Multiple Lines of Evidence for Bias in the OCO-2 Weak CO_2 Channel (1598-1618 nm)

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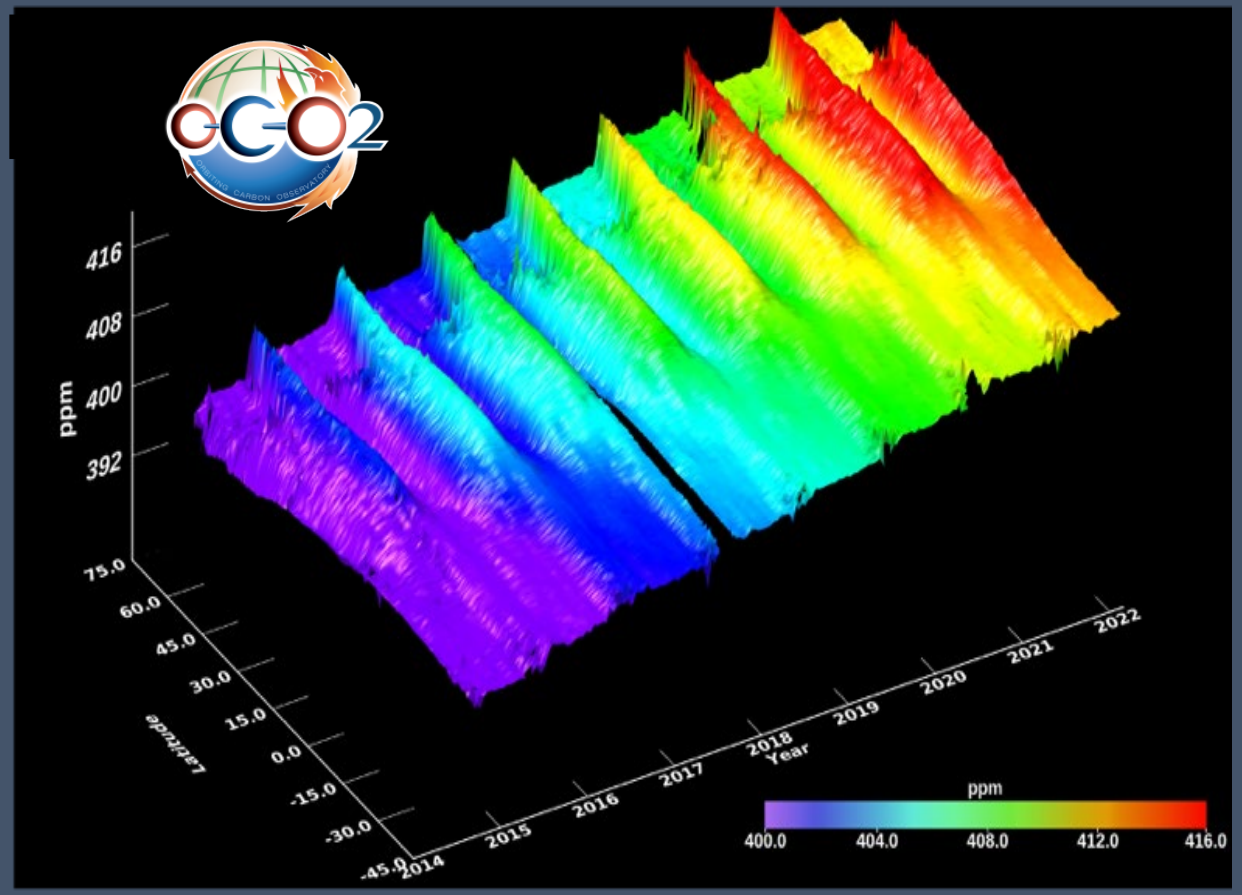
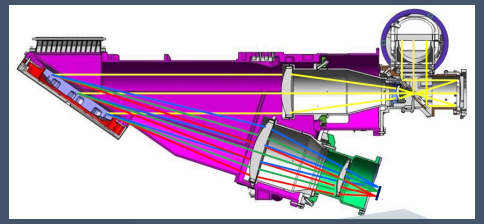
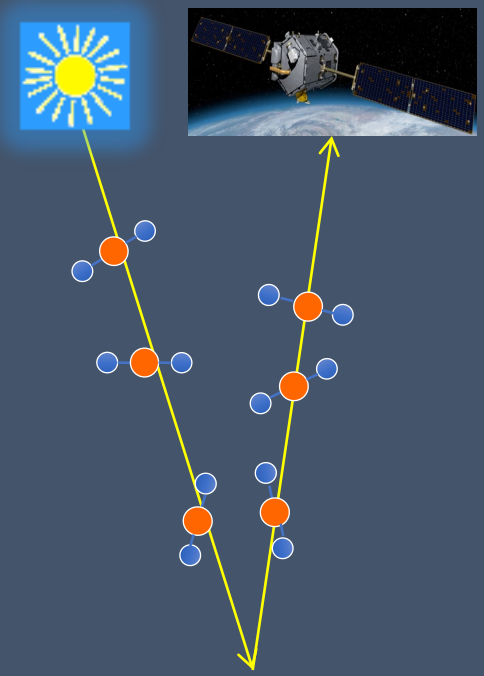
33rd CALCON Technical Meeting
Post-Launch Performance Session
Tuesday June 11, 2024, 3:30-3:50 PM MDT

