

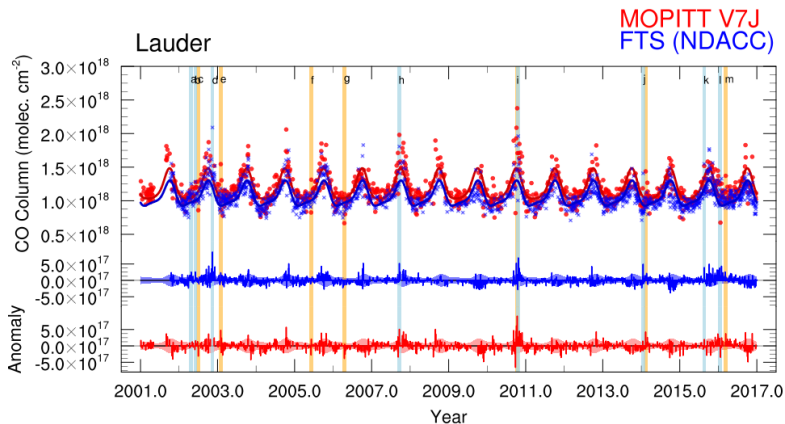
# Validation of MOPITT CO using ground-based solar FTIR measurements in NDACC



R. R. Buchholz, H. M. Worden,  
D. P. Edwards, M. N. Deeter,  
+ 14 NDACC stations

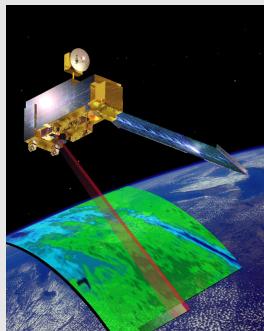
# Total column measurements of CO from space

- MOPITT (Measurements of Pollution In The Troposphere) has been measuring carbon monoxide (CO) since 2000
- Long record allows robust trend and interannual variability analysis
- Need to characterize any instrumental drift



## MOPITT

- Aboard the Terra satellite
- Gas filter correlation radiometer
- Joint TIR-NIR product: solar reflectance enhances lower troposphere sensitivity
- Co-location:  $1^\circ$  radius around station, daytime measurements ( $\sim 10:30$  am local time), 2002-onwards
- Since the Buchholz et al., 2017, comparison (V6) there have been 2 updates to the retrieval algorithm (V7 & V8)

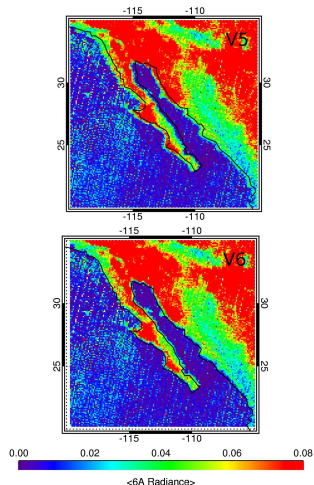


[Image: NASA]

# Recent MOPITT Product Versions

	<b>V6</b> <b>Deeter et al. (2014)</b>
Met. Data (Temp. and WV profiles)	MERRA
CO A Priori	CAM-Chem (2000-2009 climatology)
MODIS Cloud Mask	Collections 5 & 6
Radiative Transfer Modeling	Monthly-mean instrument parameters
Radiance Bias Correction Factors	Static TIR
In-situ Validation Datasets	NOAA, HIPPO

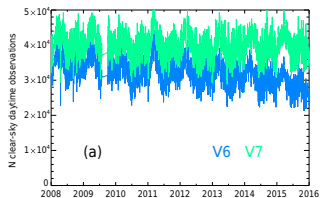
Corrected geolocation error



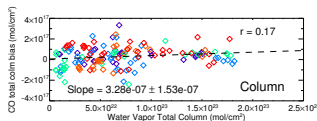
# Recent MOPITT Product Versions

	<b>V6</b> Deeter et al. (2014)	<b>V7</b> Deeter et al. (2017)
Met. Data (Temp. and WV profiles)	MERRA	MERRA-2
CO A Priori	CAM-Chem (2000-2009 climatology)	
MODIS Cloud Mask	Collections 5 & 6	Collection 6
Radiative Transfer Modeling	Monthly-mean instrument parameters	N <sub>2</sub> O growth added
Radiance Bias Correction Factors	Static TIR	Static TIR & NIR
In-situ Validation Datasets	NOAA, HIPPO	NOAA, HIPPO, ACRIDICON-CHUVA

