Application of the BSRN and RadFlux Data in Validation and Analysis of the GEWEX SRB All-Sky and Clear-Sky Shortwave Downward Fluxes

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Outline of the Presentation

- The characteristics of the GEWEX SRB data
- Surface-based observations
- Comparisons with BSRN observations:
  All-Sky and Clear-Sky
- A quick preview of SRB(Rel. 4.0-IP) as compared to Rel. 3.0
- Summary and conclusions

GEWEX SRB Data Set Characteristics

Main GEWEX SRB Flux Parameters

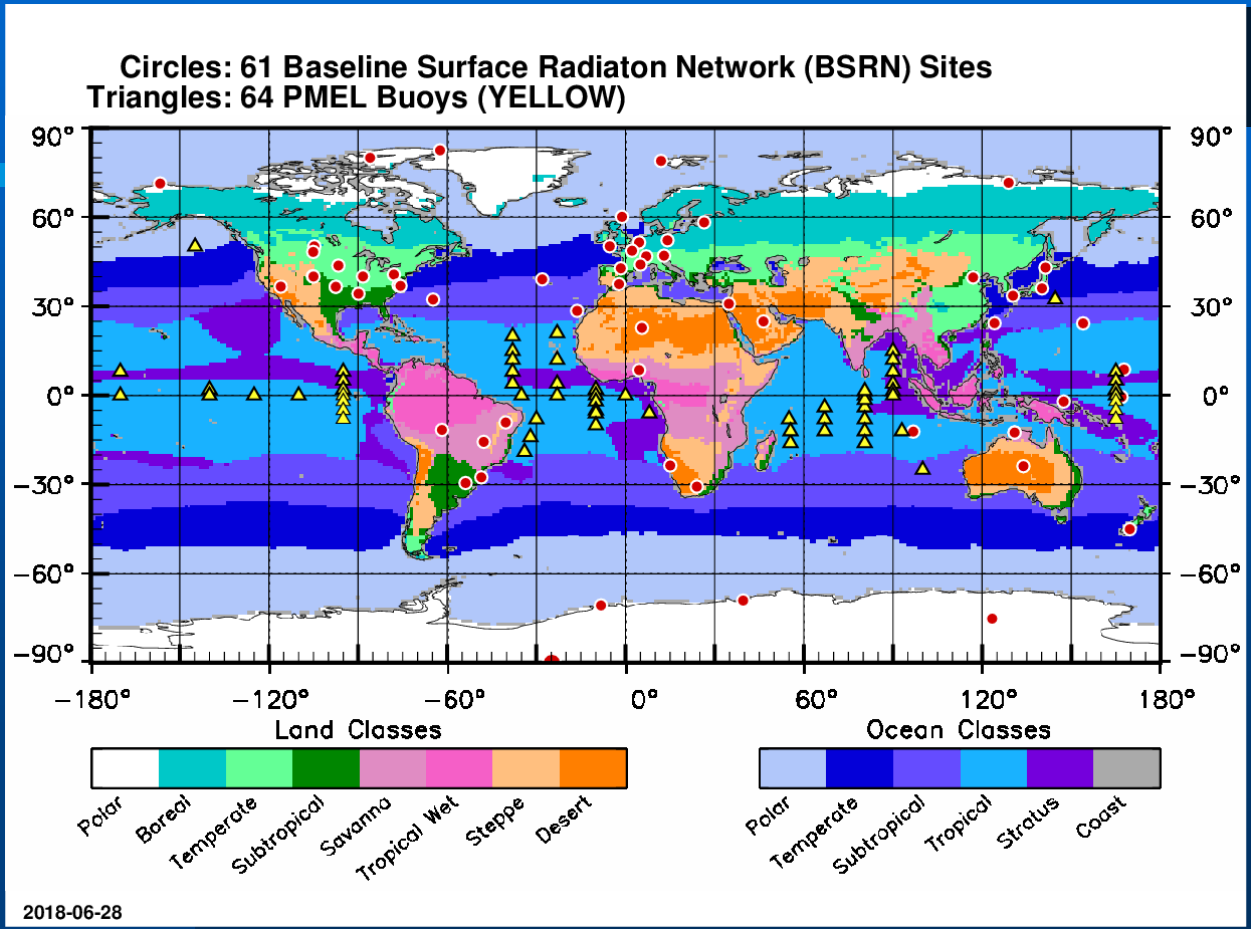
- **Rel. 3.0/3.1: GSW-Pinker/Laszlo, LPSA-Gupta, GLW-Fu/Stackhouse, LPLA-Gupta**
- **Rel. 4.0-IP: GSW-Pinker/Laszlo, GLW-Fu/Stackhouse (boldface only)**

