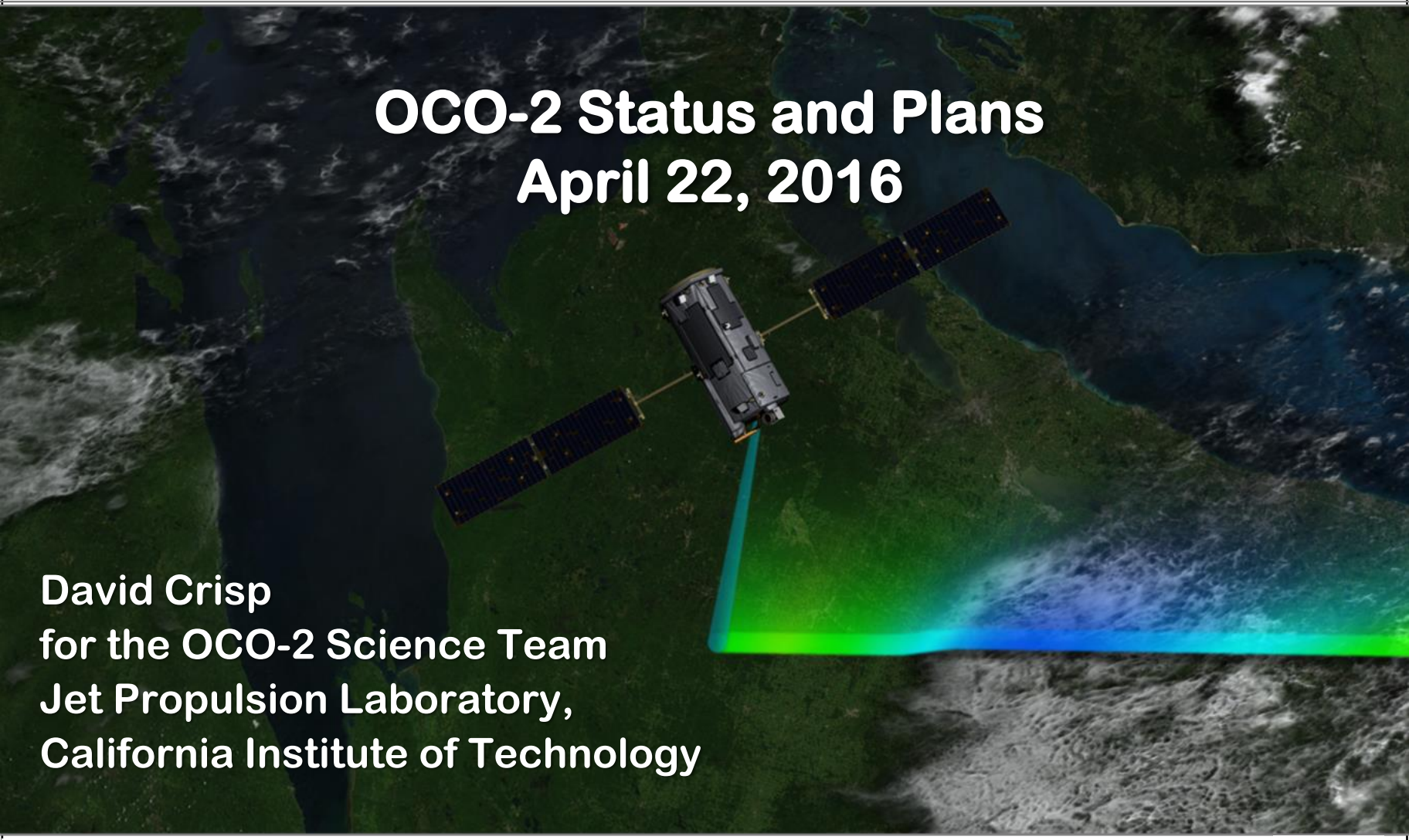
OCO-2 Status and Plans
April 22, 2016



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

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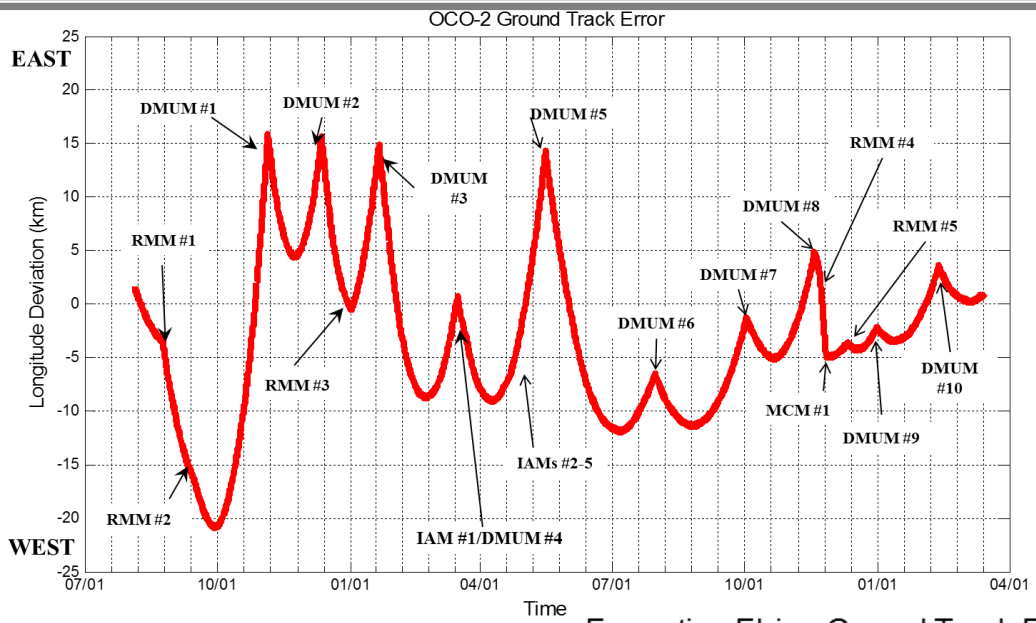
Topics Covered

- 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

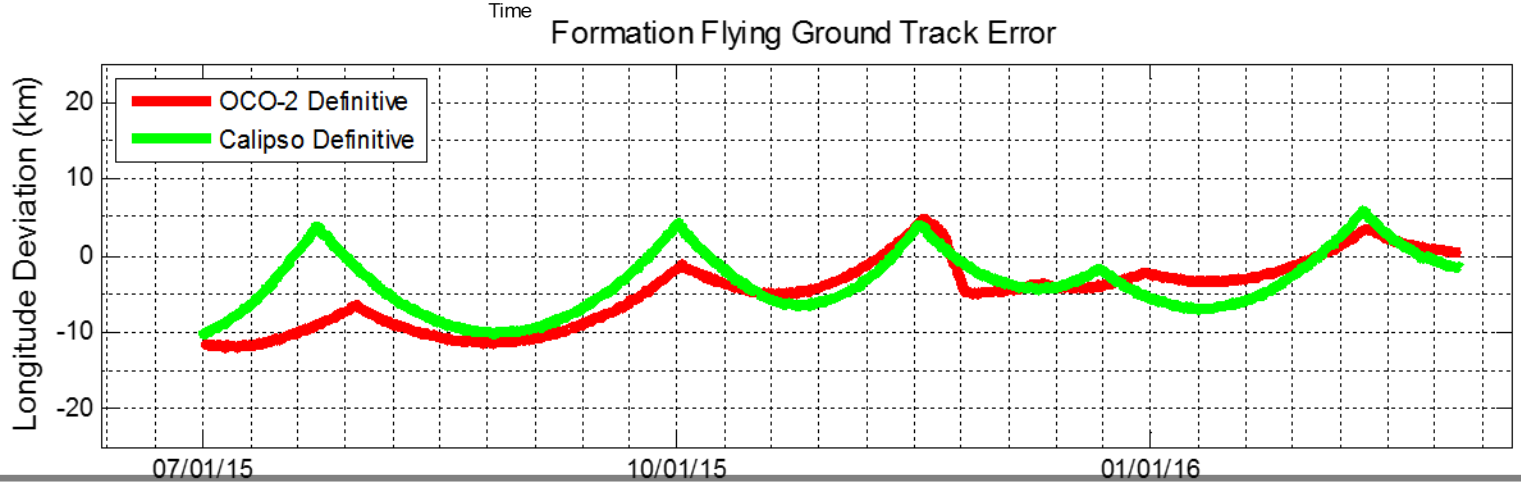
- The OCO-2 spacecraft operations are "NOMINAL"
- We are now ¾ of the way through the 2016 Inclination Adjustment Maneuver (IAM) campaign
  - 10 Mar 2016 21:43 – Successful IAM
  - 17 Mar 2016 23:28 – Successful IAM
  - 07 Apr 2016 22:07 – Successful IAM + Drag Make-up Maneuver
  - 26 Apr 2016 22:39
- The OCO-2 navigation team executed a Risk Mitigation Maneuver on 4/13 to avoid orbital debris
  - Each maneuver will preclude 1-2 orbits of data acquisition
- The OCO-2 project reported progress on the OCO-2 formation flying in the A-Train at the Constellation Mission Operations Working Group Meeting on 13-15 April

