Results from the First CIMS Intercomparison Workshop at TROPOS in ACTRiS CiGas

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Introduction

- Secondary organic aerosols (SOA) have strong effects on Earth's radiation budget, local air quality and human health
- Recent progress in understanding SOA formation mechanisms through condensable vapors
- New instrumentation delivers detailed molecular information of oxidized organic compounds
- Specifically CIMS online instruments are widely used
- Comparability is largely unknown
- ACTRIS research infrastructure aims at better comparability
- ACTRIS CiGas focuses on condensable vapors

Experiments at the Atmospheric Chemistry Department Chamber ACD-C

- FEP twin-chamber setup
- V = 19 m³
- S/V ratio ~2.1
- Acitvely stirred T-controlled enclosure
- Continuous mode operation
- Set of UVA lamps
- Special glas inlet tube designed to ensure sampling of same composition and sampling lengh

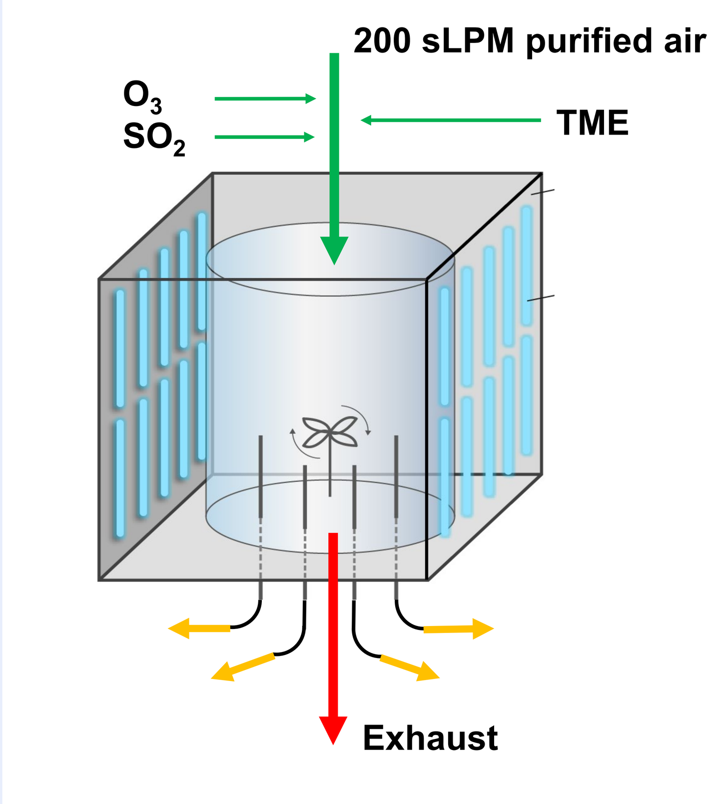

Fig. 1: Schematic experimental setup for *in-situ* sulfuric acid formation.

- Calibration experiments with 1,2-ISOPOOH and 4-nitrophenol
- α-pinene oxidation experiments
  - OH oxidation
  - O_3 oxidation
  - O_3 oxidation + NO
- *in-situ* sulfuric acid acid (SA) formation
  - 20 ppbv SO_2 + 5 ppbv O_3
  - Stepwise increase of TME
- Increase of relative humidity (RH) after each exp.
- Off-chamber activities
  - MS tuning at steady state
  - Calibration with sulfuric acid
  - Data analysis intercomparison

Instruments

10 instruments (5 connected to each chamber)

- Mediterinean Center for environmental Science - **CEAM**
- Helsinki University ACTRIS - **UHEL**
- TROPOS – **TROPOS_ACDC**
- Cyprus Institute - **CYI**
- Forschungszentrum Julich – **SAPHIR**
- Goethe University Frankfurt - **UFRA**
- Goethe University Frankfurt - **SCORPION**
- Tofwerk - **TOFWERK**
- Tampere University - **TAU**
- TROPOS – **TROPOS_MEL**

- Different ToFMS units **(cToF; hToF; LToF)**
- Different primary ion sources **(corona discharge, X-ray; Am^{241}; Po^{210})**
- Different inlet tube diameters and flow rates **(1", ¾", ½"; 2-23 sLPM)**
- Different inlet designs **(Eisele, MION, AIM, SCORPION, FIGAERO**

