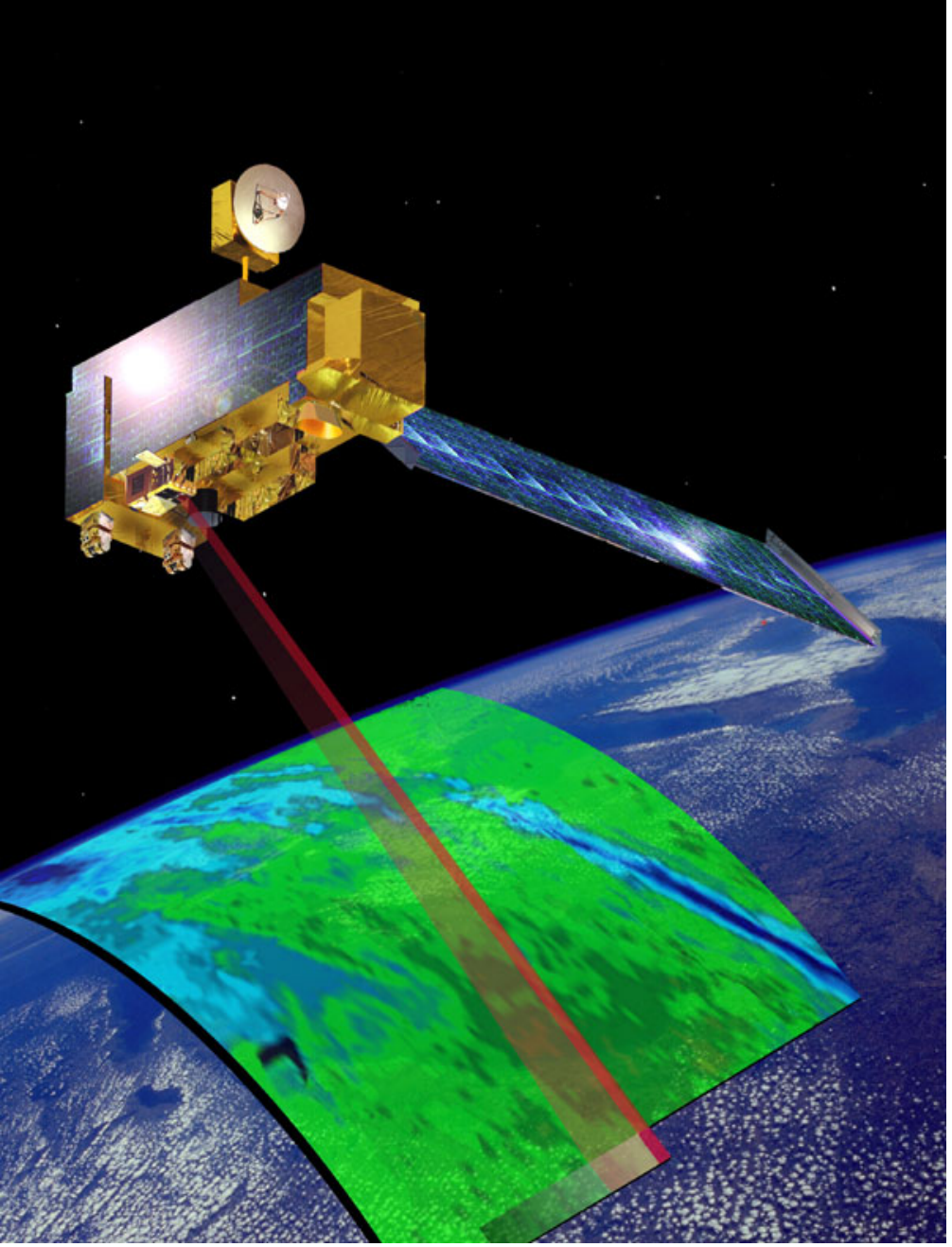


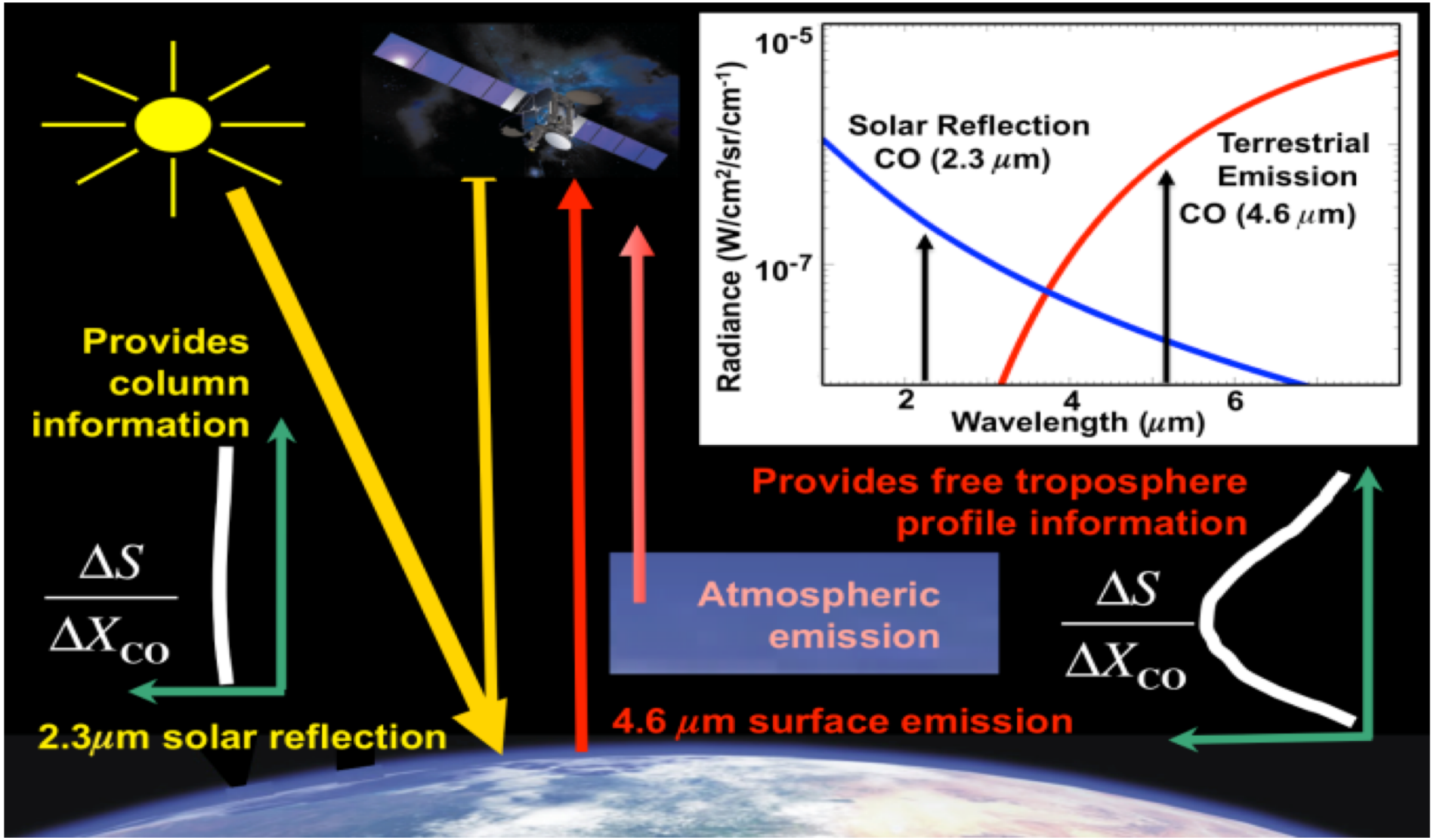
18 Years of MOPITT Carbon Monoxide Data: Selected results, validation and extending the record

