OCO-2 Status
January 2018

David Crisp

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California Institute of Technology
for the OCO-2 Science Team

3 February, 2018

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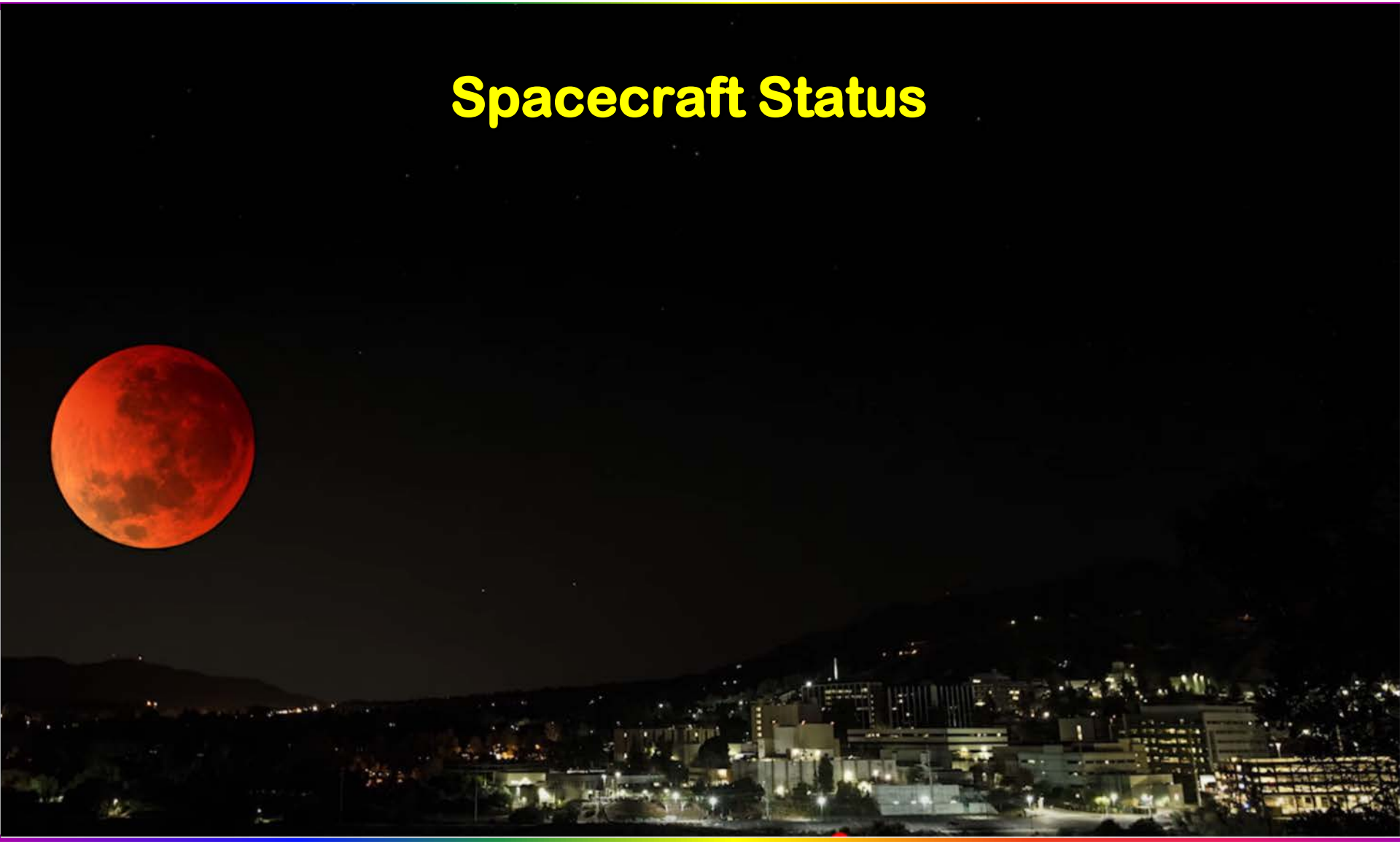
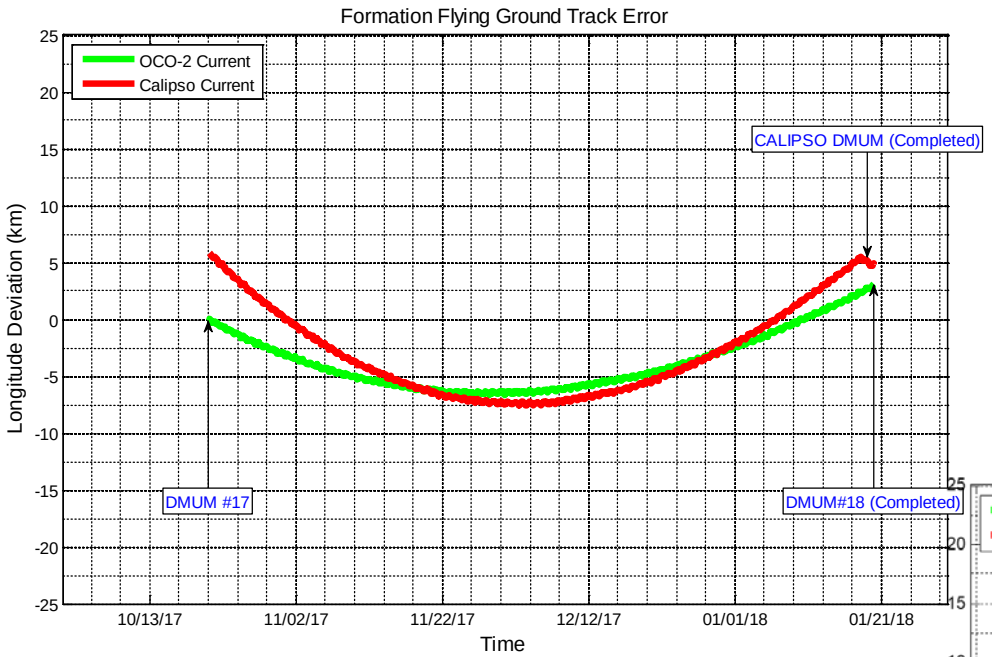
Overview

- Observatory Status: Nominal
  - Successful Drag Make-up Maneuver (DMUM) on 18 January 2018
  - Formation flying overlap 96.45% over last DMUM cycle
  - 2018 Inclination Adjust Maneuvers: 1, 8, 15, 29 March, 12 April
- Instrument Status: Nominal
  - Next Decontamination Cycle scheduled for 13-20 February
- Pointing offset study
  - Empirical Evidence of a sub-footprint pointing error
  - Lunar geometric calibration campaign
- Progress on V8 Processing of GOSAT data
- Upcoming Events
  - Tsukuba/Tokyo Visit on 14-16 February

