UP 3: Air Quality, Exposure and Atmospheric Dynamics

Remote sensing and transport modeling complemented by urban exposure, renewable energy-aerosol interactions, particle transport mechanics, and large-scale dynamics affecting aerosol transport.

Time: Tuesday 11:15–12:45 Location: MER/0002

Invited Talk UP 3.1 Tue 11:15 MER/0002

Supporting the monitoring and tracking of carbon dioxide and methane emissions with satellites — •Dominik Brunner[1], Gerrit Kuhlmann[1], and Yasjka Meijer[2] — [1]Empa, Dübendorf, Switzerland — [2]European Space Agency (ESA), Noordwijk, the Netherlands

Achieving the goals of the Paris Agreement to limit global warming to no more than 2°C above pre-industrial levels requires drastic cuts to emissions of carbon dioxide (CO2) and methane (CH4). The Enhanced Transparency Framework of the Paris Agreement requires all countries to provide transparent information on the implementation and achievement of their national mitigation objectives. The atmospheric community supports this process by providing independent emission monitoring based on atmospheric concentration measurements from ground and space. The European Copernicus CO2 Monitoring mission, CO2M, will be a constellation of three satellites to be launched from 2027, is designed to greatly enhance our capabilities to quantify CO2 and CH4 emissions from industrial sources, cities and countries. In this presentation, we will provide an overview of the CO2M mission, explain how CO2 and CH4 will be retrieved from spectral radiance measurements, and show its complementarity to other observations. We will present examples of how CO2M contributes to quantifying emissions, outline the atmospheric modelling frameworks that will assimilate its observations, and present a long-term perspective of how CO2M together with other observations will support policymakers in reaching the goals of the Paris Agreement.

UP 3.2 Tue 11:45 MER/0002

Stratification patterns of soil particle electric charge distribution boost wind-blown sand transport — •Danilo da Silva Borges, Sandesh Kamath, Gerhard Wurm, and Eric Josef Ribeiro Parteli — Faculty of Physics, University of Duisburg-Essen

Since the pioneering studies by Michael Faraday in the 19th century, it is known that wind-blown sand transport generates electric fields reaching various MV/m. Such fields are caused by contact electrification of sand particles during wind-blown transport, but their effect on the minimal threshold wind velocity (u_{ft}) required for wind-blown sand transport initiation remains controversial. Elucidating this effect is of utmost relevance for a broad range of fields, from desertification research to the geology of Mars. Here we show, by means of CFD–DEM simulations, that u_{ft} can be substantially affected not only by the presence of a particle charge distribution, but also by the spatial distribution of the charges within the granular soil. While a random spatial distribution of charges enhances u_{ft}, the presence of domains of like electric charges in the soil lowers the onset for sand transport. In a general fashion, our simulations suggest that the total electrostatic to gravitational potential energy ratio, C_0, is the most important control parameter, with u_{ft} increasing (decreasing) with the charge magnitude when C_0 is negative (positive). Our findings provide a theoretical framework for the interpretation of wind-tunnel and field data, and demonstrate that spatial charge patterns constitute a key parameter for wind-blown sand transport.

UP 3.3 Tue 12:00 MER/0002

Effective UV doses for the production of cutaneous vitamin D in Athens, Greece: assessing aerosol-related uncertainties in satellite-based retrievals — •Theodora Stavraka[1,2,5], Ilias Fountoulakis[1,5], Kostas Eleftheratos[2,5], Panagiotis Nastos[2,5], Thomais Papazoi[1], Konstantinos Fragkos[3], Andreas Kazantzidis[4], Vassilis Amiridis[6], and Christos Zerefos[1,5,7,8] — [1]Academy of Athens, Greece — [2]University of Athens, Greece — [3]The Cyprus Institute, CARE-C, Nicosia, Cyprus — [4]University of Patras, Greece — [5]Biomedical Research Foundation of the Academy of Athens, Greece — [6]National Observatory of Athens, Greece — [7]Navarino Environmental Observatory, Messenia, Greece — [8]Mariolopoulos-Kanaginis Foundation, Athens, Greece

