

Verifying NUCAPS trace gas products across time and space

Nadia Smith^(STC), Brad Pierce^(NOAA/STAR), Jim Davies^(UW/CIMSS)

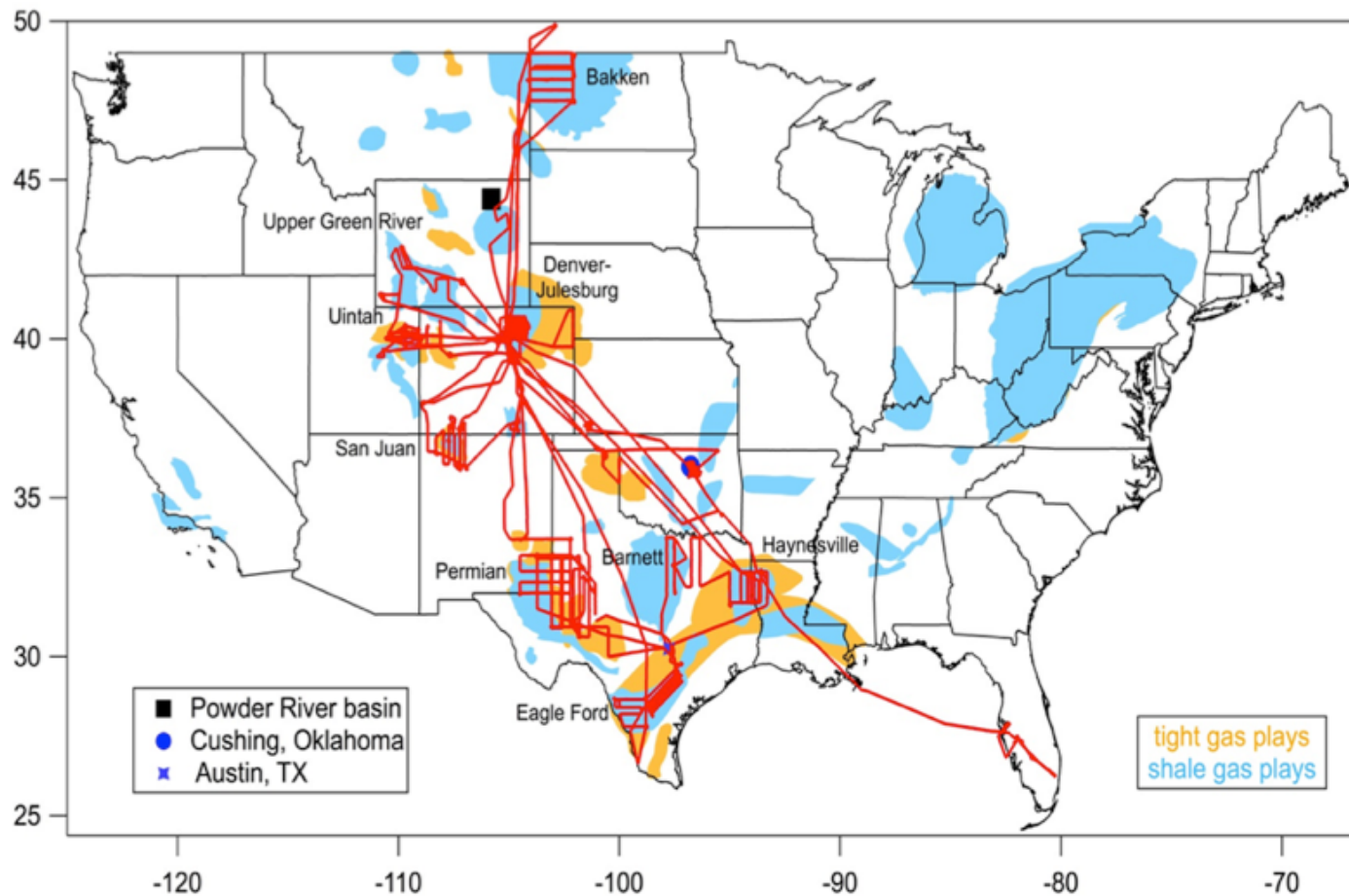
With contributions by: Greg Frost, Stuart McKeen, Chris Barnet, Ashley Wheeler, Antonia Gambacorta and many more.



What are the NUCAPS trace gas products?

By-products of physical retrieval system:

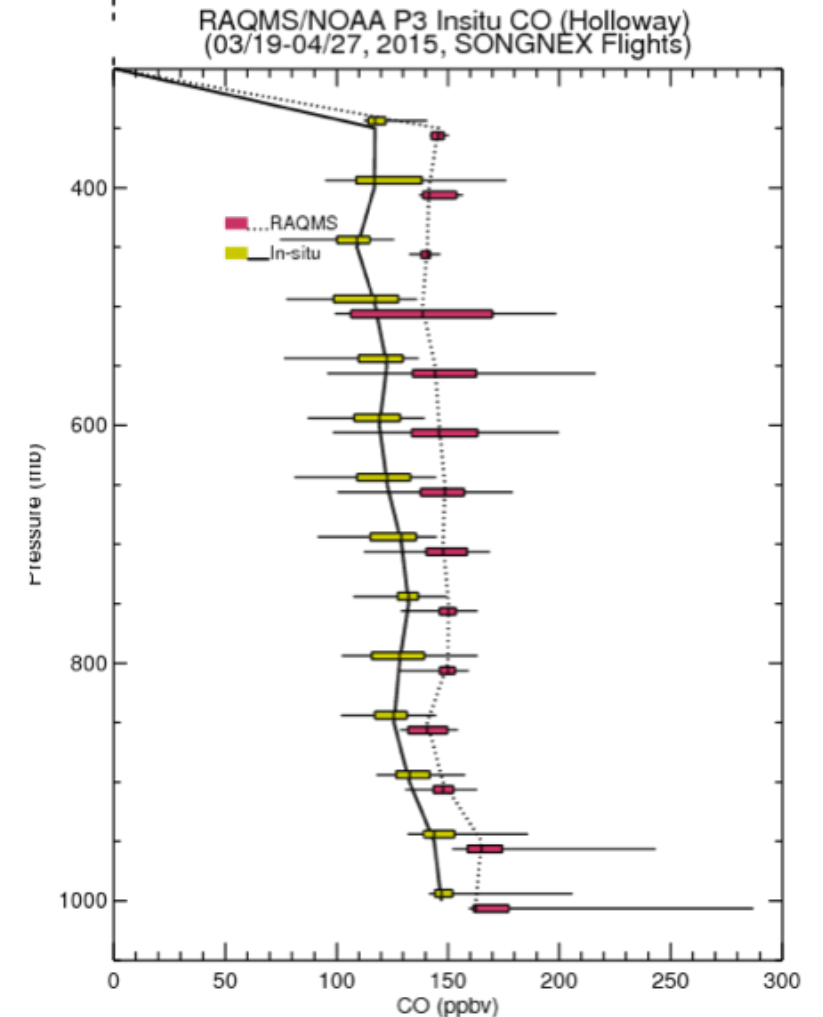
- (1) Stabilize T/q retrievals
- (2) Enable full connectivity between observed TOA radiance and geophysical state
- (3) Enable air chemistry applications from weather satellite systems



NOAA P-3 aircraft flight paths over the western US during the **SONGNEX field campaign**, March-April, 2015.

Comparisons between RAQMS and in situ CO measurements during SONGNEX show that RAQMS has a mean high bias of 29ppbv above 700mb and tends to overestimate the observed mid tropospheric variability

Brad Pierce (NOAA/STAR); Greg Frost (NOAA/ESRL)



