Long-term source apportionment of organic aerosols at Melpitz

Samira Atabakhsh[1], Laurent Poulain[1], Alessandro Bigi[2], Martine Collaud Coen[3], Mira Pohlker[1], and Hartmut Herrmann[1]

1 Leibniz Institute for Tropospheric Research (TROPOS), Leipzig, Germany
2 University of Modena and Reggio Emilia, Modena, 41125, Italy
3 Federal Office of Meteorology and Climatology, MeteoSwiss, Payerne, Switzerland

contact: atabakhsh@tropos.de

Introduction

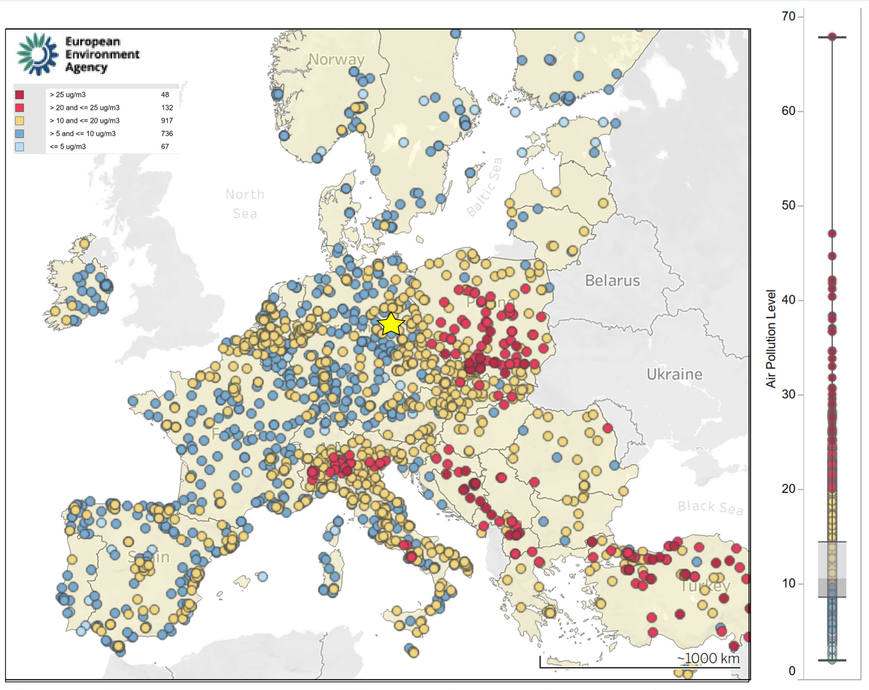

Fig. 1: PM2.5 annual mean, year 2021 (from: European Environment Agency).

Organic aerosol (OA) as a major component of PM_1 (particulate matter with an aerodynamic diameter less than 1 µm) negatively affect human health and have important climate impacts (Daellenbach et al., 2020). The TROPOS rural-background research station Melpitz (☆, 51.54 N, 12.93 E, 86 m a.s.l.) is part of the ACTRIS infrastructure network. Melpitz is under the influence of two prevailing wind directions: Eastern air masses with low PM concentration, and Western air masses with high PM concentration (Spindler et al., 2009), which make it an ideal place to study the change in the chemical composition of aerosol originating from both western and eastern Europe.

In a one year of study, Atabakhsh et al., (2023) demonstrated that OA at Melpitz can be divided in 5 factors identified as HOA (Hydrocarbon-like OA), BBOA (Biomass Burning OA), CCOA (Coal Combustion OA), LO-OOA (Less-Oxidized Oxygenated OA), and MO-OOA (More-Oxidized Oxygenated OA). Here we extended this work to more than 7 years in order to better catch the long-term variability of the OA composition with a special focus on the yearly variability on the seasonality and impact of air mass years.

