2nd Scientific Conference PANACEA

Web Conferencing

29 September – 1 October 2020

Program and Book of Abstracts

PANACEA

PANhellenic infrastructure for Atmospheric Composition and climatE chAnge

European Union
European Regional Development Fund

HELLENIC REPUBLIC
MINISTRY OF DEVELOPMENT AND INVESTMENTS
SPECIAL SECRETARIAT FOR ERDF & CF PROGRAMMES
MANAGING AUTHORITY OF EPAnEK

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PANACEA

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 hot spot 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 CO2 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/ renewable PANACEA will act as a hub for the next generation of environmental scientists and attract promising young researchers for research and industry, bridge science with industry and entrepreneurship, induce new local jobs, new investments and market at national, EU and international level, in line with EU priorities. PANACEA is implemented under the action "Reinforcement of the Research and Innovation Infrastructure", funded by the operational program "Competitiveness, Entrepreneurship and Innovation" (NSRF 2014-2020) and co financed by Greece and the European Union (European Regional Development Fund).

1st Scientific Conference PANACEA, University of Crete, Heraklion, 23-24th September 2019

Program

Second scientific conference PANACEA

Web Conferencing

29 September – 1 October 2020

DAY 1 – Tuesday 29.09.2020

Orals - 10 min presentation + 5 for questions

Posters – will have a 2 min oral introduction of the poster with only 1 slide that includes title, authors, interest of the study, methodology and conclusion. This slide has to be sent to the organizers panacea@chemistry.UoC.gr the latest one day before the presentation for inclusion in the merged ppt of the poster session. In addition, the posters will be disposed the latest the day before the poster session in the protected web site of the conference (internal to PANACEA website) in the 1-page pdf or as a pdf with 10 slides max. The questions/comments poster session will be held through slack.

Oral presentations-1.1 (12:00-13:15)

5 min Introductory remarks

25 min PANACEA Objectives and progress so-far general overview (**Nikos Mihalopoulos,** UOC/NOA)

15 min PM2.5 source apportionment in Greek urban and background environments (**Evaggelia Diapouli**, Demokritos)

15 min First time MAX-DOAS observations of tropospheric NO2 and HCHO columns in Ioannina, Greece during the PANACEA winter 2020 campaign (**Dimitrios Karagiozidis**, AUTH)

15 min The impact of biomass burning for heating on Ioannina city's air quality during winter time (**Christina-Anna Papanikolaou**, NTUA)

Poster session 1.1 (13:15-13:30)

2 min Investigating variations in the PM2.5 concentrations over Thessaloniki station during the PANACEA campaigns using different measurement techniques (**Anthi Chatzopoulou**, AUTH)

2 min Monoterpenes and Isoprene in the city of Athens: Natural vs anthropogenic origin and estimation of their contribution in secondary atmospheric pollutants' levels (**Anastasia Panopoulou**, UoC/NOA)

2 min Identification of key aerosol types in Athens based on long-term in situ optical and chemical properties (**Dimitris Kaskaoutis**, UoC/NOA)

2 min Overview of the two PANACEA campaigns for Thessaloniki station: Aerosol typing from remote sensing techniques and in situ data (**Kalliopi-Artemis Voudouri**, AUTH)

2 min Comparison of in situ and remote sensing instruments at the Helmos free troposphere background station (**Stergios Vratolis**, Demokritos)

Discussion of poster on slack+

45 min break for lunch or coffee (13:30-14:15)

Oral presentations-1.2 (14:15-15:30)

15 min First results of the summer 2020 campaign (**Spyros Pandis**, ICE-HT)

15 min Night-time chemistry of biomass burning plumes in urban areas: A dual mobile chamber study (**Spiro Jorga**, ICE-HT)

15 min The impact of wildfire aerosols on global and regional climates (**Apostolos Voulgarakis**, TUC)

15 min Implementation of a dosimetry model for calculation of deposited dose of particulate matter (PM) in different locations in Greece (**Sofia-Eirini Chatoutsidou**, TUC)

15 min Ozone and carbon monoxide measurements at the Navarino Environmental Observatory (NEO) in Messenia, Greece (**Theodora Stavraka**, BRFAA)

Poster session 1.2 (15:30-15:45)

2 min Properties of biomass burning particles as observed in PANGEA observatory (**Anna Gialitaki**, NOA/AUTH)

2 min Investigating Fire Events in the Mediterranean area using satellite-derived products (**Eleni Kalogeraki**, UoC)

2 min Intercomparison of three collocated multi-wavelength aerosol lidar systems at the National Technical University of Athens' Campus during 2020 (**Alexandros Papayannis**, NTUA)

2 min Aerosol optical, chemical and radiative properties of a 3-day dust event observed over Athens, Greece using laser remote sensing and modelling (**Ourania Soupiona**, NTUA)

2 min The effect of air quality and clouds on surface solar radiation over Greece (**Georgia Alexandri**, AUTH)

2 min The role of dust minerals in the atmosphere as precursors of Ice Nuclei Particles (**Marios Chatziparaschos**, UoC)

Discussion of poster on slack

End of day-1

Day 2- Wednesday 30.09.2020

Oral presentations-2.1 (12:00-13:15)

15 min COVID-19 campaign (**Doina Nicolae**)

15 min Changes in nitrogen dioxide levels over Greece after the outbreak of COVID-19; a satellite view (**Maria-Elissavet Koukouli**, AUTH)

15 min A satellite assessment of dust aerosol episodes over the broader Mediterranean Basin. Patterns of seasonal and inter-annual variability (**Maria Gavrouzou**, UoI)

15 min Case study analysis of aerosol shortwave radiative forcing over Athens, using the FORTH radiative transfer model, multi-wavelength Raman-lidar measurements and satellite observations (**Vasileios Stathopoulos**, UAegean)

15 min Global trends of Aerosol and Dust Optical Depth based on MIDAS fine resolution dataset during 2003-2017 (**Stavros-Andreas Logothetis**, UPatras)

Poster session 2.1 (13:15-13:30)

2 min Changes in PM and atmospheric potential gradient during the COVID measures at Xanthi (**Athanasios Karagioras**, DUTH)

2 min Observations of aerosol load in PANGEA during COVID-19 lock-down and relaxation period (**Eleni Marinou**, NOA)

2 min Investigating variations in the aerosol load over Thessaloniki during the COVID-19 lock-down period in Greece using the remote sensing infrastructure of PANACEA (**Nikolaos Siomos**, AUTH)

2 min MAX-DOAS retrieval of aerosol and NO2 vertical profiles over Thessaloniki, Greece (**Dimitrios Karagiozidis**, AUTH)

2 min Total Nitrogen Dioxide column amount over Thessaloniki, Greece and comparison with satellite data (**Fani Gkertsi**, AUTH)

2 min Detection of NO2 plumes from individual ships over the Mediterranean with the TROPOMI/S5P (**Aristeidis Georgoulias**, AUTH)

Discussion of posters on slack +

45 min break for lunch or coffee (13:30-14:15)

Oral presentations-2.2 (14:15-15:15) -mini sensors

15 min Improving the uncertainty of air quality microsensors via computational intelligence methods (**Konstantinos Karatzas**, AUTH)

15 min Evaluation and Field Deployment of Low-cost PM Sensors in Different Urban Environments in Greece (**Iasson Stavroulas**, NOA/UoC)

15 min Autonomous ground based integrated path differential absorption device for remote sensing of atmospheric CO2 and CH4 (**Panagiotis Siozos**, FORTH)

15 min New insights into the impact of atmosphere-sea interactions on carbon sequestration in the Eastern Mediterranean Sea: a three-year time-series study in the deep Ierapetra Basin (**Constantine Parinos**, HCMR)

Poster session 2.2 (15:15-15:30)

2 min	Coccolithophore production and export in three deep-sea sites of the Aegean and Ionian Seas (Eastern Mediterranean): Biogeographical patterns and biogenic carbonate fluxes (**Elisavet Skampa**, NKUA)
2 min	Evaluation of the LOTOS-EUROS NO2 simulations using ground-based measurements and S5P/TROPOMI observations over Greece (**Ioanna Skoulidou**, AUTH)
2 min	Comparison of inferred S5P/TROPOMI NO2 surface concentrations with in-situ measurements over Central Europe (**Andreas Pseftogkas**, AUTH)
2 min	Observed trends of greenhouse gases at Finokalia monitoring station (**Nikos Gialesakis**, UoC)
2 min	Variability of CO2, CH4 and CO column averaged mixing ratios from one and a half year of measurements in Thessaloniki, Greece, using a portable EM27/SUN FTIR spectrometer (**Marios Mermigas**, AUTH)
2 min	Investigation of volcanic emissions in the Mediterranean: “The Etna-Antikythera connection” (**Anna Kampouri**, NOA)

Discussion of posters on slack

***End of day 2* (16:30)**

Day 3 – Thursday 1.10.2020

Oral presentations-3.1 (12:00-13:30)

15 min Fast climate responses from present-day aerosols in a CMIP6 multi-model study (**Prodromos Zanis**, AUTH)

15 min Electrified Saharan Dust: Does it reach Greece? An overview of the electrical activity of Saharan dust inferred from surface electric field observations (**Vasiliki Daskalopoulou**, NOA)

15 min The potential of a synergestic lidar and sunphotometer retrievals for aerosol model evaluation (**Dimitra Konsta**, NKUA)

15 min Design and Development of a Lidar Temperature Profiler. The first low cost prototype (**Giorgos Georgousis**, RAYMETRIC's founder and in-house LIDAR expert)

15 min Turning research data to commercialized services and applications (**Panagiota Syropoulou**, DRAXI's Project Manager)

Poster session 3.1 (13:15-13:30)

2 min The influence of different aerosol properties and types on direct aerosol radiative forcing and efficiency in Europe and Mediterranean area (**Stavros-Andreas Logothetis**, UPatras)

2 min Study of the Planetary Boundary Layer Height over selected sites in Greece during Panacea Campaigns (2019-2020) using multi-wavelength aerosol lidar systems (**Romanos Foskinis**, NTUA)

2 min Planetary Boundary Layer Height retrievals using Polly-XT Lidar water vapor acquisitions (**Ioanna Tsikoudi**, NOA)

2 min Induced errors in Direct Normal Irradiance due to uncertain Aerosol Optical Depth from CAMS reanalysis project (**Vasileios Salamalikis**, UPatras)

2 min EVE lidar: The passport of EARLINET lidar systems towards Aeolus Cal/Val studies (**Peristera Paschou**, NOA)

2 min First assessment of AEOLUS L2A products in the framework of PANACEA: Cal/Val aspects and evaluation results (**Antonis Gkikas**, NOA)

Discussion of posters on slack

15 min Closing remarks - end of Conference (13:30-13:45)

45 min break for Coffee /lunch (13:45-14:15)

15 min Remarks from GSRT (**Antonis Gypakis**, GSRT)

90 min General Assembly (14:30-16:00)

40 min Comments by the Managing Authority (EPAnEK), GSRT and the Advisory Board

20 min Publications, progress reports, deliverables status, new instrumentation, personnel and budget status (**Evangelia Tzitzikalaki**, UoC)

30 min Status of PANACEA campaigns (past, ongoing and future), other

Oral and Poster Presentations

In first Author's Alphabetic order

The effect of air quality and clouds on surface solar radiation over Greece

Alexandri, G.[1*], **Georgoulias, A.K.**[1], **and Balis, D.**[1]

Laboratory of Atmospheric Physics, Physics Department, Aristotle University of Thessaloniki, Thessaloniki, Greece

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In this work, the effect of aerosols, clouds and tropospheric NO_2 on surface solar radiation (SSR) are studied over the two large metropolitan centers of Greece, Athens and Thessaloniki, for the period 2005-2019 by performing simulations with the SBDART radiative transfer model. Ground-based and satellite observations are used as input. The core data are taken from the AERONET sun-photometer ground network (aerosol optical properties), the Moderate Resolution Imaging Spectroradiometer (MODIS) onboard the EOS Aqua satellite (aerosol and cloud optical properties and water vapor), and the Ozone Monitoring Instrument (OMI) onboard the EOS Aura satellite (O_3 and NO_2 vertical column data). Our SSR estimates are validated against satellite-based observations from the Satellite Application Facility on Climate Monitoring (CM SAF) and measurements from ground stations. To assess the radiative effect of each parameter on SSR, simulations with and without the presence of aerosols, clouds and tropospheric NO_2 are performed. Finally, the SSR trends are also studied, in accordance to corresponding changes in air quality and clouds and socioeconomic changes that took place in the country during the last 15 years.

