Funded by the European Union

Coordinated by HYGEOS

CAMAERA

Work Package 8

“Secondary Organic Aerosol : assessment and evaluation”

activities and current status

Ben Murphy (MET Norway)

David Simpson[1], Willem van Caspel[1], Hilde Fagerli[1], Jesse Bash[1], Samuel Rémy[2], Vincent Huijnen[3], Jhilik Majumdar[3], Oriol Jorba[4], Florian Couvidat[5], Victor Lannuque[5], Jesper Christensen[6], Robert Bergstrom[7], Ana Carvalho[7]

[1]MET Norway, [2]HYGEOS, [3]KNMI, [4]BSC, [5]INERIS, [6]Aarhus University, [7]SMHI

CAMAERA General Assembly Meeting

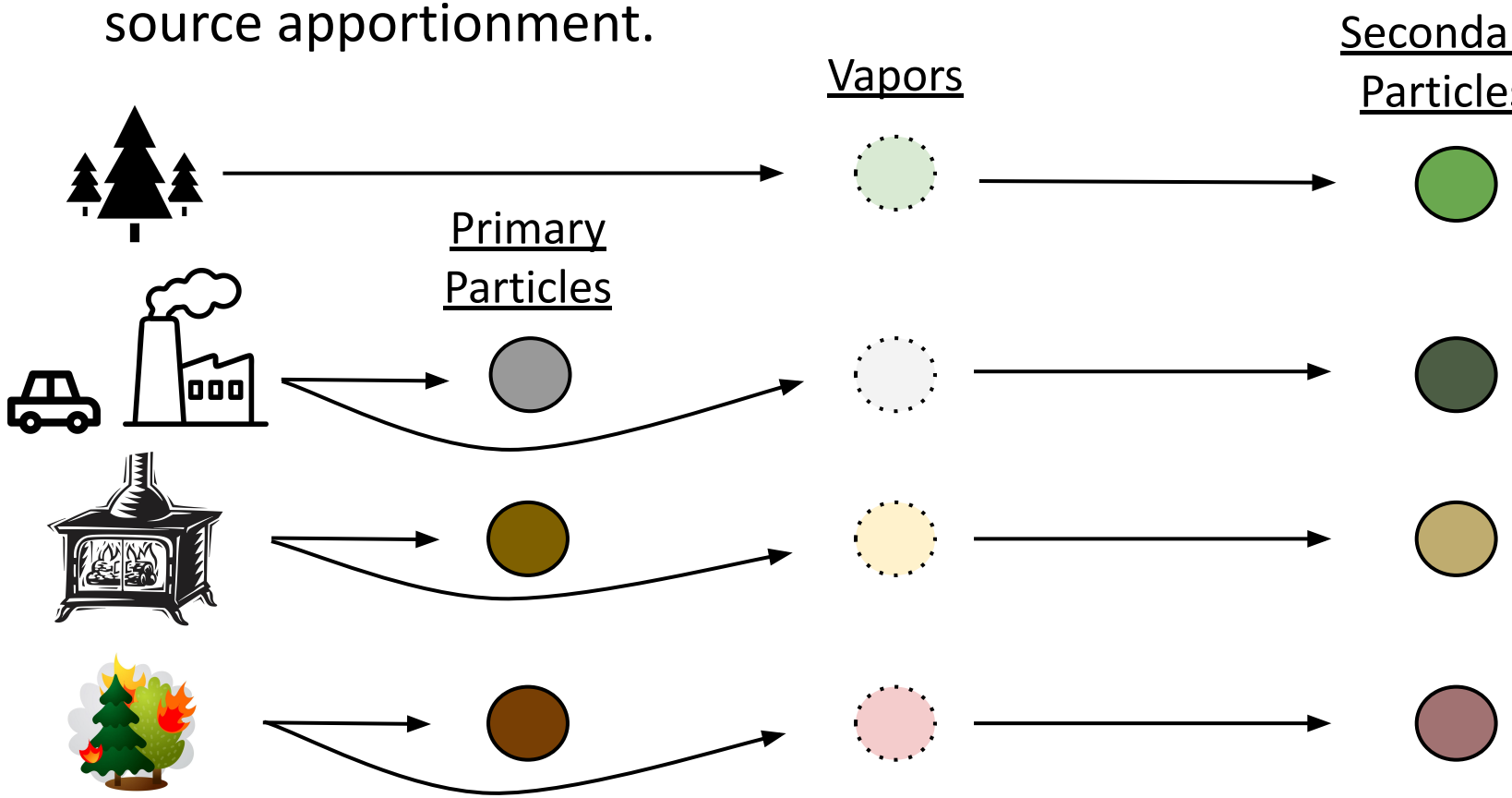
21 May 2026

Norwegian Meteorological Institute

WP8 SOA Intercomparison: assessment and evaluation

Starting Status:

- Organic aerosol predictions vary strongly across air quality models.
- Uncertainties in emissions and chemistry directly lead to uncertainties in source apportionment.



Uncertainties

Land use/cover

Emission factors

Emission Speciation

Emission Temporality

Vapor Reaction Rates

Aerosol Yield from Vapor Oxidation

Oxidation Reaction Product Chemistry

Chemical Properties (volatility, solubility, reactivity, etc.)

WP8 SOA Intercomparison: assessment and evaluation

Objectives:

- Compare Organic Aerosol predictions across models using common emissions.
- Align model predictions using AeroVal model-measurement analysis platform.
- Determine the potential impact of chemistry updates on OA concentrations.

Model	Primary Emission	SOA Formation	First-Round Data Upload
EMEP	Nonvolatile, Semivolatile	BVOCs; Anth VOCs; SVOCs; IVOCs	Complete
MONARCH	Nonvolatile, Semivolatile	BVOCs; Anth VOCs; SVOCs; IVOCs	Partially Complete
MATCH	Nonvolatile, Semivolatile	BVOCs; Anth VOCs; SVOCs; IVOCs	Complete
DEHM	Nonvolatile	BVOCs; Anth VOCs	Complete
IFS-COMPO	Nonvolatile, Semivolatile	BVOCs; Anth VOCs; SVOCs; IVOCs	Partially Complete
CHIMERE	Nonvolatile, Semivolatile	BVOCs; Anth VOCs; SVOCs; IVOCs	To be completed
SILAM			To be completed

WP8 Simulation Details

All models simulated 2019

Domain: CAMS 0.1° x 0.1°

Emissions: CAMS-REG-v8.1

- GNFR Sector C (Residential Combustion) is split into fossil and wood burning, which dominates.
- Wildfires - hourly GFAS

