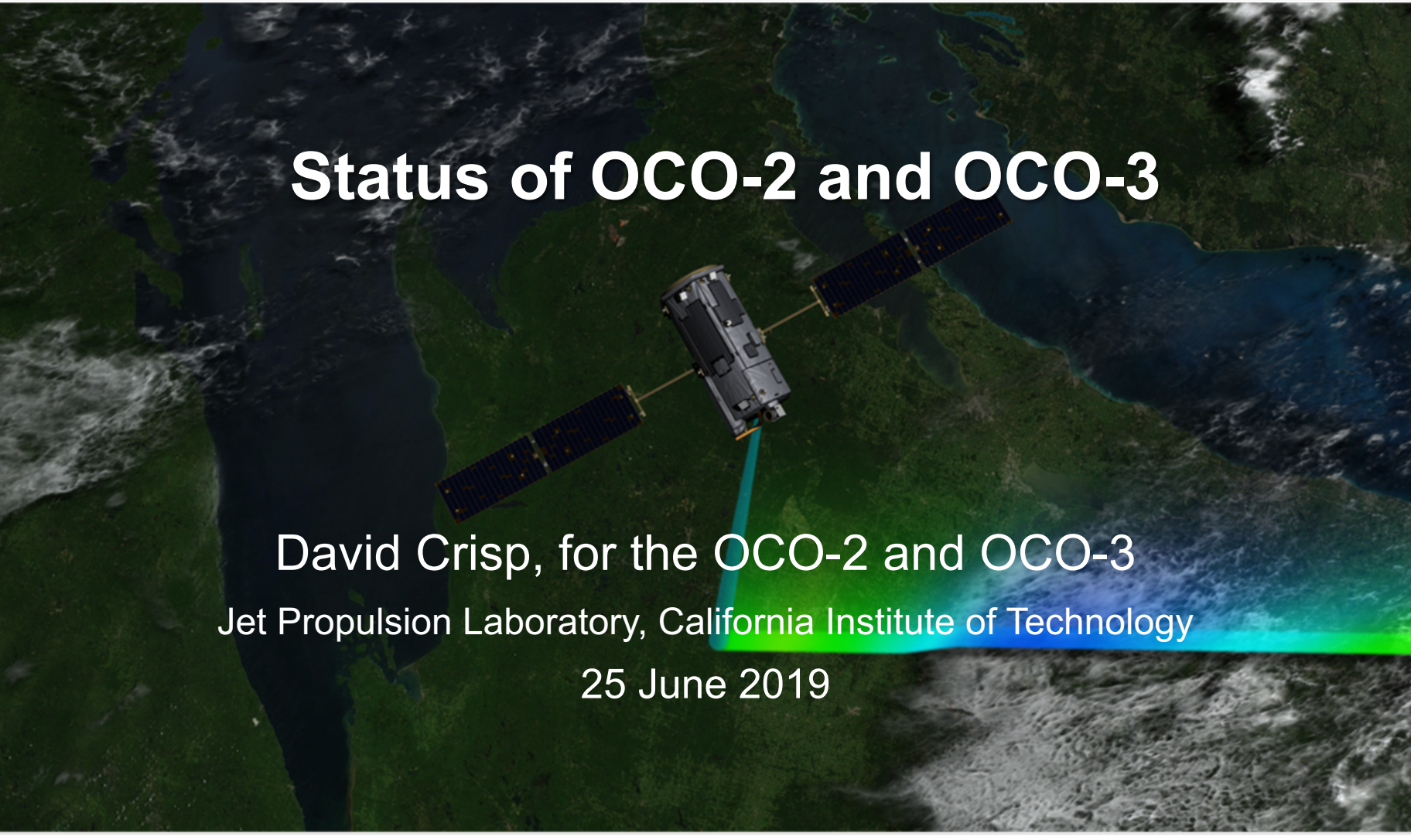


Status of OCO-2 and OCO-3

David Crisp, for the OCO-2 and OCO-3

Jet Propulsion Laboratory, California Institute of Technology

25 June 2019

Status Summary

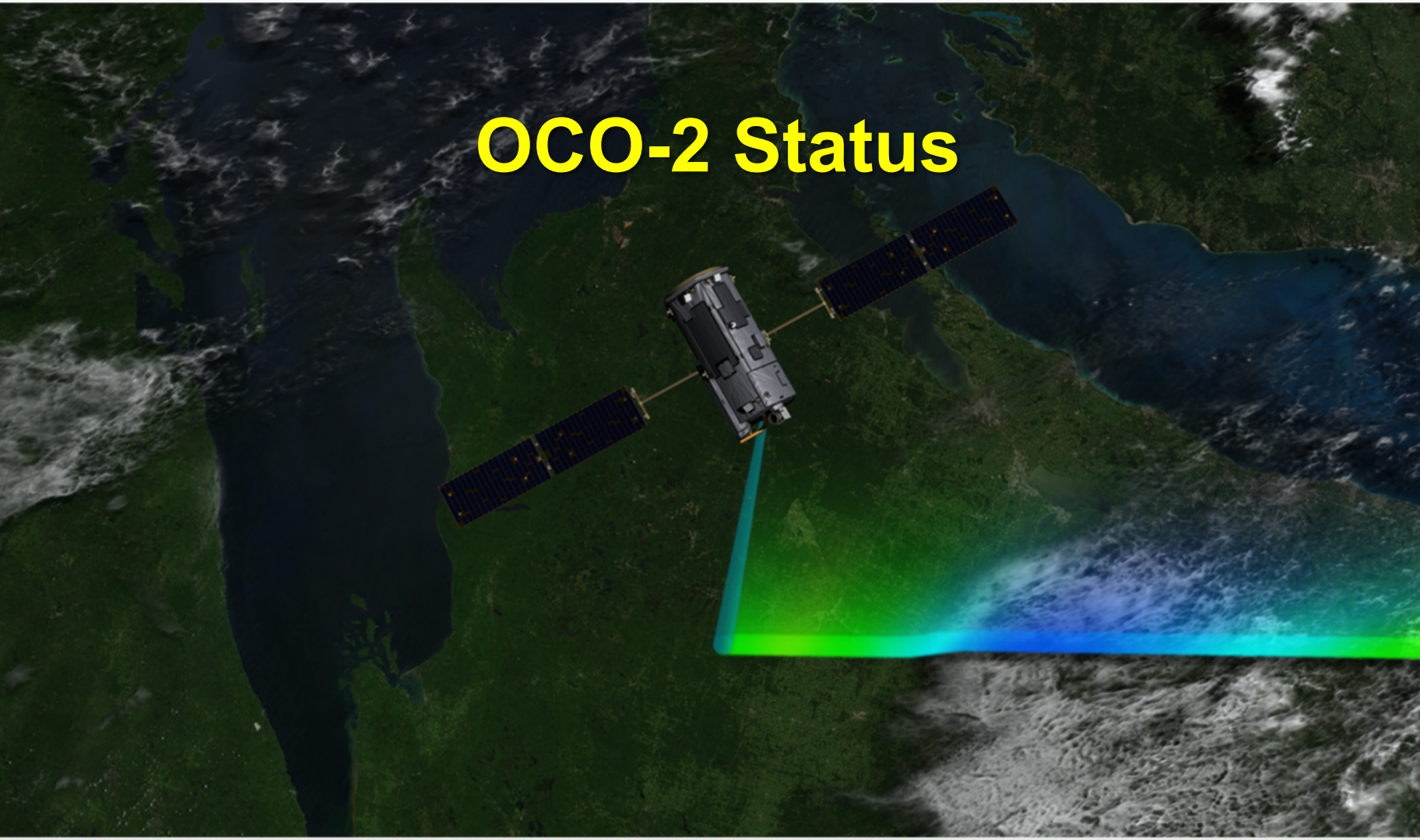
OCO-2 Status

- Observatory Status: Updating Flight Software
  - Software being patched to remove gyro from attitude control loop
- Instrument Status: Standby
  - Last Full Moon and Solar Doppler Calibration experiments performed
  - Observations suspended until patch is installed
- Science Status: Standby
  - ACOS/GOSAT version 9 – Production Run In Progress
  - "Build 10" testing ongoing

OCO-3 Status

- In-Orbit Checkout proceeding
- Cryocooler is ON and FPA cooldown is proceeding
- Next steps – FIRST LIGHT – tomorrow, Wednesday 26 June

