Source apportionment of $PM_{2.5}$ and its oxidative potential in two measurement sites in south Italy

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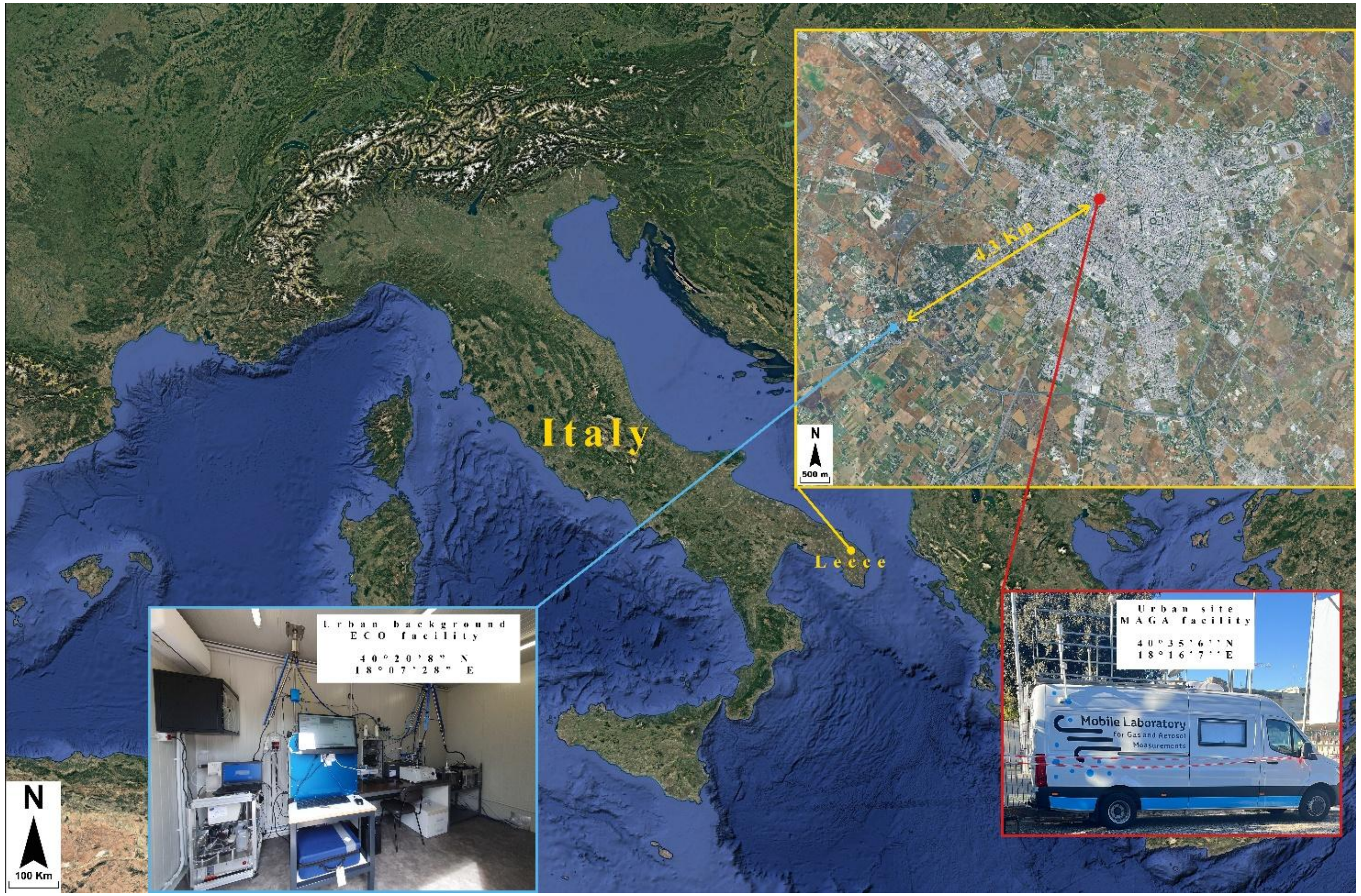
Objectives of the study

Investigate spatial (urban – urban background) and seasonal variabilities (cold-warm periods) of the contributions of sources to $PM_{2.5}$ and its oxidative potential (OP^{DTT}_{V} and OP^{AA}_{V})



Simultaneous measurements at the urban background ECO Observatory and at a traffic site in the urban area of Lecce using the MAGA mobile laboratory, both ACTRIS facilities.

Two campaigns covering approximately three months in the winter period and three months in the spring-summer period of 2024.

Samples were collected in parallel on two substrates (quartz and Teflon filters) together with additional measurements (meteo parameters, and size distributions).

