

The Evolution of Gridded NUCAPS: Transition of Research to Operations

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NUCAPS Soundings

The next-generation S-NPP and NOAA-20 Cross-track Infrared Sounder (CrIS) temperature and moisture profiles can provide valuable observations

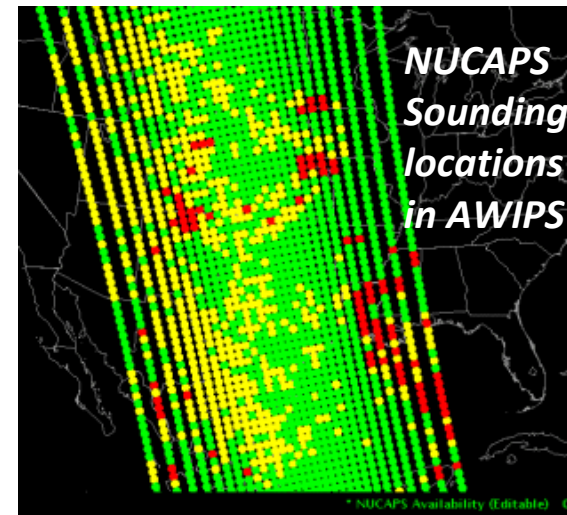
- Where conventional observations lack
- Between radiosonde launches

CrIS infrared (IR) observations are combined with the Advanced Technology Microwave Sounder (ATMS) microwave observations (MW) to produce high quality vertical soundings in clear and partly cloudy regions

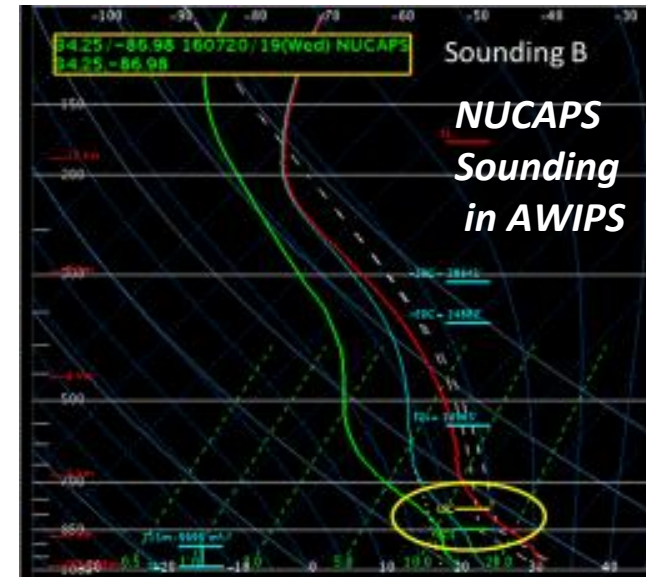
NUCAPS (NOAA Unique Combined Atmospheric Processing System) is the operational algorithm

NUCAPS Soundings are operationally available in to all National Weather Service forecaster through the Advanced Weather Interactive Processing System (AWIPS) as Skew-T plots

The capability to visualize the data in plan view or cross section would be valuable to maximize the benefits of NUCAPS data in AWIPS



Images by Kris White (NWS HUN/SPoRT)



