# The Orbiting Carbon Observatory Mission

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Carbon dioxide ($CO_2$) is the primary man-made greenhouse gas and the primary atmospheric component of the global carbon cycle. Precise measurements of $CO_2$ made since the late 1950's indicate that atmospheric $CO_2$ has increased from ~310 to over 380 parts per million (ppm) over this period. Comparisons of these data with estimates of $CO_2$ emission rates from fossil fuel combustion, biomass burning, and other human activities indicate that only about half of the $CO_2$ that has been emitted into the atmosphere has remained there. The rest has apparently been absorbed by surface "sinks" in the land biosphere or oceans. Existing $CO_2$ measurements also show that the atmospheric $CO_2$ buildup varies dramatically from year to year in response to smoothly increasing emission rates. The existing $CO_2$ monitoring network does not have the spatial resolution, coverage, or sampling rates needed to identify the natural $CO_2$ sinks or the processes that control how their efficiency variations over time.

The NASA Orbiting Carbon Observatory (OCO) is currently scheduled for launch in December 2008. OCO will make space-based measurements of atmospheric $CO_2$ with the precision, resolution, and coverage needed to characterize the geographic distribution of $CO_2$ sources and sinks and quantify their variability over year. During its 2-year nominal mission, OCO will fly in the Earth Observing System Afternoon Constellation (EOS A-Train). This circular, 705 km-altitude, near-polar, sun synchronous orbit provides global coverage of the sunlit hemisphere with a 1:26 PM nodal crossing time and 16-day ground-track repeat cycle. The observatory carries a single instrument that measures the absorption of reflected sunlight by $CO_2$ and molecular oxygen ($O_2$) at near infrared wavelengths. High spectral resolution ($\lambda/\Delta\lambda$>20,000) measurements within the $CO_2$ bands near 1.61 and 2.06 $\mu$m yield $CO_2$ column abundance estimates that are most sensitive near the surface. High resolution ($\lambda/\Delta\lambda$>17,000) measurements within the 0.765-$\mu$m $O_2$ A-band spectra yield clear-sky surface pressure estimates with accuracies near 1 mbar and constrain cloud and aerosol profiles to reduce pathlength uncertainties associated with multiple scattering. Boresighted measurements of the $CO_2$ and $O_2$ spectra will be analyzed to retrieve spatial variations in the column-averaged $CO_2$ dry air mole fraction, $X_{CO2}$. Surface sources and sinks

must be inferred from small spatial variations in $X_{CO2}$, since this quantity varies by only ~2% from pole to pole. A sensitive, stable instrument and a comprehensive ground-based validation network are being implemented to provide $X_{CO2}$ measurements with random errors and systematic biases no larger than 0.3-0.5% on regional scales. These measurements are expected to improve our understanding of the nature and processes that regulate atmospheric $CO_2$ enabling more reliable forecasts of $CO_2$ buildup and its impact on climate change.

The NASA OCO mission is part of a global $CO_2$ monitoring network that includes the NOAA ESRL Flask and tower networks, Aircraft, and the ground-based up-looking Fourier Transform Spectrometers in the Total Column Carbon Observing Network (TCCON). The OCO mission will also fly at the same time as the Japanese GOSAT mission, providing opportunities for coordinated observations and in-flight cross calibration activities.