

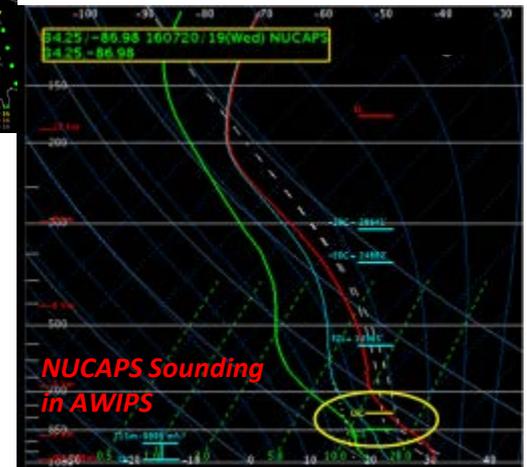
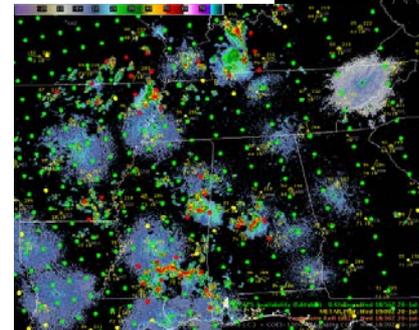
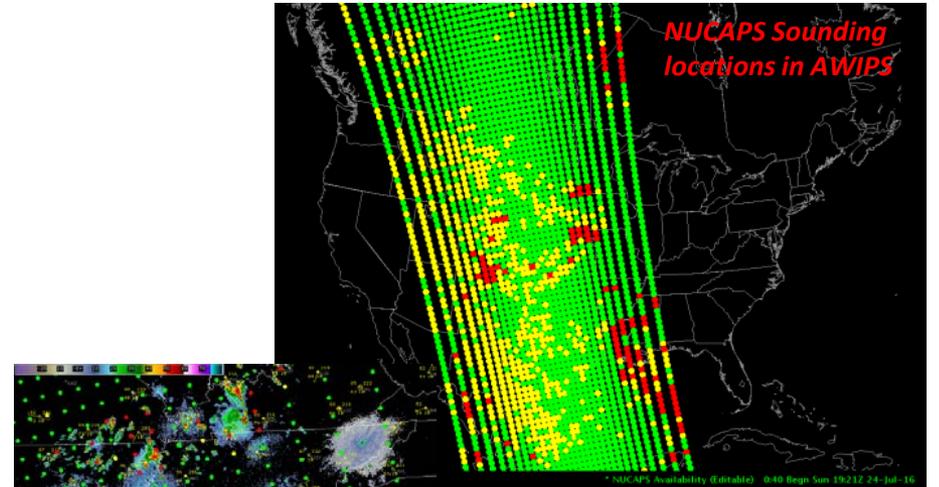
# Development and Assessment of Gridded NUCAPS Products for NWS Forecasters

- Brad Zavodsky (SPoRT)
- **Nadia Smith (STC)**
- Jack Dostalek (CIRA)
- Eric Stevens (GINA)
- Kristine Nelson (NWS HQ)
- Chris Barnet (STC)
- Emily Berndt (SPoRT)
- Antonia Gambacorta (STC)
- Tony Reale (NESDIS/STAR)
- Elisabeth Weisz (CIMSS)

Presentation to STAR JPSS 2016 Annual Science Team Meeting  
College Park, MD  
August 10, 2016

