Committee on Earth Observation Satellites

OCO-2 and OCO-3 Status

Report to CEOS AC-VC

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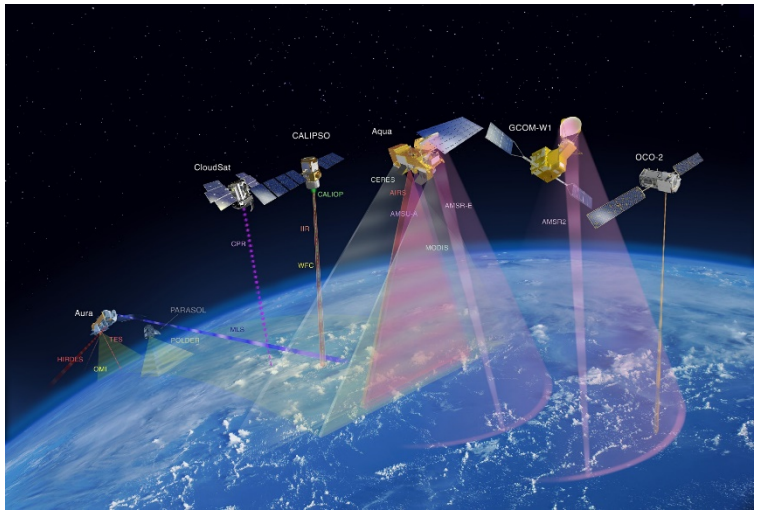
OCO-2 Status Overview

- OCO-2 was successfully launched on 2 July 2014, and completed its 2-year prime mission on October 16, 2016 with a healthy spacecraft and instrument
  - Now returning about 25000 to 75000 full-column measurements of X_{CO2} each day over the sunlit hemisphere
  - These products are being validated against TCCON and other standards to assess their accuracy and are being distributed by the GES DISC

- OCO-2 was automatically granted a one-year extended mission, because it was out of phase with the NASA Earth Science Extended Mission "Senior Review" process, but has submitted an extended mission proposal that is currently under evaluation
  - This extension would extend the mission for 3 more years (through US fiscal year 2020, which ends on September 30, 2020).

