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2025
Conference

The 7th International Electronic Conference on Atmospheric Sciences

4–6 June 2025 | Online

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Welcome from the Chair

Dear Colleagues,

You are cordially invited to participate in **the 7th International Electronic Conference on Atmospheric Sciences**. ECAS6 was the best year for the conference yet as it featured more video sessions, talks, and recorded presentations than previous years. I hope that with increased participation, we can continue to provide more live and recorded video forums. Technology is continuously improving the virtual experience, and we hope to take advantage of the latest developments in order to maintain the quality of our online meetings. Additionally, the virtual experience allows us to stretch our conference budgets and increase our interactions.

For the seventh International Electronic Conference on Atmospheric Sciences, the range of topics will remain more general, but we are open to subject areas concerning a topic of importance, especially interdisciplinary or transdisciplinary science. In recent decades, significant strides have been made in all areas of atmospheric science. We have seen the proliferation of remote sensing technologies, their instrumentation, and techniques for their use in research and operational weather forecasting. We have also seen advances in synoptic and dynamic meteorology, which have greatly enhanced weather forecasting. Advances in the capabilities of atmospheric modelling as well as increases in computing power have enhanced our understanding of atmospheric behaviours at all scales of time and space. Additionally, there have been discoveries related to the behaviour of smaller-scale systems, especially those that interact or intersect with human activity, health, and economics. These have inspired techniques for warning people that these events could affect them. An enhanced understanding of the interannual and interdecadal variability in our climate has also led to the development of long-range forecasting and projection. In conclusion, this conference will be organized around the following general and related themes that correspond to the *Atmosphere* journal:

S1. Biosphere, Hydrosphere, Land–Atmosphere Interactions;
S2. Air Quality and Human Health;
S3. Biometeorology;
S4. Meteorology;
S5. Atmospheric Techniques, Instruments, and Modeling;
S6. Climatology;
S7. Air Quality;
S8. Aerosols;
S9. Air Pollution Control;

This event will be an **online** proceeding, which enables researchers from all over the world to participate with no concerns regarding travel and related expenditures. Participation in, as well as "attendance" of this online conference, is **free of charge.** Short proceedings papers will be published in the conference's proceedings in MDPI's online journal *Environment Science Proceedings* after has peer review.

Prof. Dr. Anthony R. Lupo
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atmosphere

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Atmosphere (ISSN 2073-4433) is an open access, international, interdisciplinary scholarly journal focused on all areas of scientific research related to atmosphere. *Atmosphere* publishes original research papers, reviews, communications and short notes. Its Special Issues are devoted to highlighting cutting-edge research topics. There is no restriction on the maximum length of the papers, and all manuscripts undergo a rigorous peer-review process before publication.

Journal Webpage: https://www.mdpi.com/journal/atmosphere

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Department of Electrical and Computer Engineering, Colorado State University, Fort Collins, CO, USA

Program at a Glance

	4 June	5 June	6 June
Morning	**S5.** Atmospheric Techniques, Instruments and Modeling **S6.** Climatology	**S8.** Aerosols	**S2.** Air Quality and Human Health
Afternoon	**S3.** Biometeorology **S9.** Air Pollution Control	**S1.** Biosphere, Hydrosphere, Land–Atmosphere Interactions **S4.** Meteorology	**S7.** Air Quality

ECAS 2025 Program

4 June 2025 (Wednesday)

S5. Atmospheric Techniques, Instruments and Modeling
S6. Climatology

Time: 9:00 (CEST, Basel) | 03:00 (EDT, New York) | 15:00 (CST Asia, Beijing)

CEST Time	Speaker	Title
09:00–09:10	**Prof. Dr. Anthony R. Lupo** Event Chair	Welcome Speech by Chair
09:10–09:20	**Professor Riccardo Buccolieri** Session Chairs	Welcome from the Session Chair
09:20–09:35	**Daniela Cava** Selected Speaker	Coupling Between Urban Sublayers: High-Resolution LES Modeling of Microclimate and Energy Dynamics in Bolognina
09:35–09:50	**Roberta Valentina Gagliardi** Selected Speaker	Insights into Air Quality Index (AQI) variability with Explainable Machine Learning techniques
09:50–10:05	**Minyi Wang** Selected Speaker	An analysis of the association between polycyclic aromatic hydrocarbon pollution and environmental factors in the urban atmosphere
10:05–10:20	**Alexander Uzhinskiy** Selected Speaker	Advances in Remote Sensing and Machine Learning Techniques for Air Quality Monitoring
10:20–10:35	**Georgii Nerobelov** Selected Speaker	Evaluation of the changes in climate and atmospheric composition in the Russian Arctic according to offline-coupled ESM SOCOL and WRF-Chem
10:35–10:50	**Irina Mironova** Selected Speaker	The role of space weather in ozone depletion
10:50–11:00	**Dr. Eugene Rozanov** Session Chair	Welcome from the Session Chair Session S6. Climatology starts
11:00–11:25	**Prof. Eugeny Volodin** Keynote Speaker	Simulation of past, present and future climate with climate model INMCM.
11:25–11:40	**Tatiana Egorova** Selected Speaker	Response of cloud cover and climate to geomagnetic field changes
11:40–11:55	**Daniel Milano Costa de Lima** Selected Speaker	Future Projections (2015–2100) of Daily Temperature Range (DTR) in South America: Multiregional Analysis Based on CMIP6 Models
11:55–12:10	**Prashant Singh** Selected Speaker	Significance of summertime heat-low over northern Indian Subcontinent in the changing climate
12:10–12:25	**Eugene Rozano** Selected Speaker	Impact of biogenic emissions on climate and the ozone layer
BREAK 12:25 to 14: 00 CEST		

S3. Biometeorology
S9. Air Pollution Control

Time: 14:00 (CEST, Basel) | 09:00 (EDT, New York) | 21:00 (CST Asia, Beijing)

CEST Time	Speaker	Title
14:00–14:10	**Prof. Dr. Teodoro Georgiadis** Committee Member	Welcome by the Committee Member
14:10–14:35	**Prof. Dr. Teodoro Georgiadis** Keynote Speaker	Urban heatwaves and cognitive impairment: a link to be explored in detail

14:35–15:00	**Prof. Andre Nouri** Keynote Speaker	**TB**
15:00–15:15	**Letizia Cremonini** Selected Speaker	And for those outside the center of the Gaussian? An analysis of the needs and potential responses for elderly and disabled people living in the urban system
15:15–15:25	**Prof. Pasquale Avino** Session Chair	Welcome from the Session Chair **Session S9. Air Pollution Control starts**
15:25–15:40	**Antonio Peña-Fernández** Selected Speaker	Assessing Air Quality Through Tree Bark Biomonitoring of Praseodymium in Leicestershire, UK
15:55–16:10	**Pelin Yapicioğlu** Selected Speaker	A holistical approach for the minimization of nitrous oxide (N_2O) emissions from brewery wastewater treatment using malt-sprout-derived biochar
16:10–16:25	**Zizheng Li** Selected Speaker	Research on Synchronous Estimation of Ultra-High Spatiotemporal Resolution Concentrations for Six Standard Air Pollutants Using Satellite Remote Sensing and Street View Data
16:25–16:40	**Cao Jingru** Selected Speaker	A spatiotemporal Downscaling Framework based on machine learning for hourly 1 km PM2.5 mapping in China
16:40–16:55	**Julien Djossou** Selected Speaker	Source Identification of PM2.5 and Carbonaceous Aerosols During a Long Dry Period in the Cities of Abomey-Calavi and Cotonou, Benin

5 June 2025 (Wednesday)

S8. Aerosols

Time: 9:00 (CEST, Basel) / 03:00 (EDT, New York) / 15:00 (CST Asia, Beijing)

CEST Time	Speaker	Title
09:00–09:10	**Dr. Antonio Donateo** **Dr. Francesca Costabile** **Dr. Dimitris Kaskaoutis** Session Chairs	Welcome from the Session Chairs
09:10–09:25	**Mera Koki** Selected Speaker	Development of an analytical method for atmospheric humic-like substances that uses high-performance liquid chromatography and an automated pretreatment technique
09:25–09:40	**Siwoo Kim** Selected Speaker	Evaluation of Oxidative Potential of Nitrogen-containing heterocyclic compounds and their Metal Complexes by the DTT assay
09:40–09:55	**Dimitris Kaskaoutis** Selected Speaker	Seasonal characteristics of spectral absorption and BC source apportionment at a background site in the southern Balkans
09:55–10:10	**Carmina Sirignano** Selected Speaker	Integrating Planetary Health and Nature-Based Solutions: Assessing the Impacts of Traffic-Related Air Pollution on Human and Plant Health in Urban Forests
10:10–10:25	**Siwei Wei** Selected Speaker	Investigation of the sources of atmospheric oxidative potential and their interactions observed in Suzu, Japan
10:25–10:40	**Sami Hema Venkata Naga Vamsi Krishna** Selected Speaker	Spatiotemporal variations of Modelled Aerosols and Aerosol Subtypes over a Tropical region in South India: The Influence of Meteorology Dynamics

10:40–10:55	**Pelati Althaf** Selected Speaker	Unveiling Aerosols and Clouds with AI: Insights into Climate and Monsoon Variability Over the Bay of Bengal
BREAK: 10:55–13:30		

S1. Biosphere, Hydrosphere, Land–Atmosphere Interactions
S4. Meteorology

CEST Time	Speaker	Title
13:30–13:40	**Dr. Jane Liu** Session Chair	Welcome from the Session Chair Session S1. Biosphere, Hydrosphere, Land–Atmosphere Interactions starts
13:40–13:55	**Sayanta Ghosh** Selected Speaker	Assessing the Impact of Regional Climate Variability on Forest Vulnerability in Assam Using a GIS and Machine Learning-Based Approach
13:55–14:10	**Romaissa Harid** Selected Speaker	Ocean–Atmosphere interaction responses to marine heatwaves
14:10–14:25	**Mano Priya Angappan** Selected Speaker	Interactions across biosphere and atmosphere systems: emissions of terpenes and impact on air quality and climate
14:25–14:40	**Dursun Acar** Selected Speaker	New Consideration within Atmospheric Sciences On Whether Characteristic Lightning Strikes Belong to an Atmospheric Environment
14:40–14:50	**Dr. Merhala Thurai** Session Chair	Welcome from the Session Chair Session S4.Meteorology starts
14:50–15:05	**Andrea Antonini** Selected Speaker	GNSS Meteorology and Machine Learning for Nowcasting: A Two-Step Approach to Precipitation Prediction
15:05–15:20	**Phathutshedzo Eugene Ratshiedana** Selected Speaker	Estimation of irrigated tea evapotranspiration using micrometeorological modeling in data-scarce environment
15:20–15:35	**Paulo Vítor de Albuquerque Mendes** Selected Speaker	The Climatology and synoptic conditions of the driest and warmest months in Northeast Brazil
15:35–15:50	**Diego Abraham Jasso Reyes** Selected Speaker	On the Architecture of a Meteorological Station based on the Internet of Things (IoT)
15:50–16:05	**Daniela Lobaina Castillo** Selected Speaker	Insights into lightning activity in Cuba using GOES-16 GLM observations
16:05–16:20	sciforum-119966	TB

6 June 2025 (Wednesday)

S2. Air Quality and Human Health

Time: 9:00 (CEST, Basel) / 03:00 (EDT, New York) / 15:00 (CST Asia, Beijing)

CEST Time	Speaker	Title
09:00–09:10	**Dr. Daniele Contini** **Dr. Regina Duarte** **Dr. Muhammad Ibrahim** Session Chairs	Welcome from the Session Chairs
09:10–09:25	**Antoine Almeida** Selected Speaker	Impact of a long-distance volcano eruption on aerosol water-soluble organics composition and cytotoxic effects over monocytes

09:25–09:40	**Siwoo Kim** Selected Speaker	Evaluation of Oxidative Potential of Nitrogen-containing heterocyclic compounds and their Metal Complexes by the DTT assay
09:40–09:55	**Antonio Pennetta** Selected Speaker	Evaluation of the role of natural and anthropogenic sources on acellular and in vitro TOXicity INdicators of AtmospherIc aerosol (TOX-IN-AIR): preliminary results
09:55–10:10	**Daniela Cesari** Selected Speaker	Characterization of $PM_{2.5}$ and its oxidative potential in three regions of Southern Italy
10:10–10:25	**Antonio Peña-Fernández** Selected Speaker	Lanthanum biomonitoring using tree bark: urban vs rural patterns in Leicestershire, the UK
10:25–10:40	**Mishaal Khawar** Selected Speaker	The Impact of Smog on Public Health and Antimicrobial Resistance in Pakistan
10:40–10:55	**Natalya Stepanova** Selected Speaker	Carcinogenic health risk for the child population of the city of Kazan (Tatarstan) caused by exposure to atmospheric air
10:55–11:10	**Haider Abbas Khwaja** Selected Speaker	Impact of Fine Particulate Pollution Exposure on Respiratory Health in Megacity of Pakistan
11:10–11:25	**Aboubakr Boutahar** Selected Speaker	Urban Green Spaces and Human Health: Assessing the Allergenic Potential
BREAK: 11:25–14:00		

S7. Air Quality

CEST Time	Speaker	Title
14:00–14:10	**Prof. Viney Aneja; Dr. Marina Frontasyeva** Session Chair	Welcome from the Session Chairs Session S7. Air Quality starts
14:10–14:25	**Muhammad Shehzaib Ali** Selected Speaker	The Air Pollution Impacts of California's 2018 Wildfires
14:25–14:40	**Bianca Mihalache** Selected Speaker	A spatial and temporal analysis of the major air pollutants in the southeast area of Romania
14:25–14:55	**Chiara Metrangolo** Selected Speaker	Impact of urban morphology on vehicular pollutant dispersion: a modelling and experimental approach in the city of Lecce (Italy)
14:55–15:10	**Ibrahim Alsafari** Selected Speaker	Quantifying Urban Air Quality Across Global Megacities
15:10–15:25	**Fabiana Carriera** Selected Speaker	Assessment of Indoor Air Quality in an Academic Laboratory: A Comparative Study with a Controlled Room
15:25–15:35	**Flash Poster Session starts**	Welcome from the Host
15:35–15:40	**Merhala Thurai** Poster Presenter	Testing a technique for retrieving the rain drop size distribution moments from X-Band polarimetric radar data during a warm rain event
15:40–15:50	**Motahhareh Zargari** Poster Presenter	Long-Term Seasonal Investigation of Land Surface Temperature in Cairo
15:50–16:00	**Samuel Aires Master Lazaro** Poster Presenter	Reducing carbon dioxide (CO_2) emissions in residential buildings through envelope renovation
16:00–16:05	**Dimitris G. Kaskaoutis** Poster Presenter	Using the synergy of the spectral dependence of scattering and absorption for aerosol type identification and the application of this method over a continental background site in NW Greece

16:05–16:10	**Gianluca Di Iulio** Poster Presenter	Association between particle-bound reactive oxygen species and in vitro oxidative responses induced by traffic-related urban nanoparticles
16:10–16:15	**Theodore Chinis** Poster Presenter	Evaluation of an integrated low-cost pyranometer system for application in household installations
16:15–16:20	**Debora Mignogna** Poster Presenter	Pellet Production: Impact of Pollutants and Associated Health Risks
16:20–16:25	**Lorenzo Massi** Poster Presenter	Size distribution and seasonal evolution of airborne metals in Antarctic atmospheric particulate matter
16:25–16:30	**Mounia Tahri** Poster Presenter	Assessment of Urban Air Quality in Salé, Morocco: An In-Depth Analysis of PM2.5 Seasonal Variations, Elemental Composition, and Enrichment Factors

Session 1. Biosphere, Hydrosphere, Land–Atmosphere Interactions

sciforum-119770: Analyzing the Relationship Between Vegetation and Temperature Changes in the Sylhet Region

Sk. Tanjim Jaman Supto

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As global temperatures continue to rise, understanding the relationship between climate and vegetation is crucial for agriculture and for mitigating and adapting to environmental changes. The complex interaction between vegetation and climate becomes even more significant as temperatures increase, making it essential to comprehend these changes in the environment. This study examines how vegetation dynamics in the Sylhet Region have been affected by long-term temperature changes over the past four decades. This study aims to uncover changes in temperature trends and vegetation growth over recent decades and how it has impacted the climate of the Sylhet region. This research utilizes the Normalized Difference Vegetation Index (NDVI) data from satellites, and statistical analysis techniques are used to examine the relationship between vegetation and temperature in Sylhet. This research shows how changes in temperature affect vegetation health and density. Satellite imagery shows a steady decrease in vegetation density in the Sylhet region. Local climatic variables such as temperature, precipitation, and humidity, as well as anthropogenic factors like urbanization and deforestation, are identified as primary factors behind the loss of vegetation. This study shows a decreasing effect of climate-driven changes on vegetation over time by closely examining the relationship between NDVI and regional climatic parameters. This implies that in recent years, the direct impact of climatic variability has been less significant than the involvement of human-induced variables, such as urbanization, land-use changes, and deforestation, in shaping vegetation patterns.

sciforum-116714: Assessing the Impact of Regional Climate Variability on Forest Vulnerability in Assam Using a GIS and Machine Learning-Based Approach

Sayanta Ghosh [1,*], Aakash Warman [2], Pranjul Chauhan [3], Aniruddh Soni [4] and Jitendra Vir Sharma [5]

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Assam, one of India's richest regions in terms of biodiversity, faces significant environmental threats due to regional climate variability and anthropogenic pressures. This study explores a GIS and machine learning (ML)-based approach to assess the impact of climate change on forest and biodiversity vulnerability across the state. This analysis involves eight parameters: the Biological Richness Index (BRI), Disturbance Index (DI), Forest Canopy Density (FCD), Fire Point Intensity (FPI), Biomass Extraction Intensity (BEI), Slope, Standardized Precipitation Index (SPI), and Flood Vulnerability Index (FVI). Using the Analytical Hierarchy Process (AHP), these indicators were weighted and synthesized to develop a composite Forest and Biodiversity Vulnerability Index (FBVI). The major focus of this study is the delineation of climate change hotspots and their correlation with forest and biodiversity vulnerability zones. The assessment identified 19 grids as very highly vulnerable and 68 grids as highly vulnerable in terms of their forests and biodiversity. Climate change hotspot mapping revealed a further 38 grids experiencing very high climate exposure and 47 grids with high climate exposure which significantly overlap with vulnerable forested regions. This correlation suggests that regions with high climate sensitivity are also at increased risk of forest degradation, biodiversity loss, and ecosystem instability. An analysis of the trend over 22 years indicates a 1.56% decline in total forest cover and a 4.06% reduction in very dense forest cover, driven by factors such as a 9.3% increase in cropland area and a 1% expansion in settlements. The FPI analysis highlights six districts as very highly prone to fire incidents, while nine districts are highly prone to such events. The Standardized Precipitation Index (SPI) trends classify seven districts as very highly drought-prone zones, further exacerbating forest vulnerability. The Flood Vulnerability Index (FVI) identifies regions highly susceptible to flooding, stressing the compounded impacts of hydrological changes on Assam's forest ecosystems. The results emphasize the urgent need for climate-adaptive forest management strategies, including remote sensing-based monitoring, participatory conservation approaches, and policy-driven interventions.

sciforum-106812: Dynamics of changes in height of snow cover of chronological series of birch plantations (middle taiga subzone of European North)

Maria Vladimirovna Medvedeva [1,*], Nadezhda Nikolaevna Nikolaeva [1], Vitaly VladimirOvich Vorobiev [1] and Alexandra Vladimirovna Ukhanova [2]

[1] Forest Research Institute of the Karelian Research Centre of the Russian Academy of Sciences (FRI KarRC RAS)
[2] Institute of Biology, Ecology and Agricultural Technologies of Petrozavodsk State University

Snow cover plays an important role in soil formation and has a significant impact on vegetation. The need to study snow cover has been increasing in recent years due to global climate change. Special attention should be paid to the study of the dynamics of snow cover in artificially created biogeocenoses, in order to understand the general trends in the interaction of soils, snow mass, and vegetation under anthropogenic influence. This is especially true for the taiga zone of the European North, which is characterized by great variability in the natural environment. Insufficient attention to this problem has determined the purpose of this work: to study the depth of snow cover in a chronological series of the birch bark of various grasses. In the middle taiga subzone of Karelia, a change in the depth of snow cover was carried out in birch plantations of different ages.

