How Well Could Satellite Data Constrain Degree-Resolution Carbon Fluxes?

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With the launch of the Greenhouse-Gases Satellite, CO_2 concentrations recently affected by surface fluxes may now be measured well from space; satellites with greater accuracy and ability to avoid clouds and aerosols should follow in the next several years. From a policy standpoint, it is reasonable to ask how well a fleet of such satellites could estimate natural carbon fluxes and/or fossil fuel emissions from individual countries. Here we use simulated measurements from multiple Orbiting Carbon Observatory (OCO)-like satellites in a variational data assimilation scheme to estimate weekly CO_2 fluxes (and uncertainties) at 1.0°x2.5° resolution: for regions roughly the size (~30,000 km^2) of Belgium, Albania, or the State of Maryland. We use OCO column CO_2 measurement uncertainities as a function of surface type, aerosol optical depth, solar zenith angle (SZA), and viewing mode (nadir or glint) obtained from a linear analysis of the OCO "full-physics" retrieval scheme. The availability of cloud-free scenes, and the impact of aerosols, is calculated as a function of SZA using Moderate Resolution Imaging Spectroradiometer data. Measurements are obtained using realistic vertical weighting and viewing geometries. Fleets of up to four OCO satellites, with orbital ascending nodes centered about 13:30 local time, are considered, viewing in both nadir and glint modes. Over the land, we find that a fleet of four OCO-like satellites could constrain weekly fluxes at 1.0°x2.5° to within ~100 gG m^{-2} a^{-1}, or ~0.004 GtC/yr per box, either in glint or nadir modes. This is adequate for identifying most non-diffuse fossil fuel emission sources, and represents an error reduction of ≥ 60% in the natural biospheric fluxes, compared to our prior (Fig. 1). Since this analysis considers random retrieval errors only, these are “best case” results obtainable only after systematic errors are removed.

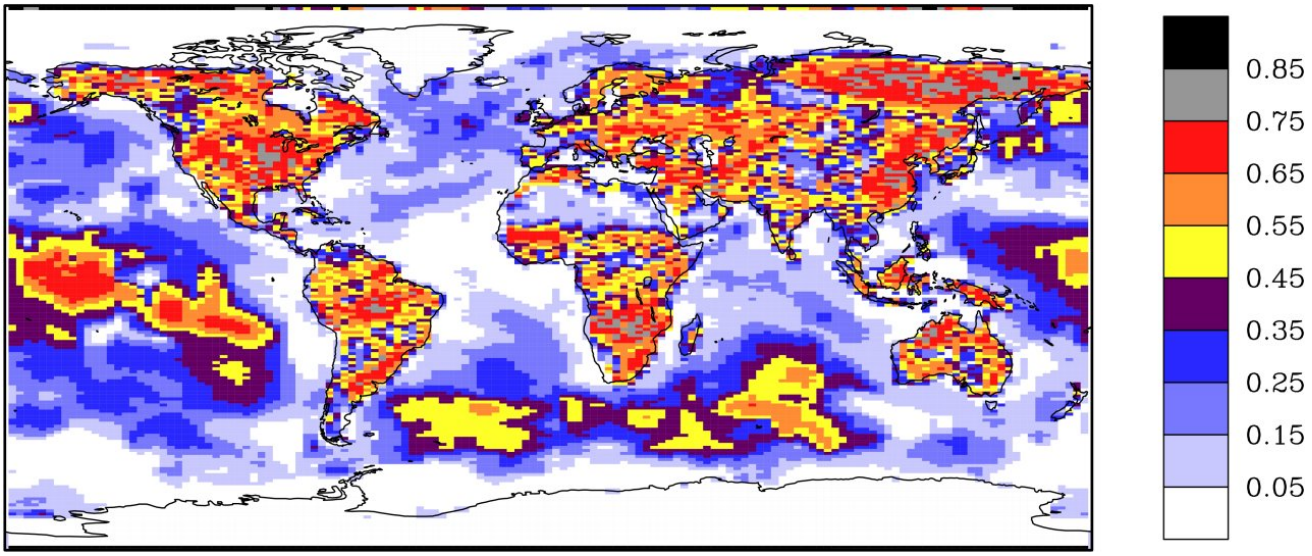

Figure 1. The constraint provided by a fleet of four OCO-like satellites, on weekly fluxes at 1.0°x2.5° resolution (lat/lon), in terms of the fractional reduction in the uncertainty of the natural fluxes (ocean and land biosphere).