

First of all we would like to thank the reviewer for the valuable comments.

Major concern:

My main concern is related to use of MODIS FRP observations. Without cloud cover, fires are observed four times a day. The chances that the satellite observes a slowly moving or stationary fire are much higher than observing a fast moving savanna fire. This is reflected for example in the amount of area burned per fire observed, which increases with decreasing vegetation cover (see for example Figure 4 in Giglio et al., 2006, doi:10.5194/acp-6-957-2006). In other words, one unit of MODIS FRP observed in a grassland (usually moving fast) is not the same as one unit of MODIS FRP observed in a woodland or forest (moving more slowly) with regard to biomass burned.

Cloud cover influences the MODIS-based retrieval of FRP, and thus, the detection of slowly moving fires might be more straightforward in general. However, there are almost no clouds over savanna biomes during the dry (fire) season, especially in the African regions, which are covered by large areas of savannas. The influence of slowly and fast moving fires on the MODIS FRP product could be relevant for smaller pixels. However, we expect this issue to be much less relevant to our estimation of FERs, as we focus on larger pixels ($1^\circ \times 1^\circ$). To our knowledge the difference between slowly and fast moving fires only means that one unit of FRP in savanna fires burns the same amount of biomass (rather horizontally) as one unit of FRP in tropical forest fires (rather vertical). The main concern for FRP is fire duration instead of fire speed. This leads to a systematic underestimation in regions with short fire durations. However, the fire duration is uncertain and an assumption on the high side may easily compensate for the underestimation. Nevertheless, we will address this issue in the manuscript by adding the following:

“Giglio et al. (2006) have indicated that the amount of burned area per fire observed increases with decreasing vegetation cover, which means that a grassland fire is moving faster than a woodland fire. This has implications for small ground scenes as the chances that the satellite observes a slowly moving and rather stationary fire are much higher than capturing a fast moving fire within a specific grid cell. However, the MODIS FRP product with a $1^\circ \times 1^\circ$ horizontal resolution is created by averaging the mean FRP of four individual $0.5^\circ \times 0.5^\circ$ grid cells. Therefore, we can rule out any severe effects of slowly and fast moving fires on our approach. In the case of FRP, the critical factor is rather the duration of the fire instead of its speed. For example, short fires may ignite and virtually extinguish between two MODIS overpasses, and thus, remain undetected. However, this effect may be partially compensated by assuming a longer duration for detected fires within the selected regions. Monthly data of FRP for the consecutive five years (2007-2011) have been downloaded at a horizontal resolution of $1^\circ \times 1^\circ$ from <ftp://neespi.gsfc.nasa.gov/data/s4pa/Fire/>.”

This means that the findings presented in the paper are valid only when using MODIS FRP observations. If the same analysis would be repeated with geostationary derived FRP or another orbiting satellite with for example another overpass time the results would almost certainly change. I would therefore stress the authors to make clear to the audience that their results are sensor specific, and refrain from presenting emission factors (as opposed to emission ratios) as done in Table 4 as these are probably unreliable. I do understand this is to some degree accounted for using biome-specific conversion factors (page 28478) but

these cannot account for the fine detail you present in Table 4 as they are averages over worldwide biomes.

The findings of our study are based on the two MODIS sensors. For future activities, we will plan to test the geostationary sensor SEVIRI and compare the results. We added the following sentence to the discussions:

“Nevertheless, the approach should be repeated for the SEVIRI instrument on board the geostationary Meteosat Second Generation (MSG) Satellite, as the obtained results are valid only for the MODIS observations.”

The general focus of the manuscript is on the estimation and uncertainties of FERs of NO_x as retrieved from satellite instruments. The exclusion of the estimated EFs could improve the clarity, and at the same time, reduce the length of the manuscript. Therefore, we agree with your recommendation to refrain the presentation of EFs in this manuscript and delete the following passage(s) from Section 3.4:

“We have converted the FERs into emission factors (EFs), in order to compare our obtained results with the EFs found in the literature and frequently used for the estimation of NO_x emissions from outdoor biomass burning via the bottom-up approach. Following the approach by Wooster et al. (2005) who suggested a constant conversion factor of 0.368 kg MJ⁻¹ for linking the FRP to the dry matter combustion rate, 2.717 MJ of fire energy are needed for the combustion of one kg dry matter. This factor could be directly applied for the translation of the obtained FERs into EFs of NO_x. However, a more recent study by Kaiser et al. (2012) has shown that this constant value is probably not valid for different types of vegetation under realistic wild fire conditions. We therefore make use of the conversion factors provided in their study for different land cover types and apply them for the conversion of FERs into EFs. Here, we use averages of the suggested conversion factors, as they are listed with and without organic soils.

