

What are NUCAPS trace gas products good for?

Nadia Smith*

**In collaboration with
JPSS NUCAPS team and PGRR initiatives**

(addressing the white elephant in the room)

*





Who uses NUCAPS trace gas products operationally?

Do you know anyone who makes (or has made) a real-world decision with information provided by NUCAPS trace gas products?

(...crickets...)

Why not?

What are the NUCAPS trace gas products?

By-products of physical retrieval system:

- (1) ...to stabilize T/q retrievals
- (2) ...to enable full connectivity between EDR + SDR for quality monitoring
- (3) ...to enable air chemistry applications from weather satellite systems



What is the baseline? Where are we at, exactly?

(1) NUCAPS trace gas validation (NOAA/STAR)

- Operational requirements

(2) NUCAPS trace gas evaluation (NOAA/JPSS PGRR initiatives)

- Suitability for real-world applications
- Creative exploration in strong, productive, multi-agency partnerships (NOAA/ESRL, NOAA/STAR, UW/SSEC; CSPP; STC, etc.)

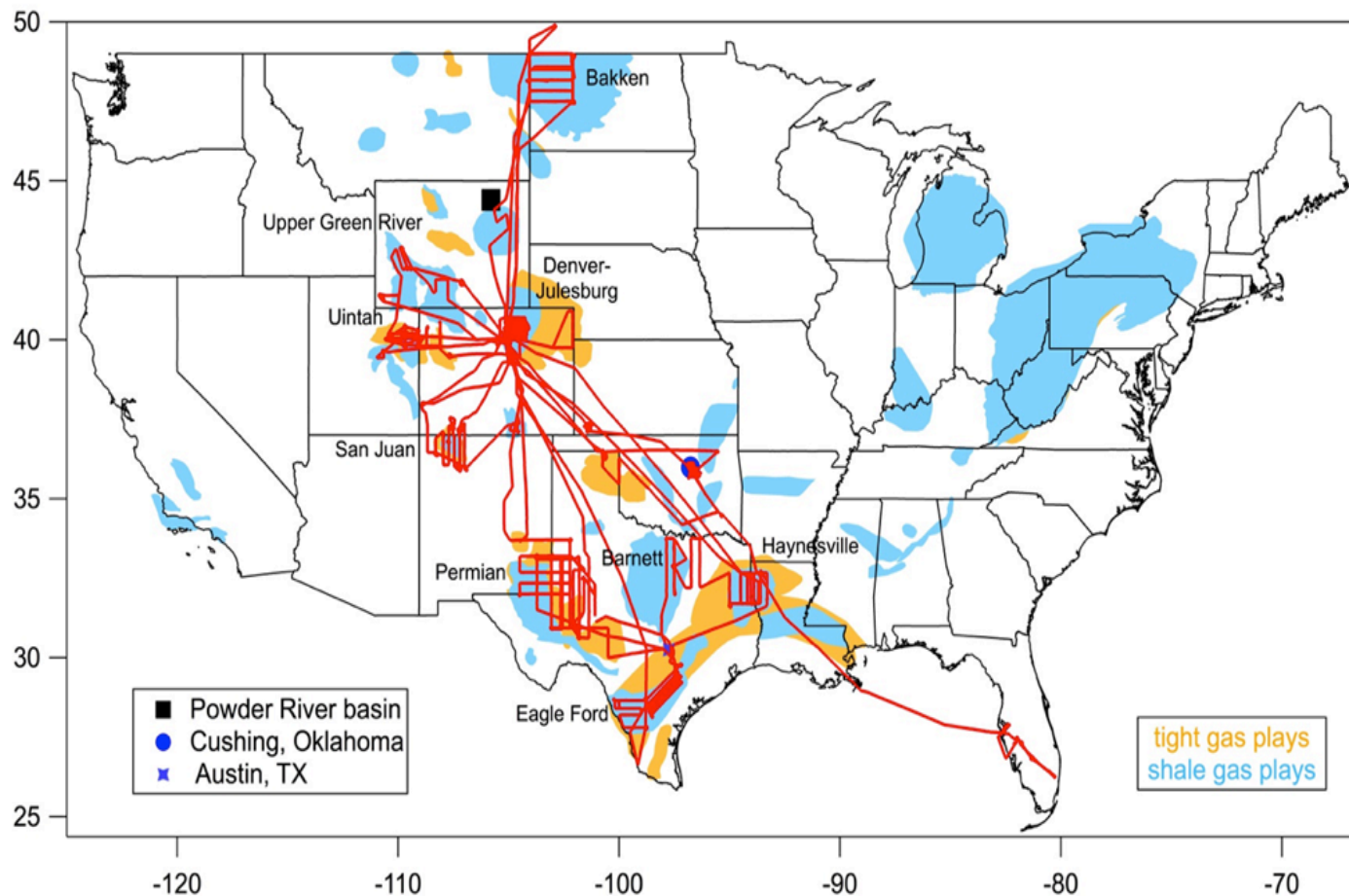
NOAA PGRR – Sounding and Fire+Smoke Initiatives

JPSS Proving Ground/Risk Reduction (PGRR) project is a collaborative effort combining expertise in satellite retrieval development (STC), airborne trace gas measurements (ESRL/CIRES), and satellite trace gas validation (STAR/CIMSS) to characterize NUCAPS retrieval quality, with the goal of improving the accuracy of the NUCAPS daily global measurements of methane (CH₄) and carbon monoxide (CO).

2014 NOAA CrIS Atmospheric Chemistry Data User's Workshop Report

(http://docs.lib.noaa.gov/noaa_documents/OAR/CPO/AC4/CrIS_workshop_2014.pdf)

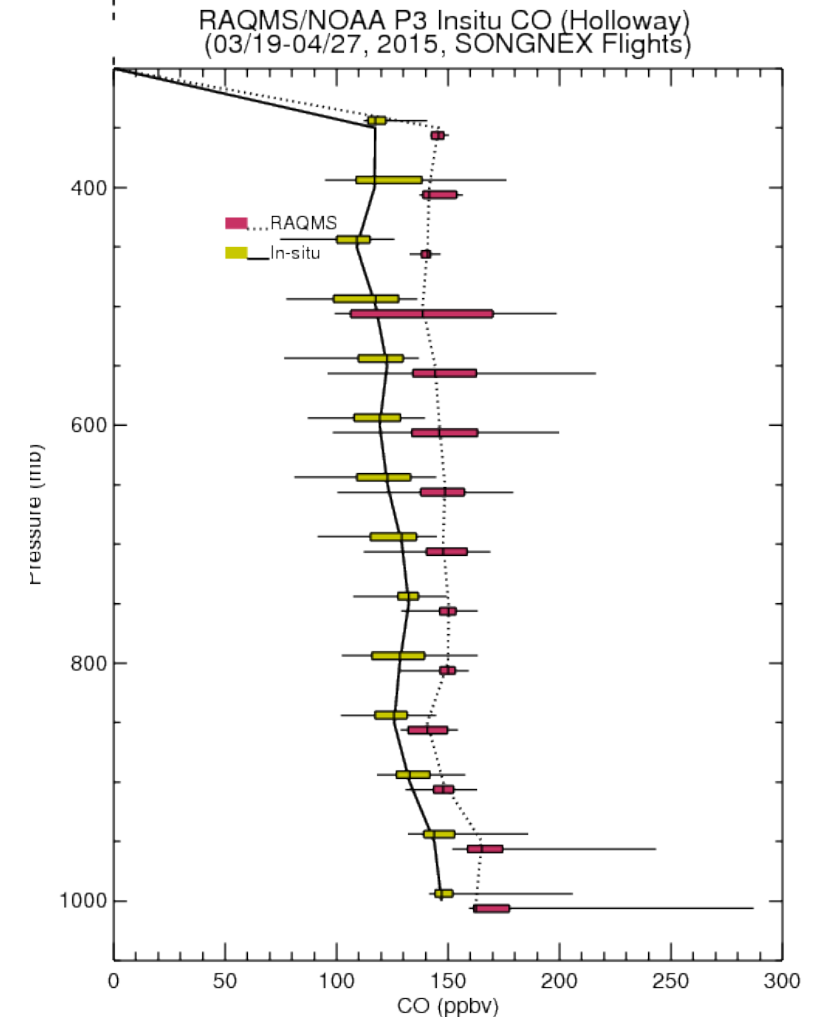
which concluded *“that the current state of validation of the NUCAPS trace gas retrievals is insufficient for the use of these retrievals in most atmospheric chemistry applications”* and recommended that the *“CrIS retrieval development community should closely coordinate with the project teams of upcoming field campaigns (aircraft, surface, balloon, etc.) on trace gas validation activities”*.



