

IN53D-04: Results from Evaluations of Gridded CrIS/ATMS Visualization for Operational Forecasting

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The Challenge

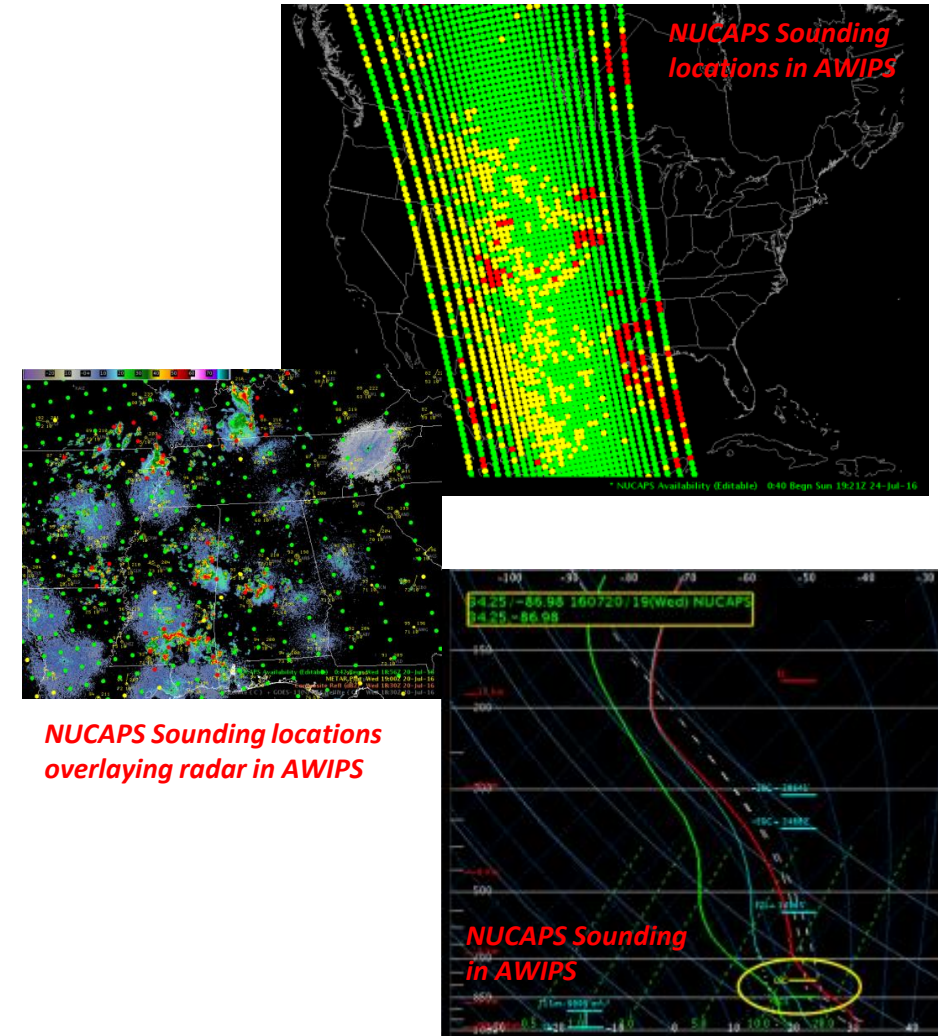
- Established knowledge: satellite-borne sounders feed essential data into NWP models and thereby improve the quality of NWP forecasts
- A new question: beyond the NWP context, do vertical profiles of temperature and moisture derived from satellite also provide value to NWS forecasters as a situational awareness tool?
- Cross-track Infrared Sounder (CrIS) and Advanced Technology Microwave Sounder (ATMS) are used to produce the NOAA Unique Combined Atmospheric Processing System (NUCAPS), the operational sounding product

How to Learn if NWS Meteorologists Can Use CrIS and ATMS data in the Forecast Process

1. Deliver NUCAPS (NOAA Unique Combined Atmospheric Profile System) into the NWS' AWIPS display system
2. Ensure that the NUCAPS data are presented in AWIPS in an intuitive and efficient way
3. Provide training to forecasters
4. Gather feedback from forecasters
5. Considering this feedback, improve NUCAPS and proceed back to Step 1 to repeat the process

