Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing

IAASARS

Evaluation
2013 - 2017

IAASARS

Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing

NATIONAL OBSERVATORY OF ATHENS

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REPORT OUTLINE

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. It commences with a description of the present situation focusing on the mission served and the role of the Institute in and for the society. This is followed by the structure of the Institute and a detailed presentation of the research activities of its three main research groups (Section A). It continues with the level of adoption of the comments received after the previous evaluation (Section B), the strategic goals of IAASARS for the period up to the present (Section C), an outlook to the Institute's goals for the coming period [2018-2022] (Section D) and concludes with an Executive summary that provides recommendations and measures to be taken (Section E).

At the end of the report we include Appendix A which presents several graphs of select metrics depicting the improvements of the institute over the 5 year period, Appendix B that presents a complete listing of the competitive projects that were attracted by the Institute during the self-study period, Appendix C that provides all of the Tables required by the self-evaluation template and Appendix D that provides listings of all postodocs and students that were supervised by IAASARS staff members within this period.

Finally, an additional document with brief CVs of all permanent researchers and research staff is provided as Appendix E. The individual personnel metrics (Table 4b) are presented in Appendix F.

A. Description of the present situation (at 31/12/2017)

1 Introduction & background

1.1 Brief history of the Institute, location and milestones

The Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing (IAASARS) is one of the three Institutes of the National Observatory of Athens (NOA), the oldest research centre in Greece. The main building of IAASARS is located on the grounds of the National Observatory of Athens in Penteli, about 19 km northeast of the historical building of the Observatory at the center of Athens. The IAASARS was established in February 2012 from the merging of the two former institutes of Astronomy and Astrophysics (IAA) and Space Applications and Remote Sensing (ISARS).

1.2 Scientific Identity of the Institute and its Distinctive Character

The Institute is the main hub for space research in Greece with an accumulated expertise on Space Sciences that is unique at national level. Its activities include the astrophysics of the Sun, the stars and galaxies, studies of the solar neighborhood, investigations of the Earth's magnetosphere and ionosphere, observations of the Earth via remote sensing and signal processing applications.

These activities are enabled by the two key assets of the IAASARS; its large infrastructures and its human capital. The facilities managed, operated and developed by the Institute include two telescopes, advanced instrumentation for monitoring the ionospheric conditions, infrastructure for Earth observations from satellites, stations for climate studies and measurements of the Earth's magnetic field. The human resources of the Institute at the end of 2017 consisted of 30 permanent staff and 27 research associates on short-term contracts. Despite the economic adversities during the evaluated period, these scientists attracted over 2M € per year from national and european competitive research grants.

The excellence of the Institute is further demonstrated by the allocation of two ERC grants in the last two years, the leading role of its researchers in numerous H2020 programmes and ESA projects, the visibility of the services it offers to the society at the International level, and the impact of the scientific publications it produces.

1.3 Mission and Purposes of the Institute

The IAASARS is committed to (i) advance scientific research in the areas of astrophysics, space sciences and remote sensing, (ii) engage in civil protection by managing natural disasters and offering specialised forecasts, (iii) increase the awareness of the society towards science, technology and innovation and (iv) encourage young people to follow scientific careers.

Highlights of IAASARS activities towards the above mission include:

- Studies of Near-Earth Objects via observations of Lunar impacts from the newly-refurbished Kryonery 1.2-m telescope.
- Development of added-value products for ESA's flagship scientific missions and science archives.
- The production of real-time nowcasts and forecasts for the ionospheric critical parameters, making predictions for upcoming disturbances over Europe.
- The dissemination to the worldwide community of real-time forecasts for solar radiation storms.
- The mapping of the impact of natural disasters such as wildfires, floods and the assessment of landscape deformations as a consequence of earthquakes or volcanic activity.
- The operation of two popular visitor centres that run lively and regular outreach and science dissemination activities for the general public.
- The hosting of a postgraduate course (M.Sc.) on Space Sciences and Earth Observation, which is jointly organised with the Computer Science and Telecommunications Department of the University of Peloponnese.

1.4 Significance of the Institute's role in the Society

I. Monitoring of the Environment & Management of Natural disasters - The European Center of Excellence BEYOND (www.beyond-eocenter.eu)

The BEYOND Center of Excellence, which is hosted (since 2013) at IAASARS, provides research and operational services in the framework of the European Union's flagship program Copernicus and to the European Space Agency (ESA) programs. The emphasis of the Center's activity is on Emergency Response (Copernicus/Emergency Management Support), monitoring and protection of the Marine and Atmospheric Environment, as well as applications on Agriculture, Renewable Energy, and Climate Change Adaptation and Resilience.

The EO Center of Excellence BEYOND for Disaster Risk Reduction (DRR), has been recognized by the European Commission as a Copernicus Focal Point, for disseminating the full set of Copernicus Emergency Management Services in support to the Civil Protection Authorities worldwide. It addresses a vast portfolio of disaster services such as forest fires, floods, earthquakes, extreme weather phenomena, landslides, tsunami, volcanic eruptions, and industrial accidents. In addition, the BEYOND Center has been selected to provide together with partners from DLR (German Aerospace) and e-GEOS (Italian Space Industry) the European Forest Fires Information System that is a flagship operational Service of Copernicus over big geographic regions namely N. Africa, entire European Union, M. East, and Black Sea.

II. Climate services

The "PANhellenic GEophysical observatory of Antikythera (PANGEA)" was established by NOA with major contributions from IAASARS to provide continuous monitoring of Essential Climate Variables and to stream real-time information to the State and the Society focusing in particular on: (i) the provision of certified data

and expertise on issues related to climate change, (ii) the improvement of climate projections at the regional scale, for effective mitigation and adaptation. The PANGEA aims to address a number of societal objectives related to challenges such as the climate change and its impact on severe weather and natural disasters in Greece and the Eastern Mediterranean. As such, PANGEA is a flagship initiative with significant benefits, such as: (a) ensuring the sustainability and development of key sectors of the economy in relation to climate change; (b) meeting the State's obligation to reduce pollutant exceedances, by providing observations of background pollutants from natural sources (e.g. deserts, forest fires). It is anticipated that PANGEA will contribute specifically and substantially to the development of Antikythera as "the island of science" in the Eastern Mediterranean region, with corresponding societal benefits related to: (a) the creation of new jobs to meet the operational and maintenance needs of PANGEA, (b) strengthening of the local tourist product by developing scientific tourism in Antikythera and Kythera, and (c) reversing the population decline of Antikythera and improving coastal shipping in this border area.

III. Forecasting ionospheric conditions over Europe

The institute operates the DIAS system, a unique infrastructure in Europe that makes available to academic and operational users, ionospheric data, products and services for the monitoring, specification, as well as the short- and long-term forecasting of the ionospheric conditions over Europe. The DIAS system address the needs of more than 1300 registered users that indicatively may be grouped as: satellite operators; HF communication and geolocation communities; radio astronomers; researchers; radio amateurs; space agencies; broadcasting organizations; and Satellite-based augmentation systems users such as EGNOS and N-RTK; humanitarian aid organizations and the general public.

IV. Forecasting solar radiation storms

The Solar and Heliospheric physics has a profound importance for the society due to the ubiquitous presence of space technology in our day-to day lives. Space weather is the most common example of a societal impact of Solar and Heliospheric Physics. IAASARS researchers work on different aspects of high-priority science questions relevant to space weather. These questions address the understanding of the structure and dynamics of the Sun, the heating of the solar atmosphere, the origin of the solar wind, the drivers of space weather. The IAASARS researchers developed and maintain two operational tools of solar energetic particle (SEP) radiation storms in space, both of which provide dissemination results to the space science community via the National Observatory of Athens/IAASARS website https://www.hesperia.astro.noa.gr

V. Monitoring Geomagnetic Conditions

ENIGMA monitors the variations of the geomagnetic field associated with the occurrence of geospace magnetic storms and magnetospheric ultra low frequency (ULF) electromagnetic waves. One of the ENIGMA main research objectives is the study of space weather effects on the ground, i.e., Geomagnetically Induced Currents (GIC). GIC flow along electric power-transmission systems and other electrically-conducting infrastructure during increased geomagnetic activity and can cause wide-spread blackouts and power failures.

VI. Science Dissemination

The IAASARS researchers are conscious of their accountability towards the society for resources allocated to them by national and European funding bodies and fully appreciate the importance to engage in public outreach activities. The Institute operates two visitors centres at Penteli and Thisio. They offer diverse outreach programmes that are designed to target different audiences and groups. The two visitor centres have become very popular, counting many thousand visitors per year, and proven extremely effective and fruitful in accentuating the role of science to society. The social-media pages for the NOA Visitor Centers is currently followed by about 12.000 people.

2 Structure

2.1 Management structure

2.1.1 Director

The current director is Dr. Spyros Basilakos who joined the Institute in October 2018. The previous director for the period 2013-2017 was Prof. V. Charmandaris (see http://www.physics.uoc.gr/~vassilis). Dr. Basilakos is a cosmologist with a career spanning scientific research, academic teaching and science communication. He has held a number of academic positions at various universities around Europe. He is President of the Greek National Committee for Astronomy that advises the Greek government for issues which are related with Astronomy and Astrophysics. Also, he is the National Delegate in the International Astronomical Union.

Dr. Basilakos completed his PhD studies in Cosmology at the University of Athens. During the period 1999-2002, he worked as a PPARC fellow at the Imperial College (UK). From 2002 to 2005, he worked within NOA's (National Observatory of Athens) program searching for the clustering properties of the large-scale structures. In 2005 he joined the astrophysics group at the University of Groningen (The Netherlands) as a NOVA fellow. For the period 2006-2014 he was a faculty member at the Academy of Athens (RCAAM) and a Visiting Professor at the University of Barcelona (2011-2012). Today he is Director of Research at the Academy of Athens and head of IAASARS. In 2013, 2014 and 2017 he participated in the international Gravity competition organized by the Gravity

Research Foundation (GRF -USA) and his scientific works received honorable mentions by GRF.

Dr. Basilakos' work has led to 190 scientific articles out of which 140 in refereed journals and 50 in conference proceedings. Out of the 140 refereed publications, he is the first or second author in ~70% of these, while he is the single author in 9 publications (monographs). Also, he published 2 review papers and 12 Letters.

Dr. Basilakos supervised a large number of PhD and MSc theses and he participated in several international collaborations and scientific programs. Currently, he gives lectures in Cosmology and General Relativity at the University of Athens and contributes to public engagement events in science. His main interests concentrate on Cosmological tests of General Relativity, constraints on the cosmological parameters using observational data, nature of dark energy and the accelerating Universe, the physics of inflation and the evolution of matter perturbations, statistical and geometrical measures for quantifying large-scale structures.

The full CV of Dr. Basilakos is available at http://astro.academyofathens.gr/people/sbasil/

2.1.2 Scientific Council

The Scientific Council of IAASARS plays an important role in the designing of the scientific policy of the Institute. The five members of the current Council are:

1) Dr. Ioannis Georgantopoulos, Research Director (President, deputy Director 2013-2017)
2) Dr. Anna Belehaki, Research Director (Vice-President)
3) Dr. Panayotis Boumis, Research Director
4) Dr. Antonis Georgakakis, Senior Researcher
5) Dr. Olga Malandraki, Senior Researcher.

During the period Sep. 2016 - Sep 2018 the scientific council consisted of the following researchers

1) Dr. Georgia Tsiropoula, Research Director (President)
2) Dr. Haris Kontoes, Research Director, (Vice-president)
3) Dr. Panayotis Boumis, Research Director
4) D. Ioannis Georgantopoulos, Research Director
5) Dr. Anna Belehaki, Research Director

2.1.3 Organogram

The institutional structure of IAASARS is based on well-defined roles and responsibilities ensuring organizational effectiveness and efficiency. The Director of IAASARS serves as the head of the Institute. He coordinates and oversees all the activities fulfilling the mission, strategic goals and commitments to the State

and the scientific community. The Deputy Director is proposed by the Scientific Council (SC) and approved by the Board of Directors. He replaces the Director when not present at the Institute. The IAASARS secretariat is the contact point with internal (NOA's) and external institutions as well as with other bodies. An important component of IAASARS is the SC, which plays an auxiliary role concerning the scientific policy of the Institute. The SC serves as an advisory entity for decision-making and planning, having also the role of monitoring the overall progress toward achieving the Institute's vision and strategic goals. The members of the SC are elected by the researchers of the Institute every two years and consist of five (5) researchers of A' and B' Grade. The Chair is designated by the SC. The SC via collaboration with the Director address the present needs and define the Institute's priorities from a short- and long-term perspective. The SC has regular meetings with the Director in order to fulfill its mission, while the SC Chair communicates the minutes of the meetings to the Institute. In order to ensure full transparency, awareness and communication of decision rationale at the Institute's level, regular plenary meetings are organized where all the members of IAASARS have the opportunity to be informed directly from the higher-level governance units as well as to express their opinion, concerns and potential solutions aiming at improving the overall performance of the Institute.
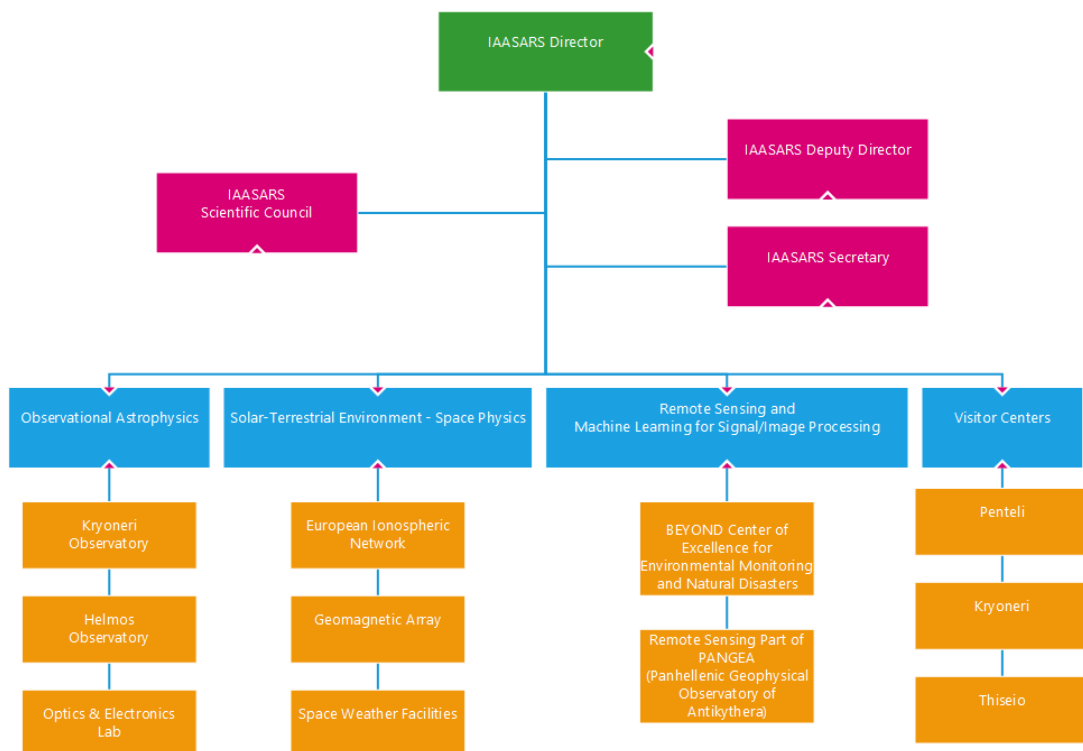
IAASARS Organogram

2.1.4 Further analysis on the management structure and operations.

The IAASARS expertise lies in a wide spectrum of thematic sessions involving applied and basic research in the fields of Astronomy, Astrophysics, Space Applications and Remote Sensing. The three main scientific disciplines

represented at the Institute are: (i) Observational Astrophysics, encompassing Space Astrophysics, Ground-based Astrophysics, etc., (ii) Solar-Terrestrial Environment - Space Physics, encompassing Solar and Heliospheric Physics, Space Research & Technology and Ionospheric Physics and (iii) Remote Sensing and Machine Learning for Signal/Image Processing. Each discipline is supported by the scientific and technical staff who are responsible for the maintenance and proper functioning of the existing infrastructure. At discipline level, a variety of novel and sophisticated research infrastructure is operated at the Institute's premises. For the optimum management of all relevant activities, aligned to Institute's mission and vision, the facilities are assigned to well-experienced personnel who are leading a group of specialists able to respond to each demanding task.

The main research infrastructure operated by the Ground-based Astrophysics group are the Helmos and Kryoneri Observatories equipped with the 2.3m "Aristarchos" and the 1.2m Kryoneri telescopes (a Cassegrain reflector), respectively. The majority of maintenance activities for Aristarchos are performed in the Optics and Electronics Laboratories at the premises of IAASARS in Penteli.

The pillars of the Remote Sensing group are the BEYOND Center of Excellence providing environmental and disaster management services and the recently established PANGEA Observatory in which essential climate variables, representative for the broader area of the E. Mediterranean, are monitored at the island of Antikythera.

In the field of Solar-Terrestrial Environment-Space Physics, the Ionospheric Group of IAASARS operates a monitoring station (Athens Digisonde) of Earth's Ionosphere contributing to several international network. The Space Research & Technology Group operates the <u>ENIGMA</u> array of ground-based magnetometers, the first ever installed in Greece, being part of the SuperMAG global network, whereas the Solar and Heliospheric Physics Group operates the Solar Telescope and the HESPERIA SEP forecasting tools.

The Visitor Centers of IAASARS consist the "gate" of the institute to the general public. The dissemination activities cover the large spectrum of interdisciplinary science performed at IAASARS, promoting and communicating the research results.

IAASARS' continuous outstanding success has been due largely to its ability to adapt its structure to meet the ever-changing needs and challenges posed by science and competence at European level. Typically, the effectiveness of the management structure is monitored by an External Advisory Committee (EAC) on an annual basis. This has been agreed in 2015 when the following EAC has been appointed by the Director of IAASARS with the approval of the SC:

- Dimitra Rigopoulou, Professor of Astrophysics, Oxford University, UK
- Günther Kohlhammer, Directorate of Earth Observation Programmes European Space Agency
- Kirpal Nandra, Director of MPI for Extraterrestrial Physics, Germany
- Jean-Luc Starck, Senior Researcher, CEA/Saclay, France

- Ronald Van der Linden, Director of Royal Obs. of Belgium, Belgium

The EAC monitoring process was not activated within the reporting period, however the Director and the SC aim to kick-off the EAC advisory meetings starting from early 2019. Specifically, the Institute aims to have fixed annual meetings with the EAC within the time window of one month after the annual report.

2.2 Location, Installation, Facilities

The main building of IAASARS is located on the grounds of the National Observatory of Athens in Penteli. There are several other installations and stations, in particular in Athens (Lofos Nymfon), Kryoneri (Corinthia), Mt. Helmos (Achaia). The description of the facilities installed at the above locations is as follows:

2.2.1 Buildings

The list of buildings which belong to IAASARS is the following:

1) The main building of IAASARS including the laboratory (~800 m2)
2) Helmos Observatory: the dome and the control room (~900m2)
3) Kryoneri Observatory: the dome and the control room (~500 m2)
4) Visitor centres at Penteli (large dome ~800m2 - small dome ~90m2) and Thisio (Sina building 210m2)

2.2.2 Infrastructures – Research Units – Core facilities

IAASARS consists of three main research units: 1) Observational Astrophysics 2) Solar-Terrestrial Environment - Space Physics 3) Remote Sensing and Machine Learning for Signal/Image Processing. In addition, there is a public outreach team which operates the visitor centres at Penteli and Thisio.

1) The Observational Astrophysics group operates a) the Helmos Observatory and b) the Kryoneri Observatories. In Helmos the ARISTARCHOS 2.3-telescope is located while at Kryoneri a 1.2-m refurbished telescope is installed. Finally it operates an optics and electronics laboratory at Penteli.
2) The Solar-Terrestrial Environment - Space Physics group operates a) the European Digital Upper Atmosphere Server - DIAS and the Athens Digisonde (DPS4D) ionospheric facilities b) the ENIGMA magnetometer network c) the HESPERIA energetic particle monitoring tools d) the solar full-disc telescope and the web-based tool HELIOSERVER e) the "Space Weather Now by NOA" web facility that provides the latest observations from the NOA space weather facilities: solar telescope, SEP occurrence probabilities and Ionospheric Specification services (http://spaceweather.space.noa.gr/).
3) The Remote Sensing Group operates a) the BEYOND centre of excellence and b) the remote sensing part of the PANGEA climate change station at

Antikythera.

Finally, the Public Outreach team operates the historic Newall Telescope at Penteli as well as the Doridis telescope at Thiseion.

Details of all these facilities are given below.

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.

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 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.

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:

1. 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.
2. CCD camera (SITeAB 2014x2048 pixels) with a field-of-view 5.5x5.5 arcmin. The camera is cryogenically cooled with a liquid Nitrogen down to a temperature of -110C.
3. 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.
4. 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 cameras, RISE2 and ATS are currently fully commissioned and were used during the 2013-2017 observing seasons. More details about the available instrumentation and the characteristics of the site can be found in the previous self-study report as Appendix II.

To date, 13 refereed publications have resulted from data obtained from the 2.3m Aristarchos telescope, 9 of which were published in the period 2013-2017. Note that the first refereed publication was published in 2013.

Kryoneri Observatory
Kryoneri Observatory (http://kryoneri.astro.noa.gr) was built by Grubb-Parsons Co. Newcastle and commissioned in 1975. The telescope is situated at Kryoneri Observatory (37 deg 58' 19" North, 22 deg 37'07" East), 100 km west of Athens in the district of Corinth in the northern Peloponnese, Greece, at the top of mount Kyllini, at an altitude of 930 m, close to Kryoneri village. During its first ~40 years of operation, the telescope's optical system consisted of a paraboloidal primary mirror of 1.2 m diameter and f/3 focal ratio and a hyperboloidal secondary mirror (31 cm). Both mirrors are made of Zerodur. This configuration produced a final focal ratio of f/13 at Cassegrain focus. The main scientific instrument in the last years was a 2.5'x2.5' CCD camera Apogee Ap47p with a set of UBVRI filters. The telescope was reasonably productive with a number of scientific publications (50 refereed publications until 2010) on a rather restricted field, namely stellar photometry and variability studies.

In 2015, the 1.2 m Kryoneri telescope was selected (after a trade-off analysis) as the optimal facility of NOA for the ESA-funded NELIOTA project (https://neliota.astro.noa.gr/). The NELIOTA science objectives imposed strict requirements on the optical design and therefore, in 2016, the telescope underwent an extensive upgrade by DFM Engineering Inc., within the NELIOTA project (for a detailed description, see Xilouris et al. 2018, A&A, 619, 141). The electro-mechanical upgrade included replacement of the telescope servo-motors and associated hardware (including new encoder systems), and deployment of a new system for dome opening and rotation as well as motorized primary mirror doors. Furthermore, and according to the requirement for lunar observations, the optics of the telescope were modified to operate with instruments at the prime focus, bringing the telescope back to its primary mirror f/3 focal ratio and providing an unvignetted field-of-view (FOV) of ~1.4 degrees. A twin imaging system, the Kryoneri Prime Focus Instrument (KPFI), designed and developed by DFM Engineering Inc., is now in use, sampling 17.0'x 14.4' of the total corrected FOV at the prime focus of the telescope, providing simultaneous high-cadence observations in two bands. A direct imaging optical configuration, using a separate CCD detector, was also added to the design to allow use of the full FOV. This was made possible through a computer-controlled camera slider plate mechanism allowing for two operating modes, either using the twin imaging system (or "Lunar imager") or the direct imaging configuration (or "Direct imager"). To date, there are 2 refereed publications using data obtained from the refurbished 1.2m Kryoneri telescope.

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

The HellENIc GeoMagnetic Array (ENIGMA)

The Space Research & Technology Group has developed, installed and operates the ENIGMA (HellENIc GeoMagnetic Array), an array of 4 ground-based magnetometer stations located in Trikala (Klokotos), Attiki (Dionysos), Lakonia (Velies) and Crete (Finokalia), Greece. ENIGMA 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 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.

ENIGMA instrumentation

The Solar Energetic Proton Flux (SEPF) tool

The group has developed and operated the Solar Energetic Proton Flux (SEPF) tool. This is a web-based tool that 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 is a European Space Weather asset.

The FORecasting Solar Particle Events and Flares (FORSPEF) tool

The group has developed and operates the FORecasting Solar Partilce Events and Flares (FORSPEF) tool, which is a web-based tool that provides forecasting of solar eruptive events, such as solar flares with a projection to coronal mass ejections (CMEs) (occurrence and velocity) and the likelihood of occurrence of a solar energetic proton (SEP) event. It also provides nowcasting of SEP events based on actual solar flare and CME near real-time alerts, as well as SEP characteristics (peak flux, fluence, rise time, duration) per parent solar event. The models developed for and incorporated in the FOSPEF tool are registered at the Community Coordinated Modeling Center (CCMC) of NASA.

The Ionospheric Group has developed a data and model e-infrastructure system that supports the DIAS, Net-TIDE, ESA-EIS and TechTIDE systems and operates the Athens Digisonde with its own computing facilities for the acquisition, post processing, archiving, distribution and publication of the collected observations.

The European DIgital Upper Atmosphere Server (DIAS) System

The DIAS system was developed under the EC eContent Programme (2006) and delivers, after four major upgrades in 2008, 2012, 2014 and 2017 systematically a

comprehensive set of data and products that characterize ionospheric, thermospheric and plasmaspheric conditions over Europe. The system retrieves data from 11 European Digisondes and Ionosondes (Athens, Rome, Ebre, Arenosillo, Chilton, Juliusruh, Pruhonice, Dourbes, 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 to serve data and products through the DIAS html interface (http://dias.space.noa.gr) and through API (on-demand services to ESA-SSA, NOAA and IZMIRAN).
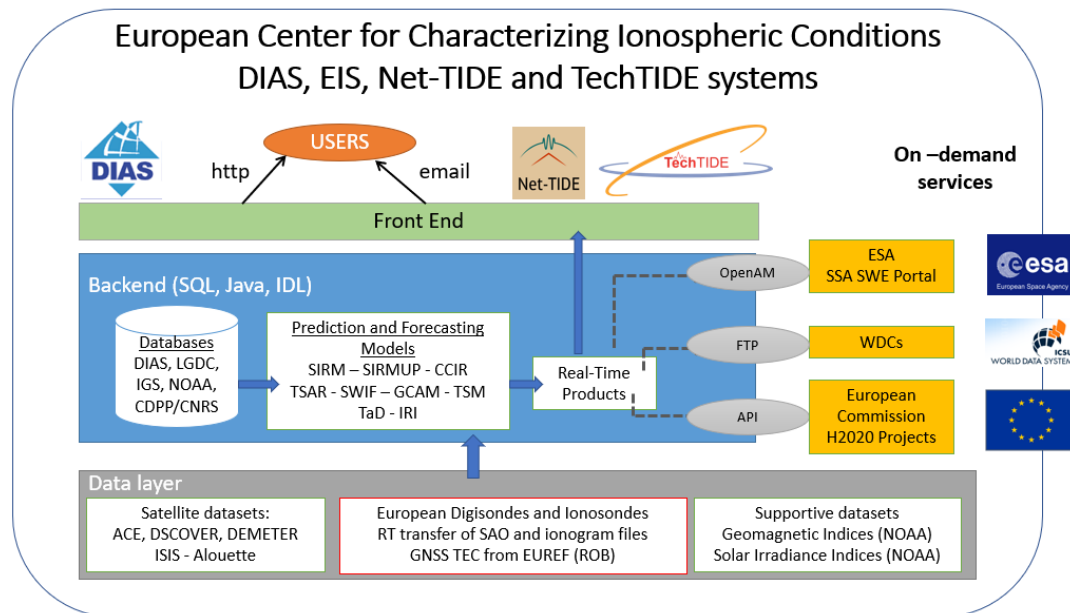
DIAS, Net-TIDE, ESA-EIS and TechTIDE systems

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.

Since 2013 the DIAS system is one of the federated services that support the pilot phase of the ESA Space Situational Awareness Programme with the European Ionosonde Service for the Space Weather Segment. The DIAS system provides its services in real-time 24/7, following the EC open access policy for research data distribution.

