NUCAPS Talking Points, April 2020 Lesson

1. This is a training on NUCAPS Soundings that are available in AWIPS. This training will explain how NUCAPS soundings are created, how to find them in AWIPS, how to use them and how to modify them.
2. NUCAPS is the NOAA Unique ~~CrIS ATMS~~ Combined Atmospheric Processing System, combining information from CriS (an infrared sounder) and ATMS (a microwave sounder) on NOAA-20. NUCAPS profiles are produced for different polar orbiters (Metop, Suomi NPP) but only NOAA-20 data are available in AWIPS. The Equatorial crossing times for NOAA-20 are shown. Data appears in AWIPS after it is downlinked at Svalbard and then proceeds through computers that process it – and that process takes about 60 minutes. If you have access to a direct broadcast antenna, as shown in that small image, you can have NUCAPS soundings in AWIPS more quickly – about 30 minutes.
3. How are profiles produced? First with a Regression, and then a Retrieval. The Regression uses static coefficients from the past and all CrIS and ATMS channels. Then a physical retrieval is used to produce the sounding, minimizing the difference between observations and calculations. The retrieval uses a Radiative Transfer Model (RTM), and the RTM has 100 levels. The retrieval is most likely to fail in regions of precipitation (even if it fails there, you might still have useful information at, say, tropopause level or in the stratosphere) The final output is mapped to 100 levels that are standard for a radiative transfer model. You'll notice the 100 levels in AWIPS are always the same pressure surfaces. It's really more levels than are resolved.
4. (First frame): Cloud-clearing is an important part of the NUCAPS algorithm. The CrIS is able to see around clouds if there are breaks, but uniform clouds present a bigger problem. Each NUCAPS footprint contains 9 CrIS (for Suomi NPP/NOAA-20) Fields-of-view; if there is spatial variability to the clouds among those 9 Fields-of-view, NUCAPS will nevertheless produce a good product. If there are uniform clouds across the 50-km scene, then it's more likely to be rejected (even if there aren't a lot clouds!) (second frame): This shows the 9 Fields of Regard in CrIS for each NUCAPS sounding. At nadir, they're closely spaced, and towards the limb they are more widely spaced. It's not uncommon for sky conditions to vary across the Fields of Regard. (I use Fields of Regards interchangeably with Fields of View). The Sounder Fields of Regard do not extend to the edge of the swath.
5. The Retrieval does not use all channels on the CrIS (although it does use all channels on the ATMS). If there are channels that are sensitive to more than 1 gas, for example CO2 and water vapor, that channel is not used in the retrieval. Rather, channels that are sensitive to only CO2 or to only water vapor are used. In the physical retrieval, the algorithm sequentially solves for temperature, moisture, ozone and other gases. The first guess for this is climatology: Think about what that means if you are in a regime that deviates significantly from normal. There are 24 channels (highlighted in green) from which surface temperature is retrieved, 62 (in red) from which water vapor is retrieved, etc. Again, iIn contrast to the subset of Sounder channels shown

above, All Microwave channels are used in NUCAPS. The ATMS retrieval is the solution if either the cloud clearing fails or if the Physical retrieval fails.

