



Relating condensable reaction product formation with nanoparticle growth rates: **Select monoterpene + NO₃ reactions under varying oxidizing conditions**

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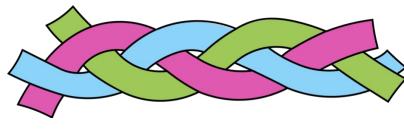
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Acknowledgements



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- Funding:



Tampere University

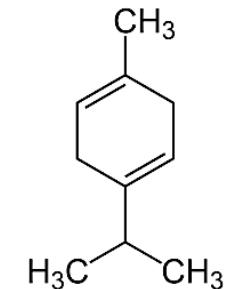


Intro – interest in NO_3 is increasing

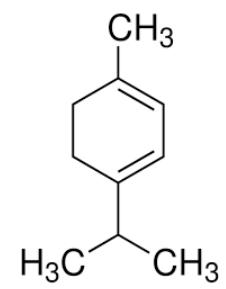
notwithstanding NO_x is going down

- Contrary to common view NO_3 can oxidize also during daytime
 - Photolysis of any vapor takes time
- Combustion emissions are going down
 - Though NO_x is kind of hanging in many places
- Monoterpenes (MT) are the main source of SOA
- Subsequently $\text{NO}_3 + \text{MT} \rightarrow \text{SOA}$ is gaining interest

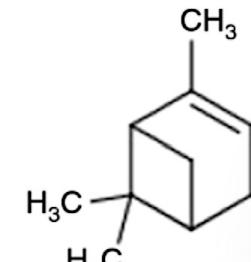
Monoterpenes studied



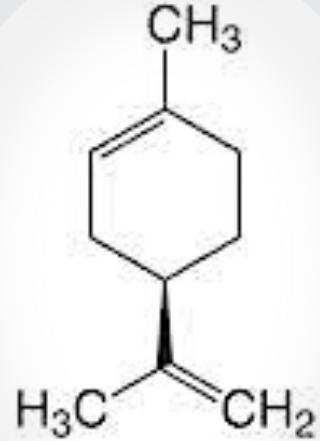
γ -terpinene



α -terpinene



α -pinene



Limonene

Experiment – CESAM chamber in Paris Creteil

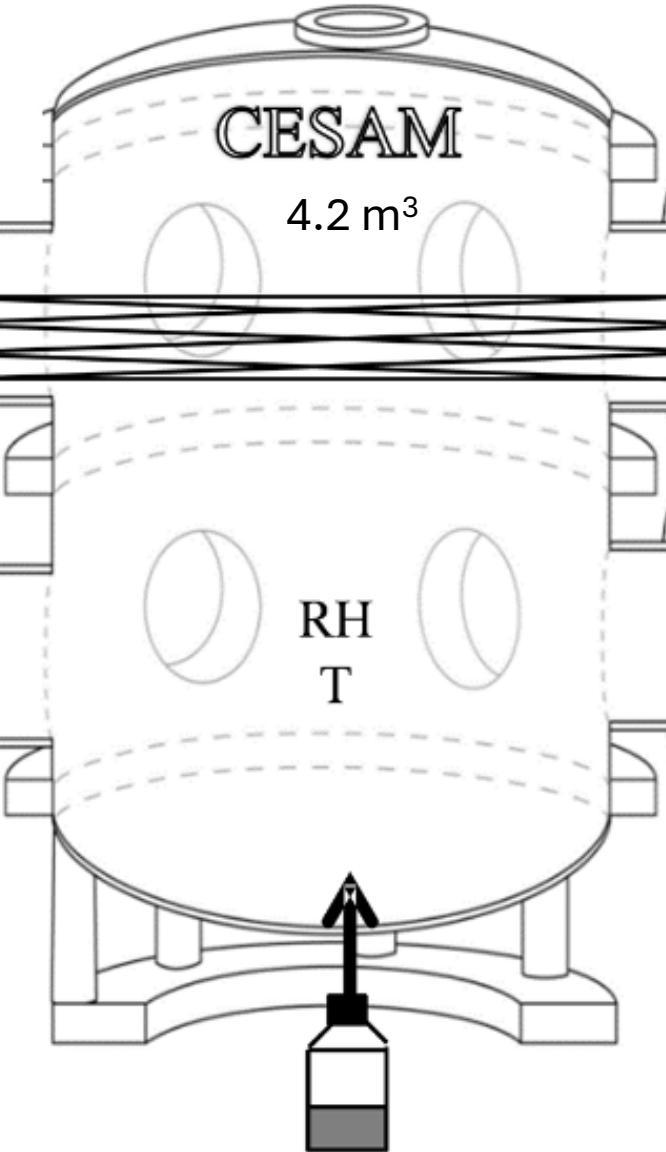
Gas-phase measurement

PTR-MS
Proton-Transfer-Reaction Mass Spectrometer

O₃/NO_x/NO₃ monitors

Br-CIMS
Br- Chemical Ionization-Orbitrap Mass Spectrometer

NO₃⁻-CIMS
NO₃⁻-Chemical Ionization-Time-of-Flight Mass Spectrometer



Particle-phase measurement

Experiment – CESAM chamber in Paris Creteil



Monoterpene + NO₃

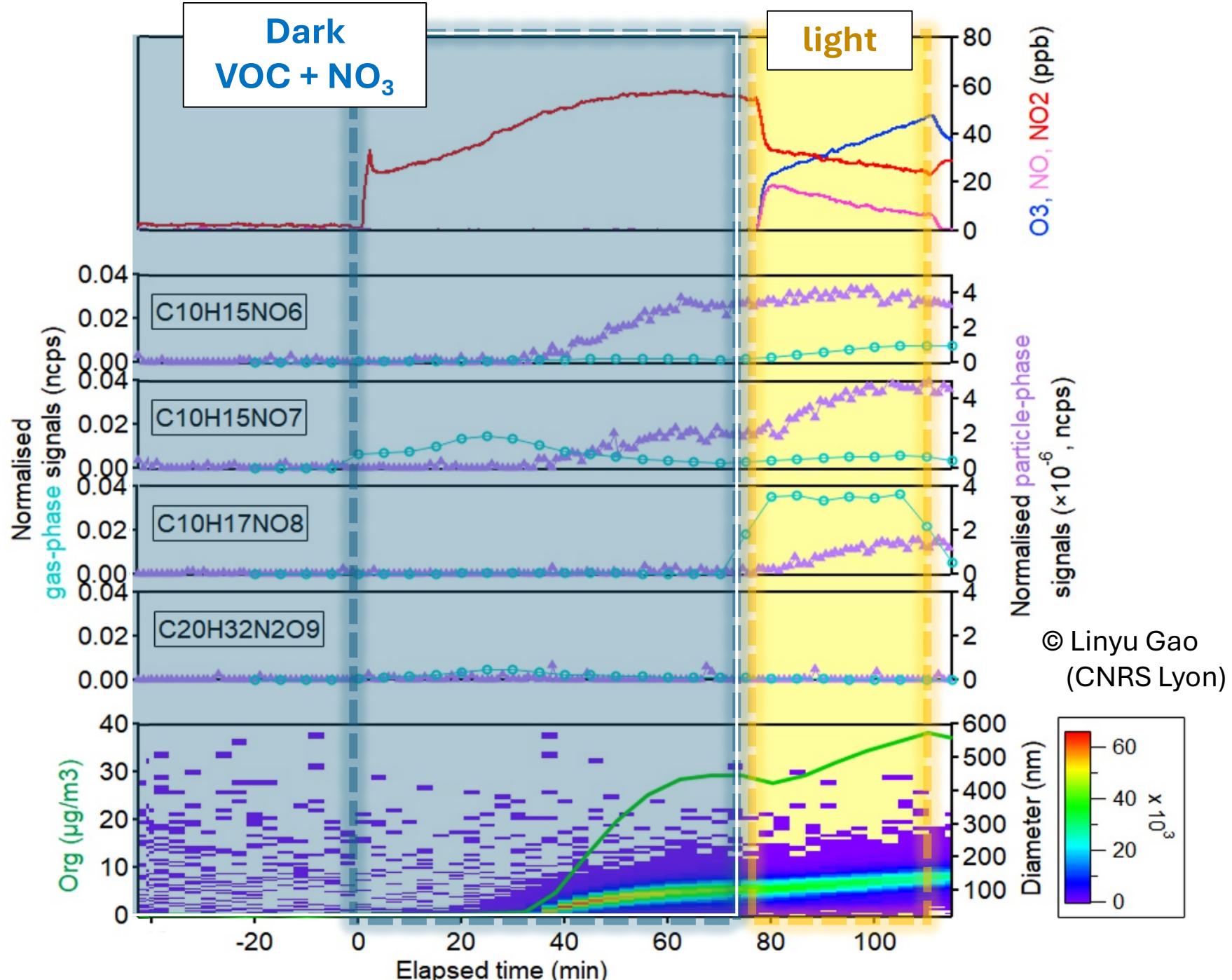
- NO₃ by (i) N₂O₅ decomposition or (ii) NO₂ + O₃
- ...and subsequent photo-oxidation
- Steady-state & Batch mode

Significant differences were observed

The Experiment

Steady-state analysis of Limonene + NO₃ (N₂O₅ injection)