Methods - chemistry

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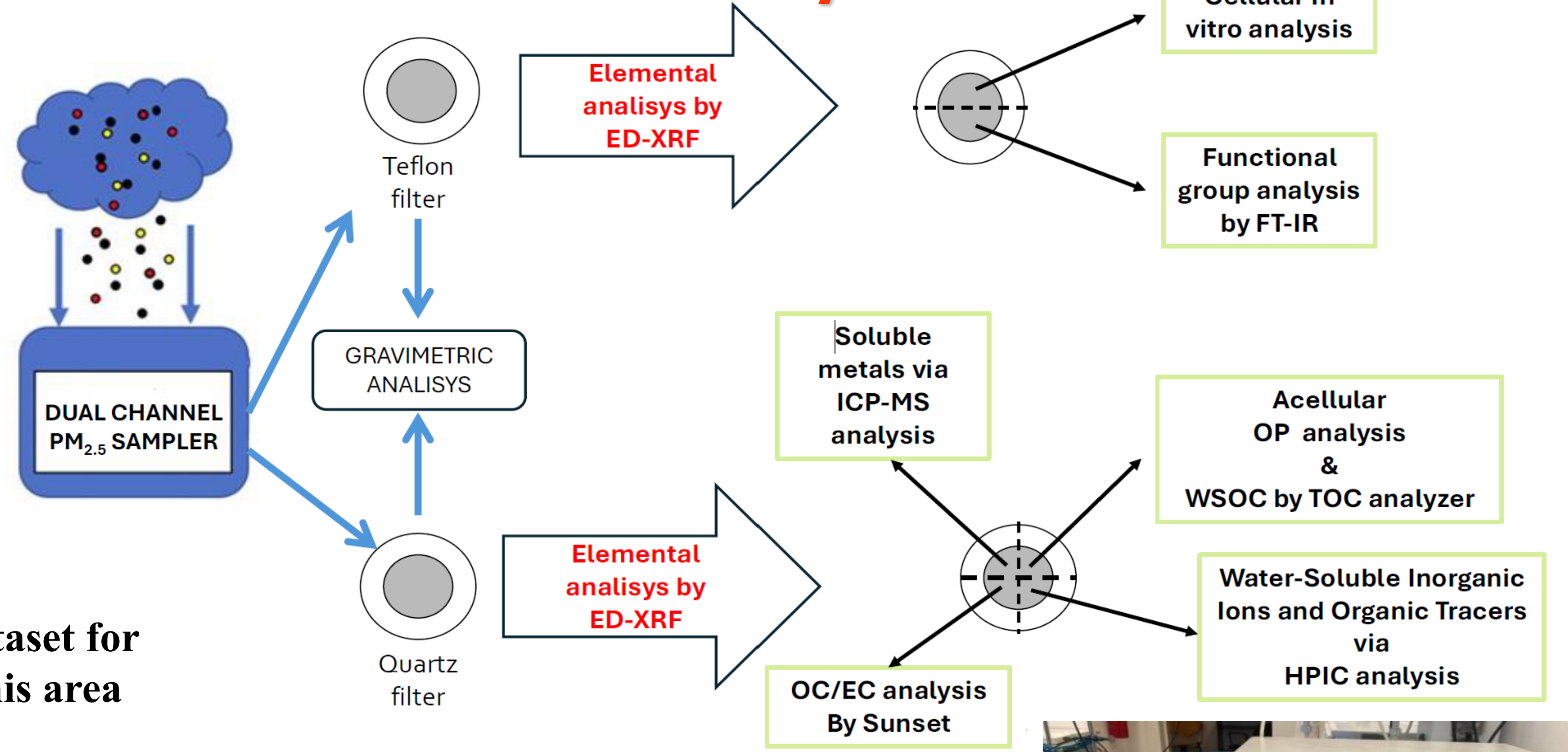
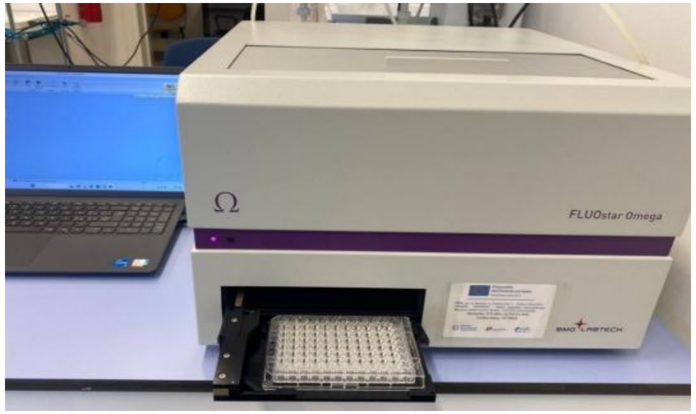
Thursday at 14:00
Presentation of A. Pennetta:
«Composizione e solubilità del $PM_{2.5}$: caratterizzazione chimica e traccianti nel progetto TOX-IN-AIR»



Highly detailed dataset for the first time in this area

- OC, EC, WSOC, WSIC.
- Water-soluble organic nitrogen WSON and amines.
- Total metals and several soluble metals.
- Ions and some organic acids.
- Organic tracers related to BB and PBA.
- OP^{DTT} and OP^{AA}.

OP^{DTT} and OP^{AA}
Determined using an UV-Vis plate reader (FLUOstar Omega - BMG Labtech)



Methods – source apportionment

Dataset of 300 samples and 38 chemical species

OP^{DTT}_V or OP^{AA}_V measured datasets

EPA – PMF5
constraints, bootstrap, displacement

Apportionment of $PM_{2.5}$ in ten sources.

