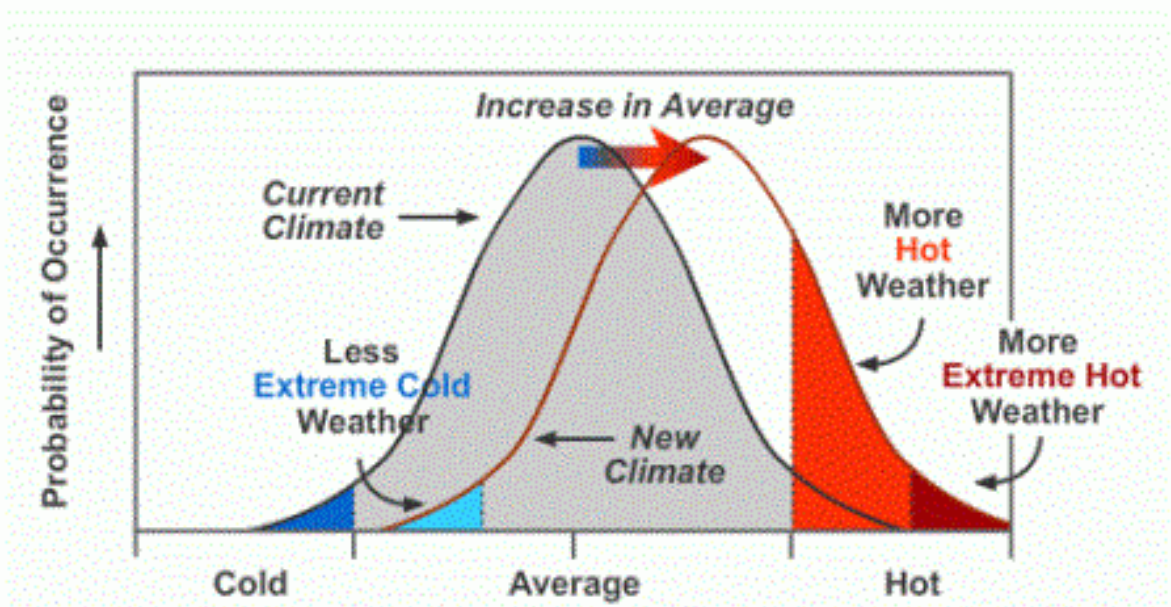
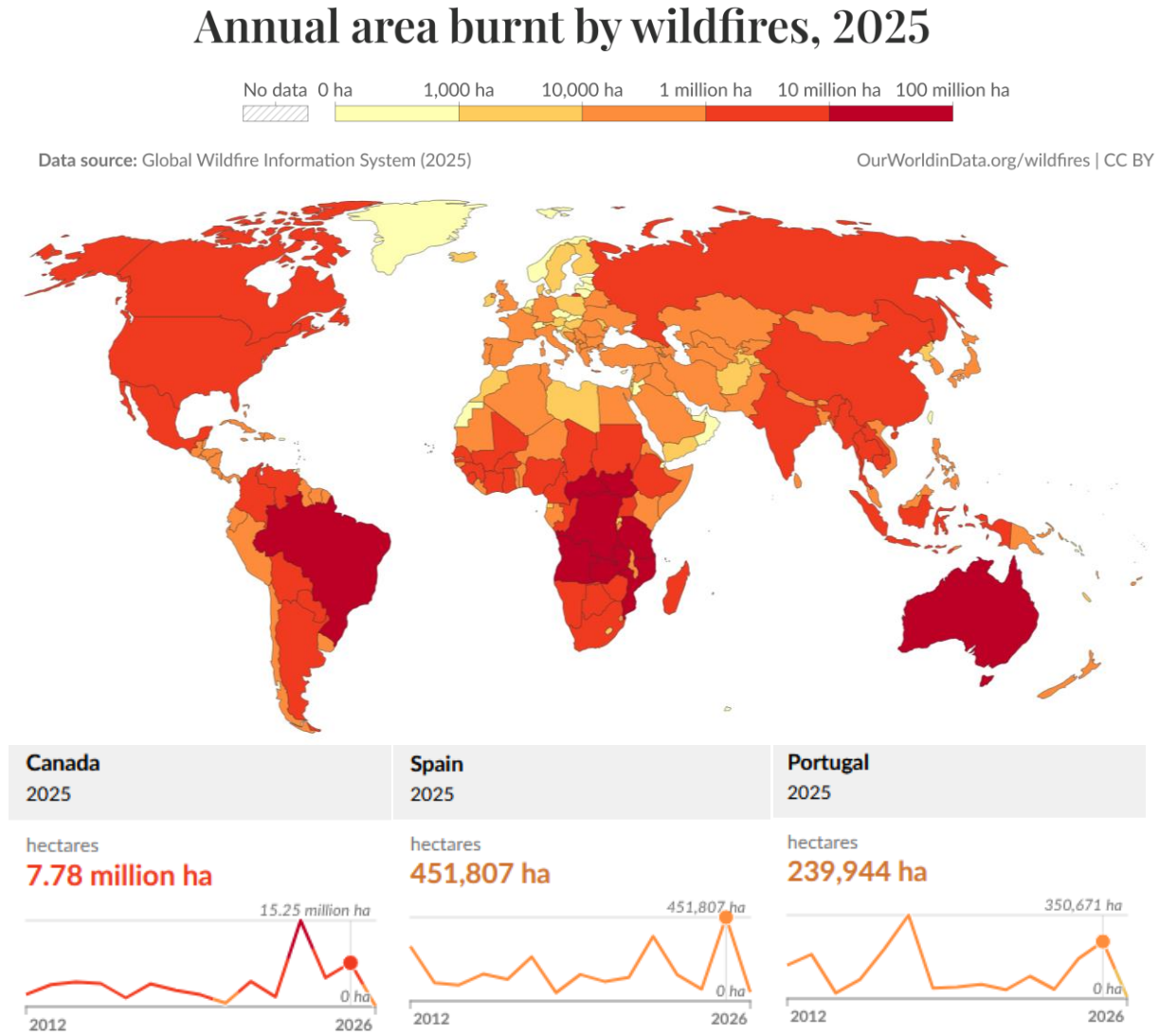
Natural hazard plumes during Summer 2025 : a pan-European overview

L.-H. Rivellini, J.-E. Petit, J. Brochet, A. Bergé, L. Foliot, V. Gros, L. Lei, J. Ovadneite, C. Magnani, M. Rapuano, A. Marinoni, J. Ondracek, P. Vodicka, L. Simon, M. Gysel-Beer, B. Brem, R. Modini, B. Chazeau, and the NF Forum WG "AMS" community

Climate Change - Increasing Occurence of Extreme Events



Credit: US EPA



- record-breaking heatwaves, causing megafires and millions of hectares burnt each year

Wildfire Emissions, Evolution and Impacts

Local Source

Emissions depend on fuel an combustion conditions

- Flaming: more **BC** & gas
- Smoldering : more **OM** including **BrC**, less gas

Regional Transport

Competing processes

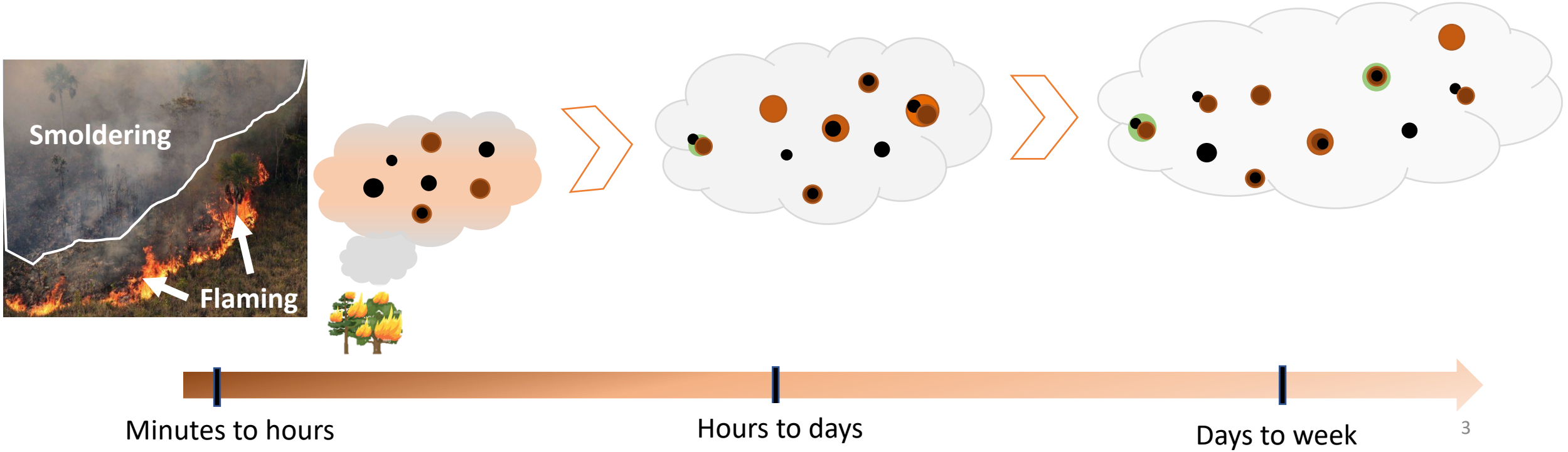
- Dilution
- Photochemistry/oxydation
  - ➔ BrC bleaching
- SOA production
  - ➔ secondary BrC formation

Global Transport

- BrC bleaching

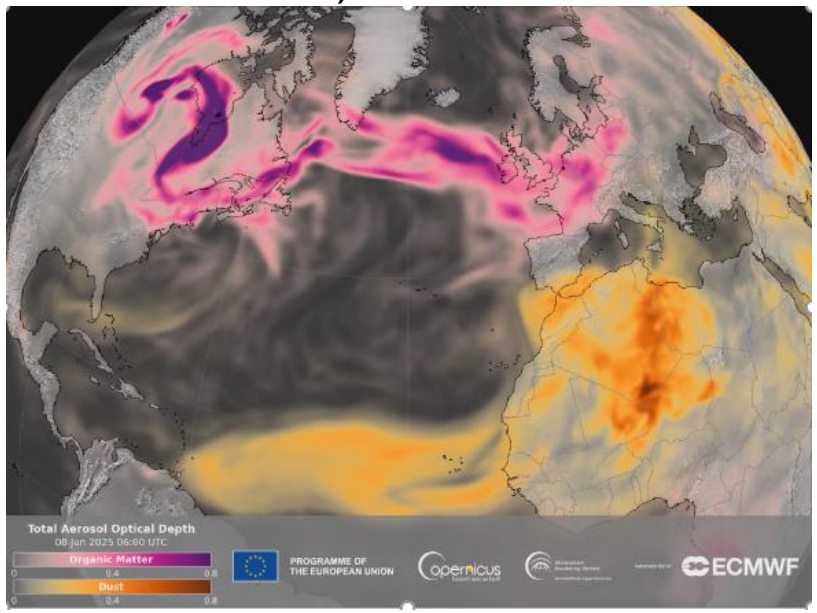
➔ BrC lost most of its absorbing properties