The purpose of this study is to evaluate satellite- and reanalysis-based retrievals of the UV effective dose for cutaneous vitamin D production using ground-based measurements over Athens, Greece. We evaluate data from (1) the climatology by Fragkos et al., (2024) based on CAMS information combined with OMI and MSG satellite data, and (2) the UV climatology of TEMIS also based on data from various sensors analyzing air quality. Ground-based spectral solar UV irradiance measurements performed with a Brewer MKIV spectrophotometer operating at the Academy of Athens have been used for the evaluation, as well as AOD measurements from a co-located CIMEL sun-photometer, part of the AERONET network. The analysis covers 2008 - 2021 when both the CIMEL and the Brewer were operating side-by-side.

UP 3.4 Tue 12:15 MER/0002

Observations of double aerosol layers below an altitude of 30 km with different causes of formation — •Christian Löns[1], Ronald Eixmann[2], and Christian von Savigny[1] — [1]University of Greifswald, Germany — [2]Leibniz-Institute of Atmospheric Physics at the University of Rostock, Germany

In December 2011, it was possible to observe a second layer with an increased Mie signal above the stratospheric aerosol layer in measurements taken with a Doppler lidar in the southern high latitudes during the collapse of the polar vortex. The signature descends from an altitude of 28 km within a few days and can be observed as a broad aerosol layer after about a week. The signature is also observable in satellite measurements of the aerosol extinction coefficient by OSIRIS and SCIAMACHY. In December 2018, the Kamchatka asteroid, approximately 10 m in diameter, exploded over the Bering Sea. It was the third largest recorded impact on Earth after the Tunguska event and the Chelyabinsk meteor. The expected transport path can be modelled using trajectory analyses. Using measurements of the aerosol extinction coefficient from OMPS-LP, signatures of the Kamchatka asteroid can be observed at an altitude of 26 km one week after its explosion. The signature can be observed on several consecutive days as an increase in the extinction coefficient at an altitude of ∼26-28 km during its transport over the North Atlantic from America towards Europe.

UP 3.5 Tue 12:30 MER/0002

Validation of Airborne HALO Wind and Aerosol Measurements Using Ground-Based Lidar and Radar Observations in Kühlungsborn — •Ronald Eixmann[1], Gerd Baumgarten[1], Frederik Ernst[1], Jan Froh[1], Josef Höffner[1], Philipp Joppe[2], Christian Löns[3], Thorben Lüke-Mense[1], Alsu Mauer[1], Mira Pöhlker[4], Pablo Saavedra Garfias[1], Marina Schimpf[5], and Marius Zecha[1] — [1]Leibniz-Institute of Atmospheric Physics, Kühlungsborn, Germany — [2]Max Planck Institute for Chemistry, Mainz, Germany — [3]University of Greifswald, Greifswald, Germany — [4]Leibniz Institute for Tropospheric Research, Leipzig, Germany — [5]German Aerospace Center, Germany

On 20 August 2025, a scientific research flight was conducted over northern Germany with destination Kühlungsborn as part of the HALO-South mission and its preparatory activities. Flight operations were led by the Leibniz Institute for Tropospheric Research (TROPOS), Leipzig, with coordination by the Max Planck Institute for Chemistry, Mainz, in collaboration with the German Aerospace Center (DLR), Oberpfaffenhofen. Ground-based measurements were carried out by the Leibniz Institute of Atmospheric Physics (IAP), Kühlungsborn.

This contribution presents the first validation results combining ground-based lidar and radar observations with airborne HALO measurements at the tropopause level to assess wind fields and aerosol distributions. The campaign demonstrates the potential of coordinated airborne and ground-based observations to provide a comprehensive, multi-dimensional characterization of atmospheric dynamics and aerosol variability at a single site.