PMF-only
OP apportionment

PMF+MLR with OLS and WLS for OP apportionment

PBA (fungal spores/plant debris) - mannitol and glucose.

Resuspension/construction – some metals, $(Ca)_s$ and $(Mg)_s$

Traffic - EC, Cu, and Cr

Sulphate, nitrate – SO_4^{2-}, NO_3^-, NH_4^+

Sea spray - Cl and Na with Cl/Na=2

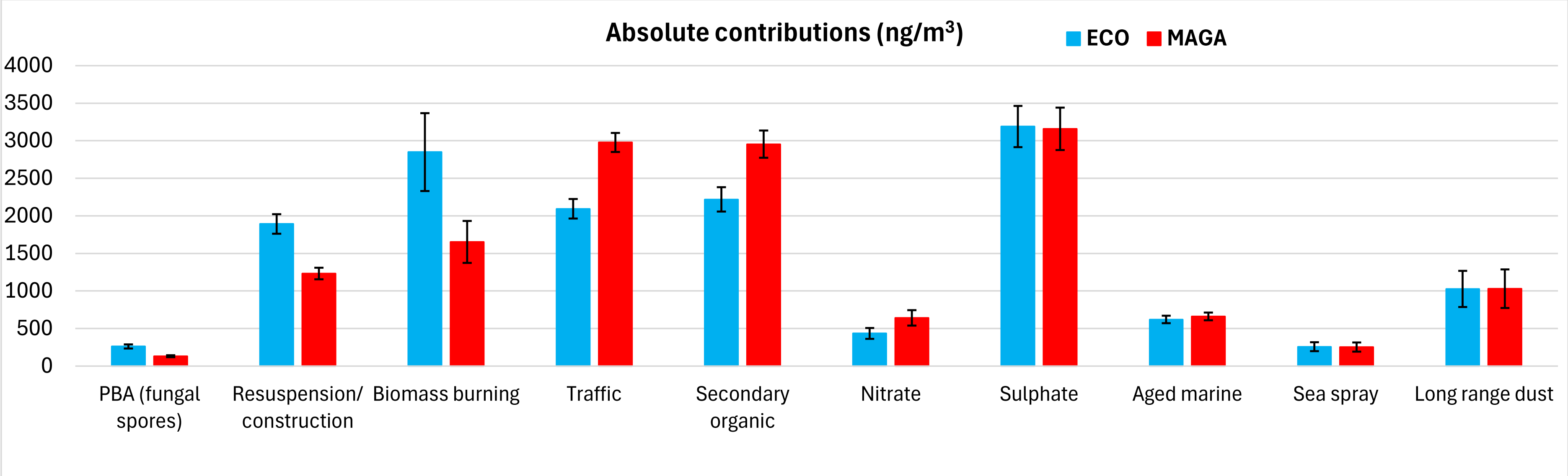
Aged marine source - Na (but not Cl) and $(Mg)_s$

Long range transport of dust - Ti, Si, Al, $(K)_i$, $(Mg)_i$, $(Ca)_i$

Biomass burning - L, M, G, $(K)_s$

Secondary organic aerosol (succinate, oxalate, and OC).

Source apportionment of $PM_{2.5}$ (I)

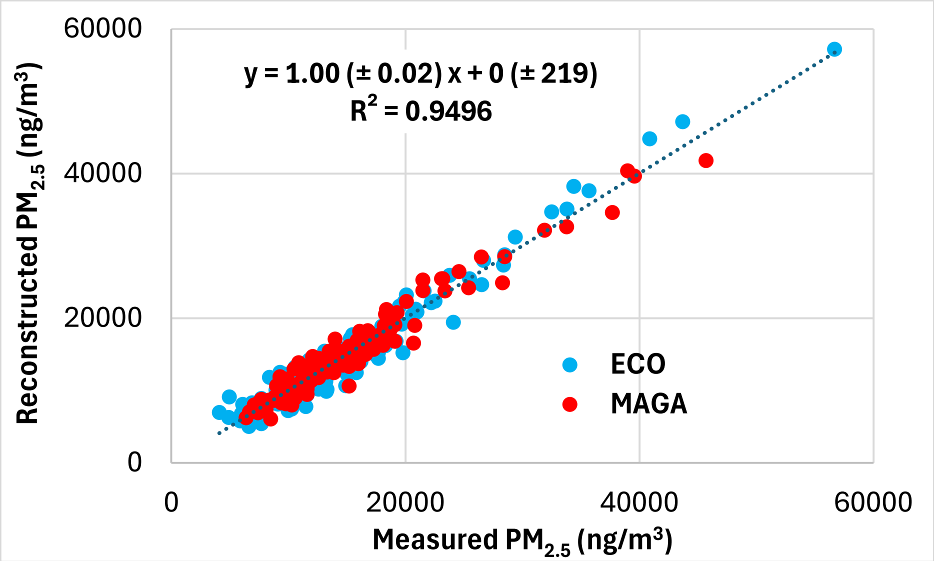


Unexplained mass negligible at both sites.

