

CSPP NUCAPS Full Spectral Resolution CO

vs

RAQMS – new results

August 2017 wildfires

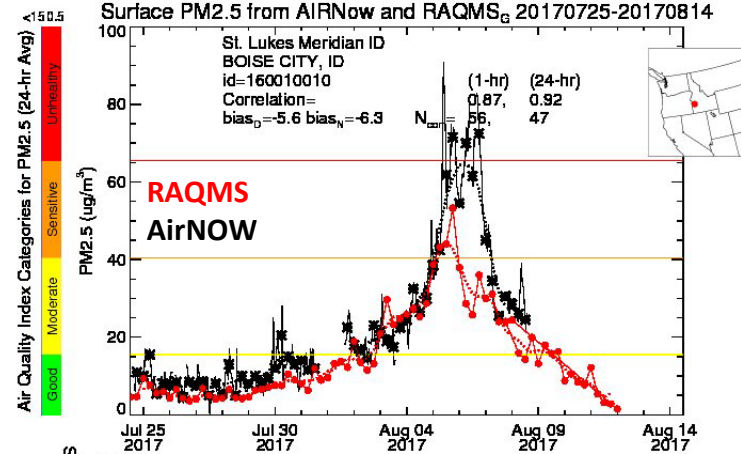
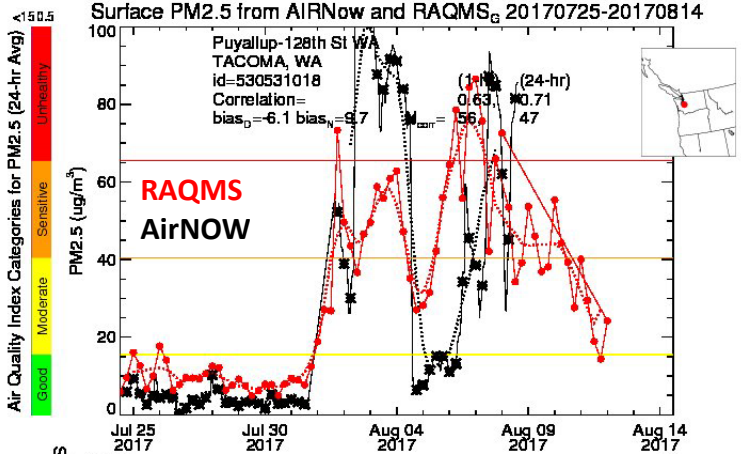
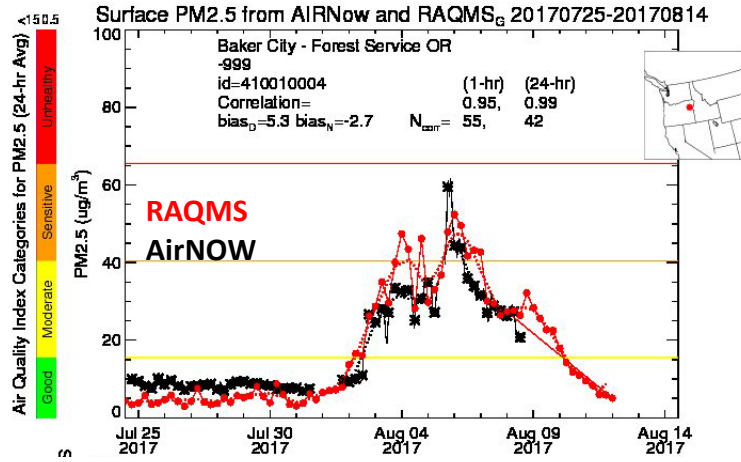
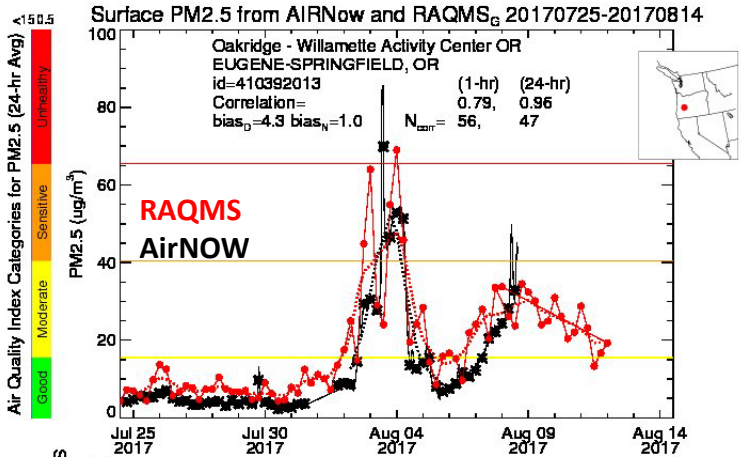
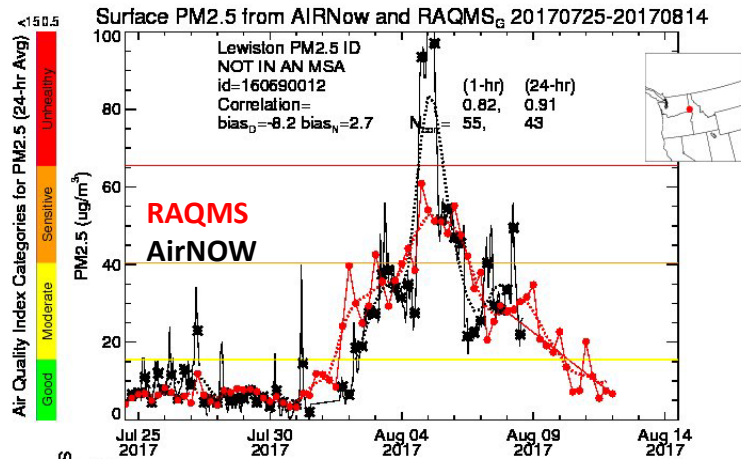
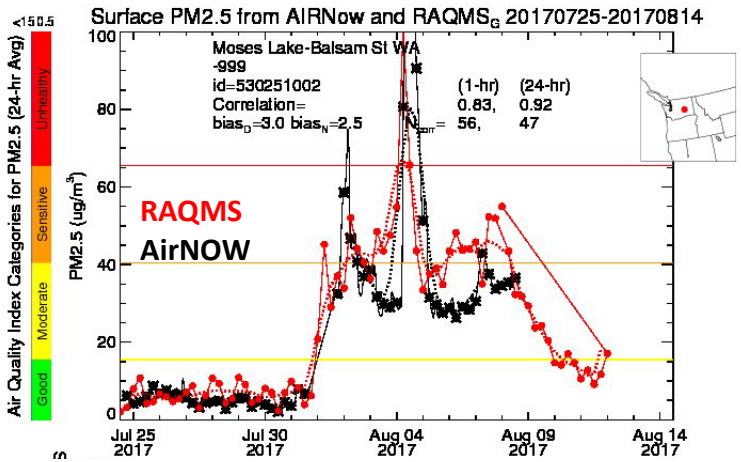
NOAA Satellite Aerosol Products Workshop

September 25, 2017

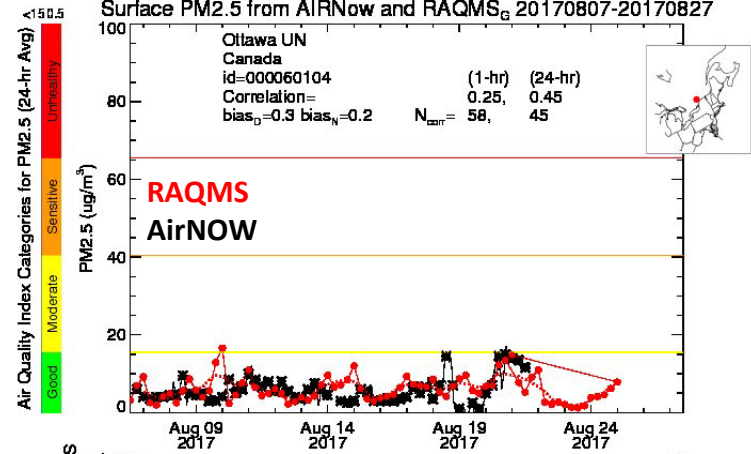
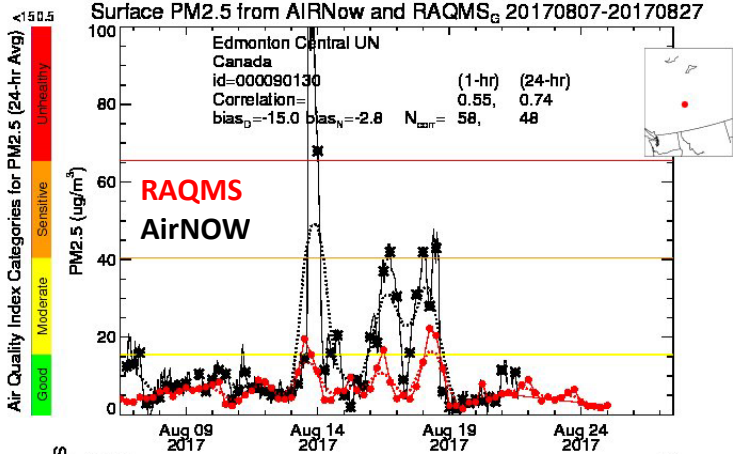
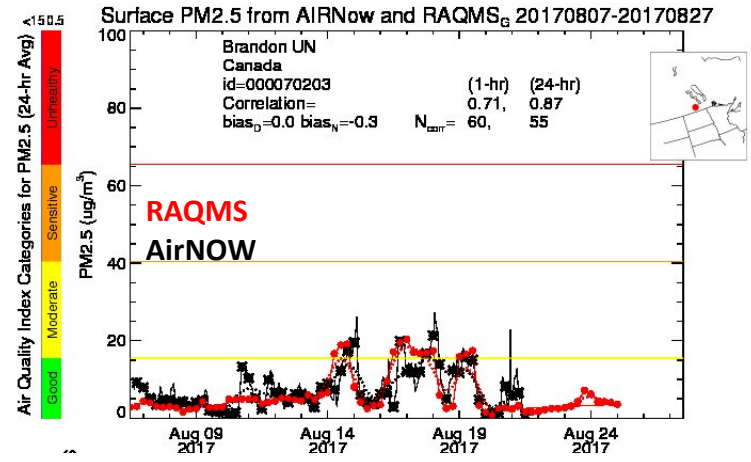
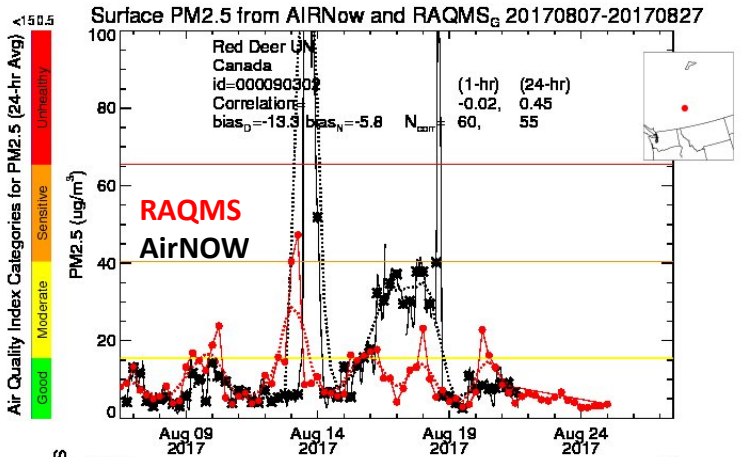
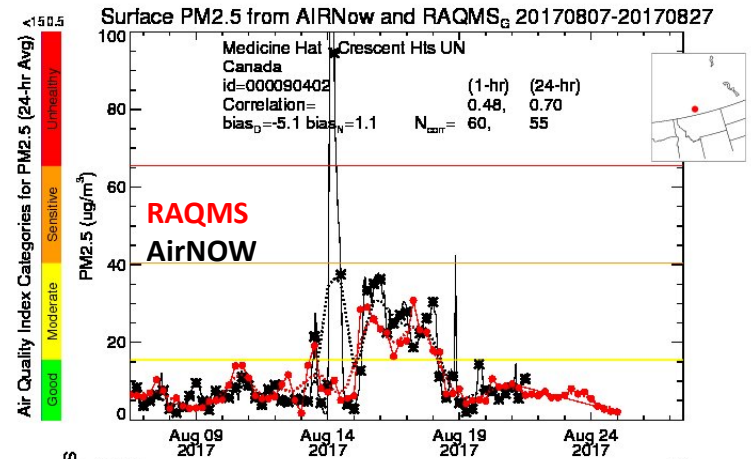
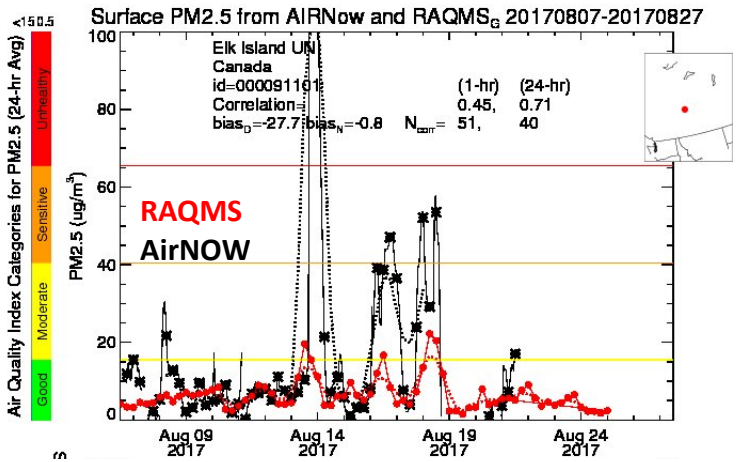
Brad Pierce (STAR), **Nadia Smith** (STC),

