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INSTITUTE for ENVIRONMENTAL RESEARCH
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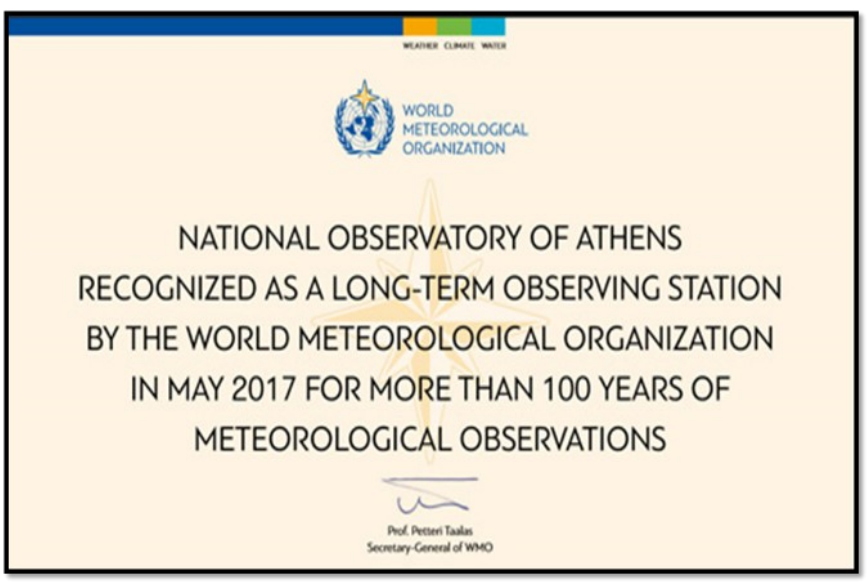
more than 170 years contribution to research and society

IERSD Activities 2018 – Executive summary



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1 INTRODUCTION

The Institute for Environmental Research and Sustainable Development (IERSD) is one of the 3 Institutes of the National Observatory of Athens (NOA). Although it was officially founded in June 1890 with its original name "Meteorological Institute", its contribution to the science of meteorology and climate began in 1858 with systematic daily meteorological and atmospheric observations in the center of Athens. In 1890, the IERSD meteorological station was upgraded to class 1 and was permanently transferred to the NOA's premises at the Nymph Hill in Thissio. Since then, it has been operating uninterruptedly. The Institute's climate observation time series are the longest time series in the country and the only source of information on the climate and its changes in our region. In May 2017, the NOA's historic station received an official certificate from the World Meteorological Organization (WMO), along with 60 other century-old stations around the world, for its contribution to the study of the climate change. During the five-year period 1891-6, a network of 22 climatic stations in other parts of the country was installed during D. Aeginitis' presidency. In 1931, the NOA network of meteorological stations numbered around 100 stations. The Institute created also the first Meteorological Service, which provided the first weather forecast in the country.

During its years of operations, and in response to modern scientific trends and demands, IERSD has expanded its scientific activities, making it an institute capable of studying most of the environmental issues. Today, the IERSD focuses on Meteorology, Climatology, Atmospheric Physics and Chemistry, Solar and Wind Energy, Climate Change, Natural Resources Management, Energy Saving, Hydrology, Air Quality, Surface and Ground Waters and, in general, the impact of development on the environment.

IERSD has a remarkable contribution both to the academic research and to the support of the State on critical decisions. The Institute has strong connections with national and international centers and services, and aims at increasing competitiveness and creating high added value in the economy, society, and the environment. The target of IERSD is to optimize the provision of services and support to the State, the private sector and the public through the research carried out, by collecting and processing data, and by participating in national and international research programs.

This report is the summary of the Institute's activities in 2018.

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2 AREAS OF EXPERTISE AND ACTIVITIES

2.1 Atmospheric chemistry

The atmospheric chemistry (with emphasis on gaseous and particulate pollutants) is monitored systematically, recorded and analysed for research purposes, public health protection, and to support decision-making. Various atmospheric properties and parameters (e.g., physical and optical properties, chemical composition) are studied to examine and interpret the physico-chemical processes taking place in the atmosphere and their contribution to the air quality, climate and human health. At the same time, methods and tools are developed and applied to identify the qualitative and quantitative contribution of different sources to the air pollution as well as atmospheric chemistry-transport models to study the spatio-temporal characteristics of pollution and the effect of human activities on the quality of the atmosphere, the climate, the ecosystems and the public health.

From 2015 and on, an integrated pollutant emission inventory for Greece and the greater area of Athens operates, which is expanded gradually. Neural network have also been developed for applications on particulate matter research, aiming at quantifying the effect of aerosols on the quality of the lower atmospheric layers through their effect on the radiation balance.

The Institute's activities include also experimental and numerical simulation studies of indoor air quality, noise and vibration measurements, as well as estimating and mapping noise levels using appropriate models. Furthermore, various parameters of solar radiation and natural lighting are recorded and monitored. Finally, in recent years, the effect of various atmospheric parameters on the corrosion of materials is examined.

In 2018, laboratory tests with filter-based measurements of light absorption by brown carbon (BrC) were performed. The water-soluble fraction of the fine aerosol fraction (PM2.5) is analysed spectrophotometrically with a one meter long liquid waveguide capillary cell (LWCC). With the recording of the absorption at multiple wavelengths (besides 365 nm corresponding to BrC absorption, five more wavelengths, i.e., 470, 590, 660, 880 and 950 nm) black carbon (BC) is measured too. The first results show that a very small percentage of BrC is detected at longer wavelengths so these (880 and 950 nm) absorption measurements are due exclusively the pure black carbon.

In winter 2018, the Aerosol Monitoring Station of IERSD provided for the seventh consecutive winter air pollution monitoring for smog episodes, to accurately and timely inform the State and the public. In February 2018, the Station's participation in the European experimental campaign of the EMEP / ACTRIS network was completed with success, aiming at quantifying the sources of Black Carbon (BC) in Europe.

In 2018, the analysis of the first years of fine particle measurements with fine temporal resolution was completed. This analysis was performed for the first time in Athens including the identification of the sources of the organic fraction of aerosols. It was found that the concentration of the organic fraction exceeded 100 μg m^{-3} on seven days during the studied period due to wood burning (Figure 1).

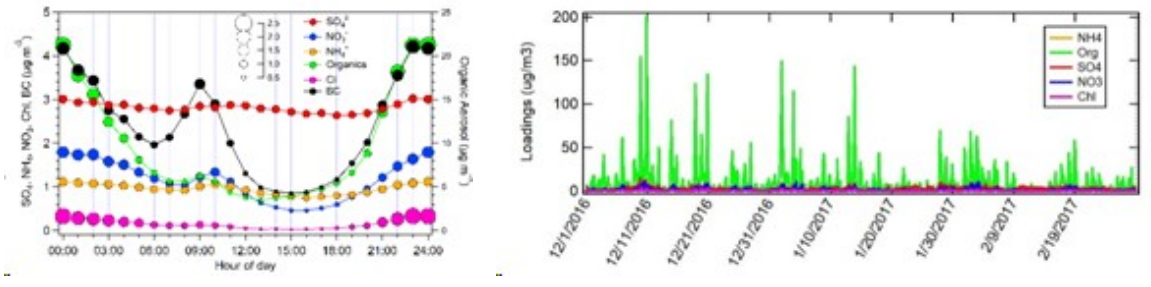


Figure 1: Main submicron aerosol constituents measured at Thission.

