LONG-TERM SIZE-SEGREGATED CCNC MEASUREMENTS IN A BOREAL ENVIRONMENT AND THE IMPLICATIONS FOR CLOUD DROPLET ACTIVATION

Besides directly influencing the radiative balance of the Earth, aerosol particles play a crucial role in cloud formation and modification. They influence the albedo, lifetime and precipitation patterns of clouds in what is known as indirect effects of aerosols on climate.

What determines the ability of the particle to act as CCN?
• How can aerosol in the boreal environment be described with respect to its CCN potential?
• What is special about size-segregated CCNC measurements and what do they provide?

WHAT?
• particles in 20–300 nm size range at 5 levels of supersaturation S_{eff} (0.1%, 0.2%, 0.4%, 0.6% & 1.0%)

WHERE?
• Hyytiälä Forestry Field Station in Southern Finland (61º 50’ 50.685’’N, 24º 17’ 41.206’’E, 179 m a.m.s.l.)

WHEN?
• February 2009–June 2010
• May 2011–April 2012

HOW?
• charger/neutrallizer
• dryer
• Inlet
• DMA
• CCNC incl. saturator unit and OPC
• CPC
• N_{CN}
• N_{CCNC}

DATA OVERVIEW

Figure 1. The location of SMEAR stations in Finland.

Figure 2. Simplified diagram of the measurement setup.

The effects of aerosols on climate. Patterns of clouds in what is known as indirect influence the albedo, lifetime and precipitation in cloud formation and modification. They of the Earth, aerosol particles play a crucial role

Figure 3. Particle dry size as a function of S_{eff}. The black line – hygroscopicity κ value of 0.27, grey lines – κ values of 0.06 and 0.48, representing the global continental mean of κ of 0.27±0.21 (Pringle et al. 2010).

Figure 4. Relative occurrence of κ calculated with log equal bins for five levels of S_{eff}.

Figure 5. Relationship between particle dry size (taken as D_{p}) and κ for 4 different sites. Shown are the median values with error bars being 25th and 75th percentiles. Legend entries indicate the slope of the linear regression y = ax + b fit.

• both χ and rate of change of χ with size are highest in Hyytiälä among 4 sites – differences in condensing species and oxidation and aging processes
• rate of change of χ with size in Hyytiälä is highest in winter – higher sulphate fraction & slower growth

INTERCOMPARISON

TEMPORAL TRENDS

Figure 6. Monthly κ shown for two levels of S_{eff}.

• seasonal trend for larger (~150 nm) particles only
• aerosol measured at S_{eff}=0.1% is more hygroscopic in winter – higher sulphate (long-range transport)
• summer – more active SOA formation and higher organic fraction
• diurnal trend for smaller (~50 nm) particles only, present only in spring and summer
• aerosol measured at S_{eff}=1.0% is more hygroscopic in the afternoon – photochemistry
• no distinguishable effect of NPF on aerosol CCN activation and hygroscopic properties

ZOOMING IN ON CHEMISTRY

• gas phase H_{2}SO_{4} and sulphate both increase aerosol hygroscopicity, with a larger effect of H_{2}SO_{4} in the spring
• organics decrease aerosol hygroscopicity in all seasons except winter
• these patterns more pronounced for larger particles (> 100 nm)

Figure 7. Critical diameter D_{c} as a function of HNO_{3} concentration (top) and NO_{3} mass fraction (bottom).

• correlations with HNO_{3} and NO_{3} are poor, but nitrogen species seem to decrease aerosol hygroscopicity
• HNO_{3} seems to increase D_{c} for particles ~170 nm in spring and summer
• positive correlation with NO_{3} for all S_{eff} levels in the summer – organic nitrate/air mass feature?

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