1. Tools for Monitoring Road Weather

Instructor Notes: Welcome to this lesson on Tools for Monitoring Road Weather. This presentation will focus on using Road Weather Information Systems (RWIS) and other surface mesonet observations in your forecast office. Some background information on RWIS networks, displaying these data (including QC test results) in AWIPS, and other on-line resources for these data will be presented. This presentation should take approximately 25 minutes. NOTE: Gray speaker notes in italics surrounded by brackets (i.e., [show text]) indicate at what point during the speaker notes specific animations occur.

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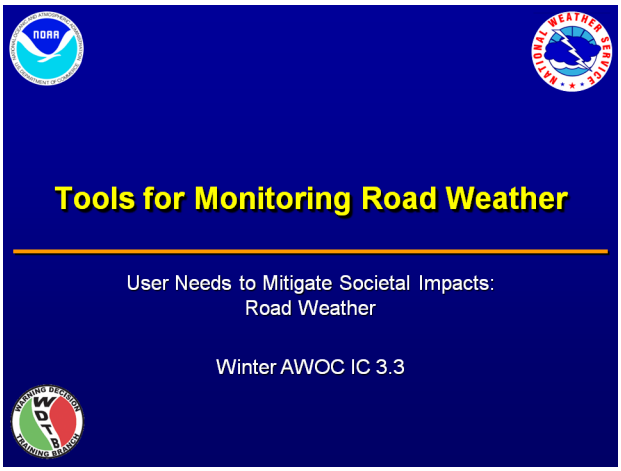

2. Lesson Outline

Instructor Notes: This training is broken up into three parts. [show 1st bullet] The first section discusses the usefulness of RWIS & other surface mesonets during DOT support. [show 2nd bullet] The second section presents which specific traits of RWIS stations may impact their usefulness to you. [show 3rd bullet] Lastly, I'll discuss how you can view these data both in AWIPS and on-line, and how using each method may be beneficial to for your office. [show last bullet] As with the previous lessons, the learning objectives for all of the road weather lessons are accessible using the objectives tab along the top of the module window.

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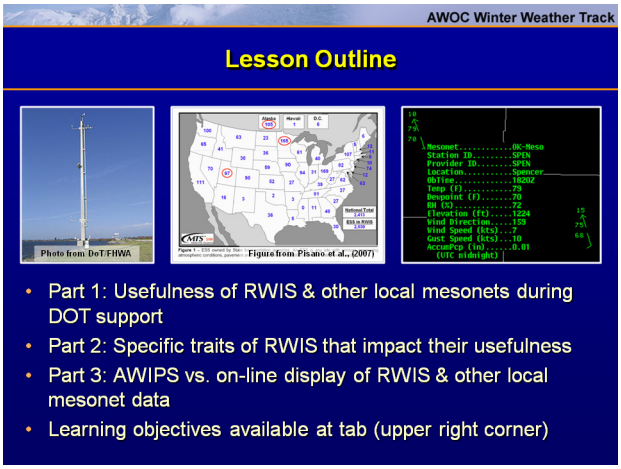

3. RWIS & Mesonet Data May Be an Overlooked

Instructor Notes: [show 1st bullet] During hazardous weather events where DOT (& other partner) support is necessary, do you sometimes wish there was an observation near a specific location? Well, are you displaying your local mesonet data (under the "Obs/Local data" menu) in AWIPS? These observations are an important tool because they greatly increase data density for standard atmospheric parameters. [show cue] In some cases, these networks also provide data that isn't normally available from ASOS sites. [show 2nd bullet] Now, I know there can be some challenges to their use. These networks are owned and operated by other agencies. It can be difficult to ensure that a stations has been well sited, is being properly maintained, or its data meets your needs. For some of the more obscure data collected, it can also be difficult to visualize the data in AWIPS. [show 3rd bullet] Having said all that, I think the benefits of these observing networks greatly outweigh the occasional difficulties in using them. This module will discuss why.

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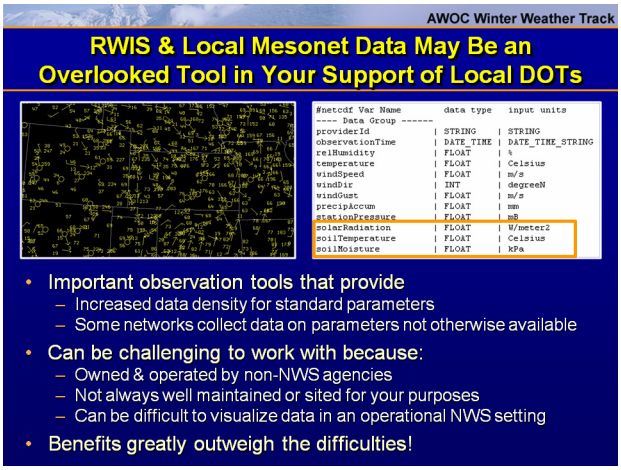

4. What Benefits Do These Data Provide

Instructor Notes: [show 1st bullet] When it comes to DOT support, RWIS data are particularly useful because these stations are sited to be representative of the road environment. ASOS sites, on the other hand, are sited to represent the air field environment. [show 2nd bullet] These networks often increase the available data density in a region by an order of two or more. This increase is both spatial and temporal. [show 3rd bullet] And for some observations, such as the soil temperature observations in the graphic shown on the right, you can access data that is not collected by ASOS, but can be helpful to you in communicating weather information to DOTs.