The Athens Digisonde

The Athens Digisonde is an infrastructure for remote sensing of the Earth's

Ionosphere, operated by NOA in Penteli since September 2000. The Digisonde was upgraded in 2015 to the latest model of a DPS-4D with four receiving antennas spaced about one wavelength apart. In 2017 several hardware and software components have been upgraded to allow bi-static operations with similar stations in Europe. Today The routine observation modes include:

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. Automatic scaling of the ionogram and archiving the resulting parameters in SAO format.
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.
6. Digisonde-to-Digisonde soundings in bi-static link mode with similar Digisondes in Europe. This results to oblique sky maps and to the identification of travelling ionospheric disturbances over the region of operations.
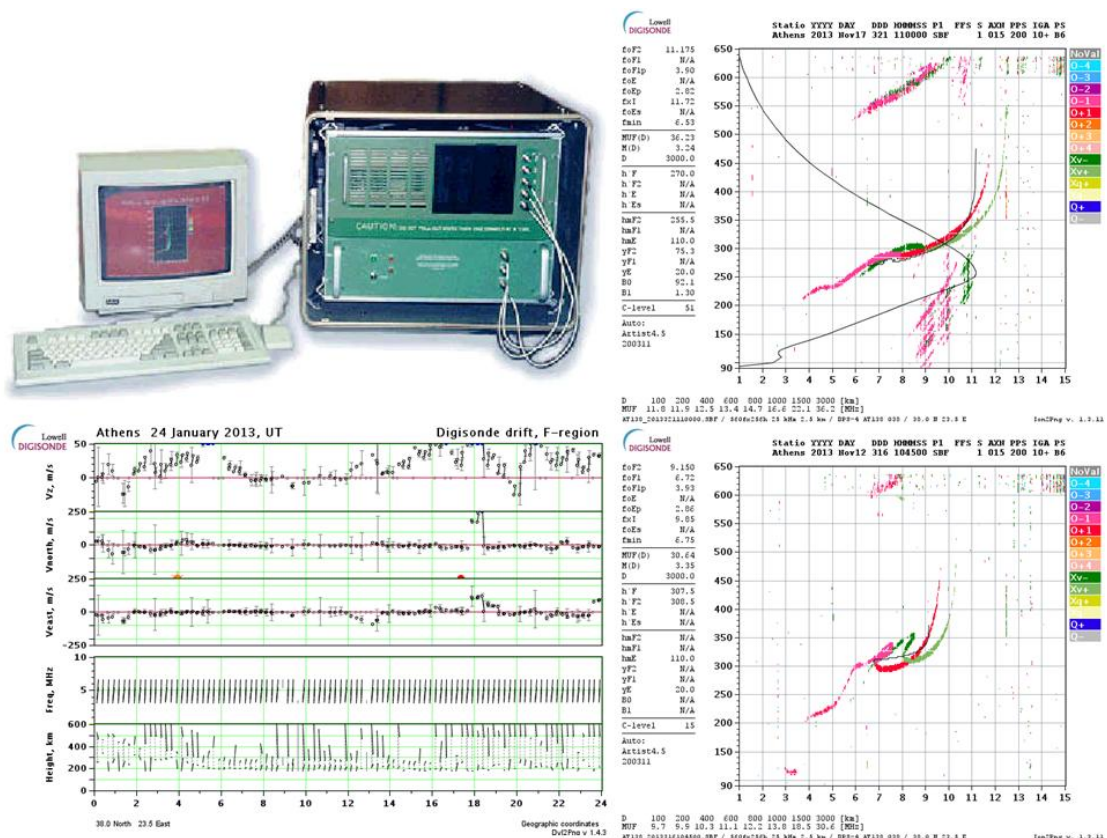
Athens Digisonde

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, while it is the main node for DIAS, Net-TIDE and TechTIDE networks.

Solar Telescope

Images of the solar chromosphere are acquired with a solar telescope manufactured by Lunt Solar Systems. The diameter of the objective lens of the telescope is 100mm and its focal length is 800 mm. The telescope has an in-built Hα étalon, able to observe at Hα, as well as Doppler-shifted features through a pressure tuner. The bandpass of the étalon is lower than 0.75Å and it can be reduced to lower than 0.5 Å, when double stacked with a second étalon. Images are acquired using a DMK51AU02 CCD camera (by The Imaging Source), equipped with a Sony ICX274AL sensor, whose size is 1600pixels x1200 pixels. In 1x1 binning, the spatial scale of the images is 1.27" per pixel.

Helioserver

A web-based server constructed to provide the output from the real time optical imaging of the Sun and the SEP prediction tool. The database is available to the users of the on-line interface and provides the ability to search and request Hα images.

HESPERIA SEP forecasting tools

A dedicated web-based server built which provides and disseminates to stakeholders worldwide the real-time forecasting results of the HESPERIA REleASE and HESPERIA UMASEP-500 tools in terms of 30-50 MeV and >500 MeV proton predictions at L1. https://www.hesperia.astro.noa.gr

BEYOND Center of Excellence

The RS group of IAASARS/ NOA has accumulated expertise and infrastructural capacities, and developed skills in the context of ESA, Copernicus and EC research projects, as well as large scale capacity building projects. It has managed to position itself as a regional EO hub for research, advanced data exploitation, and delivery of information and services in the south-eastern Europe, Middle East and North Africa, specifically for the This resulted in receiving an award from the EU in the REGPOT 2013-2016 framework program for the development and operation of the European EO Center of Excellence BEYOND.

It is worth noting that Services like Fire Area Mapping and Fire Monitoring at Middle and High Resolution delivered through the FIREHUB system have received the first prize as Best Service Challenge in the Copernicus Masters worldwide competition, while the relevant IPR is protected by the patent no. 20150100061 issued by the Industrial Patent Organization of Greece. Moreover, it has been put in operation a large Ground Segment infrastructure which has been developed in BEYOND and empowered by GRNET (the Greek partner of GEANT) which sustains in operation of a number of Sentinel DataHubs for the purposes of Copernicus and ESA which in turn disseminates approximately 55TerraBytes of

Sentinel data (S-1, S-2, S-3, S-5P) worldwide.

Within BEYOND, the RS Group designs, deploys and maintains computational infrastructure in order to support users and implement projects and services assigned. The main infrastructure consists of two "Virtualization" systems. The first one is a cluster of three Red Hat Enterprise Hypervisors servers that simulate 27 virtual machines that serve the variety of needs that need to be met for the provision of services and the execution of tasks. The second virtualization cluster is a new addition to NOA infrastructure and consists of two Dell PowerEdge Servers on which the VMware virtualization environment has been installed. Those two systems with high availability features, offer uninterrupted operation of its individual parts with expansion and reconfiguration capabilities. Infrastructure also includes two storage and archiving systems. The main storage system includes a PowerEdge server and a disk arrangement of 4 TB hard drives, providing a payload of almost 130 TB of usable storage capacity. The second storage is a Network – attached storage with a 20TB storage capacity, providing data access to a heterogeneous group of users, as it serves as a convenient method of sharing files among multiple computers. Finally, the infrastructure consists of three high performance PowerEdge R730xd Rack Servers, which offer an optimal balance of storage utilization and processing power, elements necessary for the processing chains developed within the framework of the projects and are particularly resource -demanding.

PANGEA Climate Change Observatory - Remote Sensing Facilities

The RS group of IAASARS/NOA has installed the Aerosol Remote Sensing National Facility at Antikythera, including the sophisticated multi-wavelength lidar system PollyXT (http://polly.rsd.tropos.de/), the NASA-AERONET sun-photometer (https://aeronet.gsfc.nasa.gov/), an advanced polarimeter and an electrometer. More instruments will be installed soon, while the users can already acquire data from PANGEA by visiting the respective data center of the ACTRIS Research Infrastructure (https://www.actris.eu/).

The Aerosol Remote Sensing National Facility of Antikythera

NOA will support the establishment and operations of PANGEA for the next 5 years with an amount of 3.5 million Euros from existing programs, aiming to cover part of expenses for research equipment, operating expenses and research staff. The budget originates from the approved ERC Consolidator Grant "D-TECT" focusing on desert dust research, the National Research Infrastructure PANACEA and existing research equipment already acquired under competing National and European programs by IAASARS. We use an area of 36 acres in Antikythera for installing its equipment. The property has been selected such as to meet the scientific requirements of PANGEA and has been granted for 50 years to NOA by the Municipality of Kythera and the Domestic Property Committee of Kythera and Antikythera.

2.2.3 Computing facilities

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 centre 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.

The NELIOTA observation and detection systems are deployed at the Kryoneri site on a cluster of two nodes, both using a common external high-performance storage array of a total of 38.4 TB through a dedicated switch (see Table 3, Xilouris et al. 2018). The storage subsystem is linked through 8 x 1 Gb copper connections to the switch, while the two servers are connected to this switch by their optical SFP ports. These connections form a dedicated ring, in other words, an isolated high-speed iSCSI network for data transfer between the servers and the storage.

2.2.4 Other Facilities

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, the MFMS spectrometer to test the narrowband filters etc.) in order to support the 2.3-m "Aristarchos" and 1.2-m Kryoneri telescopes, to test existing instruments and to develop new scientific instruments.
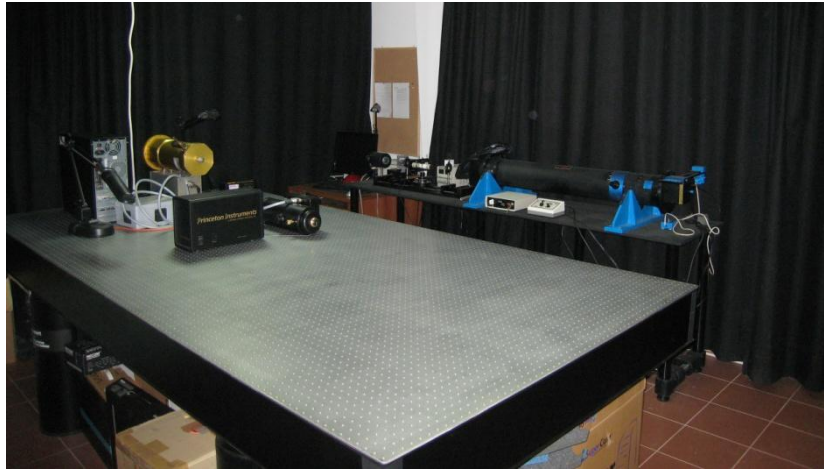
The Optical and Electronics Laboratory

2.2.5 Refer any changes in the time interval: 1/1/13-31/12/2017

In 2016, the Kryoneri 1.2m telescope underwent extensive refurbishment as part of the ESA-funded NELIOTA project (https://neliota.astro.noa.gr/). It now features new optics and a new twin imaging system placed at the prime focus (see detailed description in section 2.2.2.1.2). High-cadence, multicolor photometry with a large field of view is now the innovative feature of the upgraded telescope, the operation of which is funded through to 2021.

The ENIGMA (HellENIc GeoMagnetic Array) magnetometer array until recently consisted of three ground-based magnetometer stations, in the areas of Trikala (Klokotos), Attica (Dionysos) and Lakonia (Velies). In the framework of the KRIPIS-PROTEAS project, the upgrading and expanding of the ENIGMA network was designed and implemented. In April 2017 a new station was added to the ENIGMA magnetometer array, expanding the existing infrastructure to the South part of the country. The new station was installed in Finokalia, Crete and the instrument used is a GEOMAG-02 magnetotelluric station, providing measurements of high resolution (frequency: 10 Hz) ever since. In addition, the old ENIGMA website was re-designed and upgraded to a dynamic HTML5 webpage. The new webpage is connected to a database, where daily data from the ENIGMA stations are stored and distributed to users. At the same time, data are processed in real-time for the production of wavelet spectra, using MATLAB code, which are consecutively stored in the database.

From 2014 to 2015, the Athens Digisonde underwent extensive refurbishment as part of the KRIPIS-PROTEAS and NATO-SPS NetTIDE projects. It now features new digital transmitters and receivers in a DPS4D system. Because of this major upgrade the Athens Digisonde is able in operate in high cadence VI mode and in Digisonde-to-Digisonde oblique drift mode. These specifications make the Athens Digisonde a state of the art experimental facility, already attractive to various science projects which can support their operation (for example the new H2020 TechTIDE project, a consortium of 13 partners, coordinated by the NOA Ionospheric Physics Group).

Through the KRIPIS-PROTEAS project funded by Greece and the European Regional Development Fund i) a small full-disk solar telescope was procured and

placed inside a dome on the premises of NOA at Penteli. The telescope operates in Hα and provides images of the solar chromosphere, ii) A web-based server, the HELIOSERVER, is constructed to provide to the community a database of solar observations.

2.3 Personnel

2.3.1 Personnel at 31/12/2017

I. Distribution of personnel based on research teams

Distribution of personnel in research teams
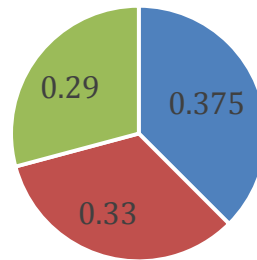
- ■ Observational Astrophysics
- ■ Remote Sensing and ML for Signal/Image Processing
- ■ Solar-Terrestrial Environment - Space Physics

II. Comment on the number and the level of involvement of personnel that are University faculty members too.

Prof. V. Charmandaris, director of IAASARS for the period 2013-2017 was also a professor at the University of Crete.

III. Social characteristics of personnel.

No. of researchers	Female researchers (%)	A-level female researchers	Nationality	People with Special needs
25	28%	20%	Greek (100%)	0%

Age distribution of IAASARS research personnel
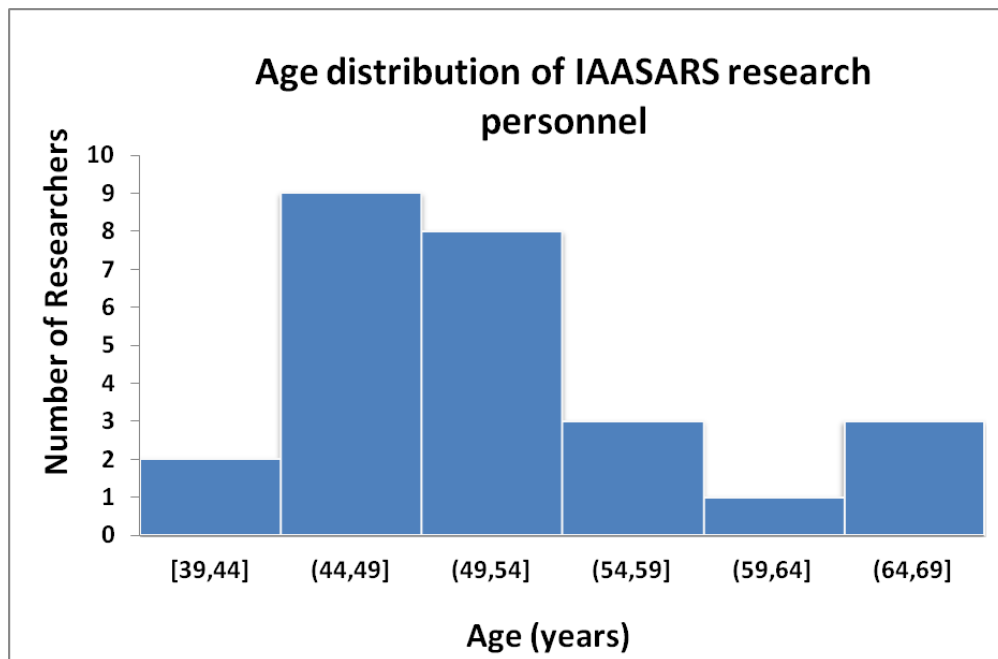
2.3.2 Mobility (2013-2017)

The reader is referred to the excel sheet 1b (Appendix B)

Additional evidence on the following topics is provided here beneath:

1) Departs (indicate number of retirements, departs to other educational/research Institutes, sabbaticals, etc.)
   - N. Matsopoulos from Technical Staff retired in 2015
   - P. Mathiopoulos (Researcher A) departed to National Kapodistrian University of Athens in 2014
   - Georgakakis (Researcher B) was on unpaid leave from 2013-11th 2016. The period from 12th/2016 to 5th/2017 was on sabbatical to Max Planck Institute.
   - N. Sifakis was on secondment to ERC (Brussels) from 2013-10st/2016. The period from 11st /16 till today is on unpaid leave.
2) New appointments and recruitments of scientific personnel (describe from where)
   None
3) Ratio of new appointments of scientific personnel over departs
   None
4) Number of foreign (visiting) researchers during the evaluation period.
   None
5) Tenure researchers' career advancement (e.g. from Researcher B to Researcher A, scientific personnel (IΔAX) to researcher, etc.)

2014

- V. Amoiridis from Researcher C to Researcher B
- I. Keramitsoglou from Researcher C to Researcher B
- G. Balasis from Researcher C to Researcher B

2016 (December)

- Rontogiannis from Researcher B to Researcher A
- O. Malandraki from Technical Scientific Staff to Researcher B.
- Akylas from Technical Scientific Staff to Functional Scientific Researcher B.
- O. Giannakis from Technical Scientific Staff to Functional Scientific Researcher B.

2017

- E. Xilouris from Researcher B to Researcher A
- P. Boumis from Researcher B to Researcher A
- A. Bonanos from Researcher C to Researcher B

3. Finance

Please find attached the relevant excel sheets 2a and 2b and 4a as appendix C and and 4b as appendix E.
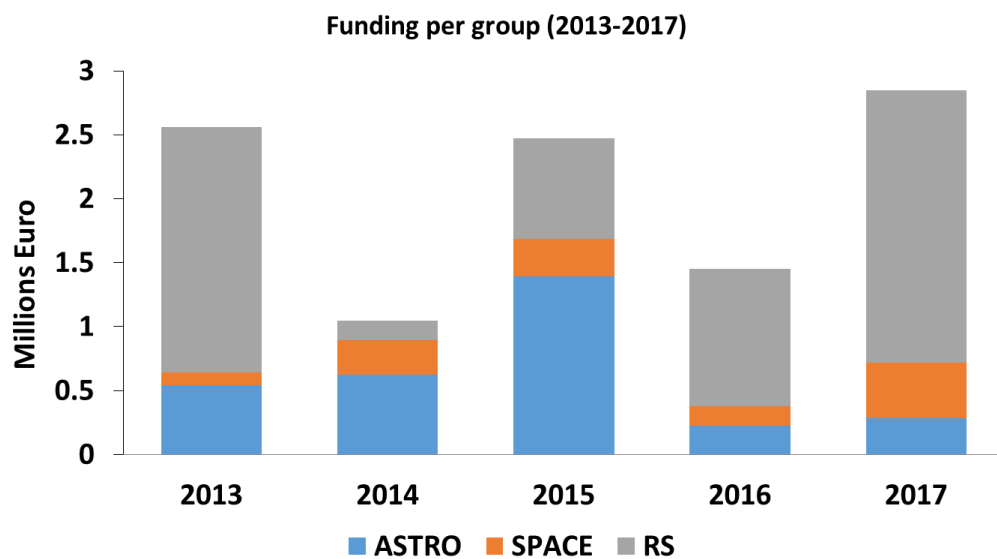
Funding per group (2013-2017)

A histogram of the external funding from competitive grants awarded to researchers (per IAASARS discipline)

4. Advancement, dissemination and implementation of knowledge (2013-2017)

4.1 Research Priorities

Observational Astrophysics	Solar-Terrestrial Environment - Space Physics	Remote Sensing and Machine Learning for Signal/Image Processing
X-ray Astronomy	Solar and Heliospheric Physics	Remote Sensing
Infrared Astronomy	Space Research and Technology	Machine Learning for Signal/Image Processing
Optical Astronomy	Ionospheric Physics	
GAIA		
Planets and the solar system		
Ground-based instrument development		

IAASARS Research Priorities and Research groups

4.1.1 Observational Astrophysics

The Observational Astrophysics group of IAASARS numbers 7 staff (Drs. Akylas, Bonanos, Boumis, Charmandaris, Georgakakis, Georgantopoulos, Xilouris). Prof. V. Charmandaris joined the group as Director of the Institute in September 2013 and departed in September 2018. In the period 2013-2017, the members of the Observational Astrophysics group have published 105 articles in refereed journals with impact factor >4. These papers have received to date (Dec 2018) more than 5700 citations. There are also more than 100 publications in non-refereed conference proceedings during the reporting period.

The main research directions of the Observational Astrophysics group of IAASARS are the evolution of supermassive black holes, the physics of galaxy evolution, the astrophysics of stars and studies of the Interstellar Medium. These activities are supported by the development and operation of ground-based instrumentation. A new area of research, which has been initiated recently is the study of the Solar system via observations of near-Earth objects.

X-ray Astronomy - Formation and evolution of supermassive black holes

The overarching questions that are being addressed are (i) when do supermassive black-holes at the centres of galaxies form during the lifetime of the Universe and how do they evolve with redshift, (ii) which physical conditions are conducive to accretion events onto supermassive black holes and (iii) how active black-holes

affect their immediate environment.

Researchers of the IAASARS address these questions using primarily observations at high energies and X-rays in particular. They develop novel tools and methods to analyze data from all the major X-ray observatories currently in orbit, such as the XMM-Newton, the Chandra, the SWIFT/BAT and the NuSTAR. These are combined with multi-waveband observations to produce advanced data products and estimate physical parameters for galaxies that host an active supermassive black hole (Active Galactic Nuclei), e.g. redshifts, stellar masses, star-formation rates, X-ray spectral properties etc. State-of-the-art statistical methods are developed and applied to these products to infer population properties of the AGN that directly relate to the questions above, e.g. the AGN luminosity function, the duty cycle of accretion events, the position of active supermassive black-holes on the cosmic web and the properties of their host galaxies.

The necessary supply of data for scientific exploitation is accomplished via the participation of the IAASARS researchers in large collaborative programmes (e.g. the XMM-CDFS, PI A. Comastri; the XMM-XXL survey, PI M. Pierre) or via observational campaigns led directly by the IAASARS, e.g. XMM-ATLAS survey (PI Georgantopoulos).

A total of 9 post-doctoral researchers (Ranalli, Lanzuizi, Mountrichas, Koulouridis, Ciesla, Nikoloudakis, Corral, Ruiz, Rovilos), 3 PhD students (Pouliasis, Masoura, Koutoulidis) and 1 M.Sc. student (Dimopoulos) worked in this area during the reporting period.

IR Astronomy - Galaxy Evolution

The fundamental research questions that are addressed are (i) the origin of the chemical elements in galaxies and the Universe, (ii) the nature of the physical processes that shape the interstellar medium (ISM) in galaxies, including the impact of star-formation and Active Galactic Nuclei.

Researchers of IAASARS pursue these goals using as starting point observations at infrared and sub-mm wavelengths to study the cold Universe and explore gas and dust within and beyond our galaxy. It the IAASARS strategic decision to join the international consortia of high-profile infrared missions, both recent (Spitzer, Herschel) and planned (SPICA) to build expertise and gain priority access to data. The participation of IAASARS to these teams include contributions to the instrumentation development and calibration, the mission planning and definition of the science goals as well as the scientific exploitation of the observations. Because of this involvement IAASARS researches are currently in a unique position, in terms of technical expertise, to scientifically explore the huge legacy datasets that recent infrared/sub-mm space missions have produced.

IAASARS researchers have developed specific expertise in the handling of data from infrared telescopes and the development of computer models to relate multiwavelength observations to the physical properties of the dust (chemical composition, size distribution, temperature) and its origins within galaxies (evolved stars, supernovae, growth in the ISM).

A total of 4 postdoctoral researchers (Drs. I. Leonidaki, L. Cassara, M. Vika, L. Ciesla) 2 PhD students (A. Nersesian, A. Psychoyios) and 1 MSc student (V. Paspaliaris) have worked in this research area during the reporting period.

Optical Astronomy - Stellar Astrophysics and Interstellar Medium

IAASARS researchers are exploring outstanding problems in stellar astrophysics and the ISM, such as (i) how do massive stars evolve before their death as supernovae, (ii) what are the progenitors of supernova explosions (iii) how do planetary nebulae and supernova remnants form?

These open questions are being explored using multi-wavelength observations obtained from both ground-based and space-based observatories. Techniques such as high precision photometry, high-resolution spectroscopy, stellar variability, modeling of eclipsing binaries, modeling the morphology and kinematics of supernova remnants and planetary nebulae are used to tackle these problems. Fundamental parameters of massive stars are measured with accuracy, while rare types of massive stars are identified in nearby galaxies, thus providing valuable constraints for uncertain input physics in the stellar evolution models.

IAASARS Researchers working in this theme are two tenured staff (Boumis, Bonanos) and 11 postdoctoral fellows (Uscanga, Chiotellis, Font, Nanouris, Liakos, Williams, Moretti, Gavras, Yang, Sokolovsky, Karampelas) and 5 PhD students (Britavskiy, Kourniotis, Spetsieri, Derlopa, Paraskeva). 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 and the 1st International Conference on Supernova Remnants, titled "Supernova Remnants: An Odyssey in Space After Stellar Death" (June 2016, Crete, Greece) as SOC and LOC chairs. Both meetings were very successful; moreover, the SNR community decided that NOA organize the 2nd international conference on Supernova Remnants in June 2019.

GAIA

The GAIA group consists of two permanent researcher and one postdoctoral scientist and participates in the GAIA DPAC. This is a large pan-European team of scientists and software developers responsible for the processing of Gaia's data with the final objective of producing the Gaia Catalogue. Drawing its membership from over 20 countries, the consortium brings together skills and expertise from across the continent. Its task is to develop the data processing algorithms, the corresponding software, and the IT infrastructure for Gaia.

The NOA group participates in CU9 which is responsible for the identification and classification of galaxies. This is performed using neuron network algorithms.

Planets and the solar system

Strategic decisions were made about the investment of NOA telescope time once the following opportunities/projects arose. Therefore, researchers from the Optical and Infrared groups proceeded to two different projects at both IAASARS telescopes. At Helmos Observatory, the RISE2 camera on Aristarchos was installed in 2010 to observe transiting exoplanets. At Kryoneri Observatory, IAASARS researchers got involved in Near-Earth Objects via lunar monitoring for

impact flashes in 2015. This is a "hot topic", which gave the opportunity for involvement in cutting-edge science and also provided a way to fund/operate Kryoneri.

Ground-based instrument development

Observations from ground-based telescopes, often in combination with multi-wavelength data from satellites, remain a key contributor to astronomical discoveries. The Observational Astrophysics group of IAASARS is in the favorable position to have access to the two ground-based facilities owned by the NOA to support and augment their research programmes on stellar evolution, studies of the ISM, the detection of NEOs and the morphology and evolution of nearby galaxies. Researchers from the Optical and Infrared groups working on the development of new instruments and the capability to maintain or upgrade existing ones is therefore important for the group.

4.1.2 Solar-Terrestrial Environment - Space Physics

Solar and Heliospheric Physics

The Solar and Heliospheric Physics Group carried out studies of the Sun and the interplanetary medium. Studies of the Sun comprised analyses of observational data acquired from spacecraft (such as SDO, IRIS, TRACE and Hinode) and/or ground-based observatories (such SST and DOT in La Palma) combined with modelling and theoretical tools (such as radiative transfer). The observational data provided, through a multi-wavelength analysis, coverage of the solar atmosphere from the lower layers to the outer corona and permitted the extraction of quantitative information about the physical parameters that describe the thermodynamic state of the solar plasma. The group investigated a wide range of solar phenomena occurring in active and quiet regions of the Sun. The research goal was to understand the rich structure and dynamics of the Sun and its impact on the interplanetary space that is determined by the solar wind.

Analysis and interpretation of Solar Energetic Particle (SEP) data, as well as complementary plasma and magnetic field data collected by ESA and NASA spacecraft (e.g. STEREO, Ulysses, ACE, Wind, Cluster) has been carried out in order to study the effects of eruptive solar events in the interplanetary space and the Earth's environment. Research has been performed on the solar origin, acceleration and transport of SEPs in the Heliosphere, Heliospheric Particle Reservoirs, Space Weather forecasting, the effect of solar storms to the environment of Mars and to astronauts of future Manned Space Missions. Moreover, the effect of small-scale magnetic islands in the solar wind and their role in particle acceleration in terms of energization inside magnetic cavities in interplanetary space has been extensively studied at Earth's orbit. A comprehensive Sun-to-Earth analysis of major geoeffective solar eruptions has been carried out as well as studies of the extreme geomagnetic storms within the last two centuries. Extensive analysis of the composition signatures of large SEP events during solar cycles 23 and 24 have been carried out. Non-extensive statistical analysis of magnetic field during the March 2012 ICME event using a multi-spacecraft approach was also implemented. In collaboration with European and American partners COMESEP, the first European Space Weather Alert System, has been implemented Furthermore, the HESPERIA forecasting tools have been implemented disseminating SEP forecasts in real-time to the worldwide community.

From mid of 2017 the group participates in the European Solar Telescope Preliminary Phase (PRE-EST) project funded by the European Commission. The principal objective of PRE-EST is to provide a detailed plan regarding the implementation of EST a revolutionary 4-m class solar telescope which entered the ESFRI Roadmap in 2016. It is also participating in Science Use Cases that built the Critical Science Plan of the Daniel K. Inouye Solar Telescope (DKIST) the world's largest telescope under construction in Hawaii to be completed in 2020. Member of the group is the National representative in the European Association for Solar Telescopes (EAST). The group has close collaborations with several well-established solar groups like the ones at the Academy of Athens (Greece), Paris Observatory (France), Ondrejov Observatory (Czech Republic) and Armagh Observatory and Northumbria University (UK). It is involved in several solar observational campaigns as Principal Investigator or Guest Investigator. 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, served as external examiners in PhD theses 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 funded projects. The group has attracted funds from the EC (HESPERIA, SEPServer, COMESEP, PRE-EST) and from national funds (EXCELLENCE project).

The activities of the Solar and Heliospheric Physics Group in 2013-2017 were supported by two permanent researchers (O. Malandraki, G. Tsiropoula), post-docs (I. Kontogiannis, S.-H. Park, K. Tziotziou, A. Papaioannou, G. Dorrian, R. Miteva, G. Share, L.C. Tan), MSc. students (I. Patsou, E. Pavlos) and support staff (A. Charisi).

Space Research & Technology

The Space Research & Technology Group specializes in studies of planetary and interplanetary plasmas, geomagnetism and space magnetism, space weather prediction and space radiation environment and its effects on spacecrafts.

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.

One of the main research lines of the SRTG is the spaceborne and ground-based magnetometry. This activity pertains to the operation of the Hellenic Geomagnetic Array (ENIGMA), a network of several ground-based magnetometer stations in Greece, as well as to the group's involvement in magnetic field satellite missions. In particular SRTG is a member of the Validation Team of the Swarm satellite mission of the European Space Agency.

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).

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
- Space radiation environment and effects

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, Swarm, etc.). Active collaboration exists with a number of research institutes in Europe, USA and Japan.

IAASARS Researchers participating in the group are three permanent staff members (Anastasiadis, Balasis, Giannakis), 4 adjunct researchers (Daglis, Tsinganos, Vourlidas, Sergis), 3 postdoctoral researchers (Dimitrakoudis, Papaioannou, Sandberg), 5 PhD students (Boutsi, Georgiou, Giamini, Katsavrias, Mitrokotsa), 2 MSc students (Papadimitriou, Vasalos) and 1 technical permanent staff member (Salustros). In the period 2013-2017, the team published 44 refereed papers, which received 489 citations as of December 2017.

