Empirical evidences for a planetary gravitational & electromagnetic modulation of total solar irradiance (TSI) satellite measurements

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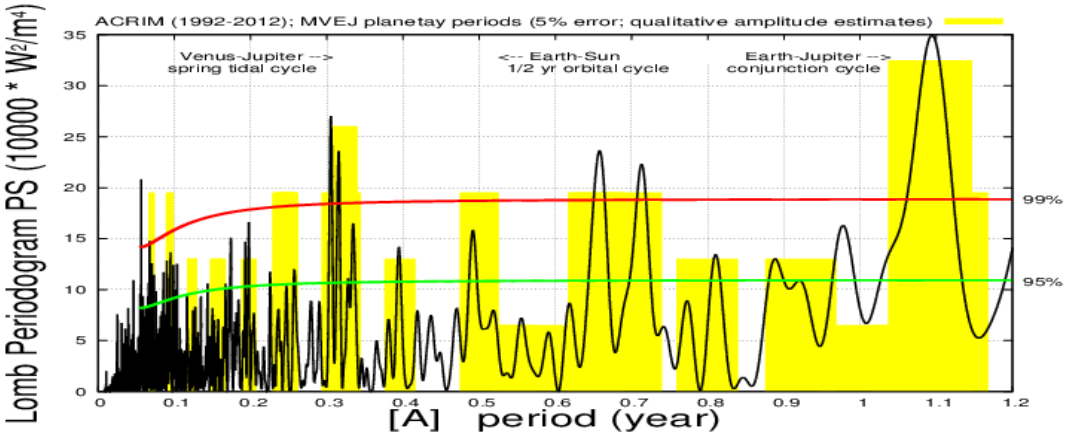
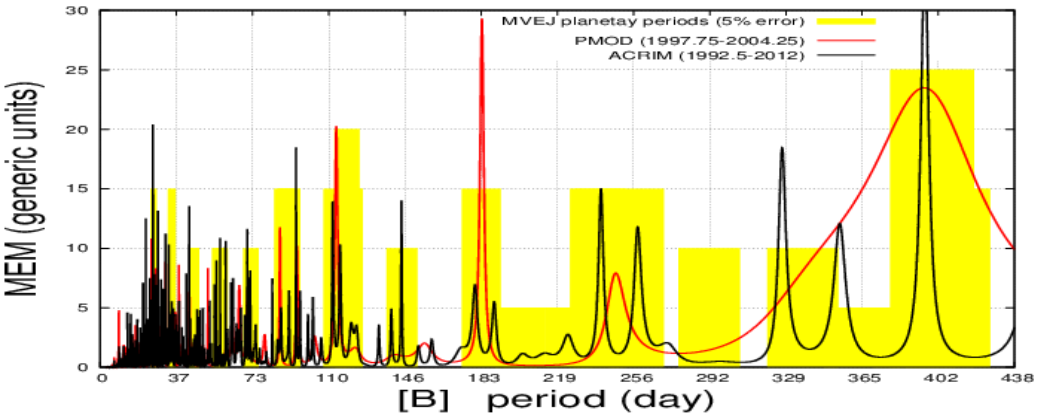
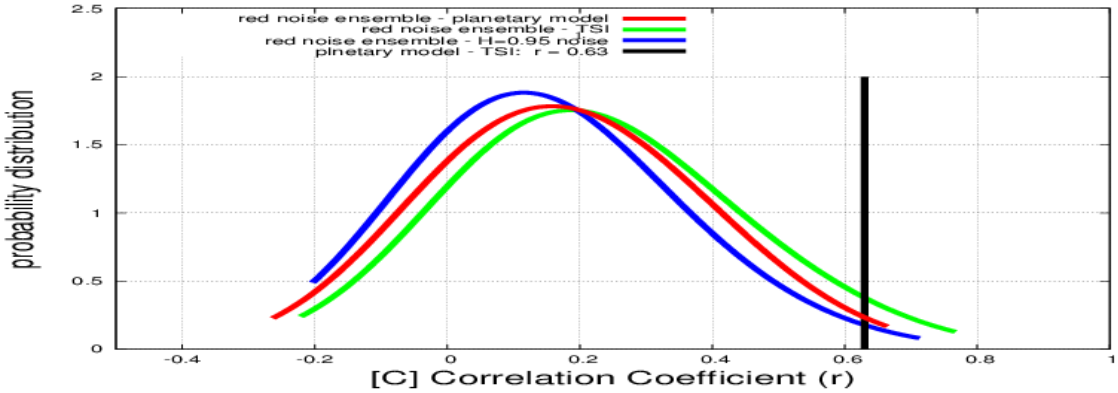
Power spectra and direct data pattern analysis of total solar irradiance (TSI) satellite observations since 1978 provided by ACRIM, PMOD and TIM present major spectral peaks that correspond to known planetary harmonics such as the spring, orbital and synodic periods among Mercury, Venus, Earth and Jupiter. We noted: the Mercury-Venus spring-tidal cycle (0.20 year); the Mercury orbital cycle (0.24 year); the Venus-Jupiter spring-tidal cycle (0.32 year); the Venus-Mercury synodic cycle (0.40 year); the Venus-Jupiter synodic cycle (0.65 year); and the Venus-Earth spring tidal cycle (0.80 year). A clear signature of the 1.09-year Earth-Jupiter conjunction cycle, in particular during solar cycle 23 maximum is observed. This appears to suggest that the Jupiter side of the Sun is slightly brighter during solar maxima. Four main frequency periods at ~24.8 days (~0.068 year), ~27.3 days (~0.075 year), at ~34-35 days (~0.093-0.096 year) and ~36-38 days (~0.099-0.104 year) characterize the solar rotation cycle, which may be related to the orbits of Jupiter, Earth and Mercury. The amplitude of the TSI oscillations, in particular of those with periods larger than 0.5 year, appears to be modulated by the ~11-year solar cycle. We conclude that solar activity is likely modulated by planetary gravitational and electromagnetic forces acting on the sun on multiple scales. The strength of the sun's response to planetary forcing depends non-linearly on the state of internal solar dynamics: planetary-sun coupling effects are enhanced during solar activity maxima and attenuated during minima.