Jim Davies (CIMSS), Chris Barnet (STC)

Need for multiple products to understand complex systems

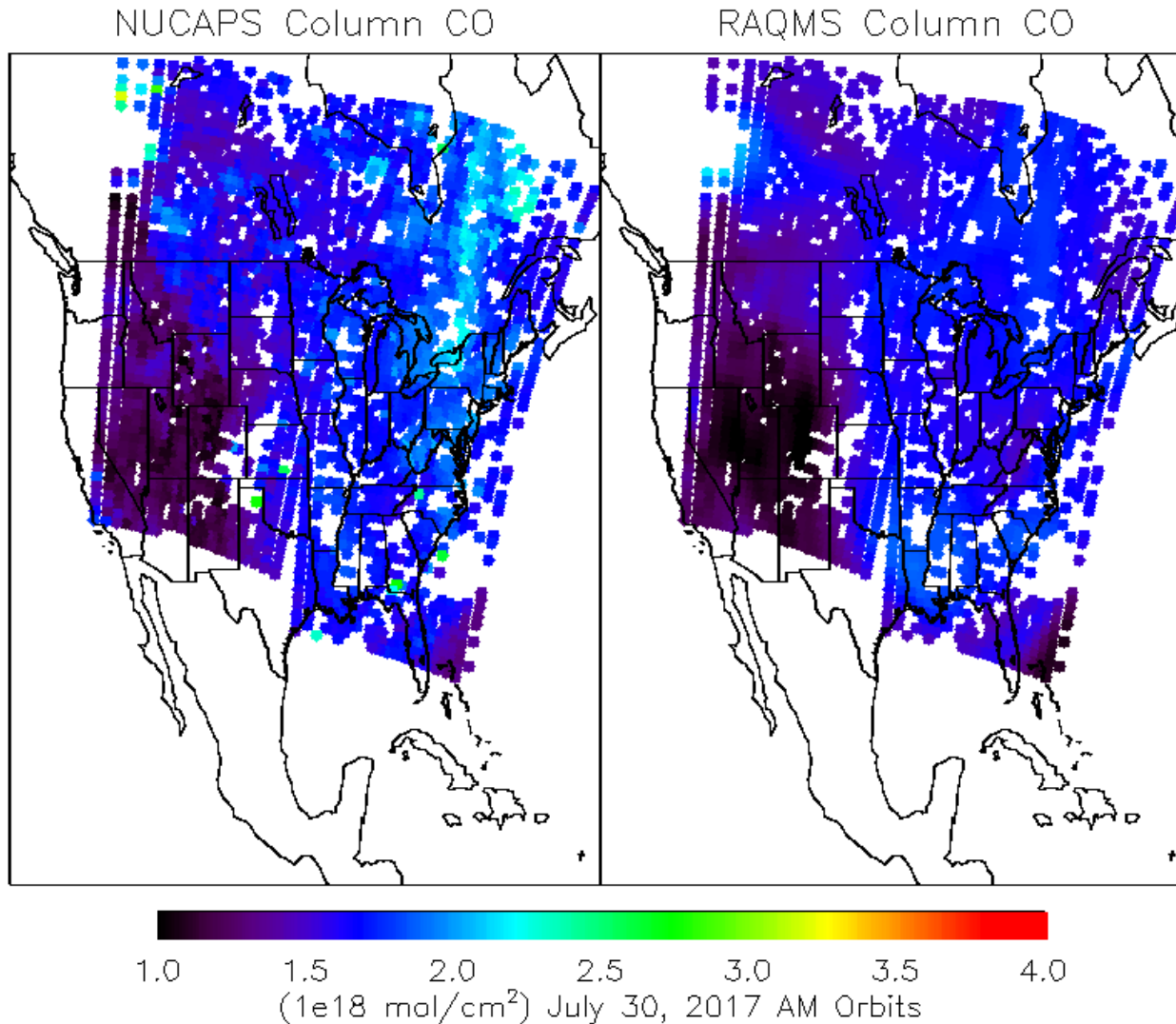


The Real-time Air Quality Modeling System (RAQMS) aerosol analysis ***captures the timing and magnitude of the surface smoke*** over the Pacific Northwest during the July 30-August 8, 2017 period.



The Real-time Air Quality Modeling System (RAQMS) aerosol analysis ***captures the timing but underestimates the magnitude of the surface smoke*** over Central Canada during the August 13-August 19, 2017 period.

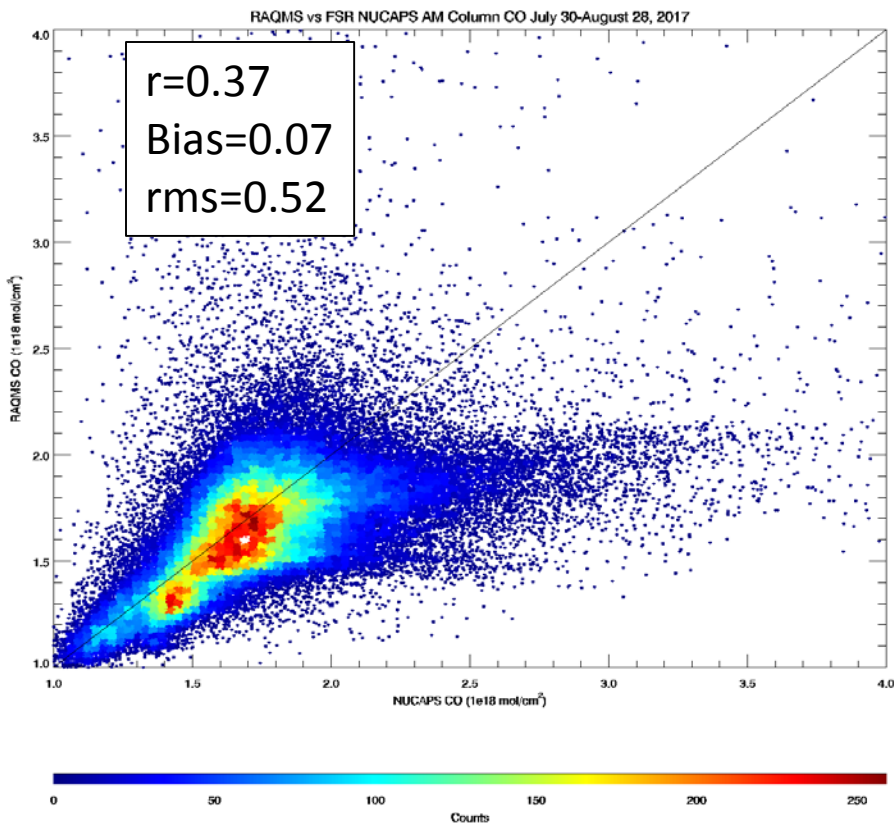
# Carbon Monoxide Column July 30 – August 28, 2017



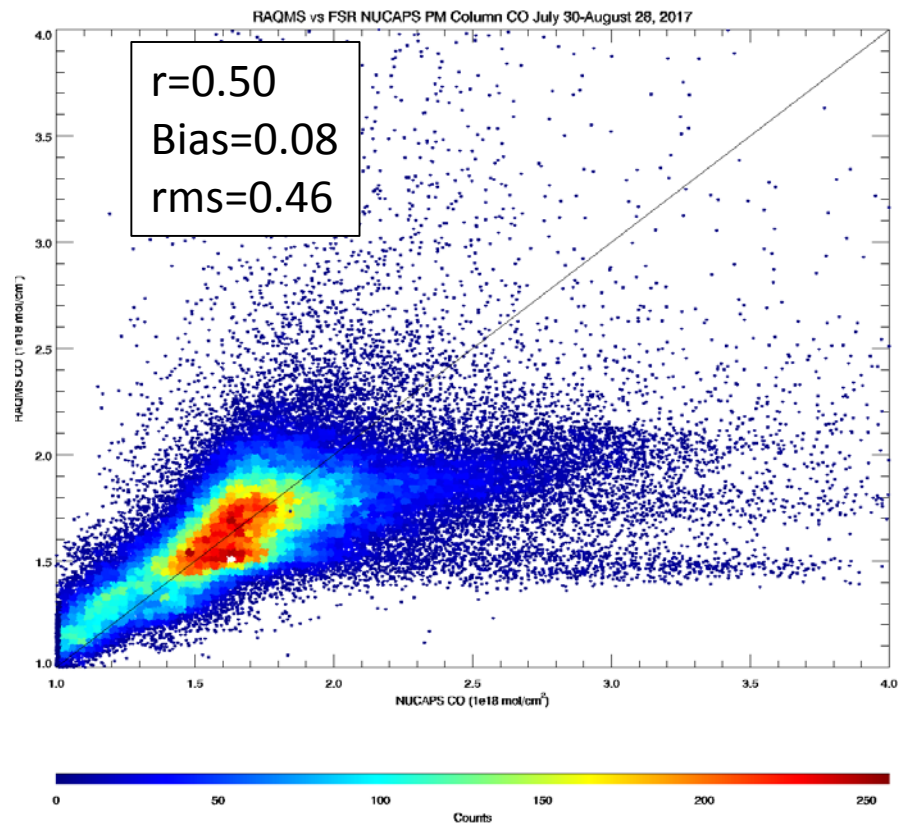
NUCAPS science retrievals use CrIS Full Spectral Resolution (FSR) SDR code run within CSPP

