Measuring Carbon Dioxide from Space: Prospects for the NASA Orbiting Carbon Observatory-2 (OCO-2)

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Space based remote sensing observations of the column-averaged CO_2 dry air mole fraction, X_{CO2}, complement *in situ* measurements from the ground and from aircraft with increased resolution and coverage. However, such measurements will be useful only if they have the precision and accuracy needed to resolve the small (< 1%) variations associated with typical CO_2 emission sources and natural sinks. X_{CO2} estimates can be derived from spatially coincident, spectra of the absorption of reflected sunlight by CO_2 and molecular oxygen (O_2). The European Space Agency's EnviSAT SCanning Imaging Absorption SpectroMeter for Atmospheric CHartographY (SCIAMACHY) and Japanese Greenhouse gases Observing SATellite (GOSAT) TANSO-FTS were the first two satellite instruments designed to use this approach. SCIAMACHY returned global maps of X_{CO2} and X_{CH4} from 2002 – 2012, when the satellite went silent. The precision of its measurements over land eventually approached ~1-2%. However, the instrument's low sensitivity precluded useful observations over the ocean and its large (30 km by 60 km) sounding footprints were often contaminated by clouds. GOSAT was successfully launched in January 2009, and has been returning global data sets since April 2009. Recent X_{CO2} products from GOSAT show little or no bias and random errors that are typically less than 0.5% (2 ppm) on regional scales over much of the Earth. While GOSAT data has driven dramatic improvements in X_{CO2} retrieval algorithms, the restricted coverage of the ocean (±20° of the sub-solar latitude) and low yield over high latitudes has limited its impact on flux inversion studies.

The OCO-2 instrument is currently under development. This spacecraft carries and points a single instrument that incorporates 3, co-bore-sighted high-resolution, imaging, grating spectrometers designed to measure O_2 and CO_2 within the same near infrared and shortwave infrared spectral ranges used by the GOSAT. To maximize spatial resolution and coverage, the OCO-2 instrument was optimized to yield a high signal-to-noise ratio over a large dynamic range with small sounding footprint (< 3 km^2). It will collect 24 X_{CO2} soundings per second, yielding up to one million soundings over the sunlit hemisphere each day. To further increase its sensitivity to CO_2 variations over dark, ocean or ice-covered surfaces, OCO-2 can point the instrument's field of view toward the bright ocean glint spot at solar zenith angles > 75°. With these capabilities, OCO-2 is expected to yield the data needed to retrieve X_{CO2} with single-sounding random errors < 0.25% over > 80% of the range of latitudes on the sunlit hemisphere each month. The OCO-2 instrument and spacecraft bus are now complete and their pre-launch characterization and calibration tests are ongoing. A Delta-II 7320 launch vehicle has been selected and the launch is planned as early as July 2014. This presentation will summarize the near the near term plans for OCO-2 integration and test activities, and describe the mission plans for OCO-2.

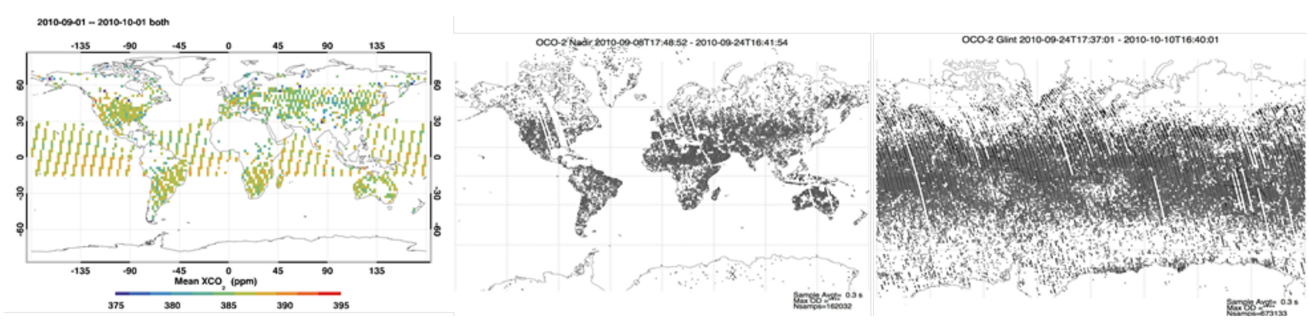

Figure 1. Actual spatial sampling from GOSAT for September 2010 (left) is compared to that expected from OCO-2 for nadir (center) and glint (right) observations collected on alternate 16-day repeat cycles.