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)



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

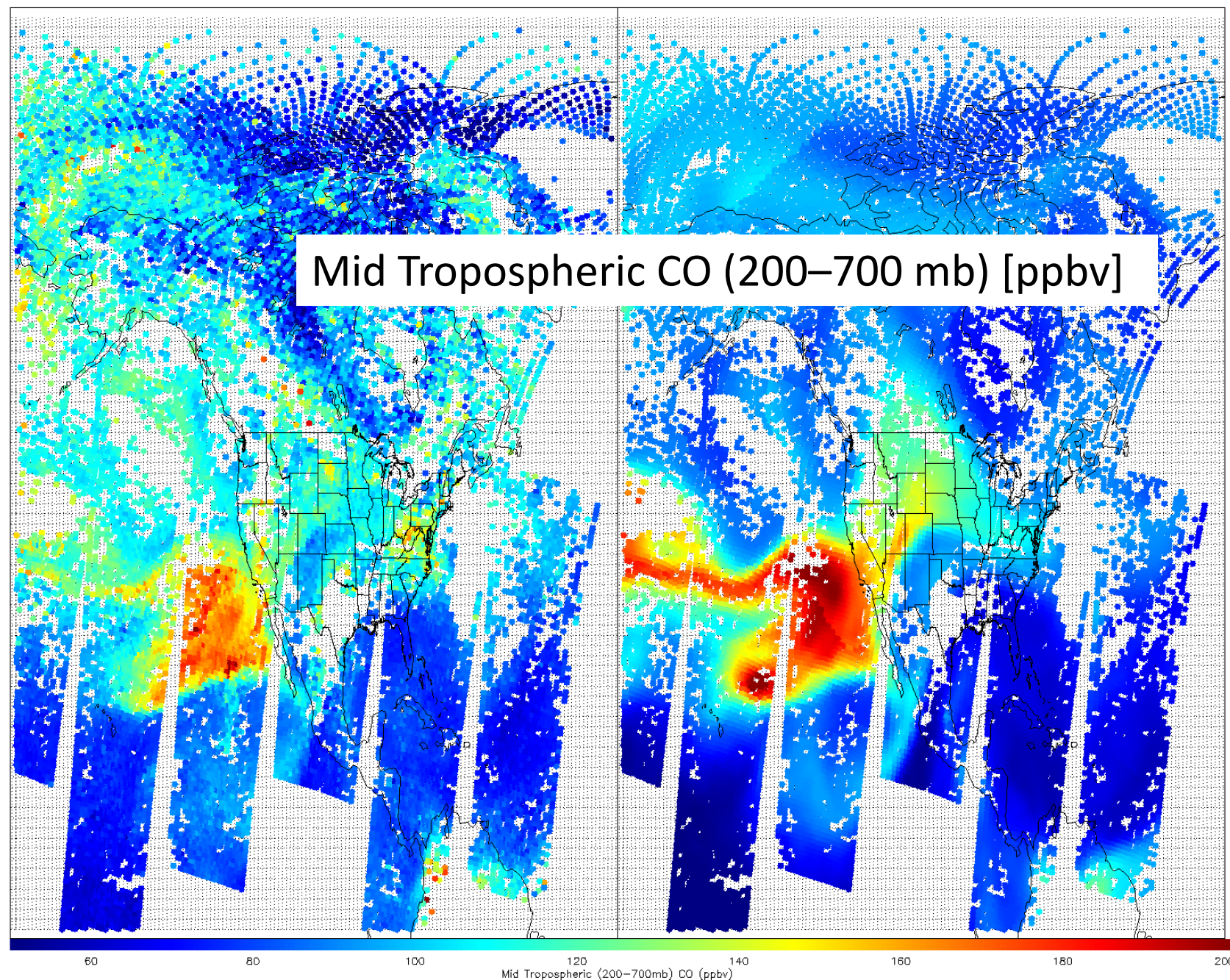
In **2016** CSPP NUCAPS supported a field campaign in real-time (**ENRR**) for the first time.

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

Brad Pierce (NOAA/STAR)

NUCAPS (FSR CrIS)

RAQMS



CSPP NUCAPS in IMAPP application

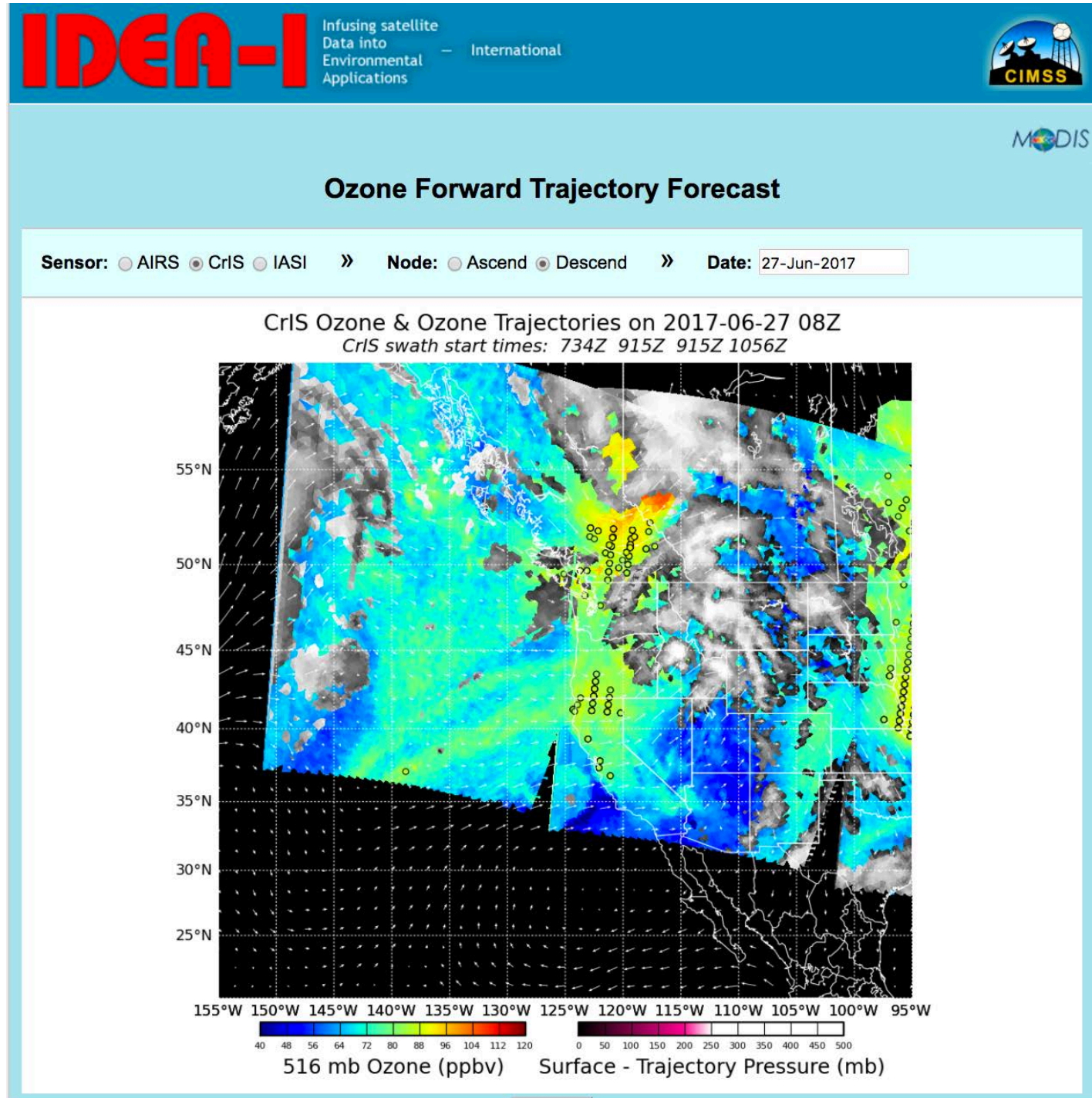
<http://cimss.ssec.wisc.edu/idea-i/USozone/>

Real-time stratospheric intrusion forecasts

The background basemap is the daily AIRS, IASI, or CrIS Dual Regression (CSPP HSRTV) Ozone retrievals at 516mb, which is used in conjunction with Dual Regression dewpoint temperature retrievals to initialize trajectories which show where the stratospheric intrusion (high ozone/dry air) is expected to move in the next ~48 hours. The products are derived from AIRS, IASI and CrIS data acquired and processed directly from the Terra, METEOP-A, and SNPP satellites, respectively

As soon as CrIS FSR SDR is available in CSPP we will ingest NUCAPS CO retrieval in IDEA-I to initialize smoke dispersion forecasts

Brad Pierce (NOAA/STAR)

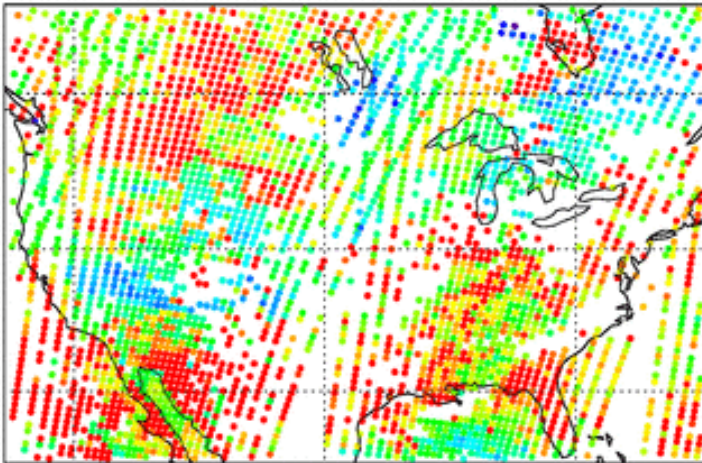


User-Developer partnership helps evaluate FSR NUCAPS CO ahead of operational deployment

