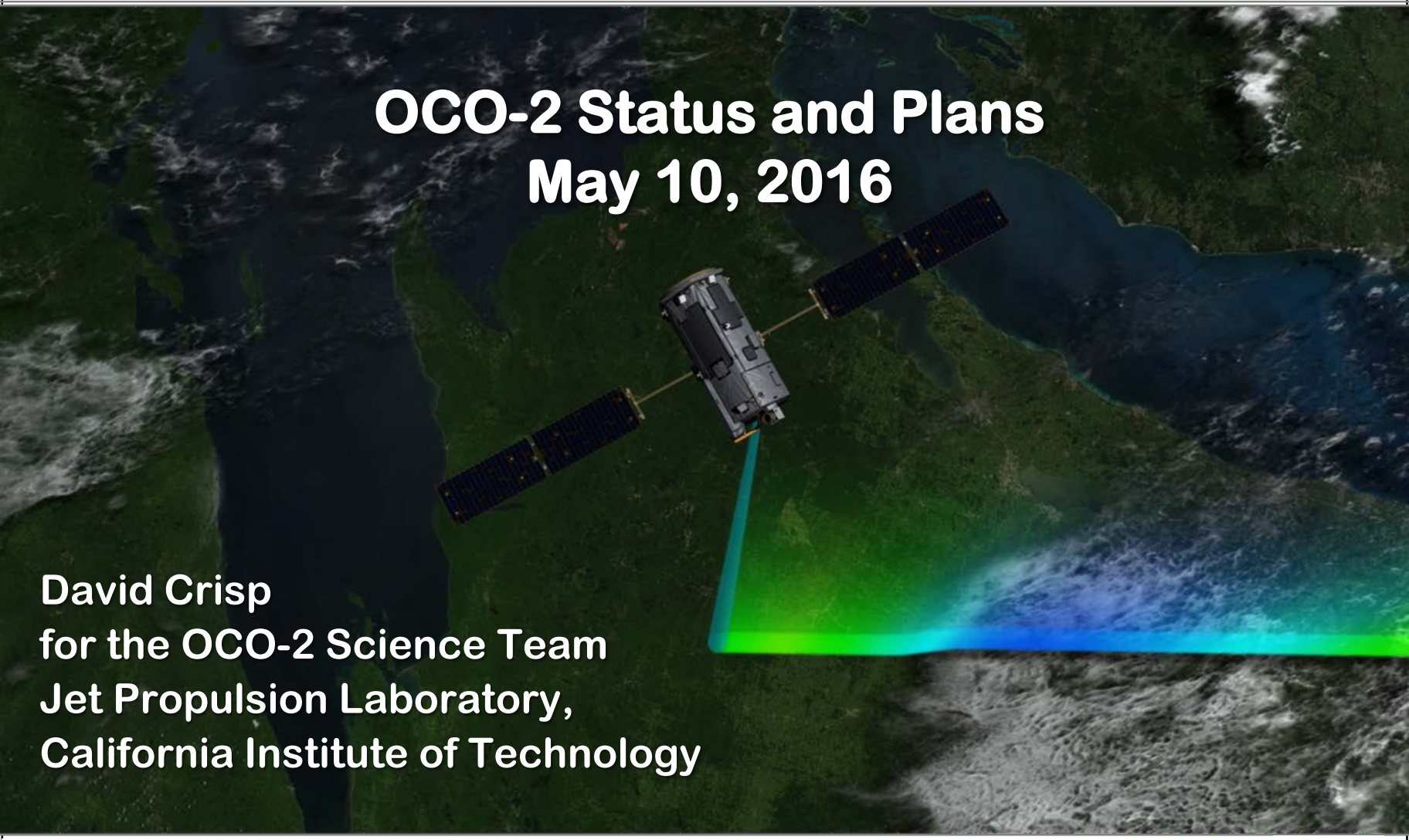
OCO-2 Status and Plans
May 10, 2016



David Crisp
for the OCO-2 Science Team
Jet Propulsion Laboratory,
California Institute of Technology

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Government sponsorship acknowledged.

