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Atmospheric Chemistry and Physics Discussions

Interactive comment on "New Constraints on Biogenic Emissions using Satellite-Based Estimates of Carbon Monoxide Fluxes" *by* Helen M. Worden et al.

Anonymous Referee #2

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Comment on : "New Constraints on Biogenic Emissions using Satellite-Based Estimates of Carbon Monoxide Fluxes " By Helen Worden et al.

The paper "New Constraints on Biogenic Emissions using Satellite-Based Estimates of Carbon Monoxide Fluxes" provides an improved estimation of the biogenic emission, comparing model simulation based on Bottom up inventories with a satellite based "Top Down" emission estimation for CO. The CO production from biogenic emissions (BIO), together with Biomas Burning (BB) and Fossil Fuel (FF) consumption is one of the three most important parts of the CO budget and Flux (F). The "Top down" estimate provides an estimate of the Total CO2 Flux (F) without the ability to distinguish

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the individual sources and sectors, but in this work the information of the total flux is used to improve the estimate of the biogenic emissions, just using the Bayes probabilities approach. The new approach is realized individually for each grid cells of 4°x5° and month. A systematic pattern and spatial distribution is obtained and compared to other measurements. 1) Biogenic emissions of the isoprene retrieved from the OMI instrument shows a very similar distribution. 2) The temporal pattern which shows a significant difference between apriori and posteriori biogenic CO flux for the north African Savanna is studied and compared to the surface temperature.

General comment:

The Work is well written, interesting and matches the scope of ACP, it should be published after minor correction and after including a bit more information about the methodology. At the moment the paper is quite compact with just one example (region), but the supplement provides more examples, which is adequate and a good idea.

The new of the paper is that it somehow combines a model study and therefore a detailed “Bottom up” estimation, which contain a detailed distribution of different sectors (BIO,BB,FF) together with a satellite based “Top Down” approach which, just report the total flux “F”, latter is somehow a measurement, while the prior is the apriori information.

Unfortunately the description is very short and the approach cannot be easily be reproduced.

I imagine that the implementation of the Baysian approach ends up in a least square fitting equation and looking finally for the minimum of something like the following cost function will help to find the posterior solution: 1/σ2 (F(BIO,BB,FF)-A)ˆ2 + (([BIO,BB,FF]-xapr)ˆT (S_(BIO,BB,FF))ˆ(-1)([BIO,BB,FF]-xapr)

with σ the uncertainty in the “Top down” approach A , F= the total Flux or Forward

Modell F= CH4 related part + BIO+BB+FF. S_(BIO,BB,FF) might be the more or less diagonal covariance matrix which describe the uncertainty.

If it is some how different, it would be nice to get an more easily insight in the criteria which equation is used to determine the vector BIO,BB,FF. Specific comments: 3 Bayesian CO flux attribution approach I think, this a very crucial section for the work and unfortunately not very easy to understand.

ðİŚİ(BB,BIO,FF|A) âĹİ ðİŚİ(BB,BIO,FF) p(F|A)/p(F) Eq. 1.

I understand that :

ðİŚİ(BB,BIO,FF|A) âĹİ ðİŚİ(BB,BIO,FF) p(A| BB,BIO,FF)/P(A) and p(F,A)=p(F|A)p(A)=p(A|F) p(F) and probable it is valid that P(A|F)=P(A| BB,BIO,FF) as P(F| BB,BIO,FF) =1.0. But here it would be helpful to get a bit more info, and define the relation between F and (BIO,BB,FF).

Where I get a bit problems is with the statement p(F) = 50%, does this mean p(F)=0.5 As F is a continuous quantity p(F) might be a probability density function pdf and it should be something like p(F) dF = 0.5. Or more likely it should say p(F) is a Gaussian distribution with a priori Fapriori as most probable, mean value and sigma as stdv .

p(F)= 1/sqrt(2 Pi sigma**2) exp(- ((F-Fapriori)/sigma)**2) and sigma=0.5*Fapriori

Or is the pdf a more general pdf, which is produced by the (MCMC) algorithm. If latter is the case, it would be nice to get somehow the formula of the a posteriori estimation, finally it should just be an weighted mean between the three a priori informations BIO,BB,FF aprioris and their a priori Stdev and the Top down estimation of their sum.

Similar might apply for other uncertainties and pdf as p(F|A). I would assume that it is assumed to be Gaussian and the standard deviation is calculated from the ensemble of three “top down” inversion estimates, but up to now this is not described clearly.

Same the different between F and A, is not be explained. Please include the equations

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how F is calculated as function of BIO,BB,FF and 877 Tg/yr, at least in the supplement.

So far I understood the methodology, the estimated BIO, BB and FF (the solution vector x) is an optimal estimation. The finally reconstructed BIO, BB and FF emission in each grid cell, matches more or less their a priories and explain more or less the "Total flux of CO" (which is some how the measurement y), which is their minus some fix parts as CO from CH4 (F-rest) matches the "Top down" estimation of (F|A). The authors recommend to read the description of another earlier publication, but I would recommend amplify the description at least a little bit, as the method is very crucial for the work. And maybe why not use the supplement document to write down the complete mathematical expression, which would allow to reproduce the approach.

4 Uncertainty prediction and limitations

The use of a measured total flux and redistribute the fluxes of the different sectors, might produce a very strong dependence between the errors in BIO,BB,FF. Is there a way to characterize this ? How could the estimate improve, if you could reduce the uncertainty in FF to 0.0 .

One of the main results is the very nice correlation between Surface Temperature and BIO-Emission: The CO flux "Top Down" estimation is based on the joint near and also mid infrared MOPIIT retrieval product. The result and sensitivity of mid infrared nadir sensors might depend on the surface temperature. Therefore it would be nice to discuss shortly if such errors could be relevant.

6 Global budgets of CO and C5H8 from biogenic emissions

Maybe it would be nice to see an correlation plot between OMI based C5H8 and a) the apriori and b) a posteriori estimated biogenic CO flux.

7 Seasonality of biogenic emissions – case study for the North African Savannas

As mentioned earlier, just for the completeness it would be nice just to discuss if the Surface Temperature or other surface properties which might have an impact on the

CO MOPIIT retrieval.

Table1: Maybe could you include “F” or “A” in this table. Suggestion: the “MEGAN” emission estimate is the apriori and might be included in the same box just in brackets together with the apriori uncertainty .

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