

Reply

Reply to Giglio et al. Comment on “Otón et al. Analysis of Trends in the FireCCI Global Long Term Burned Area Product (1982–2018). *Fire* 2021, 4, 74”

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1. Main Comments

First of all, we would like to thank the authors of the comment [1] for their interest in our work. We honestly consider that the authors of the comment are building a case over a relevant, but secondary aspect of our paper. In the Otón et al. [2] paper, the correlation analysis between the two FireCCI datasets was included to assess the extent to which the trends detected in the full study period, which includes several years of the pre-MODIS era, may be credible. We proceeded fully aware of the limitations inherent in the comparison between burned area data time series obtained from products of different quality, different temporal consistency and different technical specifications, namely in terms of spatial, spectral, radiometric and temporal resolution of the underlying data. The only reference in our paper to the correlation analysis is on page 8/16: “The common time series of FireCCILT11 (Figure 6) with FireCCI51 was analyzed and it showed similar trends, although the short-term series of FireCCILT11 presented smaller clusters. The detection resolution of FireCCI51 allowed more accurate measures and trends. Despite that, both products in the common time series showed mostly high spatial similarities. Figure 7 shows the spatial correlation between FireCCI51-FireCCILT11 in the period 2001–2018. High spatial correlations are displayed with Pearson correlation (r) > 0.75 in pixels of all regions”, adding to this sentence Figure 7 in [2]. The authors of the comment criticize this paragraph, showing two sites in Africa where correlations are low, as well as other technical decisions we took to compute the temporal trends.

We still think the majority of global trends between the two FireCCI products are similar, as indicated in our original paragraph, even though there may be regions where they have low correlation. Actually, the global inter-comparison between the FireCCILT11 and other BA products was included in Otón et al. [3], which the authors have read. This correlation analysis showed medium to high correlations between FireCCI51 and FireCCILT11 ($r = 0.6$) (even higher for MCD64A1: $r = 0.87$) for global annual BA, as well as for the continental regions (Figure 1, from Otón et al. [3]), with correlations greater than ($r >$) 0.9 in BONA, NHSA, CEAS and EQAS; $r >$ 0.8 values in AUST, SEAS, BOAS, MIDE and CEAM; and $r >$ 0.6 values in TENA, SHSA and EURO.

The two African regions selected by the authors of the comment have two important aspects to consider: one is the influence of the availability of the MODIS active fire data for the first two years of the series (2001 and 2002), which mainly affect FireCCI51 in region B of the comment. The second one is related to the prevalence of small versus large fires, which is related to the fire regimes of the three sites selected.



