



**Pacific
Northwest**
NATIONAL LABORATORY

Potential vertical BBOA and Organics INP concentrations from SGP and Amazon regions

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U.S. DEPARTMENT OF
ENERGY **BATTELLE**

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Integrated Cloud,
Land-Surface, &
Aerosol System Study
ICLASS

Objective:

Estimate potential vertical INP concentration using lab, aircraft observational, and model data.

Methodology:

Lab studies at cirrus conditions are used to obtain the Activated Fraction (AF) of organics.

Example 1: The AFs are combined with the aircraft measured ambient BBOA from SGP

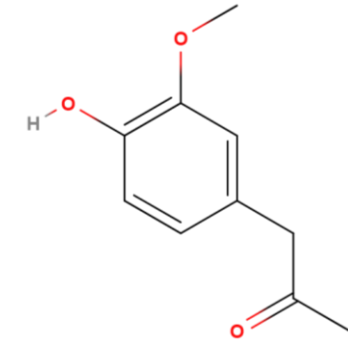
Example 2: The AFs are combined with the modeled terpene from Amazon.

Implications:

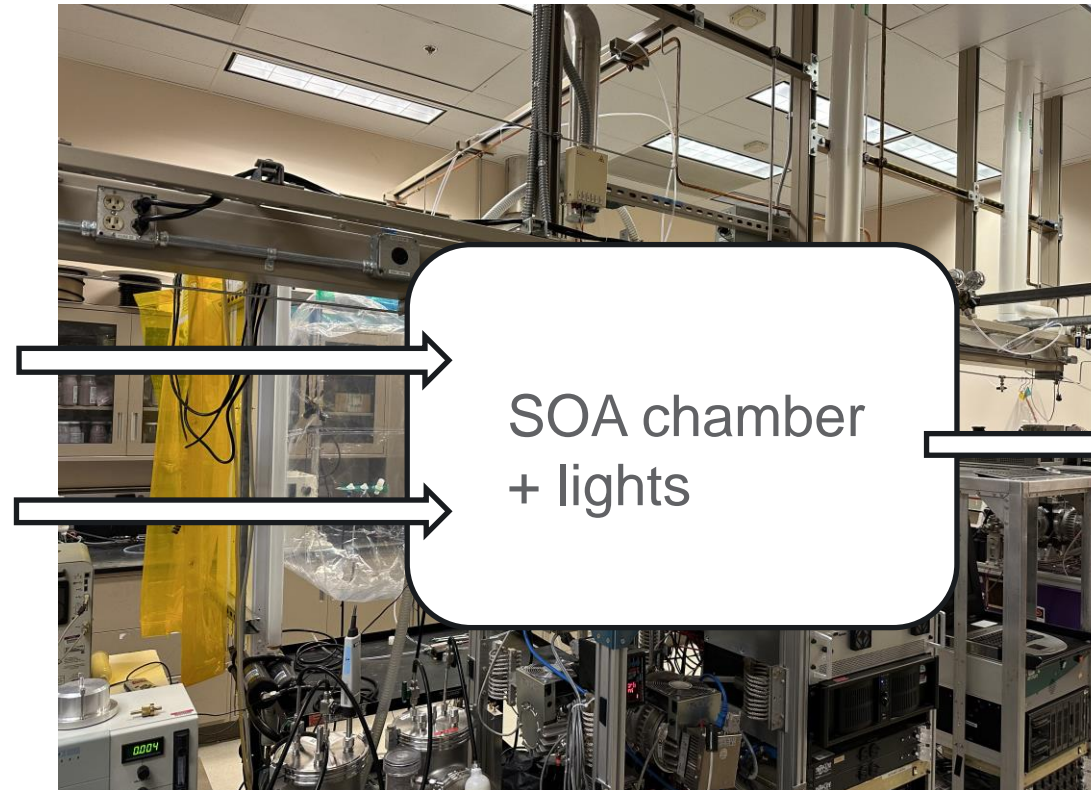
Study provides “Depositional INP Budget” at cirrus conditions at regions dominated by BBOA and biogenic organic aerosols.