Meteorology: IFS

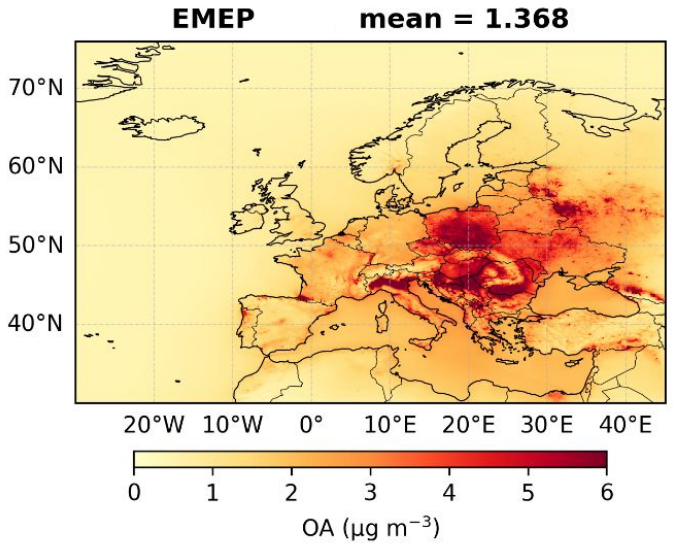
Boundary Conditions: EAC

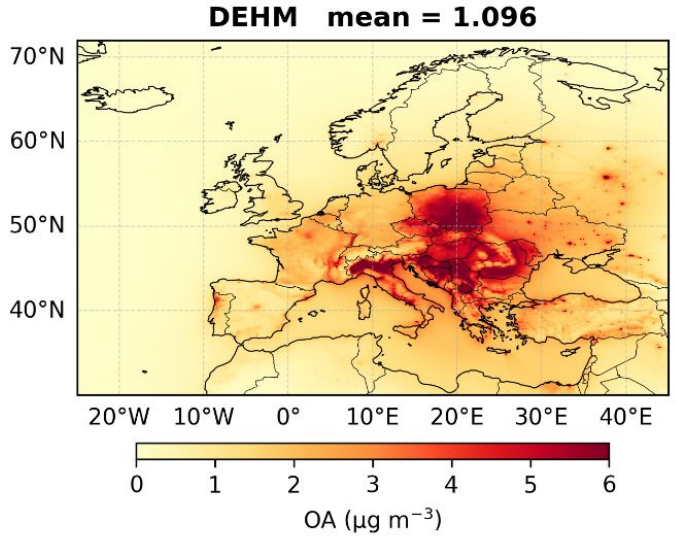
Outputs:

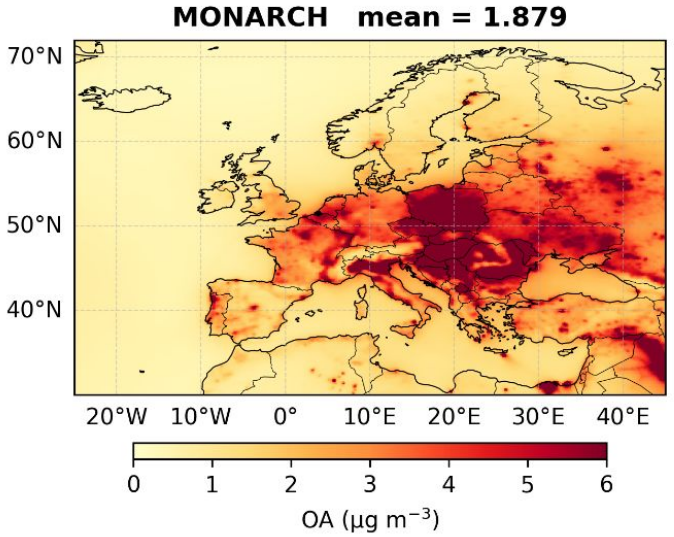
- O_3, NO_X, HCHO, SO_2, HNO_3, NH_3, Isoprene, Terpenes, OH
- $PM_{2.5}$, OC, OM, EC, SO_4, NO_3NH_4, SeaSpray, Dust
- Source-attributed OM - Road Traffic, Wood Burning, Wildfires, Other Fossil.

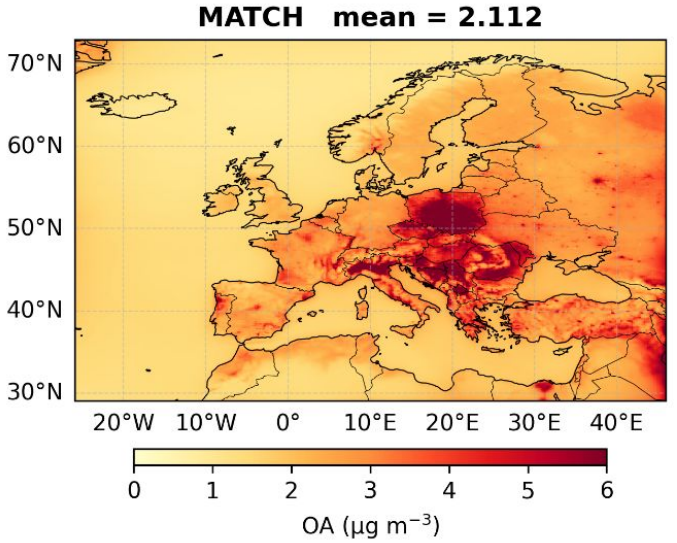
Measurements: EBAS, EEA, RI-URBANS, CARA

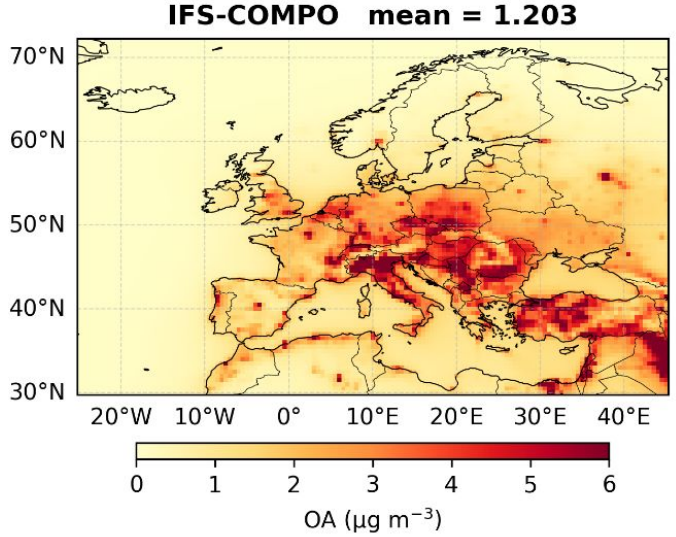
WP8 Organic Aerosol Spatial Distribution