Parameter	Surface Fluxes (W m^{-2})		TOA Fluxes (W m^{-2})	
	Upward	Downward	Upward	Downward
SW All-Sky Flux	**GSW**, LPSA	**GSW**, LPSA	**GSW**	**GSW**, LPSA
SW Clear-Sky Flux	**GSW**, LPSA	**GSW**, LPSA	**GSW**	**GSW,** LPSA
PAR All-Sky Flux	--	**GSW**	--	**GSW**
LW All-Sky Flux	**GLW**, LPLA	**GLW**, LPLA	**GLW**	--
LW Clear-Sky Flux	**GLW**, LPLA	**GLW,** LPLA	**GLW**	--
Day/Night Flag	**GLW**	--	--	--
Sun & View Angles	**GSW**	--	--	--

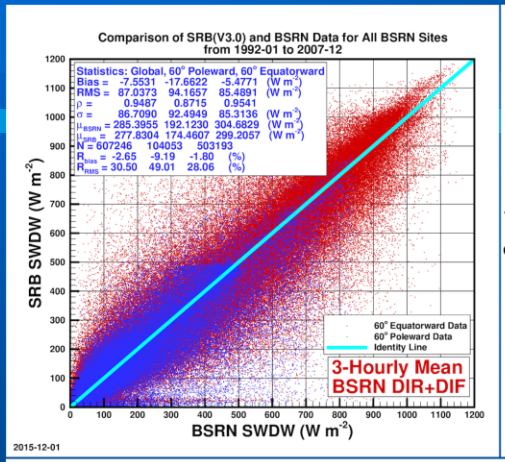
Metadata of Surface-Based Observations

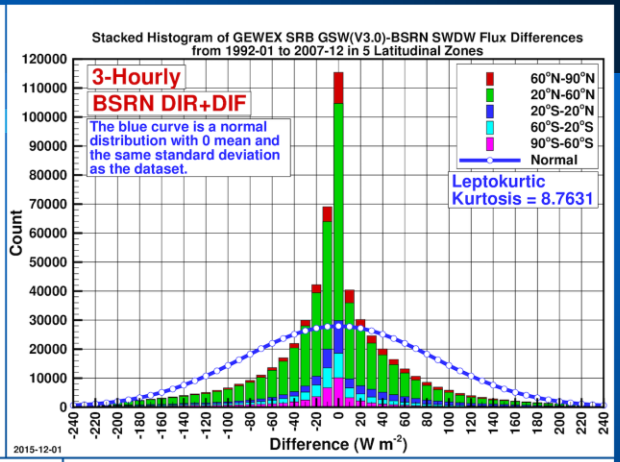
Dateset	Number of Sites	Number of Site-Months	Period
BSRN	61	9800	1992 ~ 2017
RadFlux	42	7119	1992 ~ 2017
PMEL	64	4389	2000 ~ 2017
GEBA	2261	321,942	1901 ~ 2015
WRDC	1259	23,016	1964 ~ 2013

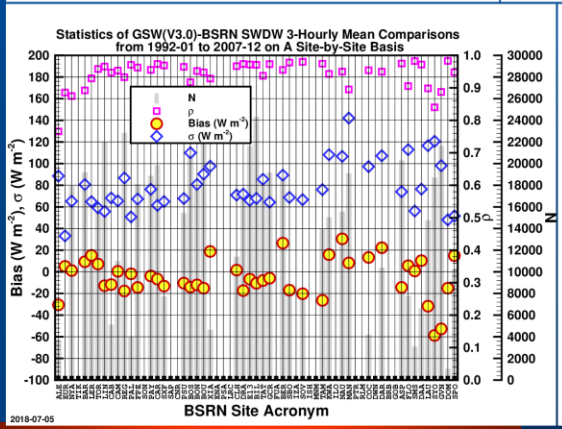
- GEWEX SRB data are being validated against all the data in the above 5 archives, but PMEL, GEBA and WRDC will not be fully covered in this presentation.

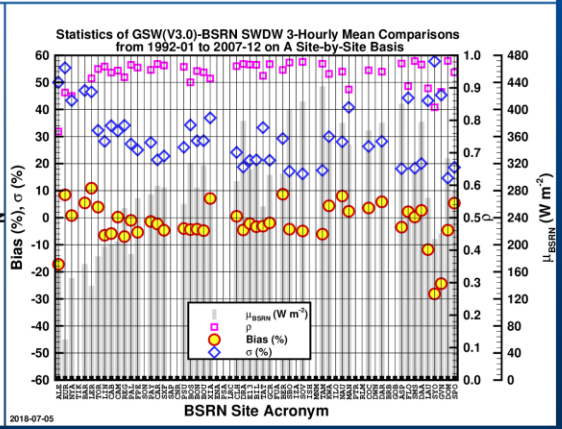

Circles: 61 Baseline Surface Radiaton Network (BSRN) Sites
Triangles: 64 PMEL Buoys (YELLOW)
90°
60°
30°
0°
-30°
-60°
-90°
-180°
-120°
-60°
0°
60°
120°
180°
Land Classes
Polar
Boreal
Temperate
Subtropical
Savanna
Tropical Wet
Steppe
Desert
Ocean Classes
Polar
Temperate
Subtropical
Tropical
Stratus
Coast
2018-06-28