Spacecraft Status

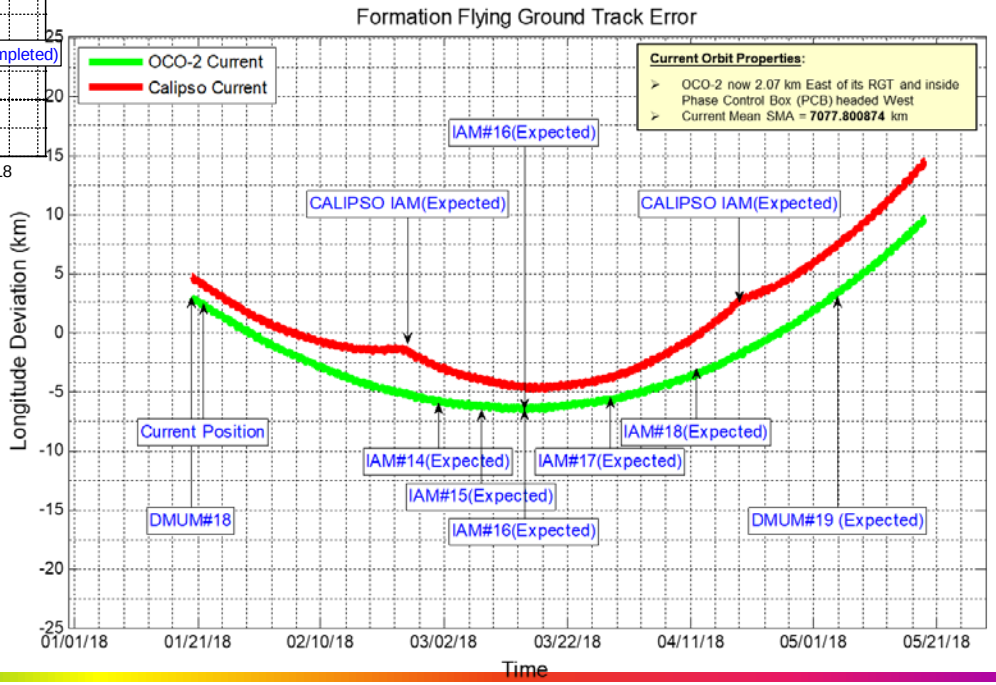


OCO-2/CALIPSO Ground Track Overlap

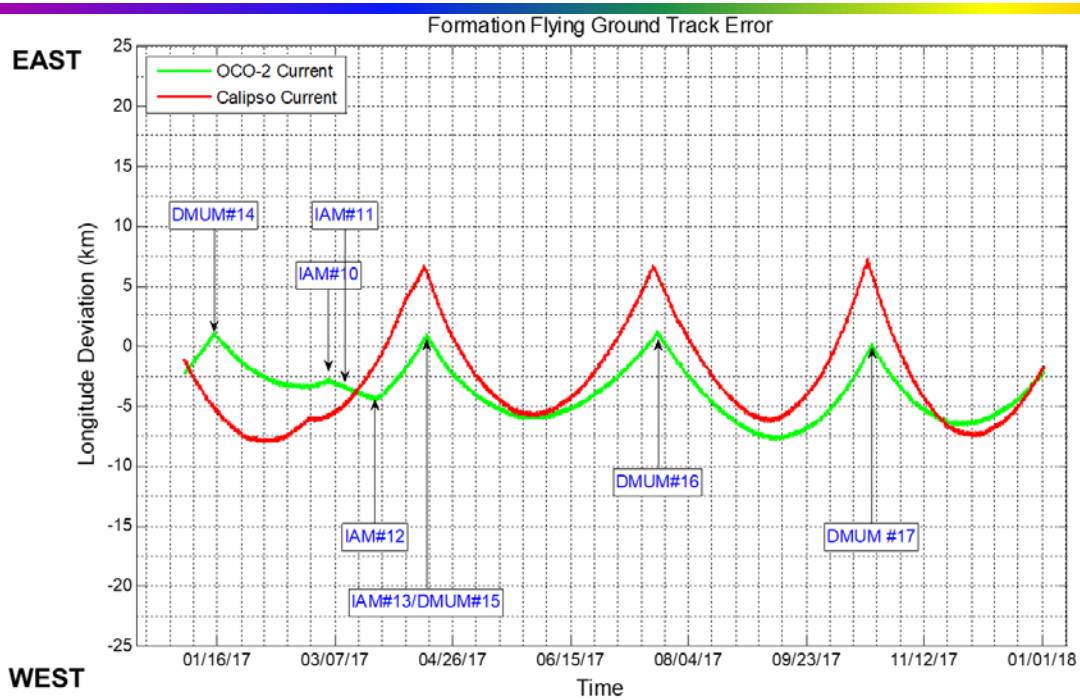


The OCO-2 Navigation team has maintained overlap with the CALIPSO ground track 96.45% of the time between the past two drag make-up maneuvers (DMUMs). No risk mitigation maneuvers were needed over this period.

The current plan is to maintain the OCO-2 ground track with +/-5 km of the CALIPSO ground-track 100% of the time during the 2018 Inclination Adjust Maneuver sequence.

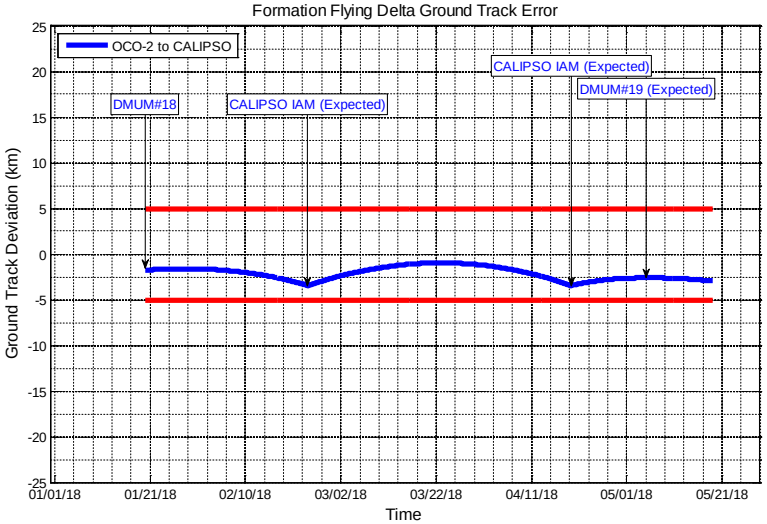


Navigation Plans for 2018



Left: Alignment of the CALIPSO (red) and OCO-2 (green) ground tracks relative to the reference ground track (0 km) over the past year. CALIPSO has a larger drag coefficient and sees larger deviations that OCO-2.

Relative alignment of the OCO-2 track to the CALIPSO track, with +/- 5 km limits. The current plan is to maintain the alignment of the OCO-2 and CALIPSO ground tracks as long as CALIPSO continues to operate nominally in the A-Train.



TanSat Encounters

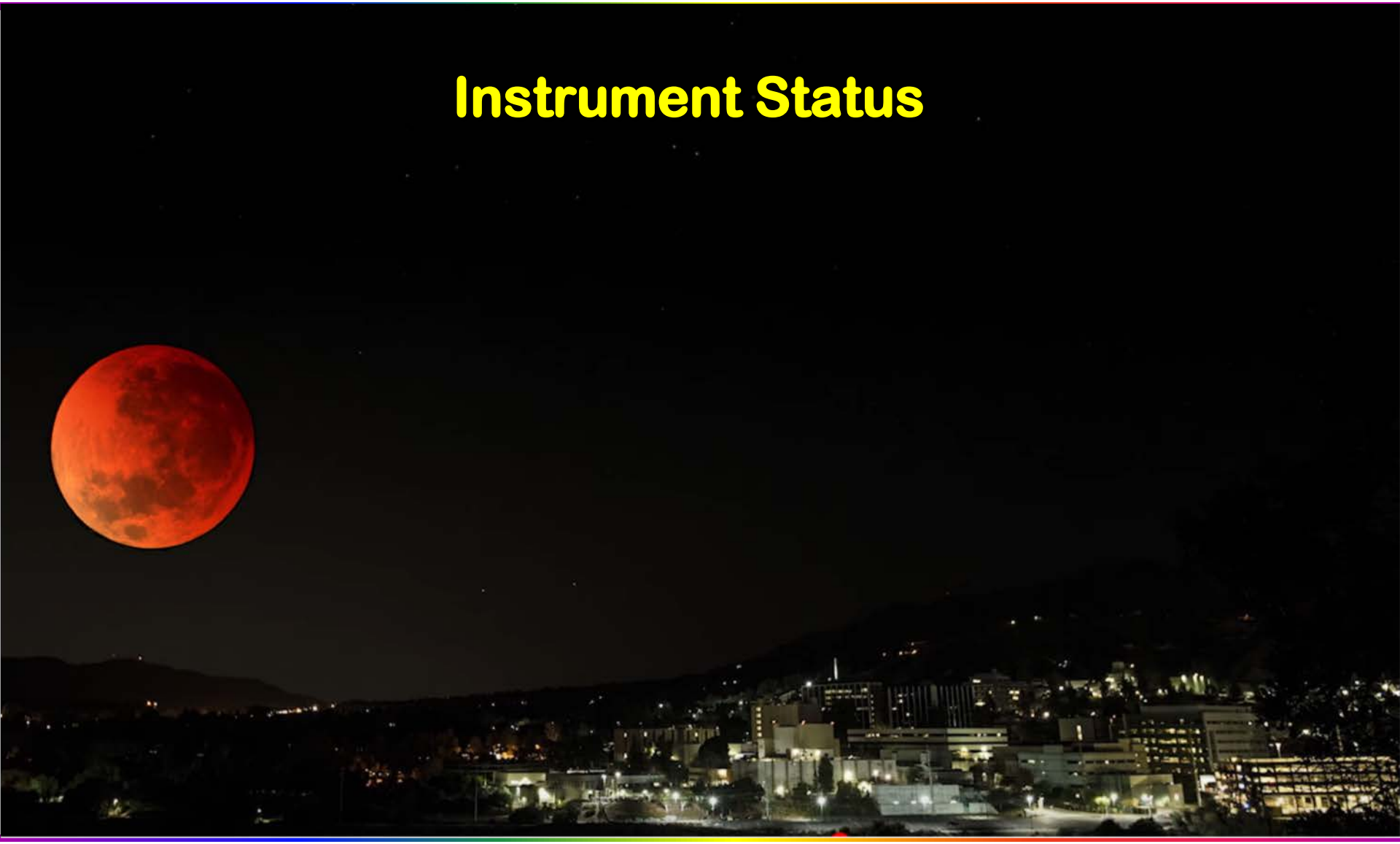
- TanSat and OCO-2 have a closest approach every ~4 months
- These times are ideal for comparing products
  - TanSat - OCO-2 Closest Approach on 4/20/17 at 04:20 GMT
    - Range is ~ 8.5 km
    - Along Track separation is ~ 5.0 km
    - Cross Track separation is ~ -6.8 km
    - Radial separation is ~ -1.0 km
  - TanSat - OCO-2 Closest Approach on 09/09/17 at 08:32 UTC
    - Range is ~ 8.0 km
    - Along Track separation is ~ 0.4 km
    - Cross Track separation is ~ 1.0 km
    - Radial separation is ~ -7.9 km

