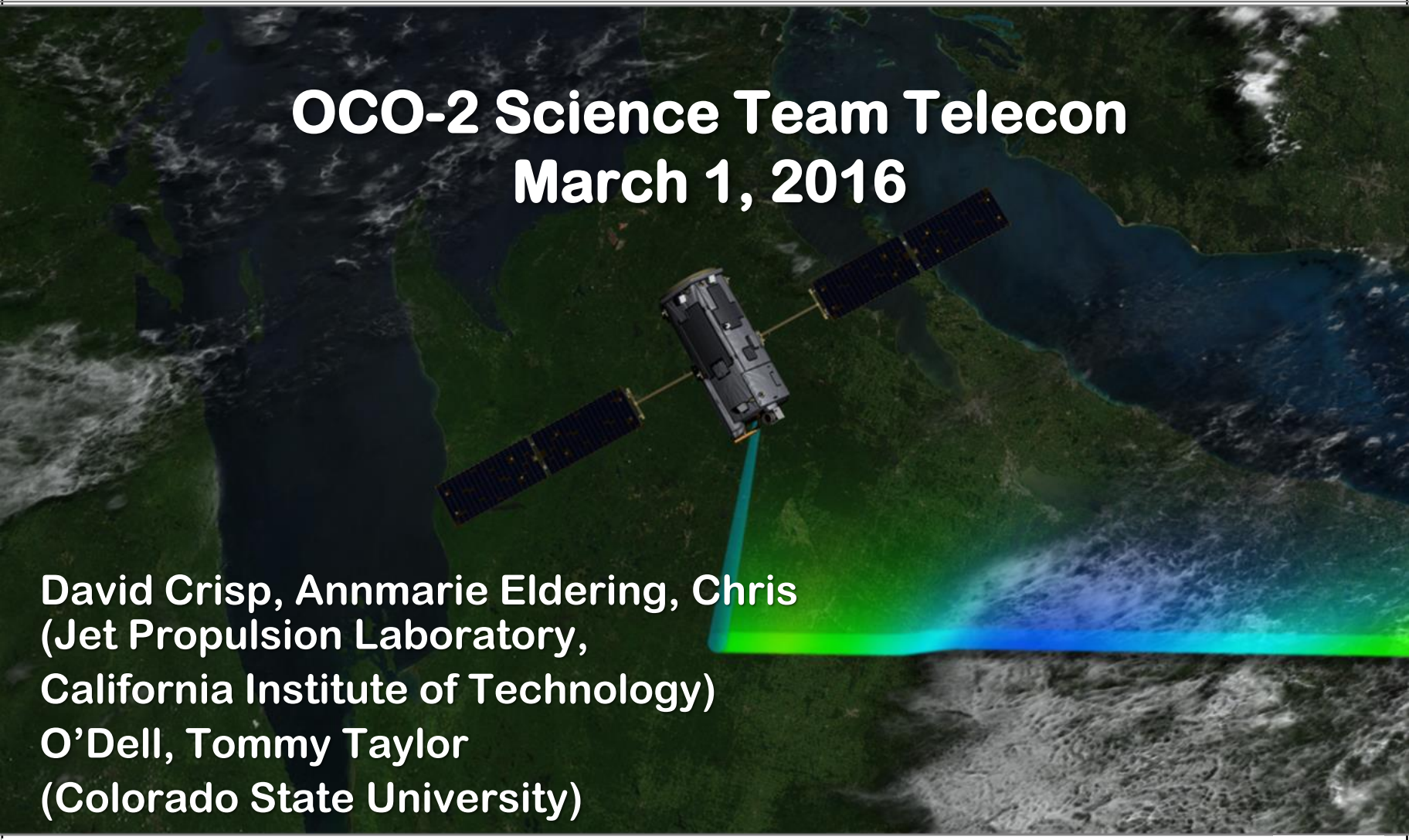
OCO-2 Science Team Telecon
March 1, 2016



David Crisp, Annmarie Eldering, Chris
(Jet Propulsion Laboratory,
California Institute of Technology)
O'Dell, Tommy Taylor
(Colorado State University)

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Topics Covered

- OCO-2 status update
  - OCO-2 V7 data product delivery status
  - Plans for processing GOSAT v201.201
  - Observatory Status
    - Upcoming Inclination Adjust Maneuvers
  - Instrument
    - Absolute Radiometric Calibration investigation
- OCO-2 V8 status and plans (Annmarie et al.)
- OCO-2 Science Team Activities
  - Theme group meetings / telecons
  - OCO-2 Science Team Meeting REGISTER!
- Other upcoming meetings

OCO-2 B7r Standard Production Calendar

as of 2/25/2016

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

	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	
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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																															
March																															

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

Production and Deliveries of B7r are now complete through the month of January 2016

OCO-2 B7r Lite Production Calendar

as of 2/25/2016 Build 7.n.00 Lite XCO2 Production & Delivery Status - Retrospective Calibra

	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
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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	
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January-15	D	D	D	D	D	D				D	D	D	D	D	D	D	D								D	D	D	D	D	D	D
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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																															
March																															

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

B7r processing
complete | - incomplete | not begun

Days delivered to GES DISC
D all orbits delivered

Production and deliveries of B7r Lite files are also complete through the month of January 2016.

Plans for Processing the GOSAT v201201 Product

- The OCO-2 Science Data Operations System (SDOS) team is preparing to reprocess the v201 product
- Sample ACOS L1B products are currently under review
- Testing program will commence as early as this week
- Schedule for production processing is contingent on test results

OCO-2 Observatory Status

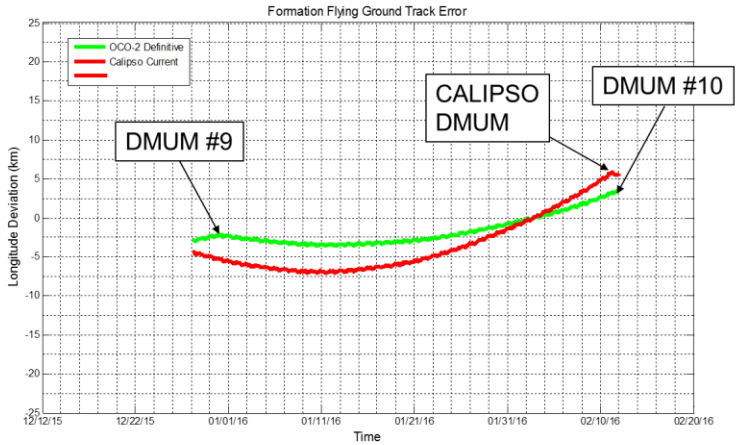
- The OCO-2 spacecraft operations are "NOMINAL"
  - The last drag make-up maneuver, DMUM#10, executed on 11 February 2016 (in close coordination with CALIPSO DMUM)
  - DMUM#11 is tentatively scheduled for 24 March 2016
- The OCO-2 spacecraft will experience its first total solar eclipse, from 23:19 UTC March 8 – 04:34 UTC March 9
  - Some data may be lost along the eclipse track
- Upcoming Inclination Adjustment Maneuvers:
  - 10 Mar 2016 21:42:35
  - 17 Mar 2016 23:26:31
  - 07 Apr 2016 22:04:11
  - 26 Apr 2016 22:36:10

