Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2020-80-RC2, 2020

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Trends and spatial shifts in lightning fires and smoke concentrations in response to 21st century climate over the forests of the Western United States" *by* Yang Li et al.

Alan Wei Lun Lim (Referee)

limwlalan@link.cuhk.edu.hk

Received and published: 7 April 2020

Overview

This paper talks about the impacts of future lightning induced wildfires in western United States as projected by a series of computational models. The main model is a fire model that uses future meteorological and land properties as inputs and predicts the occurrences of fires and how much smoke particulate emissions (black carbon and organic carbon) are generated as a result of the fires. Emissions are then used as inputs for a chemistry transport model to predict future impacts on air quality. The paper presents some very interesting results. Parts of the paper lacks specificity, hence

some clarifications are necessary.

Major Suggestions

The authors may want to consider to implement land use changes according to the RCP scenarios in the LPJ-LMfire dynamic vegetation model instead of just assuming 30% increase in cropland and pastures. I understand that anthropogenic effects may be hard to ascertain as per discussed in the paper, but it may be worthwhile to at least look at changes in croplands versus forest cover. For example in RCP4.5: more forests, less crops; RCP8.5: less forests, more crops. Having more cropland in RCP8.5 scenario may lead to more agricultural fires whereas having larger forest cover without human intervention in RCP4.5 scenario may lead to more lightning fires.

I would like to clarify if the model account for agricultural fires? In Table 2, the column for LPJ-LMfire seem to suggest that this fire model does not model agricultural fires although the GEOS-Chem model has a PFT for crops. I guess if the focus of the paper is not about anthropogenic influences on land use changes, and thus lightning fires, then not having this is fine.

It may make the paper more interesting if the authors also list and discuss in greater detail about the possible reasons for the increase in fires, for example, despite having similar lightning activity, stable air and decreased wind led to higher temperatures and hence increasing the occurrences of lightning fires. It may be scientifically interesting to also discuss the most important factor in determining lightning induced fires.

The paper could not discuss any feedback effects of fire on meteorology because the methodology employed simply did not allow such an investigation. Feedback effects of fire on meteorology can be very scientifically interesting, but complicated to investigate. Perhaps this could be future work.

Minor Suggestions

Line 26: I suggest looking at Val Martin, et.al., 2015. Atmos. Chem. Phys., 15, 2805–

2823, 2015. It may be a better cite since it also looks at air pollution and national parks, and is a later research paper.

Line 47: Also check out Li, et. al., 2019. Atmos. Chem. Phys., 19, 12545–12567, 2019 for many different fire models.

Line 81 seems to have a missing citation.

Line 84: A clarification on how the GISS model predicts lightning flashes would be beneficial. Also, only cloud to ground lightning would affect your study. A further clarification on whether cloud to ground lightning remains unchanged throughout the century would be good.

Line 106: It may be necessary to describe in greater detail how each factor in the LPJ-LMfire model affect the predicted fires (incidences of fires, intensity, area burned, etc.) because this is what the whole paper is about.

Line 174: Smoke PM definition should be moved to line 42 to define smoke PM earlier.

Line 291: I would like to suggest a clarification: You are using an offline coupling technique. The present way of phrasing may confuse readers into thinking the fire and atmosphere model are fully coupled.

Supplement Line 24: spelling of lightning

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