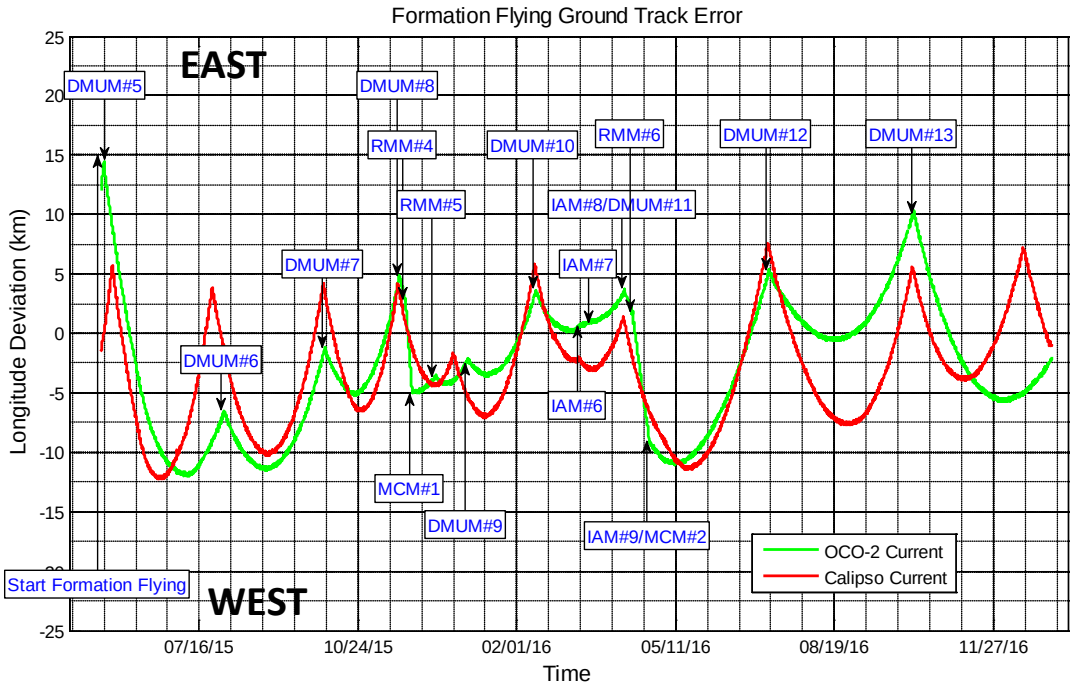
Formation Flying in the A-Train

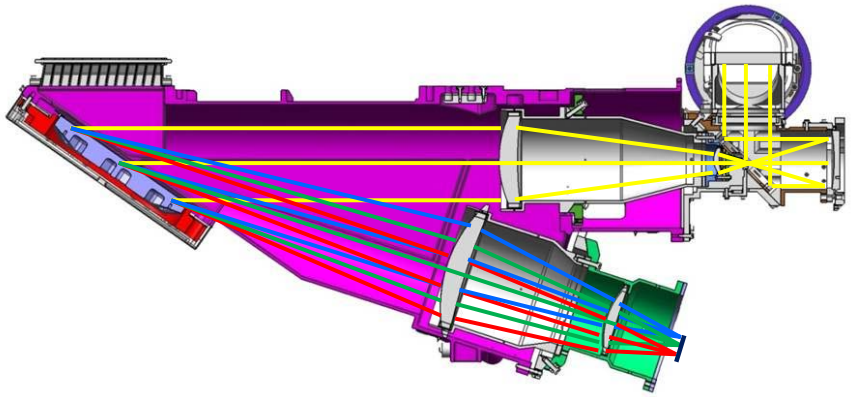


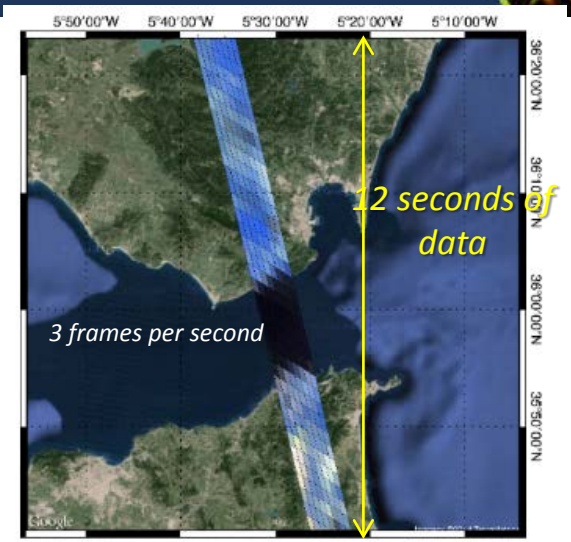
OCO-2 was inserted at the head of the Afternoon Constellation (A-Train) on 3 August 2014. It follows a ground track that is displaced 217 km to the east of the WRS-2 ground track followed by Aqua

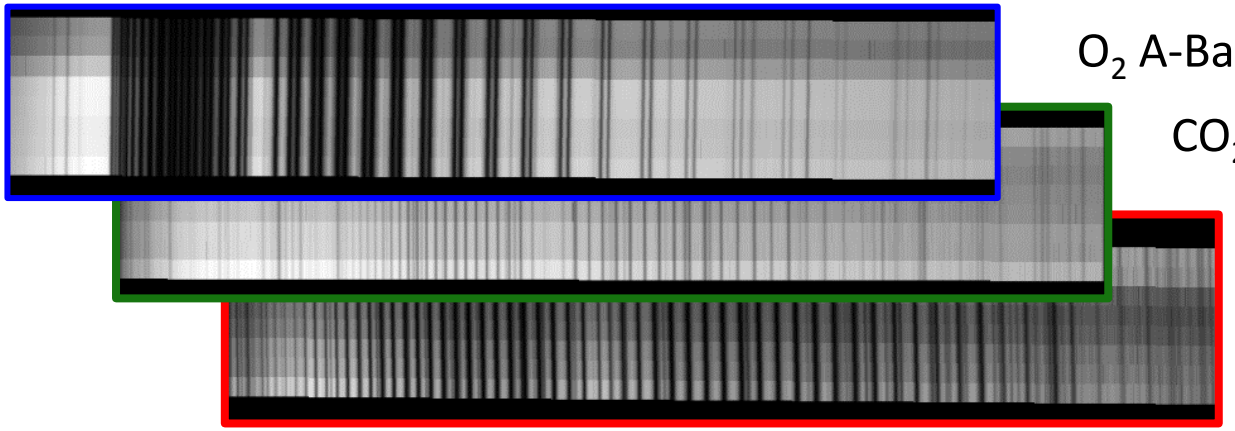
Since May of 2015, the OCO-2 navigation team has maintained the OCO-2 orbit track so that that nadir observations overlap with the CALIPSO and CloudSat ground tracks.

