Long-range transport of pollution from intense wildfires in the northern hemisphere observed by IASI in 2008-2023

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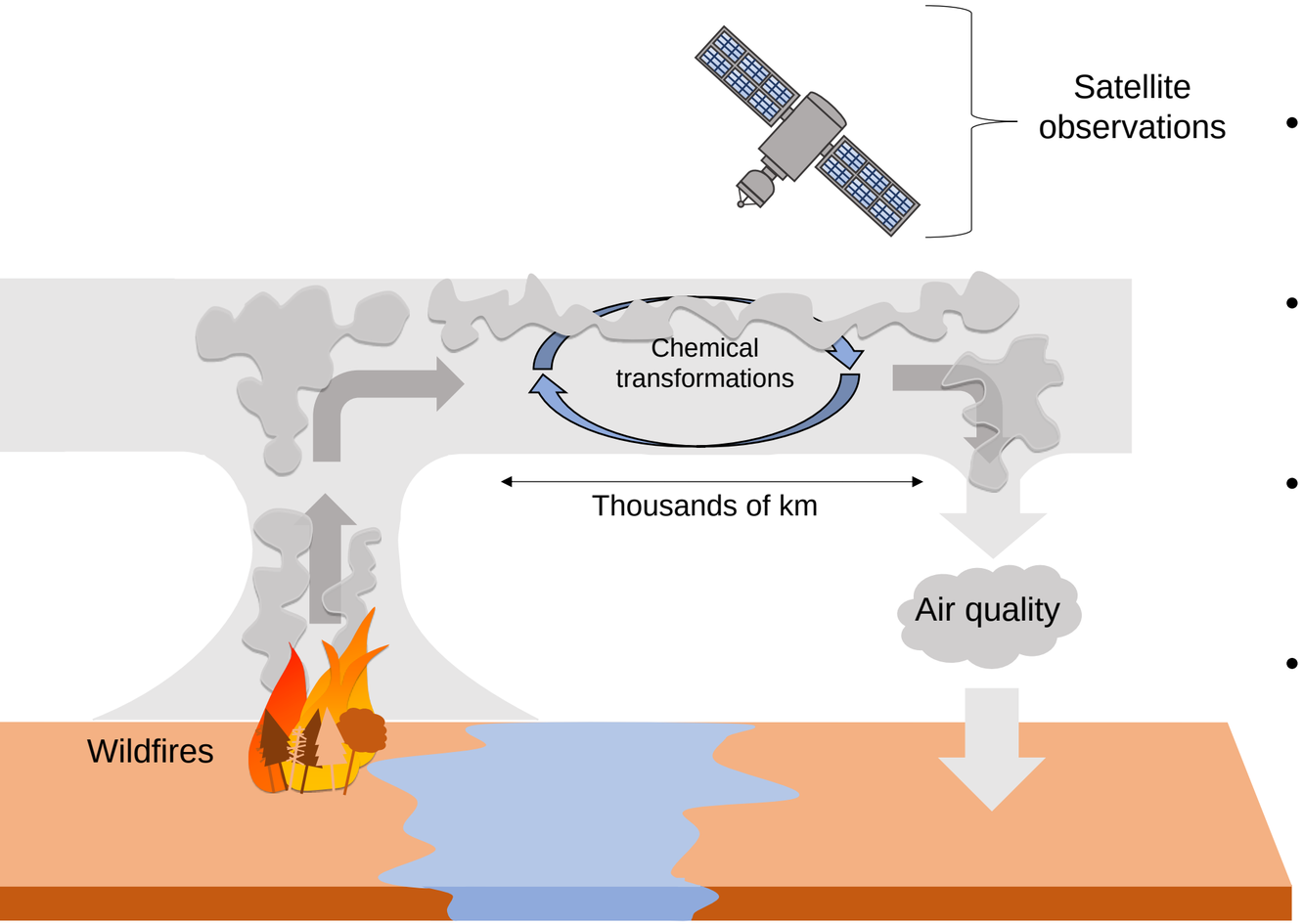
Context



- Biomass burning is a significant source of trace gases, including greenhouse gases, and aerosols
- 1.5 million deaths/year over the period 2000-2019 due to exposure to fire smoke (Xu, Rongbin et al., 2024)
- Large smoke plumes emitted by the most severe wildfires may be transported over long distances.
- CO is considered a good proxy for biomass fire smoke plumes.

Method

Fire activity :

- Burned area from MODIS fire database, processed with APIFLAME (Turquety et al., 2014).
- Analysis of fire variability (Ehret et al, 2024) :

  ↘ biomass burning due to agricultural practices.

  ↗ burned area in boreal regions and the western US, up to **+37 %** in 2017–2023 compared to 2008–2023.

IASI observations :

- CO CDR : *AC SAF (2024), EUMETSAT SAF on Atmospheric Composition Monitoring,*
  DOI: 10.15770/EUM_SAF_AC_0047
- PAN V4.0.0R (*Franco et al., 2018)*
  DOI:10.1029/2018JD029633
- NH3 V4.0.0R (*Clarisse et al., 2023)*
  DOI: 10.5194/amt-16-5009-2023
- Altitude of CO plumes (*courtesy Gilles Lecomte et al., ULB)*
- Only day-time data are used.
- All data are gridded on a 0.5°x0.5° grid.

Other observations :

