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Biogeosciences Discussions

Interactive comment on "Biomass burning emissions estimated with a global fire assimilation system based on observed fire radiative power" *by* J. W. Kaiser et al.

Anonymous Referee #2

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This paper is a very well presented description of the scientific and mechanistic detail of the GFASv1 system, that is designed to calculate global biomass burning emissions of key trace gas and aerosol species in real time, for using in atmospheric-chemistry and aerosol transport modelling. The results in comparison to e.g. AERONET observations appear very strong, and a great deal of detail is provided on the performance of the system and on its evaluation.

I have comments mainly related to the clarify of the descriptions provided.

p7340 L13 - change to "contained in the FRP observations", to make it clearer.

7340 L21 "by a factor" not "with a factor"

7341 L8 "particularly in the remote..." [lightening fires also occur elsewhere]

7341 L10 "..are experiencing an.."

7341 L16 "...of biomass burning, emissions monitoring and forecasting must be based on satellite observations of the currently active fires" [makes it clearer]

7343 L9 Please make it clear here what time period the values are being summed over (e.g. the summation in Eqn. 1)...or if it is variable say so [in Section 2.1.5 it mentions that the integration period is changeable...maybe here you can discuss the details of the influences of the different integration periods e.g. daily vs hourly etc.] Also - eqn 1 seems to have a dependence on the integration period used to ultimately calculate the daily values. For example - if the integration is performed on an e.g. hourly basis then <F> will essentially be calculated on a per-MODIS overpass, except at high latitudes. This means that that theta will be $\sim$ constant for an overpass within the grid cell of interest, so <F> will just be the sum of the FRP measurements within the cell. <F>j will be the sum of Fi. And we now average the 24 different <F>j values to get the daily average values. Now if the system was changed to a 24 hr integration. <F> will be the sum of Fi weighted by the view zenith angle, which will vary considerably for a grid cell over multiple overpasses. So the <F> will be heavily weighted towards those overpasses where the grid cell was near the swath center. This seems to mean that <F> calculated from the 24 hourly observations will not equal <F> calculated direct from the daily integration (notwithstanding the issue of the %of grid cell area viewed, which is a separate weighting fn over and above that based on the view zenith angle). Is this correct - and in any case please clarify the integration period and the effect that varying it has.

7343 L15 There are influences in MODIS FRP data away from the swath edge in addition to the "bow tie" effect. For example, Figure 8 in Freeborn et al (2010) : doi:10.1016/j.rse.2010.09.017 shows how the min, mean and max FRP per pixel varies depending on the location of the swath. Please comment on how the cosˆ2(theta)

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weighting factor affects these metrics - i presume by downgrading the weights of these off-nadir observations when you are calculating the integration over time, which seems sensible.

7343 L12 It is the "...total observed FRP, and total satellite observed area, within each global grid cell.."

7343 L16 You could explicitly say that "These equations are weighted summations, where the COSˆ2(theta) weighting factor approximately...."

7343 L19. This gamma_i [fraction of observed area in each global grid cell] appears to have values potentially greater than 1 - indeed on P7344 L 3 it says this explicitly. This is because whilst the grid cell has a fixed area, if there are many overpasses then a cumulative area greater than that of the whole grid cell might be observed. This needs some more explaining.

7344 L15 "non-fire" not "no-fire"

7346 L20 The link between "FRP=0 observations being included in the processing", and the "consequent avoidance of assumptions regarding the diurnal cycle" needs further explanation. Also, the time-step at which emissions are passed to the atmospheric model requires clarification. If the time-step is more rapid than the availability of MODIS data - which Figure 2 seems to show is only 1 to 2 observations per day for each grid cell (with the proviso given below on this metric) - then the mechanics by which the shorter time-step emissions are generated should be further highlighted.

Figure 2 - on a related point to the one immediately above, what is shown is not exactly the "number of observations of entire grid cells" is it? Since P7343 states that the total observed area is "non unique" then a grid cell with a "2" in Figure 2 could in theory be derived e.g. by the whole cell being observed twice, or by e.g. 40% of the cell being observed 5 times.

L7350 L13 Here it should be mentioned there that the 0.368 kg MJˆ-1 conversion factor

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was calculated on the basis of ground based experiments linking direct FRP observations of small-scale fires to their fuel consumption. Since the MODIS FRP observations for sure miss some proportion of "small fires", and have no atmospheric correction implemented within them, then the corresponding factor linking the GFAS FRP density measure to the 'true' fuel consumption would indeed be expected to be higher than this. This links to the next point below

L7350 L15 Whilst this is a very good strategy for delivering a realistic fuel consumption estimate from the GFAS system, the explanation behind it could be a little clearer, as could the caption for Table 2. Specifically, these are the "conversion factors" that interconvert between the GFASv1 FRP density measure and the GFEDv3.1 emissions, and it is these conversion factors that represent the ratio between these two products has been shown to have a dependence on landcover type. Whilst it may very well be that the conversion factor that links FRP density to the "true" fuel consumption does indeed depend on landcover type, that has yet to be demonstrated and we cannot really say that currently. What we can say is that the conversion factor between these two products depends on landcover type, but this (or some proportion of it) could, for example, presumably come from the fact that the relationship between the GFED BB emissions of an area and the "true" emissions of the same area have a dependence of landcover type. This could be, for example, because the burned area measures used in the GFED emissions calculation are more or less accurate in different landcover types, or similarly the fuel load estimates in GFED are more or less accurate depending on the landcover type. The point is to state that the landcover varying conversion factors are required to get agreement between GFAS and GFED, they may or may not represent the actual physics of the conversion factors required to link FRP to fuel consumption [at the scale of satellite FRP observations].

Table 2: The caption for this Table should indicate that these conversion factors link between FRP and dry matter combustion rate, where the former is FRP density calculated from MODIS as per GFASv1 and latter is calculated from GFEDv3.1

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