From forest to atmosphere
Towards a more comprehensive assessment of BVOC exchanges in a mixed temperate forest

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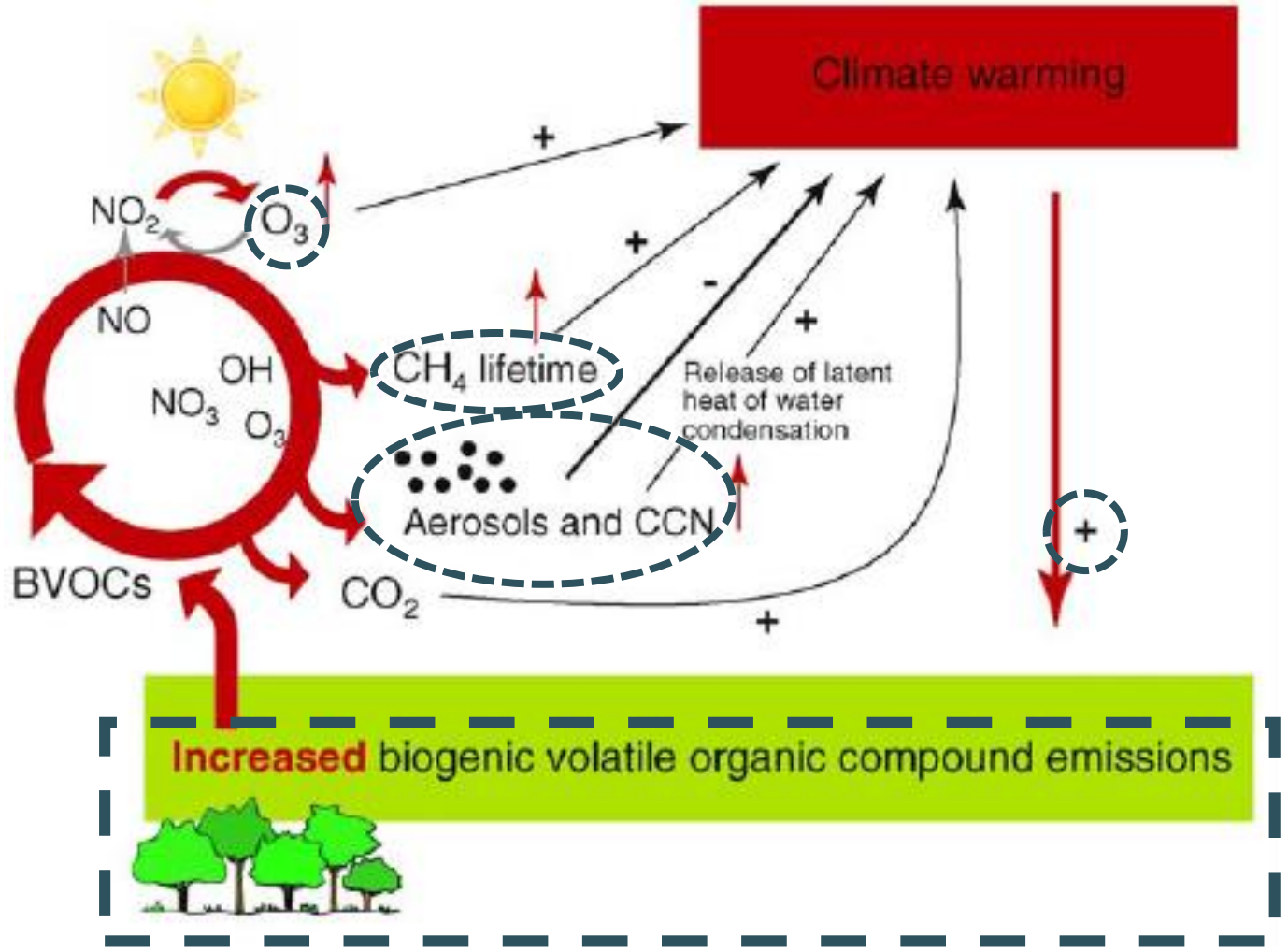
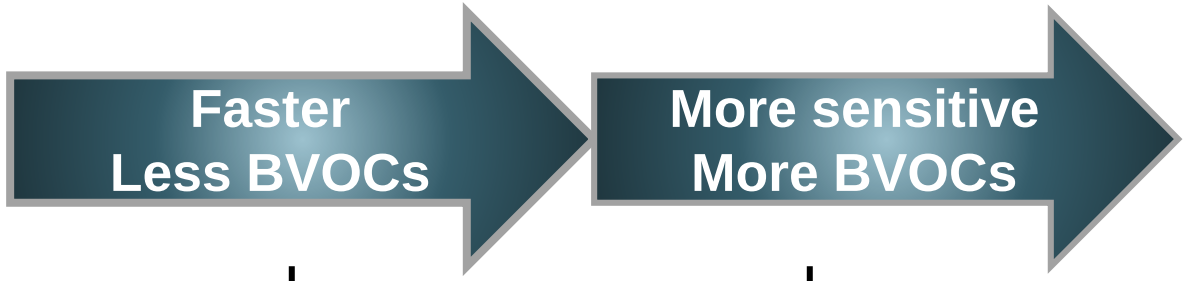
BVOCs & climate change



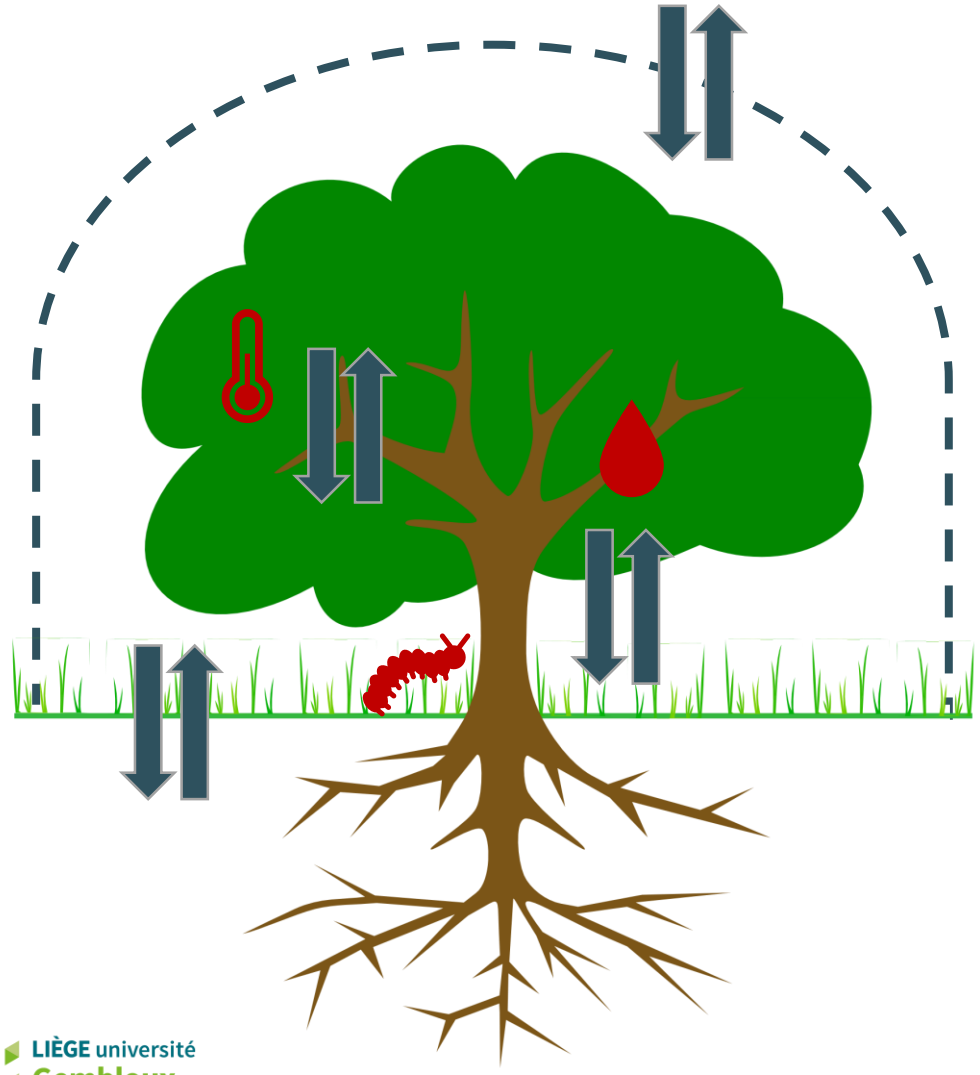
Peñuelas & Staudt (2010). Trends in Plant Science

