Preliminary Comparisons of TOA Radiation Budget between CERES Observations and MERRA Reanalysis Data

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CERES Science Team Meeting
Livermore, California
4-6 October, 2011

Objective

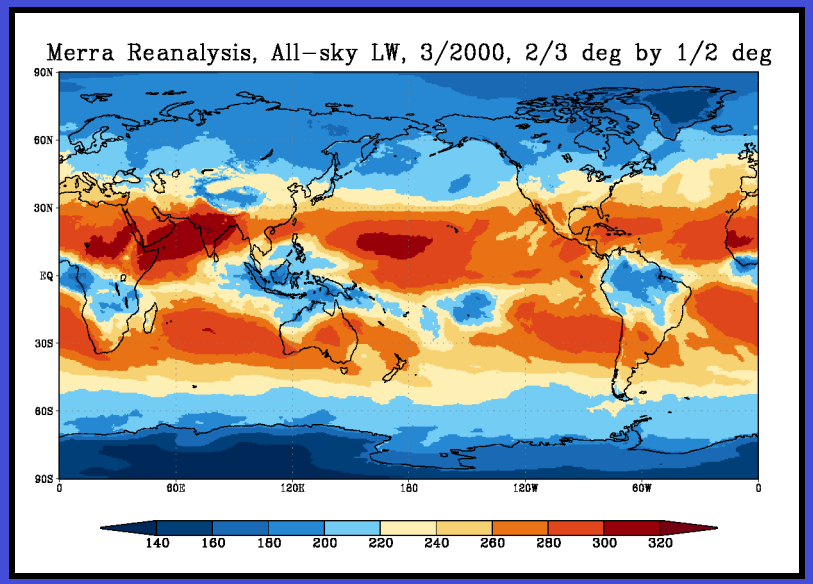
- Compare the first decade of CERES EBAF TOA radiation budget data (March 2000 to February 2010) with MERRA Reanalysis Data
  - Longwave, shortwave, net (all-sky and clear-sky), solar incomming
  - Regional, global (90N to 90S) and tropical (30N to 30S) scale
  - 10-year climatology (average)
  - Interannual variability (2-sigma)
  - Deseasonalized time series

Data Sets

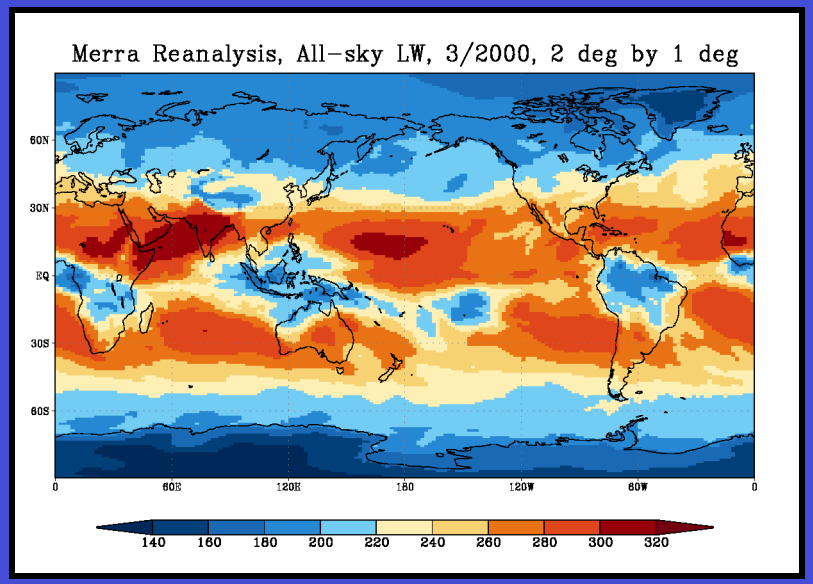
- CERES EBAF Edition 2.6 Monthly Mean Data
  - 1 degree by 1 degree equal angle global grid in NetCDF format
  - Obtained from CERES data website http://ceres.larc.nasa.gov/order_data.php
- MERRA Reanalysis Monthly Mean Data
  - 2/3 degree by 1/2 degree equal angle global grid in NetCDF format
  - Obtained from Giovanni website http://disc.sci.gsfc.nasa.gov/giovanni/overview/index.html

Data Regridding

- CERES and MERRA data are regridded to a 2 degree by 1 degree grid to facilitate comparison of these data sets
- Regridding is done using weighted-average procedure to minimize regridding noise (no interpolation) and to preserve the quality of the global mean values



MERRA, Original Data



MERRA, Regridded Data

Data Regridding (Continue)

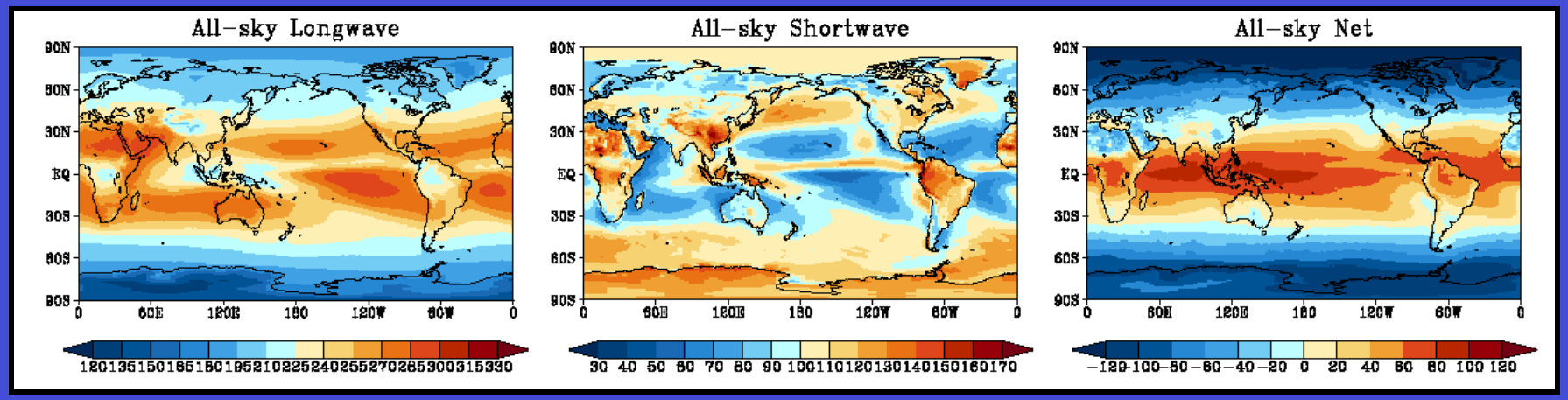
- Regridded data have the exact same global mean values as the original data; very similar but slightly smaller spatial variability