Less useful because OCO-2 was not operating due to the solar diffuser anomaly

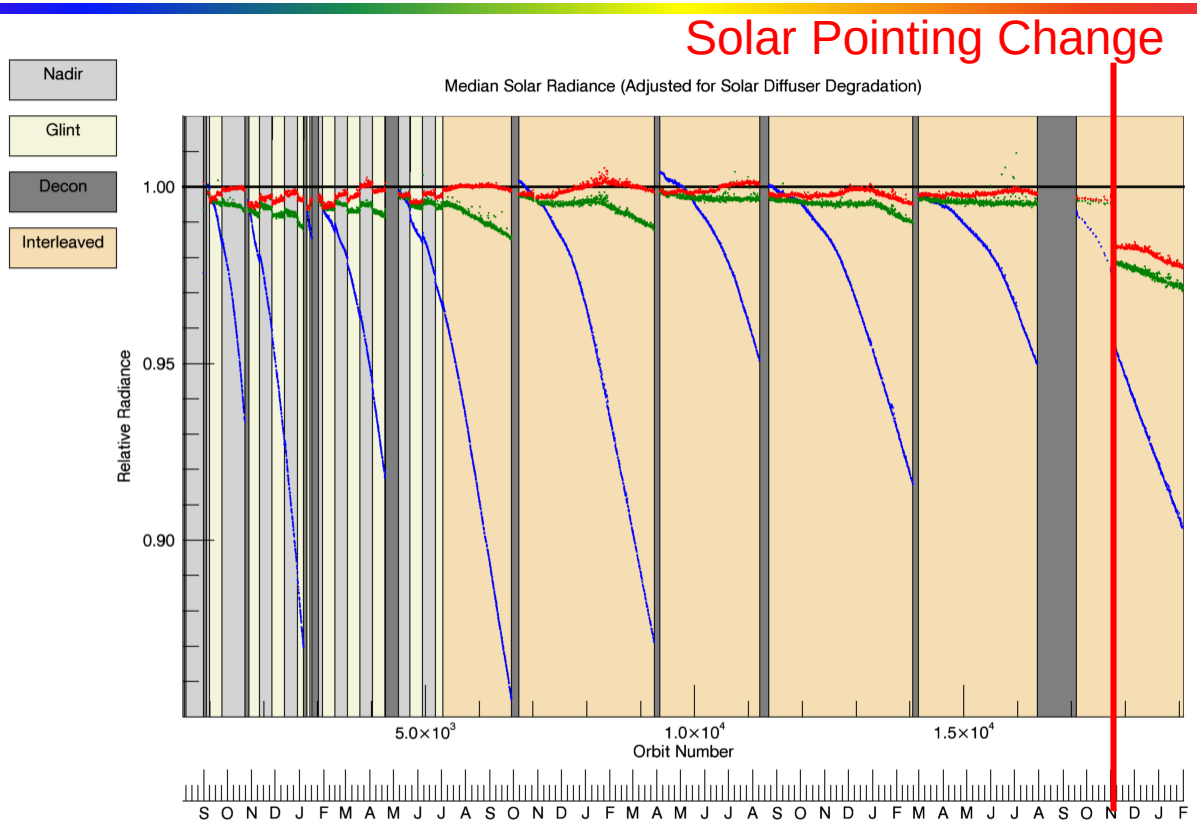
  - TanSat - OCO-2 Closest Approach on 02/12/18 12:16:18 UTC
    - Range is ~ 6.5 km
    - Along Track separation is ~ 6.4 km
    - Cross Track separation is ~ 0.11 km
    - Radial separation is ~ 1.01 km

Coming Attractions!

Instrument Status

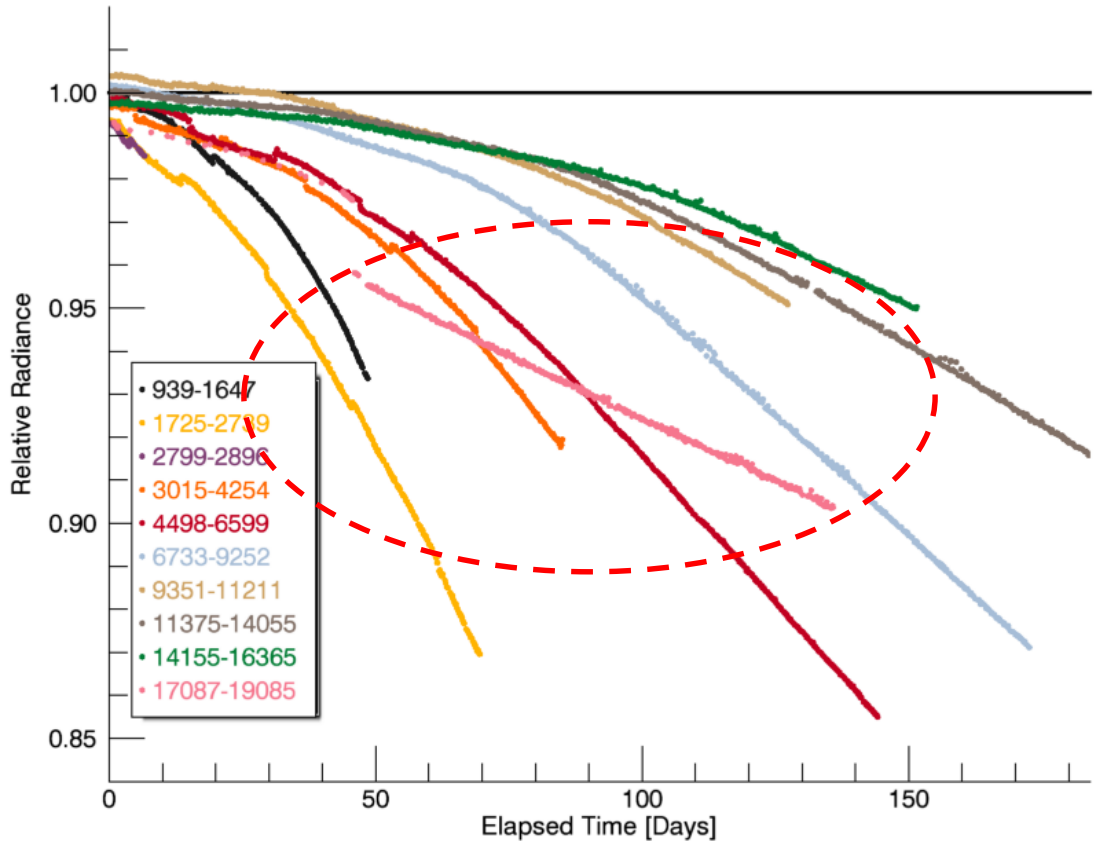


Instrument Status



The OCO-2 instrument continues to operate nominally. The apparent degradation change in November 2017 resulted from the 2.5° solar-off-pointing adopted to prevent accidentally looking right at the sun during solar calibration. This change introduced a 1.5% reduction in the throughput of the solar diffuser that is being compensated as part of the calibration process. The next decon will be performed on 13-20 February 2018.