Flux measurement techniques



	GC-MS	PTR-Quad-MS	PTR-TOF-MS
Leaf level Branch level Soil level	✓	✓	
Ecosystem level			

Objectives

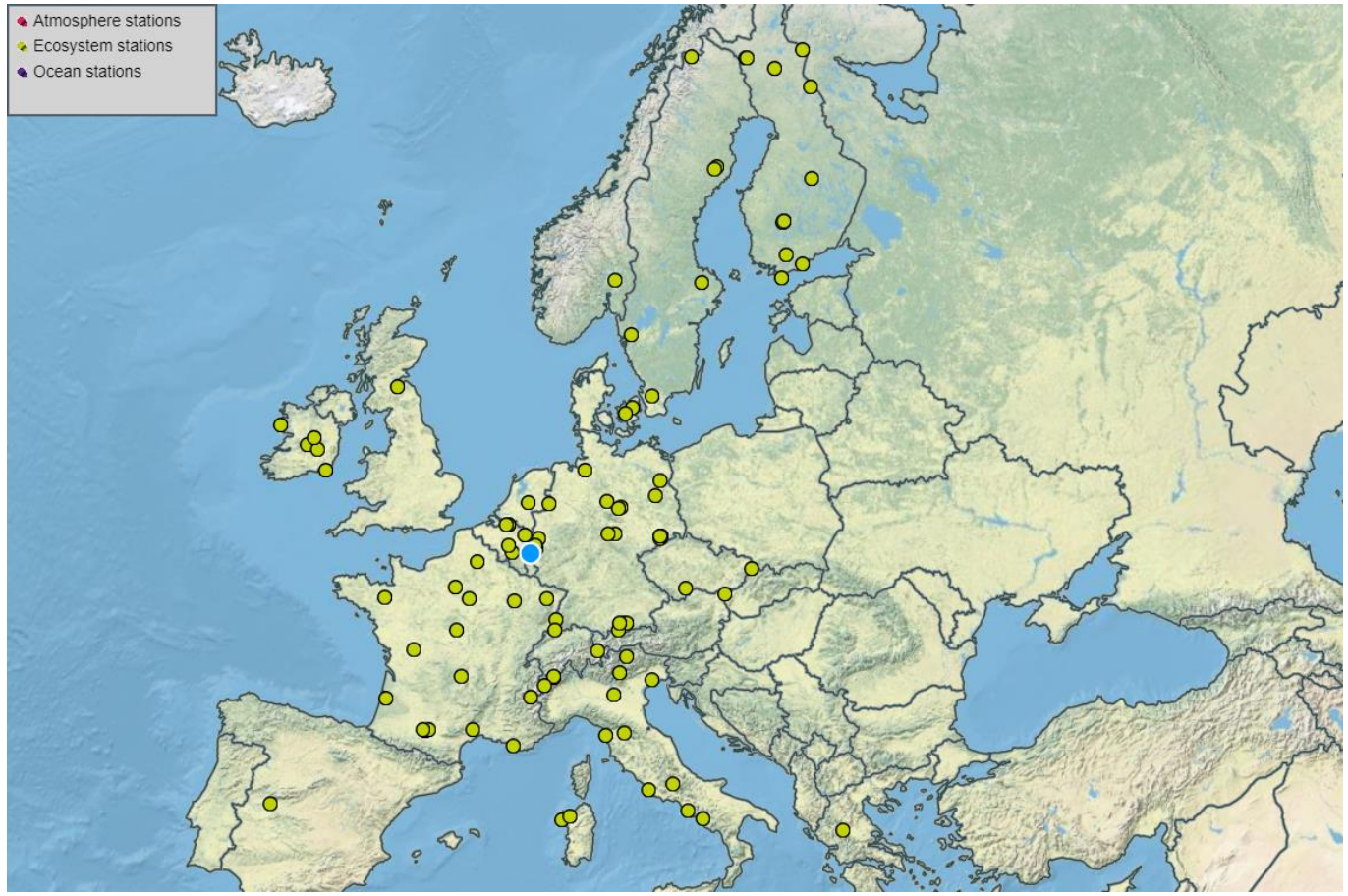


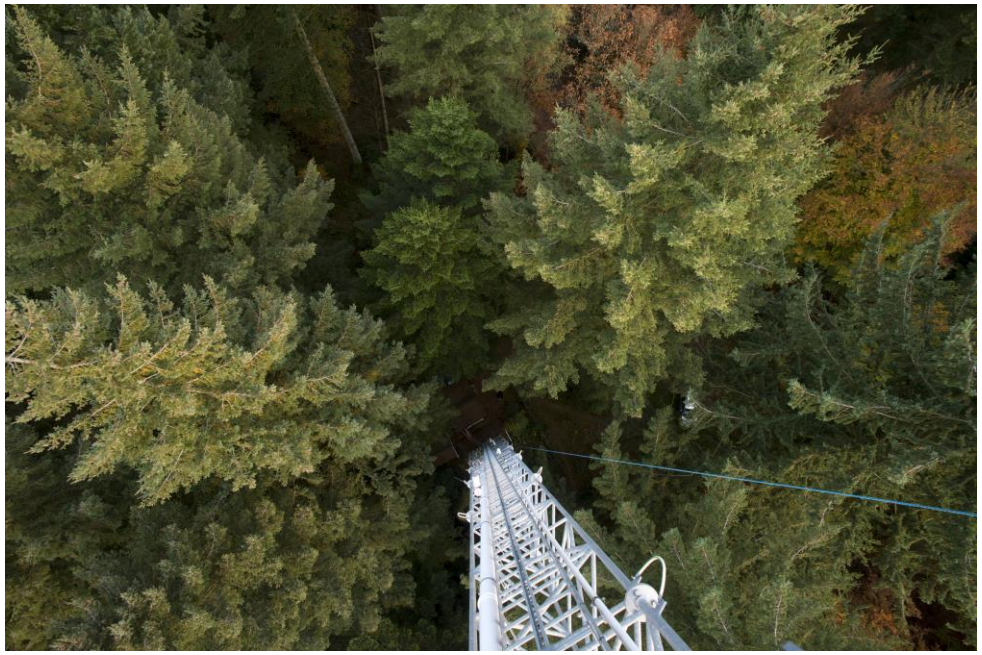
A) Provide a better overview of BVOC net exchange over a temperate forest

