Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2018-931-RC3, 2018

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Biomass burning smoke heights over the Amazon observed from space" *by* Laura Gonzalez-Alonso et al.

Anonymous Referee #3

Received and published: 3 December 2018

General Comment:

In this manuscript, the authors characterize burning biomass plume height over the Amazon using MISR and CALIOP observations. They investigate the effect of FRP, atmospheric stability and drought while considering seasonal and interannual variabilities. This is the first time that such work was performed over the Amazon. The manuscript is well structured and well written. The discussion on the drought is particularly interesting. I would recommend this manuscript for publication in ACP after considering the comments listed below. The important point that need to be addressed in the correction is the definition and the use of FRP that cannot be directly linked to fire intensity (see third comment below).

Specific comments:

P2 L3: consider including in the text some geographical location of where we should materialize this arc of deforestation.

P2 L11-14: consider referencing the review on plume injection height from Paugam et al. 2016 when discussing the effect of plume injection height.

P2 L21: fire intensity is a specific metrics in fire science expressed in [W/m] and is not the same as FRP[W] or FRP density [W/m2]. However, when dealing with satellite observation, FRP density is usually related to fire intensity. Your definition of fire intensity should be discussed at this point in the introduction. You use in the remaining of the manuscript FRP as a metric for fire intensity. FRP is an estimate of the total radiant energy emitted by the active surface area of the fire, flaming and smoldering area all included. FRP is probably better defined as a measure of fire activity including size and radiant heat flux (FRP density).

P3 L11: capital letter for Fire Radiative Power (FRP). You could add the MODIS collection version here.

P3 Section2.1: Consider grouping the paragraph on MISR and MODIS, ie l21 to 28 could be moved to the start of page 4.

P3 L32: see comment above on FRP and fire intensity.

P5 L11: replace "),in" to "), in"

P5 L20-23: consider moving the discussion on the red and blue band in the Supplementary Information. As you showed the added error is negligible compared to the MINX uncertainty. You could just mention it once and refer to the SI for more details.

P6 L2: consider also mentioning here when you consider an atmosphere stable or not.

P7 L2: "wide range of condition as in MISR". I am not sure I understand why your methodology is ensuring a wide range of condition.

P5 paragraph 3: I would move this section after you mention the choice of your horizontal resolution (line 5).

P5 paragraphs order: Consider rearranging the paragraph order in this page to make it easier for the readers. For example, you mention twice how you define CALIOP plume height. This is only a suggestion: the last paragraph on the definition of CALIOP plume height should come after you first mention how you define plume height (line 8). Then would come the discussion on how you link the plume to fire activity.

P5 L18: why do you expect a bias?

P5 L29: Most Probable Height.

P5 L10: consider mentioning that "those grid cells" are the grid cells of your gridded CALIOP injection height product.

P5 L10: How do you cluster MODIS Fire pixels? Are you taking the larger cluster or do you sum all fire pixel in the grid?

P5 L12: Are you using the same elevation model than in MISR?

P8 L15-16: as mention above, I think this is not brining any added value to the discussion here. Move the discussion on MINX band retrieval in the SI.

P9 L5-6: Could you mention how does this stability metric relate to the definition of the stability flag (stable/unstable) defined in Val Martin et al 2010? I might miss the point, but why do you define a new metric as you seem to only define atmosphere as weakly and strongly stratified as in Val Martin et al 2010.

P9 L8: "a summary of these"

P9 L14: your value of FRP contrast with the FRP density values reported by Freitas et al 2007 for the same biodomes. Grassland is reported to have an FRP density (3.3 kW/m2) an order of magnitude lower than tropical forest (30-80 kW/m2).

P9 L21: "obscuring the fire emitted 4-micron radiance [. . .] as well as low radiant emis-

sivity". Consider reformulating this sentence. Why the flame emissivity should alter the FRP retrieval in tropical forest? The FRP formulation relies on the gray body assumption. Flaming combustion (because of soot presence in the flame) is more prone to violate the gray body assumption than smoldering. In case of smoldering fire, vegetation absorption is more likely to alter FRP estimate.

P9 L25: you could mention that some simulation studies also work on the impact of atmospheric stability and that this is still an open problem in plume rise parameterization. The plume rise model proposed in Paugam et al 2015 (based on the original work of Freitas et al 2007) was shown to be sensitive to atmospheric stability unlike others existing parameterizations. However, this work was refused for publication in ACP, and despite this publication refusal, results of the same model implemented in GFAS were published in ACP in Remy et al 2017.

P9 L27: consider reformulating: "and weaker atmospheric stability conditions when low altitudes plumes then to be trapped with the boundary layer".

P9 L31: as mentioned above, why not using the same flag as in Val Martin et al 2010 to define the state of the atmosphere.

P9 L32: Figure 4

P10 L12-13: I am not sure this sentence brings much to the discussion. Consider removing it.

P10 L20-21: combustion efficiency is probably more related to FRP density than FRP. Active fire area is important in your discussion here and should be mentioned.

P10 last paragraph: AOD corelate also to the FRP time integration (= Fire Radiative Energy, FRE), see Pereira et al 2009.

P11 L17: why smaller fire in size require less conservative definition in FT injection?

P11 L24-27: I found the discussion slightly confusing. Does the height the PBL relates to the strength of the stable layer located just above? I might be wrong this is just a thought. In the presence of a deep PBL, there might have quite a lot of water vapor that could be used by the convective plume to get stronger, get across the stable layer and reach the FT.

P12 L1: "as discussed above". Mention the section.

P12 L2-3: "Note that DSI is higher in wetter years." Is this not just the definition?

P12 L5: than in severe drought condition.

P12 L23-30: I found the discussion difficult to read. If I well understood your point is that drought effects are correlated with the biodome of their geographical location. Drought between 2005 and 2007 move from one biodome to another. Could you just discuss FRP and injection height changes for the two biodomes between the two years? Why are you using in this discussion the repartition of all observed plume per biodome (Fig S1)?

P21 L32: what are the mechanisms that make a PBL deeper in dry year?

P13 L13: However, you mentioned that grassland fire might reach higher injection height in dry condition?

P14 L17: According to what your argumentation in section 3.4, regardless of PBL, tropical forest fires plumes are lower in dryer condition. So your point here only applies to grassland fire?

P15 L9: "more opportunity to mix upward". MISR data shows generally a peak injection height near the fire where the convective plume is active (with potentially pyroconvection taking place) and then a downdraft caused by the aerosol loading and the atmospheric stratification. A later updraft is possible on longer time scale for older plume through solar radiation heating (De Laat 2012). I think that the main processes responsible of the differences between plume smoke observed by MISR and CALIOP are changes of atmospheric stability and fire activity which can make the updraft core

of the plume stronger, making aerosol spreading at higher altitude. Aerosol that were emitted earlier in the day would not have time to reach higher altitude just by solar heating.

P26 L9-14: as already mentioned, the discussion on fire intensity would be better related to FRP density rather than FRP.

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Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-931, 2018.