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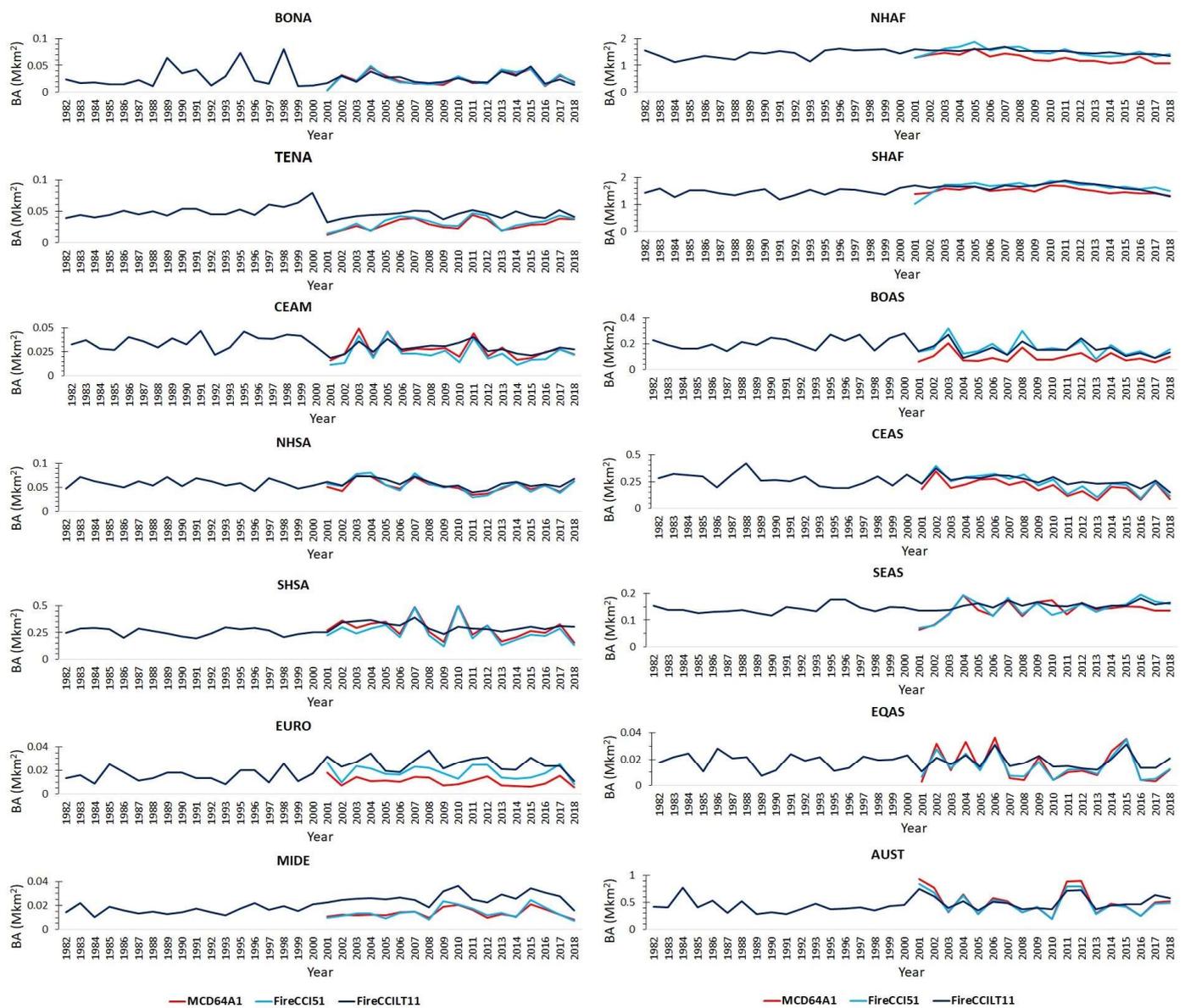


Figure 1. Annual BA trends of MCD64A1, FireCCI51 and FireCCILT11 in the different continental regions from Otón et al. [3].

The impact of the first two years of the FireCCI51 time series is clear in the NHAF region (Figure 2), which presents a correlation of $r = 0.49$ in 2001–2018, but $r = 0.68$ in 2003–2018. If we compare FireCCILT11 with another common MODIS BA product, MCD64A1 vs. FireCCILT11, the correlation is higher in 2001–2018, $r = 0.71$. In SHAF (Figure 2), MODIS active fire (2001 and 2002) issue is more significant between FireCCI51 vs. FireCCILT11, being $r = 0.32$ in 2001–2018 and $r = 0.81$ in 2003–2018. If we compare MCD64A1 vs. FireCCILT11, the correlation is higher in 2001–2018, $r = 0.72$. Both regions (Figure 2) present a correlation (FireCCI51 vs. FireCCILT11) of $r = 0.68$ in 2003–2018, and MCD64A1 vs. FireCCILT11, $r = 0.73$ in 2001–2018. In Figure 7 in [2], we perform the analysis preserving the integrity of the data considering the entire time series (2001–2018).

