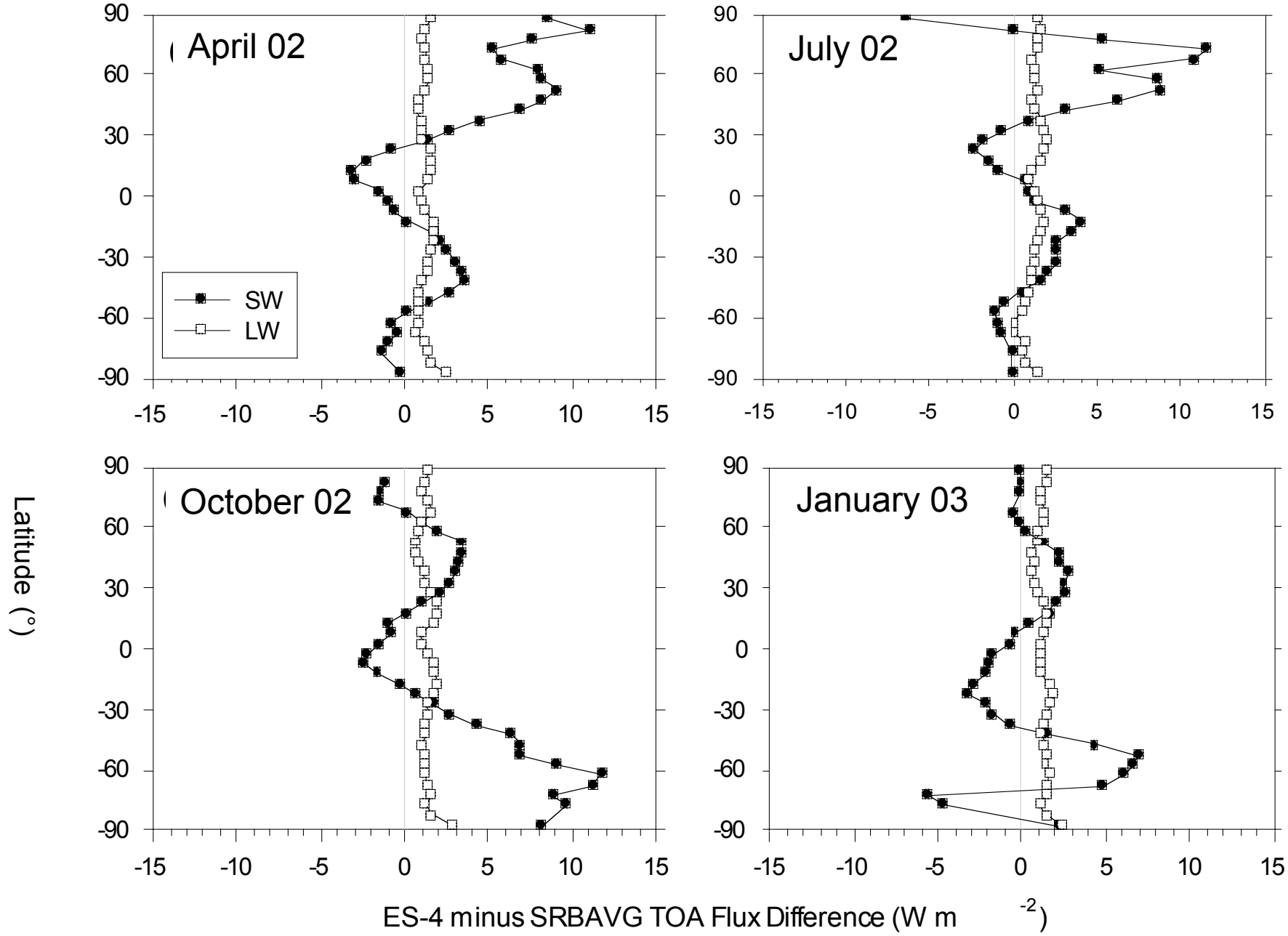
ERBE-like – SRBAVG_GEO



Global TOA flux derived from SRBAVG_nongeo and ES4 products



SW & LW TOA Flux Difference (ES4 – SRBAVG_nongeo)