H. Worden (NCAR) and the NCAR MOPITT team

Dejian Fu, Kevin Bowman, **Vivienne Payne (JPL)**

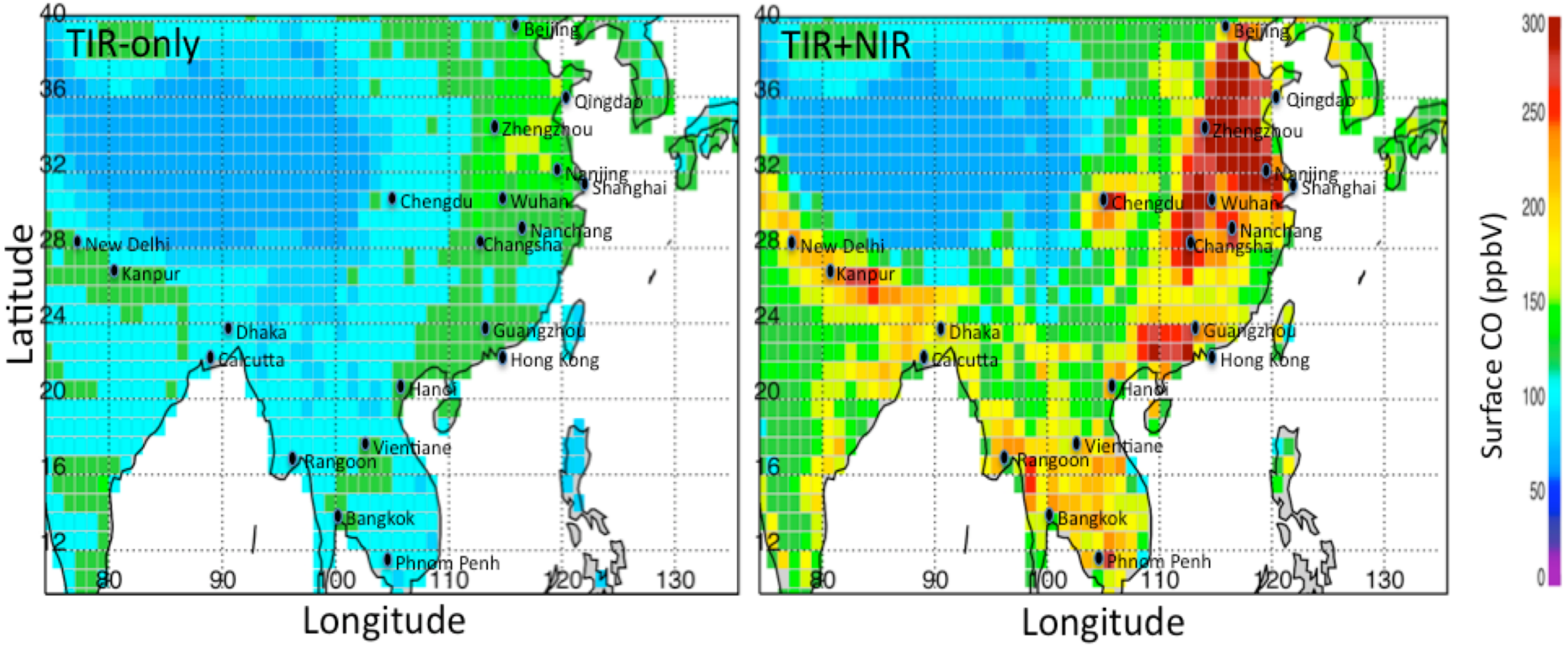
Karen Cady-Pereira (AER)

MOPITT Multispectral CO Observations



MOPITT uses gas filter correlation radiometry (GFCR) to measure TIR and NIR CO absorption

