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The NASA Orbiting Carbon Observatory - 2 (OCO-2), the next step in CO2 measurements from space

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Global, space-based remote sensing observations of atmospheric carbon dioxide (CO_2) and methane (CH_4) hold substantial promise for future, long-term monitoring of these important greenhouse gases. These measurements will complement those from the existing ground based greenhouse gas monitoring network with increased spatial coverage and sampling resolution. The principle challenge for this approach is the high precision and accuracy needed to resolve the small ($<$0.3 percent) variations in the background distributions of these gases associated with their emission sources and natural sinks. The European Space Agency (ESA) EnviSat SCIAMACHY and Japanese Greenhouse Gases Observing Satellite (GOSAT) TANSO-FTS were the first two space-based sensors designed to return high resolution spectra of the reflected sunlight in molecular oxygen (O_2), CO_2, and CH_4 bands at near-infrared wavelengths. These spectra are being analyzed to yield spatially resolved estimates of the column-averaged CO_2 and CH_4 dry air mole fractions (X_{CO2}, X_{CH4}) over the sunlit hemisphere. The availability of these data has already enabled substantial improvements in instrument calibration techniques, remote sensing retrieval algorithms, and data validation techniques. However, sensors with greater sensitivity, coverage, and resolution are needed to implement the space-based segment of a global greenhouse gas monitoring system.

In July of 2014, these space-based greenhouse gas pathfinders will be joined by the NASA Orbiting Carbon Observatory-2 (OCO-2). This satellite will fly at the front of the 705-km Afternoon Constellation (A-Train), along an orbit track aligned with the ground footprints of the CloudSat radar and CALIPSO lidar. Its 3-channel, imaging, grating spectrometer has been optimized to record high resolution spectra of reflected sunlight in the 765 nm O_2 A-band and in the 1610 and 2060 nm CO_2 bands. Coincident O_2 and CO_2 spectra are combined into soundings that are analyzed with a full-physics retrieval algorithm to yield estimates of X_{CO2} with accuracies exceeding 0.3 percent over most of the Earth. The OCO-2 spectrometer will collect up to 1 million of these soundings each day along a narrow ground track as it flies over the sunlit hemisphere. Between 20 and 30% of these soundings are expected to be sufficiently cloud free to yield full-column estimates of X_{CO2}. Even with these assets, OCO-2 is still only a research satellite, designed to validate a space-based CO_2 measurement approach. A coordinated network of satellites with similar capabilities will be needed to discriminate and quantify the CO_2 emissions from fossil fuel combustion, land use practices, and other human activities in the presence of the much larger CO_2 fluxes associated with the natural carbon cycle.

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