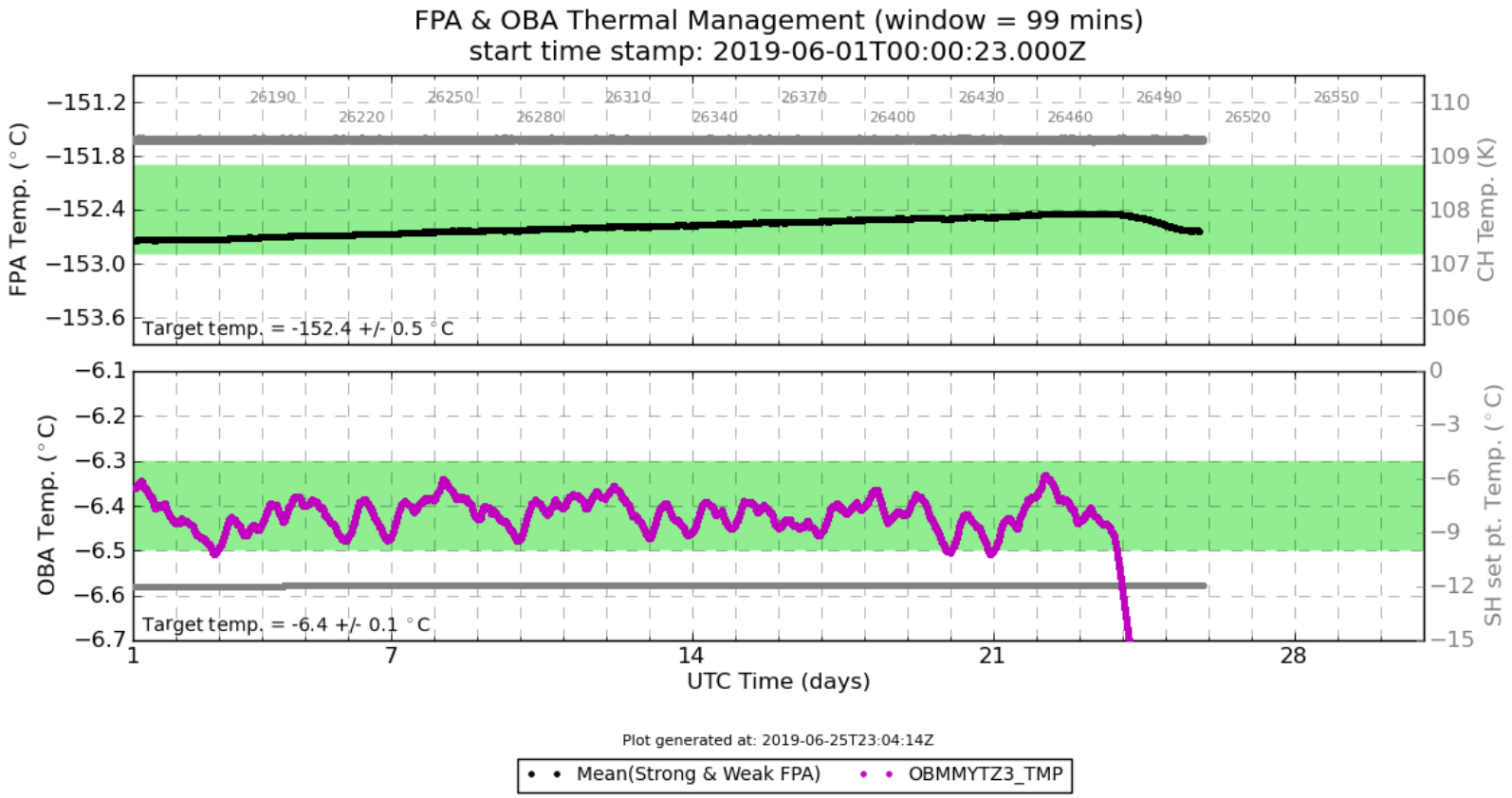
OCO-2 Status



Update on Inertial Measurement Unit Issue

- The z-axis gyro in the inertial measurement unit (IMU) that works with the star tracker has a the spacecraft attitude continuing to degrade
  - The Star Tracker is the primary pointing reference. The IMU is only needed when the Star Tracker is occulted by the Sun or Earth
- A flight software patch developed to remove IMU from control loop.
  - The patch has been uploaded on the spacecraft and is being tested
  - If all goes a planned, nominal science will resume late on Thursday 27 June
- Science impacts of IMU loss
  - Will not affect nominal science operations
  - Will preclude future Full Moon Lunar Calibration and Solar Doppler calibration operations due to obscuration of star tracker field of view by the disk of the Earth – neither loss will compromised routine calibration
- Star tracker occultations by the Earth also complicate scheduling of:
  - The second downlink each day to the Alaska Satellite Facility
  - Observations of high latitude TCCON stations (Sodankyla, Fairbanks, and East Trout Lake) may have to be truncated

Instrument Status - Standby

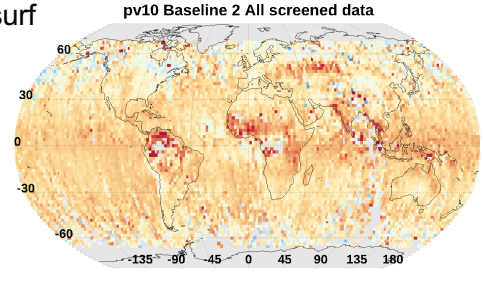


The Optical Bench Assembly (OBA) temperatures fell somewhat while in standby. Hopefully, the instrument will be back on line with stable temperatures in time to participate in next week's annual Railroad Valley campaign.

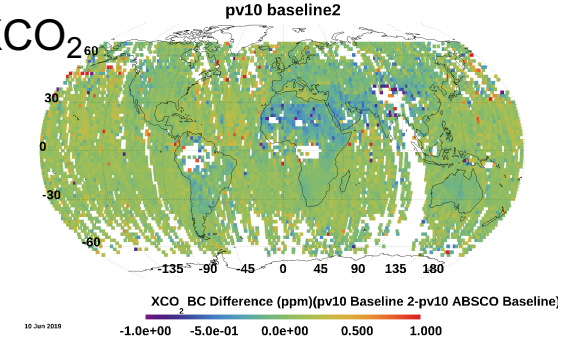
B10 Testing – An Updated Baseline

- Tests of a new B10-new-absco-baseline (baseline2) are complete
  - ABSCO 5.1
  - v41 ARP based L1b (additional calibration updates in progress)
  - TSIS solar continuum
  - Aerosol priors from time resolved GEOS FP-IT with a 0.5 sigma prior covariance