Ft. McMurray Fire; 1-16 May 2016: NUCAPS CO vs RAQMS

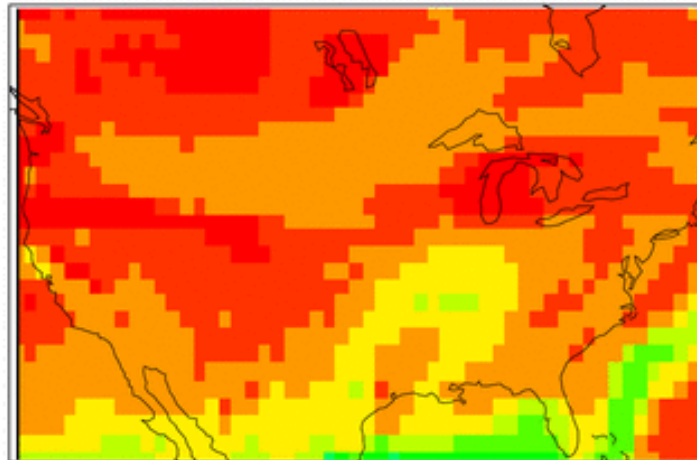
FSR NUCAPS with MOZART FG

NUCAPS CO with MOZART FG at 500 hPa 20160502 AM orbit



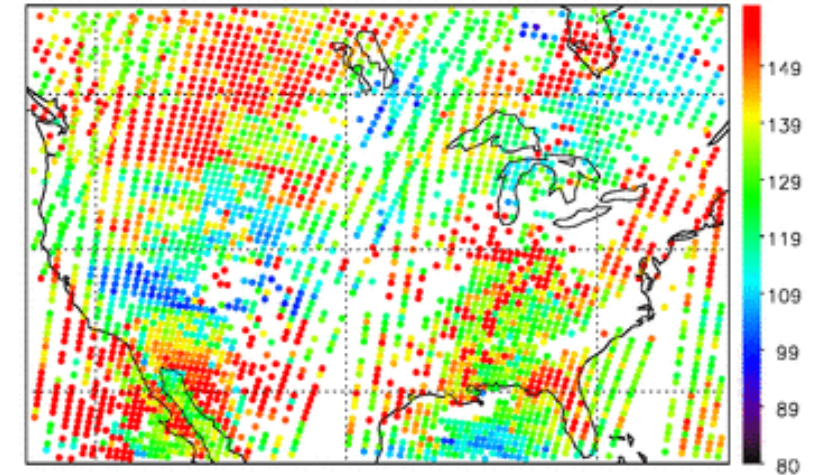
RAQMS CO MR @ 500 hPa

RAQMS CO at 500 hPa 20160502 06Z

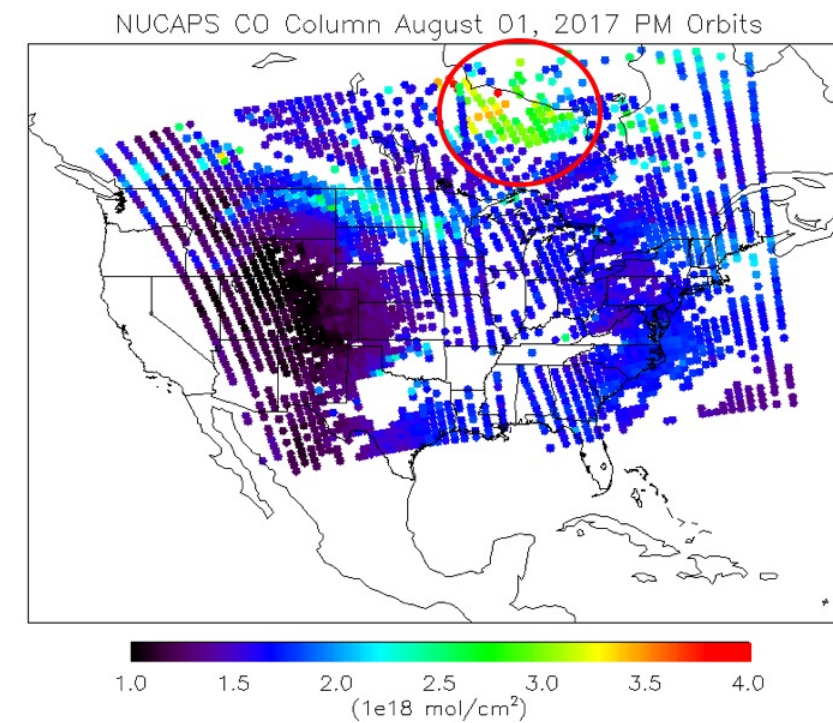
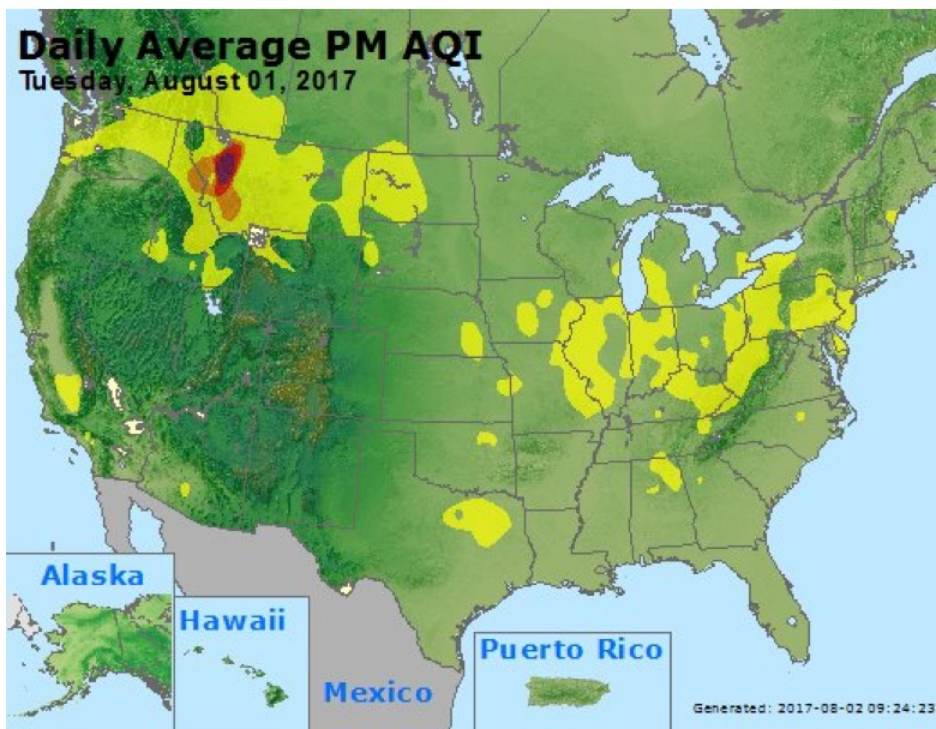
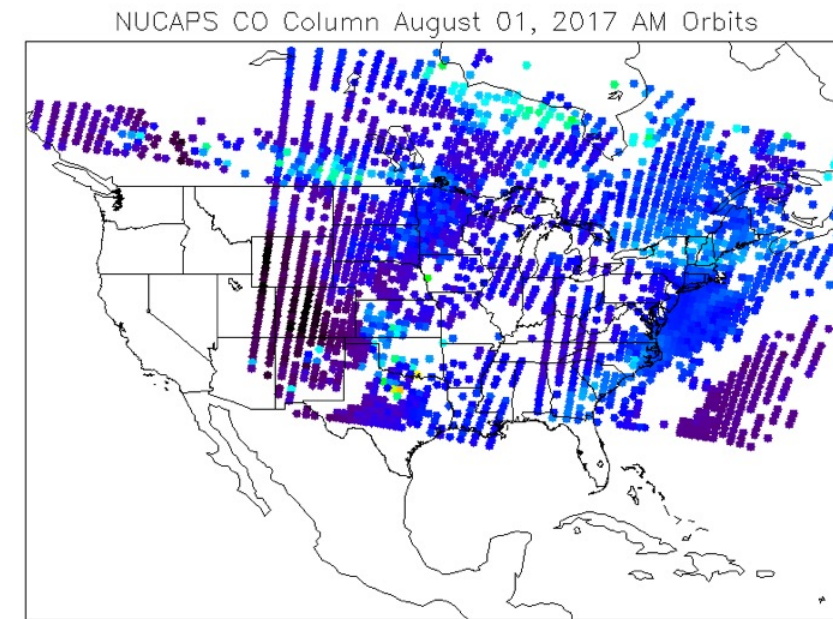
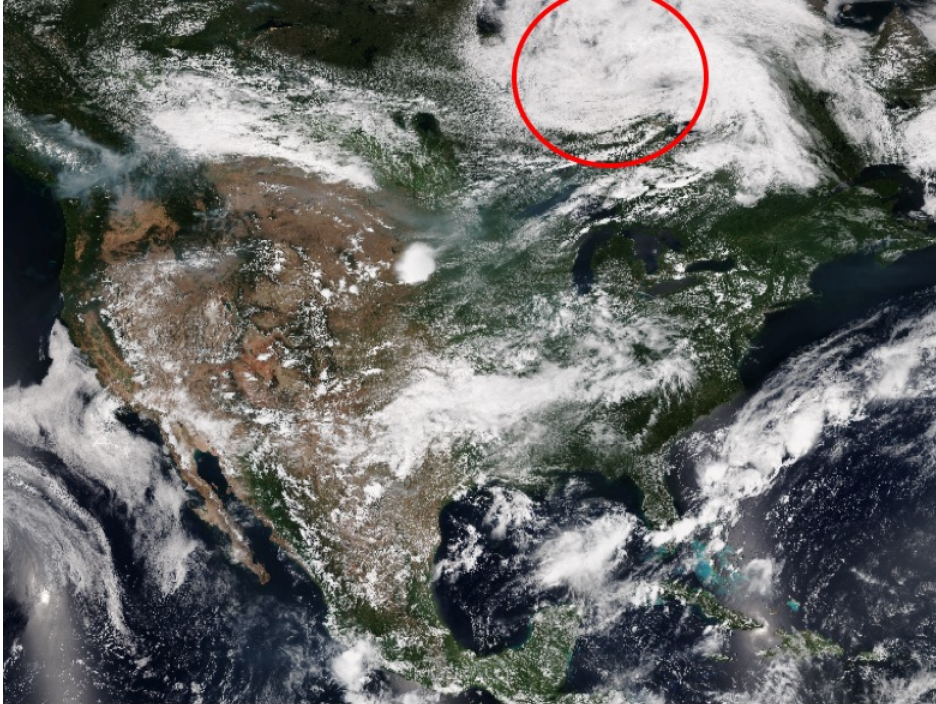


