Atmos. Chem. Phys. Discuss., 11, C8615–C8620, 2011
www.atmos-chem-phys-discuss.net/11/C8615/2011/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Short lived climate forcers from current shipping and petroleum activities in the Arctic" *by* K. Ødemark et al.

Anonymous Referee #1

Received and published: 6 September 2011

General points

This paper presents results from global atmospheric chemistry and radiative transfer modelling, to assess the radiative forcing impacts from emissions of SO2, BC, OC, NOx (and other ozone precursors) in the Arctic. Two sectors, shipping and 'petroleum activities', are investigated. I find the latter term a bit confusing – I guess it refers to oil refineries etc. – this should probably be clarified. The modelling approach seems sensible, but the presentation of results could be clearer. For example, the authors explain that the unusual characteristics of the Arctic (high albedo, continuous light/dark, high angle sun) make it different, i.e. it has starkly different seasons. Yet most of the results are presented as annual averages, thus the (presumably large) seasonal cycles in emissions, atmospheric composition, and RF are (frustratingly) concealed.

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Presumably, most of the climate forcing occurs in summer, but there may be some interesting effects in other seasons. Some of the results and discussion is quite brief and grammatically terse – this should be expanded and improved. The importance of the high albedo from the underlying ice and snow is clear, but it is less obvious why a high angle sun or continuous day/night should be important. I can imagine these factors are important, e.g. in the way aerosols scatter incoming radiation, or the photochemical lifetimes of some compounds, but these factors are not explored with model experiments, and so I don't think it is justified to include them, at least not without some further justification. If these points, and those outlined in more detail below, are rectified, then the paper should be acceptable for publication in ACP.

Specific points

p21571

l4 non-methane hydrocarbons

l5 affects -> affect

l22 forcing -> forcings

l25 Better to say identical magnitude emission reductions? Emissions are characterised by their magnitudes and distributions. Clearly, in different locations, the distributions will almost certainly differ, so describing them as identical is incorrect.

p21572

l11 on -> of

p21574

l15 emission volumes -> emissions. In several places the word 'volume' is associated with emissions, which I think is confusing. Invariably you are talking about masses, or mass fluxes, not strictly volumes.

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P21575

I think section 2.3 could benefit from a figure showing emissions maps, perhaps for NOx, BC and SO2? I guess these are shown in Peters et al., but I think they could usefully be repeated here.

Also, is there a strong seasonality in emissions? This isn't discussed, but would seem likely (especially from tourism and fishing-related emissions).

l18 Figure 1 shows the annual mean NOx change, but I would guess that the NOx change has a large seasonal cycle (much larger in winter, when photochemical processing of the NOx is switched off; although this may also be influenced by any seasonality in emissions). It would seem more useful to this reviewer for Figure 1 to show NOx values in ppt, rather than mg m-2, even if averaged over a height.

P21576

As per my previous comment, Figure 2 is an annual mean which I am sure conceals a large seasonal cycle. This is partly resolved in Figure 3, but I think it would be more useful to show winter/summer maps in Figures 1 and 2, or find some other mechanism to show the seasonality.

On line 1, both an absolute and a percentage O3 change are quoted. This is useful as it (partly) shows readers how important these local emissions are relative to other influences. It would be good to indicate percentage perturbations to NOx (and other constituents) as well, so that the relative importance (or otherwise) of local emissions is made more clear.

L7 not reformed to -> not broken down into

L12 There is a missing milli in the units: should be mW, not W.

L17 It is normal practice to number figures in the order that they are referenced in the text.

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L23 ‘reaction species’ sounds odd – rephrase this sentence

P21577

Is the CH4 RF calculation some sort of steady state extrapolation, since you only have 1 year long runs (hence CH4 will not be in equilibrium)? This is probably explained in the Berntsen et al./Myhre et al. references, but more details should be provided here.

P21578

L8-9 (and also earlier/later) When RF values are quoted, it is rather important to be clear if these refer to the average over the 60-90N region, or to global values. This is not always entirely clear. The reader should also be clearly warned of the important difference in meaning from the outset.

L12 Figure 5 shows column changes, not concentration changes.

L16-17 Revise sentence (grammar).

L20 ->of the high

L29 Should this be percent or per mille?

P21579

L1-2 Revise sentence (grammar).

L6 As earlier, I dislike the use of volume.

L20 As above, is the 20.2 mW m-2 a global value or for 60-90N?

P21580

L1 0N -> 90N!

L4 anthropogenic

L6 the Arctic

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L19 It is stated that the weaker values for OC RF over the Arctic are because the reflective aerosols are over bright surfaces, but this argument is not mentioned with respect to SO4 – why not?

L27 Equation (1): Why is there a 't' on the left-hand side? I suggest you use the nomenclature on p210 of IPCC AR4.

P21581

Section 4.1 on uncertainties seems brief and not very comprehensive. Aren't there important uncertainties associated with the indirect effect and BC on snow, for example? It seems odd just to highlight plume effects on ozone.

P21582

L7 leads -> lead

L9 exert -> exerts

L11 strongest -> stronger

L18-19 Why is the high solar angle important? Also why is continuous light/dark important? I can imagine these features of the Arctic are important, but I don't think you have demonstrated they make any difference in the experiments you have presented.

L21 show -> shows

P21583

You refer to potential changes in human activity in the Arctic – but these would also affect (for example) your RF calculations, as the underlying albedo would change. This sort of effect should also be mentioned.

P21589

Table 1: not volumes. You should clarify units – are NMVOC in kt-C or kt-NMVOC, is SO2 in kt-SO2, is NOx in kt-N?, etc.

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P21590

Table 2: I would refer to these as column amounts, rather than burdens.

P21592

Figure 1: Why not show in ppt, a more commonly used unit?

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 21569, 2011.