

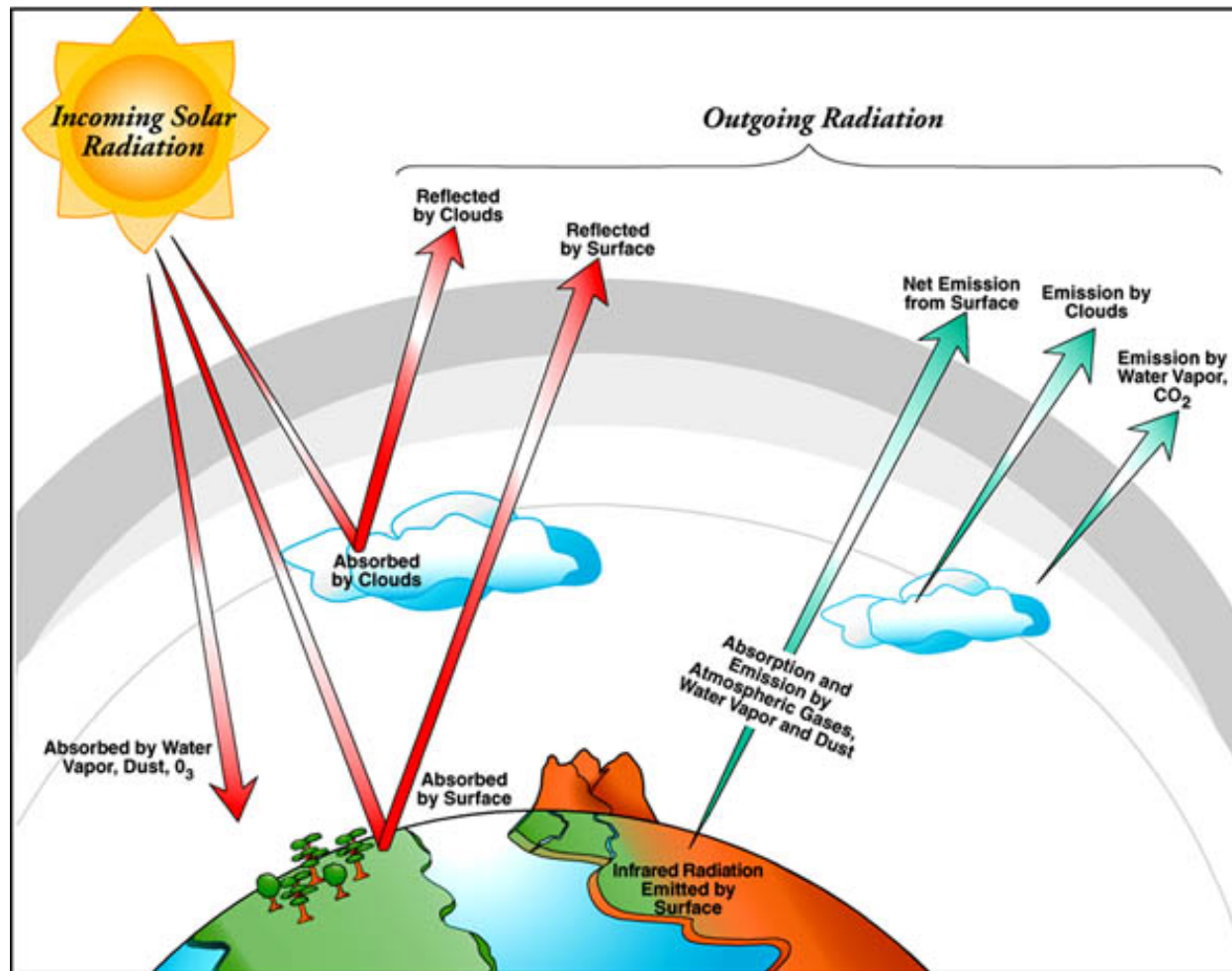
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AIRS & CERES & Model Earth's Radiative Components

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Motivation: Phase Shifts & Symmetry in Radiative Balance



Data

1. Incident Solar Irradiance -- SORCE TSI relative to the Earth center, $340.2 \pm 0.13 \text{ W/m}^2$. Annual variations 20.4 W/m^2 due to 6% Sun-Earth distance change. Max in January.
2. Incident Solar Irradiance, CERES corrected for Earth's non-sphericity, 340 W/m^2
3. Reflected Shortwave Radiance (RSW) -- CERES Lite (Aqua) and EBAF Ed 2.7, 2.8
3. Outgoing Longwave Radiance (OLR) -- CERES and AIRS L3 (version 6)
4. AIRS L1 proxy for OLR

Monthly data: from Sep 1 2002 to Aug 31 2013 (exactly 11 years)

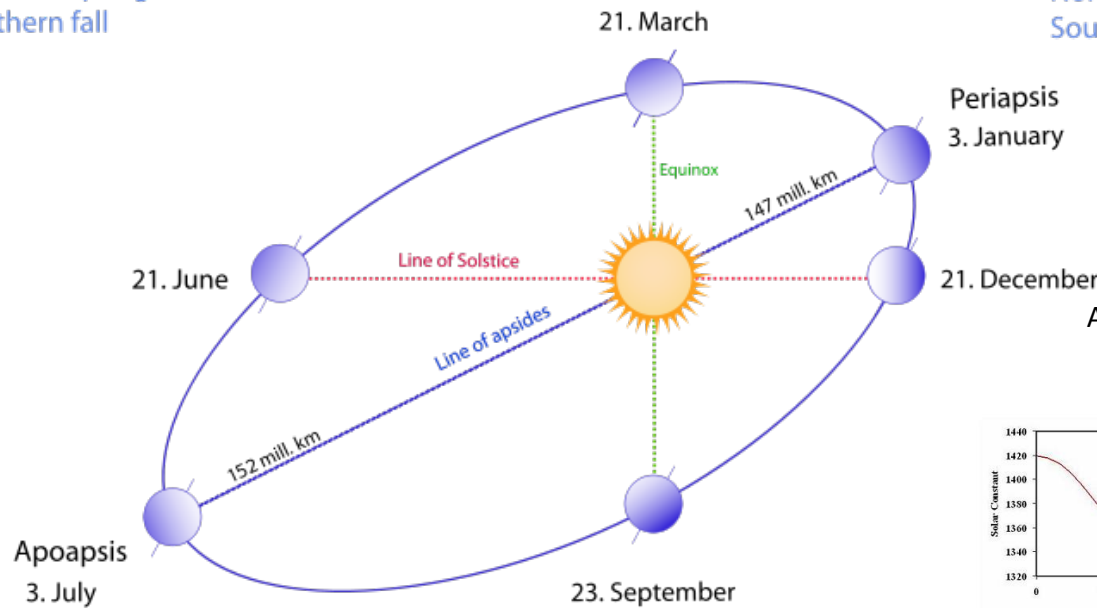
5. Model simulations (CCCMA and UKMO in 2002-2008)