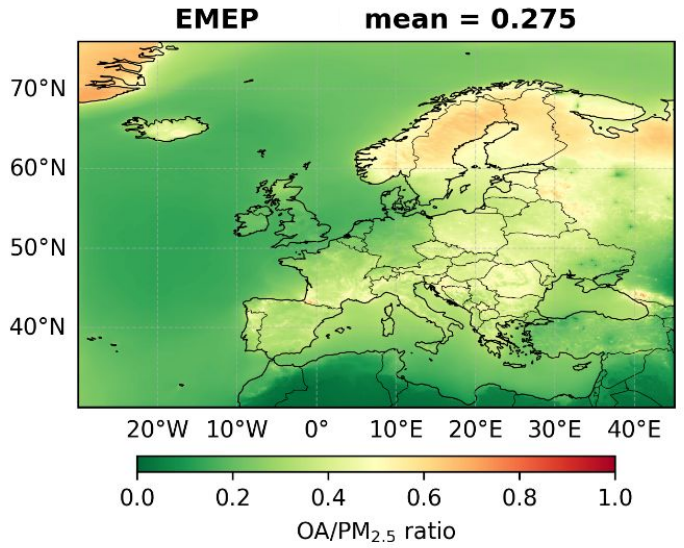


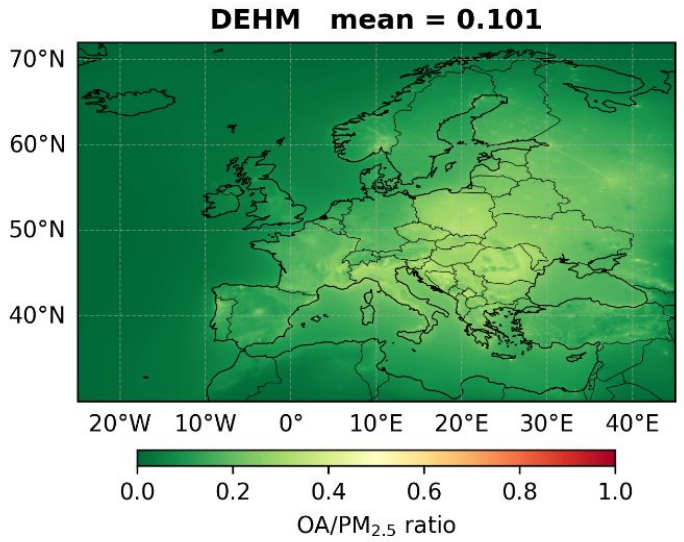


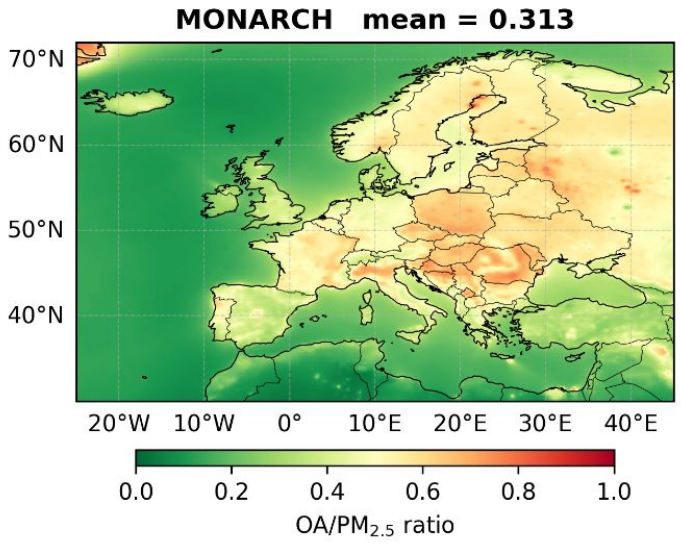


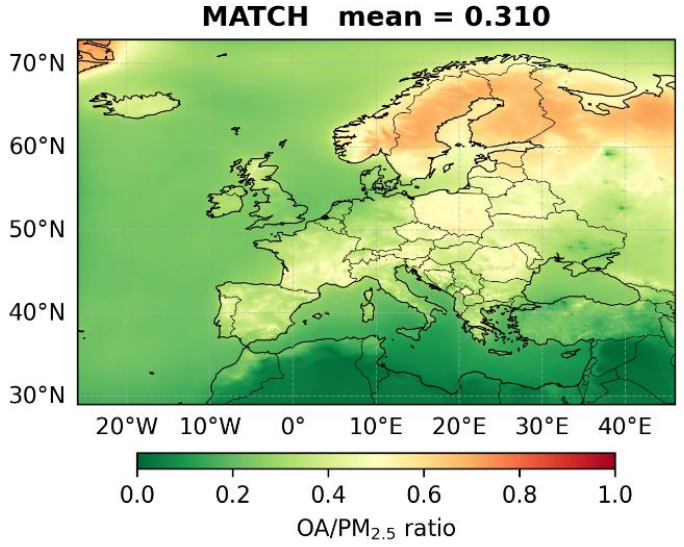


WP8 Organic Aerosol Contribution to PM2.5

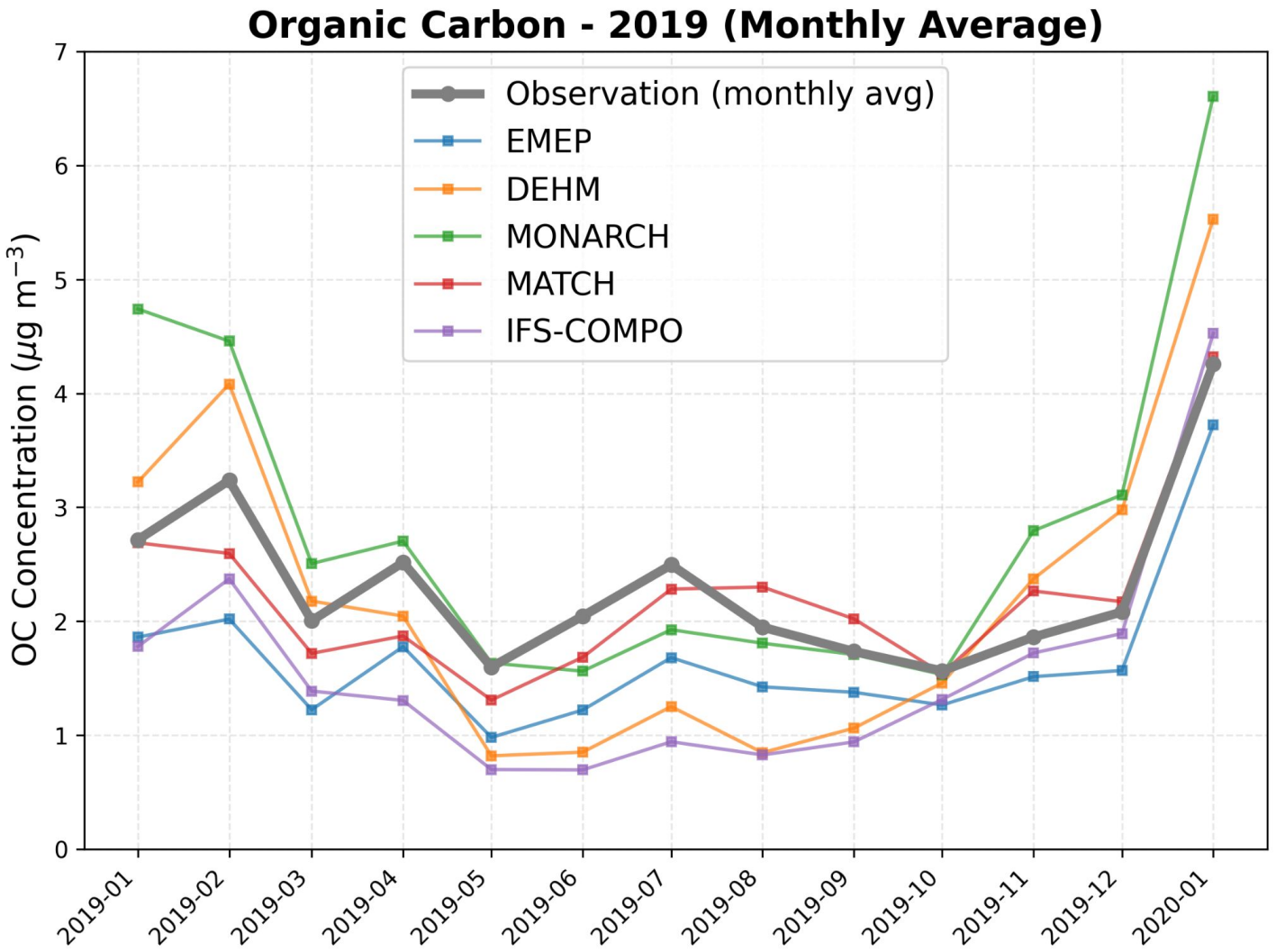








WP8 OC Evaluation

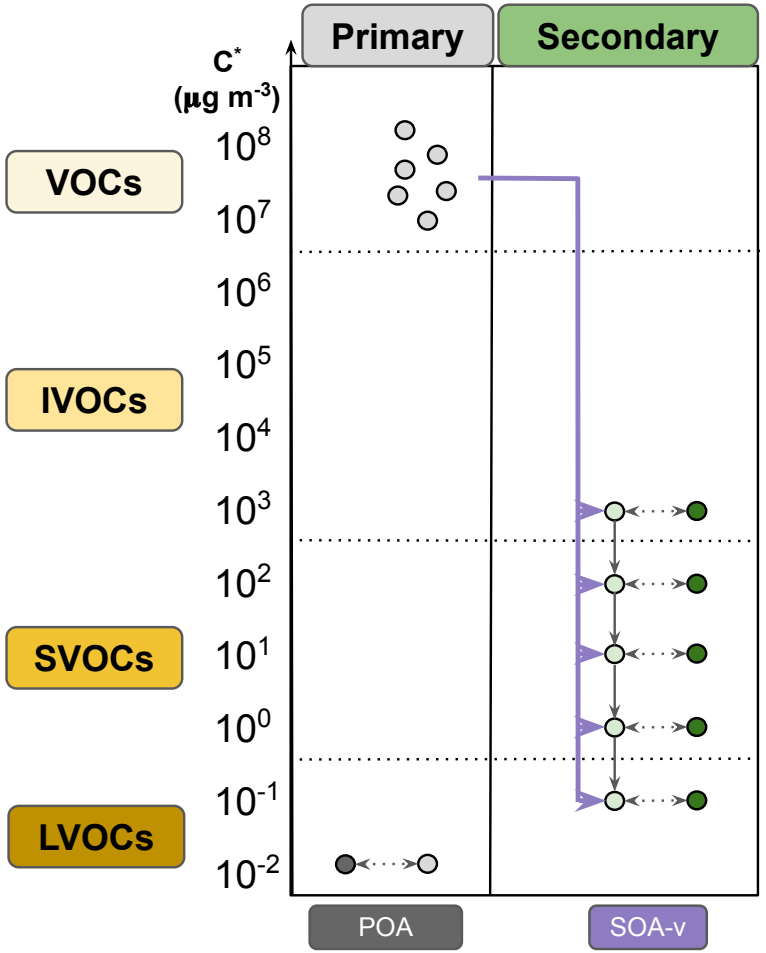


Model	OM/OC
