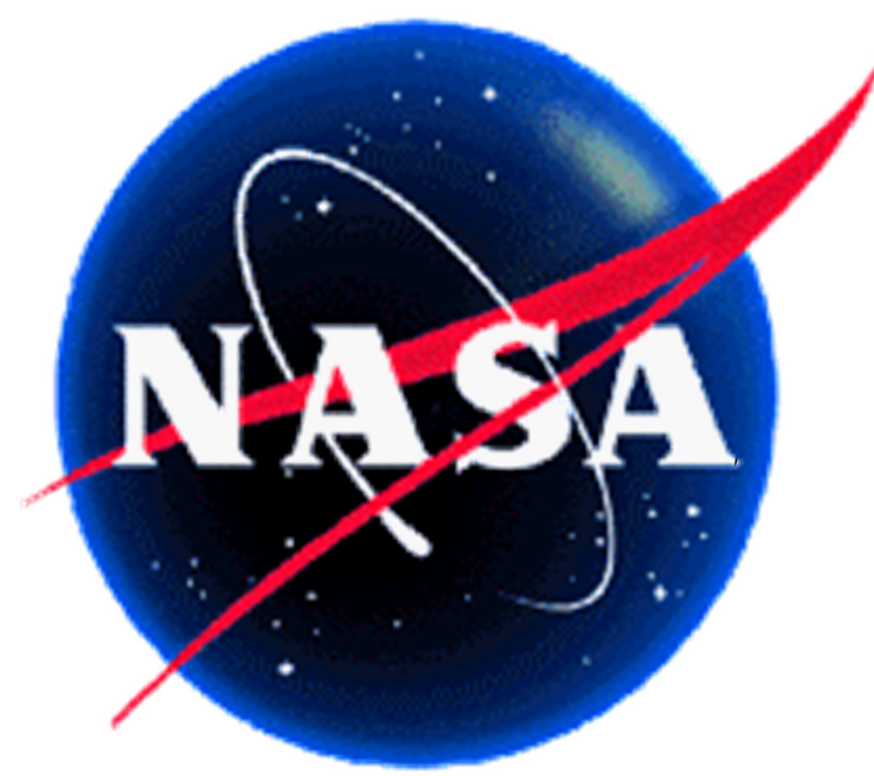




An assessment of top-of-atmosphere radiative fluxes in reanalysis data products using NASA CERES broadband radiation observations



Takmeng Wong

NASA Langley Research center, Hampton, Virginia

Goals

- Assess the quality of TOA radiation fields from four state-of-the-art reanalysis data products using CERES TOA broadband radiation observations.
- Understand the strength and weakness of the TOA radiation fields in each of the reanalysis products.

TOA Radiation Data Sets

- The following five data sets are used for this study
 - CERES EBAF Ed2.8 Data
 - ECMWF ERA Interim Data
 - Japanese JRA55 Data
 - NASA MERRA Data
 - NOAA/NCEP CFSR Data
- Spatial coverage: Regrided to 2.5° by 2.5° equal-angle grid box covering the entire globe
- Temporal period: January 2001 to December 2012
- TOA Radiation variables: Longwave, Shortwave, and Net radiation (all-sky and clear-sky condition)

Methodology

- Construct 12-year climatology of earth radiation budget variables using monthly mean data
- Construct regional map of interannual variability using annual mean data
- Construct deseasonalized monthly anomaly time series of global and tropical mean variables using monthly mean data
- Perform global mean trend analysis using time series data
- Results are presented in the form of regional map, Taylor diagram, tropical and global mean time series, and global mean statistics tables.