Solar Incident Radiation (SIR)

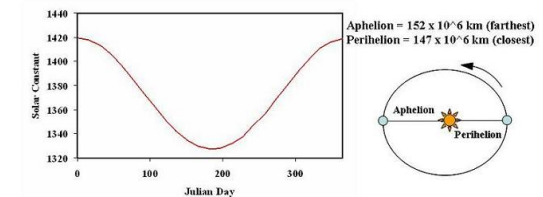
Solar Incident radiation at 1 AU = 1360.2 W/m^2 , varies by about 1 W/m^2 from solar maximum to minimum

Northern spring/
Southern fall

Northern winter/
Southern summer



Annual variation of solar constant

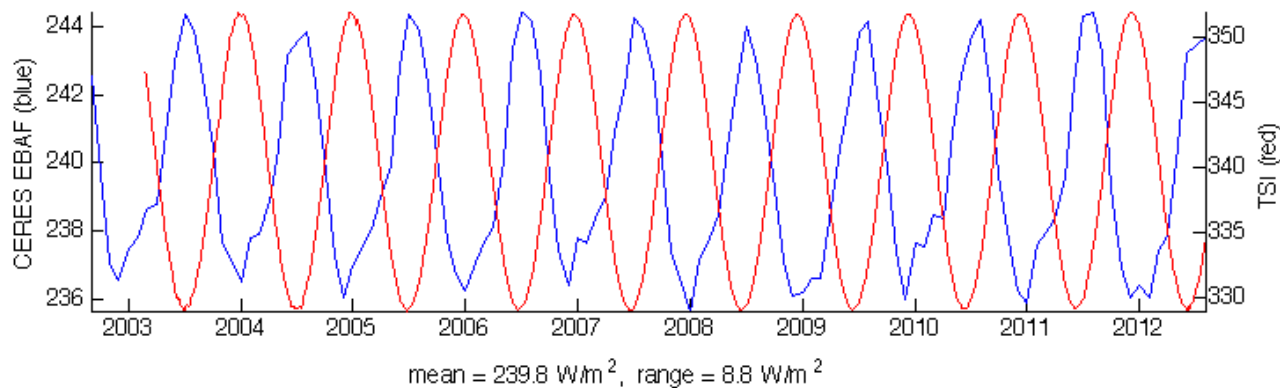
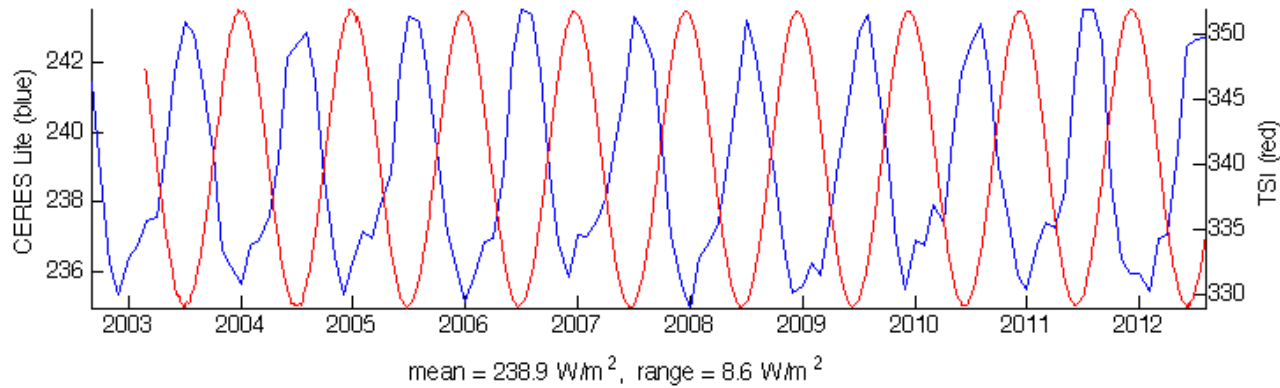
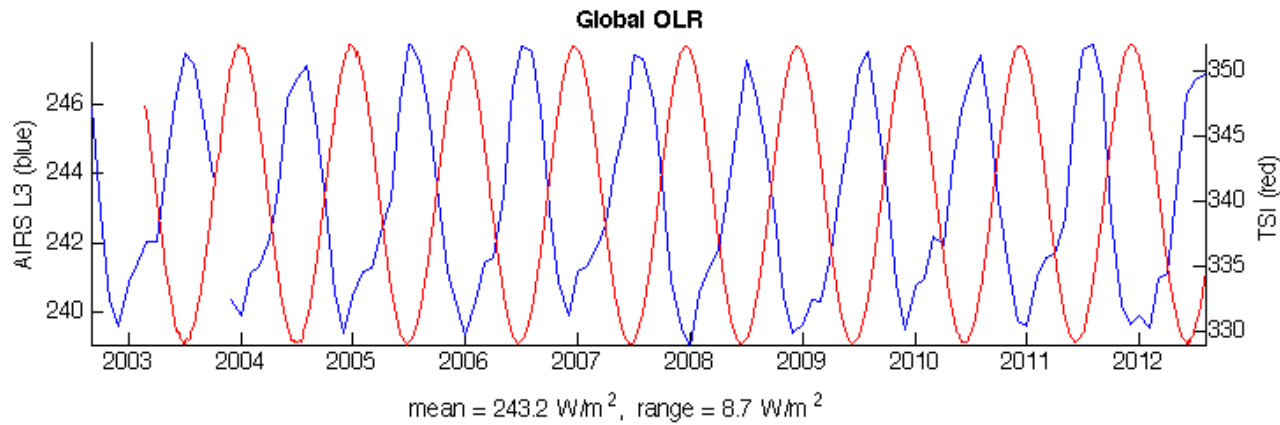