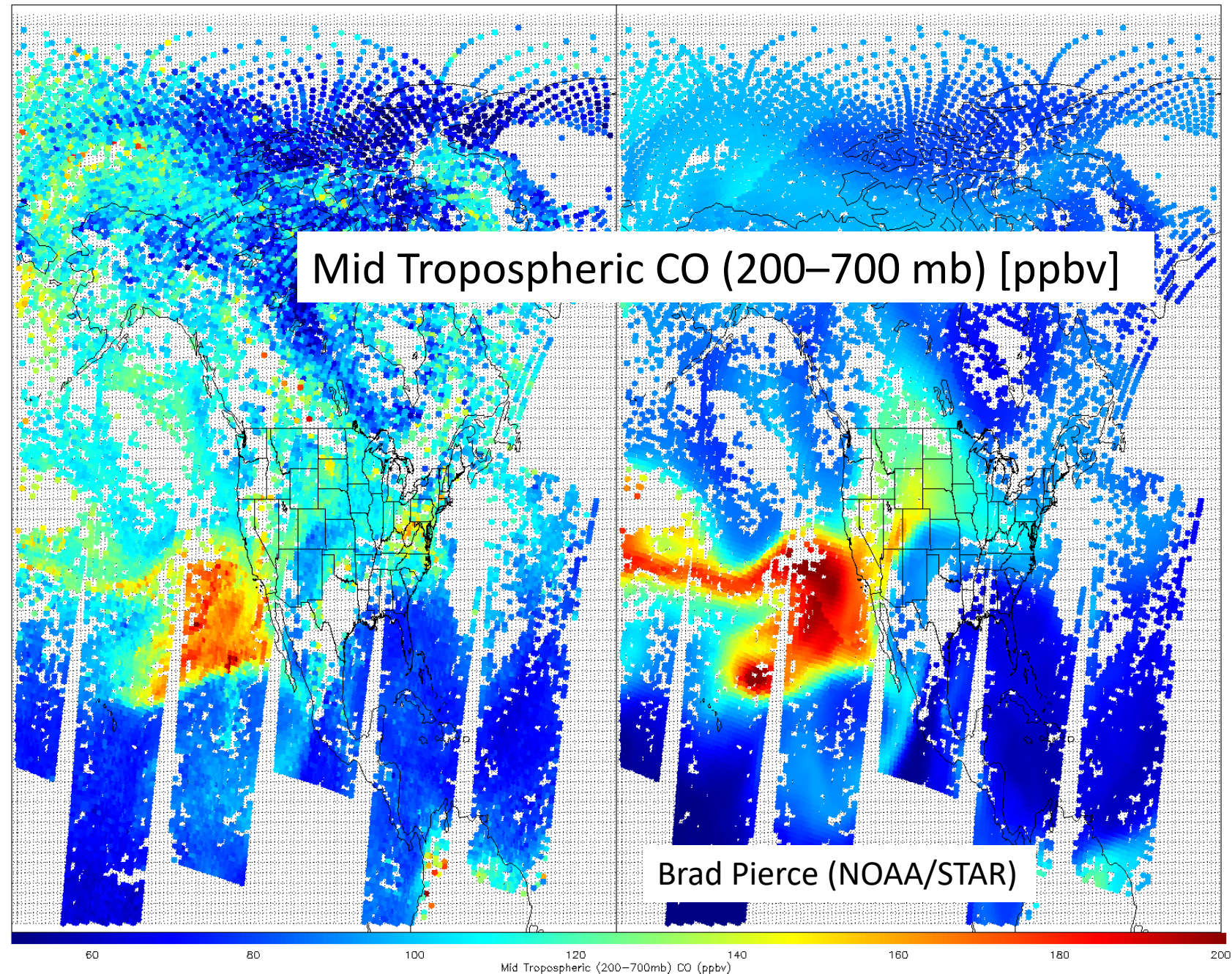
NUCAPS has the averaging kernels for each retrieval footprint.

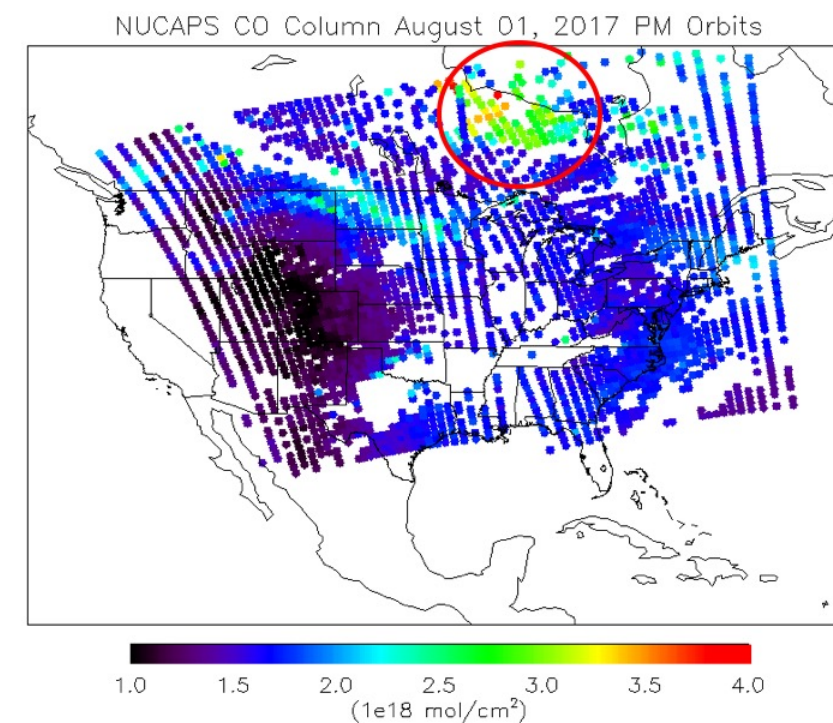
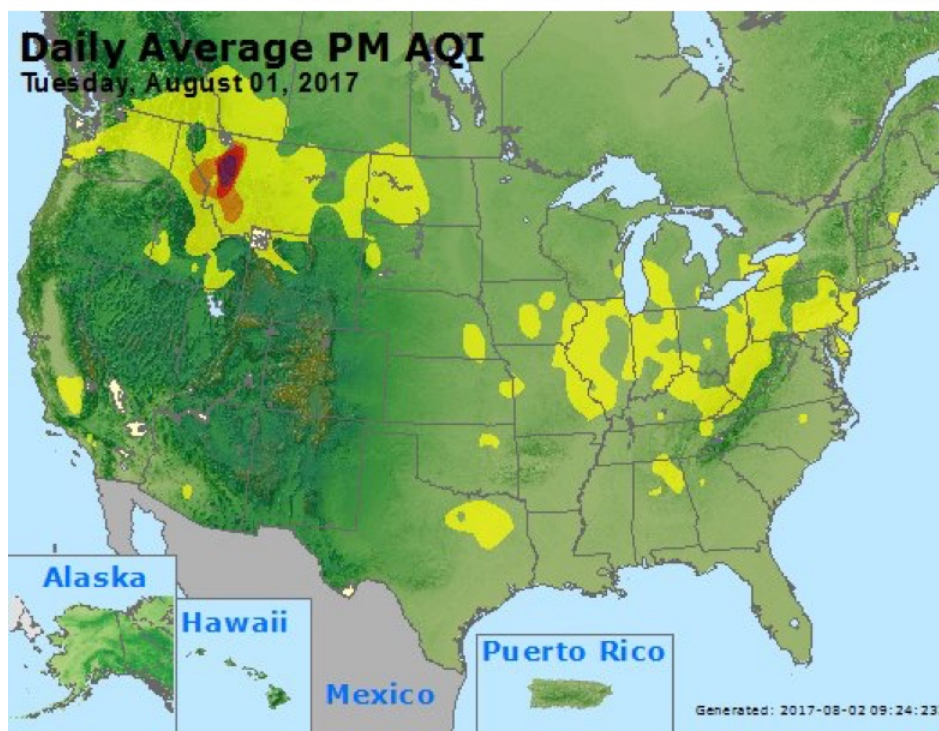
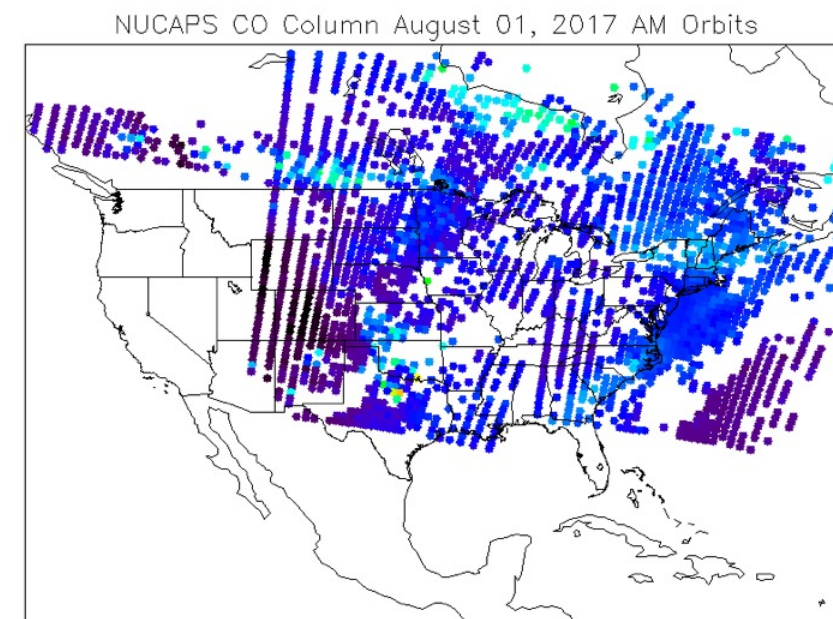
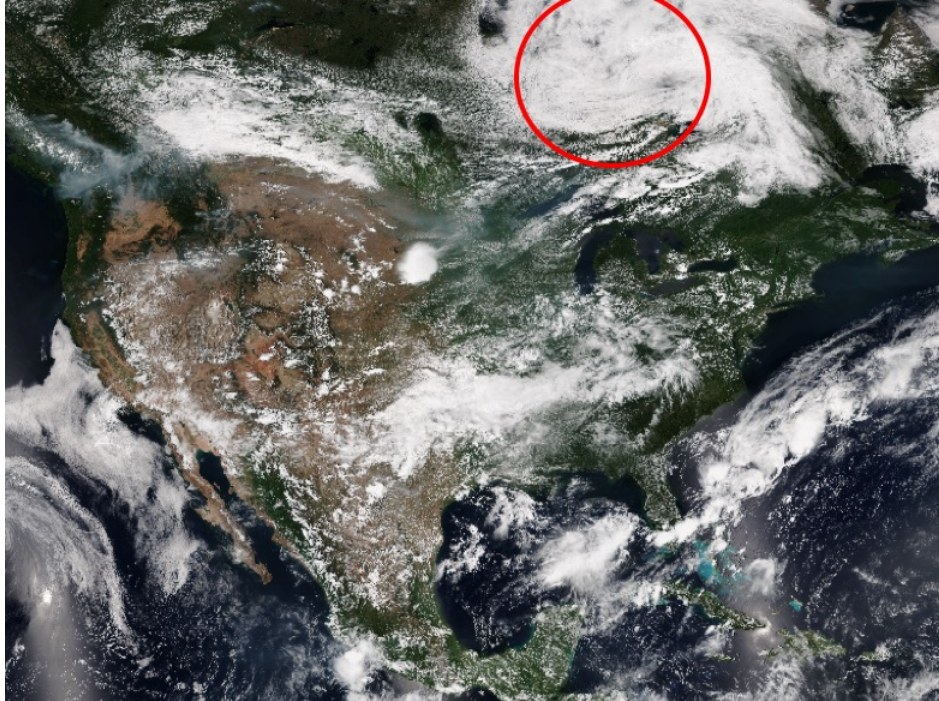
Comparisons between bias AK corrected RAQMS and NUCAPS mid tropospheric CO suggests that NUCAPS has a 6.8 ppbv high bias relative to the in situ aircraft measurements