Example 1

Biomass Burning surrogate: Guaiacyl Acetone

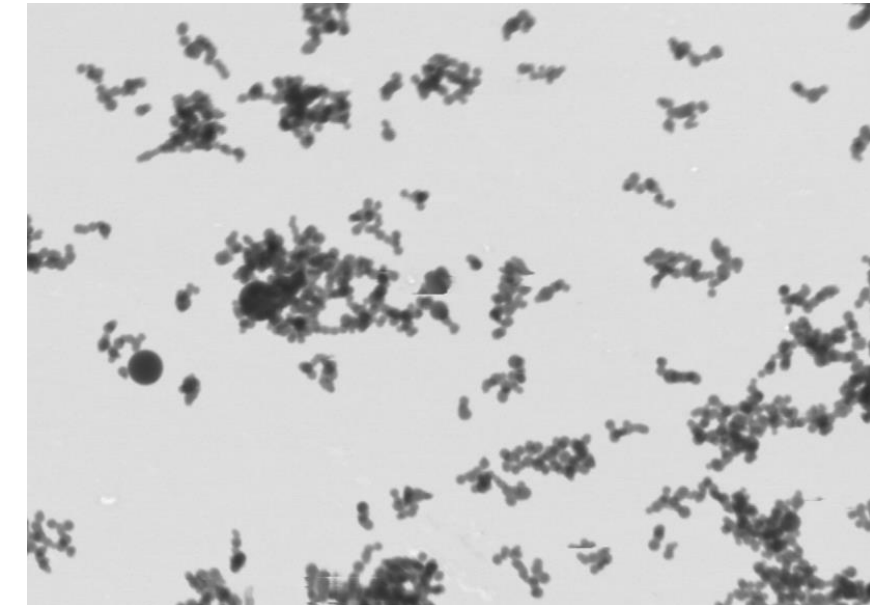


Atomize
(GA+dH₂O)
solution +
H₂O₂



SOA chamber
+ lights

GA
SOA



Images from Zezhen Cheng

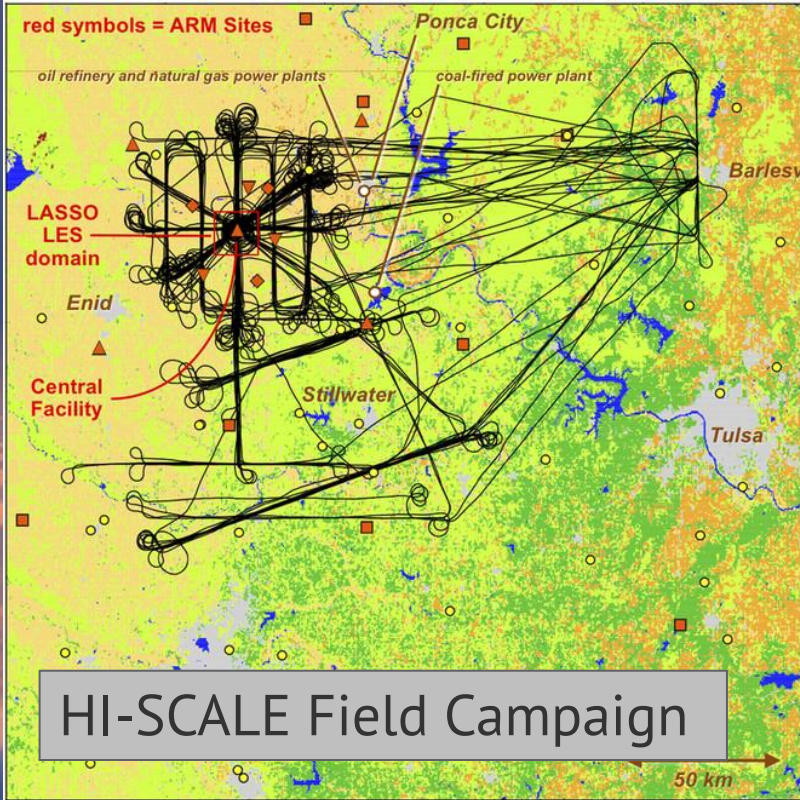
EMSL SOA Chamber

GA
precursor

Gas-Phase Oxidation
hv, NO_x, O₃

SOA
Chamber

SMPS; Filters;
miniSPLAT;
**Inline CFDC style PNNL Ice
Nucleation chamber**

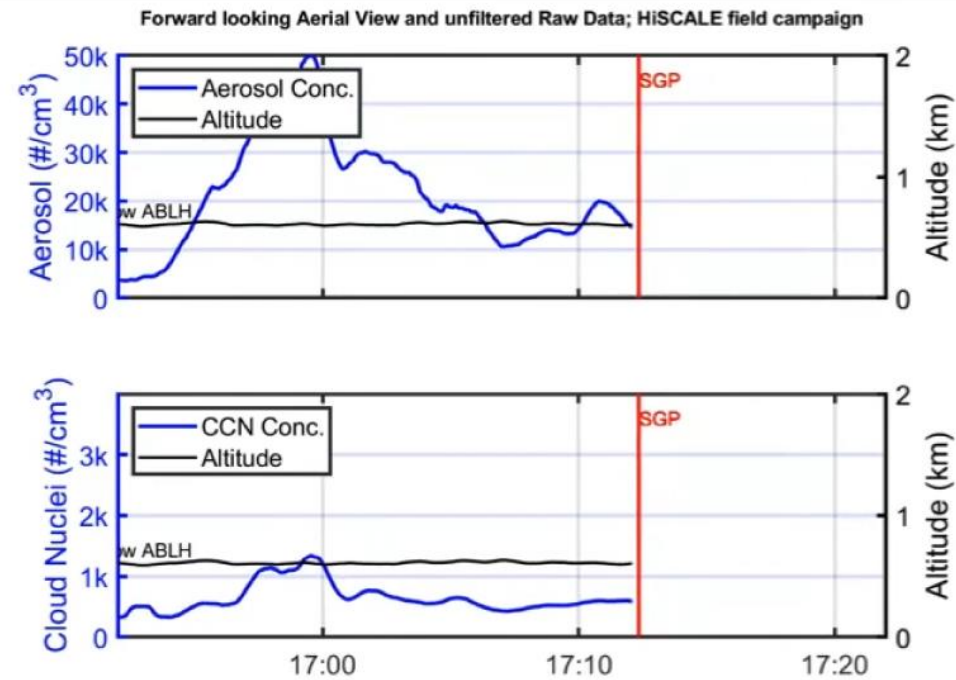