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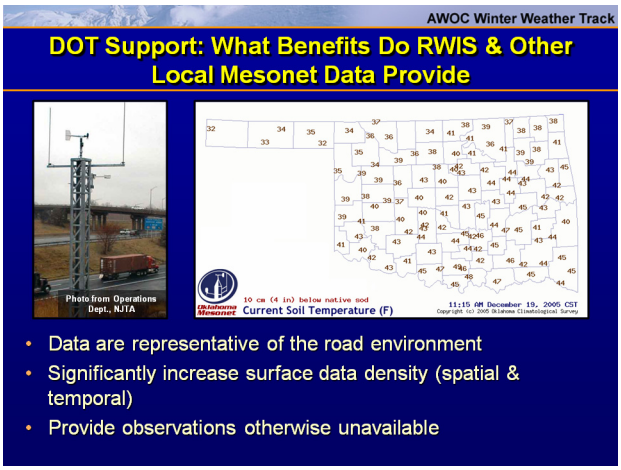

5. RWIS Data Representative of the Roadway

Instructor Notes: [show 1st bullet] On the previous slide, we mentioned how RWIS sites better represent the road environment than ASOS. The reason is RWIS Environmental Sensing Stations (ESS) sites are located near important roads to help DOTs monitor weather and road conditions. [show 2nd bullet] In fact, many other local mesonets in your area may be located fairly close to the road to enable techs to visit and maintain the site, as needed. [show 3rd bullet] In the case of RWIS sites, or mesonet sites in general, the data collected can be very useful for monitoring surface conditions and other general weather use in your area. One last note. From this point on, I will generally use RWIS to describe networks and ESS to describe an individual site in order to differentiate between the two a little better.

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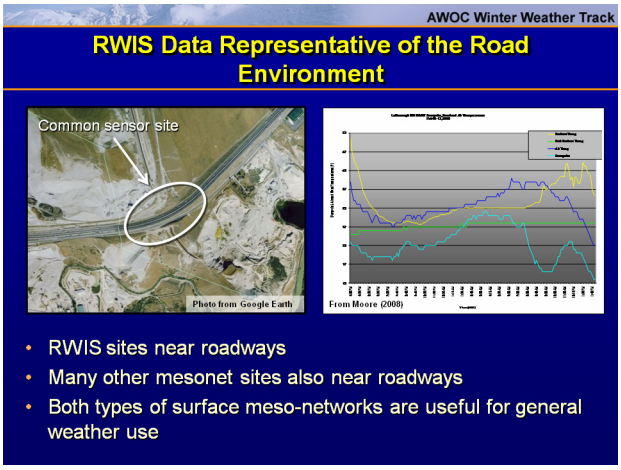

6. Increase in Data Density & Frequency

Instructor Notes: This graphic shows an example of how local mesonets can increase the data density in a particular area. The white observations in the graphic are standard METARs while the yellow obs are from local mesonets. [show circles showing areas of oversampling] Now in some areas, you can see how local mesonets might help over-sample conditions. In these locations (such as large urban areas) you might be able to monitor conditions down to near the microscale. [show ovals showing areas where only mesonet data available] However, a greater benefit of these observations is in some of the regions shown where there are few, if any, METARs available. In these regions, these local mesonet sites provide information where you would otherwise have none.

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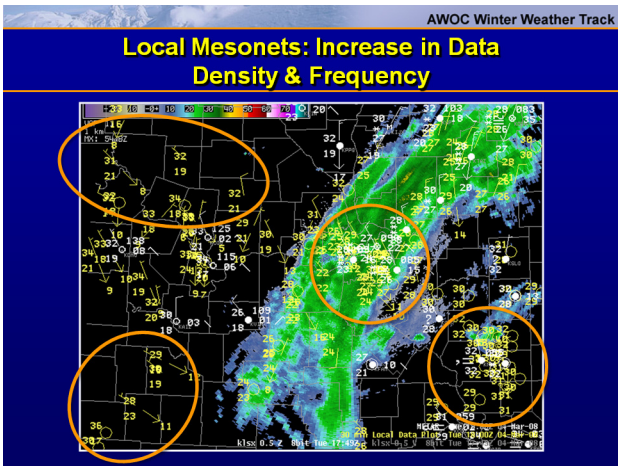

7. Provide Data Unavailable from Other Sources

Instructor Notes: [show 1st bullet] Another benefit of local mesonets to DOT support are the additional parameters for which they may collect data. ESS sites, for example, may have several additional sensors at a site, depending on what the sites purpose is. Common additional parameters for RWIS networks include road surface temperature (RST), road condition, and sub-surface temperature. [show 2nd bullet] Many locations may have nearby closed-circuit TV cameras or web cams that provide regularly updating images of road traffic critical areas. While not often thought of as an objective observations, these images can provide visual feedback of weather at that location that may not be obvious from the sensor data. [show 3rd bullet] Besides RWIS, many local mesonets collect other, less common data that can help with operational DOT support. Such observations include direct insolation, soil/sod temperature, and stream/river water levels.