Building on lessons learned, NUCAPS will support **FIREX** in **2018/2019**

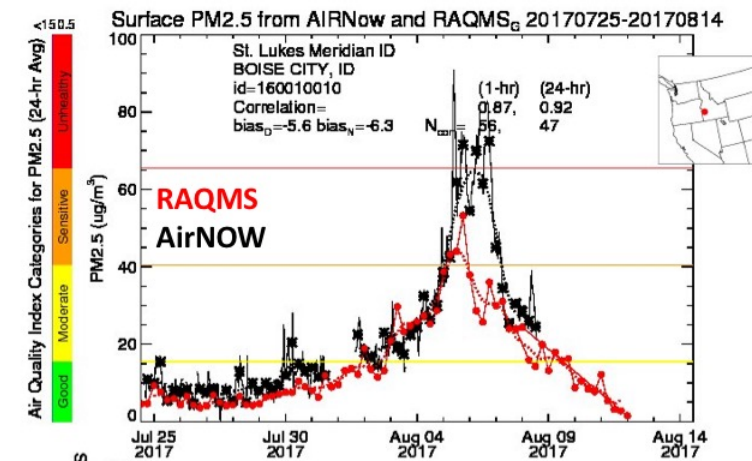
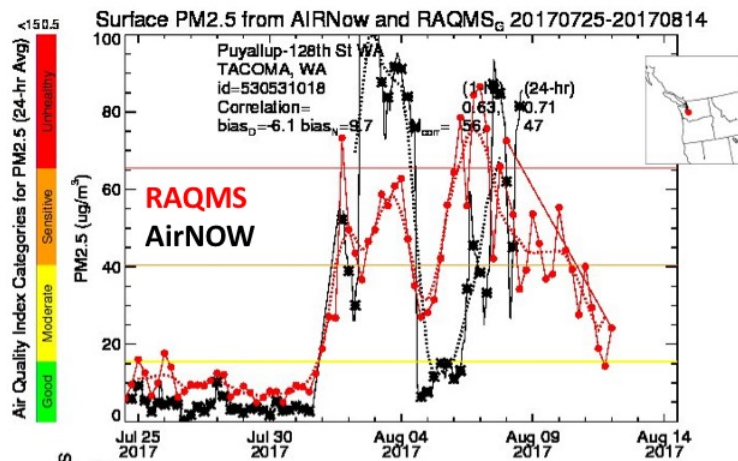
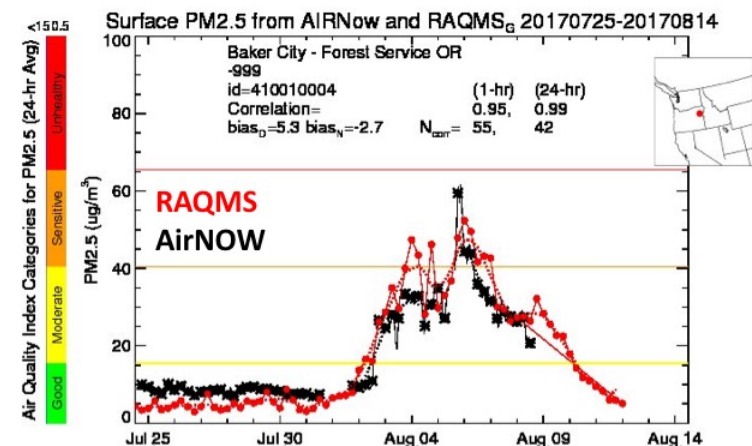
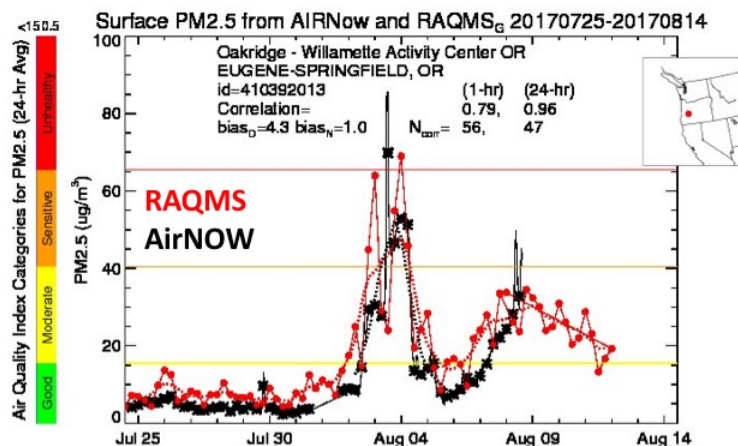
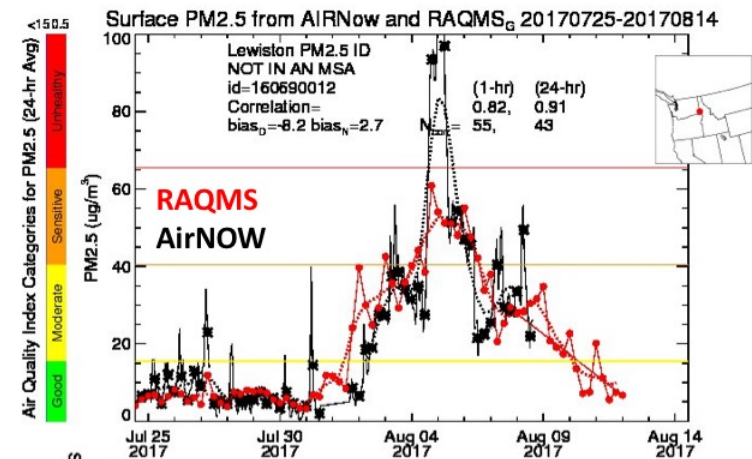
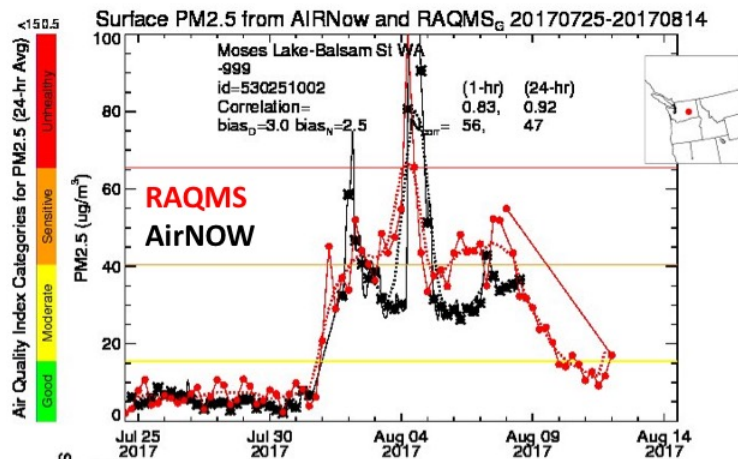
NUCAPS (FSR CrIS)