Implementation of a dosimetry model for calculation of deposited dose of particulate matter (PM) in different locations in Greece

Chalvatzaki, E.[1], Chatoutsidou S.-E.[1], Kopanakis, I.[1], Melas, D.[2], Parliari, D.[2], Mihalopoulos, N.[3,4] and Lazaridis, M.[1]

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The present study focused on the estimation of the deposited dose of particulate matter (PM) in the human respiratory tract using a dosimetry model (ExDoM2). Input data from 9 station (Athens (Ag.Paraskevi and Aristotelous), Chania (Akrotiri and Dikastiria),Heraklion, Ioannina, Patra, Thessaloniki and Volos) in Greece were selected to implement the dosimetry model. The PM_{10} concentrations were obtained from the site of the Greek Ministry of Environment and Energy for all cities (except Chania and Heraklion). Field measurements performed in Chania and Heraklion by Technical University of Crete and University of Crete for the Prefecture of Crete. Specifically, higher hourly median PM_{10} concentrations were observed in Thessaloniki (28-46 μg/m^3) followed by Athens (27-37 μg/m^3, station of Aristotelous), Heraklion (24-39 μg/m^3) and Chania (25-40 μg/m^3, station of Dikastiria) while lower concentrations were found in Chania (11-25 μg/m^3, station of Akrotiri) and Athens (15-18 μg/m^3, station of Ag.Paraskevi). Size distribution data were obtained from the scientific literature. Specifically, two different size distribution data (Athens and Chania) were used in the dosimetry model. The size distribution data of Athens and Chania were also adopted for simulations of the remaining cities. The size distribution characteristics affect the deposition of particles in the human respiratory tract. The exposure of individual to same PM_{10} levels with different size distribution characteristics gave different deposited dose in the human respiratory tract. Specifically, the daily deposited dose in extrathoracic region for residents (adult male) in Thessaloniki (city with the higher PM_{10} levels) was equal to 721 μg (size distribution of Chania) and 467 μg (size distribution of Athens) while the daily deposited dose in lungs was equal to 185 μg (size distribution of Athens) and 127 μg (size distribution of Chania).Therefore, the size distribution data of Chania increased the deposited dose in the extrathoracic region by 54 % in comparison with the size distribution data of Athens while the size distribution data of Athens increased the deposited dose in the lungs by 45 % in comparison with the size distribution data of Chania. This finding is associated with size distribution characteristics. Specifically, the particles were mainly present in the coarse mode for Chania (60 %) while in Athens presents in the fine mode (56 %). Finally, health risk indexes were calculated with higher values were observed in Thessaloniki followed by Athens (station of Aristotelous), Heraklion and Chania (station of Dikastiria) while lower values were observed in Chania (station of Akrotiri) and Athens (station of Ag.Paraskevi) as direct consequence of PM_{10} levels in each city.

The role of dust minerals in the atmosphere as precursors of Ice Nuclei Particles

Chatziparaschos, M.[1*], Myriokefalitakis, S.[2], Daskalakis, N.[3] and Kanakidou, M.[1,3,4]

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Aerosol-cloud interactions consist one the major sources of uncertainty in climate projections according to the recent Intergovernmental Panel on Climate Change (IPCC) report. The radiative properties and lifetime of clouds as well as precipitation rates are affected by the presence of particles enabling ice formation in mixed-phase clouds at higher temperatures than needed for homogeneous ice nucleation. These particles known as Ice Nucleating Particles (INPs) originate from terrestrial and marine environments. Mineral dust particles, which together with sea-salt are the most abundantly emitted particles in the atmosphere, are thought to be an important type of INPs in the mixed-phase cloud regime around the globe. While K-rich feldspar (K-feldspar) has been identified as a particularly important component of mineral dust for ice nucleation, quartz is also shown to be relatively ice-nucleation active (Harrison et al., 2019). Thus, for a decade research has focused on K-feldspar mineral dust, which however accounts on average only for 1/8 of the total mass of dust in the atmosphere (Murray et al., 2012). Given that quartz is much more abundant component of atmospheric desert dust, accounting for about 25% of the total mass of airborne dust, despite its lower ice nuclei activity (Kumar et al., 2018) than K-Feldspar, quartz could potentially be important for cloud glaciation.

In the present study we further develop the global 3-D chemistry transport model TM4-ECPL to account for INPs concentrations from both K-feldspar and quartz mineral dust particles using most recent parameterizations of ice active sites density (Harrison et al., 2019). Our model shows dominant desert dust contribution to the INPs globally, and an important role of quartz in increasing INPs concentrations over the Southern Hemisphere. The simulated distribution of INPs agrees well with available measurements when INPs concentrations are calculated accounting for the temperature of INP measurements and distinguishing fine and coarse aerosols. Our global model results support previous work suggesting that K-feldspar is the more important ice-nucleating mineral in airborne mineral dust (1- 0.1L^{-1}) compared to quartz (10^{-2}- $10^{-3}L^{-1}$ at -20 °C, 800hPa).

Investigating variations in the PM2.5 concentrations over Thessaloniki station during the PANACEA campaigns using different measurement techniques

Chatzopoulou, A.[1*], Voudouri, K.-A [1], Symeonidis, P. [2], Christelis, E.[3] and Balis, D.[1]

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During the summer of 2019 (10 July - 10 August) and the winter of 2020 (10 January – 10 February), coordinated aerosol measurements were performed in the Laboratory of Atmospheric Physics (LAP) of the Aristotle University of Thessaloniki (AUTH), in the frame of the PANhellenic infrastructure for Atmospheric Composition and climatE chAnge (PANACEA) project. Apart from the instruments that operate routinely on the rooftop of the LAP, located in the city centre of Thessaloniki, complimentary measurements were performed with low-cost PM monitors, the Purple Air Sensors.
The performance of the Purple Air was checked by comparisons with the reference instrument GRIMM, as well as with measurements from sensors operating in stations, that were close to the location of that in the AUTH, such as the station of the City Hall and the station of Ag. Sofia Square.
Generally, the Purple Air Sensor provides two kinds of data: the first correspond to the mass concentration in PM1, PM2.5 and PM10 without applying any correction (non-calibrated dataset) and the second one corresponds to the mass concentration after applying a calibration. The comparison between these two datasets showed a high correlation in the lower PM2.5 concentrations ($<30 \mu g/m^3$).
The comparison between the Purple Air Sensor and the GRIMM dataset, showed a general overestimation of the Purple Air PM concentrations. Moreover, higher PM concentration correlation agreement (0.59) was found between the Purple Air Sensor located in the AUTH and the one in the Ag. Sofia Square. A seasonal variation of the GRIMM and the Purple Air Sensor dataset is also marked. The resulting slope for the winter period is 0.32, while for the summer period increases to 0.48. This difference is mainly attributed to the fine mode fraction which depends on the aerosol type observed each season. We conclude that a seasonal dependence of the calibration equation of the sensor should be taken into account for the case of Thessaloniki.

Electrified Saharan Dust: Does it reach Greece? An overview of the electrical activity of Saharan dust inferred from surface electric field observations

Daskalopoulou, V.[1,2*], Mallios, S.A.[2], Ulanowski, Z.[3,4], Hloupis, G.[5], Gialitaki, A.[2,6], Tassis, K.[7,8] and Amiridis, V.[2]

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The specific study focuses on electric field variations during Saharan dust advection over two atmospheric remote stations in Greece, using synergistic observations of the vertical atmospheric electric field strength (Ez) at ground, and the lidar-derived particle backscatter coefficient profiles. Both parameters were monitored, for the first time, with the simultaneous deployment of a ground-based field mill electrometer and a multiwavelength lidar system. The field mill timeseries are processed to extract the diurnal variations of the Ez due to the Global Electric Circuit and remove fast field perturbations due to peak lightning activity. In order to identify the influence of the elevated dust layers on the ground Ez, we extract a Localized Reference Electric Field from the timeseries that reflects the local fair-weather activity. Then, we compare it with the reconstructed daily average behaviour of the electric field and the Saharan dust layers' evolution, as depicted by the lidar system. Reported cases of enhanced vertical electric field for detached pure dust layers suggest the presence of in-layer electric charges. Although higher dust loads are expected to result in electric field enhancement, episodic cases that reduce the electric field are also observed. To quantitatively approach our results, we examine the dependency of Ez against theoretical assumptions for the distribution of separated charges within the electrified dust layer. Electrically neutral dust is approximated by atmospheric conductivity reduction, while charge separation areas within electrically active dust layers are approximated as finite extent cylinders. This physical approximation constitutes a more realistic description of the distribution of charges, as opposed to infinite extent geometries, and allows for analytical solutions of the electric field strength, so that observed electric field variations during the monitored dust outbreaks can be explained.

PM2.5 source apportionment in Greek urban and background environments

Diapouli, E.[1*], Papagiannis, S.[1], Vasilatou, V.[1], Gini M.[1], Kanakidou, M.[2], Mihalopoulos, N.[2,3], Gerasopoulos, E.[3], Balis, D.[4], Pandis, S.[5], Hatzianastassiou, N.[6], Kourtidis, K.[7], and Eleftheriadis, K.[1]

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Atmospheric particulate matter (PM) has been identified as a major air pollutant with significant implications for human health, the natural and built environment and climate change. PM are emitted from various anthropogenic and natural sources and may be either of primary or secondary origin. The aim of the present work is to identify the main aerosol sources (primary or secondary) that contribute to the PM2.5 concentration levels observed in Greek urban and background environments and to quantify their relative contributions, with respect to type of site and season. PM2.5 sampling campaigns have been implemented during the summer of 2019 and the winter of 2019-2020, in six Greek cities (Athens, Ioannina, Patras, Thessaloniki, Volos, Xanthi) and in one regional background site in Finokalia, Crete. Each site was studied for approximately two months each season. PM2.5 was collected on Quartz fiber filters, using low or high-volume samplers. The samples were used for the determination of the PM2.5 concentrations through gravimetric analysis, as well as for detailed chemical speciation. The analytical techniques implemented include: X-Ray Fluorescence for major and trace elements, Thermo-Optical Analysis for elemental and organic carbon and Ion Chromatography for ionic species. The obtained chemical composition database was then used for the PM2.5 source apportionment, by Positive Matrix Factorization (EPA PMF 5.0 model). The results of this study highlight the temporal and spatial variability of the key aerosol sources, in terms of contribution to PM levels but also of source chemical profiles. They also provide insight into the major emission sources and atmospheric conditions that are responsible for PM2.5 pollution in Greece and may assist towards informed and effective air quality management.