CERES Global TOA Fluxes (3-year mean)

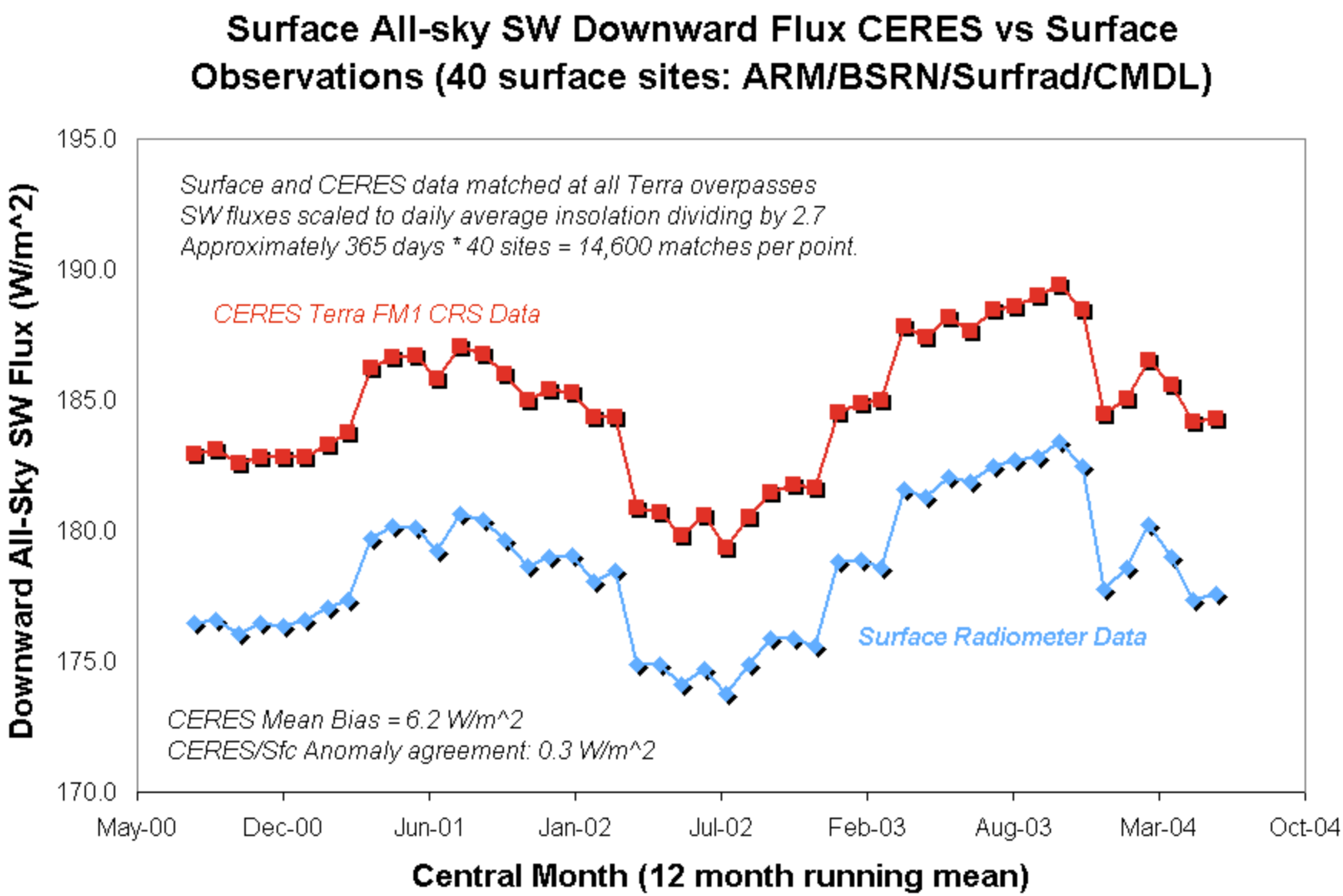
Wm^{-2}	CERES ERBE-Like	CERES SRBAVG (non-GEO)	CERES SRBAVG (GEO)
SW (all-sky)	98.5	96.7	97.8
LW (all-sky)	239.0	237.7	237.1
Net (all-sky)	3.8	6.9	6.4
SW (clr-sky)	49.4	51.2	51.1
LW (clr-sky)	266.7	266.3	264.0
Net (clr-sky)	25.4	23.8	26.3