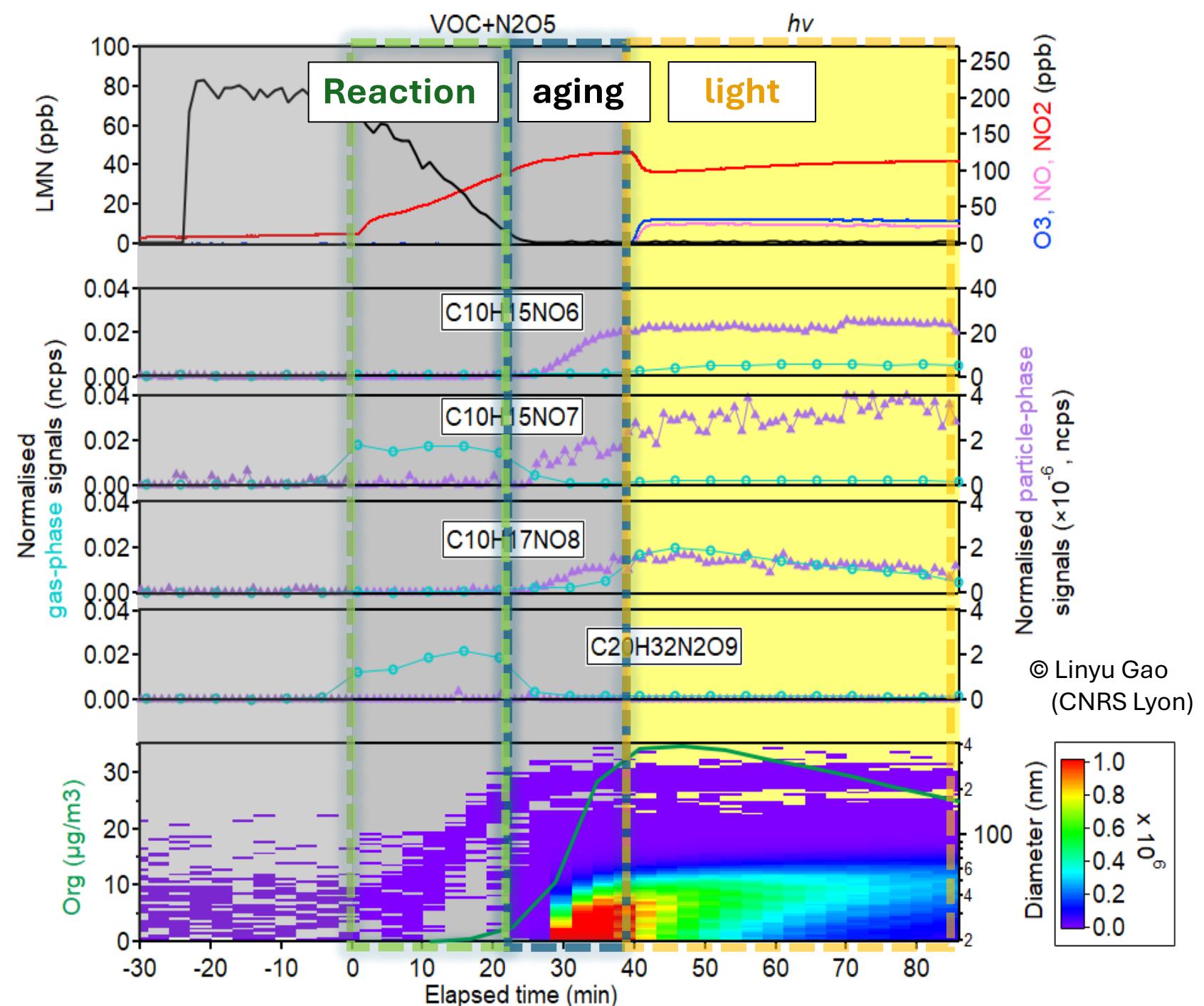
- In some experiments also by NO₂ + O₃
- Leads to mainly O₃ chemistry with NO₂ termination



Also:

Batch mode analysis of Limonene + NO₃ (N₂O₅ injection)

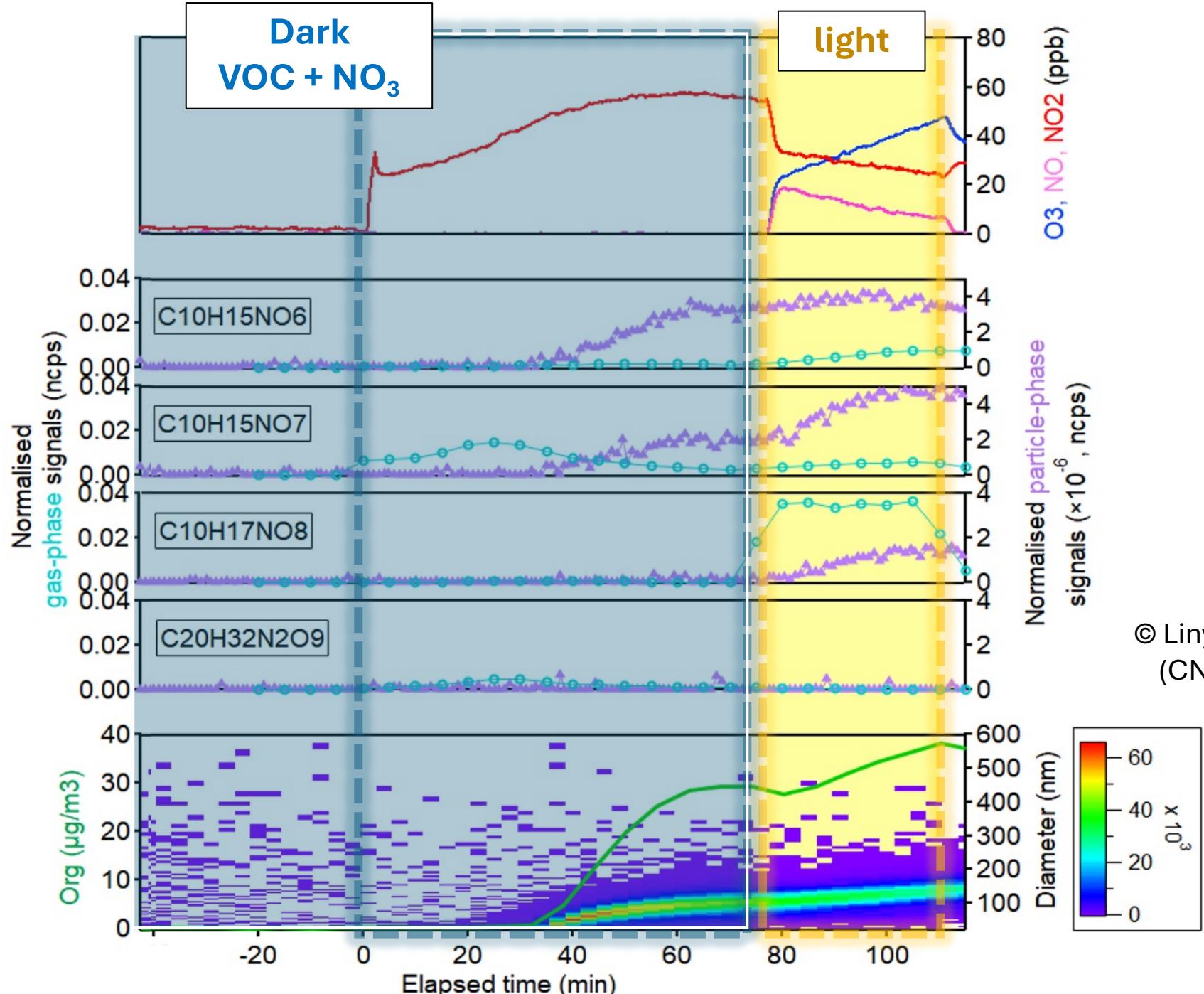
- Batch mode gives “Absolute SOA yield”
- ...but SOA is a *dynamic quantity*
- Comparisons coming up!