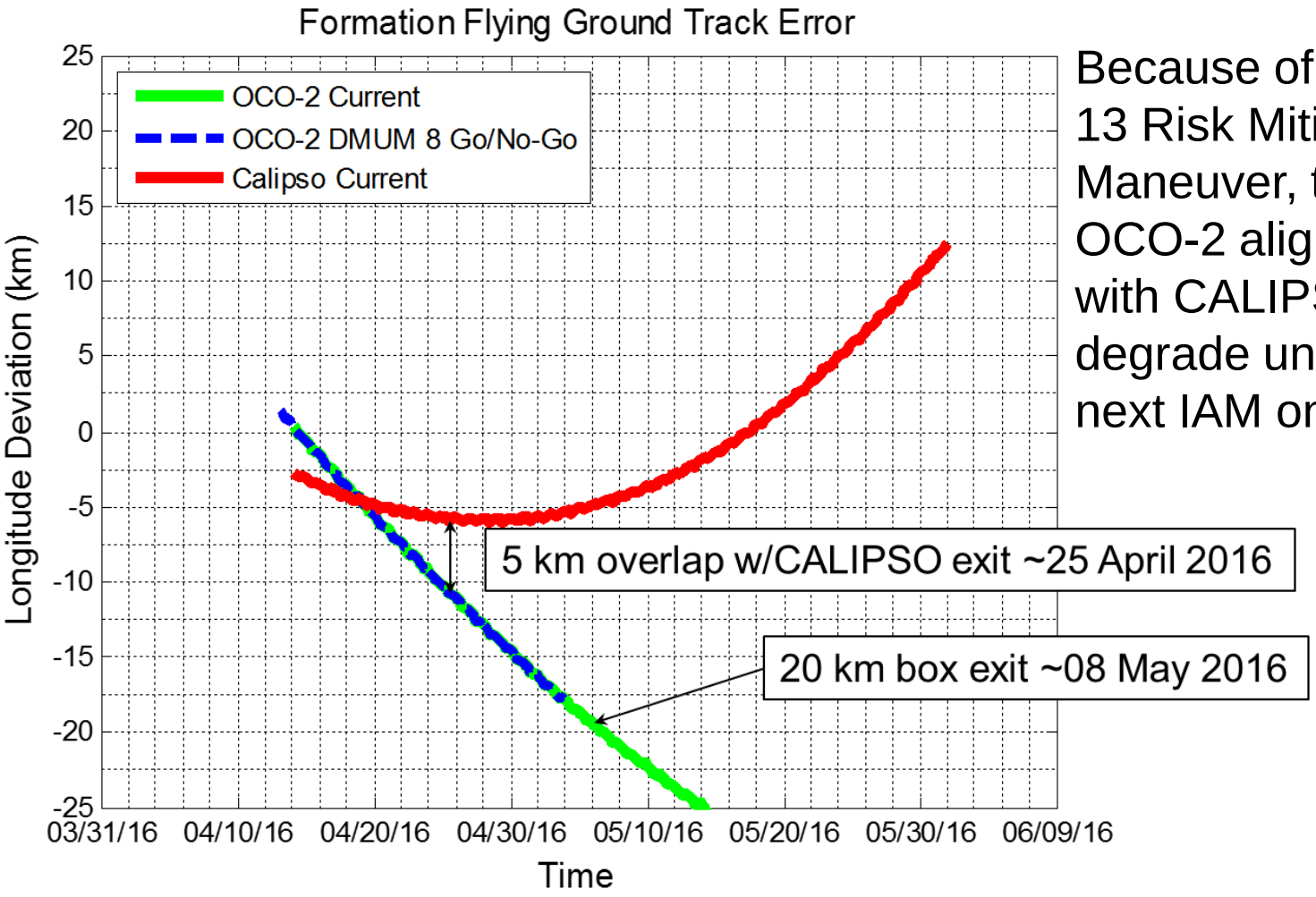
OCO-2 Ground Track



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

- > 90% overlap since August 2015

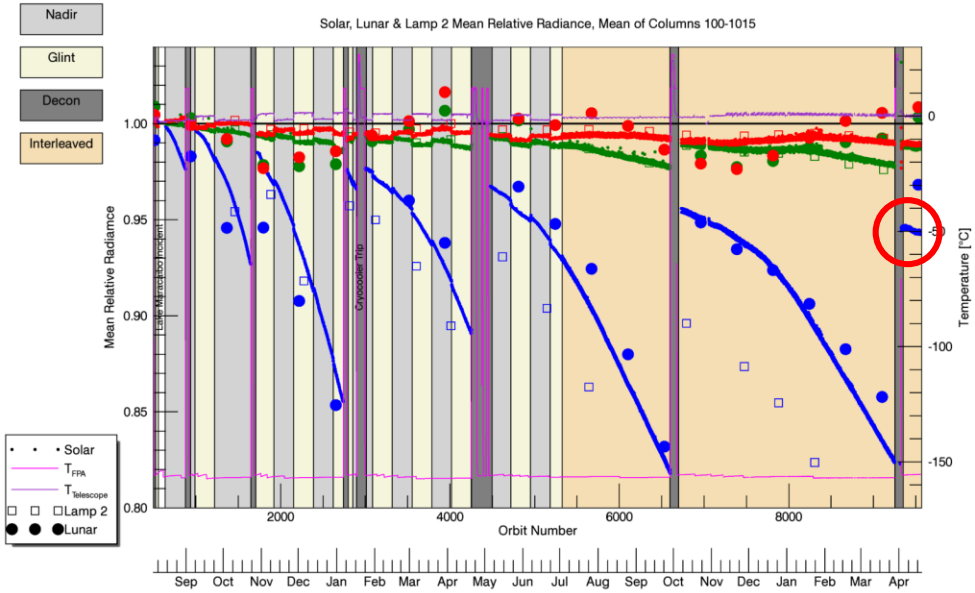




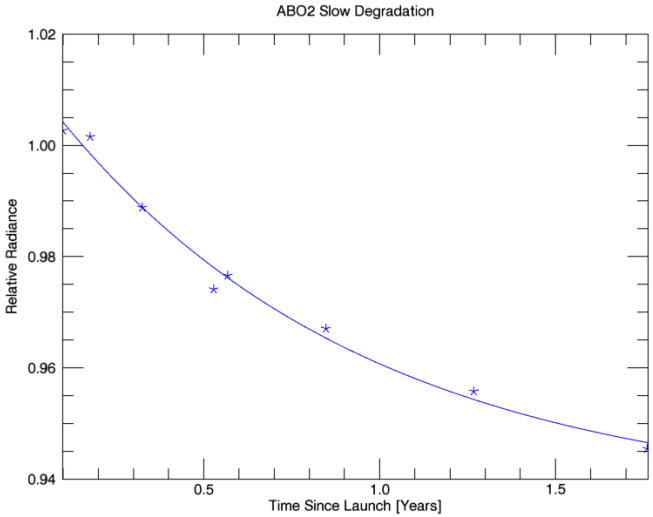
Because of the April 13 Risk Mitigation Maneuver, the OCO-2 alignment with CALIPSO will degrade until the next IAM on 4/26

OCO-2 Instrument Status

- The 6th instrument Decontamination Cycle completed successfully
  - The instrument was officially back at its operational temperatures and thermally stable at 2016-04-03T01:41:05.666Z (Orbit 9331)
  - 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.



The "slow" component of the degradation is thought to be due to the calibrator, not the instrument.

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

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	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