The research conducted has shown that the formation of snow cover changes dramatically in space and time, and depends on abiotic and biotic factors. It was found that stable snow cover had formed by October 30, 2023. The period of snowfall in the studied areas was 7 months. The maximum height of the stable snow cover was 80 cm, with a minimum of 5 cm. An analysis of the results showed that the distribution of snow on the site depends on the microsite (crown-window): higher indicators were noted “under the crown” compared to the microsite “window”. This study confirms the role of the phytocomplex in the formation of snow cover and established general trends in changing the thickness of snow cover depending on the age of birch planting. The results obtained are the basis for creating a database for the predictive monitoring of the carbon footprint ofterrestrial ecosystems of the boreal zone of the European North.

sciforum-120486: Interactions across biosphere and atmosphere systems: emissions of terpenes and impact on air quality and climate

Mano Priya Angappan * and Gisèle El Dib

Universite de Rennes, France

Biosphere–atmosphere interaction, transport energy and matter underlays various biological, physical and chemical processes. Biogenic Volatile Organic Compounds (BVOCs) are highly involved in these processes and have significant effects not only within vegetation and organisms but also in the atmosphere at different spatiotemporal scales, mainly during heat waves and in densely populated areas. Currently, there is an ongoing global health threat due to the air we inhale both in indoor and outdoor environments, as well as a health crisis following the COVID-19 pandemic. The current European Union (EU) policy and World Health Organization (WHO) significantly contributed to our understanding of urban air quality and human health from air pollutants. Monoterpenes, the second major family of BVOCs, are considered important sources of ozone formation and Secondary Organic Aerosols. Their removal in the atmosphere through chemical processes leads to the formation of oxygenated compounds as first-generation Terpene Oxidation Products (TOPs). These compounds emitted by natural sources like plants and conifers have been detected in the atmosphere during observation campaigns. Hence, this project concerns the study of pollution by terpenes emitted from plants and trees and its consequences on the quality of the air we breathe, and its contribution to the global climate. We have chosen α and β-pinene-emitted first-generation products such as Nopinone ($C_9H_{14}O$), Limona ketone ($C_9H_{14}O$) and Myrtenal ($C_{10}H_{14}O$). The absolute rate coefficient was measured for the first time using a cryogenically cooled cell along with the pulsed laser photolysis–laser-induced fluorescence technique for OH radical. The hydrogen abstraction and OH addition pathways were found by using density functional theory method to determine the most favourable position. Our obtained results confirmed that these processes are of high interest for the Earth system scientific community and should be taken into account in Climate Models and Earth System Models.

sciforum-114269: New Consideration within Atmospheric Sciences On Whether Characteristic Lightning Strikes Belong to an Atmospheric Environment

Dursun Acar [1,*], Ozcan Kalenderli [2] and Demet Biltekin [3]

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While examining how the orientation of particles and droplets in the air subject to static electric fields during atmospheric transport affect sedimentation processes, an important point that has been overlooked throughout the history of electricity was realized. The type of lightning and its refraction angle with respect to the pathway of the electrical discharges seen in the air column, which is pushed by a buffer area of atmospheric fronts, or in the lower stable air flows moving from upper unstable air layers are the same in a given geographical region. The similarity seen in the refraction angles within the whole column of a lightning strike during grounding is quite impressive, as is the similarity in the shape of different lightning strikes at different times in history. When historical lightning photographs taken in the same geological region are examined, we can see that this shape has not changed in 100 years. The shape of lightning strikes seen at different times in the same region and relevant visual evidence have been collected.

The characteristic atmospheric features that create stable erosion and transportation properties are more important than geological stratigraphy and have a greater effect on our findings. The geological lithography of these areas is the second most impactful feature. The different types of suspended material involved in float laminarization processing during transportation is the reason a separated laminar column flow occurs under the same atmospheric conditions. The physical multi-layered separation these materials experience is the result of their varying physical properties, such as their static electric field, humidity, or internal relative displacements. Multi-laminar volumetric leakages of the same air density by the same type of suspended material occur at different heights in the main air column, with an increased number of layers occurring due to static electricity. The pathway of a lightning strike always hasthe same refraction shape, making this a regional marker of constant atmospheric conditions in a stable climate.

sciforum-105677: Ocean–Atmosphere interaction responses to marine heatwaves

Romaissa Harid [1,*] and Azzedine Hadef [2]

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Ocean–atmosphere interaction is defined as the exchange of energy at the interface of the ocean and atmosphere. The ocean surface energy, which is largely related to Sea Surface Temperature (SST), determines the stability of the lower atmosphere and ocean surface ecosystems and mechanisms. Marine Heat Waves (MHWs) are characterized by Sea Surface Temperature hotspots, which are practically linked to increases in air temperature. This strongly influences phytoplankton production, causes the appearance of specific phytoplankton blooms, and indirectly impacts the marine food web. In this work, we used Sea Surface Temperature of MODIS remote sensing data and their equivalent daily Ocean Color MODIS remote sensing data for over 20 years in the Algerian Basin (South-Western Mediterranean Sea). Mainly, we found the location of Marine Heat Waves specific to the Algerian Basin. However, the Marine Heat Waves generate specific phytoplankton blooms in coastal areas which are highly related to seasonality (regional climate). For example, some phytoplankton species bloomed after days of increased sea surface temperature. Moreover, the days on which these specific phytoplanktonic blooms (such as the coccolithophore bloom) appeared are sometimes followed by rainy days because of the chemical composition of phytoplankton species (coccolithophore species live on the ocean surface and have limestone shells).

Session 2. Air Quality and Human Health

sciforum-119442: The Impact of Smog on Public Health and Antimicrobial Resistance in Pakistan

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Introduction

Since 2016, smog has been an annual health and environmental crisis in Pakistan, commonly known as the “fifth season.” This hazardous phenomenon results from a combination of vehicle emissions, industrial pollution, crop residue burning, and fossil fuel consumption. Smog season intensifies in October, dropping visibility considerably while increasing respiratory problems and antimicrobial resistance. We seek to analyze the correlation between deteriorating air quality and rising public health concerns, specifically antimicrobial resistance.

Methods

This study was supported by multiple sources, including the existing literature, environmental data, air quality indices (AQIs), and public health reports, to assess the impact of smog on respiratory ailments and antimicrobial resistance. The global study on particulate matter proved to be resourceful. Additionally, we reviewed the data from the U.S. Environmental Protection Agency (EPA) and NASA’s research statistics regarding cross-border crop burning. The relation between airborne pollution levels and antimicrobial resistance rates was interpreted based on the direct correlation found between them.

Results

In 2024, Pakistan’s urban cities reported toxic AQI levels, with Multan reaching an unprecedented 1,392, followed by Lahore (826), Peshawar (575), and Rawalpindi (271). A 10% rise in PM 2.5 levels caused a 2.6% increase in antimicrobial resistance in Pakistan. This led to premature deaths and difficulty in disease management. The government was forced to take temporary measures such as school closures, enforcing work-from-home policies, and limiting commercial activities. However, these short-term actions failed to deal with the root causes of pollution.

Conclusions

The smog crisis in Pakistan is causing serious environmental and public health concerns, particularly by accelerating antimicrobial resistance. Without resolute action, it will continue to jeopardize public health and strain the health care system. Policy recommendations involve stricter emissions standards, large-scale afforestation, investment in clean energy, and global collaboration to reduce crop burning. While emergency measures provide momentary relief, long-term sustainable solutions are necessary to mitigate the problem.

sciforum-120570: Assessment of Indoor Air Quality in an Academic Laboratory: A Comparative Study with a Controlled Room

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Introduction

University laboratories are complex environments characterized by confined spaces, high occupant density, and the frequent use of potentially hazardous chemicals. These factors contribute to elevated concentrations of airborne pollutants, which may pose health risks to students and laboratory personnel. Ensuring adequate indoor air quality (IAQ) is therefore crucial for safeguarding well-being and maintaining operational efficiency. This study aims to quantitatively assess IAQ in an analytical chemistry laboratory by comparing it with a controlled room under similar baseline conditions.

Methodology

Air quality was assessed using a DustTrak aerosol monitor for real-time measurements of particulate matter (PM) concentrations, specifically PM_{10}, $PM_{2.5}$, PM_{1}, and total PM. Measurements were conducted in both the laboratory and the controlled room to facilitate a direct comparison of environmental conditions.

Results

The findings indicate that $PM_{2.5}$ concentrations within the laboratory consistently exceeded the recommended exposure threshold of 15 $\mu g/m^3$. This increase was particularly evident during student activities, suggesting that occupant presence and experimental procedures contributed to the emission and resuspension of particulate matter.

Conclusions

The elevated levels of particulate matter observed in the laboratory highlight the need for improved ventilation strategies and pollution mitigation measures. Maintaining optimal IAQ in laboratory environments is essential to protect the health and productivity of students and academic staff.

sciforum-116430: Characterization of $PM_{2.5}$ and its oxidative potential in three regions of Southern Italy

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Introduction

The study of the atmospheric particulate matter (PM) oxidative potential (OP), a general indicator of human health risks associated with PM exposure, has become a focal point in research. However, in the Italian territory, the number of studies concerning OP is limited, especially for the fine fraction of particulate matter ($PM_{2.5}$). This study aims at investigating the impact of different natural and anthropogenic sources on $PM_{2.5}$ and its oxidative potential in different areas of Southern Italy.

Methods

Samples of $PM_{2.5}$ were collected in sites of different typology (i.e. rural, urban background, urban and industrial sites) from three regions of Southern Italy. The $PM_{2.5}$ sources were identified and characterized with the PMF5.0 receptor model, while the contribution of each source to the OP (measured with a DTT assay) was estimated with the MLR approach. The results were compared with those obtained from other similar studies performed in Northern Italy, related to different typology sites.

Results and Conclusions

The PMF5.0 identified similar sources for the southern sites (biomass combustion, vehicular traffic, crustal and marine contributions, secondary inorganic aerosols and industrial emissions), with different contributions to $PM_{2.5}$ and OP. The MLR analysis highlighted that combustion sources (i.e., biomass combustion and traffic emissions) were the main contributors to the OP activity of $PM_{2.5}$. Furthermore, it was also observed that the relative contributions to OP and $PM_{2.5}$ were not comparable for all sources. The results of this study represent a contribution to a better understanding of the potential health impact of $PM_{2.5}$; of its spatial variability; and of the role of different sources.

sciforum-120341: Exposure to $PM_{2.5}$ while walking in the city center

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Physical activity, such as walking, plays a key role in preventing noncommunicable diseases. However, in urban environments, pedestrians are often exposed to elevated air pollution levels, especially fine particulate matter ($PM_{2.5}$), which poses significant health risks. This study investigates personal exposure to $PM_{2.5}$ while commuting on short walking routes in Gliwice, Poland, a city known for its high air pollution levels. It compares measurements made using a low-cost air quality sensor with data from stationary air quality monitoring stations and an air quality laboratory at the Silesian University of Technology (SUT). The aim of this study is to assess real-time $PM_{2.5}$ exposure and address data gaps for health risk assessments. This study was conducted between January and November 2022, focusing on the participants' daily walking routines to the university campus. Data analysis included pollutant concentrations, environmental conditions, and statistical comparisons between different seasons (heating and non-heating). The results indicated that $PM_{2.5}$ levels measured by the low-cost sensor were lower than those recorded at the stationary sites, with average concentrations of 7.3 μg/m^3 during both seasons. The stationary data from the monitoring station and the SUT laboratory reported higher average concentrations of 12.3 and 20.1 μg/m^3, as well as 16.0 and 29.1 μg/m^3, during the non-heating and heating season, respectively, showing statistically significant seasonal variations, unlike the low-cost sensor. The results suggest that low-cost sensors, while useful for real-time individual exposure monitoring, may lack the sensitivity needed to detect seasonal variations compared to reference-grade instruments. Overall, this study emphasizes the importance of appropriate measurement methods for assessing air quality and highlights the potential role of low-cost sensors in personal exposure tracking, raising awareness about air pollution.

sciforum-113116: Assessing air quality through biomonitoring of neodymium in urban and rural tree bark across Leicestershire (UK)

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Air quality for neodymium (Nd) was biomonitored in the English county of Leicestershire after low levels of the element were detected in topsoils from various urban parks in the city of Leicester. Thin layers of bark were collected from 55 and 41 trees growing in the city of Leicester and surrounding rural areas, respectively. Nd was monitored by ICP-MS in clean/ground/homogenised samples [LoD=0.504 ng/g dry weight (dw)]. The levels of Nd were higher in bark samples collected in Leicester city (median and ranges, in ng/g dw): 8.382 (2.021-198.91) and 7.778 (1.577-59.123). The higher concentrations of Nd in bark collected from trees growing in Leicester could be attributed to its technological uses. The Nd content varied between bark samples collected in the four cardinal sub-areas into which the city was divided (medians, ng/g dw): 45.132 (SE) > 14.397 (SW) > 7.709 (NE) > 5.950 (NW). This trend differed from the concentrations found in trees growing in the three Leicestershire cardinal points (medians, ng/g dw): 28.175 (NW) > 7.215 (NE) > 1.772 (SE). Finding a hypothesis that could explain the differences found in airborne Nd content across the monitored region is challenging as the atmospheric transport of Nd is poorly understood. Our results show a high dispersion of Nd across Leicestershire, which would be little influenced by its distribution in the topsoil, as the enrichment factors obtained as a function of the average Nd and scandium content in the upper continental crust were lower than unity in both areas (0.383 and 0.423). However, further studies are needed to identify the potential sources of Nd that could have contributed to the observed trends, because the levels found were higher than those described in bark from trees growing in uncontaminated areas. The development of a $^{143}Nd/144Nd$ isotope map could help to distinguish sources of pollution.

sciforum-114402: Carcinogenic Health Risk for the Child Population of the City of Kazan (Tatarstan) Caused by Exposure to Atmospheric Air

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Introduction

According to epidemiological research data, the regional quality of atmospheric air is the cause of considerable population morbidity growth, its vulnerable groups in particular.

Methods

The assessment of carcinogenic risk (ICR) for the health of children aged 3-6 years living in four zones of Kazan was performed corresponding to atmospheric air monitoring points. Data on air pollution (with formaldehyde, soot, and benzol) were obtained based on the research results of FSFHI “The Center of Hygiene and Epidemiology in the Republic of Tatarstan” for the years 2017-2023. A daily dose via the chronic inhalation route was calculated at the level of the upper 95th % of the confidence bound of average annual concentrations.

Results

An average annual level of carbon (soot) exceeded the standards in all zones by a factor of 2, 32 - 9,96. A high level of ICR for children’s health was observed in all zones: 2,69x10^{-3} in the first zone; 6,68x10^{-2} in the second; 7,4x10^{-3} in the third, and 1,18x10^{-2} in the fourth zone. The highest levels of ICR exceeding the allowable level (1x10^{-4}) registered in the territories, where enterprises of the first and second classes of hazard (chemical complex) were concentrated, which was especially true of zones 2 and 4. In the residential area of the first and third zones with a high level of truck traffic load, the levels of ICR varied from 2,69x10^{-3} to 7,4x10^{-3}, with the largest contribution of soot to its concentration value.

Conclusions

The results dictate the necessity of developing and implementing of such strategies reducing atmospheric emissions as transport and industry modernization and regulation, as well as organizing the continuous monitoring of pollutants for the efficient assessment of the total level of carcinogenic substances in residential zones.

sciforum-120601: Correlation Between Hair Element Concentration, Sex, and Body Mass Index in Young Italian Population

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Introduction

Human hair is an excellent biological indicator for assessing human health conditions. It can provide an indication of mineral levels and accumulation of toxic metals resulting from long-term or acute exposure. This study investigates the relationship between the concentration of toxic elements in hair and Body Mass Index (BMI) in adolescents with no environmental or occupational exposure. The latter physiological factor influences the metabolism of both essential and toxic elements in the human body, providing a valuable diagnostic framework for various diseases.

Methodology

Instrumental Neutron Activation Analysis (INAA) was used for a highly sensitive and accurate element determination. The collected samples were pre-treated with acetone and drying before the analysis.

Results

The results obtained suggested the abundance of zinc (Zn) (100 μg g^{-1}), followed by iron (Fe), and copper (Cu), all with concentrations above 1μg g^{-1}. A weak positive correlation was found between Zn and K, while magnesium (Mg) levels proportionally increased with BMI (173±129 μg g^{-1}; 24.0 BMI 25.4). Further statistical analyses, including cluster analysis and principal component analysis, suggested low similarity between sulphur (S) and chlorine (Cl), which were indirectly associated with BMI. The data obtained have been studied and discussed with data from an inorganic fraction of particulate matter, PM_{10} and $PM_{2.5}$, registering very low levels of the elements investigated (As = 1.06 ng m^{-3}, Cr = 3.3 ng m^{-3}, and Ni = 3.5 ng m^{-3} in fine granulometric fractions).

Conclusions

The results provide an important basis for assessing the effects of anthropogenic phenomena, such as atmospheric emissions, in urban areas. Although no significant correlations with BMI were found for any of the elements studied, the findings represent a baseline for further and more comprehensive understanding of the mechanisms of the accumulation or release of toxic elements in the bodies of individuals exposed in relation to BMI.

sciforum-116445: Evaluation of the role of natural and anthropogenic sources on acellular and in vitro TOXicity INdicators of Atmospherlc aerosol (TOX-IN-AIR): preliminary results

Antonio Pennetta [1,*], Ermelinda Bloise [1], Daniela Cesari [1], Giuseppe Deluca [1], Adelaide Dinoi [1], Lorena Carla Giannossa [2], Livia Giotta [3], Maria Rachele Guascito [3], Giulia Lionetto [3], Gianna Manelli [2], Annarosa Mangone [2], Serena Potì [1,3], Paola Semeraro [1], Florin Unga [1] and Daniele Contini [1]

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Introduction

Fine particulate matter ($PM_{2.5}$) is a significant risk for public health. The mechanisms underlying its toxicity are still not fully understood, with contrasting results across acellular, cellular, and in vivo toxicity metrics. The TOX-IN-AIR project aims to analyse correlations between toxicity indicators and chemical composition, considering seasonal and site dependencies, and assess the contributions of natural and anthropogenic sources and their nonlinear interactions.

Methods

Two campaigns were conducted in winter and summer in Lecce, Italy. The Mobile Laboratory for Gas and Aerosol Measurements (MAGA) and the Environmental-Climate Observatory (ECO) platforms were used for the urban and urban background sites, respectively. $PM_{2.5}$ samples were collected on Teflon and quartz filters. Particle size distributions, meteorological data, and gas concentrations were measured online. In the laboratory, the $PM_{2.5}$ fraction was weighed, and subsequently, the chemical composition was measured by ED-XRF. The filters were then fractionated and subjected to a) chemical characterization; b) acellular determination of oxidative potential; and c) cellular in vitro analysis.

Results and Conclusions

The $PM_{2.5}$ mass concentrations were very similar between the ECO and MAGA sites during both campaigns. Particle number concentrations (diameter ≤2.5 μm) were higher at the urban site compared to the suburban site, particularly during the winter period. Coarse particles (diameter≥ 2.54μm) were similar at the two sites. Peaks in coarse particles were observed during three days in both campaigns, attributed to long-range Saharan dust transport. The results of source apportionment by using the PMF receptor model will be presented.

This work was co-funded by Next Generation EU – Mission 4 – Ministry of University and Research (MUR) – Call PRIN 2022 PNRR – Project TOX-IN-AIR, P2022JKPS.

sciforum-116617: Health risk assessment of atmospheric air pollution: a case study of adolescents and adults in Kazan.

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Introduction

The state policy of many countries is aimed at reducing atmospheric air pollution. The purpose of this work is to assess the health risk of adolescents and adults associated with the impact of atmospheric air chemicals in the city of Kazan.

Materials and Methods

This study was carried out on the basis of the data of socio-hygienic monitoring (2015-2022). Non-carcinogenic risk assessments werecarried out in accordance with Guideline 2.1.10.3968-23 to calculate the average daily doses for adolescents (14-17 years old) and the adult population. The total risk of carcinogenic effects (HQs) and the hazard index of non-carcinogenic effects (HIs) were calculated..

Results

The main contributors to the risk (HQ) for adolescents and adults in Kazan are carbon at 32.8%, nitrogen dioxide at 21.7%, PM10 at 20.7%, formaldehyde at 8.5%, and PM2.5 at 8.2%. Annual mean concentrations for the city of Kazan for carbon were 0.189 mg/m3, for nitrogen dioxide 0.081 mg/m3, for PM10 0.074 mg/m3, for formaldehyde 0.004 mg/m3, and for PM2.5 0.02 mg/m3. The cumulative risk of non-carcinogenic effects is 4.1 (high risk) for adolescents and 2.9 (alarming risk) for adults. The highest toxic load is respiratory: HI=3.8 for adolescents (alarming risk) and HI=2.7 for adults (acceptable risk). Mortality indices are HI=1.7 and HI=1.2, respectively, remaining within acceptable limits. Dental and systemic diseases ranked third, with HI=1.4 for adolescents and HI=1.0 for adults.

Conclusions

The comparative assessment of non-carcinogenic effects in adolescents corresponds to a high level, requiring comprehensive risk reduction measures, while for adults it is alarming, requiring routine wellness interventions.

sciforum-116359: Health risk associated with inhalation exposure to aromatic hydrocarbons (BTEX) in the City of Novi Sad

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Road traffic is one of the major sources of air pollutants, including aromatic hydrocarbons. The current study assessed the presence of benzene, toluene, ethylbenzene and xylenes (BTEX) in the City of Novi Sad's ambient air and the health risk for its inhabitants.

A total of 686 24h air samples were collected at two sites in the City of Novi Sad during 2024 and analyzed using a GC-MS method.

As expected on traffic sites, BTEX compounds were quantified in the majority of the samples: toluene 94.3% > benzene 88.3% > xylenes 75.6% > ethylbenzene 59.0%. The mean concentrations (μg/m^3) of benzene and toluene were higher at urban traffic sites (1.7 vs. 1.3; 3.9 vs. 2.3), while ethylbenzene and xylenes reached higher means at suburban traffic sites (1.0 vs. 1.7; 2.6 vs. 4.2). Benzene's annual concentration was in compliance with the calendar year limit established by Directive 2008/50/EC. The hazard index (HI), calculated as a sum of hazard quotients related to reference inhalation concentrations of individual compounds, was used as a measure of non-carcinogenic risk. The HI values on suburban (0.087) and urban traffic sites (0.085) indicated no health risk. Benzene and xylenes were the main HI contributors (>98%). The carcinogenic risk was based on benzene and ethylbenzene inhalation risk units. In the case of children, it was very similar on suburban and urban traffic sites (2.1E-06 and 2.3E-06), while in the case of adults, it was slightly higher on urban traffic sites (9.1E-06 *vs.* 8.2E-06). However, the health risk was low regardless of the population group. As expected, due to its higher inherent carcinogenic potential as well as its higher population exposure level, benzene showed a 2.5-fold higher impact on carcinogenic risk than ethyl benzene.