δP_{surf}

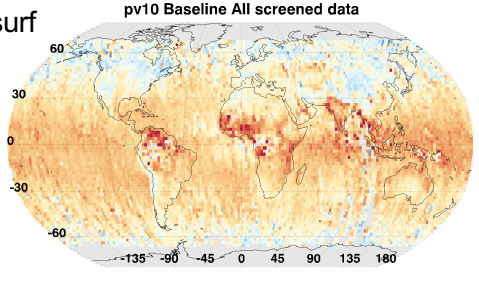


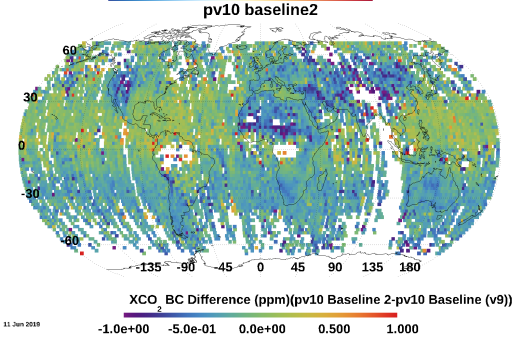
δXCO_2



Differences w.r.t. 5.1 Baseline

δP_{surf}





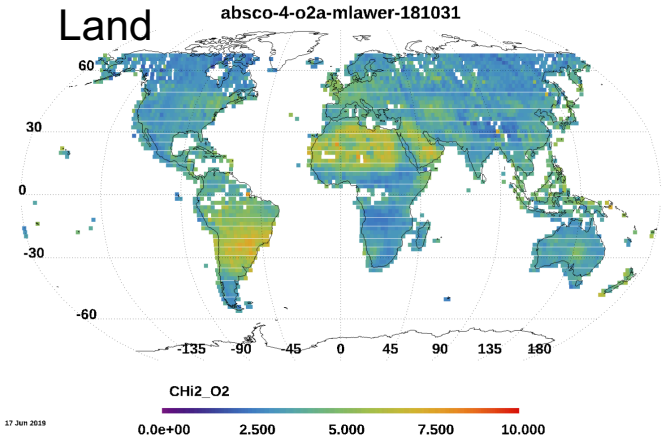
Differences w.r.t. v9

In general, baseline2 is only slightly different than the original baseline (which incorporated only ABSCO 5.1).

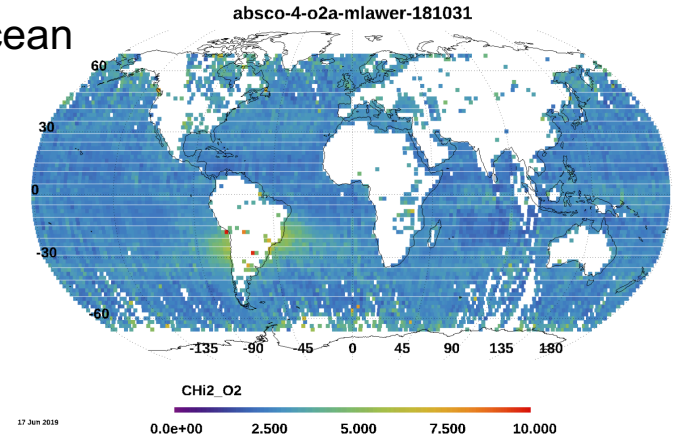
It does slightly increase the differences between v9 and v10 in some areas (central Africa, South America).