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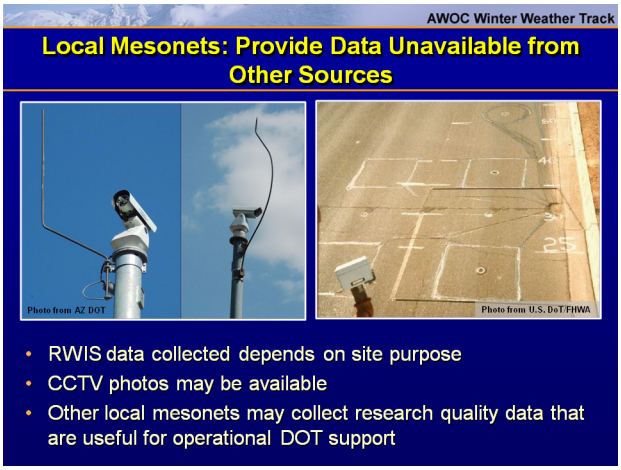


8. Quiz #1

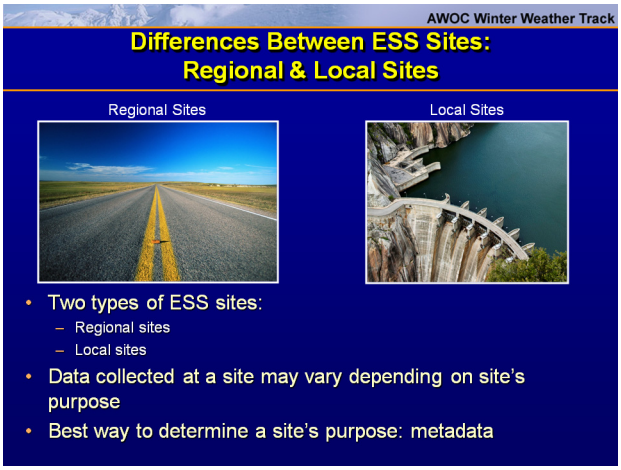
Instructor Notes: Please take a moment to complete the quiz question shown.

Student Notes:

9. Regional & Local ESS Sites

Instructor Notes: [show 1st bullet] In the previous section, we discussed that RWIS data may vary depending on the sites purpose. I want to talk about this subject in a little more detail now. In general, there are two types of RWIS sites: regional & local. In some cases, an ESS location may be classified as both. [show 2nd bullet] The parameters collected at any given site depend primarily on the site's purpose. However, determining that purpose is often not trivial. [show 3rd bullet] Many DOTs have metadata available to public users for each ESS in their RWIS network. Unfortunately, the process (and level of documentation) isn't uniform. It's possibly you may have to do some significant legwork to determine the siting purpose for all ESS locations in your area.

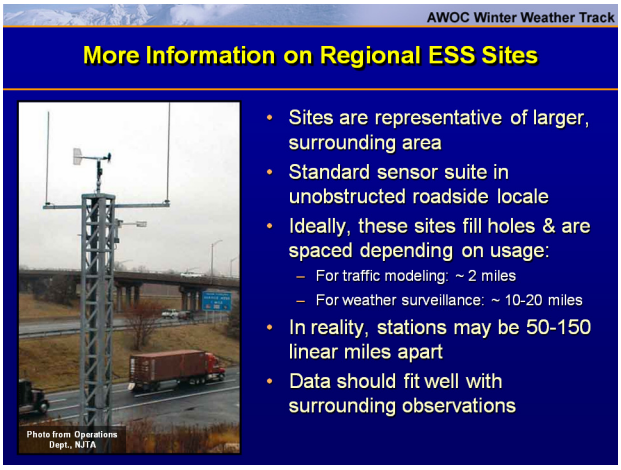
Student Notes:



10. More Information on Regional ESS Sites

Instructor Notes: [show 1st bullet] Regional ESS sites are considered to be representative of the larger, surrounding area. [show 2nd bullet] They generally include a standard suite of sensors located in a relatively unobstructed, roadside location. These sites are thought to be representative of the roadway for an area of approximately 20-30 miles (Manfredi et al., 2005). [show 3rd bullet] The spacing of ESS stations would ideally fill any data gaps in your area. Of course, that isn't always the case. You will notice some duplication in areas where there are multiple DOT data providers, as well as with other local mesonets in the area. Ideally, the sites would be located relatively close to each other, say every 2-20 miles or so. [show 4th bullet] In reality, distances of 50-150 linear miles between ESS obs can be common. [show 5th bullet] Regardless of the station density, regional sites should fit reasonably well with surrounding surface observations (Cambridge Systematics Inc., 2003).

