Mem. S.A.It. Suppl. Vol. 9, 82

Memorie della
Supplementi

SINERGIES (Sun, INterplanetary, EaRth Ground-based InstrumEntS) or the potential of the Italian Network for Ground-Based Observations of Sun-Earth Phenomena

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Abstract. The Italian Network for Ground-Based Observations of Sun-Earth Phenomena, whose instruments monitor the Sun, the Interplanetary Space, and the Earth's Magnetosphere, has recently started to operate in a coordinated scheme. In this paper, we describe few significant examples of this coordination effort. 1) During the year 2003, several coordinated observational campaigns were carried out in order to study the solar photospheric dynamics. 2) Reconstruction of TSI in time, for periods spanning from a solar rotation up to the whole current solar cycle. 3) Extreme solar events occurring during the late October - early November 2003.

Key words. Solar activity – Space Weather

1. VAMOS and PSPT coordinated observing campaign

In Fig. 1 we can see the l-ν phase difference and coherence diagrams between the intensity fluctuations observed with PSPT and the velocity fluctuations observed with VAMOS. l is the spherical harmonics degree and ν is the temporal frequency. The left bar indicates the phase values ranging from $-180°$ to $+180°$. The right bar represents the coherence values ranging from 0 to 1. The reported data refer to a ten

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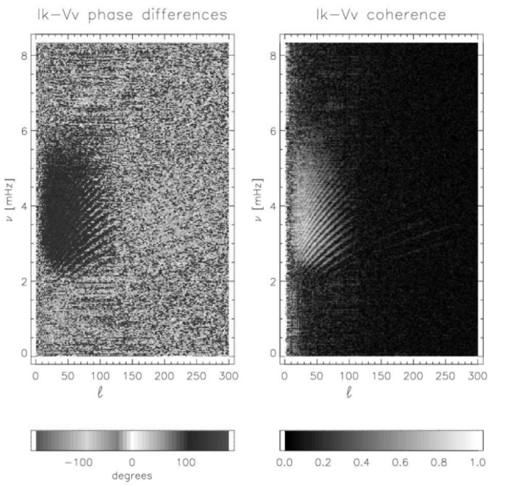

Fig. 1. See text.

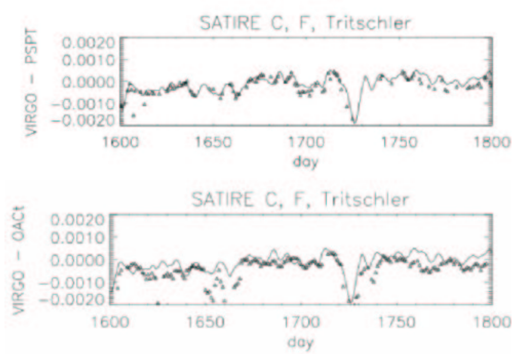

Fig. 2. See text.

hour long series of simultaneous observations. The phase difference values close to 90° on the p-modes, between 2 and 6 mHz, where coherence is maximum, indicate that oscillations are evanescent in the photosphere and low chromosphere with some non adiabatic behavior which deserves more detailed studies.

2. Total and Spectral Irradiance Variability Studies

About 90 % of the measured solar irradiance variations are reproduced by recent models assuming both evolution of the observed magnetic regions over the solar disk and results

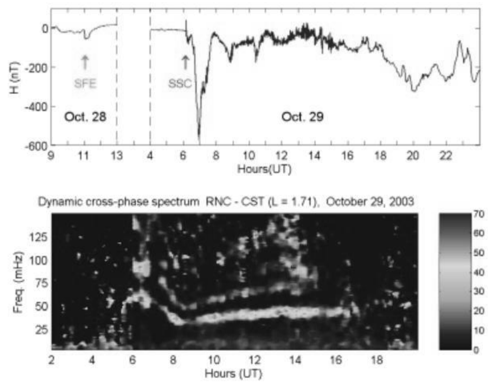

Fig. 3. See text.

of atmospheric models computation. These approaches have successfully reproduced the total and the spectral irradiance measured by VIRGO using MDI and PSPT data, only available since 1996. To extend the application of these approaches back in time we analyzed the solar data archives of the Roma and Catania Observatories. In Fig. 2 we compare the percentage variations of the total solar irradiance measured by VIRGO (line) from May to Dec 2000 and the result of the irradiance reconstruction based on atmosphere models and data of both Rome (PSPT) and Catania (OACt) synoptic programs (dots in the upper/lower panels). Existing measurements of magnetic region properties show systematic differences and gaps, but seem not to prevent the compilation of a complete and cross-calibrated time series useful for irradiance studies.