Topics Covered

- OCO-2 status update
  - Observatory Status – Inclination Adjustment Maneuver Campaign
  - Instrument Status – Recovery from Decontamination Cycle
  - Data Delivery status
- Progress and plans for processing GOSAT v201.201
- Progress on v8 testing
- Publication Status

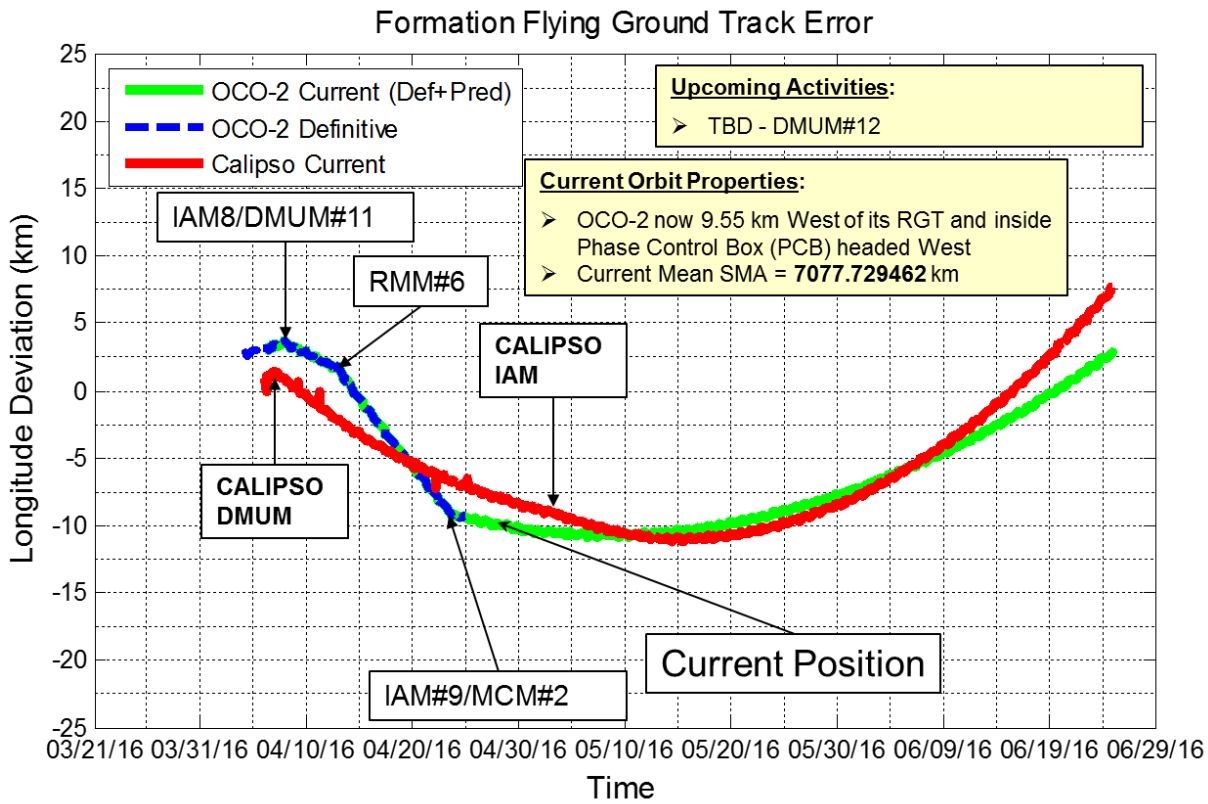
OCO-2 Observatory Status

- The OCO-2 spacecraft operations are "NOMINAL"

- The 2016 Inclination Adjustment Maneuver (IAM) campaign is complete (4 out of 4 maneuvers completed)
  - 10 Mar 2016 21:43 – Successful IAM
  - 17 Mar 2016 23:28 – Successful IAM
  - 07 Apr 2016 22:07 – Successful IAM + Drag Make-up Maneuver
  - 23 Apr 2016 22:39 – Successful IAM

