



TOWARDS BETTER QUANTIFICATION OF SECONDARY AEROSOL PARTICLE FORMATION

Problem

- Ca. half of global cloud condensation nuclei might have formed through secondary particle formation in the atmosphere → understating particle formation and growth is relevant for improving global aerosol models
- Measuring recently formed aerosol particles is difficult due to their extremely small size (< 2 nm in diameter), leading to high diffusivity and low charging probability
- Quantification of aerosol precursor vapors (e.g. sulphuric acid and oxygenated organic vapors) is even bigger challenge, as their concentrations in the atmosphere are typically very low (ppq-level)
- Several new instruments exist, but their uncertainties are large, making their comparison difficult (see example in Fig1)
- There is no standard procedures for instrument set-up, calibration and operation. Only few intercomparisons have been performed.

Role of ACTRIS

University of Helsinki will be hosting two ACTRIS Topical Centre units related to standardizing measurements of secondary aerosol formation.

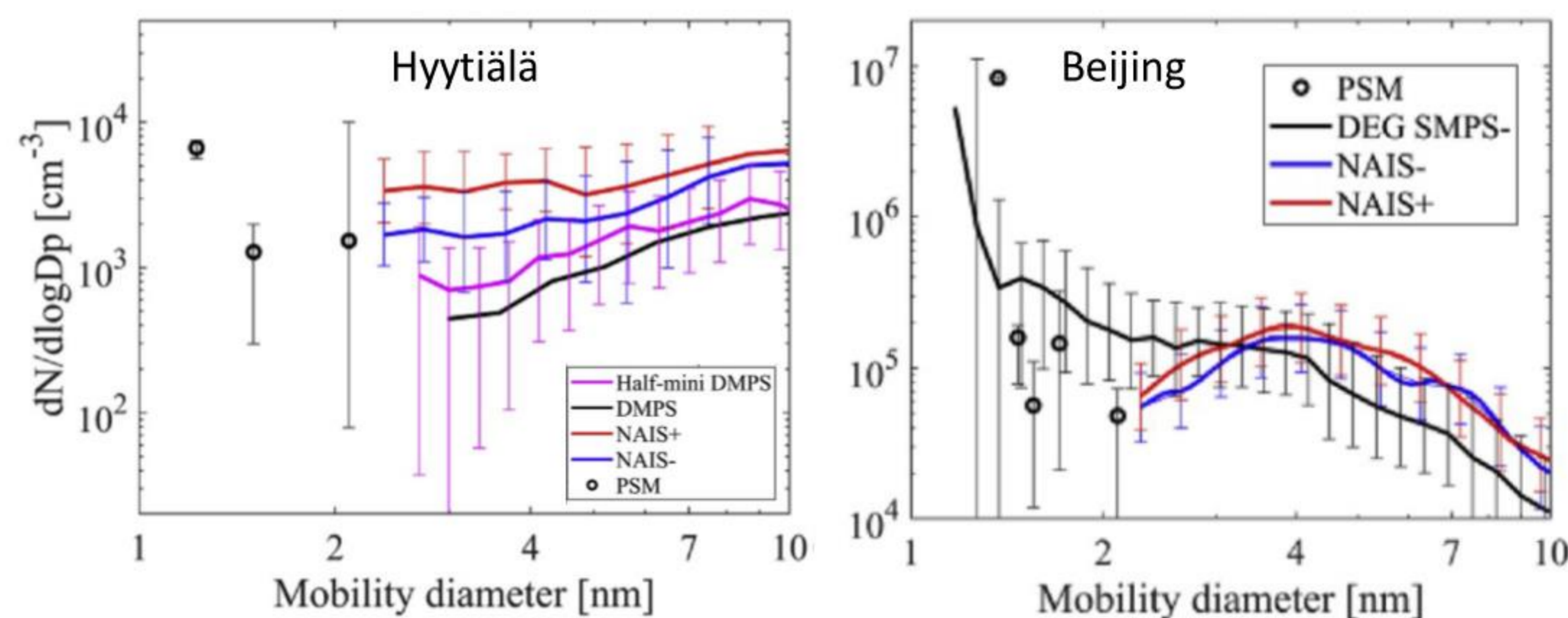
The Cluster Calibration Center (CCC) is part of the ACTRIS Centre for Aerosol In Situ Measurements (CAIS-ECAC), focusing on sub-10nm aerosol concentration and size distribution measurements.

CiGas-UHEL unit is part of ACTRIS Centre for Reactive Trace Gases In Situ Measurements (CiGas), focusing on condensable trace gases, which can serve as aerosol precursors

The tasks of the units are:

- to test and validate the measurement methods
- to improve the methods to calibrate the relevant instrumentation, provide calibration services for ACTRIS National Facilities and other users
- to produce data procedures and tools (e.g. measurement protocols and recommendations)
- to organize calibration and intercomparison workshops
- to provide training and consultancy

Fig1. Intercomparison of different instruments measuring aerosol size distribution during an new particle formation event. Figure from Kangasluoma et al., *J. Aerosol Sci.*, 2020



Recent progress

- **Sub-10nm instrument comparison:**
*Overview of measurements and current instrumentation for 1-10 nm aerosol particle number size distributions (Kangasluoma et al., *J. Aerosol Sci.*, 2020)*
- **SOP for NAIS:**
*How to reliably detect molecular clusters and nucleation mode particles with Neutral cluster and Air Ion Spectrometer (NAIS) (Manninen et al., *Atmos. Meas. Tech.*, 2016)*
- **SOP for PSM/nCNC:**
*The standard operating procedure for Airmodus Particle Size Magnifier and nano-Condensation Nucleus Counter (Lehtipalo et al., *J. Aerosol Sci.*, 2021)*
- **ACTRIS recommendations:**
Preliminary ACTRIS recommendation for aerosol in-situ sampling, measurements, and analysis (www.actris-ecac.eu/actris-gaw-recommendation-documents.html)

Future directions

We have identified several development areas, which would advance the quantification of particle formation:

- technological improvements in the instrumentation
- improved calibration methods and practises; development of traceable references and standards
- more frequent instrument intercomparisons
- development of advanced data tools and products
- advancing the fundamental knowledge on relevant processes (e.g. aerosol charging probabilities, effect of charge and composition on particle activation in CPCs, identifying vapors relevant for particle formation)

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