MERRA	Original Mean	Original 1-σ	Regridded Mean	Regridded 1-σ
Solar Inc.	*341.33*	*88.96*	*341.33*	*88.80*
All-sky LW	*242.38*	*38.15*	*242.38*	*37.88*
All-sky SW	*99.62*	*17.66*	*99.62*	*17.30*
All-sky Net	*-0.67*	*62.44*	*-0.67*	*62.31*
Clr-sky LW	*268.19*	*42.55*	*268.19*	*42.41*
Clr-sky SW	*52.29*	*29.10*	*52.29*	*28.76*
Clr-sky Net	*20.85*	*69.21*	*20.85*	*69.03*

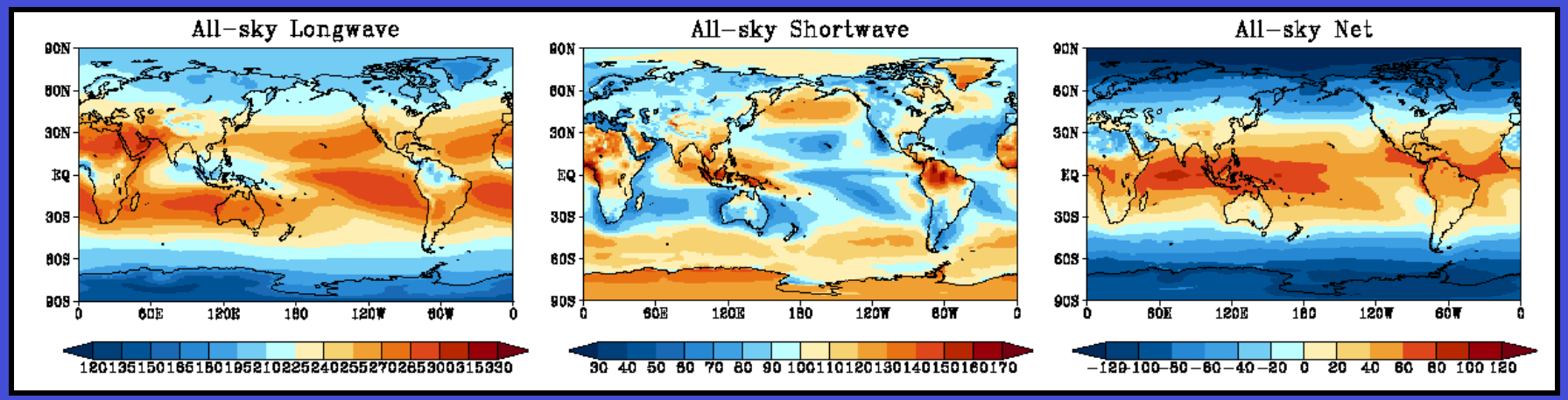
Based on 10-year Climatology (March 2000 to February 2010)

All-sky TOA Climatology (3/2000 to 2/2010)

