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Comment on bg-2021-83

Anonymous Referee #2

Referee comment on "Reviews and syntheses: Arctic fire regimes and emissions in the 21st century" by Jessica L. McCarty et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-83-RC2, 2021

The manuscript by McCarty et al. presents a review of our current understanding on fire regimes in the Arctic and boreal regions, as well as how they are changing. The work has been motivated by policy questions, and therefore its content is of both science and policy relevance. The main foci of the review are a) the drivers of Arctic fires, b) the future of Arctic fires, c) emissions from high-latitude fires, and c) the role of humans. In addition to reviewing existing literature, the authors also present new analysis on Arctic wildfire emissions that builds on the 2015 AMAP assessment of black carbon and ozone. I find the paper well-written and nicely structured, and its content a useful addition to the existing literature on Arctic wildfire and its future. I have no major reservations regarding the manuscript, and believe that it will be ready for publication following the minor refinements that I list below.

SPECIFIC COMMENTS:

Page 2, Line 41: I suggest rephrasing to "and how severe future Arctic wildfire seasons can potentially be".

Page 3, Line 68: Suggested rephrasing: "(both starting earlier and ending later)"

Section 3, paragraph 3: It is worth also highlighting that the Arctic has been identified as a hot-spot region for the interannual variability of key atmospheric constituents, with wildfire being the major driver of this variability (Fisher et al., 2010; Monks et al., 2012; Voulgarakis et al., 2015).

Page 3, Line 90: Subscript 2 in CO2.

Page 4, Sect. 2: This section contains plenty of useful information and references, but could benefit from better organisation. It features a mixed discussion about different regions, periods, and types of fires (human-driven and natural) in a way that is not well structured and coherent. I suggested some re-organisation of the section so that it flows better.

Page 4, Lines 114-115: Aren't forest fires and peat fires different kinds of wildfires (and, therefore, wildland fires, which is the broader term)? Also, doesn't the term 'wildland fire' include prescribed fires?

Page 4, Lines 117-118: Fuel condition as well as ignitions depend on climate too. Could rephrase to "Broadly speaking, wildfires are driven by climate and weather conditions influencing flammability, fuels and fuel conditions…"

Page 4, Line 119: Human-caused fires can also be accidental.

Page 4, Line 120: Need a space before "Pollen-based".

Page 4, Lines 125-127: This sentence is probably not needed, as it is stating something obvious, which is not true just for Arctic fires.

Page 5, Lines 129: Precipitation is also a determinant of fire weather. Also, what about fuel abundance?

Page 5, Line 133: scenario 8.5 -> scenario RCP8.5

Fig. 1: Instead of "boreal forest" or "boreal", maybe use "taiga", to be consistent with other parts of the manuscript?

Page 6, Line 185: Why "in turn"?

Page 7, Line 203: "predicted to expand by as much as 20 days globally" – under which scenario?

Page 9, Line 270: I suggest rephrasing to "and a decrease in its regeneration cycle"

Page 10, Lines 298-299: I am not sure it will be clear to the reader after reading this paragraph why "Therefore… the springtime burning of northern grasslands, peatlands, and croplands - often human-caused - means these emissions are more likely to be transported to the Arctic than summertime forest fires". Please clarify.

Page 11, Line 335: I would suggest "Note, however" rather than "Note also".

Page 11, Line 340: Certainly there is a sharper trend in >60N, but I would not say that the following statement is supported by the figure: "More fire is now taking place north of 60° N than in the temperate zone of 45° to 50° N". Also, FINN does not show an increasing trend anywhere.

Page 11, Lines 344-346: 2008 appears both in highest and in lowest!

Page 11, Line 352: Please subscript 4 in CH4.

Page 12, Lines 366-367: "fires in temperate zones of the CONUS tend to emit double the emissions of boreal ecosystems" – would be useful to the readers to comment on why this happens.

Page 12, last paragraph of section: Focusing on BC deposition effects in Greenland is nice, but maybe this session requires some mention of findings from other regions regarding this mechanism? Otherwise the focus on Greenland seems a bit disproportional.

Page 12, Lines 372: on deposition -> on BC deposition

Page 12, Lines 386-387: "while the average instantaneous BOA (Bottom Of the

Atmosphere) radiative forcing over Greenland at noon on 31 August 2017 (post-fire) was between 0.03 and 0.04 Wm-2, with locally occurring maxima up to 0.77 Wm-2" – does this refer to the atmospheric effect of aerosols (not the surface albedo effect)? Please clarify.

Section 5: There are some bits where GFAS emissions are referred to as "wildfire emissions". Given that they also include e.g. agricultural fire emissions, I would suggest referring to them as "biomass burning emissions".

Page 13, Line 411: Maybe "replicate" is too strong a word?

Page 14, Line 427: phenomena -> phenomenon

Page 14, Line 450: black -> black carbon

Page 15, Lines 464-466: Suggest rephrasing to "…and fires from grasslands, forests, and agricultural lands in southern Siberia (Kukavskaya et al., 2016) and the Russian Far East (Hayasaka et al., 2020) are most common during the spring months of March, April, and May."

Page 15, Line 491: Maybe instead of "in practical terms" the authors meant to write "in theory"?

Page 16, Line 515: is important -> they are important

Page 17, Lines 533-535: This sentence may need to be rephrased as it does not read very clearly.

Page 18, Lines 569-571: There has also been an important body of recent laboratory work on how organic soils burn and how peat fires spread, e.g. Christensen et al. (2020), Santoso et al. (2021), Huang et al. (2019), Huang et al. (2017), Huang et al. (2015), Prat-Guitart (2016), Yuan et al. (2021), amongst others.

Page 18, Line 580: Here it is worth mentioning that peat fires and related feedbacks are not typically represented in current Earth system models, which limits predictability of the future. Suitable references could be Loisel et al. (2020) and Lasslop et al. (2019).

Page 20, Lines 687-688: What does "agreement was less than 10%" mean?

Page 22, Lines 700-702: it is worth mentioning whether there is any explanation of why GWIS may be giving such contrasting performance when compared to ground-truth information compared in neighbouring locations such as Noway and Sweden.

Conclusions: It would be good to highlight how important it will be to improve our understanding of the future of Arctic wildfires and emissions, for being able to better predict the future of Earth system processes, both at high latitudes and globally.

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