Ionospheric Physics

The main activities of the Ionospheric Physics 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.

The Ionospheric Group coordinates large European Commission funded consortia (DIAS/FP6, COST Action ES0803, ESPAS-RI/FP7, TechTIDE/HORIZON2020) and multi-year research projects funded by the European Space Agency, by the NATO Science for Peace and Security Programme and by the US Air Force Research Laboratory. Furthermore, the Ionospheric Physics Group participates to large scale global research initiatives supported by the European Science Foundation, NASA and COSPAR for the consolidation and validation of space weather activities.

The research priorities of the Ionospheric Group are:

- The operation of ionospheric monitoring systems for probing the ionosphere, the development of data and model infrastructures and the provision of ionospheric - space weather services that cover the whole European region;
- The development of novel modeling techniques for the prediction of ionospheric perturbations, including both large scale effects, instabilities and irregularities, triggered by the geospace and the lower atmosphere, based on observational data from ground and space-based experiments.
- The enhancement of international collaboration for the standardization of data exchange, archiving and curation methodologies, and for the development of novel validation procedures for the performance of space weather predictions models

The activities of the Ionospheric Physics Group are supported by three permanent researchers (A. Belehaki, I. Tsagouri, K. Koutroumbas), one adjunct researcher (I. Kutiev) and six support scientists (P. Elias, K. Themelis, K. Tziotziou, A. Charisi, I. Xenaki, A. Mouzakis).

4.1.3 Remote Sensing and Machine Learning for Signal/Image Processing

Remote Sensing

The research priorities of the Remote Sensing group in IAASARS/NOA focus on the following pillars: (a) understanding the Earth system from land to atmosphere, its climate and natural/human-induced hazards, (b) utilizing the wealth of information from the acquisition infrastructures and ground-based research infrastructures in order to advance knowledge on the thematic areas defined within the BEYOND (e.g. Agriculture, Natural Disasters, Energy), (c) studying the critical components that affect climate change such as aerosols, clouds and trace gases employing remote sensing techniques and utilizing the PANGEA observations, (d) implementing innovative imaging techniques in environmental applications with emphasis on geological mapping, chemical/mineral exploration (earth and planetary), analysis of landscape dynamics, vegetation status and ground deformation. In the period 2013-2017, the members of the RS group published 130 articles in refereed journals and refereed international conferences proceedings

(~26 articles per year), which have received more than 1800 citations.

Machine Learning for Signal/Image Processing (MLSIP)

The basic research activities of the Machine Learning for Signal/Image Processing (MLSIP) group in IAASARS/NOA are focused on the development, analysis and validation of advanced machine learning algorithms for signal processing, image processing and pattern recognition, aiming at the extraction of information from (big) data originating from various sources, including earth observation data, astronomical data, ionospheric data, lidar data, etc. The main engineering problems of interest are, but not restricted to, a) data classification and clustering for object recognition and material identification in imaging data b) data dimensionality reduction and subspace learning, c) sparse and low-rank data representations and compressed sensing, d) outlier detection and removal from data via robust principal component analysis, e) image data restoration from partial information using matrix completion, f) signal and image denoising by exploiting structural properties of the data such as sparsity and low-rank. In the period 2013-2017, the members of the group published 44 articles in refereed journals and refereed international conferences proceedings (~9 articles per year), which have received more than 500 citations (source Google Scholar Citations). This work has been published in highly competitive and high impact IEEE journals including the IEEE Transactions on Signal Processing, IEEE Transactions on Fuzzy Systems, IEEE Transactions on Image Processing, IEEE Transactions on Geoscience and Remote Sensing, IEEE Transactions on Computational Imaging and IEEE Transactions on Communications. In addition, the research results of the group were presented in the top relevant refereed conferences, such as IEEE ICASSP, EUSIPCO, IEEE IGARSS, WHISPERS, CoSeRa, IEEE ISSPIT, IEEE SSP and the SPARS workshop. Two of our conference papers (in CoSeRa 2015 and in IEEE ISSPIT 2013) received Best Paper Award distinctions.

Some characteristic research activities of the group are listed below.
- A large part of our work is related to the development of generic machine learning techniques for information retrieval from multispectral and hyperspectral images acquired by sensors onboard satellites such as the Sentinels and ESA Mars Express. Novel clustering and unmixing algorithms have been devised and applied for a) mineral exploration on the surface of planet Mars, b) recognition of different crop species types based on earth observation hyperspectral images, c) lava flow characterization based on hyperspectral images from Mt. Enta.
- In collaboration with the Ionospheric Physics group, the group has developed models for forecasting (a) the state of the ionosphere in the near future and (b) the propagation of ionospheric disturbances.
- The MLSIP group is collaborating with the ground-based remote sensing group of IAASARS in the processing and analysis of lidar data. More specifically, by exploiting the inherent structural properties and noise type of lidar measurements, we aim at developing beyond the state-of-the-art algorithmic tools for estimating various atmospheric parameters of interest with high accuracy.
- With the collaboration of the X-ray astrophysics group of IAASARS, the MLSIP group is working on the design and implementation of efficient online robust principal component analysis and deep learning methods for

accurate detection of sources in big X-ray astronomical data.

4.2   Research projects

4.2.1 Observational Astrophysics

Formation and evolution of supermassive black holes

This research area has been funded by 0.81M€ through competitive National and European calls of proposals. High-profile projects include participation in the H2020 Research Infrastructures program AHEAD (Integrated Activities in the High Energy Astrophysics Domain) and leading ESA-PRODEX programmes to develop advanced data products for the XMM serendipitous source catalogue.

Researchers of the IAASARS remain heavily involved in the German-led eROSITA telescope with representation both in the data analysis team and the AGN Science Working Groups of the telescope. The involvement of the IAASARS in the L2-ESA/Athena mission was established by the acceptance of the group as partner in the consortium that will build the WFI detector of that mission.

Galaxy Evolution

The total funding sums to 0.47M€, gained through competitive National and European calls of proposals. High-profile projects include participation in the FP7 Space Research program "DustPedia: A Definitive Study of Cosmic Dust in the Local Universe". Within this program, the group has developed and maintains the "DustPedia" archive, the largest multiwavelength database of nearby galaxies all observed at infrared wavelengths by Herschel (http://dustpedia.astro.noa.gr).

IAASARS researchers also participate in large international collaborative programmes (e.g., GOALS, HER33MES, HerCULES, HeViCS and Herschel-GOODS). Infrared Astrophysics is on the threshold of a revolution worldwide. Members of the IAASARS joined the SPICA extragalactic science team, contributing to the definition of the science goals.

The group also actively participates in the processing and analysis of data from the GAIA mission of ESA. They are members of the Coordination Unit 8 (CU8 "Astrophysical Parameters) of the Data Processing and Analysis Consortium (DPAC) and are leading two top-level work packages, the GWP806 "Utility Library and Data Model" and the GWP832 "Unresolved Galaxy Classifier". They are developing an Artificial Intelligence based system (UGC) for automated classification and parameterisation of galaxies observed by Gaia, as part of the ground-based scientific pipeline developed by DPAC. The researchers also contributed to the CU2 "Data Simulations" by preparing libraries of synthetic galaxy spectra and modelling them to low-resolution BP/RP spectrograph of the satellite.

Stellar Astrophysics and Interstellar Medium

The total funding sums to 2.68M€, gained through competitive National and European calls of proposals. High-profile projects include the ESA NELIOTA project, which boasts the largest facility and most advanced detectors world-wide conducting lunar monitoring and makes available the resulting impact flashes within 24 hours of observation.

The ESA-funded Hubble Catalog of Variables project is another high-profile project involving astronomers at ESAC and STScI, which aims to produce a catalogue of variable sources chosen from the 90 million sources in the Hubble Source Catalog. The Hubble Catalog of Variables is expected to contain one of the largest collections of variable point sources and extended objects available, spanning a long time baseline up to 25 years, and reaching unprecedented magnitude depths.

Group members also perform observations with optical telescopes in Greece and abroad in order to answer questions primarily related to stars, their evolution and complex interplay with the ISM, as well as binary stars, supernovae and other transients.

Ground-based instrument development

The total funding sums to 1.21M€, gained through competitive National and European calls of proposals. The Group participates in a number of international scientific collaborations (e.g. OPTICON), and there is significant, ongoing development of instrumentation, with the design and construction of new astronomical instruments (MAWFC, AWFC, Kryoneri Prime Focus Instrument) as well as the upgrade of existing instruments (ATS, CCD imaging Cameras) and the retrofit of the 1.2m Kryoneri telescope. A new dome is under construction for the MAWFC instrument at Kryoneri Observatory, the AWFC upgrade is ongoing, and a new calibration system for the ATS spectrometer is to be designed and built. All these projects offer opportunities to the group members to establish new collaborations and to get new funding through national and international agencies (GSRT, ESA, EU FP7 and H2020 etc.). In particular, we aim to attract collaborations and funding in order to operate the 1.2m Kryoneri telescope full-time.
Furthermore, the ESA project NELIOTA gave group members the opportunity to study NEOs, while the ESA project HCV required expertise in stellar variability and familiarity with archival data from the Hubble Space Telescope.

During this period, two new instruments have been designing, testing and integrating new astronomical instruments:

- The Manchester-Athens Wide-Field (Narrow-Band) Camera (MAWFC), the first scientific instrument for astronomy that constructed and tested completely in Greece. The instrument is ready, first light tests have been started in 2016 and 2017. Once a new dome is ready for this instrument at the Kryoneri site, a large-area emission-line (Halpha) sky survey will be carried out to search for extended and low surface-brightness emission-line regions.
- The Aristarchos Wide-Field Camera (AWFC) is a new state-of-the-art wide field imager which will be used at the 2.3m Aristarchos telescope (Helmos Observatory) and it is also constructed and tested completely in Greece. It Is main scientific goals are: (a) Calculation of precise photometric redshifts of objects in sky fields already covered by XMM using the SDSS filters (u, g, r, i, Z, Y), and (b) Detection and/or study extended faint filamentary structures using narrow-band interference filters (Hα, [O III], [S II], [N II]). The instrument has been manufactured (only an optical mirror and a mechanical part for the collimator lense are expected to be complete within 2017) and it will be then fully tested in the optical lab. First light is expected in 2019 to 2020.

4.2.2. Solar-Terrestrial Environment - Space Physics

Solar and Heliospheric Physics

The research themes addressed by the Solar and Heliospheric Physics group were mainly the following:

1) Derivation of accurate physical parameters of solar small-scale events, comprehension of their dynamical behavior, their association with the magnetic field and their role in the heating of the solar corona and the acceleration of the solar wind
2) Propagation of waves in the solar atmosphere and the formation of the magnetic canopy
3) Investigation of the characteristics and dynamics of vortex flows in the solar atmosphere
4) Investigation of the origin, acceleration and transport of SEP events in the 3-Dimensional Heliosphere
5) Effect of coherent structures on particle acceleration in the solar wind
6) Study of extreme geomagnetic storms
7) Compositional signatures of large SEP events during solar cycles 23 and 24
8) Real-time prediction of Ground Level Enhancement events (GLEs)
9) Statistical study of the relationship between SEPs and properties of flares and CMEs during solar cycle 23.

Space Research & Technology

In the period between 2012-2017 the Group participated in several National, European Commission and ESA projects. For instance, in the context of the ESA's Swarm mission, the Space Research & Technology group has been developed, maintained and upgraded the Time-Frequency Analysis (TFA) tool, an advanced suite of algorithms based on wavelet transforms, tailored to the analysis of Level 1b electric and magnetic field data from the mission. TFA tool has received funding through the following ESA projects:

- ESA's study "Multi-satellite, multi-instrument and ground-based observations analysis and study of ULF wave phenomena and products (ULFwave)" (Prime Contractor) [2011–2014]
- ESA's Support to Science Element (STSE) Swarm + Innovation Program project "Swarm Investigation of the Role of High-Frequency (0.1-5 Hz) ULF Waves in Magnetosphere-Ionosphere Coupling" (Subcontractor, led by the University of Alberta) [2015–2016]

Moreover, "Monitoring, Analyzing and Assessing Radiation Belt Loss and Energization" (MAARBLE) FP7 project employed multi-spacecraft monitoring of the geospace environment, complemented by ground-based monitoring, in order to analyze and assess the physical mechanisms leading to radiation belt particle energization and loss. These processes are of great importance, because radiation enhancements due to radiation belt energization can adversely impact satellites that modern society increasingly depends on. MAARBLE paid particular attention

to the properties of ultra-low frequency (ULF) and very low frequency (VLF) waves and their critical role in radiation belt dynamics. As a central deliverable, a database containing characteristic properties of ULF and VLF waves was created and is now publicly available to the scientific community. Based on the wave database, statistical models of wave activity for different types of waves were created. These models - or maps - provide statistical distribution of amplitudes and, moreover, wave normal angles and other polarization and propagation characteristics, which determine how the waves interact with particles.

Overall, the MAARBLE project generated extensive new knowledge in a very large number of scientific publications in leading international scientific journals (38 papers), with many exciting and high-impact scientific publications expected to provide guidance and new research directions for the international radiation belt community for many years to come.

The group has significant experience in the development of novel concepts and the implementation of forecasting systems for solar flares and solar energetic particle events. NOA/IAASARS designed, established, validated and operates a new, automated three-tier forecasting tool entitled FORSPEF (Forecasting Solar Particle Events and Flares) which provides successful forecasts of solar flares based on the metric B_{eff}, as well as, forecasting (pre-event) and nowcasting (post-event) of the occurrence of SEP events and their corresponding expected characteristics based on solar flare and coronal mass ejections input data. The outputs of each module of the FORSPEF tool, developed by the group, have been successfully validated with both archived (spanning over three solar cycles) and near real-time data (during its operational period).

NOA/IAASARS has participated in numerous EC and ESA-funded projects and space missions. Examples include:

- ESA space missions, Solar Orbiter (Co-I status in the Spectrometer/Telescope for Imaging X-rays STIX), PROBA-3 (members of the ASPIICS Greek participation), ATHENA mission (membership in the Science Working Team);
- the EU projects: FP7-Space "MAARBLE" (coordinator); FP7-Space "Space- Data Routers"
- and the ESA projects: "Forecasting Solar Particle Events and Flares" (prime contractor), "Slot Region Radiation Environment Models" (prime contractor), "SREM Solar Particle Event scientific analysis" (prime contractor), "Extension of SREM SPE scientific analysis" (prime contractor), "Multi-Satellite, multi-instrument and ground based observations analysis and study of ULF wave phenomena and products" (prime contractor), "Athena Radiation Environment Models and X-ray Background Effects Simulators" (sub-contarctor), Prodex project GAIA DPAC, Instrument Control Center of the HIFI detector onboard ESA's mission Herschel, Observational programmes Hercules, HERMES and Hevics (co-I) with the Herschel mission; participation in the XMM/XXL and XMM/CDFS 'very large programs' with the XMM mission.

In more detail, over these years the group has coordinated the following projectsl:

- FORSPEF – Forecasting Solar Particle Events and Flares (ESA contract 2014-2015). (http://proteus.space.noa.gr/~forspef)
- MAARBLE - Monitoring, Analyzing and Assessing Radiation Belt Loss and Energization (EU FP7-Collaboration Space, 2012-2014), five EU partners, one from Canada and one from USA. (http://www.maarble.eu)
- SRREMs: Slot Region Radiation Environment Models, (ESA contract, 2011-2014). (http://proteus.space.noa.gr/~srrems/)

Ionospheric Physics

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 competitive research projects of the Ionospheric Group and funding from national institutional projects. 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), the multi-year research project Net-TIDE (2014 – 2017) funded by the NATO Science for Peace and Security Programme, and the ESA Space Situational Awareness Phase-1 Project EIS (2012 – 2013), while the group was in charge for the scientific management of the EC-ESPAS FP7 e-Infrastructure project (2011-2015). Currently the Ionospheric Group, works with the European Space Agency for the coordination and extension of the SSA Ionospheric Expert Service Center with two relevant projects implemented from 2014 until 2019. In the latest Space Weather Call of the European Commission (Horizon 2020 – COMPET 2017) the Ionospheric Group was awarded with a research grant for the TechTIDE project – the first among the two proposals funded in this call, with an excellent evaluation score (15/15). TechTIDE aims at the development of warning and mitigation technologies for identifying the effects of travelling ionospheric disturbances in operational systems. The TechTIDE project will run until 2020.

In collaboration with the NASA Community Coordinated Modeling Center (CCMC), our group develops standardized validation procedures applicable to the scientific models and to the resulted actionable products that can be exploited in mitigation procedures by operational systems. This is a systematic collaboration which started in 2016 in the framework of the International CCMC and expands as one of the clusters within the International Space Weather Action Teams, jointly coordinated by NASA and COSPAR.

4.2.3 Remote Sensing and Machine Learning for Signal/Image Processing

The Remote Sensing group of IAASARS/NOA participates in strategic research projects to fulfil its research priorities (see 4.1), aiming also to increase the Institute's visibility to an international audience and to support other researchers in the country by utilizing its innovative infrastructure, research and products/services. During the reporting period, the RS group participated in a range of competitive programs of the EU and ESA as well as National Programs. The benefited organizations are across the entire value added chain and research

ecosystems, including Excellence Frameworks of the H2020 such as the ERC, Marie Curie and Research Infrastructures, EC Services (DG-ENV, DG-ECHO, DG-GROW), Ministries, Regional Authorities, Civil Protection Organizations, Forestry Services, Environmental Organizations, International Funding Organizations (IFIs), and Governmental Entities.

The RS group of IAASARS/ NOA has accumulated expertise and infrastructural capacities, and developed skills in the context of the aforementioned frameworks, as well as large scale capacity building projects. It has managed to position itself as a regional EO hub for research, advanced data exploitation, and delivery of information and services in the south-eastern Europe, Middle East and North Africa, specifically for the monitoring of the environment and the management of natural and manmade disasters. This resulted in receiving an award from the EU in the REGPOT 2013-2016 framework program for the development and operation of the European EO Center of Excellence BEYOND.

Beyond BEYOND, the RS group had two additional major highlights within the reporting period. The first was the recognition of the IAASARS excellence in atmospheric remote sensing with the award of Dr. Vassilis Amiridis with the 2016 ERC Consolidator Grant D-TECT, aiming to advance research on desert dust processes and impacts in the region employing innovative remote sensing techniques. Moreover, the lead role of IAASARS in the Eastern Mediterranean was highlighted with the GEO-CRADLE project, a collaborative EU action led by IAASARS and Dr. Haris Kontoes. GEO-CRADLE brought together 25 partners from 3 continents, aiming to promote the uptake and exploitation of EO activities in North Africa, Middle East and the Balkans.

The complete list of the research projects for the RS group within the reporting period (2013-2017) is provided in paragraph 4.5.1. The participation of IAASARS/NOA at this wide range of EO frameworks resulted in an expansion of the research and innovation portfolio, addressing priorities in line with the Societal Benefit Areas of GEO, the strategic UN Agenda 2030 for Sustainable Development Goals, the Sendai Framework for DRR, the Water Directive and the Common Agricultural Policy.

4.3 Academic outputs

4.3.1 Publications

Overall, during the reporting period the members of the IAASARS have published 319 in refereed journals, while these papers have received more 15450 citations. For the benefit of the reader we provide the following figures:
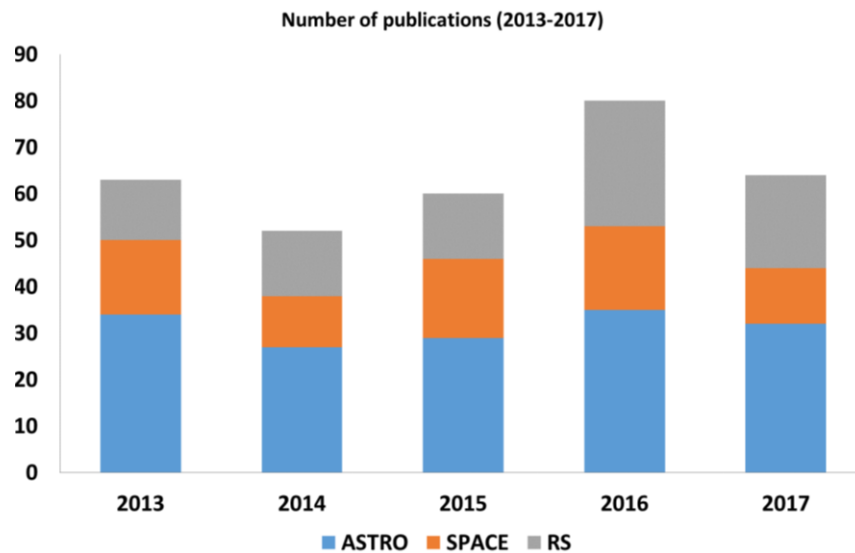
A histogram of the refereed papers per IAASARS discipline
(source ISI-Web of Science)
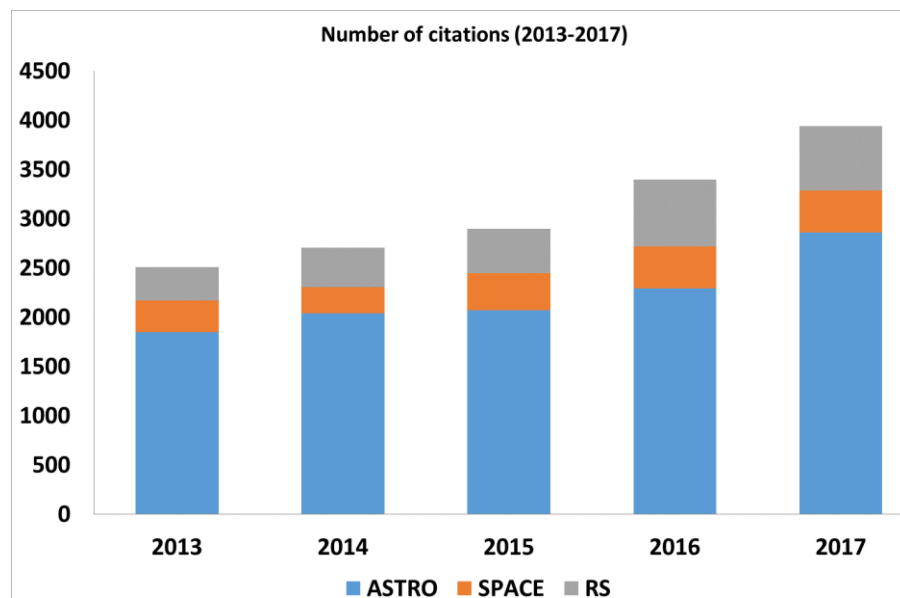
A histogram of the citations per IAASARS discipline
(source ISI-Web of Science)
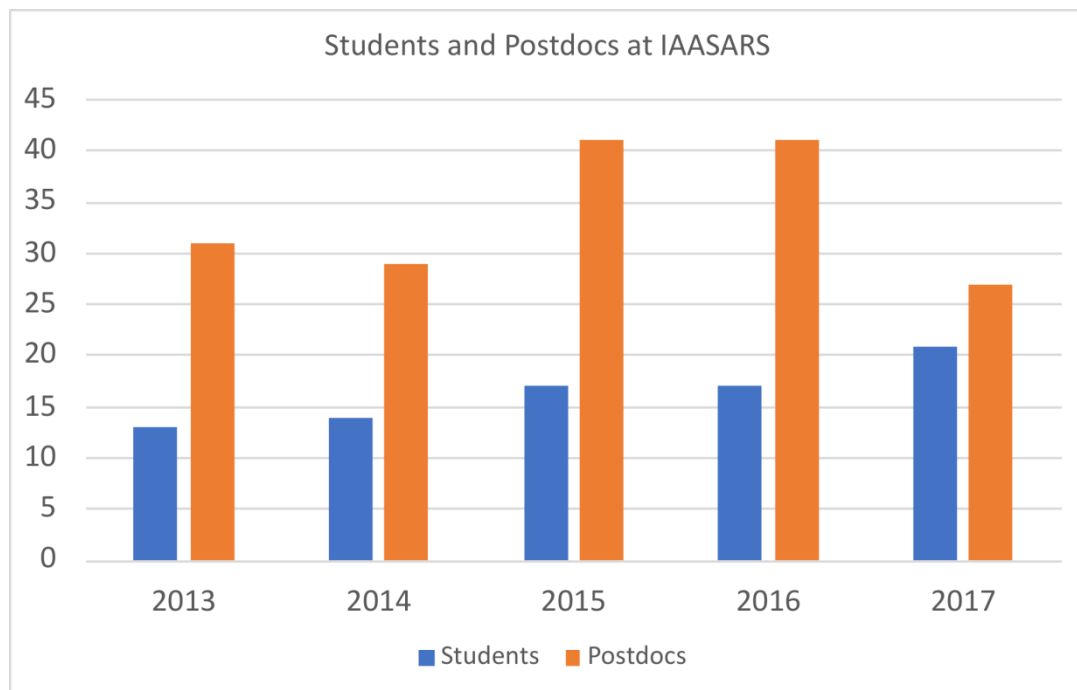
A histogram of PhD students and postdoctoral researchers of IAASARS

4.3.2 Scientific Projects/Programs, Grants and competitive funding

The IAASARS has been managing a total of ~10.5 million € during the reporting period via competitive proposals to the ESA, EU and national opportunities. A list of all the funded projects is presented in the Appendix B. Highlights from this exhaustive list include:

- ERC Consolidator Grant 2016: Vassilis Amiridis, D-TECT (Does dust triboelectrification affect our climate?)
- ERC Consolidator Grant 2017: Alceste Bonanos, ASSESS (Episodic MAss LoSS in Evolved MaSsive Stars: Key to Understanding the Explosive Early Universe)
- H2020 REGPOT framework program (PI Kontoes) for the development and operation of the European Earth Observation Center of Excellence BEYOND.
- ESA funding to monitor Lunar Impact Events (NELIOTA; PI Bonanos) from the Kryoneri 1.2m telescope, thereby enabling a high-visibility programme using a small facility.
- The H2020 Coordination and Support Action "GEO-CRADLE" (PI Kontoes) to coordinate and integrate state-of-the-art Earth Observation Activities in the regions of North Africa, Middle East, and Balkans.

4.3.4 Participation in networks of excellence

IAASARS participates in EU networks of excellence in the frame of the COST EU

actions InDUST (https://cost-indust.eu/) and eLECTRONET (https://www.atmospheric-electricity-net.eu/action-description).

InDUST

The overall objective of inDust is to establish a network involving research institutions, service providers and potential end users of information on airborne dust that can assist the diverse socio-economic sectors affected by the presence of high concentrations of airborne mineral dust. On behalf of IAASARS, Dr. Vassilis Amiridis is member of committee (MC) and PI of the WG1 on the identification and catalogue of dust observations (ground-based and satellite); IAASARS PostDocs Antonis Gkikas and Stavros Solomos are MC-substitutes for Greece.

eLECTRONET

The main objective of *ELECTRONET* is to improve knowledge of the multiple effects and interconnections of the atmospheric electric field, including those on biological systems, and its interconnections with other important components of the earth system by enhancing the interactions between national research teams and projects, exploiting the European-level potential and creating a EU-level network AEF facility. Dr. Vassilis Amiridis participates in eLECTRONET on behalf of IAASARS.

4.3.5 External Collaborations, Networking, Linkages

Observational Astrophysics

Formation and evolution of supermassive black holes

The X-ray astronomy group of NOA is member of the consortium that will be build the Athena/WFI detector. The group's involvement is on the development of source detection tools for the ground-segment analysis of the data from that instrument. The group also develops software for the source-detection pipeline of the eROSITA telescope. A. Georgakakis is also co-chair of the eROSITA AGN Working Group. The group has a strong background in developing auxilliary products for ESA's XMM-Newton mission. In particular we have produced photometric redshifts using machine learning techniques for the serendipitous XMM sources and in a related project we provided spectral fits for these sources using Bayesian techniques which take the photometric redshift error into account. The group has a long history in participating in ESA's advisory structure. In particular, we served as members in the Astronomy Working Group, in the XMM-Newton's user group and finally in ESA Astronomy Archives Group.

Galaxy Evolution

Members of the group participate in the DustPedia consortium (funded by the EU) dedicated to the study of cosmic dust in the local Universe. The group's involvement is on the development of the "DustPedia" archive, the largest

multiwavelength database of nearby galaxies all observed at infrared wavelengths by Herschel (http://dustpedia.astro.noa.gr) but also on the scientific exploitation of the properties of dust in galaxies of different morphological types and environments. Members of the group also participate in GOALS. The project aims to study a complete IR selected flux-limited sample of local LIRGs in order to understand the properties of similar high-z systems dominating the energy density of the Universe at the early epochs of galaxy formation (http://goals.ipac.caltech.edu). During the reporting period the work for focused on exploiting the Herschel Space Observatory and AKARI data as well as analyzing early results from ALMA sub-mm observations of select systems.

Stellar Astrophysics and Interstellar Medium

Members of the group participate in the "Detection and study of exoplanets" consortium (funded by different EU countries). The group in collaboration with research teams from UK has built and installed on th 2.3m "Aristarchos" telescope the 'RISE2' instrument, which is dedicated to observe candidate exoplanets detected by WASP with the aim to measure transit timing variations of low mass planets.

The ESA lunar monitoring NELIOTA project and the subsequent refurbishment of the Kryoneri telescope helped IAASARS researchers to network with NEO experts not only at the European Space Technology Center (ESTEC) and European Space Astronomy Center (ESAC) of ESA (to collaborate on scientific publications), but also at the NASA Marshall Center (to further exploit the NELIOTA observations) and other EU universities and research centers (to receive invitations to join both H2020 and ESA proposals). The NELIOTA team includes 5 IAASARS staff researchers, the Institute director and NOA director, as well as a colleague from the University of Thessaloniki, some of which are collaborating closely for the first time.

