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Implementing the European Neutron Monitor Service for the ESA SSA Program

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Abstract: Ground level enhancements (GLEs) are observed as significant cosmic ray intensity increases at neutron monitor measurements, followed by an intense solar flare and/or a very energetic coronal mass ejection. Due to their space weather impact it is crucial to establish a real-time operational system that would be in place to issue reliable and timely GLE Alerts. Such a Neutron Monitor Service that will be made available via the Space Weather Portal operated by the European Space Agency, under the Space Situational Awareness Program, is currently under development. The ESA Neutron Monitor Service will provide two products: a web interface providing data from multiple Neutron Monitor stations as well as an upgraded GLE Alert. Both services are now under testing and validation and will probably enter to an operational phase next year.

1 Introduction

The Space Situational Awareness (SSA) Program of the European Space Agency (ESA) has been lunched with the aim to support Europe's utilisation of, and access to, space through provision of timely and accurate information, data and services. Therefore, comprehensive knowledge, understanding and maintained awareness of the population of *space objects*, of the *space environment*, and of the existing *threats/risks* was considered mandatory. As a result, three SSA segments were defined: Surveillance and Tracking, Space Weather and Near Earth Objects. The role of the Space Weather Segment (SWE) is a) Detection and forecasting of the Space Weather events and the effects it has on space assets and ground based infrastructure, b) Comprehensive knowledge, understanding and maintained awareness of the natural space environment, c) Detection and understanding of interferences due to SWE, d) Prediction and/or detection of permanent or temporary disruption of mission and/or service capabilities and e) Provision of predicted local spacecraft and launcher radiation, plasma and electromagnetic environment data.

In the frame of this project, a Neutron Monitor Service that will be made available via the Space Weather Portal operated by the European Space Agency (ESA) will be developed. This ESA Service will provide two products: a web interface providing data from multiple Neutron Monitor stations as well as an upgraded GLE Alert. Both services are now under testing and validation and will probably enter to an operational phase next year. The core of this Neutron Monitor Service is the GLE Alert software, and therefore, the main goal of this research effort is to upgrade the existing GLE Alert software and to minimize the probability of false alarms. The ESA Neutron Monitor Service is building upon the infrastructure made available with the implementation of the High-Resolution Neutron Monitor Database (NMDB). In this work the structure of the ESA Neutron Monitor Service, the core of the novel GLE Alert Service and its validation results will be presented and further discussed.

2 The Neutron Monitor Service

The Cosmic Ray group of the Athens Neutron Monitor Station (A.Ne.Mo.S.) at the National and Kapodistrian University of Athens is working towards the establishment of a European Neutron Monitor Service that will be made available via the ESA SSA SWE portal. The European Neutron Monitor Service is intended to provide [a] Access to the Neutron Monitor Data of Multiple Stations and [b] Reliable and timely GLE Alerts. Both services have been released via A.Ne.Mo.S. and will probably enter to an operational phase next year. The ESA SSA SWE European Neutron Monitor Service is building upon the infrastructure made available with the implementation of the Neutron Monitor Database (NMDB) [1].

a) Multi Station Neutron Monitor Data

Multi-station neutron monitor (see Figure 5) data are provided via a form that reads the **NMDB mirror** operated by the **A.Ne.Mo.S**. The multi-station interface provides an easy way to access the data that are stored in the NMDB database. The interface connects to the NMDB slave server located at the Athens station. The user has to select the stations, the variables, the time interval and the resolution of the exported data. The output can be obtained in both plot and ascii format. Moreover a feature that allows the retrieval of data in csv file has been implemented, allowing further processing of the data by the user.

b) GLE Alert Plus

GLE Alert Plus monitors the recordings of each NM station providing data to NMDB. For every minute, it calculates the moving average of the previous hour (i.e. 60 1-min measurements) and the threshold that represents the upper limit for which the NM station is considered to be at 'Quiet' mode, for every NM. If three consecutive 1-min measurements exceed this threshold, the particular NM station is considered to be at a ***'Station Alert'*** mode and an elapsed time window of 15 min is being triggered. In case 3 NM stations, independently of each other enter the ***'Station Alert'*** mode within the aforementioned time window a General ***'GLE Alert'*** is being marked and an Alert is issued [2], [3], [4]

3 Conclusions

- ✓ The **European Neutron Monitor** Service provides both access to the **Multi-Stations Neutron Monitor Data** and reliable and timely **GLE Alerts**.
- ✓ **GLE Alert Plus is a** novel **European Neutron Monitor** Service that will be made available via the **ESA SSA SWE** portal has been implemented.
- ✓ It is also distributed via a dedicated email notification engine
- ✓ Both services are available in the **A**thens **Ne**utron **Mo**nitor **S**tation (**A.Ne.Mo.S.**) at http://cosray.phys.uoa.gr

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