Response to referee #1 for manuscript :

S. Remy and J.W. Kaiser, Daily global fire radiative power fields estimation from one or two MODIS instruments, Atmos. Chem. Phys. Discuss., acp-2014-327.

Dear Editor,

Please find below the answer to the remarks raised by referee #1 during the discussion stage. The manuscript has been modified accordingly.

Best regards,

The authors

Dear Referee #1,

Thanks for your constructive comments and suggestions. Please find our answers below.

Major comments:

Figures must be sorted by their order of appearance. It is not correct to talk about Figure 5 first (P11 L10), then Fig. 4, and so on. This is quite confusing for the reader.

This has been corrected in the new version of the manuscript: references to Figures 5 and 4 in section 2.5.2 were deleted, and the paragraph that presents Figure 5 (section 3.2.1) have been completed with a description of that figure.

In my opinion, authors should be more specific when analyzing their results. Throughout the article they use many qualitative expressions such as "a lot", "better", "satisfactory", or "worse" than lack of precision. I would suggest to give a more quantitative look of results by giving figures and statistics where possible. This is especially critical in the summary (Section 5), which will greatly benefit from a recapitulative table with the major results of the authors' work. Please find below a non-exhaustive list of somewhat vague assertions:

o P10 L8 "very positive".

o P17 L8 "slightly larger"

o P17 L24 "large"

o P17 L24 "rather small"

o P20 L22 "much improvent"

o P20 L 25 “significant way”

o P21 L1 “better”

o P21 L2 “large”

Thanks for the suggestion! Section 5 has been modified, with a new table 4 that sums up the results. Also, the assertions listed above (and a few others) have been made more precise, with figures or statistics, including in the abstract.

Minor comments:

P2 L20 Please give value of biases and the percentage of improvement.

Done

Introduction Section: Please add a short summary of FRP definition and of methods of retrieval by satellite.

A paragraph have been added in the introduction, describing what is FRP and how it is observed by the MODIS sensor.

References in the introduction are quite scarce, especially in Section 1.1. Please consider adding more.

Four more references have been added; two concerning the MOD14 product and the FRP observations by MODIS, one about the SEVIRI FRP product and one about a significant fire event (the Pagami Creek fire).

It might seem obvious but a definition of what FRP is would be appreciated by the

readers.

Done, thank you.

P4 L15 Why GEO data are not used? LSA-SAF project disseminates in NRT FRP product with MSG geostationary satellite (http://landsaf.meteo.pt/). Do you think your method could be also used to merged GEO and LEO data.

At an earlier stage, it was attempted to use both GEO and LEO observations of FRP in GFAS. However, it was found that observations from SEVIRI are strongly biased as compared to MODIS. As a consequence it was decided to use only observations from MODIS in GFAS, as they provide global coverage (at the expense of observational frequency). A sentence was added to explain that.

Indeed this work could be a step towards merging GEO and LEO observations. However, additional steps would be required, such as assessing the relative weights of GEO and LEO in the merging operation (the equivalent of observational error in a data assimilation system), representing the diurnal fire cycle in the Kalman filter, and, most importantly finding a correction for the omission error due to the larger detection threshold of GEO observations: gridded SEVIRI FRP is on average 50% lower than gridded MODIS FRP. The GEO omission error depends on viewing angle and gridded FRP value, and the problem of merging GEO and LEO observations has not been solved yet.

Also, the fact that observations from MODIS are dependent on the viewing angle would need to be taken into account. Work has been going on in this direction (check the "Recommanded Fire Emission Service Enhancement" deliverable, available at http://atmosphere.copernicus.eu/documents/maccii/deliverables/fir/

In any case, it is planned in a future version of GFAS to use both GEO and LEO observations.

P5 L12 Again, MODIS is not the only satellite providing real time FRP products. Please check the LSA-SAF website, for example.

True, but MODIS observations are the only global ones: SEVIRI and GOES E and W provide FRP observations at a much higher frequency (every 15mn for SEVIRI), but only for the parts of the globe that they "see". As such, when a choice had to be made between GEO and LEO observations, LEO were chosen because they provide global coverage.

