



**INSTITUTE FOR ASTRONOMY ASTROPHYSICS  
SPACE APPLICATIONS & REMOTE SENSING**

**NATIONAL OBSERVATORY OF ATHENS**

**IAASARS**

**ACTIVITY REPORT 2018**

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## **1. INTRODUCTION**

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IAASARS is the largest Institute of the National Observatory of Athens. In 2018 it hosted 27 permanent researchers, 5 permanent supporting personnel 27 postdoctoral research associates 32 research support personnel and 20 research students. In addition there were ten adjunct researchers associated to the Institute.

The Institute boasts a high scientific productivity as this reflected by the number of publications in international refereed journals. Moreover the Institute has the privilege to host two prestigious European Research Council (ERC) Grants. One on Massive stars (PI A. Bonanos) and the other one on the long-range transport of atmospheric dust (PI V. Amiridis). Additionally, the Institute hosts four major Research Infrastructures: (i) the 2.3-m Aristarchos telescope on Mt. Helmos which currently runs its tenth year of successful operations; (ii) the Kryoneri 1.2-m telescope that has recently been refurbished and has been used continuously ever since - mainly in the framework of the ESA NELIOTA project, monitoring the infall of meteorites on the lunar surface; (iii) the BEYOND center for the monitoring of natural disasters and recently (iv) the PANhellenic GEophysical observatory of Antikythera (PANGEA) which is a major climate change monitoring infrastructure.

Last but not least, in 2018 IAASARS operated two visitor centers. The first in Penteli and the second at the heart of Athens, in Thiseion. All visitor centers are open on a daily basis, in order to, facilitate educational visits from school, while each center opens about three times per week accommodating visits of the public combined with observations of the night sky with our historical telescopes. Indicative numbers that highlight the Educational & Public Outreach service provided by IAASARS this year, are the 50,000 students from 400 schools that visited our telescopes at both Penteli and Thiseion.

Spyros Basilakos  
Director of IAASARS/NOA  
Research Director RCAAM Academy of Athens

## 2. SCIENTIFIC FOCUS & CORRESPONDING ACTIVITIES

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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 specialized 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 fulfillment of the above mission include:

- Studies of Near-Earth Objects via observations of Lunar impacts from the newly-refurbished Kryoneri 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 establishment of a national facility for climate change monitoring at the island of Antikythera
- The operation of two popular visitor centers 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 organized with the Computer Science and Telecommunications Department of the University of Peloponnese.

Regarding research, the activities of IAASARS cover the following areas:

- ❑ **Astronomy & Astrophysics:** (a) Physics of the interstellar medium, (b) High Mass Stars, (c) Stellar systems and galaxies, (d) Infrared Astronomy, (e) X-ray Astronomy, (f) Cosmology, (g) instrumentation. The research is carried out using both ESA and NASA space telescopes (e.g. HST, XMM-Newton, Chandra, Swift, NuSTAR, Herschel) as well as ground-based telescopes. The ground-based telescopes include those operated by NOA at Helmos and at Kryoneri, as well as, overseas telescopes at ESO.
- ❑ **Space Physics:** the research concerns (a) space in the vicinity of the earth (b) interplanetary space, (c) planetary exploration (d) solar physics (e) particle and electromagnetic interaction of solar phenomena in the heliosphere (f)

magnetosphere και (g) ionospheric physics. The space physics group is involved in the development of instruments for both ESA and NASA missions. Moreover, it offers products and services related to the observations of solar activity, the interplanetary space, the magnetosphere and the ionosphere. These products are used by the European Space Agency (ESA) for the protection of operational systems, missions and of course human personnel (telecommunication systems, civil aviation radar, aircraft pilots, space missions' electronic systems, electric power grids).

- ❑ **Earth observation by satellite and ground-based remote sensing:** In the field of remote sensing, research focuses on: (a) the design and implementation of observational facilities for the monitoring of the Land-Ocean-Atmosphere system, (b) the study of dynamical physical processes and the development of Earth System Models, (c) the development of prototype data processing algorithms for remote sensing sensors; and (d) the creation of global Earth Observation and Monitoring databases. In addition, more complex and value-adding products are generated; such as diachronic mapping of land and monitoring of changes in sensitive natural and anthropogenic environment due to climate change and economic activity; natural disasters management (forest fires, floods , earthquakes, volcanoes, episodes of air pollution), and the monitoring of the Urban Thermal Island phenomenon.
- ❑ **Machine learning for signal and image processing (MLSIP):** our research activities in MLSIP focus 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, astronomical, ionospheric, 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) image data restoration from partial information using matrix completion and (e) signal and image denoising by exploiting structural properties of the data such as sparsity and low-rank using robust principal component analysis.

### **3. STRUCTURE**

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#### ***Director***

Basilakos Spyridon (10/2018-present; Research Director at the Academy of Athens)

Charmandaris Vassilis (13/09/2013-23/09/2018; Professor at the University of Crete)

#### ***Researchers***

Amiridis Vassilios (Deputy Director)

Anastasiadis Anastasios (Research Director)

Balasis Georgios (Research Director)

Belehaki Anna (Research Director)

Bellas-Velidis Ioannis (Senior Researcher)

Bonanos Alceste (Senior Researcher)

Boumis Panayotis (Research Director)

Dapergolas Anastasios (Research Director)

Georgakakis Antonios (Senior Researcher)

Georgantopoulos Ioannis (Research Director)

Hantzios Panayotis (Senior Researcher)

Keramitsoglou Iphigenia (Research Director)

Kontoos Charalambos (Research Director)

Koutroumpas Konstantinos (Research Director)

Malandraki Olga (Senior Researcher)

Papaioannou Athanasios (Associate Researcher)

Rontogiannis Athanasios (Research Director)

Sifakis Nikolaos (Research Director)

Sinachopoulos Dimitris (Senior Researcher)

Sykioti Olga (Senior Researcher)

Tsagouri Ioanna (Senior Researcher)

Tsiropoula Georgia (Research Director)

Xilouris Manolis (Research Director)

#### ***Research Scientists***

Akylas Athanasios (Senior Research Scientist)

Giannakis Omiros (Senior Research Scientist)

#### ***Adjunct Researchers***

Daglis Ioannis

Hatzidimitriou Despina

Kiranoudis Christos

Kollias Pavlos

Kutiev Ivan

Magdis Giorgos  
Sergis Nick  
Theodoridis Sergios  
Tsinganos Kanaris  
Vourlidas Angelos

***Permanent Research Support Personnel***

Elias Panagiotis  
Kolokotronis Evangelos  
Paronis Dimitrios  
Saloustros Georgios  
Varsos Thomas

***Postdoctoral Researchers***

Alikakos Ioannis  
Athanasopoulou Eleni  
Gavras Panagiotis  
Gkikas Antonis  
Giampouras Paris  
Dasyra Kalliopi  
Ieronymidi Emanuela  
Kosmopoulos Panagiotis  
Koutoulidis Lazaros  
Liakos Alexios  
Maravelias Grigoris  
Mountrichas Georgios  
Mylona Eleftheria  
Paouris Evangelos  
Papoutsis Ioannis  
Proestakis Emmanouil  
Ruiz Angel  
Sandberg Ingmar  
Sismanidis Panagiotis  
Sokolovsky Kirill  
Solomos Stavros  
Tsekeri Alexandra  
Tsironis Christos  
Tziotziou Konstantinos  
Vika Marina  
Xenaki Irida  
Yang Ming

***Research support***

Antoniadi Sylvia (Research Specialist)  
Apostolakis Alexis (Research Specialist)  
Charisi Anna (IT specialist)  
Christia Eleni (Research Specialist)  
Filippas Dimitris (Research Specialist)  
Giannaraki Georgia (Research Specialist)  
Georgiou Thanasis (IT specialist)  
Gourzelas Alex (Telescope Support)  
Herekakis Themistocles (IT Specialist)  
Karagiannopoulou Aikaterini (Research Specialist)  
Karamanolis George (Research Specialist)  
Katsanaki Peggy (Research Specialist)  
Mageiridis Charalampos (Research Specialist)  
Makri Kiki (MSc in SSTA Coordinator)  
Metallinou Fiori-Anastasia (Public Outreach Officer)  
Metaxa Margarita (Astronomy Education)  
Milonas Aris (Public Outreach Astronomer)  
Nantsou Tina (Astronomy Education)  
Papatheochari Stavroula (Assistant Project Manager)  
Parselia Elisavet (Research Specialist)  
Pavlos Apostolos-Evgenios (Research Specialist)  
Petala Christina (Head of Information Systems)  
Psalidas Michael (Research Specialist)  
Roussakis Christos (Research Specialist)  
Sitokonstantinou Vassilis (Research Specialist)  
Trypitsidis Anestis (Research Associate)  
Tsamis Fotis (Research Specialist)  
Tsimpidas Dimitrios (Public Outreach Officer)  
Tsioutsia Dimitra (Public Outreach Support)  
Tsonzou Anastasia (Research Specialist)  
Tsouni Alexia (Research Specialist)  
Varsou Konstantina (Astronomy Outreach Support)

***Postgraduate students - supervisor***

Boutsi Adamantia Zoe (PhD student) – G. Balasis  
Chira Maria (PhD student) – E. Plionis  
Daskalopoulou Vasiliki (PhD student) – V. Amiridis  
Derlopa Sophia (PhD student) – P. Boumis  
Drivas Thanassis (MSc student)  
Gialitaki Anna (PhD student) – V. Amiridis  
Giamini Sigiava (PhD student) – G. Balasis  
Kampouri Anna (MSc Student) – V. Amiridis



Katsavrias Christos (PhD Student) – I. A. Daglis  
Masoura Vasileia Aspasia (PhD student) – I. Georgantopoulos  
Mouzakis-Christopoulos Angelos (MSc Student)  
Nersesian Angelos (PhD Student) – E. Xilouris  
Papachristou Michalis (PhD Student) – K. Dasyra  
Papadimitriou Constantinos (MSc student) – G. Balasis  
Paraskeva Emmanouela (PhD Student) – A. Bonanos  
Paschou Peristera (MSc Student) – V. Amiridis  
Pouliasis Ektoros (PhD student) – I. Georgantopoulos, A. Bonanos  
Spetsieri Zoi – Tzogia (PhD student) – A. Bonanos  
Tompolidi Athanasia-Maria (PhD Student) – O. Sykioti, K. Koutroumbas  
Vasalos Georgios (MSc Student) - G. Balasis

## **4 RESEARCH ACTIVITIES**

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### **4.1 DETAIL DESCRIPTION OF SCIENTIFIC ACTIVITY**

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#### **4.1.1 ASTROPHYSICS**

##### **Ground Based Astrophysics**

##### **Massive Stars**

Research on massive stars is an active research area of IAASARS. Specifically, we are seeking to answer the following questions: What is the highest possible mass of a star? What is the role of episodic mass loss in the evolution of massive stars? Due to complex instabilities during the formation and evolution of massive stars, the theoretical prediction of the maximum mass limit and the exact evolutionary path followed by a massive star remain uncertain. IAASARS astronomers use a special mass measurement technique, using eclipsing binary systems, as well as variability of massive stars and the infrared properties of evolved massive stars to tackle these questions and provide insight on their mass loss and evolution. This research is funded by the ERC COG ASSESS project.

##### **NELIOTA: NEO impact lunar monitoring project**

The research program NELIOTA (Near-Earth object Lunar Impacts and Optical TrAnsients) is an activity launched by the [European Space Agency \(ESA\)](#) at the [National Observatory of Athens](#) in February 2015. It aims to determine the distribution and frequency of small near-earth objects (NEOs) by monitoring lunar impact flashes, which are visible for a fraction of a second. The NELIOTA project has established an operational system that started monitoring the Moon for faint NEO impacts in early 2017, using the refurbished 1.2m [Kryoneri telescope](#), located in the Northern Peloponnese, in Greece. So far, it has detected 57 impact flashes (April 2019). The NELIOTA campaign has been extended and will run until January 2021. The impact events are reported and made available to the scientific community and the general public within 24 hours of observation via the [NELIOTA website](#).



### **Hubble Catalog of Variables**

The Hubble Catalog of Variables (HCV) is a research program funded by the European Space Agency (ESA) from 2015 to 2019. Its aim is to identify variable sources among 108 million sources in the Hubble Source Catalog (HSC), to validate candidate variables and make them available through a catalog. The algorithms developed by the HCV team include the removal of unreliable photometry measurements, the calculation of statistics characterizing the variability of a source as well as a validation procedure to confirm variable sources. The software developed has been installed at the Space Telescope Science Institute's computing center, and a catalog of variable sources has been created. The HCV is scheduled to be released in June 2019 and is expected to contain very faint, variable stars that have been observed to vary over the last 25 years.

### **INTERSTELLAR MEDIUM (ISM): SUPERNOVA REMNANTS (SNRs), NOVA, PLANETARY NEBULAE (PNe).**

Supernova explosions belong to the most spectacular events in space. Observations of galaxies reveal several events every year, where the supernova is of comparable brightness to the entire galaxy for days up to weeks. SNRs, which are the subsequence of such events, belong to the strongest radio sources observed. SNRs have a major influence on the properties of the interstellar medium (ISM) and on the evolution of galaxies as a whole. They enrich the ISM by heavy elements, release about  $10^{51}$  ergs and heat the ISM, compress the magnetic field and accelerate in their shock waves efficiently energetic cosmic rays as observed throughout the Galaxy. The three-dimensional structure of complex systems like SNRs, Nova and PNe is a very interesting problem by itself. Studying their shape provides us with significant information on their formation and evolution as well as their interaction with the ISM. Our aim is to investigate the kinematics and dynamics of the interaction zone between these phenomena and their surrounding medium and try to map the kinematics of this zone as well as of the whole area for each individual object of study. The observational results together with theoretical and/or morphological models provide a very nice interpretation and help to come closer to the real picture of such complex objects.

A number of PNe, Nova shells and SNRs have already been studied and published by our team, while there are more under study.

## **EXOPLANETS.**

The detection of terrestrial mass planets is a major theme in astrophysics. Measuring transit timing variations is one of the few ways to detect warm, low-mass planets, by measuring perturbations in the transit times induced by another planet. The RISE2 instrument on the 2.3m Aristarchos telescope was built for such transit timing experiments. Its precision allows the detection of Earth-size planets in resonant orbits or more massive planets in non-resonant orbits. We have started to observe candidate planets since 2014 (in collaboration with other telescopes abroad, i.e. LT/RISE) and the first results of our contribution have started to be published in refereed articles in 2016. In this project, we study the planetary nature of the exoplanets systems by performing photometric observations, while other telescopes perform spectroscopic observation, so we are able to define the type of the star, effective temperature, mass, radii, orbital period etc.

### **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 the 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.). We aim to attract collaborations and funding in order to operate the 1.2m Kryoneri telescope full-time.

Furthermore, the ESA NELIOTA project gave group members the opportunity to study NEOs, while the ESA HCV project required expertise in stellar variability and familiarity with archival data from the Hubble Space Telescope.

Recently, the Team at IAASARS has 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 as a whole in Greece. The instrument is ready, first light tests have started in 2016 and 2017. Once a new dome is ready for this instrument at the Kryoneri site, a large-area emission-line

(H $\alpha$ ) 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 (Hermes Observatory) and it is also constructed and tested as a whole in Greece. It's 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 (H $\alpha$ , [O III], [S II], [N II]). The instrument was manufactured (only an optical mirror and a mechanical part for the collimator lenses are expected to be complete within 2017) and it will be then fully tested in the optical lab. First light is expected in 2019.

#### **4.1.2 SPACE ASTROPHYSICS**

**INFRARED ASTROPHYSICS.** The infrared group consists of two senior researchers, two postdocs and two PhD students. The research is focused on the study of star-forming galaxies. The group exploits data mainly from Herschel (ESA), Spitzer (NASA), WISE (NASA) space observatories and has a record of 87 refereed journal publications with 2600 citations within the last five years. Members of the group are involved in two main projects. DustPedia is a project funded by the European Union under the FP7 framework and deals with exploitation of infrared data focusing on the analysis of the Spectral Energy Distributions (SED) of 4000 nearby galaxies, all of which are detected by Herschel. The aim of this project is to study the properties of cosmic dust, and provide constraints on the chemical evolution of the interstellar medium in galaxies. For the interpretation of the data the group has developed state-of-the-art SED fitting codes including Monte Carlo radiative transfer modeling. More information can be found at <http://dustpedia.com>. The second project, GOALS (Great Observatories Allsky LIRG Survey), deals with the analysis and interpretation of the SEDs of large sample of Ultra Luminous Infrared Galaxies (ULIRGs) making use of data from, mainly, the Spitzer, Herschel and Hubble telescopes. More information on GOALS can be found at <http://goals.ipac.caltech.edu>.

The total funding sums to 0.47M€, gained through competitive National and European calls of proposals. High-profile projects include the 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>).

