

Interactive comment on “Factors Controlling Black Carbon Distribution in the Arctic” by Ling Qi et al.

A. Stohl (Referee)

ast@nilu.no

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This paper presents a model study of factors influencing BC distribution in the Arctic. The authors use a state-of-the-art model and perform several sensitivity studies to test how treatment of several model processes and emissions influence the simulation results. The study is largely solid, and the authors certainly know what they are doing. However, there are many ways in a complex model to influence the BC lifetime and simulated concentrations in remote areas. The authors only tested a few of them, and there needs to be some justification why exactly the selected ones are tested, while others are not touched upon. The authors also demonstrated some model improvements, but to what extent are they “right for the right reasons”? Couldn't some changes (including, for instance, increased emissions) just compensate errors somewhere else in the model? The comparison with the measurement data is not detailed enough to give process-specific information. Nevertheless, the paper could be published after some

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considerable improvements, as also specified below.

The language in the paper often does not differentiate well enough between facts and model results. For instance, on page 10, line 1-2, it is said: “Our results show that WBF increases BC_{snow} by 20-80% in the eight Arctic sub-regions”. In fact, the results show that, in the model, this is the case, but not that the WBF process in reality necessarily has the same effect. I think this reflects some over-confidence in the model which is not warranted. The wording should be such that the reader can distinguish between model-based findings, and findings that are more robust than just a model result. A similar example, not related to the model is “Gas flares are a rather small fraction of the global BC emissions but a dominant source in the Arctic”. Again, this is not a fact but based on one study that used a highly uncertain emission factor. The language should reflect such uncertainties, e.g., “It has been suggested” or similar.

One problem of the paper is the use of the English language and, generally, a somewhat sloppy style of writing. What I mean with the latter is, for instance, that references are not always written in the correct format (e.g., three examples on page 5, lines 28-29), or that there are quite many unnecessary mistakes like hyphenating within a line (page 5, line 23: John-son) or typos like “boundary layer eight” (Page 9, line 36). I suggest a much more careful checking of the manuscript, and a substantial improvement of the language. Numerous language errors like “The resulted BC...” (Page 9, line 3) make the paper difficult to read. I am sure there must be some native American speakers around at an American university who could help with that.

The Discussion section is more a repetition, rather than a real discussion. A discussion should go deeper, compare more with the existing literature, etc.

Page 2, ca. lines 32-35: It is true that models struggle reproducing Arctic BC. However, there have been recent improvements. For instance, the model intercomparison of Eckhardt et al. (2015) shows better results than the cited papers.

Page 11, middle paragraph: You discuss the differences it makes for snow radiative

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forcing whether BC is deposited via dry deposition, or with wet deposition. However, is this really relevant? Processes within the snow are likely to redistribute the BC. Wouldn't this quickly eliminate any differences in the mode of BC deposition?

Minor:

Page 4, line 5: It is not really true that Barrow "receives minimal influence from anthropogenic effects". I assume you mean local emissions? There is quite some influence from the town of Barrow, which is partly filtered out based on wind sector analysis.

Page 4, line 36: Three stations are named, but only two MAC values are given.

Page 11, line 12: isentropically, not isotropically

Throughout the paper: It is not Ny_Ålesund, but Ny Ålesund

Page 13, line 23: latitude-longitude bands: What is that? Do you mean grid cells?

Page 13, line 2: boundary -> boundary layer?

Language (only a few examples):

Page 3, line 11: comprehensive measurements **OF** BC_snow

Page 4, line 4: through **A** filter

Page 4, line 5: It receives minimal. . .

Page 6, line 3: over snow and ice, **AND** found; delete AND)

Page 9, line 9: leads to significantLY reduction; remove "LY"

Page 9, line 39: "when the stacks elevated BC emissions to the free troposphere": What does that mean?

Page 15, line 19: could -> cloud

Page 15, line 31: AeroComp -> Aerocom

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Page 16, line 10: in Western Russia IS biased high.

Page 16, line 30: decrease caused by

Reference:

Eckhardt, S., et al. (2015): Current model capabilities for simulating black carbon and sulfate concentrations in the Arctic atmosphere: a multi-model evaluation using a comprehensive measurement data set. Atmos. Chem. Phys. 15, 9413-9433, doi:10.5194/acp-15-9413-2015.

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-707, 2016.

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