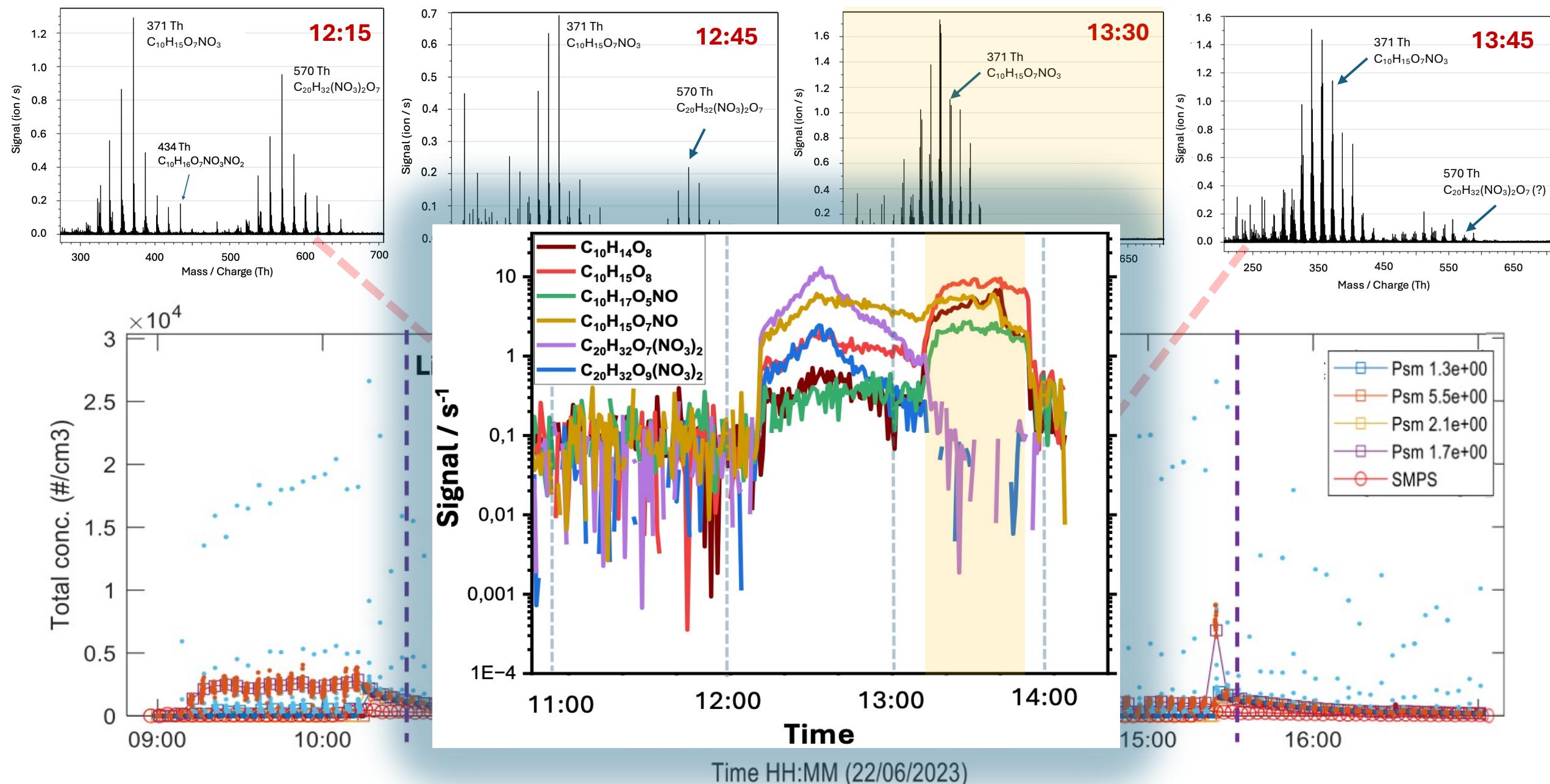
The Experiment

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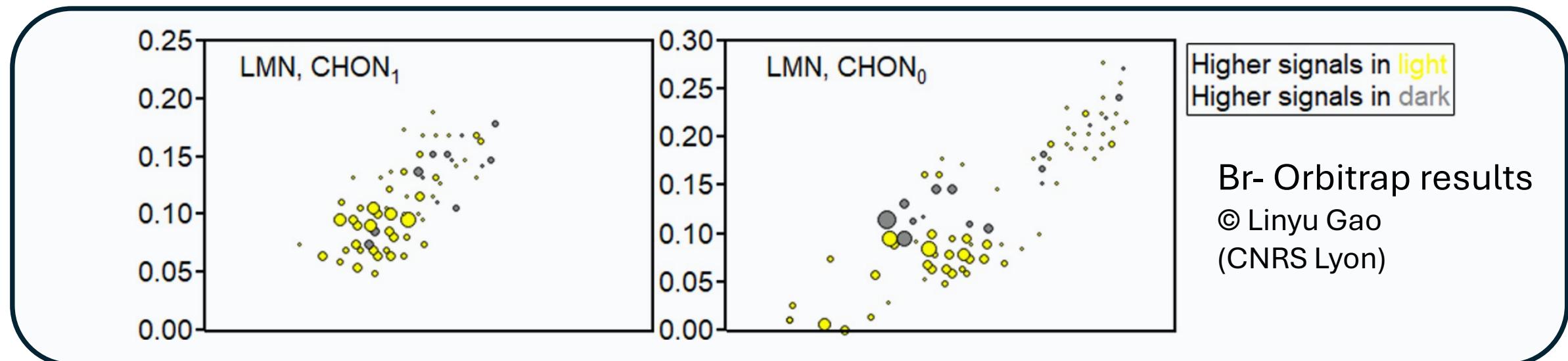
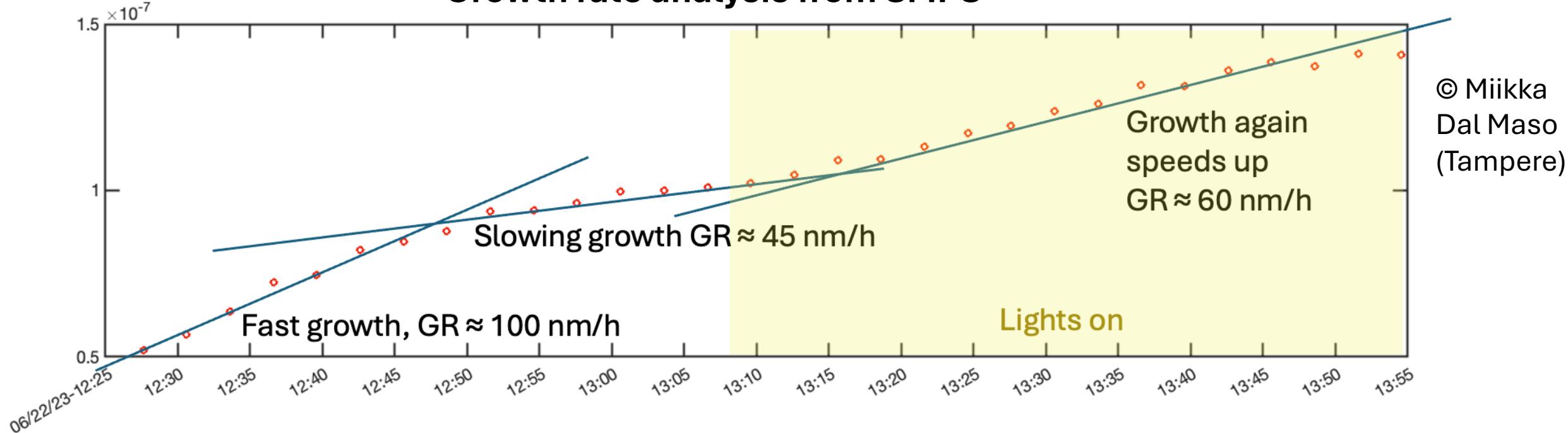
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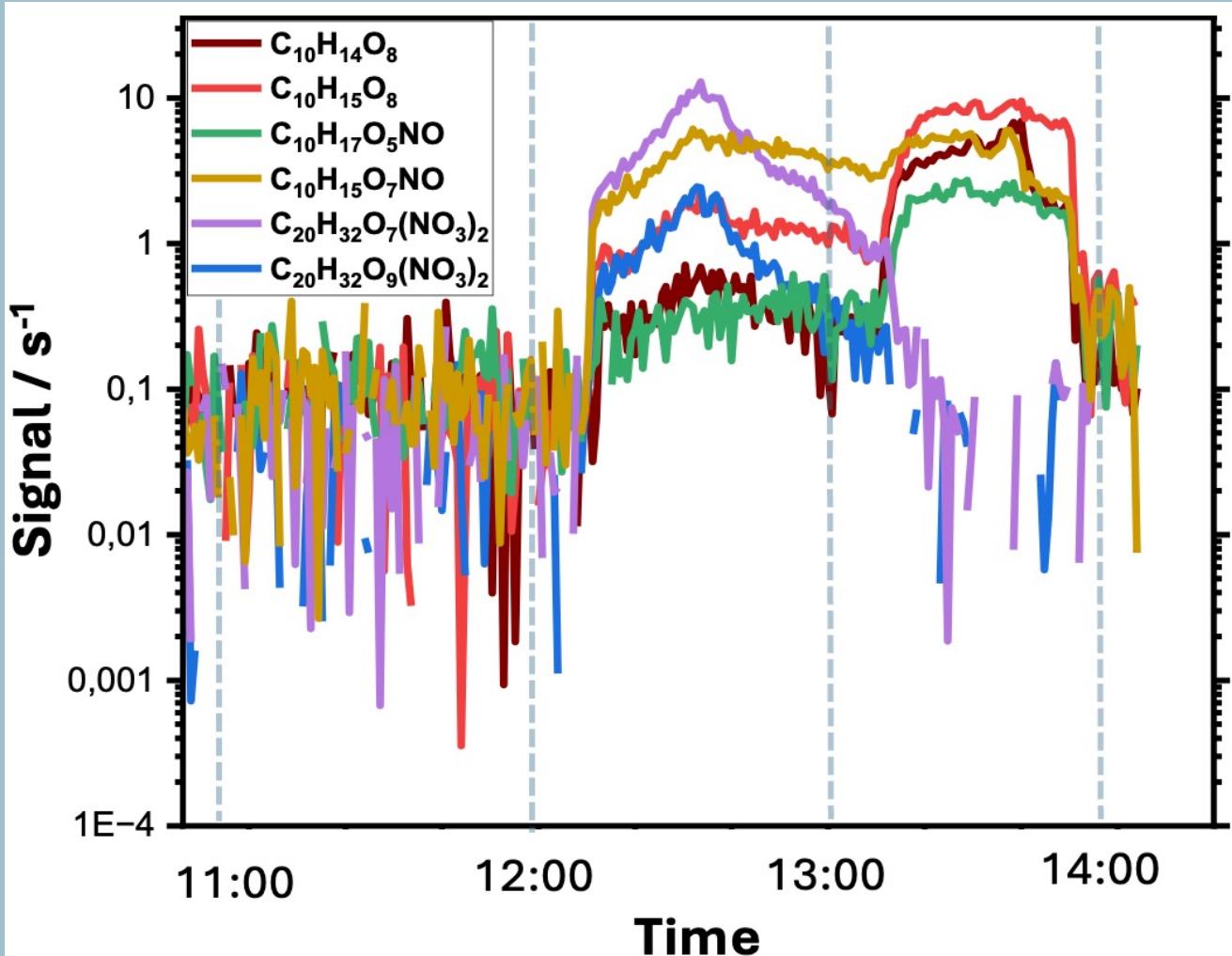
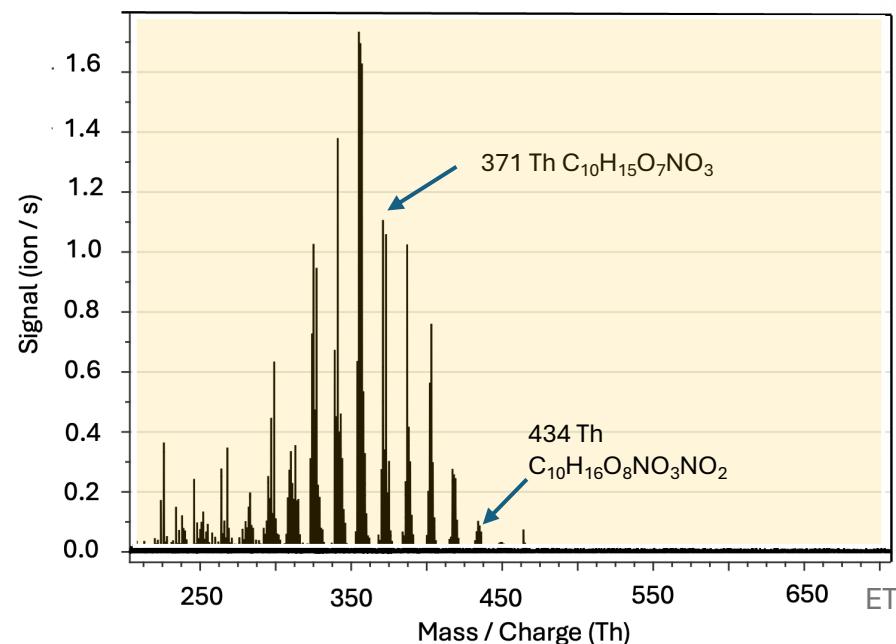
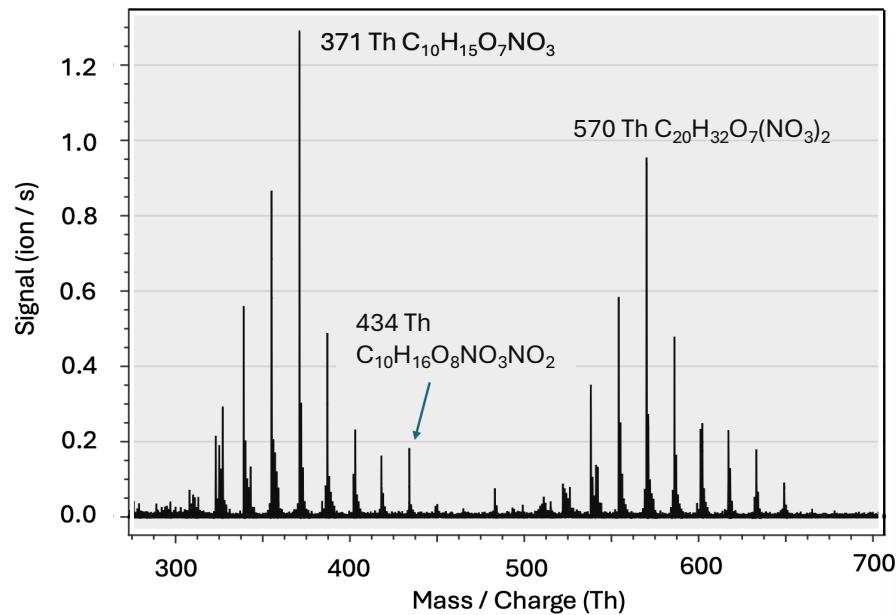
Steady state experiments (PSM + NO₃⁻ CIMS)