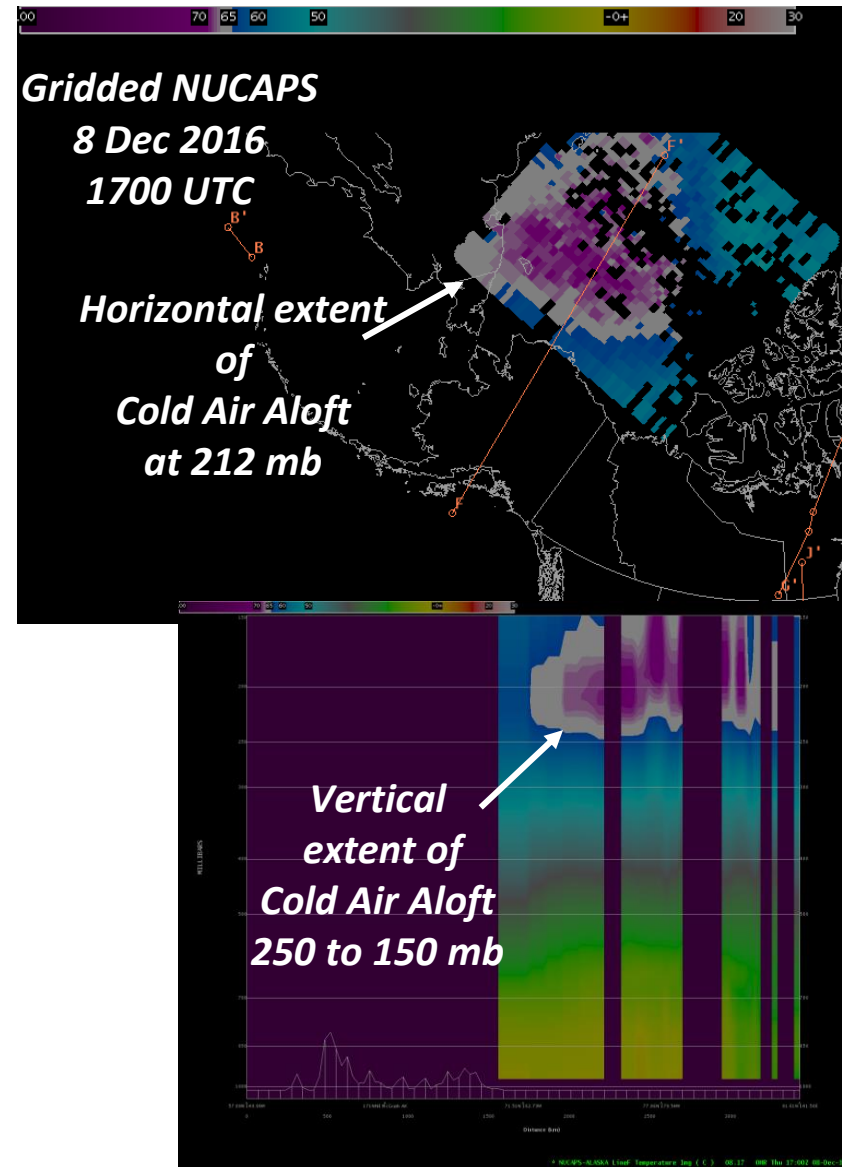
Gridded NUCAPS

This presentation describes a multi-organizational collaboration through the JPSS Sounding Applications Initiative to develop an experimental capability for plan view and cross section displays of NUCAPS Soundings observations in AWIPS (Gridded NUCAPS)

Gridded NUCAPS has been evaluated for utility for assessing

- ❑ cold air aloft at high latitudes
- ❑ the pre-convective environment

The success of these assessment activities has led to the operational transition of Gridded NUCAPS within baseline AWIPS

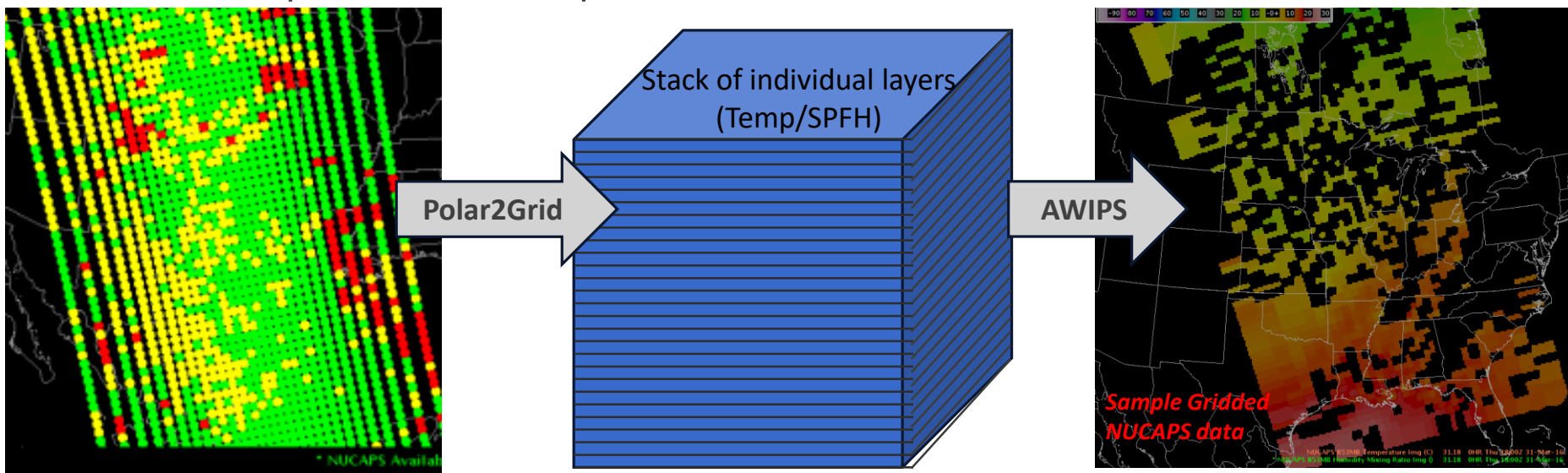


Experimental Gridded NUCAPS

CIMSS modified polar2grid software package to include readers for NUCAPS

SPoRT obtains Direct Broadcast data, runs polar2grid, and converts output to gridded binary (GRIB2) format for ingest into AWIPS

GRIB2 files are pushed to NWS partners in real-time



NUCAPS Soundings:
Need to click on each 'point' to review the vertical information

- *Pros: Can choose specific locations*
- *Cons: A lot of individual interrogation*

A subset of 58 layers are output using Polar2Grid from the 100 layers output by NUCAPS.

