Institute for Astronomy, Astrophysics, Space Applications & Remote Sensing

National Observatory of Athens

IAASARS Report 2005-2012

CONTENTS

PREFACE

The report presents a summary of the activities of the Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing (IAASARS) of the National Observatory of Athens. The report commences with a description of the main infrastructure of the Institute, followed by a presentation of the research activities of the various groups. It continues with highlights of a few key events organized by members of the Institute and closes with the description of the educational and public outreach activities, as well as the services offered.

The operation plan of the Institute for the next five years is presented in Section 7.

At the end of the report, we include in Appendix I several graphs of select metrics depicting the improvements in the institute over the 8-year period. Also, in Appendix II we present a more detailed description on the status of Helmos Observatory and the 2.3m Aristarchos telescope.

Finally, an additional document will brief CVs of all permanent researchers and research staff is included in Appendix III.

EXECUTIVE SUMMARY

The Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing (IAASARS) was created in February 2012, by the merging of two independent institutes of the National Observatory of Athens (NOA): The Institute of Astronomy and Astrophysics (IAA) and the Institute for Space Applications and Remote Sensing (ISARS). IAA was the result of renaming, in 1999, the old Astronomical Institute, which was founded in 1942. It carried-on the tradition of ground-based observational astronomy that commenced with the construction of the Observatory of Athens in 1842, but also expanded it to modern research fields such as space observational astrophysics. ISARS was also established in 1999 via the renaming of the old Ionospheric Institute, which was founded in 1955.

The past history provides IAASARS with an extensive experience in both applied and basic research in space physics and astrophysics, as well as earth observation. The permanent staff of the institute currently consists of 24 researchers, 7 research support specialists, a secretary and 5 technicians. In addition, 24 postdoctoral researchers are currently on term contracts, making IAASARS the largest institute in its field in Greece. The scientists of the Institute have been successful in attracting over 500,000 euros per year in national and european competitive research grants. Even though the science topics addressed by the various groups are rather diverse, over the past few years close synergies have been established. In the process the personnel have developed expertise in sophisticated signal processing and data analysis techniques applying them to datasets produced by space-born and ground based facilities. This has enabled them to play a leading role in major international scientific collaborations in fields such as X-ray and Infrared astrophysics, solar physics, space weather and ionospheric physics. It should be stressed that the earth observation and remote sensing group of IAASARS is the most active in Greece and has a long record of delivering novel methodology and high data products to the community.

The Institute supports and operates a number of research facilities including ionospheric and remote sensing stations as well as a mobile Lidar and a network of magnetometers. The 2.3m Aristarchos telescope, the largest in Greece, is the major infrastructure of IAASARS. It produced its first science results in 2013 and it is expected to support the activities of the astrophysics group, as well as other researchers & collaborators in Europe.

Last but not least, the Institute has a solid record of nearly 20 years of a public outreach program. The recently renovated Visitor Center in Penteli has passed the 200,000 visitors mark in 2013, showing the wonders of the night sky to the general public as well as organized groups and schools from across Greece. Other educational activities include the annual astrophysics summer school for high-school seniors, regular organization of international conferences and a vigorous seminar program.

1. INFRASTRUCTURE

1.1 Astronomical Infrastructure

1.1.1 Helmos Observatory

The 2.3 m "Aristarchos" telescope is installed at Helmos Observatory (http://helmos.astro.noa.gr/). It is the largest research infrastructure of the National Observatory of Athens and the 2nd largest telescope in continental Europe. Helmos Observatory is located at an altitude of 2340 m, approximately 220 km southwest of Athens, near the city of Kalavryta, in one of the darkest locations in Europe. The Aristarchos telescope (Ritchey-Chretien design) was constructed by the German company Carl Zeiss and was inaugurated in the summer of 2007. The telescope uses technology that is common in larger 8-10 m class telescopes. As a consequence the telescope's positional accuracy is better than 2 arcsec, while it can follow targets with a positional offset better than a fraction of an arcsec within an hour. The field of view is about 10 arcmin in diameter at the sideport, and 1 degree diameter at the Cassegrain focus. The telescope can reach a limiting magnitude of V~24 in an hour of observation on a dark night, while the limiting magnitude for spectroscopy is about V~19 with the low resolution ATS spectrograph.

Left: The dome at Helmos Observatory that hosts the 2.3m "Aristarchos" telescope, with one of the vehicles. ***Right:*** The "Aristarchos" telescope. Its moving part weighs about 40 tons and can point to astronomical objects on the sky with an accuracy of 2 arcsec.

The facilities at Helmos Observatory include the dome building, which hosts the telescope, the telescope control and guest house building, a dome housing the small telescope used for atmospheric monitoring, as well as the building that hosts the electrical power equipment and the supporting power generators. The facilities can accommodate up to 10 persons (astronomers and technicians). Moreover, some office space has been given to NOA by the Kalavryta City Council for the administrative needs of the Astronomical Station.

The telescope is equipped with a wide range of instrumentation. During the period covered by this report, the following instruments were available on the telescope:

a. CCD camera (SITeAB 1024x1024 pixels) with a field-of-view 5x5 arcmin. The camera is cryogenically cooled with liquid Nitrogen down to a temperature of -120C.
b. Exoplanet Detector RISE-2. The device allows the accurate measurement of the flux variability of a star due to the passage of a putative planet. This instrument is identical to

RISE-1, which is installed at the Liverpool telescope at the Canary Islands.

c. Aristarchos Transient Spectrometer (ATS). The spectrograph resolution depends on the grating: (a) RED yields a resolution of 2.5 Angstroms and a wavelength range 5780-7070 Angstroms, (b) BLUE yields a resolution of 2.5 Angstroms and a wavelength range 4370-5780 Angstroms and (c) FULL yields a resolution of 6 Angstroms and a wavelength range 4120-7200 Angstroms. The spectrograph is fed using a bunch of 50 optical fibers, giving a 10 arcsec diameter field of view. The spectrograph is equipped with an Apogee U47, E2V-CCD4710 back illuminated CCD camera with 1024x1024 pixel, 13μm pixel size.

The CCD camera and RISE2 are currently fully commissioned and were used during the 2013-observing season, while the spectrograph is expected to enter normal operations in the 2014-observing season. More details about the available instrumentation and the characteristics of the site can be found in Appendix II.

1.1.2 Kryonerion Astronomical Station

The Kryonerion Astronomical Station is situated 100 km west of Athens at an altitude of 800 m. The station hosts the 1.23 m telescope, built in 1975 by Grubb-Parsons Co. Newcastle, which is equipped with a 2.5x2.5 arcmin CCD camera. The telescope had been reasonably productive with a number of scientific publications (50 refereed publications until 2010) on a rather restricted field, namely stellar photometry and variability studies. However, the progressive increase of light pollution from Athens and lack of funding which made it challenging to perform proper maintenance and upgrades, reduced substantially the science use of the telescope. Currently the telescope is progressively being phased out as the only technical support person on site is retiring in 2014. We are in the process of exploring possibilities to collaborate with local authorities and amateur astronomers in order to convert the site to be used exclusively for public outreach and educational purposes.

Left: The dome building at Kryoneri Observatory. ***Right:*** The 1.23 m telescope inside the dome.

1.1.3 Newall Telescope

The historic Newall 62.5 cm refractor is located at the Visitor Center in Penteli. The telescope was commissioned by Robert Stirling Newall (1812-1889), a wealthy Scottish engineer and amateur astronomer for his private observatory at Ferndene (Gateshead). In 1890 the telescope was donated to the University of Cambridge. In 1957 it was donated to the National Observatory of Athens. The telescope is now used as the main observational and public outreach facility of the Visitor Center.

1.2 Earth and Space Remote Sensing Infrastructure

1.2.1 Meteosat Second Generation SEVIRI Ground Station System

Since 2007, the Institute has installed and has been using on a 24/7 operational basis a ground station for systematically receiving satellite imagery from the MSG-SEVIRI system maintained by EUMETSAT. The operating agreement for the collection, archiving, and exploitation for research purposes of MSG images, signed between IAASARS/NOA and EUMETSAT, was recently renewed in 2012. New images are collected every 5 minutes, and cover a large part of the globe that fully includes Europe, and subsequently the entire Greek territory, which constitutes the core research area of interest of the Institute. The data transmission channel is based on EUMETCast and uses Digital Video Broadcast technology.

Operational use of MSG-SEVIRI system at IAASARS/NOA

On an operational level, the main application of the MSG/SEVIRI ground station is the detection, monitoring and mapping of forest wildfires in near-real time (every 5 minutes) for the entire Greek territory, the briefing of the public authorities and stakeholders involved in the management and suppression of wildfires, and informing the citizens whose properties are threatened by ongoing catastrophic fire events **(http://ocean.space.noa.gr/fires).**

The IAASARS/NOA station consists of a parabolic antenna with a 1.1 m diameter, a PC processing station for data collection and decoding having 1 TB disk capacity, a DVB card, a key unit (EUMETCast Key Unit), data decoding software (EUMETCast Client Software), and a series of hard drives for storing and archiving historical acquisitions. The collected images are of high radiometric resolution (Meteosat HRI Data) and record the radiation received from the earth and its atmosphere in the following wavelengths: a) Infra-red band (IR), b) Water-vapour band (WV), and c) Visible band (VIS). The spectral data come in raster format with an approximately 3 km ground spatial resolution, exactly below the satellite position, except from channel HRV (Channel 12) whose resolution is 1 km. In the following we present, the frequency channels accumulated on a 5 minutes basis along with their radiometric characteristics, which make up for the entire MSG-SEVIRI system:

- Visible band centered at 0.6μm – Channel 1 (VIS 0.6)
- Visible band centered at 0.8μm – Channel 2 (VIS 0.8)
- Near-infra-red band centered at 1.6μm – Channel 3 (NIR 1.6)
- Infra-red band centered at 3.9μm – Channel 4 (IR 3.9)
- Water Vapour band centered at 6.2μm – Channel 5 (WV 6.2)
- Water Vapour band centered at 7.3μm – Channel 6 (WV 7.3)
- Infra-red band centered at 8.7μm – Channel 7 (IR 8.7)
- Ozone band centered at 9.7μm – Channel 8 (IR 9.7-O3)
- Infra-red band centered at 10.8μm – Channel 9 (IR 10.8)
- Infra-red band centered at 12.0μm – Channel 10 (IR 12.0)

- Carbon Dioxide band centered at 13.4μm – Channel 11 (IR 13.4 – CO2)
- Broadband high-resolution visible band – Channel 12 (HRV)

1.2.2 Atmospheric Remote Sensing Station

Since February 2009, IAASARS has been operating a ground-based Atmospheric Remote Sensing Station (ARSS) to monitor ground solar radiation levels and aerosol pollution over the city of Athens, Greece. ARSS is located on the roof of the Biomedical Research Foundation of the Academy of Athens (37.9 N, 23.8 E) at an elevation of 130 m above mean sea level. The site is located close to the Athens city centre and 10 km from the sea. ARSS is equipped with a CIMEL CE318-NEDPS9 solar photometer for the retrieval of the aerosol optical depth at 8 wavelengths from 340 to 1640 nm, including polarization observations. The CIMEL instrument is a part of NASA's Aerosol Robotic Network (AERONET - http://aeronet.gsfc.nasa.gov/). The data are processed on a daily basis and are available at AERONET's webpage along with aerosol inversion retrievals, useful for aerosol characterization purposes (e.g. classification of Saharan dust advection, smoke or volcanic ash episodes etc). ARSS is additionally equipped with a UV-MFR instrument for radiation measurements in the UV spectral region. The instrumentation of IAASARS constitutes a state-of-the-art passive remote sensing suite for atmospheric research, the first one that ever operated in Athens with such specifications.

The Atmospheric Remote Sensing Station of IAASARS, operating passive remote sensors for monitoring the atmospheric environment in Athens.

1.2.3 Mobile Lidar EMORAL

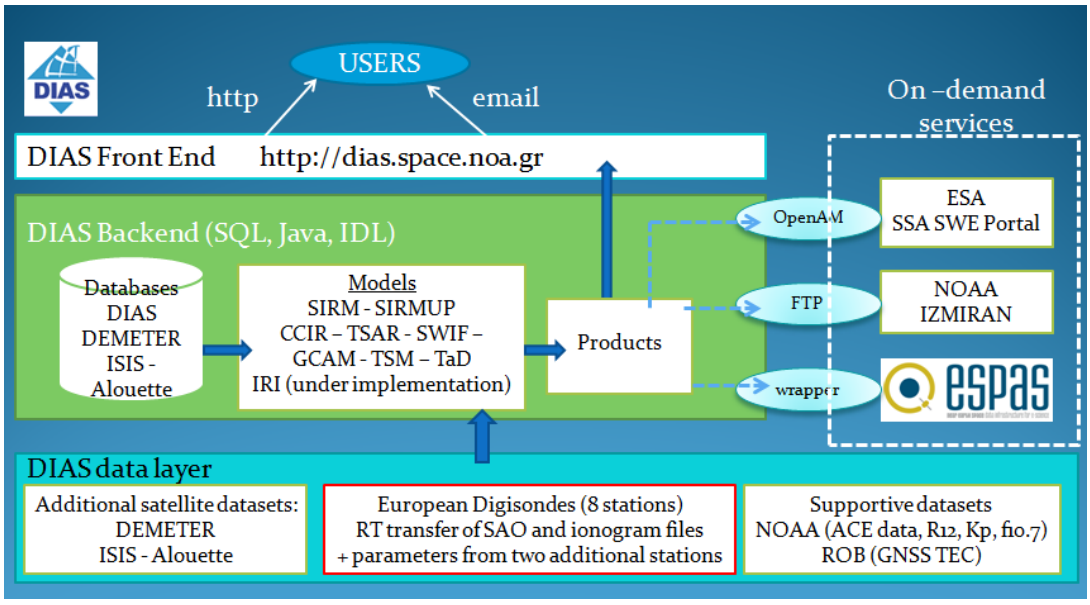
Since 2011, IAASARS has been operating the mobile lidar system EMORAL in collaboration with the European Space Agency (ESA). EMORAL is a portable depolarization – Raman lidar, mounted in a minivan, capable of detecting polar and cross-polar signal at 355nm, total linear polarized signal at 532nm and nitrogen's Raman return at 387nm. EMORAL is capable of providing aerosol extinction, backscatter and depolarization vertical distributions, as well as aerosol microphysical properties utilizing innovative inversion techniques. The system currently operates in campaign mode, participating in satellite validation activities and aerosol characterization experiments like HYFLEX (Verification of the Hyperspectral Plant Imaging Spectrometer), ACEMED (Evaluation of CALIPSO's aerosol classification scheme over Eastern

Mediterranean), ChArMEx (The Chemistry-Aerosol Mediterranean Experiment), ARGON (Aerosol and TRace Gases Observational Campaign at NEO).