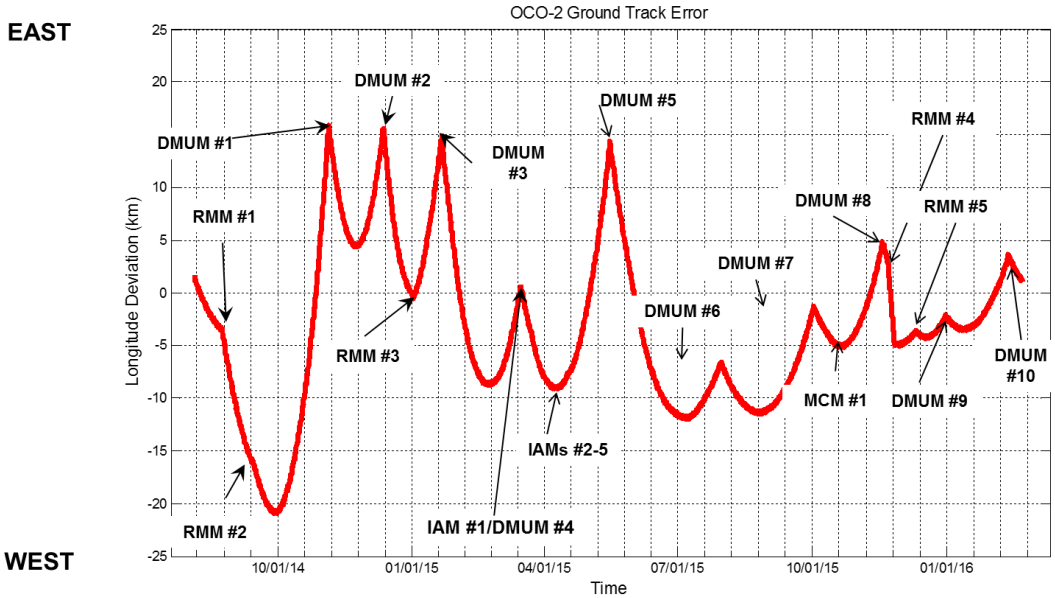
1-2 Orbits of Data Loss for each Maneuver

- The next instrument decontamination cycle is scheduled for early March 28 – April 3 2016. As in the past, that will preclude data acquisition for about one week

OCO-2 Navigation Status (23 February 2016)

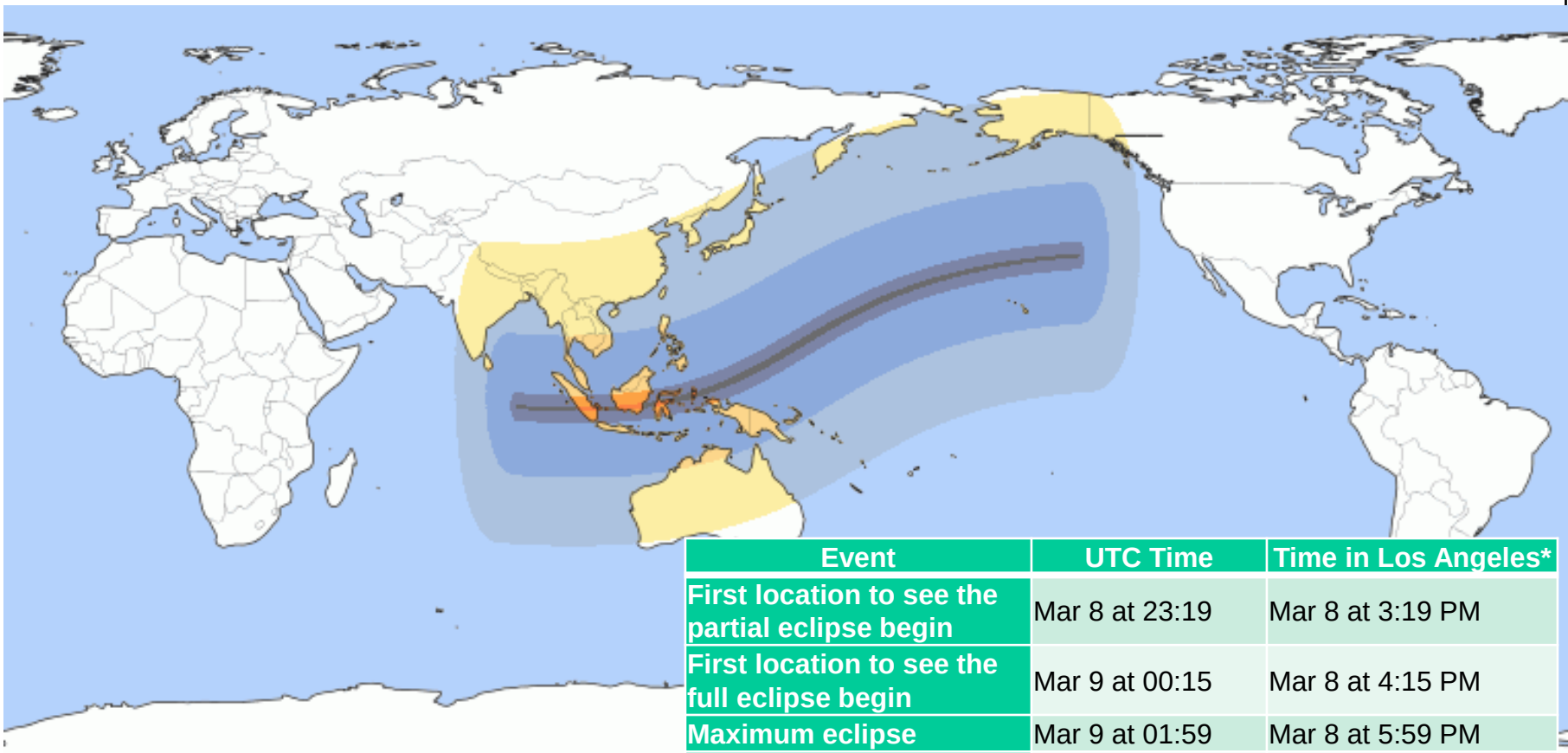
Since August of 2015, the OCO-2 Navigation team has done an excellent job of maintaining the alignment of the OCO-2 ground track with the CloudSat/CALIPSO ground footprints.





- Maintaining close alignment has a resource impact because it requires more maneuvers and more planning.
- The project has asked the science team to justify those resources.

A Total Solar Eclipse: March 8-9 2016



Event	UTC Time	Time in Los Angeles*
First location to see the partial eclipse begin	Mar 8 at 23:19	Mar 8 at 3:19 PM
First location to see the full eclipse begin	Mar 9 at 00:15	Mar 8 at 4:15 PM
Maximum eclipse	Mar 9 at 01:59	Mar 8 at 5:59 PM
Last location to see the full eclipse end	Mar 9 at 03:38	Mar 8 at 7:38 PM
Last location to see the partial eclipse end	Mar 9 at 04:34	Mar 8 at 8:34 PM

