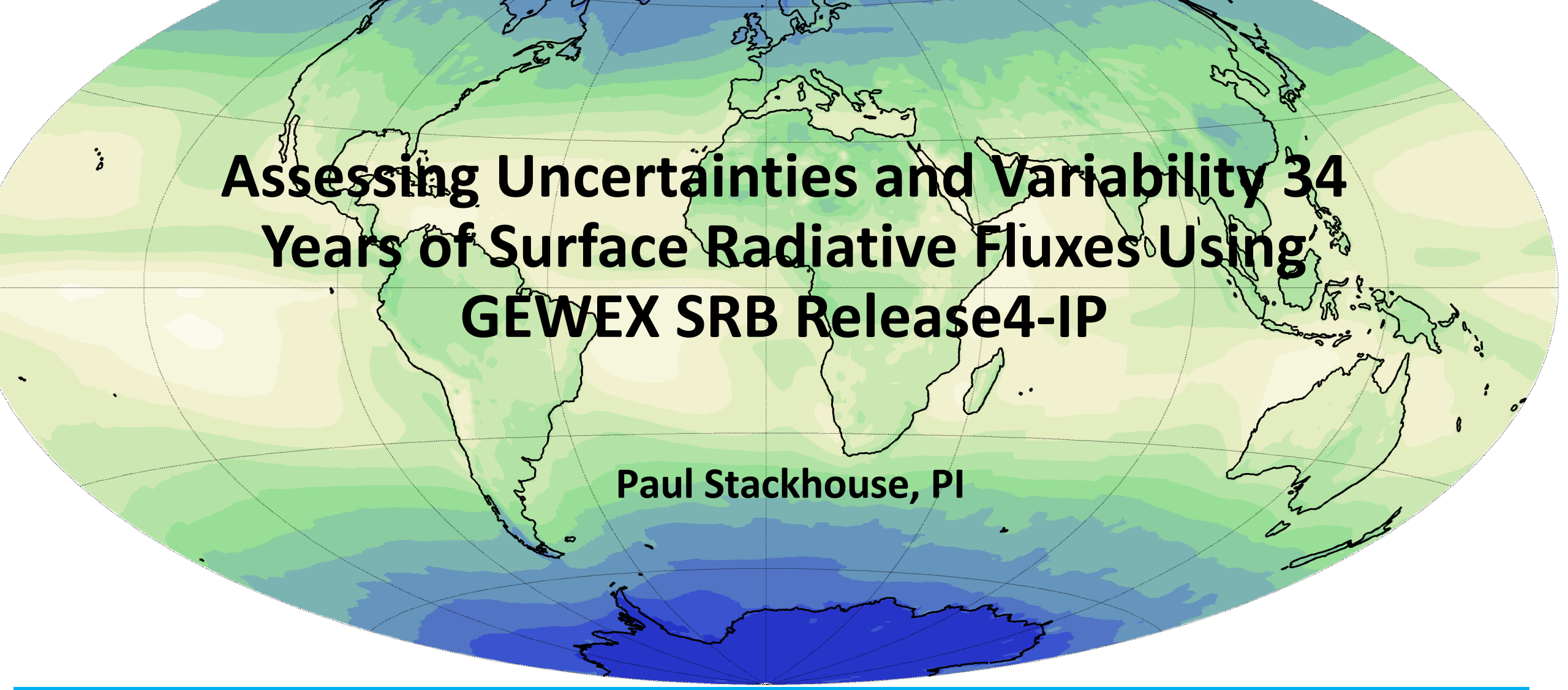


Assessing Uncertainties and Variability 34 Years of Surface Radiative Fluxes Using GEWEX SRB Release4-IP

Paul Stackhouse, PI

SRB Team Members:

Dr. Stephen J. Cox, J. Colleen Mikovitz, Dr. Taiping Zhang

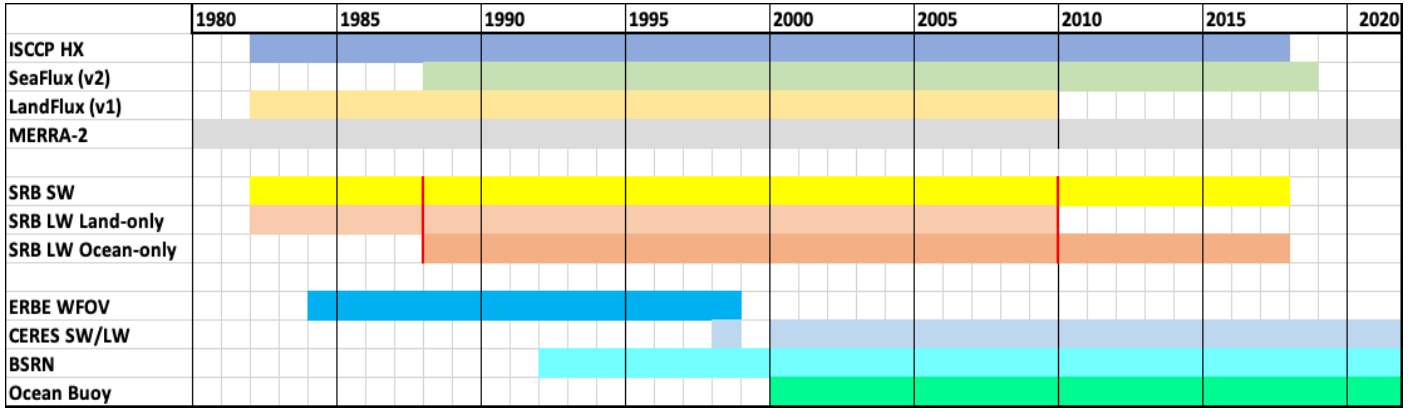
GEWEX SRB Rel4-IP Production and Release

- In FY2021, GEWEX SRB Rel4-IP production was finalized
- Key inputs:
  - ISCCP HX, nnHIRS Met., Ice/Snow, O3; MAC v1 aerosols
  - SST: SeaFlux v2; LST: LandFlux
- Flux Algorithms:
  - SW: Pinker/Laszlo LUT w/ Fu/Liou RT; spectral & ocean refl
  - LW: Fu/Liou; max/random cloud overlap, trace gases
- ATBD including validation and intercomparison (NASA technical report)
- Web site completely updated
- Publication being finalized

SRB Rel4-IP Data Parameters

Data Types	Model Name	Temporal Resolution	Parameters
SW	GEWEX SW (Pinker/Laszlo) (v4.0)	3-hourly, Monthly Averaged 3-hourly, Daily and Monthly Averaged (UTC and local sun time)	All-sky: Surface down, up, down direct and diffuse, PAR down, direct, diffuse; TOA Down, Up
			Clear-Sky: Surface Down, Up; PAR down; TOA Up
			Pristine-sky: Surface down, up; TOA up
LW	GEWEX LW (Fu/Liou/ Stackhouse) (v4.0)	3-hourly, Monthly Averaged 3-hourly, Daily and Monthly Averaged	All-sky: Surface Up and Down; TOA up
			Clear-sky: Surface Up and Down; TOA up
			Pristine-sky: Surface Up and Down; TOA up
Input Properties	Cloud, Aerosol and Surface Properties	3-Hourly	Surface emissivity, skin temperature, atmospheric profile; cloud phase, fraction, optical depth and LWC