Left: The mobile lidar system EMORAL. ***Right:*** The emission/detection units of the mobile system.

1.2.4 The European DIgital Upper Atmosphere Server (DIAS) System

The DIAS system was developed under the EC eContent Programme (2006) and delivers systematically a comprehensive set of data and products that characterize ionospheric and plasmaspheric conditions over Europe. The service was recently expanded to retrieve data from 10 European Digisondes and Ionosondes (Athens, Rome, Ebre, Arenosillo, Chilton, Juliusruh, Pruhonice, Moscow, Tromso and Sodankyla), as well as solar wind data from ACE, and supportive data from NOAA (solar and geomagnetic indices) and ROB (GNSS data). Data are collected in the DIAS backend and ingested into prediction models. The resulting products serve more than 500 registered users through the DIAS html interface (http://dias.space.noa.gr) and through API (on-demand services to ESA, NOAA and IZMIRAN).



The main groups of products available for the European middle and high latitudes are:

(1) ionograms and frequency plots;

(2) nowcasting and forecasting maps of ionospheric parameters e.g., foF2, M(3000)F2, MUF;

(3) nowcasting maps of the 3D electron density distribution, of TEC and partial TEC;

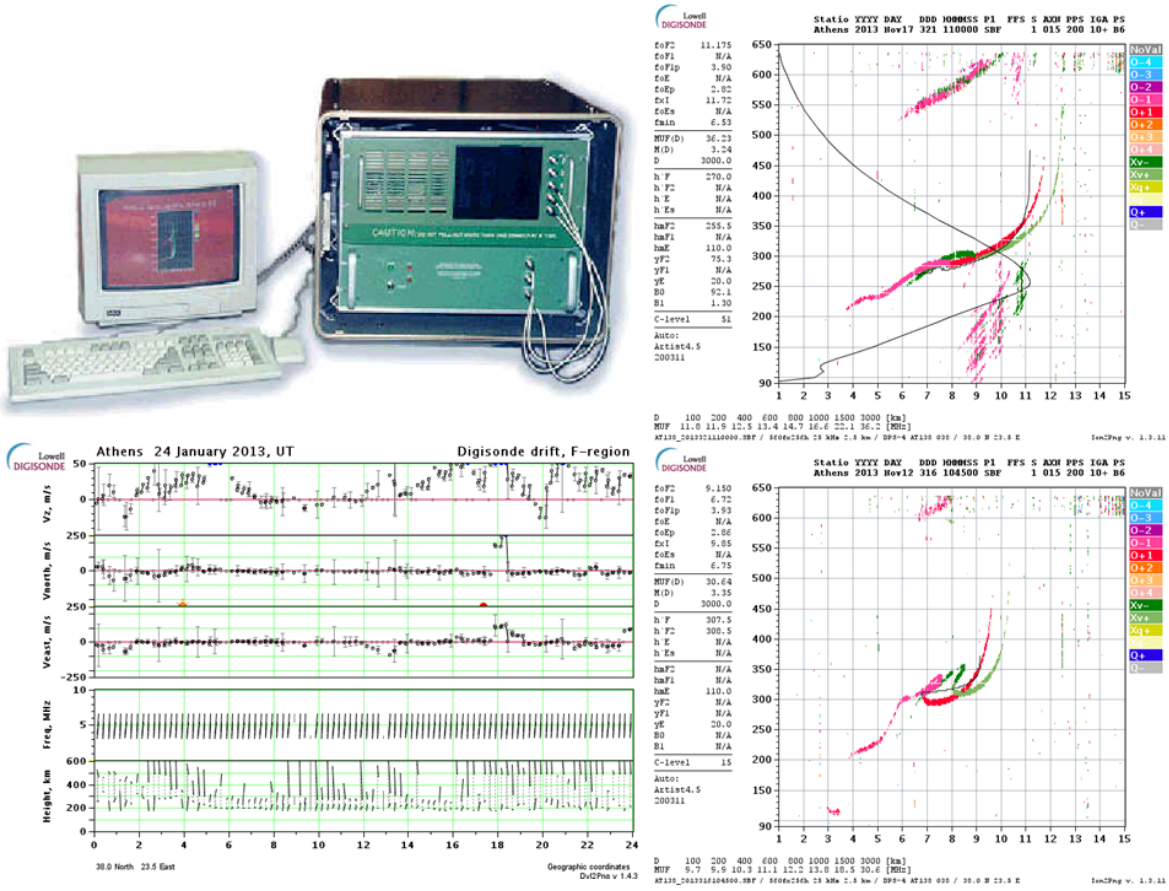
(4) alerts for forthcoming ionospheric disturbances in the European sector; (5) long term predictions for frequency planning.

In 2013, the DIAS database was selected by the FP7- RI ESPAS consortium as the main data repository for European ground-based ionospheric datasets. Since 2013 the DIAS system is one of the federated services that support the pilot phase of the ESA/SSA Preparatory Phase. The DIAS system provides its services in real-time 24/7, following the EC open access policy for research data distribution.

1.2.5 The Athens Digisonde Portable Sounder

The Athens Digisonde is an infrastructure for remote sensing of the Earth's Ionosphere, operated by NOA in Penteli since September 2000. The Digisonde is a Digital Portable Sounder with four receiving antennas (DPS-4), spaced about one wavelength apart. The station can operate in multiple modes (Scanning/Drift/Oblique). The routine observation mode includes:

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 and Directograms giving the direction of the recorded echoes versus their height.



Data are collected and retrieved in real time (24/7 operation) and are openly available through the main portal of the Ionospheric Group of IAASARS/NOA (http://www.iono.noa.gr). The Athens Digisonde is part of the following international networks: GIRO, ESPAS, *WDC* for Solar-Terrestrial Physics (RAL) and IPS/WDC. The Athens Digisonde participates systematically in cal/val campaigns for LEO satellites.

1.2.6 Geomagnetic Array ENIGMA

NOA currently operates ENIGMA (HellENIc GeoMagnetic Array), an array of 3 ground-based magnetometer stations located in Trikala (Klokotos), Attiki (Dionysos) and Lakonia (Velies), Greece. ENIGMA (http://prote us.space.noa.gr/~srtg/index.php/groupfacilities/2-uncategorised/20-geomag) provides measurements for the study of geomagnetic pulsations, resulting from the solar wind- magnetosphere coupling. Ground-based magnetometers have proven to be the workhorse of magnetosphere-ionosphere coupling physics. They enable effective remote sensing of geospace dynamics and therefore their importance in space weather monitoring and research is indisputable. ENIGMA is the first magnetometer station array that has ever operated in Greece and within a few years of operation has succeeded in becoming a SuperMAG contributor. SuperMAG (http://supermag.jhuapl.edu/) is a worldwide collaboration of organizations and national agencies that currently operate more than 300 ground-based magnetometers. SuperMAG provides easy access to validated ground magnetic field perturbations in the same coordinate system, identical time resolution and with a common baseline removal approach. The purpose of SuperMAG is enable scientists, teachers, students and the general public to have easy access to measurements of the Earth's magnetic field.

1.2.7 The Solar Energetic Proton Flux (SEPF) Tool

NOA has developed and operates the Solar Energetic Proton Flux (SEPF) tool (http://proteus.space.noa.gr/sepf_tool/) which is a European space weather asset. The tool provides solar energetic proton fluxes at various locations in space using the count-rate measurements of the ESA Standard Radiation Environment Monitor (SREM) units on-board INTEGRAL, Herschel, Planck, and Rosetta spacecraft. The SEPF tool downloads SREM data, calculates the differential proton fluxes and displays derived results from past and current SREM measurements. The tool is based on the application of a linear algorithm solver for the inverse problem of calculating fluxes from the SREM count-rate measurements. The inverse method has been developed by IAASARS/NOA and has been validated by comparing results of selected number of past solar energetic particle events with measurements from other proton monitors.

1.3 Computer Infrastructure

The IAASARS LAN network is part of the extended NOA network. The IAASARS network is connected to the internet via the The Greek Research and Technology Network (www.grnet.gr) at a speed of 1 Gbps. The IAASARS LAN operates at 100/1000 Mbps (FO and UTP wiring) and uses 4 CISCO routers (3825, 3640 and 2600) and six CISCO switches. The main network computer is an HP server rx2640 installed in 2006. AstroLAN serves about 100 units (computers and printers). The system is supported by UPS units. Helmos Observatory is connected to AstroLAN using an optical fibre. There is also a wireless (antenna) connection between Helmos and Penteli, which serves as a backup.

The computer center of the Institute includes a linux cluster with 40 processors. The cluster is used extensively by researchers at NOA (e.g. on the X-ray Astronomy ESA PRODEX project) but also by researchers outside NOA (e.g. Academy of Athens) on solar physics projects

2. MAIN RESEARCH ACTIVITIES

2.1 Space Astrophysics

2.1.1 Infrared Astrophysics

The Infrared Astrophysics team of IAASARS/NOA currently consists of three tenured researchers, Dr. E. Xilouris Dr. A. Bonanos, and Prof. V. Charmandaris (who joined the Institute as Director in September 2013), as well as Dr. I. Leonidaki, as a postdoctoral fellow. An additional postdoctoral researcher and a PhD student will join the group in 2014. The team has a strong expertise in infrared data analysis obtained with the Spitzer Space Telescope of NASA and the Herschel Space Observatory and Infrared Space Observatory of ESA. The team addresses various topics in extragalactic astrophysics and in particular in galaxy evolution, dust formation and gas depletion in interacting galaxies and Active Galactic Nuclei, gas and dust properties of Luminous Infrared Galaxies, as well as radiative transfer modeling and dust properties of nearby galaxies. Furthermore, the team participates in several large Spitzer and Herschel projects including GOALS, HER33MES, HerCULES, HeViCS and Herschel-GOODS.

In addition to the science results it should be mentioned that the team members have experience in instrument calibration and characterization. Dr. Xilouris was involved in the pre-launch and inflight calibration of the Heterodyne Instrument for the Far-Infrared (HIFI) onboard the ESA's Herschel mission. Prof. Charmandaris was a member of the instrument team of the infrared spectrograph (IRS) of Spitzer Space Telescope at Cornell University, being responsible for the photometric calibration of IRS as well as its cross-calibration with the other Spitzer instruments.

Currently the activity of the group is funded by a three-year program of Dr. Xilouris under the "Aristeia I" action of the "Education and Lifelong Learning" Operational Programme of the Ministry of Education in Greece (GSRT): “A Step in the Dark: The Dense Molecular Gas in Galaxies (DeMoGas)”. Additional support is expected from the “KRIPIS-PROTEAS” project of IAASARS. The group has attracted over **220,000 euros** in competitive grants in the past eight years.

In the period 2005-2012, prior to the arrival of Prof. Charmandaris, the team published 46 papers in refereed journals, which received over 1500 citations.

2.1.2 X-ray Astrophysics

The X-ray Astrophysics group (http://xraygroup.astro.noa.gr) is one of the largest groups at the National Observatory of Athens, employing four permanent staff (I. Georgantopoulos, M. Plionis, currently at the Univ. of Thessaloniki, A. Georgakakis currently on leave of absence at MPE, A. Akylas) and six postdoctoral researchers (P. Ranalli, G. Lanzuisi, A. Corral, G. Mountrichas, E. Koulouridis, N. Nikoloudakis) and two PhD students (L. Koutoulidis and H. Stavrinos). The group has extensive experience in X-ray data analysis mainly from the XMM-Newton space observatory and also from the Chandra X-ray observatory (having ~120 refereed publications in international refereed journals in the past 8 years with over 3000 citations, source: Astrophysics Data System). Recently, the group is implementing techniques that exploit both X-ray and mid-IR observations for the detection of obscured AGN. The group participates in some of the largest X-ray Astronomy projects: a) the XMM CDFS (3 Ms), PI A. Comastri, b) the XMM/XXL project (PI M. Pierre; 3Ms, 50sq. degrees) c) the Chandra AEGIS Project (PI K. Nandra). Finally, the Institute leads a large XMM project in the Herschel ATLAS survey (PI I.

Georgantopoulos).

The group is currently leading an ESA PRODEX program, which aims to provide a catalog of X-ray spectral fits for the brighter sources (>100 counts) in the XMM serendipitous source catalog. XMM is ESA's cornerstone X-ray Astronomy mission, smoothly operating after 13 years of launch. XMM is probably the most successful X-ray mission ever, judging from the number of published papers and corresponding citations. The provided spectral fits employ the simplest models, i.e. a power-law plus intrinsic absorption. This project is run under the guidance of the XMM Survey Science Center Consortium and in particular the University of Leicester. This program will provide X-ray spectra for at least 100,000 sources to the worldwide community as well as software for the automatic analysis of the new sources, which accumulate on a daily basis to the XMM archive.