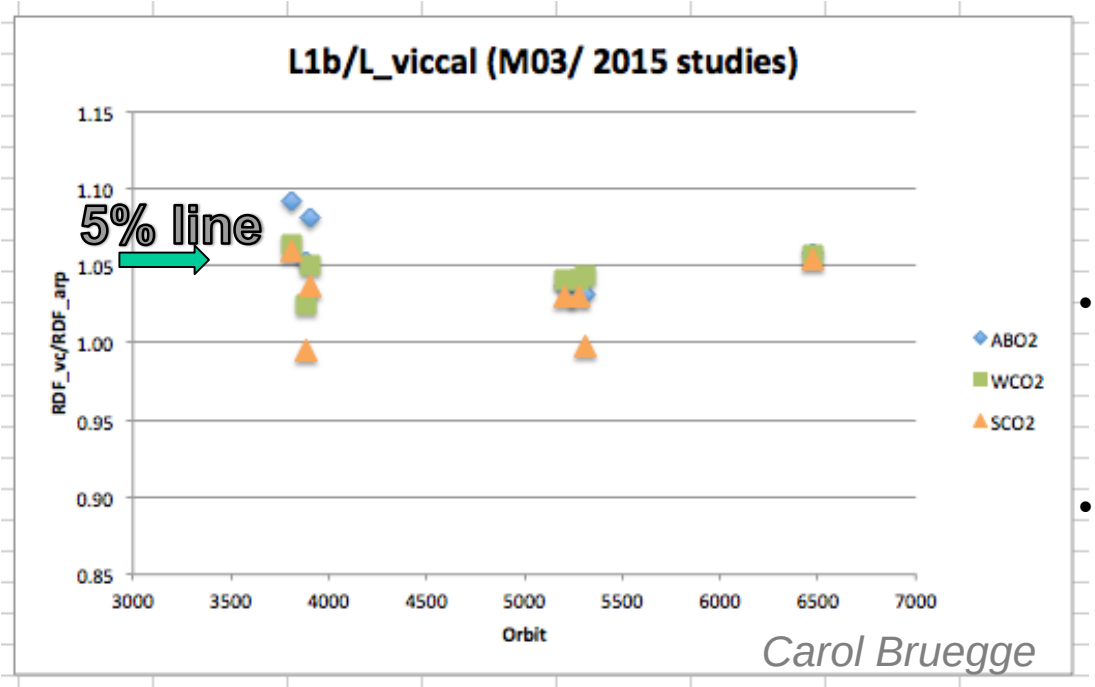
Orbits 8965 – 8969
(8968-8969 most affected)

OCO-2 Instrument Status

- The instrument operations are nominal
- A series of Calibration issues are currently under investigation
  - ~5% high bias in the O2 A-band and Weak CO2 band
  - Possible overcorrection of A-band sensitivity degradation
- Special Calibration Activities
  - Full Lunar Calibration Completed on 23 February 2016 (DOY 054)
  - Solar Doppler Diffuse Completed on 25 February 2016 (DOY 058)
- Next decontamination cycle is scheduled for March 28, 2016
  - This will result in the loss of about one week of data

Absolute Radiometric Calibration: Level 1B vs Vicarious Calibration

- Measurements over Railroad Valley (RRV) suggest that the reported OCO-2 Level 1B radiances may be 5% high compared to Vicarious Calibration (VC) estimates.
  - The radiometric scale is established by trending the response degradation in lamp, solar, and lunar calibration datasets, relative to preflight tests.



- Cross-comparisons show an OCO-2/ VC radiance ratio of 1.05, 1.07, and 0.99 for ABO2, WCO2, and SCO2, with a standard deviation of 1% over 3 comparisons.
- GOSAT also uses RRV VC to define its radiometric scale, so OCO-2 is also biased 5% high relative to GOSAT
- Lunar Calibration data are being analyzed to see if it supports this 5% high bias

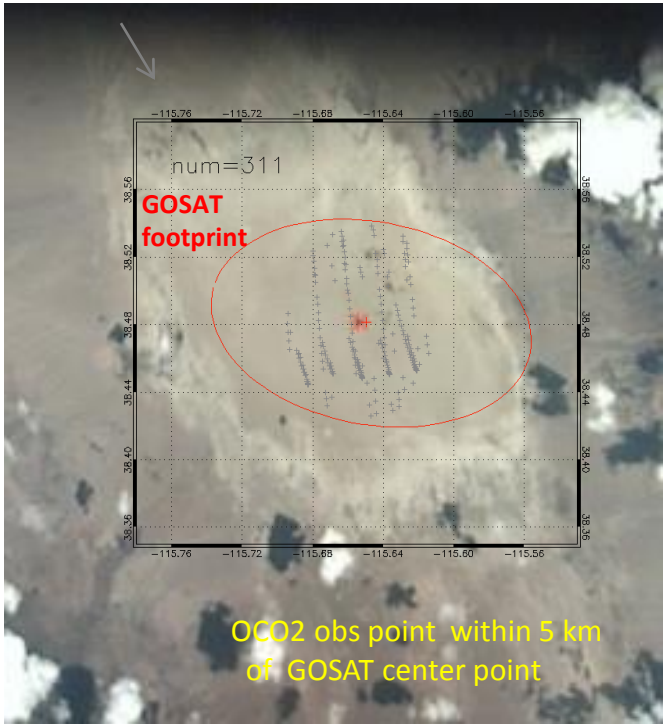
OCO2- GOSAT Spectra Comparison

Comparisons between OCO-2 and GOSAT indicate that the OCO-2 ABO2 and WCO2 bands have a ~5% radiometric bias.

Jun29,2015

OCO2: path139 (looking from West)

GOSAT: path37 (looking from West)



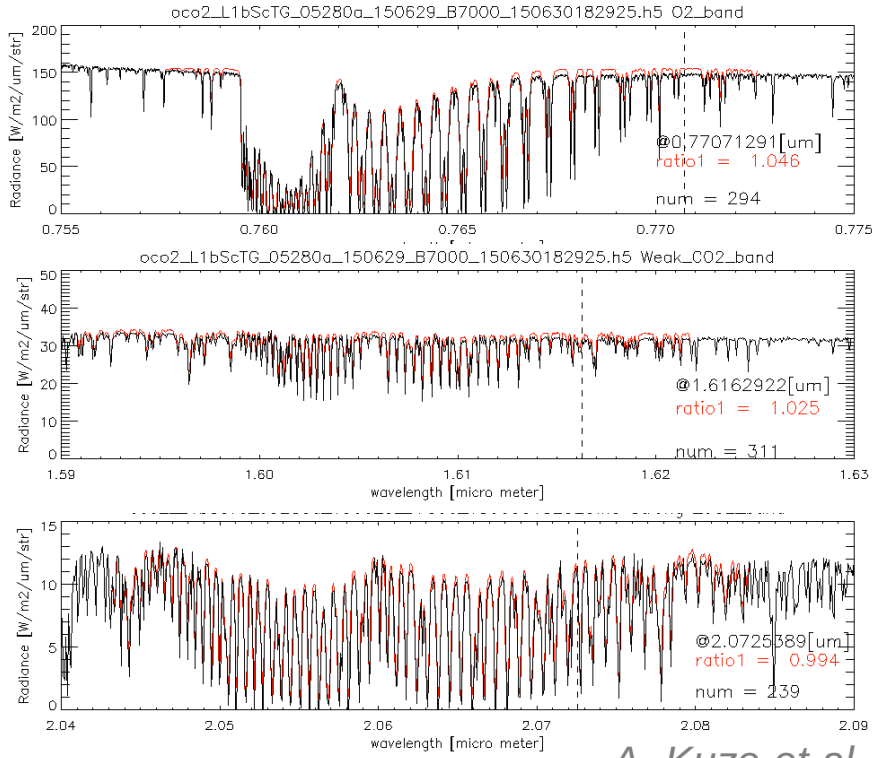
oco2_L1bScTG_05280a_150629_B7000_150630182925.h5

