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Book of Abstracts

Welcome to the 3rd Annual Climate and Atmosphere Research & Innovation in the Eastern Mediterranean and Middle East Workshop

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Dear Colleagues,

Dear Friends,

It is with great pleasure that we welcome you to our 3rd Annual Climate and Atmosphere Research and Innovation in the Eastern Mediterranean and Middle East Workshop.

First, on behalf of the Scientific Committee and the Organizers, we would like to thank all of you for your participation at the workshop. In this booklet we are delighted to share with you an exciting program, reporting the main innovations in the field of atmospheric sciences with the participation of 58 invited talks discussing about the recent relevant advances in the field.

All this has been possible thanks to your contribution.

We do hope that you enjoy your attendance at our Virtual Workshop!

The Hosts & Organizers

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Athina Kasini, CARE-C, The Cyprus Institute, *Cyprus*

Agenda

Opening Session		
09:00	Workshop Introduction & Opening	**Charbel Afif** Saint Joseph University of Beirut (Lebanon) The Cyprus Institute (Cyprus)
Air Pollution Sources and Impacts (Chair: Charbel Afif)		
09:10	**Invited Speaker**	
	Air quality projections in the Middle East: from observations to model validation and impacts	**Sergey Osipov** King Abdullah University of Science and Technology (Saudi Arabia)
9:30	**Oral Presentations**	
	Machine learning-enabled high-resolution downscaling of ultra-fine particle concentrations: bridging the gap in air quality assessment	**Pantelis Georgiades** The Cyprus Institute (Cyprus)
	Impact of the construction of rubberized and conventional asphalt roads on air quality: a pilot study in Kuwait	**Mohamed F. Yassin** Kuwait Institute for Scientific Research (Kuwait)
	Long-term source apportionment of submicron organic aerosol at the urban environment of Athens, Greece	**Kalliopi Petrinoli** National Observatory of Athens (Greece)
	Remote sensing observations from AREAD ship campaign in the Mediterranean and Middle East	**Alkistis Papetta** The Cyprus Institute (Cyprus)
	Emission Inventory for Cyprus	**Eva Eriksson** The Cyprus Institute (Cyprus)
	Enhanced sulfate formation through synergistic effects of chlorine chemistry and photosensitization in atmospheric particles	**Ruifeng Zhang** City University of Hong Kong (China)
10:30	**Coffee Break (10 Min)**	
vPICO session (Chair: Fatma Öztürk)		
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	Source apportionment of PM2.5 oxidative potential in an East Mediterranean site	**Marc Fadel** Université du Littoral Côte d'Opale (France)
	Quantification of NOx emissions from fossil-fuel fired power plants using satellite data in the EMME region	**Anthony Rey-Pommier** The Cyprus Institute (Cyprus) Laboratoire des Sciences du Climat et l'Environnement (France)
	Emission of volatile organic compounds from residential biomass burning and their rapid chemical transformations	**Maximilien Desservettaz** The Cyprus Institute (Cyprus)
	Thermal processes and secondary recycling regulate the atmospheric levels of highly toxic polychlorinated naphthalenes in an urban mediterranean site	**Minas Iakovides** The Cyprus Institute (Cyprus)
	Quantifying the synergy of heat-stress and air-quality on human mortality	**Theo Economou** The Cyprus Institute (Cyprus)
	Validating national emission inventories with satellite-derived estimates: world emissions case study for Cyprus	**Jonilda Kushta** The Cyprus Institute (Cyprus)

	Preliminary estimate of short-lived air pollutants from the July 2021 Arakapas wildfire in Cyprus and implications for nation emissions reporting	**Corey McClintock** The Cyprus Institute (Cyprus)
	Speciation of the PM2.5 carbonaceous fraction in an urban site in Greater Cairo Area	**Eliane Farah** Saint Joseph University of Beirut (Lebanon) Université du Littoral Côte d'Opale (France)
	Road tailpipe emissions, secondary aerosol formation and pertinent health implications in Cyprus	**Michelle Duri** University of Nicosia (Cyprus)
	Chemical characterization of PM2.5 in the tunnel of a Middle Eastern capital	**Nansi Fakhri** Saint-Joseph University of Beirut (Lebanon) The Cyprus Institute (Cyprus)
	VEClim - an early warning support system for climate-sensitive vector-borne diseases	**Ahmet Arca** The Cyprus Institute (Cyprus)
	Evaluation of urban heat island (UHI) effect from a double perspective: observations and simulations. The case of the Nicosia area.	**Giandomenico Vurro** The Cyprus Institute (Cyprus)
	Variation in trends of maximum temperature change on the Libyan coast for the period (1961-2099) by using spatial techniques.	**Asmahan Ali AlMukhtar Othman** University of Zawia (Libya)
	Modelling new particle formation in the Asian monsoon upper troposphere-lower stratosphere	**Christos Xenofontos** The Cyprus Institute (Cyprus)
	Modelling of carbonaceous aerosols for air pollution health impact studies in Europe	**Niki Paisi** The Cyprus Institute (Cyprus)
	Urban scale WRF-PMCAMX forecasts: evaluation of the meteorological forcing and its impact onto the pm predictions	**Areti Pappa** University of Patras, Department of Physics (Greece)
	Simulated future thermal comfortability over cities in Cyprus	**Katiana Constantinidou** The Cyprus Institute (Cyprus)
	Assessing the spatial distribution of urban thermal risk in Nicosia through machine learning techniques	**Konstantina Koutroumanou-Kontosi** The Cyprus Institute (Cyprus) National and Kapodistrian University of Athens (Greece)
	Sensitivity simulations of Izmit bay water circulation to wind speeds and directions using MITGCM	**Sabri Mutlu** Istanbul Technical University (Turkey)
	Atmospheric chemical kinetics using posits arithmetic	**Kyriacos Sophocleous** The Cyprus Institute (Cyprus)
	Predicting future wet and dry spell durations in Europe: an analysis with bias-corrected Q-GAM data	**Georgia Lazoglou** The Cyprus Institute (Cyprus)
	Assessment of the relationship of atmospheric blocking and heatwaves over the Mediterranean region	**Iliana Koutsoupi** National and Kapodistrian University of Athens / National Observatory of Athens, IAASARS (Greece)
	Comparison study between heat index(hi) of different algorithms over Egypt	**Rania S. Ezzeldeen** Egyptian Meteorological Authority (Egypt)
	A global approach to define concurrent atmospheric and marine heatwaves	**Lorine Behr** Justus Liebig University Giessen (Germany)
	Alexa storm and its effect on Egypt	**Eman Said Mohamed** Egyptian Meteorological Authority (Egypt)

	Exploring the relationship between grace/grace-fo terrestrial water storage anomalies and the standardized precipitation index (SPI) in arid regions.	**Rihan Al Saodi** The university of Jordan (Jordan)
	Feedbacks on weather via fire-generated aerosols over Greece	**Anastasios Rovithakis** Technical University of Crete (Greece)
	Greenhouse gas data for emission inventories from atmospheric inversions what have we learned? What do we need?	**Christian Mielke** German Federal Environmental Agency (Germany)
	Decarbonizing lifestyles: strategies for a sustainable future	**Doaa Salman Abdou** October University for Modern Sciences and Arts (Egypt)
	FUTUREMED: a transdisciplinary network to bridge climate science and impacts on society	**Samira Khodayar** Mediterranean Centre for Environmental Studies (CEAM) (Spain)
	Calibration and validation campaign for EARTHCARE using UAVs and lidars in Cyprus	**Franco Marenco** The Cyprus Institute (Cyprus)
	Refined flux calculations for greenhouse gases: insights from automated non-steady-state transparent soil chambers	**George Themistokleous** Agricultural Research Institute (Cyprus)
	Calibration and validation campaign for EDU4CLIMATE using UAVs and PMEYE lidar in EMME	**Maria Kezoudi** The Cyprus Institute (Cyprus)
	Single instrument for simultaneous monitoring of up to ten greenhouse gases and air pollutants	**Morten Hundt** MIRO Analytical AG (Switzerland)
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12:45	**Lunch (45 Min)**	
Atmospheric Dust, Climate change and weather extremes (Chair: Diana Francis)		
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	Atmospheric desert dust: impacts and measurements for this relevant atmospheric constituent in the East Mediterranean and the Middle East	**Lucia Mona** National Research Council (Italy)
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	Quantifying the effect of giant dust particles on radiative forcing, deposition rate, and atmospheric loading over the Middle East	**Georgiy Stenchikov** King Abdullah University of Science and Technology (Saudi Arabia)
	Toward dust monitoring using AeroTape, an IOT image processing-based aerosol analyser	**Adrien Reynaud** Oberon Sciences (France)
	Exploring the association of heat stress and human health in Cyprus	**Fragkeskos Kekkou** Aristotle University of Thessaloniki (Greece)
	Drivers of accelerated warming in mediterranean climate-type regions	**George Zittis** The Cyprus Institute (Cyprus)
	Temperature trend from different sources in Cyprus: a methodological challenge	**Jocelyne Gerard** Saint-Joseph University of Beirut (Lebanon)
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New Instrumentation and Research Infrastructure (Chair: Salwa Hassan)		
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	Assessing spatial and temporal urban air quality variabilities with the VAISALA-AQT530 monitor	**Roubina Papaconstantinou** The Cyprus Institute (Cyprus)
	Elevating GHG emission surveillance in Cypriot agriculture: introducing a cutting-edge infrastructure	**Andreas Savvides** Agricultural Research Institute (Cyprus)

	Real-time detection of condensed polycyclic aromatic hydrocarbons on a molecular composition level at low pg.m^{-3} by CHARON fusion PTR-TOF	**Markus Leiminger** IONICON Analytik (Austria)
	ACTRIS - University of Helsinki topical centre units provide support for measurements of secondary aerosol formation	**Nina Sarnela** University of Helsinki (Finland)
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Atmosphere & Climate Modelling and Prediction (Chair: Tareq Hussein)		
16:00	**Invited Speaker**	
	Trends in global and East Mediterranean fine particulate matter air pollution	**Li Chi** Washington University in St. Louis (USA)
16:20	**Oral Presentations**	
	An estimation of the anthropogenic aerosols effective radiative forcing based on seven CMIP6 earth system models	**Alkiviadis Kalisoras** Aristotle University of Thessaloniki (Greece)
	High resolution paleoclimate simulations with the COSMO-CLM model in the Eastern Mediterranean and Middle East	**Eva Hartmann** Justus-Liebig-University Giessen (Germany)
	A statistical approach to estimate future burnt area and GHG emissions from mediterranean wildfires	**Tim Van der Schriek** National Observatory of Athens (Greece)
	Estimating BC concentration in EMME using a generalised proxy	**Pak Lun Fung** University of Helsinki (Finland)
17:00	**End of the Scientific Workshop**	

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ORAL PRESENTATIONS

Machine learning-enabled high-resolution downscaling of ultra-fine particle concentrations: bridging the gap in air quality assessment

Pantelis Georgiades

The Cyprus Institute

Ultra-fine particles (UFPs), characterized by aerodynamic diameters less than 0.1 micrometers, are a significant component of ambient particulate matter (PM). Emerging as a critical concern in the field of air quality research, UFPs possess unique properties that contribute to their profound impact on human health. When inhaled, these particles can reach the alveoli, bypassing the body's natural defense mechanisms, leading to adverse health effects. Numerous studies have linked exposure to elevated UFP concentrations with an increased risk of respiratory diseases such as asthma, bronchitis, and even lung cancer. Moreover, UFPs have been associated with cardiovascular diseases, including hypertension and atherosclerosis, as well as neurological disorders due to their ability to translocate across the blood-brain barrier [1].

The importance of accurate UFP concentration mapping at high spatial resolutions cannot be overstated. Fine-grained maps of UFP concentrations are indispensable for epidemiological assessments aiming to unravel the intricate relationships between air pollution and public health outcomes [2]. High-resolution data enables researchers to conduct detailed spatial analyses, identifying vulnerable populations and understanding the complex interplay between environmental factors and health disparities. Additionally, such data are fundamental for policymakers, empowering them to formulate targeted interventions and regulatory policies to reduce UFP exposure and mitigate associated health risks effectively [3].

In this study, we present a novel approach employing machine learning techniques to downscale UFP concentration maps to a spatial resolution of 1 km, leveraging open-access datasets. The model is trained on historical UFP concentration data and auxiliary variables, learning the intricate patterns and correlations between land use, NO2 and UFP levels. Our research contributes significantly to the field by providing accurate, high-resolution UFP concentration maps essential for advancing our understanding of the health impacts associated with UFP exposure.