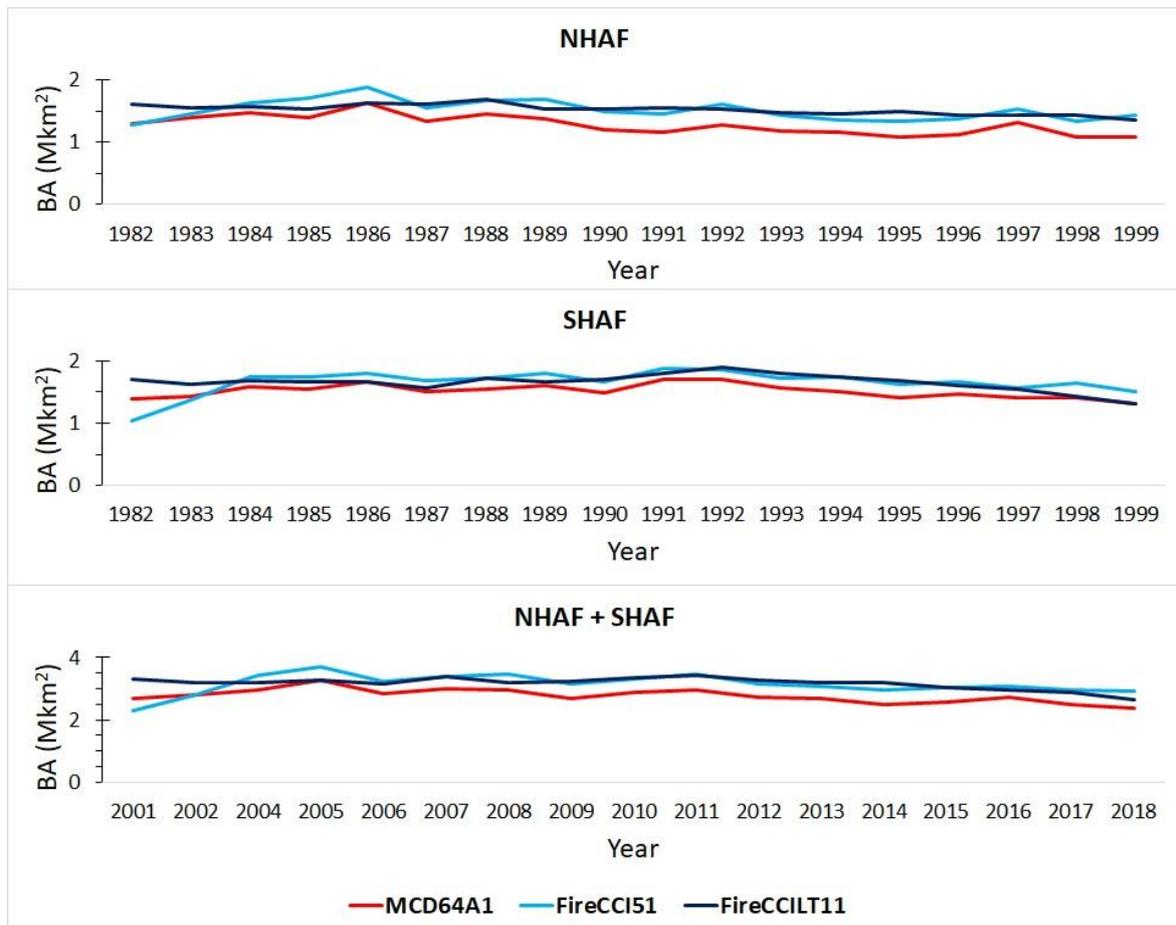


Figure 2. Annual BA trends of MCD64A1, FireCCI51 and FireCCILT11 in the different African regions.

We have analyzed Figure 3 of the comment that includes three regions (A, B, C) and added four additional ones (D, E, F, G), two of them in Africa and two in other tropical regions.