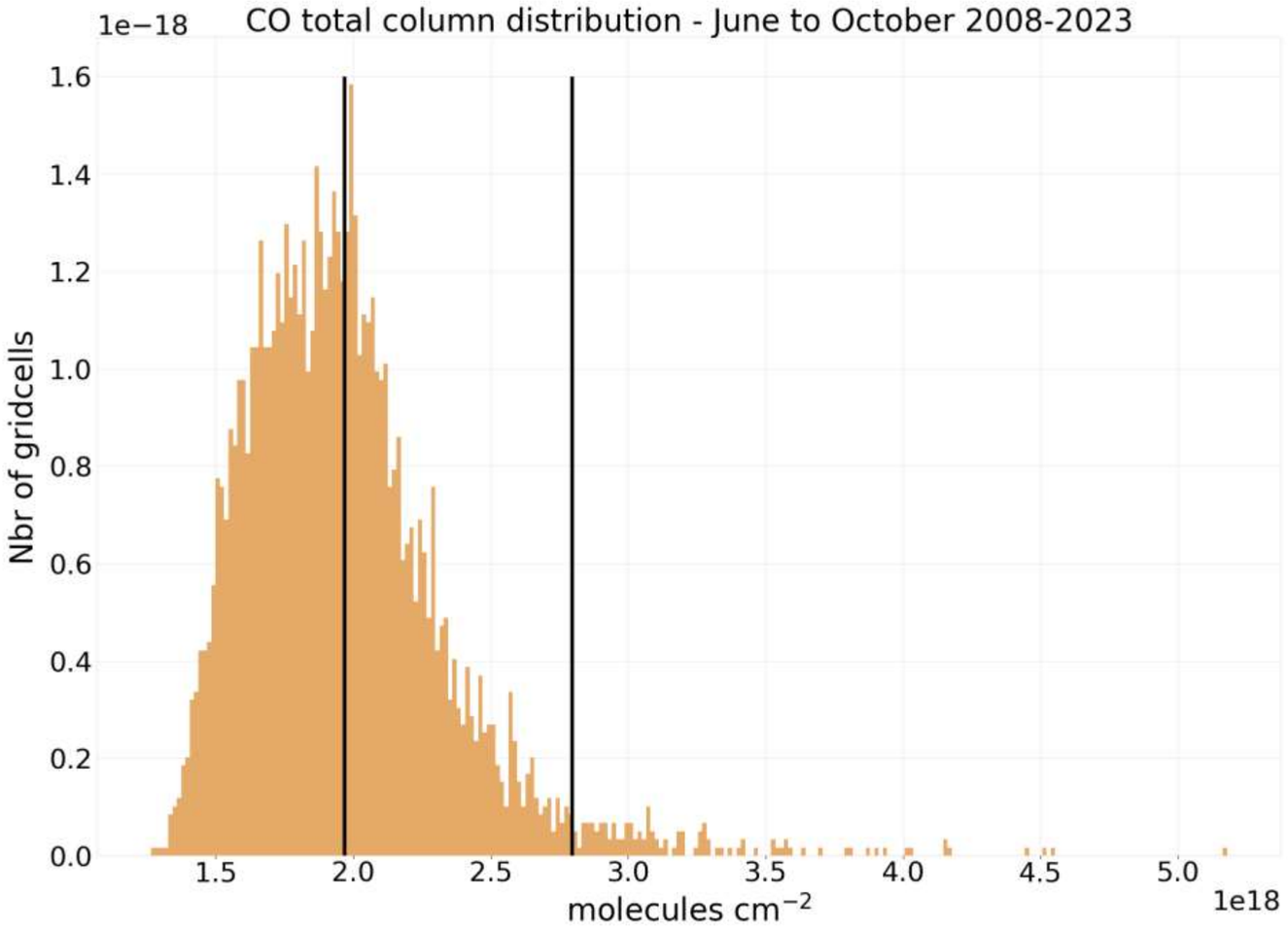
- CALIOP : *extinction and aerosol feature mask (VFM).*

Impact of fires on the long-range transport of pollution in the Northern Hemisphere (2008-2023)

Extreme selection :

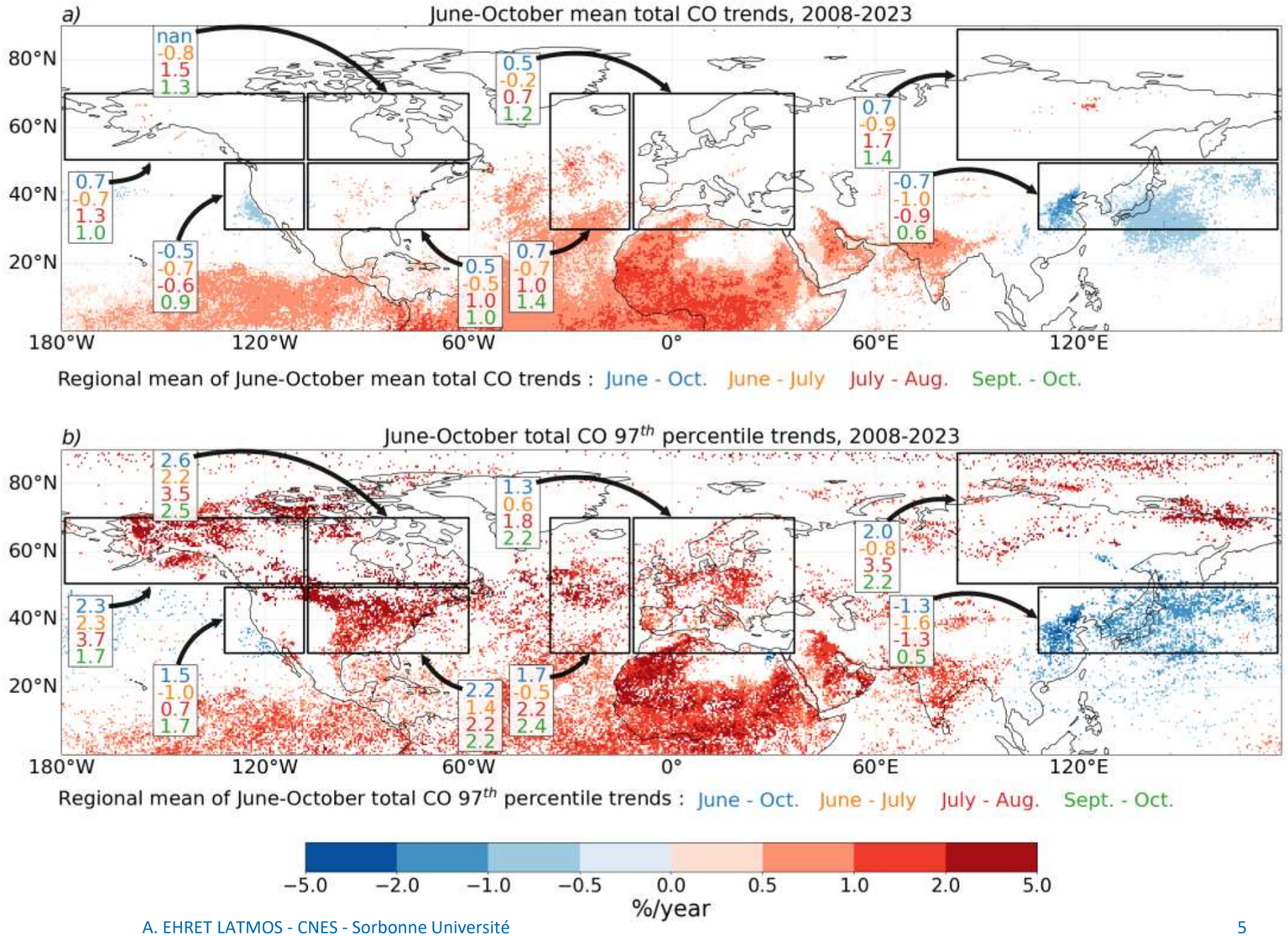
- In each 0.5°x0.5° gridcell :

