**Atmospheric
Chemistry
and Physics
Discussions**

Interactive comment on "Arctic climate response to forcing from light-absorbing particles in snow and sea ice in CESM" *by* N. Goldenson et al.

Anonymous Referee #1

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This is a well-written description of well-designed experiments isolating the climate forcing and response due to absorption of sunlight by black carbon and dust in snow and ice. It complements previous studies that focused on land and ocean separately. The selection of figures is appropriate and the figures nicely illustrate key points. Statistical significance of all results is provided.

The most significant comment is regarding page 5353, last paragraph. The explanation for not comparing simulated and observed BC concentrations over land is not convincing, particularly given the much larger deposition rates there. Please add land data to your analysis.

1. Page 5342, lines 15-19. The text implies that the number of wavelengths treated for absorbing particles is limited by the cost of transporting particulate tracers in the

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sea ice model. I don't think that is the case. I suggest removing the phrase "and wavelengths" and offer another explanation for the lower number of wavelengths used in the sea ice model later, in section 2.2. 2.Page 5342, lines 21-22. This sentence is confusing, as it seems to say there are another two layers of snow at the top of the ice. I suggest instead "Light absorption by particulates is treated in two layers of snow and the upper two layers of sea ice." 3. Page 5347, first paragraph. The sentences in this paragraph seem unrelated. The first sentence seems needless and should be removed. The second and fourth sentences say almost the same thing. The third sentence belongs in the section on experiment design, and the phrase "for which those light transmission differences might be relevant to simulations" is confusing and seems to be meaningless. 4. Page 5347, line 12. Remove "inherent", as it seems superfluous. 5. Page 5347, last line. Remove the phrase "as discussed in Sect. 2.1.2". 6. Page 5350, line 17. Change "BC in snow and sea ice as well as in the atmosphere" to "BC in the atmosphere as well as in snow and sea ice". 7. Page 5350, lines 18-19. This sentence is not parallel. I suggest instead "Unlike GATOR, which calculates deposition fluxes interactively with the atmospheric aerosol, the CESM simulations presented here will prescribe deposition rates . . ." 8. Page 5352, last paragraph. You should also say here that snow on Greenland never melts completely, so there is no need to treat effects of absorbing particles on the albedo of the ice beneath the snow. 9. Page 5353, lines 8-9. Please state the depth range of the measurements too, and the depth of the model layers with particulates. 10. Page 5353, last paragraph. Simulated BC concentrations are realistic, not reasonable. 11. Page 5353. Insert "the" before "same". 12. Page 53556, lines 8-9. Please explain the difference in the season of maximum forcing and temperature response. I suspect it involves changes in the insulation of heat exchange between the ocean and atmosphere, but any explanation should be backed up with analysis. 13. Page 5358, line 2. Change "are" to "is". 14. Page 5359, last line. Say something about Figure 13. 15. Page 5364, line 16. Insert "from" before "about", and replace "parts" with "contributions".

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