Ozone and carbon monoxide measurements at the Navarino Environmental Observatory (NEO) in Messenia, Greece

Eleftheratos, K.[1,*], Stavraka, Th.[2], Kapsomenakis, J.[3], Zerefos, C.[2,3,4], Gerasopoulos, E.[4,5], Pantazis, C.[4,5], Maneas, G.[4], Kouvarakis, G.[5] and Mihalopoulos, N.[5,6]

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We present the atmospheric concentrations of ozone (O_3) and carbon monoxide (CO) in Messenia, Greece, from measurements conducted at NEO's atmospheric monitoring station in Methoni since 2016. The role of the site, which is part of the PANACEA Research Infrastructure, is to maintain long-term monitoring of key particulate and gaseous species, in an attempt to shed light on the factors that control their levels and variability, and to discriminate the relevant contribution from long-range transport versus local sources. Monthly means are calculated in order to study the seasonal cycle of the two pollutants. The data are compared with corresponding data from the Copernicus Atmosphere Monitoring Service (CAMS) and chemical transport model simulations (OsloCTM3) as a means of model evaluation in the region. To investigate the regional representativeness of the measurements, especially within the climatologically different parts of the western and eastern part of Greece, the data are also compared with corresponding concentrations from the Finokalia station, on Crete Island. The correlation coefficients between the mean daily O_3 and CO concentrations in Methoni and Finokalia, are about +0.5 and +0.6, respectively, and special focus is given on the factors that govern their covariance or periods where the levels differ significantly.

Study of the Planetary Boundary Layer Height over selected sites in Greece during Panacea Campaigns (2019-2020) using multi-wavelength aerosol lidar systems

Foskinis, R.[1*], Papayannis, A.[1], Kokkalis, P.[2], Soupiona, O.[1], Mylonaki, M.[1], Papanikolaou, C.-A.[1] Kralli, E.[1], and Anagnou, D.[1]

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A study of the Planetary Boundary Layer Height (PBLH) variations over selected sites in Greece has been performed during the PANhellenic infrastructure for Atmospheric Composition and climatE chAnge (PANACEA) Campaigns (2019-2020). The study was applied to the different sites where experimental campaigns have been performed: Volos (10th of July to 10th of August 2019); Ioannina (5th of January to 10th of February 2020) and Athens (3rd of March to 1st July 2020). The instruments that used are separated into the operating lidar systems of the Laser Remote Sensing Unit (LRSU) of NTUA. The LRSU lidars included the mobile lidar AIAS (532 nm with depolarization capability) located at the different experimental sites and the stationary multi-wavelength lidar EOLE (355-532-1064 nm). Located in Athens. The PBLH estimation was performed hourly by applying the Kalman Filtering technique to the range-corrected background-Subtracted lidar signals. Moreover, those results were combined with the hourly in-situ measurements of the meteorological variables, such as surface temperature and humidity. Summarizing all those data a Cluster analysis was used of each case to calculate the mean states of the meteorological variables compared with the PBLH.

A satellite assessment of dust aerosol episodes over the broader Mediterranean Basin. Patterns of seasonal and inter-annual variability

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Aerosols play a key role in climate and weather patterns, since they interact with shortwave, but also with longwave, radiation, thus modifying the atmospheric temperature structure and the radiation budget. In general, they tend to cool the planet, cooling its surface and warming its atmosphere. However, their radiative effects significantly vary in magnitude, but also in sign in different regions. This arises from the strong variety of aerosol types and properties. In fact, the aerosol physical, chemical, optical and radiative properties are highly variable due to the variability of their sources and emission, transport, and removal processes, their short lifetime, as well as to their involvement in various atmospheric physical and chemical processes. The strong spatial and temporal variability of aerosols urges the scientific community for a better understanding. To this aim, an important priority is the accurate characterization and quantification of different aerosol types. Among them, Desert Dust is the most abundant one on a global scale. For this reason, also because of its action as ice nuclei (IN) and cloud condensation nuclei (CCN), as well as because of its importance and effects on various fields, namely flora and fauna, human health, transports or energy production, dust is of great importance. All these effects are maximized under the presence of high amounts of dust, called dust aerosol episodes (DAEs). The greatest amount of dust originates from the world's great deserts, and subsequently it is spread over nearby or remote areas, undergoing short to long-range transport. Sahara, in north Africa, is the greatest global desert and dust source area. The Mediterranean basin, being in proximity to Sahara, but also to the Middle East and Arabian deserts, receives significant amounts of dust transported during DAEs. The determination and characterization of these DAEs, especially at a complete spatial scale and on a climatological basis, is very important in many aspects.

Here, climatological assessment of Mediterranean DAEs is attempted using a satellite algorithm. The operation of the algorithm relies on the use of different aerosol optical properties to which specific thresholds are applied. The algorithm's input is MODIS Collection 6.1 spectral Aerosol Optical Depth (AOD) and OMI OMAERUV Aerosol Index (AI) daily data, covering the 15-year period from 2005 to 2019. Both data are at 1˚x1˚ spatial resolution. The algorithm operates on a daily and pixel level basis and determines the occurrence of strong and extreme dust episodes whenever dust exists and the AOD value exceeds the corresponding mean AOD value plus two or four standard deviations, respectively. If at least 30 pixels undergo DAE on a specific day, this day is considered as a Dust Aerosol Episode Day (DAED). 166 DAEDs are determined during the study period. The 116 of them are strong and the remaining 50 extreme ones. Most episodes are observed in spring (47%) and summer (38%), while a different seasonality is noted for strong and extreme episodes. Finally, a decreasing, but not statistically significant, trend of DAED's frequency, spatial extent and intensity is revealed from the interannual analysis.

Detection of NO_2 plumes from individual ships over the Mediterranean with the TROPOMI/S5P

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Here, we observe for the first time NO_2 pollution plumes from individual ships with the TROPOspheric Monitoring Instrument (TROPOMI) onboard the Copernicus Sentinel 5 Precursor satellite (central Mediterranean; 2 July 2018). With the synergistic use of TROPOMI tropospheric NO_2 measurements, Automated Identification Signal (AIS) ship data and near surface wind field data from the European Center for Medium range Weather Forecasts (ECMWF), and the application of a simple "morphing" technique, we manage to show that nearly all the NO_2 plume-like structures seen in the TROPOMI data can be attributed to projected plumes of the largest ships or groups of ships that were sailing in the area the last three hours prior to the TROPOMI overpass. The low winds on that day and the fact that the TROPOMI measurements were taken under sunglint conditions favor the detection of such structures. Using an emission proxy based on ship length and speed we show that the projected plumes of larger and faster ships, which are expected to emit more, indeed coincide with higher NO_2 levels (Pearson correlation coefficient R of 0.85).

Interannual and seasonal variability of greenhouse gases at Finokalia station in the East Mediterranean

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The annual and diurnal variability of CO_2, CH_4 and CO greenhouse gases concentrations measured at Finokalia station on Crete in the Mediterranean region is here presented and discussed based on flask measurements since 2002 and continuous observations since June 2014. Long term trends and interannual variabilities have been calculated for the period 2015-2019 with continuous measurements. The CO_2 concentrations showed an increase of 2.3 ppm/year with maximum values during winter and minimum values during summer. CH4 concentrations maximized in winter and minimized in summer, overall showing an increase of 7.4 ppb/year. CH_4 diurnal variation was very small and not considered significant. CO showed a decreasing trend of 8.1 ppb/year with maxima during winter and minima during summer. The observations have been compared with worldwide observations from the NOAA database. Multiple linear regression and back trajectory analyses were used to unravel the factors that are driving the variability of these greenhouse gases.

This work has been supported by the CLIMPACT and SNO ICOS-France-Atmosphere projects.

Properties of biomass burning particles as observed in PANGEA observatory

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In this study we analyze the properties of biomass burning particles using lidar and sun-photometer measurements from the newly established PANhellenic GEophysical observatory of Antikythera (PANGEA) of the National Observatory of Athens (NOA) in Greece. PANGEA is a remote station, located at the island of Antikythera, in the south-eastern Mediterranean, across the travel path of various aerosol species (i.e., sea salt, dust, smoke). Since June 2018, PANGEA is equipped with a suite of remote sensing sensors in order to monitor the properties of aerosols and clouds in the area, on a continuous base. For the case studies presented, biomass burning particles of different origin and age are considered. In particular, long-range transported biomass burning particles from North-America on July 2019, and local smoke plumes from the Peloponnese region on July 2020 are presented. The case studies are analyzed in terms of particle intensive optical properties and concentration profiles above the station.

Total Nitrogen Dioxide column amount over Thessaloniki, Greece and comparison with satellite data

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This study presents a comparison of total NO_2 data between a ground-based DOAS/MAX-DOAS system and the TROPOMI/S5P satellite over Thessaloniki, Greece. The DOAS/MAX-DOAS system operates at the Laboratory of Atmospheric Physics, Aristotle University of Thessaloniki, and consists of a cooled, miniature CCD spectrograph (AvaSpec-ULS2048LTEC) and a 2-axis tracker. The retrieval of total NO_2 is based on the Differential Optical Absorption Spectroscopy (DOAS) analysis of spectral direct solar irradiance in the visible area (425-490 nm) with respect to a reference spectrum. The Tropospheric Monitoring Instrument (TROPOMI) operates on board the Copernicus Sentinel-5 Precursor (S5P) satellite, which was launched in October 2017. TROPOMI has a pixel size of roughly 5.5 km x 3.5km. This is considerably smaller than all its predecessor satellites and provides the opportunity to study NO_2 in urban scales. The TROPOMI NO_2 retrieval algorithm was developed by the Royal Netherlands Meteorological Institute and utilizes the bands of the visible area (405-465 nm). The retrieval algorithm is based on the NO_2 DOMINO previously used for Ozone Monitoring Instrument (OMI) spectra with improvements made for all retrieval steps within the Quality Assurance for Essential Climate Variables (QA4ECV) project.

First assessment of AEOLUS L2A products in the framework of PANACEA: Cal/Val aspects and evaluation results

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The launch of Aeolus on 22nd August 2018 was a major step forward for atmospheric sciences. The scientific mission of Aeolus, operated by the European Space Agency (ESA), is to improve numerical weather forecasts and to facilitate our understanding about atmospheric dynamics and their impacts on climate. ALADIN (Atmospheric LAser Doppler Instrument), the first-ever Doppler Wind Lidar placed on a satellite platform, acquires wind profiles up to 30km all over the globe thus upgrading substantially the existing poor observational capabilities over oceanic regions and remote continental areas. In addition, via the High Spectral Resolution Lidar technique, ALADIN retrieves aerosol and cloud (grouped as particulates) optical properties at 355 nm (Standard Correct Algorithm, SCA) known as L2A (or spin-off) products. Taking advantage of its HSLR configuration, it is feasible the retrieval of the aerosol backscatter and extinction coefficients independently without requiring a priori assumption of the lidar ratio.

