Caratterizzazione delle sorgenti di Aerosol Organico in due siti urbani (Bologna e Milano) in Pianura Padana: confronto annuale nell'ambito del progetto RI-URBANS

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[4]ARPA Lombardia, Milano, 20124, Italia
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What is RiURBANS?

A European project upgrading urban air quality monitoring infrastructures to tackle emerging health impacts.

Its goal

Develop complementary monitoring systems to **empower air quality policies**.

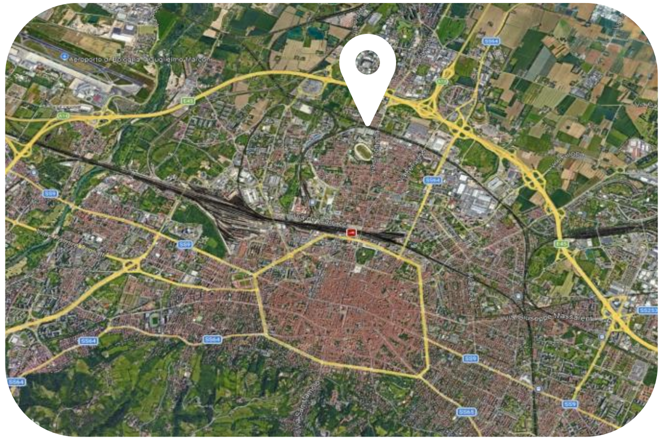
Why Po Valley?

One of the most polluted areas in Western Europe, with poor air quality driven by its **orography, population density and anthropic activities**.

Measurements sites

RiURBANS campaign: Dec 2022 – Dec 2023

Bologna



- **Urban background** (CNR Research Area)
- **2700 inh/km²**
- **Central Po Valley, 54 m a.s.l.**

Milan

- **Urban background** (CNR Research Area)
- **7500 inh/km²**
- **North-western Po Valley,** 120 m a.s.l.

Instruments

(Q- and ToF)ACSM

NR-PM$_1$
(Org, NO_3, SO_4, NH_4, Chl)

AE33

eBC
Liquis vs solid fuels

Gas analyzers

NO_x, O_3

Meteo

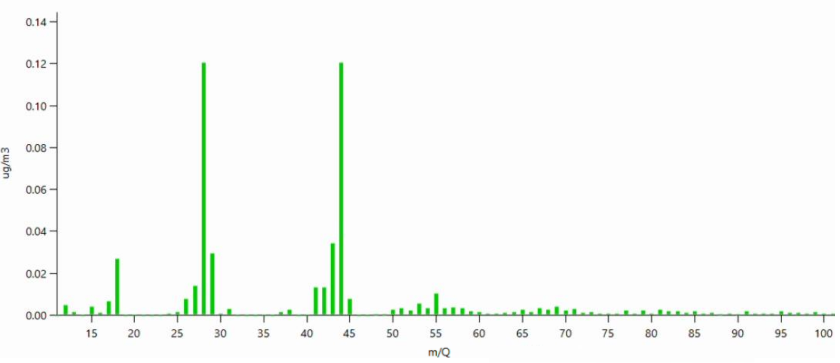
WS, RH, Sol. Rad., T

Methods

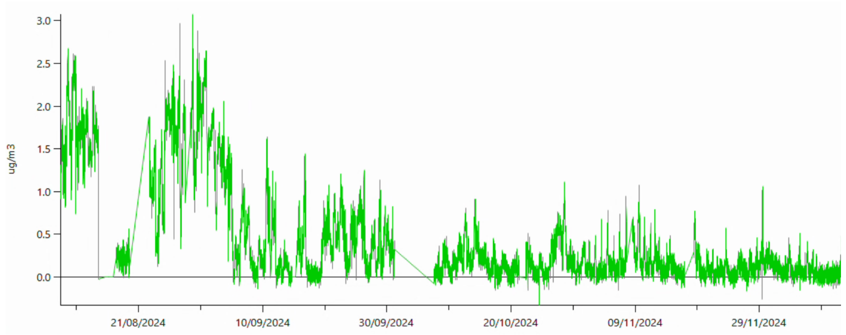
Source Apportionment

Data input

Org Mass Spectra



Org Time Series



ME-2

SoFi[1]

from Datalystica

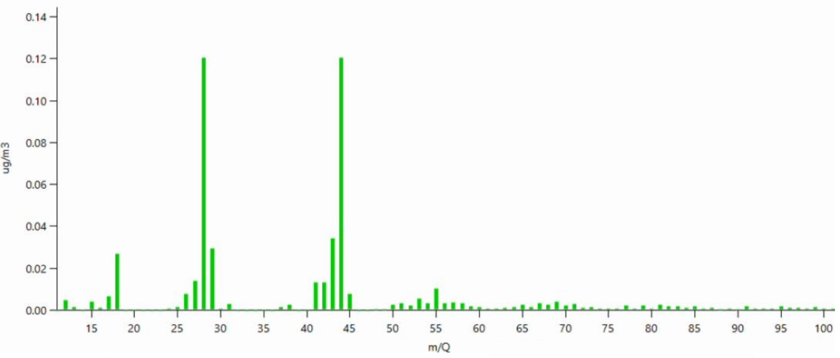
[1]Canonaco et al. (2013)

Methods

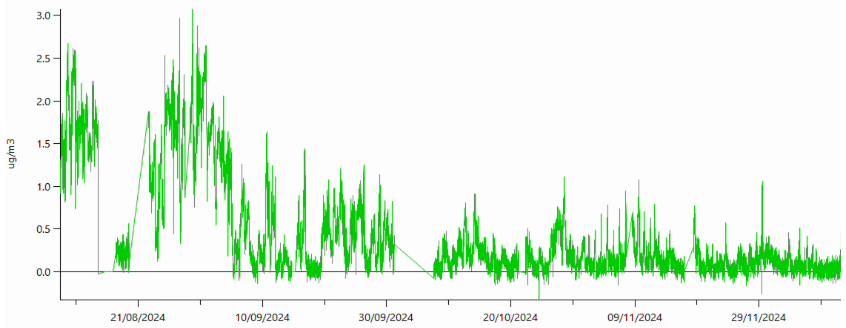
Source Apportionment

Data input

Org Mass Spectra



Org Time Series



ME-2

SoFi[1]

from Datalystica

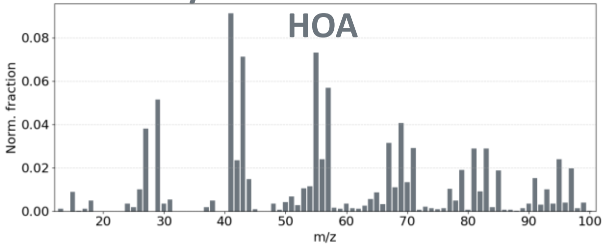
Results

Factors

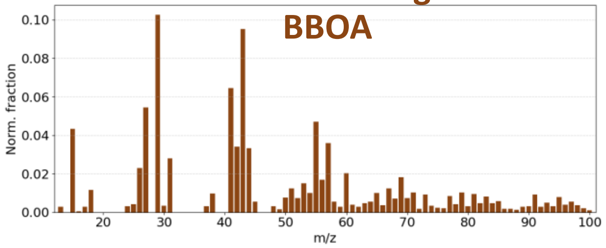
Recurring chemical classes from specific Organic Aerosol sources/formation processes.

Primary OA

Hydrocarbon-like OA

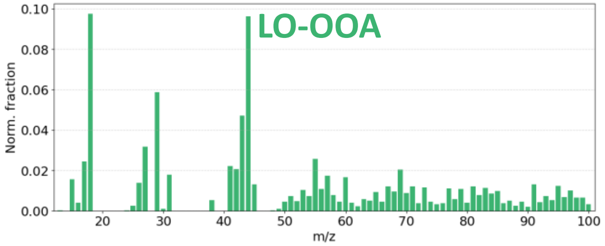


Biomass-burning OA

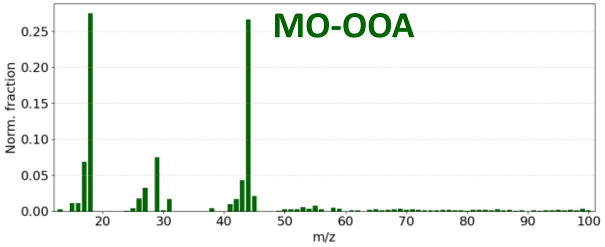


Oxygenated OA

Less Oxidized – OOA



More Oxidized – OOA

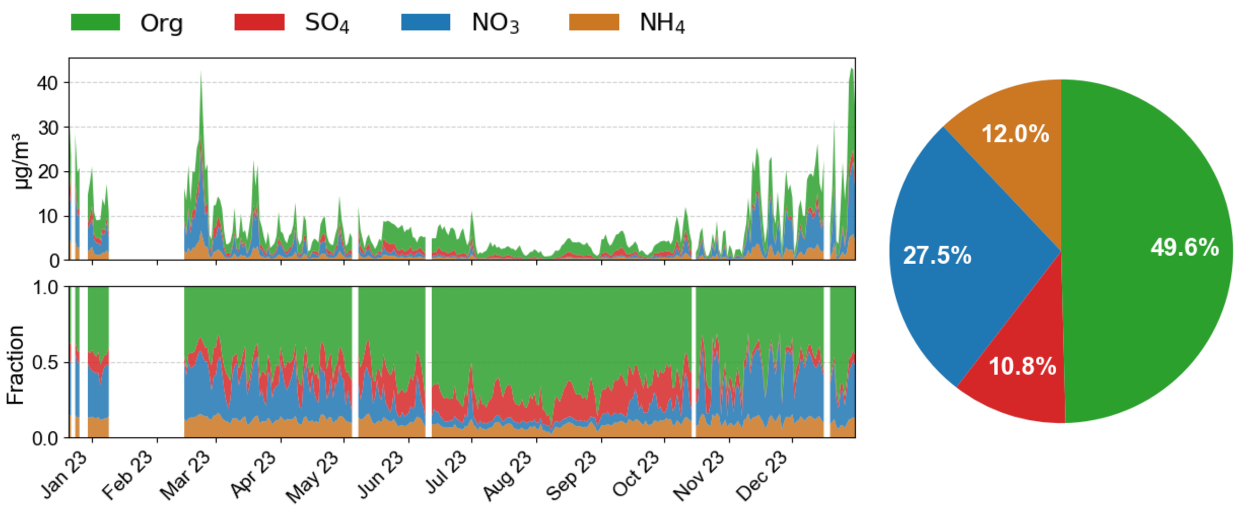


[1]Canonaco et al. (2013)

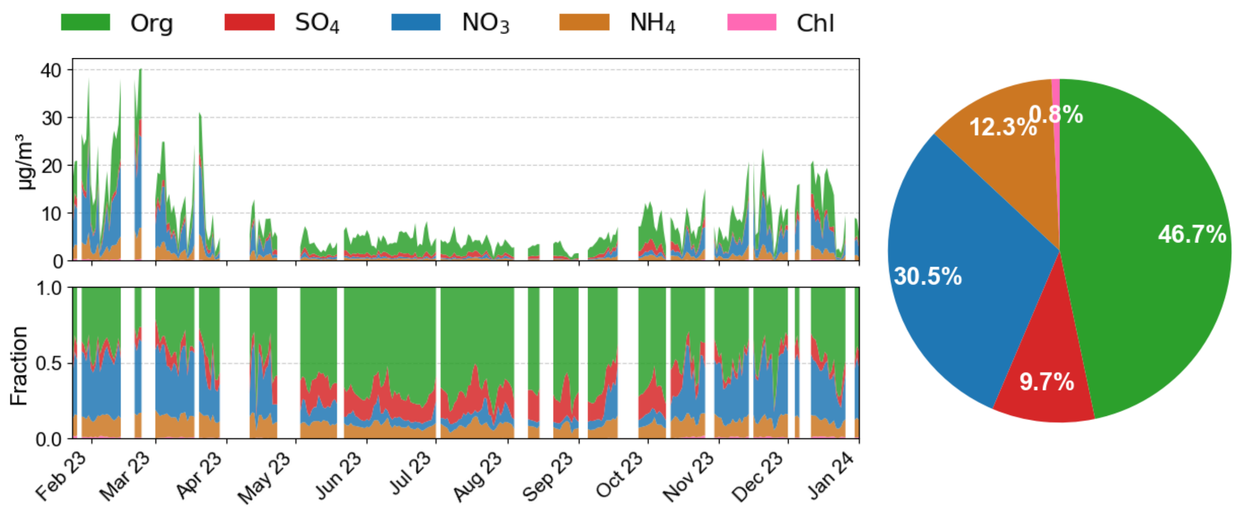
Results

NR-PM$_1$ trends overview

Bologna



Milan



Key drivers across the Po Valley

Mass & Composition: ~8 µg/m^{3}annual average, dominated by Organic Aerosol and Nitrates

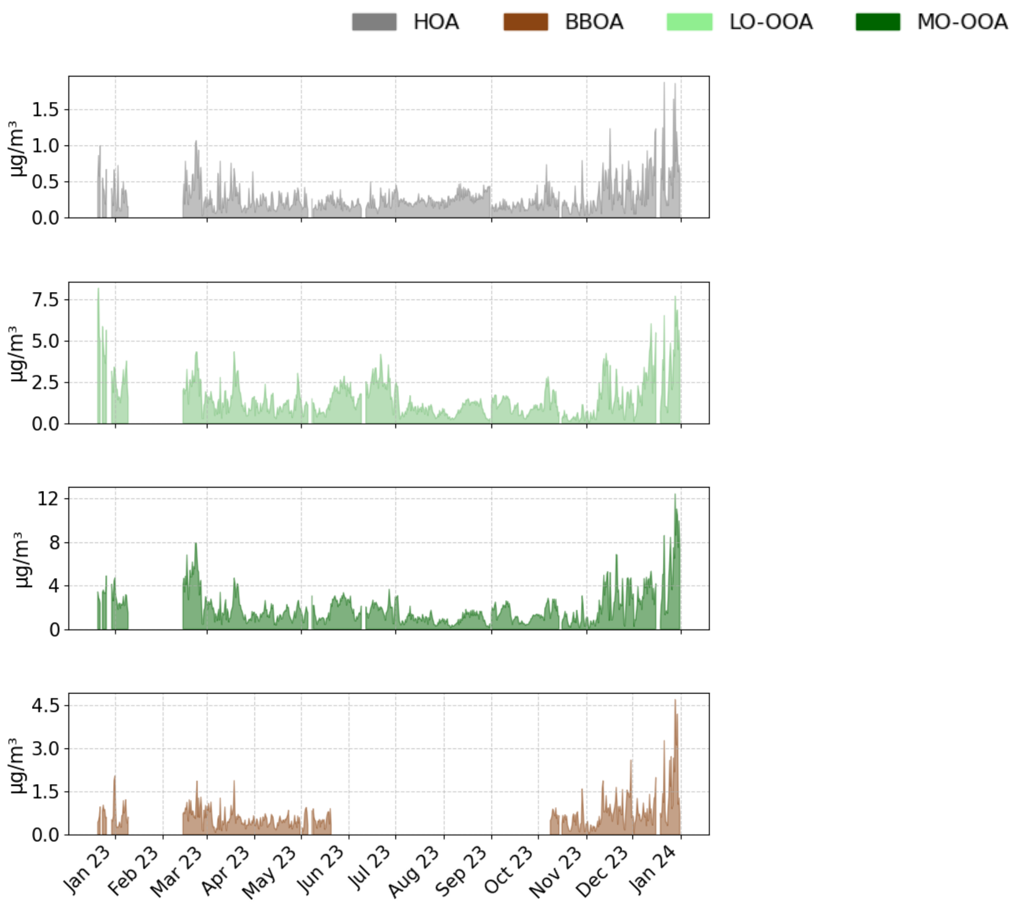
Winter Accumulation: Strong concentration peaks driven by low Boundary Layer Height, Nitrate condensation and higher emissions.

Summer Dynamics: Overall mass decreases due to dilution, the relative fraction of Organics increases.