Fast et al. 2019

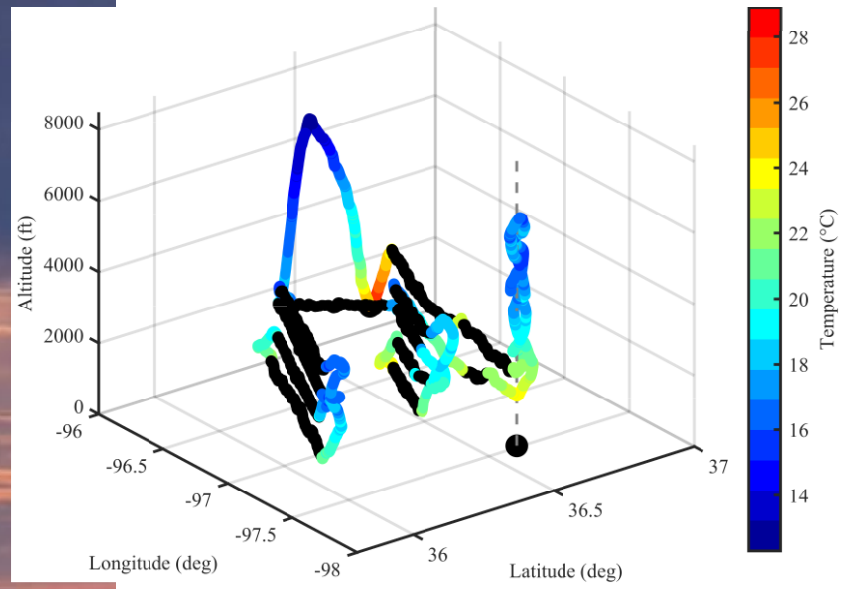


SCALE 2016-08-17 17:12:03

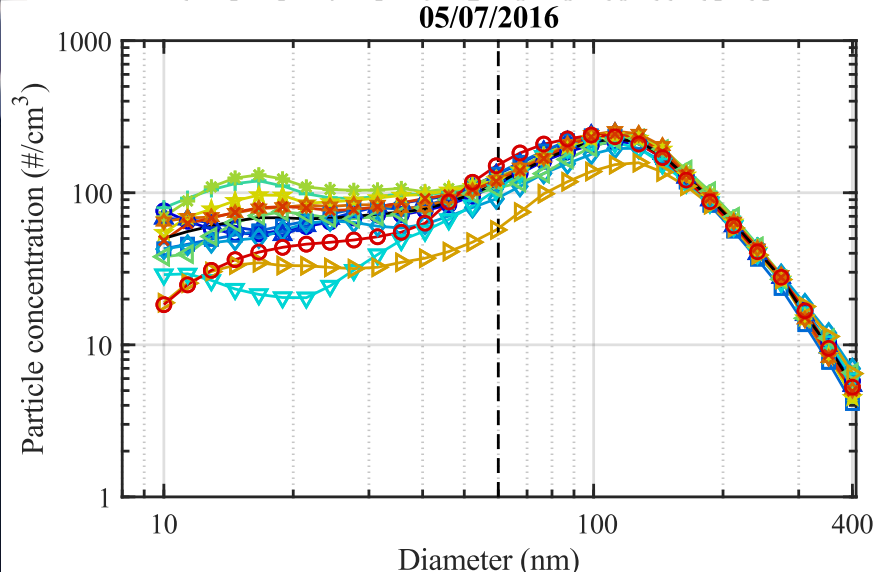
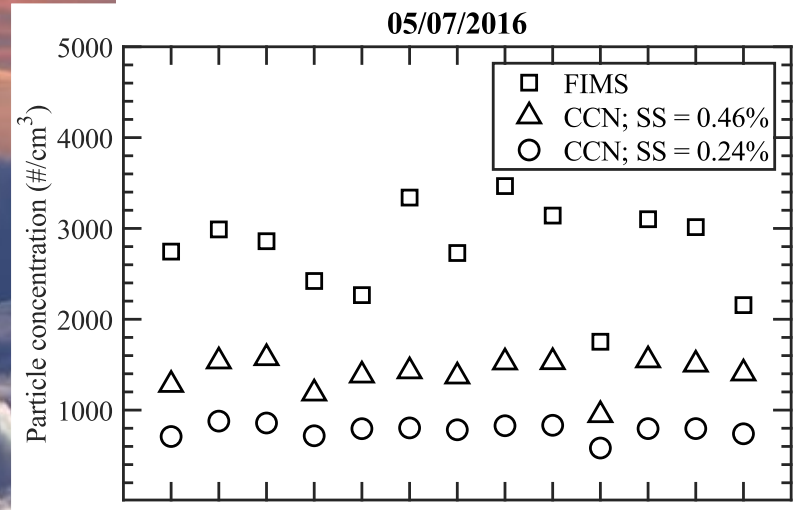
We have time series of airborne Aerosol and CCN data + air met data + **single particle composition** data



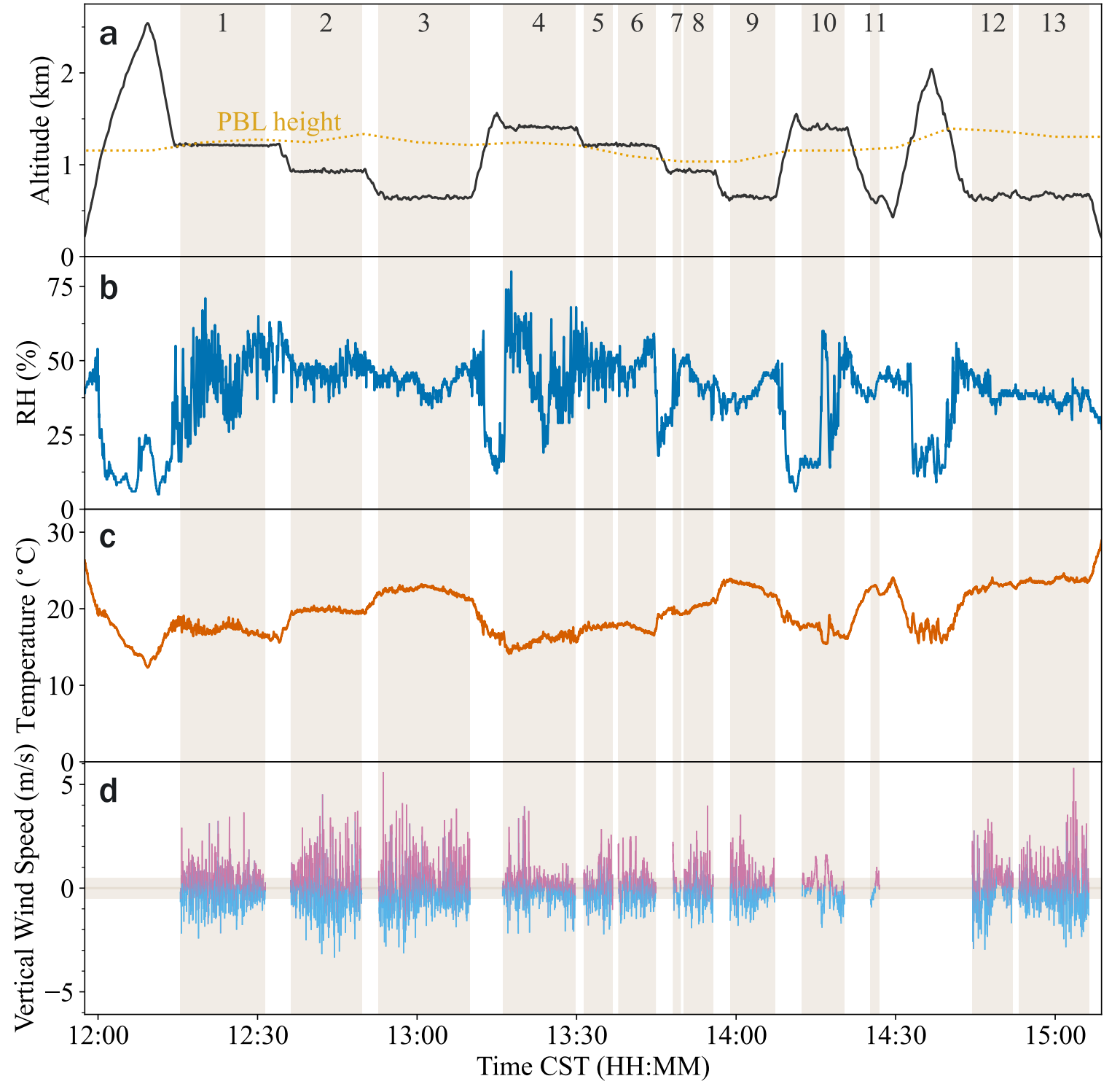
Forward looking aircraft movie; Supplementary, Kulkarni et al. 2023