OCO-2 will continue to maintain this alignment until CALIPSO expends the rest of its fuel and leaves the A-Train









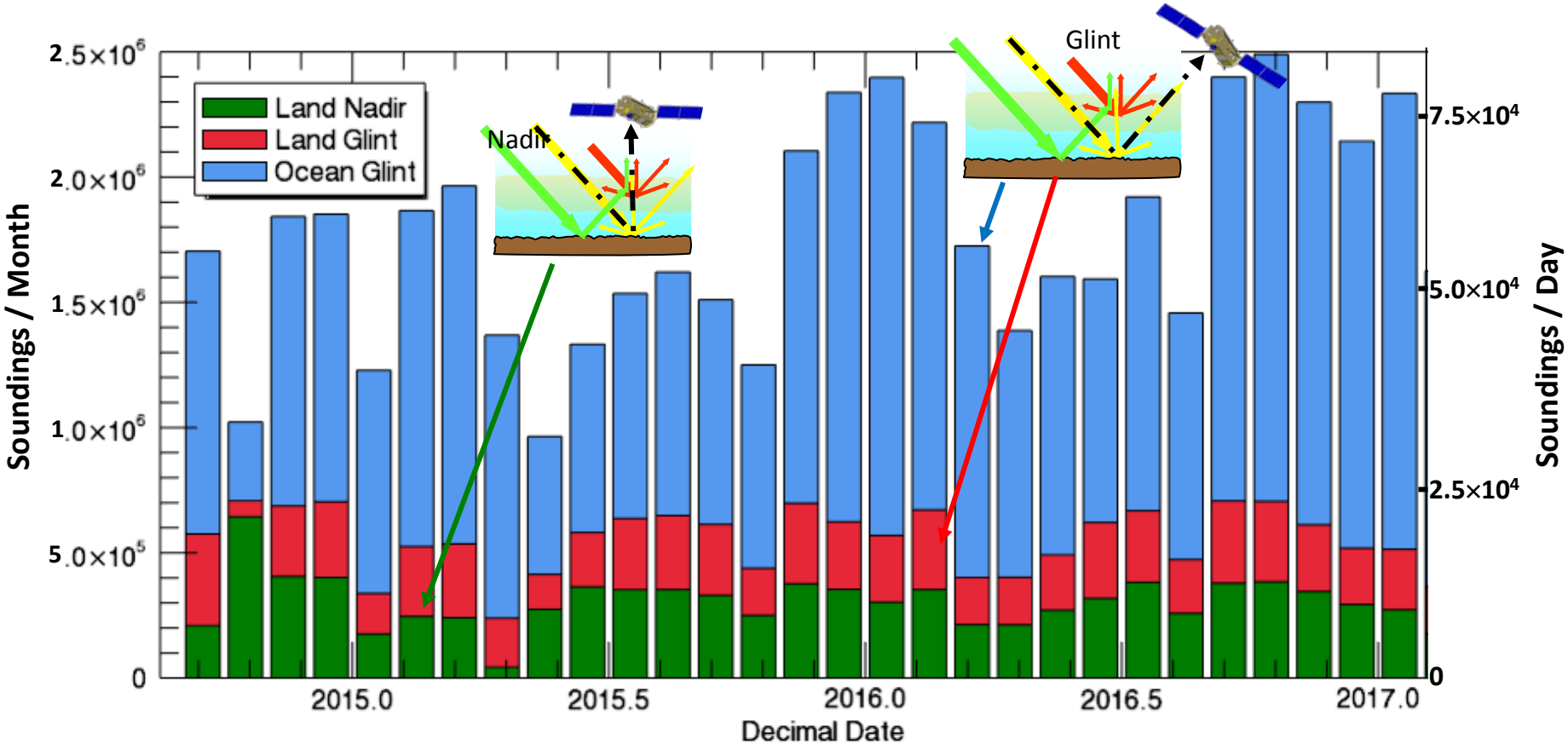
O_2 A-Band

CO_2 1.61 μm Band

CO_2 2.06 μm Band

The OCO-2 instrument collects 24 soundings each second over a narrow (0.8°) swath as it flies over the sunlit hemisphere of the Earth, yielding almost 1 million soundings each day

