Measuring Atmospheric Carbon Dioxide with the NASA Orbiting Carbon Observatory-2 (OCO-2)

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The NASA Orbiting Carbon Observatory-2 (OCO-2) was successfully launched from Vandenberg Air Force Base in California on 2 July 2014. Two months later, its spectrometers began routinely returning almost one million soundings over the sunlit hemisphere each day. About 10% of these soundings are sufficiently cloud free to yield full-column estimates of the column-averaged CO_2 dry air mole fraction, X_{CO2}. Nadir soundings over land yield X_{CO2} estimates with single-sounding random errors that increase from 0.5 ppm to 1 ppm between the sub-solar latitude and solar zenith angles near 60 degrees. Observations of the glint spot over the ocean yield X_{CO2} estimates with single sounding random errors near 0.5 ppm at solar zenith angles below 70 degrees. The initial observing strategy recorded only glint or nadir observations over the entire sunlit hemisphere for a complete, 16-day, ground-track repeat cycle, and then used the other observing mode in the next 16-day cycle. This approach provided adequate coverage of oceans and continents on monthly time scales, but produced 16-day long gaps in the coverage of the ocean while in nadir mode, and limited coverage of high latitude continents while in glint mode. In early July of 2015, this observation strategy was modified to alternate between glint and nadir observations on alternate orbits to yield more continuous coverage of the entire sunlit hemisphere every day.

Preliminary, global maps of X_{CO2} compiled from soundings collected over 16-day ground track repeat cycles reveal some of the most robust features of the annual atmospheric carbon cycle. Regions of enhanced X_{CO2} that are co-located with intense fossil fuel emission sources in the eastern US and eastern China were most obvious in the fall and early winter of 2014, when the north-south gradient in X_{CO2} was small. X_{CO2} enhancements coincident with intense biomass burning in the Amazon, central Africa, and the Indonesian Archipelago were also most obvious during this season. In the early spring, when the pole-to-pole gradients in X_{CO2} are largest, contributions from these emission sources were clearly seen in individual orbit tracks but were much less obvious in the global maps. However, between late May and early July of 2015, OCO-2 maps show a 2-3% reduction in X_{CO2} across much of the northern hemisphere, as the land biosphere rapidly absorbs CO_2 through photosynthesis. As the carbon cycle science community continues to analyze these OCO-2 data, quantitative estimates of regional-scale emission sources and natural sinks (absorbers) are expected to emerge.

The OCO-2 team started delivering Version 7 products to the Goddard Earth Sciences Data and Information Services Center (GES-DISC) in early June 2015. These products include calibrated, spectral radiances (Level 1 products), and retrieved geophysical quantities, including spatially resolved estimates of XCO2, surface pressure, and solar-induced chlorophyll fluorescence (Level 2 products). The calibration of the Level 1 products continues to be refined, and the effort to cross calibrate these products with those from the Japanese Greenhouse gases Observing SATellite (GOSAT) are under way. The Level 2 products are currently being validated against observations from the Total Carbon Column Observing Network (TCCON) and other standards to identify and correct biases. This presentation will summarize these and other aspects of the OCO-2 mission status, early products, and near-term plans.

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