Power Spectrum Estimates of ACRIM and PMOD



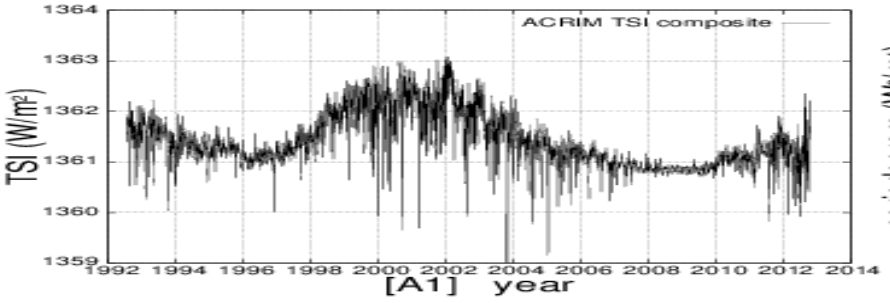


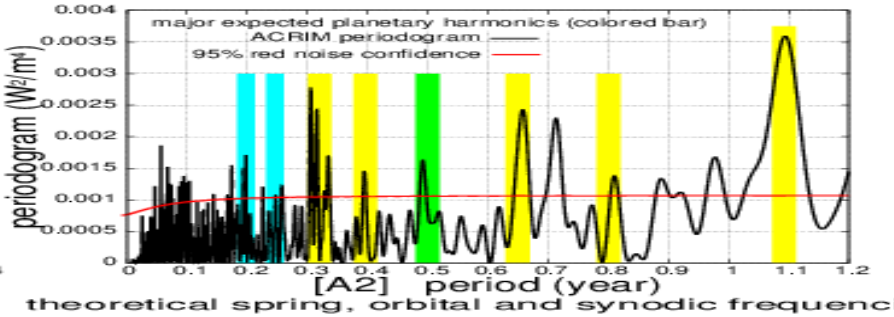


Main planetary periods

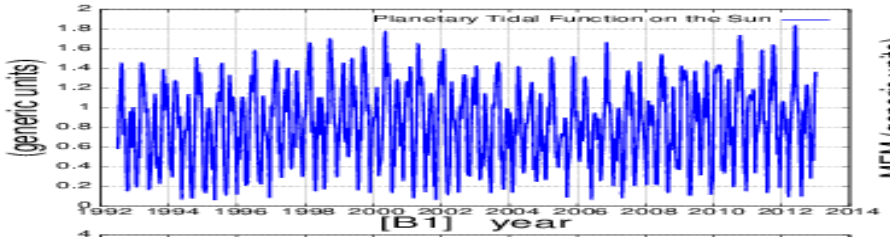
Cycle	Type	P (year)
Me	$\frac{1}{2}$ orbital	0.120 ± 0.000
Me–Ju	spring	0.123 ± 0.024
Me–Ea	spring	0.159 ± 0.027
Me–Ve	spring	0.198 ± 0.021
Me	orbital	0.241 ± 0.000
Me–Ju	synodic	0.246 ± 0.002
Ea	$\frac{1}{4}$ orbital	0.250 ± 0.000
Ve	$\frac{1}{2}$ orbital	0.307 ± 0.000
Me–Ea	synodic	0.317 ± 0.024
Ve–Ju	spring	0.324 ± 0.003
Ea	$\frac{1}{3}$ orbital	0.333 ± 0.000
Me–Ve	synodic	0.396 ± 0.033
Ea	$\frac{1}{2}$ orbital	0.500 ± 0.000
Ea–Ju	spring	0.546 ± 0.010
Ve	orbital	0.615 ± 0.000
Ve–Ju	synodic	0.649 ± 0.004
Ve–Ea	spring	0.799 ± 0.008
Ea	orbital	1.000 ± 0.000
Ea–Ju	synodic	1.092 ± 0.009
Ea–Ve	synodic	1.599 ± 0.016