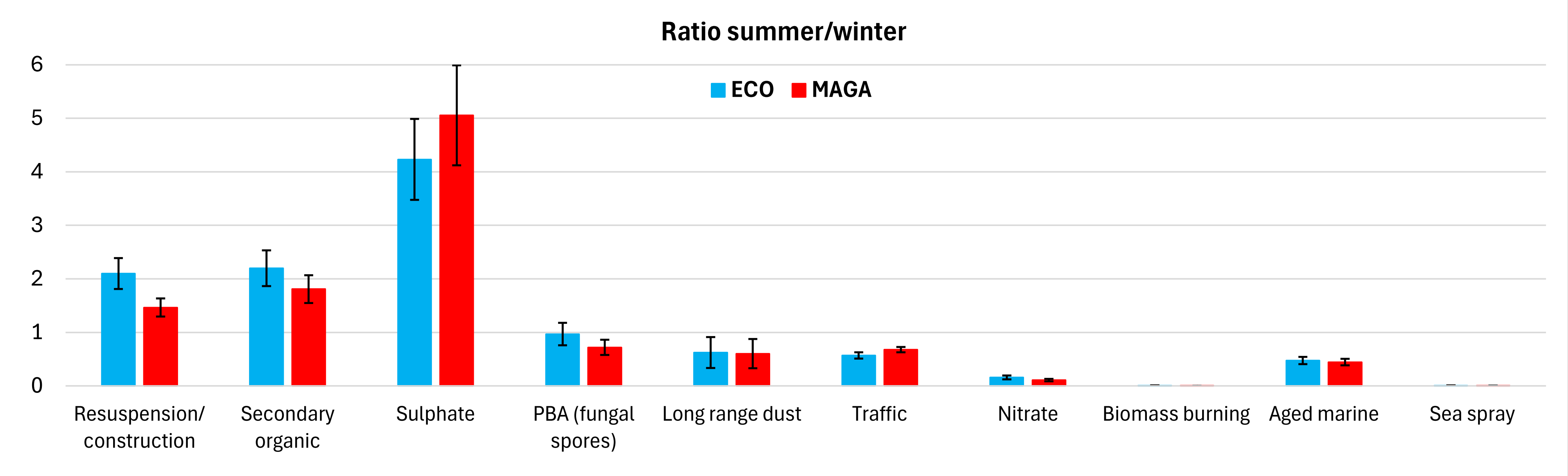
Very good reconstruction of $PM_{2.5}$ by the apportionment.

Average $PM_{2.5}$ is not statistically different at the two sites, approximately 0.7 µg/m³ difference.

Contrasting trends of different sources efficiently contrast and reduce spatial variability: **primary traffic and secondary organics** (partly traffic-induced) **larger** in urban site while **BB and resuspension/construction lower** at urban site.



Source apportionment of $PM_{2.5}$ (II)

