Climate and Atmosphere Research Center (CARE-C) Activity Report 2020-2023



THE CYPRUS INSTITUTE

Contents

1-2 Foreword

4-11 About

- 4-5 CARE-C, The Cyprus Institute
 - 6 Research & Innovation Vision
- 7-9 Research Departments
- 10-11 Research Infrastructures

12-19 Achievements

- 12-16 Science
- 17-18 Innovation
 - 19 Education

20-25 Activity highlights

- 20-21 Campaigns
- 21-22 CERN Cloud Experiment
- 22-23 Technology Development
- 23-25 Events

26-29 Partnerships & extroversion

- 26-27 National collaborations
 - 28 Regional Collaborations
 - 29 International Networks
- **30-31 Annex**
 - 32 Contact information

Photograph from an atmospheric balloon taken at an altitude of 30km over Cyprus, during an AirCore campaign to monitor greenhouse gases.

Foreword



Prof Jean Sciare

Director, Climate and Atmosphere Research Center (CARE-C), The Cyprus Institute

The year 2024 marks the 4th year of the establishment of the Climate & Atmosphere Research Center (CARE-C) of the Cyprus Institute which started its operation on 1st January 2020. It reminds us the long path we have taken since 2016, when we submitted to the European Commission (EC) the scientific vision of our Research Center under the competitive "Teaming" call of the Horizon 2020 Widening Programme.

A long and highly competitive process which led, by the end of 2019, to the successful funding of the "Eastern Mediterranean & Middle East Climate & Atmosphere Research Center" (EMME-CARE), which received over 45 million euros from the EC, the Cyprus Government, and the Cyprus Institute, to establish itself as a regional center of Excellence, in order to address urgent needs of the current climate change crisis.

Since then, CARE-C has gradually grown and developed from 30 to 100 research staff, to become a highly international center, hosting young talents from 17 different nationalities. While the Research footprint of CARE-C was spreading across the Eastern Mediterranean and the Middle East region with active scientific collaborations with top Universities and expert consulting to several Governments, the Innovation dimension of CARE-C further developed within pan-European Environmental Research Infrastructures, adding international visibility, recognition, and new revenue streams.

Time has come to highlight all these major achievements: four (4) years of existence to develop the four (4) dimensions of CARE-C (Research, Innovation, Education, Networks) and provide here a comprehensive overview of CARE-C and its missions; how its Departments and Facilities have been structured a to timely respond to the current environmental crisis; and what the center has achieved so far to prepare our society to better mitigate and adapt to climate change.

Foreword



Dr Michel Jarraud

Secretary-General Emeritus of WMO, Chair of the CARE-C Scientific Expert Panel

Although the Climate and Atmosphere Research Center (CARE-C) of the Cyprus Institute officially came into existence in 2020, it was the result of a highly challenging process, over several years. After having successfully bid for funding from the European Commission under the Horizon 2020 framework, and with strong support from the Cyprus Institute and the Cyprus government, it is now time to reflect on its achievements over these four initial years and to ensure that it meets with the original expectations.

From my perspective, as chair of its Scientific Expert Panel, it has already delivered very impressive results and has from the start acquired a recognized international dimension, in all its components. It is now an important regional actor in many key areas related to climate change and air pollution. These are clearly illustrated in this activity report. It is an illustration that Cyprus, through the Cyprus Institute, can contribute to address some of the biggest challenges faced, not only at the national, but also at the regional and international levels.

But success brings with it even higher expectations. After the initial development phase, CARE-C now moves into a consolidation phase, with new challenges. I am convinced that CARE-C will be an even more important actor in years to come.

Simulation of regional transport of atmospheric pollution by EPD using WRF-CHEM model

3

The Climate and Atmosphere Research Center (CARE-C)







The Climate and Atmosphere Research Center (CARE-C) is a regional Center of Excellence for Climate and Atmosphere Research, part of The Cyprus Institute.

CARE-C is based in Cyprus, with a focus on addressing challenges relating to climate change and air pollution in the wider Eastern Mediterranean and Middle East (EMME) region, through a combination of research, innovation, and education actions.

CARE-C was founded in January 2020 through competitive funding secured from the European Commission and the Cyprus Government, within the framework of the Horizon 2020 Teaming project "EMME-CARE". The Center was established in collaboration with Advanced Partners: the Max Planck Institute for Chemistry in Mainz, Germany; the University of Helsinki in Finland; and the French Alternative Energies and Atomic Energy Commission (CEA) in France.



CARE-C Vision:

"A knowledge hub for addressing climate change and air pollution challenges, in Cyprus, and the Eastern Mediterranean and Middle East region".

CARE-C has set to address the urgent climate crisis by implementing a comprehensive program of research, innovation, and education with a regional focus.

Science to tackle the climate crisis: why focus on the EMME?

Cyprus, and the wider EMME region, are recognized as a global climate change and air pollution hotspot, experiencing the impacts of climate change faster than the rest of the world. The region is already facing adverse weather events such as heat waves, droughts and atmospheric dust storms which are only due to intensify in the coming decades. Without proper mitigation and adaptation actions, these harmful effects could soon lead to intolerable environmental conditions, ultimately forcing mass migration for the 400 million people living in the region. This could have widespread socio-economic implications in the region and beyond.

CARE-C mission and alignment with National and European priorities

Mission #1

Fill-in critical atmospheric observational gaps over the EMME to better assess current levels and trends of air pollutants and greenhouse gases (GHG); characterize their sources to better support abatement measures.

Mission #3

Assess the impact of environmental and climate change on public health, society and key economic sectors. In conjunction, to develop policy options and plans for coping with causes and effects.

Mission #2

Identify the processes that govern regional climate change, leading to weather extremes, air quality deterioration, and desert dust storms, for better prediction, mitigation, and adaptation.

Mission #4

Develop novel/cost-effective technologies (e.g. scientific instrumentation, low-cost sensors, drone-sensor systems) and services (e.g. high-quality chemical analyses, atmospheric and climate forecasting) to enhance the socio-economic impacts of the CARE-C Research through Innovation.

These missions are aligned with the Cyprus smart specialization strategy (climate & environment), adhere to (inter) national priorities (e.g. Paris Agreement, "Green Deal" and "fit for 55" of the European Commission) and benefit from many funding opportunities (e.g. clusters 5-6 of Horizon Europe).

The Cyprus Institute



The Cyprus Institute (CyI) is a non-profit research and educational institution with a strong scientific and technological orientation. It is an issue-oriented organization, emphasizing international collaborations, cross-disciplinary research, and postgraduate education. CyI has developed by establishing research centers among which to address important and challenging problems at both the regional and international levels, in partnership with leading, world-class institutions in their respective domains.

Cyl aims to strengthen the research community of Cyprus and to help transform its economy to a knowledge-based economy. Recognizing the unique geopolitical location of Cyprus, Cyl also aspires to serve as a European Union gateway to research and technology in the EMME region and in this way, advance regional cooperation for a more prosperous and sustainable future.

About Research & Innovation Vision



Scope

The Center's research activities are focused on Environmental Observations and Environmental Predictions in the EMME region. This includes experimental and modelling activities on key climate drivers such as reactive trace gases, aerosols, clouds, greenhouse gases, and addressing their impacts on regional air pollution and climate.

CARE-C conducts environmental **observations** to fill the gap that exists in the EMME (mission #1), to inform better **predictions** of the impacts of climate change (mission #2)

and enable science-led mitigation and adaption **policies** (mission #3). This is also supported by the development of **new environmental technologies** by the centre, and the ongoing operation of CARE-C's state-of-the-art Research Infrastructure (mission #4).