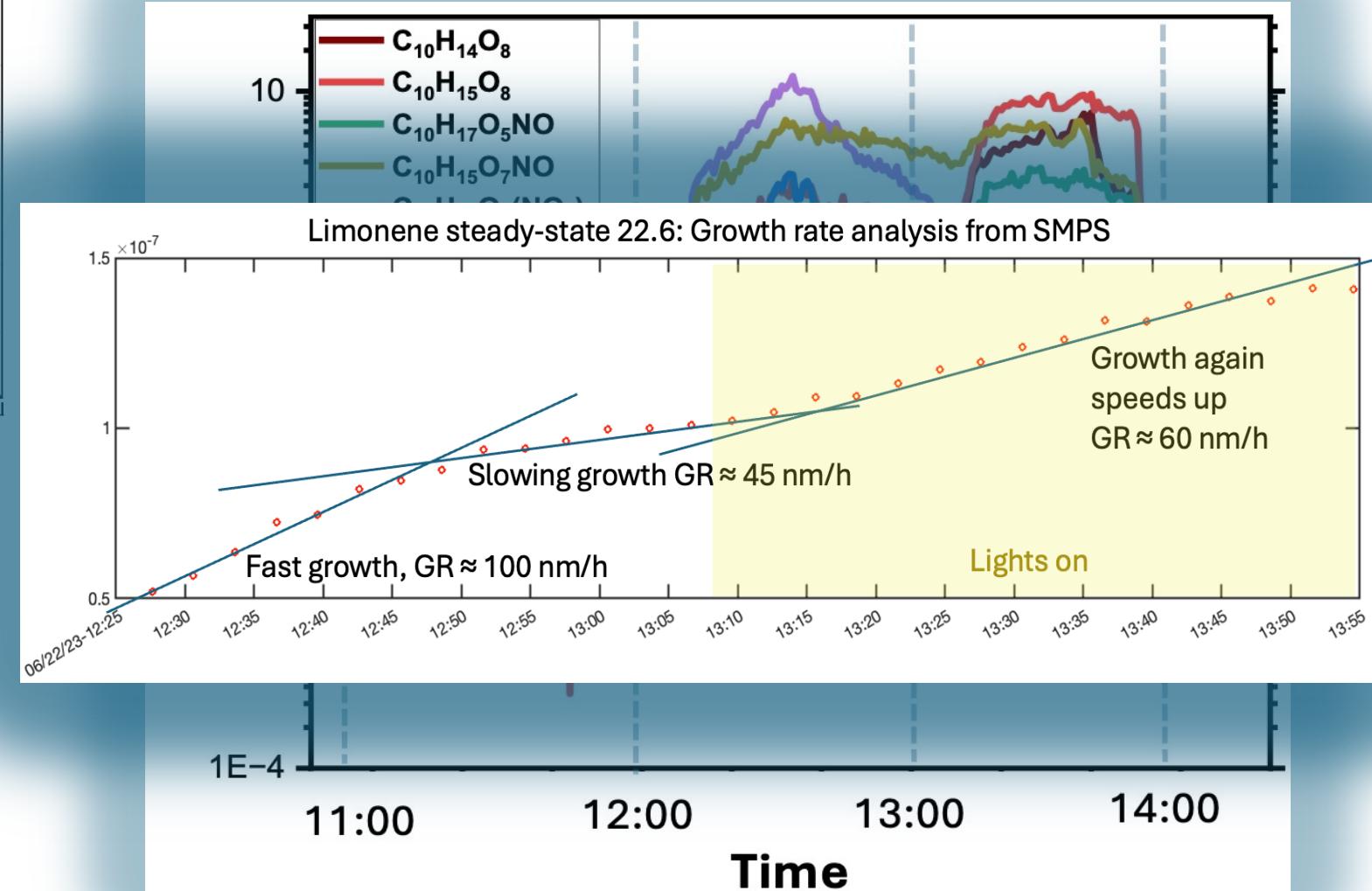
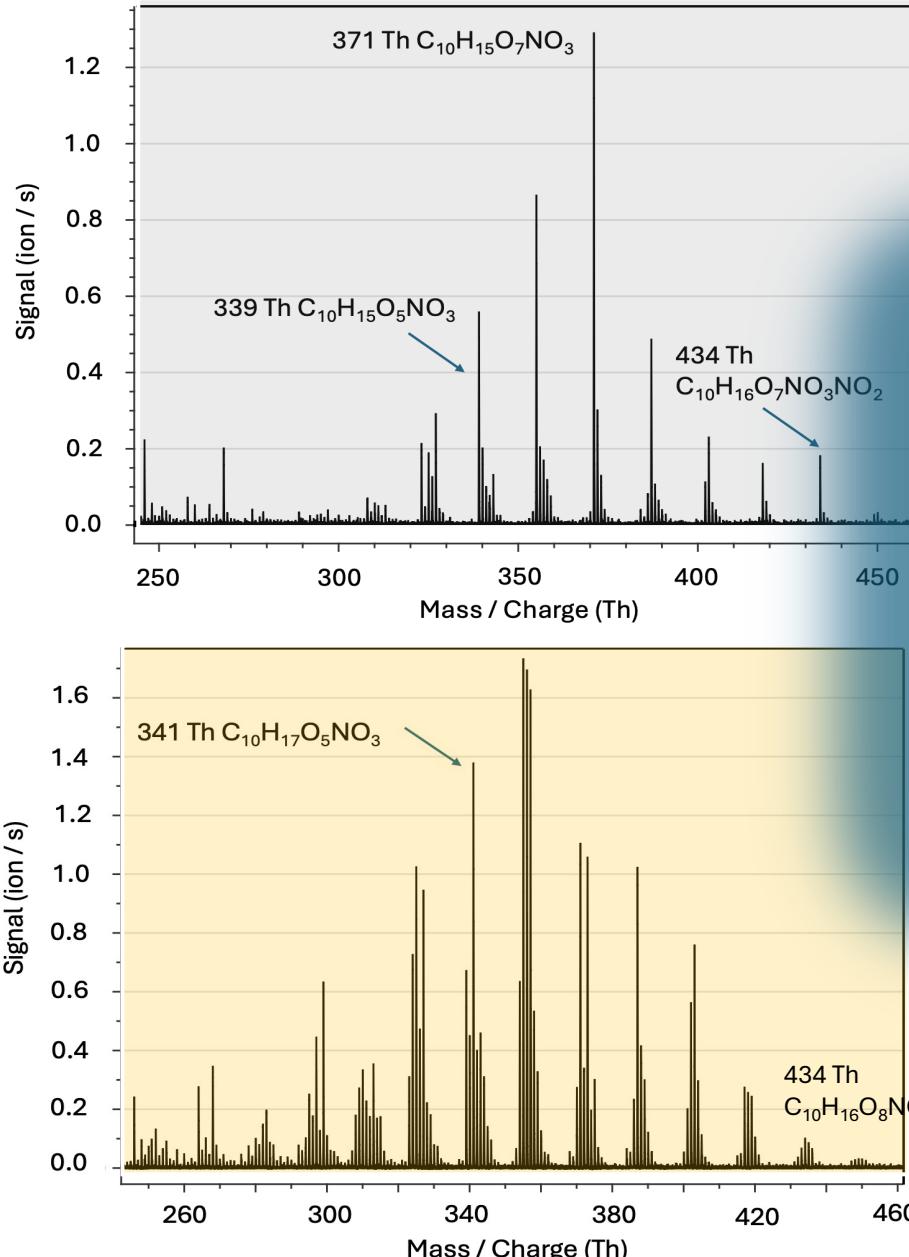
Growth rate analysis from SMPS