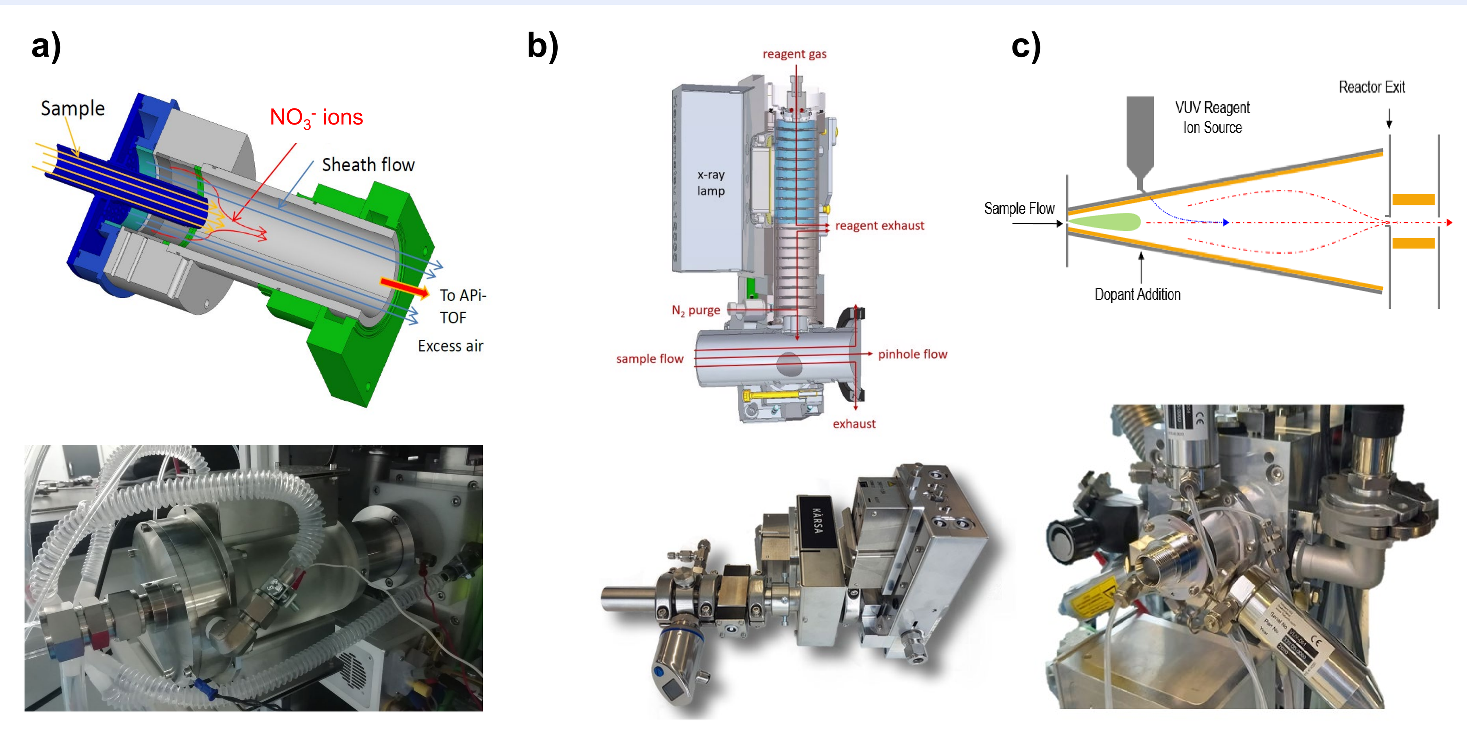

Fig. 2: Selected inlet designs of compared NO_3^--CIMS instruments: a) Eisele-type inlets[1-2] b) Multi-scheme chemical ionization inlet (MION)[3] c) AIM reactor[4].

Large influence of observed signals caused by variation of:

- Primary ion concentration
- Reaction chamber pressure
- Inlet line loss

Key results

- **SA concentration** for steady states calculated from off-chamber **calibration**
- Mostly good qualitative agreement
- Differences in background level, absolute values
- Still **high variation** of SA concentrations of sulfuric acid, **despite thorough correction**
- Further discussion points:
  - Inlet tube effect (bends)
  - calibration setup differences
  - Background handling
- HOMs show larger variation in **SVOCs** and **ULVOCs** concentrations
- Comparatively good agreement in **LVOCs** and **ELVOCs**