The group is also contributing to the software development for the eROSITA instrument onboard the Russian Spectrum-RG mission, by writing code for modeling. eROSITA will provide an all-sky survey in the 0.5-10 keV energy band, detecting about 3,000,000 sources (in their vast majority Active Galactic Nuclei, but also clusters of galaxies, stars and normal galaxies). Finally, members of the group are involved in the ESA project "Science Archives Publication System", which will link the observations of ESA missions with the corresponding publications in scientific journals.

The X-ray Astronomy group is funded from the following projects: 1) PRODEX: constructing an XMM spectral fit database (ESA), 2) Thales: the dark side of the accretion history of the Universe (GSRT), 3) KRIPIS-PROTEAS (GSRT), 4) Support of Postdoctoral Researchers: multi-wavelength studies of AGN environments (GSRT), 5) Support of Postdoctoral Researchers: multi-wavelength studies of star forming galaxies (GSRT). The group has attracted over **1,500,000 euros** in competitive grants of in the past eight years.

2.1.3 GAIA Mission Support

The IAASARS group "Stellar Systems and Galaxies" (SSG) actively participates in the preparation of the ESA's cornerstone mission Gaia. The group consists of two tenured researchers (I. Bellas-Velidis, A. Dapergolas) and is member of the Data Processing and Analysis Consortium (DPAC), accepted by ESA to process the data that will arrive from the satellite. Within the Coordination Unit CU8 ("Astrophysical Parameters") of the DPAC the SSG leads the Work Package GWP806 "Utility Library and Data Model". The group is also member of the GWP832 "Unresolved Galaxy Classifier". The members of SSG are developing an Artificial Intelligence based system for classification and parameterization of galaxies, part of the Gaia ground-based scientific pipeline being prepared by DPAC. It is also contributing to the CU2 "Data Simulations" (DU3 "Universe Model") by preparing libraries of synthetic galaxy spectra and is an associated member of the "Gaia Research for European Astronomy Training" (GREAT), an ESF program aimed at the scientific exploitation of the Gaia mission results.

Currently, actions are under way by DPAC to form a coordination unit CU9 "Catalogue Access" for preparation of the Gaia Archive, which will be the final result of the mission. It will contain astrometrical, photometrical and spectroscopic information of about one billion objects in our Galaxy and of a few million extragalactic sources. The IAASARS group is highly interested in participating in the following work packages of the CU9: WP200 "Tailoring" (WP201 Science Scenarios), WP400 "Tools" (WP430 Data Mining) and WP500 "Validation" (WP530 Models). The experience acquired from CU8 and CU2 qualifies the team to contribute to the archive and in tool preparation.

2.1.4 Ground-Based Astrophysics

The team currently consists of 3 tenured researchers (Boumis, Bonanos, Xilouris), 2 postdoctoral researchers (Uscanga, Williams), 2 PhD students (Britavskiy, Kourniotis) and 3 additional postdocs, who are expected to arrive in early 2014. In the period 2005-2012, Dr. Boumis supervised or co-supervised 3 PhD (Akras, Alikakos, Leonidaki), 3 MSc students (Akras, Alikakos, Galanakis) and 3 undergraduate students (Abartzi, Kaparianou, Kyparissis), while Dr. Bonanos supervised 3 MSc students (Koumpia, Markakis, Kourniotis) and 1 postdoctoral researcher (Castro).

The team has expertise in ground-based observations with optical telescopes in both photometry and spectroscopy. The goals of the team are to address outstanding questions in stellar evolution, e.g.: (a) the mass loss mechanisms in the final stages of massive star evolution, (b) constraining formation and evolution models of massive stars by providing dynamically measured fundamental parameters from eclipsing binaries, (c) the formation mechanisms of planetary nebulae and supernova remnants by studying their morphology and kinematics and via theoretical modelling, (d) supernova remnants as catalysts in the structure and transformation of the interstellar medium, (e) calibrating the extragalactic distance scale with eclipsing binary distances to Local Group galaxies, (f) studying the nature of the supermassive black hole in the Galactic Center via the properties of hypervelocity stars, (g) as well as in galactic morphology through radiative transfer modeling of optical and infrared data..

Observations are conducted with ground-based telescopes (Aristarchos 2.3m, Skinakas 1.3m, INT, VLT 8m, Magellan 6.5m, Swope 1m, Dupont 2.5m, San Pedro Martir 2.1m, William Herschel Telescope 4.2m, Blanco 4m), which are also supplemented by space based archival data (e.g. Spitzer, XMM). The team has >500 nights of observing experience.

The group is currently funded by the following grants: 1) Aristeia I: “Revealed by their Own Dust: Identifying the Missing Links in Massive Star Evolution” (GSRT), 2) Support of Postdoctoral Researchers: “THEoretical Modelling and multi-wavelength Observations of evolved Stars (THEMOS)” (GSRT), 3) Aristeia II: “The Manchester-Athens Wide-Field Narrow-Band Camera: A Deep Sky-Survey of the Extensive Line Emission Regions at High Galactic Latitudes” (GSRT). In total, the group has attracted over **800,000 euros** to the Institute in national and European competitive grants.

In the period 2005-2012, the team published 40 (83) refereed papers, which received 613 citations (628) as of November 2013. (The number including non-refereed papers is given in parentheses). Furthermore, the group undertook the organization of the 10th Symposium on Massive Stars, titled “Massive Stars: From α to Ω” (June 2013, Rhodes, Greece), as SOC and LOC chairs.

2.2 Solar-Terrestrial Environment-Space Physics (STE)

The solar-terrestrial system is dominated by effects from the Sun and the solar wind, which impact the Earth’s upper atmosphere. The field of work includes studies of the solar atmosphere, the interaction of the earth’s magnetosphere with the solar wind, and the impact of charged particles that originate from the Sun on the upper atmospheric conditions. There are three research groups involved in this broad research activity.

2.2.1 Solar Physics

The Solar Physics group 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). These observational tools provide, through a multi-wavelength analysis, coverage of the solar atmosphere from the lower layers to the outer corona and permit the extraction of quantitative information about the physical parameters that describe the thermodynamic state of the solar plasma. 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 are mainly based on observations of fine-scale structures, with the aim of investigating their morphological characteristics, dynamical behaviour, physical properties etc. The ultimate goal is to understand the role they play in coronal heating (which is one of the unsolved problems of solar physics). Active Sun studies of the group mainly focus on sunspots. Sunspots are the best known features on the solar surface, and are associated with high concentrations of magnetic field fluxes. Sunspot observations and analyses of the group mainly focus on the study of oscillations and waves observed in their atmospheres through wavelet analysis.

The group has close collaborations with several well-established solar groups like the ones at the Academy of Athens (Greece), Paris Observatory (France), Utrecht University (The Netherlands), Ondrejov Observatory (Czech Republic) and Armagh Observatory (UK). It is involved in several observational campaigns as Principal Investigator or Guest Investigator and has been funded several times by the European Commission or through OPTICON to carry out these campaigns. The members of the group have published several papers in peer-review journals and conference proceedings, served as referees in a large number of international scientific journals, supervised PhD students and post-docs, and participated in several international and national conferences and in public outreach activities. They have been involved in the organization of international/national meetings, have submitted several proposals for funding as PIs or CoIs and have coordinated or participated in several observational campaigns and funded projects. The group has attracted funds from the EC (Marie-Curie reintegration grant) and the GSRT (bi-lateral research projects, PENED project, Support for Post-doctoral Research project and an EXCELLENCE project). It is also worth mentioning that in 2012 members of the group have participated in a consortium consisting of 60 researchers from different Institutes around Europe, which submitted a proposal to ESA (after an open call) for an S-class solar space mission. The proposal, although not selected at the end, has been ranked among the first 3 out of the 50 submitted proposals.

2.2.2 Space Research and Technology

The Space Research and Technology Team specializes in studies of planetary and interplanetary plasmas, geomagnetism and space magnetism, and space weather prediction. It operates the HellENIc GeoMagnetic Array (ENIGMA) an array of 3 ground-based magnetometer stations in the areas of Trikala, Attiki and Lakonia that provides measurements for the study of geomagnetic pulsations, resulting from the solar wind - magnetosphere coupling. (For more details visit: http://proteus.space.noa.gr/~srtg/index.php/groupfacilities/2-uncategorised/20-geomag). ENIGMA is part of SuperMAG (http://supermag.jhuapl.edu/), a worldwide collaboration of organizations and national agencies that currently operate more than 300 ground-based magnetometers.

The team has developed and operates the Solar Energetic Proton Flux (SEPF) tool (http://proteus.space.noa.gr/sepf_tool/), which provides solar energetic proton fluxes at various locations in space using the count-rate measurements of the ESA Standard Radiation Environment Monitor (SREM) units on-board INTEGRAL, Herschel, Planck, and Rosetta spacecraft. The team is a member of the Validation Team of the Swarm satellite mission of the European Space Agency. Active collaborations exist with the Department of Physics at the University of Athens (Prof. I. Daglis, former Director of IAASARS), the Department of Physics at the University of Thessaloniki (Prof. L. Vlahos) and the Academy of Athens (Dr. M. Georgoulis).

The main scientific objective of the team is the detailed investigation of interconnected space plasma physics phenomena at the Sun, the interplanetary space and the Earth and other planets. The Group has become involved in the design and implementation of space instrumentation and in the application of innovative space communications for efficient space-data exploitation.

Research topics include among others:

- Charged particle acceleration mechanisms and radiation processes
- Geospace magnetic storms
- Magnetosphere-ionosphere coupling
- Ring current and radiation belts
- Solar energetic particle events
- Wave-particle interactions

The research activity of the Group involves:

- Development of original advanced algorithms for processing raw space measurements of particles and the electromagnetic field, as well as methodologies for data assimilation in order to study physical parameters related to space exploration, i.e. surveying, mapping and understanding of the near-Earth Space and our Solar System planets (Research programs ESA/SREM-SPE, ESA/ULFwave, ESA/SRREMs, FP7/MAARBLE, FP7/SDR, Thalis/Hellenic National Space Weather Research Network, participation in data analysis ESA/Cluster, ESA/MarsExpress, NASA/THEMIS).
- Modelling and analysis software development for the implementation of space mission objectives.
- Theoretical studies and numerical simulations of basic plasma physical processes.
- Technology development for space instrumentation.

The Group has been participating in several ESA and NASA space missions under the Co-Investigator or Group Member status (e.g., BepiColombo, Solar Orbiter, Rosetta, Cluster, THEMIS, etc.). Active collaboration exists with a number of research institutes in Europe, USA and Japan. In the period 2005-2012, the team published 41 referred papers in International Journals and has attracted over **2, 900,000 euros** to the Institute trough National and European competitive grants.

2.2.3 Ionospheric Physics

The main activities of the Ionospheric Group focus on the performance of systematic ionospheric monitoring and the development of ionospheric and trans-ionospheric nowcasting and prediction systems through the on-line implementation of advanced modelling techniques ingesting ground and space data from all geospace regions. Since 2000, the group operates the Athens Digisonde, which is of key importance for HF communications due to its unique geographic location. The Digisonde is maintained and upgraded with funding provided by research projects of the Ionospheric Group. The Ionospheric Group participates in a large number of European and international projects funded by EC, ESA, NATO, EOARD, etc., either as the prime investigator and coordinator or contractor (http://www.iono.noa.gr). The Ionospheric Group coordinated the EC-DIAS Project (2004-2006), the EC COST Action ES0803 (2008-2012), and currently is a key partner in the EC-ESPAS FP7 e-Infrastructure project (2011-2015), having the responsibility of the scientific management of the project.

The strategic goal of the Ionospheric Group of IAASARS is the establishment of a unique e-infrastructure in Europe and worldwide for the monitoring, specification, forecasting and prediction of the ionosphere - plasmasphere – thermosphere environment for both scientific

and operational applications. The DIAS system (European Digital Upper Atmosphere Server) that is operated, maintained and upgraded through research projects managed by the Ionospheric Group, is the core of this activity and the main system in Europe that provides alerts, nowcasts and forecasts for ionospheric conditions. The DIAS network supports 12 international organizations, providing data in real-time and having more than 550 users of its products, which come from academia and the private sector, including ESA, NOAA and IZMIRAN. DIAS was recently upgraded with the implementation of advanced ionospheric prediction and electron density reconstruction models using data from additional ionosondes, spacecraft data from the interplanetary medium and the near-Earth geospace, as well as data from space and ground GNSS receivers. All scientific models implemented in DIAS are validated according the CCMC/NASA methodology.

Today, the Ionospheric Group though its research infrastructures, provides services able to systematically support HF communication systems, satellites orbiting at LEO and MEO heights and systems relying on transionospheric propagation, at any location of the Earth's upper atmosphere up to the plasmapause, and protect these systems from ionospheric disturbances and irregularities triggered by space weather events.

The ionospheric group is a key player in the space weather community in Europe, coordinating - in collaboration with ROB and ESA - the scientific organization of the European Space Weather Weeks (since 2009), the organization of training schools for PhD students, young researchers and engineers, and leading the main scientific peer review journal of this field in Europe, the Journal of Space Weather and Space Climate, published by EDPS.

Incoming funds to the Institute attributed to activity of the Ionospheric Group (2005 - 2012): **1,117,000 euros**.