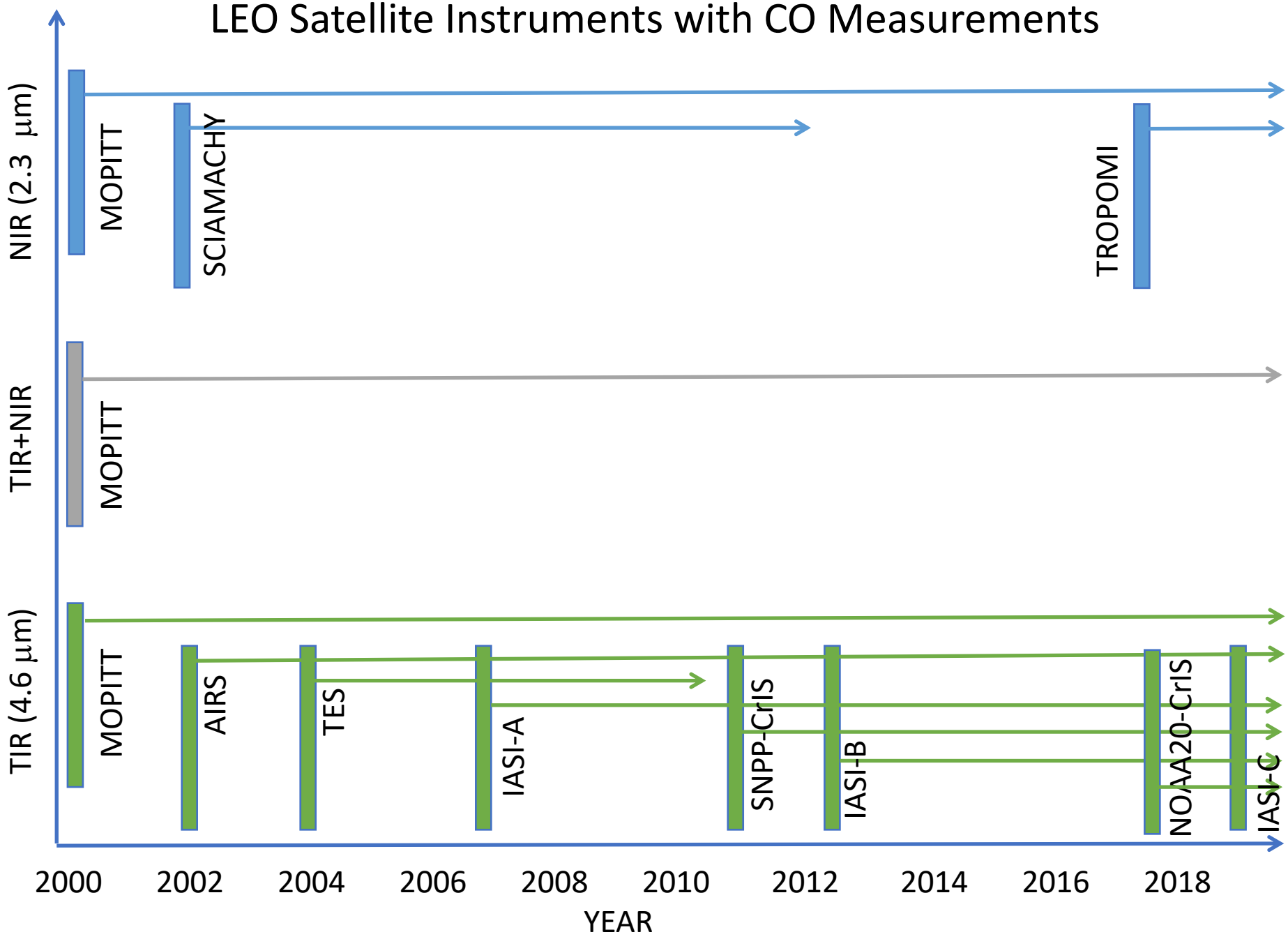
MOPITT near surface CO Observations



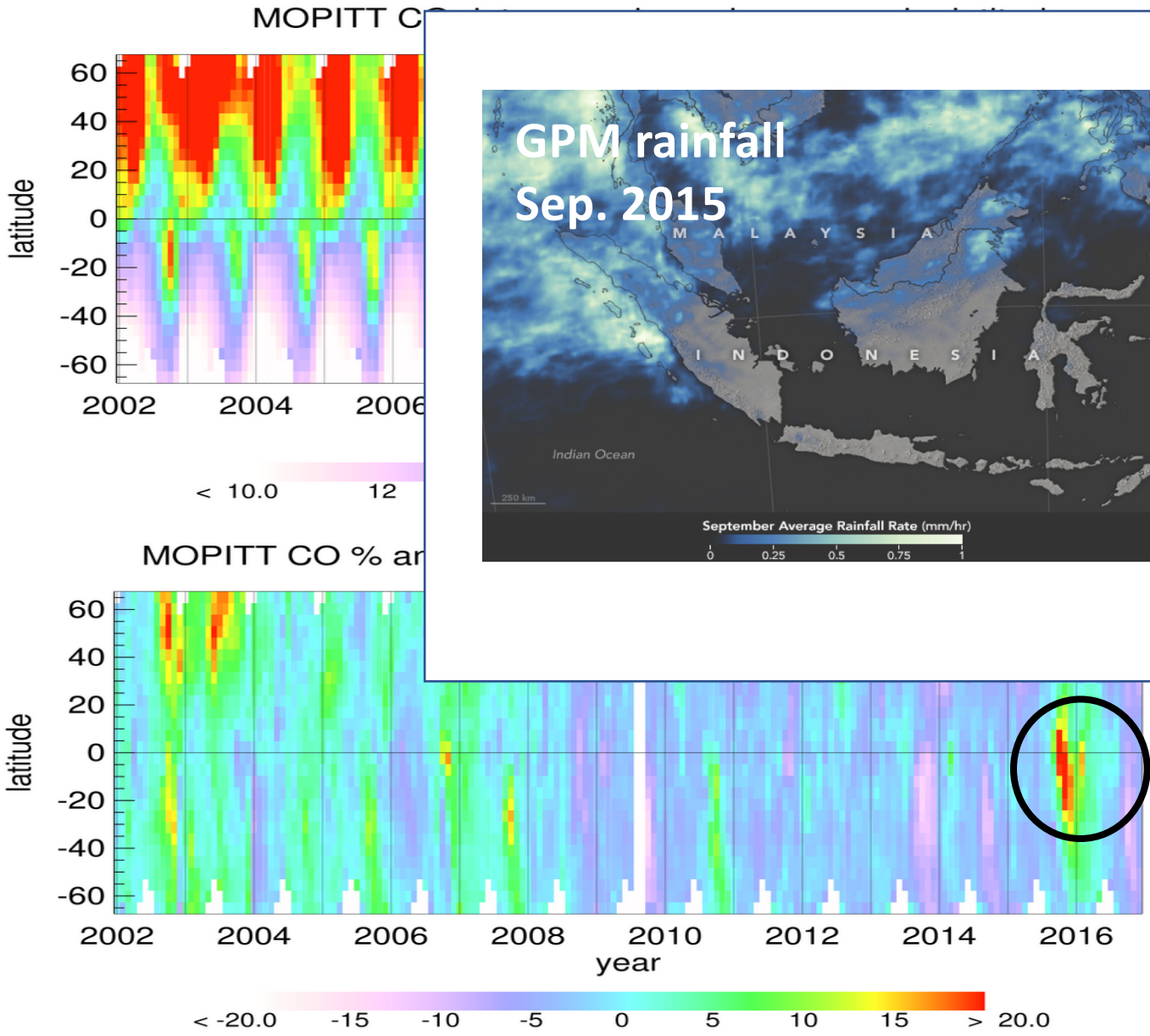
only 4.6 μm

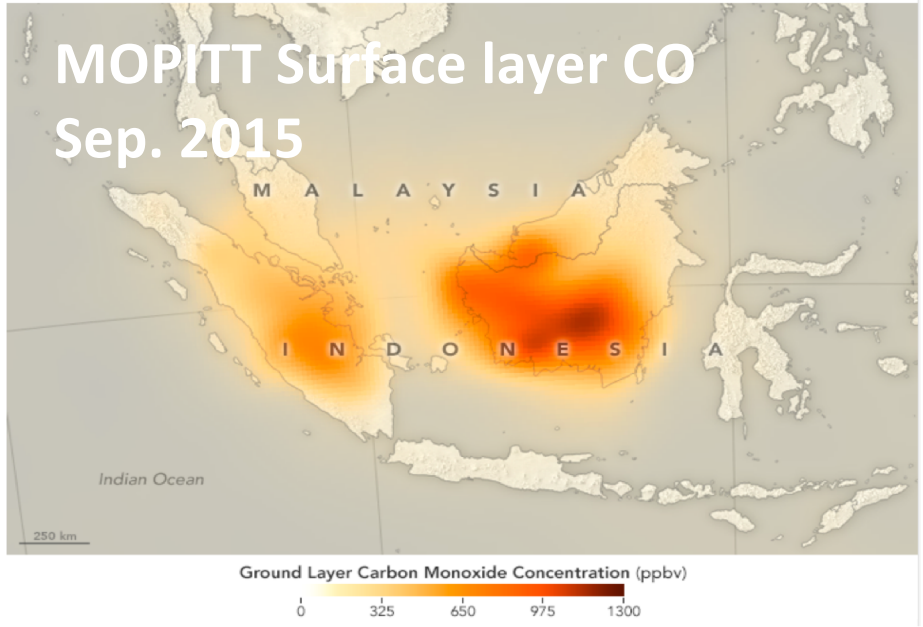
4.6 μm and 2.3 μm

Worden et al., JGR, 2010


LEO Satellite Instruments with CO Measurements
NIR (2.3 μm)
MOPITT
SCIAMACHY
TROPOMI
TIR+NIR
MOPITT
TIR (4.6 μm)
MOPITT
AIRS
TES
IASI-A
SNPP-CrIS
IASI-B
NOAA20-CrIS
IASI-C
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
YEAR

CO trends

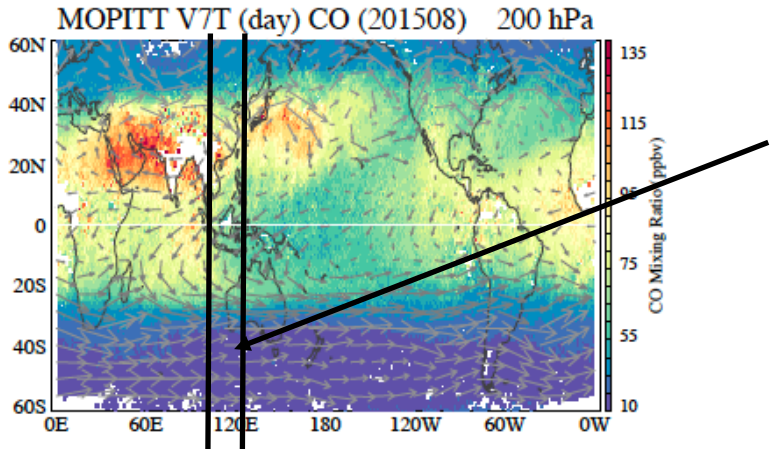




2015 ENSO

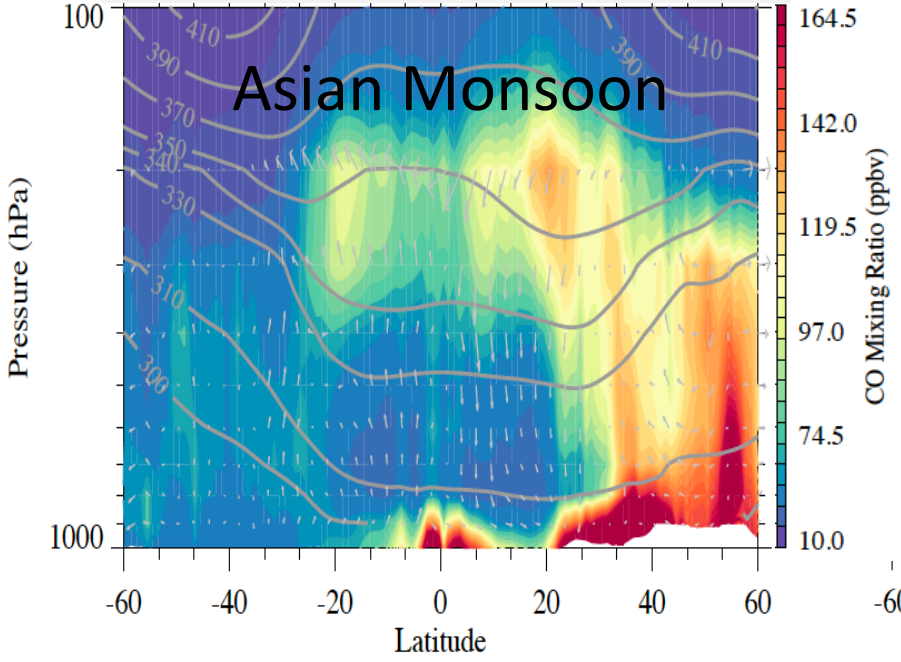
MOPITT CO Profiles: Asian Monsoon and 2015 Indonesian Fires