The Glint/Nadir Observing Strategy has been Optimized for Data Yield

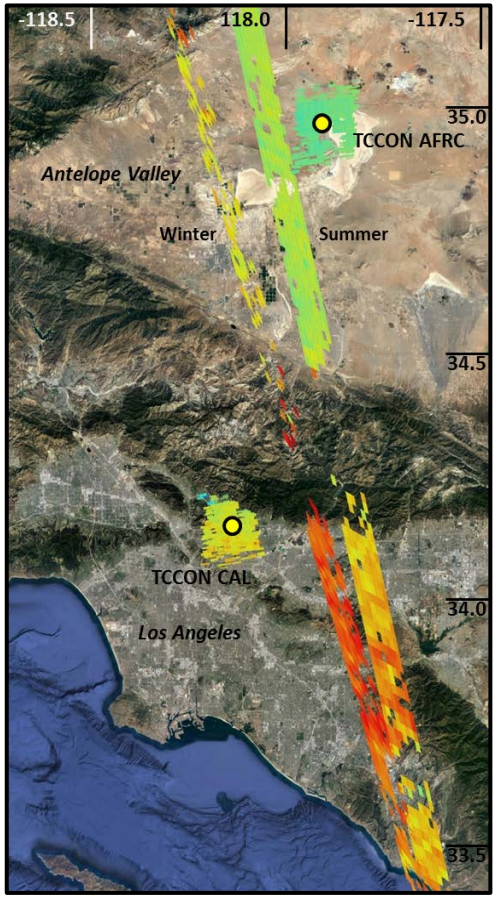


The glint/nadir observations strategy has been refined to maximize the number of full-column X_{CO2} retrievals. The "optimal" strategy, implemented in November 2015 acquires ocean glint on all orbits predominately over the Atlantic or Pacific Oceans.

