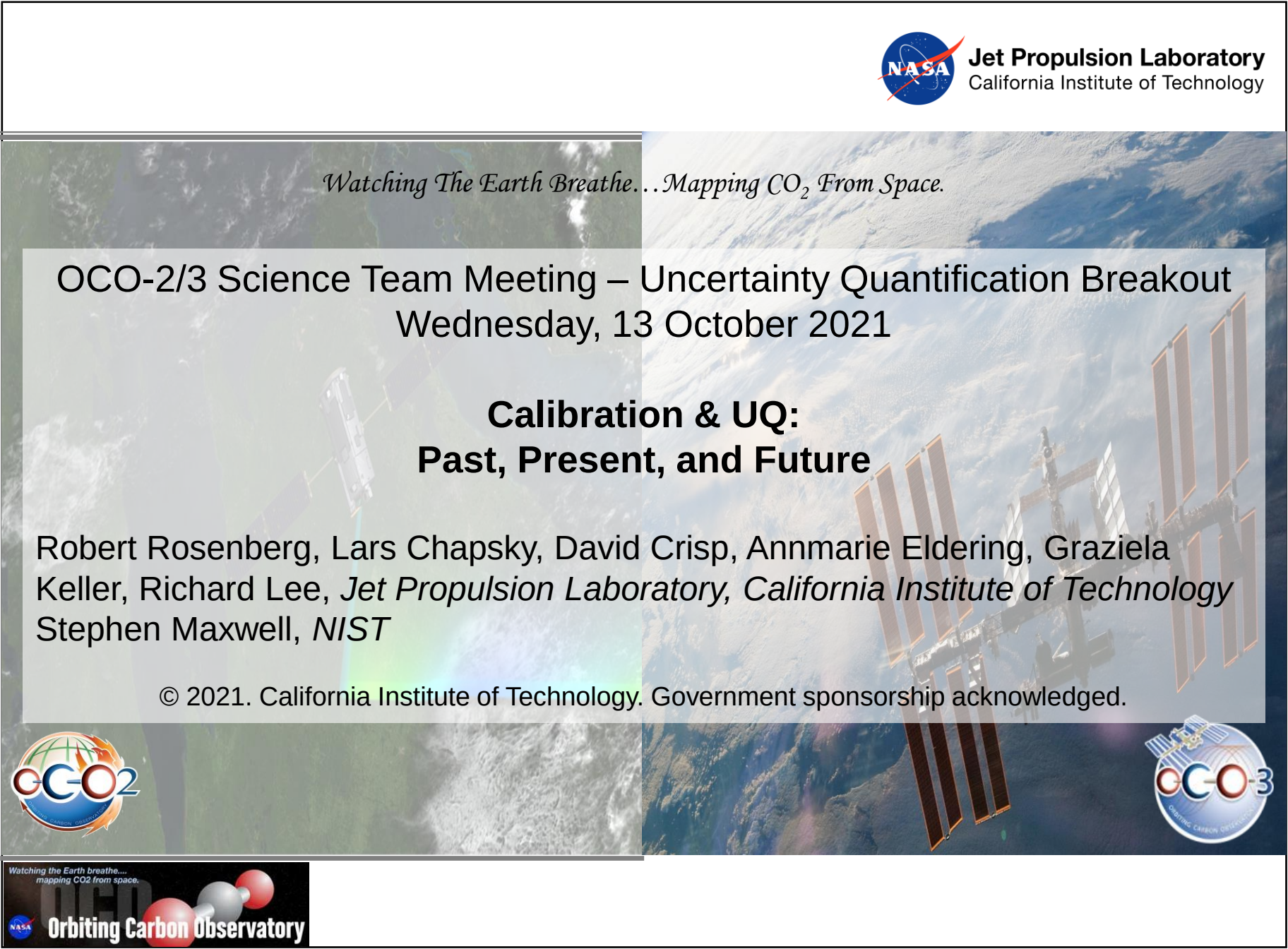


Jet Propulsion Laboratory
California Institute of Technology

Watching The Earth Breathe…Mapping CO_2 From Space.

