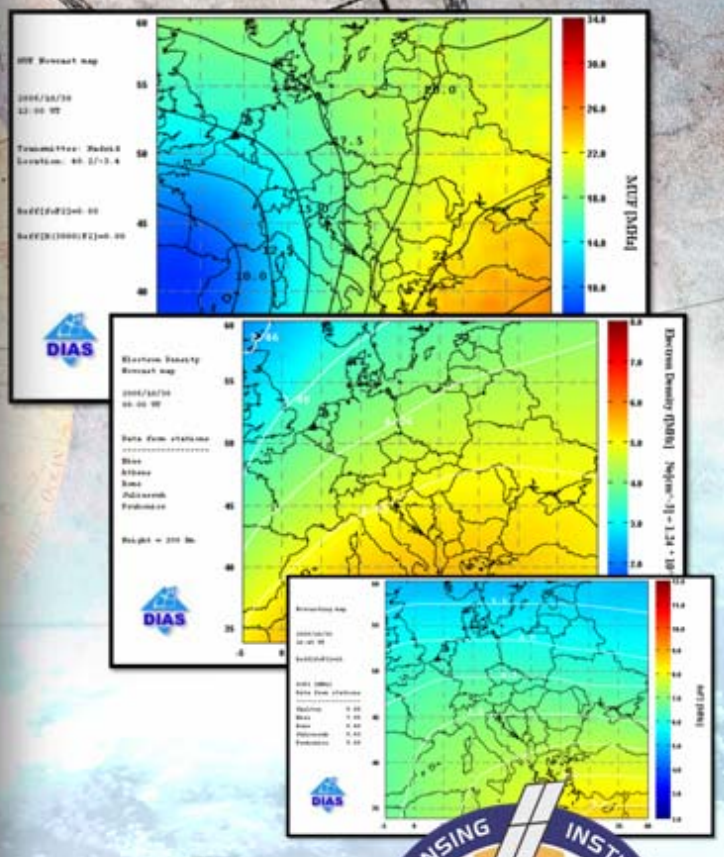
National Observatory of Athens

Institute for Space Applications & Remote Sensing

ANNUAL REPORT

2007



INSTITUTE

FOR

SPACE APPLICATIONS

AND REMOTE SENSING

ANNUAL REPORT 2007

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1. Introduction

The Institute for Space Applications and Remote Sensing (ISARS) is one of the five research Institutes of the National Observatory of Athens (NOA), the oldest research institution in Greece and South-Eastern Europe. It is supervised and supported by the General Secretariat of Research and Technology of the Greek Ministry of Development.

ISARS reflects the multi-disciplinary character of NOA, being active in a wide range of research areas, spanning from planetary exploration to wetland monitoring by satellites. With regard to its research objectives and its know-how and research experience, ISARS is a focal institute of space research and applications in Greece. The present report covers the year 2007, which beyond the usual activities included important new national and international collaborations, organisations of scientific conferences and workshops, and upgrade and extension of research infrastructures.

Concerning ISARS new collaborations, we indicatively report the collaborations with the following institutions: with the Service of the Conservation of Acropolis Monuments (YSMA) in the frame of the restoration of the Parthenon; with the Institute of Engineering Seismology and Earthquake Engineering (ITSAK) in the framework of geomagnetic measurements of ground conductivity; with the Friends of the Goulandris Natural History Museum for the space sciences outreach activities; with the University of California Los Angeles (USA) and Kyushu University (Japan) in the framework of space storm monitoring through geomagnetic measurements; with the Society for the Protection of Nature of Lebanon and the Royal Society for the Conservation of Nature of Jordan for the monitoring and mapping of wetlands with the use of satellite images.

Furthermore, the infrastructures of ISARS were considerably upgraded and extended in 2007. We mention the installation and operation of the geomagnetic station at Klokotos (Trikala prefecture); the geomagnetic station at Dionysos (Attiki prefecture); a receiving station for Meteosat Second Generation (MSG) satellite data, and a CIMEL multispectral photometer for remote sensing of atmospheric parameters, leading to the participation of ISARS in the global network of measurement of aerosols AERONET (AErosol RObotic NETwork) of NASA.

ISARS had the responsibility of the local arrangements for the ESF/ESA Workshop on The Science of European Space Exploration, which took place in Athens in May 2007. The Workshop involved the European community of space sciences and had a strategic importance for the future of European space exploration. The eventual outcome of the meeting was the report “Science-Driven European Scenario for Space Exploration”, a strategy text submitted by the European Space Sciences Committee (ESSC) of the European Science Foundation (ESF) to the European Space Agency (ESA).

Also in May, ISARS organised the first seminar course of the training research network PROTIPA on Advanced Techniques of Remote Sensing for Monitoring and Protection of Forest and Land Ecosystems. In June, ISARS organised the Urban Heat Island Consultation Meeting in collaboration with the national delegate at the Earth Observation Program

Board of ESA Prof. Konstantinos Kourtidis and with the ESA Executive, and with the participation of representatives of European institutions and various national institutions of Greece (General Secretariat of Civil Protection, City of Athens, et al.). In December, ISARS organised the workshop on "Advanced Techniques of EO for the Management and Protection of the Environment" in the region Aspropotamos of the Trikala prefecture.

During the extended wildfires that Greece suffered in the summer of 2007, ISARS developed a pilot tool for the detection of fire outbursts and monitoring of fire fronts using low resolution geostationary satellite data. Furthermore, ESA contracted ISARS to implement the RISK-EOS service in Greece in order to produce repeatedly burn scar maps every fire season.

Ioannis A. Daglis
Director of ISARS

1.1. Activities

The Institute is engaged in a wide array of activities in the thematic area of Space Research and Applications.

Its main objective is to carry out R&D projects in a wide number of fields included in the following main scientific domains:

- Space Sciences
- Earth Observation and Remote Sensing
- Wireless Communications

The activities of the Institute can be classified in the following general categories:

- Systematic collection and processing of data derived from observations made in space or from the surface of the Earth.
- Performance of autonomous studies in other specific subjects of space research and applications.
- Education, continuing education and awareness-raising.
- Rendering of specialized services.

The Institute is equipped with satellite and ionospheric ground stations, various RF and electronic test and measurement equipment, as well as an advanced computing centre connected to international networks.

1.2. Personnel

Director
Dr. I.A. Daglis

Researchers (tenured or tenure-track)
Dr. V. Amiridis
Dr. A. Anastasiadis
Dr. G. Balasis
Dr. A. Belehaki
Dr. I. Keramitsoglou
Dr. H. Kontoes
Dr. K. Koutroumbas
Dr. P.T. Mathiopoulos
Dr. A. Rontogiannis
Dr. N.I. Sifakis
Dr. O. Sykioti
Dr. I. Tsagouri
Dr. G. Tsiropoula

Scientific staff (permanent)
Mr. P. Elias
Mr. D. Paronis
Ms. C. Haffner

Scientific staff (on contract)
Dr. B. Di Fiore
Ms. M. Georgiou
Dr. G. Goumas
Mr. C. Iossifidis
Mr. P. Kapiris
Ms. F.-A. Metallinou
Dr. I. Panagopoulos
Dr. S. Papaharalabos
Mr. I. Papoutsis
Dr. N. Sagias
Mr. K. Themelis
Dr. K. Tziotziou

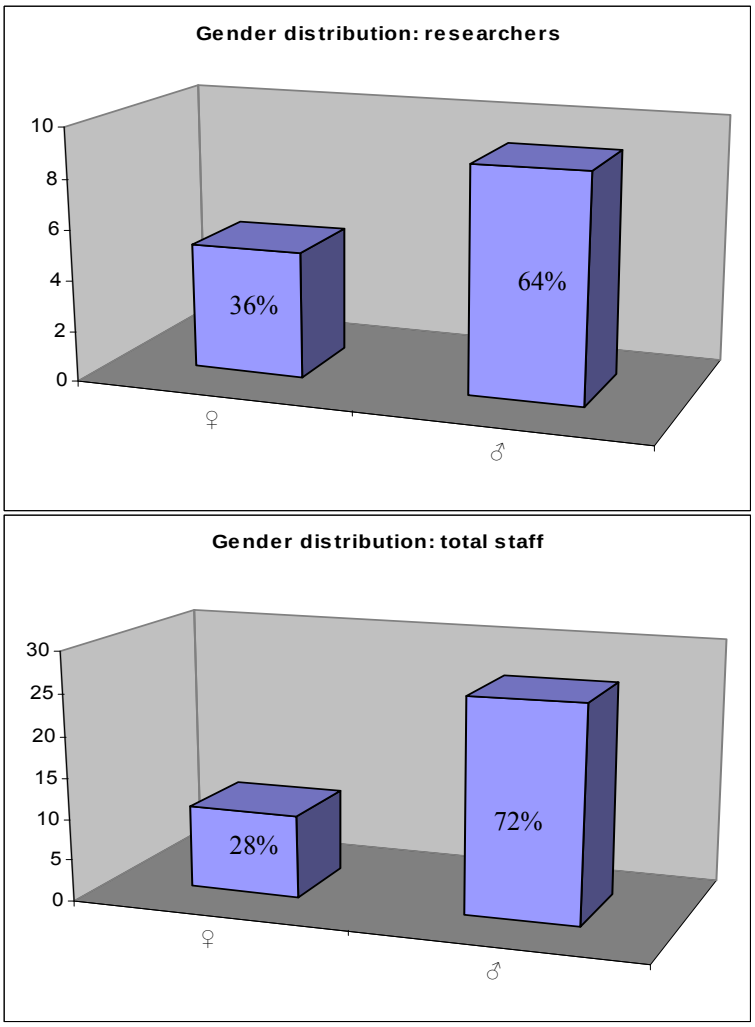
Technical staff (on contract)
Mr. Th. Herekakis

Secretariat
Ms. L. Papadaki

Graduate students
Mr. D. Benmayor
Mr. P. Bithas
Mr. J. Giannikakis
Mr. N. Kokkalis

Mr. I. Kotsis
Ms. Z. Papadimitriou
Mr. G. Ropokis
Mr. S. Stagakis

1.3. Statistics



Gender distribution of researchers (top) and of total staff (bottom) of ISARS

2. Research and development activities

2.1. Space sciences

The research activities of the Space Sciences branch of ISARS refer to space physics and planetary exploration, solar physics, and ionospheric physics. Research is being pursued through:

a) Data processing, analysis and interpretation of spacecraft measurements from various space missions.
b) Data processing, analysis and interpretation of ground-based measurements.
c) Development of modelling software for the implementation of mission objectives.
d) Computer simulations of relevant physical processes.

ISARS researchers have been participating in several ESA and NASA space missions under the Co-Investigator or Group Member status. Active co-operation exists with a number of research institutes in Europe and USA.

2.1.1. Research areas

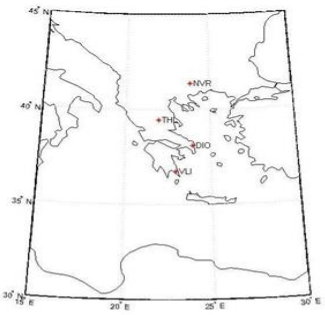
- **Space physics and planetary exploration**

The activities of the space physics and planetary exploration group refer to a wide range of research topics, spanning from geomagnetic pulsations, geospace storm dynamics and space weather through coronal and interplanetary particle acceleration to the exploration of Mercury.

In 2007 group members participated in 4 out of 19 mission proposals for ESA's Cosmic Vision programme. Two of these proposed missions were selected by ESA for the assessment phase: Cross-Scale, a mission dedicated to quantifying the coupling in space plasmas between different physical scales (participation of A. Anastasiadis) and TANDEM, a mission to explore in situ Titan and Enceladus, two of the most interesting bodies in the Saturnian system (participation of I.A. Daglis).

The group operates a newly installed magnetometer array in Greece for the study of geomagnetic pulsations, resulting from solar wind – magnetosphere coupling. The array is expected to eventually consist of 4 low-latitude ground-based observation sites of the geomagnetic field. These stations will be latitudinally equi-spaced between 30º and 36º corrected geomagnetic latitude. The particular spatial configuration is suitable for detecting geomagnetic field line resonance (FLR) signatures, thus allowing the study of the dynamics of the inner magnetosphere. An interesting option in this field of research would be to compare ultra-low-frequency (ULF) wave observations in space performed by ESA

magnetic satellite missions and on the ground acquired by this low-latitude magnetometer array. The new magnetometer array will also provide the potential for collaboration with the South European GeoMagnetic Array (SEGMA).



Geographic locations of the magnetic stations.

GSM-90F1 scalar overhauser magnetometer.

Station Name	Station Abbreviation	Geographic Latitude (°)	Geographic Longitude (°)	Altitude (m)	Geomagnetic Latitude (°)	Geomagnetic Longitude (°)	L-shell value
Nevrokopi	*NVR*	41.35	23.86	595	35.63	96.61	1.51
Klokotos	*THL*	39.45	21.97	110	33.18	94.61	1.43
Dionyssos	*DIO*	38.08	23.93	480	31.68	96.3	1.38
Velies	*VLI*	36.72	22.95	220	29.89	95.25	1.33

Stations' details.

CHIMAG vector fluxgate magnetometer.

Figure 1: The National Observatory of Athens magnetometer array. Left: A map of the magnetic chain and a table with the details of the stations. Right: Instruments currently operated by ISARS.

In 2007 the group joined the consortium designing and building the PICAM (Planetary Ion CAMera), part of the SERENA instrument suite for ESA's BepiColombo Cornerstone Mission to planet Mercury. PICAM is an ion mass spectrometer operating as an all-sky camera for charged particles to study the chain of processes by which neutrals are ejected from the soil, eventually ionised and transported through the environment of Mercury. It will provide the mass composition, energy and angular distribution of low energy ions up to 3 keV in the environment of Mercury. These observations will uniquely allow to study the low energy particles emitted from the surface of Mercury, their source regions, composition and ejection mechanisms, and to monitor the solar wind which may impinge on the surface and constitutes a major ejection process. This will allow to better understand the formation of Mercury's tenuous atmosphere and its magnetospheric plasma.

Selected research projects of the group are described in section 2.1.2.

(A. Anastasiadis, G. Balasis, I.A. Daglis, B. Di Fiore, M. Georgiou, G. Goumas, P. Kapiris, F.-A. Metallinou, I. Panagopoulos)

- **Solar physics**

The solar physics group at the Institute for Space Applications and Remote Sensing of the National Observatory of Athens studies the Sun using observational data from satellites (such as SoHO, TRACE and Hinode) and/or ground-based observatories (such as THEMIS

in Tenerife and DOT in La Palma) in combination with modelling and theoretical tools (such as radiative transfer). The SoHO satellite is a cornerstone mission of the European Space Agency. Its continuous monitoring of the outer solar atmosphere has been proven to be of immense scientific value. TRACE, a NASA solar mission, has provided impressive observational information which has enabled an improved understanding of the physical processes and phenomena occurring at the solar atmosphere. The JAXA/NASA/ESA mission Hinode (Solar-B) is the most recent solar mission launched in 2006 and provides continuous, high-resolution imaging and spectroscopic polarimetry, along with imaging and spectroscopy of the chromospheric and upper solar layers. These significant observational tools from space when complemented with ground-based telescopes provide, through a multi-wavelength analysis, coverage of the solar atmosphere from the lower layers to the outer corona. THEMIS and DOT, very often used by the group for acquiring observations, are among the most high-standard solar European telescopes installed in the Canary Islands. They provide images and profiles in several spectral lines covering the photosphere and chromosphere which permit the extraction of quantitative information about the physical parameters that describe the thermodynamic state of the solar plasma.

Figure 2: **THEMIS and DOT in Tenerife and La Palma respectively.**

The group is currently investigating a wide range of solar phenomena occurring in active and quiet regions that include sunspots, loops, surges and fine scale structures.

Quiet Sun studies of the group are mainly based on observations of fine-scale structures. These are small structures of short length (~10000 km) and width (~1500 km) observed mostly in chromospheric lines (Hα, Ca). They are called mottles when observed on the solar disc and spicules when observed on the solar limb, they occupy most of the surface of the quiet Sun regions and are associated with the network boundaries defined as the borders of supergranular cells on the Sun. They are observed either with ground-based telescopes or solar satellites. The aim of such studies is the investigation of their morphological characteristics, dynamical behaviour (evolution, lifetime, periodicities), physical properties (velocities, temperatures, densities etc), which are deduced from their spectral line profiles with the use of radiative transfer theory, and their association with physical drivers in the lower atmosphere, as well as with similar structures observed higher up in the solar atmosphere. The on-going work of the solar group at ISARS has demonstrated that magnetic reconnection is probably their driving mechanism, since it interprets well the majority of the observational characteristics of these structures. Magnetic reconnection is a key process, since it provides the means for heating the solar corona and drives material towards the solar atmosphere and away to the solar wind.