# Current Operational NUCAPS Visualization

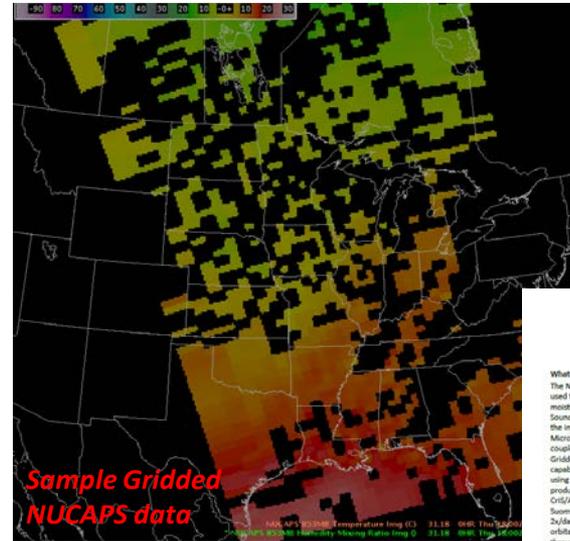
- NUCAPS is the NOAA Operational Retrieval algorithm for CrIS/ATMS and IASI/AMSU T and q profiles
- Capabilities for displaying individual Skew-T plots are available in the latest versions of AWIPS II with quality control flags
- Skew-Ts are valuable for some forecast challenges, but ***visualizing the data in plan view or cross section may be more useful for others***
- Multi-organization group—started through NUCAPS Initiative—has been funded by JPSS PG/RR to demonstrate these capabilities with NWS forecasters



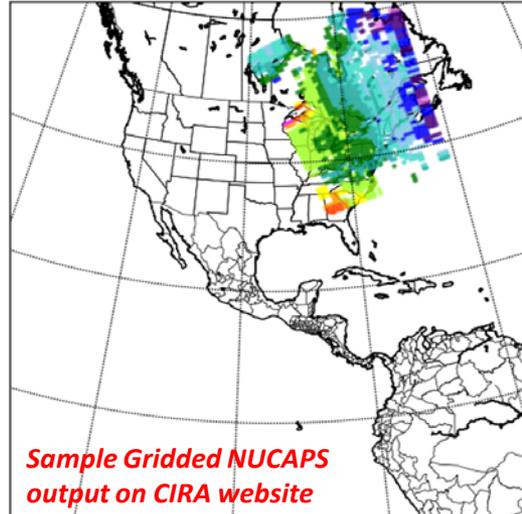
Images by Kris White (NWS HUN/NASA SPoRT)

# Gridded NUCAPS for Demonstration

- CIMSS has modified its 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 II
- GRIB2 files are pushed to NWS partners in real-time
- CIRA obtains the GRIB2 output and creates graphics for its website that can be linked by forecasters in public statements
- Team has developed training and quick guides that leverage foundational NUCAPS training



NUCAPS 853 mb T, 175432 UTC, 17 Jun 2016



## Gridded NUCAPS Quick Guide



Gridded NUCAPS Retrievals Quick Guide by NASA/SPoRT

**What is Gridded NUCAPS and when is it available?**  
The NOAA Unique CrIS(ATMS) Processing System (NUCAPS) is used to derive atmospheric profiles of temperature and moisture using observations from the Cross-track Infrared Sounder (CrIS)—a hyperspectral sounder with 1305 channels in the infrared and near-infrared—and the Advanced Technology Microwave Sounder (ATMS)—a microwave sounder which is coupled with the infrared to allow for cloud clearing. The Gridded NUCAPS product is complementary to the Slew-T capabilities already integrated into AWIPS (NUCAPS Availability), using the same data and retrieval algorithms. Each pixel in the product represents a single field of regard for the combined CrIS(ATMS) product. CrIS and ATMS are aboard the polar-orbiting Suomi-NPP spacecraft, so NUCAPS retrievals are available 2x/day, valid approximately 1:30 AM & PM locally (light daily orbital variation) with a latency of only 40 minutes to 1 hour through use of Direct Broadcast data.

