

# SOLAR – TERRESTRIAL RESEARCH AND SPACE WEATHER ACTIVITIES IN GREECE

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## ABSTRACT/RESUME

Although the technical aspects of space weather have not yet gained wide political and public attention, a vital scientific community engaged in solar – terrestrial research exists in Greece.

The Greek space physics community, although relatively small in numbers, has acquired a rich experience and has gained international recognition over the past years. The field of research covers solar, interplanetary and magnetospheric physics. Here we briefly review these research activities, which provide a suitable background for creating a national space weather initiative that is still missing.

## 1. BACKGROUND

The Greek space physics community is relatively small in quantitative terms. Nevertheless, it has acquired a rich experience and has gained international recognition through early and productive involvement in a number of space missions (e.g., IMP, ISEE, AMPTE). The field of research has covered solar, interplanetary and magnetospheric physics. In terms of numbers, the Greek scientific community is composed by approximately 40 scientists, the 25 of them are permanent staff, hosted in seven different institutions, located in five cities (see Fig. 1). We ought to mention that the numerous Greek space scientists living and working abroad have been very helpful to the community, in establishing strong collaborations in an international level. Needless to say, this report does not include their activities.

Currently, there is active involvement of Greek space physicists as Co-Investigators and Guest Investigators in several space missions (e.g. Geotail, Interball, Ulysses, Polar, STEREO, ACE, TRACE, Cluster, etc). Measurements from these missions are highly suitable for studies on solar-terrestrial coupling, energy flow in the interplanetary medium and the terrestrial magnetosphere, space storm dynamics, space weather predictions, and impulsive particle acceleration in the heliosphere. The Greek space physics community complements the analysis of these measurements with state-of-the-art computer simulations.

## 2. MAIN RESEARCH ACTIVITIES

In the following we will briefly outline the research activities that are carried out in the Greek solar – terrestrial research groups. The respective www-sites are provided for the interested readers to find a more detailed description on the activities of each research group.

### 2.1 National Observatory of Athens (NOA)

The solar – terrestrial research group of NOA is part of the Institute for Space Applications and Remote Sensing (<http://www.space.noa.gr>) and counts 4 staff scientists and 2 PhD students. The main research activities of the group are:

- Solar chromosphere and corona
- Solar flares and CMEs
- Interplanetary shock waves
- Energetic particle acceleration and radiation processes
- Solar wind – magnetosphere – ionosphere coupling
- Space storm and substorm dynamics
- Acceleration, source and loss processes of magnetospheric plasma
- Ionospheric physics

The members of the group are involved in data processing and analysis as well as in modelling of relevant physical processes.

### 2.2 National and Kapodistrian University of Athens (NKUA)

Activities relevant to solar – terrestrial research in NKUA are performed in the Physics Department at the Section of Astrophysics, Astronomy and Mechanics as well as in the Section of Nuclear and Elementary Particle Physics (<http://www.uoa.gr>). The personnel involved in such research activities are 5 staff scientists, 4 post-doc fellows and 5 PhD students. Their main research interests are:

- Solar Flares – Radio Observations
- Solar wind – MHD models
- Solar and Interplanetary energetic particles
- Cosmic rays
- CMEs and interplanetary shock waves
- Dynamics of the Earth's magnetosphere

The group is active in data processing and analysis, and numerical simulations.

### 2.3 Academy of Athens (AOA)

In the Academy of Athens there is a research group at the Research Center of Astronomy of 4 staff scientists and one post-doc fellow, mainly active in data processing and analysis. Their activities are:

- Fine structure of the quiet Sun
- Evolving solar active regions
- Solar flares and CMEs



Fig. 1. A satellite image of Greece. The five cities, where the Greek solar – terrestrial groups are located, are marked.

### 2.4 Aristotelian University of Thessaloniki (AUTH)

In the Physics Department, at the Section of Astrophysics, Astronomy and Mechanics (<http://www.astro.auth.gr>) of AUTH there is a research group of 1 staff scientist, 1 post-doc fellow, and 2 PhD students mainly working on:

- Energy release processes in the Solar Chromosphere
- Solar Energetic Particle acceleration and radiation processes
- Dynamics of evolving solar active regions and flares

The group in AUTH is heavily involved in theory and modelling based on numerical simulation techniques.