Authors

Pantelis Georgiades, Matthias Kohl, Theo Christoudias, Mihalis A. Nicolaou, Jos Lelieveld, Constantine Dovrolis

Impact of the construction of rubberized and conventional asphalt roads on air quality: a pilot study in Kuwait

Mohamed F. Yassin

Kuwait Institute for Scientific Research

The development and maintenance of road infrastructure play a crucial role in urbanization, but they also have a significant impact on the environment. A pilot study was conducted to compare the effects of constructing rubberized and conventional asphalt roads on air quality in Kuwait, a region undergoing

rapid development. Rubberized asphalt, which includes recycled rubber from tires, is known for its potential benefits in road durability and sustainability. The research aimed to evaluate and compare the effects of rubberized and conventional asphalt road construction on air quality parameters, including nitrogen oxides (NOx), nitric oxide (NO), nitrogen dioxide (NO2), sulfur dioxide (SO2), Hydrogen sulfide (H2S), Ozone (O3), and carbon monoxide (CO) and carbon dioxide (CO2). The KISR mobile air pollution laboratory monitored air quality by conducting comprehensive field measurements during road construction.

The data collected from the monitoring equipment was analyzed to determine the levels of pollutants during the construction period. The preliminary findings indicate that the mean values of the pollutant concentrations were below the KW-EPA ambient air quality standard during both rubberized and conventional asphalt road construction. The monitoring data obtained during the construction phase of the rubberized asphalt road demonstrated that the emissions of pollutants from the road surface were considerably lower than those from conventional asphalt roads, which could have a positive impact on the health and well-being of the surrounding communities. This study provides valuable insights into the environmental implications of rubberized and conventional asphalt road construction, providing a foundation for more extensive investigations in the future. By understanding and comparing the effects on air quality, policymakers and engineers can make informed decisions to balance the benefits of sustainable road construction with the need to protect environmental quality and public health in Kuwait and similar regions.

Authors
Mohamed. F. Yassin, Musaed. Shalash, Fatma Al-Shatti

Long-term source apportionment of submicron organic aerosol at the urban environment of Athens, Greece

Kalliopi Petrinoli

National Observatory of Athens

According to latest reports, a significant number of life loss in the European Union can be attributed or associated to long-term exposure to PM, and especially fine PM (EEA, 2021). Given that Organic Aerosol (OA) comprise a significant fraction of the fine particles in the atmosphere, monitoring of OA levels in near real time and successfully identifying their sources, is a key component for developing further emission reduction strategies. So, the systematic monitoring of PM is deemed necessary as the Agency's independent scientific advisors of EPA are about to make the PM standards stricter. In this respect, we analyze the chemical composition of fine aerosols in Athens, aiming to determine their levels, seasonality, diurnal patterns, their associated sources and mixing processes in the atmosphere, which may be significantly different between seasons and hours of the day.

In this study, long-term measurements of non-refractory submicron aerosol chemical composition using an Aerosol Chemical Speciation Monitor (ACSM), as well as source apportionment of recorded OA, was performed at the Eastern Mediterranean urban environment of Athens over a five-year period (2016 – 2021). Measurements were conducted at the Thissio Monitoring Site in the center of the city. OA source apportionment was conducted via positive matrix factorization (PMF) using the SoFi Pro toolkit

implementing the multilinear engine (ME-2) solver (Canonaco et al., 2013). Ancillary data include source specific black carbon concentrations meteorological parameters and standard gaseous pollutants.

OAs (or Organic Matter, OM) contributed the largest fraction to submicron PM (59%) on an annual basis, with the highest contribution occurring during winter (66%) due to increased emissions of residential wood burning. The secondary maxima observed in summer, suggest long-range transported pollution (regional aerosols) and secondary formation processes. NO3- and Cl- exhibited a clear seasonal cycle with maximum during winter and minimum during summer.

The source apportionment analysis of the OA, identified 5 components namely HOA, COA, BBOA, LO-OOA, MO-OOA. Elevated OA concentrations are clearly linked to BB, attributed to residential wood burning during the cold months and wildfire plumes affecting the city in the warm period. Secondary OA dominate lower OA concentrations pointing to long range transported pollution in the absence of local sources. In general MO-OOA was found to be the most abundant among factors contributing 33% to total OA.

Authors

K. Petrinoli, A. Bougiatioti, I. Stavroulas, D. G. Kaskaoutis, M. Tsagkaraki, E. Liakakou and N. Mihalopoulos

Remote sensing observations from AREAD ship campaign in the Mediterranean and Middle East

Alkistis Papetta

The Cyprus Institute

Atmospheric Research Expedition to Abu Dhabi (AREAD) is a ship campaign that sailed from Vigo, Spain to Abu Dhabi, UAE between 26/11/2022 and 19/12/2022, aimed at the characterization of the atmospheric composition and at identifying pollutants transport over the Mediterranean, Red Sea and Arabian Sea. In this study, we present preliminary results from the remote sensing observations acquired during the cruise. The area of interest, surrounded by deserts and anthropogenic sources, has been recognized as a climate change hotspot due to extreme temperature increases and an important contribution to greenhouse gas emissions. Limited studies focus on the area because of limited and few observational data are available.

AREAD's main objective was to contribute to the knowledge of trace gases and aerosol concentrations in the region and to complement with wintertime observations the AQABA campaign (24/06/2017-03/09/2017) performed in the same region during the summer season. The research vessel's voyage included observations in the Suez Canal, one of the most heavily used navigational hubs in global trade routes. The on-board instrumentation included in-situ observations for trace gases (NO, NO2, O3, SO2, CO2, CH4) and aerosol optical, physical and chemical properties (PM1, PM10, particle sizes, aerosol spectral absorption and scattering). In addition, remote sensing of aerosol, clouds and boundary layer height (BL) was obtained with a VAISALA CL51 ceilometer and a CIMEL sunphotometer modified for marine applications (by LOA, France).

The preliminary results suggest a change of regime between the Mediterranean and the Suez Canal. AOD levels remained below 0.1 for the first part of the cruise and increased to more than 0.2 after the entrance of the ship into the Suez Canal. Even though there was no significant variation in BL height which remained below 1km for most of the cruise, increased particle backscatter is observed within the BL and in elevated

layers after the Suez Canal. Desert dust, trade ship emissions and pollution from Middle East fossil energy production plants could be some of the species contributing to the higher aerosol loading observed in the latter leg of the cruise.

Authors

Papetta A., Marenco F., Pikridas M., Parolin M., Lekaki N.,Yves Quehe P., Konatzi R., Blarrel L., Dubois G, Goloub P., Chatzikonstantinou P. and Sciare J

Emission Inventory for Cyprus

Eva Eriksson

The Cyprus Institute

Investigations of air quality and climate change, and their projected future impacts, are limited by the quality of input data, notably from emission inventories. Recent comparison of pollutant emission inventories with satellite observations has shown that the EMME is the region with the most “missing” sources worldwide. An “Emission inventory” boost project” was implemented as part of the EMME-CARE project, aiming to establish a much-needed air pollution emission inventory through local and regional networking, to improve the input for models used in air quality and climate change assessments.

ARIA Technologies collaborated with Cyprus Institute to build a homogenized and high-resolved emission inventory (1 km grid size) for Cyprus focusing on data collection and constitution of inventory databases with special focus on road traffic emissions:

• Identification of existing emission inventory data for Cyprus

• Building institutional capacity for creating and maintaining state-of-the-art EI for Cyprus using European and international research guidelines and references

• Identification of data gaps (data collection and processing for main sources in Northern Cyprus)

• Implementing methods for spatial and temporal disaggregation of emissions for dispersion modelling

• Discussion on future collaboration with neighbouring countries in the EMME region (data exchange, partnerships…)

The advantage of the final methodology applied is the consistency with the Cyprus national Informative Inventory which is prepared on an annual basis by the department of Labour of inspection at the Ministry of Labour. The boost project allowed the CyI team to conduct a first spatial and temporal disaggregation of the national inventory data through guidance on data collection requirements and definition of procedures step-by-step to transform the national inventory estimates into model-ready emissions. Most of the work was done with local available GIS data and EDGAR time profiles which could further be upgraded in the future as refined or local information becomes available.

Authors

Dubart F., Eriksson E., Kushta J., McClintock, C., Velay F., Violaris A.

Enhanced sulfate formation through synergistic effects of chlorine chemistry and photosensitization in atmospheric particles

Ruifeng Zhang

City University of Hong Kong

Numerous studies have demonstrated that organic photosensitizers from biomass burning can generate oxidants to effectively convert inorganic/organic precursors into secondary aerosols. Particulate chloride ions can be internally mixed with organic photosensitizers in biomass burning particles. In this study, we further investigate the impact of the interaction of chlorine chemistry and photosensitization on the oxidative potential of aerosols by utilizing SO2 oxidation to form sulfate as an indicator. Mixed particles of chloride with glyoxal and its reaction products of ammonia of imidazole-2-carboxaldehyde (IC) were studied. Premixed NH4Cl + glyoxal particles have a 4~5 times higher sulfate formation rate than premixed NaCl + glyoxal, particularly at low relative humidity, suggesting the role of photosensitization. Furthermore, the addition of IC resulted in ~73-fold increase in sulfate production rate compared to NH4Cl alone. No noticeable sulfate formation was observed in the presence of IC alone, likely due to the high particle acidity. Furthermore, kinetic analysis of these particle results yields a reaction rate constant of chloride ions with the triplet state of IC, 3IC*, ~3 orders of magnitude higher than previously reported values in bulk solution. These results underscore the significance of the synergetic effect of chlorine chemistry and photosensitization in promoting sulfate formation in particles.

Authors
Ruifeng Zhang, Chak K. Chan

Quantifying the effect of giant dust particles on radiative forcing, deposition rate, and atmospheric loading over the Middle East

Georgiy Stenchikov

King Abdullah University of Science and Technology

The size of dust particles determines their lifetime in the atmosphere and their radiative properties. Our size-segregated dust deposition (DD) measurements show that coarse dust particles with geometric radius r > 10 μm comprise most of the deposited mass. Still, these particles are not represented in the current models tuned to fit the observed visible aerosol optical depth (AOD) but not dust emission (DE) or DD. As a result, the existing models and reanalysis products severely underestimate DD and DE. This is the first study to constrain the dust simulations by both AOD and DD measurements to quantify the effect of coarse and fine dust on radiative fluxes and DD/DE rates using the WRF-Chem model. We found that, on average, coarse dust contributes less than 10% to dust shortwave (SW) radiative forcing (RF) at the

surface but comprises more than 70% of DE. Coarse dust warms the atmosphere more effectively than fine dust in longwave (LW), comprising 30% of LW RF at the surface. However, the dust LW effect is three times smaller than its SW effect. Aerosol annual mean net radiative cooling at the surface over the Arabian Peninsula and regional seas locally reaches 25 W m−2. Airborne fine dust particles with radii r < 3 μm are mainly responsible for the significant dimming (5-10%) of solar radiation, cooling the surface and hampering solar energy production. However, dust mass deposition is primarily linked to coarse particles. Simultaneously tuning the model by AOD and DD observations led to a 25% increase in dust atmospheric loading and tripling of the simulated DE. Therefore, incorporating coarse dust in model simulations and data assimilation would improve the overall description of the dust mass balance and its impact on environmental systems and solar devices.

Authors

Georgiy Stenchikov, Suleiman Mostamandi, Alexander Ukhov, Johann Engelbrecht, Ilia Shevchenko, Sergey Osipov

Toward dust monitoring using AeroTape, an IOT image processing-based aerosol analyser

Adrien Reynaud

Oberon Sciences

Atmospheric mineral dusts influence the climate, biogeochemistry and air quality. Thus, concentration monitoring of dust particles is of interest for many stakeholders such as the scientific community, medical doctors or the public health authorities. Most commonly used methods to identify airborne particle origin and chemical nature are chemical analysis of samples collected on quartz filters. Another widely used technique relies on the coupling between particulate number measurement and weather data (measured and simulated). However, the first method suffers from poor time resolution and is expensive, and thus is not suitable for long-term monitoring, and the second has to be calibrated using the first one. In order to tackle these drawbacks, we investigate the ability of our IoT instrument, Aerotape, to monitor dust concentration in real time. Historically dedicated to bioaerosol monitoring, the Aerotape measurement technique is based on image processing (machine learning) of inertially deposited aerosol particles (1 – 200 μm). An instrument has been deployed at Cyprus Institute, where an aerosol instrument platform is operated to monitor desert dust events. The first phase of this experimental campaign was the comparison between Aerotape measurement with other instrument's (TEOM and PALAS Fidas), which showed good agreements. In the future, a collection of particle images will be built in order to identify the relevant metrics to perform automated recognition of particle type (sea spray aerosol, desert dust…). The relevancy of the sample selection will be ensured by the atmospheric aerosol composition thanks to chemical analysis. This methodology paves the way to desert particle source apportionment using the Aerotape and to use it as a network.

Authors

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Exploring the association of heat stress and human health in Cyprus

Fragkeskos Kekkou

Aristotle University of Thessaloniki

High temperatures during the summer months are a common feature in countries with a Mediterranean climate, such as Cyprus and Greece. However, the increase in the frequency, intensity, and duration of extreme high temperatures in the broader Eastern Mediterranean area, particularly since 1990, can be attributed to anthropogenic climate change. Furthermore, future climate projections indicate that the high temperatures and heatwaves witnessed at the start of the 21st century, which were considered as extreme, are poised to become the new normal in the coming years.