The IERSD Mobile atmospheric Pollution laboratory was used in September 2018 to assess the

environmental conditions after the Mati wildfire at East Attica in collaboration with the Environment & Climate Change Division of the Attica Prefecture. Specifically, air quality measurements were made at three locations within the affected area, focusing on vulnerable social groups, to investigate the exposure of the local population to potentially dangerous pollutants. The measurements included monitoring the particulate and gaseous air pollution with automatic continuous recordings and high temporal resolution. At the same time, soil samples were taken at ten points of the wider region and analysed for trace metals. This study indicated that in all samples the measured values were not greater than the average values appearing in the literature for the wider area of Athens.

Within 2018, targeted applications of the atmospheric model (meteorology-chemistry) COSMO-ART continued in Greece, and were focused on the area of Athens, aiming to study the effect of biomass combustion for domestic heating (Figure 2).

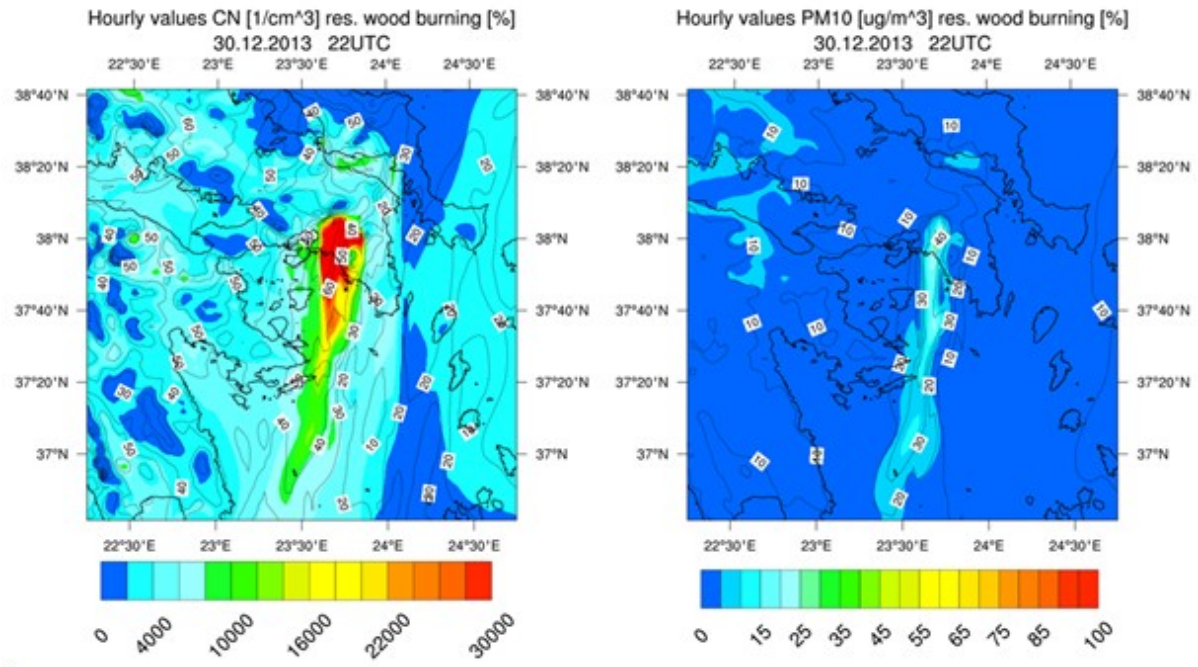


Figure 2: Concentration of particle number (left) and mass (right) during night time of the studied period.

2.2 Remote sensing applications

Continuous measurements of NO_2, HCHO, CHOCHO and O4 with the system MAX-DOAS take place in the Athens basin throughout the year on specific orientations (Figure 3).

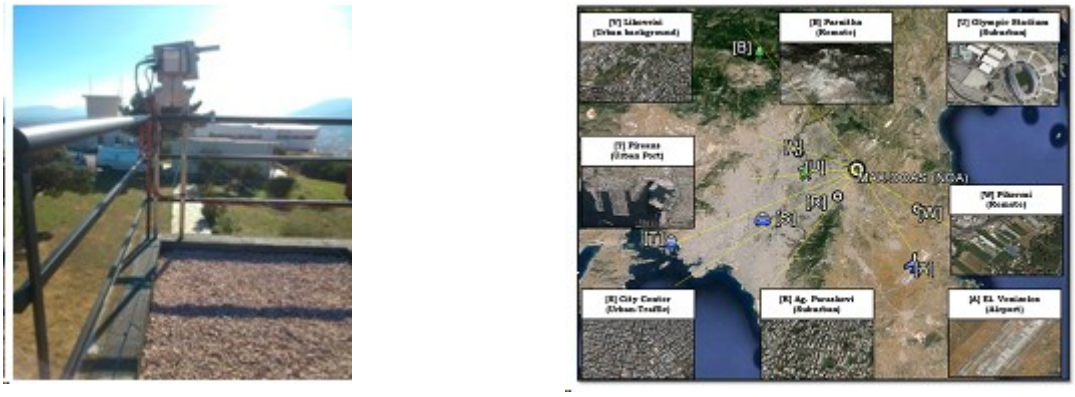
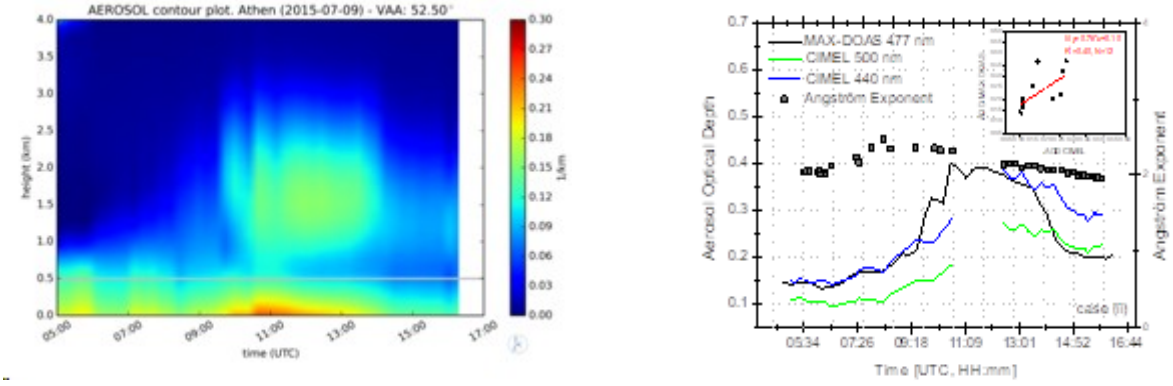


Figure 3: (left) The system MAX-DOAS at NOA premises at Penteli, (right) the orientations of measurements.