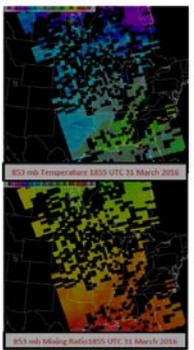
### Caveats

Clouds interfere with the infrared energy measured by CrIS and result in missing values; therefore, missing data will occur across the swath in areas that are not clear. When viewing the gridded NUCAPS retrievals, only the highest quality retrievals that include both the microwave and infrared components of the retrieval will be displayed. Gaps in the data correspond to the locations of the yellow and red dots in the NUCAPS Availability product. To reduce gaps across the swath, future product development may include quality control adjustment to also display retrievals that have small quality error (i.e., yellow dots in NUCAPS Availability) based on forecaster feedback.

### Why are Gridded NUCAPS Retrievals Important?

This demonstration product was created to allow forecasters the ability to view satellite derived temperature and moisture in plan view in addition to Slew-Ts. While understanding the vertical structure at point locations is important, a regional perspective of isobaric temperature (top figure) and moisture (middle figure) can aid in identifying patterns at different vertical levels that impact stability in the pre-convective environment. For example, rather than searching many Slew-Ts for the extent of low-level moisture, the plan view product can give a snapshot of where this moisture patterns have set up. Although, there are gaps in the afternoon pass in the examples, the product demonstrates the capability to analyze pre-convective temperature and moisture characteristics on 31 March 2016, prior to severe weather in the central and southern U.S. (left figure). With a 1:30 pm local time orbit pass, NUCAPS can provide additional observations of the pre-convective environment, especially if retrievals with both good and high quality were displayed. Future capabilities will include cross-section analysis across the swath and the ability to view derived stability parameters.

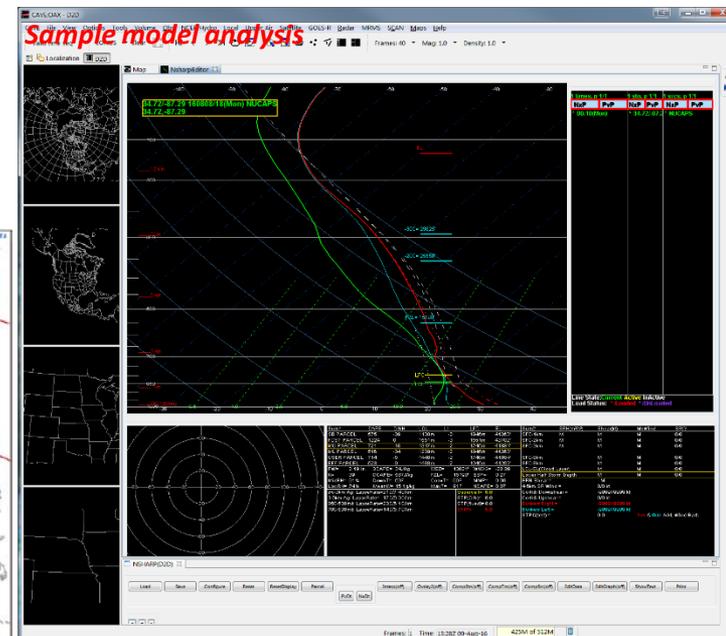
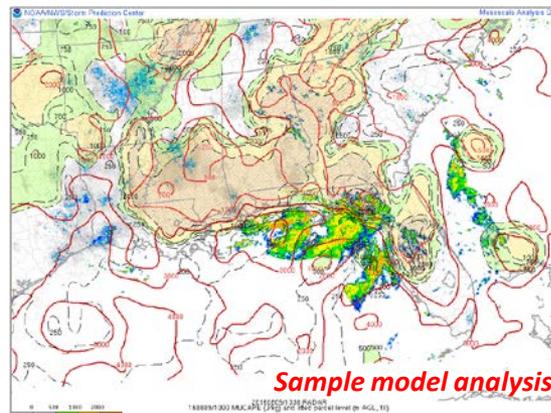
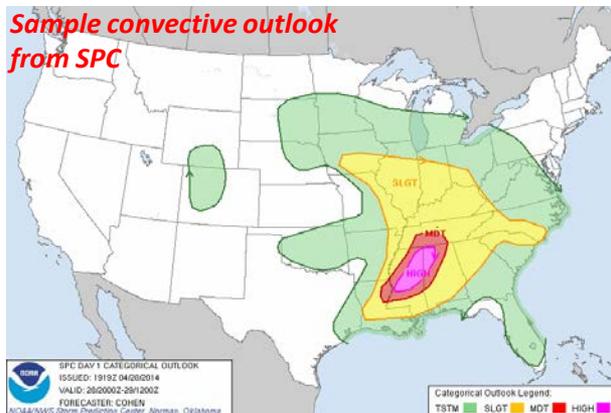
Last Modified April 2016