RAQMS





Brad Pierce
(NOAA/STAR)

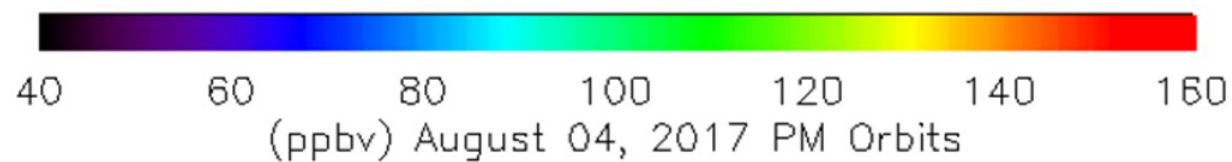
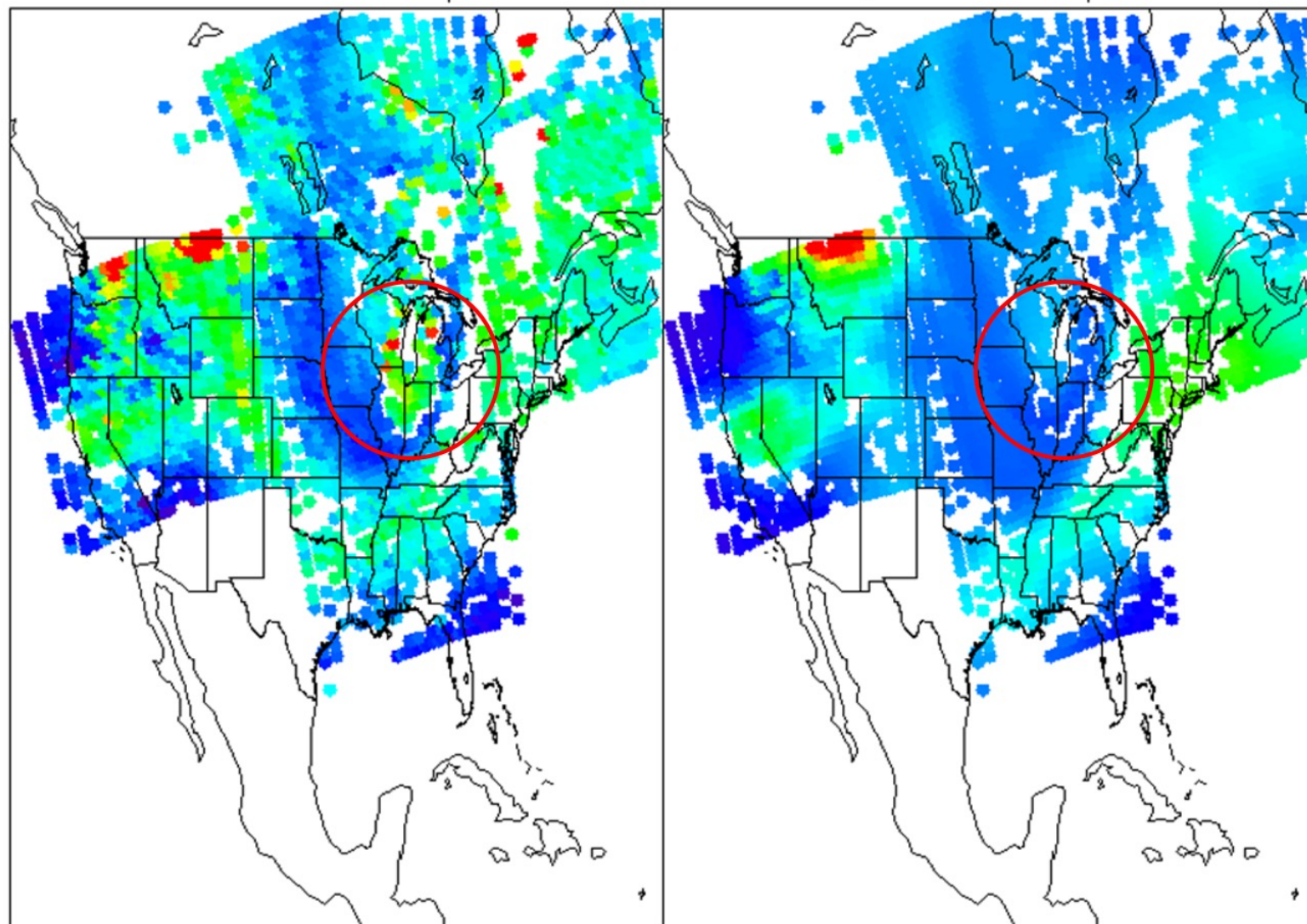


The Real-time Air Quality Modeling System (RAQMS) aerosol analysis captures the timing and magnitude of the surface smoke over the Pacific Northwest during the July 25-August 8, 2017 period.

Comparisons between RAQMS and NUCAPS CO columns can be used to evaluate the NUCAPS CO retrieval