- No High Interest Events (HIE) last week

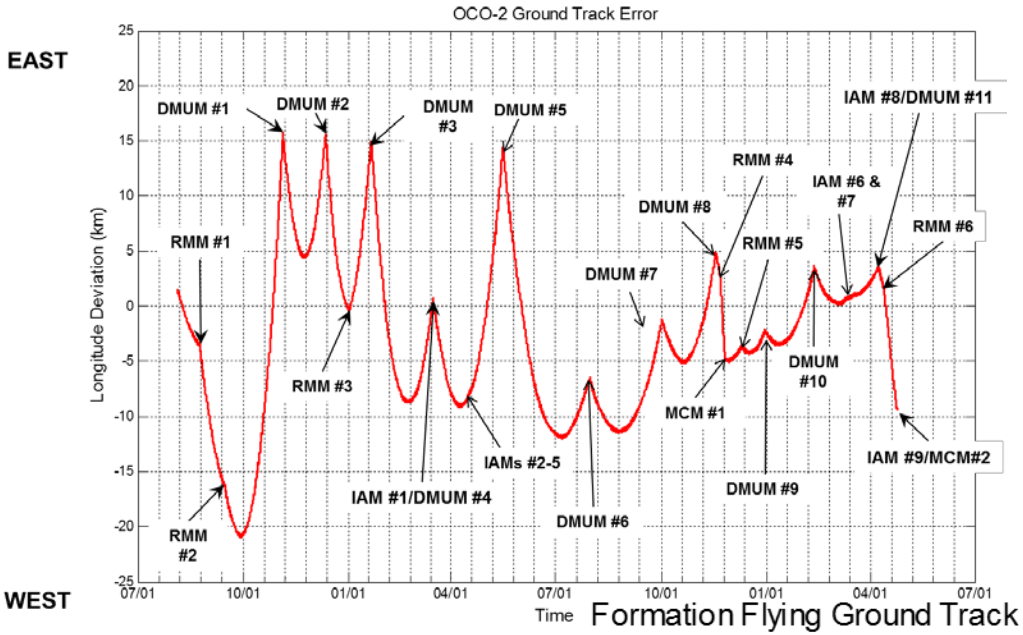
OCO-2 Navigation Status (25 April 2016)



The April 13 Risk Mitigation Maneuver compromised the OCO-2 alignment with CALIPSO

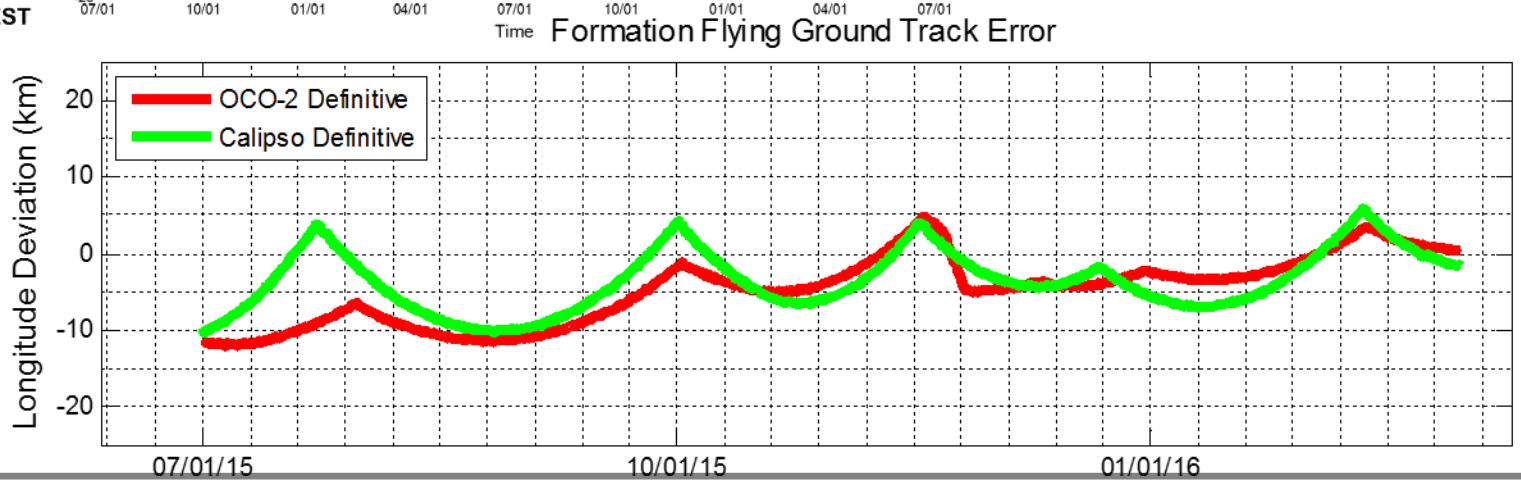
The alignment was restored by the 4th IAM on 4/23

