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# Evaluation of NUCAPS products in AWIPS-II:

*Case studies in the pre-convective environment*

**Presented by:** Ashley Wheeler

**With contributions from:** Chris Barnet, Nadia Smith, Antonia Gambacorta,  
and many others...

Fall 2017 NASA Sounder Science Team Meeting  
Wednesday, October 25, 2017 (Session #4 – 3:20 pm)



# NOAA Hazardous Weather Testbed (HWT)

## NOAA HWT is a joint project between:

- National Weather Service (NWS)
- National Severe Storm Laboratory (NSSL)

Located at the National Weather Center  
in Norman, Oklahoma

## The HWT...

- Facilitates and provides opportunity for unique interactions between researchers and forecasters to test and evaluate emerging technologies for National Weather Service operations

## 2 main programs within the HWT:

1. Experimental Forecast Program (EFP)
  - detection of events hrs to week in advance
2. Experimental Warning Program (EWP)\*
  - detection of events up to several hrs in advance



***NUCAPS products evaluated during the  
GOES-R/JPSS Experiment as part of the HWT  
Satellite Proving Ground activities***



# 2017 NOAA HWT GOES-R/JPSS Experiment

## Experiment held over 4 weeks

- 3 NWS forecaster, 1 broadcaster meteorologist per week
- Experiment Facilitator: Michael Bowlan

## 2017 GOES-R/JPSS Products

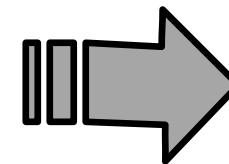
- GOES-16 GML, GOES-16 ABI (imagery, derived products, channel differences, RGB composites), ProbSevere & ProbTor, NUCAPS

## A typical day at HWT...

- 1) Starts ~12pm with interactive Q&A between forecasters and developers on previous day
- 2) Mesoscale analysis and selection of 2 County Warning Area's (CWA) for forecasters operate
- 3) During forecast shifts, forecasters utilize the experimental satellite products – with current operational products – to issue mesoscale updates as well as watches and warnings
- 4) Throughout the shift forecasters document their feedback on the HWT "live" blog
- 5) Day ends ~8pm and forecasters complete overall evaluation of products in a daily survey

## Focus of EWP is to evaluate products in pre-convective environment

- How do the products contribute to a forecasters ability to characterize the stability of a region prior, during, and ahead of storm development



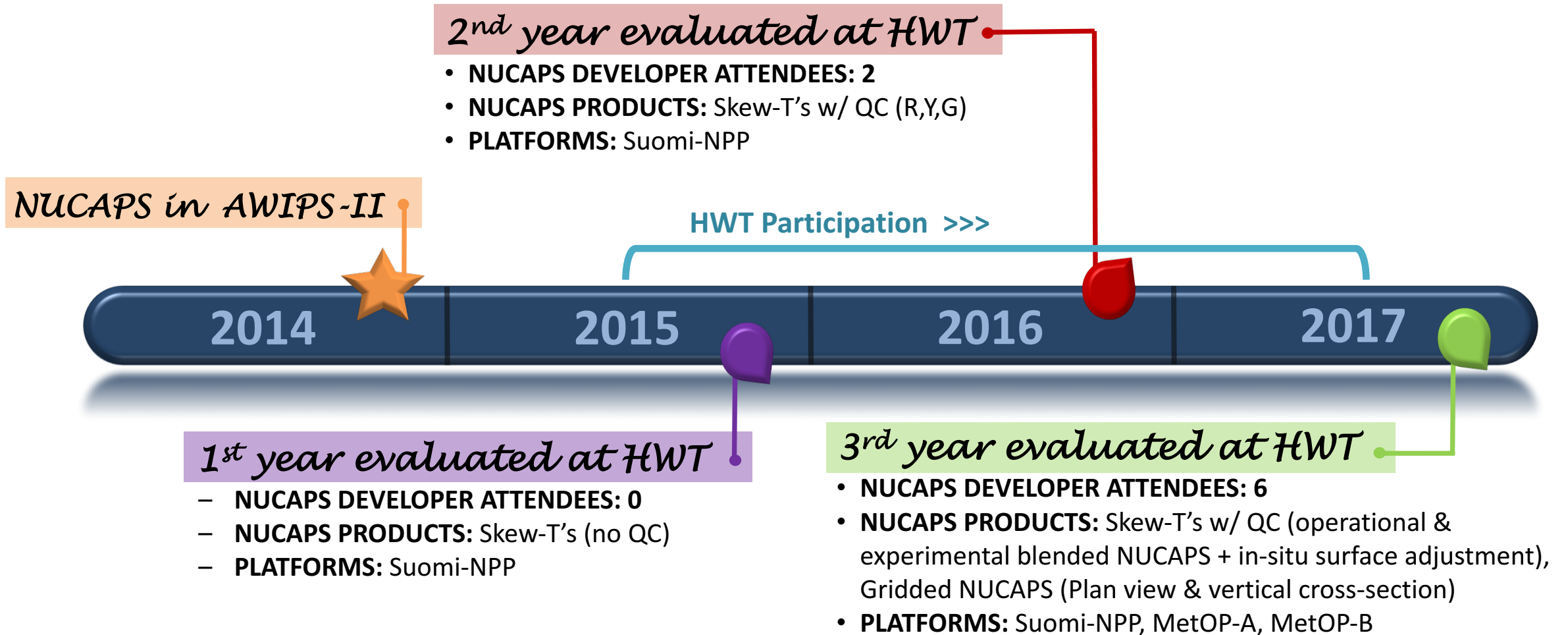
Afternoon overpass of Suomi-NPP is valuable to forecasters because it falls between RAOB launches and is often during convective initiation/development

- HWT Home Website: <http://hwt.nssl.noaa.gov/>
- HWT Blog: <http://goesrhwt.blogspot.com/>
- "Tales From the Testbed": <http://hwt.nssl.noaa.gov/tales/>
- HWT Report: Available Soon...