The current study consists the first assessment of Aeolus L2A products against vertical profiles acquired from the three lidar stations contributing to the Greek National Research Infrastructure PANACEA, which acts as an ACTRIS component. Specifically, they have been identified the Aeolus profiles residing within a circle of radius 100 km centered at the stations of Antikythera, Athens and Thessaloniki. Based on this collocation criterion, 32 cases were found and for each one of them the ground-based retrievals are obtained within a timeframe of ±1 hour centered at the satellite overpass. Our preliminary results (i.e., a primary evaluation of the raw Aeolus L2A retrievals) reveal that the backscatter coefficient is overestimated (up to 6 Mm-1 sr-1) below 5-6 km while reverse biases of lower magnitude (down to -1 Mm-1 sr-1) are recorded at higher altitudes. Considering the lack of features classification of the probed atmospheric scene by Aeolus, a group of ancillary data including reanalysis datasets (CAMS, MERRA-2), backward/forward trajectories (FLEXPART), sunphotometric observations (AERONET) and cloud cover (MSG-SEVIRI) are taken into account. Through their utilization it is aimed not only to characterize the atmospheric scene but also to improve the collocation method between spaceborne and ground-based retrievals by selecting the most representative Aeolus' "observation" (or Basic Repeat Cycle, BRC). Focus is given on the elimination of potentially cloud contaminated Aeolus observations as well as on the selection of BRCs (corresponding to distance of ~90km along satellite track) in which the same air mass is sampled at the coincident ground-based profiles. Additional aspects which are under investigation are related to the particulates' homogeneity in the surrounding area of the site and within the BRC as well as the potential impact of the terrain morphology. All the aforementioned considerations are checked case-by-case in order to define the final dataset and subsequently to obtain more robust evaluation metrics. Finally, emphasis is given on a desert dust outbreak that affected the Antikythera island on 10th July 2019 aiming at quantifying the expected underestimation of the backscatter coefficient by ALADIN when depolarizing mineral particles are recorded due to the misdetection of the cross component of the returned lidar signals.

Night-time chemistry of biomass burning plumes in urban areas: A dual mobile chamber study

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Wildfires and human-induced biomass burning are sources of gaseous and particulate pollutants in the atmosphere. Although, important changes in the size distributions and the chemical composition of the biomass burning aerosol during daytime chemistry have been observed, the corresponding changes at nighttime or in winter where photochemistry is slow, have received relatively little attention. In this study, we tested the hypothesis that nighttime chemistry in biomass burning plumes can be rapid in urban areas using a dual smog chamber system.

Ambient air during cold nighttime periods with high concentrations of biomass burning organic aerosol (OA) was introduced in both chambers. Ozone was added in one of them (perturbed chamber) and upon reaction with the existing NOx formed NO3 radicals. The other chamber was used as a reference to monitor the natural evolution of the system. Following the injection of ozone (approx. 150 ppb), rapid secondary organic aerosol formation was observed in all experiments. NO3 radicals were measured in the perturbed chamber. The OA mass concentration increased by 20-70% in just one hour, while an average increase of 50% in the O:C ratio of OA was observed. Nitrate formation was detected with most of it (on average 70%) being organic nitrate. The AMS mass spectrum of the formed OA showed similarities with oxidized OA mass spectra during winter in urban areas and with spectra from biomass burning plumes oxidized under dark conditions with nitrate radicals.

Investigating Fire Events in the Mediterranean area using satellite-derived products

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Forest fires are an important environmental issue throughout the Mediterranean area. Anthropogenic, natural or unknown causes, lead to open fires of various intensities deteriorating the natural environment and leading to significant air pollution that is observable by remote sensing from space. The Mediterranean countries and in particular Portugal, Spain and Greece were among the countries that suffered from forest fires in 2018.

The present study aims to detect the impact of forest fires plumes to Aerosol Index (dimensionless) and to NO_2 / CO levels (in molecules.cm^{-2}) during these fire events. For this purpose, Aerosol Index (AI) and nitrogen dioxide (NO_2) and carbon monoxide (CO) Level-2 concentration data from TROPOspheric Monitoring Instrument (TROPOMI) on board the Copernicus Sentinel-5 Precursor satellite at 7x7 km have been analysed.

The impact of fire plumes on atmospheric composition has been investigated examining covariation of AI, NO_2 and CO levels. Differences in column concentrations between a reference day and during fires have been derived at pixel level and indicate that forest fires lead to higher values of AI (by up to 6 times) than observed under background conditions and also enhance NO_2 and CO levels column concentrations by up to 9 times (0.2×10^{16} to 2.0×10^{16} molecules.cm^{-2}), and up to 3 times (1.5×10^{18} to 6.5×10^{18} molecules.cm^{-2}), respectively.

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Investigation of volcanic emissions in the Mediterranean: "The Etna-Antikythera connection"

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Volcanic emissions may remarkably impact the atmospheric composition and the regional and global climate. The Mt Etna eruption on 30 May 2019 was followed by an eastward transport of the volcanic plume towards Greece. The days following the eruption, lidar measurements conducted at the PANhellenic GEophysical observatory of Antikythera (PANGEA) in Greece, reveal the presence of particles of possibly volcanic origin above the area. FLEXPART simulations and satellite-based SO2 observations from the TROPOMI/S5P, confirm the volcanic plume transport from Etna towards PANGEA, while co-existence with desert dust particles should not be excluded. This is the first time that Etna volcanic elements are monitored at PANGEA with implications for the investigation of their role in the Mediterranean weather and climate.

Changes in PM and atmospheric potential gradient during the COVID measures at Xanthi

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We present here results on the changes of the near-ground atmospheric electric field (Potential Gradient, PG) and PM 2.5 that were observed during the COVID-19 measures at Xanthi, N. Greece. We use measurements from two PM 2.5 Purpleair sensors, one in the city of Xanthi and one in a semirural location outside the city, and a Campbell CS110 atmospheric electric field mill at the semirural location. Xanthi is particularly interesting because apart from the lockdown, additional measures were implemented, such as a total curfew from 20:00 to 08:00. The changes observed in PM 2.5 and PG during these measures are presented. Moderate decreases of PM 2.5 were observed in the daily mean during the curfew, whereas high decreases were observed during the morning and afternoon rush hours during both the lockdown and the curfew, being around 30 μg/m3 during the latter. Some changes were observed also in the intensity of the atmospheric elective field, probably as a result of the changes in the particulate matter concentrations.

First time MAX-DOAS observations of tropospheric NO_2 and HCHO columns in Ioannina, Greece during the PANACEA winter 2020 campaign

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Multi Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) is a measurement technique that has been used over the past years to conduct simultaneous measurements of atmospheric columns of trace-gas species and their vertical distribution in the lowermost troposphere. In the frame of the winter 2020 campaign of the PANACEA project, a MAX-DOAS system was installed in January 2020 on the rooftop of the Physics Department, University of Ioannina, in order to measure tropospheric trace-gases for the first time in Ioannina. The University campus is located approximately 6 km from the center of Ioannina city. The azimuth and elevation viewing directions, as well as the integration times were selected in a way that urban, suburban and background levels of trace-gas concentrations can be distinguished, providing high spatial and temporal resolution. Diurnal cycles of NO_2 and HCHO are examined and differences in trace-gas amounts between weekdays and weekends are investigated. A MAX-DOAS system was also operating at the Laboratory of Atmospheric Physics in Thessaloniki, Greece during the same winter campaign. An inter-comparison of columnar trace-gas concentrations retrieved at the two measurement sites, as well as collocated S5P/TROPOMI space-born observations, is presented.

MAX-DOAS retrieval of aerosol and NO_2 vertical profiles over Thessaloniki, Greece

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In this study, we present short-term retrievals of vertical profiles and column densities of atmospheric aerosols and nitrogen dioxide (NO_2) over Thessaloniki, Greece, using retrieved from short-term measurements of a ground-based Multi-AXis Differential Optical Absorption Spectroscopy (MAX-DOAS) instrument. The MAX-DOAS system is installed on the rooftop of the Laboratory of Atmospheric Physics, Aristotle University of Thessaloniki (40.63° N, 22.95° E) which is located downtown Thessaloniki. The system comprises a new charge-coupled device (CCD) spectrograph (AvaSpec-ULS2048x64-EVO) by Avantes and its operation began in the end of May 2020. The aerosol and NO_2 vertical profiles and column densities are retrieved by performing stand-alone runs of two different inversion algorithms, both adopted within the FRM_4DOAS framework. The Mexican MAX-DOAS Fit (MMF) algorithm relies on online radiative transfer modeling (using VLIDORT) and applies restricted least square fitting with an optimal estimation (OEM) regularization method (OEM) to the measured slant columns based on a priori profile and covariance matrix information to retrieve the aerosol and trace-gas profiles in a two-step process, while the Mainz Profile Algorithm (MAPA) is based on a parameterized approach and its forward model is provided as offline pre-calculated LUTs, relating the profile parameters to O_4 and trace-gas differential air mass factors (dAMFs). The integrated columns, i.e. the Aerosol Optical Depth (AOD) and the Vertical Column Densities (VCD) for aerosols and NO_2, derived by the two models are inter-compared and a good correlation is found, especially for the NO_2 VCDs. The vertical profiles of aerosols and NO_2, retrieved by the two models, are also compared for the whole period of the instrument operation and their azimuthal dependency is examined by performing MAX-DOAS measurements at in four different azimuth viewing directions. The AOD from a co-located CIMEL sun-photometer and vertical profiles of the aerosol extinction from a co-located LIDAR system are used in order to validate our results.

Improving the uncertainty of air quality microsensors via computational intelligence methods

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The performance of low-cost air quality sensors in comparison to reference instruments is characterized by deviations especially in terms of correlation, error metrics and relative expanded uncertainty. The later plays a key role in the characterization of a measurement as indicative and in categorizing the measurement in terms of data quality objectives. In the current paper we present a methodology based on the use of computational intelligence methods that allows for the improvement of measurements taken by low cost instruments, and we discuss advantages and limitations. Our analysis focuses on OPS for PM, but also addressed sensors for gaseous pollutants.

Identification of key aerosol types in Athens based on long-term in situ optical and chemical properties

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In this study, a classification of key aerosol types is performed in Athens from October 2016 to September 2019, by combining in situ measurements of Scattering Ångström Exponent (SAE), Absorption Ångström Exponent (AAE), single scattering albedo (SSA) and its wavelength dependence (dSSA). In addition, chemical composition of fine aerosols (PM1) and precursor gases from collocated measurements are utilized to provide further insights on the optical-chemical characterization of the seven identified aerosol types.
"BC-dominated" aerosol was identified as the most frequent type (76.3%), distributed year-round and characterized by moderate levels of scattering and absorption, low SSA (0.69) and dominance of fine-mode aerosols. It corresponds to emissions from fossil-fuel combustion sources (mainly traffic), also representing regional characteristics. The aerosol chemical composition was mainly characterized by organics (43%), with significant fractions of sulfate (27%) and BC (16%) and an average OM/BC ratio of 3.2. The second more frequent type was "BrC/BC" (14.3%), which was frequent during wintertime, especially at nights, corresponding to a mixture of fossil-fuel and biomass-burning emissions. Its chemical profile was dominated by organics (60%) mostly from primary combustion sources. A small fraction (0.65%) was related to relatively pure BrC aerosol from residential wood-burning emissions, observed at certain winter nights under calm winds and intensive use of fireplaces. The "large/BC mix" type (5.3%), which was more frequent in spring, practically reflected aged BC conditions mixed with larger-size particles in the Athens basin. Coarse dust particles mixed with urban pollution corresponded to 1.2% of the cases, characterized by high PM10 levels (83 μg m^{-3}), and were associated with southern airflows reflecting to Saharan dust transport. The enhanced presence of sulfate and nitrate was linked to another aerosol type ("small/LA" = 1.9%), which was dominant in winter. The increased contribution from inorganic mass and processed organics led to low spectral dependence of the absorption (AAE< 1). Very few cases (72, 0.32%), mostly in winter, were related with the "large/LA" aerosol type. It was exclusively from the southern sector, with higher possibility to carry marine coarse aerosols and represented the clean atmospheric conditions in Athens under strong winds with weak influence from local combustion sources.