2008-2023 Total CO distribution → Determination of the 97th percentile (Q97)



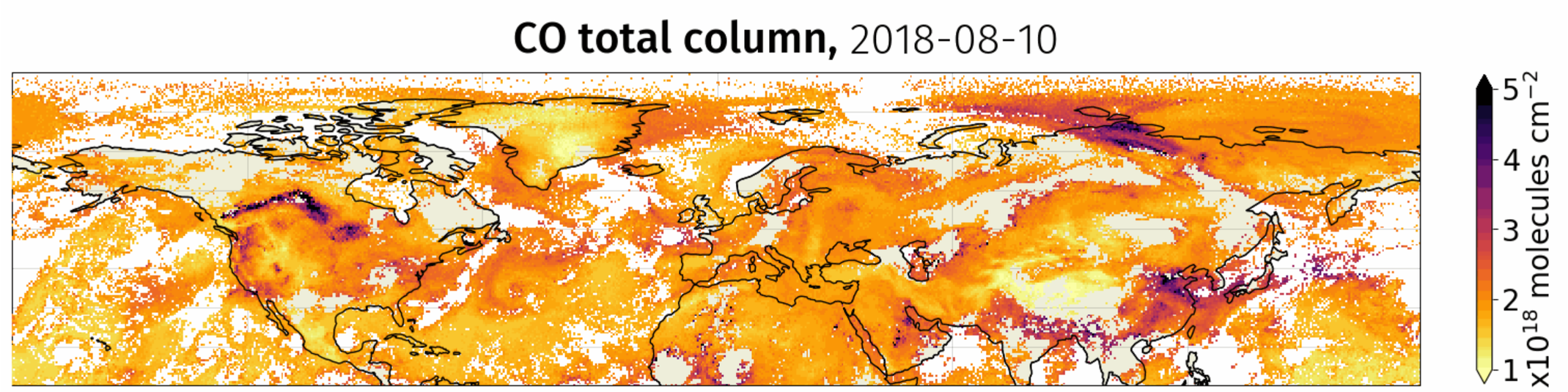
Impact of fires on the long-range transport of pollution in the Northern Hemisphere (2008-2023)

- June-October mean TCO :
  - extent of the significant trends is relatively limited
- June-October Q97 TCO :
  - **+1.3 to +2.6 %.year^{-1}** in North America, Europe and boreal Asia
  - **-1.3 %.year^{-1}** in eastern Asia
  - Regions exhibiting the most pronounced positive trends = those experiencing increasingly severe fire seasons in recent years
  - Regions downwind : long-range transport of CO plumes ?



Impact of fires on the long-range transport of pollution in the Northern Hemisphere (2008-2023)

Plume selection :



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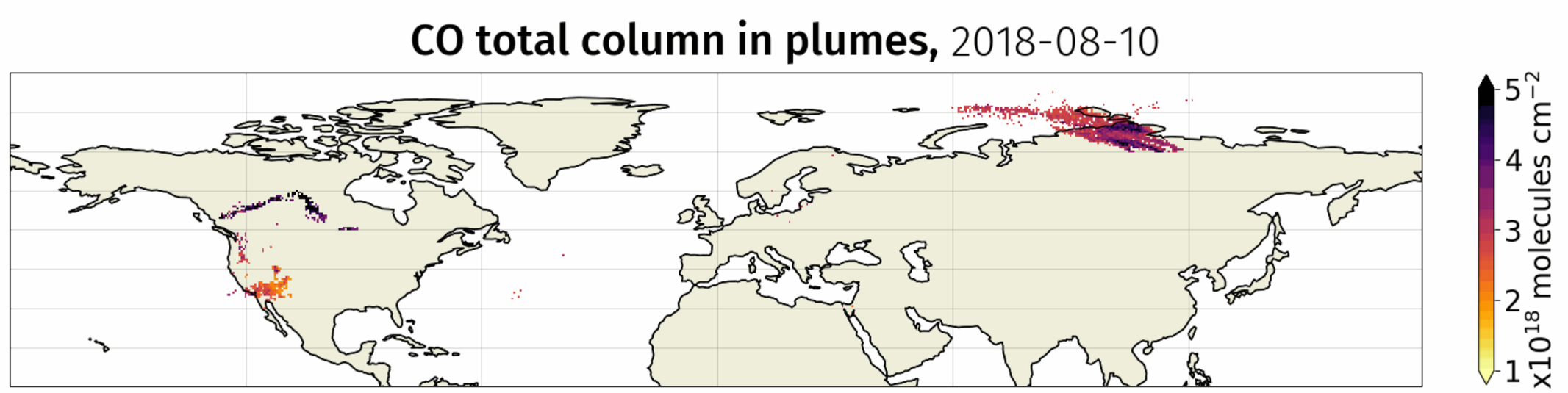

Impact of fires on the long-range transport of pollution in the Northern Hemisphere (2008-2023)