P5 L20 Please define LST.

It is Local Solar Time; the acronym was replaced by the full definition.

P8 the following links are not available:

Corrected, thank you!

P9 Please insert a brief summary of your article before Section 2.

Done, thanks for the idea!

P10 L22 Please give the number of the results' section.

It was done for two references to sections.

Tables 1-3 Are values of RMSE and bias (10-4 or 10-5) significant? I would suggest to include relative bias and RMSE in the referred tables to provide more significant

As the average FRP is actually 2.2e-4 for full GFAS, yes, these values are significant and actually represent a significant proportion of the average, for uncorrected Aqua- and Terra-GFAS.

P14 L12 What value of RMSE and bias would be acceptable?

The aim is to have a globally unbiased estimated, so a near-total elimination of the bias is the objective, as explained in section 1.3. As for the RMSE, there is no specific objective; maximal reduction is the best.

p15 Could you give the percentage of 'extreme results' obtained with the non-linear regression and give the threshold for 'extreme'?

Extreme values for FRP would be values that are not physical, or values that are "too much" outside the distribution of FRP values for a given location. Enough non-physical values, ie above 100 W/m2 for example, were produced to alter the daily average FRP. It was only a few values per day, so the percentage was negligible, but they were enough to alter the average result. Three sentences were added to section 3.2 to explain that.

P18L24 "the causes … are clear …". Please clarify the meaning of this sentence.

A few sentences were added to explain why the correction wasn't so successful for Terra as for Aqua in this case. As the whole subsection was deemed to be too long after that, a new subsection entitled "Results of the combined algorithm to linear regression in two case studies" was added to contain this discussion about the 3rd of April 2012 and 23rd of October 2012.

P20L22 replace "doesn't" by "does not".

Done (also in 2 more occurrence), thank you.

Figure 7 Please use the same Y-Axis range [0-0.0008] in the two subplots.

Done

Figures 8, 9, and 10 need to be redrafted (legend or label too small).

The three figures have been remade, with larger legends.

I would suggest to superimpose statistics (mean value/rmse/bias, …) in all your figures.

The preferred approach was to display these scores and values in tables, as that would make figures probably a bit harder to read (especially many of them show several plots).

It would be nice to include a brief discussion on the benefits of including the improvements presented by the authors in the MACC-II system on the smoke emissions. This will give a more "atmospheric" flavor to the manuscript and will make it even more suitable for ACP.

The improvement consists of the backup in case Terra or Aqua fails, and of the extension of the GFAS data base to 2000-2014 instead of 2003-2014. These two points have been mentioned several times in the paper. Another improvement is to provide a method for correcting FRP observations, with potential benefits later for the inclusion of FRP observations from other sensors (SEVIRI, VIIRS,…) in GFAS. This point has also been mentioned, a sentence has been added in the conclusion to remind the reader of it.

Finally, I would also suggest to discuss a little bit more performances of the presented approach compared to previous works. For example, it seems that Ellicott et al. (2009) managed to use observations from a single satellite only (P6 L26). Did the authors compared their method with Ellicott's? Can they at least add a comment about the main differences between these two methods in the conclusions?

The work from Ellicott et al. (2009) was mentioned in Section 1.3. The systems considered in this paper and in Ellicott et al. are quite different so a quantitative comparison would not be useful. However, qualitatively speaking, the results are close. A sentence has been added in the conclusion about this point.

Best regards,

The authors

Response to referee #2 for manuscript :

S. Remy and J.W. Kaiser, Daily global fire radiative power fields estimation from one or two MODIS instruments, Atmos. Chem. Phys. Discuss., acp-2014-327.

Dear Editor,

Please find below the answer to the remarks raised by referee #2 prior to the discussion stage. The manuscript have been modified accordingly.

Best regards,

The authors

Dear Referee #1,

Thanks for your constructive comments and suggestions. Please find our answers below.

