2nd Workshop
RADIO SYSTEMS AND IONOSPHERIC EFFECTS
Rennes, 3-7 October 2006

ADVANCES IN ESWUA PROJECT AT INGV

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Abstract

The eSWua (electronic Space Weather upper atmosphere) project is based on measurements performed by all the instruments installed by upper atmosphere group of INGV (Istituto Nazionale di Geofisica e Vulcanologia, Italy) and on all the related studies. The aim is the realization of a hardware-software system for a Data Base to standardize historical and real time observations for different instruments.

An interactive web site supported by a well organized DB could be a powerful tool for scientific and technological community in the field of telecommunications and Space Weather. The most common and useful DB type for our purposes is the relational one in which data are organized in tables. This allows huge data amount archiving and the complete flexibility in data retrieving.

The project started in June 2005 and will last till 2007. The breakdown schedule is reported in a Gantt diagram. In the first phase the major effort has been focused on the design of hardware and data base architecture. The first two DBs related to the DPS digisonde and GISTM measurements has been completed concerning population, tests and output procedures. The following phase will be dedicated to: all DBs completion, a web user interface realization and a system complete automation. At the end of the project, in summer 2007, a dynamic web site will be opened to the community for a real time access to raw and processed data. In this work a general description of the observatories and the plan are reported as well as the state of art of the project. Details on some web tools concerning ionosonde and scintillations data treatments are presented.

Introduction

Data handling has become more and more important in the frame of ionospheric nowcasting, forecasting, propagation conditions warning, model development and evaluation (Stamper et al, 2004; Galkin et al., 2006). In particular space weather prediction systems rely on real-time information on ionospheric conditions such as for instance autoscaled parameters from the ionograms (Belehaki et al., 2005). The eSWua project is based on measurements performed by all the instruments installed by the upper atmosphere physics group of the Istituto Nazionale di Geofisica e Vulcanologia, Italy and on all the related studies. The aim is the realization of a hardware-software system to standardize historical and real-time observations for different instruments. The INGV monitoring activities can be divided into two main categories: middle latitude and high latitude observations. The middle latitude observations are carried on in Rome (Italy 41.8 N, 12.5 E) and Gibilmanna (Italy 37.9 N, 14.0 E) ionospheric observatories and Chania (Greece 35.3 N, 24.1 E) station. The high latitude observations are performed at Mario Zucchelli Station (MZS, Antarctica 74.7 S, 164.1 E), Ny Ålesund (Svalbard, Norway 78.9 N, 11.9 E) and Longyearbean (Svalbard, Norway 78.2°N, 16.0°E). The eSWua database is populated with the data provided by the following instruments installed and managed by the INGV:

- a Digital Portable Sounder 4 (DPS4) produced by the University of Lowell, Massachusetts, USA (Reinisch and Huang, 1983) operating at Rome since 1997;
- three Advanced Ionospheric Sounder designed and developed by the INGV (AIS-INGV) (Zuccheretti et al., 2003; Pezzopane and Scotto, 2005) installed at Gibilmanna in 2002 (Baskaradas et al., 2005), MZS in 2003 (Romano et al., 2004) and Rome in 2004;
- a Radio Chirp Sounder (RCS) sweeping HF receiver for oblique sounding installed at Chania in 2004 and an Improved Radio Ionospheric Sounder (IRIS) oblique chirp sounder installed at Rome in 2005 both of them receiving the ionospheric echo from Inskip, United Kingdom (54.0 N, 3.0 W) (Zolesi et al., 2007);
- four GPS Ionospheric Scintillation and TEC Monitor (GISTM) receivers specifically configured to measure amplitude and phase scintillation from the L1 frequency GPS signal, and ionospheric TEC from the L1 and L2 frequency GPS signals (Van Dierendonck et al., 1993). Two were installed at the "Dirigibile Italia" Arctic Station in Ny-Ålesund between 2003 and 2004 and two more were installed at Longyearbean and MZS in 2006 (De Franceschi et al., 2006);
- three solid state La Jolla riometers (Chivers and Prescott, 1967) one at 30.0 MHz and two at 38.2 MHz, operating at MZS since 1993.

The project started in June 2005. In the first phase the major effort has been focused on the design of hardware and database architecture. The first two databases related to the DPS4 digisonde and GISTM measurements are complete concerning population, tests and output procedures. A general description of the project and some details concerning the two databases completed are presented.

Description of eSWua

System's architecture is reported in Fig. 1. The system is based on three highly performing servers *eSWua, Ionos* and *Eskimo*. The first, *eSWua*, hosts the system web site and it is devoted to the user interface management. The other two servers are dedicated to collect in real-time all the data coming from the INGV upper atmosphere stations and to arrange them in different databases. *Eskimo* and *Ionos* are devoted to the polar and to the middle latitude data respectively. The functions of the two servers are:

- to populate automatically the database;
- to manage the queries coming from the eSWua server in order to process user requests and to make different outputs available;
- to guarantee a protected access to databases' tables and data files;
- to manage all the system backup using a dedicated Network Attached Storage (NAS).