- Loss of OA due to volatility
- Cloud processing & deposition

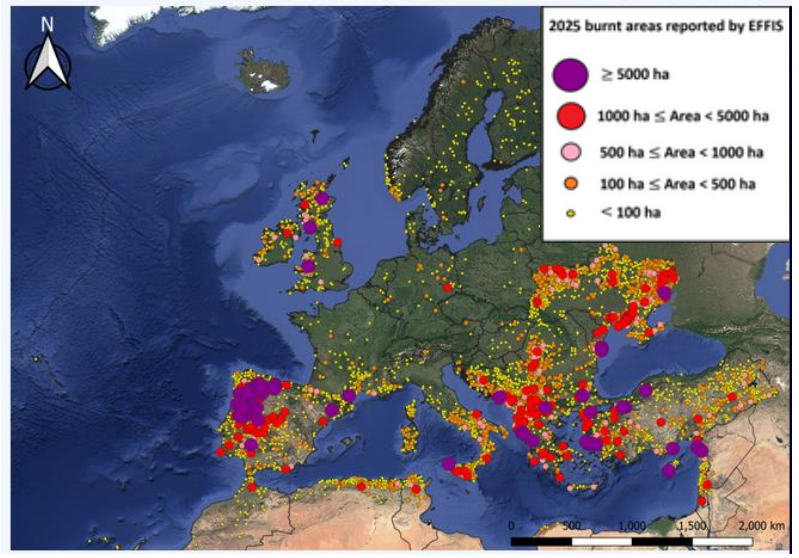


Summer 2025 : Canadian & European wildfires

June 8th, 2025 – 6 am UTC



Europe - burnt areas in 2025

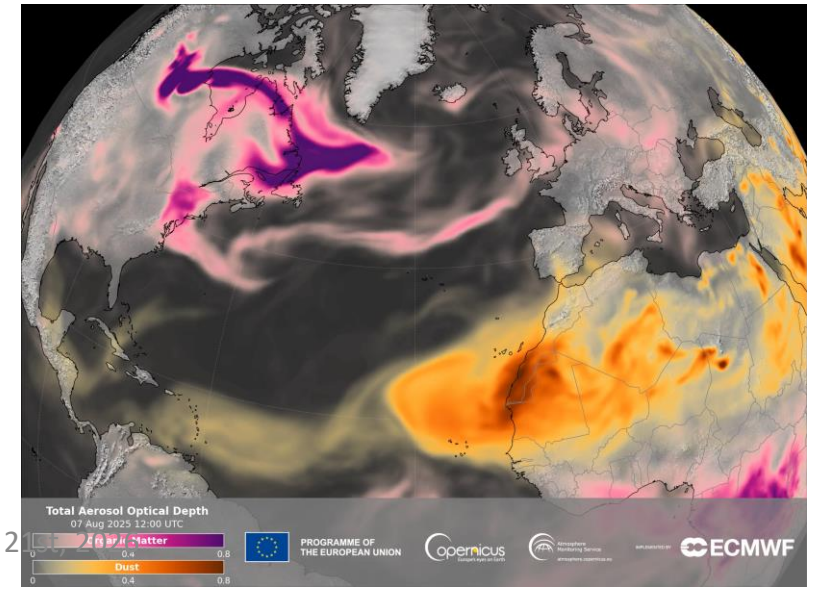


Source: https://publications.jrc.ec.europa.eu/repository/handle/JRC146199

Switzerland Alps on June 9th, 2025

Credit: HansPeter Roesly

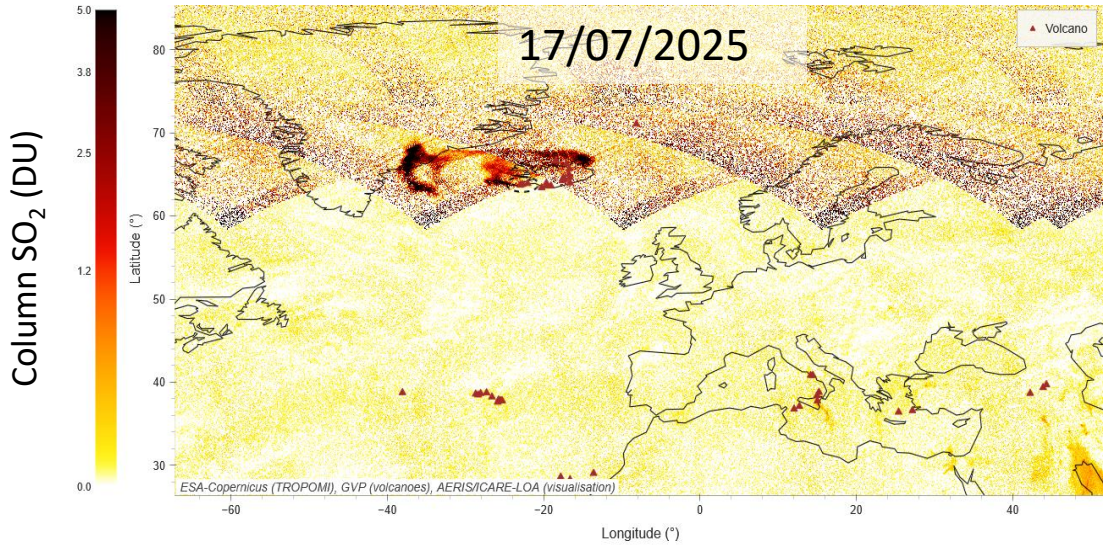
August 8th to 25th, 2025

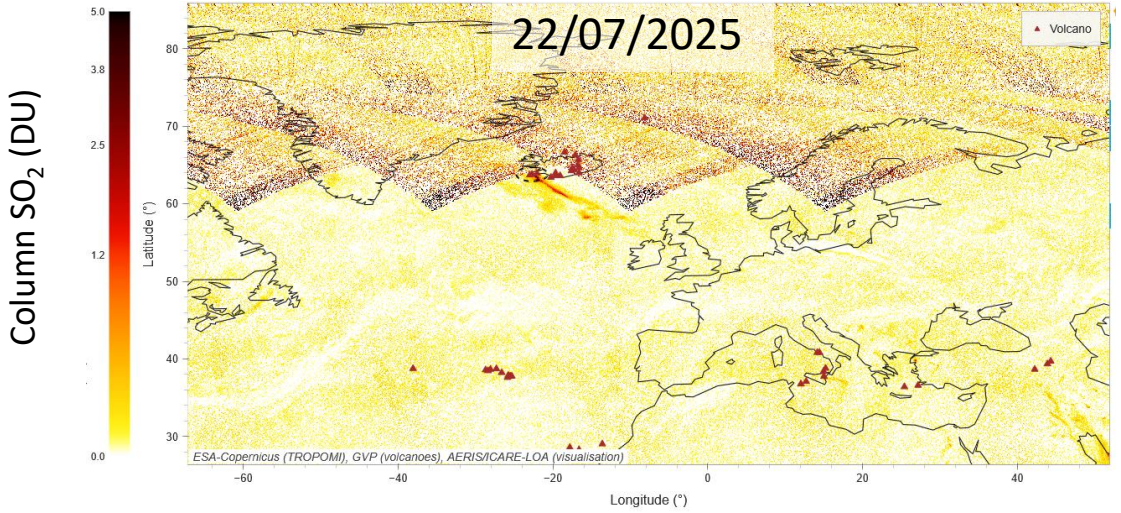


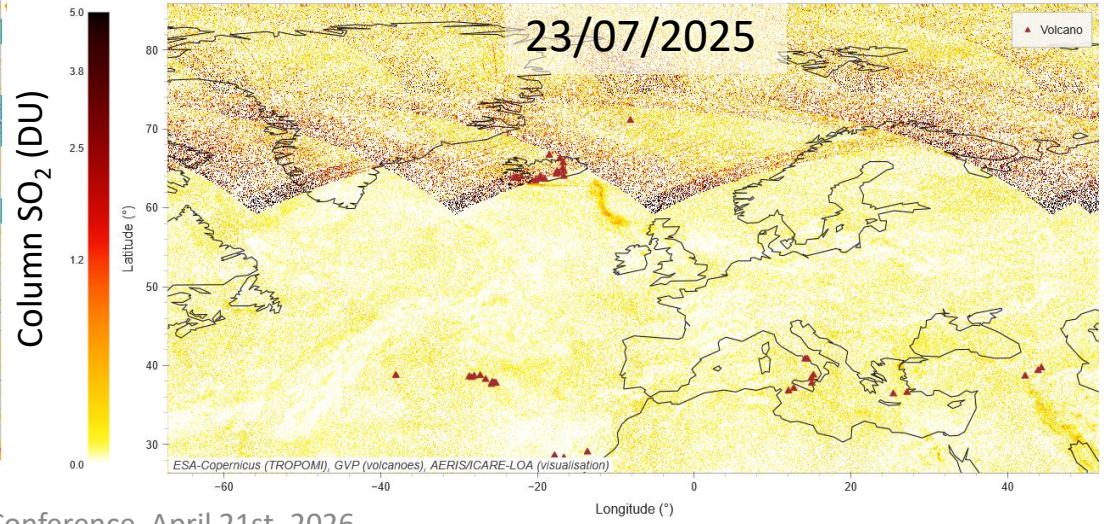
Summer 2025 : Iceland volcanic eruptions

Eruptions in the Reykjanes peninsula, from July 16th to 25th

Sundhnúksgígar crater







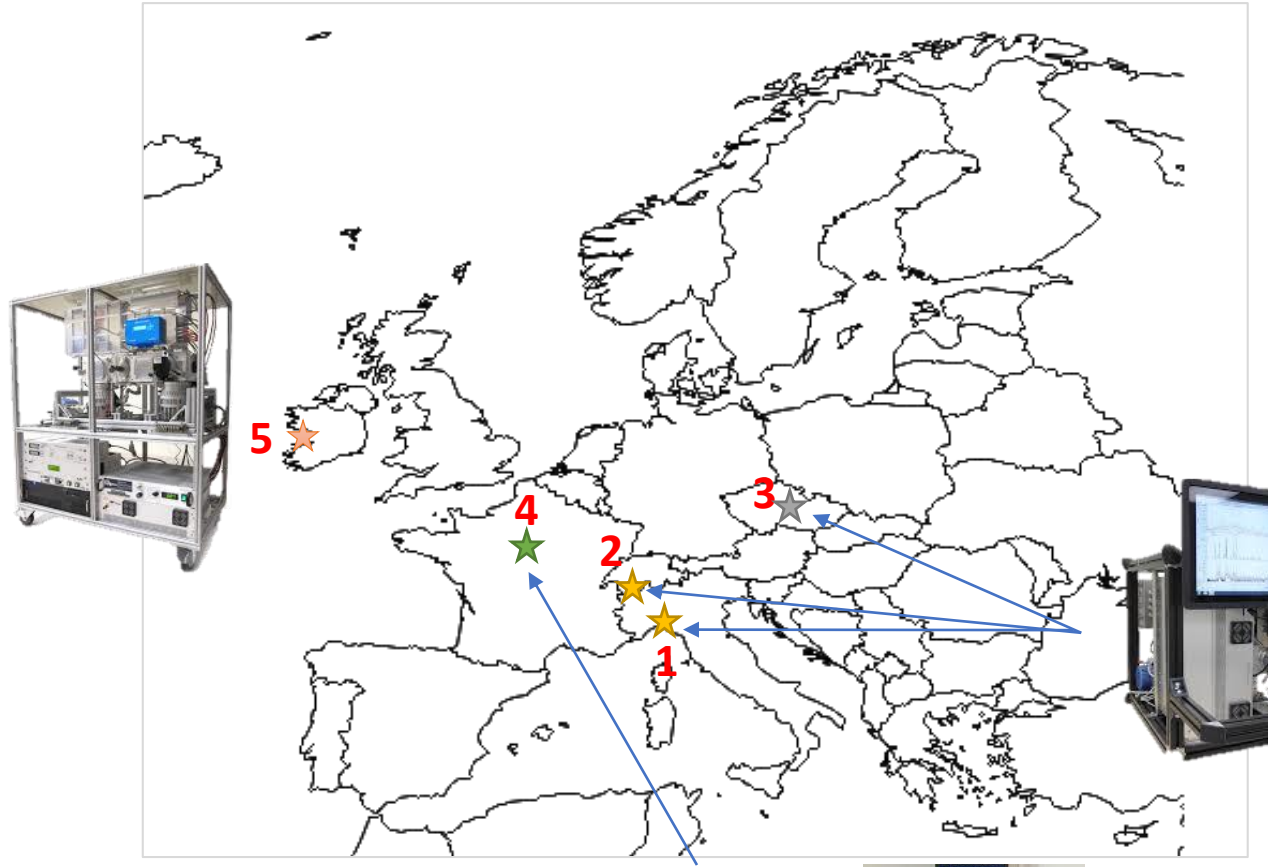
Credits: Volcplume; source: aeris-data

In-situ Measurements from ACTRIS Observatories

Period of interest: May 15th to August 31, 2025

ACTRIS observatories

1. Monte Cimone [MC]– Italy, 2165 m a.s.l
2. Jungfraujoch [JFJ] – Switzerland, 3580 m, a.s.l
3. Košetice [KS] – Czech Republic, 534 m, a.s.l
4. SIRTA [ST] – France, 150 m a.s.l
5. Mace Head [MH] – Ireland, 30 m, a.s.l



