NUCAPS Talking Points

1. Title slide. Satellite for Foundational Course for JPSS. NUCAPS Soundings are available in your AWIPS Menu.
2. This slide describes the information you will be learning in the next 10-15 minutes. Also – thanks and acknowledgements to some people who provided vital information.
3. This slide describes what NUCAPS stands for. Note 'CA' *used to mean* CrIS/ATMS – but then NUCAPS expanded to include Metop with IASI/MSU/AMSU. At present, NUCAPS in AWIPS are restricted to Suomi NPP – soon to be JPSS. Inclusion of Metop data is in the future.
4. JPSS is in the same orbit as NPP – but it's half an orbit behind, about 40-50 minutes. The orbit is mid-day – around 1:30 PM – and mid-night – around 1:30 AM. In contrast Metop is a morning pass, with Metop-B about half an hour behind.
5. Note how the orbits shift eastward, slightly, each day.
6. The data flow from the Suomi NPP is shown on the left. It is downlinked at Svalbard, then passes through a variety of computers before showing up in AWIPS. That transit of computers takes around 90 minutes. If you have access to a direct broadcast antenna, as shown on the right hand side, your access to data can be significantly reduced, to about 20 minutes or less. Work is ongoing in the National Weather Service to reduce data latency to less than 30 minutes, in part by using a downlink in the southern Hemisphere, at McMurdo station.
7. NUCAPS Vertical profiles are generated in two steps. First a regression is run using static coefficients from 4 focus days that generated the best statistical fit between the observations and the vertical profiles. These regressions use data from all infrared and microwave channels. This Microwave/Infrared regression is used to determine if the scene is clear or not. Step two, the Retrieval, uses a Radiative Transfer Model to iterate to a solution that minimizes the observation-calculation value. The Calculation is the top-of-atmosphere radiance spectrum calculated with the Radiative Transfer model; the observation: top of atmosphere radiance spectrum; initially this is computed using the Regression output. In regions of clouds, where the infrared retrieval typically fails, microwave data still produce a retrieval. MW retrievals can fail where precipitation is falling.
8. CrIS and IASI have many many channels, and not all are used in the creation of vertical profiles. There's a balance between adding information and adding computations; two very close channels need not be included because they won't give independent information but they'll have to be processed. So, not all data are used in the Retrieval. The channels chosen are those that are sensitive to only one gas, not to more than one. In addition, adjacent channels that are highly correlated are not used.
9. Vertical profiles from NUCAPS are smooth. The Degrees of Freedom (d.o.f.) represents the number of layers that are realistically resolved by the vertical Profiles. Note well: 4-6 levels for moisture, 6-10 for temperature (these are values in the troposphere). The number of levels you can see in the AWIPS is far in excess of this: you get more levels than are resolved – but you are seeing all the layers in the radiative transfer model. To repeat: NUCAPS vertical profiles are

usually smooth and typically have 6-10 layers of temperature information, and 4-6 layers of moisture information in the troposphere. Don't expect to see very thin layers -- hot or cold, dry or moist -- in the NUCAPS vertical profile.

10. Fields of Regard from the CrIS / IASI are combined to create a NUCAPS sounding. The above shows CrIS. One FOR that's cloudy isn't a problem. As long as there is clear field of regard…. It's important to remember from this graphic that a NUCAPS Sounding represents information from a Volume of Air measured by up to 9 CrIS or 4 IASI fields of Regard! If it's cloudy across all scenes, that's an issue, but partly cloudy is not.
11. NUCAPS coverage. Note that there are holes over the southern CONUS – these gaps shift eastward from one day to the next. There are regions over northern CONUS (and Alaska!) where sequential swaths overlap! So you can have two vertical profiles about 90 minutes apart
12. Here's what the data look like in AWIPS. This is if you select 'NUCAPS Sounding Availability' Green Points: The Retrieval has converged. Expect to see a representative sounding. Yellow points: the infrared retrieval has failed, but the microwave has not and will return a sounding (that is very smooth). Red points: Both retrievals failed to converge. The sounding will look wonky.
13. I like to overlay the NUCAPS Sounding on a VIIRS cloud image from the same time. Note that the NUCAPS soundings do not extend to the edge of the VIIRS swath.
14. Another example that shows the NUCAPS Sounding points plotted on top a VIIRS 11.45 micron image. NUCAPS sounding data do not extend to the edge of the VIIRS image swath. There's pretty good spatial correlation between thick clouds and red and yellow sounding locations.
15. Now, let's look at soundings from 3 locations in close proximity to one another. Two green, one red.
16. Note: Profiles are smooth! Given that these are 9 Fields of View, this is a sample of a volume of air. From the red point, you can get very unphysical profiles, but the green ones look reasonable, albeit smooth.
17. There are lots of soundings! Imagine having to launch balloons at all these points! There is a way to more quickly scan through the profiles, and that is using pop-up SkewTs in AWIPS. This is something that's selected in the Volume Browser. The Pop-Up SkewT lets you do simple things like find a threshold, perhaps, or find the most unstable sounding.
18. After accessing them in the Volume Browser, Turn on Sampling. Then right-click in the image and click on NUCAPS. Now you can mouse over the NUCAPS points and a NUCAPS sounding will pop up in the small window.
19. Move your mouse over the points, and the image shows up. If you find one you like, click on the actual point and the profile pops up in the window, large.
20. Profiles are readily available from NWP sources. NAM Nest, WRF, GFS… Why not use those? Well, you can have a convective feedback occurring that gives a profile that is not representative of the environment.
21. Models can have timing issues: Convection might be early, or late. In this case wouldn't you rather have something based on observations over SE Colorado?
22. NUCAPS information is most robust in the mid-troposphere; there are challenges for a satellite to view the surface through an atmosphere that is opaque to radiation at different wavelengths.