Introduction: “Watching the Earth Breathe”

- Orbiting Carbon Observatory 2 measures O_2 and CO_2 from low Earth orbit using a 3-channel imaging grating spectrometer with a common telescope
- Science requires retrieved column-average dry air CO_2 mole fraction to have precision better than 1 ppm, < 0.25 % of background







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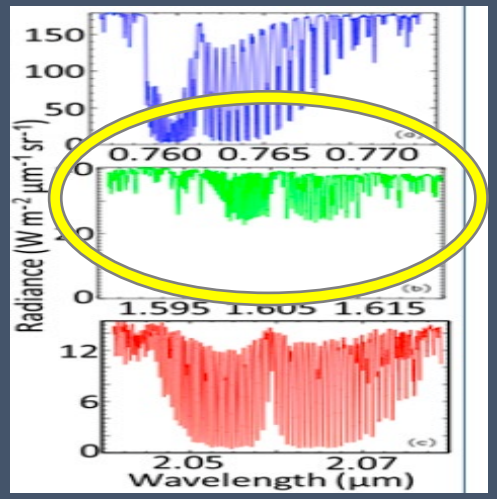
Outline: Weak CO_2 may be 5 % too bright

- Ruled Out:
  - Relative inflight radiometric calibration using lamp, Sun, and Moon
- Independent Line of Evidence # 1:
  - Vicarious calibration at Railroad Valley, NV
  - 44 good targets Jul 2015– May 2024
- Independent Line of Evidence # 2:
  - Simultaneous nadir overpasses with OCO-3
  - Active Aug 2019 to Nov 2023, stored now, Jul 2024 reinstall
- Independent* Line of Evidence # 3: (magnitude motivated by 1 & 2)
  - Cloud microphysical property retrievals
- Limited Information:
  - Preflight calibration (doi.org/10.1109/TGRS.2016.2634023) & link to early mission