OCO-2/3 Science Team Meeting – Uncertainty Quantification Breakout
Wednesday, 13 October 2021

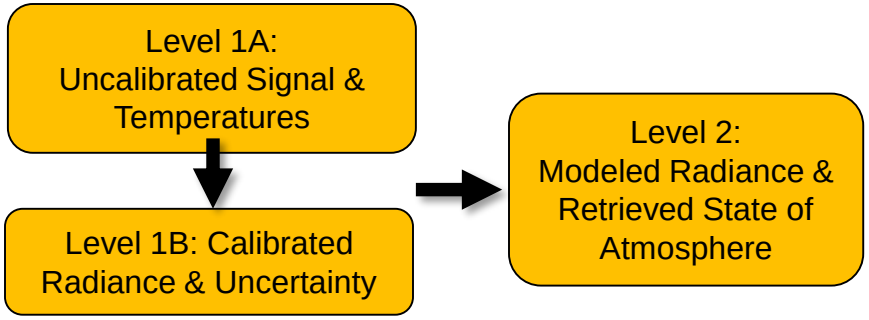
Calibration & UQ:
Past, Present, and Future

Robert Rosenberg, Lars Chapsky, David Crisp, Annmarie Eldering, Graziela Keller, Richard Lee, *Jet Propulsion Laboratory, California Institute of Technology*
Stephen Maxwell, *NIST*

Watching the Earth breathe.... mapping CO2 from space.
Orbiting Carbon Observatory

Introduction

- The cal team greatly values collaboration with the UQ team – well designed sensitivity studies help us objectively weigh the importance of different improvements we consider
- The parameter space is very large – many types of calibration coefficients and the XCO2 sensitivity to most of them is scene-dependent
- Experiment setup is key to conserve human effort and data volume / runtime



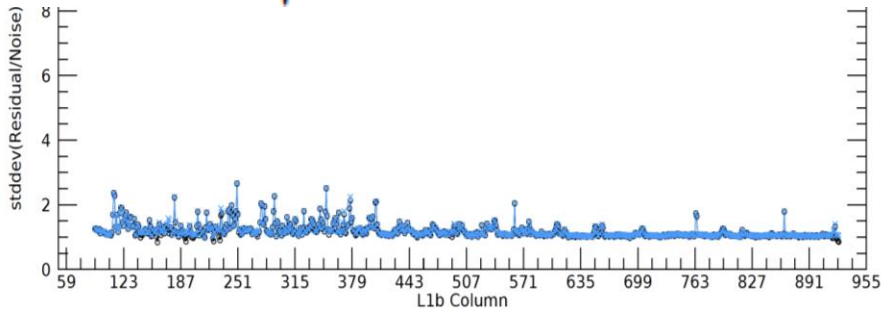
Level 1B Inputs: Radiometric Calibration	
Dark Correction	Function of temperature
Stray Light	Function of avg signal
Preflight Gain	Corrects nonlinearity
Gain Degradation	Linear inflight scaling

