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Multi-year datasets of PM₁ chemical composition and organic aerosol sources in different French urban and suburban areas

H. Chebaicheb, O. Favez, J.F. de Brito, F. Couvidat, B. Chazeau, J.-E. Petit, N. Marchand, C. Marchand, V. Riffault, and French Air quality networks



1. CONTEXT & OBJECTIVES

✓ Diverse impacts of particulate matter (PM) on climate (IPCC, 2021) and human health (WHO, 2021).

✓ Importance of **Organic Aerosols (OA)**, a complex mixture of different emission sources and formation mechanisms.

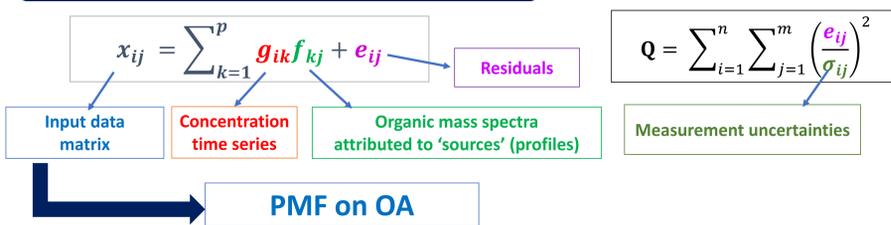
✓ Exceedance of PM levels in various **French cities (EEA, 2022)**

French **long-term** observations at **(peri)-urban sites**
=> **CARA program** (funded by the French Ministry of Ecological Transition).

13 **datasets** were collected for this analysis (2015-2021) using **ACSM** (Aerosol Chemical Speciation Monitor; NR-PM₁: OA, NH₄, SO₄, NO₃ et Cl; TR ≈ 30 min) and **Aethalometer** (AE33; BC et σ_{abs}; TR ≈ 1 min).

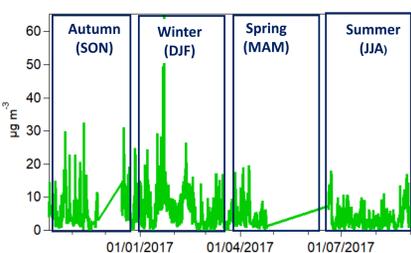
2. METHODOLOGY: Characterization of the OA sources

Positive Matrix Factorization (PMF)



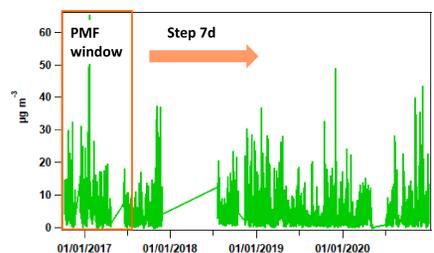
Seasonal PMF

Individual analysis over 4 seasons



Rolling PMF with a 28-day window

(Canonaco et al., 2021)

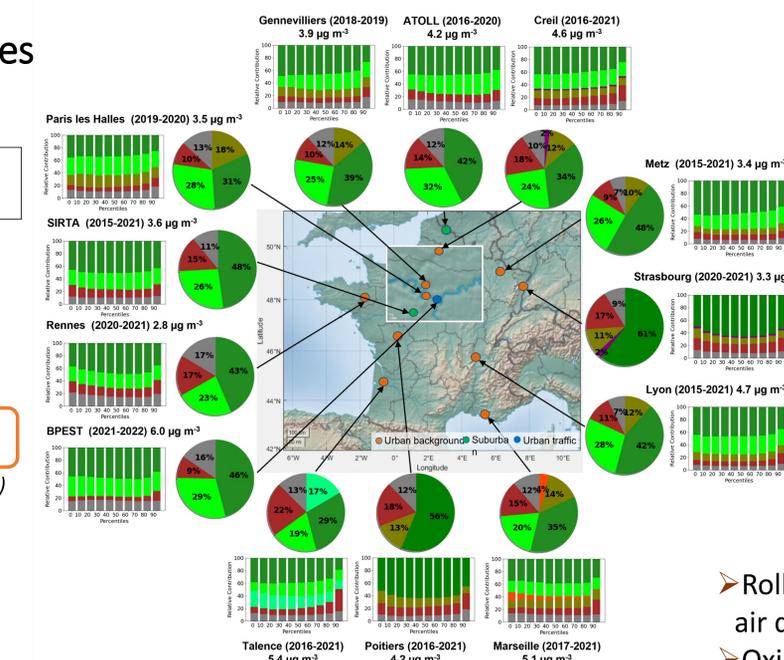
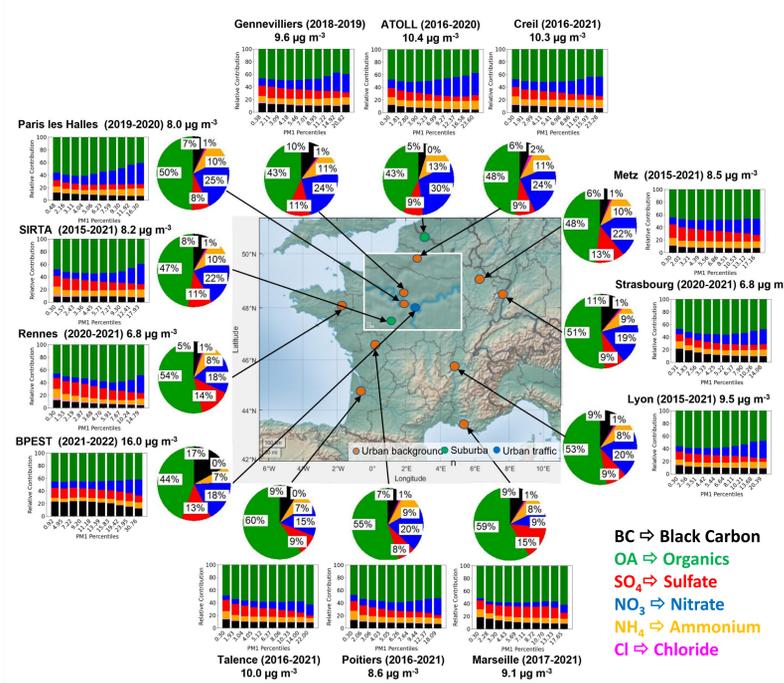