## Cloud filtering comparison



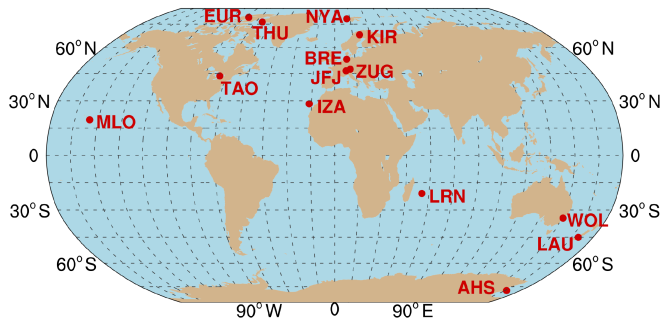
## Remaining bias relationship with water vapor



# Recent MOPITT Product Versions

	<b>V6</b> Deeter et al. (2014)	<b>V7</b> Deeter et al. (2017)	<b>V8</b> Deeter et al. (2019)
Met. Data (Temp. and WV profiles)	MERRA	MERRA-2	MERRA-2
CO A Priori	CAM-Chem (2000-2009 climatology)		
MODIS Cloud Mask	Collections 5 & 6	Collection 6	Collection 6.1
Radiative Transfer Modeling	Monthly-mean instrument parameters	N <sub>2</sub> O growth added	HITRAN and MT_CKD updated; N <sub>2</sub> radiative effects
Radiance Bias Correction Factors	Static TIR	Static TIR & NIR	Parameterized (time and WV total column)
In-situ Validation Datasets	NOAA, HIPPO	NOAA, HIPPO, ACRIDICON-CHUVA	NOAA, HIPPO, ACRIDICON-CHUVA, KORUS-AQ, ATom

# NDACC stations



Update the comparison for the 14 stations from Buchholz et al. (2017)  
Downloaded the data in 2016 (most were retrieved with SFIT4)

# Data preparation

## 1. Vertical regrid of FTS

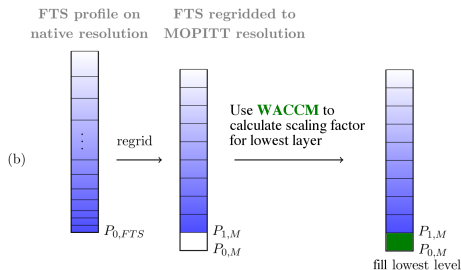
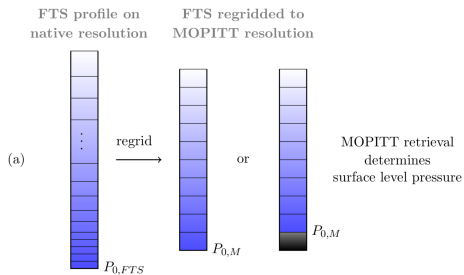
(a)  $p_{surf_M} < p_{surf_{FTS}}$