Improvements in χ^2 in ABO2 from EOFs

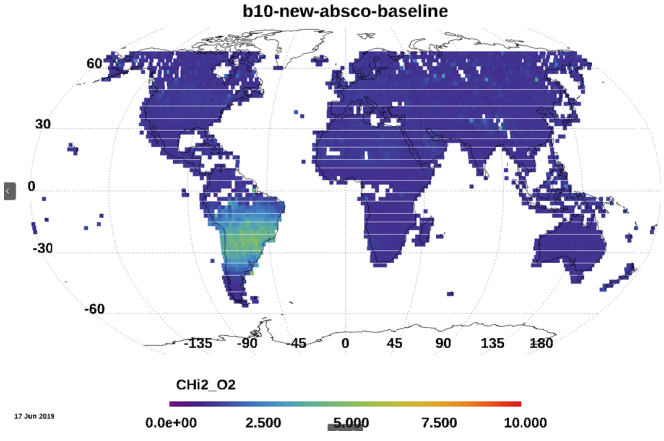
Land

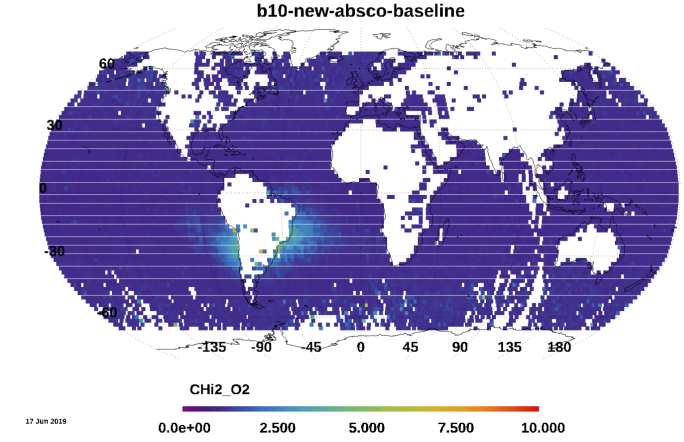


Ocean



No EOF





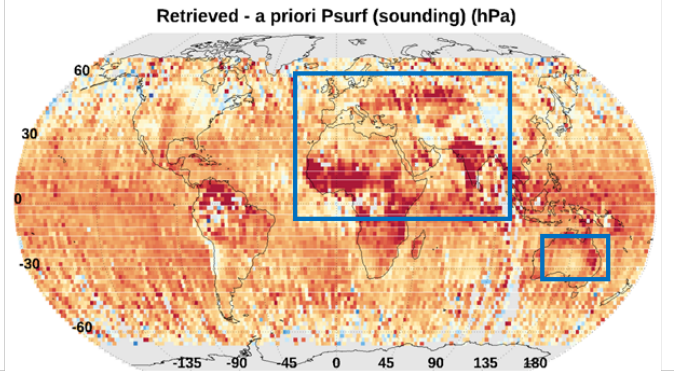
With EOFs

Updated EOF's substantially improve the ABO2 χ^2 in the new baseline.

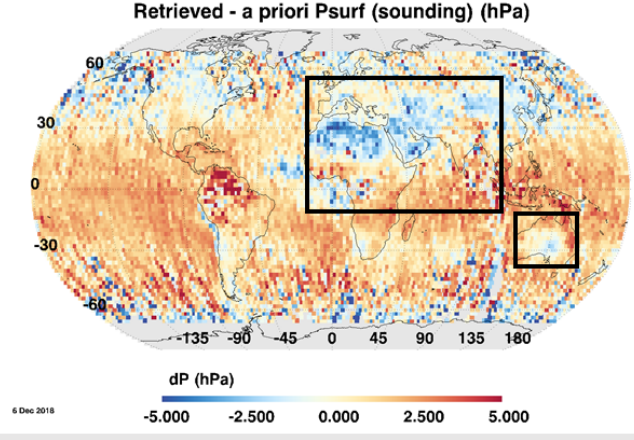
Impact of EOFs on New Baseline

EOFs reduce pole-to-equator and dry region surface pressure bias but introduce a high bias over land

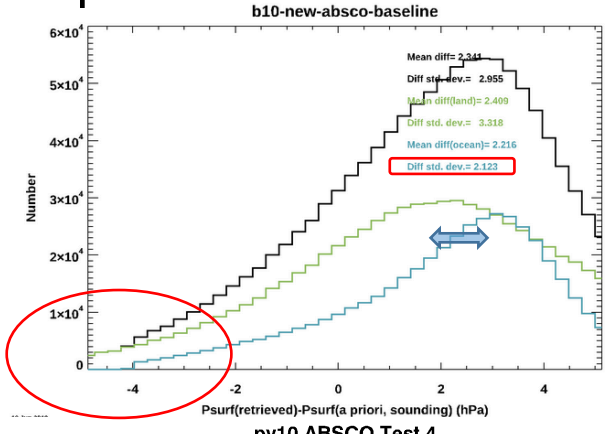
With EOF

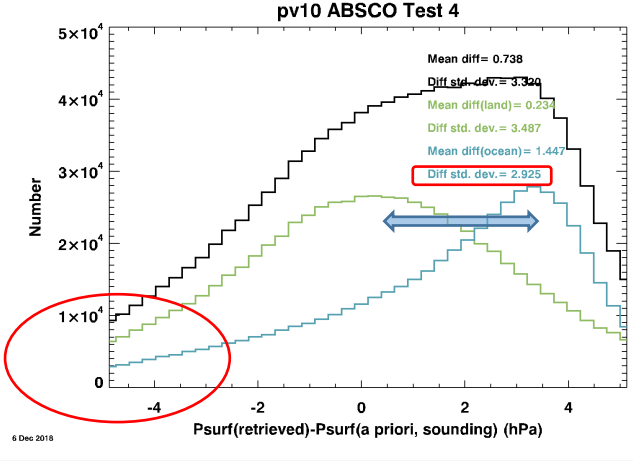


Without EOF



EOFs also reduce land-ocean bias and amplitude of low-pressure tail.





Preliminary Bias Correction Results

(from Chris O'Dell)

- B10 baseline2 has smaller XCO_2 Errors (vs TCCON & Models) than B9 (not matched soundings, hence the word "appear").
  - Should be able to improve further by adjusting filtering & BC.

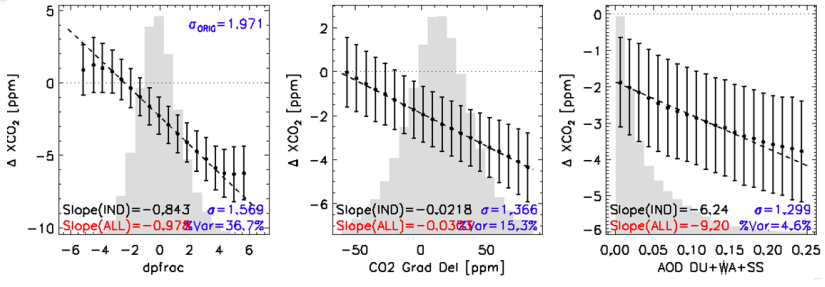
vs TCCON

	Ntot	% Pass	Sigma(single)	Sigma(averaged)
B9 LandNG	1154K	54.7%	1.31 ppm	1.21 ppm
Baseline2 LandNG	481K	62.6%	1.21 ppm	1.08 ppm
B9 OceanG	598k	60.2%	0.98 ppm	0.93 ppm
Baseline2 OceanG	179k	68.4%	0.82 ppm	0.77 ppm