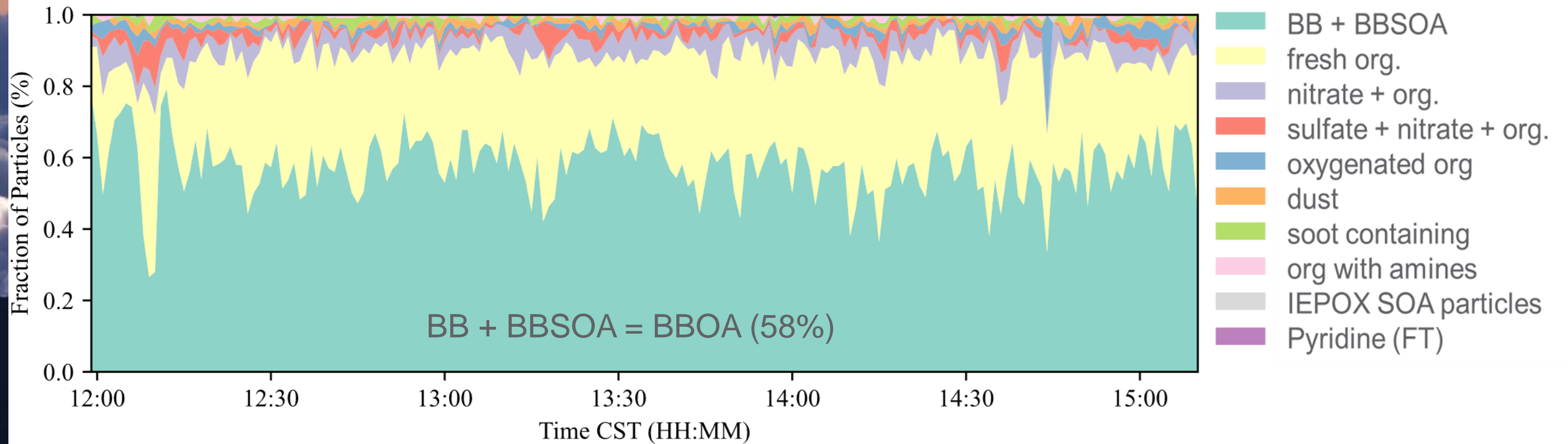
Aerosol properties and met conditions.



- 17:15:28-17:31:28 ; 1162 (m) ; 1
- △ 17:36:13-17:49:36 ; 887 (m) ; 2
- 17:52:46-18:09:57 ; 619 (m) ; 3
- ◇ 18:16:04-18:29:45 ; 1347 (m) ; 4
- ▽ 18:31:21-18:36:46 ; 1164 (m) ; 5
- ⊕ 18:37:49-18:44:55 ; 1165 (m) ; 6
- △ 18:48:05-18:49:37 ; 908 (m) ; 7
- * 18:50:10-18:55:40 ; 896 (m) ; 8
- ☆ 18:58:52-19:07:16 ; 627 (m) ; 9
- ▽ 19:12:23-19:20:23 ; 1348 (m) ; 10
- ☆ 19:25:16-19:26:58 ; 605 (m) ; 11
- * 19:44:25-19:52:05 ; 640 (m) ; 12
- 19:53:09-20:06:19 ; 643 (m) ; 13
- Avg