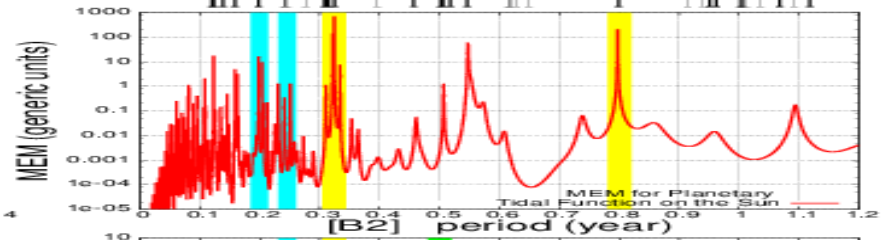
Power Spectrum Estimates of ACRIM and Planetrary indices

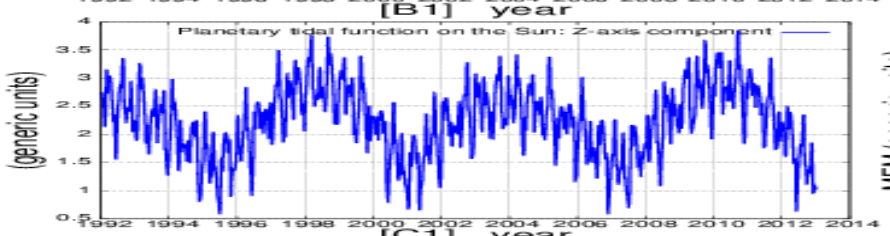


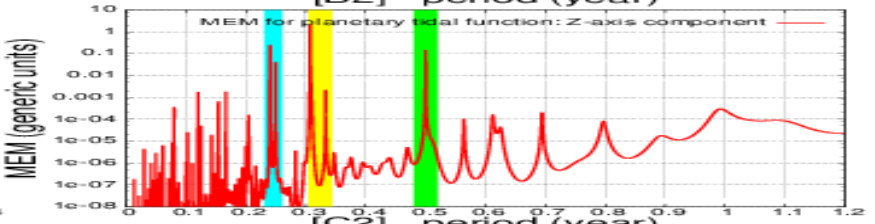


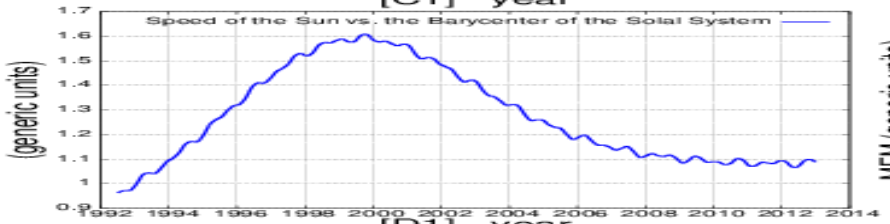
theoretical spring, orbital and synodic frequencies

