QUASI-10-DAY AND 4-DAY PERIODICITIES IN SOLAR IRRADIANCE

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There are many investigations of the total solar irradiance (TSI) variability over the time scales from days to years. Particular emphasis has been placed on the sources of this variability and on the problems concerning stable equipment operation. The investigations made aboard SMM/ACRIM showed a relation between solar variability and various solar activity manifestations. Even then the TSI power spectrum revealed some peculiar periodicity in the range from 9 to 11 days that was not explained and also a well-defined quasi-4-day periodicity (Froelich and Pap, 1989). Their distinctive feature is that they manifest themselves in many processes both on Sun and on Earth. An understanding of their nature is of importance to solar-terrestrial physics. The earlier investigations of Nimbus-7 data pointed out the possible effect of solar sources of unknown nature and also some residual instrumental effects on the behaviour of TSI variations. As a further development of these studies the spectral analysis was made of the TSI variations using the final data set derived over the range from November 1978 to April 1992 aboard Nimbus-7. In our study the data gaps were filled with an artificial noise signal. The autocorrelation function (ACF) was used for detrending and filtering of the data.

Figure 1 shows the power spectrum of ACF of TSI variations over the short-period range. The spectral power within the frequency range corresponding to the solar rotation period does not exceed the confidence level $p = 0.99$; other spectral peaks (SPs) are concentrated within two frequency ranges. Within the first range there is the SP (marked as 1 on fig.1) corresponding to well-known 13-day periodicity observed in various solar parameters including Nimbus-7 data. The next five SPs (2-6) form the quasi-10-day range with the mean value being equal to 10.54 days. Within the second range three SPs (7-9) form the quasi-4-day range. Taking into consideration the fact that the gaps were regular at the beginning of Nimbus-7 mission the 4-day periodicity might be

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considered as artificial one. However, filling the gaps with white noise and the

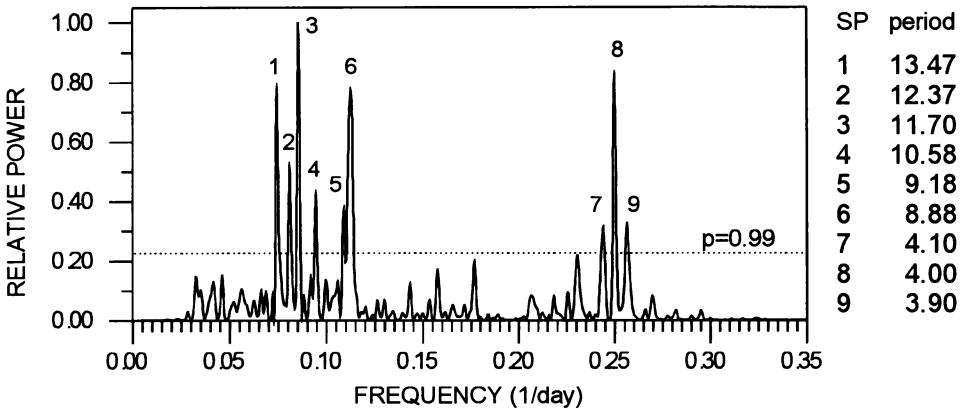

Figure 1. Power spectrum of TSI variations with basic peaks marked

following filtering of data suggest that 4-day periodicity is related to the gaps to a lesser extent. It might be assumed that the gaps are related to the regular interruptions in the normal operation of Nimbus-7. These upsets might be associated with the wave disturbances in the Earth's atmosphere that reveal 10- and 4-day periodicities with the last one being the most pronounced (Philbrick and Chen, 1992). These two periodicities are often revealed simultaneously. In geophysics they are typical of so-called planetary waves. 10- and 4-day periodicities are also present in the Earth's seismic noise, in the ionospheric variations and in variations of the solar wind density.

Thus, the 10- and 4-day periodicities are suggested to be global. As to the quasi-10-day periodicity it was shown (Klochek and Nikonova, 1989) that this periodicity revealed in the power spectrum of X-ray solar radiation may be caused by explosive processes of stellar pulsation type. It is interesting to note that variable stars of classical cepheid type that may be grouped with the stars of G2 spectral class, at the epoch of the middle light of cepheids, reveal the basic periods of the fundamental radial pulsations close to this periodicity.

References

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