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# First results from Orbiting Carbon Observatory-2 (OCO-2) and prospects for OCO-3

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Since September 6, 2014, NASA's Orbiting Carbon Observatory-2 (OCO-2) instrument has been routinely returning almost one million soundings of the column averaged $CO_2$ dry air mole fraction, $XCO_2$, over the sunlit hemisphere each day. On monthly time scales, 7 to 21% of these soundings are sufficiently cloud free to yield full-column estimates of $XCO_2$ of the with single sounding random errors near 0.5 parts per million (ppm) at solar zenith angles as large as 70 degrees. These $XCO_2$ estimates are being validated against results obtained from the Total Carbon Column Observing Network (TCCON) and other standards to assess their accuracy and correct regional scale biases. After correction, the median bias between OCO-2 and TCCON $XCO_2$ estimates is less than 0.5 ppm, and root-mean-square (RMS) differences are typically less than 1.5 ppm.

The OCO-2 data are now being used to investigate the impacts of the 2015/2016 El Nino on the carbon cycle, as well as examples of local emission enhancements and the seasonal patterns of solar induced fluorescence. Highlights of the latest science findings will be presented.

The Orbiting Carbon Observatory-3 (OCO-3) instrument will explore, for the first time, daily variations in the release and uptake of carbon dioxide by plants and trees in the major tropical rainforests of South America, Africa, and Southeast Asia, the largest stores of aboveground carbon on our planet. NASA will develop and assemble the instrument using spare materials from OCO-2 and host the instrument on the International Space Station (ISS) (earliest launch readiness in early 2018.)

The low-inclination ISS orbit lets OCO-3 sample the tropics and sub-tropics across the full range of daylight hours with dense observations at northern and southern mid-latitudes (+/- 52º). At the same time, OCO-3 will also collect measurements of solar-induced chlorophyll fluorescence (SIF) over these areas. The instrument utilizes an agile, 2-axis pointing mechanism (PMA), providing the capability to look towards the bright reflection from the ocean and validation targets.

The PMA also allows for a snapshot mapping mode to collect dense datasets over 100km by 100km areas. Measurements over urban centers could aid in making estimates of fossil fuel $CO_2$ emissions. This is critical because the largest urban areas (25 megacities) account for 75% of the global total fossil fuel $CO_2$ emissions, and rapid growth (> 10% per year) is expected in developing regions over the coming 10 years.
Similarly, the snapshot mapping mode can be used to sample regions of interest for the terrestrial carbon cycle. For example, snapshot maps of 100km by 100km could be gathered in the Amazon or key agricultural regions. In addition, there is potential to utilize data from ISS instruments ECOSTRESS (ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station) and GEDI (Global Ecosystem Dynamics Investigation), which measure other key variables of the control of carbon uptake by plants, to complement OCO-3 data in science analysis.