EMEP	1.9 SOA 1.7 Wood Burning POA 1.25 Fossil POA
MONARCH	1.6 SOA 1.4 hydrophobic POA 2.1 hydrophilic POA
MATCH	1.66 Wood Burning, BSOA 1.25 Fossil
DEHM	1.3
IFS-COMPO	1.4 hydrophobic 2.3 hydrophilic

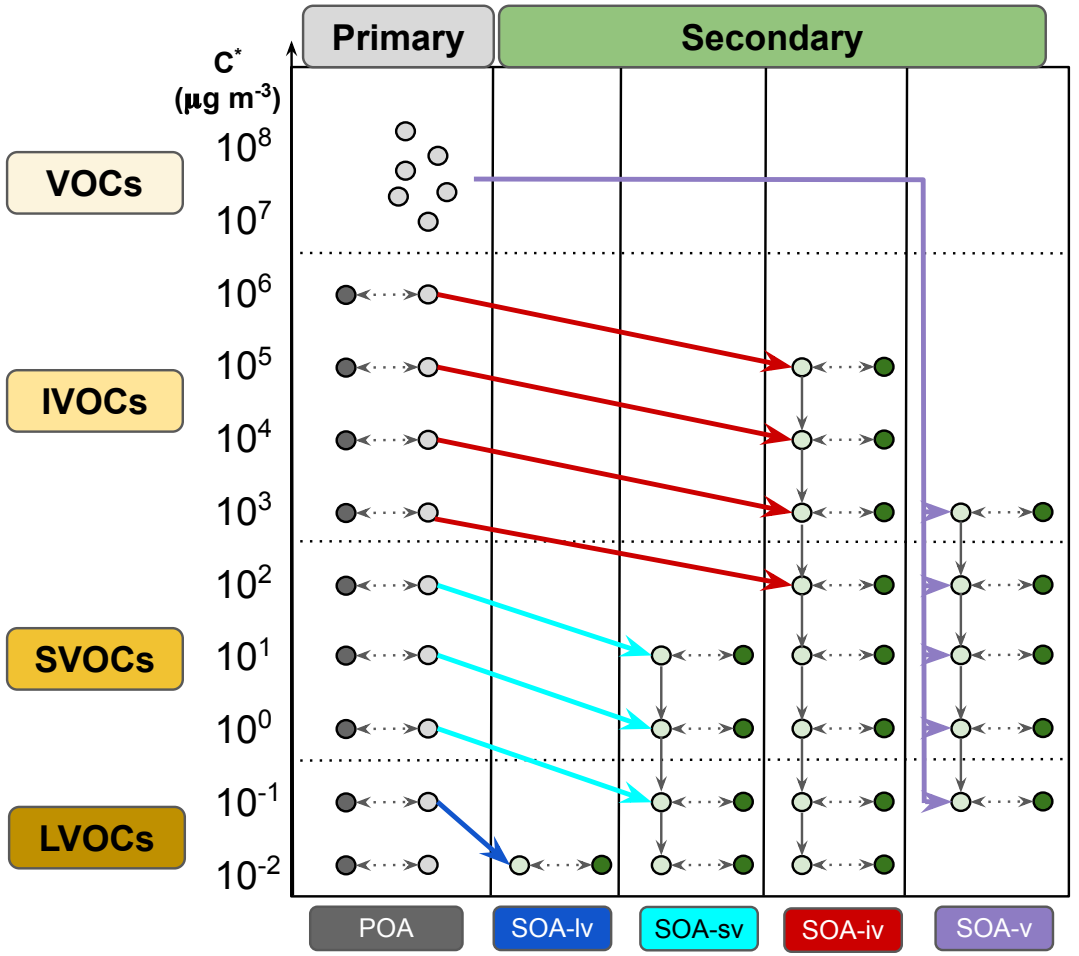
AeroVal
Evaluation of climate and air quality models

WP8 Organic Aerosol Model Details

EMEP_NV (Operational EMEP)