B) Disentangle sources and sinks within the soil-plant-atmosphere continuum

C) Improve characterization of emission/deposition processes

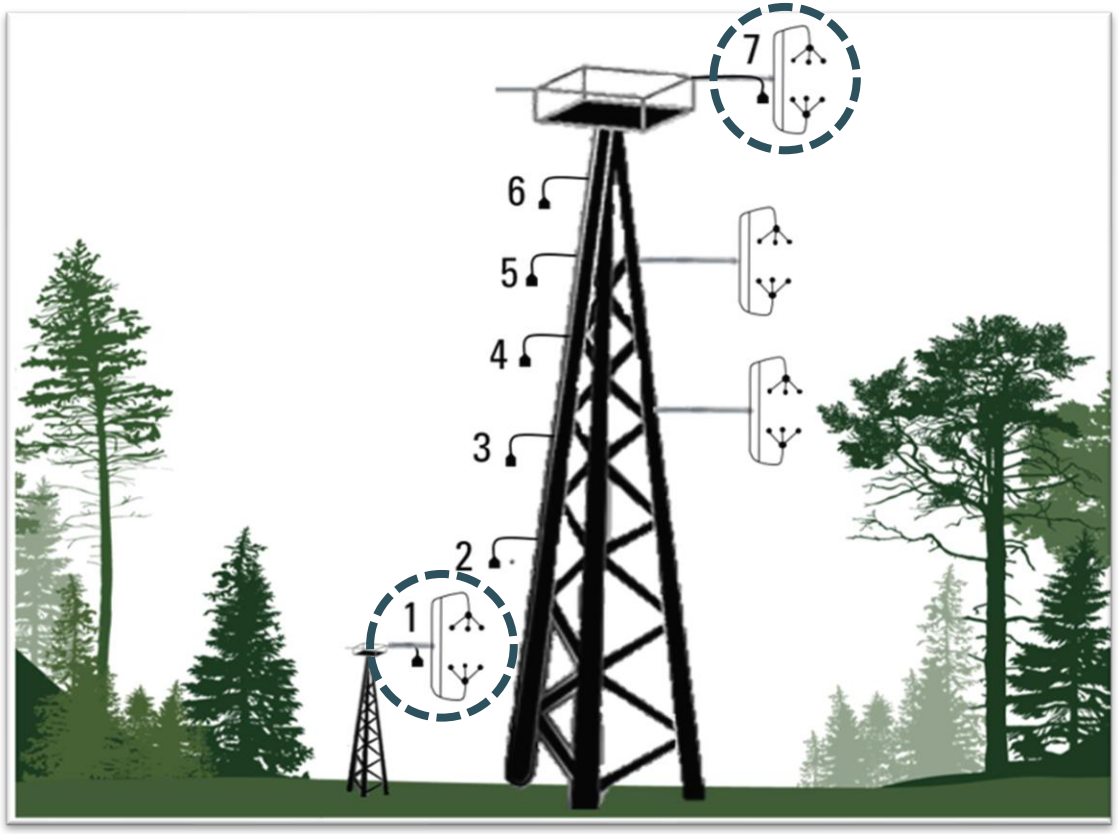
BE-Vie: mixed temperate forest, Belgian Ardenne





- **Temperate maritime** climate
- **Coniferous** (douglas fir, Norway spruce, silver fir) + **deciduous** (beech) species
- Measurements since **1996**