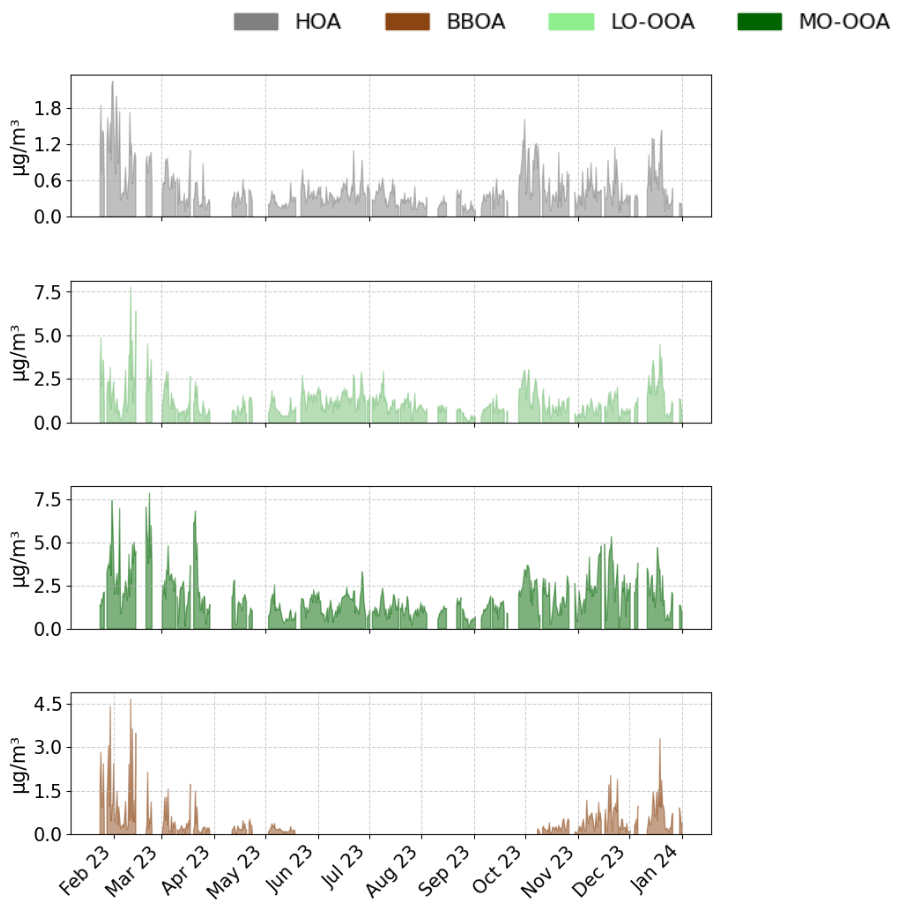
Results

OA Source Apportionment

Bologna



Milan



Results

OA Source Apportionment

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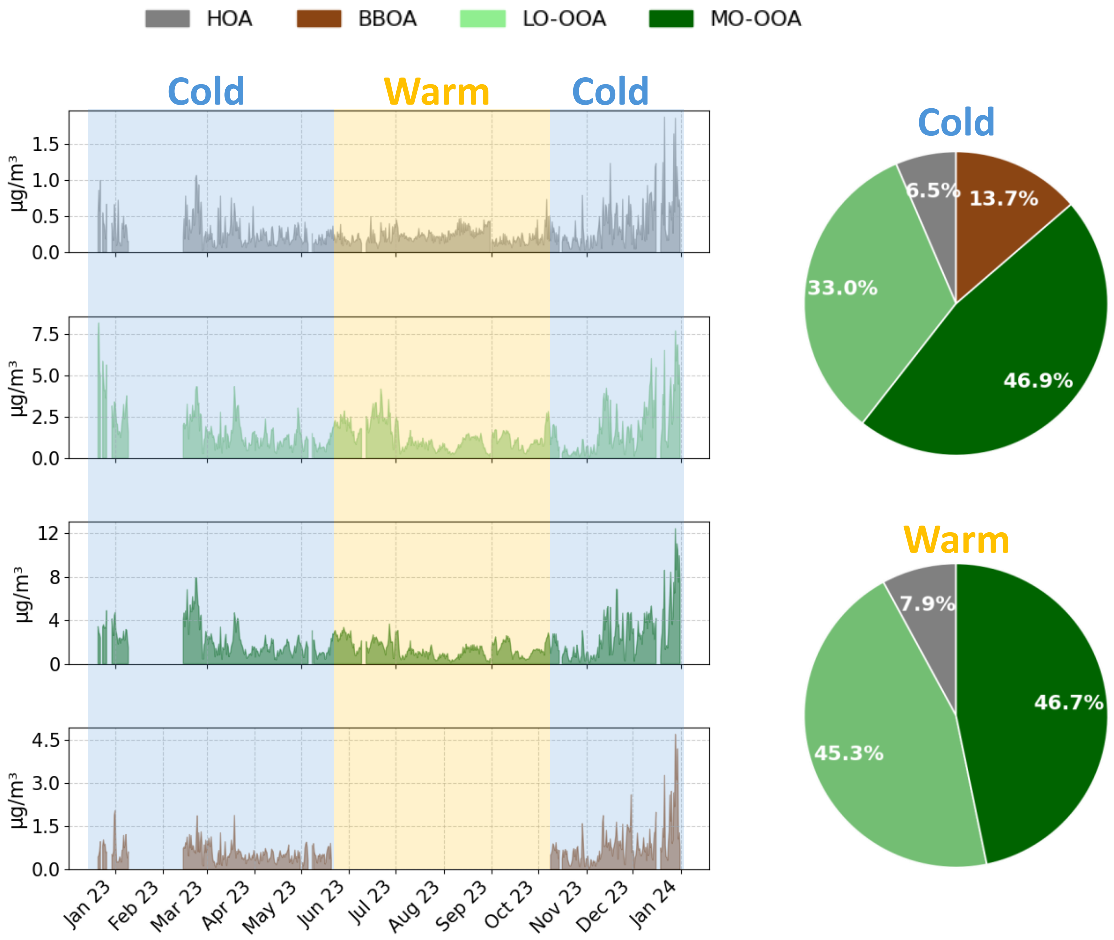

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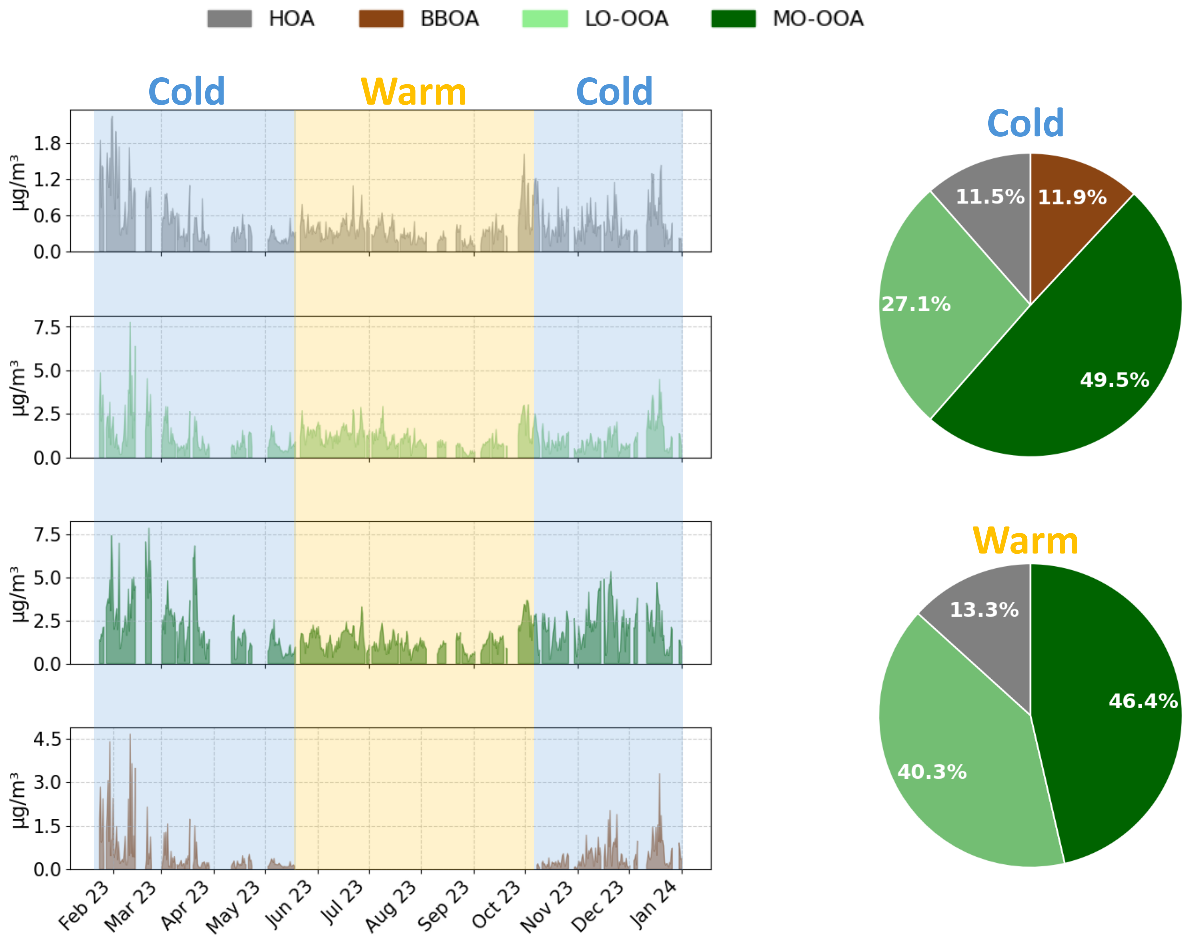


Regional and Seasonal consistency

Cold period: BBOA constitutes the most abundant POA component at both sites.

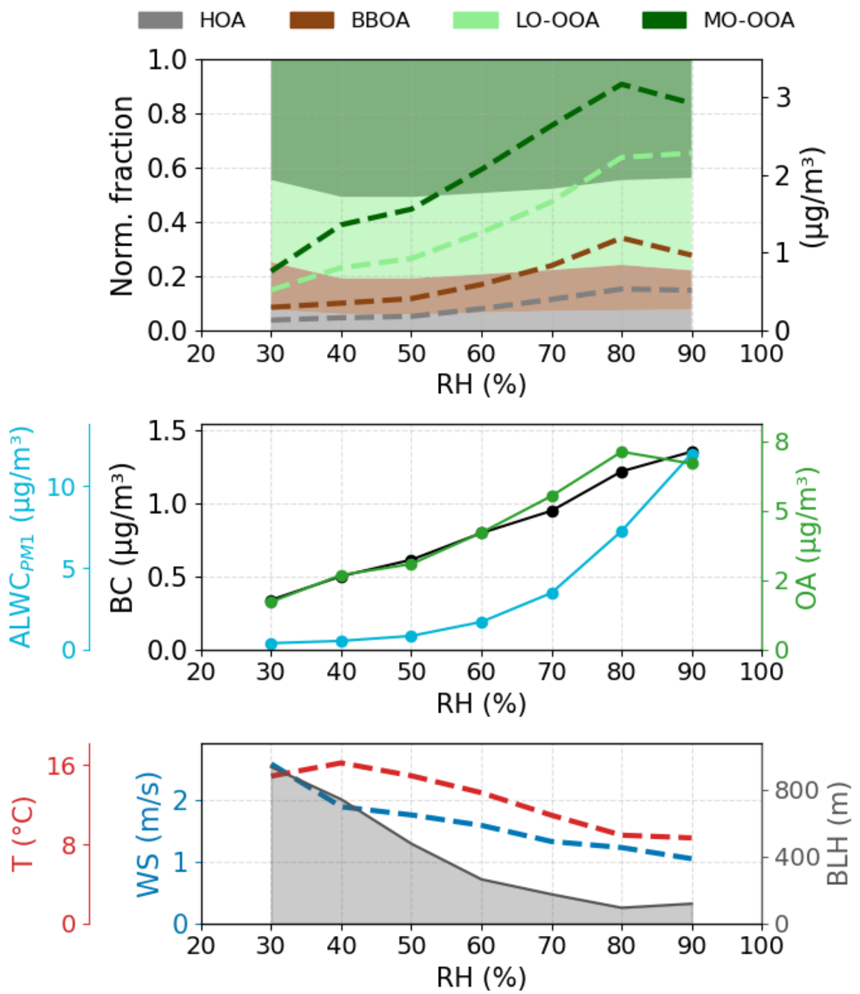
Warm period: Consistent lack of BBOA between May and October

Results

OA formation processes and drivers

Cold period

Bologna



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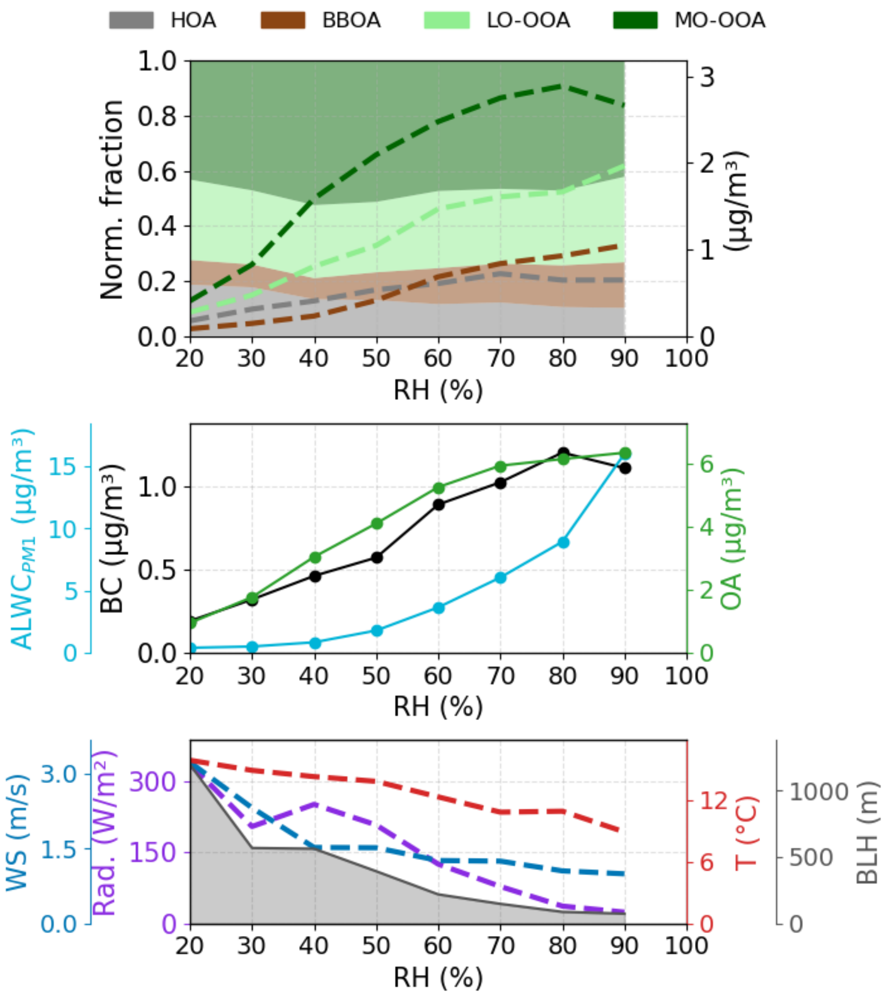
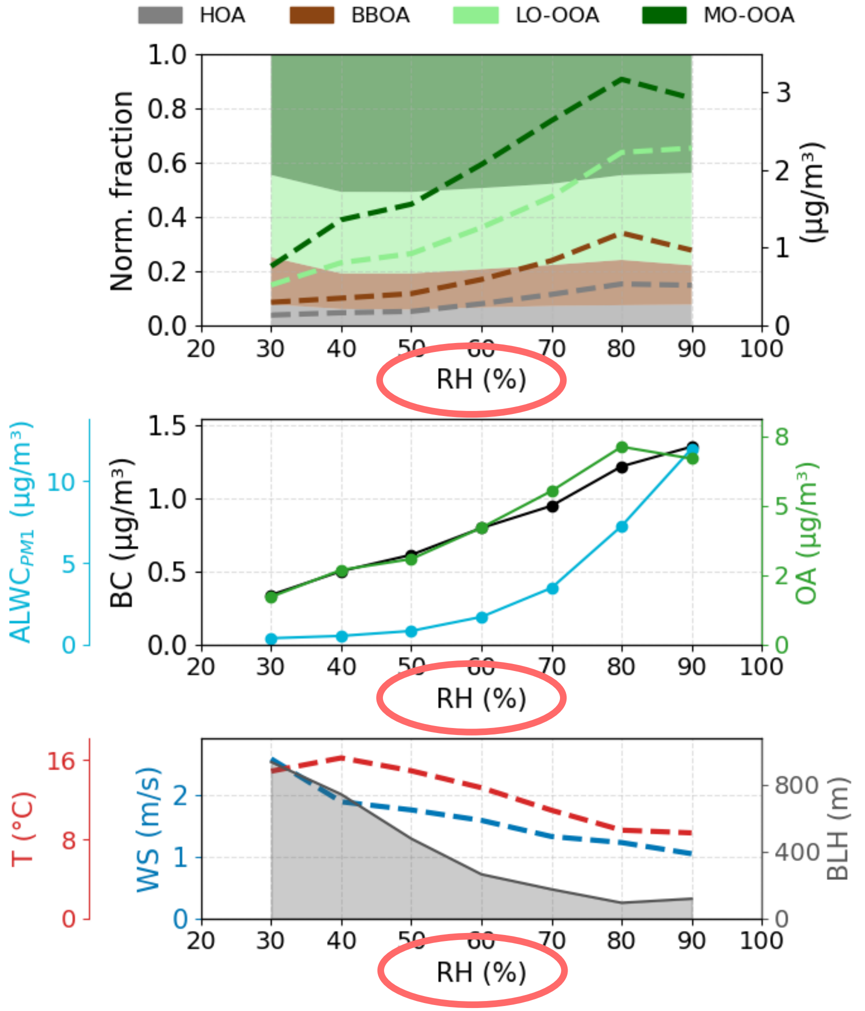