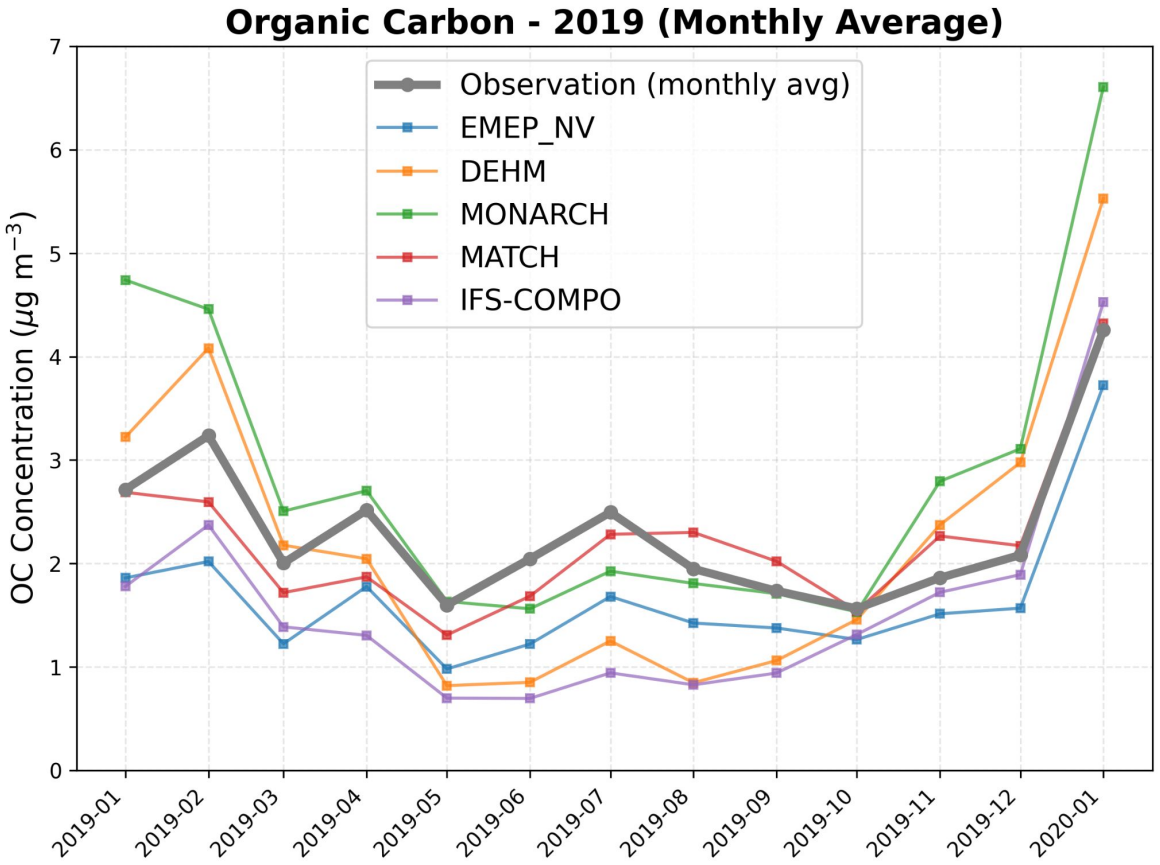


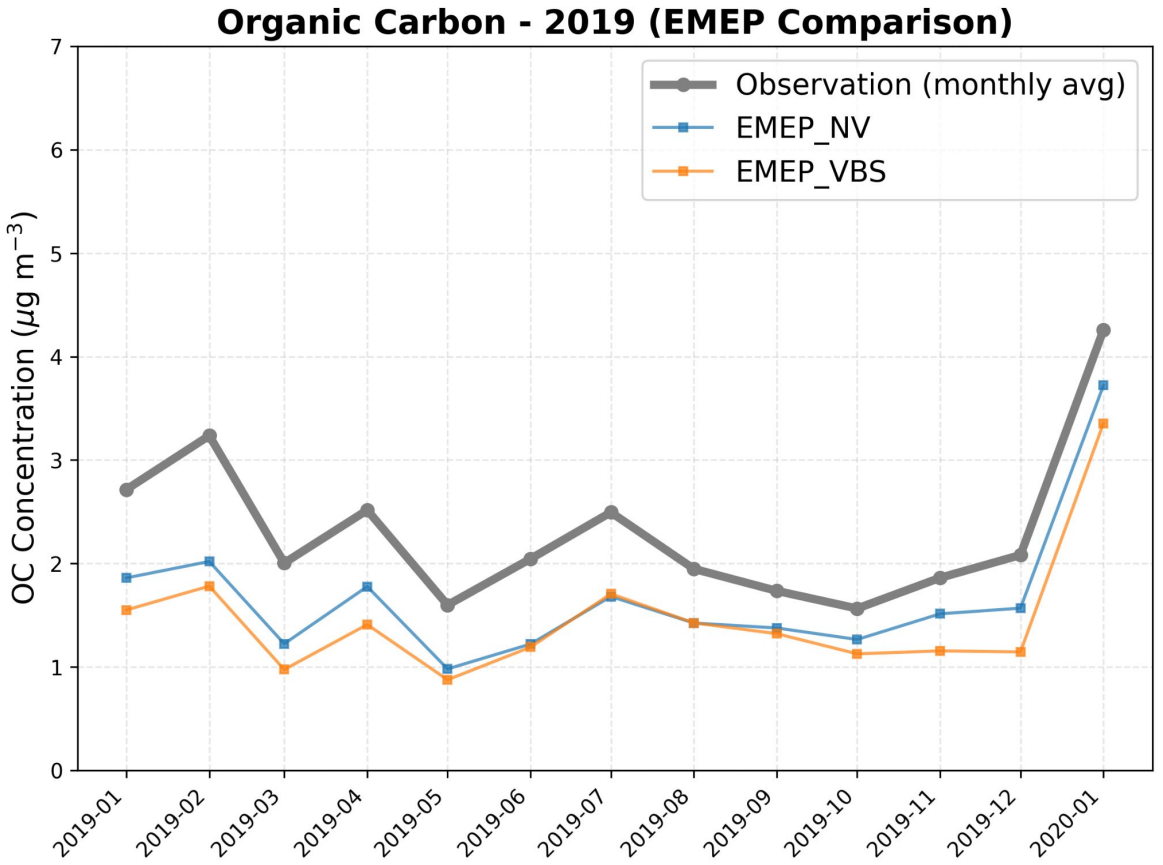
EMEP_VBS (Semivolatile POA + IVOCs)



Graphic Adapted from Tsimpidi et al., *Atmos. Chem. Phys*, 2017. Species properties and yields are based on the 1.5D-VBS (Koo et al., *Atm. Environ.*, 2014).

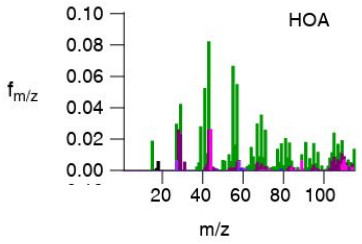
WP8 OC Evaluation



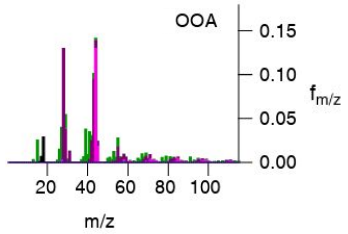


For total OC predictions, the choice of chemistry can be less significant than the host model variability.

WP8 Source-associated factors inferred from OA mass spectra

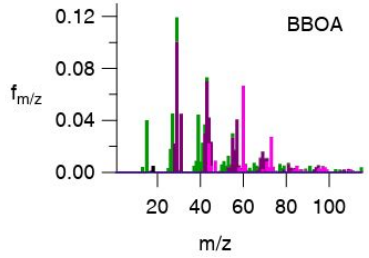


HOA
Hydrocarbon-like
Organic Aerosol



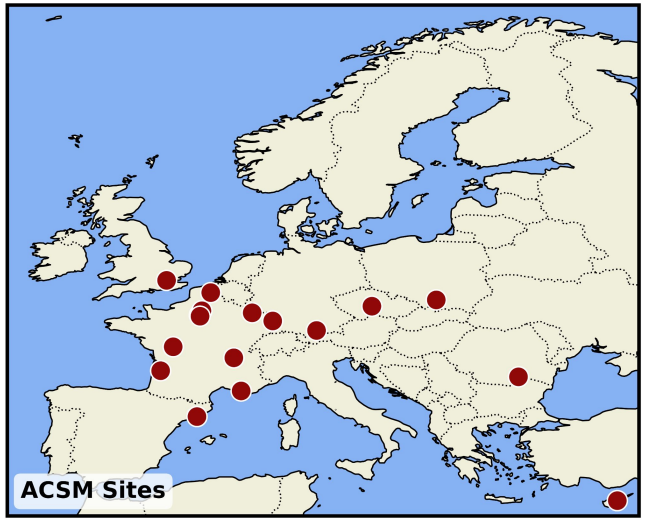
OOA
Oxygenated
Organic Aerosol

BBOA
Biomass Burning
Organic Aerosol

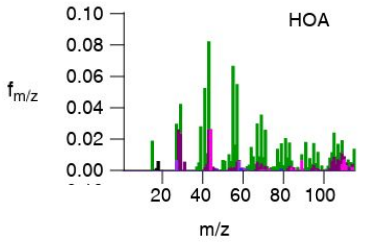


Aerosol Chemical Speciation Monitor (ACSM) data collection and analysis provided by the:

- Chemical On-Line cOmpoSition and Source Apportionment of fine aerosol (COLOSSAL) project (Chen et al., 2022)
- Chemical Characterization of Particles (CARA) program (Chebaicheb et al., 2024)