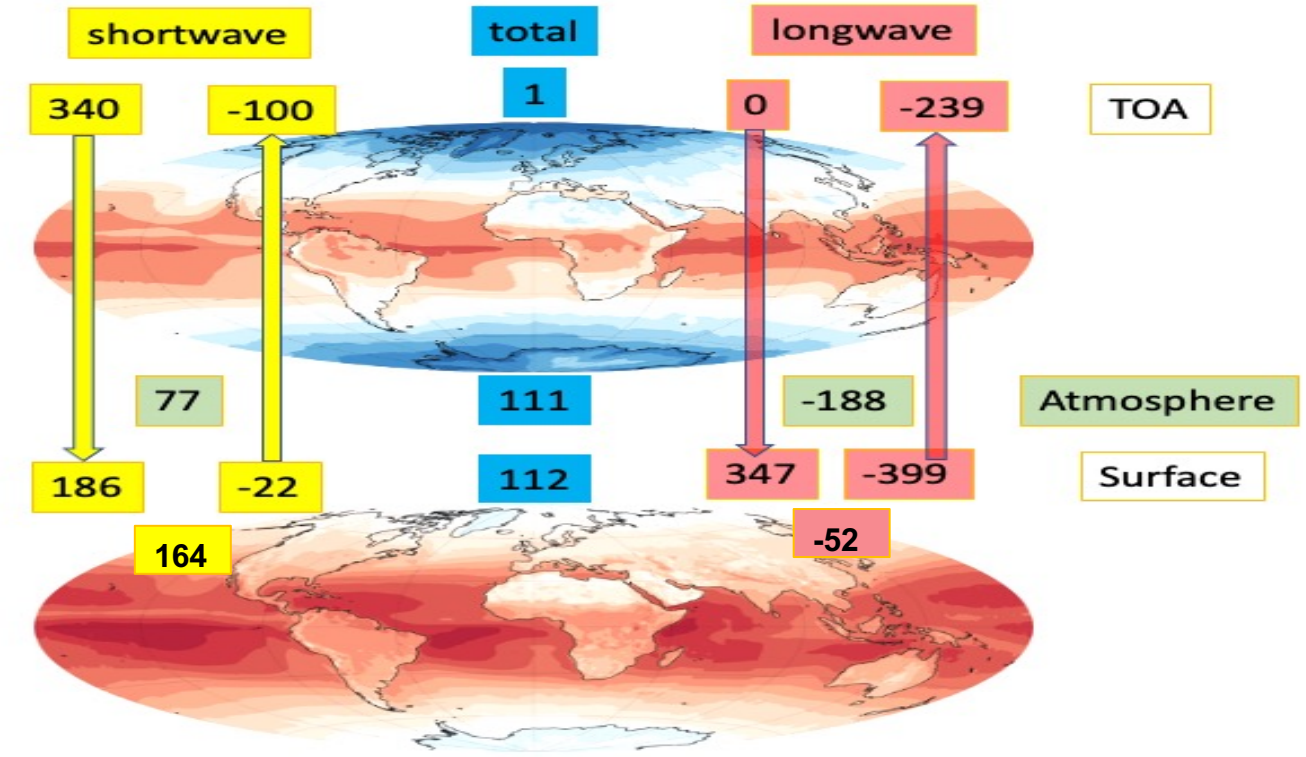
Time Span of Production



GEWEX SRB Rel4-IP: Global Mean Comparisons

Long-term Global Averaged Radiation Budget Components from SRB R4-IP (1988-2009)

Wild et al (2015) provided a review and assessment of globally averaged long-term radiative budgets using CERES, surface measurements and other data sources. SRB fluxes agree within the stated uncertainties for all components.



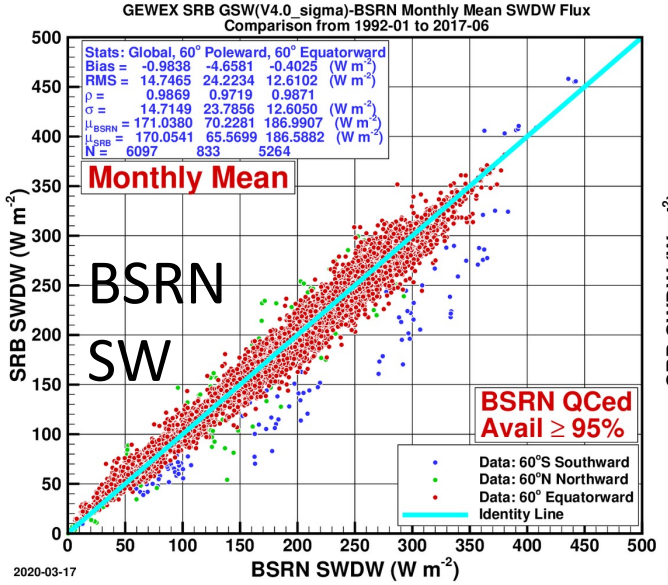
Level	Flux Component	Wild et al (2015) SW	Wild et al (2015) LW	Level	Flux Component	Wild et al (2015) SW	Wild et al (2015) LW
Surface	Down	185 (179:189)	342 (338:348)	Top-of-Atmosphere	Down	340 (340:341)	0
	Up	25 (22:26)	398 (394:400)		Up	100 (96:100)	239 (236:242)
	Net	160 (154:166)	-56 (-46:-62)		Net	240 (240:245)	-239 (-236:-242)
				Whole Atmosphere	Net	80 (74 :91)	-183 (-174:-196)

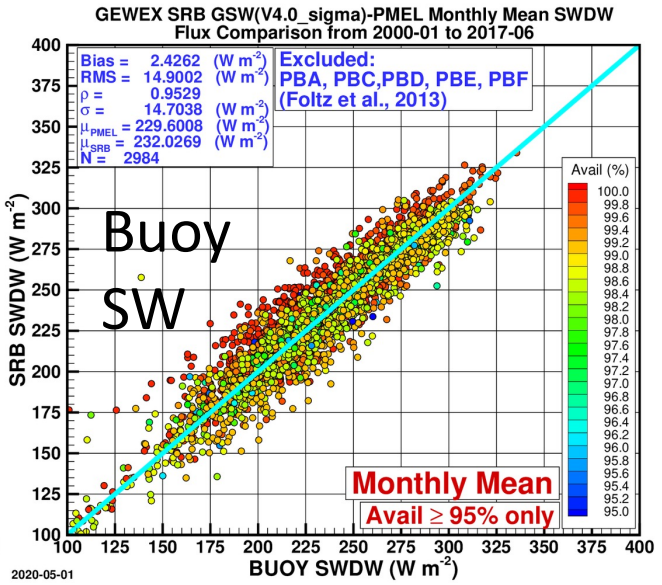
GEWEX SRB R4-IP: Analysis and Assessment