The grib2 file only contains:

- Temperature, Specific humidity
- Surface pressure and temperature
- Topography

Ingested into AWIPS on a uniform model grid, so AWIPS will interrogate the information in the same way it handles model data.

- Plan view and cross sections
- Temperature, moisture, and stability indices.

Forecast Challenge: Cold Air Aloft

Gridded NUCAPS was initially developed to address Cold Air Aloft

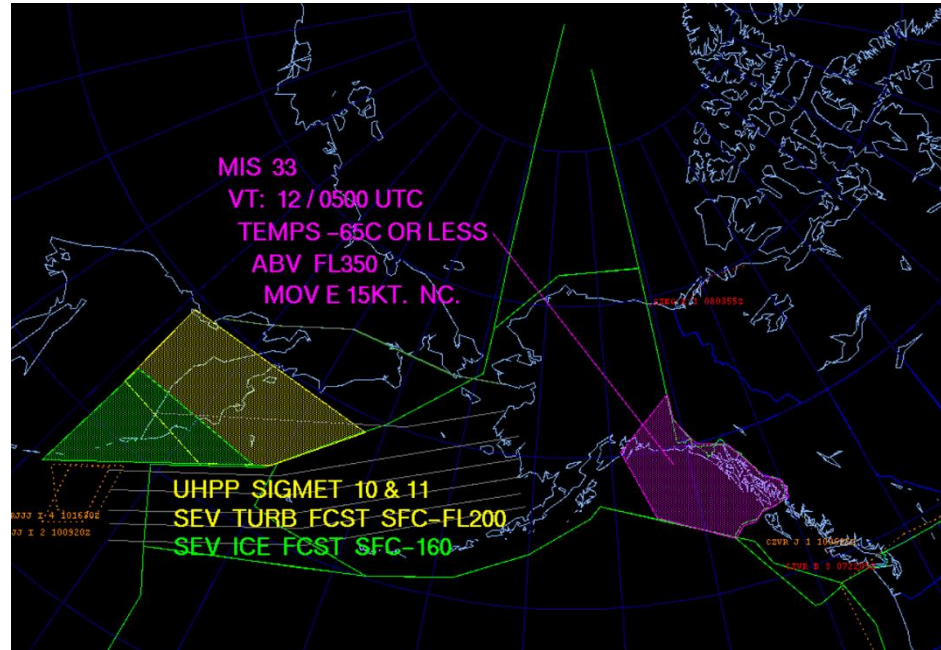
Cold Air Aloft ($\leq -65^{\circ}\text{C}$) events can freeze airliner fuel and regularly occur at flight levels in the arctic

Center Weather Service Units (CWSU) provide Meteorological Impact Statements (MIS) to Air Traffic Controllers to direct flights around the 3D air features

In data sparse Alaska, forecasters have relied on analysis and model fields and limited radiosonde observations to guess the 3D extent of the Cold Air Aloft

Use of satellite observations provides an opportunity for forecasters to observe the 3D extent of the Cold Air Aloft in real-time

Alaska CWSU domain (green line) and warning guide for 11 January 2017. Purple hatched area is an advisory for Cold Air Aloft



Example text product disseminated by Alaska CWSU for Cold Air Aloft; valid 14 November 2015

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FAAK20 KZAN 121458
ZAN MIS 01 VALID 121500-130300
...FOR ATC PLANNING PURPOSES ONLY...
COLD AIR ALOFT
FROM 185NE SCC-65NE ORT-55SW ENN-110NW BRW-185NE SCC
TEMPS -65C OR LESS FM FL350-400. AREA MOVG NE 40 KTS.
CMW NOV 14
    