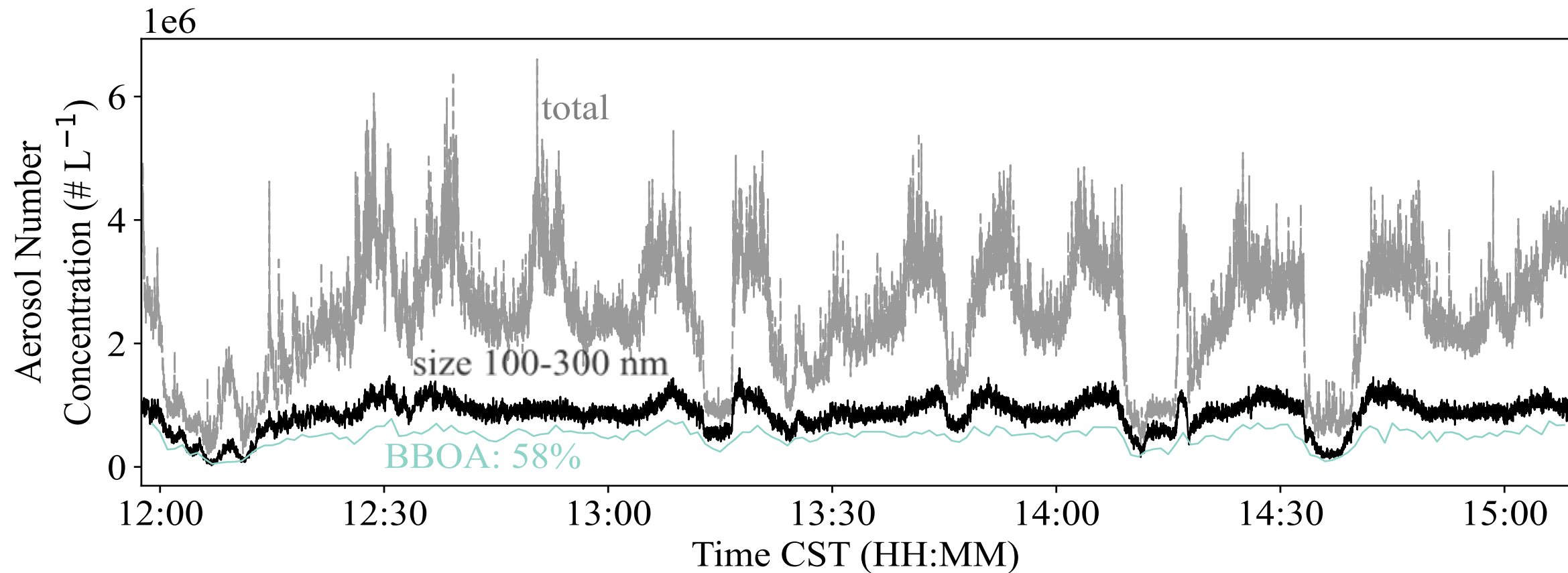


Single particle aerosol composition from miniSPLAT instrument



Data from Alla Zelenyuk

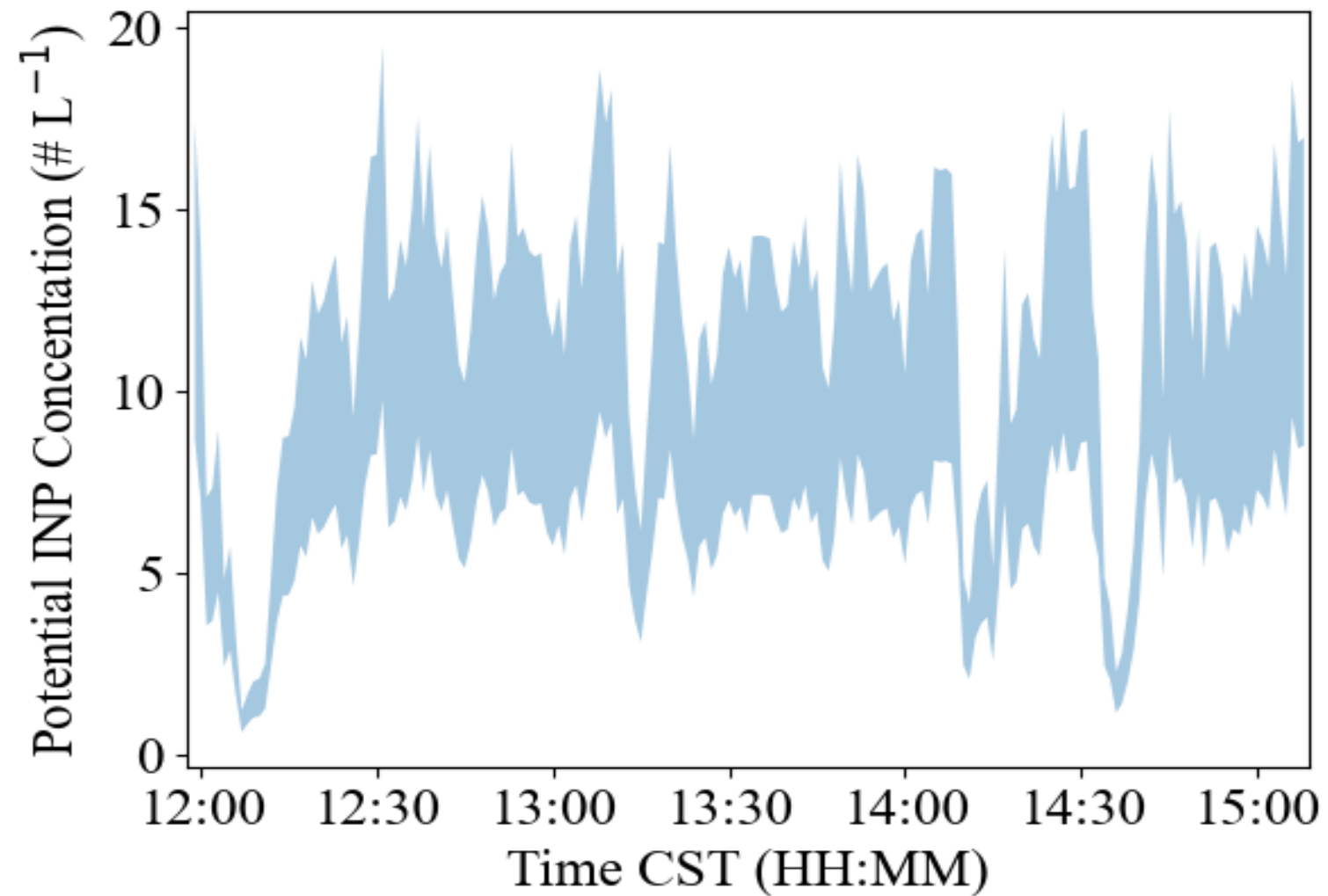
Aerosol size and number concentration from Fast Integrated Mobility Spectrometer (FIMS) instrument