FSR NUCAPS with MOPITT FG

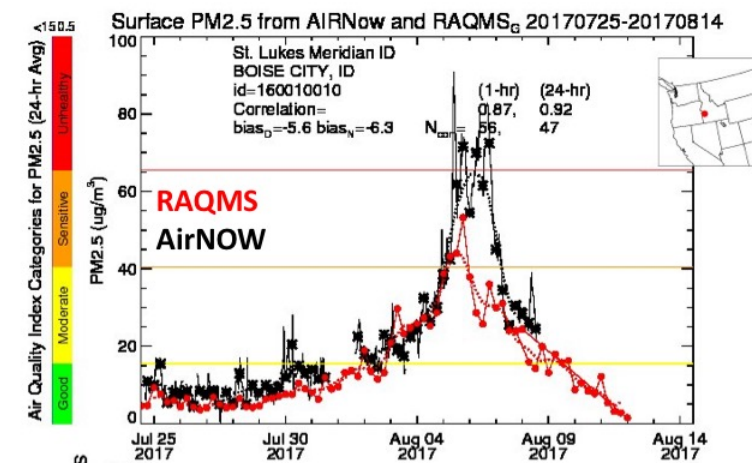
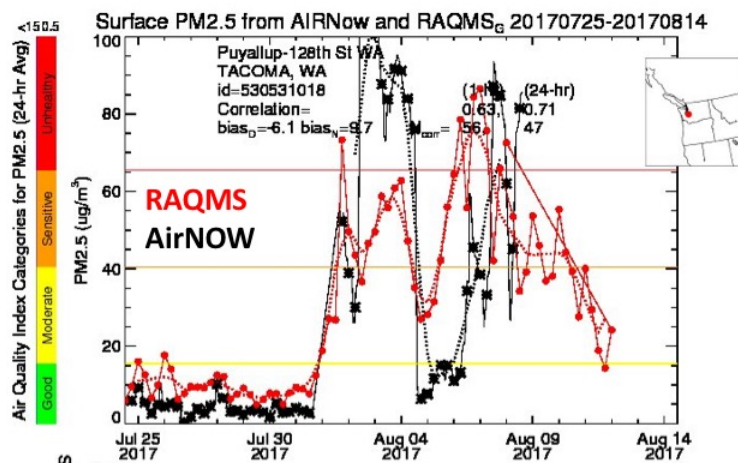
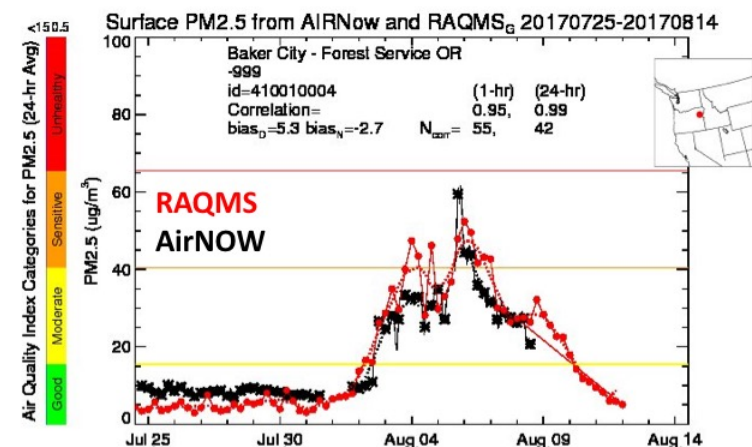
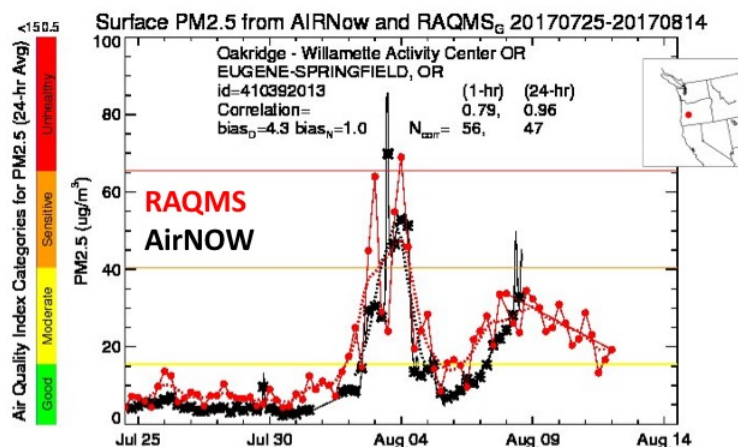
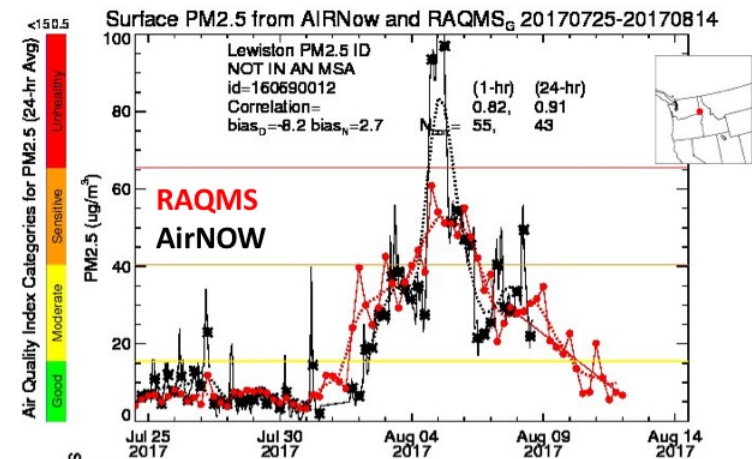
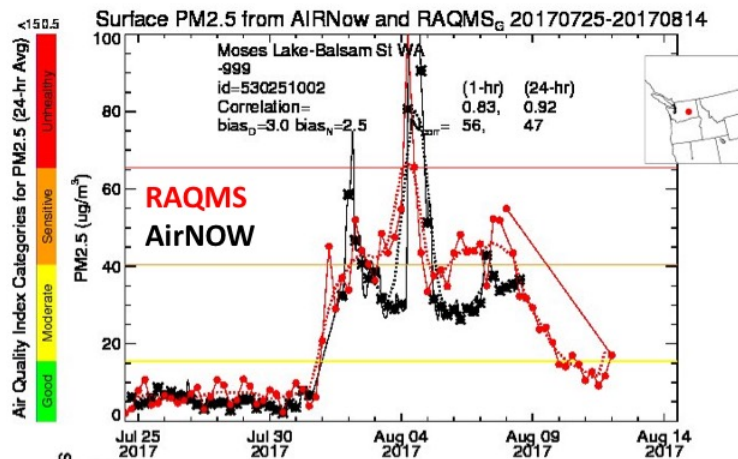
NUCAPS CO with MOPITT FG at 500 hPa 20160502 AM orbit



Brad Pierce 6 April 2017: "Since we have aircraft measurements in the SH with ATom, it might be interesting to compare all three first guess retrievals during the Atom flights."



Brad Pierce
(NOAA/STAR)

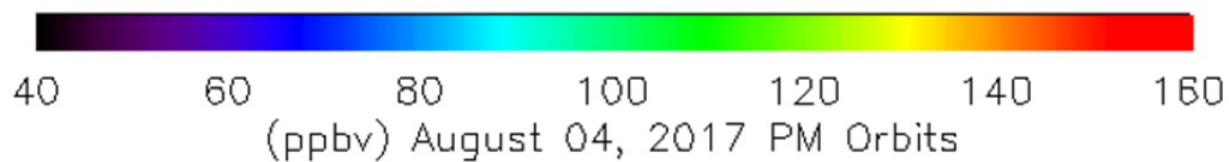
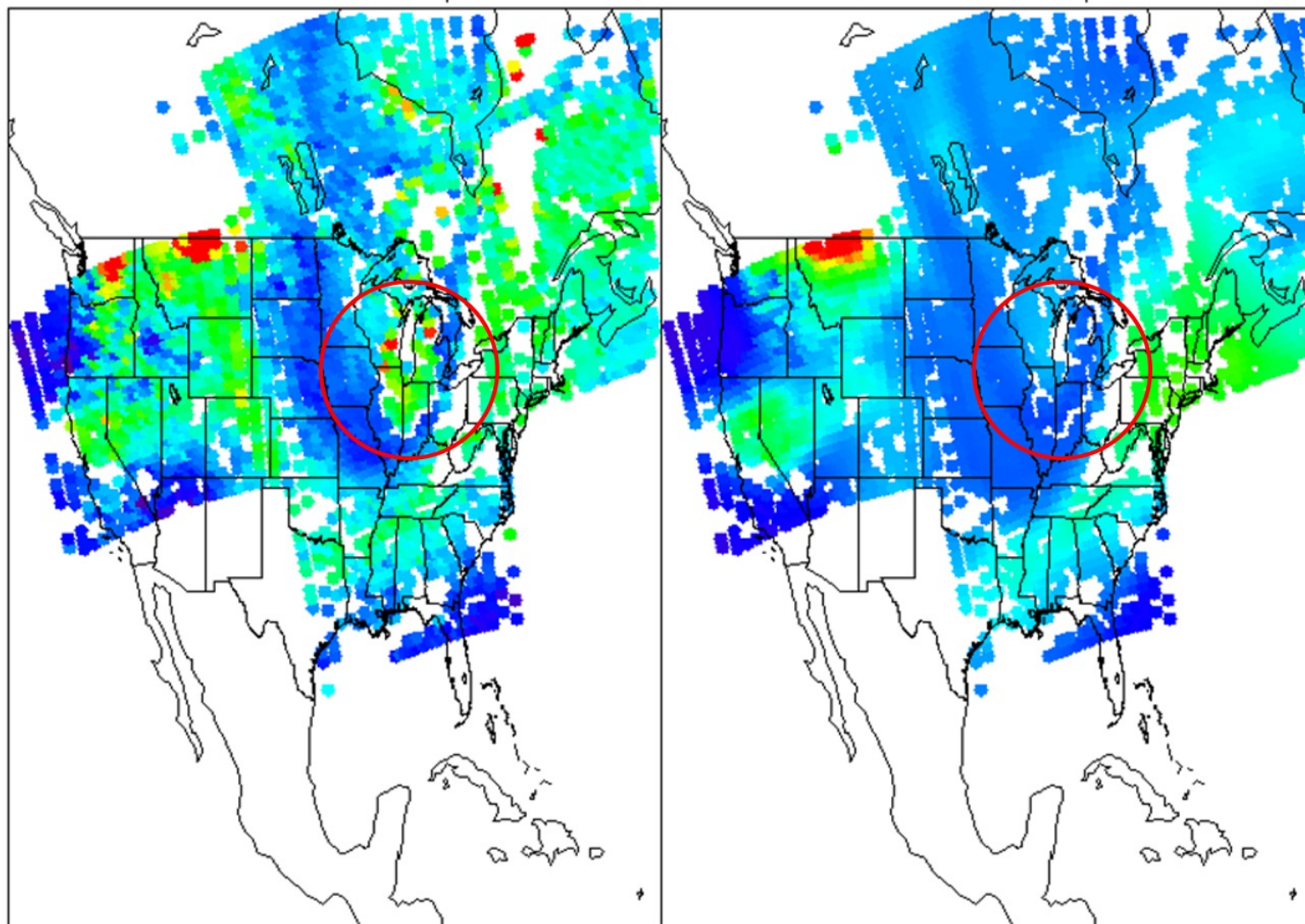


The Real-time Air Quality Modeling System (RAQMS) aerosol analysis captures the timing and magnitude of the surface smoke over the Pacific Northwest during the July 25-August 8, 2017 period.