In-situ variable used

- NR-PM_1 mass concentrations and m/z fragments
- VOC mixing ratios
- eBC mass concentrations and AAE(470/950)
- CO and CO_2 mixing ratios
- Modified Combustion Efficiency

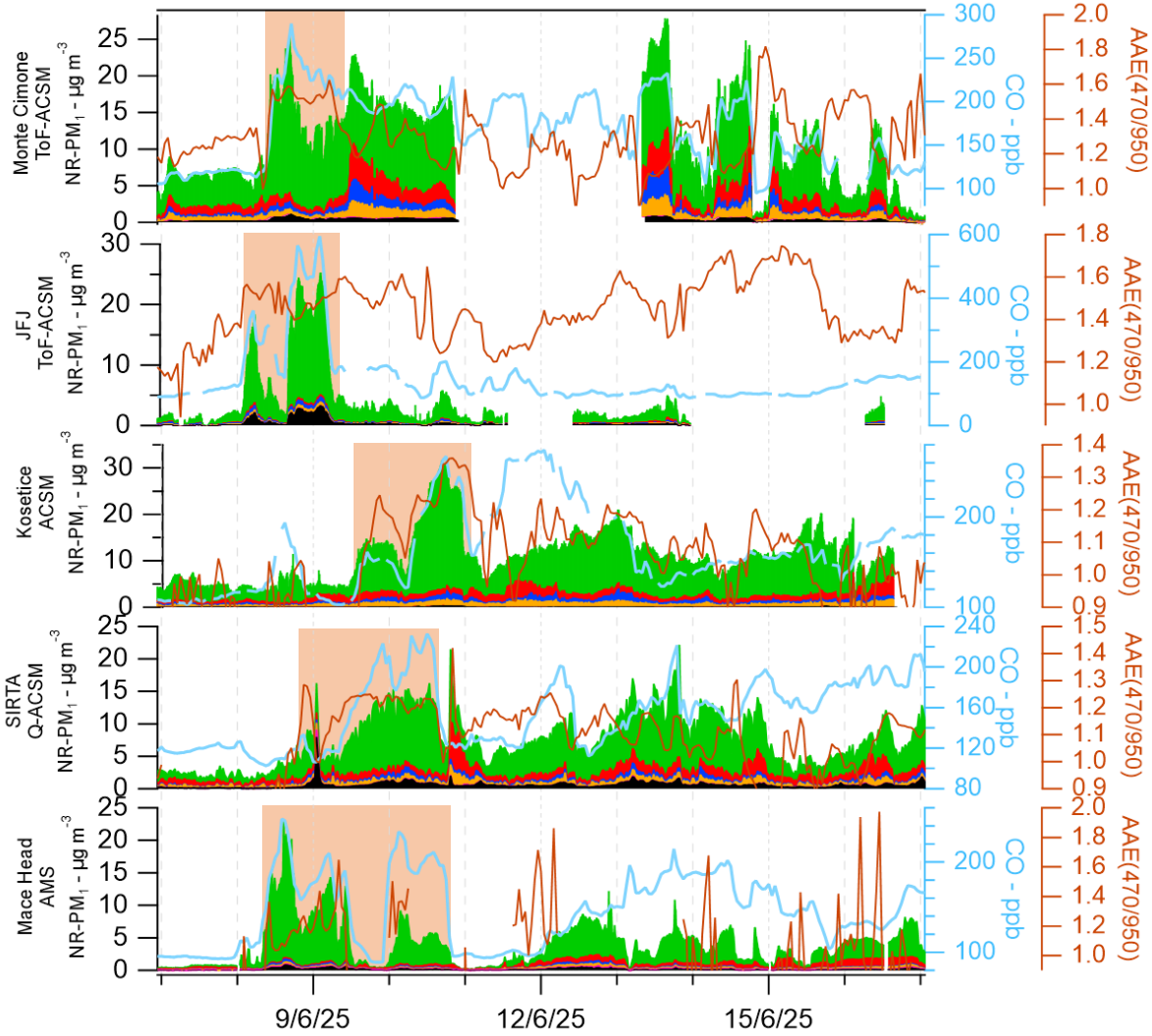
$$MCE = \frac{\Delta CO_2}{\Delta CO + \Delta CO_2}$$

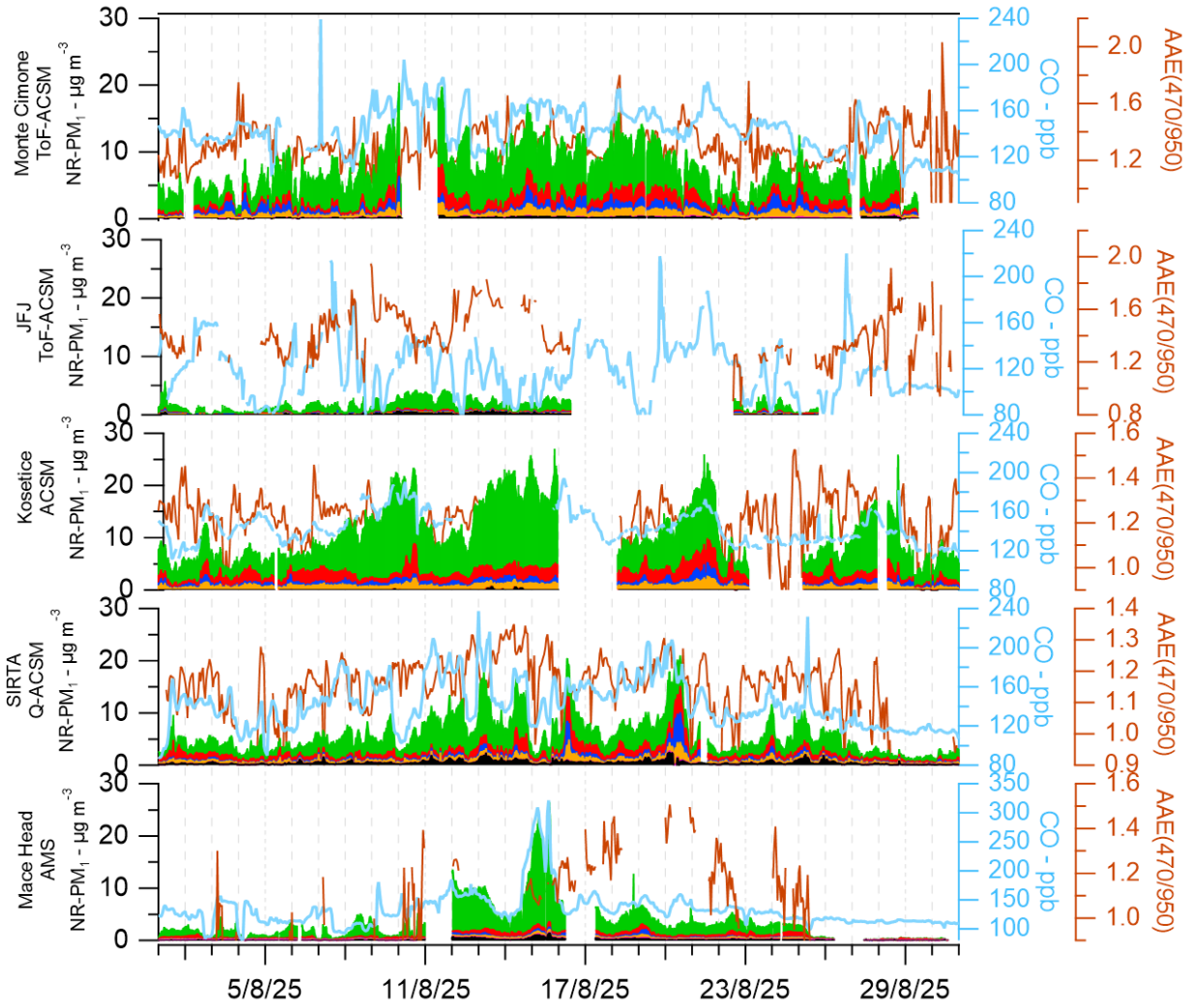
Bonus

Hysplit backtrajectories: 210 hours, GDAS, alt. 500 m

Zefir (Petit et al.): Concentration weighted Trajectories (CWT)

Canadian & European plumes: PM & tracers variability



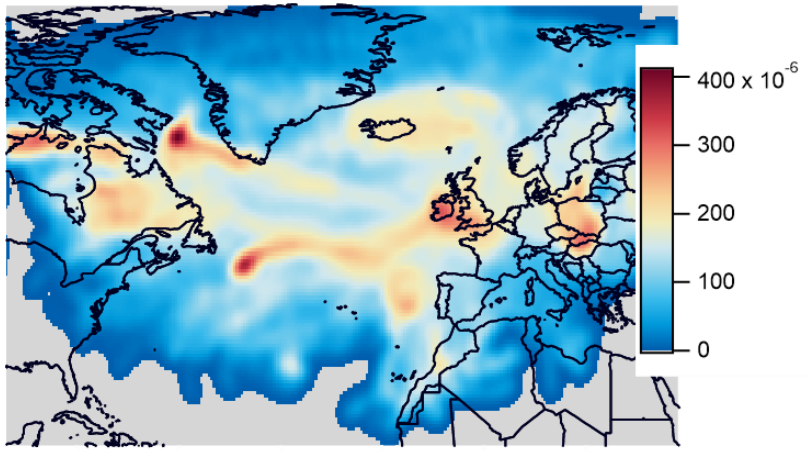


- Sites in altitude are impacted slighly earlier by LRT plumes
- Harder to distinguish specific events, except for MH

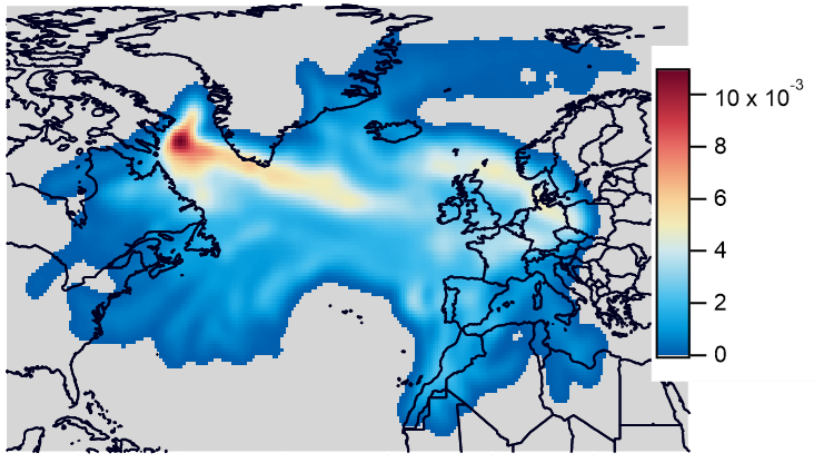
Canadian plumes: Multi-site backtrajectories

