Geophysical Research Abstracts
Vol. 15, EGU2013-5632, 2013
EGU General Assembly 2013

Tracking and verifying anthropogenic CO_2 emissions over the Swiss Plateau

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The Swiss Plateau is the densely populated and industrialized part of Switzerland producing more than 90% of the country's total greenhouse gas emissions. Verification of the efficacy of emission mitigation measures in a post Kyoto Protocol era will require several levels of scrutiny at local and regional scales. We present a measurement and modeling system, which quantifies anthropogenic CO_2 emissions at a regional scale using the Lagrangian particle dispersion model FLEXPART driven by output from a high-resolution regional scale atmospheric model (COSMO) and observations from two tall tower sites. These rural measurement sites are situated between the largest cities of Switzerland (Zürich, Geneva, Basel and Bern). We present methods used to discretize the anthropogenic CO_2 signal from atmospheric CO_2 measurements. First, we perform high resolution, time-inverted simulations of air transport combined with a new high quality Swiss CO_2 emissions inventory to determine a model-estimated anthropogenic portion of the measured CO_2. Second, we assess the utility of CO measurements and the relationship between CO_2 and CO in combustion processes as a proxy to quantify the anthropogenic CO_2 fraction directly from the measurements. We then compare these two methods in their ability to determine the anthropogenic portion of CO_2 measurements at a high temporal resolution (hours). Finally, we assess the quality of the simulated atmospheric transport by comparing CO concentrations obtained with the same atmospheric transport model and a high resolution CO emission inventory with the measured CO concentrations. This comparison of methods for determining anthropogenic CO_2 emissions provides information on how to independently certify reported CO_2 emissions. This study is a first step towards a prototype GHG monitoring and verification system for the regional scale in a complex topographic setting, which constitutes a necessary component of emissions reporting.