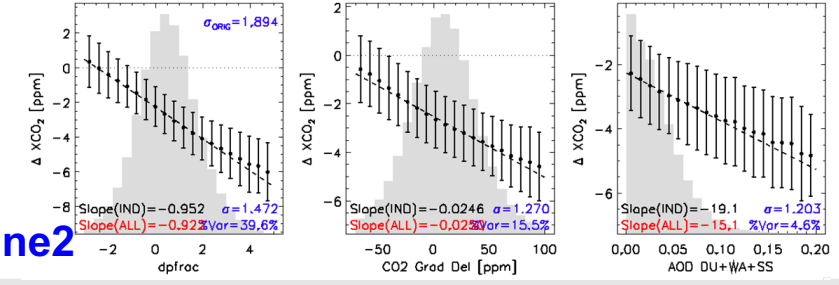
vs Models

	Ntot	% Pass	Sigma(single)	Sigma(averaged)
B9 LandNG	1984K	48.2%	1.19 ppm	0.93 ppm
Baseline2 LandNG	1064K	55.0%	1.16 ppm	0.93 ppm
B9 OceanG	4967k	54.2%	0.86 ppm	0.75 ppm
Baseline2 OceanG	627k	56.1%	0.78 ppm	0.65 ppm

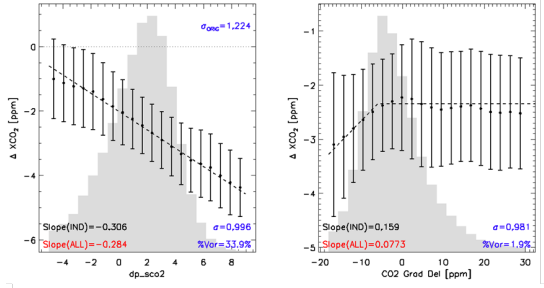
B9



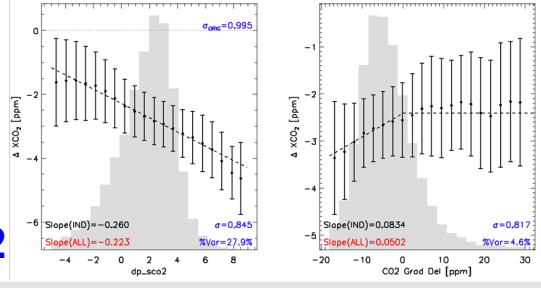
B10 Baseline2



B9

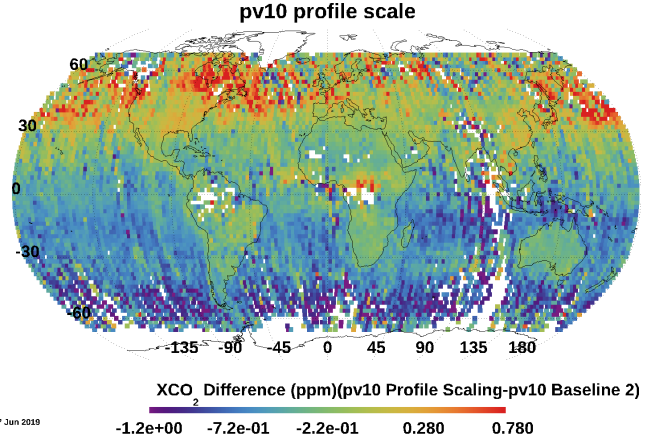


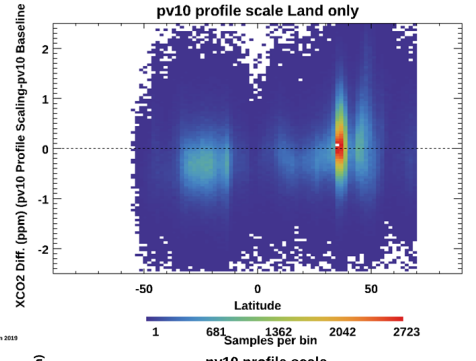
B10 Baseline2

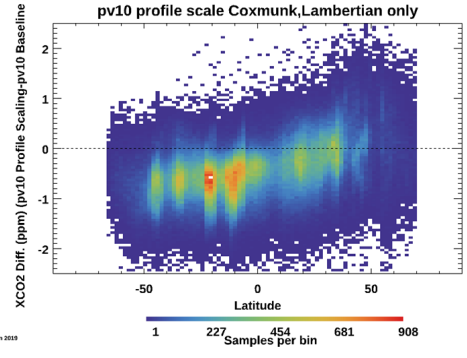


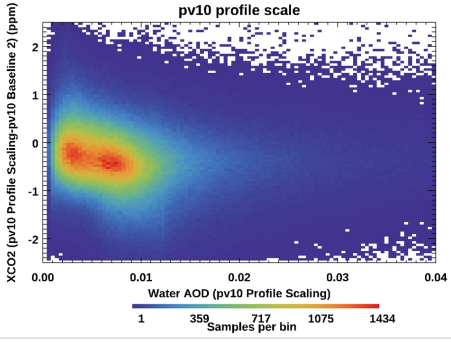
B10 CO_2 Profile Scaling Retrievals

- Here, the prior CO_2 profile is multiplied by a scalar (as for TCCON).
- Produces a systematic south-north gradient in XCO_2 relative to pv10 Baseline 2