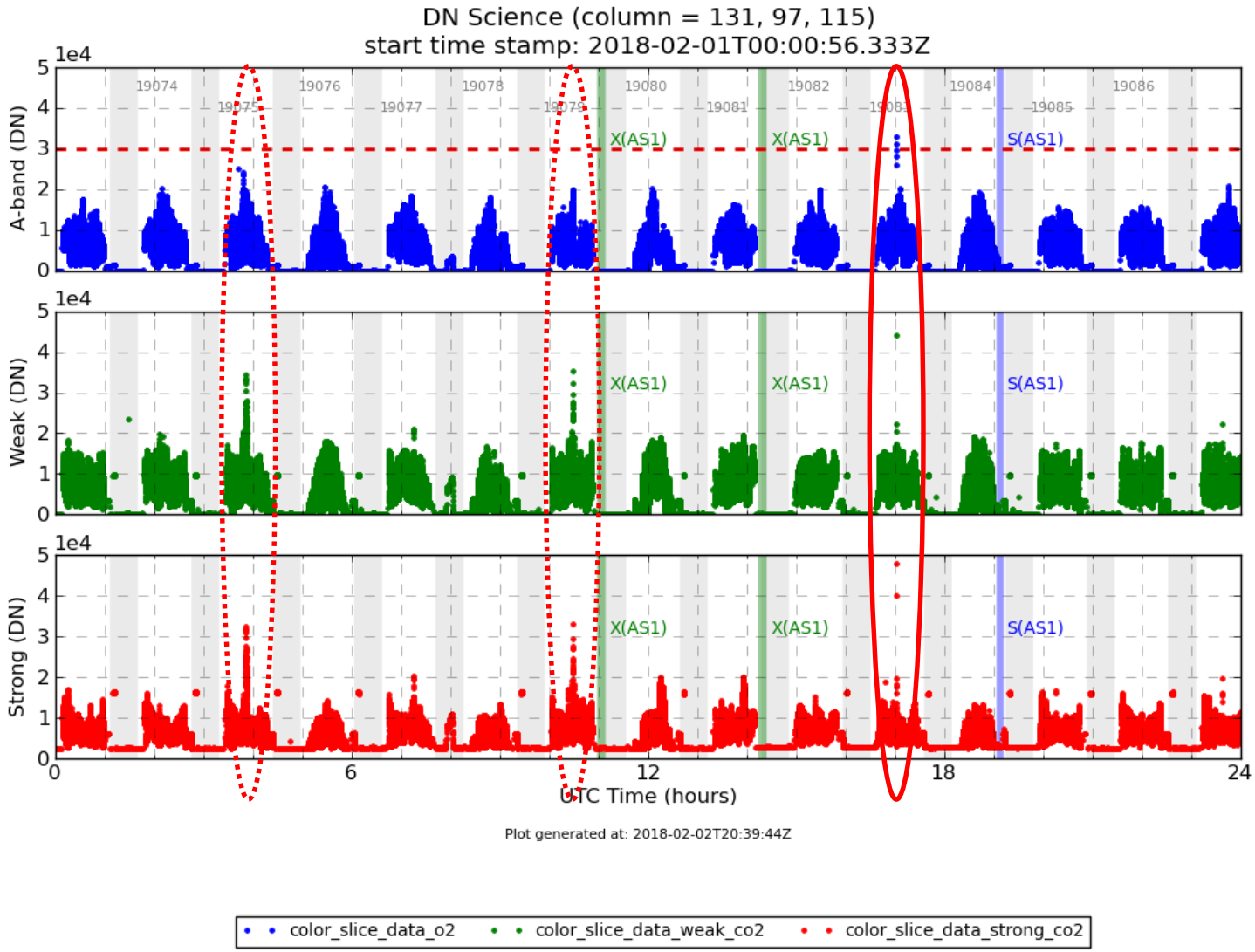
Contamination Rate



The rate of degradation is shown for each degradation cycle (see legend with orbit numbers). The values for the latest cycle (pink) are offset from 1.0 by the 2.5° solar off-pointing and appears to have a slightly larger slope than that seen in the previous (green) cycle.

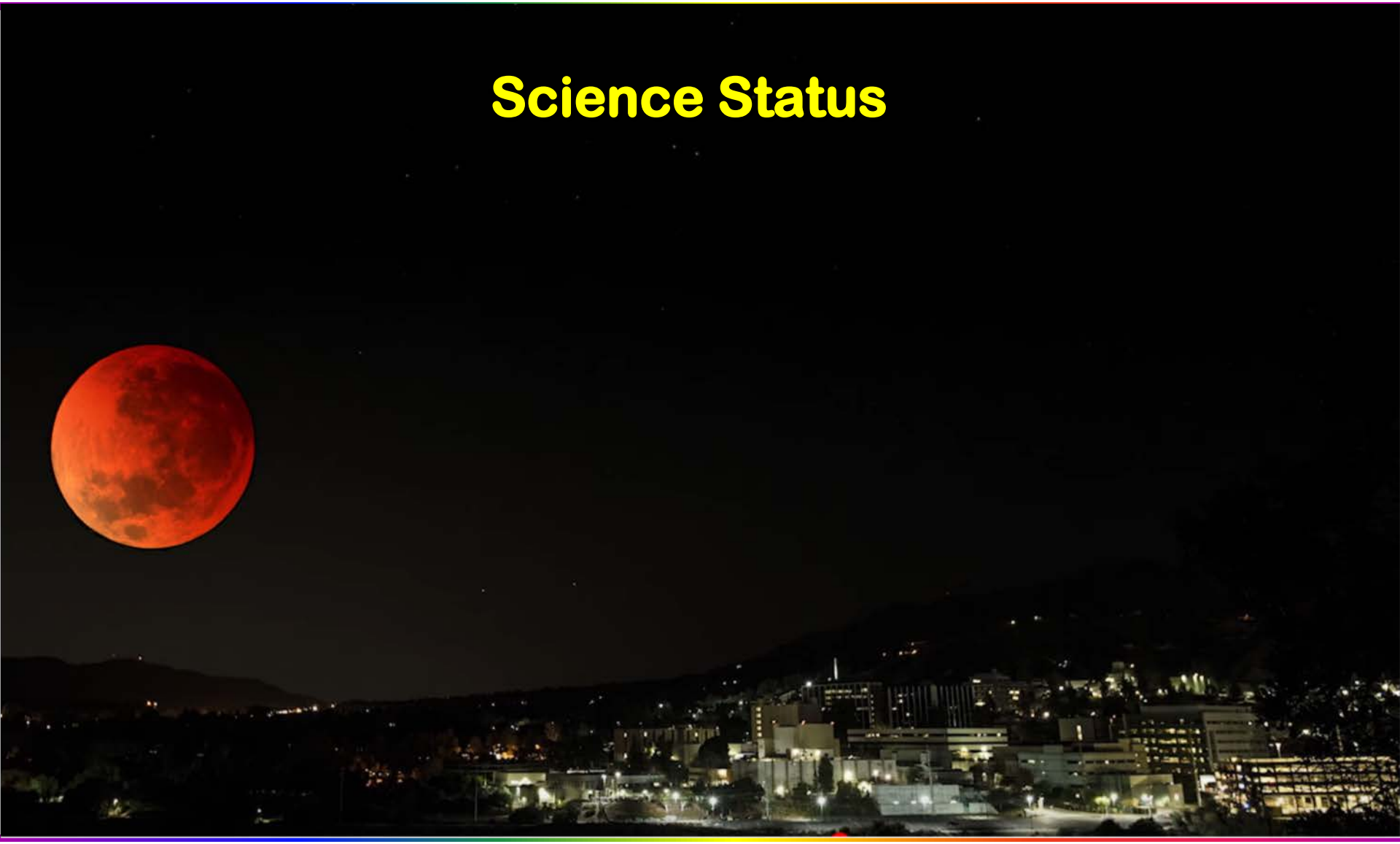
In general, the rate of degradation has been decreasing over time. However, the rate of degradation was slightly faster since the last decon because that decon was conducted with the optical bench and FPAs at 12 °C instead of 28 °C. The upcoming decon will be conducted at 28 °C.

A Glint Saturation Event

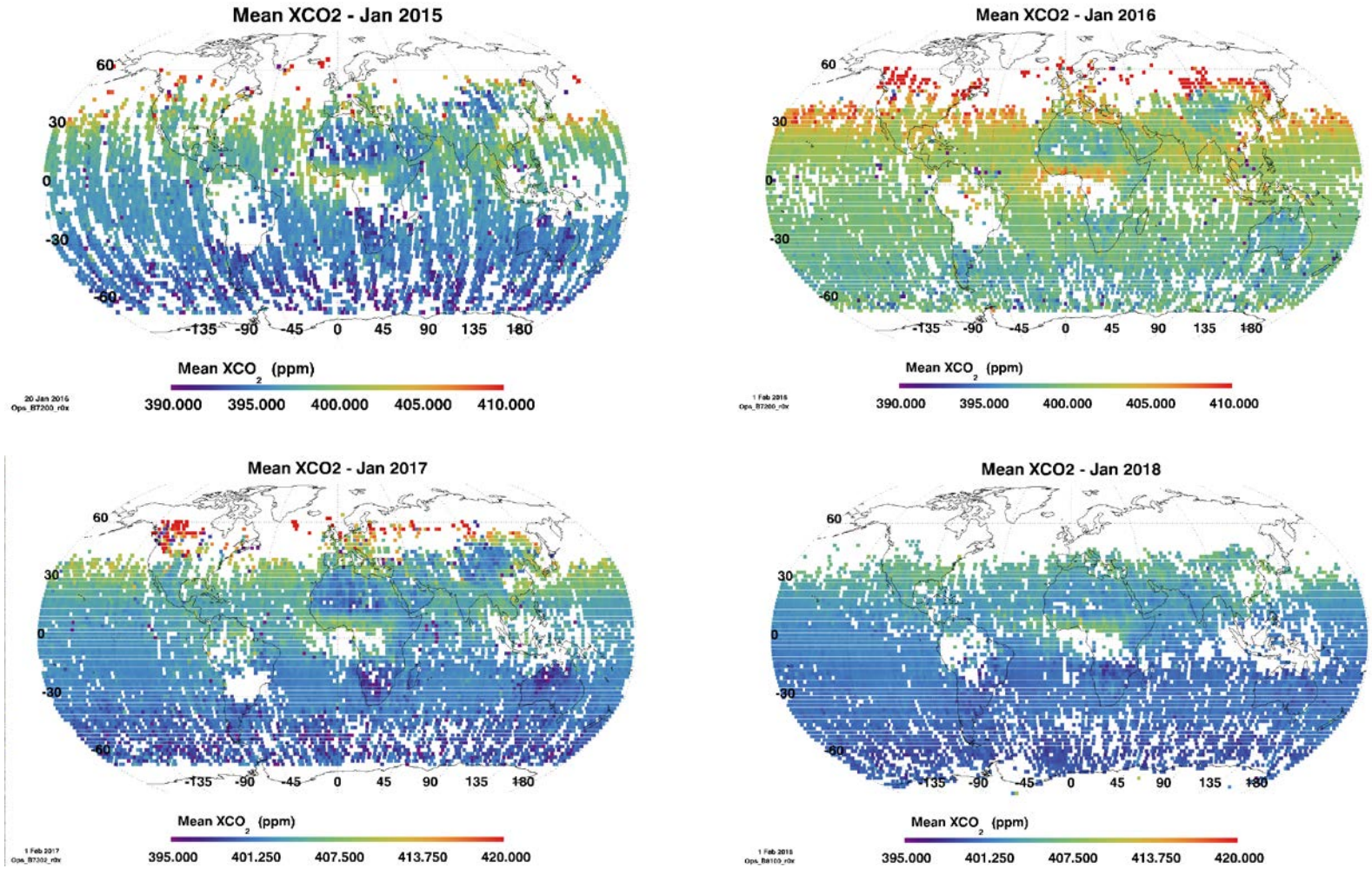


Three intense glint observations were seen on 1 February. The third one produced saturated signals in all 3 channels.