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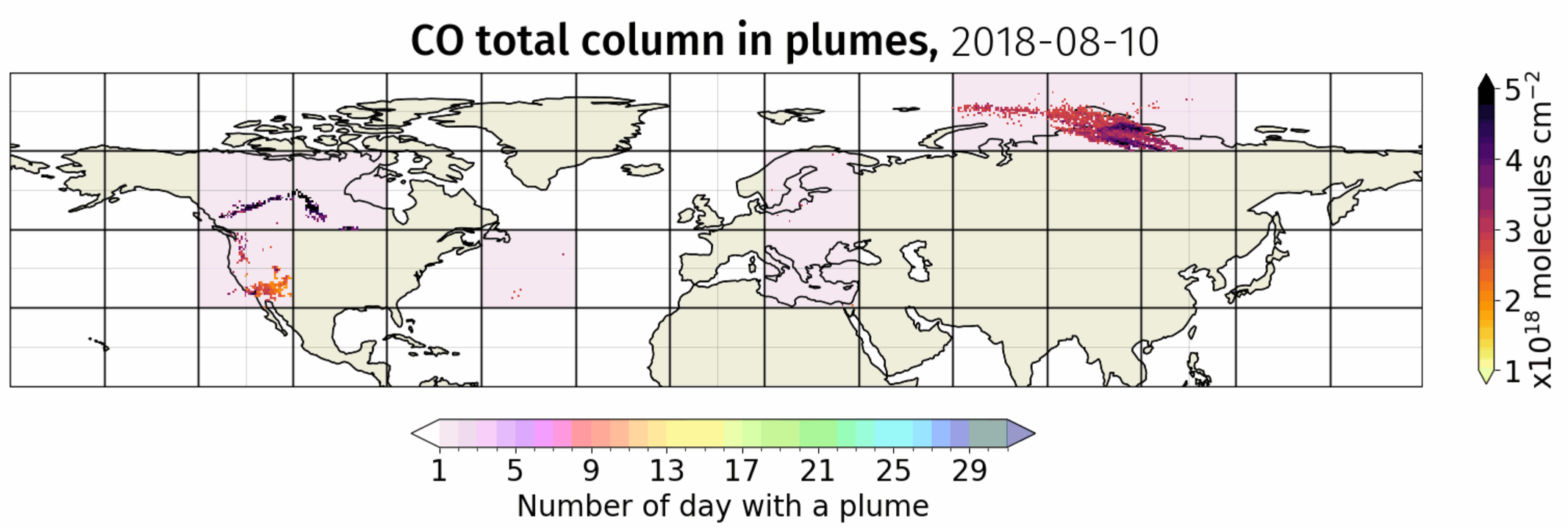
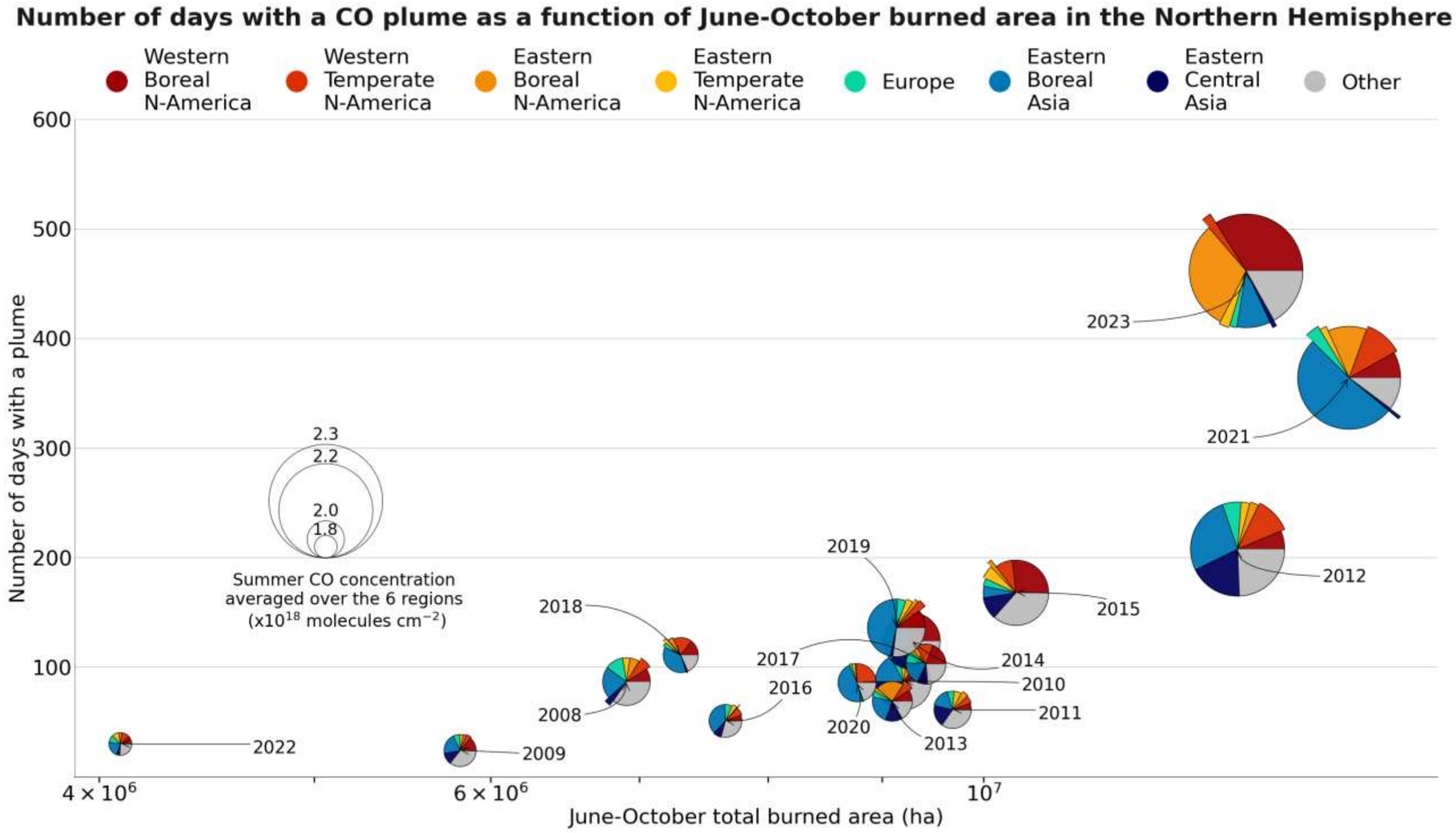


Impact of fires on the long-range transport of pollution in the Northern Hemisphere (2008-2023)

- The number of days with a plume ➚ with the severity of the fire season across the Northern Hemisphere (NH).

- Correlation between total number of days with a plume in June-October and the total burned area in the NH :
  R-value = 0.83

Ehret et al, 2024, EGUsphere [preprint], DOI: 10.5194/egusphere-2024-3128.

