How NUCAPS made it into the hands of decision-makers

Thoughts on achieving relevance with satellite products

Presented by: **Nadia Smith**[STC]

With contributions by many …

Why is this worth discussing?

- Because we have failed at this for a long time
  - **Lack of evidence that satellite sounding products were used operationally**
  - Satellite soundings do not make "pretty pictures"
  - Compare "quicklooks" of soundings to satellite images (sub-km horizontal resolution) and radiosondes (sub-km vertical resolution)… this hindered early adoption.
  - The information in satellite soundings is difficult to understand and use – not visually obvious especially not with operational tools such as AWIPS
- The "Valley of Death": where good products go to die (see "*Travels through the Jornada del Muerto*.." Chris Barnet AIRS STM, 03/23/16)
- We can now see the edge of the desert, the air is no longer burning our lungs, we can smell water (and pollution) in the air…**forecasters are now putting satellite soundings up with radiosondes** in analyzing weather events…How did did this happen?

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Who are the decision makers I'm talking about?

Local and Regional Weather Forecasters

- Responsible for issuing warnings, MIS (mesoscale impact statements)…
- High stress environment, fast decision making, visual interpretation, multi-scale analyses (zoom in/out over time and space), in-depth interrogation, search for anomalies + patterns using whatever is available.
- Direct interface between our data products and the general public
  - Held accountable for their work by the community they serve
  - Need to work with products they understand
- Too much data + limited time
  - Highly critical of new products; must add value or it is out
- One of the most difficult user groups to reach – they interrogate individual soundings/footprints to analyze specific events.

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Working within the NOAA system of R2O

JPSS Proving Ground and Risk Reduction (PGRR) – Initiatives

Improving NOAA Products and Services

- **Fire and Smoke**
- River Ice and Flooding
- Arctic
- **Soundings** (NUCAPS; Atmospheric Chemistry)
- NWP Impact Studies and Critical Weather
- Ocean and Coasts
- Hydrology (Precipitation; Soil moisture)
- Hurricanes and Tropical Cyclones
- New Innovation
- Training

What is an initiative?

Interagency group of **developers**, **service area providers** and **stakeholders** that frequently interact in a structured forum to address operational and scientific challenges and meet goals.

Developers: Algorithm (NUCAPS retrieval)
Product (L2 in Application)
Visualization tools (AWIPS)

Hats off to Chris Barnet, Mitch Goldberg, Arron Layns and Bill Sjoberg

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JPSS PGRR Sounding Initiatives – 2017 activities

- NUCAPS blended products to **improve boundary layer** characterization (Dan Lindsey, Jack Dostalek)
- **Gridded NUCAPS** to allow visualization of 3-D features and comparison to models (Brad Zavodsky, Emily Berndt, Kris White)
- Novel **Trace gas data evaluation** methods (Stuart McKeen, Greg Frost, Brad Pierce)
- **New Products in New Applications**: FSR NUCAPS CO to initialize smoke trajectory forecasts (Brad Pierce, Jim Davies)
- Derived indices and the **pre-convective environment** (HWT participants)