The group also participates in large international collaborative programs (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 consists of one permanent member of staff (M. Xilouris) and two Ph.D. students (A. Nersesian, V. Paspaliaris)

**X-RAY ASTROPHYSICS.** The main research topic is the study of supermassive black holes in the centers of active galaxies (Active Galactic Nuclei). This research is based on observations performed with the X-ray missions XMM-Newton, Chandra, NuSTAR and SWIFT (NASA, UK). The X-ray group is active in research having over 50 publications in international refereed journals in the past five years (2013-2017). This work is influential as it has accumulated over 2000 citation in the same time period.

Apart from the research work the group carries out support work for the international high energy astrophysics community. An important project is the European project AHEAD (H-2020) (Activities for High Energy Astrophysics). This program aspires to unify the activities of all High energy Astrophysics Laboratories in Europe. The AHEAD activities involve the training of scientists on the analysis of high energy astrophysics data access to space laboratories, the organization for schools and conferences. Our team is responsible for the coordination of the public outreach activities of AHEAD. We also train students and postdoctoral scientists in the analysis of X-ray data especially in the field of X-ray surveys.

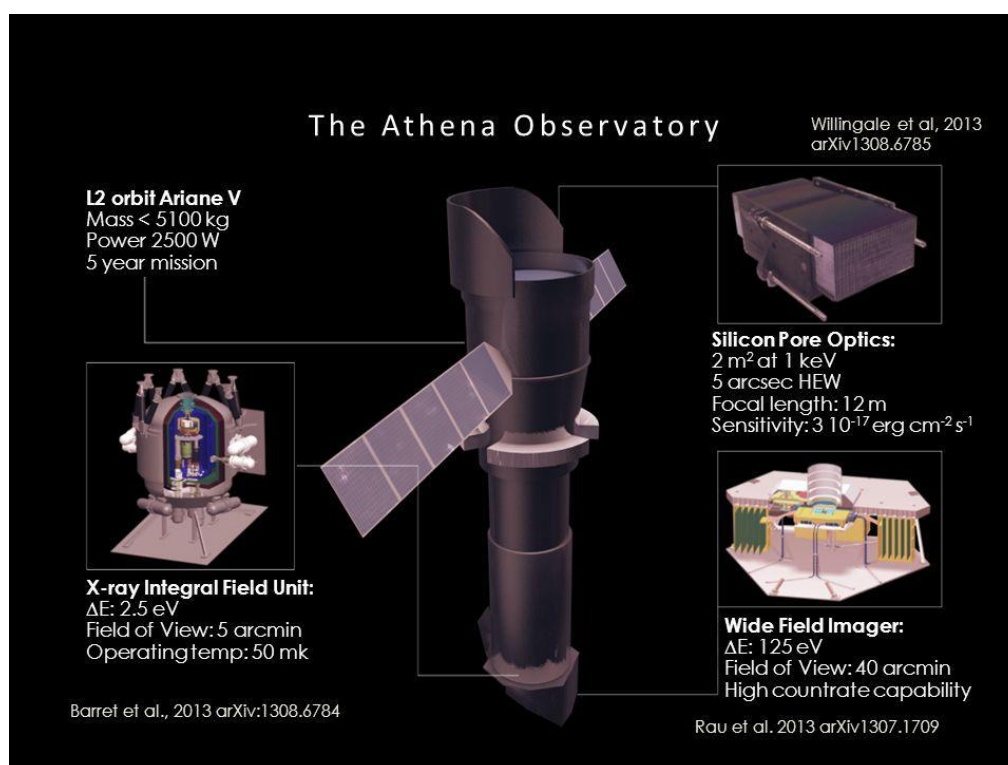
Another program we are carrying out has to do with the ESA's XMM mission and in particular with the 3XMM catalogue. Under the support of an ESA's PRODEX program we estimate photometric redshifts for all the sources in the 3XMM catalogue the largest sample of X-ray sources ever produced. This catalogue comes from the analysis of all serendipitous sources found in XMM observation. Currently the catalogue contains 700,000 sources covering 1000 sq. degrees. Photometric redshifts for these sources have been estimated using optical and near-IR observations from the PANSTARRS, SDSS, WISE and VISTA surveys.

Our team is a member of the consortium that is responsible for the construction of the Wide Field Imager (WFI) instrument on board the ATHENA mission. The ATHENA mission will carry the largest X-ray telescope ever constructed. It is an L-class mission with a cost of 1M€ and is expected to be launched in 2028.

The X-ray Astrophysics group has been funded by 0.81M€ through competitive National and European projects in the past five years. For 2018 high-profile projects include the participation in the H2020 Research Infrastructures program AHEAD (Integrated Activities in the High Energy Astrophysics Domain) and leading ESA-PRODEX programs 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 X-ray Astronomy group consists of three permanent researchers (A. Akylas, A. Georgakakis, I. Georgantopoulos) two postdoctoral researchers (G. Mountrichas, A. Ruiz) and three research students (V. Masoura, E. Pouliasis, G. Dimopoulos).



### GAIA MISSION SUPPORT.

The Space Astrophysics team is engaged in the software development and the data analysis of the ESA / GAIA mission. The Gaia mission was launched at the end of 2013 with the main goal to study in detail our Galaxy through repeated sweeps of the whole sky. It is expected to reveal the stellar content and potential. Gaia will make available to the scientific community information for about a billion stars of our Milky Way, as well as for all objects we will see as  $V = 20$ , including extragalactic sources. It will provide astrometric, photometric and spectroscopic data and furthermore will perform classification and parameterization of the observed objects. A large proportion of unresolved galaxies, about one million sources, will be included in the final sample.

Since 2006, IAASARS is a member of the DPAC, the Consortium accepted by ESA for the processing and analysis of the mission's scientific data and is actively involved in two of the nine Coordination Units of DPAC, with the supervision of two top-level work packages (GWP-806, GWP-832). Our Institute is entrusted with the development and implementation in the DPAC's pipeline of software for the classification and parameterization of unresolved



galaxies, Unresolved Galaxy Classifier (UGC), where we implement artificial intelligence algorithms. We have already processed the data available to DPAC and we have matched to the known galaxies, the sources that have been detected so far and we estimate that the total number of galaxies Gaia will repeatedly see is above one million. With the UGC system we will offer significant and uniform astrophysical data for these objects as galaxy type, redshift, star-formation parameters, which will be included in the final release of the Gaia Archive.

The GAIA team consists of two permanent research staff (A. Dapergolas, I. Bellas-Velidis) and one postdoctoral scientist.

#### **4.1.3 SPACE SCIENCE**

##### ***Solar and Heliospheric Physics***

The Solar and Heliospheric Physics Group carries out studies of the Sun and the interplanetary medium. Studies of the Sun comprise 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 modeling and theoretical tools (such as radiative transfer). The observational data provided, through a multi-wavelength analysis, cover the solar atmosphere from the lower layers to the outer corona and permit the extraction of quantitative information about the physical parameters that describe the thermodynamic state of the solar plasma. The group 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-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. The Group also participates 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 are 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 (SRGT) 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 (ESA).

The team has developed and operates the Solar Energetic Proton Flux (SEPF) tool ([http://proteus.space.noa.gr/sepf\\_tool/](http://proteus.space.noa.gr/sepf_tool/)), which provides Solar Energetic Particle (SEP) intensity variations recorded from the ESA Standard Radiation Environment Monitor (SREM) units on-board INTEGRAL, Herschel, Planck, and Rosetta spacecraft. 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, Thalís/Hellenic National Space Weather Research Network, participation in data analysis ESA/Cluster, ESA/MarsExpress, NASA/THEMIS).
- Modeling 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.
- Development of Solar Energetic Particle (SEP) event forecasting concepts focusing on the identification of the probability of SEP occurrence, the expected SEP characteristics (fluence, peak flux) and the SEP time profile evolution at respective energies (ESA/FORSPEF, ESA/ASPECS, IKY).

- The identification and quantification of large scale structures propagating in the interplanetary space (ICMEs) through their resulting modulation on galactic cosmic rays (Forbush decreases) (NOA/TRACER).
- The analysis and interpretation of high energy SEP events, utilizing combined observational evidence and advanced simulations, in order to shed light in the particle's acceleration mechanisms (ISSI/HEROIC).
- The characterization of the radiation environment at Mars (MSL/RAD data).

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 four permanent staff members (Anastasiadis, Balasis, Giannakis, Papaioannou), four adjunct researchers (Daglis, Tsinganos, Vourlidas, Sergis), two postdoctoral researchers (Dimitrakoudis, Sandberg), five PhD students (Boutsi, Georgiou, Giamini, Katsavrias, Mitrokotsa), 2 MSc students (Papadimitriou, Vasalos) and one technical permanent staff member (Salustros).

### ***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 modeling 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 in 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).

### **Machine Learning for Signal/Image Processing (MLSIP)**

The main activities of MLSIP group cover the following research topics: analysis and validation of advanced machine learning algorithms for signal processing, pattern recognition, image processing, aiming at the extraction of information from (big) data originating from various sources (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) out-lier detection and removal from data via robust principal component analysis, e) image data restoration from partial information utilizing matrix completion, f) signal and image denoising by exploiting structural properties of the data such as sparsity and low-rank. Over the last five years, 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.

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 soon 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.

The activities of the MLSIP Group are supported by two permanent researchers (A. Rontogiannis, K. Koutroumbas), and three post-doctoral scientists (P. Giabouras, K. Themelis, I. Xenaki).

#### **4.1.4 REMOTE SENSING**

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. The Center continues its successful operation until today.

Beyond BEYOND, the RS group had two additional major highlights. 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 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.

The Earth-Observation team hosts the largest number of scientists in NOA. It consists of over 30 scientists of which four are permanent researchers, three permanent support scientists, and more than 23 researchers (either at Ph.D. or postdoctoral scientist level)

### ***Sentinels Greek Hub***

For the period 2012-2017 ESA has assigned to the IAASARS, in collaboration with the National Network of Research & Technology (NNRT), the operation of the International Data Hub (IntHub) or Sentinels Greek Hub, which transfers the Sentinels mission data to users around the world.



The Sentinels Greek Hub collects, archives and distributes, in real time, the data to a large number of users including NASA, USGS, NOAA, JAXA. The signed agreement supports the operation of the Hub by NOA under the support of NNRT which include data networks, computer facilities.

### **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**

GEO-CADLE is a Coordination and Support Action established for providing support to the Intergovernmental Organization [GEO \(Group on Earth Observations\)](#) and the Program for



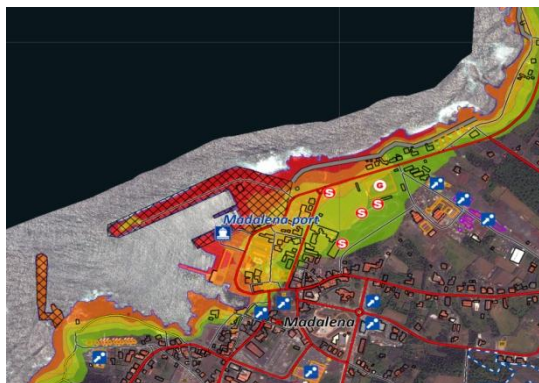
Global Monitoring for the Environment and Security [Copernicus](#). GEO-CRADLE is also a synergetic action that establishes a network of stakeholders across the entire value added chain in Earth Observation (research, service providers, data providers, decision makers) and builds on platforms for the integration and dissemination of EO data and know-how across the regions of **N. Africa, Middle East, and the Balkans (NAMEBA - also called as RoI-Region of Interest)**. For the time being **GEO-CRADLE coordinates Earth Observation activities in 21 countries over NAMEBA**. It supports practices of research organizations, public authorities, and private sector entities for accessing to and exploiting the satellite data of Copernicus and Copernicus contributing missions, as well as accessing to open and high quality in-situ platforms, data portals and arithmetic modeling capacities linking with the more advanced European research and industry facilities. The program establishes links with International Organizations and International Funding Mechanisms and creates roadmaps for actions towards using the Earth Observation technology and data in support to the four thematic priority areas of the project that are Adaptation to Climate Change, Improved Food Security and Water Extreme Management, Exploitation of Renewable Energy Resources, and Access to Raw Material in the regions of RoI. GEO-CRADLE as such has been recognized as [Community Activity](#) of GEO, and its outcomes so far have been used as fundamental components in the definition and development of following European Union flagship initiatives and big projects in the domain such as [EuroGEOSS](#) and [NextGEOSS](#).

In the course of its lifetime the project has succeeded to:

- Promote the uptake of EO services and data in response to regional needs.
- Support the effective integration of existing Earth Observation Capacities in the RoI.
- Facilitate the networking and engagement of the EO stakeholders in the RoI.
- Build trust and capacity among the actors, and enhance their participation in and contribution to the implementation of GEOSS and Copernicus in the RoI.
- Propose a roadmap (<http://geocradle.eu/en/regional-capacities/roadmap/>) for the implementation of GEO, GEOSS and Copernicus in the RoI.

### ***Copernicus Emergency Management Service***

NOA provides services through the EU Joint Research Center within the framework of Copernicus EMS project. The services provide an estimate for the level of risk in physical disasters and can be used to enhance public safety. The service has a worldwide coverage. The delivery of the products is completed within 20 days after the activation. So far, over 7000 7,000 maps have been delivered after the following activations:



- Multiple natural hazard risk assessment - Planning and Recovery, Azores Islands
- Multiple natural hazard risk assessment - Planning and Recovery, Madeira and Porto Santo islands, Portugal
- Earthquake risk assessment Austria – Planning and Recovery
- Post-disaster analysis, damage assessment, recovery and rehabilitation planning and monitoring, flood risk assessment, disaster preparedness in Bulgaria
- Forest fire damage assessment – Planning and Recovery in Greece
- Post-disaster assessment of toxic cloud dispersion after an industrial accident in Catalonia
- Ground deformation mapping and monitoring by satellite based multi-temporal DInSAR technique, in Solotvyno, Zakarpattya region, Ukraine
- Forest fire damage assessment and landslide risk, Madeira Island, Portugal

A variety of natural disasters are covered by this service including fires, floods, tsunamis, landslides, soil corrosion, sandstorms, industrial accidents.

### **PANGAEA Climate change observatory**

The "PANhellenic GEophysical observatory of Antikythera (PANGAEA)" 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 PANGAEA 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, PANGAEA 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 PANGAEA 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 PANGAEA, (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.

### **Remote Sensing of Aerosols, Clouds and Trace gases**

The Remote Sensing of Aerosols, Clouds and Trace gases (ReACT) group includes highly specialized scientists in the field of atmospheric sciences leaded by Dr. Vassilis Amiridis. The ReACT team operates within IAASARS, also contributing to the BEYOND Center for Excellence and the PANGAEA station. ReACT group has more than 15 members (Post-Docs, PhD Students, MSc administration and technical stuff) funded on competing scientific



programs. The natural laboratory of PANGEA facilitates the scientific needs of ReACT and the ERC Consolidator Grant D-TECT (PI: V. Amiridis). Until now the IAASARS / ReACT group has installed and operates the following equipment at PANGEA:

*Polly-XT lidar:* Multi-wavelength lidar for the 24/7 monitoring of the atmospheric state. The system enables the determination of the particle backscatter coefficient at 355, 532, and 1064 nm and of the extinction coefficient at 355 and 532 nm, allowing aerosol classification and microphysical characterization to derive the particle size distribution and concentration. In addition, the system operates two polarization-sensitive channels at 355 and 532 nm, to determine the aerosol particle shape from the (particle) linear depolarization ratio, to separate dust and non-dust particles in mixed aerosol layers, and to investigate mixed-phase clouds.

*UV Multi-Filter Rotating Shadowband Radiometer (UV-MFR 7):* Ultraviolet (UV) Multi-Filter Rotating Shadowband Radiometer (Model UVMFR-7), an instrument that measures global, diffuse, and direct UV solar irradiance at the same time. The recording channels are centered around seven wavelengths (300, 305, 311, 317, 325, 332 and 368 nm) with Nominal Full Width Half Maximum at 2 nm. Measurements are performed every 10 seconds and averaged values are stored every 1 minute. It is designed to operate automatically and autonomously in remote locations with only periodic manual cleaning of the fore optic.

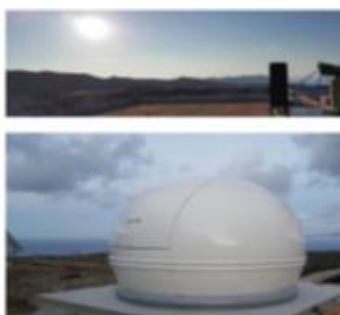
*CIMEL sunphotometer:* CIMEL is a high-precision multiband, automatic sun-and-sky scanning radiometer that provides measurements of the optical properties of the atmosphere by measuring the sun and sky radiance. Due to its very low power consumption and its self-powered system, it meets the requirements of continuous monitoring in terms of reliability, long term and very low maintenance cost.

