

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

Anonymous Referee #1

Received and published: 6 June 2003

This manuscript presents analysis of a large data set of aerosol number size distributions in Nordic countries. The data set is unique, there are very few long-term measurements available and the findings should be published. The analysis has been done carefully and much effort has been devoted. However, there are some aspects that the authors should consider (see below) and before publication in ACP revisions are required.

General comments

1. The Vavihill data is available only for shorter period and it is used and discussed very limitedly in the manuscript. The authors should consider either omitting this data or explaining clearly the measurement period and discussing the limitations for the use of this data set.

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2. On page 2787 line 27, the authors tell that three modes are used for fitting the size distributions. This has to be motivated clearly using this specific data, and not only using general statements on aerosol processes. It is conflicting to see four modes used in tables 3,5, and 6 and especially conflicting with statement p.2802 lines 5-6, which indicates that 3 modes were not enough and actually 4 modes were used. In addition, the definition of the modes is rather unclear, especially as the authors introduce the concept of Aitken 1 mode (p.2799 last line and p.2800 first line). So what is the difference between nucleation mode and Aitken 1 mode? And also, looking at table 2, some values of D_{g1} (Värriö) are same order of magnitude as D_{g2} (Pallas, Värriö). The limitations in the fitting procedure need to be considered.

3. Nucleation is discussed extensively in the manuscript. However, the authors do not show any example of how nucleation is detected at various stations (e.g. during northern air masses at all stations). The data shown and examples selected should be more balanced with the manuscript text.

4. Discussion related to trajectories is somewhat confusing. The authors should e.g. clearly explain what means that "trajectories oriented NE" (page 2799 line 23). Similarly, p. 2800 line 4: how is SW airflow defined (i.e. what is the wind direction)? And p. 2803 lines 3-5: NE-transport path / NE oriented clusters? And more critically: p. 2804 last paragraph: What is northerly-southerly oriented airflow and how it is related to NE transport (title of the section)?

Specific comments

1. Page 2788 lines 11-17: This part needs to be more clearly explained. Now it is difficult to follow which mode is coagulating with what and which mode number concentrations the authors refer to.

2. Page 2788 line 27: The authors should mention also the role of coarse mode.

3. All the symbols need to be defined. E.g. D_g s on page 2789.

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4. Page 2793 lines 22-23: I disagree. There is substantial variation in number concentration especially during DJF and also MAM.
5. Page 2794 lines 18-20: It is not obvious why diurnal variation results from local sources.
6. Page 2794 line 23: The authors state that the nucleation events occur at other stations as often as in Hyytiälä. This statement needs supporting data or reference.
7. Page 2795 line 8: word "banana" sounds like an internal joke. What do the authors mean exactly?
8. Page 2795 line 10: Jansson -> Janson. By the way, is this the central reference to the nucleation classification?
9. Page 2795 lines 21-22 and Page 2796 lines 12-14: The nucleation in Aspvreten is highest in winter!
10. Page 2796 lines 1-3: I understood that nucleation is a natural phenomenon. If that is correct, how do the smelters in Kola Peninsula relate to nucleation? What do the authors mean by nucleation? How is nucleation defined?
11. Page 2796 lines 8-9: At minimum, the measurement period in Vavihill needs to be given (see also the general comment). Page 2796 line 12: Is the Vavihill data complete enough for such a statement?
12. Page 2796 lines 18-20: There are several other potential explanations as well. E.g. role of temperature or height of the mixed layer.
13. Page 2797 line 5: Where does the continental influence come from to Värriö/Aspvreten?
14. Page 2797 line 8: What means decoupled in this context?
15. Page 2798 line 28: Does the size of mode refer to (mean) diameter or number

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(concentration) of the mode?

16. Page 2800 line 5: What means "good statistical representation"? What is the total number? Are the situations simultaneous?

17. Page 2801 line 1: Is Kulmala et al, 2001, the central reference for this?

18. Page 2801 line 27: What are "anthropogenic properties"?

19. Page 2802 lines 14-16: It is confusing that the authors speak about Aitken mode and Aitken mode2 right after each other. How is Aitken mode defined here in relation to Aitken mode2?

20. Page 2803 last paragraph: What is the time scale for transport between stations? Is deposition out of question in shaping aerosol size distributions?

21. Page 2804 lines 10-11: Hyytiälä is actually bigger than Aspvreten.

22. Table 1: Why are these size ranges used? Is that based on literature or on actual data?

23. Table 2: Why is the comment "...and this does not necessarily cover for the whole season"?

24. Figure 14: What do the authors mean by "model" in figure caption? These figures would be better with expanded x-scale.

25. Figures 15 and 17: What means: "Each endpoint corresponds to approximately 5 h."?

Technical corrections

1. In several occasions, the authors write "in figure below/above" or "in table below/above". These should be changed to refer the figure/table number.

2. Figures 7-10 would benefit if in multicolour.

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3. Page 2785 line 17: change to "a larger aerosol mass..."
4. Page 2791 line 25: spectra -> spectrum
5. Page 2793 line 11: on -> one
6. Page 2800 line 25: investigating
7. Page 2801 line 15: the -> they
8. Page 2801 line 18: is -> are
9. Figure 9: The subplot Dec-Feb has dashed line for accumulation mode whereas in other plots it is for nucleation mode.

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

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