Expected high CO in UTLS due to Asian Monsoon circulation
(e.g., Park et al., 2009)

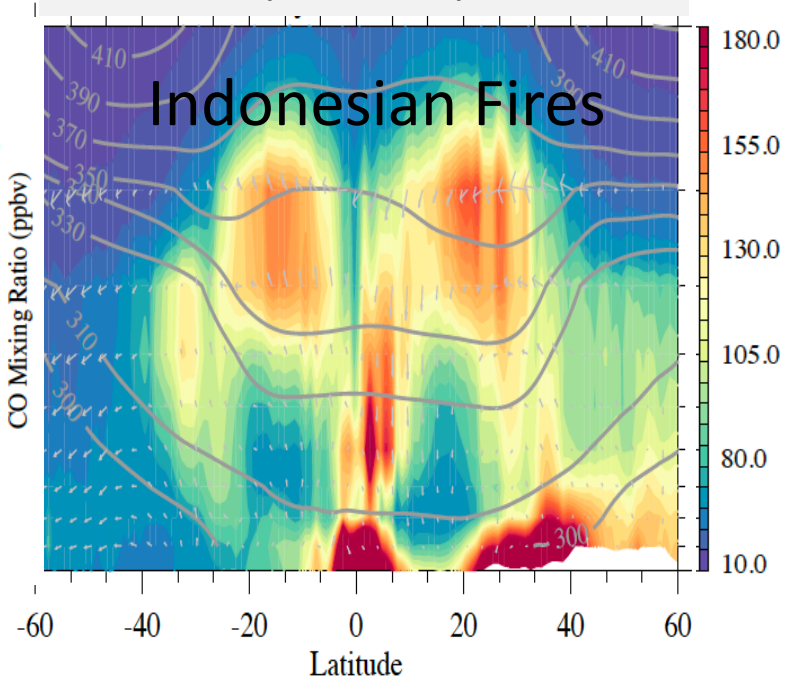


Lon: 110-120E Averages

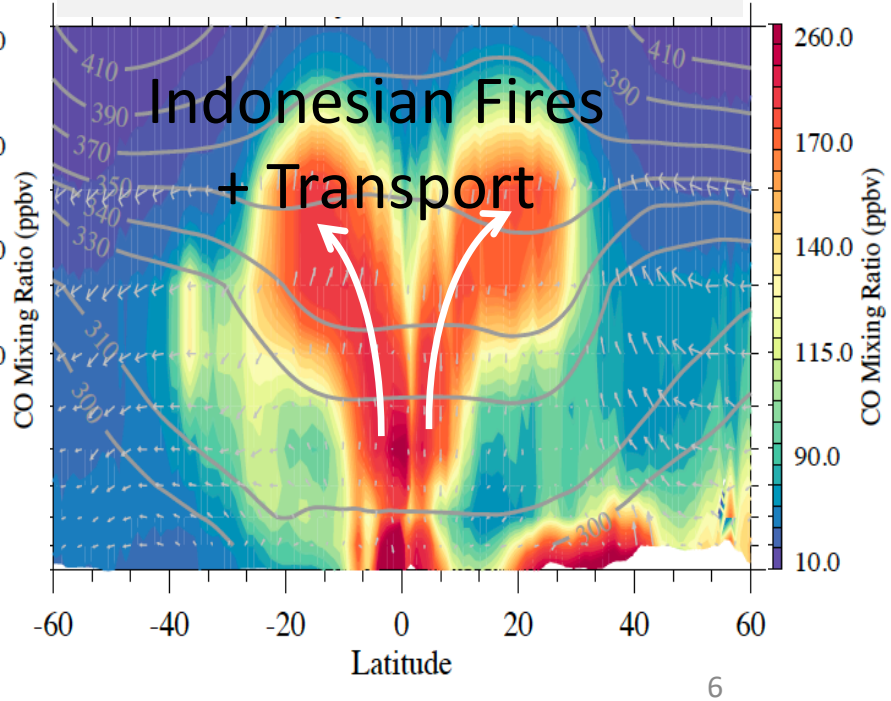
MOPITT V7J CO (201508)



(201509)



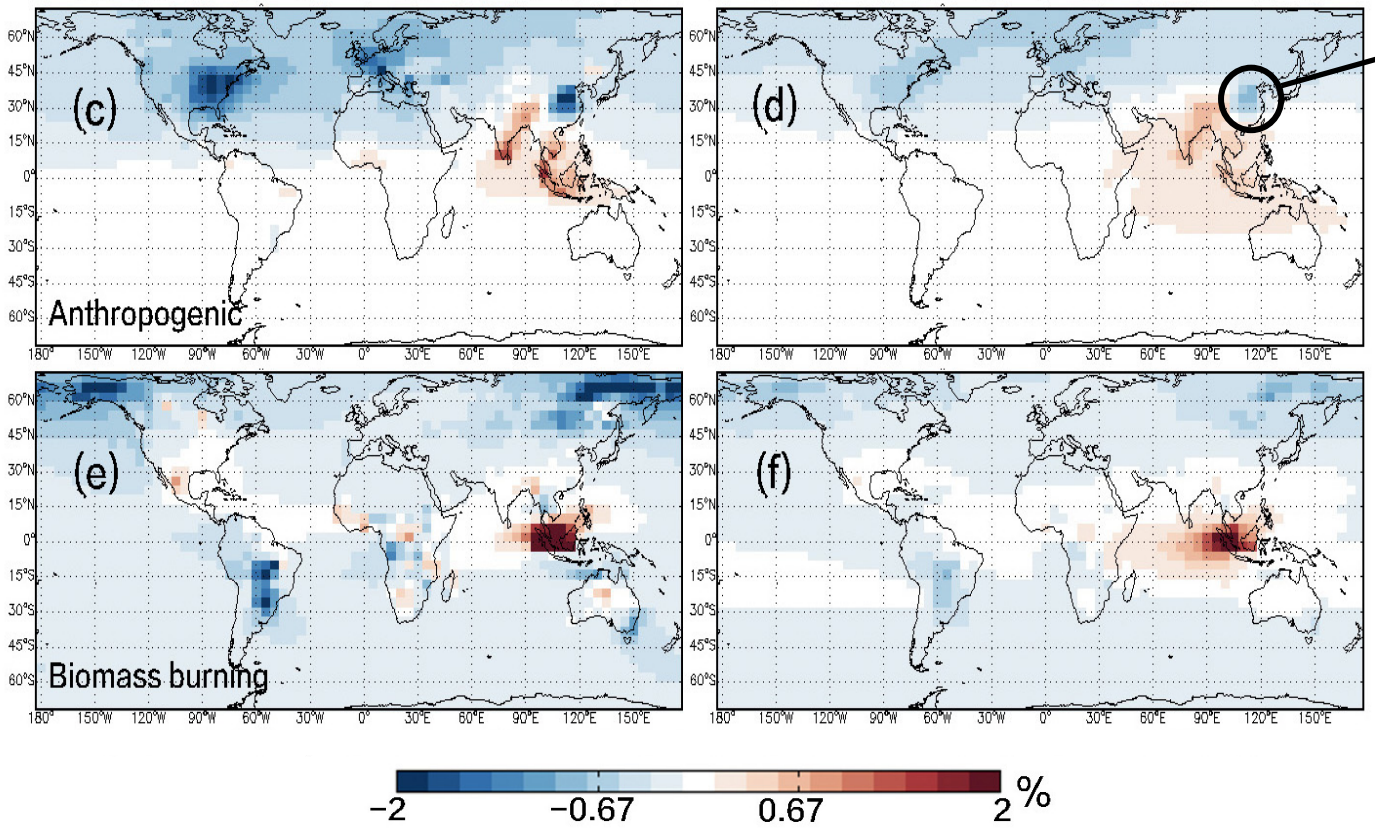
(201510)