Methodology

Instrumentation

- **ACSM** (Aerosol Chemical Speciation Monitor) PM_1 Chemical components.
- **MAAP** (Multi-Angle Absorption Photometer) Equivalent black carbon mass (eBC).

Model

- **Rolling PMF** (Positive Matrix Factorisation) **(ME-2** (Multi-linear Engine)**).**
- **SoFi Pro package through Igor pro environment.**
- **HYSPLIT.**

Results and Comclusion

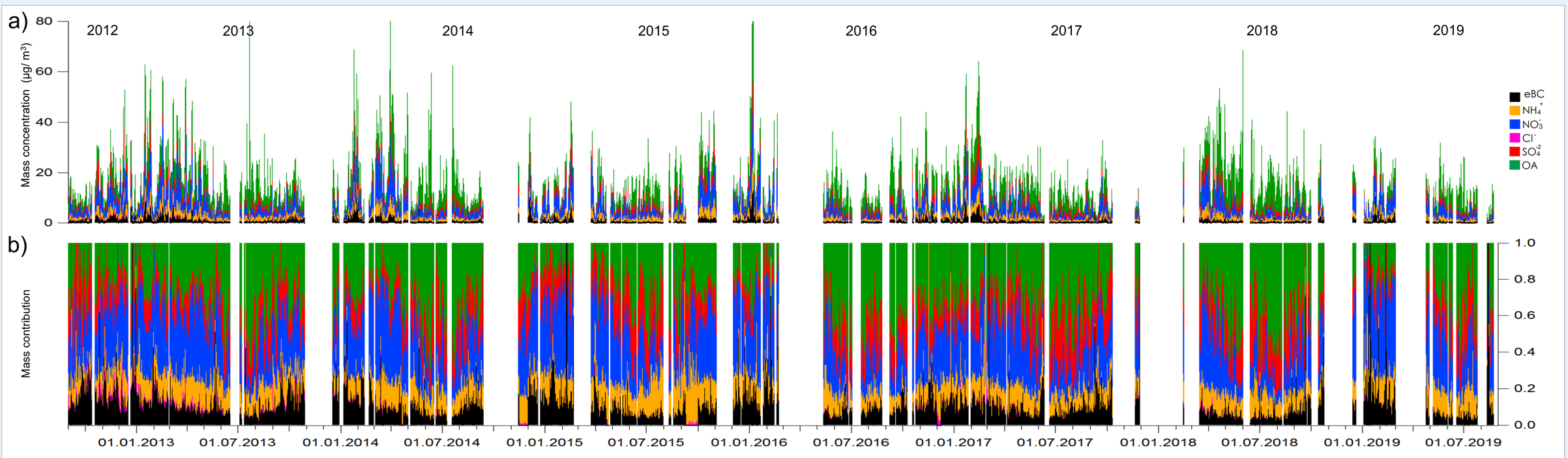

Fig. 2: Cumulative mass concentration (a) and fraction (b) of the main submicrometre components; organic aerosol (OA), sulfate (SO_4^{-2}), chloride (Cl^-), nitrate (NO_3^-), ammonium (NH_4^+), and equivlant bleack carbon (eBC).