**NEW!**

Developer report:  
By email request  
[nadiaz@stcnet.com](mailto:nadiaz@stcnet.com)

# NUCAPS progression over the past 3 years at HWT





# 2017 HWT Preparation and Participants

## Successful 3<sup>rd</sup> year at HWT can be attributed to planning and collaboration...

- As part of the JPSS Proving Ground Sounding Initiative, progress towards 2017 HWT was discussed and organized during monthly telecons
- NUCAPS developer representation across all 4 weeks
  - For the 1<sup>st</sup> time, product developers participated alongside algorithm developers
- ...because of this collaboration we accomplished more between the 2016 and 2017 experiments  
i.e. Improved user guides and training modules, development of new products

		WEEK 1 (June 18-23)	WEEK 2 (June 25-30)	WEEK 3 (July 9-14)	WEEK 4 (July 16-21)
FORECASTERS	NWS	Tony Fuentes (REV) Vivek Mahale (OUN) David Stark (OKX)	Orlando Bermudez (EWX) Mike Moritz (GID) Anita Silverman (RNK)	Steven Fleegel (ABR) Jonathan Kurtz (OUN) Kevin Sullivan (JKL)	Carly Kovacik (FFC) Jeremy Martin (GLD) Mike Seaman (SLC)
	Broadcast	Davis Nolan (WKRN-TV Nashville, TN)	Brad Panovich (WCNC-TV Charlotte, NC)	Dan Skoff (KNWA-TV Fayetteville, AR)	Jay Trobec (KELO-TV Sioux Falls, SD)
DEVELOPERS	Algorithm	Nadia Smith (STC)		Antonia Gambacorta (STC)	Ashley Wheeler (STC)
	Product	Kris White (NWS/SPoRT)	Jack Dostalek (CIRA)		Brad Zavodsky (NASA/SPoRT)

# NUCAPS AWIPS-II Products Evaluated at 2017 HWT

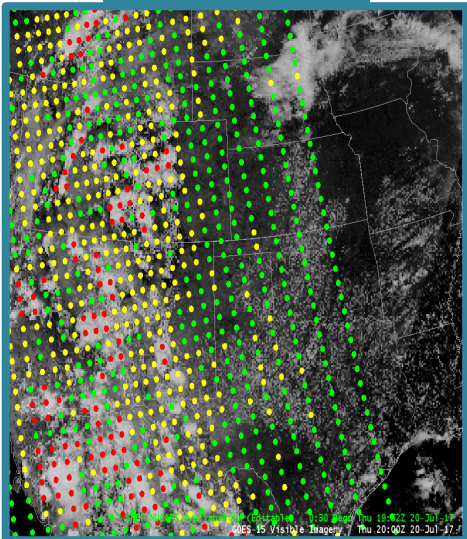
In addition **NUCAPS operational products** from previous years:

- Operational Skew-T's w/ QC (Red, Yellow, Green)

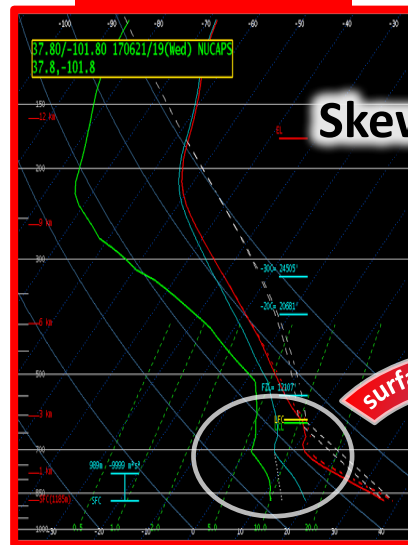
**Two externally developed products** were added in response to forecaster requests:

- Gridded NUCAPS plan view & vertical cross-section (NASA/SPoRT)
  - addressed forecaster need to spatially visualize NUCAPS in “map” view, similar to models
- Experimental “blended” NUCAPS & in-situ obs skew-t's (Jack Dostalek, Dan Lindsey)
  - addressed forecast request for automated surface adjustment