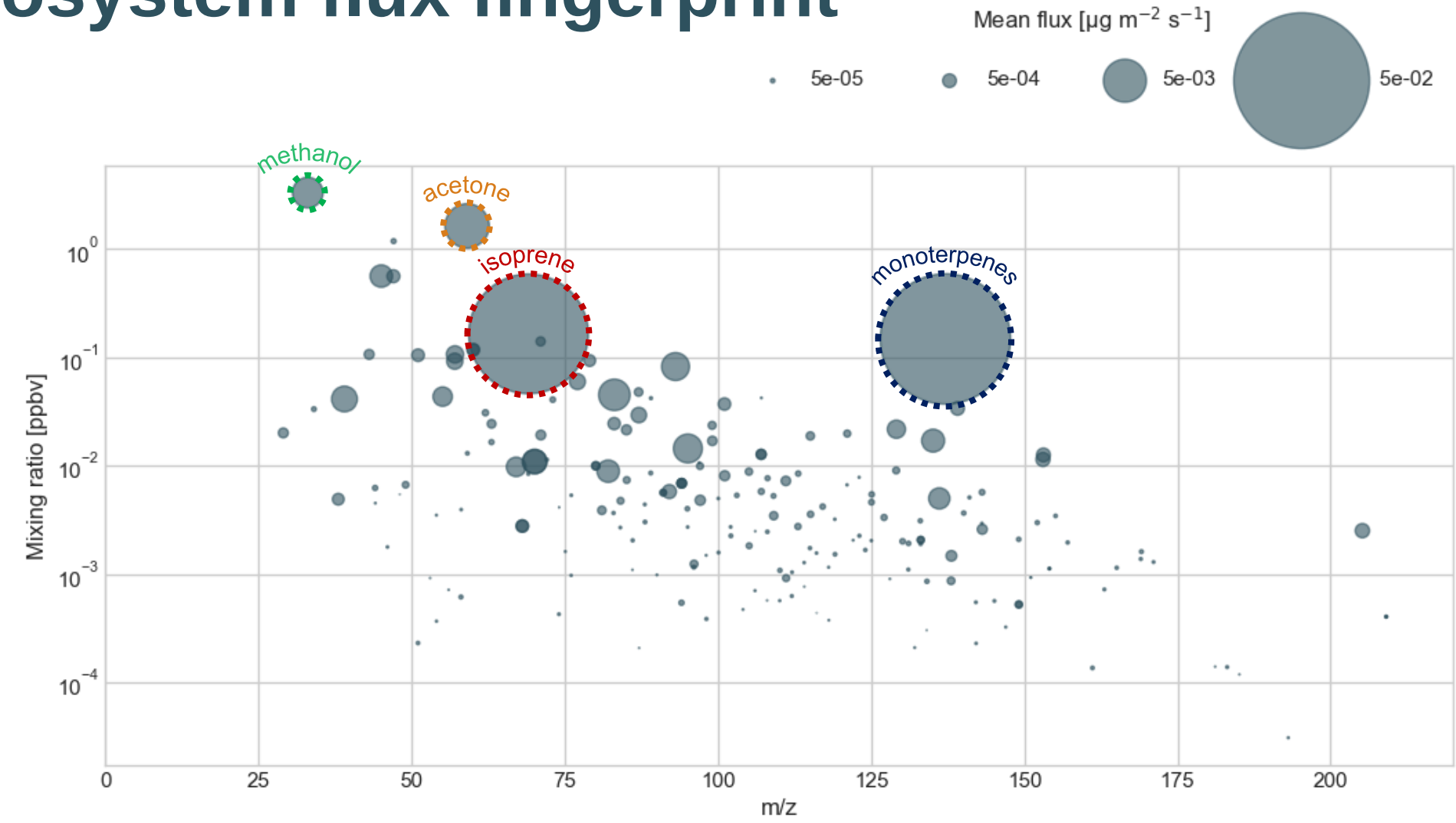
Fluxes computation



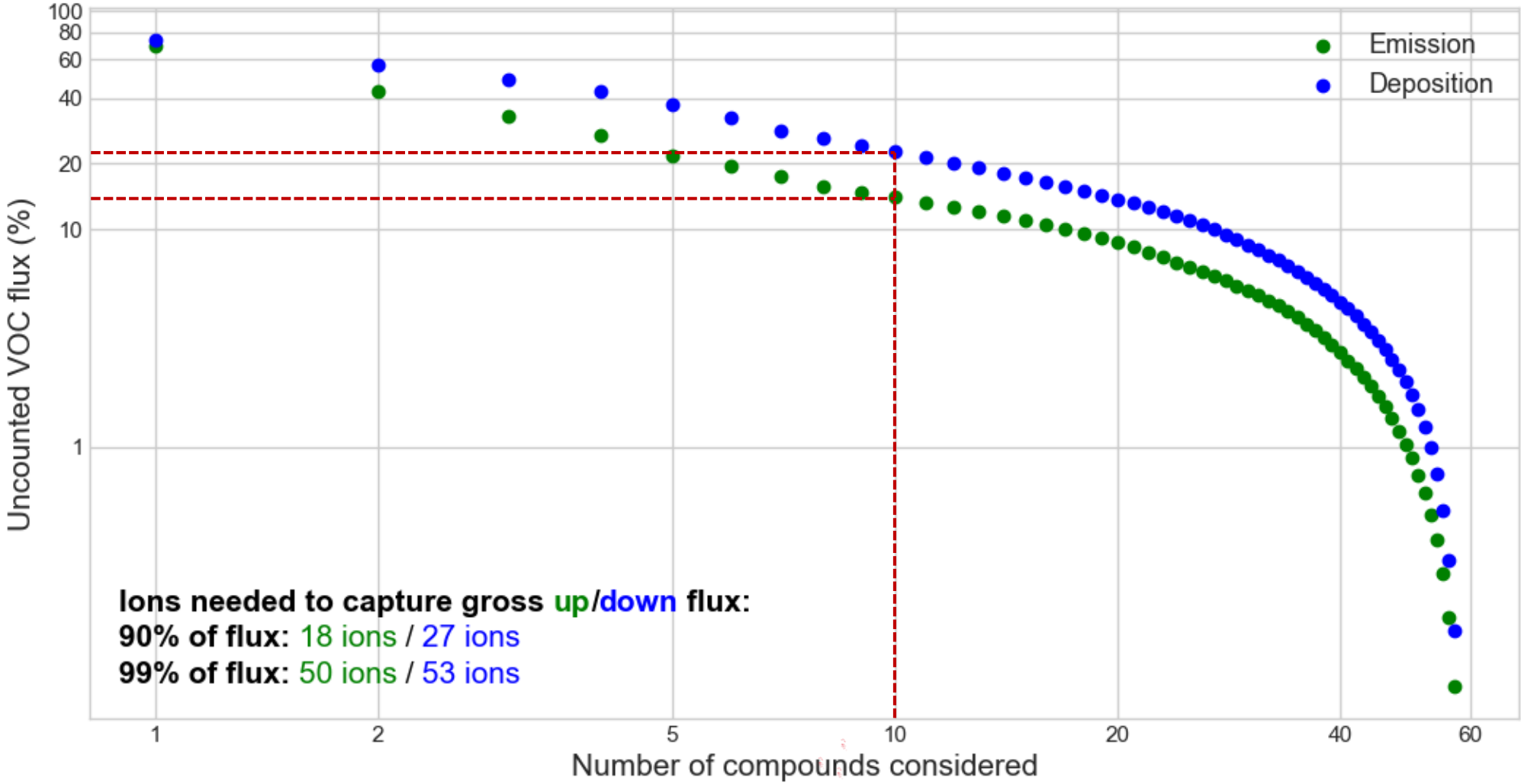
- EC method: $F_i = \overline{w' c_i'}$
  Tool: **InnFlux** (Striednig et al., 2020), converted and expanded in Python (GEddySoft)
- Many BVOCs with low signal/noise ratio
  Isoprene used as benchmark
- Detect significant exchange
  ± 70 ions
- Data for 2022 (Top), **2023** (Top & Trunk), 2024 (Top & Trunk) from April to December