Although the estimated values of the risk indicators are low, it is of utmost importance to reduce exposure to carcinogenic compounds in ambient air.

sciforum-116360: Health risks associated with inhalation exposure to benzo(a)pyrene in the City of Novi Sad

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Polycyclic aromatic hydrocarbons (PAHs) in the ambient air can pose serious health risks for humans when inhaled and are usually adsorbed on particulate matter (PM). The current study aimed to investigate the content of benzo(a)pyrene (BaP), the most famous representative of PAHs, in PM10 (inhalable PM, with diameter up to 10 μm) in ambient air in the City of Novi Sad and to assess the associated health risks.

PM10 sampling performed at five monitoring sites (basic-rural/urban, urban/suburban-traffic, industrial) in the City of Novi Sad during 2024 resulted in1340 samples, which were analyzed using the GC-MS method.

The overall share of the samples with quantified amounts of BaP was 46.6 (53.8% basic-rural > 53.7% suburban-traffic > 49.3% industrial > 45.2% urban-traffic > 34.6% basic-urban site). The lowest mean concentration was recorded at the basic-urban site (0.5 ng/m^3), while the highest was related to suburban-traffic (0.9 ng/m^3); when averaged over all monitored sites, the BaP level was 0.7 ng/m^3. The annual level of BAP was in compliance with regulatory requirements. The health risks were estimated using the hazard quotient (HQ) and lifetime cancer risk (LCR) approaches. The HQ was below the limit value of 1 in all monitored sites (0.24-0.47, overall average 0.37), indicating no risk. LCR was negligible for both children (from 4.5E-08 to 8.0E-08, mean 6.4E-08) and adults (from 1.8E-07 to 3.2E-07, mean 2.5E-07).

Although the estimated values of the risk indicators are low, the population is still exposed not only to BaP but also to other polycyclic aromatic hydrocarbons, with some of them also being carcinogens. As exposure occursnot only via inhalation but also through the consumption of foods such as grilled and smoked food, it is of utmost importance to reduce the population's exposure to carcinogenic compounds via all relevant exposure pathways.

sciforum-116362: Health risks associated with inhalation exposure to toxic metal(loid)s in the City of Novi Sad

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The toxic metal(loid)s bound to particulate matter (PM) in ambient air can cause serious harm to human health. The current study aimed to investigate the toxic element composition of PM10 (diameter up to 10 μm) and to address the risks to human health.

Sampling of PM10 was performed at five sites (basic-rural/urban, urban-/suburban-traffic, industrial) in the City of Novi Sad during 2024. A total of 1357 samples was subjected to microwave digestion followed by the ICP-MS determination of lead (Pb), cadmium (Cd), arsenic (As), and nickel (Ni) content.

The overall share of the samples with quantified amounts of elements was 85.3% Pb > 65.2% As > 36.6% Cd > 27.7% Ni. The lowest mean concentrations (ng/m^3) were recorded at the basic-urban site (Pb 4.5, Cd 0.15, As 0.80, Ni 3,0), while the highest were related to the suburban-traffic (Pb 5.9, Cd 0.24, As 0.83) and urban-traffic site (Ni 4.2); the order of the concentrations averaged over all monitored sites (ng/m^3) was as follows: Pb 5.1 > Ni 3.4 > As 0.80 > Cd 0.20. The Hazard index (HI), an indicator of non-carcinogenic risk, ranged from 0.29 in the basic-rural/-urban to 0.38 in the suburban-traffic site, with a mean of0.32 (averaging over all the sites), revealing no health risk. Ni was the element with by far the highest contribution to non-carcinogenic risk (68.3%). Carcinogenic risk for children ranged from 6.8E-07 (basic-urban) to 7.6E-07 (urban-traffic), with a mean of7.2E-07, showing negligible risk. In the case of adults, carcinogenic risk varied only slightly, with a mean of2.9E-06, indicating low risk. As was the element with by far the highest contribution to carcinogenic risk (68.7%), followed by Ni (16.1%), Pb (8.0%), and Cd (7.2%).

Considering that toxic metal(loid)s are ubiquitous contaminants, low levels of risk indicators related to the inhalation exposure are not enough to ensure protection of human health.

sciforum-120606: Impact of a long-distance volcano eruption on aerosol water-soluble organics composition and cytotoxic effects over monocytes

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Volcano eruptions significantly impact air quality, due to their large emissions of particulate matter, SO_2 and trace metals [1,2]. Exposure to these emissions can exert adverse effects on cardiorespiratory health as well as causing dermal and ocular irritation [2]. As such, it is important to understand which characteristics of volcanic air pollution are responsible for these reported negative health outcomes. To this end, two sets of $PM_{2.5}$ samples were collected at a suburban location during a period impacted by volcanic activity and a reference period. The structural features of these aerosol WSOM samples were assessed through liquid-state NMR spectroscopy, whereas their cytotoxic effects were evaluated on the THP-1 human monocytic cell line.

Overall, a total of 25 structures were identified in the WSOM samples, of which 12 were common to both samples. The WSOM samples effectively activated THP-1 monocytes and enhanced their expression of adhesion molecules. This effect over cells suggests that some WSOM components may accelerate the formation of atherosclerotic plaques, potentially elevating the risk of cardiovascular diseases. Nonetheless, and even though both samples presented toxicological properties, overall, the volcanic activity did not appear to cause a significant alteration in the chemical properties and cytotoxic effects over monocytes of the fine aerosol WSOM.

Thanks are due to FCT/MCTES for the financial support to CESAM (UID Centro de Estudos do Ambiente e Mar (CESAM) + LA/P/0094/2020) to iBiMED (UIDB/04501/2020, DOI: https://doi.org/10.54499/UIDB/04501/2020 and project reference UIDP/04501/2020, DOI: https://doi.org/10.54499/UIDP/04501/2020) and for a PhD grant (2020.05804.BD; DOI: https://doi.org/10.54499/2020.05804.BD) through national funds and the European Social Fund.

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sciforum-115975: Impact of Fine Particulate Pollution Exposure on Respiratory Health in Megacity of Pakistan

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Air pollution poses a substantial barrier to global environmental sustainability and citizen well-being. However, there is a lack of research that specifically examines the effects of short-term exposure to $PM_{2.5}$ and its components on health outcomes in developing nations in Asia. The present study evaluated the associations between $PM_{2.5}$ components and hospital admissions (HAs) and emergency room visits (ERVs) for respiratory diseases in a megacity of Karachi, Pakistan. We assessed the lag structure of the excess risk (ER) of the pollutant—outcome association (0-6 single and cumulative lag days) using time-series quasi-Poisson models, after adjusting for temperature, humidity, and day of the week. This first study in Pakistan found that $PM_{2.5}$ and its constituents were associated with respiratory HAs and ERVs for the inhabitants of the megacity of Karachi. These associations varied by different PM constituents, disease subtypes, age, and gender. The leading causes for HAs were COPD (21.5%), asthma (17.3%), and TB (12.3%). Asthma (24.4%), TB (18.0%), and COPD (17.3%) were the principal causes of ERVs. Males accounted for 62.0% of the HAs and 58.1% of the ERVs. The prevalence of respiratory diseases increased with age, peaking with the age group 18-64. The highest ERs for all respiratory morbidity were observed for $PM_{2.5}$ (10.3, 95% CI: 2.59%-18.59), NH_4^+ (9.58%, 95% CI: 1.50%-18.30%), air quality index (9.11%, 95%CI: 2.54%-16.09%), and SO_4^{2-} (7.26%, 95% CI: 1.03%-13.87%) within 0-4 lag days. Additionally, patients with COPD, TB, or other pulmonary diseases, and older or male patients, were more vulnerable to these pollutants. Our results provide important information for policy makers for developing regulations for improving air quality and public health. Further studies are urgently needed in other developing countries to disentangle the effects of air pollution on health.

sciforum-116215: Issues and challenges around classification of respiratory sensitizers/allergens in the United Nations Globally Harmonized System

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Introduction

The United Nations Globally Harmonized System (GHS) of classification and labelling provides specifications for the classification, management, and communication of hazards, crucial for protecting workers and consumers. However, issues and challenges exist in its application, particularly concerning respiratory sensitizers, many of which can become airborne pollutants in occupational settings and in broader environments, where they may engulf entire regions.

Methods

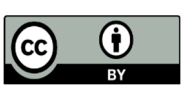
This is a narrative review that assesses relevant GHS documents and internationally accepted methods for determining respiratory sensitizers.

Results

Chemical sensitization is complex and depends on factors like allergen nature, dose, and exposure route, including inhalation. Sensitization initially involves the induction of specialized immunological memory in an individual by exposure to an allergen, followed by elicitation, which is the production of an allergic response following exposure of a sensitized individual to an allergen. Consequently, predictive tests also involve both induction and elicitation, followed by classification as Category 1, 1A or 1B, depending on the evidence. Unfortunately, GHS classification relies heavily on epidemiological data captured retrospectively with diagnostic testing rather than on prospective (predictive) data. Moreover, there are issues regarding the potency of chemicals and absence or presence of no-adverse-effect levels (NOAELs). Accurately assessing airborne exposure to sensitizers can be challenging, especially in complex environments, making it difficult to establish clear dose–response relationships. Lastly, the potential for certain respiratory sensitizers to become airborne and persist in the atmosphere increases the risk of prolonged inhalation exposure, underscoring the necessity for accurate GHS classification.

Conclusions

Challenges exist in interpreting results and accurately classifying sensitizers, potentially underestimating risks associated with airborne exposure. Users of GHS SDSs and labels must be aware of these limitations, particularly concerning inhalation exposure and potential airborne pathways. Further research is needed to improve GHS classification and understanding of the atmospheric behavior of sensitizers.



sciforum-113114: Lanthanum biomonitoring using tree bark: urban vs rural patterns in Leicestershire, the UK

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The presence and distribution of lanthanum (La) in the topsoil and wild edible mushrooms in the English city of Leicester could pose some risks to the population. A biomonitoring study was carried out to determine the air quality for La across the region of Leicestershire. Bark samples (2–6 mm thick) were collected from 55 trees in the city and 41 surrounding rural areas. La was measured using ICP-MS in appropriately mineralised samples [LoD = 0.00068 ng/g dry weight (dw)]. Higher levels were found in the bark collected from the trees growing in Leicester (median and ranges, in ng/g dw)—9.679 (2.128-150.769) vs. 8.344 (1.815-59.801)—a distribution consistent with the trend found in the topsoils and which could be attributed to its technological use and traffic volumes. The La content varied between the bark samples collected in the three cardinal sub-areas into which Leicestershire was divided (medians, ng/g dw): 29.772 (NW) > 7.855 (NE) > 2.027 (SE). However, this pattern was different to the distribution of La in the topsoil samples monitored across Leicestershire, which showed statistical significance (p-value = 0.03997, medians, mg/kg): 25.874 (SE) > 24.290 (NE) > 19.470 (SW) > 13.401 (NW). In general, our results showed lower airborne La contamination in Leicestershire, which is supported by the lower levels of La in the bark from the monitored trees compared to those reported in the literature for trees growing in uncontaminated areas, and low enrichment factors (0.383 and 0.393) in the urban and rural areas, which were calculated using the averages in the Earth's continental crust and the scandium content. Moreover, the enrichment calculated in the topsoils (1.118 and 0.909) also suggests little anthropic influence on the presence/distribution of this metal in the English region studied. Leicestershire's atmosphere represents a minimal risk to the population in terms of La.

sciforum-120609: Occurrence of persistent chemical pollutants, heavy metals, in regions influenced by different human activities by means honey matrix.

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Introduction

The insect's body may potentially absorb pollutants from its surroundings while it is in flight. Furthermore, the sources of bee products, such as pollen, nectar and water, can be exposed to environmental contaminants, which can be transferred to bee products. Because of these characteristics, bees and honey are low-cost tools that are increasingly being used for environmental biomonitoring, which seeks to detect environmental contaminants within a reasonable radius (1.5–3 km) surrounding the hive. Heavy metals, defined as inorganic chemical pollutants, are a class of contaminants that can be found either in nature or as a result of anthropogenic activity. Anthropogenic sources of heavy metals encompass a wide range of activities, including mining, smelting, vehicle emissions, and the production of cosmetics. These pollutants are of particular concern due to their ability to generate reactive oxygen species (ROS) and disrupt vital bodily functions. This study investigates heavy metals in honey to verify the safety of the honey and evaluate environmental pollution in specific areas, highlighting the interconnectedness of honey and the environment.

Methods

Honey samples, collected from six hives located in the Molise Region of Italy, were mineralised and then analysed with ICP-AES, in accordance with the EPA method 6010C.

Results

The most common metals are aluminium, selenium and antimony. Cobalt, nickel, and cadmium exhibit the highest levels of variability, with standard deviations of 253.3%, 207.2% and 82.4%, respectively. Principal component analysis (PCA) and Pearson correlation were usedto ascertain which metals most accurately represent the data sample and how they are associated with each other in order to hypothesise the anthropic pollution sources.

Conclusions

In the atmospheric domain, forest fires and vehicular traffic were identified asthe two main sources of anthropogenic pollution .

sciforum-120613: Pellet Production: Impact of Pollutants and Associated Health Risks

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The current energy crisis, together with the depletion of fossil fuels and climate change, has made it essential to find alternative energy sources that are both economically sustainable and environmentally friendly. Renewable energy resources represent sustainable strategies for reducing the use of fossil fuels. Biomass is used to produce heat, electricity or biofuels through combustion or conversion. Most biomass comes from wood. The introduction of pellets in the bioenergy market aims to reduce environmental emissions, offering an alternative solution to polluting energy sources. In recent years, the trade and use of wood pellets as fuel has increased steadily, making the quality of the pellets essential to limit air pollution. Recent studies show that the use of pellets produces pollutants such as benzene and its derivatives, as well as heavy metals. Inhaling these substances causes an increase in the amount of reactive oxygen species within the body, with potentially harmful effects on human health. The impact of pellet use on air pollution and health was evaluated through the analysis of raw materials, sampled according to the UNI EN ISO 18135:2018 standard. In this study, the analysis of inorganic fractions, carried out with ICP-AES, showed that the most abundant elements are calcium, potassium and magnesium. The analysis of organic fractions, on the other hand, carried out with GC-MS, raised concerns about the presence of formaldehyde, an indication of the use of unsuitable raw materials. Statistical analysis confirmed that the inorganic fraction is fundamental for the quality of the pellets, but also highlighted that the organic fraction should not be neglected. The adoption of UNI EN ISO 17225 has led to an improvement in pellet quality, in particular by increasing its calorific value and reducing emissions into the environment. However, current regulatory gaps require further action to protect the environment and human health.

sciforum-120575: Py-GC-MS for determining Microplastic Release from Take-Away Containers

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Introduction

This research study examines the release of microplastics from containers made of three different polymer types, such as polypropylene (PP), polystyrene (PS), and polyethylene terephthalate (PET).

Methods

Experiments were conducted by simulating three different conditions by which foods could be delivered. Milli-Q water at room temperature, 100 °C, and pH 4.5 were used for the experimental tests. To simulate the transport, containers were exposed for 20 minutes to milli-Q at room temperature, 100 °C Milli-Q water, and slightly acidified water with agitation at 10 rpm. Then, water solutions were filtered using a Whatmann Glass Fiber Filter, with a pore size of 1.6 μm, for microparticle recovery. Microparticles were quantified using optical microscopy. The same experimental conditions were replicated for micro-Raman analyses, using stainless-steel frits (0.2 μm), due to the low background. This approach was used to confirm the polymeric composition of the particles.

Results

The findings reveal that PET and PS containers released microplastics in varying amounts: 9 and 1 particles at room temperature, 7 and 3 in acidic conditions, and 17 and 30 at 100 °C, respectively. The detected particles measured between 13 and 32 μm. Notably, no microplastic release was observed from PP containers under any tested conditions.

Conclusions

These results highlight the significant microplastic release from PET and PS containers. These findings have great environmental implications. The release of microplastics from plastic containers raises concerns not only for direct human ingestion but also for their potential to become airborne contaminants. Microplastics in food may be subjected to evaporation, aerosolization, or mechanics, facilitating their transfer into the air. Given their small size, these particles could be inhaled, contributing to atmospheric microplastic pollution. These findings highlight the need for further research on the airborne dispersal pathways of microplastics from food packaging and their broader environmental and health implications.

sciforum-116574: Urban Green Spaces and Human Health: Assessing the Allergenic Potential

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Urban green spaces play a vital role in enhancing ecological balance, providing recreational opportunities, and supporting public health in cities. However, their allergenic potential presents significant challenges, especially in areas where urban vegetation planning does not account for the impact of allergenic plant species. This study focuses on evaluating the allergenic risks associated with the Moulay Rachid Garden, a key public park in Tetouan, northern Morocco, that is characterised by a Mediterranean climate. By analysing the park's vegetation composition and calculating IUGZA values, the research explores the relationship between urban green space design and allergenic risks. The findings highlight how both native and introduced plant species influence pollen concentrations, with direct implications for public health. This study emphasises the importance of strategic vegetation management to reduce allergenic risks. It advocates for hypoallergenic green space planning as a critical approach to promoting climate resilience, improving public health, and creating more sustainable urban environments. In addition, the results underline the significance of considering allergenic potential in urban planning, particularly in Mediterranean and African contexts, where plant diversity and climate conditions create unique challenges. This research contributes to the growing body of knowledge on urban green spaces and their role in fostering healthier, allergy-aware cities.

Session 3. Biometeorology

sciforum-116113: Trends in Intense Heat and Cold Conditions in Cuba

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Climate change has various negative environmental consequences, such as rising temperatures and the intensification of extreme weather events. These repercussions represent one of the greatest challenges for sustainable development and the population's well-being. Heat/cold waves are among the meteorological events associated with climate change. A trend analysis should be used to assess the change in the behavior of a variable over long periods. Therefore, the objective of this work was to analyze the trends in extreme heat and cold events, expressed through the indicators of Intense Cold Conditions and Intense Heat Conditions, during the period 1981-2023. This study covered the entire country, and 67 meteorological stations belonging to the Institute of Meteorology's network of stations were used. The existence of a trend is determined mainly using the Mann–Kendall statistic (Sneyers, 1975), in the direct and inverse sense, and change points are determined using Pettitt's test. The Spearman's and Wald–Wolfowitz tests were used as alternative tests. The significance level was chosen as 0.05 since the 95th percentile provides a good result in meteorology. In general, the existence of highly significant increasing trends was confirmed in the series corresponding to CCIsv and CCIcv in Cuba. However, this did not occur for CFIsv and CFIcv, for which, although they showed a lower number of cases in recent years in the multiannual analyses, the existence of trends could not be confirmed.

sciforum-112104: And for those outside the center of the Gaussian? An analysis of the needs and potential responses for elderly and disabled people living in the urban system

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Climate change in urban areas is not neutral concerning different social groups and vulnerable people. People such as the elderly or people with disabilities are more exposed in terms of vulnerability than the rest of the population simply because they are less mobile. This is not the only aspect to be taken into account; in fact, the vulnerabilities mentioned above are often linked to situations of chronic illness, low social income, and potential situations of energy poverty, which prevent de facto protection from heat waves, at least in one's own home. The protection of those beyond the limits of the average individual is, therefore, a major social and economic challenge in a system of "advanced countries" in which the demographic pyramid of the young population is shrinking and that of the elderly is growing considerably, which is also thanks to developments in medicine and quality of life. The first results of the European CARMINE project are presented, which, in a specific study area (the metropolitan city of Bologna, Italy), aimed to study the mobility pathways of these frailties to reach potential markets and to identify the NBS that could potentially be used along the highlighted pathways to protect the physiological balance of these sectors of the urban population.

Session 4. Meteorology

sciforum-120670: An analysis of fire dynamics in the state of alagoas and their relationship with meteorological variables

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Studies that address the dynamics of fires in the state of Alagoas and their relationship with meteorological conditions remain scarce, especially ones that use Machine Learning in their methodology. Thus, to analyze the spatiotemporal dynamics of fires in the state of Alagoas and their relationship with meteorological variables, daily data from the VIIRS active fire detection product (on board the S-NPP and NOAA-20 satellites) were used to analyze fires from 2012 to 2023 in the state of Alagoas. The dataset was filtered, including only Fire Radiative Power (FRP) values above zero and considering only detections that were greater than 24 hours. Subsequently, the clustering methodology of Nascimento et al. was used, using the DBSCAN algorithm to identify and group fires. To analyze the behavior of meteorological variables, a range of ERA5 reanalysis variables were used. The results showed significant variability in the climatology of the FRP and Fire Radiative Energy (FRE), where the highest FRP averages occurred in the months of October to March, with the highest records occurring mainly in January (~10 MW/h), February (~9 MW/h), March (~9 MW/h), and December (~9 MW/h). During these months, the climatology of temperature at 2 meters presented the highest records, mainly in the sertão (~37°C). In addition, the climatology of relative humidity varied between 0 and 50% throughout these months in the sertão, coastal, and forest zone regions. The climatology of the FRE presented the highest averages in the months of November (~9000 MJ) and December (~8000 MJ), where the highest records of wind speed were obtained, mainly on the coast and in the forest zone (~6 m/s). The highest concentrations of FRP and FRE and the longest stretch of days of fires occurred on the coast and in the forest zone.

sciforum-114955: An evaluation of the impact of emissions from airports in Egypt.