Kulkarni et al. 2023

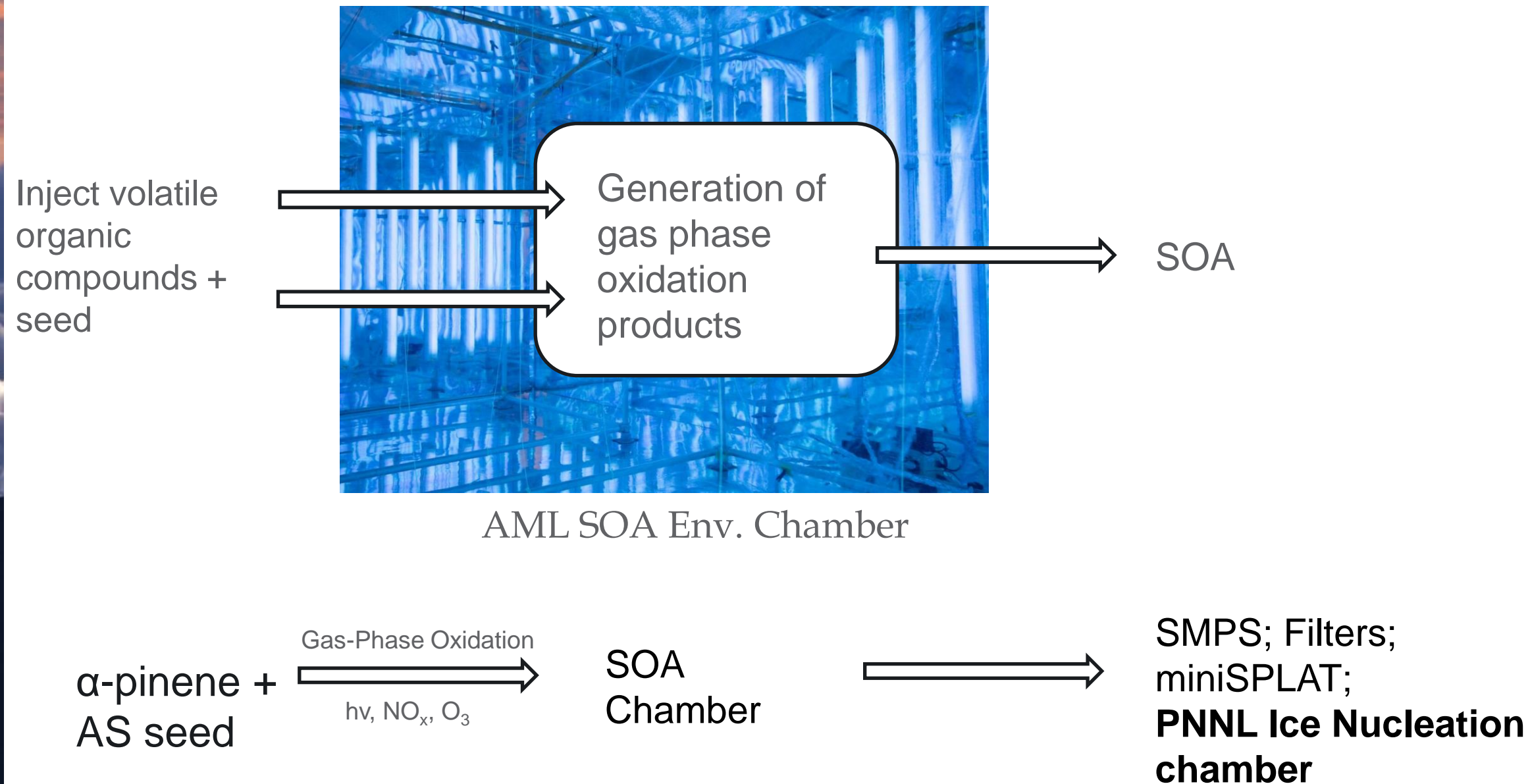
Potential INP concentration from BBOA

$$\text{Potential INP} = \text{Activated Fraction} \times \text{Fraction}_{\text{BBOA}} \times \text{Total Aerosol}_{100-300}$$



Example 2

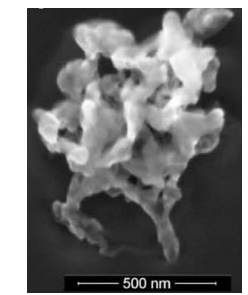
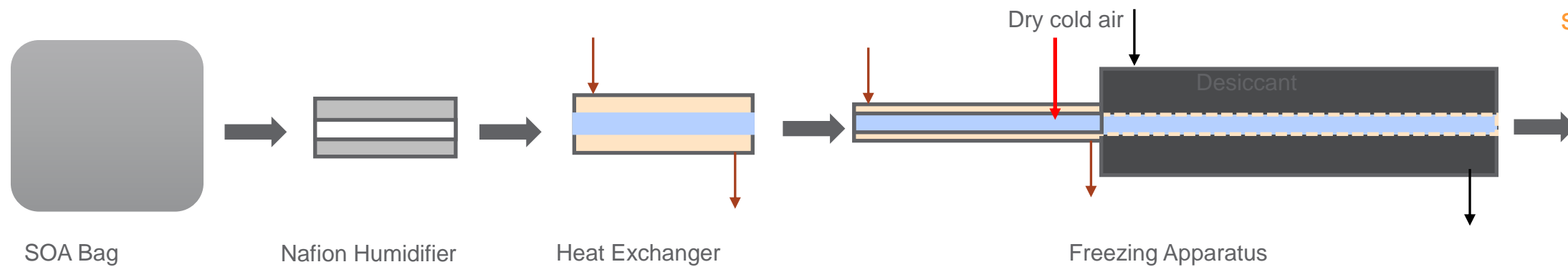
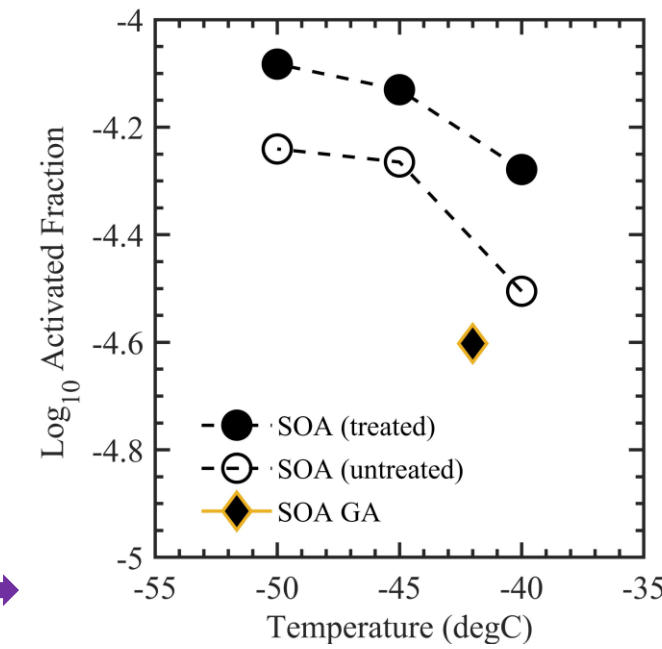
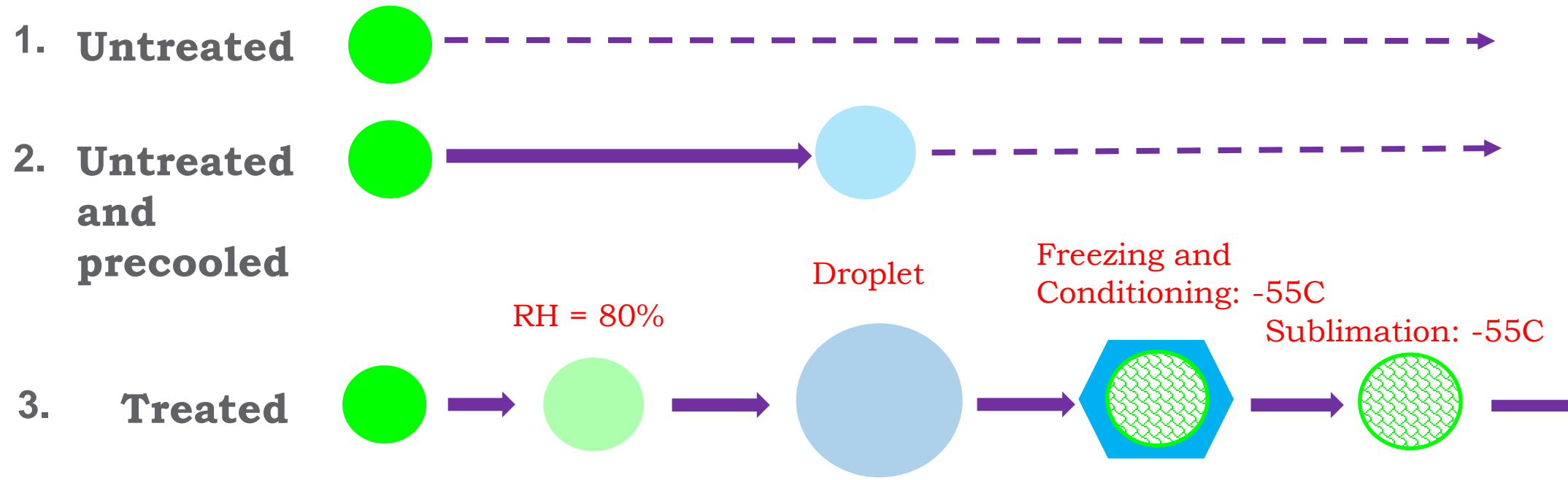
Biogenic SOA surrogate: α -pinene (an abundant monoterpene – a biogenic VOC)



