Evaluation of various observing systems for the global monitoring of CO2 surface fluxes

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In the context of rising greenhouse gas concentrations, and the potential feedbacks between climate and the carbon cycle, there is an urgent need to monitor the exchanges of carbon between the atmosphere and both the ocean and the land surfaces. In the so-called top-down approach, the surface fluxes of CO2 are inverted from the observed spatial and temporal concentration gradients. The concentrations of CO2 are measured in-situ at a number of surface stations unevenly distributed over the Earth while several satellite missions may be used to provide a dense and better-distributed set of observations to complement this network. In this paper, we compare the ability of different CO2 concentration observing systems to constrain surface fluxes. The various systems are based on realistic scenarios of sampling and precision for satellite and in-situ measurements.

It is shown that satellite measurements based on the differential absorption technique (such as those of SCIAMACHY, GOSAT or OCO) provide more information than the thermal infrared observations (such as those of AIRS or IASI). The OCO observations will provide significantly better information than those of GOSAT. A CO2 monitoring mission based on an active (lidar) technique could potentially provide an even better constraint. This constraint can also be realized with the very dense surface network that could be built with the same funding as that of the active satellite mission. Despite the large uncertainty reductions on the surface fluxes that may be expected from these various observing systems, these reductions are still insufficient to reach the highly demanding requirements for the monitoring of anthropogenic emissions of CO2 or the oceanic fluxes at a spatial scale smaller than that of oceanic basins. The scientific objective of these observing system should therefore focus on the fluxes linked to vegetation and land ecosystem dynamics.

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