(b)  $p_{surf_M} > p_{surf_{FTS}}$

## 2. Smooth with MOPITT AK & a priori (from a $1^\circ$ radius)

## 3. Integrate smoothed values to column CO

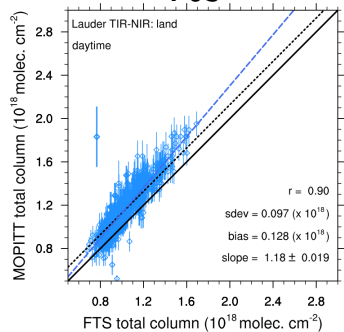
## 4. Compare with MOPITT total column



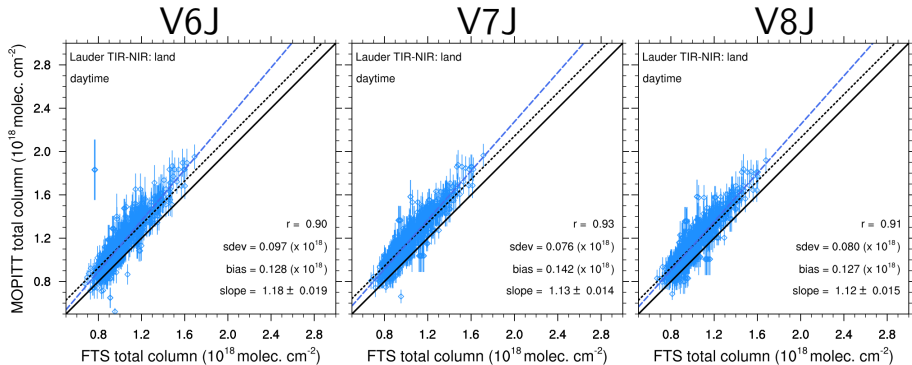


# Comparison at Lauder

## V6J

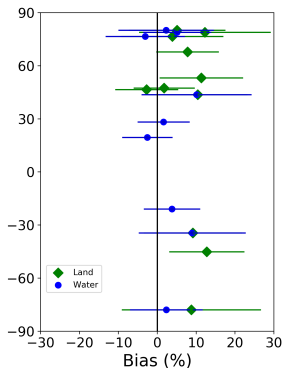


# Comparison at Lauder

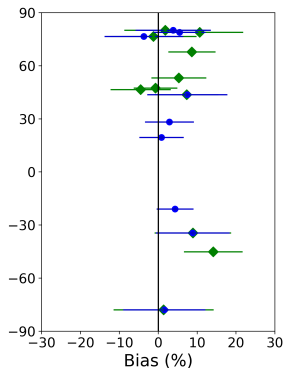


# Latitude versus bias

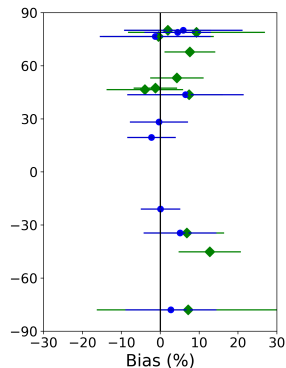
Latitude vs. bias V6 TIR-NIR



Latitude vs. bias V7 TIR-NIR



Latitude vs. bias V8 TIR-NIR

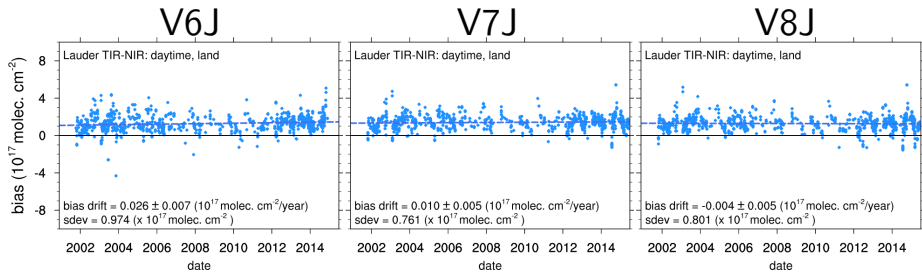


Mean bias: 5.31%  
Mean std dev: 11.1%

3.91%  
8.70%

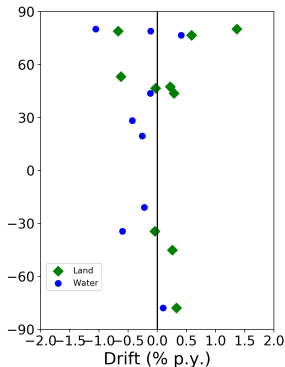
3.40%  
10.9%

# Bias drift at Lauder

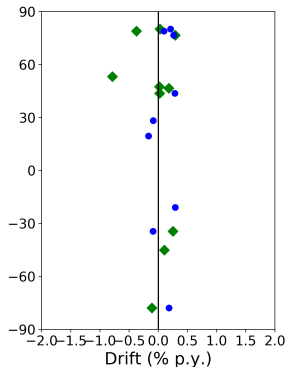


# Latitude versus bias drift

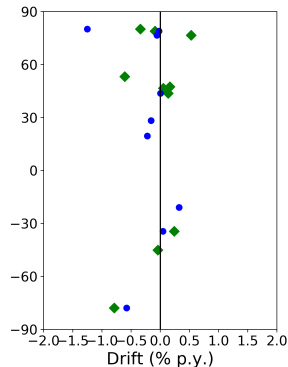
Latitude vs. bias drift V6 TIR-NIR



Latitude vs. bias drift V7 TIR-NIR



Latitude vs. bias drift V8 TIR-NIR



Mean drift: -0.03% p.y.  
(-60 to 60): -0.14% p.y.  
RMS: 0.33% p.y.

0.03% p.y.  
0.001% p.y.  
0.29% p.y.

-0.14% p.y.  
-0.006% p.y.  
0.24% p.y.

# Summary

- MOPITT CO retrieval updates require updated validation.
- Comparing MOPITT CO with NDACC CO found no major changes between retrieval versions 6, 7 and 8.
- Bias: No degradation, station-mean values suggest some improvement for updated retrievals.
- Drift: V7 showed improvement, V8 is most improved from 60N to 60S, but high latitudes are degraded compared to V7.

## Next Steps

- Harmonize the a priori
- Expand number of stations
- Extend comparisons to December 2018

### **Acknowledgments:**

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## References



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Deeter, M. N. et al., (2014), The MOPITT Version 6 product: algorithm enhancements and validation *Atmos. Meas. Tech.*, 7(11), 3623–3632



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# Extra: Averaging Kernels

Land and water retrievals are analyzed separately due to AK differences