In line with its approach, CARE-C has been structured into four Departments, composed of Researchers, Faculty and Technical Personnel, which pursue the Research and Innovation agenda of the Center.

About Research Departments

Environmental Observations Department (EOD)

The **Environmental Observations Department (EOD)** conducts continuous long-term measurements and analysis of atmospheric and environmental parameters and trends in Cyprus and the EMME region to further our understanding of the changing regional environment. These observations offer a comprehensive description of the atmospheric composition at the Cyprus Atmospheric Observatory (CAO), far from local emissions and representative of the regional (EMME) atmospheric environment. EOD is structured into five (5) Research Groups:

Aerosol In-Situ (AIS) (properties, sources, and trends): The (AIS) Group aims to better characterize the natural/ anthropogenic sources and the geographical origin of Particulate (Aerosol) Pollution in contrasted atmospheric environments of Cyprus and the EMME with a focus on urban environments, in order to better assess their health impact and support local mitigation strategies. The AIS Group exploit long-term observations of the chemicalphysical-optical properties of aerosols at the CAO stations to document their trends and better address their impact on regional climate (direct and indirect radiative forcing).



Remote sensing: The Group aims to become a regional and international reference point on aerosol remote sensing. The group's focus is on aerosol observations in the boundary layer and free troposphere, and on the transboundary transport of these atmospheric constituents in the EMME region. The group exploits a range of techniques, from ground-based remote sensing to "remote" UAV-based in-situ sampling. Its activities and aims are centered on developing along three lines of research, namely (1) long-term observations; (2) intensive field campaigns; and (3) contribution to improving simulations and predictions.

The Reactive Trace Gases (RTG) and New Particle Formation (NPF) Groups aim to characterize the atmospheric pollution levels in Cyprus and in the wider EMME region, through long-term observations in CAO stations and field campaigns in collaboration with regional and international partners. The team has state-of-the-art instrumentation for monitoring atmospheric pollutants (O3, NOx, CO, SO2), Volatile Organic Compounds (VOC) and aerosol precursor -molecules and clusters. The core aims of these groups are to discover the pathways that lead to gas to particle conversion, to quantify the regional biogenic and anthropogenic emission emissions, and to evaluate their impact in regional atmospheric chemistry mechanisms for producing policy-related results regarding pollution level regulation. Eventually, the team aims to assess the impact of climate-driven environmental changes on emissions, atmospheric processes and air quality implications.

Greenhouse gases (GHG): The GHG Group focuses on monitoring Greenhouse Gases and better understanding and quantifying their sources and sinks from local to global scales, through innovative and high precision atmospheric measurements using a combination of stateof-the-art in-situ/remote sensing instrumentations and UAV technologies. The Group is involved in atmospheric monitoring including in-situ GHG measurements fulfilling the "ICOS" EU Research Infrastructure quality requirements and a TCCON sun spectrometer for columnintegrated GHG observations which are extensively used to validate new ESA/NASA space missions.

Environmental Predictions Department (EPD)

The **Environmental Predictions department (EPD)** is dedicated to the study of the role of anthropogenic emissions in biogeochemical cycles, air quality and climate change with a focus on the EMME region. EPD is structured into five (5) Research Groups:

Climate System Processes: The Climate System Processes (CliSP) group investigates the drivers and evolution of climate at different spatial and temporal scales. Current research topics include the optimization of the choice of physical parameterizations in regional climate simulations; urban heat island characterization and mechanisms to quantify urbanization effects with climate change and model climate at the city level; regional climate change and atmospheric circulation.

Earth System Modelling: The Earth System Modelling (ESM) group develops and applies numerical atmospheric and Earth-system models, ranging from regional to global scales, to address interdisciplinary problems. The research aims of the group include modelling physical, chemical and meteorological processes in the atmosphere to provide insight and improve scientific knowledge on aerosol formation and growth, pollution transport, air quality, clouds, weather, and climate.

Emissions & Regional Air Quality Modelling: This team performs studies related to emission and air pollution analyses for the EMME region in support of the development, inter-comparison and validation of emissions for Cyprus and other countries (i.e Egypt, Lebanon, Qatar), and the investigation of the atmospheric processes that define air pollution conditions in the EMME. It does so by utilizing bottom-up and top-down approaches such as satellite spaceborne measurements, advanced modeling systems, re-analysis and assimilated data and in-situ networks and ancillary measurements needed to address the air quality challenges over the region.

The Environmental Technologies Department (ETD)

The **Environmental Technologies Department (ETD)** is dedicated to the development of innovative air quality observation and mitigation technologies, with activities falling under three categories and groups:

Low-cost Air Quality Sensors: An important limitation in air quality monitoring is the sparsity of the observational sites. The objective of the group working on low-cost air quality sensors is to develop and deploy cost-effective and miniaturized sensing systems, integrate them in compact air quality monitors, and deploy them in the field for distributed observations. In collaboration with researchers from the Cyl Computation-based Science and Technology Research Center (CASTOR-C) and the CARE-C EPD, the group is also developing methods for handling and analysing the big volumes of data from the distributed networks of low-cost sensors.



Climate Change Downscaling & Weather Extremes: The Climate Change Downscaling and Weather Extremes (ClimEx) group specializes in developing regional climate projections of increased spatial and temporal resolution for the broader region of the Mediterranean, Middle East and North Africa. The group's research includes predicting and understanding high-impact extreme events such as heatwaves, droughts, and extreme precipitation.

Model & Data Analysis tools: The Modelling and Data Analysis Tools (MDAT) group employs various numerical climate and weather prediction models focusing on global and regional scales to address challenging research problems related to climate change impacts. high-performance The team utilizes computing resources to plan and conduct climate model simulation experiments in collaboration with other research groups of the department. In addition, the team specializes in geospatial data processing, statistical climate data analysis, and scientific visualization to investigate largescale datasets from model outputs. Finally, the group manages the Atmosphere and Climate Data Center (DAC).



About

Advanced Aerosol Instrumentation: Being able to probe Aerosol-based Nanotechnology: Great advancements in the physical and chemical properties of ambient aerosol particles is key for understanding their impacts on human health and climate. The mission of this group is to develop the next generation of instruments that will allow us to measure physical properties such as size, morphology, volatility and hygroscopicity, as well as directly the chemical composition of atmospheric particles having sizes in the range of less than one nanometre and up to several microns. Working closely with researchers at EOD, members of the group participate in field campaigns where they deploy the new instruments and contribute novel measurements.

technologies for monitoring and improving air quality can come from the fascinating world of nanotechnology. In this respect, using the very particle generation tools that researchers in ETD employ to calibrate aerosol instruments and sensors, this group develops novel methods for synthesizing well-defined nanostructured materials to build gas sensors for measuring the concentration of pollutants in the atmospheric environment. Using the same tools, the group is also developing nanomaterials for capturing air pollutants from ambient air, as well as for energy conversion and storage in collaboration with researchers at the Cyl Energy Environment and Water Research Centre (EEWRC). Research in this group is supported by advanced computational techniques carried out together with researchers at CASTOR-C.

Impacts and Policy Department (IPD)

The Impact and Policy department is dedicated to pursuing multi- and cross-disciplinary research on societal challenges (environmental health, food security, water availability) requiring regional and local solutions. It is developing a "dialogue platform" where national and regional stakeholders can discuss science-based practical solutions to challenges related to air quality and climate change.

Greenhouse Gas Emissions: The team focuses on regional GHG (inverse) modelling, and emissions monitoring using a wide range of tools ranging from observations (in-situ/ remote sensing) to models to better constrain, through top-down approach emissions at various scales (e.g. from emission hotspot, to countries and region).