```

Lat/Lon Extent of Cold Air from soundings, aircraft reports, model

Vertical Extent of Cold Air from soundings/aircraft reports/model

Motion determined from model data

Why is CAA important

British Airways Flight 038 Boeing 777 crash on approach at London Heathrow Airport on 17 January 2008

Fuel freezing points vary from -40°C to -60°C , but water in fuel can freeze at higher temperatures (below -10°C); either results in a loss of engine performance due to restricted fuel flow

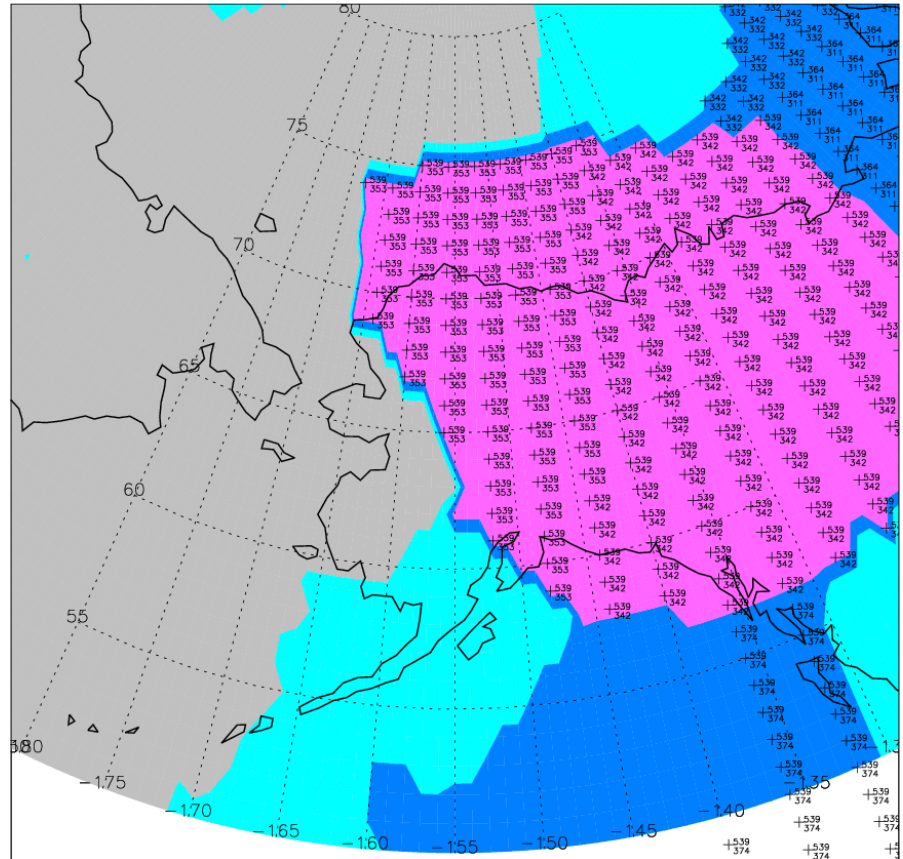
CAA mitigating factors include aircraft design, fuel type, initial fuel temperature, fuel quantity, aircraft speed, and flight route

The ZAN CWSU CAA forecast/warning threshold is an air temperature of -65°C outside the aircraft

CIRA developed the first display concept:

- http://rammb.cira.colostate.edu/ramsdis/online/cold_air aloft.asp
- Displays CAA heights in units of flight level (hundreds of feet)
- Polar-orbiting satellite data and GFS model output

NUCAPS 2018-02-20 12:04

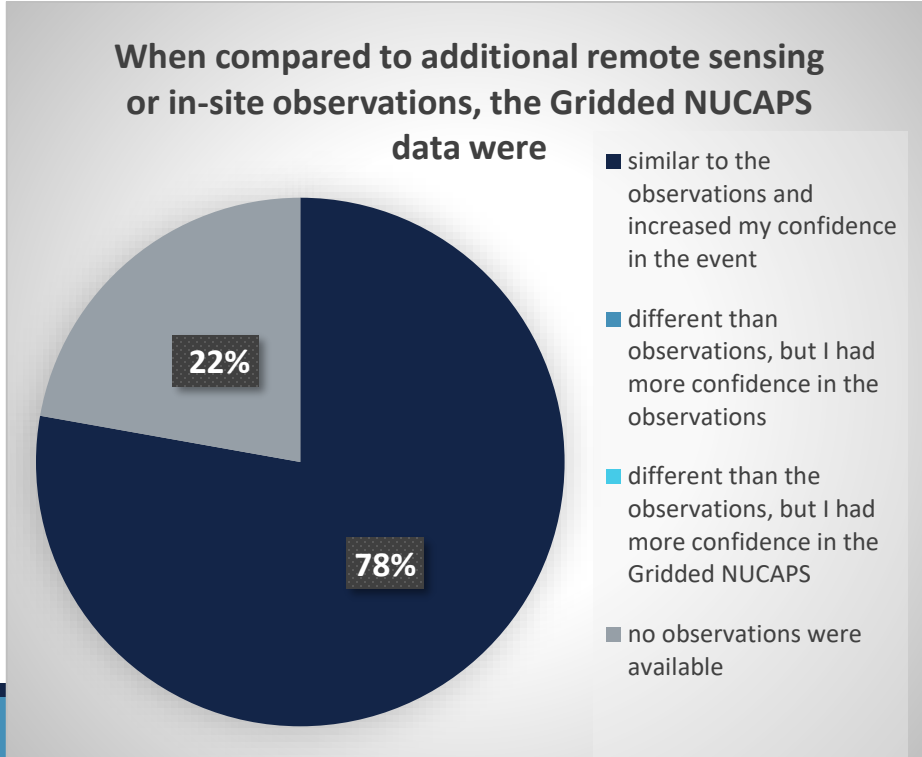
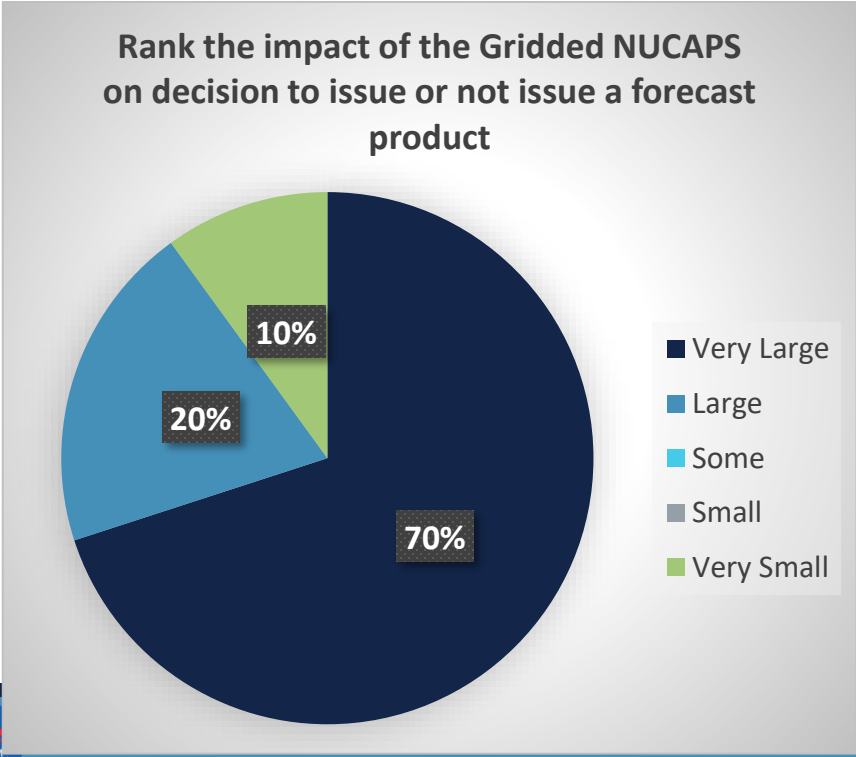


Forecaster Product Evaluations

Forecasters at the Anchorage CWSU evaluated the Gridded NUCAPS during the 2016-2017 & 2017-2018 Winter