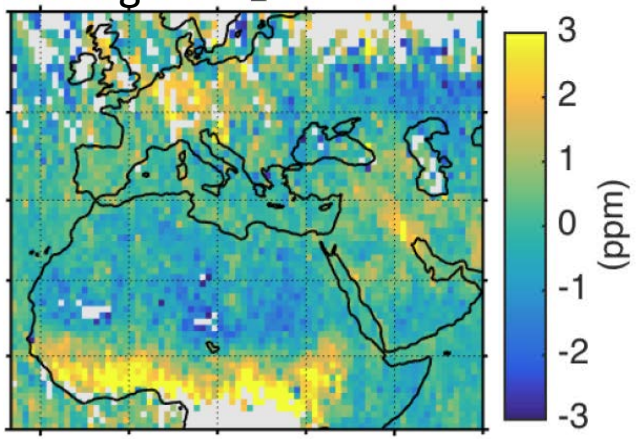
A Quick Look at the OCO-2 Prime Mission

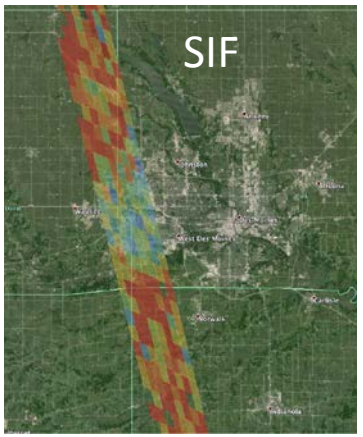
A Quick Overview of OCO-2 Results

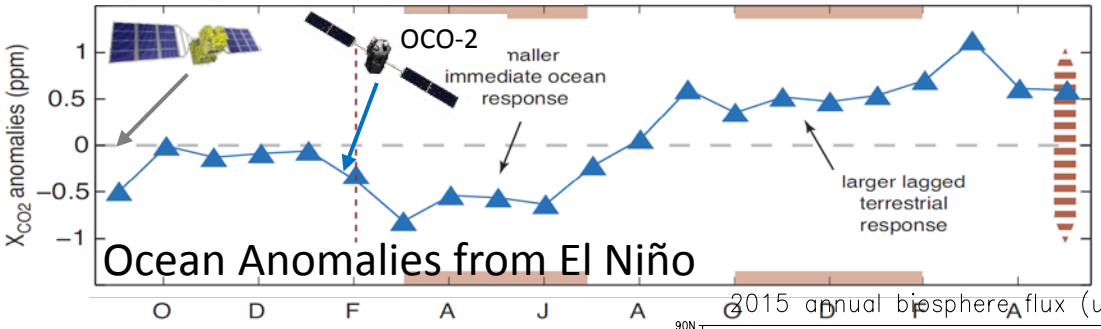
Urban-Scale Anomalies



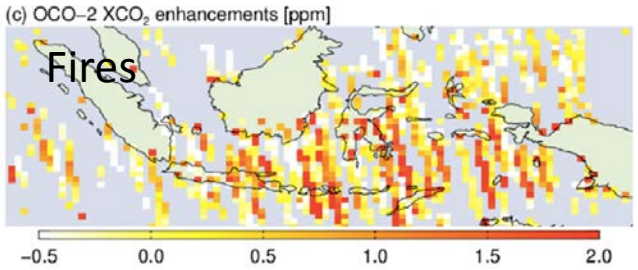
Regional Anomalies

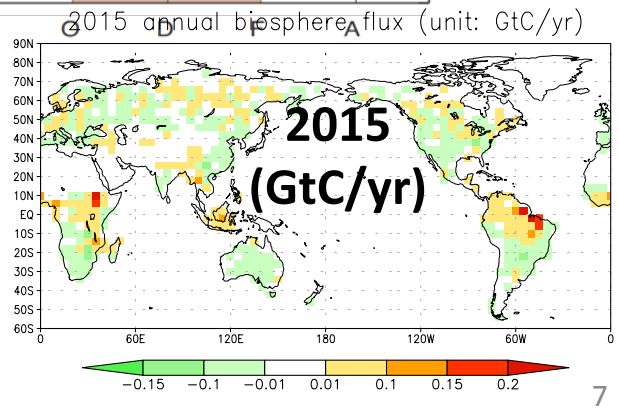




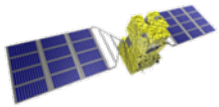


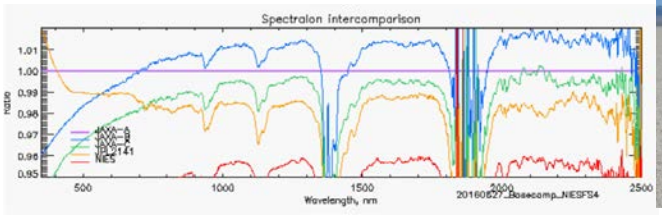
Ocean Anomalies from El Niño



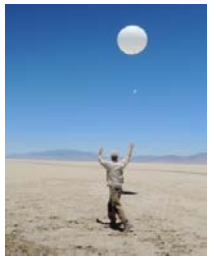


Vicarious Calibration: Railroad Valley



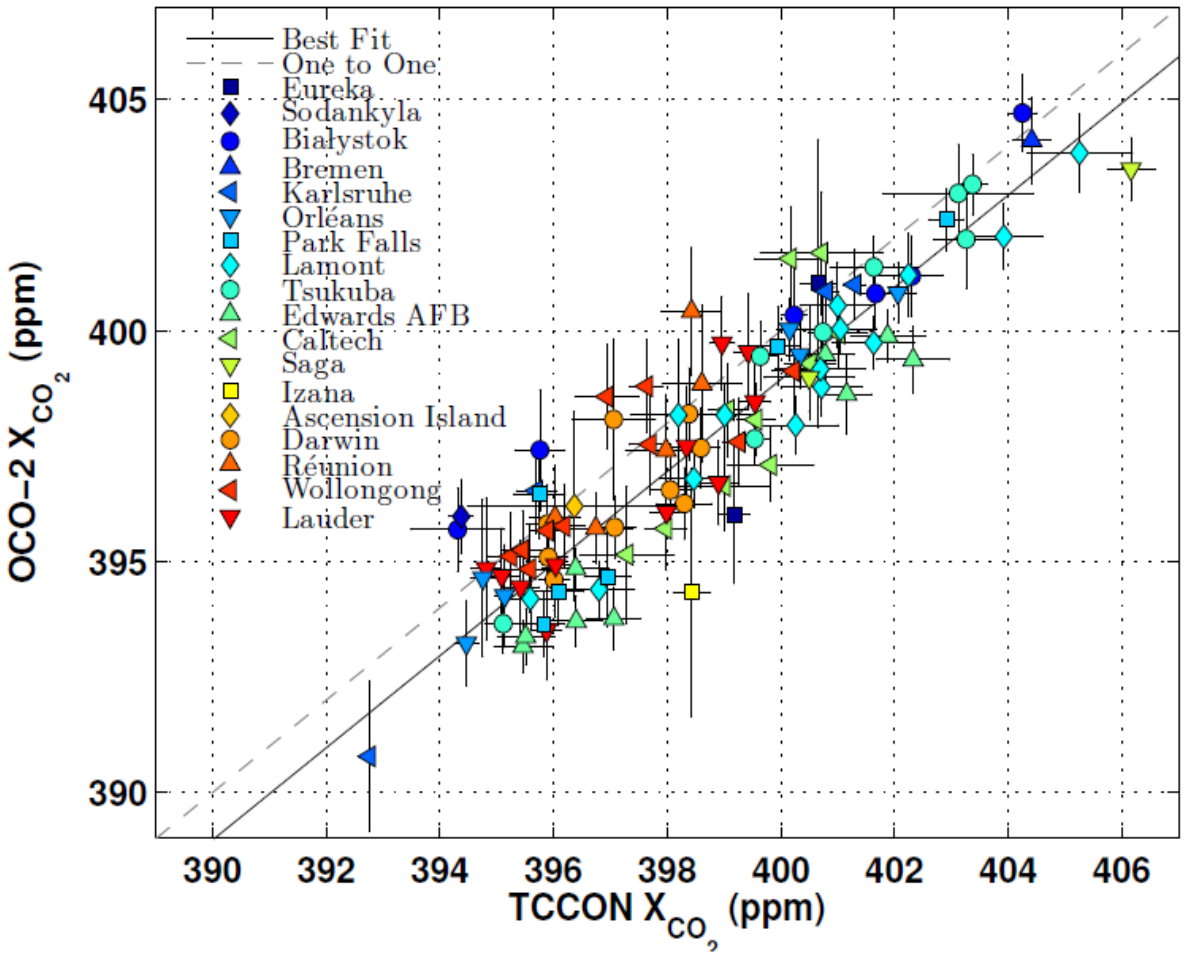




	Day of year		OCO-2	orbit	GOSAT		
19-Jun-17	170	Monday	8	none	no path		LAX
20-Jun-17	171	Tuesday	9	137	36	Golden	Comparison (unpacking)
21-Jun-17	172	Wednesday	10	none	37		Comparison
22-Jun-17	173	Thursday	11	none	no path		(Comparison)
23-Jun-17	174	Friday	12	none	36		Loading
24-Jun-17	175	Saturday	13	none	37		moving
25-Jun-17	176	Sunday	14	none	no path	Training	RRV
26-Jun-17	177	Monday	15	none	36		RRV
27-Jun-17	178	Tuesday	16	none	37		RRV
28-Jun-17	179	Wednesday	1	none	no path		RRV
29-Jun-17	180	Thursday	2	136	36	Golden	RRV
30-Jun-17	181	Friday	3	none	37		RRV
1-Jul-17	182	Saturday	4	none	no path		JPL
2-Jul-17	183	Sunday	5	none	36		Salton Sea

The OCO-2 and GOSAT teams are continue to collaborate on annual Vicarious Calibration Campaigns in Railroad Valley, NV

Validation against TCCON



Comparisons with the Total Carbon Column Observing Network (TCCON) stations are being used to identify and correct biases in X_{CO2} estimates.