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Studying the impact of aircraft emissions on the climate and environment is a complex and important issue, especially given the increasing frequency of extreme weather events linked to climate change. In this study, we examine the potential impact of aircraft emissions from four Egyptian airports on their surrounding areas using the Graz Lagrangian dispersion model (GRAL). Furthermore, we investigate how climate change may interact with potential increases in airport capacity in the future. To analyze the dispersion of pollutants emitted by aircraft at the selected airports, we utilized the GRAL model, which incorporates various inputs related to emission sources and meteorological data. The meteorological data for the studied periods (2021, 2025, 2030, and 2035) were derived from the output of the ICTP regional climate model (RegCM4), using the RCP4.5 climate change scenario as input for the dispersion model. The emissions were calculated based on the expected emissions from several aircraft types during 2021, which served as our reference year. We assumed that airport capacity would increase over the coming years until 2035, leading to an expected rise in pollutants emitted by aircraft. Our results indicate that, based on projected rates of emissions for carbon monoxide, sulfur dioxide, and nitrogen oxides, an increase in the capacity of these airports will not result in pollutant concentrations exceeding the maximum limits established by Egyptian Environmental Law, either at the airports or in the surrounding areas.

sciforum-120433: Assessing Future Drought Migration Patterns in China Using an Improved 3D Drought Tracking Approach Under CMIP6 Scenarios

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The evolution of drought events is a dynamic process with spatio-temporal continuity. Analyzing the migration characteristics of drought events from a three-dimensional perspective is significant to objectively identify the nature of droughts and improve our monitoring and projection capabilities. Existing three-dimensional drought identification methods focus on utilizing a simple overlapping logic to characterize the spatial and spatio-temporal continuity of drought patches, which ignores the dynamic of drought evolution. Here, we propose a three-dimensional drought identification method that considers both spatial autocorrelation and anisotropy. Subsequently, the spatio-temporal characteristics and migration patterns of meteorological drought events in China were identified during a historical period (1961-2010) and a future period (2031-2080, SSP2-4.5 and SSP5-8.5) using the ERA5 dataset and the multi-model ensemble mean (MEM) of CMIP6. The results suggest that, in the future, the number of meteorological drought events will decrease by over 70% in comparison with the historical period, but the severity, duration, affected area, and distance will increase significantly. The majority of future meteorological drought events will occur during spring and summer, specifically 96.3% under the SSP2-4.5 scenario and 95.0% under the SSP5-8.5 scenario. Future meteorological drought events will migrate predominantly to the north-east, with 33% (SSP2-4.5) and 38% (SSP5-8.5) being shown to do so. The hotspot area of the migration trajectory of meteorological drought events will shift from the upper Yangtze River Basin to the upper Yellow River Basin. These findings will help us implement drought prevention strategies and allocate water resources.

sciforum-113614: Estimation of irrigated tea evapotranspiration using micrometeorological modeling in data-scarce environment

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Water scarcity has become a critical and concerning global issue due to climate variability and demographic changes. The increasing demand for food and fiber places immense pressure on the agricultural sector to meet the needs of a growing population, which often requires large volumes of water for irrigation in water-limited environments. This leads to significant water loss through evapotranspiration (ET), which is the combined water loss through evaporation and plant transpiration. ET also shows the volume of water that must be replenished in subsequent irrigation schedules. In South Africa, a major challenge in irrigation management is the lack of measured actual evapotranspiration (ETa) data due to the limited availability of measurement devices. To address this, micrometeorological models offer a practical alternative. This study estimated crop evapotranspiration (ETc) using the Priestley–Taylor and Makkink models, validated against the Penman–Monteith standard model. The results revealed that both the Priestley–Taylor and Makkink methods effectively quantified ETc, with the Priestley–Taylor method showing higher accuracy. These findings show that in the absence of direct ETa measurements, ETc can be reliably estimated using meteorological data, enabling precise adjustments to irrigation schedules. This contributes to improved irrigation water management, promoting the conservation of scarce water resources while ensuring irrigation efficiency.

sciforum-109485: Evaluation of an integrated low-cost pyranometer system for application in household installations

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The climatic conditions of a region are a constant object of study, especially in our days as climate change is clearly affecting the way and quality of life, and are studied through meteorological data. Meteorological installations include a set of sensors to monitor the meteorological and climatic conditions of an area. Meteorological data parameters comprise measurements of temperature, humidity, precipitation, wind speed and direction, and instruments include oratometers and pyranometers, etc. Specifically, the pyranometer is a high-cost instrument that has the ability to measure the intensity of sunshine on the surface of the earth, expressing measurements in Watt/m^2. In this research work, both the implementation and the evaluation of an integrated low-cost pyranometer system are presented. The proposed pyranometer device consists of affordable modules: both the microprocessor and sensor. In addition, a central server, as an information system, was created for data collection and visualization. The data from the measuring system is transmitted via a wireless network (Wi-Fi), over the Internet, to an information system (central server), which includes a database for collecting and storing the measurements, and visualization software. The end user can retrieve the information through a webpage.

sciforum-120456: GNSS Meteorology and Machine Learning for Nowcasting: A Two-Step Approach to Precipitation Prediction

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Global Navigation Satellite System (GNSS) Meteorology has emerged as a valuable tool for atmospheric monitoring, providing high-resolution, near-real-time data that can significantly enhance nowcasting applications. By analyzing GNSS signal delays caused by atmospheric water vapor, it is possible to retrieve accurate estimates of Precipitable Water Vapor (PWV), a crucial parameter in short-term weather forecasting. This study presents a novel two-step machine learning framework for precipitation nowcasting, integrating GNSS-derived PWV with meteorological observations.

In the first step, a Random Forest (RF) model estimates precipitation based on GNSS-derived PWV, surface weather parameters, and auxiliary atmospheric variables. In the second step, a Long Short-Term Memory (LSTM) network predicts precipitation for the next hour, leveraging temporal dependencies within the data to improve forecasting accuracy. This hybrid approach combines the ability of RF to capture nonlinear relationships with the strength of LSTM in modeling sequential patterns.

The proposed methodology demonstrates interesting performance as compared to traditional forecasting models, particularly for extreme weather events such as intense rainfall and thunderstorms. The integration of GNSS meteorology with advanced machine learning techniques enhances short-term precipitation forecasting, offering a reliable tool for meteorological services, disaster prevention agencies, and early warning systems. This study highlights the potential of GNSS-based nowcasting for real-time decision-making in weather-related risk management.

sciforum-116454: Influence of Quasi Biennial Oscillation(QBO) on tropical cyclones in North Indian Ocean from 1979 to 2017

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This study investigates the occurrence of tropical cyclones in the North Indian Ocean region, examining the influence of solar activity on the Quasi-Biennial Oscillation (QBO) and El Niño-Southern Oscillation (ENSO). The primary objective is to assess the impact of QBO and ENSO on tropical cyclone formation. The equatorial QBO anomaly is analyzed across pressure levels ranging from 10 hPa to 70 hPa, with a particular focus on 30 hPa, using data from the Freie Universität Berlin. To establish a correlation, a normalized occurrence rate of tropical cyclones was derived following the methodologies of Sonnemann and Grygalashvyly (2007) and Ekaterina Vorobeva (2019).

Between 1979 and 2017, a total of 389 tropical cyclones formed in the North Indian Ocean, specifically in the Bay of Bengal and the Arabian Sea. This study primarily examines cyclonic activity during the pre-monsoon (May–August) and post-monsoon (October–December) seasons, utilizing data from the India Meteorological Department (IMD). The results indicate that tropical cyclones predominantly occur during the easterly QBO phase, with 24 out of 39 years exhibiting easterly winds and 15 years experiencing westerly winds.

Statistical analyses, including regression analysis, correlation coefficients, and tests of statistical significance, reveal a strong positive correlation between QBO and tropical cyclone activity. Specifically, a correlation coefficient of 0.7 suggests a significant association between QBO variations and cyclone occurrence in this region.

sciforum-116050: Insights into lightning activity in Cuba using GOES-16 GLM observations

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Lightning is a natural hazard that significantly impacts human safety, infrastructures, and ecosystems. In recent decades, it has been monitored as a key indicator of severe weather and to understand climate change. This work examines the behaviour of lightning in Cuba from 2018 to 2022 using the Geostationary Lightning Mapper (GLM) onboard the Geostationary Operational Environmental Satellite 16 (GOES-16). We focused the analysis on the annual trends and spatial distribution of the keraunic level, i.e., the number of thunderstorm days and the total and cloud-to-ground lightning flash density. Our results showed a GLM efficiency of ~60-70% for detecting thunderstorms, which is aligned with previous studies using surface weather station data. In addition, we obtained an equation to determine the relationship between the number of thunderstorm days and the cloud-to-ground lightning flash density per year over an area of 1 km^2. Overall, this research resulted in the first keraunic level map developed for Cuba, using geostationary satellite data, and it provided the first maps of the total and cloud-to-ground lightning flash density. Although the keraunic level values were underestimated compared with reports from weather stations, they captured the characteristic climatic behaviour of thunderstorms in the study area. In summary, our findings demonstrate the feasibility of using GLM data to study thunderstorms and lightning activity in Cuba.

sciforum-119563: On the Architecture of a Meteorological Station based on the Internet of Things (IoT)

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The state of Zacatecas, Mexico, has a territorial extension of 75,275.3 km^2 and is located in the center-north of the country. The climate of Zacatecas is classified as arid and semi-arid. However, in recent decades, the climate in the region has changed, making it necessary to observe, predict, and determine which renewable energy source would be ideal for supporting the metereological sector, depending on the region. Agriculture and livestock farming are also affected. For this reason, the description of a portable prototype that is designed, developed, and implemented to measure meteorological variables and obtain indirect variables is presented. A microcontroller from the Arduino family was used for this purpose. The variables of temperature, humidity, and atmospheric pressure were measured. The variables of the UV index, thermal sensation, dew point, altitude above sea level, and air density were measured indirectly. An interface was created to check the data in real time via the Internet. The information can be checked from a cell phone, an electronic tablet, or a computer using a program developed in the HTML language. The information can also stored on a micro-SD memory device. The first results were collected over 45 days. The sampling of the data that were read by the system took 10 seconds. The data were compared with those obtained from a commercial meteorological station, which produced similar results. The design of the meteorological station will be further improved by adding new measurement variables and setting up a series of portable stations in different regions of the state.

sciforum-119966: Severe Wind Shear at Soekarno–Hatta International Airport: The Role of Sea Breeze Front and Meteorological Factors

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Wind shear presents a significant hazard to aviation, particularly during critical flight phases such as takeoff and landing. On 12 February 2025, six aircraft at Soekarno–Hatta International Airport conducted go-arounds due to wind shear events between 07:35 UTC and 08:37 UTC. This study employs meteorological observations (AWOS and METAR), remote sensing data (Doppler radar and wind profiler), and pilot reports (PIREPs) to investigate the underlying meteorological mechanisms and assess the effectiveness of issued warnings.

Doppler radar detected a Sea Breeze Front (SBF) moving inland, which created sharp thermal and pressure gradients, further intensifying wind shear along the final approach path. Wind profiler data revealed substantial vertical wind variations of up to 3,000 m, while surface observations recorded gusts reaching 28 knots, indicating significant near-surface turbulence. METAR reports issued "WS ALL RWY" (wind shear affecting all runways) warnings at 07:30 UTC and 08:00 UTC, coinciding with pilot-reported wind shear encounters. Additionally, Wind Shear Warnings and an Aerodrome Warning for strong winds were disseminated via the Aeronautical Message Handling System (AMHS) and other communication channels, ensuring timely and effective communication with relevant stakeholders. This proactive approach enabled air traffic controllers and flight crews to implement risk mitigation measures, minimizing operational disruptions.

These findings offer crucial insights into the operational impacts of wind shear and underscore the need for continuous advancements in meteorological support for aviation. Strengthening early warning systems and fostering interdisciplinary collaboration between meteorologists, air traffic controllers, and pilots are essential for enhancing aviation safety, particularly in tropical regions prone to localized wind shear phenomena.

sciforum-120632: The Climatology and synoptic conditions of the driest and warmest months in Northeast Brazil

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This study examines the climatology and synoptic patterns during the warmest and driest months in Northeast Brazil (NEB) using 120 years of monthly reanalysis data. The warmest months were detected based on the 90th (10% warmest) percentile of the maximum, minimum, and mean near-surface temperature from the Climate Research Unit (CRU), while the driest months were identified based on the SPEI-1 index from the Consejo Superior de Investigaciones Científicas (CISC). Both datasets have a spatial resolution of 0.5° x 0.5° and cover the period from 1901 to 2021. A total of 141 simultaneous drought and high-temperature events were detected, spanning 314 months (about 22% of the period), with 89% occurring between Austral spring and summer (August–March). The spatial extent of the events showed a seasonal shift, starting in the western sector of NEB between August and October and progressing eastward between November and April. The average event duration was 2.2 months, with the longest and strongest event lasting 9 months (June 2016–February 2017). The mean (maximum) spatial extent covered about 6% (11%) of NEB's territory, peaking at 47% (68%) during the second strongest event (August–December 2015). The mean (maximum) temperature and SPEI values during the events were 34.66°C (38.10°C) and -1.98 (-2.85), respectively. A Mann–Kendall test (95% confidence) revealed increasing (or decreasing) trends in all temperature and spatial variables (SPEI), suggesting an intensification of events over time. A synoptic analysis of the 10 strongest events based on the fifth-generation ECMWF atmospheric reanalysis (ERA5) suggested atmospheric blocking over the Atlântic and anomalous positioning of Upper Tropospheric Cyclonic Vortices (UTCVs) over NEB's central and western sectors to be the main contributors to these events. It is believed that long-lasting UTCVs contribute to surface heating and precipitation reduction due to the subsidence of cold air in their center.

sciforum-115997: Unveiling Mechanisms Behind Typhoon Track Sensitivity and Predictability over Different Topographies: A Dynamic Modeling Perspective

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This study investigates the intricate dynamics of typhoon-like vortex track deflections over complex terrain, explicitly focusing on Taiwan Island. We develop a novel dynamic model based on the conservation of potential vorticity (PV) that incorporates a topographic adjusting parameter (α) and a meridional adjusting velocity (MAV) to capture the vortex's response to terrain variations. We elucidate the fundamental mechanisms driving track sensitivity and predictability using idealized simulations and real-case scenarios that use Taiwan's topography. Our results show that steeper terrain gradients consistently deflect tracks, with this topographic steering effect amplified for stronger vortices due to their more significant α value, leading to an enhanced MAV and more pronounced deflections. Shallower impinging angles, resulting in prolonged interactions with steep terrain, further enhance these deflections. We identify distinct Track Diverging Zones (TDZs) and Track Converging Zones (TCZs) associated with Taiwan's Central Mountain Range (CMR), highlighting the significant impact of the initial position of a vortex and terrain resolution on forecast reliability. The model successfully captures the key features of vortex–topography interactions, providing a physical basis for understanding the observed variability in typhoon tracks near Taiwan. This work demonstrates the practical value of a dynamic modeling perspective and PV analysis in improving typhoon track forecasting and risk assessments in regions with complex topography. It suggests that future research should focus on refining numerical models.

Session 5. Atmospheric Techniques, Instruments and Modeling

sciforum-116531: Advances in Remote Sensing and Machine Learning Techniques for Air Quality Monitoring

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Various techniques are used to assess air quality. Basic parameters such as particulate matter (PM) and certain gases can be easily obtained from local meteorological stations. However, for more detailed data, such as heavy metal concentrations, researchers must collect and analyze samples in laboratories. Due to natural limitations, regulatory monitoring is often restricted in both spatial and temporal coverage.

Satellite imagery provides a valuable source of atmospheric and surface data. Each year, new missions with advanced sensors enhance remote sensing capabilities. Modern instruments like Sentinel-5 offer near-ready air quality data, including information on gases and aerosols. However, the Sentinel-5's orbital cycle and resolution remain limited. Meanwhile, widely used public satellite missions such as Landsat, MODIS, and Sentinel provide high-resolution data with frequent updates. Integrating in situ measurements with satellite data and machine learning techniques enhances air quality monitoring. Modeling helps fill gaps in in situ data, provides detailed assessments of specific areas, and enables a partial automation of environmental control processes.

This report reviews widely used satellite-based programs, tools for efficient data processing, and machine learning approaches for air quality estimation. It highlights the effectiveness and advantages of ML-driven remote sensing for air quality monitoring. Additionally, we discuss commercial satellite missions, firsthand experiences, and future directions for advancing air quality monitoring technologies.

sciforum-114923: An analysis of the association between polycyclic aromatic hydrocarbon pollution and environmental factors in the urban atmosphere

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Polycyclic aromatic hydrocarbons (PAHs) are key atmospheric pollutants with significant carcinogenic potential that pose serious environmental and public health challenges due to their wide distribution and complex sources. In the atmosphere, PAHs exist in both gas and particle phases, with their concentrations and distributions influenced by atmospheric pollutants and meteorological conditions. This study systematically analyzed urban atmospheric PAHs using high-resolution spatiotemporal sampling data obtained from long-term monitoring. By integrating major atmospheric pollutants and meteorological parameters, spatiotemporal variations, potential sources, and complex environmental interactions of PAHs were comprehensively explored. Advanced machine learning algorithms and statistical methods were employed to identify the key factors driving PAH concentration changes and to reveal nonlinear associations with meteorological conditions and pollution sources. The results indicated significant seasonal and spatial variations in PAH concentrations, highlighting the influence of specific meteorological factors such as temperature, wind speed, and atmospheric pressure. Furthermore, the optimization of clustering and association rule mining algorithms allowed for more precise identification of emission sources and their interactions with environmental variables. These findings provide a novel perspective on the dynamic behavior of PAHs and contribute to a comprehensive understanding of their spatiotemporal distribution, sources, and environmental interactions. This study offers valuable insights for developing effective pollution control strategies, optimizing urban air quality management, and mitigating public health risks associated with PAHs exposure.

sciforum-120655: Applying remote sensing techniques to investigate the trajectory of smoke plumes during biomass burning events

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The wildfires in Brazil in 2024 reached unprecedented levels, serving as yet another indicator of the effects of climate change. LIDAR measurements conducted in São Paulo detected intense aerosol plumes generated during the wildfire period in August and September in the Mato Grosso do Sul and Pará regions. This study investigates the potential transport of aerosol plumes generated by these wildfires to São Paulo. To analyze the relationship between these plumes and wildfires in other regions of Brazil, data from the recently launched EarthCARE satellite, backward trajectory analysis using the HYSPLIT model, and AERONET sun photometers and Raman–LIDAR measurements were utilized. As part of the EarthCARE satellite calibration and validation process, this study compared three days of LIDAR data collected for São Paulo. After validating the backscatter and extinction coefficients and the LIDAR ratio, the HYSPLIT model was used to determine the potential trajectories of the aerosol plumes on the days with the highest heat source index. Once the source locations were identified, their correlation with wildfire-affected areas was examined. Sun photometer data were analyzed to infer the properties of the aerosol plumes. The results indicated three trajectories that coincided with fire hotspots, enabling the identification of wildfires in the city of Corumbá (Mato Grosso do Sul) and São Félix do Xingu (Pará) as the likely primary sources of the aerosol plumes observed in São Paulo.

sciforum-116604: Coupling Between Urban Sublayers: High-Resolution LES Modeling of Microclimate and Energy Dynamics in Bolognina

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The rapid growth of the global urban population in recent years emphasises the need to understand urban environments in order to build sustainable, resilient cities and enhance residents' quality of life. Despite its significance, the urban microclimate remains one of the most complex and least understood phenomena, largely due to the heterogeneity of urban environments. The physical structure of cities alters the exchange of momentum, energy, and pollutants between the surface and the atmosphere, creating an urban surface layer where classical turbulence laws no longer apply.

This study uses LES (PALM-4U) simulations to analyse key micrometeorological parameters with high spatio-temporal resolution in the Bolognina district of Bologna. The area is a typical example of Italian urbanisation. PALM-4U is coupled with the GLOBO-BOLAM-MOLOCH system. The MOLOCH model, developed specifically for Italy, provides more accurate mesoscale predictions than models like COSMO and WRF, which is crucial for LES simulations. Data from remote sensing, municipal datasets, and a census of over 5,000 trees within a 1 km^2 area were used as static drivers for the Bolognina study.

The case study spans three days, from 23 to 25 August 2023, characterized by clear skies, intense daytime solar radiation, and light winds—optimal conditions for turbulent flow detachment from the surface and the development of the UHI effect.

The study aims to investigate i) the role played by the type of pavement and urban vegetation in mitigating or amplifying the UHI effect and influencing thermal comfort; ii) how different pavements and vegetation affect the micrometeorological processes in the roughness sublayer (RSL), thereby influencing the flow in the inertial sublayer (ISL); and iii) the intensity of the coupling between the RSL and ISL and how it modifies the closure of the energy balance in the urban boundary layer.

sciforum-116162: Effect of The Form of The Error Correlation Functions on The Uncertainty in The Estimation of Atmospheric Aerosol Distribution When Using Spatial–Temporal Optimal Interpolation

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A common approach to estimate the spatial–temporal distribution of atmospheric species properties is data assimilation. This comprises methods to combine information from different sources for obtaining the best estimate of a system state. Data assimilation is based on minimizing the error in the estimate (optimal interpolation and Kalman filtering methods) or on minimizing the cost function (variational methods). Under certain conditions, variational methods turn out to be equivalent to optimal interpolation or Kalman filtering. All data assimilation techniques require an understanding of data error statistics. Optimal interpolation is a relatively simple and computationally cheap non-sequential method. In the optimal interpolation method, error correlations can be modeled with analytical functions on the base of the gathered data. In the present work, we investigate the effect of the form of the error correlation functions on the uncertainty in the estimate when using the spatial–temporal optimal interpolation (STOI) technique. We apply STOI to the estimation of aerosol distribution over Europe. To perform STOI, we use results of the chemical transport model GEOS-Chem simulations, as well as observations from a ground-based radiometric network AERONET that provides data on aerosol properties with low uncertainty. We show that the results of the STOI estimation are very tentative to the form of the error correlation functions. We perform some tuning of the correlation function parameters to improve the accuracy of the estimation.

sciforum-116536: Evaluation of the changes in climate and atmospheric composition in the Russian Arctic according to offline-coupled ESM SOCOL and WRF-Chem

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Significant climatic changes have been observed in the Arctic over the past few decades. The ongoing increase in the Earth's surface temperature has accelerated permafrost melting and contributed to a rise in the number of wildfires. In addition, state programs aimed at reducing anthropogenic emissions of certain pollutants (e.g., NOx, SO2, CO, etc.) in the future could lead to an increase in ozone (O_3), one of the most harmful atmospheric pollutants. In the future, these and other consequences of climate change in the Arctic could become more dramatic. Therefore, assessments of changes in the climate and atmospheric composition over the next 100 years on a regional scale (~1000 km) are of great importance today. The assessment results could indicate which regions of the Earth will be most affected by future climate change and anthropogenic activity.