*Direct-sun Solar Polarimeter (SolPol):* a prototype solar polarimeter, kindly conferred by the University of Hertfordshire, is designed to operate with direct sun tracking capabilities and measures the degree of linearly and/or circularly polarized sunlight due to forward scattering from atmospheric aerosols. Measurements are centered on 550nm, due to light detector current limitations, while the instrument's precision and accuracy are of order of the 1ppm and 1%, respectively. SolPol is a robust instrument capable of manual operation per demand, especially under heavy Saharan dust loads and with low maintenance requirements. It is hosted within a medium sized astronomical dome for the optimum protection-to-applicability relation.

*Field Mill Electrometer (JCI 131 FM):* a compact and robust instrument for continuous long term measurements of the ambient electric field, adverse environmental conditions. It is particularly suitable for continuous monitoring of atmospheric electric field conditions, associated with varying weather conditions and electric content, such as during thunderstorms or extreme volcanic activity. The output signal is proportionate to the electric field strength and currently operates at a range of 2kV/m with a precision better than 1%.

The instrument is mounted on a 3m mast in order to avoid ground distortions. The FM is ideal for remote site installation due to its low power consumption and straightforward data collection system.

GRAW Radiosonde launch station (DFM-90, GS-E): specialized launching site for the deployment of meteorological GRAW radiosondes with attaching capabilities of newly developed atmospheric electricity sensors. The used radiosondes are of the DFM-09 type, are extremely light, small and robust, and provide reliable measurements of core atmospheric parameters with a columnar distribution. Effective telemetry and optimum reception guaranteed by the GS-E ground station, make it the ideal set-up for on demand launches.



*Current status at Antikythera: the Polly XT multi-wavelength aerosol backscatter/Raman/depolarization and water vapor lidar (upper-left); the NASA-AERONET sun-photometer CIMEL and the Solar Polarimeter SolPol (upper-right); a view of the current installations of NOAA at Antikythera (lower panel).*



## Remote Sensing participation in Infrastructure Networks

PANACEA (<http://panacea-ri.gr/panaceari-wip/index.php/observational-facilities> )

The PANhellenic infrastructure for Atmospheric Composition and climate change (PANACEA) is envisioned to become the high-class, integrated Research Infrastructure (RI) for atmospheric composition and climate change not only for Greece, but also for southern Europe and eastern Mediterranean, an area that is acknowledged as a hotspot for climate change. The RI is designed to be: in full compliance with EU Regulation 651/26.6.2014 and act as the Greek component of ACTRIS/ESFRI (Aerosols, Clouds and Trace gases Research Infrastructure) and ICOS/ESFRI (Integrated CO<sub>2</sub> Observation System). PANACEA addresses the need for monitoring of atmospheric composition, solar radiation variations, climate change and related natural hazards in Greece, and for providing tailored services to crucial national economy sectors that are affected by air pollution and climate change, such as public health, agriculture/food security, tourism, shipping and energy/renewables. The overarching goal of PANACEA is the integration of all existing national

facilities to create a single harmonized high-class innovative distributed RI to serve and provide access to all academic/research institutions and the private sector (industry/SMEs) in the wide scientific range covered by PANACEA. IAASARS participates in PANACEA since 2017 with the PANGAEA Climate Change Observatory of Antikythera.

**EARLINET** ([https://www.earlinet.org/index.php?id=earlinet\\_homepage](https://www.earlinet.org/index.php?id=earlinet_homepage) )

The European Aerosol Research Lidar Network, 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 specific 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** (<http://polly.rsd.tropos.de/> )

Lidars are a key instrument for the characterization of aerosols and their impact on the Earth's environment as they are able to provide vertically resolved information of aerosols. With multiwavelength-Raman-polarization lidars, aerosol layers can be characterized in terms of types, size distribution, and concentration. The sophisticated multiwavelength-Raman-polarization lidar (PollyXT) has been designed for scientific purposes, but with the advantages of an easy-to-use and well-characterized instrument with same design, same automated operation, and same centralized data processing in line with the CIMEL Sun photometer of AERONET. These Polly systems have been developed for continuous, stand-alone operation in remote environments and were successfully deployed in the high northern latitudes of Finland, in the rain forest of the Amazonian Basin, and under permanent mechanical stress from motor vibrations plus rough sea aboard the research vessel Polarstern. As the number of Polly systems and measurement sites has increased with time, an independent, voluntary, international network of cooperating institutes, the so-called PollyNET 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 PANGAEA at Antikythera.

**SDS-WAS** (<https://sds-was.aemet.es/> )

The mission of the World Meteorological Organization Sand and Dust Storm Warning Advisory and Assessment system (WMO / SDS-WAS) is 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. The SDS-WAS, as an international framework linking institutions involved in SDS research, operations and delivery of services, addresses the following objectives: Provide user communities access to forecasts, observations and information of the SDS through regional centers connected to the WMO Information System (WIS) and the World Wide Web, identify and improve SDS products through consultation with the operational and user communities, enhance operational SDS forecasts through technology transfer from research, Improve forecasting and observation technology through coordinated international research and assessment, build capacity of relevant countries to utilize SDS observations, forecasts and analysis products for meeting societal needs and build bridges between SDS-WAS and other communities conducting aerosol related studies (air quality, biomass burning, etc.). IAASARS is represented at the Regional Steering Group of SDS-WAS by researcher Vassilis Amiridis.

#### AERONET (<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](#) (PHOtométrie pour le Traitement Opérationnel de Normalisation Satellitaire; [Univ. of Lille 1](#), [CNES](#), and [CNRS-INSU](#)) 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](#). IAASARS researcher Vassilis Amiridis is the PI of the AERONET stations in Athens and Antikythera.

#### ACROSS

The primary goal of ACROSS is to conduct in-depth research on the EarthCARE satellite products for Greece, an area known for its complex atmospheric environment. Experiments will be designed to achieve the following key objectives: (1) validation of EarthCARE automatic aerosol and cloud algorithms using ground sensors and space observations of passive and active satellite instruments; (2) use the validated aerosol and cloud products radiative transfer simulations; (3) Extend the IAASARS ESA-LIVAS application to include CALIPSO-based radiation estimates (PI: V. Amiridis)

#### VADAM

The general objective of VADAM is to validate the cloud and aerosol products of the ESA-Aeolus L2A mission. Validation activities are carried out using measurements from five EARLINET stations: PANGAEA in Antikythera, TROPOS in Leipzig, Germany, FMI in Kuopio, Finland, UW in Warsaw and CUT in Limassol, Cyprus. All selected stations are members of the European Infrastructure Network ACTRIS ([www.actris.eu](http://www.actris.eu)) and use the advanced

Raman / polarization PollyXT system in combination with the AERONET-CIMEL sun-photometric measurements. Two additional lidar systems (Lidis portable POLIS in LMU, and EMORAL Raman / polarization lidar of ESA in IAASARS) are deployed along the Aeolus orbit path. Also the lidar system EVE that is developed in VADAM, will be a circular polarization system adapted to mimic the Aeolus static measurement from the ground. Finally, VADAM is an important component of the ASKOS experimental campaign to be held in June-July 2020 in Cape Verde. (PI: V. Amiridis)

## **4.2 BRIEF EXAMPLES OF SCIENTIFIC ACTIVITY**

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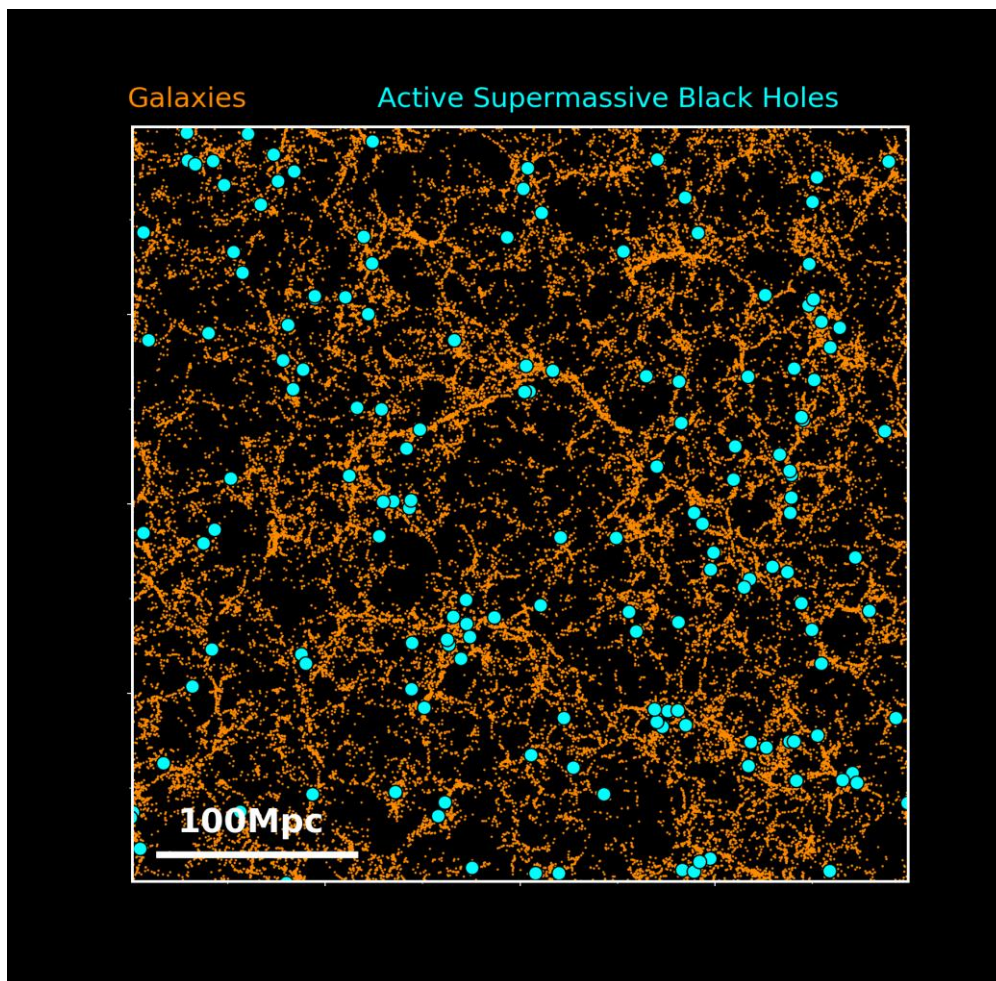
### **Connecting supermassive black-holes with the cosmic web**

The most recent observational campaigns have placed the total number of galaxies in the Universe in the trillions. The majority, if not all of them, are thought to host at their centers large black holes, millions or even a billion times heavier than our Sun. These beasts build up their mass over time by devouring material from their surroundings. During this process they emit huge amounts of energy that impacts the physical conditions of the surrounding interstellar and intergalactic medium, with far-reaching implications for the formation and evolution of stars, galaxies and large-scale structures in the Universe. Despite the ubiquity of black holes among galaxies, observations show that at any given time only a tiny fraction, fewer than 1 in 1000, are active, i.e. accreting material and growing their masses at a significant rate. The vast majority appear dormant. This observational fact had led astronomers to debate the physical conditions and environments that may be responsible for the activation of supermassive black holes. Are there specific triggering mechanisms required to initiate an accretion event at the centers of galaxies (e.g. interactions between galaxies)? Or is black-hole growth a stochastic phenomenon that occurs naturally as part of the normal life-cycle of the stars and gas in galaxies and does not require specific triggers or favourable conditions?

To answer these questions astronomers are trying to isolate those factors that can potentially modulate the level of activity in the centers of galaxies. One of them is the environment around the host galaxy, measured by the local density of galaxies in their neighborhood. It is well established that matter in the Universe is organized in filaments, groups and clusters separated by large voids (see Figure 1.). The conditions in these diverse environments of the cosmic web vary widely in terms of density of matter, frequency of galaxy encounters, and temperature of the intergalactic medium. We know that these different conditions imprint observable signatures on galaxies and affect the way they evolve with time. It is therefore natural to wonder if the position of a galaxy on the cosmic web also determines the activity of its central “supermassive” black hole.



In a recent [publication](#) researchers of the IAASARS used cosmological N-body (see Figure 1.) simulations to investigate the connection between environment and black-hole activation. They showed that the incidence of AGN in galaxies does not depend on the density of matter on large-scales ( $>1\text{Mpc}$ ). This finding disfavors scenario that postulate causality between accretion events onto supermassive black-holes and galaxy-density averaged on Mpc-scales. The highlight from this study, however, was evidence that the distribution of AGN on scales smaller than  $1\text{Mpc}$  deviates from the stochasticity (no-causality) assumption. The density of matter on these scales may modulate the incidence of accretion events among galaxies. This finding can reveal physical processes that regulate the activity of supermassive black holes as a function of the environment.

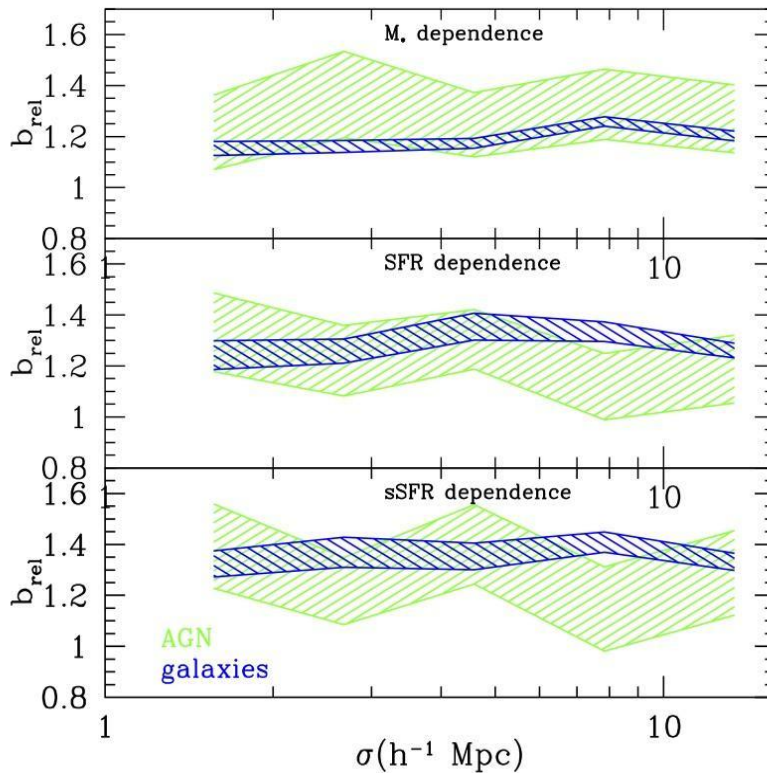


**Fig. 1:** N-body simulation of the cosmic web as traced by galaxies and active galactic nuclei. The red dots show the positions of simulated galaxies. These are organized in groups, and clusters (high density of dots), which in turn are connected by filaments and separated by low-density voids. The cyan circles mark active supermassive black holes within the galaxy population. Astronomers of the IAASARS have been combining such N-body simulations with observational data to map the distribution of accretion events (i.e. the red stars) on the cosmic web and explore the connection between activation of the supermassive black-hole and the density of the local environment.

### Co-evolution of supermassive black holes and their host galaxies.

In the last decade there has been growing evidence supporting the coeval growth of galaxies and their resident Supermassive Black Hole (SMBH). However, it is still not clear what are the physical mechanisms that drive the black hole (BH) growth, how the large-scale environment (the mass of their Dark Matter Halo, DMHM) affects these feeding mechanisms and what is the connection between the environment of the SMBH and the host galaxy properties, e.g. Star- Formation Rate (SFR) and stellar mass ( $M_*$ ).

Astronomers of the X-ray group of the IAASARS, used galaxies observed in X-rays that have an active SMBH at their center (AGN), from one of the largest contiguous X-ray fields (XMM-XXL). They studied the dependence of their large-scale environment on the host galaxy properties and compared it with galaxies that host inactive SMBHs ([Mountrichas, Georgakakis, Georgantopoulos 2019](#)). Their analysis revealed that both active and normal galaxies have a similar dependence on the properties of the host galaxy. Even more importantly, active and normal galaxies seem to live in similar environments. These results suggest, that the activity of the SMBH does not affect its large-scale environment (DMHM) nor its dependence on the host galaxy properties.



**Fig. 2:** Relative bias,  $b_{rel}$ , as a function of distance. The  $b_{rel}$  parameter is used as a proxy to study the dependence of the galaxy large-scale environment on the galaxy properties.  $b_{rel} = 1$  indicates that there is no dependence, where  $b_{rel} > 1$  suggests a positive dependence. The blue and green shaded regions present the measurements for the galaxies and the X-ray AGN, respectively. In both cases, we observe a dependence of the galaxy environment on stellar mass ( $M_*$ ), star-formation rate (SFR) and specific SFR. The latter is defined as the ratio of SFR per unit stellar mass.