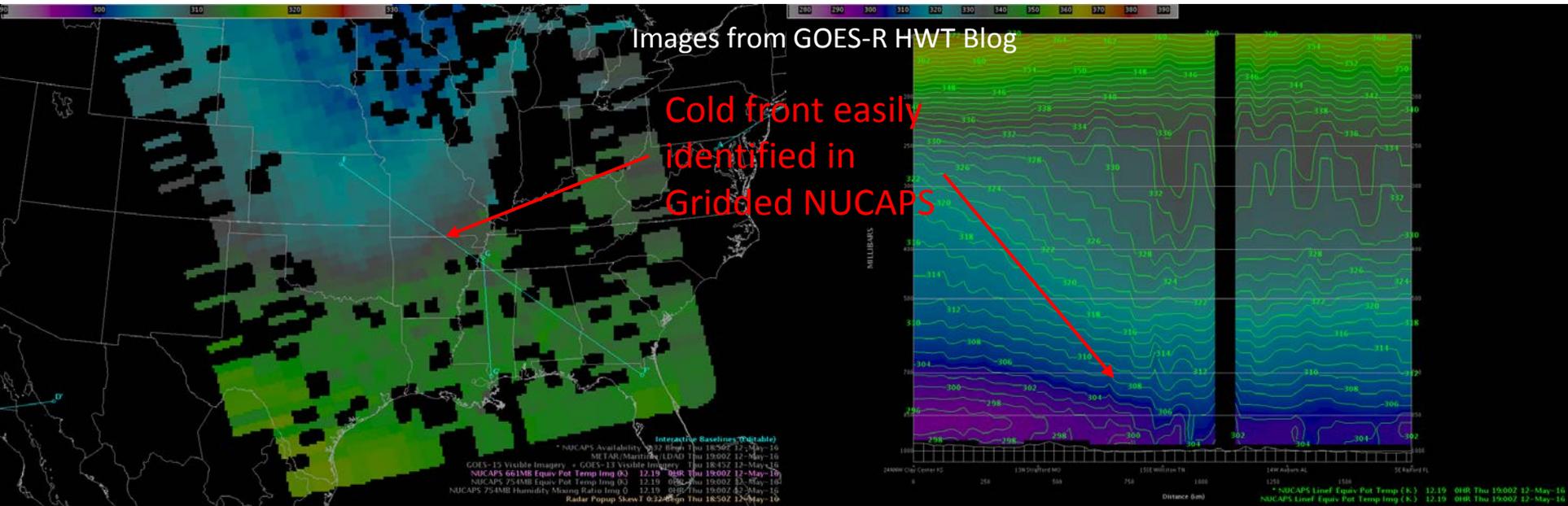
# Forecast Challenge: Diagnosing Convective Environment

- The vertical distribution of temperature and moisture in the lower atmosphere determines convective potential
- Forecasters use a combination of in situ observations, satellite data, and models to determine the location of boundaries and areas of instability
- Ability to view plan view and cross sections of NUCAPS data in a beta version were demonstrated at the 2016 Hazardous Weather Testbed Experimental Warning Program
- Next slides detail feedback from forecasters at HWT on utility of Gridded NUCAPS products