One of the most promising approaches for such evaluations is model downscaling, which uses the simulation results of Earth System Models (ESMs) as boundary conditions in regional-scale models. This approach takes into account both global factors of ESMs (e.g., distant pollutant transport) and local factors of regional-scale modelling (such as complex landscapes and anthropogenic activity). In the current study, the model system, which consists of the SOCOLv4 ESM and the regional tropospheric composition model WRF-Chem, is used to evaluate changes in the climate and atmospheric composition in the Russian Arctic over the next ~100 years.

The authors acknowledge Saint-Petersburg State University for research project 116234986.

sciforum-116656: Insights into Air Quality Index (AQI) variability with Explainable Machine Learning techniques

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Air pollution is a global environmental and health issue and is also strongly interlinked with the issue of climate change. A thorough understanding of the complex nonlinear phenomena that govern the spatiotemporal variability of air pollution is still lacking, although this knowledge is essential for defining effective strategies to safeguard public health and environmental sustainability, and to counteract climate change.

In recent decades, machine learning models (MLMs) have shown great potential in the air pollution research sector due to their capability in describing complex non-linear phenomena. Moreover, thanks to interpretability methods developed in the fields of the Explainable Artificial Intelligence (XAI), MLM results can be interpreted for assessing the impact of individual factors and their interrelationships on the model output, also providing visual representations which can facilitate the comprehension of such complex phenomena.

In this study, the XGBoost algorithm and SHAP (SHapley Additive exPlanations) method have been employed to explore the influence of several driving factors, namely air pollutants (including surface ozone (O_3) and fine particulate matter ($PM_{2.5}$)) and meteorological parameters, on air quality index (AQI) variability.

Based on the air pollutant and meteorological data, acquired at different typologies of air quality monitoring stations over the 2018-2022 period, an XGBoost MLM has been developed to simulate the AQI temporal pattern, obtaining good model performance. Subsequently, the SHAP method has been employed to explore the importance of each driving factor and the relationship with the model output. Special focus is given to the interaction effect among driving factors on AQI.

sciforum-116285: Modeling the Role of Urban Green Spaces in Cooling Urban Environments: The Case of Villa Ada, Rome

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Cities worldwide are facing the dual challenges of urban heat islands (UHIs) and the increasing frequency of heatwaves. Concrete and asphalt, combined with reduced vegetation, cause urban areas to retain more heat than their rural counterparts. This not only leads to discomfort but also poses significant health risks, including heat-related illnesses and increased mortality rates. Urban green spaces, such as parks, play a crucial role in mitigating UHI effects through shading and evapotranspiration, which help cool urban environments.

This study focuses on Villa Ada, a 160-hectare park in central Rome, characterized by relatively unmanaged vegetation. We aim to assess its effectiveness in reducing local UHI effects during a heatwave from October 8 to 10, 2023. Using the Parallelized Large-Eddy Simulation Model (PALM), we simulate three urban greenery scenarios: (1) replacement of the park with asphalt, (2) replacement of the park with short grass, and (3) replacement of short grass areas with trees featuring high leaf area density, representing the most adaptive scenario.

The preliminary results suggest that Villa Ada exerts a cooling effect on its immediate surroundings, with increased tree coverage leading to more substantial temperature reductions. These findings underscore the critical role of urban green spaces in mitigating UHI effects and highlight the importance of strategic urban planning that preserves and enhances such areas. Future research should explore the long-term impacts of different vegetation management strategies and their implications for urban climate resilience.

sciforum-119160: Numerical Weather Prediction Models Using Atmospheric and Weather Parameters to Enhance Accurate Weather Forecasting and Risk and Hazard Mitigation

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Numerical Weather Prediction (NWP) models are essential tools for forecasting atmospheric weather conditions and mitigating weather-related hazards. This research investigates the integration of certain atmospheric and weather parameters (rainfall, temperature, relative humidity, cloud cover, geomagnetic storms, and solar radiation) into NWP models to enhance the forecasting accuracy to a high degree. This research evaluates different NWP approaches, including deterministic and ensemble models, focusing on the parameterization schemes and data assimilation techniques. The NWP model was selected due to its flexibility in regional forecasting. Simulations were conducted using different parameterization schemes to ascertain the impact of geomagnetic and solar influences on weather conditions. This research employed data assimilation techniques, including 4D-Var, to integrate real-time observations into the model. The results demonstrate forecast reliability that was improved by a reasonable percentage by the addition of solar and geomagnetic influences, contributing to improved disaster preparedness and climate risk management and control. A stronger correlation (R = 0.85) between the modeled and observed cloud cover was obtained when both solar and geomagnetic influences were incorporated. The outcomes of this research are expected to offer valuable insights for improving weather forecasting accuracy, strengthening early warning systems, and enhancing preparedness for potential weather-related disasters, thereby providing more robust and effective risk and hazard management strategies. This study underscores the role of comprehensive atmospheric modeling techniques in strengthening early warning systems and reducing the uncertainties in weather forecasts.

sciforum-116670: Photochemical Processes of Tropospheric Ozone Formation: The Role of NOx and Methane in Atmospheric Chemistry

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Growing urbanization and industrialization heighten air pollution concerns. Tropospheric ozone, a challenging pollutant, draws scientific attention. Nitrogen oxides (NOx) and methane (CH4) are key, influencing ozone dynamics. Methane and NOx are primary precursors in tropospheric ozone's complex formation. Elevated methane can substantially increase ozone, while excess NOx triggers self-regulation. Atmospheric reactions, including ozone destruction, illustrate this complexity, where NO reacts with O3.

Research on long-term NOx and methane emissions is crucial for understanding climate change. Analyzing scenarios fixing 2010 NOx levels while varying methane to 2100 offers insights into climate consequences. Elevated ozone has adverse effects: deteriorating air quality, respiratory issues, vegetation damage, and an enhanced greenhouse effect.

Advanced atmospheric chemistry modeling and data analysis are employed in this research. Global climate models like SOCOL-v3 simulate atmospheric processes and chemical reactions involving NOx and methane. These models, incorporating meteorological data, emissions inventories, and chemical reaction mechanisms, predict tropospheric ozone formation accurately. They enable the analysis of complex atmospheric interactions and forecast future air quality scenarios under varying emission conditions

Integrated chemical climate modeling, scenario analysis, and synergistic pollutant effects are crucial in current research. Understanding these interactions is vital for effective air quality management. Continued growth in pollutant concentrations underscores the need for emission control measures. This research's practical applications include enhancing air quality monitoring, developing pollution reduction strategies, forecasting atmospheric changes, and shaping environmental policies. Future studies should focus on detailed interactions between atmospheric components and innovative air quality control approaches. International cooperation is essential for effective tropospheric ozone management.

Funding: Russian Science Foundation project under the contract No.23-77-30008.

sciforum-116584: Study of spatial and temporal variability of tropospheric ozone over Russia

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Tropospheric ozone is a greenhouse gas and a reactive and toxic pollutant detrimental to human health and ecosystem productivity. Therefore, the study of tropospheric ozone column (TrOC) variability by means of measurements and modeling is an essential task.

The IKFS-2 spectrometer aboard the Meteor-M N2 satellite measured outgoing thermal radiation in the 5-15 μm spectral range with an un-apodised spectral resolution of 0.4 cm^{-1} in 2015-2022. A retrieval technique based on the artificial neural network (ANN) algorithm and the method of principal components has been developed for interpreting the IKFS-2 spectral measurements. For the ANN training, we used TrOCs derived from ozonesonde measurements at different ground-based sites taken from the archive created by the TOAR-II HEGIFTOM working group, thus solving the problem of calibration of the IKFS-2 TrOC data product. The uncertainty estimated for IKFS-2 TrOC measurements equals ~3 DU (~12-15 %). The IKFS-2 TrOC data product has been validated by comparison with independent TrOC measurements at the NDACC IRWG and with IASI satellite measurements.

The spatiotemporal variability of TrOC over Russia was studied based on IKFS-2 and IASI satellite measurements, as well as the WRF-Chem numerical modeling and EAC4 reanalysis data. The seasonal variability in TrOCs was estimated, and the observed anomalous values in TrOC distribution were analyzed. It was revealed that over most of the territory of Russia, except for certain regions of Siberia and the Far East (Kamchatka region), a decrease in TrOC was observed over the 2016-2022 period.

This research was supported by SPbU grant No. 116234986.

sciforum-113956: Testing a technique for retrieving the rain drop size distribution moments from X-Band polarimetric radar data during a warm rain event

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A method for retrieving the moments of rain drop size distributions (DSDs) from X-band polarimetric radars is tested using data from a warm rain event which occurred near Incheon, Republic of Korea. The method involves the use of attenuation-corrected radar reflectivity for horizontal polarization, attenuation-corrected differential reflectivity, and specific attenuation for horizontal polarization. The method had been previously tested for an event in Greeley, Colorado, USA, and had resulted in very encouraging results. In this paper, we apply the same method to an isolated warm rain cell which occurred during the summer season of 2020 in Incheon. The height profiles of the retrieved moments were examined. We showed that the application of our retrieval method results in very plausible results in terms of the dominant microphysical processes associated with warm rain events. We also included a convergence region where the drop break-up process is clearly highlighted as being the dominant process. With such encouraging results, our future plan will be to increase the accuracy of the retrieval method by reducing the parameterization errors, for example, by using finely tuned shape parameters to represent the underlying function of the DSDs for warm rain events. The tuning will entail accurate measurements of the full DSD spectra in Incheon.

sciforum-115902: The role of space weather in ozone depletion

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Space weather is a set of phenomena in the chain of solar–terrestrial connections observed at a certain point in time at a particular point in space. Usually, space weather connects processes occurring in the ionosphere and atmosphere of the Earth with processes on the Sun and near-Earth space.

Ozone plays a key role in the chain of solar–terrestrial connections and affects climate change, both local and global. Ozone is a gas that determines the temperature and circulation regime of the middle atmosphere, as well as effectively absorbing solar ultraviolet radiation, thereby protecting all living things from dangerous radiation. It is well known that the precipitation of energetic particles leads to the ionization of the Earth's atmosphere, initiating the formation of active chemical compounds that destroy ozone and can affect the composition and dynamics of the atmosphere down to the troposphere.

Here, we evaluate the vulnerability of the ozone layer to space weather processes. Seasonal and latitudinal effects of ozone depletion associated with strong geomagnetic storms and geoeffective solar events are considered separately. We investigate enhancements of mesospheric volume mixing ratios of HO2 and nitric acid HNO3 as well as ozone depletion in the Northern Hemisphere (NH) polar night regions during energetic particle precipitation. We utilize mesospheric observations of HO2, HNO3 and ozone from the Microwave Limb Sounder (MLS/Aura). The analysis of observations made with the MLS/Aura shows that the highest volume mixing ratios of HO2 and HNO3 and also the deepest ozone destruction are observed at a latitudinal range from 60NH to 80NH inside the north polar vortex right after the maximum flux of energetic particle precipitation. .

The work was supported by Saint Petersburg State University under research grant 116234986.

Session 6. Climatology

sciforum-120677: A Spatiotemporal Analysis of the Occurrence of Fires in the Caatinga Biome: A Climatological Approach Using Machine Learning

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The Caatinga is a semi-arid forest biome with a climate that is marked by severe droughts and recurrent fires, resulting in a loss of biodiversity. This research uses daily data from the VIIRS active fire detection product (onboard the S-NPP and NOAA-20 satellites) to analyze fires from 2012 to 2023 in the Caatinga Biome, where the data set was filtered, including only Fire Radiative Power (FRP) values above zero and considering only detections that were longer than 24 hours. The clustering methodology of Nascimento et al. was then applied, using the DBSCAN algorithm to identify and group the fires. The latitude, longitude, and time coordinates were transformed into a common Cartesian space, allowing for the identification of patterns in the distribution of fires, in which unique identifiers, called “fire_id”, were used to identify the frequency, duration, and intensity of these fires. The climatology of the FRP and Fire Radiative Energy (FRE) data showed significant variability, especially from July onwards, where the highest climatological averages of the FRP occurred in November (~17 MW/h) and October (~16 MW/h), respectively. The highest climatological averages of the RES occurred in August (300.000 MJ) and September (200.000 MJ), respectively. The annual distribution showed FRP peaks throughout all years, with a significant increase in 2021 (~1500 MW/h), but the highest frequency of fire_id markers was recorded in October 2023 (7455). In addition, the highest fire_id frequencies occurred mainly in the months of September to November. A kernel density analysis, which mapped the spatial distribution of the FRP density, showed that the states of Bahia and Piauí had the highest FRP intensities, indicating a significant concentration of fires in these regions. These results contribute to the development of prevention and mitigation strategies, both in the short and long term.

sciforum-105972: Significance of summertime heat-low over northern Indian Subcontinent in the changing climate

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The Indian heat-low, a strong atmospheric circulation pattern marked by low pressure and high temperatures, significantly impacts weather patterns over Pakistan and northern India. Understanding how terrestrial heating patterns vary over time is critical to climate change. Such changes can profoundly impact large-scale systems such as the heat-low and monsoon. The evolving characteristics of the heat-low area over the Indian subcontinent from 1950 to 2020 are investigated using a decadal analysis of reanalysis data (ERA5). The data show that the heat-low trend shifted eastward over this period. Furthermore, as part of the CMIP5 RCP8.5 ensemble, the CMCC-CMS model predicts a further eastward shift of this circulation pattern between 2050 and 2100. The heat-low pattern's eastward movement substantially impacts the monsoon circulation system, potentially resulting in large adjustments in rainfall patterns across the Indian subcontinent. The results of both the ERA5 and CMCC-CMS models support the idea of an eastward shift in rainfall, demonstrating the possibility of altered precipitation distribution in the future. Furthermore, this study emphasizes the possible drying of the western Indian subcontinent, including Pakistan and western India, because of the altering heat-low trend. These findings highlight the necessity of considering changing atmospheric circulation patterns in climate change assessments and the need for a better understanding of the associated implications for regional climate dynamics.

sciforum-120416: Advancements and Challenges in Climate Modeling: From Conventional GCMs to Artificial-Intelligence-Driven Predictions

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The field of climate modeling is undergoing a significant transformation, moving away from the traditional General Circulation Models (GCMs) and toward the use of sophisticated artificial intelligence (AI)-based prediction systems. Research has shown that artificial intelligence (AI) has the potential to improve climate modeling's regional accuracy and computing efficiency. Nevertheless, these investigations have frequently functioned in discrete settings and oversimplified situations without a thorough connection with basic physical concepts. This drawback emphasizes the necessity of a more comprehensive strategy that can handle the intricacies of climatic variability and guarantee reliable model validation. In order to assess the possibilities and challenges of hybrid models in comparison to conventional GCMs, this study synthesizes proven climate models, AI methodologies, and their accuracy in climate predictions and analyzes existing climate models to evaluate the potential and limitations of hybrid models compared to traditional GCMs. Integrated AI-driven models show notable improvements in predicting regional variations in climate and accelerating simulation processes, especially when dealing with the growing presence of extreme weather occurrences. However, it is important to have consistent datasets and open evaluation procedures in order to guarantee accuracy and deal with the difficulties that come with model benchmarking. This research highlights how crucial it is to maintain interdisciplinary cooperation in order to properly utilize what artificial intelligence (AI) has to offer in climate modeling. This partnership is essential to creating more accurate and useful climate projections, which will eventually guide successful mitigation and adaptation plans for a changing global environment. In order to have a greater understanding of our climate's future, we must keep pushing the limits of the existing modeling tools.

sciforum-120525: Assessment of Climate Variability and Trends in Water Availability in South America

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This study examines the climatic water availability, defined as precipitation minus potential evapotranspiration (PET), in continental South America during historical (1960–2014) and future (2015–2100) periods. Observed (CRU TS, ERA5) and modeled (CMIP6) data were used, with future projections under the SSP2-4.5 and SSP5-8.5 scenarios derived from an ensemble of five models best representing the continent. To improve the drought analysis, the SNIPE (Standardized Nonparametric Indices of Precipitation and Evaporation) methodology was applied. This method aggregates the data over multiple time scales (1, 3, 6, and 12 months) and uses nonparametric rescaling to produce standardized indices (zero mean, unit variance). Unlike the SPI and SPEI indices, which rely on parametric assumptions that may bias the results if the data deviate from the assumed distributions, SNIPE uses a distribution-free approach, making it a robust tool for drought assessment. Historical data from both the observed and modeled sources show similar water availability patterns: drought in Patagonia, the Atacama, the Central Andes, and the Brazilian northeast and high availability in the Amazon and southeast Brazil. Future projections indicate an expansion and intensification of drought, mainly affecting transition zones such as the Brazilian Cerrado, the edges of the Amazon, the Chaco, and the semiarid areas of the Brazilian northeast, with more pronounced changes under SSP5-8.5. Correlation analyses between SNIPE and various climate indices (AMO, ONI, PDO, SAM, TNA, TSA, and TPI-IPO) reveal that indices such as TPI-IPO, ONI, and TSA play key roles in the water regime dynamics in southeastern South America (including the areas of southern/southeastern Brazil, Paraguay, Uruguay, and northeastern Argentina), a region frequently impacted by floods. These findings underscore SNIPE's potential to enhance forecasting systems and water resource management strategies.

sciforum-120523: Future Projections (2015-2100) of Daily Temperature Range (DTR) in South America: Multiregional Analysis Based on CMIP6 Models

Daniel Milano Costa de Lima [1,*], Helber Barros Gomes [1,2,3,4,5], Maria Cristina Lemos da Silva [2,6], Paulo Vítor de Albuquerque Mendes [2] and Katyelle Ferreira da Silva Bezerra [2]

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This study investigates future projections of the DTR over the South American area using CMIP6 modeled data on the maximum (Tmax) and minimum (Tmin) temperatures under two socioeconomic scenarios, SSP2-4.5 (low greenhouse gas emissions) and SSP5-8.5 (high emissions). The continental region was divided into 10 subregions, with the boundaries drawn based on their climatic characteristics, and for each one, ensembles of the five best-performing models were generated. This selection of models is based on a comparison of their historical series with an observed reference series obtained from the Climatic Research Unit (CRU)'s time series (TS). The statistical analysis, which used the modified Mann–Kendall test and the Theil–Sen slope estimator, reveals that Tmin and Tmax show an increasing trend over time. However, the increase in Tmin is more pronounced, resulting in a reduction in the DTR in most subregions. For example, it is estimated that in SSP2-4.5, the DTR will decrease by approximately –0.71 °C between the periods 2015–2025 and 2090–2100, while in SSP5-8.5, this reduction could reach approximately –1.04 °C. Some areas, such as the south of northeast Brazil, southeast Brazil, south Brazil, and Uruguay, show opposite patterns, with an increase in the DTR. These results reinforce the influence of anthropogenic factors in modulating the DTR, and the findings provide support for the development of policies to adapt to and mitigate the impacts of climate change on the South America continent.

sciforum-116418: Impact of biogenic emissions on climate and the ozone layer

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We analyze the influence of both biogenic natural emissions and anthropogenic emissions on atmospheric chemistry and climate using the SOCOLv4 Earth climate model. To achieve our objective, we simulated climate behavior from 2015 to 2100 using two IPCC scenarios: SSP2-45 and SSP5-85. Additionally, we created an artificial scenario wherein all biogenic emissions in SSP2-45 were replaced with those from the SSP5-85 scenario. The last scenario helps elucidate the contribution of biogenic emissions to the differences observed between the climates simulated with SSP2-45 and SSP5-85. The model results indicate that the impact of using biogenic emissions from the SSP5-85 scenario instead of those from the SSP2-45 scenario for the calculation of the future climate is significant for the tropospheric ozone, potentially leading to an increase of up to 10% in the troposphere. Regionally, changes in tropospheric ozone can vary, showing positive effects in regions like Australia and South Africa, while resulting in a negative response for Russia. The distribution of the surface temperature response resembles the tropospheric ozone change pattern. We observed significant warming in South America and the high latitudes of the Northern Hemisphere, alongside cooling in parts of Russia. A more detailed description of the local and seasonal features will be presented in this talk. The Saint Petersburg State University supported this work under research grant 116234986.

sciforum-114065: Long-Term Seasonal Investigation of Land Surface Temperature in Cairo

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Cairo is one of the most populous cities in the world. The city's unplanned urbanization has led to significant challenges, including an increase in Land Surface Temperature (LST), which is defined as the skin temperature of the land. LST is crucial for studies on radiative temperature in this densely populated and rapidly developing metropolitan area. The aim of this research is to analyze the seasonal variations in LST using MODIS Aqua satellite data, which offer a spatial resolution of 1 km and a temporal resolution of twice daily over an extended period from 2003 to 2022. This analysis involves calculating longitudinal and latitudinal temperature differences during both day and night to assess LST variations across different seasons, as well as annually, between the central area defined by coordinates (29˚.89´ to 30˚.15´ N and 31˚.17´ to 32˚ E) and the surrounding regions extending from south to north (29˚.69´ to 30˚.35´ N) and from west to east (30˚.65´ to 31˚.75´ E). Additionally, this study examines the daytime and nighttime averages of the spatial and temporal distributions of LST for each season. The results indicate that, compared to daytime measurements, both the city and its suburbs exhibit a closer alignment with the annual average during nighttime across south-to-north and west-to-east charts. During nighttime, temperature differences suggest that central areas experience higher temperatures than surrounding suburbs; however, conditions differ during daytime measurements when temperature differences indicate that central areas have cooler temperatures compared to neighboring suburbs. The warm seasons—summer, autumn, and spring—show higher temperatures in central Cairo compared to the cold season. The number of LST values peaks in summer rather than in other seasons in Cairo. This research contributes to a broader understanding of LST dynamics and provides valuable insights for policymakers, urban planners, and researchers alike.

sciforum-116666: Microclimate analysis through advanced modelling: a case study in Lecce, Italy

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The present study aims to analyse the effects of climate change on the urban environment, focusing on sustainable urban planning and an analysis of microclimate and thermal comfort. The considered study area is composed of a square domain of app. 400 x 400 m in the city of Lecce (Italy), where temperature and relative humidity data are still being measured.