5 sites - OM concentrations – CWT

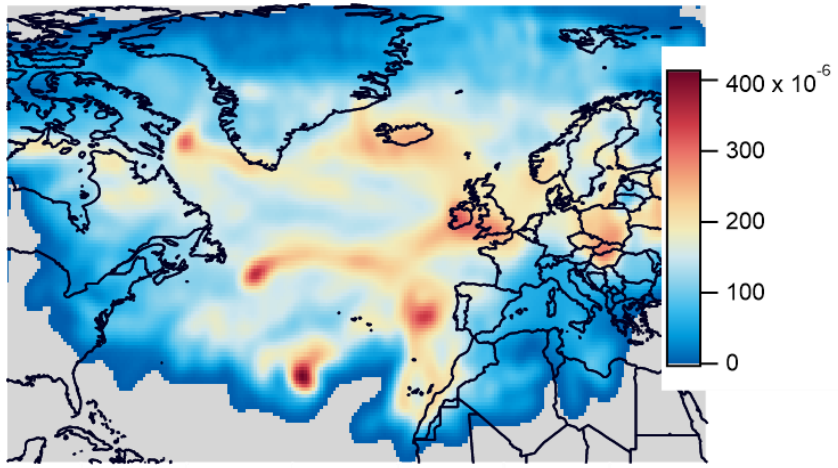
Entire period

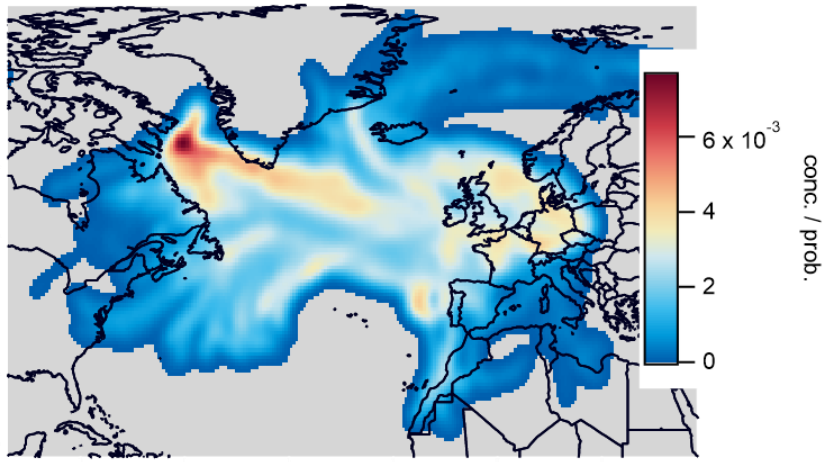


June 6th to 14th



5 sites - **eBC** concentrations – CWT

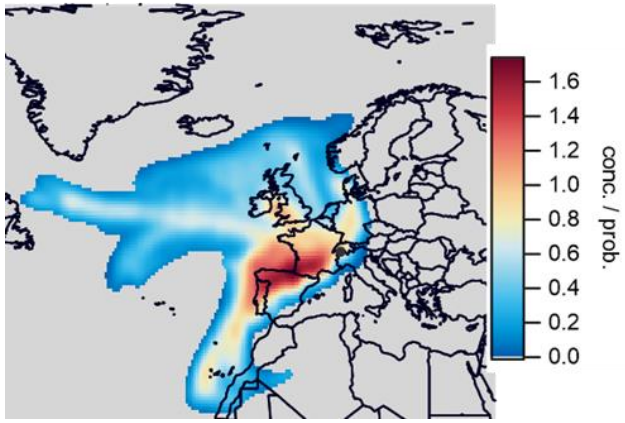




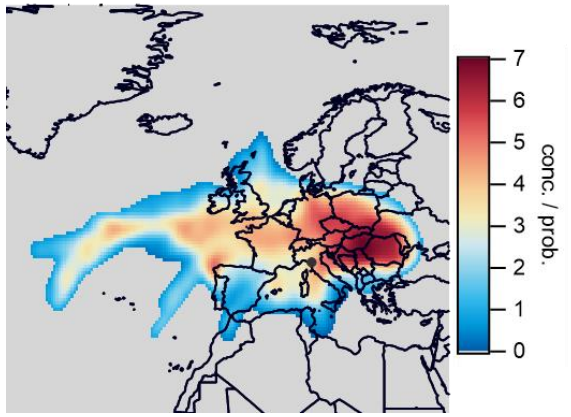
August plumes: Backtrajectories

August - OM concentrations – CWT

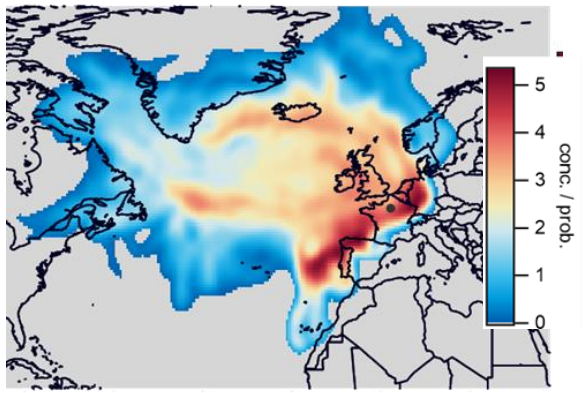
JFJ



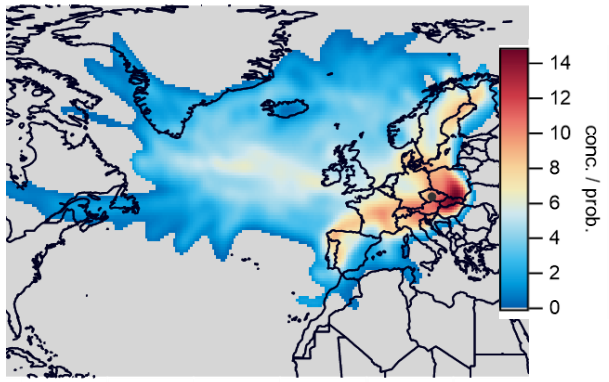
Monte Cimone



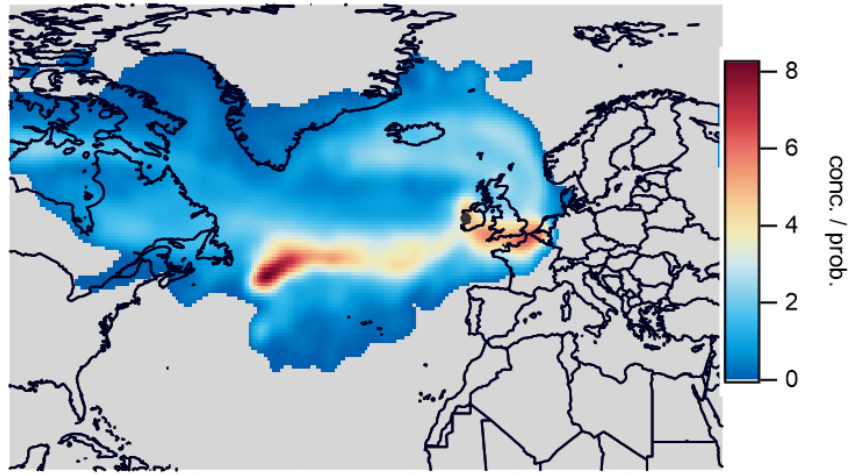
SIRTA



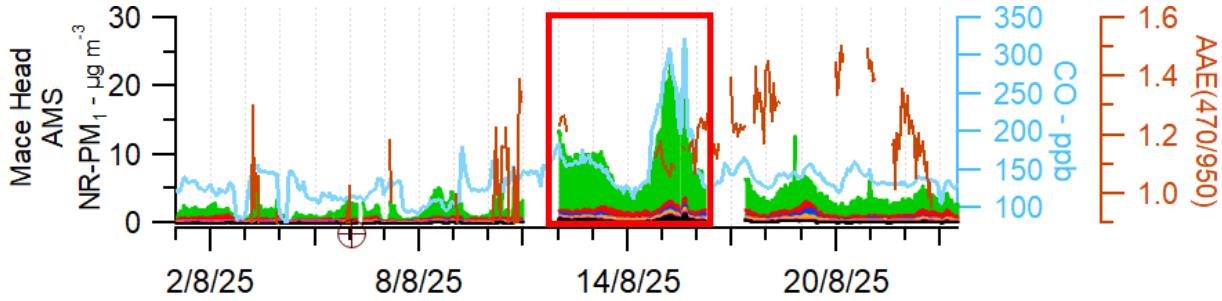
Košetice



Mace Head



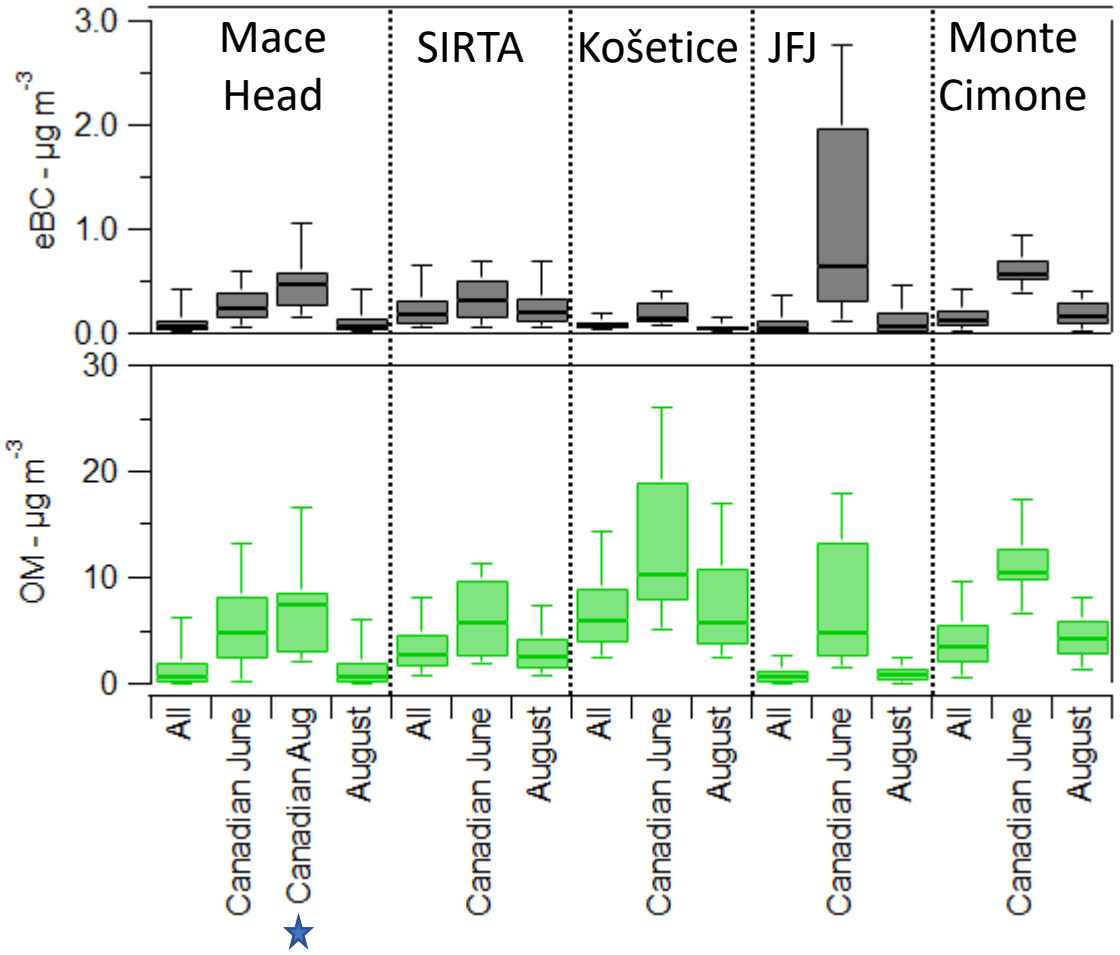
Canadian plume(s)