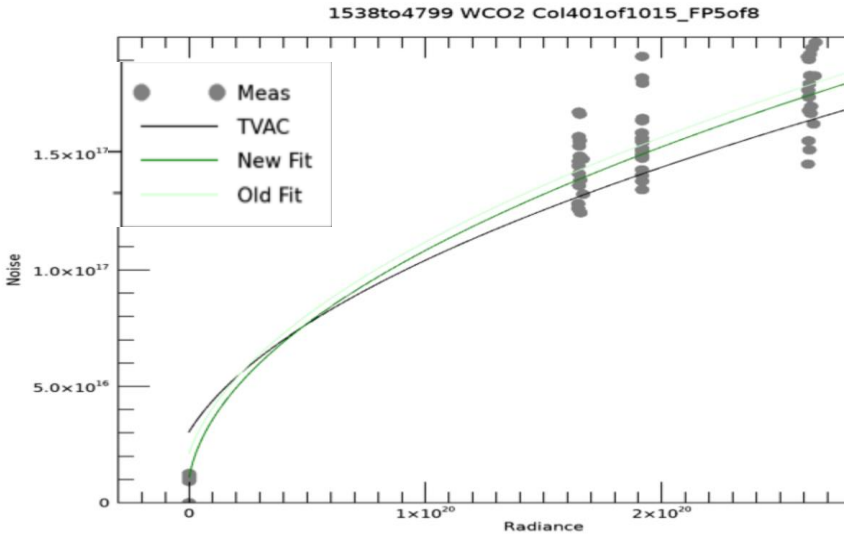
Level 2 Inputs: Calibration and More	
Dispersion	Wavelength vs column
Instr Line Shape	200 element lookup table
SNR Model	Background and photon
Bad Sample List	Remove outliers
ABSCO Tables	High resolution spectra
Geolocation	To resample meteorology
Retrieval Config	Prior, covariance, + more

Noise & Uncertainty

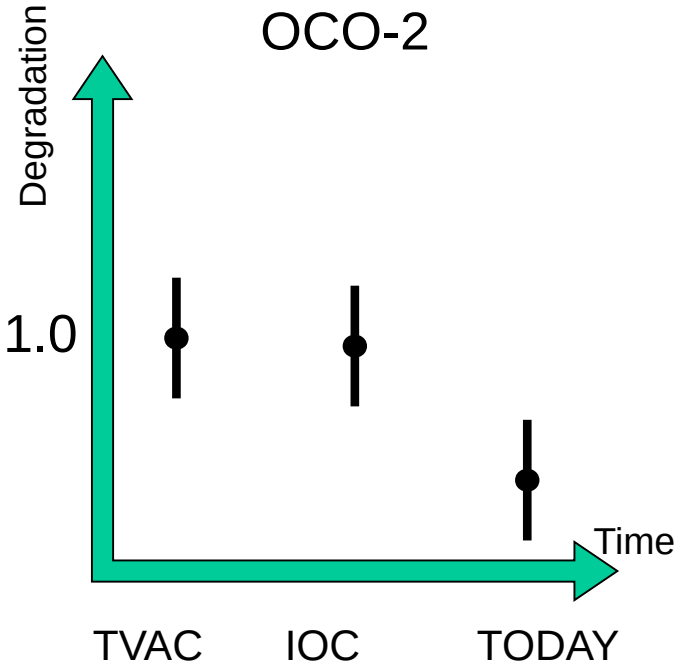
- 675,840 pixels in calibration mode (1024 col. x 220 rows x 3 bands)
- 24,384 samples in science mode, middle 160 rows become 8 footprints
- Each sample has 1 coef for fixed dark noise and another proportional to $N^{0.5}$
- Recently improved by re-fitting using inflight lamp & dark data
- Stddev(resid/noise)<1 overestimate, >1 could be forward model error
- FPA noise shouldn't remain only **measured_radiance_uncert** input!

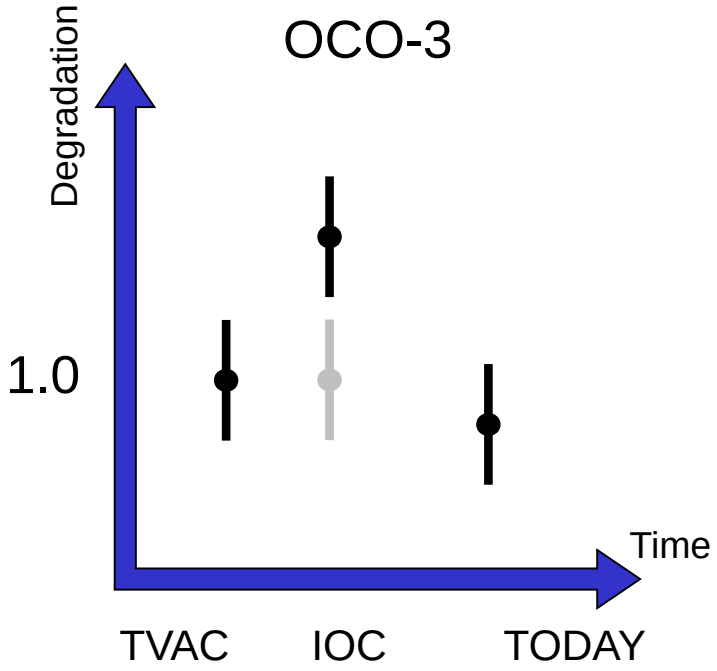
$$\sigma_N = \frac{N_{\max}}{100}\sqrt{\left|\frac{100N}{N_{\max}}\right| c^2_{\text{photon}} + c^2_{\text{background}}}$$