The analysis further focused on December 2017 and March 2018, which are characterized by highly variable aerosol types and specific characteristics like high wood-burning emissions and multiple dust events, respectively. On these two months, special emphasis was given on the spectral curvature effect, since the different aerosol types display notable changes in the spectral dependence of scattering and absorption on logarithmic coordinates. Enhanced presence of BrC results in negative curvature for scattering (concave curves) and highly positive for absorption (convex curves), while BC mostly indicates a better fitting of the Ångström formula and low curvature effects. Intense dust events result in positive curvature in absorption and mostly negative in scattering, while combination of dSSA and curvature can differentiate the key aerosol types.

The potential of a synergestic lidar and sunphotometer retrievals for aerosol model evaluation

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Desert dust is one of the most dominant aerosol types on the Earth, produced in arid regions and traveling long distances far from its sources. The impacts of dust upon climate have increased the need to better understand and predict the atmospheric dust cycle. Towards this end, dust studies need accurate measurements and sophisticated retrievals of dust properties, but also trustworthy dust modeling. Ground based monitoring of the atmosphere through passive (e.g. sun-photometer) and active (e.g. lidar) remote sensing instruments has been used to observe and characterize the properties of aerosols and dust. The synergistic retrieval of the active and passive remote sensing measurements and the simultaneous use of the information about columnar and vertical aerosol properties has been recognized as crucial and has been developed in retrieval algorithms (e.g. GARRLiC – Generalized Aerosol Retrieval from Radiometer and Lidar Combined data).

In this study, the GARRLiC algorithm is applied to coincident EARLINET (European Aerosol Research LIdar NETwork) lidar and AERONET (Aerosol Robotic Network) sun-photometer observations performed at Finokalia station in Crete during PRE-TECT campaign. The algorithm was applied during an intense Saharan dust episode of 14/5/2017 and derived detailed properties for both columnar and vertical dust properties, including aerosol sizes, shape, spectral complex refractive index and the vertical profiles of the aerosol's concentrations. It is shown that the combination of lidar with sunphotometer data in GARRLiC provides an advancement in aerosol characterization. The retrieved dust concentration profile is used to evaluate the NMME-DREAM dust model simulations. LIRIC (Lidar-Radiometer Inversion Code) and POLIPHON (Polarization-LIdar PHOtometer Networking) retrievals and MERRAero (Modern-Era Retrospective analysis for Research and Applications Aerosol Reanalysis) are also used to estimate the mass concentration profile and enhance the driven conclusions. It is found that the NMME-DREAM model strongly underestimates the dust concentrations at low levels (<2km) where the maximum concentration values are observed.

Changes in nitrogen dioxide levels over Greece after the outbreak of COVID-19; a satellite view

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The strict enforcement for near total lockdown of the Greek population due to the Severe Acute Respiratory Syndrome CoronaVirus-2 (COVID-19) pandemic in March 2020 has offered a unique opportunity to study the contribution of vehicular nitrogen dioxide (NO_2) emissions to the country's air quality. Currently is it postulated that transport is the second largest sector that affects Greece's air quality and during this, otherwise unsavory, occasion this contribution can be enumerated and studied based on satellite observations. S5P/TROPOMI monthly mean NO_2 observations show an average decrease of -3% to -26% [-1% to -27%] with an average of -22% [-11%] for March and April 2020 respectively, compared to the previous year, over the six larger Greek metropolitan areas, attributable mostly to vehicular emission reductions. Furthermore, significant effects for shipping emissions over the Aegean Sea as well as the areas surrounding major Greek ports were observed, of approximately -12% [-5%]. For the capital city of Athens, weekly analysis was possible which revealed a marked decline in NO_2 load between -8% and -43% for seven of the eight weeks studied. Chemical transport modelling, provided by the LOTOS-EUROS CTM, shows that the magnitude of these reductions cannot solely be attributed to the difference in meteorological factors affecting NO_2 levels during March and April 2020 and the equivalent time periods of the previous year. Taking this factor into account, the resulting decline was estimated to range between 0% and -37% for the largest Greek cities, with an average of ~ -10%.

The influence of different aerosol properties and types on direct aerosol radiative forcing and efficiency in Europe and Mediterranean area

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The Direct Aerosol Radiative Forcing (DARF) has a crucial role in the assessment of the impact of aerosol particles on the Earth's climate. In this study, the effect of various aerosol types and properties in DARF and DARF efficiency at the Top and Bottom of the Atmosphere (TOA and BOA) are examined for the period between January 2008 and December 2017 in a spatial region for latitudes 16° N-54° N and longitudes 23° W-55° E, using the AERONET Level 2 (L2) Version 3 (V3) data. In order to eliminate the contribution of surface reflectance on DARF and DARF efficiency, the overall analysis is divided at three Surface Albedo intervals (SA≤0.2, 0.2<SA<0.3, and SA≥0.3). The narrow range of Solar Zenith Angle between 55 and 65° is selected to achieve a good approximation of the similar solar geometry among the various ground stations. Regarding the aerosol particles, the results from the aerosol clustering methodology of Logothetis et al. (2020) are employed for the determination of the aerosol classes. Using the particle size and the absorptivity for determining the boundaries of the aerosol clusters, four distinct categories are generated, namely, the fine absorbing (Type I-III), fine non-absorbing (Type IV), mixed absorbing (Type V) and coarse absorbing (Type VII). Aerosols of Type V were found in the Arabian Peninsula and Middle East-North Africa whereas Type I-III and IV were documented in South and Central-Eastern Europe. Dust particles (Type VII) were not represented in Centra-East Europe. Subsequently, the impact of Aerosol Optical Depth (AOD) and Single Scattering Albedo (SSA) on DARF and DARF efficiency is examined for each sub-region of the study area and SA category. Most negative values of DARF-BOA (-79.0 to -70.0 W m^{-2}) and DARF-TOA (-48.0 to -38.0 W m^{-2}) were calculated for dust particles (Type VII). Mixed and fine absorbing particles indicated the most negative values for DARF-BOA efficiency (-149.0 to -134.0 W m^{-2}), while the non-absorbing particles have the most DARF-TOA efficiency (-79.0 to 73.0 W m^{-2}). Concerning the effect of aerosols absorptivity, SSA is divided into six sub-groups (SSA≤0.85, 0.85<SSA≤0.87, 0.87<SSA≤0.89, 0.89<SSA≤0.91, 0.91<SSA≤0.93, and 0.93<SSA≤0.95) for each SA interval. Regardless of the SA group, the highest and lowest values of DARF-BOA efficiency are documented for the coarse (0.93<SSA≤0.95, aerosols type VII, -115 W m^{-2}) and fine absorbing particles (SSA≤0.85, aerosol type I-III, 200 W m^{-2}), respectively.

Global trends of Aerosol and Dust Optical Depth based on MIDAS fine resolution dataset during 2003-2017

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Aerosols burden constitutes elementary information to better understand the effect of aerosols on Earth's climate. In terms of mass, dust particles have the largest contribution to the total aerosols load. This study deals with the estimation of temporal trends of Aerosol and Dust Optical Depth (AOD and DOD), respectively. Both optical parameters are derived from the MIDAS (ModIs Dust AeroSol) dataset (Gkikas et al, 2020) and they are provided at global scale and at fine spatial resolution (0.1° x 0.1°), on a daily basis, over the period 2003-2017. The existence of temporal trends is performed by applying a linear regression model to the deseasonalized AOD and DOD time series also considering the presence of serial correlation among consecutive temporal steps while the trend significance is assessed at the 95% confidence level. Since the studied parameters (i.e., AOD and DOD) are in general log-normally distributed, monthly-aggregated data series, calculated based on temporal representativeness criteria, are generated in terms of geometric mean. Considering the AOD annual trends, strong positive tendencies are observed in Central Sahara (CSA, up to +0.026 yr^{-1}), the Arabian Peninsula (APE, up +0.029 yr^{-1}) and India (IND, up to +0.023 yr^{-1}) whereas declining tendencies are recorded in the Bodélé Depression (BOD, down to -0.024 yr^{-1}), Middle East and Europe (MEE, down to -0.009 yr^{-1}), the Thar Desert (THA, down to -0.027 yr^{-1}), the Gobi Desert (GOB, down to -0.013 yr^{-1}), Eastern Asia (EAS, down to -0.008 yr^{-1}) and the United States (USA, down to -0.007 yr^{-1}). In most of the aforementioned regions (CSA, APE, BOD, MEE, THA and GOB), the obtained AOD trends are regulated by the corresponding of DOD thus highlighting the dominant contribution of mineral particles to the total aerosol load. In order to interpret the calculated DOD trends, both over sources and downwind regions, the impact of driving forces (i.e., wind) on dust emission and transport as well as the role of meteorological variables (i.e., precipitation), affecting either directly or indirectly the amounts of mineral particles, are under investigation.

Observations of aerosol load in PANGEA during COVID-19 lock-down and relaxation period

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In this study, we present the aerosol loads observed in the PANhellenic GEophysical observatory of Antikythera (PANGEA) of the National Observatory of Athens (NOA) during the COVID-19 lock-down and relaxation period. During that time, PANGEA was equipped with an ACTRIS (Aerosol, Clouds and Trace Gases Research Infrastructure) Aerosol Remote Sensing Unit consisting of a sun-photometer (member of AERONET; Aerosol Robotic NETwork) and the PollyXT-NOA polarization/Raman lidar (member of EARLINET; European Aerosol Research Lidar Network). The observations collected are analyses in terms of cloud coverage, dust outbreak occurrences and aerosol load and compared to the observations collected above the station during the previous year (2019).