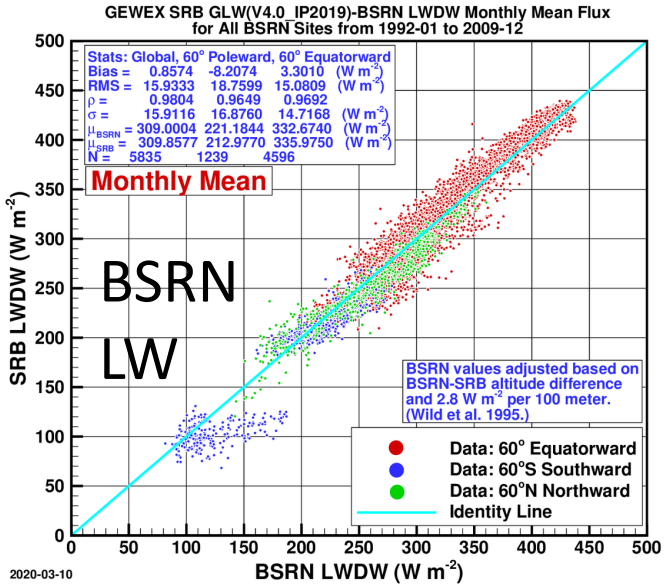
Surface downward fluxes assessed against surface measurements from BSRN and the ocean buoy networks.

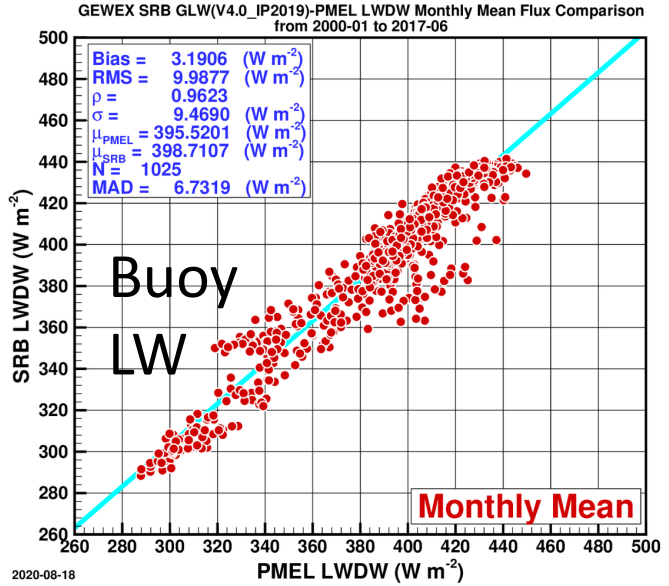
Surface fluxes comparable to or better than last version.

Bias in LW fluxes occurs in polar daytime when cloud properties are difficult to define from ISCCP 2 channel algorithm.