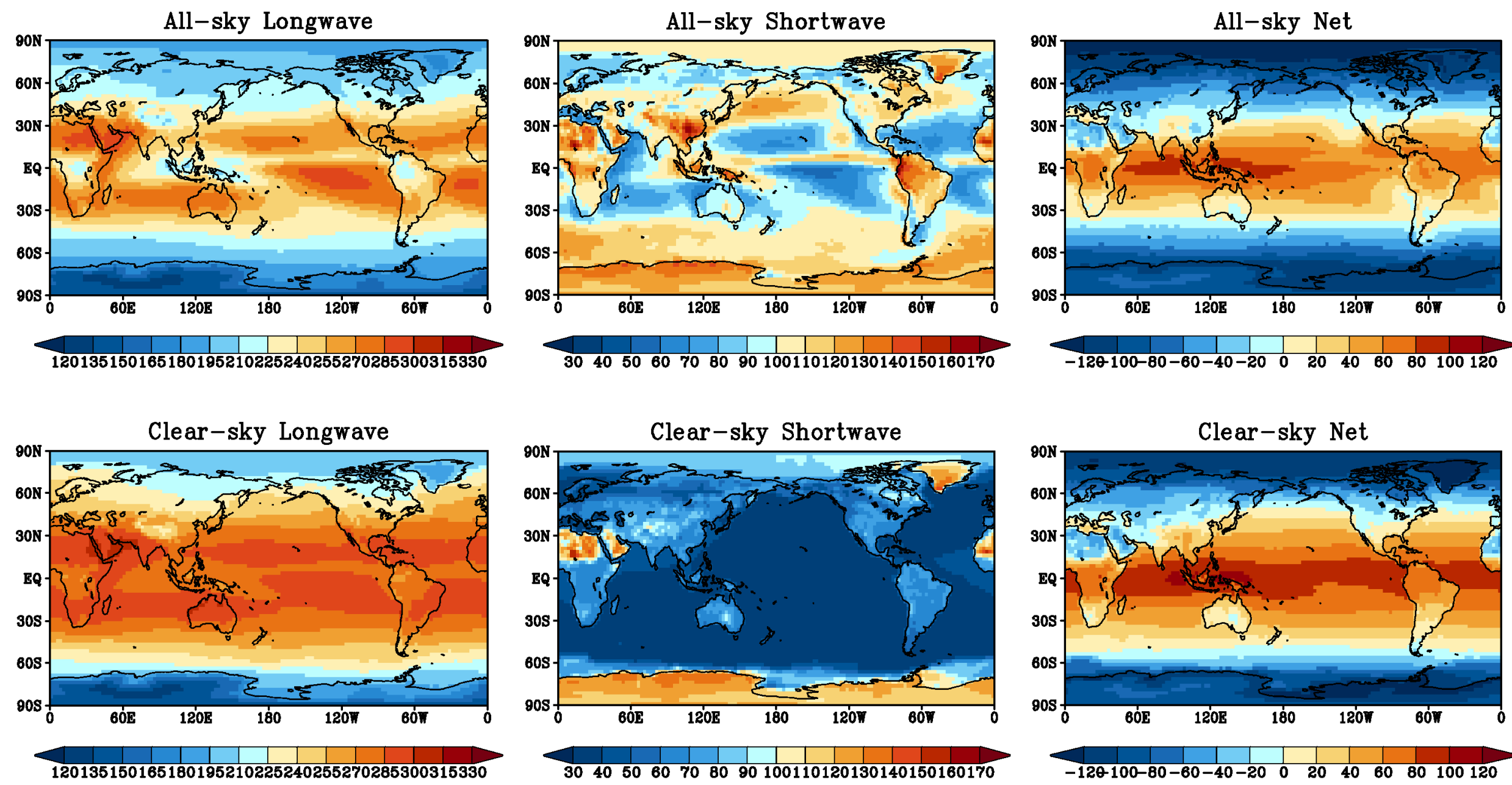
Results

- All four reanalysis shortwave flux products are deficient when compared to CERES data. Improvements in reanalysis shortwave fluxes will also help to increase the quality of their net radiation.
- With the exception of CFSR data, all three other reanalysis datasets are missing the 11-year solar cycle. Solar cycle is needed in these products.
- Reanalysis products have too much interannual variability in all-sky shortwave and longwave fluxes when compared to observations. This is probably caused by excessive cloud variability in reanalysis data products since their clear-sky results are reasonable.
- All four reanalysis data are missing clear-sky shortwave interannual variability over Australia and South Africa. Better dynamic surface albedo map over these two regions should fix this problem.
- CFSR dataset has some issues with all-sky shortwave and net radiation after 2009.
- Global decadal trends of TOA radiation from current reanalysis products are unreliable and should be avoided.