GOSATTFTS2015062921160370242_1BSPOD161161.01

GOSAT Rad

OCO2 average Rad within 5km of GOSAT cnt point X 2

ratio1 = OCO2/GOSAT



A. Kuze et al.

OCO-2 Cal/Val Activities

Annmarie Eldering and team

3/1/2016

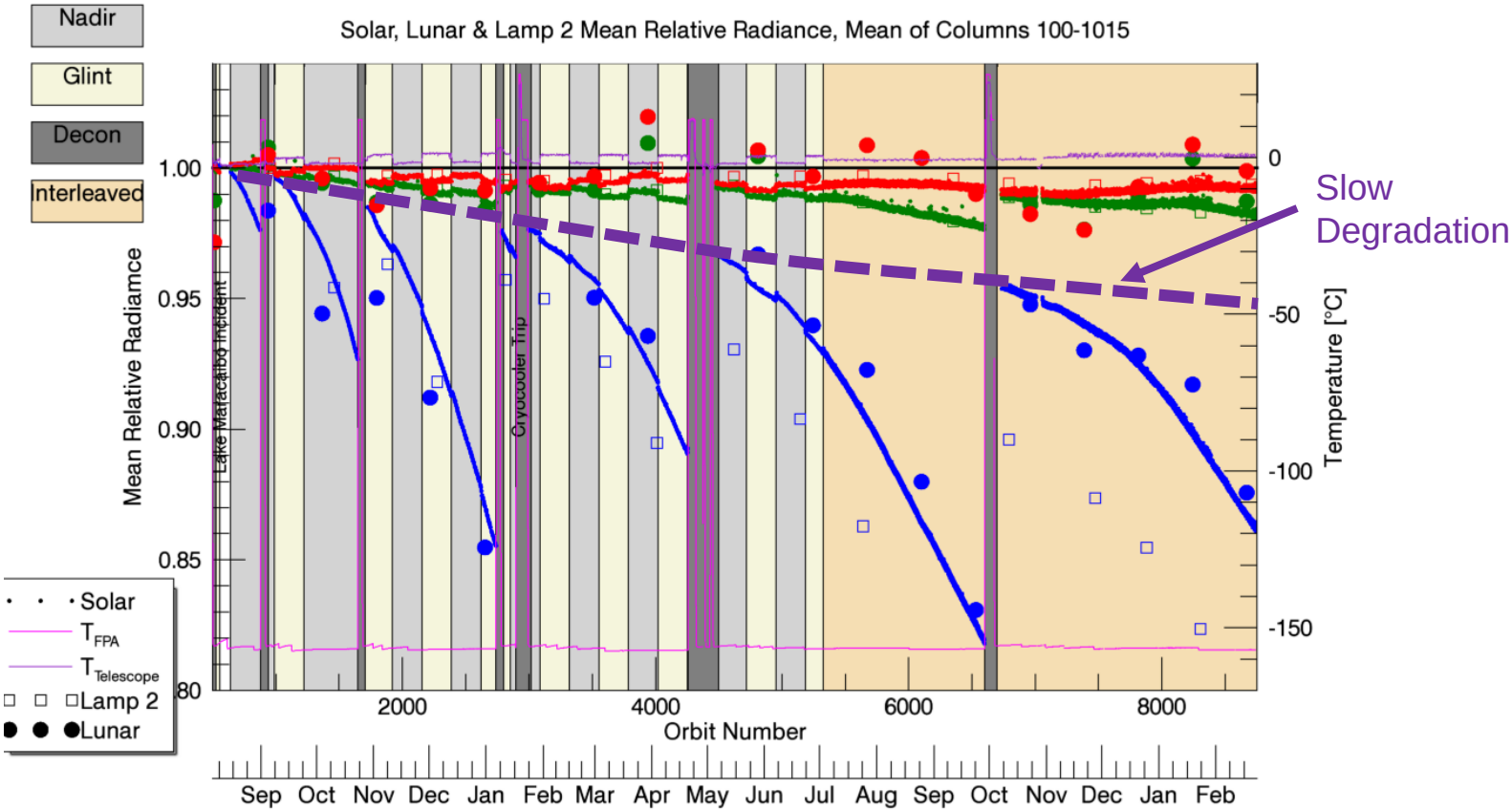
A-Band Sensitivity Variations

The sensitivity degradation has two separate components

- A "fast degradation" reversed by decontamination cycles
  - Attributed to temporary degradation of the anti-reflection coating on the A-band focal plane array detector due to ice accumulation
- A "slow degradation" that is monotonic
  - There is increasing evidence from Lunar and Vicarious Calibration measurements that this component of the degradation might be due to degradation of the lamp and solar diffusers rather than a throughput loss in the instrument

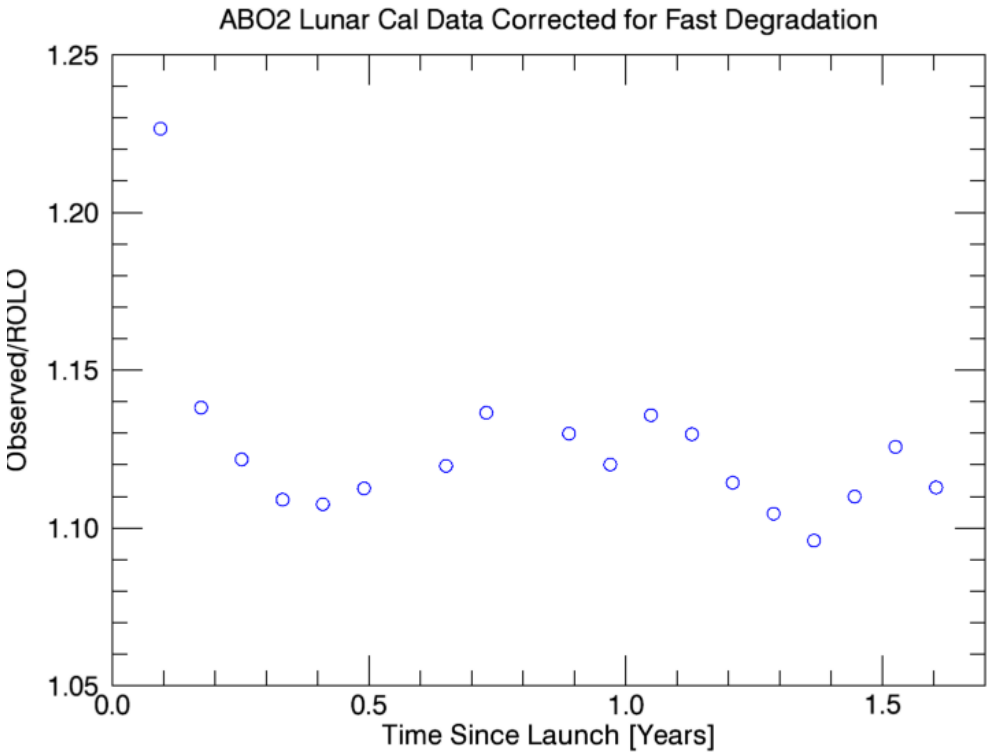
Background

- These solar measurement data are basis for A-band degradation correction factors

