

# Measurements of sub-3nm atmospheric clusters and particles in different environments

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Keywords: clusters, nanoparticles, nucleation, new particle formation.

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Atmospheric new particle formation (NPF) takes place via the formation of sub-2nm atmospheric clusters and their subsequent growth to larger sizes (Kulmala *et al.*, 2013). Therefore, to estimate the impact of this process on the climate, the knowledge of cluster concentrations in different environments is essential. In this work, we compare the concentrations of sub-3nm clusters and particles measured at five different sites. Our aim is to understand how atmospheric cluster concentrations and their role in NPF depend on environmental conditions.

The measurements were conducted at five sites:

1) Hyytiälä (HTL): a boreal forest site in Central Finland, 17.3–10.5.2011 and 23.8.2011–11.9.2011 (Kulmala *et al.*, 2013)

2) San Pietro Capofiume (SPC): a rural site in Po Valley, Northern Italy, 9.6–9.7.2012 (Järvinen *et al.*, 2014)

3) Puy de Dôme (PDD): a mountain site in Central France, 23.1–29.2.2012 (Rose *et al.*, 2014);

4) Brookhaven (BRH): a coastal site in New York, USA, 22.7–13.8.2011 (Yu *et al.*, 2014);

5) Kent (KNT): a continental site in Ohio, USA, 15.12.2011–6.1.2012 (Yu *et al.*, 2014).

The total concentration of clusters and particles larger than ~1 nm was measured with an Airmodus PSM (Particle Size Magnifier; Vanhanen *et al.*, 2011). In Hyytiälä and San Pietro Capofiume a DMPS (Differential Mobility Particle Sizer) and in Brookhaven and Kent a SMPS (Scanning Mobility Particle Sizer) was used to measure the size distribution of particles larger than 3 nm. In addition, at European sites a NAIS (Neutral cluster and Air Ion Spectrometer; Manninen *et al.*, 2009) measured ion size distribution between 0.8 and 42 nm. From these data, the concentrations of sub-3nm clusters and particles were obtained.

We observed large differences in the concentrations of sub-3nm clusters in different measurement campaigns (Fig. 1). The median sub-3nm concentrations were highest in San Pietro Capofiume and in Hyytiälä during spring. In these campaigns the fraction of ions of all sub-3nm clusters was clearly lower than in Hyytiälä during autumn and in Puy de Dôme. Furthermore, in San Pietro Capofiume and in Hyytiälä during spring sulfuric acid concentration was higher and NPF events were more frequent than in other

measurement campaigns. Thus, sulfuric acid seems to be essential for the formation of sub-3nm atmospheric clusters. On the other hand, it is likely that other environmental factors, such as the concentrations of biogenic vapors, also affect the sub-3nm cluster concentrations.

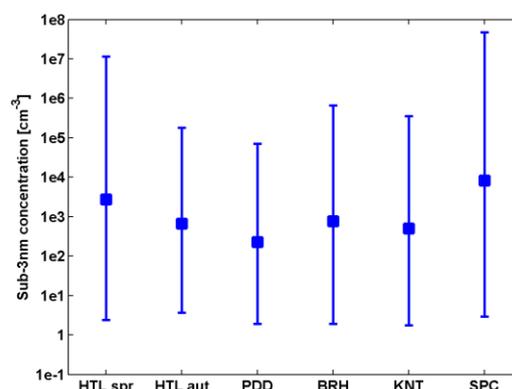


Figure 1. The median sub-3nm cluster concentrations at different sites. The error bars show 25- and 75-percentiles.

This work was funded by a European Research Council (ERC) Advanced Grant (ATM-NUCLE, 227463) and the Academy of Finland Centre of Excellence program (grant no. 1118615).

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