This study confirms the ongoing upward trend in both maximum and minimum temperatures over the past four decades in Cyprus, by using gridded reanalysis data from ERA5-LAND dataset. To gauge the human discomfort arising from these thermal conditions, bioclimatic indices were employed. Specifically, the UTCI index from the ERA5-HEAT dataset was utilized to assess heat stress experienced by average individuals during heat events. The study also examined the spatial distribution of maximum monthly UTCIdaily values for the period spanning from 2004 to 2019.

At the same time, the research delved into the correlation between hospital admissions and high UTCIdaily values, as well as the association between mortality rates and elevated UTCIdaily values. Mortality and morbidity data from eight public hospitals located in five districts of Cyprus were analyzed as obtained from the Ministry of Health and the Cyprus Statistical Service. The results show that there is a certain positive correlation of UTCI with mortality and morbidity, depending on the month and the years. Nevertheless, the presence of considerable variability in the results, motivates us to use more sophisticated statistical methods of analysis in future work in order to obtain better, useful and more meaningful results.

Authors

Fragkeskos Kekkou, Georgia Lazoglou, Theo Economou, Christina Anagnostopoulou

Drivers of accelerated warming in mediterranean climate-type regions

George Zittis

The Cyprus Institute

The near-surface temperature in Mediterranean climate-type regions has increased overall similarly or more rapidly than the global mean rates. Although these regions have comparable climate characteristics and are located at similar latitudes, recent warming acceleration is most pronounced in the Mediterranean Basin. Here, we investigate the contributions of several climate drivers to regional warming anomalies. We consider greenhouse gases, aerosols, solar irradiance, land–atmosphere interactions, and natural climate variability modes. Our results highlight the dominant role of anthropogenic greenhouse gas radiative forcing in all Mediterranean climate-type regions, particularly those in the northern hemisphere. In the Mediterranean Basin, the recent warming acceleration is largely due to the combined effect of declining aerosols and a negative trend in near-surface soil moisture. While land-atmosphere feedbacks are also important in other locations (e.g., California and Southern Africa), this synergy is unique in the Mediterranean Basin. These two regional climate drivers have natural and anthropogenic components of equivalent importance. Such feedbacks are not fully resolved in the current regional climate projections.

Authors

Diego Urdiales-Flores, George Zittis, Panos Hadjinicolaou, Nikos Mihalopoulos, Maria Kanakidou, Theo Economou, Sergey Osipov, Klaus Klingmüller, Jos Lelieveld

Temperature trend from different sources in Cyprus: a methodological challenge

Jocelyne Gerard

Saint-Joseph University of Beirut

Studying climate change in the Levant is vital to understand past human occupation and to plan for human settlement now & in the future. A project the “High Resolution Palaeoclimate Archives and Societal Changes in the Levant during the Holocene” aims to produce new paleoclimate data spanning the Early-Holocene from high-resolution (annual to decadal) well-dated speleothems in the poorly studied northern Levant (Near East). This project uses innovative aspects in both approaches & techniques. One of the challenges is to reconstruct the past climate in Cyprus, on its spatial dimension and at the finest possible scale. Therefore, one of the first objectives is to relate weather data and proxies, especially for the most recent period. The first step is to collect data over the longest period, from all available data (archives particularly from historical archives, such as the Blue books from the British colonial period and whose information dates back to the nineteenth century, data from meteorological stations, NCDC data, satellite images) to understand the climate trend.

Data collection and data processing faces multiple challenges due to sites changes location, break in the time series, different sources of information at a given station and a lack of metadata. Moreover, for the most recent period, satellite images give different data from that of stations (e.g. land surface temperature instead of air temperature). Overall, climate reconstruction needed: homogenization of local data and matching this information to satellite images for spatialization.

In this presentation, after a critical approach to the data, we will focus on a comparative analysis of the different results. It will enable us to understand the evolution of air temperature trends based on different data sources and geographical locations and to deduce heat waves event over an extended time period.

Authors

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Assessing spatial and temporal urban air quality variabilities with the VAISALA-AQT530 monitor

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Low-cost gas and particle sensors can significantly increase the spatial coverage of Air Quality (AQ) monitoring networks in urban settings. Considering that the accuracy of such sensors is not high enough to replace reference instruments for AQ monitoring, the question is whether they can be used to capture spatial and temporal variabilities of air pollutant concentrations. To investigate that, we carried out measurements over a period of 19 months with two VAISALA AQ Transmitters (AQT530), which employ Low-Cost Sensors (LCSs) for gaseous pollutants (i.e., CO, NO2, NO, and O3) and Particulate Matter (PM), at two different stations in Nicosia: an urban traffic and an urban background station. The transmitters were collocated with reference-grade AQ instruments. Analysis of the reference measurements shows that the concentrations of the gaseous pollutants and PM at the two stations were statistically different over the entire study period. The LCSs comprising the transmitters were also able to capture this significant difference. For shorter time scales (i.e. individual months or diurnal measurements), there are cases that the same Vaisala sensors exhibit no statistically significant differences of mean concentrations among the sites, while on the contrary the reference instruments do for the same time scale. All LCSs were able to capture differences between the workdays and weekends diurnal variabilities. The CO LCSs at both stations managed to capture most accurately the reference monthly and diurnal variability compared to the rest LCSs tested as well as which station measures higher CO concentrations. This makes the CO sensors in the AQT530 capable for hotspot recognition and identification of seasonal patterns. On a temporal basis, the PM2.5 LCSs exhibited the best agreement with reference measurements for month-to-month variability at the same site, making them the most suitable indicators of temporal variabilities within urban agglomerates against the rest sensors tested.

Authors

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Elevating GHG emission surveillance in Cypriot agriculture: introducing a cutting-edge infrastructure

Andreas Savvides

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In the current study, we introduce a cutting-edge infrastructure developed under the EU Recovery and Resilience Mechanism and the Cyprus Recovery and Resilience Plan aimed at monitoring and mitigating greenhouse gas (GHG) emissions in Cypriot agriculture.

Central to this initiative are high-frequency automated soil chamber systems strategically placed in key agricultural crop areas and livestock farms throughout Cyprus. These systems quantitatively measure GHG fluxes, providing high-temporal-resolution data on emissions from various agricultural systems. Complementing this, meteorological stations track microclimatic conditions at the experimental sites, providing insights into local environmental factors influencing GHG emissions. Three specialized laboratories bolster the analytical depth of the infrastructure. The first two are dedicated to chemical and physical analysis respectively, facilitating detailed evaluations of soil composition and nutrient profiles. The third specializes in molecular studies and next-generation sequencing, deepening our understanding of soil microbial communities and their association with GHG emissions. A rigorous soil sampling program, tailored to both chemical and biological analyses, augments the dataset, enabling holistic exploration of soil properties, microbial dynamics, and GHG emissions. Moreover, a controlled environment experimentation facility has been inaugurated to swiftly assess various soil types and fertilizers, amplifying our capacity to pinpoint and assess emission-reduction strategies.

The overarching objective is to precisely gauge GHG emissions and decipher their key drivers within Cypriot agriculture. By elucidating the complex interplay between soil, climate, and agricultural practices, our endeavor aims to recommend potent mitigation strategies to reduce emissions while promoting sustainable agricultural practices. This infrastructure heralds a monumental advancement in understanding GHG emissions in Cypriot agriculture, arming decision-makers with requisite knowledge and tools for evidence-driven policies, ensuring the sector's enduring sustainability.

Authors

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Real-time detection of condensed polycyclic aromatic hydrocarbons on a molecular composition level at low pg.m-3 by CHARON fusion PTR-TOF

Markus Leiminger

IONICON Analytik

Condensed polycyclic aromatic hydrocarbons (PAHs) are a group of highly toxic organic compounds that are formed through incomplete combustion of organic materials, e.g. by wildfires, transportation and waste incineration. Condensation on aerosols lead to their wide distribution by long range transport.

Detecting these compounds can be challenging due to their semi-volatile nature. Typically, PAHs are sampled on filters and analyzed by HPLC or GC. However, these methods have low a time resolution and are prone to sampling artifacts.

Here, we present an alternative method using proton transfer reaction mass spectrometry (PTR-MS). PTR-MS is a soft chemical ionization technique that can quantitatively detect volatile organic compounds (VOC). A new generation PTR-TOF instrument combining a clean Fast-SRI ion source, a radio-frequency ion molecule reaction chamber (FUSION) and a high mass resolution (>10k) TOF-MS reaches sensitivities up to 80.000 cps ppbV-1 and limits of detection <1 pptV at 1s. Coupled to the CHARON particle inlet, this instrument can also detect condensed PAHs in the low pg m-3 range for 1-min integration time allowing real-time detection of condensed PAHs on a molecular composition level, well below harmful long-term exposure levels.

We show a characterization of ambient organic aerosol during summer time in Innsbruck, Austria. From this dataset, a series of PAHs ranging from C16 to C26 is identified and high-resolution time series of these compounds are determined. Subsequently, matrix factorization is applied to gain valuable insight into the separate sources of the PAHs.

Authors

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ACTRIS - University of Helsinki topical centre units provide support for measurements of secondary aerosol formation

Nina Sarnela

University of Helsinki

ACTRIS is a European distributed research infrastructure producing high-quality data on short-lived atmospheric constituents and providing free access to this long-term atmospheric data. ACTRIS offers also e.g., access to its world-class facilities, measurement guidelines, instrument calibrations, training possibilities and technology development for users from academia as well as from the private sector and general public. ACTRIS consists of National Facilities (observational and exploratory platforms), and

Central Facilities. ACTRIS ERIC has currently 17-member countries. Considering the EMME-region, Cyprus is already a member of ACTRIS ERIC and Greece has expressed interest in joining at later stage.

University of Helsinki (UH) is hosting two ACTRIS Topical Centre Units focusing on standardizing measurements of secondary aerosol formation. The Cluster Calibration Centre (CCC) is focusing on sub-10nm aerosol particle concentration and size distribution measurements whereas CiGas-UHEL is focusing on condensable trace gases, which can serve as aerosol precursors.

The main tasks of the UH Topical Centre Units are to 1) provide training and consultancy, 2) produce and provide measurement and data procedures and tools 3) improve the methods to calibrate the relevant instrumentation and provide instrument calibrations for ACTRIS National Facilities, 4) organize calibration and intercomparison workshops and 5) carry out measurement and calibration method and instrument development.

The CCC and CiGas-UHEL are currently mid-way in their implementation as full operative capacity of these Units is expected in 2026. Pilot ACTRIS workshops have been/ will be organized in 2023: 1st Chemical Ionization Mass Spectrometer intercomparison workshop March 2023 (Leipzig) by CiGas-UHEL, and 1st Neutral cluster and Air Ion Spectrometer (NAIS) intercomparison workshop May 2023 (Helsinki) and 1st Nanoparticle instrument intercomparison workshop November 2023 (Helsinki) by CCC and The Cyprus Atmospheric Observatory (CAO) has been actively involved in these workshops. The intercomparison workshops provide crucial information about the functioning of the instruments.

Authors

Sarnela, N. Häme, S., Lehtipalo, K., Lampilahti, J. Chan, T., Kulmala, M. and Petäjä, T.

An estimation of the anthropogenic aerosols effective radiative forcing based on seven CMIP6 earth system models

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The effective radiative forcing (ERF) of present-day anthropogenic aerosols is estimated using fixed sea surface temperatures (SSTs) simulations from seven Earth System Models participating in the Coupled Model Intercomparison Project Phase 6 (CMIP6). ERF is calculated using one control simulation with all forcings set to the year 1850 and a series of perturbation experiments with aerosol precursor emissions set to the year 2014 and all other forcings identical to the control. The ERF of individual aerosol species, like black carbon, organic carbon, and sulphates is estimated along with the total forcing due to all anthropogenic aerosols. The ERF over the historical period (1850-2014) is also calculated using transient simulations with prescribed sea surface temperatures and sea ice. Furthermore, ERF is split into three components using the method of Ghan (2013): (a) ERFari, representing aerosol-radiation interactions, (b) ERFaci, accounting for aerosol-cloud interactions, and (c) ERFalb, which is largely due to surface albedo changes induced by anthropogenic aerosols. The total aerosol ERF is estimated to be -1.11 (±0.26) W m-

2, mostly due to the large contribution of ERFaci, which is -1.14 (±0.33) W m-2 compared to ERFari and ERFalb, which are estimated at -0.02 (±0.20) W m-2 and 0.05 (±0.07) W m-2, respectively. Sulphates dominate both present-day and transient ERF at the top of the atmosphere (TOA), exerting a strongly negative ERF especially over industrialized regions of the Northern Hemisphere, such as North America, Europe, East and South Asia. Global mean ERF patterns at TOA as well as the time evolution of ERF during the historical period are also investigated.