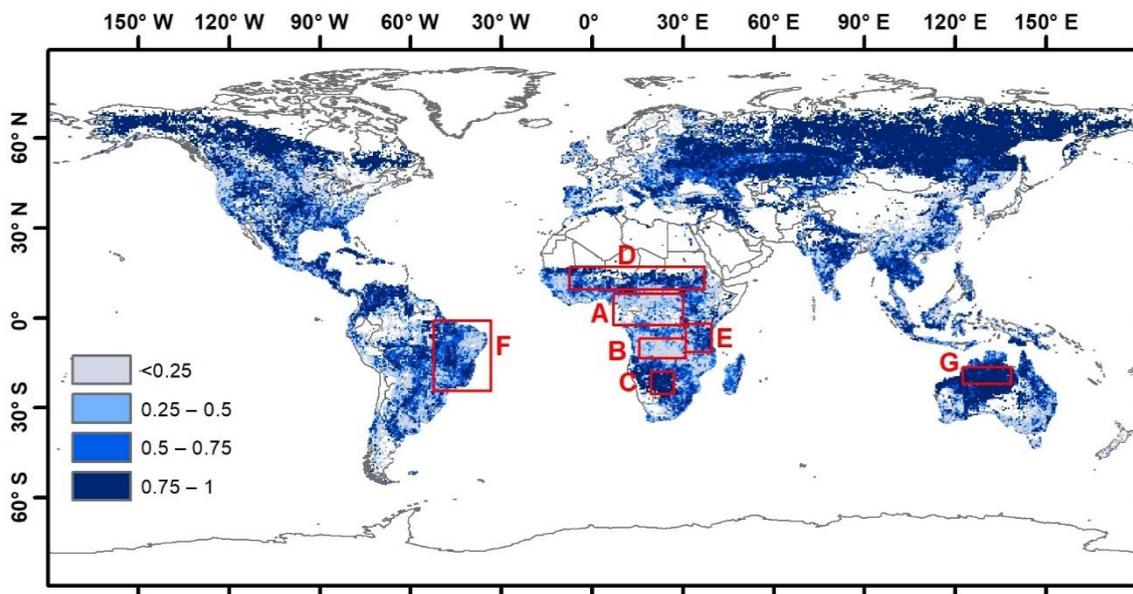


Figure 3. Global subset with seven regions of interest (A to G).

In Zone A (Figure 4) the correlation of global BA products and VIRS is very low: FireCCI51 vs. FireCCILT11 ($r = 0.04$), MCD64A1 vs. FireCCILT11 ($r = 0.12$), VIRS vs. FireCCILT11 ($r = 0.06$), VIRS vs. FireCCI51 ($r = 0.35$) and VIRS vs. MCD64A1 ($r = 0.35$). Therefore, in this case none of the global BA products seems to provide good correlation with active fire trends, which is related to the fire regime of the region, dominated by excessively heterogeneous fire patterns. It includes large areas of tropical rainforest, with very little area burned and very small fires, and large areas of Sudanian savanna, with extensive area burned and substantially larger fires.

