



Ice nucleating particle concentration from a 600-year-old ice core from Greenland

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The ice nucleating particle (INP) concentration is a vitally important parameter for precipitation processes and cloud related radiation properties. Yet, the global coverage of measurements in today's atmosphere is regrettably low. It is therefore not surprising that INP concentrations before the 1950s, when the first measurements were made, are not known at all. However, the information of a pre-industrial baseline of cloud-active aerosols is important when trying to evaluate the current radiative forcing of anthropogenic aerosols (e.g. Andreae et al., 2005, Carslaw et al., 2013).

Using the FRIDGE droplet freezing assay we measured the freezing curves of about 100 melt water samples of an ice core from Greenland (B17, Weißbach et al., 2016) dating back to 1370. Samples were selected in regular intervals of 10 years (in some cases 50 years), in addition to a number of special events that showed peaks in the Continuous Flow Analysis data (CFA; particles $>1.2 \mu\text{m}$, conductivity, Na^+ , Ca^{2+} , NH_4 , NO_3^-). The typical time resolution of a sample is in the order of a few months. For each sample 3 x 65 droplets of $2.5 \mu\text{L}$ melt water were pipetted onto a silanized silicon wafer. Temperature was decreased by 1 K min⁻¹ until every drop froze.

Ice core INP concentrations at $T < -23 \text{ }^\circ\text{C}$ are significantly correlated with the number concentration of insoluble particles and soluble non-sea-salt calcium. INP concentrations of a high resolution period (1 – 2 month per sample) show a seasonal variation following the particle concentration. Historical atmospheric INP concentrations (per volume of air) were estimated using a conversion factor which depends of the accumulation rate of the ice core (here 11.4 cm a^{-1}), and an assumption for an average particle dry deposition velocity and wet scavenging ratio (Fischer et al., 2007). The conversion factor of $9.3\text{E-}7$ is only about a factor of 2 off from the conversion factor that Petters & Wright (2015) used for their analysis of precipitation samples. Preliminary results suggest that 50 year mean INP concentrations may have risen during the last 100 years. The significance of the latter preliminary finding still needs to be confirmed though.

References

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