Current Operational Visualization of NUCAPS

- 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
- Forecasters must point and click on points to reveal sounding information

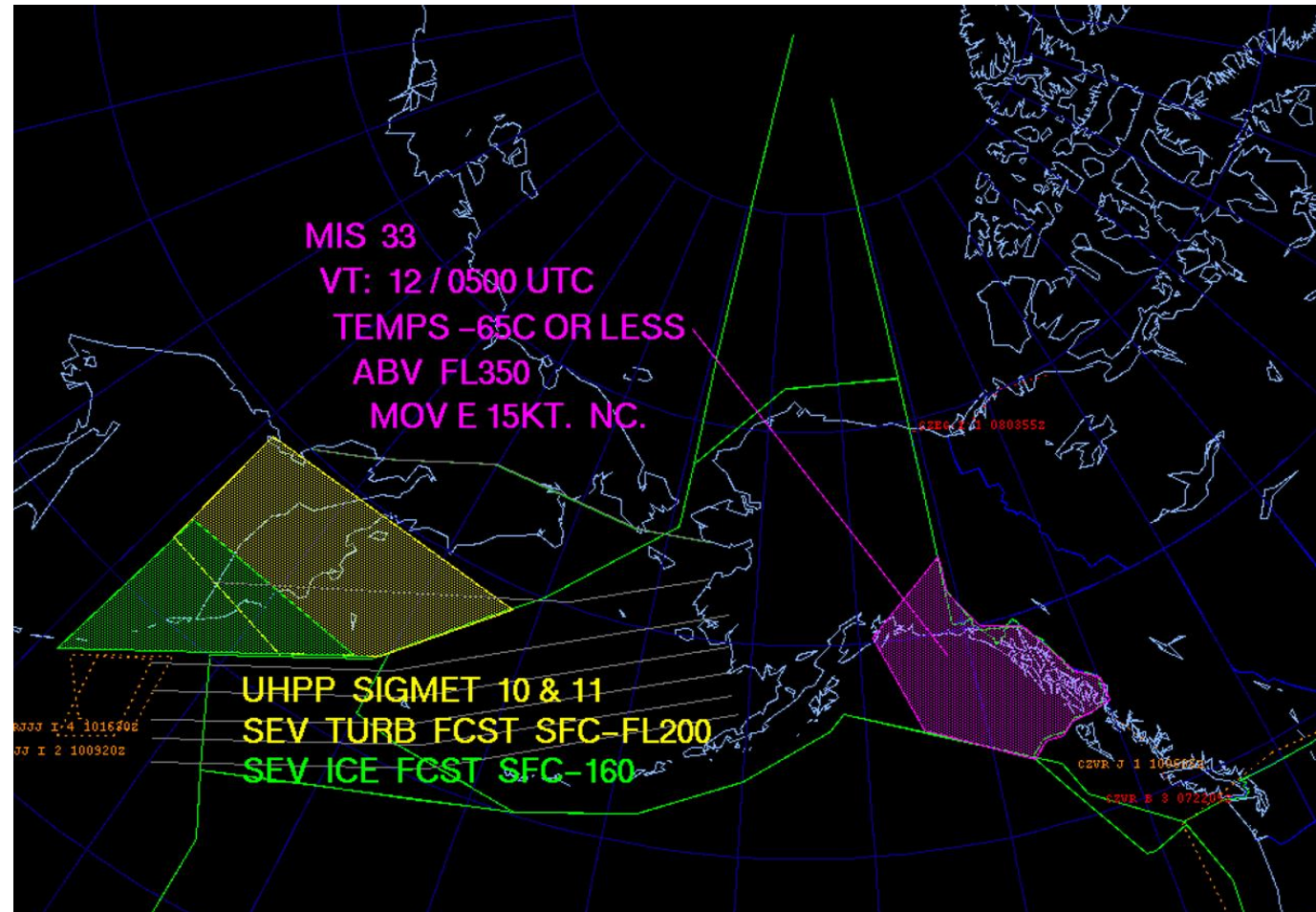


Turning Point-Based Data Into A Gridded Field

- Some atmospheric features of interest are bounded in 3-D space
- Hunting and pecking at numerous NUCAPS points to find the boundary of the -65C air in horizontal and vertical space is inefficient
- Skew-Ts are valuable for some forecast challenges, but visualizing the data in plan view or cross section may be more useful for others
- Solution: create a gridded 3-D field of temperatures derived from the point-based NUCAPS data
- AWIPS can already display 3-D gridded NWP and radar data, so why not 3-D gridded NUCAPS data?
- Multi-organization group—started through NUCAPS Initiative—has been funded by JPSS PG/RR to demonstrate these capabilities with NWS forecasters