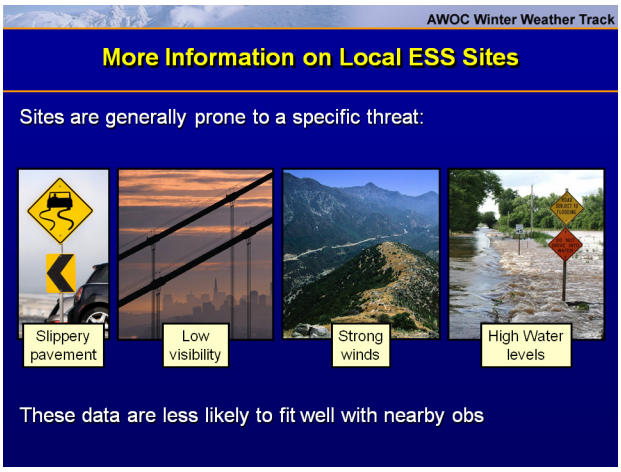
Student Notes:



11. More Information on Local ESS Sites

Instructor Notes: Local sites, on the other hand, are chosen to represent a smaller area because of specific weather threats at that location. These sites often include additional sensors that can be used to close road segments, change traffic signal timing, or post messages on DMS boards as part of advisory and control management strategies. Examples of recurring weather-related traffic problems that local ESS sites may address include: [show 1st image] Slippery pavement during rain or winter weather; [show 2nd image] Low visibility conditions due to fog, smoke, or dust; [show 3rd image] Strong surface winds; and [show 4th image] High water levels from nearby water bodies. Since these sites were chosen to observe a specific threat, their data may not match as well with surrounding sites. However, the do provide important meso-to-microscale event data that aren't otherwise available.

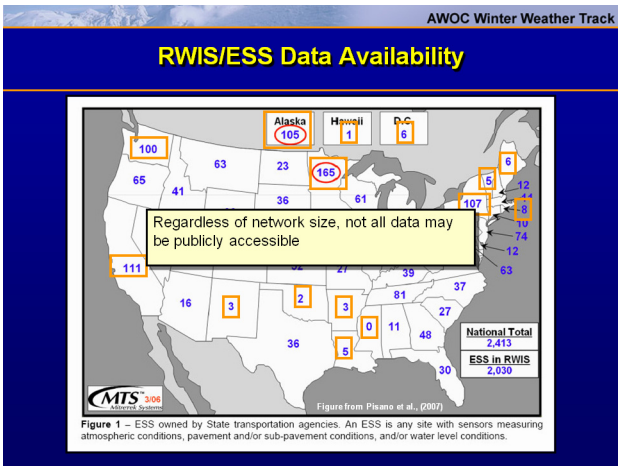
Student Notes:



12. RWIS/ESS Data Availability

Instructor Notes: The availability of RWIS data varies from state to state, but so do the reasons for this variability. Some DOTs are more aggressive with their RWIS development than others. Some states, such as those with separate turnpike authorities, have multiple DOT agencies that may operation ESS sites in the same general area. [show 1st set of cues] Some states have hundreds of ESS locations. [show 2nd set of cues] Other states have less than 10. In some of these states, DOTs rely on outside data providers who already have significant mesonets in place (Pisano et al., 2007). [text box appears] Regardless of the RWIS network's size, not all data may be publicly available. Due to maintenance and liability issues, some DOTs are not willing to share their observations with outside users in real-time. And that is what your office needs for RWIS data to be operationally useful.

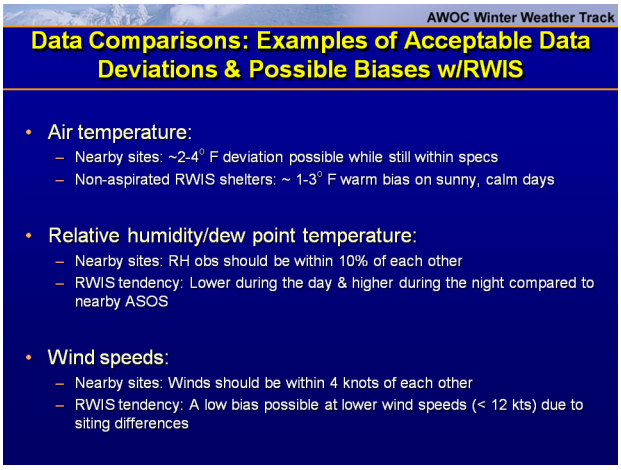
Student Notes:



13. ESS Acceptable Deviations & Biases

Instructor Notes: Before we finish discussing the specific of RWIS network data, here are a few examples of documented deviations you may observe in your CWA between RWIS and ASOS: [show 1st bullet] While temperatures should have close agreements, any given site could have a 2-4 F bias and still be operating within specifications Most RWIS networks use non-aspirated temperature shelters than can exhibit a 1-3 F warm bias on sunny, relatively calm days (Pisano et al., 2003) [show 2nd bullet] Humidity sensor require more regular calibration than other common sensors, so maintenance related errors are most likely to visible with these obs RH values should be within 10%, with ESS dew points generally a little lower during the day and higher during the night (Pisano et al., 2003) [show 3rd bullet] ESS anemometers often exhibit a low bias at lower winds speeds (<12 kts) due to more nearby obstacles allowed in their siting requirements In general, wind speeds are usually within 4 kts

Student Notes:



14. Quiz #2

Instructor Notes: Please take a moment to complete the quiz question shown

Student Notes:

15. Display Data On-Line or in AWIPS

Instructor Notes: Now that I've spent some time talking up the benefits of RWIS & local mesonet data, and some of the details that may help or hinder its usefulness for you specifically, now let's talk about actually viewing the data either on-line or via AWIPS. [show 1st bullet] Many DOTs make their RWIS data available on-line via their homepage or a 511-related web site. Many of these providers bundle the RWIS obs with traffic accident, construction, and regularly updating CCTV imagery on one site. These web pages often make it easy to access the data you need and visualize the data in helpful ways. [show 2nd bullet] AWIPS, on the other hand, can be a useful way to display RWIS data because the surface obs can be integrated with radar, satellite, and model data in one display. [show 3rd bullet] To be honest, neither solution is truly optimal. Ideally, you'll integrate both display platforms into your operational environment. Let's go into a little more detail on some of the issues, with a focus on the AWIPS side.

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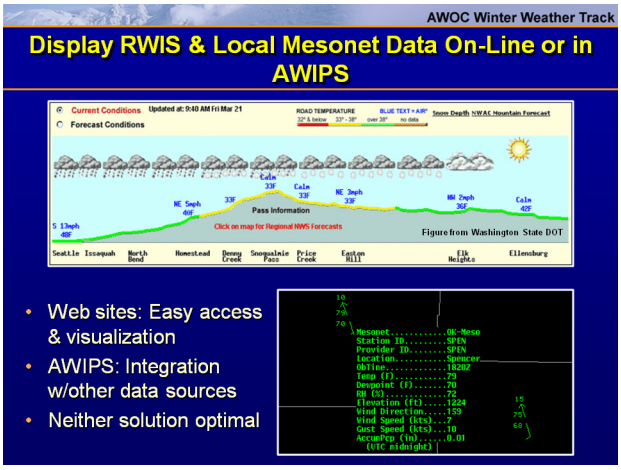
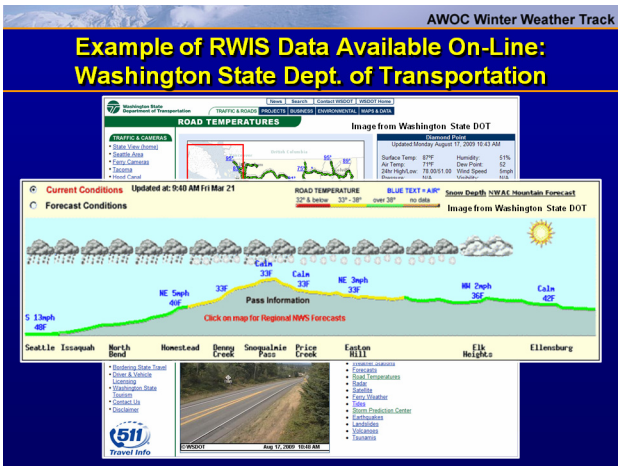


16. Example of RWIS Data Available On-Line

Instructor Notes: An example of a good RWIS web site with lots of relevant information is the Washington State DOT web page. The Washington State site provides users with a clickable map to access data, a display region to the side for displaying additional info, and a separate area near the bottom of the page for additional images and navigation. [show 2nd image] Users can access three separate scales by clicking on the map, click on observation values to see all parameters for the site, and even access traffic camera images if they are available. [show 3rd image] It's even possible to pull up some road specific cross-sections of surface data with user-friendly visualization schemes that can help forecasters identify elevations where road conditions are deteriorating.

Student Notes:

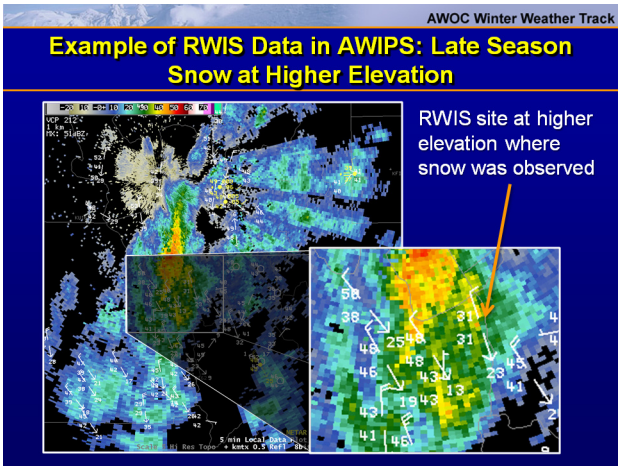


17. Example of RWIS Data in AWIPS

Instructor Notes: Here is different example using RWIS data. This case uses AWIPS to display the RWIS data. This event occurred in early June in the Salt Lake City area. Most surface stations were well above freezing and reported rain. However, some higher elevations reported snow. [show close up & text] An example of one RWIS station

where snow was observed is shown in the close-up area. In this case, some heavier snow was moving into the area near the RWIS site.