B7r processing
complete | - incomplete | not begun

Facility
cluster | Pleiades | Amazon

Days delivered to GES DISC
D all orbits delivered

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

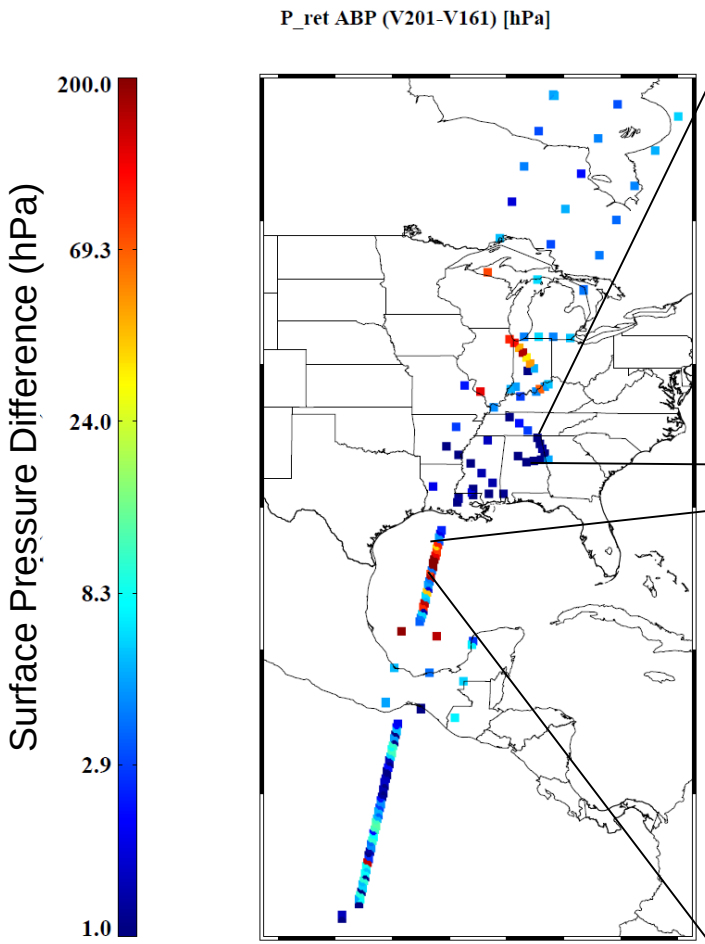
Days delivered to GES DISC

D all orbits delivered

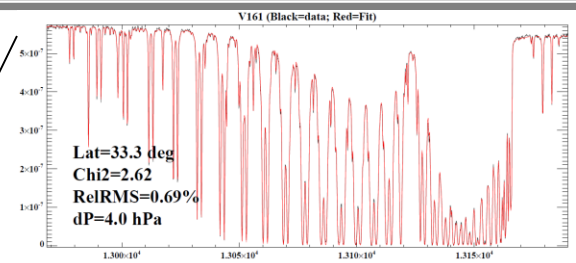
Plans for Processing the GOSAT v201201 Product

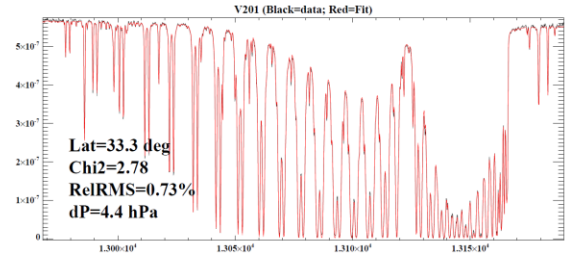
- Substantial progress has been made in understanding the differences between the v161.161 and v201.201 product
- A "sample" L1b orbit has been created and has been reviewed (see next page)
- Testing program is proceeding
  - A-Band cloud preprocessor (ABP) tested & verified @ CSU
  - IMAP DOAS preprocessor (IDP) tested & verified @ CSU
  - L2 testing ongoing @ JPL
- Schedule for processing is contingent on test results
  - we hope to have preliminary results before the JpGU meeting in late May

GOSAT v201 Test Orbit

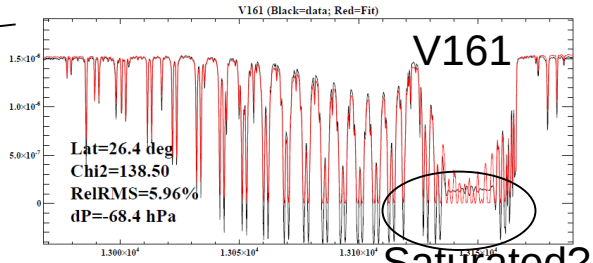


Good to Go?

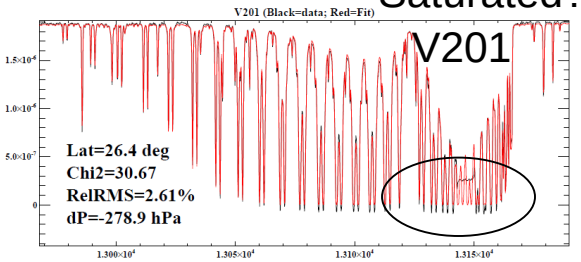




Agreement of v161 and v201 retrievals is very good in clear scenes



Saturated?