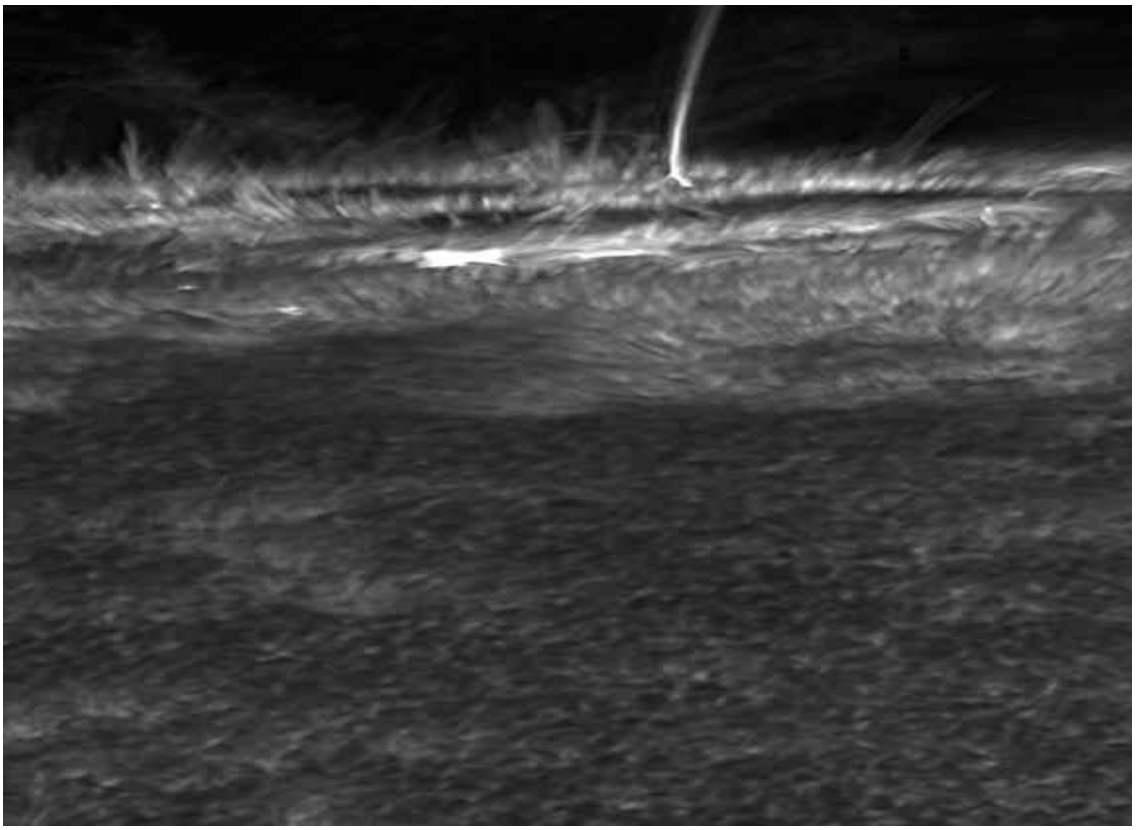


Figure 3: **High-resolution image of the solar limb revealing the fine structure of the solar atmosphere. The image was obtained in November 4, 2003 in the Ca II H line, with the Deutch Open Telescope (DOT).**

The group has a long experience in observational studies of small-scale activity combining ground-based and space-based data. We feel that the simultaneous sampling of the same solar regions at different heights is a necessary tool for the study of the countless small scale structures visible even in absence of large scale magnetic structures and for their interrelationship. This study is of great relevance because these structures being ubiquitous on the Sun, they could provide at least part of the energy input necessary for coronal heating and solar wind acceleration. For that reason we very often run successful, well focused multi-instrument, multi-wavelength campaigns. As an example we show in the following figure the appearance of the Sun as observed by different ground-based and space-based instruments.

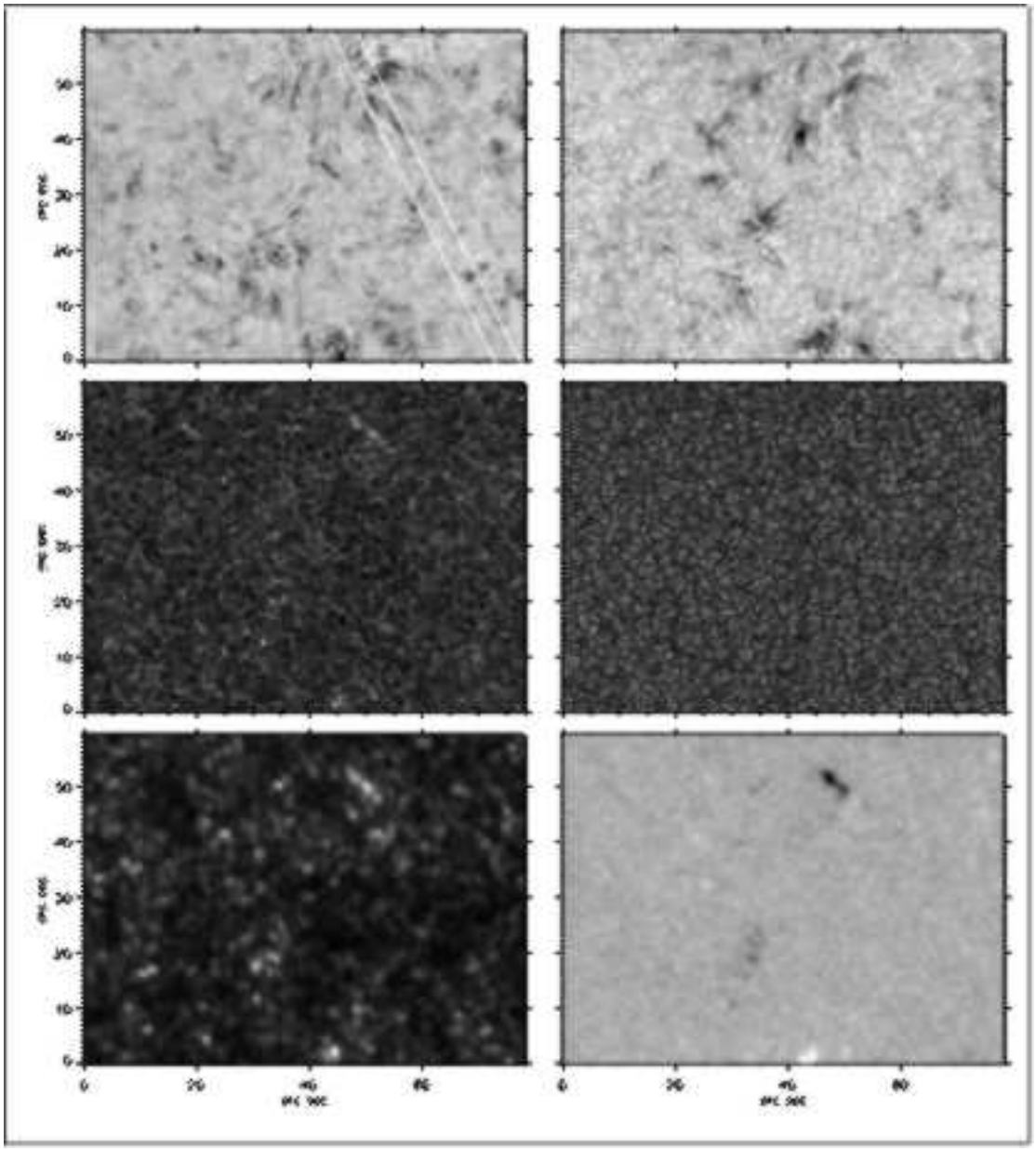


Figure 4: Solar images of a quiet region observed with different instruments. ***First row:*** **in Hα-0.7Å (*left*) and Hα+0.7Å (*right*) and** ***Second row:*** **in Ca II H (*left*) and G-band (*right*) obtained from DOT.** ***Third row:*** **in C IV obtained with TRACE (*left*) and an MDI magnetogram obtained with SoHO (*right*).**

Active Sun studies of the group mainly focus on sunspots. Sunspots are the best known features on the solar surface, which are sometimes much larger in size than Earth itself, and are associated with high concentrations of magnetic field fluxes. Sunspot observations and analyses of the group focus mainly on the study of oscillations and waves observed on their atmospheres. The work carried out has great impact on the solar community, since it clearly demonstrated the association between oscillations at the umbrae and running waves at the penumbrae of the sunspots.

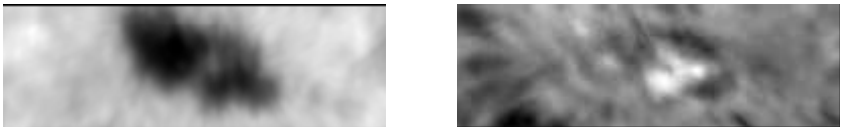


Figure 5: **A sunspot intensity image (*left*) and Doppler velocity image (*right*) at Hα±0.58Å**

The solar physics group has close collaborations with several well-established solar groups like the ones in Meudon (France), Utrecht (The Netherlands), Ondrejov Observatory (Czech Republic) and MSSL (UK). It is involved in several observational campaigns under the status of Principal Investigator or Guest Investigator and has been funded several times by the European Commission or through OPTICON to carry out these campaigns. In 2007 the group succeeded, after a successful proposal, to include Hinode in an observational campaign which also included THEMIS, DOT, TRACE, and SoHO and was awarded two OPTICON grants.

(G. Tsiropoula: georgia@space.noa.gr, K. Tziotziou, J. Giannikakis)

- Ionospheric physics

The ionospheric group of ISARS has a long tradition in ionospheric investigations, since 1960's when the first ionospheric station has been installed in the Athens area. Today, the ionospheric group of NOA has a leading role in the European ionospheric community, coordinating pan-European research projects on monitoring and forecasting HF propagation conditions over Europe and developing models for trans-ionospheric propagation and for plasmasphere specification.

The DIAS system: The DIAS system has been developed in the framework of the EC DIAS Project (FP6 eContent Programme, 2004-2006). The ionospheric group of NOA, having been PI of the DIAS project (European Digital Upper Atmosphere Server, http://www.iono.noa.gr/DIAS) has the responsibility to install, operate and maintain the final DIAS server. The DIAS system has two main components, the ionospheric stations participating in the DIAS Network, and the digital server, that transforms the data from the ionospheric stations in useful added value products and services.

Currently, nine stations participating in the DIAS Network operations are located in Athens (Greece), Juliusruh (Germany), Rome (Italy), Chilton (United Kingdom), Ebre (Spain), Lycksele (Sweden), Warsaw (Poland), Pruhonice (Czech Republic) and El Arenonsillo (Spain).

To support acquisition, elaboration, dissemination and archiving of ionospheric information provided by the DIAS network stations, the DIAS server has been developed based on a distributed sensors system. The server has been built with an open architecture, providing with the possibility to accommodate new stations in the future. All contributed DIAS stations are scheduled to perform simultaneous ionospheric soundings every 15 minutes. The files generated after each ionospheric sounding are collected in near real-time at the central DIAS server, located in ISARS/NOA consisting of two servers, the *back-end* and the *front-end*. The extracted information is homogenized and stored into a database (*back-end*). Then DIAS generates the added value products and services based on the codes and algorithms (*back-end*) and makes them available, still in real-time, to the users via the World Wide Web (WWW) using HTTP, FTP and email (*front-end*).

The users can access DIAS products and services at http://dias.space.noa.gr.

The DIAS products available to specify the current conditions of the ionosphere over Europe include:

- Real-time ionograms from the contributing DIAS stations in a common format
- Daily values and plots of scaled ionospheric parameters, e.g. the critical frequency of the F2 layer (foF2), the lowest frequency reflected by the ionosphere which appears on the ionogram (fmin), the ratio of the maximum reflected frequency from the F2 layer over a 3000km range to the critical frequency of the layer (M(3000)F2), etc.
- Profiles of the electron density versus height over each contributing DIAS station
- Regional maps showing the variation of relevant ionospheric parameters over the European area (i.e. maps of foF2, M3000F2, Maximum Usable Frequency (MUF) and electron density (Ne) at various specified heights)
- Daily plots of the Effective Sunspot Number, Reff, which give estimates of the best fit between the Simplified Ionospheric Regional Model (SIRM) and the foF2 measurements from the DIAS sounder grid.
- Point to point calculation of the MUF for user-defined coordinates
- Activity Index for foF2 providing an alert for current ionospheric disturbances.

Research activities

The Earth's ionosphere has a strong impact on the performance and reliability of modern sophisticated radio systems. Since high technology systems become increasingly vulnerable to space weather effects, the ionospheric impact on ground and space based radio communication and navigation systems becomes more and more important. Space plasma can produce some quite significant effects on radio systems which operate in or through the near-Earth environment. Advanced technologies are often more vulnerable to ionospheric space weather effects than older ones. As experience of GPS users working under high solar activity conditions has shown, the high spatial and temporal variability of the ionosphere can influence the performance and reliability of radio communication and navigation systems. Both systems play a permanent increasingly important role in the modern technology-oriented society.

Ionospheric disturbances can cause disruption on the HF communications but also can cause rapid phase and amplitude fluctuations of satellite signals leading to degradation of the system performance and reliability (tracking loss). Due to the complex relationships with other systems mentioned above, the specification and forecasting of signal perturbations is extremely difficult and - if possible at all - requires global near-real-time data deduced from a permanent monitoring system. The DIAS system operated by the Ionospheric group of ISARS intends to serve this goal. The DIAS system delivers real-time and historical data from seven ionospheric stations and several products including daily plots and European maps of ionospheric parameters for nowcasting and forecasting Hf propagation conditions. The DIAS project was coordinated by the National Observatory of Athens, and the operational system is accessible through the address http://dias.space.noa.gr. Further details concerning DIAS are available from the project's web site http://www.iono.noa.gr/DIAS.

DIAS products and services are based on traditional ground-based vertical incidence sounding (ionosonde) measurements that are sufficient for the precise determination of the bottom-side electron density profile, but they are incapable of measuring the topside

electron profile (above *hmF2)*. To partially solve the problem, the modern digital ionosondes use a Chapman layer, which needs only the peak density and height values to calculate the topside distribution. This model provides reliable results up to 700 km altitude. During the years, the researchers have developed and used other means to gather information on the upper ionosphere and plasmasphere, such as: coherent scatter radar observations, observations from topside sounders onboard satellites, in situ rocket and satellite observations, tomography, and occultation measurements. Nevertheless none of these methods can be used for monitoring the ionosphere/plasmasphere system and of its mapping over a large geographic area.

Recent results, obtained in the frames of two research projects coordinated by the team, demonstrate that the development of models assimilating ionospheric parameters, and vertical TEC data would lead to the development of a system for real-time specification and prediction of the near-Earth geospace conditions up to plasmaspheric heights, if we manage to coordinate the operation of the European Network of Ionospheric Stations with the European Network of GNSS receivers. The introduction of GNSS TEC measurements opened new opportunities for the achievement of this complicated task. The TEC is one of the most important quantitative characteristics of Earth's ionosphere and plasmasphere providing the electron content out to approximately 20,000 km. Although reconstruction of the electron density profile from GNSS TEC measurements presents several difficulties, especially during disturbed conditions, the combination of existing models with TEC observations and ground-based ionospheric observations has open new possibilities for reliable plasmaspheric reconstruction. Very recently we proposed a new method to fully determine the topside electron density profile up to geosynchronous altitudes based on the empirical formulation of data from topside sounders that can provide the value of the topside scale height and of the O^+-H^+ transition height, assimilating ground based VI ionospheric data. The GNSS TEC measurements can be also used to determine the functional form of the remaining part of the electron density profile from the 0^+-H^+ transition height up to 20,000 km. The results of this method have been compared with scale height values from CHAMP satellite and validated with data from the Radio Plasma Imager onboard the IMAGE satellite and from the database of the ISIS topside sounders.

This research is funded by the European Commission, the NATO Science for Peace Programme, the European Office for Aerospace Research and Development and the International Space Science Institute.

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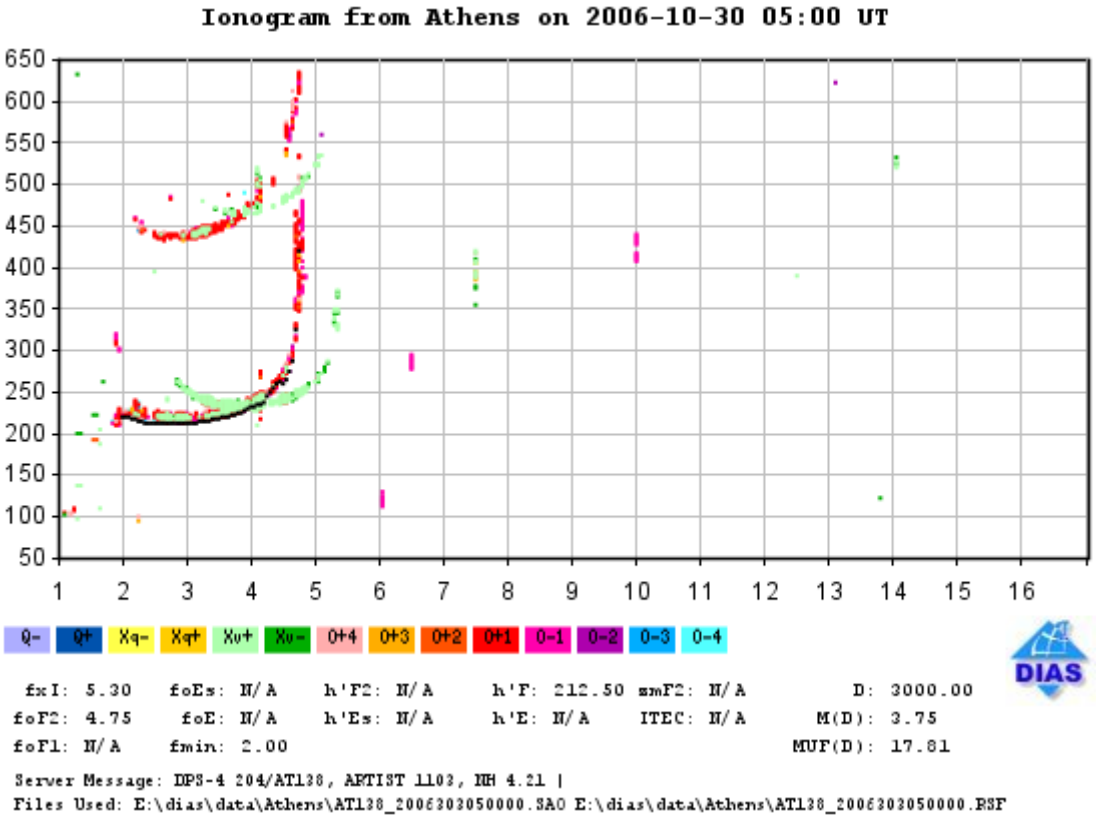

Figure 6: An ionogram from Athens Digisonde in DIAS layout. The results of the automatic scaling are also shown.