Effort to automate the processing of hundreds of tracers

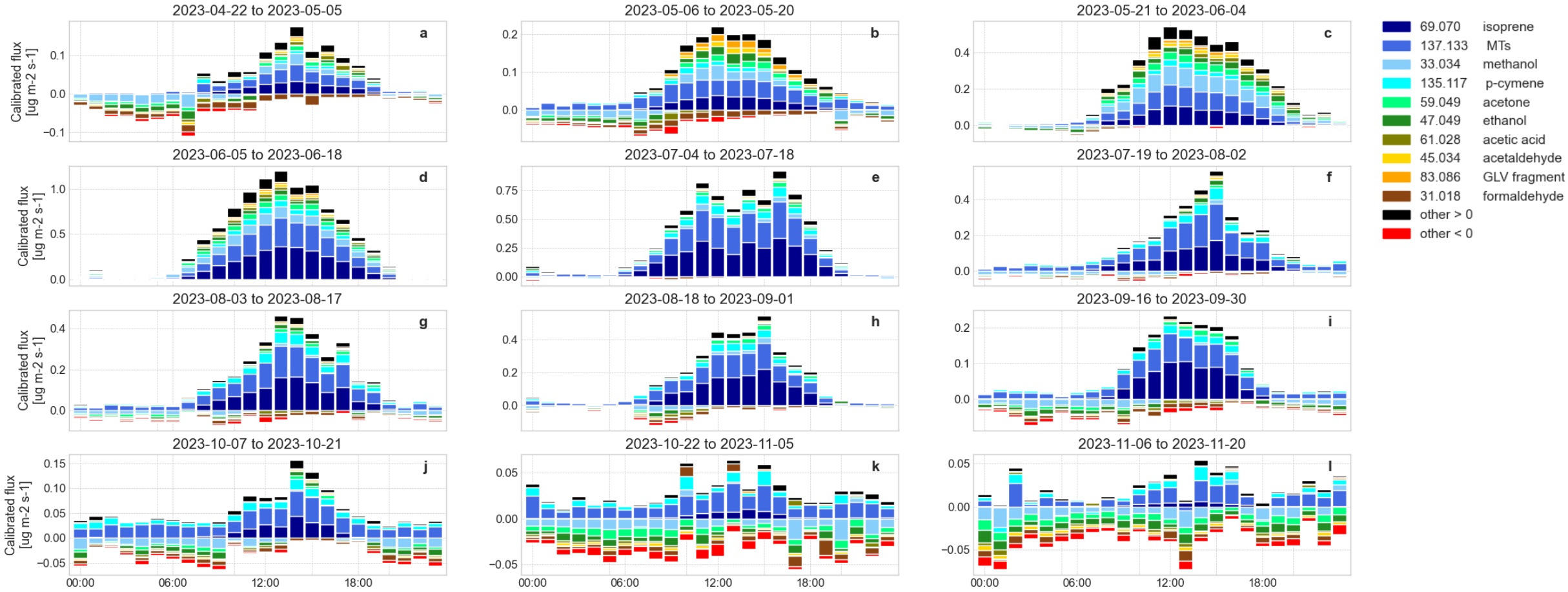
Ecosystem flux fingerprint



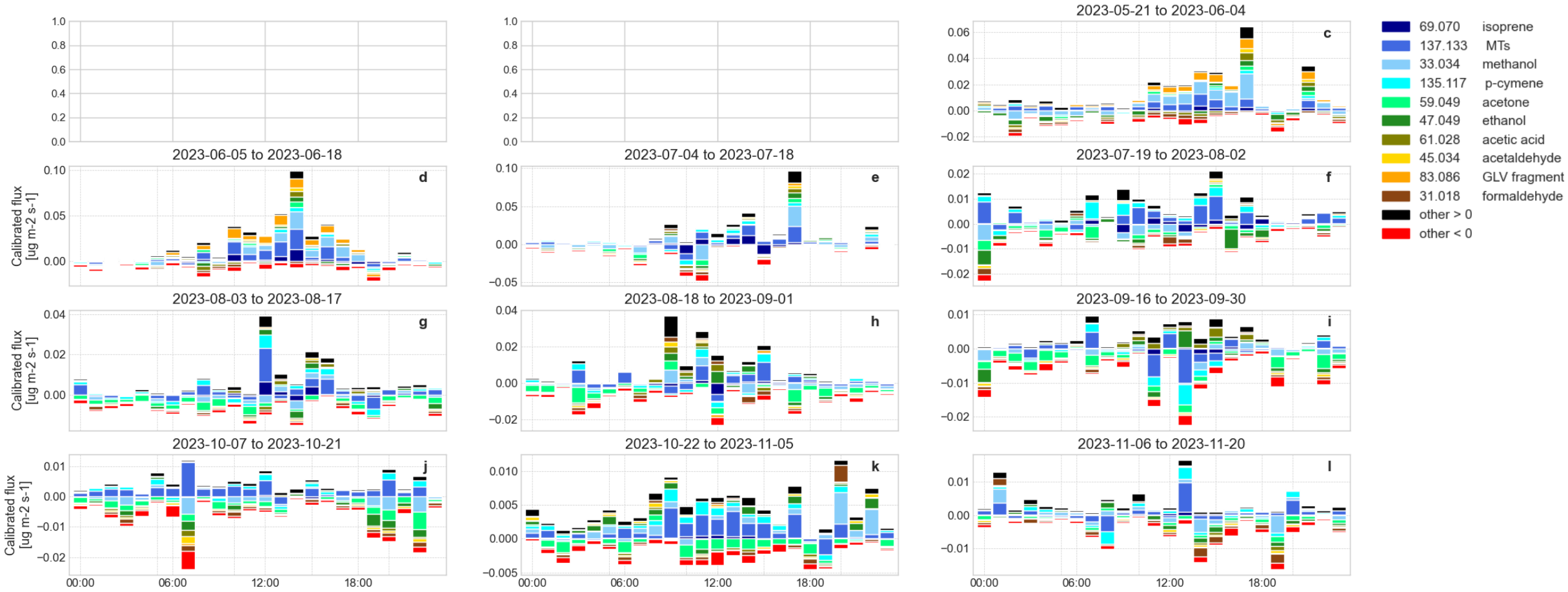
BVOCs relative contribution



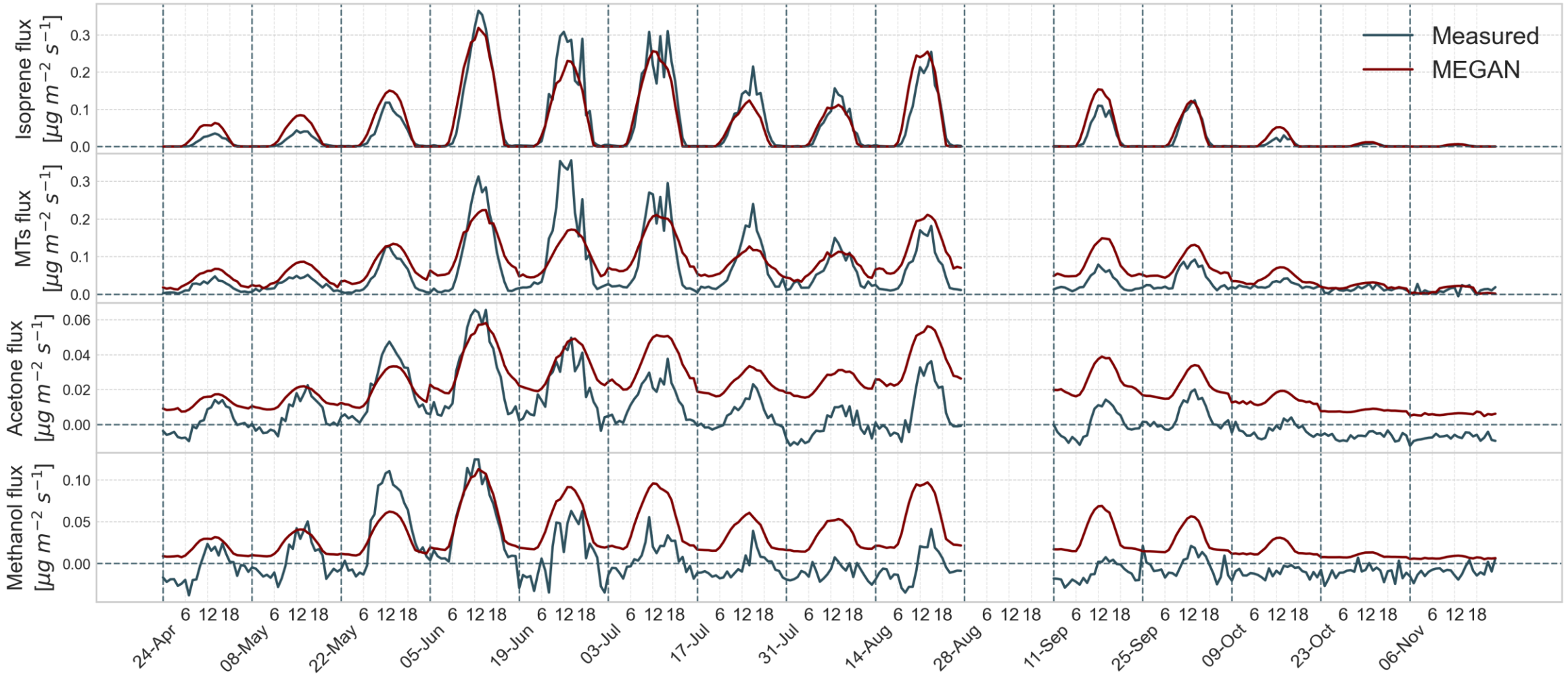
Ecosystem seasonal behavior – TOP



