

Interactive comment on “Particulate emissions from large North American wildfires estimated using a new top-down method” by T. Nikonovas et al.

Anonymous Referee #2

Received and published: 22 December 2016

Dear Authors, First thank you for a well-written description of a very large and hopefully significant experiment. Your approach includes numerous novel components, and represents a significant new attempt at reducing uncertainties in a crucial area where uncertainties remain very large, biomass burning emissions. My comments are organized roughly from important questions about the science to minor issues with the text, with typos and such at the end of this review. I look forward to seeing this study finalized and in print.

Your atmospheric simulation of smoke transport explicitly retains all smoke in the boundary layer. Wind shear in the vertical column, and other transport differences, will be a source of error in your estimates of smoke from many active fires that re-

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lease smoke above the boundary layer (around 20% according to Val Martin ACP 2013 and Peterson 2014 JGR, but both of these estimates are based on satellite data with 1030am local overpass time, and thus likely conservative relative to overall fire behavior). Is there any way these effects can be estimated with the data you have corralled for this study?

The difference between boreal and temperate fires' day-night behavior is an interesting sidelight to this work. However, there is a good chance it is an artifact, and you must explore this before you finalize the paper. The basic idea is this: Terra and Aqua MODIS have nominal equatorial overpass times of 1030 and 1330 local solar time (LST, this can be calculated as $UTC + [\text{longitude}/15.]$, where longitude is from -180 to 180), with the opposite orbital nodes crossing at 2230 and 0130 respectively. At higher latitudes, the wide MODIS swath covers a larger range of LST. Thus, a portion of the 2230 Terra swath will have $LST < 2100$, and that portion will increase with latitude. So, if you define "daytime fires" as fires detected from 0900-2100LST, this will include all fires from the 1030 Terra overpass, all fires from the 1330 Aqua overpass, and depending on latitude, some fires from the 2230 Terra overpass. In order to avoid this, you should run the calculation using daytime=0600-1800LST, and see if the boreal-vs-temperate difference you observed holds up. I have attached a figure to illustrate this point, based on the MOD14 MODIS fire product.

page 4 Section 2.5 AOT attribution. This is the first of several very complicated steps, it is worth the effort to express very carefully how this was done. You have these ingredients:

- 1) modeled plume extent: this is a point cloud with the locations of all the smoke particle endpoints at solar noon on each day
- 2) MODIS AOT: you have the centroid location and retrieved AOT of each valid AOT retrieval on the day
- 3) background MODIS AOT: you have MODIS AOT and centroids for valid retrievals

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from two days prior to construct the background estimate

As I understand it, you take these steps:

- 1) you interpolate modeled plume extent to 25km equal area grid, taking every grid cell that contains a portion of the plume and including it in the sample;
- 2) you interpolate MODIS AOD to the same 25km equal area grid;
- 3) you determine whether the number of valid same-day MODIS AOT data is at least $(\text{plume area} / 100\text{km}^2) * 0.8$ ("80% coverage of plume area")

If #3:

- 4) You calculate the background AOT using the 2-days-prior AOT
- 5) you calculate the smoke AOT increment for each grid cell by subtracting background AOT from same-day AOT

If the median AOT increment is > 0 :

- 6) you set negative AOT increments equal to zero
- 7) steps 1-6 are repeated for smoke transport times of up to 3 days, in increments of 12 hours.
- 8) If multiple days / multiple fires contribute to a grid cell AOT increment, you apportion the grid cell AOT increment to fire events and emission periods according to the number of smoke particles from the HYSPLIT simulation in each grid cell

Note that the cutoff in Step 3 will systematically eliminate coverage from scenes covered by the MODIS swath edge, because the smoke retrievals will be too few to cover the area based on the assumed 100km² retrieval footprint.

page 2 Line 55: "Consumed biomass estimates inherit errors of... fire location..."
The papers cited here cover a lot of ground, but I don't think they really cover errors associated with fire location. That source of uncertainty is described by Hyer and Reid

(GRL, 2007).

page 3 line 11 “larger than 100km² and with duration longer than 7 days” Please elaborate slightly on the data and calculations used for these determinations, especially the 7 days.

page 3 line 15 the Stocks and Kasischke papers relate to fire size distribution in the boreal forest. While the dominance of large fires has been documented for certain parts of temperate north America (see Strauss, Bednar, and Mees, Forest Science, 1989), it does not hold for all areas and in any event is not covered by those citations.