The ESA HCV project has helped IAASARS members work closely with colleagues from the University of Athens and form collaborations with scientists both at the Space Telescope Science Institute (STScI) and ESAC, which were strengthened during several research visits of the team. HCV includes 3 IAASARS researchers as well as the Institute director and NOA director, who have therefore had the opportunity to collaborate closely.

Solar and Heliospheric Physics

The Solar and Heliospheric Physics group has close collaborations with several well-established solar groups like the ones at the Academy of Athens (Greece), Paris Observatory (France), Ondrejov Observatory (Czech Republic), Armagh Observatory and Sheffield and Northumbria Universities (UK). It is involved in several solar observational campaigns as Principal Investigator or Guest Investigator. The group participates in the European Association for Solar Telescopes formed by solar physicists from 17 European countries, in an international consortium having as an objective the implementation of the European Solar Telescope and in an international team that developed Science

Use Cases that built the Critical Science Plan of the Daniel K. Inouye Solar Telescope (DKIST) the world's largest telescope under construction in Hawaii to be completed in 2020. The group is also a collaborating on Co-Investigator level at the Energetic Particle Detector (EPD) experiment onboard the future mission Solar Orbiter of ESA. Members of the group have a constant and long-standing collaboration with a large number of expert scientists in order to fulfill the research goals of the group e.g. the heliophysical laboratory, Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation of the Russian Academy of Sciences (IZMIRAN), Moscow, Russia, the Istituto di Astrofisica e Planetologia Spaziali, Istituto Nazionale di Astrofisica (IAPS-INAF), Roma, the Center for Space Plasma and Aeronomic Research (CSPAR) and Department of Space Science, University of Alabama in Huntsville, Huntsville, AL 35805, USA, the University of California, San Diego, CASS / UCSD, La Jolla, CA, USA, the RAL Space, United Kingdom Research and Innovation - Science & Technology Facilities Council - Rutherford Appleton Laboratory, Harwell Campus, Oxfordshire, OX11 0QX, UK, the Department of Physics and Astronomy, University of Delaware, Newark DE, the Physics Department, University of Calabria, Italy the Space Research Institute (IKI) RAS, Moscow, Russia, the Helmholtz Centre Potsdam, GFZ German Research Centre for Geosciences, Potsdam, Germany, the Bay Area Environmental Research Institute, NASA Research Park, Moffett Field, CA, USA, the Christian-Albrechts-Universitaet zu Kiel, Germany, the University of Malaga, Spain. Dr. Malandraki is a team member of the International Space Science Institute Team 405: 'Current Sheets, Turbulence, Structures and Particle Acceleration in the Heliosphere' in collaboration with research institutes in the USA, Russia, and Italy for the study of the physical processes of particle acceleration in the Heliosphere.

Space Research & Technology

ESA Swarm mission & related activities

- The Space Research & Technology Group has been actively participated in ESA's Swarm mission, a constellation of 3 satellites measuring Earth's magnetic field, which was launched in November 2013, through the following activities:

  MEMBER (G. Balasis) of the Validation Team of ESA's Swarm Mission
  MEMBER (G. Balasis) of the Quality Working Group of ESA's Swarm Mission
  PRINCIPAL INVESTIGATOR (G. Balasis) of ESA's Swarm Mission Science Exploration

GEO-CRADLE

The Remote Sensing Group of IAASARS coordinates the EU funded Coordination and Support Action GEO-CRADLE. Through this action it has been integrated the state-of-the-art Earth Observation (EO) activities in the regions of North Africa, Middle East, and Balkans (NAMEBA) and have been developed links with GEO related initiatives towards GEOSS and Copernicus. GEO-CRADLE is an EU H2020 Project which encompasses 25 partners from the 3 continents around the Mediterranean Sea, and recently it has been approved by the GEO-XV Ministerial to be upgraded to a GEO Initiative. It has been continuously enriching and

sustaining a network of key players around the three regions, representing the entire EO value chain, and promoting the uptake and exploitation of EO activities in NAMEBA. The network comprises of more than 300 stakeholder from the research, academic, SME, and decision making sectors engaged in EO. Moreover GEO-CRADLE enhances the current knowledge of existing EO capacities in the region (through an ongoing Survey), it facilitates the cooperation between EO stakeholders (through a Networking Platform and several Regional Events, Capacity Building and Training Actions), it identifies the gaps and the maturity level (through analysis) and boosts the Maturity of the different countries in the three regions, it enables the exchange of EO data (through a Regional Data Hub), it showcases concrete ways of tackling regional challenges related to adaptation of climate change, improved food security & water extremes management, better access to raw materials and energy (through Feasibility Studies), and finally it proposes a Roadmap for the implementation of GEO, GEOSS and Copernicus in NAMEBA. The GEO-CRADLE Initiative will be a continuation and extension of the work of the GEO-CRADLE which will capitalize, sustain and scale-up its results, as well as key outcomes of other relevant EU flagship projects and initiatives (e.g. GEOGLAM, NextGEOSS, ERAPLANET, EuroGEOSS, AfriGEOSS, GEO-VENER, EO4SDG), in support of the 3 GEOSS priorities, namely Climate Change, Disaster Risk Reduction and UN Strategic Development Goals. The GEO-CRADLE Initiative has upgraded so as to include a geographic expansion to the Black Sea, a thematic expansion to the Disasters Management & Water Resources Management, and an advanced Operational Maturity for the operationalization of services to the engaged users. It is worth noting that several of the feasibility studies have been considered among others in the development of the recently launched EuroGeoss initiative.

Sand and Dust Storm – Warning Advisory System

IAASARS/NOA contributes to the works of the World Meteorological Organization Sand and Dust Storm Warning Advisory and Assessment system (WMO / SDS-WAS: https://sds-was.aemet.es), aiming to enhance the ability of countries to deliver timely and quality sand and dust storm forecasts, observations, information and knowledge to users through an international partnership of research and operational communities. RS group is a member of the Regional Steering Group of SDS-WAS.

EARLINET

IAASARS Atmospheric Remote Sensing Group is a member of The European Aerosol Research Lidar Network, EARLINET (https://earlinet.org). EARLINET was established in 2000 as a research project with the goal of creating a quantitative, comprehensive, and statistically significant database for the horizontal, vertical, and temporal distribution of aerosols on a continental scale. Since then EARLINET has continued to provide the most extensive collection of ground-based data for the aerosol vertical distribution over Europe. EARLINET is supported by the EU ACTRIS project under the H2020 specifi-c programme for "Integrating and

opening existing national and regional research infrastructures of European interest" Grant Agreement n°654109 (1 May 2015 - 1 May 2019). Since 2017, IAASARS researcher Vassilis Amiridis has been elected at the 5-member EARLINET council.

PollyNET

The RS group is a member of PollyNET (http://polly.rsd.tropos.de), a lidar network that has evolved as an additional contribution to the world-wide aerosol observational efforts. Namely the Finnish Meteorological Institute (FMI), the National Institute of Environmental Research (NIER) in Korea, the Évora University in Portugal (UE-ICT), the University of Warsaw (UW) in Poland, The German Meteorological Service (DWD) and the National Observatory of Athens (NOA) in Greece contribute actively to the network by hosting Polly systems. Each group contributes with its expertise and knowledge to the network and to joint scientific projects. IAASARS participates in PollyNET with the PollyXT lidar system of PANGEA at Antikythera.

AERONET

IAASARS is a member of the NASA-AERONET network with its stations in Athens and Antikythera (https://aeronet.gsfc.nasa.gov). The AERONET (AErosol RObotic NETwork) project is a federation of ground-based remote sensing aerosol networks established by NASA and PHOTONS and is greatly expanded by networks (e.g., RIMA, AeroSpan, AEROCAN, and CARSNET) and collaborators from national agencies, institutes, universities, individual scientists, and partners. For more than 25 years, the project has provided long-term, continuous and readily accessible public domain database of aerosol optical, microphysical and radiative properties for aerosol research and characterization, validation of satellite retrievals, and synergism with other databases. The network imposes standardization of instruments, calibration, processing and distribution.

100 Resilient Cities

Since 2017, NOA via EXTREMA service is included in the platform partners of the prestigious international city network of "100 Resilient Cities" (100RC; http://www.100resilientcities.org/; pioneered by Rockefeller Foundation). Other 100RC Platform Partners include Microsoft, Swiss Re, the World Bank, WWF and CISCO. This accomplishment is expected to give further international visibility to NOA and to promote collaborations with world-leading organizations.

World Health Organization (WHO)

Following the work in TREASURE and EXTREMA on heat waves, the RS group acts as external advisor of the Working Group for the update of the Heat Health Action Plan due in 2019. WHO has co-authored a recent consolidated paper of the satellite approach (TREASURE) and aims to include EXTREMA in the above

update.

Group on Earth Observations (GEO)

The RS group is co-leader of the action on Global Observation of Urban Areas (Global Urban Observation and Information Task, GI-17, ex-SB-04) of the Group on Earth Observation (GEO).

Machine Learning for Signal/Image Processing

In the framework of the **PhySiS project** the MLSIP group collaborated with a) the Institute of Computer Science of FORTH, b) the Institute of Astrophysics, CEA, Saclay, c) PLANETEK Italia and d) IMEC, Belgium.

In the framework of **educational activities** (teaching, PhD supervision, etc.) the MLSIP group collaborated with a) the Department of Informatics and Telecommunications, University of Athens, b) the Department of Computer Engineering and Informatics, University of Patras, c) the Department of Informatics, Athens University of Economics and Business, d) the School of Rural and Surveying Engineering, National Technical University of Athens, e) the Department of Informatics and Telecommunications, University of Peloponnese**.**

4.3.6 Participation to national and European infrastructures

Solar and Heliospheric Physics

The Solar and Heliospheric Physics Group of IAASARS participates in the Preparatory Phase of the European Solar Telescope (EST). EST is a 4-m class ground-based telescope dedicated to study fundamental processes on the Sun. EST is in the ESFRI Roadmap since 2016. EST will enter the Implementation Phase in 2021. First light is planned for 2027. From the time being there is not a budgeting plan for EST from Greece and NOA.

Remote Sensing and Machine Learning for Signal/Image Processing

The RS group of IAASARS represent NOA to national and European Research Infrastructures, following the operating principles and the QA/QC procedures defined. The budget of the observation units and data processing infrastructures currently in operation at IAASARS, together with the cost of operating and maintaining the infrastructure, amounts to ~ 2-2.5 M€.

ACTRIS RI

The RS group participates in the European Research Infrastructure for the observation of Aerosol, Clouds, and Trace gases (ACTRIS, http://actris.eu) and in the H2020 preparatory phase project ACTRIS-PPP. ACTRIS is composed of observing stations, exploratory platforms, instrument calibration centres, and a Data Centre and serves a vast community of users working on atmospheric research, climate and Earth system and air quality models, satellite retrievals, weather analysis and forecast systems by offering high quality data and research

infrastructure services for atmospheric aerosols, clouds, and trace gases. ACTRIS PPP is crucial for implementing ACTRIS into a fully operational pan-European Research Infrastructure. ESFRI, the European Strategy Forum on Research Infrastructures, identifies those research facilities of pan-European importance that correspond to the long-term needs of the European research communities, covering all scientific areas, regardless of possible location, and that are necessary to strengthen scientific excellence and competitiveness in the EU. ACTRIS has been selected to the ESFRI roadmap in 2016. IAASARS participates to ACTRIS infrastructure through the Antikythera PANGEA station and the operation of the Aerosol Remote Sensing National Facility consisting of the PollyXT lidar and the NASA-AERONET sun photometer.

Satellite Acquisition Units and Data Processing Infrastructure

The RS Group operates and sustains the following equipment with regional to continent dimension in terms of coverage capability and offering of data (raw & value added):

- ESA Copernicus infrastructure installed at NOA comprising of a) Collaborative Ground Segment (Mirror Site) of ESA Sentinels' missions, and b) the International Hub for distributing Sentinels data to the Space Agencies worldwide (NASA, NOAA, JAXA, etc).
- Satellite reception equipment: X-/L-band acquisition station for the reception of a multitude of satellite missions (e.g. EOS AQUA, EOS TERRA, NOAA/AVHRR, METEOSAT, NPP, METOP)
- ESA-EUMETSAT equipment installed at NOA: MSG SEVIRI acquisition stations
- Big satellite archiving and management: Computer facilities of Ground Segments (storage and high performing processing center; > 500Tbytes of storage capacity and a cluster of a large number of servers).

Collaboration with the EUFAR RI

The RS group used the Transnational Access program of the EUropean Facility for Airborne Research (EUFAR: https://www.eufar.net/). EUFAR brings together infrastructure operators of research aircrafts with the scientific user community, both expert and early-stage researchers, other data users and stakeholders. The RS group of IAASARS has been granted with EUFAR TNA studies three times during 2013-2017 to conduct atmospheric research experiments:

- **DOGMA**: Evaluating Dust forecasting over the eastern Mediterranean Area, April 2017.
- **CLIMA**: Evaluation of ground-based lidar methodologies for continuous profiling of Cloud condensation and Ice nuclei concentrations in the Mediterranean, April 2017.
- **ERiSMA**: Investigation of the dust particle microphysical properties from the Namib desert and the Etosha Pan, for improving the description of dust in the area by assimilating satellite observations in dust transport

models, September 2017.

Collaboration with the Corinth Rift Laboratory (CRL)

The RS group participates in the CRL initiative (http://crlab.eu) to study tectonic fault mechanics (from plate tectonic to local scales) and related hazards in the study area. This rift is one of the most seismically active regions of Europe and one of the narrowest and fastest extending continental regions worldwide. The knowledge acquired is applicable to other seismically active regions worldwide and, thus, has a general signification. The CRL area is one of the Near Fault Observatories of European Plate Observing System (WP9 of EPOS RI) and a large number of surface networks are operating. A total number of 82 (as in September 2018) permanent instruments such as seismometers, accelerometers, GPS, strain meters, tilt meters and tide gages are fully operating, many of them for more than a decade. Moreover, a campaign network of ~200 points is being re-measured partly every year, with the Institute participating to all of them. All three institutes of NOA are participating to this imitative.

4.3.7 Distinctions and other results. Awards, prizes, nominations, outstanding outcomes

Solar and Heliospheric Physics

- National Representative in the European Association for Solar Telescopes (EAST, 2017-present) (Dr. Tsiropoula)
- Member of the Board of the European Solar Telescope Preparatory Phase (2017-present) (Dr. Tsiropoula)
- Elected member of the Board of the European Solar Physics Division (2014-2017, 2017-2020) (Dr. Tsiropoula)
- Secretary of the Board of the Association of Greek Researchers (Dr. Tsiropoula)
- President of the Board of the Association of the Researchers of NOA (Dr. Tsiropoula)
- Expert, Member of the Delegation Team of Greece to the European Space Agency/Science Programme Committee (2010-2017). (Dr. Malandraki)
- National Co-ordinator, International Space Weather Initiative (upon invitation) under the aegis of the United Nations (2010-2016) (Dr. Malandraki)
- Solar-Terrestrial 'Heliosphere' Science Officer, European Geosciences Union (EGU) (2011-present) (Dr. Malandraki)
- Solar-Terrestrial (ST) Sciences Division Deputy President, European Geophysical Union (EGU) (2015-2017) (Dr. Malandraki)
- EGU incoming President of the Solar-Terrestrial (ST) Sciences Division, European Geophysical Union (EGU), 2017 (Dr. Malandraki)
- Spokesperson, ESA Space Weather Working Team (SWWT), Topical Working Group (TWG): Drivers of Space Weather' on the Topic 'Sub-

group 2: Solar Storms (solar flares, CMEs, SEP events) (Dr. Malandraki)

- International Astronomical Union (IAU) - Organizing Committee Member & Member, IAU Commission E3 Solar Impact Throughout the Heliosphere (2015-today), Member of Division E Sun and Heliosphere (2015-present) (Dr. Malandraki)
- NASA Proposal Reviewer Panelist (upon invitation), Panel: 'Particles', Roses 13 'Heliophysics Support Research', 1-3 October 2013 (NASA Science Mission Directorate) (Dr. Malandraki)
- Chair of Steering Committee: Balkan, Black Sea and Caspian Sea Regional Network for Space Weather Studies (BBC SWS Regional Network) (2014 - present). The BBC SWS Regional Network comprises 12 countries: Russia, Roumania, Bulgaria, Croatia, Turkey, Armenia, Arzembaitzan, Bosnia/Erzegovina, Georgia, Greece, Serbia and Ukraine : (http://www.bbc-spaceweather.org/) (Dr. Malandraki)
- Working Group Leader, WG6: Solar Energetic Particles, SCOSTEP/Variability of the Sun and Its Terrestrial Impact (VarSITI) International Programme (2014-2018) (Dr. Malandraki)

Space Research and Technology Group

GEORGIOS BALASIS

- National Delegate of Greece to the Programme Board of European Space Agency (ESA) Space Situational Awareness (SSA) Programme, 2009–2017
- Reviewer, NASA Postdoctoral Program, 2017 –
- Reviewer, Canadian Space Agency, 2017
- Evaluator, Horizon 2020, Marie Skłodowska-Curie Individual Fellowships, Panel Physics, 2014 –
- Reviewer, Greek State Scholarships Foundation (IKY) Postdoctoral Program, 2017
- Evaluator, Greek General Secretariat for Research & Technology, 2014
- Member of Scientific Committee, Fourth Swarm Science Meeting & Geodetic Missions Workshop, Banff, Alberta, Canada, 20 – 24 March 2017
- Member of Scientific Committee, ESA Living Planet Symposium 2016, Prague, Czech Republic, 9 – 13 May 2016
- Member of Scientific Committee, Geospace revisited: a Cluster / MAARBLE / Van Allen Probes Conference, Rhodes, Greece, 15 – 20 September 2014
- Member of the Validation Team of ESA's Swarm Mission
- Member of the Quality Working Group of ESA's Swarm Mission
- Principal Investigator of ESA's Swarm Mission Science Exploration
- Secretary, Earth Magnetism and Rock Physics Division, European Geosciences Union (EGU)
- Keynote Lecture, 13th European Space Weather Week, Ostend, Belgium, 14–18 November 2016

ANASTASIOS ANASTASIADIS

- Reviewer NASA Postdoctoral Program (2015 -)
- Reviewer NASA/ SMD Program (2015 -)
- Reviewer FW Austrian Science Fund (2016 -)
- Reviewer, Greek State Scholarships Foundation (IKY) Postdoctoral Program, 2017
- Elected Board Member of the Hellenic Astronomical Society (2012 - 2014)
- Elected vice-President of the Board of the Association of the Researchers of NOA (2017-)
- ESA/Science Individual Award for outstanding contribution to the ESA Rosetta Mission (2017)
- Member of the Editorial Board of the journal "Entropy"

ANNA BELEHAKI

- Editor in Chief for Space Weather and Space Climate Journal (IF: 2.6, 2017 ISI Thomson Reuters JCR®) since 2011.

- Member of the Scientific Advisory Board of the Academy of Finland (since 2013)
- Member of the Scientific Advisory Board of the European Commission Horizon 2020 LOFAR4SW Project (since 2017)
- Member of the Space Weather Working Group of the European Space Science Committee ESSC/ESF (since 2017). Member of the 2016 international committee for the scientific evaluation of the Royal Observatory of Belgium for the period 2010 – 2015
- Member of the Space Weather Birkeland Medal Committee of the Norwegian Academy of Science (since 2013)
- Member of the Space Weather Working Team Board of the European Space Agency (since 2012)

Remote Sensing and Machine Learning for Signal/Image Processing

Remote sensing

The FireHub services of the BEYOND Center have been internationally recognized (Copernicus Masters 2014 - Best Service Challenge Award) winning the 1st prize as the Best Challenge Service among over 70 competitive proposals.

The BEYOND Center has been recognized by the United Nations Organization as the UN-SPIDER Regional Support Office, in the area of the Southeast Europe, Middle East, and the Balkans. The aim is to assist the transfer of know-how, capacity building and training of the competent authorities, as well as the provision of natural disaster management services.

Machine Learning for Signal/Image Processing

- Chair, IEEE Signal Processing Society Greece Chapter (A. Rontogiannis)
- Associate Editor, IEEE Transactions on Signal Processing (A. Rontogiannis)
- Member of the Editorial Board, Elsevier Signal Processing (A. Rontogiannis)
- Member of the Editorial Board, EURASIP Journal on Advances in Signal Processing, Springer (A. Rontogiannis)
- P.V. Giampouras, A.A. Rontogiannis, K.D. Koutroumbas, K.E. Themelis, "A Sparse Reduced-Rank Regression Approach for Hyperspectral Image Unmixing," In proceedings of the 3rd *International Workshop on Compressed Sensing Theory and its Applications to Radar, Sonar and Remote Sensing (CoSeRa)*, Pisa, June 2015. (2nd Best Student Paper Award winning paper).
- P. Bithas, A.A. Rontogiannis, "Performance Analysis of Mobile Communication Networks in the Presence of Composite Fading, Noise and Interference," In proceedings of the *IEEE International Symposium on Signal Processing and Information Technology (ISSPIT)*, Athens, Dec. 2013. (Best Paper Award winning paper in the Information Technology track of the conference).

4.4 Education

4.4.1 Space science technologies and applications MSc program

IAASARS co-organizes together with the Department of Informatics and Telecommunications of the University of Peloponnesus the Master's Degree program "*SPACE SCIENCE TECHNOLOGIES AND APPLICATIONS*". IAASARS researchers are responsible for providing courses as "Fundamentals of remote sensing", "Space Applications" and "Advanced Space Applications" and Image/Signal Processing.

The postgraduate course in Space Science Technologies and Applications aims at educating students to steer them to leadership positions in the Aerospace field. The objective of the Space Science Technologies and Applications programme is to seek excellence in the particular field and its related technological applications and to provide students with the specialized knowledge in space technologies and applications, both in theory and through applied hands on experience. The programme is organized accordingly and is focused on the promotion of knowledge and research on current evolving technologies and their technical challenges faced therein. The postgraduate program is staffed by 10 Researchers of IAASARS and 6 Postdoctoral Researchers, as teaching staff, and 1 Administrative Staff member. In 2017-18, it hosted 25 postgraduate students, including 2 doctoral candidates studying and undertaking research projects towards their Ph.D. The researchers participating in the program are, Amiridis Vassilis, Anastasiadis Anastasios, Balasis George, Keramitsoglou Iphigenia, Kontoes Charalampos, Koutroumbas Konstantinos, Rontogiannis Athanasios, Sykioti Olga, Giannakis Omiros, Paronis Demetrios, and the Postdoctoral Researchers Gikas Antonios, Papoutsis Ioannis, Proestakis Emmanouil, Solomos Stavros, Tziotziou Kon/nos. Of the total of 25 students up to 2017, the following have elaborated a MSc thesis or have been employed in a IAASARS project:

1. Apostolakis Alexis-Risar, MSc thesis: Remote Sensing Service system development, Supervisor Dr Haris Kontoes. <u>Participation in project by Dr Haris Kontoes</u>:
   - NextGEOSS: Next Generation GEOSS for Innovation Business
2. Baseiliadis Vyron, MSc thesis: "*Advancements in monitoring the Mediterranean Sea with the use of Copernicus data Delineation of Possible Fishing*", Supervisor Dr Iphigenia Keramitsoglou.
3. Bouskou Eirini, MSc thesis: "*Analysis of Diurnal Evolution of Spatial Land Surface Temperature Patterns in urban areas of Europe and Middle East*", Supervisor Dr Iphigenia Keramitsoglou.
4. Boutsi Zoe, MSc thesis: "*Wavelet Spectral Analysis of the ENIGMA Magnetometer Array Time Series and Solar Wind Conditions around the Strongest Magnetic Storms of Solar Cycle 24*", Supervisor Dr George Balasis. Since November is PhD candidate with title *Investigating the probability of GIC development in the Hellenic territory*, Supervisor Dr George Balasis.
5. Daskalopoulou Vasiliki, MSc thesis: "*Comparison of Hyperspectral Signal Transformation Techniques in Spectral Unmixing of the Historic ``1536-1669'' Torre del Filosofo volcanic products of the Mongibello Volcano of Mt.*

ETNA (Italy)", Supervisor Dr. Sykioti Olga. Since November 2017 is PhD candidate with title "*The impact of triboelectrification on desert dust flow dynamics*" Supervisor Dr. Vassilis Amiridis. <u>Participation in project by Dr Vassilis Amiridis:</u>

- ERC D-TECT (D-TECT-Does dust TriboElectrification affect our ClimaTe?

6. Drivas Athanasios, MSc thesis: "*An automated object-based crop identification algorithm for the monitoring of the CAP Cross-Compliance obligations"*, Supervisor Dr Haris Kontoes. <u>Participation in project by Dr Haris Kontoes:</u>

- RECAP Reinforcing the Common Agricultural Policy
- EOPEN Open Interoperable Platform for Unified Access and Analysis of Earth Observation Data.

7. Kottas Michael, MSc thesis: "*Complementing the satellite LIDAR missions of the future - Determination of dust particles depolarizing properties"*, Supervisor Dr Vassilis Amiridis <u>Participation in project by Dr </u>Vassilis Amiridis:

- ERC D-TECT (D-TECT-Does dust TriboElectrification affect our ClimaTe?

8. Papageoriou Stauros, MSc thesis: "*Distribution of Desert Dust & Aerosols in Greece*", Supervisor Dr Vassilis Amiridis.

9. Sitokonstantinou Vassils, MSc thesis: "*An automated object-based crop identification algorithm for the monitoring of the CAP Cross-Compliance obligations"*, Supervisor Dr Haris Kontoes. <u>Participation in project by Dr Haris Kontoes:</u>

- RECAP Reinforcing the Common Agricultural Policy
- EOPEN Open Interoperable Platform for Unified Access and Analysis of Earth Observation Data.

Machine Learning for Signal/Image Processing

During the period 2013-2017, the members of the group were involved in educational activities on subjects relevant to Machine Learning in both undergraduate and postgraduate level. The members of the group have offered the following courses: a) "Machine Learning and Computational Statistics", graduate course in the MSc in Data Science Program (Dept. of Informatics, Athens University of Economics and Business, K. Koutroumbas), b) "Signal/Image Processing and Pattern Recognition", graduate course in the MSc in Space Science Technologies and Applications Program (IAASARS/NOA and Dept. of Informatics, University of Peloponnese, K. Koutroumbas/A. Rontogiannis), c) "Digital Image Processing and its Applications", undergraduate course (Dept. of Informatics and Telematics, Harokopio University, A. Rontogiannis), d) "Pattern Recognition – Machine Learning", undergraduate course (Dept. of Informatics and Telecommunications, National and Kapodistrian University of Athens, S. Theodoridis/K. Koutroumbas).

In addition, the group has trained three Master's students (V. Daskalopoulou, A. Fytsilis, I. Tsaknakis), three PhD students (P. Giampouras, D. Sykas, S. Xenaki) and five postdoctoral researchers (P. Bithas, E. Mylona, G. Ropokis, K. Themelis,

C. Tsinos). All our students continue their postgraduate and postdoctoral studies or have obtained academic faculty positions in Greece and abroad.

4.4.2 Postdoc and student supervision

Members of the IAASARS are involved in the supervision and training of researchers at all levels (postdoctoral, doctoral, graduate). Plot shows the number of students and postdocs that have been directly involved in research carried out at the Institute during the reporting period.
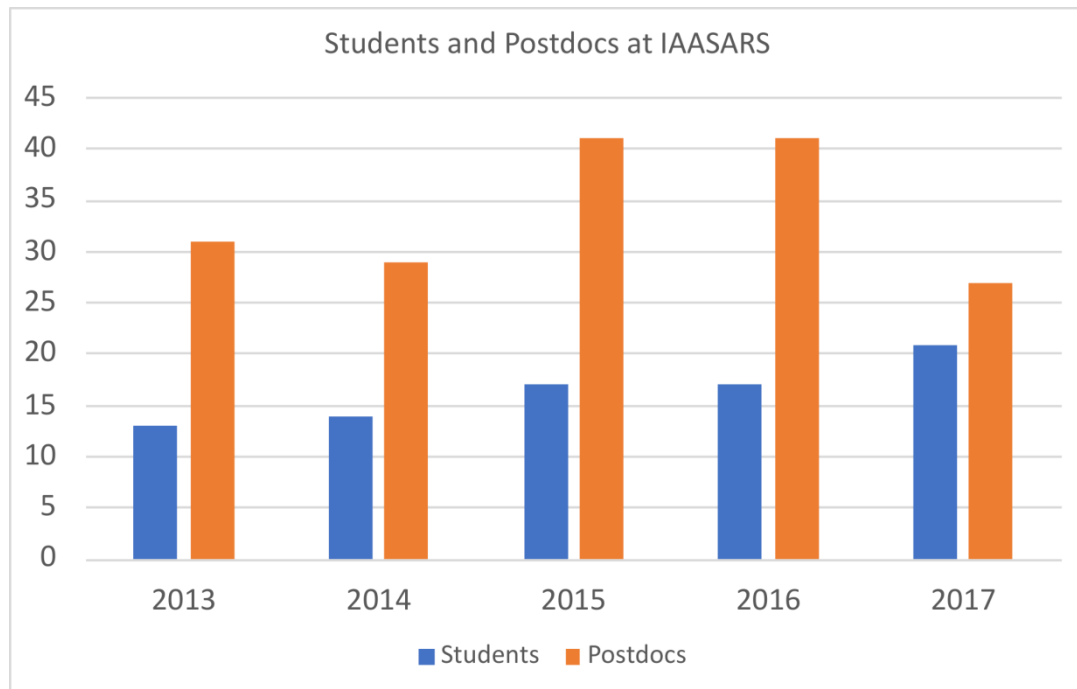
A histogram of PhD students and postdoctoral researchers of IAASARS

Also members of the IAASARS participate regularly in supervising commitees of external PhD students that carry out their research in Greek or international Universities. A complete list of the of the latter supervision activities is presented in Appendix D.