NUCAPS in AWIPS–II: skew–T plots

Since 2014

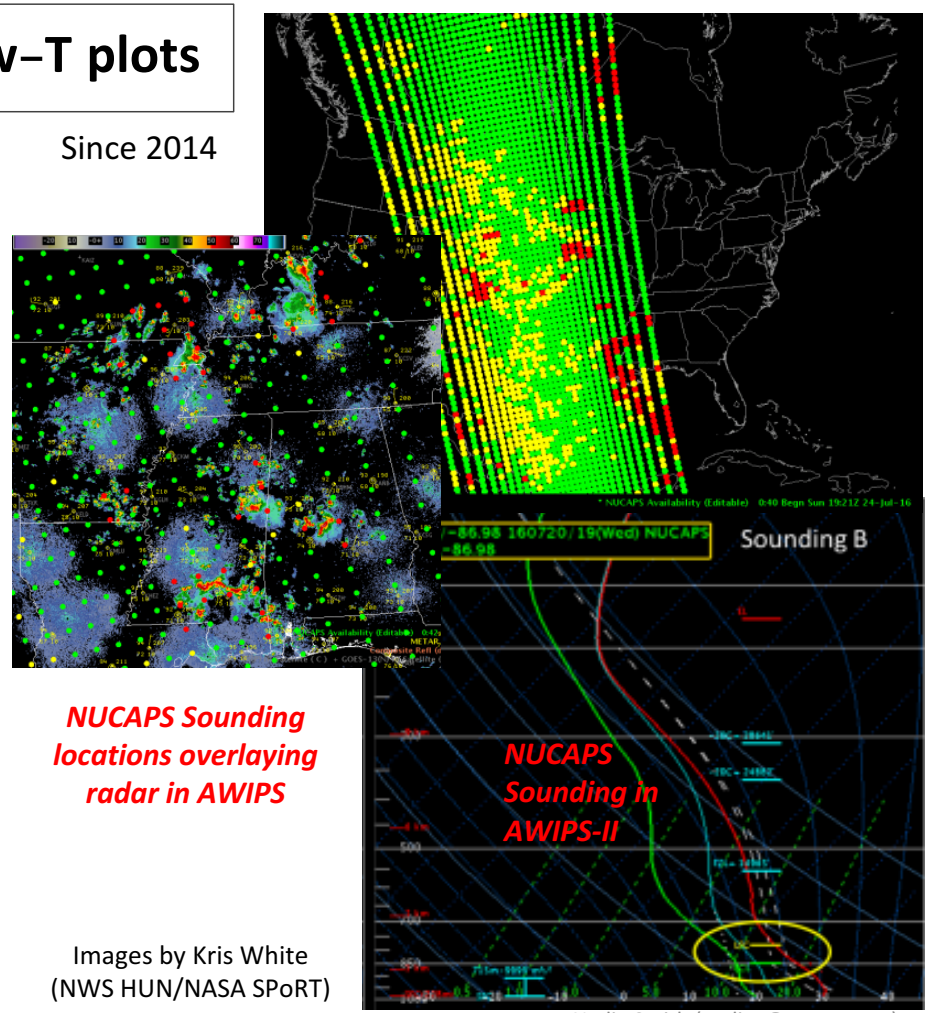
Closing the gap: NUCAPS in native forecasting analysis/decision environment.

NUCAPS as skew-T plots located on a map by a point indicating center of footprint.

Forecasters interrogate individual soundings and compare to many other sources: models, sondes, imagers (VIIRS, GOES-16).

The spatial resolution of a skew-T plot is not represented by the size of the green dot...

"Looks like sounding is inside a cloud field…but I don't see the cloud in the skew-T"...



NUCAPS Sounding locations overlaying radar in AWIPS

NUCAPS Sounding in AWIPS-II

Images by Kris White (NWS HUN/NASA SPoRT)

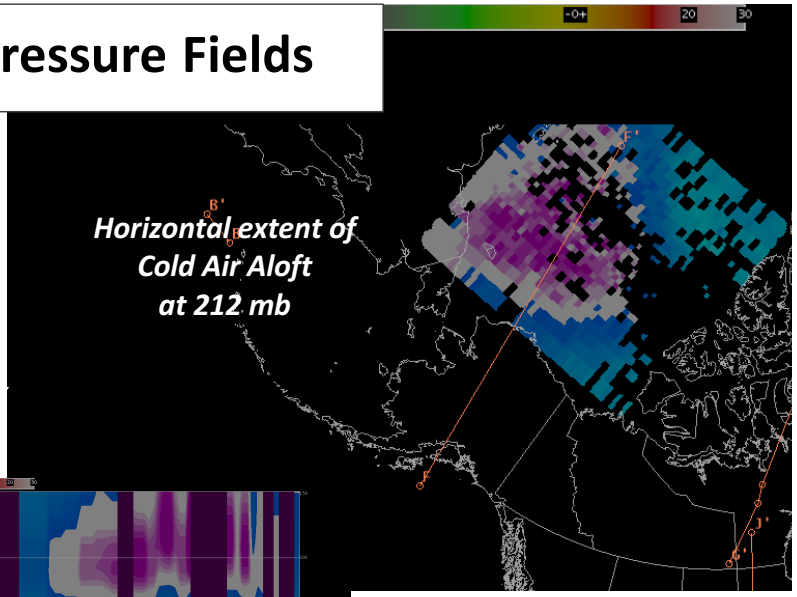
Nadia Smith (nadias@stcnet.com)