# Carbon Monoxide Column July 30 – August 28, 2017

## AM Orbits



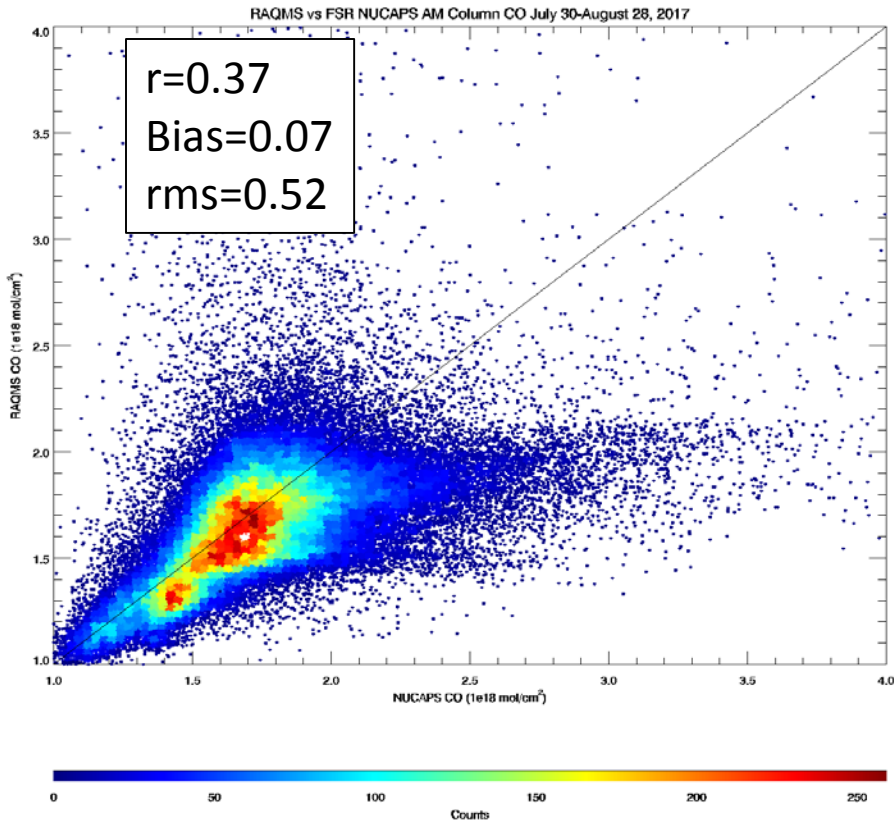
## PM Orbits



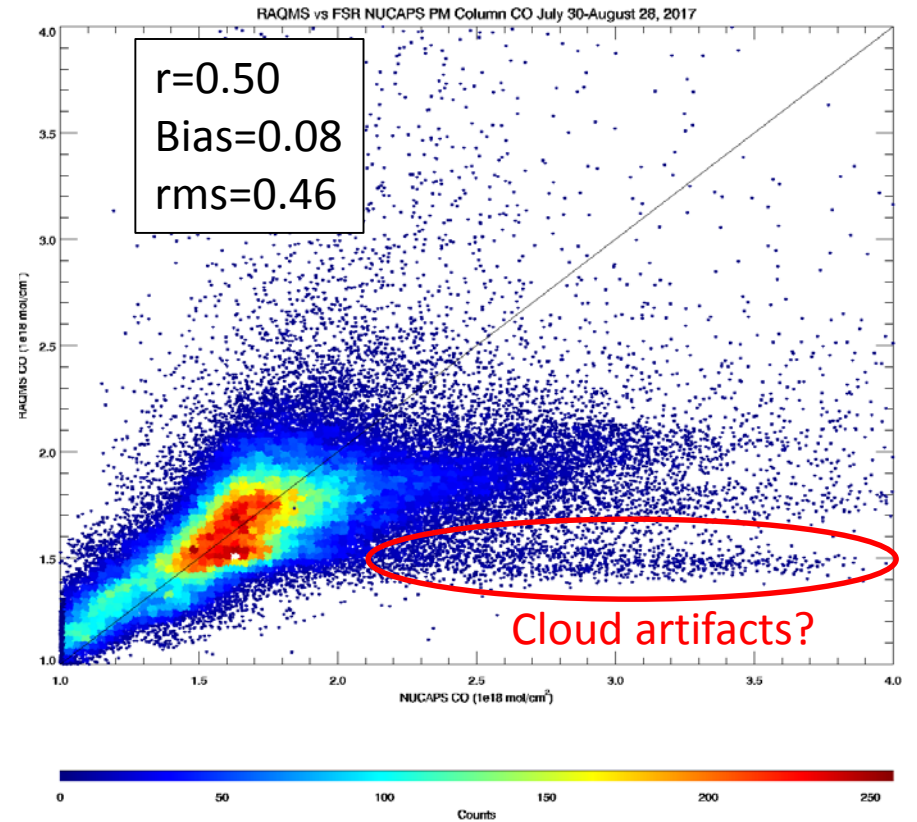


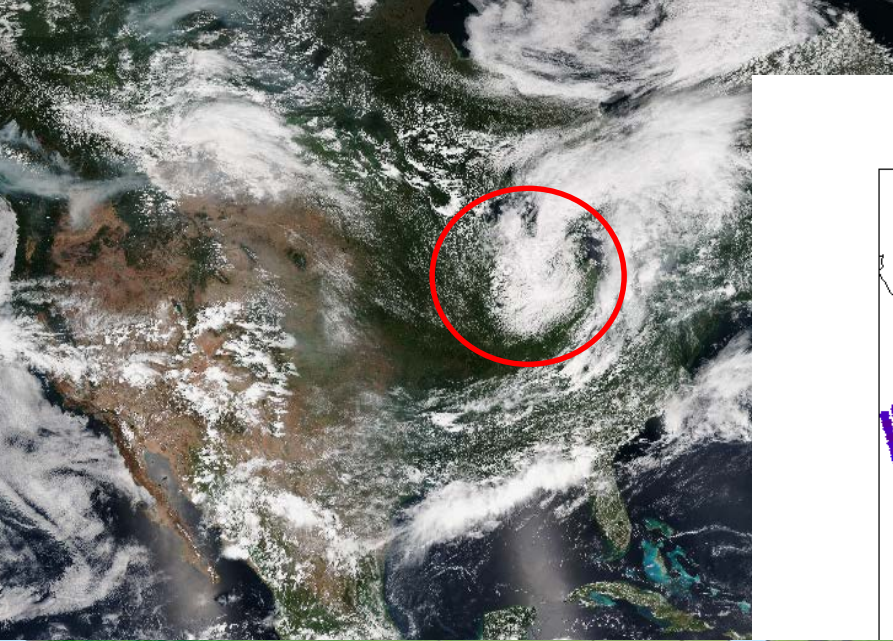
# Carbon Monoxide Column July 30 – August 28, 2017

## AM Orbits



## PM Orbits

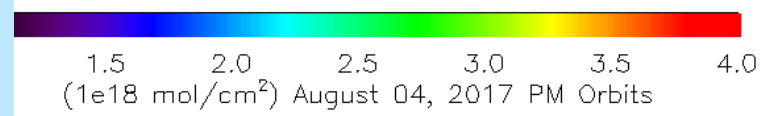
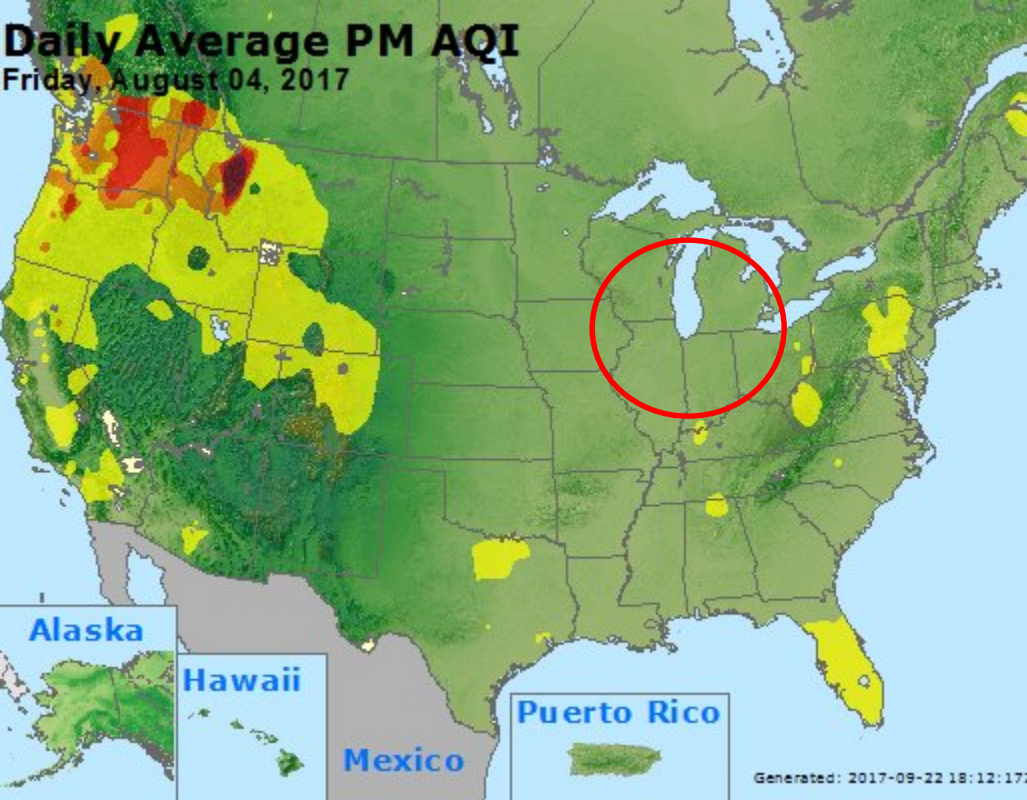
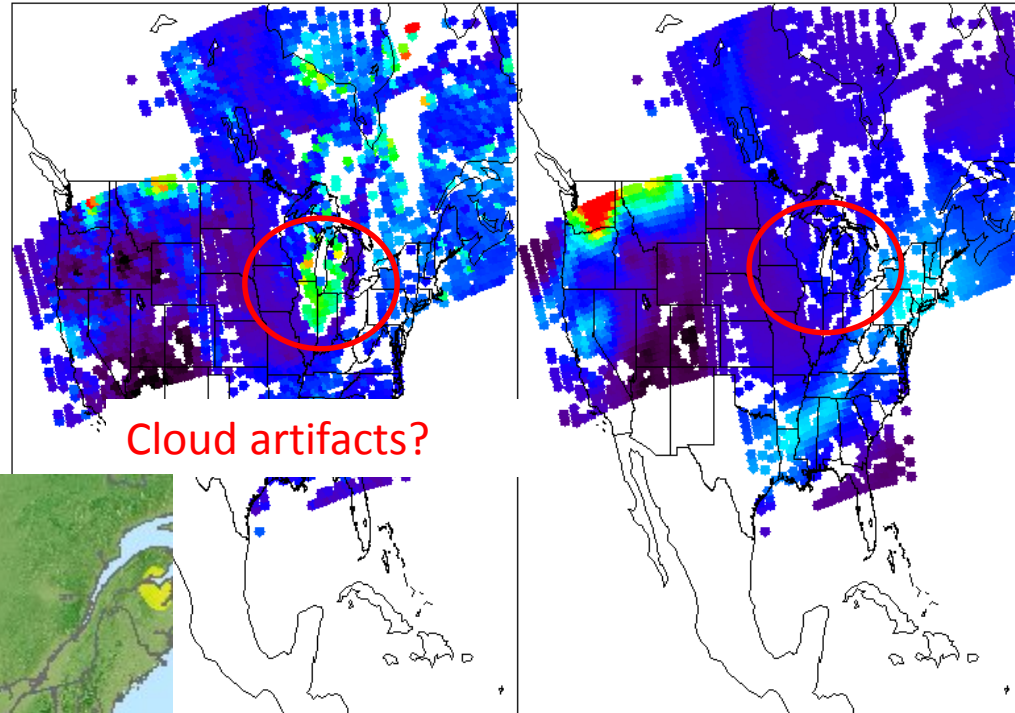




