



Monitoring atmospheric composition and long-range pollutant transport with NUCAPS satellite soundings

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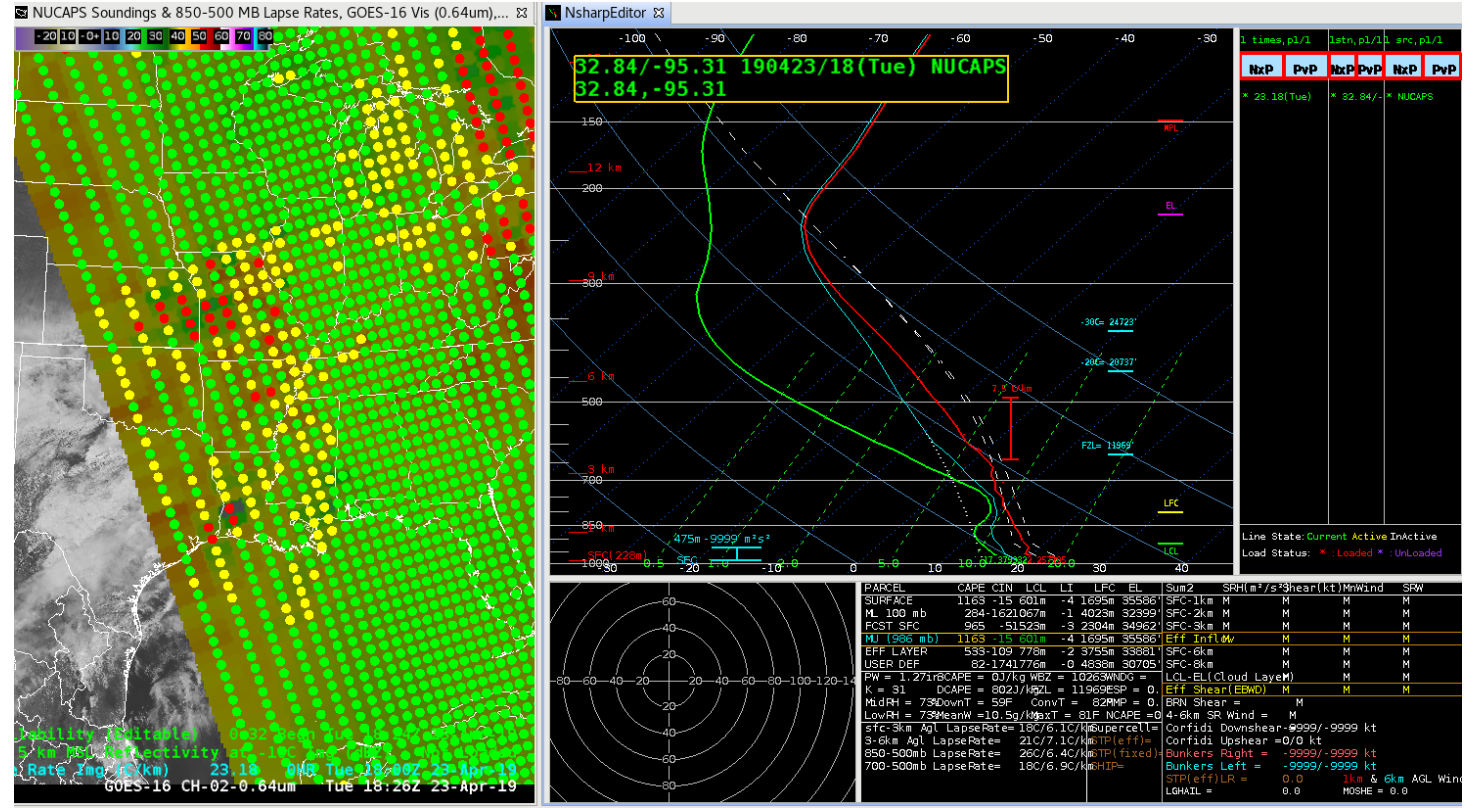
NUCAPS Soundings in real-time weather forecasting

NOAA-Unique Combined Atmospheric Processing System (NUCAPS) for CrIS/ATMS (SNPP, NOAA-20)

NUCAPS soundings supplement radiosondes with wide swaths of model-independent soundings from the NOAA-20 (May, 2019) and Suomi-NPP satellites, multiple times during the day.