Global Net Flux Balance Error Budget

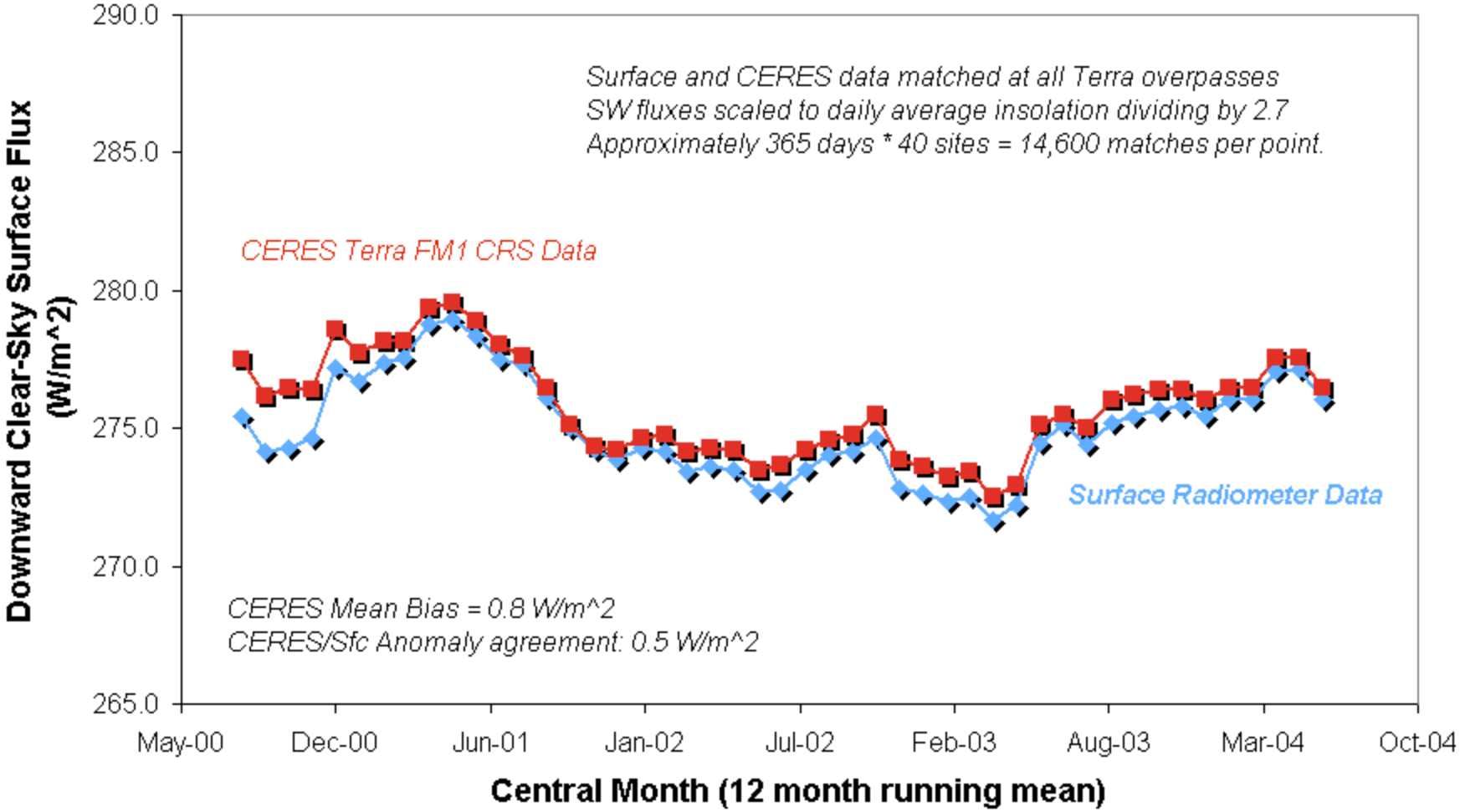
(out of 1365/ 4 = 341.25 Wm^{-2} = SW + LW)

