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Comparing model predicted atmospheric CO2 with satellite retrievals and in-situ observations - Implications for the use of upcoming satellite data in atmospheric inversions

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Atmospheric CO2 concentration has risen since pre-industrial times from ˜ 280 ppm to ˜380 ppm today and keeps rising steadily (Indermuehle et al. 1999, P. Tans, personal comm.). As CO2 is the most important anthropogenic greenhouse gas, credible predictions of its future accumulation in the atmosphere and therefore of carbon sources and sinks is important. While we currently understand many components of the carbon cycle well, we still lack an understanding of the nature and spatio-temporal distribution of the land carbon sink implied by atmospheric and oceanic carbon inventories (Sabine et all. 2004) combined with fossil fuel burning emissions (Keeling et al. 1989, Tans et al. 1990). One approach to estimate carbon sources and sinks is inverse modeling of atmospheric tracer transport combined with atmospheric CO2 concentration data. For example recently Rödenbeck et al. used 20 years of NOAA/CMDL atmospheric CO2 concentration data and the TM3 global atmospheric tracer transport model to estimate interannual variation and spatial patterns of surface CO2 fluxes using this technique. While these studies give important insights on flux variability the estimates have large uncertainties because there are not many atmospheric concentration data. Most atmospheric measurements are point observations near the surface and these station locations are biased towards to the oceans. There is a lack of data both in the lower - particularly over land - and upper troposphere. A potentially promising measurement method for closing some of these data gaps is the retrieval of CO2 from space. As part of the European Project COCO Richard Engelen from ECMWF and Cyril Crevoisier at LMD (Paris) have recently developed methods and then retrieved

CO_2 from space. They use radiances in the thermal infrared spectral region measured by the AIRS instrument on the AQUA satellite. The AQUA satellite is in orbit since May 2002. As the retrievals using AIRS data should be still viewed as experimental in nature it is important to confront and analyse CO_2 satellite retrievals with our best knowledge and expectations of atmospheric CO_2. While the CO_2 distribution at upper troposphere levels, the atmosphere region where AIRS is mainly sensitive to CO_2, is to some extent "no-mans-land", CO_2 in the upper troposphere can at least be simulated using atmospheric transport models based on credible estimates of carbon sources and sinks. The present study is dedicated to a comparison of such a prediction based on the CO_2 flux estimates of Rödenbeck et al. 2003 with the CO_2 AIRS retrievals of R. Engelen based on a retrieval algorithm embedded into the ECMWF weather forecast model. In the talk we will give a very short introduction of retrieval specifications like region sensed and retrieval uncertainties. We then compare a set of different key characteristics of atmospheric CO_2 such as inter-hemispheric gradients and seasonal cycle. We will then outline what additional measurements and research would be needed to decide on questions raised and draw a picture what perspective is opened by the satellite data.