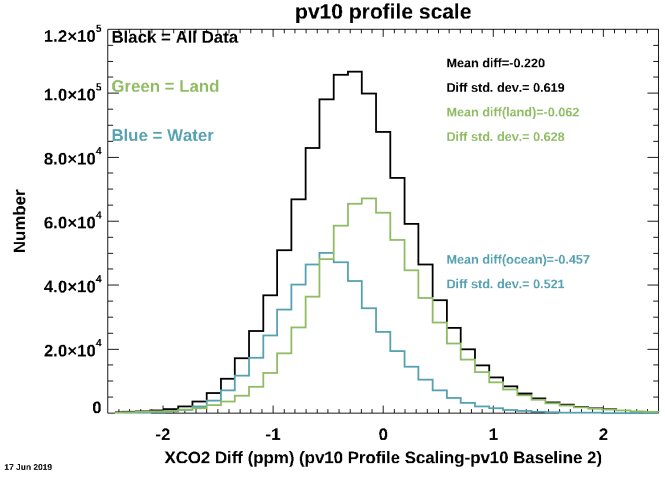






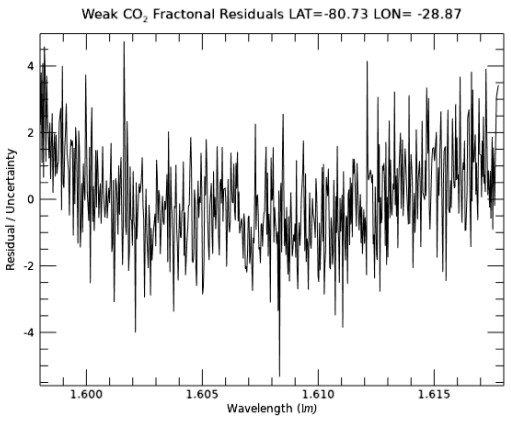


Hemispheric gradients in XCO_2 larger over ocean (above)
There is also a small change in liquid water AOD (left)



Upcoming B10 Tests

- Tighter Psurf prior constraint
  - The surface pressure a priori constraint will be tightened to determine whether this can reduce Psurf-related biases
- Quadratic albedo dependence
  - Retrievals over snow and ice covered surfaces exhibit significant curvature in their residuals in the weak CO2 band
  - Current algorithm assumes albedo varies linearly across band
- Individual band radiance offsets
  - SRON researchers have found that adding a band-dependent offset reduces XCO2 biases
- Updated SIF prior
  - Current prior too simple/inaccurate
- Updated TCCON XCO2 Prior.
  - Exploit recent updates



WCO2 residuals over Antarctica and other snow/ice covered regions show strong curvature

Publications Statistics

- 2014: OCO-2: 7 refereed papers, 1 book chapter
- 2015: OCO-2: 8 refereed papers
- 2015: ACOS: 3 refereed papers, 1 book chapter
- 2016: OCO-2: 18 refereed papers
- 2016: ACOS: 12 refereed papers
- 2017: OCO-2: 48 refereed papers
- 2017: ACOS: 2 refereed papers
- 2018: OCO-2: 37 refereed papers
- 2018: ACOS: 5 refereed papers
- 2019: OCO-2: 14 refereed papers
- 2019: ACOS: 1 refereed paper

Blue text indicates items that have been updated since the last report on 16-April-2019
Source: http://www.isiknowledge.com (key word: OCO-2 OR Orbiting Carbon Observatory-2 OR Atmospheric CO2 Observations from Space OR ACOS)

Publish!

- The OCO-2 publication record is lagging
- The anomalously low publication rate makes it hard very for Ken or I to advocate for new OCO-2 R&A funding
- It also compromises our ability to compete for funds to extend the OCO-2 and OCO-3 missions