Northern summer/
Southern winter

Northern fall/
Southern spring

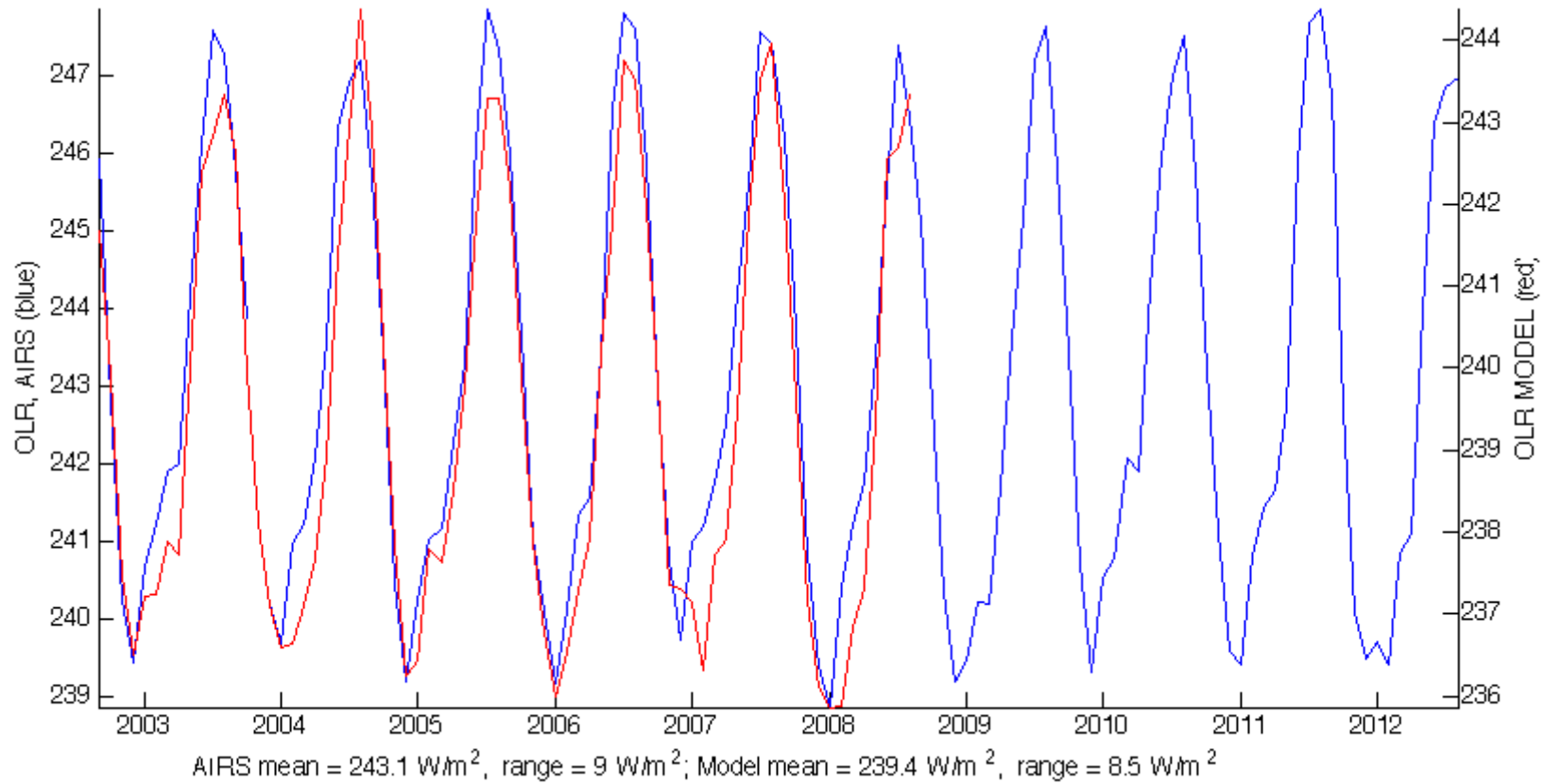
- The global averaged Solar Incident Radiation incident on the Earth surface = 339.8 W/m^2
- Max of Solar Incident Radiation (January, Sun's closest approach), $\text{maxS} - \text{maxN} = 22.5 \text{ W/m}^2$
- On average Southern Hemisphere gets 0.6 W/m^2 more SIR than Northern Hemisphere
(numbers are based on CERES EBAF 2.8 data)

OLR vrs Solar



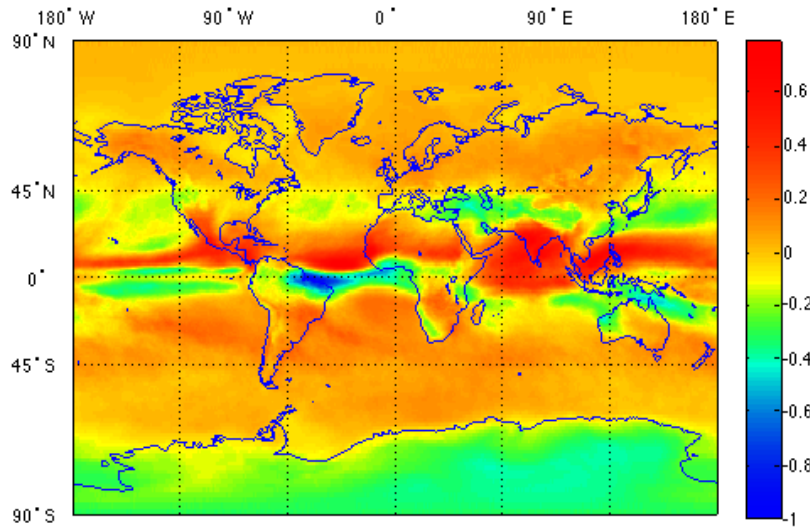
Maxima of OLR (June)
trail TSI by 6 months

