

## ***Interactive comment on “One year boundary layer aerosol size distribution data from five Nordic background stations” by P. Tunved et al.***

### **Anonymous Referee #2**

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This paper contains interesting material about aerosol size distribution measurements at various background stations in Scandinavia. The paper's data are unique, and it merits consideration for publication in ACP. Before publication, however, some more work needs to be done to make this an attractive paper.

The major criticisms are:

1. The data set spans 1 year, and also includes significant gaps for some stations. I believe it is not sound to suggest that these data are representative enough do discuss an annual variability unless supported by climatological information.
2. Besides the presentation of various data, the paper is poor in actual scientific findings. The authors recognize the obvious importance of air mass types, pre-

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precipitation, solar radiation, and more meteorological factors, but fall short of meeting the many expectations aroused in a reader by the introduction.

3. I would like to see a more thorough motivation, i.e., why this kind of analysis is done and what can be accomplished later with the author's data.

Conclusion: The paper needs major revisions before final publication in ACP. I would suggest that the present paper be condensed by roughly a third (this makes the paper more attractive for a reader, and can be done without loss of information), and some more specific analyses be added.

Justification of points 1)-3):

1)

Data from 1 year were used in this study, split up into 4 seasonal periods, and discussed in terms of an annual cycle. The authors have recognized that the aerosol size distribution is a seasonal function because of the seasonal variations of sources, but also because of a seasonal function in meteorological processes. If the latter is true, the discussion of an annual cycle based on just one year's data is only sound if the data are representative enough for longer periods in terms of the large-scale advection, air mass histories, and local meteorological conditions.

A look into the climatology of Southern Scandinavia shows that July 2000 was one of the coldest months of July in Southern Sweden over the past 15 years. Conversely, December 2000 was one of the warmest months of December over the same period. This indicates that the periods selected by the authors are not really representative for the perennial situation.

Therefore more care is advocated for the discussion of these annual cycles. Solutions would be the inclusion of more data, or a justification of representativity based on a long-term climatological statistics, or a more focussed discussion of aerosol data only as a function of specific weather situations (trajectory, humidity, solar radiation, local

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meteorology) instead of seasons of the year (see also point 2 below).

Incomplete data sets: The data set for Pallas, e.g., is quite patchy (see Fig. 11), especially in Summer, so that it is quite misleading to generate a “Jun-Aug” representative average, as done in Fig. 10. Besides Pallas, Vå vihill seems to be a problematic site with little data capture only (see also comment 1 by Referee # 1). It is therefore recommended to reduce the description of these stations to annual averages, or study meteorology related cases.

2)

The paper provides extensive statistics on diurnal profiles (e.g., section 3.1), seasonal variation (section 3.2) including large tables showing parameters of lognormal fits, but most of these exercises do not provide any real insight into the underlying atmospheric processes. This includes, unfortunately, the trajectory cluster analysis, too. On p. 2787, line 9 the authors say that certain trajectory clusters “will represent some typical weather situation”. It is necessary that the authors give more specific information about the weather situations (pressure, humidity, stability, subsidence, etc.) here and do not leave this work up to the reader.

Although the authors have recognized that “the evolution of the size distribution...is strongly dependend on the weather situation...” (p. 2787), they do not actively take account of factors such as humidity, precipitation, sunshine, atmospheric stratification, time of frontal transitions, etc. to explain their observations. An analysis including more of these factors, however, would be necessary to fundamentally address those interesting questions such as which atmospheric processes are associated with the generation and removal of particles in different air masses. This was initially also the authors’ intention when they suggest to “detect determining atmospheric processes” (p. 2785, l. 28). Unfortunately, not many results into this direction can be seen in the conclusions.

When discussing the issue of particle nucleation, the analysis remains similarly superfi-

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cial. A nucleation day “inventory” is presented in Section 3.2, but neither are illustrative examples shown (cf. comment 3 by Reviewer # 1), nor is an analysis being carried out with respect to the possibly associated meteorological factors, such as solar radiation, humidity, aerosol surface area etc. This would be valuable to put the study in a closer context with the previous work. Section 3.2 ends with the conclusion that “Potential explanations for this might be seasonal changes in air masses, lower rate of incoming solar radiation, and thus less particle formation during the winter period and/or higher rate of precipitation and overall cloudiness during the winter”. As a reader, I would be pleased to see at least some of these aspects addressed more specifically — based on the sources of data the authors can provide. An extended phenomenological analysis, such as done in many of the referenced papers by the Helsinki group, would be a standardized, but valuable round-up to this study.

A further way to generate more interesting results would be a more detailed study of the capture of emissions from the Kola peninsula. Why not show a map with the locations of smelters, and more individual trajectories and associated size distributions? The authors are able to work out relationships between trajectories and size distributions on the time scale of a few hours, so the scenario around the two North Finnish stations seems ideal for studying plumes of localized point sources.

3)

It would help the reader to see a more thorough motivation, i.e. why the particular size distributions measured are important for climate, what can be accomplished later with the author’s data, and whether additional information like the light scattering properties of particles are necessary. Aerosol health effects are overwhelmingly caused by anthropogenically produced particles in big cities, homes, or workplaces, so it would also be interesting to know how the size distribution measurements at the background sites are related to the issue of health. ACP is a multidisciplinary journal, and not all potential readers are familiar with these issues.

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Individual points:

p. 2792, l. 17 “No indications of local anthropogenic influence was found”. Please explain in more detail how this judgement was made.

p. 2792, l. 20 “The frequency of the nucleation events has been found...”. Does this statement refer to the data from this study? This is not clear.

Fig. 2: “Time dependent evolution”: It would be more illustrative to have nucleation days and non-nucleation days plotted separately.

Fig. 11: How is it possible to calculate running means during some periods of missing data?

Figs. 15-16: Change color coding, so that trajectory clusters and their corresponding size distributions bear the same color.

Fig. 16, 18: What is the justification of normalizing size distributions at different stations? This feature appears irritating to a reader, rather than illustrative because it suggests concentrations ratios between distributions that are not real.

Fig. 17: The nomenclature “NE oriented clusters” is contrary to convention, and intuition. The practical meteorologist labels winds after the direction from which they arrive. The clusters would be better termed “Clusters arriving from SW”, or shortly “SW clusters”. For clarity, please highlight the measurement sites with an additional symbol in Fig. 17.

Word choice: I find the term “Nordic” in the title inappropriate. The authors may correct me if they wish. “Nordic” (“Nordic combination”, “Nordic war”, “Nordic council”, “Nordic literature”) refers to the more cultural issues. Why not use “Scandinavian”, a proper geographic term, globally understood, which may also be used to include Finland?

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Interactive comment on Atmos. Chem. Phys. Discuss., 3, 2783, 2003.