Authors

Kalisoras, A., Georgoulias, A. K., Akritidis, D., Allen, R. J., Naik, V., Zanis, P.

High resolution paleoclimate simulations with the COSMO-CLM model in the Eastern Mediterranean and Middle East

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The Eastern Mediterranean and Middle East (EMME) region is influenced by multiple large-scale atmospheric circulation patterns and offers a broad spectrum, both in time and space, of long high-quality instrumental time series, documentary information and natural archives. Recent reviews have shown that paleoclimate modelling with low horizontal resolution cannot fully contribute to understanding the interactions of the multiple atmospheric patterns in such highly complex regions. High-resolution regional climate modelling adapted to paleo applications will close the gap between the coarse resolution of climate models and the regional to local scale that is covered by the proxy and historical evidence and will allow a better data-model comparison. We use the regional climate model COSMO-CLM in an adjusted paleoclimate version (with orbital, solar and volcanic forcing, greenhouse gas concentrations and land-use changes) with 0.44° spatial resolution on a domain including the Eastern Mediterranean and the Middle East in the first millennium of the common era. It is forced by the MPI-ESM-LR 'past2k' simulations performed under the CMIP6 protocol and the forcings used therein. The period, focusing on the 6th century CE, was chosen because of the high volcanic activity and the known and still uncertain influence on the global and regional climate. Contrary to the impact of single volcanic eruptions, both winters and summers are cooler in the EMME region from 536 to 545 AD, with clear regional variations following two successive major volcanic eruptions. On the other hand, the seasonal precipitation shows significant spatial and temporal variability. Future challenges include the comprehensive study of the relevant circulation processes and the links between climatic conditions and past societies during this period.

Authors

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A statistical approach to estimate future burnt area and GHG emissions from Mediterranean wildfires

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Wildfires burn annually over 100,000 ha in the N Mediterranean and burnt area may double to triple in size by the end of the 21st century. However, there is no single method used to estimate future Burnt Area (BA) throughout the Mediterranean.

We developed a robust statistical methodology for rapidly estimating the Burnt Area (BA), and associated Green House Gas (GHG) emission, from wildfires under future climate change scenarios in regions located in Greece, Montenegro and southern France. At the target study areas fire danger modelling, utilizing the Fire Weather Index (FWI) and gridded observational meteorological data, established current fire danger conditions. Subsequently, the FWI, selected drought indices and meteorological variables were correlated against regional BA and GHG-emission data to create statistical projection models.

Future fire danger is calculated under three future climate change scenarios (RCP 2.6, RCP4.5 and RCP8.5), with business-as-usual management, up to 2070. State-of-the-art regional climate models, at a horizontal resolution of 12km developed within the EURO-CORDEX initiative, simulated future climate data that drive statistical projection models for BA and GHG estimates related to wildfires. All data were sourced from EU-wide databases that are publicly accessible, for the methodology to be Mediterranean-wide applicable.

This methodology was developed for the project “MediterRE3 - REstoring REsilience of Mediterranean landscapes to REduce GHG emissions from wildfires” (https://www.euki.de/en/euki-projects/mediterre3/). It will support Climate Change mitigation and climate-resilient landscape planning policies and strategies, providing quantitative information to the estimation of the Forest Reference Level (FRL) provided for by the “LULUCF (Land Use, Land Use Change and Forestry)” EU Regulation 2018/841.

The methodological approach outlined in this presentation permits up-scaling of the study results throughout the Mediterranean. It will enable stakeholders to formulate regional mitigation- and adaptation plans, and help them access new funding instruments.

Authors

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Estimating BC concentration in EMME using a generalised proxy

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Although black carbon (BC) has received increasing attention due to its adverse health effects, in-situ BC measurements are not often included as a regulated variable in air quality monitoring networks. Machine learning models as virtual sensors for BC, on the other hand, have been studied and developed to improve their generalisability and accountability. These generalised and accountable virtual sensors show great potential to serve as an alternative reference to provide long-term ambient BC concentrations in places with scarce measurements, for example in EMME regions.

The model we used in this study was an input adaptive proxy (IAP), which has high flexibility for places with fewer measurements. The model was trained using the long-term air pollutant and weather measurements in Barcelona urban background site and tested in other European urban and traffic sites. Despite the difference in geographical locations and measurement sites, the model trained in Barcelona performs prominently at the traffic site in Helsinki (R2 = 0.82–0.91; MAE = 3.26–4.37%; RMSE = 4.13–5.49%) and at the urban background site in Dresden (R2 = 0.67–0.85; MAE = 4.07–4.39%; RMSE = 4.93–5.73%). Particle number of accumulation mode and nitrogen dioxide on average have the strongest contribution to estimate BC in the generalised model.

We applied the generalised model at two locations in Cyprus and Jordan where BC measurements were not available. Although some of the input variables at the two locations were not compatible with the model trained in Barcelona, IAP managed to estimate BC concentrations in a reasonable way. This opens up possibility to estimate longer-term BC concentrations in EMME regions in the future.

Authors

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vPICO PRESENTATIONS

Sulfate formation in incense burning particles

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Incense burning is a common ritual in Asian communities, and it emits massive amounts of particles. These particles can undergo atmospheric aging upon exposure to sunlight and other pollutants. In this work, we observed sulfate formation in fresh incense particles upon exposure to SO2, using a single-particle aerosol mass spectrometer (SPAMS). Analysis of the positive mass spectra classified the particles as K-type and OC-type. In both dark and light experiments, SO2 uptake and oxidation were found preferentially in OC-type particles over K-type particles. Sulfate formation, as represented by the number fraction of sulfate-containing particles (FS), under dark was likely due to gaseous oxidants. FS increased with UV, mainly attributable to photosensitization reactions. While more sulfate formed at higher relative humidity (RH) under dark, sulfate formation under light was independent of RH. The increase in FS due to photochemistry was more effective under lower RH, where the photo-active compounds were more concentrated, and likely generated more photo-oxidants. This effect outweighed that due to reduced SO2 dissolution. Since incense burning particles contain organic photosensitizers that have also been found in biomass burning particles, our findings could shed light on the potential of biomass burning particles to trigger sulfate formation.

Authors

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Source apportionment of PM2.5 oxidative potential in an East Mediterranean site

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The East Mediterranean is the third region with the highest ambient and household air pollution attributable death rate, with an average of 125 per 100,000 population in 2016. This number could tend to rise in the future with the increase of aerosol concentrations due to climate change. These high concentrations of PM result from transported pollution mixed with anthropogenic emissions (traffic, industrial, and residential emissions), and natural emissions (Saharan and African deserts). Therefore, it is crucial to determine the pollution sources and the species that contribute the most to the toxicity in order to develop efficient air quality strategies.

PM2.5 samples were collected for almost a year in Zouk Mikael (ZK), an urban site under industrial influence in Lebanon. ZK is characterized by the biggest power plant in the country which runs on heavy fuel oil, a high density of population (4,200 inhabitants/km2) along with high road traffic and the use of diesel generators for electricity generation.

These samples were characterized for their carbonaceous fraction, water-soluble ions, elements, and organic species. Several tracer compounds were gathered in the PMF model to assess the contribution of the sources to PM2.5. Additionally, the oxidative properties of PM components were studied using the oxidative potential (OP) with two acellular methods: the ascorbic acid (AA) and the dithiothreitol (DTT) assays. The objectives of this work are to study the relationship between OP results and the PM2.5 chemical components, and to conduct a source apportionment of PM2.5 OP by coupling PMF results and multiple linear regression models.

The mean volume normalized OP-AAv value was 0.64 ± 0.29 nmol.min¬-1.m-3 and the mean OP-DTTv was 0.49 ± 0.32 nmol.min-1.m-3. Spearman correlations revealed strong correlations between OP-AAv and the carbonaceous fraction as well as organic compounds while OP-DTTv seemed to be more correlated with elements emitted from different anthropogenic activities. The apportionment of OP showed that local anthropogenic sources such as biomass burning (26% of OP-AAv and 10% of OP-DTTv), vehicular emissions (20% and 19%), and heavy fuel oil combustion (23% and 33%) contribute the most to the OP-AAv and OP-DTTv, respectively. The contribution of biomass burning in winter was at least 33 times higher compared to summer while the highest contribution between the sources was found for HFO combustion during summer.

Authors

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Quantification of NOx emissions from fossil-fuel fired power plants using satellite data in the EMME region

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Laboratoire des Sciences du Climat et l'Environnement

Fossil-fuel fired power plants are important sources of air pollution. In the Eastern Mediterranean and Middle East region, the corresponding emissions result in adverse impacts on air quality and serious implications for global climate. In many countries of this region, emission inventories are uncertain or outdated, which hinders an optimal implementation of air quality monitoring strategies. To overcome such issues, the use of independent observation systems is becoming increasingly prevalent. Spectrally resolved satellite measurements of from the TROPOMI instrument, onbaord the Sentinel-5 Precursor satellite, are one such system: they enable the daily quantification of atmospheric nitrogen dioxide column densities, which can be used to identify and calculate emissions of nitrogen oxides from power plants at high spatial resolution. We use a flux-divergence method to quantify monthly emissions from gas and oil power plants in Qatar, Saudi Arabia and Cyprus from 2019 to 2022, and compare the obtained outputs to the corresponding power capacity or electricity generation. Despite relatively high uncertainties, inferred emissions of nitrogen oxides differ from those of existing air pollutant inventories, suggesting a possible lack of knowledge in technology, fuel type and emission factors in the latter.

Authors

Anthony Rey-Pommier, Frédéric Chevallier, Theodoros Christoudias, Philippe Ciais, Jonilda Kushta, Jean Sciare

Emission of volatile organic compounds from residential biomass burning and their rapid chemical transformations

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Biomass combustion releases a complex array of Volatile Organic Compounds (VOCs) that pose significant challenges to air quality and human health. Although biomass burning has been extensively studied at ecosystem levels, understanding the atmospheric transformation and impact on air quality of emissions in urban environments remains challenging due to complex sources and burning materials. In this study, we investigate the VOC emission rates and atmospheric chemical processing of predominantly wood burning emissions in a small urban centre in Greece. Ioannina is situated in a valley within the Dinaric Alps and experiences intense atmospheric pollution accumulation during winter due to its topography and high wood burning activity. During pollution event days, the ambient mixing ratios of key VOC species were found to be similar to those reported for major urban centres worldwide. Positive matrix factorisation (PMF) analysis revealed that biomass burning was the dominant emission source (>50%), representing two-thirds of OH reactivity, which indicates a highly reactive atmospheric mixture. Calculated OH reactivity ranges from 5 s-1 to an unprecedented 278 s-1, and averages at 93 ± 66 s-1 at 9 PM, indicating the presence of exceptionally reactive VOCs. The highly pronounced photochemical formation of organic acids coincided with the formation of ozone, highlighting the significance of secondary formation of pollutants in poorly ventilated urban areas. Our findings underscore the pressing need to transition from wood burning to environmentally friendly sources of energy in poorly ventilated urban areas, in order to improve air quality and safeguard public health.

Authors

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Thermal processes and secondary recycling regulate the atmospheric levels of highly toxic polychlorinated naphthalenes in an urban Mediterranean site

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Although production of industrial- and pesticide-grade Persistent Organic Pollutants (POPs) has been prohibited since early 00's, residues are still present in all environmental compartments and illicit usage is still documented at a global scale. Island of Cyprus comprises a unique location for exploring air quality over the broader Eastern Mediterranean and Middle East (EMME) region. The present work extends previous reports on the occurrence and fate of a large panel of highly toxic compounds in the atmosphere over Cyprus, and explores comprehensively the atmospheric distribution of polychlorinated naphthalenes (PCNs) and polybrominated diphenyl ethers (PBDEs), both listed under the Stockholm Convention text. Total (gas/particulate phase) concentrations of PCNs were measured similar to urban locations in the broader EMME region. Contrarily, the corresponding levels of PBDEs were similar to remote locations. Regressions of logarithms of partial pressure against ambient temperature for PCNs revealed that secondary recycling from contaminated terrestrial surfaces regulates their atmospheric variability. Enthalpies of surface-air exchange (ΔHsa) for PCNs were significantly correlated to vaporization enthalpies (ΔHv) determined by chromatography, corroborating presence of short-range revolatilization sources. Homologue concentration ratios of PCNs and ternary diagrams suggested inputs from thermal processes all over the sampling period (Jan-May 2018), whereas potential influence of Aroclor technical mixtures cannot be excluded. An inverse pattern for PBDEs was observed. The corresponding regression slopes were shallow, implying long-range atmospheric transport, whereas ΔHsa were insignificantly correlated and close to ΔHv, suggesting that, unlike PCNs, volatilization sources of PBDEs are of minor importance. Equilibrium models predicted well the gas/particle partitioning quotients (Kp) of PCNs, whereas steady-state models predicted better the partitioning behavior of PBDEs. The temperature-dependent quantitative structure-property relationship (QSPR) model, developed and calibrated by our research team, exhibited equal performance in predicting Kp and can be used as reference for studies being conducted within similar temperature ranges.