# Total Column CO density

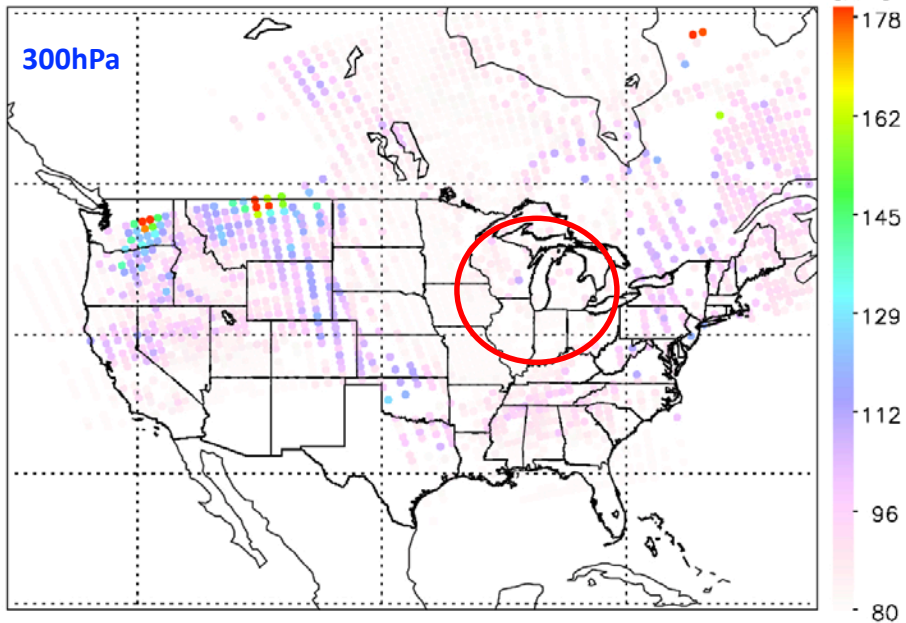
NUCAPS CO Column

RAQMS CO Column

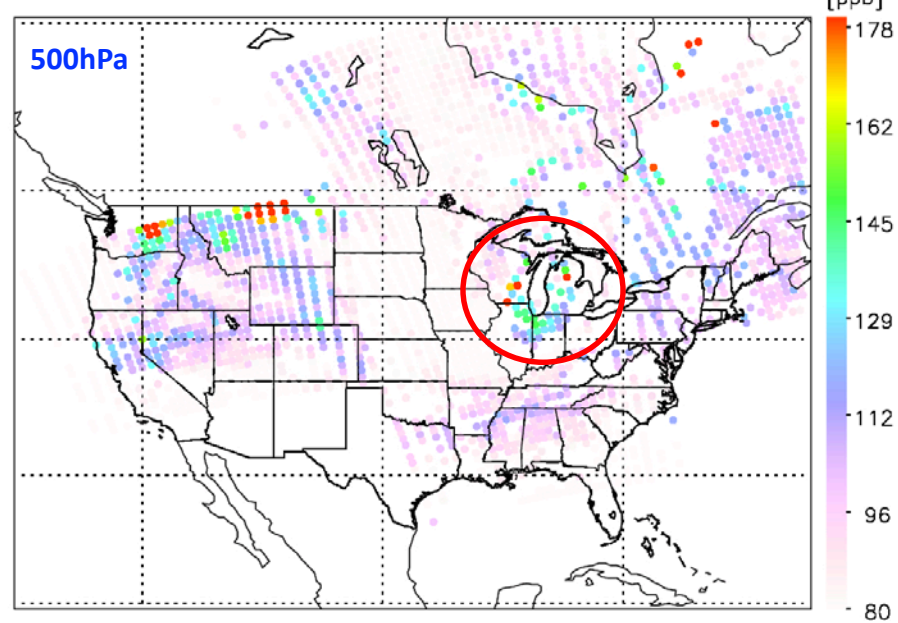




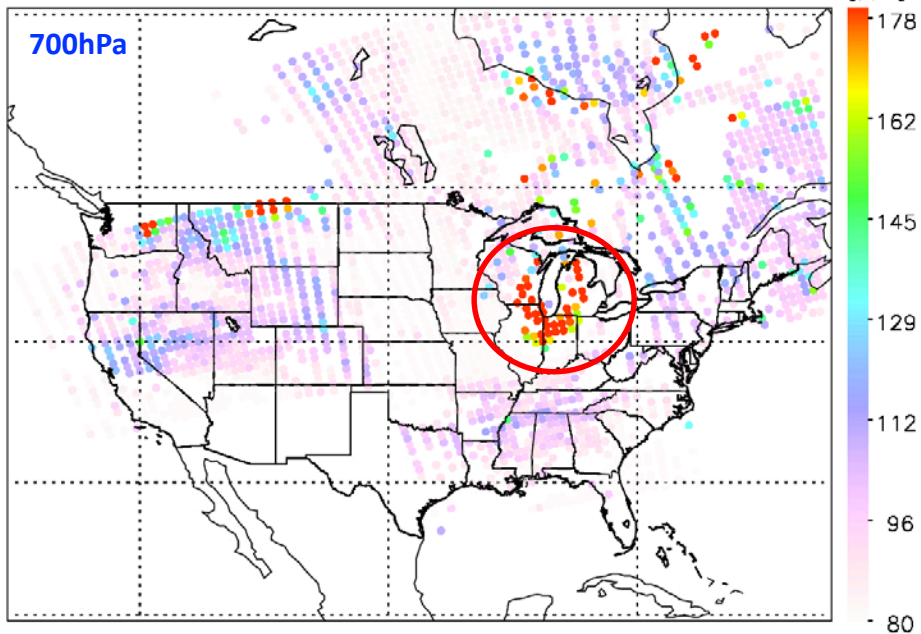
NUCAPS CO with FG at 300 hPa 20170804 PM orbit



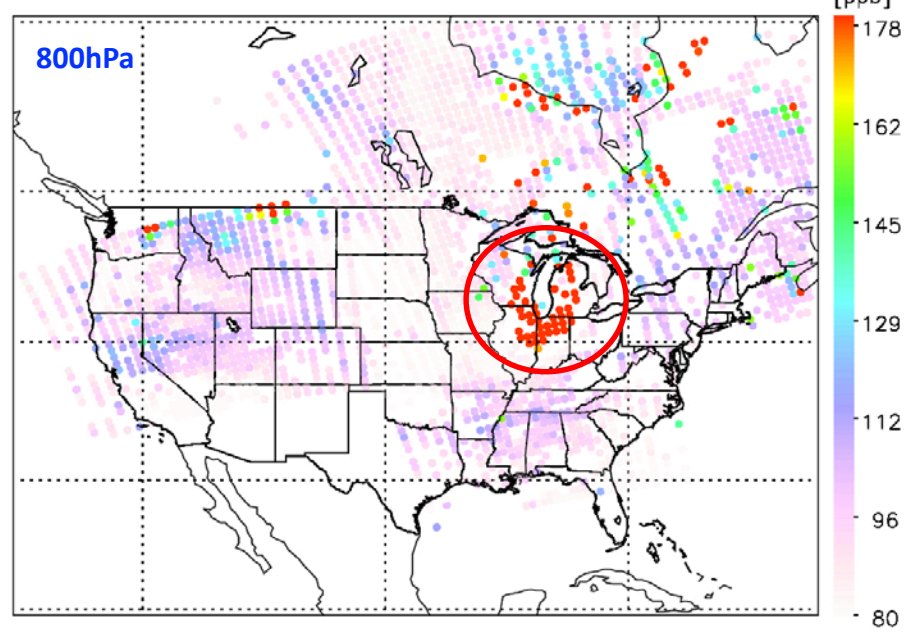
NUCAPS CO with FG at 500 hPa 20170804 PM orbit



NUCAPS CO with FG at 700 hPa 20170804 PM orbit

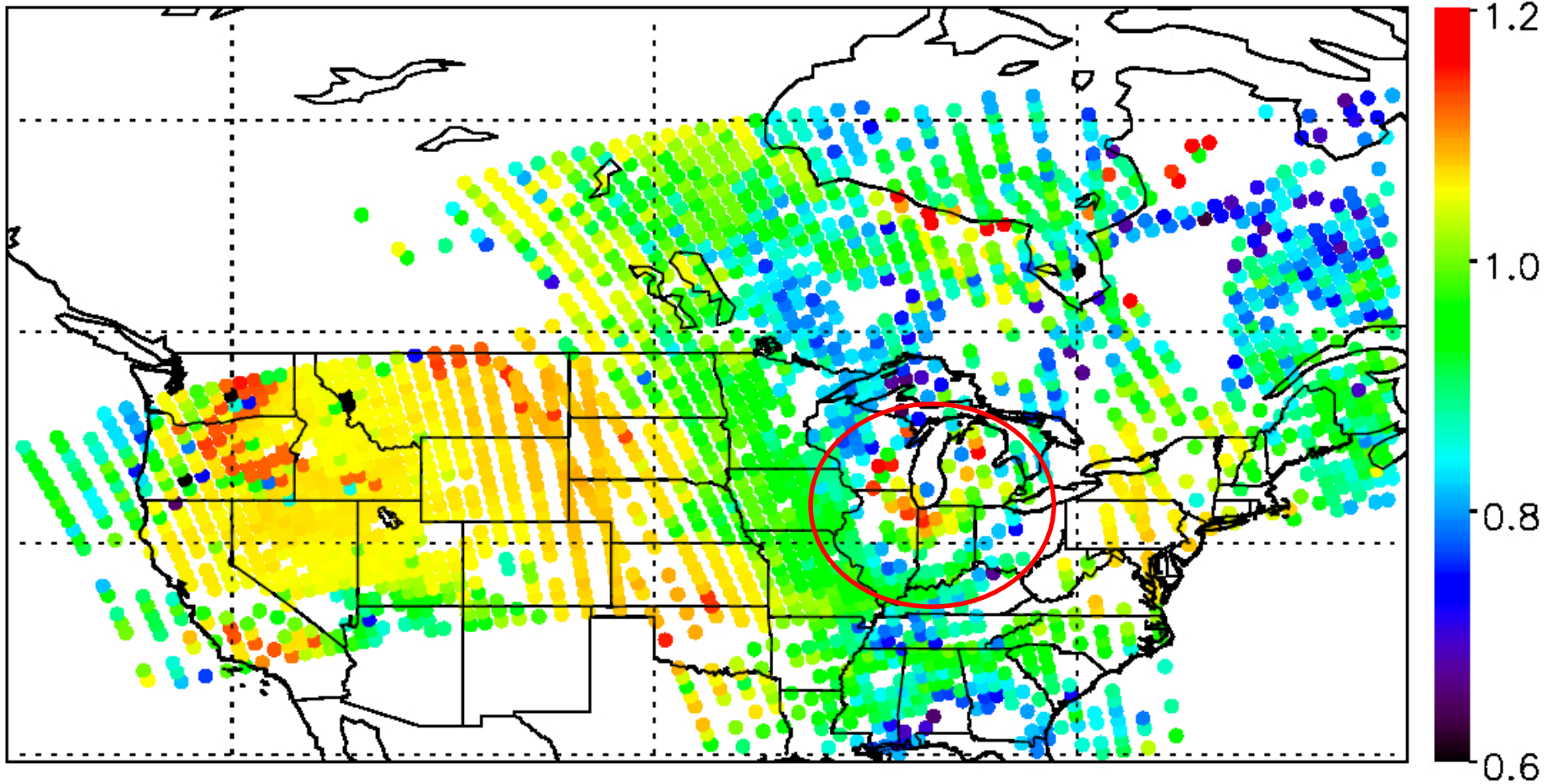


NUCAPS CO with FG at 800 hPa 20170804 PM orbit





NUCAPS CO DOF with MOPITT FG; 20170804 PM orbit



Degrees of Freedom for CO is high -> high sensitivity, low uncertainty.

Could these high CO concentrations in Midwest be real?

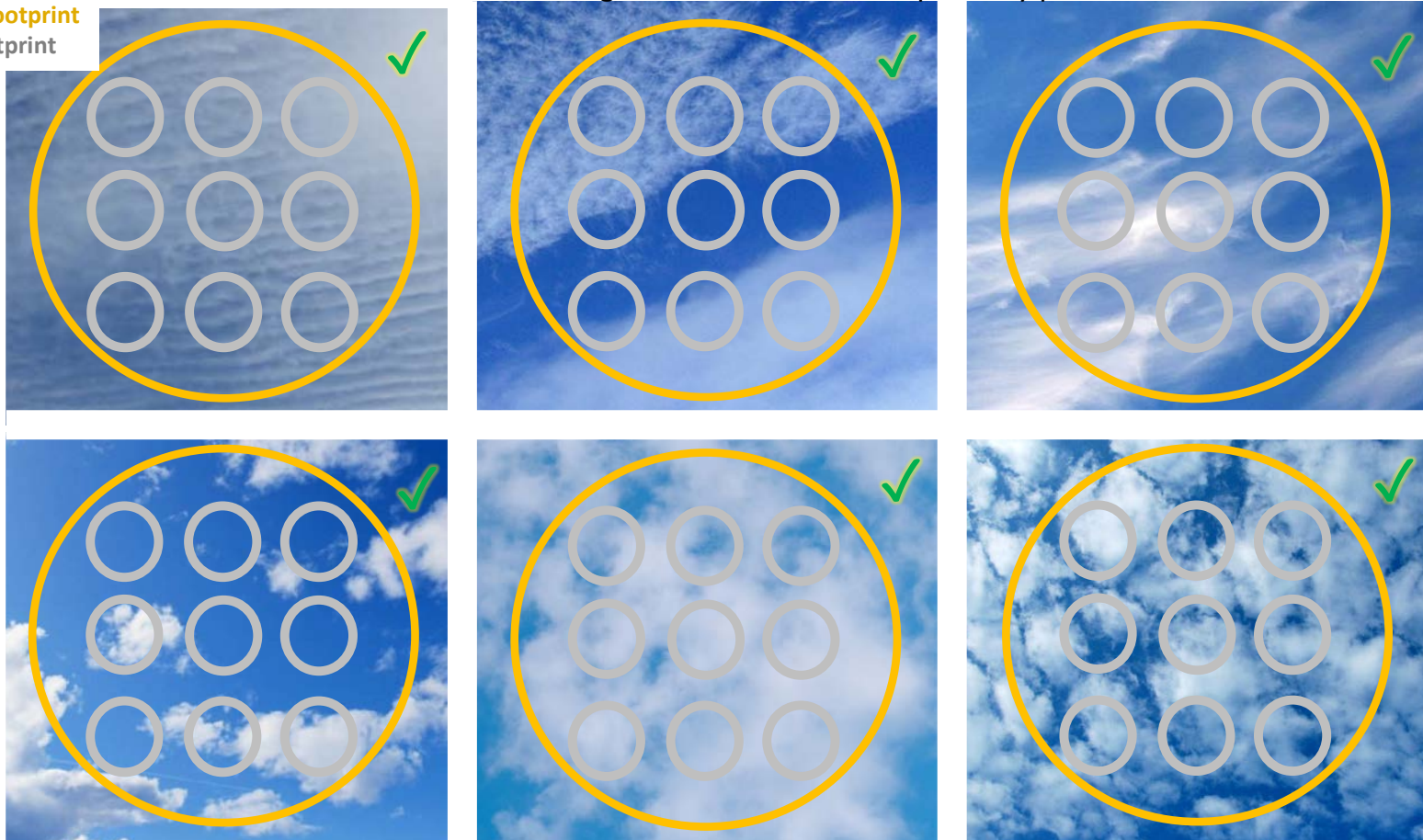
# What does NUCAPS measure?