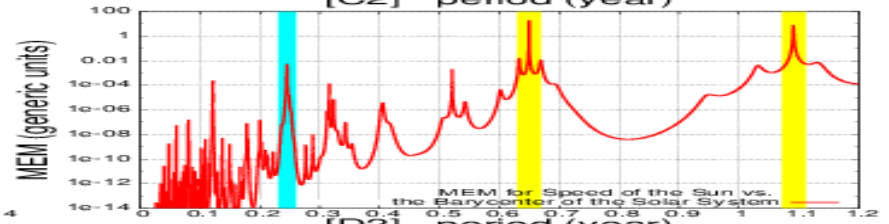


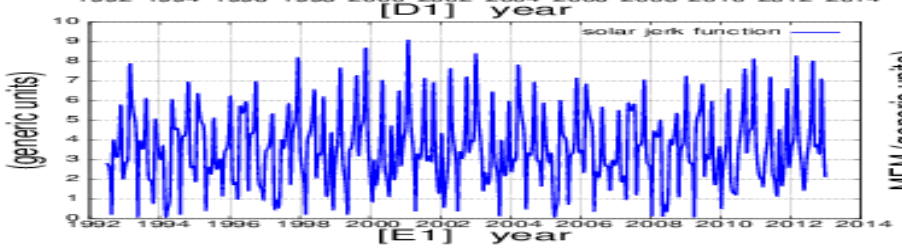


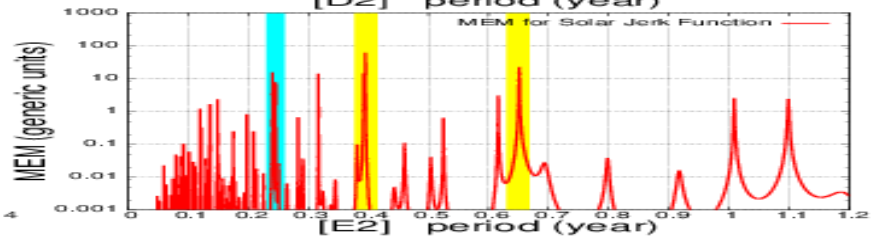




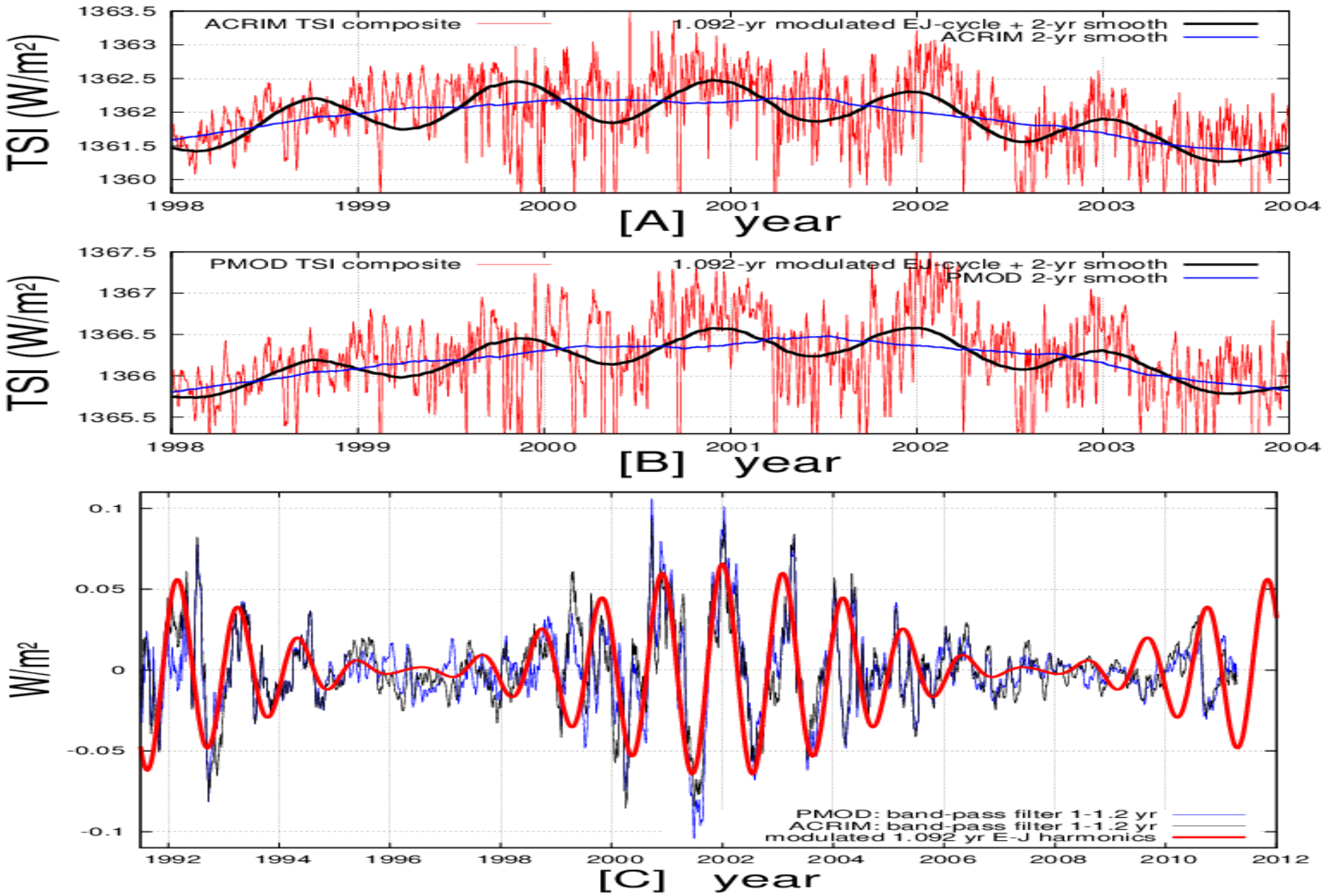