Sample convective outlook from SPC

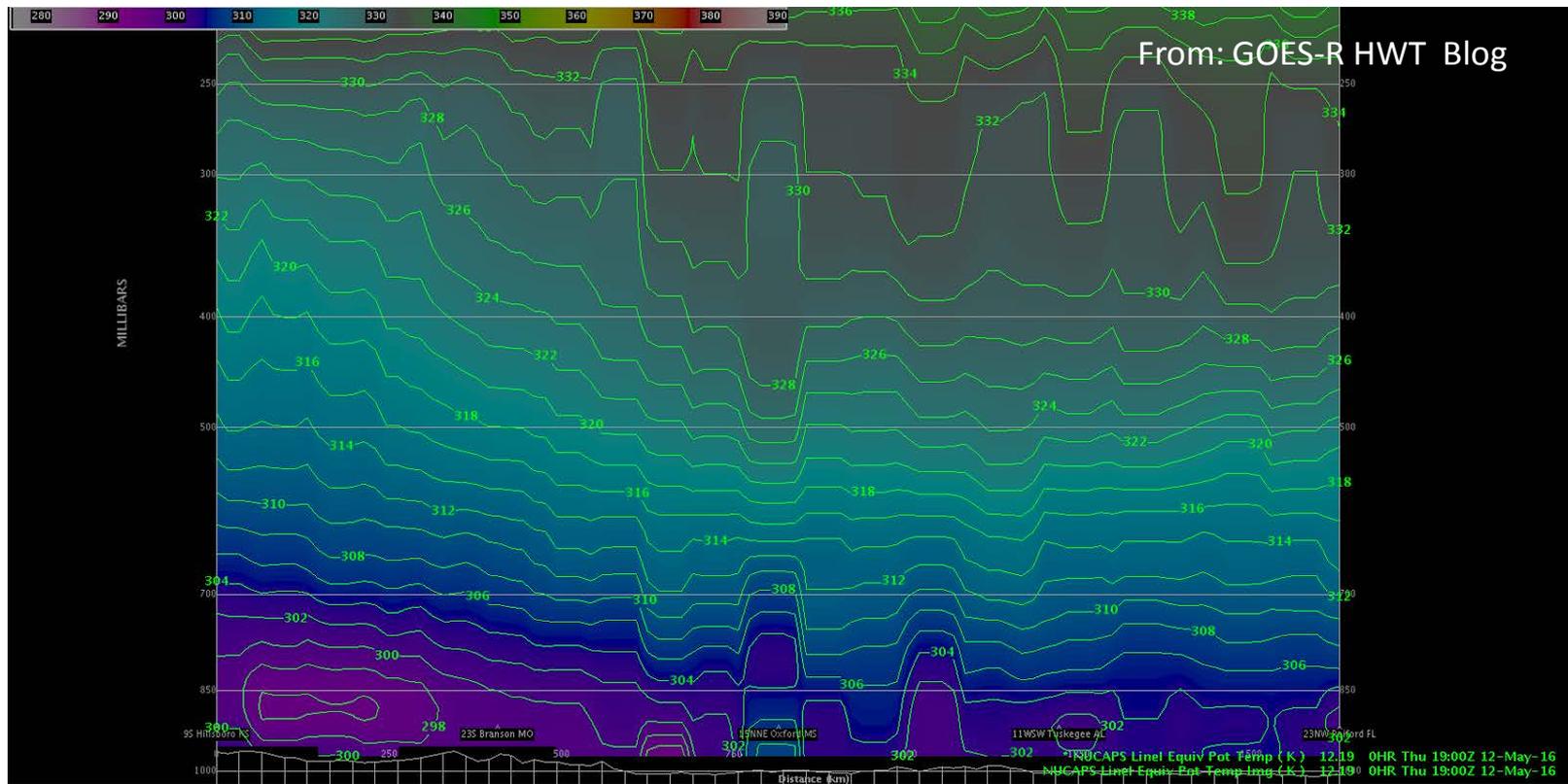


# Gridded NUCAPS Convection Application



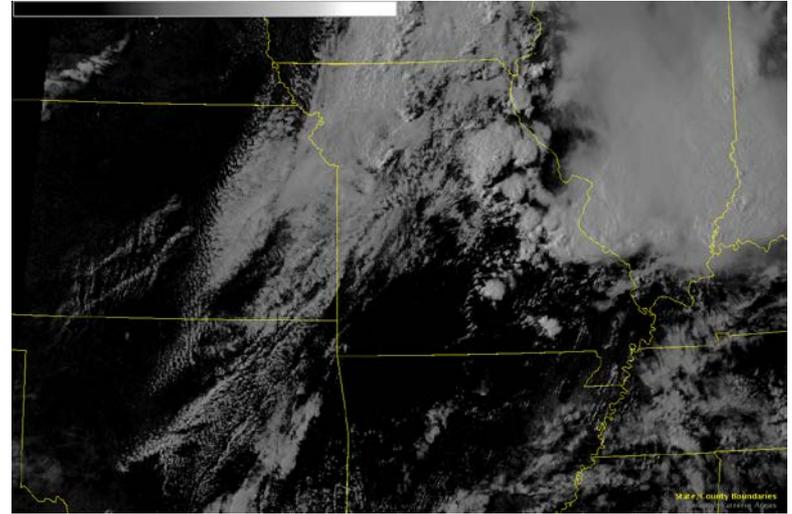
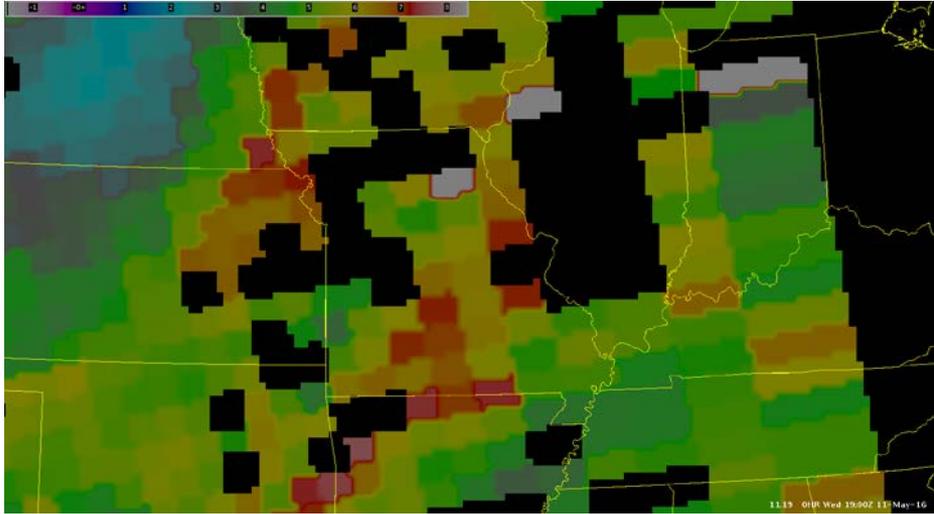
“We recently gained the ability to create cross sections through the NUCAPS swaths. This will be helpful for diagnosing phenomena such as boundaries and convective instability. The first image below is a plan view display of theta-e at 660 mb across the region. Obvious is the much cooler, drier air behind the cold front (low theta-e) with moist, warmer air ahead of it to the east (high theta-e). Also plotted is a line, denoting the location for which the cross-section (image below) was taken, through the cold front. The cross-section depicts theta-e vertically through the atmosphere. This provides another perspective on the cold front, which is obvious in the image.”