Trends in CO Emissions using top-down estimates constrained by MOPITT

Surface CO trends

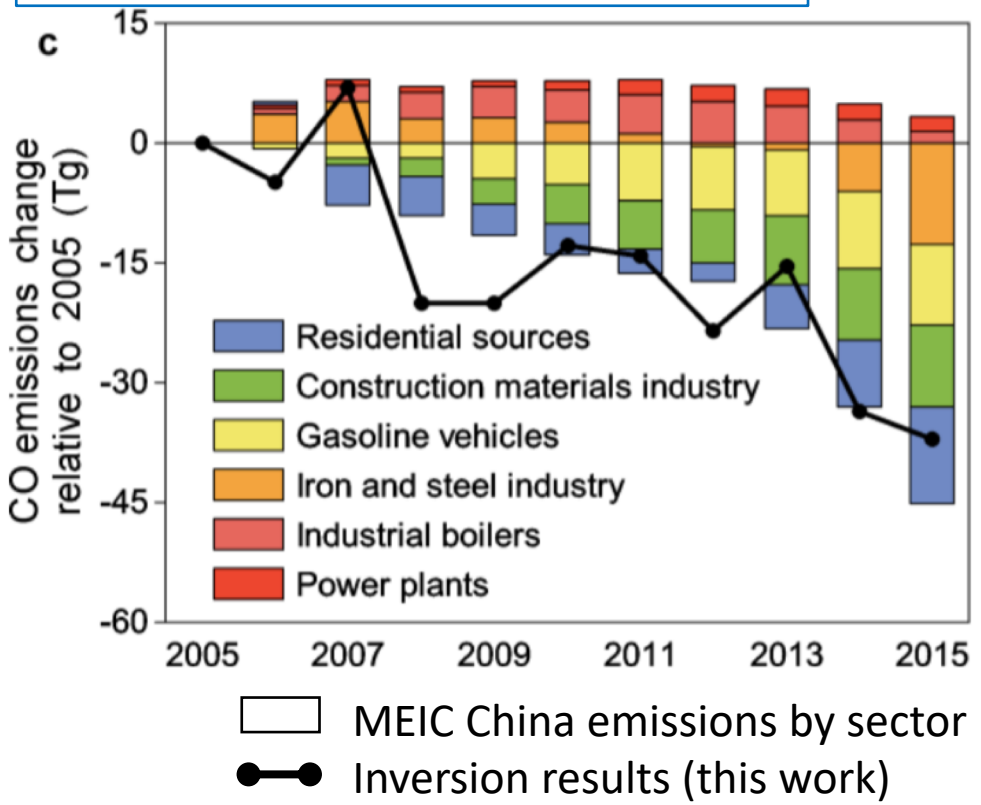
Total column CO trends



2001 – 2015 Linear Trend (%/yr)

Jiang et al., ACP, 2017

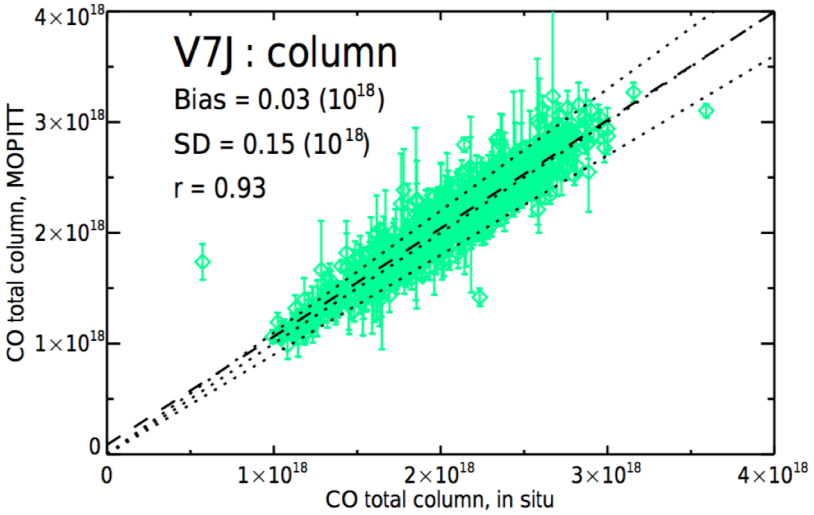
"Rapid decline in carbon monoxide emissions and export from East Asia between years 2005 and 2016"

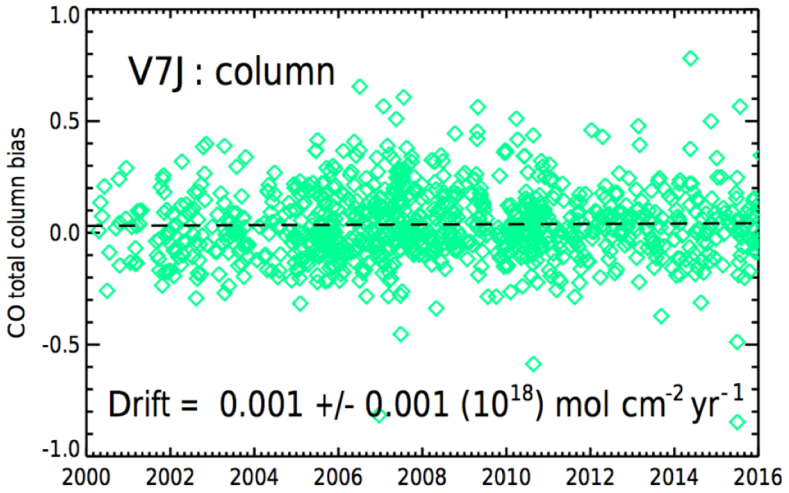


Zheng et al., ERL, 2018

MOPITT Validation and Intercomparisons

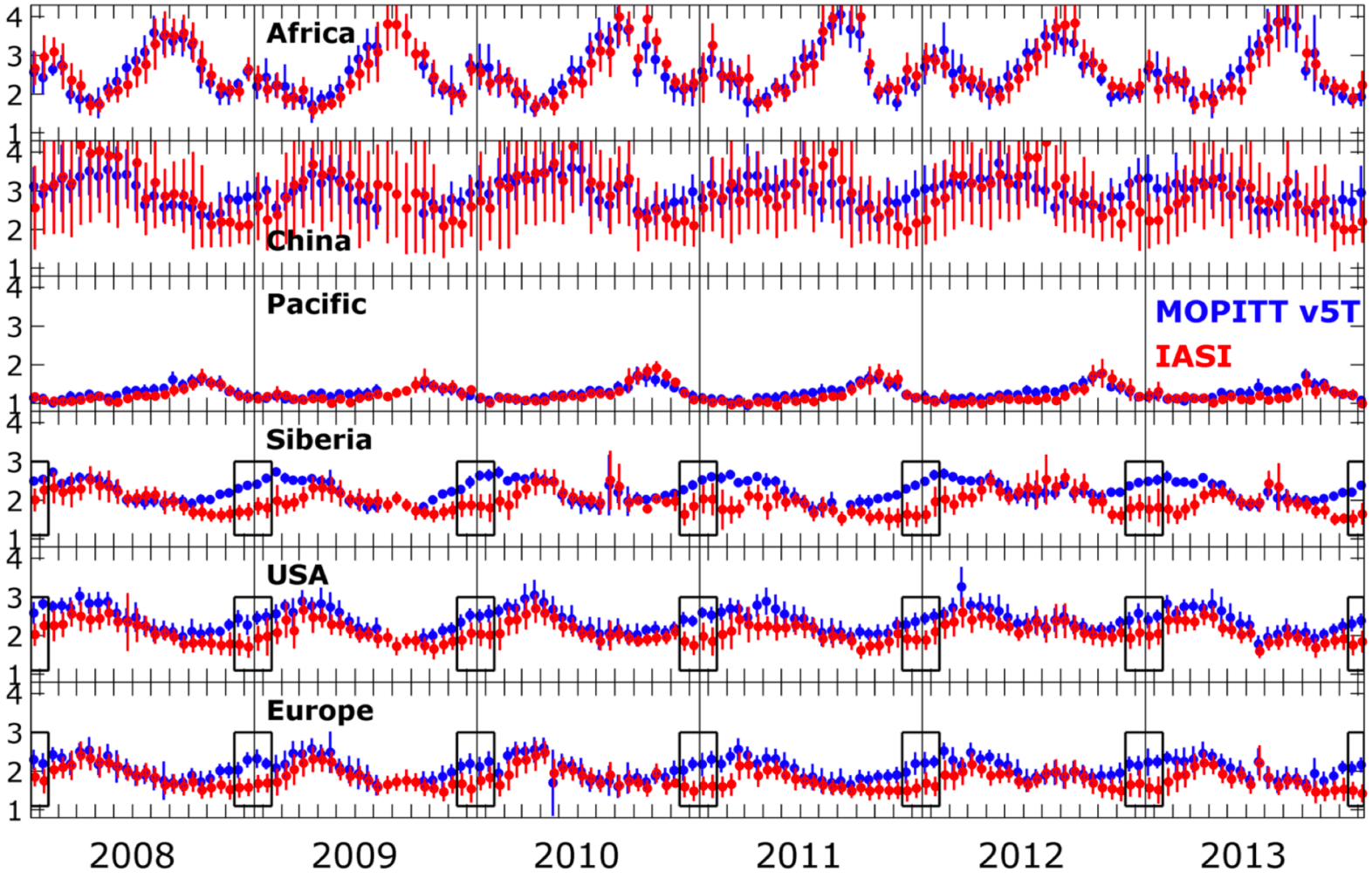
Comparisons to in situ NOAA data: Significant improvement for V6N to V7N (Deeter et al., AMT, 2017)