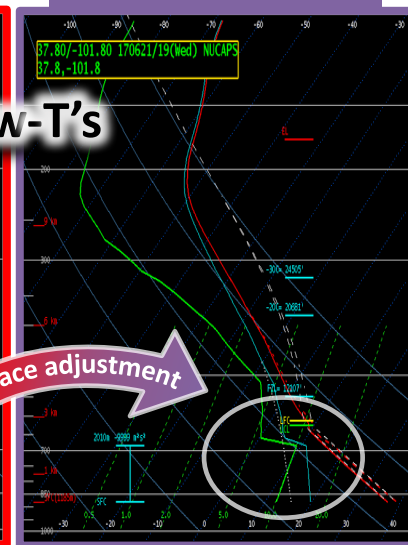
**QC (R,Y,G)**



**Operational**



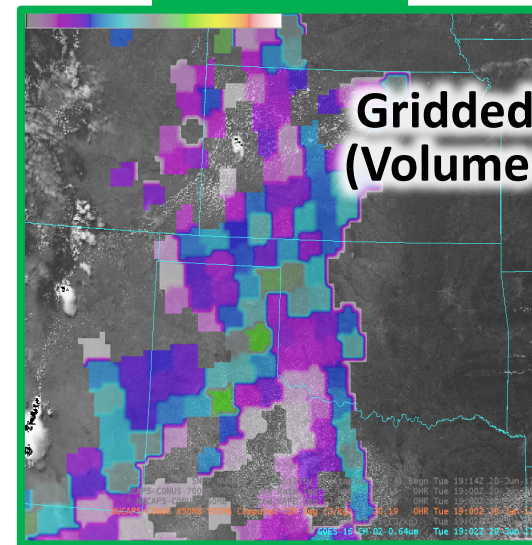
**Experimental**



Skew-T's

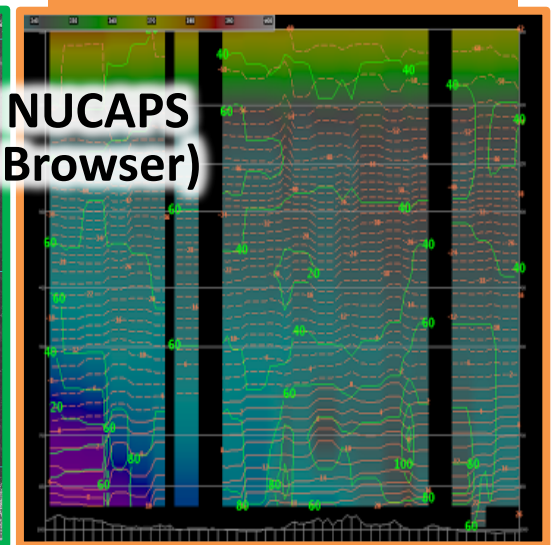
surface adjustment

**Plan View**



Gridded NUCAPS  
(Volume Browser)

**Vertical Cross-Section**





# HWT Blog Cases

***70+ blog posts about NUCAPS products from 2017 HWT...***

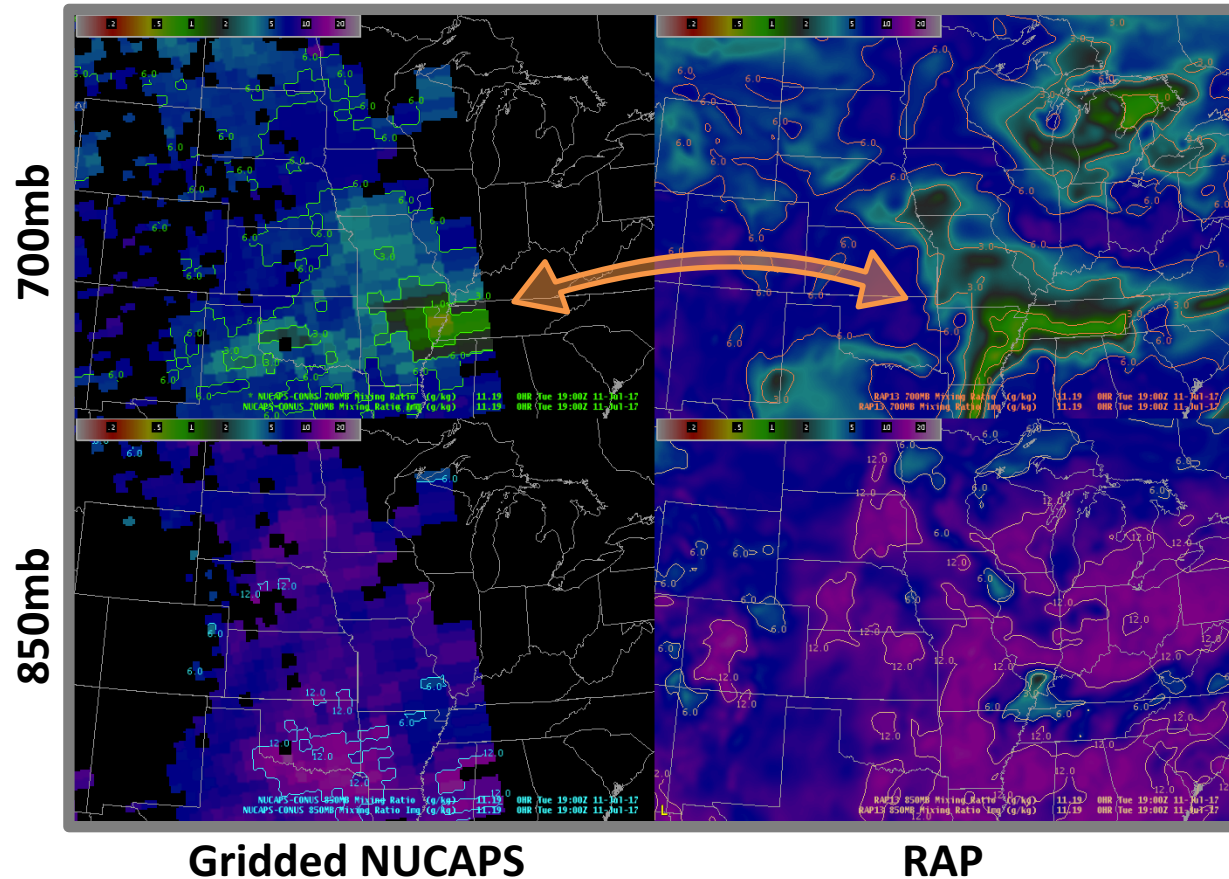
To view all NUCAPS tagged posts go to <http://goesrhwt.blogspot.com/search/label/NUCAPS>

**– OR –**

See supplementary slides & relevant links at end of presentation

# EXAMPLE #1 – Mixing Ratios

<http://goesrhwt.blogspot.com/2017/07/nucaps-mixing-ratio.html>



Forecaster compared mixing ratio at 700mb (top) & 850mb (bottom) from **Gridded NUCAPS** (left) & **RAP Model** (right)

700mb → both **Gridded NUCAPS** & **RAP** “generally” exhibited a dry tongue (**orange arrow**)

