OCO-2 Status, September 19, 2017

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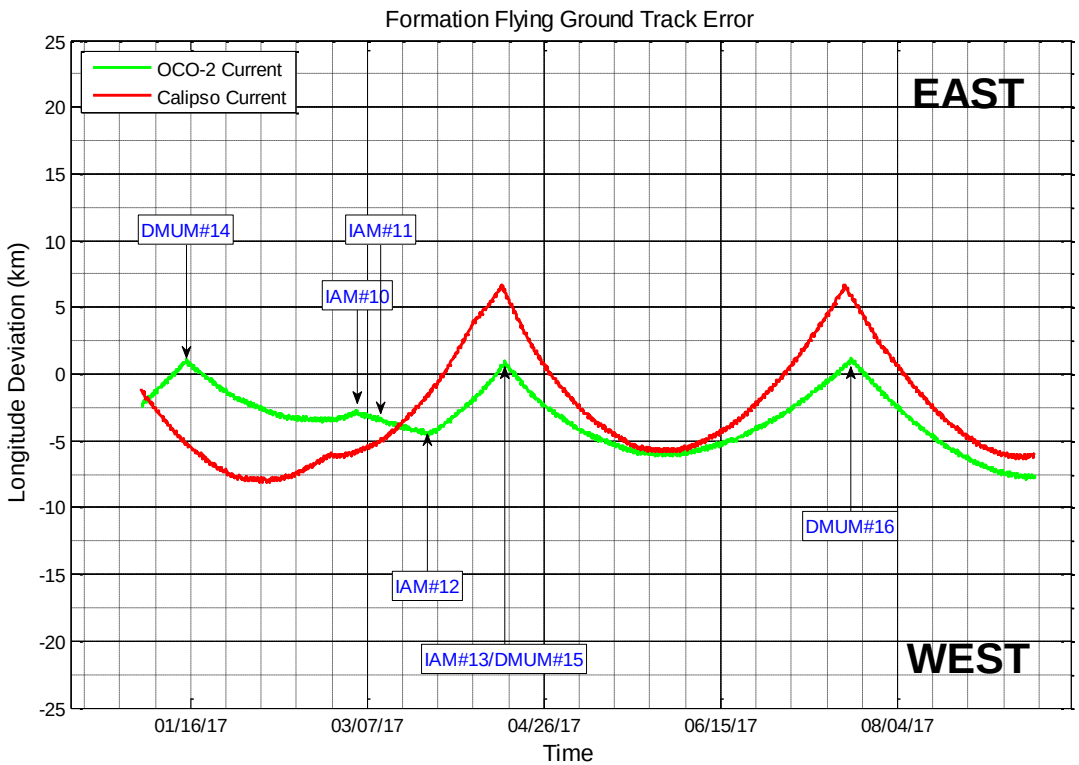
Overview

- Observatory Status: Nominal
- Instrument Status: Collecting "Opportunistic Science" data
  - Recovery from the July 30 instrument reset was suspended to address an anomaly with the baffle calibration position sensor
  - A near-term solution that allows the collection of "Opportunistic Science observations" 5 days of each week has been developed while flight software changes are implemented
  - Opportunistic Science observations were initiated SUNDAY 9/17
    - First Lamp/Dark Orbit: 17085. First Science Orbit: 17114
- V8 production is proceeding
  - Level 2 B8r production continues to go smoothly
  - Data filtering and bias correction efforts for v8a Lite files finalized
- V8a filtering and bias correction approach (O'Dell et al.)

OCO-2 Ground Track



The OCO-2 Navigation Team continues to maintain the orbit track to ensure overlap between the OCO-2 nadir observations and the CALIPSO and CloudSat ground tracks.