CERES EBAF

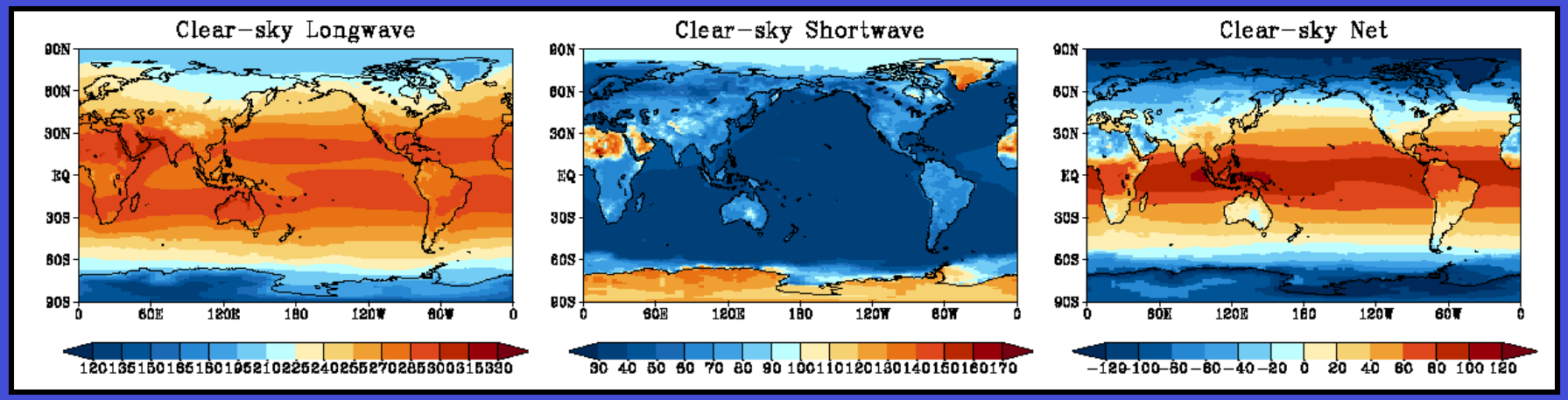


MERRA

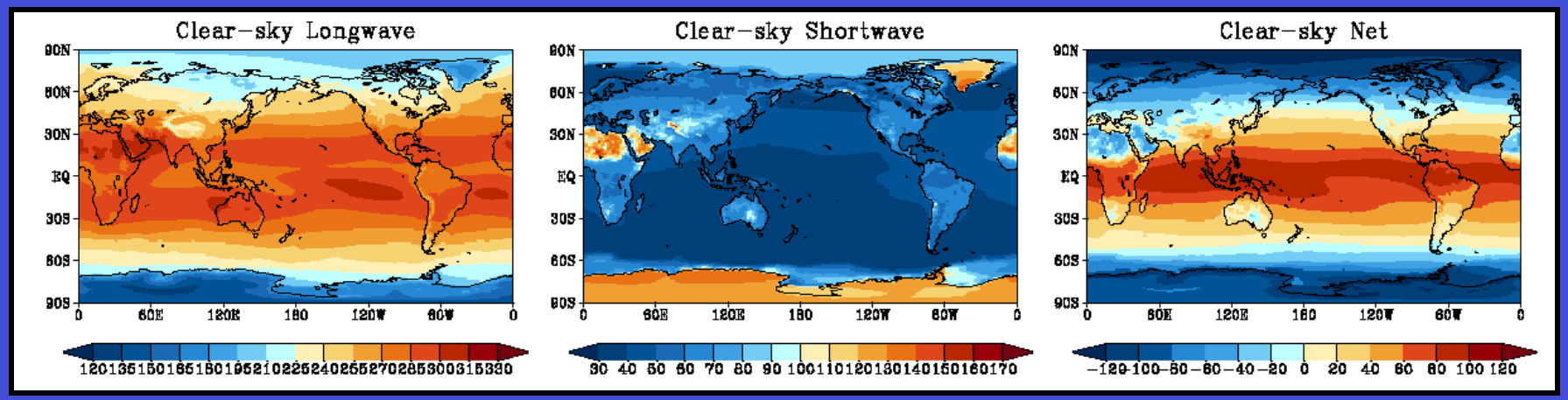


Clear-sky TOA Climatology (3/2000 to 2/2010)