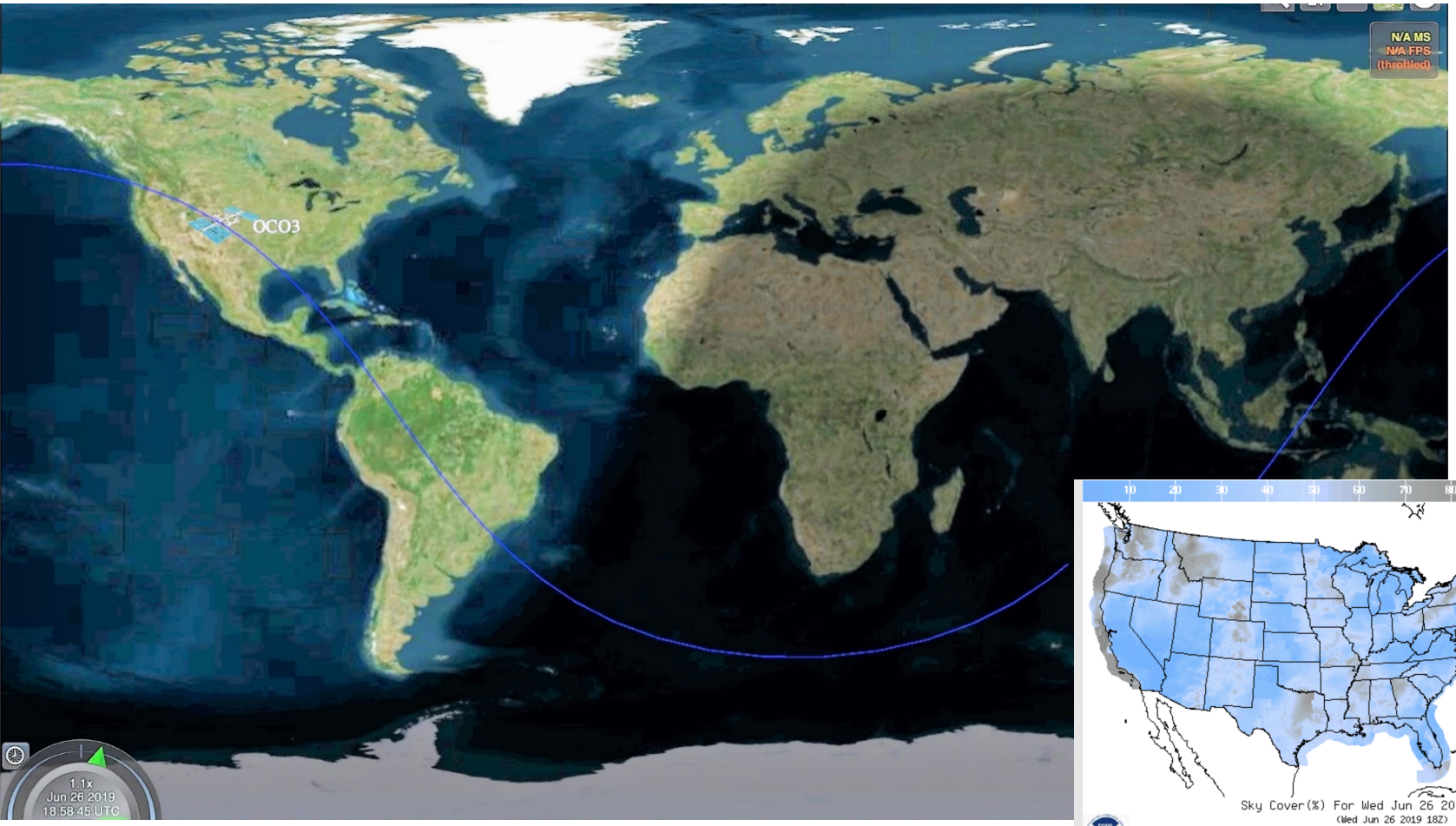
- Drop whatever you are doing and start writing it up!


OCO-3 Status

OCO-3 Status and Near Term Plans

- Pointing Mechanism Assembly (PMA) calibration is ongoing
  - Functionality verified last week
    - Exposure times on the context cameras being adjusted
  - PMA Calibration starts tomorrow and will proceed through the next two weeks
- FPA Cooldown Initiated on Tuesday, 25 June
- First light expected to occur Wednesday, June 26
- Calibration commences immediately after first light
  - PMA calibration with flight instrument field of view
  - Radiometric and spectroscopic calibration commences
- Science checkout commences in parallel with calibration activities
  - Evaluating the observing strategy, software and sequence planning process
- IOC expected to be complete around August 7th
- Post Launch Assessment Review (PLAR) tentatively set to August 9th

OCO-3 First Light Orbit Path # 1



Daytime path crosses the Americas.

Predicted Sky Cover

2019 Railroad Valley Campaign

- **OCO-2:** If all goes as planned for the OCO-2 flight software patch, we have two opportunities to observe RRV:
  - July 3, 20:53:52 UTC (1:53:52 pm local time)
  - July 5, 20:41:37.5 UTC (1:41:37.5 pm local time)
- **OCO-3:** Based on the most recent ISS ephemeris that I have seen (now about 1 week out of date), we have three possible overpasses:
  - July 2nd, 9:29am local time overpass (17:29 UTC)
    - 82 km from orbit track to RRV, SZA = 35.8 degrees
  - There are two other opportunities at higher solar zenith angles (SZA):
  - July 5th, 8:28am local time overpass
    - 160km from orbit track to RRV, SZA = 47.4 degrees
  - July 6th, 7:53am local time overpass
    - 176km from orbit track to RRV, SZA = 54.8 degrees
  - We may target all 3, but we will review the plan as we proceed through the IOC.

Key Near Term Activities

Planned Date	Activity Description
24-28 Jun	OCO-2 No-Gyro Patch Upload and Test
26 Jun	OCO-3 First Light
30 Jun-5 Jul	2019 RRV Campaign
9 August	OCO-3 Post Launch Assessment Review (PLAR)
26-29 Aug	Chapman Conference: Carbon-Climate Feedbacks, San Diego
10 Nov	OCO-3 L1b Product Delivered
9-13 Dec	2019 Fall AGU Meeting, San Francisco