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Interactive comment on "Contiguous United States wildland fire emission estimates during 2003–2015" *by* Shawn P. Urbanski et al.

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Referee #1 Comments

RCX. Denotes the referee comment

ARX. Denotes the authors' response including associated manuscript revisions

RC1. In the introduction, the authors describe the various emissions inventories for the US (page 1, third paragraph). They may wish to mention Larkin, N. K., Raffuse, S. M., & Strand, T. M. (2014). Wildland fire emissions, carbon, and climate: US emissions inventories. Forest Ecology and Management, 317, 61-69.

Also, the authors may wish to mention the work by Canadians, which follows a similar

methodology to that presented in this manuscript

De Groot, W.J., Landry, R., Kurz, W.A., Anderson, K.R., Englefield, P., Fraser, R.H., Hall, R.J., Banfield, E., Raymond, D.A., Decker, V. and Lynham, T.J., 2007. Estimating direct carbon emissions from Canadian wildland fires1. International Journal of Wildland Fire, 16(5), pp.593-606.

Anderson, K., Simpson, B., Hall, R.J., Englefield, P., Gartrell, M. and Metsaranta, J.M., 2015. Integrating forest fuels and land cover data for improved estimation of fuel consumption and carbon emissions from boreal fires. International Journal of Wildland Fire, 24(5), pp.665-679.

AR1. We have added the Larkin et al. reference to P3, line 31. The revised text reads:

"Several biomass burning emission inventories that include CONUS are available (van der Werf et al., 2017; Zhang et al., 2017; French et al., 2014; Larkin et al., 2014; Wiedinmyer et al., 2011)."

We have also referenced the Canadian wildfire emission inventories at Page 4, Line 1. The text now reads:

"MFLEI uses a forest type map and a new forest fuel classification, both of which are based on a national forest inventory dataset, providing more accurate fuel loading estimates compared to the fuels layer used in WFEIS (Keane et al., 2013). The methodology used to develop MFLEI is similar to that employed to develop carbon emission estimates for Canadian wildland fires (Anderson et al., 2015; De Groot et al., 2007). As a retrospective inventory, MFLEI is able to leverage geospatial fire activity information including high spatial resolution burned area and burn severity products that are not available for real-time inventories (e.g. FiNN)."

RC2.On page 2, line 26, when the authors state "each burned grid cell is burned in its entirety", I assume the authors are referring to spatial extent (ha) and not fuel load (tonnes).

AR2. The reviewer is correct. We did not intend to imply that all fuel present was burned. The text has been changed to: "The inventory assumes that the burning and emissions for each burned grid cell occur on the estimated burn day (Sect. 2.3.2)."

RC3. Under 2.2 Land cover, are there not several US land cover maps (NFDRS, Hardy, LANDFIRE, Ok-Wen, FCCS), that produce different fuel loads? The authors may wish to reference these and justify their choice.

AR3. The reviewer is correct, there are several CONUS wide maps of land cover and fuel type. The LANDFIRE Project (https://www.landfire.gov/data_overviews.php) has created many geospatial data products including fire behavior fuel models (FBFM), which include the model used for NFDRS, vegetation type, and surface fuel loading models (FCCS and FLM). We assembled our own land cover map so we could use the large dataset (>27,000 plots) of USFS Forest Inventory and Analysis Program vegetation and fuels data for forests and use fuel loading from the Rangeland Vegetation Simulator (RVS) for grasslands and shrublands. The RVS map and fuel loading was developed using LANDFIRE products along with MODIS NDVI and rangeland productivity data as described in Sect. 2.4.2. Our justification for assembling our own land cover map is detailed in following text which has been added to Section 2.2 of the manuscript on Page 5, Line 4:

"The LANDFIRE project (LANDFIRE, 2016) provides CONUS wide maps for Fuel Characteristics Classification System (FCCS; Ottmar et al., 2007; McKenzie et al., 2012) and Fuel Loading Models (FLM, Lutes et al., 2006) fuelbed models, both of which are suitable for estimating fuel consumption and emissions. FCCS is used in both the NEI+ (Larkin et al., 2014) and WFEIS (French et al., 2014) CONUS fire emission inventories. We assembled a new map based on the USFS forest type group map because it provides three important benefits over other land cover maps with respect to forests. First, the accuracy of the forest type group map is significantly better than either the FCCS or FLM maps (Keane et al., 2013). Second, it enabled us to use the Fuels Type Group (FTG) surface fuel classification system (Sect. 2.4.1) which provides a more accurate

estimate of average surface fuel loading than either the FCCS or FLM (Keane et al., 2013). Finally, because the USFS forest type group classification is an FIA plot variable, we are able to use the large (>27,000 plots) dataset of FIA fuel measurements estimate uncertainty in surface fuel loading and emissions (Sect. 2.9)."

RC4. Under 2.3.3 Unburned and lightly burned grid cells, the authors describe the 6 BSEV categories inside the fire polygon. I am not clear on how a category of increasing green would be mapped inside a fire polygon. Presumably this would have described in the referenced paper (Eidenshink et al., 2007) but it would be helpful to briefly describe the process (perhaps in 2.3.1).

AR4. The burn severity classification of increased greenness is very rare. During our period (2003-2015) only 0.3% of MTBS pixels were classified as increased greenness. Given the rare occurrence of the increased greenness classification, it has negligible effect on our emission product. The MTBS burn severity class data are derived from Landsat imagery by analysis of a pre-fire scene and a post-fire scene to create a Differenced Normalized Burn Ratio (dNBR) image (as described in Eidenshink et al., 2007). For some fires, an increased response in vegetation productivity, results in increased greenness. This could results from an area that did not burn and was greener at the time of the post-fire scene than it was pre-fire scene. It is not uncommon for the pre-fire scene to be from the previous year. In which case an area that did not burn or was very lightly burned may have increased greenness compared to the previous year due to increased productivity or other factors. The availability of optimal Landsat scenes is limited by the 16-day Landsat revisit cycle, atmospheric conditions (clouds, smoke from active fires, terrain shadows), and factors such as sun angle and length of growing season limit the availability of optimal scenes for analysis (https://www.mtbs.gov/mapping-methods).

Given the rare occurrence (0.3% of pixels) and negligible effect of the increased greenness classification, we believe that an explanation is not warranted in the text. We have revised the text clarifying that the increased greenness classification is very rare.

In Sect. 2.3.3 Unburned and lightly burned pixels, Page 8, line 14, following the sentence "We elected to designate BSEV = 1 as unburned, which is consistent with MTBS program publications that describe this classification as areas which are either unburned or where visible fire effects occupy < 5 % of the site at the time of observation (Schwind, 2008)." we have added the text:

"The increased green classification may indicate unburned that exhibited more green at the time of the post-fire Landsat scene relative to the pre-fire scene. The increased green classification was assigned to just 0.3% of MTBS pixels and thus has a negligible impact on our inventory."

Lutes, D. C., Keane, R. E. and Caratti, J. F.: A surface fuel classification for estimating fire effects, Int. J. Wildland Fire, 18(7), 802–814, doi:10.1071/WF08062, 2009.
McKenzie, D., French, N. H. F. and Ottmar, R. D.: National database for calculating fuel available to wildfires, Eos, Transactions American Geophysical Union, 93(6), 57–58, doi:10.1029/2012EO060002, 2012.

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