Variability of CO_2, CH_4 and CO column averaged mixing ratios from one and a half year of measurements in Thessaloniki, Greece, using a portable EM27/SUN FTIR spectrometer

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Column-averaged dry air mole fractions of XCO2, XCH4 and XCO- atmospheric gases which a direct or indirect impact to climate change- are presented for a period of 18 months, at Thessaloniki, Greece. Measurements were made from January 2019 to June 2020 in the Laboratory of Atmospheric Physics, in Aristotle University of Thessaloniki, using the Bruker EM27/SUN portable, ground-based, low resolution Fourier Transform spectrometer provided by Karlsruhe Institute of Technology (KIT). The EM27/SUN spectrometer allows precise measurements of abundances of greenhouses gases in Thessaloniki, contributing to the COllaborative Carbon Column Observing Network (COCCON), aiming to increase the global density of greenhouse gas observations

The observed XCO2 shows an expected seasonal cycle for a northern mid-latitude site varying between 404 and 416 ppm. XCH4 values, varying between 1.83 and 1.89 ppm, increase in the second half of the year while XCO, following anthropogenic sources, shows higher winter and lower summer values (from 0.077 to 0.125 ppm). Observed seasonal and diurnal patterns of the time series are investigated for possible association with local sources, natural or anthropogenic

Monoterpenes and Isoprene in the city of Athens: Natural vs anthropogenic origin and estimation of their contribution in secondary atmospheric pollutants' levels

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Monoterpenes and isoprene are important volatile organic compounds (VOCs), usually of biogenic origin. Due to their high reactivity, they participate in ozone and secondary aerosol formation, which in turn have a strong impact on climate, vegetation and human health. These compounds, along with other VOC, were monitored continuously for 13 months (February 2016 – February 2017) during the Athens VOC Campaign. The high resolution, time-resolved measurements took place at the Thissio urban background station in Athens (Greece) and they constitute the first continuous reported levels of monoterpenes (α-pinene and limonene) at an urban area of Eastern Mediterranean. On an annual basis, monoterpenes surpass the isoprene levels (mean values of 0.70 ±0.83 μg m^{-3}, 0.33 ±0.78 μg m^{-3} and 0.19 ±0.36 μg m^{-3} for α-pinene, limonene and isoprene respectively). Although isoprene presents a typical seasonal cycle with a summer-time maximum, monoterpenes deviate from the expected biogenic pattern, presenting higher mean levels during the cold period and a night-to-early morning enhancement. The examination of the relationship to meteorological parameters (including wind speed, temperature, solar radiation) and the height of the mixing layer, showed firstly the impact of low wind speed (increase of the levels, mainly local influence) and of photochemistry, which resulted to a decrease of the concentrations especially in summer. In addition, the strong correlation to local anthropogenic tracers such as BC, CO, NO or toluene (similar trend, more profound in winter) indicated an influence of additional sources other than biogenic. The latter was investigated by estimating the anthropogenic and biogenic fractions based on the enhancement ratios of α-pinene versus a variety of anthropogenic tracers, which demonstrated a clear dominance of the anthropogenic sources in all studied seasons, as well as the increase of the biogenic contribution in summer. Furthermore, the contribution of α-pinene and limonene to locally formed secondary organic aerosol (SOA; determined by means of an ACSM) and oxidants levels (O_3+NO_x) was estimated. In particular, it was found that they could account for at least 22% and 13% of the SOA levels in summer and winter respectively, as well as 6% to the observed oxidants levels (O_3+NO_x) during summer.

The impact of biomass burning for heating on Ioannina city's air quality during winter time

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In this work is presented the vertical distribution of aerosols over the city of Ioannina (Greece) during winter time. The aerosol backscatter coefficient (β) and the linear particle depolarization ratio (LPDR) were retrieved by the AIAS depolarization lidar system at 532 nm, during the 2nd PANACEA campaign (10/01/2020-07/02/2020). The aerosol layers were detected mostly inside the Planetary Boundary Layer (PBL) during the afternoon and nighttime hours, when the city's inhabitants burned wood for heating purposes. The mean values of the layers' altitude (1.1 to 1.9 km amsl) and LPDR (less than 0.08) indicated biomass burning (BB) particles from local sources. The aerosol mass concentration measurements by in situ sensors (Purple Air) and the relevant Air Quality Index (AQI) data of PM2.5 were also used to imprint the impact of BB activities on the city's air quality.

Intercomparison of three collocated multi-wavelength aerosol lidar systems at the National Technical University of Athens' Campus during 2020

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A lidar intercomparison Campaign was held at the National Technical University of Athens (NTUA) Campus during 2020, to assess the performance of the operating lidars of the Laser Remote Sensing Unit (LRSU) of NTUA, in the frame of the European Aerosol Lidar Network (EARLINET). The Campaign implemented three advanced lidar systems operating at several wavelengths: two steady lidars; EOLE (355-387-407-532-607-1064 nm) and DEPOLE (355 nm with depolarization capability) and one mobile lidar; AIAS (532 nm with depolarization capability). For all lidars only products retrieved by the EARLINET Single Calculus Chain (SCC) have been compared. The multi-wavelength EOLE lidar system had been successfully compared against the EARLINET reference lidar system MUSA from CNR-IMAA, Potenza (Italy), in the frame of the ATHLI16 (ATHens Lidar Intercomparison) Campaign, held in Athens from 26/09 to 07/10/2016.

EVE lidar: The passport of EARLINET lidar systems towards Aeolus Cal/Val studies

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The Enhancement and Validation of ESA products (EVE) lidar is a combined linear/circular depolarization lidar system with a dual-laser/dual-telescope configuration. This dual configuration enables the simultaneous emission of linearly and circularly polarized radiation at 355 nm and the detection of the co- and cross-polar components of the elastically backscattered light as well as the inelastic backscattered light at 387 nm. The EVE lidar is designed to provide the ground reference measurements for Cal/Val studies on ESA's Aeolus L2A products. ALADIN, on board Aeolus satellite platform, also emits circularly polarized radiation at 355 nm and detects only the co-polar component of the backscattered signal. Currently, the assessment of L2A products relies on the conversion of the linear-derived to circular-derived aerosol optical properties obtained by lidar systems of the EARLINET network. This conversion is, in principle, valid for randomly oriented particles but it is expected to fail for aerosol scenes where aerosol orientation and/or multiple scattering takes place. The EVE lidar gives a unique opportunity to test the validity of linear to circular aerosol depolarization conversion for different aerosol species in real-time conditions. Moreover, it is capable of reproducing not only the Aeolus L2A products by enabling the system's circular configuration but also the Aeolus like L2A products by enabling the system's linear configuration, similar to a typical EARLINET lidar system. Thus, EVE will be able to evaluate the effort of the EARLINET lidars on Aeolus L2A products Cal/Val studies under the presence of different aerosol types.

New insights into the impact of atmosphere-sea interactions on carbon sequestration in the Eastern Mediterranean Sea: a three-year time-series study in the deep Ierapetra Basin

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Sinking particles are a critical conduit for the export of organic material from surface waters to the deep ocean. Despite their importance in oceanic carbon cycling, little is known about the biotic composition and seasonal variability of sinking particles reaching abyssal depths. Herein, sinking particles flux data, collected in the deep Eastern Mediterranean Sea (EMS) (4285 m depth, Ierapetra Basin) for a three-year period (June 2010 to June 2013), have been examined at the light of atmospheric and oceanographic parameters and main mass components (lithogenic, calcium carbonate, opal and organic matter), stable isotopes of particulate organic carbon (POC) (δ13C) and lipid biomarkers with the aim of improving the current understanding of the dynamics of particle fluxes and the linkages between atmospheric dynamics and ocean biogeochemistry shaping the export of organic matter in the deep EMS. Particle fluxes showed seasonality and interannual variability over the studied three-year period. POC fluxes peaked in spring April-May 2012 (12.2 mg m−2 d−1) related with anomalous atmospheric conditions. Overall, summer export was approximately fourfold greater than mean wintertime, fall and springtime (except for the episodic event of spring 2012), fueling efficient carbon sequestration. Lipid biomarkers indicate a high relative contribution of marine-, terrestrial- and fossil-derived POC during both spring (April-May) and summer (June-July). This study highlights that both seasonal and spring episodic pulses are crucial for POC export to the deep Ierapetra Basin. Furthermore, our results show that the coupling of extreme weather events and ash deposition can trigger the influx of both marine labile carbon and anthropogenic compounds to the deep Levantine Sea, which is a critical factor determining food supply for deep ocean ecosystems but also an influx anthropogenic carbon to the deep ecosystems of the EMS. Therefore, this study underscores that accounting the episodic pulses of organic carbon into the deep sea is critical in modeling the depth and intensity of natural and anthropogenic POC sequestration and understanding global carbon cycle.

Comparison of inferred S5P/TROPOMI NO2 surface concentrations with in-situ measurements over Central Europe

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The present study evaluates the surface concentration of nitrogen dioxide (NO_2) inferred from S5P/TROPOMI NO_2 tropospheric column densities over central Europe. The air quality over countries such as Germany, the Netherlands, Belgium, France, and Italy are studied in detail for two time periods, the summer of 20XX and the winter of 20XX-20XX. The methodology to be used requires as input simulations of the NO_2 tropospheric column densities and surface concentrations from the LOTOS/EUROS CTM as well as the CAMS 2015 emission inventory over Europe.. Before applying the conversion between column and surface concentration, the TROPOMI fields were corrected for their known high background levels. More than two hundred in-situ stations, reporting to the European Environmental Agency air quality database, are used to carry out comparisons between the CTM simulations and the space-born inferred surface concentrations. Seven station types (traffic urban, traffic suburban, background urban, background suburban, background rural, industrial suburban and industrial rural) are separated so as to examine the shortcomings and the strengths of the different air quality markers. TROPOMI NO_2 derived surface concentrations show improved correlations with in-situ stations NO_2 surface concentrations compared to LOTOS/EUROS simulations. Specifically, during the summertime period, TROPOMI derived NO_2 surface concentrations show better agreement with the in-situ measurements for all station types with the highest correlation being noted in the background suburban stations (r=0.6). On the contrary, during the wintertime period, TROPOMI derived NO_2 surface concentrations correlate better with the in-situ measurements for all the station types except from the traffic suburban and the background suburban stations, where LOTOS/EUROS simulations have better results. Background rural stations show the highest correlations for both datasets in the winter period (r=0.64 and r=0.54 respectively).

Induced errors in Direct Normal Irradiance due to uncertain Aerosol Optical Depth from CAMS reanalysis project

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Direct Normal Irradiance (DNI) is a valuable parameter for the design and the performance of Solar Concentrating Technologies. Under clear-sky conditions, aerosols mostly affect the DNI attenuation explaining much of the observed DNI spatiotemporal variability. On a small spatial scale, the accurate description of aerosol radiative effects on DNI is rather complex, since the abrupt short-term aerosol variability cannot be resolved accurately by the present satellite technology. In this study, firstly AOD at 550 and 1240 nm from CAMS reanalysis project is compared against AERONET Level 2 Version 3 (L2V3) and then the induced uncertainties on clear sky DNI due to the uncertain CAMS aerosol parameters are further investigated. DNI is simulated by the combination of Radiative Transfer Model outputs and aerosol products (Ångström turbidity β and wavelength exponent α) of CAMS and AERONET, respectively. The analysis is performed for the region extending from latitude: 10°N to 66°N and longitude: 18°W to 55.5°E. For the AERONET stations of the study area, the systematic bias (MBE) for AOD_{CAMS} at 550 nm ranges from -0.08 to 0.14. Lower MBE magnitudes are observed at 1240 nm. On the other side the dispersion error (RMSE) extends between 0.02 and 0.26 for both wavelengths. Teide, Spain and Kuwait University, Kuwait exhibit the highest MBE and RMSE. CAMS cannot resolve the height of the volcanoes (e.g. Teide, Spain) and therefore fails in a certain extent to reproduce the 'real' AOD in cases with enhanced sulfate aerosols originated from volcanic activity. On the other side, Kuwait University is mainly affected by mineral dust from the proximal deserts which explains the high dispersion error. The induced errors in DNI are assessed in terms of the relative systematic and dispersion errors (rMBE and rRMSE). rMBE extends from -18 to 8% and rRMSE from 0 to 26%. Since aerosols are the main source of DNI variability, the extreme DNI errors are represented in regions where CAMS is unable to reproduce accurately $AOD_{AERONET}$. On a regional scale, the West and East Europe depict extremely low rMBE approaching zero and average rRMSEs lower than 10%. Arabian Peninsula - strongly dominated by coarse aerosol particles - shows high average rRMSE, exceeding 15%. Then Middle East -North Africa (MENA) region is affected by desert dust while also mixed aerosols are also represented. The different aerosol sources contribute to the complex patterns in DNI errors with rRMSE exceeding 10% and negative regional rMBE (-4.1% for North Africa and -1.7% for Middle East).