National Emission Reporting (NER): The National Emissions Reporting (NER) team supports the competent government agencies for the monitoring, validation and reporting of the air pollutants and greenhouse gas emissions in Cyprus. Specifically, the group is supporting the Department of Environment of the Ministry of Agriculture, Rural Development and Environment of the Republic of Cyprus towards its obligations for submitting an annual Greenhouse Gas (GHG) inventory and projections report to the EEA and to the UNFCCC secretariat. NER is also supporting the Department of Labour Inspection of the Ministry of Labour, Welfare and Social Insurance who is responsible for emission reporting of air pollutants following international directives (NEC, LRTAP Convention) and emission reduction strategies of the atmospheric pollutants of NOx, SOx, NH3, NMVOC, and PM2.5, contributing towards the achievement of the goals and targets set in the national air quality plan and the national energy and climate plan.



Climate & Vector Borne Diseases: The group aims at improving the understanding of the intricate physiological links between disease vectors, the pathogens they transmit, and their environment to quantify the climate impacts on the risk of future disease outbreaks. Through developing mathematical models applicable at different spatial and temporal scales, the group aims at generating reliable risk predictions and advancing vector control and outbreak management strategies. By developing interactive opensource digital platforms, the group aims at facilitating user engagement, data sharing, and communication with citizens, public health experts, and fellow researchers.

Climate change and health: The overarching aim of this research theme is to understand the effects of climate change on human and animal health for the EMME region. The research activity of the group lies at the interface of observational environmental data, physical model output data and health data, employing statistical, mathematical and AI methods along with data analytics skills to integrate the various sources of information. Specific topics addressed include the effect of heat-stress and cold-stress on human mortality and morbidity for the EMME region; the synergistic effect of heat and air pollution in human health; global projections of heat indices and the implications to animal farming; and understanding the response to extreme temperatures across demographics in the EMME region.

About Research Infrastructures



The Cyprus Atmospheric Observatory (CAO)

https://cao.cyi.ac.cy/

CAO provides high quality long-term observations of key (climate relevant) atmospheric constituents through a national network of **four (4)** monitoring stations comprehensively distributed to document various Cypriot atmospheric environments (marine, rural, urban, mountain) and capture regional (EMME) background **air pollution** signals and trends. CAO is a **key facility** for the further development of EOD, and is already a strategic component of many international monitoring networks (e.g. EMEP, TCCON, ACTRIS, WMO-GAW, NASA-AERONET), providing unique (open access) regional atmospheric datasets used for the validation/improved of satellite retrievals and computer-based chemistry-transport models (e.g. WRF-CHEM).



Instrumentation and Nanotechnology Laboratory (INL)

The Instrumentation and Nanotechnology Laboratory (INL) offers great possibilities for designing, building and testing a wide range of instruments for measuring atmospheric gases and particles, ranging from portable and cost-effective particle sizers and counters to high-tech mass spectrometers. In addition, INL is equipped with state-of-the-art nanotechnology tools for fabricating gas sensors capable of measuring the concentrations of key air pollutants. Thus far, the INL facility has been employed to develop and successfully test an optical particle sizer (OPS) that offers comparable specifications to other laboratory-grade instruments yet at a highly competitive cost, and a very high resolution aerosol mobility-mass spectrometer, which significantly contributes in the research for novel nanomaterials for technological and environmental applications. R&D activities pursued in INL over the last 3 years have led to the spin-off of 3 companies (half of the spin-off companies established by the CyI) and provides great support for the research carried out in ETD.



The Unmanned Systems Research Laboratory (USRL)

https://usrl.cyi.ac.cy/

Supported by a team of 12 pilots and engineers, USRL is the largest drone facility in Cyprus and ranks among the first in Europe for the provision of unmanned aerial solutions to monitor air pollution. This Facility offers on-site related infrastructure for research development, and testing of technologies related to UAVs (Unmanned Aerial Vehicles) with two advanced electro-mechanical workshops, and a private airfield and airspace granted permanently by the Department of Civil Aviation, and located nearby the CAO station. USRL has continuously developed over the years a large range of various in-house developed UAVs (fixed wings, multi-rotors) using the latest composite material carbon fiber technologies in order to enhance their endurance (>4 hours) and maximum altitude ceiling (>7km altitude). The Auto-pilot developed by USRL makes its drones with full capacity for complex unmanned pre-programmed flights operating a fully integrated range of sensors. Accredited by the European Union Aviation Safety Agency for the "specific" category, USRL can fly its drone technology in the European sky for the implementation of large international research programmes (e.g. calibration/validation of satellites from the European Space Agency).

About



The Cyprus Institute High-Performance Computing Facility (CyI HPCF) and the Atmosphere and Climate Data Center (DAC)

CyI HPCF supports cutting-edge scientific applications, including climate modelling research, computational science and industrial/engineering applications, offering also HPC training programs and user support. Through major investments provided by the EMME-CARE teaming project), CARE-C contributes to the purchase of additional high-end HPC compute nodes and data storage servers dedicated to the Atmosphere and Climate Data Center (DAC) of CARE-C that are hosted by the CyI HPCF. The infrastructure is essential as it enables the EPD/CARE-C climate modellers, students and partners to conduct competitive climate model simulation experiments at global and regional scales, generating enormous amounts of gridded data that are processed, analyzed and stored using the resources provided by DAC/CARE-C.



The Environmental Chemistry Lab (ECL)

ECL gathers the latest state-of-the-art trace analytical instruments for the chemical analyses of ultra-trace pollutants within environmental samples (air, water, soil). The spectrum of Pollutants monitored by ECL ranges from major anions/cations, to highly toxic trace metals and trace organics and makes it unique to identify and monitor specific pollution sources. Certified by international organizations (WMO, EMEP, IAEA), this facility supports the long-term atmospheric observations performed in Cyprus (CAO) and the EMME. With no equivalence in the region, ECL is actively supporting Air Quality Monitoring Networks in the EMME to comply with national and EU regulated Air Quality Directives.

Achievements Science

Scientific Publications through the years



366 peer-reviewed publications since the founding of CARE-C in 2020

Over 60% of Publications in Top25 Journals

50 Publications in Top5 Journals

Two (2) CARE-C Faculty Recognized among World's Most Highly Cited Researchers in 2021, 2022 & 2023





Prof Jos Lelieveld Head of the Environmental Prediction Department at CARE-C and Director of the Max Planck Institute for Chemistry in Mainz.



Prof Philippe Ciais Head of the GHG Emissions group at CARE-C and research director at Laboratoire des Sciences du Climat et de l'Environnement (LSCE)

Featured publications

Severe atmospheric pollution in the Middle East is attributable to anthropogenic sources

Summary: In the Middle East, desert dust is assumed to dominate air pollution, being in permanent violation of public health guidelines. Here we present ship-borne measurements from around the Arabian Peninsula and modeling results to show that hazardous fine particulate matter is to a large extent of anthropogenic origin (>90%), and distinct from the less harmful, coarse desert dust particles. Conventionally, it was understood that desert dust dominates both the fine and coarse aerosol size fractions, which obscures the anthropogenic signal. We find that the annual excess mortality from the exposure to air pollution is 745 (514-1097) per 100,000 per year, similar to that of other leading health risk factors, like high cholesterol and tobacco smoking. Furthermore, anthropogenic pollution particles account for a major part (~53%) of the visible aerosol optical depth. Therefore, in the Middle East anthropogenic air pollution is a leading health risk and an important climatic factor.

Significance: The very detailed field observations of fine aerosol pollution performed here around the Arabic Peninsula are the first of their kind in the region. They confirm that the EMME is an Air Pollution Hotspot with adverse impacts on regional climate and health, and they highlight the urgent need to better characterize the various anthropogenic sources responsible for this pollution so as to implement timely efficient abatement measures.