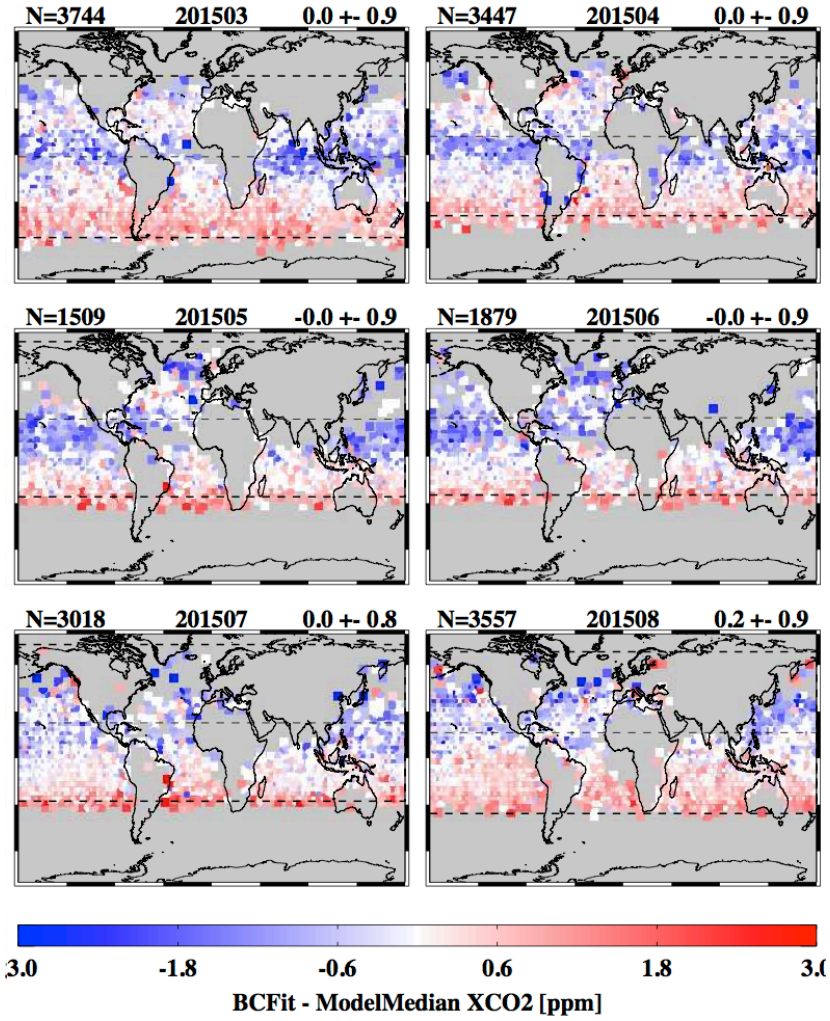
After applying a bias correction

- **Global bias is reduced to < 0.4 ppm**
- **Station-to-station biases reduced to ~1.5 ppm**

Wunch et al. (2017)

own Issues and Coming Attractions: The O-2 Version 8 Data Product

With Strat Aerosols

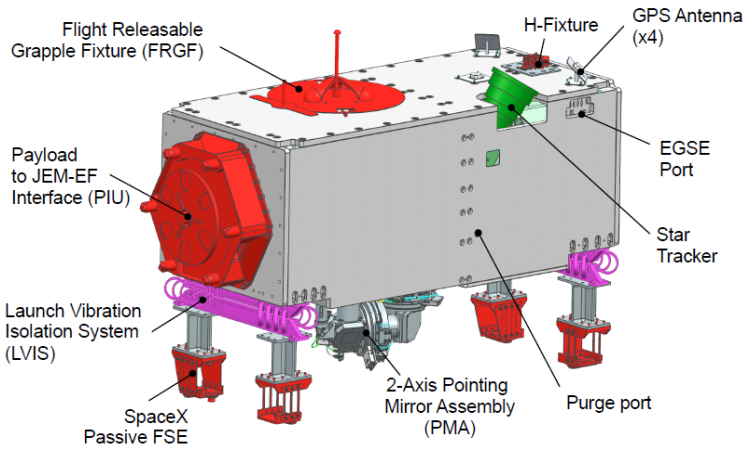


- Optically-thin stratospheric aerosol layers can introduce biases in the OCO-2 X_{CO2} products
  - The largest effects are seen at high latitudes over the ocean
  - Volcanic activity and fires that enhance stratospheric aerosols can introduce large errors
- More subtle biases are introduced by limitations in the instrument calibration, gas absorption cross sections, cloud screening and surface reflection model
- These issues and others are addressed in the OCO-2 Version 8 data Product, which will be produced later this summer