Thus, it's sometimes necessary to adjust the NUCAPS soundings so that the lower portions are more in line with observations. It's on the forecaster's shoulders to decide whether or not the NUCAPS boundary layer is representative (sometimes it is!). It's also on the forecaster's shoulders to make the adjustment, or to choose the NUCAPS sounding product that is automatically adjusted (more on that in a bit)

23. Here's an example from several years ago. There's a broken cumulus field over the Missouri River valley, and the GFS is suggesting QPF. What is your forecast?
24. There was a NUCAPS overpass shortly after noon. (Note this shows the 'old' AWIPS display of NUCAPS points; All green!) Let's look at the point in eastern Nebraska and consider what we see there and whether it will inform the forecast process.
25. Here's the vertical profile from that point. The surface of this sounding is near the values observed via METARs, so adjustment was not necessary. Would you expect convection here? Probably not. There's not a lot of instability, and it's dry.
26. Nothing happened. Clear skies by day's end.
27. As noted already, you can be fortunate up north in CONUS, and have sequential profiles about 90 minutes apart. That can be a handy way to visualize destabilization. We will look at the two profiles indicated in this image over Pennsylvania.
28. This is the 1700 UTC profile, from the earlier pass. Note the smooth nature of the profile.
29. This is the 1830 UTC profile. There are small changes in the soundings in those 90 minutes that might guide your forecast – note this was very near a SLGT RSK, and convection is approaching the region – with wind events as a result.
30. Here's another example from a High Risk day. Note a couple things here: There's an obvious dewpoint gradient across the region, so which point you choose with respect to the gradient is important.
31. Let's look first on the North edge of the dewpoint gradient – at the profile in the box.
32. This was a partly cloudy scene, and the surface temperature and dewpoint had to be adjusted so that the boundary layer in the profile matched the observations.
33. Now –look at the sounding to the south of the one just viewed. This profile is more deeply in the very moist air, and the un-modified sounding is shown. As is sometimes the case, the near-surface temperature and dewpoint in the sounding don't match surface observations.
34. After modifying the sounding to more closely match surface conditions, you will see a very unstable profile.
35. How do you modify soundings? If this material is familiar to you, just scan through the next several slides.
36. Here's the display that you'll see once you click on a point.
37. Toggle 'Edit Graph' to 'On'
38. Then you can drag points around to create a sounding that – to you – looks more in line with observations. When you're done, toggle 'Edit Graph' to 'Off'
39. And now you have a new sounding, with new thermodynamic variables.
40. Based on feedback from the Hazardous Weather Testbed (HWT), software was developed to automatically adjust afternoon NUCAPS soundings. At present, the sounding that is produced

from this automatic adjustment has a well-mixed boundary layer. Ask yourself: is the atmosphere well-mixed?

41. Here's a sounding from Aberdeen SD.
42. The soundings is far too dry near the surface
43. The automatic adjustment created a well-mixed boundary layer that was far more moist at the surface. The CAPE increased. If you want this feature, Dan Lindsey at CIRA is someone to contact.
44. NUCAPS soundings can be used to produce horizontal fields of convective parameters, or of simple atmospheric variables such as temperature or dewpoint.
45. NUCAPS Soundings are now available in AWIPS -- but only with data from Suomi NPP. But coming soon are NUCAPS soundings JPSS, and then from Metop A and B. JPSS-1 launched in late 2017; NUCAPS soundings from that platform (now NOAA-20) will be available in 2018. Soundings at many different times are available at high latitudes; in mid-latitudes, there are soundings available at fewer times, but those times are useful.