TanSat passed ~8 km below OCO-2 on 9/7/2017

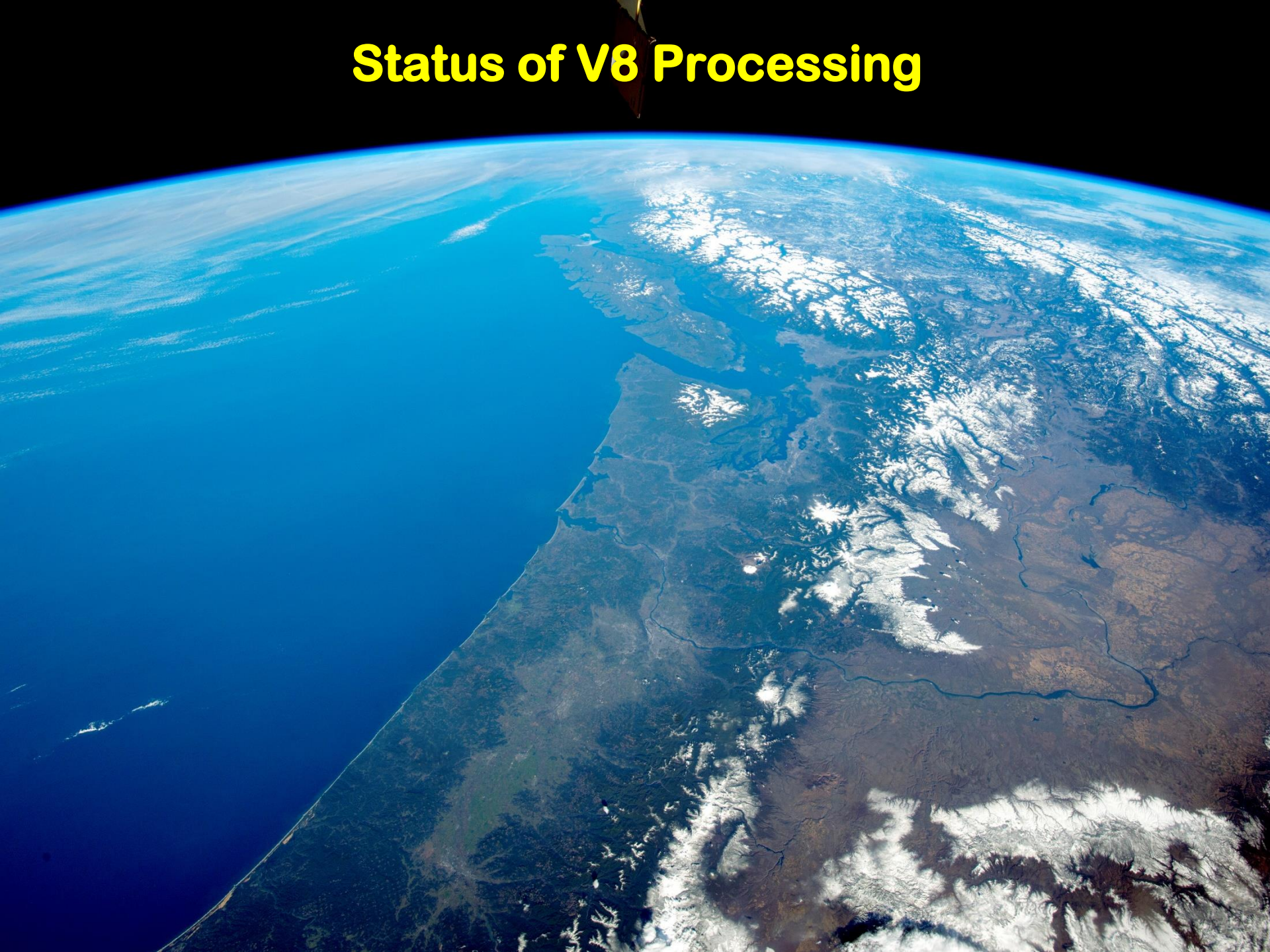
- TanSat mean semi-major axis still above that of OCO-2, but TanSat orbit is more essentric

We continue to monitor the status of CALIPSO and CloudSat, both of which have encountered age-related issues.

Instrument Status – Opportunistic Science

- The instrument controller was reset on July 30 to reload a corrupted memory location
  - The reset restored the corrupted memory, but the instrument reported that the potentiometer monitoring the calibration door position indicated that the door was in the wrong position
    - An investigation indicated that the potentiometer was failing
  - Flight software changes are needed to implement an alternate method for determining the door position and ensuring that we do not point at the sun without the diffuser in place
  - Flight software changes will take ~2.5 weeks to implement and test
- While this flight software changes are being implemented, a "human in the loop" approach was developed to safely collect a limited amount of "Opportunistic" science and calibration data
  - This "Opportunistic Science" mode will collect Science data for 5 days out each week and calibration data on the other 2 days
  - Opportunistic Science observations were (re)initiated on 9/17

Status of V8 Processing



V8 data product development

- V8r processing is ongoing!
  - Using OCO-2 cluster, NASA supercomputer, and Amazon cluster
  - Processing Status as of 9/19 shown below

L1bSc (ND, GL, TG, XS) Production

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	x	x	x	x	x	x	x	x				
2015												
2016												
2017							x	x	x	x	x	x

L2Std Production

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	x	x	x	x	x	x	x	x				
2015												
2016												
2017							x	x	x	x	x	x

Color Legend:

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>50% complete	100% complete

Remaining steps:

- Complete Documentation
- Generate Lite Files
- Deliver to GES-DISC

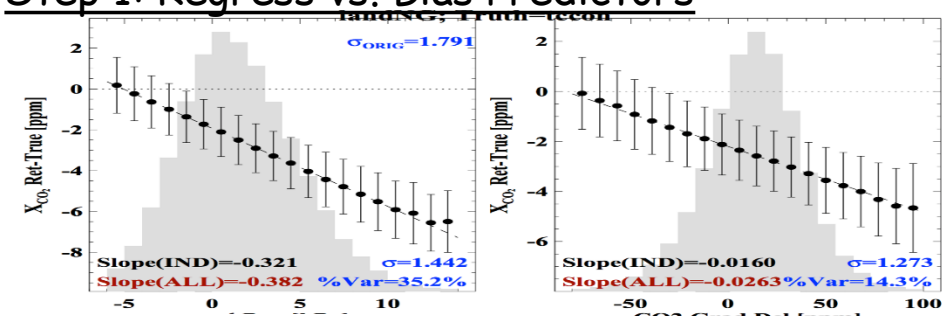
Status as of September 19, 2017

V8 Bias Correction Approach
Chris O'Dell

Bias Correction Methodology

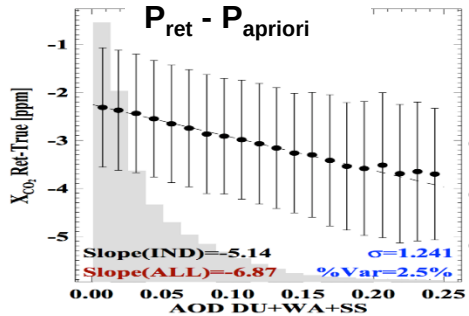
$$X_{CO2}^{BC} = \frac{X_{CO2}^{Raw} - c_1 P_1 - c_2 P_2 - \cdots - FPbias}{global_offset}$$

Step 1: Regress vs. Bias Predictors



P_{ret} - $P_{apriori}$

Log AOD(Dust+Water+SS)

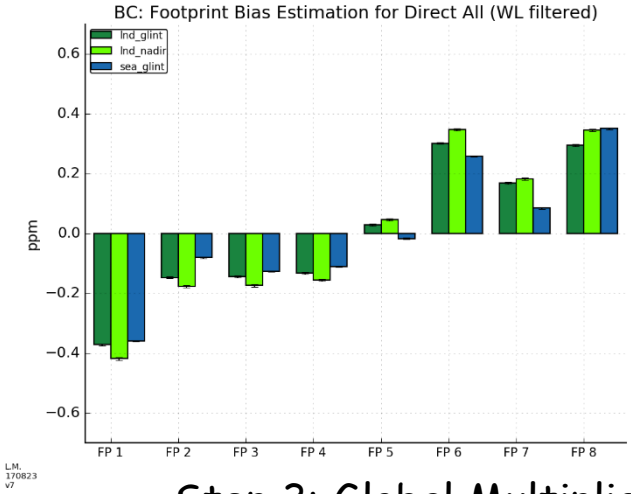


ΔCO_2 Vertical Gradient

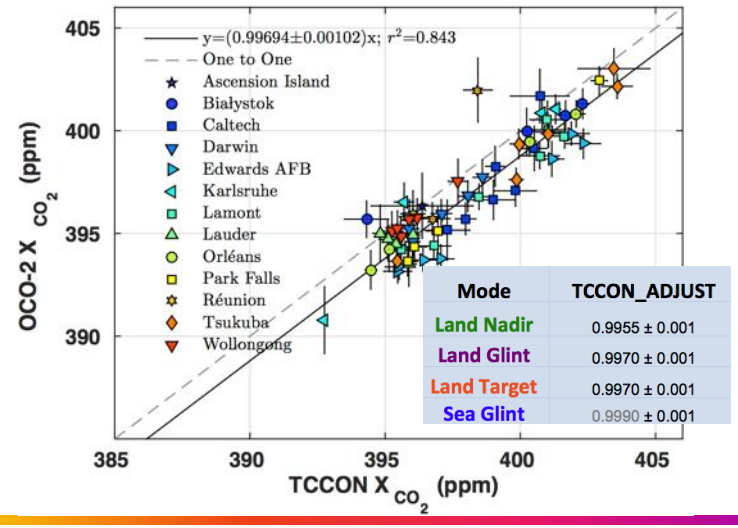
Predictors:

- Surface Pressure Error
- CO2 Vertical Gradient
- Large Aerosol+Water Clouds (land only)

Step 2: Per-Footprint Offset



Step 3: Global Multiplier



Mode	TCCON_ADJUST
Land Nadir	0.9955 ± 0.001
Land Glint	0.9970 ± 0.001
Land Target	0.9970 ± 0.001
Sea Glint	0.9990 ± 0.001

Truth Data Set Methodology

- Must have truth datasets to compare against.
- Two people: O'Dell & Mandrake
- O'Dell uses TCCON, multi-model mean, models in S.H., SAA.
- Mandrake uses TCCON, S.H.A., and SAA.
- O'Dell uses a "by-eye" technique to derive filters; looks for variables that maximimally reduce bias and scatter.
- Mandrake uses a single cost function that weights each truth metric to derive warn levels. Some purely scatter, some RMS error: sqrt (bias^2 + scatter^2).
- Both O'Dell and Mandrake must come to agreement on bias correction variables. Filters currently separate, though working to unify.