A dynamic web site (www.eSWua.rm.ingv.it) has been opened for a real-time access to the first two databases related to the ionospheric soundings and scintillation measurements. Within the 2007 the other databases completion is planned along with the complete web access features. Follow a brief description of the two completed databases.

The ionospheric database contains ionospheric parameters obtained by scaling ionograms (Piggot and Rawer, 1972) that are the raw measure of the radio sounding performed by a dedicated radar system called ionosonde. The historical and real-time data coming from the ionospheric stations of Rome, Gibilmanna and MZS were structured. Each station, in different period, was equipped with different ionosondes. Data from DPS4 ionosonde are organized in tables containing 56 ionospheric characteristics and 9 values related to the instrument and site; AIS-INGV ionograms are scaled by the Autoscala program (Pezzopane and Scotto, 2005) that produces 15 parameters for every sounding; manually scaled data are organized in tables containing 14 ionospheric characteristics including qualitative and descriptive letters. Ionogram pictures are stored when available.

Concerning the population procedure of the database, it is distinguished between manual and automatic scaling. In one year the total amount of data produced by the stations is around 6 GB and the databases dimension is 60 MB.

The scintillation database contains scintillation values obtained by GISTM receivers. Every 15 minutes a binary file is produced by each instrument and sent to the *isacco* server. The measurement is realized with respect to every visible GPS satellite with a minute sampling rate. The measure produces

a total of 35 navigational and observational parameters that are real-time structured in the database for every station. GISTM station performs the 50 Hz sampling too, the files are stored by the system and only addressed in the database. The database organization allows a quicker analysis and a easy extrapolation of the interesting events. For each instrument different automatic procedures are developed to realize the database population. In one year the total amount of data produced by the 4 stations is around 600 GB and the databases dimension is 14.4 GB.
The users can access to the completed databases at www.eSWua.rm.ingv.it (Fig. 2). The home page allows the registered users to log in and the new users to register. The site is organized in four main sections whose title is *Ionospheric monitoring*, *Scintillation monitoring*, *Riometer monitoring* and *Educational* respectively. Each main section is divided into further sections according to a geographical criterion. Hence under the title Ionospheric monitoring the user can choose between *Italy*, *Mediterranean Area* and *Antarctica*, under the title *Scintillation monitoring* the user can choose between *Arctic*, *Antarctica* and under the title *Riometer monitoring* the user can choose *Antarctica*. The figure 3,4,5,6 show some tools concerning the web site.

Summary

The final goal of the project is to integrate the existing INGV upper atmosphere observation technologies with an hardware and software system that will allow a modern, reliable and fast treatment of the data acquired. The COST296 Action (www.cost296.rl.ac.uk) offers the possibility to share expertises of excellence in Europe to test the potentialities of the system, which can be, in turn, extended to host other data and scientific tools provided and suggested by the partners of the same Action. The first results obtained confirm the usefulness of the project for the scientific and technological community; this system will contribute to international project like the Virtual Observatories (www.egy.org) and Italian projects, such as SIRIA (Information System for the Italian Research in Antarctica) (Piervitali et al 2004) where the interoperability of the system and effective data access are necessary requirements.

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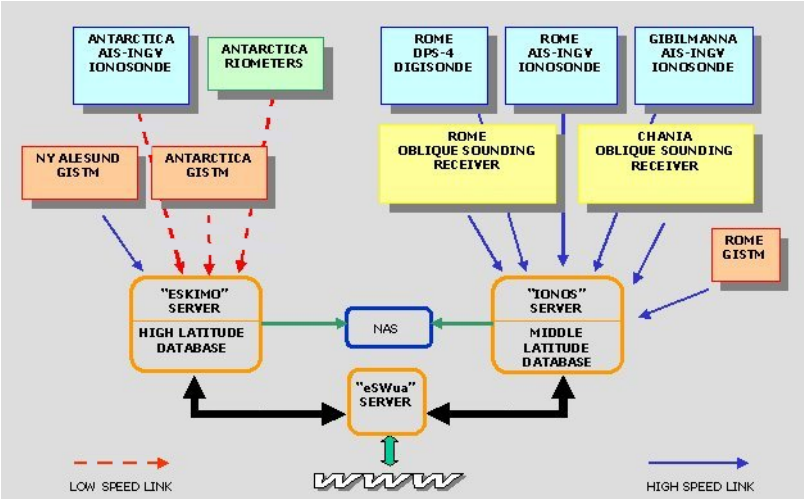

Figure 1. Data flow and system architecture.