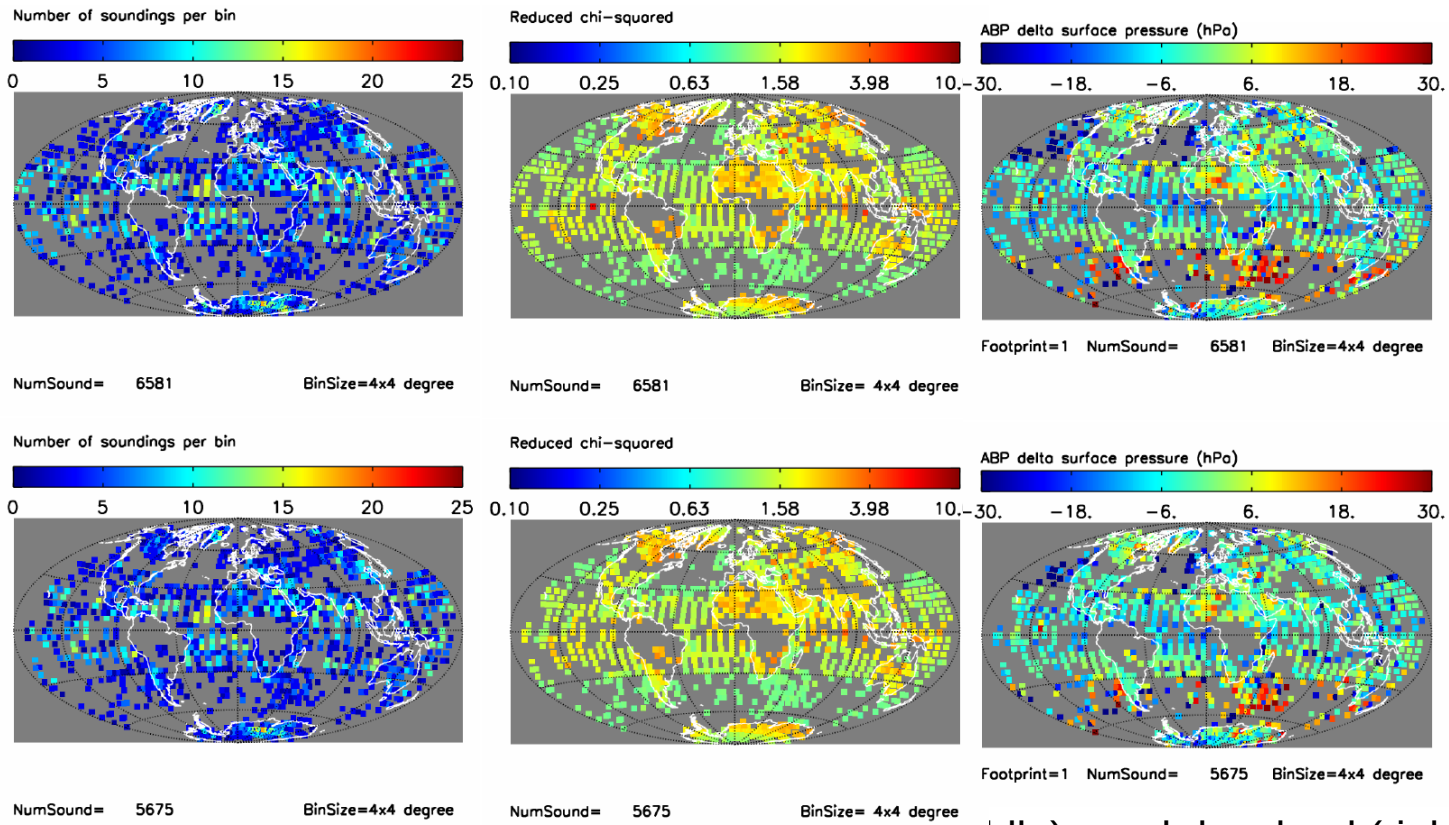


Agreement degrades in optically thick regions where spectra look saturated

C. O'Dell and T. Taylor

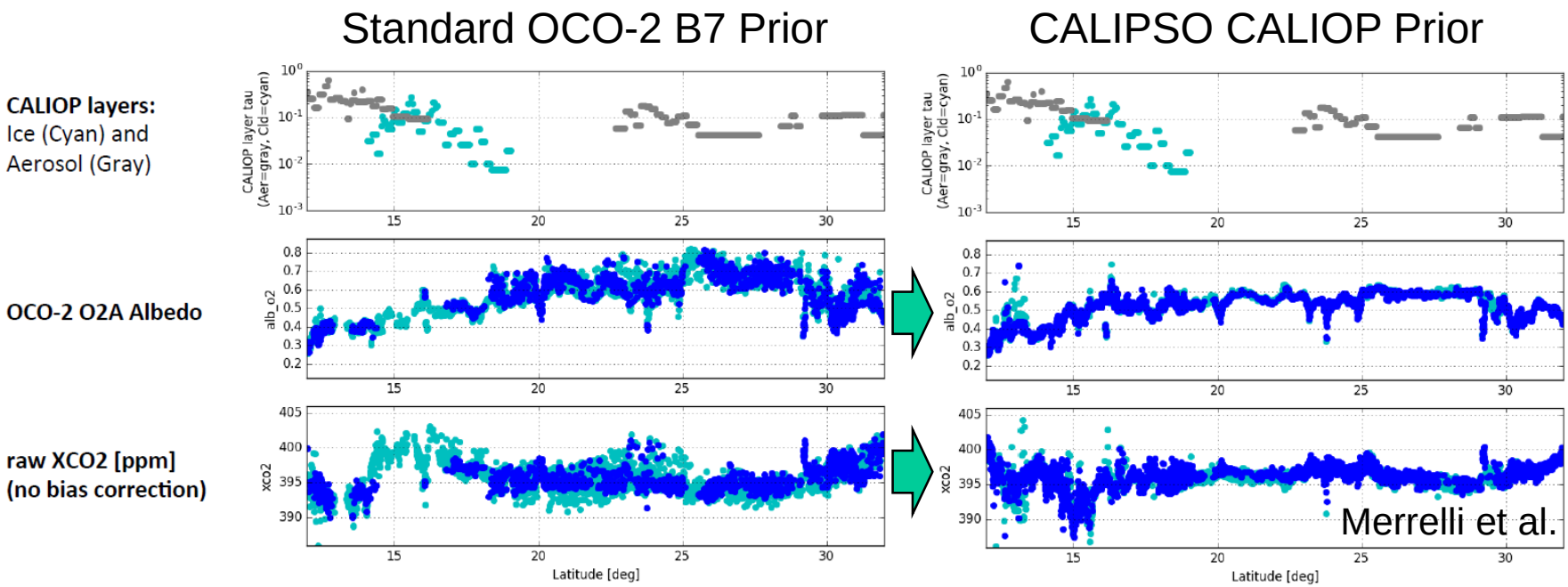
A-Band Preprocessor (ABP) Tests

Sounding density maps | ABP χ^2 maps | ABP dp cloud maps



