

Interactive comment on “Aerosol distribution around Svalbard during intense easterly winds” by A. Dörnbrack et al.

Anonymous Referee #1

Received and published: 27 August 2009

Review of "Aerosol distribution around Svalbard during intense easterly winds" from Dörnbrack et al.

In this paper, the authors analyse a aerosol Lidar data set acquired during 3 research flights in the area of Spitzbergen during spring 2004, and support their observational findings with results from a numerical high-resolution model. The findings are interesting an fit well into the scope of ACP as they show the interplay of atmospheric chemistry and physics during a case study. However, the presentation of the material in terms of the writing and clarity of the figures needs some improvement.

Major comments

1. The Introduction is not presented in a logical sequence. This is may be rooted

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in the fact that during the first flight the researchers set out to characterise aerosols in the Svalbard region, and then found a mesoscale dynamic feature that was worth investigating. The writing should however rather than the temporal sequence of the research follow a logical sequence, i.e. make clear what the mesoscale environment is, that it impacts aerosol transport in the region and is connected to air-sea interaction, which aerosols are to be expected, and then describe that you were lucky enough to catch a dust storm and characterised the aerosols in the lee jet. As it is currently written, the task of bringing the facts into a logical sequence is left to the reader.

2. Throughout the paper, it should be immediately referred to the corresponding figure panels when a statement is made. It is very tedious to read the paper while figuring out which panel is talked about.

3. The sensitivity experiment with different heat fluxes does not add a lot of valuable information to the paper and differences between the two simulations are hard to see in the figures. Only the results with sensible heat flux should be presented in the figures, and the differences to the simulation without heat flux mentioned in the text.

4. It needs to be clarified if particle sedimentation is included in the model equations, and how this affects the simulation.

5. The Discussion and conclusions section needs rewriting and should be better structured. Consider focusing the discussion on issues that bring together your observational and model results.

Detailed comments

pg. 16442

L.2, L.6: There is a lot of emphasis on 'unique' but this is not a main point of the paper. The abstract should be more in line with the overall paper, i.e. present the types of aerosol observed and the jet in the lee of Spitzbergen.

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L. 3: could remove 'but'

L. 5: not clear why this conditions are favourable. The information about the general flow characteristics around Spitzbergen during the year and during spring (Skeie and Gronas, Sandvik and Furevik) should be included here.

L. 11: 'if the observed aerosol particles': at this point it is not clear yet what kind of aerosol particles were observed. The distinct mesoscale pattern is also unclear at this point. The lee jet should be introduced in a paragraph above, and the connection to sea salt, dust, and snow particles made clear upfront.

L. 14: 'these different mesoscale aerosol patterns': not clear at this point what patterns were observed.

L. 19: 'On the other hand' makes no sense here, since no contradicting views are discussed.

L. 28: 'in accordance with our findings' this statement does not make sense to the reader in the introduction, we haven't seen the findings at this point.

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L. 5: rephrase 'by showing graphs of'

L. 10: remove 'analysed in this paper'

L. 14: add symbols to Fig. 1 identifying the locations Adventsdalen, Isfjorden, and Svalbard, or consider adding a separate map showing the topography of the island.

Figure 1: Explain in the caption what the red/white sections of the flight track signify.

Figure 2: It is not possible to identify the location of Spitzbergen in the satellite images. Are the images projected or unprojected? A box in Fig. 1 could outline the location of the satellite images. A coast line and lat-lon grid may also help.

L. 15: till -> to

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L. 22: 'On 18 and 19...' sentence needs verb, refer to corresponding panel of Fig. 1

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L. 1: refer to corresponding panel of Fig. 1

L. 17: online reference not practical, consider either adding the image as a panel in Fig. 2 or creating an electronic supplement to the paper.

L. 20: refer to figure panel

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Fig. 3: Outline the location of panel b in panel a. Panel a and b should be described in the legend.

Fig. 4 and 5: the profiles need to be identified by numbers in the figure panels, it is virtually impossible to map profiles to numbers just from the different shades of red.

L. 5: refer to figure panel

L. 9: 'cf. the compression...' This forward reference is confusing to the reader. Include a statement that this will be talked about later here and refer back to this paragraph when discussing Fig. 6. If this does not work, consider moving Fig. 6 into this paragraph.

L. 14: 'of the both flights' -> 'of both flights'

L. 17: refer to flight track in Fig. 1a

L. 20: move imagery into electronic supplement

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L. 11: What is implied about the particles by the low volume depolarisation ratio?