850mb → **Gridded NUCAPS** slightly lower than **RAP**

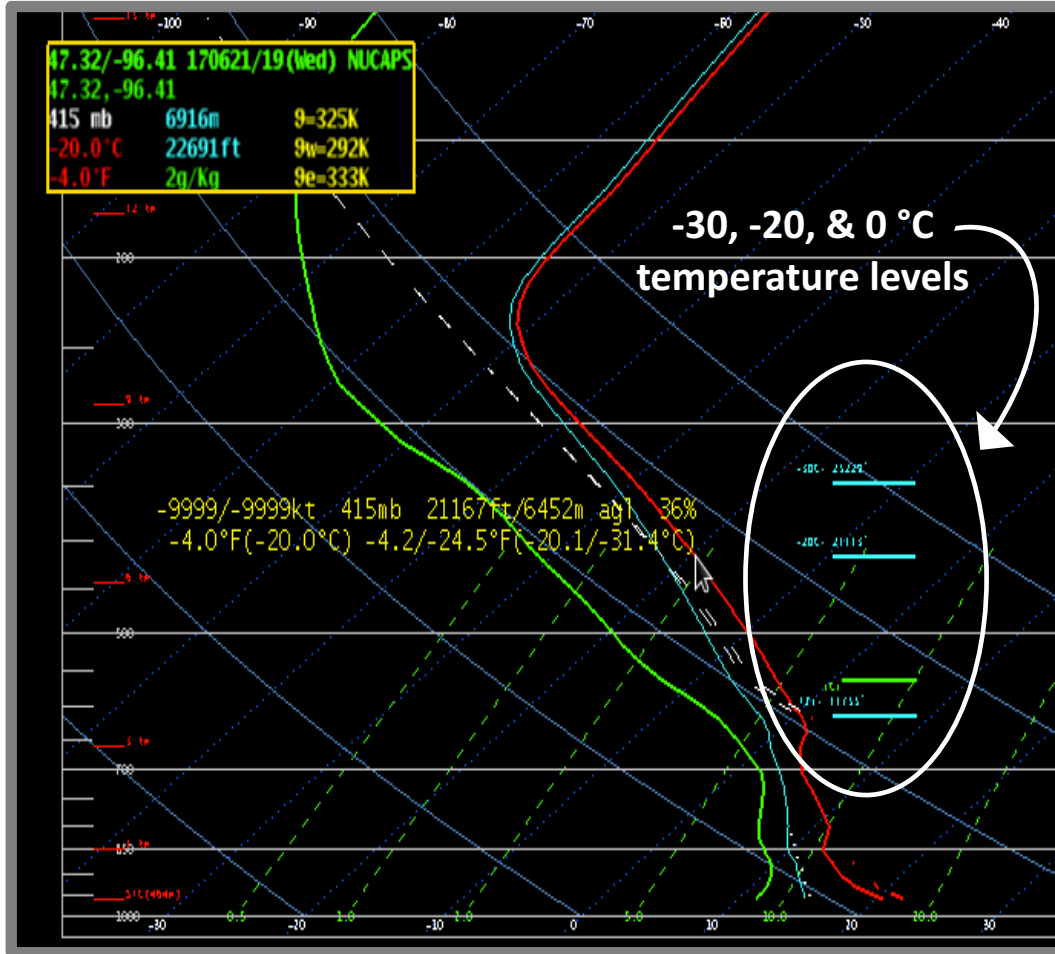
“Thus, confidence may be a bit better at levels at or above 700mb, but not so good for 850mb or lower. Overall, as you get closer to the surface, it looks like there is a tendency for NUCAPS to trend towards a drier solution than the models.” –ISU2004

This is a case where it could benefit forecasters to have a “blended” surface adjusted product in gridded layers.



## EXAMPLE #2 – Identifying Temperature Levels

<http://goesrhwt.blogspot.com/2017/06/nucaps-for-0c-and-20c-levels.html>



NUCAPS Sounding Skew-T for 19z Wednesday June 21, 2017

Forecasters used **NUCAPS operational skew-T's** to quickly locate temperature levels (0,-20,-30 °C)