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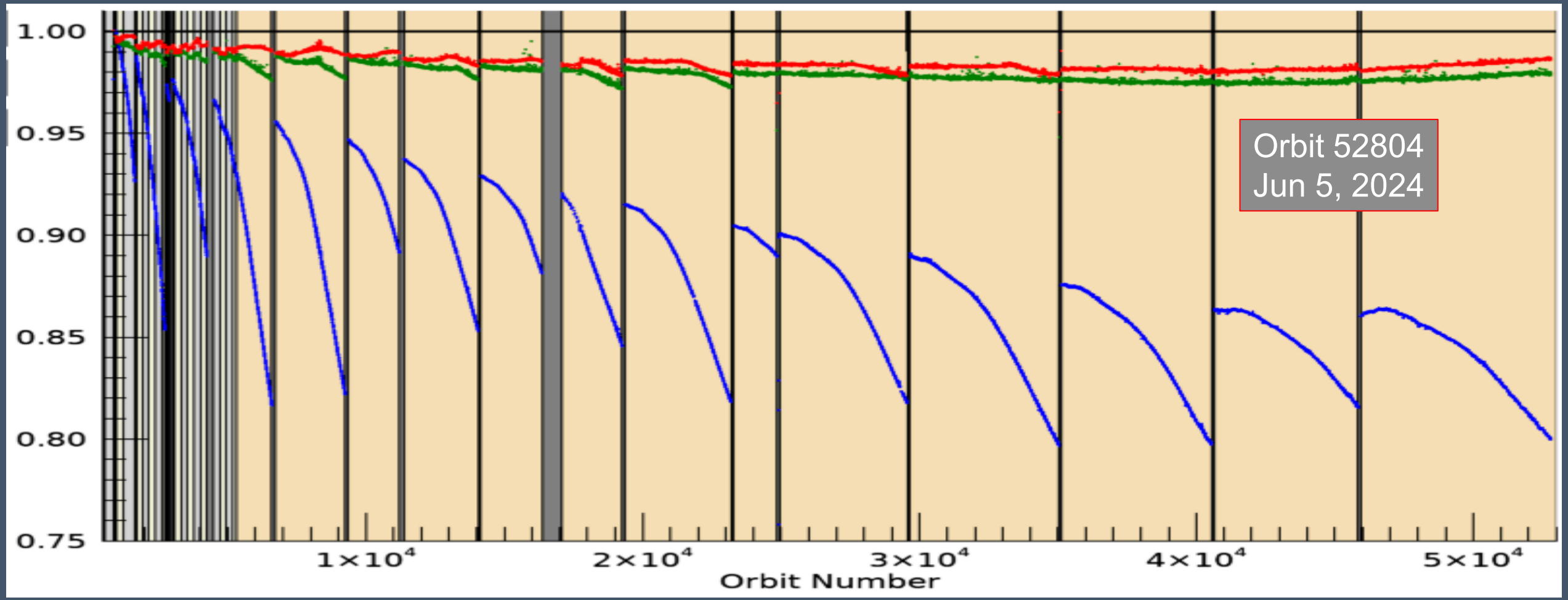