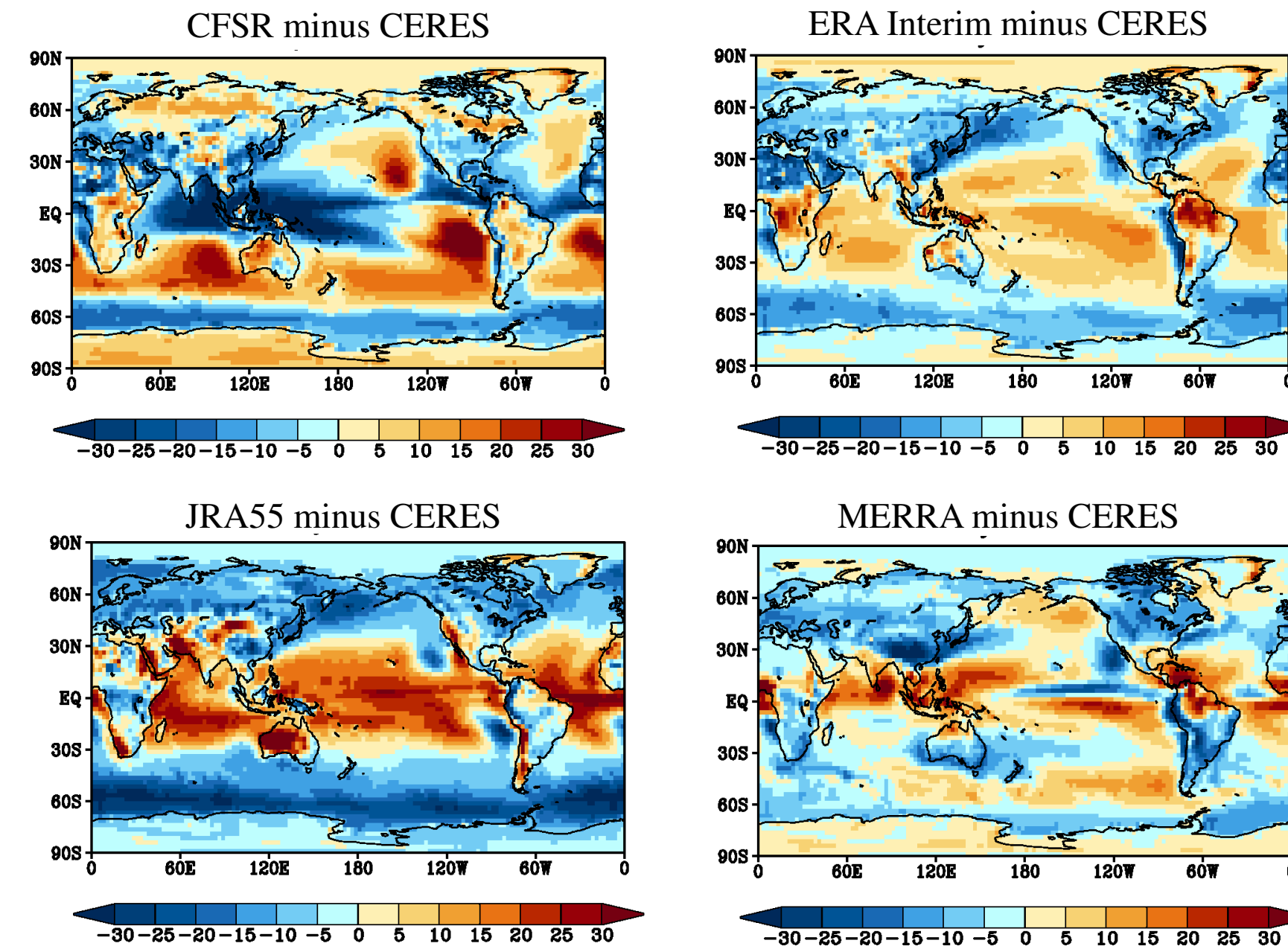
Acknowledgment

This study is funded by the NASA Science Mission Directorate through the CERES project. CERES, ECMWF, and MERRA data are obtained from the CERES, ECMWF, and Giovanni website, respectively. JRA55 and NOAA CFSR data are downloaded from NCAR.