Gridded NUCAPS provides plan views at temperature, moisture, and derived values (CAPE, lapse rate, etc.) specific pressure level(s).

Albuquerque has a NOAA-20 overpasses at ~9Z and 20Z, with a typical latency of 30-45mins.

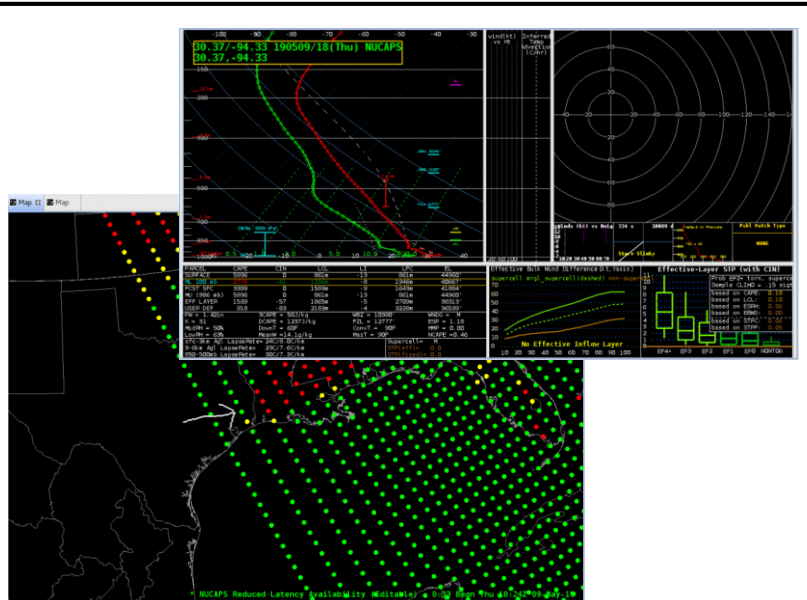


NUCAPS in National Weather Service Operations



Dot Color Meaning		
Green	Yellow	Red
Successful infrared (IR) + microwave (MW) NUCAPS retrieval under clear or partly cloudy conditions	Failed IR + MW NUCAPS retrieval. Successful MW-only NUCAPS retrieval under cloudy conditions	Failed IR + MW NUCAPS retrieval. Failed MW-only NUCAPS retrieval under precipitating cloudy conditions

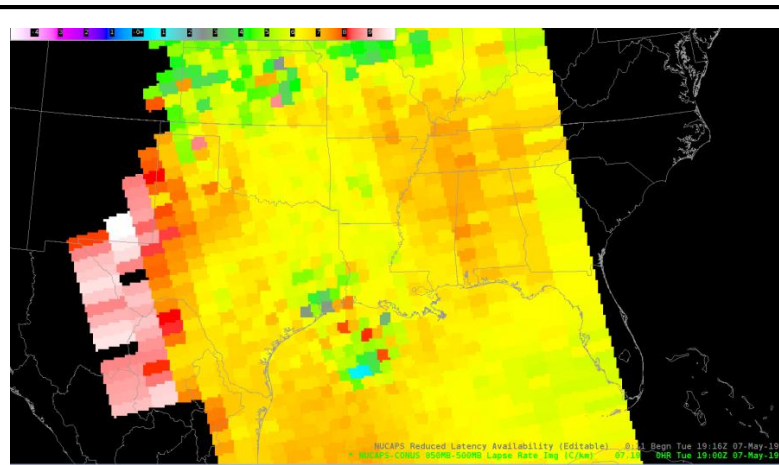
Feedback from the NOAA Hazardous Weather Testbed 2019



Post: [Wherefore art thou Convection?](#)