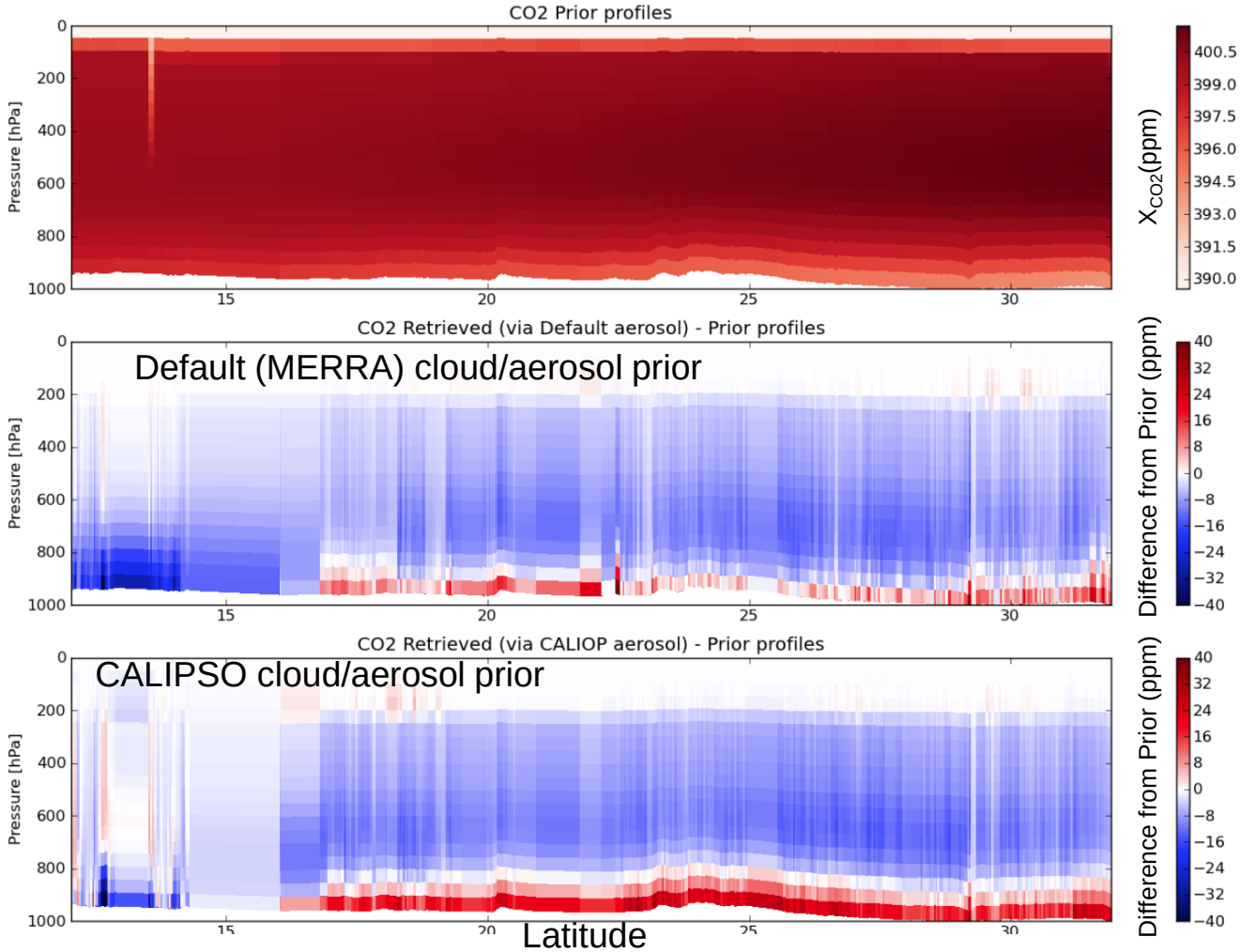
Cloud free sounding selection statistics (left), χ^2(middle), and dp_cloud (right) for the Baseline v161 (top) and v201 (bottom). Clear-sky defined as ABP cloud ag < 2. Results are very consistent.