The data retrieval algorithm was parameterized in collaboration with the University of Bremen in order to calculate the vertical distribution of the suspended particles and thus their optical thickness

in the atmosphere. An initial effort was made to evaluate the results by comparing them with corresponding Lidar and CIMEL measurements in the Athens basin. This paper was published at the 11th International Conference on Air Quality - Science and Application, held in Barcelona, Spain, March 12-16, 2018, with the title 'Retrieval of aerosol vertical profiles over Athens using MAX-DOAS measurements'. Results from the implementation of the algorithm for the urban area of Athens are presented and compared with the corresponding CIMEL measurements (Figure 4). The comparison for the specific case study, which is characterized by the presence of fine particles, shows that the efficiency of the algorithm is quite satisfactory, especially regarding the optical thickness levels of the suspended particles.



(α) (β)

Figure 4: (α) Contour plot of aerosol extinction (β) aerosol optical depth measured with MAX-DOAS and CIMEL network of AERONET.

The Spectrophotometric Radiometric Platform, which measures the spectrum of the solar radiation, operates at the Thissio station. Among the measuring instruments, a Pandora spectrophotometer operates as part of the Pandonia global network. The measurements provide estimations of the vertical column of ozone and NO_2. The Pandora measurements are used also to study the quality of the atmosphere in cases of air pollution episodes, to derive long-term trends, and to calibrate the satellite measurements.

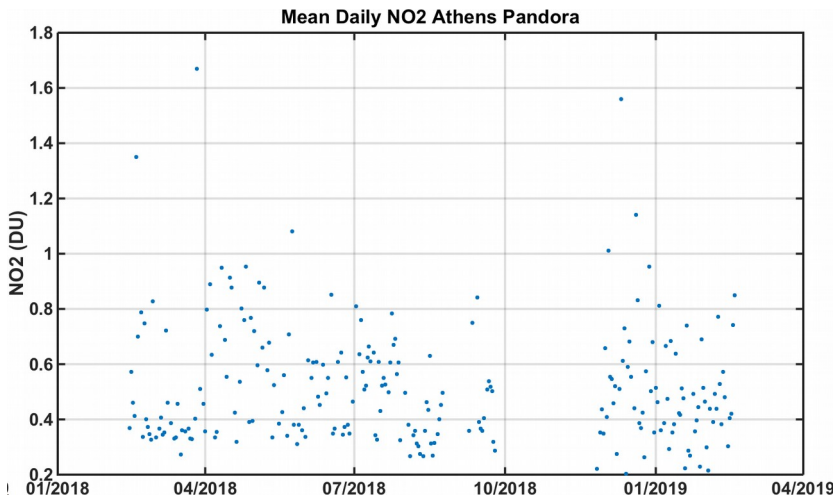


Figure 5: Daily measurements of the vertical column of NO_2 over Athens area.

2.3 Noise and vibration measurements – noise maps

The required infrastructure and know-how for noise and vibration measurements and noise assessment and mapping have been developed over the past 10 years using appropriate models and methodologies in line with the requirements of the Environmental Noise Directive 2002/49/EC.

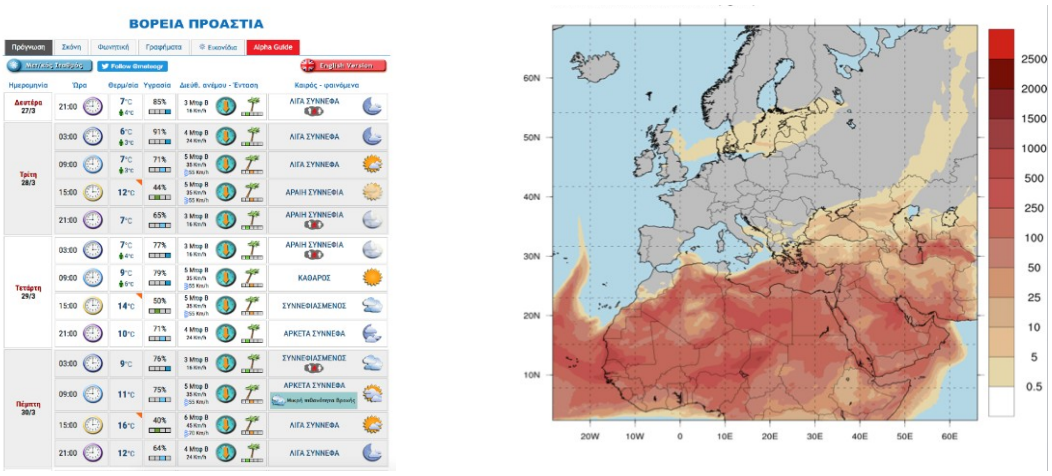
In 2018, research was carried regarding the exposure to urban noise using a noise model and appropriate statistical analysis of the results obtained from measuring campaigns carried out in previous years during the participation of IERSD as a consultant in projects of the Ministry of Environment and Energy for the strategic mapping of environmental noise in urban areas. In this context, the noise model was upgraded and fully updated with the Common Assessment Methods in EU CNOSSOS-EU, defined by Directive 2015/996/EC, with effect from 31/12/2018.

During 2018, IERSD prepared the Strategic Map of Noise and Action Plans in Greece contributing to the Environment Status Report 2018 of the National Center of Environment and Sustainable Development in the context of the implementation of the END for urban developments, road axes, and the Athens International Airport. The report summarizes the results of all the studies and presents a synthesis and evaluation of the data, and assess the status of the acoustic environment in Greece.

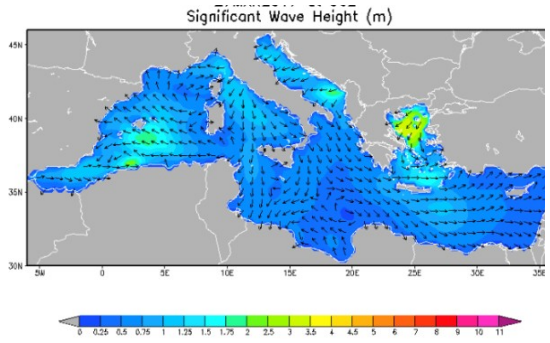
Figure 6: Noise measurements with the IERSD mobile station.

2.4 Numerical models and weather forecast

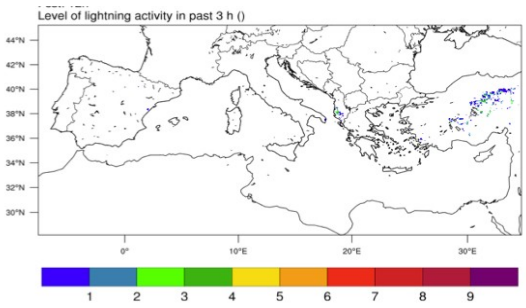
Operational weather forecasting is provided online at www.meteo.gr site (Fig. 7). This site was launched in June 2001. It is the simplified version (in Greek) of the already existing page of the National Observatory of Athens (http://www.noa.gr/forecast). The design and development of the site aims at providing weather forecasts for the public. Operational weather forecasting includes also lightning forecast, dust forecast, wave forecast in the Greater Mediterranean Region, and wildfire spread.