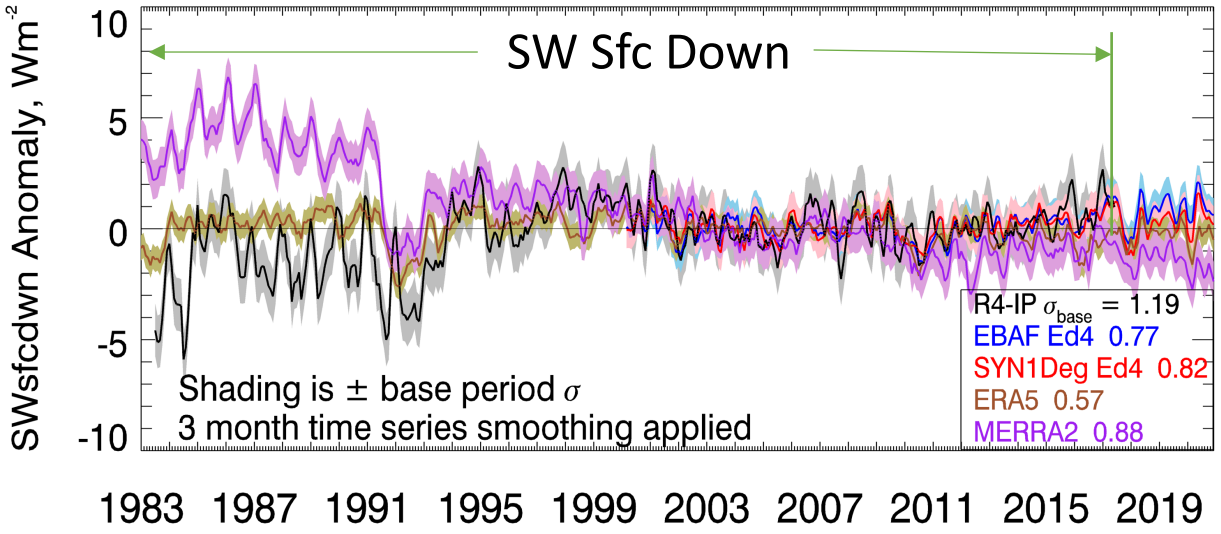


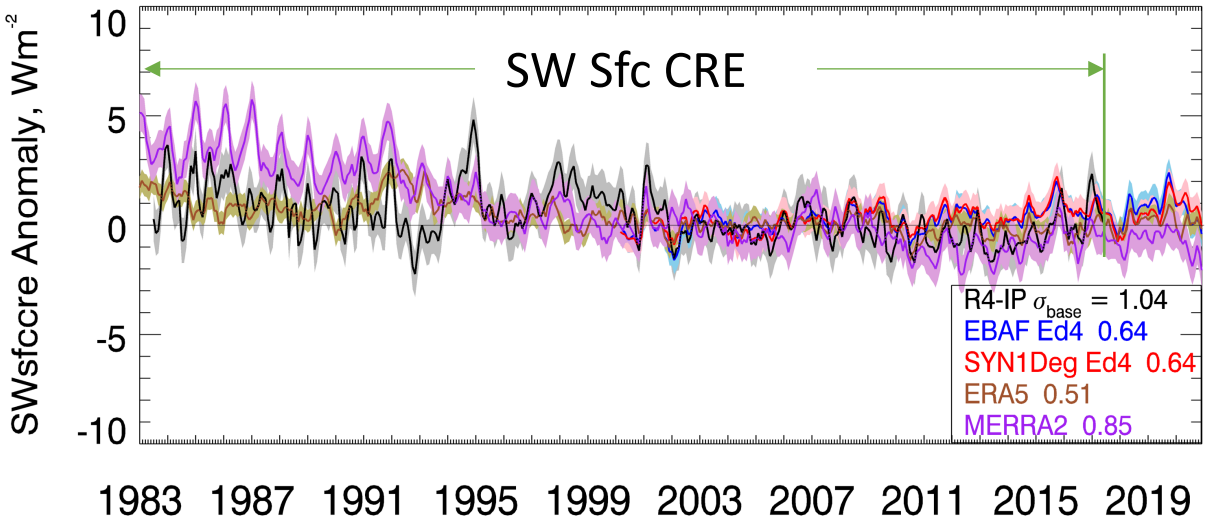


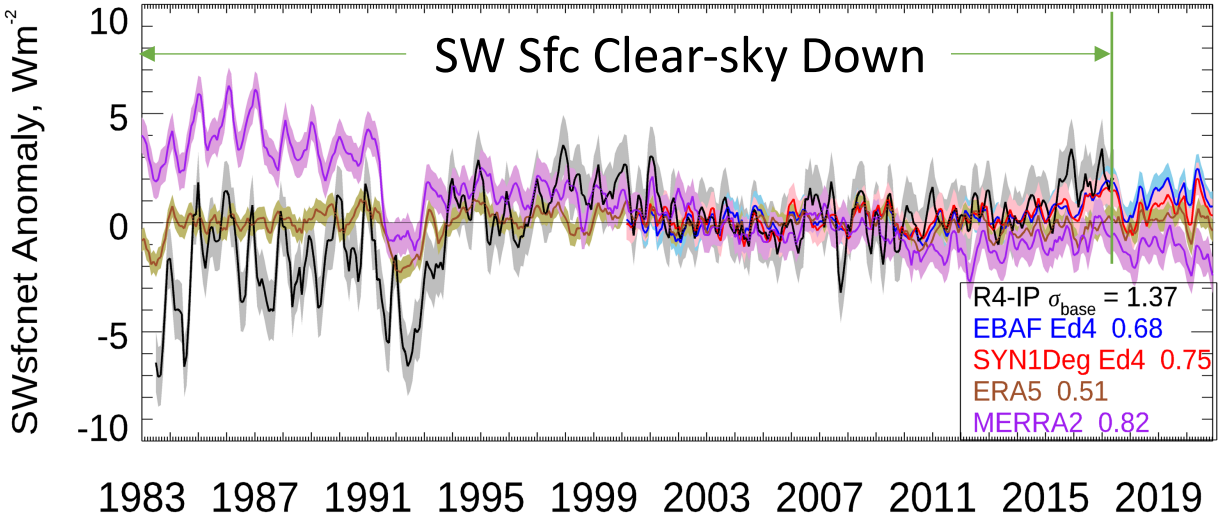


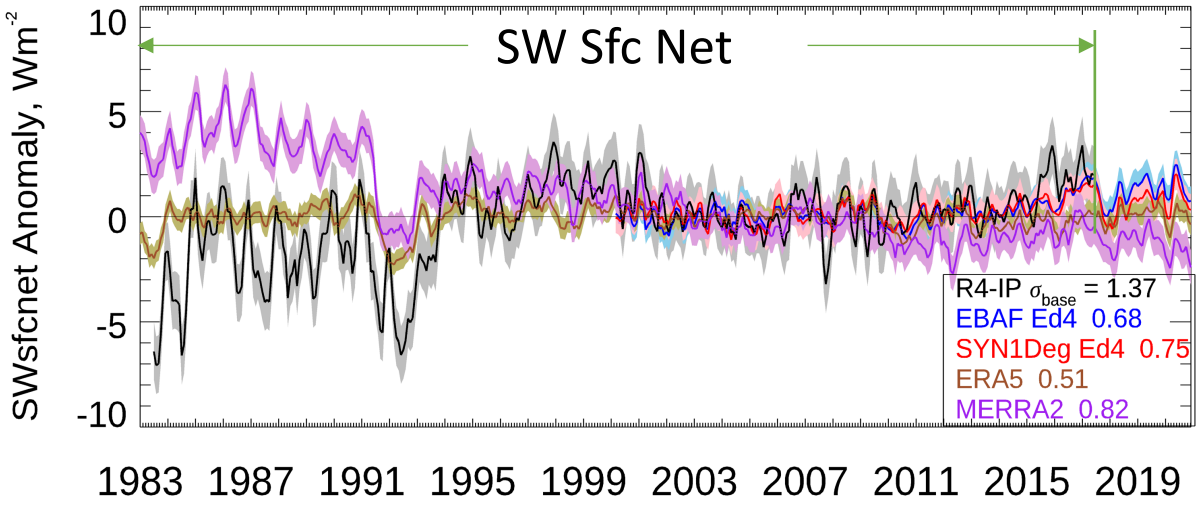
GEWEX SRB R4-IP: Analysis and Assessment

SW Global All-sky Monthly Averaged Radiative Flux Component Anomalies
(CERES Overlap for base period 2001-2007)