- The amount and quality of IR spectral information about the vertical atmospheric column (i.e., ‘retrievability’ of the sounding) varies with
  - **local weather conditions**, e.g., cold, warm, wet, dry
  - **surface temperature and emissivity**, e.g., land, ocean; day, night; ice, forest, bare soil
  - the presence and **concentration of trace gases**, e.g., methane plumes, carbon monoxide from fires, cities versus wilderness
- Clouds significantly alter the measured infrared (IR) radiance. Clouds are everywhere most of the time so dealing with them is a primary issue. So NUCAPS:
  - Does NOT retrieve any cloud information nor does it retrieve the thermodynamic environment inside clouds (complex problem; unstable solution).
  - Performs “cloud clearing” to remove the radiative effects of clouds from the IR radiance measurement (this is enabled by combining microwave and infrared)
  - Retrieves the ‘**clear-sky**’ **thermodynamic environment** AROUND clouds from cloud-cleared IR radiances (simplified problem; stable solution).
  - Achieves a 70% global yield despite clouds
  - Retrieves successfully (high quality soundings) under many types of cloudy conditions and with cloud cover as high as 90% per footprint

Cloud Clearing **succeeds** when NUCAPS footprint has **cloud variability**; i.e. when the CrIS footprints have variable cloud fractions

NUCAPS retrieve soundings if there is a radiative pathway past clouds

NUCAPS footprint  
CrIS footprint



The clear-sky radiative pathway PAST clouds can be determined using a cluster of 3x3 CrIS footprints with variable cloud fractions.

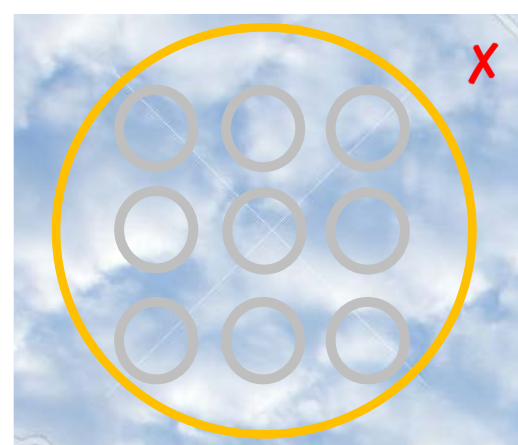
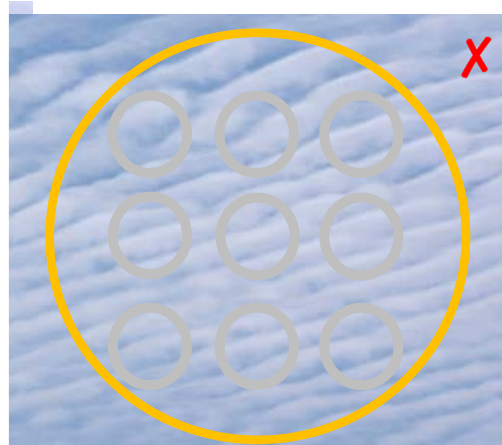
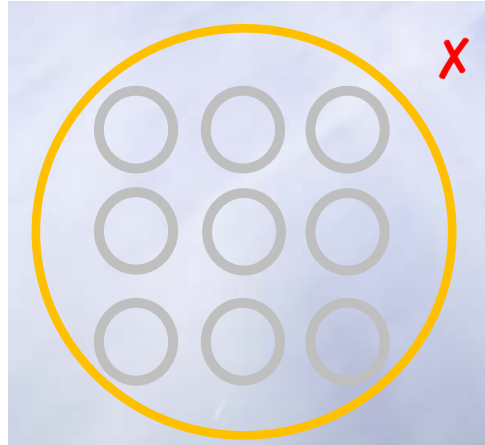
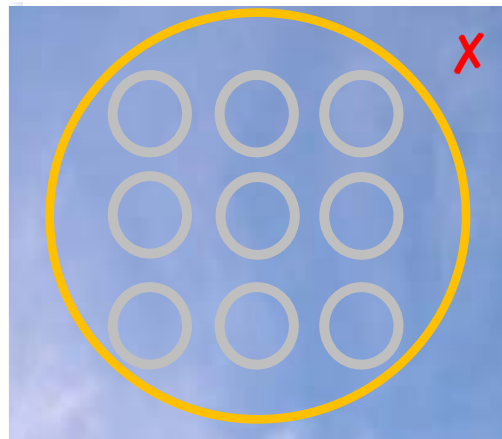
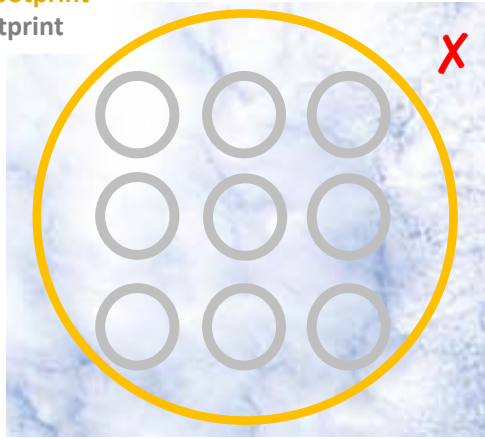
NUCAPS soundings are successfully retrieved from clear-sky or cloud-cleared radiance measurements



Cloud Clearing **FAILS** when NUCAPS footprint is **uniformly cloudy**, i.e. when each CrIS footprint has the same cloud fraction

NUCAPS cannot retrieve soundings if there is no radiative pathway past clouds

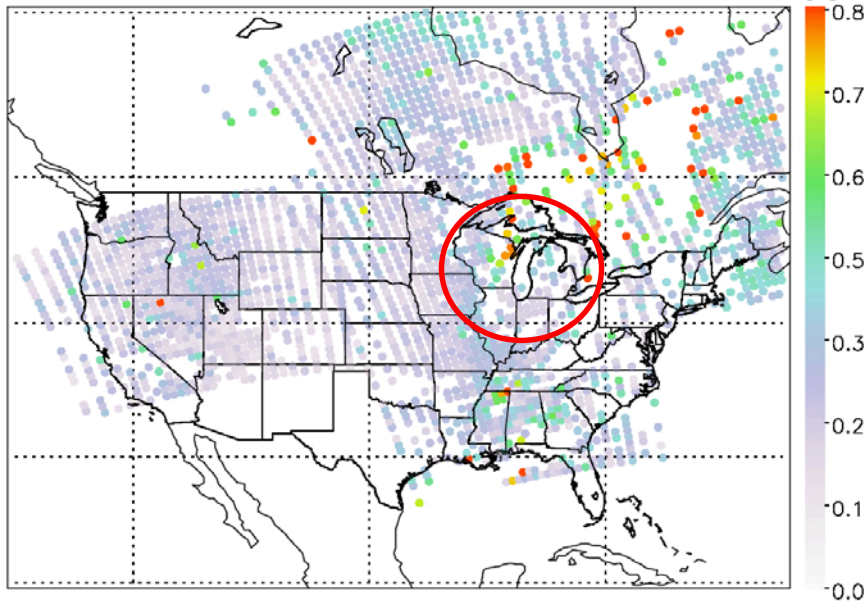
NUCAPS footprint  
CrIS footprint



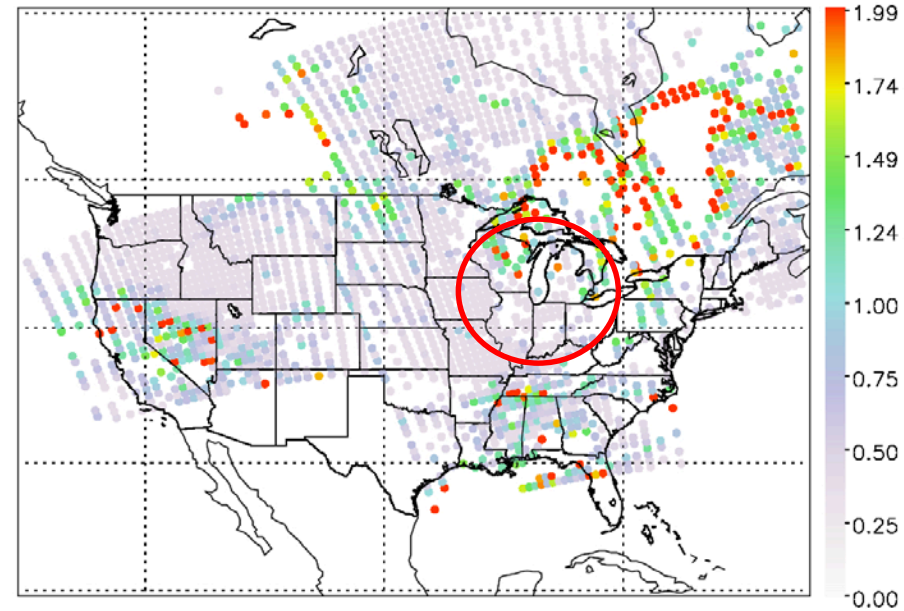
NUCAPS soundings **CANNOT** be retrieved from cloudy measurements of the radiative the pathway through clouds.

This is why optical thickness (cirrus versus stratocumulus) is irrelevant to NUCAPS.

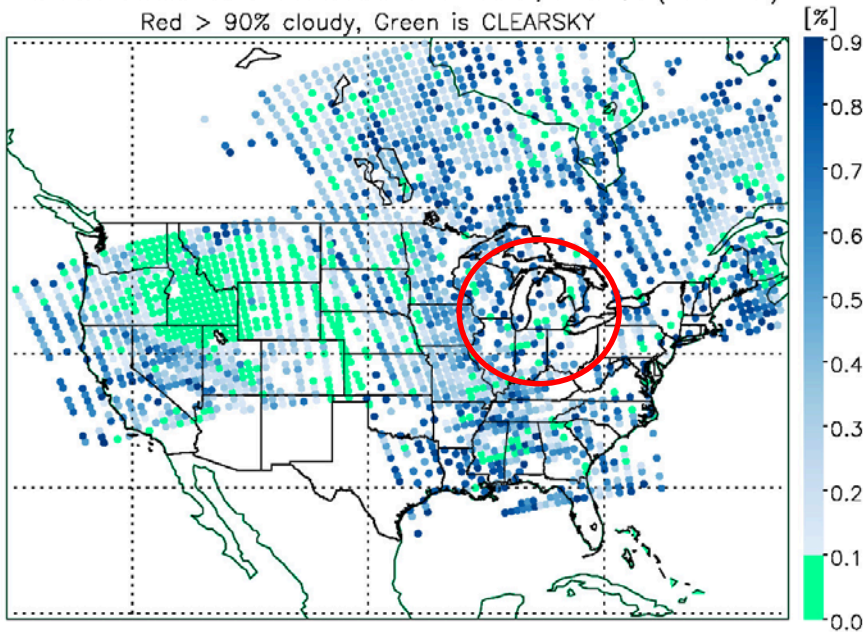
NUCAPS cloud clearing uncertainty 20170804 PM orbit



NUCAPS CC Noise Amplification Factor 20170804 PM orbit



NUCAPS cloud fraction 20170804 PM orbit, With QC (max=0.9)  
Red > 90% cloudy, Green is CLEARSKY



The area has cloudy patches (bottom) but the cloud clearing uncertainty (top) is low, meaning that there's little cloud contamination.

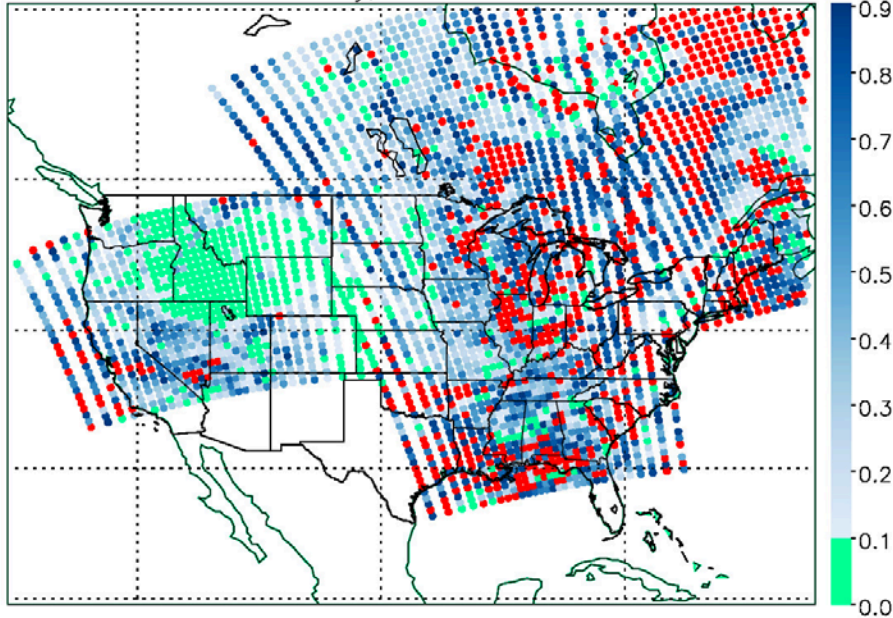
Looking at NUCAPS diagnostic metrics we can determine that there are very few cloud artifacts in the region.