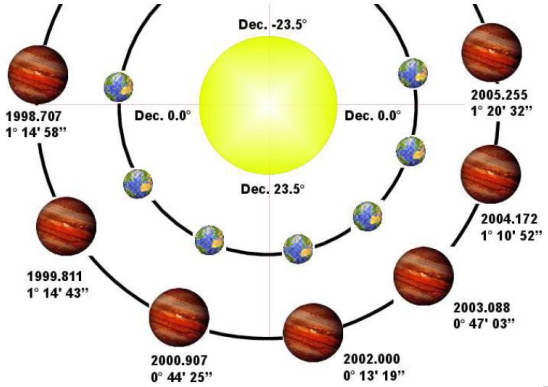






1.092 year jupiter-Earth modulation of TSI





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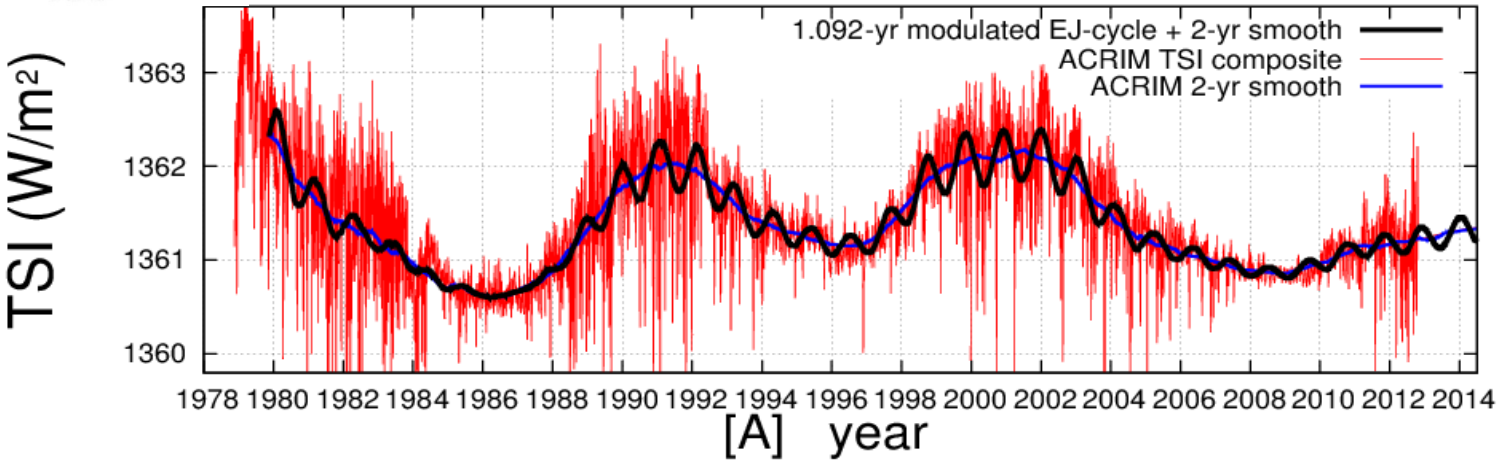
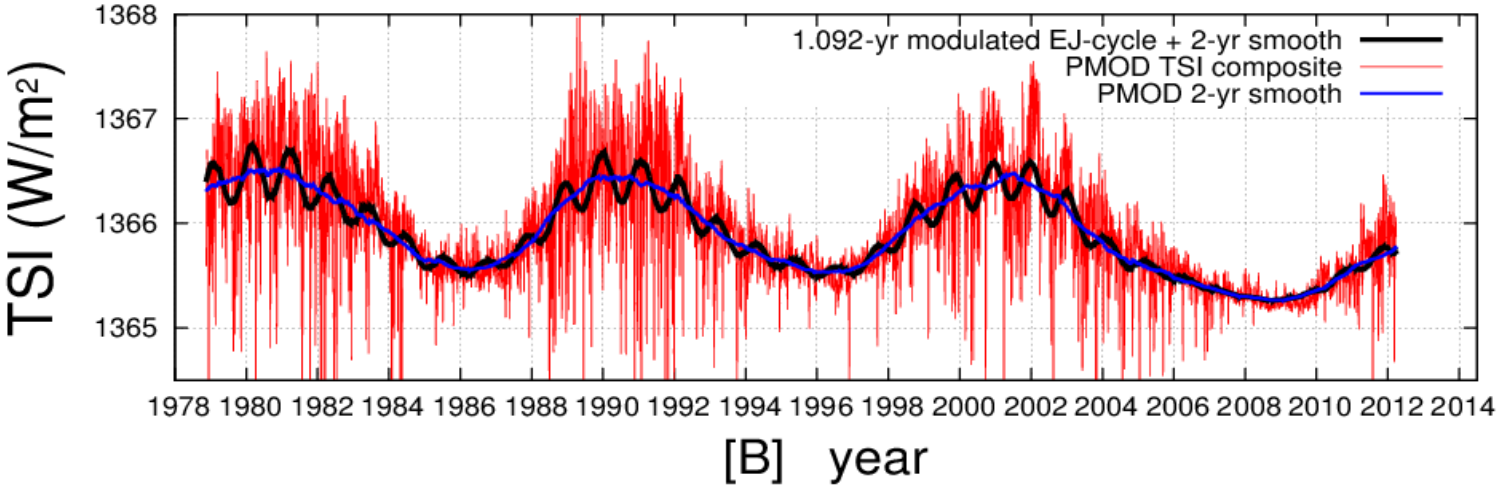
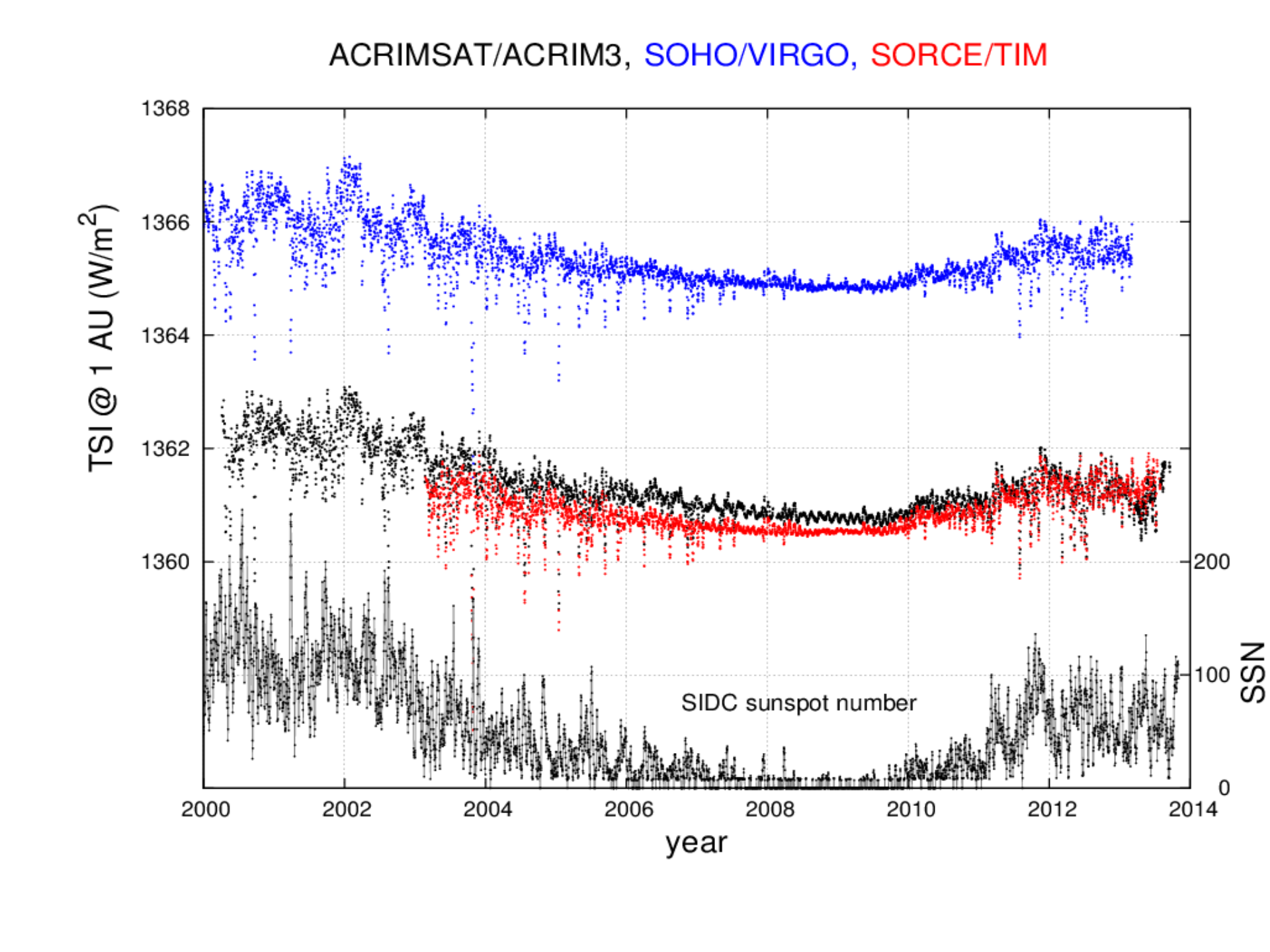
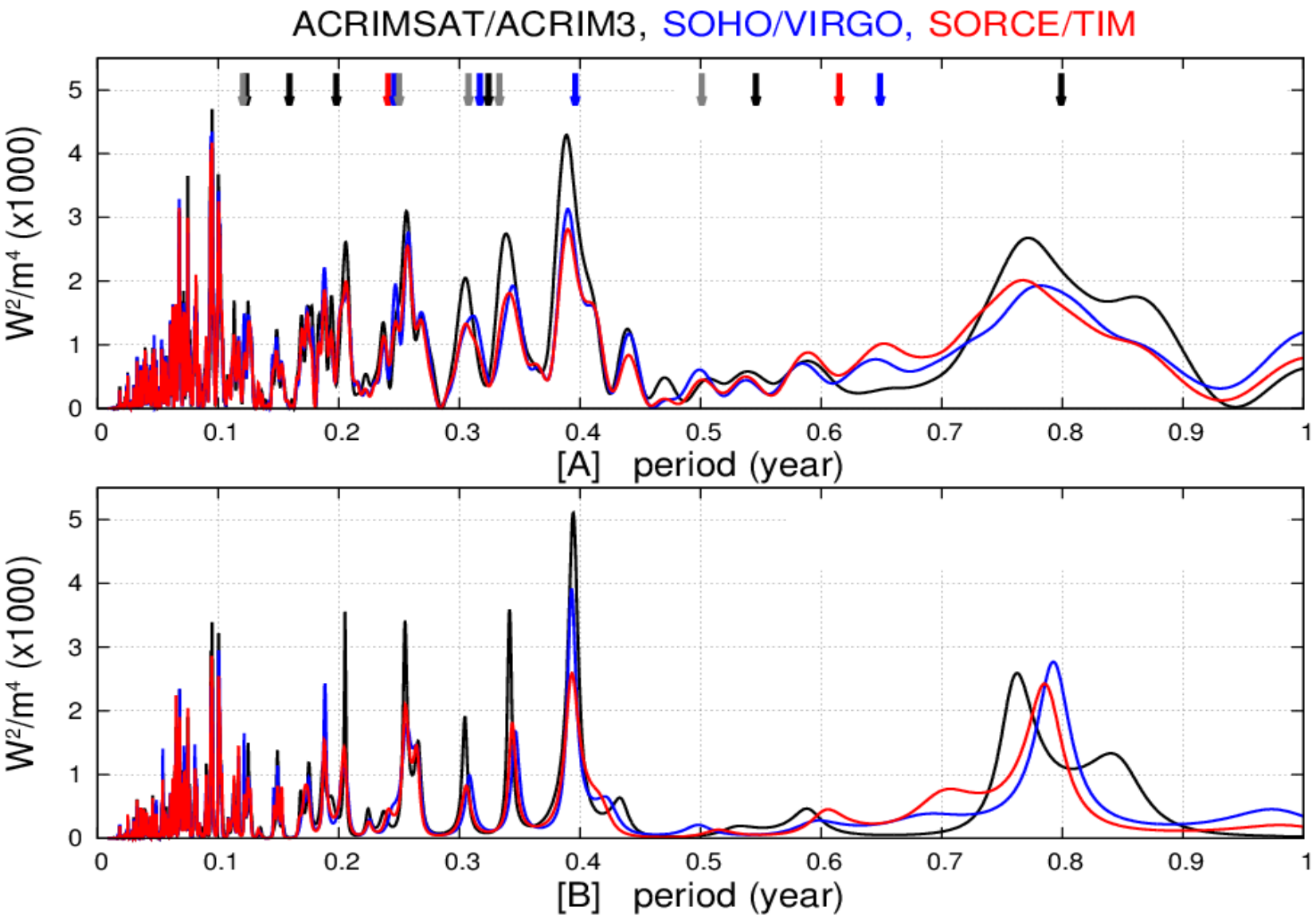