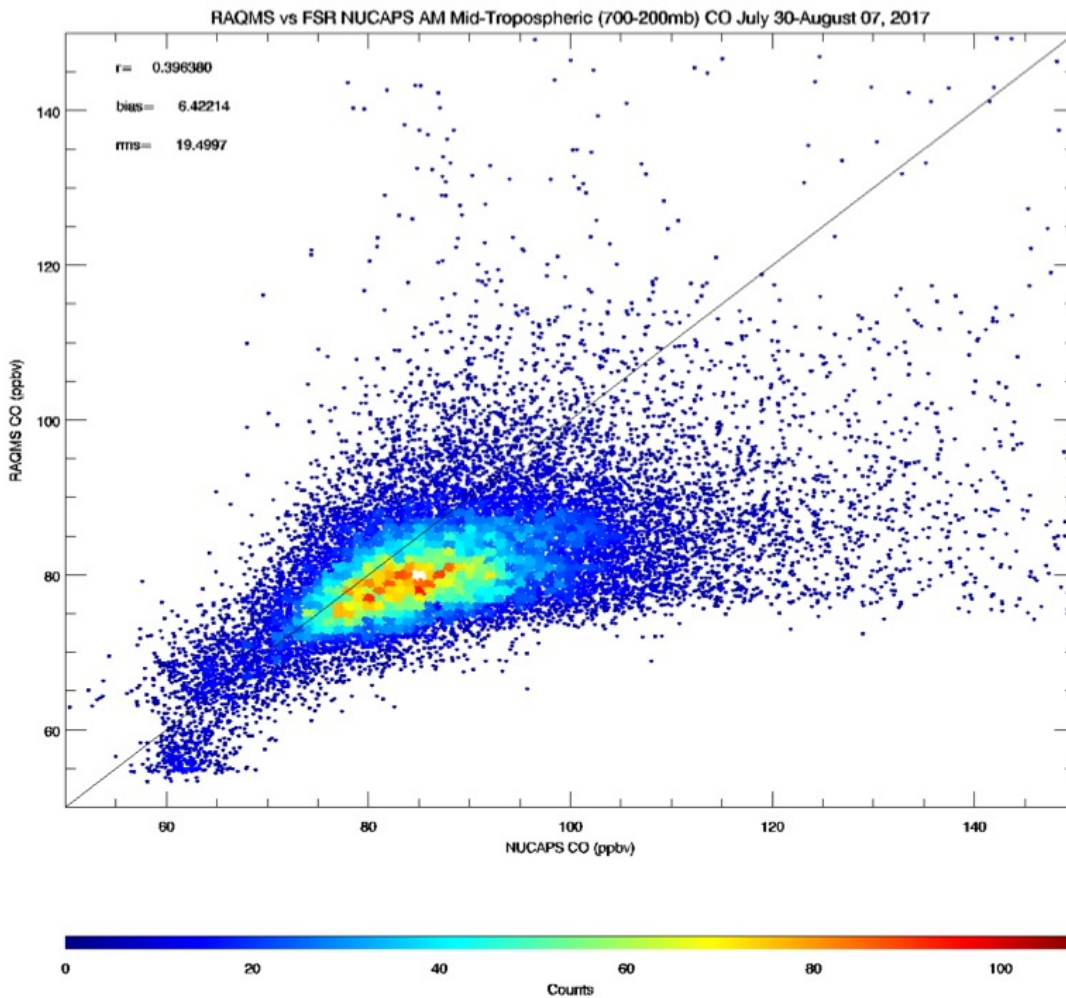
NUCAPS MidTrop CO

RAQMS MidTrop CO

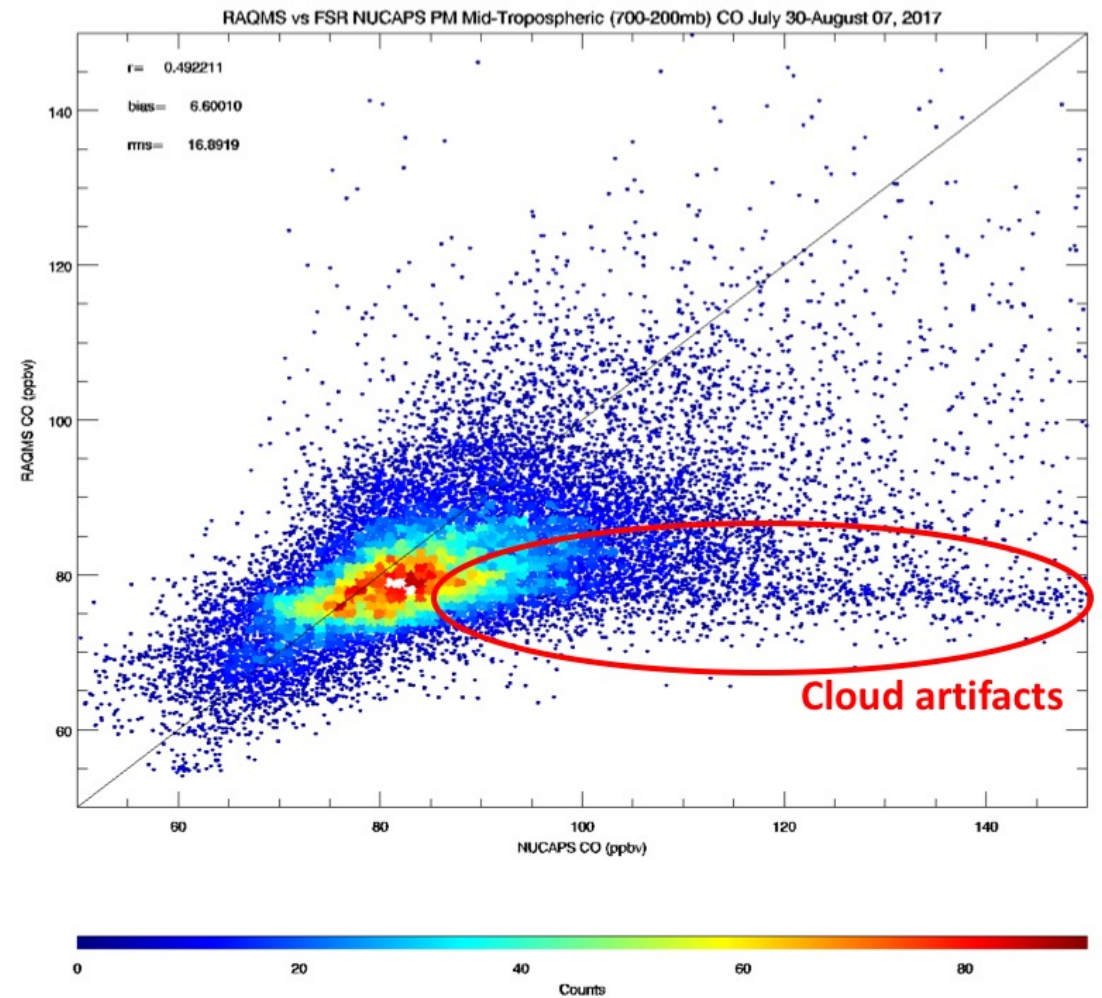


RAQMS vs FSR NUCAPS Mid-Tropospheric CO

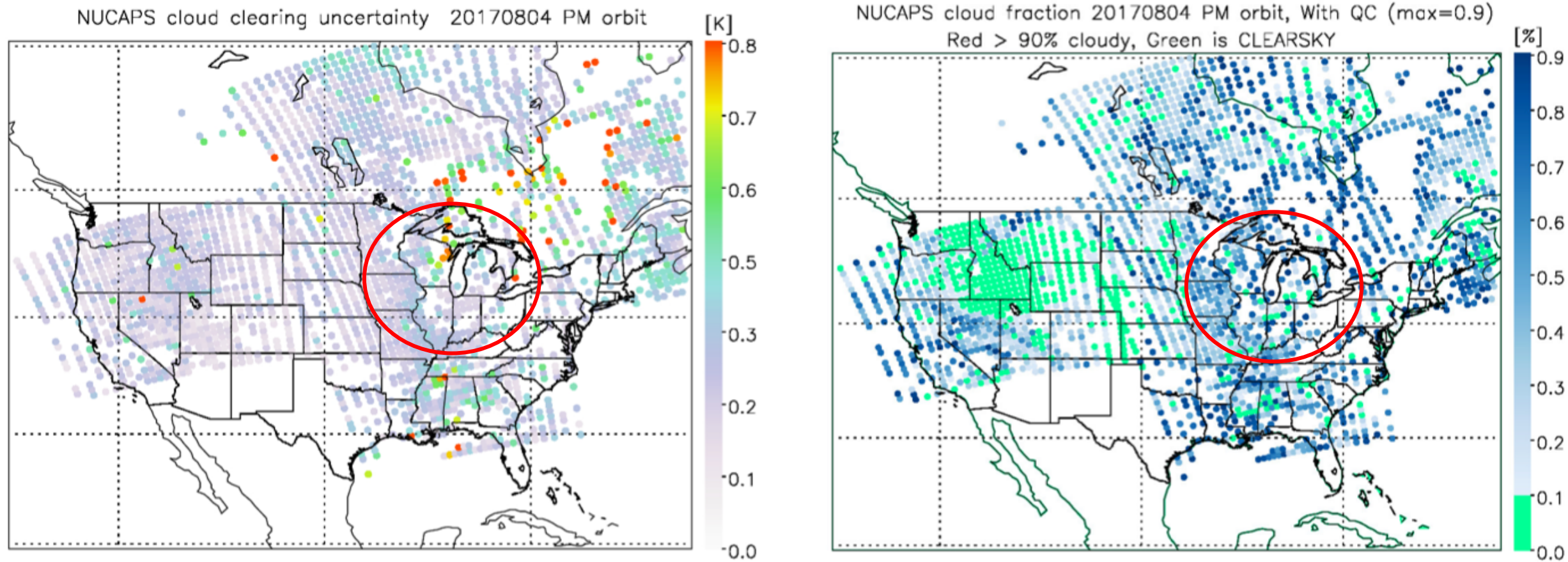
RAQMS vs NUCAPS mid-trop CO; Night time



RAQMS vs NUCAPS mid-trop CO; Day time



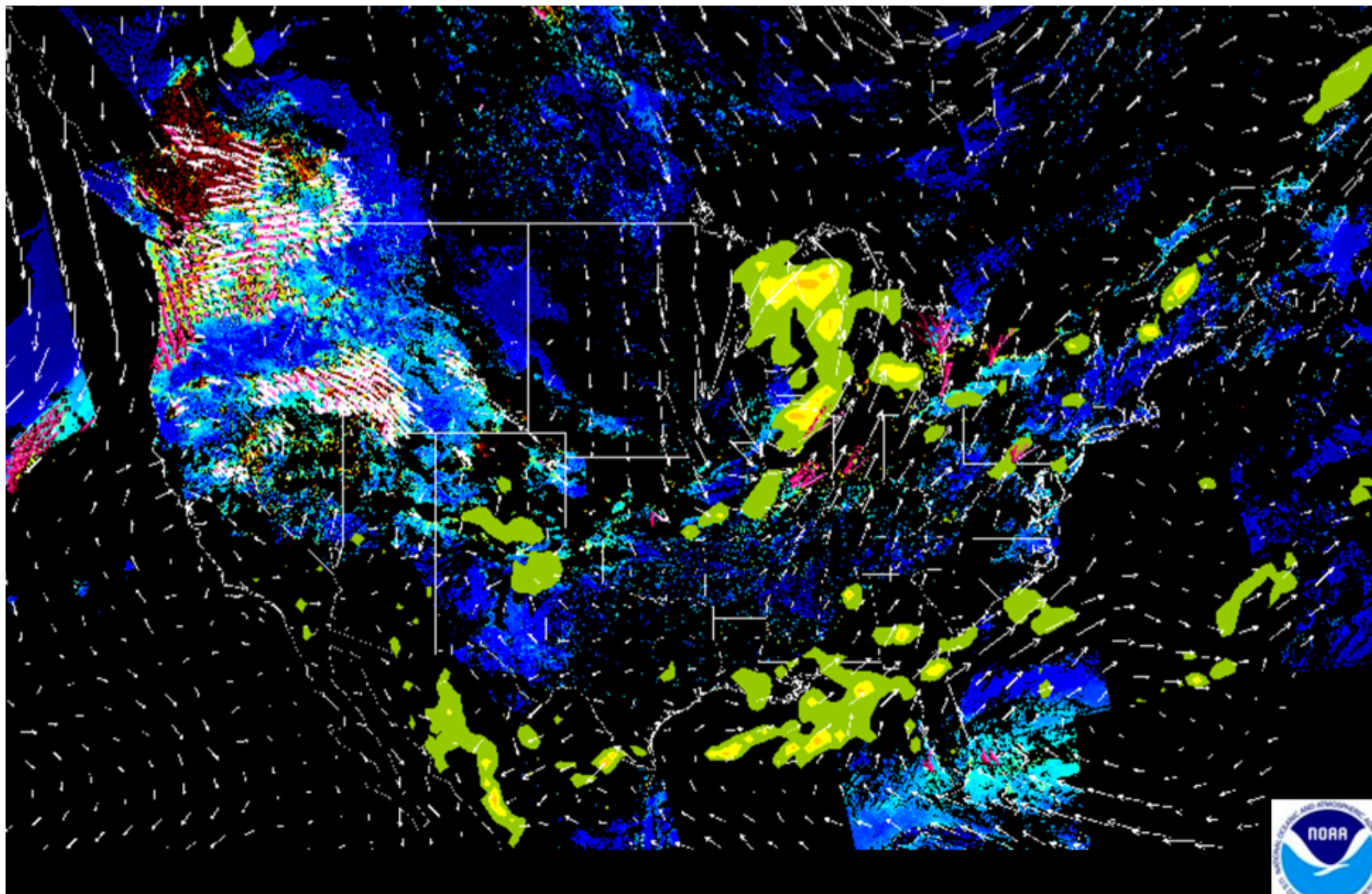
NUCAPS diagnostics and uncertainty metrics



The area has cloudy patches but the cloud clearing uncertainty is low, meaning that cloud contamination is low

Looking at NUCAPS diagnostic metrics we can determine that there are very few cloud artifacts in the region