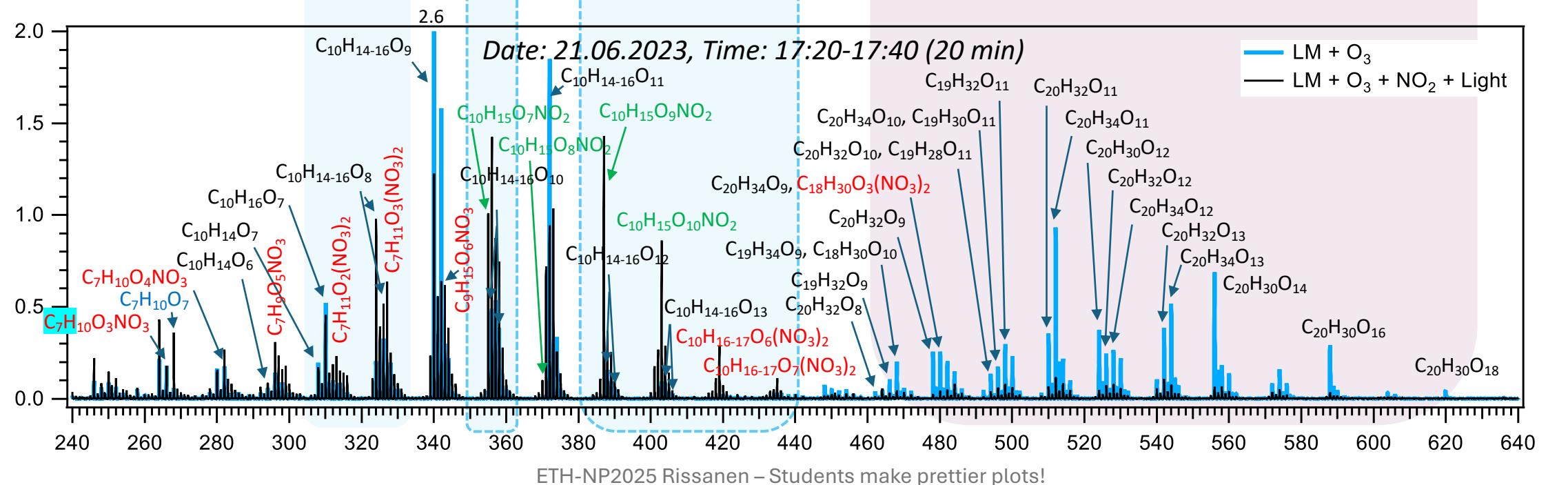
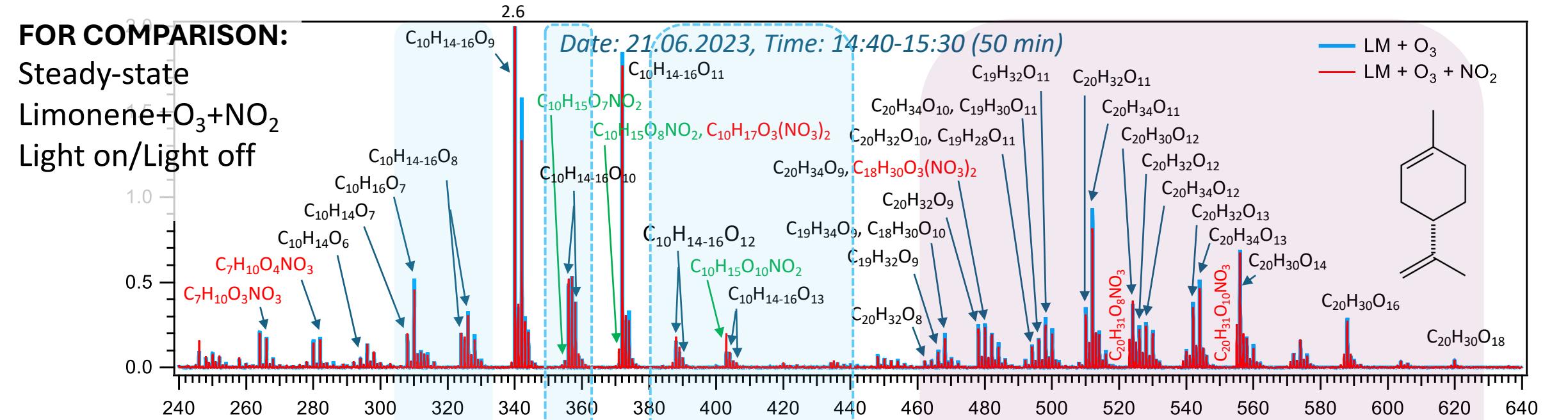


The influence of light – dimers disappear...



The influence of light – dimers disappear **but monomers make up the dent!**





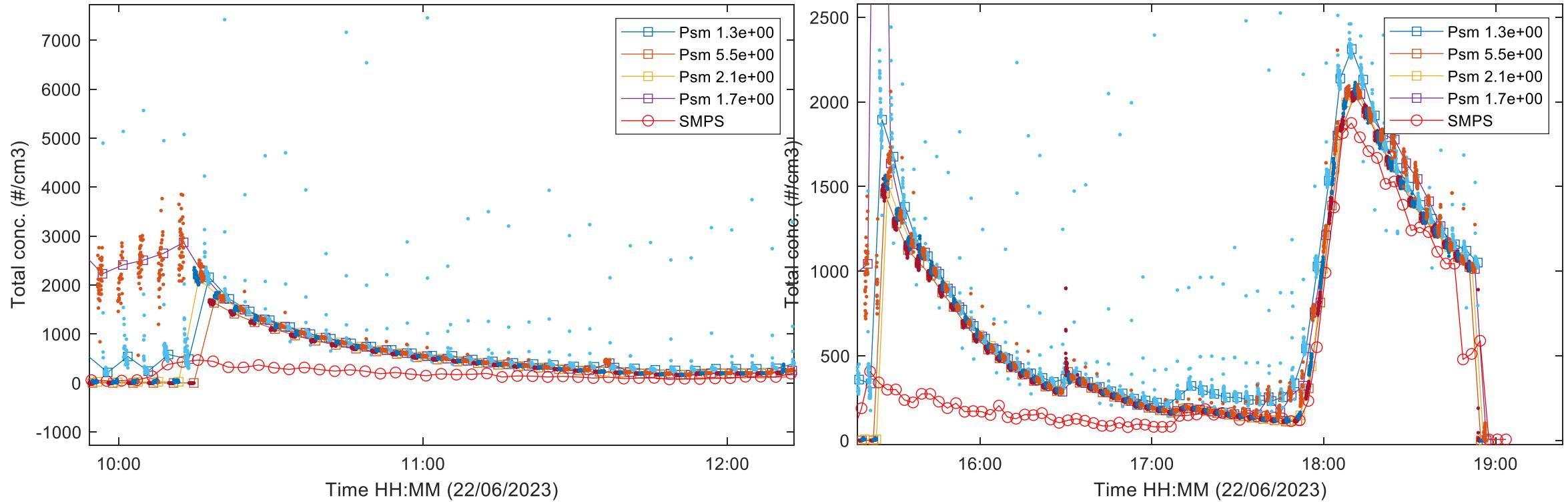
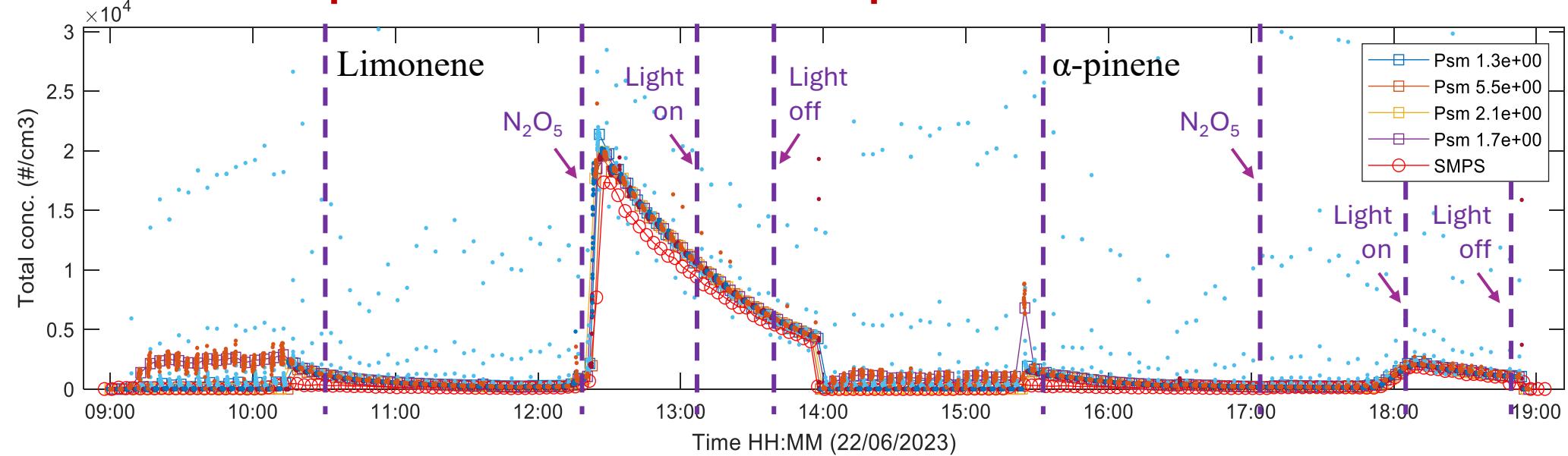
Conclusions