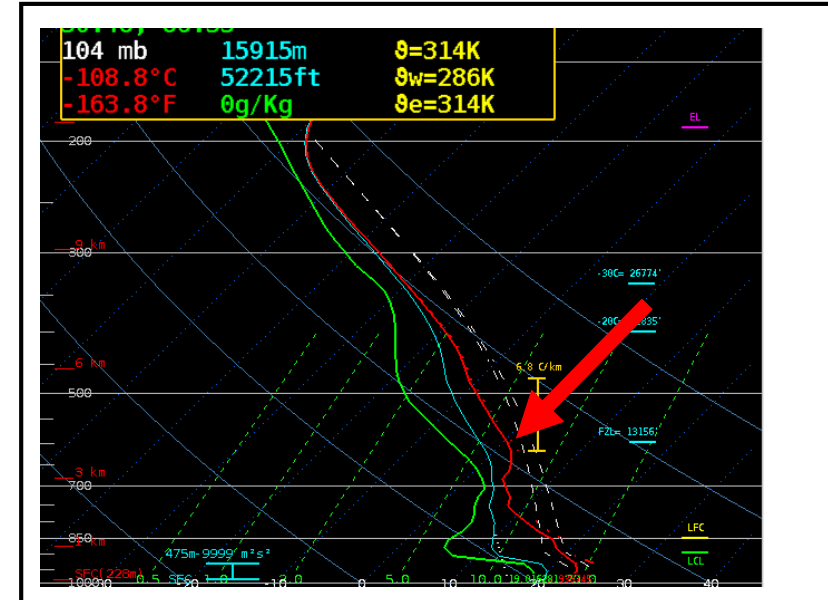
(May 9)

- Forecaster used NUCAPS soundings to observing capping, which diagnosed why convection was delayed when compared to models in Houston, TX.



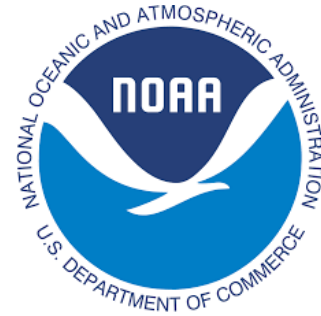
Post: [NUCAPS Lapse Rates](#) (May 7)

- Forecaster used gridded NUCAPS to see mid-level Lapse Rate across West Texas, which indicates convective potential. Values above reflect the drier air advancing east leading to steeper lapse rates.



Post: [TAE Mesoanalysis #1](#) (April 25)

- Forecaster diagnosed building instability ahead of a line of convective storms. The warm “nose” can impact storm intensity due to decreased CAPE.



What is a NUCAPS sounding?

- Profiles of temperature and water vapor
- Cloud amount and cloud top pressure
- Column amounts of O₃, CO, CH₄, CO₂, SO₂, NO₂