2.3 Remote Sensing

IAASARS is the only Greek Research Institution with a constant presence and activity in Earth Observation (EO) using space-borne and ground-based remote sensing techniques. The Remote Sensing (RS) group consists of seven (7) tenured researchers (H. Kontoes, N. Sifakis, K. Koutroumbas, A. Rontogiannis, V. Amiridis, I. Keramitsoglou, O. Sykioti) and more than 15 postdoctoral researchers and PhD students. The RS group of IAASARS focuses on scientific research and development of products and services related to environment dynamics, and on-going climate change, with the objective to monitor and assess the physical phenomena occurring in Earth's environment. Taking advantage of the data-receiving infrastructure and the systematic access in space observations in different spatial and spectral resolutions, as well as the use of ground-based infrastructure and advanced models, the group provides on a daily basis and in near real time observations and services to EC, ESA and to various authorities and entities at National and European level (e.g. Ministries, Civil Protection Authorities, municipalities, Regional Services, Environmental Organizations). In this way IAASARS has been designated and established at a European Committee and ESA level, as a National link for the generation, collection and distribution of satellite products and services with emphasis on natural disaster management and civil protection, related to (a) Management and monitoring of Natural Disasters (e.g. fires, floods, volcanic eruptions, earthquakes, landslides) and protection of citizens from these phenomena, (b) Protection of the Natural Environment and Forests, (c) Monitoring of the Atmospheric Environment, (d) Monitoring and study of heat-wave risk and the urban heat island in large cities and (e) Mineral/chemical detection and mapping (earth and planetary).

Key areas of expertise that has been developed by the group are:

- Operation of space based and in-situ observational networks, systematic acquisition and archiving of satellite images and environmental data from the most known satellite missions such as MSG-SEVIRI, MODIS, NPP, AVHRR, METOP, ERS, ENVISAT, Landsat, and other third party missions.
- Systematic operation of ground-based remote sensing Infrastructure, i.e. the Atmospheric Remote Sensing Station of IAASARS (part of NASA-AERONET global Network) and the EMORAL mobile lidar facility.
- Routine processing of EO imagery (optical, thermal, radar) of different spatial resolutions (HR to VHSR), in conjunction with other space related and in-situ derived observations (e.g. GPS/GNSS, gravity, seismic, and meteo/hydrology data) for the production of added-value products and information, providing services to Civil Protection authorities for the environment, as well as the security of citizens in periods of crisis and/or natural disasters (forest fires, earthquakes, landslides, floods, heat waves, desert dust storms).
- Development of innovative algorithms for satellite data processing from advanced Space sensors (e.g. HR-VHSR, thermal, infrared, lidar, SAR, and hyperspectral sensors), aiming to monitor physical parameters critical to Earth, ranging from the atmosphere to the subsoil.
- Validation of EO data using ground-based stations of NOA and similar global networks, as well as data acquired by aircrafts in the framework of experimental campaigns.
- Processing and interpretation of interferometric measurements from satellite-borne synthetic aperture radar systems (SAR) to investigate the displacements of the solid crust of the Earth as a result of earthquakes, volcanic activity, urban subsidence and other manmade activities (e.g. underground water or gas extraction). Analysis of observations from infrared and optical sensors using sophisticated processing software and specialized applications.
- Development and theoretical analysis of innovative algorithms in the following research areas: signal and image processing, pattern recognition (classification, clustering), compressive sensing and sparse signal representations, hyperspectral image (HSI) processing.
- Application of HSI techniques in Imaging Spectroscopy environmental applications such as chemical/mineral (Earth and planetary) exploration/mapping and analysis of landscape dynamics and vegetation status. Analysis of hyperspectral measurements from ESA, NASA, and third party space missions and ground based spectral measurements.
- Development and population of databases of long time series of raw, lower level and added-value space products using observations from ESA, NASA, and third party space missions, and future Copernicus missions.
- Integration of state-of-the-art array database and semantic-web technologies for effectively managing big EO data volumes and connecting to other distributed geo-databases.
- Development of GMES/GNSS mobile services relating to environmental status for the benefit of the European citizens.

IAASARS has a longstanding experience in developing EO based observation and information systems, and services for Emergency Planning and Emergency Support, Environmental Monitoring, Civil Protection and Public Security, supporting governmental bodies, decision makers, environmentalists, ministerial bodies, civil protection, and local authorities. IAASARS/NOA with its dedicated EO activity has been nominated and also qualified at a European level as GMES (Copernicus) Emergency Response and Emergency Support Core Service Provider, with the mandate to (a) generate and distribute in Greece and EU Services and Application Products supporting the Emergency Management (through the dedicated GMES

(Copernicus) related projects), and (b) Support the implementation of an operational Global Monitoring for Environment and Security service in the field of emergency management.

Current activities of the Remote Sensing group aim at the consolidation of activities for establishing a Centre of Excellence for EO-based monitoring of Natural Disasters in southeastern Europe, with a prospect to increase its access range to the wider Mediterranean region. This initiative, supported by the EU in the frame of the BEYOND capacity building program awarded to IAASARS (http://beyond-eocenter.eu/), in conjunction to the foreseen installation at IAASARS of an ESA mirror site for collecting, processing and distributing data and higher level products for the upcoming Sentinel satellite family, is anticipated to constitute the Remote Sensing group as a European innovation hub in the following years.

Additionally, the group shows significant research activity in the development of innovative hyper-spectral image processing techniques and tools, utilizing sophisticated concepts from the signal processing and pattern recognition fields, suitable for earth and planetary mineral and chemical exploration and vegetation thematic monitoring and mapping.

The last eight years the group has attracted over **2,500,000 euros** in competitive national and European grants.

3. SCIENTIFIC EVENTS ORGANIZED

3.1 Conferences

IAASARS research groups regularly undertake the organization of international conferences:

1) The X-ray Astronomy group organizes a large conference on X-ray Astronomy and Cosmology approximately every four years. The last two events were:
   "X-ray Surveys: Evolution of AGN, galaxies & Large Scale Structure", Rhodes, Greece, July 2007 (130 participants)
   "50 years of X-ray Astronomy", Mykonos, Greece, September 2012 (130 participants)

2) In 2009, the *International Astronomical Union* Working Group on Massive Stars selected two IAASARS researchers to organize the most recent symposium on Massive Stars, which occur every 4-5 years:
   "Massive Stars: From α to Ω", Rhodes, Greece, June 2013 (226 participants)
   http://a2omega-conference.net

3) The Gaia group in collaboration with the University of Athens organized the meeting:
"The Cosmic Odyssey of the Elements", Aegina, Greece, June 2008

4) The Ionospheric Group in collaboration with ESA and ROB organized the following conferences:

   - "Second European Space Weather Week", Noordwijk, The Netherlands, November 2005 (120 participants)
   - "Third European Space Weather Week", Brussels, Belgium, November 2006 (150 participants)
   - "Fourth European Space Weather Week", Brussels, Belgium, November 2007 (170 participants)
   - "Fifth European Space Weather Week", Brussels, Belgium, November 2008 (170 participants)
   - "Sixth European Space Weather Week", Brugge, Belgium, November 2009 (230 participants)
   - "Seventh European Space Weather Week", Brugge, Belgium, November 2010 (250 participants)
   - "Eighth European Space Weather Week", Namur, Belgium, November 2011 (240 participants)
   - "Ninth European Space Weather Week", Brussels, Belgium, November 2012 (290 participants)
   - In collaboration with INGV, the group also organized the:
   - "DIAS Final Conference", Rome, Italy, May 2006 (50 participants)

5) The Solar Physics group in collaboration with the Academy of Athens organized the following meetings:
   - "13th European Solar Physics Meeting", Rhodes, Greece, September 2011 (220 participants)
     http://astro.academyofathens.gr/espm13/

   - "Novel methods for the transmission, reception and analysis of signals and images from space instruments", Athens, Greece, June 2009 (~30 PhD and postdocs)

- "Solar small-scale transient events", Bern, Switzerland, January 2009 (1st meeting) and January 2010 (2nd meeting) (18 participants)

6) The Space Research and Technology group organized the following conferences:
   - "Cluster 10th Anniversary Workshop - Understanding the solar wind-magnetosphere interaction at multiple scales with Cluster, THEMIS and Double Star", Corfu, Greece, Sept. 2010 (180 participants) http://caa.estec.esa.int/wksp/cluster_workshop20.xml
   - "Modern Challenges in Nonlinear Plasma Physics", Halkidiki, Greece, June 2009 (150 participants) http://www.astro.auth.gr/~vlahos/kp
   - "ESF Workshop on Tracing dust in spiral galaxies", Ghent, Belgium, May 2007 (29 participants) http://www.arcetri.astro.it/radtran/
   - "ESF/ESA Workshop on the Science of European Space Exploration", Athens, Greece, May 2007 (100 participants) http://www.space.noa.gr/esfesa/index.html
   - "Second Solar Orbiter Workshop", Athens, Greece, October 2006. http://conferences.phys.uoa.gr/solo2006/

7) The Remote Sensing group in collaboration with National Technical University of Athens and the Aristotle University of Thessaloniki organized the:
   "26th International Laser Radar Conference", Porto Heli, Greece, June 2012 (216 participants)
   http://ilrc26-2012.gr/mdlcms/index.php

3.2 International Workshops

Research groups of the Institute regularly undertake the organization of international workshops related to projects they participate in. The meetings usually involve 20-40 people and take place at NOA facilities or other venues in Greece. Members of the Institute have organized the following workshops: the "Double stars with Gaia" meeting in 2006, the "Workshop of the Hermean Environment Working Group" in 2009, the workshop "M33 as seen by Herschel" in 2010, the "Herschel Virgo Cluster Survey (HeViCS)" consortium meeting in 2012, the "Coronal Mass Ejections and Solar Energetic Particles (COMESEP)" project meeting in 2012, the "2013 Radiation Belts Workshop", and the GREAT-ESF workshop "Extragalactic Science with Gaia" group meeting in 2013. An XMM/XXL AGN consortium meeting is planned for the Spring of 2014.

3.3 Seminars

The Institute organizes a seminar series on a semi-regular basis, with over 20 seminars each academic year. All current and past seminar are available online. The series includes many seminars by distinguished professors and scientists from all over the world, e.g. from University of Oxford, Space Telescope Science Institute, Durham University, Harvard University, University of Hawaii, NASA Goddard, Observatoire de Paris etc.

4. EDUCATION

4.1 Ph.D. and M.Sc. Supervision

Members of IAASARS regularly supervise postgraduate students (Ph.D. and M.Sc.). In the period 2005-2012, at total of 13 M.Sc. (Leonidaki, Koulouridis, Akras, Fotopoulou, Koutoulidis, Koumpia, Alikakos, Markakis, Giannaki, Tsouni, Papoutsis, Hairekakis, Georgiou) and 13 Ph.D. (Alikakos, Akras, Koulouridis, Leonidaki, Akylas, Ropokis, Thelemis, Kontogiannis, Metallinou, Bithas, Sagias, Papadimitriou, Benmayor) theses have been supervised by Institute researchers. Since the Institute cannot formally award academic degrees the students were registered in collaborating Universities, primarily the University of Athens, the University of Patras and the University of Thessaloniki.

4.2 Advanced Astronomy Schools

The X-ray group has so far organised four "Advanced Astronomy Schools", which are aimed at postgraduates and young postdoctoral researchers working in Greece and are offered to them free of charge. The schools were held in September 2006 (NOA), September 2008 (NOA), September 2010 (University of Athens) and December 2012 (University of Athens) and attracted 20-30 participants each. The topics revolved around X-ray Astronomy, Active Galactic Nuclei, the Obscured Universe and the European Space Agency's (ESA) X-ray Multi-Mirror Mission (*XMM-Newton*). Keynote speakers included well-known international experts in the field, such as Prof. K. Nandra (Director at the Max Planck Institute for Extraterrestrial Physics, Germany), Prof. M. Rowan-Robinson (Imperial College London, UK), Dr. G. Chartas (College of Charleston, USA), Dr. L. Granato (INAF-Padova, Italy), Dr. A. Comastri (Astronomical Observatory of Bologna, Italy), as well as several University professors and researchers from Greece.

4.3 Postgraduate Teaching

Members of the Institute are often invited by colleagues at various universities in Greece to deliver postgraduate lectures (e.g. University of Thessaloniki). Moreover, they deliver courses at summer schools for graduate students, such as the winter schools organized by the University of Thessaloniki in 2010 and 2011, or the Institute's "Advanced Astronomy Schools" described above.

4.4 Internships for Undergraduate Students

The Institute actively participates in the "practical training and career experience" program, which is a requirement for all undergraduate students in Greek Universities to obtain their degree. Typically 3-4 undergraduate students per year have the opportunity to carry out short scientific projects (3 month duration) supervised by researchers of the Institute. Such internships provide the students – for the first time – with experience in research projects, e.g. with literature searches, data analysis, software development and preparing scientific reports.

4.5 Astronomy Summer School for High School Students

The Institute runs a 3-day summer school every September (since 1996), which is aimed at talented high school (Lyceum) students (11^{th}-12^{th} grade, i.e. 17-18 yrs old) with an interest in Astronomy. The summer school attracts about ~50 students each year, selected out of ~150 students who apply to participate in the school. The summer school consists of lectures on modern Astrophysics by NOA researchers, short hands-on group projects and observations using the 60cm Newall telescope and other historical telescopes of NOA on one or more evenings. On the last day, the student groups present the results of their projects, receive their certificates of participation and attend a talk by a prominent invited speaker.

5. PUBLIC OUTREACH

5.1 Visitor Center

The Visitor Center of the Institute has been operating in Penteli since 1995. Its purpose is science education and public outreach aiming in particular at middle- and high school students. This is accomplished through special seminars, talks, and observations with the historic 62.5cm Newall refractor in Penteli. The Center also produces educational movies on various astronomy related topics, which are presented to our visitors during the tours. The Visitor Center is located in the original building of the Newall refractor at the Penteli Astronomical Station (about 15 km from the center of Athens) and was completely refurbished in 2013. **More than 200.000 people and about 6.000 schools have visited the Center** since it commenced its operations. The Visitor Center opens to the public at least two weekends a month (Friday and Sunday nights). The tours consist of oral and video presentations, followed by a tour of the Newall telescope and observations, weather permitting.