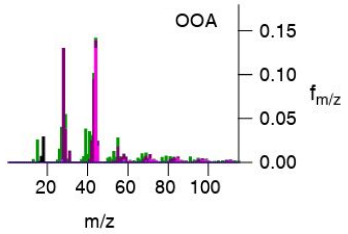


WP8 Source-associated factors inferred from OA mass spectra



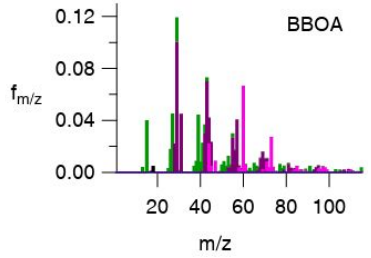
HOA
Hydrocarbon-like
Organic Aerosol

Particle Emissions



OOA
Oxygenated
Organic Aerosol

BBOA
Biomass Burning
Organic Aerosol



Particle Emissions

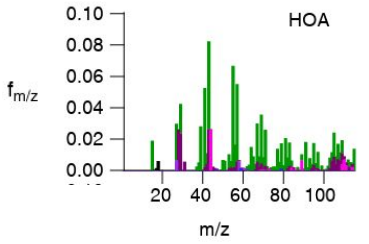
CAMAERA ...ice AERosol Advancement

Fossil Fuel Sources

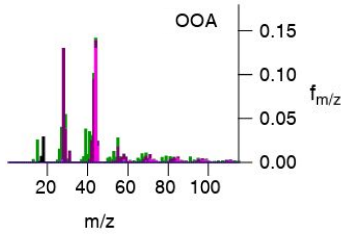
Example Mass Spectra from Dallenbach et al.