(α) (β)



(γ)



(δ)

Figure 7: Forecast of (α) weather meteo.gr, (β) dust, (γ) wave, (δ) lighting.

2.5 Extreme weather events

The observation and study of the intense weather phenomena is made by employing the network of meteorological stations installed in the Greek territory, the ZEUS electric discharging network, the analysis of satellite observations, and the implementation of advanced numerical models. Furthermore, the meteorological radar XPOL installed at Penteli is used for studying the processes associated with extreme weather events.

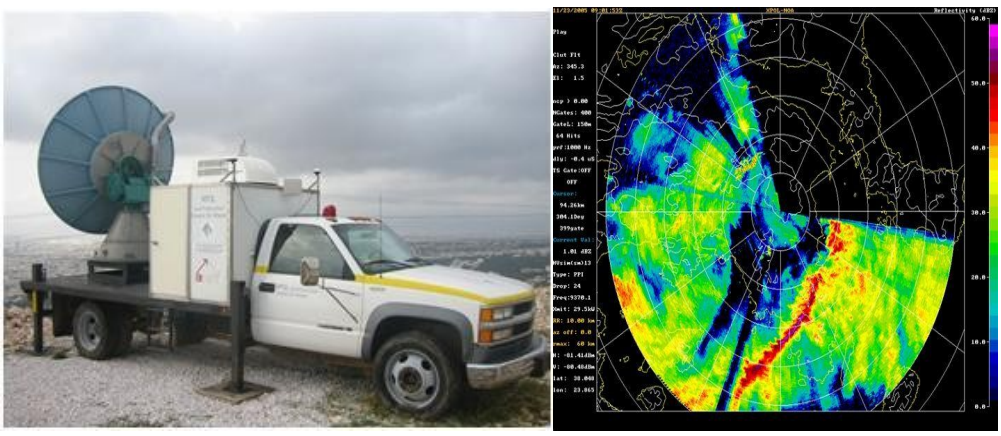


Figure 8: (α) Meteorological radar, (β) radar display, reflectivity.

2.6 Solar energy and wind power

IERSD has developed the Meteorological Radiation Model, an analytical model for estimating the intensity of the incident solar radiation on a horizontal plane in Greece based only on meteorological parameters.

Furthermore, an operational solar energy tool has been developed (nextSense), which has been applied for both real-time estimation and two hours ahead forecast. The method is based on the use of real time satellite images from the MSG satellite in conjunction with models for the propagation of solar radiation and neural networks. The outputs of the tool are the horizontal surface energy and the direct irradiance provided with a resolution of 7 km^2.

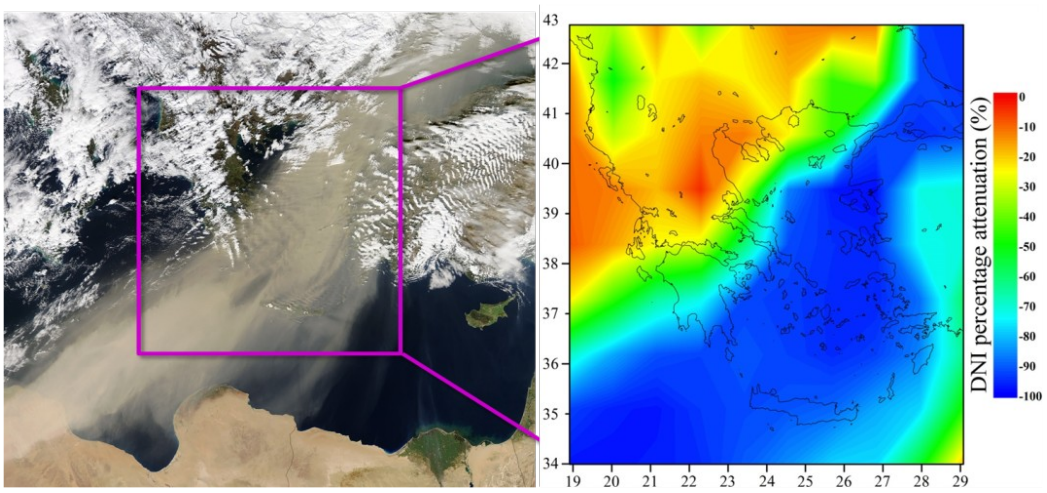


Figure 9: Attenuation of the solar irradiance due to dust event of 1st February 2015 (right)and the corresponding satellite image (left).

The model nextSense has been applied during the project Geo-Cradle (http://geocradle.eu/en/regional-capacities/feasibility-studies/) at:

- BlueStar Ferries at Aegean sea and SuperFast Ferries at Adriatic sea, Ministry Of Electricity And Renewable Energy of Egypt.
- Crete, Greece, Independent Power Transmission Operator, The PRE-TECT campaign
- Egypt, Solar Atlas of Egypt, (http://geocradle.eu/wp-content/uploads/2018/03/SOLAR-ATLAS-2018-digital1.pdf).

2.7 Hydrological research

The hydrology team of IERSD is running the HYDRO-NET research project since the end of 2017. The aim of the project is to upgrade the existing streamflow gauge infrastructure of NOA, and develop a hydro-telemetry network for the monitoring of surface water bodies, with the long-term objective to obtain experience for designing and optimal operation of monitoring networks in the Greek Territory. These networks will provide data to the Open Water Information System OpenHi.net. In 2018, the report on Best Hydrometry Practices was completed and systematic hydrological measurements were carried out by the hydrology team at the locations of the stations to update the flow-level curves (rating curves).

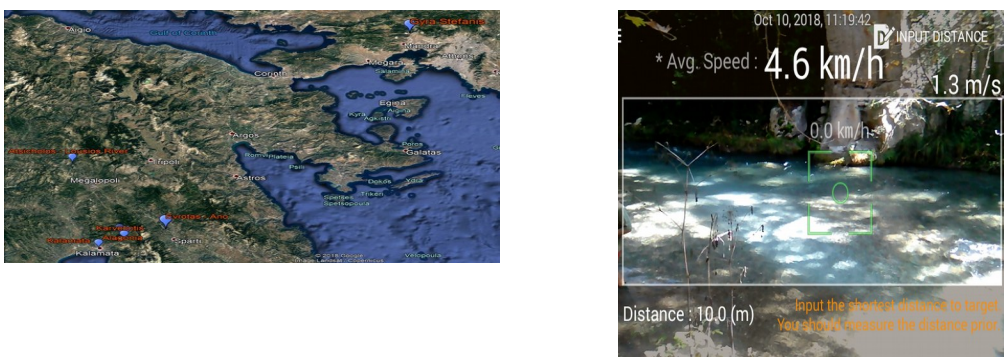


Figure 10: Upper left: HYDRO-NET gauging stations by the end of 2018. Upper right: rough speed estimation with Android applications.