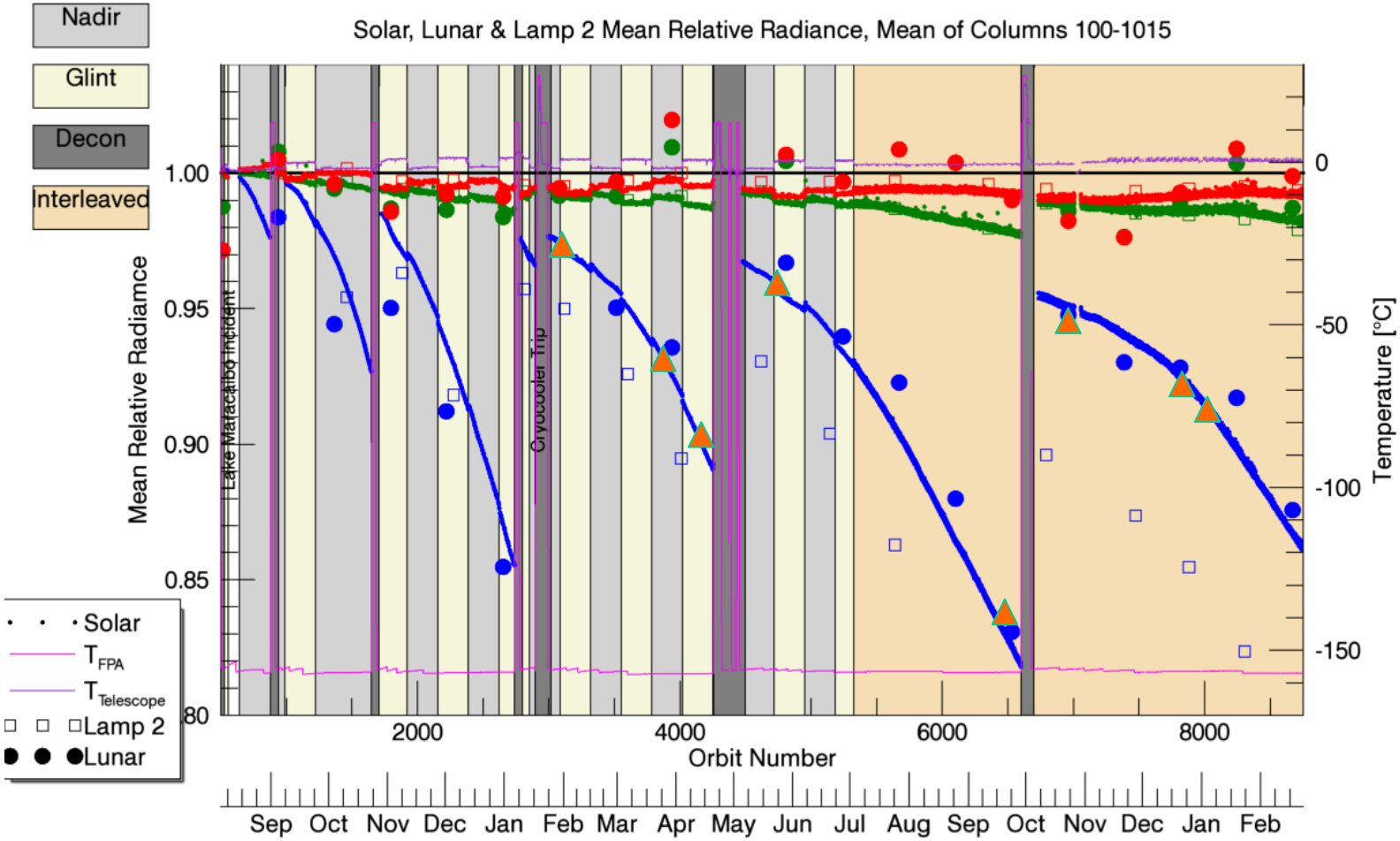


Background

- But lunar data does not suggest slow change
- We suspect that the solar diffuser is degrading and imparting a change on the solar measurements.
- Tommy and Chris are reviewing earth viewing data – do we see evidence of change?



The test set – orange triangles



Analysis

- We have 15 days of data run with radiance scaling applied to take out 'slow degradation'
- Choose data based on xco2 quality flag in lite files

- Scatterplot XCO2, albedos, surface pressure difference from prior
- Ratio of XCO2 and albedos
- Differences of dP

- Current analysis shows that
  - A-band albedo changes nearly proportionally to radiance scaling for nadir data
  - Glint land shows similar behavior
  - Glint ocean shows dP and XCO2 changes, which are removed by bias correction to some extent
  - Still need to analyze other variables used in bias correction
  - Jury is still out on the magnitude of the impact and time dependent impact

Verification of OCO-2 radiometric calibration using MODIS

Tommy Taylor, Chris O'Dell :: Colorado State University
Annmarie Eldering :: Jet Propulsion Laboratory

29-Feb-2016

Introduction/Motivation

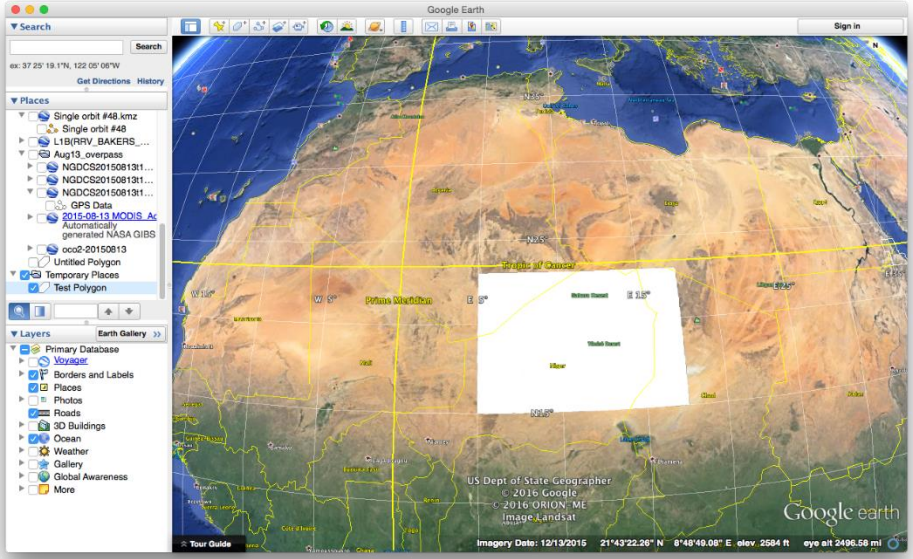
- Solar calibration data show
  - "fast degradation" that recovers after decontamination cycles,
  - "slow degradation" that does not change after decons.
- Corrections based on the solar data were implemented into the L1b radiances via Ancillary Radiometric Product (ARP) files.
- The fast degradation appears to be from a contamination that is deposited on the detectors during normal science operations.
- The slow degradation may be due to changes in the solar diffuser, as lunar calibration data seems to have an annual cycle but no time trend. Need more info!
- Can MODIS radiances be used to provide an additional source of verification by looking at the time series compared to OCO-2?
- Furthermore, a number of independent sources are suggesting that the absolute OCO-2 radiometric calibration is too high by 5-20%;
  - Vicarious calibration at Railroad Valley [Bruegge].
  - Direct comparison with GOSAT radiances [Kuze].
  - On-board lunar calibration [Chapsky].
  - CFIS measurements from OCO-2 airplane underflights [Frankenberg].