Science Status



The January 2018 V8 XCO2 Product



The coverage and spatial variability of the V8 forward products for January are in family with those from V7, but includes better screening at high northern latitudes.

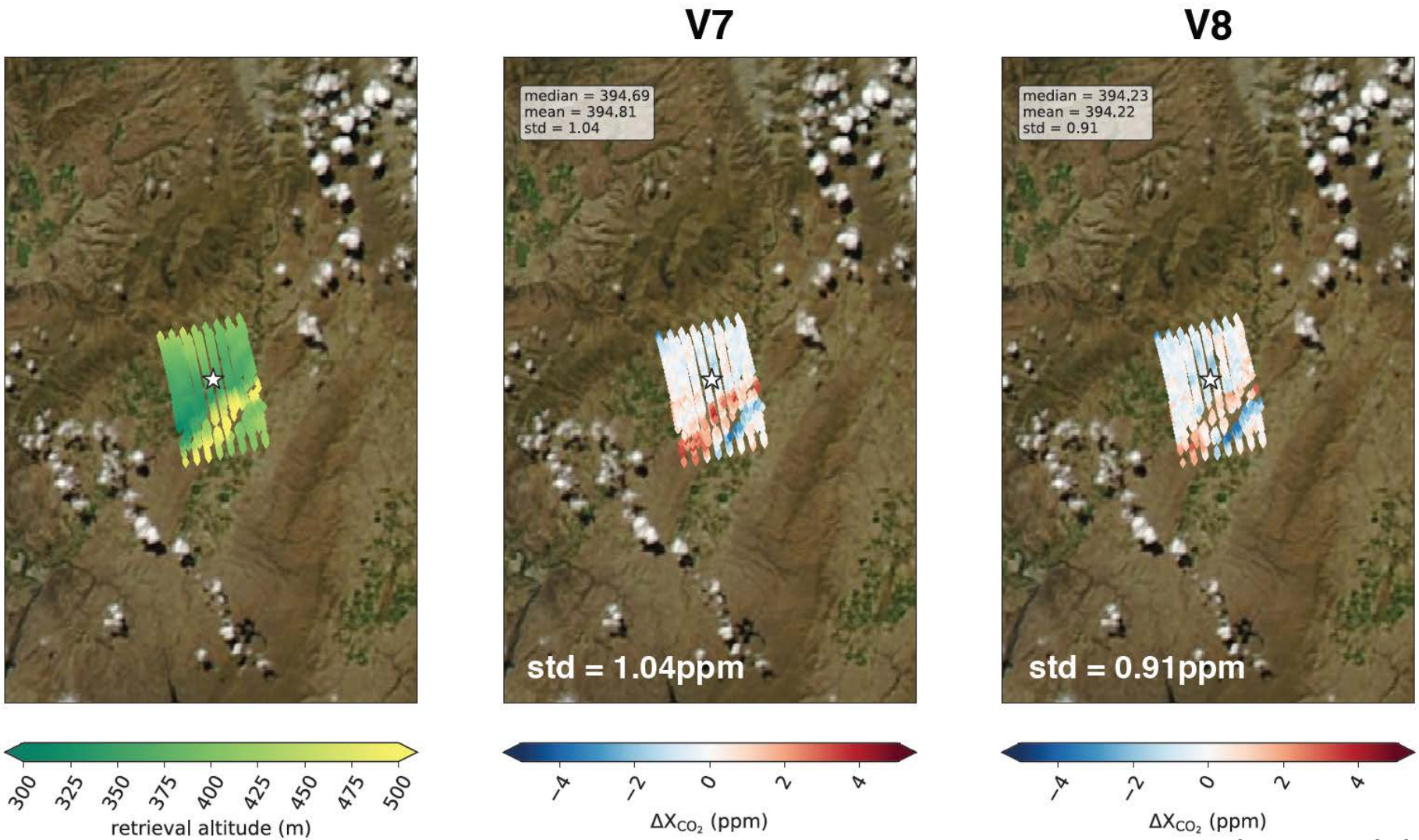
Ongoing Work: Pointing Corrections

- XCO2 estimates retrieved from OCO-2 glint, nadir, and target observations over regions with significant topography show spurious correlations with surface elevation

- These changes have been interpreted as evidence of a small (sub-footprint) error in the boresight pointing

- The science and instrument teams are pursuing a range of activities to characterize and correct this pointing offset
  - Some of the most compelling evidence has been the persistent errors seen in target observations over Lauder, New Zealand
  - Glint and nadir observations show XCO2 anomalies associated with rough topography

Surface-Related Biases over Lauder



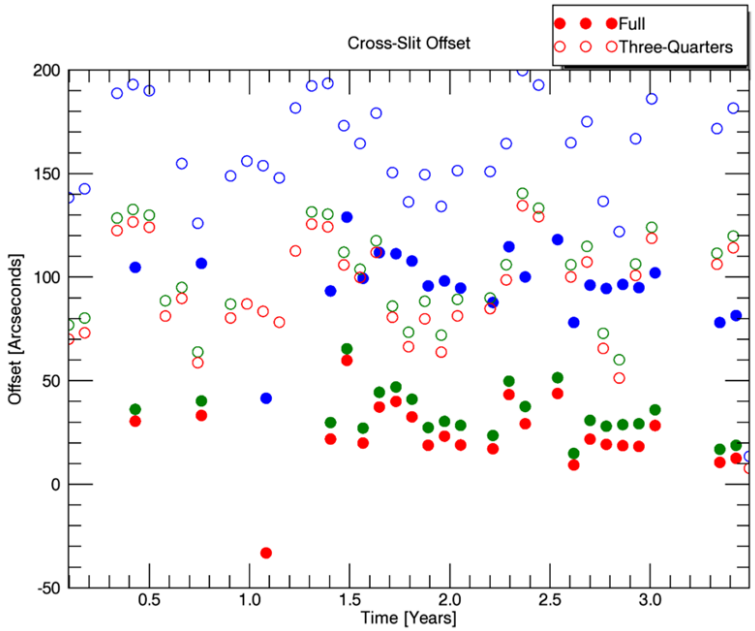
Matthaeus Kiel

Ongoing Work: Pointing Corrections

- A survey of OCO-2 glint and nadir observations by MacDonald and Nassar shows that the sign of the XCO2 bias changes with spacecraft yaw angle
  - High XCO2 anomalies are correlated with upward slopes that are northerly or easterly-facing slopes at latitudes north of the sub-solar latitude (where the top of the satellite is facing south)
  - High XCO2 anomalies are correlated with upward slopes facing southerly or easterly at latitudes south of the yaw flip latitude (where the top of the spacecraft is facing north
  - Target observations show XCO2 anomalies with similar behaviors at all latitudes since they are always performed with the Z-axis pointed along track (north/north-west)
  - This is consistent with a small angular error in the pitch direction
- Experiments are under way to quantify the amplitude of this pitch error so that it can be corrected in future L1B products
  - Lunar campaign (Lars Chapsky)
  - Empirical Geolocation offset studies (Brendan Fisher)

Lunar Geolocation Tests

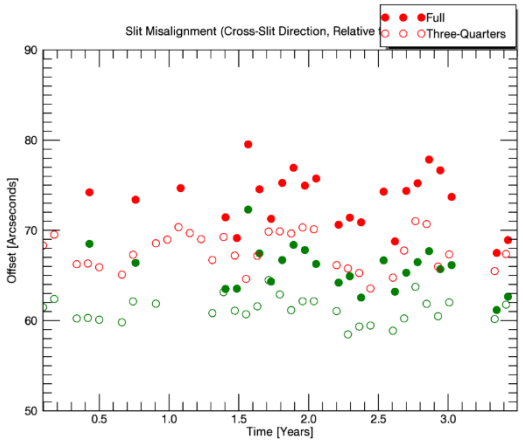
- **Cross-slit pointing offsets exhibit periodic (but not seasonal) variation before switchover to umbra-centered lunar cals**
  - **Not evident in along-slit offsets**



Preliminary analysis of lunar geolocation data show offsets of ~100-200 arcseconds. Note that the full moon results (solid symbols) are not as reliable as s the three-quarter moon results because the start tracker is partially occulted during full-moon observations.