2.8 Climate Change

Research in this field focuses on studying the climate trends and the extreme weather events of the past, present and future, assessing the environmental, economic and societal impacts of climate change, and designing adaptation and/or mitigation measures. Furthermore, the greenhouse gas emissions from various economic activities are studied, and the efficiency and financial attractiveness of estimated emissions, and the design policies to build low-carbon economies are assessed.

The study of the timing of extreme weather phenomena regarding the occurrence of the first and last hot extremes in a year and consequently of the possible changes in the duration of the hot season was completed and submitted to a journal in 2018. The survey showed for the areas of the Greece and Cyprus a significant gradual shift earlier in the year on the date of first extreme temperatures and gradual lengthening of the hot season. The paper was published in the journal Global and Planetary Change (Founda et al., 2019, https://doi.org/10.1016/j.gloplacha.2019.02.012).

During 2018, a survey was launched on the change of the heat stress in Athens over the last decade. The results were submitted to the International Journal of Biometeorology (IJBM-D-18-00444). In this study, both simple and more sophisticated bioclimatic indicators were used, which indicated that the period of "thermal discomfort" has increased at a rate of 4-11 days/decade (depending on the index) from 1960. The work was carried out within the framework of the THESPIA II.

In 2018, IERSD started a collaboration with several universities around the world to create a global inventory of meteorological data before 1850. The initiative is led by the Institute of Geography and Oeschger Center and the consortium consists of large research centers like Stockholm University, Melbourne University, Met-Office, University of East Anglia, etc.

The National Observatory of Athens is the coordinator of the LIFE ADAPT2CLIMA project: Adaptation to Climate change Impacts on the Mediterranean islands' agriculture. LIFE ADAPT2CLIMA main objective is to increase knowledge on the vulnerability of EU Mediterranean agriculture to climate change and to support decision making for adaptation planning. The project implementation area comprises Crete (Greece), Sicily (Italy) and Cyprus (three of the largest islands of the Mediterranean Europe). More information can be found at: http://www.adapt2clima.eu/el.

In order to support decision-making, a tool was developed to map the vulnerability assessment of rural areas and to evaluate adaptation measures. This tool uses data from two state-of-the-art regional climatic models (RCA4-MPI and RCA4-MOHC) and was developed under the project EURO-CORDEX (http://www.euro-cordex.net). Figure 11 shows a screenshot of the tool.

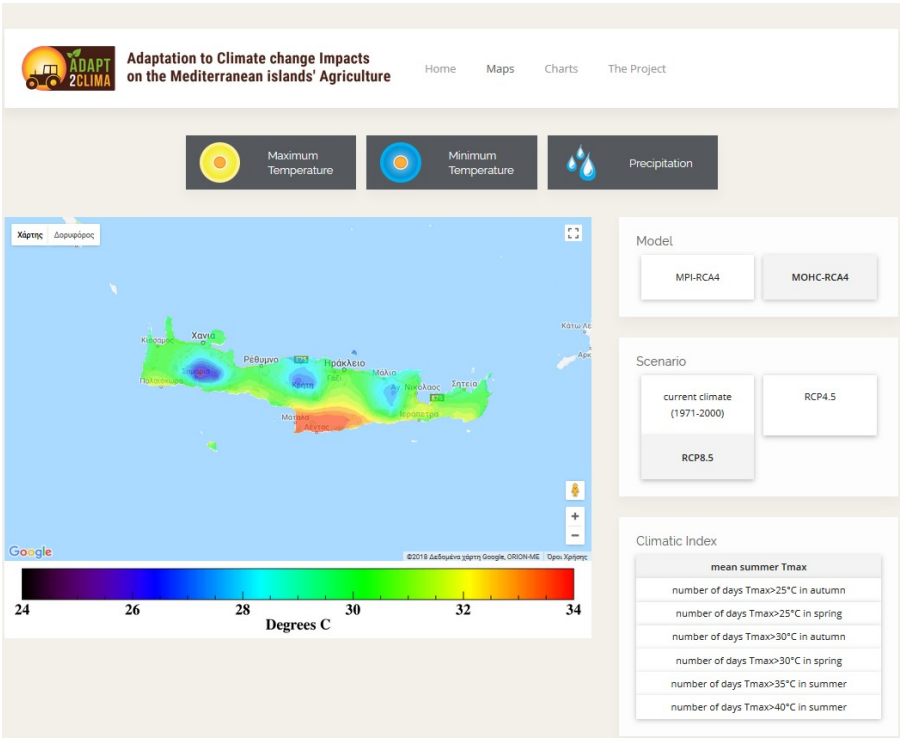


Figure 11: Map of climate indicators related to agriculture and mean summer temperature for the period 2031-2060 obtained from RCA4-MOHC for the representative concentration pathway RCP8.5.

During the TRIBUTE project, the future trend for extreme rainfall events has been studied for five European Union member countries (Greece, Italy, the Netherlands, Spain and Bulgaria). Daily rainfall data from regional climatic models was used, taking into account two different emission scenarios: the modest RCP4.5 scenario and the most extreme RCP8.5. Fluctuations in annual and seasonal rainfall as well as changes in extreme rainfall indicators for two future periods (2021-2050 and 2071-2100) were investigated.