GEWEX SRB GSW(V3.0)-BSRN (Global 1) *3-Hourly* Mean All-Sky SW Downward Flux Comparison for the 16-Year Period from 1992 - 2007

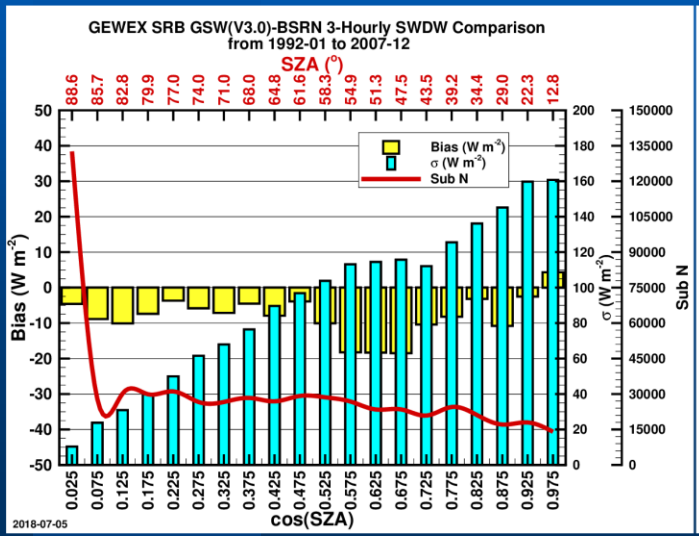


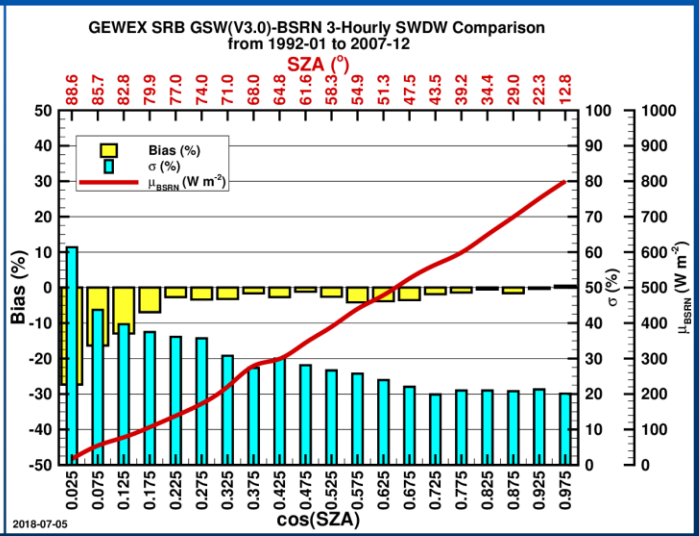






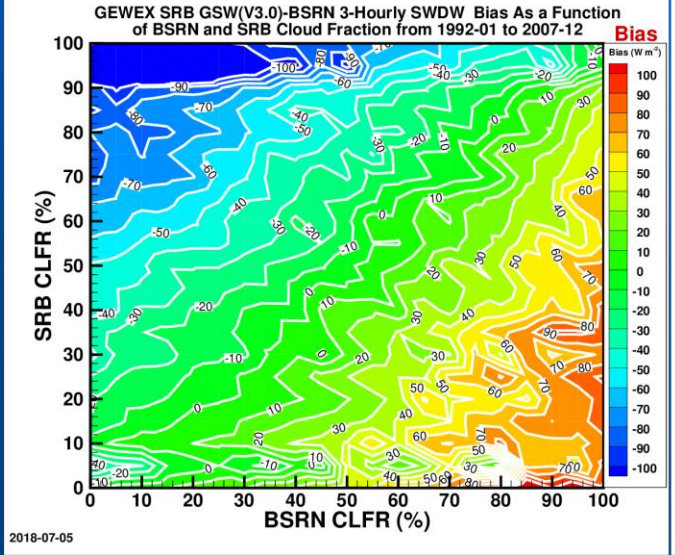
GEWEX SRB GSW(V3.0)-BSRN (Global 1) *3-Hourly* Mean All-Sky SW Downward Flux Comparison for the 16-Year Period from 1992 – 2007 in 0.05-Sized Bins of cos(SZA)