Page 3 line 25 “particles were continuously injected” HYSPLIT in your configuration simulates transport of discrete particles, please specify the interval at which particles were released in HYSPLIT

Page 3 line 25 “vertically distributed” please specify the discrete intervals at which particles were released in HYSPLIT

page 3 line 25 “within the planetary boundary layer” as diagnosed by GDAS? Please specify.

page 4 line 6 “is about twice the size at swath edges.” Actually, the single MODIS pixels increase roughly 8x in size from nadir to swath edge, and the 20x20 pixel footprints used by MxD04_L2 increase proportionally. However, there is significant overlap between MxD04_L2 footprints at swath edge, see Sayer et al. (<http://www.atmos-meas-tech.net/8/5277/2015/>). You may not need to quantitatively account for this for this study, but you should be aware of this.

Page 4 Section 2.4 how were AOT data selected from MxD04_L2 (quality flags, cloud fraction, etc.)?

Page 7 line 21: “the agreement between two or more estimates for the same emission period is reasonably static across the plume age categories.” I do not see where this is shown in figures or tables— if it is there somewhere, please direct the reader to it when

you make this statement. One simple change would be to add a second panel to Figure 5 showing the agreement between Day 1 and Day 3 AOT for the same event/time pairs.

Minor corrections and typos

page 1 line 14 “take into account . . . efficiency when converting”

page 1 Line 27 “increase in AOT”

page 2 Line 50 “introduced by” => “results from”

page 2 Line 51 “within biome” => “within-biome”

page 2 Line 57 “are effected” => “are affected”

page 2 Line 63 “representative to” => “representative of”

page 2 Line 67 “need of” => “need for”

page 3 line 27 “proportional to active fire” => “proportional to the active fire”

page 3 line 35 “where detected” => “were detected”

page 3 line 36 “minimum positive value” => “minimum nonzero value”

page 3 line 37 capitalization

page 4 line 10 “have an upper limit”

page 4 line 83 “allow to retrieve” => “allow retrieval of”

page 4 line 75 “representative to” => “representative of”

Page 4 line 92 “(table 1).”

Page 10 line 90 biases

Page 11 line 19 overestimates

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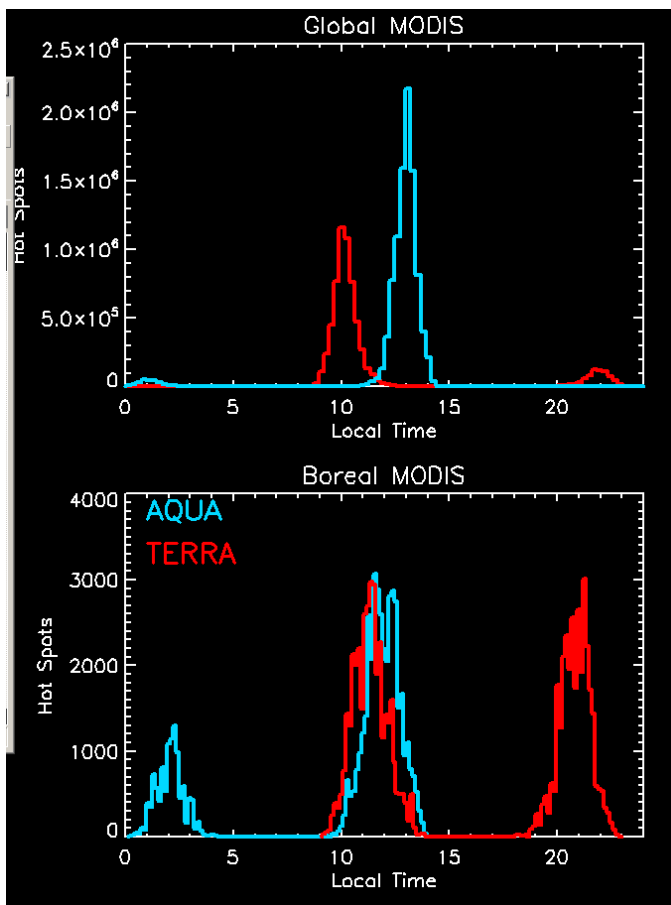


Fig. 1.

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