Experimental Methodology

● SOA: α -pinene 300-500 nm

- ### Real-time Ice Nucleation Chamber
- Cirrus temperatures (-40, -45, -50 C)
 - $RH_w < 95\%$



Wagner et al. 2017

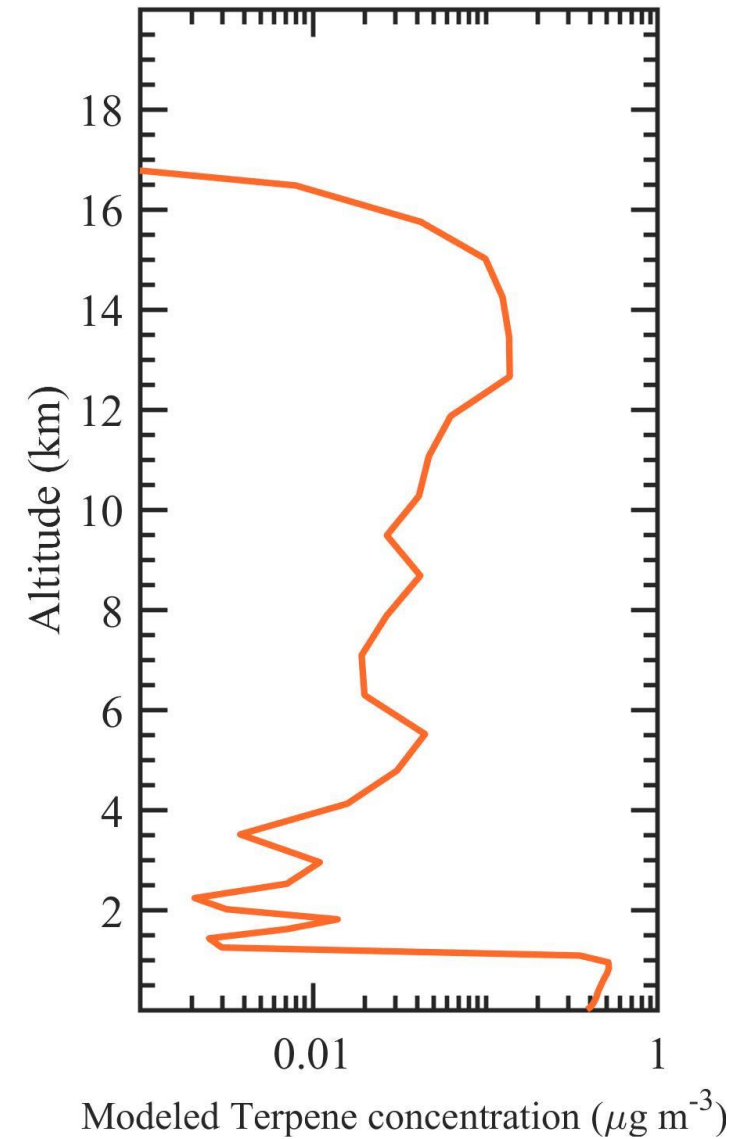




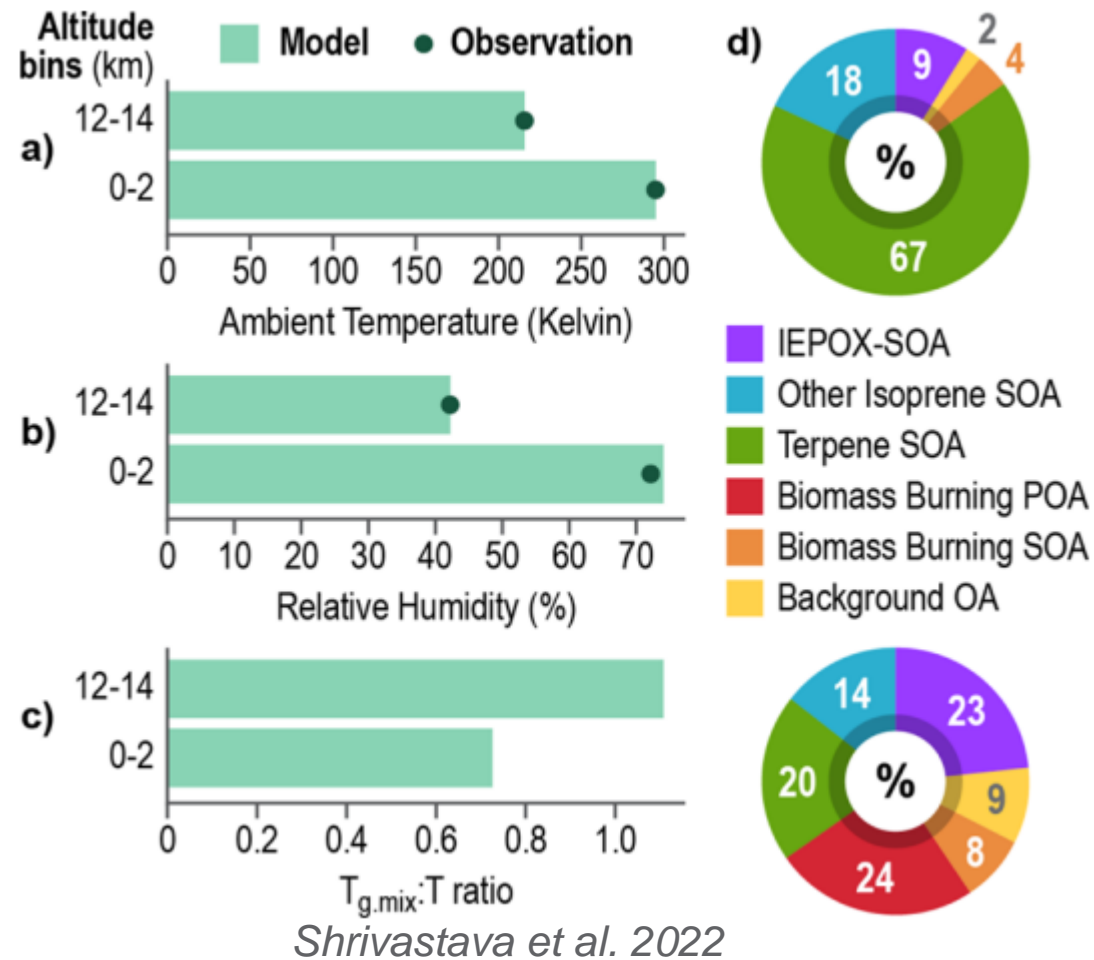
GoAmazon Field campaign research site (Martin et al. 2016)