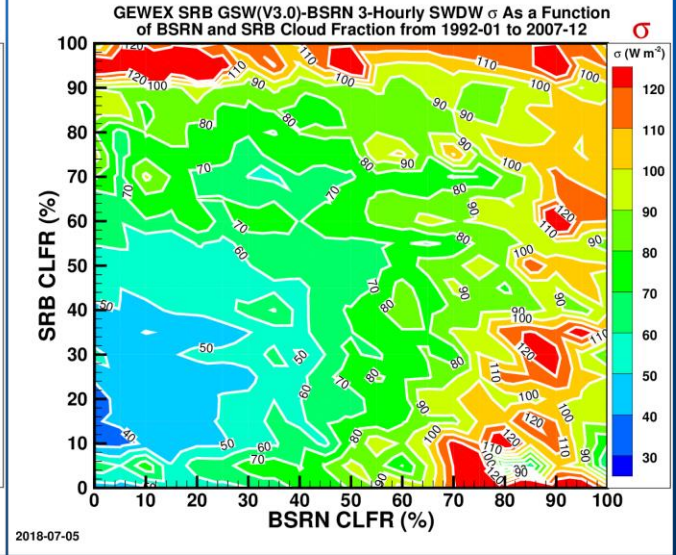


The Effect of SRB-BSRN (Global 1) Cloud-Fraction Difference in the GSW(V3.0)-BSRN *3-Hourly* Mean All-Sky SW Downward Flux Comparison (1992-2007)

Bias (W m^{-2})



σ (W m^{-2})



GEWEX SRB GSW(V3.0) All-Sky Overall Monthly Mean Comparison Statistics

Comparison	Bias	RMS	ρ	σ	μ_{OBS}	N	Period
GSW-BSRN	-5.58	22.72	0.9730	22.02	170.19	4625	**1992-2007**
GSW-GEBA	5.52	22.60	0.9597	21.91	157.47	130809	**1983-2007**
GSW-WRDC	4.76	22.85	0.9632	22.35	158.89	109606	**1983-2007**
GSW-PMEL	11.07	19.00	0.9074	15.44	238.21	1644	**2000-2007**

ρ: correlation coefficient;
σ: standard deviation of differences;
μ_{OBS}: mean of surface-based observations;
N: number of data points.

***Units of Bias, RMS, σ and μ: W m^{-2}**

The Ground-Based RadFlux Clear-Sky Data Derived from BSRN Data

The RadFlux algorithm subjects high temporal resolution (1- to 5-minute data) regularly observed data to 4 tests to identify clear-sky episodes which are then fit to exponential functions of cosine of the Solar Zenith Angle:

1. A normalized total shortwave magnitude test;

2. A maximum diffuse shortwave test;

3. A rate of change of magnitude test; and

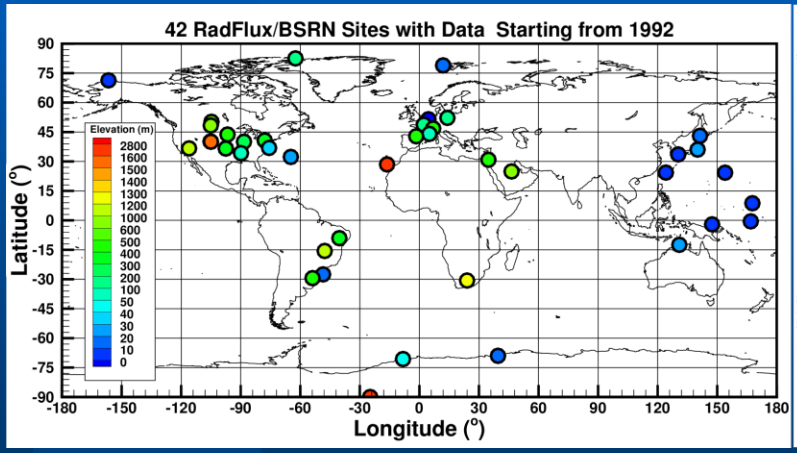
4. A normalized diffuse ratio variability test.

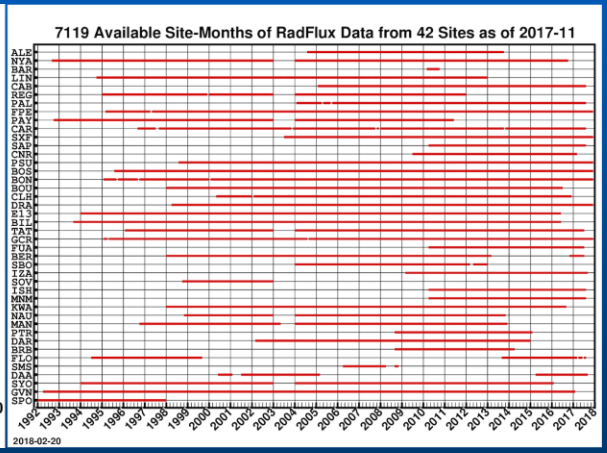
References

Long C.N., Ackerman T.P. Identification of clear skies from broadband pyranometer measurements and calculation of downwelling shortwave cloud effects. J Geophys Res 2000; 105(D12): 15609-26.