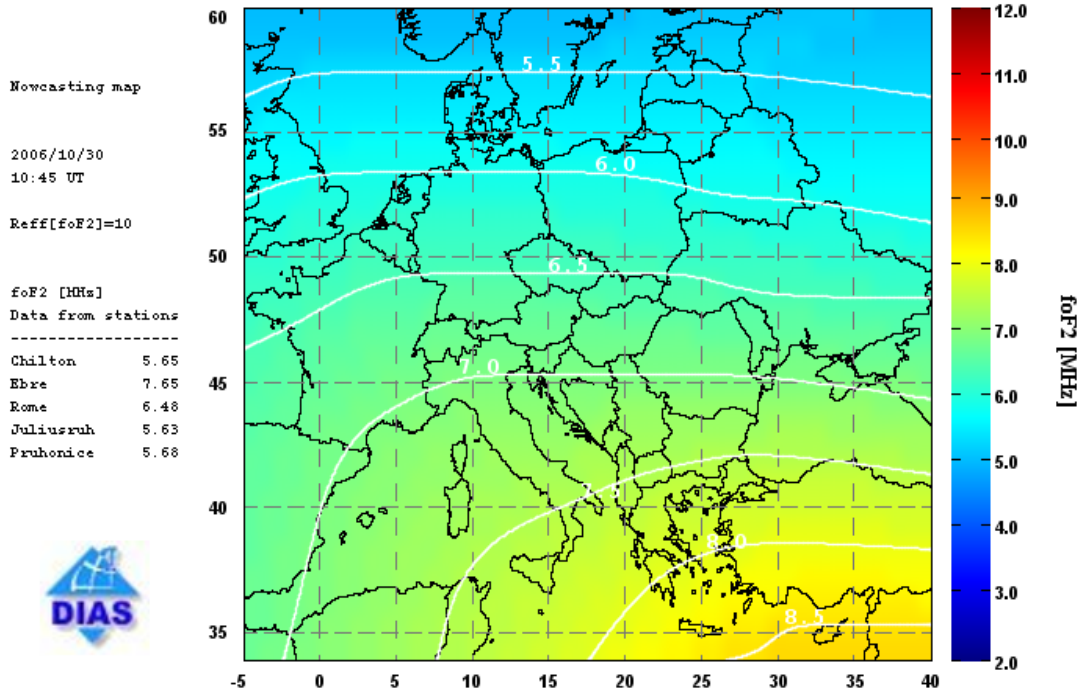

Figure 7: An example of a regional foF2 now-casting map which has been generated using the ionospheric data from the DIAS sounders. The estimated value of the effective sunspot number Reff as well as the real-time values of the foF2 parameter observed from the DIAS stations at the specific epoch are given on the left hand side of the figure.

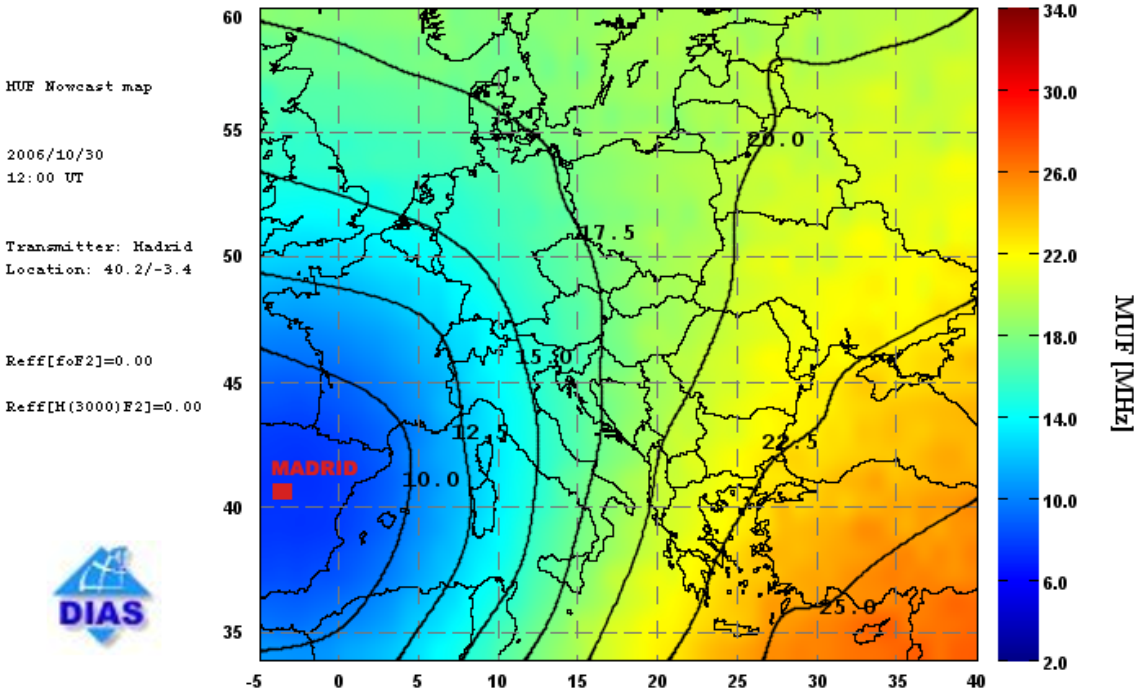

Figure 8: The MUF produced for now-casting purposes, assuming that the transmitting antenna is located in Madrid.

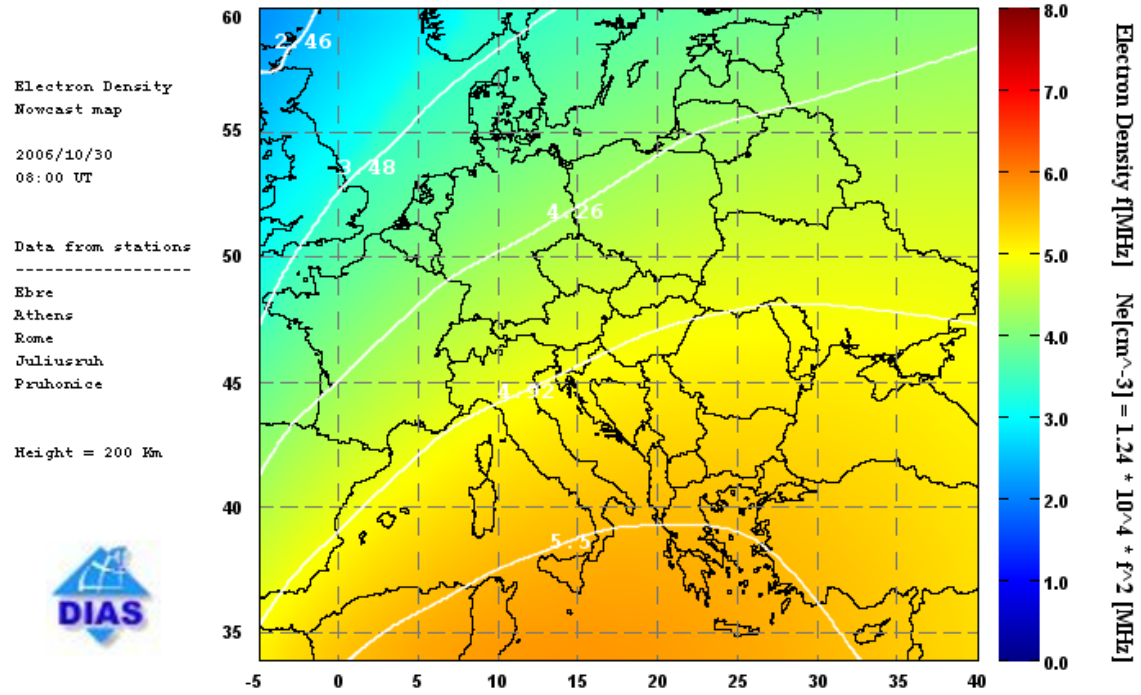

Figure 9: An example of the electron density now-casting map over Europe at 200 km

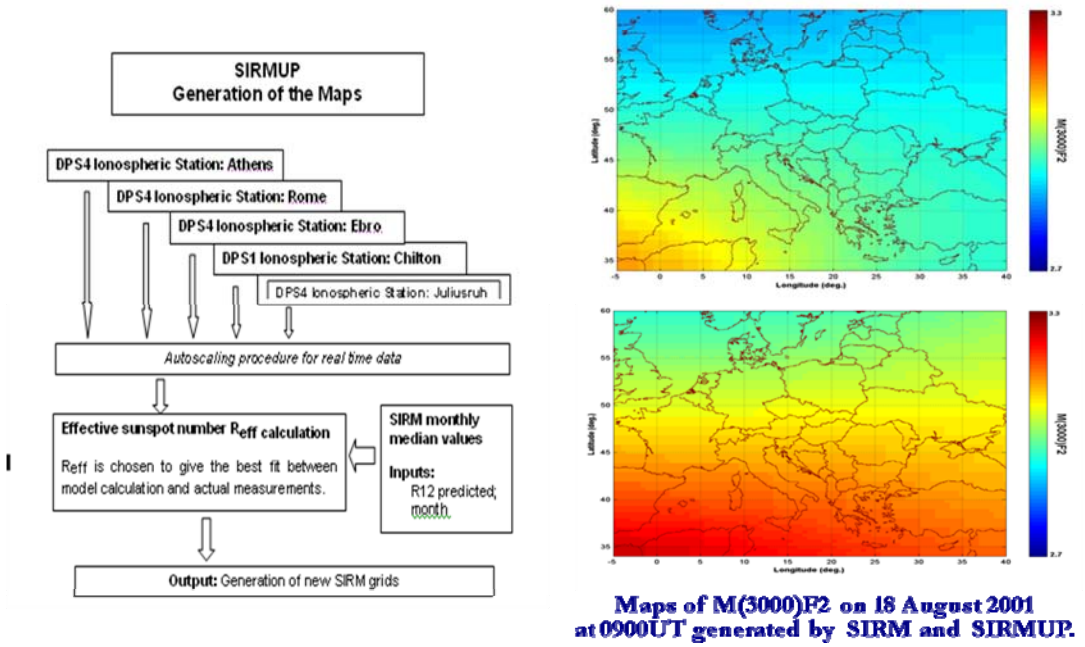

Figure 10: The operation of the real-time algorithm SIRMUP that provides maps of critical ionospheric parameters over Europe

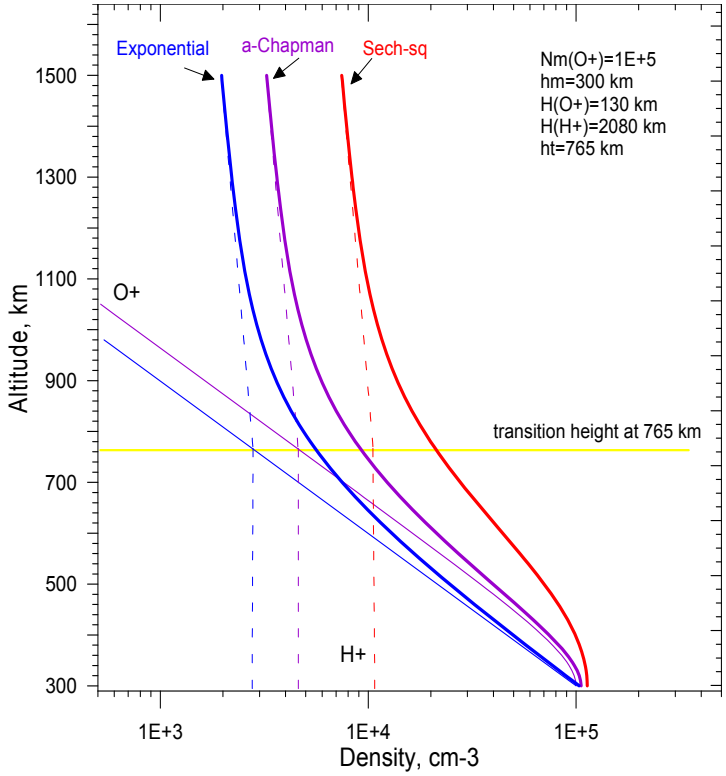

Figure 11: The performance of different profilers tested for the development of the Digisonde assisted topside sounders model

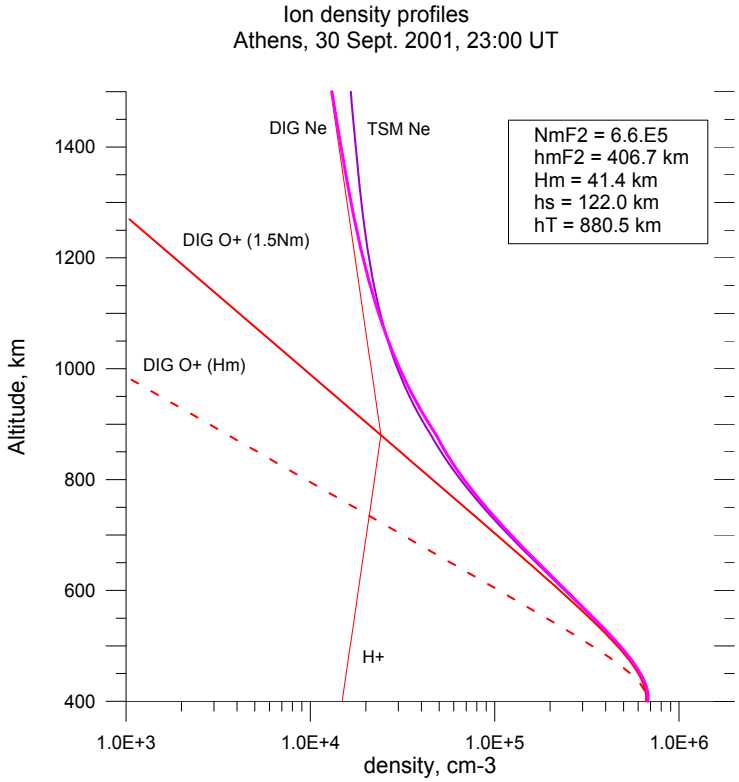

Figure 12: The Digisonde-assisted topside sounders model supported extrapolation up to the plasmaspheric heights

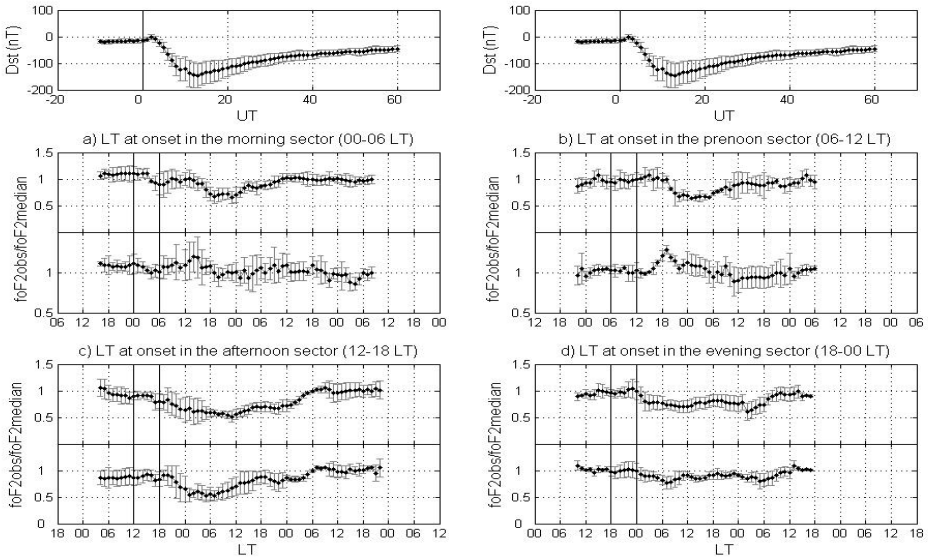

Figure 13: The Solar Wind driven auto-regression model for Ionospheric short term Forecast (SWIF): The "averaged" ionospheric response for middle-to-high (top panels) and middle-to-low latitudes (bottom panels) when the LT of the observation point at IMF disturbance onset is determined in a) the morning sector, b) the prenoon sector, c) the afternoon sector and d) the evening sector. The rectangle denotes the onset sector in each case, while the bars in the plot denote standard deviations. The "averaged" variation of the Dst index is also provided for comparison purposes.

2.1.2. R&D projects

2.1.2.1. Particle dynamics and acceleration in 3D reconnecting current sheets in the solar corona

The orbits of charged particles (electrons and protons), in a Harris-type and in an X-point 3D field topology of a reconnecting current sheet (RCS), are analyzed by dynamical systems methods. The focus is on values of the magnetic and electric fields relevant to RCSs in the solar atmosphere. First, a perturbative form of the equations of motion is used to determine the stability perpendicularly to the plane of reconnection, which is crucial in the efficiency of the RCS as an accelerator. The problem is shown to correspond to a case of "parametric resonance". The orbits are then studied with the complete form of the equations of motion. These can be reduced to a two degrees of freedom Hamiltonian nonlinear system by exploiting the existence of an additional integral of motion besides the energy. The orbits are studied analytically by normal form theory. We find that, despite the presence of a strong electric field, a mirror trapping effect persists to certain extent for orbits with appropriate initial conditions within the sheet. The mirror effect is stronger for electrons than for protons.