# Demonstrating NUCAPS quality filtering

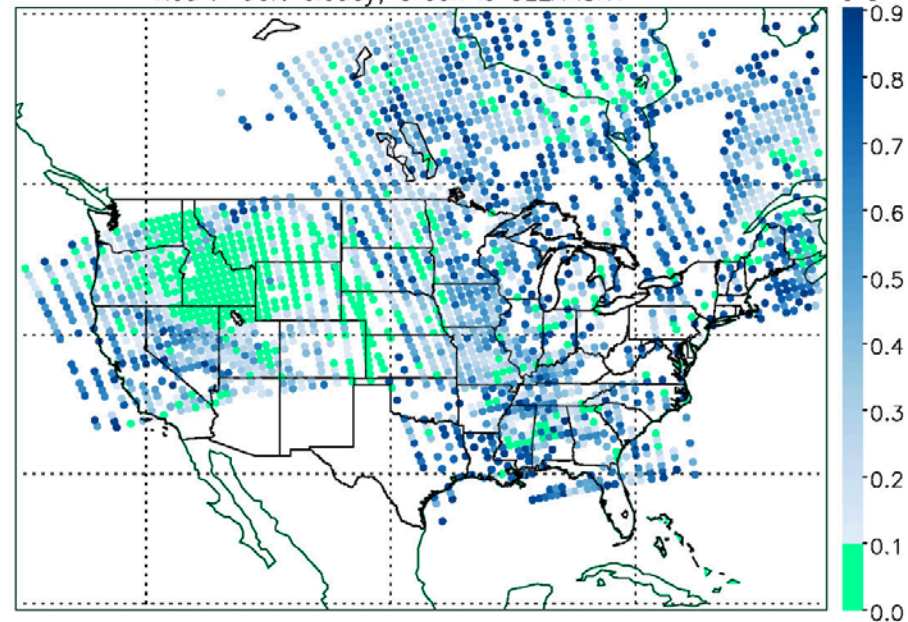
NUCAPS without QC  
Red > 90% cloudy

NUCAPS cloud fraction 20170804 PM orbit, With QC (max=1.0)  
Red > 90% cloudy, Green is CLEARSKY



NUCAPS with QC

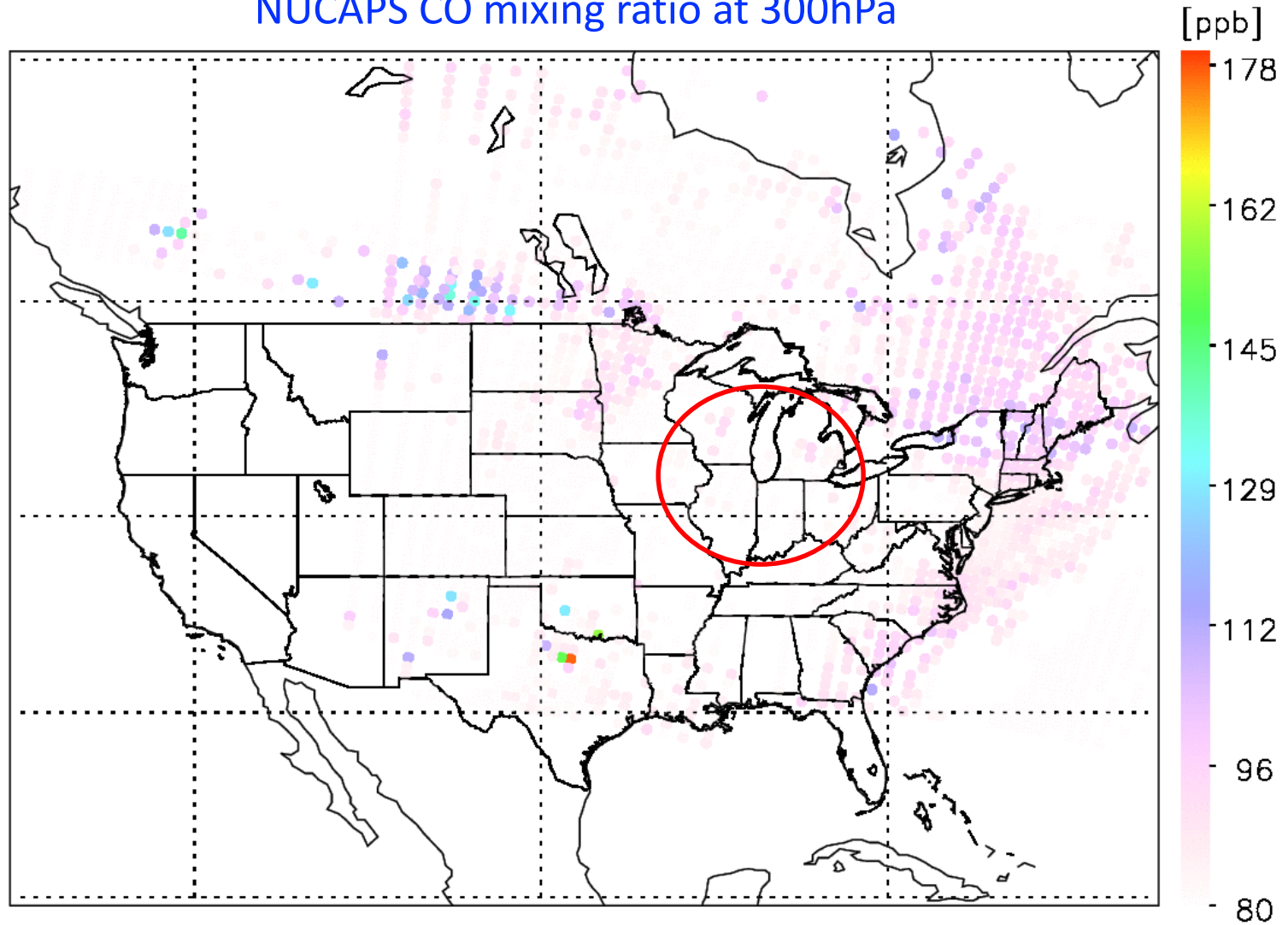
NUCAPS cloud fraction 20170804 PM orbit, With QC (max=0.9)  
Red > 90% cloudy, Green is CLEARSKY