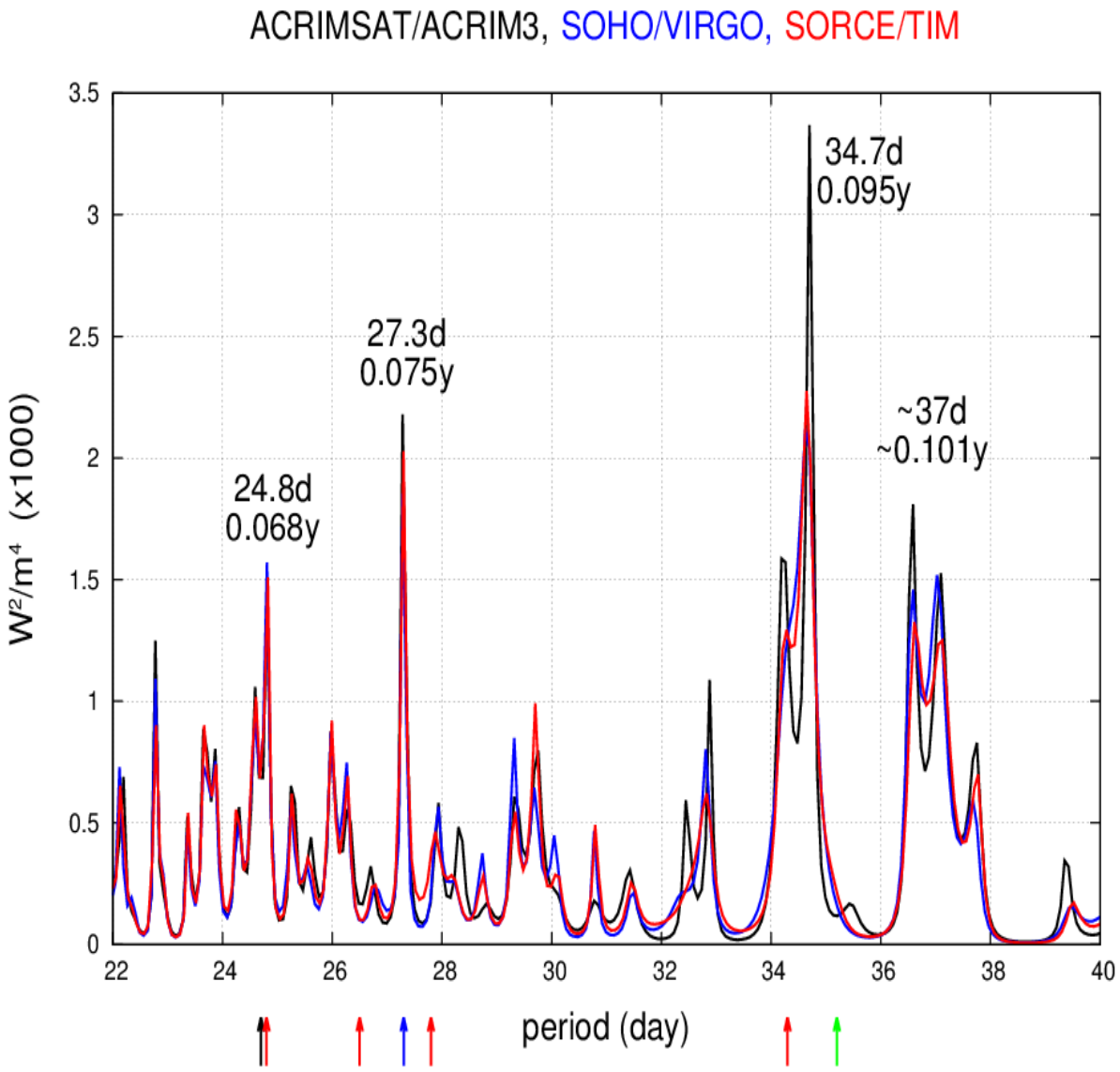



ACRIMSAT/ACRIM3, SOHO/VIRGO, SORCE/TIM
TSI @ 1 AU (W/m^2)
1368
1366
1364
1362
1360
SSN
200
100
0
SIDC sunspot number
2000
2002
2004
2006
2008
2010
2012
2014
year