Goal was to provide data to improve Cold Air Aloft analysis and increase confidence when issuing operational MIS statements used by the FAA and airlines.

After two evaluations forecasters have integrated NUCAPS into their forecast process for Cold Air Aloft



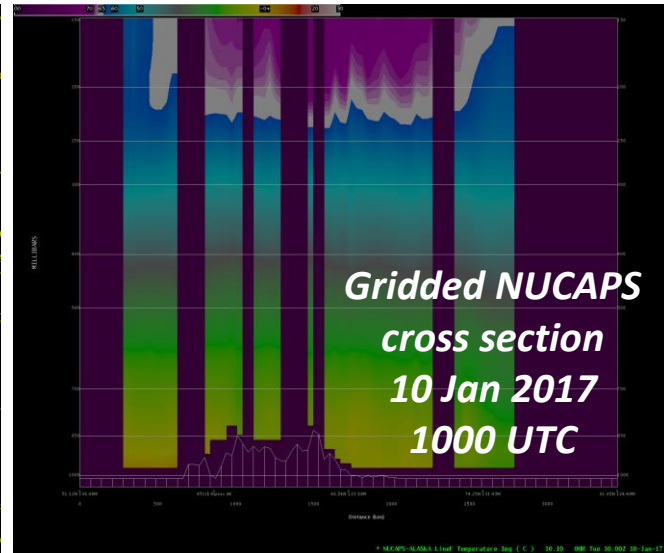
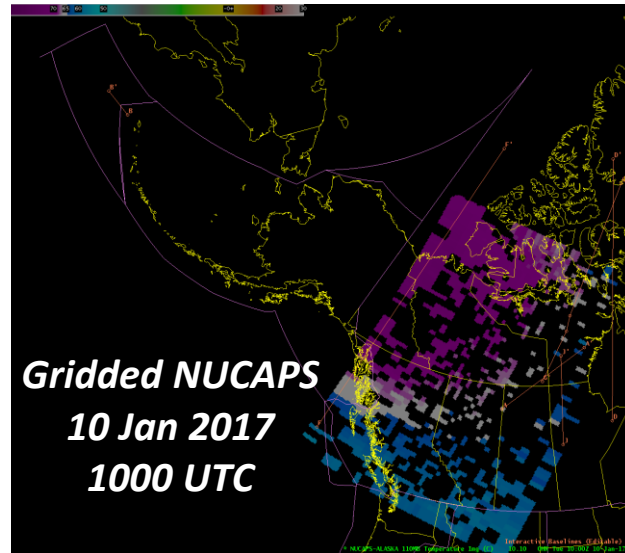
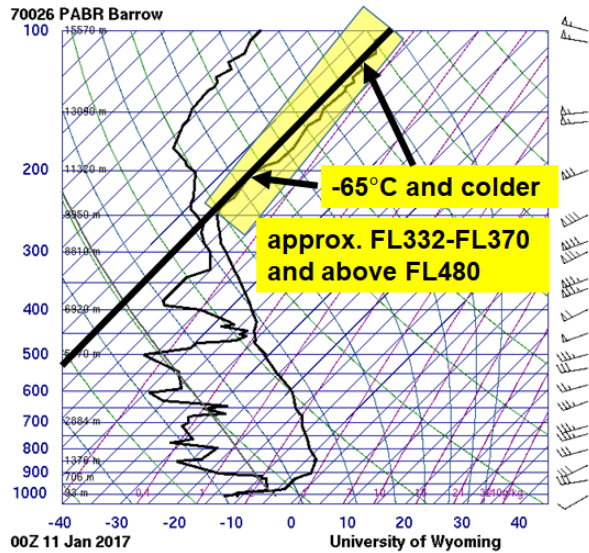
CAA Example

Forecasters used NUCAPS data to confirm model data, compare to observations, and fill in observational gaps

Gridded NUCAPS closely matched model data, Aircraft Reports, and observations

This increased forecaster confidence to use Gridded NUCAPS to complement model data in determining the vertical and horizontal extent of the CAA for the MIS

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FAAK20 KZAN 101720  
ZAN MIS 31 VALID 101730-110530  
...FOR ATC PLANNING PURPOSES ONLY...  
FROM 400NE BRW-150SE KTN-160S PDN-300NW BRW-400NE BRW  
COLD AIR ALOFT  
TEMPS -65C OR LESS ABV FL350. MOV E 15KT. NC.  
CMW JAN 17
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Example courtesy of Chris Waterhouse and Gail Weaver
Anchorage CWSU

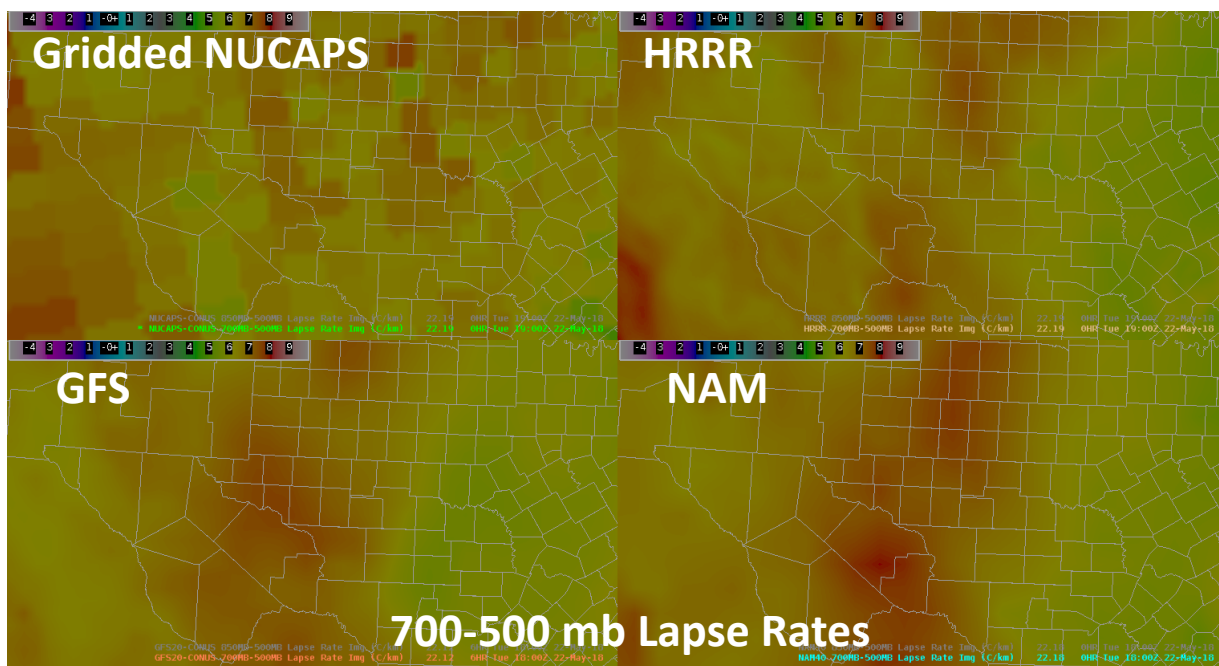


Pre-Convective Environment

Gridded NUCAPS was first demonstrated at the Hazardous Weather Testbed (HWT) in 2016, while point Soundings were first demonstrated in 2015