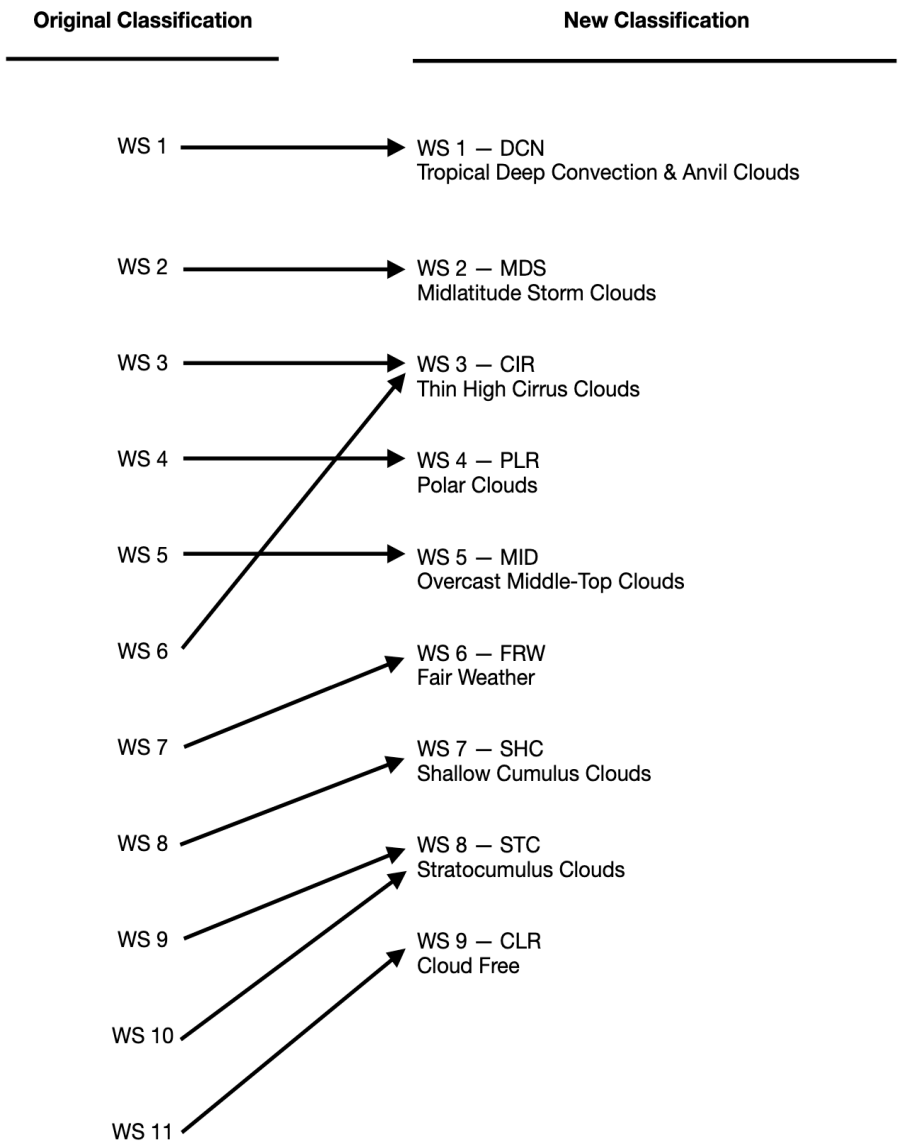




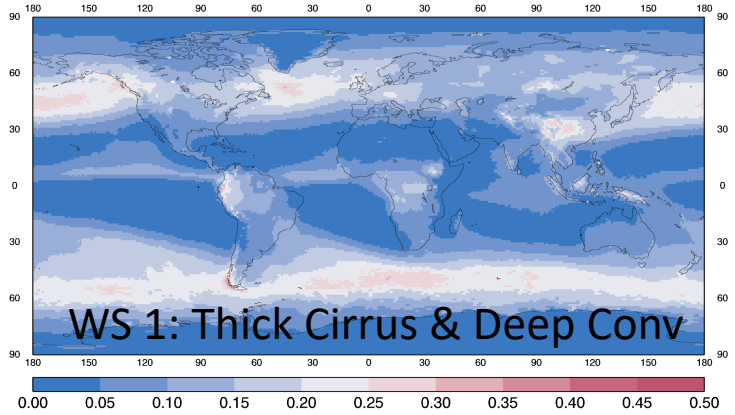
Flux by ISCCP Weather State Analysis

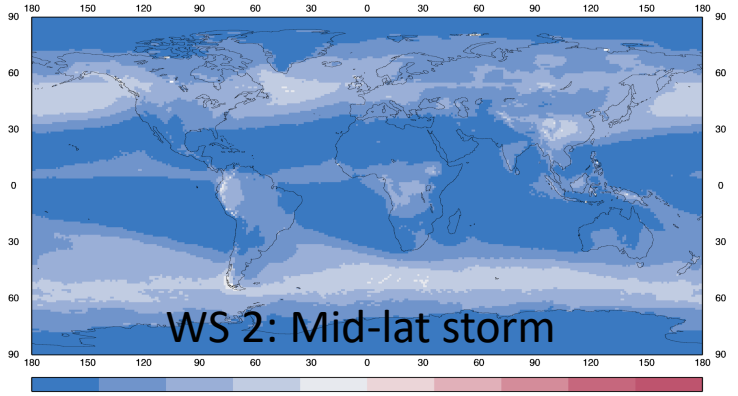
Weather States

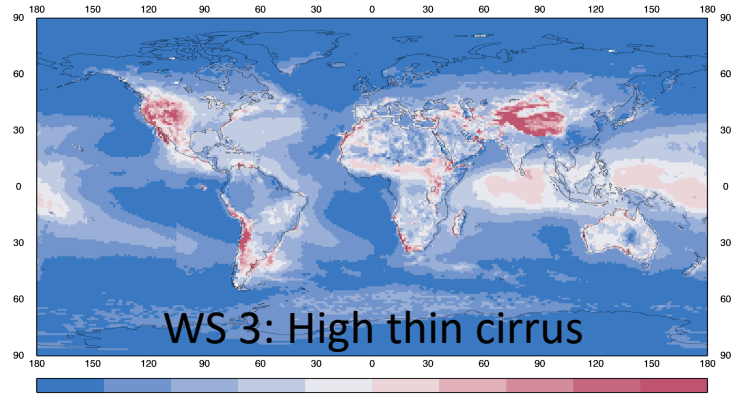
- SRB produces fluxes at the full 3-hourly temporal resolution globally; thus, an approximate diurnal cycle of clouds is treated.
- Weather State (WS) analysis includes all 3-hourly daytime hours rather than just morning and afternoon overpasses; we utilize analysis from Tselioudis *et al*. (2021).
- WS 1-9 are chosen by a k-cluster statistical analysis and roughly correspond to various 1x1 degree cloud configurations using 2D histograms of cloud AOD and Pctop.

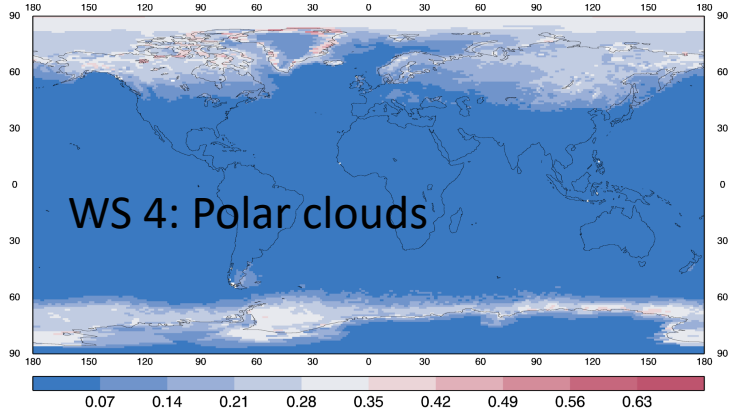


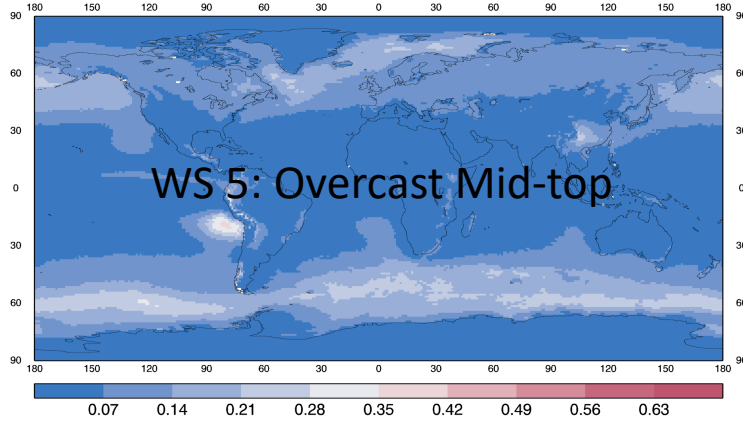
Mean ISCCP H Weather State Spatial Distributions (from Tselioudis et al., 2021)