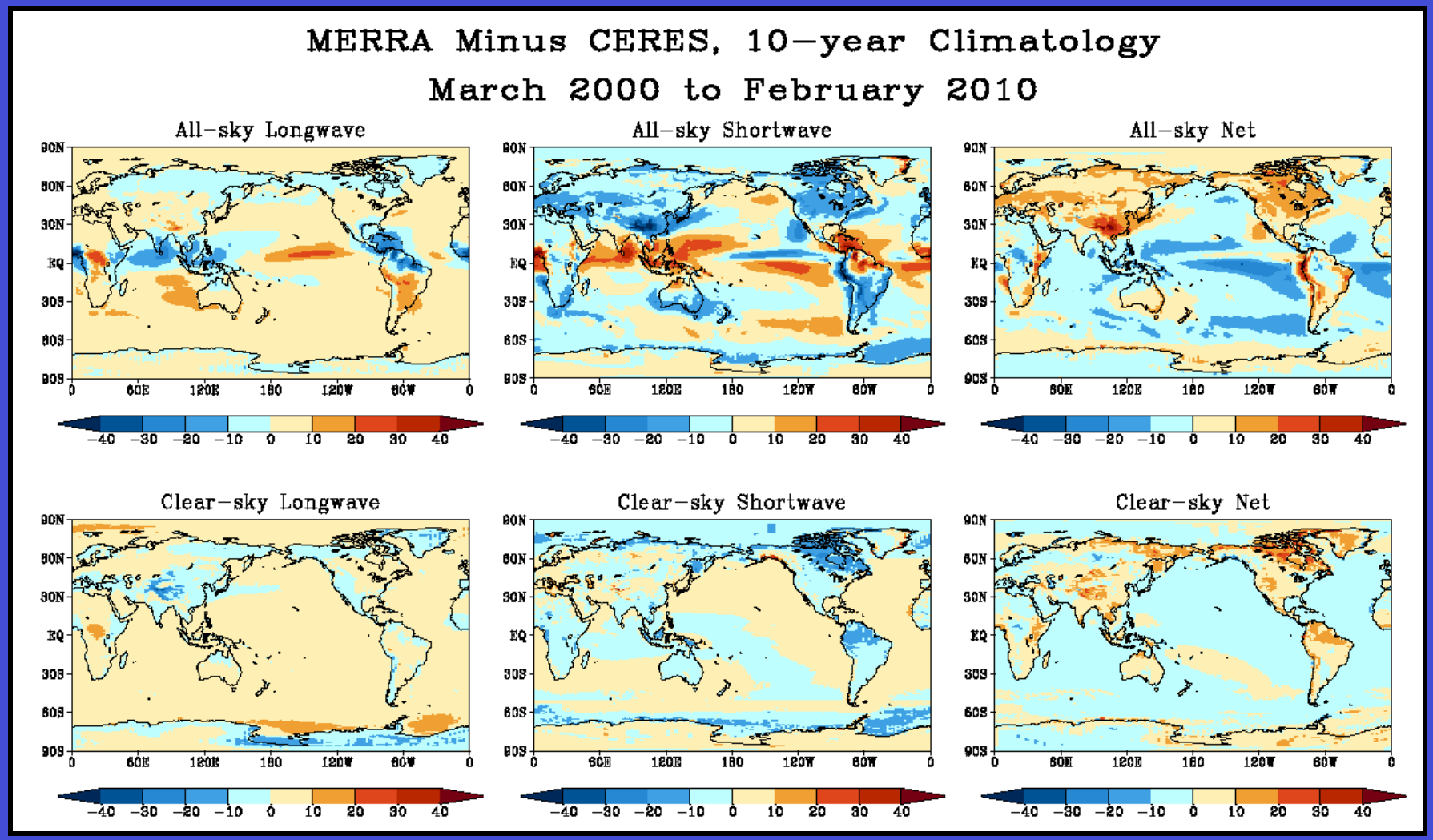
CERES EBAF



MERRA



MERRA Minus CERES TOA Differences



Global (90NS) Mean Comparison

Parameters (Wm^{-2})	MERRA 10y-avg	CERES 10y-avg	Mean Diff. Merra-Ceres	MERRA 2-σ	CERES 2-σ
Solar Incoming	341.33	340.22	1.11 (0.3%)	0.00	0.23
Longwave	242.38	239.77	2.61 (1.1%)	1.11	0.52
Shortwave	99.62	99.95	-0.33 (-0.4%)	1.07	0.46
Net	-0.67	0.51	-1.18 (-231%)	1.45	0.54
Clear Longwave	268.19	266.25	1.94 (0.7%)	0.42	0.66
Clear Shortwave	52.29	52.57	-0.28 (-0.5%)	0.18	0.24
Clear Net	20.85	21.41	-0.56 (-2.6%)	0.34	0.46

- MERRA has higher global mean values of solar in. and outgoing LW; but lower values of reflected SW and Net
- MERRA uses a different solar irradiance value than CERES. CERES value is based on SORCE observations

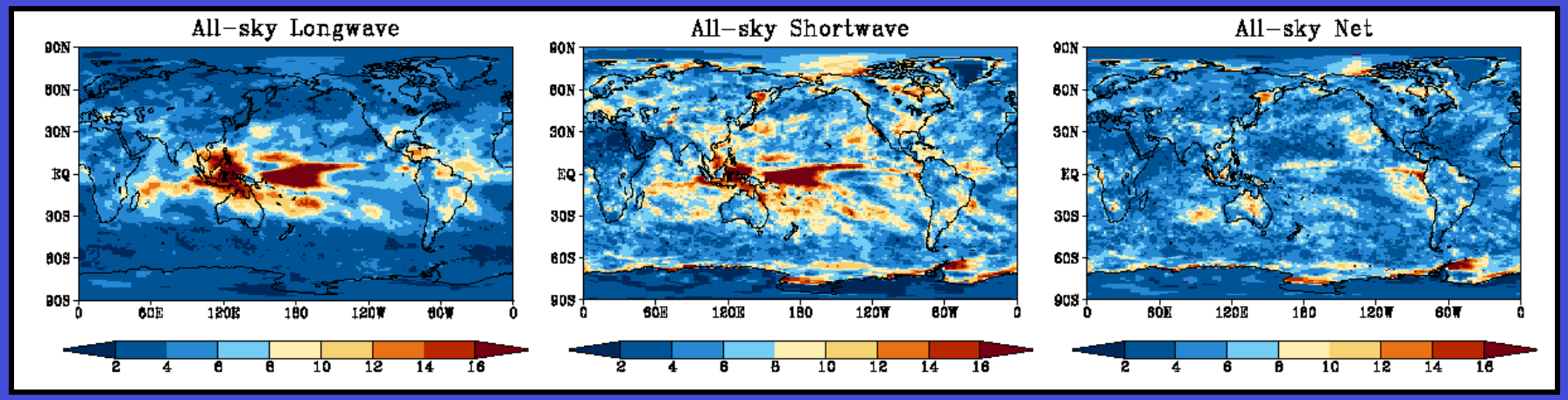
Tropical (30NS) Mean Comparison

Parameters (Wm^{-2})	MERRA 10y-avg	CERES 10y-avg	Mean Diff. Merra-Ceres	MERRA 2-σ	CERES 2-σ
Solar Incoming	*400.48*	*399.29*	*1.19 (0.3%)*	*0.00*	*0.27*
Longwave	*261.56*	*259.82*	*1.74 (0.7%)*	*1.81*	*0.94*
Shortwave	*97.83*	*94.58*	*3.25 (0.3%)*	*1.50*	*0.65*
Net	*41.09*	*44.88*	*-3.79 (-8.4%)*	*1.40*	*0.88*
Clear Longwave	*289.61*	*287.28*	*2.33 (0.8%)*	*0.77*	*0.87*
Clear Shortwave	*49.20*	*49.24*	*-0.04 (-0.1%)*	*0.05*	*0.14*
Clear Net	*61.67*	*62.76*	*-1.09 (-1.7%)*	*0.73*	*0.75*