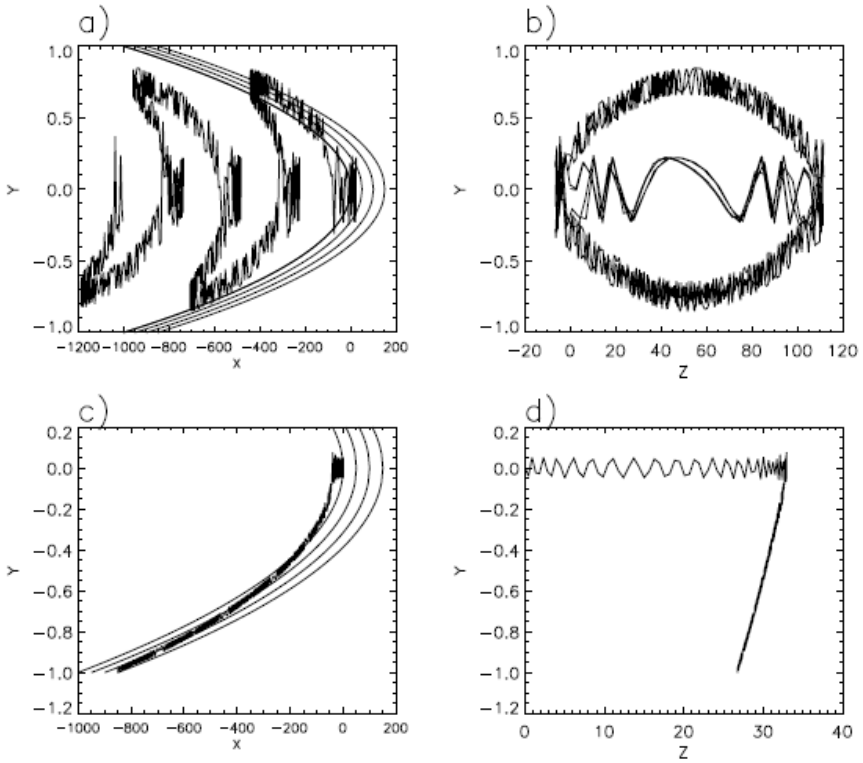

Figure 14: Examples of single electron orbits inside a 3D Harris-type RCS. In panels a) and b) the projections of a trapped (mirrored) trajectory are shown. In panels c) and d) the projections of an escape orbit are presented.

In summary, three types of orbits are distinguished: a) chaotic orbits leading to escapes by stochastic acceleration, b) regular orbits leading to escapes along the field lines of the reconnecting magnetic component, and c) mirror-type regular orbits that are trapped in the sheet, making mirror oscillations. Dynamically, the latter orbits lie on a set of invariant KAM tori that occupy a considerable measure in the phase space of particles' motion. We

also observe the phenomenon of stickiness, namely chaotic orbits that remain trapped in the sheet for a considerable time. A trapping domain, related to the boundary of mirror motions in velocity space, is calculated analytically. The kinetic energy gain for escaping particles is calculated as a function of the initial conditions of injection of an orbit in the sheet.

Our main goal is to investigate how the particle acceleration process affects the initial thermal distribution. The acceleration is studied for different parameters of the model, which are the electric field and the magnetic field components strength as well as the particles injection position. An analytic interpretation of the shape of the resulting distributions as a function of our model parameters is given. The problem of particle acceleration due to their interaction with multiple RCSs is also aborted. Other characteristics of the acceleration process are given, such as the mean acceleration time and the pitch angle distributions of the particles. Finally the emitted X-ray spectrum by the accelerated particles, using a thick target model is computed.

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2.1.2.2. Modelling storm-time substorms

This study intends to clarify the relative influence of magnetospheric convection and sub-storm injections on ring current development. To meet our goals, we need to examine temporal and spatial variations of ion energy densities in the inner magnetosphere during storms both with and without sub-storm occurrence. We use a three-dimensional dynamic ion-tracing model to examine temporal and spatial variations of ion number densities during storm-time sub-storms. The geomagnetic field used is simulated through the Tsyganenko model, which gives a description of the average magnetic field configuration for 6 different levels of geomagnetic activity. It includes contributions from external sources such as the ring current, the magnetotail current system, the magnetopause currents and the large-scale system of field-aligned currents. The large-scale steady convection electric field in the magnetosphere is calculated by the Volland-Stern model. It has been arranged to fit most general features of electric fields observed by polar orbiting satellites. The electric field induced by a transition of the geomagnetic field, from an initial level to a final one, more or less disturbed, is derived by the vector potential technique of D. Delcourt. The plasma sheet in the Earth's magnetotail plays a key role as a source of the ring current particles. We therefore traced plasma sheet particles under the scenarios described above, after having parallelized the code and having run it on the Hellas-Grid computing grid. In the following figure we present temporal and spatial variations of the energy density of plasma sheet O+ particles. During this particular run we traced 2000 particles with the following initial parameters: magnetic local time (MLT): near midnight, magnetic latitude: 5–15 degrees, pitch angle: 60 degrees, energy: 1keV.

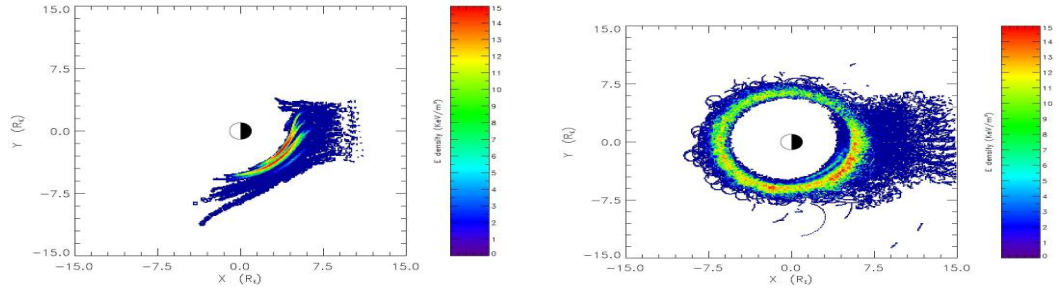

Figure 15: Temporal and spatial variations of energy densities of plasma-sheet O+, in the equatorial plane, under the influence of (a) a large convection electric field only and (b) a storm-time substorm, during the growth phase.

This work addresses the importance of sub-storm-induced electric fields in the build-up of particle radiation during geospace magnetic storms. We do this through a test-particle approach of ion transport and energization, simulating a convection-only storm and a storm-with-sub-storms case. The results of the simulation show that for both ion species the inclusion of sub-storm-induced electric fields renders ion acceleration much more efficient. The difference in energization is much more prominent for O^+ ions, which have been known to be preferentially accelerated by sub-storm-induced electric fields.

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2.1.2.3. Wavelet analysis of CHAMP fluxgate magnetometer data

On December 26, 2004, the world's fourth largest earthquake since 1900 and the largest since the 1964, Prince William Sound, Alaska earthquake, occurred off the west coast of northern Sumatra with a magnitude of 9.3. On March 28, 2005 another event of magnitude 8.7 took place in the same region. The December 26, 2004 earthquake has prompted scientists to investigate possible electromagnetic signatures of this event, using ground magnetic observations. Iyemori *et al.* (2005) have suggested that a 3.6 min long geomagnetic pulsation, observed shortly after this event, was generated by the earthquake. They have speculated that a 30 s magnetic pulsation was also caused by the earthquake. In Balasis and Mandea (Balasis and Mandea, 2007) for the first time, CHAMP satellite magnetic and electron density data were examined to find out if electromagnetic signatures which were possibly related to these recent megathrust earthquakes were observed in satellite magnetic data. It was shown that some specific features were observed after the two earthquakes, with periods of about 16 and 30 s. The results favoured an external source origin for the 30 s pulsation. Moreover, after more than 1 h, CHAMP magnetic data indicated the existence of a feature characterized by the same parameters (duration, amplitude, and frequency content), which could be associated with each earthquake, respectively. We continue to investigate in order to answer the question of whether these signals can be associated with earthquakes and to assign their possible usefulness with respect to earthquake development. In the context of this study, and in order to analyze these highly accurate data, we are developing specific codes based on wavelet transforms. We point out that similar wavelet tools have been applied by Mandea and Balasis (2006) to analyze satellite magnetic data from various missions for an astrophysical application, thus showing remarkable applicability to the delineation of fine electromagnetic structures

contained within geophysical signals (see report http://www.sciencemag.org/content/vol314/issue5798/ twil.dtl).

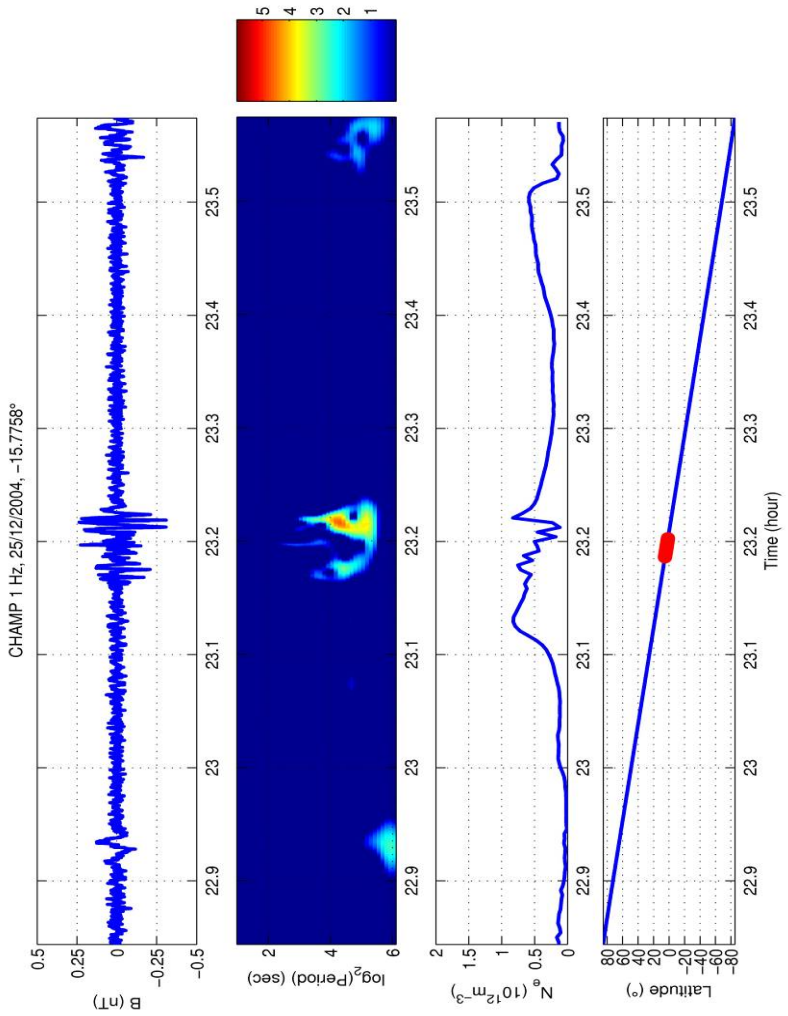

Figure 16: CHAMP satellite pass 1 ½ hour before the Sumatra earthquake (magnitude 9.3) on 26 December 2004. From top to bottom: The temporal variation of the CHAMP total magnetic field data after applying a 32 s high-pass filter; Corresponding wavelet power spectrum; The temporal variation of the CHAMP electron density data; The latitudinal position of the satellite with time. At the lowermost panel the area of the epicenter (±2°) is marked with red.

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2.2 Earth observation and remote sensing

The primary mission of the Earth Observation and Remote Sensing group at ISARS is to collect and fruitfully exploit space derived data and provide information and services to citizens and decision makers, interested to know about the state of Earth's environment and its dynamics. Parts of the current research relate to the study of natural resources and the development of EO systems capable to support environmental management in the Mediterranean. In the domain of satellite data collection and distribution image reception stations for NOAA/POES and Meteosat Second Generation (MSG) data are operational. The collected data are processed and distributed systematically to the user's community by using commercial and in-house developed software tools for image processing, archiving and delivery.

2.2.1. Research areas

- **Urban planning and land use mapping**

Significant research is done on methodological approaches that permit the integration of the newly acquired high-resolution satellite imagery in urban planning and land use mapping. The development of advanced image analysis techniques to process the next generation of high-resolution satellite imagery is among the main research tasks.

- **Risk assessment and mitigation**

Natural and anthropogenic hazards, such as wildfires, floods, earthquakes, oil spills and toxic clouds from industrial accidents or volcanic eruptions are studied in the framework of various research projects. The use of Remote Sensing techniques for risk assessment and mitigation is evaluated through specific experiments. The technique of radar interferometry to observe very small changes of the crust due to volcanic and seismic activity in Hellenic territory is currently tested.

- **Aerosol retrieval and air pollution**

ISARS is one of the few research institutions that implement innovative research in the area of aerosol retrieval by using high and moderate spatial resolution satellite data. In the framework of three research projects satellite sensors that did not originally address atmospheric peering, such as Landsat TM/ETM+ and SPOT HRV, have been used in combination with ground measurements and modelling to retrieve quantitative information on the spatial distribution of the aerosol optical thickness over urban and industrial areas; this has allowed assessing the degree of air pollution at local and at regional observational scales. Latest research addresses the operational use of moderate spatial resolution satellite sensors (e.g., MERIS, MODIS, MSG) in air quality monitoring.

- **Special forest focus**

In response to the severe forest fires which swept over Greece in the summer of 2007 the remote sensing group has focused its attention on the monitoring and follow-up of fire

outbursts with the use of moderate (e.g., MODIS) and low (e.g., SEVIRI) spatial resolution satellite imagery recorded in the shortwave and thermal infrared parts of the electromagnetic spectrum. With the help of high (e.g., SPOT) and very high (e.g., FORMOSAT) resolution imagery, powerful application tools have being developed providing, amongst other results, the possibility to create accurate maps of the affected areas on a yearly basis.

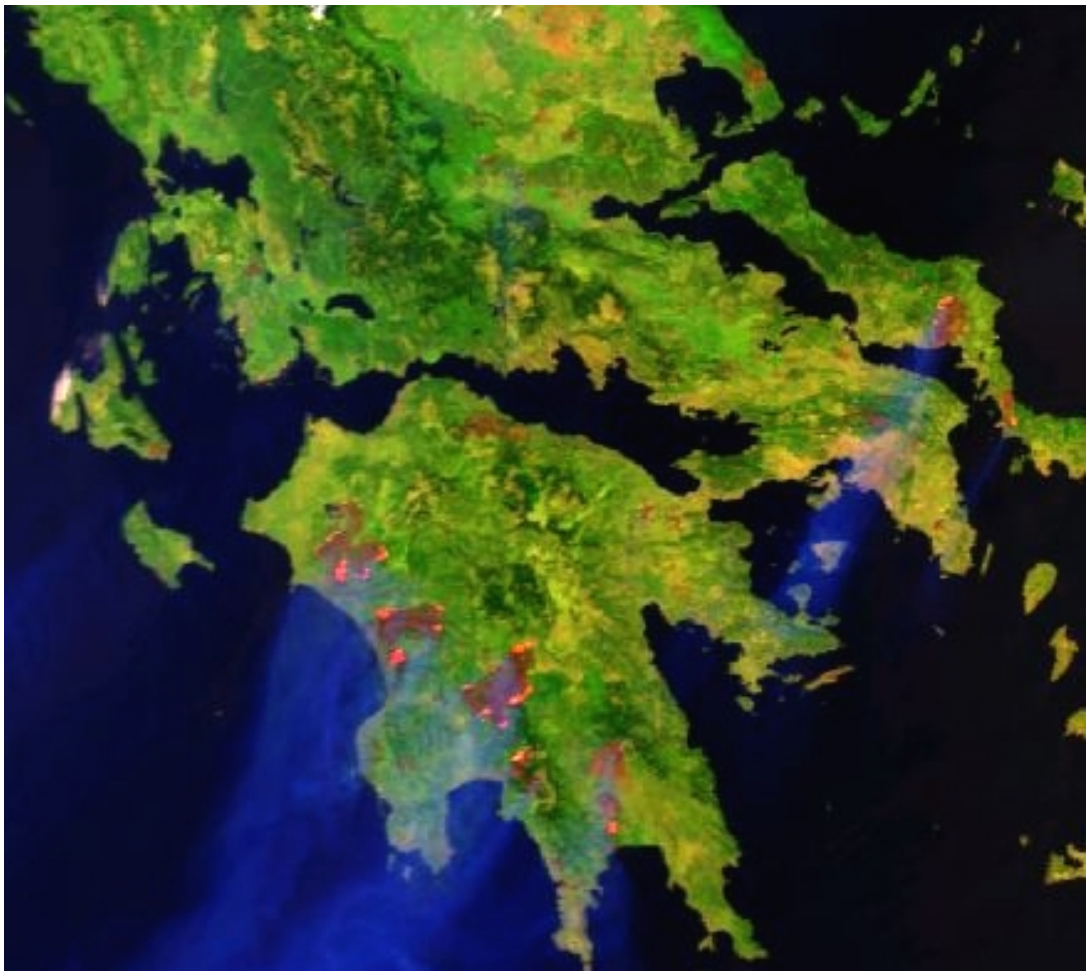

Figure 17: Color composite satellite image acquired by the MODIS sensor on board the Terra satellite (25 August 2007) showing with moderate spatial resolution the extended wildfires over Greece.