The goal was to test the utility of Gridded NUCAPS for analyzing the pre-convective environment

NUCAPS 700-500 mb lapse rates were generally around 6.5-7 C/km over SE NM & W TX. Comparing these lapse rates to the HRRR, GFS, & NAM40 the NUCAPS were the least steep with the GFS & NAM40 especially forecasting 700-500 mb lapse rate values of 7-7.5 C/km...



... In this case NUCAPS actually compared the best to SPC mesoanalysis values which are what I usually look at in a warning operation environment. This helped add to my confidence in the overall evolution of the event & widespread severe weather still looks unlikely. [sic] ~HWT Forecaster 2018

Pre-Convective Environment

Forecaster feedback led to product improvements and best practices

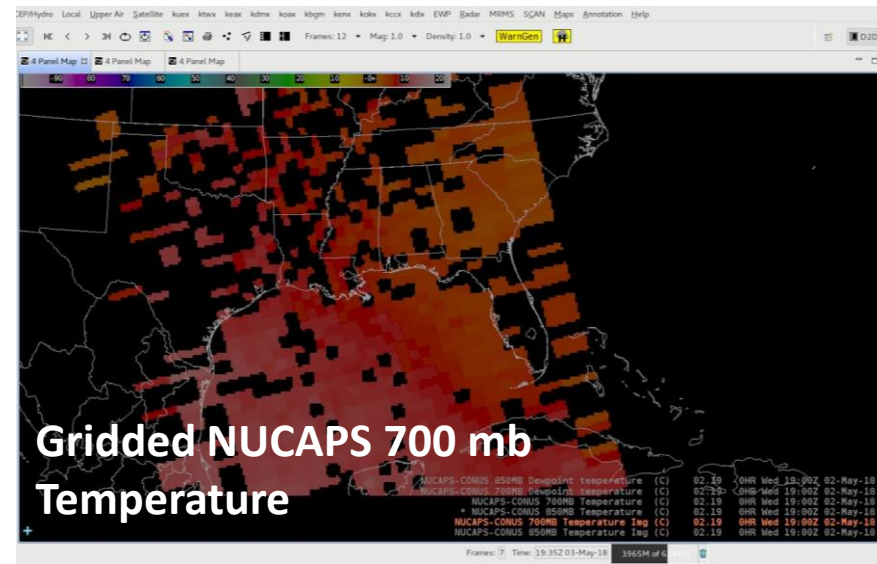
- ❑ View the data on standard pressure levels
- ❑ Leverage AWIPS derived parameters to calculate and display stability indices or thermodynamic fields
- ❑ The value of spatial gradients in mid-level fields
- ❑ AWIPS procedures and recommended fields to analyze
- ❑ Best practices to address data quality and gaps

See the HWT blog for more examples:

<http://goesrhwt.blogspot.com/search/label/NUCAPS>

3 years of testing at HWT solidified the value of Gridded NUCAPS:

- ❑ To assess thermodynamic spatial gradients/patterns