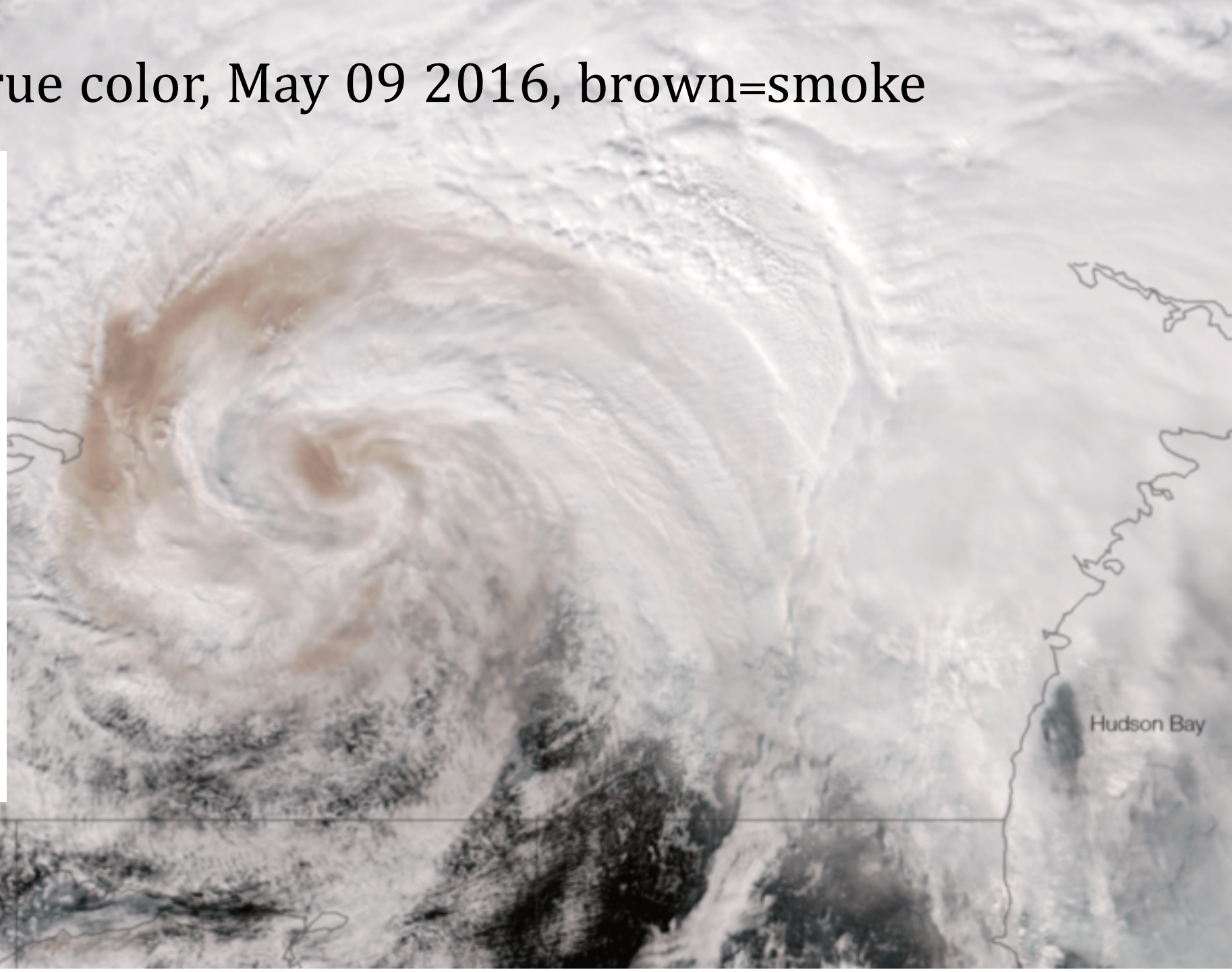
Brad Pierce: “OK, looking at AOD trajectories I see that it could be possible that there was enhanced CO within this cloud system”



VIIRS true color, May 09 2016, brown=smoke

NOAA visualization lab
(<https://www.nnvl.noaa.gov/>):

"Smoke from the Fort McMurray, Red Lake, and surrounding fires has been swept up in the cyclonic spin of a low pressure system over northern Canada. This true color image from the Suomi NPP satellite on May 9, 2016 at around 20:15 UTC shows the clouds, stained brown from the smoke."