- Monoterpene NO_3 oxidation leads to SOA
- We did limonene in batch vs steady-state
 - Significant differences
 - E.g. HOM dimers higher in batch mode
 - SOA is a dynamic quantity → Steady state analysis is more realistic
- NO_3 from $\text{NO}_2 + \text{O}_3$ difficult
 - Results: Too much O_3 , too much NO_2
- N_2O_5 is a **much** cleaner source for NO_3
- Doubly-nitrated dimers disappeared during UV-illumination
- Growth even speeded up without dimers which is a tad bit odd in considering prior research

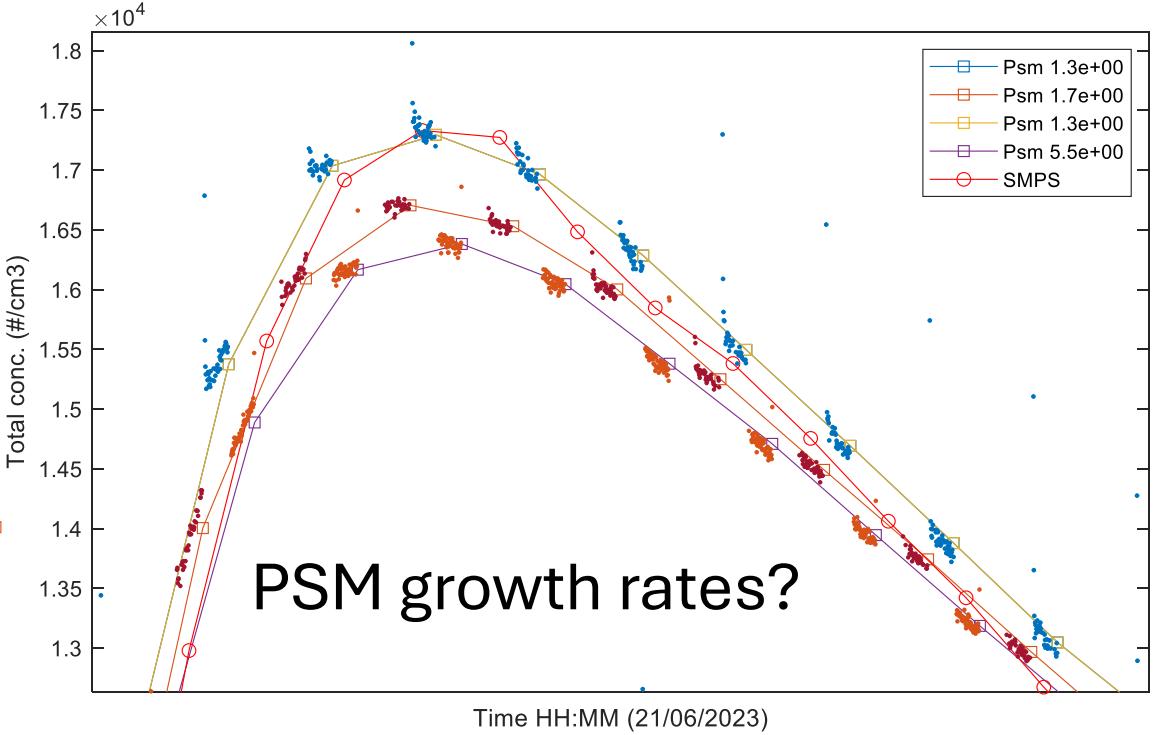
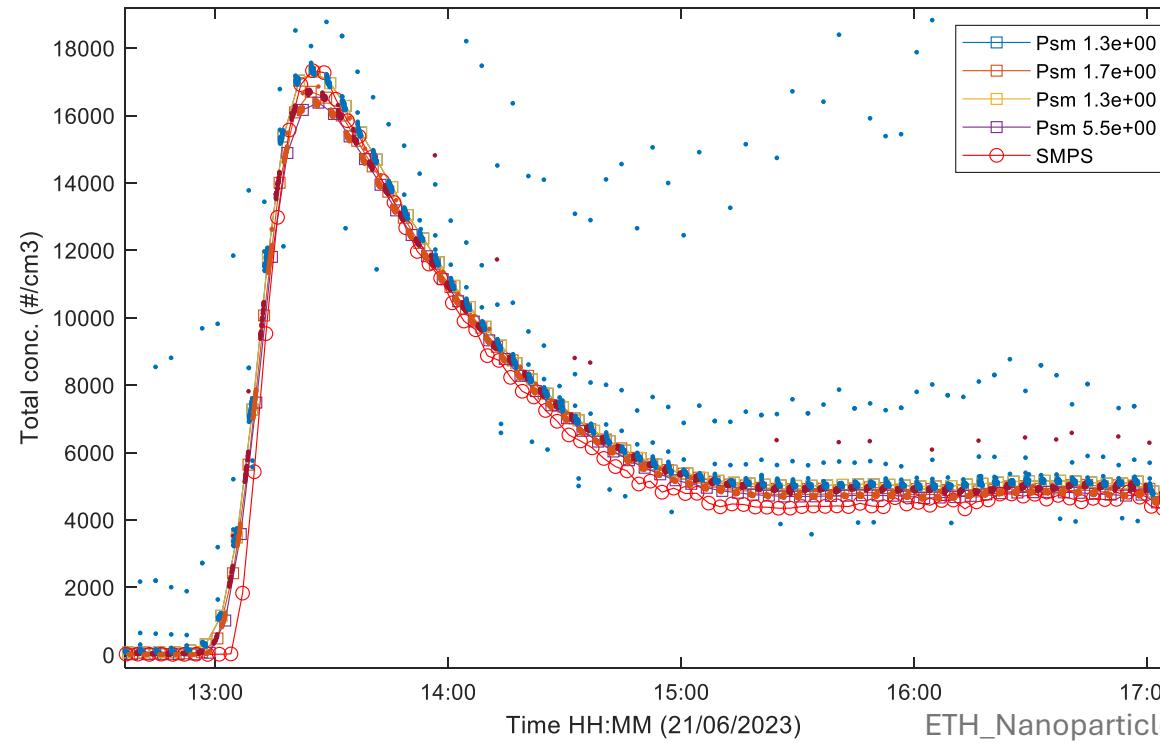
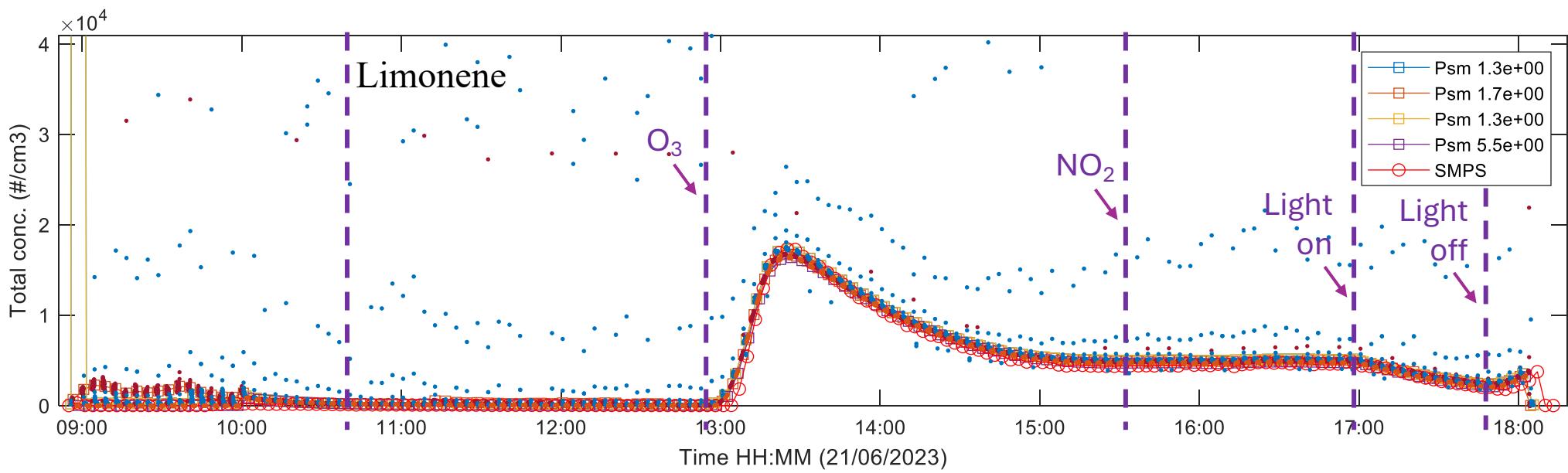
Extra slides