- ❑ As another observation tool to increase situational awareness



AWIPS Baseline

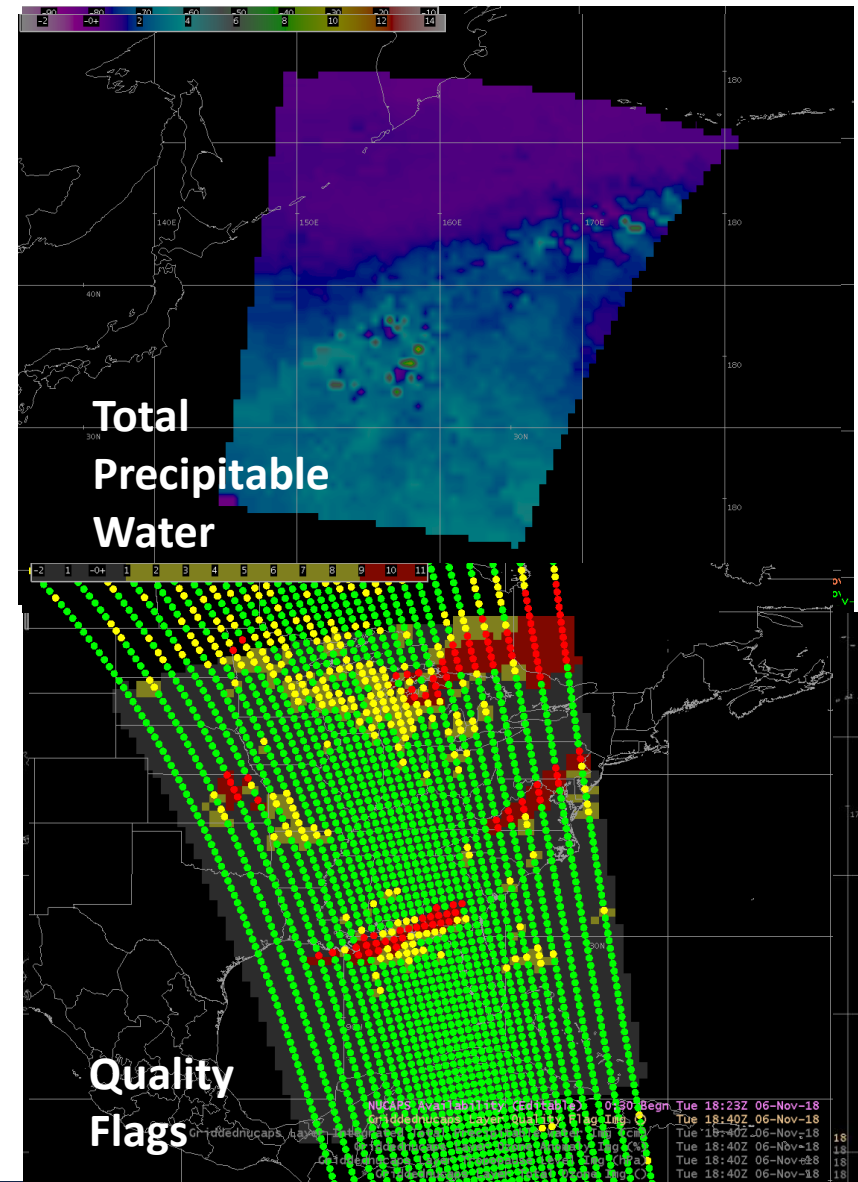
Gridded NUCAPS as an AWIPS Baseline capability is currently under development and testing

Targeting incorporation in AWIPS 19.1.1 with a 2019 release to the NWS operational AWIPS

S-NPP and NOAA-20 data delivered through the SBN will pass through the Gridded NUCAPS decoder to output a Grid Record to be displayed similar to gridded model data

Introduction of additional fields such as

- precipitable water (total and layer)
- total ozone and anomaly
- tropopause level
- Haines index
- Quality flags



AWIPS Baseline

Scientists are working with the AWIPS developer to ensure forecaster requirements are incorporated

- Vertical interpolation to standard levels
- Display on flight levels for aviation forecasting
- Minimum horizontal interpolation to retain data integrity and spatial gradients
- Leverage derived parameters to calculate thermodynamic fields
- Best practices for data quality and gaps
- Easy access menus and recommended display fields

Next steps include

- Develop necessary derived parameters, color maps, procedures
- Continue testing functionality and display
- Official JPSS training

Summary

A multi-organization collaborative effort through the JPSS Proving Ground developed and introduced to NWS forecasters

Gridded NUCAPS was developed to allow for 3-D interrogation of the atmosphere and specifically to diagnose areas of Cold Air Aloft

Forecasters have provided feedback that Gridded NUCAPS has a positive impact on identifying Cold Air Aloft events and increases confidence when issuing Meteorological Impact Statements

Gridded NUCAPS was evaluated at HWT for 3 years to explore its use for diagnosing the pre-convective environment

Forecasters found utility in spatial patterns and gradients, while specific values were not as valuable, especially at lower levels of the atmosphere.

Successful product assessments have led to the operational implementation of Gridded NUCAPS in AWIPS

The AWIPS baseline will include forecaster requirements plus a few new features to support additional applications

Check out the Aerospace America Feature Article "[Danger In the Air](#)"

Plan to explore other applications such as turbulence, icing, and fire weather as well as use of microwave-only soundings

Acknowledgements

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Any questions?

Contact: emily.b.Berndt@nasa.gov

Additional Presentations

Aerospace America Feature Article [“Danger In the Air”](#)

[Virtual Alaska Weather Symposia](#)

[JPSS Science Seminar](#)