Lunar Geolocation Tests

- **Results reveal slit misalignments of 60-65 arcseconds (Weak CO_2) and 65-75 arcseconds (Strong CO_2) in the cross-slit direction**
  - **Greater than originally estimated**
  - **Exceeds requirement (0.26 milliradians, or 54 arcseconds)**
  - **Stable over time**
  - **Might explain some of the observed topography-related anomalies in surface pressure and XCO2 as it is the A-band slit that is farthest out of alignment**

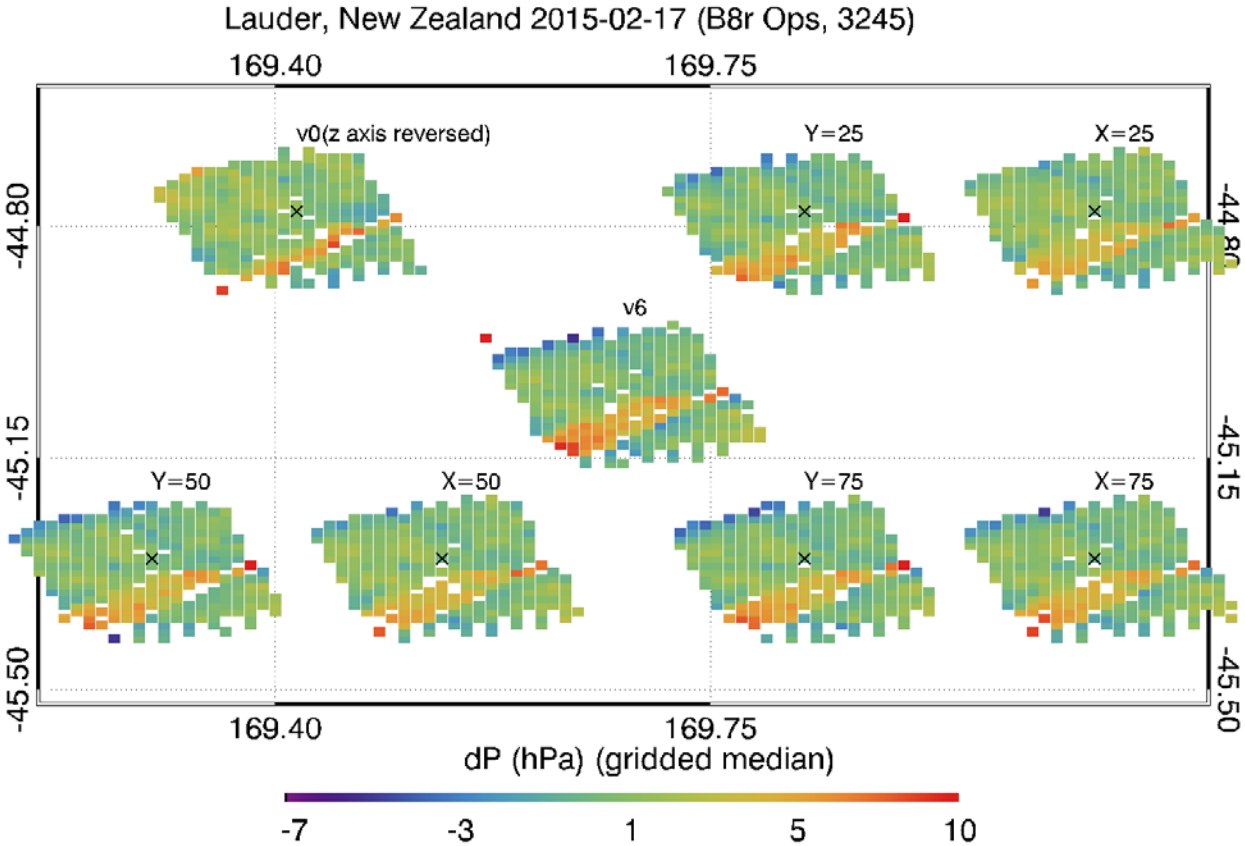


Slit offsets between the Weak CO2 (green) and Strong CO2 (red) bands and the O2 A-band are shown for Full moon (solid) and three-quarters moon (unfilled) observation. Efforts are ongoing to verify the sign of the offsets and to determine the cause of the quasi-periodic behavior.

Empirical Geolocation Offsets: dP

Pointing Offset Tests

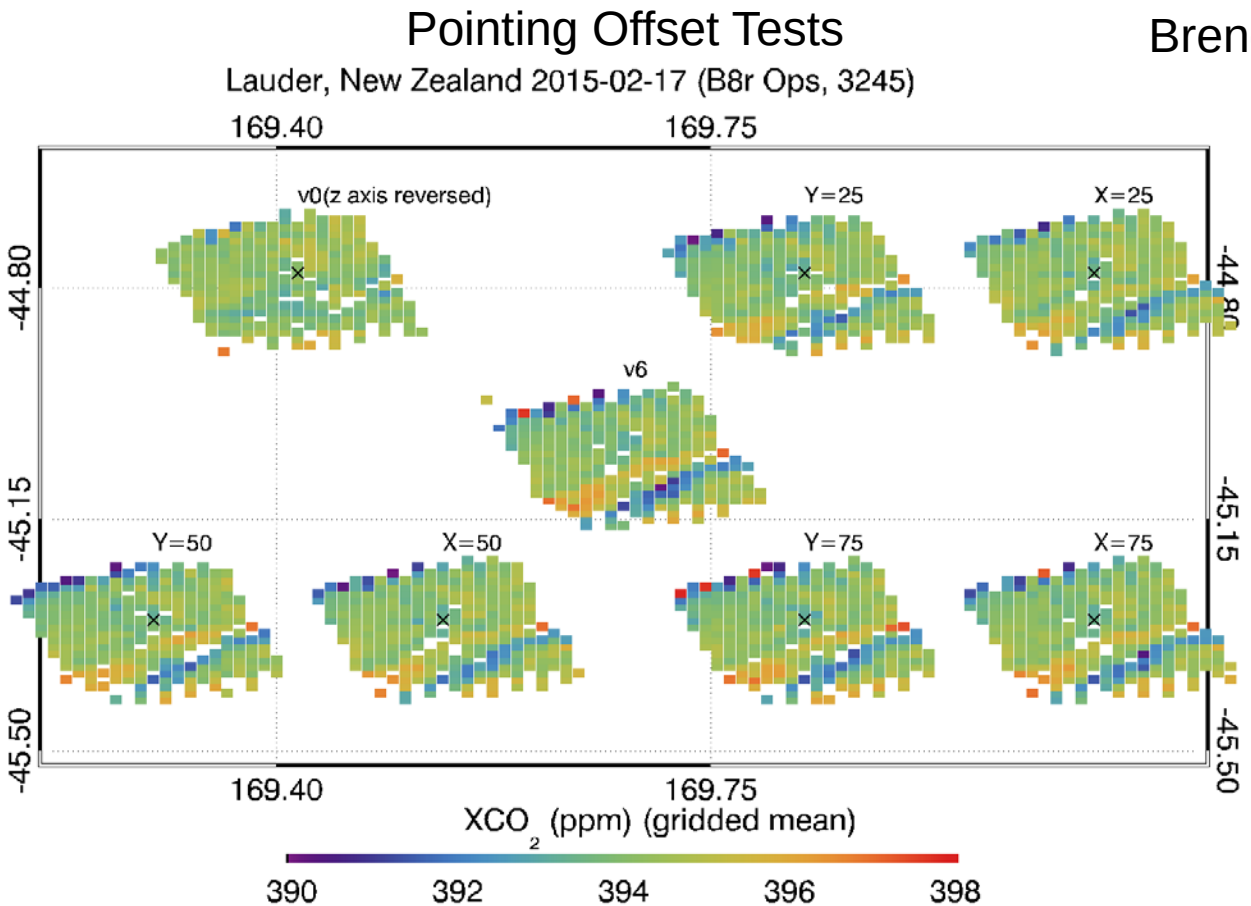
Brendan Fisher



Empirical geolocation offset tests indicate that surface pressure anomalies over Lauder can be reduced by adjusting the assumed pointing by 25 to 75 arcseconds.