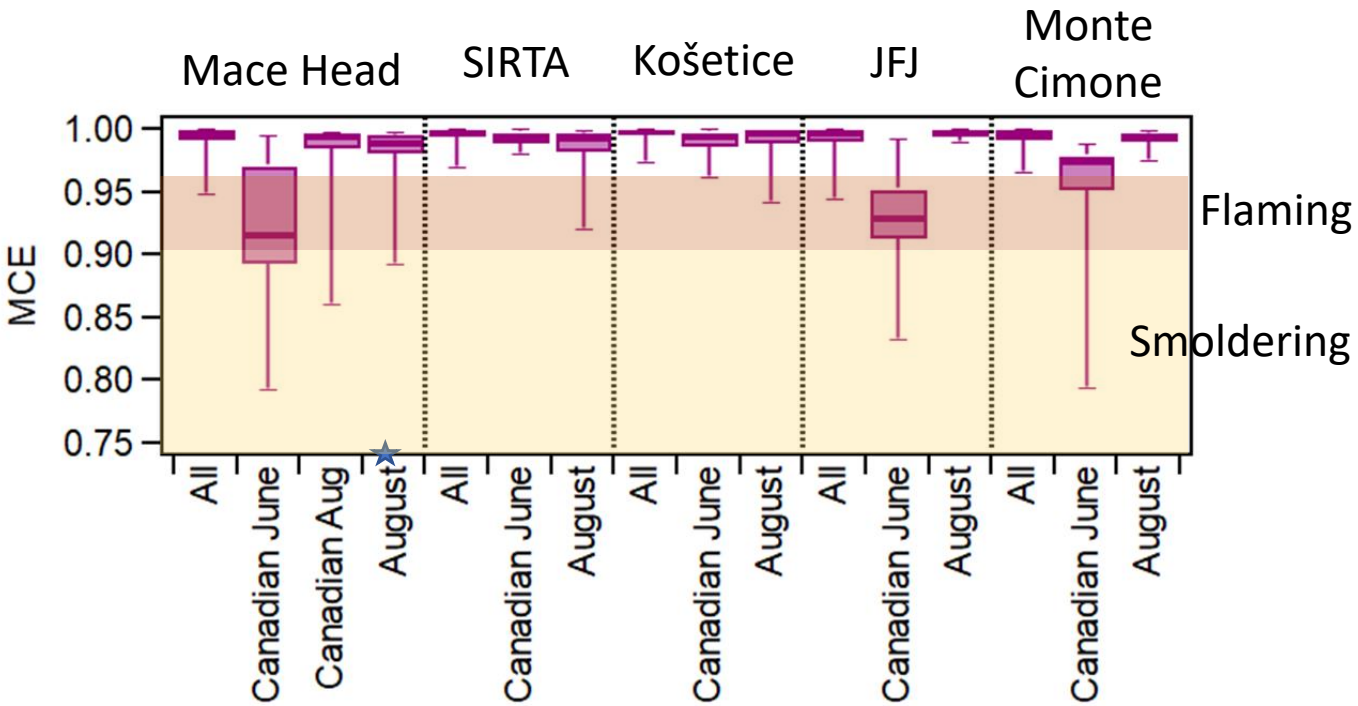


➢ August : Mixture of wildfire plumes from Europe and Canada

Wildfires Impact on carbonaceous aerosols and MCE

- Increase of **OM** & **eBC** concentrations under first Canadian plumes influence

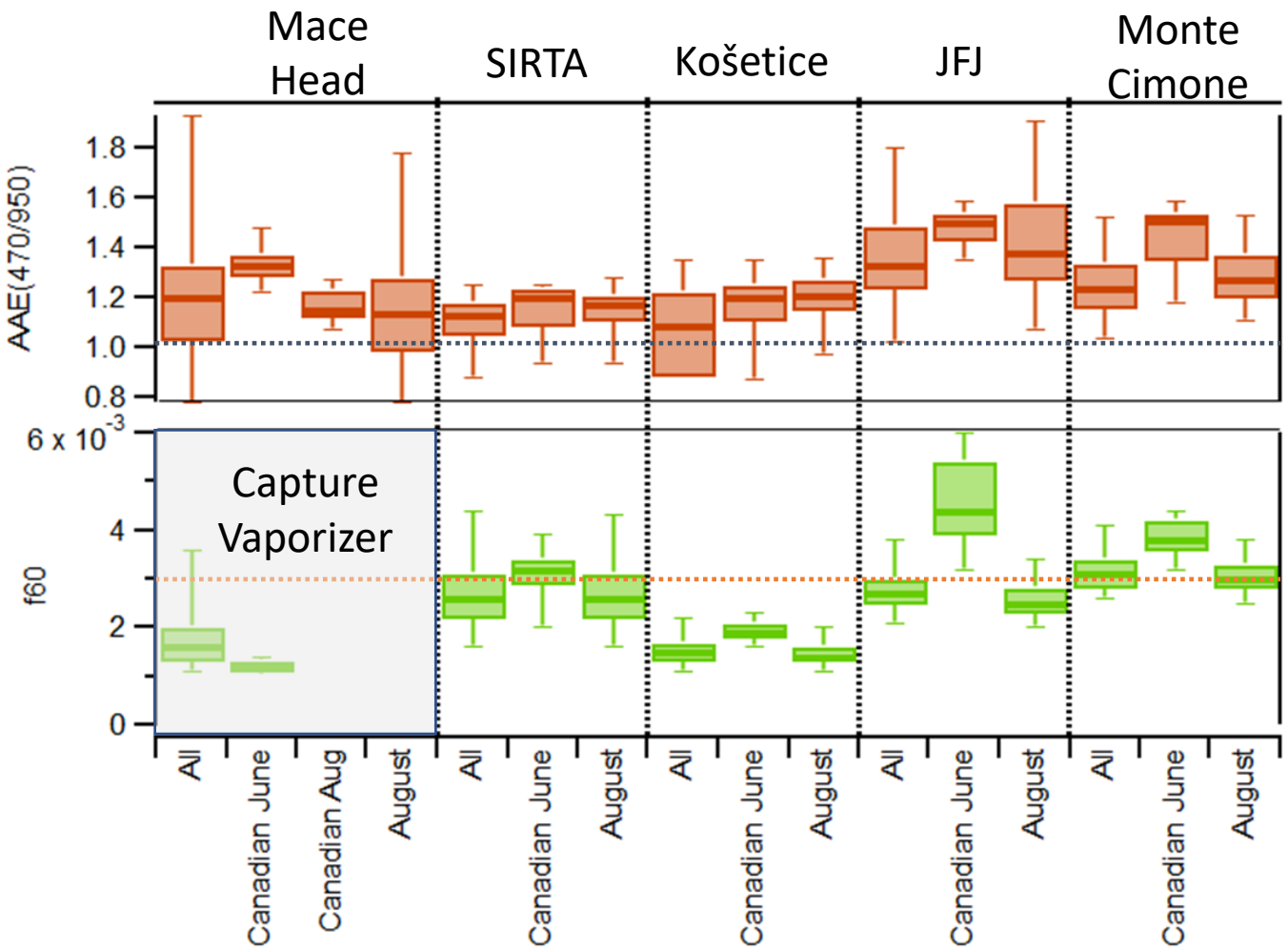




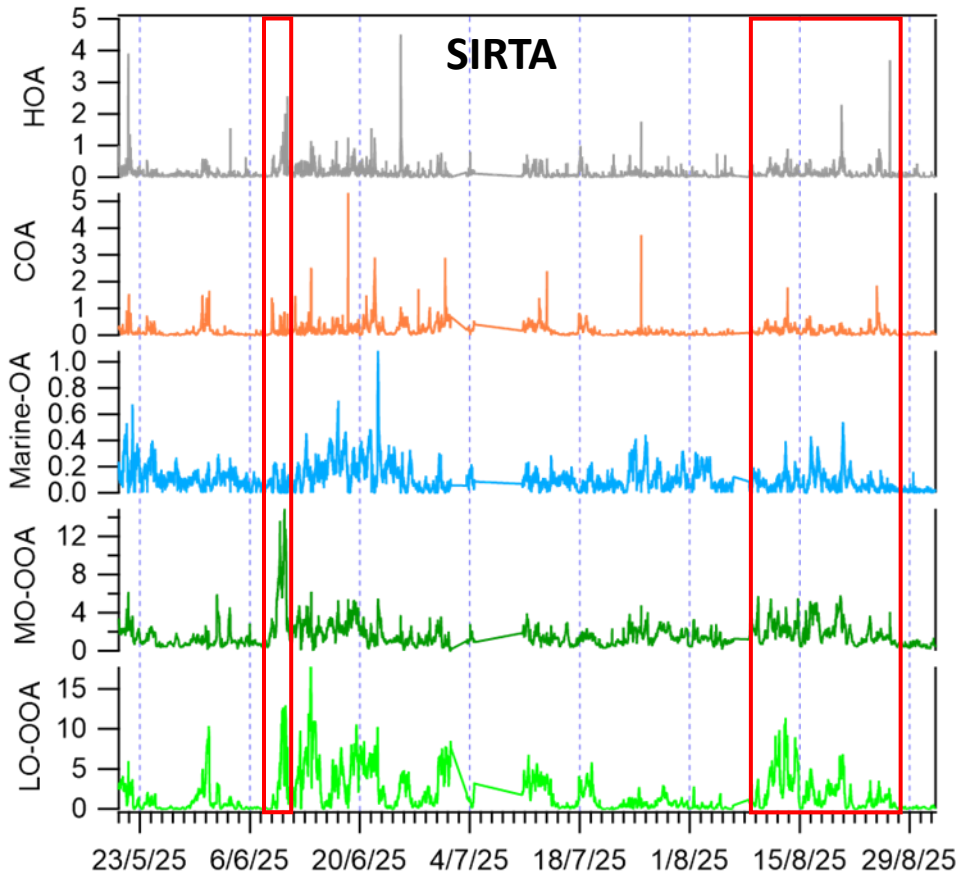
- June Canadian emissions ➔ flaming & smoldering

★Canadian Aug. 11/08 – 17/08

BB Aging and Source Apportionment



PMF ToF-X: Juliette Brochet

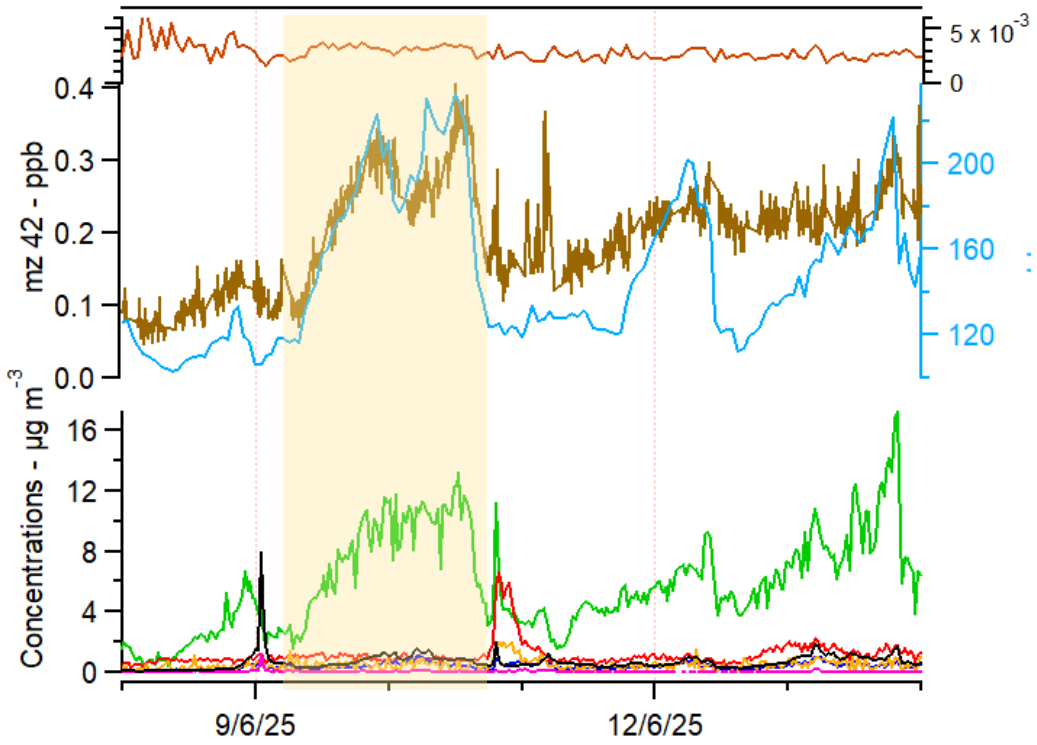


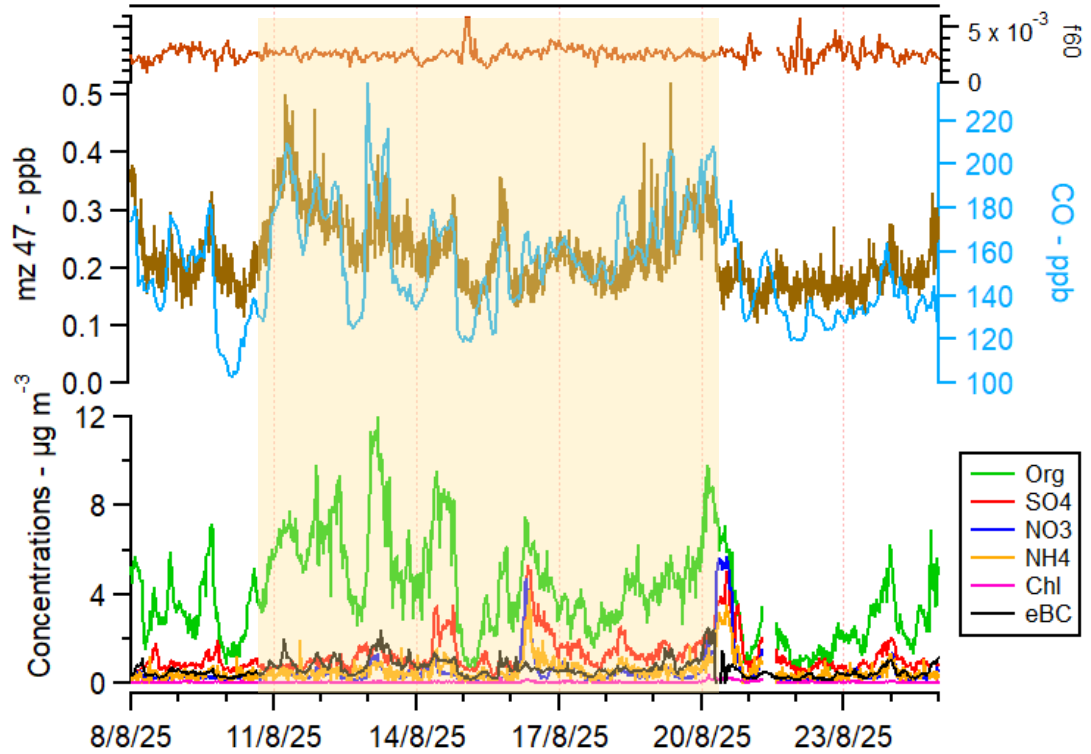
August fire plumes lower than f60 background level*
➔ Levoglucosan degrade fast, even at regional scale