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

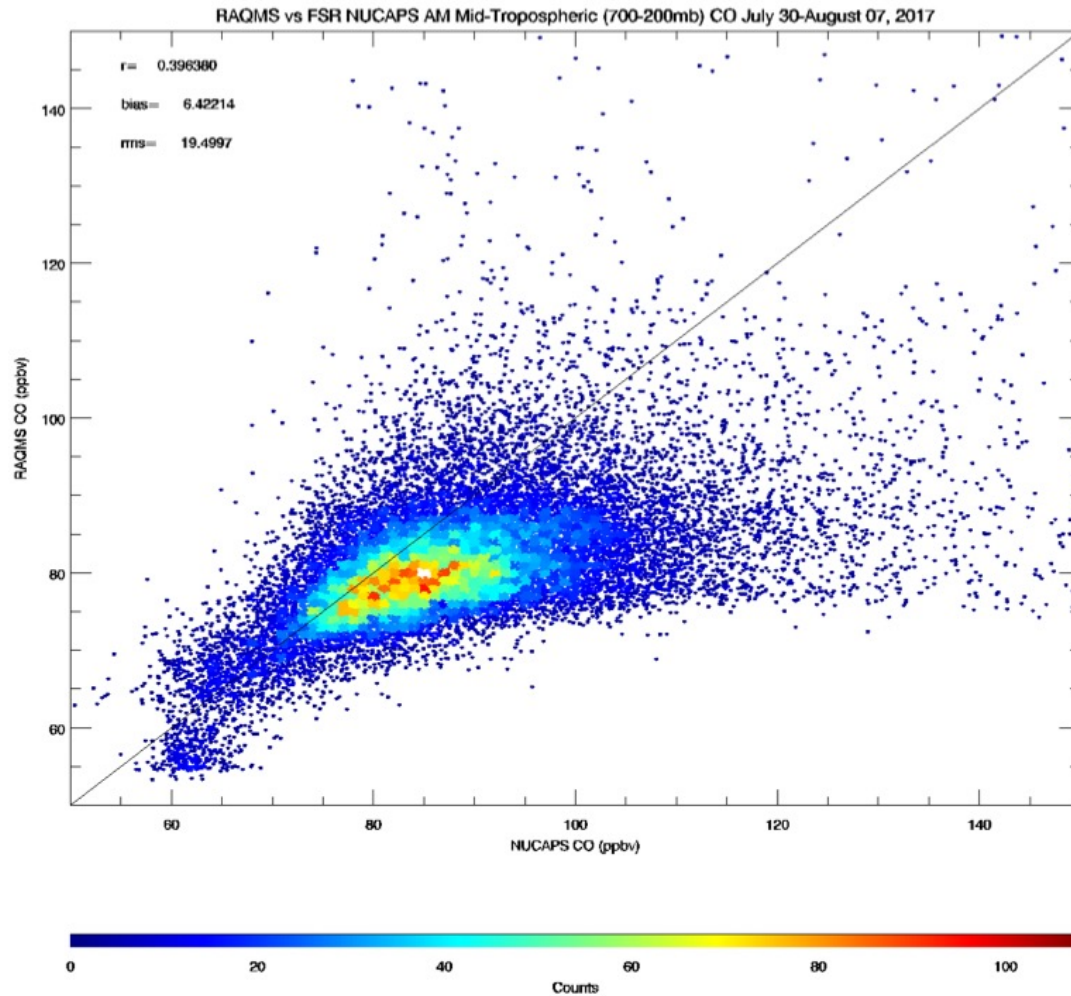
NUCAPS MidTrop CO

RAQMS MidTrop CO

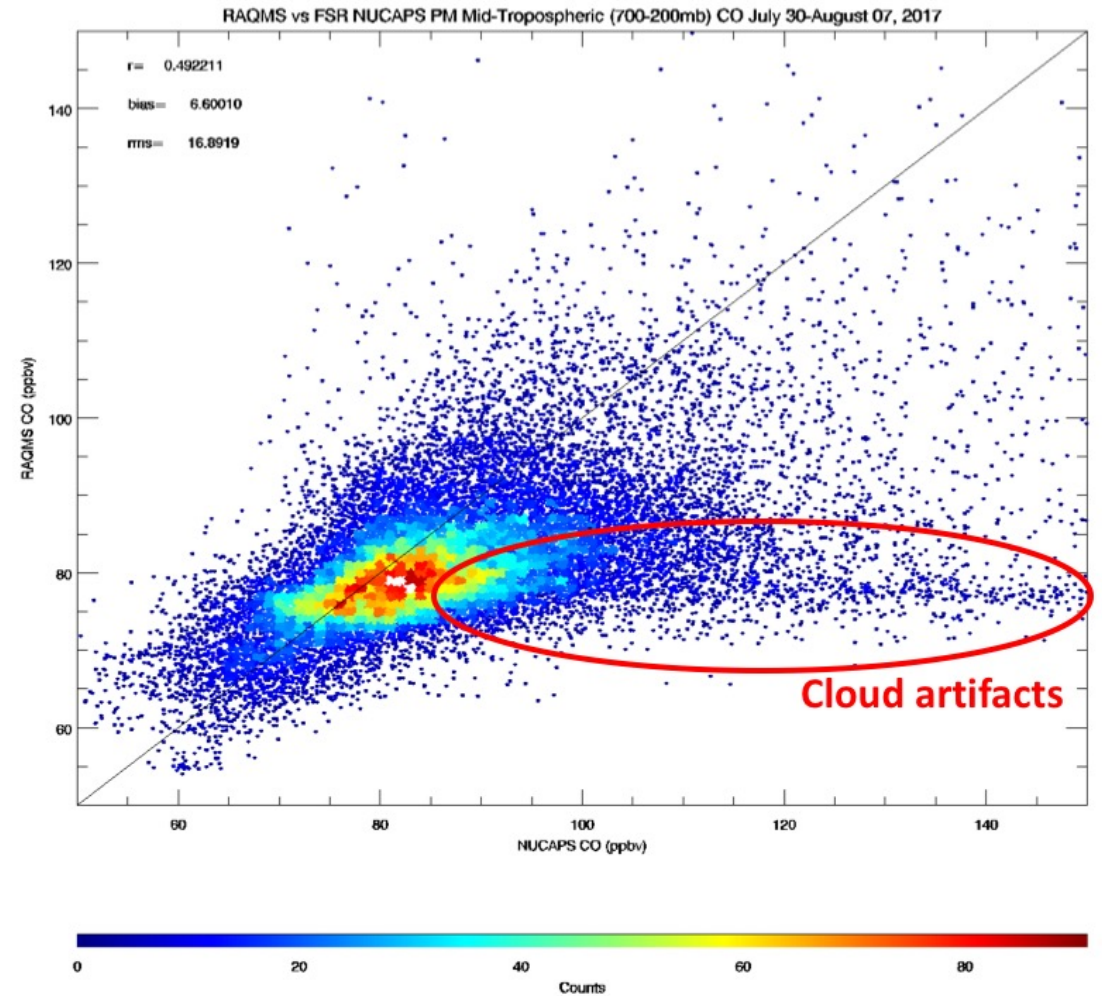


RAQMS vs FSR NUCAPS Mid-Tropospheric CO

RAQMS vs NUCAPS mid-trop CO; Night time



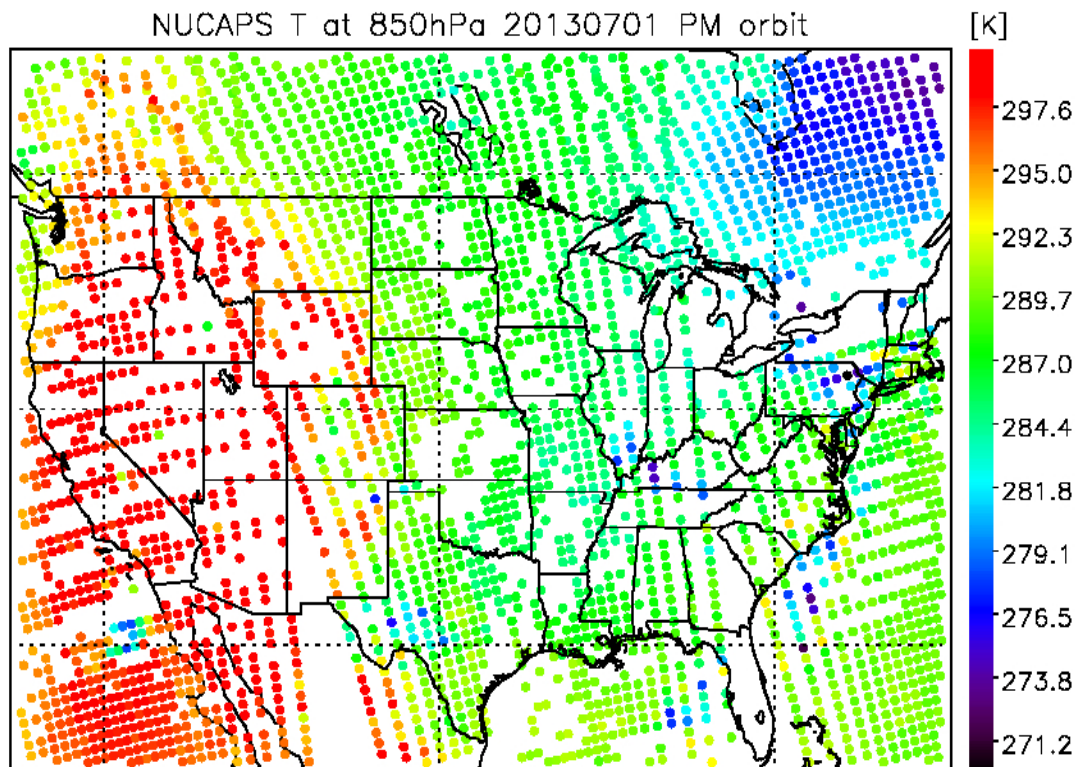
RAQMS vs NUCAPS mid-trop CO; Day time



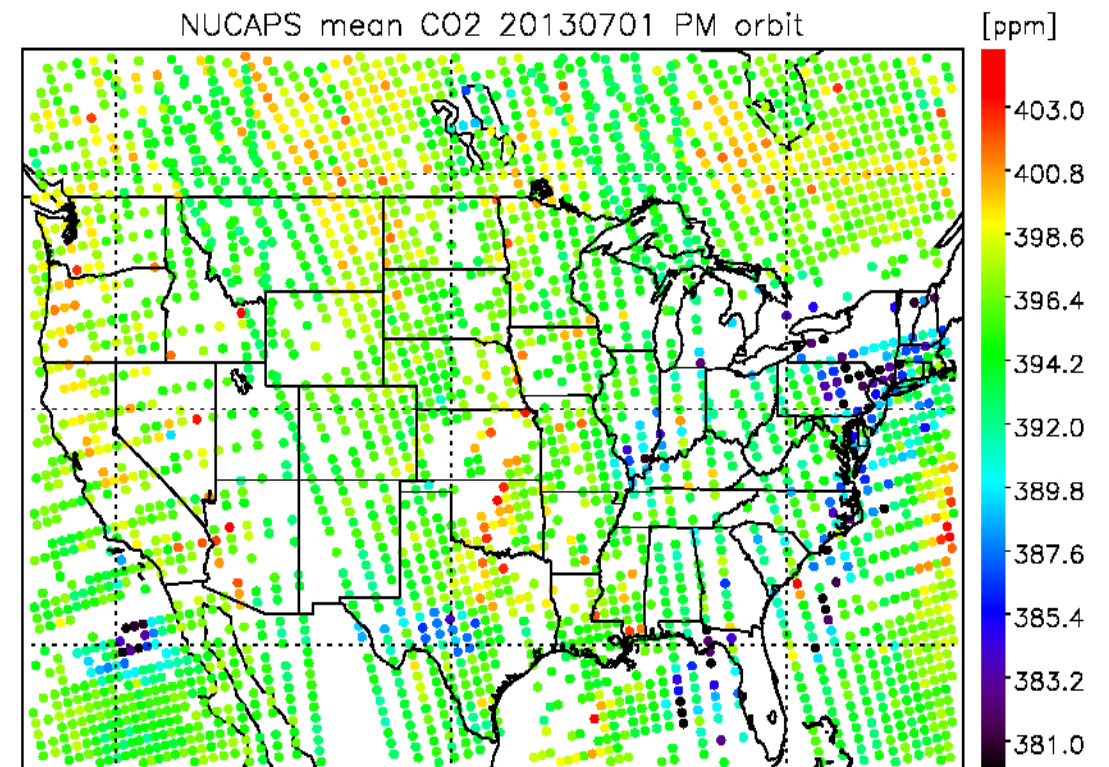
NUCAPS CO₂ helps determine T/q retrieval quality

