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SINERGIES, the Italian Network for Ground-Based Observations of Sun-Earth Phenomena

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Abstract. Since many years, the complex phenomena occurring on the Sun have been continuously monitored by different and complementary ground based instruments managed by groups of the Italian Astrophysics Community. Recently some of these instruments have started to operate in a coordinated scheme, the Italian Network for Ground-Based Observations of Sun-Earth Phenomena. In this paper, we describe the characteristics of the nodes belonging to the Network, called SINERGIES, the scientific objectives, the facilities and the data storage system of the Network itself. Due to its capabilities, the Network allows the Italian Solar Terrestrial Physics Community to monitor solar activity and its effect on the Earth.

Key words. Sun: solar activity – Space Weather

1. INAF - Trieste Astronomical Observatory

High time resolution measurements of the radio flux density and circular polarization from the solar corona are acquired at fixed frequencies (237, 327, 408, 610, 1420, 2695 MHz) on a daily basis by the Trieste Solar Radio System (TSRS) in Basovizza (Trieste) (see http://radiosun.ts.astro.it/ for further instrument information). These data are archived and published in real-time for Space Weather purposes. TSRS is a node

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of the Space Weather European Network (SWENET) promoted by the European Space Agency (ESA). TSRS solar radio data and radio indices can be obtained in real-time on the WEB URL http://radiosun.ts.astro.it and via mobile phones on the WAP URL http://radiosun.ts.astro.it/wap/en.wml. TSRS solar radio data are effective diagnostics for plasma processes occurring in the perturbed solar corona, which are used for studying and modelling: flare precursor signatures; solar radio flares and their non-radio counterparts; particle acceleration signatures; magnetic topology changes; radiophysical processes at the source; propagation effects and related plasma parameters.

2. INAF - Roma Astronomical Observatory and Roma "Tor Vergata" University

Daily images of the solar photosphere and chromosphere (spatial scale 2arcsec/pixel, photometric accuracy 0.5 % pixel) are available trough the OAR webpage and regularly distributed to several data centers. 450 Gb of images have been acquired since mid 1996. They are mainly used to study total and spectral irradiance variability, photometric properties of magnetic regions in time (see http://www.mporzio.astro.it/solare/Ilpsptdiroma.htm for further information on PSPT and http://www.fisica.uniroma2.it/∼solare/index.htm for information on the solar station in Tor Vergata).

3. INAF - Interplanetary Space Physics Institute

3.1. SuperDARN

The Super Dual Auroral Radar Network (SuperDARN) consists of two chains of HF (8 - 20 MHz) coherent radars, in the Northern and Southern hemispheres. Each radar consists of a 16 T/R antennae main array and a 4 antennae interferometric array, spanning a field of view of roughly 4 millions square km (from 180 to over 3550 km from the radar) with spatial resolution varying between 40 and 100 km. The SuperDARN radars allow the continuous, two-dimensional, observation of the ionospheric plasma convection electric field in the auroral zones and in the polar caps. The convection electric field has significant impacts on the global state of the ionosphere and magnetosphere, and on the coupling and closure of electric currents flowing between them. INAF-IFSI (Rome) participates to the SuperDARN project through the Kerguelen radar (PI Dr. J.-P. Villain, LPCE-CNRS, Orléans, France Co-PI Dr. E. Amata, INAF-IFSI, Rome) and through the two new radars to be installed at DOME C, in Antarctica, at the end of 2006 (PIs E. Amata and J.-P. Villain).

3.2. ITACA^2

ITACA^2 is a twin monitor system devoted to the high-latitude auroral observation in the Greenland-Svalbard zone (http://sung3.ifsi.rm.cnr.it/∼massetti/index.html), in the frame of the Sun-Earth relationship. The system is maintained by the Interplanetary Space Physics Institute (PI Dr. S. Massetti, INAF-IFSI, Roma Italy) and supported by the PNRA. The two station, ITACA-NAL and ITACA-DNB, are equipped with automatic all-sky cameras, and can monitor an area up to about 120° × 25° CGM (@500km of height), centered on 76° CGM. The system is focused on the study of the dayside auroral activity, which is connected to the precipitation of the solar wind plasma through the geomagnetic cusp(s). It can also monitor the poleward expansion of the auroral oval during geomagnetic substorms. ITACA^2 is the Italian contribution to the international network Miracle, distributed along the Scandinavian peninsula and the Svalbard archipelago.

4. SVIRCO Observatory and MINI-NETWORK of Cosmic Ray Detectors

A Mini-Network with Italian partnership, performs ground-based measurements of the Cosmic Ray (CR) nucleonic component. The observatories have different threshold rigidities and asymptotic cones of acceptance. They are included inside a world-wide network of CR detectors. The instrument in each observatory includes a standard detector (NM-64 type) which is a complex structure of lead (producer), polyethylene (particle reflector and moderator), and proportional counter filled with BF3 for CR secondary component record. The Mini-Network allows investigation on interplanetary medium and solar activity, together with studies of CR variations and their connection with solar sources (CMEs, flares,), interplanetary medium disturbances, and Earth environment. SVIRCO Observatory, unique in Italy and currently operating at Roma Tre University, records continuously data since July 1957. Revised yearly data and prompt reports on monthly basis are published (see http://www.fis.uniroma3.it/ svirco/ for further information).

5. Magnetometer stations operated by the Physics Department of the University of L'Aquila (Italy)

In cooperation with the Institut fuer Weltraumforschung (Graz, Austria) and the Geophysical Institute of the Bulgarian Academy of Science (Sofia, Bulgaria), SEGMA magnetometer array is a net of high sensitivity triaxial fluxgate and search-coil magnetometers, with a sampling period of 1 s, continuous recording, timing via GPS.

Particular topics under investigation are the following: low latitude manifestations of solar wind-driven sudden impulses, geomagnetic storms and substorms; generation and propagation mechanisms of ULF waves in the inner magnetosphere and relation to solar wind conditions; determination of low-latitude geomagnetic field line eigenfrequencies to monitor temporal and spatial variations of the plasma mass density in the plasmasphere and ionosphere.

6. INAF - Capodimonte Astronomical Observatory

VAMOS (Velocity And Magnetic Observations of the Sun) is a solar imager, based on the technology of the magneto-optical filter (MOF), used to obtain high cadence observations of the Sun's intensity and velocity fluctuations, and longitudinal magnetic field component at the photospheric level. The VAMOS observations, together with other ground-based and space data (PSPT, GONG, SOHO/MDI etc.) are currently used to study the solar photospheric dynamics and the non-adiabatic effects of solar global oscillations (see http://www.na.astro.it/vamos/ for further information on VAMOS).

7. INAF - Catania Astrophysical Observatory

The observational program include: daily drawings of sunspots and pores by projection of the Sun image; digital image acquisitions (every 15 minutes) in the Hα line center and wings of the solar chromosphere, besides than monitoring of transient phenomena. These data are regularly distributed to the following Institutes: Boulder, Moscow, Freiburg, Meudon, SIDC Bruxelles, Cracow, Bologna, Trieste. INAF-OACt is a node of the Global Hα Network and of the Max Millennium Program for Solar Flare Research. Information about the instruments, as well as daily images of the lower solar atmosphere, are available at: http://web.ct.astro.it/sun/.

The reaserch activity carried out in this node are: solar dynamo; emerging active regions; static loop modeling; flare analysis and precursors; magnetic helicity computation.