Authors

Iakovides, M., Bhowmick, S., Stavroulas, I., Iakovides, G., Pikridas, M., Biskos, G., Sciare, J., Mihalopoulos, N.

Quantifying the synergy of heat-stress and air-quality on human mortality

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The latest Intergovernmental Panel on Climate Change (IPCC) report estimates that the global mean temperature increase will be up to 5.4°C. One of the most affected areas globally is the Eastern Mediterranean and Middle East (EMME), a wide and highly diverse region, identified as a hotspot that is warming twice as fast compared to the global increase. Climate change, in conjunction with poor air quality are two key factors impacting human health. In this work, we use flexible statistical modeling approaches to quantify the joint effect of temperature, humidity and air quality on human mortality for the city of Thessaloniki in Greece. In this work we briefly expose the statistical methodology we propose, and how it was used to quantify the joint effects of temperature, humidity and air quality over prolonged periods of exposure, on human mortality.

More specifically, we utilize data on all-cause but also cause-specific daily mortality and model this as a function of temperature, humidity, ozone, PM10 and nitrogen dioxide – all measured from monitoring stations in Thessaloniki. We extend the well-established framework of Distributed Lag Models (DLMs) as Generalized Additive Models (GAMs), to capture the complex interactions between the aforementioned exposures on the risk of mortality. Such models capture the exposure effect through time and thus enable understanding into how prolonged periods of poor air quality and heat stress affect human health. Results confirm the intuition that exposure to extreme heat and humidity in conjunction with poor air quality significantly increases the risk of mortality. This increase in risk varies considerably by case-of-death and also by age group. We show how the type of air pollutant results in different risk profiles, but also that there are correlations across the pollutants that affect the risks.

Authors

Theo Economou, Daphne Parliati and Jonilda Kushta

Validating national emission inventories with satellite-derived estimates: world emissions case study for Cyprus

Jonilda Kushta

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The World Emission project, funded by the European Space Agency, aims to provide an enhanced global emission monitoring service by developing emission estimates based on satellite data. The consortium brings together industrial entities such as GMV, Capgemini, and Kayrros, as well as research organizations such as the Climate and Environmental Sciences Laboratory of the Pierre Simon Laplace Institute, the Max Planck Institute of Chemistry, the Free University of Brussels, the Climate and Atmosphere Research

Center of the Cyprus Institute, and the National Supercomputing Center (BSC), with the support of the Free University of Amsterdam.

The main technological achievements include the evaluation of existing inventories and the algorithms used for retrieval and conversion, as well as taking into consideration the broadening of the range of gases emitted, along with the emission sources over a large number of monitored geographic areas. The satellite-derived emission inventory data extracted from earth observations are being compared with bottom-up inventories in close collaboration with end-user organizations to define related product target requirements. One such vital case country is Cyprus, which was used to validate the inversion of CO2 and NOx emission fluxes against the nationally reported emission inventories.

The analysis was performed with two sets of data using varied a priori information for the source and satellite data to derive the new emission estimates. The Phase I dataset comprises the VERIFY inversions based on the TNO inventory (EMEP national budgets) and is constrained with the coarse resolution OMI data, while the Phase II product is based on the Carbon Monitor and CEDS emission data and is corrected with high resolution TROPOMI observations. It was shown that for the CO2 emissions, the reported national total emissions were higher than the satellite-derived values for both Phase I & II products, but the reported values and satellite estimates both exhibited similar temporal trends. The sectoral analysis revealed that the largest uncertainties produced are for the energy and road transport sectors. For NOx, the satellite emission estimates are larger than the reported values, varying by a factor of 10 to 15% depending on the year. Moreover, the exercise highlighted the importance of high-resolution estimates for countries of smaller extents and the complication of signal overlap from point, line and area emissions in coarse domains.

Authors

Angelos Violaris, Florence Dubart, Jonilda Kushta

Preliminary estimate of short-lived air pollutants from the July 2021 Arakapas wildfire in Cyprus and implications for nation emissions reporting

Corey McClintock

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Emissions from forest fires qualify as a memo item under the European Monitoring and Evaluation Protocol/European Environment Agency (EMEP/EEA) reporting protocol, but as of Cyprus' latest Informative Inventory Report they are not estimated. According to the CORINAIR-1990 inventory, forest fires contribute 1.9% of CO emissions and 0.5% of NMVOC emissions in Europe. Yet these totals can be much higher for specific countries with climates conducive to frequent wildfires. Cyprus is situated in the Mediterranean region, where the frequency of wildfires is predicted to increase due to climate change. As such, it is important to quantify pollutants released from these events and understand their contribution to national totals and air quality. We conducted a preliminary bottom-up estimate for the July 2021 Arakapas event, reported as Cyprus' worst fire in decades. We obtained the event's spatial

extent from the Copernicus Emergency Management Mapping Service, considering only areas classified as 'destroyed' or 'damaged,' and aggregated them according to 2018 Corine Land Cover classifications to estimate the emissions using the EMEP/EEA methodology. Our initial calculation indicates that the single event of the Arakapas fire in July 2021 released quantities of CO and NMVOCs equivalent to 82% and 11%, respectively, of the annual total reported national pollutants for 2021. These preliminary results suggest the importance of considering emissions from Cyprus wildfires. We recommend further calculations using more sophisticated methodologies and official survey data, when available, as well as validation of their accuracy through comparison with top-down estimates and in-situ measurements.

Authors

McClintock, C., Kushta, J., Demetriou, D., Dubart, F., Violaris, A.

Speciation of the PM2.5 carbonaceous fraction in an urban site in Greater Cairo Area

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PM have drawn much attention in the Mediterranean region, which is considered as a hotspot of climate change and air pollution. The increase of anthropogenic emissions of gases and particles and the accumulation of atmospheric pollutants are suspected of being responsible for such changes. These emissions affect not only air quality, but also the health of the population. Greater Cairo Area, located in this region is considered as one of the most polluted megacities in the world. Therefore, the implementation of public policies to manage air quality has become a major challenge. For this reason, an exhaustive chemical characterization of PM2.5 samples were performed in this study, in order to identify potential pollution sources in Greater Cairo Area.

PM2.5 samples were collected between 26 November 2019 and 28 January 2020 in an urban site, in Dokki (Giza), in Greater Cairo. This area features 10.3 million inhabitants and 2.6 million vehicles running in the streets. Other than the influence of natural emissions from deserts, the sampling site might be also impacted by different anthropogenic sources such as road traffic, electricity generation, open waste burning, etc.,

Within the organic fraction of PM2.5 samples, different classes of compounds were identified such as alkanes, polycyclic aromatic hydrocarbons (PAHs), sugars, hopanes, and biogenic secondary organic aerosols (BSOA) such as isoprene, α-pinene, and β-caryophyllene oxidation products.

PM2.5 concentrations varied from 47 to 507 µg/m3 with an average of 145 ± 78 µg/m3. The average OC and EC concentrations in Cairo were 17.77 ± 6.60 µg/m3 and 4.45 ± 1.46 µg/m3, respectively. OC/EC concentration ratio ranged between 2.2 and 10.8 and might be attributed to combustion sources such as gasoline vehicular emissions and biomass burning. Alkanes were mainly emitted from anthropogenic sources, specifically gasoline emissions based on diagnostic tools such as Carbon Preference Index (CPI)

and Wax ratio besides a small contribution of natural emissions. The 3 most abundant PAHs were indeno[1,2,3-c,d]pyrene, dibenzo[a,h]anthracene, and benzo[a]pyrene, and they account 60% of total PAHs concentration. The concentration ratio of benzo[a]anthracene/(benzo[a]anthracene+chrysene) ranged between 0.29 and 0.43 with an average of 0.36 showing that pyrogenic emissions such as vehicular emissions are the primary source of PAHs in Cairo. A small increase of 1.3 times for 17α(H)-21β(H)-hopane and 1.5 times for 17α(H)-21β(H)-norhopane in concentrations during weekends was observed which shows that traffic is more dense during weekends in this residential area. Glucose, arabitol, and mannitol showed average concentrations of 49, 7, and 9 ng/m3, respectively. Among BSOA, α-pinene oxidation products account for 91% of total BSOA concentration.

Authors

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Road tailpipe emissions, secondary aerosol formation and pertinent health implications in Cyprus

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Cyprus, in the Eastern Mediterranean, is burdened by regional particulate pollution from frequent desert dust storms (Lelieveld et al., 2002), high solar radiation intensity of about 5.3 kWh/m²/day, and warm temperatures that foster the photochemical production of secondary aerosols and tropospheric ozone in metropolitan areas (Kanakidou et al., 2011). Recent studies that have investigated mitigation of on-road tailpipe emissions in Cyprus focus on PM, NOx and CO2 (Demetriou & Hadjistassou, 2022), (Giannakis et al., 2020). However, research has shown that volatile organic compounds (VOCs) contribute to the secondary formation of particulate matter, up to 50% of total PM2.5. Dust particles can also act as nucleation sites for aerosol formation. Meanwhile, the increasing trend of ozone can be attributed to VOCs despite rigorous NOx-control strategies in VOC-limited urban environments in Cyprus. PM10 triggers inflammation in the lungs, whilst ultrafine-PM potentially infiltrates the bloodstream and disrupts the blood-brain barrier. Long-term exposure to NOx, and O3 impairs lung function and causes oxidative stress to the cardiovascular system. In 2021, non-methane volatile organic compounds (NMVOC) from on-road vehicles was about 13% of the national total, and NOx emissions were around 33%. Motorbikes accounted for 25% of VOCs, whilst making-up only 5% of the total vehicle stock and a small mileage share of 3.8%. Following the COVID-19 period, NMVOCs in 2020 fell by an average of 61% and O¬3 decreased by 48.5% over the 2.5month lockdown period where road mobility and economic activity were restricted. Benzene averaged 0.46 μg/m3, a 30.7% reduction, during the lockdown pointing to the contribution of road transport to ambient pollution levels. Furthermore, traffic volume in Griva Digeni Avenue fell by 70% compared to February 2020 before the lockdown. Premature deaths associated with PM2.5, PM10, NOx,

NO2, O3 and SO_2 were calculated for Nicosia's population over 30 years using integrated exposure response functions. Cardiovascular fatalities attributable to secondary PM2.5 constituted 37%, 40% and 43% of cardiovascular PM2.5 deaths in 2017, 2019, and 2020, respectively. Limiting PM2.5 to 12 µg/m3 could reduce deaths by 42%. Similarly, 34 deaths per 100,000 from cardiovascular complications occurred in 2020, where-as, 17 could have been spared, had the lockdown NOx concentrations been maintained throughout the year. NO2 cardiovascular and respiratory mortality rates of about 59 in 2019, drop to 34 at lockdown concentrations. Total mortality rates from O3 resulted in 6 and 7 deaths per 100,000 inhabitants for 2019 and 2020, respectively. These results highlight the importance of controlling VOC precursor emissions alongside PM and NOx, especially for motorcycles in Cyprus. Replacing petrol motorcycles with electric ones would reduce VOCs due to their zero-tailpipe emissions, ultimately, reducing ozone and PM concentrations and associated mortality rates.

Authors

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Chemical characterization of PM2.5 in the tunnel of a Middle Eastern capital

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Traffic emission is an important source of pollution in the Middle East and other countries with no law enforcement. Energy use in transportation has almost doubled in the Middle East in the last 2 decades, but with a future increase rate of almost double what is foreseen for Europe (Haddad et al., 2018). Measurements of PM from road transport in the Middle East are scarcely reported. In this study, a sampling campaign was conducted in Salim Slam tunnel which is located in the heart of Lebanon's capital. The chemical composition of PM2.5 from samples collected inside the Salim Slam tunnel in Beirut, Lebanon included carbonaceous matter, water-soluble ions, elements, and organic compounds. The emission factors of PM2.5 related components were higher than those of other tunnel studies, highlighting the need for implementing national regulations for vehicles emissions and upgraded fuel standards. PM2.5 source apportionment was conducted by chemical mass balance (CMB) method with a combination of organic and inorganic markers. In this study, we explored the sensitivity of CMB results to source profiles from three sites in a typical Middle Eastern country. CMB results revealed a high contribution from non-exhaust emissions, accounting for 72% (urban, Hersh), 64% (urban, Zouk) and 51% (suburban, USJ). This study's findings are of great importance as it provides a better understanding of PM traffic-related emissions which is beneficial for subsequent studies in Lebanon and the Middle East region such as source apportionment and policy-control for reducing road transport emissions.

Authors

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VEClim - an early warning support system for climate-sensitive vector-borne diseases

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Global warming, due to human-made greenhouse gas emissions, affects biodiversity, species phenology and ranges, and ecosystem processes. Many insect species that are disease vectors, including the pathogens they transmit, are exposed to these global trends, posing challenges to human and environmental health. To plan effective control strategies, early warning and decision support systems are urgently needed.