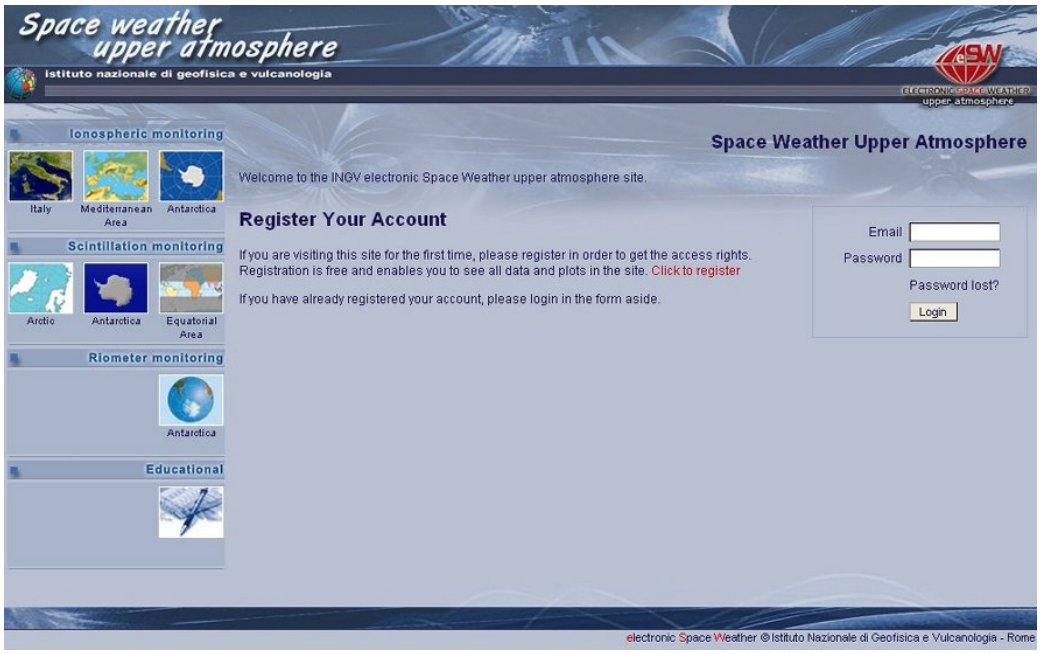

Figure 3. The eSWua home page.

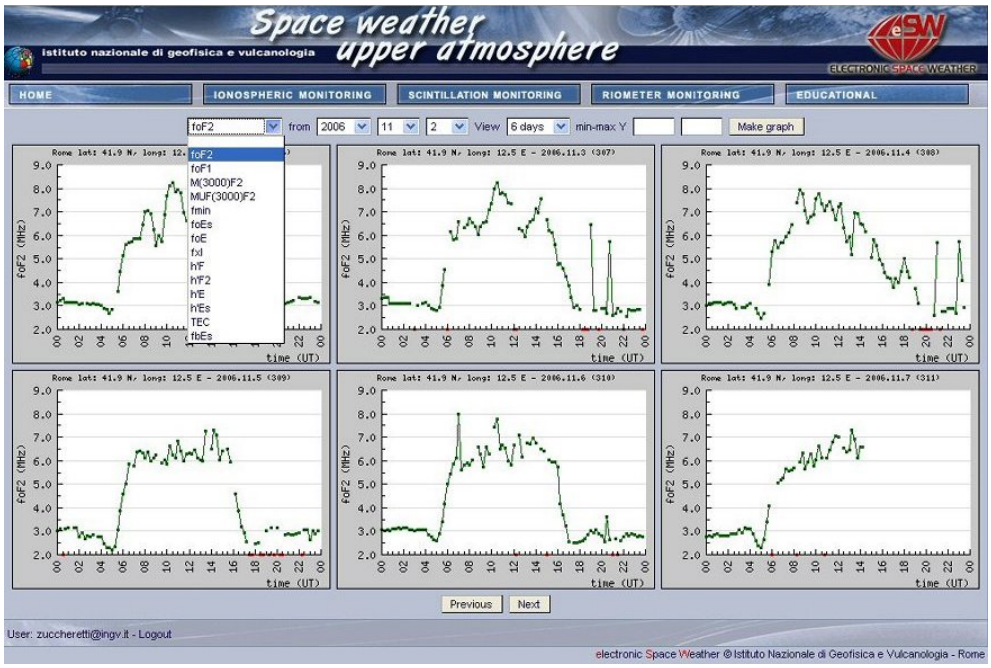

Figure 4. Six foF2 daily plots. Different parameters can be chosen from the menu.