## **The HESPERIA HORIZON 2020 Project and Book on Solar Particle Radiation Storms Forecasting and Analysis**

Solar energetic particles (SEPs), ranging in energy from tens of keV to a few GeV, constitute an important contributor to the characterization of the space environment. They are emitted from the Sun in association with solar flares and coronal mass ejection-driven shock waves. SEP radiation storms may have durations from a period of hours to days or even weeks and have a large range of energy spectrum profiles. These events pose a threat to modern technology strongly relying on spacecraft, are a serious radiation hazard to humans in space, and are additionally of concern for avionics and commercial aviation in extreme circumstances. The High Energy Solar Particle Events forecasting and Analysis (HESPERIA) project, supported by the HORIZON 2020 programme of the European Union (Project 637324, Project Coordinator: Dr. Olga Malandraki, NOA/IAASARS), has furthered our scientific understanding and prediction capability of high-energy Solar Energetic Particle (SEP) events by developing new European capabilities for SEP forecasting and warning while exploiting novel as well as already existing data sets. The results of the HESPERIA project as well as our current understanding of SEP physics are reviewed in the recently published book entitled *Solar Particle Radiation Storms Forecasting and Analysis, The HESPERIA HORIZON 2020 Project and Beyond*, edited by Malandraki and Crosby, Springer, Astrophysics and Space Sciences Library, 2018, ISBN 978-3-319-60051-2.

In Chapter 1, the book provides a historical overview on how SEPs were discovered back in the 1940s and how our understanding has increased and evolved since then. Current state of the art based on the unique SEP measurements analyzed in the three-dimensional heliosphere and the key SEP questions that remain to be answered in view of the forthcoming missions Solar Orbiter and Parker Solar Probe that will explore the solar corona and inner heliosphere are also presented. This is followed by an introduction to why SEPs are studied in the first place describing the risks that SEP events pose on technology and human health.

Chapters 2 through 6 serve as background material covering solar activity related to SEP events such as solar flares and coronal mass ejections; particle acceleration mechanisms; and transport of particles through the interplanetary medium, Earth's magnetosphere, and atmosphere. Furthermore, ground-based NMs are described. The last four chapters of the book are dedicated to and present the main results of the HESPERIA project. This includes relativistic SEP-related gamma-ray and radio data comparison studies, modeling of SEP events associated with gamma-rays and the inversion methodology for NM observations that infers the release timescales of relativistic SEPs at or near the Sun, and the two real-time HESPERIA SEP forecasting tools that were developed.

The HESPERIA UMASEP-500 tool makes real-time predictions of the occurrence of >500 MeV and ground level enhancement (GLE) events from the analysis of soft X-ray flux and high-energy differential proton flux measured by the GOES satellite network. An important



finding is that the use of proton data alone allowed this tool to make predictions before any NM station's alert. Regarding the prediction of GLE events for the period 2000–2016, this tool had a probability of detection of 53.8% and a false alarm ratio of 30.0%. For this period, the tool obtained an advanced warning time of 8 min taking as reference the alert time from the first NM station; using the time of the warning issued by the GLE Alert Plus tool for the aforementioned period as reference, the HESPERIA UMASEP-500 tool obtained an advanced warning time of 15 min (Núñez et al., 2017). Based on the Relativistic Electron Alert System for Exploration (REleASE) forecasting scheme (Posner, 2007), the HESPERIA REleASE tools generate real-time predictions of the proton flux (30–50 MeV) at the Lagrangian point L1, making use of relativistic electrons ( $v > 0.9c$ ) provided by the Electron Proton Helium Instrument on the SOHO spacecraft and near-relativistic ( $v < 0.8c$ ) electron measurements from the Electron Proton Alpha Monitor aboard the Advanced Composition Explorer. An analysis of historic data from 2009 to 2016 has shown that the HESPERIA REleASE tools have a low false alarm ratio (~30%) and a high probability of detection (63%).

In summary, the goal of the presented HESPERIA tools has been to improve mitigation of adverse effects both in space and in the air from significant solar radiation storms, providing valuable added minutes of forewarning to users of space weather services. Both HESPERIA SEP forecasting tools are operational through the project's website (<http://www.hesperia.astro.noa.gr>) at the National Observatory of Athens.

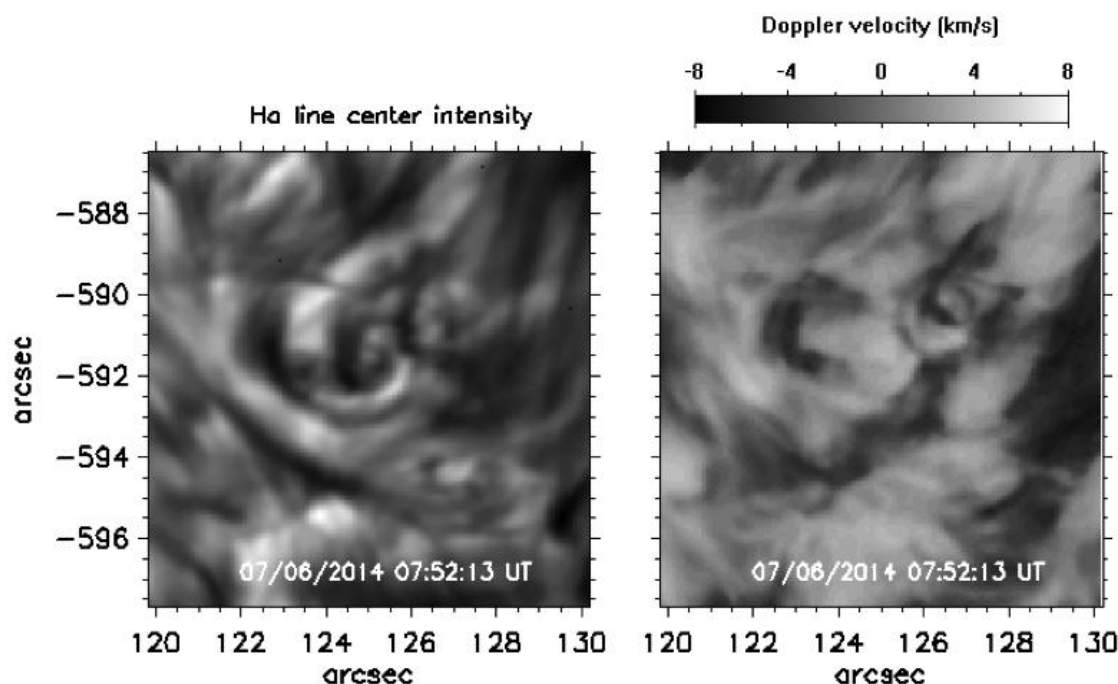
It is noteworthy that this book is published with open access under a CC BY 4.0 license and is freely available to the whole community at <https://www.springer.com/de/book/9783319600505>. The book was rated by Springer as one of the top downloaded books of 2018.

### **Solar small-scale vortex flows**

High spatial and temporal resolution solar observations have revealed the existence of ubiquitous small-scale swirling motions (more than 10,000 at any given time across the Sun) with a mean radius of ~2,000 km that last about 5-10 minutes. Theory and numerical simulations show that they are formed at the boundaries of convective cells of size ~1,000 km called granules that correspond to bubbles of hot material rising from the sub-surface layers of the Sun (resembling bubbles of water in a boiling kettle). When these bubbles reach the solar surface, their material cools down and starts falling back towards their edges called intergranular lanes, often in a swirling motion like water flowing in a bathtub. As intergranular lanes are also the locations of magnetic field concentrations, these downward motions can sometimes cause the rotation of these magnetic field structures and of the plasma material travelling upwards along them forming a structure resembling a dust-devil or an upwards moving mini-tornado. Such swirling structures can act as a channel for

transferring material and energy (often in the form of waves) from the lower solar atmospheric heights higher up.

Recently, such swirling motions have been detected in observations of one of the spectral emissions of hydrogen (H $\alpha$ ) that is the most abundant solar element. For the first time a long duration (at least 1.7 hours) small-scale vortex flow event has been observed with the Swedish Solar Telescope (SST) that has a radius of  $\sim 2,200$  km and, moreover, shows complex substructure as it seems to consist of several individual, intermittent, recurring smaller swirling motions. Despite recent advancements in observations, theory, simulations and modeling, the detection and precise physics of these swirling motions and how they transport energy in the solar atmosphere remain poorly understood. Nowadays, it is a real challenge to detect and follow such structures in even smaller scales simultaneously in several atmospheric layers, measure their magnetic field and investigate in further detail their properties and dynamics.



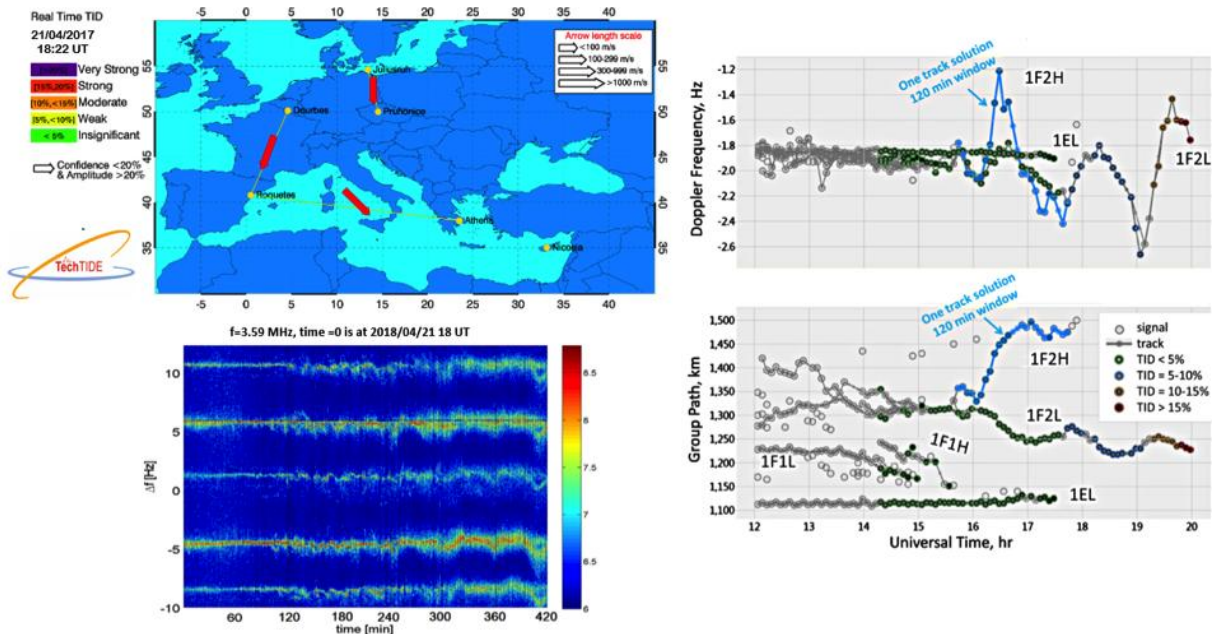
**Fig. 3:** A long duration vortex flow observed on the Sun in one of the spectral emission lines of hydrogen with the Swedish Solar Telescope. The vortex exhibits significant substructure in the form of smaller intermittent swirling motions. For context, 1 arcsec on the solar surface is equal to 725 km so the solar area depicted in this figure is about 60 million square kilometres.

### Real-time identification of Travelling Ionospheric Disturbances

The Earth's upper atmosphere is directly affected by the solar variability, by the near-Earth space dynamics and by lower atmosphere phenomena. This, results in a complex and dynamic environment influenced by solar radiation, energy transfer, winds, waves tides, electric and magnetic fields, and plasma processes.

Travelling Ionospheric Disturbances (TIDs) are an important Space Weather effect in the upper atmosphere driven by this complexity. TIDs are plasma density fluctuations that propagate as waves through the ionosphere at a wide range of velocities and frequencies and play an important role in the exchange of momentum and energy between various regions of the upper atmosphere. TIDs are the ionospheric manifestation of internal atmospheric gravity waves (AGW) in the neutral atmosphere and are associated with auroral and geomagnetic activity and with lower atmosphere phenomena of non-space origin (e.g., severe tropospheric convection or passages of cold fronts, seismicity, volcanic activity, and artificially triggered events such as explosions).

TIDs constitute a threat for operational systems using predictable ionospheric characteristics as they can impose disturbances with amplitudes of up to ~20% of the ambient electron density, and a Doppler frequency shifts of the order of 0.5 Hz on HF signals. The last years it was clearly demonstrated that TIDs can have multiple effects in the operation of aerospace and ground-based infrastructures and especially in the European Geostationary Navigation Overlay Service (EGNOS) and Network Real-Time Kinematic (N-RTK) services, in High Frequency (HF) communications, in radio reconnaissance operations and in Very High Frequency – Ultra High Frequency (VHF-UHF) radiowave propagation. Despite these important effects in the reliable operation of infrastructures that are critical for the safety and security of the citizens, the identification and tracking of TIDs is very complicated and has not been achieved in operational service mode.



**Fig. 4:** The Digisonde-to-Digisonde and CDSS methods observations retrieved on 21 April 2017 magnetospheric substorm, show clear evidence of a strong TID activity over Europe

The TechTIDE-HORIZON 2020 project comes to fill in this gap. TechTIDE is a consortium formed around 13 research organizations and providers of operational services coordinated by the Ionospheric Group of IAASARS. TechTIDE is delivering in real-time data, products and services capable of detecting the occurrence of TIDs over specific regions. Furthermore, in close collaboration with operators of the technologies concerned, TechTIDE consortium will design and test new viable TID impact mitigation strategies and will demonstrate the added value of the proposed mitigation techniques which are based on TechTIDE products. The TID detection methodologies are based on the analysis of Digisonde, GNSS and Doppler Sounding data using complementary modeling techniques for Medium Scale and Large Scale TID identification. In the figure we present travelling Ionospheric disturbances detected with data retrieved from Digisonde to Digisonde bistatic operations, the resulting Doppler shift at the reflection point and the corresponding fluctuations of the Doppler shift of the transmitted frequencies recorded from the Continuous Doppler Sounding System. The first TechTIDE prototype is to be launched in spring 2019 and the final system will be delivered in April 2020. More information is available through the web site of the project <http://tech-tide.eu>.

### **Forecasting Solar Flares and Solar Energetic Particle Events**

Large Solar Energetic Particle (SEP) events may be a significant hazard to humans and equipments outside the protection of the Earth's magnetosphere. Additionally, the strongest events (in terms of energy) can even pass through the magnetosphere, all the way through the atmosphere and create cascades, leading to enhanced ionization rates - especially at flight altitudes. In order to provide mitigation actions for these effects, the scientific community has turned to precursors that hold prognosis potential and can reliably lead to the prediction of the onset and magnitude of SEP events.

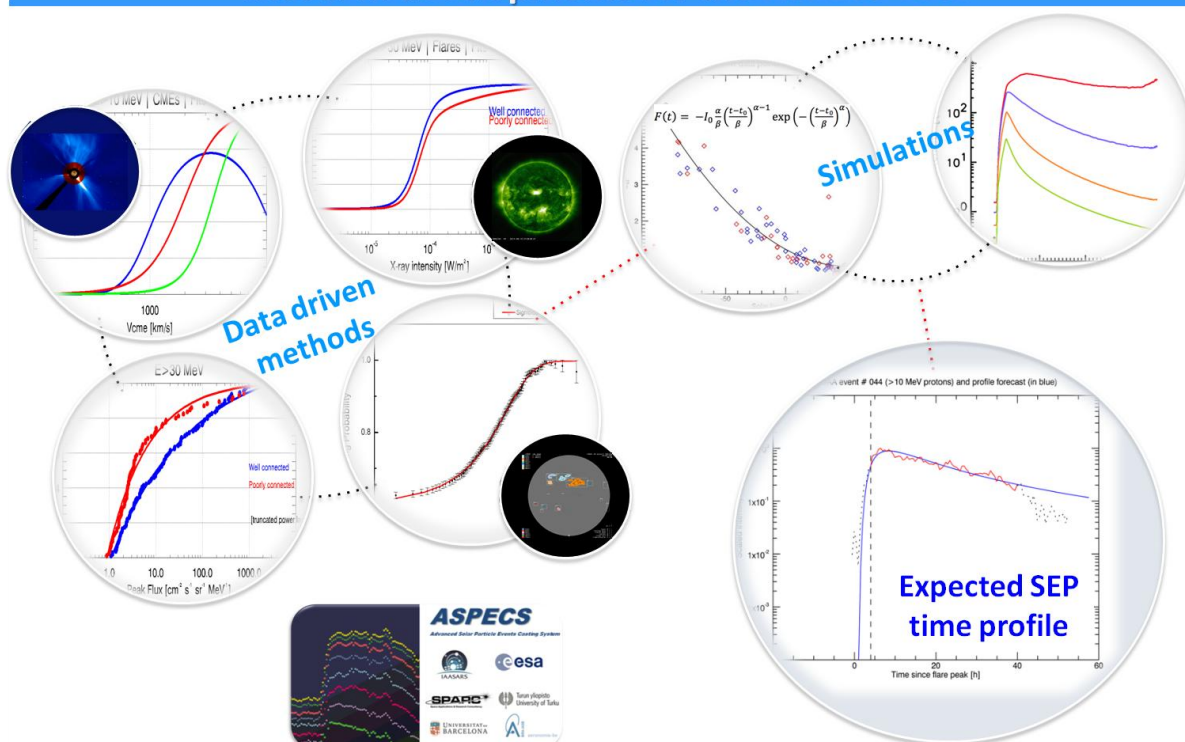
Over the last five years the Space Research and Technology Group of the Institute for Astronomy, Astrophysics, Space Applications & Remote Sensing (IAASARS), of the National Observatory of Athens (NOA), has been involved in the development of novel scientific techniques, spanning from statistical data driven methods to higher order multivariate concepts. SRTG has further implemented and operate web based tools, that provide reliable predictions of Solar Flares and Solar Energetic Particle Events in real-time (**FORSPEF**, <http://tromos.space.noa.gr/forspef/>). These activities were financed by the European Space Agency (ESA) and the State Scholarships Foundation (IKY).