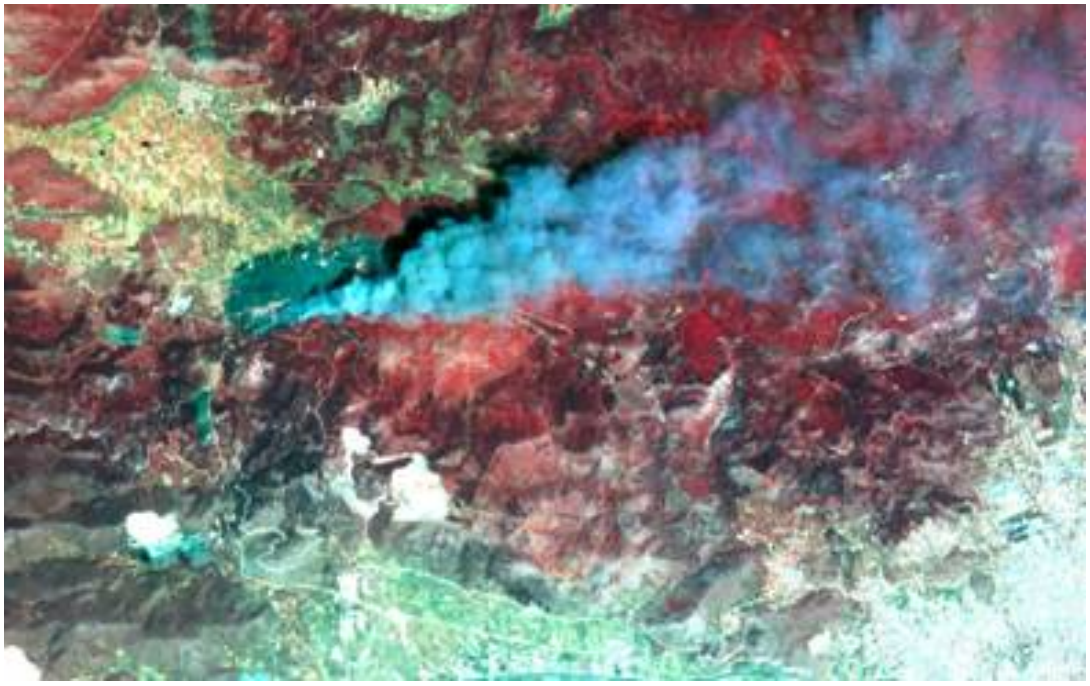

Figure 18: Color composite satellite image acquired by the HRVIR sensor on board the SPOT satellite (28 June 2007) showing with high spatial resolution the wildfire in mount Parnitha north of Athens.

2.2.2 R & D projects

2.2.2.1. Operational mapping of burnt surfaces in Greece (RISK-EOS)

Every year new forest fires occur across Europe and especially in south Mediterranean, with thousands of people affected and houses and infrastructure destroyed. In recent years forest fires across the Mediterranean destroy up to half a million hectares of woodland per year. Knowledge about past fire events and fire damages greatly enhances the forecasting capability and allows for a better understanding of the risk. Forecasting largely depends on risk mapping and land use change in burnt areas. A reliable estimate of the damage is of critical importance for forestry services in order to coordinate plantation campaigns, and also for the targeted fire fighting services. Such areas have to be monitored with attention during the years following the fire, since the growth of the young species can lead to faster fire propagation.

The damage brought to the landscape by forest fires is being monitored from space using Earth Observation satellites. “Burn Scars” left by the forest fires can be clearly identified due to the spectral capacities of the satellites. The use of satellite images recorded in the visible, infrared and near infrared portion of the electromagnetic spectrum provides the possibility to create maps of the affected areas on a yearly basis. The European Space Agency (ESA) contracted the Institute for Space Applications and Remote Sensing of the National Observatory of Athens (ISARS/NOA) to implement the RISK-EOS service element in Greece (a GMES project) in order to regularly produce burn scar maps over Greece. The service is repeated every fire season (May-October) and covers the entirety of Greece (132 000 km^2). It delivers burn scars and damage assessments to Institutional Users

who have the mandate to implement the national but also European legislation for damaged areas management, as well as to take measures for land use/land cover and soil conservation after the end of the fire season in the affected zones. The Greek users who receive and use the BSM_NOA service deliverables are summarized in Table 1.

Users of BSM_NOA service	BSM_NOA Methodology
1. ***Ministry of Agricultural Development and Foodsv*** (Directorate for the Protection of Forests and Natural Environment) 2. ***National Agricultural Research Foundation*** (Institute for Forest Research) 3. ***Hellenic Centre for Biotopes/Wetlands*** 4. ***Region of Peloponnesus*** (Forest Inspection Service) 5. ***Province Forestry Services*** (Provinces of Corinth, Lakonia, Messinia) 6. ***Region of Attica*** (Directorate for Forest Restoration) 7. ***Ministry of Environment and Public Works*** (Ktimatologio SA)	*The service developed has been qualified following the RISK-EOS project validation and qualification standards. The service is known with the name BSM_NOA. It uses satellite technology of various commercial satellites, like LANDSAT TM, SPOT XS, IRS, FORMOSAT2, MODIS, etc in a uni-temporal or multi-temporal approach. It is an automatic approach able to map the affected by the fire areas and assess the damages in land use/land cover types.*

Table 1: Main users of BSM service in Greece and methodology description

The service delivers products in a variety of map scales (e.g.1:10 000, 1:50 000, 1:250 000), depending upon the types of the satellite sensors used. The methodology is a combination of a Fixed Thresholding (Li *et al.* 2001, Peng *et al,* 2006) approach together with a Change Vector Analysis (Chen *et al.* 2003). Both techniques have been adapted to meet the project specification standards using specific research developments conducted inside ISARS/NOA by the project coordinator Dr. C. Kontoes.

1. *Pre-processing of satellite data*
2. *Creation of comparable timely satellite image acquisitions*
3. *Calculation and analysis of spectral indices directly related to bio-physical parameters of burnt areas (e.g. vegetation indices, burn ratio indices, soil reflectance indices, etc)*
4. *Calculation and analysis of Change Vectors*
5. *Generation and elaboration of detailed burnt area maps excluding non-burned forest stands, settlements and agricultural lands located inside the burnt forested zones*
6. *Integration of the generated products in GIS environment*
7. *Assessment of burnt surfaces and creation of land cover damage statistics*

Table 2: Data Processing – BSM_NOA Methodology

The opinion of end users
The BSM_NOA service returned timely, standardized and accurate geo-referenced information on burnt areas for all identified fires throughout Greece. The End Users recognize the advantage of using satellite data for burnt scar mapping and damage assessment, as they allow timely and accurate processing of large geographic areas, while maintaining the cost of the operations at reasonable level. The End Users find the delivered products suitable for fire fighting planning activities, and post-fire management of the affected zones. The generated products have been useful to support monitoring and controlling the enforcement of the relevant legislation towards maintaining the original land uses in the affected areas, and managing the reforestation of the areas according to the Greek legislation. Finally the BSM services have been recognized as important support to implement medium to long-term policies for soil conservation and forestry.

Mapping products
1. Burn Scar Maps *(scale: 1:10:000-1:50.000, seasonal update, vector format, cartographic projection EGSA87)*
2. Burn Area Maps *(scale: 1:10:000-1:50.000, seasonal update, vector format, cartographic projection EGSA87)*
3. Mask data for clouds, urban areas & water *(scale: 1:10:000-1:50.000, seasonal update, vector format, cartographic projection EGSA87)*
4. Geo-referenced post-fire images *(scale: 1:10:000-1:50.000, seasonal update, raster format, cartographic projection EGSA87)*
5. GIS file integrated product *(scale: 1:10:000-1:50.000, seasonal update, vector & raster format, cartographic projection EGSA87)*
6. Rapid Mapping of Burnt Areas *(daily/weekly update, cartographic projection EGSA87))*

(C. Kontoes: kontoes@space.noa.gr, I. Keramitsoglou, N. Sifakis, C. Iossifidis)

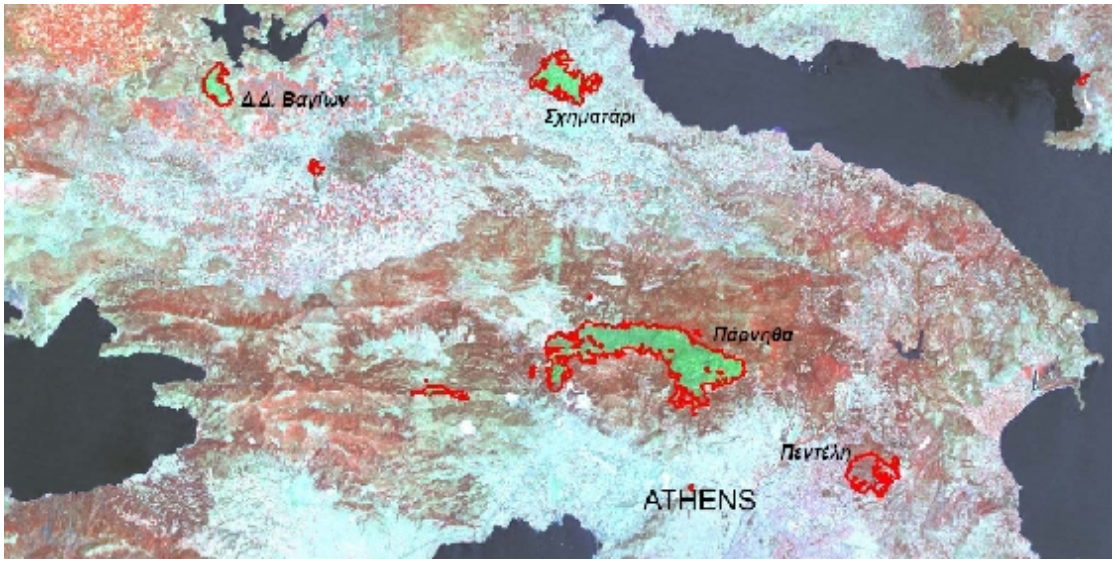

Figure 19: Fires detected and mapped in the surrounding of Athens during the period May-July 2007. Mapping was based on LANDSAT TM data of 30m spatial resolution. The big fire of mount Parnitha (4746 ha), as well as the fires occurred at Schimatari (1133 ha), the community of Bagia close to Thebes (478 ha), and mount Pendeli (897 ha) are outlined.

Figure 20: The devastating fire event of mount Pendeli held on August 2007 at the fringe of the city of Athens. Mapping was based on very high spatial resolution data of FORMOSAT 2 sensor (2m/pixel). The area burnt was estimated to be 897 ha. The use of FORMOSAT 2 data allowed detailed and accurate discrimination between burnt forests and neighboring settlements, and provided detailed input for reforestation areas definition.

2.2.2.2. HypED - Study of ecosystem dynamics using CHRIS/PROBA hyperspectral data

This project is conducted by ISARS/NOA in collaboration with the Laboratory of Botanics of the University of Ioannina (Prof. Aris Kyparissis). The purpose of the project is the use of hyperspectral images for the evaluation of vegetation status in space and time. Two test sites are selected which include a typical semi-decidual Mediterranean natural ecosystem of "*phlomis fruticosa*" (Figure 21). For this species, specific vegetation indices are extracted, like Photochemical Reflectance Index (PRI), Derivative Chlorophyll Index (DCI), Water Index (WI) etc, which are closely related to plant physiological parameters, like chlorophyll fluorescence, chlorophyll and carotenoid concentration, Leaf Area Index (LAI), relative water content etc. Such physiological parameters are also measured in the field at the same dates when hyperspectral images are acquired. The intercomparison of the satellite and the ecophysiological datasets provide valuable information about the vegetation status and its possible responses to environmental stress, like summer drought, high or low temperatures, and photoinhibition.

ISARS is carrying out the hyperspectral image processing and extraction of the vegetation indices. The Laboratory of Botany possesses all the necessary instrumentation required for field measurements. Since 2006, thirteen clean image acquisitions of the one test area and six from the other one are acquired. The hyperspectral images are geometrically corrected and atmospherically adjusted. The reflectance spectra obtained are used for extracting indices related to numerous plant physiological parameters. The first results showed that fast responsive plant processes, such as the function of the photosynthetic apparatus, the photoprotective response to stress factors (low or high temperature, lack of precipitation) and the detailed pigment content of leaves (chlorophyll a, chlorophyll b, carotenoids) may well be followed by such indices issued from hyperspetral data, offering great advantage over multispectral images for ecosystem remote sensing. These first results were presented by Kyparissis *et al.* (2007).

This study is in progress and will continue with new acquisitions and field measurements added to the existing datasets. The following tasks will be carried:

- validation of the results for both sites and,
- conducting a comparative study between the vegetation status of the same species in the two different test sites in space and time and,
- investigating the correlation between geomorphologic parameters (extracted from a DEM of the areas such as slope, orientation etc.) and meteorological measurements (temperature, precipitation etc.)

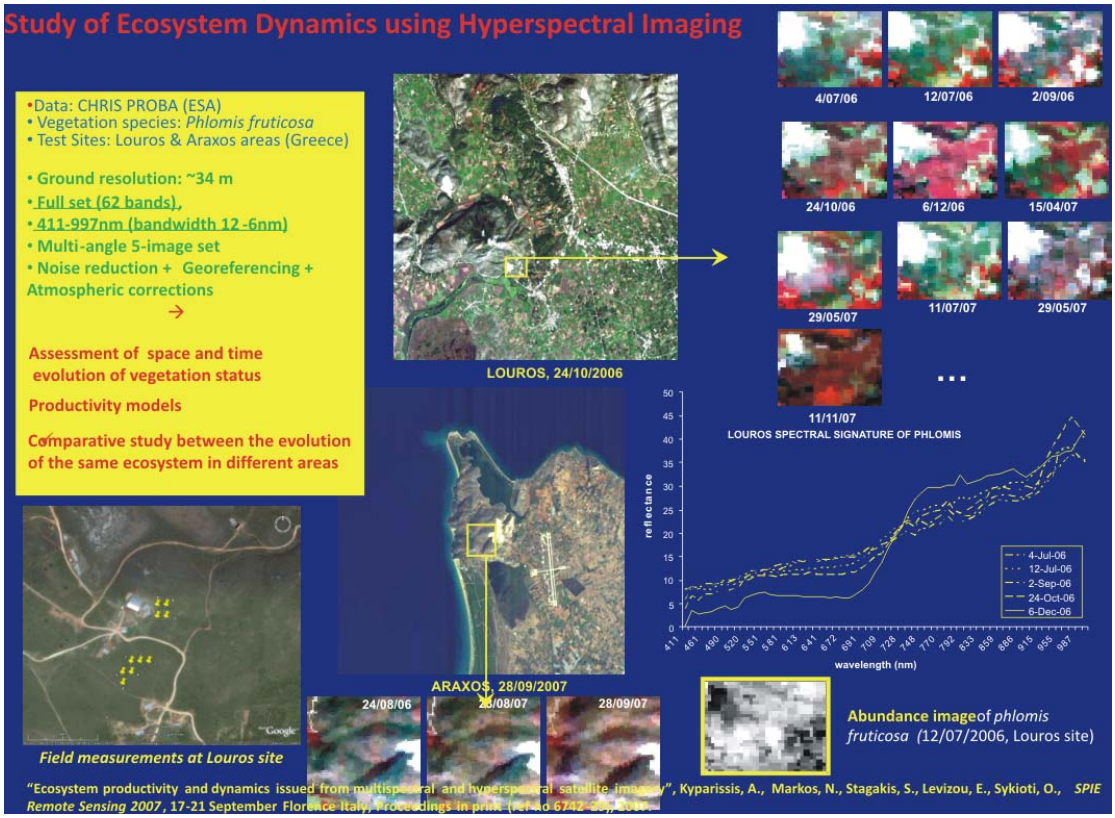

Figure 21: Study of ecosystem dynamics using CHRIS/PROBA hyperspectral data. Two test sites are selected (Louros, Araxos) in order to assess vegetation status. Specific vegetation indices from "*phlomis fruticosa*" seasonal spectral signatures are extracted in order to correlate them with in-situ measurements and consequently use them as input to productivity models. Moreover, abundance images of this particular species are calculated for each acquisition date.

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2.2.2.3. Research project OMI-VAL: Validation of UV radiation, total ozone and aerosol measurements derived from OMI instrument on board the AURA satellite from the ground in a complex aerosol environment

The main objective of the OMI-VAL research project was to study the differences between satellite and ground-based radiative measurements, using state-of-the-art ground-based instrumentation. Other scientific objectives were the validation of satellite derived aerosol optical properties by the combined use of radiometric measurements and radiative transfer algorithms against ground-based retrievals and the study of differences due to spatio-temporal aerosol and radiation variability.

In the framework of OMI-VAL, ISARS participated in the field experimental campaign that took place in Thessaloniki duting fall of 2007, in order to investigate differences between the Ozone Monitoring Instrument solar UV products and ground based measurements. The campaign grid was chosen in order to simulate the spatial resolution of the OMI satellite. The spatial and temporal variability of UV irradiance and aerosol optical properties were measured at three different locations in the greater area of Thessaloniki representing different air quality conditions: rural (Epanomi), urban (University - AUTH)

and industrial (Sindos). The CIMEL sunphotometer of ISARS was operated at Sindos under the supervision of ISARS and NASA's researchers. The aerosol optical depth (AOD) day to day variability as measured at the three stations during the OMI campaign is presented in the following figure.

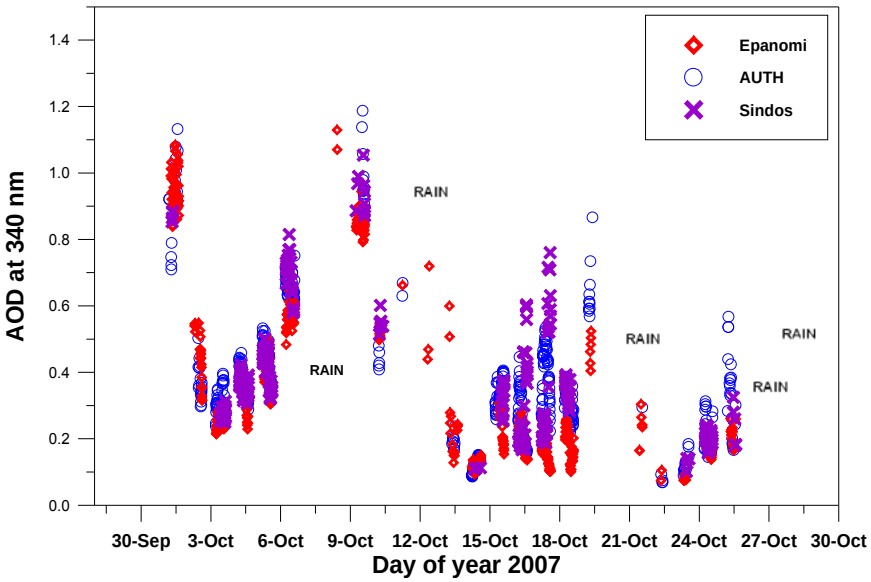

Figure 22: Aerosol optical depth (340 nm) day to day variability as measured at three stations during the October 2007 OMI campaign. Data represent cloudless sky cases.