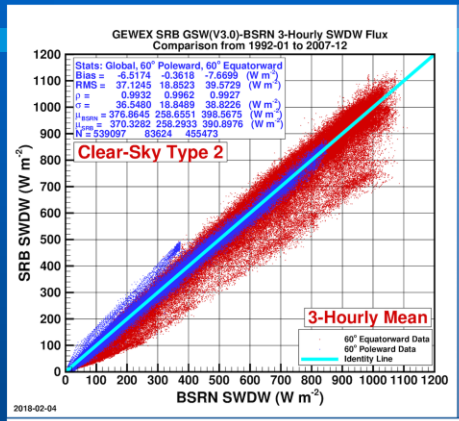
Long C.N., Gaustad K.L. The shortwave (SW) clear-sky detection and fitting algorithm: Algorithm operational details and expressions 2004; DOE/SC-ARM/TR-004.1.

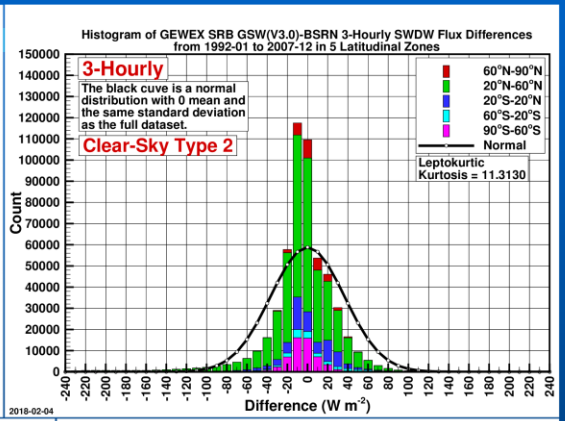
The 42 RadFlux Clear-Sky Data Sites and Available Site-Months as of 2017-11

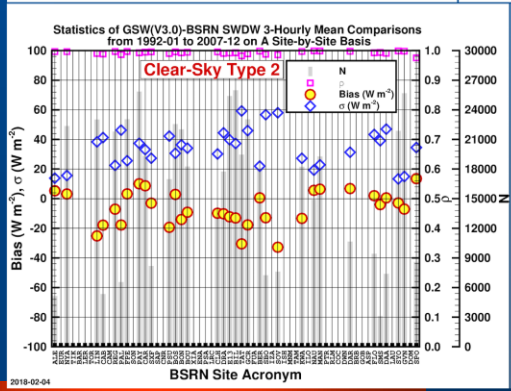


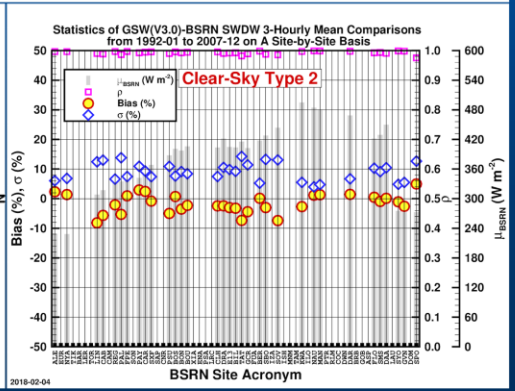


GEWEX SRB GSW(V3.0)-RadFlux *3-Hourly* Mean Clear-Sky SW Downward Flux Comparison for the Period 1992-2007