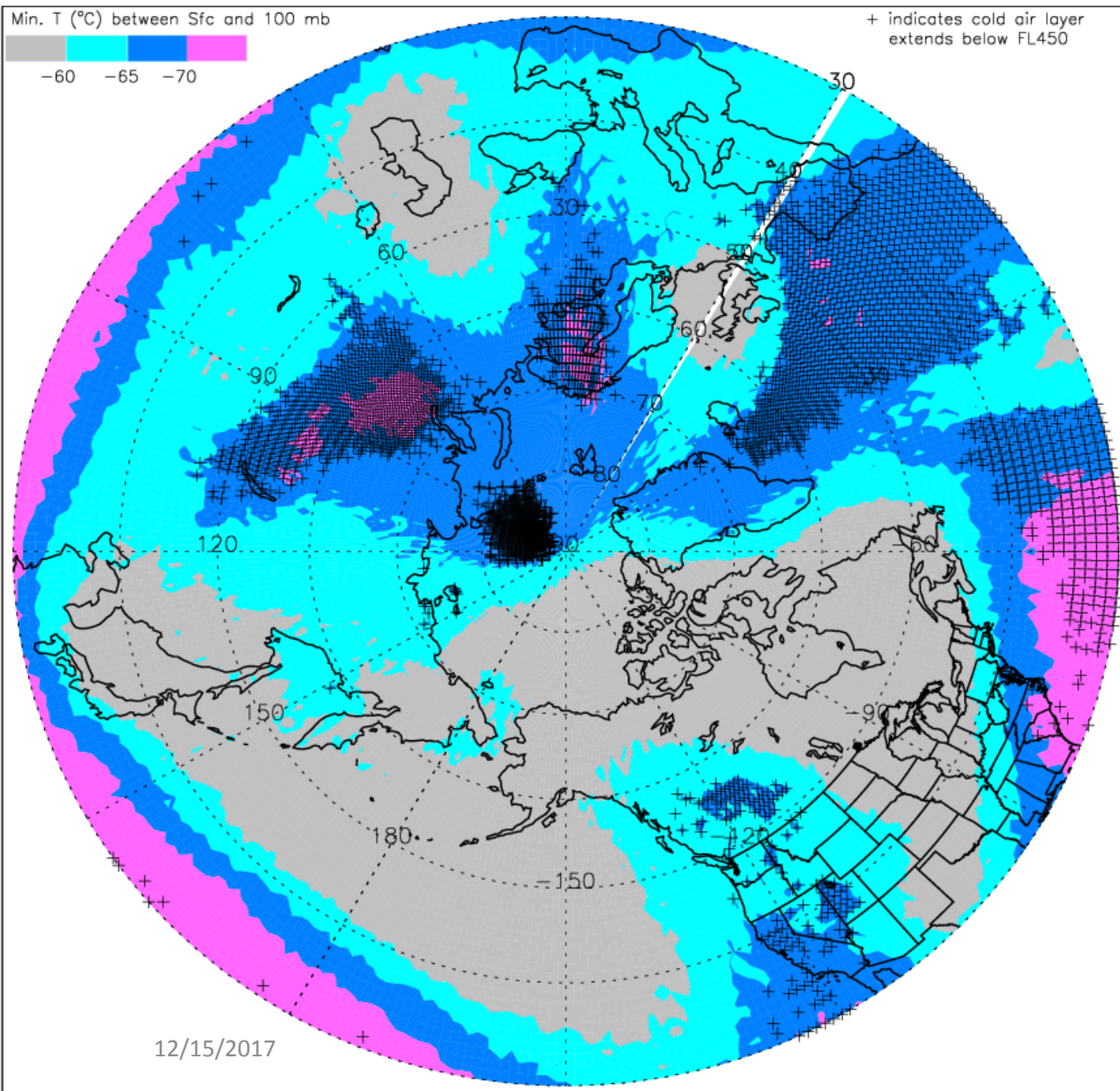
Cold Air Aloft

- Air temperatures colder than -65C at the cruising elevations for jet aircraft can cause fuel to gel...pilots are thus motivated to avoid such areas
- Cold air aloft can occur over higher latitudes (like Alaska and the Arctic Ocean) during winter and spring
- NWP models depict areas of cold air aloft...but models are not observations
- CrIS and ATMS offer spatially-comprehensive 3-D observations of temperature over the data-sparse Arctic