The analysis involves a modelling chain that uses ERA5 data to provide the boundary conditions for the 1D Multi-Layer Urban Canopy Model (MLUCM) based on the BEP+BEM (Building Effect Parameterization + Building Energy Model) model, which subsequently generates the inputs for ENVI-met, a CFD model used for microclimate simulations and thermal comfort studies. This methodology allows us to bridge the gap between different scales.

Another model applied in this work is PALM-4U, which is an advanced atmospheric simulator for the simulation of urban atmospheric boundary layers, as well as urban climate and the interactions between the built environment and the atmosphere. It can work in turbulence-resolving LES (Large Eddy Simulation) mode, and is suitable for a wide range of applications, such as urban climate, air quality and pollutant dispersion, urban ventilation, and thermal comfort. Among the advantages of PALM-4U are its high spatial and temporal resolution, its modular approach, and the fact that it represents support for real data, as well as being open-source.

The modelling outputs are first validated against measured data and are further employed to develop strategies for adapting to climate change by improving urban thermal comfort for citizens.

sciforum-116606: Modeling the Impact of a Supervolcanic Eruption on the Climate System Under Present and Future Conditions

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Powerful volcanic eruptions are among the most significant natural factors global affecting Earth's climate system, capable of causing substantial changes in temperature, atmospheric circulation, and air chemical composition.

This study presents a powerful volcanic eruption (similar to the Tambora eruption in 1815) impact on the climate system under various background conditions. We performed a series of experiments with the chemistry–climate model SOCOL-MPIOM for three time periods: present conditions and two future climate scenarios: SSP3-70 and SSP2-45. The experimental design is based on quasi-random sampling methodology, allowing the optimal exploration of key model parameter space with minimal numerical experiments.

The climatic effect of a powerful volcanic eruption intensifies in the warmer climate of the late 21st century, manifesting in a deeper temperature drop (up to 2.5-3K for SSP2-45) and a longer recovery period, compared to the present period (1-1.5K).

Unlike the temperature response, the ozone layer reaction demonstrates a complex spatial structure with pronounced latitudinal asymmetry: a decrease in ozone content at high latitudes (up to -8 DU) and an increase in tropical latitudes (+4-6 DU). This effect is associated with changes in circulation and the photochemical processes of ozone formation.

The most intense analog of the historical 'year without summer' is observed in the SSP2-45 scenario, which may be related to higher concentrations of methane and NOx in this scenario, affecting photochemical processes in the atmosphere and enhancing the radiative effect of volcanic aerosols.

The recovery timescales of the ozone layer (5-7 years) exceed the period of temperature relaxation (3-4 years), indicating the long-term impact of volcanic forcing on the chemical composition of the atmosphere and highlighting the importance of considering chemical feedback when assessing the climatic consequences of powerful volcanic eruptions. This work was supported by Saint Petersburg State University under research grant 116234986.

sciforum-116421: Response of cloud cover and climate to geomagnetic field changes

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We aimed at addressing how the weakening of the geomagnetic field affects cloud properties and climate, and whether this weakening could lead to an environmental crisis, as suggested by paleoclimatic data. To investigate this, we performed climate simulations driven by the relationship between geomagnetic field strength, atmospheric ionization rates, global electric circuit, and the cloud life cycle. The ionization rates were calculated using a model applicable to both regular and geomagnetic excursion periods. Our model modifications focused specifically on the cloud parameterization scheme, introducing a dependency of the cloud droplet coagulation on the global electric field strength. This dependency was determined as a function of fair weather vertical electric currents (J_z), which were interactively calculated from the simulated atmospheric ion concentrations and conductivity. The model results indicate that the impact of the geomagnetic field weakening on the atmospheric electrical currents is the most pronounced in the middle and low latitudes, leading to an increase in J_z of up to 20%. We also observed statistically significant changes in cloud cover and surface cooling of about 0.4K in global and annual mean surface temperatures. Local and seasonal effects are even more pronounced; for instance, substantial temperature drops of up to 2 K are observed in the Northern Hemisphere. These findings will be described in further detail during the talk. However, based on our results, we cannot conclude that the introduced mechanism would lead to a large-scale environmental crisis.
This work is supported by the Swiss National Science Foundation (project Spark GECO; CRSK-2_221368).

sciforum-116623: Spatiotemporal evolution of drought episodes in Austria: A high-resolution assessment from 1950 to 2023

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Drought is among the most severe climate-related hazards, posing significant threats to ecosystems and economies worldwide. Consequently, numerous countries have conducted locally focused studies to develop effective adaptation strategies. In this study, we examined the occurrence and evolution of drought in Austria, a relatively small country (83,878 km^2) in Central Europe. Our analysis was based on long-term ERA5-Land monthly datasets spanning 1950–2023, incorporating precipitation, surface net radiation, surface pressure, 2 m air and dew point temperatures, and 10 m wind speed components. The precipitation and temperature data from this source exhibited strong agreement with observed datasets, supporting their reliability for this study. These datasets enabled the calculation of the Standardised Precipitation Index (SPI) and the Standardised Precipitation-Evapotranspiration Index (SPEI) at 1-, 3-, 6-, and 12-month timescales. Drought episodes were identified using a threshold of -0.84, with duration determined from the first month the index falls below zero, continuing until it reaches -0.84, and ending before the last month the index becomes positive. Severity was calculated as the sum of all SPI/SPEI values throughout each episode. Given that index variability decreases as the temporal scale increases, the highest number of drought episodes was identified using SPI1 (123) and SPEI1 (124), primarily affecting the western half of the country. The spatial distribution of drought episodes suggests a strong influence of topography. Furthermore, we found a statistically significant relationship between the severity of drought episodes and the affected area. However, differences between SPI and SPEI were consistently small across all temporal scales, indicating that evapotranspiration does not play a crucial role in the severity of drought episodes. These findings contribute to a historical understanding of drought in Austria and will be extended to future periods under different socioeconomic and climate scenarios.

sciforum-116582: The atmospheric hydrological cycle and the El Niño Southern Oscillation in the inter-American seas

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The hydrological cycle plays a fundamental role in the Earth's climate system. It is the result of a continuous circulation of water on the planet through a series of interconnected reservoirs, which involves processes of evaporation, atmospheric transport of humidity, condensation, precipitation, and surface runoff. To analyze the dynamics of water vapor in the atmosphere, a diagnosis of the integrated humidity flow in the vertical can be made with information from atmospheric humidity and wind data, while the divergence of the flow, net evaporation, and precipitation contribute to explain the precipitable water in the atmosphere. Various studies show that El Niño conditions affect the interannual and interdecadal variability in rainfall in the tropical Americas, by modifying the flow of humidity towards the region, as well as the activity of easterly waves and tropical cyclones in the Atlantic. A first approximation can be made by comparing El Niño and La Niña years and their effects on the rainy season in the intra-American seas. This comparison is made from the components of the atmospheric water balance equation. A comparison is made between the summer of 1982, characterized by the presence of an El Niño event, and the summer of 2010, influenced by a La Niña event. The main finding is that during El Niño, the moisture content in the Atlantic and eastern Caribbean region is significantly lower compared to during La Niña. This decrease in humidity translates into a reduction in rainfall in the tropical Americas.

sciforum-116062: Warming projections of the eastern Mediterranean in CMIP6 simulations according to SSP2-4.5 and SSP5-8.5 scenarios

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This study investigates the future temperature changes in the climate-vulnerable region of the eastern Mediterranean. The results from seventeen (17) CMIP6 (6th Phase of Coupled Model Intercomparison Project) model simulations are analyzed in order to study the temperature changes. The analysis is focused on the moderate and extreme emissions in the Shared Socioeconomic Pathways (SSP2-4.5 and SSP5-8.5, respectively). The fifth generation ECMWF reanalysis (ERA5) is used as reference dataset in order to investigate the performance of CMIP6 simulations to accurately reproduce the mean temperature in the eastern Mediterranean region. The results show that CMIP6 model simulations vary regarding their efficiency to capture the mean temperature. In particular, Kling-Gupta efficiency Index (KGE) values fluctuate from -0.13 to 0.46. Future projections show that significant warming is shown during the last period of the 21st century (related to the historical basis period that covers the years from 1970 to 2000). The continental Balkan and Turkish regions are recognized as the most affected areas regarding future warming. The increase in temperature ranges from 1.5°C to 4.5°C for SSP2-4.5 and from 3.0°C to 8.0°C for SSP5-8.5 scenarios, respectively. Finally, the seasonal analysis indicates that summer (JJA) shows the maximum temperature increase compared to the other seasons.

Session 7. Air Quality

sciforum-116671: Assessment of NO_2 and CO Air Pollutions in the Marmara Region Using Sentinel-5P TROPOMI Observations

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Air pollutant gases emitted by anthropogenic activities significantly contribute to climate change and pose serious threats to human health. Among these pollutants, nitrogen dioxide (NO_2) and carbon monoxide (CO) are particularly significant contributors to urban air pollution. Satellite-based remote sensing has long been employed to monitor global air quality. This study aimed at investigating the temporal and spatial changes in average atmospheric NO_2 and CO concentrations in the Marmara Region of Türkiye during the summer (July–August) and winter (January–February) seasons between 2019 and 2024. For this purpose, we utilized high-resolution measurements from the recently launched Sentinel-5P TROPOMI sensor, which provides detailed insights into local air quality and pollution levels. Data processing was conducted using Google Earth Engine (GEE), and spatial distribution patterns were mapped in ArcGIS Pro. **Within this framework, the study was structured around the following key research question: "How have NO_2 and CO concentrations changed seasonally and annually before and after the COVID-19 outbreak?" The findings revealed that NO_2 and CO concentrations exhibited seasonal fluctuations throughout the study period, with significant increases and decreases at specific intervals.** Notably, a sharp decline in these pollutant levels was observed during the COVID-19 pandemic in 2020, whereas a considerable rebound has been detected in certain regions since 2021. Moreover, NO_2 and CO concentrations were found to be significantly higher in cities characterized by high population density and intensive industrial activities, such as Istanbul, Bursa, and Kocaeli. **These findings offer critical insights into the spatiotemporal changes in NO_2 and CO emissions, underscoring the effectiveness of Sentinel-5P satellite data as a powerful tool for air quality monitoring. This study serves as a roadmap for policymakers by supporting policy development processes in cities striving to enhance air quality and ensure sustainable air pollution management through comprehensive spatial analyses of NO_2 and CO concentrations.**

sciforum-119245: Continuous Sensing and Automated Dispersion Modeling of Fugitive Dust Emissions at a Steel Plant: A Proactive Response to Complaints

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Since 2021, the ArcelorMittal Tubarão steel mill (Brazil) has used a real-time total suspended particles (TSP) monitoring system, which estimates fugitive emissions, quantifies off-site transport, and provides real-time feedback for remedial actions. It consists of 60 towers with Alphasense N3 (EcoSoft ECOPR-N3) optical particle counters to sense PM concentrations around areas such as materials handling, stockpiling, and industrial processes like coking and sintering. PM emission rates are derived by applying a plume profiling methodology. These emissions were coupled to an automatic dispersion modeling tool, developed in Python, which runs AERMOD dispersion modeling automatically. The tool produces hourly plume concentration maps at receptors, helping to determine the impact of emission sources on surrounding communities and facilitating the evaluation of complaints. To run the meteorological pre-processor AERMET, a SAMSON format input file is generated using online METAR data from the Iowa Environmental Mesonet. For AERMOD, fixed emissions are provided in a separate Excel file, while diffuse emission from sensing is obtained online in the Azure Databricks cloud. Receptor information and the effects of building downwash are also provided in a separate text file. Each hour of the selected day is processed individually, requiring a separate namelist for each hour, which is automatically generated by a coded loop. The output files containing hourly average concentrations at each receptor are processed to create maps visualizing the plume over the domain using a cropped Google Earth image as a background, enabling the detailed visualization of pollutant dispersion. By integrating real-time data with advanced modeling tools, the system not only enhances the accuracy of emission estimates but also provides actionable insights for immediate corrective actions. This promotes a more sustainable industrial operation, contributes to responses to surrounding communities regarding potential complaints related to the issue, and facilitates precautionary actions in response to forecast scenarios.

sciforum-113318: Efficient nitrous oxide capture from dam lake treatment by malt dust-derived biochar

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According to the European Union (EU) Green Deal, the greenhouse gas (GHG) emissions from water resources should be reduced by 30% until 2030. Dam lake treatment is one of the main important GHG resources according to the European Union (EU) Green Deal. Due to the natural texture of dam lakes, they emit nitrous oxide (N_2O) emissions at higher amounts. The main aim of this study was the reduction of the N_2O emissions resulting from dam lake treatment using malt dust-derived biochar. The biochar was derived from malt dust using a slow pyrolysis process under three various temperatures:250 (M1), 300 (M2) and 500 °C (M3). A biochar adsorption process was applied as not only as a water treatment technique but also a nitrous oxide emission reduction method. Before and after the biochar adsorption process, N_2O was sampled and measured seasonally using gas chromatography equipped with an electron capture detector (GC-ECD). The water samples were taken seasonally from Ataturk Dam Lake inTurkey. Also, the GHGs originating from water treatment was collected and adsorbed using the same biochar to determine the experimental nitrous oxide capture ability of biochar in a gas adsorption column. On average, a 21.1% reduction in N_2O emissions from dam lake treatment was reported using malt dust-derived biochar. The maximum nitrous oxide capture capacity corresponded to the malt dust-derived biochar produced at the minimum temperature (M1). This study verified that malt dust-derived biochar was an efficient N_2O adsorbent and air pollutant disposer. The Box–Behnken experimental design method was performed using MATLAB to determine the optimum operating parameters for the minimum N_2O emission. The statistical analysis results revealed that the optimum parameters were 4 mg/L of dissolved oxygen (DO) and 11 mg/L of nitrate (NO_3^-) concentration for the minimum N_2O emission.

sciforum-120336: Size distribution and seasonal evolution of airborne metals in Antarctic atmospheric particulate matter

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Introduction: Aerosols play a crucial role in Earth's climate system, influencing the balance of radiation and cloud formation. Antarctica, despite its remoteness, provides an ideal environment in which to study background aerosol composition and the long-range transport of pollutants. This study investigates size-segregated elemental composition, seasonal variations, and potential sources of atmospheric aerosols in Antarctica. Methods: Seven size-segregated aerosol samples were collected at Faraglione Camp (~3 km from Mario Zucchelli Station) between November 2019 and January 2020 using a high-volume cascade impactor. Samples were analyzed for major (Na, Ca, K, Mg), minor (Al, Fe, Mn), and trace elements (Cd, Cr, Cu, Hg, Ni, V) using ICP-OES, GF-AAS, and DMA after acid microwave digestion. Results: The elemental concentrations of PM10 followed the order K > Na > Al Ca > Mg Fe > Mn > Cr > Ni > Cu V > Cd Hg. Seasonal trends were element-specific, influenced by katabatic winds and pack ice melting. Notably, Mg, Cu, Cr, and Hg peaked in late November/mid-December, likely due to sea spray emissions, while Fe, V, and Mn showed a decreasing trend. The size distribution analysis identified three modes of particle dispersion: accumulation (0.1–1 μm) and two coarse fractions (~2.5–3 μm and ~9.5 μm). Crustal enrichment factors (EFs) indicated geogenic origins for Mn and Fe (EF 1), while Cu, Ni, K, Ca, and V enrichment was linked to soil resuspension. Mg and Na showed moderate enrichment (EF ~10), associated with sea spray, while Cd, Cr, and Hg exhibited high EFs (10 EF 100), suggesting an anthropogenic influence. Conclusions: These findings underscore the importance of continuous monitoring in assessing the contributions of aerosols to polar environments and their potential climatic and ecological impacts.

sciforum-116568: A spatial and temporal analysis of the major air pollutants in the southeast area of Romania

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Significant climate change has been detected in Southeastern Romania (SERO) in recent decades. This region also suffers from the influence of different pollution sources. Therefore, the spatial and temporal variations in the particulate matter PM_{10} and $PM_{2.5}$ and trace gases (NO_2, CO, SO_2, and O_3) in the atmosphere of different zones of this region need to be analyzed.

We studied time series of the above major air pollutants' mass concentrations, measured by the national air quality monitoring network (RAQMN) in the southeastern area of Romania. The data are from 59 locations (12 urban traffic, 14 urban background, 8 urban industrial, 4 suburban traffic, 8 suburban background, 8 suburban industrial, 4 rural background, and 1 rural industrial site). For the short-term variations, we used data from 2018 to the present, while for the long-term analysis regarding trend identification and quantification, we used a time period as long as currently possible, as the data were provided by the RAQMN.

The temporal pattern analysis and other statistical analyses were performed using R software with the Openair package. The temporal trend analysis was performed using the Mann–Kendall approach and Theil-Sen's slope method. The univariate spatial analysis (LISA clusters and Moran's I) was performed using the GeoDa software package.

Among the key findings, we include the identification of a so-called O_3 weekday–weekend effect in a mid-size petrochemical city, according to which the temporal patterns in O_3 precursors (elevated VOCs despite the reduced NOx during weekends); themain pollution sources, through a Principal Component Analysis; and different levels of spatial interactions were identified, which proved to be pollutant-dependent.

The present work provides important insights into the variations in major air pollutants in the SERO area that have not been identified in previous studies, in the larger context of defining new pollution abatement strategies at the local and regional scales.

sciforum-119323: Assessment of Urban Air Quality in Salé, Morocco: An In-Depth Analysis of PM2.5 Seasonal Variations, Elemental Composition, and Enrichment Factors

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Sale, situated along the Atlantic Ocean, ranks as the third-largest city in Morocco, characterized by its high demographic density and significant air pollution challenges. The Bouregreg River delineates Sale from Rabat, the capital of Morocco. Key sources of air pollution in Sale include traffic emissions, maritime activities, potteries, fishing, domestic heating, and artisanal operations. From July 2018 to July 2019, we conducted a comprehensive study on ambient PM2.5 concentrations in an urban area of Sale. Using a Dichotomous sampler, we collected PM2.5 samples and employed Total X-Ray Fluorescence to analyze the elemental composition of the collected filters. The results indicated that PM2.5 mass concentrations fluctuated between 3.08 μg/m³ and 49.48 μg/m³, with an average of 17.30 μg/m³. Notably, peak concentrations occurred during winter months, contrasting with lower levels observed in summer. To investigate the influence of atmospheric transport on PM2.5 levels, we applied the HYSPLIT™ model for air mass back-trajectories analysis, identifying four primary transport clusters arriving at the monitoring site in Sale: Iberian Coast (24%), Near Atlantic Ocean (33%), local sources (28%), and Oceanic influences (15%). Seasonal analysis revealed variations in metal concentrations. Elements such as K, Ca, V, Mn, Fe, Ni, Cu, Zn, As, Sr, Ba, and Pb showed elevated levels during winter, while Ti and Cr peaked in autumn. Enrichment Factor (EF) assessments indicated that Ti, Sr, Mn, K, Ca, and Ba predominantly originated from airborne dust (EF 10). Meanwhile, V, Cu, and Cr exhibited both natural and anthropogenic contributions (10 EF 100), while Ni, Zn, and Pb were largely anthropogenic (EF > 100). According to the Morocco National Ambient Air Quality Standard, the annual mean limit for PM2.5 is set at 35 μg/m³, indicating that the average PM2.5 concentration of 17.30 μg/m³ observed in Sale is below this limit, suggesting that while air quality is better than the standard, seasonal spikes could still pose health risks.

sciforum-116667: Backward trajectory and potential source locations of Ambient $PM_{2.5}$ at University of Lagos, Nigeria

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Globally, Particulate Matter (diameter 2.5 - $PM_{2.5}$) and other pollutants have created a lot of problems health wise. It is not possible to mitigate their effects without quantifying the amount within the environment both indoors and outdoors. On this premise, the $PM_{2.5}$ within the University of Lagos (UNILAG), Nigeria (Central Laboratory and the Main gate of the campus) was evaluated with the aim of disseminating the outcome to stakeholders who would work towards mitigating the potential pollution around the surroundings. Also, a HYSPLIT model was used to track backward trajectories and the potential source locations of $PM_{2.5}$. The eight-month (2023-08-01 to 2024-03-01) air quality data were obtained from AirQo at Makerere University, Uganda. The data were subjected to Anderson—Darling Normality Testing and were compared with the National Environmental Standards and Regulations Enforcement Agency (NESREA) and World Health Organization (WHO) standards. The results were as follows. Main gate: minimum (7.23 **µg/m^3**), maximum (180.50 **µg/m^3**), mean (26.69), Std. (19.07), and A-Squared (104.28); Central lab: gate: minimum (6.32 **µg/m^3**), maximum (181.13 **µg/m^3**), mean (24.26), Std. (20.86), and A-Squared (227.28). The means of the two locations were 5.34 times (Main gate) and 4.86 times (Central Lab) higher than the WHO annual limit, while they were 1.34 times (Main gate) and 1.21 times (Central Lab) higher than the NESREA annual limit, which may likely be due to high local emissions from solid fuel combustion, waste burning, and high vehicular movements within the vicinity. The air mass came from the ocean in a southwestern direction. These findings demonstrated the significance of local emission sources in determining fluctuations in PM2.5 within the university and the necessity of focused mitigation techniques to solve serious environmental air pollution issues.

sciforum-116692: Effects of nitrogen oxide (NO and NO_2) concentration levels and meteorological variables on ozone (O_3) formation in the petrochemical industry area in the Monterrey Metropolitan Area, Mexico

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The petrochemical industry emits large amounts of nitrogen oxides (NOx). It is the second source of volatile organic compounds (VOCs), which, through photochemical reactions, can form tropospheric ozone (O_3) and, together with geographic and meteorological conditions, determine pollution's spatial and temporal behavior. The objective of this study is to assess the influence of air pollutants NOx, NO_2, and NO, as well as meteorological factors, on O_3 concentration levels in the city of Cadereyta, Nuevo Leon, which is characterized by its petrochemical industry as part of the metropolitan area of Monterrey, Mexico. The data were analyzed using the Spearman correlation coefficient, identifying a weak to moderate negative association between NOx and NO_2 with O_3 in the spring season and a null relationship in the summer. However, the fall and winter seasons observed a moderate to strong negative relationship. Subsequently, a multiple linear regression analysis determined the influence of air pollutants NOx, NO_2, and NO, as well as meteorological factors, on O_3 concentration levels. In this sense, when the concentration levels of NOx and NO_2 decrease, the concentration of O_3 will increase proportionally according to the year's season. The prediction model obtains a coefficient of determination (R^2) of 0.61 and a value in the root-mean-square error (RMSE) metric of 0.0107 ppm. In the prediction model, all variables presented a significant effect on the interpretation of the dependent variable, and the independent variables that provided the most significance in the variation in the concentration levels of O_3 were NOx and NO_2.

sciforum-116513: Evaluation of modelling and remote sensing tools for improving air quality in surroundings of open-pit mines

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The nature of the activities carried out in open-pit mines necessitates appropriate and efficient management of the dispersion of pollutants generated and of local air quality levels. The blasting, excavation, and transportation of minerals are some of the main mining activities that can cause the release of particles into the atmosphere. These particles may contain heavy metals and other chemical species that can affect the respiratory health of people living near mines.