GLOBAL AIRS OLR vrs MODEL OLR

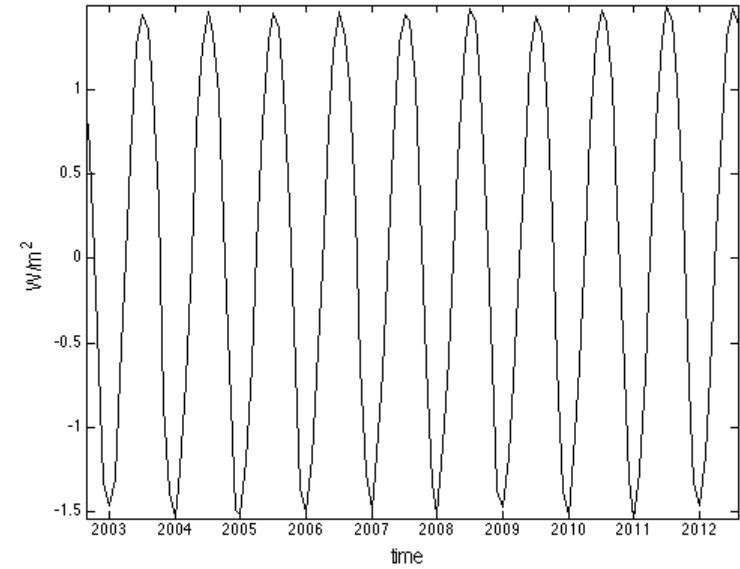
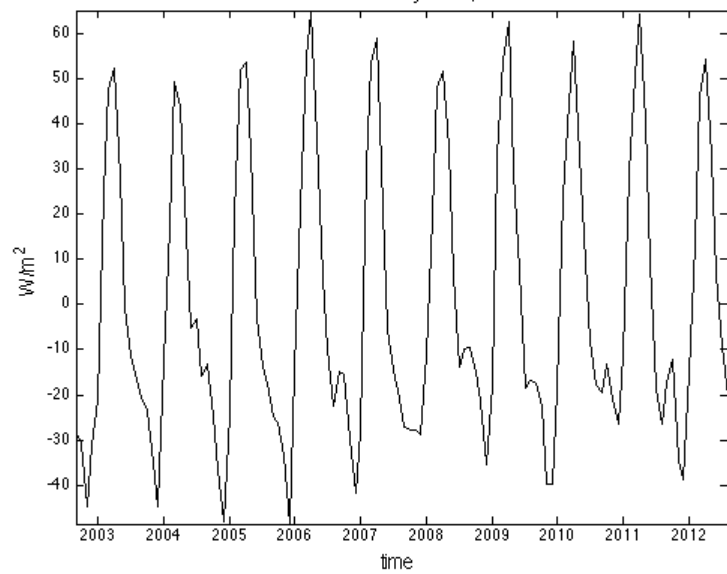
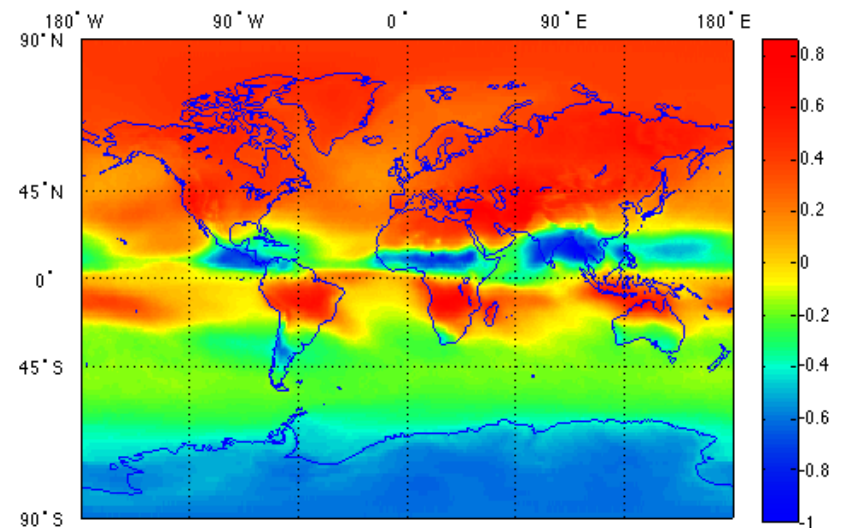


EOFs of AIRS OLR

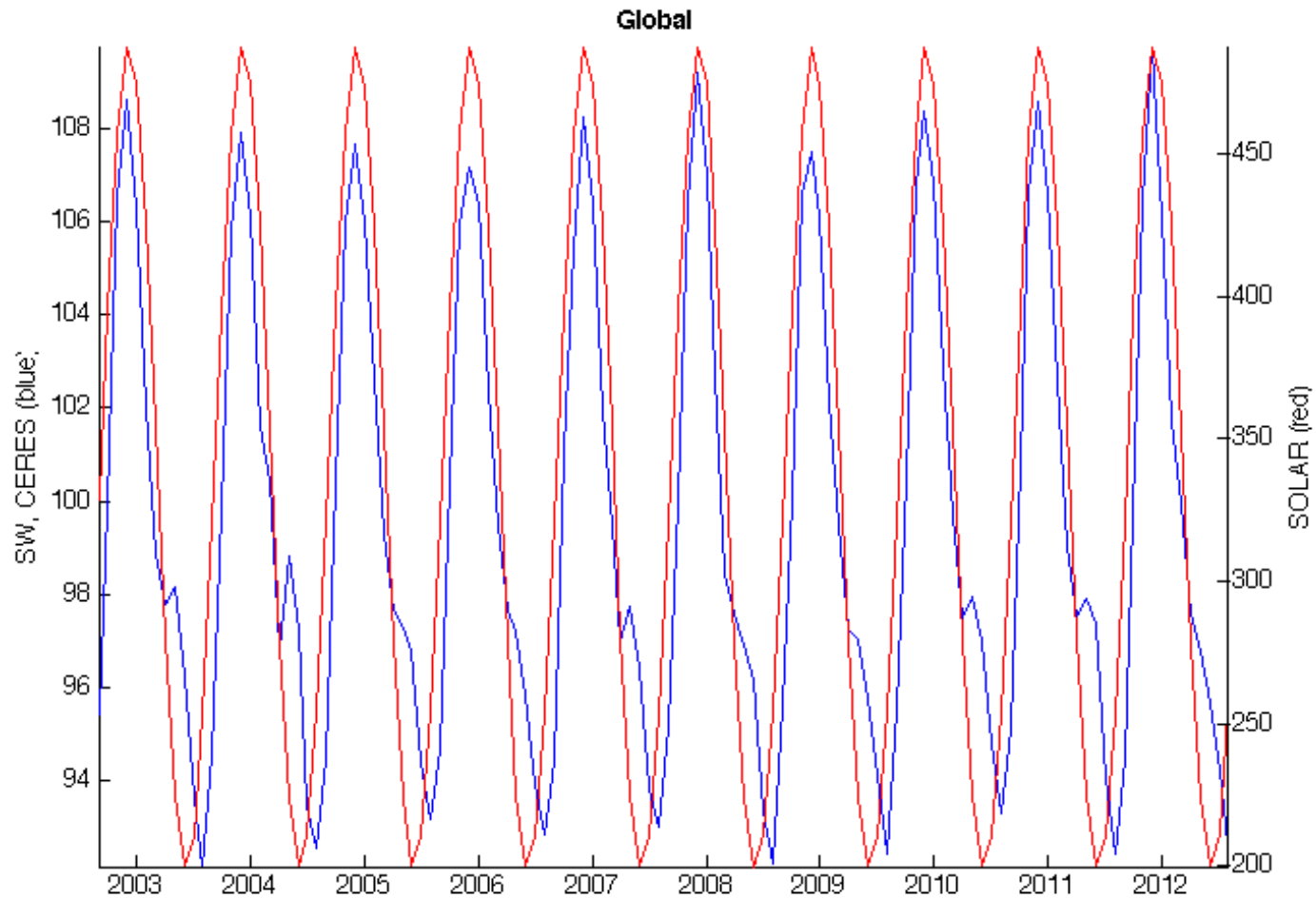
EOF & PC 1 (99.5%)



