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Classifying previously undefined days from eleven years of aerosol-particle-size distribution data from the SMEAR II station, Hyytiälä, Finland

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Abstract. Studies of secondary aerosol-particle formation depend on identifying days in which new particle formation occurs and, by comparing them to days with no signs of particle formation, identifying the conditions favourable for formation. Continuous aerosol size distribution data has been collected at the SMEAR II station in a boreal forest in Hyytiälä, Finland, since 1996, making it the longest time series of aerosol size distributions available worldwide. In previous studies, the data have been classified as particle-formation event, nonevent, and undefined days, with almost 40% of the dataset classified as undefined. In the present study, eleven years (1996–2006) of undefined days (1630 days) were reanalyzed and subdivided into three new classes: failed events (37% of all previously undefined days), ultrafine-mode concentration peaks (34%), and pollution-related concentration peaks (19%). Unclassified days (10%) comprised the rest of the previously undefined days. The failed events were further subdivided into tail events (21%), where a tail of a formation event presumed to be advected to Hyytiälä from elsewhere, and quasi events (16%) where new particles appeared at sizes 3–10 nm, but showed unclear growth, the mode persisted for less than an hour, or both. The ultrafine concentration peaks days were further subdivided into nucleation-mode peaks (24%) and Aitken-mode peaks (10%), depending on the size range where the particles occurred. The mean annual distribution of the failed events has a maximum during summer, whereas the two peak classes have maxima during winter. The summer minimum previously found in the seasonal distribution of event days partially offsets a summer maximum in failed-event days. Daily-mean relative humidity and condensation sink values are useful in discriminating the new classes from each other. Specifically, event days had low values of relative humidity and condensation sink relative to nonevent days. Failed-event days possessed intermediate condensation sink and relative humidity values, whereas both ultrafine-mode peaks and, to a greater extent, pollution-related peaks had high values of both, similar to nonevent days. Using 96-h back trajectories, particle-size concentrations were plotted as a function of time the trajectory spent over land. Increases in particle size and number concentration during failed-event days were similar to that during the later

stages of event days, whereas the particle size and number concentration for both nonevent and peaks classes did not increase as fast as for event and failed events days.

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