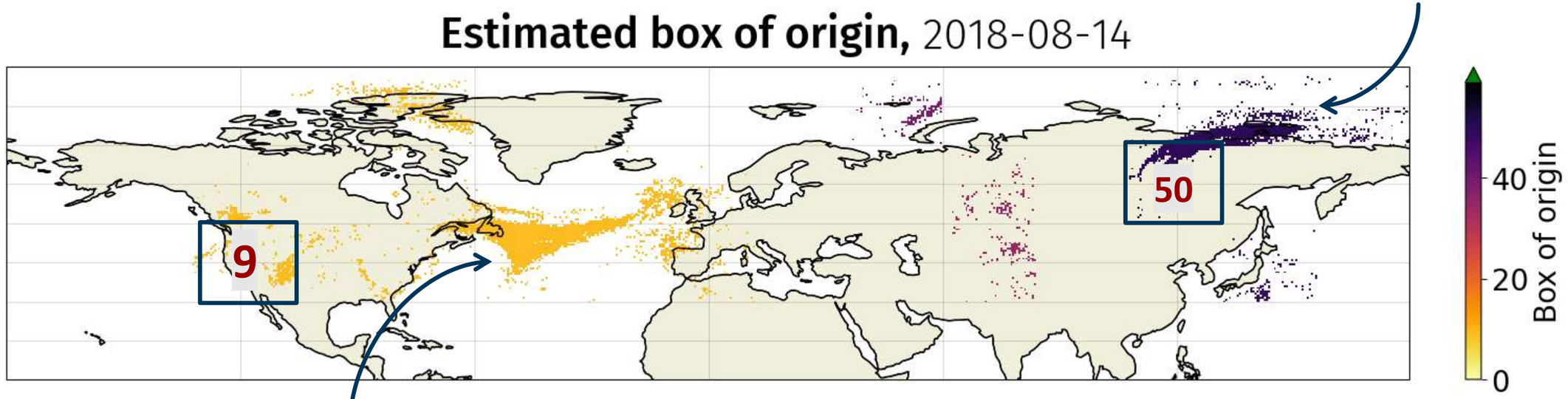


Origins of transported plumes

Back trajectories algorithm :

- Origin of a plume estimated by examining the probability of each adjacent box in the plume's path on the previous day :
  - Number of gridcells considered as a plume in each boxes.
  - Wind field at 300 hPa from ERA5.

Box of origin = 50 —> Eastern Boreal Asia



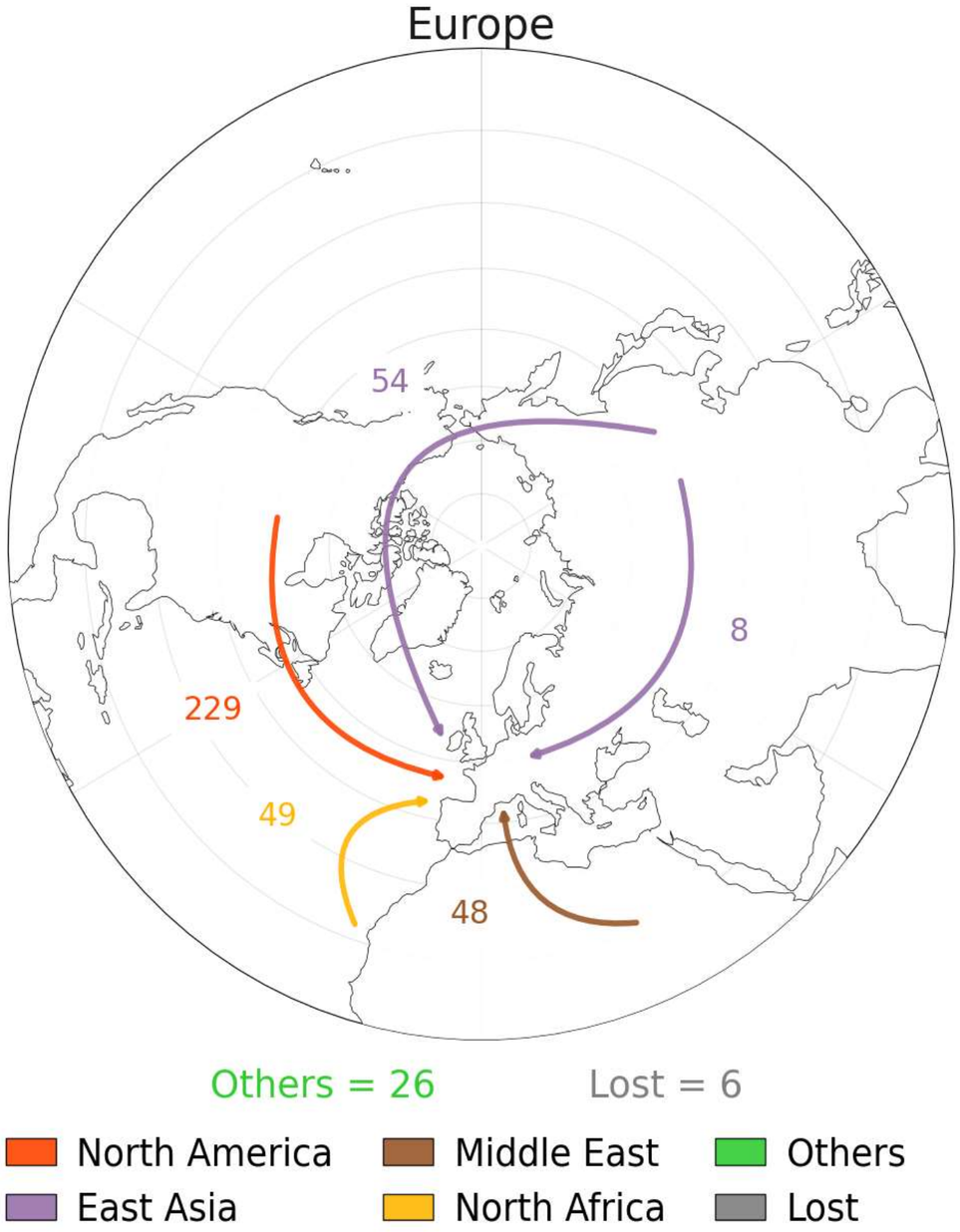
Box of origin = 9 —> Western Temperate North America