EOF & PC 2 (0.5%)



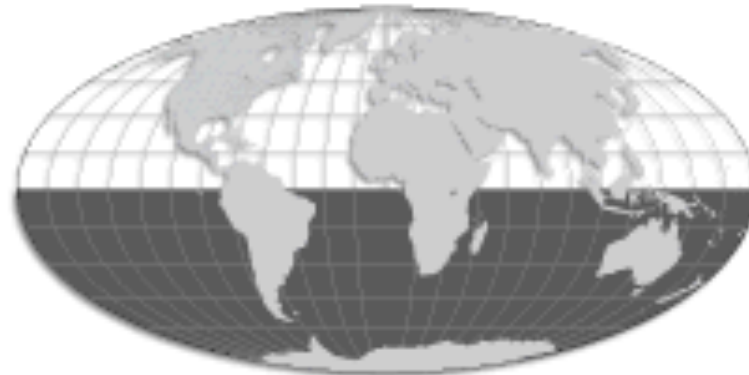
Global RSW vrs Solar



Minima of RSW trail Solar Incident Radiation minima by ≈ 2 months

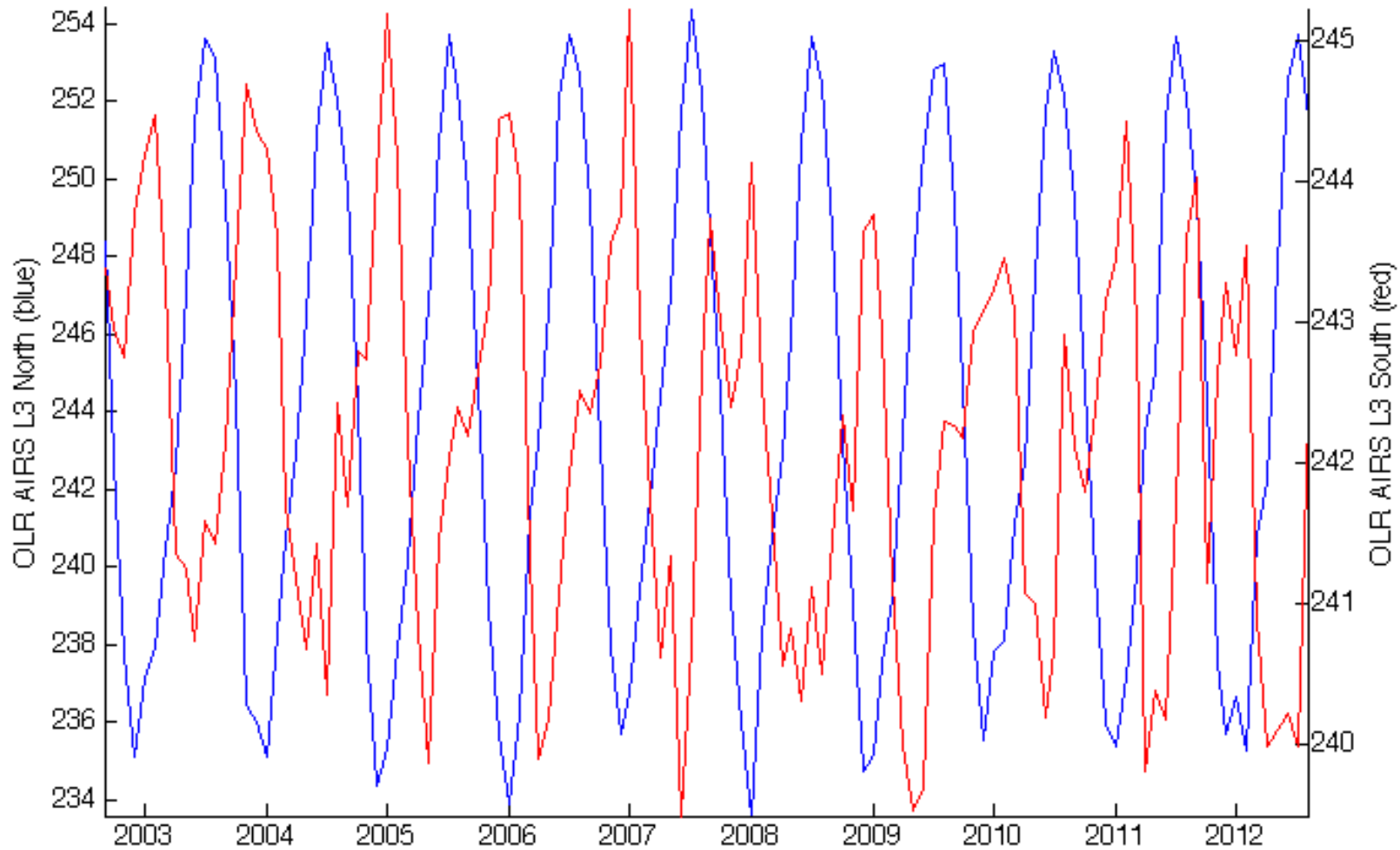
North-South Symmetry & Asymmetry

Northern Hemisphere



Southern Hemisphere

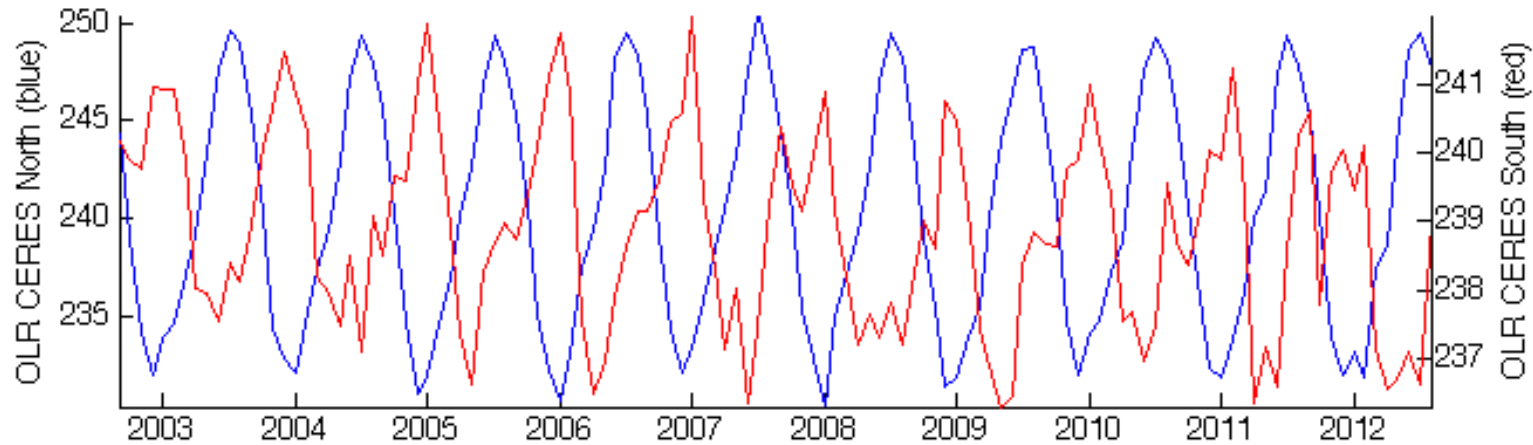
AIRS OLR, North-South



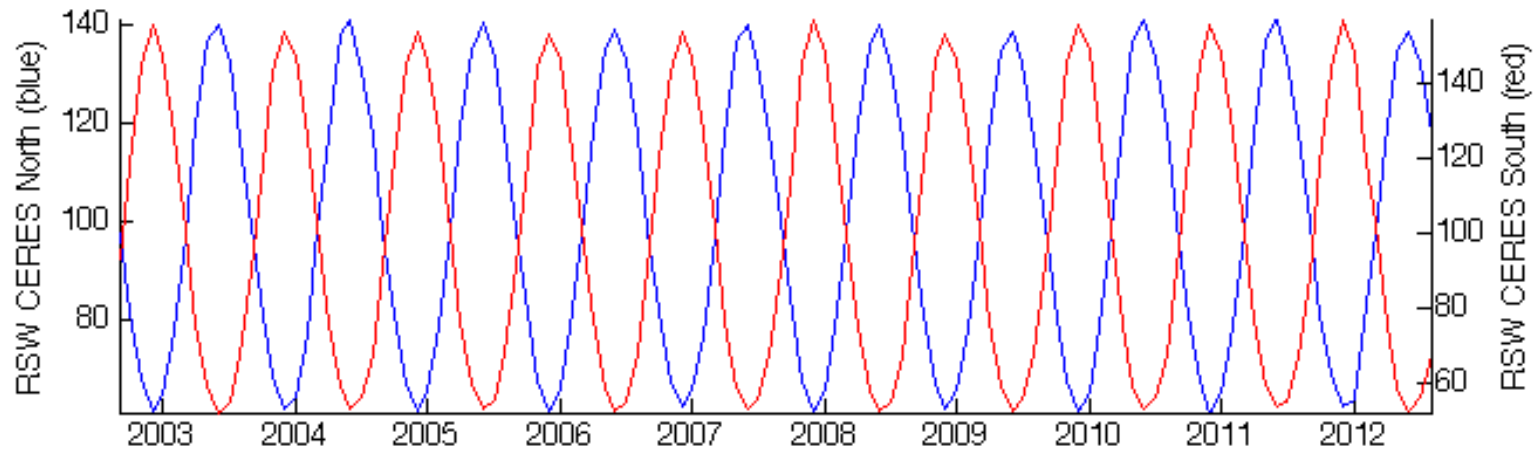
mean North = 244 W/m^2 , range = 20.8 W/m^2 ; mean South = 242.2 W/m^2 , range = 5.7 W/m^2

AIRS OLR mean(N-S) = 1.8 W/m^2

CERES OLR & RSW, North-South



mean North = 240.3 W/m², range = 20 W/m²; mean South = 238.9 W/m², range = 5.7 W/m²