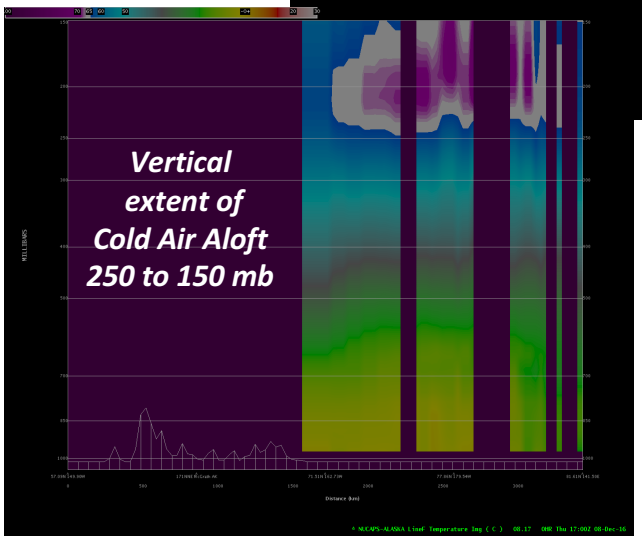
NUCAPS in AWIPS–II: Gridded Pressure Fields

Emily Berndt, Kris White, Brad Zavodsky, Jack Dostalek Since 2016

Cold Air Aloft: we had a user (Kristine Nelson, Alaskan forecaster) who wanted to use satellite soundings as "confidence metric" of CAA events.

We had to develop a NEW type of NUCAPS product for AWIPS-II





Gridded NUCAPS:

- Need spatially uniform grid display in AWIPS-II
- Preserve extremes present in NUCAPS at native resolution; Take care not to "wash out" the signal.
- Unlike model, sat soundings are not vertical everywhere. How to grid where slant profile observe below cloud.

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...FOR ATC PLANNING PURPOSES ONLY...
FROM 575NNW BRW-510NNE BRW-175NE SCC-BRW-200W BRW-572N BRW
COLD AIR ALOFT
TEMPS -65C OR LESS FM FL310-FL340. MOV E 15 KT. INTSF.
GMW DEC 16