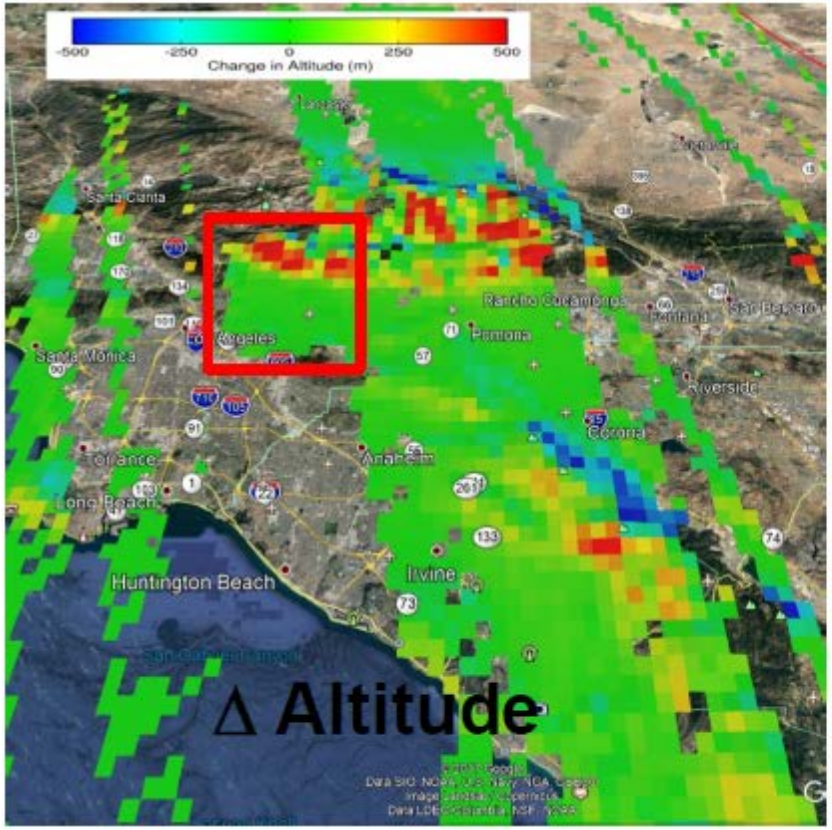
Empirical Geolocation Offsets: XCO2

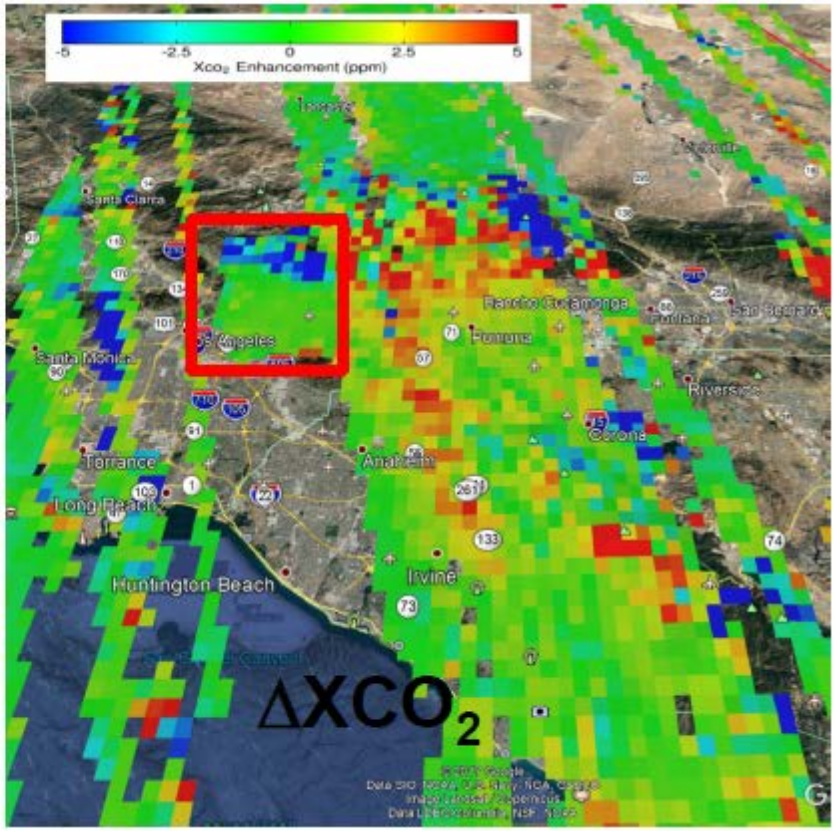
Brendan Fisher



Empirical geolocation offset tests indicate that XCO2 anomalies over Lauder can be reduced by adjusting the assumed pointing by 25 to 75 arcseconds. A larger range is currently being explored.

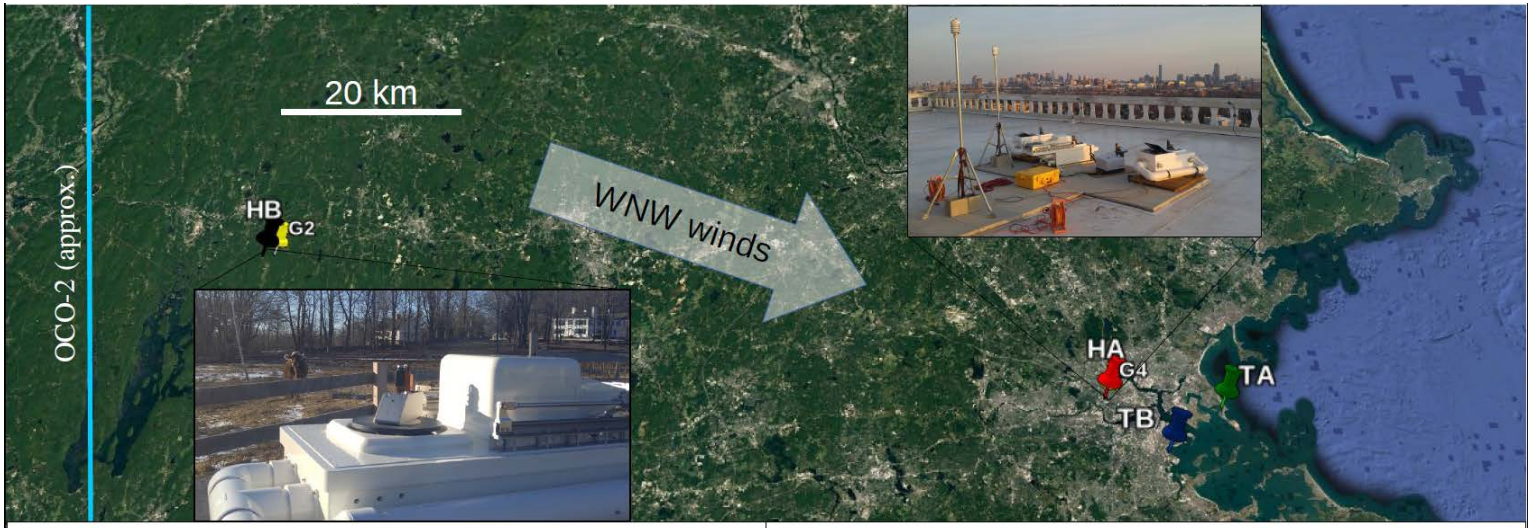
Correlation between Surface Elevation and XCO2 Anomaly

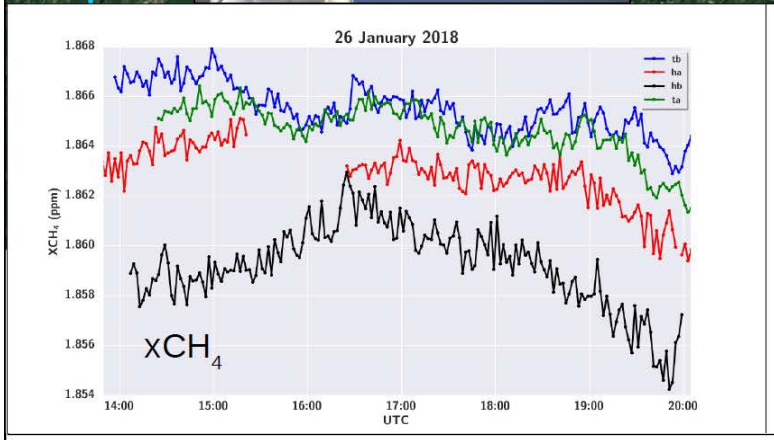


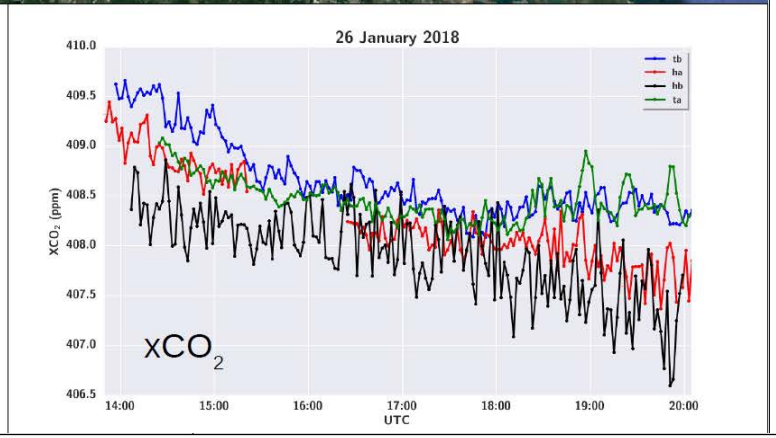


Maps of surface elevation (left) and XCO2 anomaly over the LA basin show that positive anomalies are correlated with slopes with altitude increasing to the north or east. Target observations (red boxes) show the opposite correlation. These observation are consistent with a pitch error (Nassar and MacDonald).