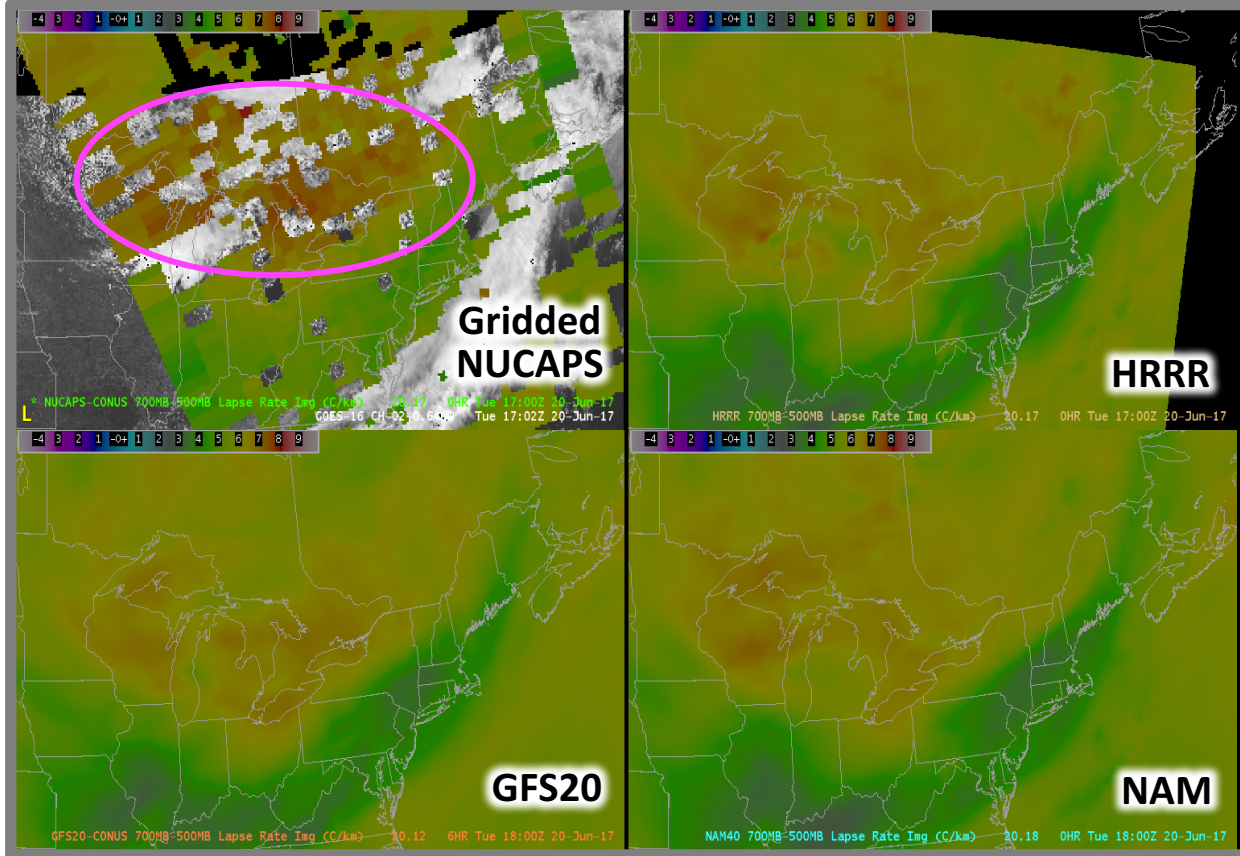
- Operational NUCAPS (without surface correction) has sufficient skill to accurately identify these levels
- These levels were used during storm interrogation to assess radar heights of 50 and 60 dBZ for size of hail aloft and warning issuance

"Many other tools use model data which can have their own errors, but NUCAPS is actual observation and can bring more confidence when analyzing storms in the vertical."—**Ironman**

In future, these levels could be implemented as a gridded NUCAPS product viewed in "plan view"

# EXAMPLE #3 – 700-500mb Lapse Rates

<http://goesrhwt.blogspot.com/2017/06/hello-from-hazardous-weather-testbed-in.html>



700-500mb Lapse Rate Comparison

Forecaster compared 700-500mb lapse rate from **Gridded NUCAPS** (top left), **HRRR** (top right), **GFS20** (bottom left), & **NAM** (bottom right)

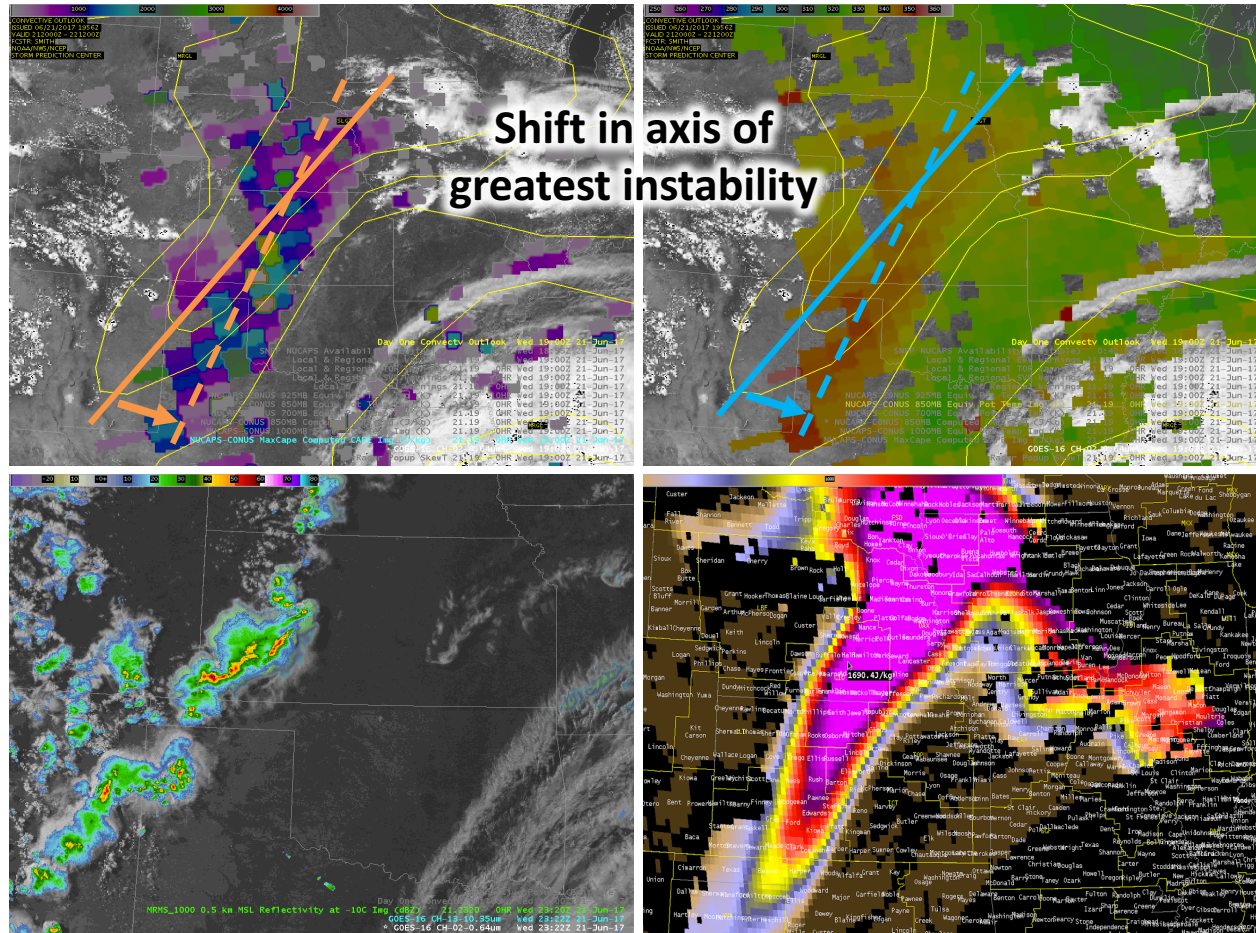
- Gridded NUCAPS indicates slightly steeper lapse rates, over Great Lakes (**magenta**)