The Climate-Driven Vector-Borne Disease Risk Assessment project (VEClim), supported by the Wellcome Trust as part of Digital Technology Development Awards in Climate-Sensitive Infectious Disease Modelling, aims to improve vector-borne disease prediction and management by employing data-driven, mechanistic, and climate-sensitive geographical modelling to represent vector populations and disease transmission.

The VEClim platform hosts mathematical models, incorporating physiological processes driven by climate and environmental factors. A user-friendly web-based GIS is designed as a versatile interface to improve accessibility to the models and to present short-, medium-, and long-term predictions of habitat suitability, vector activity, and disease risk and impact.

The platform displays vector presence and risk maps and seasonal profiles of vector activity and disease risk. It is planned to include (i) an extensive database of meteorological variables, climate projections, and environmental covariates and (ii) an up-to-date longitudinal vector surveillance dataset. Customised simulations under different climate scenarios and vector control activities will also be possible. A comprehensive application programming interface (API) will extend the capacity of advanced data analysis tools, such as Python and R, to accommodate climate-sensitive mechanistic modelling. The platform is operationally maintained at The Cyprus Institute and is permanently available via its dedicated domain: veclim.com.

Through an active user community and maintaining communication with citizens, public health specialists, and fellow researchers, we prioritise identifying needs and designing for better utility and accessibility. We advocate predictive tools to reduce the environmental impact of insecticides due to better timing and higher efficiency of vector control and to prevent disease outbreaks due to the incorporation of climate-sensitive risk assessments into early warning systems.

Authors

Kamil Erguler, Ahmet Arca, Behich Koyutourk, George Tsouloupas, George Christophides, Jos Lelieveld

Evaluation of urban heat island (UHI) effect from a double perspective: observations and simulations. The case of the Nicosia area.

Giandomenico Vurro

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Given the rapid growth of the population worldwide, urban areas are expanding their boundaries, becoming more dense and more vulnerable to climate change impacts and threats. Replacing natural surfaces with artificial, dry, and impermeable ones causes a modification of the atmospheric processes and variables at the local scale, affecting the local weather and enhancing climate-induced phenomena. One of the most common outcomes of this land surface alteration is the Urban Heat Island (UHI), a thermal phenomenon due to the changes in the surface energy balance that causes higher temperatures in urban environments than in rural surroundings. Regional climate models (RCMs) can reproduce climate-induced phenomena by simulating many atmospheric variables. Furthermore, to better represent the urban environment, the Building Effect Parameterization (BEP) urban canopy model (UCM) can be coupled with an RCM. The reliability of these numerical models is confirmed by the comparison against measured data, like those provided by meteorological stations. For this reason, the importance of the meteorological weather station is twofold, being not only a measurement tool but also a quality assessment tool. Therefore, in this study, we investigate the UHI effect for the Greater Area of Nicosia for the period July 10, 2021, to August 10, 2021, exploiting the observed data provided by the Department of Meteorology of Cyprus and the results of the simulations run with the Weather Research and Forecast (WRF) model. For this purpose, we compare the modeled maximum and minimum air temperatures against the observed ones and explore the suitability of available pairs of urban and rural stations.

Authors

Giandomenico Vurro, Katiana Constatinidou, Panos Hadjinicolaou

Variation in trends of maximum temperature change on the Libyan coast for the period (1961-2099) by using spatial techniques

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This research aims to predict the maximum temperatures for three selected stations from the Libyan coast, which are the Benina meteorological station to represent the eastern coast, the Sirte

meteorological station to represent the central coast, and the Tripoli airport meteorological station to represent the western coast for the period (2010-2099). Depending on the maximum temperature monitored and recorded at the Libyan National Meteorological Center for the base period (1961-1990) using the ((Statistical Downscaling Model (SDSM)) technique, according to climate change scenarios (A2a) (B2a); these are scenarios approved by the concerned team. Climate change, IPCC, in a report known as SRES in the year 2000 to develop climate and environmental forecasts based on greenhouse gases. In addition to the use of statistical analysis methods by means of the SPSS program to detect the trends of change in the maximum temperatures of the three stations during the study periods, namely: (1961-1990), (2039-2010), (2069-2040), (2070-2099), To achieve the objectives of the study, the equation of variance and total variance was applied between the three study stations.

The results showed trends for the change in the annual and seasonal maximum temperature towards an increase compared to the first period (the base period) for the three stations and at a level of statistical significance less than 0.05. Contrast results confirmed that there is a discrepancy and difference in the averages of the three stations.

Authors

Asmahan Ali AlMukhtar Othman.

Modelling new particle formation in the Asian monsoon upper troposphere-lower stratosphere

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In this study, we investigate new particle formation events within the Asian Tropopause Aerosol Layer (ATAL) over the Asian monsoon region, using the ECHAM/MESSy Atmospheric Chemistry (EMAC) model. Both primary and newly-formed secondary aerosols play pivotal roles in cloud dynamics and the atmospheric radiative balance, leading to significant climatic and socioeconomic implications. Data from the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) instrument on the Envisat satellite highlight the presence of ammonia in the upper troposphere-lower stratosphere (UTLS), emphasising its potential role in aerosol nucleation. The StratoClim 2017 campaign (Stratospheric and upper tropospheric processes for better Climate predictions) further indicated heightened aerosol mass concentrations in the UTLS within the Asian monsoon region. Within EMAC, we employ the Global Modal-aerosol eXtension (GMXe) and New Aerosol Nucleation (NAN) submodels to simulate aerosol microphysics and nucleation processes, respectively. Model outcomes align closely with observational data, suggesting a robust representation of the ATAL. Through a detailed analysis of the ATAL particle composition and size distribution, we quantify the effects of multi-acid nucleation and delve into the associated atmospheric and climatic impacts.

Authors

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Modeling of carbonaceous aerosols for air pollution health impact studies in Europe

Niki Paisi

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Air pollution from fine particulate matter (PM2.5) has been associated with various health implications that can lead to increased morbidity and excess mortality. Epidemiological and toxicological studies have shown that carbonaceous particles (black carbon and organic aerosols) may be more hazardous to human health than inorganic ones. Health impact studies and emission reduction policies are based on total PM2.5 concentration without differentiating the more harmful components. In such assessments, PM2.5 and their sub-component concentrations are usually modeled with air quality models. Organic aerosols have been shown to be consistently underestimated, which may affect excess mortality estimates. Here, we use the WRF-Chem model to simulate PM2.5 (including carbonaceous particles) over the wider European domain and assess some of the main factors that contribute to uncertainty. In particular, we explore the impact of anthropogenic emissions and meteorological modeling on carbonaceous aerosol concentrations. We further assess their effects on excess mortality estimates by using the Global Exposure Mortality Model (GEMM). We find that meteorological grid nudging is essential for accurately representing both PM2.5 and carbonaceous aerosols and that, for this application, results improve more significantly compared to spectral nudging. Our results indicate that the explicit account of organic precursors (semi-volatile and intermediate-volatile organic carbons - SVOCs/IVOCs) in emission inventories would improve the accuracy of organic aerosols modeling. We conclude that uncertainties related to PM2.5 modeling in Europe lead to a ∼15% deviation in excess mortality, which is comparable to the risk model uncertainty. This estimate is relevant when all PM2.5 sub-components are assumed to be equally toxic but can be higher by considering their specific toxicity.

Authors

Niki Paisi

Urban scale WRF-PMCAMX forecasts: evaluation of the meteorological forcing and its impact onto the pm predictions

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The health risks due to air pollution necessitate reinforced public health measures. Accurately predicting atmospheric composition, considering the continuous chemical processing of air pollutants, remains a significant challenge. High-resolution models have become vital for improved regional air quality forecasting, due to advancements in meteorological and chemical transport modeling. Meteorological conditions, along with precursor emissions, influence air pollutant levels and their duration in the atmosphere. Meteorological forecast inaccuracies affect the predictions of chemical transport models often more than errors in emissions or chemical processes. This study evaluates the high-resolution (1x1 km) WRF model's ability to simulate surface weather parameters in a major coastal urban area in the east Mediterranean on several timescales, gaining valuable insights into the PMCAMx chemical transport model performance. Additionally, it examines the influence of WRF, as the meteorological driver for the SMARTAQ air quality system (which includes among other modules the WRF and PMCAMx models), on high-resolution air quality forecasts for the same area. WRF reproduces well the observed values for actinometric and thermodynamic variables, but it systematically overestimates soil moisture and wind speed (particularly at night). These biases stem from WRF's boundary layer schemes and rain prediction mechanisms. The model successfully reproduces 2 out of 3 rain events, a capability crucial for atmospheric pollutant deposition. Throughout the year, the accuracy of wind predictions is closely tied to the precision of PM2.5 forecasts. Wind errors have a more pronounced effect during the cold season at most stations when local emissions are elevated, impacting both daytime and nighttime predictions. During the warmer season, wind-related effects are most noticeable during the day. High-emission areas are less affected by wind inaccuracies, while during cold seasons, suburban areas face notable PM2.5 shifts due to wind and pollution migration.

Authors

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Simulated future thermal comfortability over cities in Cyprus

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Urbanization significantly affects a region's climate due the changes it causes on the land surface properties of the area, which in turn modifies the surface energy balance. More specifically, urban areas experience higher temperatures compared to their rural surroundings and in combination with humidity impacts human comfort and the quality of the citizens' lives. Wet-bulb temperature (WBT) is an important

and widely used metric to assess the effects of this humid heat. Prolonged exposure beyond the considered survivability limit of WBT= 35◦C could be deadly even for the fittest of humans.

Humans in regions like eastern Mediterranean and the Middle East (EMME), are vulnerable to climate change and are also highly susceptible to high WBT values, especially in densely populated areas, where humid heat events with WBT≥35◦ C are projected by the end of this century. It is therefore crucial to assess the projected levels of humid heat over this particular area and especially in Cyprus, which is located in the center of this domain.

This work uses the Weather Research and Forecasting (WRF) model to simulate climate over the EMME coupled with the bulk urban parametrization and NoahMP land surface scheme. The simulations are performed at 4 km horizontal resolution for a recent past (2000-2004) and a future (2056-2060) period driven by the Representative Concentration Pathway (RCP) RCP 8.5. The aim of this study is to investigate how the simulated maximum wet bulb temperatures, computed as a function of maximum air temperatures and relative humidity, are projected to change in the future during the summer period over Cyprus and more specifically over two of the island's major cities Nicosia and Limassol.

Authors

Katiana Constantinidou, Panos Hadjinicolaou

Assessing the spatial distribution of urban thermal risk in Nicosia through machine learning techniques

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Heat stress is a major hazard for the urban population, especially, for citizens in the Eastern Mediterranean and Middle East (EMME) region which constitutes a climate change hot spot. This study focuses on the production of urban heat risk maps for the city of Nicosia aiming to identify intra-urban vulnerability. The framework incorporates critical elements related to urban heat risk, such as heat indices, Earth Observation (EO) imagery, urban form, and socioeconomic data that have the ability to associate the effect of climate change with the urban environment. The Weather Research and Forecasting (WRF) model coupled with the Single Layer Urban Canopy Model (SLUCM) is used to dynamically downscale climatic variables from the regional to the local scale (1km) incorporating the hybrid Global Land Service Land Cover (CGLC)- MODIS - Local Climate Zones (LCZs) dataset for the better representation of the land cover. High-resolution EO retrievals, such as Land-Surface Temperature (LST) and the Normalized Difference Vegetation Index (NDVI) will offer insights into thermal distribution within urban areas as well as the distribution of vegetation cover. LCZ data serves as an indicator of the special characteristics of Nicosia's urban form, while socio-demographic data helps identify population groups vulnerable to extreme heat impacts. Once these indices are defined, the assessment of thermal risk is

conducted using machine learning model tools (unsupervised clustering) to address the spatial distribution of the exposure and sensitivity, thus, resulting in the development of urban heat risk maps. Ultimately, this work provides valuable scientific evidence to support the formulation of spatially differentiated resilience plans for dealing with temperature extremes at the city scale as it pinpoints areas that are highly susceptible to heat risk forming thermal hot spots.

Authors

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Sensitivity simulations of Izmit bay water circulation to wind speeds and directions using MITGCM

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İzmit Bay's water circulation is critical for a healthy and resilient marine environment because it affects nutrient distribution, stratification, sedimentation, oxygen levels, heat levels, and pollution levels. The circulation is heavily impacted by local meteorological circumstances, including as short-term strong wind occurrences, in addition to water exchange with the Sea of Marmara. The sensitivity of İzmit Bay to wind speed, direction, and duration was explored in this study by adopting the MITgcm model with Orlanski boundary conditions and utilizing the process-oriented modeling method. For 11 days, the MITgcm was forced by 6 distinct wind speeds from 8 different directions in the simulations. There are no substantial changes in water masses or stratification in the bay when wind speeds are low. On the other hand, easterly component winds drag the upper layer out of the bay, resulting in upwellings in the bay. It is also expected that strong winds from the N, NE, and E sectors will cause the lower layer waters of the western basin to rise and overflow into the central basin through the Hersek Delta sill. Overall, wind speeds greater than 4.9 m/s are observed to have considerable and diverse effects on the hydrography of the bay depending on direction and duration.