Combining OCO-2 and CALIPSO Data



When the standard OCO-2 cloud and aerosol prior is used in X_{CO2} retrievals (left), uncertainties in the aerosol distribution and optical properties introduce scatter in the retrieved aerosol and surface scattering, which introduce uncertainties in the X_{CO2} retrievals. When the aerosol properties are taken from CALIPSO (right), the yield is increased and scatter is reduced.

CO2 Profile Comparison



Comparisons of retrieved CO_2 profiles to the prior CO_2 profile (top) also look more realistic (e.g. fewer large sounding-to-sounding changes) when the CALIPSO cloud/aerosol prior is used (bottom) than when the standard (MERRA) prior is used (Merrelli et al.)

Progress with v8 Testing

Progress is being made in several areas on B8 algorithm testing

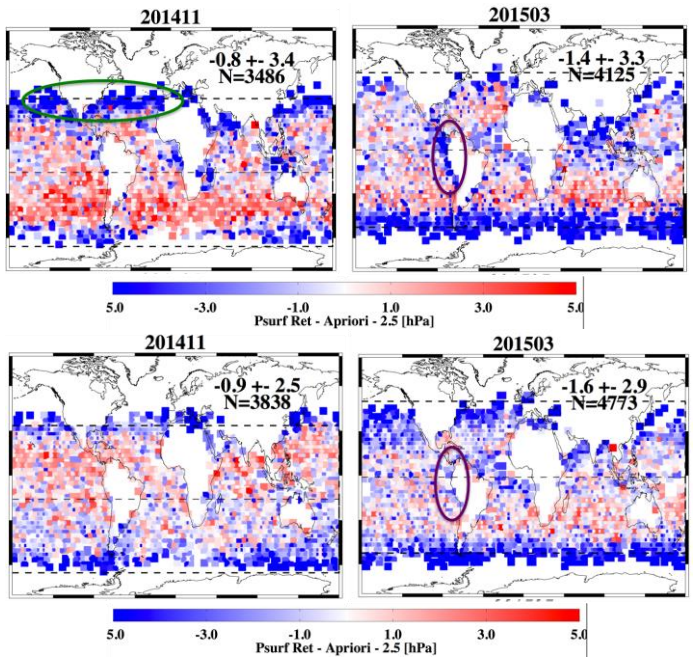
- ABSCO changes: New A-band ABSCO tables reduce surface pressure biases relative to B7 (prior to application of EOF's)

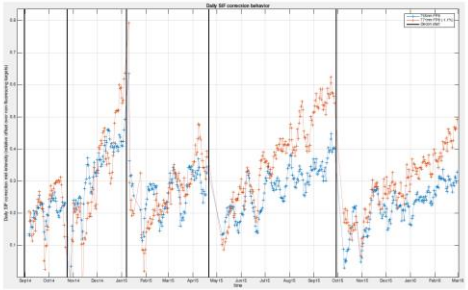
- Zero level Offsets associated with ice buildup on the ABO2 can introduce psurf and XCO2 errors and must be corrected

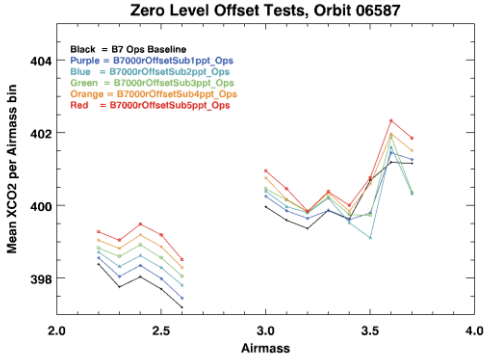
- Tests of a modified CO2 prior are ongoing

B7

New ABSCO







OCO-2 Publications

- Recently Published
  - Nelson et al. The potential of clear-sky carbon dioxide satellite retrievals, Atmos. Chem. Phys., 15, 13023–13040, 2015.
  - Sanghavi, et al., Sensitivity analysis of polarimetric O_2 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.
  - 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.
- In Review
  - Bloom, et al., Southern Africa fire CO_2 emissions detected 1 from OCO-2 and MOPITT
  - Connor et al., Quantification of Uncertainties in OCO-2 Measurements of XCO2: Simulations and Linear Error Analysis
  - Drouin, et al. Multispectrum analysis of the Oxygen A-band
  - Lee, et al., Preflight Spectral Calibration of the Orbiting Carbon Observatory 2
  - Rosenberg, et al. Preflight Radiometric Calibration of Orbiting Carbon Observatory 2

OCO-2 Publications in Preparation

- Others in preparation/press
  - 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

Recent ACOS/GOSAT Publications

- Recently Published
  - 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
  - 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.
- 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