Assessment of methane emissions from oil, gas and coal sectors across inventories and atmospheric inversions

Summary: Emissions from fossil fuel exploitation are a major contributor to global anthropogenic methane emissions, but are highly uncertain. The lack of reliable estimates hinders monitoring of the progress on pledges towards methane reductions. In this study we analyze methane emissions from exploitation of coal, oil and gas for major producing nations across a suite of bottom-up inventories and global inversions. Larger disagreement in emissions exists for the oil/gas sector across the inventories compared to coal, arising mostly from disparate data sources for emission factors. Moreover, emissions reported to the United Nations Framework Convention on Climate Change are lower than other bottom-up and inversion estimates, with many countries lacking reporting in the past decades. This study highlights the need to improve consensus on the methodological inputs among the bottom-up inventories in order to obtain more consistent inverse modelling results at the sub-sectoral level.

Significance: The EMME region holds a third of the total oil and gas reserves in the world and stands for one of the top major emitter of greenhouse gases (GHG) worldwide. Results presented here highlight the major uncertainties associated with actual emissions of GHG from the oil and gas sector, especially over the EMME. They point out the current lack of accurate monitoring, reporting, and verification of GHG emissions in the region, hereby compromising the implementation the Paris Agreement and its objective to limit the global warming to +1.5°C.



Figure: Model results for ozone and fine particulate matter.

Reference: Osipov, S., ..., Lelieveld, J., Severe atmospheric pollution in the Middle East is attributable to anthropogenic sources. Commun Earth Environ 3, 203 (2022). https://doi.org/10.1038/s43247-022-00514-6



Figure: Time series of CH4 emissions (2000 - 2020) from oil & gas sectors across bottom-up and top-down approaches.

Reference: Tibrewal, K., Ciais, P., Saunois, M. et al. Assessment of methane emissions from oil, gas and coal sectors across inventories and atmospheric inversions. Commun Earth Environ 5, 26 (2024). https://doi. org/10.1038/s43247-023-01190-w

Climate Change and Weather Extremes in the Eastern Mediterranean and Middle East

Summary: Observation-based and modeling studies have identified the Eastern Mediterranean and Middle East (EMME) region as a prominent climate change hotspot. While several initiatives have addressed the impacts of climate change in parts of the EMME, here we present an updated assessment, covering a wide range of timescales, phenomena and future pathways. Our assessment is based on a revised analysis of recent observations and projections and an extensive overview of the recent scientific literature on the causes and effects of regional climate change. Greenhouse gas emissions in the EMME are growing rapidly, surpassing those of the European Union, hence contributing significantly to climate change. Over the past half-century and especially during recent decades, the EMME has warmed significantly faster than other inhabited regions. At the same time, changes in the hydrological cycle have become evident.

The observed recent temperature increase of about 0.45°C per decade is projected to continue, although strong global greenhouse gas emission reductions could moderate this trend. In addition to projected changes in mean climate conditions, we call attention to extreme weather events with potentially disruptive societal impacts. These include the strongly increasing severity and duration of heatwaves, droughts and dust storms, as well as torrential rain events that can trigger flash floods. This review is complemented by a discussion of atmospheric pollution and land-use change in the region, including urbanization, desertification and forest fires. Finally, we identify sectors that may be critically affected and formulate adaptation and research recommendations toward greater resilience of the EMME region to climate change.

Significance: This study, led by CARE-C, represents the most exhaustive overview of all scientific knowledge on climate change accumulated so far over the EMME, providing a comprehensive understanding of the current state, future trends, and various adverse impacts.

EMME VS. GLOBAL MEAN ANNUAL TEMPERATURE ANOMALY



EMME VS. REGIONAL ANNUAL MEAN TEMPERATURE ANOMALY



Figure: Eastern Mediterranean and Middle East versus global (top panel) and regional (bottom panel) temperature anomalies since 1901(w.r.t. the 1961–1990 reference period) as annual values (thin curves) and cubic smoothing splines (thick curves). Linear trends are also presented for Europe (EUR), the United States of America (USA), Africa (AFR), Australia (AUS), and South America (SAM).

Reference: Zittis, G., et al., Climate change and weather extremes in the Eastern Mediterranean and Middle East. Reviews of Geophysics, 60, 3 (2022). Doi: https://doi.org/10.1029/2021RG000762.

Projects

>40.000.000 €

from the EMME-CARE Teaming project

>8.540.000 €

from Competitive Projects raised since 2020

projects

Projects as coordinator

Featured projects Projects coordinated by CARE-C

Active research

projects

Title: The Role of Base Molecules in AErosol Formation - BAE Funding Body: European Research Council (ERC) Call: ERC starting grant PI: Asst Prof Tuija Jokinen

Description: The project focuses on the role of base molecules in the formation of new particles and their fate in the atmosphere. This project will underpin the modelling of atmospheric aerosol processes, which are subject to major precursor emission changes in Europe and beyond. The project has a duration of five years and a total budget of 2.24 million euros.

BAE was the only ERC Starting Grant proposal to be selected for funding at a Cyprus-based Research Organization in 2022 and the sixth Starting Grant awarded to Cyprus since the beginning of the program in 2007.

Funded by the European Union ERC-2022-STGERC-BAE-Project: 101076311. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Council Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

Title: ENVironment Research infrastructures INNOVation Roadmap – ENVRINNOV Funding body: European Research Executive Agency- European Commission Call: HORIZON-INFRA-2023-DEV-01 Coordinator: Ms Marina Papageorgiou and Prof Jean Sciare

Description: ENVRINNOV secured 2.5 million euros funding from the European Commission. Starting in January 2024, and with a duration of three years, the project will co-design, test, and validate a common Innovation Roadmap for the European Research Infrastructures (ENVRI) community, to establish and operate an ENVRI Innovation Hub, for the development of new state-of-theart technologies and services. The project will also develop the tools, policies, and community necessary for the Roadmap's successful implementation.

Title: European Higher Education Institutions Network for Climate and Atmospheric Sciences- Edu4Climate **Funding body:** European Research Executive Agency- European Commission **Call:** HORIZON-WIDERA-2021-ACCESS-05 **Coordinator:** Prof Jean Sciare

Description: The Edu4Climate project aims to engage its European Partners in order to strengthen and align their respective Educational and Training programs in Climate and Atmosphere science, establish new impact-oriented Research Infrastructures on decarbonization and atmospheric model prediction, and co-develop innovative environmental products and services with their respective surrounding ecosystems to address climate-relevant challenges across the EMME region.

Funded by the European Union. Views and opinions expressed are however of those of the author(s) only and do not necessarily reflect those of the European Union or REA. Neither the European Union nor the granting authority can be held responsible for them.



European Research Council



Funded by the European Union









Funded by the European Union

Featured projects

CARE-C as Consortium Partner

Title: Next generation models and methods for aircraft pollutants and noise estimation - NEEDED **Funding body:** European Research Executive Agency- European Commission **Call:** HORIZON-CL5-2022-D5-01 **Cyl PI:** Prof George Biskos

Description: Air transport is a crucial part of modern logistics and transportation, yet it is necessary to reduce the sector's emissions and environmental damage, and introduce green innovations. The EU is trying to collect reliable and precise data on predicted aircraft emissions, whether noise or pollutants, to create improved policies.

The EU-funded NEEDED project will provide next generation data-driven reference models and methods to properly deduce current and future aircraft emissions. To achieve this, the project will use real-world ADS-B data to enhance aircraft operations reconstruction and to improve the estimations of the aircraft emissions and the number of people affected by local air transport operations.