Authors

Sabri Mutlu, Barış Önol, Mehmet Ilicak, Hüsne Altiok

Atmospheric chemical kinetics using posits arithmetic

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Double precision IEEE-754 floating point arithmetic has been the standard used for Atmospheric chemical kinetics simulations, mainly due to the level of accuracy required due to the stiffness of the underlying ordinary differential equations (ODE). However, moving towards higher resolution and complexity simulations, performance and scalability are restricted while power consumption is increased by the required amounts of memory. In addition, since a floating-point variable is represented by a finite number of bits, computer hardware is limited when representing an arbitrary real number range. To fit into a designated number of bits, many real numbers are rounded after mapping.

Posits are a direct replacement of the floating-point number representation. An n-bit posit consists of 1 bit for the sign and variable binary string sizes for regime, exponent and fraction. This representation allows for tapered accuracy. Numbers close to unity in magnitude, which are commonly used in calculations, are more accurate than extremely large or extremely small numbers which are not so common. Replacing floats with posits is expected to provide more accurate species concentrations and reaction rates for the same size memory addresses, faster operations for similar hardware resources, and lower power usage. In many cases, 64-bit double precision floats can be safely replaced by 32-bit Posits, as the atmospheric reaction rates are known to only a few percent, enabling faster memory transfer, better scalability and effectively halving the required memory.

We have refactored common atmospheric chemical mechanisms (e.g. Small Stratospheric mechanism and SAPRC-99) to exploit this by developing Rosenbrock ODE solvers with emulated 32-bit Posits. These mechanisms have been ported to the Julia language and compared in terms of accuracy of the solution with their double- and single- precision floating point arithmetic counterparts. Our results indicate that 32-bit Posits can replace double precision floating points with results that are within 1% relative difference, using half the required memory. Posits are also shown to maintain stability where single-precision fails and produce more accurate results, with the same memory utilization.

Authors

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Predicting future wet and dry spell durations in Europe: an analysis with bias-corrected Q-GAM data

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Accurate climate data is paramount for informed decision-making in the context of climate change. This study focuses on correcting the bias in daily precipitation data across Europe, specifically under the RCP8.5

climate scenario, using the Quantile Generalized Additive Models (Q-GAM) method. Climate models frequently exhibit a bias where they overstate the frequency and duration of rainfall events while underestimating their intensity. Q-GAM serves to rectify this bias, substantially improving the accuracy of rainfall projections. The primary objective of this analysis is to assess future wet and dry spells, with dry spells being crucial indicators of drought, with far-reaching implications for agriculture, health, and economic sectors. The study utilizes daily rainfall data from three EURO-CORDEX climate models, spanning the period from 1981 to 2100. The bias correction is applied specifically to future sub-periods under the RCP8.5 scenario, which represents a high greenhouse gas emissions trajectory. The findings of this research indicate that as a result of global warming, short-term rainfall is expected to intensify, potentially leading to increased risks of floods and landslides. Additionally, the enhanced detection of dry spell probabilities forecasts longer and more severe drought episodes in the future. These trends are particularly pronounced during future summers, and they extend into transitional and moderate seasons. Understanding the evolving patterns of wet and dry spells under the RCP8.5 scenario, with the aid of Q-GAM bias correction, is essential in preparing for the challenges posed by climate change in Europe.

Authors

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Assessment of the relationship of atmospheric blocking and heatwaves over the Mediterranean region

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National Observatory of Athens, IAASARS

Atmospheric blocking describes strong and stationary high-pressure systems at mid-latitudes, with a lifetime of 5 days to a few weeks. The pattern's persistence interrupts the westerly atmospheric flow in the upper atmosphere, allowing heat to accumulate in the blocked areas and, resulting in extreme weather conditions at the surface, such as heat waves, cold spells and heavy rainfall.

The study focuses on investigating and understanding a specific type of blocking, the omega block. This is an atmospheric pattern during which isobars or geopotential isopleths form the Greek letter omega. It consists of two low-systems ('cut-off' lows) at the upward and downward the system and a high-pressure system in the centre, arranged in the west-east direction.

Initially, the omega blocks are identified using ERA5 Reanalysis 0.25° x 0.25° geopotential data at 500 hPa for the period 1981-2020 for the summer months in the European region by calculating the geopotential height anomaly. Of the 115 blocking systems identified in the period above, 77 are classified as omega, the duration of most of them does not exceed 20 days.

The calculation of the blocking intensity is necessary in order to classify them as weak, average and strong and is carried out using the pressure gradient between the high and low systems. Few strong omega blocks are observed, while the most significant proportion belongs to systems of average intensity.

The correlation between the North Atlantic Oscillation (NAO) phase and the occurrence of Omega-type blocking systems is also of interest. We observe a remarkable association of omega blocks occurring during the negative phase of the NAO in Western Europe. Therefore, we conclude that changes in the zonal wind component at 250 hPa play a catalytic role in the development of the appropriate conditions for the omega blocking formation.

Last but not least, we examine the correlation between extreme high temperatures in the Mediterranean region and the simultaneous occurrence of omega blocks, by calculating the Excess Heat Factor (EHF). Finally, severe heatwave cases in this region and, particularly, in Greece are investigated.

In conclusion, an increasing trend in the duration and intensity of omega blocks is recognized only in the last decade, with the most significant part of them affecting western Europe, during the summer period.

Authors

Koutsoupi, I., Cartalis, C., Philippopoulos, K., Agathangelidis, I.

Comparison study between heat index(hi) of different algorithms over Egypt

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Calculating apparent temperature which represents heat index (HI) using Steadman's equations that describe heat (air temperature) and moisture(relative humidity or dew point temperature) of the same weather condition (air temperature >=20°C) using daily weather data for 20 station over Egypt (BALTIM, LUXOR, SALLUM, ASYUT, KHARGA, RAS SEDR, WADI EL NATROON, DABAA, SIWA, EL ARISH, DAKHLA, MERSA MATRUH, ASWAN, MINYA, CAIRO, ALEXANDRIA, ISMAILIA, BAHARIA, FARAFRA, HURGHADA) of period (2000-2015). Studying 21 heat index algorithms over Egypt. Then we calculated the difference between the heat index value calculated by the algorithm and the apparent temperature value in the Steadman's table for those weather conditions for dew-point and relative humidity. Case study of heat wave over Egypt August, 2015.

Authors

R.S.Ezzeldeen, Z.Salah, A.S.Zakey

A global approach to define concurrent atmospheric and marine heatwaves

Lorine Behr

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Atmospheric and marine heatwaves (AHW/MHW) have been observed around the world and are expected to increase in intensity and frequency under future climate change. Despite numerous studies that have examined AHW or MHW independently, only few regional studies investigate potential associations between these two types of extreme events. However, the co-occurrence of AHW and MHW could have broader and greater environmental, human, and economic impacts than an individual event, such as changes in species distributions, land and marine mass mortalities, or increased heat stress in coastal areas due to interactions between warm and moist air over the ocean. Based on research on AHW and MHW, we propose a comprehensive and globally applicable definition that relates the two extreme events and the two realms, and allows comparison with past and present concurrent and single events. Our definition is based on a conditional approach: We define a concurrent heatwave as an extreme event where sea surface temperature (SST) and 2 m air maximum temperature (Tair) exceed their daily 90th percentiles, based on a 30-year historical baseline period, for at least 5 and 3 consecutive days, respectively (Perkins & Alexander 2013; Hobday et al. 2016). Thereby, we account for a potential lagged relationship between the two extremes by calculating and choosing the lag that provides the maximum probability of observing a MHW and an AHW simultaneously or delayed. In this work, we show the results of the most common heatwave metrics, such as duration, frequency, intensity, and cumulative intensity, for concurrent and single heatwaves in the Mediterranean Sea. We use SSTs from Advanced Very High-Resolution Radiometer (AVHRR) satellite data (NOAA OISST V2) as well as Tair from the ECMWF Reanalysis v5 (ERA5), both provided daily and globally on a high resolution (0.25°) for the period 1982 – 2022. In the Mediterranean Sea, we find concurrent heatwaves to be shorter and less frequent, but more intense and cumulatively intense than their single variants. For concurrent events, the MHW component (SST) is observed to be most intense in summer and spring, and the AHW component (Tair) in fall and winter.

Authors

Lorine Behr, Niklas Luther, Elena Xoplaki, Stamatis Petalas, Elina Tragou, and Vassilis Zervakis

Alexa storm and its effect on Egypt

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In the early morning of Friday, the 13th 2013, parts of Cairo witnessed the first snowfall in more than 100 years. Nighttime temperatures were expected to drop as low as 2°C. Snow also fell heavily on mountains in the Sinai Peninsula.

The study aims to investigate the synoptic conditions associated with Alexa storm that affected Egypt between 11th and 14th of December, 2013.

The weather records for eight weather stations (Sant_Cathrine, Cairo, Alexandria (El_Nozha), Alexandria (Borg_ElArab), Marsa_matruh, Baltim, AlDabaa, El_Arish) were also studied.

The storm resulted in accumulated snow that reached 3.7 cm over Sinai Peninsula, and a lot of Snow falling in different region over Egypt like Madinaty, 40km east of Cairo.

The study indicate that temperature dropped below the average from 10 December to 16 December, when the temperature dropped to -2C over Sant_Cathrine, also started snowing on the 13 December at 12.00PM for seven hours.

Nighttime temperatures were expected to drop as low as 5°C over Cairo from 11 December to 14 December. The study will investigate the damage in agriculture associated with Alexa storm.

In addition, Reanalysis Data (ERA5 Land) from European Centre for Medium-Range Weather Forecasts were used to visualize the Daily thickness of surface snow amount over Egypt at the same duration, 10 until 16 December 2013 with resolution 10KM, which were in agreement with satellite images. Also, Reanalysis Data (ERA5) were used to visualize the total accumulated daily maximum a, minimum and mean temperature over Egypt at the same duration, 10 until 16 December 2013 with resolution 25KM, and Reanalysis Data (ERA5 Land) were used to visualize the total accumulated daily Rain over Egypt at the same duration, 10 until 16 December 2013 with resolution 10KM, which were in agreement with observation.

Authors

Eman Said Mohamed

Exploring the relationship between grace/grace-fo terrestrial water storage anomalies and the standardized precipitation index (SPI) in arid regions.

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In the face of increasing climate change impacts, arid regions are confronting increasingly frequent and severe drought events, posing significant threats to water resources and agricultural sustainability. The Terrestrial Water Storage (TWS) data from the GRACE/GRACE-FO satellite missions has been extensively used to analyze global water mass variations and develop new approaches for monitoring hydrological drought conditions.

This study investigates the relationship between GRACE/GRACE-FO TWS anomalies and the hydrological drought index, specifically the Standardized Precipitation Index (SPI), within the Amman-Zarqa Basin (AZB) in Jordan, spanning from 2008 to 2018. This study aims to assess the effectiveness of GRACE/GRACE-FO data in tracking hydrological drought, tests the viability of SPI as a reliable indicator for TWS, and

investigates the response of TWS to rainfall variability. Daily rainfall data from four monitoring stations in AZB, encompassing three governorates in Jordan, were collected, and SPI-1 month values were computed. TWS anomaly data from the GRACE satellite mission website were processed using ArcGIS 10.8 software.

The study results indicate a decline in TWS at stations situated in the eastern segment of the basin, while stations in the western portion exhibit TWS fluctuations, alternating between increases and decreases. Notably, neighboring stations share a consistent trend in TWS, which can be attributed to the similarities in their climatic, geologic and soil conditions. No significant correlation was found between the investigated variables, potentially attributed to the uncertainties in GRACE/GRACE-FO data. Consequently, the findings propose that TWS operates as an independent variable distinct from SPI-1 changes, implying the existence of an additional TWS component unaffected by rainfall variability. Recognizing this independence of TWS from short-term precipitation variations contributes to a more comprehensive understanding of hydrological processes in AZB and similar arid regions.

Authors

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Feedbacks on weather via fire-generated aerosols over Greece

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Wildfires are a major source of atmospheric aerosols and can have significant impacts on air quality and radiative forcing. In our work, we have utilised the Weather Research and Forecasting model coupled with Chemistry (WRF-Chem) to study the impact of wildfires on aerosol pollution and associated meteorological feedbacks, focusing on the geographical area of Greece as a test case. We study the summer season of 2021, during which intense wildfire activity occurred in the country. We conducted sensitivity experiments with and without emissions from fires as well as perturbations to the initial conditions to quantify the impact of such emissions on atmospheric pollutants, aerosol optical depth (AOD), radiative forcing and key weather variables such as temperature. We demonstrate that the impact of wildfires on AOD influences the local temperature over the fire affected areas negatively. Our study identifies fire-emitted aerosols as a significant factor affecting the evolution of short-term meteorological conditions, with implications for weather prediction, and provides new insights into the mechanisms leading to such effects

Authors

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Greenhouse gas data for emission inventories from atmospheric inversions-what have we learned? What do we need?

