Geophysical Research Abstracts
Vol. 13, EGU2011-13011, 2011
EGU General Assembly 2011

Detection of greenhouse gas point and regional scale sources from next generation space instruments

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The next generation of greenhouse gas-monitoring satellites, including the high-resolution imager CarbonSat and the active MERLIN methane DIAL system, will provide new opportunities for identifying and monitoring sources and sinks of carbon dioxide and methane from space. The very small footprint of these systems allows the observation of point sources, e.g. anthropogenic hot spots such as power plants, landfills, natural gas pipelines and compressor stations, but also natural sources such as forest fires, seeps, and volcanoes. However the mixing ratio signature of individual point sources on the integrated column can be obscured given realistic meteorology and background signals. In order to test the plausibility of retrieving these point source emissions via remote sensing, forward simulations of methane and carbon dioxide have been carried out at a spatial resolution of 2 km for a domain in western Siberia for July and August 2009. In addition to specified high-resolution "best guess" fluxes, an artificial point source is advected as a separate tracer. The column-integrated mixing ratios are then sampled according to the simulated cloud-screened CarbonSat orbit and sampling schedule. These pseudo data are then used with two inversion schemes in order to retrieve the surface flux: a simple Gaussian plume model; and a more complex scheme based on a stochastic Lagrangian particle dispersion model. The measurement precision and the source strength are varied in order to determine the strength of point source that can be detected given different assumptions regarding sensor accuracy. The small footprint of the next generation instruments also allow measurements to be made through moderately small cloud holes thus providing global coverage with a higher density of observations. Using a global inversion system the effect of this higher observation coverage is demonstrated by the resulting error reduction of regional (1000 km)2 source estimates as a function of instrument precision. This modeling system also allows for the quantitative evaluation of the relative differences between the passive CH4 CarbonSat instrument and the active MERLIN CH4-DIAL.