## Response to Anonymous Referee #2

We would like to thank the referee for their review of this manuscript and their useful comments which have helped to improve the paper. Below we provide our response to the comments. Text in blue refers to text that has been added to or adjusted in the manuscript.

Jenkins et al. (1998): the reference is missing

The reference has now been added to the reference list :

Jenkins, B. M., Baxter, L. L., Miles Jr, T. R., and Miles, T. R. (1998) Combustion properties of biomass. *Fuel Processing Technology*. 54. 17 – 46.

The authors state that the products may omit small and/or low intensity wildfires which are very frequent in the Mediterranean region. What would be the strategy to evaluate carefully this bias? Would the use of "ground truth" information e.g. from EFFIS European fire database be of any interest?

Non-detection of small and/or low intensity fires (i.e. low FRP fires) is an important issue, particularly in regions where SEVIRI's pixel area is largest (i.e. furthest from the West African sub-satellite point). MODIS obtains FRP measurements using a 1 $km^2$ pixel area at nadir and is therefore able to detect many of the small fires that are omitted by the SEVIRI ~ 10 $km^2$ pixel area measurements (see Freeborn *et al.*, 2014). Nevertheless, the performance of the FRP-PIXEL product in this regard is far better than that of the competing products (see Figure 5 for example). The errors of omission reported in the manuscript during the SEVIRI to MODIS regional FRP comparisons (e.g. Table 2) result directly from SEVIRI's inability to see the lowest FRP fire pixels that MODIS can quite often detect. So this bias has been quantified here, and indeed is reported in Table 1 as the "Slope of linear best fit relationship between SEVIRI-to-MODIS Area-based FRP measures".

The LSA SAF FRP-GRID product, discussed in companion manuscript (Wooster *et al.,* 2015), accounts for the average bias introduced by the non-detection of low FRP fires by SEVIRI (in addition to biases resulting from factors such as cloud cover obscuration and MWIR pixel saturation). The approach used in the FRP-GRID product, discussed in Freeborn *et al*. (2009), applies a statistical matching method, developed using MODIS and SEVIRI FRP measurements made at the same time over a grid cell area (e.g. 5° cell size; Figure 20 in the companion paper Wooster *et al.,* 2015), to adjust SEVIRI grid cell total FRP to that which would have been measured by MODIS.

The use of high spatial resolution burned area data, such as EFFIS, to improve FRP-derived emission estimates has been attempted previously (Roberts *et al*., 2011). The approach is able to harness the benefits of active fire and burned area datasets and the resulting fuel consumption estimates are closer to those found in emissions inventories such as GFED since the fuel consumption delivered by lower-FRP pixels that can remain undetected can be incorporated via the burned area parameter. However, burned area measurements are made one or more days after the fire event and are therefore not appropriate for the sort of near real-time emissions modelling that the FRP-PIXEL product is aimed at, and which the CAMS is designed to deliver. Burned area datasets, such as EFFIS, could be used to determine which fires are not detected at all by SEVIRI, and it can be expected these are likely to be small and/or low intensity fires. However, it is also the case that prior work by Freeborn *et al.* (2014) indicates that the vast majority of MODIS active fire pixels over the Central African Republic had a SEVIRI active fire pixel located within 3 - 5 km at some point during the wildfires lifetime (just not necessarily at the time of the MODIS overpass). This leads to the conclusion that SEVIRI may detect one or more active fire observations in a very large proportion of burned areas, for example those included in EFFIS, but in some cases these detections may just occur at the times of 'peak' fire intensity. This is not always the case, it depends on the fire behaviour, and for example our study of the Peloponnese fires conducted here does not show a significant undercounting of low intensity fires by SEVIRI since the fire activity was of an extreme magnitude.

Freeborn, P. H., Wooster, M. J., Roberts, G., and Xu, W. D. (2014) Evaluating the SEVIRI fire thermal anomaly detection algorithm across the Central African Republic using the MODIS Active Fire product, Remote Sens., 6, 1890–1917, 2014.