Power Spectra Comparison

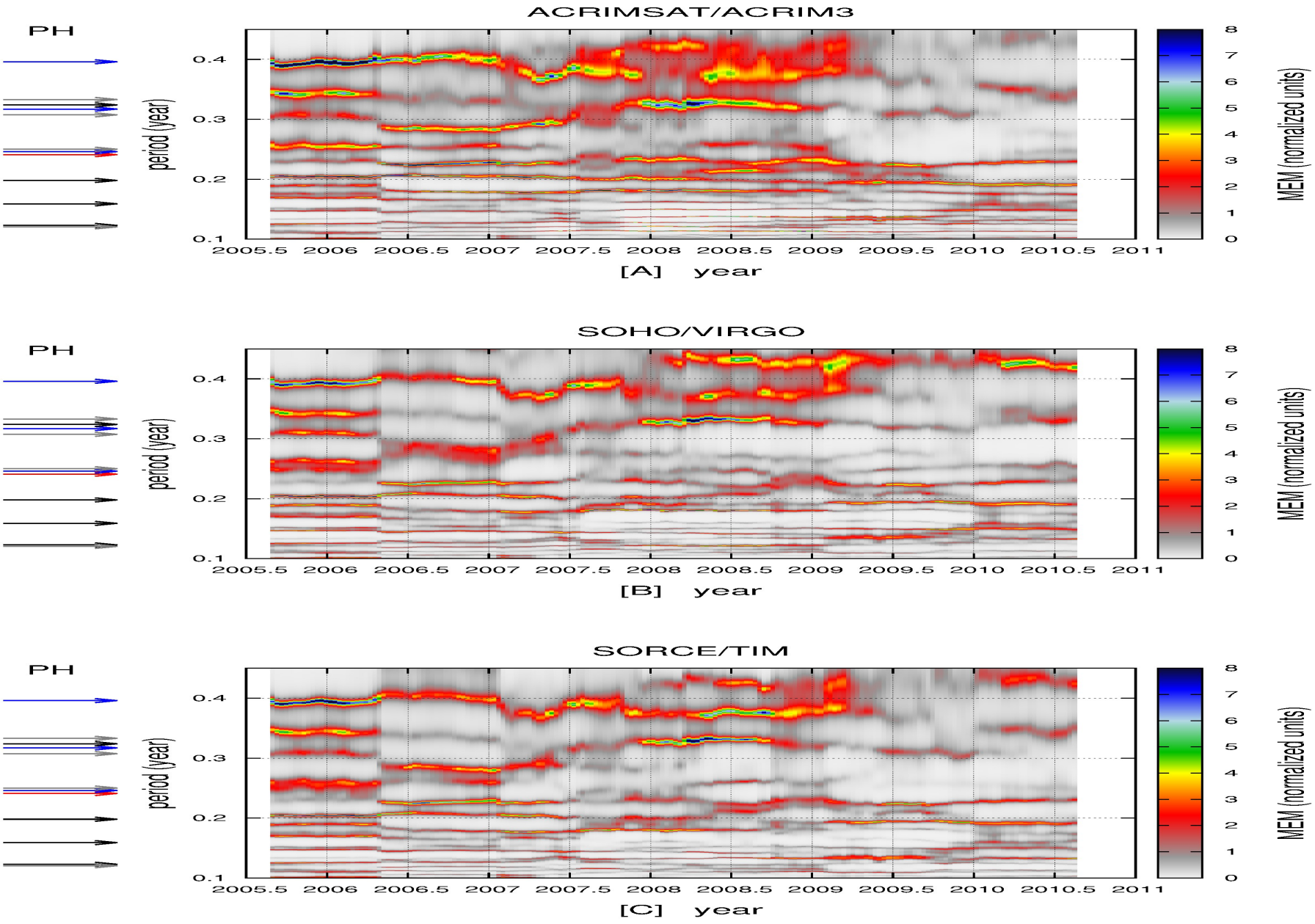


Solar Rotation Range



Cycle	Type	P (day)
Sun	equ-rot	24.7
Sun – Ju	equ-rot	24.8
Sun – Ea	equ-rot	26.5
Sun – Ea	Car-rot	27.3
Sun – Ve	equ-rot	27.8
Sun – Me	equ-rot	34.3

Moving Power Spectra Comparison



References

- Scafetta, N., and R. C. Willson, 2013. Multi-scale comparative spectral analysis of satellite total solar irradiance measurements from 2003 to 2013 reveals a non-linear planetary modulation of solar activity depending on the 11-year solar cycle. **Pattern Recognition in Physics** 1, 123-133. http://www.pattern-recogn-phys.net/1/123/2013/prp-1-123-2013.pdf

- Scafetta N., and R. C. Willson, 2013. Empirical evidences for a planetary modulation of total solar irradiance and the TSI signature of the 1.09-year Earth-Jupiter conjunction cycle. **Astrophysics and Space Science** 348(1), 25-39.

  http://link.springer.com/article/10.1007%2Fs10509-013-1558-3