Comparing NUCAPS Temperature with NUCAPS CO₂ highlight cloud contamination not filtered out by QC

Temperature @ 850 hPa



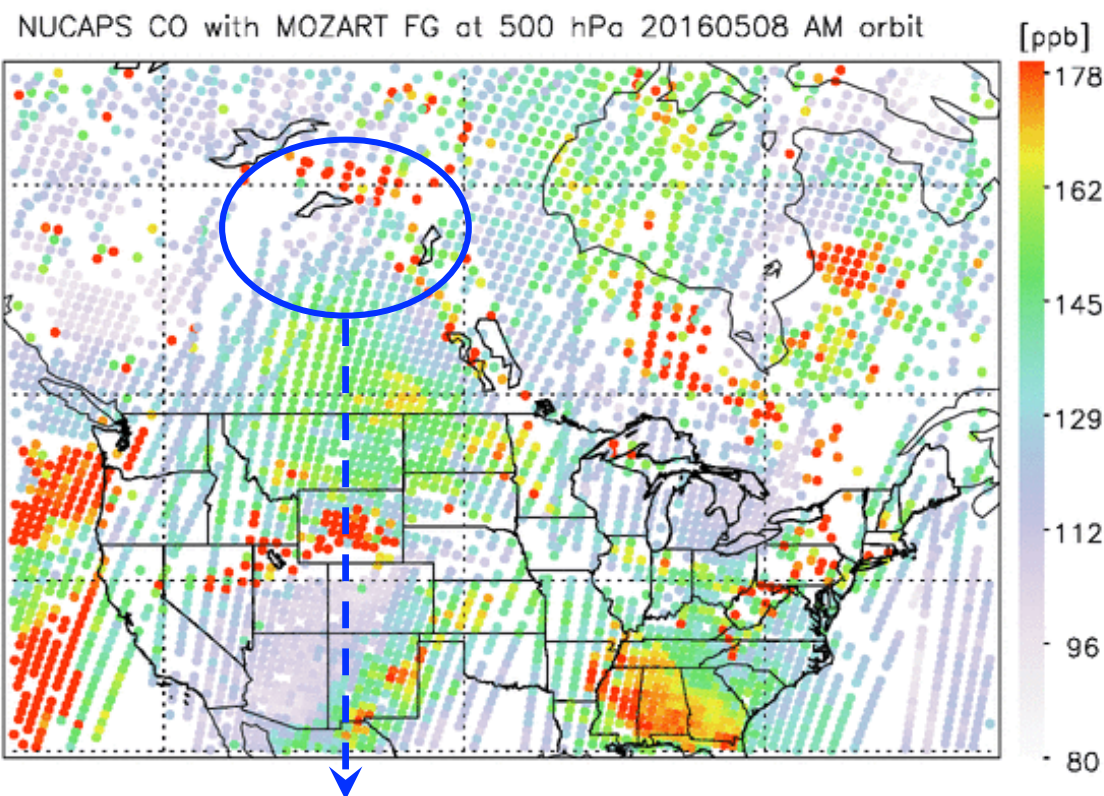
Column integrated CO₂



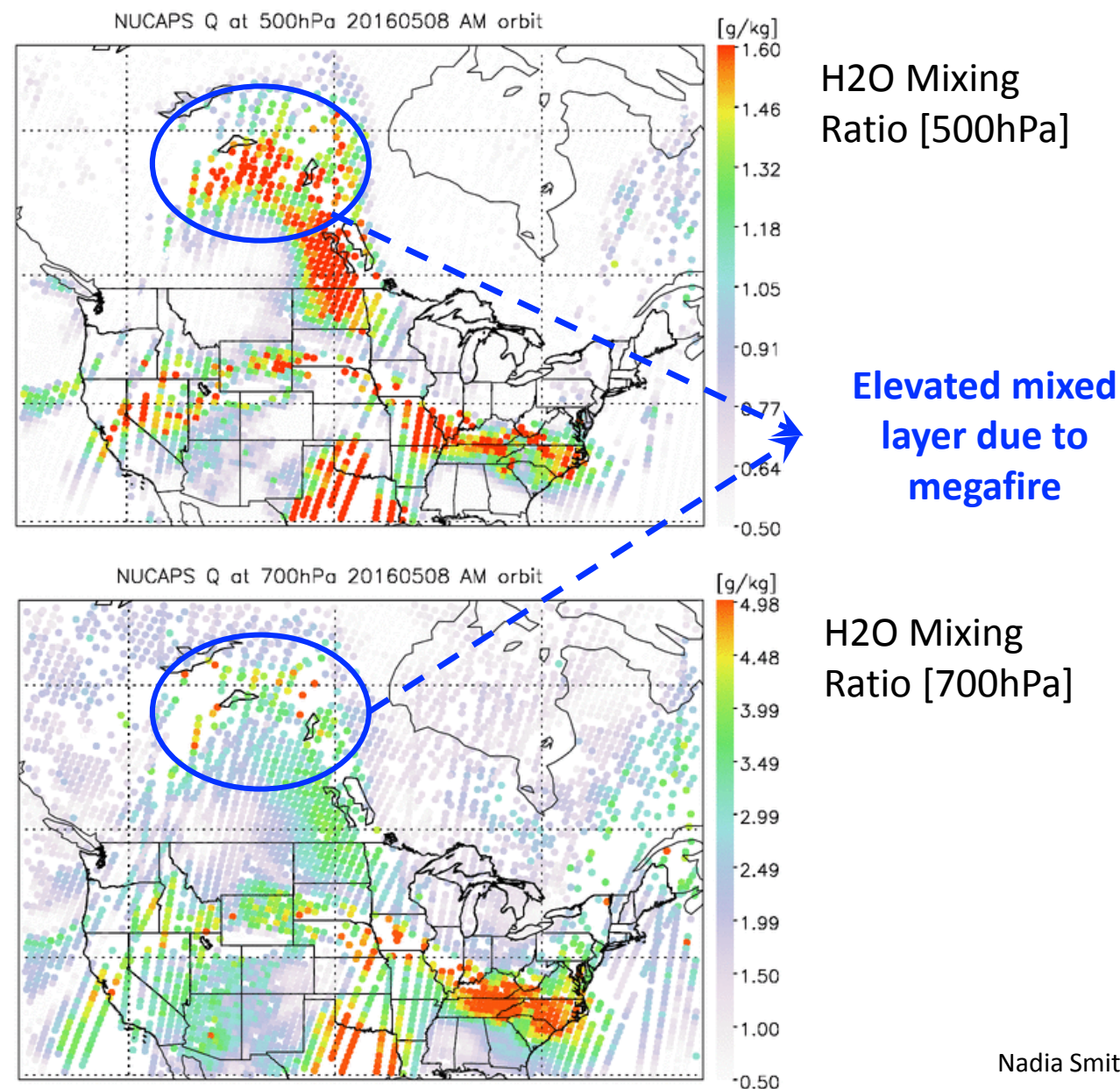
User-Developer partnership helps evaluate NUCAPS CO applications

investigating the presence of elevated H₂O mixed layer due to large scale biomass burning