Investigating variations in the aerosol load over Thessaloniki during the COVID-19 lock-down period in Greece using the remote sensing infrastructure of PANACEA

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The sudden spread of the COVID-19 virus in a global scale has forced many countries around the world to apply unprecedented social distancing regulations that in some cases led even to the complete lock-down of urban centers during the period March to June 2020. Specifically in Greece, the first restriction measures were imposed on the 6th of March and were gradually lifted starting on the 4th of May until the 15th of June. The Laboratory of Atmospheric Physics (LAP) in Thessaloniki, Greece, that is part of the PANhellenic infrastructure for Atmospheric Composition and climatE chAnge (PANACEA), has monitored the atmospheric aerosol levels prior and during this unusual event of the Greek quarantine period. The scientific equipment deployed for this purpose includes three remote sensing instruments: a multi-wavelength depolarization Raman lidar, a multi-wavelength CIMEL sunphotometer, and a double monochromator Brewer spectrophotometer. In this study, we search for patterns in the evolution of the atmospheric particles during the lock-down period in Thessaloniki, which contradict the usual climatological conditions. Fortunately, long timeseries of climatological data are available for all pieces of equipment involved here that allow the calculation of climatological reference values for the products of each instrument. The lidar products include the aerosol backscatter and extinction profiles at 355nm and their respective integrals, the integrated backscatter and the aerosol optical depth (AOD), in the planetary boundary layer (PBL), in the free troposphere (FT) and in the whole atmospheric column. The CIMEL sunphotometer provides the AOD in multiple wavelengths, also in the ultra violet (UV) spectrum at 340nm, as well as aerosol properties such as the Angstrom exponent at 440-675nm and the fine mode fraction at 440nm, both of which are indicative of the aerosol size. The Brewer spectrophotometer is also capable of providing the UV AOD in the region 320-360nm and also the respective Angstrom exponent at 320-360nm. On top of that, the single scattering albedo (SSA) that is indicative of the aerosol absorptivity is also available in the region 320-360nm. Consequently, the prevalent aerosol type among the following types (Fine Non-Absorbing Mixtures, Black Carbon Mixtures, and Dust Mixtures) can also be inferred based on the Angstrom exponent and the SSA with this instrument. The common period July 2006 to June 2016 has been used here as the reference climatological period. Mean climatological values and variances have been obtained and compared with the period July to June for the last 4 years. In that sense, the quarantine period (March 2020 to June 2020) and the one prior to it (July 2019 to February 2020) are included in the comparison. In addition to this, the natural aerosol variability of the previous 3 years is also examined in order to ensure whether any observed discrepancies from the climatology are indeed exceptional.

Autonomous ground based integrated path differential absorption device for remote sensing of atmospheric CO_2 and CH_4

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LIDAR-based instruments have been used for a long time in greenhouse gases monitoring however, wider use is hindered by their low autonomy level and high complexity. In this work, a compact, fully autonomous, ground-based, integrated path, differential absorption light detection and ranging (IPDA LIDAR) system that is capable to measure CO_2 and CH_4 concentration in the atmosphere is presented. The device is equipped with two low optical power continues-wave DFB diode lasers at 1.57 μm for the detection of CO_2 and 1.65 μm for the detection of CH_4 and H_2O. The weak backscattered light is recorded by an InGaAs photodetector and the absorption signal is extracted from the noise using a lock-in amplifier. The distance required to determine the CO_2 and CH_4 concentration using differential absorption lidar (DIAL) equation, has been measured directly and additionally calculated based on the H_2O absorption line. It was found that the calculation of the gas concentration in the atmosphere based on H_2O peak provides similar values with those of the direct distance measurement. Accuracies in the measurement retrievals of CO_2 and CH_4 are estimated at 5 ppm and 0.2 ppm, respectively.

Coccolithophore production and export in three deep-sea sites of the Aegean and Ionian Seas (Eastern Mediterranean): Biogeographical patterns and biogenic carbonate fluxes

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Coccolithophore export fluxes were investigated via the analysis of sinking matter, obtained from Eastern Mediterranean time-series sediment traps moored in three open sites of the north-eastern Mediterranean Sea located in the Athos Basin of North Aegean (M2 site), Cretan Sea of South Aegean (M3 site) and at Ionian Sea (Nestor site). The aim of our study was to determine the spatial, temporal and seasonal variability in coccolithophore fluxes, as well as to estimate coccolith biogenic carbonate contribution to the sedimentation process. Data from an additional time-series sediment trap located in the southwestern Black Sea were also considered for the comparison of the oligotrophic Eastern Mediterranean setting with the eutrophic Black Sea. Coccolithophore fluxes revealed a highly seasonal pattern during February–March in the North Aegean, during March–May in the Cretan Sea and during February–March and May–June in the Ionian Sea. The recorded maxima coincide with low sea surface temperatures, increased precipitation and high PIC fluxes. Coccosphere fluxes were dominated by *Emiliania huxleyi* comprising ~70% of the total abundance, in the North Aegean and ~50% in the Cretan and Ionian Seas. *Syracosphaera pulchra* was also prominent in the study sites, where its abundance reached 14% in the North Aegean and ~10% in the Cretan and Ionian Seas respectively. *Florisphaera profunda* represented one of the major taxa in the coccolith fluxes of all three Eastern Mediterranean sites (~25% in North Aegean, ~20% in Cretan and Ionian Seas), while *Algirosphaera robusta* and *Umbilicosphaera sibogae* were the most abundant among the minor taxa. The North Aegean Sea exhibited a considerably higher coccolith flux when compared to other sediment traps due to the prominent seasonal peak of *E. huxleyi* during winter (February–March) (>95% of the total abundance). In contrast to the Eastern Mediterranean sediment traps, the time-series data from the Black Sea showed presence of monospecific *E. huxleyi* assemblage increasing its abundance during late September–November. In the Eastern Mediterranean, biogenic carbonate fluxes followed the general pattern of the total mass flux in all investigated areas, with the Black Sea coccolithophore $CaCO_3$ flux being the lowest due to low the *E. huxleyi* coccolith mass. Overall, in the North Aegean Sea, coccolithophore fluxes are strongly dependent on surface waters nutrients enrichment due to winter vertical water column mixing, riverine inputs and Black Sea water inflows, while the fertilization and/or formation of fast-sinking aggregates due to episodic dust input event are affecting the coccolithophore fluxes in the Cretan and Ionian Seas. The intercomparison of the coccolith export fluxes in the studied NE-SW mooring transects implies a north-south and east-west decreasing pattern, depending on the variable oceanographic regimes and the associated environmental factors controlling the investigated areas.

Evaluation of the LOTOS-EUROS NO_2 simulations using ground-based measurements and S5P/TROPOMI observations over Greece.

Skoulidou, I.[1*], Koukouli, M.-E.[1], Manders, A.[2], Segers, A.[2], Karagkiozidis, D.[1], Gratsea, M.[3], Balis, D.[1], Bais, A.[1], Gerasopoulos, E.[3], Richter, A.[4], Stavrakou, T.[5], van Geffen, J.[6], Eskes, H.[6]

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In this study we investigate the performance of LOTOS-EUROS v2.2.001 regional chemical transport model simulations of nitrogen dioxide, NO_2, over Greece from June to December 2018. In-situ NO_2 measurements obtained from the National Air Pollution Monitoring Network are compared with surface simulations over the two major cities of Greece, Athens and Thessaloniki. Overall, the model underestimates the NO_2 surface concentrations mostly during daytime (12 to 15 pm local time) and overestimates the low concentrations during night-time (0 to 3 am local time), while during daytime about half of the 14 air quality monitoring stations show a good correlation to the simulations, higher than 0.6. Furthermore, the simulated tropospheric NO_2 columns are evaluated against ground-based MAX-DOAS NO_2 measurements in both cities of Athens and Thessaloniki for July and December 2018. The correlation coefficients between the measurements and the simulations in July for the different directions studied are between 0.49 and 0.59 while in December are between 0.41 and 0.64. Lastly, space-borne Sentinel 5-Precursor TROPOMI tropospheric NO_2 observations are compared with LOTOS-EUROS NO_2 columns in July and December 2018. The simulations over Athens agree well with the TROPOMI observations both in July and December (slope 0.82 and 0.94 and intercepts -0.07 and 0.97×10^{15} molec.cm^{-2}, respectively). Overall, the comparison of the simulations with the TROPOMI observations shows a model underestimation during summertime and an overestimation in wintertime.

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Aerosol optical, chemical and radiative properties of a 3-day dust event observed over Athens, Greece using laser remote sensing and modelling

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An intense 3-day lasting Saharan dust episode was detected over Athens, during the period 26-28 May 2014 by the depolarization Raman lidar system, EOLE, of NTUA. During this event, the Ångström Exponent related to extinction ($AE_{a355/532}$) values were found below 1 from 2000 to 4500 m height, within the dust layer, indicating the presence of large particles. The mean linear particle depolarization ratio values (δ_{p532}) ranged from 15 to 22%, depending on the intensity of the episode, indicating dust mixtures. To further investigate the mixing state and chemical properties of the aerosols, the WRF-Chem model was used. The model successfully simulates the dust layer. Carbonaceous aerosols (up to 45 $\mu g/m^3$) and sulfates (up to 6 $\mu g/m^3$) are also present mainly during the first two days of the episode and inside the PBL. The instantaneous radiative forcing was estimated by using the Libradtran radiative model. During this dust event a cooling behavior was simulated both at the top and the bottom of the atmosphere in the shortwave region and a slightly positive radiative forcing values was estimated in the longwave region. Any deviations in the radiative forcing estimations can be attributed to the solar zenith angle and the different mass concentrations and load intensity during the dust event.

Case study analysis of aerosol shortwave radiative forcing over Athens, using the FORTH radiative transfer model, multi-wavelength Raman-lidar measurements and satellite observations.

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In this work we calculate the shortwave radiative effect induced by aerosol pollution events over Athens with the FORTH radiative transfer model. The aerosol optical depth is derived from the nocturnal extinction coefficient profiles measured by the multi-wavelength depolarization Raman lidar system operated at the National Technical University of Athens (NTUA, Athens, Greece). The source areas are identified with back-trajectory analyses and information from satellite observations. The SphInx inversion algorithm is used to retrieve the shape-size distributions and single scattering albedo. SphInx approximates the particle distributions with a spheroid model assuming wavelength-independent refractive index values. The shape-size distributions are reduced to volume size distributions of equal volume spheres and the corresponding number size distributions are derived. Mie calculations are employed for the effective spherical number size distributions, providing the single scattering albedo and the asymmetry parameter. These two parameters along with the optical depth constitute the necessary input data to the FORTH model. Additionally, the column-integrated aerosol optical properties are validated with the collocated AERONET station, as well as with satellite data. The vertically-resolved aerosol radiative effect is presented for selected cases, depending on data availability and overlap among the data sources.