4.4.3 Training courses, summer schools etc.

Solar-Terrestrial Environment - Space Physics

Solar and Heliospheric Physics

Organiser of the HESPERIA Summer School dedicated on Space Weather: 'Understanding Solar Eruptions and Extreme Space Weather Events. The physics behind', held in Kiel, Germany, from 29 August - 2 September 2016. The summer school was hosted by the Christian-Albrechts-Universitaet zu Kiel. Numerous travel grants were awarded to students, based on their evaluation by the scientific

organizing committee of the summer school.

Ionospheric Physics Group

Main organizer of the ESPAS training school (Near-Earth space data infrastructure for e-science, FP7/Research Infrastructure), held in Warsaw, Polar by 19 to 23 October 2015. The school was hosted by the Space Research Center of the Polish Academy of Science. A total of 14 travel grants have been awarded to selected students, after evaluation by the scientific committee of CV's and motivation letters. The school allowed to present in detail the ESPAS system to PhD students and early career scientists and to let them develop the competence to exploit the ESPAS e-infrastructure and to interface it into their own operating systems. The school was tuned on the use of ESPAS e-infrastructure based on specific use cases, but it also included lectures and tutorials concerning the physical problems that can be further explored with the ESPAS system, together with insights into the system technical features, architecture, data model and ontology.

Space Weather School for Engineers: Two 4-days schools organised jointly by KULeuven and the Royal Observatory of Belgium, held in Leuven, Belgium in 2013 and 2014 back-to-back with the European Space Weather Weeks the same years. Anna Belehaki gave two courses for the ionospheric effects in operational systems focusing on ionospheric storms and travelling ionospheric disturbances, on observational and modelling techniques, data access and data quality. The schools were attended by 30 postdocs and engineers from universities and industrial organizations.

Remote Sensing and Machine Learning for Signal/Image Processing

Remote Sensing

1) Pre-TECT ECARS Summer School in Remote Sensing
   The 2nd ECARS SUMMER SCHOOL entitled: "Satellite Cal/Val Activities employing ground-based remote sensors" was organized by IAASARS at Agios Nikolaos, Crete, Greece during the PRE-TECT campaign (http://pre-tect.space.noa.gr/). This school was a first-class opportunity for PhD students and early career scientists to participate in a large-scale atmospheric cal/val exercise, focusing on the evaluation of aerosol and cloud satellite products employing ground-based and airborne sensors. During the summer school the students were exposed on dedicated hands-on training activities. The young researchers had the opportunity to participate in the campaign and its daily briefings, the instrument setup and data analysis as well as the data interpretation while also attending the school lectures. The school was organized in the framework of the ECARS H2020-TWINNING project.

2) The iSPEX Citizen's Observatory (http://beyond-ispex.gr/)
   IAASARS participated through BEYOND in the iSPEX-project aiming to introduce the general public to atmospheric research and to educate to contribute to the understanding of air pollution. Athens through BEYOND

participated to the first Europe-wide citizen campaign iSPEX-EU. From 1 September to 15 October 2015, thousands of citizens in major European cities take to their streets, squares and parks to measure air pollution with their smartphone. Participating cities include: Athens, Barcelona, Belgrade, Berlin, Copenhagen, London, Manchester, Milan, and Rome. iSPEX-EU distributes small devices that can be attached to smartphones to measure air pollution. These add-ons are "spectropolarimeters" that, in combination with the phone's camera, sensors, computing and communications capabilities, can be used to measure tiny particles in the air that contribute to air pollution and its impacts on our health and environment in an as-yet poorly understood way. They add to heart and respiratory disease, in the shape of volcanic ash they are of danger to air traffic, and they form one of the largest uncertainties in our current estimates of climate change. The application of iSPEX is two-fold: 1) It enables crowd-sourced measurements of tiny atmospheric particles, also known as aerosols, at locations and times that are not covered by current air pollution monitoring efforts. 2) It makes atmospheric science accessible to everyone, by active participation in scientific measurements.

3) The Corinth Rift Laboratory School (http://crlab.eu/)
In the framework of the "Corinth Rift Laboratory (CRL)", the 1st (2016) and 2nd (2017) CRL School were held in the area of the Gulf of Corinth (Greece) during September. It is a five days school with lectures, hands-on and educational field works. The general objective of the School is to unite Master and PhD students from various Greek and foreign universities collaborating in the Corinth Rift Observatory together with high school European teachers to introduce them to different geophysical and geological observations and methods as well as to first-hand scientific knowledge. At the School, methods such as seismology, space geodesy (GPS and SAR interferometry, Copernicus SENTINEL mission and ESA's Geohazards Exploitation Platform) are examined from a theoretical point of view and their applications in the specific area of the Corinth Rift. IAASARS member during September in the organizing and scientific committee of the school.

4) PSP Applied Geography and Spatial Planning, Harokopio University (2015-today).
Invited seminars to MSc students on "Imaging Spectroscopy in Remote Sensing: Principles and Applications in Geosciences" and "Introduction to Atmospheric corrections of satellite data".

5) SplitRS Summer School.
(https://splitrs2016.com/,http://splitremotesensing.com/split-remote-sensing-summer-school-2017/)
Intensive learning remote sensing international summer school program for professionals and graduate students which presents best insights into most recent techniques learned from top international professors and researchers through hands-on sessions and lectures (Thessaloniki 2015 and Chania 2016). Lectures and hands-on exercises on "Principles of Imaging Spectroscopy: Minerals and other materials", "Principles of

imaging spectroscopy. HSI indicators and methods for vegetation status assessment" and "Introduction on Atmospheric Corrections of Remote Sensing data".

4.5 Innovation

IAASARS is active on converting research into services and technological developments for the society and the market. In this framework IAASARS shows an increased collaboration with SMEs and the Greek Industry. Examples include:

Development of the EMORAL ESA mobile lidar

EMORAL is mobile lidar capable of measuring backscatter, Raman and depolarization atmospheric returns for aerosol characterization. The EMORAL lidar system has been constructed by RAYMETRICS S.A. in collaboration with IAASARS.

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

Development of the MULTIPLY airborne HSRL system

IAASARS develops the simulator for the MULTIPLY airborne High Spectral Resolutions Lidar system to be delivered to ESA.

Development of the WALL-E lidar system (ERC D-TECT)

IAASARS develops the novel lidar instrument "WALL-E" within the framework of the ERC Consolidator grant D-TECT. WALL-E lidar is the first system that will be capable of performing linear and circular polarization measurements for studying the dust alignment due to the triboelectric phenomenon. The development is done with collaboration with RAYMETRICS S.A.

4.5.1 R&D projects

All research projects and grants appear in Appendix B

4.5.2 Patents and IP's

FireHub service has been granted a patent diploma by the Industrial Property Organization. Patent Title: "Method that detects areas of active fire hotspots in real time, calculates the most probable starting point and assesses the fire probability indicators, using satellite images and fuel data", Publication Number: WO2016132161 A1; Application number: PCT/GR2016/000005. Inventors: Dr. Charalampos KONTOES, Themistocles CHAIREKAKIS; Publication date: Aug 25, 2016 (Source: Google Patents).

4.6 Impact to the Society and Economy

4.6.1 Advisory role for the state, participation in crisis management

Nowadays, natural disasters have shown great evidence for high quality Earth Observation (EO) services as it regards disaster and emergency management, and risk reduction (DRR & EMS). The Remote Sensing Group of IAASARS within the BEYOND Center of Excellence develops research and provides disaster management services addressing priorities. The operational activity of the BEYOND Center serves the Civil Protection and Decision Making Process for disaster management, and the stakeholders acting in Institutional Disaster Management Authorities at International level. The Center in its activity has been validated, and is performing in compliance to European Copernicus and ESA standards in the provision of disaster management services. The Center's activity focuses on Emergency Response (during crisis) and Emergency Support (preparedness and recovery) (according to the Copernicus EMS standards).

Many Institutional Authorities and International Organisations have profited from the services offered by the BEYOND Center such as The European Forest Fires Information System/EFFIS, The Global Fire Monitoring Center-GFMC, the European program for disasters Copernicus EMS, a large number of Civil Protection Authorities in countries over EU, Africa, Latin America, and Asia, as well as a number of Fire Brigade authorities, Forestry Departments, Directorates for the Protection of Forests and Natural Ecosystems, Environmental Agencies and Ministerial Bodies, Rehabilitation Services, etc. IAASARS is also represented in the Greek national platform for disaster reduction (part of the international Hyogo Framework for Action – HFA, and recently the Sendai Framework).

Indicatively and only in the period of 2016-2018, the BEYOND Center has been activated more than 20 times by the Copernicus EMS for the purposes of civil protection authorities worldwide, in order to address multi-hazard management needs, in cases of devastating earthquakes, volcanic eruptions, landslides, soil

and coastal erosion, wildfires, floods, toxic gas emissions, dust storms, industrial accidents.

4.6.2 Dissemination and outreach of Scientific Knowledge

I. Visitor Centers

The IAASARS has always placed great emphasis on science dissemination and outreach. Since 1995 the main component for science dissemination and outreach is the Penteli Visitor Center (PVC). In the 5-year period (2013 – 2017) a new component has been added, namely the Thiseio Visitor Center (TVC, 2014). Both visitor centers have joined forces and are very active, engaging in a huge variety of outreach activities, and also covering a large age-range, which was non-existent in the previous years. The new scheme has proven extremely effective and fruitful in accentuating the role of science to society.

The PVC has recently completed 23 years of operation since the Fall of 1995. Its purpose is to mediate between science and the public using a variety of activities paved by modern educational means and always based on the interaction between the specialised staff and the audience. This has been made possible through customized schemes that serve the needs of a particular age group. Special presentations are chosen from a plethora of topics regarding astronomy, space science or related subjects in coordination with the main research areas of the IAASARS.

The main venue is the dome of the Penteli observatory that proudly hosts the historic and impressive 62.5 cm NEWALL telescope which was the largest refractor of the world from 1869 until 1873. Approximately 45,000 school kids from more than 1100 elementary and high schools have visited the premises of PVC for morning tours and about 35,000 visitors during evening tours, between 2013 and 2017. All morning visits include interactive presentations, educational movies produced by IAASARS, demonstration of the NEWALL operation room and solar observations. Approximately 12,000 students have observed the Sun since the onset of the project in October 2016. All night tours are similar to the ones in the morning except that visitors also participate in night sky observations, weather permitting. In addition to being open to the general public, the PVC is also accessible to all kinds of organized groups for both morning and night tours.

A large collection of diverse outreach activities has been also initiated by members of PVC, ranging from thematic lectures out of the domain of IAASARS science tank, open days for the public during rare astronomical phenomena, lectures for non-Greek speaking visitors, visits to schools for special projects and AstroCamp schools for children held at the premises of National Observatory of Athens at Penteli. Furthermore, a facebook page for the NOA Visitor Centers was created for the promotion of the outreach activities and is currently followed by ~12.000 people.

Starting in 2016, the IAASARS participates in Asteroid Day by hosting an open night at Kryoneri Observatory, including a facility tour, presentations, and telescope viewing. This event attracts over 400 people each year.

II. Outreach related to specific IAASARS research projects

Apart from the visitor centres, IAASARS successfully runs research and support programmes with a large public outreach component. Specifically:

- In the context of the H-2020 project, AHEAD (Activities for High Energy Astrophysics) NOA is leading the Public outreach programme among 27 Institutes across Europe. In the framework of this project we have produced a number of videos which are freely distributed to schools over Europe via our web-page. The highlight was the dome video for planetaria which has been translated to over ten languages and is estimated to have reached an audience of over 10 million people over the globe. The IAASARS launched a new webpage in 2014, which includes up-to-date information on its staff, research projects, events, job openings etc.
- Participation in the EU Researcher's Night activity every September, showcasing various research projects of our members.
- Extensive dissemination and outreach of scientific results of the SEPServer, COMESEP and HESPERIA FP7 and H2020 EU projects to the general public.
- In the framework of the GEO-CRADLE project has successfully organized a series of regional workshops (12), dedicated side events (3) and national networking activities (2). These events offered a prime opportunity to train and exchange with various stakeholders representing the national, regional and international EO ecosystem.
- Dissemination activities have been taken in cooperation with the Corinth Rift Laboratory (CRL) and the local Municipality (Nafpaktos, Greece), including open lectures, stands, high school classes and field activities open to the public.

III. IAASARS summer school for pupils

The Institute runs since 1996 a 3-day summer school every September, which is aimed at talented high school (Lyceum) students (11th-12th grade, i.e. 17-18yrs old) with an interest in Astronomy. The summer school attracts about ~50 students each year, selected out of ~150 applications. 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.

4.6.3 Services & Research Applications

Observational Astrophysics

The ESA NELIOTA project maintains a website that is automatically updated with new lunar impact flashes within 24 hours of the observations and provides the data to the community.

Solar-Terrestrial Environment - Space Physics

Space Radiation storms constitute a large radiation risk for electronic equipment onboard satellites as well as humans onboard manned space mission in our solar system en route e.g. to Mars or on the Moon. These storms may lead to a large financial loss may result due to satellite failure during solar storms. Thus, mitigation of these radiation hazards is very important, with their forecasting being an important mitigation strategy. In this context, the HESPERIA SEP forecasting tools operational at the IAASARS Institute of the National Observatory thus provide important services to the scientific community as well as stakeholders worldwide.

Space Research & Technology

The new dynamic ENIGMA webpage (http://enigma.space.noa.gr/), developed in the framework of KRIPIS-PROTEAS project, provides a series of services to users, such as the possibility of viewing available data and products in real time. Moreover, the enhanced and expanded measurements of the ENIGMA magnetometers allowed the development of a visual service, regarding the level of ULF disturbance activity. The webpage has been designed in order to meet 3 primary use cases:

1. **CASE 1** The user chooses, via a search form, the output of a figure with daily data for a specific station; OUTPUT 1: Time series plot of daily data (Magnetogram)
2. **CASE 2** The user chooses, via a search form, the output of a figure with daily data for a range of dates for a specific station; OUTPUT 2: Time series plot of daily data for a range of dates (Magnetogram)
3. **CASE 3** The user chooses, via a search form, the output of a wavelet figure with daily data for a specific station; OUTPUT 3: Wavelet power spectra plot (Spectrogram).

Ionospheric Physics

- The Ionospheric Group Infrastructures and Services can support the operation of critical systems (telecommunication, navigation, positioning, geolocation) whose reliable operation is a requirement for the safety and security of the European citizens
- The Ionospheric Group Infrastructures and Services can be used as a test-bed for setting up the methodologies and standards for models' validation, through which the output of models developed by the community will be optimized, leading to validated geospace predictions. This is of critical importance, since accurate predictions are important to protect our technology and our society from space weather hazards. If unmanaged, space weather hazards create additional stress during

emergencies, compounding disasters. How to integrate this risk management into our technology infrastructure is a challenge we still face. In an era of climate change we may see an increased coupling of global natural disasters with severe space weather (this was occurred during the Katrina Hurricane Disaster in New Orleans in 2005).

- There are a number of SMEs in Europe active in space applications and the Ionospheric Group Infrastructures and Services can support their operations providing them access to the required data and value-added products.

- The Ionospheric Group scientists are able to provide consultancy to space agencies and SMEs for the optimum exploitation of data from the Earth's geospace and support them for the development of mitigation procedures and technologies.

Remote Sensing

BEYOND services with impact to societies and economies

Firehub

The main objectives of the FireHub of BEYOND is to facilitate the early warning and decision making in support to emergency response and evacuation processes, as well as to address diachronic and near real-time Burnt Scar Mapping needs, at various spatial resolutions. Both active-fire and BSM services are offered online and are publicly open, and cover the wider Mediterranean, the North Africa, the Balkans, and the Middle East territories. The service is totally open to the public and user authorities for accessing the fire detection information in real time. FireHUB system is used by many operational users namely Fire Brigades Authorities, Copernicus EMS Risk and Recovery, Ministerial Services and Organizations for Forest Protection and Territorial Recovery and Planning, WWF, private sector entities, and Local Authorities. From 2018 and on, the FireHUB will be integrated to the European Fire Information System (EFFIS), and to the web system of the Global Fire Monitoring Center of the International Strategy of UN for Disaster Reduction (UNSDR).

Floodhub

The main objectives of the FloodHub of BEYOND is to contribute by using satellite remote sensing to the establishment of flood risk management plans focused on prevention, protection and preparedness, in order to reduce and manage the risks that floods pose to human health, the environment, cultural heritage, economic activity and infrastructure.

Copernicus EMS - Mapping

The infrastructure and excellence developed in the BEYOND Center of Excellence are actively involved in the provision of Risk & Recovery Mapping which consists of the on-demand provision of geospatial information in support of Emergency Management activities related to Emergency Support. This applies in particular to activities dealing with prevention, preparedness, disaster risk reduction and recovery phases. There are three broad product categories: Reference Maps, Pre-disaster Situation Maps and Post-disaster Situation Maps. The research developed in BEYOND, exploits satellite data and ingests fusions of geo-partial information and data in rush mode, when, where needed, for enhanced risk modelling and improved assessment of the expected disaster impacts.

Solarhub

In the framework of the BEYOND and GEO-CRADLE projects, we introduced and applied a novel Solar Energy Nowcasting System (SENSE), in order to coordinate, improve and support the regional Earth Observation (EO) infrastructures and capabilities, in Europe, North Africa and Middle East, related to "access to energy".

The niche for this feasibility study is the operational, satellite-driven and real-time system for solar energy applications. SENSE was intended to be a starting point for energy related investments towards and beyond the implementation of GEO, GEOSS and Copernicus Energy activities and visioning innovative high-end applications and technologies with multifarious collaborations and carefully selected end-users.

Additionally, the BEYOND Centre is working in topics related to Agriculture and Food Security. Agriculture monitoring, for the purposes of food security, control of the implementation of sustainable agriculture policies and the improvement of the overall agricultural productivity, is a top priority for the European Union. In this broad domain, BEYOND Center of Excellence has advanced its technical capacities in the development of tailored Earth Observation (EO) based services for agriculture monitoring, addressing the diverse thematic areas of food security, monitoring of the Common Agricultural Policy (CAP) and smart/precision farming.

The Remote Sensing Group of IAASARS (BEYOND team), within the framework of the H2020 project RECAP, has developed a fully automated earth observation system for the monitoring of the Common Agricultural Policy (CAP). Specifically, RECAP aims to improve the remote monitoring of CAP Cross Compliance and Greening obligations to assist the Paying Agency inspection processes and at the same time offer farmers a tool supporting them to understand and better comply with the rules. In RECAP, we collected and analyzed datasets from the various Paying Agencies, members of the consortium. Utilizing this unique data received by the Paying Agencies and Copernicus Sentinel data (Sentinel-2) we have developed a novel parcel-based machine learning processing workflow for classifying crops, therefore directly addressing the crop diversification requirements of the CAP. We have also developed a runoff risk assessment, at parcel level, according to the Statutory Management Requirements (SMR 1) of the policy. Finally, we have developed a burn scar-mapping algorithm for the detection of stubble burning (GAEC 6), using Sentinel-2 data.

The Remote Sensing Group of IAASARS (BEYOND team), now extends and scales up the application of the RECAP crop monitoring scheme by incorporating big satellite data and technologies under the H2020 project EOPEN (rice production in South Korea). Fusion of Sentinel-1 (SAR polarimetry) and Sentinel-2 data is explored, for the generation of very dense temporal profiles. In EOPEN the notion of big data in multiple dimensions is addressed with respect to 1) the area of application - national and international scale, 2) the spatial resolution of thematic information, 3) the volume of data (national scale mosaics of dense time-series of S-1 and S-2), 4) computational efficiency (big data processing technologies).

TREASURE and EXTREMA

With IAASARS activities on Urban Thermal Remote Sensing, the general objective is to help European countries to achieve a higher level of protection against extreme temperature events (heatwaves and cold spells) by raising awareness and improving the resilience of the European population. Firstly TREASURE

project (2015-2016) and now EXTREMA project (2018-2019), both funded by DG-ECHO, aim to enhance the risk management and planning capability of European countries at urban level, and improve the current knowledge about extreme temperature risks and how their impacts are distributed geographically (this corresponds to United Nations' (UN) Sendai framework for disaster risk reduction (SFDRR) first priority for action. EXTREMA is building a better understanding about the future impacts of such events due to climate change and is improving city-to-city and cross border cooperation. This is being achieved by facilitating their access to multiple international city networks that promote city and community resilience. A key impact of EXTREMA is also the establishment of strong links between different communities, e.g. policy-makers with scientists and stakeholders that will result to better informed and more effective disaster risk reduction actions and further cooperation on building community resilience. The above are in line with SFDRR and the EU efforts to implement it. To that end, EXTREMA will help EU countries reduce disaster mortality and the number of affected people (SFDRR's 1st and 2nd global target, respectively) and also increase the availability of, and access to, disaster risk information and assessments to people (SFDRR's 7th global target). Paris, Rotterdam and Athens have already launched EXTREMA.

4.7 Access policies

N/A

B. Level of adoption of the recommendation of the previous evaluation

Observational Astrophysics

The group continued fostering collaborations with high-profile international projects and missions. We maintain our involvement in the exploitation of data from current space telescopes (e.g. XMM-Newton, Chandra, GAIA) and actively participate in the development of future/planned missions at high energies (eROSITA, ESA/Athena) and the infrared (SPICA, JWST). The group continues using large national and international facilities to conduct state-of-the-art research and produce high-impact science publications. Participation in large collaborations built around specific datasets include the XMM-XXL, DustPedia, HER33MES, HerCULES, HeViCS.

Since January 1, 2016, the 2.3m Aristarchos telescope, after successful evaluation by the OPTICON committee, is a full member of the OPTICON network and participates in the TNA program, making its instrumentation available to the international community. Three observers have been awarded time through OPTICON, in 2017, and conducted successful observations while an observing run is to be conducted in January 2019. The site of the Helmos Observatory has been fully evaluated with weather data collected sparsely on-site starting in 2002 and continually starting in 2013 (http://helmos.astro.noa.gr/Downloads/weather/Helmos_SiteConditions.pdf). Two permanent positions are approved for qualified technical staff supporting the facilities at Helmos Observatory. The selection process through ASEP (the Supreme Council for Civil Personnel Selection) is expected to begin within 2019. To date, 13 refereed publications have resulted from data obtained from the 2.3m Aristarchos telescope, 9 of which were published in the period 2013-2017. Note that the first refereed publication was published in 2013.

The 1.2m Kryoneri telescope was facing critical problems at the time of the previous evaluation. This is because of the progressively increasing light pollution from Athens and the lack of funding, which made it challenging to perform proper maintenance and upgrades. It was therefore recommended to be shut down. However, in 2015 the telescope was selected as the optimal facility for the ESA-funded NELIOTA project (https://neliota.astro.noa.gr/), as described in detail in section 2.2.2.1. The telescope was upgraded with new optics, two new fast-frame cameras at the prime focus and currently carries out monitoring observations primarily for the detection of near-earth objects. ESA has recently decided to continue funding the project and the operation at the Kryoneri 1.2-m telescope until January 2021.

Visitor Centres

The Thisio Visitor centre is now fully operational and offers a successfully and financially viable programme. The volume of visitors in both the Penteli and the Thisio visitor centres are receiving an increasing volume of visitors every year. The regular use of electronic means of communication and dissemination of the planned activities has significantly contributed to this growth. Both centres also offer diverse outreach programmes targeting different audiences (e.g. astronomy treasure hunt for children, summer camps etc.).

C. Strategic goals, scientific and technological priorities for the period 2013-2017

1.   Strategic Goals of the evaluation period

For the sake of clarity and brevity the most salient points of the IAASARS/NOA 5-year strategic operation plan for the period 2013-2017 submitted in the previous self-evaluation are listed in the Table below:

Table: Summary of IAASARS/NOA 5-year operation plan for the period 2013-2017	
Relevant Research Unit or Activity	Goal Description
Generic	Invite senior and dynamic junior scientists outside NOA to become "affiliated researchers" of IAASARS and have full access to all research infrastructures and facilities of the institute. We envision that this will foster closer collaborations and twining between their groups and ours.
Observational Astronomy	Continue software development to the GAIA mission. Further pursue development of added-value data products for the XMM-Newton. Strengthen ties with the teams that lead the eROSITA and the ESA/Athena X-ray telescopes. Encourage closer collaboration between different researchers within the group.
Observational Astronomy	Open first call of proposals in 2014. Become full member of the OPTICON (Optical Infrared Co-ordination Network) consortium.
Space Physics	Continue cooperation with the International Community to understanding the physical processes governing the Sun and the Solar-Terrestrial system. Integrate existing knowledge, infrastructure and tools together with new research achievements into a Regional Center of Excellence for Space Weather.
Remote sensing	Join 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.
Education and Public Outreach	Improve on the education program offered to the visitors. Improve the infrastructure of the Visitor Center in Penteli. Organise public outreach activities at the Thisio site. Rescope the use of the old 1.2m telescope at Kryoneri by integrating it as an element of the public outreach activities of the IAASARS. Use web to reach out to a much larger Greek-speaking audience, who cannot visit our facilities in person.

2. Planning, Policies and Communication to fulfill the goals

The IAASARS has a number of procedures in place to monitor the implementation and progress of the strategic goals set out for the 2013-2017 period. These included:

- The Scientific Council monitors the progress of the implementation of the IAASARS strategic plan and advices the Director on actions. The Scientific Council also communicates any decisions to the research staff.
- Internally teams have been setup to implement the various aspects of the strategic plan. Informal and regular meetings ensured continuous assessment of the overall progress.
- Although formal progress meetings at the Institute level were not organized, the director had regular interactions with the teams, thereby monitoring the development of the various aspects of the strategic plan.
- The public annual reports of the IAASARS are milestones that provide a means to assess and communicate the overall progress of the 5-year plan.
- Many large projects of the IAASARS have external advisor committees that provide regular (typically annually) feedback on the overall work development.
- The General Secretariat of Research and Technology (GSRT) acts as an external reviewer of the overall planning and implementation via the triennial KRIPIS programme funding proposals.
- The ultimate peer review of the IAASARS activities are the National and International calls for competitive proposals, in which the Institute can demonstrate a highly successful track-record.
- The open seminar series of the IAASARS (www.astro.noa.gr/en/seminars/) is regularly used to disseminate the results of the strategic plan activities.

3. Alignment and implementation of National and European legal and regulatory framework

Within the present regulatory framework, the Scientific Council of the IAASARS monitors the progress toward achieving institute's vision and strategic goals and advises the Director on actions and decisions that need to be taken. It interfaces with the researchers by discussing problems and communicating action plans. Conflicts of interest and more generally ethical issues are discussed by the Scientific Council and in collaboration with the Director are resolved. The Scientific Council also decides the composition of the committees that evaluate the promotions of IAASARS researchers and assess applications for new positions.

In line with current regulations, the mid-term assessment of the IAASARS Director consists of a report that summarises the results of a staff opinion poll. The implementation of the process is overseen by a small committee (size 3 to 5) that is setup from within the Institute by vote. The Scientific Council discusses the assessment with the Director and necessary actions are then proposed.

4. Socioeconomic impact

IAASARS maintains close contacts with local authorities and communities for public outreach activities (e.g. Penteli "Free University", Kryonery site), civil protection projects, deployment of infractures (e.g. PANGEA Observatory, island of Antikythera; Helmos Observatory, Achaea prefecture; Kryonery Observatory, Korinthia prefecture).

5. Measures to combat/reverse brain drain/waste, retain the highly skilled personnel, attract foreign talents

The IAASARS has been striving to create an appealing research environment at a level that can attract skilled researchers that are competitive at the international level. This is achieved by a number of measures:

- Funding: An adequate flow of grants is arguably a prerequisite for creating an appealing research environment. The IAASARS researchers have been actively and successfully pursuing funding opportunities, both national and international. This results in a healthy level of funding, which is used to hire skilled and highly-specialized personnel, invest on basic infrastructures and support large facilities. It is indicative that the IAASARS attracta International researchers from e.g. the U.S., Italy, Spain, Mexico, China and Russia.
- Computer facilities: The IAASARS maintains state-of-the-art computers and a fast network. Researchers of the IAASARS also have access to the National Greek Research and Technology Network (www.grnet.gr) cloud and super-computing facilities.
- Doctorate studies: The IAASARS in collaboration with the major Universities in Greece offers supervision to PhD candidates. Graduate students have access to the IAASARS facilities and infrastructures as well as office space. They are supervised by 3-member committees that include non-NOA researchers. This ensures adequate supervision and sufficient diversity in specific expertise. PhD candidates have regular meetings with members of their respective committees. The close ties of the IAASARS with the local Universities offers many career-development opportunities through specialised training. Practical and complementary skills are acquired through their involvement in research projects and experimental work. Conflicts are resolved at the supervising committee level. If this is

not possible, serious issues can be resolved by the Scientific Council and ultimately the Director.

- Colloquia: The IAASARS runs a regular seminar programme. There have been over 100 research talks in the reporting period, half of which are from international visitors.
- Journal Club: The graduate students of the IAASARS organise and run a weekly journal club meeting, where recent research articles are reviewed, and the latest space news are shared and discuss.
- Equal opportunities and gender balance: The fraction of women scientists in the IAASARS is about 30% at both the staff and post-doctoral level and about 50% at the graduate level. These fractions should be compared with the international representation of women in space sciences, e.g. 13% of female members International Astronomical Union (IAU; Cesarky & Walker 2010, A&G, 51, 33). The institute is also committed to developing, maintaining and supporting a culture of equality and diversity in employment in which staff are treated equitably. Equality of opportunity and inclusivity is fundamental to the vision and values of IAASARS.
- Academic freedom: The overall management structure of the IAASARS includes different advisory and decision-making bodies, thereby fostering academic freedom. All researchers can develop their own collaborations and apply independently and without limitation to the various funding schemes to which they are eligible. Conflicts are resolved by the Scientific Council and ultimately the Director.
- Professional development: IAASARS staff have the freedom to define their career development path. Sabbaticals, research or educational leaves are encouraged.
- Attracting high-quality researchers: IAASARS regularly announces its availability for hosting Marie Curie Individual Fellowships, encouraging Greek or foreign researchers working abroad to join the research groups of the Institute. One example is the Marie Curie IF Grant Dust-Glass (Dr. Antonis Gkikas) that is currently working in the Remote Sensing Group.