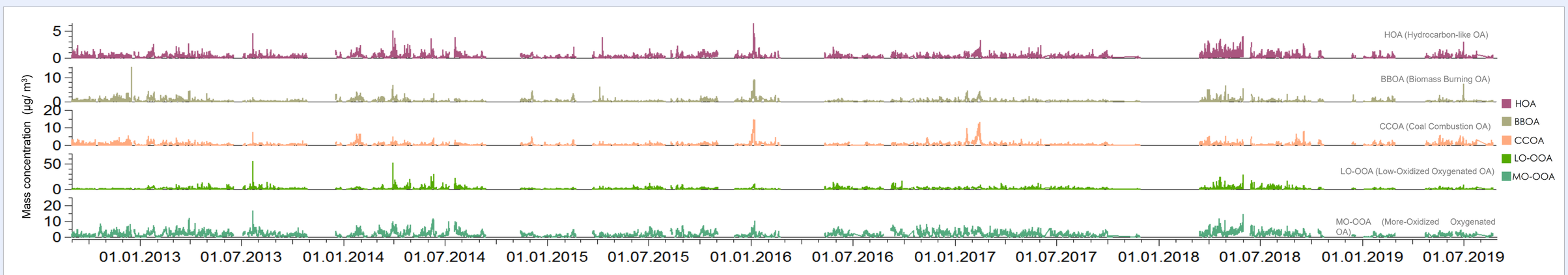

Fig. 3: Mass concentration of organic aerosol source apportionment for 7-years.

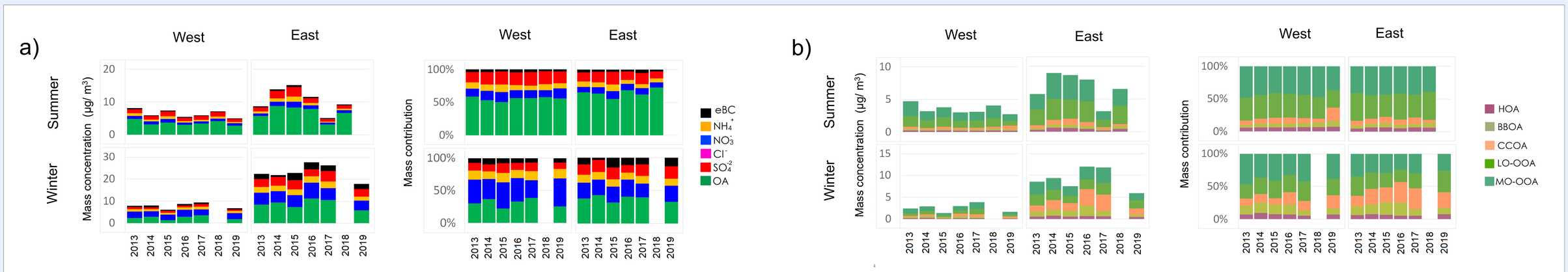

Fig. 4: Mass concentration and contribution of (a) ACSM chemical composition and (b) OA sources based on East-West direction for summer and winter time.

For 7-year long ACSM dataset, a differentiation into four categories for winter (Wi) and summer (Su), and air mass inflow from West (W) and East (E) was carried out following the approach developed by Spindler et al., (2009). The highest PM concentrations were observed for WiE with mean value 23.2 µg/m³, which is in agreement with a previous study for the same station (≈22 µg/m³, Spindler et al., 2009). During summer time, OA was the dominant fraction of the PM mass concentration, while during winter, the inorganic fraction were dominating (Fig. 4a).

During summer time, despite the change on the absolute concentration, the contribution of different OA sources (Fig. 4b) showed the lowest inter-annual fluctuation, while in winter the high variability could be linked to the meteorological parameter like temperature and precipitation. However, anthropogenic sources as BBOA and CCOA showed clear air mass dependency with highest concentration and contribution from eastern air mass, which is highlighting the role of long-range transported emission in this region. Nevertheless, HOA was not affected by the years, seasons, and eastern/western air masses, emphasizing the local emission of HOA for the entire period for Melpitz station.

References

[1] Daellenbach, K, R., et al. (2020) Nature, 587(7834), 414–419.
[2] Spindler, S., et al. (2009) Atmos. Environ., 44, 164-173.
[3] Atabakhsh, S., *et al.* (2023) *Atmospheric Chem. Phys., 23, 6963–6988.*

Acknowledgements

This project has received funding from the European Union's Horizon 2020 research and innovation programme within the infrastructure projects ACTRIS (Aerosols, Clouds, and Trace gases Research InfraStructure Network; EU FP7 grant agreement no. 262254) and ACTRIS-2 (grant agreement no. 654109). This work was also supported by the COST Action COLOSSAL CA16109.