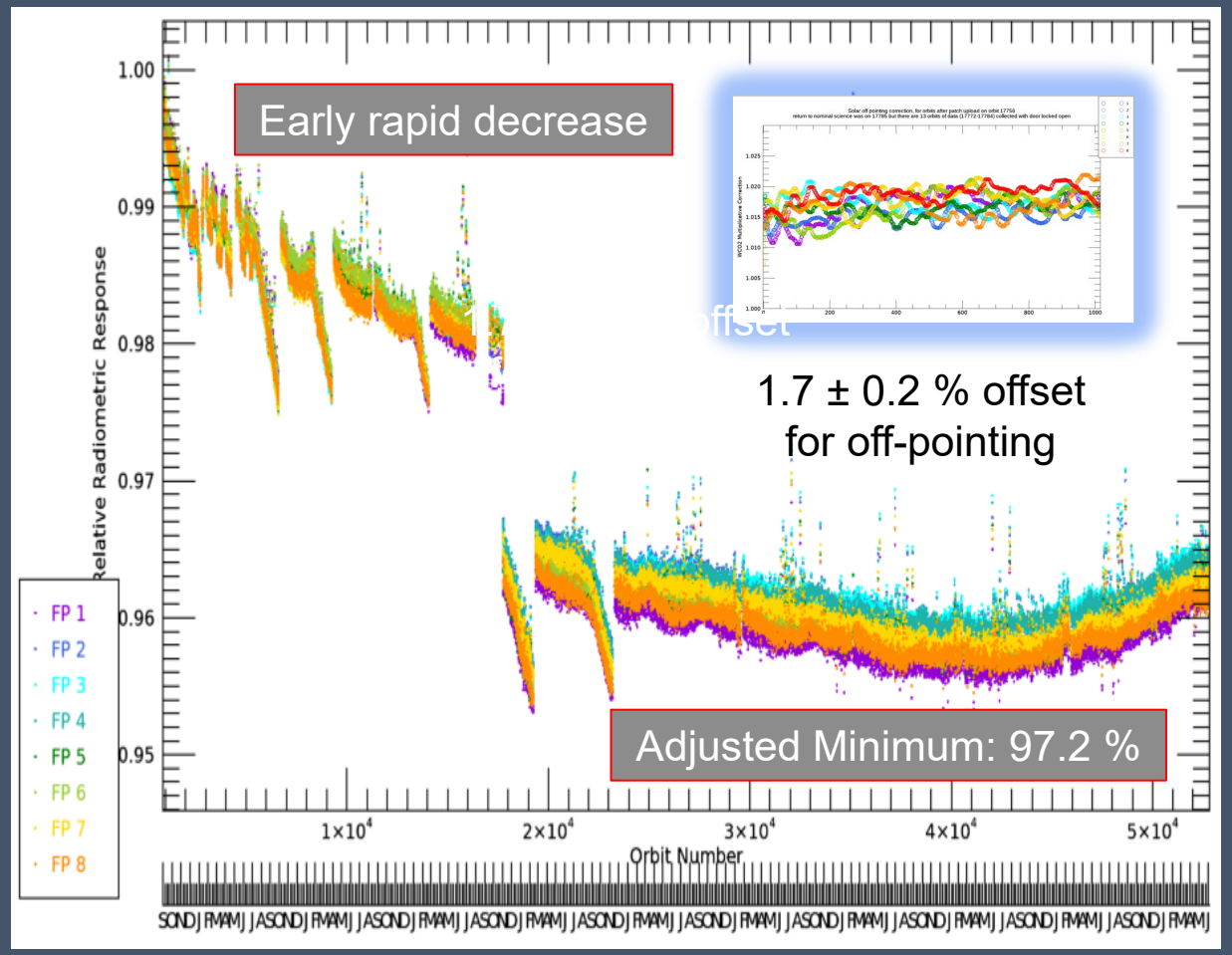
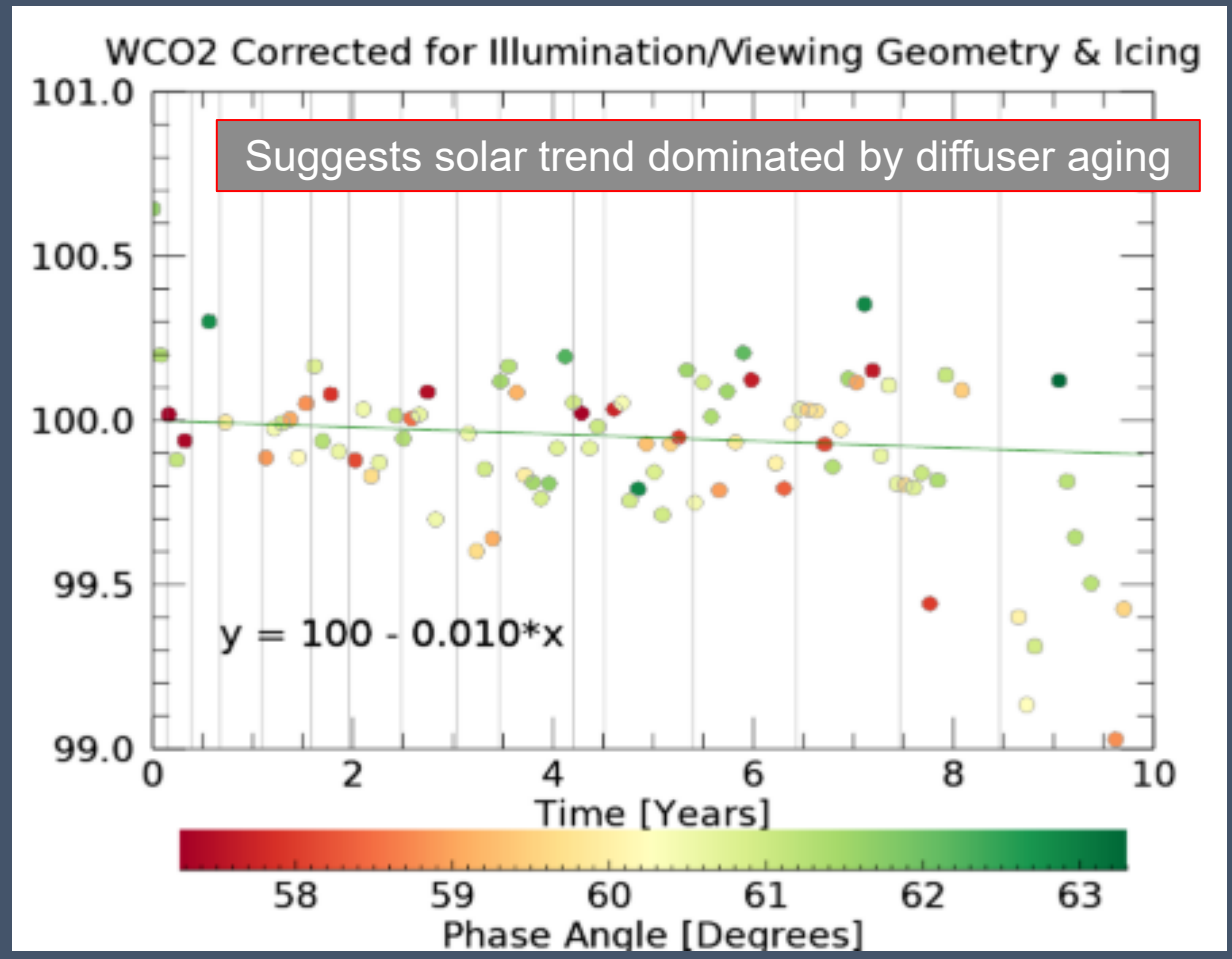
Relative Solar Trend, All Channels