ABO2 Gain Knowledge Schematics





TVAC: integrating sphere with transfer chain to NIST standards
IOC: lamp radiance similar to preflight

Inflight: 4% signal loss over 7 years

TVAC: integrating sphere with transfer chain to NIST standards
IOC: lamp radiance increased sharply

Inflight: 0-4% signal loss over 2.2 years

TVAC = Thermal VACuum [Preflight] testing, IOC = In Orbit Checkout

Trends of Primary Standards (All Bands)

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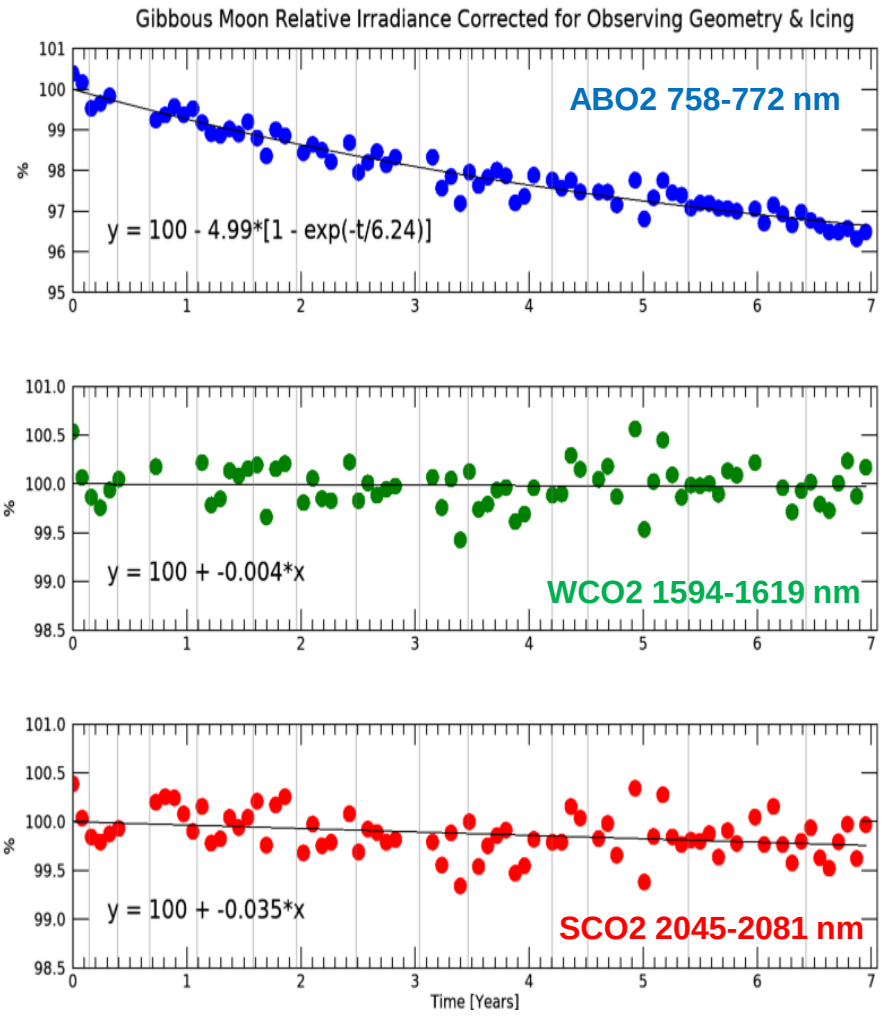