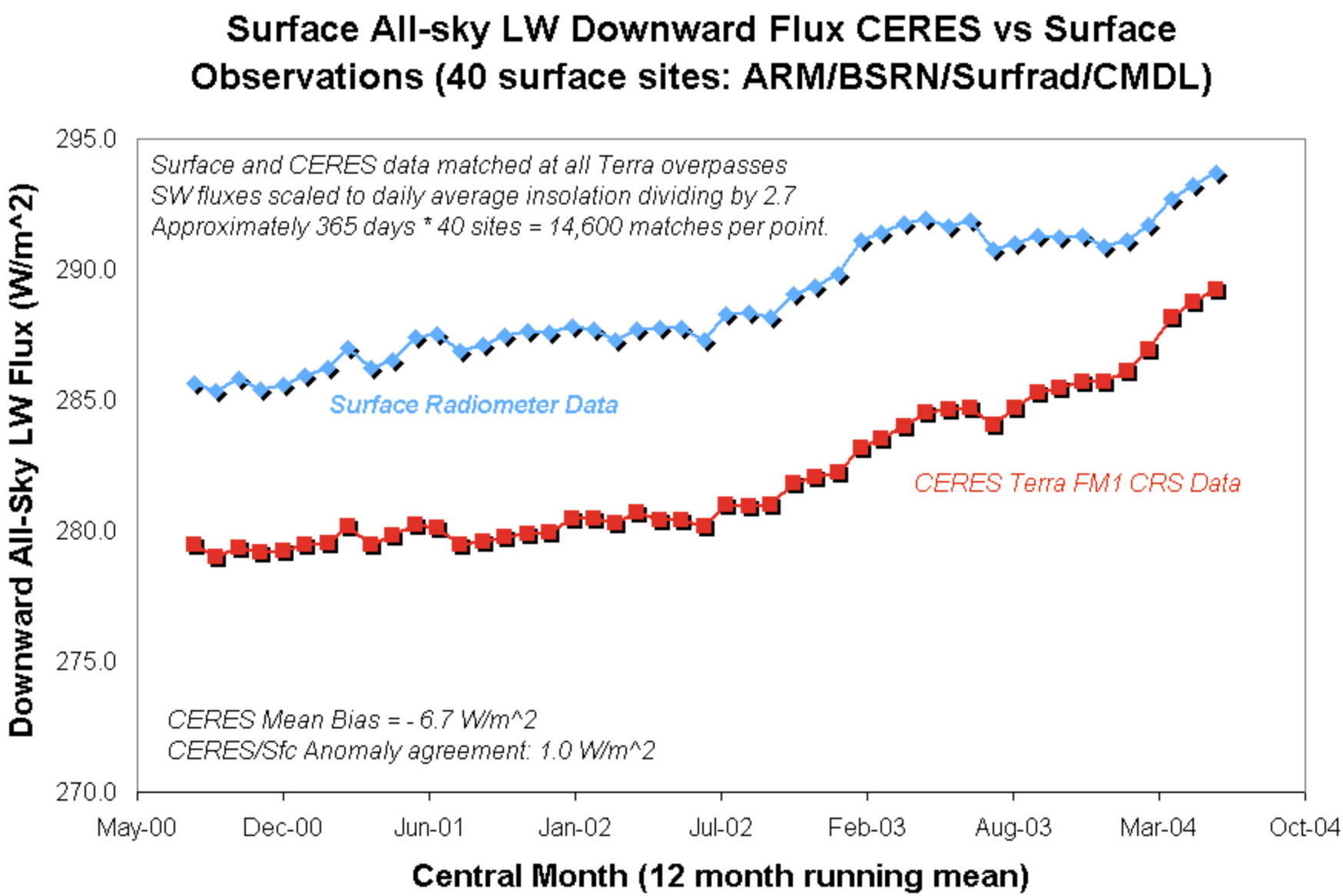
Error Source (white = heating)	SW	LW	Net
Solar Constant (1361 vs 1365)	+ 1.0	0.0	+ 1.0
Absolute Calibration	1.0	1.0	2.0
Spectral Correction	0.5	0.3	0.8
Spatial Sampling	< 0.1	< 0.1	< 0.1
Angle Sampling (ADMs)	+ 0.2	- 0.1	+ 0.1
Time Sampling (diurnal)	< 0.2	< 0.2	< 0.2
Reference Altitude (20km)	0.1	0.2	0.3
Twilight SW Flux (= 0.25 Wm^{-2})< 0.1	0.0	< 0.1	
Near Terminator SW Flux	+ 0.7	0.0	+ 0.7
3-D Cloud τ_{vis} bias on $\alpha(\Theta_o)$	+ 0.7	0.0	+ 0.7
Ocean Heat Storage			+ 0.4 - 1.0
Expected Global Net Range:			0 to + 6.5
CERES SRBAVG Ed2D Global Net			+ 6.4