“While specific values at various locations differ by relatively small percentages, patterns and gradients are overall fairly similar.” – Kris White

Lead the forecaster to consider that there may be *“slightly more robust convective development in this region, than the model data alone imply”*

# EXAMPLE #4 – Derived Convective Indices

<http://goesrhwt.blogspot.com/2017/06/nucaps-observations-in-w-kansas-for-21.html>



Forecaster compared **Gridded NUCAPS CAPE** & **850mb Theta-e** to SPC Day-1 Convective Outlook (yellow contours)

- Both **Gridded NUCAPS** products suggest that a better axis of largest instability is slightly east of SPC (shown as solid and dashed **blue/orange** lines)
- Titled axis seen also supported by GOES-16 Derived CAPE

"[NUCAPS] data indicated sufficient instability to keep convective development ongoing downstream and that increased intensity is possible as the storm moves into that region of higher instability." –Kris White

SPC Day-1 Convective Outlook (yellow contours) with Gridded NUCAPS Max CAPE (TOP LEFT) & 850mb Theta-e (TOP RIGHT). BOTTOM LEFT: MRMS -20 °C reflectivity BOTTOM RIGHT: GOES-16 Derived CAPE





# Forecaster Product Feedback

Positive Comments...	Things to work on...
<ul style="list-style-type: none"><li>• <b>NUCAPS soundings are valuable in RAOB and radar sparse regions</b></li><li>• NUCAPS contributes to decision making within pre-convective environment</li><li>• Both operational and experimental “blended”</li><li>• Forecasters want access to both operational and experimental “blended” skew-T’s</li><li>• NUCAPS provides independent measurements for model validation</li><li>• <b>Gridded NUCAPS enables situational awareness of spatial patterns</b></li><li>• NUCAPS Skew-T’s and Gridded products are valuable in different situations and supplement each other</li><li>• NUCAPS overpass provides observations during the temporal gap between the morning 1200 UTC and evening 0000 UTC RAOB</li></ul>	<ul style="list-style-type: none"><li>• <b>Latency is #1 limiting factor</b></li><li>• Gridded NUCAPS needs improvements; new derived products, fix visualization, missing values, etc</li><li>• The automated surface adjustment in experimental blended NUCAPS and in-situ skew-T’s can produce unrealistic or non-physical results</li><li>• Training modules should focus more examples demonstrating HOW to use NUCAPS, not the sounding theory behind it</li><li>• <b>NUCAPS products need continuity across platforms and products</b></li><li>• Skew-T visualization makes it difficult to keep track of “which you just clicked on” when going back and forth between QC selection map and skew-T</li><li>• NUCAPS need an easy access “ProbSevere” type readout (ex: hover over area to view summary of sounding)</li></ul>





## Conclusions: ***What we have learned...***

- Forecasters use indices, like CAPE, as a physical quality index to assign confidence to a product as a whole
  - they are not evaluating T&q directly...they are assessing NUCAPS value through derived products such as CAPE
- We have found it is important to have continuity across platforms and products
- Now that forecasters are more comfortable with NUCAPS, they recognize the value of MW-only soundings in data sparse regions or within complicated scenes

By observing forecasters in their work setting we have a better appreciation and understanding of their needs...

**Forecasters have difficult jobs in a fast paced and stressful environment that requires products be delivered in the simplest most efficient way, while still providing the maximum information content**

**...and this does not have an obvious solution...**

*This can only be accomplished in interactive settings like the HWT and by **LISTENING** to forecaster so that we can find the balance between what the need and what NUCAPS can realistically provide*



**Thank you, Questions???**



# HWT Relevant Links

## HWT Overview:

[http://hwt.nssl.noaa.gov/ewp/training\\_2017/overview/presentation\\_html5.html](http://hwt.nssl.noaa.gov/ewp/training_2017/overview/presentation_html5.html)

## HWT BLOG:

<http://goesrhwt.blogspot.com/>

## NUCAPS Tagged Blog Posts:

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

## 2017 HWT Developer Report:

*Available on request...*

Contact Nadia Smith ([nadias@stcnet.com](mailto:nadias@stcnet.com))