OCO-2 Ground Track



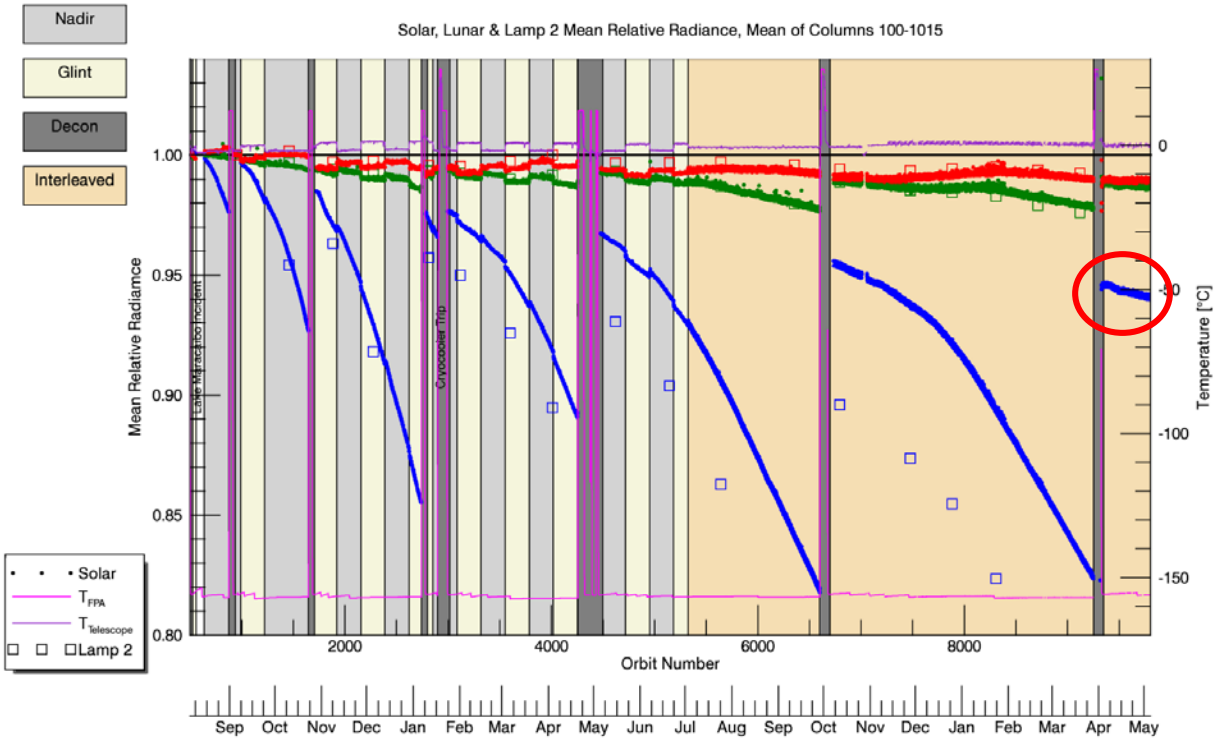
The OCO-2 Navigation team has maintained a tight formation with CALIPSO.