# Gridded NUCAPS Convection Application



“In this image, Florida is to the right and Kansas is to the left. Based on METAR observations, the cold front was oriented over central Missouri and Arkansas at 19Z. The cold front appears to be approximately 600 km from western-most point of the cross-section. Lower theta-E values can be seen at the lower levels west of this point, with the isotherms sloping upward from east to west on the cool side of the frontal boundary. **This is a cool way to visualize the location and structure of a frontal boundary!** –JP”

# Gridded NUCAPS Convection Application



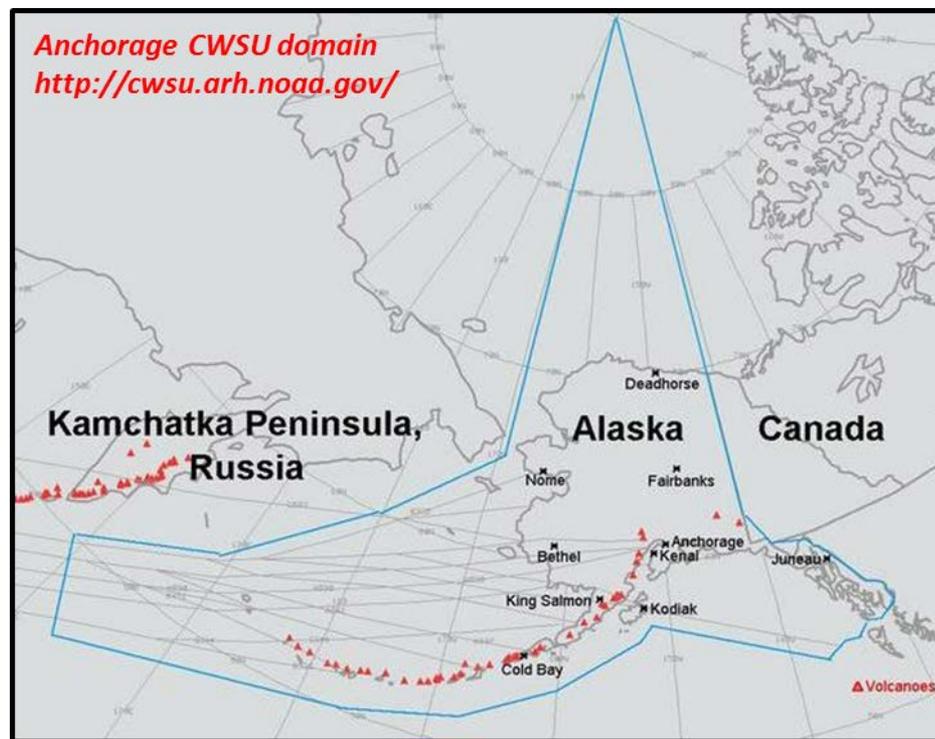
Images from GOES-R HWT Blog

“We took a look at a NUCAPS plan view image of mid-level moisture (754 mb mixing ratio) from 19Z. Image shown below. Areas of higher moisture were apparent over south-central Missouri in our SGF CWA, and over the St. Louis metro area.

Several hours later, we noted that convective activity was focused in these general areas. The few cells that developed over our CWA were over the south-central part of the state. Much more significant convection triggered over the St. Louis area. –JP”