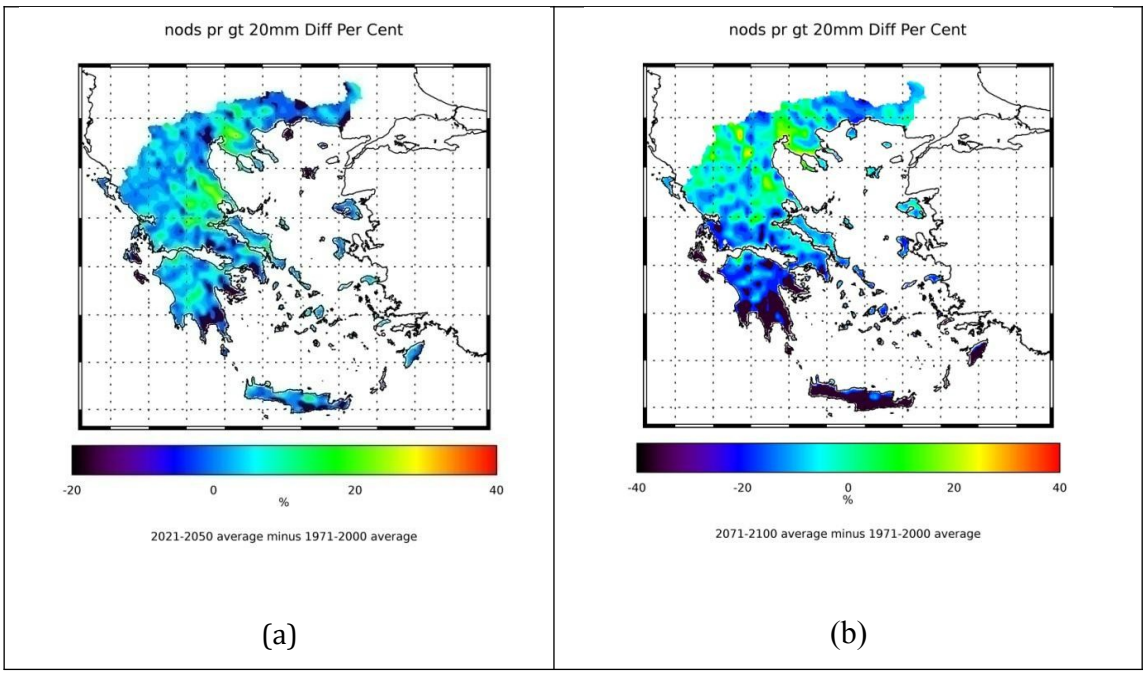


Figure 12: Percentage change (from current conditions) of the number of days with rainfall > 20 mm for the period 2021-2050 (a) and 2071-2100 (b) for the representative scenario RCP8.5.

2.9 Energy and environment

The physical properties and processes related to the insulation and energy conservation are studied to understand the energy performance of buildings. Specialized tools of thermal simulation and fluid dynamics are employed. The potential benefits of the integration of innovative energy saving systems and renewable resources are investigated. Methodologies and tools are developed to assess the energy performance of buildings aiming at the virtually zero energy consumption buildings. Classification of the buildings is carried out based on prominent typological characteristics. Also, a study of issues related to environmental and energy management is carried out.

During 2018, IERSD participated in the European project CESBA MED for Sustainable Mediterranean Cities that aims at an innovative decision making process based on synergies in energy efficiency, a common sustainability assessment framework at urban scale employing a set of 8 regional assessment tools (CESBA MED SNTool), and an innovative decision making process. The pilot application in Greece was successfully completed in the Filis Municipality. More information can be found at: https://www.energycon.org/CESBA-MED_booklet_GR.pdf.

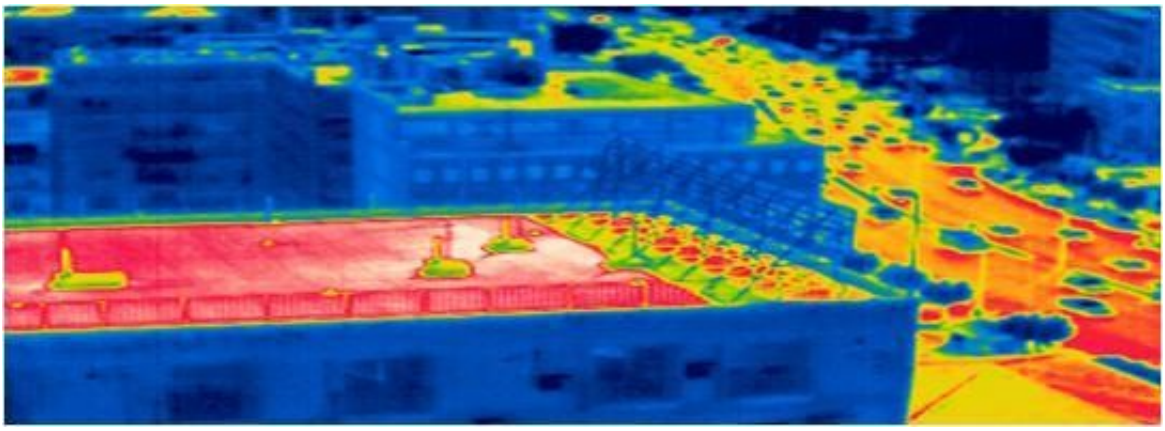


Figure 13: Thermal image of a building.

In 2018, in cooperation with Technical Chamber of Greece (TEE) it was further developed the TEE-KENAK tool. This is the official national computational tool for the calculation of energy efficiency and the issuance of energy performance certificates for Greek buildings, Up to this moment it has received more than 1,500,000 applications.

2.10 Material corrosion

IERSD is studying the effect of various atmospheric parameters (temperature, humidity and rain, and pollutants such as sulphur dioxide and ozone) on corrosion of materials. The study focuses on the materials common in ancient monuments (e.g., marble, limestone), but extends also to materials used in modern constructions such as glass and aluminium. The aim of the study is the calculation and mapping of the rate of corrosion of the above materials in areas of interest of the country with the final objective to indicate measures for the prevention of disasters in the materials. Figure 14 shows surface corrosion (SC) in μm in the Greater Athens area.

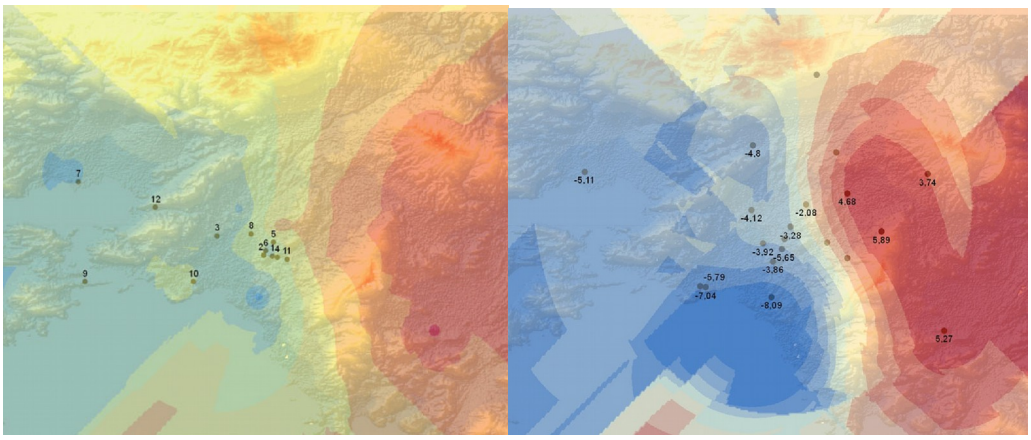


Figure 14: Left, corrosion of marble for the period 2000-2009, blue SC≈2 µm, red SC≈3,7 µm. Right, corrosion rate of iron, blue -8 g/m^2/y, red 5 g/m^2/y.

3.1 Environment Annual Report 2018

The National Center for Environment and Sustainable Development (EKDPA) presented the Environment Annual Report 2018. This is the 4th report ever issued describing the state of the environment in Greece in terms of climate change impact, air quality, noise, nature, water, and waste disposal, according to the latest available data. IERSD was in charge in writing 3 among the 6 chapters (climate change impact, air quality, noise). The report can be found at: http://ekpaa.ypeka.gr/index.php/soer-2018.