NEEDED is funded by the European Union's Horizon Europe research and innovation programme under GA no. 101095754

Title: Optimal High-Resolution Earth Systems Models (ESMs) for exploring future climate change-OptimESM **Funding Body:** European Climate, Infrastructure and Environment Executive Agency (CINEA) **Call:** HORIZON-CL5-2022-D1-02-02 **Cyl PI:** Dr George Zittis

Description: The programme will develop a novel generation of Earth system models (ESMs), combining high-resolution with an unprecedented representation of key physical and biogeochemical processes. These models will be used to deliver cutting-edge and policy-relevant knowledge around the consequences of reaching or exceeding different levels of global warming, including the risk of rapid change in key Earth system phenomena and the regional impacts arising both from the level of global warming and the occurrence of abrupt changes.

OptimESM will realise these goals by bringing together four ESM groups with Integrated Assessment Modelling teams, as well as experts in model evaluation, Earth system processes, machine learning, climate impacts and science communication. This knowledge will provide a solid foundation for actionable science-based policies.

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No101081193.

Title: Attributing and Verifying European and National Greenhouse gas and aerosol Emissions and Reconciliation with Statistical bottom-up estimates" project- AVENGERS Funding body: European Climate, Infrastructure and Environment Executive Agency (CINEA) Call: HORIZON-CL5-2022-D1-02 Cyl PI: Dr Jonilda Kushta

Description: AVENGERS unites a diverse group of experts in order to establish how top-down techniques can support the verification of national greenhouse gas (GHG) inventories and other regulated estimates of emissions and removals, in order to improve or supplement the methods/approaches currently used. In recognition of the need for a truly multi-actor approach, the team represents experts in atmospheric inverse modelling and data assimilation, remote sensing, environmental monitoring and observation, terrestrial ecosystem modelling, policy and stakeholder interaction together with national inventory compilers.

Acknowledging the complexity and challenges of the Eastern Mediterranean and Middle East region, and the fact that it consists a climate change hotspot that warms faster than other areas, CARE-C scientists will contribute to the project with their research outcomes and experience in addressing the relevant scientific questions focused on the specificities of the EMME region.

This project has received funding from the European Union's Horizon Research and Innovation Actions, under grant agreement No 101081322













Achievements Innovation

CARE-C leverages its state-ofthe-art Research Infrastructure to develop **new technologies** and provide **highly specialized products and services** towards addressing climate change and air pollution challenges.

service contracts

Provision of a total of

3 spin-off companies

Development,

2.000.000€

revenue generated from Products/Services since 2020

validation

of

The Center provides several competitive services to both public and private clients. CARE-C's portfolio currently includes:

- Bespoke UAS system development (drones, autopilots, and sensor integration) and UAV pilot training
- Customized Environmental drone applications (e.g. for forest fires, stack emissions, Methane leaks)
- UAV-based 3D Digital twinning of (critical) infrastructure
 Complex chemical analyses of toxic contaminants at
- ultra-trace concentrations in the Environment

Featured collaborations

Combating Forest fires in collaboration with the Department of Forests, Cyprus Ministry of Agriculture, Rural Development and Environment



USRL, the drone facility of CARE-C, provides services to the Department of Forest with preventive forest surveillance for detecting fires at an early stage. More specifically, this facility provides tailor-made Unmanned Aerial Systems for the detection, monitoring, and prevention of forest fires.

USRL staff also offers training to the forest firefighters to effectively operate and manage the provided Unmanned Technology. The bespoke training contains a theoretical and a practical part on how to start, fly and land the drones safely. Finally, USRL provides annual services for regular patrols in forest areas and respond during emergency situations (e.g. wildfires).

Impacts: Being aligned with its mission to support the government of Cyprus with scientific and technical knowledge, this collaboration highlights the innovation capacities of CARE-C in developing high-tech end-user solutions to combat forest fires and better mitigate with the effects of Climate Change (Mission #4 of CARE-C).

Lightweight environmental sensorsAdvisory on environmental regulation & compliance

test, calibration,

- Regional Air Quality and Dust Forecasting
- Customized regional climate change projections
- National emission reporting and projections (e.g. greenhouse gases, air pollutants)

Improving Regional Air Quality via support to the Ministry of Environment of the Arab Republic of Egypt



CARE-C and the Ministry of Environment of Egypt have recently joined forces to enhance the air quality monitoring network of the Greater Cairo Area, by expanding its capabilities to measure new pollutants and short-lived climate active species (e.g. Black Carbon, Methane), setting up an advanced early warning system and the ability to identify major regional and local pollution sources such as desert dust, traffic, and open biomass and solid waste burning. This builds on past efforts of the Ministry of Environment of Egypt to improving air quality, and is materialized through several ongoing projects with the funding support of the World Bank.

Impacts: Through this strategic collaboration with a governmental stakeholder, CARE-C materializes its vision of building long-term capacities in the EMME to better monitor Air Pollution in order to assess the effectiveness of local abatement strategies (Mission #3 of CARE-C); with Egypt, the most populated country of the EMME, bearing one of most polluted capital cities worldwide.

Achievements

Enhancing regional capacities to monitor desert dust (storms) in cooperation with the National Center for Meteorology (NCM) of the Kingdom of Saudi Arabia



In its endeavor to better mitigate the adverse impacts of sand and dust storms over the Arabic Peninsula, the NCM is partnering with the Environmental Chemistry Laboratory (ECL) of CARE-C to develop and operate on the long-term an early warning dust monitoring network which will help to forecast (and adapt to) large desert dust events. This network is primarily composed by eight (8) atmospheric supersites geographically distributed over the Kingdom of Saudi Arabia in order to better assess the role of desert dust particulate matter (PM) on air Pollution (mass contribution, seasonality).

Impacts: This scientific collaboration will allow the further development of atmospheric monitoring capacities of dust in the Middle East herewith filling up critical environmental observational gaps in the region (Mission #1 of CARE-C).

Reporting of emissions in Cyprus

Department of Labour Inspection, Ministry of Labour and Social Insurance Department of Environment, Ministry of Agriculture, Rural Development and Environment The CARE-C "Emission Team" (Impact & Policy Department) provides technical support to the Cypriot authorities responsible for the emission reporting of Air Pollutants (AP) (Department of Labour Inspection, DLI) and Greenhouse Gases (GHG) (Department of Environment, DoE).



Projections of total national GHG Emissions (excluding LULUCF) under three scenarios: BaU (Business as Usual), WeM (with existing measures) and WaM (with additional measures)

Improving our knowledge on national Air Pollution emissions in collaboration with the Department of Labour Inspection, Cyprus Ministry of Labour and Social Insurance



Regional and national gridded emissions of NOx over Cyprus

Monitoring, Reporting, and Verifying National Greenhouse Gas (GHG) emissions in support of the Department of Environment, Cyprus Ministry of Agriculture, Rural Development and Environment

The preparation of the annual national inventories of greenhouse gas (GHG) emissions and their future projections is done by the Impact & Policy Department of CARE-C, in accordance with the provisions of the United Nations Framework Convention on Climate Change (UNFCCC), the Paris Agreement and the Regulation EU 2018/1999 of the European Parliament and of the Council on the Governance of the Energy Union and Climate Action has been performed.

Impacts: CARE-C is helping the Cyprus Government to design the best strategies to implement its green transition and meet its objectives of GHG reduction by 55% in 2030 (Mission #2 of CARE-C).

Each National Inventory Reporting submission process involves preparation of the emissions data, calculations and facilitation of the reporting format. Activity data are collected from the different responsible bodies such as the Statistical Service, Department of Environment, Department of Labour Inspection, etc, in order to calculate with a top-down approach the GHG and air pollutants emissions for Cyprus, using the methodologies and emission factors described in the IPCC 2006 Guidelines.