Truth DataSets (O'Dell)

- TCCON: Most trustworthy, but limited global coverage and errors due to TCCON itself, plus colocation errors.
- Multi-Model Mean: Currently 6 models, mostly have assimilated in-situ. (CT2015+NRT, UnivEd v2.1, Crowell, Jena_s04v3, MACC_2015v2, Basu in-situ+tccon-long). 2014-2015 (some longer).
  - Nmodels >= 3
  - max(|models – mean(models)|) < 1.5 ppm
  - Stddev(models) < 1.0 ppm
- "Models in the southern hemisphere" (replaces southern hemisphere approximation). Same as above but with Lat < 25S.
- Small Area Approximation
  - Use difference from mean for < 100 km segments of data.

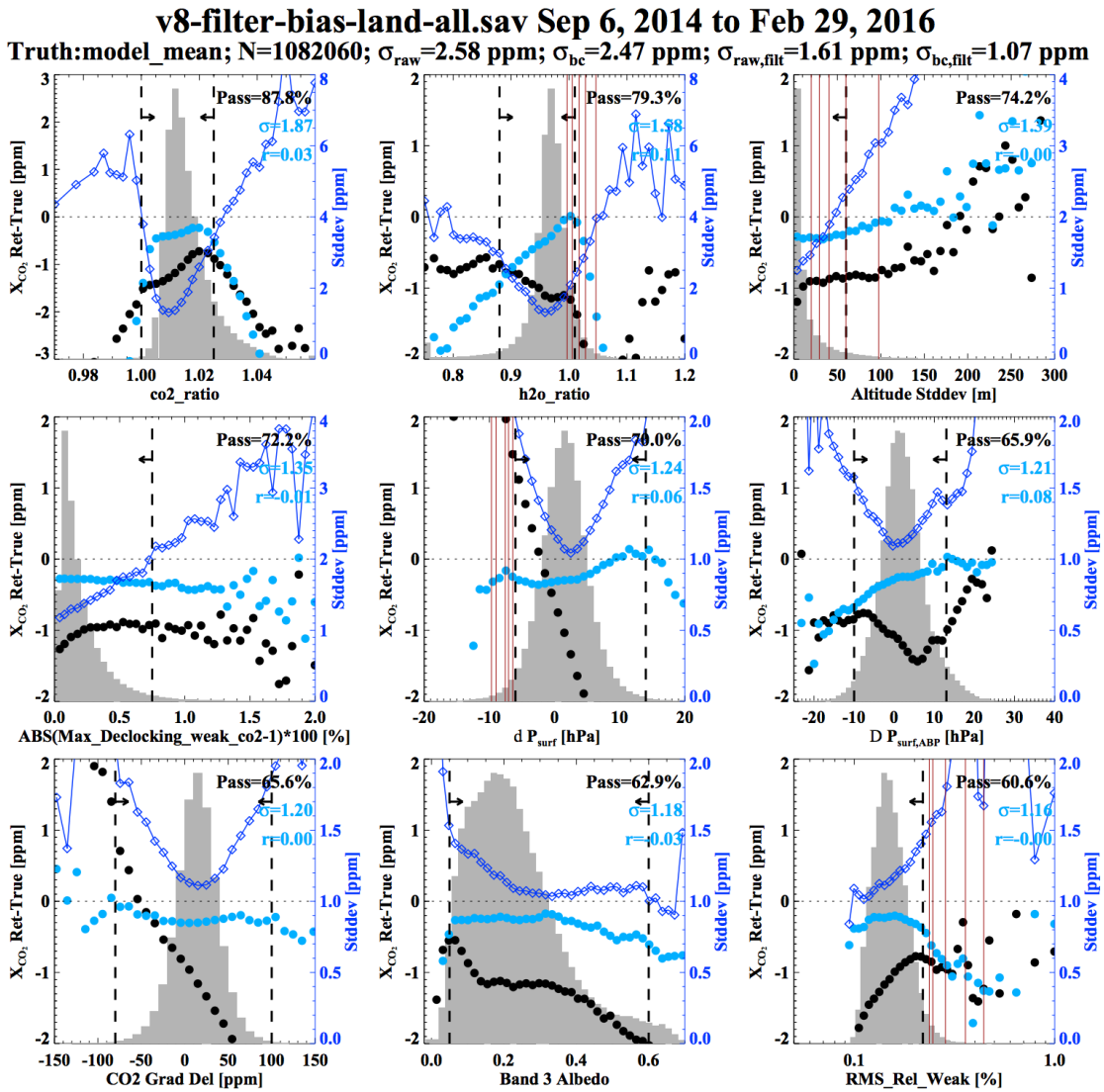
B8a Warn Levels

- 0-5 instead of 0-19!
- Span 50-100% data coverage:

