Geophysical Research Abstracts,
Vol. 11, EGU2009-11233, 2009
EGU General Assembly 2009

Inverse modelling of CO_2 sources and sinks using satellite data and the importance of transport model uncertainties

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OCO and GOSAT will likely bring a wealth of accurate total column CO_2 measurements that will allow the estimation of CO_2 sources and sinks from space. Meanwhile even more advanced measurement concepts are being investigated for the next generation of instruments, such as the CO_2 lidar A-SCOPE. Despite numerous attempts to simulate the benefit of remote sensing for the quantification of CO_2 sources and sinks using theoretical Observing System Simulation Experiments (OSSEs) it is difficult to predict the performance of a real-world application. One of the potentially important shortcomings of the OSSEs, which have been reported so far, is the difficulty to account, in a realistic manner, for the impact of transport model uncertainties. As part of a preparatory study for the A-SCOPE mission we have tried to quantify these errors using a model inter-comparison experiment, including the IFS, LMDZ, TM3, and TM5 models. Synthetic A-SCOPE measurements were generated for each model using a common setup of CO_2 fluxes and initial boundary conditions. The difference between the samples generated by any combination of models has been prescribed as pseudo measurements in CO_2 inversions. The deviations of the retrieved fluxes from the true (common set-up) fluxes quantify the impact model errors provided that the ensemble of models can be considered a realistic representation of transport model uncertainty. This representativeness has been tested by comparing the ensemble performance against available total column CO_2 measurements. The derived transport model uncertainties are put into perspective by comparison with the anticipated A-SCOPE measurement uncertainties.