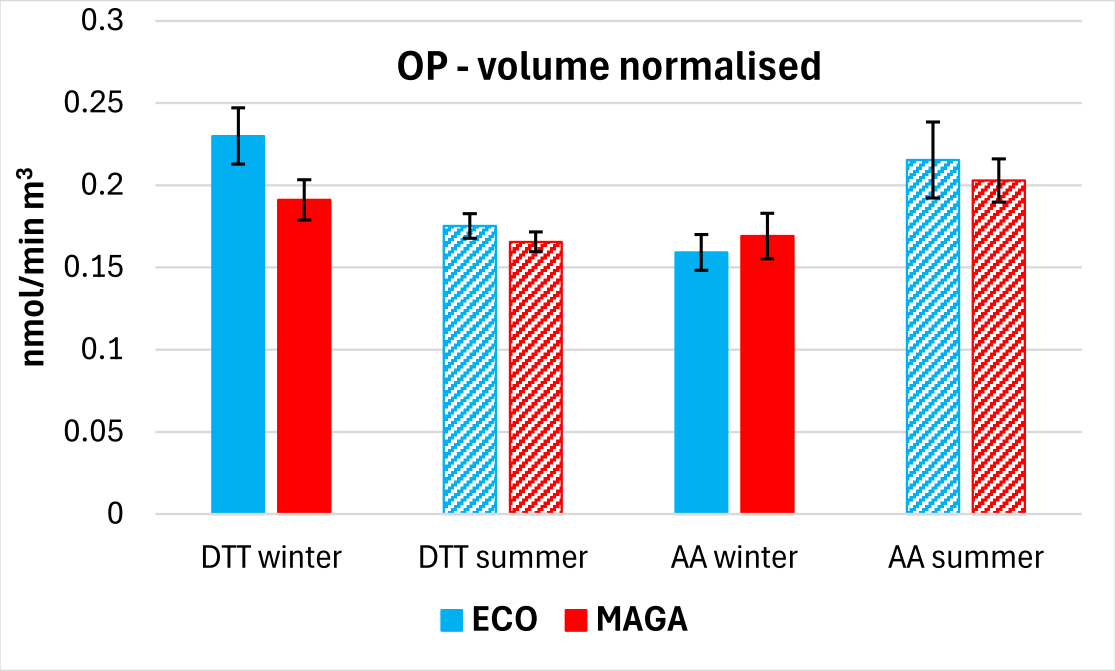


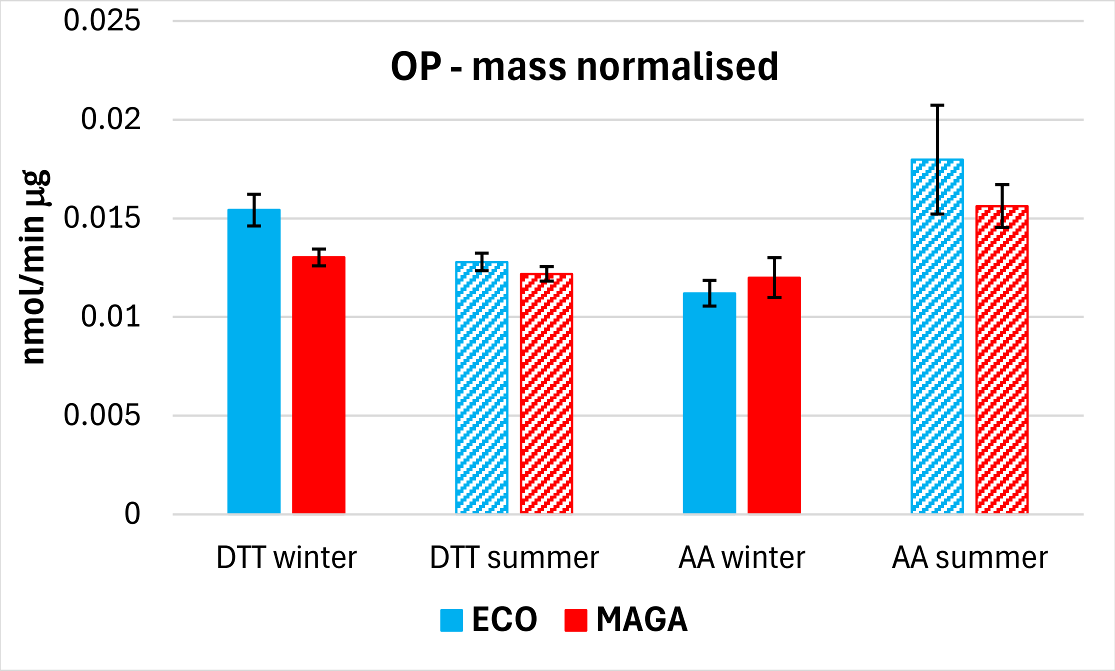
$PM_{2.5}$ concentrations at the two sites are slightly lower (not statistically significant) during the warm period compared to the cold one. **Reductions of approximately 9-11%.**

Competing seasonal trends with **local soil, secondary organic aerosol and secondary sulphate** larger during summer while **combustion sources, nitrate (thermally unstable), and natural sources** higher during winter.

These findings, even if limited to a specific area, are promising for suggesting season-specific air quality mitigation strategies.

Variabilities of OP





Divergent seasonal trends for OP^{DTT}_{V} and OP^{AA}_{V}. **OP^{DTT}_{V} is higher during winter**, particularly at the urban background site (impact of biomass burning), in contrast, **OP^{AA} values are higher during the summer**.

Spatial variability is significant only **during winter for OP^{DTT}** suggesting that biomass burning is the driver of spatial variability of DTT activity in this area.

OP^{DTT} and OP^{AA} are likely **influenced by different drivers**.

