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Introducing SWERTO: A regional space weather service

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Summary. — The Space WEeatherR TOr vergata university (SWERTO) service is an operational Space Weather service based on data from space-based and ground-based instruments, located in the Physics Department of the University of Rome Tor Vergata, Italy (UNITOV). The service is designed to promote the access to technical and scientific information by the regional industries whose technologies are sensible to Space Weather effects and allows registered users to access scientific data from instrumentation available to UNITOV researchers through national and international collaborations. To non-registered users, it provides a quick-look interface (spaceweather.roma2.infn.it) for the selection and visualization of such data and the visualization of the forecast for flare probability and Solar Energetic Particles (SEP) fluxes from prototype codes. The SWERTO database contains data on particles fluxes from the space missions ALTEA and PAMELA, and high-resolution and full disk spectro-polarimetric solar data. The solar data are related to solar Active Regions (ARs), observed at high resolution with the IBIS (Interferometric BIdimensional Spectropolarimeter) instrument, and full disk Line-of-Sight Doppler and magnetic field at different heights in the solar atmosphere, observed with the MOTH II telescope. SWERTO main goals are: i) design and realize a data-base with the particle fluxes recorded by the space missions and with the spectropolarimetric measurement of the solar photosphere; ii) allow an Open Access to the data-base and to prototype forecast to regional industries involved and exposed to Space Weather effects; iii) implement a tutorial and a FAQ section to help decision makers to realize and evaluate the risks from Space Weather events; iv) outreach and customer products.

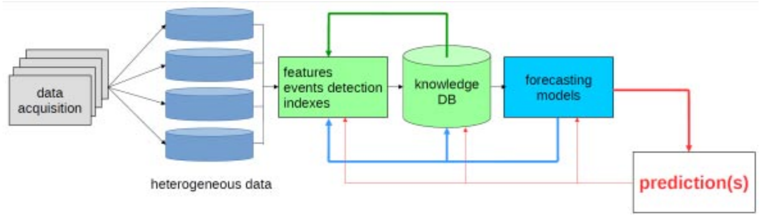

Fig. 1. – Scheme of the SWERTO database concept.

1. – Introduction

The effects of Space Weather (SWx) on human high-tech activities, infrastructures and health on the ground, in the air, and in space is well documented in a large number of technical and scientific reports (e.g., [1-3]).

The Regione Lazio, in central Italy, hosts a large number of high-tech industries and critical infrastructures whose operators need awareness of SWx events in order to mitigate possible SWx impacts. The SWERTO service allows the registered user to access scientific data from instrumentation available to the Physics Department researchers through national and international collaborations, and provides fluent software for the selection and visualization of such data, promoting the access to technical and scientific information by the industries which employ technologies vulnerable to Space-Weather effects. A flowchart of the SWERTO database and forecasting service is shown in Figure 1. Moreover, it offers a user web interface consisting in a dashboard designed to present easy to read SWx information for operational users and decision makers.

2. – SWERTO database

The SWERTO database (*swerto.roma2.infn.it* [4]) currently collects data from four space-based (PAMELA and ALTEA) and ground-based (IBIS and MOTH II) observing systems that measure the space environment. PAMELA (A Payload for Antimatter-A Matter and Light-nuclei Astrophysics) is an instrument to measure populations of particles from energies of a few tens of MeV up to a few TeV. ALTEA (Anomalous Long Term Effects on Astronauts) instrument measures the radiation field (e.g., [5, 6]) inside the International Space Station (ISS). It has been on-board the ISS since 2006, taking data till 2012 in different configurations and will be back on-board the ISS in 2019. IBIS (Interferometric BIdimensional Spectropolarimeter) is a spectropolarimetric imager based on capacitance-stabilized piezoelectric scanned Fabry-Perot etalons (e.g., [7-10]). MOTH II (Magneto-Optic Two-Height Instrument) consists of two telescopes, operating at K line at 770 nm and Na I D2 line at 589 nm, which allow observations at two heights of the solar atmosphere [11]. The core of MOTH II is a tandem of magneto-optical filter (MOF) constituted by a cell containing vapours of K (or Na) immersed in a longitudinal magnetic field. The telescope is managed by the University of Hawaii's Institute for Astronomy (IfA), Georgia State University (GSU) and JPL.

The analysis and forecasting allowed by these observing systems and other additional instruments (e.g., SDO/HMI magnetograms or GOES-X X-ray fluxes) is fed into the second SWERTO component: the operational SWx service. This corresponds to: features event detection and indexes, knowledge DB, forecasting models and predictions layers (see Figure 1). All these information are computed autonomously and in real-time by SWERTO servers and provided to the public through the SWERTO dashboard.

3. – SWERTO dashboard

The web interface (*spaceweather.roma2.infn.it*) consists in a dashboard designed to organize and present information in a way that is easy to read for final operational users and decision makers. The dashboard shows six gauges which provide graphical nowcasting and forecasting information. In detail, they show: i) recent proton flux near Earth, from the 10 MeV particle energy range GOES-13 sensors (by the U.S. Dept. of Commerce, NOAA, Space Weather); ii) the particle flux in the ISS; iii) recent flare events; iv -v) M- and X-class flare probabilities for the next 24h, currently based on HMI magnetograms using the algorithm reported in [12]; vi) SEP flux created making use of detected CME parameters, using the statistical correlation found by [13].

Moreover, the dashboard has a carousel to show: a) a composite image of the whole Sun to highlight the AR more prone to activity; b) a composite image of the whole Sun to show the location of recent M- or X- class solar flares; c) the X-ray flux measured by GOES-13 sensors in the last 2 hours; d) the energetic particle fluxes, for three different energy ranges, measured by GOES-13 sensors in the last 2 hours; e) the z component of the Interplanetary Magnetic field measured by ACE in the last 2 hours; f) the Solar Wind Speed measured by ACE in the last 2 hours; g) a composite image of the Sun to highlight the detection of CMEs from the Sun; h) a view of the inner Heliosphere to visualize the forecast propagation of CMEs, computed using the model by [14, 15].

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