Wood Burning Sources

WP8 Source-associated factors inferred from OA mass spectra

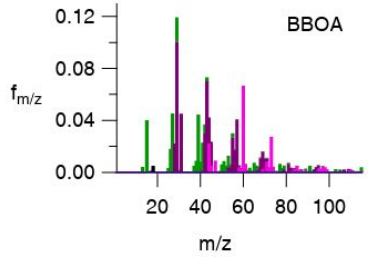


HOA
Hydrocarbon-like
Organic Aerosol



OOA
Oxygenated
Organic Aerosol

BBOA
Biomass Burning
Organic Aerosol



Particle Emissions

Particle Emissions

Oxidation

Vapor Emissions

VOC

VOC

Vapor Emissions

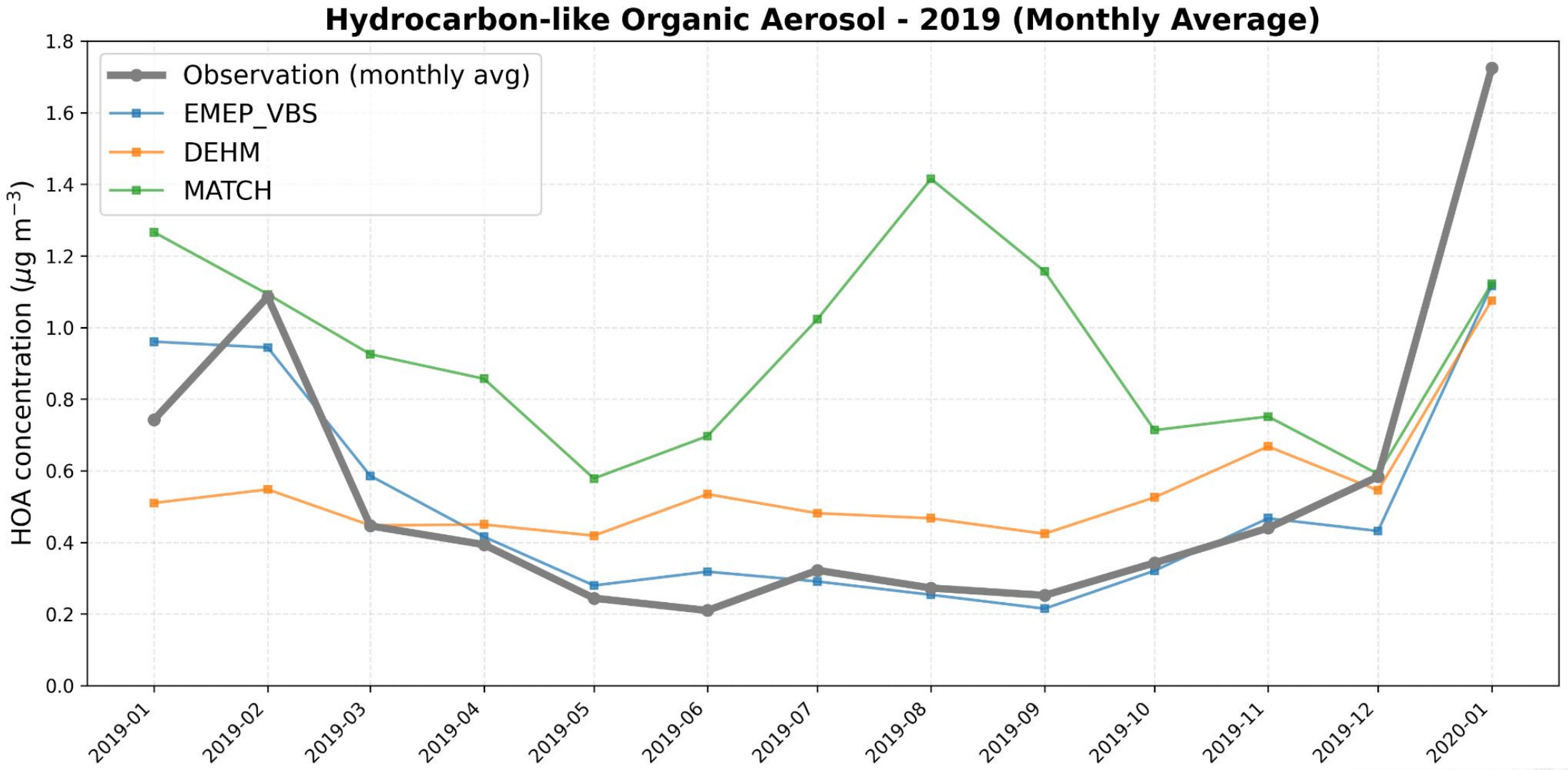
Fossil Fuel Sources

Wood Burning Sources

CAMAERA ice AERosol Advancement

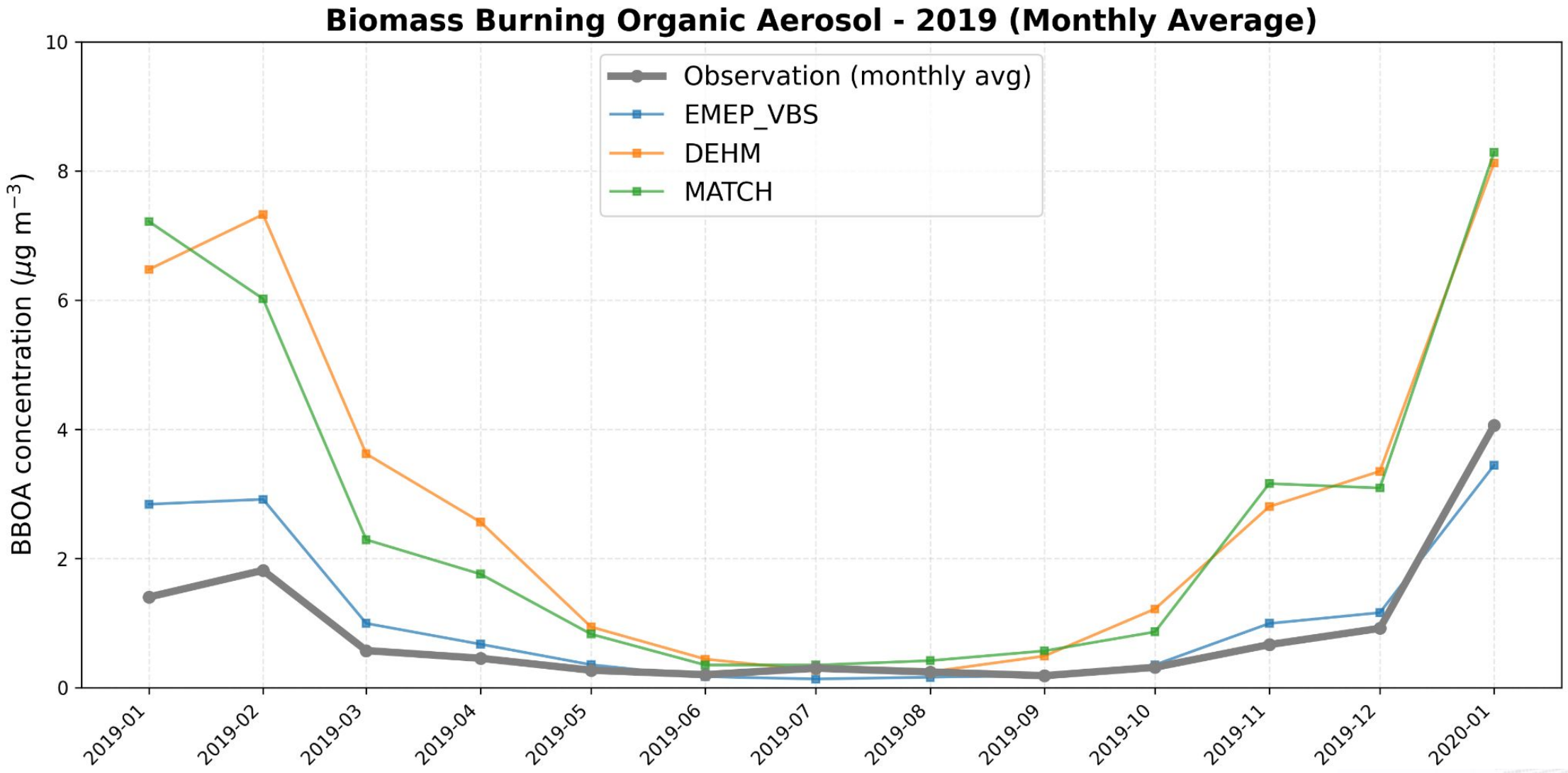
Example Mass Spectra from Dallenbach et al.

WP8 Hydrocrabon-like OA Evaluation



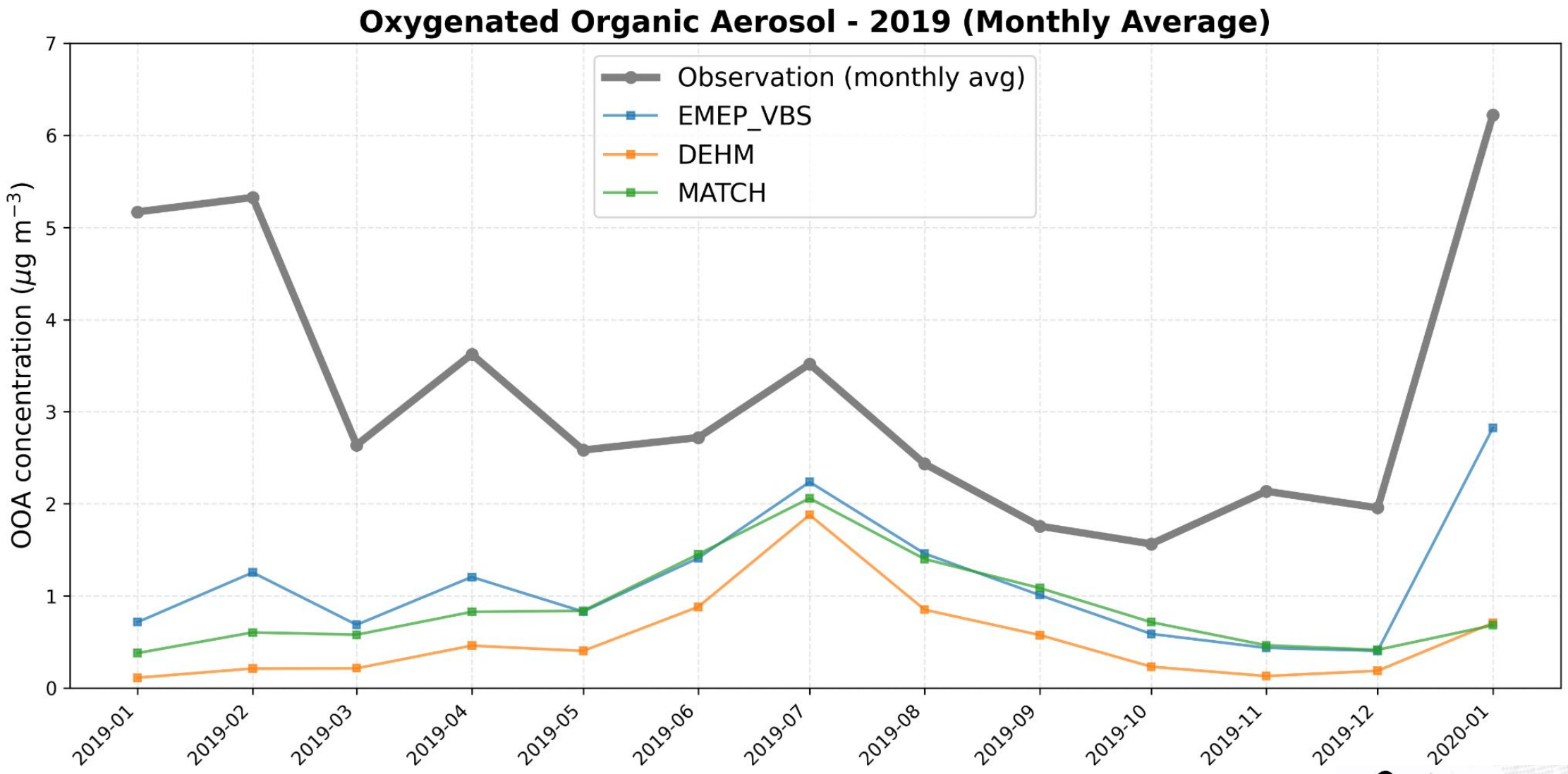
AeroVal
Evaluation of climate and air quality models