# Forecast Challenge: Cold Air Aloft

- Cold Air Aloft ( $-65^{\circ}\text{C}$  and below) can lead to freezing airliner fuel
- 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 where conventional observations are lacking



```
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

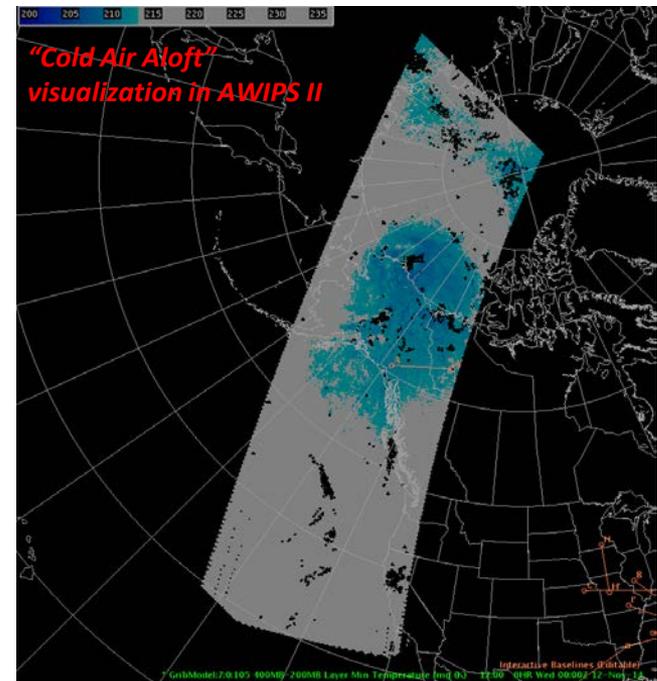
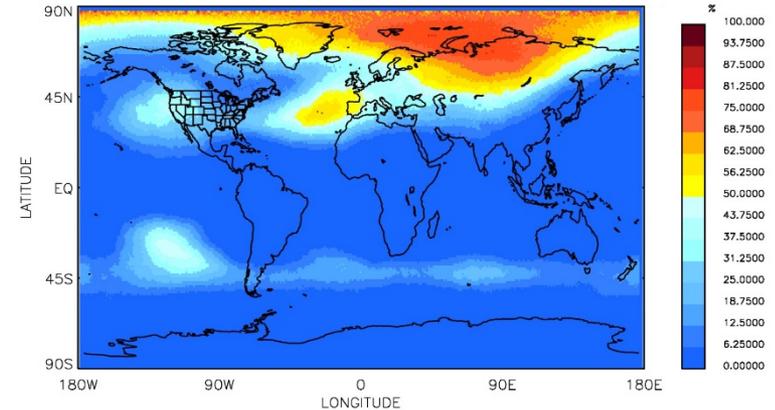
Vertical Extent of Cold Air from soundings/aircraft reports/model

Motion determined from model data

# Forecast Challenge: Cold Air Aloft

- Have found that temperatures below  $-60^{\circ}\text{C}$  at flight levels occur regularly in the arctic and also pockets of colder air even occur over the mid-latitudes
- Using visualization color curve based on web graphics developed by CIRA, the Gridded NUCAPS products will be evaluated
  - Light blue shading for temperatures anywhere below 100 hPa in the column that are  $< -60^{\circ}\text{C}$
  - Darker blue shading for temperatures anywhere below 100 hPa in the column that are  $< -65^{\circ}\text{C}$
- Will be deploying NUCAPS data and visualization capabilities as part of an operational demonstration with forecasters at the Alaska CWSU in the fall/winter

*Probability of observing  $T \leq -60^{\circ}\text{C}$  in AIRS at at 200 hPa from Jan. 2005 to Jan. 2015*



# Next Steps

- Demonstration scheduled for November – February with AK CWSU for Cold Air Aloft
- Plan to participate in next HWT Spring Experiment with more robust training on using the gridded products
- Develop unique color curves in AWIPS II for convective variables for easier decision making
- Working with the Experimental Products Development Team to develop gridding capabilities internal to AWIPS II source code that will use NUCAPS files already coming over the Satellite Broadcast Network (SBN) directly into NWS offices to reduce data flow and provide full transition of capability into operations

Contacts for Proposal Team: [brad.zavodsky@nasa.gov](mailto:brad.zavodsky@nasa.gov)  
[nadiaz@stcnet.com](mailto:nadiaz@stcnet.com)  
[Jack.Dostalek@colostate.edu](mailto:Jack.Dostalek@colostate.edu)  
[eric@gina.alaska.edu](mailto:eric@gina.alaska.edu)  
[kristine.nelson@noaa.gov](mailto:kristine.nelson@noaa.gov)