Building on the gained experience, the Space Research and Technology Group of the IAASARS/NOA, is currently leading a large effort by a consortium of 5 experienced partners from 4 countries aiming at providing a scientifically advanced and easy to use integrated solution to the problem of SEP forecasting: the **ASPECS** ([Advanced Solar Particle Event Casting System](#)) tool. ASPECS collates and combines outputs from different modules providing forecasts of solar eruptive phenomena, solar energetic particle event occurrence flux and duration; tailored to the needs of different spacecraft and launch operators, as well



as the aviation sector. The predictions shall start with the solar flare forecasting and will continuously evolve through updates based on near-real time inputs (e.g. solar flare and coronal mass ejections data/characteristics) received by the system. For *the first time ASPECS will provide the complete time profile of the SEP event at respective energies in near real-time, utilizing both simulations and observations.*

### Research developments for the **ASPECS Tool**



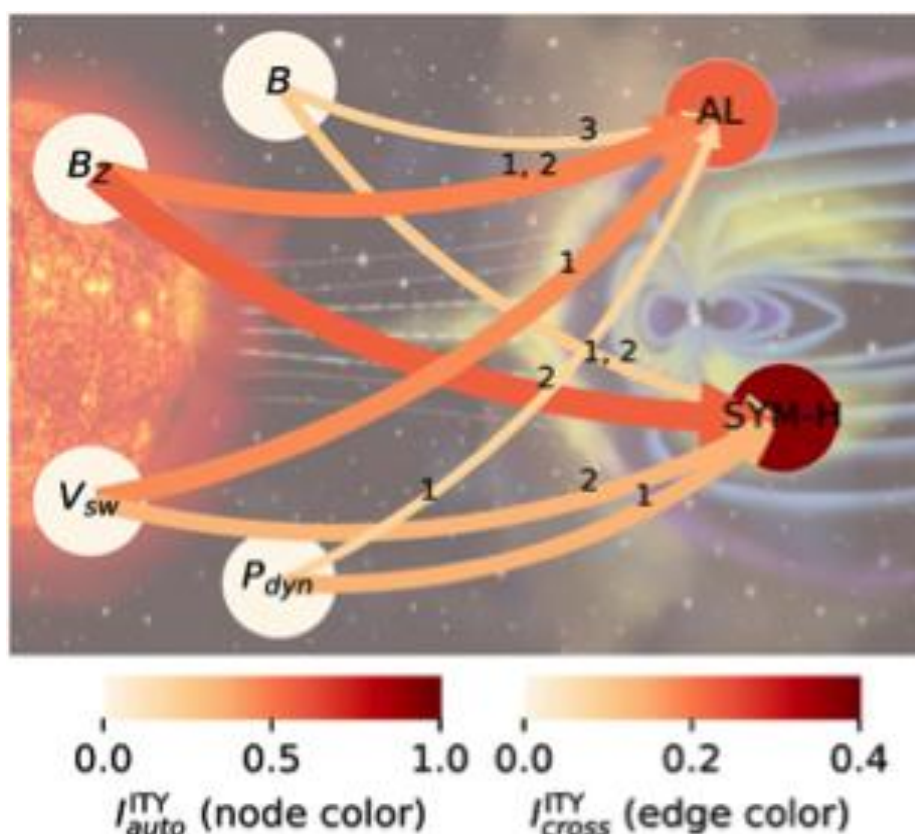
**ASPECS – Advanced Solar Particle Events Casting System**



### Common solar wind drivers behind magnetic storm–magnetospheric substorm dependency,

The time-dependent coupling between the solar wind and the magnetosphere along with the relationship between magnetic storms and magnetospheric substorms is of paramount importance for space weather processes. However, the storm/substorm relationship is one of the most controversial aspects of magnetospheric dynamics [Daglis et al., Journal of Geophysical Research 2003]. In order to further disentangle this relationship and the role of relevant solar wind variables as drivers and mediators, multivariate causality measures employing the concept of graphical models constitute one particularly promising tool [Runge et al., Nature Communications 2015]. Toward this goal, in a recent article we highlighted the

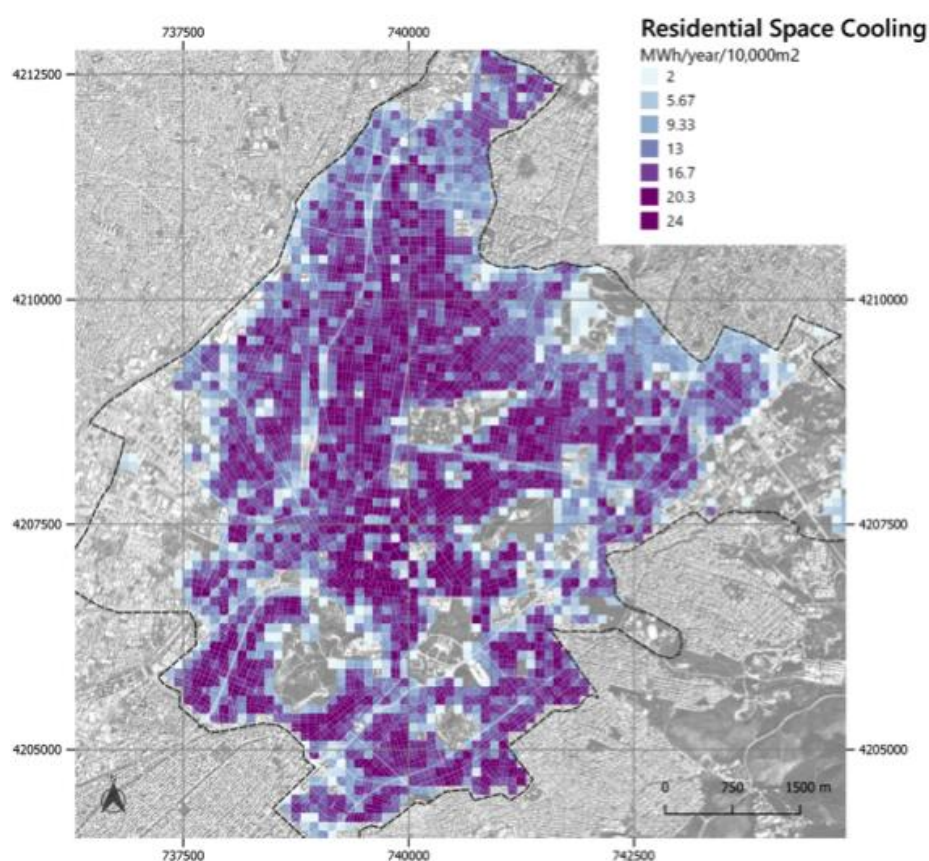
great potential of combining a causal discovery algorithm with a multivariate and lag-specific extension of transfer entropy for tackling contemporary research questions in magnetospheric physics, such as the storm-substorm relationship (Runge et al., Nature Scientific Reports 2018).



### Planheat Training Event for the City of Athens

The National Observatory of Athens (NOA) in cooperation with the City of Athens' Office of Resilience and Sustainability organized a training event at the City Hall where the project consortium presented the Planheat tool to the municipal staff. The participants, coming from several departments of the municipality, were introduced to the three modules of the Planheat tool and shared experiences with representatives from the *three validation cities*. *Athens, as part of its 2030 Resilience Strategy, aims to increase the use of renewable energy sources by 20% and reduce Greenhouse gas emissions by 40%. The Office of Resilience and Sustainability of the city of Athens, with the support of NOA, has already tested Planheat's City and District Mapping Modules for mapping the final energy demand*

*for residential space heating and residential space cooling.*



**BEYOND/IAASARS is proud to be part of the European Forest Fire Information System since 2018**

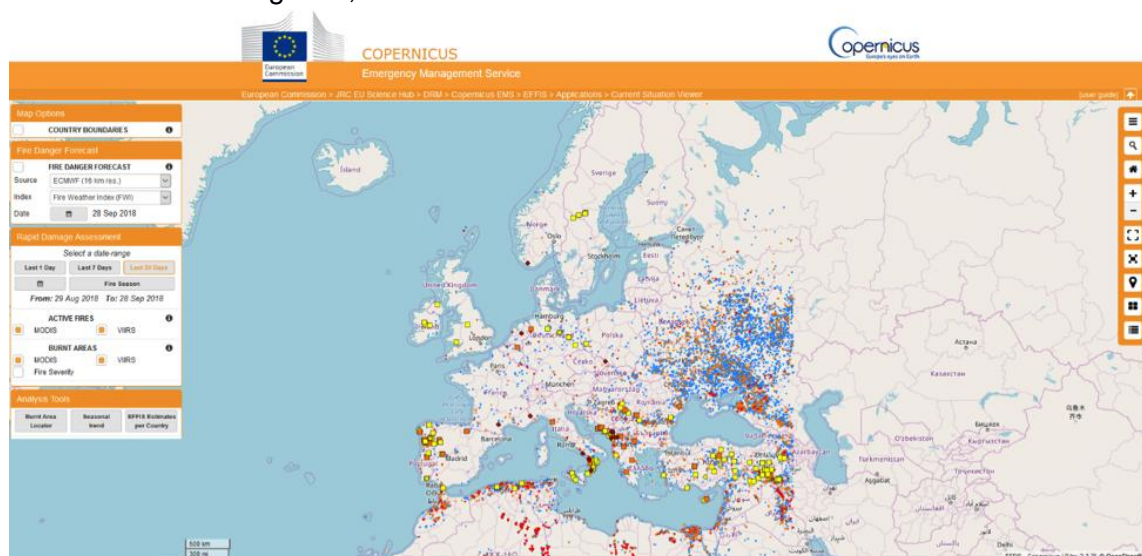
BEYOND/IAASARS Center of Excellence in Earth Observation in 2018 became responsible for delivering to the Copernicus European Forest Fire Information System (EFFIS) a series of rapid fire damage assessment products covering the entire Europe, North Africa and Middle East on a 24/7/365 basis. BEYOND/IAASARS processes data from its Satellite Antenna Ground Station installed in Penteli, Athens, Greece, and complemented by the Ground Station of the University of Dundee for covering this huge Area of Interest. The product portfolio includes active fire detections using medium resolution satellite sensor data (VIIRS-NPP and FengYun-3b), burnt areas delineation at medium resolution, and detailed fire damage assessment using high resolution Sentinel-2 data.

The European Forest Fire Information System (EFFIS - <http://effis.jrc.ec.europa.eu/>) supports Civil Protection Agencies in charge of the protection of natural ecosystems against fires in the EU countries, and provides the European Commission services and the

European Parliament with updated and reliable information on wildland fires in Europe. EFFIS was operated since 1998 by the Joint Research Center (JRC) - the EU Science Hub, and in 2015 became part of the Early Warning component of the [Emergency Management Services](#) in the EU Copernicus program.

In September 2018 and for the first time after 20 years, the EFFIS products responsibility has been transferred from JRC to an external consortium, comprising of Earth Observation industry e-GEOS, the National Observatory of Athens (NOA), the German Aerospace Agency (DLR) and the French company Sertit SME. The start of this new era was marked in the EFFIS Kick-off Meeting that took place at JRC ISPRA on the 21<sup>st</sup> of September 2018.

EFFIS is an important tool at the hands of the European Commission and the national agencies for the protection of human lives and their properties, natural ecosystem preservation, and climate change studies at European scale and beyond. Analysis of the historical fire records within the so-called EFFIS Fire Database, which includes detailed information of individual fire events provided by the EFFIS network countries combined with satellite observations, are a critical source of information for policy formulation, planning, risk reduction and mitigation, and reconstruction activities.



## IAASARS/NOA & GRNET operate several Copernicus Sentinel Hubs for the European Space Agency

Copernicus is a European system for monitoring the Earth. This is achieved by putting into orbit a series of earth observation satellites, called the Sentinels, which provide about 15 TB of fresh satellite data every day. IAASARS/NOA and the Greek Research & Technology Network (GRNET) have been operating for the European Space Agency (ESA), a number of Copernicus Sentinel Hubs, to seamlessly deliver satellite data to different user groups.



This Greek node is the one of the three available nodes in Europe for the dissemination of Sentinel satellite data. During 2018, the following Hubs, have been operating on a 24/7/365:

- the S5P Pre-Operational and the S5P Expert Hubs, making the Greek node the only access point for an entire Sentinel satellite mission, the S5P.
- The International Access Hub, delivering satellite data to NASA, USGS, NOAA and Geoscience Australia following having established agreements with the European Commission.
- The Africa Cast Hub for supplying Level-2 Sentinel-3 products to EUMETSAT.
- The Collaborative Node 3 and the DIAS Node 3 Hubs, serving European public and commercial stakeholders respectively.
- The temporary Hub that provides an alternative access route to all Sentinel data if the other two European nodes fail, or in case there is a major infrastructure maintenance.
- In order to support this service, IAASARS/NOA operates a big data infrastructure that consists of more than 60 Virtual Machines, with 800 TiB of storage, more than 680 CPU cores and about 2.2 TiB of RAM. On a monthly basis, our users download 2.5 million satellite products that account for about 1.5 PetaBytes of data.

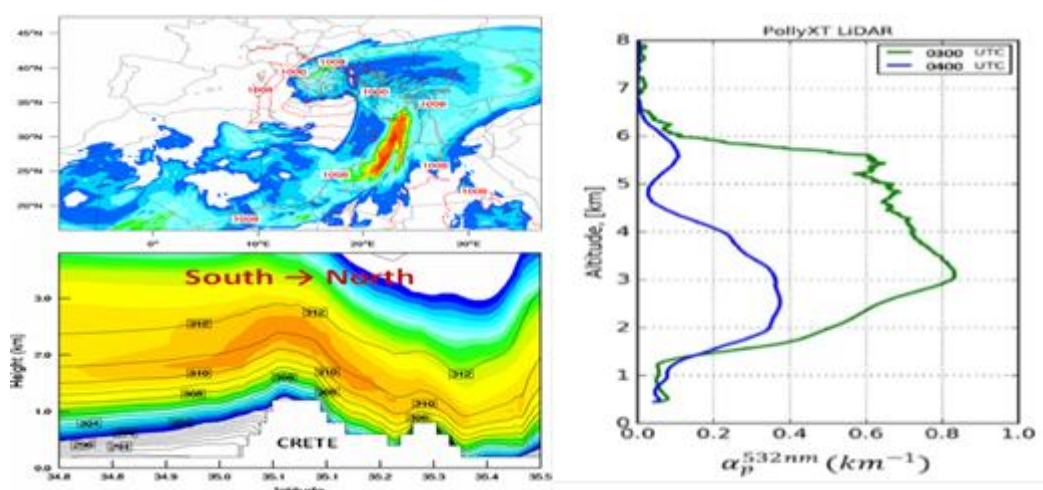
This is an important activity that has been entrusted to IAASARS/NOA by ESA. Copernicus is a multi-billion euro investment, leveraged through its satellite space programme. The Greek Node plays a vital role in ESA's overall architecture for the delivery of satellite products to the end-users, and IAASARS/NOA has assumed this responsibility that brings high visibility to the institute.

**COPERNICUS DATA HUB**  
Operations Center



### Modeling and remote sensing of a hazardous dust event in Crete

On 22 March, Crete was affected by a particularly severe North African dust event. The presence of dust was initially detected in the western parts of the island (Chania) and by the afternoon huge amounts of dust affected the central and eastern parts (Heraklion). The main driver for such strong episodes in Mediterranean is atmospheric dynamics at various scales: (i) at synoptic scale, the weakening of the polar vortex allows descending of cold stratospheric air towards Mediterranean and North Africa; (ii) at mesoscale, mid-latitude cyclones transport dust particles from the Sahara (Khamsin winds); (iii) at local scale, the vertical stability of the dusty air mass is disturbed when the plumes reach the island orographic barriers (e.g., Crete, Cyprus, Sicily). Topography may act either as a stopping barrier that leads to increased dust concentrations at the windward ridge or as a primary reason for the generation of downslope Foehn winds and downward mixing of dust over the leeward side, which was the case for the current event (Solomos et al., 2018).