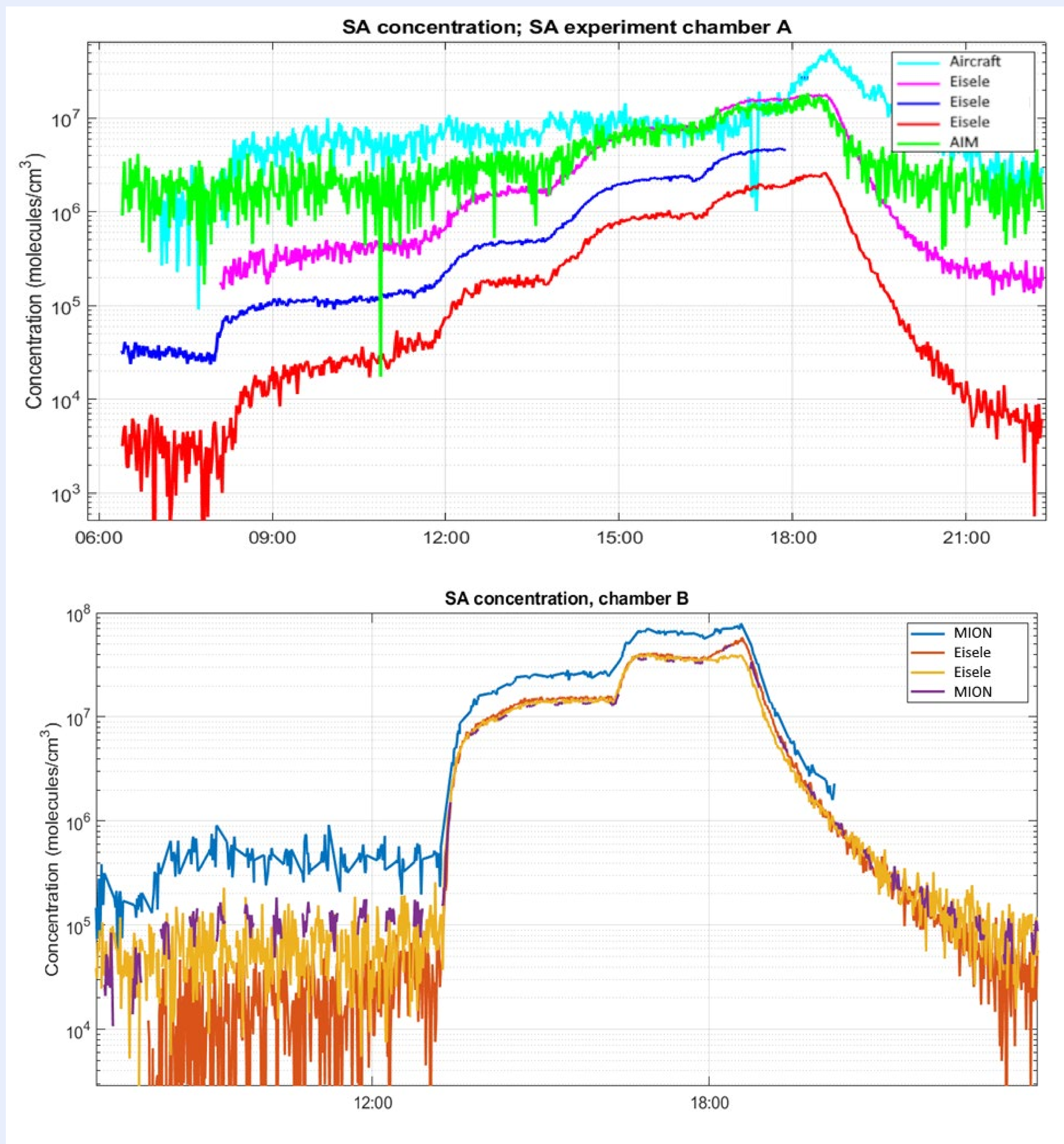

Fig. 3: Time series of inlet line loss corrected sulfuric acid concentrations for instruments in both chambers (chamber A upper plot; chamber B lower plot).