- > 90% overlap since August 2015



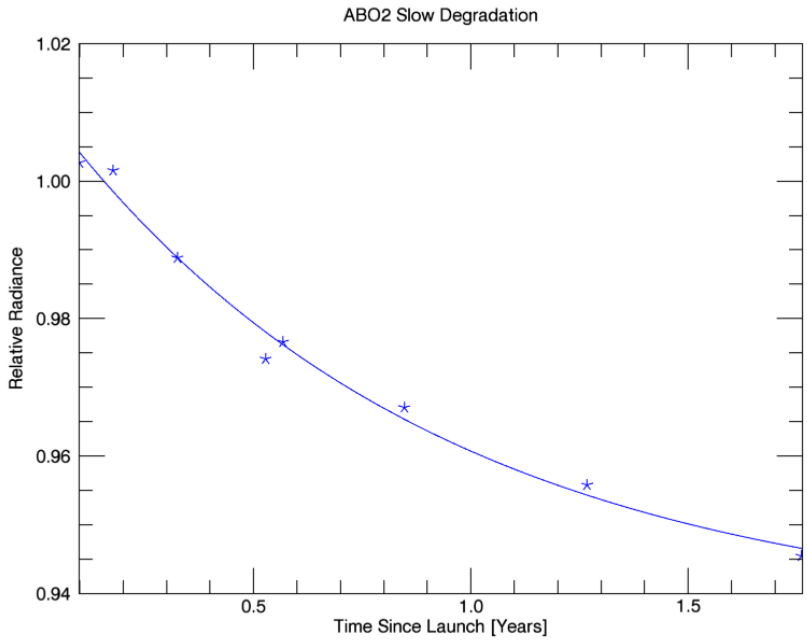
OCO-2 Instrument Status

- The 6th Instrument Decontamination Cycle completed at 2016-04-03T01:41:05.666Z (Orbit
  - The ABO2 throughput was restored to near 100% (once 5.5% "slow degradation contribution is removed)

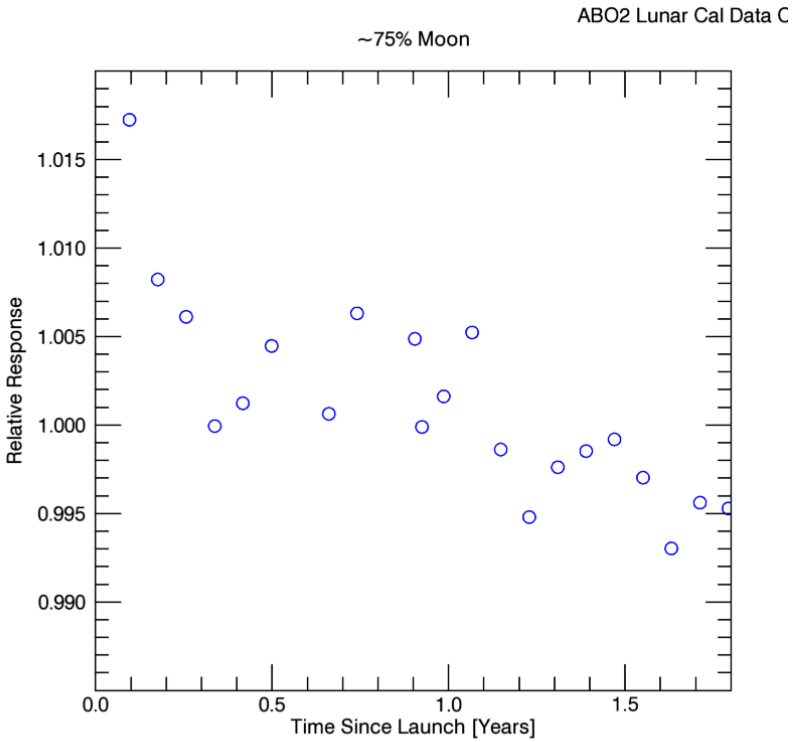


Total response (as determined by on-board calibration system.

More Insight on the Slow Degradation



The "slow" component of the degradation is ***mostly*** due to the calibrator, not the instrument.