Carbon Monoxide [500hPa]

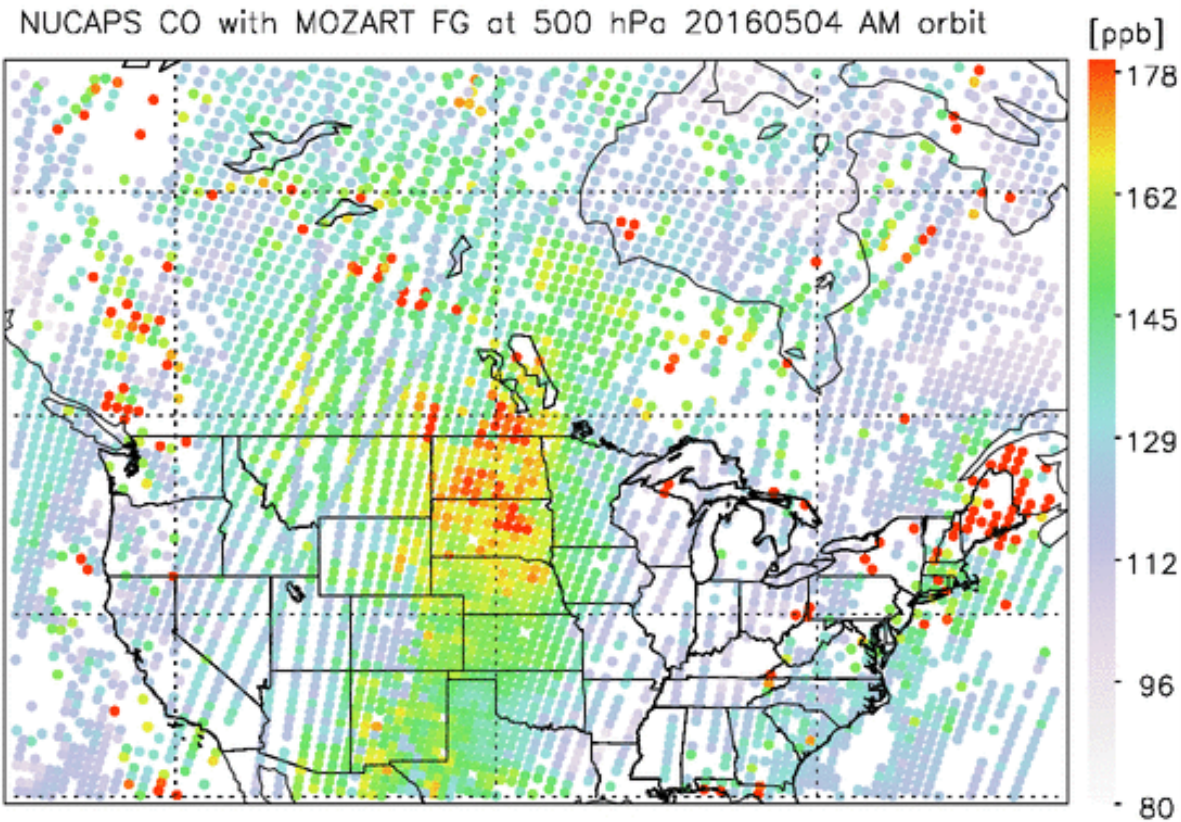


Ft McMurray Mega-Fire CO emissions

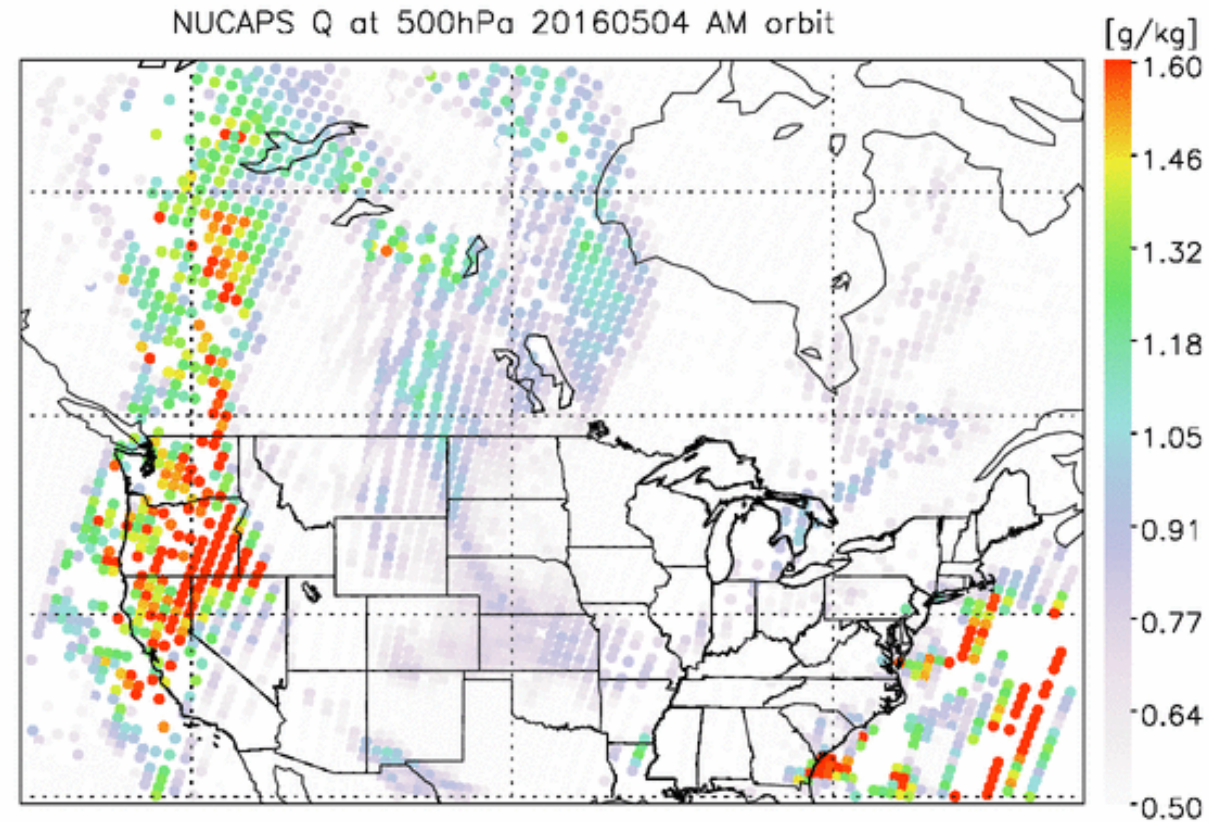


User-Developer partnership helps evaluate NUCAPS CO applications

Carbon Monoxide [500hPa]



H2O Mixing Ratio [500hPa]



With NUCAPS it is possible to investigate CO emissions as well as the change in moisture regime due to large scale burning

We have done (and continue to do) validation

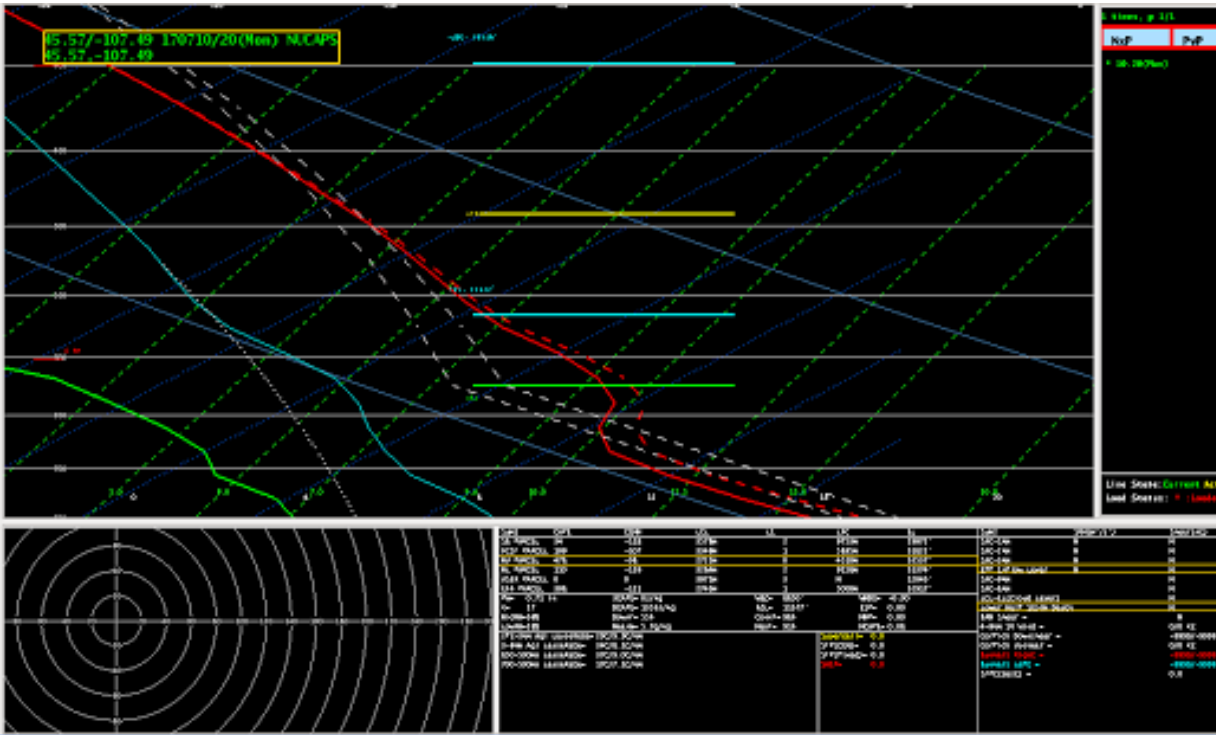
We have determined that there is potential for strong applications

So what is next?

