Comparing night-time with day-time ion cluster events in a boreal forest

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Keywords: Night-time, new particle formation, sub-3 nm, ions.
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Global observations of new particle formation (NPF) events are centered during daylight hours when photochemical oxidation occurs. Night-time nucleation mode particles (<25 nm) have, nonetheless, been reported in various locations around the world including Hyytiälä, Finland (Junninen *et al.* 2008, Lehtipalo *et al.* 2011). We analyzed 0.9-8 nm ion data from 2003–2013 in SMEAR II station, Hyytiälä, Finland, where we observed sub-3 nm nocturnal events in a third (30-34%) of the days in both positive and negative polarities. From this preselection, we selected the events with elevated 2-3 nm ion concentration (>70 cm^{-3}), so as to go beyond the constant ion pool (<2nm) and investigate possible particle formation. The remainder of the study is based on these 2-3 nm cluster events (hereafter, nCE).

Nocturnal CE ion concentrations and maximum ion diameters were compared to daytime ion concentrations during NPF events to identify the limits of nocturnal clusters.

Daytime vs. nighttime ion concentrations: 0.9-1.5 nm, 1.5-2 nm, 2-3 nm, and 3-7 nm

Median nCE 2–3 nm ion concentrations started from ~10 cm^{-3} and increased to ~100 cm^{-3} at event peak, with a median concentration of 31 cm^{-3} during the 18:00-24:00 hr window (Figure 1). Day-time (08:00–12:00) 2–3 nm ion concentrations during NPF events had a similar median concentration of 39 cm^{-3}, while non-event days and nights had ~3 cm^{-3}, respectively. Small ions (0.9–1.5 nm) median concentrations were similar (~500-700 cm^{-3}) in day and night events and non-events. Nocturnal CE presented the highest 1.5–2 nm median concentration (235 cm^{-3}) compared to NPF days (96 cm^{-3}) and non-events (day and night: ~20 cm^{-3}). This indicates a clear nocturnal enhancement of 1.5–2 ions during CE nights, greater than during NPF event days. However, ~3–7 nm ions concentrations were substantially lower during CE (median: <10 cm^{-3}) than during NPF events (median: 52 cm^{-3}). Interestingly, however, 90% of CE occurred during the night of a NPF event (55%) or undefined day (35%).

This study (Buenrostro Mazon *et al.* 2016) concludes that ions >3 nm in size are not effectively produced in night-time Hyytiälä.

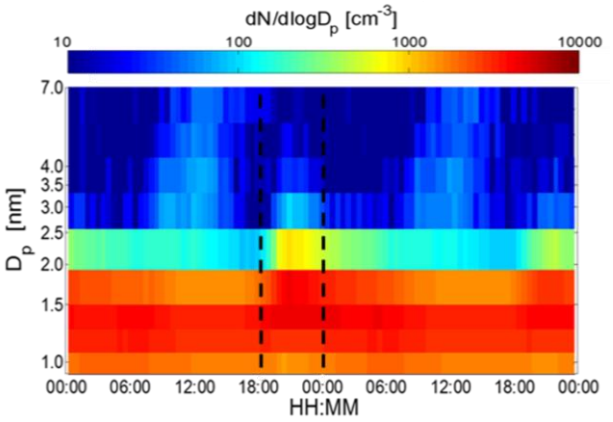

Figure 1. Median 48-h (n = 166 d) number size distribution plot for nocturnal cluster events (CE). CE commonly occur during 18:00–24:00 hr, reaching median ion concentration of 100 cm^{-3}. They have a ~55% co-occurrence with NPF days, as can be seen in the figure around noon in day 1 and day 2.

Acknowledgements

This project was supported by the Horizon 2020 research and innovation programme (No. 654109, ACTRIS-2), and the EU 7th Framework Programme (FP7/2007-2013) (No. 262254, ACTRIS). We also thank the Academy of Finland Center of Excellence program, the Cryosphere-Atmosphere Interactions in a Changing Arctic Climate (CRAICC), and the European Research Council Project (ATMNUCLE).

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