Impacts: While previously relying on technical support from abroad, the Cyprus Government has now acquired (through CARE-C) the scientific and technical capacity to handle on its own the reporting of national Air Pollutant emissions, herewith further improving the monitoring, reporting and verification of its emissions (Mission #2 of CARE-C).

Achievements **Education**

Supported by CARE-C, the Cyl Graduate School offers attractive and accredited Master (MSc) and Doctoral (PhD) Programmes in Environmental & Atmospheric Sciences. Fully embedded within CARE-C Departments/Research Facilities and (financially) supported by competitive EU projects, these programmes cover European Priorities and Policies (e.g. Green Deal),UN Sustainable Development Goals relevant for the region, and offer joined PhD scholarships (cotutelle) with its Advanced Partners and other European universities enhancing international exposure and secondments of students through the ERAMUS + programme.













students trained (Autumn School)

Autumn School

CARE-C has been organising the Autumn School since 2022. Autumn school is a short, intensive free course offered for M.Sc. and Ph.D. students in atmospheric and Earth system sciences and it takes place at the CyI premises in Nicosia. It combines practical and theoretical approaches and students have the opportunity to learn more about a topic related to atmospheric sciences.

The 2022 Autumn School focused on "Analysis of aerosols, air pollution and their sources in the Eastern Mediterranean" and took place on 31 Oct–11 Nov, 2022.

The 2023 Autumn school focused on "Atmospheric measurements using miniaturised sensors and drones" and took place on 30 Oct–3 Nov, 2023.



Featured: Joined PhD with University Paris-Saclay

CARE-C offers joined PhD scholarships with highlyesteemed educational institutions such as the prestigious University Paris-Saclay (first EU University in the Academic Ranking of World Universities, Shanghai ranking):



Yunsong Liu

Thesis: Characterizing methane (CH4) and carbon dioxide (CO2) emissions through mobile platforms from local to national scale.



Anthony Rey-Pommier

Thesis: Detection and quantification of the emissions of nitrogen oxides using satellite data across the Eastern Mediterranean and Middle East region.

Emeric Germain-Piaulenne Thesis: Contribution of Light Alkanes to Estimates of Anthropogenic Methane Sources in the Middle East.



Siginq Xu Thesis: Vegetation - D

Thesis: Vegetation - Dust Cycle Feedback in the IPSL Earth System Model

Pioneering Shipborne Observations of Air Quality in the Middle East

In a hotspot region increasingly shadowed by the global challenges of air pollution and climate change, CARE-C is actively engaged at of the forefront experimental atmospheric research. Through pioneering shipborne campaigns collaboration and active with Environmental Governmental Agencies of the Middle East, the centre has laid the ground for a comprehensive understanding of air pollution across the Mediterranean, the Red Sea, and the Gulf, unravelling the complexities of trans-boundary regional pollution dynamics.



The oceanographic research vessel Jaywun (Environment agency Abu Dhabi ; UAE)

The AREAD oceanographic campaign (December 2022)

Launched in late 2022, the Atmospheric Research Expedition to Abu Dhabi (AREAD) marked the first-ever wintertime air quality monitoring expedition along the coastlines of 25 countries across three continents. Spanning over 10,000 kilometres from the coastlines of Spain to the United Arab Emirates, AREAD's journey provided unparalleled insights into the dynamics of particulate and gaseous air pollution. This research expedition collected critical data, enhancing our understanding, and aiding in refining atmospheric and climate models in a region of the world (the Middle East) where atmospheric observations are critically lacking to assess regional air pollution, GHG emissions and assess their impacts on regional climate.

The THOFA oceanographic campaign (June 2023)

Building on AREAD's success, the Transport of Hydrocarbons and Ozone Formation downwind of the Arabian Gulf (THOFA) campaign focused on a pressing environmental concern: the formation of ozone, a notoriously harmful atmospheric pollutant. Sailing downwind of the Arabian Gulf, a region under significant environmental stress from the accumulation of emissions from oil and gas operations and urban growth, THOFA delved into the complex atmospheric chemistry leading to ozone formation. This investigation not only bridged a crucial data gap but also highlighted CARE-C's dedication to tackling complex environmental issues through rigorous scientific exploration and collaboration with Governmental bodies across the EMME region.

A novel UAV-based strategy for the calibration & validation of satellites from the European Space Agency (ESA)



The ESA EARTHCARE campaign (2024)

Specialists teams of CARE-C are actively involved with the European Space Agency's (ESA) upcoming cloud, aerosol and radiation explorer mission, EarthCARE. The expedition, a joint venture between ESA and the Japan Aerospace Exploration Agency (JAXA), is the most complex Earth Explorer mission to be attempted to date.

EarthCARE (Earth Cloud, Aerosol and Radiation Explorer) aims to significantly improve our understanding of how clouds and aerosols (atmospheric particulates such as pollution and Saharan dust) influence the climate, by exploring how they affect reflecting incident solar

radiation back into space and trapping infrared radiation emitted from Earth's surface. The data to be collected through the EarthCARE mission will provide information on the relationship of clouds, aerosols, and radiation at unprecedented levels of accuracy, and help improve predictions about the weather, and the future climate. The EarthCARE mission is planned to be launched in 2024, and the Cyprus Institute's CARE-C teams will be performing dedicated activities for the validation and calibration of this novel satellite using a combination of remote sensing (e.g. LIDAR) and in-situ UAV vertical profiling, which approach is unique in Europe.



The ESA ASKOS campaign (2022)

Teams from CARE-C, including scientists from the remote sensing group and USRL, were in Sao Vicente, Cape Verde, as part of ASKOS, the Aeolus satellite calibration / validation Campaign, coordinated by the National Observatory of Athens (NOA) and funded by the European Space Agency (ESA). The campaign took place on 10th-30th June, 2022.

Aeolus is the first satellite mission to acquire profiles of Earth's wind on a global scale, with its observations being used to improve weather forecasts and climate models. The ASKOS Campaign is deploying advanced ground-based remote sensing and surface/airborne in situ instrumentation to provide observations of aerosol, clouds, water vapor and wind. These measurements are being used for the calibration and validation of the Aeolus satellite aerosol, cloud and wind products.

During the ASKOS Campaign, Aeolus flights were performed by lightweight carbon fiber fixed wings drones developed by USRL and flying below, inside, and above the desert layer outflow from Africa, up to an altitude of 6km.

These UAVs were equipped with atmospheric sensors measuring particle size-distribution and orientation and are able to collect samples of dust for further analysis. ASKOS is a component of the Joint Aeolus Tropical Atlantic Campaign (JATAC), which is clustered with additional airborne observations, also using aircrafts from NASA, the German Aerospace Centre (DLR), Laboratoire Atmosphères, Milieux, Observations Spatiales (LATMOS) and University of Nova Gorica (Slovenia).

CERN Cloud Experiment

Active contribution to the Cloud Experiment-CERN



The Cloud Experiment-CERN

Since 2020, CARE-C participates in the CERN CLOUD experiment 10-year scientific programme. The EMME-CARE TEAMING advanced research partners The University of Helsinki, and the Max Planck Institute for Chemistry are also participating in CLOUD.