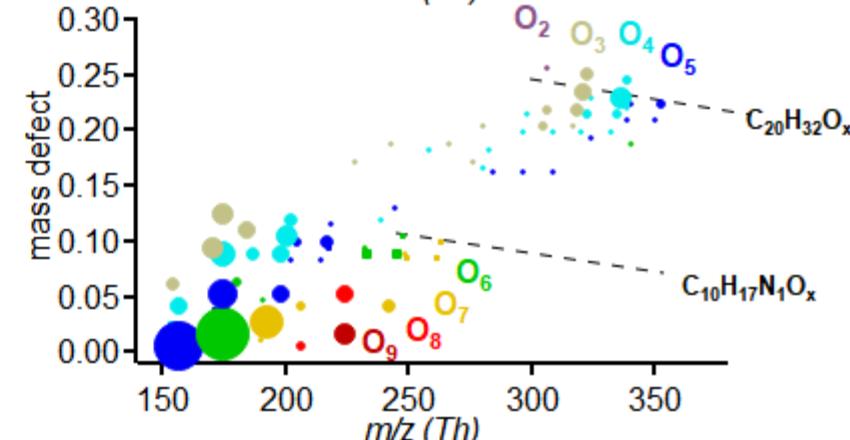
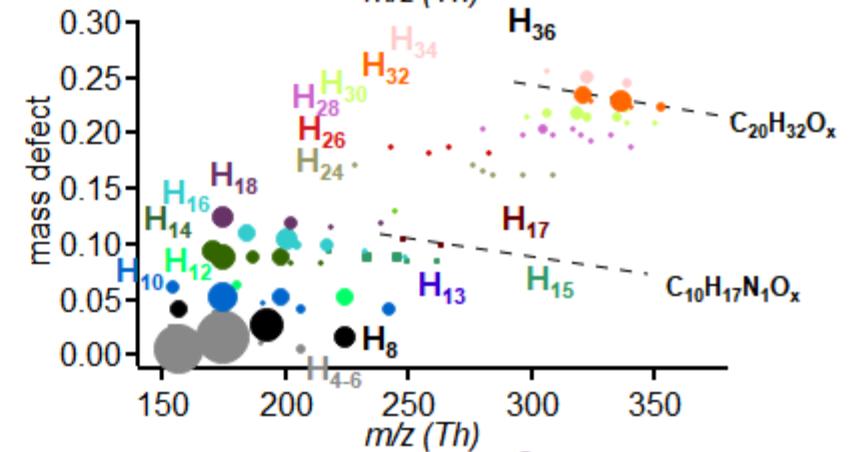
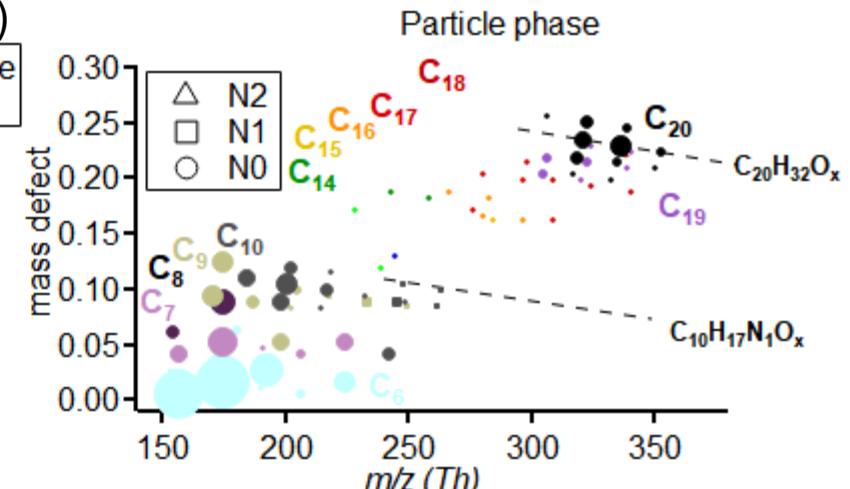
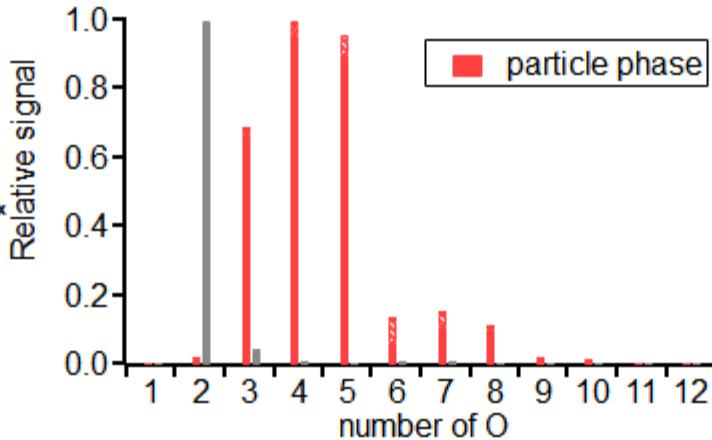
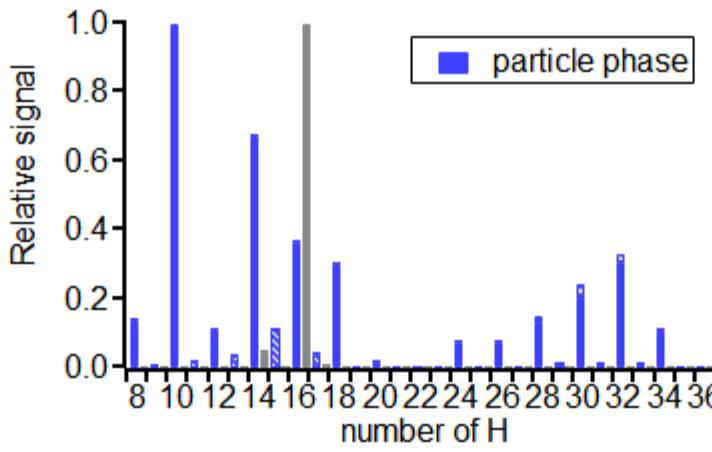
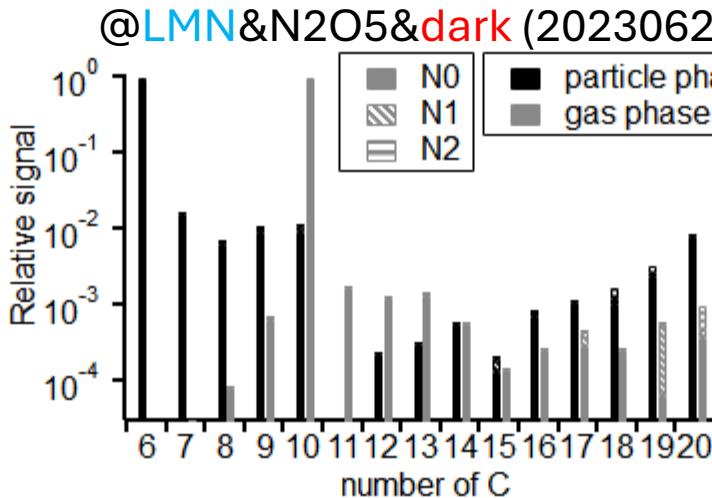
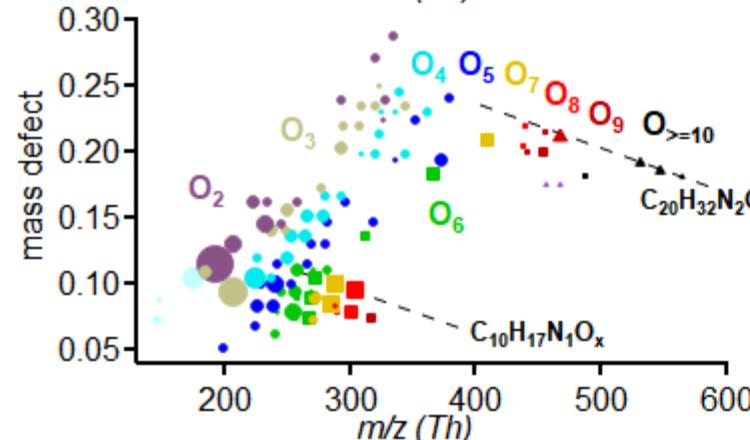
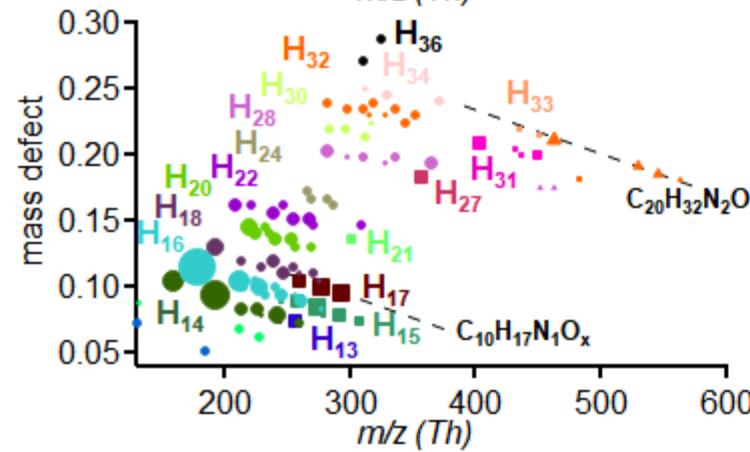
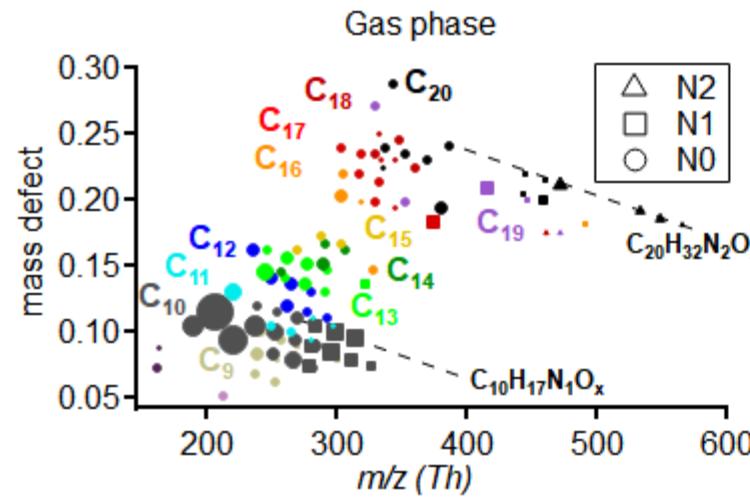
Comparison of limonene and α -pinene