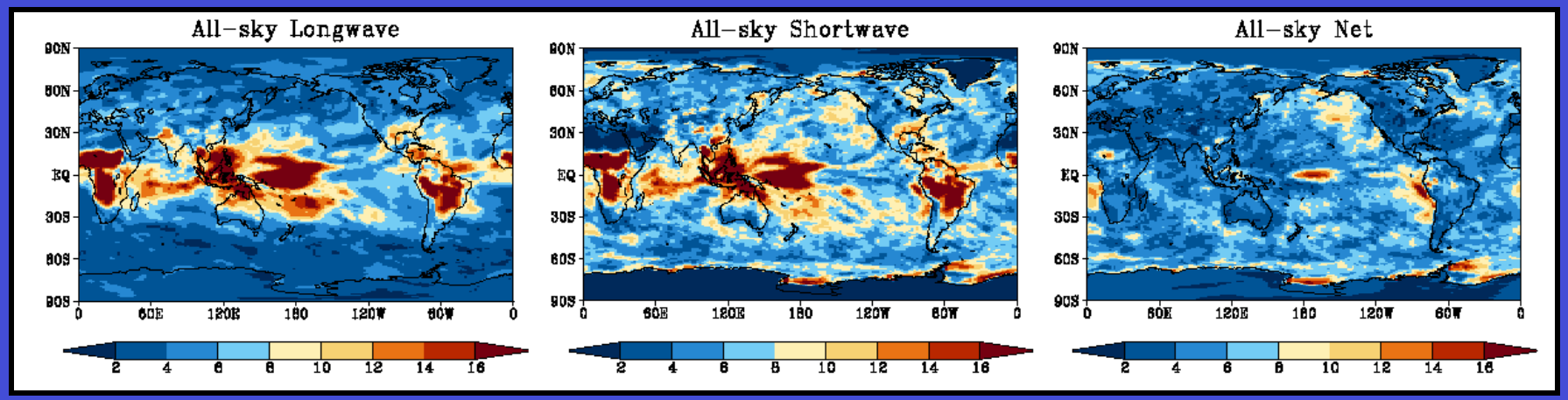
- Tropical results similar to those of global mean; but MERRA all-sky SW mean is now much higher than CERES
- Clear-sky shortwave fluxes are almost identical between MERRA and CERES