Results

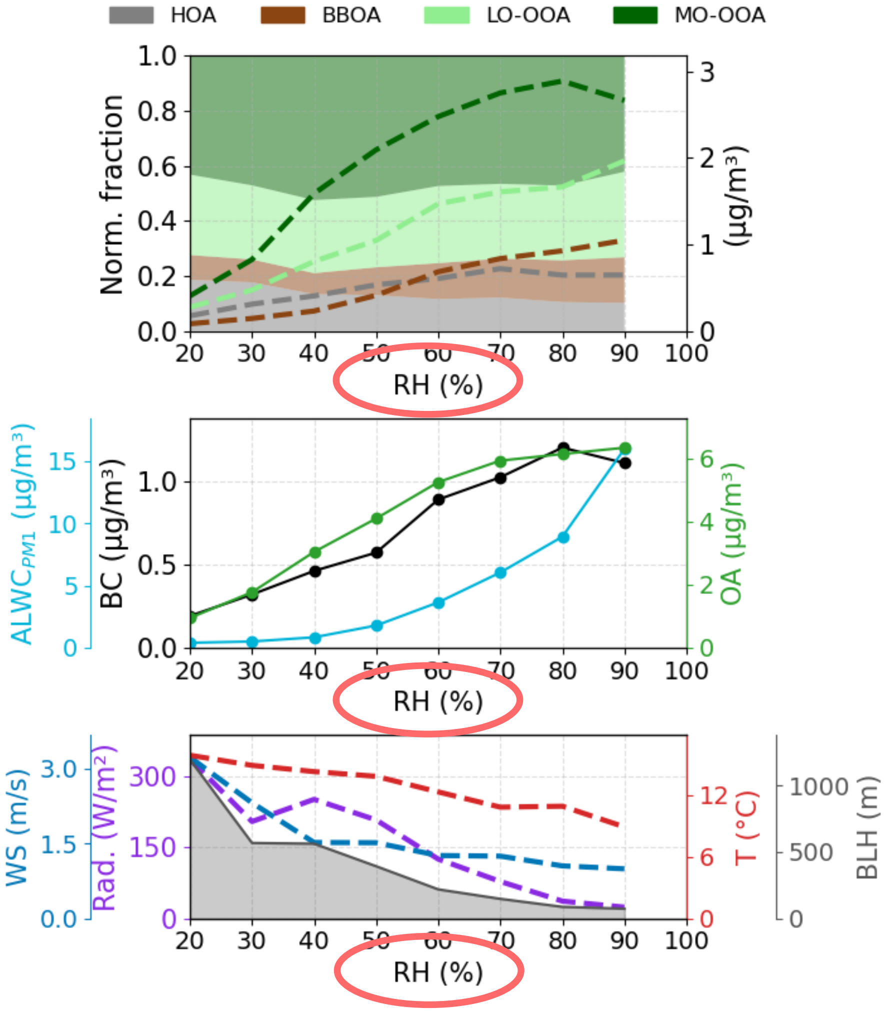
OA formation processes and drivers

Cold period

Bologna



Milan



Data are grouped over RH!

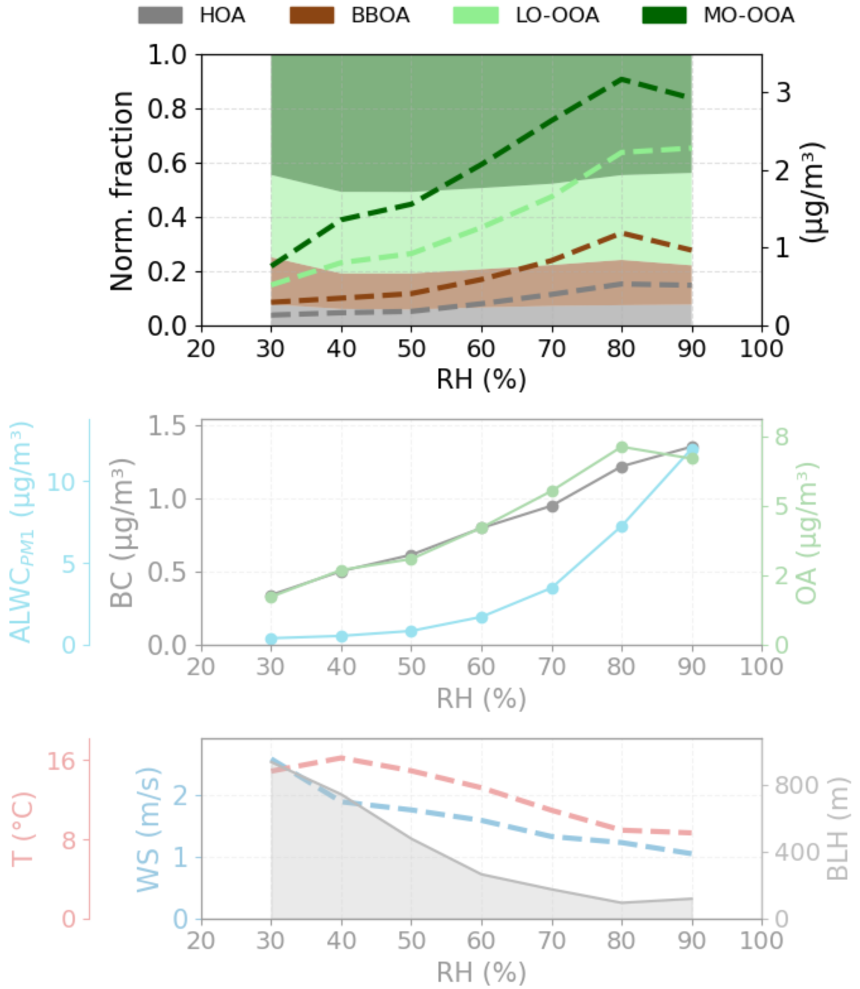
Results

OA formation processes and drivers

Cold period

OA factors

Bologna



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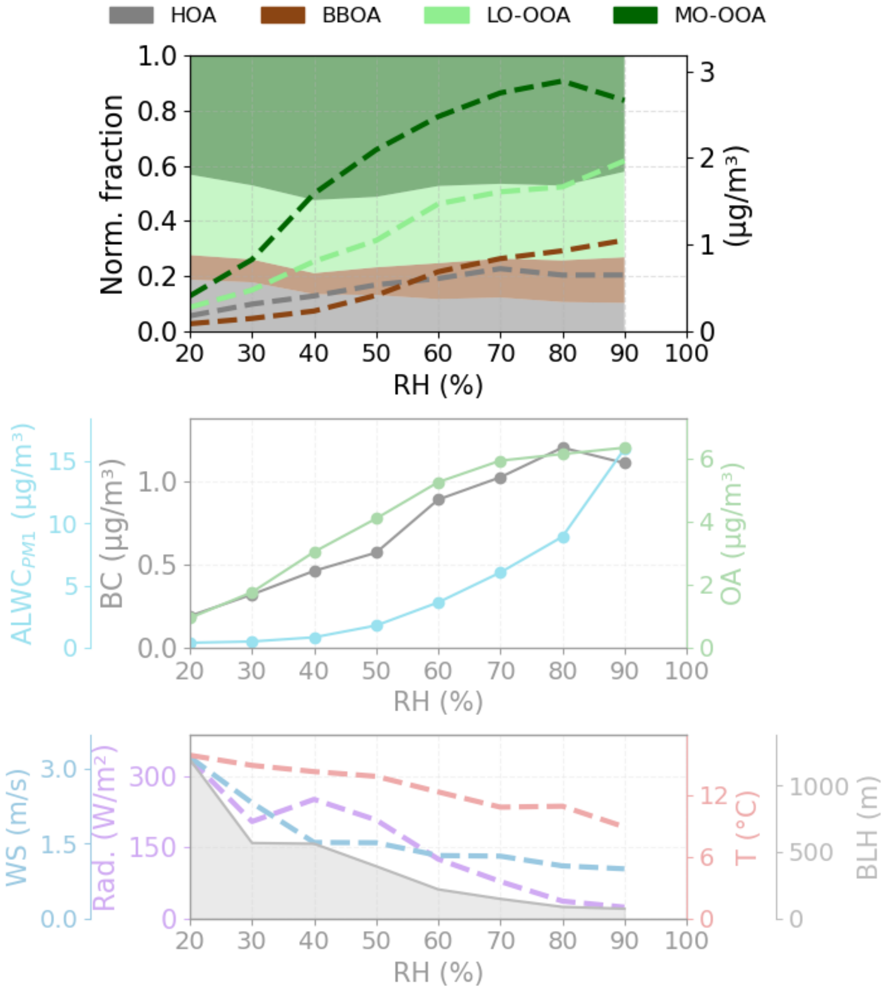
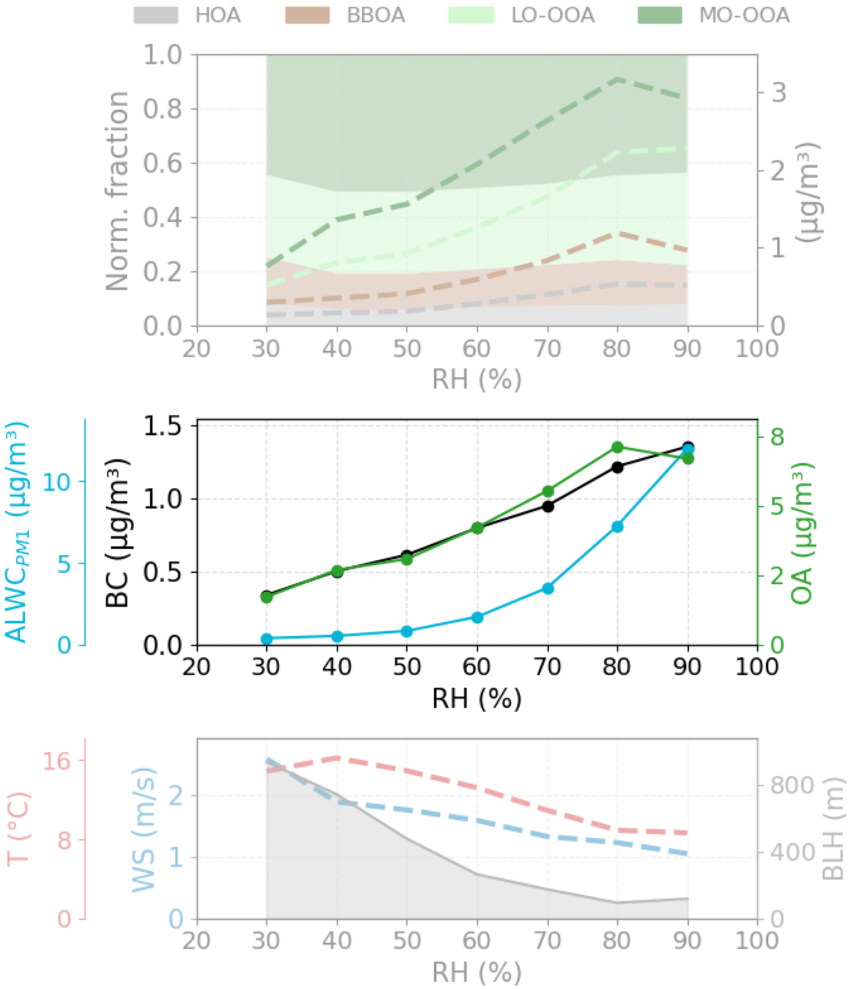


Results

OA formation processes and drivers

Cold period

Bologna



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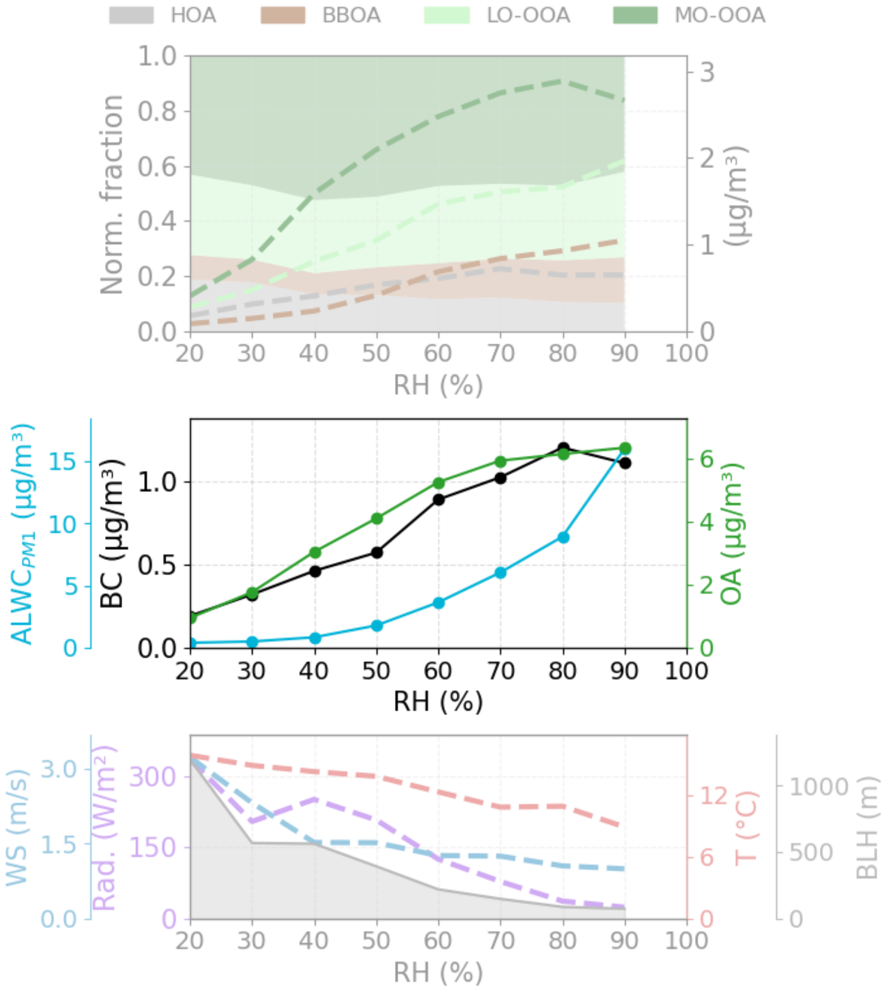


Ancillary variables

$ALWC_{PM_1}$ = Aerosol Liquid Water Content in PM_1[2]

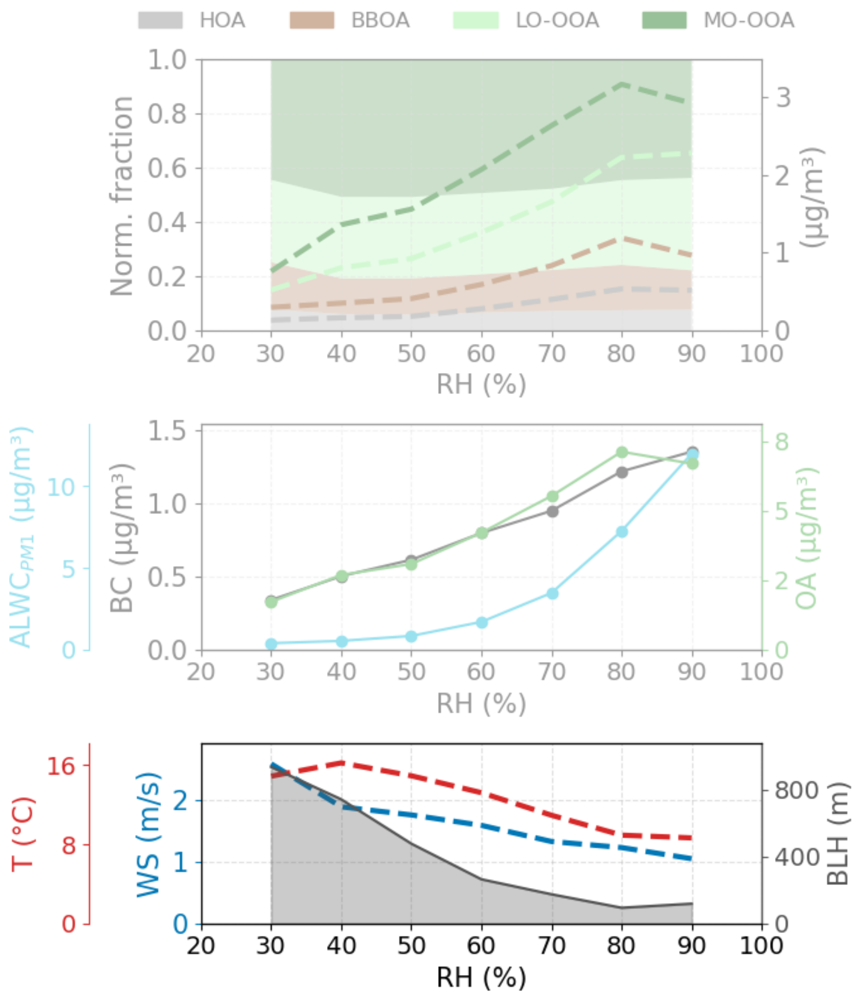
[2]Fountoukis and Nenes. (2007)