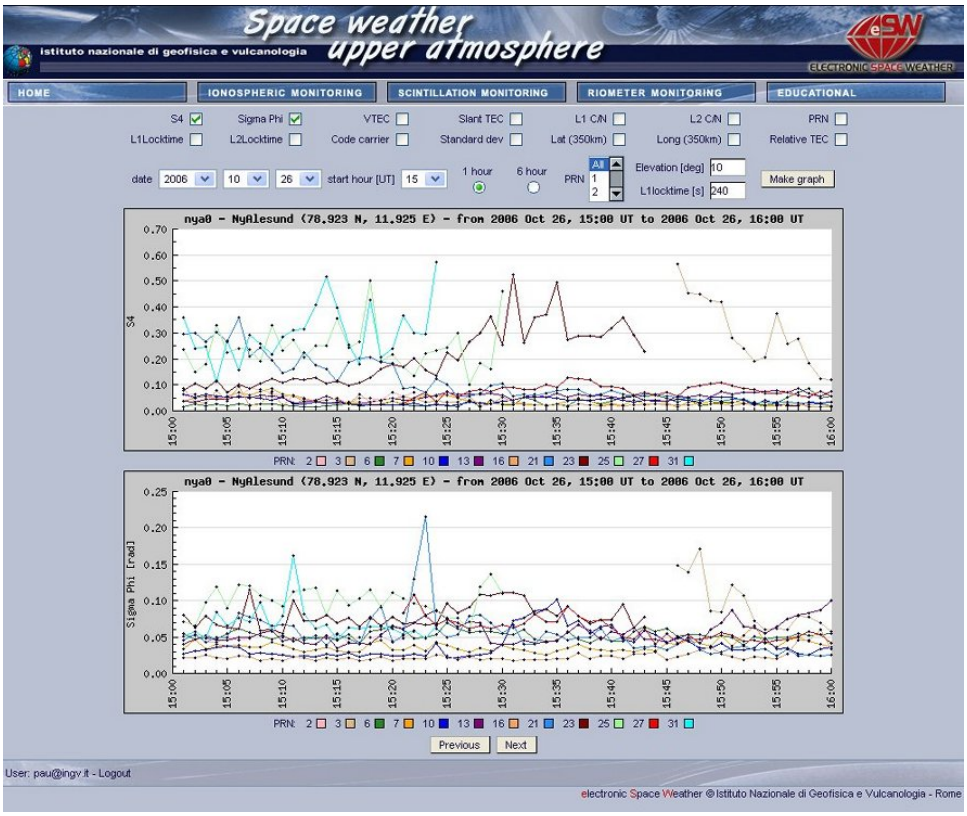

Figure 5. Example of hourly linear data plots. The parameters S4 and SigmaΦ are plotted for all the visible satellites.

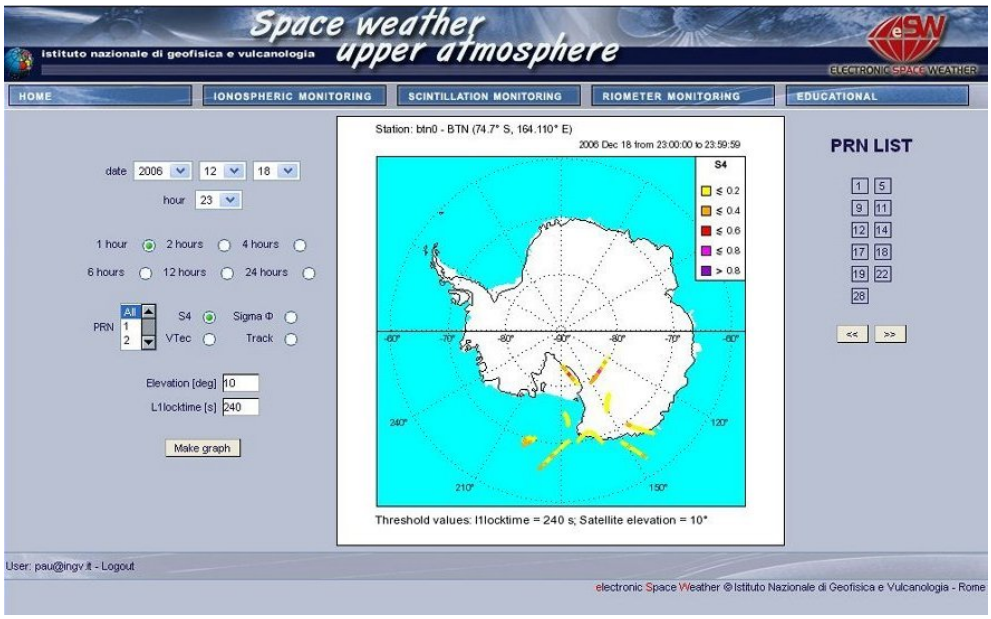

Figure 6. Example of hourly polar map. The parameter S4 is plotted for all the visible satellites.