All-sky TOA Interannual Variability

CERES EBAF

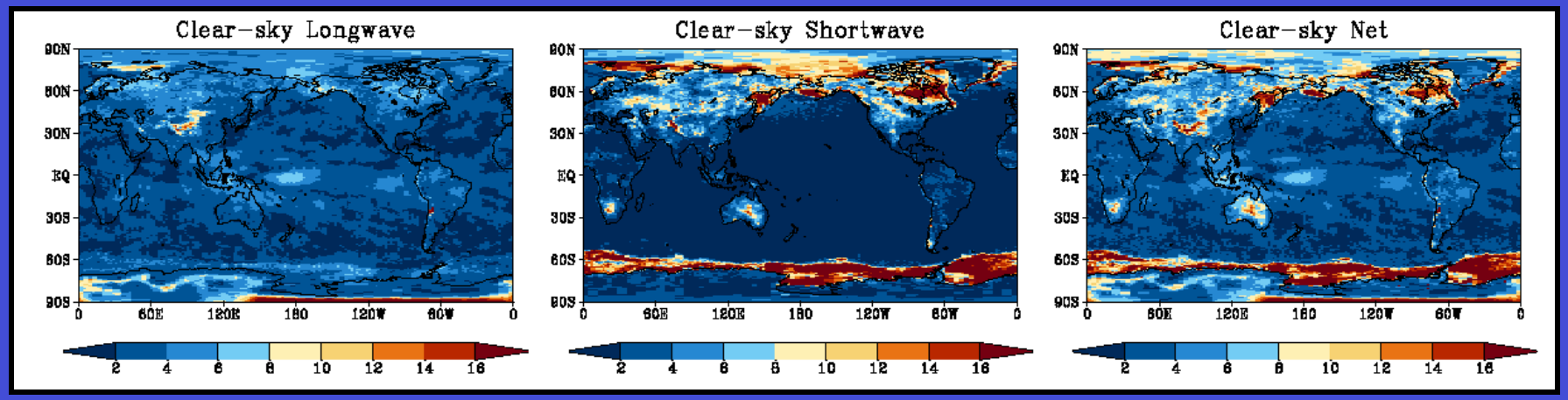


MERRA

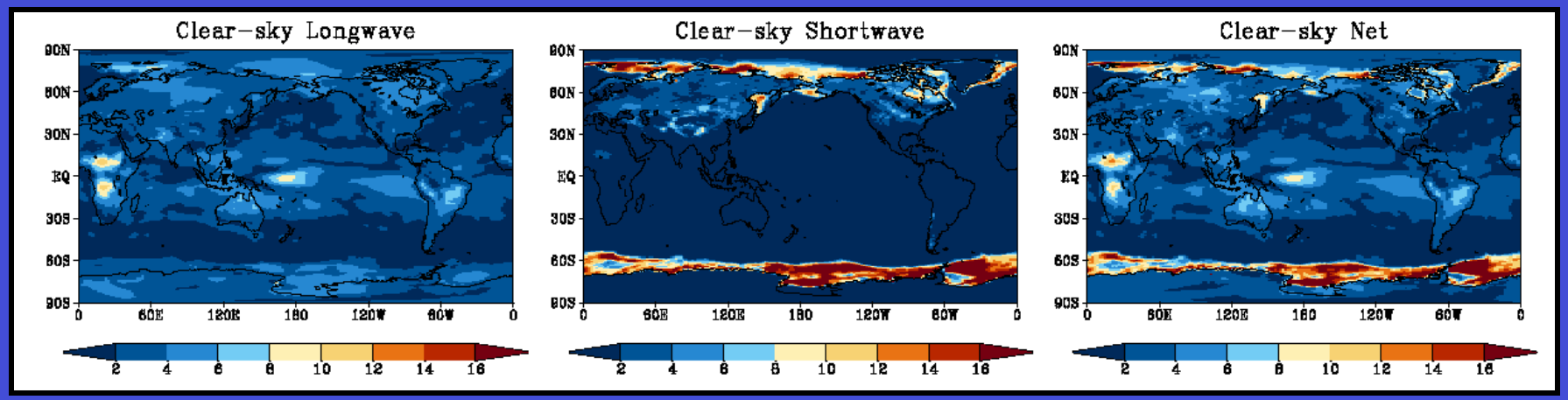


MERRA TOA Interannual Variability

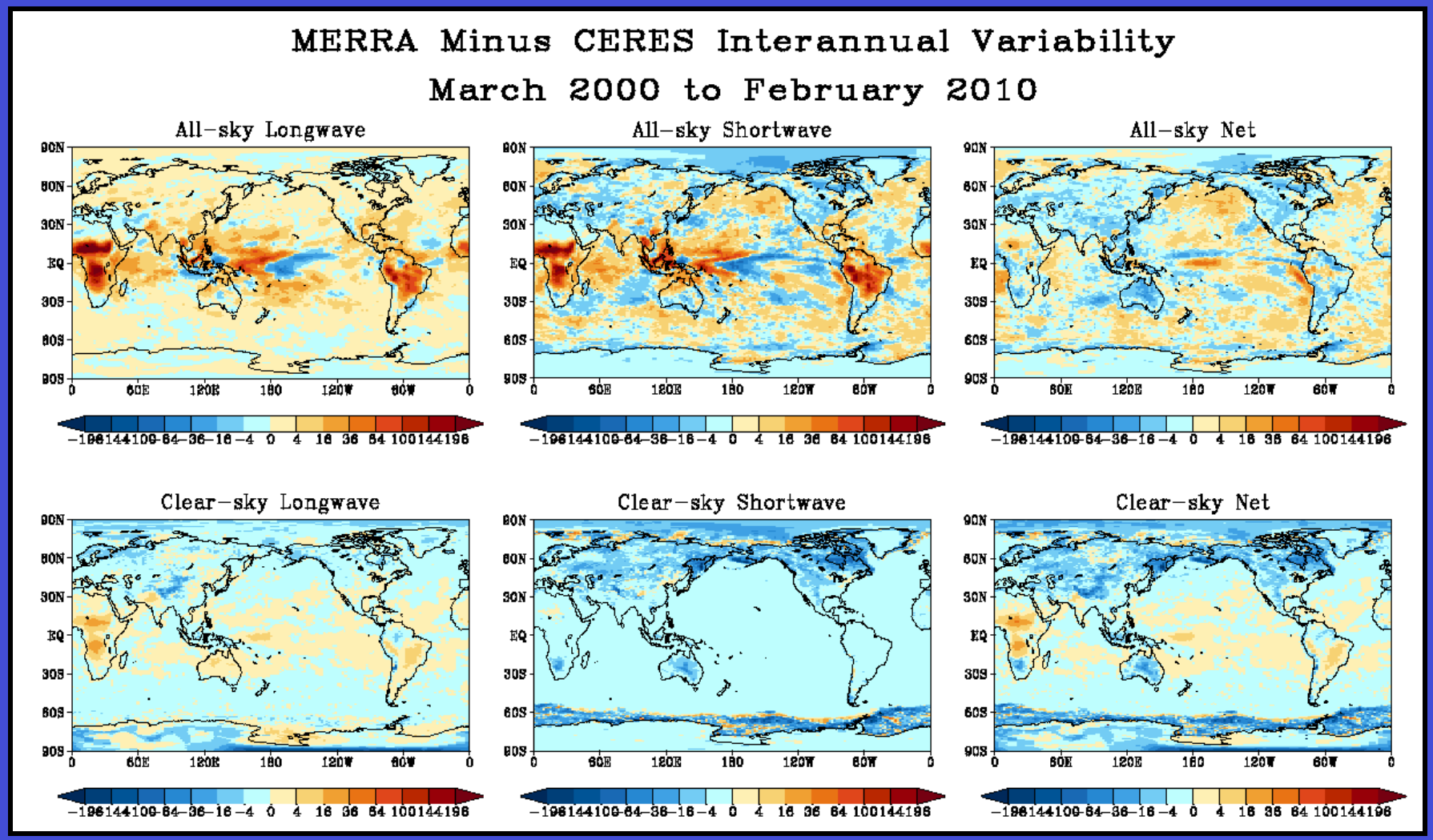
CERES EBAF



MERRA



MERRA Minus CERES TOA Interannual Variability



Global (90NS) Mean and Interannual Variability

Parameters (Wm^{-2})	MERRA 10y-avg	CERES 10y-avg	Mean Diff. Merra-Ceres	MERRA 2-σ	CERES 2-σ
Solar Incoming	341.33	340.22	1.11 (0.3%)	0.00	0.23
Longwave	242.38	239.77	2.61 (1.1%)	1.11	0.52
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- MERRA has higher interannual variability of all-sky fluxes; but lower interannual variability of clear-sky fluxes
- MERRA uses a constant solar irradiance value while CERES uses a time varying solar irradiance observations from SORCE

