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Promises and pitfalls of estimating CO_2 fluxes from space-based measurements

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Atmospheric flux inversions, which use observed concentration gradients of atmospheric CO_2 to infer its surface sources and sinks, are presently limited by the surface observation network. The current network is sparse near several areas with large surface exchange of carbon, such as the Tropics and the oceans. Present (GOSAT) and future (OCO-2, CarbonSat, GOSAT II, TanSat) satellite missions hope to make up for this sparsity by providing total column CO_2 (XCO_2) measurements globally.

I will show with examples that satellite missions can indeed provide surface flux information over under-sampled areas such as the Tropics and the Boreal region. However, the increased spatial sampling density and coverage come at some cost: satellite-based XCO_2 measurements are less accurate than in situ measurements, have systematic biases correlated over thousands of kilometers, have a much higher data volume than what most inversion systems are geared to handle, and are generally trying to measure a very small signal on top of a very large background. I will show how each of these can be a killer for atmospheric inversions, with strategies for separating robust results from unrealistic flux estimates, and possible ways in which future CO_2-sensing satellites could minimize the impact of these pitfalls. In the end, remote sensed XCO_2 has the potential to add to our knowledge of surface exchange of CO_2, but is not a silver bullet to overcome all the limitations of current in situ observations.