WCO2 trend since Aug 2014 very stable

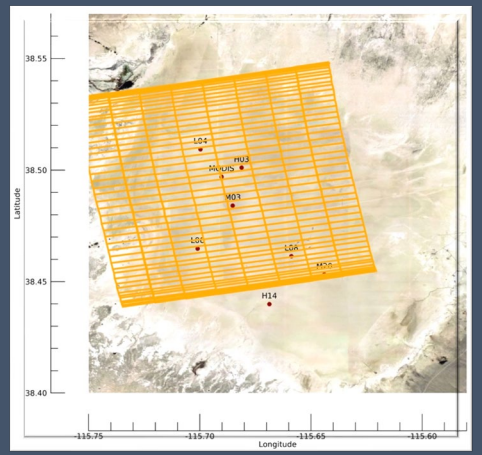




V. Adumitroaie

Railroad Valley, NV Vicarious Calibration

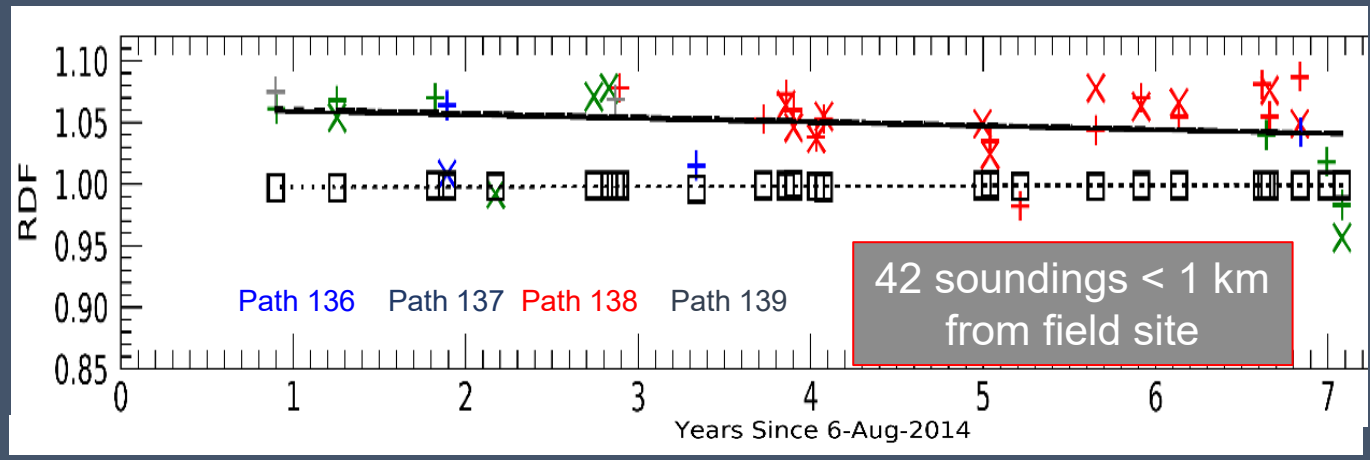
- Version 10 data up to 9/03/21 shared here 9/12/22
- Version 11 reprocessing in progress, better performance over a range of view zenith angles, similar magnitudes so far
- Field campaign with MISR and GOSAT teams starts tomorrow!