CERES Climatological Mean (Wm^{-2})



Climatological Mean Shortwave Differences (Wm^{-2})

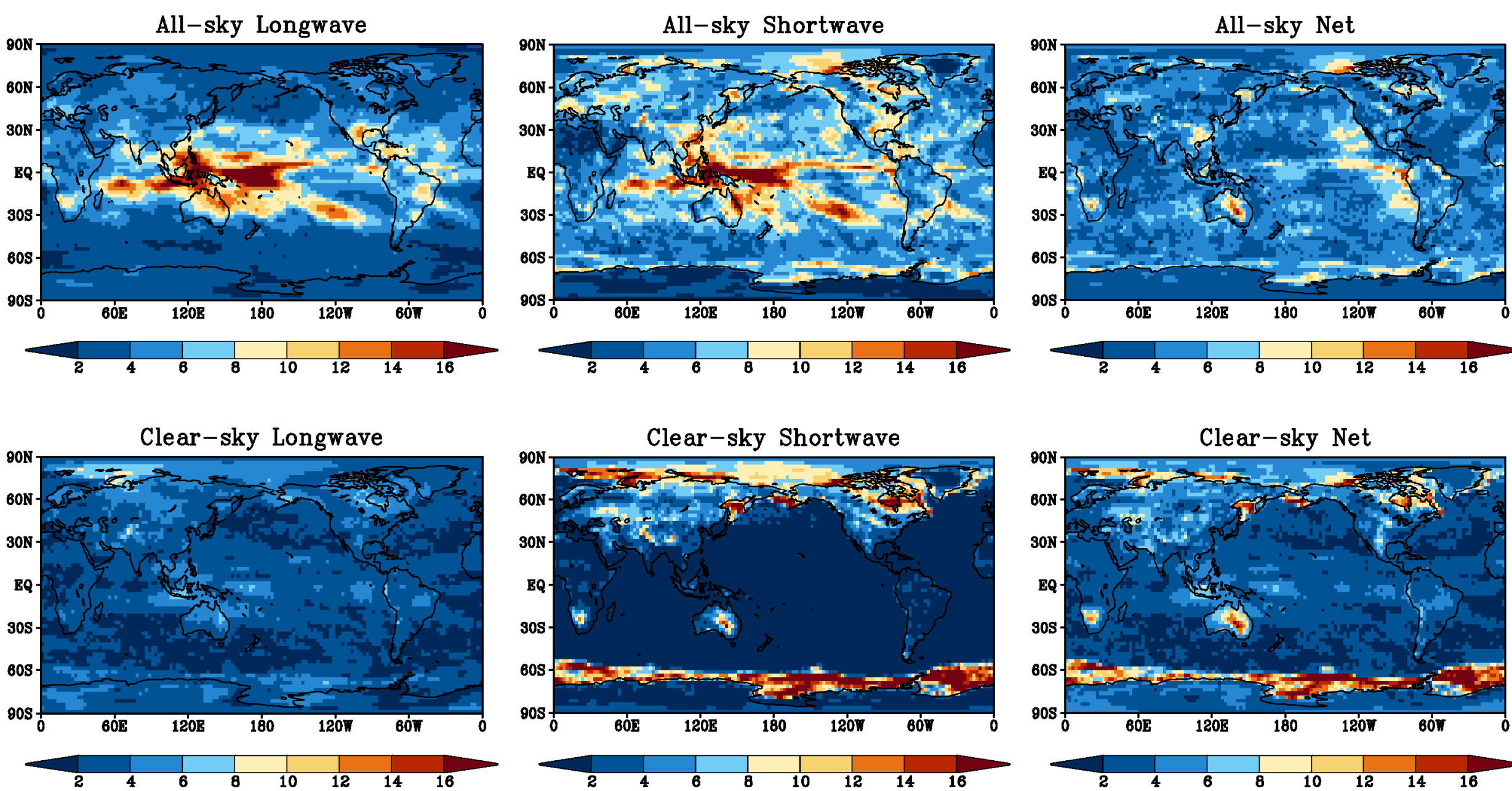


Global Mean Climatology (Wm^{-2})