The experimental campaign that took place in Thessaloniki greater area showed that high day to day variability of aerosol optical depth can be found in the -similar to OMI nadir viewing- 13x25Km grid that was investigated. Even though Epanomi site was well outside the city limits, for most of the days, it followed the same aerosol pattern as the city center and the industrial area site. In some cases spatial aerosol optical depth differences among the three sites can result in differences up to 20% on the UV irradiance measured with the NILU-UV instruments at these sites. This fact reveals the spatial limitations that have to be considered in satellite validation studies, due to the small scale spatial aerosol variability. For days with cloudy conditions UV differences at the three sites were found up to 100%; a percentage that depends on UV irradiance integration time. The results of the campaign could be used to define certain spatial and temporal limitations when validating satellite UV products under cloudy conditions retrieved for a specific grid using ground based synchronous UV measurements.

The research project OMI-VAL was funded by the General Secretariat for Research and Technology of the Hellenic Republic Ministry of Development in the framework of "Scientific and Technological Co-operation between RTD organizations in Greece and RTD organizations in USA" action (2007). The project was coordinated by the Aristotle University of Thessaloniki and NASA Goddard Space Flight Center.

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2.2.2.4. Evaluation of aerosol and ozone photochemical models over Athens using in situ sensors (DOAS) and lidar techniques combined with health indicators

The main objective of this bilateral USA-GREECE project was to evaluate existing aerosol and photochemical forecast models for the greater Athens area, through a comparison of modelling results with measured ground-based data for ozone and PM_{10} concentrations in conjunction with space-borne aerosol observations (on aerosol optical depth). This evaluation improved the forecast models for more accurate air pollution levels prediction, which in turn can help regulatory agencies and decision makers develop efficient emission control strategies to improve air quality over GAA. The partners in the project were: The School of Chemical Engineering NTUA (coordinator), the Institute of Radiation Technology and Radioprotection DIMOKRITOS, the Medical School of Athens NKUA, Raymetrics SA, the School of Environmental Engineering Technical University of Crete, and the Robert Wood Johnson Medical School UMDNJ. The project will be completed in 2008.

ISARS-NOA was in charge of the WP "Space aerosol data" carrying out the selection, acquisition and processing of space-borne observations in order to approximate the aerosol optical depth (AOD) in the planetary boundary layer (PBL) over the GAA at various spatial scales. The comparison with satellite data was carried out over limited but selected data sets, and was used as a complement and as cross-validation to both techniques (i.e., ground-based and modelling). The main advantages of satellite data are, in this case, their *spatial continuity* vs. point ground measurements, and their *reliability* vs. initial conditions depended modelling. On the basis of available lidar measurements during the intensive field campaign period in 2007, satellite data with a variety of spatial resolutions were selected. Satellite based AOD was then calculated by applying the DTA method (Differential Textural Analysis, Sifakis *et al.*, 1992 and 1998) on the selected IRS, MODIS and AVHRR imaging data. The latter were processed according to Retalis *et al.* (2003). Furthermore newly developed codes using the multi-spectral variation criterion for reduced misclassification due to land cover changes, was tested for the first time on IRS data. AOD values were also retrieved locally for selected dates over the Physics Department building and over the DEMOKRITOS monitoring station when ground based measurements were in conjunction with the satellite data.

Satellite AOD retrievals from various sensors were compared, on the one hand among them and, on the other hand, with ground measurements. The satellite data purchased and processed in the framework of the project were very limited, and they do not consent to a thorough statistical analysis. The following important conclusions were derived from the examination of the results:

- With respect to IRS derived AOD, the initially derived relative values differ considerably (up to 60%) when various "reference" images are used. Nevertheless these differences are considerably reduced (difference: 5-30%) when relative values are normalized as to approximate absolute AOD values on the basis of MODIS products for the respective reference images. This confirms the robustness of the DTA methodology for relative AOD retrieval.
- With respect to the MODIS products an overall 25% difference from IRS or MODIS derived AOD when using the DTA method. This difference was observed after normalization for approximation of absolute AOD values.

- The difference in retrieving AOD from IRS compared to AOD retrieved from MODIS is of the order of ±20%.
- The relative-to-reference satellite derived AOD (IRS or MODIS) differs from lidar derived AOD by 50%. This drops to 20% and 40% for IRS and MODIS respectively, when AOD is normalised as to approximate absolute values considering MODIS AOD products for the respective reference images.

(N. Sifakis: sifakis@space.noa.gr, C. Iossifidis)

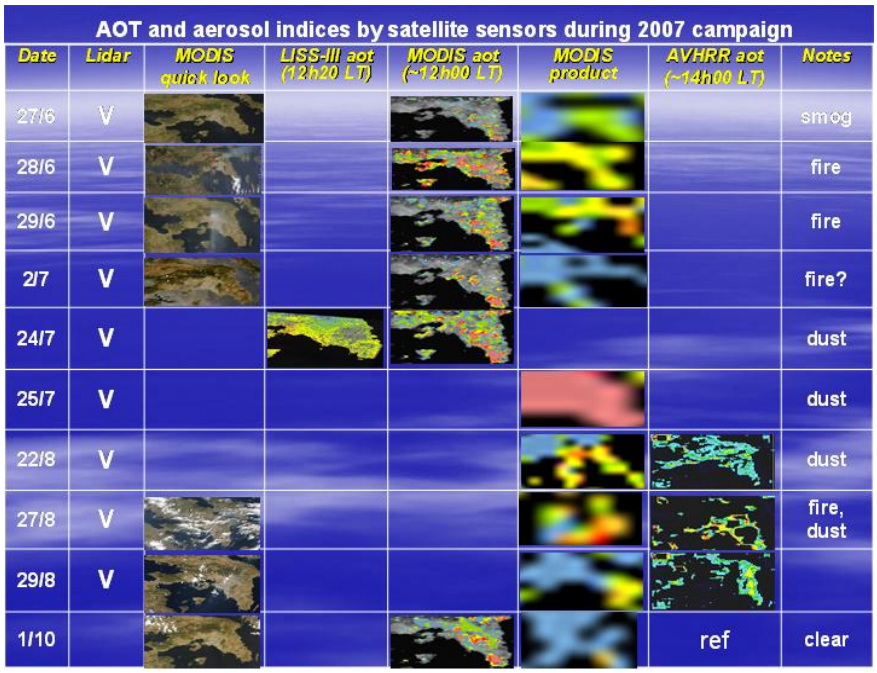

Figure 23: Aerosol optical depth satellite maps retrieved by various sensors

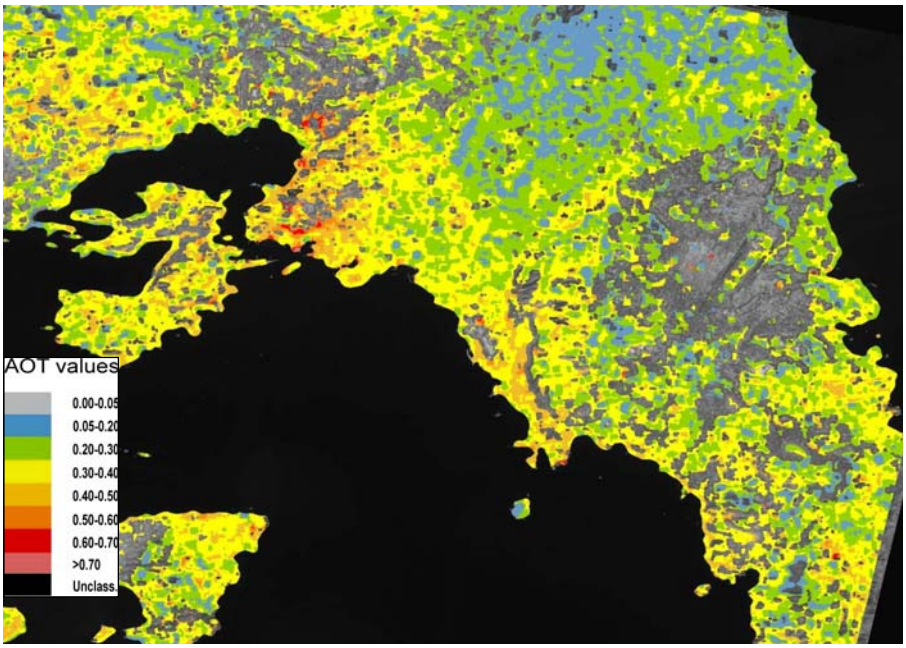

Figure 24: Satellite map depicting the aerosol distribution over Athens derived, for the first time, using high spatial resolution IRS-LISSIII data.

2.2.2.5. Mapping and monitoring of wetlands using Earth observation

In the framework of this project, NOA-ISARS has selected, collected and ordered all the necessary data and produced MedWet habitat maps of two wetland sites for the pilot studies, namely Camargue (France) and River Strymon (Greece). NOA-ISARS has contributed to and edited the contents of the following publication: "Space Observations of Wetlands: A manual to mapping wetlands using Earth Observation techniques", 2007, Fitoka E. and Keramitsoglou I. Editors. Finally, Dr. Keramitsoglou participated in the training courses entitled "MedWet Tools for Wetland Inventory, Monitoring and Assessment" held in the Greek Biotope/Wetland Centre (EKBY, Thessaloniki) and APRAT (Florence) in November and December 2007, respectively.
This project was funded through "MedWet Reseau CODDE No. 380078N", INTERREG IIIC SUD. Total project budget: 1.461.075,00€, NOA-ISARS budget: 15.000€, Starting date: 01.10.2007, Duration: 8 months.

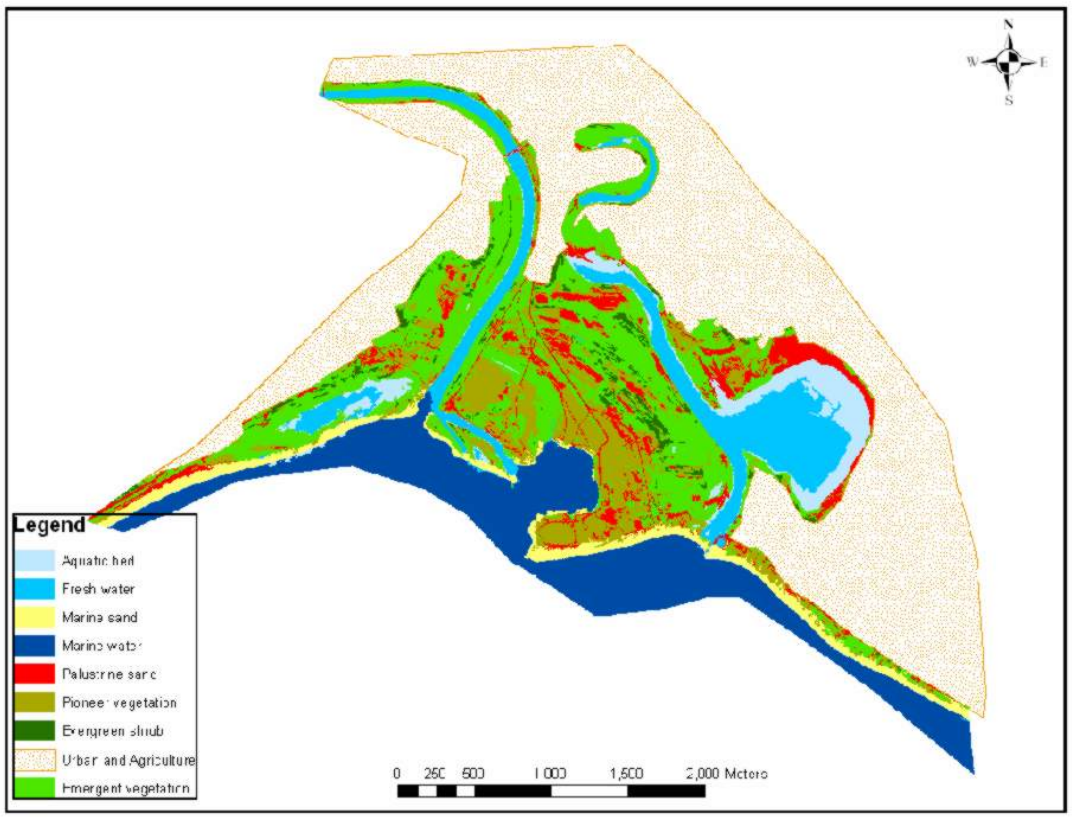

Figure 25: Classification result for the Strymon study area

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2.3. Wireless telecommunications

The research and development (R&D) activities of the Wireless Communications Group (WCG) deal with state-of-the-art terrestrial and satellite communication systems supporting users employing fixed, mobile and portable terminals. Emphasis on our R&D activities is given to future, e.g. 3rd and 4th Generation (3G and 4G) Universal Mobile Telecommunication Systems (UMTS) for multimedia applications and the integration of terrestrial and satellite telecommunication systems. The group's research efforts focus mainly on the physical layer of these communication systems. Group members have proposed many novel techniques which significantly improve the performance of these state-of-the-art communication systems.

2.3.1. Research areas

The group's research can be classified in the following directions:

A. Multiple-Inputs Multiple Outputs (MIMO) Systems;
B. Orthogonal Frequency Division Multiplexing (OFDM) and Code Division Multiple Access (CDMA) Systems;
C. Ultra Wideband Radios;
D. Sensor Networks;
E. Software and Cognitive Radios;
F. Cooperative Communication Systems;
G. Advanced Coding (e.g. Turbo and LDPC) Techniques;
H. Direct Video Broadcasting (DVB) Systems.

In these areas, the group has published results in the most prestigious international journals and its members have received international recognition and awards for their research activities. Since 2000, the group has participated in more than 15 R&D projects national and European projects, for several of which as coordinator. The total budget for these projects is more than 1.5 M€, which comes from the EC, the Hellenic General Secretariat for Research and Technology (GSRT), the Ministry of Transportation, and companies. Since 2004, it has participated as a partner in the European project SatNEx, which is the European Network of Excellence in Satellite Communications, where currently plays an important role by leading the R&D activities of several Work Packages and Focus Topics.

2.3.2. R & D projects

The group is currently involved in the following projects:

2.3.2.1 Enhanced multicarrier OFDM digital transmission techniques for broadband satellites

The scope of this project is to seek and define solutions to improve the appeal and the competitiveness of satellite communication systems with respect to their terrestrial counterparts, in the present context characterized by the steady increase of bandwidth

demand. The adoption of new and more efficient modulation schemes could help at that regard, if they can result in a higher bandwidth efficiency and, ultimately, in a lower service cost. Such new techniques should be compatible with the state-of-the-art digital processing solutions that permit communications equipment to be produced and marketed a relatively low cost.

One of such solutions is to adopt the OFDM (Orthogonal Frequency Division Multiplexing) scheme which is today widely used for terrestrial networks, it offering a good spectral and energy efficiency over channels affected by multi-path propagation. Although satellite systems operating in the SHF / EHF frequency ranges are typically not affected by multi-path, the use of OFDM can anyway result in certain advantages, such as the possibility to share the same frequency band and same user-equipment technology between the satellite system and the terrestrial gap-filler, the increase in spectral efficiency that can result, in multiple-carrier-per-beam FDM systems by compacting carriers and eliminating the guard bands, the simplification of the on-board switch architecture and of the on-board multiplexing filters requirements in terms of group delay and amplitude distortions.

More specifically, the main objectives of the subject activity are:

- To study the applicability and to quantify the potential advantages deriving from the exploitation of OFDM-based enhanced digital transmission techniques for broadband fixed satellites applications;
- To investigate new techniques that can enhance the mobile satellite broadcasting networks efficiency taking into account the satellite mobile spectrum limitations and the increasing demand for number of broadcasted channels;
- To define a technology roadmap and a proposal for future activities.

Project Coordinator: Space Engineering; Partners Mavigex and ISARS-NOA; Funding Agency: European Space Agency; Budget for ISARS € 80,000; Time Duration 1/1/2008 - 31/6/2009.

(P. Mathiopoulos: mathio@space.noa.gr, S. Papaharalabos, N. Sagias)

2.3.2.2. Ultra-wideband wireless networks for multimedia applications

In this project a high data rate ultra-wideband (UWB) network for multimedia applications will be designed and evaluated with focus on the currently open research issues involved. Considering that UWB technology is not yet universally standardized or commercially deployed, the project has three main objectives. The first one is to conduct fundamental research on improving the performance of the physical layer. This will involve studying the different transmission and multiple access schemes proposed for such systems, evaluating the system performance in terms of bit error rate (BER) and capacity and pursuing multi-user interference (MUI) mitigation and multi-path diversity reception techniques. The second objective is to investigate the requirements and exploit the advantages of UWB technology from the perspective of network protocols and services. The medium access control (MAC) layer that is responsible for the operation of the radio link will be examined in detail and carefully designed to provide a solid basis upon which the entire network can be built. The rest of the network protocols will be designed taking into account problems such as user mobility and possibly ad-hoc dynamic topology. Then, the middleware to support multimedia services will be developed in a context-aware environment that supports pervasive computing. The third objective is to build a versatile software simulation platform for evaluating UWB systems. This tool will not only be valuable for performance evaluation throughout the project, but will also be published to the scientific community. As such, it will be built for maximum reusability and compatibility with existing software. Our research will provide valuable conclusions about the deployment and design of UWB networks, as well as techniques and tools that can be exploited in all aspects of UWB technology.

Partners University of Ottawa, University of Thessaloniki and Precicom; Funding Agency: General Secretariat for Research and Technology; Participants form ISARS: Budget for ISARS € 55.000; Time Duration 1/6/2006 - 31/3/2008.