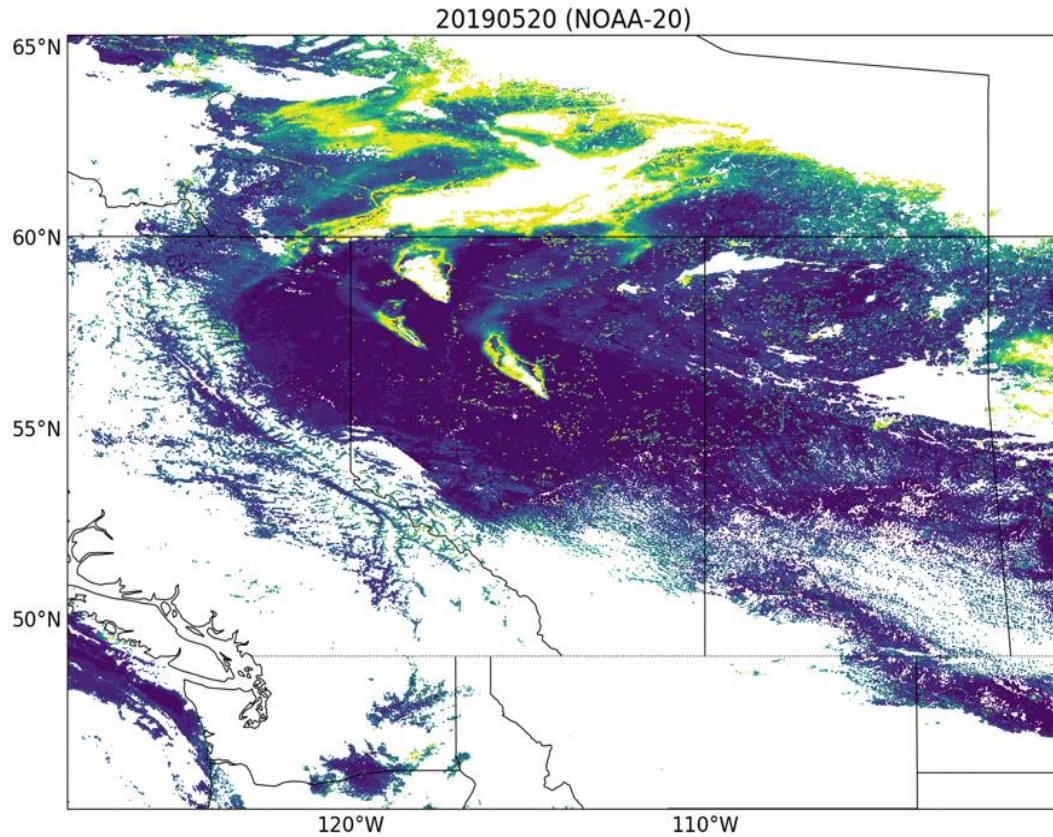
Clear and partly cloudy scenes
Day and night

NUCAPS soundings can be used to monitor:

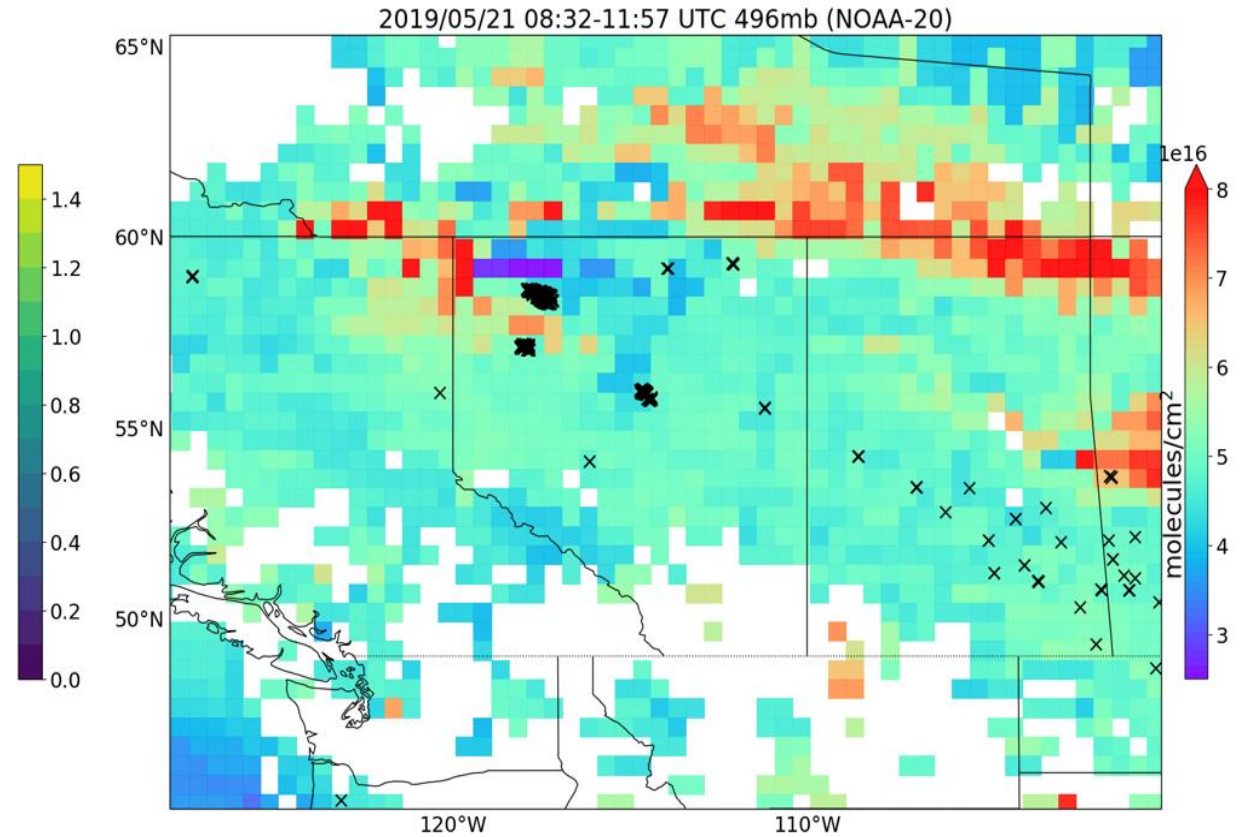
- (1) Fire weather ahead of and during a fire event
- (2) Atmospheric composition during a fire event
- (3) Long-range transport of pollutant air to neighboring regions

