

Review of “Impact of a Strong Biomass Burning Event on the Radiative Forcing in the Arctic” by Lisok et al.

General comment:

This study investigating the intense radiative impacts in the Arctic (Ny-Ålesund, Svalbard) of an extreme biomass burning event is scientifically significant and of good scientific quality, and is in my opinion appropriate for ACP. However, I think there are serious issues with the English language. Specifically, I found that, while some sections (e.g. 2.2, 2.3, 3.7) are well written, most sections of the manuscript (and especially the introduction and Sections 3.4) are very difficult to understand even by someone already quite familiar with the topic. As a result, I think the paper fails to pass these ACP criteria

(https://www.atmospheric-chemistry-and-physics.net/peer_review/review_criteria.html)

10- Is the overall presentation well structured and clear?

11- Is the language fluent and precise?

I think the authors should have another look at the English language in the whole paper, and in the indicated sections in particular.

Comments (line numbers and pages refer to the revised version of the manuscript with tracked changes):

1. Title: “impact ...on the radiative forcing in the Arctic”, the wording is strange, in my opinion it should be instead “Radiative forcing of a strong BB event” or (better) “Radiative impact of a strong BB event”
2. Abstract: “the factor of 10 in comparison to the average” should be “a factor of 10 above the average”
3. P1 L17: “2.0 Pg of carbon aerosols is released into the atmosphere **by fires** each year”, for now the text makes it seem like this includes all sources.
4. P2 L3: **“90% of which are present in the fine mode (sizes XX nm – XX nm)”**
5. P2 L5-18: This section is unfortunately extremely difficult to read, please rephrase.
6. P2 L16: Please rephrase, BB plumes are darker than bright clouds or snow but do not directly decrease the albedo of clouds and snow (unless this sentence is about absorbing aerosols deposited on snow or cloud/aerosol interactions).
7. P2 L24 This is also very unclear. “it is unlikely”, what is “it” ?
8. P2 L28 Please define AERONET and add a reference
9. P3 L26, I think you should use “in the vicinity of Ny-Ålesund (Svalbard)” here instead of “Kongsfjorden”, since “Kongsfjorden”, will not be known by most readers. I understand that this was implemented to remove “Ny-Ålesund valley” from the manuscript, but in most cases it seems like using “Ny-Ålesund” or “near Ny-Ålesund” would be clearer than using “Kongsfjorden”.
10. P3 L 27 A section number is missing.

11. P4 L9-10: If simulation names are introduced, they should be mentioned later in the text when appropriate, e.g. when showing simulation results in Figure 3, mention that this is the ‘polluted’ simulation.
12. P4 L7: I think you should mention there that thermodynamical variables are “from radiosonde measurements (see section ??)”, for now it seems like you say that they are from HITRAN.
13. P4 L 11: Say why you also use Fu-Liou, if MODTRAN is the main RTM used in the study.
14. P5 L15: This should also say what GEM-AQ is used for.
15. P7 L22: What do you mean by “generalized”? Do you mean “regridded” or “upscaled”?
16. P9 L7: Does this apply to aged BB aerosols?
17. P10 L 23: For clarity I suggest “were changed **by a factor** of 10”
18. P11 fig1: Replace “tau/alpha” by “tau & alpha”, for now it seems like the ratio of the 2 is plotted. Same for omega/CL.
19. P11 L6 “variability of alpha was rather stable” should be replaced by “variability of alpha was rather low” or “rather limited”.
20. P12 L26 remove “may” in “may support the above statement”
21. P12 L30: Please rephrase, “exemplary” here is confusing, since this word usually means “perfect, exceptional” and also less commonly “providing an example”.
22. P13 Fig2. There is a problem with the legend and labels in this figure. For example the green line is supposed to be sigma_a_ext but is in fact only sigma_a_ext observed by LIDAR. The legend should say specifically that green is observed sigma_ext, or lines in the second column (GEM-AQ) should also be in green. Columns should also be labeled to make this clearer, e.g. column 2 should be “GEM-AQ sigma_a_ext”, column 1 should be “observed ...”
23. P14 L1. It says there that in the last case vertical mixing is suppressed, when the following paragraph only mentions “the existence of vertical mixing”. Where is this suppression shown or discussed?
24. P14 l6, replace “the next day” by “the 11th”, since just above the “10th and 11th” are mentioned, which would mean that “the next day” is the 12th.
25. P14 L17 Do you really mean “resulting from” (smoke mixing creates cumulus) or do you mean “resulting in” (cumulus lead to smoke mixing)?
26. P14 L20: Please rephrase the last sentence, which I could not understand as is.
27. Section 3.3: I think you should mention here that (if I’m not mistaken) part of this good correlation is due to the daily cycle in insolation.
28. P15 L 2 I think the following would be clearer: “**occasionally** represent all-sky conditions”
29. P15 L11 and elsewhere: Is “translation” the right term here? Maybe “correction”? This is also present later in the text.
30. P15 L13-15 There’s a problem here with how the parentheses are placed, for now it seems like radiometer measurements are labeled as “polluted simulation”.