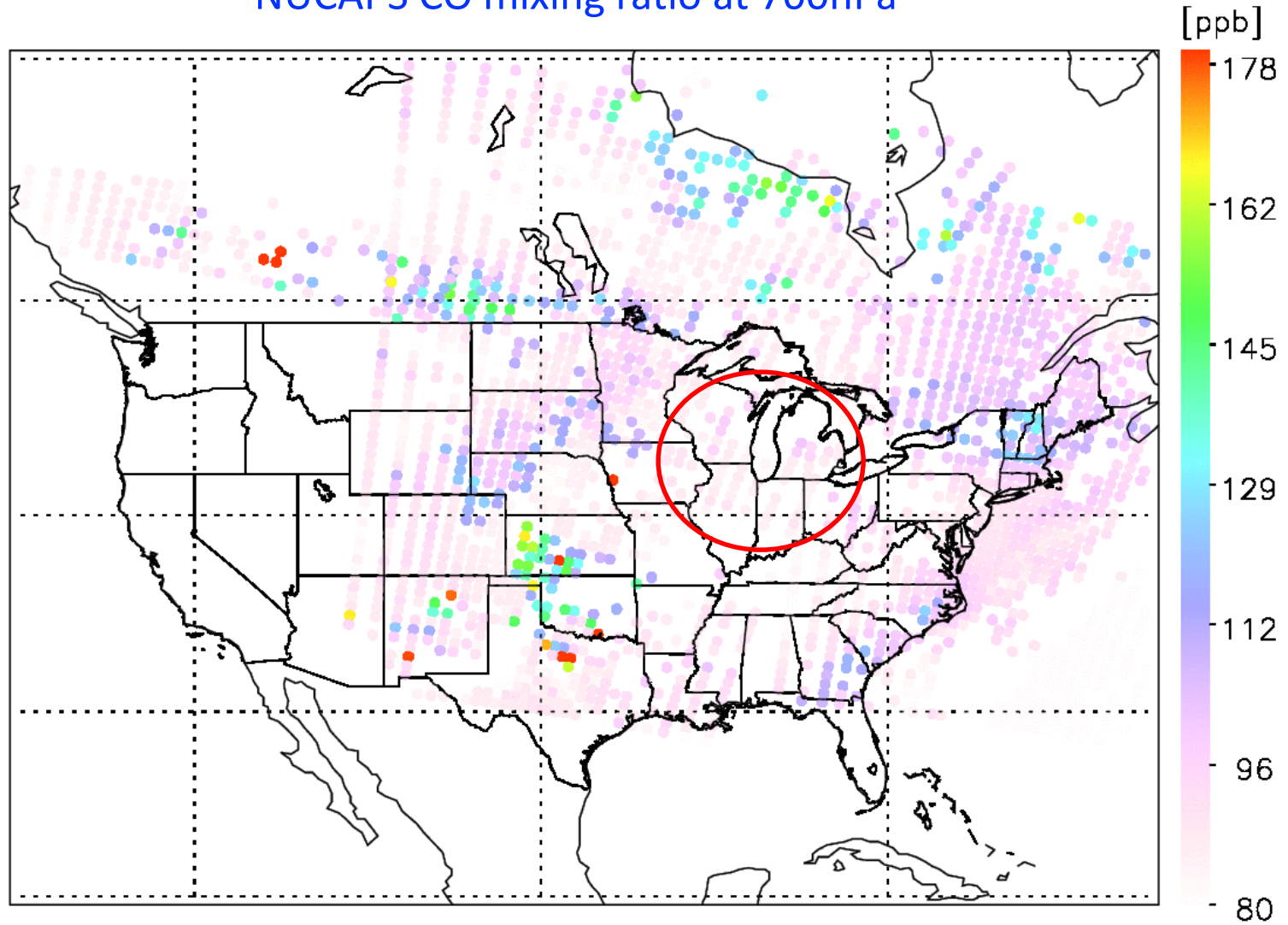


# NUCAPS CO mixing ratio at 300hPa



At 300 hPa NUCAPS CO product depicts mesoscale transport

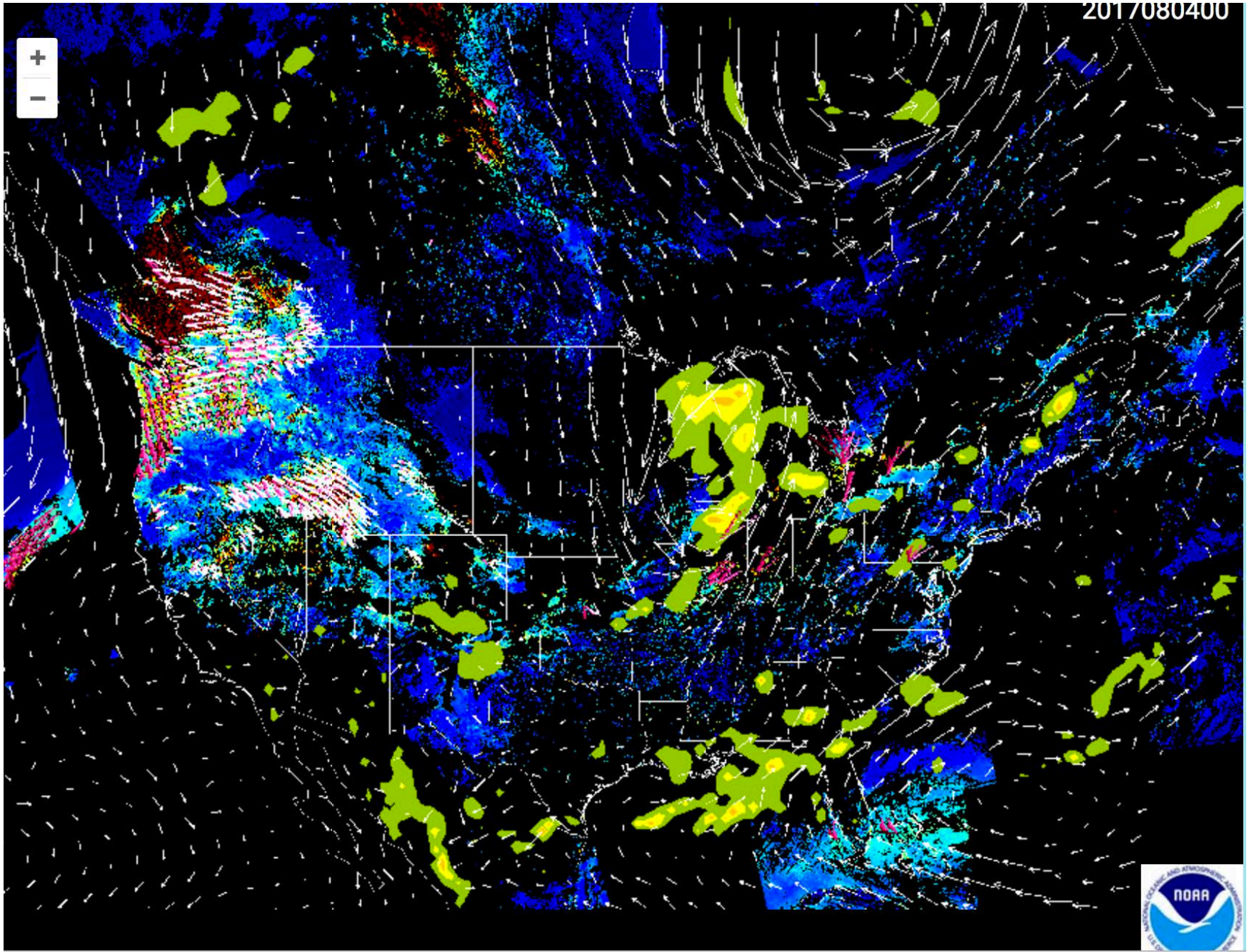
# NUCAPS CO mixing ratio at 700hPa



At 700 hPa NUCAPS CO product depicts additional features

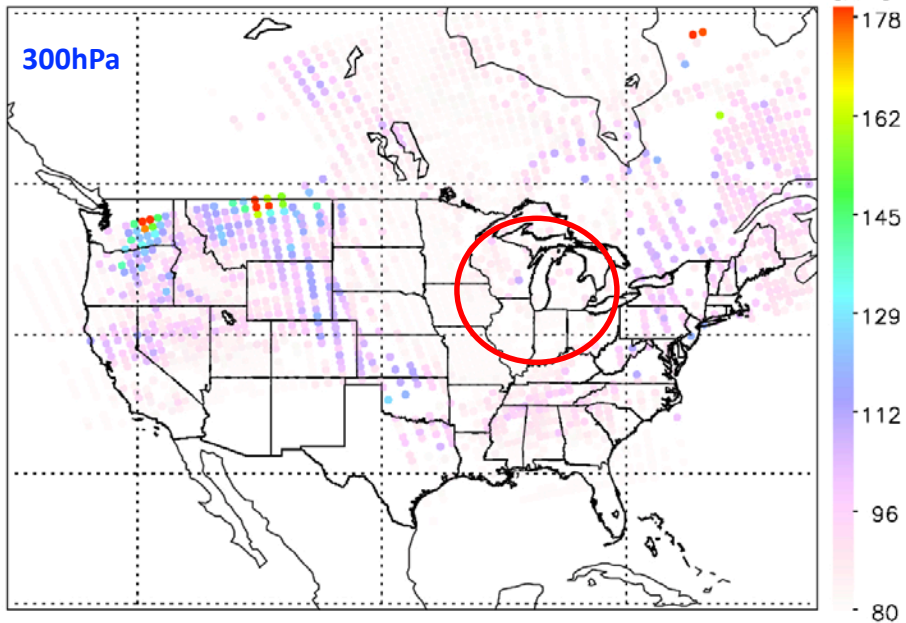


2017080400

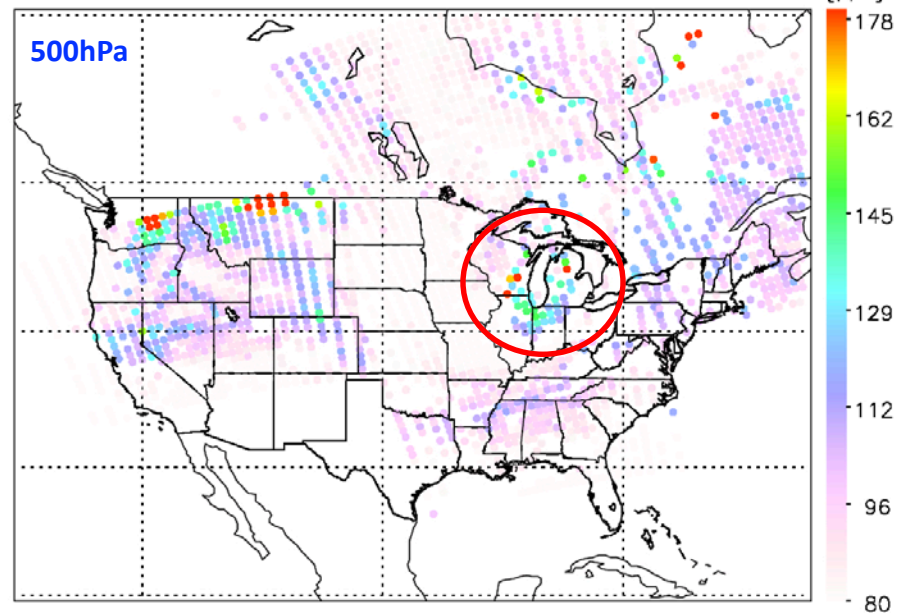




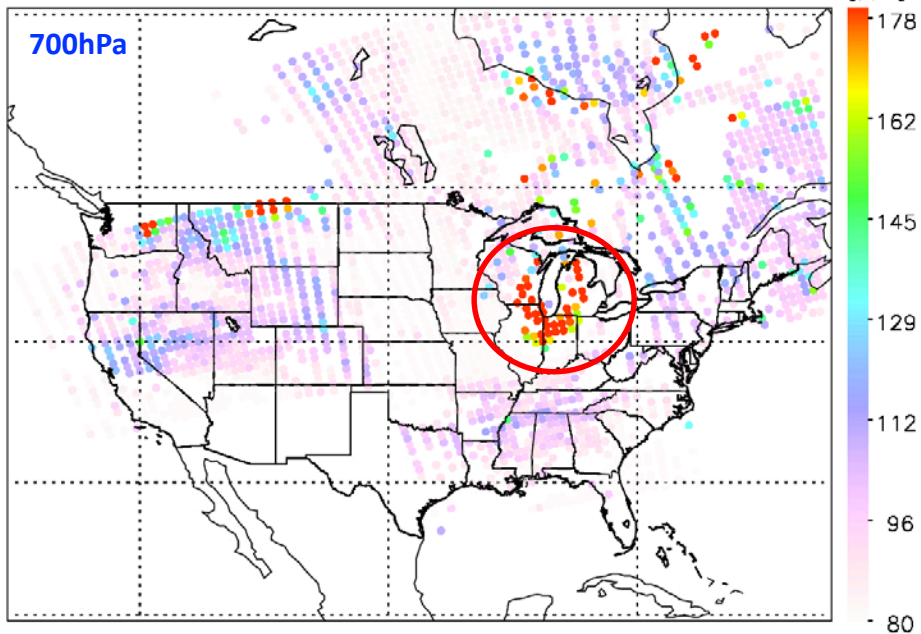
NUCAPS CO with FG at 300 hPa 20170804 PM orbit



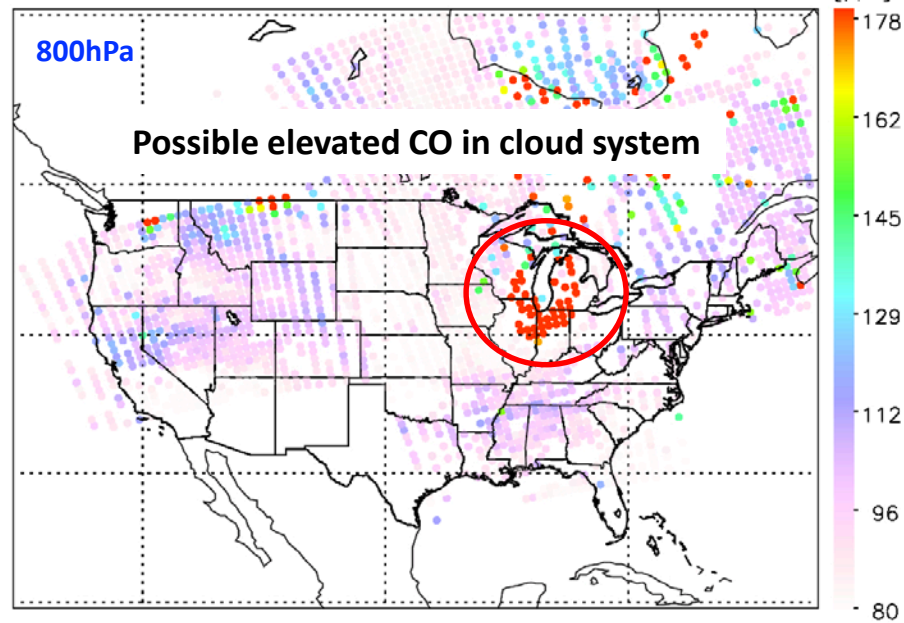
NUCAPS CO with FG at 500 hPa 20170804 PM orbit



NUCAPS CO with FG at 700 hPa 20170804 PM orbit



NUCAPS CO with FG at 800 hPa 20170804 PM orbit



Thank you

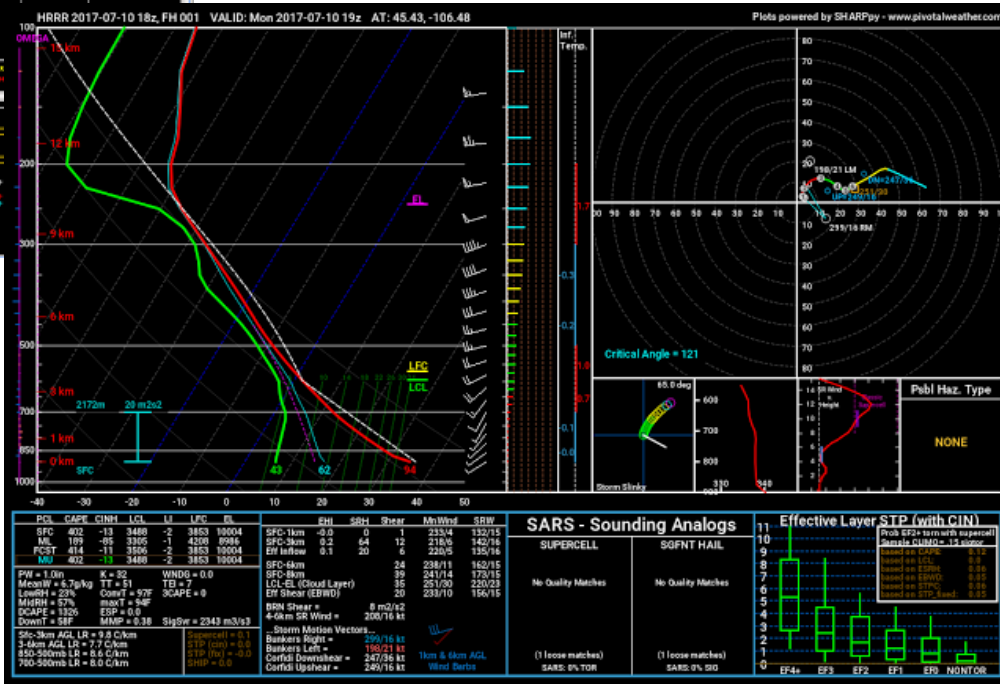
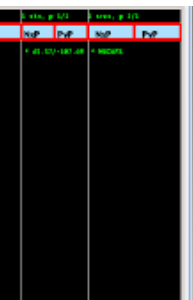
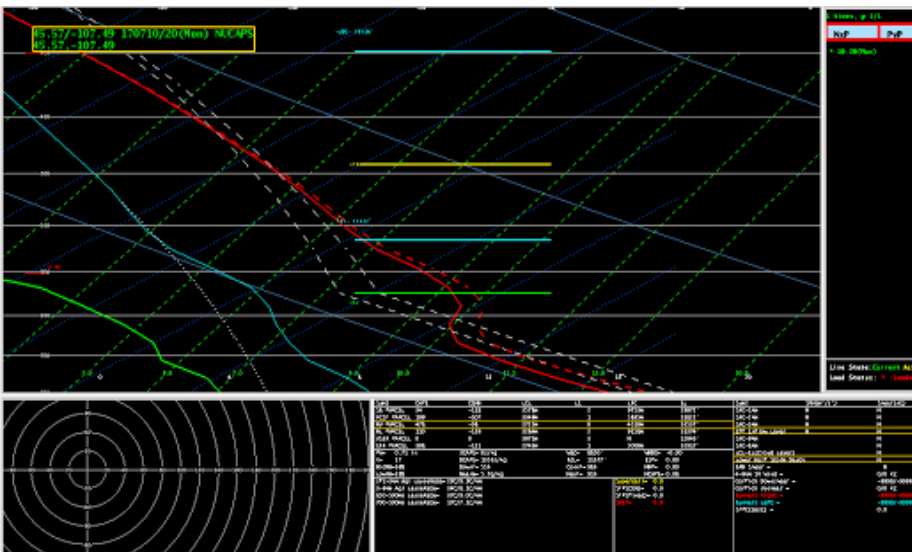