## SOME INTERESTING BLOG CASES:

<http://goesrhwt.blogspot.com/2017/06/hello-from-hazardous-weather-testbed-in.html>  
<http://goesrhwt.blogspot.com/2017/06/17-19z-snp-p-nucaps-passes.html>  
<http://goesrhwt.blogspot.com/2017/06/gridded-nucaps-verification.html>  
<http://goesrhwt.blogspot.com/2017/06/its-been-interesting-to-observe-and.html>  
<http://goesrhwt.blogspot.com/2017/06/observation-of-gridded-nucaps-data-with.html>  
<http://goesrhwt.blogspot.com/2017/06/follow-up-to-observation-of-gridded.html>  
<http://goesrhwt.blogspot.com/2017/06/nucaps-suggestions.html>  
<http://goesrhwt.blogspot.com/2017/06/nucaps-observations-in-w-kansas-for-21.html>  
<http://goesrhwt.blogspot.com/2017/06/some-observations-and-thoughts-on.html>  
<http://goesrhwt.blogspot.com/2017/06/an-assessment-of-why-convective-clouds.html>  
<http://goesrhwt.blogspot.com/2017/06/nucaps-soundings-and-tale-of-two-air.html>  
[http://goesrhwt.blogspot.com/2017/06/nucaps-soundings-and-tale-of-two-air\\_22.html](http://goesrhwt.blogspot.com/2017/06/nucaps-soundings-and-tale-of-two-air_22.html)  
<http://goesrhwt.blogspot.com/2017/06/nucaps-experimental-soundings-showed.html>  
<http://goesrhwt.blogspot.com/2017/06/extracting-data-from-nucaps-soundings.htm>  
<http://goesrhwt.blogspot.com/2017/06/18z-nucaps-op-vs-experiment-viewing-and.html>  
<http://goesrhwt.blogspot.com/2017/06/gid-environmental-analysis-nucapes-and.html>  
<http://goesrhwt.blogspot.com/2017/06/18z-nucaps-op-vs-experiment-viewing-and.html>  
[http://goesrhwt.blogspot.com/2017/06/nucaps-soundings-and-tale-of-two-air\\_22.html](http://goesrhwt.blogspot.com/2017/06/nucaps-soundings-and-tale-of-two-air_22.html)  
<http://goesrhwt.blogspot.com/2017/06/nucaps-soundings-and-tale-of-two-air.html>  
<http://goesrhwt.blogspot.com/2017/07/nucaps-samples-inversion-absent-on.html>  
<http://goesrhwt.blogspot.com/2017/07/nucaps-mixing-ratio.html>  
<http://goesrhwt.blogspot.com/2017/07/nucaps-in-buf-cwa.html>  
<http://goesrhwt.blogspot.com/2017/07/experimental-snp-p-nucaps-in-buf-cwa.html>  
<http://goesrhwt.blogspot.com/2017/07/testing-out-nucaps-cross-section.html>  
<http://goesrhwt.blogspot.com/2017/07/snp-p-nucaps-vs-experimental-nucaps-over.html>  
<http://goesrhwt.blogspot.com/2017/07/opening-day.html>  
<http://goesrhwt.blogspot.com/2017/07/south-dakota.html>  
<http://goesrhwt.blogspot.com/2017/07/monitoring-for-convective-initiation.html>

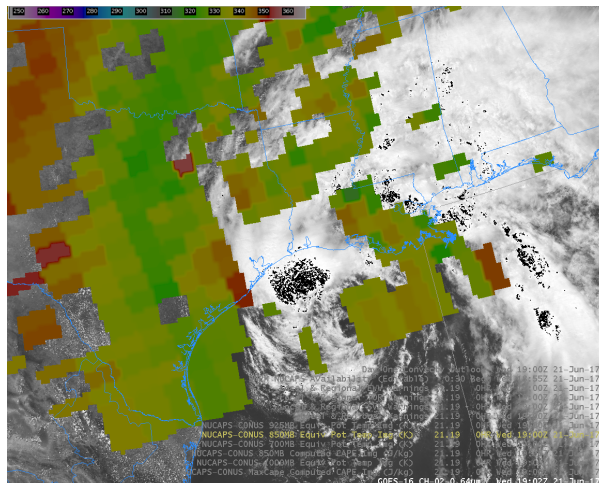
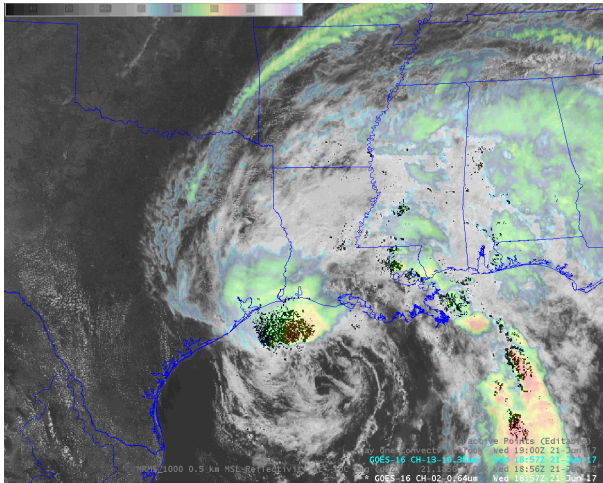
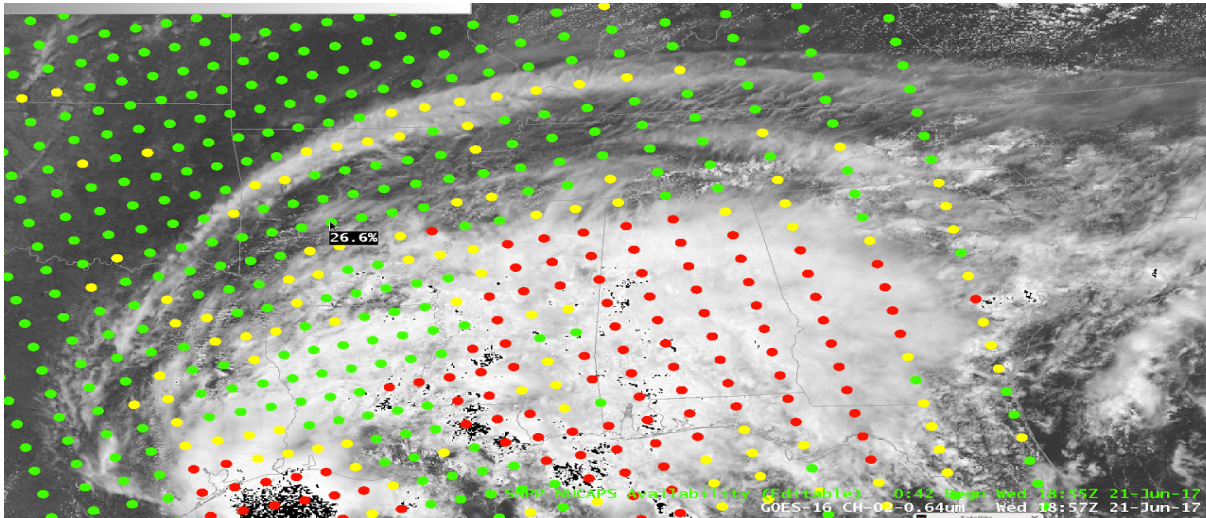