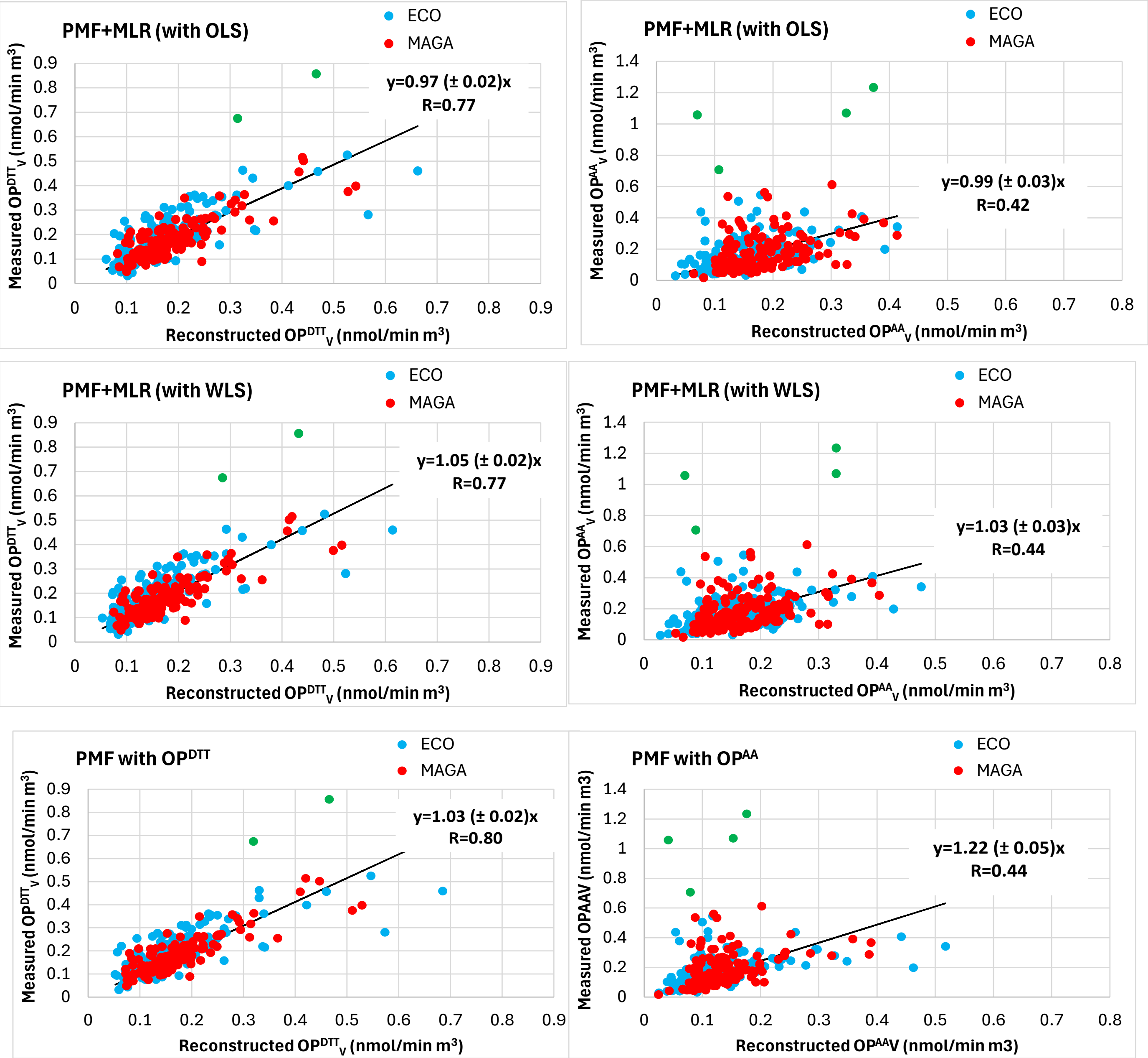
Apportionment reconstruction of OP

Efficiency of reconstruction is similar for the three approaches used at the two sites.

Unexplained	OLS	WLS	PMF-only
OP^{DTT}_V	3%	10%	10%
OP^{AA}_V	10%	15%	31%

The reconstruction of OP^{AA} is less efficient compared to OP^{DTT}.

Two possible reasons: the trends of the sources does not capture the variability of all species influencing OP^{AA}; non-linear interactions are stronger for OP^{AA} compared to OP^{DTT}.



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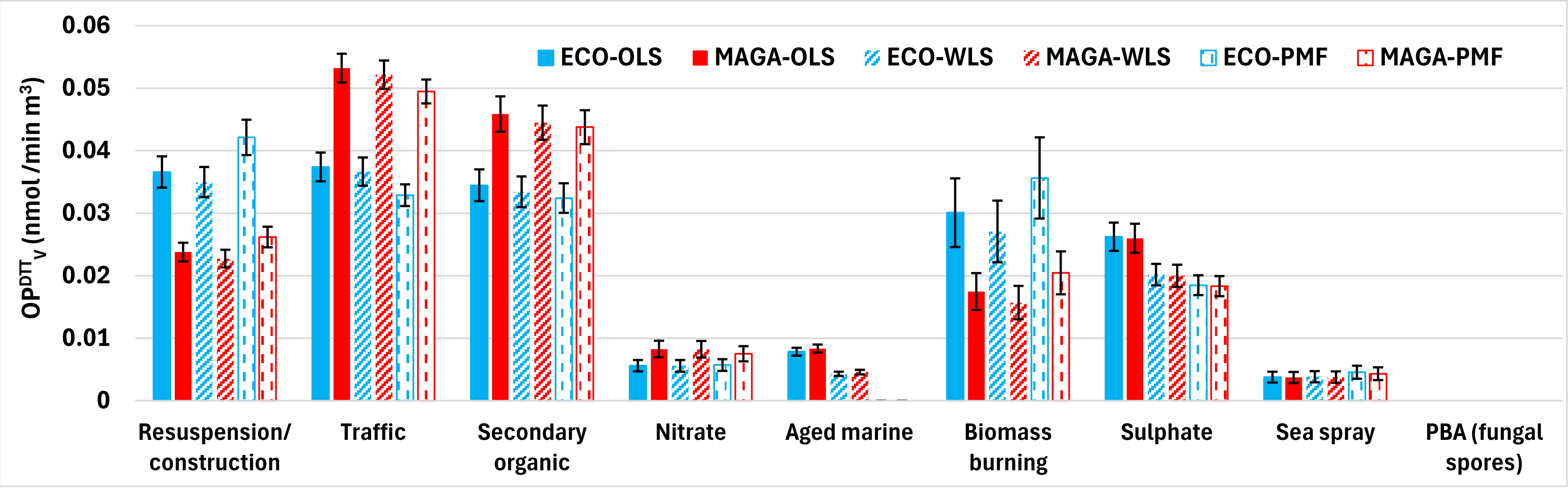
Source apportionment of OP

