Long-term analysis of non-cloudy new particle formation events over Hyytiälä

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Introduction

Studying atmospheric aerosols and their effects allows a wider range of understanding of air quality and global climate. These aerosols (1nm -100µm) which are condensed phase particles suspended in air originate either from primary or secondary sources. Our focus lies in the order of secondary gas-to-particle conversion, specifically new particle formation (NPF) events which are reported and studied in many areas globally (e.g. Kulmala *et al.*, 2004, Kulmala *et al.*, 2014 and references therein). The aim of this study is to combine 20 years of measurements in boreal forest environment with accumulated knowledge and advanced analysis focusing only on clear-sky NPF events.

Methods

This work starts by selecting the clear sky (non-cloudy) days from the data set. Non-cloudy days are chosen based on the median brightness parameter per day. The brightness parameter (P) is the ratio of measured global radiation to the theoretical maximum and have values between 0 and 1. Using the data set from 1996-2015, the non-cloudy event days and non-cloudy non-event days are compared. Comparison between events and non-events can be done via the apparent formation rate at 3 nm (simplified nucleation parameter) (J_3) which combines the growth rate (GR) to the formation rate 1.5nm particles ($J_{1.5}$) as suggested by the Kerminen–Kulmala equation (Kerminen and Kulmala, 2002).

$$J_3 = J_{1.5} \cdot \exp(-CS/GR);$$

Each of $J_{1.5}$ and GR is calculated from different combinations of precursors.

Results

Results at clear sky conditions show that the median BLH is only slightly lower on non-cloudy non-event days in comparison to non-cloudy event days. However, cloudy non-event days seem to have much lower BLH. Moreover, other comparable parameters show that non-cloudy events and non-cloudy non-event days have significant differences. For instance, in Figure 1 we show higher median values for (condensation sink) CS. Median CS values at every half-hour during non-event days show similar values during night time and daytime, while the median CS during event days has a fish shaped plot with higher values during night-time. Similarly, the dependence of NAIS particles and ions (median concentrations) on the nucleation parameter J_3 show a clear difference between non-cloudy events and non-cloudy non-events.

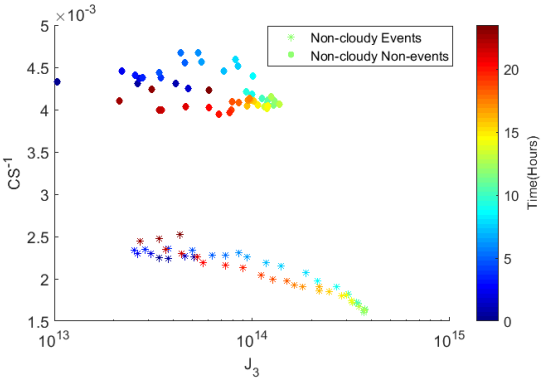

Figure 1 Median of half-hourly condensation sink (CS) as a function of calculated new particle formation rate J_3 during non-cloudy event and non-event days. $J_3 = [H_2SO_4]_{proxy} \times [OxOrg]_{proxy} \times \exp(-CS/[H_2SO_4]_{proxy} + 2.6[OxOrg]_{proxy})$.

Conclusions

Here we are able to give using almost 20 years observations at SMEAR II station, Hyytiälä, a threshold value on nucleation parameter J_3 below which there are not NPF event days. To obtain this we have compared event and non-event clear sky days. However, further analysis to quantify the results is needed.

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