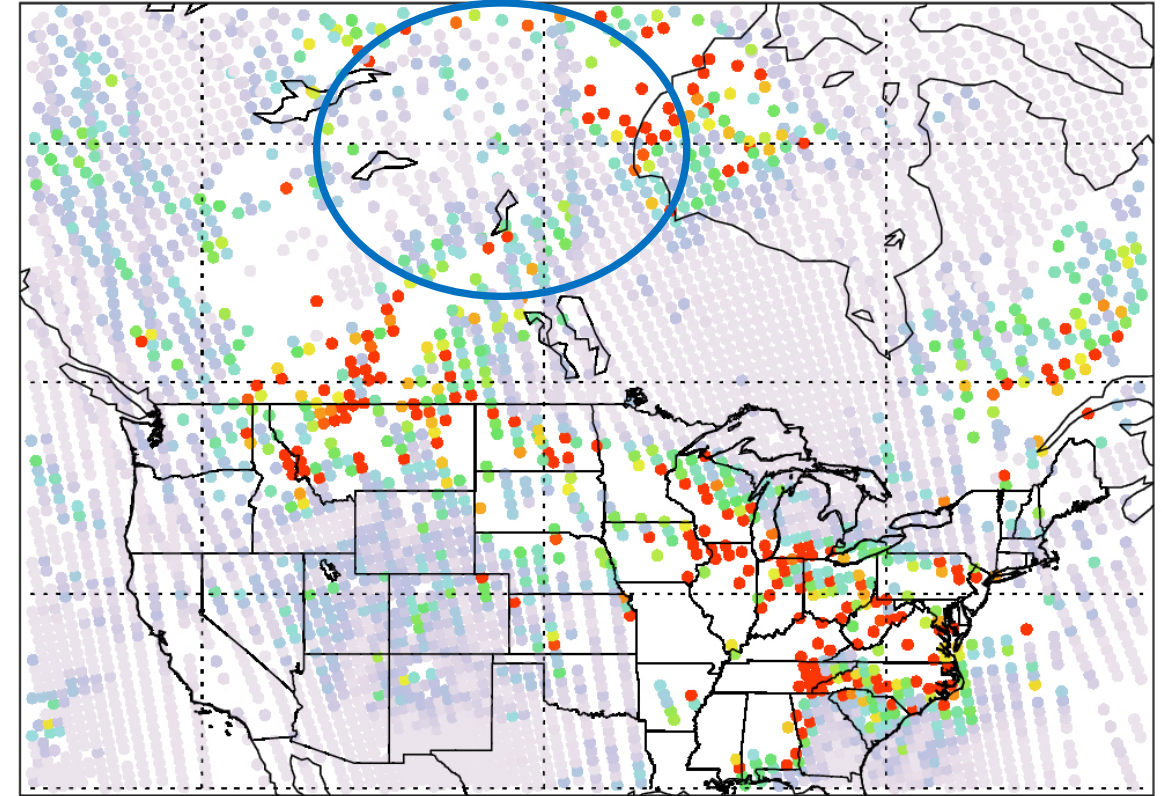
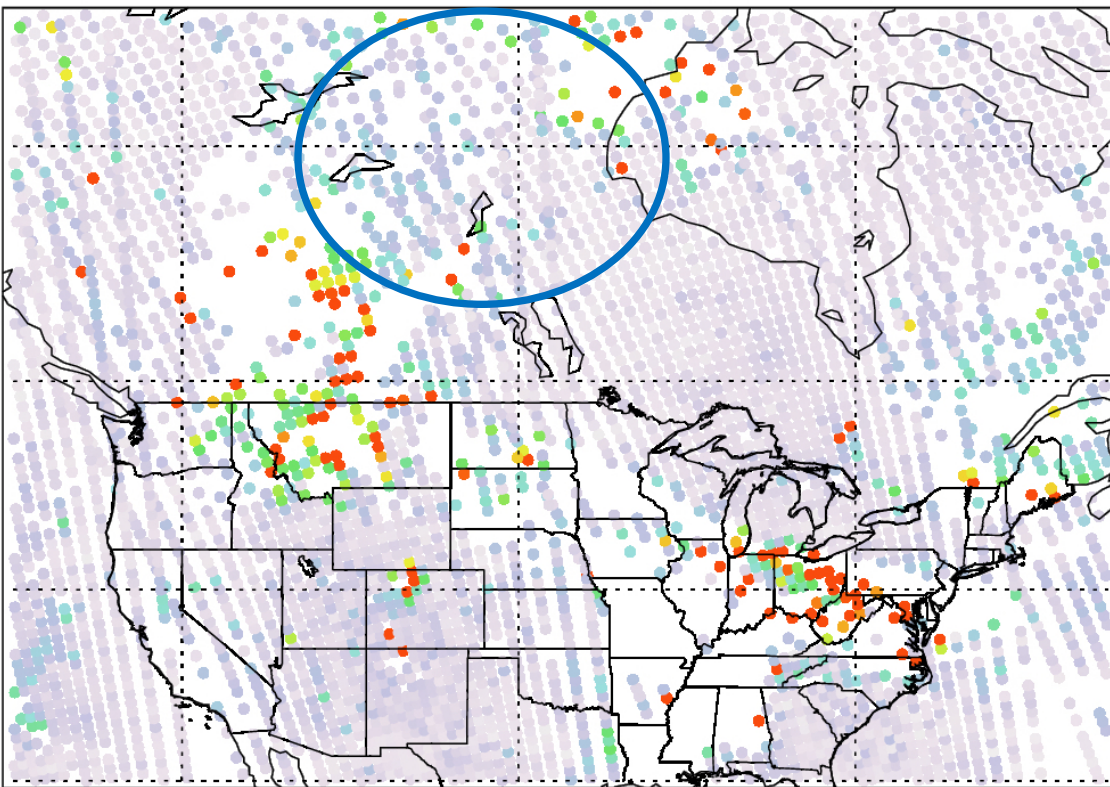
NUCAPS diagnostics – we can measure cloud clearing uncertainty

NUCAPS cloud clearing uncertainty 20160509 PM orbit

[K]



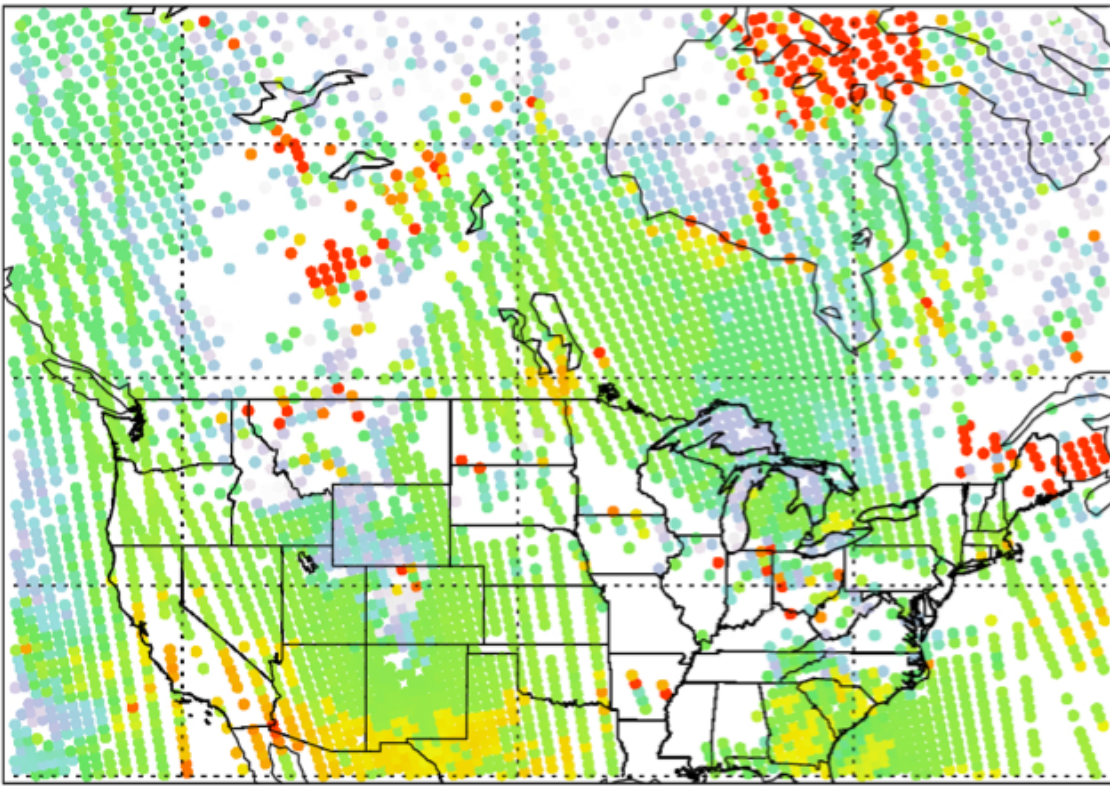
NUCAPS CC Noise Amplification Factor 20160509 PM orbit



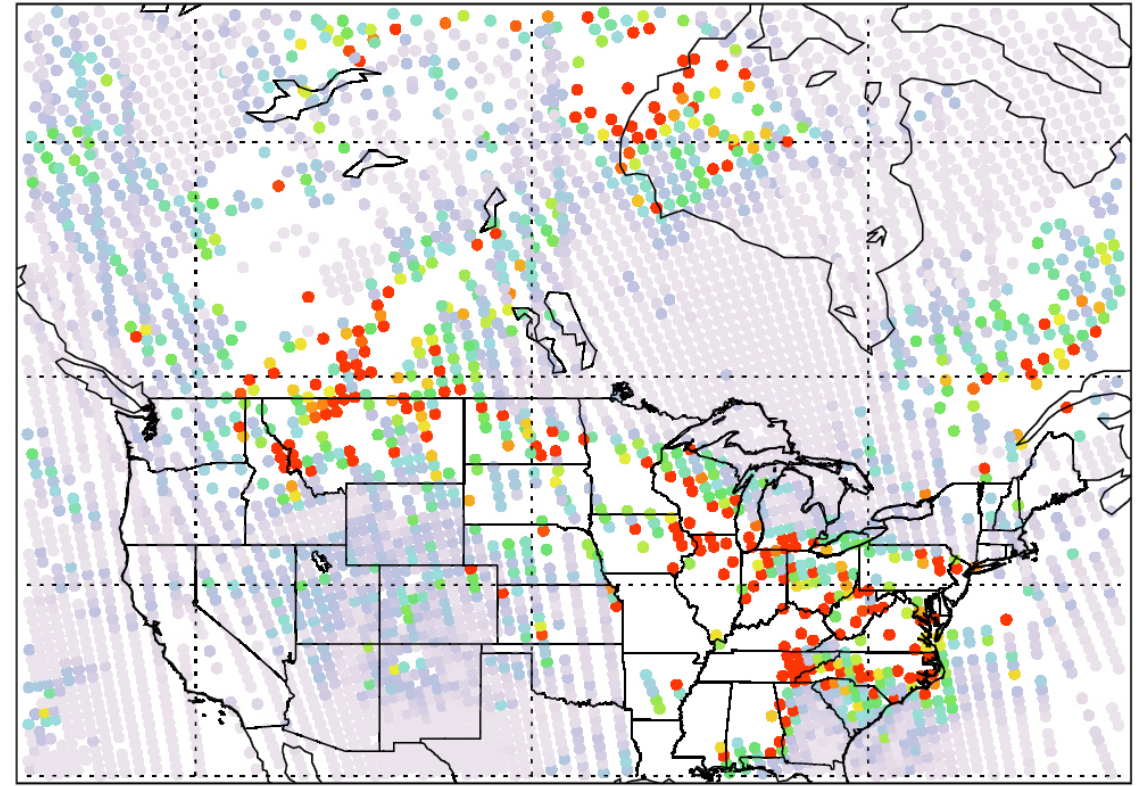
NUCAPS diagnostics – CO degrees of freedom