MOPITT V8 (in progress) will address bias drift in UT vs. LT for profiles and latitude bias due to water vapor dependence.

Comparisons with IASI



MOPITT vs. IASI

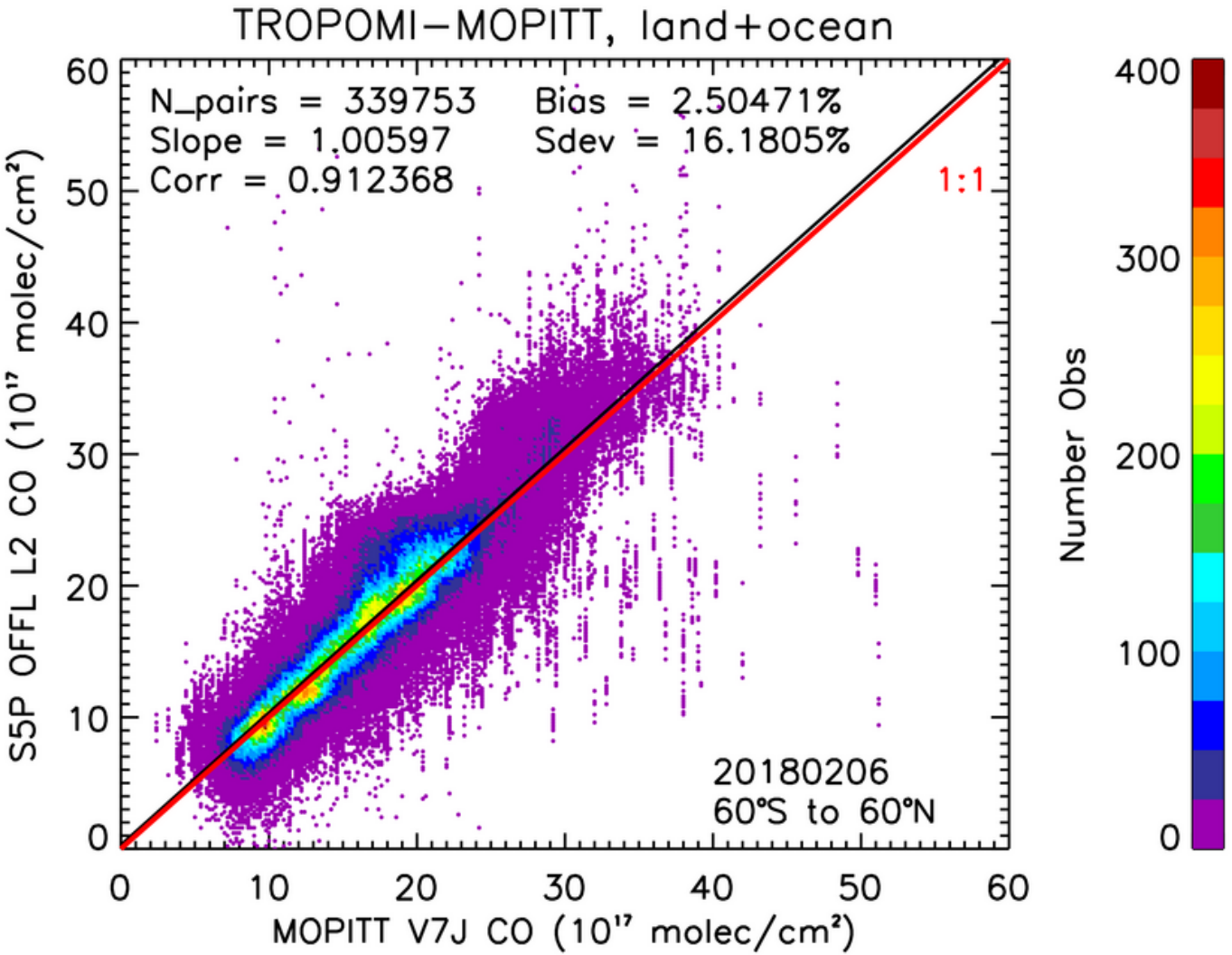
From George et al., AMT, (2015):

CO column in 10^{18} mole./cm2 for 15-day averages in selected regions.

Error bars = 1 st. dev.

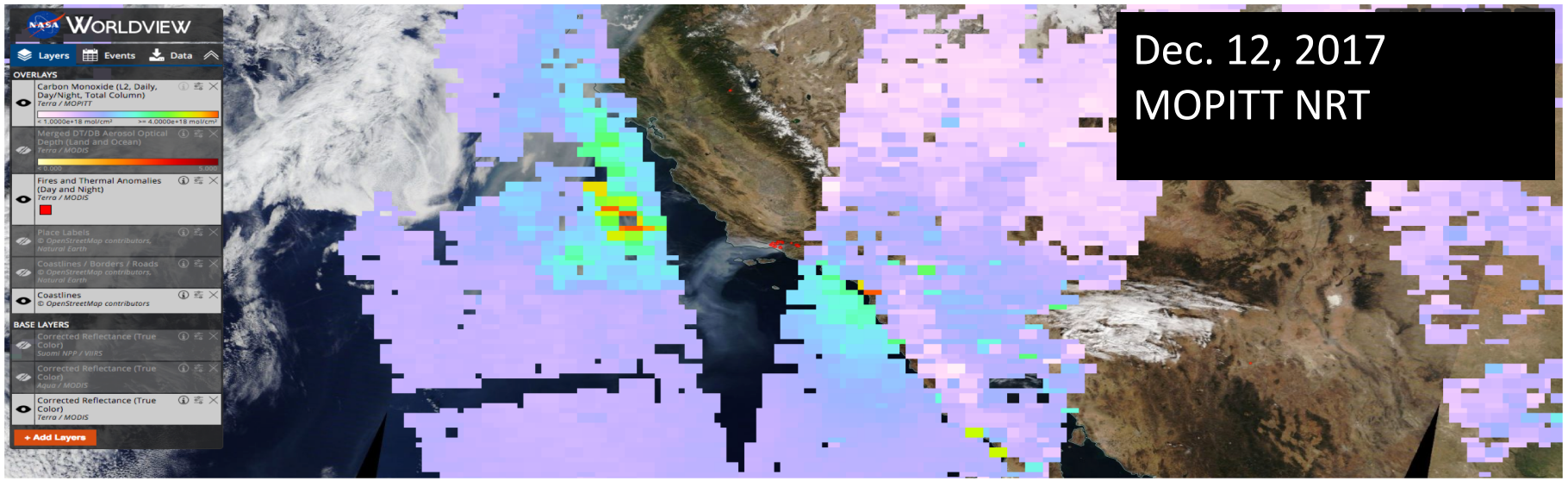
Areas with significant differences due to different winter sensitivity for TIR measurements