31. P15 L20-24: this is also very confusing, consider separating into 2 sentences, one comparing model and measurements, and one comparing the 2 model simulations.
32. Section 3.4. The naming of the modeled quantities is confusing, since the simulations are called “polluted” and “reference”, but the model results use the index “c” (e.g. F_c_in) for the “reference” simulation and no index for the polluted case. Maybe use F_pol_in and F_ref_in for clarity (or p and r). I suppose “c” stands for “clean” but you present this simulation as a “reference”, not “clean” case. This is also not clear in the caption of Figure 4, where you say “no aerosol load” instead of “reference aerosols”.
33. P16 L13-19. This section is extremely hard to understand, please rephrase and correct the English.
34. P 16 L 33-35. You mention 3 variables but then mention discrepancies between “both variables”. What variables are these? Do you mean “all variables”?
35. P17 L2: There should be other / more general references (e.g. review papers, multimodel analysis, IPCC) than Stone et al. (2008) mentioning this, since this is a well-known feature of the RF of aerosols.
36. P17 L 10 “the RF sign **at TOA**”
37. P17 L11-16: If I’m not mistaken, if both BC and OC increase a lot and sulfate increases less, than the ratio of BC/(OC+sulfate) should increase and all else being equal, the plume would be more absorbing than reference conditions. In addition, if the reference conditions were causing a positive RF, then increasing aerosol levels would also likely cause a positive RF (all else being equal). I agree that in this case, increased OC overwhelms the BC signal (since RF results are negative) but I am not sure the explanation is as straightforward as this section makes it appear. As a result I don’t think this part adds a lot to the understanding of the event and I suggest removing these lines, or making a stronger case for this.
38. P18 L 14: I suggest removing “We found” and adding references supporting these statements, since I don’t think this was investigated in detail in the present study.
39. P18 L25: Markowicz et al. (2017) studied the same case, right? If they did, this should be mentioned explicitly here, e.g. “transport of this BB plume over the Northern Hemisphere” or “the same BB plume”
40. P18 L29: Can you say here why this comparison is only done over the ocean?
41. P18 L30; Can you remind why the input parameters for the models are different, i.e. MODTRAN uses LIDAR and radiosondes, Fu-Liou uses NAAPS etc.
42. P20 L13: “of MODTRAN and simulations is”, “Fu-Liou” is missing from the text here?
43. P21 L 11: “3D distribution”, maybe use instead “3D effects on radiative forcing” or something similar, since you don’t show directly here “3D distributions” but 3D effects on RF.
44. P21 L 12: You can remind here where this single-cell is located.
45. P21 L 16-23: This section is confusing, consider giving a name to the simulations (e.g. Control and PP) and saying clearly at the beginning that you perform 2 simulations, one with and one without 3D effects. The way this section is worded makes it seem like “ICA” and “plane-parallel” are equivalent terms, but it is not clear to a reader unfamiliar with these terms if this is true since

these terms are not clearly defined. If this is indeed the case, I suggest dropping most mentions of ICA later in the text, and only include “ICA” here when describing the “PP” simulation.

46. P21 L.25: RFcell_rel is not properly defined here and it is not explained why this quantity is needed in addition to RF_rel.
47. P22 L1: “the noise of the Monte-Carlo method may enhance it”. Can you elaborate why?
48. P25 L16: Can you add a concluding remark discussing the interest or significance of these ILES results?
49. P25 L 27: This should be LIDAR instead of lidar.