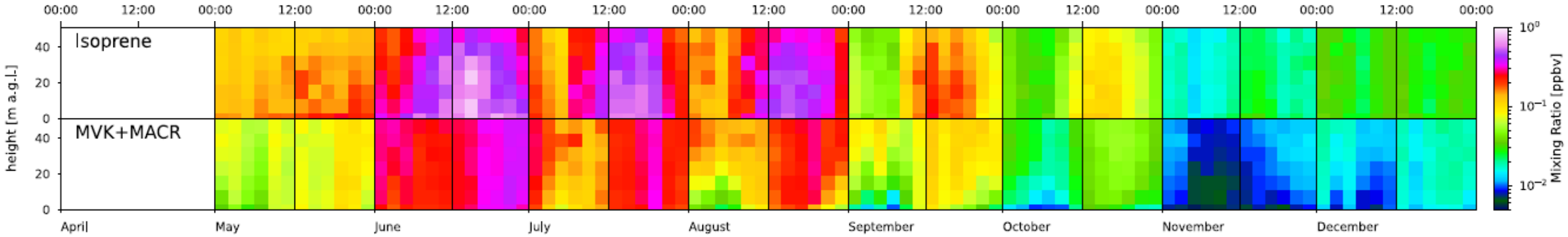
Ecosystem seasonal behavior – TRUNK



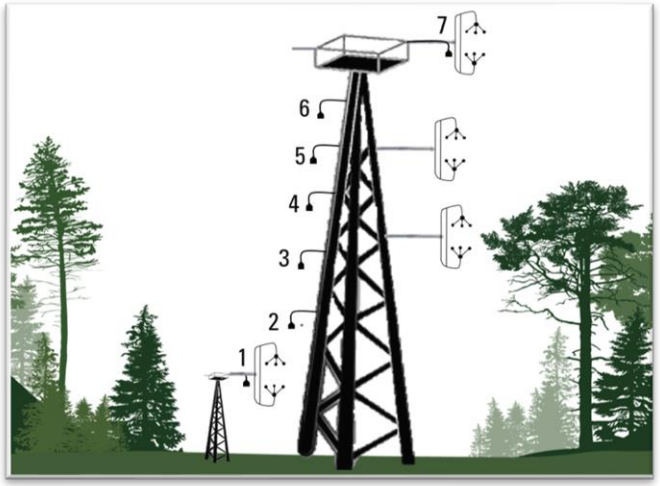
MEGAN to understand emissions… & depositions?

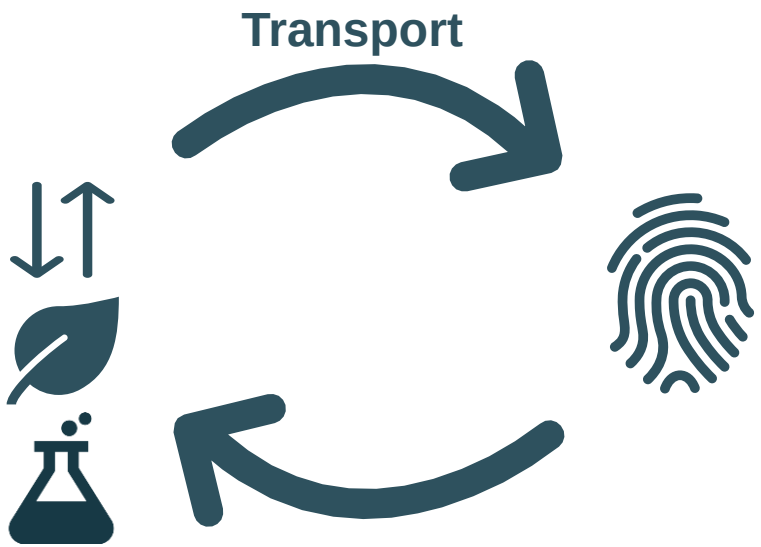


What's happening within the canopy?



Verreyken et al. (2023). Poster at IGAC conf.