The comparison of the EFs estimated in our study with EFs found in the emission factor compilations by Andreae and Merlet (2001) and Akagi et al. (2011) demonstrates partial agreement (Table 4). The EFs for evergreen broadleaf forest (tropical forest) estimated in the present study are 2-3 times smaller than the one suggested by Andreae and Merlet (2001) and Akagi et al. (2011). We found a better agreement with the two studies for woody savannas and savannas (savanna and grassland). One possible reason for the lower values found for evergreen broadleaf forest could be an overestimation of the NO_x lifetime over these tropical forests. As discussed above, the elevated VOC concentrations over such biomes enhance the removal of NO_x. In general, the EFs for woody savannas and savannas are slightly lower when compared to the EFs found in the literature. Lower values of EFs for savanna and grassland were also pointed out by Martin et al. (2003) and Inness et al. (2013). The authors of the latter study have indicated discrepancies between their reanalysis of TVC NO₂ and TVC NO₂ retrieved from SCIAMACHY for the African regions. They relate the overestimation of their NO₂ reanalysis data to the use of too large EFs for the translation of biomass burned into emissions of NO_x. At this point, we find that the large discrepancies between bottom-up and top-down fire emission estimates of NO_x might be related to these large differences in EFs found for woody savannas (savanna), which is one of the most frequently burned land cover type in Africa. Overall, we found the highest EFs for cultivated crops, being 1.5-2.5 times higher than the one suggested by Andreae and Merlet (2001) and Akagi et al. (2011).

It should be mentioned that both the EFs derived from laboratory and outdoor measurements as well as the EFs estimated in our study are associated with uncertainties. For instance, laboratory studies do not account for the seasonal variability of EFs, which is known to depend on the weather conditions and the connected moisture content in the fuel. The decreasing fuel moisture in Southern African savanna throughout the dry season was shown to have a significant impact on the EFs obtained for different trace gases (Korontzi et al., 2003). Recently, Mebust and Cohen (2013) considered a second possible mechanism for the seasonal variation in EFs. They argue that a possible reason for the drop of TVC NO₂ over the fire season could be related to the decreasing N content in the fuel throughout the dry season. In our approach, such temporal changes in emission fluxes are averaged out by applying a least-squares fit and a binning method.”

We will briefly address this issue in the discussions instead:

“The application of our obtained values in bottom-up emission inventories only requires a conversion factor for deriving EFs of NO_x. To the authors’ knowledge, there exist constant and biome-specific conversion factors in the literature (Vermote et al., 2009; Kaiser et al., 2012).”

Minor comments:

- Please save Figure 10 and 11 as jpg or another format, right now the whole file is 15Mb and slower computers have difficulty because they have to render all the data points in the two figures

We will plot Figure 10 and 11 in another format to reduce the file size of the manuscript.

- Introduction: "Although GFASv1.0 is based on a different approach, average annual emissions of NO_x from vegetation fires are in good agreement (50 %) with the widely used Global Fire Emission Database (GFEDv3.1)." Yes, but later you mention these two data sets are linked using conversion factors, so there is little confidence to be gained from the agreement between the two datasets.

There is indeed a quantitative link between GFASv1.0 and GFEDv3.1 due to the use of GFEDv3.1 dry matter combustion rate for the GFASv1.0 approach. In accordance to the suggestion made by the reviewer, we have removed this part in the revised paper.

- 28470: "In some years, more than 10 % of the total continental area is burned in Africa". Earlier you mentioned most of the global burned area is from Africa, please reconcile

This seems to be a misunderstanding. We have deleted the following sentence:

“In some years, more than 10% of the total continental area is burned in Africa.”

- Summary: "In conclusion, the FERs of NO_x derived for different types of vegetation form the foundation of future efforts aimed at a new top-down based method for estimating global NO_x emissions from vegetation fires". Yes, but please do look carefully into issues with regard to FRP.

We will consider FRP issues for the planned future work in detail.