**Left (up):** The Khamsin dust outbreak on 22 March 2018; **Left (down):** The Foehn wind bringing dust downwards towards the north coast of Crete; **Right:** Extinction coefficient profiles at 532 nm from IAASARS PollyXT lidar

### Construction of a scattering database for dust

Vassilis Amiridis has been awarded a total of 45 Million CPU-core-hours by the PRACE and GRNET at MareNostrum and ARIS HPC systems, respectively, for developing for the first time a scattering database for large oriented dust particles with irregular shapes. This scattering database is of high importance for optimizing a wider range of applications including radiative transfer models and inversion algorithms. It will have a large impact that will be a paradigm shift for satellite remote sensing applications, especially if the orientation of the dust particles proves to be largely extended. The applications are not only limited on Earth's environment but is anticipated to open new horizons for atmospheric dust research on Mars, Moon and asteroids.

### **IAASARS participation in European Networks of Excellence (COST actions)**

#### *e*ELECTRONET (<https://www.atmospheric-electricity-net.eu/action-description>)

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. Researcher Vassilis Amiridis participates in eELECTRONET on behalf of IAASARS.

#### *In*DUST (<https://cost-indust.eu/> )

The overall objective of [inDust](https://cost-indust.eu/) 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, Researcher 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.

## 5. DEVELOPMENT & RESEARCH PROJECTS

### Current Research Projects

#### European Commission Funding

Title	Scientist in Charge	Duration	IAASARS Budget (€)
IMPRESSIVE : Integrated Marine Pollution Risk assessment and Emergency management Support Service In ports and coastal enVironmEnts	I. Keramitsoglou	2018-2021	174,000
ASSESS - Episodic MAss LoSS in Evolved MaSSive Stars: Key to Understanding the Explosive Early Universe	A. Bonanos	2018-2023	1,128,750
EXTREMA: EXTReMe tEMperature Alerts for Europe	I. Keramitsoglou	2018-2019	169,000
D-TECT - Does dust TriboElectrification affect our ClimaTe?	V. Amiridis	2017-2022	1,968,000
EFFIS: Copernicus Data LOT. 2 - "Fire Monitoring Service"	H. Kontoes	2017-2021	695,183
EOPEN: opEn interOperable Platform for unified access and analysis of Earth observation data	H. Kontoes	2017-2020	218,125
EXCLELSIOR: Excellence Research Centre for Earth Surveillance and Space-Based Monitoring of the Environment	H. Kontoes	2017-2018	80,000
TechTIDE: Warning and Mitigation Technologies for Travelling Ionospheric Disturbances Effects	A. Belehaki	2017-2020	275,000
PRE-EST - Preparatory Phase for the European Solar Telescope	G. Tsiropoula	2017-2020	18,000
NextGEOSS - Next Generation GEOSS for Innovation Business	H. Kontoes	2017-2020	420,000
Marine-EO - Bridging Innovative Downstream Earth Observation and Copernicus enabled Services for Integrated maritime environment, surveillance and security	H. Kontoes	2017-2020	123,375
Optical Infrared Coordination Network for Astronomy	S. Basilakos	2017-2020	

<b>DUST-GLASS - Improving global dust prediction and monitoring through data assimilation of satellite-based dust aerosol optical depth</b>	V. Amiridis	2017-2019	164,653
<b>Improving the conservation effectiveness of wetlands - WetMainAreas</b>	I. Keramitsoglou	2017-2019	156,082
<b>CLAIRE - Copernicus Application Facility for Environmental Effects on Health and Comfort</b>	I. Keramitsoglou	2017-2019	49,968
<b>TRIBUTE: TRigger BUffer zones for inundaTion Events</b>	I. Keramitsoglou	2017-2018	136,650
<b>PLANHEAT - Integrated tool for empowering public authorities in the development of sustainable plans for low carbon heating and cooling</b>	I. Keramitsoglou	2016-2019	201,562
<b>East European Center for Atmospheric Research (ECARS)</b>	V. Amiridis	2016-2019	178,925
<b>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</b>	H. Kontoes	2016-2019	794,812
<b>RECAP - PeRsonalised public sErVICES in support of the implementation of the new CAP</b>	H. Kontoes	2016-2019	291,375
<b>AHEAD - Integrated Activities for the High Energy Astrophysics Domain</b>	I. Georgantopoulos	2015-2019	163,551
<b>FRAMEWORK SERVICE CONTRACT FOR COPERNICUS EMERGENCY MANAGEMENT SERVICE RISK AND RECOVERY MAPPING- Call for tender JRC/IPR/2014/G.2/0012/OC, EC project</b>	H. Kontoes	2015-2018	
<b>DustPedia: A definitive Study of Cosmic Dust in the Local Universe</b>	E. Xilouris	2014-2018	266,070

### ESA FUNDING

Title	Scientist in Charge	Duration	IAASARS Budget (€)
ESA SAPS Software Update (SAPS-SU)	O. Giannakis	2018-2019	50,000
Characterisation of Ionospheric Turbulence level by Swarm constellation (INTENS)	G. Balasis	2018-2019	42,000
Development of recommendation for new Swarm products and services	G. Balasis	2018-2019	25,000
Eo For Sustainable Development In The Climate Resilience Domain	H. Kontoes	2018-2021	240,000
Sentinels Rolling Archive User Access, Operations, Maintenance and Evolutions	H. Kontoes	2017-2020	538,830
ASPECS - Advanced Solar Particle Events Casting System	A. Anastasiadis	2017-2019	130,000
Ionospheric Weather Expert Service Centre extension	I. Tsagouri	2017-2019	42,000
LPUB-SAPS - Linking data and publications in ESA's Science Archives Publications System	A. Akylas- O. Giannakis	2017-2018	49,000
AREMBES - Athena Radiation Environment Models and X-Ray Background Effects Simulators	A. Anastasiadis	2016-2018	5,000
MULTIPLY - Development of a European HSRL airborne facility	V. Amiridis	2015-2018	227,000
HCV - Hubble Catalogue of Variables	A. Bonanos	2015-2019	1,050,000
NELIOTA - NEO Lunar Impacts and Optical Transients with the Aristarchos Telescope	A. Bonanos	2015-2021	900,000

### NATIONAL FUNDING

Title	Scientist in Charge	Duration	IAASARS Budget (€)
KRIPIS/PROTEAS II	S. Basilakos	2017-2020	873,000

### OTHER FUNDING

Title	Scientist in Charge	Duration	IAASARS Budget (€)
Support the National Centre for the Collection, Analysis and	V. Amiridis	2016-2019	250,000



Dissemination of Satellite Data for the Observation of the Earth, Atmosphere and the Sea			
Pilot Network for the Identification of Travelling Ionospheric Disturbances	A. Belehaki	2014-2018	400,000
TRacking interplanetary Coronal mass Ejections with foRbush decreases (TRACER)	A. Papaioannou	2018-2020	8,000
High EneRgy sOLar partICle events analysis (HEROIC)	A. Papaioannou	2018-2020	

## **6. PUBLICATIONS & PRESENTATIONS**

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### **6.1 LIST OF PUBLICATIONS IN REFEREED JOURNALS**

1. Adami, C., Giles, P., Koulouridis, E., et al., 2018, *Astronomy & Astrophysics* 620.
2. Aird, J., Coil, A.L., & Georgakakis, A., 2018, *Monthly Notices of the Royal Astronomical Society* 474(1): 1225.
3. Arabsalmani, M., Le Floc'h, E., Dannerbauer, H., et al., 2018, *Monthly Notices of the Royal Astronomical Society* 476(2): 2332.
4. Balasis, G., Daglis, I.A., Contoyiannis, Y., et al., 2018, *Journal of Geophysical Research-Space Physics* 123(6): 4594.
5. Belov, A., Eroshenko, E., Yanke, V., et al., 2018, *Solar Physics* 293(4).
6. Bianchi, S., De Vis, P., Viaene, S., et al., 2018, *Astronomy & Astrophysics* 620.
7. Bonanos, A.Z., Avdellidou, C., Liakos, A., et al., 2018, *Astronomy & Astrophysics* 612.
8. Britavskiy, N., Pancino, E., Tsymbal, V., Romano, D., & Fossati, L., 2018, *Monthly Notices of the Royal Astronomical Society* 474(3): 3344.
9. Cao, T.W., Lu, N.Y., Xu, C.K., et al., 2018, *Astrophysical Journal* 866(2).
10. Chen, X.D., Wang, S., Deng, L.C., de Grijs, R., & Yang, M., 2018, *Astrophysical Journal Supplement Series* 237(2).
11. Chiappetti, L., Fotopoulou, S., Lidman, C., et al., 2018, *Astronomy & Astrophysics* 620.
12. Chira, M., Plionis, M., & Corasaniti, P.S., 2018, *Astronomy & Astrophysics* 616.
13. Clark, C.J.R., Verstocken, S., Bianchi, S., et al., 2018, *Astronomy & Astrophysics* 609.
14. de Leeuw, G., Sogacheva, L., Rodriguez, E., et al., 2018, *Atmospheric Chemistry and Physics* 18(3): 1573.
15. Demangeon, O.D.S., Faedi, F., Hebrard, G., et al., 2018, *Astronomy & Astrophysics* 610.
16. Dey, L., Valtonen, M.J., Gopakumar, A., et al., 2018, *Astrophysical Journal* 866(1).
17. Dong, X.Y., Wu, X.B., Ai, Y.L., et al., 2018, *Astronomical Journal* 155(5).
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## 6.2 PUBLICATIONS PER RESEARCHER

The productivity of the permanent researchers in 2018 are summarized in the following table. This is according the ISI/Web of Knowledge database. Complementary we also utilize NASA-ADS database.

A/A	Name	Publications		Citations		h-index
		2018	Total	2018	Total	
1	S. Basilakos <sup>1</sup>	11	138	580	3770	35
<b>Research Personell</b>						
1	V. Amiridis	12	93	460	2899	31
2	A. Anastasiadis	4	57	100	733	15
3	A. Georgakakis	7	124	920	5819	37
4	I. Georgantopoulos	5	132	212	3493	34
5	A. Dapergolas	1	51	687	1931	18
6	I. Keramitsoglou	2	38	110	746	16
7	C. Kontoes	5	57	175	1337	22
8	K. Koutroumpas	2	27	60	272	10
9	O. Malandraki	1	47	141	740	18
10	G. Balasis	7	57	154	1024	18
11	A. Belehaki	4	85	101	965	18
12	I. Bellas Velidis	9	43	1061	2646	19
13	A. Bonanou	5	73	219	1899	23
14	P. Boumis	5	73	86	608	13
15	M. Xilouris	5	112	343	3304	34
16	A. Papaioannou	7	31	117	429	12
17	A. Rontogiannis	2	37	131	746	12
18	N. Sifakis	0	41	24	397	11
19	O. Sykioti	2	21	42	287	9
20	D. Sinachopoulos	0	35	2	159	7
21	I. Tsagouri	5	54	83	621	14
22	G. Tsiropoula	2	49	72	904	18
23	P. Hantzios	0	4	1	35	2
24	V. Charmandaris <sup>2</sup>	10	250	920	11876	56
<b>Scenior Scientists</b>						
1	A. Akylas	2	42	67	611	14
2	O. Giannakis	3	9	9	145	5
<b>Research support Specialists</b>						
1	P. Ilias	2	25	31	156	7
2	D. Paronis	1	11	20	190	7

In summary, in 2018 in total, there were 95 publications in refereed journals with ~3700 citations

<sup>1</sup> S. Basilakos (new Director) joined IAASARS in October 2018.

<sup>2</sup> V. Charmandaris (ex-director of IAASARS) completed his term in September 2018



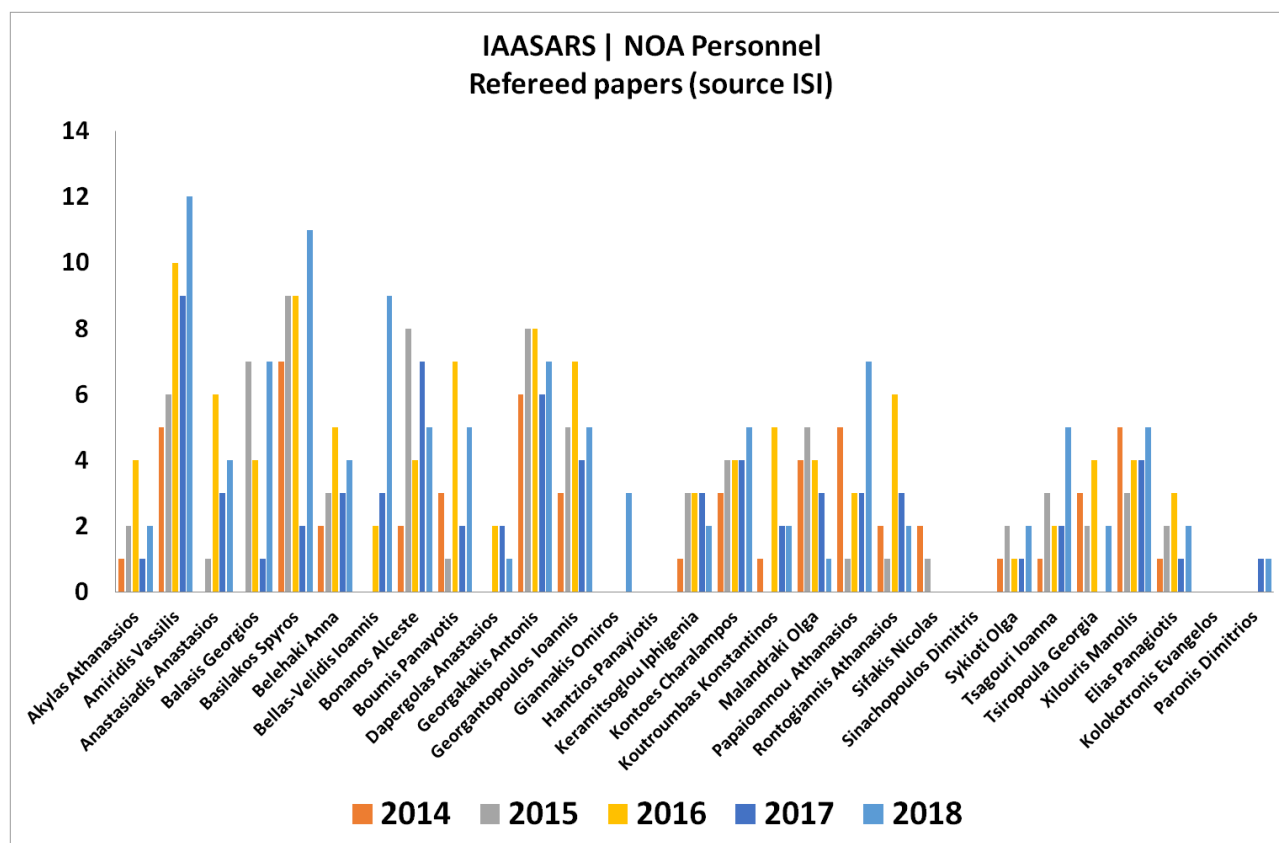


Figure. The number of publications per researcher over the last five years.

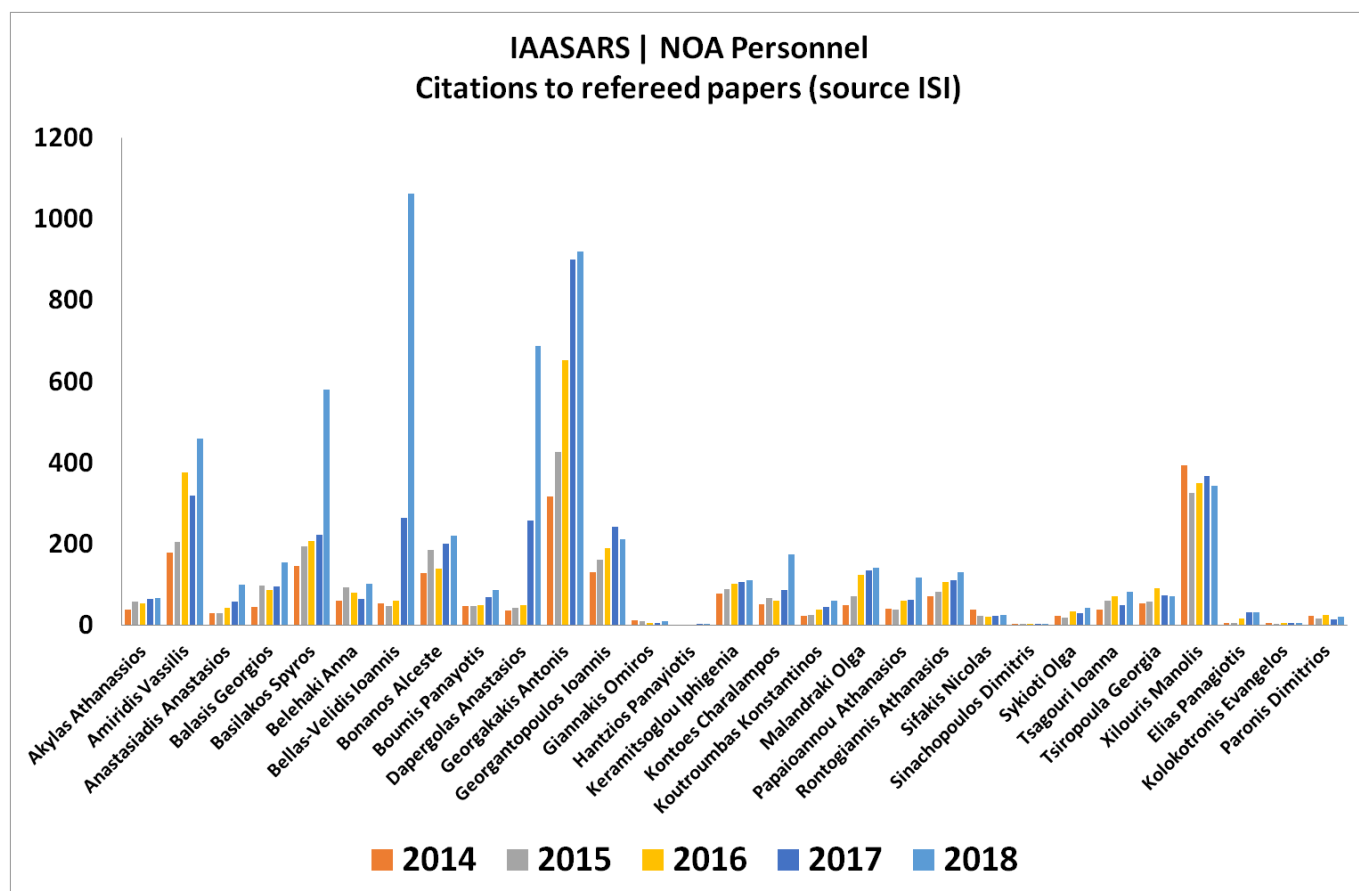


Figure. The number of citations per researcher over the last five years.

