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Geoscientific Model Development Discussions
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Interactive comment on "Development of a new gas flaring emission data set 1 for southern West Africa" *by* Konrad Deetz and Bernhard Vogel

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Dear Dr. Elvidge (Referee, Geoscientific Model Development),

thank you for your reviewer report from 3 August 2016. We have accounted for the comments and suggestions in the revised manuscript version. Please find our replies to the particular comments in the following.

Sincerely,

Konrad Deetz and Bernhard Vogel

Referee comments:

1) The VIIRS Night Fire (VNF) "flares only" dataset is not suitable for scientific applications. It is generated by stripping out VNF detections with either no temperature or

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temperatures under 1400K. This eliminates most biomass burning and ambiguous detections. The purpose of this is to provide a quick daily overview of global gas flaring activity. There are many times when a flare was detected in a single spectral band (usually M10 at 1.6 um), in which case the Planck curve cannot be fit and a temperature cannot be calculated. These detections have been lost in the dataset used by the authors. In addition, some flares are known to fluctuate in temperature and dip below 1400 K. These low temperature flaring events are also lost in the "flares only" daily summaries. The produce a more thorough analysis, the authors should work from the original daily VNF files. At best the "flares-only" version of the data provides a 'quick-and-dirty" depiction of global gas flaring.

For our work in the project Dynamics-aerosol-chemistry-cloud interactions in West Africa (DACCIWA) we wanted to have a consideration of gas flaring in our regional atmospheric model which includes the up-to-date characteristics of southern West Africa (SWA). The DACCIWA measurement campaign took place in June/July 2016 and for this time we need the flaring information for our model. Emission estimates for 2012/2013/2014 are not meaningful in our case, because the emissions are not constant from year to year. Also your new estimation (http://ngdc.noaa.gov/eog/viirs/download_global_flare.html) shows a decrease in flaring for Nigeria. To use older data would lead to overestimations. The SWA emission inventory for flaring was not available when we started our research. The presented method is therefore our first approach to tackle the problem with the missing flaring emissions in our atmospheric chemistry simulations. Instead of using just constant emissions factors for flaring, we now have very regional information available. We are concentrating on the description of the air pollution in our modelling system COSMO-ART and try to include all relevant emission sources. We are no experts in extracting the flaring sources from the general combustion sources detected by VIIRS Nightfire. Therefore we have relied on the "flares only" product published at http://ngdc.noaa.gov/eog/viirs/download_viirs_flares_only.html. Even if the data basis for our study is not perfect regarding VNF, there is a strong progress compared to the state before. We have changed our manuscript according to this problem. We have remarked, that the use of the “flares only” product is just a first approach and that this data contains greater uncertainties compared to the original VNF product. Future users of this parameterization can change the VNP input. The general method of the parameterization will not be affected by that.

2) The authors do not account for variations in cloud cover. This can be done based on the VIIRS Cloud product suite.

I see your point but our study focus is located to the creation of an emission dataset based on a VNF climatology rather than taking the VNF data day by day. In section 3.3.1 we describe the problem of flares that are masked by clouds (and the overall question whether the flare below the cloud is active or not) in detail and assess the uncertainty by using remote sensing cloud data from MSG and Aqua/AIRS. By deriving a flaring climatology (over two month), we are able to identify all flares (even if there are sometimes covered by clouds). With this climatological approach we get the mean emission strength of every flare (more precisely for every flare box). Therefore it is not necessary to account for the variations in cloud cover. Even if we would know, that a certain flare is masked by clouds at a certain day we don’t know whether this flare is currently active and how large the radiant heat is. When we use our flaring climatology in our regional atmospheric model, all available flares are active at once with their mean emission strength.

3) The text should reference the following paper: Methods for Global Survey of Natural Gas Flaring from Visible Infrared Imaging Radiometer Suite Data (http://www.mdpi.com/1996-1073/9/1/14).

We agree on that and have referenced the publication.

4) NOAA has global flaring data spanning 2012-2014 available at: http://ngdc.noaa.gov/eog/viirs/download_global_flare.html. There is a csv that contains locations and annual summaries of temperatures and radiant heat output

of individual flares, normalized for cloud cover. The flared gas volume estimates are derived from an empirical calibration with CEDIGAZ reported flaring. It would be interesting to compare the NOAA results with those from the methods described in this paper.

From the xlsx file VIIRS_Global_flaring_d.7_slope_0.331_web.xlsx we have selected the 193 available Nigerian upstream flares and selected the flares which have a detection frequency greater than zero for 2014. We assume that “Avg. K” mean source temperature in K and “Ellipticity” means the radiant heat in MW. This data we have used as input for the parameterization presented in this study (with the same configuration). Finally we have integrated the volume stream of all Nigerian flare boxes from m-3 s-1 to m-2 y-1 and finally transformed it to bcm. The result is 8.55 bcm (271.0391 m-3 s-1). In the xlsx file the flared volume is estimated as 8.442995283 bcm for Nigeria in 2014. So if we use the same source temperature and radiant heat input as Elvidge et al. (2015) for Nigeria in 2014, we can reproduce the estimated flared volume with our method with a deviation below 1.3%. Within our VNP data set for 2014 we estimate the flaring to 29.8 bcm. Regarding the uncertainty range of this estimation, the value is approx. by a factor of two higher than the other inventory. The uncertainty might result from the uncertainties in the estimation of the gauge pressure pg and the fraction of the total reaction energy that is emitted as radiation f. In our flaring climatology we assume that all available flares are active at once with their mean emission strength, so this could lead to the higher values of the flared volume.

5) In the last sentence of the first paragraph, the text references the World Bank for a set of national flared gas volume estimates. The text should make it clear that these estimates were produced by NOAA using DMSP satellite data. There is a new set of estimates derived from VIIRS data at http://ngdc.noaa.gov/eog/viirs/download_global_flare.html.

We agree on that and have changed the manuscript accordingly. A remark to the availability of updated global flaring estimates for 2013 and 2014 at http://ngdc.noaa.gov/eog/viirs/download_global_flare.html are mentioned in the manuscript.

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