Identification of OA factors

Intra-seasonal variability of profiles

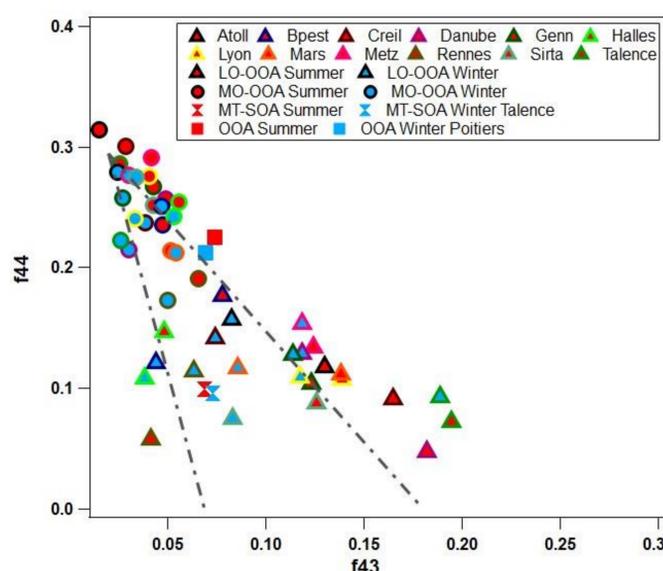
3. RESULTS

- OOA dominates OA at all sites (74%).
- Strong seasonality for HOA and BBOA factors, with maximum concentrations in winter and autumn due to residential heating emissions, and decreasing in summer
- POA from wood combustion increases with OA levels, dominating at highest OA loadings (pollution episodes).
- Strong correlation between LO-OOA and BBOA in winter increases biomass combustion's contribution during cold periods.
- Spatial and seasonal variabilities of f44 vs f43 in the OOA factors (LO-OOA and MO-OOA).

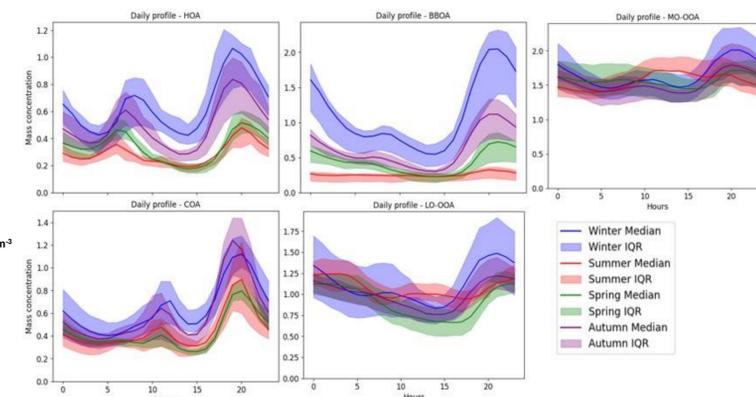


Primary OA factors;
HOA⇒Hydrocarbon-like OA; LO-OOA⇒Less Oxidized
BBOA⇒Biomass burning OA; Oxygenated OA
COA⇒Cooking-like OA; MO-OOA⇒More Oxidized OOA
58-OA⇒Site-specific OA; MT-SOA⇒Monoterpenes SOA
Sh-IndOA⇒Mixed shipping/industrial factor

Secondary OA factors;

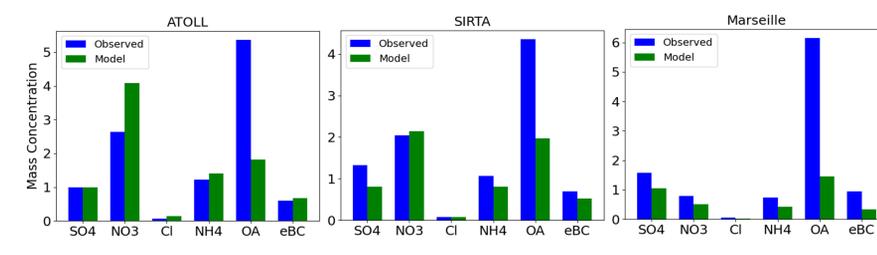


- **OA** dominates PM₁ in France, accounting for 43-60% of the total mass concentration.
- Stations in central and southern France have higher **OA** mass concentrations (due to more intense secondary formation processes?).
- **OA** shows higher contributions to elevated PM1 levels during winter pollution episodes (due to the influence of biomass combustion?) and during summer due to the impact of secondary formation of organic compounds.
- **NO₃** contributions are more pronounced at northern sites due to more favorable conditions for the formation of AN particles, which play an important role during pollution episodes (particularly in spring).



4. CONCLUSIONS & PERSPECTIVES

- Rolling PMF applied on 13 multi-annual datasets from the French air quality network.
- Oxidized OA (aged/secondary) dominated organic matter throughout all sites (74%).
- Biomass combustion dominates OA during winter (not only BBOA)
- Unique factors or specific aged components identified at some of the sites. Further work is required to better constrain the oxidized factors => Future work includes comparison with the CHIMERE 3D model and filter-based aerosol tracers.



5. REFERENCES

- IPCC: Short-Lived Climate Forcers. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, 2021.
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