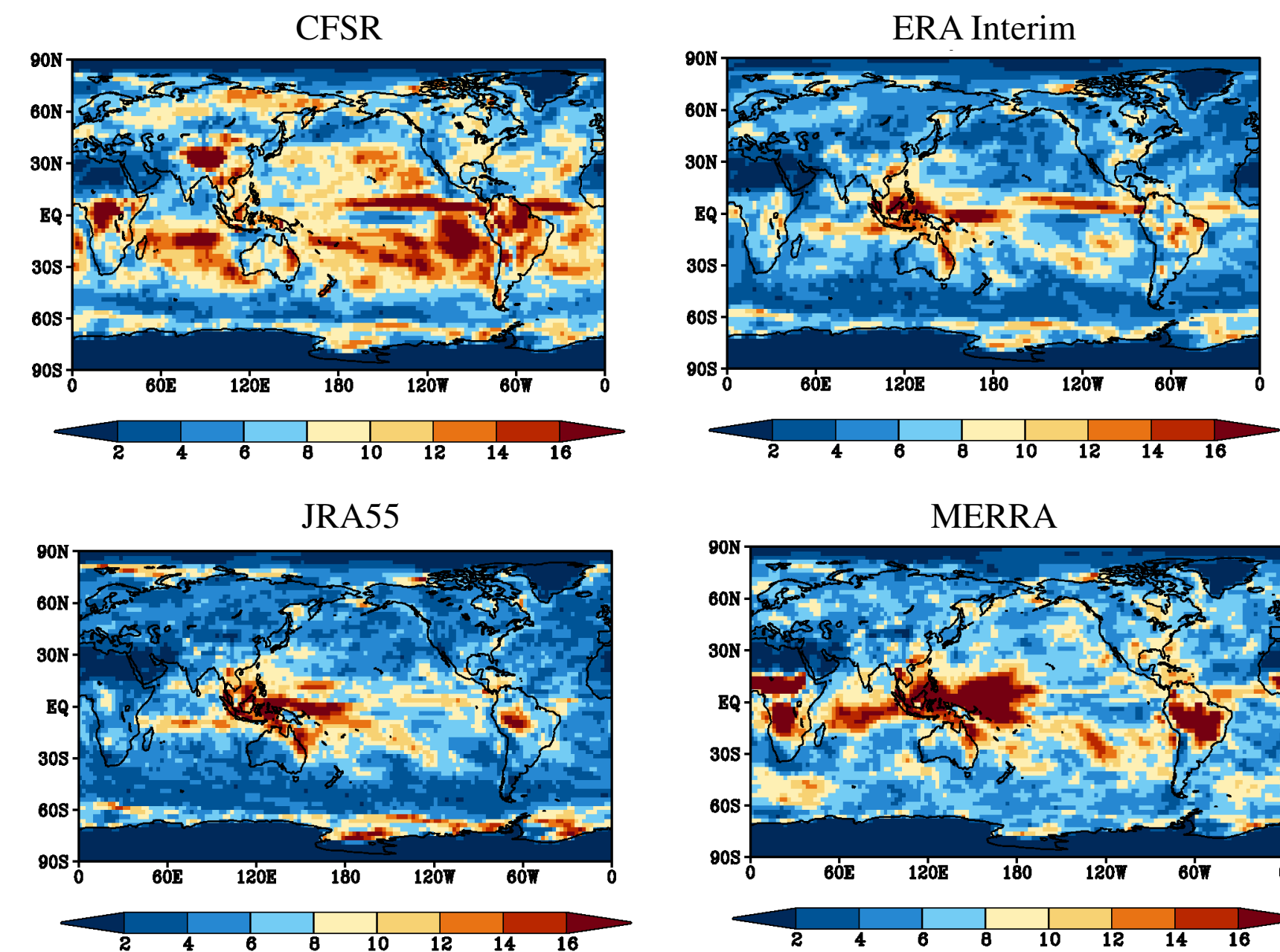
	CERES	ERAINT		JRA55		CFSR		MERRA	
		BIAS	RMSD	BIAS	RMSD	BIAS	RMSD	BIAS	RMSD
SC	340.11	1.04	1.41	1.20	1.28	1.50	1.57	1.19	1.27
SW	99.61	-0.32	9.34	0.60	15.02	-2.08	14.87	-0.29	10.63
LW	239.66	5.87	6.80	11.55	13.25	3.74	6.32	2.99	7.41
Net	0.84	-4.51	10.98	-10.95	19.71	-0.16	12.46	-1.51	8.56
CSW	52.46	0.73	5.43	2.78	8.26	2.38	7.17	-0.14	4.49
CLW	265.70	-1.69	3.13	0.10	2.66	0.38	2.54	2.49	3.88
CNet	21.94	2.00	5.61	-1.69	7.07	-1.26	7.11	-1.16	4.83