  0-50%: WL=0, 50-60%:WL=1,… 90-100%:WL=5
- Found to need 5 variables to get "most bang for buck"
- Separately solved for: land ND+GL+TG, ocean GL.

SEA_GL:					
<L2/RetrievalResults/co2_vertical_gradient_delta	-1.18E-05	-1.26E-05	-1.42E-05	-1.60E-05	-1.78E-05
>L2/RetrievalResults/co2_vertical_gradient_delta	2.40E-06	5.15E-06	9.63E-06	1.61E-05	2.73E-05
>L2/AlbedoResults/albedo_weak_co2_fph	0.04152818	0.04290641	0.04870763	0.05159356	0.183427
<L2/AlbedoResults/albedo_slope_strong_co2	9.11E-06	6.77E-06	5.06E-06	8.75E-07	-1.53E-05
>Mandrake/abs_minus_1_max_declock_strong_co2	0.00188552	0.002298161	0.002635343	0.00462906	0.009252626
LND_AL:					
>Mandrake/aerosol_log_dustwatersalt_large_aod	-0.8263409	-0.6938695	-0.619922	-0.5784207	-0.05069106
<Mandrake/dP_fph	-6.404422	-7.054969	-7.561389	-8.995695	-9.690548
>L2/RetrievalGeometry/retrieval_surface_roughness	19.90433	29.2552	40.46891	59.79335	97.43734
>L2/PreprocessingResults/h2o_ratio_idp	0.9966815	1.005532	1.017087	1.028502	1.046504
>L2/SpectralParameters/relative_residual_mean_square_weak_co2	0.002365796	0.002463946	0.002850933	0.003588029	0.00442925

Filtering Example



Key

Warn Levels (0-5)

Distribution of variable

XCO2_Raw + 2 (Mean)

XCO2_BC (Mean)

XCO2_BC (Stddev)

Main Points

- Handful of variables do most of the work.
- Remaining variables seem to drive bias in a small number of soundings; currently these are filtered on (conservative approach).
- WL variables do not include these “outlier filters”

Parameter Coefficients

Reasonable consistency across truth metrics + people

Land Bias Correction

		N	Sigma [ppm]	dP	Co2_grad_del	DWS
TCCON:	LandN	106K	1.81 → 1.28	-0.37 (31%)	-0.027 (16%)	-8.0 (4%)
	LandG	76K	1.91→ 1.34	-0.38 (36%)	-0.026 (13%)	-5.1 (2%)
	LandT	314K	1.60 → 1.18	-0.26 (16%)	-0.025 (24%)	-6.9 (5%)
MODELS:	LandN	336K	1.70 → 1.17	-0.34 (27%)	-0.029 (19%)	-8.5 (7%)
	LandG	372K	1.77 → 1.20	-0.34 (29%)	-0.027 (18%)	-8.2 (7%)
SAA:	LandN	275K	1.58 → 0.87	-0.34 (34%)	-0.031 (24%)	-9.9 (11%)
	LandG	286K	1.67→ 0.90	-0.37 (45%)	-0.029 (20%)	-7.9 (6%)
SHA_Mod:	LandN	98K	1.54 → 0.96	-0.35 (29%)	-0.031 (25%)	-8.5 (8%)
	LandG	99K	1.63 → 0.97	-0.36 (30%)	-0.029 (22%)	-9.8 (12%)
Ensemble Statistics		-	-	**-0.346 ± 0.035 (-0.356 ± 0.016)**	**-0.028 ± 0.002 (-0.029 ± 0.002)**	**-8.1 ± 1.5 (-8.2 ± 1.5)**
B70		-	-	**-0.30**	**-0.028**	**-7 to -11**

