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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A multi-decadal history of biomass burning plume heights identified using aerosol index measurements" *by* H. Guan et al.

Anonymous Referee #2

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Review of "A multi-decadal history of biomass burning plume heights identified using aerosol index measurements" for publication in ACP.

General comments The manuscript entitled, "A multi-decadal history of biomass burning plume heights identified using aerosol index measurements" provides a simple, seemingly robust relationship between aerosol index (AI) and plume height (from CALIPSO) that allows plume height to be estimated without CALIPSO measurements. This reduces the restrictions on plume height information placed by satellite overpass time/location and provides an additional constraint on chemistry transport models. The manuscript is clear and well written. One concern I have is the dependence of AI on plume age, discussed below. I recommend this article for publication with the following changes.

Specific comments Abstract To be more direct, the abstract to should say what aerosol property (optical properties or absorption, etc.) is being used to estimate plume height, rather than the measurement (AI). For example, "We have quantified the relationship between aerosol backscattering (Aerosol Index, AI) measurements and plume height for young biomass burning plumes . . ."

Introduction Paragraph 5: The authors should provide the value corresponding to "relatively good agreement" from the Jeong and Hsu 2008 study.

Aerosol Index (AI) should be explained with 1-2 sentences somewhere in the introduction before the last paragraph. Not all readers will be familiar with it enough to understand why it is ideal for this analysis.

Section 3, Identification methodology for high-altitude plumes What, if any, are the effects of using a very short calibration period (3 yrs) to estimate plume heights over more than 30 years? Have the authors checked the AI set for drifting values? These issues should be addressed explicitly in the manuscript to add confidence to the observed (positive) relationship between AI and plume height.

Results Paragraph 4: Could chemistry (in addition to dilution) be responsible for the difference in AI between young and old plumes at the same altitude? Can the authors distinguish between the effects of chemistry (e.g. oxidation, increasing hygroscopicity) and dilution? Either way this issue should be addressed explicitly since there have been documented observations of chemical changes coincident with aging smoke particles (Capes et al., 2008) that will certainly affect the AI.

Capes, G., Johnson, B., McFiggans, G., Williams, P. I., Haywood, J., Coe, H., 2008. Aging of biomass burning aerosols over West Africa: Aircraft measurements of chemical composition, microphysical properties, and emission ratios. Journal of Geophysical Research–Atmospheres 113, doi:10.1029/2008JD009845.

Section 5 The authors show that plume age affects the relationship between AI and

plume height. However, in this section historical plume height is determined from the demonstrated relationship with addressing how the authors know that these are all young plumes. If they are not young plumes, then the plume height is likely underestimated. Perhaps this has been accounted for but it is not clear to me and should be addressed explicitly. The authors should also caution users of the AI/plume height relationship to confirm that only young plumes are being characterized, in order to preserve the integrity of the calibration.

Figure 5. This figure would provide more information if instead of showing only high-altitude plumes, points were colored by AI and all plumes where shown. This would reinforce the authors' point that most of the high altitude plumes come from North America but would provide more information than is currently available from this figure. An alternative would be to pair this map with a map of the same points colored by plume height (using the relationship in Fig. 4).

Figure 6. It seems there is room on the x-axis to provide region name instead of ID (A-D) for simplicity. If available, it would be beneficial to add the number of low-altitude plume observations for each region to this figure.

Technical Corrections Future submissions should include line numbers to aid reviewers.

Abstract Consider defining OMI in the abstract. Rephrase "injection heights $\geq$ 8 km but below 12 km" as "injection heights between 8 and 12 km" for clarity.

Introduction Sort lists of citations by year, from earliest to most recent.

Section 5 Last paragraph: In "may have a most important impact on the radiative budget," the word "a" should be replaced with "the"

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 1, 2010.