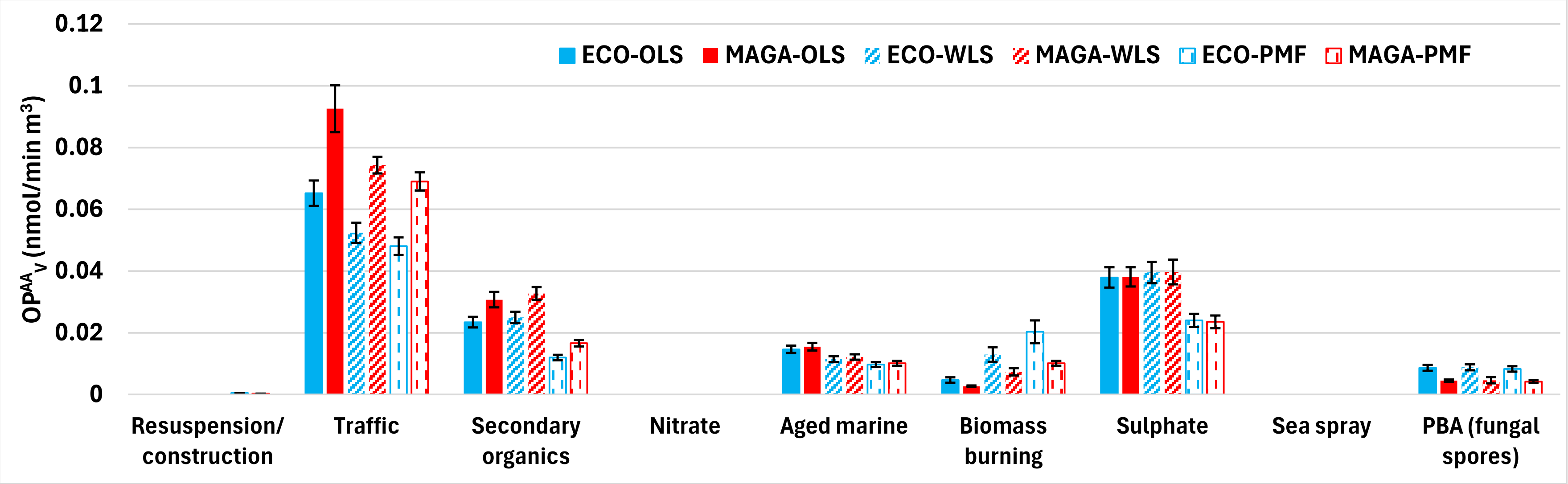
Traffic was the main contributor to OP^{AA} at both sites, while OP^{DTT} was influenced by a more complex mixture of sources.

Sea spray, nitrate, and construction-related emissions impacted OP^{DTT} but not OP^{AA}. PBA (fungal spores) influenced OP^{AA}.

Biomass burning seems to influence OP^{AA}_V much less compared to its influence on OP^{DTT}_V.

No clear reason to prefer one SA method compared to the other, however WLS and PMF seems to be more comparable.





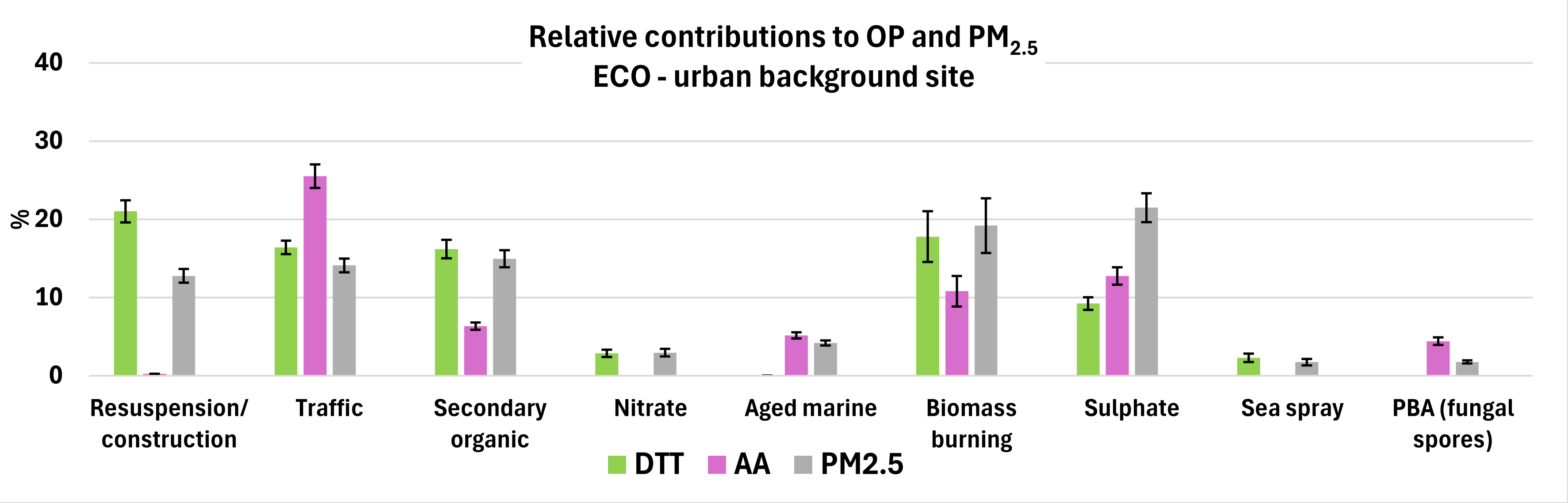
Relative contributions to $PM_{2.5}$ and OP (PMF-only)