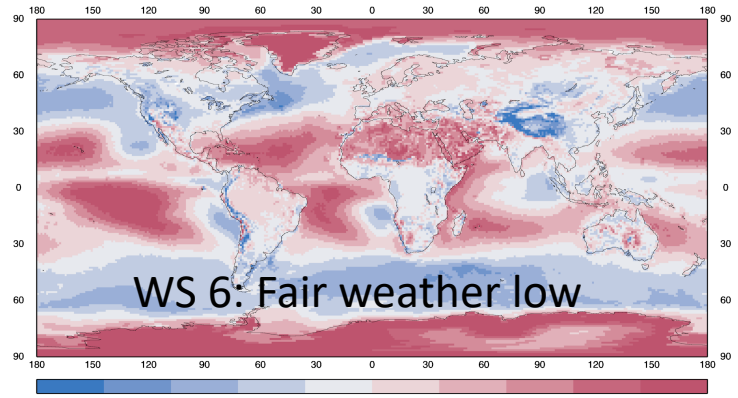


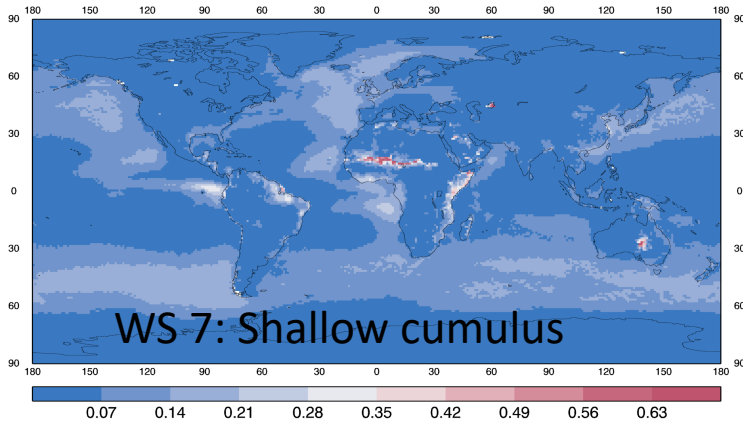


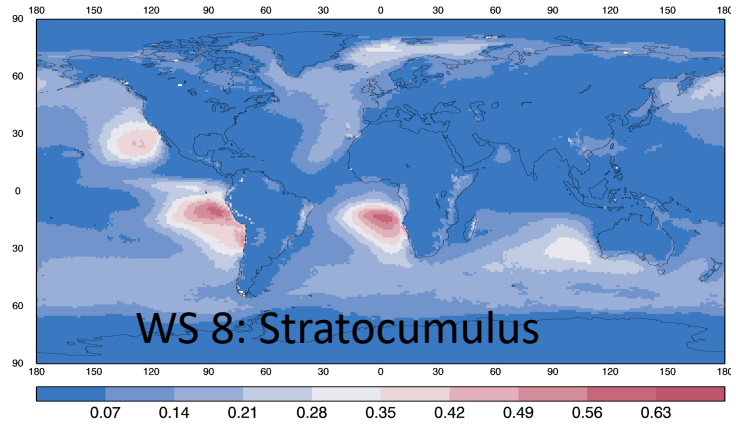


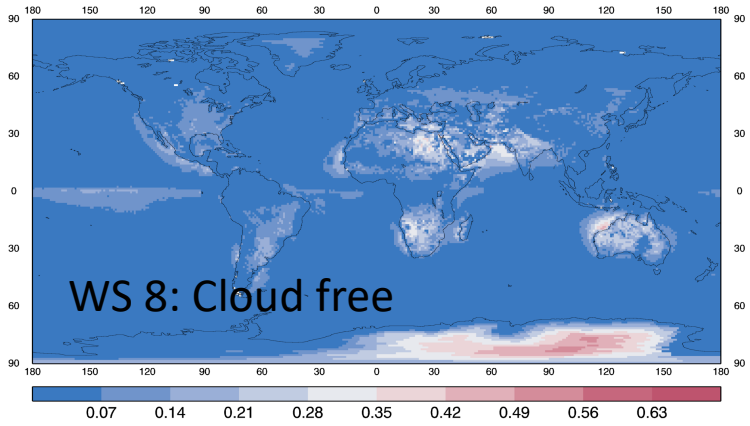








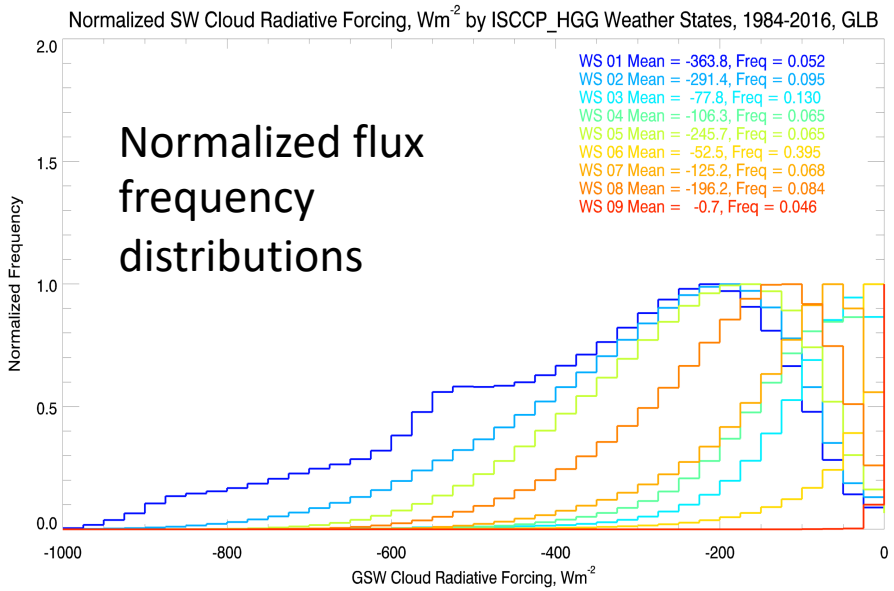




SW Surface Cloud Radiative Effect by Weather State

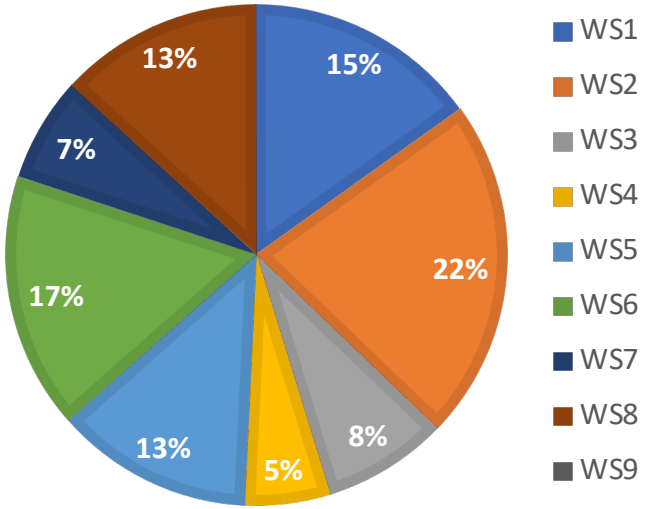
Sorting SRB CRE fluxes by WS shows:

- WS 1 (thk cir/conv) has the largest frequency of large CRE (tropical)
- WS 6 (fair wx) has the largest the frequency; but has smaller frequency spread
- WS 2 (mid-lat clouds) contributes most to CRE (2nd is Fair Wx - #6)
- WS 1 appears to be decreasing; WS 6 increasing

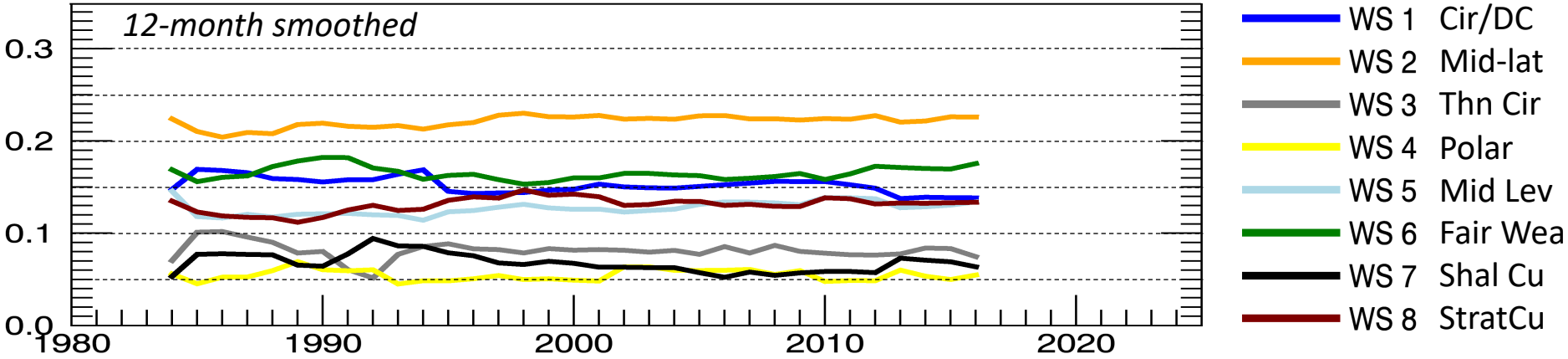


GLOBAL SW CRE

Fract Contribu-tion by WX State



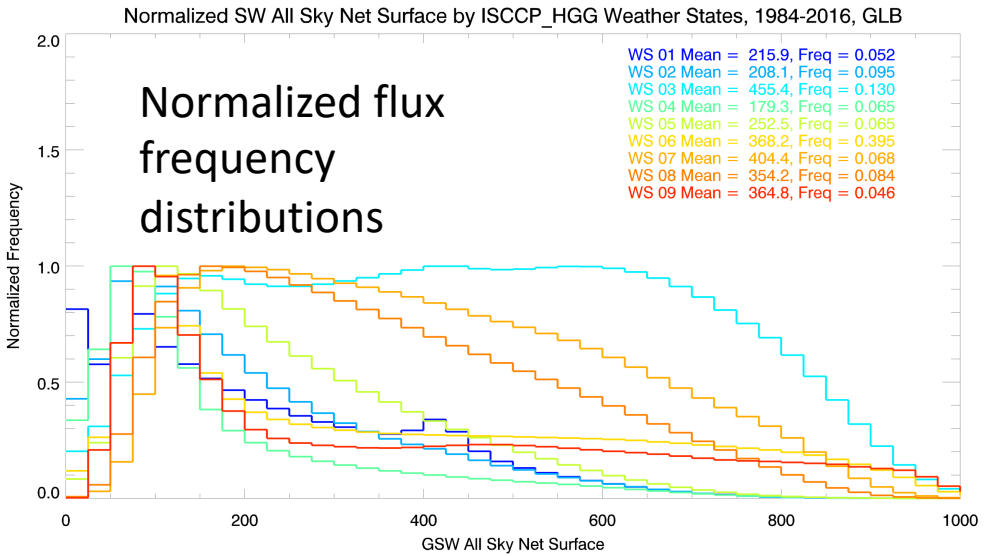
Fractional Contribution by each WS to Surface SW CRE



SW Surface Net by Weather State

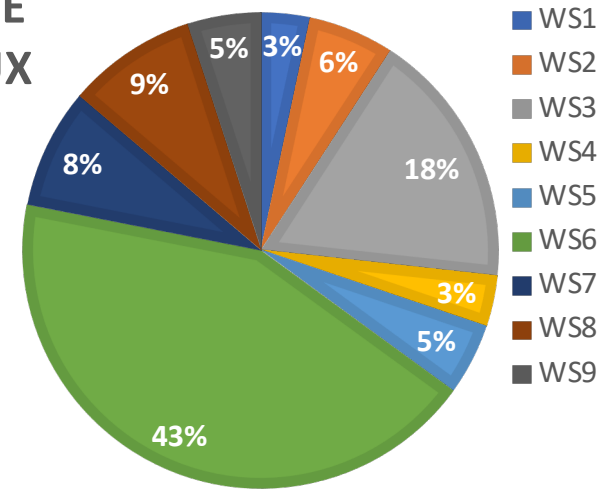
Sorting SRB SW Net fluxes by WS shows:

- WS 6 (fair wx) has the largest the frequency and contributes most to SW net
- WS 3 (thin cirrus) contributes 2nd most and has widest spread
- WS 6 appears to be increasing; WS increasing