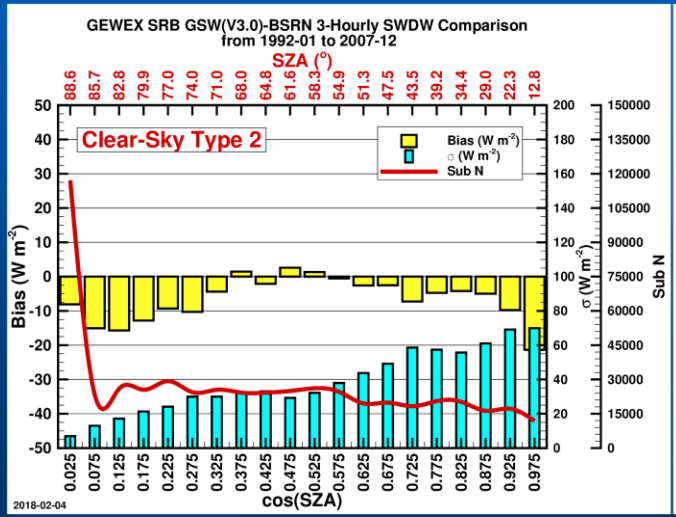


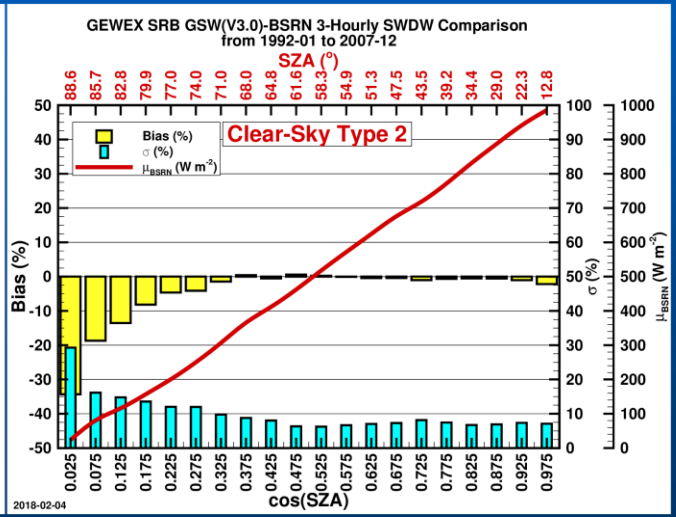




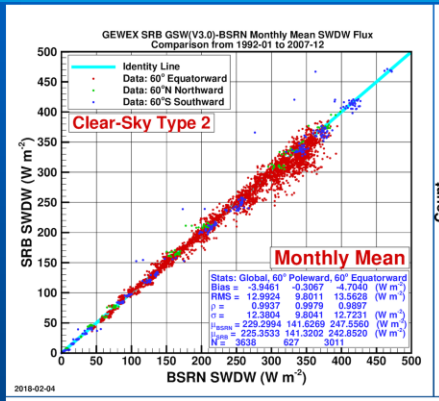


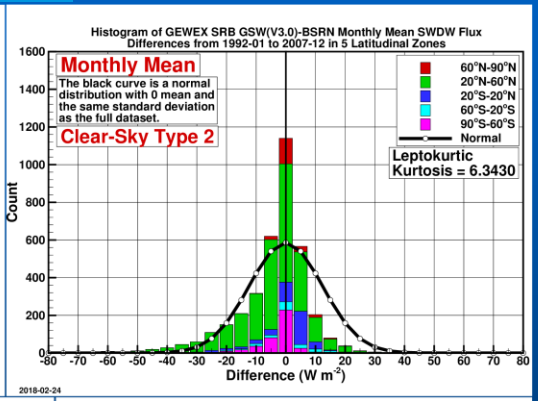
GEWEX SRB GSW(V3.0)-RadFlux *3-Hourly* Mean Clear-Sky SW Downward Flux Comparison for the Period 1992-2007 in 0.05-Sized Bins of cos(SZA)

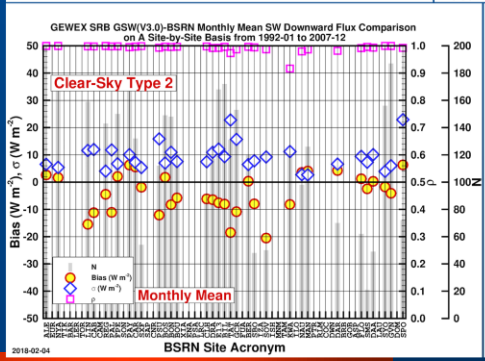


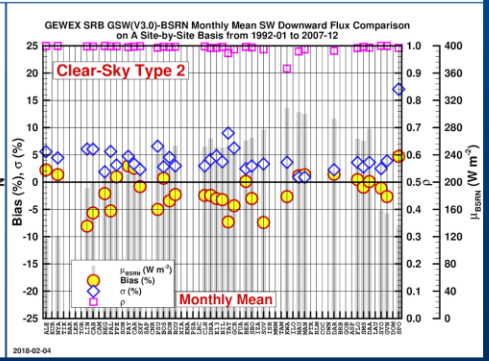


GEWEX SRB GSW(V3.0)-RadFlux *Monthly* Mean Clear-Sky SW Downward Flux Comparison for the Period 1992-2007