Origins of transported plumes

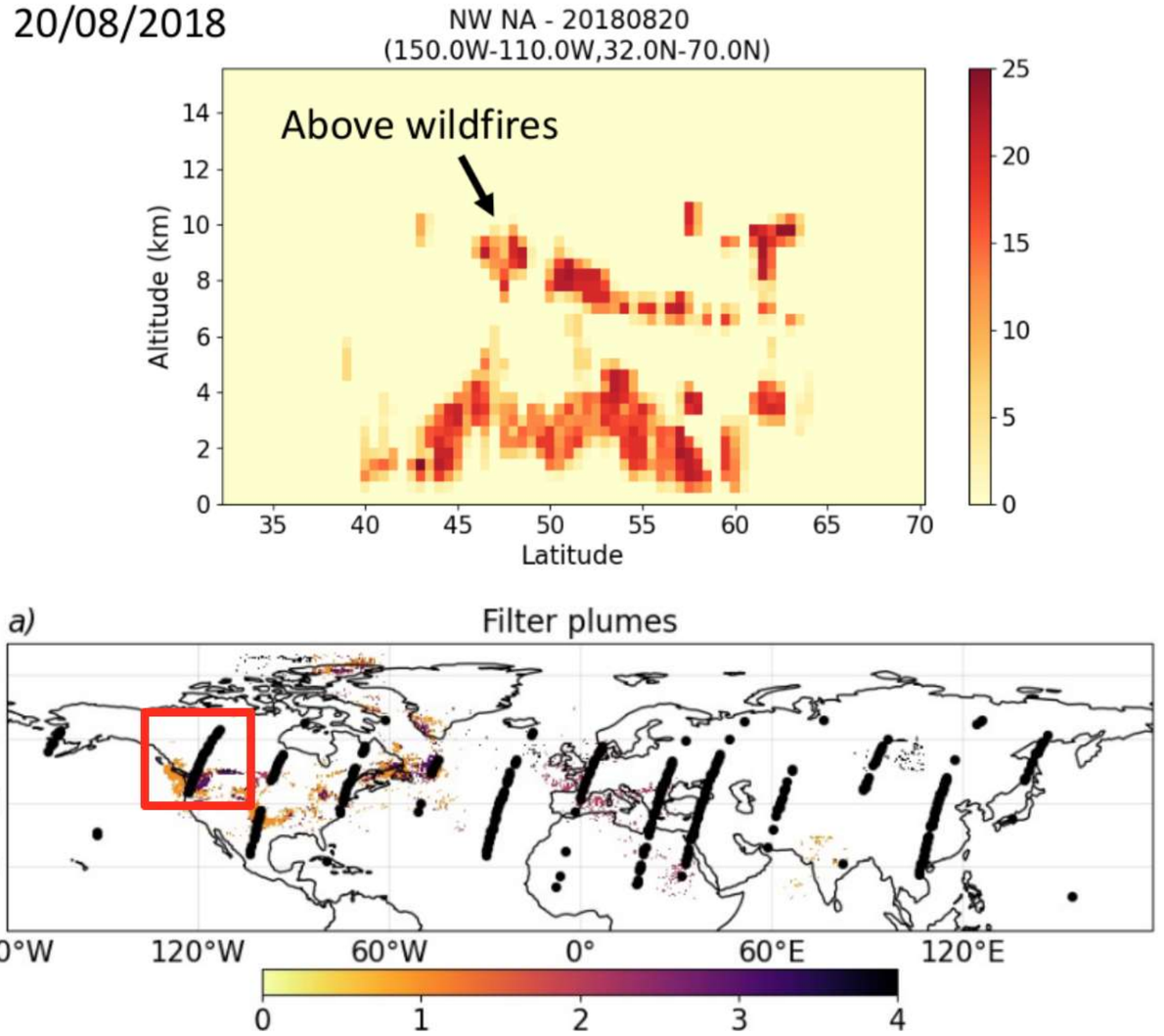
- 414 pathways associated with transported plumes detected in June-October 2008-2023 in Europe

- 15 % are from East Asia :
  - 14 % are from Boreal Asia

- 55 % are from North America :
  - 20 % are from Boreal North America.
  - 26 % are from Temperate North America.