Comparisons with TROPOMI



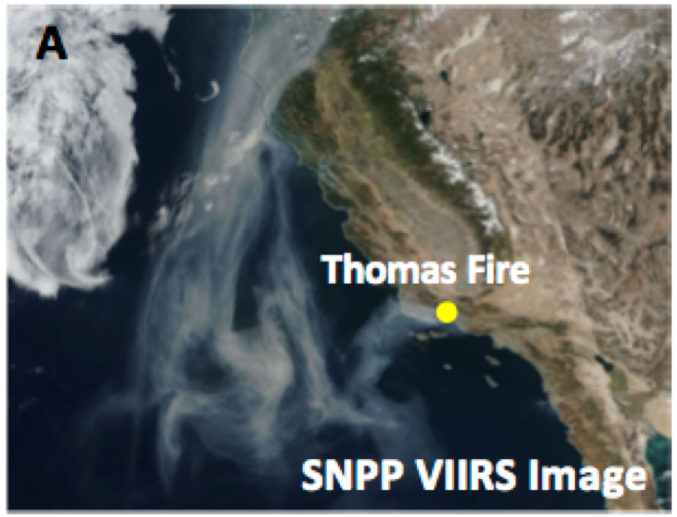
Initial comparison of MOPITT and TROPOMI total col. CO (25 km coincidence, day only)

MOPITT and CrIS observations of 2017 Thomas Fire



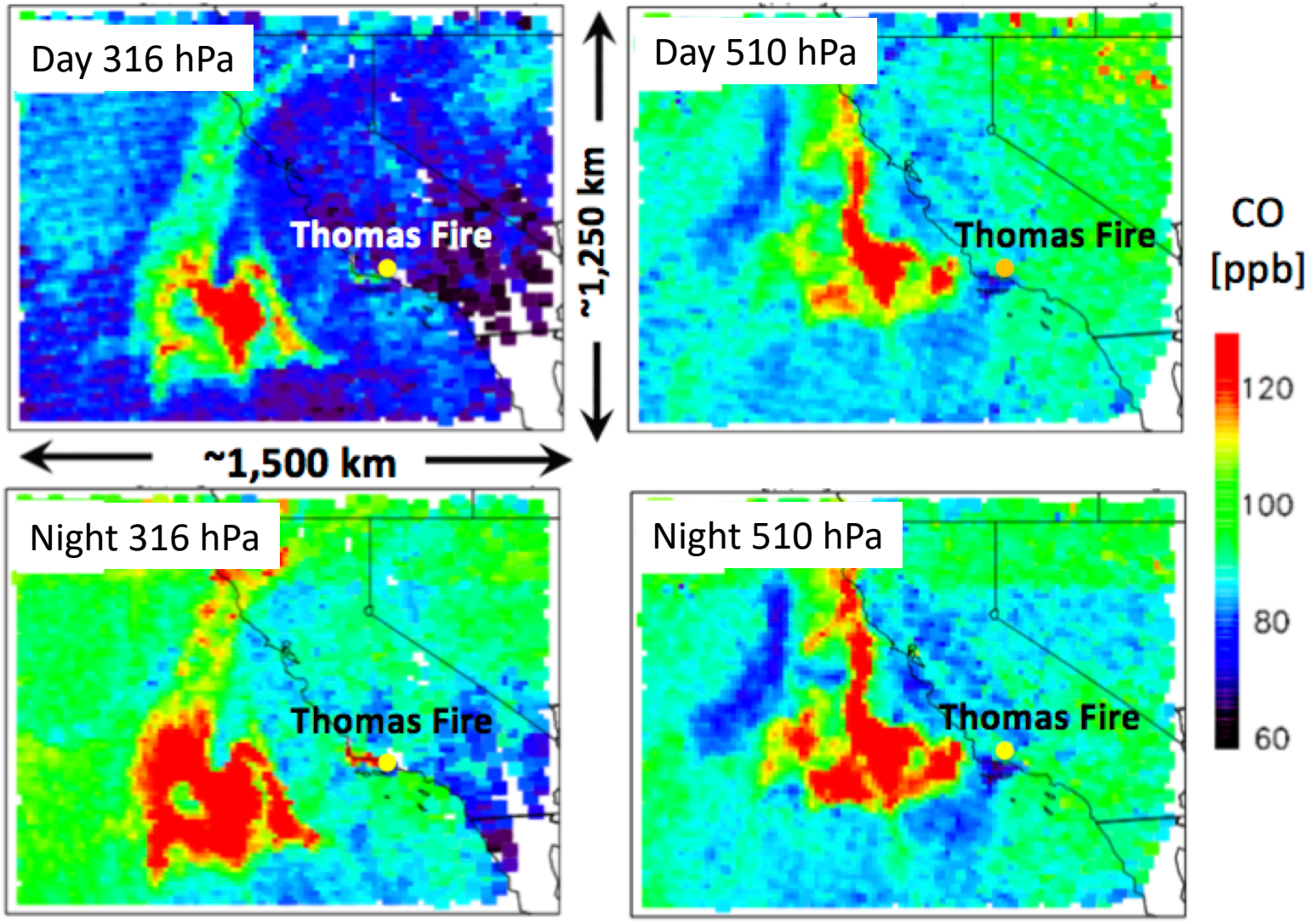
MOPITT TIR Near-Real-Time (NRT) data in WORLDVIEW: https://worldview.earthdata.nasa.gov

Single-Pixel SNPP-CrIS observations of 2017.12.12 (MUSES algorithm from JPL: Fu et al., AMT, 2016)



Hazard of Thomas Fire

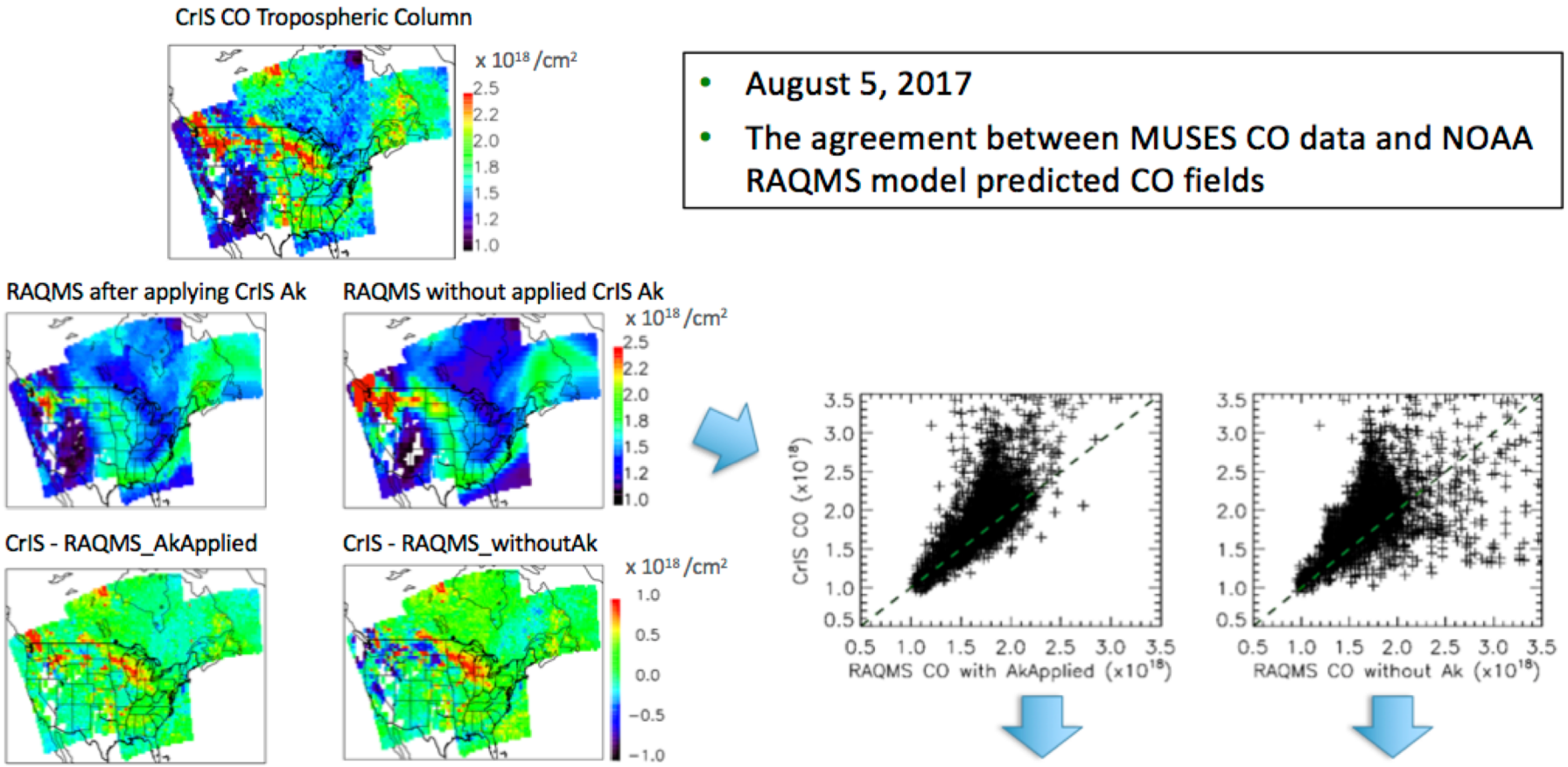
Location: near Los Angels, CA
Date: Dec 4, 2017 - Jan 12, 2018
Burn Area: 281,893 acres
Buildings Destroyed: 1,063
Fatalities: 1 firefighter, 1 civilian (20 indirectly)