(P. Mathiopoulos: mathio@space.noa.gr, N. Kokkalis, P. Bithas, E. Doukeli)

2.3.2.3. Satellite network of excellence II (SatNEx - II)

Today, Europe is a space power - the space industry, satellite operators and space organisations are major players in their respective fields, which are global in nature. Over the years, European R&D in satellite communications has encompassed a large number of activities spanning many programmes and organisations, however, such initiatives have been restricted in their strategic value, with only limited collaboration and coordination and further exasperated by a lack of the critical mass required to make an impact on the world stage. The Commission's recently published White Paper on Space states that if Europe is to remain a Space Power it will need a policy to develop and deploy applications and to support the research and development, technology and infrastructures.

As a first approach to integrate European research in satellite communications, the SatNEx NoE was established with the broad aims of removing barriers, integrating research and

spreading excellence. The follow-on Phase-II project, SatNEx-II, aims to build on the groundbreaking SatNEx programme and, in so doing, achieve the longer-term goals that have been set in motion.

The primary goals of the SatNEx-II NoE are to achieve long-lasting integration of European research in satellite communications and to develop a common base of knowledge. SatNEx-II will establish an innovative satellite communication platform for use by all members of the Network as a means for integrating research, teaching and training.

SatNEx-II will disseminate the knowledge and the expertise generated to the international research community through various media at its disposal. SatNEx-II personnel will benefit from opportunities to move between institutions within the Network, to exchange ideas, share best practice and make use of specialist facilities. Training and lecture material will be developed and SatNEx-II will look to the creation of new business opportunities via the management and exploitation of its knowledge base.

Project Coordinator: Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR); Partners: ISARS-NOA, Aristotle University of Thessaloniki (Auth), Budapest University of Technology and Economics, University of Bradford, Centre National d'Etudes Spatiales (CNES), Consorzio Nazionale Interuniversitario per le Telecomunicazioni (CNIT), European Space Agency (ESA), Fraunhofer Gesellschaft zur Förderung der Angewandten Forschung e.V., Groupe des Ecoles des Télécommunications (GET/ENST), Istituto di Scienze e Tecnologia dell'Informazione "Alessandro Faedo" (ISTI), Jozef Stefan Institute, Office National d'Etudes et de Recherches Aérospatiales (ONERA), Paris Lodron Universität Salzburg, TéSA, Technische Universität Graz, Universitat Autònoma de B arcelona, Universidad Carlos III de Madrid, The University of Surrey, University of Aberdeen, Università di Bologna, Universita Degli Studi Di Roma "Tor Vergata", Universidad De Vigo, Institute of Communications and Computer Systems (ICCS).; Funding Agency: European Commission; Budget for ISARS € 454,000; Time Duration 1/4/2006 - 31/3/2009.

(P. Mathiopoulos: mathio@space.noa.gr, P. Bithas, S. Papaharalabos, N. Sagias, A. Rontogianis)

2.3.2.4. Turbo equalization for nonlinear satellite communication channels

The goal of this project was the development of efficient turbo equalization techniques for high data rate satellite communication systems. Turbo equalization is an iterative equalization and decoding technique that can achieve impressive performance gains for systems suffering from InterSymbol Interference (ISI). Turbo equalization has been successfully applied for linear ISI communication channels and a number of techniques, which trade off performance for computational complexity, have been recently described. In satellite communication systems, however, due to the on-board high power amplifier, which is usually forced to work at or near the saturation point, non-linear ISI distortion is introduced in the communication channel. In this joint research project, we have analyzed and extended the turbo equalization principle to compensate for non-linear ISI distortion. To achieve this goal, the non-linear satellite channel has been modeled using a finite-order Volterra filter representation. Based on this representation a linear multi-channel equalizer has been developed, which is designed to exchange information with the decoder in a turbo

fashion. By transforming the non-linear equalization problem into a linear multi-channel problem, the ideas of turbo equalization for linear ISI channels can be applied. Moving one step further, a different turbo technique has been explored, which uses an ISI canceller as a distortion compensation block, instead of a conventional equalizer. In a turbo canceller, the non-linear ISI is first estimated and then cancelled from the received symbol sequence, before this sequence is processed by the decoder. The proposed turbo schemes are expected to offer significant performance gains in terms of Bit Error Rate (BER), for non-linear satellite communication channels, at a low computational cost.

In collaboration with the University of Bologna and University of Patras and Precicom; Funding Agency: General Secretariat for Research and Technology; Budget for ISARS € 11,740; Time Duration 1/6/2006 - 31/3/2008.

(A. Rontogianis: tronto@space.noa.gr. G. Ropokis, V. Kekkatos)

2.3.2.5. Sensor network studies

This research project is focused on sensor networks and especially on subjects concerning the lower levers of the seven-layer OSI model of computer networking. More specifically, it concerns the study of the physical layer, the multiple access control – MAC – layer, the network layer and the interaction between them. The sensor networks particularities are analyzed next in the proposal. Moreover, the study will be based upon the cooperation and the information exchanged between the layers in order to achieve performance optimization. The special goals of the project are:

- Optimization and study of the end-to-end communication in sensor networks, by selecting the appropriate signal gain of the intermediate relays.
- Investigation of the use of space time coding techniques in combination with collaborative diversity in sensor networks.
- Design of a multiple access control protocol for sensor networks, for optimizing the existing solutions' performance, in terms of information traffic needs and channel use.
- Design of a sensor network routing algorithm, providing robustness and optimized performance in a variety of possible conditions.

Partners: University of Athens, University of Patras, ATMEL and ISARS-NOA; Funding Agency: General Secretariat for Research and Technology; Budget for ISARS € 55.000; Time Duration 1/6/2006 - 31/11/2008.

(P. Mathiopoulos: mathio@space.noa.gr, Z. Papadimitriou)

2.3.2.6. Studies for MIMO Systems

The aim of this project is the development of computationally efficient space-time signal processing algorithms for wireless Multiple Input - Multiple Output (MIMO) communication systems and the performance analysis of MIMO systems. The several research and experimental results that have been published in the technical literature show

that the use of multiple antennas at the transmitter and the receiver of wireless communication systems can result in an important increase of the transmission rate. In this project, algorithms for space-time channel equalization and decoding are developed, as well as detection and multiple user interference algorithms for MIMO systems. Additionally, the performance of MIMO communication systems in terms of capacity, bit error rate and outage probability in generalized fading channels is studied.

Project Coordinator: University of Patras; Partners: University of Athens, ISARS-NOA, and InAccess; Funding Agency: General Secretariat for Research and Technology; Budget for ISARS € 49.700; Time Duration 1/6/2006 - 30/11/2008.

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2.3.2.7. Adaptive Modulation/Coding and Amplifier Linearization Techniques for Advanced Satellite Mobile Communication Systems

In this project adaptive modulation and coding as well as amplifier linearization techniques are proposed for future mobile satellite communication systems employing WCDMA and OFDM multiple accessing techniques. Firstly, we will conduct a system study analyzing the advantages and disadvantages of these two multiple access techniques for state-of-the-art mobile satellite systems for multimedia applications. Secondly, the physical layer performance of these satellite systems in terms of bit and packet error rates for various modulation (e.g. PSK and QAM) and coding schemes (e.g. turbo, Woven and LDPC codes) for two important mobile satellite channel impairments namely multipath fading and amplifier non-linearities will be obtained. Thirdly, in order to improve the performance, two techniques, namely adaptive modulation and coding and amplifier linearization will be proposed, analyzed and evaluated. The first technique will be used to combat the multipath fading impairments whereas the second one will be dealing with the inherent problem of satellite transponder nonlinear amplification. Although both techniques have been used in the past for terrestrial mobile telecommunication systems, their application to mobile satellite systems for multimedia applications is novel. Our research will provide important conclusions as for the applicability of these techniques for such mobile satellite systems.

Partners: Shandong University and ISARS-NOA; Funding Agency: General Secretariat for Research and Technology; Budget for ISARS € 11.740; Time Duration 1/6/2006 - 31/11/2007.

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3. Awareness raising activities

3.1. Education and outreach

3.1.1. Advanced research training network PROTIPA

ISARS organized the first seminar course of the Research Training Network PROTIPA on Advanced Remote Sensing Technologies and Techniques for Monitoring and Protection of Forests and other Land Ecosystems in May 2007.

3.1.2. GAIA public outreach activities

In the framework of the educational program "Exploration of the Mind and Space" ISARS organized the following lectures and activities in collaboration with the association "Friends of the Natural History Museum of Goulandris":

1. Escaping from the Earth's atmosphere - 50 years of exploration
   (Lecture given by Dr. I.A. Daglis, November 2007)
2. Traveling to the Moon, Mars and other planets
   (Lecture given by Dr. I.A. Daglis, January 2008)
3. Extra solar planets- The exploration of the Universe is continued
   (Lecture given by Dr. A. Anastasiadis, March 2008)
4. Visiting the optical telescope of the National Observatory of Athens in Penteli and Observation of the Sun (February 2008)
5. Observing and protecting our planet from near space- Using remote sensing techniques for environmental purposes. (Lecture given by Dr. O. Sykioti, May 2008).

The above lectures were targeted at students of the ages 6-12 years old. They were given in the GAIA Centre of the Goulandris Natural History Museum and in the Institute of Space Applications and Remote Sensing. After the end of each lecture the children participated in several activities, related to the subject of the talk, such as:

- Constructing space equipment mockups by using materials like paper, plastic, tinfoil.
- Making play dough replicas of the planets of our solar system
- Drawing imaginary landscapes of other planets
- Filling in questionnaires referring to the subject of each talk

Figure 26: Children making play dough replicas of planets during an outreach activity at the GAIA Centre of the Goulandris Natural History Museum.

3.1.3. ISARS colloquia series

The second cycle of colloquia, inaugurated in February 2006 and organised by ISARS at its premises, was continued in 2007 with the following scientific lectures held by scientists of other institutions and by members of ISARS:

Name/Institute	Title
Dr. K. KOUTROUMBAS ISARS / NOA	Clustering Algorithms and Applications
Prof. V. KARATHANASI National Technical University of Athens	The Greek airborne hyperspectral system. Application on the detection of submarine springs
Dr. A. ANASTASIADIS ISARS / NOA	Charged Particle Dynamics in Reconnecting Current Sheets
Dr. T. BŐSINGER University of Oulu, Finland	Research with pulsation magnetometers
Dr. I. KERAMITSOGLOU ISARS / NOA	Monitoring and mapping of ecologically important sites from space
Prof. A. PAPAYANNIS National Technical University of Athens	Laser Remote Sensing of the Atmosphere
Dr. S. K. ANTIOCHOS Head of Solar Theory Section, Naval Research Laboratory, USA	The Magnetic Origins of Explosive Solar Activity
Dr. D. VASSILIADIS NASA/GSFC and George Mason University, USA	Interplanetary Drivers of Radiation Belt Storms
Dr. J-P. LUMINET LUTH, Observatoire de Paris-Meudon, France	The shape of space, from black holes to the Universe

Dr. L. OREOPOULOS JCET-UMBC/ NASA-GSFC, USA	How MODIS observations can be used to quantify cloud heterogeneity and susceptibility
Dr. I. TSAGOURI ISARS/NOA	Ionospheric forecasting empirical models for real time applications
Prof. Z. MARTINEC Charles University, Czech Republic	Analysis and interpretation of GRACE gravity-field solutions
Dr. V. LAPENNA IMAA-CNR	In-situ and satellite Earth Observation technologies for environmental and geo-hazards monitoring: the activities of IMAA-CNR (Italy)

3.1.4. Invited talks and lectures of ISARS staff

- "Particle acceleration by direct electric fields in flaring complex active regions", Seminar at the Research Center for Astronomy and Applied Mathematics, Academy of Athens, May 2007 (A. Anastasiadis).
- "Differential Interferometry using SAR". Laboratory of Geodesy Bulgarian Academy of Science, Sofia, Budapest, June 2007 (P. Ilias).
- "From pre-storm activity to magnetic storms: a transition described in terms of fractal dynamics", Seminar at the Research Center for Astronomy and Applied Mathematics, Academy of Athens, January 2007 (G. Balasis).
- "What wavelets help us to discover in geomagnetic data?", GeoForschungsZentrum Potsdam, Germany, 7 February 2007 (G. Balasis).
- "What wavelets help us to discover in geomagnetic data?", Charles University in Prague, Czech Republic, March 2007 (G. Balasis).
- "The DIAS system: Overview and future potential", DIAS special event: Achievements and Future Potential, Instituto Técnica Aeroespacial (INTA), Madrid, February 2007 (A. Belahaki).
- "DIAS project: An important result of the Greek – Italian scientific cooperation", Italian Cultural Centre of Athens, Athens, 4 June 2007 (A. Belehaki).
- "Twenty years of research and applications in identifying, tracking and mapping the spatial distribution of air pollution over urban areas using satellite remote sensing", invited presentation for the Plenary Session of the 6th International Conference on Urban Air Quality (UAQ 2007), Cyprus, 27-29 March 2007; and invited lecture in the Environmental Engineering School of the New University of Lisbon, June 2007 (N. Sifakis).
- "Mapping the spatial distribution of urban aerosols using satellite Earth observation", invited presentation at the National Centre for Scientific Research (DEMOKRITOS) during the 2nd Meeting of the Hellenic Association for Aerosol Research (HAAR), 13 December 2007 (N. Sifakis).

- “Remote sensing and Geology”. Seminar at the Research Center for Astronomy and Applied Mathematics, Academy of Athens, November 2007 (O. Sykioti).
- “Properties, morphologies and dynamics of chromospheric fine structure”, Seminar at the the Research Center for Astronomy and Applied Mathematics, Academy of Athens, October 2007 (K. Tziotziou).
- “Small-scale solar transient events and their role in coronal heating”, 3rd World Space Environment Forum, Alexandria, Egypt, October 2007 (G. Tsiropoula).
- “Small-scale dynamic phenomena on the quiet sun and their role on the mass balance of the solar atmosphere and coronal heating”, Seminars of the Physics Department of the University of Athens. November 2007 (G. Tsiropoula).
- “Involving stakeholders: the use of Participative tools in environmental management.”; “The EU policy framework”. MedWet twinning workshop Azraq, Jordan and Beirut Lebanon, November 2007 (C. Haffner).
- “The use of digital technology in wetland management” MedWet twinning workshop Azraq, Jordan and Beirut Lebanon, November 2007 (I. Keramitsoglou)

Figure 27: Azraq Nature reserve, Twinning workshop, Jordan, November 2007

3.2. Publications

3.2.1. Books

1. *Remote sensing for inventorying and monitoring Mediterranean wetlands*. EKBY. (MedWet INTERREG IIIC Sud / MW – CODDE MedWet – Mediterranean Wetlands Ramsar), edited by Fitoka E. and Keramitsoglou I. 2007.

3.2.2. Publications in refereed journals

1. Amiridis V., D. Melas, D.S. Balis, A. Papayannis, D. Founda, E. Katragkou, E. Giannakaki, R.E. Mamouri, E. Gerasopoulos, and C. Zerefos, "Aerosol lidar observations and model calculations of the planetary boundary layer evolution over Greece, during the March 2006 total solar eclipse", *Atmos. Chem. Phys. Discuss.*, 7, 13537-13560, 2007.
2. Balasis G., and M. Mandea, "Can electromagnetic disturbances related to the recent great earthquakes be detected by satellite magnetometers?", Special Issue "Mechanical and Electromagnetic Phenomena Accompanying Preseismic Deformation: from Laboratory to Geophysical Scale", ed. by K. Eftaxias, T. Chelidze and V. Sgrigna, *Tectonophysics*, 431, doi:10.1016/ j.tecto.2006.05.038, 2007.
3. Balis D., J-C. Lambert, M. van Roozendael, R. Spurr, D. Loyola, Y. Livschitz, P. Valks, V. Amiridis, P. Gerald, J. Granville, and C. Zehner, "Ten years of GOME/ERS2 total ozone data: the new GOME Data Processor Version 4: Paper 2: Product Ground-based validation and comparisons with TOMS V7/V8", *J. Geophys. Res.*, 112, D07108, doi:10.1029/2005JD006376, 2007.
4. Belehaki A., Lj. Cander, B. Zolesi, J. Bremer, C. Juren, I. Stanislawska, D. Dialetis and M. Hatzopoulos, "Ionospheric specification and forecasting based on observations from European ionosondes participating in DIAS project", *Acta Geophysica*, Volume 55, 3, doi: 10.2478/s11600-007-0010-x, pp 398-409, 2007.
5. Daglis I.A., "Ring current dynamics", in *Solar Dynamics and its Effects on the Heliosphere and Earth*, *Space Science Series of the International Space Science Institute*, edited by D.N. Baker, B. Klecker, S. Schwartz, R. Schwenn, and R. von Steiger, pp. 183-202, Springer, Berlin, 2007.
6. Daglis I.A., B.T. Tsurutani, W.D. Gonzalez, J.U. Kozyra, S. Orsini, J. Cladis, Y. Kamide, M.G. Henderson and D. Vassiliadis, "Key features of intense geospace storms - A comparative study of a solar maximum and a solar minimum storm", *Planetary and Space Science*, *55*, pp. 32-52, doi:10.1016/j.pss.2006.04.007, 2007.
7. Dauphin C., N. Vilmer and A. Anastasiadis, "Particle acceleration and radiation in flaring complex solar active regions modelled by cellular automata", *Astron. Astrophys.*, 468, 273-288, 2007.
8. Giannakaki E., D.S. Balis, V. Amiridis and S. Kazadzis, "Optical and geometrical characteristics of cirrus clouds over a Southern European lidar station", Atmos. Chem. Phys., 7, 5519-5530, 2007.