A reanalysis of the Lunar Calibration Data indicates that about 20% of the slow degradation is in the instrument optics

OCO-2 Data Return Calendar

as of 4/14/2016 Orbit Reference

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
July																															
August																															
September						14								13												14	13	13	12	13	
October	12																						6				8				
November													14			13					13										
December												13		13						13											
January-15	13					6				8							2								11						
February																		13		13											
March															13	14						12				13					
April		12														12			14	6											
May							6								13																
June						14						13									13										
July																								14						13	
August																															
September			14																									7			
October							6										14								14	9				14	
November																		13			13				9						
December										12																				12	
January-16																														14	
February											14																				
March										13							17									13		7			
April											5																				

Glint

Number of science orbits to expect if not nominal (not granules)

Warm

Cold, unstable

Cold, stable

Completely without Science

No predictive calibration; see retrospective collection

No Update

OCO-2 B7r Standard Production Calendar

as of 4/14/2016

Build 7.n.00 L2 XCO2 Production & Delivery Status - Retrospective Calibration

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
July																															
August																															
September						D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	
October	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D				D	D	D	D	D
November	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	
December	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
January-15	D	D	D	D	D	D				D	D	D	D	D	D	D	D								D	D	D	D	D	D	D
February	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D			
March	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
April	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D											
May							D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
June	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	
July	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
August	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
September	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D			
October							D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D				D	D
November	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	
December	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
January-16	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
February	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
March	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D			
April																															

Warm | Cold, unstable | Cold, stable | Completely without Science

B7 processing: complete | - incomplete | not begun

Facility: cluster | Pleiades

B7r processing: complete | - incomplete | not begun

Days delivered to GES DISC: D all orbits delivered

No Update

OCO-2 B7r Lite Production Calendar

as of 4/14/2016

Build 7.n.00 Lite XCO2 Production & Delivery Status - Retrospective Calibratio

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
July																															
August																															
September						D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	
October	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D					D	D	D	D
November	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	
December	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
January-15	D	D	D	D	D	D				D	D	D	D	D	D	D	D								D	D	D	D	D	D	D
February	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D			
March	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
April	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D											
May							D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
June	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	
July	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
August	D		D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
September	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D			
October							D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D				D	D
November	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	
December	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
January-16	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D
February	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D		
March	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D			
April																															

Warm | Cold, unstable | Cold, stable | Completely without Science

B7r processing
complete | - incomplete | not begun

Days delivered to GES DISC
D all orbits delivered

No Update

Plans for Processing the GOSAT v201201 Product

- Substantial progress has been made on the reprocessing effort for the v201.201 product

- A plan for the remainder of the reprocessing effort is in place
  - This week: ABP and IMAP products being assessed to determine
    - if a zero level offset (ZLO) is needed (and in which bands)
    - If ABO2 cross sections must be scaled to minimize surface pressure offset
    - Deliver results of ZLO and ABO2 scaling to SDOS team
    - Met re-sampler testing ongoing
  - Next week:
    - Run enough L2 data to generate EOF's and deliver to SDOS
    - Start rerunning all 7 years of GOSAT data -- ACOS 7.3
  - End of month – finish reprocessing effort