Results

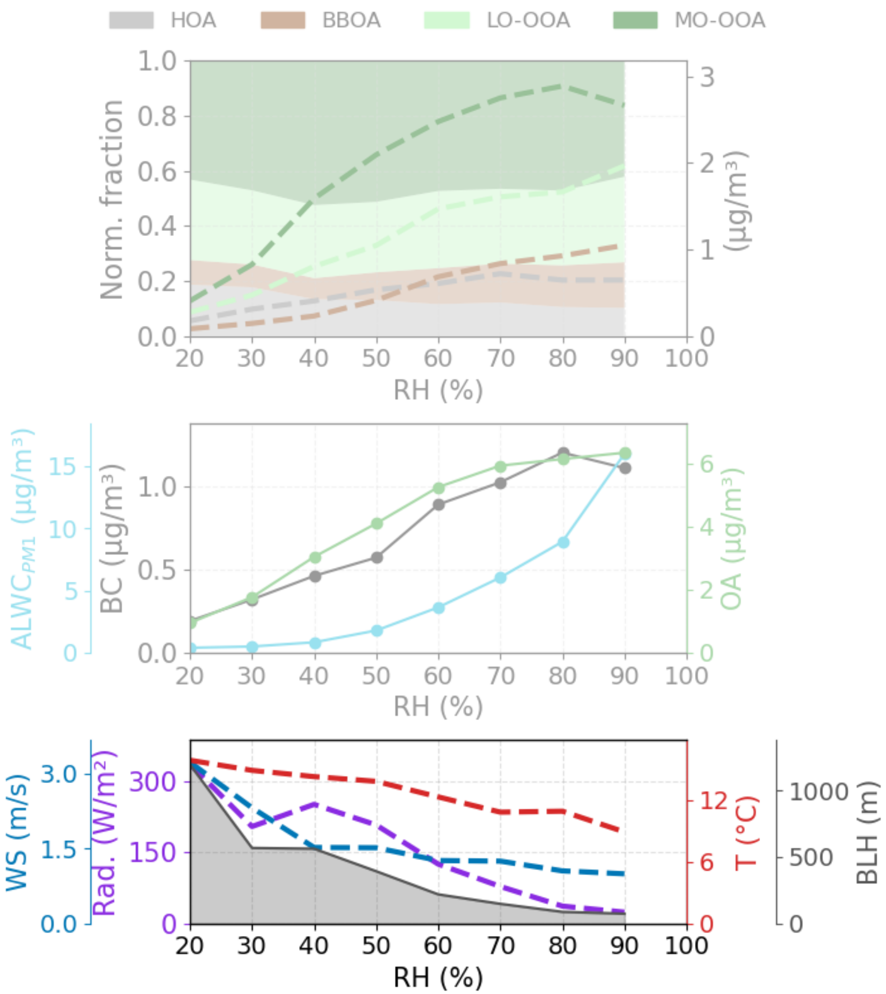
OA formation processes and drivers

Cold period

Bologna



Milan



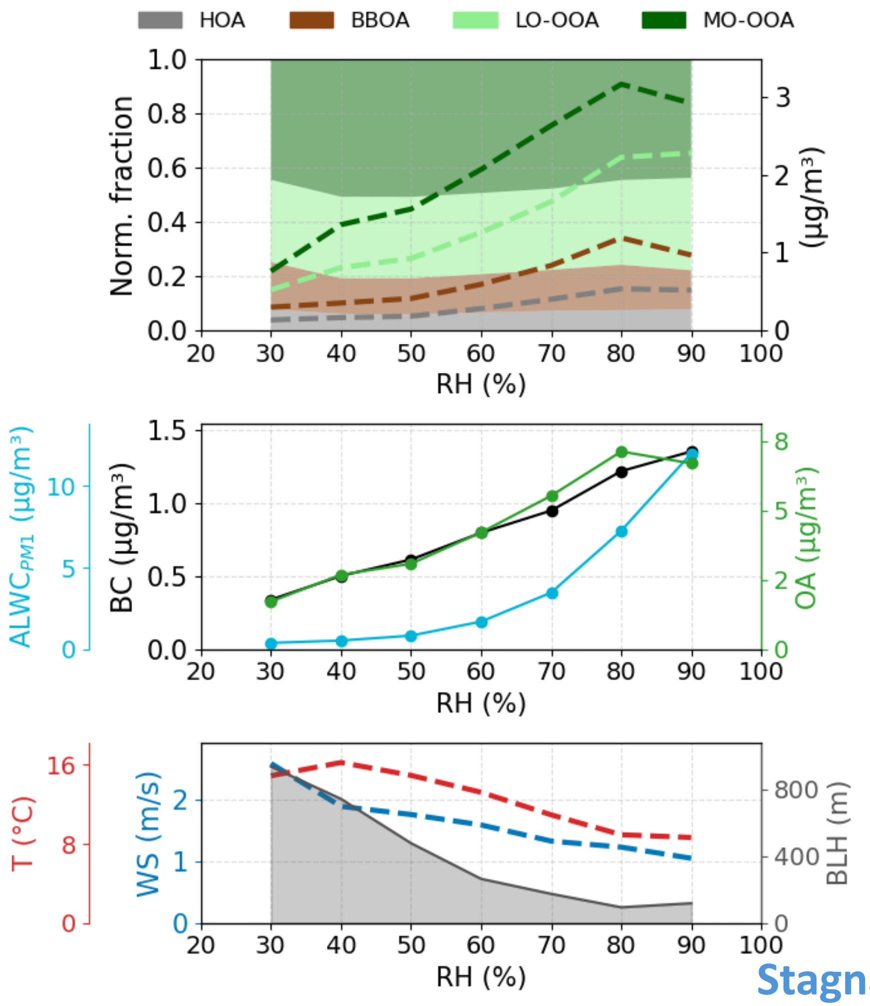
Meteo and BLH data

Results

OA formation processes and drivers

Cold period

Bologna



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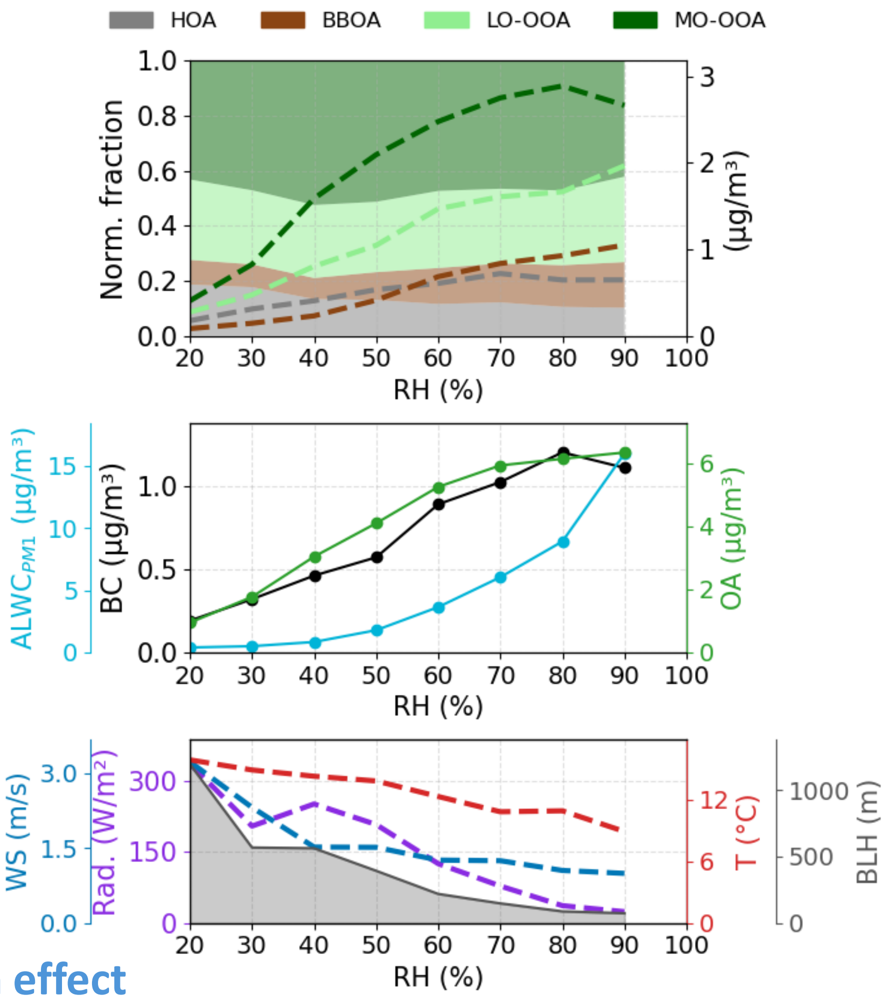


Stagnation effect

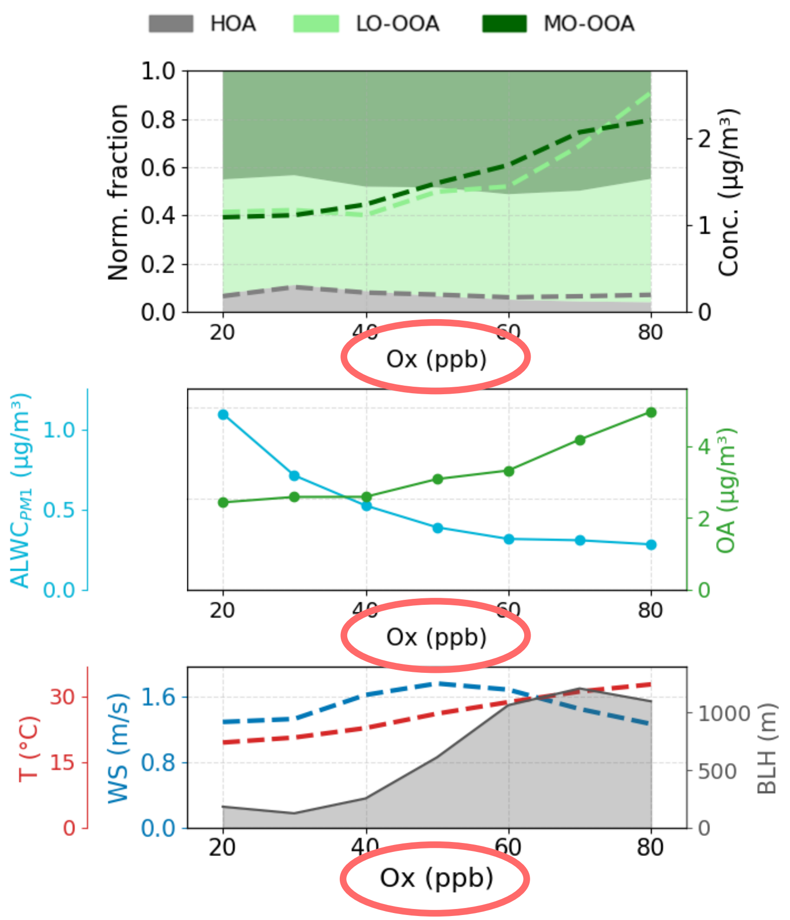
Wintertime aerosol accumulation is driven by poor dispersive conditions, regardless of the specific emission source and formation processes.

Results

OA formation processes and drivers

Warm period

Bologna



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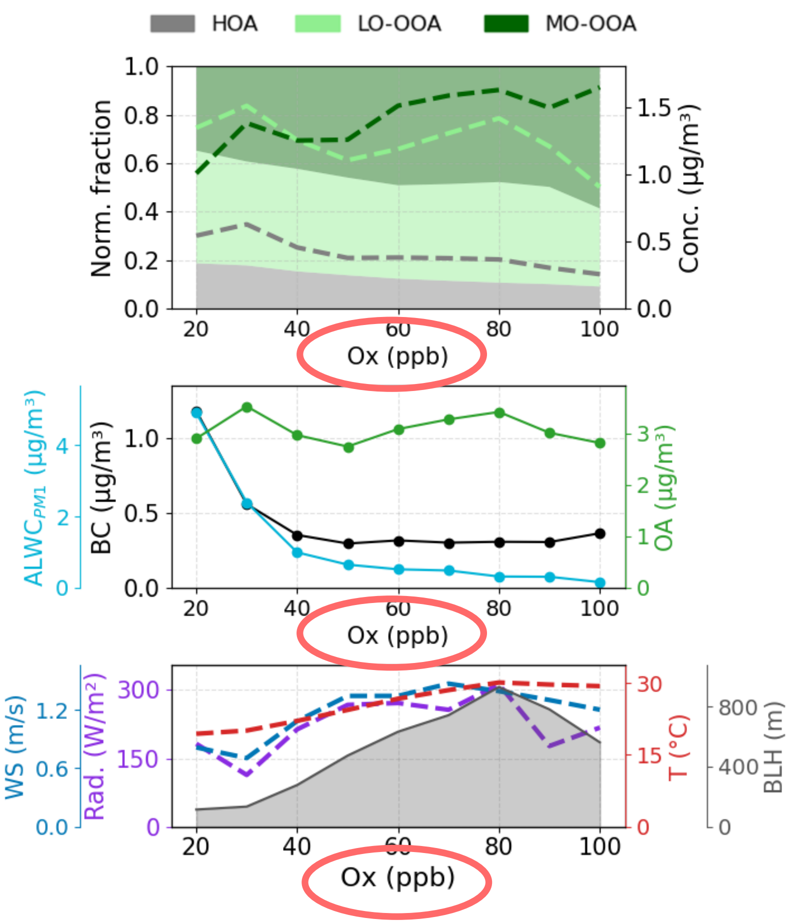


Data are grouped over O_x, odd oxygen, (NO_2+O_3), tracer of photochemical activity[3]

[3]Herndon et al. (2008)