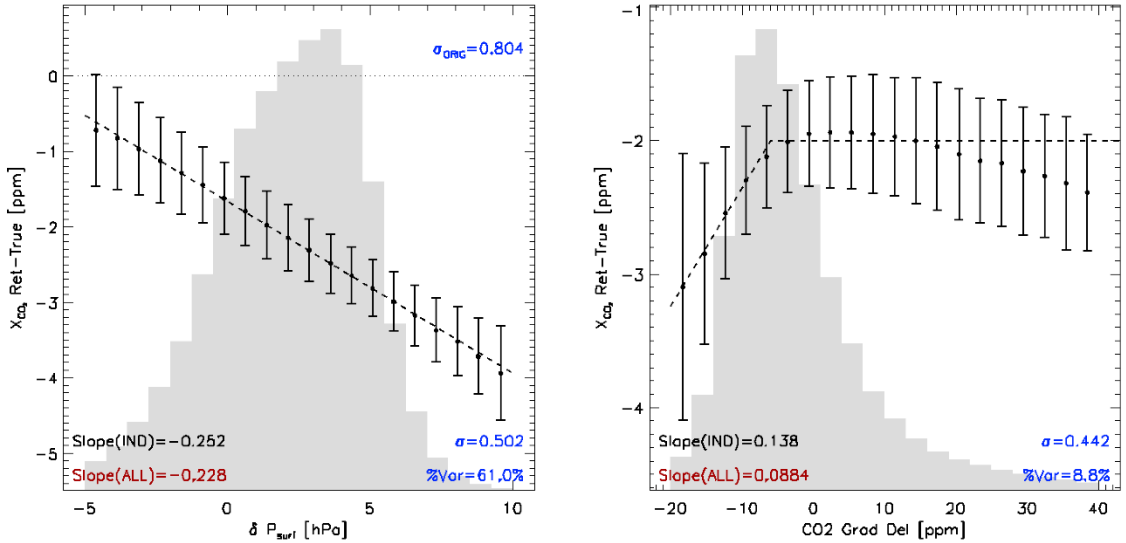
Excluding land Target

Ocean Bias Correction

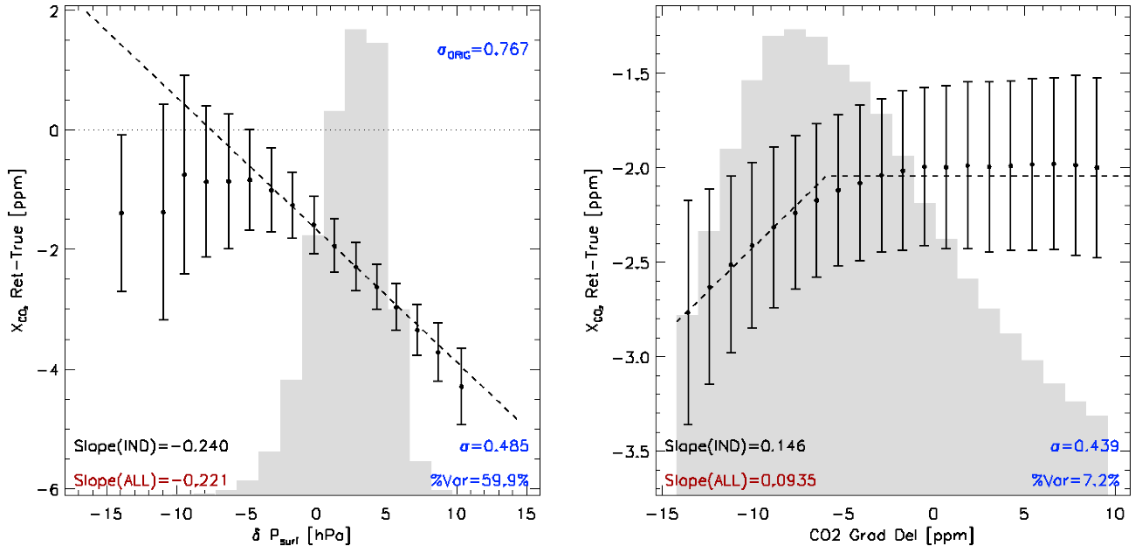
		N	Sigma [ppm]	dP	Co2_grad_del<-6
TCCON:	WL<=2	71K	0.96 → 0.82	-0.24 (24%)	0.063 (1.8%)
	Chris	73K	0.96 → 0.82	-0.23 (25%)	0.066 (3%)
MODELS:	WL<=2	607K	1.00 → 0.78	-0.23 (33%)	0.106 (6%)
	Chris	647K	1.02 → 0.77	-0.24 (36%)	0.104 (8%)
SAA:	WL<=2	324K	0.77 → 0.44	-0.22 (60%)	0.094 (7%)
	Chris	368K	0.80 → 0.44	-0.23 (61%)	0.088 (9%)
SHA_Mod:	WL<=2	155K	0.83 → 0.68	-0.11 (14%)	0.155 (18%)
	Chris	164K	0.83 → 0.67	-0.11 (14%)	0.135 (21%)
Ensemble Stats (Chris) (No SHA_Mod)		-	-	**-0.20 ± 0.06 -0.233 ± 0.01**	**0.098 ± 0.029 0.086 ± 0.019**
B70		-	-	**-0.08** (there was evidence this was too weak)	**0.077**