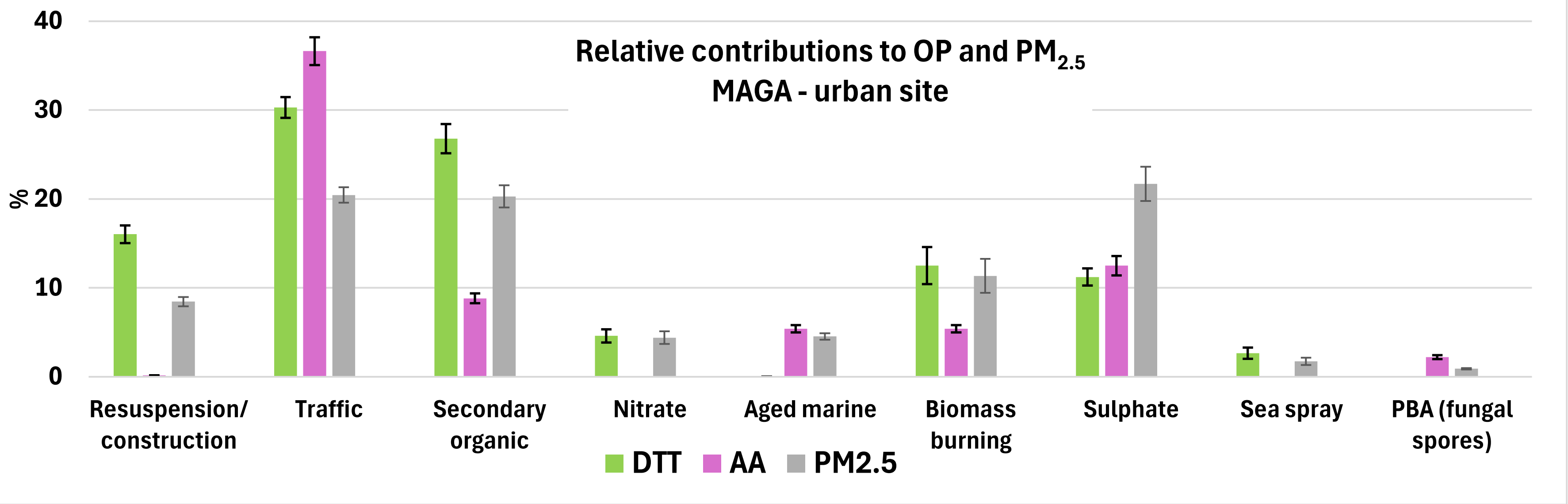
Traffic has disproportionated relative contribution to both assays compared to $PM_{2.5}$.

The same for resuspension/construction but limited to OP^{DTT}.

The **weight of SOA seems to be larger for OP^{DTT}** compared to OP^{AA}.

Sulphate influence both OP assay less than $PM_{2.5}$ mass. This is likely due to the Sulphate profiles that is not a pure stoichiometric profile.





Key messages

Contrasting spatial trends of traffic, BB and resuspension/construction **dampen spatial variability.** While **seasonal trends of $PM_{2.5}$ are damped** by opposite trends of primary combustion sources and secondary organic and inorganic aerosol. **Possible gain from season-dependent mitigation strategies.**

Divergent seasonal trends for OP^{DTT}_{V} and OP^{AA}_{V}. **OP^{DTT}_{V} is higher during winter**, particularly at the urban background site (impact of biomass burning), in contrast, **OP^{AA} values are higher during the summer**. **Spatial variability** is significant only **during winter for OP^{DTT}** with biomass burning being the driver of winter spatial variability of DTT activity in this area.

The source apportionment of OP^{DTT} is more efficient of that of OP^{AA}. This suggests that the identified sources are not capturing all changes of tracer elements influencing OP^{AA} or that there are non-linear effects stronger compared to those of OP^{DTT}.

Traffic was the main contributor to OP^{AA} at both sites, while OP^{DTT} was influenced by a more complex mixture of sources. **Biomass burning influences OP^{AA}_{V} much less compared to OP^{DTT}_{V}.**

No clear reason to prefer one SA method compared to the other, however WLS and PMF seems to be more comparable.

Thanks for the attention!

With the support of the projects

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1 **Unraveling the Different Drivers of $PM_{2.5}$ Mass and Oxidative**
2 **Potential at Two Sites of Southern Italy**

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