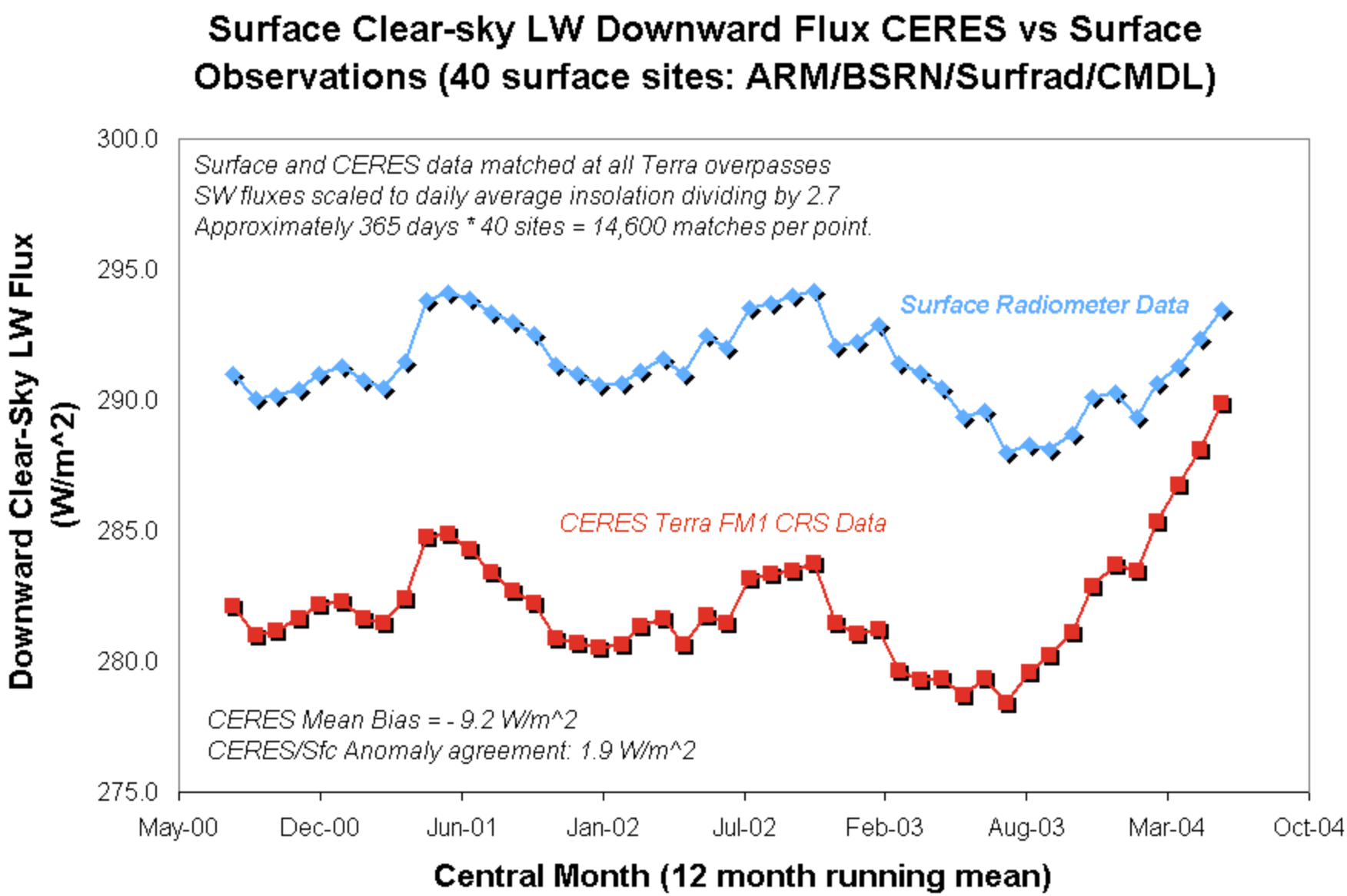
- *Will provide community with advice for optimal global "closure"*