Different Filtering BC Effect (Ocean GL, SAA)

Chris Prelim QF

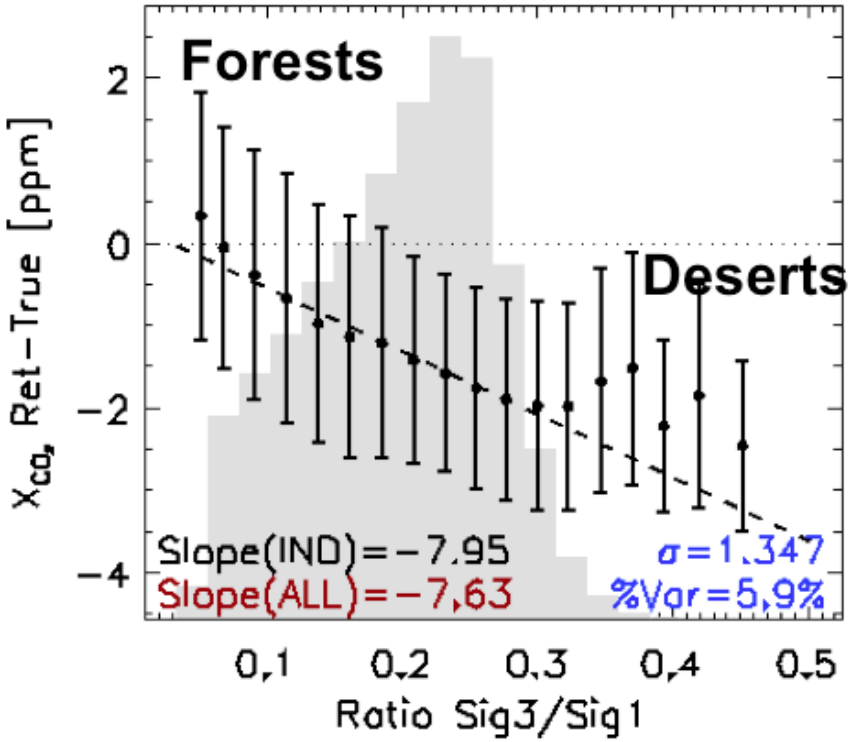


Lukas WL <=2



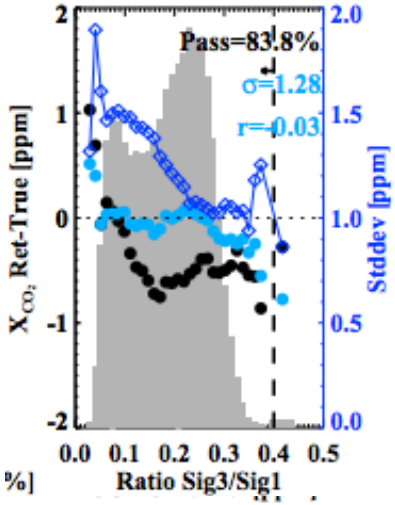
Land : Dependency on S31 gone

B7: LandND vs. TCCON

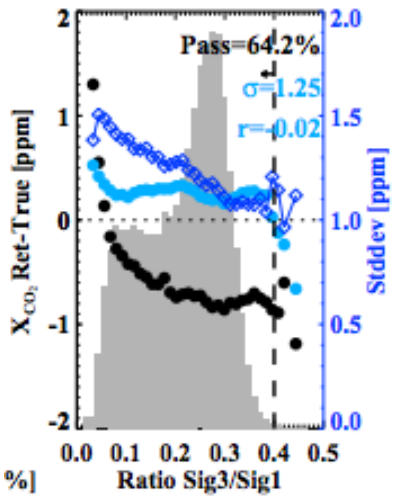


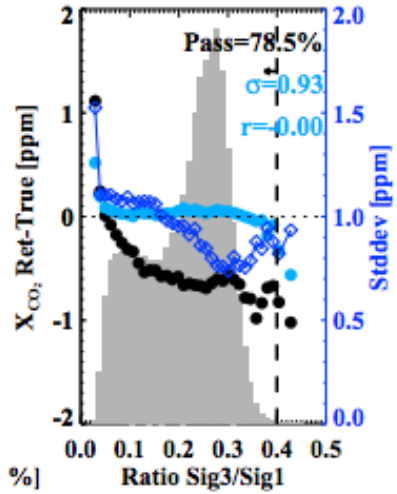
B8

LandGL TCCON

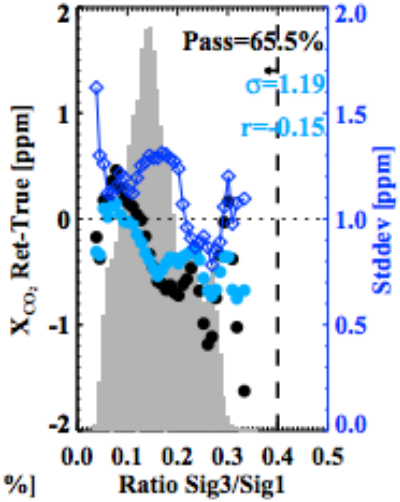


LandND Models





LandND SAA



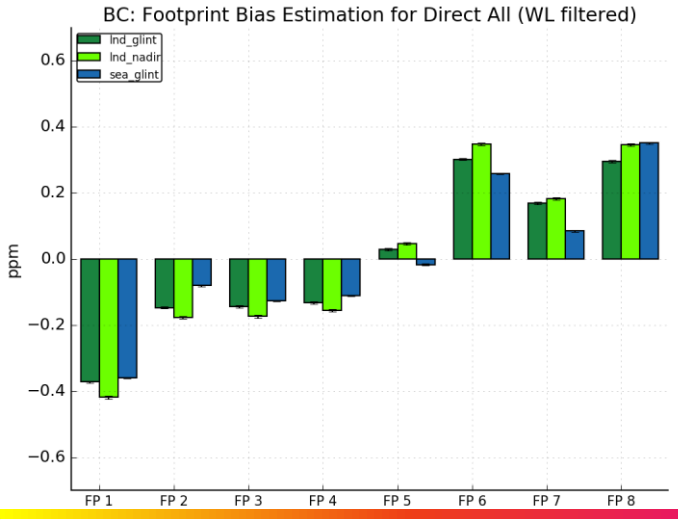
LandTG TCCON

Footprint Biases

- Rough average of Lukas Unified & Chris Unified Biases
- No Time Dependence (to be re-checked for v8b)
- Single solution for all modes & surface types!

Mode	FP1	FP2	FP3	FP4	FP5	FP6	FP7	FP8
Lukas Unified	-0.38	-0.14	-0.15	-0.13	0.02	0.30	0.15	0.33
Chris Unified	-0.35	-0.17	-0.16	-0.16	0.02	0.36	0.11	0.35
B8 Accepted	**-0.36**	**-0.15**	**-0.16**	**-0.14**	**0.02**	**0.33**	**0.13**	**0.34**

Example: *Lukas-derived values for different modes*



L.M. 170823 v7

Global Divisors Summary/Status

- **Adopt 0.9958 for land**
  - Agrees with TCCON Target (Kiel and O'Dell independent calcs)
  - TCCON direct ND+GL overpasses more like 0.9960
  - Direct comparison to Models (no AK correction): 0.9950

- **Adopt 0.9955 for sea**
  - Direct TCCON value: 0.9956
  - Coastline Crossings (Lukas): 0.9956
  - Coastline Crossings (Chris): 0.9953
  - Model Bootstrap value: 0.9954
  - Direct comparison to models (no AK correction): 0.9946

- Much more thorough and careful than B7