- BBOA material associated to SOA ➔ despite higher f60 in June
- Low f60 in August ➔ limit for NRT SA with constrained BBOA

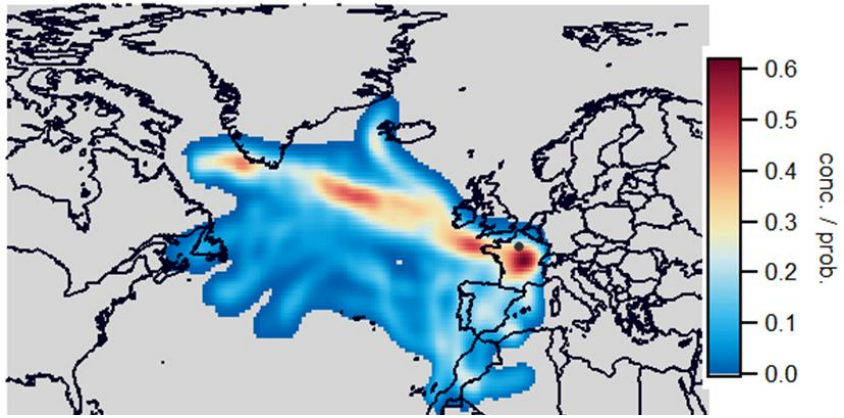
*Cubison et al., ACP (2011)

SIRTA – Gas and Aerosol BB tracers

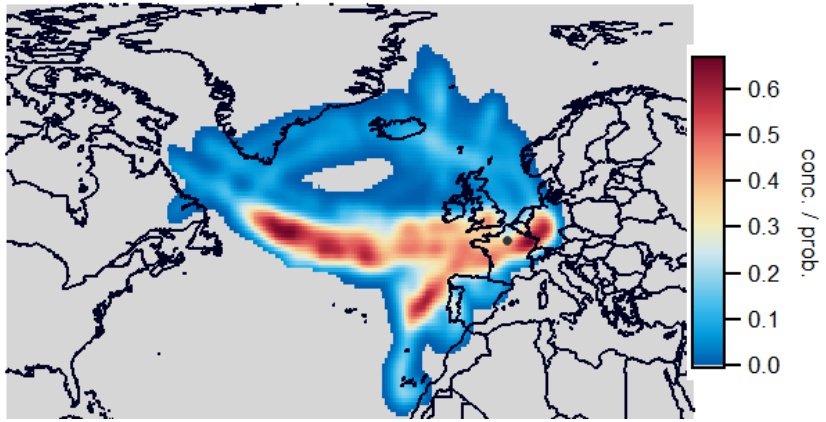




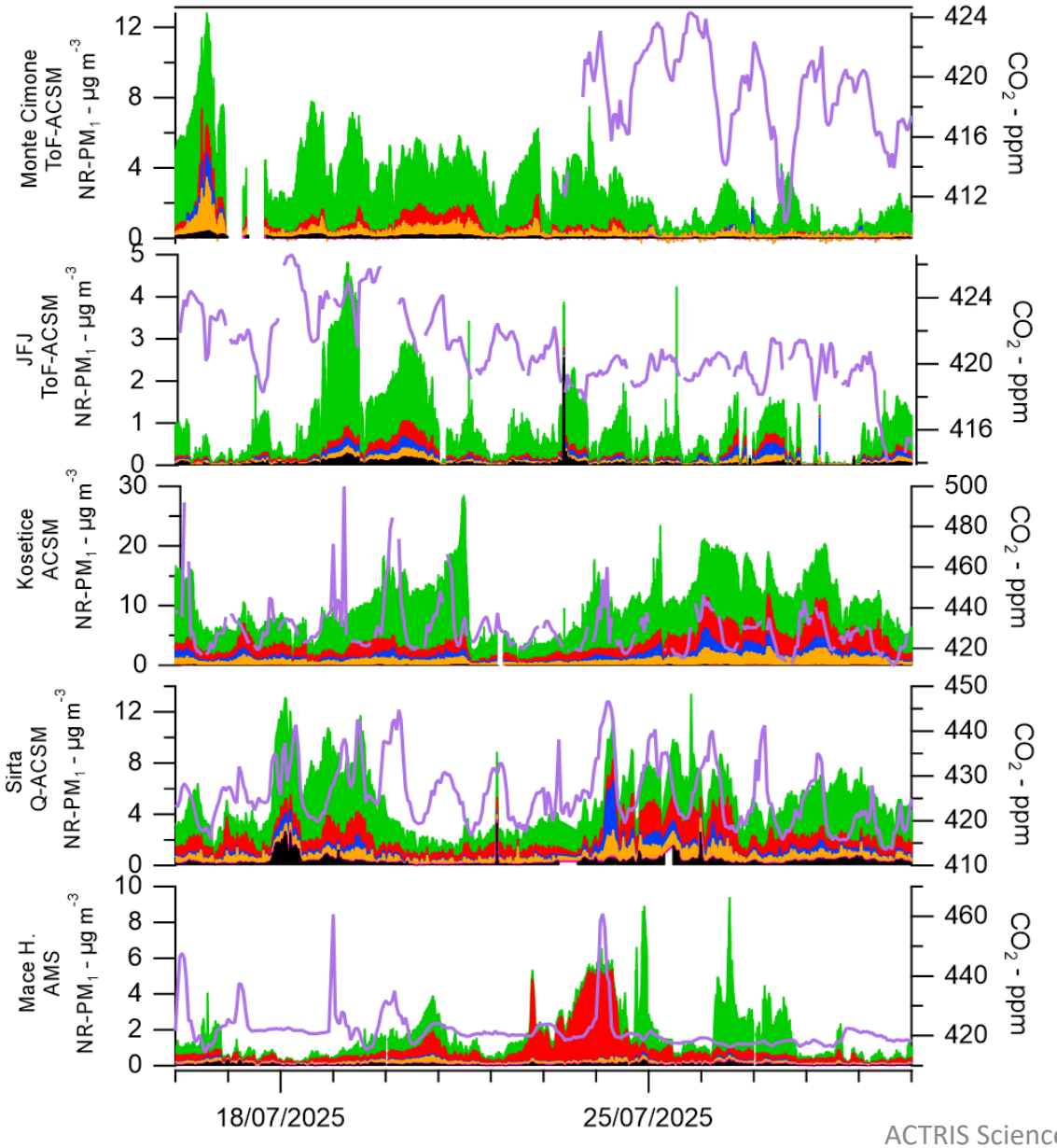
m/z 42 - acetonitrile

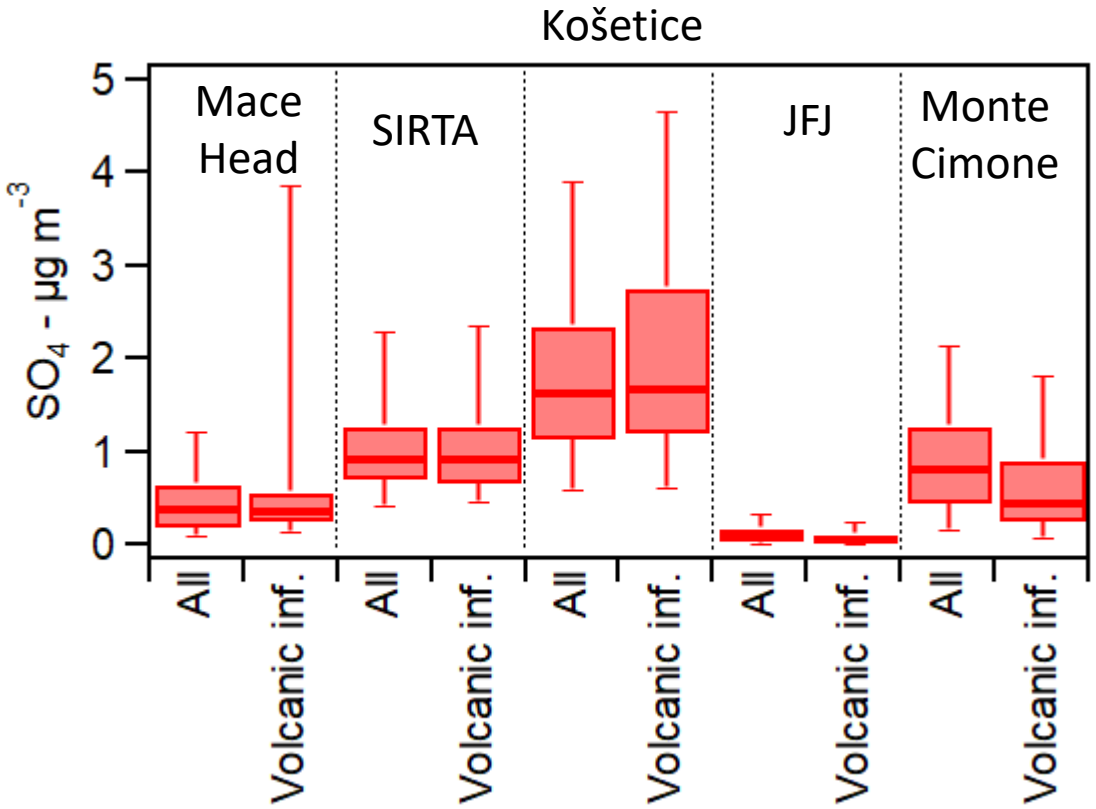


m/z 42 - acetonitrile



Volcanic Eruptions – Impact on Sulfate (SO_4)