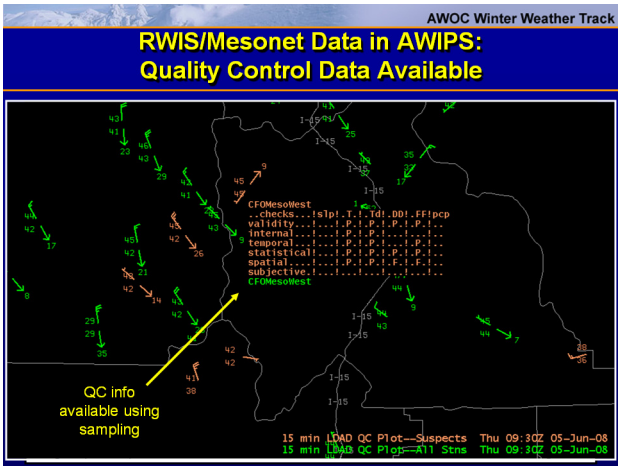
Student Notes:



18. Availability of QC Data Important

Instructor Notes: An additional benefit of using AWIPS to display RWIS & local mesonet data is the ability to easily view the quality control (QC) data for these same observations. These QC data are generated by MADIS and provided to all users of these mesonet data. [swap images & text/arrow cue] Besides the standard station plot, details of both the observation data and the QC test results are available to forecasters using the sampling function in AWIPS.

Student Notes:



19. MADIS Automated QC Procedures

Instructor Notes: There are a total of 6 QC test results that MADIS provides its users and can be displayed in D-2D (MADIS, 2008). For each test, a “P” or “F” indicates whether the observation passed or failed in the sampling display. The 6 QC tests are: [show 1st oval] A validity check to ensure observations fall within a range of tolerance

limits; [show 2nd oval] An internal consistency check to determine if reasonable meteorological relationships are maintained at a specific site; [show 3rd oval] A temporal consistency check to ensure the data doesn't change to rapidly in time; [show 4th oval] A statistical consistency check to determine if a specific parameter has failed any QC test 75% of the time in the last week; [show 5th oval] A spatial consistency check is performed to see if any observation deviates significantly from neighboring sites; and [show 6th oval] A subjective test that allows MADIS and local users to manually override the automated QC checks using a "reject" or "accept" list.

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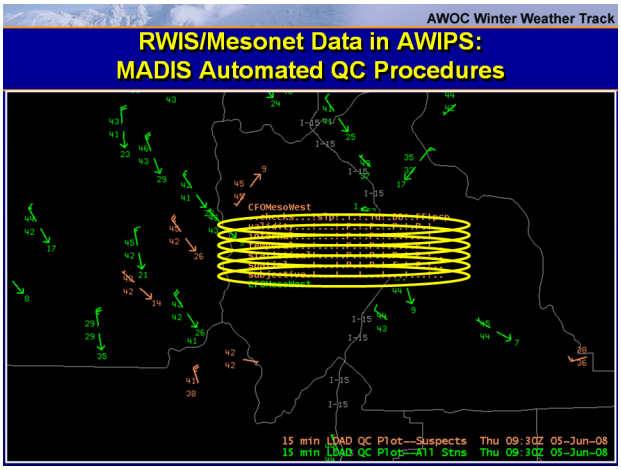

20. Displaying & Interpreting the QC Products

Instructor Notes: So let's walk through loading and interpreting some QC products. [show obs menu] We start off by selecting the Obs menu. [show sub menu] For this example, we'll select Other Local Plots and the 15 min stn plot + QC. [cue menu item] QC data is available for the 30 min plots as well. [show QC plot] The data will come up as two separate surface plots. In this example, the green obs passed all QC tests and the salmon colored obs failed at least one. To find out exactly which tests failed, just use the sampling feature in AWIPS. Now lets look at some actual data.

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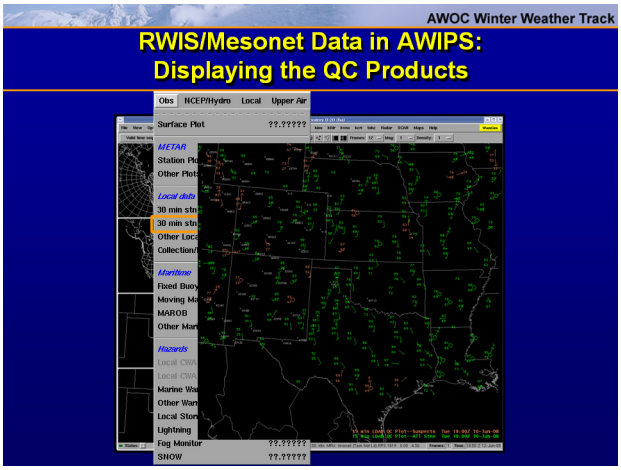

21. Displaying & Interpreting the QC Products

Instructor Notes: [show 1st cue] I'll sample QC data from three separate obs to show you how to quickly interpret the test results. The first ob is out in the four corners region. The sampling data indicates the observation failed the temporal test for temperature. In other words, there was too large of a temperature change between observation times. The reason, just prior to this time the sensor had malfunctioned and was reporting a temperature of -20o F. [show 2nd ob/cue] The next ob is for a RWIS site in NW Nebraska. This site failed the spatial, or "buddy", check for dew point temperature. This one is straight forward as the surrounding sites have dew points 10-15 F higher. [show 3rd ob/cue] The last observation I'll show is in northern Kansas. In this example, the weather bug site with calm winds failed the spatial test for both wind speed and direction. The reason is that the surrounding sites are all observing south winds at 10-15 kts.