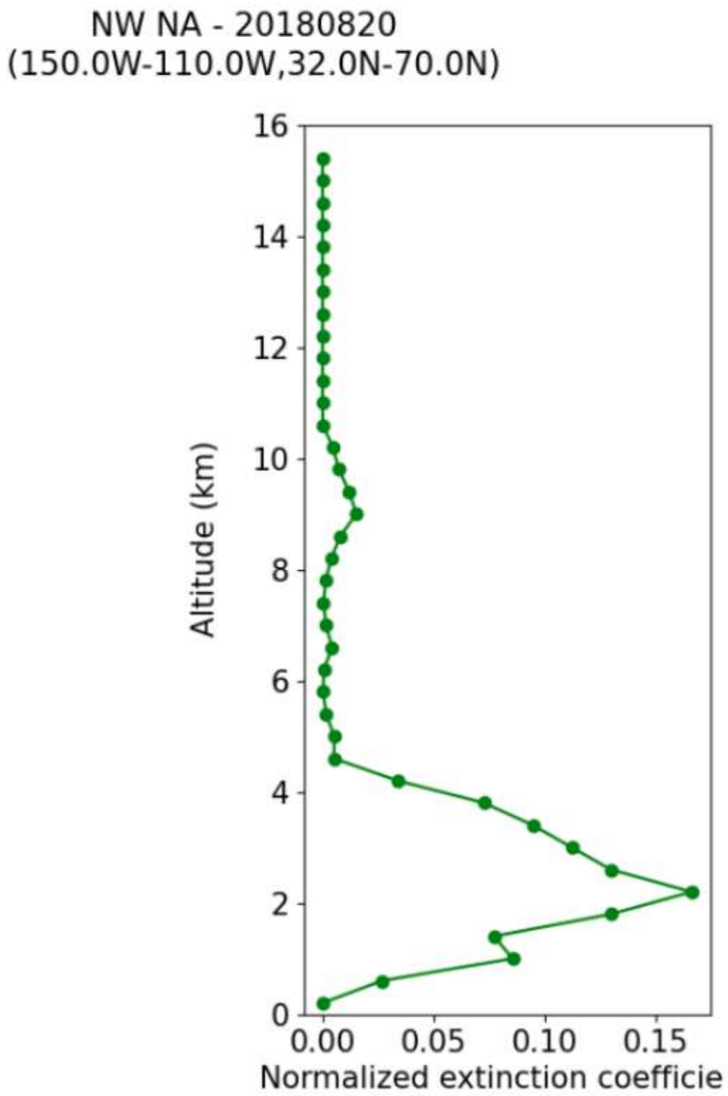


Origins of transported plumes



Courtesy of Solène Turquety

Origins of transported plumes



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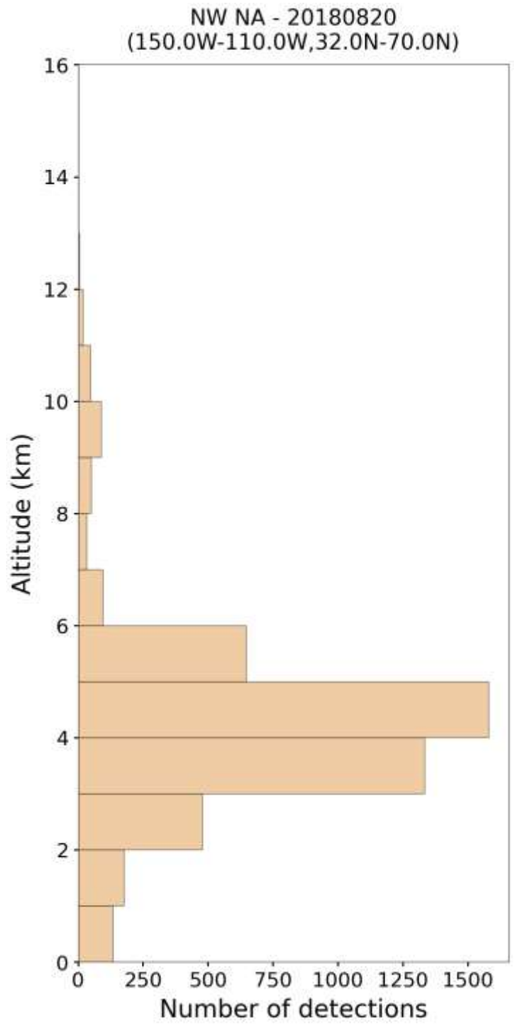