CLOUD allows to measure aerosol nucleation and growth. Atmospheric aerosols and their effect on clouds are recognised by the IPCC as the main uncertainty in climate models. CARE-C in particular will participate with:

 Atmospheric and climate modelling of the CLOUD data with our global climate-chemistry model that interactively simulates chemistry and climate

processes, and in particular aerosols effects on the hydrologic cycle, climate, air quality and planetary health. Comparison of CLOUD measurement data with those obtained in field campaigns to investigate tropical tropospheric oxidant photochemistry in combination with aerosol particle formation and growth under clean, pristine conditions over land, and contrast the results with those in marine and polluted conditions.

The invitation had the unanimous support of the CLOUD Steering Committee and all principal investigators on the CLOUD experiment:

Technology Development

The USRL "Forest Surveyor" UAV

Answering the urgent needs of the Cyprus Department of Forests (DoF), USRL has developed a new generation of UAS (multi-rotor « Inspector » and fixed wing « Surveyor ») to enhance the early detection and monitoring of Forest Fires.

Performances of these drones are beyond those currently available in the market, combining, for the Forest Inspector, high agility and robustness, extreme thrust, low weight (1.1 kg), fast horizonal speed (>50 km/h), high ceiling (> 6km altitude), fast deployment (<1 min) with autonomy up close to 1h30. The deployment of these drones is effective since the fire season 2023.

A team of 10 UAV pilots (from CARE-C and DoF) is continuoulosy trained to operate these drones over the Mountains of Troodos making of the use of drones an important component of the Forest Fire Monitoring in Cyprus.



Impacts: The contribution of CARE-C to the CLOUD experiment and its growing international visibility and reputation is valued by its contribution in top Scientific publications (e.g. Nature) and participation in top EU research projects and networks.





The USRL "UAV Autopilot" Software

USRL operates its UAS with its own Autopilot software/ firmware to enable 1) Plug-in new sensor and provide easy control, recording, and visualization at the ground, 2) Uniform data collection through optimal control of flight parameters, 3) Real-time streaming of sensor data available online.

Such in-house software allows USRL to develop efficient, customized, and cost-effective solutions for the integration of any new sensors in its drones (compared to commercially available autopilots. Hence, USRL constantly develops its autopilot with new features to make it more reliable and compatible with national IT networks/ systems with no dependence on foreign technologies.

Methanesense: A novel solution for methane leaks detection and quantification

Methanesense combines advanced drone and sensor technologies. The project is developing a new solution for the accurate and cost-effective geolocation of leaks and quantification of methane emissions. MethaneSense's innovative environmental technology solution offers a new, cost-effective path to regulatory compliance, while also enabling companies to realize further financial benefit through the recycling of methane in the value chain. It also contributes to the green economy transition, and supports efforts towards meeting the goals of the Paris Agreement, for the benefit of people and the planet.





Atmospheric sensor developments

Portable and cost-effective Optical Particle Sizer for measuring the number concentration and size distribution of particulate matter- developed by Instrumentation for Nanoparticle Synthesis and Characterization Laboratory (INL).

Events Science



RESEARCH: Supporting the development of an Eastern Mediterranean & Middle East Research Network on Climate & Atmosphere

Climate and Atmosphere Research and Innovation in the Eastern Mediterranean and Middle East virtual workshop

- Annual conference-leading climate and atmosphere R&I ecosystem networking at EMME regional level
- Over 300 participants from over 40 countries, 50 oral presentations and virtual PICOs

INNOVATION: Promoting the development of new technologies in Atmospheric Sciences across European Research Infrastructures

Innovation in Atmospheric Measurement techniques virtual workshop

- Annual conference-leading atmoinnovation ecosystem networking at European level
- Over 300 participants per year from 40 different countries, and over 30 presenters



Activity Highlights Policy: Promoting Science-Policy collaborations in the EMME



Invitation at the UAE Pavilion of COP28 (Dec. 2023) to promote scientific regional collaborations

The critical contribution of CARE-C in advancing scientific knowledge on climate change and air quality in the Eastern Mediterranean and Middle East (EMME) region, was highlighted in a dedicated session hosted on 9 December at the COP28 Summit by the government of UAE.

The session titled "Jaywun Research Vessel and Marine Expedition", took place at the UAE Pavilion in the COP's Blue Zone, a UNFCCC-managed site, open only to accredited party and observer delegates where the official negotiations between countries take place. At the session, insights from a pioneering Atmospheric Research Expedition undertaken by the Environment Agency – Abu Dhabi (EAD) in collaboration with Cyl and the Max Planck Institute for Chemistry in Mainz (MPIC) were presented. The expedition, a first of its kind, took place between November and December 2022 and involved EAD's new research vessel "Jaywun", which travelled through international waters from Spain to Abu Dhabi, passing through three continents and eight major bodies of water, from the Atlantic Ocean to the Arabian Gulf, and covering a distance of more than 10,000km.



Presentation at UNFCCC's 1st MENA Climate Week in Dubai (UAE, 2022)

CARE-C further strengthened its commitment and contributions to shaping regional climate action by participating in UNFCCC's 1st Middle East and North Africa (MENA) Climate Week that was held in Dubai March 28 – 31, 2022. Hosted by the government of the United Arab Emirates, the event was organized in collaboration with UN Climate Change, UN Development Programme, UN Environment Programme and the World Bank Group.

The Center of Excellence's delegation actively participated in the Conference's sessions and meetings in Dubai, and presented a side event on the 30th of March, which was attended by participants in-person and online. The sideevent titled "Coordinating Climate Action in the Eastern Mediterranean and Middle East: Initiatives in Research & Innovation and Policy", presented new initiatives within these remits, which aim to accelerate climate actions in the EMME, for the benefit of the MENA and expected impacts globally.

Activity Highlights **Outreach**



Expo booth at the 11th International Aerosol Conference in Athens

CARE-C participated at the 11th International Aerosol Conference held in Athens from 5th to 9th September 2022.

The Center of Excellence participated at the Conference as an exhibitor with its own Booth, showcasing the latest technologies and innovation from the Center in the areas of Aerosol Science, as well as its research areas and research infrastructure. Through this approach CARE-C instigated conversations with Conference participants to raise awareness about its work and identify new opportunities for collaboration.

The main goal of the International Aerosol Conference is to introduce the broad field of aerosol science, as well as to explore and analyze topics and subtopics referring to Aerosol Technology, Atmosphere Aerosol Studies, Aerosol Measurement Techniques, Aerosol and Health, and Basic Aerosol Processes.



Reflect Festival

CARE-C has successfully participated in the 2023 Reflect Festival, held in Limassol on 20- 21 September 2023, with a dedicated booth alongside other Institute colleagues from different departments, as well as a 20-minute talk by the Centre's Director Prof Jean Sciare.

The Reflect Festival is one of the largest technology, innovation, and business festivals in Cyprus and offers a dynamic environment that encourages cross-disciplinary dialogue, creative thinking, and networking opportunities with experts and enthusiasts from various fields, and it has provided a great platform for showcasing the Centre's contribution to research and innovation as well as establishing meaningful connections and expanding the Centre's network.



European Researchers' Night

CARE-C among other colleagues from the Institute, actively participated in the 2023 European Researcher's Night that took place in the Cyprus Expo in Nicosia. The Cyprus Institute showcased the work of the Sustainable Built Environment Group in a joint booth with colleagues from EEWRC, STARC and CARE-C, under the title "I never thought trees were so important to the city".

The European Researchers 'Night event aims to encourage the public to become familiar with the world of science and research and at the same time to strengthen the public image of researchers, whilst highlighting the important role they play in society.