WRF-Chem Modeled vertical data of terpene SOA

SOA size 300-500 nm

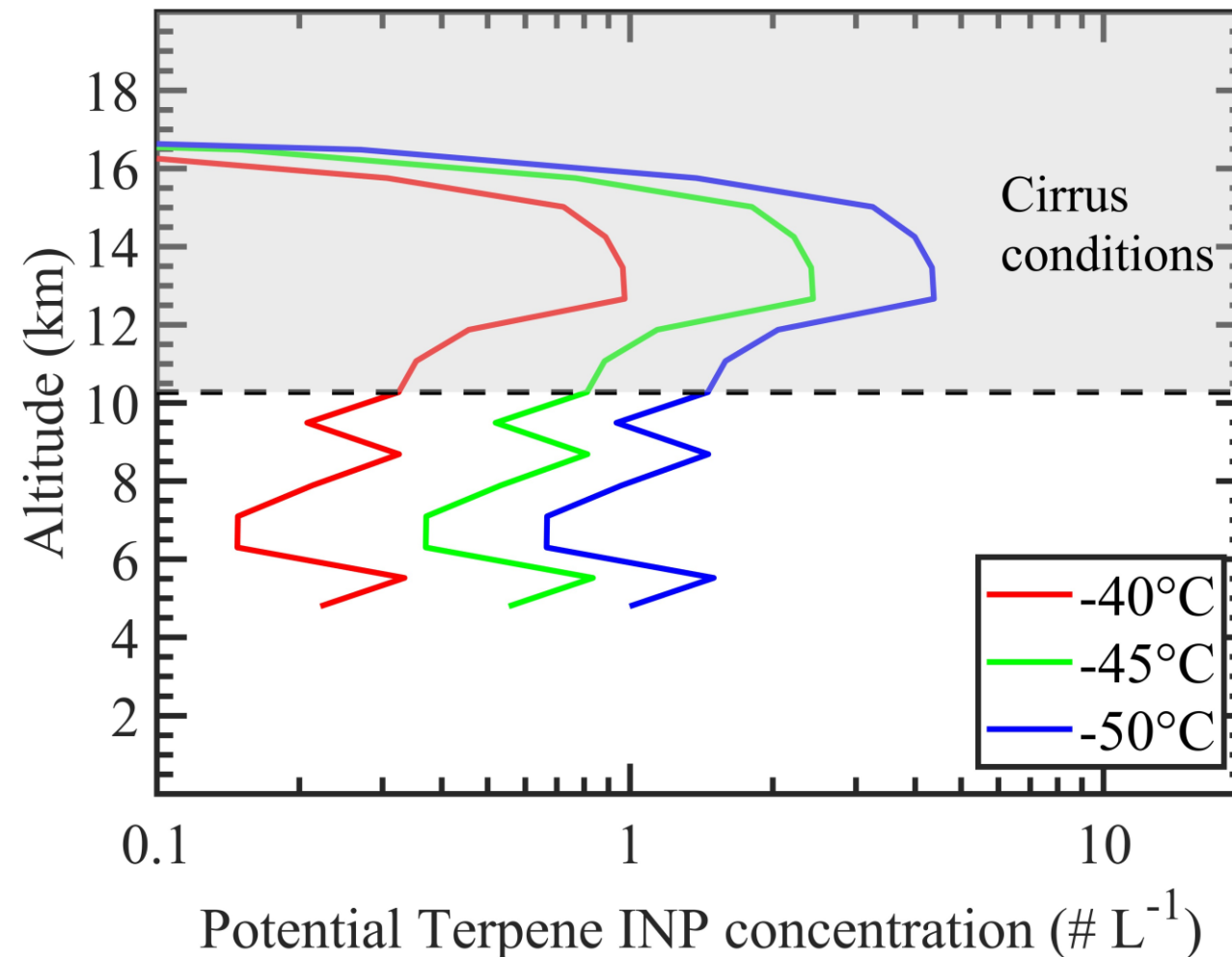


Data from Manish Shrivastava



Potential INP concentration from biogenic organics (SOA)

$$\text{Potential INP} = \text{Activated Fraction} \times \text{WRF-Chem}_{\text{terpene}(300-500\text{nm})}$$



Summary

In this study, lab measurements were combined with field and model data to obtain potential vertical INP concentrations at SGP and Amazon regions.

Preliminary analysis shows:

- Potential depositional INP budget of BBOA at SGP varies from 5 to 15 per L.
- Potential depositional INP budget of terpene organics at Amazon varies from 0.2 to 5 per L.

In future, direct (in-situ) INP measurements at cirrus conditions would be useful. Also, cirrus cloud model simulations to further probe the implications of these INP concentrations are also needed.

Thank you