6.   SWOT analysis (Strengths – Weaknesses- Opportunities – Threats)

Strengths
- Scientific excellence (e.g. observational astrophysics, space physics, earth system sciences) with extended network of collaborations worldwide.
- State-of-the-art instrumentation (Aristarchos Telescope, refurbished 1.2m Kryoneri Telescope, Upgraded Athens Digisonde DPS4D, BEYOND infrastructure, DIAS infrastructure, PANGEA observatory)
- Operational Centers and flagship initiatives for real time provision of services to the State and the public (BEYOND, DIAS, PANGEA)
- Participation in large European Research Infrastructures (ACTRIS, EST) and funded networks (OPTICON, AHEAD)
- Participation in large consortia and to key international activities (GEO, WMO)
- Coordination of large consortia funded by the European Commission and the European Space Agency
- The diversity of the Institute expertise that creates opportunities for cross-field collaborations

Weaknesses
- Limited manpower at the permanent-staff level. Key members of IAASARS will be retiring by the end of 2018 (Dapergolas, Bellas).

- Lack of systematic technical support, e.g. for server maintenance and upgrades, operation of large infrastructures (e.g. NOA telescopes, BEYOND, PANGEA, DIAS, DPS4D).
- The IAASARS premises require significant upgrades and extensions to ease severe pressure on working-space produced by the large number of contractors employed by the Institute.
- The administrative, grant management and legal support by NOA does not meet expectations despite the high overhead rate.

Opportunities
- Involvement of the Institute researchers in many major upcoming and future missions and international collaborative programmes.
- The refurbished 1.2m Kryoneri telescope, the upgraded Athens Digisonde, the BEYOND center of excellence and the PANGEA observatory are attractive to various science projects which can support their operation.
- BEYOND may develop as the focal point for monitoring of the environment and management of natural disasters in the Mediterranean.
- PANGEA will contribute substantially to the development of Antikythera as "the island of science", capable of offering Physical Access to scientists and young researchers for using the research equipment for their scientific projects.
- Open Access scientific data and model infrastructures such as DIAS, BEYOND and PANGEA, that can be used as a test bed for testing and validating the performance of new scientific models, expandable to integrate new data from ground-based facilities and space missions.
- IAASARS researchers are able to provide consultancy to space agencies and large organizations for the planning of space missions and the optimum exploitation of data.

Threats
- Ability to maintain the technological and scientific expertise and know-how in the Institute, given funding fluctuations and the large number of scientists employed on short-time contracts.
- Low-level of funding available to support and maintain the large research infrastructures (Aristarchos, PANGEA, DIAS etc) as well as obtain new instrumentation.
- Probability of failure to meet the operating costs due to the crisis
- Serious competition in Europe and worldwide in seeking funding from new research projects – national support is required at EC and ESA level.
- Increasing bureaucracy.

D. Priorities, targets and perspectives for 2018-2022

Observational Astrophysics

Secure funding to maintain the involvement of the group in large international projects, such as the development of the Athena/WFI instrument. Reinforce the international orientation of the group to maintain access to state-of-the-art data and produce high-impact science. Secure funding to make Kryoneri fully operational. Increase the scientific output of the Aristarchos telescope through strategic collaborations and the initiation of large and focused observational programmes.

Moreover, an important scientific target of the next period will be the collaboration of the Helmos observatory with the LIGO/Virgo group to perform follow-up optical observations of gravitational events, detected through gravitational waves. Discussions have already started between the two parts.

A major prospect for the dissemination of science, is the establishment of a visitor's center in the town of Kalavryta, including a planetarium. In order to accomplish this, we are in advanced discussions and collaboration with the local authorities. The visitor center will contribute significantly to the educational, cultural, and touristic development of the Peloponnese and the region of Western Greece. Moreover, it will assure the full coverage of the operational costs of the Helmos observatory, making it a viable and self – sustainable unit.

Solar-Terrestrial Environment - Space Physics

Solar and Heliospheric physics: The future looks very bright for ground-based observations of plasma processes on the Sun and of ground-based and space observations of the interplanetary medium. A major new telescope, the Daniel K Inouye Solar Telescope (DKIST), is under construction at the top of Haleakala volcano on the Hawaiian island of Maui. This 4 m class solar telescope will provide exquisite spatial resolution (about 30 km) of features on the solar surface and will strongly complement space-based observations of the Sun being made by NASA spacecraft. Such a NASA spacecraft is the Parker Solar Probe (PSP) mission one of the most novel and long-sought *in situ* observational platforms for studying the Sun launched in August 2018. PSP will fly within 6 million km of the solar 'surface' and will make multiple passes through the solar corona over its several year lifetime. By measuring the local plasmas, magnetic fields, and plasma waves, PSP should give unprecedented insights into how the solar wind is accelerated and how energetic particles are produced in the million K solar atmosphere. SPP represents the first mission ever to fly into the region just outside of where solar plasmas accelerate from subsonic to highly supersonic speeds. Another space mission, Solar Orbiter, to be launched in 2020 is expected to make significant breakthroughs in our understanding of the solar activity and its effects on the inner heliosphere. The members of the Solar and Heliospheric Physics group participate

with observing proposals in DKIST and on Co-Investigator level in the Energetic Particle Detector (EPD) on board the Solar Orbiter spacecraft.

Ionospheric Physics: The main target for the next 5 years is the expansion of the coverage of our prediction systems to other world regions outside Europe and the systematic monitoring and prediction of all types of ionospheric perturbations, not only the ionospheric large-scale effects but also the instabilities and the irregularities which are the most unpredictable and threatful for terrestrial and aerospatial operational systems. A first step has been achieved with the Net-TIDE project and the new TechTIDE project which will conclude its activities in 2020. We continue on this direction with systematic international collaborations to enhance our monitoring, specification and forecasting capabilities with the main target to improve space weather forecasting capability. Within this framework, standardization and validation is also a priority for the next 5 years and will be attempted through international collaboration projects.

Space Research & Technology

The ENIGMA array provides geomagnetic field measurements which are essential for correlative satellite and ground-based studies of various magnetospheric phenomena.

For the years to come the Space Research & Technology Group aims to continue contributing to the specific research field by providing innovative, new research services/products, emanating from the enhanced ENIGMA capabilities. The advanced research products, regarding the geospace environment, will be developed in order to meet the operational users' requirements.

Knowing the consequences that severe space weather can have to space-borne or ground-based infrastructure it is a growing necessity that new tools and services of supportive content are developed. In order to ensure smooth operation of the affected infrastructure or to alleviate potential disturbances in their operation, early warnings can be provided.

In the framework of upgrading the ENIGMA services, two new products are planned and designed to be available: The GIC index and the ULF wave index. The goal is to provide the distribution of GIC throughout the greek territory, as well as the ULF wave index, uninterruptedly, as a function of the wider geomagnetic activity. The future services to be developed will facilitate and support operational systems against the destructive consequences that space weather can have.

GIC index: Strong electric currents that flow in the near-Earth space and close through the upper atmosphere can be generated during geospace magnetic storms. The magnetic field of these currents induces currents in the Earth's surface (Geomagnetically Induced Currents – GIC), the intensity of which depends on the distribution of the electrical properties in specific areas of the Earth's solid crust. GIC are the end of the space weather chain: Sun – solar wind – magnetosphere – ionosphere – Earth's surface. Hence, nowadays they constitute an integral part of the space weather research. Conductive channels of any kind

can be considered as appropriate candidates for the development of powerful GIC (https://geomag.usgs.gov/research/GIC.php). In case where technological systems of critical infrastructure, such as electricity transmission networks, oil and natural gas pipelines, telecommunication cables and railway equipment, are inside the area of GIC development, currents flow along these systems as well, and could result in causing serious disrupts or damages.

The new service aims at the development of a service that will identify the degree of vulnerability that the Greek Public Power Corporation (DEI) network will suffer in case of severe space weather and particularly geomagnetically induced currents (GIC). The service (GIC index) will be based on ENIGMA magnetometers measurements.

ULF wave index: The ENIGMA network provides long-term continuous monitoring of ultra-low frequency magnetospheric waves related to geomagnetic activity in the near-Earth electromagnetic environment. The ENIGMA data combined with the magnetometer measurements performed onboard the Swarm satellites will provide the unique opportunity to study the geomagnetic pulsations, resulting from solar wind - magnetosphere coupling.

The new service aims at the development of a computational tool that detects magnetospheric ultra-low frequency (ULF) waves, using ground-based magnetometer measurements. The algorithms forming the ground time-frequency analysis (G-TFA) tool were developed in MATLAB and are based in wavelet transforms. Measurements of the ENIGMA network will be utilized for calculating the characteristic activity index of the ULF disturbances (ULF wave index), via G-TFA tool.

FUTURE ENIGMA STATIONS (ANTIKYTHERA & METHONI)

In the framework of upgrading the monitoring infrastructure and of enhancing the ENIGMA capabilities, in the following years it is anticipated that two more stations will be installed, one in the island of Antikythera (in the context of PANGEA) and a second one in the area of Methoni, Peloponnese (in the context of the Navarino Environmental Observatory - NEO). The new research facilities will allow exploitation of data in the optimal possible way, in order to contribute in providing new services such as the ULF wave index and the GIC index, as described above.

Visitor Centres

Reach out to vulnerable social groups (e.g. children in hospitals, kids from schools outside Attica county or the extended Athens area, people that serve sentences at correctional facilities). Expand current outreach activities to science workshops and lecture-series for the general public either on the IAASARS disciplines or on cross-discipline themes that combine the expertise of all three NOA institutes. Maintain and improve the existing infrastructure and equipment to ensure the high quality of the offered education product.

E. Executive Summary-Recommendations and measures to be taken

The Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing (IAASARS) is one of the three institutes of the National Observatory of Athens (NOA). It obtained its current structure in 2012, after the merging of two Institutes: the Institute of Astronomy and Astrophysics, which carried on the tradition of optical astronomy in Greece since the establishment of the Observatory of Athens in 1842, and the Institute for Space Applications and Remote Sensing, which evolved from the old Ionospheric Institute, founded in 1955.

Scientific mission and disciplines: IAASARS mission is to carry out state-of-the-art basic and applied research in ground-based and space-borne astrophysics, from distant galaxies to the solar neighborhood, as well as near-Earth space physics, remote sensing, earth observation and signal processing. In particular, the three (3) main scientific disciplines represented by the Institute are: (i) Observational Astrophysics using both space and ground-based facilities, (ii) Solar-Terrestrial Environment - Space Physics, encompassing Solar and Heliospheric Physics and Ionospheric Physics, and (iii) Remote Sensing and Machine Learning for Signal/Image Processing.

Staff: Each discipline is supported by the scientific and technical staff who are responsible for boosting cutting-edge research as well as scientific and technological excellence. At the end of 2017 the permanent staff of the institute consisted of the Director, 23 researchers, 2 functional scientific personnel, 3 research support specialists and 2 technicians. Moreover, 27 postdoctoral researchers and 21 scientists & engineers under research training (i.e. students) were on term contracts, making IAASARS the largest institute in its field in Greece.

Infrastructure: The Institute operates a wide range of national facilities aiming to support research and services in the respective disciplines, including: (a) the Aristarchos 2.3m and Kryoneri 1.2m telescopes and corresponding instrumentation; (b) the European Digital Upper Atmosphere Server System - DIAS and the Athens Digisonde DPS4D station for monitoring the ionosphere; (c) the BEYOND Center of Excellence maintaining satellite acquisition antennas and computational infrastructure; (d) the PANGEA climate observatory of Antikythera; (e) the ENIGMA Hellenic GeoMagnetic Array; (f) the Optical and Electronic Laboratory in Penteli.

Excellence: The excellence of the Institute is demonstrated by the two ERC Grants received in the past two years, one in the field of Astrophysics and the other in Earth System Sciences. In addition, members of the Institute coordinate competitive H2020 projects in the area of Space Weather and Earth System Sciences, indicating European leadership in the specific fields of expertise. Through the TechTIDE H2020 Research and Innovation Action, IAASARS is developing the first worldwide warning system for Travelling Ionospheric Disturbances exploiting the expertise of 13 organizations in Europe and in US and to support operators for the development of mitigation technologies able to protect critical aerospace and ground infrastructures from ionospheric disturbances triggered by space weather effects. Furthermore, under the leadership of IAASARS and with the participation of 8 European partners, HESPERIA H2020 Research and Innovation Action develops novel and unique worldwide forecasting tools for High-Energy Solar Energetic Particles (SEPs). Finally, IAASARS is a regional coordinator of the GEO-GRADLE Coordination and Support Action, integrating the Earth Observation activities in the regions of North Africa, Middle East and Balkans, establishing links with GEO related initiatives and Copernicus.

The coordination role for IAASARS on space science activities is also critical as it concerns its role as a national hub for the Space Agencies (ESA, EUMETSAT) and other relevant organizations and bodies within the European Union (GEO, WMO). Some highlights include the activity of IAASARS in the ESA Space Situational Awareness programme to improve the monitoring and understanding of potential Earth hazards by developing experimental methods and analysis techniques to study the Impact of asteroids on the Moon. ESA has also singled out IAASARS to produce time-domain value-added products for the Hubble Space Telescope Archive. Last but not least, IAASARS has increased its competitiveness in all H2020 Excellence frameworks such as the ERC, Marie Curie and COST actions, while the Institute successfully participates in important Space/Copernicus initiatives and programs as well as large European Research Infrastructures (ESFRIs) such as ACTRIS and EST, or to funded European networks such as OPTICON and AHEAD.

Technology and innovation: IAASARS is active in converting basic and applied research into services and technological developments, connecting the research outcomes with entrepreneurship and the Greek industry. Within the evaluation period, IAASARS has provided knowhow to the Greek Industry for developing sophisticated surface-based and airborne remote sensors, including prototypes such as advanced ground-based polarization lidar systems for atmospheric research (WALL-E, EVE, EMORAL systems). Moreover, IAASARS has been designing and developing instrumentation for astronomical observations, such wide-field imaging cameras (e.g. MAWFC, AWFC) and spectrographs (ATS). Researchers of the Institute are members of the consortium that develops and tests the Wide-Field Imager detector for the ATHENA mission. ATHENA is an ESA L-class X-ray Astronomy   mission that will launched in 2028

Services to the State and the public: IAASARS offers critical information to the Greek State Authorities and the public, through the operation of its centers for providing dedicated services on Natural Disasters, Climate Change and Space Weather. This mission of IAASARS is largely fulfilled by the BEYOND Center of Excellence for the provision of services in the framework of the European Union's flagship program Copernicus. The emphasis of the Center's activity is on Emergency Response (Copernicus/Emergency Management Support), monitoring and protection of the Marine and Atmospheric Environment, as well as applications on Agriculture, Renewable Energy, and Climate Change Adaptation and Resilience, including a vast portfolio of natural disasters. Another flagship initiative of IAASARS is the establishment of the "PANhellenic GEophysical observatory of Antikythera (PANGEA)" in 2017, following the monitoring standards of the World Meteorological Organization (GAW/WMO), for the continuous observation of Essential Climate Variables representative for the Mediterranean. PANGEA aims to address a number of societal objectives related to challenges such as the climate change and its impact on severe weather and natural disasters in Greece and the Eastern Mediterranean. Furthermore, IAASARS is providing continuously and in real-time, innovative standardized and validated services to the European Space Agency Space Situational Awareness Programme for the Space Weather System of Federated Services, through the European Ionosonde Service that is supported from the DIAS system.

Outreach and Education: The Institute has a solid record of nearly 20 years of a public outreach and science education program. This includes special seminars, talks, and observations with the historic telescopes of the Institute. During the 5-year period, the Visitor Centers of IAASARS in Penteli and Thiseio were totally refurbished and since then, the Centers attracted more than 200.000 people and about 3000 schools. Other educational activities of the Institute include the annual astrophysics summer school for high-school seniors, regular organization of

international conferences and a vigorous seminar program. Starting from 2016, IAASARS co-organizes with the University of Peloponnesus the Master's Degree program "Space Science Technologies and Applications ".

Performance metrics **(please also refer to the diagrams included in the Appendix A):** The scientific activity within the evaluation period 2013-2017, resulted in more than 300 papers in refereed scientific journals with more than 15000 citations from third-parties. IAASARS has been also granted one patent for its Service on forest fire detection FireHub. Moreover, despite the economic crisis during the evaluation period, the scientists of the Institute have been successful in attracting on average more than 2 M€ per year in national and European competitive research grants, which is almost double than the income. Specifically, IAASARS attracted a total of 10.4 M€ within the period 2013-2017, while received 5.7 M€ from the Greek State (that is salaries of the permanent personnel). Thus IAASARS, provided novel applied and basic research results, services and public outreach activities, supporting at the same time nearly 50 full-time soft money positions (postdocs, engineers and IT support) at zero cost to the taxpayers.

Diagrams of the IAASARS performance metrics
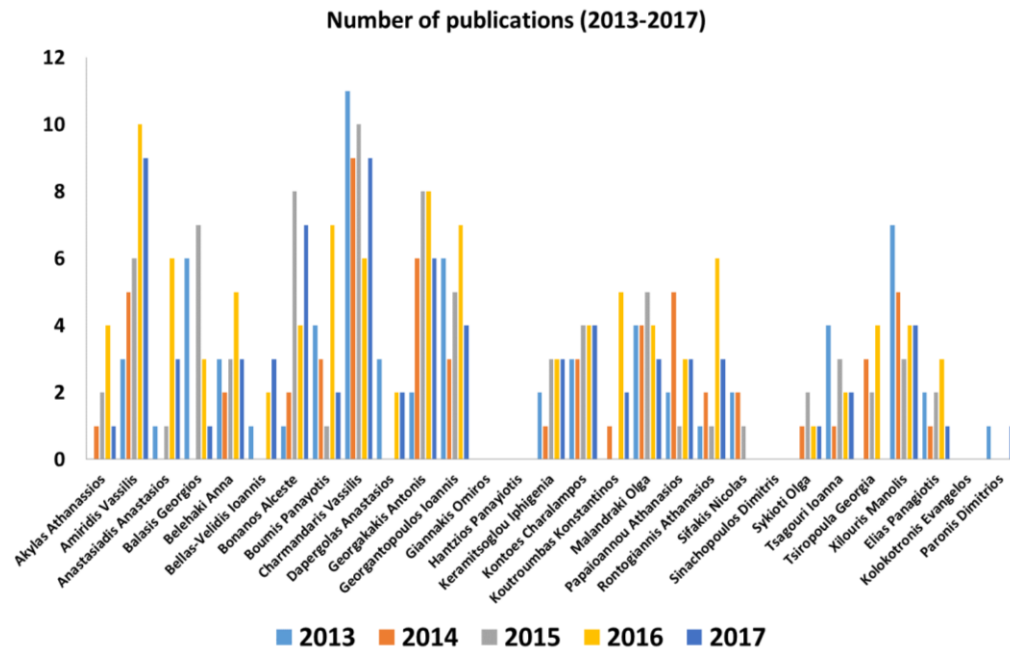
*A histogram of the refereed papers
published by the research personnel
(source ISI-Web of Science)*
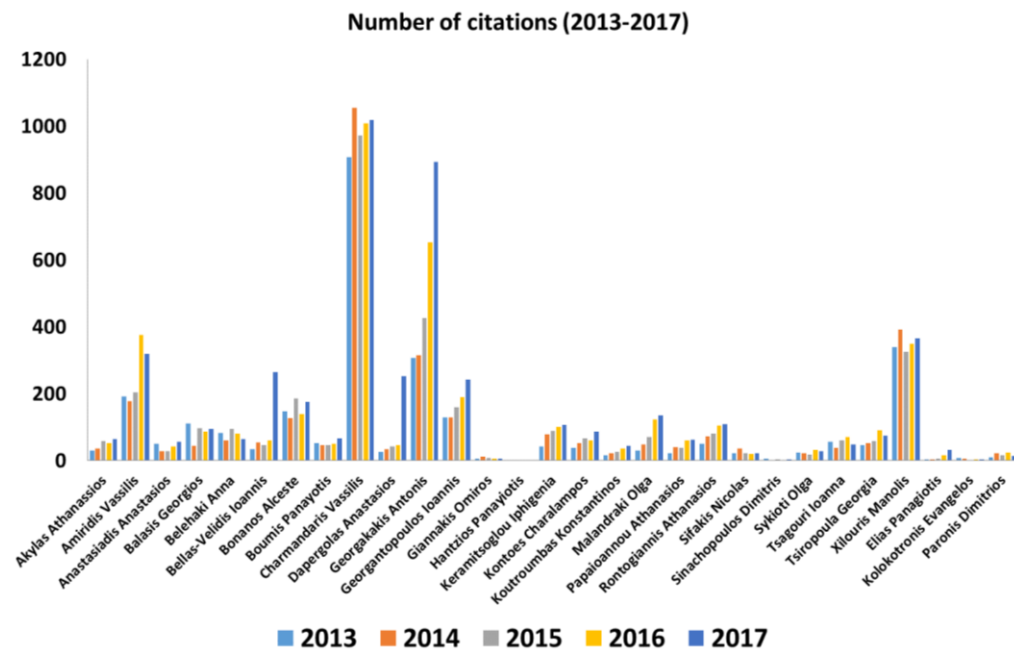
*A histogram of the citations to refereed papers
published by the research personnel
(source ISI-Web of Science)*
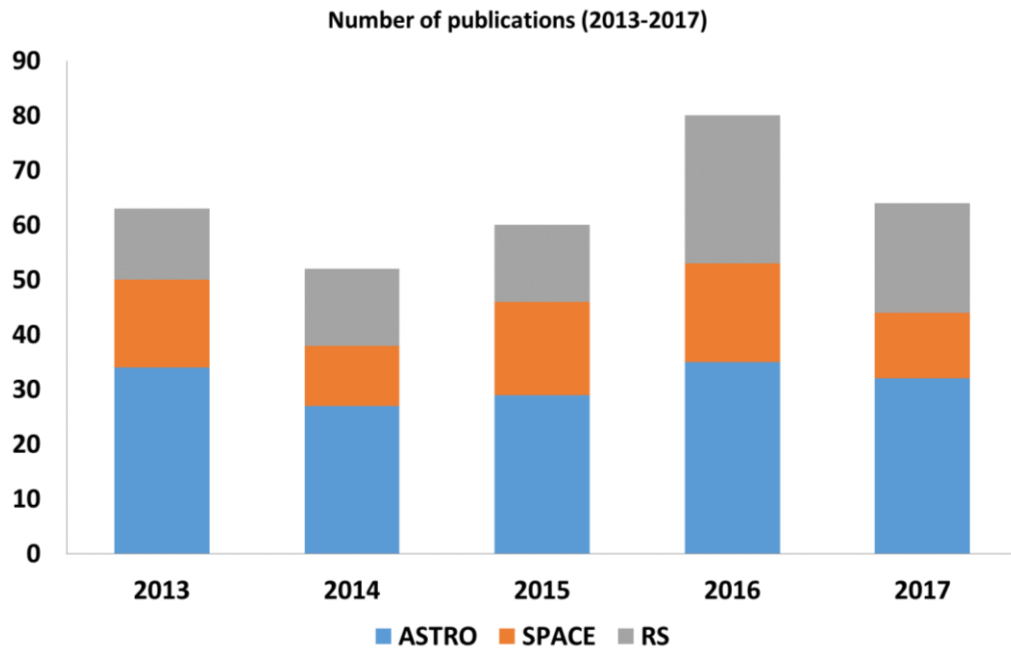
Number of publications (2013-2017)

A histogram of the refereed papers per IAASARS discipline
(source ISI-Web of Science)

Number of citations (2013-2017)

A histogram of the citations per IAASARS discipline
(source ISI-Web of Science)

Funding per group (2013-2017)
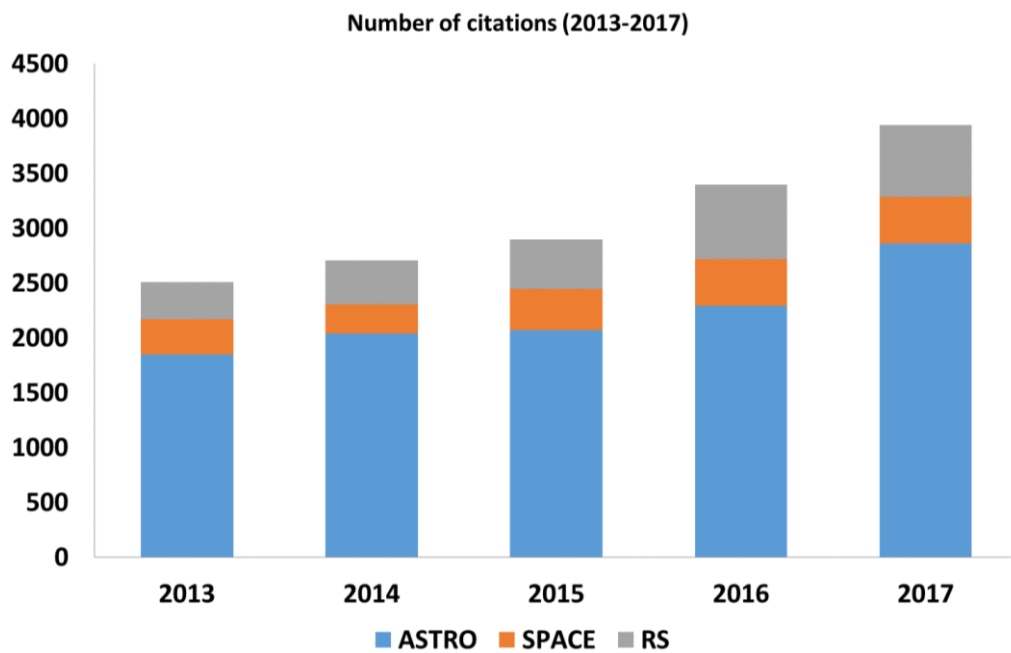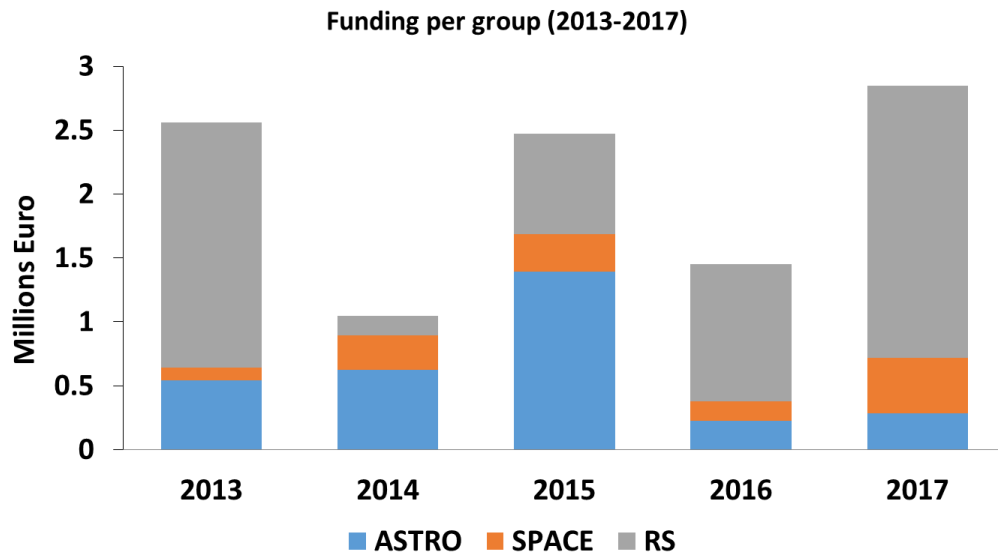
A histogram of the external funding from competitive grants awarded to researchers (per IAASARS discipline)
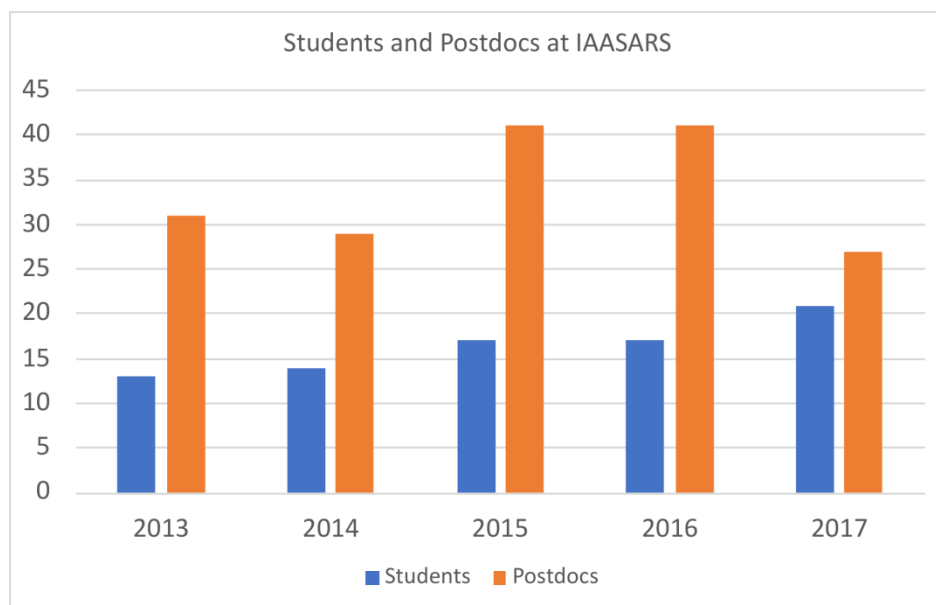
A histogram of PhD students and postdoctoral researchers of IAASARS

Appendix B

List of Research Funding

This section presents the exhaustive list of research-funded projects of the IAASARS during the reporting period.