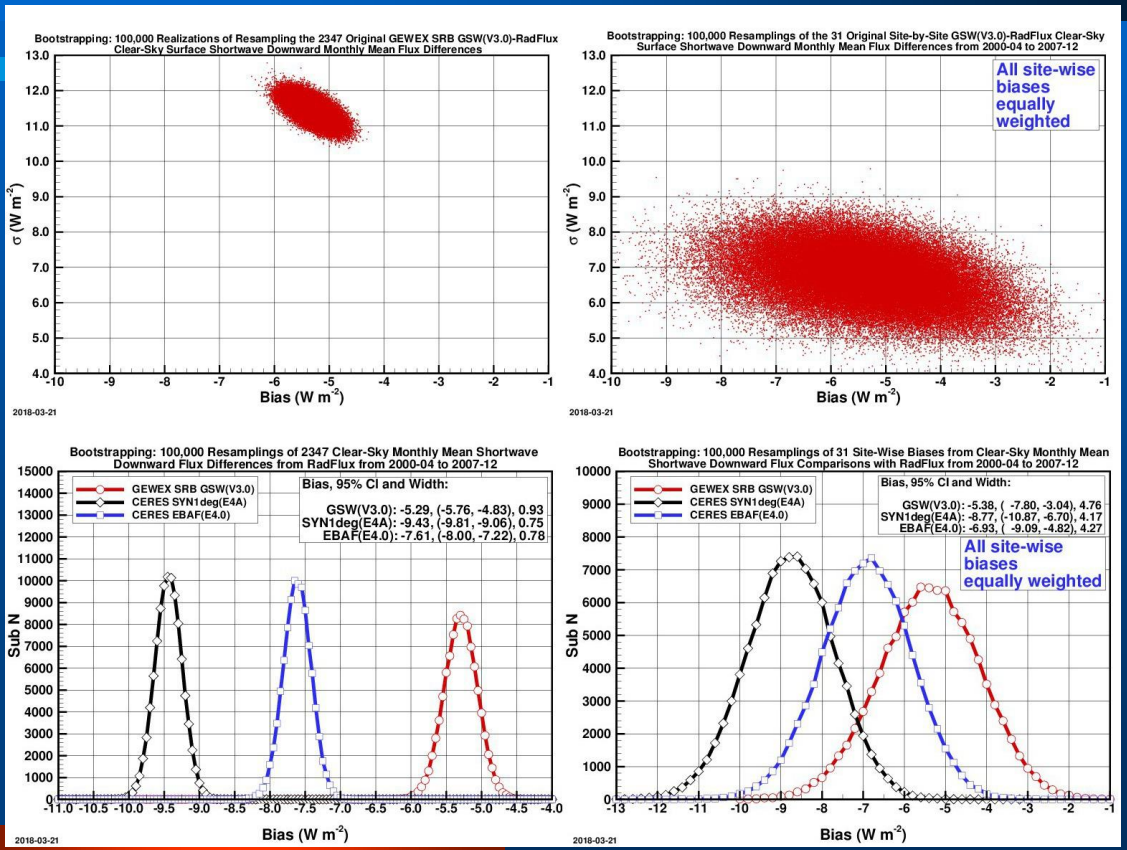


Intercomparison between GSW(V3.0), CERES SYN1deg(Ed4A) and CERES EBAF(Ed4.0) as against RadFlux Clear-Sky Fluxes from 2000-04 to 2007-12

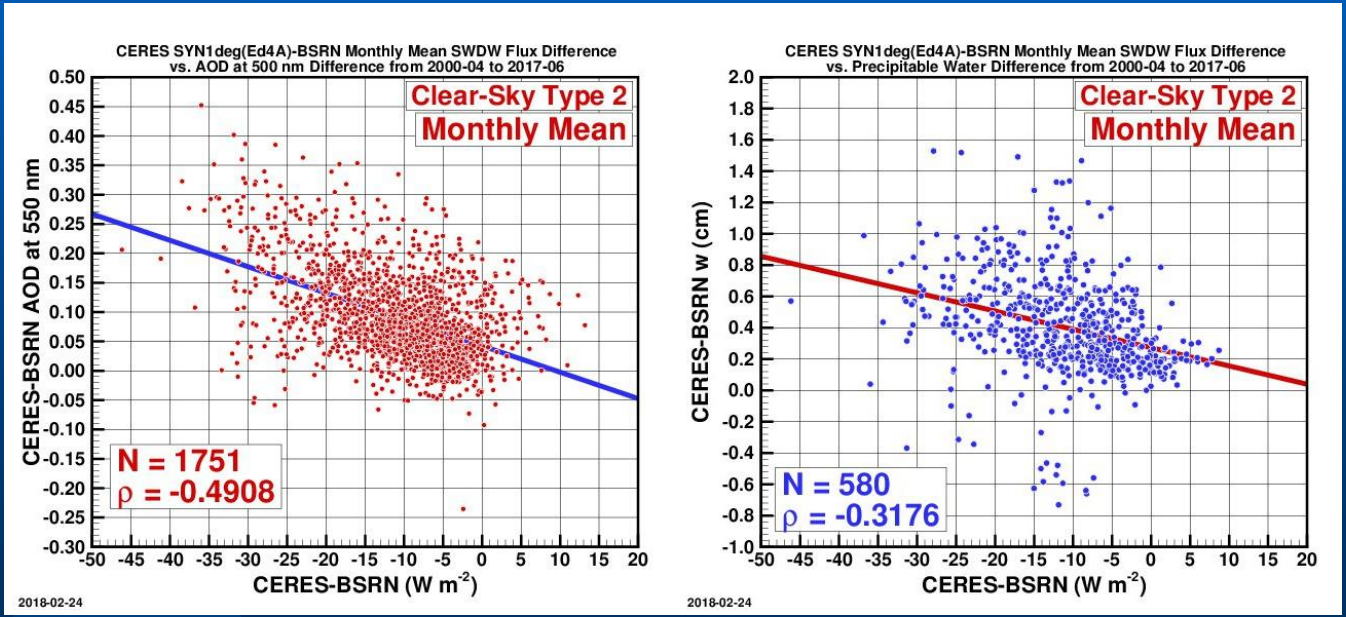
Dataset	Bias	RMS	ρ	σ	μ_{DATA}	N
GSW(V3.0)	-5.29	12.59	0.9941	11.42	232.96	2347
SYN1deg(Ed4A)	-9.43	13.27	0.9966	9.33	228.82	2347
EBAF(Ed4.0)	-7.61	12.23	0.9963	9.57	230.65	2347