Alberta fires May/June 2019

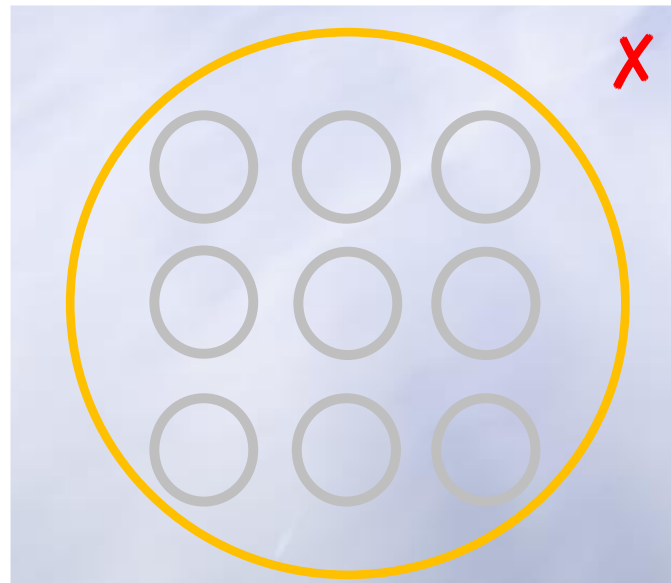
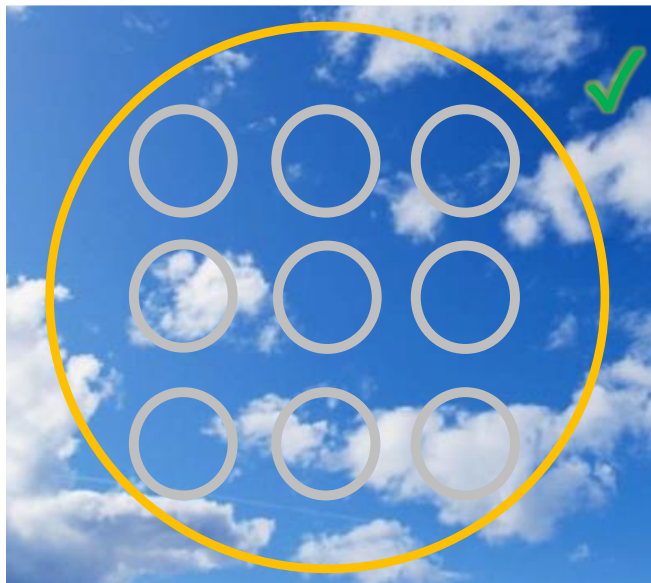
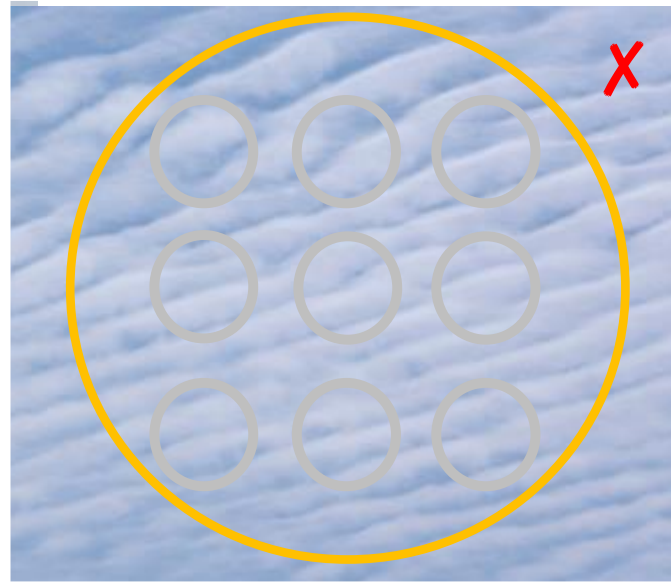
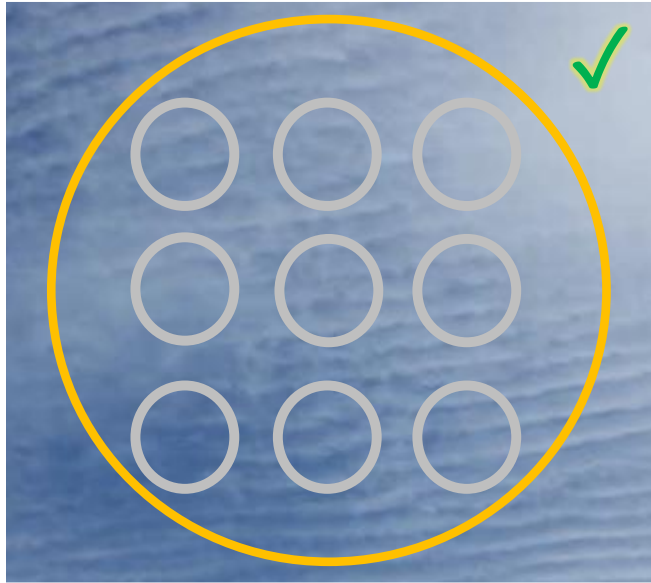
VIIRS AOD (day only)