## **7. RESEARCH COLLABORATIONS**

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1. WFI instrument consortium of the ATHENA ESA mission. Collaboration with other Institutes and Universities for the construction of the WFI instrument onboard the ATHENA ESA X-ray mission. The consortium is led by MPE in Munich. From the Greek side, the Physics Department of the University of Crete also participates (I. Georgantopoulos, A. Georgakakis, A. Akylas)
2. AHEAD programme (Horizon-2020). Collaboration with 28 European Research Institutes and Universities in Europe in the area for High energy Astrophysics. The areas addressed range from development of new instruments, training of researchers in the analysis of space data to public outreach in the area of high energy astrophysics. (I. Georgantopoulos)
3. Dustpedia programme (FP-7). Collaboration with five european Institutes and Universities for the analysis of data from ESA's Herschel mission. In particular the goal is to understand the properties of the interstellar dust in nearby galaxies (M. Xilouris)
4. eROSITA X-ray detector. Collaboration with Max Planck (Munich). The eROSITA instrument onboard the Spectrum-RG mission will perform an all-sky survey at hard X-ray energies. IAASARS collaborates in the analysis of the X-ray data (A. Georgakakis)
5. SWARM mission. IAASARS has a very active involvement in the validation team and the quality working team and the Science Exploration of the SWARM mission. (G. Balasis)
6. The Modeling & Data Analysis Working Group (MADAWG) of the ESA/Solar Orbiter mission. IAASARS collaborates on the establishment of Space Weather Tools for the Solar Orbiter Science Operations (A. Anastasiadis, A. Papaioannou)
7. The ASPECS (Advanced Solar Particle Event Casting System) activity (ESA funding) brings together a European consortium of 5 partners coordinated by IAASARS/NOA. The aim of the project is the accurate forecasting of solar flares and solar energetic particle events. For the first time ASPECS will provide the complete time profile of the SEP event at respective energies in near real-time, utilizing both simulations and observations (A. Anastasiadis, G. Balasis, A. Papaioannou, O. Giannakis)

## **8. EDUCATION & PUBLIC OUTREACH**

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### **8.1 Courses**

Researchers of IAASARS are actively involved in the education of many undergraduate and postgraduate students (Masters), of the Universities of the wider Attica region, as either responsible or jointly responsible for the preparation of diploma theses, Masters work, as well as their practical training. These students are doing part of their research using the IAASARS infrastructure.

#### **8.1.1 Postgraduate Program in collaboration with the University of Peloponnese**

Since September 2015, in collaboration with the University of Peloponnese, the National Observatory of Athens established a M.Sc. Program on Space Science Technologies and Applications. Its purpose is to educate students and to bring up scientists of high quality in this subject. Space applications are constantly developing and evolving and it is currently estimated that in the coming years those will play an important role in the global economy. The objective of the M. Sc. Program on Space Science Technologies and Applications is to provide students with specialized knowledge both theoretical but also through hands on experience. The Program is organized in such a strategic way so that it promotes knowledge and research on current technological issues, focusing on solving issues that arise from them.

The courses are delivered in English, while the lessons are held in Athens, Thiseio. From IAASARS lecturers are: V. Amiridis, I. Daglis (Collaborating Researcher), I. Keramitsoglou, C. Kontoes, K. Koutrombas, G. Balasis, I. Papoutsis, A. Rodogiannis, O. Sykiotis, S. Solomos, A. Tsouni and the collaborators P. Sismanidis and Th. Herekakis.

The duration of the M. Sc. program spans over four semesters. The students have to attend three semesters of the course, while the fourth one is dedicated to their dissertation.

More info at <http://space.uop.gr/> Twitter: @SpaceMSc

### **8.2 Public Outreach**

#### **8.2. Visitor Centers**

The Institute of Astronomy, Astrophysics, Space Applications and Remote Sensing (IAASARS) has always given great emphasis on science dissemination and outreach since

1995; a year that the Penteli Visitor Center (PVC) commenced its operation. Quite recently (2014) a new component of the institute has been added, namely the Thiseio Visitor Center (TVC). Both visitor centers have joined forces and are very active on the subject engaging in a huge variety of outreach activities also covering a large age range non-existent in the previous years. The new resultant has been proven extremely effective and fruitful in accentuating the role of science to society.

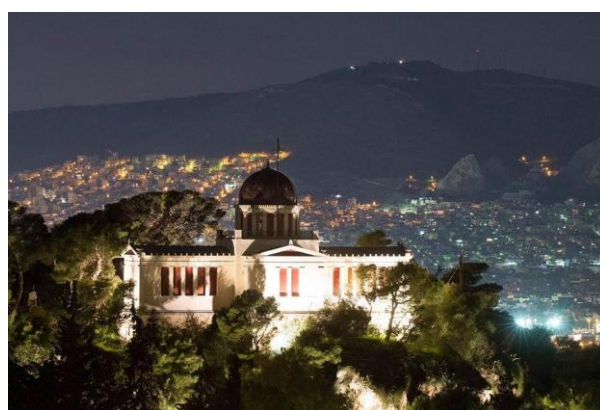


*Events for the public, at the courtyard area of the historic Doridis Telescope at Thiseio premises.*



*Newall telescope in Penteli, one of the oldest large telescopes of the world.*

### 8.2.1 Thiseion Visitor Centre



In 2018, **32.870 visitors** visited Thissio Visitor Center, during 230 scheduled morning visits and 174 open nights, for students and general public.



The tickets that were given are distributed as follows: 8.381 (of 5€), 16.325 (of 2.5€), 1.126 (of 10€) and 7.038 of free admission. According to the above ticket numbers, the total income corresponds to **93.977,50€**.

The total number of visitors at Thissio Visitor Center, during the year is distributed as follows:

13.504 visitors attended the morning tours, 19.366 the open nights, 1.713 attended public talks and thematic nights, 1.029 musical and artistic performances and 2.457 activities for children.

#### **A. Public Talks**

12 public talks for various scientific topics took place, under the dome of Doridis telescope that were followed by observation through the historical telescope. The talks have been given by: Dr. V.Charmandaris (NOA), Ms. M. Dourou (*Archaeological Authority of Athens*), Dr. T. Krimizis (*Academy of Athens*), Dr. C. Zerefos (*Academy of Athens*), Dr. A. Metallinou (NOA), Dr. A. Floros (*Ionian University*), Dr. N. Prantzos (*Institut d'Astrophysique de Paris*), Prof. S Trachanas (*University of Crete*), Dr. G. Grammatikakis (*University of Crete*), Angelos Chaniotis (*Institute for Advanced Study, Princeton*).

Total number of the attendants: 1.713

#### **B. Artistic Performances: "Musical Constellations"**

- 10/05 *Performance of electronic music* by P. Alexiadis
- 31/05 *Jazz music concert* by the "Jazz & New Technologies" post graduate course students of the Department of Music Studies, University of Athens.
- 07/06 *"Expanding the Jazz Universe"*, by D. Vassilakis (professor at the Department of Music Studies, University of Athens)
- 18/06 *"Seicento / 'amoroso"* Baroque music songs of mythological themes by the soprano Mariandela Chatzistamatiou
- 28/6 *"Full Moon Concert"*, in collaboration with the Danish Institute in Athens
- 12/7 *"Opera Chaotique"* concert
- 19/7 *"Ancient Greek Music"* concert by Aliko Markantonatou on the hill of the Nymphs.

Total number of the attendants: 1.029

#### **C. Activities for children**

"Hunt of the hidden telescope":

An interactive astronomical treasure hunt for children 7-11 years old.

11 activities took place, involving 512 children.

"Young Scientists in Action"

Astronomy seminars for young children (7-11 years old). 477 children attended during 17 courses

"The Space Explorers"

An activity for children 4-6 years old. The activity took place 20 times and 1044 infants attended.

#### **D. Guided Tours to Special Groups**

Special groups of students having health or mental problems visited the Observatory in Thission, with free admission. Total number: 301 people

Additionally, 100 refugees (children and adults) attended guiding tours at the Observatory with free admission.

#### **E. Activities outside the Observatory**

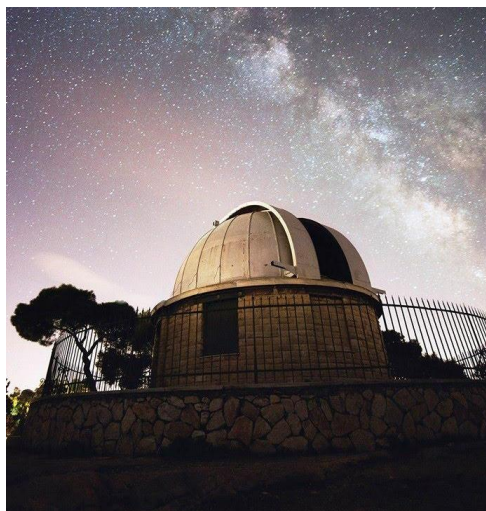
##### In the city of Athens:

Total number of attendants: ~ 2.000

- Pre-event evening for the “Researcher Night 2018” on the hill of Pnyx.
- Participation in the “Researcher Night 2018” at NCSR DEMOKRITOS Research Institute.
- Portable Planetarium presentations for young children during the “Researcher Night 2018”
- Public talk during the Presentation of the documentary “Children of the Universe” at the Benaki Museum
- “Eratosthenes Experiment” for calculating Earth’s radius, on the Hill of Pnyx for high school students.
- Participation in the Athens Science Festival.
- Participation in the Children's Festival at “Technopolis” of the Municipality of Athens.
- Participation in the "Nights of the Museum" organized by the Municipality of Athens.
- Participation to the events of the World Space Week.
- Observation of the total lunar eclipse of July 28, 2018, on the Hill of Pnyx.
- Participation at the “Metz Festival” by giving talks and observing the moon by portable telescopes.

##### In the rest of the country:

Total number of attendants: ~ 800



- Visiting the “ELPIDA” Association of Friends of Children with Cancer in Corinth, for night observation of the sky.
- Participation to the “Herea -Pythagoreia Festival”, in Samos: Public talk about the mythology of the constellations, recognizing the constellations of the night sky and observing planets and the moon.
- Participation to the “12<sup>th</sup> Hellenic Meeting of Amateur Astronomers, in Drimonas Aitolioakarnania.

- Visits the penal institutions for young people in Domokos, Malandrino and Avlona: Giving talks about the sun and observing the sun by a solar telescope.

### **8.2.2 Penteli Visitor Center**

The Penteli Visitor Center (PVC) has recently completed 23 years of operation since 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 specialized 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 11,000 school kids from more than 250 elementary and high schools have visited the premises of PVC in the morning sessions and about 11,000 visitors spread through 120 nights, in the year 2018. All morning visits include interactive presentations, educational movies produced by IAASARS, demonstration of the NEWALL telescope and solar observation. Approximately 5,000 visitors (mainly students) have observed the Sun (chromosphere and photosphere) during 2018. All night sessions are similar to the ones in the morning except that visitors 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 both in the morning and the night sessions.

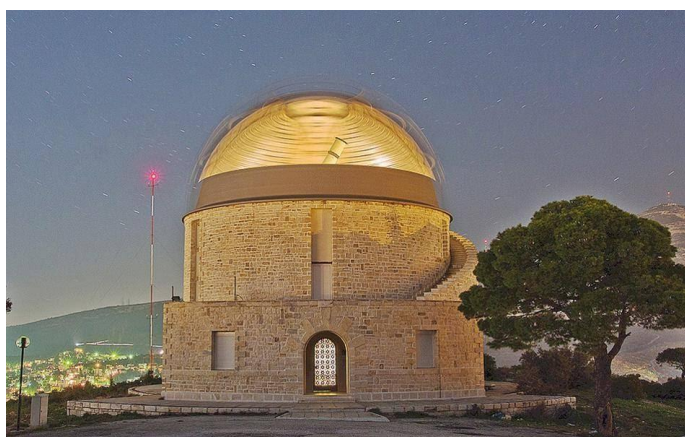
A large collection of diverse outreach activities has been also initiated in 2018 by members of PVC, ranging from thematic lectures out of the domain of IAASARS science tank, open days for the public at rare astronomical phenomena (such as eclipses), lectures for non-Greek speaking visitors, visits to schools for special projects, astro-camp schools for kids and astro-school events for children and adults held at the premises of the National Observatory of Athens at Penteli.

The longevity of the experience gained by both PVC and TVC has designated IAASARS as one of the main public outreach centers in Greece. The IAASARS is therefore planning to expand its activities by pursuing the following tactical scheme for 2019.

1. An outreach component of the Institute should be oriented towards vulnerable social groups such as children in hospitals, kids from schools outside Attica county or the extended Athens area, people that serve sentences at correctional facilities (juveniles and adults) and in general people from isolated or deprived areas within

the country. Enterprises of this kind have already appeared this year within IAASARS (and NOA) as pilot programmes and need systematic integration so as to further highlight the social role of NOA.

2. Organization of science workshops for the general audience from a wide range of topics encompassing all possible components of IAASARS disciplines or even engagement in multidisciplinary projects from all three institutes of NOA, as a reasonable commitment of a public institution to share the knowledge acquired with the society that constantly supports its activities. In this line of argument, several thematic lectures have been delivered at both visitor centers to serve as pilot phase studies since 2014.
3. Last, but not least, is to maintain and improve the existing infrastructure and equipment consistently as a sensible requirement for orderly functioning and investment in education.



### **8.2.3 Summer School of Astrophysics for High School Students**

Continuing a long standing tradition, the Institute organised the 22nd summer school, in the beginning of September 2018. This is focuses on final year high school students, lasts for three days and its subject was “the Universe and recent discoveries”. Responsibles for the coordination were A. Dapergolas and M. Metaxa ( Arsakeion School). The NOA researchers I. Georgantopoulos, A. Anastasiadis, I. Keramitsoglou, A. Bonanou, V. Charmandaris gave lectures during the school.

## **8.3 Supervision of students**

### *8.3.1 PhD students*

The Institute hosts 20 postgraduate students. These under the supervision of Institute’s researchers At the same time the Institute’s researchers participate in the committee’s of numerous Ph.D. students in Greek Universities, as well as in Universities abroad. The details are provided in the cv’s of the Institute’s researchers.

### *8.3.2 Practical Apprentiships of B.Sc. students*

The Institute participates in the practical training of students from Greek Universities. These internships usually last between two and three months and are funded by the ATLAS program. On average there are about 10 students trained per year at the Institute.



## 9. ACTIVITIES PROMOTING NOA

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### 9.1 International and National Awards

The Institute has the honor to currently host two prestigious European Research Council (ERC) consolidator grants. One by V. Amiridis (2017-2022; “D-TECT - Does dust TriboElectrification affect our ClimaTe?”) and the other one by A. Bonanos (2018-2023; “ASSESS - Episodic MAss LoSS in Evolved MaSsive Stars: Key to Understanding the Explosive Early Universe”). Additionally, in 2018, the ESA/Science Individual Award was awarded to A. Anastasiadis for his outstanding contribution to the ESA Rosetta Mission.