NUCAPS CO DOF 20160509 PM orbit

[DOF]



NUCAPS CC Noise Amplification Factor 20160509 PM orbit

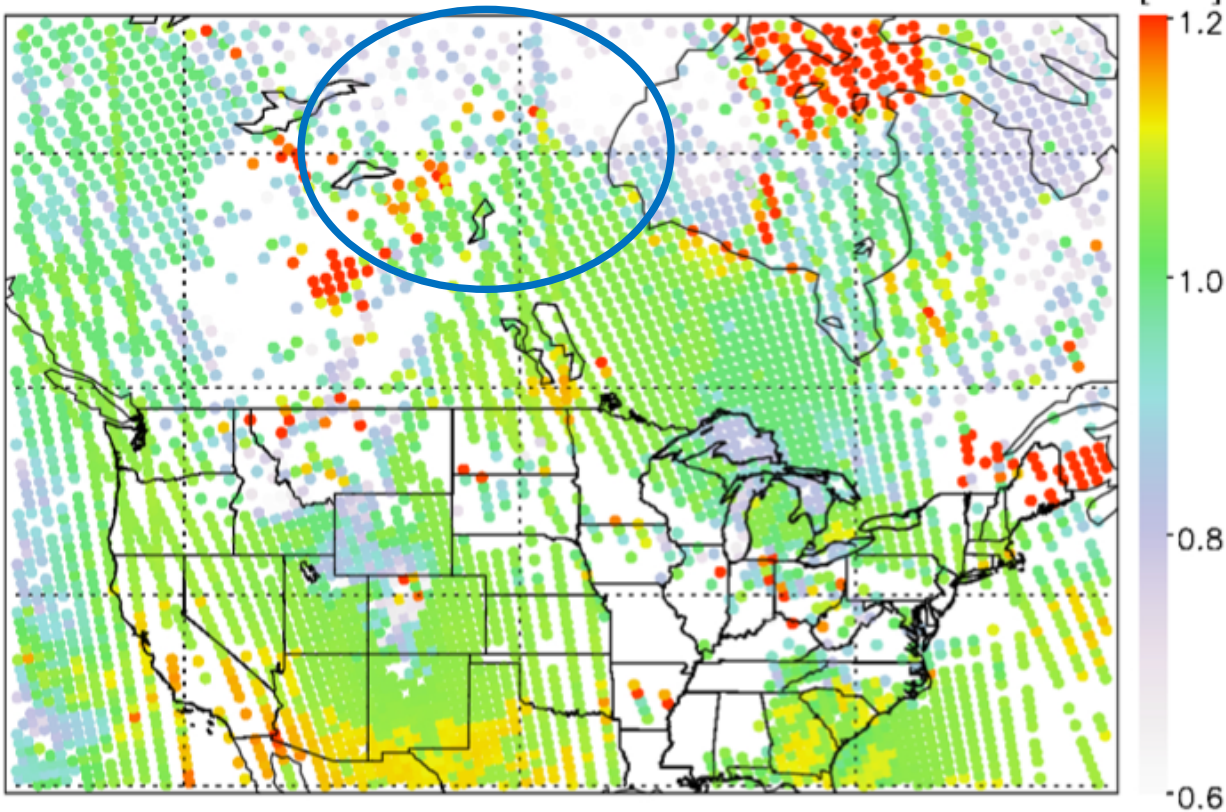


NUCAPS embedded IC analysis

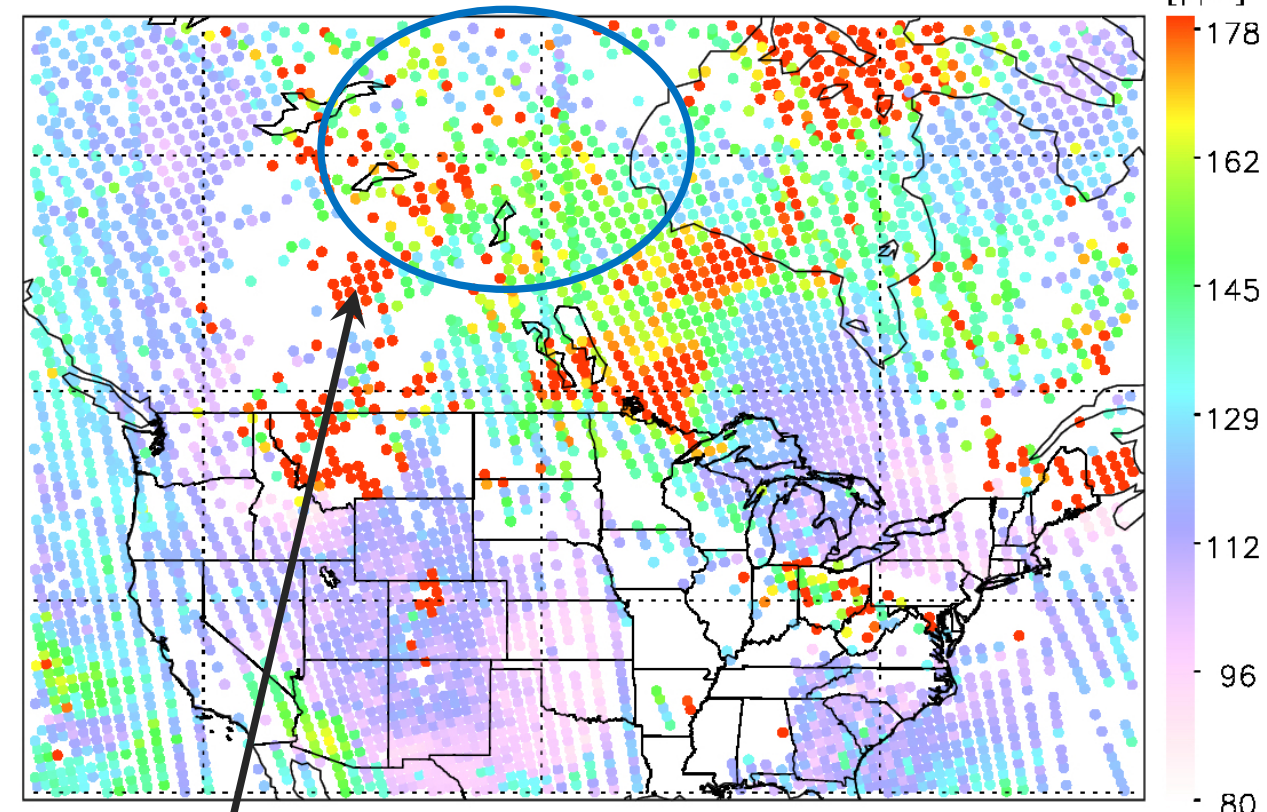
DOF as metric of information contributed by the radiance measurements.

Retrieving NUCAPS CO in cloudy regions with confidence

NUCAPS CO DOF 20160509 PM orbit



NUCAPS CO mixing ratio [ppb] at 500 hPa 20160509 PM orbit



Fire source: Ft McMurray

High DOF + low CC error = confidence in NUCAPS CO retrieval

Summary

- NUCAPS CO in complex cloudy scenes where other data sources lack skill
- Care should be taken in using data comparisons to strengthen assumptions that may not be true.
- We continue our efforts to determine the best way to use these products in research and decision-making
- These exploratory efforts could lead to:
 - parameter-specific QC in application
 - algorithm improvements
 - target areas for validation
 - Trace gas assimilation into global chemistry models (RAQMS and NG GFS)