3.2 ΠΑΝΑΚΕΑ-PANACEA: Greek network to study climate change and atmospheric chemistry

The National Observatory of Athens (institutes IERSD and IAASARS) has an important role among the 14 participants of the National Research Infrastructure PANACEA. PANACEA aims at creating a coordinated national network for monitoring atmospheric chemistry, changes in solar radiation, climate change and related natural hazards, by integrating all existing Greek terrestrial networks (e.g., ground, LIDAR and AERONET aerosol monitoring stations, meteorological RADARs, solar radiation networks, etc.) aiming at scientific excellence and innovation. More information at: https://panacea-ri.gr/.

Figure 15: PANACEA logo.

3.3 Historical observations of cloudiness from 19th century

Researchers of IERSD, in collaboration with the University of Athens, studied the cloudiness time series of NOA. The study revealed that the cloud cover in Athens has fluctuated significantly from the late 19th century up to present time with an increasing trend, which is higher in the hot season of the year (Figure 16). This increase is not the same for all types of clouds. Particularly, since the mid-20th century, there has been a significant increase in the incidence of low (<2000m) and high altitude (> 6000m) clouds, as opposed to the mid altitude clouds that have declined. The research also showed a decrease in the prevalence of low clouds, but an increase in the convective cloud, which is in agreement with studies in other parts of the world.

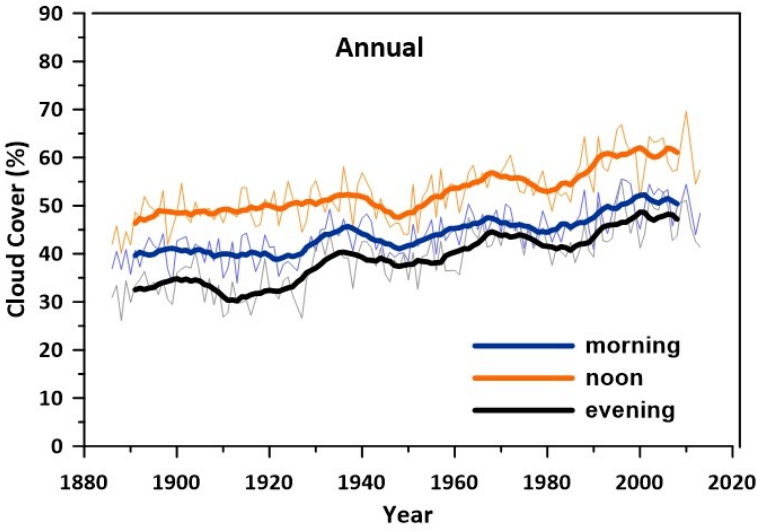


Figure 16: Athens cloudiness from 1882.

3.4 Project DISARM: The Mati wildfire

The project DISARM, coordinated by IERSD, is funded by the European Union and aims at developing state-of-the-art observation and modelling techniques to prevent and manage droughts and forest fires. The tools of this project were used to investigate the meteorological conditions that contributed to the rapid spread of the deadly wildfire of July 23, 2018 in Mati, Attica.

On July 23, 2018, Attica was affected by a major wildfire that occurred in a mixed zone (forest and urban) and exhibited a unique behaviour characterized by a very fast spread. It killed 102 citizens, being the second most deadly natural disaster due to weather in Greece after the heat wave of July 1987. The meteorological conditions can be classified in the following stages: 1) development of strong west winds in Western Attica, 2) strengthening the western current due to a great difference in pressure between the north-south, 3) stormy west winds in Eastern Attica, 4) very high temperatures on the coasts of Eastern Attica and persistence of dry conditions for 10 hours.

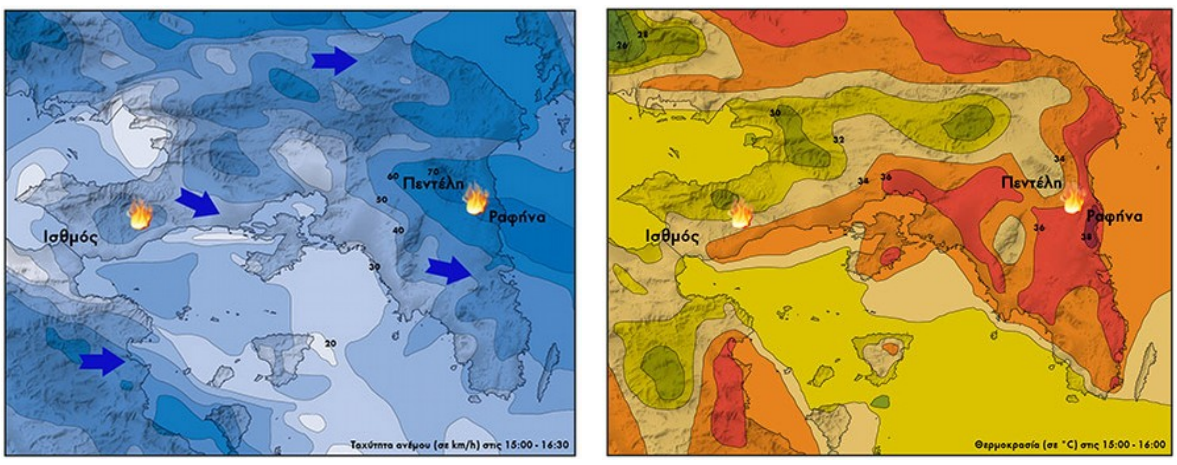


Figure 17: Left: wind filed during 12:00-13:00 of 23 July 2018, Right: temperatures during 15:00-16:00 of 23 July.

In conclusion, the air masses over Mount Penteli accelerated and created a fast, very hot and dry flow (Figure 18 left). The results of the modelling (Figure 18 right) showed that WRF-FIRE is capable of properly simulating the spatial distribution of the spread of wildfires.

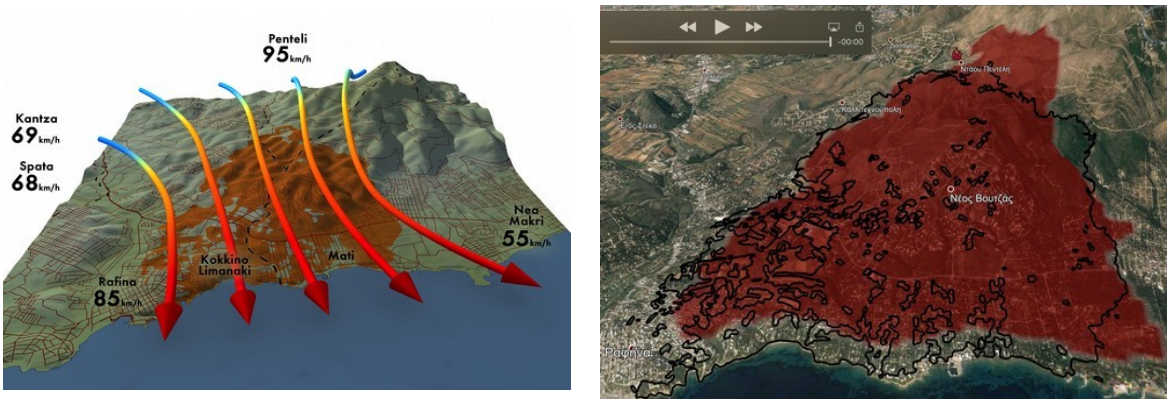


Figure 18: Left: conceptual model of drifting winds during Mati wildfire event, Right: wildfire spread according to WRF-SFIRE model(red) and burnt area from satellite image (black).

