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TESTING COSMIC-RAY PERIODICITIES DURING A FORBUSH DECREASE

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Figure 1: INAF/IFSI-Rome U.d.R. (SVIRCO Observatory and Terrestrial Physics Laboratory: 41.86° N – 12.47° E, about sea level).

The 5-min data recorded during September 2005 [1] by the neutron monitor of SVIRCO Observatory and Terrestrial Physics Laboratory (see Fig. 1) were used to investigate the behaviour of cosmic ray periodicities (up to about 100 h) before and during a huge Forbush decrease (FD) beginning on September 10. Results concerning CR periodicities in the pre-event period were discussed by Diego and Storini, 2009 [2]. Here attention is paid to periodicities during the event time interval.

The wavelet technique [3] was applied to the time series of Rome data (see left upper panel of Fig. 2) by using the Morlet mother function (plane wave modified by a Gaussian envelope; ω = 6, dj = 0.0625) and the main periodicities have been identified. The Morlet mother wavelet has been chosen for its high capability in detecting significant periodicities and their localization in the investigated time interval. It was found that four main periodicities had a persistent significant value (power/noise > 1), as shown in the left lower panel of Fig. 2. They are 24h, 34h, 48h, and 100 h (see the GWPS [Global Wavelet Power Spectrum] reported in the enclosed box of Fig. 2); they were detected with an uncertainty lower than 4.5% (e.g. 24 h +/- 1 h).

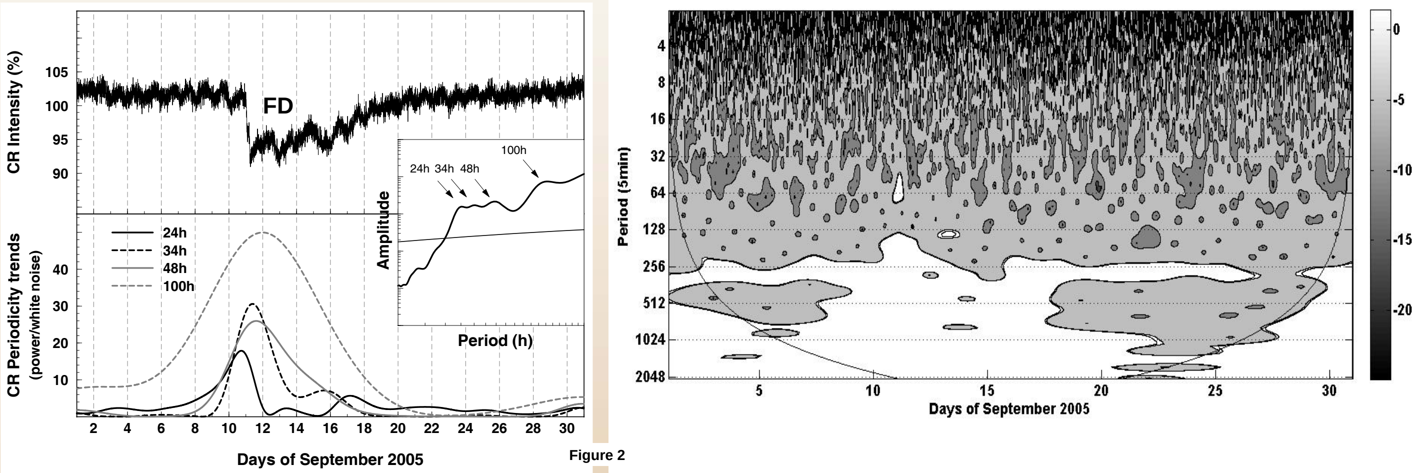
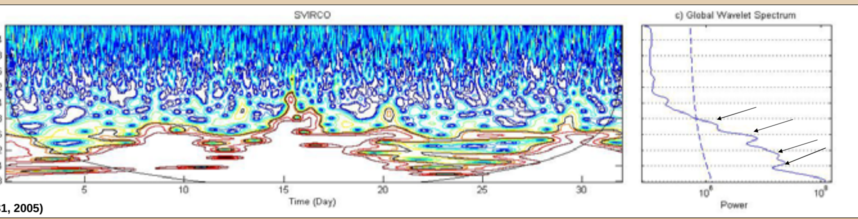


Figure 2

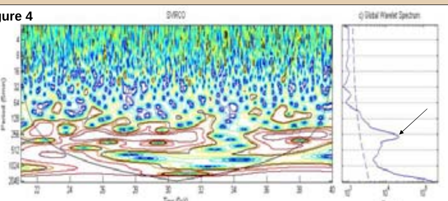
To verify the reliability of the above periodicities, two other time intervals were considered in the wavelet analysis. They are: May 1-31, 2005 [4] (Fig. 3) and January 21-February 8, 2000 [5] (Fig. 4).

Figure 3



(MAY 1-31, 2005)

Figure 4



(JAN. 21 – FEB. 8, 2000)

During May 2005 (characterized by transient solar-wind streams and Forbush decreases) several periodicities were again significant (see arrows reported in Fig. 3 and examples of the power/noise ratios in Fig. 5), while during the second time interval (characterized by regular high-speed solar-wind streams) practically only the 24-h periodicity can be identified (see arrow in Fig. 4 and Fig. 6).

(MAY 1 – 31, 2005)

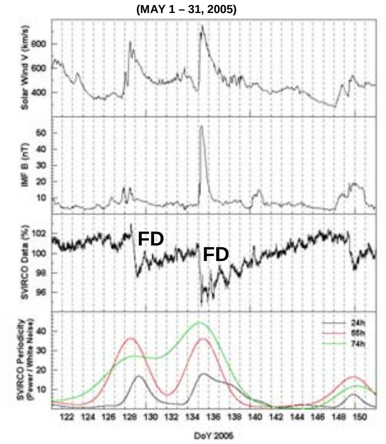


Figure 5 : *ACE level 2 data, cosmic ray intensity and three periodicity trends for May 1- 31, 2005.*

CONCLUSIONS

The investigation of cosmic-ray periodicities during the time intervals characterized by the presence of traveling interplanetary perturbations revealed that transient and co-rotating plasma streams are associated with different responses not only in the cosmic ray intensity but also in their related periodicities, at least at neutron monitor energies. More precisely:

1) the only outstanding signal (power/noise > 5) pertains to the 24-h for co-rotating streams;

2) several enhanced signals (power/noise > 5) can be singled out for transient streams.

This is another characterization of the cosmic ray response to interplanetary perturbations useful for Space Weather or for a correct stream identification when no interplanetary data are available.

(JAN. 21 – FEB. 8, 2000)

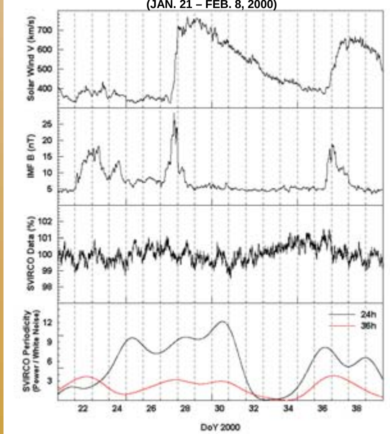


Figure 6 : *ACE level 2 data, cosmic ray intensity and two periodicity trends for Jan. 21 – Feb. 8, 2000.*

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