6. NUCAPS Soundings resolve about 6-10 layers of temperature in the troposphere, and about 4-6 layers of moisture. Do not expect to see very thin layers in a NUCAPS sounding.
7. How do you access NUCAPS soundings in AWIPS? NUCAPS soundings are satellite data. They sit under the Satellite tab. Click on it, and then click on S-NPP and NOAA-20 Products. Then click on 'NUCAPS Sounding Availability' (There's also a 'Gridded NUCAPS' tab you can select)
8. This shots The location of NUCAPS sounding points in one swath. The colors of the points means something! Green points denote retrievals that succeeded – both infrared and microwave. Yellow points denote points where the infrared retrieval failed (likely due to clouds) and red points show where both infrared and microwave retrievals failed (likely due to precipitation). Plotting points on a satellite image (this is VIIRS 11.45 micrometer infrared image) is a worthwhile task – it helps you anticipate what the soundings will show
9. It's hard – and tedious/laborious – to step through all the soundings to find information. A quicker way to do that is with pop-up SkewTs that you can activate in the Volume Browser, then selecting NUCAPS soundings with a right-click on the image (and also you turn on sampling). Then when you scan over the points, you can see soundings in the small pop-up skewT viewer. This is a handy way to find thresholds, or boundaries, or specific values.
10. This example shows profiles in clear air, at a cloud edge, and in deep clouds (two green and a red point).
11. This example shows NUCAPS soundings just to the east of a convective feature, and the soundings from north to south show variations in stability that might make nowcasting easier: Will the convection develop to the south based on the soundings? Maybe not!
12. When you're kinda far north (north of around 35-40 N), you can occasionally get sequential NUCAPS profiles – that is the western most profiles from an early pass will overlap the easternmost profiles from the next pass. This case shows an example from a SLGT RSK day over Pennsylvania. The later sounding does show an erosion/lifting of the inversion in this case, and that information should certainly inform your decision-making.
13. Why not use a numerical model to divine the thermodynamic structure of the atmosphere? Well, sometimes the numerical model is early and/or otherwise erroneous in its prediction. In this case, using observations from the satellite in southeast CO is likely to give a better feel for the atmosphere than the erroneous model forecast!
14. NUCAPS was evaluated at HWT in 2015 through 2019. Some commentary from the GOES-R HWT Blog (http://goesrhwt.blogspot.com) is shown on this slide.
15. NUCAPS data are statistical improvements over GFS information, compared to Radiosonde data.
16. If you need to edit the Sounding, you can do so with a table editor in AWIPS, but the more common method is to use the graphical editor. Toggle 'Edit Graph' to on, then move the draggable points around (Be careful – there's no "undo" button). Convective parameters will change as you change the boundary layer temperature and/or moisture distribution. That sequence of events is shown on this series of slides.
17. The first, classic forecast problem that came from Dan Nietfeld, then the SOO in Omaha: Will showers develop as the GFS suggests? Suomi NPP overflies the central US around 18 or 19z;

this provides timely information on the state of the atmosphere in early afternoon. Here we have three different scenes, zooming in from North America to the Plains to WFO Omaha. Let's look at the sounding at the location circled in red. Surface T/Td in this sounding match nearby METARs, so you don't have to edit it – CAPE values are low. Would you forecast showers? The near-sunset visible image shows that clouds dissipated.

18. A couple days later, severe weather hit Omaha. Let's look at the sounding in the Green Box. (Note the big dewpoint gradient in this image!) Modify this sounding to match METARs, and you get a SB CAPE of ~1900. Some of the FORs for this sounding are likely cloudy, but some aren't. Look at the point to the south – in the region of higher dewpoints. The central point is in clear air, and many of the 9 FORs for this point are also likely clear. Original unmodified sounding shows CAPE of 686. Modified to match the METAR and the CAPE exceeds 3095! This gradient in instability as depicted in the profiles might inform your understanding of how storms might behave from south to north.
19. New in 2020! Gridded NUCAPS. The thermodynamic information in profiles is interpolated in the horizontal to a field that underlies the swath of points. This is a much faster way of finding gradients, for example.
20. Gridded NUCAPS are accessed under the Satellite Menu. But you can also access things via the Volume Browser – and the Volume Browser allows you to view more thermodynamic variables than you have time for! Best process: Find what works, and put it in a Procedure.
21. Many different ways to use gridded NUCAPS fields. You can probably think of even more!
22. Here's a case from the Mid-Atlantic States, and a snow event. Use the thermodynamic information to pin down the rain/snow line, for example. This example shows the Binary Probability of T < 0 at 950 mb. You can also show temperature at different levels – I show 850, 900 and 950 mb. Keep in mind that when you use these fields, all data are used: Data from green, yellow and red points are all used. It's up to the Meteorologist to ascertain whether the information is valid!
23. Here's an example of Total Totals index with a maximum value over west-central Tennessee; this data is from the date of tornadoes in Nashville TN, and strong instability is obvious to the south and west of the tornadic storm. Instability is feeding into the storm.
24. Here's an example showing lower-tropospheric lapse rates over the Pacific. Strong stability is indicated in regions where the Night Fog Brightness Temperature difference suggest stratus is present. So you can use lapse rates to view fronts, see where stratus might be meddlesome in terms of burning off, etc.
25. Reminder slide: NUCAPS points are actually measuring information from a cylindrical volume, not from a point. Remember that each point includes information from 9 CrIS fields of regard and 1 ATMS footprint.
26. Summary. The best information from NUCAPS is moisture information in the middle troposphere. Because NUCAPS is a mid-afternoon (or midnight) data product, it provides a timely update to the 12z or 00z soundings; use it to judge how the thermodynamics of the atmosphere are changing.