Cold Air Aloft: Recipe for Success

- NUCAPS is well-suited to address this issue
 - Quality of NUCAPS data is best at higher elevations, and this cold air is aloft, from 30,000ft to 40,000ft or so
 - Compared to satellite imagery, spatial resolution of NUCAPS is coarse...but the cold air aloft phenomenon tends not to feature extreme gradients, so coarse resolution is less of a concern
 - Thanks to Alaska's high latitude, several SNPP (and soon NOAA-20) passes are available each day

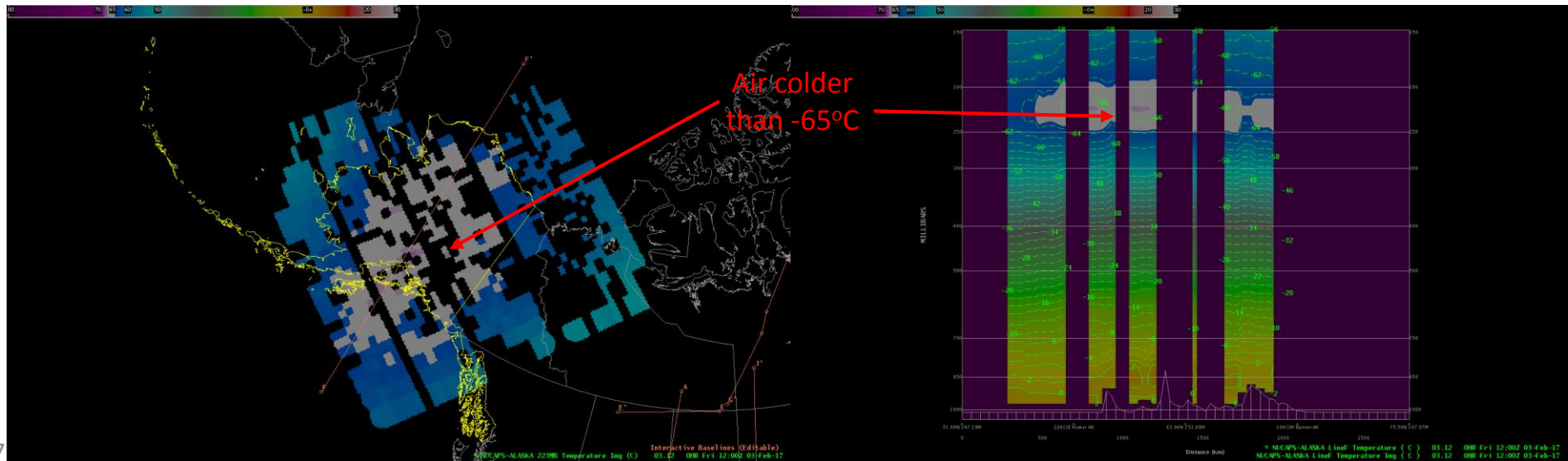


Web-Based Approach

- Coldest temperatures in column determine color of each pixel
- Zoomed views also depict lower and upper bounds (in kft) of cold air at each pixel
- Available to non-AWIPS users

Plan View and Cross Sections in AWIPS

- AWIPS procedure allows forecasters to toggle through different vertical layers using left/right keyboard arrows
- Developed specific visualization color curve and AWIPS procedures to outline the coldest air and allow forecasters to easily toggle between pressure levels
 - Blue shading for temperatures below $< -60^{\circ}\text{C}$
 - Gray shading for temperatures below $< -65^{\circ}\text{C}$
 - Purple shading for temperatures below $< -70^{\circ}\text{C}$
- Forecasters at Anchorage and Fairbanks WFOs and Alaska CWSU can access this visualization in their operational AWIPS systems