NUCAPS CO at 500 hPa (day + night)



NUCAPS soundings in cloudy atmospheres



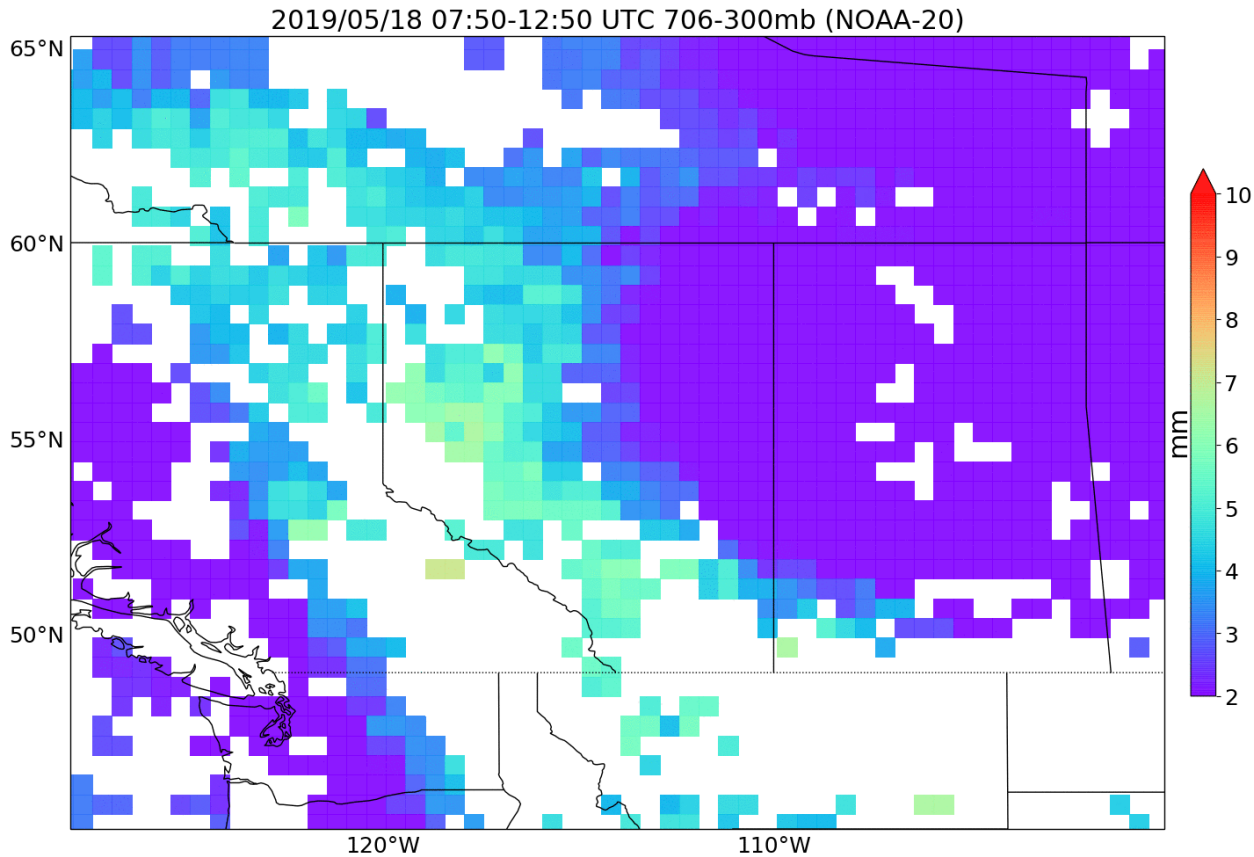
NUCAPS employs a technique called **cloud clearing** to retrieve soundings in partly cloudy scenes – 0 to 90% cloudy

NUCAPS sounding is an observation of atmospheric state passed the cloud, not through the cloud