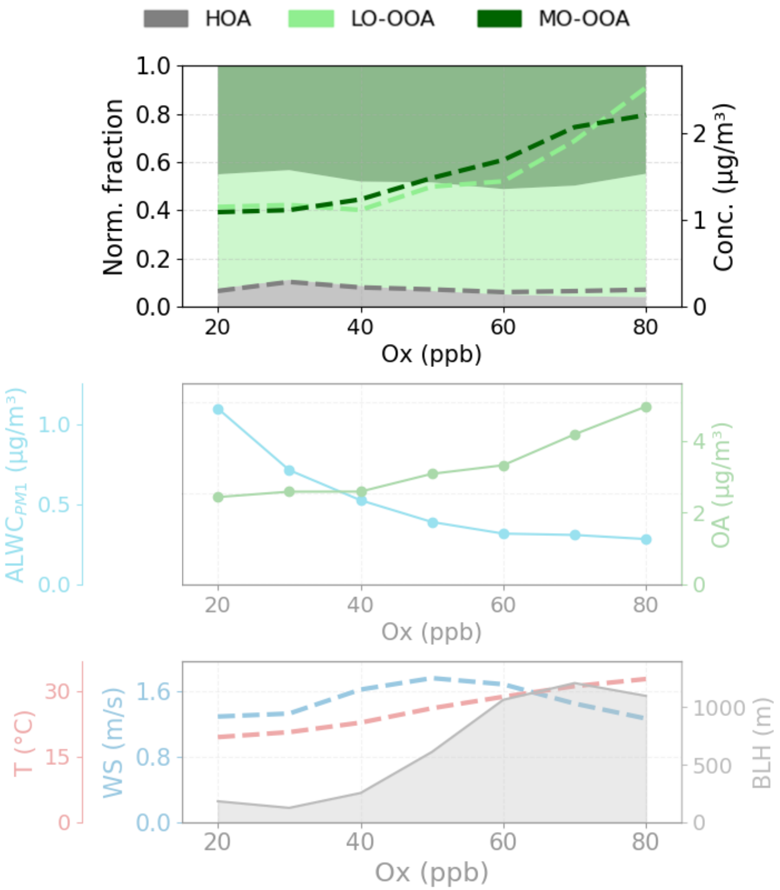
Results

OA formation processes and drivers

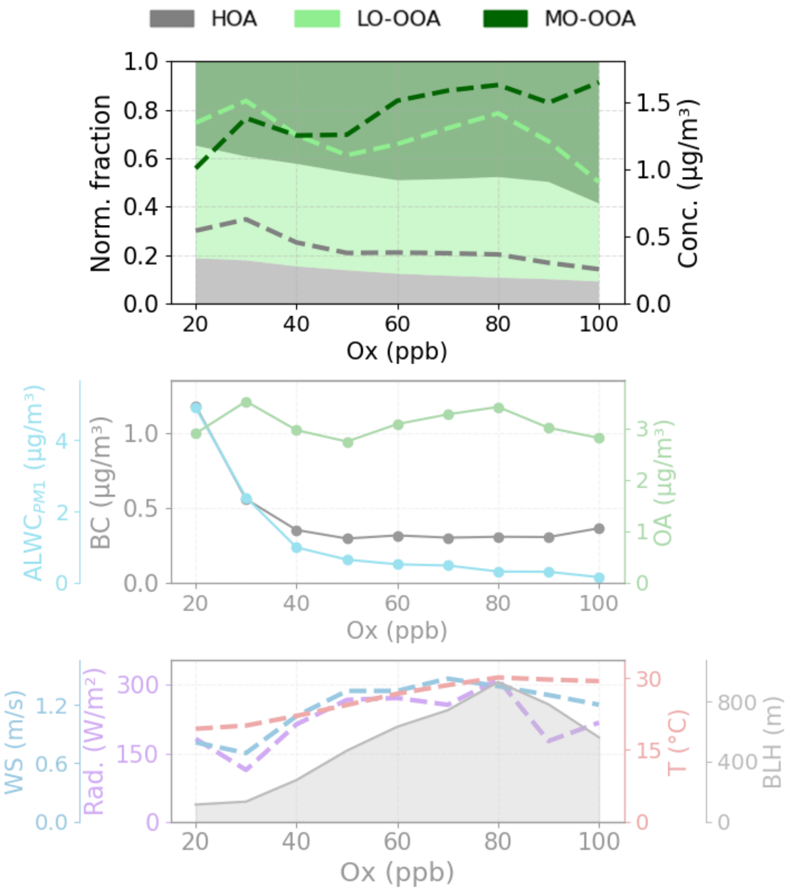
Warm period

OA factors

Bologna



Milan

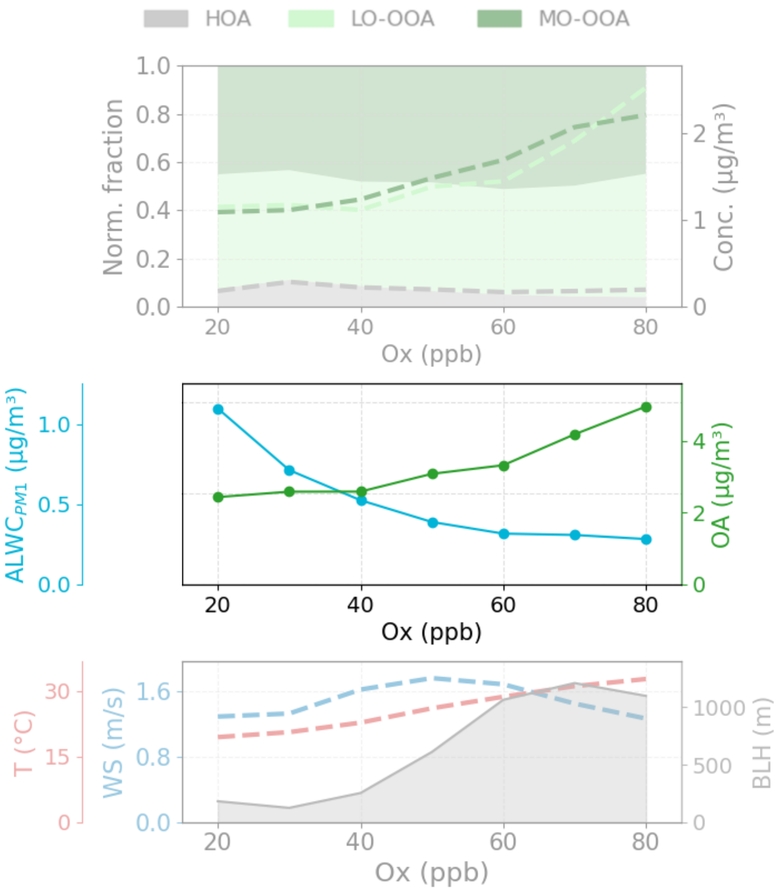


Results

OA formation processes and drivers

Warm period

Bologna



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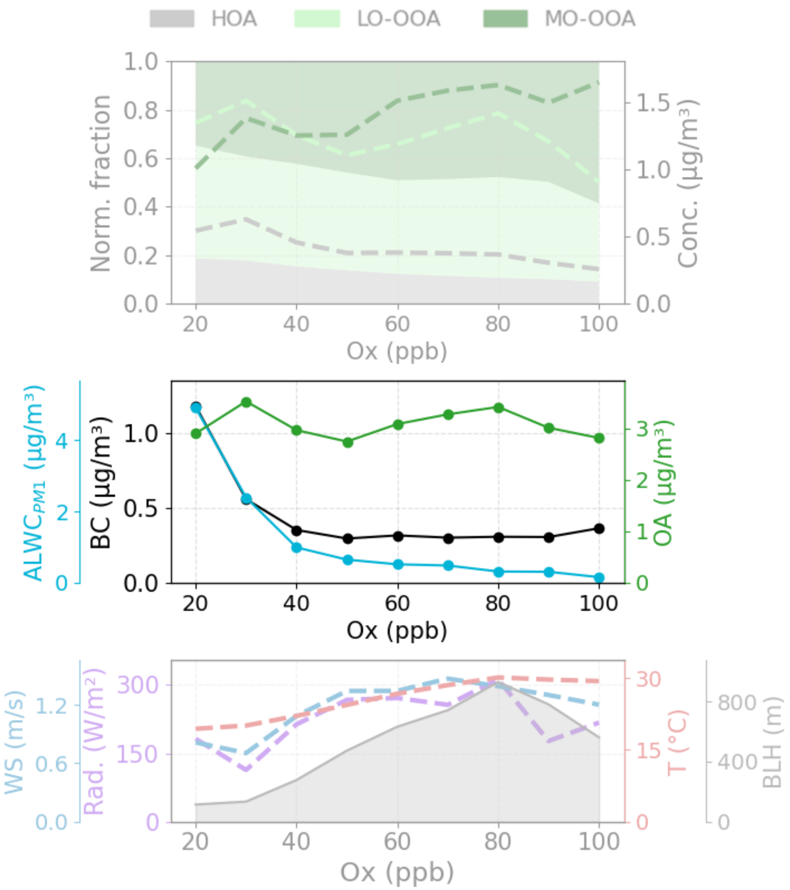


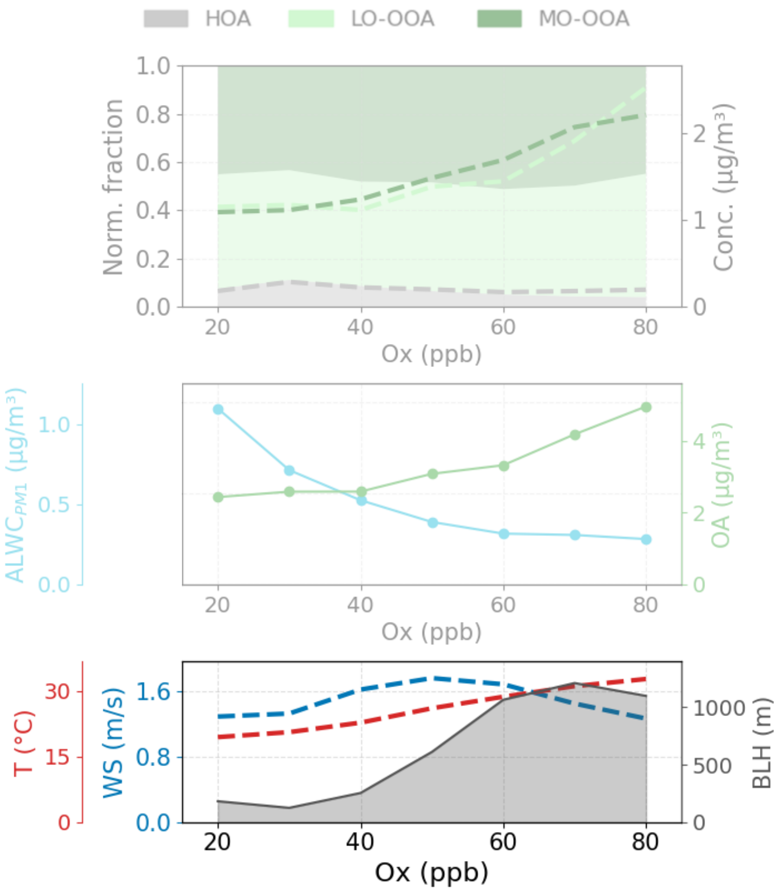
Ancillary variables

Results

OA formation processes and drivers

Warm period

Bologna



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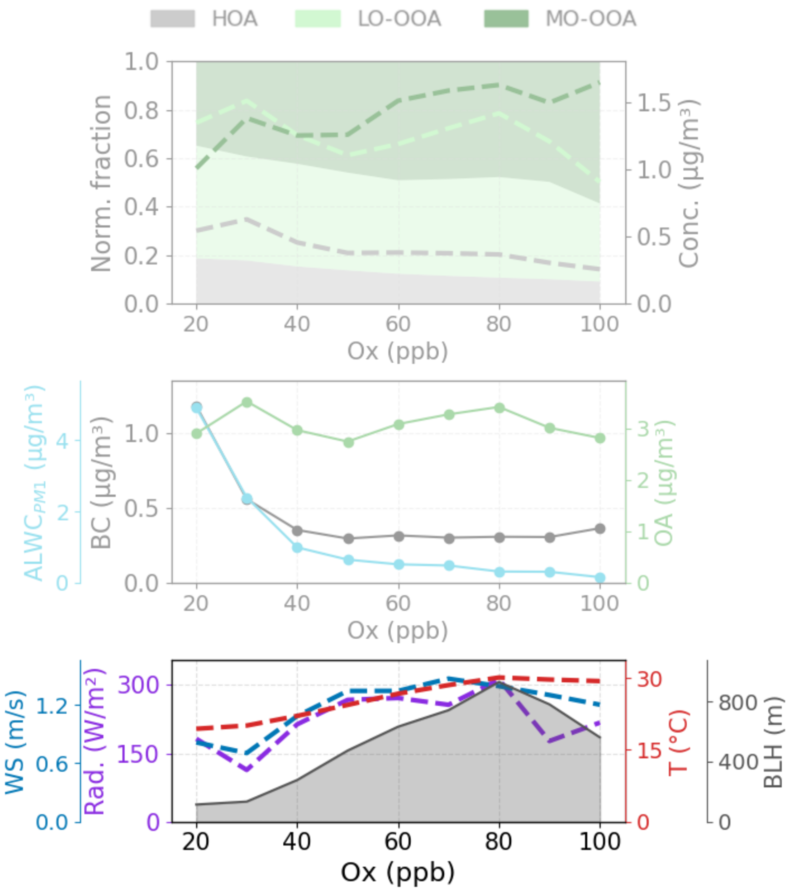

Meteo and BLH data

Results

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Warm period

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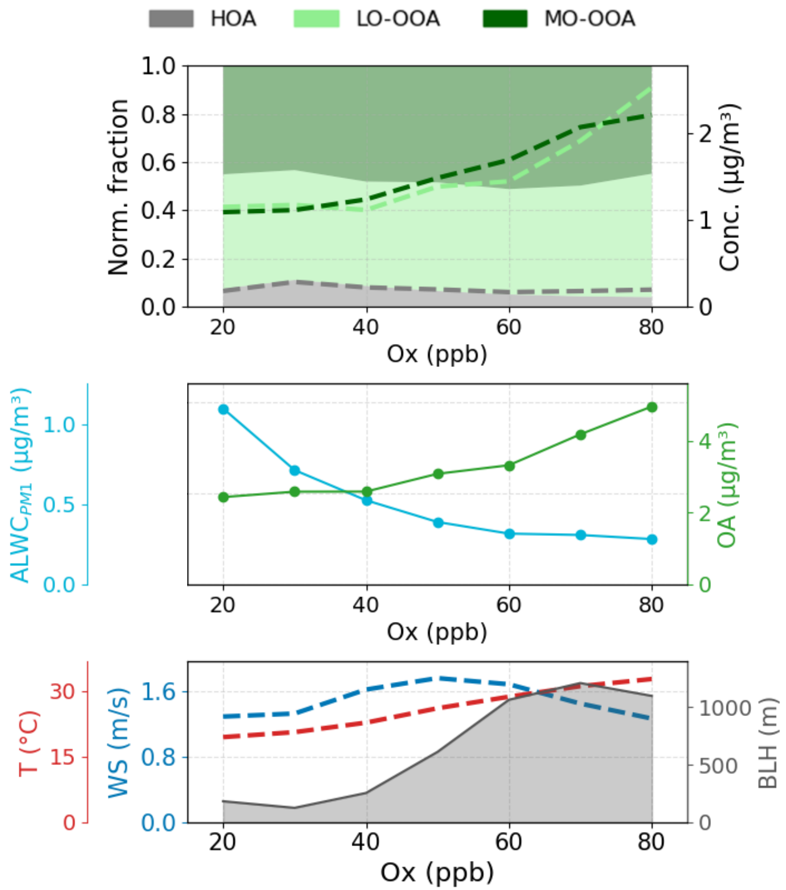

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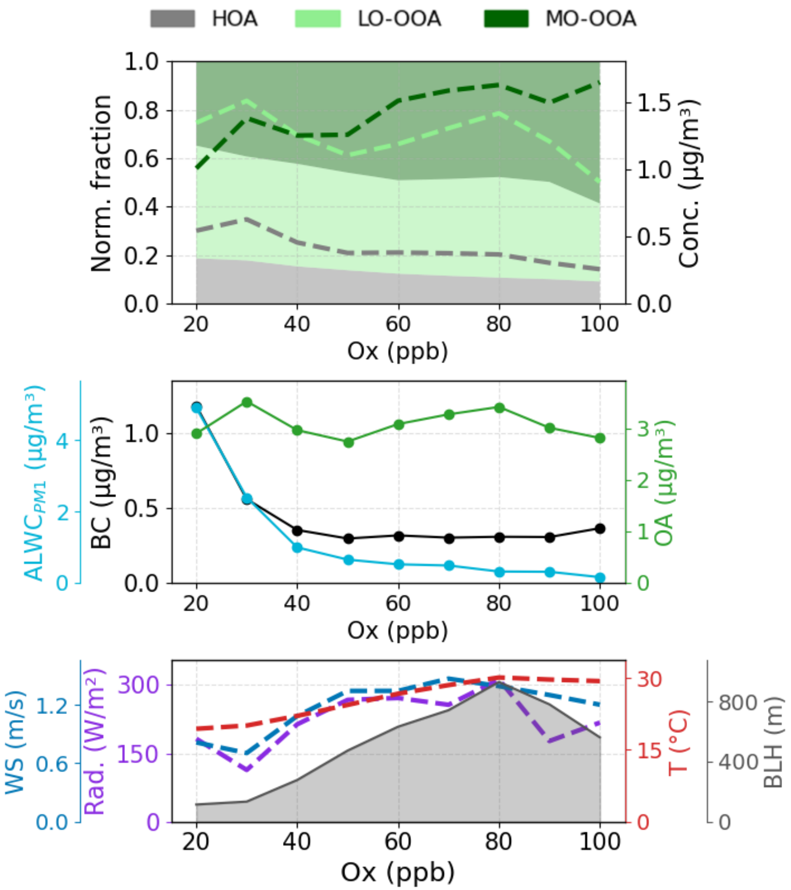

Photochemical activity

Photo-oxidation drives SOA formation (represented by OOA factors). This significantly **increases total OA in Bologna, whereas in Milan it suggests to favor aging** (reflected by higher MO-OOA fraction).