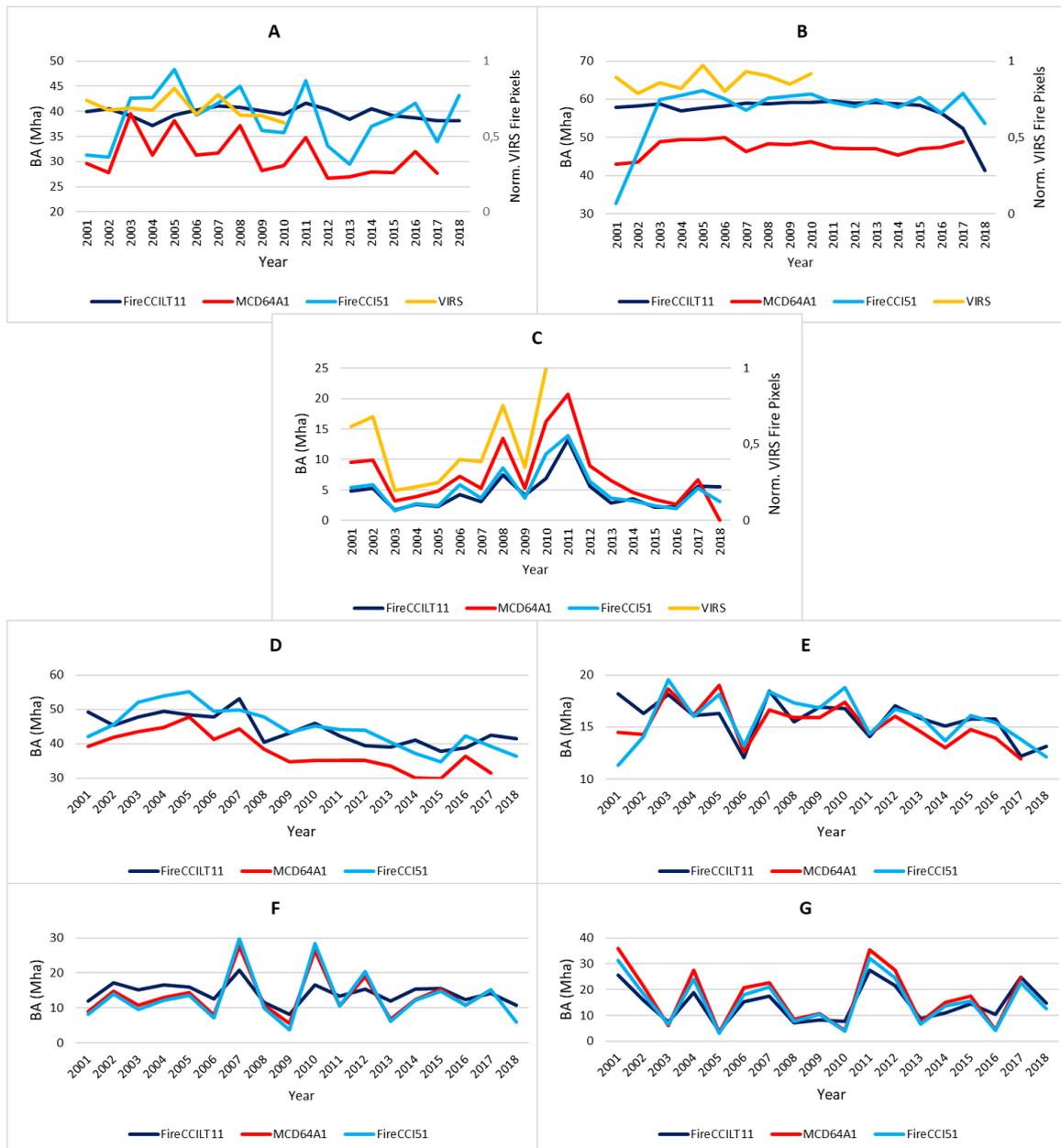
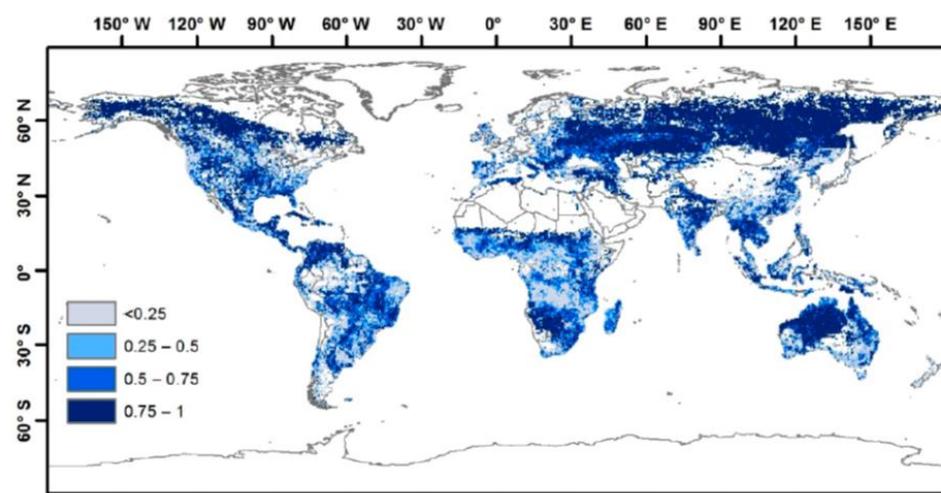