The Visitor Center expanded in 2007 with the opening of the Observatory's Geoastrophysics Museum at Thiseio. Tours of the telescopes of the Institute at the historic site of Thiseio at the center of Athens (including the 40-cm Doridis refractor and the 16-cm Syggros refractor) routinely take place. The 1.2m telescope of Kryoneri is also used for public outreach activities.

5.2 Cosmic Pathways

Since 2004, the Institute publishes, electronic journal called "*Cosmic Pathways*" with the goal of informing and educating the Greek public about new discoveries in the field of Astronomy and Astrophysics, as well as the basic principles of the field. (see http://www.astro.noa.gr/journal/). Even though changes in the personnel and structure of the Institute caused a temporary cessation of the regular website updates in mid-2010, the web page has been reorganized and regular publications will commence in January 2014, with a component in the social media. It should also be mentioned that two permanent staff members of IAASARS maintain the facebook page of the National Observatory of Athens, publishing astronomy news on a weekly basis. In the peak of its activity in 2006 and 2008, the "Cosmic Pathways" website recorded almost 2,000 visits per day.

5.3 Public Outreach Lectures

IAASARS researchers actively contribute to public outreach by participating in various events or giving lectures around Greece. The Institute organized an extensive series of lectures and events during the 2009 International Year of Astronomy (IYA2009), participated in the annual FP7 Researchers' Night event during 2007-2013, collaborated with the British Council in Athens in the framework of its Café Scientifique activity. It also initiated and co-organized two public talks with the Eugenides Foundation: by NASA astronaut James Newman (September 2011) and ESA astronaut C. Nicollier (June 2013), which attracted ~700 people each. In addition, many Institute members receive invitations to give public lectures, e.g. at the Open Popular University in Crete, the Municipality of Thessaloniki, the Association of High School Astronomy Teachers, the Municipality of Kavala, the Conference of Amateur Astronomers in Greece, the Society of Friends of Astronomy (Kos), UNESCO Association (Kalamata), the Athens University History Museum.

6. SERVICES

The institute provides the following services

6.1 Astronomical Data

- Regular services: The yearly Astronomical Almanac of the Institute is published and sold to specific publishing companies in Greece. It is also provide upon request and free of charge to government institutions and non-profit organizations.
- Services by request: – issuing certificates for legal cases requiring astronomical data and preparing information on specific phenomena (e.g. sunset and sunrise times).
- Online service: An almanac with all major astronomical events, rise and set times of the sun and the planets, visibility of stars, sky maps etc. is available online in a dedicated location of the web server of the institute (http://www.astro.noa.gr)

6.2 Ionospheric Data

- Athens Digisonde (http://www.iono.noa.gr) provides the following services through its GUI to 553 subscribed users: Doppler Ionograms; Critical ionospheric parameters; Drift velocities; Sky maps; Daily Directograms; Ionospheric forecasts over Athens; Maximum Usable Frequencies for specific transmission paths in Greece. All products are available in real-time. Historical data can be also downloaded through the GUI interface.

- The DIAS system (http://dias.space.noa.gr) provides the following services in real-time to more than 500 subscribed users through its GUI: nowcasting of the ionosphere and plasma-sphere over Europe; long term predictions and forecasts; ionospheric alerts. A full archive of historical data and products is also kept and can be accessed through the GUI.

7. IAASARS/NOA FIVE-YEAR OPERATION PLAN

In the following we present in brief the operation plan (OP) for the Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing (IAASARS). This is the first long term 5-year OP since the institute was formed in early 2012, from the merging of the Institute of Astronomy and Astrophysics (IAA) and the Institute for Space Applications and Remote Sensing (ISARS). The directions described and strategy to be followed relies heavily on a) the recommendations of the 2000 and 2005 evaluation reports (ERs) of the committees of experts for IAA and ISARS b) the successful evaluation and assessment by the General Secretariat of Research and Technology (GSRT) of the 3-year planning of IAASARS presented in its 2012 KRIPIS-PROTEAS proposal.

The structure of the document is as follows: First we highlight the key strengths and weaknesses identified by the ERs until 2005. Then we summarize the measures taken to address them during the 2005-2012 period and how these fall within the new structure of IAASARS. Finally, we expand on the key areas of research, service and public outreach excellence of the institute and how we propose to continue our activities along these directions.

7.1 Main Strengths and Weaknesses Identified

The 2000 and 2005 ERs on the personnel, infrastructure, and quality of research of IAA and ISARS, that now comprise IAASARS, identified a number of positive elements. These included scientific excellence in cutting edge areas of basic science, such as the X-ray astrophysics, the space physics (solar & terrestrial), and ionospheric physics, as well as in more applied fields such as satellite remote sensing and telecommunications, in which the institute plays a leading role in Greece. The researchers of both institutes were found of high quality, the R&D and innovation activity well developed and the potential for synergy among the various groups very promising.

In parallel, the ERs identified that for the total number of permanent researchers of the institute there were many research groups with small critical mass, affecting the competitiveness in the international field. It also appeared that there was some lack of flexibility in reassigning technical personnel to new functional tasks. Furthermore, the limited resources provided by the state, as well as the bureaucracy in recruiting new personnel, made the maintenance and upgrade of the research infrastructures rather challenging. In particular, it was identified that performance of major new facilities of the institute, such as the Aristarchos telescope were not fully evaluated and its research potential was not fully explored. Moreover, the use of older out-of-date facilities, which were no longer competitive in research, such as the Kryoneri telescope, would have to be rescoped.

7.2 Key Measures Taken during 2005-2012

Responding to the issues mentioned above, the leadership of IAA and ISARS as well as NOA were able to recruit six high quality junior researchers (four males and two females) with international research experience. The individuals had a strong background in key research areas where the institute either had documented excellence (X-rays astrophysics, space physics, and remote sensing) or covered new research directions associated with major infrastructure that needed support (ie optical astrophysics and instrumentation related to Aristarchos telescope).

The quality of the additional personnel and the recent merging of IAA and ISARS into the new structure of IAASARS, greatly facilitated the interaction among researchers and the development of close synergies. As we will discuss in more detail later this has already become evident by the close collaborations among members of the signal processing/pattern recognition and remote sensing groups, as well as by the development of common projects between the space physics and X-ray astrophysics groups. Furthermore, the permanent research support and technical personnel are currently under a single unit, which greatly facilitates their assignment to new tasks that need additional support. As a consequence the critical mass and personnel issue raised in the ERs is currently being addressed and the outlook is positive.

The issue of research infrastructure support was addressed in a twofold manner: The researchers of IAASARS were able to attract substantial external funding via competitive proposals, in particular over the past three years, which is enabling the upgrades of key elements of the infrastructures (see CVs of permanent researchers in the Annex for details on funding and projects/infrastructure supported)

The institute as a whole was awarded over 1.2 million euros by the GSRT, under the KRIPIS-PROTEAS grant. This will enable us to upgrade a substantial part of its research facilities as well as recruit, in the short term (OR on short term contracts), engineers, senior experts, and postdoctoral researchers. Furthermore, as discussed in the public outreach section of the operation plan, out-of-date resources, such as the 1.2m telescope at Kryoneri, is being phased out from supporting research into a purely public outreach and educational facility which is mainly supported by the local region.

7.3 Operation Plan towards Horizon 2018

The strategic and operational plan of IAASARS over the next five years has as a main goal to strengthen the pure and applied research of the institute and increase its output in a measurable manner in terms of science publications, services provided and impact to the society. In the following we identify each of the six individual elements (subsections 7.3.1 to 7.3.6) needed to achieve it.

7.3.1 Human Resources

The fiscal challenges currently facing the Greek government make it highly unlikely that funding for additional permanent research personnel will become available. We are thus limited to the present permanent personnel of the institute, as well as postdoctoral researchers and engineers that can be supported via soft money from competitive grants. In parallel -in close coordination with the central administration of NOA- we are actively contacting select senior and dynamic junior scientists in other institutes in Greece and abroad, who have common interests and/or existing collaborations with research groups of our institute. Our goal is to offer them the possibility of becoming "affiliated researchers" of IAASARS, a status that will provide to them full access to all research infrastructures and facilities of the institute, currently reserved to permanent staff. We envision that this will foster closer collaborations and twining between their groups and ours, which will have long-term positive impact for the institute.

7.3.2 IAASARS as a Center of Excellence in Astrophysics and Space Physics

As already described in detail in the 2005-2012 activity report, there is a vigorous high quality research activity in several areas of observational astrophysics. The institute has been significantly involved in astrophysics missions (Herschel, XMM-Newton, GAIA, eROSITA) and has accumulated substantial experience both in project realization as well as scientific exploitation of the results.

It should be stressed that two tenured researchers of the Institute are members of the data processing and analysis consortium of GAIA, an ESA cornerstone mission. They have thus developed an in-depth knowledge of the analysis of the huge volume of data to be released once GAIA is in full operation. We envision that their experience, along with the expertise of the signal processing group of IAASARS, will provide our researchers with a strategic advantage in harvesting the scientific results of the mission. In addition scientists of IAASARS have established strategic collaborations with MPE (Germany), via a sabbatical leave of a permanent researcher, who is directly involved with the science feasibility and support of eROSITA as well as the recently approved Athena+, the major future X-ray mission of ESA to be launched in 2028. The expertise of the X-ray group acquired from the collaboration with the XMM-Newton Survey Science center is an important asset for future software development for Athena+. The same holds true for the expertise developed through the collaboration with MPE on eROSITA software development. A close synergy is also being developed between the X-ray and IR astrophysics groups, facilitated by a recently funded THALES project. The IR group will use the experience developed in the calibration and validation of Herschel/HIFI and Spitzer/IRS and explore all possibilities to become involved in the next contribution of ESA to a space infrared mission (possibly via SPICA).

IAASARS supervised the construction and currently operates the 2.3m Aristarchos telescope, the largest in Greece and 2nd largest in continental Europe. After a long period of validation, engineering, and testing, the first refereed publications of science observations were published in 2013. There are two instruments fully commissioned at the telescope an optical camera and RISE2 - an instrument dedicated to studying exoplanets. More are expected to come online in 2014 and in particular a low-resolution optical spectrograph. Assuming that the present level of funding remains we should be able to support the science operations of the telescope for the estimated ~100 nights of clear weather per year, over the next five years. The telescope will

support the activities of the astrophysics group, as well as other researchers and collaborators in Europe. A number of observing projects commenced in the past observing season and will be continued in the near future. In particular there are plans on the following projects:

- Search for earth mass companions to exoplanet host stars
- Morpho-kinematic study of Galactic SNRs
- Study of boxy/peanut shape bulges in edge-on galaxies
- B,V,R imaging of edge-one galaxies: comparison with far-IR Herschel data and radiative transfer modeling
- Narrow-line imaging of elliptical galaxies – evidence of star forming and shocked gas
- Narrow-line imaging of Hickson Compact Groups
- Optical imaging of open clusters: deriving their rotation periods.

More details on Aristarchos and the characterization of the Helmos Observatory site are available in Appendix II.

In the area of Space Physics, IAASARS has been a key partner in the ROSETA and CLUSTER missions. Activity along these lines is expected to continue as researchers of the institute are directly involved in seven space missions that are under development. The Solar-Terrestrial Environment-Space Physics (STE) Group has extensive experience in the area of data analysis, theoretical interpretation and modelling of observations and measurements taken from space-borne and ground-based instruments covering all layers of the solar atmosphere, the interplanetary medium, the magnetosphere and the ionosphere. It also has a strong record in monitoring, modeling and forecasting space weather effects originating in the Sun and affecting the geospace environment, through the coordination of three large EC consortia (DIAS/eContent, MAARBLE/FP7, COSTES0803/COST Office), through its initiatives for the establishment of the "European Space Weather Week" as the main conference for the space weather community in Europe (in collaboration with SIDC/ROB and ESA), its leadership for the setup of the open access international Journal of Space Weather and Space Climate and its systematic participation to a series of EC projects (COST Office, FP6, FP7, CIPS), and to a number of ESA, NATO, EOARD and ISSI contracts and grants. These activities have led already to the operation of the European Ionsonde Service, which is part of the ESA Space Situational Awareness Programme, releasing a number of worldwide unique products and services to space agencies, telecommunication and broadcasting companies, civil protection agencies, satellite operators and academic institutions among others. Moreover, the group has developed and maintains a unique network of magnetometers (ENIGMA - HellENIc GeoMagnetic Array) in southeast Europe and through this it is a partner in the SuperMAG world network.

For the next five years the strategic plan of the Space Physics group is to continue, more intensively and in cooperation with the International Community, with the detailed investigation and understanding of the physical processes governing the Sun and the Solar-Terrestrial system. A major goal of the group is to integrate existing knowledge, infrastructure and tools together with new research achievements into a Regional Center of Excellence for Space Weather that a) will develop advanced models through data assimilation and simulation for the evolution of dynamic solar phenomena covering the whole chain of processes from the Sun to the Earth's upper atmosphere, b) will improve the space weather predictions in the geospace environment to meet the operational users requirements, and the distribution of

services to users with an upgraded set of products and with a documented accuracy following the standards of CCMC/NASA for the validation of space weather models.