Conclusions

This work shows strong **regional consistency in NR-PM$_1$ mass** (~ 8 µg/m^3), **chemical composition** (dominated by Org and NO$_3$), **and Primary OA sources.**

Seasonality highlights similarities and differences:

Stagnant conditions promote the accumulation of POA and SOA at both sites, resulting in a generalized increase across all carbonaceous components.

Phochemistry differently influences OA components: it **drives an overall increase of OOA in Bologna and potentially promotes aerosol aging in Milan.**

Thank you

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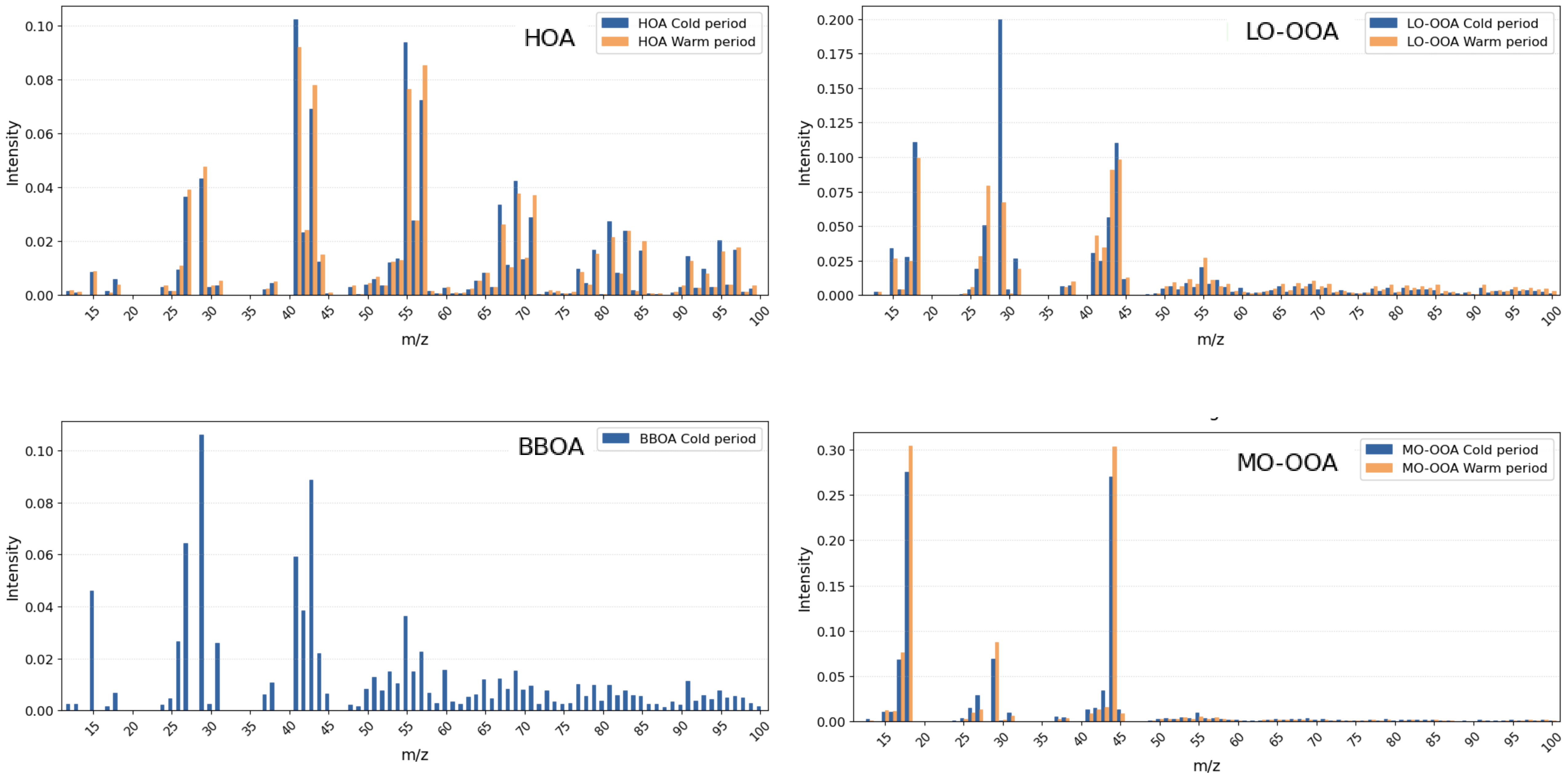
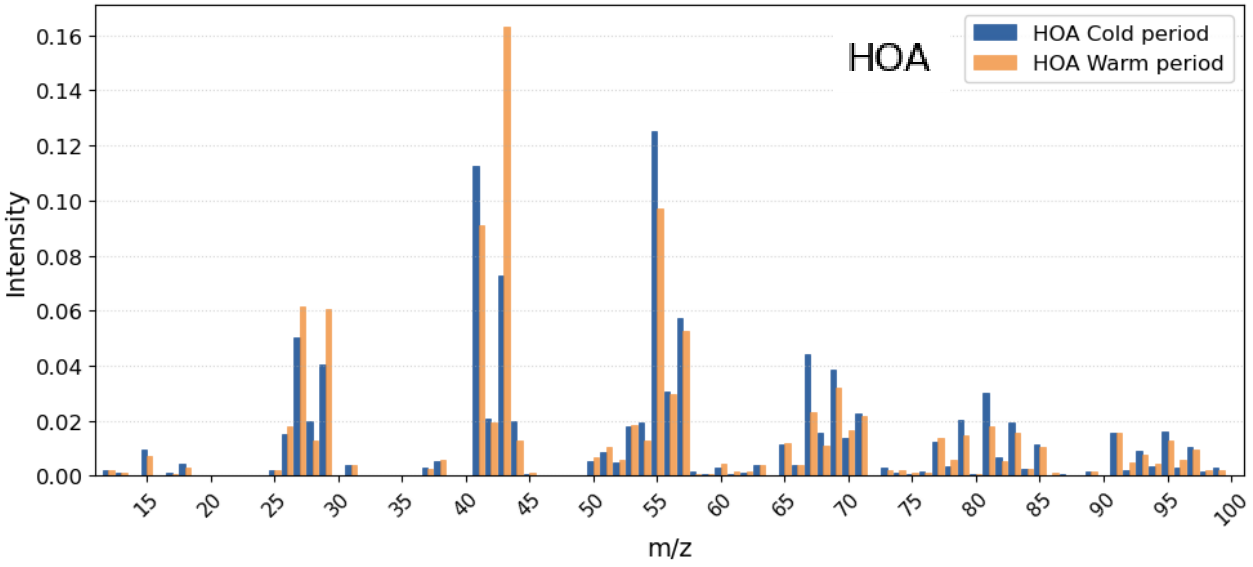
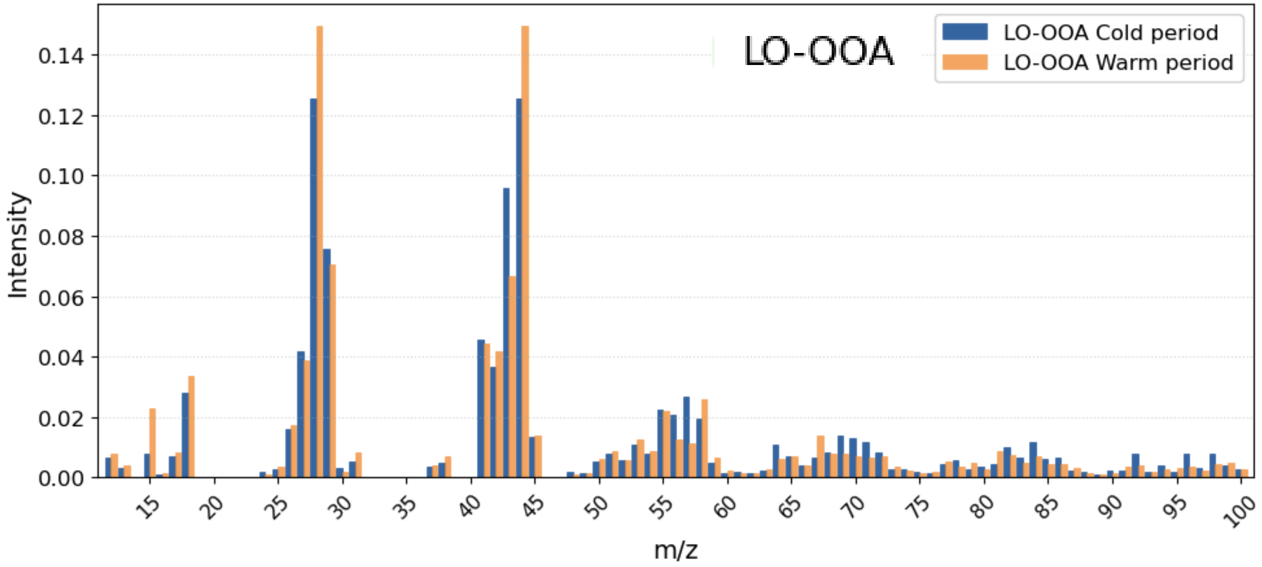
Bologna

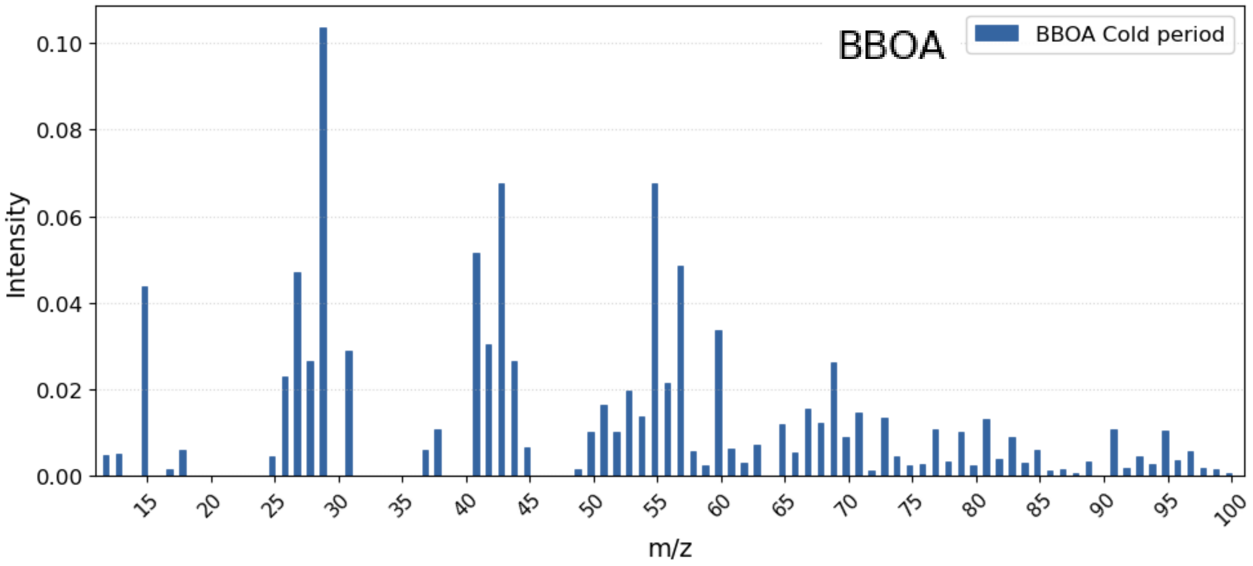


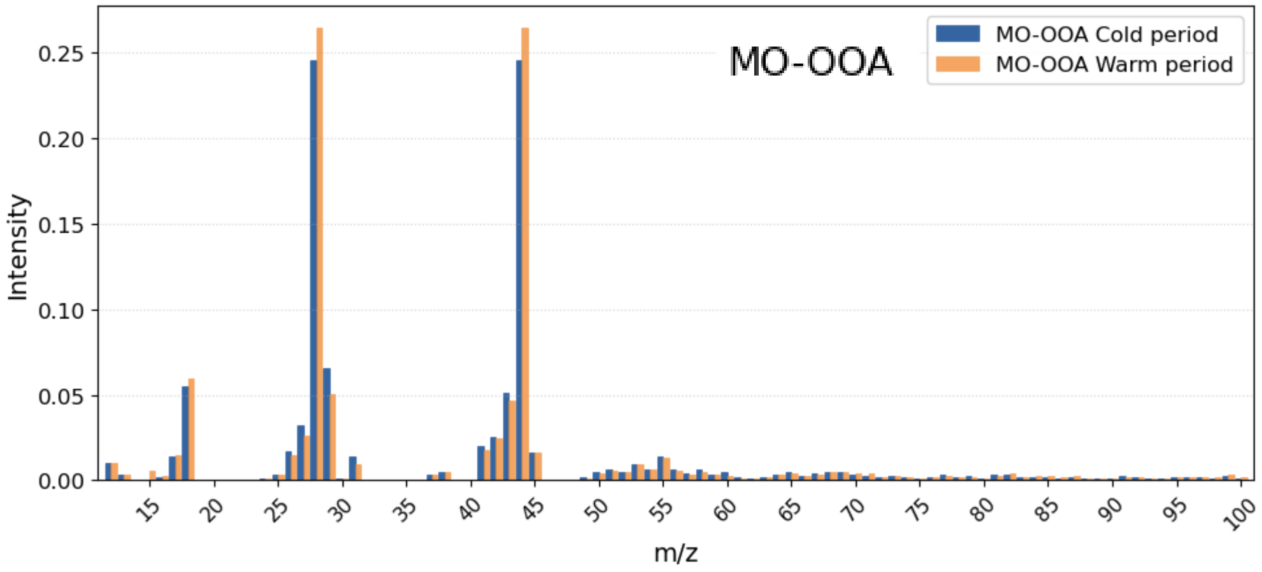
HOA
HOA Cold period
HOA Warm period
Intensity
m/z
LO-OOA
LO-OOA Cold period
LO-OOA Warm period
Intensity
m/z
BBOA
BBOA Cold period
Intensity
m/z
MO-OOA
MO-OOA Cold period
MO-OOA Warm period
Intensity
m/z