One issue I recommend is that early on the reader should be explicitly reminded that GFAS produces a best estimate of "daily average" FRP for each 0.1 or 0.5 degree grid cell, based on a combination of all the FRP observations available for that grid cell that are available over a 24 hr period, weighted by their cloud cover and their viewing geometry. This "daily average" FRP is then used to produce a "daily average emission rate" of the various chemical species mentioned, and they can be referred to Kaiser et al. (2012) for more detail on this. Currently the FRP observations come from just the two MODIS instruments. The way the emissions rate actually changes over the daily cycle is not currently given by GFAS, and is not tackled here either. So the aim here is to try to best reproduce the "daily average" FRP value that is obtained currently with GFAS when assimilating both AQUA and TERRA MODIS FRP observations, but to do so when only one or other of these datasets is available. This needs to be explained very clearly very early on so the reader knows the exact task to be undertaken, and also the functionality of the GFAS system. All these things are stated in various parts of the paper – but I suggest it should also be stated early on around the current line 80.

Thanks for the suggestion, it is indeed important to stress that here only daily average is considered. While the diurnal cycle of fires impacts how Aqua and Terra observations differ, our aim is to provide daily estimates of FRP and biomass burning emissions. A few sentences have been added in the introduction, between lines 105 and 110, to emphasize that point.

Ellicote et al (2009) already show that Terra alone can reproduce global biomass burning estimates relatively well, and this paper should be referenced and perhaps have its results compared to the current work.

A reference has been added to Ellicott et al (2009). There are quite a few differences between the system used by Ellicott et al. and GFAS : they are using geostationary FRP observations that are not used in GFAS, there is no assimilation step in their system and they aim to produce monthly and not daily FRP estimate. While the qualitative conclusion is the same, i.e. that Terra alone can reproduce relative well biomass burning estimates, in my opinion quantitative comparison would not be so relevant.

The explanation "The value of this distance depends on the size of the vector; instead of normalizing it with the number of fires, it was preferred to use this distance only for the relative comparison of the various algorithms that were tried. " needs further detail to explain it fully.

A sentence has been added to explain that in more detail.

"and show a decreasing accuracy as the viewing angle increases." Reference should be provided

Thanks! Reference added.

"The diurnal fire cycle is reflected in a significant bias in the FRP observations from the two MODIS instruments. This bias has a strong geographic dependency because the diurnal cycle of fire intensity depends on the land cover type: for example, peat fire's intensity hardly vary between day and night while savannah fires nearly extinguish at night." References are required for this e.g.

References added, thanks for the suggestion.

Line 185 "to produce a best estimate of the daily average FRP", rather than just "daily". Since it is important to get across to the reader that GFAS does not produce information on FRP at better than "daily average" temporal resolution (at least this version of GFAS does not).

Corrected.

Figure 6 and 7. I think it would be instructive to include a figure like that of Figure 7 but for an area smaller than global, which will provide more

evidence for the reader of the improved ability of Aqua alone to estimate the full GFAS (TERRA+AQUA) values compared to Terra alone (as seen in Figure 6). Only showing the global results means a lot of the differences are averaged out and Terra and Aqua only values look very similar (after the adjustments). If you use a smaller geographic area I suggest that the Aqua-only values will be much less "noisy" with regard to the Aqua+Terra values than are the Terra-only values (judging by the scatterplot shown as Figure 6).

A new figure have been added, figure 8, that shows average FRP over Africa, Indonesia, North and South America, for Full GFAS, Terra- and Aqua-GFAS. In them, a well known problem of GFAS appears prominently : an oscillation of FRP estimates with a 2 day frequency, caused by the fact that the detection threshold of Aqua varies with the viewing angle. This figure adds much information as to how Aqua and Terra differ, and how the correction of observations improve Aqua- and Terra-GFAS. Thanks a lot for this idea!

Figure 8 and 9 - It would surely be useful to include the Aqua results in Figure 8 and the Terra results in Figure 9 would it not ? So all permutations can be seen by the reader for each event and the clear story that "Aqua only" is better than "Terra only" is easily apparent to them (i.e. this will probably be the case for both fire events, even though they are of rather different types of fire).

These results have been added to figures 8 and 9 (now 9 and 10). This completes nicely with the new figure 8, and shows indeed that a correcting Aqua observations is more efficient than correcting Terra observations.

Best regards,

The authors