- Uncertainty on order 0.0005 (0.2 ppm)

B8(a) filtering & Bias Correction Status

- Only land, ocean GL. Missing ocean ND, separate analysis for high latitudes / bright surfaces (e.g. snow+ice).
- Warn Levels complete: 0-5, uses 5 parameters for land, ocean.
- Quality Flag complete: very conservative on outliers.
- BC parameters complete: purely linear, remove muddled regimes for SeaSalt + Fine Mode aerosol.
- Footprint biases complete – one static solution across modes
- Global divisors for land and ocean found with different techniques.
  - General consistent for all metrics except direction model comparisons.
  - Error <~ 0.2 ppm.
- Full comparison to B7 vs. TCCON etc. pending.

OCO-2 Science Team Meeting

Plans for the OCO-2 Science Team Meeting

- The OCO-2 Science Team Meeting is scheduled for 10/25-10/27 at the NCAR Mesa Facility in Boulder Colorado
  - Breaks at noon on 10/27, followed by a GeoCarb ST meeting
- For more details, see the web site:

https://sites.google.com/view/oco2stm1017/home

- If you plan to attend the meeting or participate via WebEx and have not yet registered, please register here:

https://sites.google.com/view/oco2stm1017/register-abstracts

- Plenary presentations are being coordnated by the Theme leads
- Submit abstracts or speed talk titles to web site ASAP
- Please contact Annmarie and I if you plan to attend by WebEx so that we can add you to the list for WebEx updates