# Supplementary Slides & HWT Blog Examples



# EXAMPLE #5 – Tropical Storm Cindy

<http://goesrhwt.blogspot.com/2017/06/observation-of-gridded-nucaps-data-with.html>



Forecaster used **Gridded NUCAPS** 850mb Theta-e and **Skew-T's** to identify the areas of deepest convection within Tropical Storm

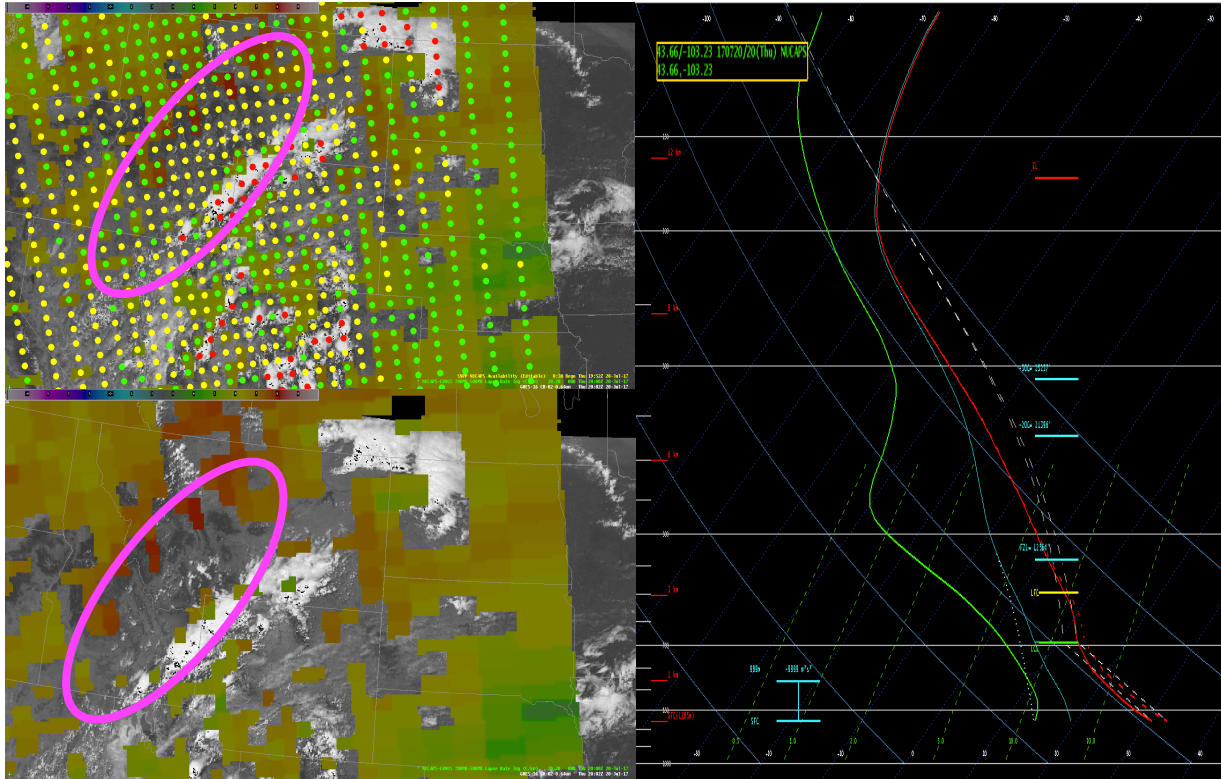
- Noted that deeper convection confined to regions closer to center of circulation, and then along eastern side (main moisture axis)

"I have to say, this was a bit unexpected, but the soundings have tended to indicate a general lack of instability within this region of higher insolation and thus offered an appropriate adjustment of my mental model of the situation." – Kris White

*"In a similar fashion, I think that these data could be very valuable over open ocean locations, where there are less direct observations, and could provide valuable information about lapse rates and instability."* – Kris White

## Example #6 - Possible Emissivity Issues

<http://goesrhwt.blogspot.com/2017/07/missing-gridded-nucaps-data-in-complex.html>



Forecaster noticed that in western US Rockies region **NUCAPS QC** indicated lots of yellow (MW-only) soundings, even in relatively clear skies (**magenta**)

- Could be a result of simplified emissivity first guess over dry desert

"For locations in the west, for this data to be useful and for us to have confidence in using it, we really need a more complete data set." -64BoggsLites

Here is a case where forecasters in data sparse regions would use NUCAPS soundings flagged as "yellow" QC (MW-only)

- In this blog post, the forecaster comments that "A sounding from the Black Hill is shown at the bottom, which seems meteorologically reasonable" (shown in skew-T on left)