The OCO-3 Mission: Global Observations of CO₂ and Solar-Induced Fluorescence from the ISS – Snapshot Area Map and Target Modes

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OVERVIEW

The Orbiting Carbon Observatory-3 (OCO-3) [Eldering et al., 2018] will continue and complement global CO₂ and solar-induced chlorophyll fluorescence (SIF) using the flight spare instrument from OCO-2 [Eldering et al., 2017]. The instrument was installed on the International Space Station (ISS) on 30 May 2019 and is currently undergoing decontamination, with all systems behaving nominally. 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 (±52°). The instrument utilizes an agile, 2-axis pointing mechanism (PM2A), providing the capability to look towards the bright reflection from the ocean and validation targets. In addition to the nadir-, glint-, and target-mode geometries familiar from OCO-2, OCO-3 includes a new observation mode dedicated to mapping out larger spatial-scale emitters like cities. This Snapshot Area Map (SAM) mode will be used to map areas of up to 80x80 km² on the Earth surface with the standard OCO-3 ground footprints of 1.6x2.1 km², providing unprecedented high spatial resolution coverage of large-scale CO₂ emitters worldwide. The list of OCO-3 Target and SAM observations currently includes the top Scope 1.3 fossil fuel emitting cities [Fong et al., 2014], TCCON [Wunch et al., 2010] and OCOCOr [Frey et al., 2018] stations, volcanoes, as well as CO₂ and SIF calibration sites.

SIMULATION OF OCO-3 POINTING AND OBSERVATIONS

24 hours of ISS simulated spatial coverage on 2015-12-19. The image shows ISS daylight track together with simulations OCO-3 observations in Nadir, Glint, Target, and SAM modes on 2015-12-19 performed with the pointing control software that will be used to position the PMA in flight.

OCO-2 and OCO-3

OCO-3 was built as the OCO-2 spare instrument and will continue the OCO-2 data record as well as complement it due to the unique spatial and temporal coverage of the ISS orbit.

<table>
<thead>
<tr>
<th>OCO-2</th>
<th>OCO-3</th>
</tr>
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<tbody>
<tr>
<td>Launch</td>
<td>2014-07-02</td>
</tr>
<tr>
<td>Orbit</td>
<td>sun-synchronous, A-Train</td>
</tr>
<tr>
<td>Coverage</td>
<td>pole-to-pole, 1330h eq.c.t.</td>
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<tr>
<td>Footprint Size</td>
<td>3 km²</td>
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<tr>
<td>Spectrometer</td>
<td>5 bands: 0.765 µm, 1.61 µm, 2.09 µm, 20,000 resolving power</td>
</tr>
<tr>
<td>Observed Species</td>
<td>CO₂ (dry-air column (XCO₂)), solar-induced fluorescence (SIF)</td>
</tr>
<tr>
<td>Observation Modes</td>
<td>nadir, glint, target</td>
</tr>
</tbody>
</table>

SNAPSHOT AREA MAP (SAM) AND TARGET MODE OBSERVATIONS

OCO-3 observations will include up to 100 2-minute long Target and SAM sequences daily, covering areas of 80x80 km² (SAM) and stretches of 40 km (Target). All images below show the +13 km wide OCO-3 swath coverage, without subdivision into 5 cross-track footprints.

Fossil Fuel Targets and SAM Frequency

Most of the targets of interest are in the Northern Hemisphere (NH). Given the ISS processing orbit, the NH targets go through cycles of being sunlit, and thus the total number of targets sampled each day cycles. The targets are estimated to have from 30 to 5 cloud-free observations per year.

DETAILS OF PARIS SAM SAMPLING

SAMs collected over Paris cover a range of local times, due to the ISS processing orbit. The histogram below shows that the distribution ranges from early morning to late evening. Data collection is lumped – there are 30-40 day periods of no data collection – and periods where 20 data sets happen over 15-25 days, occasionally twice per day. Cumulative over the course of a year, we collect about 50 observations, up to 20 of which are expected to be of sufficient science quality (e.g., cloud free).

SIX WAYS TO SEE PARIS

SAM geometry will vary – depending on the distance from the flight track, direction of flight, location of target relative to ISS track, etc. Here are six examples of SAMs over Paris for a range of cases, the desired 80x80 km² (SAM) coverage is achieved in all cases, allowing for measurements over the city and over some background areas. The footprints have some rotation that is imparted by the pointing system, which varies for each case.

REFERENCES

Eldering et al. (2017), The Orbiting Carbon Observatory (OCO-2): First results after spacecraft reconfiguration, Geophysical Research Letters, 44(22), 11,992-11,998.

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As above, but including target sequences (PMA repositioning sections, where the mirrors are basically locked in place), no control over where these segments will fall, big possibility on additional unsolved background information.

SNAPSHOT AREA MAP (SAM) AND TARGET MODE OBSERVATIONS

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OCO-3 DATA RELEASE SCHEDULE

Launch | 04 May 2019
Launch + 2 months | Initial Operations and Checkout (IOC)
End of IOC + 3 months | L1B release (October 2019)
L1B + 3 months | L2 release (January 2020)

OCO-3 PROJECT WEB SITE
oco3.jpl.nasa.gov
for information and discussions on SAM and Target observation strategies