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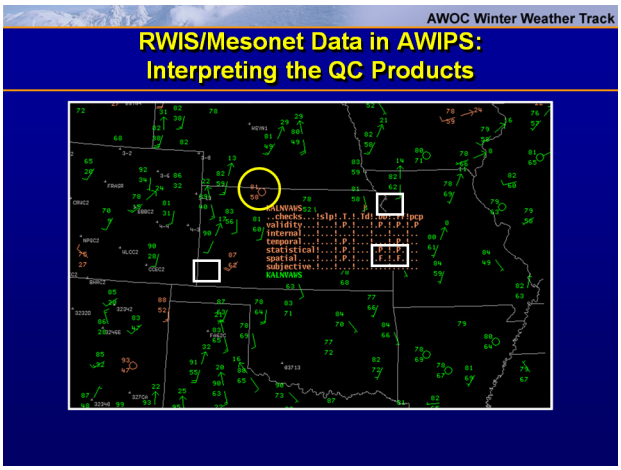
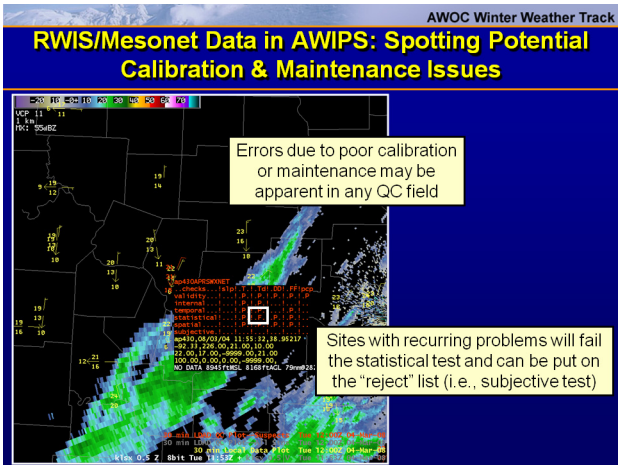


22. Spotting Calibration & Maintenance Issues

Instructor Notes: Instrument calibration and site maintenance can be significant issues for RWIS and other local mesonets. If funding for these tasks is limited, many meteorologists may not be comfortable using the data operationally. [show 1st text box] Problems with calibration or maintenance can result in any of the QC tests to fail consistently. [show 2nd text box] Once a sensor has errors more than 75% of the time for at least a week, the statistical test will flag the data (MADIS, 2008). The statistical test continues to show "F" until the failure rate falls below 25% for a week long period. Sites that regularly fail the statistical test may be put on the "reject" list by MADIS. As a result, a "F" will appear in the subjective line. This list gets updated weekly by MADIS, so it's worthwhile to download the information regularly.

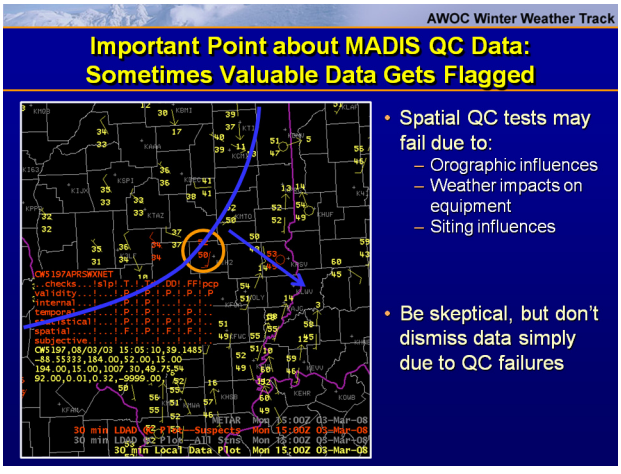
Student Notes:



23. Important Point about MADIS QC Data

Instructor Notes: In some cases, quality observations will get flagged by QC tests. You'll most likely see it with the spatial QC test. Three such examples where QC failures may be common are: [show 1st sub-bullet] Orographic influences [show 2nd sub-bullet] Weather impacts on equipment [show 3rd sub-bullet] Siting influences (i.e., local ESS) [show circle] In the example to the left, the circled ob failed the temperature and both wind spatial tests. [show boundary & arrow] The reason for the failure is that a cold front is approaching the site and the station density is higher on the cold side of the front. [show 2nd bullet] The point of this and subsequent examples is simply this: don't just dismiss observations because of QC failures. Be skeptical and investigate, especially if the observation is critical to a pertinent weather impact.