Figure 4. Annual time series analysis for the seven regions shown in Figure 3. Total annual FireCCILT11, FireCCI51 and MCD64A1 BA for the 2001–2018 time series for each region, with (A–C) corresponding to 2001–2010 normalized annual TRMM VIRS active fire counts. Zone (D) $r = 0.71$ in 2001–2018 and $r = 0.80$ in 2003–2018, Zone (E) $r = 0.54$ in 2001–2018 and $r = 0.85$ in 2003–2018, with also high values in the other tropical zones: Zone (F) $r = 0.81$ and Zone (G) $r = 0.95$ in 2001–2018.

In Zone B (Figure 4) neither of the products provide high correlations: FireCCI51 vs. FireCCILT11 ($r = 0.1$), MCD64A1 vs. FireCCILT11 ($r = -0.20$), VIRS vs. FireCCILT11 ($r = 0.18$), VIRS vs. FireCCI51 ($r = 0.12$) and VIRS vs. MCD64A1 ($r = 0.1$). If we remove the first two years, we can even find negative correlations, FireCCI51 vs. FireCCILT11 ($r = 0.09$), MCD64A1 vs. FireCCILT11 ($r = -0.33$), VIRS vs. FireCCILT11 ($r = 0.19$), VIRS vs. FireCCI51 ($r = 0.03$) and VIRS vs. MCD64A1 ($r = -0.39$). Furthermore, FireCCI51 and FireCCILT11 in Zone A and B, despite low correlation, present similar BA values that are consistent over time, unlike MCD64A1, which shows a notable underestimation. These low correlation locations occur primarily in areas where a large fraction of the area burned is fragmented into many small fires [4–6]. These fire regimes show a high influence on burned area detectability among products with different spatial resolution characteristics. On the other hand, according to Otón et al. [3]: “From 2018 onwards the data quality (of LTDR data) has been degrading due to important gaps in the images and the presence of artefacts”, so FireCCILT11 presented a drop, especially evident in this Zone.

Zone C (Figure 4) shows similar BA and a high correlation (FireCCI51 vs. FireCCILT11) $r = 0.93$, as indicated in the comment. High correlations are computed for other areas in Africa that we have now selected: Zone D (Figure 4) $r = 0.71$ in 2001–2018 and $r = 0.80$ in 2003–2018, Zone E $r = 0.54$ in 2001–2018 and $r = 0.85$ in 2003–2018, with also high values in the other tropical zones: Zone F $r = 0.81$ and Zone G $r = 0.95$ in 2001–2018. Therefore, it is not true that the African continent does not show similar trends between the FireCCI51 and FireCCILT11. We have shown that the continental regions and three out of five of the windows presented in Africa are highly correlated and show similar trends between FireCCI products. Our original Figure 7 [2] in the paper showed correlations at pixel level, where anyone can observe the spatial variability of the correlations.