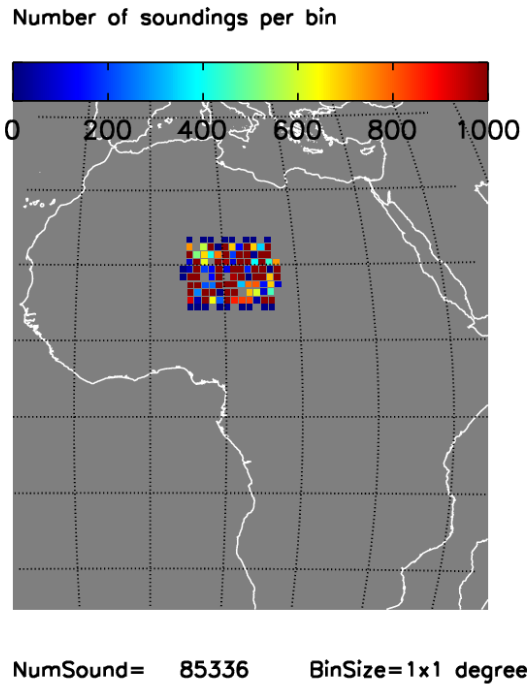
Data/Methodology

- OCO-2 data versions; Ops_B7000, Ops_B7200, Ops_B7300
- OCO-2 data products;
  - L2ABP (cloud screening, OCO-2 ABO2 signal)
  - L2IDP (cloud screening)
- MODIS collocated products;
  - MYD061KM :: one-km cloud product (Cld), collocated to the OCO-2 fp. Use a 2km circular region around OCO-2 footprint. (cloud screening)
  - MYD02HKM :: half-km radiances (HKM), collocated to the OCO-2 footprints. Use a 1km circular region around OCO-2 footprint. (surface homogenitey screening, MODIS signal)
- Spectral bands;
  - MODIS :: bands (B1+B2)/2 = (0.645+0.859)/2=0.75μm
  - OCO-2 :: band B1 (ABO2) = 0.76μm
- Radiance, aka, signal;
  - OCO-2 :: signal_o2_abp (ten brightest channels in continuum, excluding bad pixels and cosmic ray spikes, converted to radiance ($W/m^2/\mu m/sr$)
  - MODIS :: EV_250_Aggr500_RefSB, converted to radiance ($W/m^2/\mu m/sr$), divided by 2 to account for total intensity vs single linear polarization for OCO-2
  - Comparison of green to red apples!
- Select small spatial regions with limited surface variation and high albedo;
  - Sahara
  - Arabia
  - Australia outback
- Apply cloud/surface filtering (ABP + IDP + MODIS Cld + MODIS HKM deviation)
- Quantify time-dependence (fast/slow degradation) and bias (absolute radiometric calibration) in signal ratio

Sahara Region

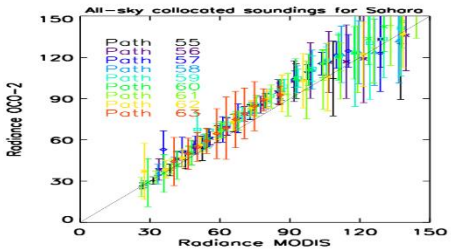
- Use search box 15° -23° N, 5° -17.5° E.
- Date range; 2014/09/28 – 2015/12/20
- Orbit range; 1284 - 7808
- Path numbers; 55-63
- Number of hit frames; ~39,500/footprint
- Number clear frames; ~10,600/footprint



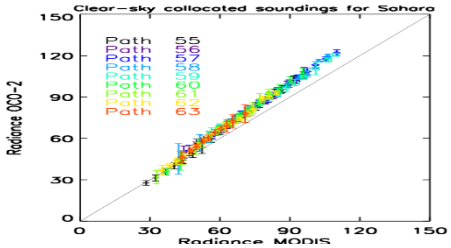


Results :: Sahara Region

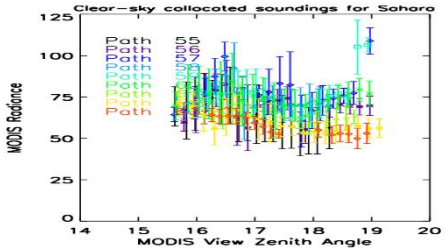
All-sky soundings per path

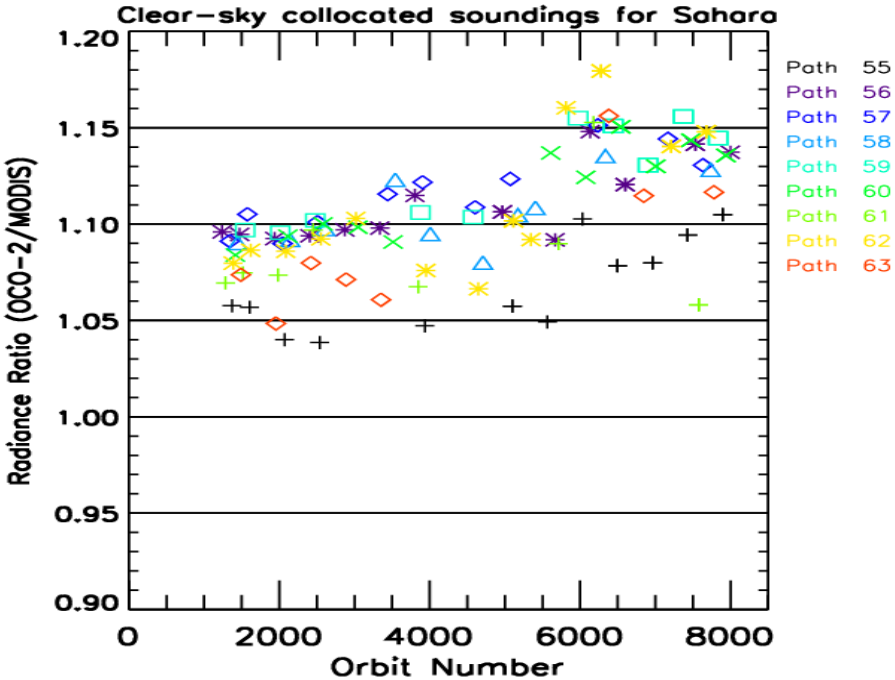


Clear-sky soundings per path



Clear-sky soundings per path



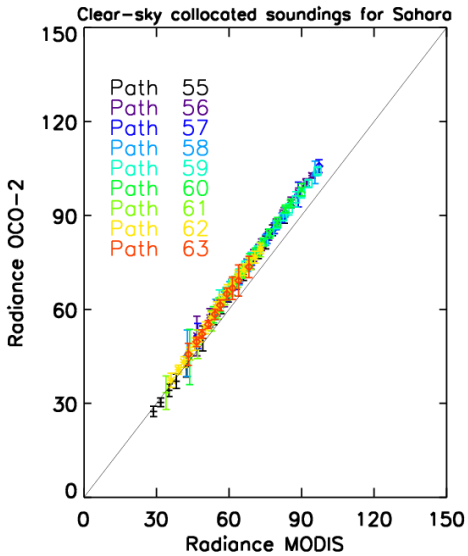


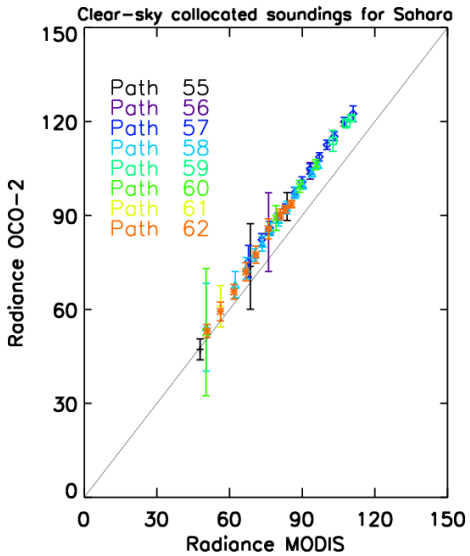
Mean value of all soundings in each granule.