EM27/Sun Observations over Boston







Friday, 26 January 2018
4 EM27/SUN (2 Harvard – U., 2 U. of Toronto), GOSAT, & OCO-2

J. E. Franklin (jfranklin@g.harvard.edu), N. Pak, J. Hedelius, T. Jones

Clear enhancements in xCH_4 and xCO_2 (2 min average) between Harvard Forest (black) and Cambridge (red), and to shoreline (blue – UMass Boston, green – Winthrop) Significant scatter in xCO_2 seen at HF (black) appears to be real – no increase in residuals of spectral fitting. Ground not completely frozen – possible soil respiration into turbulent layer? Instruments scaled to side by side measurements, but not yet to TCCON. OCO-2 track to West will provide great background curtain for models. GOSAT targeting coincident with HA and HB.

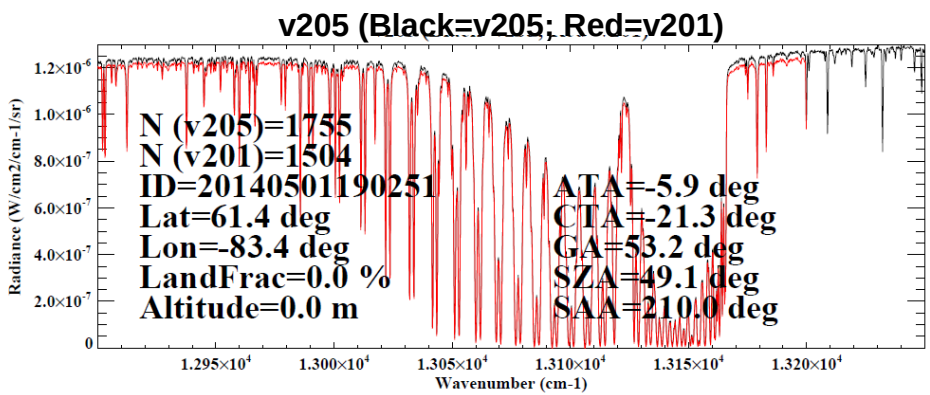
PRELIMINARY DATA

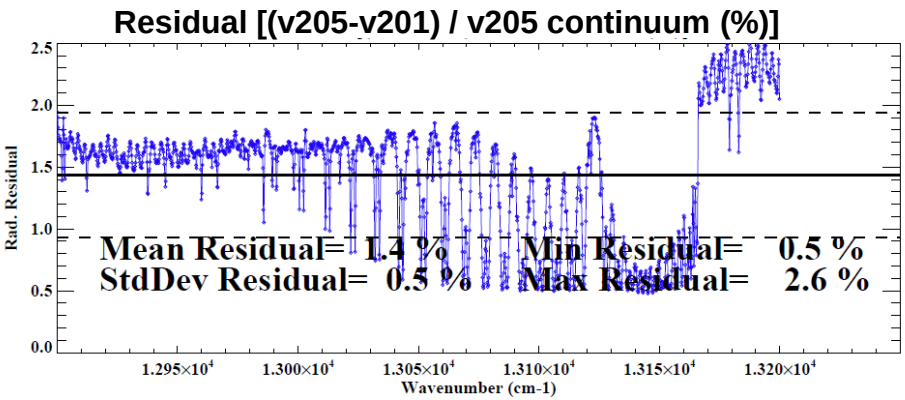
J. E. Franklin (jfranklin@g.harvard.edu), N. Pak, J. Hedelius, T. Jones

ACOS GOSAT V8.x

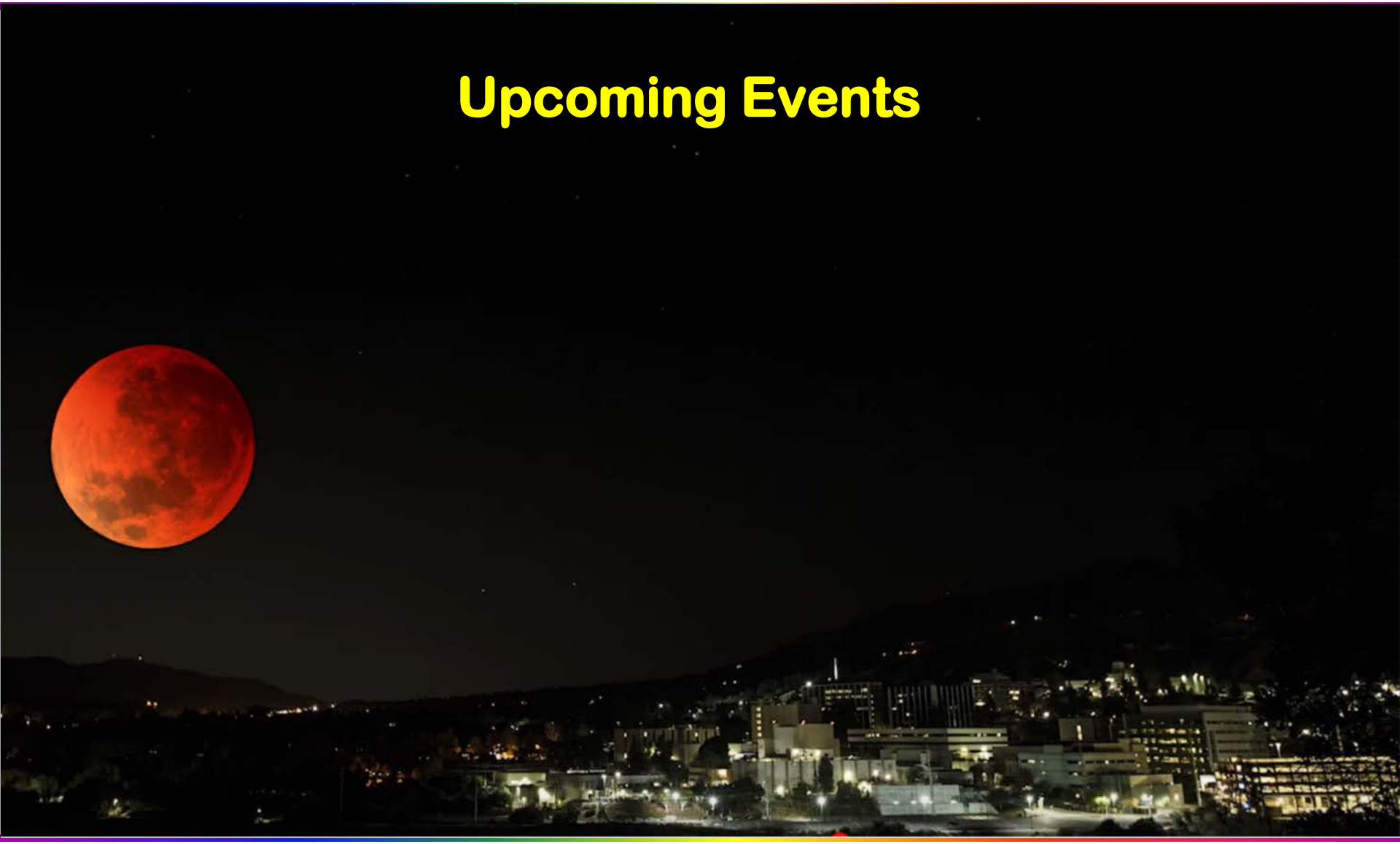
Progress on V8 Processing of GOSAT data

- The ACOS team has downloaded samples of the v205 product and is verifying the GOSAT to ACOS L1B conversion process
  - The bandpass change for ACOS L1b will require updates to all PGEs
  - As an initial step in updating the cloud-screening algorithm, Tommy Taylor has compared the GOSAT v201 and v205 products
    - These tests indicate that the v205 "best-estimated" products in the O2 A-band (band 1) are up to 2% brighter than those from the v201 product used for B7.3. We are in the process of verifying that this is correct.
  - Chris delivered a version of the GEOS met resampler for ACOS





Upcoming Events



Upcoming Events

Planned Date	Activity Description
Jan-Feb 2018	Extended Lunar Calibration campaign
13-20 Feb 2018	28 °C FPA & Optics Decontamination Cycle (8 days)
Mar/Apr 2018	Annual Inclination Adjust Maneuver (IAM) campaign
19-21 Mar 2018	OCO-2 Science Team meeting in Pasadena, CA, USA
8-10 May 2018	IWGGMS (International Workshop on Greenhouse Gas Measurements from Space) in Toronto, Canada
3-8 Jun 2018	AOGS (Asia Oceania Geosciences Society) in Honolulu, HI
11-15 Jun 2018	2018 NDACC-IRWG & TCCON Annual Meeting, Mexico City
26 Jun – 2 Jul	2018 Railroad Valley Campaign, Railroad Valley, NV, USA
14-22 Jul	42nd COSPAR Scientific Assembly, Pasadena, CA, USA