Intercept
106.5 ± 1.1 %

Slope
-0.33 ± 0.24 % / yr

Residual
3.5 % rms



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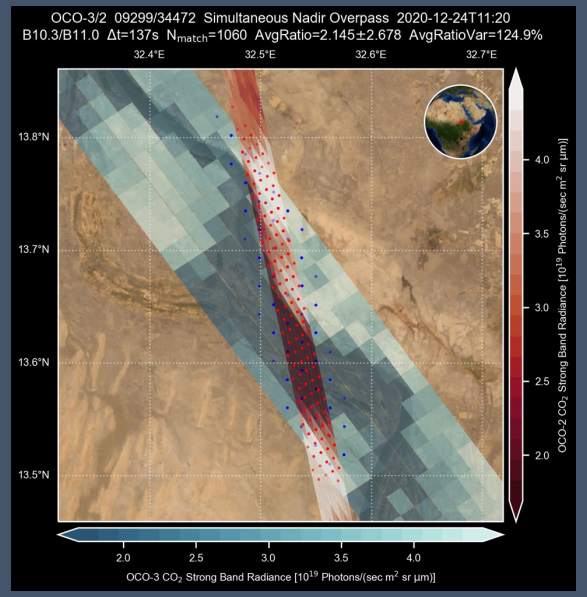
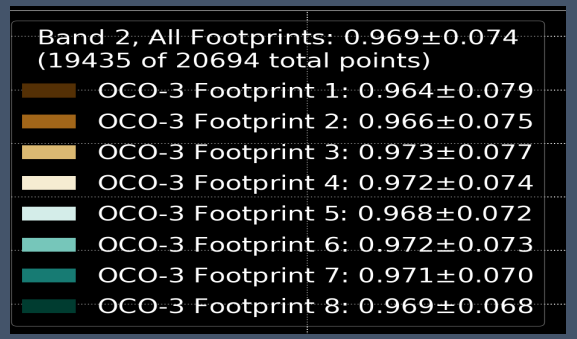
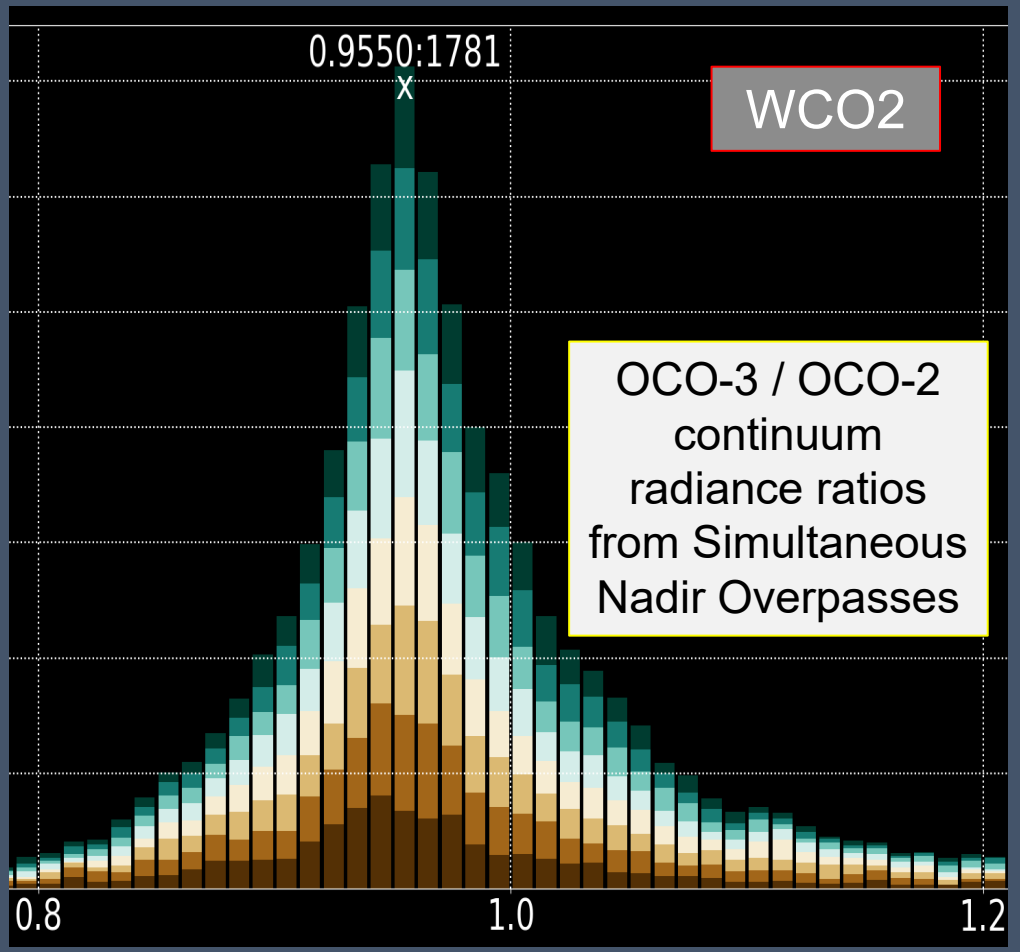
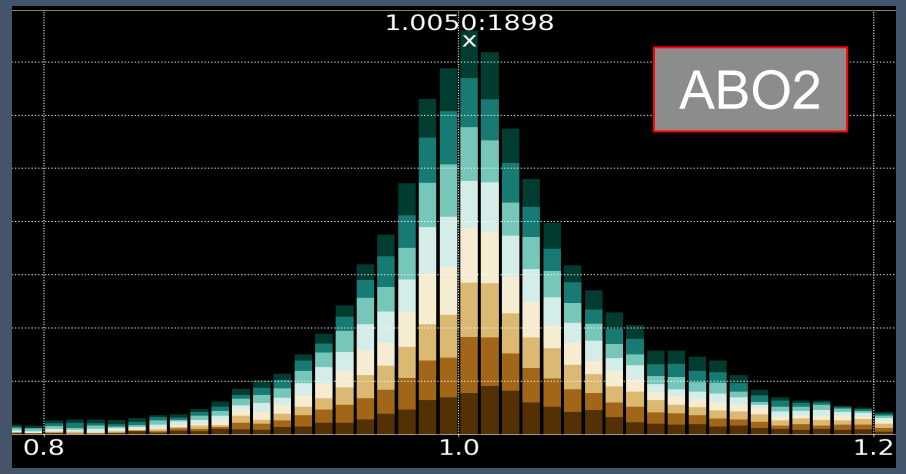
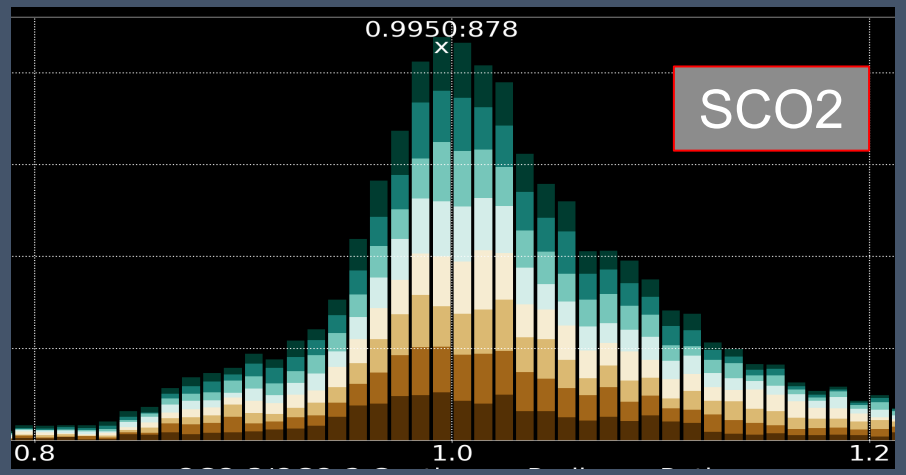
OCO-3 SNO Histograms (2 km, 600 s)