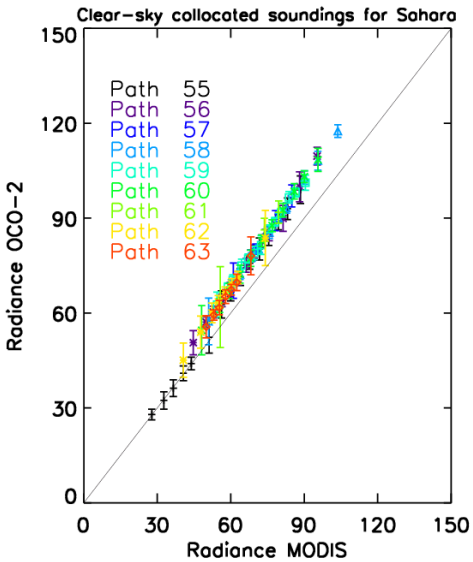
- Long term upward trend indicates L1b cal correction not right (slow-degrad).
- OCO-2 radiances biased high relative to MODIS; supports previous findings.
- 9 paths provide slightly different time dependence and bias. BRDF, instrument sensor or atmospheric effects?

Results :: Sahara Region

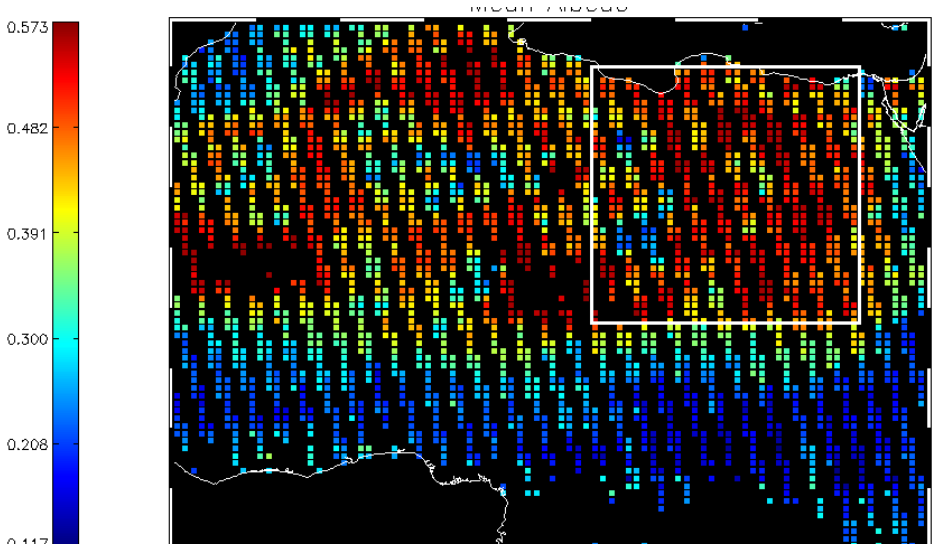
- If we are incorrectly adjusting the OCO-2 radiances for slow degradation, then the agreement with MODIS should become demonstrably worse over time when chunking the time range into orbit periods.
- Used orbit chunks [0-3500], [3501-5500], [5501-9000]