Extra cases

# NUCAPS T/q used in AWIPS to monitor fire weather

Slide by Michael Bowlen; HWT 2017

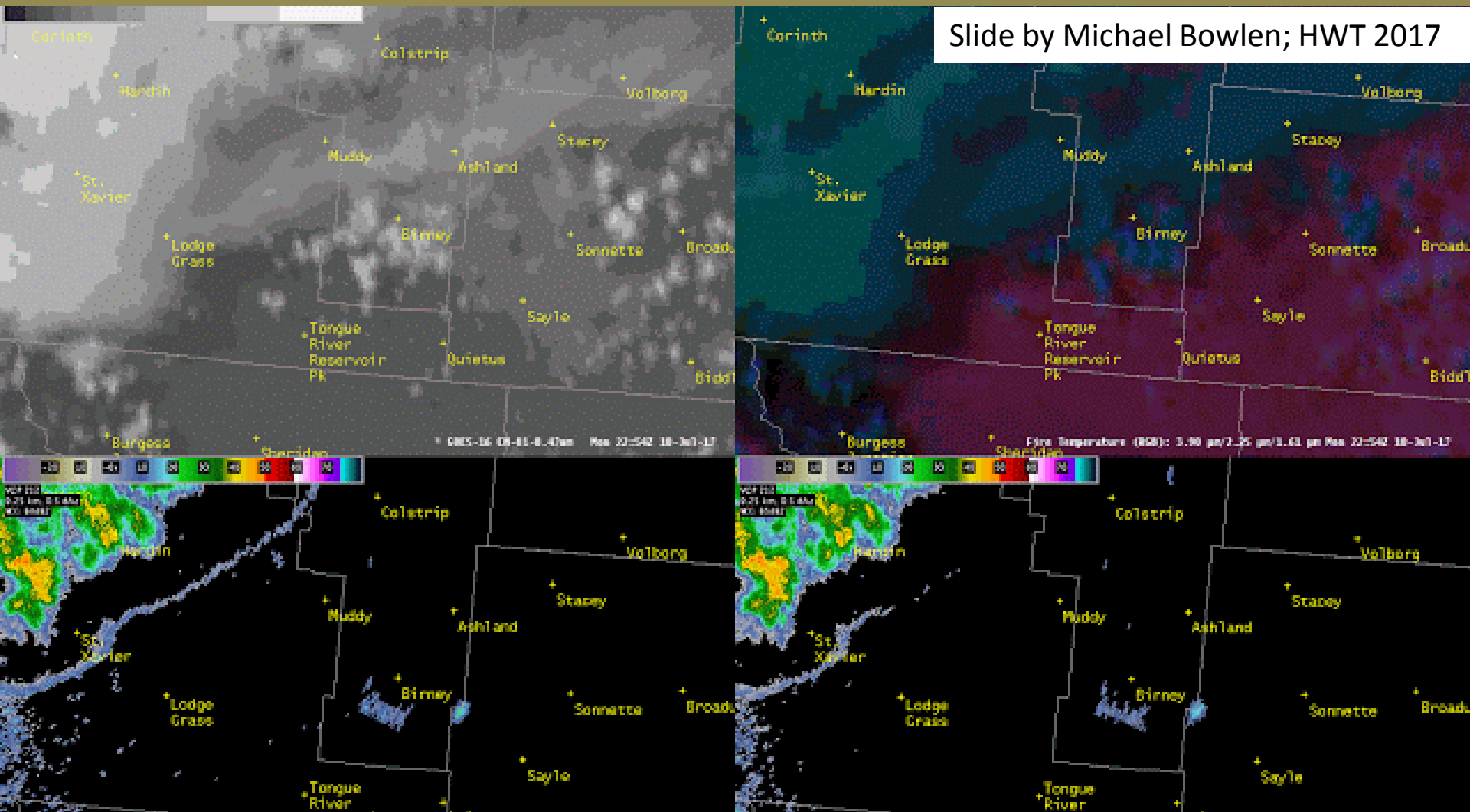
## HRRR Forecast Sounding



## NUCAPS Sounding

- A noticeable inversion was detected near/just above 700mb.
- Compared to HRRR, RAP, and NAM soundings taken at a similar time, guidance was unable to detect this feature.
- Decided to investigate a smoke plume seen from KBLX radar

# NUCAPS T/q used in AWIPS to monitor fire weather



Slide by Michael Bowlen; HWT 2017

“The placement of the fire and smoke plume suggests some accuracy of the NUCAPS capture of the inversion, which is missing from model guidance.”

“Additionally, it has been noticed that as convection has pushed eastward this afternoon, it's intensity has been decreasing, which could be an impact of the inversion.”

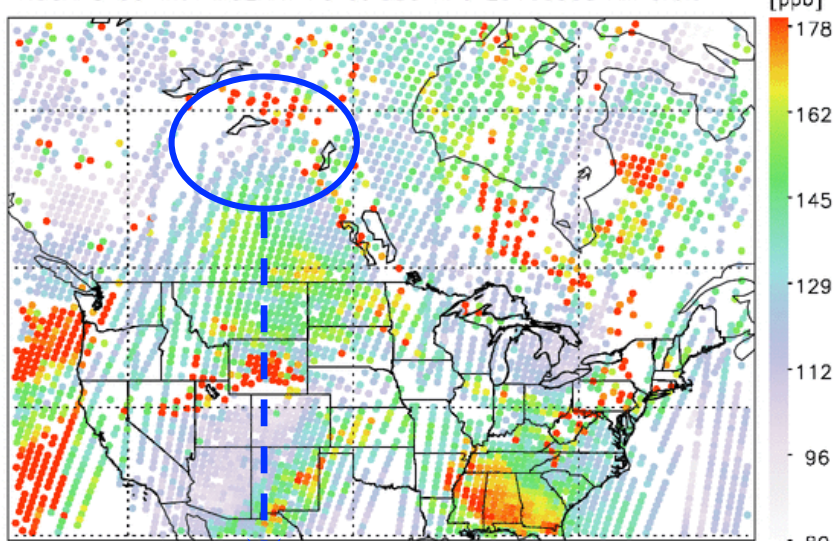


# JPSS PGRR Initiatives foster user-developer partnerships that evaluate NUCAPS CO applications

## Investigating the presence of elevated H<sub>2</sub>O mixed layer due to large scale biomass burning

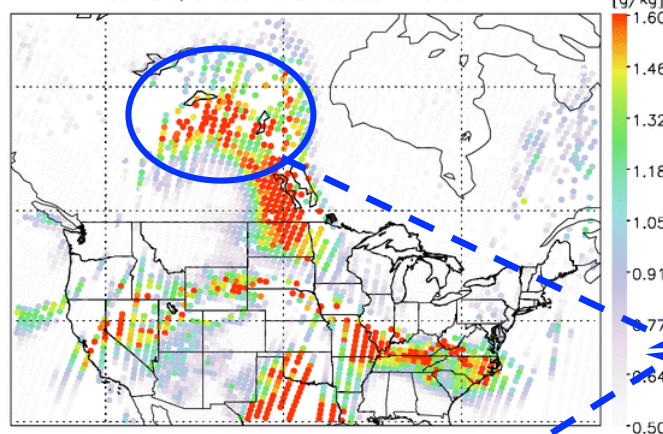
### Carbon Monoxide [500hPa]

NUCAPS CO with MOZART FG at 500 hPa 20160508 AM orbit



**Ft McMurray Mega-Fire CO emissions**

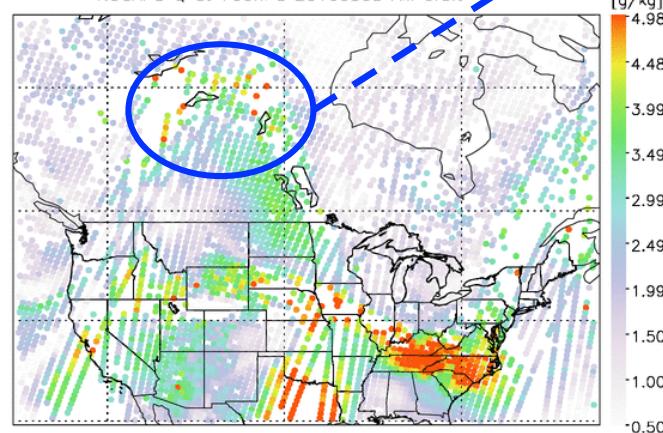
NUCAPS Q at 500hPa 20160508 AM orbit



**H<sub>2</sub>O Mixing Ratio [500hPa]**

**Elevated mixed layer due to megafire**

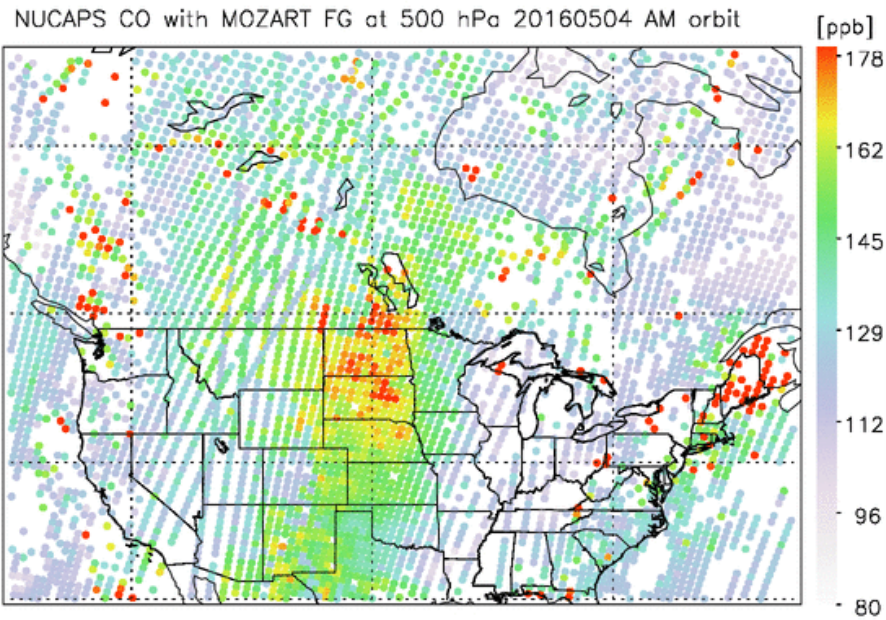
NUCAPS Q at 700hPa 20160508 AM orbit



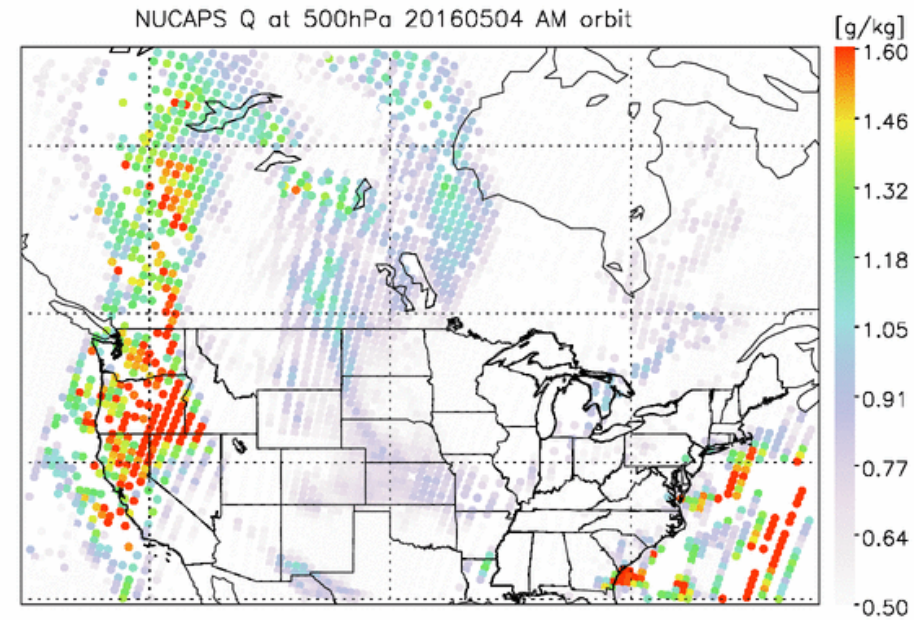
**H<sub>2</sub>O Mixing Ratio [700hPa]**

# JPSS PGRR Initiatives foster user-developer partnerships that evaluate NUCAPS CO applications

Carbon Monoxide [500hPa]



H2O Mixing Ratio [500hPa]



Investigating CO emissions as well as the change in moisture regime due to large scale burning