OCO-2 Publications

Recent ACOS/GOSAT Publications

- Chevallier, F., P. I. Palmer, L. Feng, H. Boesch, C. W. O'Dell, and P. Bousquet, Toward robust and consistent regional CO2 flux estimates from in situ and spaceborne measurements of atmospheric CO2, Geophys. Res. Lett., 41, 1065–1070, 2014, doi:10.1002/2013GL058772.
- Lindquist et al., Does GOSAT capture the true seasonal cycle of CO2?, Atmos. Chem. Phys., 15, 13023-13040, doi:10.5194/acp-15-13023-2015, 2015.
- Nelson et al., The potential of clear-sky carbon dioxide satellite retrievals, Atmos. Chem. Phys., 15, 13023–13040, 2015.
- Ott, L. E., et al., Assessing the magnitude of CO2 flux uncertainty in atmospheric CO2 records using products from NASA's Carbon Monitoring Flux Pilot Project, J. Geophys. Res. Atmos., 120, 734–765, 2015. doi:10.1002/2014JD022411.
- Feng et al. Estimates of European uptake of CO2 inferred from GOSAT XCO2 retrievals: sensitivity to measurement bias inside and outside Europe, Atmos. Chem. Phys., 16, 1289–1302, 2016.
- Jiang, X.,*, D. Crisp., E. T. Olsen., S. S. Kulawik, C. E. Miller, T. S. Pagano, M. Liang, and Y. L. Yung, CO2 Annual and Semiannual Cycles From Multiple Satellite Retrievals and Models, Earth and Space Sci., 3, 2016, doi:10.1002/2014EA000045.

ACOS/GOSAT Papers in Review

- Kulawik et al., Consistent evaluation of GOSAT, SCIAMACHY, CarbonTracker, and MACC through comparisons to TCCON
- Frankenberg et al. Using airborne HIAPER Pole-to-Pole Observations (HIPPO) to evaluate model and remote sensing estimates of atmospheric carbon dioxide
- Kuze et al., Update on GOSAT TANSO-FTS performance, operations, and data products after more than six years in space, Atmos. Meas. Tech., 2016.

OCO-2 Publications – Old Stuff

- Crisp, D. Measuring CO_2 from space: the NASA Orbiting Carbon Observatory-2, 61st International Astronautical Congress, Prague, CZ, 2010.

- Boesch, H.; Baker, D., Connor, B., Crisp, D., Miller, C., Global Characterization of CO2 Column Retrievals from Shortwave-Infrared Satellite Observations of the Orbiting Carbon Observatory-2 Mission. Remote Sens. 3, 270-304, 2011.

- Frankenberg, C., R. Pollock, R. A. M. Lee, R. Rosenberg, J.-F. Blavier, D. Crisp, C.W. O'Dell, G. B. Osterman, C. Roehl, P. O. Wennberg, and D. Wunch, The Orbiting Carbon Observatory (OCO-2): spectrometer performance evaluation using pre-launch direct sun measurements, Atmos. Meas. Tech., 7, 1–10, 2014. www.atmos-meas-tech.net/7/1/2014/doi:10.5194/amt-7-1-2014.

- Moore et al., CEOS Strategy for Carbon Observations from Space, CHAPTER 4: ATMOSPHERE DOMAIN, Issued date: September 30 2014.

Recent OCO-2 Publications

ABSCO Papers:

- B. J. Drouin, D. C. Benner, L. R. Brown, M. Cich, T. Crawford, V. M. Devi, A. Guillaume, J.T. Hodges, E. J. Mlawer, D. Robichaud, F. Oyafuso, V. H. Payne, K. Sung, E. Wishnow and S. Yu, Multispectrum analysis of the oxygen A-band, J. Quant. Spectrosc. Radiat. Transfer, accepted March 25th 2016, available online as of 11th April 2016

- D. C. Benner, V. M. Devi, K. Sung, L. R. Brown, C. E. Miller, V.H. Payne, B. J. Drouin, S. Yu, T. J. Crawford, A. W. Mantz, M. A. H. Smith and R. R. Gamache, Line parameters including temperature dependences of air- and self-broadened line shapes of 12C16O2: 2.06 micron region, J. Mol. Spec., in press, available online as of 20th Feb 2016

- V. M. Devi, D. C. Benner, K. Sung, L. R. Brown, T. J. Crawford, C. E. Miller, B. J. Drouin, V. H. Payne, S. Yu, M. A. H. Smith, A. W. Mantz and R. R. Gamache, Line parameters including temperature dependences of air- and self-broadened line shapes of 12C16O2: 1.6 micron region, J. Quant. Spectrosc. Radiat. Transfer, in press, available online as of 31st December 2015