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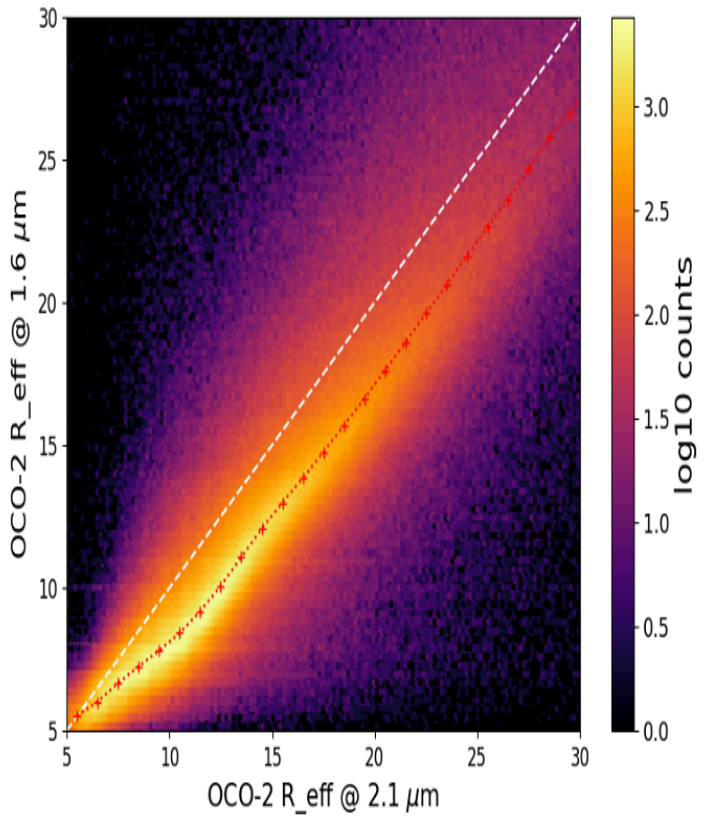
Cloud Retrievals: R_{eff} vs. λ

Past Results

- Bias in OCO-2 LUT retrieval intercomparison
- More clearly shows the relative bias
- The comparison to MODIS suggests the O2A-SCO2 results are more accurate, and the WCO2 results are biased

