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Interactive comment on "Climate and demographic impacts on wildfire air pollution hazards during the 21st century" *by* Wolfgang Knorr et al.

Anonymous Referee #2

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Review of "Climate and demographic impacts on wildfire air pollution hazard during the 21st century," by Knorr et al.

Knorr and coauthors use the global dynamic vegetation model LPJ-GUESS to calculate the response of air quality to changes in wildfires in the recent past and going forward to 2100. The paper is one in a series of papers on future wildfires. An earlier paper (Knorr et al., 2016) examined future trends in area burned. This paper compares annual mean pollution from anthropogenic sources to that from smoke. The authors find that air quality in many regions of the world is dominated by wildfire smoke in the present-day and that the number of people and the percentage of world population exposed to high levels of smoke PM2.5 from wildfires will increase in all the scenarios they considered.

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Discussion paper

In some regions – e.g. south Saharan Africa – the trend in smoke pollution depends on whether population densities will increase in these regions.

I cannot recommend the paper for publication as the paper's method for calculating mean PM2.5 concentrations at the surface is simplistic. The authors neglect horizontal transport between 0.5 x 0.5 gridcells and compute an annual budget based on annual mean emissions and pollutant lifetime. But smoke can be transported many hundreds of kilometers downwind of source fires. See for example Lee et al. (2005), Singh and Kaskaoutis (2014), and Marlier et al. (2015). The approach in this paper likely overestimates PM2.5 in source regions and underestimates PM2.5 in regions downwind.

Other criticisms. 1. The authors need to better identify the new results in this work. For example, it wasn't clear whether the finding that population density could affect future wildfires occurrence had already been presented in Knorr et al. (2016). A brief 1-2 paragraph summary of the Knorr et al. (2016) results would be helpful to clear up this confusion. Detailed reasons for the modeled response of wildfire to climate change were absent in the current paper, and the summary could succinctly describe these drivers as determined by Knorr et al. (2016). The summary could also describe what triggers fires in LJM-GUESS and reassure the reader that present-day fire occurrence and area burned have been validated against observations.

2. The authors should focus just on trends in wildfire smoke, not in anthropogenic pollution. The atmospheric community has already extensively examined projected trends in anthropogenic pollution (e.g., Fiore et al., 2012). As is, it is difficult for the reader to determine what accounts for the PM2.5 trends in Figures 4 and 5.

3. The paper describes three types of fires: wildfire, deforestation fires, and peat fires. It looks like agricultural fires are lumped in with wildfires. Is that right, and if yes, what does that mean for projected area burned? Some studies put agricultural fires at 10% of total fire occurrence (e.g., Korontzi et al., 2006), with areas such as China and eastern Europe exhibiting much larger occurrences. See also Singh and Kaskaoutis

(2014) regarding agricultural fires in India and Figure 12 in van der Werf et al. (2010), which puts wildfire emissions from agricultural burning at 25-30% in Europe and central Asia, including China.

It's also not clear how deforestation and peat fires are distinguished from wildfires.

4. It's not clear that the authors have validated the PM2.5 results against observations. Given the simple method of calculating PM2.5 concentrations, readers are curious how well this method works. Also does the PM2.5 in their calculations include both black carbon and organic carbon?

5. The paper is long, about double what is needed. The authors should decide on key points regarding wildfire PM2.5 and delete the rest.

6. The paper focuses on annual mean PM2.5, when fire is episodic and strongly seasonal. Emerging evidence suggests that smoke episodes have large impacts on human health, even if the annual mean PM2.5 is lower than the EPA threshold. Using annual mean PM2.5 minimizes the importance of such episodes as well as the seasonality. See for example, Haikerwal et al. (2015). It would be good if the paper could discuss PM2.5 trends during wildfire seasons, which differ around the world.

7. Other relevant papers that examine wildfire PM2.5 in the future atmosphere include Spracklen et al. (2009), Pechony et al. (2010), and Yue et al. (2013).

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