Extending the MOPITT CO record with SNPP/CrIS and S5P/TROPOMI

	Terra/MOPITT	SNPP/CrIS	S5P/TROPOMI
Instrument type	Gas Filter Correlation Radiometer (GFCR)	Fourier Transform Spectrometer (FTS)	Imaging Spectrometer
Launch date	December 1999	October 2011	October 2017
Orbit (sun-synch.)	705km, 10:30 LST (desc.)	828 km, 13:25 LST (asc.)	824 km, 13:30 LST (asc.)
Pixel size; Swath	22km x 22km; 640 km	14 km diam.; 2200 km	7km x 7km; 2600 km
Global coverage	~ 3 days	~1 day	~1 day
CO spectral sampling	0.04 cm^{-1} (eff. TIR) 0.25 cm^{-1} (eff. SWIR)	2.5 cm^{-1} (normal mode) 0.625 cm^{-1} (full res. > Dec. 2014)	0.458 cm^{-1}
CO spectral range	2140-2192 cm^{-1} 4265-4305 cm^{-1}	2155-2210 cm^{-1} (TIR only)	(SWIR only) 4277-4303 cm^{-1}
NEDT@270K	0.05K/channel	0.1K/spectral sample (full res.)	SWIR min. SNR: 100-120

Extending the TIR-only CO record with SNPP/CrIS



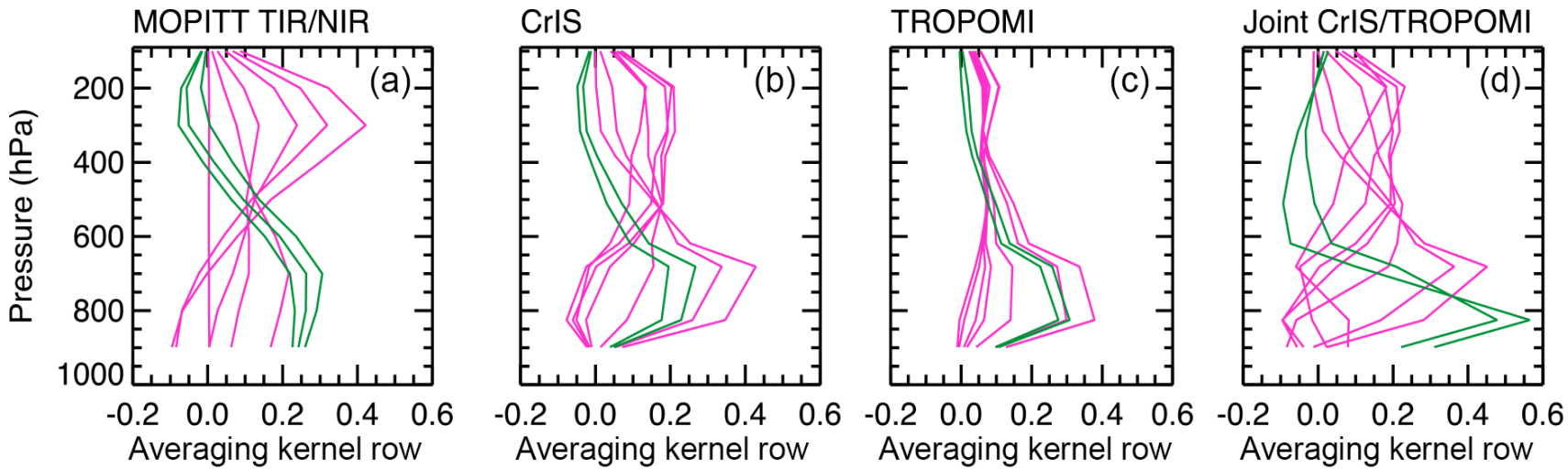
- August 5, 2017
- The agreement between MUSES CO data and NOAA RAQMS model predicted CO fields

Applying MUSES CrIS CO Observation Operator to RAQMS Predicted CO Fields	Correlation Coefficient	Mean Diff		RMS	
		x10¹⁸	%	x10¹⁸	%
With applying AK to RAQMS CO data	0.68	-0.15	6.9	0.27	11.1
Without applying AK to RAQMS CO data	0.40	-0.15	6.6	0.45	25.7

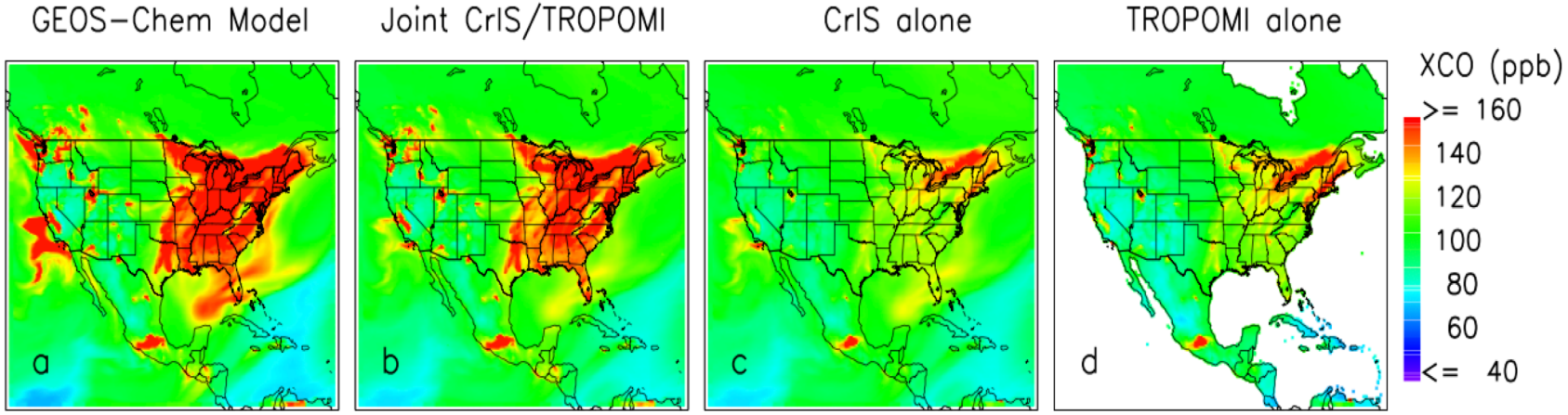
RAQMS model simulations are courtesy of B. Pierce, NOAA

Extending the TIR+NIR MOPITT CO record with SNPP/CrIS and S5P/TROPOMI

Averaging Kernels
From Fu et al., AMT, 2016



Simulated retrievals of surface layer CO (0-2km)



Conclusions:

- MOPITT has the longest satellite record of global CO.
- Multispectral observations allow sensitivity to surface layer CO in some conditions over land.
- Except for 2015 El Niño related fires, global CO emissions are mostly decreasing for both fire and fossil fuel combustion.
- Combining SNPP/CrIS and S5P/TROPOMI observations could potentially extend the MOPITT record of TIR+NIR multispectral observations

MOPITT GFCR Multispectral CO observations

GAS FILTER CORRELATION RADIOMETER (GFCR) CONCEPT