FSR NUCAPS in IDEA–I: Initialize Smoke Trajectories

Since 2017

Brad Pierce, Jim Davies

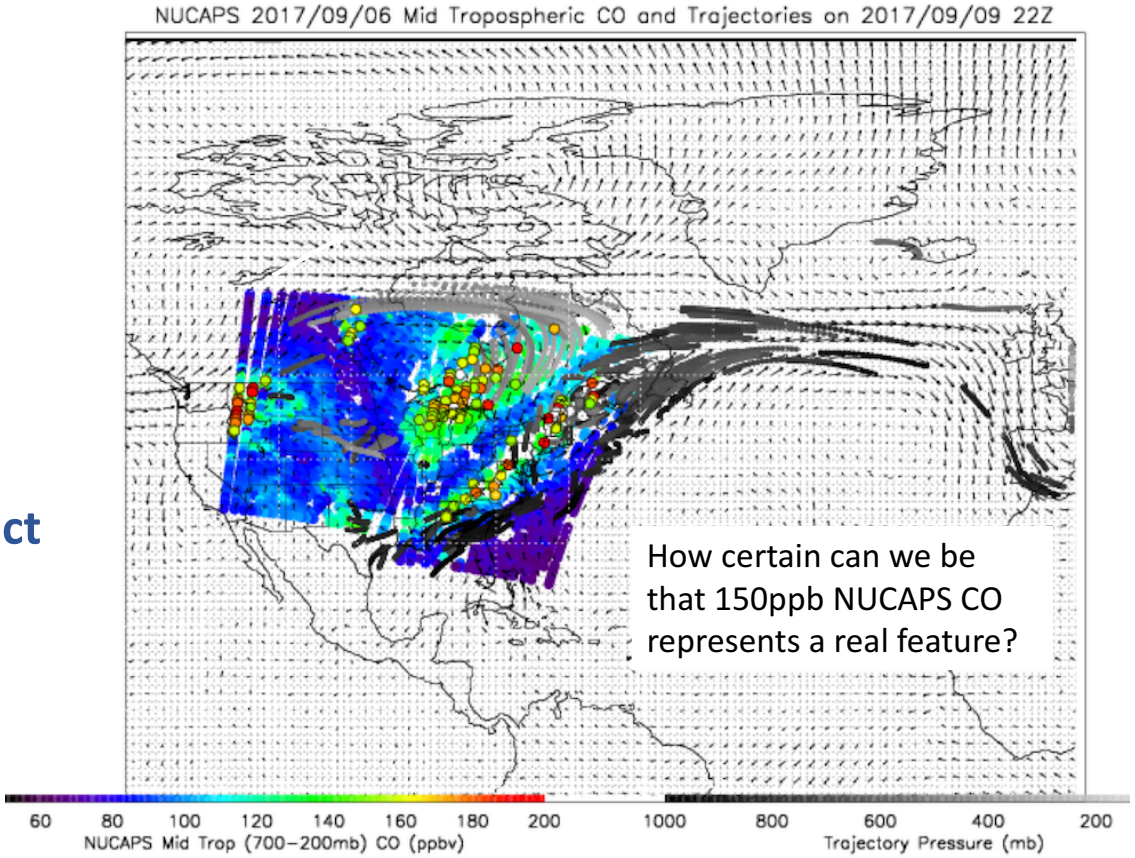
Trajectories are initiated with
FSR NUCAPS CO mid-trop avg >= 150ppb

Black trajectories are near the surface

Customer: EPA, NWS

Why NUCAPS CO? (i) diurnal continuity,
(ii) retrievals in complex cloudy scenes

Evaluation of new NUCAPS product and development of target application ahead of operational release – hit the ground running.



We have demonstrated success in crossing this "Valley of Death" *because* of the NUCAPS product system

Foresight of the NUCAPS system architects: **Chris Barnet** and **Walter Woolf**

- **Stability in signal-to-noise**: MW, cloud-clearing, sequential retrieval
- **High yield**: clear and partly cloudy scenes
- Retrieval code is instrument independent
- **Diagnostic metrics**: netCDF "spare" fields (*ispare* and *rspare*), deep dive evaluations, averaging kernels, understanding why a retrieval failed or where information comes from.
- **Full set** of atmospheric state parameters: T(p), q(p), CO(p), O3(p), CH4(p) etc.
- **Embedded within the NOAA system**: multiple pathways to users depending on latency requirements and format; robust R2O pathways
- **Common code base** between research and operations allows "deep dive" evaluations within applications
- Co-located model fields as 'truth' for quick evaluation

Thoughts on achieving relevance with satellite products

- Willingness to wrestle with the tough questions
  - What is NUCAPS showing forecasters/decision-makers they don't already know?
- Identify the areas where sounding information is needed and then provide the "user" with the right information at the right time in the right format.
- It requires strong team effort – the PGRR Sounding Initiative brings together a diversity of talents and skills in productive partnership with open two-way communication

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Conclusion

- User applications presented here this week (talks by A. Gambacorta, A. Wheeler) – the **tip of the iceberg**.
- Level 2 (EDR) as intermediate product – **need product developers** to adapt it for specific applications.
- Critical to **maintain close collaboration** between algorithm and product developers, trainers, service providers and decision-makers to ensure the correct use of information.
- Nuts and bolts understanding of retrieval system + application-specific data products + uncertainty metrics are all vital components of ongoing efforts.