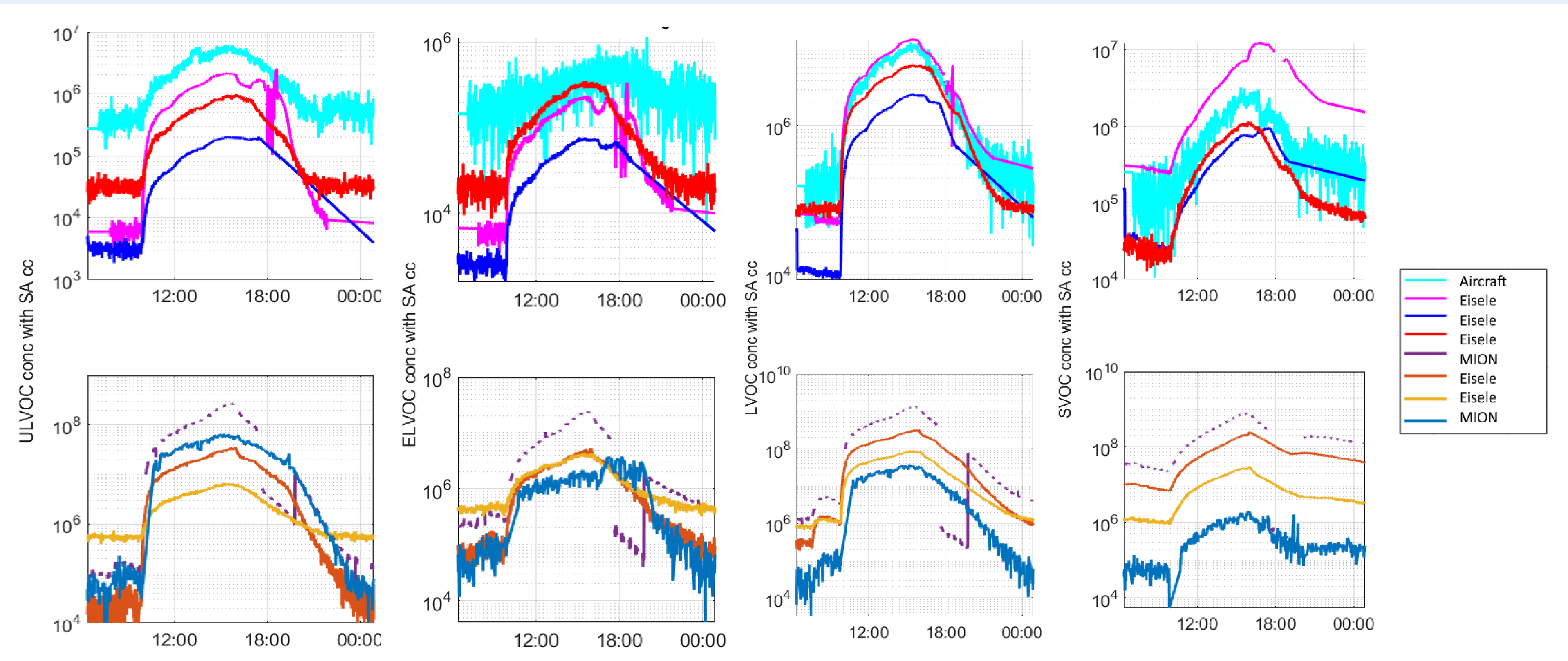

Fig. 4: Time series of inlet line loss corrected concentrations of HOMs classified by volatility[5] for instruments in both chambers (chamber A upper plots; chamber B lower plots). Sulfuric acid concentations were used to correct all CIMS data accordingly.

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References

[1]**Eisele, F.;** D. Tanner; J. Geophys. Res. 1993, 98, 9001-9010. [2]**Junninen, H.**; M. Ehn, T. Petäjä, L. Luosujärvi, T. Kotiaho, R. Kostiainen, U. Rohner, M. Gonin, K. Fuhrer, M. Kulmala, D.R. Worsnop, Atmos. Meas. Techn., 2010, 3, 4, 1039-1053. [3]**Rissanen, M.P.;** J. Mikkilä, S. Iyer, J. Hakala, Atmos. Meas. Techn., 2019, 12, 12, 6635-6646. [4]**Riva, M.**; V. Pospisilova, C. Frege, S. Perrier, P. Bansal, S. Jorga, P. Sturm, J.A. Thornton, U. Rohner, F.D Lopez-Hilfiker; Atmos. Meas. Techn., 2024, 17, 19, 5887-5901. [5]**Mohr, C.**; J.A. Thornton, A. Heitto, F.D. Lopez-Hilfiker, A. Lutz, I. Riipinen, J. Hong, N.M. Donahue, M. Hallquist, T. Petäjä, M. Kulmala, T. Yli-Juuti