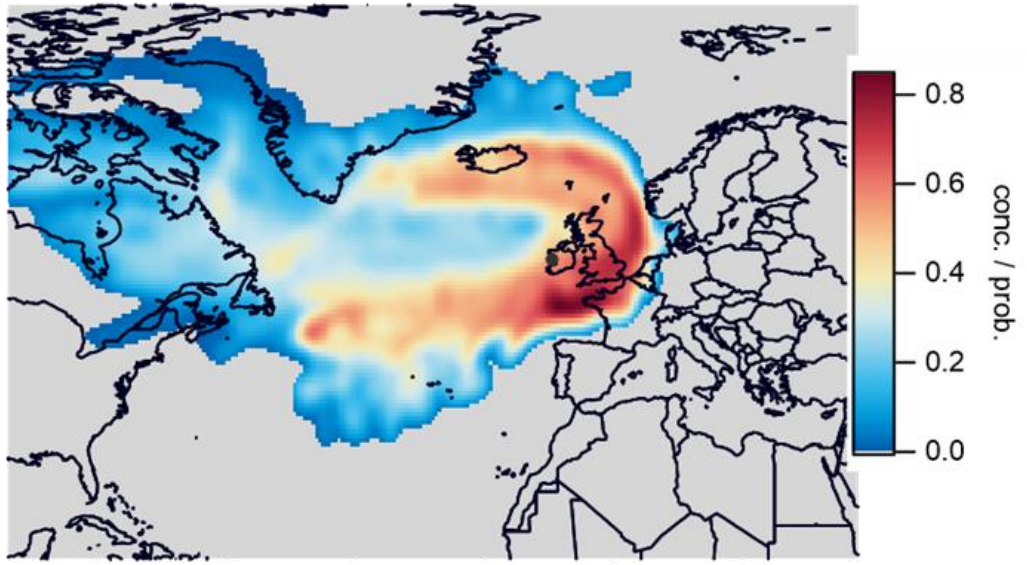




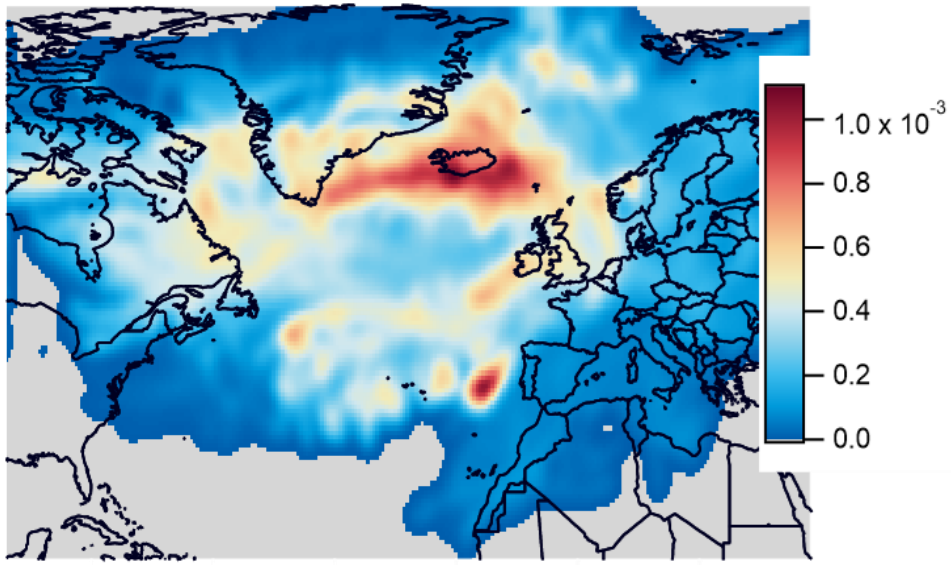
- Not all sites appear impacted
- From SO4 alone, hard to differentiate marine biogenic or anthropogenic SO4 emissions from volcanic ones
  - ➔ *Need to better apportion SO_4 sources*

Multi-site backtrajectory analysis – Volcanic eruptions

Mace Head: SO_4
Entire period

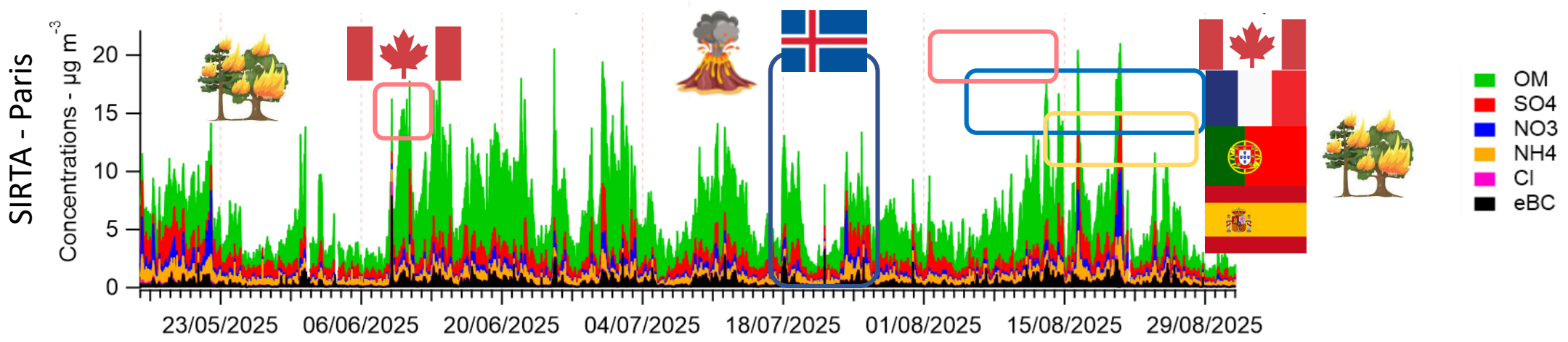


5 sites: SO_4
Entire period



➔ Valuable insight from backtrajectory analysis even for sites with lower concentrations and multiple SO_4 sources

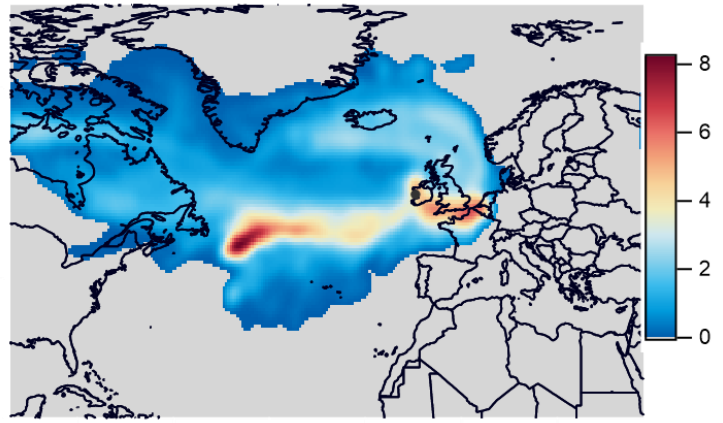
Takeaway messages



	Environment	June Canadian wildfires	Iceland Volcanic Eruption	Canadian & European Wildfires
Mace Head	Coastal	↑↑OM, eBC, AAE$_{470/950}$> 1.2 ↓MCE flaming + Smoldering	↑↑ SO4	↑OM, eBC
SIRTA	Sub-urb.		↑ SO4	No clear trend! Due to mixture?
Košetice	Sub-urb.		↑ SO4	
Monte Cimone	Local and LRT free troposph.			
Jungfraujoch	Remote free troposph.			

Mace Head

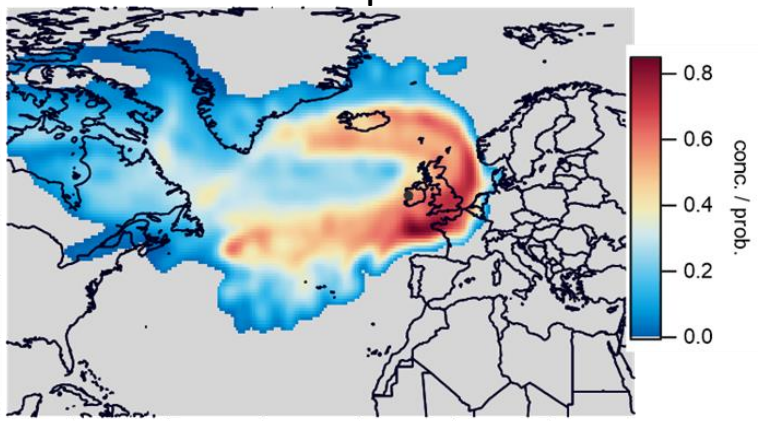
OM concentrations - August



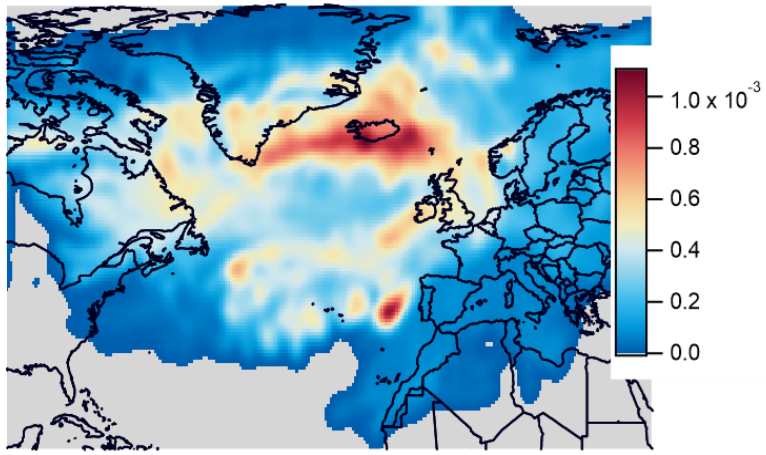
➔Both multisite and individual site backtraj. analysis provide valuable insights!

Multi-site backtrajectory analysis – Volcanic eruptions

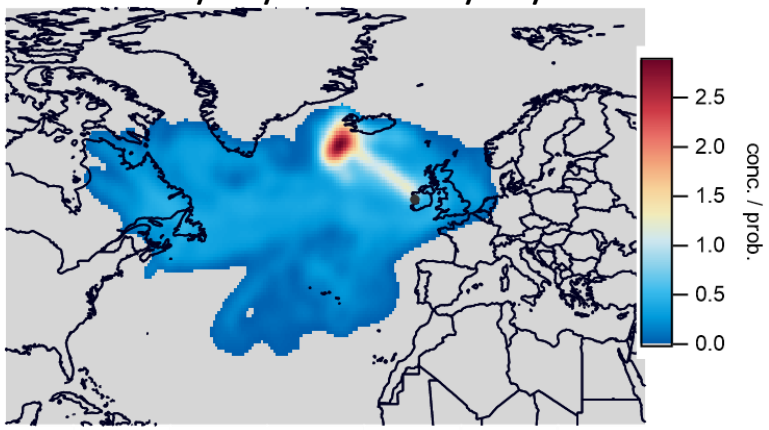
Mace Head: SO_4
Entire period



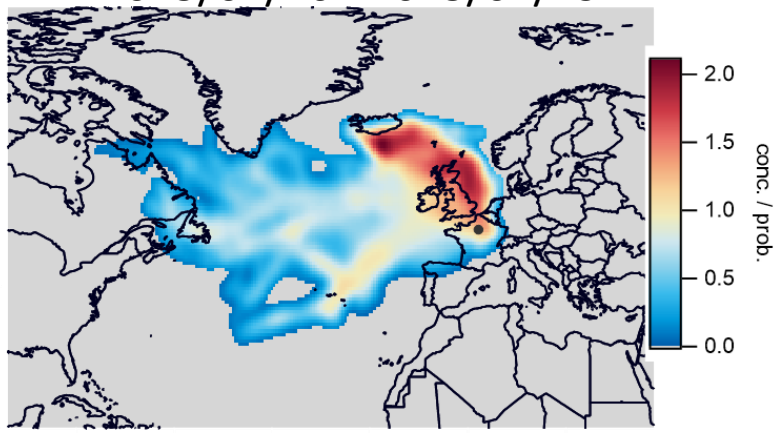
5 sites: SO_4
Entire period



Mace Head: SO_4
2025/07/16 - 2025/07/29



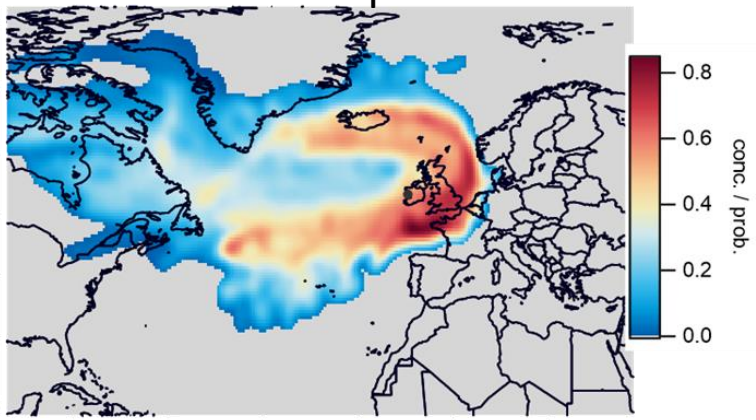
SIRTA: SO_4
2025/07/16 - 2025/07/29



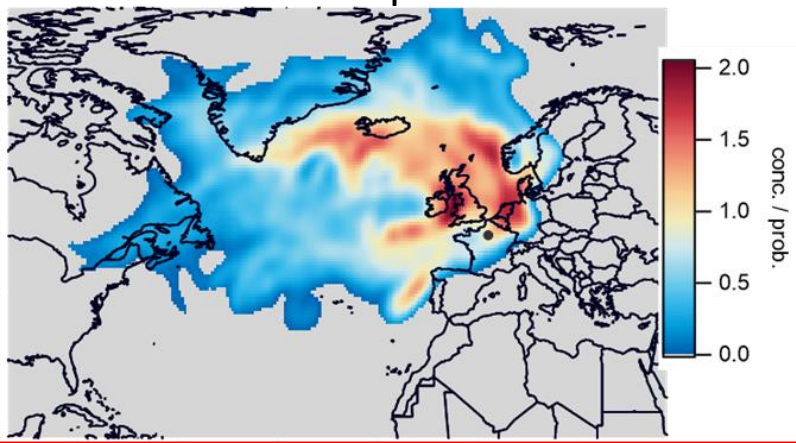
➔ Valuable insight from backtrajectory analysis even for sites with lower concentrations and multiple SO_4 sources