	CERES	ERAINT		JRA55		CFSR		MERRA	
		SD	COOR	SD	COOR	SD	COOR	SD	COOR
SC	72.91	1.0000	0.9885	1.0000	1.0014	1.0000	1.0020	1.0000	1.0013
SW	17.62	0.8501	0.9064	0.5906	0.8637	0.7162	1.1761	0.8177	0.9973
LW	29.61	0.9933	0.9912	0.9757	0.9902	0.9857	1.0206	0.9767	1.0565
Net	56.04	0.9882	0.8962	0.9755	0.7826	0.9764	1.0300	0.9893	0.9524
CSW	22.92	0.9757	0.8922	0.9462	1.0496	0.9559	0.9302	0.9813	0.9441
CLW	29.96	0.9964	0.9737	0.9961	0.9882	0.9968	0.9726	0.9952	1.0096
CNet	57.26	0.9962	0.9696	0.9928	0.9867	0.9928	1.0190	0.9968	0.9798

CERES Interannual Variability (2σ , Wm^{-2})



Shortwave Interannual Variability (2σ , Wm^{-2})



Global Mean Interannual Variability (2σ , Wm^{-2})

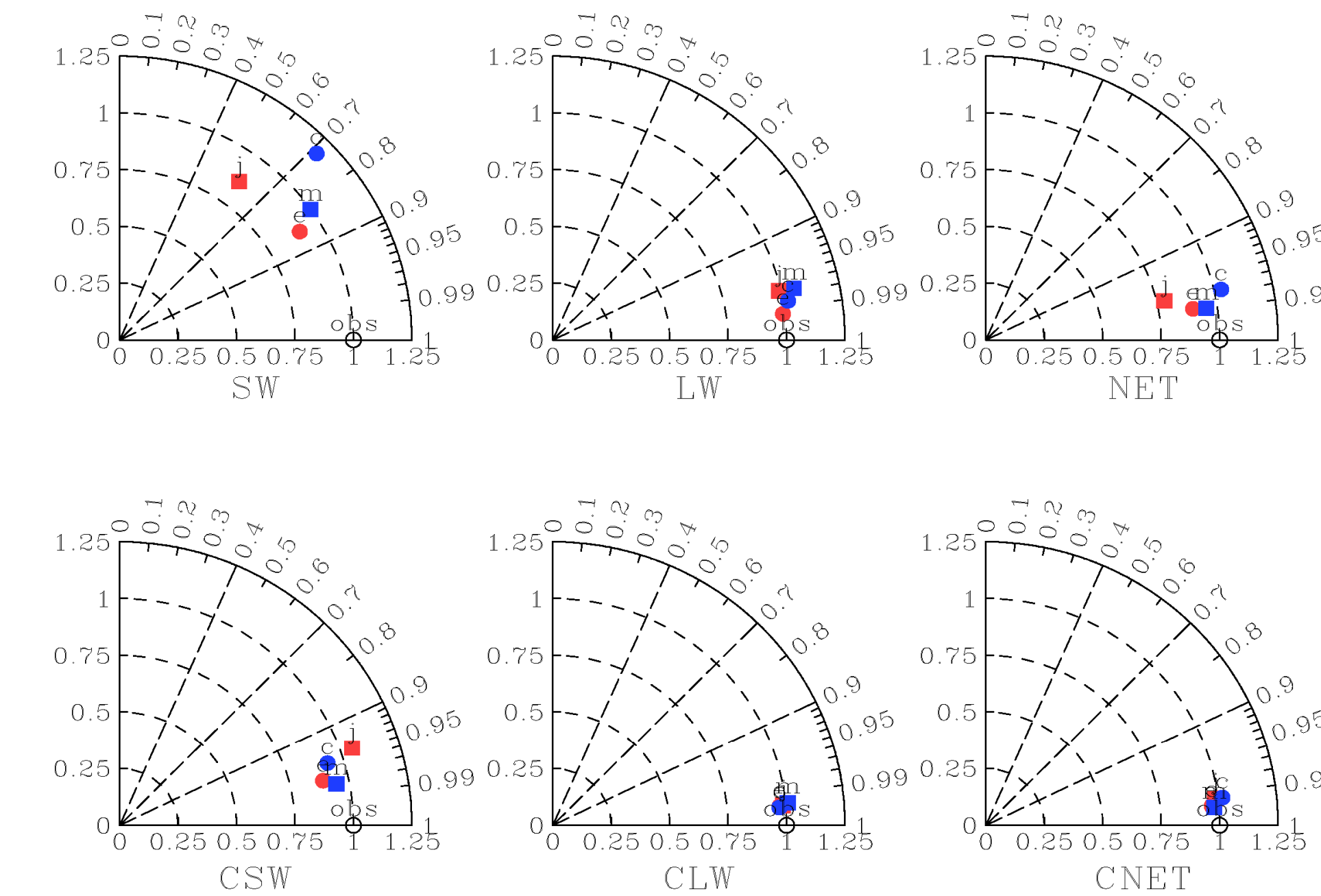
	CERES	ERAINT	JRA55	CFSR	MERRA