9. Gontikakis C., A. Anastasiadis and C. Efthymiopoulos, "Particle distributions and X-ray spectra in single or multiple solar current sheets", *Mon. Not. Roy. Astron. Soc.,* 378, 1019-1030, 2007.
10. Kalouptsidis N., K. Koutroumbas and V. Psaraki, "Classification methods for random utility models with iid disturbances under the most probable alternative rule", *European Journal of Operational Research*, 176(3), 1778-1794, 2007.
11. Kazadzis S., A. Bais, V. Amiridis, D. Balis, C. Meleti, N. Kouremeti, C. S. Zerefos, S. Rapsomanikis, M. Petrakakis, A. Kelesis, P. Tzoumaka, and K. Kelektsoglou, "Nine years of UV aerosol optical depth measurements at Thessaloniki, Greece", *Atmos. Chem. Phys.*, 7, 2091-2101, 2007.
12. Kekatos V., A.A. Rontogiannis, K. Berberidis, "Cholesky Factorization-Based Adaptive BLAST DFE for Wideband MIMO Channels", *EURASIP Journal on Advances in Signal Processing*, Special Issue on *Numerical Linear Algebra in Signal Processing Applications,* vol. 2007, Article ID 45789, 11 p., 2007.
13. Mamouri R.E., A. Papayannis, G. Tsaknakis and V. Amiridis, "Six-month ground-based water vapour Raman lidar measurements over Athens, Greece and system validation", *Journal of Optoelectronics and Advanced materials*, 9, 11, 3546 – 3548, 2007.
14. Maus S., H. Lühr, M. Rother, K. Hemant, G. Balasis, P. Ritter, and C. Stolle, "Fifth generation lithospheric magnetic field model from CHAMP satellite measurements", *Geochem. Geophys. Geosyst.*, Q05013, doi:10.1029/2006GC001521, 2007.
15. Papayannis A., H. Q. Zhang, V. Amiridis, H.B. Ju, G. Chourdakis, G. Georgoussis, C. Pérez, H.B. Chen, P. Goloub, R.E. Mamouri, S. Kazadzis, D. Paronis, G. Tsaknakis and J.M. Baldasano, "Extra-ordinary dust event over Beijing, China, during April 2006: Lidar, Sun photometric, satellite observations and model validation", *Geophys. Res. Lett.*, 34, L07806, doi: 10.1029/2006GL029125, 2007.
16. Papayannis A., R.E. Mamouri, G. Ghourdakis, G. Georgoussis, V. Amiridis, D. Paronis, G. Tsaknakis and G. Avdikos, "Retrieval of the optical properties of tropospheric aerosols over Athens, Greece combining a 6-wavelength Raman-lidar and the CALIPSO VIS-NIR lidar system: Case-study analysis of a Saharan dust intrusion", *Journal of Optoelectronics and Advanced materials*, 9, 11, 3514 – 3517, 2007.
17. Tsiropoula G., K. Tziotziou, T. Wiegelmann, T. Zachariadis, C. Gontikakis and H. Dara, "Evolution of a coronal loop system", *Solar Phys.,* 240(1), 37-48.
18. Tziotziou K., G. Tsiropoula, N. Mein and P. Mein, "Dual-line spectral and phase analysis of sunspot oscillations", *Astr. Astroph.,* 463, 1153-1163, doi: 10.1051/0004-6361:20066412, 2007.
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20. Zanis P., E. Katragkou, M. Kanakidou, B. Psiloglou, S. Karathanasis, M. Vrekoussis, E. Gerasopoulos, I. Lysaridis, K. Markakis, A. Poupkou, V. Amiridis, D. Melas, N. Mihalopoulos, and C. Zerefos, "Effects on surface atmospheric photo-oxidants over Greece during the total solar eclipse event of 29 March 2006", *Atmos. Chem. Phys. Discuss.*, 7, 11399-11428, 2007.
21. Zerefos C.S., E. Gerasopoulos, I. Tsagouri, B. E. Psiloglou, A. Belehaki, T. Herekakis, A. Bais, S. Kazadzis, C. Eleftheratos, N. Kalivitis, and N. Mihalopoulos,"Evidence of gravity waves into the atmosphere during the March 2006 total solar eclipse", *Atmos. Chem. Phys*., 7, 4943–4951, 2007.

3.2.3. Conference Presentations

1. Amiridis V., D. Balis, E. Giannakaki, S. Kazadzis, A. Arola and A. Papayannis, "Characteristics of biomass burning aerorols over SE Europe determined from Lidar and Sunphotometer measurements", *4th Workshop on Lidar Measurements in Latin America*, Ilhabela, São Paulo, Brazil, June 17-23, 2007.
2. Anastasiadis A., C. Gontikakis and C. Efthymiopoulos, "Particle acceleration and radiation by single or multiple 3D reconnecting current sheets", *CESRA Workshop Abstract Book*, (Ed. A. Nintos), p.9, 2007.
3. Daglis, I.A., "Efficiency of particle acceleration: a key parameter in the transition from moderate magnetospheric activity to geospace storms" (invited talk), *International Forum "Space Science and Problems of XXI century" (50th anniversary of Sputnik launch)*, Russian Academy of Sciences, Moscow, Russia, October 1-5, 2007.
4. Daglis I.A., G. Balasis, P. Kapiris, B. Di Fiore, W. Baumjohann, W. Magnes, A. Anastasiadis and M. Georgiou, "A New Magnetometer Array in Southeast Europe for Space Weather Monitoring", *International CAWSES Symposium*, Kyoto, Japan, October 23-27, 2007.
5. Daglis I. A., F.-A. Metallinou, T.E. Moore, M.-C. Fok, and A. Varotsou, "Efficiency of particle acceleration in geospace and its role in storm-time ring current development and radiation belt enhancement", *International CAWSES Symposium*, Kyoto, Japan, October 23-27, 2007.
6. Elias P., C. Kontoes, I. Papoutsis and I. Kotsis, "Small Scale Surface Deformation Detection of the Gulf of Corinth (Hellas) Using Permanent Scatterers Technique", *IEEE Geoscience and Remote Sensing Symposium (IGARSS)*, Barcelona, Spain, July 23-27, 2007.
7. Elias P., C. Kontoes, I. Papoutsis and I. Kotsis, "Small scale linear deformation detection using Permanents Scatterers technique applied to the Gulf of Corinth (Hellas)", *ENVISAT Symposium*, Montreux, Switcherland, April 23-27, 2007
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4. Infrastructure and equipment

4.1. Satellite receiving stations

NOAA/POES-AVHRR IMAGE ACQUISITION STATION

- The National Observatory of Athens operates a NOAA/POES-AVHRR image acquisition station manufactured by Telonics Inc. The receiving antenna in the NOA campus in Penteli. Satellite data from NOAA 12, 14, 15 and 16 are acquired on a daily basis. Images are archived (since 1998), pre-processed (radiometric calibration, navigation, enhancement) and value added products are produced according to a variety of specific user requirements.

METEOSAT SECOND GENERATION RECEIVING STATION

- The Meteosat receiving station installed at ISARS is a Dartcom PDUS system. Data in the visible, in infrared and in the water vapour spectral bands are continuously acquired with frequency 4 images per hour by the SEVIRI sensor on board the Meteosat Second Generation geostationary satellite. The acquired images are stored for several days but not archived on a regular basis.

4.2. Athens digisonde

- The ionospheric group operates a state of the art ionospheric station (Athens Digisonde) and the European Server for the Upper Atmosphere (DIAS).

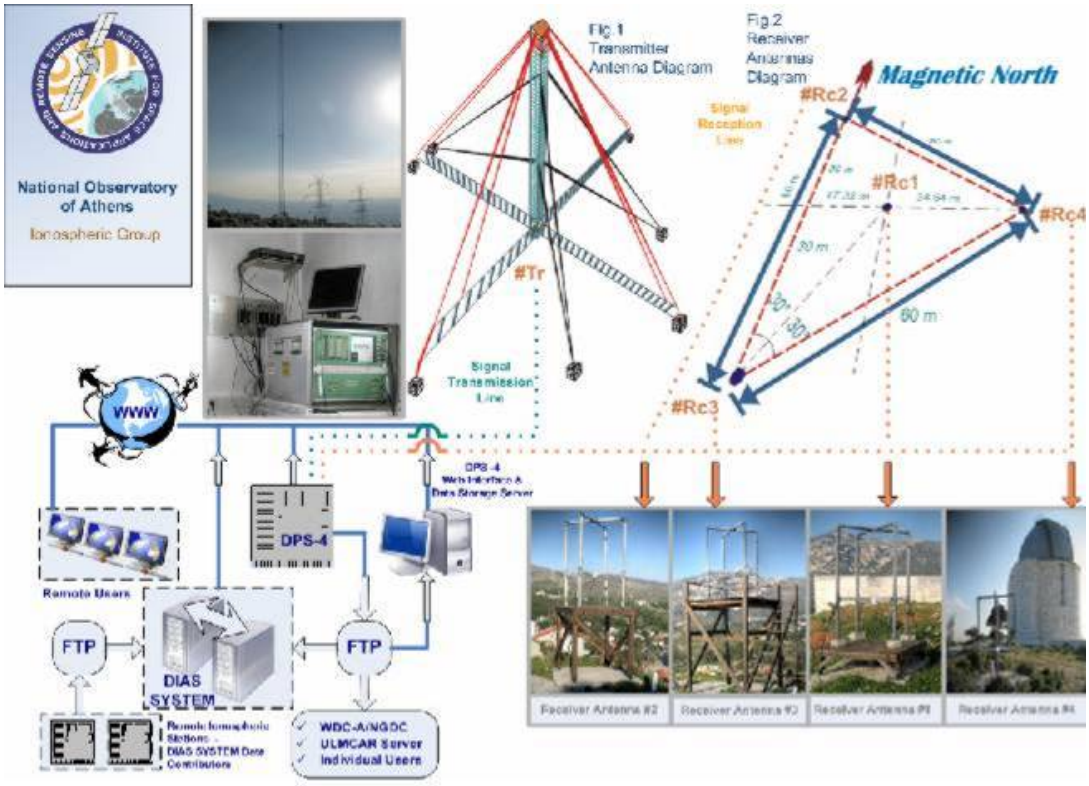

Figure 28: Research infrastructure operated of the Ionospheric group of ISARS/NOA

The infrastructure operated by the Ionospheric group of NOA is shown in Figure 28. Two main systems are operated and maintained by the group a) The Athens Digisonde and b) The DIAS system.

a) The Athens Digisonde: A state of the art infrastructure for remote sensing of the Earth's Ionosphere is operating in the National Observatory of Athens since September 2000. The ionospheric station is a Digital Portable Sounder with four receiving antennas (DPS-4), spaced about one wavelength apart. The station can operate in four different modes: 1) Scanning ionogram, 2) Drift ionogram 3) Fixed Frequency ionogram 4) Oblique ionogram. The types of data currently selected automatically from Athens Digisonde are:

1. Doppler ionograms in RSF format which allows for two bytes for each sampled height to store a multi-beam directional measurement. O and X data are stored in separate arrays.
2. SAO files with the result of the automatic scaling of the ionogram
3. Raw Drift data for input to the GDDA program. The complex amplitude Doppler spectra are stored separately for all heights requested and for each antenna, in order to detect angles of arrival for each Doppler component.

4. Sky maps showing the locations of the radio sources (reflection points) each source having its own line-of-site (LOS) velocity. The velocity vector of the moving plasma is obtained from the set of LOS velocities.
5. Drift velocities calculated with the GDDA method corresponding to the peak of a distribution of velocities
6. Daily Directograms giving the direction of the recorded echoes versus their height.

Real-time ionograms with the results of their automatic scaling and the history of past soundings are currently available on the main web site of the Ionospheric group of ISARS/NOA (http://www.iono.noa.gr).

4.3. Geomagnetic field stations

The space physics group operates 4 state-of-the-art Geomagnetic Field Stations with the following instrumentation:

- 1 GEOMAG-02M fluxgate magnetometer (GEOMAGNET, Ukraine)
- 1 GEOMAG-02 MT station (GEOMAGNET, Ukraine)
- 2 CHIMAG fluxgate magnetometer (Graz, Austria)
- 1 GSM-90F1 v7.0 overhauser magnetometer (GEM Systems, Canada)
- 1 search-coil magnetometer (Oulu, Finland)
- 6 Ag/AgCl electrodes (GFZ Potsdam)

CHIMAG is a fluxgate magnetometer especially for Earth field variation and pulsation measurements with 10 pT field resolution, a maximum data rate of 64 Hz and GPS for time synchronization. The instrument was developed by IWF Graz in co-operation with the Institute of Geophysics and Planetary Physics (IGPP) in Los Angeles.

GSM-90F1 v7.0 is a scalar overhauser magnetometer of high absolute accuracy (0.2 nT) and low long term drift (0.05 nT / year). It is optimized for use in magnetic observatories, long term monitoring arrays in geophysics and space physics, etc. where the following are essential:

- long term stability and high accuracy
- high resolution and low noise (0.02 nT)

4.4. CIMEL radiometer

A newly installed sun-photometric station including currently a CIMEL radiometer is operated at ISARS. ISARS has become part of NASA's AERONET (Aerosol Robotic Network, http://aeronet.gsfc.nasa.gov/new_web/photo_db/ATHENS-NOA.html). The instrument is located on the roof of the Research Center for Atmospheric Physics and Climatology of the Academy of Athens. The campus is located in the city center and 10 km from the sea. The radiometric station will be additionally equipped with a UV-MFR

instrument for radiation measurements in the UV spectral region. The instrumentation of ISARS will constitute a state-of-the-art radiometric station, the first one that ever operated in Athens with such specifications.

Figure 29: Aerosol sunphotometric station of ISARS will provide a long-term, continuous and readily accessible public domain database of aerosol optical, mircrophysical and radiative properties for aerosol research and characterization, validation of satellite retrievals, and synergism with other databases.

4.5. Computer centre

Platform: 1 intel Server System SR2520SAXR , intel Server Board S5000VSASATAR , intel Server Chassis SR2520, 2U Rack, SATA midplane with integrated 6 port SATA controller, up to 2 dual / quad core intel Xeon 5300 / 5400 processor, LGA 771 socket, intel 5000V chipset, 4 PCI buses
5 slots
2 low profile PCI-X 64-bit 100/133MHz ,
2 low profile PCI-Express x4,
1 low profile PCI 32-bit ,
8 FB DIMMs, max memory 16GB,
2 x intel Pro/1000EB Ethernet connections,
6 x hot-swap SATA,
RAID 5 activation key AXXRAKSW5, **supporting 0,1,10,5**
2 x 600 Watt (Extra power supply **intel TLIACPS003 600 Watt ,)**
dual line cord PFC PSU, 3 system fans, VGA ATI 16MB,
Processors: 2 intel Xeon 5440, 64-bit, quad core socket LGA 771, 2.83GHz, 2 x 6MB L2 cache, 1333MHz fsb, 45nm, Enhanced Core 2 architecture
Hard disks: 3 Seagate Barracuda 7200.11 ST31000340AS, 1 TB(1000GB) , 7200rpm, 32MB cache, 105MB/sec sustained data rate, 4 platters, 8 heads, 750000 hours MTBF, SATA 300 (3Gbit/sec), second generation perpendicular recording, 5 years limited

warranty, RoHS compliant
Memory: 16GB, 8 Kingston KVR667D2D4F5/2G, 2GB DDR II 667 ECC Fully Buffered CL5 DIMM Dual Rank, x4
Optic: 1 LG GSA-T20L Super Multi DVD Rewriter slimline
Network controller (extra)**: 1 intel EXPI94202PT ,** 2 RJ-45 low profile PCI-Express x4 , INTEL 82571GB Ethernet controller
Platforms: 3 intel Server System SR2520SAXR , intel Server Board S5000VSASATAR , intel Server Chassis SR2520, 2U Rack, SATA midplane with integrated 6 port SATA controller, upto 2 dual / quad core intel Xeon 5300 / 5400 processor, LGA 771 socket, intel 5000V chipset, 4 PCI buses
5 slots,
2 low profile PCI-X 64-bit 100/133MHz,
2 low profile PCI-Express x4,
1 low profile PCI 32-bit,
8 FB DIMMs, max memory 16GB,
2 x intel Pro/1000EB Ethernet connections,
6 x hot-swap SATA,
dual line cord PFC PSU, 3 system fans, VGA ATI 16MB,
Processors: 2 intel Xeon 5440, 64-bit, quad core socket LGA 771, 2.83GHz, 2 x 6MB L2 cache, 1333MHz fsb, 45nm, Enhanced Core 2 architecture
Hard disks: 1 Seagate Barracuda 7200.9, ST3808110AS, 80GB 7200rpm, 8MB buffer, NCQ, Serial ATA300t
Memory: 16GB, 8 Kingston KVR667D2D4F5/2G, 2GB DDR II 667 ECC Fully Buffered CL5 DIMM Dual Rank, x4
Optic: 1 LG GSA-T20L Super Multi DVD Rewriter slimline.

ANNEX I: References

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ANNEX II: Financial data 2007

ISARS	2007
INCOME TOTAL	**1 451 827.23**
Regular public budget funding	619 186.21
Public investment funds- national projects & studies	443 171.64
Public investment funds- structural funds	29 147.06
Public investment funds- other funding	154.86
Income from the EU Framework Programmes	360 167.46
Income from R&D contracted by firms and other private legal entitles	0.00
Income from sales of products and services, studies, tests, etc for third parties	0.00
Income from education and training services etc	0.00
Income from real estate exploitation	0.00
Income from capital investments	0.00
Income from intellectual property exploitation	0.00
Donations	0.00
Other income	0.00
Expenditure total	**1 371 696.67**
Personnel costs	599 864.25
Third party remuneration (incl. Project assignments)	437 244.91
Travelling costs	83 660.81
Other operating expenses	95 300.55
Expenditure for equipment	155 147.13
Depreciations	155 147.13
Other expenditure	479.02

ISARS staff (several colleagues absent)

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