L. 16: 'exhibited a different' -> 'exhibited different'

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L. 5-9: Could you use a background profile from further E in the Isfjorden to support the hypothesis that dilution is taking place? Could this be used to quantify how strong the turbulent mixing is, e.g. with the help of vertical profiles of stability measures such as the Richardson number?

L. 17: This information would be much clearer if presented as a temporal cross-section such as in Fig. 6, probably zoomed in on the area downstream of the Isfjorden. Such a figure would also be important to back up the modelling results in Sec. 3.

L. 27: remove 'However'

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L. 5: The reader is left puzzled after this paragraph. There is no mentioning of sea salt, which turns out to be a dominant aerosol type at lower layers towards the end of the paper. A figure showing the Lidar curtain in the area of profiles 1-4 is necessary to get a clearer impression of the extend of the supposed ice-particle layer, the dust layer below, and the surrounding sea salt particles.

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L. 5: It is not clear why the term 'triangular shape' is chosen to characterise the aerosol and cloud distribution. Obviously, as mentioned in the next sentence, the triangular appearance of the cloud feature stems from the symmetry of the flight pattern, whereas in reality the jet might have been not as symmetric. It would be more exact to talk about an upward sloping cloud layer, for instance.

L. 12: 'it appears as possible to explain': after this statement, the reader expects that you will explain the boundary layer height growth, but instead the observations from another flight are presented.

L. 27: From Fig. 6, it appears that the thermal stratification is the major difference between the flights on 19 and 21 May, it is not clear why you conclude that surface wind speed is the major driver of boundary layer height. Also, why is the low-level

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stratification on 21 May so different from two days before? Potentially, a point could be made about the connection between wind speed and the surface heat flux. It could also be useful to characterise the turbulence along your flight profiles by the Richardson number.

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L. 8: This paragraph seems out of place here, should be mentioned when Fig. 6 is first described. Sea salt should already be mentioned when describing Fig. 4.

L. 15: Statement should be more specific: aerosol observations? Which characteristic mesoscale features do you mean?

L. 21: last two sentences of the paragraph need rewriting, include ice particles already in L. 19.

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Is sedimentation of the particles included in the parameterisation? If no, what are the implications?

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Figure 8: valida -> valid

L. 11: Fig. 9 is referred to before Fig. 8 has been described. It is not clear from Fig. 9 that a realistic topography has been used - how high are the highest peaks compared to reality, how wide is Adventdalen in the model and in reality?

L. 23: For the presentation of the results, it should be focused on one simulation with a realistic value for the sensible heat flux, and differences to the simulation without sensible heat flux described as text only.

L. 26: A sentence should be added emphasising that static boundary conditions are used throughout the simulation.

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Figure 9: can the same colour scale for temperature be used as in Fig. 1? Only show results with heat flux. The profiles should extend all the way to the north of the domain to cover the full extend of the jet.

Figure 10: The complete calculation domain should be shown as in Fig. 9 to facilitate the comparison of features, and since the zoomed region cuts off half the area where the jet is found. Add panel letters to this figure. Only show results with heat flux.

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L. 10-12: refer to figure panels

L. 13-25: refer to figure panels

pg. 16455

L. 2: 2x only

L. 10: Since the thermal gradient in the simulation was initialised with the conditions on 19 May, the simulation results are less representative for the observations on 21 May. This should be discussed.

L. 22: These differences between a simulation with and without sensible heat fluxes are fairly obvious and do not require to be presented as additional figure panels.

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L. 10: Examining stability measures might help to support this conclusion.

L. 11: coastal jet -> lee jet?

L. 18: Coal particles are first mentioned here - why coal?

L. 22: Where is Sassendalen?

L. 25: The total aerosol concentration should be shown as a separate panel in Fig. 12 to compare with Figs. 4,5.

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L. 26: The simulated ice particle distribution does not show the spike observed in Fig. 5. Why is this so? The conclusion is then that ice particles are not simulated well. What is the role of gravitational settling?

Fig. 11: only show the cross-section along $x=202$ km but all the way to the north and both with and without heat flux. Make vertical scale comparable to Fig. 6,7.

pg. 16457

L. 1-10: could be moved to the introduction

L. 23: Soot particles first mentioned here, what evidence is there for soot?

L. 25: Why is this event 'unique' if dust storms are common during the fall season?

pg. 16458

L. 5: needs clarification if sedimentation is included in the model simulations.

L. 13: I would not consider sea salt a contamination.

L. 14: triangular shape -> upward slope

L. 16: From the discussion on pg. 16456 L. 10, it is not clear that stream-wise vortices explain the observed boundary layer structure.

L. 18: The discussion on sea salt seems out of place

L. 27: lying in -> lying on?

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 16441, 2009.

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