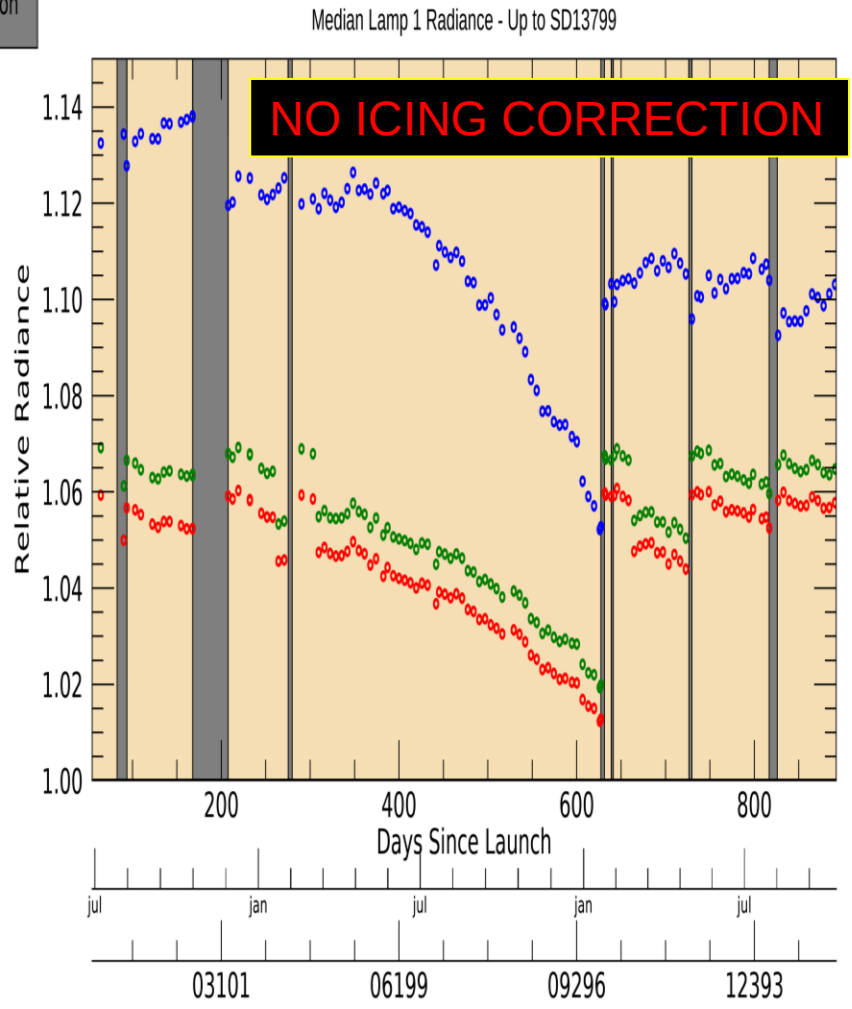
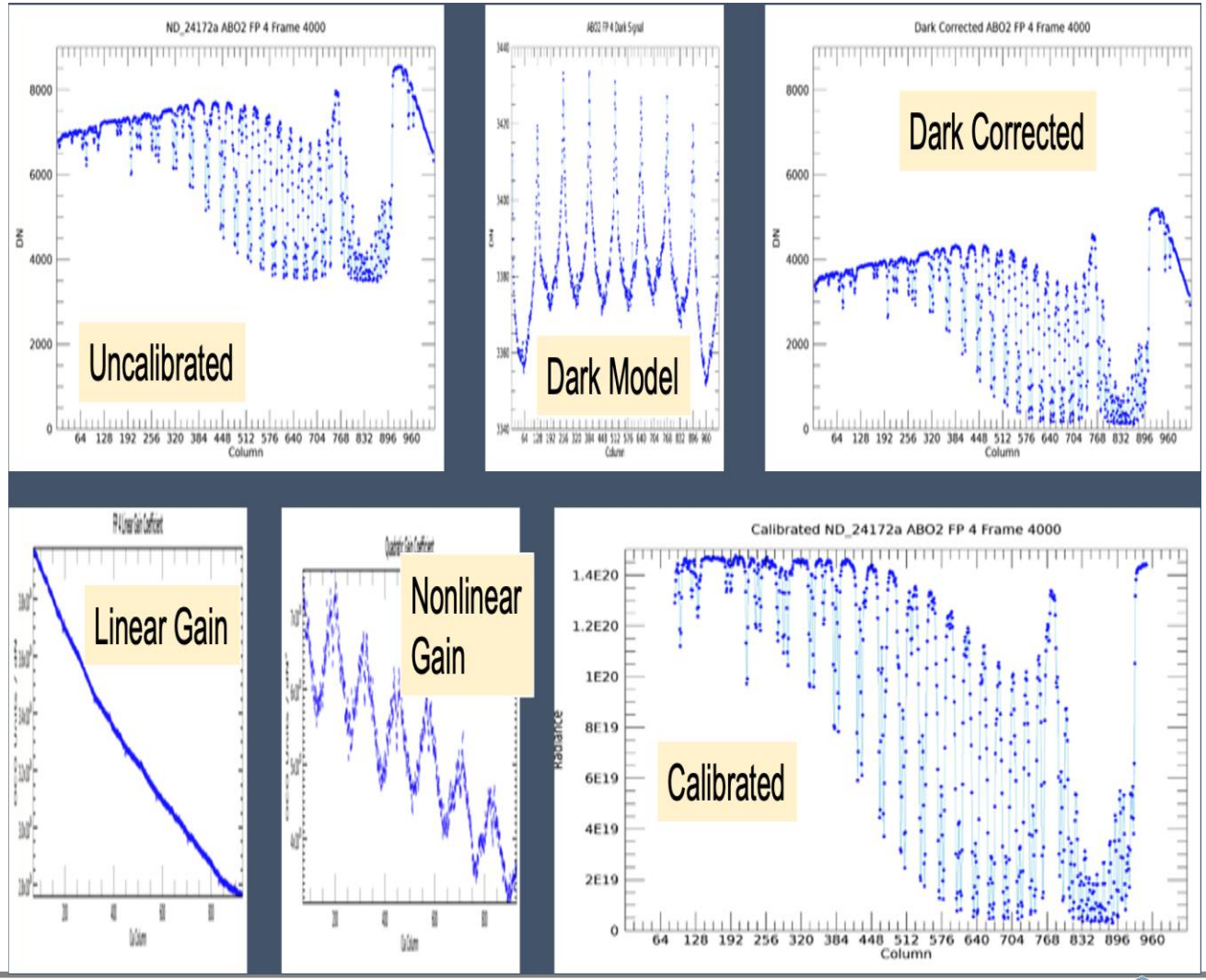


Decon



Spectral Patterns in Preflight Rad Cal (OCO-2)

- Can these corrections be applied in reverse to simulated L1b data?
- Doing so would allow propagation of uncertainties on each factor into the final measured radiance!



Concluding Questions

- When is it better to use UQ techniques (linear error analysis, simulation based) instead of running L1a -> L1b -> L2 with different calibration inputs?
- What happens to UQ calculations when EOFs are used in a retrieval, and Bias Correction is performed afterward?
- Simplifying assumptions (consistency with column, footprint, band, time, signal level, surface type, airmass, …) can greatly reduce runtime and human effort, but what do they obscure?
- How to better link **measured_radiance_uncert** and the apriori covariance to the calibration coefficients used to create **measured_radiance** and **modeled_radiance**, and what will happen to **xco2_uncert** as a result?