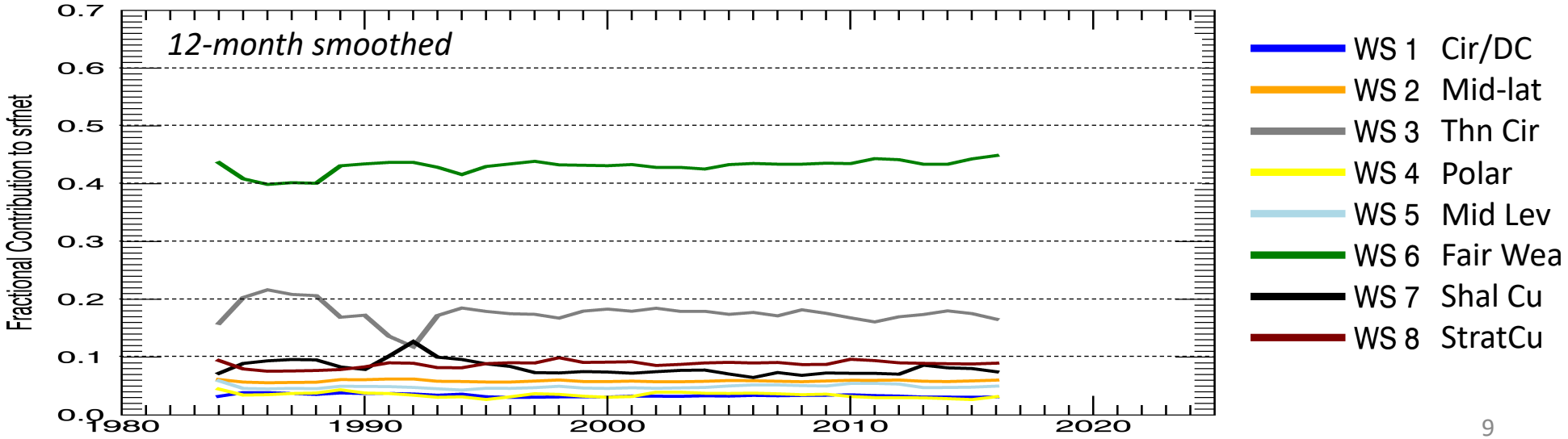


GLOBAL SURFACE NET FLUX

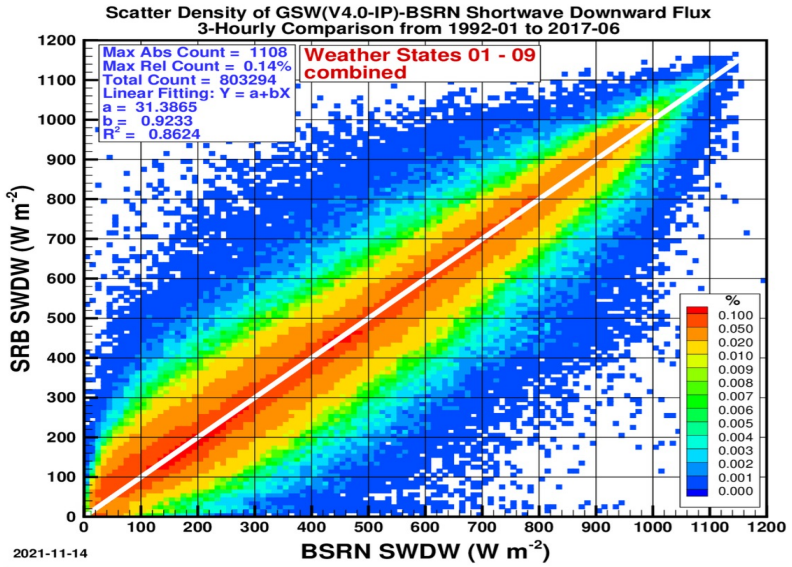
Fract Contribu-tion by WX State

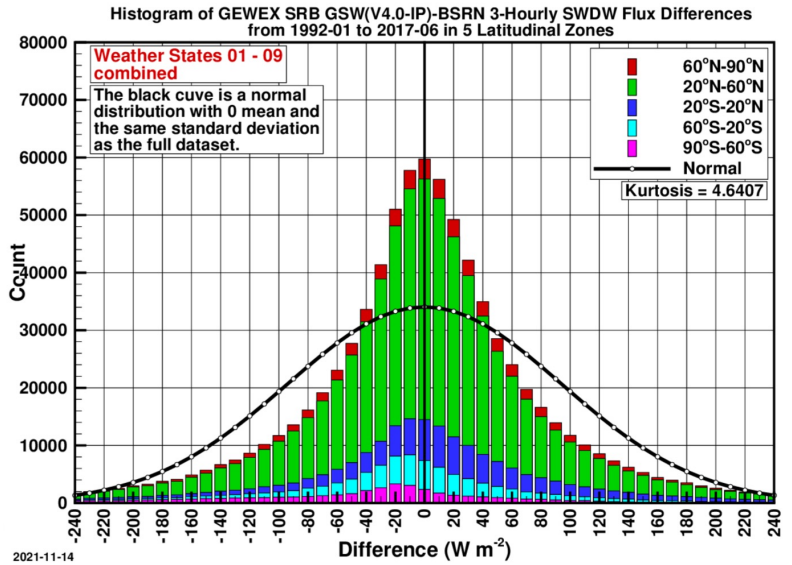


Fractional Contribution by each WS to Surface SW Net



Validation by Weather State: 3-Hourly Daytime Assessment





BSRN Obs averaged to 3-hourly, sorted by Weather State (Day-time only) and compared to SW Fluxes

WS	Bias	RMS	ρ	σ	MAE	μ_{BSRN}	N
01	-25.3269	121.0073	0.8107	118.3283	82.3430	260.1601	50092
02	-7.4661	102.7503	0.8238	102.4794	72.7674	242.7001	80183
03	8.4086	94.6608	0.9243	94.2869	63.5794	523.1347	202387
04	-13.4982	105.1652	0.8708	104.2969	74.5313	387.7973	34846
05	0.2323	106.8684	0.8084	106.8695	78.7766	272.2272	39868
06	-2.1742	84.4639	0.9435	84.4360	56.6747	462.6274	287556
07	-1.7182	109.0500	0.8800	109.0380	81.1523	440.9097	36351
08	9.1278	106.1530	0.8577	105.7617	80.1758	335.9073	27536
09	-0.5742	45.8691	0.9773	45.8660	29.1942	498.4093	44475
WS 1-8	-1.4008	96.2165	0.9264	96.2064	65.9145	423.0944	758819
WS 1-9	-1.3550	94.1327	0.9289	94.1230	63.8850	427.2650	803294
All Obs	-2.9323	77.5973	0.9599	77.5419	46.1121	288.3983	1280023

GEWEX SRB: Summary Status

- **GEWEX SRB Rel 4-IP:**
  - Now fully released with ATBD on-line (NASA technical report; publication in prep)
    - SW (Shortwave) spans 34 years: reprocessed to resolve data quality issues; prepared and released products
    - LW (Longwave) spans 22 years: prepared and released Rel4-IP from 1988 through 2009 and extended ocean-only LW to 2017.
  - Mean radiative budget components: agree within community consensus values
  - Time series analysis shows:
    - Good agreement with CERES during overlap years but nearly 2X more noisy than CERES
    - Noise obscures small long-term changes; although largely consistent
    - Some noise attributed changes in sampling; some long-term changes may be due to key input issues
- **Weather State Analysis**
  - Applied Tselioudis et al WX state analysis; evaluated states
  - Sorted fluxes by weather state showing relative contributions to cloud radiative effect
  - Utilized to validate fluxes at BSRN sites relative to weather states:
    - Top 3 contributors to surface SW CRE: Mid-lat systems, fair weather, thick cirrus/deep convection
    - SW flux validation depends upon class despite overall low bias; points to needed improvements
  - More analysis needed to determine class robustness and evaluate any potential changes