Training Module with Needs of NWS Forecasters in Mind

MetEd » Home x NUCAPS Soundings in AWIPS x

https://www.youtube.com/watch?v=U-w6EBnOzb0

YouTube nucaps

NUCAPS Soundings in AWIPS

Chris Barnet NOAA/STC Antonia Gambacorta NOAA/STC
Scott Lindstrom UW CIMSS Bill Line NOAA / SPC
Brian Motta NOAA / FSDT Dan Nietfeld NOAA / NWS O&A

0:00 / 16:38

NUCAPS Soundings in AWIPS v2

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Published on Jun 24, 2015
Training video for NUCAPS soundings in AWIPS II. Version 2.

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For users to view training: <https://hwt.nssl.noaa.gov/ewp/internal/2016/Training/NUCAPS2016/player.html>

Assessment Results

- 24 surveys filled out between December 6, 2016 and March 14, 2016
- 2/2/17 6:00a Some Operational Impact, High Confidence
 - “NUCAPS images on the WEB site were about 5 degrees C too cool over the eastern Bering and western Alaska compared to 12Z raobs and the NAM/GFS. **NUCAPS 12Z image on AWIPS at 212 mb was right on though with temperatures and with the models and observations.**” –unnamed AK CWSU forecaster
- 2/22/17 2:00p Very Large Operational Impact, High Confidence
 - “**The Gridded NUCAPS data performed better than the GFS data today.** The NUCAPS CAA levels were a much better match to actual sounding data vs. the GFS model depictions.” –Gail Weaver, AK CWSU
- 3/1/17 8:00a Very Large Operational Impact, High Confidence
 - “GFS model data showed temps near -65C over the northern Bering Sea this morning. SYA and SNP 12Z raobs did show -65C right around FL330, but it was only about 500 feet deep. The NAM was slightly colder than the GFS in the area between and north of SYA-SNP to the FIR boundry. Based on the SNPP-NUCAPS it showed a deeper layer, nearly 5000 feet, from FL350-FL400 in this area that was not sampled by the raobs. **Due to the models trending colder the next 12-24 hours I decided to issue a MIS for Cold Air Aloft based on the Gridded NUCAPS data. I felt very confident in the NUCAPS data based on the surrounding raobs, model data, timing, and intensity of the data represented in these graphics.**” –unnamed AK CWSU forecaster

NUCAPS and the Hazardous Weather Testbed

- Conventional radiosondes provide vital data in anticipating severe convection over the Great Plains
- But there are serious gaps between balloons in both space and time
- Can NUCAPS help fill those gaps between balloons?
- Similar training tailored towards convective potential forecast challenges provided; data integrated into AWIPS II

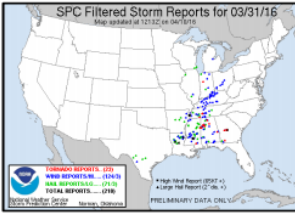
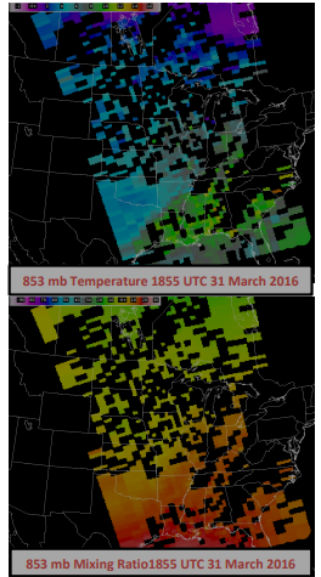
SPORT

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 Skew-T capabilities already integrated into AWIPS (NUCAPS Availability), using the same data and retrieval algorithm. 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 (slight 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 Skew-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 Skew-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.