Tropical (30NS) Mean and Interannual Variability

Parameters (Wm^{-2})	MERRA 10y-avg	CERES 10y-avg	Mean Diff. Merra-Ceres	MERRA 2-σ	CERES 2-σ
Solar Incoming	*400.48*	*399.29*	*1.19 (0.3%)*	*0.00*	*0.27*
Longwave	*261.56*	*259.82*	*1.74 (0.7%)*	*1.81*	*0.94*
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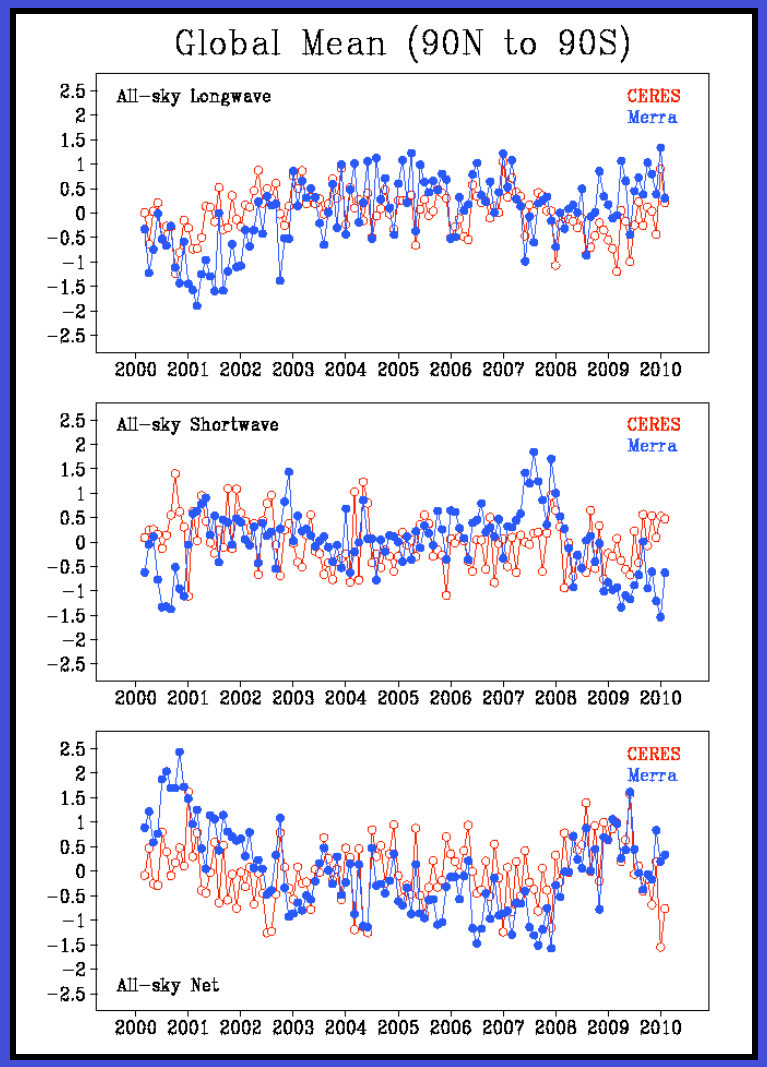
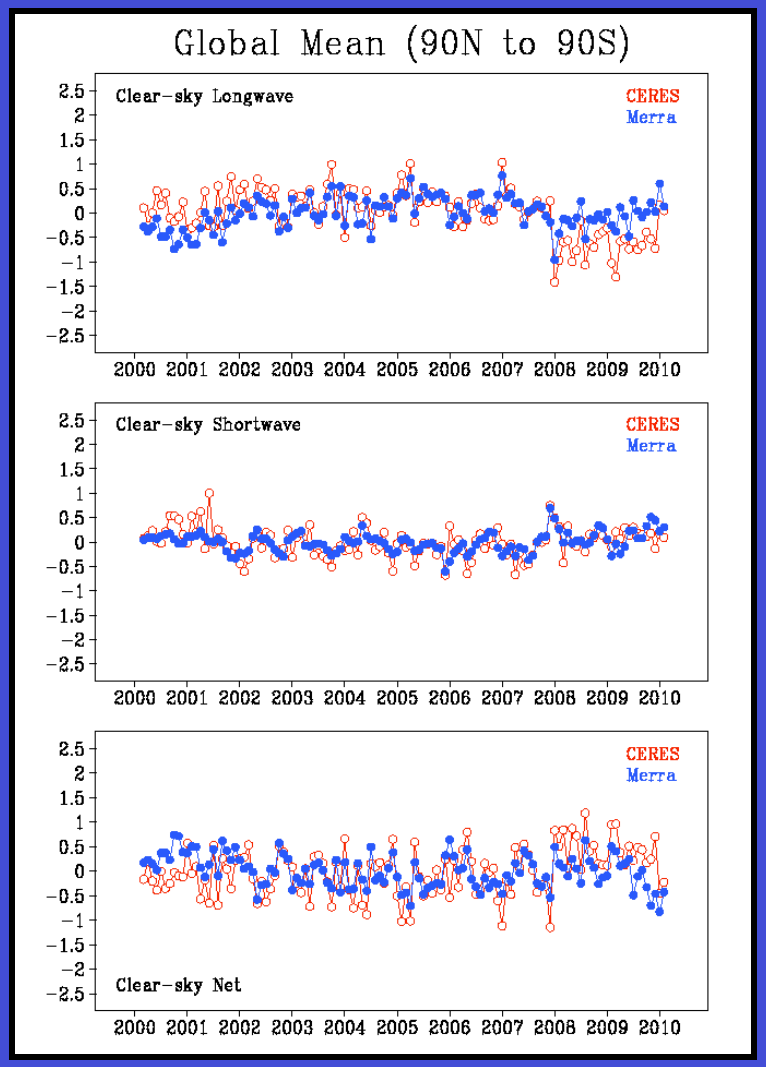
Clear Net	*61.67*	*62.76*	*-1.09 (-1.7%)*	*0.73*	*0.75*