Evaluation and Field Deployment of Low-cost PM Sensors in Different Urban Environments in Greece

Stavroulas, I.[1,2*], Grivas, G.[1], Michalopoulos, P.[1], Liakakou, E.[1], Bougiatioti, A.[1], Kalkavouras, P.[1], Fameli, K.M.[1], Hatzianastassiou, N.[3], Mihalopoulos, N.[1,2], and Gerasopoulos, E.[1]

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Recent developments in miniaturized particle sensor technology, has led to a significant increase in the utilization of low-cost, compact, particulate matter (PM) monitors. These devices can be deployed in dense monitoring networks, complementing already established regulatory networks, thus allowing for detailed characterization of the spatiotemporal variability of ambient PM levels and citizen exposure. However, acquiring reliable measurements, proves to be a demanding task, involving rigorous performance evaluation and calibration against reference-grade instrumentation. A field evaluation and calibration exercise of the Purple Air PA-II device is presented in this study. Calibration was performed in two different Greek urban settings, namely Athens and Ioannina, across three seasons in 2019-20, involving both a reference grade beta attenuation monitor and a reference equivalent optical particle counter. Correlation of the PA-II device measurements against the reference techniques was strong in both cases (R2 = 0.87 against the BAM and R2 = 0.98 against the OPC). PA-II measurement error was mainly related to elevated coarse particle concentrations and high ambient relative humidity. Trying to compensate for such errors, simple and multiple regression models were tested, leading to a dramatic improvement in sensor response. The calibrated sensor network was used to monitor PM levels during air quality deterioration events, and results are presented as different case studies, namely during a peri-urban forest fire event affecting Athens in August 2019, an industrial accident at a recycling facility within the Athens basin that occurred in August 2020 and during extreme wintertime smog events in Ioannina, related to wood combustion in stoves and fireplaces, for residential heating.

Planetary Boundary Layer Height retrievals using Polly-XT Lidar water vapor acquisitions

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This study aims to analyse the Planetary Boundary Layer height (PBLH), using Polly-XT Raman Lidar observations from the Pre-TECT Campaign that took place in Finokalia, Greece (35.34°N, 25.67°E, 250 m a.s.l.) during 1-30 April 2017 and from the campaign that took place in PANGEA (PANhellenic Geophysical observatory of Antikythera; 35.86N, 23.31E, 193 m a.s.l.) during 1-20 September 2018. More specifically, water vapor mixing ratio measured by the multiwavelength polarization Raman Lidar Polly-XT, is used for the derivation of PBLH. The water vapor channel was calibrated by means of co-located microwave radiometer and radiosonde temperature-pressure profiles. The method for the retrieval of PBLH is the wavelet covariance. In a second stage, the obtained PBLH is validated against PBLH provided by co-located Halo Stream Line Doppler Lidar, providing a good agreement between the two instruments. The retrieved PBLH varies between 500 and 700m, while aerosol measurements will be also checked against our retrievals. Nighttime measurements were performed; hence the largest water vapor gradients are often associated with residual layer above the nocturnal boundary layer.

Overview of the two PANACEA campaigns for Thessaloniki station: Aerosol typing from remote sensing techniques and in situ data

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Two measurement campaigns were performed in Thessaloniki urban station in the frame of the PANhellenic infrastructure for Atmospheric Composition and climatE chAnge (PANACEA) project: the first one covers the period from July to August 2019 and the second from January to February 2020. Both periods included a wide range of atmospheric conditions, with extreme aerosol cases (e.g. Sahara dust episodes) and moderate cases of local pollution. An overview of the aerosol optical properties (columnar and layering) is presented in this contribution, taking advantage of the multispectral information and the high temporal and vertical resolution acquired with all the remote sensing infrastructure of the Laboratory of Atmospheric Physics (LAP) of the Aristotle University of Thessaloniki (AUTH), as well as the additional instrumentation that participated during these campaigns.

Aerosol layers were detected during the summer of 2019 with thickness ranging between 0.3 and 1.8km. A persistent stratospheric layer was also appeared above Thessaloniki, initially at 12km and later on even up to 20km and was monitored with the multi-wavelength Depolarization Raman lidar. Saharan dust episodes took place during the summer, whereas biomass burning events were also present during both campaigns and further confirmed by the high black carbon concentrations of the Aethalometer measurements.

In what follows, automated aerosol-type characterization methods based on the lidar-derived aerosol-intensive properties, developed within the European Aerosol Research Lidar NETwork (EARLINET) that have already been evaluated for Thessaloniki dataset, as well as algorithms that deploy spectrophotometer and sunphotometer data are applied in order to provide the predominant aerosol type over Thessaloniki. The aerosol optical properties in parallel to the in-situ data, allow us to perform a full characterization of the aerosol load, based on the extensive and intensive properties and the chemical composition.

The impact of wildfire aerosols on global and regional climates

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Fire is a central component of the Earth system. Its occurrence depends on climate, while simultaneously its effects on atmospheric composition drastically impact radiative forcing and air quality. Fire-emitted aerosols have large impacts near their emission region, but they can also have effects on the climate of remote locations. This work uses the UKESM1 global Earth system model to investigate the atmospheric composition and climate effects of tropical aerosols on local and remote climates. We performed three idealised model sensitivity experiments in which a) tropical biomass burning carbonaceous aerosol emissions were entirely removed; b) tropical biomass burning carbonaceous aerosol emissions were multiplied by 10; and c) tropical SO_2 emissions were multiplied by a factor of 10 (the latter for comparison with biomass burning aerosols effects). Impacts on radiation fluxes, temperature, circulation and precipitation are investigated, both over the emission regions, where microphysical effects dominate, and remotely, where dynamical influences become more relevant. The experiment with the large increase (10x) in tropical biomass burning organic carbon (OC) and black carbon (BC) features a net warming globally, and a local cooling in locations where the aerosol load increases the most, since OC and BC reduce radiation at the surface locally, causing cooling. However, whereas OC scatters radiation with a negative forcing, BC has a warming effect since it reduces the planetary albedo, and this warming wins out on the global scale. Despite this warming, global precipitation decreases due to the atmospheric stabilising effect of BC. In addition to the above described results, we will also outline preliminary steps of work in the following related areas: 1) Impacts of extratropical wildfire emissions on climate; 2) impacts of wildfire emissions under realistic future scenarios (i.e. the Shared Socioeconomic Pathway scenarios (SSPs)), 3) influences of local and remote wildfire emissions on the Mediterranean atmosphere and climate, work that has commenced as part of the National Climate Change Network (CLIMPACT) in Greece.

Comparison of in situ and remote sensing instruments at the Helmos free troposphere background station

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In the winter of 2019 in situ and remote sensing instruments were deployed at Helmos station (37.98 °N, 22.2 °E, 2314 m asl, Figure 1), in order to study the concentration, physical properties, and chemical composition of aerosols. During this time the station resides almost exclusively in the free troposphere.
As the size distribution of two instruments (SMPS, OPC), which measure with two different principles, (the Scanning Mobility Particle Sizer measures the Electrical mobility diameter while the Optical particle counter measures the Optical diameter) was available, we combined the two in order to acquire an Equivalent Refractive Index (ERI) and a unified size distribution up to 2.5 μm. Then we compared the scattering coefficient (SD-ERI-MieScatter) acquired with Mie code by this size distribution and the ERI, to the scattering coefficient of the TSI nephelometer (Neph660) operating at Helmos station (Figure 2). The results indicate that the unified size distribution up to 2.5 μm can be used to determine the optical properties of aerosols at Helmos station during this period, as the red line depicted in Figure 2 (best fit) has a slope of almost 1.

Figure 1

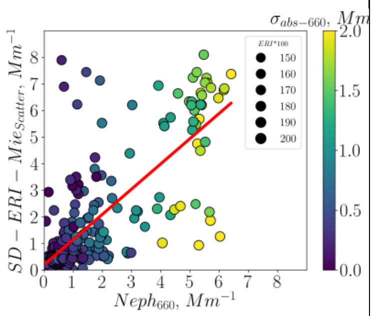

Figure 2

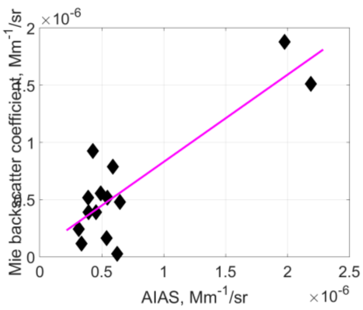

Figure 3

In Figure 3 we display the results for the comparison of AIAS lidar backscattering coefficient (AIAS) to the backscattering coefficient calculated by Mie code for the unified size distribution up to 2.5 μm on the 15th of November 2019.

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Fast climate responses from present-day aerosols in a CMIP6 multi-model study

Zanis, P.[1*], Akritidis, D.[1], Georgoulias, A.K.[1], Allen, R.J.[2], Bauer, S.E.[3], Boucher, O.[4], Cole, J.[5], Johnson, B.[6], Deushi, M.[7], Michou, M.[8], Mulcahy, J.[6], Nabat, P.[8], Olivié, D.[9], Oshima, N.[7], Sima, A.[10], Schulz, M.[9], Takemura, T.[11], and Tsigaridis K.[3,12]

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In this work, we use Coupled Model Intercomparison Project Phase 6 (CMIP6) simulations from 10 Earth System Models (ESMs) and General Circulation Models (GCMs) to study the fast climate responses on pre-industrial climate, due to present-day aerosols. All models carried out two sets of simulations; a control experiment with all forcings set to the year 1850 and a perturbation experiment with all forcings identical to the control, except for aerosols with precursor emissions set to the year 2014. In response to the pattern of all aerosols effective radiative forcing (ERF), the fast temperature responses are characterised by cooling over the continental areas, especially in the Northern Hemisphere, with the largest cooling over East Asia and India, sulfate being the dominant aerosol surface temperature driver for present-day emissions. In the Arctic there is a warming signal for winter in the ensemble mean of fast temperature responses, but the model-to-model variability is large, and it is presumably linked to aerosol induced circulation changes. The largest fast precipitation responses are seen in the tropical belt regions, generally characterized by a reduction over continental regions and presumably a southward shift of the tropical rain belt. This is a characteristic and robust feature among most models in this study, associated with weakening of the monsoon systems around the globe (Asia, Africa and America) in response to hemispherically asymmetric cooling from a Northern Hemisphere aerosol perturbation, forcing possibly the Intertropical convergence zone (ITCZ) and tropical precipitation to shift away from the cooled hemisphere despite that aerosols' effect on temperature and precipitation are only partly realized in these simulations as the sea surface temperatures are kept fixed. An interesting feature in aerosol induced circulation changes is a characteristic dipole pattern with intensification of the Icelandic Low and an anticyclonic anomaly over Southeastern Europe, inducing warm air advection towards the northern polar latitudes in winter.

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