Surface All-sky SW Downward Flux CERES vs Surface Observations (40 surface sites: ARM/BSRN/Surfrad/CMDL)
Surface and CERES data matched at all Terra overpasses
SW fluxes scaled to daily average insolation dividing by 2.7
Approximately 365 days * 40 sites = 14,600 matches per point.
CERES Terra FM1 CRS Data
Surface Radiometer Data
CERES Mean Bias = 6.2 W/m^2
CERES/Sfc Anomaly agreement: 0.3 W/m^2
Downward All-Sky SW Flux (W/m^2)
195.0
190.0
185.0
180.0
175.0
170.0
May-00
Dec-00
Jun-01
Jan-02
Jul-02
Feb-03
Aug-03
Mar-04
Oct-04
Central Month (12 month running mean)

Surface Clear-sky SW Downward Flux CERES vs Surface Observations (40 surface sites: ARM/BSRN/Surfrad/CMDL)




Surface All-sky LW Downward Flux CERES vs Surface Observations (40 surface sites: ARM/BSRN/Surfrad/CMDL)
Surface and CERES data matched at all Terra overpasses
SW fluxes scaled to daily average insolation dividing by 2.7
Approximately 365 days * 40 sites = 14,600 matches per point.
Surface Radiometer Data
CERES Terra FM1 CRS Data
CERES Mean Bias = - 6.7 W/m^2
CERES/Sfc Anomaly agreement: 1.0 W/m^2
Downward All-Sky LW Flux (W/m^2)
295.0
290.0
285.0
280.0
275.0
270.0
May-00
Dec-00
Jun-01
Jan-02
Jul-02
Feb-03
Aug-03
Mar-04
Oct-04
Central Month (12 month running mean)


Surface Clear-sky LW Downward Flux CERES vs Surface Observations (40 surface sites: ARM/BSRN/Surfrad/CMDL)
Surface and CERES data matched at all Terra overpasses
SW fluxes scaled to daily average insolation dividing by 2.7
Approximately 365 days * 40 sites = 14,600 matches per point.
Surface Radiometer Data
CERES Terra FM1 CRS Data
CERES Mean Bias = - 9.2 W/m^2
CERES/Sfc Anomaly agreement: 1.9 W/m^2
Downward Clear-Sky LW Flux (W/m^2)
300.0
295.0
290.0
285.0
280.0
275.0
May-00
Dec-00
Jun-01
Jan-02
Jul-02
Feb-03
Aug-03
Mar-04
Oct-04
Central Month (12 month running mean)