Acknowledgement

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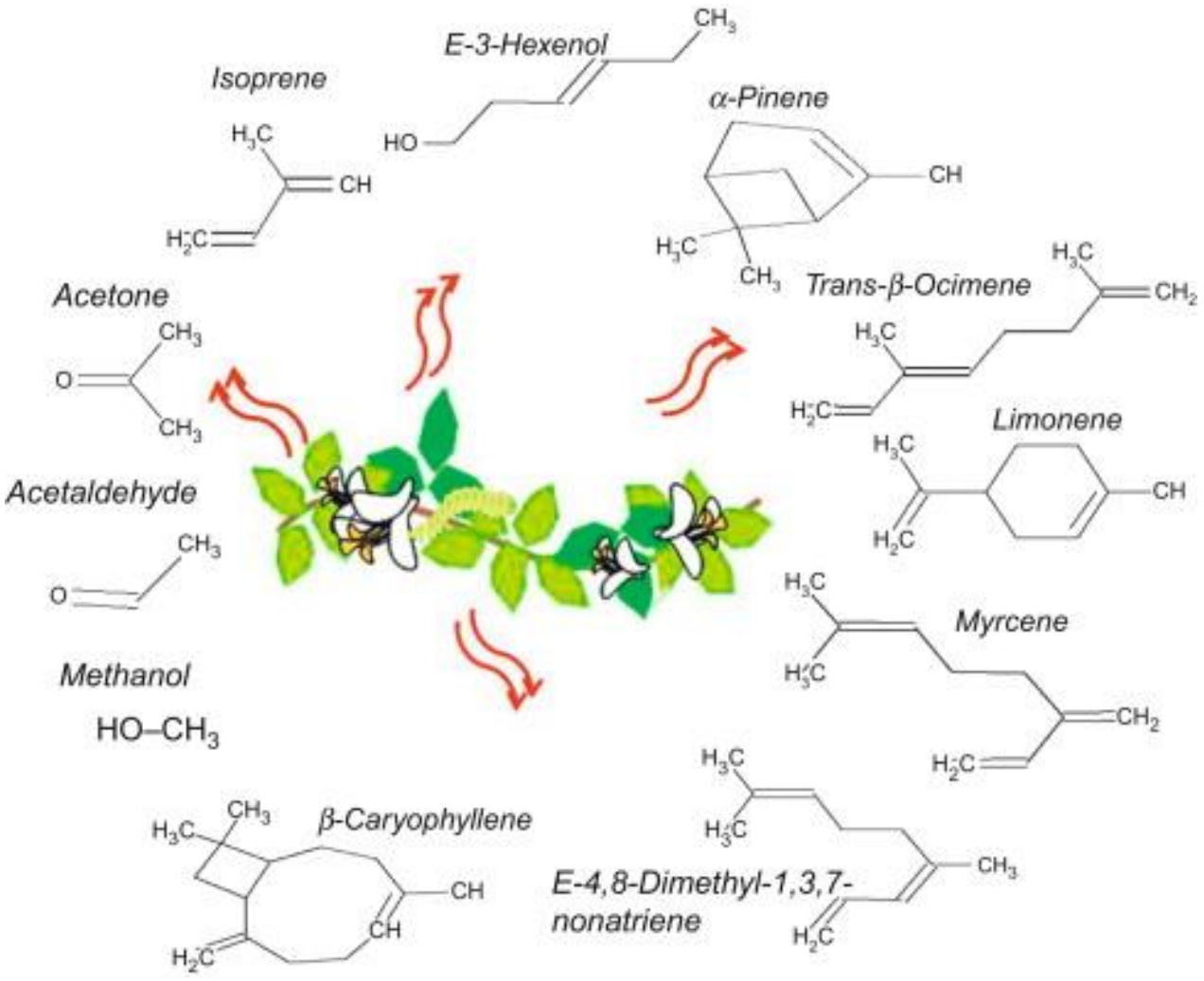
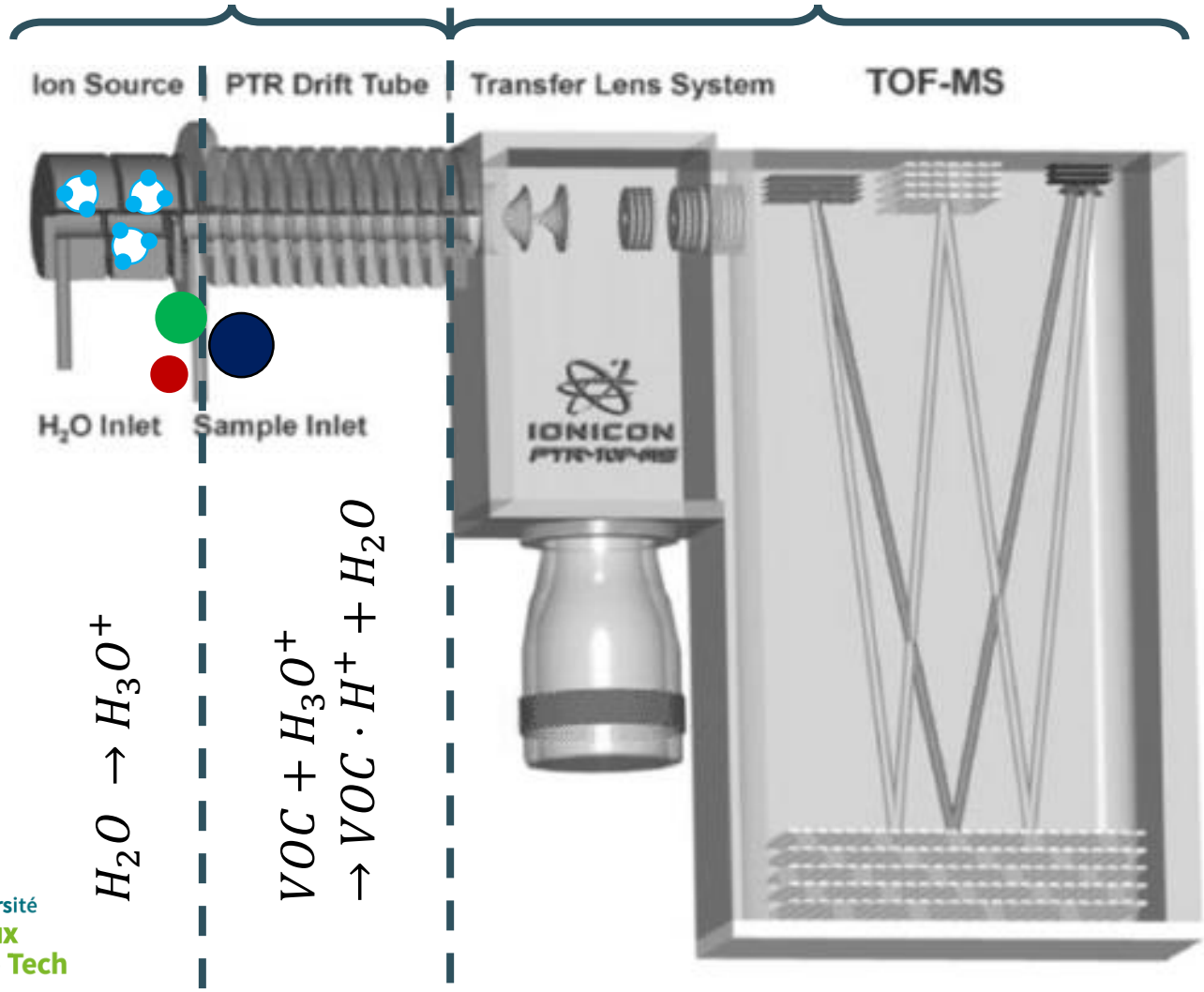
BVOCs?

