The Hungarian SSA/Space Weather capabilities



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Plasmasphere: why is it important?

Space Weather

Radiation Belts dynamics: wave-particle interactions – *acceleration* and *precipitation* (Relativistic Electron Precipitation -REP) → damage satellite electronics

- take place in *plasmasphere*
- \rightarrow we need a model
- of the plasmasphere /plasmapause location to make *forecasts* or model *events*



Whistlers



Automatic Whistler Detector and Analyzer Network (AWDANet)

A **unique**, global network of Very Low Frequency recording and processing stations capable to produce plasma densities real-time

- Covering low-, mid- and high (magnetic) latitudes since 2002 including *conjugate* locations
- ${\sim}50\ 000{\text{--}}10\ 000\ 000$ whistler traces/year/station

Real time operation is in *experimental* phase

The network is led by Eötvös University, Hungary

AWDANet -Europe



AWDANet - World



existing stations planned stations

Field Line Resonances – obtaining plasma mass densities *EMMA + South African network*



Antarctic-Arctic Radiation-belt (Dynamic) Deposition - VLF Atmospheric Research Konsortium (AARDDVARK) :

Mapping and modeling **REP** events

AARDDVARK Aarmory





existing network

AARDDVARK

extended network



Led by British Antarctic Survey and University of Otago



Objectives

- Regular longitudinally-resolved measurements plasmaspheric electron and mass densities and hence monitor the changing composition of the plasmasphere, one of the properties which determines wave growth in wave-particle interactions in the Radiation Belts
- To develop a data assimilative model of the plasmasphere using. Even dense measurements only sample the plasmasphere at limited resolution in both space and time. Yet determining the effect of wave-particle interactions on the Radiation Belts require a continuous map of the plasma density in both time and space. In order to provide such a complete map it becomes necessary to interpolate between measurements, again in both time and space with data assimilation schemes to combine plasmaspheric measurements with a numerical physics-based plasmasphere model. The two data assimilation schemes which we are pursuing are Ensemble Kalman filtering and particle filtering.
- To monitor the occurrence and properties of Relativistic Electron Precipitation, tying the time-resolved loss of relativistic electrons to the dynamic plasmasphere observations. Our approach will primarily use ground-based networks of observing stations, operating in the ULF and VLF ranges, deployed on a worldwide level

Workpackages and methology

- WP1: Automatic retrieval of equatorial electron densities and density profiles by Automatic Whistler detector and Analyzer Network (AWDANet)
- WP2: Retrieval of equatorial plasma mass densities by European quasi-Meridional Magnetometer Array (EMMA) magnetometer arrays and cross-calibration of whistler and Field Line Resonance method
- WP3: Data assimilative modeling of the Earth's plasmasphere
- WP4: Modeling REP losses from the radiation belts using the Antarctic-Arctic Radiationbelt (Dynamic) Deposition – VLF Atmospheric Research Konsortia (AARDDVARK) network

PLASMON structure



Participants

Participant		Country
Eötvös University	János Lichtenberger	Hungary
British Antarctic Survey	Mark Clilverd	UK
Eötvös Loránd Geophysical Institute	Balázs Heilig	Hungary
University of L'Aquila	Massimo Vellante	Italy
Sodankyla Geophysical Observatory	Jyrki Manninen	Finland
University of Otago	Craig Rodger	New Zealand
Hermanus Magnetic Observatory	Andrew Collier	South Africa
New Mexico Institute of Mining and Technology	Anders Jorgensen	USA
Institute of Geophysics, Polish Academy of Sciences	Jan Reda	Poland
University of Washington	Robert Holzworth	USA
Los Alamos National Laboratory	Reiner Friedel	USA

Requests and comments to EU/ESA SSA program from Hungary

- NATO RTA initiated a SSA program (*SCI-229*)
 EU/ESA SSA should be aware of it
 - (SSA is a global program)
- 2. EU supports SSA projects (e.g. *PLASMON*) and complementary research through FP7-Space (e.g. *POP-DAT*)

Requests and comments to EU/ESA SSA program from Hungary

- 3. As *AWDANet* is *unique, global* network
 - (all potential concurrent country is involved:
 - US, Russia, India, Brazil, etc.)

Hungary offers it for EU/ESA SSA as a *operational service* ↔ at the present economical situation support to Hungary and interaction with the Hungarian government is needed

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