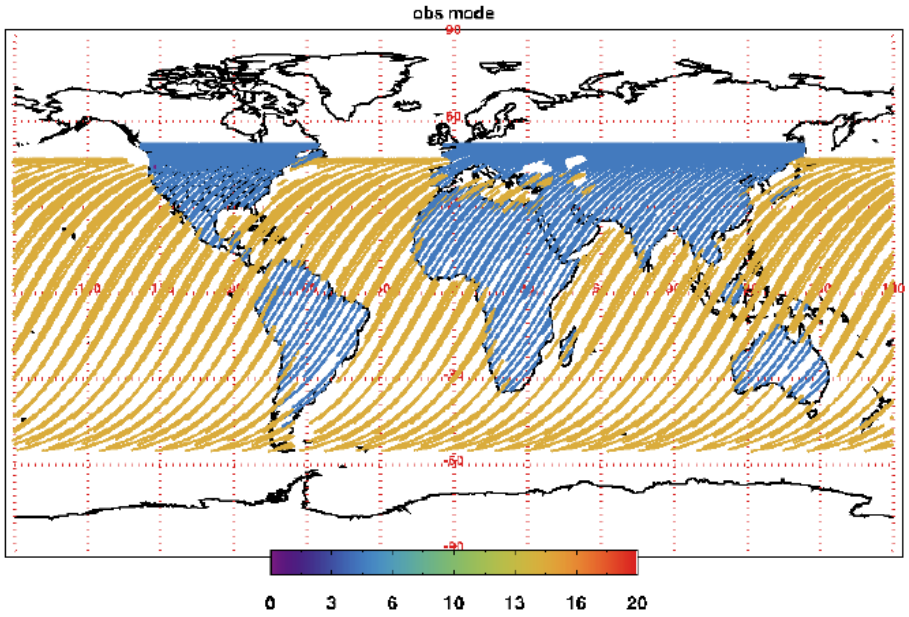
See presentation by O'Dell et al.

OCO-3 Mission Status

- The OCO-3 mission deploys the OCO-2 flight spare instrument on the International Space Station
  - The administration has targeted this mission in their 2018 budget proposal, but this is just a proposal. The fate of OCO-3 will be determined by Congress
- The current orders are to complete the instrument and its testing, in preparations for a delivery in March 2018
- Thermo-vacuum testing is planned for August - December of 2017
- ISS delivery is tentatively scheduled for October 2018



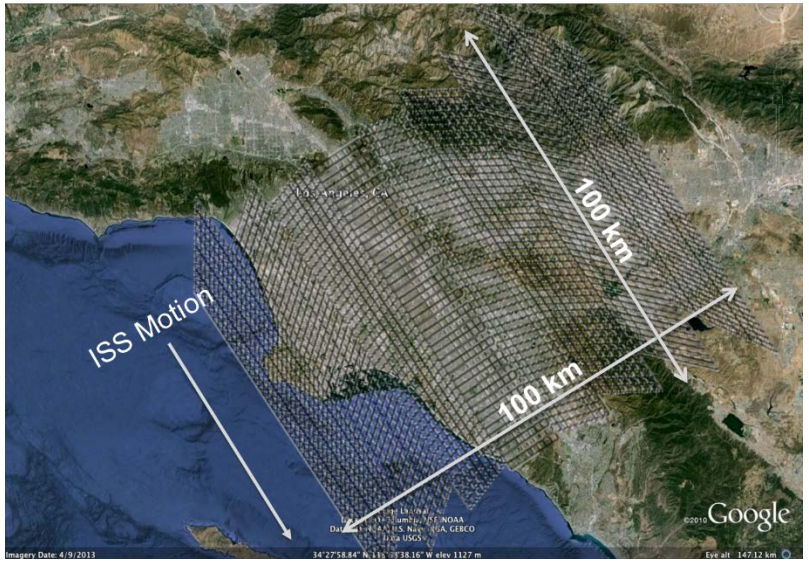
OCO-3 Sampling Capabilities



OCO-3 will only sample latitudes poleward of 51 degrees, but

- Can record XCO2 and SIF at all local times between dawn and dusk
- Includes a "city mode" that can be used to map areas as large as 100 km x 100 km

- No real repeat cycle
- Latitudinal coverage changes daily (slowly), as does time of day sampling
- Solar zenith angle distribution no longer tied to latitude
- Glint data over ocean, nadir over land



Summary

OCO-2:

- OCO-2 has completed its prime mission, and is beginning its first extended mission with a healthy spacecraft and instrument
- OCO-2 data are being widely used by the science community to study the impact of the 2015-2016 El Niño on the carbon cycle
- OCO-2 is also demonstrating the capabilities needed for future space based elements of a global greenhouse gas monitoring system

OCO-3:

- The OCO-3 team is busy building and testing hardware, in preparation for a March 2018 delivery
- Science, algorithm, and validation groups are maturing simulations, tools, and plans – taking advantage of OCO-2 measurements that did not exists in the early planning!