The basic cornerstones of the Regional Center of Excellence for Space Weather are already in place within distinct and clear actions: a) The DIAS system that produces and distributes, in collaboration with world leading institutes, worldwide unique services for the specification of conditions in the ionosphere and the plasmasphere; b) The ENIGMA array that provides geomagnetic field measurements which are essential for correlative satellite and ground-based studies of various magnetospheric phenomena. The ENIGMA data combined with the magnetometer measurements performed onboard the Cluster satellites and the recently launched Swarm satellites will provide the unique opportunity to study the geomagnetic pulsations, resulting from solar wind - magnetosphere coupling; c) The KRIPIS-PROTEAS project that focuses on the upgrade of the monitoring infrastructure and on enhancing the DIAS capabilities with procurement of a small solar telescope and the deployment of the Helioserver that will automatically issue information for solar flares, proton events and coronal mass ejections, triggering new algorithms and leading to a more accurate forecast of the space weather effects on the geospace environment; d) The new "Excellence" project that focuses on the study of solar phenomena and their role in the solar wind; e) The operation of the European Ionosonde Service within the ESA SSA Programme; f) The ESPAS project, funded from EC FP7-RI, that has the objective to develop standards and e-science tools that will facilitate the access to data from the near-Earth space environment. The DIAS database is the main ESPAS repository for ionospheric datasets, and the work of homogenizing DIAS metadata and harvesting them to the ESPAS platform is already under implementation. This will provide us with the necessary know how to apply standards for data archiving, data transfer and query; g) The Hellenic National Space Weather Research Network, funded under the THALES program, where the Space Physics team participates in addition to a number of space weather related activities/contracts funded by ESA; h) The continuous operation of the Athens Digisonde that identifies in real-time the vertical and horizontal structure of the ionospheric plasma over Greece, releases its products to the WDC and supports cal/val campaigns of MEO and LEO satellites; i) The computer cluster of the institute that performs time demanding numerical calculations in order to address complex questions and compare theoretical models with observations.

Given the research, experimental and operational background developed in the previous ten years, the funding attracted and the favorable prospects following the scheduled operations for the next five, the Regional Center of Excellence for Space Weather, will further enhanced its activities with focus on the modeling of the near-Earth space environment; validation of models; issuing predictions and alerts for the state of space weather; continue more systematically the educational and awareness activities towards users and emergency management agencies, given that space weather has been recognised as a natural risk. Systematic scientific collaborations with leading institutes abroad and in Greece will be maintained and further enhanced in the following years to ensure the excellence and international recognition of the Center.

7.3.3 IAASARS as the Center of Excellence in Remote Sensing & Earth Observation in Greece

The remote sensing group of IAASARS has achieved considerable excellence in the area of Earth Observation (EO)-based environmental and natural disaster monitoring and management

during the last decade, through its systematic participation to a series of FP7 and ESA projects, in the framework of the Global Monitoring for Environment and Security (GMES), the European Programme for the establishment of a European capacity for EO. These activities have established IAASARS in the European Research Area (ERA) as a key node for conducting EO research and delivering high value GMES products and services, and have led to the creation of a solid user community base.

The group will build upon this scientific and technical excellence to move ahead for the next five years. The focus has been lying in joining forces among the various research teams in IAASARS and NOA for creating the critical mass of scientist and infrastructure that can make the difference in the ERA, towards establishing a sustainable Center of Excellence for Remote Sensing & Earth Observation. The synergetic venture envisages conducting trans disciplinary research with the participation of scientists from diverse research fields, including the fields of EO, signal processing, geophysics, atmospheric physics, forestry, climate change, and database technologies. The key thematic areas of the Center address various research domains: the management and monitoring of natural disasters, including fires, floods, volcanic eruptions, earthquakes, the protection of the natural environment and forests, the monitoring of the atmospheric environment, the study of heat-wave risk and the urban heat island in large cities and the monitoring of solar radiation.

The remote sensing group is anticipated to upscale its research potential through the foreseen Center of Excellence. Efforts for realizing this center have recently commenced in the framework of distinct and clear actions: a) the BEYOND project, funded from the FP7-Regpot-2012-23-1 activity, a capacity building project aiming at fostering cutting edge research for EO-based monitoring of natural disasters in south-eastern Europe, in close collaboration with a European experts network in the field, b) the KRIPIS-PROTEAS project that focuses on the development of innovative algorithms for the generation of added-value EO products and services, the upgrade and integration of the available space-based and in-situ monitoring networks of NOA, the active involvement of public and industrial stakeholders as users of the research and applications outcomes, and the setup of a web focal point to become a reference hub related to natural disasters products, c) the agreement with ESA (ongoing negotiations) for setting up a mirror site in IAASARS premises to archive and disseminate real-time data and higher level products from the Sentinel family of satellites, d) the IRIS proposal, a national scale effort led by NOA with significant contribution from the remote sensing group, following which an innovative, multi-disciplinary and long-missing Hellenic Space Data Exploitation Centre will be established, along with a cluster of optical sensor systems for ground-based and aerial remote sensing to calibrate and validate (Cal/Val) satellite sensors and data products, and e) the invitation to participate to the Group of Earth Observations Work Plan, concerning Task DI-01 ”Informing Risk Management and Disaster Reduction”.

Therefore, given the research background developed in the previous five years and the favorable prospects following the scheduled operations for the next five, IAASARS Center of Excellence in Remote Sensing will focus on the acquisition, processing and dissemination of satellite data, the advancement of the state-of-the-art in EO science, and the generation, enrichment, validation and distribution of satellite derived new information, products, services and integrated solutions that are related to environment monitoring, management and security, indicatively:

Operational disaster management with emphasis on wildfire monitoring focusing on fire prevention, fire fighting and post fire evaluations in the greater geographic area of southeastern Mediterranean. We will use a wide range of available data and models, covering fire danger forecast, fire propagation, fire emission, fire damage assessment, and post-fire vegetation recovery. Additionally we will address flood risk, flood monitoring and flood disaster management issues while fire and flood products will be used for short- and long- term disaster risk analysis to support both climate change studies and the design of prevention and response strategies. The integrated use of diverse EO sensors, namely MSG/SEVIRI, MODIS, Landsat 4,5,7, 8, and future Sentinel missions will be exploited for assessing environmental risks at near-real time mode during crisis.

Monitoring the Urban Environment, central to a range of issues in urban climatology, global environmental changes, human-environment interactions, energy demand and health-related issues. Applications include heat wave risk assessment, urban heat islands, land-use land cover changes, and air quality.

Terrestrial ecosystem dynamics monitoring with emphasis on biomass estimations, ecosystem productivity, biotope and wetland habitat mapping, assessments of the effects of climate variability and other causal factors on carbon sequestration/release from ecosystems for the implementation of sustainable agricultural practices and forest protection and management policies.

Air quality monitoring focusing on extreme atmospheric phenomena and hazards (e.g. dust storms, volcanic eruptions, smoke episodes, nuclear accidents) and utilizing space-borne synergies, in order to understand the atmosphere/climate connection, assess impacts on human health and enhance society's ability to plan and respond.

Crustal deformation monitoring, using EO based differential interferometry techniques and GPS data from the NOANET GNSS network. Diverse geophysical phenomena will be studied, including earthquakes, volcanic activity, landslides and tsunami threats, along with subtle deformation incurred from construction and other man-made activities.

Support security policy at local, regional, and EU scale over sea and land, including the control of EU borders, monitoring of sensitive & danger cargoes, early detection and monitoring of suspect and/or hostile movements across EU borders, through the incorporation, processing, integration and fusion of data and information available from state-of-the-art in-situ surveillance systems with the existing satellite observing systems.

Supporting the humanitarian community in crisis situations occurring in the surrounding geographic regions, through integration and fusion of satellite data and geoinformation sources along with the development and incorporation of new technologies, and resources in the field of navigation and communication.

7.3.4 Foster Partnerships with Greek Industry to become involved in European Space Programs

It is well known that even though Greece became an ESA member state, which was a major step forward in provide new possibilities to both science and technology, there is very limited involvement of the Greek private sector in ESA related industrial projects. IAASARS has an established record of direct collaboration in ESA funded projects both in terms of science as

well as in instrumentation, support and services. We envision that the experience of the researchers of IAASARS can act as a catalyst in involving the Greek industry in ESA missions and projects. This can be achieved by establishing industry-academia partnerships in areas where IAASARS researchers have strong expertise, in particular in projects such as TER, GSTP and of ESA Strategic Initiative. This will help improve the current state of poor "geo-return" of national funds, back to Greece. A first such an partnership has already been established with a collaboration of the X-ray and Space Physics group of the Institute with Planetek Hellas under the ESA-SAPS framework.

Clearly this is a challenging task given the difference in mentality and goals (research and discovery compared to deliverables and profits) between industry and academia. However, the recent decisions of the European Commission (COM(2011)831) related to the Global Monitoring for Environment and Security – GMES, which are also funded by ESA open new possibilities both in terms of funding as well as in scientific collaborations after 2014 involving ESA, the European Environmental Agency, the European Center for Medium Weather Forecast and EUMETSAT. We anticipate that despite the difficulties, the personnel of IAASARS has the necessary background to make tangible contribution in this area, with obvious direct and indirect benefits for the nation.

7.3.5 Support and Upgrade Research Infrastructure

The following years are anticipated to boost the infrastructural capacity of IAASARS, in the framework of several capacity building projects (BEYOND, KRIPIS-PROTEAS, IRIS), which are expected to support the existing monitoring equipment, both space and ground based, and complement it with new state-of-the-art components, crucial for conducting leading edge research and standardize the added value products and services. Therefore, research infrastructure will be upgraded as follows:

The support and maintenance of the instrumentation of the 2.3 Aristarchos telescopes is supported by an Optical and Electronics laboratory operating at the premises of IAASARS in Penteli since 2007. The lab also supports the development of new scientific instruments, as well as the calibration and testing of existing ones. Two new instrumentation projects are currently on going at IAASARS: (a) the design and development of a wide field camera (field of view 27'x27'), for the 2.3m Aristarchos telescope (under KRIPIS-PROTEAS) which is designed to perform follow-up observations of satellite missions (e.g., XMM-Newton, Herschel) and (b) the design and development of a wide-angle field camera/telescope (field of view 30 degrees) which will be used to perform a narrowband deep sky-survey of the extensive line emission regions at high Galactic latitudes (under ARISTEIA II/MAWFC program). Furthermore, a complete upgrade on the Aristarchos telescope software is planned (under KRIPIS-PROTEAS) which will vastly improve the functionality of the telescope and its scientific instrumentation.

Upgrade the IAASARS Ground Segment for satellite data acquisition with reference to missions as MODIS, NPP (VIIRS, ATMS, etc), NOAA, the FYI, the MetOP, and future NPOESS satellites, and ESA Sentinels mission satellite data. This will supplement the existing Meteosat ground station installed for the seamless reception of data from a series of geostationary meteorological satellites operated by EUMETSAT. The new ground segment will allow the operational remote sensing monitoring by integrating high temporal, spectral and spatial resolution satellite data

and applicable to numerous weather, atmosphere, ocean, and land applications. The proposed upgrade of the IAASARS Ground Segment infrastructures comprises of the installation of HW/SW acquisition components, towards the operation of an X-, and L-band satellite acquisition station for reception, acquisition, and processing of the direct broadcast downlinks from several satellite missions, and the deployment of an additional pick-up point from the Hellenic ESA Mirror Site installed in IAASARS for the direct (real time) access to ESA's Sentinel missions dedicated to GMES, as part of the ESA's Collaborative Ground Segment Process.

Following the systematic operation of ground-based remote sensing infrastructure, i.e. the Atmospheric Remote Sensing Station of IAASARS (part of NASA-AERONET global Network) and the EMORAL mobile lidar facility, a new prototype backscatter/Raman/dual-wavelength polarization lidar system will be procured, designed to monitor atmospheric episodes and support cal/val campaigns. The lidar will be constructed in IAASARS and will offer significant information for optimization of smoke dispersion, validation of desert dust model forecasts, and volcanic ash monitoring.

The IAASARS ENIGMA network provides long-term continuous monitoring of ultra low frequency magnetospheric waves related to geomagnetic activity in the near-Earth electromagnetic environment. It is foreseen that a new suspended overhauser magnetometer delta inclination / delta declination observatory system will be added to the existing magnetometer network, which ensures long term stability for accuracy and reliability of magnetic field measurements. Additionally, a super gradiometer system, designed for earthquake prediction applications, will be acquired aiming at the detection seismic electromagnetic signals.

The Athens Digisonde will be upgraded to an advanced high resolution sounder DPS-4D able to perform high time resolution and precision height observations to identify ionospheric irregularities, and in networking with other similar stations in Europe it can support the development of a prototype system for identifying and tracking travelling ionospheric disturbances over Europe. In parallel the DIAS system will be enhanced with the procurement of a solar telescope and the deployment of the Helioserver that will provide in real time observations for solar flares, proton events and coronal mass ejections from ground and space-born instruments, something that will make feasible the implementation of propagation models and consequently will greatly improve the predictions of the ionospheric forecasts.

A series of software licenses will be updated and new s/w packages will be obtained to cover the diverse and challenging requirements of the institute: 1) SARScape software, a sophisticated COTS product that is capable to effectively manage and process Synthetic Aperture Radar data for various EO applications, 2) Forest Fire Simulation Software Developers Kit to simulate fire propagation for crisis management, Urban Heat Islands Patterns extraction Software Developers Kit to extract surface temperature from MODIS and Meteosat satellites, 3) ArcGIS, a complete system for designing and managing solutions involving maps and geographic knowledge, 4) Envi for advanced processing and analyzing geospatial imagery, and 5) S/W capabilities for data and meta-data management of the IAASARS Ground Segment facilities.

Bearing in mind that satellite data flow in IAASARS will increase greatly in the upcoming years, following both the increased data availability (new and more satellite platforms are scheduled

to be launched) and the institute's specific needs (ground segment, ESA mirror site), the anticipated accommodation of big data volumes will call for robust Archiving facilities.

7.3.6 Education and Public Outreach

It has been recognized early-on that IAASARS (and NOA) as a public institute has an added obligation to share with the Greek community, which supports its activities, the knowledge acquired by the researchers, as well as their excitement of discovering the Universe and how it operates.

The institute has been extremely active over the past 20 years in a variety of education and public outreach activities. Most of them are centered on topics related to astronomy and space physics, as these are attracting the interest of the general public and students alike. In terms of educating focused groups, IAASARS has been organizing an annual astrophysics school targeting 40-50 high-school seniors and juniors from the Athens metro area. The students spend several days at the institute attending lectures and engaging in practical hands-on experiments involving astronomical data analysis and interpretation. This is a practice that we plan to expand in the future.