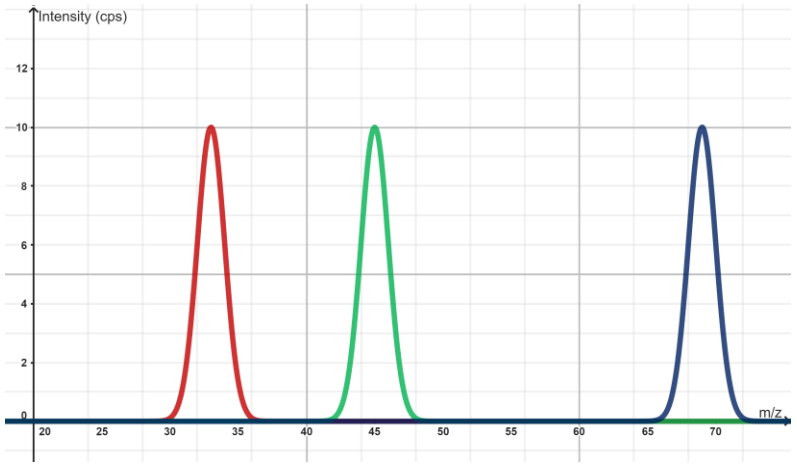


Loreto & Fares, 2013. Developments in Environmental Science

Fast instrument: PTR-TOF-MS

Proton transfer reaction | Time-of-flight mass spectrometer

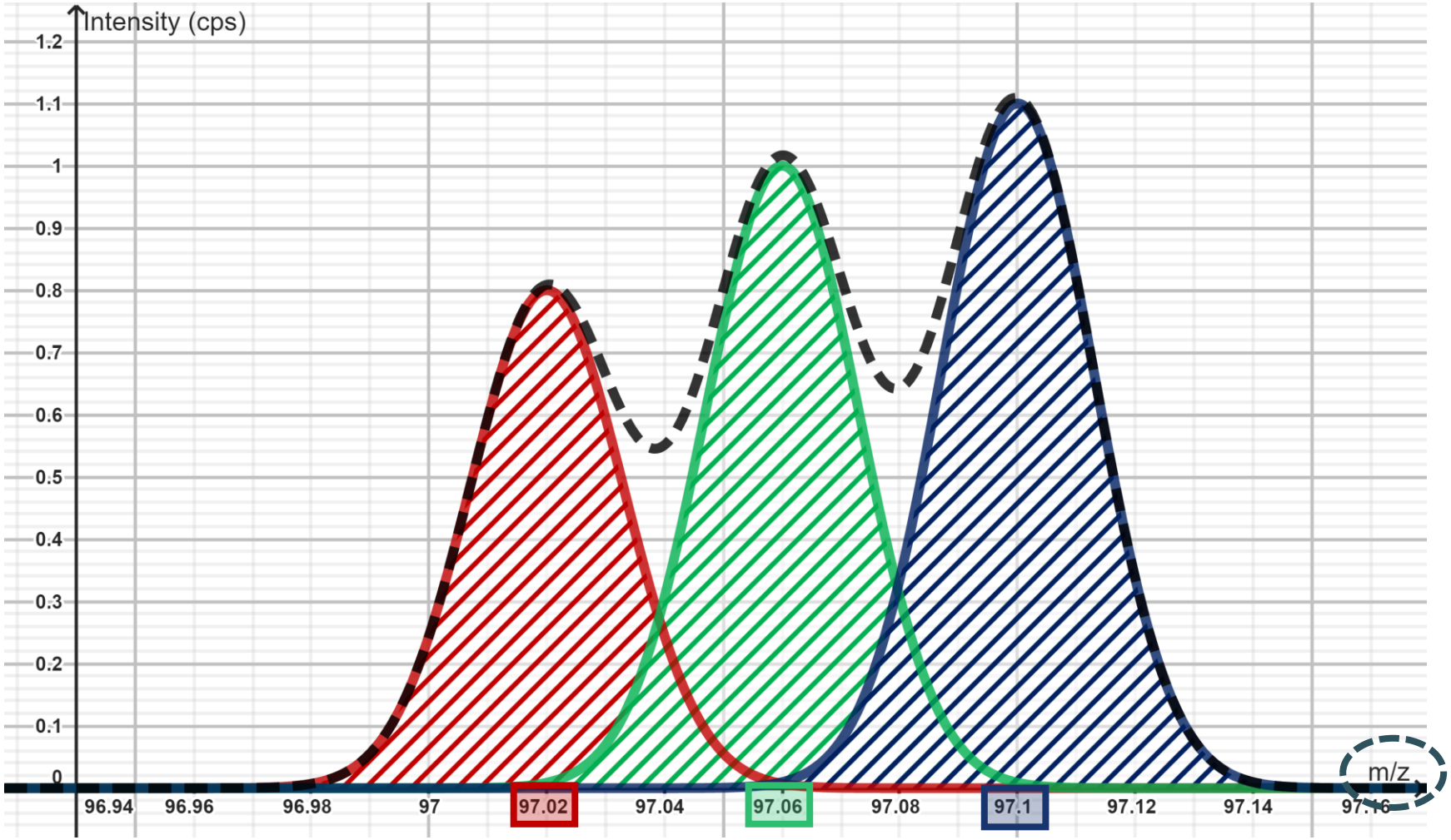




PTR-TOF-4000
Ionicon Analytik GmbH

From mass spectra to mixing ratios

IDA software

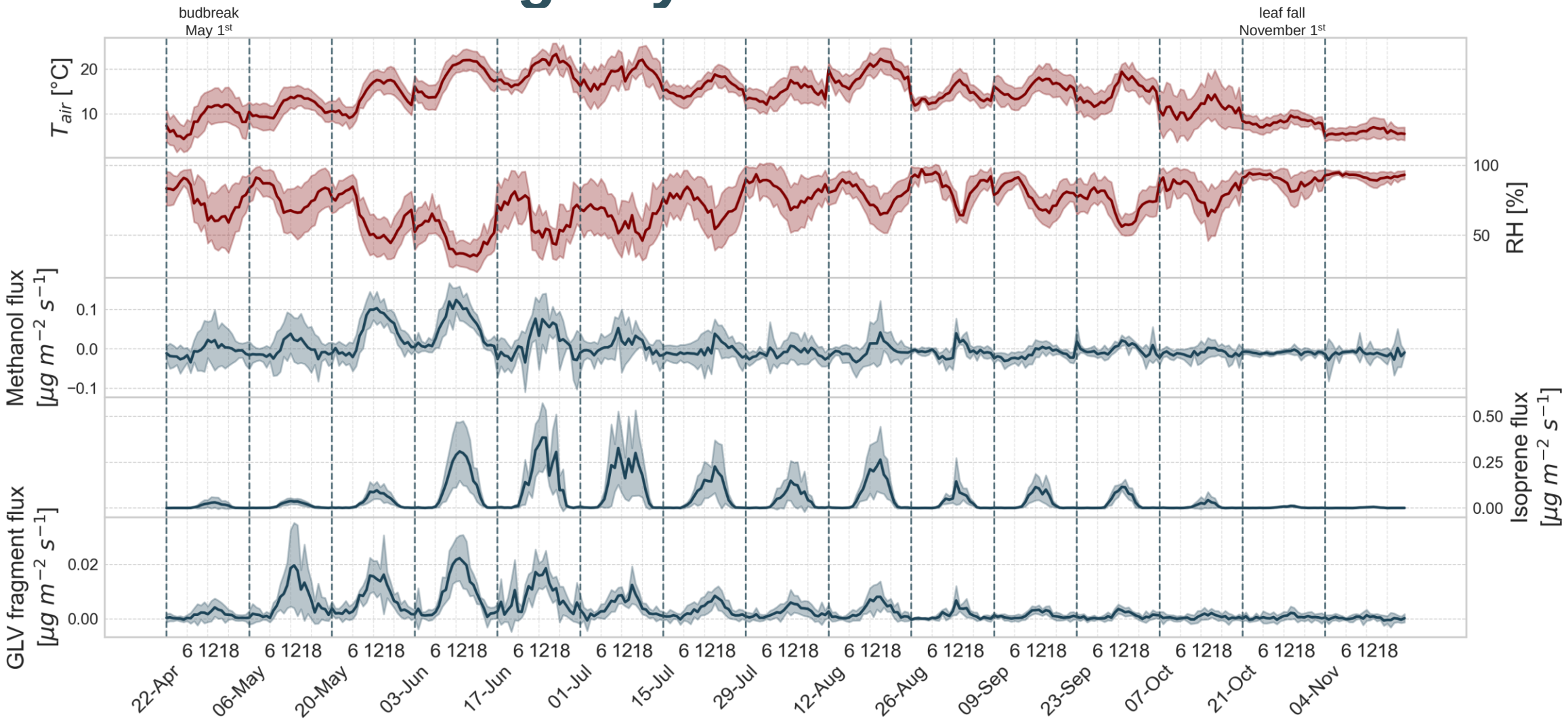


- Mass scale calibration
- Peak shape fitting + peak integration
- Peak identification
  ± 820 m/z per day

- Quantification
  - background substr.
  - transmission correction
  - normalization
  - RH dependence
  - (use of calibration coefficients)

- Identification of confined clusters **224 m/z for 2022**

Distinct exchange dynamics



Modelling with MEGAN

$$F_i = \gamma_i \sum \varepsilon_{i,j} \cdot \chi_j$$

- $\varepsilon_{i,j}$: standard emission factor
- χ_j: fractional grid box areal coverage
- γ_i: emission activity factor

$$\gamma_i = C_{CE} \cdot LAI \cdot \gamma_{P,i} \cdot \gamma_{T,i} \cdot \gamma_{A,i} \cdot \gamma_{SM,i} \cdot \gamma_{C,i}$$

PPFD; T°; leaf age; soil moisture; CO_2 inhibition

+ canopy model

References

Peñuelas, J., & Staudt, M. (2010). BVOCs and global change. *Trends in Plant Science*, *15*(3), 133–144.

Loreto, F., & Fares, S. (2013). Biogenic volatile organic compounds and their impacts on biosphere-atmosphere interactions. In *Developments in Environmental Science* (1st ed., Vol. 13). Elsevier Ltd. https://doi.org/10.1016/B978-0-08-098349-3.00004-9