3. The X17.2 flare on Oct 2003

On 28 Oct 2003 a X17.2 flare occurred in NOAA 10486, with peak at 11:10 UT. Images acquired at INAF-OACt 90 minutes before the flare showed the eruption of a filament characterized by negative magnetic helicity, as inferred from its reverse S-shape and its chirality. A very intense decimetric radioflare (TENFLARE) was observed by the Trieste Solar Radio System (peak total flux at 2695 MHz: 8,600 sfu (solar flux units) at 11:15 UT) accompanied by a very intense metric radioflare (type IV burst) (peak total flux at

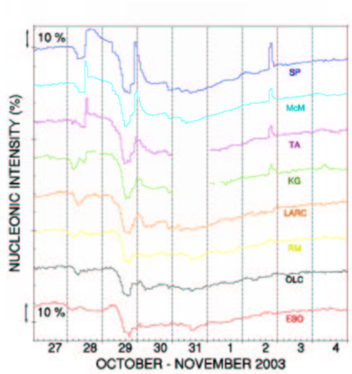

Fig. 4. See text.

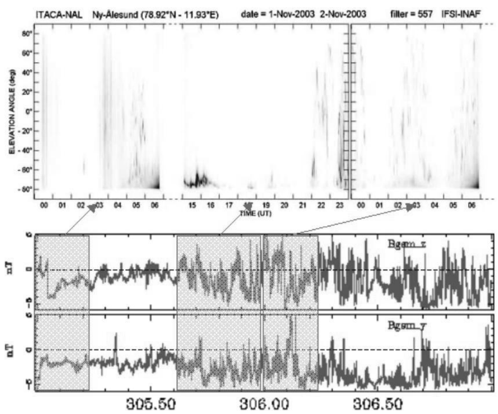

Fig. 5. See text.

237 MHz: > 16,000 sfu at 11:03 UT). This indicates that the coronal layers diagnosed by TSRS (heights 0.1-0.4 $R_\odot$) were strongly perturbed. Complementary radio spectral data confirm that the flare interested extremely wide layers of the corona. Following the X17.2 flare, a CME leaved the Sun in the Earth's direction and on Oct 29 a huge geomagnetic storm started on the ground (SSC at 06:10 UT). Fig. 3 (upper panel) shows the time behavior of the north-south component of the geomagnetic field at L'Aquila (the lowest latitude station of SEGMA). Note the clear bay-like signature (SFE) at ~ 11:00 UT. The storm is characterized by a strong field decrease of ~ 600 nT and by a significant ULF wave activity. From ULF measurements we studied the time variation of the local geomagnetic field line resonance (FLR) frequencies to monitor the corresponding variations of the field aligned plasma density. Fig. 3 (bottom panel) shows the time behavior of the FLR frequencies (bright traces) at L'Aquila. After the SSC, the FLR frequencies decrease to unusually low values, corresponding to an increase of the plasmaspheric density, presumably due to heavy ions (O+) outflowing from the ionosphere. During the period 27 Oct - 4 Nov, a Forbush decrease (FD) and three ground level enhancements (GLEs) occurred. Fig. 4 shows the response of 8 neutron monitors located at different latitudes in Antartica and in the northern hemisphere: GLEs are identified from the spikes on 28, 29 Oct and 2 Nov. The start of the CR decrease phase (FD reaches the minimum intensity of about -24.61 % at McM station) coincides with the shock arrival at the Earth. Fig. 5 shows the high-latitude auroral emission at 557.7nm (ITACA-NAL, upper panel), and the IMF B_y and B_z data (ACE satellite, lower panel), during 1-2 Nov. This activity was produced by a series of poleward expansions of the auroral oval, during intense geomagnetic substorms that were triggered by the X17.2 flare. The ionospheric currents associated to the substorm activity between 23:20-23:22 were also visible in the SuperDARN convection maps (see http://web.ct.astro.it/sun/sait2005.htm).