Geophysical Research Abstracts
Vol. 12, EGU2010-8279, 2010
EGU General Assembly 2010

4D-Var atmospheric data assimilation and flux inversion using in-situ and satellite observations of CO2 and CH4

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Under the umbrella of the European Global Monitoring for Environment and Security (GMES) framework, the Global and regional Earth-system (Atmosphere) Monitoring using Satellite and in-situ data (GEMS) project and its follow-on project, Monitoring of Atmospheric Composition and Climate (MACC), have been building and running a comprehensive monitoring system for atmospheric composition. This monitoring system has been built around the European Centre for Medium-range Weather Forecasts (ECMWF) data assimilation system for numerical weather prediction (NWP).

An important component of the 2 projects is the monitoring system for atmospheric greenhouse gases and their surface fluxes. The system consists of a 4-dimensional variational (4D-Var) atmospheric data assimilation system embedded in the ECMWF operational weather data assimilation system, 2 separate 4D-Var flux inversion systems that uses the output of the atmosphere system, and relevant validation efforts. The rationale for using a NWP assimilation system for greenhouse gas flux inversions is that such a system is better suited to extract the information from a wide array of satellite sensors. NWP already has a long heritage on using satellite observations to constrain the modelling of the atmosphere.

Here we present results for CO2 using radiance observations from the Atmospheric Infrared Sounder (AIRS) and the Infrared Atmospheric Sounding Interferometer (IASI) as well as for CH4 using retrievals from the SCIAMACHY instrument. Assimilation and inversion results for both species will be shown illustrating the current strengths and weaknesses of the 2-step approach and the used observational data. Finally, expectations for the near future using data from the Japanese GOSAT satellite as well as from the various ground-based networks will be discussed to illustrate the full potential of the system.