Milan


HOA
HOA Cold period
HOA Warm period
Intensity
m/z


LO-OOA
LO-OOA Cold period
LO-OOA Warm period
Intensity
m/z

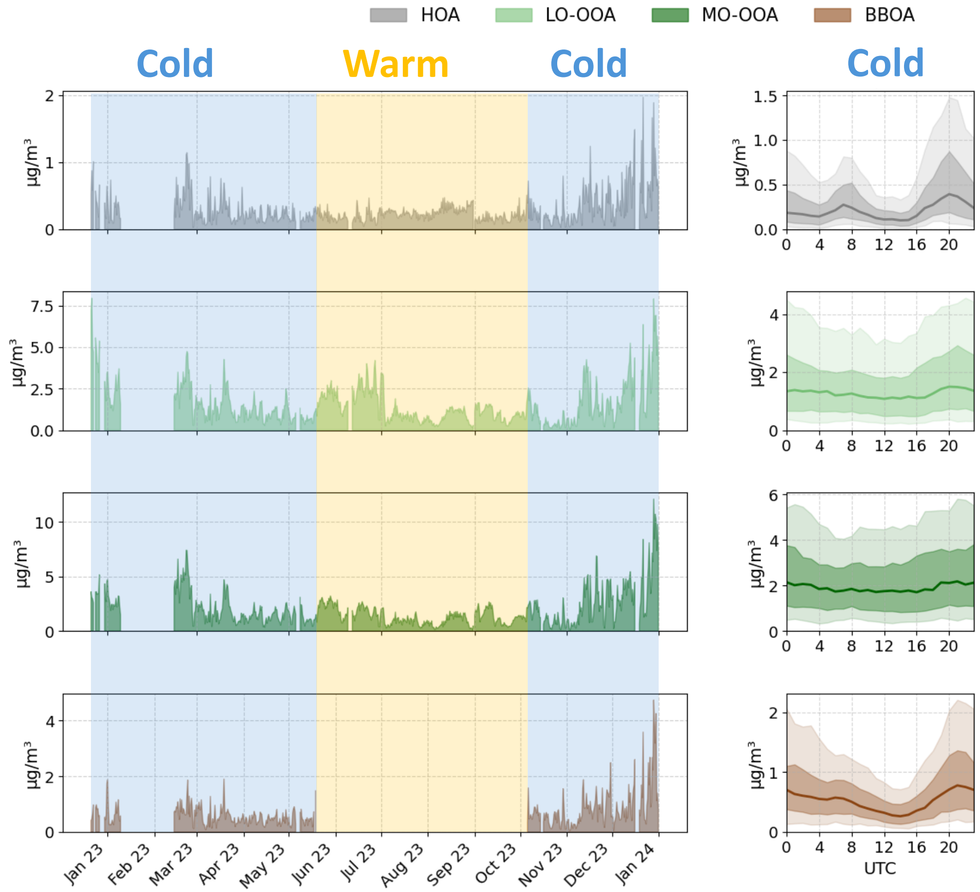

BBOA
BBOA Cold period
Intensity
m/z


MO-OOA
MO-OOA Cold period
MO-OOA Warm period
Intensity
m/z

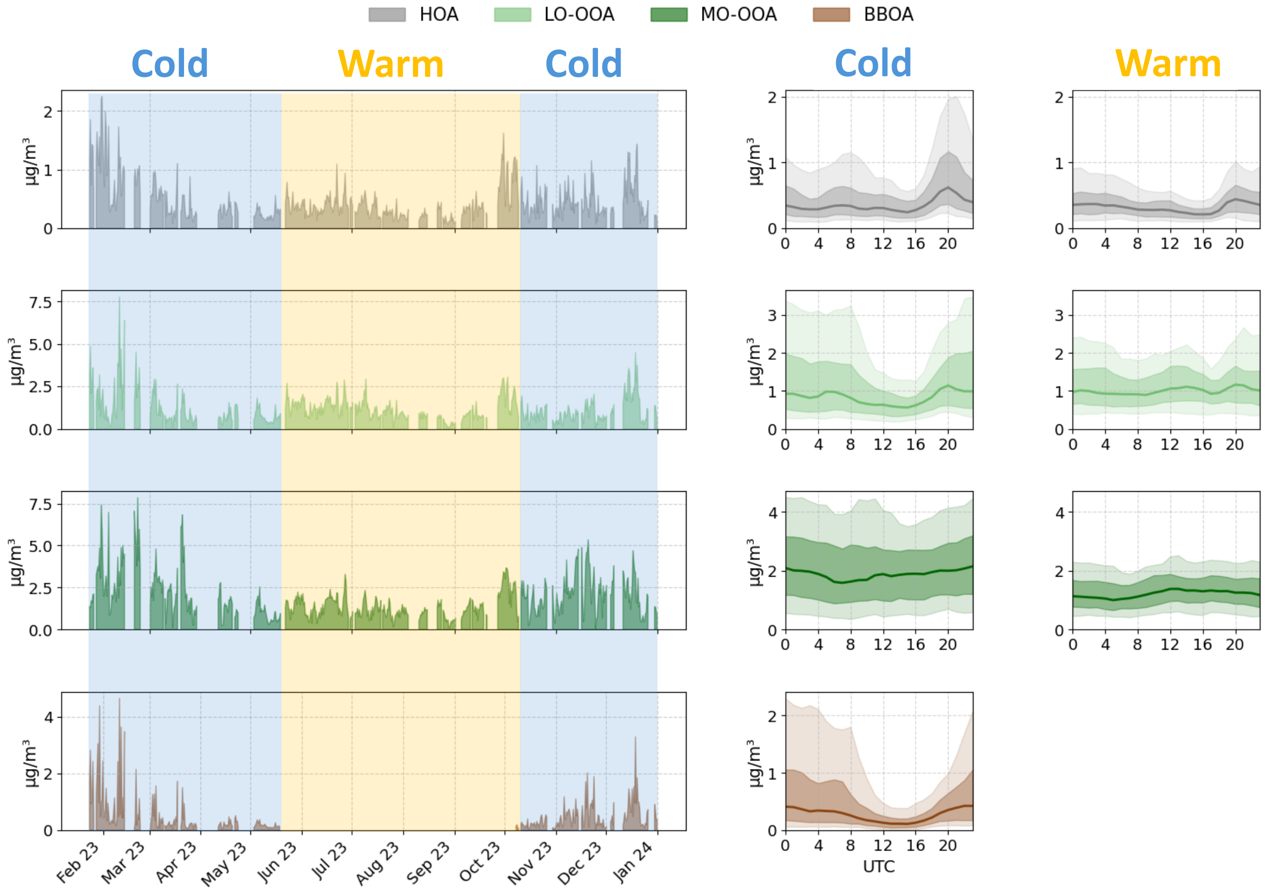
Results

OA Source Apportionment

Bologna

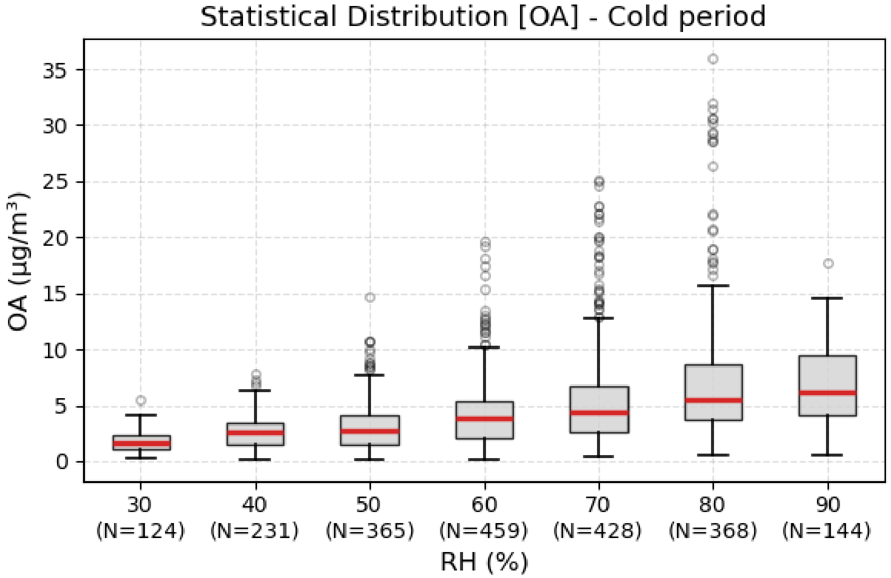


Milan

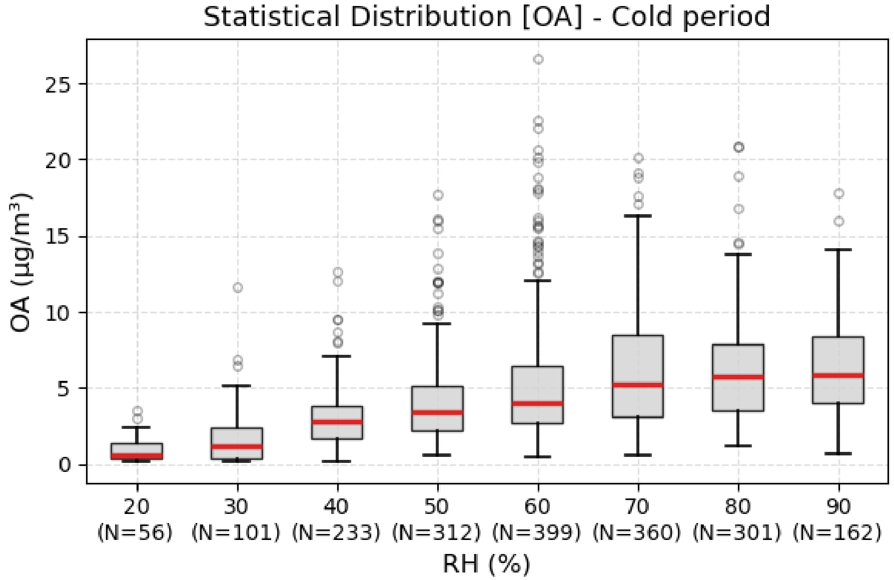


Cold period

Bologna

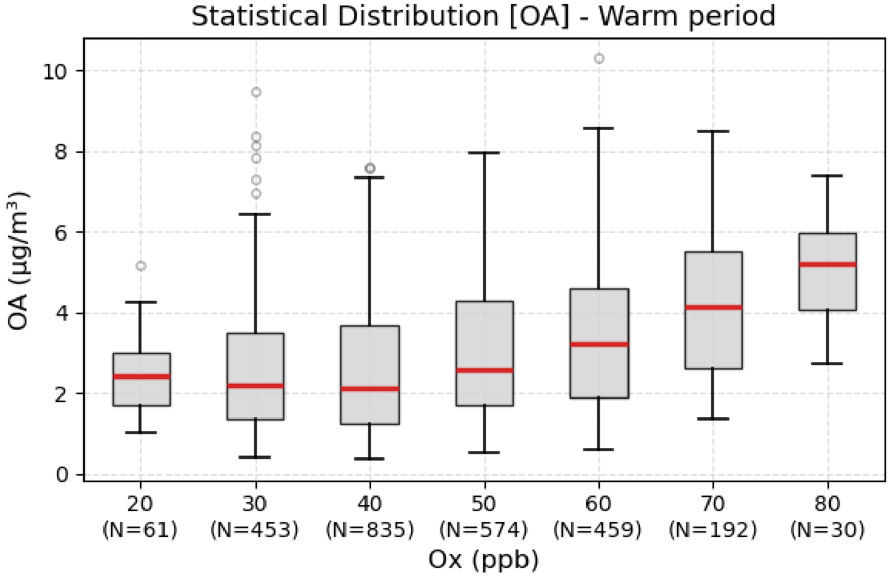


Milan

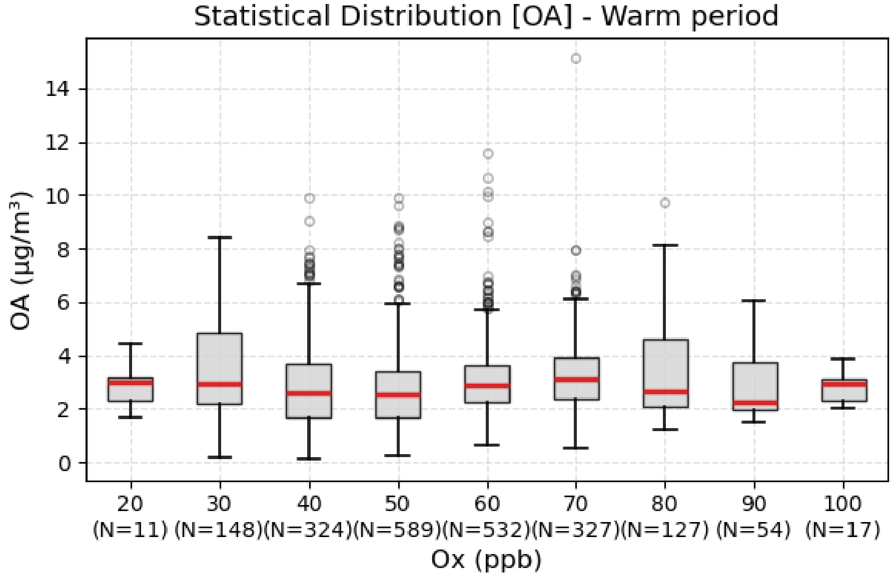


Warm period

Bologna



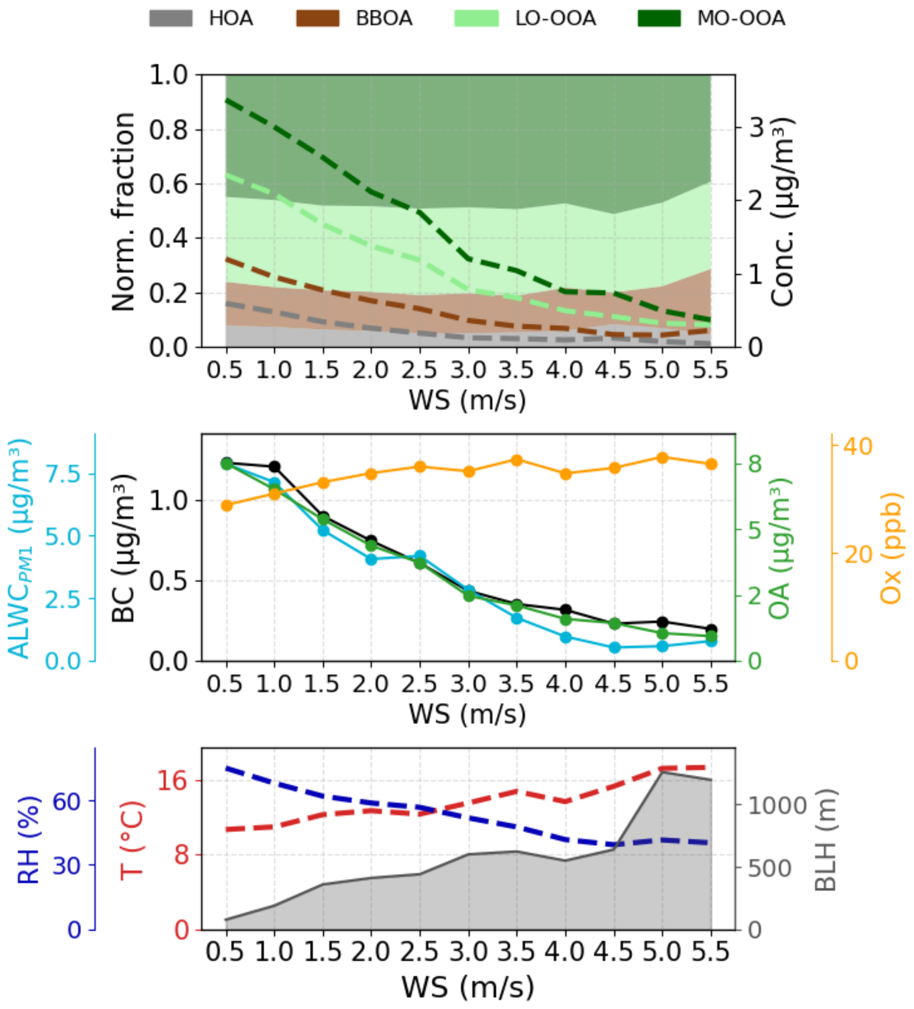
Milan



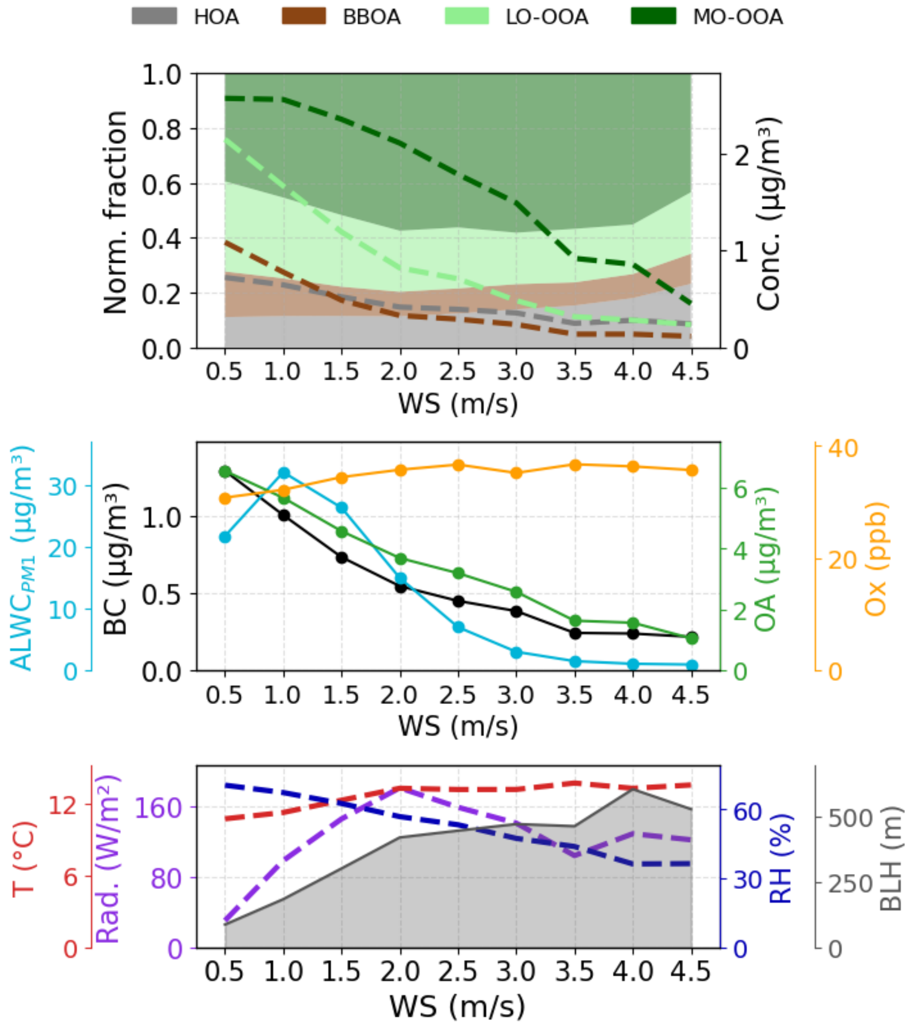
Wind speed effect

Cold period

Bologna



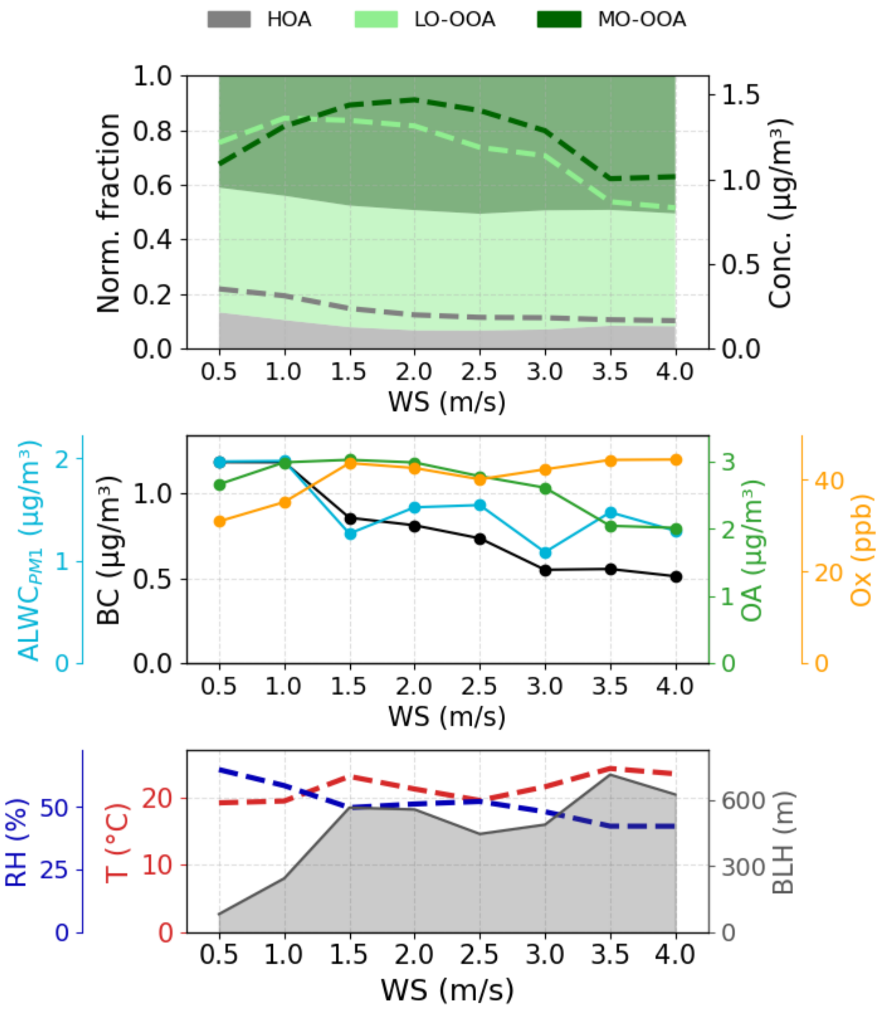
Milan



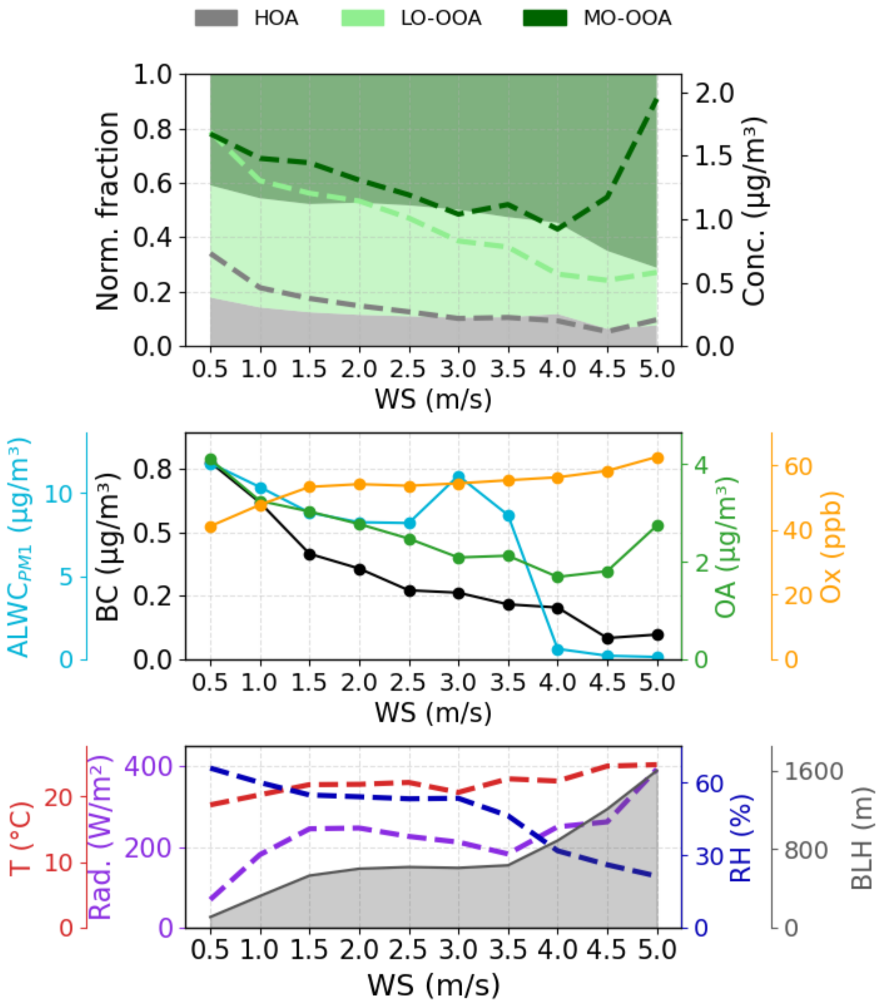
Wind speed effect

Warm period

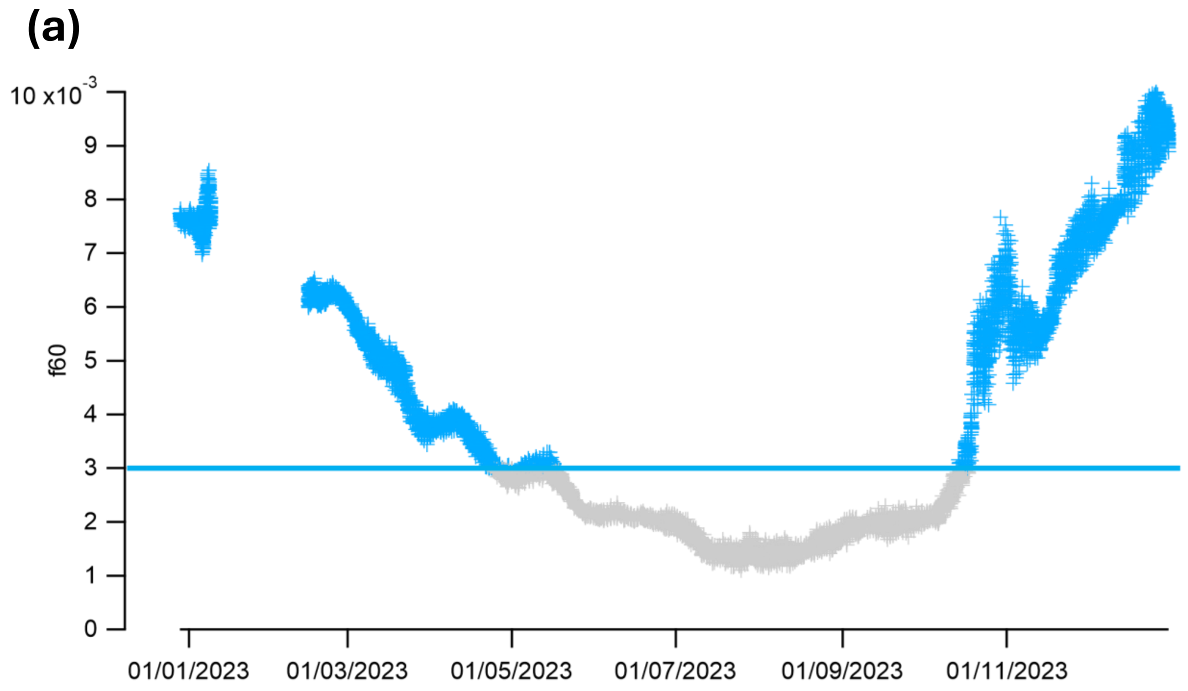
Bologna

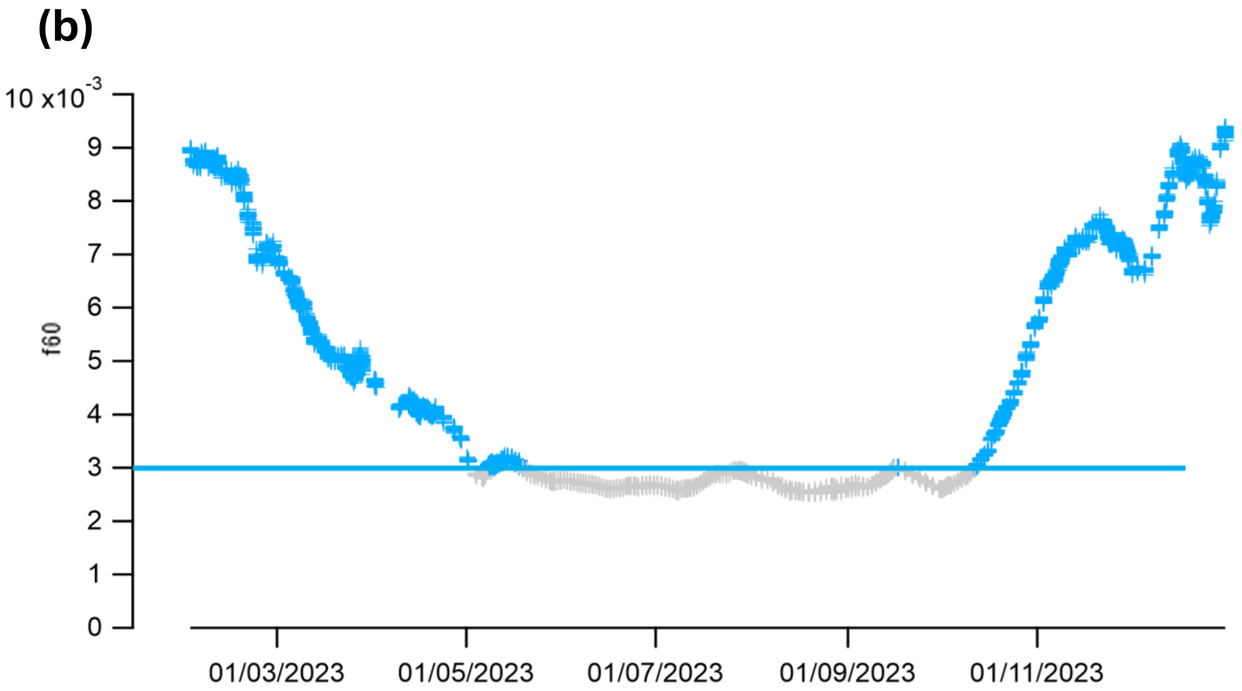


Milan