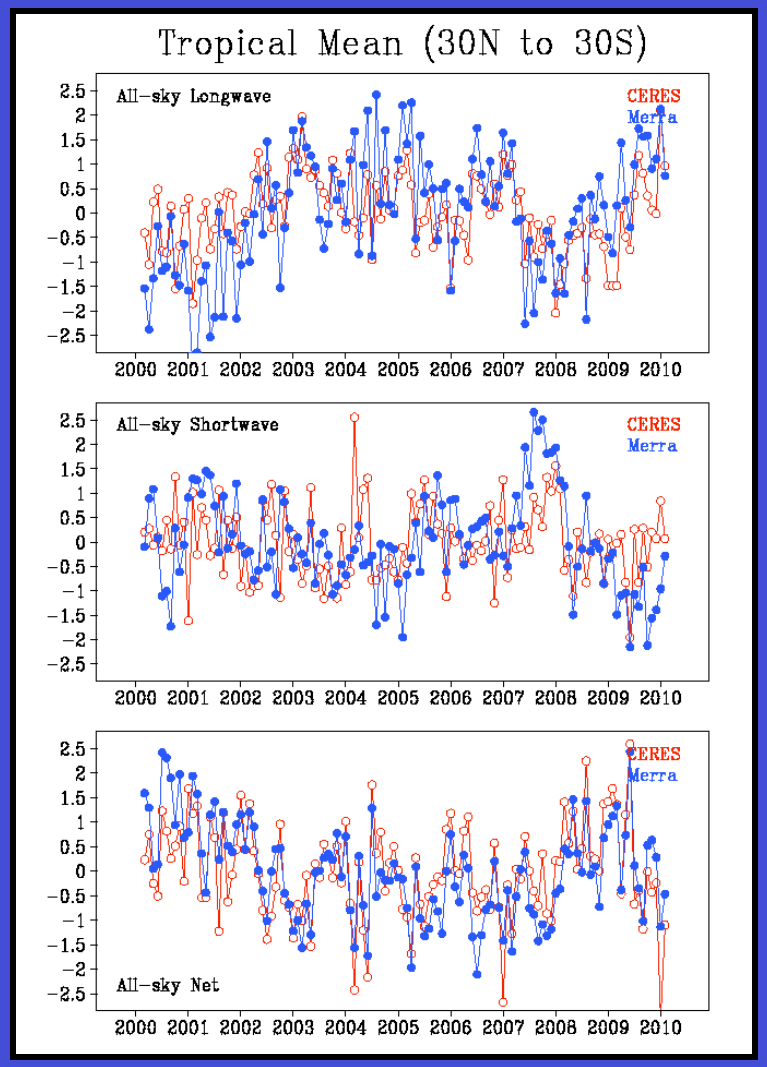
- Tropical results similar to those of global mean; larger values of interannual variability in the tropics for both CERES and MERRA
- MERRA has very little interannual variability in clear-sky shortwave flux

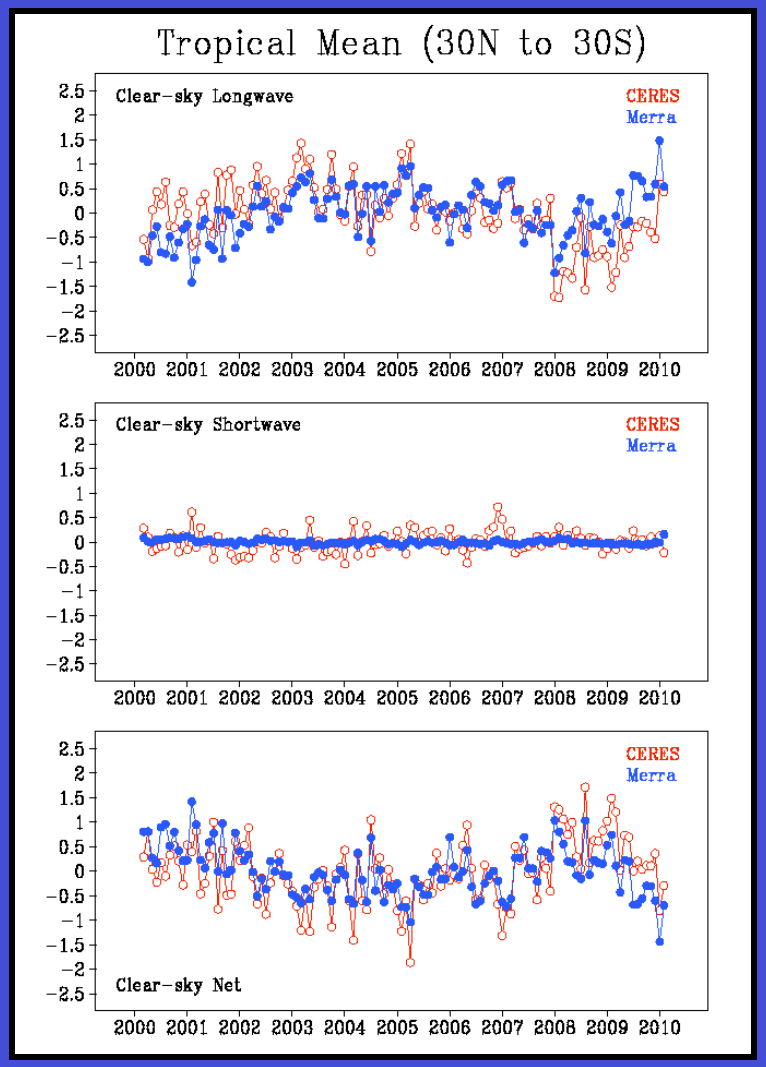
Global Mean Deseasonalized Time Series





Tropical Mean Deseasonalized Time Series





Summary

- MERRA uses a constant solar irradiance value (~1365 Wm^{-2}) while CERES EBAF uses a time varying solar irradiance from SORCE observations with a solar constant ~ 1361. This leads to differences in solar incoming fluxes and also contributes to the Net differences
- MERRA global mean all-sky longwave are much higher than CERES values. Large regional differences are found in the tropics for all-sky longwave and shortwave radiation
- MERRA 10-year averaged global mean all-sky Net is negative (losing energy) while the corresponding CERES value is positive (gaining energy)
- MERRA has larger interannual variability of all-sky fluxes; but smaller interannual variability of clear-sky fluxes than CERES
- There are some large differences in times series in the beginning and the ending of the 10-year period