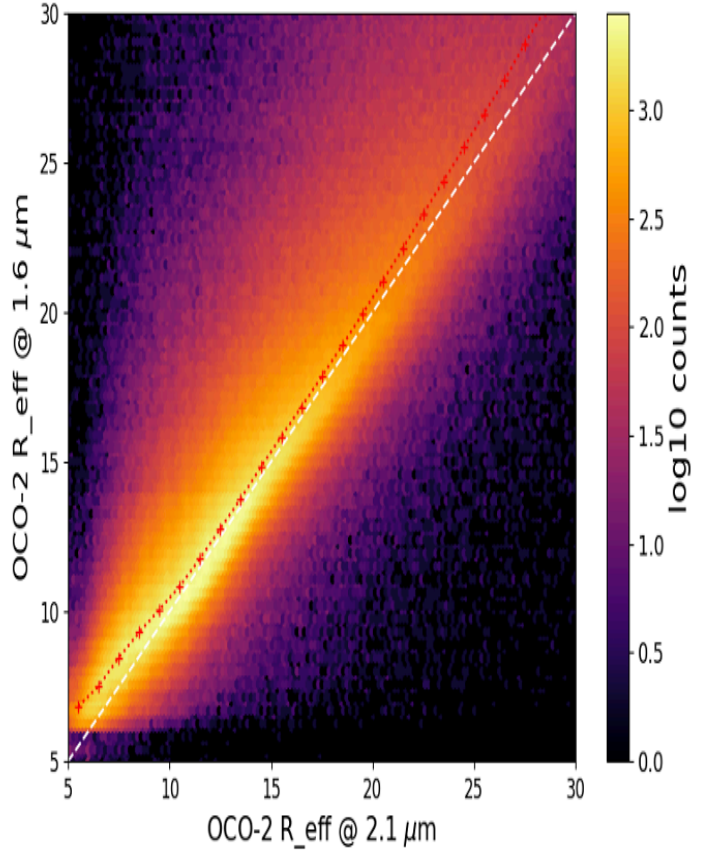


N. Miller, J. Rausch, R. Bennartz

Cal-Alg Collaboration!

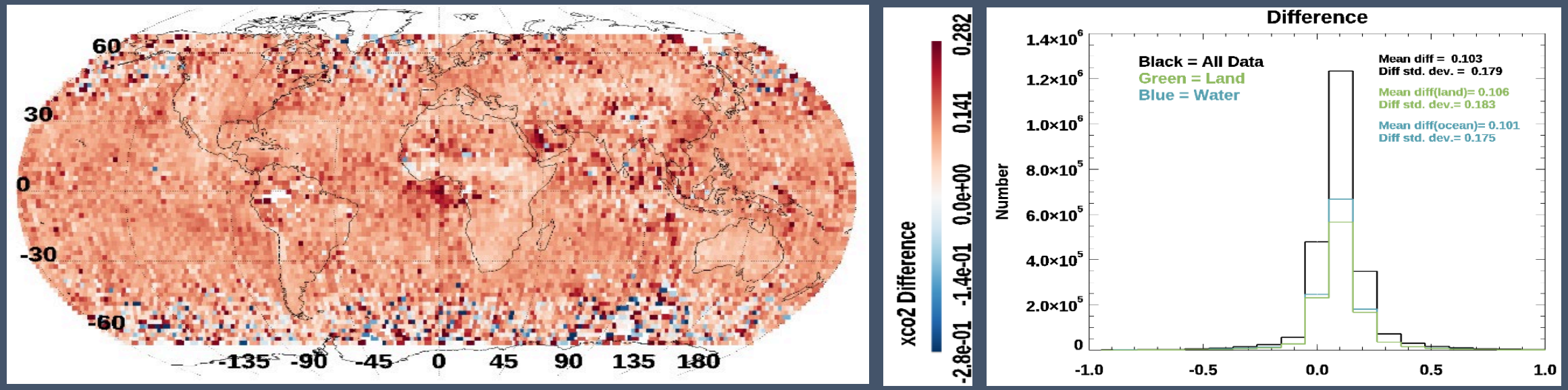
New Results

- Motivated by:
  - OCO-2/3 SNOs (T. Kurosu)
  - RRV results (Dejian Fu)
  - Together suggesting OCO-2 radiance is about 5% too high
- Scale all L1B WCO2 radiance by x 0.95, then rerun the LUT retrievals
- Now, the WCO2 & SCO2 retrievals are well matched



Minor Impact at Level 2: 0.1 ± 0.18 ppm

- Retrieval is somewhat insensitive to spectrally flat scaling that does not change the relative depth of absorption features
- Information from 3 bands is used to constrain aerosols



Conclusion

- “Once is Happenstance, Twice is Coincidence, the Third Time is Enemy Action”
  - *Goldfinger* by I. Fleming
- Preflight radiometry claimed 3.2 % precision (k = 2) but still could have had bias
- Worth return to preflight & early mission lamps?
- V12 internal delivery of new calibration: soon
- V12 public release of science results: not soon