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Inverse modeling of methane sources and sinks using GOSAT and SCIAMACHY retrieved xCH4

G. Monteil (1), S. Houweling (2), S. Guerlet (2), D. Schepers (2), I. Aben (2), and T. Röckmann (1)

(1) IMAU (Institute for Marine and Atmospheric Research), Utrecht University, Utrecht, The Netherlands, (2) SRON Netherlands Institute for Space Research, Utrecht, The Netherlands

Among all the anthropogenic greenhouse gases, methane is one of the most important since it accounts for roughly 25% of the human induced climate forcing. It is also one of the less well known, mainly because of the important, but poorly quantified, variability of its natural emissions. Methane emissions can be estimated using bottom-up inventories and inverse modelling methods, which make use of time series of surface concentration measurements. Unfortunately, the coverage of such ground-based measurements is mostly limited to populated areas (Northern-America, Europe, Eastern-Asia) and polar regions, whereas the observational constraints on fluxes in regions of important methane emissions, such as tropical forests and wetlands, are very limited.

To overcome this problem, satellite measurements of total column averaged methane (xCH4) are studied for use in inverse modelling. Currently two satellites are in orbit capable of measuring total column averaged methane (xCH4) with sensitivity to the lower troposphere: The Japanese greenhouse gas observing satellite GOSAT (since early 2009) and the European atmospheric chemistry mission SCIAMACHY onboard ENVISAT (since 2003). Compared to SCIAMACHY, GOSAT offers an improved spectral resolution, which allows to retrieve methane independently from carbon dioxide (Butz et al, 2011). On the other hand, the spatial coverage of GOSAT is lower, which has implications, in particular for regions that experience frequent cloud cover.

We evaluated the use of the RemoteC GOSAT retrievals for estimating methane emissions, in comparison with the use of NOAA ground-based measurements and SCIAMACHY, for the period June 2009 to June 2010. All the satellite inversions were able to significantly reduce the flux uncertainties over South-America, Africa and Asia, compared to the NOAA-only inversion. However, comparisons of our results with independent measurements show that GOSAT inversions are more capable of reproducing observed methane seasonal cycle and latitudinal gradients than those based on SCIAMACHY data. The GOSAT inversions also reproduce the vertical gradients of methane more accurately than the NOAA-only inversions.

Our results demonstrate that the use of GOSAT retrievals constitutes an important step forward in global methane monitoring. In comparison with SCIAMACHY, the use of GOSAT leads to a significant improvement in consistency between the optimized model and independent data, which makes it a valuable tool for studying source/sink budgets of methane in the coming years.