In this contribution, innovative techniques related to air quality modelling and remote sensing have been evaluated. These three techniques aim to address previously unanswered questions and sources of uncertainty identified based on the authors' experience, with areas such as the following: (1) recommended emission factors for blasting activity in copper mines do not exist; (2) to adapt environmental management and ensure compliance with legislation, the concentration of particulate matter for the next few hours, depending on meteorological conditions and the mine operation plan, should be known; and (3) methods of generating a heat map of the particulate matter levels in the mine and nearby populations.

To respond to these questions, we have tested innovative techniques: (a) a semi-empirical approach based on real data and Gaussian dispersion modeling has been used to accurately estimate the emission factors of particulate matter in the atmosphere related to blasting activity; (b) a data-science model has been prepared to generate a nowcasting of the levels of particulate matter considering, mainly, the evolution of the meteorological conditions and a large amount of historical data; and (c) an air quality monitoring service has been used that derives particulate matter properties from space by transforming public satellite data, and other public sources has been tested. These techniques have been evaluated over one of the most relevant open-pit mines in southern Europe: the Riotinto mine, Huelva (Spain).

sciforum-116613: Impact of urban morphology on vehicular pollutant dispersion: a modelling and experimental approach in the city of Lecce (Italy)

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This study, conducted within the framework of the PNRR Italian National Centre for Sustainable Mobility CNMS (European Union – Next Generation EU - PNRR – MISSIONE 4 – COMPONENTE 2- INVESTIMENTO 1.4 – Spoke 7 - Code CN00000023, CUP: F83C22000720001), investigates the impact of urban morphology on the dispersion of vehicular pollutants, specifically nitrogen dioxide (NO_2) and particulate matter ≤10 μm (PM_{10}). The aim is to analyse pollutant concentration patterns in areas characterised by different urban forms and to evaluate potential strategies for improving air quality in sensitive locations such as school environments.

The primary phase of this study focuses on the city of Lecce, integrating modelling with ADMS-Roads, QGIS elaborations and meteorological analyses to estimate pollutant dispersion under varying urban morphologies. In this initial phase, traffic data is kept constant for consistency. The preliminary modelling results indicate a strong influence of urban morphology on the dispersion of traffic-related pollutants. Urban forms characterised by a low planar area index (λ_p) have been observed to lead to increased NO_2 and PM_{10} levels, with concentrations decreasing in areas with higher λ_p.

In addition to modelling efforts, experimental measurement campaigns will be carried out near two schools in Lecce to assess real-world pollutant concentrations. These campaigns will employ an air quality monitoring station, a meteorological station and a traffic-counting camera. The meteorological and traffic flow data collected will enable the reproduction of real scenarios in ADMS-Roads and will be used to validate the model through comparison with measured air quality data and enabling future scenario simulations that assessmitigation measures to reduce traffic-related emissions. This, in turn, will improve air quality in sensitive areas such as school environments.

sciforum-116511: Particulate Matter (PM2.5) Prediction in Tashkent Using Machine Learning

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Air pollution is a growing concern in urban areas, and fine particulate matter poses significant risks to public health. Fine particulate matter is defined as particles that are 2.5 microns or less in diameter (PM2.5). Emissions from the combustion of gasoline, oil, diesel fuel, and wood produce much of the PM2.5 pollution found in outdoor air.

This work explores the use, for the first time, of machine learning techniques to predict PM2.5 air quality levels in Tashkent, Uzbekistan. The primary goal is to develop robust predictive models that can accurately estimate PM2.5 concentrations based on environmental and temporal factors. Open-source air quality datasets from ten automated air quality monitoring stations were utilized, and additional features, such as weather conditions and seasonal trends, were implemented to improve model accuracy. A hypothesis-driven approach was adopted to test the relevance of these features and assess their impact on model performance. This study employed a range of regression models, starting with linear regression and progressively advancing to more sophisticated methods, including ensemble models such as Random Forest and Gradient Boosting.

The performance of these models was evaluated using the R^2 metric, with a focus on balancing accuracy and model interpretability.

Our results exhibit the great potential of machine learning in addressing urban air quality challenges and pave the way for informed environmental strategic decision making in Tashkent city and similar urban contexts.

sciforum-116676: Quantifying Urban Air Quality Across Global Megacities

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This study aims to understand the trends in air pollutant concentrations across five megacities, Shanghai, Delhi, Paris, Los Angeles, and São Paulo, from the year 2018-2020. Relevant Air Quality Data for $PM_{2.5}$, PM_{10}, O_3, NO_2, and SO_2 were obtained from sources such as the World Air Quality Index and the U.S. Embassy and Consulates' air quality monitors, and compared with various meteorological elements to ascertain the annual and seasonal trends in air quality. The findings revealed significant variations in key pollutants such as $PM_{2.5}$, PM_{10}, Ozone (O_3), Nitrogen Dioxide (NO_2), and Sulfur Dioxide (SO2). According to our findings, Shanghai exhibited an overall decrease in $PM_{2.5}$ and SO_2 levels over the period, while concentrations for O_3 and PM_{10} remained stable. Delhi showed significant seasonal fluctuations in $PM_{2.5}$ and PM_{10} levels, with the highest pollution levels during the paddy burning season and the lowest during the monsoon season, with a notable reduction in NO_2 and SO_2 concentrations, reflecting better vehicular and industrial emissions standards. Paris displayed a clear downward trend in $PM_{2.5}$, PM_{10}, and NO_2 levels, exhibiting the effectiveness of their measures in reducing emissions from vehicle and industrial sources.

$PM_{2.5}$ and PM_{10} levels in Los Angeles showed slight variations throughout the year with sudden unexpected peaks in air pollution, with a consistent decline in NO_2 and SO_2 concentrations, indicating improved air quality management. São Paulo showed variability in $PM_{2.5}$ and NO_2 levels, while O_3 concentrations fluctuated, reflecting the complexities of urban pollution control. This study highlights the impact of regulatory measures, industrial activities, and meteorological conditions on air quality, and emphasizes the importance of continuous monitoring and effective pollution control strategies.

sciforum-116517: Size-resolved aerosol Mass Concentrations, Elemental Composition, and Long-Range Transport Effects in Four Moroccan Coastal Cities

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Morocco has experienced notable urban and industrial growth in recent years, resulting in increasing air pollution concerns. This study investigates the characteristics of size-resolved aerosols (PM_{10} and $PM_{2.5}$) and their sources across four distinct locations: two Mediterranean coastal cities (Tetouan and Nador) and two Atlantic coastal cities (Kenitra and Salé). Aerosol samples were collected and analyzed for elemental composition (Al, Fe, Ni, V, Cu, Cr, Zn, and Pb) using a range of analytical techniques such as Total X-ray Fluorescence (TXRF), Atomic Absorption Spectroscopy (AAS), Microwave Plasma Atomic Emission Spectrometry (MP-AES), and Instrumental Neutron Activation Analysis (INAA). Gravimetric analysis was performed to determine daily PM mass concentrations. To evaluate the effects of long-range transport, air mass back-trajectories were generated using the HYSPLIT™ model. Source apportionment was conducted using inter-elemental ratios, Positive Matrix Factorization (PMF) receptor modeling, and air mass back-trajectory statistics. The analysis of inter-elemental ratios highlighted urban emissions, largely attributable to traffic and construction activities, as the primary anthropogenic source. Contributions from long-range transport were identified by linking PM mass concentrations with air mass flow directions, demonstrating the significant impact of emissions from the Mediterranean Basin and the Atlantic Ocean on air quality in Moroccan cities. Moreover, the PMF source apportionment indicated that the contributing sources vary between PM fractions. For $PM_{2.5}$, major sources were identified as vehicle exhaust/non-exhaust emissions, regional secondary aerosols, and local anthropogenic activities. In contrast, PM_{10} was predominantly associated with soil dust, re-suspended road dust, and fresh/aged sea salt emissions. Finally, the study highlighted that the $PM_{2.5}/PM_{10}$ ratio is site-dependent. Mediterranean coast cities presented higher $PM_{2.5}$/PM10 ratios (>0.5), indicating a significant contribution from fine anthropogenic particles. Conversely, Atlantic coastal cities displayed ratios below 0.5, suggesting a predominance of coarse particles, likely emanating from local pollution sources characteristic of those areas.

sciforum-116653: The Air Pollution Impacts of California's 2018 Wildfires

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Wildfires emit large quantities of air pollutants into the atmosphere and are emerging as a significant global threat. As global warming increases the frequency, intensity, and duration of wildfires, the resulting air pollution also increases. This study investigates the role of meteorological conditions and topographical features on the three-dimensional transport and distribution of PM2.5 during California's unprecedented 2018 wildfire season, with a particular focus on two major wildfires: the Mendocino Complex Fire and the Camp Fire. Multiple data sources, such as EPA ground monitoring stations, MODIS satellite products, and HYSPLIT trajectories, were integrated to analyze the horizontal and vertical pollutant transport patterns. The results revealed that persistent low-pressure systems and weak winds (≤2 m/s) created pronounced atmospheric stagnation, leading to pollutant accumulation near the surface. An analysis of PM2.5-AOD (Aerosol Optical Depth) correlations demonstrated stronger relationships during wildfire events compared to baseline periods, indicating the significant role of the wildfire-induced aerosols throughout the atmospheric column. HYSPLIT back trajectory analysis during peak pollution episodes revealed that while air masses originated from the Pacific Ocean, they remained confined to lower atmospheric layers (below 1.5 km), exacerbating surface-level pollution. Due to these conditions, the Camp Fire, despite its shorter duration, demonstrated more severe air quality impacts than the larger Mendocino Complex Fire, highlighting the significant role of burning intensity and meteorological conditions in pollution transport.

Session 8. Aerosols

sciforum-116528: Association between particle-bound reactive oxygen species and in vitro oxidative responses induced by traffic-related urban nanoparticles

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Exposure to fine particulate matter (PM1) has been associated with health impacts, but understanding PM1 concentration–response (PM1-CR) relationships remains incomplete, especially at low PM1 levels. Here, we present data related to the RHAPS experiment carried out in the Po Valley in 2019 [Costabile et al., 2023].

This study investigated the association between particle-bound reactive oxygen species (PB-ROS) and in vitro pro-oxidative responses. To mimic exposure of the lungs to ambient air, we employed an Air–Liquid Interface (ALI) model using cultures of human bronchial epithelial cells (BEAS-2B). PB-ROS were measured using the DCFH assay via two approaches: offline 24-hour resolution measurements from PTFE filters ($PB\text{-}ROS_{filter}$) and semi-continuous (2-hour resolution) measurements using a Particle-Into-Liquid Sampler (PILS) ($PB\text{-}ROS_{PILS}$).

A comparative analysis of the $PB\text{-}ROS_{filter}$ and $PB\text{-}ROS_{PILS}$ measurements showed significant differences in the types of ROS detected, primarily driven by the sampling resolution. The $PB\text{-}ROS_{filter}$ measurements predominantly identified long-lived species, which are more stable and indicative of aged aerosols, associated with secondary organic aerosols (SOAs). In contrast, $PB\text{-}ROS_{PILS}$ measurements revealed transient PB-ROS related to urban nanoparticles, which are abundant during the day due to traffic emissions and photochemical processes. Statistically significant correlations suggest that transient PB-ROS are influenced by fresh traffic nanoparticles, with the Condensation Sink (CS) playing a decisive role in their persistence in the atmosphere. The CS having a low value indicates atmospheric conditions in which condensable compounds (including ROS) do not sink rapidly into pre-existing accumulation-mode particles and may form nanoparticles [Costabile et al., 2023].

Finally, this study highlights a positive correlation between the mass-normalized $PB\text{-}ROS_{PILS}$ and oxidative stress gene expression, underscoring the potential health implications of short-lived ROS. Limitations of this study relate to the limited temporal coverage of the PILS and the absence of fully online ROS detection methods for characterizing highly reactive species, which may pose immediate health risks in urban environments with fresh emissions.

sciforum-116387: Development of an analytical method for atmospheric humic-like substances that uses high-performance liquid chromatography and an automated pretreatment technique

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Introduction

Humic-like substances (HULISs) are a group of substances with no specific chemical structure, resembling the humic substances found in soil and water. They constitute the main component of water-soluble organic matter in the atmosphere and are known to exhibit absorption properties in the ultraviolet to visible light range, potentially influencing atmospheric radiative balance. Understanding their environmental dynamics is therefore crucial. However, existing analytical methods for HULISs involve labor-intensive pretreatment steps, which can lead to reduced quantification accuracy and hinder improvements in analytical efficiency. To address this issue, this study aims to develop a system for HULIS analysis using high-performance liquid chromatography (HPLC) equipped with an integrated sample cleanup mechanism, enabling the direct analysis of atmospheric particles through their simple extraction using water.

Methods

The automated system for sample cleanup and detection consists of four HPLC pumps, an autosampler, a cleanup column (Oasis-HLB, 3 mmφ × 20 mm, Waters), a column heater, a six-port valve, and a photodiode array detector (DAD) . The following steps were performed in accordance with a time program:

Before sample injection, the flow path was cleaned with ultrapure water.

The cleanup column was conditioned with methanol and ultrapure water.

The system was acidified with hydrochloric acid (pH = 2).

After injecting the sample, the HULISs in the acidified sample were adsorbed onto the column.

HULISs were eluted with a 2% ammonia–methanol solution (w/w) and detected using the DAD.

Results and Conclusions

This automated pretreatment analysis system achieved highly favorable peaks. The recovery rate of a 100 mg/L standard fulvic acid solution was 91.2±0.9% with this method, under optimal conditions. We are planning to optimize the time program conditions and apply this system to actual atmospheric samples.

sciforum-116533: Evaluation of Oxidative Potential of Nitrogen-containing heterocyclic compounds and their Metal Complexes by the DTT assay

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Atmospheric particulate matter (PM) is known to induce oxidative stress by generating reactive oxygen species (ROS) when inhaled. To understand the sources of ROS production by PM, evaluating its individual components is essential. Previous studies have reported that metals and oxidized derivatives of polycyclic aromatic hydrocarbons (PAHs) exhibit high ROS generation capacity. However, the diversification of energy sources has raised concerns about the emergence of new harmful air pollutants, such as nitrogen-containing organic compounds, including nitrogen heterocyclic compounds (PANHs). PANHs can act as ligands, forming coordination complexes with metals such as iron, but the ROS production capability of such complexes remains unclear.

This study evaluated the oxidative potential (OP) of coordination complexes as an indicator of ROS production using the Dithiothreitol (DTT) assay. Test samples included 1,10-Phenanthroline iron(II) perchlorate (Fe-phen), Tris(1,10-Phenanthroline) cobalt(II) bis(hexafluorophosphate) (Co-phen), and Tris(2,2'-Bipyridine) cobalt(II) bis(hexafluorophosphate) (Co-bpy). For comparison, divalent iron [Fe(II)], cobalt [Co(II)], copper [Cu(II)], and manganese [Mn(II)] were also tested. DTT consumption rates were measured spectrophotometrically at 415 nm after reaction with the test samples for 20 minutes.

The formation of coordination complexes generally increased OP compared to individual metal ions or ligands. Notably, the Fe-phen complex exhibited a DTT consumption rate 50 times higher than Fe(II) alone, while the Co-bpy complex showed a 10-fold increase compared to Co(II). Furthermore, the DTT consumption rates of all complexes exceeded those of Cu(II), which has previously been reported to exhibit relatively high OP. To thoroughly evaluate the contribution of these complexes to the OP of atmospheric particles, it is essential to obtain atmospheric concentration data for each complex. Therefore, future studies should focus on developing sample preparation methods as well as separation and analytical techniques for detecting and quantifying these complexes in real atmospheric particles.

sciforum-116569: Integrating Planetary Health and Nature-Based Solutions: Assessing the Impacts of Traffic-Related Air Pollution on Human and Plant Health in Urban Forests

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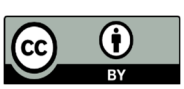
Addressing climate change, biodiversity loss, global pollution, and planetary health requires novel holistic approaches. Here, we present the initial results of the NBFC project (www.nbfc.it/en), combining numerical modelling and observational data to assess the interplay between exposure to urban air pollution and human and plant health.

The analysis was conducted in an urban forest in Rome (Italy). We assessed the potential of freshly emitted traffic-related air pollution (TRAP) to cause oxidative stress and inflammation in humans and plants. Fresh TRAP is characterized by high levels of emerging atmospheric pollutants (black carbon, ultrafine particles, and reactive oxygen species; EC/2024/2881) and low levels of fine particulate matter (PM2.5), which in an urban environment can occur after precipitation or ventilation events. TRAP-associated epigenetic markers of inflammation and oxidative stress (microRNA) were assessed on human lung epithelial cell lines and human specimens over sub-daily periods (6-12h). Functional traits related to photosynthetic machinery were analysed on two evergreen species, Quercus ilex L. and Laurus nobilis L., which were sampled at increasing distances from a major road and expected to have different sensitivities to PM2.5-induced oxidative stress. The Parallelized Large-Eddy Simulation Model (PALM) was used to simulate vegetation cover variations, using two nested domains with different resolutions and treating aerosol as a passive tracer.

The preliminary results show pro-oxidative and inflammatory responses in humans after exposure to fresh TRAP. A reduction in TRAP-related BC is observed when air masses traverse specific urban forest transects with a higher leaf index, particularly during months of high vegetative activity.