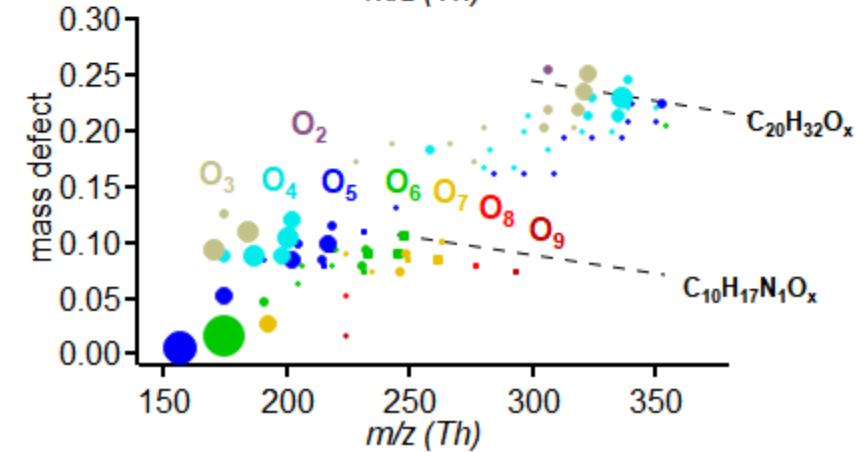
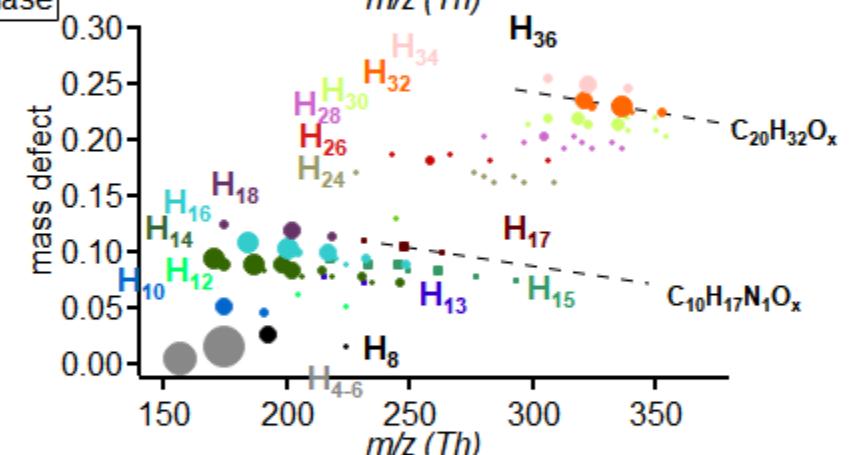
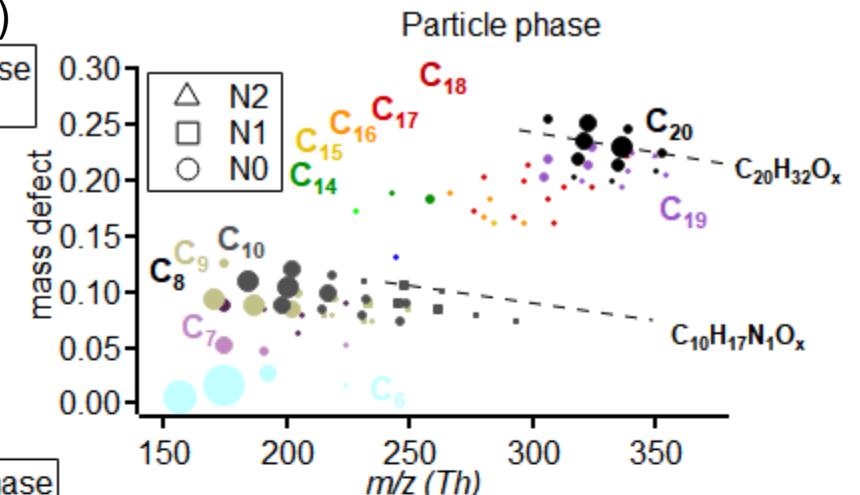
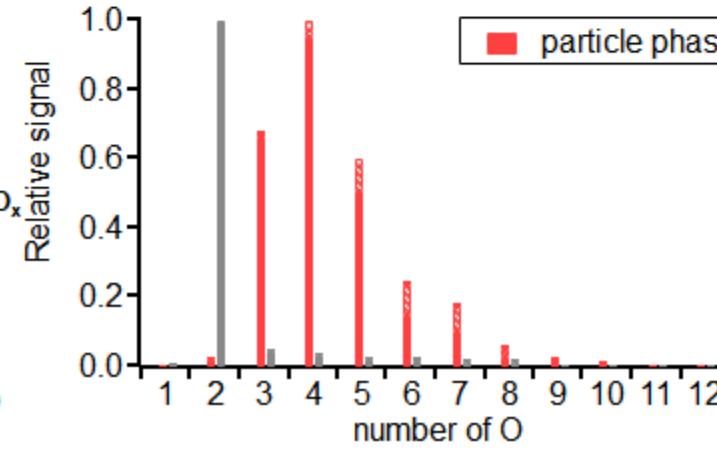
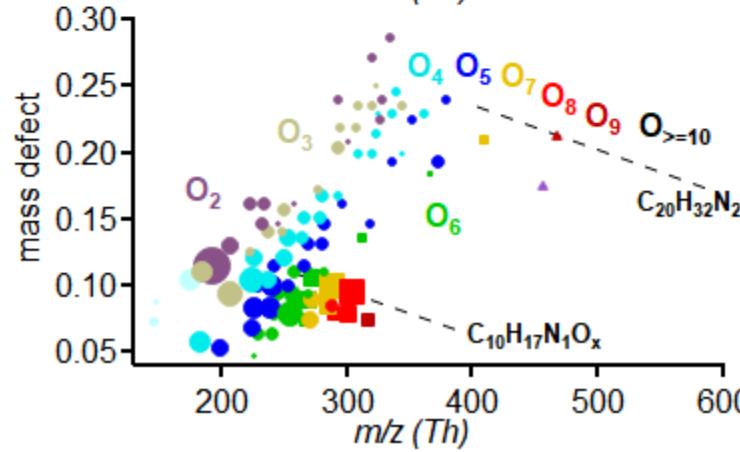
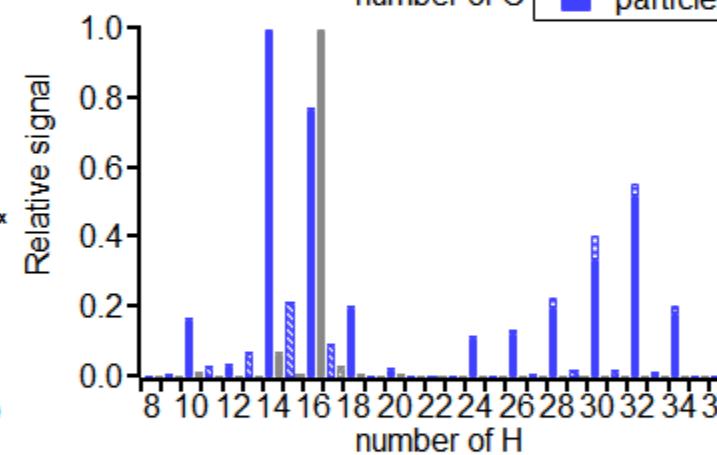
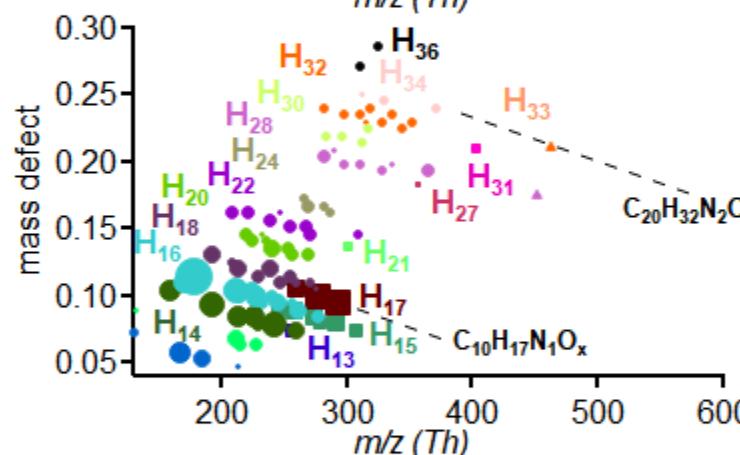
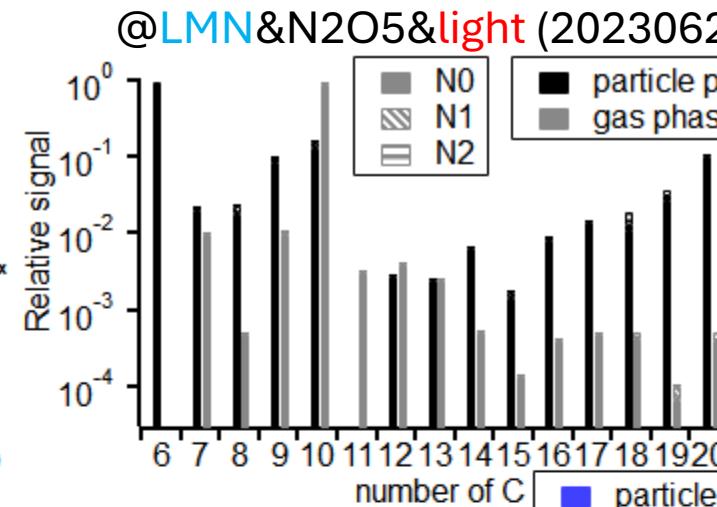
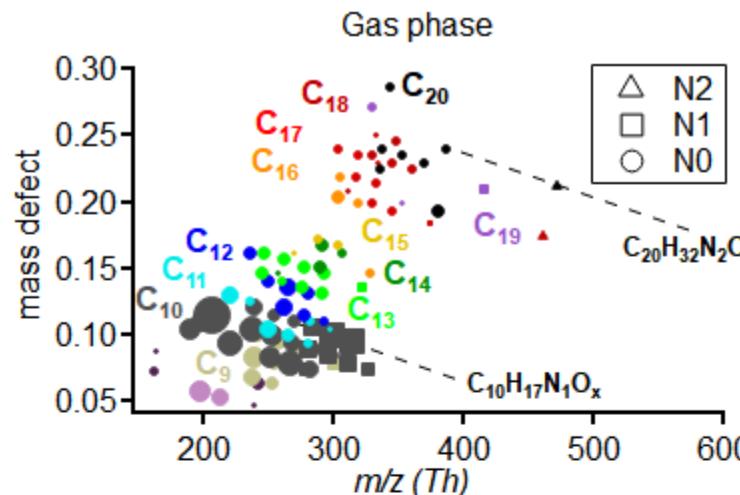
STEADY-STATE MODE EXPERIMENTS



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Where are HOMs needed?

Formation of atmospheric nanoparticles