Partnerships & extroversion National collaborations



Featured collaboration

Joining forces with the Eratosthenes Center of Excellence (ECOE) (Limassol, Cyprus) to explore the atmosphere above Cyprus. Long-term atmospheric observations over Cyprus are synergistically performed by CARE-C and ECoE as part of the Cyprus contribution to the European Research Infrastructure "ACTRIS" (Aerosols, Clouds, and Trace Gases Research Infrastructure). While CARE-C is focusing on ground-based and UAV-based in-situ gas and aerosol measurements through its CAO and USRL facilities, EcoE is monitoring high altitude aerosols and clouds through remote sensing technologies. These observations, together with the GHG insitu and column integrated observations operated by CARE-C, constitute the most advanced atmospheric monitoring in the EMME region.

The "Open Weather Data" project – Department of Meteorology



The importance of open and freely accessible weather data cannot be overstated, as it underpins resilience, enables well-informed decision-making, and allows progress across various scientific domains. This contribution is instrumental in bolstering the safety and welfare of individuals while fostering sustainable development within communities.

For these reasons, the "Open Weather Data" project (2024 to 2026), jointly undertaken by the Environmental Predictions Department (EPD) of CARE-C and the Cyprus Department of Meteorology (DoM), is dedicated to establishing a comprehensive web-based weather database portal. The primary goal of this initiative is to furnish high-quality meteorological information for Cyprus openly and freely accessible to both the general public and the scientific community.

This ambitious initiative seeks to empower stakeholders and practitioners by providing them with the tools and resources necessary to navigate and respond effectively to weather-related challenges. By facilitating easy access to a wealth of data over Cyprus, the "Open Weather Data" portal aims to enhance preparedness, optimize resource allocation, and mitigate the impacts of extreme weather events. Through a user-friendly web interface and an accessible API service, this portal will serve as a central hub for easy querying and retrieval of pertinent weather information. It will offer access to quality-controlled historical weather station datasets, high-resolution (hourly; ~ 2 km) operational numerical weather forecasts, and radar weather datasets, specific to Cyprus. This comprehensive approach ensures that interested users can make informed decisions and take proactive measures to safeguard lives, property, and the environment.

Partnerships & extroversion Regional Collaborations

EMME Regional Collaborations of CARE-C

Research Organizations and Universities listed here are actively collaborating with CARE-C through MoU and collaboration agreements.

• Active collaboration with MoU 💧 🛦 Established scientific collaboration



International Collaborations & Networks

Collaborations

Number of organizations per country that CARE-C collaborates with

- 5 Austria
- 2 Belgium
- 2 Bulgaria
- 2 Czech Republic
- 1 Denmark
- 2 Egypt
- 2 Estonia
- 7 France7 Germany

1 Ireland

3 Israel

5 Finland

- 12 Greece
- - 6 Italy
- 1 Jordan 1 Kuwait
- 2 Lebanon
- 1 Malta
- 5 Netherlands
- 2 Norway
- 2 Poland

- 1 Portugal
- 1 Qatar 2 Romania
- 2 Saudi Arabia
- 8 Spain
- 3 Sweden
- 3 Switzerland

- 1 Turkey
- 2 U.A.E.
- 5 United Kingdom













Annex

CARE-C current projects



Acronym	Full title	Funding source	CARE-C role	Cyprus Institute Budget
META-Sat 06/2018 - 06/2024	Modeling of Emissions, Trends and Air quality, using Satellite measurements	European Space Agency	Coordinator	€ 219.700
EMME-CARE 09/2019 - 08/2026	Eastern Mediterranean and Middle East – Climate and Atmosphere Research Centre	HORIZON 2020/ Cyprus government	Coordinator	€ 9.000.000/ € 10.000.000
COST MEDCYCLONES 11/2020 - 10/2024	European Network for Mediterranean Cyclones in weather and climate	EU COST Association	Grant Holder	€ 640.000
ATMO-ACCESS 04/2021 - 03/2025	Sustainable Access to Atmospheric Research Facilities	HORIZON 2020	Partner	€ 305.500
TROPHY 02/2022 - 01/2024	Transition Metal Optical Hydrogen Sensors: Enhancing performance through tailored nanostructuring	Cyprus Research and Innovation Foundation	Coordinator	€ 200.000
RM Roadmap 09/2022 - 08/2025	Creating framework conditions for research management to strengthen the European Research Area	HORIZON EUROPE	Partner	€ 177.250
Edu4Climate 10/2022 - 09/2026	European Higher Education Institutions Network for Climate and Atmospheric Sciences	HORIZON EUROPE	Coordinator	€ 635.000
LIFE SIRIUS 09/2022 - 07/2025	A System for Integrated EnviRonmental Information in Urban areaS	HORIZON EUROPE	Partner	€ 204.263
CLOUD doc 10/2022 - 09/2026	CLOUD Doctoral Network	HORIZON EUROPE	Partner	€ 235.080
ASPASIA 11/2022 - 04/2024	Mass Spectrometer for Advanced Investigations of the AtmospherIc Aerosol	Cyprus Research and Innovation Foundation	Partner	€ 305.500
VECLIM 01/2023 - 12/2027	Climate-driven vector-borne disease risk assessment	Wellcome Trust	Coordinator	€ 609.711
BAE 05/2023-04/2028	The role of Base molecules in AErosol formation	European Research Council	Coordinator	€ 2.248.644
OptimESM 05/2023 - 12/2027	Optimal High Resolution Earth System Models for Exploring Future Climate Change	HORIZON EUROPE	Partner	€ 398.000
Avengers 07/2023 - 06/2026	Attributing and Verifying European and National Greenhouse gas and aerosol Emissions and Reconciliation with Statistical bottom-up estimates	HORIZON EUROPE	Partner	€ 457.000
ORPHEAS 05/2023 - 01/2024	Online Aerosol Morphology Differentiation and Analysis	Cyprus Research and Innovation Foundation	Coordinator	€ 40.000

Annex

Acronym	Full title	Funding source	CARE-C role	Cyprus Institute Budget
LC3 09/2023 - 08/2025	Limassol City ³	HORIZON EUROPE	Partner to T. Hadjilacos	€ 80.000-€ 173.000
PREVENT 10/2023 - 09/2026	Improved predictability of extremes over the Mediterranean from seasonal to decadal timescales	HORIZON EUROPE	Partner	€ 634.000
ML-NANOCAT 01/2023 - 01/2025	Multi-scale computational modelling, advanced machine learning (ML) algorithms and tailored design of novel catalysts.	Cyprus Research and Innovation Foundation	Coordinator	€ 120.000
Net4Cities 1/2024 - 12/2027	Real Time Monitoring Networks and Transport Emission for Tailored Zero Pollution Action Plans in European Cities	HORIZON EUROPE	Coordinator	€ 251.719
ENVRINNOV 2024 - 2027	ENVironment Research infrastructures INNOVation Roadmap	HORIZON EUROPE	Coordinator	€ 544.866
CLEANCLOUD 2024 - 2027	Clouds and climate transitioning to post-fossil aerosol regime: CleanCloud	HORIZON EUROPE	Partner	€ 400.904

Services By client

Department of Labour Inspection

- Emissions Inventory
- Filter Analysis

Department of Environment

- Greenhouse Gas Emissions
 Inventory
- Greenhouse Gas Emissions Projections

Department of Forests

- Provision of tailor-made Unmanned Aerial Systems (UAS) for the detection, monitoring, and prevention of forest fires
- Training of the forest firefighters to effectively operate and manage the provided Unmanned Technology
- Annual services for regular patrols in forest areas and respond during emergency situations (e.g. wildfires)

Department of Meteorology

Development of a webbased weather portal

European Space Agency

The World Emission project- enhanced global emission monitoring service by developing emission estimates from satellite data

Ministry of Environment of Egypt

Consulting services (SCQuaM and S.I.D.E projects)

Contact Information

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in collaboration with Advanced Partners







UNIVERSITY OF HELSINKI