NUCAPS retrieval footprint
CrIS spectral measurement area

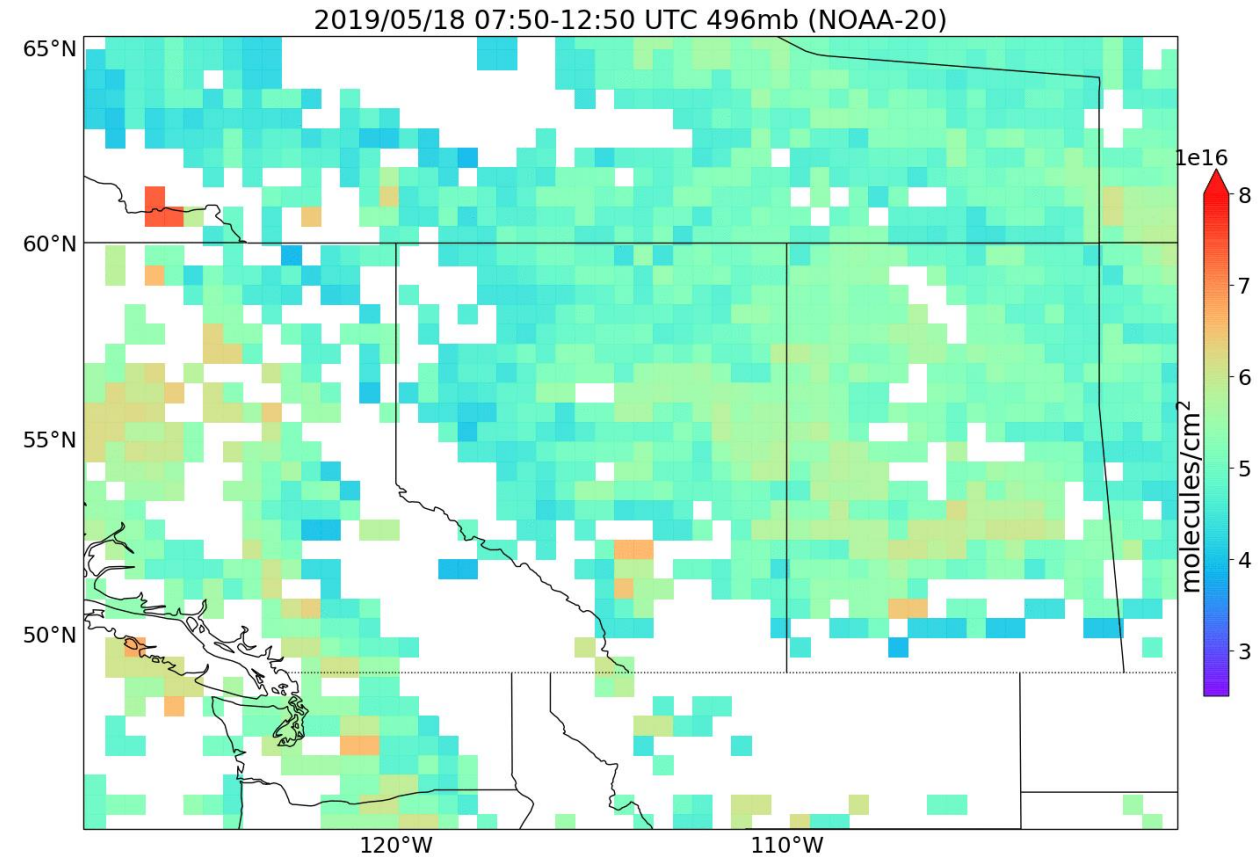
Alberta fires May/June 2019

NUCAPS Precipitable H₂O (300-500hPa)



Atmospheric Structure

NUCAPS CO at 500 hPa



Atmospheric Composition



New in 2019 National Weather Service Operations

- NUCAPS Ozone anomaly successfully transitioned from research to operations

- <https://nasasport.wordpress.com/2014/05/15/sport-expands-ozone-products/>

- NUCAPS Haines Index available for the first time to support Fire Weather forecasting

- <https://nasasport.wordpress.com/2019/08/14/transition-of-research-to-operations-gridded-nucaps/>

The screenshot shows the 'Gridded NUCAPS' interface. It features a main list of products on the left and a 'Pressure Levels' dropdown menu on the right. The background is a map of the United States.

----- Level/Layer Products -----	
Temperature	▶
Dewpoint Temperature	▶
Dewpoint Depression	▶
Relative Humidity	▶
Lapse Rate	▶
Theta-E	▶
Theta-E Lapse Rate	▶
Precipitable Water	▶
----- Single Level Products -----	
Temperature 2m	01.1632
Relative Humidity 2m	01.1632
Ozone Anomaly	01.1632
Total Ozone	01.1632
Tropopause Level	01.1632
Haines Index	01.1632
Quality Control	01.1632

The 'Pressure Levels' dropdown menu is open, showing the following options:

1000 MB	01.1632
925 MB	01.1632
850 MB	01.1632
700 MB	01.1632
500 MB	01.1632
300 MB	01.1632
250 MB	01.1632
200 MB	01.1632
100 MB	01.1632

Red boxes highlight the 'Ozone Anomaly', 'Total Ozone', and 'Haines Index' products in the main list, and the 'Ozone in AWIPS for the first time' and 'NUCAPS to support Fire Weather applications for the first time' text overlays.

Ozone in AWIPS for the first time

NUCAPS to support Fire Weather applications for the first time



Forecasting wildfires and fire weather

Example: Taixtsalda Hill Fire near Northway, AK burned ~27,000 acres; started on July 23, 2018

- Gridded NUCAPS in AWIPS is a unique opportunity to analyze fields derived from temperature and moisture variables
- Haines Index is a new capability that will be available with the release of Gridded NUCAPS in AWIPS 19.2.1
- This example, shows NUCAPS depicts a similar Haines Index spatial pattern compared to 0.5 deg GFS to indicate a Moderate potential for large fire growth
- Currently investigating the ability of NUCAPS to capture the pre-fire environment (warm, dry conditions).