f_{60} = ratio of m/z 60 to total OA signal, representative for levoglucosan fragment

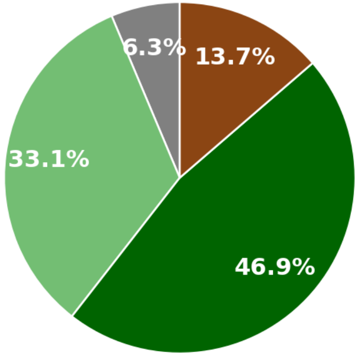


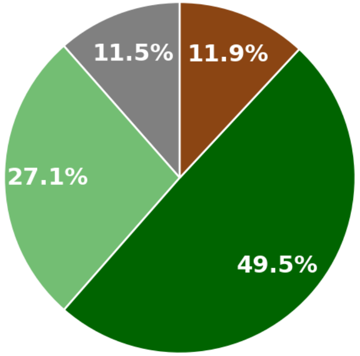


A background threshold of f_{60} = 0.3% was applied to distinguish periods influenced by fresh biomass burning in a SOA-dominated environment (Cubison et al. 2011)

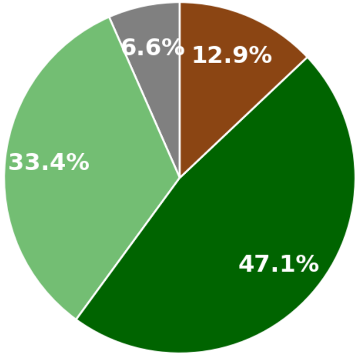
Bologna | Milan

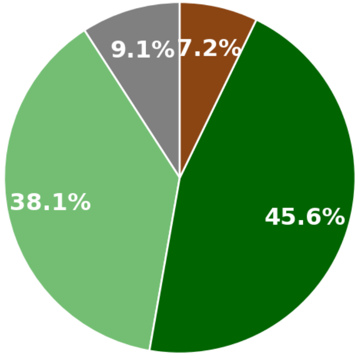
4 factors, cold period, constrained BBOA



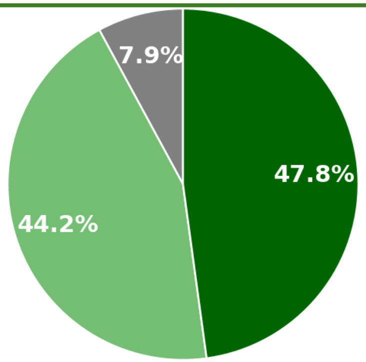


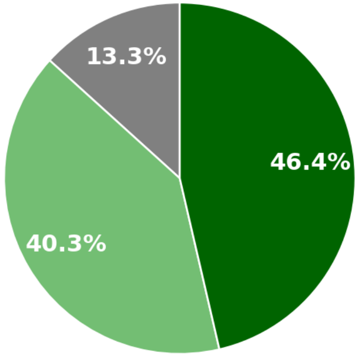
4 factors, warm period, constrained BBOA



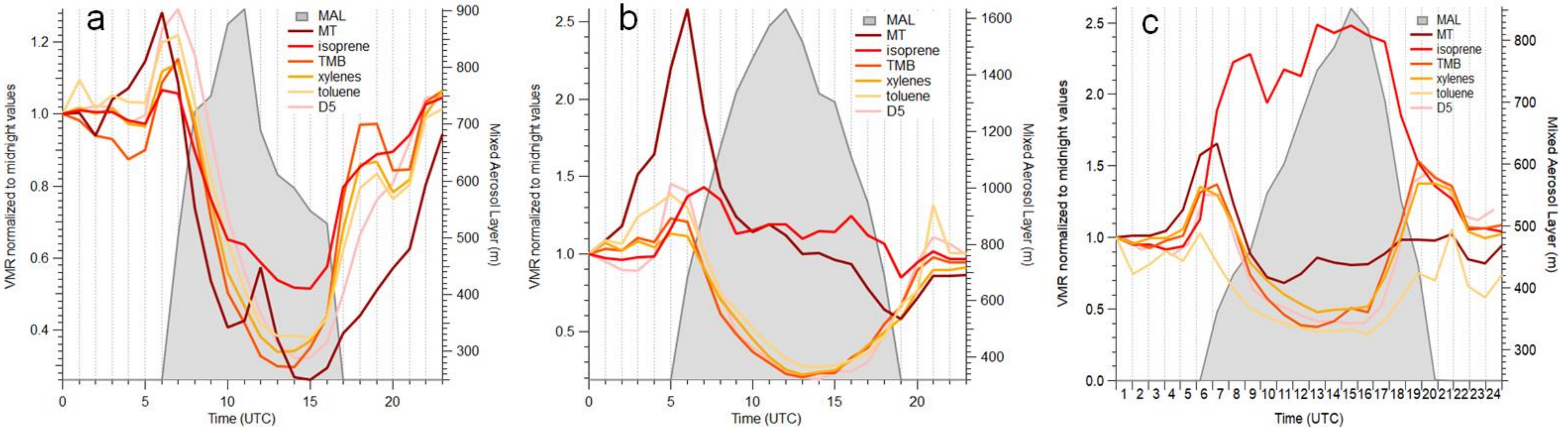


3 factors, warm period, no BBOA





Milan winter 2023 | Milan summer 2023 | Bologna September 2024



Diel variabilities of the median seasonal volume mixing ratios normalized to the respective midnight values of MT (sum of monoterpenes), **isoprene, TMB** (sum of trimethylbenzenes), **sum of xylenes, toluene and D5.**

from Zannoni et al. (in preparation)