B0. Institutional-wide Funding

General Secretariat for Research and Technology, "Advanced space applications for space and earth exploration" (KRIPIS – PROTEAS)

PI: V. Charmandaris

Total budget: 1.5M€

Period: 2012-2015,

Description: This is an Institutional project funded by the Ministry for Education to support the diverse activities and groups of the IAASARS.

B1. Observational Astrophysics

Formation and evolution of supermassive black holes
EU-H2020, Research Infrastructures: AHEAD (Activities in the High Energy Astrophysics Domain).
PI for NOA: I. Georgantopoulos
Total budget for NOA: €170,000
Start date: 01.01.2015
Description: The project unifies the efforts of all Research Institutes and universities in Europe. IAASARS leads the WP "Public Outreach" and is are part of the Transnational access to data analysis. In the framework of the first package we have produced education material focusing on X-ray Astronomy. The highlight of this work is the production of a dome (planetarium) video. This has been translated in over 10 languages and has been played in hundreds of planetaria around the world. The estimated number of spectators is well above 10,000,000 making it one of the most successful public outreach tools ever produced. In the transnational access package we train astronomers in the use of X-ray astronomical software employing advanced analysis techniques.

National funding, THALES , Ministry of Education: ''The Dark side of the accretion history of the universe" (MIS 383549)
PI: A. Georgakakis
Total budget: 469,000€
Start date: 01.11.2012
Duration: 36 months
Description: Development of novel statistical methods and analysis tools to constrain the obscured accretion history the Universe from multiwavelength data.

ESA-PRODEX: "X-ray spectra for the 3XMM catalogue"
PI: I. Georgantopoulos
Total budget: €85,000
Start date: 01.01.2013
Description: Provide X-ray spectral fits for the serendipitous sources in the 3XMM catalogue.

ESA-PRODEX: "Photometric redshifts for the 3XMM catalogue"

PI: I. Georgantopoulos

Total budget: €85,000

Start date: 01.01.2015

Description: Derive photometric redshifts have been for the serendipitous sources in the 3XMM catalogue using optical and near-IR photometry from the PANSTARRS and the WISE surveys

ESA/LPUB-SAPS: "Linking data and publications in the ESA's science archive publication system"

PI: A. Akylas

Total budget: 50.000€.

Start date: 15.10.2017.

Duration: 12 months.

Description: The objective of the activity is the extensive use the SAPS system to link ESA's mission publications with the data they stem from. During this procedure bags and improvements should be identified and reported.

Galaxy Evolution

EU-FP7, SPACE-2013-1: "DustPedia: A Definitive Study of Dust in the Local Universe".

PI for IAASARS: M. Xilouris

Total IAASARS budget: €266,000

Start date: 01.11.2014

Duration: 48 months

Description: DustPedia is a project funded by the EU under the heading 'Exploitation of space science and exploration data'. It is a collaboration of six European institutes with a primary goal of exploiting existing data in the Herschel Space Observatory and Planck Telescope databases. These data are combined with other available data from both ground-based and space-based telescopes to make the most extensive and intensive study of galaxies in the nearby Universe.

National funding, Aristeia program, GSRT: "A Step in the Dark: The Dense Molecular Gas in Galaxies (DeMoGas)".

PI: M. Xilouris

Total budget: €210,000

Start date: 26.09.2012

Duration: 36 months

Descriptions: "DeMoGas" was a project implemented under the "ARISTEIA" Action of the "OPERATIONAL PROGRAMME EDUCATION AND LIFELONG LEARNING" and was co-funded by the European Social Fund (ESF) and National Resources. The goal was to analyze observations of (U)LIRGs obtained through a long-term campaign (~10 years) from ground-based telescopes supplemented by observations made by the Herschel Space Observatory. These observations mainly reflect the presence of the molecule of carbon monoxide (CO) provided us with the tools to probe deep into the molecular clouds and determine the conditions in the densest environments of the interstellar medium in galaxies.

Stellar Astrophysics and Interstellar Medium

ESA: "Hubble Catalog of Variables"
PI: A. Bonanos
Total budget: 1.150.000€
Budget for IAASARS: 1.050.000€
Start date: 01.03.2015
Duration: 48 months (36 + 12 month extension)
Description: The goal is to produce a catalogue of variable sources chosen from the 30 million sources in the Hubble Source Catalog (HSC), validate those candidates and make them available in a catalogue. The task undertaken by the HCV team is to define an algorithm that will detect and validate a candidate variable star within the HSC.

National funding, Support of the Post-doctoral Fellows, GSRT: "Theoretical modelling and multi-wavelength observations of evolved stars"
PI: P. Boumis
Total budget: 150.000€
Start date: 03.09.2012
Duration: 36 months
Description: The aim of this project was to determine the genesis of asymmetry in evolved stars by studying the physical conditions, morphology and kinematics of ionized and molecular gas around these stars through multi-wavelength observations. Since various structural components of PNe have different observational properties, the optical and radio ranges are needed to derive a complete picture of the evolution of low and intermediate mass stars. The postdoc fellow was Dr. L. Uscanga.

National funding, Aristeia I, GSRT: "Revealed by Their Own Dust: Identifying the Missing Links in Massive Star Evolution"
PI: A. Bonanos
Total budget: 249.804€
Budget for IAASARS: 249.804€
Start date: 26.09.2012
Duration: 36 months
Description: The goal of the project was to perform a systematic study of rare, luminous, dusty massive stars in nearby (D<10 Mpc) galaxies as a next important step towards understanding their importance in massive star evolution.

ERC-COG-2017 Consolidator grant "ASSESS - Episodic MAss LoSS in Evolved MaSsive Stars: Key to Understanding the Explosive Early Universe"
PI: A. Bonanos
Total budget: 1,128,750€.
Budget for IAASARS: 1,128,750€.
Start date: 1.9.2018.
Duration: 60 months.
Description: The objective of the project is to determine whether episodic mass loss is a dominant process in the evolution of the most massive stars. The ubiquity of episodic mass loss, if confirmed, will be key to understanding the explosive early Universe and will have profound consequences for low-metallicity stars, reionization, and the chemical evolution of galaxies.

Ground-based instrument development

National funding, Excellence II, GSRT: "The Manchester-Athens Wide-Field Narrow-Band Camera: A Deep Sky-Survey of the Extensive Line Emission

Regions at High Galactic Latitudes"
PI: P. Boumis
Total budget: 312.000€
Start date: 01.03.2014
Duration: 19 months
Description: The goal of the project was to design and construct a state-of-the art, wide-field (~30 degree diameter), narrow-band, optical filter camera (MAWFC). The camera was the first scientific instrument for astronomy that was constructed and tested completely in Greece and the scientific aim was to conduct a large-area sky survey that will provide high resolution maps, in order to investigate the very extensive, but faint, line emission regions over the whole sky.

ESA: "NEO Lunar Impacts and Optical TrAnsients (NELIOTA)"
PI: A. Bonanos
Total budget: 900.000€
Budget for IAASARS: 900.000€
Start date: 01.02.2015
Duration: 71 months (47 months + 24 month extension)
Description: The project aims to determine the distribution and frequency of small near-earth objects (NEOs) by monitoring lunar impact flashes. The NELIOTA project has established an operational system that started monitoring the Moon for faint NEO impacts in early 2017, using the 1.2m Kryoneri telescope, located in the Northern Peloponnese, in Greece. The NELIOTA project entails a 22 month campaign ending in January 2019, which given its success, has been extended by 24 months. During this period the NELIOTA system will further be used to observe asteroid occultations and obtain NEO photometry.

B2 Solar-Terrestrial Environment - Space Physics

Solar and Heliospheric Physics

Co-funded by the European Social Fund and Greek national funds, Excellence II Action "Solar small-scale events and their role in the heating of the solar atmosphere".
PI: G. Tsiropoula
Total budget: 110.000 euros.
Start date: February 2014
Duration: 20 months.
Description: The aim of the proposed research was the derivation of accurate physical parameters of solar small-scale events, the comprehension of their dynamical behavior, their association with the magnetic field and their formation mechanism(s).

EC-H2020 – Research and Innovation Programme, Call: H2020-INFRADEV-2016-2 "PRE-EST-Preparatory Phase for the European Solar Telescope".
Total budget: 9.000.000 euros
Budget for NOA: 75.000 euros.
Start date: March 2017
Duration: 36 months
Description: The specific objectives of the proposed preparatory phase are: (1) to explore possible legal frameworks and related governance schemes that can be used by agencies to jointly establish, construct and operate EST as a new research infrastructure, with the implementation of an intermediate temporary organisational structure, as a previous step for future phases of the project; (2) to

explore funding schemes and funding sources for EST, including a proposal of financial models to make possible the combination of direct financial and in-kind contributions towards the construction and operation of EST; (3) to compare the two possible sites for EST in the Canary Islands Astronomical Observatories and prepare final site agreements; (4) to engage funding agencies and policy makers for a long-term commitment which guarantees the construction and operation phases of the Telescope; (5) to involve industry in the design of EST key elements to the required level of definition and validation for their final production; (6) to enhance and intensify outreach activities and strategic links with national agencies and the user communities of EST.

European Commission HORIZON 2020 - Research and Innovation Framework Programme, Call: H2020-PROTEC-2014, 'HESPERIA: High Energy Solar Particle Events foRecastIng and Analysis', (GA-637324)

Project Coordinator and PI for Greece: Dr. O. E. Malandraki

Total budget: 1.208.791,25 €

Budget for NOA: 215.625,00 €.

Description: The aim of this European project was the implementation of two novel forecasting tools, which are based upon already proven models (UMASEP, REleASE). At the same time, the HESPERIA project resulted to great advances on the understanding of the physical mechanisms that results to High-Energy Solar Energetic Particles (SEPs) by utilizing and taking advantage of unique data by the spacecraft FERMI (LAT/GBM instruments), PAMELA and AMS onboard the International Space Station (ISS) Other Collaborative Partners: Christian-Albrechts Universitaet zu Kiel, Germany, Observatoire de Paris, France, University of Barcelona, University of Malaga, Spain, University of Turku, Finland, University of Bern, Switzerland, ISNet, Greece, Institut d'Aéronomie Spatiale de Belgique, Belgium.

European Commission Seventh Framework Programme, Call: FP7-SPACE 2010-1, 'SEPServer - Data Services and Analysis Tools for Solar Energetic Particle Events and Related Electromagnetic Emissions', (GA-262773)

PI: Dr. O. E. Malandraki

Total budget: 186.166,00€

Duration: 2010-2013

Description: The aim of the project was the implementation of a new tool which greatly facilitates the research of Solar Energetic Particles (SEPs) and their origin: a database which provides SEP data and their associated electromagnetic emissions and analysis methods, a complete catalogue of the observed SEPs and outreach material for solar storms. Project Coordinator: University of Helsinki, Finland, Other Collaborative Partners: Christian-Albrechts Universitaet zu Kiel, Germany, Centre Nationale de la Recherche Scientifique, France, University of Barcelona, Spain, University of Turku, Finland, University of Oulu, Finland, Julius–Maximilians Universitaet, Wuerzburg, Germany, University of Ioannina, Greece, Astrophysikalisches Institut Postdam, Germany, DH Consultancy, Belgium.

European Commission Seventh Framework Programme, Call: FP7-SPACE 2010-1, 'COMESEP – COronal Mass Ejections and Solar Energetic Particles: forecasting the space weather impact', (GA-263252)

PI: Dr. O. E. Malandraki

Total budget: 281.671,00€

Duration: 2011-2014

Description: The aim of the project was the development of tools for the forecasting of geomagnetic storms and solar energetic particle storms, based on scientific analysis and modelling. The tools have been integrated into an operational European automated Warning Space Weather Alert System. The results of the

project led to the safety of astronauts of the extreme conditions of the particle radiation environment in space, and to safe future manned space mission to the Moon, with next stop Mars or an asteroid. Project Coordinator: Institut d'Aéronomie Spatiale de Belgique, Belgium, Other Collaborative Partners: Universitaet Graz, Austria, Koninklijke Sterrenwacht van Belgie, Belgium, Sveuciliste Zagrebu, Croatia, Danmarks Tekniske Universitet, Denmark, University of Central Lancashire, UK.

Ionospheric Physics

European Commission Horizon 2020 Programme, Call: COMPET-Space Weather-2017, "TechTIDE - Warning and Mitigation of Travelling Ionospheric Disturbances Effects", European Commission Horizon 2020, Grant Agreement 776011
PI: Dr Anna Belehaki

Total Budget: 1,590,000 euro

Description: The overarching objective of TechTIDE is to design and test new viable TID impact mitigation strategies for the technologies affected and in close collaboration with operators of these technologies, to demonstrate the added value of the proposed mitigation techniques which are based on TechTIDE products.

European Space Agency, Space Situational Awareness Programme, "ESA SSA Expert Center Coordination, Phase 3"
PI: Dr Ioanna Tsagouri

Duration: 2018 – 2019

Total budget: 4.5 M€.
Budget for NOA: 52,000 €
Description: This is the third phase of the ESA SSA SWE programme and the task of the ionospheric group is to maintain the operation of the European Ionosonde Service and to propose a validation strategy applicable to all Expert Service Centers Services. Task for NOA: Provision and EIS and validation of Ionospheric Services

NATO Science for Peace and Security multi-year project (SPS 984894) 2014 - 2017, https://sites.google.com/site/spsionosphere/, " Pilot Network for the Identification of Travelling Ionospheric Disturbances "
Project Director for NATO Countries: Dr Anna Belehaki
Project Director for NATO-affiliated Countries: Prof. Mamoru Ischii
Total budget: 400,000€
Duration: 2014 - 2017
Description: The objective of this project is the development of a pilot network among all European Digisondes with upgrades operational functionalities suitable for the identification of travelling ionospheric disturbances of large and medium scale. The resulting Net-TIDE system is operated by the Ionospheric Group of NOA and provides TID characteristics in real time from the web interface: http://tid.space.noa.gr/.

European Space Agency, "ESA SSA Expert Center Coordination" 2015 – 2017, Consortium built around all ESA member states coordinated by Airbus
PI for NOA: Anna Belehaki
Total budget: 4M€
Budget for NOA: 45,000€
Duration: 2015 – 2017

Description: This is the second phase of the ESA SSA SWE programme and the task of the ionospheric group is to adjust the European Ionosonde Service to the technical and Service Level Agreement (SLA) requirement of the Agency and to verify the Technical Readiness Level (TRL) of the service. – Task for NOA: Upgrade and acceptance of the EIS Service

US Air Force Research Laboratory, " Identification and tracking of LSTID exploiting 3D electron density distributions", USAF Grant, 2014 - 2016
PI: Anna Belehaki
Total budget: 130,000 USD
Duration: 2014 - 2016
Description: The objective of this grant is to verify the capabilities of the 3D version of the Topside Sounder Model -assisted Digisonde (TaD) to simulate electron density perturbations resulting from large scale TIDs. The grant was awarded by the European Office for Aerospace Research of the US Air Force Research Lab.

European Commission FP7, Research Infrastructures (e-Infrastructures), "Near-Earth space data infrastructure for e-science" (ESPAS), GA 283676, 2011-2015 (http://www.espas-fp7.eu)
PI for NOA: Dr Anna Belehaki
Total Budget: 5M€
Duration: 2011-2015
Description: The ESPAS Consortium is formed around 22 partners from European and US organizations. The aim of is to facilitate the access to data from the near-Earth space environment enabling exploitation of multi-instrument multi-point science data for analysis, model building, data assimilation into models, model-observation comparison, space environment nowcast and forecast, to name just a few.

European Space Agency, Space Situational Awareness Programme, ESA SSA SN IV-3 European Ionosonde and Neutron Monitor Network, ESA, 2012-2013
PI: Dr Anna Belehaki.
Total Budget: 200K€
Duration: 2012-2013
Description: This is the first phase of the ESA SSA SWE programme. The objective for NOA is to establish the European Ionosonde Service (EIS) and to provide in real time ionospheric specifications services to the ESA SSA. The objective for NKUA is to establish the European Neutron Monitor Service and to provide services adjusted to the ESA SSA requirements.

NASA Community Coordinated Modeling Center, International Forum for Space Weather Capabilities Assessment, supported by COSPAR and NASA/CCMC
Primary Leader of the Ionospheric Plasma Density Working Team: Dr Ioanna Tsagouri
Moderator of the Ionospheric Variability cluster: Dr Anna Belehaki
Description: An international network of space environment experts, model and application developers, data providers, forecasters and end-users of space weather products and services. The forum aims to address the challenges in model-data comparisons and evaluate the current state of space environment predictive capabilities in international level. The forum is facilitated by the Community Coordinated Modeling Center (CCMC) of GSFC/NASA.

Space Research & Technology

ESA-SAPS: Design, Implementation and Maintenance of a Publications System for

the ESAC Science Archives
PI: I. A. Daglis
Total budget: 600.000€.
Budget for IAASARS: 187.000€.
Start date: 1.3.2013.
Duration: 30 months.
Description: The main objective of the activity is to develop a system that can provide information on the scientific performance of ESA's operating missions by examining the publications and the observational data used to produce them.

LPUB-SAPS: Linking data and publications in the ESA's science archive publication system (ESA-SAPS) and software update
PI: O. Giannakis
Total budget: 98,907.50€.
Budget for IAASARS: 98,907.50€.
Start date: 12.09.2017.
Duration: 24 months (12 +12 months extension).
Description: The main objectives of the SAPS system are: 1) To provide information on the scientific performance of ESA's space science missions by examining the publications and the observational data used to produce them. The main goal of this project is to support the evaluation of the scientific productivity of a space science mission and of how it evolves over time, as well supporting decision-making regarding future science missions, such as the role of detectors, the specific areas of the sky studied, or the wavelength bands of major interest; 2) To provide an easier ingestion of publications metadata and potential links to data products in ESA Science Archives; 3) To provide a central database of all ESA Space Science missions publications that could be used by the Science Archives to link to; 4) The implementation of software improvements of the ESA SAPS code, the verification and validation of the improved code.
The SAPS project funded two students (1 PhD candidate, 1 MSc candidate) and one Software Engineer.

ULFwave
PI: G. Balasis
Budget for IAASARS: 295,000.00€
Start date: 2011
Duration: 36 months
Description: Multi-satellite, multi-instrument and ground based observations analysis and study of ULF wave phenomena and products

Swarm-HFW
PI: G. Balasis
Budget for IAASARS: 20,000.00€
Start date: 2015
Duration: 12 months
Description: Swarm Investigation of the Role of High-Frequency (0.1-5 Hz) ULF Waves in Magnetosphere-Ionosphere Coupling, Coordinator: University of Alberta, Canada, ESA

SAFE
PI: G. Balasis
Budget for IAASARS: 16,000.00€
Start date: 2016
Duration: 12 months

Description: Swarm for Earthquake Study, Coordinator: Istituto Nazionale di Geofisica e Vulcanologia (INGV), Italy, ESA

IKYDA2013

PI: G. Balasis

Budget for IAASARS: 15,000.00€

Start date: 2013

Duration: 24 months

Description: Transdisciplinary assessment of dynamical complexity in magnetosphere and climate: A unified description of the nonlinear dynamics across extreme events, Programme for the promotion of the exchange and scientific cooperation between Greece and Germany, German Partner: Potsdam Institute for Climate Impact Research - PIK (Prof. Dr. Dr. h.c. Jürgen Kurths), IKY-DAAD

FORSPEF (ESA Contract No. 4000109641/13/NL/AK)

PI: A. Anastasiadis

Budget for IAASARS: 120,000.00€

Start date: 2013

Duration: 24 months

Description: The development of a web based tool capable to perform 3-tier forecasts of Solar Particle Events (SPE). The tool will be consisted by the following modules: a)Module for Solar Flare Prediction; b)Module for SEP Occurrence and Onset Prediction; c) Module for SEP Flux Profile, Peak Intensity and Duration Prediction. The web based tool is used to provide reliable SPE predictions to assess the risk associated to the Agency's launch campaigns, prior to the launch and/or during the mission duration.

SAWS-ASPECS (ESA Contract No. 4000120480/NL/LF/hh)

PI and Coordinator: A. Anastasiadis

Total Budget: 300,000.00€

Budget for IAASARS: 130,000.00€

Start date: 2017

Duration: 24 months

Description: The objective of this activity is to advance the technology development of a Solar Particle Radiation Advanced Warning System (SAWS) which can collate and combine outputs from modules providing forecasts of solar phenomena, solar proton event occurrence and solar proton flux and duration characteristics which can be tailored to the needs of different spacecraft and launch operators. This activity shall improve on the precursor developments particularly in terms of the clarity of output forecasts for end users. Forecasts shall be made available through a web interface appropriate for end users and more detail for advanced space weather forecasters. User requirements shall include a derivation of energies and thresholds important for different users and warning levels with the system providing a clear traffic light system for quick look by operators.

Swarm-VIS

PI: G. Balasis

Budget for IAASARS: 35,000.00€

Start date: 2015
Duration: 24 months
Description: Swarm mission visualization and analysis tools, Funding: General Secretariat for Research and Technology

MAARBLE

PI: I.A Daglis, G. Balasis
Budget for IAASARS: 598,242.00€
Start date: 2012
Duration: 24 months
Description: The MAARBLE (Monitoring, Analyzing and Assessing Radiation Belt Loss and Energization) project has two focused and synergistic aims: to advance scientific research on radiation belt dynamics; and to enhance data exploitation of European space missions through combined use of European and US spacecraft measurements and ground-based observations.

SDR

PI: I.A Daglis, G. Balasis
Budget for IAASARS: 236,203.00€
Start date: 2010
Duration: 24 months
Description: Space-Data Routers for Exploiting Space Data, European Commission

B3 Remote Sensing and Machine Learning for Signal/Image Processing

Remote sensing

FP7- REGPOT-2012-2013-1 Coordination and Support Actions: "BEYOND - Center of Excellence (Building a Center of Excellence for EO based Monitoring of Natural Disasters"

PI: C. Kontoes
Total budget: 2.305.000€
Starting date: 2013
Duration: 36 months
Description: BEYOND (http://www.beyond-eocenter.eu/) develops research and provides disaster management services addressing priorities and needs in South Eastern Europe, Mediterranean, N. Africa, Middle East and the Balkans.

H2020 SC5-18b-2015 - Coordination and Support Action: "GEO-CRADLE - Coordinating and integRating state-of-the-art Earth Observation Activities in the regions of North Africa, Middle East, and Balkans and Developing Links with GEO related initiatives towards GEOSS "
PI for NOA: C. Kontoes
Total budget: 2.910.800€
Budget for NOA: 798.990€
Starting date: 2016
Duration: 34 months
Description: GEO-CRADLE is established for providing support to the Intergovernmental Organization GEO (Group on Earth Observations) and the Program for Global Monitoring for the Environment and Security Copernicus. GEO-

CRADLE is also a synergetic action that establishes a network of stakeholders across the entire value added chain in Earth Observation (research, service providers, data providers, decision makers) and builds on platforms for the integration and dissemination of EO data and know-how across the regions of N. Africa, Middle East, and the Balkans (NAMEBA).

JRC/IPR/2014/G.2/0012/OC: "Copernicus Emergency Management Service Risk and Recovery Mapping"
PI: C. Kontoes
Framework Service Contract: 1.000.000€
Budget for NOA: 248.500€
Starting date: 2.2015
Duration: 48 months
Description: The project provides all actors involved in the management of natural disasters, man-made emergency situations and humanitarian crises, with timely and accurate geospatial information derived from satellite remote sensing and completed by available in situ or open data sources.

ESA-EOPG-CSCOP-CR- 0006: "Sentinels Rolling Archive Products User Access, Operations, Maintenance and Evolutions"
PI: C. Kontoes
Budget for NOA: 538.830€
Starting date: 2017
Duration: 36 months
Description: The BEYOND Center is operating for the needs of the European Space Agency (ESA), in collaboration with the Greek Research & Technology Network (GRNET) (the HPC provider), the nodes Copernicus International Data Hub, Collaborative Data Hub, and DIAS Data Hub. The International Access Hub provides a dedicated access to a Rolling Archive of Sentinels satellite products.

ESA AO/1-8130/14/F/MOS, ESA Express Procurement (EXPRO+)/ Open-Competitive: "DRR – (Disaster Risk Reduction Using Innovative Data Exploitation Methods and Space Assets)"
PI for NOA: C. Kontoes
Total budget: 300.000€
Budget for NOA: 72.900€
Starting date: 2015
Duration: 36 months
Description: The project exploited the infrastructure and research developed in the BEYOND Center of Excellence (pillar GeoHub) and the network of stakeholders maintained by the GEO-CRADLE coordination and support action. The project addressed scientific objectives as: i) provide evidence based indications on how current space assets and EO data exploitation platforms offer optimum contribution to user organizations involved in Disaster Risk Management (DRM) and Disaster Risk Reduction (DRR) ii) assess the needed developments in terms of space assets which are required to further progress into the successful exploitation of EO based products in DRM/DRR domains.

EC-H2020 EO-2-2017: "EOPEN - Open Interoperable Platform for Unified Access and Analysis of Earth Observation data"
PI for NOA: C. Kontoes
Total budget: 1.999.500€
Budget for NOA: 218.125€
Starting date: 2017
Duration: 36 months

Description: EOPEN relies on (i) the infrastructures and research developed in BEYOND Center of Excellence, (ii) the roadmap resulted from GEO-CRADLE in regards to the priorities concerning the gathering and channeling of information over extended geographic areas in the agriculture sector, and (iii) the Copernicus DataHubs operated by the BEYOND Center of Excellence (e.g. Hellenic Mirror Site, DIASHub).

EC-H2020-WIDESPREAD-04-2017-Teaming Phase 1: "EXCELSIOR - ERATOSTHENES: Excellence Research Centre for Earth Surveillance and Space-Based Monitoring of the Environment"

PI for NOA: C. Kontoes

Total budget: 400.000€

Budget for NOA: 80.000€

Starting date: 2017

Duration: 36 months

Description: the project envisions the creation of an Earth Observation Centre at the Cyprus University of Technology (CUT), an inspiring environment for conducting basic and applied research and innovation through the integrated use of cutting-edge remote sensing and space-based techniques for monitoring physical and built environment in the eastern Mediterranean region.

EC-H2020 EO-2-2016: "EO-MARINE - Bridging Innovative Downstream EO and Copernicus enabled Services for Integrated maritime environment, surveillance and security"

PI for NOA: C. Kontoes

Total budget: 4.378.584€

Budget for NOA: 111.037€

Starting date: 2017

Duration: 36 months

Description: The project develops, tests and validates two sets of demand-driven EO-based services, adopted on open standards, bringing incremental or radical innovations in the field of maritime awareness and leveraging on the existing Copernicus Services and other products from the Copernicus portfolio.

EC-H2020 SC5-20-2016: "NextGEOSS - The next generation of the GEOSS Data Hub"

PI for NOA: C. Kontoes

Total budget: 10.000.000€

Budget for NOA: 420.000€

Description: The project develops the next generation of the GEOSS Earth Observation (EO) initiative, enabling global access to EO data, prototype and higher TRL innovative services using a single platform.

EC-H2020 INSO-2014-2015/CNECT: "RECAP - Personalized public services in support of the implementation of the CAP using EO"

PI for NOA: C. Kontoes

Total budget: 2.142.382€

Budget for NOA: 291.375€

Starting date: 2016

Duration: 24 months

Description: the project relies on (i) the roadmap resulted from the GEO-CRADLE project with respect to the research priorities concerning the gathering and channeling of information in support to the Common Agriculture Policy, and (ii) the Copernicus DataHubs operated by the BEYOND Center of Excellence (e.g. Hellenic Mirror Site, DIASHub).

EC-FP7-ICT-2009-5 Collaborative Project: "TELEIOS - Virtual Observatory Infrastructure for Earth Observation Data"
PI for NOA: C. Kontoes
Budget for NOA: 303.000€
Starting date: 2009
Duration: 48 months
Description: the project consisted a fundamental action that supported the definition, and the development of the basic processes of the innovative FIREHUB system of services of the BEYOND Center of Excellence, which offers real-time fire monitoring and burnt scar mapping applications.

National funding, GSRT - Program for the Reinforcement of the interdisciplinary and/or inter-institutional research and innovation: "SWEFS - Sensor Web Fire Shield for dynamic data-driven assimilation towards mitigation of environmental risks"
PI for NOA: C. Kontoes
Total budget: 519.798€
Budget for NOA: 77.000€
Starting date: 2012
Duration: 36 months
Description: Project consisted a complementary action that supported the further development of the innovative FIREHUB system of services of the BEYOND Center of Excellence, which offers real-time fire monitoring and burnt scar mapping applications.

National funding, GSRT - Operational Program for «Competitiveness & Entrepreneurship» «Cooperation 2011»: "ACRITAS - Space Technologies for Surveillance and Monitoring Integrated Applications"
PI for NOA: C. Kontoes
Total budget: 1.320.547€
Budget for NOA: 131.095€
Starting date: 2013
Duration: 36 months
Description: the project effectively responded to the development of an integrated border control system, applicable to land and sea borders. It provided rapid deployment to harsh and isolated environments providing multifunctional surveillance capabilities, intelligent data products and innovative services to regional and national authorities for border control.

European Research Council (ERC) Consolidator Grant 2016, H2020-EU.1.1., Excellent Science: "D-TECT - Does dust TriboElectrification affect our ClimaTe?"
PI: V. Amiridis
Budget: 1.968.000€
Starting date: 2017
Duration: 36 months
Description: D-TECT aims to parameterize the physical mechanisms responsible for dust triboelectrification, assess the impact of electrification on dust settling, quantify the climatic impacts of the process, particularly the effect on the dust size evolution during transport, on dry deposition and on CCN/IN reservoirs, and the effect of the electric field on particle orientation and on radiative transfer.

