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Interactive comment on "Theoretical uncertainties for global satellite-derived burned area estimates" *by* James Brennan et al.

Anonymous Referee #1

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The study provides uncertainty estimates for satellite burned area datasets. The methods are plausible and certainly go beyond any approach that has been described before. The manuscript is well written and requires only in few places some clarifications. Understanding uncertainties in datasets is crucial to apply them and to extract information that is valid. The manuscript does however provide only few background on how these uncertainty estimates can be used. The method also only represents random errors. This is a big limitation as the true burned area is likely far higher than what is estimated with these coarse resolution datasets. A recent study using Landsat data estimates an 80% higher burned area for Africa (Roteta et al. 2019). This indicates that the systematic errors are high and global burned area estimates of all globally available datasets are likely far too low. However, the relative differences of uncer-

tainties between regions and between land cover types may be very useful in spite of the lack of including systematic errors in the uncertainty estimates. Including the recent publication (Roteta et al. 2019) in the discussion and the consequences for the interpretationf of the uncertainties presented here is necessary. A broader discussion of how such uncertainties can be used in modelling studies and data analysis could strongly increase the impact of the paper.

I have a number of specific comments that hopefully improve the manuscript:

p.1, l. 1/2: essential for the scientific application of these datasets.. They are already used in science so please be more specific on why uncertainties are important.

p.1,l. 9: how about data analysis studies?

p.1,l. 5-6: how are these uncertainty measures to be interpreted given new dataproducts that indicate 80% higher burned area in Africa?

p.1,l. 12: looks like a unit (m-1 km) probably change to 250-1000m, or anything else more precise.

p. 4 l. 3: total burned area of what? the gridcell? The method also assumes that the error scales with the magnitude of the burned area, which is mentioned on p. 5 (heteroscedasticity). Here some restructuring would be useful.

p.4 l. 5 : Another arising concern is that the standard error maybe not only scales with the magnitude of burned area but other factors could be important. For instance land cover (e.g. woody cover that could hide subcanopy fires, cropland cover that usually is exposed to small sized fires, cloud cover, or other failures of the sensor or data transmission).

p.4 l. 7: how large are they, how to they differ from GFED

p.4 l. 21: Rabin et al. 2017: is this the correct ref? This is a model documentation paper.

p.4 l. 21-22: I don't understand what you want to say here?

p.4 l. 23: how are these uncertainties estimated?

p.5 l. 20: What is the distribution of the errors?

p.5 l. 25: the random errors or the standard deviation of the random errors is correlated with the magnitude?

p.5 l.26: Figure 1 could be changed to show the standard deviation over the products vs. the mean. That would more clearly show the heteroscedasticity and also the homoscedasticity for the log transformed data.

p.6,l. 12,p.7 l.1: move the "C" to diretly follow "sample covariance matrix"

p.7 l. 11-15: how about using the square root or maybe 10th root transformation to keep the 0 values?

p.7 l.1: Why are the annualised uncertainties of interest. please provide an overview on how uncertainties can be used and how the uncertainties are used by users at some place in the manuscript (maybe introduction).

p.8. l. 5: what about temporal auto-correlation of errors?

p.8 l. 12: total burned area of individual years or a multiyear mean?

p.8 l. 14: reason for using land cover type classification is that you assume that the local fire behaviour is driven by land cover type? Please clarify and add a reference for this assumption.

p.9 l. 2: change to "4) savannas"

p.9 l. 13-14: maybe add that no assumptions on the error structure are necessary in that way.

p.9 l.18-19: what does it actually mean if the random errors are larger than 100%? can the data be used for anything at all? Or is there no information content in these parts

then?

p.9 l. 33: As far as I know the FireCCI50 dataset has only been released last year, are you sure it is included in Humber et al. 2018? In their description it says the product is based on MERIS.

p.10 l. 4: what exactly is consistent?

p.10 l.6-7: maybe a root transformation could be advantageous then.

p.11 l. 9: mean annual burned area?

p.12 l. 1: why are the uncertainties in shrublands high? has this been documented before? the higher uncertainty in croplands is well known due to the smaller fire size. But what could be a reason for high uncertainty in shrublands?

p.12 l.8: 8-10% seems low, given that the contribution of small fires, which are suggested to be mostly cropland fires is around 100 Mha (Randerson et al. 2012). And what does this estimation of the random error mean for the global extent of cropland burning? Systematic errors are not considered and the main effect of the small sized fires should be a systematic underestimation of the burned area on croplands.

p.12 l. 13-15: First sentence says lower uncertainties in BOAS, second sentence says larger uncertainties in BOAS. Please clarify.

p.13, l. 3: what is the shared uncertainty envelope and where can it be seen?

p.13 l. 4: now the relative uncertainties for savannas are larger than for croplands?

p.13 l. 7: "region" is double.

p.13 l.11-13: I don't understand: GFED4 is exclusively derived from MCD64 and tehn next sentence says GFED4ustilised the older MCD64 col. 5.1. Please clarify.

p.17 l. 3: " as evidenced..." I do not understand, can you explain this better?

p.18 l.12-13: do you mean errors of your error estimates or the estimated errors?

p.19 l. 11: but the uncertainties for shrublands were largest?

p. 20 l. 1: globally there should be still a large underestimation due to the coarse resolution. for instance Roteta et al. (2019) recently estimated a 80% higher burned area in Africa. How does this influence the interpretation of the here presented uncertainties. The true global burned area is then very likely outside of the range of global burned areas presented here, as only random errors are captured.

p.20 l. 7: I can't find confidence bounds presented in Rabin et al. 2017.

p.21: I think the conclusions as well as the discussion chapter should provide information how and for what the uncertainties can be used. You write theoretical uncertainties, but they are meant to be used in practice right?

p.21 l. 11: what do you mean with unique error characteristics? the regional and land cover specific differences in uncertainties?

References:

Randerson, J. T., Chen, Y., van der Werf, G. R., Rogers, B. M. and Morton, D. C.: Global burned area and biomass burning emissions from small fires, J. Geophys. Res. Biogeosciences, 117, G04012, doi:10.1029/2012JG002128, 2012.

Roteta, E., Bastarrika, A., Padilla, M., Storm, T. and Chuvieco, E.: Development of a Sentinel-2 burned area algorithm: Generation of a small fire database for sub-Saharan Africa, Remote Sens. Environ., 222, 1–17, doi:10.1016/j.rse.2018.12.011, 2019.

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