WP8 BBOA Factor Evaluation



AeroVal
Evaluation of climate and air quality models

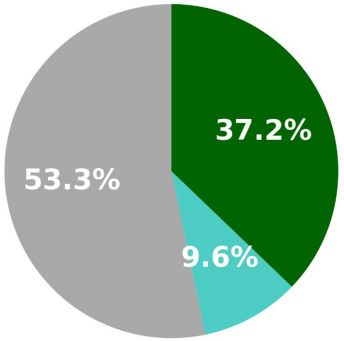
WP8 Oxygenated OA Evaluation



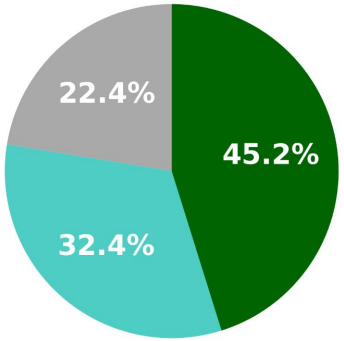
WP8 Organic Aerosol Formation Pathways

Domain Average

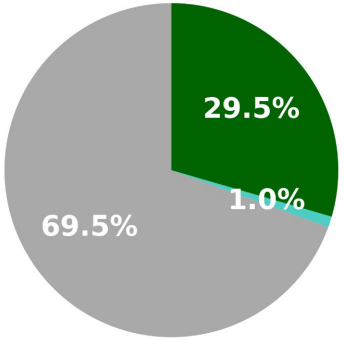
EMEP_NV



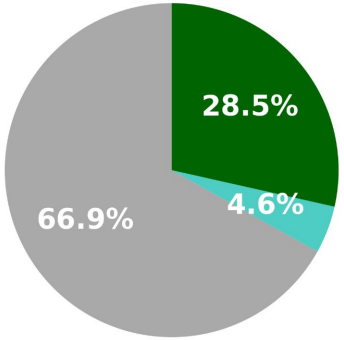
EMEP_VBS



DEHM

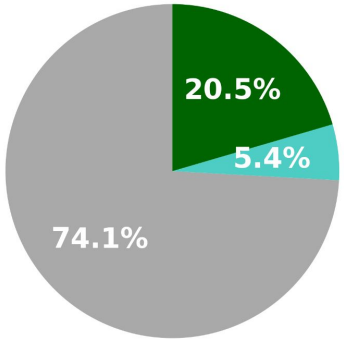


MATCH

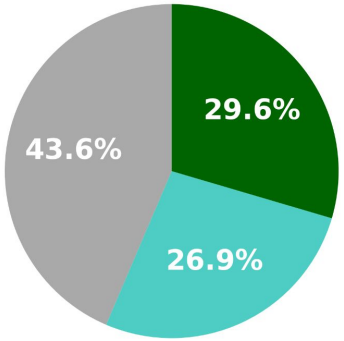


Population-Weighted Average

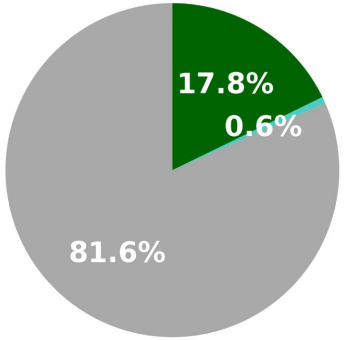
EMEP_NV



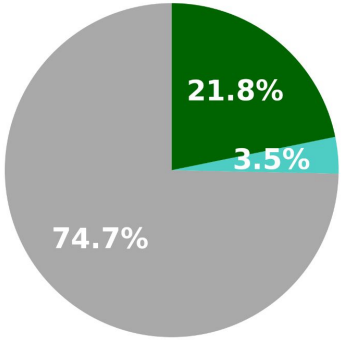
EMEP_VBS



DEHM



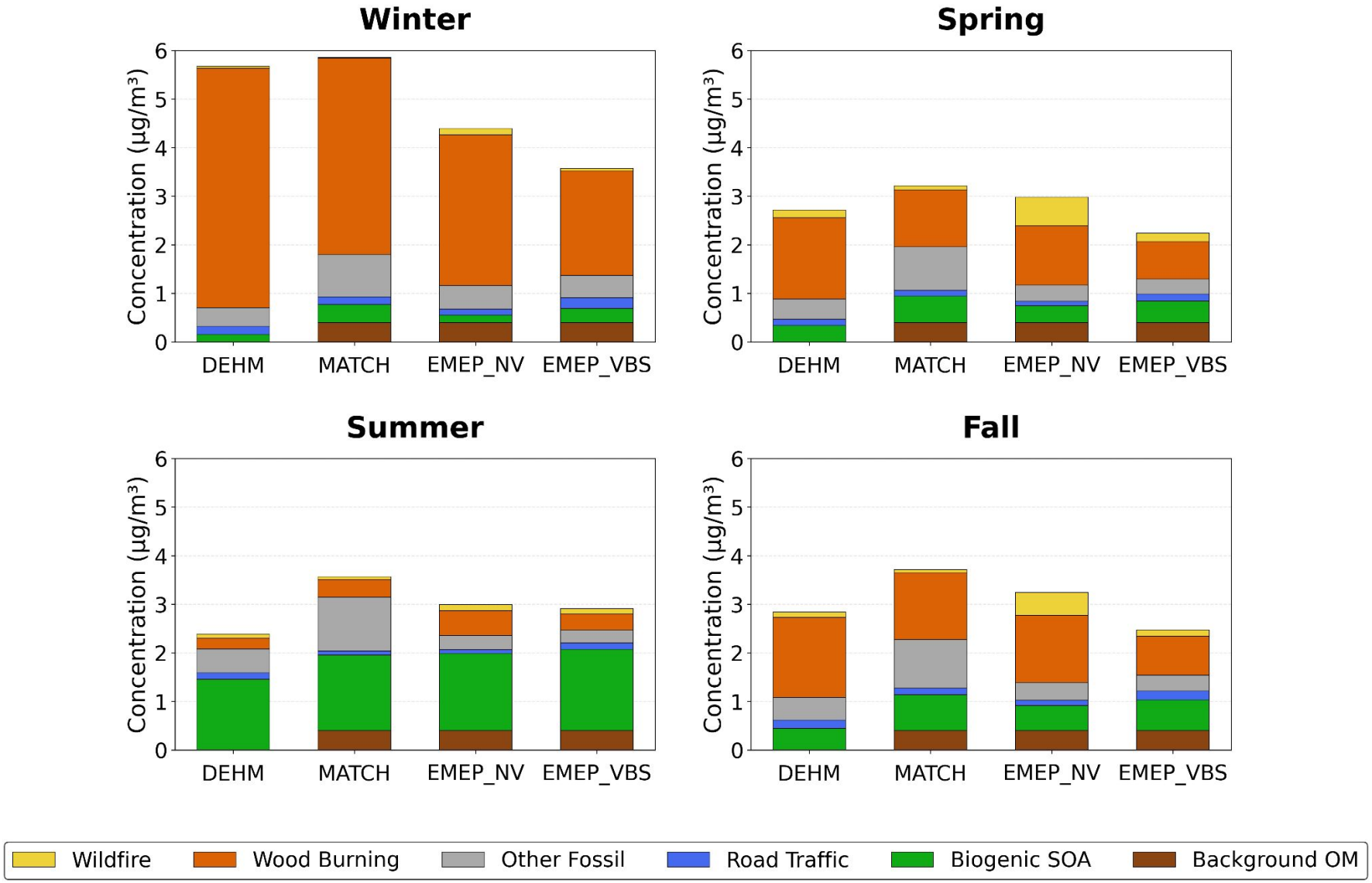
MATCH



Primary OA Combustion SOA Biogenic SOA

Primary OA Combustion SOA Biogenic SOA

WP8 Seasonality of source contributions (population-weighted)



WP8 SOA Intercomparison: Summary

- First stage of intercomparison of organic aerosol predictions among seven models is nearly complete.
- Similar spatial predictions for OA concentration and contribution to total $PM_{2.5}$
- Bias with OC prediction ranges from +17.8% to -38.5%, and is seasonally dependent.
- Probably need to evaporate POA in order to predict HOA and BBOA well. OOA appears underpredicted across models. *There is not enough oxidation in the system.*
- Models generally agree on the following average contributions for 2019:
  - wood burning: 1.0-2.1 $\mu g\ m^{-3}$
  - road traffic: 0.1-0.17 $\mu g\ m^{-3}$
  - other fossil: 0.3-0.9 $\mu g\ m^{-3}$
  - biogenic VOCs: 0.6-0.8 $\mu g\ m^{-3}$.

WP8 SOA Intercomparison Next Steps

- Models are currently performing sensitivity simulations with POA evaporation (i.e. SVOCs), IVOC oxidation, etc.
- Several simple SOA schemes are being tested (Pai et al., 2020; Jo et al., 2023; Tsimpidi and Karydis, 2026).
- Planned Second Round of Intercomparison (Fall 2026):
  - BVOC updates from WP8
  - Wood-Burning IVOC chemistry updates from WP7
  - Consider other SOA precursor and POA sources like solvents and cooking.
- Information Needs
  - Review wood-burning and other emission sectors (e.g. offroad engines, cooking, solvents)
  - Consistency in speciation and interpretation of particles vs. vapors from emission measurements