Furthermore, given that small fires are very important in NHAF and SHAF [4–6], and that FireCCILT11 has very low spatial resolution, the observed discrepancies are to be expected. Depending on the specifics of fraction of the pixel burned and size distribution of intra-pixel burned patches, FireCCILT11 may over/underestimate BA relatively to FireCCI51, and the discrepancies are likely to be non-linear, leading to poor correlations due to the typically very skewed nature of fire size distributions. These issues were noticed long ago by Razafimpanilo et al. [7] and also by Laris’ [8] study on “mosaic burning” in NH West Africa. Therefore, in Africa, the presence of low correlations is to be expected, given the very large differences in pixel size between the two products, and the very large contribution of small fires to total area burned. Figure 5 shows that correlations are high where burned area is concentrated in large fires, and are low where burned area is broken up into many small fires.



Spatial correlation between the common time series (2001–2018) of both BA datasets.

Figure 5. Cont.

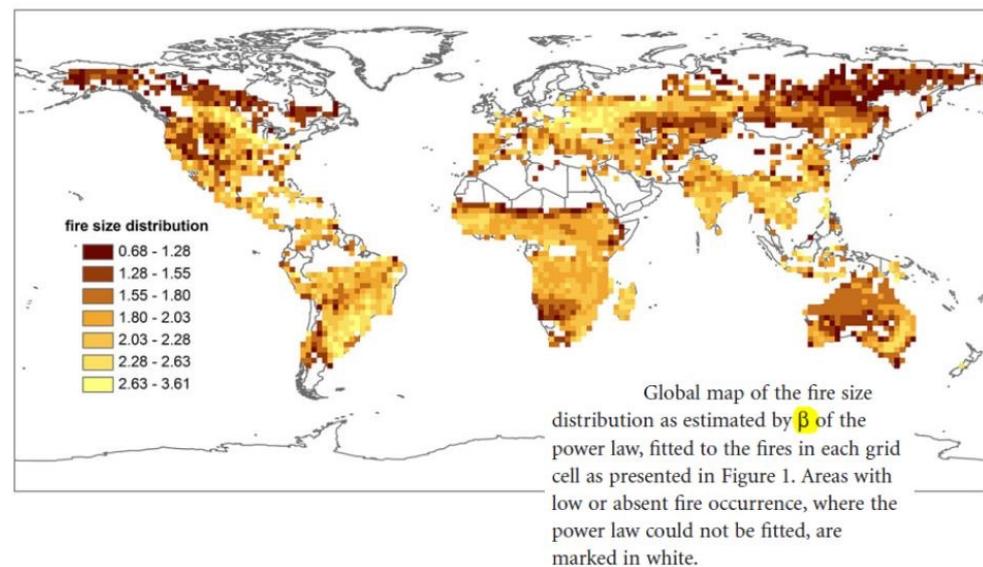


Figure 5. Comparison between spatial correlation map between the common time series (2001–2018) of FireCCI51–FireCCILT11 from Otón et al. [2] and global map of fire size distribution from Hantson et al. [5]. Higher values in the latter map correspond to fire size distributions where a large fraction of the total area burned is contributed by small fires, well below the detection ability of the FireCCILT11 product.

We understand that there are locations with low correlations (especially where we find many small fires) and these are clearly noticeable to readers, when we offer Figure 7 in Otón et al. [2] and annual correlations in Otón et al. [3]. Likewise, we understand that the correlations are positive and greater than $r > 0.5$ in more than half of the total BA.

2. Specific Comments

The authors of the comment focus on a sentence (lines 10–13) from our study [2]: “High spatial correlations are displayed with Pearson correlation (r) > 0.75 in pixels of all regions”. It means, there are high correlations in all regions, but we never said that these high correlations are predominant in all regions.

Lines 16–17: “Notably, nearly half (48.5%) of the total global FireCCILT11 BA mapped from 2001–2018 is located within low-correlation ($r < 0.5$) grid cells”, and 49–50: “Notably, nearly half (48.5%) of the total global FireCCILT11 BA mapped from 2001–2018 is located within grid cells for which $r < 0.5$ ”. Thus, more than half (51.5%) of the total are above $r = 0.5$. Therefore, this statement supports our map (Figure 7 [2]) and results.