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Emission inventory agencies are in the spotlight of international attention with respect to climate policies and Greenhouse Gas (GHG) regulation. They need to adapt and cater for an ever more complex field of sources and sinks for the individual GHGs. They also need to implement refinements in GHG reporting issued by the IPCC such as the IPCC 2019 refinements in quality assurance and quality control and verification, which mention the usage of spaceborne data and atmospheric inversions as independent verification tools for the emission inventory. The European research project VERIFY assembled emission inventories across Europe for the first time and brought them together with the modelling community. Here we would like to present the lessons learned from VERIFY and introduce the new EU-Project "AVENGERS", which for the first time has put inventory staff into the "drivers-seat" of scientific development in order to reconcile top-down inversion data with bottom-up emission inventories. The projects modular structure hosts several work packages that are specifically designed to cater for the needs of inventory staff and introduces new techniques to them such as current and future capabilities of spaceborne sensors, process-models and inversion models. In addition, AVENGERS will produce an atmospheric inversion demonstrator tool for methane that may be used by emission inventories world-wide to learn more about atmospheric inversion in a "hands on "way. Therefore, with this presentation we would like to share our current efforts and thoughts about such an inversion demonstrator system. We are looking for emission inventory agencies from the eastern mediterranean and the middle-east, who would be interested in using and shaping such an inversion demonstrator tool together with us in order to make it more useful towards a wide base of different emission inventories world-wide.

Authors

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Decarbonizing lifestyles: strategies for a sustainable future

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The concept of a carbon diet has emerged as an innovative strategy to combat climate change by mitigating greenhouse gas (GHG) emissions. This article explores the impact of carbon diets on climate change, focusing on the experiences of the United Kingdom (UK) and Egypt from 1990 to 2019. The study investigates how adopting a carbon-based diet can effectively reduce GHG emissions, with carbon being

the longest-lived gas in the atmosphere. It is observed that a carbon diet encourages individuals to purchase environmentally friendly products, thereby reducing their carbon footprint.

Comparing the carbon diets of the UK and Egypt, it is evident that the UK has made significant progress in reducing CO2 and GHG emissions, while Egypt is still in the early stages of implementing such measures. The study employs a combination of primary and secondary sources, including surveys conducted among Egyptians to gather insights into their awareness and practices related to carbon diets. The findings highlight that the UK has been successful in curbing CO2 and GHG emissions through the adoption of carbon diets, whereas Egypt faces challenges due to increasing outputs in various sectors. In Egypt, it is predicted that emissions from power, road transport, and basic industries will continue to rise, while emissions from agriculture, solid waste, and construction are expected to decrease. Energy generation and road transportation account for a significant portion of Egypt's overall emissions.

Authors

Doaa Salman Abdou And Asmaa Mohamed Ahmed Mourad

FUTUREMED: a transdisciplinary network to bridge climate science and impacts on society

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The Mediterranean region, encompassing southern Europe, northern Africa, and the Middle East, is recognized as a climate change hotspot warming 20 % faster than the rest of the world. Several types of risks are currently affecting the region, from frequent extreme weather events to coastal erosion from rising sea levels or increased pollution. Furthermore, climate change impacts propagate as “cascades'' across socio-economic sectors. Recent findings show the exacerbation of existing environmental problems in the Mediterranean Basin, while current change and future scenarios consistently point to significant and increasing risks during the coming decades in most impact domains (such as water, ecosystems, food, health, and security).

Despite the ubiquity of these connections, scientists and decision-makers are typically working on addressing isolated risks, advancing in parallel, and missing added value from cooperative efforts. It is thus necessary to move beyond siloed approaches towards integrated efforts that promote effective science-based and agent-based decision-making. It is necessary to establish unprecedented networks of transdisciplinary partnerships, including scientific, human health, social approaches, to governance, and risk management. Such networks facilitate stakeholders and researchers to reach more accurate recommendations, strategies, and policies addressing climate change impacts and risk management.

FutureMed will foster new climate change-related science and synergies serving as a transdisciplinary and integrative platform effectively connecting scientific knowledge on high-impact weather events and climate change impacts with stakeholders from priority socio-economic sectors such as energy supply and demand, agriculture, health, and migration. For the first time, an Action coordinates a platform where

scientific communities, key stakeholders, and citizens can interact for the ends of promoting climate change impacts awareness, establishing future research priorities, and building capacities based on knowledge exchange in a living lab.

Authors

S. Khodayar

Calibration and validation campaign for EARTHCARE using UAVs and lidars in Cyprus

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The Cyprus Institute

The Cyprus Institute's Climate and Atmosphere Research Centre (CARE-C) develops, adapts and optimises novel unmanned aerial vehicles (UAVs) and sensors for dedicated atmospheric campaigns, in order to document and contrast long range transported pollution and dust aerosols, within the framework of the Unmanned Systems Research Laboratory (USRL). This facility is a mobile exploratory platform of ACTRIS and it represents a valuable validation infrastructure for spaceborne lidar validation. In addition to the UAVs, CARE-C operates the Cyprus Atmospheric Observatory, providing long-term in-situ and remote sensing observations over the island, which is another valuable validation infrastructure, and also part of ACTRIS.

CARE-C has acquired expertise during the ASKOS campaign, for the cal/val of Aeolus, which has seen our UAVs deployed in Cape Verde, fitted with aerosol and cloud instruments (optical particle counters, backscattersonde, and impactors for dust sample collection). The UAVs were able to reach altitudes up to ~5,000 m above sea level, and they permitted to observe the height-resolved particle size-distribution within the Marine Boundary Layer and the Saharan Air Layer. The mineralogy of airborne dust was obtained through the collected samples, and the presence of large dust particles (up to 40 um) in diameter was highlighted.

In this presentation we will discuss the potential of these infrastructures for the cal/val of EarthCARE, the strategical location of Cyprus for this activity, and the great potential coming from the collaboration with the nearby aerosol and cloud remote sensing observational platform of the ERATOSTHENES centre of excellence, also planned National Facilities of ACTRIS-ERIC operating in Limassol. The existing cal/val plans, the room for the development of further validation projects, the funding opportunities and the challenges will also be discussed.

Authors

Franco Marenco, Rodanthi Mamouri, Maria Kezoudi, Alkistis Papetta, Christos Keleshis and Jean Sciare

Refined flux calculations for greenhouse gases: insights from automated non-steady-state transparent soil chambers

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Non-steady state chambers serve as an indispensable tool for the quantification of soil emissions, namely CO2, CH4, and N2O. When integrated with online gas analyzers, the automated non-steady-state soil chambers (a-NSS), facilitate the acquisition of high-frequency measurements of greenhouse gas (GHG) fluxes. Notwithstanding their utility, these systems present inherent post-measurement challenges, encompassing the management of voluminous datasets, intricate flux calculations, and considerations pertinent to temporal upscaling.

In the present study, we developed a computationally efficient algorithm to calculate instantaneous fluxes and extrapolate diel flux patterns using continuous, high-resolution data obtained from an a-NSS system. This algorithm was rigorously applied to a comprehensive 38-day dataset, which encompassed simultaneous field measurements of CO2, CH4, and N2O fluxes. The automated sampling system enables the acquisition of high-frequency data, thereby discerning episodic gas flux events.

By carefully selecting and employing a combination of linear and nonlinear regression models, we effectively minimized biases associated with GHG fluxes. By invoking Simpson's rule, we accomplished temporal upscaling, transitioning from instantaneous to diel flux metrics.

Consequently, the devised algorithm proficiently calculates fluxes of CO2, CH4, and N2O fluxes, providing both instantaneous and diel values directly from raw, high-temporal-resolution data. These advancements significantly contribute to the field of GHG flux quantification, enhancing the efficiency and accuracy of a-NSS chamber measurements and providing profound insights into the temporal dynamics of GHG emissions.

Authors

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Calibration and validation campaign for EDU4CLIMATE using UAVs and PMEYE lidar in EMME

Maria Kezoudi

The Cyprus Institute

Although the Eastern Mediterranean and Middle East (EMME) region is a climate change hotspot with high concentrations of atmospheric pollutants, it has received very little attention. One reason is that observational data is insufficient, unavailable or of limited quality. The European Higher Education Institutions Network for Climate and Atmospheric Sciences (EDU4CLIMATE) project (HORIZON) aims to

address challenges related to air pollution and climate change in support of the EU Green Deal, with a specific focus on the EMME.

One of the main objectives of the project is the real-time monitoring of PM and gases in major air pollution hotspots of EMME. This involves research deployment and campaigns using state-of-the-art instrumentation. The RAYMETRICS PMeye is a lidar-based aerosol monitoring system (Kostopoulos et al., 2023) enabling 3D mapping of Particulate Matter (PM) with up to several kilometres radius of detection, providing PM concentrations mapping over large emission areas. Optical Particle Counters (OPCs) integrated on-board Uncrewed Aerial Systems (UASs) of the Cyprus Institute (CyI; Kezoudi et al., 2021) will be used to calibrate/validate the PMeye retrieval algorithms for 3D PM monitoring. In particular, this will involve plume mapping and monitoring of ship emissions at the Limassol port, stack emissions at power plants, cement works and quarries.

In addition to the PM measurements, gas observations are essential for monitoring and assessing air quality and pollution levels. A latest generation package of SO2/CO2 sensors is being modified, calibrated and tested, before its integration on-board the UASs of the CyI and OURANOS RPAS of ALTUS. Field deployment and campaigns with this system will be performed in ports and open-sea. This presentation will give more insight into the scope of the project and technicalities on the implementation on the activities.

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Single instrument for simultaneous monitoring of up to ten greenhouse gases and air pollutants

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Air pollution and greenhouse gas emissions are two closely linked problems. They can be attributed to a variety of sources, such as transportation and buildings, waste management and agricultural production,

natural events such as forest fires and many others. Monitoring air pollutants and GHG simultaneously with high selectivity and sensitivity enables to detect and evaluate their sources and sinks and to discover the links between them. Precise measurements at various spatial and temporal scales are required for modelling and validation of emission inventories or satellite observations.

Solutions to monitor air pollutants or GHG with high precision and temporal resolution were commonly offered as “one-species-one-instrument”, leading to large, immobile measurement setups with high energy consumption. We provide a new compact laser absorption spectrometer “MGA” that combines several mid-IR lasers. Our solution allows direct high-precision measurements of up to 10 gases simultaneously and with high time resolution (1 or 10 Hz). Potential compounds are the greenhouse gases CO2, N2O, H2O and CH4, the pollutants CO, NO, NO2, O3, SO2 and NH3 as well as COS, HONO, and HCHO. With 10 gases in one compact and rugged instrument, our MGA is the perfect solution to detect the relations of the co-emitted pollutants and GHGs, even in the field or during mobile campaigns.

We will demonstrate examples of our instruments’ applications for mobile monitoring of 10 GHGs and air pollutants in urban areas and airborne measurements. Furthermore, we will present the results of parallel monitoring with our instrument and standard conventional gas analysers. This demonstrates the ability of our MGA to serve as an all-in-one solution and to replace up to 7 standard gas analysers opening a wide range of new mobile multi-compound gas monitoring applications, for example, in (small) airplanes or cars.

Authors

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Sampling atmospheric volatile organic compounds using unmanned aerial vehicles: from Estonia to Cyprus

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Terrestrial vegetation and anthropogenic activities produce vast amounts of Volatile Organic Compounds (VOCs) which impact air quality, human health, and ecosystem functioning. The demand for innovative techniques to determine the atmospheric composition in remote and sensitive areas is highly increasing, and an emerging approach is the employment of Unmanned Aerial Vehicles (UAVs). Here, we present the development of a UAV-based VOC sampler system, specifically designed to collect samples using VOC-adsorbent cartridges and subsequent analysis through offline thermal-desorption gas chromatography.

A single-tube system was initially deployed in Estonia and further developed to a stand-alone, 4-tube system by the Cyprus Institute in the frames of the ATMO-ACCESS TNA project. The new sampler allows for the collection of multiple samples during a single flight, providing flexibility for various sampling approaches, including vertical and horizontal profiles, with options for single tube and simultaneous sampling using different combinations. Basic meteorological parameters, i.e., temperature and humidity,

are collected alongside geographical coordinates and inlet flow performance. During a field campaign in Cyprus during October 2023, 16 flights were performed above different environments, generating a wealth of data awaiting analysis.

Interpreting the obtained results requires the understanding of numerous factors such as wind speed and direction, atmospheric lifetimes of individual VOC species, turbulence, alongside the complex nature of the surfaces above which samples are collected. To address this challenge, we present several available tools, developed during our initial single-tube flights in Estonia, that enable the utilization of both micrometeorological and surface cover data and unfold the vast potential of the newly developed VOC sampling system.

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Authors

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