The main public outreach activities of the institute revolve so far around the Visitor Center in Penteli. The Center passed the 200,000 visitors mark in 2013, showing the wonders of the night sky to the general public as well as to organized groups and schools from across Greece. Currently five of the technical staff of IAASARS (one of which will retire at the end of 2014) is directly involved in supporting this effort. It should be mentioned that this is the longest active public outreach astronomy activity in Greece and it has been receiving very positive reviews from the audience, expert scientists, as well as amateur astronomers.

The strategic plan of IAASARS is to build upon this experience and become the main center of public outreach in astronomy in Greece, by taking the following steps:

1. Improve on the education program we offer to the visitors, addressing the special needs of the various groups (i.e. targeted programs for students of various levels, adults, non-Greek speaking visitors). We plan to include higher quality material, also showcasing the results of IAASARS researchers, and train the visitor center staff in presenting simple demos of the basic laws of physics that rule the Universe as well as the physical scales involved following examples and practices of successful visitor centers abroad.
2. Improve the infrastructure of the Visitor Center in Penteli, which has been renovated in 2013 thanks to the funds made available by the KRIPIS-PROTEAS GSRT grant. We will reorganize the area of the Center to include an indoor guest-waiting area, essential for the winter, as well as a gift shop, which has been in high demand by our guests.

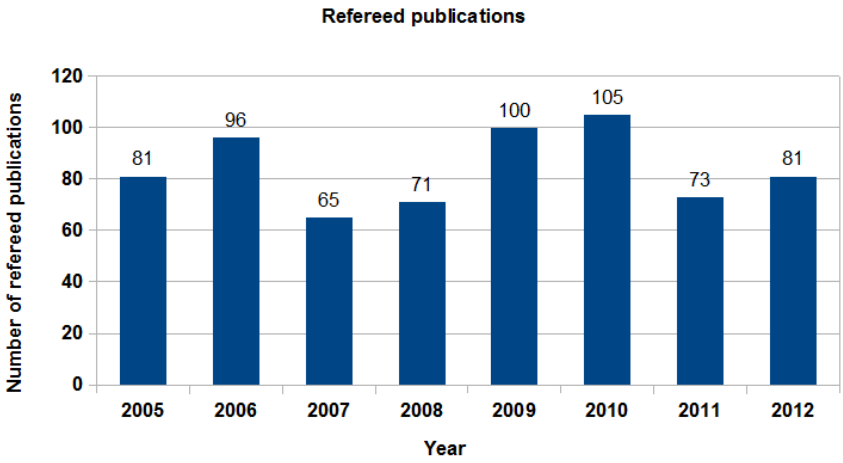
In coordination with the central administration of NOA include the telescopes at the Thissio site and provide support in terms of man-power and knowhow to public outreach activities that will take place there.

Improve the lasting impact of the public outreach by keeping in contact with past visitors, using the web and social networks. A handful of research support specialists of the institute have been contributing at regular intervals small articles on astronomy news and typical astronomy

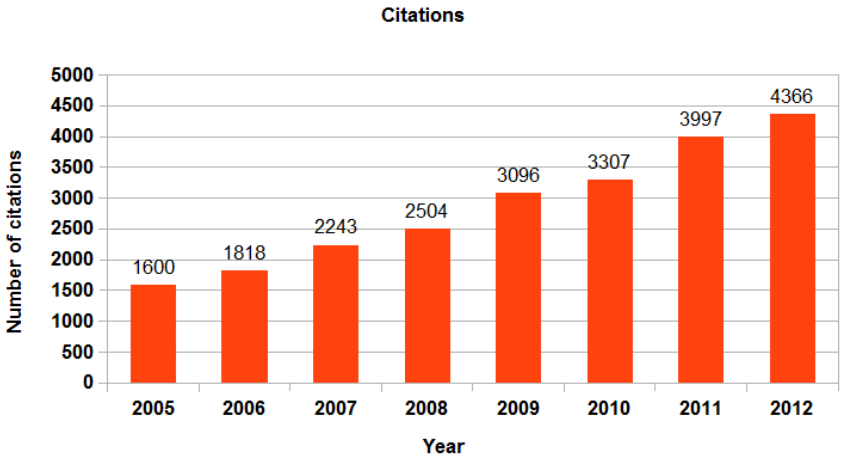
questions raised by the visitors. This activity will continue and become more organized. We feel that this is an important tool as it will expand the reach of our activities to a much larger Greek-speaking audience, who cannot visit our facilities in person.

Finally we intend to completely rescope the use of the old 1.2m telescope at Kryoneri, by integrating it as an element of the public outreach activities of IAASARS. The telescope has been used for a number of public events over the years, as well as for training of undergraduate and MSc students. However, the last telescope operator who lives on-site is retiring in 2014 and IAASARS does not have the personnel to fully support these activities. We are currently in close contact with the local authorities of the region as well as amateur astronomers, in order to a) secure external funds needed for some essential upgrades in the guiding and the electronics of the telescope to make it reliable and remotely accessible, b) establish a viable long-term operation with part time support from IAASARS limited on resolving technical issues.

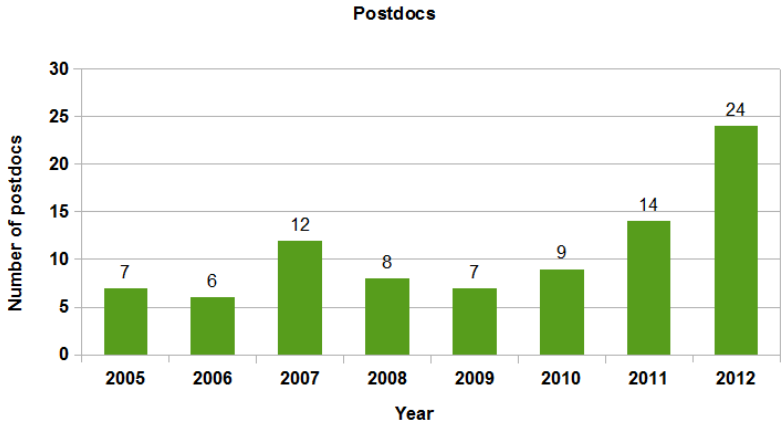
APPENDIX I: Diagrams of the performance metrics for the 2005-2012 period.



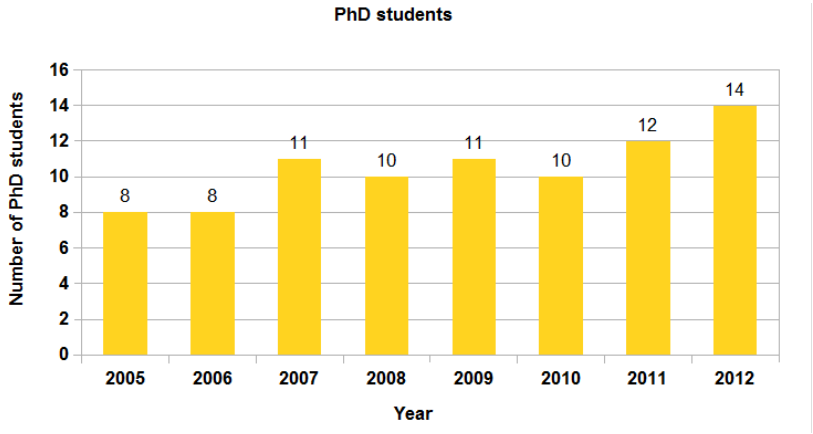
A histogram of the refereed papers published by the researchers of the Institute



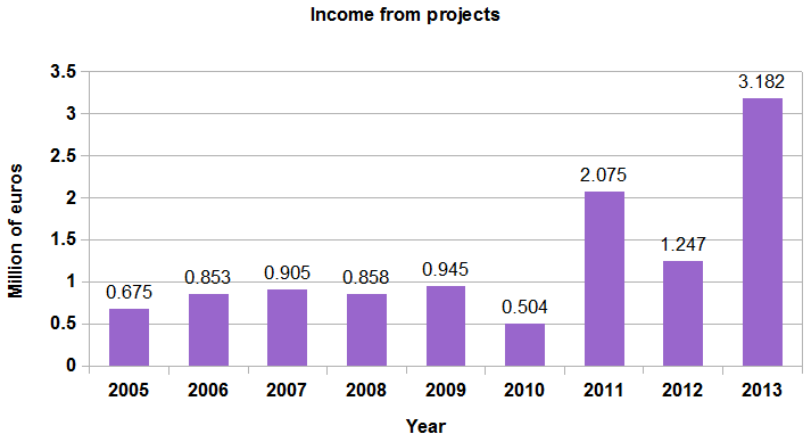
A histogram of the citations to refereed papers of researchers of the institute, received each of the years of the report.



A histogram of the postdoctoral researchers of the Institute



A histogram of PhD students directly supervised researchers of the Institute



A histogram of the external funding from competitive grants (in million euros) awarded each year to researchers of the Institute

APPENDIX II: Helmos Observatory and the 2.3 m "Aristarchos" Telescope

1. Introduction

Helmos Observatory is one of the largest contemporary research infrastructures in Greece with an invested value of 11 million euros. It hosts the 2.3m "Aristarchos" telescope, the largest optical telescope in the Balkans and the second largest in continental Europe, located on the top of Helmos mountain in the central Peloponnese, at an altitude of 2340 meters. Due to its high altitude, the observatory very often lies above the clouds and the inversion layer of the atmosphere, yielding excellent seeing conditions. This location is one of the darkest sites in Europe (Figure 1). The mild climate of southern Greece translates to a yearly average of 150-200 clear nights, compared to the yearly average of less than 100 clear nights in mainland continental Europe (NASA International Satellite Cloud Climatology Project). Moreover, Helmos mountain has a low frequency of lightning, while dust from the Sahara is rare at this latitude. Last, but not least, the nearby Kalavryta Ski Center enabled the development of the basic infrastructure at Helmos Observatory, i.e. access by road and electric power, and guarantees access to the observatory during the winter via the ski lifts.

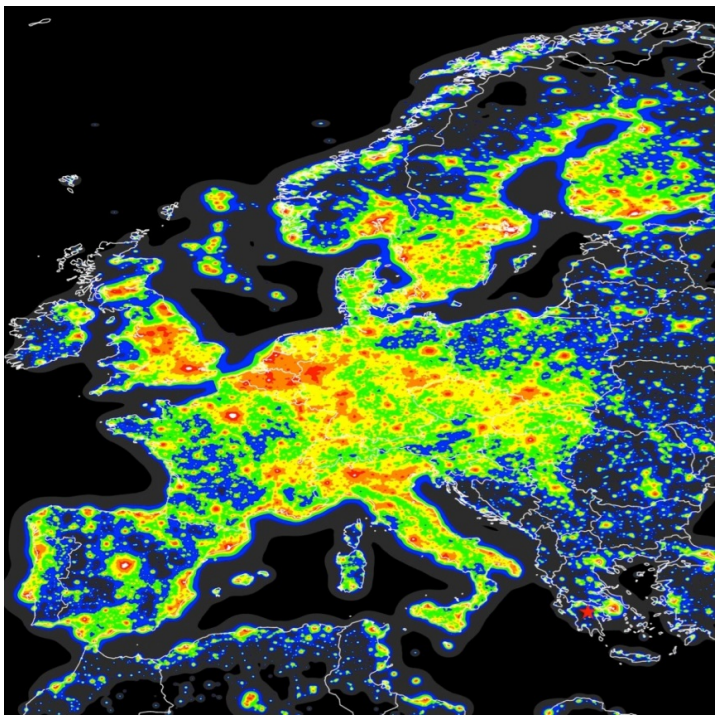


Figure 1. *Light pollution map of Europe from the Light Pollution Atlas 2006. The red star marks the location of Helmos Observatory.*

2. The 2.3m "ARISTARCHOS" telescope

2.1 Instrumentation

The main section of this report summarizes the main features of the 2.3m "Aristarchos" telescope and the instruments that have been commissioned. The following instruments will be commissioned in the near future:

- Vernikos-Eugenides CCD camera (VEC). This is a FAIRCHILD-486 (4096x4096 pixels) camera with a field of view of 10x10 arcmin. The camera has been acquired by EU/GSRT funds and partially by a donation from the Eugenides Foundation.

- Aristarchos Transient Spectrometer (ATS). The spectrograph resolution and spectral range depend on the grating: (a) RED yields a resolution of 2.5 Angstroms and a wavelength range 5780-7070 Angstroms, (b) BLUE yields a resolution of 2.5 Angstroms and a wavelength range 4370-5780 Angstroms and (c) FULL yields a resolution of 6 Angstroms and a wavelength range 4120-7200 Angstroms. The spectrograph is fed using a bunch of 50 optical fibers, giving a 10 arcsec diameter field of view. The spectrograph is equipped with an Apogee U47, E2V-CCD4710 back illuminated CCD camera with 1024x1024 pixel, 13μm pixel size.

- Manchester Echelle Spectrometer (MES-AT). The instrument has been already used at the following telescopes: 2.1-m San Pedro Martir in Mexico, 3.9-m Anglo-Australian Telescope in Australia, 3.9-m William Herschel Telescope in the Canary Islands, Spain. The spectrograph uses a SITe 2048x2048 pixel CCD camera. The spectrograph's spectral resolving power is $\leq 10^5$ while it covers the wavelength range 3900 - 7500 Angstroms.

- A focal reducer is currently being constructed in collaboration with the University of Manchester. The focal reducer, which will be installed at the telescope before the end of 2015 will increase the telescope's field-of-view to 27x27 arcmin. Hence the telescope will become capable of observing a wide field of view in the following bands: *u,g,r,i,z*,Y.