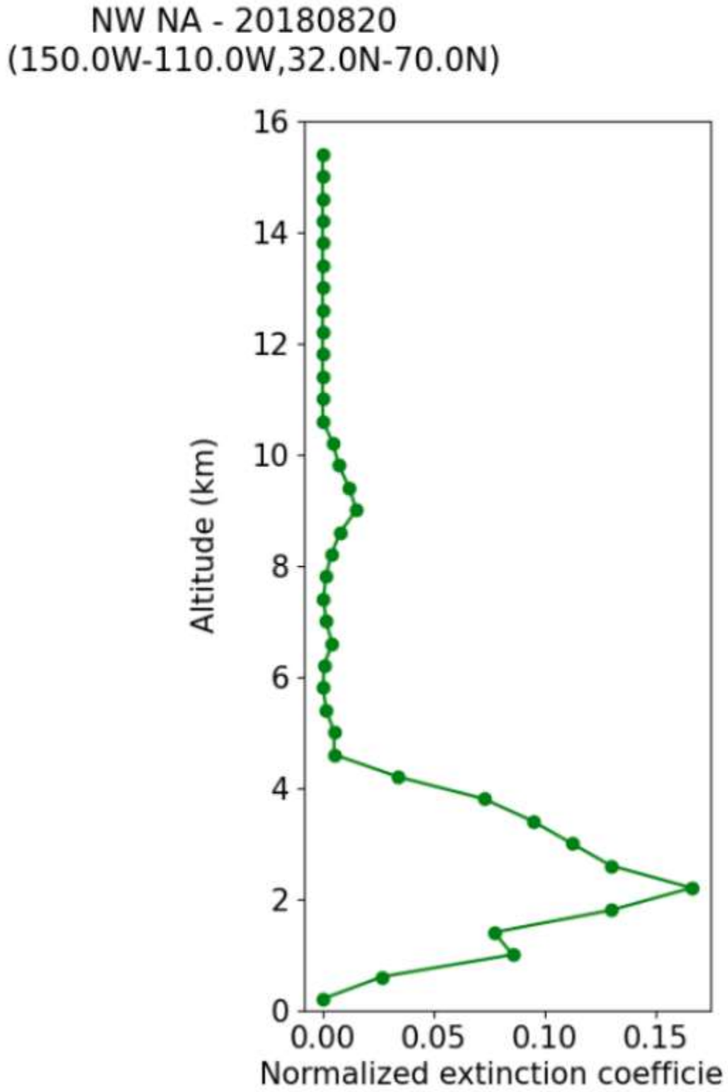

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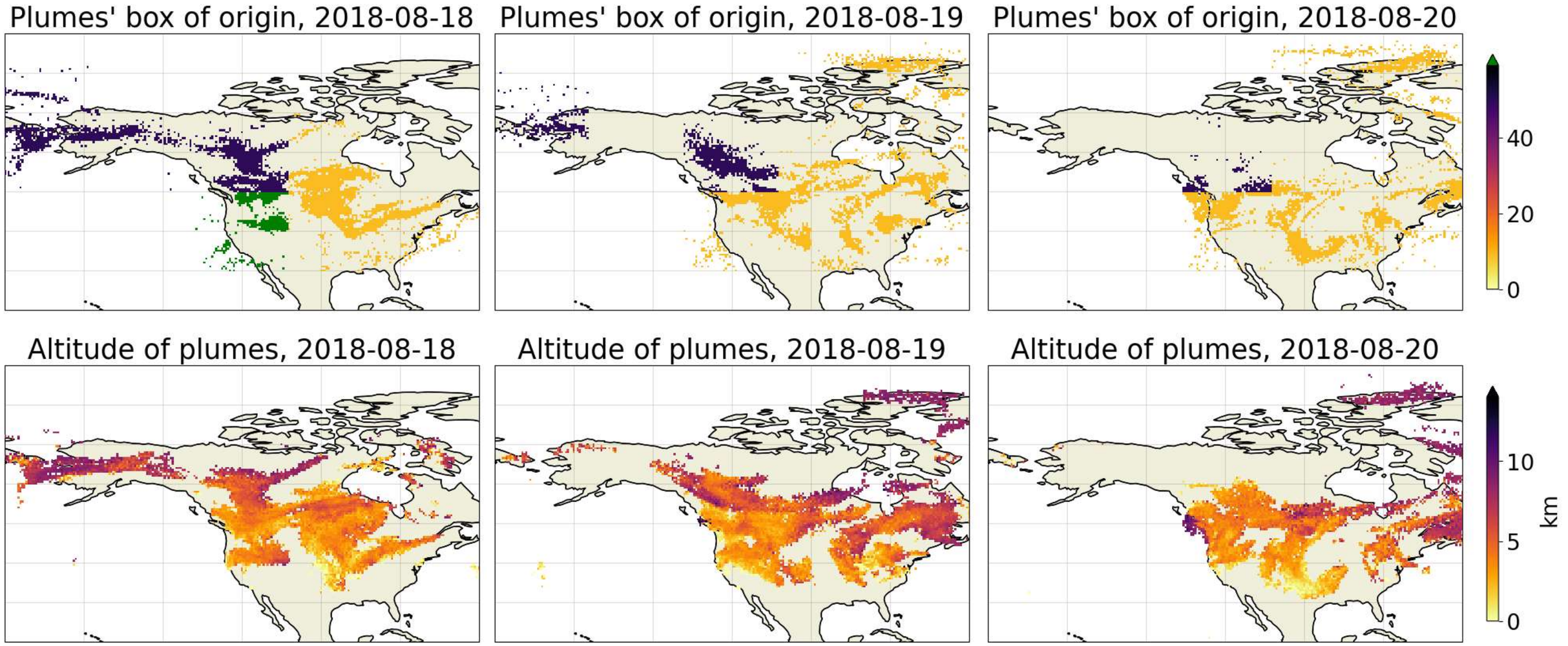
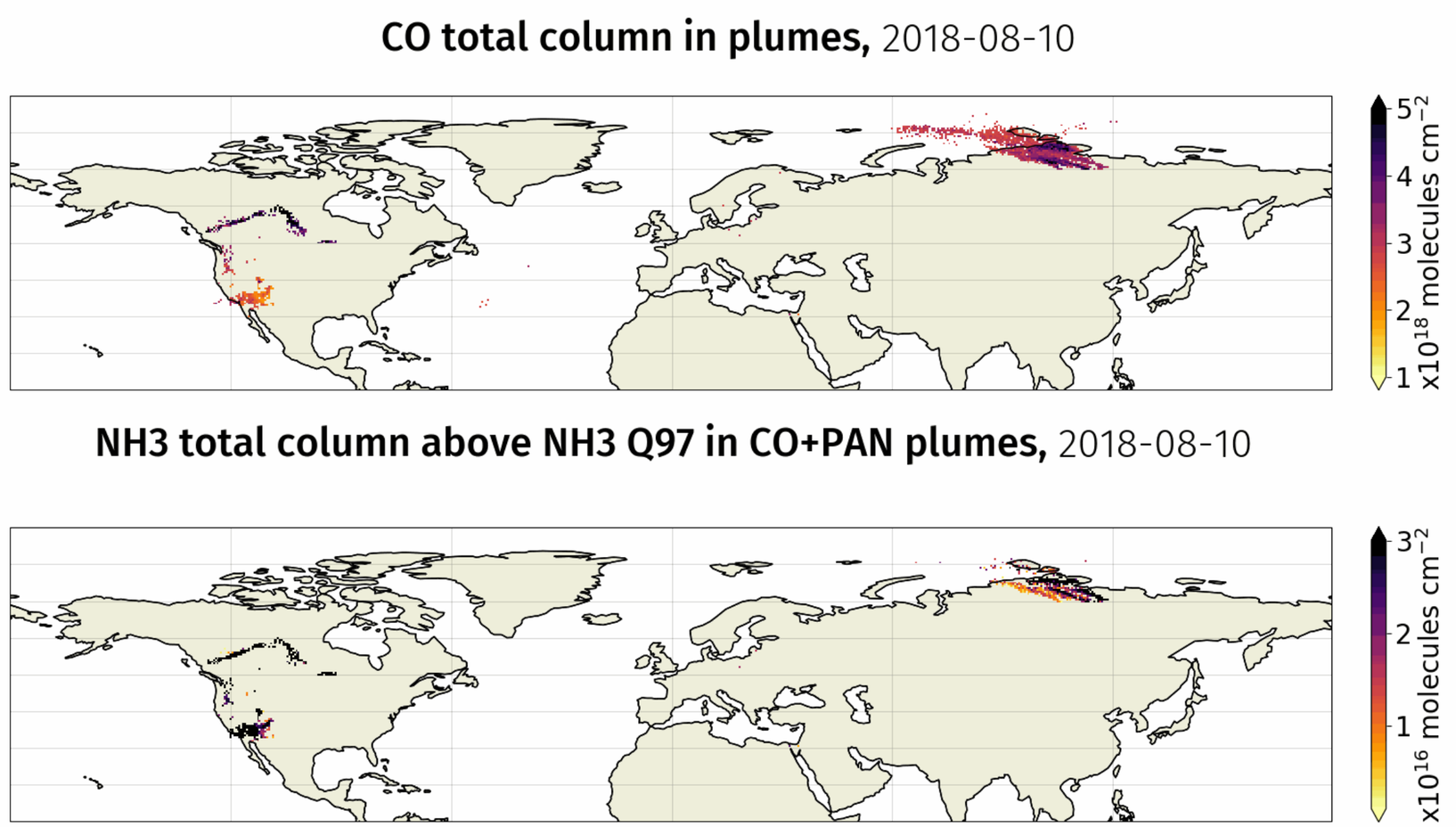
Origins of transported plumes



NEXT STEPS

- Analysis of identified plume composition (NH3, VOCs)



CONCLUSION

- Extreme concentrations of CO and AOD have increased during summer and early fall over most of the Northern Hemisphere due to an increase in intense wildfires in boreal regions and the western US.

- IASI observations allow to track plumes and estimate their origin. Most of the plumes are from boreal regions and the Western US.

- The plumes dataset could help to discriminate situations with two plumes, one from a local source and one from a long-range transport.

- Preliminary results indicate the potential for using IASI to observe other compounds in plumes.

THANKS !

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