Marie-Curie European action - Research Fellowship Programme: "DUST-GLASS - Improving global dust prediction and monitoring through data assimilation of satellite-based dust aerosol optical depth"
PI: V. Amiridis
Budget: 164.653€

Starting date: 2017

Duration: 24 months

Description: DUST-GLASS aims at improving global dust prediction and monitoring by optimizing an advanced data assimilation system (LETKF scheme) coupled with a sophisticated atmospheric-dust model (NMMB/BSC-Dust).

HORIZON 2020: "ECARS - East European Centre for Atmospheric Remote Sensing"

PI for NOA: V. Amiridis

Budget for NOA: 179.980€

Starting date: 2016

Duration: 24 months

Description: ECARS addresses the challenges of the Twinning programme by tackling deficiencies and networking gaps between INOE and internationally-leading counterparts at EU level. The overarching objective of the ECARS project is to boost INOE's research capacity in the domain of atmospheric remote sensing and create a pole of excellence in East Europe.

FP7-SPACE-2013-1: "MarcoPolo"

PI for NOA: V. Amiridis

Budget for NOA: 110.178€

Starting date: 2014

Duration: 24 months

Description: MarcoPolo aims using European and Chinese expertise to improve air quality monitoring, modelling and forecasting over China by improving emission database using satellite data with a focus on emission estimates from space and their refinement for anthropogenic and biogenic sources through spatial downscaling and source sector apportionment. State-of-the-art techniques and recent wide range satellite and in-situ data and GIS information will be applied. New emission inventories will serve as input to air quality modelling on regional and urban scales, and it is expected to improve considerably existing air quality information and forecasts (to be supported by validation and following international standards and recommendations) interactively customized at MarcoPolo website.

ESA: "LIVAS - LIdar climatology of Vertical Aerosol Structure for space-based lidar simulation studies"

PI for NOA: V. Amiridis

Budget for NOA: 173.248€

Starting date: 2011

Duration: 24 months

Description: LIVAS is an ESA project aiming to provide a global and extensive aerosol and cloud optical database, to be used for current and future space-borne lidar end-to-end simulations of realistic atmospheric scenarios, as well as retrieval algorithm testing activities. LIVAS provides a global 3-dimensional aerosol and cloud optical climatology and a collection of case studies focused on atmospheric episodes related to specific aerosol/cloud types (extended atmospheric scenes, i.e. Saharan dust events, smoke and volcanic eruption events, polar-stratospheric clouds etc). In order to cover the different spectral domains for HSRL and IPDA lidars, the compiled database addresses the three harmonic operating wavelengths of Nd-YAG lasers (355 nm, 532 nm and 1064 nm) as well as typical wavelengths of IPDA lidars in the SWIR spectral domain (1570 nm and 2050 nm).

ESA: "HyFlex - Verification of the Hyperspectral Plant Imaging Spectrometer"

PI for NOA: V. Amiridis

Budget for NOA: 20.000€

Starting date: 2013

Duration: 36 months

Description: HYFLEX aims to deliver maps of sun-induced fluorescence recorded from aircrafts measurements using the approaches of the space & airborne FLEX mission. Ai borne data will be validated by ground based measurements and these data will provide a crucial element related to fluorescence retrievals from space in the context of the FLEX mission, as implemented in tandem with Sentinel 3. NOA participates in HYFLEX campaign by providing atmospheric lidar data that will be used for the much needed atmospheric corrections in order to retrieve reliable hyperspectral retrievals.

ESA: "DEDICAtE - Development Of A Dual-Channel Depolarization Lidar Technique For The Derivation Of CALIPSO/AEOLUS/EARTHCARE-Related Conversion Factors"

PI for NOA: V. Amiridis

Budget for NOA: 150.000€

Starting date: 2015

Duration: 24 months

Description: This ESA study aims at delivering spectral conversion factors for the lidar linear depolarization ratio between 355 and 532 nm in order to convert CALIPSO observations (532 nm) to EarthCARE-related observations (355 nm).

ESA: "CHARADMEXP - Characterization of Aerosol mixtures of Dust And Marine origin"

PI for NOA: V. Amiridis

Budget for NOA: 50.000€

Starting date: 2014

Duration: 12 months

Description: The CHARADMExp campaign aims to derive optical, microphysical and chemical properties of marine component and its mixture with dust, employing sophisticated instrumentation installed on an appropriate site. Specifically, aerosol characterization will be established by ground-based active/passive remote sensing techniques, surface in-situ measurements and airborne UAV observations.

ESA: "MULTIPLY - Development of a European HSRL airborne facility"

PI for NOA: V. Amiridis

Budget for NOA: 227.000€

Starting date: 2014

Duration: 60 months

Description: MULTIPLY is a ESA-ESTEC project which proposes the development of a novel multi-wavelength HSRL system (3b + 2a + 3d) for airborne operation

National funding, Stavros Niarchos Foundation: "NCCAD - Support the National Centre for the Collection, Analysis and Dissemination of Satellite Data for the Observation of the Earth, Atmosphere and the Sea"

PI: V. Amiridis

Budget: 264.000€

Starting date: 2016

Duration: 36 months

Description: NCCAD supports the operation and sustainability of the National Center of Excellence for EO-based monitoring of Natural Disasters (NCEON) of NOA for the next three years, including the upgrade and maintenance of the infrastructure and the employment of young researchers to support operations. The action aims on sustaining the continuous operation of our National hub for EO-related collection, validation and distribution of near-real time observations and services with emphasis on natural disasters (e.g. fires, floods, desert dust monitoring and forecasting, volcanic eruptions, air pollution, earthquakes, landslides).

ECMWF CAMS Use Cases 2017/CAMS_95B/SC2: "CLAIRE - Copernicus Application Facility for Environmental Effects on Health and Comfort".
PI for NOA: I. Keramitsoglou
Budget for NOA: 49.968€
Starting date: 2017
Duration: 36 months
Description: The overall purpose of CLAIRE application is to utilize CAMS products so as to provide citizens, tourists, public authorities and tourism operators with up-to-date information about weather and air quality conditions, including personalised, location-specific and user-specific indices and alerts.

H2020-EE5-2016: "PLANHEAT - Integrated tool for empowering public authorities in the development of sustainable plans for low carbon heating and cooling"
PI for NOA: I. Keramitsoglou
Budget for NOA: 201.562€
Starting date: 2016
Duration: 36 months
Description: The main objective of PLANHEAT is to develop and validate through real use-cases an integrated georeferenced tool for the mapping, planning and simulation of heating and cooling systems at local level towards the identification of future low carbon and economically viable supply scenarios matching the forecasted demand.

INTERREG V-B – BalkanMED 2014-2020: "WetMainAreas - Improving the conservation effectiveness of wetlands"
PI for NOA: I. Keramitsoglou
Budget for NOA: 155.615€
Starting date: 2017
Duration: 24 months
Description: WetMainAreas' objective is protection, conservation and development of wetlands, as a shared asset of the Balkan Mediterranean (BalkanMed) territory. BalkanMed wetland ecosystems are biodiversity hotspots with significant natural and cultural values and with high potential for territorial development and cooperation, including ecosystem basis development, improvement of knowledge, know how exchange and capacity to take informed decisions with positive impact on the whole territory.

EC DG European Community Humanitarian Office (ECHO) ECHO/SUB/2016/742480/PREV08: "TRIBUTE - TRigger Buffers in inundaTion Events"
PI for NOA: I. Keramitsoglou
Budget for NOA: 136.650€
Starting date: 2017
Duration: 24 months
Description: The general objective of TRIBUTE is to improve knowledge and understanding of inundation (flooding) risk, one of the most commonly occurring risks in the European territory, by developing tailored risk management tools based on state-of-the-art technologies.

EC DG European Community Humanitarian Office (ECHO) ECHO/SUB/2014/695561: "TREASURE"
PI for NOA: I. Keramitsoglou
Budget for NOA: 140.358€

Starting date: 2015

Duration: 24 months

Description: Appraisal and quantification of spatially distributed heat wave risk currently and in the future are required to develop innovative tools and services for the subsequent design of targeted measures and strategies.

National funding, GSRT: "ARISTOTELIS-URBAN"

PI: I. Keramitsoglou

Budget: 46.000€

Starting date: 2015

Duration: 24 months

Description: Monitoring the urban thermal environment by developing and applying advanced image processing techniques on diurnal geostationary satellite data.

Machine Learning for Signal/Image Processing

National funding, Aristeia I, GSRT: "HSI-MARS - Advancing Hyperspectral Image Processing for Planetary Mineral Exploration and Thematic Mapping: the Case of Planet Mars"

PI: A. Rontogiannis

Total budget: 355.000€

Budget for IAASARS: 355.000€

Start date: 26.09.2012

Duration: 36 months

Description: The goal of the project was the development, analysis and validation of novel clustering and unmixing algorithms for hyperspectral image processing and their application for identifying different types of minerals on the surface of Planet Mars.

EC funding, H2020-COMPET-4: "PHySIS – Sparse Signal Processing Technologies for Hyperspectral Imaging Systems"

PI for IAASARS: A. Rontogiannis

Total budget: 1.000.000€

Budget for IAASARS: 190.000€

Start date: 01.03.2015

Duration: 24 months

Description: The goal of the project was the development of new algorithmic tools and technologies for hyperspectral image processing, by exploiting inherent structural properties of hyperspectral imaging data such as sparsity and low-rank.

National funding, THALES, GSRT: "ENDECON - Energy Efficient Design of Communication Networks"

PI for IAASARS: A. Rontogiannis

Total budget: 600.000€

Budget for IAASARS: 86.000€

Start date: 01.03.2012

Duration: 36 months

Description: The goal of the project was the design, implementation and validation of new wireless and optical communication technologies based on energy efficient schemes.

Appendix C

Tables originating from the excel sheets of the evaluation template

Table 1a Summary of the personnel on 31/12/2017

RESEARCH INSTITUTE:

IAASARS

TABLE 1a

PERSONNEL on 31/12/2017

Type of personnel (only personnel under contract)	Total	Gender		Citizenship		Type of contract				Age		
		male	female	greek	other	permanent	fixed duration	project assignment	other	<35	35-55	>55
Researchers A	11	9	2	10	0	10	0	0	0	0	7	4
Researchers B	11	7	4	11	0	11	0	0	0	0	8	3
Researchers C	2	2	0	2	0	0	2	0	0	0	2	0
Researchers D	0											
Functional Scientific Personnel A												
Functional Scientific Personnel B	2	2	0	2	0	2	0	0	0		2	
Functional Scientific Personnel C												
Functional Scientific Personnel D												
TOTAL	**26**	**20**	**6**	**25**	**0**	**23**	**2**	**0**	**0**	**0**	**19**	**7**
Collaborating Faculty Members												
Visiting researchers												
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Post-docs	27	16	11	23	3	0	0	27	0	10	17	0
Collaborating researchers	10	8	2	9	1	0	10	0	0	0	3	7
Scientists & engineers under research training [MSc and PhD students]	21											
TOTAL	**58**	**24**	**13**	**32**	**4**	**0**	**10**	**27**	**0**	**10**	**20**	**7**
Technical scientific personnel	4	4	0	4	0	4	0	0	0	0	4	0
Technical personnel	4	4	0	4	0	4	0	0	0	0	1	3
Administrative personnel	1	0	1	1	0	1	0	0	0	0	1	0
Auxiliary personnel [Research Support]	35	17	18	35	0	0	0	35	0	4	29	2
TOTAL	**44**	**25**	**19**	**44**	**0**	**9**	**0**	**35**	**0**	**4**	**35**	**5**
Other												
Overall sum of Totals	**128**	**69**	**38**	**101**	**4**	**32**	**12**	**62**	**0**	**14**	**74**	**19**

Table 1b
Summary of the mobility of IAASARS personnel from 2013-2017 (see also
Subsection 2.3.1)

RESEARCH INSTITUTE: IAASARS					TABLE 1b
Type of personnel	2013	2014	2015	2016	2017
Researchers A	9	9	8	8	11
Researchers B	7	10	10	10	11
Researchers C	8	5	5	5	2
Researchers D	0	0	0	0	0
Functional Scientific Personnel A					
Functional Scientific Personnel B					2
Functional Scientific Personnel C					
Functional Scientific Personnel D					
TOTAL	24	24	23	23	26
Collaborating Faculty Members					
Visiting researchers					
TOTAL	0	0	0	0	0
Post-docs (fellowships)	34	32	42	41	27
Collaborating researchers	5	7	9	8	10
Scientists & engineers under research training [MSc and PhD students]	13	14	17	17	21
TOTAL	52	53	68	66	58
Technical scientific personnel	7	7	7	7	4
Technical personnel	5	5	4	4	4
Administrative personnel	1	1	1	1	1
Auxiliary personnel [Research Support on contract]	3	17	24	34	35
TOTAL	16	30	36	46	44
Other					
Overall sum of Totals	92	107	127	135	128
* 1 on posting in 2017					
** 2 persons left IAASARS					

Table 2a
Financial statement of IAASARS (2013-2017)

RESEARCH INSTITUTE:					TABLE 2A
IAASARS					
		FINANCIAL STATEMENT			
					in euros
	2013	**2014**	**2015**	**2016**	**2017**
Income total	**3.779.015.06**	**2.246.841.55**	**3.597.571.34**	**2.552.921.38**	**3.941.142.46**
Regular public budget funding	1.217.664.40	1.201.930.20	1.124.698.89	1.103.612.90	1.095.027.20
Public investment funds - national projects & studies	722.770.30	666.540.43	794.103.96	126.086.31	62.048.82
Public investment funds - structural funds					
Public investment funds - other funding					
Income from the EU Framework Programmes	**1.738.370.36**	**275.309.96**	**1.584.731.76**	**1.052.243.77**	**2.688.816.39**
Income from other International Organizations or foreign public sources		80.679.66	48.976.86	61.139.00	68.931.00
Income from R&D contracted by firms and other private legal entities	7.000.00	22.381.30		128.397.11	26.319.05
Income from sales of products and services, studies, tests, etc to third parties					
Income from education and training services etc.	93.210.00		45.059.87	56.415.39	
Income from real estate exploitation					
Income from capital investments					
Income from intellectual property exploitation					
Donations					
Other income				25.026.90	
Expenditure total	**2.288.912.99**	**2.922.533.17**	**3.176.387.74**	**2.706.395.23**	**2.574.696.19**
Researchers' overall compensations (including salaries and grands) — Researchers A	401.608.80	428.325.16	343.085.90	391.083.30	338.403.25
Researchers B	331.373.53	444.987.18	446.469.41	433.090.54	471.212.78
Researchers C	204.455.81	124.897.31	92.586.70	82.255.59	74.712.34
Researchers D	-	-	-	-	-
Functional Scientific Personnel A	-	-	-	-	-
Functional Scientific Personnel B		-	-	-	33.034.95
Functional Scientific Personnel C	-	-	-	-	-
Functional Scientific Personnel D	-	-	-	-	-
Technical Scientific Personnel's Compensations	222.003.97	229.837.16	365.386.04	213.470.20	152.407.96
Personnel costs (Technicians, Administration and auxiliary personnel)	155.340.70	324.145.51	491.782.79	480.767.10	599.438.99
Compensations of Post-docs, PhD's Masters	615.329.31	1.043.495.58	771.127.90	497.650.88	457.160.22
Third party remuneration (incl. Project assignments)	131.863.00	147.195.85	235.860.94	235.860.94	127.931.62
Functional expenses — Electricity	45.566.05	17.749.28	40.201.38	78.854.62	49.378.77
Heat					
Water					
Telephone - Internet	65.441.13	16.298.95	27.050.63	50.859.50	26.064.99
Other					
Other expenditure	115.930.69	145.601.19	362.836.05	242.502.56	244.950.32
Expenditure for equipment	187955.23	410892.78	187955.23	347976.95	107568.9

Table 2b
Financial statement of IAASARS (2013-2017), in percentage

RESEARCH INSTITUTE:					TABLE 2B
RESEARCH CENTRE:					
FINANCIAL STATEMENT					
					% based on the year's total
	2013	**2014**	**2015**	**2016**	**2017**
Income total	**100%**	**100%**	**100%**	**100%**	**100%**
Regular public budget funding	32%	53%	31%	43%	28%
Public investment funds - national projects & studies	19%	30%	22%	5%	2%
Public investment funds - structural funds	0%	0%	0%	0%	0%
Public investment funds - other funding	0%	0%	0%	0%	0%
Income from the EU Framework Programmes	46%	12%	44%	41%	68%
Income from other International Organizations or foreign public sources	0%	4%	1%	2%	2%
Income from R&D contracted by firms and other private legal entities	0%	1%	0%	5%	1%
Income from sales of products and services, studies, tests, etc to third parties	0%	0%	0%	0%	0%
Income from education and training services etc	2%	0%	1%	2%	0%
Income from real estate exploitation	0%	0%	0%	0%	0%
Income from capital investments	0%	0%	0%	0%	0%
Income from intellectual property exploitation	0%	0%	0%	0%	0%
Donations	0%	0%	0%	0%	0%
Other income	0%	0%	0%	1%	0%
Expenditure total	**100%**	**100%**	**100%**	**100%**	**100%**
Researchers' overall compensations (including salaries and grands)	Researchers A	18%	15%	11%	14%	13%
	Researchers B	14%	15%	14%	16%	18%
	Researchers C	9%	4%	3%	3%	3%
	Researchers D	0%	0%	0%	0%	0%
	Functional Scientific Personnel A	0%	0%	0%	0%	0%
	Functional Scientific Personnel B	0%	0%	0%	0%	1%
	Functional Scientific Personnel C	0%	0%	0%	0%	0%
	Functional Scientific Personnel D	0%	0%	0%	0%	0%
Technical Scientific Personnel's Compensations	10%	8%	12%	8%	6%
Personnel costs (Technicians, Administration and auxiliary personnel)	7%	11%	15%	18%	23%
Compensations of Post-docs, PhD's, Masters	27%	36%	24%	18%	18%
Third party remuneration (incl. Project assignments)	6%	5%	7%	9%	5%
Functional expenses	Electricity	2%	1%	1%	3%	2%
	Heat	0%	0%	0%	0%	0%
	Water	0%	0%	0%	0%	0%
	Telephone - Internet	3%	1%	1%	2%	1%
	Other	0%	0%	0%	0%	0%
Other expenditure	5%	5%	11%	9%	10%

Table 4a
Scientific output (2013-2017)

RESEARCH INSTITUTE:		2013	2014	2015	2016	2017	**Table 4a**
IAASARS							
1. Scientific publications	papers in refereed journals	**63**	**52**	**60**	**80**	**64**	
	proceeding of International Conferences (full paper reviewed)						
	papers in other Conferences (abstract)	*122*	137	138	117	141	
	other articles (including articles of popular science, etc)	*9*	18	*7*	7	8	
	book chapters in collective volumes	*5*			3	11	
2. Books - Monographs					2		
3.Ph.D. theses supervised by the researchers							
4.Citations						WoS (oblicatory)	SCOPUS (if necessary)
	Total number of citations on 31/12/2017					32091	
	Total number of citations for the papers published during 2013-2017					15453	
5. Professional publications and products	Professional publications						
	List the products, the names the companies, the persentage participation of the Research Center/Institute and its role, the start-up and end-dates)						
	other						
6.other results	patents						
	awards / prizes /distinctions						
	other outcomes						
7. Total number of programmes / projects of the Institute							
8. Total income from programmes / projects of the Institute (real distribution per year)							

Appendix D

Postodoc and student supervision

Postodoc supervision

Observational Astrophysics

Total of 23 distinct postdoctoral researchers. These are broken down as follows in the different research areas:

Formation and evolution of supermassive black holes: Nine (9) postdoctoral researchers: Drs. Ranalli, Lanzuizi, Mountrichas, Koulouridis, Ciesla, Nikoloudakis, Corral, Ruiz, Rovilos.

Galaxy evolution: Four (4) postdoctoral researchers, Drs. Leonidaki, Cassara, Vika, Ciesla

Stellar Astrophysics and Interstellar Medium: Nine (9) postdoctoral researchers: Drs. Uscanga, Chiotellis, Font, Gavras, Karampelas, Moretti, Williams, Yang, Sokolovsky.

Ground-based instrument development: Two (2) postdoctoral researchers: Drs Liakos, Nanouris.

Solar-Terrestrial Environment - Space Physics

S. Dimitrakoudis, A. Papaioannou, I. Sandberg

Remote Sensing and Machine Learning for Signal/Image Processing

Supervisor of two post-doc researchers: Dr. E. Nikolaeva and Dr. S. Stagakis during 2014-2015 (Sykioti).

PhD students' supervision

Observational Astrophysics

Total of 10 PhD students. These are broken down as follows in the different research areas:

Formation and evolution of Supermassive black holes: Three (3) PhDs: Pouliasis, Masoura, Koutoulidis

Galaxy evolution: Two (2) PhDs, A. Nersesian, A. Psychoyios

Stellar Astrophysics and Interstellar Medium: Five (5) PhDs, Britavskiy, Kourniotis, Spetsieri, Derlopa, Paraskeva

Solar-Terrestrial Environment - Space Physics

Solar and Heliospheric Physics
Main supervisor of the PhD thesis of J. Kontogiannis entitled "Study of the role of the fine structure of the solar chromosphere in the formation of the magnetic canopy and the propagation of waves" (Thesis Defence:2013, University of Athens) (Tsiropoula).

Space Research and Technology Group
Member of the Advisory committee of the Ph.D. thesis of A. – Z. Boutsi (2017 - today), Department of Physics, University of Athens. (G. Balasis)

Member of the Advisory committee of the Ph.D. thesis of S. Mitrokotsa (2016 – today), Department of Physics, University of Athens. (G. Balasis)

Member of the Advisory committee of the Ph.D. thesis of V. Pitsis (2015 – today), Department of Physics, University of Athens. (G. Balasis)
Member of the Advisory committee of the Ph.D. thesis of C. Katsavrias (2014 – today), Department of Physics, University of Athens. (G. Balasis)

Supplementary supervision of the Ph.D. thesis of M. Georgiou (2010 – 2017), Department of Physics, University of Athens (G. Balasis in cooperation with Prof. I. A. Daglis).

Remote Sensing and Machine Learning for Signal/Image Processing

Member of the Advisory committee of the PhD thesis of A. Anyfandi entitled "Detection and mapping of mineral resources in Greece utilizing imaging spectroscopy techniques in hyperspectral and multispectral EO data" (Department of Geology and Geoenvironment , Univ. of Athens, 11/2016-today) (Sykioti).

Member of the Advisory committee of the PhD thesis of G. Mavrokefalou entitled "Study of radioactivity pollution with marine parameters from satellite observations and comparative imaging in a GIS system" (Department of Physics, Univ. of Thessaloniki, 11/2016-today) (Sykioti).

Member of the Advisory committee of the PhD thesis of T. Vanikiotis entitled "Utilization of advanced remote sensing techniques for the study of vegetation dynamic parameters" (Department of Biological Applications and Technologies, Univ. of Ioannina, 2/2013-today) (Sykioti)

Member of the Advisory committee of the PhD thesis of Dr. A. Argyrouli, (with Prof. A. Papayannis) National Technical University of Athens, 2016 (current position: researcher at the DLR German Aerospace Center) (Amiridis).

Member of the Advisory committee of the PhD thesis of Dr. Eleni Marinou, (with Prof. D. Balis) Aristotle University of Thessaloniki, 2017 (current position: researcher at the DLR German Aerospace Center) (Amiridis).

Member of the Advisory committee of the PhD thesis of Nikolaos Siomos, (with Prof. D. Balis) Aristotle University of Thessaloniki (2013 - today) (Amiridis).

Member of the Advisory committee of the PhD thesis of Kalliopi Voudouri, (with Prof. D. Balis) Aristotle University of Thessaloniki (2015 - today) (Amiridis).

Member of the Advisory committee of the PhD thesis of Ourania Soupiona, (with Prof. A. Papayannis) National Technical University of Athens (2017 - today) (Amiridis).

Member of the Advisory committee of the PhD thesis of Vassiliki Daskalopoulou, University of Crete (2017 - today) (Amiridis).

MSc and BSc student's supervision

Stellar Astrophysics and Interstellar Medium

Seven (7) MScs & BScs: Kopsacheili, Paraskeva, Abartzi, Moutzouri, Kaparianou, Karoussi, Trouboulos.

Space Research & Technology Group

Member of the examining committee of the M.Sc. thesis (Master program: "Space Science, Technologies and Applications") of A. – Z. Boutsi (2017), University of Peloponnesus & National Observatory of Athens. (G. Balasis)

Member of the examining committee of the M.Sc. thesis (Master program: "Astrophysics, Astronomy and Mechanics") of P. Evangelopoulos (2017), Department of Physics, University of Athens. (G. Balasis)

Advisor of the M.Sc. thesis (Master program: "Space Science, Technologies and Applications") of A. – Z. Boutsi (2016 – 2017), University of Peloponnesus & National Observatory of Athens. (G. Balasis)

Supplementary supervision of the B.Sc. thesis of M. Koletti (2017 – 2018), Department of Physics, University of Athens (in collaboration with Prof. I. A. Daglis). (G. Balasis)

Supplementary supervision of the B.Sc. thesis of A. Adami (2015 – 2016), Department of Physics, University of Athens (in collaboration with Prof. I. A. Daglis). (G. Balasis)

Remote Sensing

Supervisor of 5 MSc students and 5 BSc students (in collaboration with the National Kapodistrian University of Athens, Harokopio University of Athens, National Technical University of Athens, Technical University of Crete, TEI of Crete) (Sykioti).

Participation in (inter)national educational University programs

Stellar Astrophysics and Interstellar Medium

External Examiner of the PhD thesis entitled: "Evolution of Planetary Nebulae with WR-Type Central Stars" of Mr. A. Danehkar, Macquarie University (Australia) (Thesis Defence, September 2013) (Boumis)

External Examiner of the PhD thesis entitled: "A New Population of Galactic Bulge Planetary Nebulas" of Mr. T. Stenborg, Macquarie University (Australia) (Thesis Defence, September 2015) (Boumis)

External Examiner of the PhD thesis entitled: "The shaping of bipolar planetary nebulae" of Mr. N. Clyne, NUI Galway (Ireland) (Thesis Defence, October 2015) (Boumis)

Galaxy evolution

External Examiner of the PhD thesis entitled: "3D grid structures for realistic radiative transfer simulations of dusty galaxies" of Ms. W. Saftly, Ghent University (Belgium) (Thesis Defence, September 2015) (Xilouris)

Solar and Heliospheric Physics

External Examiner of the PhD thesis entitled: "The role of chromospheric jet-like events in coupling the chromosphere and corona: A multi-instrument approach" of Ms K. Vanninathan, Queen's University (UK) (Thesis Defense, April 2013) (Tsiropoula)

External Examiner of the PhD thesis entitled: "High-resolution imaging and spectroscopy of the solar atmosphere" of Ms J. Shetye, Queen's University (UK) (Thesis Defense, November 2016) (Tsiropoula)

External Examiner of the PhD thesis entitled: "Dynamic wave-modes in solar chromospheric structures" of Mr R. Sharma, University of Sheffield (UK) (Appointed November 2017, Thesis Defense, March 2018) (Tsiropoula)

Member of the Jury for the evaluation of the PhD thesis entitled: ""Study of the role of the fine structure of the solar chromosphere in the formation of the magnetic canopy and the propagation of waves" of Mr J. Kontogiannis. University of Athens (Thesis defense: March 2013)

Member of the Jury for the evaluation of the PhD thesis entitled: "Integrated model simulating solar flares" of Ms M. Dimitropoulou. University of Athens (Thesis defense: February 2014)

Evaluation Reviewer of the Ph.D. thesis entitled: *'The longitudinal distribution of Energetic Particles in the Inner Heliosphere – Multi-point Observations with STEREO'* of Mrs. Nina Dresing, following invitation by Prof. Dr. W. Duschl, Dean of the Christian-Albrechts-Universitaet-zu-Kiel, Germany (April 2014) (Malandraki).

RELATORA, Member of the Jury for the evaluation of the Ph.D. entitled: *'Analysis of Near Relativistic Protons and Electrons in Solar Events, Using the HI-SCALE and EPAM* instruments' of Mr. J.B.S. Morgado, Universidade de Lisboa, Instituto Superior Técnico, Portugal, (Thesis Defense, 25/7/2016) (Malandraki).

Members of the Jury for the evaluation of the Ph.D. thesis, entitled: 'Investigation of shock waves in the solar corona and the interplanetary medium of Mr Athanasios Kouloumvakos, University of Ioannina (Thesis defense: December 2017) (Malandraki, Tsiropoula).

Space Research & Technology

Member of the 7-member Examining committee of the Ph.D. thesis of M. Georgiou (2017), Department of Physics, University of Athens (G. Balasis).

Member of the 7-member Examining committee of the Ph.D. thesis of A. Kouloumvakos (2017), Department of Physics, University of Ioannina (A. Anastasiadis).

Member of the 7-member Examining committee of the Ph.D. thesis of E. Paouris (2017), Department of Physics, University of Athens (A. Anastasiadis).

Member of the 7-member Examining committee of the Ph.D. thesis of C. Bouratzis (2017), Department of Physics, University of Athens (A. Anastasiadis).

Remote Sensing and Machine Learning for Signal/Image Processing

External Examiner of the PhD thesis entitled "Identification of the facial psychosomatic state using thermal infrared radiation" of Ms. G. Koukiou (Department of Physics, University of Patras, 2014) (Sykioti).

External Examiner of the PhD thesis Dr. Valentyn Bovchaliuk, University of Lille, 2016.

External Examiner of the PhD thesis of Qiaoyun Hu, University of Lille (ongoing).
Member of the 7-member PhD committee of Dr. Athanasios Tsikerdekis, Aristotle University of Thessaloniki, 2017 (Amiridis).

Member of the 7-member PhD committee of Dr. Panagiotis Kosmopoulos, Aristotle University of Thessaloniki, 2017 (Amiridis).

Member of the 7-member PhD committee of Dr. Emmanouil Proestakis, University of Patras, 2018 (Amiridis).