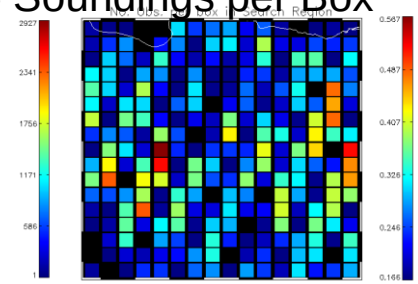




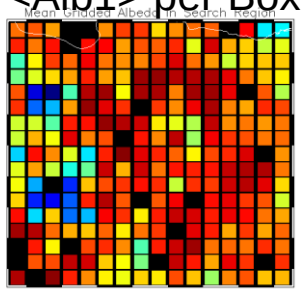
Sahara Albedo Analysis



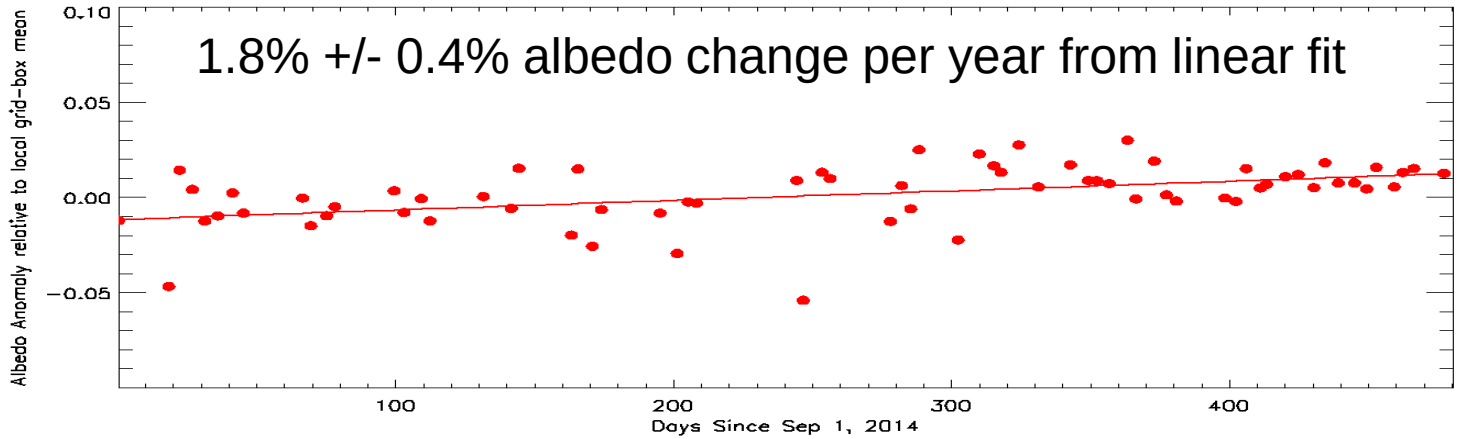
Soundings per Box



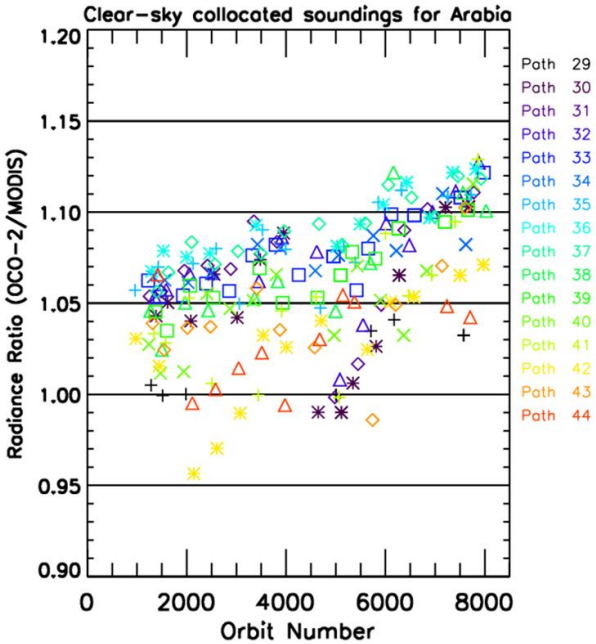
<Alb1> per Box

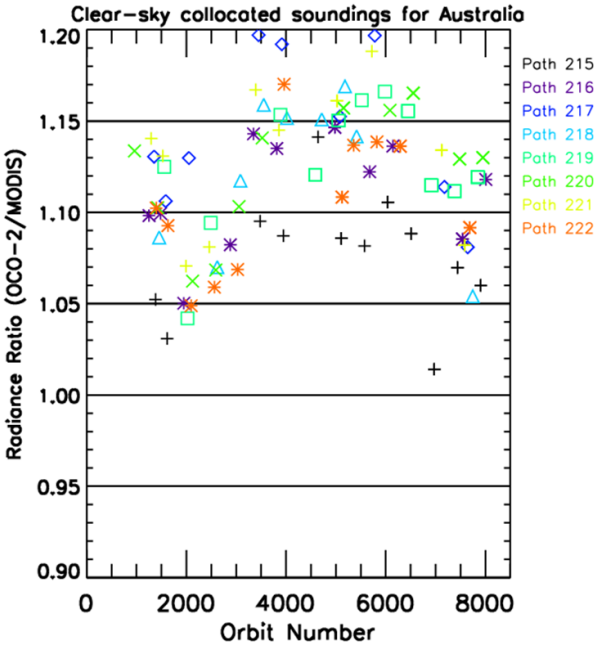


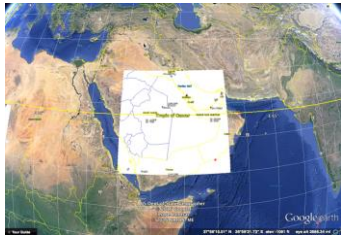
- Require 400 obs per square deg
- Require albedo in {0.38,0.50}
- Remove grid-box mean from each valid sounding.
- Linear fit over time.

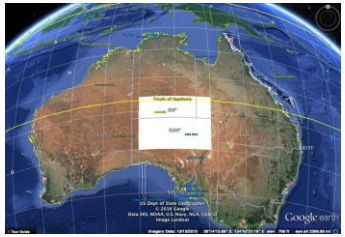


Trends over Arabia and Australia









Regions over Arabia (left) and Australia (right) show similar trends, although the trend over Australia is less clear.

OCO-2 Alg Activities

Annmarie Eldering and team

3/1/2016

V8?? Only when we make significant advances

- Straightforward items
  - ABSCO update – improvement, but to date does not look like drastic change
  - BRDF – improved throughput, much better target retrievals
- In evaluation, expected to be straightforward
  - Solar line list update, updated TCCON prior, ice cloud height prior

- In evaluation, need answers/additional info before we reach decision
  - Aerosol prior – to date, not a significant impact, but need to finalize evaluation
  - What is the impact of the ECMWF geopotential height error?
  - Can we confirm that there is an error in the calibration (slow degradation not real?)
  - If this is confirmed, what is the implication for the L2 algorithm??

- In addition,
  - Need the GOSAT data run through the OCO-2 algorithm to help identify algorithm errors that drive SH glint and tropical data, or show that it is the data
  - Need to have OCO-2 data run through other algorithms to confirm that errors are due to OCO-2 data, not the algorithm

Science Team Activities

Theme Group Reports

Science Team Meeting: 21-23 March

Theme Group Meeting/Telecon Schedules

- Absorption Coefficient, Alternate Mondays, 11 AM PST
- Calibration: Wednesdays, 11-12 AM
- Cloud/Aerosol: Alternate Tuesdays 9-10 PST
- Flux Inversion: Alternate Tuesdays, 1-2 PM PST
- Level 2 Algorithm: Monday and Wednesday at 10 AM PST
- Uncertainty Quantification: Alternate Wednesdays, noon to 1 PM PST
- Validation: Alternate Mondays, noon PST
- Local Sources: ??

OCO-2 Science Team Meeting

21-23 March 2016 @Caltech

REGISTER! https://sites.google.com/site/oco2stmmar2016/

Monday, March 21st - Breakout groups

Validation	Sharp	9am-12	Greg Osterman
Spectroscopy	Buwalda	9am - 3pm	V. Payne
Clouds	136 Linde Robinson	9am-12	Crisp/Winker
Uncertainty Quantification	Salvatori	9am-12	A. Braverman
Flux	Sharp	1-5pm	D. Baker
Local sources	integrated with flux		

OCO-2 Science Team Agenda: Day 2

Tuesday, March 22nd - Baxter Lecture Hall

Topic	Discussion Leader	Start Time	duration (min)
Registration and check in		8:15 AM	30
Welcome from HQ	Ken Jucks	8:45 AM	5
Welcome, Overview, Logistics and Introductions	Dave Crisp	8:50 AM	15
Mission Status	P.J. Guske	9:05 AM	10
Introductions (all team members)	ALL	9:15 AM	15
Data/ Algorithm Performance Overview	Eldering & O'Dell	9:30 AM	20
Validation Overview	Paul Wennberg/Debra	9:50 AM	20
BREAK		10:10 AM	30
SIF overview	Christian Frankenberg	10:40 AM	25
UQ overview	Amy Braverman	11:05 AM	25
Discussion	ALL	11:30 AM	20
LUNCH		11:50 AM	70
Flux team breakout - kick off (rest of day structured by DB)	David Baker	1:00 PM	120
BREAK	ALL	3:00 PM	30
rest of flux breakout	flux team	3:30 PM	100
Discussion	All	5:10 PM	20
End of Day	ALL	5:30 PM	0

OCO-2 Science Team Agenda: Day 3

Wednesday, March 23rd - Baxter Lecture Hall			
Topic	**Discussion Leader**	**Start Time**	**duration (min)**
Registration and check in		8:00 AM	30
Welcome, Overview and Logistics	Dave Crisp	8:30 AM	10
Overview of proposed algorithm changes	Chris O'Dell	8:40 AM	10
L1b Updates	Eldering	8:50 AM	10
ABSCO Update	Vivienne Payne	9:00 AM	20
BRDF Update	Vijay Natraj	9:20 AM	20
Aerosol Update	Dejian Fu	9:40 AM	20
BREAK	ALL	10:00 AM	30
data use recommendations	Eldering/Odell	10:30 AM	15
Discussion	ALL	10:45 AM	20
preprocessor updates	Chris/Tommy	11:05 AM	15
local studies report	Eric Kort	11:20 AM	30
LUNCH	ALL	11:50 AM	75
local stduy - next steps	Eric Kort	1:05 PM	20
Cloud theme group integrated report	Dave W et al	1:25 PM	30
Discussion	ALL	1:55 PM	15
flux group plan	David B	2:10 PM	30
alg plan	Chris O'Dell	2:40 PM	20
BREAK	ALL	3:00 PM	30
UQ plan	Amy Braverman	3:30 PM	20
validation plan	Greg Osterman	3:50 PM	20
Discussion	All	4:10 PM	30
Review of day/ Action items	Crisp/Eldering	4:40 PM	20
End of Day	ALL	5:00 PM	

Other Upcoming Meetings

- 17-22 April 2016: EGU, Vienna
- 17-22 April 2016: International Radiation Symposium, Auckland
- 9-13 May 2016: ESA Living Planet Symposium, Prague
- 17-18 May 2016: NOAA ESRL GMD Annual Meeting, Boulder
- 22-26 May 2016: JpGU, Makuhari Messe, Japan
- 7-9 June, 2016: IWGGMS-12, Kyoto, Japan
- 10 June, 2016 OCO-2/GOSAT TIM, Nara, Japan
- 6-8 July, 2016: O2 A-band Workshop, KNMI, De Bilt, Netherlands
- 31 July-5 Aug, AOGS 2016, Beijing, China
- 12-16 December, AGU, San Francisco, CA, U.S.A.
- Save the Date: 18-21 April 2017, A-Train Science Symposium, Pasadena, CA, U.S.A.