SC	0.19	0.01	0.01	0.22	0.01
SW	0.40	1.28	1.21	3.85	1.66
LW	0.54	1.05	1.00	1.75	1.27
Net	0.72	0.78	0.72	5.48	1.30
CSW	0.29	0.26	0.20	0.26	0.20
CLW	0.77	0.44	0.53	1.43	0.39
CNET	0.75	0.44	0.55	1.39	0.33

Global Mean Decadal Trend ($Wm^{-2}/Decade$)

	CERES	ERAINT	JRA55	CFSR	MERRA
SC	-0.11±0.05	0.0±0.02	0.00±0.02	0.04±0.05	0.00±0.02
SW	0.04±0.25	1.43±0.26	1.47±0.21	-3.29±0.80	-1.81±0.32
LW	-0.32±0.21	-1.22±0.19	-1.21±0.19	-2.19±0.26	1.35±0.31
Net	0.26±0.31	-0.21±0.28	-0.26±0.28	5.53±0.95	0.46±0.38
CSW	-0.14±0.14	-0.05±0.12	-0.13±0.09	0.14±0.16	0.20±0.11
CLW	-0.86±0.18	-0.31±0.15	-0.54±0.15	-1.77±0.21	-0.06±0.15
CNET	0.89±0.20	0.36±0.16	0.68±0.15	1.68±0.25	-0.13±0.16

* Red color indicates statistical significant trend at 95% confidence level.