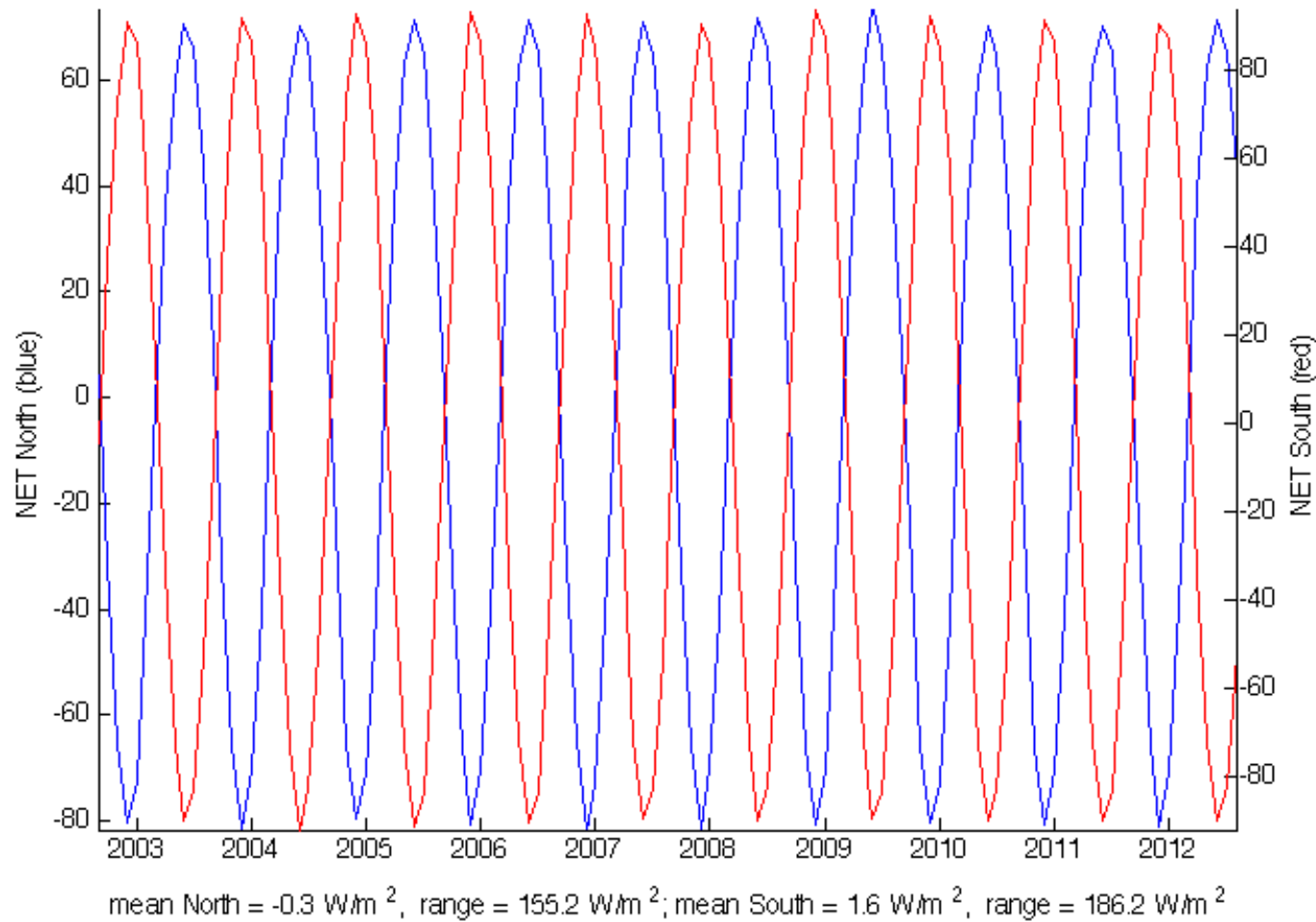
mean North = 99.6 W/m², range = 80 W/m²; RSW mean South = 99.6 W/m², range = 104.9 W/m²