Lines 50–53: “Curiously, some 12.1% of the total global FireCCILT11 BA mapped during this period is located within grid cells where the FireCCILT11 and FireCCI51 annual time series are inversely correlated (i.e., $r < 0$)”. Yes, it means that 87.9% of the total BA have positive correlations. The number of cells with negative correlations is small, with only 5 pixels with $r < -0.5$.

The comment’s authors propose a continuous color scale map, but the intention of our map was to show the different levels of correlation, more difficult to see with a continuous scale, where it becomes hard to distinguish medium and high correlation values. Furthermore, negative correlations are few (only 12% of the total global BA mapped) and we believe it is more important to focus the map on the positive and predominant correlations (88% of the total global BA mapped). Moreover, the comment’s authors create an undefined class, but in our case, it is blue-grey (< 0.25) as one reviewer advised.

According to the comment (lines 13–14): “However, they overlooked several extensive zones in Africa where the BA time series for the two data sets are inconsistent”. Considering the important differences between the inputs of the two products, in terms of spatial resolution (5 km versus 250 m), radiometric corrections (much finer in the MODIS data),

lack of active fire information in LTDR, etc., the observed temporal agreement between the two products is remarkable. Again, our intention was not to emphasize this in the paper, but rather to show that most temporal trends are consistent regardless of spatial resolution. Although 69% of all grid cells have $r > 0.5$ (according to their results in lines 60–61), there are locations of poorly correlated BA ($< 1/3$ of all grid cells), particularly (but not only) in those areas where small fires are predominant [4–6].

We did not consider appropriate to focus on non-significant BA sites because the focus of the paper was on something else. The negative correlation is low globally, only 5 pixels less than $r \leq -0.5$. Furthermore, our study is not a study to compare the products, rather it is a study to analyze global trends in BA using the FireCCI11 long-term BA product. Logically, between two products there will be more and less correlated places.

In addition, these places (with low correlation) also show positive correlations. Looking at Figure 7 [2], everyone can see where the positive correlations predominate and where the high/low correlations are.

Moreover, the authors of the comment analyze several years (2001, 2002, 2017 and 2018), but not including these years and not taking that into account would be a serious omission. The reasons that explain the behavior in those years are in the publications of each product, and it makes no sense to introduce the methodology of these algorithms here. We used the datasets as they are freely published. Furthermore, despite these years of worse performance, the analysis provided significant trends in the time series, demonstrating the robustness of our methodology. Additionally, if we eliminate these years, the correlations improve substantially and support our results, as we have seen previously.

Lines 17–20: “In addition, while Otón et al. reported widely predominant spatial agreement and only minor disagreement between FireCCI51 and FireCCI11 BA trends for the period 2001–2018, we note that this finding is a result of the unusually selective criterion they used to flag disagreement”. It may be argued about the convenience or not of this criterion, but we think it is not essential for the goals of the paper, which again were not aiming to compare trends between two products but rather to analyze long-term trajectories of FireCCI11.

Lines 110–112: “The spatial extent of inconsistent trends is consequently understated, to the point of implying that the disagreement is restricted to a handful of grid cells worldwide”. This is an overstatement that is not supported by our original text. The methods and results were explained in the manuscript, and they were not inconsistencies but trends of low correlation.

Lines 114–115: “Agreement in trend magnitude is an important consideration as well, and in this regard the analysis of Otón et al. [2] provides no insight”. Given the substantial differences between the quality and technical specifications of FireCCI11 and the other products, we were less ambitious than the authors of the comment and considered that agreement in the sign of correlations would be an appropriate criterion for comparison.

Lines 126–128: “Our analysis demonstrates that this claim is not justified for much of Africa, where the majority of global BA occurs annually”. As indicated before, the African sites selected by the authors do not show significant correlation, which is understandable taking into account regional fire size distributions and differences in spatial resolution between FireCCI11 and the other products. Other sites do display substantially better correlations.

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