An analysis of these findings can provide proof of a cause–effect relationship between short-term exposure to fresh TRAP and oxidative stress in humans and plants, with implications for chronic responses. In a highly urbanized world, this evidence could be pivotal for motivating the widespread implementation of nature-based solutions (NBSs) to address planetary health.



sciforum-113732: Investigation of the sources of atmospheric oxidative potential and their interactions observed in Suzu, Japan

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The oxidative potential (OP) of particulate matter (PM) is widely recognized as an important measure for evaluating the risk of oxidative stress imbalances caused by air pollution. Despite its significance, the primary sources of OP in different regions and the interactions among these sources remain unclear. This study investigates OP sources and their interactions using $PM_{2.5}$ samples from Suzu, Japan, collected during 2015–2016. Chemical composition analyses were conducted and positive matrix factorization (PMF) was applied to identify the sources of $PM_{2.5}$ in Suzu. The dithiothreitol (DTT) assay was used to quantify the OP of $PM_{2.5}$. To capture the nonlinear behavior of atmospheric processes, a multilayer perceptron (MLP), a type of artificial neural network, was utilized to model OP contributions from the PMF-identified sources. The constructed models were then applied to simulate the interactions between the pollution sources in different seasons by modifying their input intensities. The results indicate that while the contributions of $PM_{2.5}$ sources to OP are generally within the range of additive effects, there is a possibility of significant interactions between certain $PM_{2.5}$ sources, whether synergistic or antagonistic, which deviate from the additive assumptions of traditional linear models. Furthermore, some interactions intensify as $PM_{2.5}$ concentrations increase. These findings underscore the necessity of accounting for source interactions and call for detailed monitoring of various $PM_{2.5}$ sources to accurately assess OP risks and develop effective air pollution management strategies.

sciforum-120363: Seasonal characteristics of spectral absorption and BC source apportionment at a background site in the southern Balkans

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Carbonaceous aerosols constitute a major component of the lower atmosphere in both urban and rural environments, originating from a variety of natural sources and anthropogenic combustion processes. This study examines the seasonal variability of BC and its fractions related to fossil fuel combustion (BC_{ff}) and biomass burning (BC_{bb}), along with the spectral absorption characteristics associated with BC and BrC. Aethalometer (AE-33) measurements were performed and analysed at a continental background site in NW mountainous Greece (Kozani, 40.27 °N, 21.76 °E, 768 m a.m.s.l) throughout the year 2023. The measuring station, located within the University of Western Macedonia campus, is mostly affected by regional background aerosol plumes with different optical and physicochemical characteristics. Major contributing sources include emissions from nearby lignite-fired power plants, the long-range transport of polluted air masses from the Balkan region, and, to a lesser extent, local emissions such as traffic within the university campus—where private vehicle use is restricted—and domestic heating in nearby villages (1–2 km away), particularly during the winter season. Furthermore, secondary aerosol formation plays a role in modifying the local aerosol burden. Hourly BC concentrations ranged from ~0.1 μg m^{-3} to ~2.2 μg m^{-3}, with higher concentrations noted during winter due to enhanced residential biomass burning for heating. The BC_{bb} is about 50% during winter and much lesser (~25%) during summer, reflecting the absence of combustion processes and dominance of fossil-fuel sources, although the summer BC concentrations are low. Absorption due to BrC is mostly detected during winter, while its summer values are significantly lower. The contribution of BrC to the total absorption recorded is about 44% at 370 nm during winter, dropping to 16% during summer. This seasonal contrast reflects the influence of biomass combustion in the winter and the dominance of secondary organic aerosol formation and naturally occurring sources of BC during the summer.

sciforum-116594: Spatiotemporal variations of Modelled Aerosols and Aerosol Subtypes over a Tropical region in South India: The Influence of Meteorology Dynamics

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Aerosols plays a crucial role in climate dynamics and human health through atmospheric processes. Their effects, both direct and indirect, contribute to the cooling and warming of the earth. This paper provides an analysis of the spatiotemporal variation of different types of aerosols over Andhra Pradesh (AP) state in South India, retrieved from the Modern-Era Retrospective Analysis for Research and Application, Version 2 (MERRA-2) reanalysis data. We comprehensively analysed the datasets on the aerosol optical depth (AOD) and the optical depths of their subtypes (Black Carbon, Organic Carbon, Dust, Sea Salt, and Sulphate). The significant results revealed that the higher AOD observed in the northern coastal AP were influenced by anthropogenic emissions and natural sources such as sea spray and wind-blown dust. Seasonal trends indicate an elevated AOD during the premonsoon period due to an increase in the transportation of dust and during monsoon because of the high humidity and sea salt aerosols; meanwhile, in the winter and postmonsoon seasons, we discovered lower AOD levels. In addition, the anomalies in the AOD were primarily linked to meteorological parameters such as wind patterns, temperature, and relative humidity, as well as emissions from the different industrial, vehicular, and agricultural activities in the central and northern parts of AP. This study highlights the influence of synoptic meteorological conditions, including monsoonal wind dynamics and regional temperature variations, which leads to the spatial distribution and transport of aerosols types. These findings provide crucial insights into aerosol dynamics over AP state, aiding in air quality management and climate impact assessments.

sciforum-120431: The Impact of Changing Policies on Aerosol Pollution in China from 2000 to 2022

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China has implemented a series of air pollution policies and measures to address its severe air pollution problem, particularly in relation to particulate aerosols. However, the temporal effectiveness of these policies remains unclear. This study investigates the impact of policy changes on aerosol pollution across China's seven major geographical regions from 2000 to 2022. The period is divided into four stages: 2000–2007, 2008–2014, 2015–2017, and 2018–2022. Using CALIPSO, MERRA2, and AERONET data, the study analyzes changes in the aerosol optical depth (AOD), an important indicator of aerosol loading, and the vertical distribution of aerosol types in the seven regions, as well as the long-range transport of aerosols at five sites during each stage. The results show that China's annual average AOD increased from 2000 to 2007, a period that was characterized by minimal air pollution restrictions and a focus on economic development. From 2008 to 2013, the increasing trend of the AOD was curbed due to the implementation of air pollution policies, resulting in relatively stable changes. From 2014 to 2017, the AOD exhibited a significant downward trend under the influence of the "Air Pollution Prevention and Control Action Plan." From 2018 to 2022, the AOD remained relatively stable. These results suggest that more stringent air pollution policies are needed to continue improving particulate aerosol pollution.

sciforum-115885: Unveiling Aerosols and Clouds with AI: Insights into Climate and Monsoon Variability Over the Bay of Bengal

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The Bay of Bengal (BoB), a critical region within the northern Indian Ocean, experiences complex interactions between aerosols and cloud properties, driven by anthropogenic emissions and natural processes. This study analyzes long-term aerosol and cloud optical properties using coupled Moderate Resolution Imaging Spectroradiometer (MODIS) and Modern Era Retrospective for Research Applications (MERRA-2) datasets with an advanced Artificial Intelligence (AI)-based Machine Learning (ML) model. Seasonal comparisons reveal significant aerosol optical depth (AOD) variability, with peaks during the summer due to dust transport and anthropogenic activities and reductions during monsoons due to wet scavenging effects. The regional patterns highlight elevated AOD and cloud optical depths in the northern BoB, which are linked to industrial emissions and biomass burning, whereas the southern BoB exhibits cleaner marine air, a lower AOD, and larger cloud droplets. Aerosol–cloud interactions are analyzed via spatial correlations, demonstrating how aerosols influence clouds' microphysics, including their optical depth, liquid water path, and precipitation efficiency, with distinct regional disparities. This research provides novel insights into the role of aerosols in modulating cloud characteristics and climate variability in the monsoon-dominated BoB, advancing our predictive capabilities for regional weather and climate systems. It also advances our understanding of aerosol–cloud interactions to improve climate predictions and mitigation strategies while addressing the impacts of air quality on human health and protecting marine ecosystems that are affected by atmospheric processes.

sciforum-120361: Using the synergy of the spectral dependence of scattering and absorption for aerosol type identification and the application of this method over a continental background site in NW Greece

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Aerosol particles suspended in the atmosphere originate from a variety of natural and anthropogenic sources, with their optical, physical, and chemical properties often serving as indicators of their origin. However, long-range aerosol transport, ageing processes, and the mixing (external and internal) of various types in the atmosphere render aerosol-type identification a real challenge. Nevertheless, several techniques and classification matrices have been established for the better classification of aerosols into groups representative of their specific or dominant sources.

In this context, this study focuses on the first attempt at aerosol-type classification using in situ measurements from an aethalometer and a nephelometer at a continental background site in NW Greece (Kozani; 40.27 °N, 21.76 °E, 768 m). The classification matrix was based on the combined analysis of the Absorption Ångström Exponent (AAE) and the Scattering Ångström Exponent (SAE) values over a one-year period (2023).

Using appropriate threshold values, seven key aerosol types were identified and analyzed in terms of their seasonal, monthly and diurnal variations. The Black Carbon (BC)-dominated type was the most frequent, indicative of a regional background atmosphere influenced by fossil fuel combustion. A mixed Brown Carbon (BrC)–BC type was also frequently observed in winter, along with occasional occurrences of a pure BrC type, both of which are associated with biomass burning for residential heating in nearby villages. Another common category was a mix of large aerosols and BC, present throughout the year, while dust was detected episodically, primarily during Saharan dust transport events. Two types of aerosol, characterized by AAE values below 1 for fine (SAE>1) and coarse (SAE1), were of lower frequency, indicating a possible mixing of carbonaceous aerosols with inorganic species of weaker spectral absorption. We analyzed the spectral absorption and scattering coefficients of each type of aerosol, as well as their single scattering albedo and $PM_{2.5}$ levels, which exhibit substantial seasonal variations.

Session 9. Air Pollution Control

sciforum-113316: A holistical approach for the minimization of nitrous oxide (N_2O) emissions from brewery wastewater treatment using malt-sprout-derived biochar

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Industrial wastewater treatment is regarded as one of the significant greenhouse gas (GHG) resources by the Intergovernmental Panel on Climate Change (IPCC). Nitrous oxide (N_2O) is a major GHG which could be released from agro-industrial wastewater treatment plants. From this point of view, this study investigated the minimization of the nitrous oxide (N_2O) emissions originating from brewery wastewater treatment using malt-sprout-derived biochar. The main objective of the study was the minimization of N_2O emissions from brewery wastewater treatment using the biochar adsorption process. The hypothesis of this study was that biochar could effectively uptake the N_2O from wastewater due to the higher adsorption capacity from the soil. This study was unique in that malt-sprout-derived biochar was used as the N_2O adsorbent for brewery wastewater treatment. The biochar was derived using slow pyrolysis at three different temperatures: 300 (MS1), 400 (MS2), and 550 °C (MS3). The malt sprout and industrial wastewater were ensured from a full-scale brewery industry wastewater treatment plant in Turkey. The correspondence between the N_2O emission and wastewater treatment quality was investigated by Monte Carlo simulation. The gas resulting from wastewater treatment was collected and determined using gas chromatography equipped with an electron capture detector (GC-ECD). N_2O was sampled and measured seasonally, before and after the biochar adsorption process. Furthermore, gas adsorption was performed using the same biochar to verify the N_2O capture capacity of the biochar and minimize the GHG emissions. An average of 25.6% of minimization in N_2O emissions from brewery wastewater was reported using malt-sprout-derived biochar. The simulation results showed that the total Kjeldahl nitrogen (TKN) and ammonium (NH_4-N) had the highest correspondence with N_2O emissions. The highest N_2O uptake capacity was correlated with the biochar derived at the lowest temperature (MS1).

sciforum-110805: Reducing Carbon Dioxide (CO_2) Emissions in Residential Buildings Through Envelope Renovation

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The construction sector significantly influences environmental development and is a significant source of carbon dioxide (CO_2) emissions worldwide. Over the years, the sector's decision-making procedures have frequently prioritised economic concerns over sustainability. Nonetheless, recently, there has been growing recognition of the importance of evaluating the environmental impacts at every stage of a building's lifecycle, from the design process to its demolition. This study uses Design Builder software to simulate a base case residential building in Mozambique, aiming to identify the most impactful design parameters for reducing its CO_2 emissions while reducing its energy consumption. By analysing data from both the base case and modified design schemes, this research reveals that employing 95 mm thick foamed expanded polystyrene (EPS) panels for roofing and double glazing of 6 mm/13 mm within an air/wood frame for exterior windows can reduce the energy consumption by 42.14% and decrease CO_2 emissions by 42.20% compared to these values in conventional construction designs. These results emphasise how crucial it is to use alternative building materials to reduce energy consumption and lessen the environmental impact of residential buildings. This study also urges stakeholders to embrace progressive policies and practices that promote sustainable growth in the industry and push for a paradigm change that strikes a balance between environmental and economic viability.

sciforum-113563: Source Identification of PM2.5 and Carbonaceous Aerosols During a Long Dry Period in the Cities of Abomey-Calavi and Cotonou, Benin

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Carbonaceous components are important components of fine atmospheric particulate matter ($PM_{2.5}$) and can affect the local environment, climate, and human health. In this study, the daily atmospheric PM2.5 and carbonaceous aerosol (organic carbon (OC) and elemental carbon (EC)) concentrations were measured at Arconville in Abomey Calavi and Mahoule in Cotonou, Benin, Southwest Africa, from December 2016 to March 2017. The mass concentration and ratios of PM2.5 aerosol and organic and elemental carbon and the OC/EC radio were evaluated together to obtain better insight into their possible local and regional sources. For the studied period, the mean mass concentrations of PM2.5 aerosol were 64 ±16 $\mu.gm^{-3}$ and 79 ±18 $\mu.gm^{-3}$ at the traffic sites in Arconville and Mahoule, respectively. The OC and EC concentrations were 31 ± 13 $\mu g{\cdot}m^{-3}$ and 9 ± 06 $\mu g{\cdot}m^{-3}$ for Arconville's traffic and 38 ± 16 $\mu g{\cdot}m^{-3}$ and 13 ± 08 $\mu g{\cdot}m^{-3}$ at Mahoule, respectively. Adding together the total carbon (TC), it accounted for 62.5% and 64.56% of the PM2.5 at Arconville and Mahoule. The OC/EC ratio was 3.44 at Arconville and 2.92 at Mahoule, exceeding 2.0, which confirmed the presence of secondary organic aerosols during the long dry period at these two traffic sites.

sciforum-120435: A spatiotemporal Downscaling Framework based on machine learning for hourly 1 km PM2.5 mapping in China

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PM2.5 pollution is a global environmental problem, and its hourly exposure characteristics are closely related to short-term health risks. Traditional estimation methods are mainly based on satellite AOD, which are limited by AOD's daily timescale and cloud/snow interference, resulting in difficulties in meeting the short-term prediction needs of PM2.5 pollution and in achieving high spatial resolution. This study proposes a spatiotemporal downscaling framework based on the Light-GBM (ST-Light-GBM) algorithm that integrates multi-source data. It innovatively integrated the daily 1 km PM2.5 data derived from AOD and other auxiliary predictors as a primary predictor for the hourly modeling instead of using the satellite AOD directly. Based on this, coupling with meteorological high-temporal-resolution data, this study successfully constructed a 1 km, hourly PM2.5 concentration prediction model. Testing on China in 2019, cross-validation results showed that the model was significantly superior to traditional methods in three dimensions (the random 10-fold cross-validation (10CV) R^2 reached 0.94, the spatial 10CV R^2 was 0.85, and the temporal 10CV R^2 was 0.92). The modeling process results indicated that incorporating the daily average variation in PM2.5 is important in capturing the hourly fluctuation characteristics, with a 0.84 correlation coefficient with hourly measurements and ranking top in variable importance analysis. The framework developed in this study realizes the importance of daily pm2.5 in the dynamic downscaling modeling of hourly concentration, providing a theoretical paradigm for building a "daily constraint-hourly response" PM2.5 prediction model, and produces gap-free pm2.5 data with both high spatial and temporal resolution for supporting refined pollution prevention and control and health risk assessment.

sciforum-113106: Assessing Air Quality Through Tree Bark Biomonitoring of Praseodymium in Leicestershire, UK

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Praseodymium (Pr) has been detected in the air of the city of Leicester (England). To further biomonitor air quality for Pr, thin layers of bark were collected from 96 trees in Leicester (n=55) and surrounding rural/suburban areas (41). Pr was monitored by ICP-MS [LoD=0.157 ng/g dry weight (dw)]. Levels were slightly higher in the samples collected from trees growing in urban areas (median and ranges, in ng/g dw): 2.611 (0.714-47.603) and 2.450 (0.757-14.839). Pr content varied between bark samples collected across the city (medians, in ng/g dw): 11.374 (SE) > 4.183 (SW) > 2.471 (NE) > 1.967 (NW), and between the three quadrants into which the rural areas were divided: 7.348 (NW) > 2.244 (NE) > 0.881 (SE). Finding a hypothesis that could explain the differences found is challenging as the atmospheric transport of this metal and other rare earth elements (REEs) is poorly understood. However, our results could suggest that the airborne Pr content is little influenced by its presence in the topsoils, as the patterns found were different for the two main areas: NE>SW>SE>NW and SE>NE>SW>NW. Levels were much higher than the range reported in bark samples (1.85-2.69 ng/g dw) collected in an area of eastern Washington (US) with little anthropic pollution, suggesting that the air quality of Leicestershire would have some anthropic input. However, the enrichment factors (0.436 and 0.487), calculated in relation to the average Pr concentration in the Earth's continental crust and the scandium content, were very low in both areas, suggesting no discernible enrichment. These values were also lower than those observed for other REEs monitored in the same bark samples, reinforcing the minimal anthropogenic input of Pr into the air of Leicester city and surrounding areas, as REEs are known to behave as a coherent group of elements in plants.

sciforum-116548: Concept and development of air quality sensor for citizen science

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This paper presents the concept and development of an autonomous DIY air quality sensor for citizen science. Large civil monitoring projects often rely on air quality calculations based on PM2.5 and PM10 dust readings in combination with some gases and do not cover the full list of air quality indicators. The authors have analyzed existing air quality calculation methodologies and attempted to conceptualize a universal AQI monitoring device for use in citizen science and by volunteers. This device is based on the available ESP32 DevKit v1 platform to which compatible sensors have been selected to monitor AQI indicators such as PM2.5 and PM10 dust particles, Ozone, Carbon Monoxide, Nitrogen Dioxide, Sulphur Dioxide, and Ammonia. The SD card module was chosen for data storage, the NB-IoT module for data transmission, and a battery pack for autonomy. The housing, sensor design components and fasteners were also selected. All components are available on the international market. Based on the selected element base, an electrical connection diagram was designed, the device's design, presented in the form of 3D models, was developed, and the assembly process was described. The cost of the device was also evaluated and compared to the price level of existing DIY devices used in citizen science.

sciforum-120434: Daily High-Resolution XCO_2 Mapping across China Using OCO-2 Data and Machine Learning Model

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Accurately monitoring the spatiotemporal distribution of atmospheric CO_2 is essential for understanding the carbon cycle, formulating effective emission reduction strategies, and achieving carbon neutrality. However, research in this area is constrained by a lack of high-quality carbon monitoring data. While satellite remote sensing technologies can provide atmospheric CO_2 data with a high spatial resolution and broad coverage, inherent limitations often result in substantial data gaps. Addressing these gaps and generating high-resolution, gap-free CO_2 concentration datasets have thus become a critical research focus. This study utilizes column-averaged dry air CO_2 mole fraction (XCO_2) data retrieved from the OCO-2 satellite (2021–2022) as its observational input. It integrates XCO_2 data from the coarse-resolution CarbonTracker (CT) reanalysis (3° × 2°) and multiple environmental variables as the predictive inputs to develop and optimize an extreme random tree (ET) model. The goal is to generate a daily, high-resolution (0.01°) XCO_2 dataset with full spatial coverage across China. Spatiotemporal cross-validation demonstrates the model's high accuracy and stability, yielding an R^2 of 0.93 and an RMSE of 0.75 ppm. Independent validation using data from the TCCON and WDCGG sites further confirms the model's effectiveness in capturing atmospheric CO_2 dynamics. This approach not only bridges critical gaps in the existing observational networks but could also enhance carbon cycle analyses and related research. Additionally, it can be extended to longer time series and broader regions, providing robust scientific support for policymakers in climate decision-making.

sciforum-120438: Research on Synchronous Estimation of Ultra-High Spatiotemporal Resolution Concentrations for Six Standard Air Pollutants Using Satellite Remote Sensing and Street View Data

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$PM_{2.5}$, PM_{10}, sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and ozone (O_3) are six fundamental pollutants in atmospheric pollution, posing significant threats to human health and the ecological environment. Given the high spatiotemporal heterogeneity of atmospheric pollutants, there is a lack of in-depth exploration into the fine spatial variations and interactions among multiple atmospheric pollutants, at ultra-high spatiotemporal resolution. In addition, most of the current studies are single-pollutant predictions, which are deficient in time and resource consumption compared with multi-pollutant synergistic predictions. To address these issues, we integrated ground-measured pollutant data, top-of-atmosphere (TOA) radiation remote sensing data, Baidu Street View data, reanalysis data, and other relevant spatiotemporal data. Using a multi-output extremely randomized trees model, we collaboratively predicted six atmospheric pollutants, generating an ultra-high-spatiotemporal-resolution (temporal resolution: hourly; spatial resolution: 100 meters) dataset of atmospheric pollutants in Wuhan, where air quality still suffers from concentration exceedances in the year 2023. The ten-fold cross-validation R^2 for $PM_{2.5}$, PM_{10}, O_3, NO_2, CO, and SO_2 models were 0.71-0.95, respectively. Synergistic prediction models consume only one-fifth the time of single prediction models. The spatiotemporal analysis revealed that among them, the annual average values of $PM_{2.5}$ and PM_{10} exceeded the first-level concentration limits in China. In addition, the annual average values of pollutants have obvious spatial and temporal heterogeneity, showing a distinct spatial pattern of higher concentrations in urban centers and decreasing outwards. Correlation analyses on annual and hourly scales showed some correlation between atmospheric pollutants. In addition, the correlation between them was found to be dynamic over time at the hourly scale. These findings provide a comprehensive, high-resolution dataset of atmospheric pollutants in Wuhan, offering valuable insights into their spatiotemporal distribution and interactions.

sciforum-113095: Tree bark biomonitoring of lutetium contamination in Leicestershire, England

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Tree bark was used to gain an understanding of the atmospheric presence of lutetium (Lu) in Leicestershire (UK). Bark samples were collected from 96 trees in Leicester (n=55), as well as from the surrounding rural/suburban areas (41). Lu was monitored using ICP-MS in cleaned/ground/homogenised samples mineralised with HNO_3/H_2O_2 [LoD=0.000654 ng/g dry weight (dw)]. The results were compared with those of previous studies performed on 106 mushrooms and 850 topsoils collected from the same areas. Slightly higher levels were found in bark samples collected in rural areas (median and ranges, in ng/g dw): 0.584 (0.402-1.071) vs. 0.580 (0.182-2.118), which is in line with the trend detected in the topsoils [0.123 (0.069-0.162) vs. 0.117 (0.084-0.182), mg/kg]. This may be logical as metals released into the air from pollution sources will eventually reach the soil surface. However, the content of Lu was higher in mushrooms collected in the main urban area [0.347 (0.285-293.837) vs. 0.196 (0.780-8.116), ng/g dw)], which could be explained by the small effect of topsoils on the levels of Lu detected in mushrooms, as they showed no statistical correlation (p-value=0.506). Furthermore, our previous observations showed minimal anthropic contamination in the topsoils, which could explain the similar concentrations of Lu in the bark of trees monitored in the urban and rural areas. Lu content varied between bark samples collected across the city of Leicester (median values, in ng/g): 0.892 (SE) > 0.646 (SW) > 0.585 (NE) > 0.544 (NW). Similarly, lower concentrations were found in the soil samples monitored in parks located in the northwest quadrant. The calculated enrichment factors were 2.15 and 2.58 using scandium relative to the upper continental crustal concentration, suggesting particulate phase deposition of Lu at natural background levels in both areas of Leicestershire. However, further studies are required as the atmospheric transport of Lu and other lanthanide elements is poorly understood.

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