- Units of Bias, RMS, σ and μ_{DATA}: W m^{-2}

Bootstrapping Analyses: Site-Month-Wise and Site-Wise



SYN1deg(Ed4A)-BSRN Clear-Sky SW Downward Flux Difference vs. Their AOD at 550 and Precipitable Water Counterparts



Intercomparison between Preliminary GSW(V4.0-IP)-BSRN and GSW(V3.0)-BSRN Comparison Statistics from 1998-2007

	Bias	RMS	ρ	σ	μ_{SRB}	N
3-Hourly	-2.54	79.55	0.9576	79.51	286.11	524571
	-7.67	86.98	0.9499	86.64	281.55	522540
Daily	-1.61	31.49	0.9554	31.45	172.56	107252
	-4.55	34.72	0.9466	34.42	169.63	107252
Monthly	-1.36	14.86	0.9867	14.80	170.61	2494
	-3.74	17.72	0.9817	17.32	168.22	2494

RED: Preliminary GSW(V4.0-IP)
BLUE: GSW(V3.0)

- Units of Bias, RMS, σ and μ_{SRB}: W m^{-2}

Intercomparison between Preliminary GSW(V4.0-IP)-PMEL and GSW(V3.0)-PMEL Comparison Statistics from 2000-2007

	Bias	RMS	ρ	σ	μ_{SRB}	N
3-Hourly	1.76	94.95	0.9565	94.94	389.08	201514
	15.60	94.48	0.9601	93.18	403.10	201416
Daily	1.05	34.32	0.8366	34.30	241.71	39198
	9.66	34.47	0.8523	33.08	250.33	39198
Monthly	0.64	12.69	0.9329	12.68	241.47	1238
	9.38	15.53	0.9368	12.37	250.21	1238

RED: Preliminary GSW(V4.0-IP)
BLUE: GSW(V3.0)

- Units of Bias, RMS, σ and μ_{SRB}: W m^{-2}

Summary and Conclusions

- The GEWEX SRB GSW(Rel. 3.0)-BSRN all-sky monthly mean comparison shows a bias/RMS/N of -5.58/22.72/4625; GSW(Rel. 3.0)-RadFlux clear-sky monthly mean comparison shows -3.94/12.99/3638;

- Compared with CERES SYN1deg(Ed4A) and EBAF(Ed4.0), GEWEX SRB GSW(V3.0) has the smallest bias against RadFlux clear-sky fluxes, but EBAF(Ed4.0) has the highest correlation and smallest standard deviation of error;

- The systematic negative bias of clear-sky SW downward fluxes could be partly explained by the systematically lower moisture and aerosol loads as observed at BSRN sites, although the observations are limited. CERES literature also indicates that satellite observations can sometimes miss the presence of clouds and misidentify slightly cloudy sky as clear. More work is needed to address the issue;

- The bootstrapping analyses of the GSW(V3.0)-RadFlux clear-sky monthly mean errors indicate that the resampling by site-month does not cause much variability in the overall bias, but resampling by site causes more variability in the overall bias. This implies that increasing the number of BSRN/RadFlux sites can improve the certainty of the ground-based observation as a global standard of surface-based observation;

- FUTURE WORK: Assess cloud radiative effect using RadFlux data; compare CERES and SRB(Rel. 3.0, Rel. 4.0) data with RadFlux data.

Thank you!

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Extras