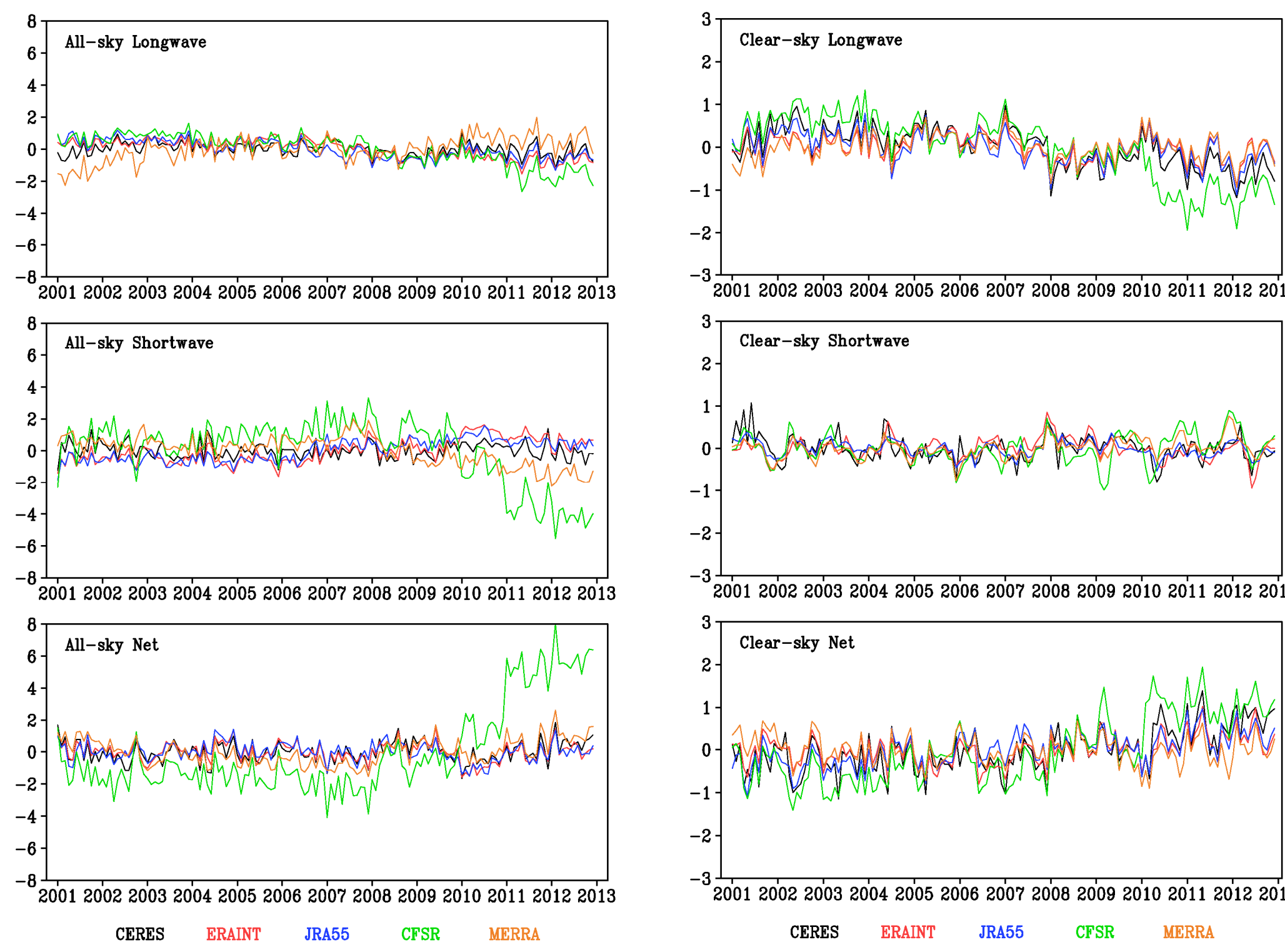
Taylor Diagram



○ CERES ● ERAINT ■ JRA55 ● CFSR ■ MERRA

Radius = Spatial SD Ratio, Angle = Spatial Correlation

Global Mean Deseasonalized Time Series (Wm^{-2})



Tropical Mean Deseasonalized Time Series (Wm^{-2})