Freeborn, P. H., Wooster, M. J., Roberts, G., Malamud, B. D., and Xu, W. (2009) Development of a virtual active fire product for Africa through a synthesis of geostationary and polar orbiting satellite data. *Remote Sensing of Environment*. 113. 1700–1711. FRP

Roberts, G., Wooster, M., Freeborn, P.H., & Xu, W. (2011). Integration of geostationary FRP and polar-orbiter burned area datasets for an enhanced biomass burning inventory. *Remote Sensing of Environment, 115*, 2047-2061

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This has been corrected

The authors highlight the uncertainties in the smoke injection height. They could mention briefly that FRP products could be used to refine this parameter as well.

A number of approaches exit to estimate smoke plume injection height such as using direct satellite observations (e.g. MISR or CALIOP) or various forms of plume-rise model. A comprehensive review of these approaches is provided by Paugam *et al.* (2015a). FRP measurements have been used along with other parameters to characterise plume injection height. The following text has been added to the manuscript (section 5.6) to reflect this :

Smoke emissions from the Peloponnese fires were calculated using Equations 3 and 4, along with the emissions factors given in Table 4. The smoke emissions must be injected into the atmosphere at a particular height, or distribution of heights, and such injection height assumptions can have implications for the resulting spatio-temporal distribution of the emitted species. Leung *et al.* (2007) and Guan *et al.* (2008) demonstrated that use of more detailed plume injection height assumptions resulted in a reduction in near surface CO concentrations, since more plumes were assumed to be lofted above the boundary layer. Paugam *et al.* (2015a) provided a recent review of approaches to estimate smoke plume injection height, including the methods of Sofiev *et al.* (2012) and Paugam *et al.* (2015b) that use FRP measurements to characterise wildfire thermal properties related to plume rise. This research remains at a relatively early stage, but it appears that FRP measures may indeed have a role to play in characterising smoke plume injection height as well as the rate of emission of chemical and aerosol species. Here we retained the commonly used assumption that the calculated smoke emissions are injected into the lowest atmospheric level, since this is generally what has been assumed in the series of MACC projects thus far (Kaiser *et al.,* 2012). The CAMS is anticipated to use injections heights from Paugam *et al.* (2015b) in the future.

Guan, H., Chatfield, R., B., Freitas, S. R., Bergstrom, R. W., Longo, K. M. (2008) Modeling the effect of plume-rise on the transport of carbon monoxide over Africa with NCAR CAM. *Atmospheric Chemistry and Physics*. 8. 6801–6812.

Leung ,F-Y, T., Logan, J. A., Park, R., Hyer, E., Kasischke, E., Streets, S and Yurganov, L. (2007) Impacts of enhanced biomass burning in the boreal forests in 1998 on tropospheric chemistry and the sensitivity of model results to the injection height of emissions. *Journal of Geophysical Research*. 112. D10313, doi:10.1029/2006JD008132

Liu, Y., Kahn, R. A., Chaloulakou, A. and Koutrakis, P. (2009) Analysis of the impact of the forest fires in August 2007 on air quality of Athens using multi-sensor aerosol remote sensing data, meteorology and surface observations. *Atmospheric Environment*. 43. 3310-3318.

Paugam, R., Wooster, M., Freitas, S. R. and Val Martin, M. (2015a) A review of approaches to estimate wildfire plume injection height within large scale atmospheric chemical transport models – Part 1. *Atmospheric Chemistry and Physics Discuss*ions. 15. 9767-9813.

Paugam, R., Wooster, M., Atherton, J., Freitas, S. R., Schultz, M. G. and Kaiser, J. W. (2015b) Development and optimization of a wildfire plume rise model based on remote sensing data inputs – Part 2. *Atmospheric Chemistry and Physics Discuss*ions. 15. 9815-9895.

Sofiev, M., Ermakova, T., and Vankevich, R. (2012) Evaluation of the smoke-injection height from wild-land fires using remote sensing data. *Atmospheric Chemistry and Physics*. 12. 1995-2006. doi:10.5194/acp-12-1995-2012.