4 SCIENTIFIC PUBLICATIONS

Table 1 reports the publications per researcher during 2018 according to the Web of Science database.

Table 1: Publications and citations during 2018 of IERSD researchers according to Web of Science

Name	Publications 2018	Total number of publications	Citations 2018	Total no. of citations	Total no. of citations excluding self refs.	H index	Citations /publication
Nikolaos Mihalopoulos	23	290	1229	11879	10282	57	41
Evangelos Gerasopoulos	3	79	295	2725	2489	32	34
Christos Giannakopoulos	2	82	244	2032	1903	24	25
Harry Kambezidis	2	139	221	2647	2214	29	19
Anastasia Kotronarou	0	24	57	1063	1018	17	44
Vassiliki Kotroni	11	118	315	2084	1650	25	18
Kostas Lagouvardos	9	111	276	1869	1469	24	17
Sevastianos Mirasgentis	0	40	122	1201	1170	19	30
Constantinos Balaras	1	63	278	2594	2501	29	41
Adrianos Retalis	4	35	96	510	474	13	15
Vassiliki Assimakopoulos	4	36	96	755	724	15	21
Elena Georgopoulou	0	29	271	1417	1396	17	49
Elena Dascalaki	0	34	145	1261	1224	22	37
Stylianos Kazadzis **	17	103	330	2436	2133	30	24
John Kalogiros	4	40	79	514	442	14	13
Nikolaos Sakelariou	0	19	8	140	137	5	7
Ioannis Sarafidis	1	29	75	903	889	15	31
Dimitra Founda	2	31	99	970	943	15	31
Vassilis Psiloglou	3	37	72	540	487	14	15
Eleni Liakakou	3	15	76	574	545	11	38
Stelios Myriokefalitakis	2	23	182	945	877	12	41
Evangelos Rozos	3	16	51	248	211	9	16
Nenes Athanasios*	23	269	1989	12955	11062	60	48
Antonis Koussis***	2	72	86	963	769	18	13
Michael Petrakis ***	0	46	83	1315	1301	19	29
Dimitris Katsanos	2	15	45	176	163	8	12
Maria Lianou	1	11	18	227	214	7	21
Katerina Mazi	1	15	41	195	159	8	13
Angelina Metaxatos	0	5	4	96	92	4	19
Katerina Papagiannaki	1	8	19	130	123	5	16
Kalliopi Droutsa	0	17	85	664	642	13	39
Simon Kontogiannidis	0	13	64	507	486	11	39
Theodora Kopania	1	1	3	7	7	1	7
Frangiskos Pierros	1	4	6	31	31	3	8
Total	***126***	***1869***	***7060***	***56573***	***50227***	***18***	***26***

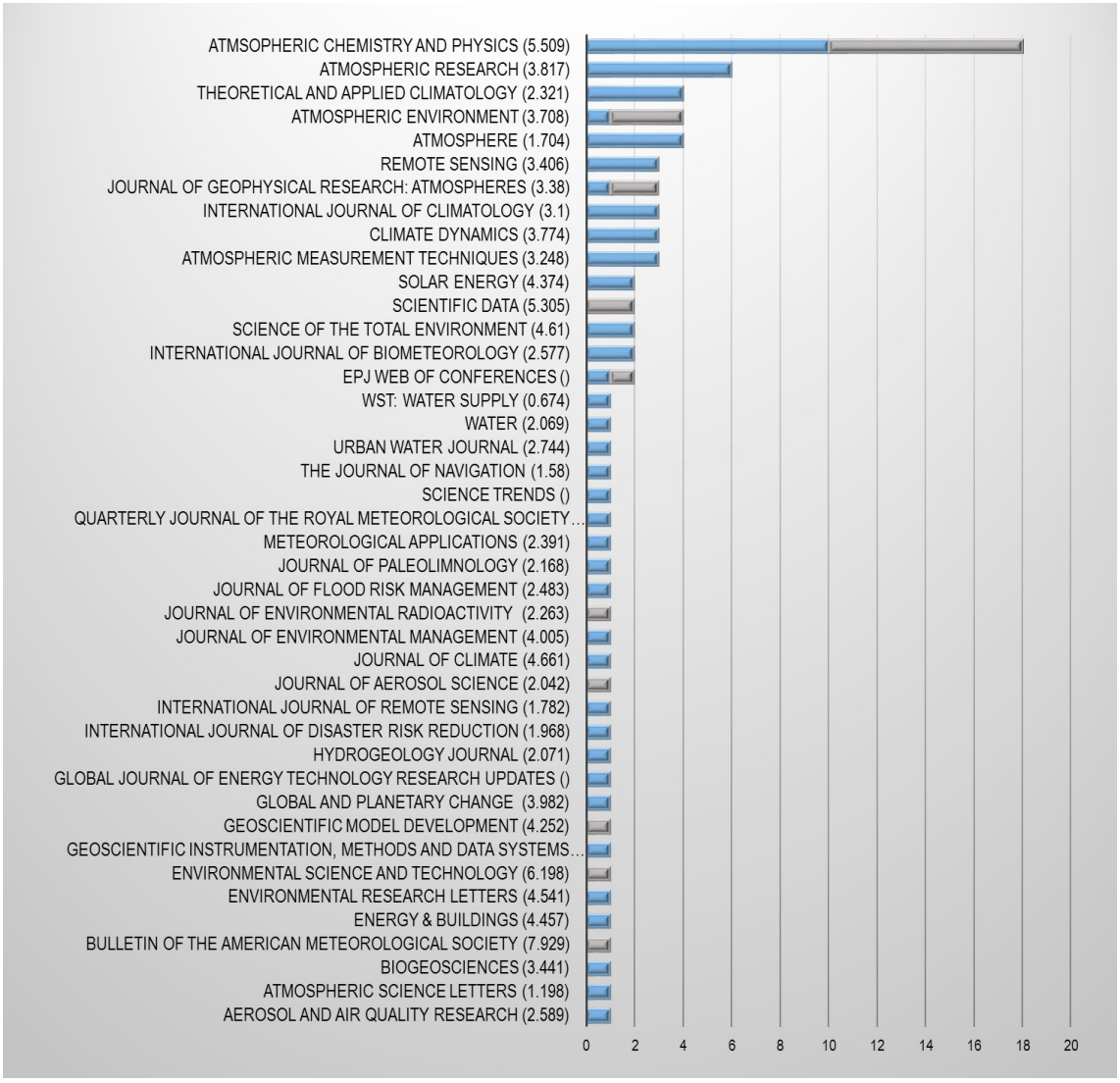


Figure 19: Publications per scientific journal of IERSD researchers during 2018 (grey: collab. researcher).