Astrophys Space Sci (2013) 348:25–39
DOI 10.1007/s10509-013-1558-3

ORIGINAL ARTICLE

Empirical evidences for a planetary modulation of total solar irradiance and the TSI signature of the 1.09-year Earth-Jupiter conjunction cycle

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Received: 30 April 2013 / Accepted: 2 July 2013 / Published online: 26 July 2013

Abstract The time series of total solar irradiance (TSI) satellite observations since 1978 provided by ACRIM and PMOD TSI composites are studied. We find empirical evidence for planetary-induced forcing and modulation of solar activity. Power spectra and direct data pattern analysis reveal a clear signature of the 1.09-year Earth-Jupiter conjunction cycle, in particular during solar cycle 23 maximum. This appears to suggest that the Jupiter side of the Sun is slightly brighter during solar maxima. The effect is observed when the Earth crosses the Sun-Jupiter conjunction line every 1.09 years. Multiple spectral peaks are observed in the TSI records that are coherent with known planetary harmonics such as the spring, orbital and synodic periods among Mercury, Venus, Earth and Jupiter: 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). Strong evidence is also found for a 0.5-year TSI cycle that could be driven by the Earth's crossing the solar equatorial plane twice a year and may indicate a latitudinal solar-luminosity asymmetry. Because both spring and synodic planetary cycles appear to be present and the amplitudes of their TSI signatures appear enhanced during sunspot cycle maxima, we conjecture that on annual and sub-annual scales both gravitational and electro-magnetic planet-sun interactions and internal nonlinear feedbacks may be modulating solar activity. Gravitational tidal forces should mostly stress spring cycles while electro-magnetic forces could be linked to the solar wobbling dynamics, and would mostly stress the synodic cycles. The observed statistical coherence between the TSI records and the planetary harmonics is confirmed by three alternative tests.

Keywords Solar dynamo · Solar total irradiance · Helioseismology · Planet-star interactions · Magnetohydrodynamics (MHD)

1 Introduction

Numerous observations—e.g. sunspot, total solar irradiance (TSI) satellite (Willson and Mordvinov 2003; Fröhlich 2006) and magnetic flux records (Ball et al. 2012)—have demonstrated that solar activity is characterized by a variable ∼11-year Schwabe cycle, by complex dynamics on monthly-to-annual time scales and by possible multidecadal trending. In addition to a varying 11-year solar cycle, spectral analyses of solar records have also identified a number of distinct periodicities at the multidecadal, secular and millennial scales (Abreu et al. 2012; Bond et al. 2001; Frick et al. 1997; Ogurtsov et al. 2002; Scafetta 2012c; Scafetta and Willson 2013; Tan 2011). The statistically estimated periodicities depend on the length and nature of the analyzed records. However, typical major spectral peak values are found at 43–45 years, 55–61 years, 81–87 years (Gleissberg), 98–130 years, 150–180 year, ∼207 years (de Vries), ∼500 years, ∼980 years (Eddy), and others. See for example Scafetta (2012c) and Scafetta and Willson (2013) where high resolution spectral analyses of a 438-year long

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