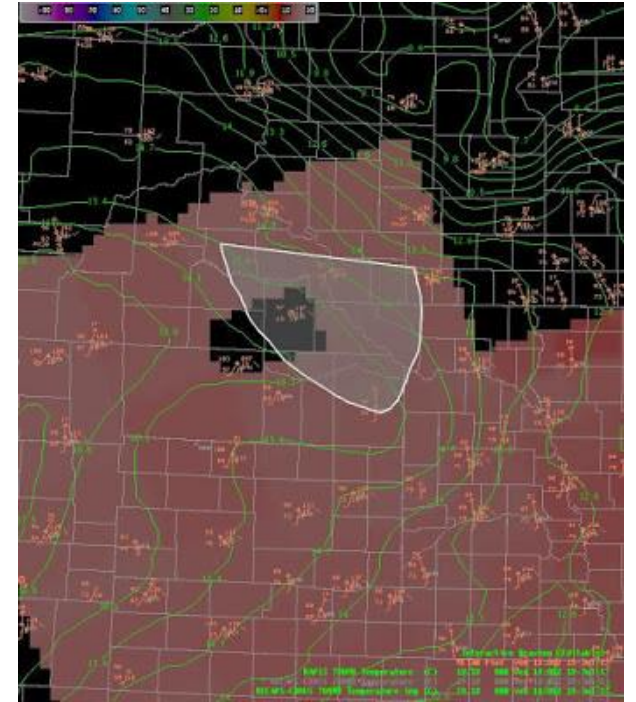


Last Modified April 2016

Example of HWT Forecaster Feedback

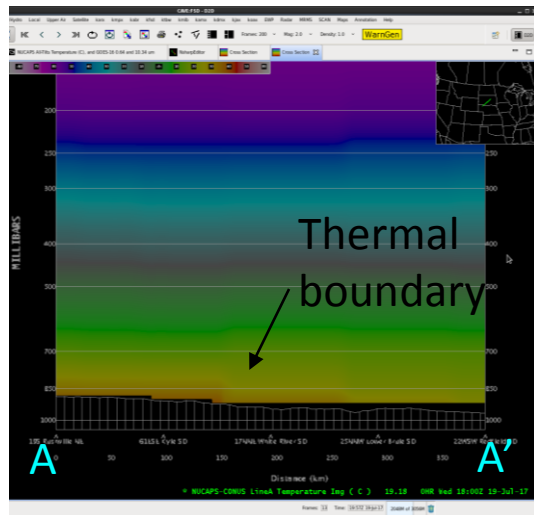
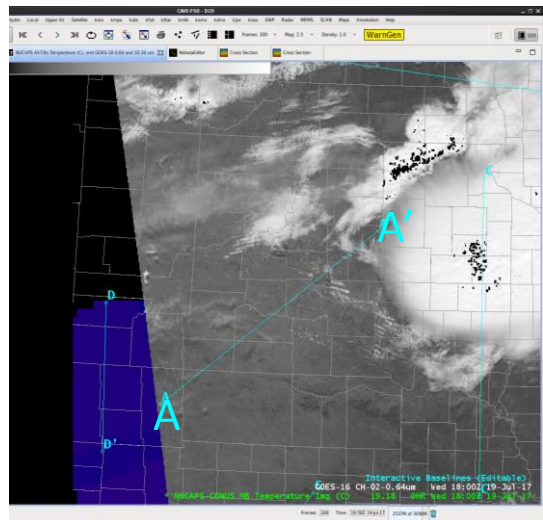
“By 19z shifted attention to possibility of new convective development along what appears to be outflow boundary across southwest corner of FSD CWA...First concern is how strong capping inversion is in this area. RAP analysis fields indicate [700 hPa] temps around 14-15C in area of interest. This is well supported by NUCAPS soundings around 18z which showed a large area of [700 hPa] temps in the 13-14C range.” (top image)

<http://goesrhwt.blogspot.com/2017/07/monitoring-for-convective-initiation.html>



“Drew a line A across a thin line of towering Cu. In the middle of the cross section, I could see a thermal boundary right [where] the line of Cu had developed...Convection quickly popped up along that boundary...” (bottom images)

<http://goesrhwt.blogspot.com/2017/07/south-dakota.html>



Summary

- NUCAPS is the NOAA operational sounding product for temperature, moisture, and trace gases
- NUCAPS has already proven valuable to NWS meteorologists in a surveillance context in of identification of Cold Air Aloft and convective potential and its use has improved through the development of a gridded product
- Recent launch of JPSS-1 / NOAA-20 will bring even more NUCAPS data into the forecast process
- Additional projects involving NUCAPS are under development
 - Can NUCAPS help anticipate extreme wildfire behavior?
 - Can NUCAPS identify winter weather potential?