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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Estimating regional methane surface fluxes: the relative importance of surface and GOSAT mole fraction measurements" *by* A. Fraser et al.

Anonymous Referee #1

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This study investigates the application of total column CH4 measurements from the GOSAT satellite instrument to global inverse modeling of sources and sinks. After several studies demonstrating the quality of GOSAT retrievals it is very useful to see how this translates into source/sink estimates. More studies of this kind will certainly follow, which will be able to take advantage of the numbers that are reported here. Despite the significant constraints that are provided by the GOSAT data in terms of uncertainty reduction, they don't seem to bring important new insights. A latitudinal shift in rice paddy emissions is reported, but the robustness of this result remains unclear. GOSAT allows an important extension of the measurement coverage in the tropics, but how this translates into adjustments in emissions versus bias corrections remains unclear.

A further effort in this direction would strengthen the value of the manuscript. The reported OSSEs provide useful insights in the functioning of the inversion, but also raise questions as explained below. These and a few other issues will need to be addressed to make the step to ACP.

GENERAL COMMENTS

Looking at Figure 2 it is unclear why the reported posterior global emissions in Table 1 are lower than the prior. All regions except Boreal Eurasia show a significant increase in XCH4 when GOSAT data is used, which somehow is not reflected in the global emissions. The answer may be in the treatment of the initial condition in the inversion, but I couldn't find information describing what was done. Another option might be the lifetime of methane, but if I understand well it is not optimized. Further information is needed to explain the relation between Table 1 and Figure 2 and how the initial concentrations are treated.

It is unclear why an OSSE with perfect data representing a truth that is equal to the prior, nevertheless leads to the flux updates in the inversion as shown in Figure 8. In this case, the prior model should be in the cost function minimum already so that there is nothing left to optimize. Else it is very surprising that a bias of several ppb leads to virtually no adjustment in the inverted fluxes. Even if the bias correction captures most of the bias, some adjustment is expected since the bias parameters have a limited uncertainty and therefore the inversion should find an optimal compromise between adjustments of the prior fluxes and bias parameters. It raises the question how well the optimized model fits the satellite data.

SPECIFIC COMMENTS

Abstract: It is mentioned that that the largest emission changes of 75Tg/yr are found for Temperate Asia, but Table 1 lists only order $\sim$15 Tg/yr differences for this region.

Page 998: Are the bias correction parameters specified by month or is one single set

used for the whole analyzed period? Page 31007: “changes in methane emissions affect the surface concentrations before the total column measurements” It is not clear why this should be the case. It is mentioned elsewhere that the emissions have to be transported upwards, which takes time. However, the total column measurements, as provided by GOSAT, have sensitivity all the way down to the surface. Therefore there is no need for this signal to be transported upwards for detection by GOSAT.

Page 31008: “The error reductions for inversions using GOSAT data are at least twice the error reductions when only surface data” It should be mentioned that the use of a short assimilation window is not in the advantage of background surface measurements. It means that part of the information that is provided by the surface network is not used by the inversion. Else GOSAT measurement errors are likely to be correlated in time and space, not to mention biases that are not captured by the bias correction algorithm. No attempt is made to represent the uncertainty associated with this, which leads to over optimistic error reductions in comparison with the surface network.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 30989, 2012.