### 2.5 Demokritos University of Thrace (DUTH)

The largest space physics research group in Greece is located in DUTH at the Department of Electrical and Computer Engineering, in the Section of Telecommunications and Space Sciences (<http://www.eee.duth.gr>). The group counts 6 staff scientists, and more than 6 PhD students. The main activities are:

- Solar and interplanetary energetic particles
- CMEs and interplanetary shock waves
- Chaotic dynamics of the Earth's and Jupiter's magnetosphere
- Energetic particle acceleration processes

The space physics group in DUTH is engaged in data processing and analysis, in theory and modelling, but also in the design of microchips for several space instruments.

### 2.6 University of Ioannina (UIO)

In the UIO a small solar physics group is hosted at the Department of Physics in the section of Astrogeophysics at the Laboratory of Astronomy (<http://www.physics.uoi.gr/seci/tomeas.html>). The two staff scientists are mainly involved in data processing and analysis of:

- Energetic particles from Solar flares and CMEs
- Fine structure of the quiet Sun
- Solar Dynamo processes

### 2.7 University of Crete (UOC)

At the Physics Department in the Section of Astrophysics and Space Physics of UOC (<http://astrophysics.physics.uoc.gr>) there is one staff scientist who is actively in ionospheric physics research by performing data processing and analysis, as well as modelling.

## 3. INFRASTRUCTURE IN GREECE

In this section will be briefly report on the relevant infrastructure that already exists in Greece.

### 3.1 Ionospheric Station of NOA

A new fully automatic ionospheric station operates in Penteli a suburb of Athens, from September 2000. The station (<http://www.iono.noa.gr>) operates with a Digisonde Portable Sounder-4 (DPS-4) sounding system, with a transmitting power of 300W. It covers the frequency range from 1 – 40 MHz and has two crossed delta transmit antennas on a 30m tower. The ionospheric station provides real time on-line ionograms to the World Data Centers and to individual users via FTP.

### 3.2 SESCAT at UOC

SESCAT stands for Sporadic E SCATter experiment and refers to a continuous wave (CW) radar facility, which has been operating in Crete since 1992, by the UOC and the Max-Planck Institut fuer Aeronomie (<http://www.physics.uoc.gr/2000/ergastiria/haldoupis/sescat99.html>). The experiment is a state of the art bistatic CW Doppler radar operating at 50.52 MHz with the transmitting and receiving arrays beaming northward to a region perpendicular to the earth's magnetic field at the E region peak of the ionosphere.

### 3.3 ARTEMIS-IV

Since 1996, the NKUA operates the ARTEMIS-IV solar radiospectograph. It is located at the Thermopylae Telecommunications Stations and has a 7m parabolic antenna. The observations cover the frequency range from 110 to 700 MHz. The radiospectograph has a sweep frequency receiver and a multi channel acousto – optical receiver that work in parallel.

### 3.4 Cosmic Ray Station of NKUA

The NKUA operates from November 2000 a new cosmic ray station (<http://cosray.phys.uoa.gr>). The station has a Neutron Monitor (Super 6NM64) that consists of six BF<sub>3</sub> proportional counters with the enriched isotope B type BP28 Chalk River Canada. The cosmic ray station is providing real time data to the Worldwide Network of Neutral Monitors.

## 3. OTHER ACTIVITIES AND CONCLUDING REMARKS

During the last five years the members of the Space Physics group at the Institute for Space Applications and Remote Sensing in NOA have made a big effort to promote the activities of the Greek space physics community, by organising three widely attended international conferences/workshops. For details on these events, the interested readers can visit the www-site: [http://www.space.noa.gr/isars\\_events.htm](http://www.space.noa.gr/isars_events.htm).

A few important facts that set the framework of space physics and space weather research in Greece are the following:

- There is no co-ordination on a National level between the different groups.
- Besides the salaries of the permanent scientists, there is practically no Government funding.
- There have been no attempts in Greece to establish a national space weather initiative, as there is no apparent industrial need for space weather services.
- Greece is the only country of the European Union that is not a member of ESA; accordingly, Greek scientists cannot lead proposals for ESA missions.