OLR Mean(N-S) = 1.4 W/m²

RSW mean(N-S) = 0. W/m²

N-S OLR asymmetry!
N-S RSW symmetry

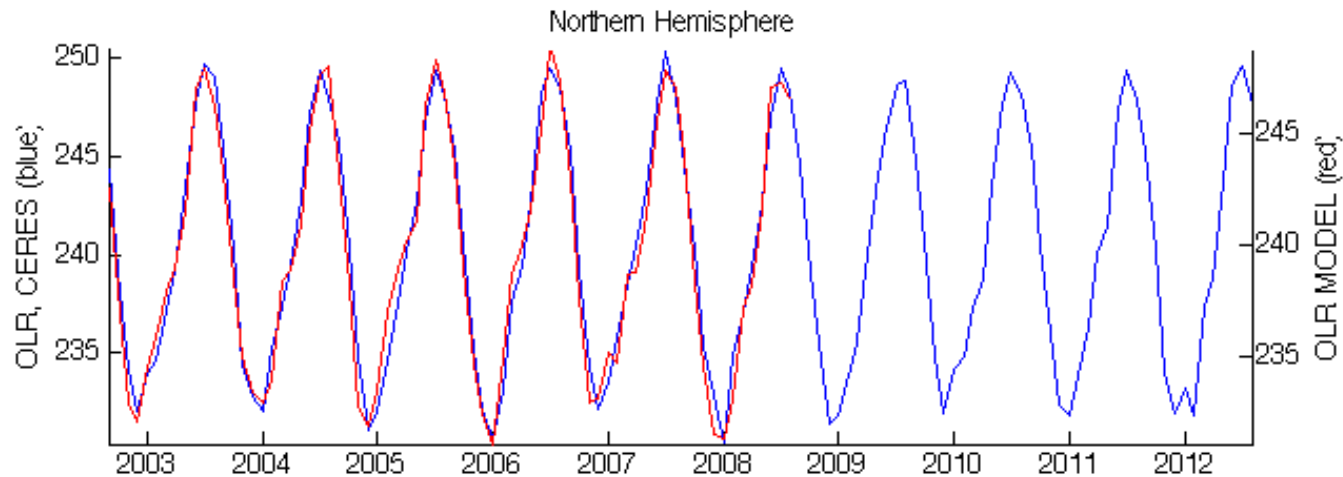
CERES NET, North-South



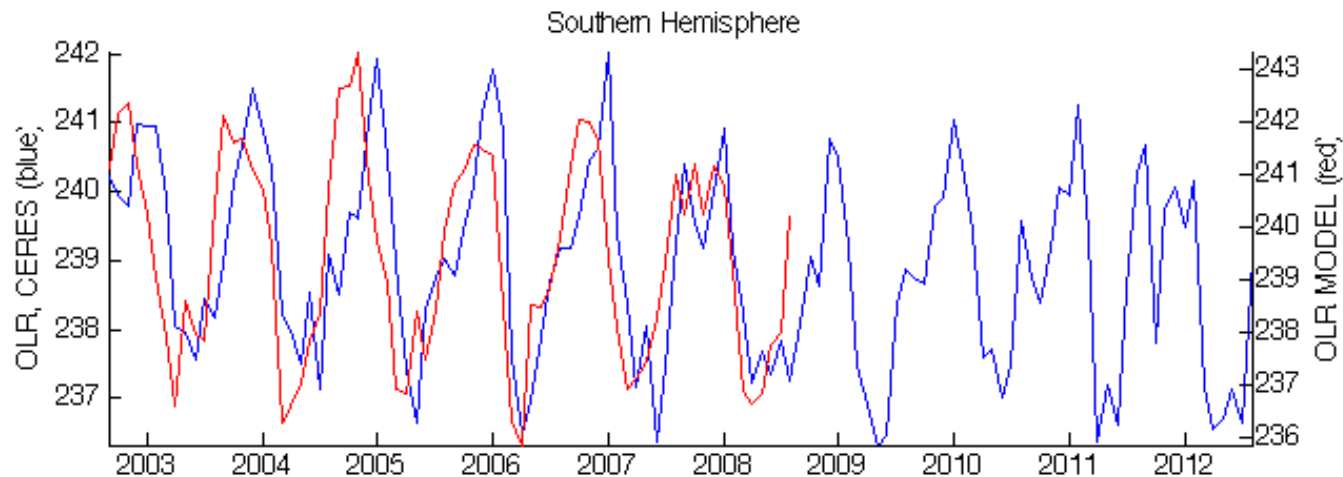
Net Mean(N-S) = -1.9 W/m^2

S-N asymmetry

CERES OLR - MODEL, North-South



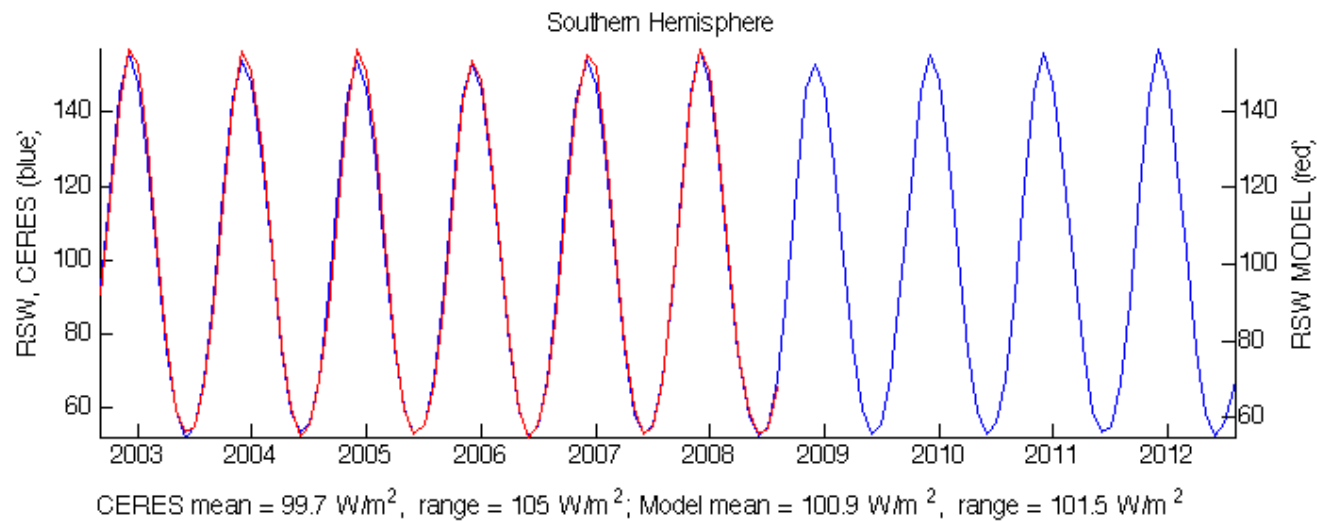
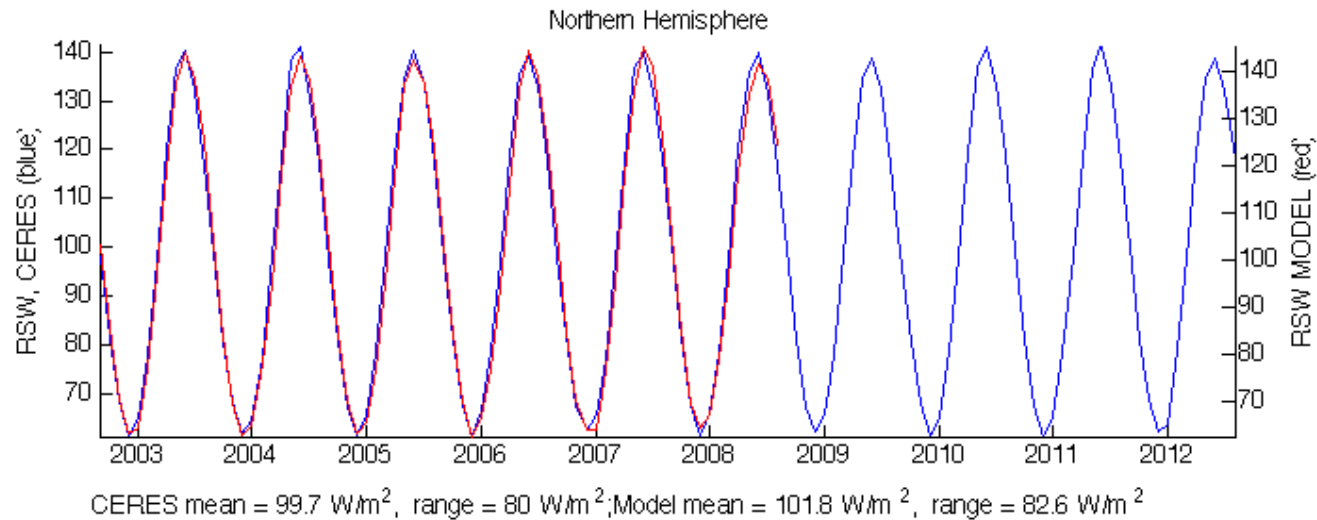
CERES mean = 240.3 W/m^2 , range = 20 W/m^2 ; Model mean = 239.7 W/m^2 , range = 17.6 W/m^2



CERES mean = 238.9 W/m^2 , range = 5.7 W/m^2 ; Model mean = 239.5 W/m^2 , range = 7.5 W/m^2

CERES OLR N-S = 1.4 W/m^2 . Model OLR N-S = 0.2 W/m^2

CERES RSW- MODEL, North-South



CERES RSW N-S=0. W/m^2 , Model RSW= 0.9 W/m^2

Conclusions

- ✧ Phase shifts of OLR and SWR relative Solar Incident differ for Northern and Southern Hemispheres due to land-ocean reflectance difference
- ✧ RSW North-South mean difference is 0. W/m^2 -- N-S symmetry
- ✧ OLR North-South mean difference is about 1.4 W/m^2 -- N-S asymmetry
Models show better N-S symmetry
- ✧ Net North-South mean difference is about -1.9 W/m^2 -- S-N asymmetry