NUCAPS T/q used in AWIPS to monitor fire weather

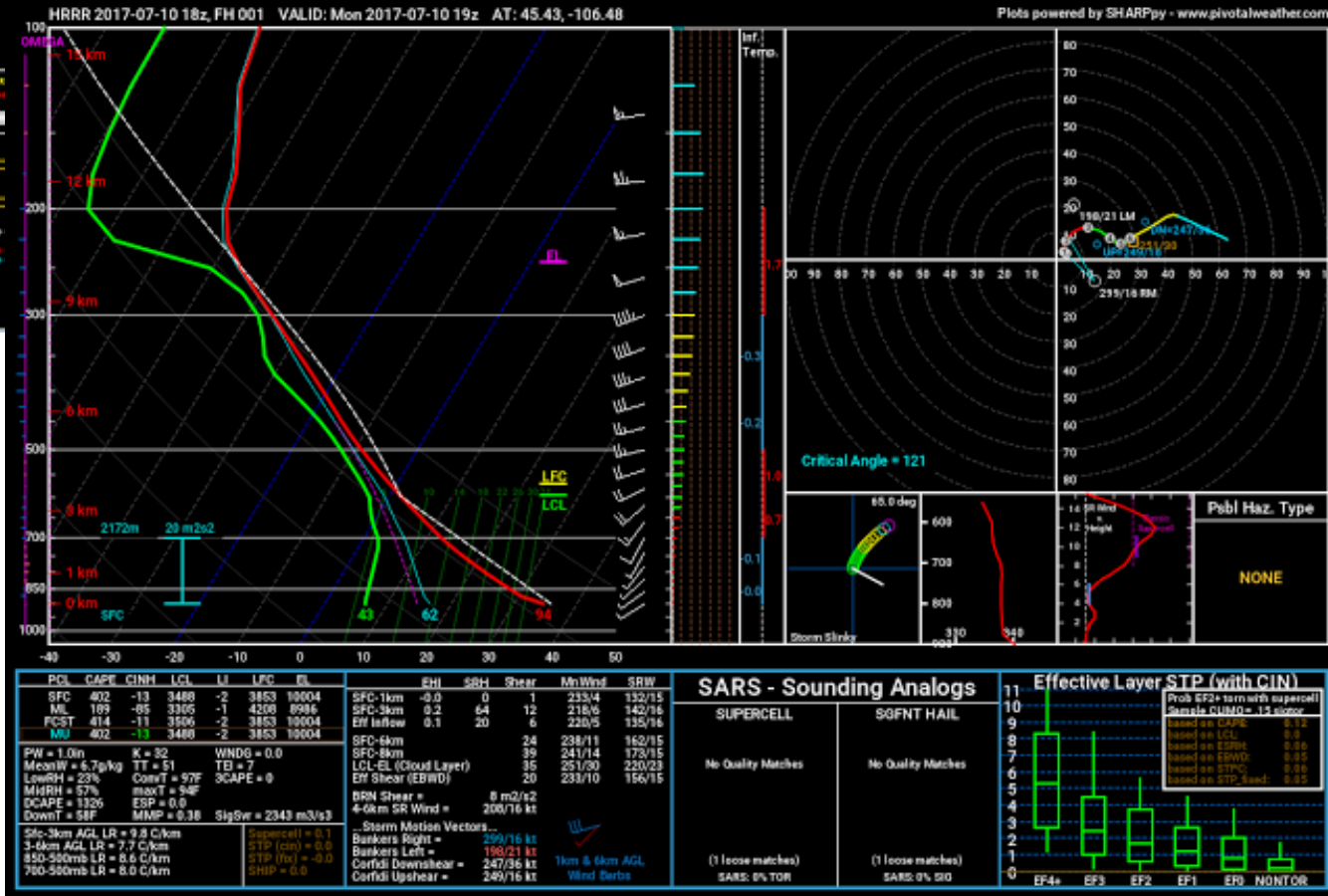
Slide by Michael Bowlen; HWT 2017

HRRR Forecast Sounding



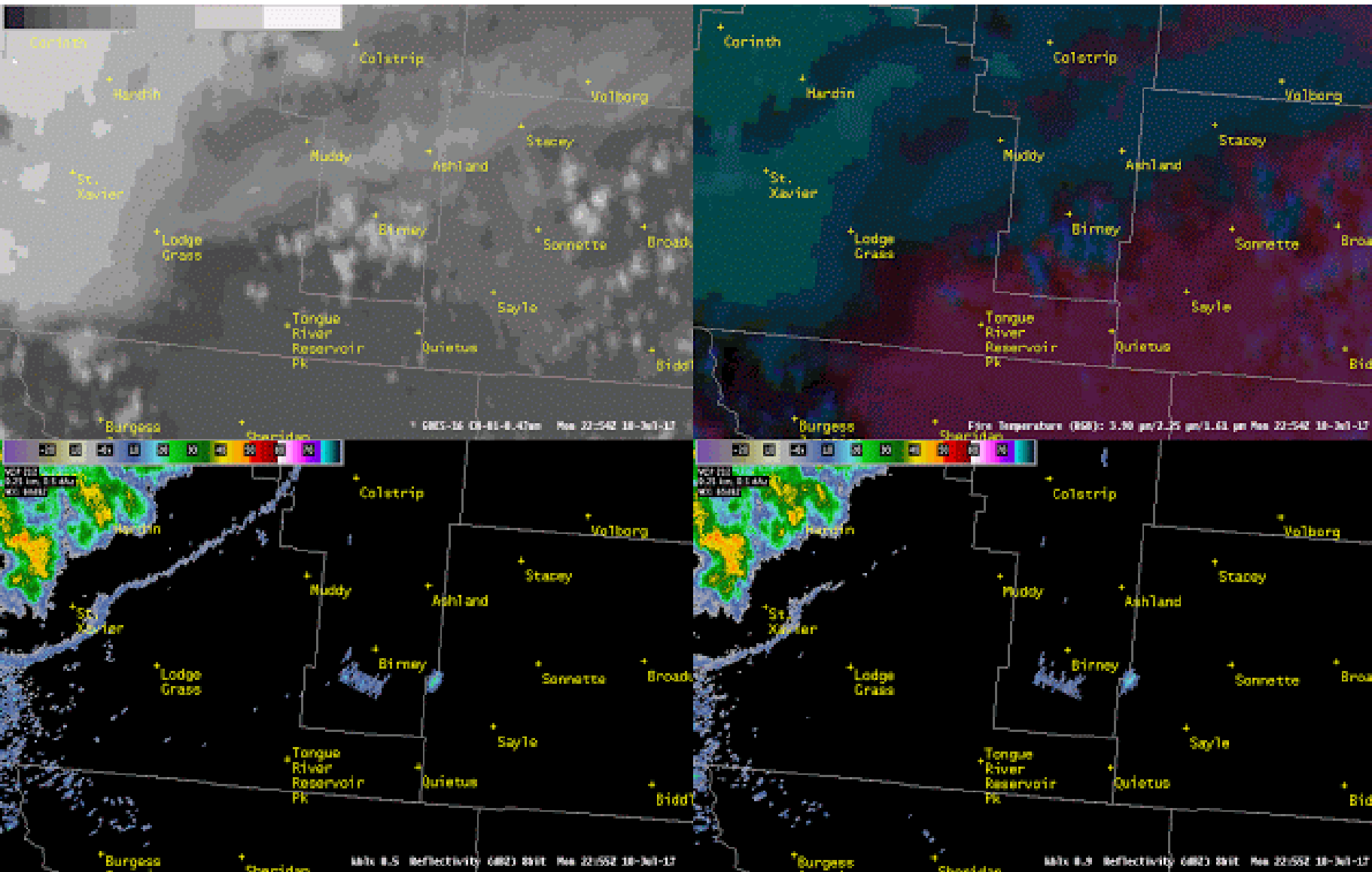
NUCAPS Sounding

- 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.”

What about NUCAPS
trace gas products –
would they have been
valuable here in AWIPS?

<http://www.npr.org/sections/thetwo-way/2017/03/03/518323094/rise-in-smog-in-western-u-s-is-blamed-on-asias-air-pollution>

the two-way BREAKING NEWS FROM NPR

AMERICA

Smog In Western U.S. Starts Out As Pollution In Asia, Researchers Say

March 3, 2017 · 10:21 AM ET

BILL CHAPPELL



Nitrogen oxide pollution in India and China is offsetting U.S. gains in cutting emissions, researchers say. This photo from October shows road traffic, along with smoke and smog, in front of the landmark India Gate in New Delhi.

Manish Swarup/AP

“A global perspective is necessary when designing a strategy to meet US O₃ air quality objectives,” the scientists wrote

They concluded that the spike in man-made emissions in Asia “is the major driver” of the rise in ozone levels in the western U.S. for both spring and summer in recent decades.

Lin et al. 2017, ACP, doi.org/10.5194/acp-17-2943-2017

How can this research make its way into the public domain?

NUCAPS has the quality and coverage to contribute to air quality monitoring at global scales....

“... even quick-look images of CO ... during fire periods would be very useful to us. We don't need a fancy display”

Greg Frost (NOAA/ESRL)

“Now-casting tools are important in case of disasters?” Tony Wimmers (SSEC/CIMSS)

“We need to be able to monitor trace gases over time” Monica Kopacs (NOAA/CPO)

<https://worldview.earthdata.nasa.gov/>

<https://realearth.ssec.wisc.edu/>

<http://www.esri.com/>

We need more options for interactive display

Quality Validation → Application Evaluation → Every-day Verification



The questions really should be:

Do you know what NUCAPS trace gas products look like for today?

Will you be able to look at NUCAPS trace gas products tomorrow when this meeting is over?