Multi-site backtrajectory analysis – Volcanic eruptions

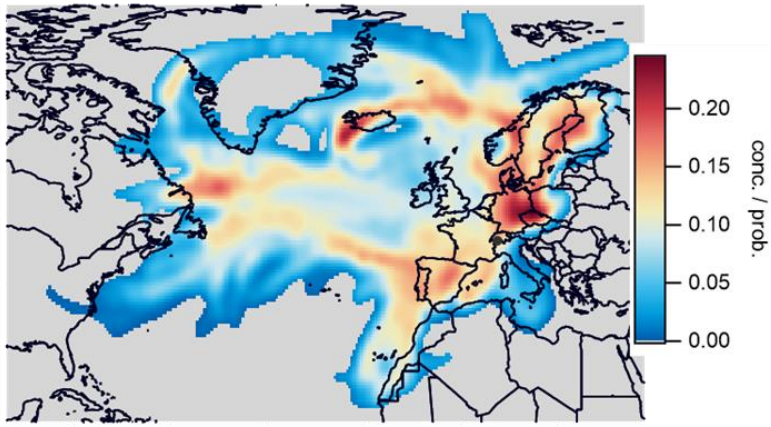
Mace Head: SO_4
Entire period



SIRTA: SO_4
Entire period

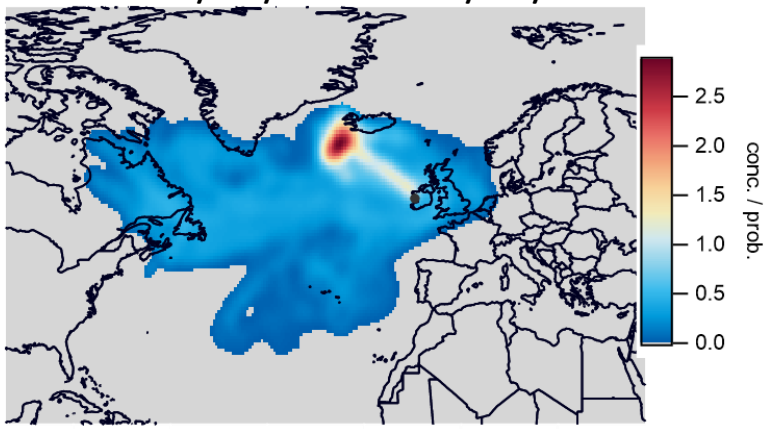


JFJ: SO_4
Entire period

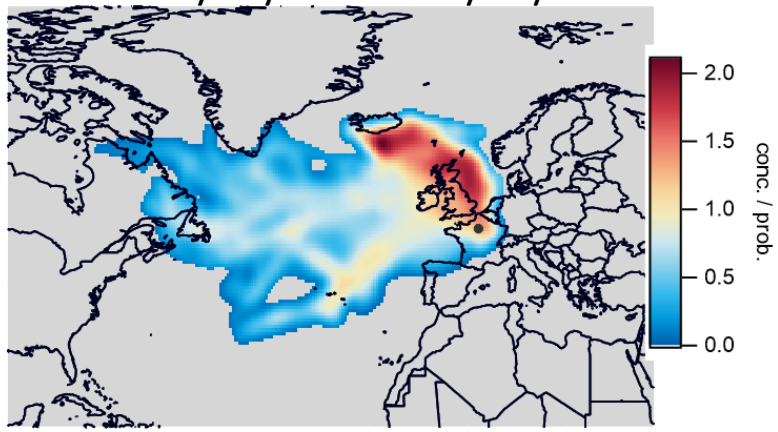


➔ Valuable insight from backtrajectory analysis even when sites seem less impacted

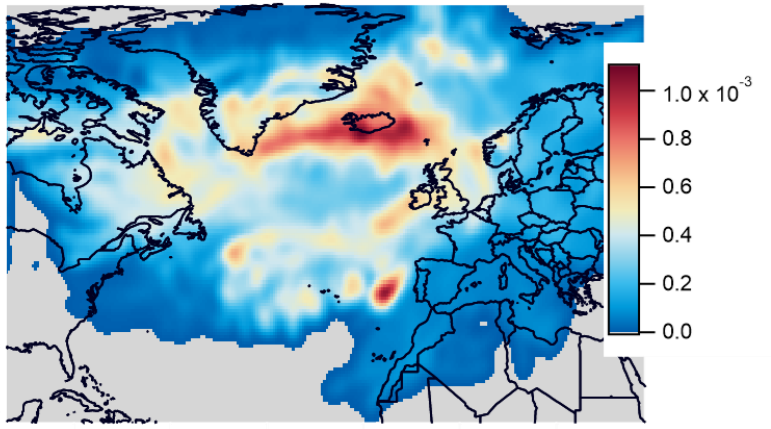
Mace Head: SO_4
2025/07/16 - 2025/07/29



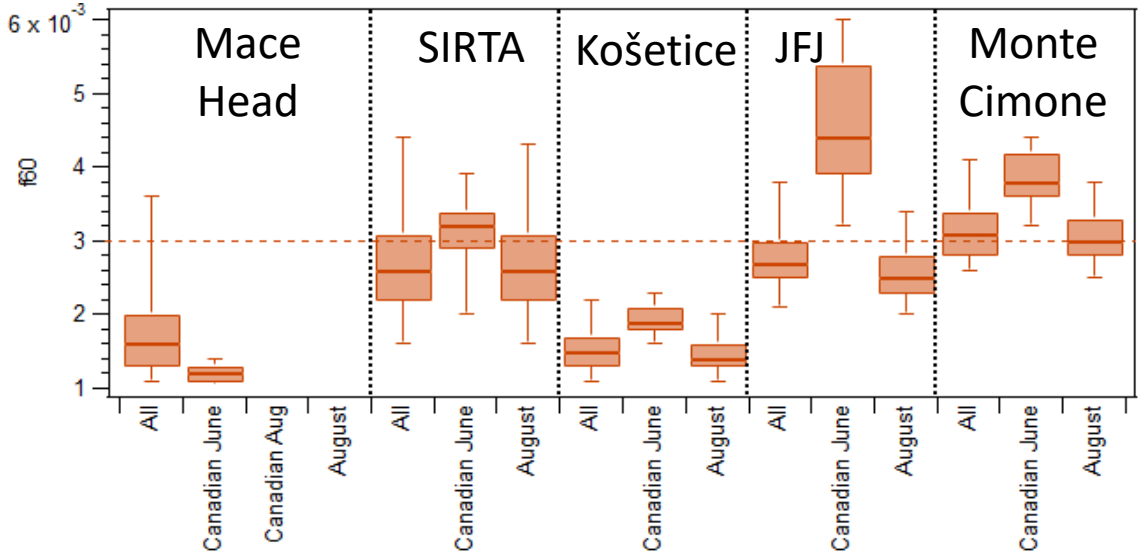
SIRTA: SO_4
2025/07/16 - 2025/07/29



5 sites: normalized SO_4

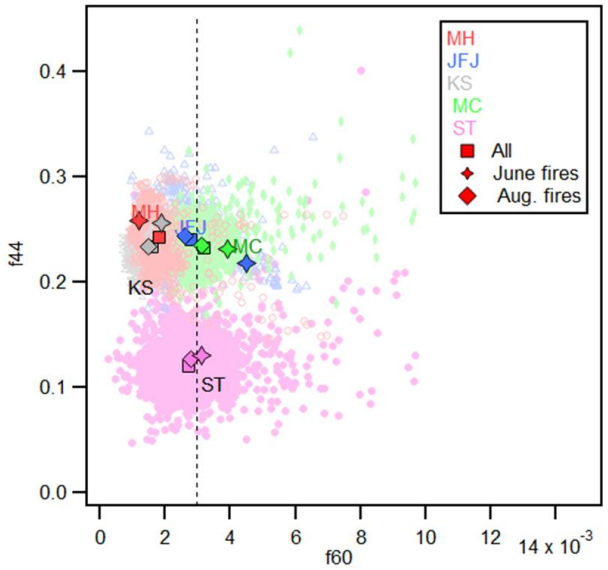


BB Tracer and Source Apportionment

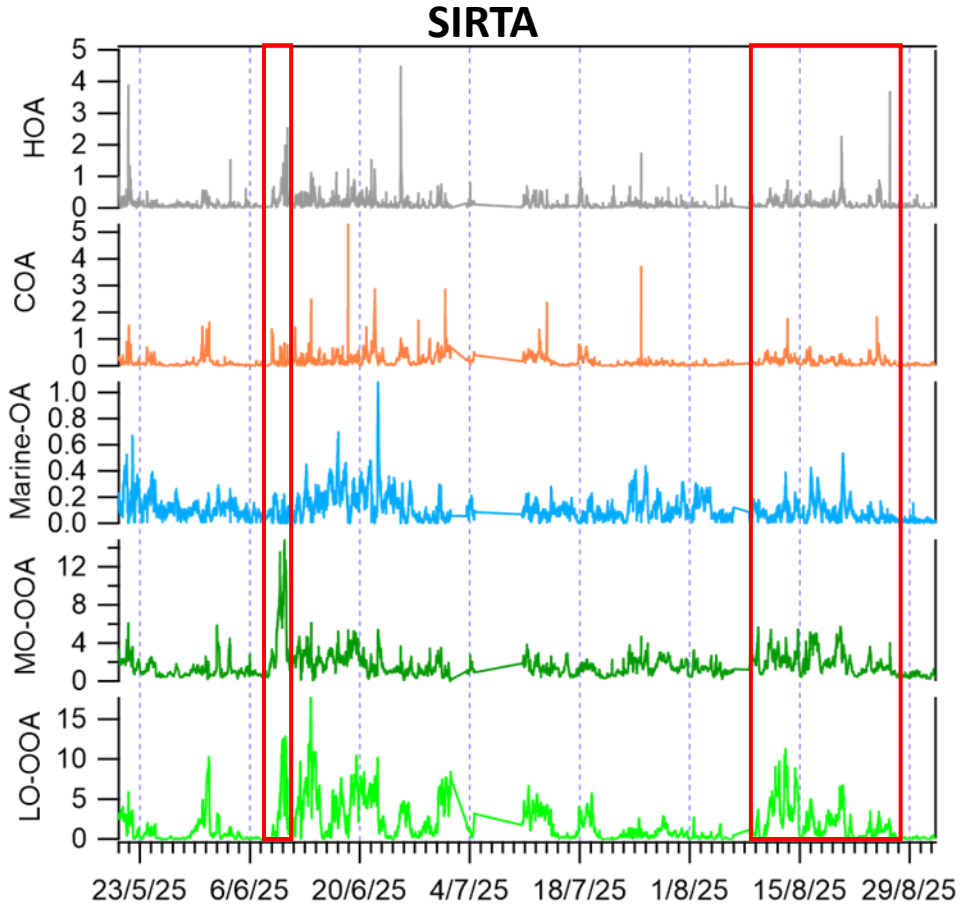


August fire plumes present background level f_{60}

➔ degradation through atmospheric processing



PMF ToF-X: Juliette Brochet - Poster 230 17:00-19:00



BBOA material associated to SOA

- Too low f60 in August
- Despite high f60, June wildfire plumes may be too short