Recent OCO-2 Publications

Other Papers

- Merrelli, et al., Estimating bias in the OCO-2 retrieval algorithm caused by 3-D radiation scattering from unresolved boundary layer clouds, Atmos. Meas. Tech. Atmos. Meas. Tech., 8, 1641-1656, 2015. doi:10.5194/amt-8-1641-2015
- D. Crisp for the OCO-2 Team: Measuring Atmospheric Carbon Dioxide from Space with the Orbiting Carbon Observatory-2 (OCO-2), Proc. SPIE 9607, Earth Observing Systems XX, 960702 (8 September 2015); doi: 10.1117/12.2187291
- Sanghavi, et al., Sensitivity analysis of polarimetric O2 A-band spectra for potential cloud retrievals using OCO-2/GOSAT measurements, Atmos. Meas. Tech., 8, 3601-3616, doi:10.5194/amt-8-3601-2015, 2015.
- Geddes et al. Tropospheric aerosol profile information from high-resolution oxygen A-band measurements from space, Atmos. Meas. Tech., 8, 859–874, 2015, www.atmos-meas-tech.net/8/859/2015/ doi:10.5194/amt-8-859-2015
- Taylor et al., Orbiting Carbon Observatory-2 (OCO-2) cloud screening algorithms: validation against collocated MODIS and CALIOP data, Atmos. Meas. Tech., 9, 973–989, 2016.
- Zhang et al., XCO2 Retrieval Error over Deserts near Critical Surface Albedo, Earth And Space Science, 3, 36-45, 2016. DOI: 10.1002/2015EA000143

OCO-2 Book Chapters

Moore et al., CEOS Strategy for Carbon Observations from Space, CHAPTER 4: ATMOSPHERE DOMAIN, Issued date: September 30 2014.

Bovensmann et al., CarbonSat Report for Mission Selection, ESA SP-1330/1, June 2015.

P. Ciais, D. Crisp, H. van der Gon, R. Engelen, G. Janssens-Maehout, M. Heimann, P. Rayner, M. Schloze, Towards a European Operational Observing System to Monitor Fossil CO2 emissions, Copernicus, European Commission, 2015.

OCO-2 Publications in Review/Revision

- Bloom, et al., Southern Africa fire CO_2 emissions detected 1 from OCO-2 and MOPITT, Geophysical Review Letters, in revision
- Connor et al., Quantification of Uncertainties in OCO-2 Measurements of XCO2: Simulations and Linear Error Analysis, submitted to the Journal on Uncertainty Quantification
- Hobbs et al. Uncertainty Quantification for Remote Sensing Retrievals, submitted to the Journal on Uncertainty Quantification
- Lee, et al., Preflight Spectral Calibration of the Orbiting Carbon Observatory 2, IEEE Transactions on Geoscience and Remote Sensing (TGRS) , in revision
- Rosenberg, et al. Preflight Radiometric Calibration of Orbiting Carbon Observatory 2, IEEE Transactions on Geoscience and Remote Sensing (TGRS)

OCO-2 Publications in Preparation

- Crisp, et al. Measuring Atmospheric Carbon Dioxide with the Orbiting Carbon Observatory-2 (OCO-2)
- Eldering, et al. The Orbiting Carbon Observatory-2: First year status and results
- O'Dell, et al., Retrievals of Carbon Dioxide from Orbiting Carbon Observatory-2
- Wunch, et al., Target-mode measurements from the Orbiting Carbon Observatory-2 (OCO-2)
- Chatterjee et al., Influence of El Nino on atmospheric CO2: Findings from the Orbiting Carbon Observatory-2, manuscript in preparation
- Prata et al., Orbiting Carbon Observatory (OCO-2) Tracks 2-3 Giga Tons Of Carbon Release To The Atmosphere During The El Nino 2015
- Schwandner et al., OCO-2 detects small scale atmospheric CO2 anomalies from space
- Schwandner et al., Space-borne detection of volcanic CO2 plumes with OCO-2
- Worden et al. Evaluation, validation and attribution of OCO-2 XCO2 uncertainties
- Crisp et al., Surface Pressure Measurements from the Orbiting Carbon Observatory-2 (OCO-2): A Progress Report