2.2 Optical and Electronics Laboratory

In addition to the facilities at the Helmos site, an Optics and Electronics Laboratory was set up at the premises of the Institute in Penteli in 2005 and began operating in mid-2006. The Laboratory is equipped with all the necessary equipment (two optical tables with special isolator legs for removing vibrations, calibration lamps, laser equipment, etc.) in order to support the 2.3m "Aristarchos" telescope, to test existing instruments and to develop new scientific instruments.

3. Helmos Site Characteristics

In this section we provide the first site characteristics mainly derived from the meteorological station installed at Helmos Observatory. Given the lack of formal site testing prior to the installation of the telescope and the lack of permanent staff on site, the data were taken only when personnel from our premises in Athens were sent for observations or technical work. In addition, due to the various technical problems of the telescope during the first years of operation, there were long intervals of downtime and little activity on the site. For this reason, the yearly sampling of meteorological data is not very dense and concentrates mainly in the summer and autumn periods. Currently (as of the 2013 observing season), the telescope is in good operating condition and the data sampling has improved significantly.

3.1 Cloud Coverage

For the cloud coverage statistics, we used in situ observations carried out by the personnel on site. The cloud coverage was categorized into three levels (namely, clear sky, intermediate cloudiness, and heavy cloudiness) in a log that was kept. In Table 1 we present the data (yearly sampling), which were limited to the period of operations. Specifically, 90% refer to the period from June to November and only 10% to the rest of the year. With the telescope currently being functional, we expect to collect more data for the winter – springtime. Apart from that, in September 2013 we also installed a heavy-duty meteorological station 250m from the telescope to monitor the conditions all year round.

Table 1: Site Observations

Year	# days with cloud data (night)	# days with cloud data (day or night)	# days with meteo data
2001	No data	No data	26
2002	No data	45	45
2003	No data	No data	No data
2004	No data	No data	54
2005	No data	No data	12
2006	No data	No data	25
2007	53	54	58
2008	36	40	60
2009	12	40	43
2010	46	99	101
2011	0	40	41
2012	9	30	30
2013	No data	96 (Mar-Oct)	99 (Mar-Oct)
Total	156	444	594

For the 156 nights in 2007-2012 with night activity (whole or partial), which are equivalent to 120 full nights, we determined the percentage of observable nights to be 60%, having subtracted the time lost to high humidity and winds. If we instead consider the 444 days with both meteorological data and cloud coverage observations (daytime or night-time), we find the observable nights to be >60%. Figure 2 shows a histogram of the breakdown per year.

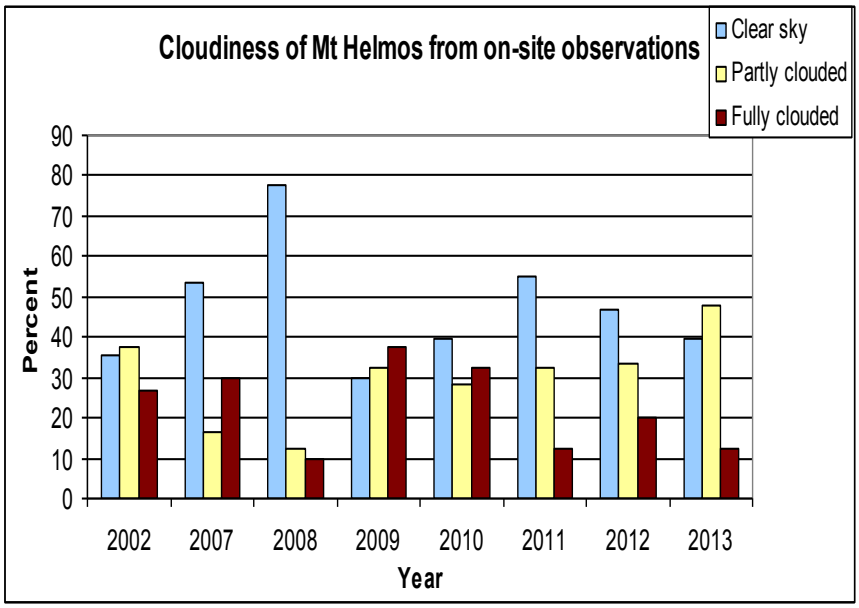


Figure 2. Cloud coverage assessed by on-site observations.

The results are in agreement with satellite data. Satellite observations (mainly using data from NOAA, MeteoSAT, and MeteoFrance providing resolutions between 1 and 2 km) were visually inspected and evaluated and the cloud coverage was determined based on three categories mentioned above. Analysis of the satellite data per month showed that the lowest cloud coverage months are: June, July, and August (percentage of clear skies >70%) and the highest cloud coverage months are: December, January, and February (percentage of clear skies <30%).

3.2 Observable Nights

The percentage of observable nights depends not only on cloud coverage, but also on the humidity and wind speed. The telescope and dome operational limits for relative humidity and wind speed are 80% and 50 km/h. The percentage of clear and partly clear days and nights in our sample is 77%. Subtracting the percentages lost to high winds (6.2%) and high humidity (10.5%) yields a fraction of 64.1% of nights having observable weather conditions, in agreement with the results of section 3.1. However, these values refer to the summer/autumn period and we are in the process of collecting data to determine the total number of observable nights per year. *Between June and November we have on average 100 clear or partly clear observable nights, with ~15% of them being photometric*.

Below we present the summary of the meteorological conditions for Helmos Observatory determined from 594 days of data collected during 2001 – 2013.

3.2.1 Temperature

The average temperature at Helmos Observatory is 8.4C, with a recorded minimum of -9C and maximum of 25C. A typical temperature difference between day and night on a clear day in August is 8C.

3.2.2 Humidity

The average relative humidity is 60%, with a recorded minimum of 10% and maximum of 100%. The relative humidity exceeds the telescope operation limit (humidity > 80%) on average 17.4% of the time, 47.5% for cloudy days/nights and 8.5% for clear days/nights.

3.2.3 Wind

The average of the mean wind speed is 15 km/h and the average of the peak wind speed value (gust) is 25 km/hr. The maximum mean wind speed measured is 90 km/hr and the maximum gust measured is 145 km/h. The percentage of times with winds stronger than the operating limits of the telescope (> 50 km/hr) is 7.1%, while for 20% of the days/nights there was practically no wind (speed < 10 km/h). The strongest winds measured are coming from the west–northwest direction.

3.2.4 Seeing

A Differential Image Motion Monitor (DIMM) was installed in 2013 to record the seeing parameter, which is a measure of the atmospheric turbulence that affects the sharpness of the observed astronomical images. We have so far collected 19 nights of seeing measurements (see Figure 3), which yielded a median value for the seeing of 0.78 arcsec and contained values as low as 0.25 arcsec. The planned installation of an autoguider to automatically correct the tracking is expected to improve the measured values for the seeing. We therefore have a first indication of a very stable atmosphere, which we plan to characterize in detail by collecting a large amount of seeing data.

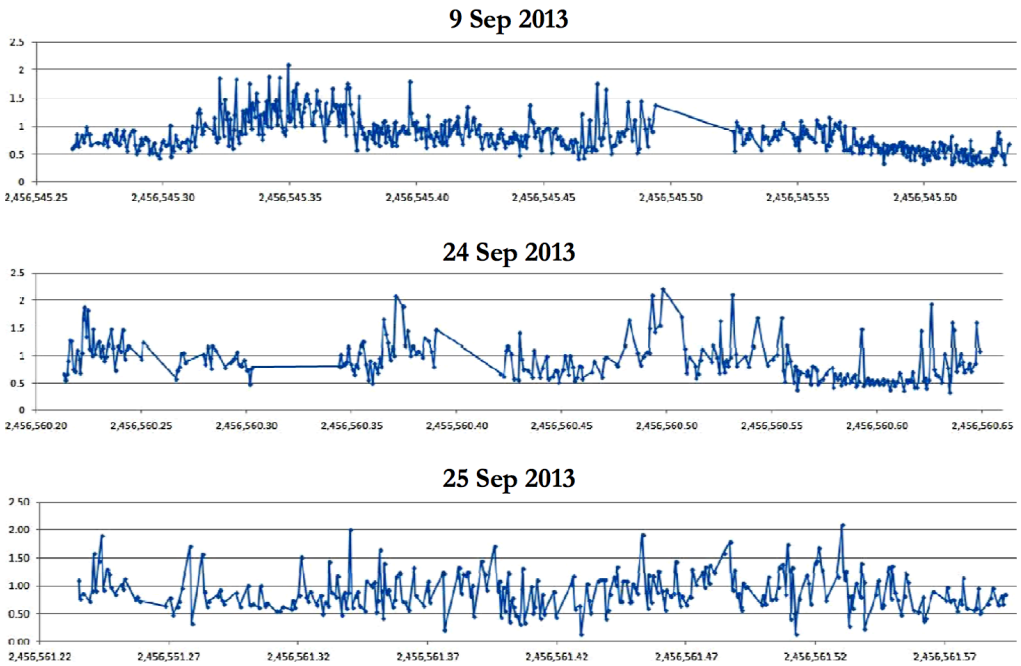


***Figure 3**. Seeing monitoring sequences for a sample of three nights using the DIMM method.*

3.2.5 Night sky brightness. The sky brightness was measured in the moonless night of 10 September 2013 and yielded the following values in the U, B, V, R, I photometric bands:

U filter: 21.6 mag/arcsec^2
B filter: 22.1 mag/arcsec^2
V filter: 21.1 mag/arcsec^2
R filter: 20.5 mag/arcsec^2
I filter: 18.8 mag/arcsec^2

However, the specific night turned out to not be photometric because there were some very thin sparse clouds, which affected the sky brightness. In other astronomical images taken in the R and I filters in mid-July during photometric nights, it was found that the sky brightness was 20.2 and 18.6 magnitudes/arcsec^2 respectively. We estimate that repetition of the measurements during a good moonless photometric night may yield sky brightness in the various filters by half a magnitude fainter on the average. In any case, the above values show that the site is very dark.

4. Activities and Achievements

On average the Observatory is accessible 10 months per year. The inaccessible periods are in mid-November to mid-December and late-April to late-May, when the access by road is inhibited by snow and the Kalavryta Ski Center lifts and snow vehicles are not operating. Our presence at Helmos Observatory was not very dense until last year, when the telescope became functional. In Table 5, we show the data for our presence on the mountain over the years 2008-2012.

Table 5: Yearly operations at Helmos Observatory

Year	Science observations		Engineering technical work	
	Days	Persons	Days	Persons
2008	35	75	105	323
2009	4	8	95	305
2010	41	89	91	409
2011	16	48	60	210
2012	9	24	62	196
2013	88	186	21	72
Total	193	430	434	1515

4.1 Current Observing Programs

Currently observing time with "Aristarchos" telescope is given to researchers within the astrophysics group of IAASARS and to close collaborators, while observing time is expected to be awarded to external observers within 2014, with the goal of becoming a full member of the

FP7 OPTICON (Optical Infrared Co-ordination Network) consortium. The main observing programs underway at the 2.3m "Aristarchos" telescopes are:

- Narrow band imaging of Supernova remnants
- Narrow band imaging of Planetary nebulae
- Broad-band imaging of Boxy/peanut bulges in edge-on galaxies
- Hα, Hβ imaging of M33
- Monitoring of eclipsing binaries in nearby galaxies for distance determination
- Monitoring of cataclysmic variables
- CCD photometry of stars in the open cluster NGC7243 (rotation period determination).

4.2 Publications using observations with "Aristarchos" telescope

4.2.1 Refereed Publications

- "The expansion proper motions of the extraordinary giant lobes of the planetary nebula KjPn 8 revisited", P. Boumis and J. Meaburn, 2013, MNRAS, 430, 3397
- "The bow-shock and high-speed jet in the faint, 40 arcmin diameter, outer halo of the evolved Helix planetary nebula (NGC 7293)", J. Meaburn, P. Boumis, S. Akras, 2013, MNRAS, 435, 3462
- "On the stability of bow shocks generated by red supergiants: application to IRC-10414", D.M.-A. Meyer, V.V. Gvaramadze, N. Langer, J. Mackey, P. Boumis, S. Mohamed, 2013, MNRAS, (submitted)

4.2.2 Conference Proceedings

- 'Aristarchos Instrumentation: Manchester Echelle Spectrometer (MES) and Aristarchos Transient Spectrometer (ATS)', 2004, P. Boumis, J. Meaburn, and C. Goudis, in the proceedings of the 6th Hellenic Astronomical Conference, 313.
- 'Aristarchos: The New 2.3m Greek Telescope', 2006, C. Goudis, P. Hantzios, P. Boumis, E. Xilouris, in the proceedings of the 7th International Conference of the Hellenic Astronomical Society, AIP Conf. Proceed., 848, 800.
- 'The Aristarchos Telescope', C. Goudis, P. Hantzios, P. Boumis, E. Xilouris, A. Katsiyannis, A. Maroussis, in the proceedings of the 9th International Conference of the Hellenic Astronomical Society, ASPC, 424, 422.
- 'Aristarchos Instrumentation: Meaburn Filter Measuring Spectrometer (MFMS)', P. Boumis, E. Xilouris, O. Giannakis, A. Maroussis, A. Katsiyannis, 2010, ASPC, 424, 424.
- 'Aristarchos RISE2: A Wide-Field Fast Imager for Exoplanet Transit Timing', P. Boumis, D. Pollacco, I. Steele, J. Meaburn, E. Xilouris, A. Katsiyannis, M. Bode, S. D. Bates, C. Goudis, F.P. Keenan, C. Watson, 2010, ASPC, 424, 426.
- 'First Images from the Aristarchos Telescope', C. Goudis, P. Boumis, E. Xilouris, A. Katsiyannis, P. Hantzios, J. Alikakos, D. Abartzi, A. Maroussis, 2012, in the proceedings of the 10th International Conference of the Hellenic Astronomical Society, 28.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