

EGU21-12472

<https://doi.org/10.5194/egusphere-egu21-12472>

EGU General Assembly 2021

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Monitoring ambient aerosol size distributions from 1 – 55 nm with the GRIMM-AIRMODUS PSMPS

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Here, we present the final, commercially available, version of a mobility particle size spectrometer that is able to access the 1 nm particle size range for ambient atmospheric measurements.

The overall system performance was tested in a multitude of laboratory experiments, determining various size dependent parameters like DMA's transfer function, DMA penetration efficiency, PSM and CPC counting efficiency. With the knowledge of these parameters, we are able to define a well-known overall system performance, a critical prerequisite for measurements that start at 1 nm sized particles.

The instrument originates from a collaboration of Grimm Aerosol Technik, Germany and Airmodus Ltd, Finland, combining a Grimm SMPS+C system with the Airmodus Particle Size Magnifier (PSM). Accordingly, it is named: PSMPS.

The main system components comprise a modified version of the short Grimm Differential Mobility Analyzer (Grimm S-DMA), the diethylene glycol-based PSM (Airmodus A10) and the new butanol-based CPC (Grimm 5417). The modified S-DMA is specially optimized for the transmission of small ions. Typically, it is operated with an aerosol sample flow rate of 2.5 L/min and a sheath flow rate of 10 L/min, allowing particle size distribution measurements from 1.1-55.7 nm. The PSM is used to lower the detection efficiency of the Grimm CPC below 2 nm in electrical mobility equivalent diameter. The new Grimm 5417 CPC is an upgraded version of the well-known 5416 CPC, that features two switchable aerosol sample flow rates of 0.3 and 0.6 L/min and also supplies the S-DMA with sheath airflow rates of either 3.0 or 10.0 L/min.

In this presentation, we will introduce the features and performance of the PSMPS system, will highlight some laboratory characterization tests and report the results from an ambient aerosol measurement campaign at the Hohenpeissenberg Observatory of the German meteorological service (DWD), monitoring new particle formation events starting at a particles size of 1 nm.