### 9.2 Participation of Researchers' of the Institute in Advisory Committees and International Organizations

- ☐ A. Anastasiadis: science team member of the ASPIICS (Association of Spacecraft for Polarimetry and Imaging of the Corona of the Sun) coronagraph of the future ESA/Proba-3 mission
- ☐ A. Anastasiadis: science team member of the X-ray Imager (STIX) instrument of the future ESA/Solar Orbiter mission.
- ☐ A. Anastasiadis member of the Modeling & Data Analysis Working Group (MADAWG) of the ESA/Solar Orbiter mission
- ☐ V. Amiridis: National Representative in the GMES/COPERNICUS committee.
- ☐ V. Amiridis: Elected member of the board of the European Network of lidar systems EARLINET : (European Aerosol Research Network).
- ☐ G. Balasis: National delegate in ESA’s programme board “Space Situational Awareness”.
- ☐ G. Balasis: Secretary, Earth Magnetism and Rock Physics (EMRP) Division, European Geosciences Union (EGU).
- ☐ G. Balasis: Evaluator, Horizon 2020, Marie Skłodowska-Curie Individual Fellowships, Panel Physics.
- ☐ G. Balasis: Review panelist, NASA Heliophysics Space Weather Operations-to-Research.
- ☐ G. Balasis: Reviewer, NASA Postdoctoral Program.
- ☐ G. Balasis: Reviewer, Canadian Space Agency.
- ☐ G. Balasis: Review panelist, “la Caixa” Junior Leader Programme: Postdoctoral Studies at Spanish Research Centres of Excellence.
- ☐ G. Balasis: Expert-evaluator – for Greek State Scholarships Foundation (IKY)
- ☐ G. Balasis: Expert-evaluator – for GSRT
- ☐ S. Basilakos President of the Greek National Committee for Astronomy.
- ☐ S. Basilakos National Delegate in the International Astronomical Union (IAU).
- ☐ A. Belehaki: Member of the committee for the evaluation of candidates for the Norway academy "Birkeland Medal"
- ☐ A. Belehaki: member of ESA’s Space Weather Working Team.

- ☐ A. Belehaki: member of the Scientific Board of Excellence in space Research of the Finnish Academy of Science.
- ☐ A. Belehaki: Member in EU committees for the evaluation of science programs.
- ☐ I. Georgantopoulos, Member of ESA's XMM-Newton User group
- ☐ I. Georgantopoulos member of ESA's Advisory Structure, Astronomy Archives User group
- ☐ I. Georgantopoulos, member of the WFI instrument consortium of ESA's ATHENA mission
- ☐ O. Giannakis: Certified Evaluator of the General Secretariat for Research and Technology of Greece (GSRT)
- ☐ O. Giannakis: Certified Evaluator of the Research Promotion Foundation of Cyprus (RPF)
- ☐ I. Keramitsoglou: co-Leader of "Global Urban Observation and Information" action of the international initiative "Group on Earth Observations" (GEO).
- ☐ I. Keramitsoglou: Representing IAASARS/NOA in the National Greek Platform for Risk Mitigation coordinated by the Greek General Secretariat for Civil Protection.
- ☐ C. Kontoes: National Representative in European Committee Εθνικός H2020-Space programme.
- ☐ O. Malandraki: member of the greek delegation in ESA's Science Programme Committee.
- ☐ O. Malandraki: Solar-Terrestrial (ST) Deputy President, European Geophysical Union (EGU), Solar-Terrestrial Sciences Division (2014 - ).
- ☐ A. Papaioannou: member of the Modeling & Data Analysis Working Group (MADAWG) of the ESA/Solar Orbiter mission
- ☐ A. Papaioannou: Liaison Officer Solar-Terrestrial (ST) Division, European Geosciences Union (EGU) (2014-2018).
- ☐ A. Rontogiannis: Affiliate Member of the Signal Processing Theory and Methods (SPTM) Technical Committee of the IEEE Signal Processing Society
- ☐ N. Sifakis: national expert at the executive service of the european Research Council.
- ☐ G. Tsiropoula: elected member of the governing body of the European Solar Physics Division/European Physical Society
- ☐ V. Charmandaris: member of the Board of Directors of the Astronomy & Astrophysics journal.
- ☐ V. Charmandaris: member of the Haute Conseil Scientifique Obs. de Paris

### 9.3 Organization of Conferences and International Workshops

- Amiridis, V. co-organiser "European LiDAR Conference", 3-5 Ιουλίου 2018, Thessaloniki (<https://elc2018.eu/>)

- Amiridis, V. co-organiser "Second International Workshop on Space-based lidar remote sensing techniques and emerging technologies", 4-8 Ιουνίου 2018, Μήλο (<https://www.lidar-workshop-2018.com/>)
- Anastasiadis A., co-convenor, "[Session 6: Unveiling Current Challenges in Space Weather Forecasting](#)", European Space Weather Week 15 (ESWW15), Leuven, Belgium, 5 -9 November, 2018
- Anastasiadis A. and Papaioannou A., ESA/Solar Orbiter Workshop on "Modeling & Data Analysis Working Group (MADAWG)", Athens, Greece, 26 - 28 September 2018
- Balasis, G., Convener, Earth Observation with Swarm: Results from Four Years in Orbit, *European Geosciences Union General Assembly 2018*, Vienna, Austria, 8 April–13 April 2018.
- Bonanos, A., SOC member of the 44th COSPAR General Assembly in Athens (July 2022)
- Bonanos, A., SOC member of the EWASS 2018 meeting, 3-6 April, 2018, Liverpool, UK (<http://eas.unige.ch/EWASS2018>)
- Bonanos, A., LOC co-chair of the Supernova Remnants II meeting, 3-8 June 2019, Crete (<http://snr2019.astro.noa.gr/>)
- Boumis, P., SOC and LOC co-chair of the Supernova Remnants II meeting, 3-8 June 2019, Crete (<http://snr2019.astro.noa.gr/>)
- Georgantopoulos, I., SOC member of the X-ray surveys splinter meeting, COSPAR meeting, Palo Alto, US
- Papaioannou A., co-convenor, "[ST1.5/PS4.6 Solar Eruptions and their Heliospheric imprint](#)", EGU General Assembly 2018, Vienna, Austria, 8 - 13 April 2018
- Sykioti, O., member of organisation and scientific committee of the 1st Workshop on Remote Sensing and Space Technologies, organized by the Committee of Remote Sensing and Space Applications of the Geological Society of Greece, 21 February, Athens.

#### 9.4 Participation in Editorial Boards of international scientific journals

- ☐ V. Amiridis: Atmospheric Measurement Techniques της European Geophysical Union (EGU).
- ☐ V. Amiridis: "ISRN Meteorology" Hindawi Publishing Corporation
- ☐ A. Anastasiadis: Entropy Journal.
- ☐ A. Anastasiadis: International Review of Physics.
- ☐ A. Anastasiadis: Topical Editor, Journal of Space Weather and Space Climate, Topical Issue "[Space Weather research in the Digital Age and across the full data lifecycle](#)"
- ☐ G, Balasis: Editor for Magnetosphere and Space Plasma Physics, Annales Geophysicae.

- ❑ G. Balasis: Review Editor, Frontiers in Physics; Frontiers in Astronomy and Space Sciences.
- ❑ G. Balasis: Guest Editor, Journal of Space Weather and Space Climate.
- ❑ S. Basilakos: Review Editor, High Energy and Astroparticle Physics.
- ❑ I. Keramitsoglou: Remote Sensing Applications: Society and Environment (Elsevier)
- ❑ I. Keramitsoglou: Co-Guest Editor in the Special Issue "The Application of Thermal Urban Remote Sensing to Understand and Monitor Urban Climates" του περιοδικού Remote Sensing (MDPI)
- ❑ O. Malandraki: American Journal of Space Science.
- ❑ O. Malandraki: Sun and Geosphere, The International Journal of Research and Applications.
- ❑ A. Papaioannou: Guest Associate Editor, Journal of Space Weather and Space Climate, Topical Issue "[Measurement, specification and forecasting of the Solar Energetic Particle \(SEP\) environment and Ground Level Enhancements \(GLEs\)](#)" eds. A. Mishev & P. Jiggins
- ❑ A. Belehaki: Studia Geophysica et Geodaetica, Associate Editor (Publisher: Springer)
- ❑ A. Belehaki: Journal of Space Weather and Space Climate, Editor-in-Chief (IF: 2.519, Publisher: EDP Sciences)
- ❑ A. Rontogiannis: EURASIP Journal on Advances in Signal Processing, Springer.
- ❑ A. Rontogiannis: Signal Processing Journal, Elsevier.
- ❑ N. Sifakis: co-editor of the International Journal of Navigation and Observation.
- ❑ I. Tsagouri: Space Weather and Space Climate.
- ❑ G. Tsiropoula: ISRN Astronomy and Astrophysics Journal.

### 9.5 Refereeing for international scientific journals.

IAASARS researchers acted as referees in a wide range of international refereed journals in 2018. These include: Nature - International Journal of Remote Sensing, Sensors, MDPI JAG, Elsevier - IET on Image Processing - Annales Geophysicae - Astronomy & Astrophysics - Astrophysical Journal - Monthly Notices of the Royal Astronomical Society - Advances in Space Research - Entropy - Journal of Geophysical Research - Natural Hazards and Earth System Sciences - IEEE Transactions on Signal Processing, IEEE Transactions on Image Processing - IEEE Transactions on Geoscience and Remote Sensing, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing (JSTARS) - Remote Sensing of Environment - International Journal of Navigation and Observation - Solar Physics - Journal of Geophysical Research-Space Physics - International Journal of Remote Sensing - International Journal of Remote Sensing - Journal

of Geophysical Research - Space Weather, Remote Sensing, Sensors, Journal of Applied Remote Sensing, Journal of Basic and Applied Sciences, Land, Forests.

Moreover, they participate in the evaluation of scientific proposals both in Greece (ESPA, ELIDEK) and worldwide (H-2020, Marie Curie, NASA/ADAP, NASA/NPP).

### 9.6 Seminars of IAASARS

In 2018 we continued our weekly seminar series. The details of the seminars had as follows.

Speaker (Affiliation)	Title
Dr. Anezina Solomonidou (ESA-ESAC, Spain)	The icy moons of Jupiter and Saturn: The lesson learnt from Cassini and the preparation of ESA's JUICE mission
Dr. Elias Koulouridis (CEA Saclay, France)	Active galactic nuclei and clusters of galaxies: evolution, interactions, cosmological applications
Dr. Filippas Koliopoulos (Research Institute in Astrophysics and Planetology, IRAP, France)	The broad and ubiquitous ~1 keV emission line complex in the spectra of X-ray binaries
Dr. Eleni Vardoulaki (Argelander-Institut fuer Astronomie, University of Bonn, Germany)	The importance of radio observations in understanding galaxy formation and evolution, and why AGN are special
Dr. Sofia Lianou (CEA-Saclay, France)	(Dwarf) galaxy evolution: clues from the local Universe
Dr. Alexandra Tsekeri (NOA, Greece)	Aerosol Remote Sensing: Challenges and prospects
Dr. Marina Vika (NOA-IAASARS, Greece)	Structure and morphology of galaxies in the nearby Universe
Dr. Antonis Gkikas (National Observatory of Athens, Greece)	Implementation of Earth Observations for monitoring dust aerosols from regional to global scales
Dr. Panagiotis Elias (National Observatory of Athens, Greece)	Synergy of ground deformation and other observations to study geophysical processes, contributing to related hazards assessment
Dr. Alexios Liakos (National Observatory of Athens, Greece)	A journey from the dark labs to the Moon and the Stars
Dr. Odysseas Dionatos (Institut fuer Astrophysik, Universitaet Wien, Austria)	The role of feedback processes in regulating the star formation
Dr. George Mountrichas (National Observatory of Athens, Greece)	The environment of AGN and their interplay with their host galaxies.
Dr. Danae Polychroni (Universidad de Atacama, Chile)	A tale of Two Clouds: Cores and Filaments in Orion & W3
Dr. Ioannis Papoutsis (National	Big Earth Observation data for Disaster Risk Reduction

<b>Observatory of Athens, Greece)</b>	
<b>Dr. Sotirios A. Mallios</b>	A study of the contribution of thunderstorms to the Global Electric Circuit using a time-dependent numerical model and a fractal model
<b>Lukasz Wyrzykowski (Warsaw University Astronomical Observatory, Poland)</b>	Probing the population of Galactic and extragalactic black holes with Gaia
<b>Emmanuel Saridakis (National Technical University of Athens &amp; Baylor University, USA)</b>	Theoretical and observational confrontation of cosmology and gravity, and the new era of multi-messenger astronomy
<b>Dr. Emmanouil Angelakis (Max-Planck-Institut für Radioastronomie, Germany)</b>	Conditions and processes of relativistic plasma outflows through multi-band all-Stokes parameters monitoring
<b>Dr. Hanae Inami (Centre de Recherche Astrophysique de Lyon, France)</b>	The AKARI 2.5-5μm Spectra of Local Luminous Infrared Galaxies
<b>Dr. Evangelia Ntormousi (Foundation for Science and Technology, Greece)</b>	Non-ideal MHD simulations of molecular clouds: filament and core formation
<b>Dr. Konstantina Boutsia (Carnegie Institution for Science, USA)</b>	The contribution of faint AGN to reionization
<b>Ass. Prof. Elias Chatzitheodoridis (Earth Sciences Department, School of Mining &amp; Metallurgical Engineering, NTUA, Greece)</b>	Habitable environments on Mars: evidence from Martian meteorites



## 10. SERVICES

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### 10.1 Ionospheric Conditions / Observations

- ➔ The Athens Digisonde (<http://www.iono.noa.gr>) makes available in real time (24/24, 7/7) the following scientific observations:
  - Ionospheric observations that characterize conditions in real-time:
    - Vertical incidence ionograms
    - Autoscaled ionospheric characteristics
    - Drift velocities
    - Sky maps
    - Daily directograms
  - Ionospheric short-term forecasts for the next 24 hours
  - Alerts for expected ionospheric perturbations over Greece
  
- ➔ The European Digital Upper Atmosphere Server – DIAS, <http://dias.space.noa.gr> provides data that characterize ionospheric conditions over Europe in real-time:
  - Ionospheric conditions over Europe in real-time, updated every 15 min:
    - Ionograms from all European Digisondes
    - European maps of foF2, M(3000)F2, MUF, and of the electron density at various altitudes in the bottomside and topside ionosphere
    - The current ionospheric activity over Europe
  - Maps for long term prediction of the foF2 parameter over Europe for three months ahead, to be used for frequency management purposes
  - Maps for short term forecast of the foF2 parameter over Europe for the next 24 hours
  - Alerts for ionospheric storms over Europe based on solar wind and ionospheric data
  - Characteristics of travelling ionospheric disturbances over Europe
  
- ➔ Service to the Europe Space Agency: European Ionosonde Service (ESA-SSA) <http://swe.ssa.esa.int/web/guest/dias-federated> This is a special service developed to meet the requirements of the Space Situational Awareness Space Weather Segment for ionospheric nowcasting and forecasting services. It provides in real-time:
  - Maps of the Total Electron Content over Europe and analytical maps of the integrals of the electron density at the bottomside ionosphere, topside ionosphere and the plasmasphere,
  - Maps of the cut off frequency extended to cover middle and high latitudes in Europe.

**10.2 Predicting Solar Flares and Solar Energetic Particle (SEP) events with the FORSPEF tool.** The FORSPEF (FORecasting Solar Particle Events and Flares) tool (<http://tromos.space.noa.gr/forspef>) is a prototype system that consists of three modules aiming to forecast i) the likelihood of upcoming solar flare eruptions, ii) the occurrence of Solar Energetic Particle (SEP) events by making a prediction of the time before onset, and iii) the SEP characteristics for an upcoming event, respectively. FORSPEF incorporates two operational modes, the forecasting and the nowcasting mode. The former is understood as the pre-event mode, since no actual solar event (i.e. SF or CME) has yet taken place. The latter corresponds to the post-event mode, in which a solar event has actually taken place and its characteristics (for solar flares the longitude and the magnitude, and for CMEs the width and the velocity) are available.

The FORSPEF system is registered to the SEP Scoreboard Challenge of the Community Coordinated Modeling Center (CCMC) of NASA. FORSPEF provides continuous forecasts and nowcasts of SFs and SEP events in real-time. All outputs can be freely accessed and used by the scientific community and the general public.

**10.3 Urban Thermal Surveillance System from Space** From the homepage of the National Observatory of Athens (NOA) ([www.noa.gr](http://www.noa.gr)) the service «City Temperatures» is available to all interested parties.

**10.4 Calculation and Annual Publication of Calendar data from IAASARS.** Calculations of astronomical phenomena and other calendar data for different regions of the country requested by citizens and/or public and private organizations, by formal application to NOA. The calculations and publication of these data is handled by Dr. A. Dapergola and Dr. I. Bella-Velidis. The publication and distribution of these data is one of the financial resources of IAASARS.

## **11. CONTACT**

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*IAASARS Personnel in front of the Newall dome*