Student Notes:

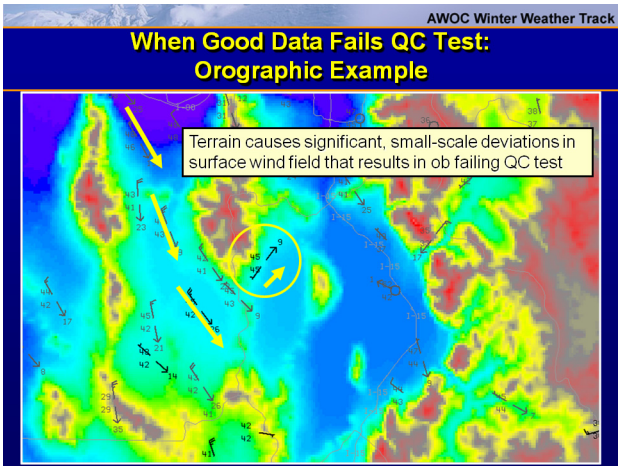


24. When Good Data May Fail a QC Test

Instructor Notes: Here's an example of how orographic effects can cause spatial test failures. The data are from south of Salt Lake City, UT. [show cue] The QC test indicate that this particular ob failed the spatial wind speed and direction test. When you overlay

the terrain map with the data, it's pretty obvious why it failed. [show terrain map] Here are the same observations with a surface terrain map overlay. Now, the failed observations are black & the others are grey. With the terrain visible, you get a better picture of what's going on. [show circle] The mountain to the north and west of the observation is blocking the northerly flow at the surface. [show arrows] So, as the winds near the surface flows down the valley, they turn southwesterly and slow down as they flow around the mountain barrier. In areas with significant terrain, these sorts of QC test failures may be fairly common. So, watch out for them.

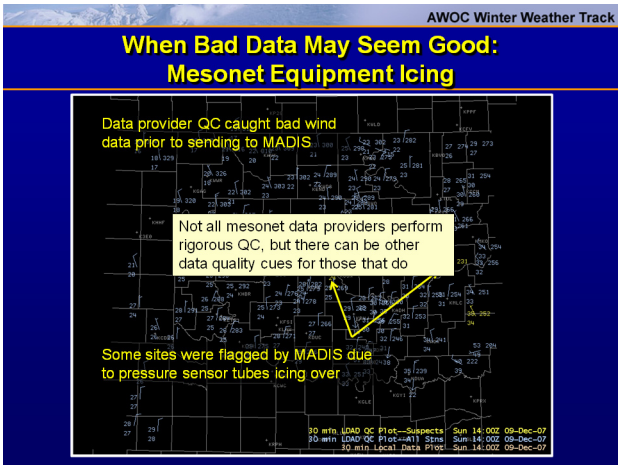
Student Notes:



25. When Bad Data May Seem Good

Instructor Notes: Now let's look at the opposite situation from the previous example. This image of local mesonet data is for the morning hours of December 9, 2007. In the center of the image, you'll see several observations with missing wind data. [show overlay circles] The white circles indicate these obs, while the red circles indicate sites where no data was reported. The reason for the missing data is a significant ice storm. [show contours] These contours show the cumulative ice totals for the event and you can see a strong correlation with the missing data and the significant icing. [show ASOS data] This instrument failure can be helpful in indicating areas where significant icing is occurring on elevated surfaces. [show QC data] So, what did the MADIS QC data show? [show upper left text] Because this data provider, the Oklahoma Mesonet, has a strong QC program, they caught the poor wind data before it was shipped out. Hence, the missing data. [show lower left text & arrows] However, there were a few of their sites where the digital barometers froze up, resulting in the MSLP data getting flagged. [show text box w/light yellow background] In other words, even when you know a data quality issue is occurring, the QC data in AWIPS might not indicate a problem if the data is well filtered by the mesonet owner. Fortunately, in this case, the missing & partial observations give the clues you need.

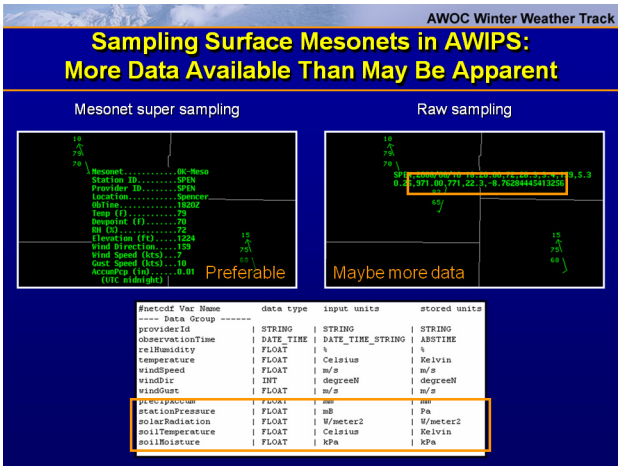
Student Notes:



26. More Data Available Than May Be Visible

Instructor Notes: Now let's talk about one of the problems, so to speak, of viewing mesonet data in AWIPS. I'm assuming that most offices have localized their AWIPS using the "mesonet super sampling" readout. If you're using it, which is preferred, your sampling readout will look something similar to the image on the left. If not, your sampling will look something like the image on the right. [show left text] The upside to the "super sampling" readout is it's easy to read and it provides the Mesonet and Location ID variables in the display. [show right text] The downside is that some parameters may not show up in "super sampling", but will display in the raw readout. [show text file] All of the parameters available from a particular mesonet are listed in that network's .desc file. An example of such a file is shown. [show cues] the final four variables listed in this file appear at the end of the raw sampling readout. RSTs often fall into this category. Nearly half of state DOTs make their data available to the NWS through this local mesonet feed, but these data are only available for sampling using the raw readout.

Student Notes:

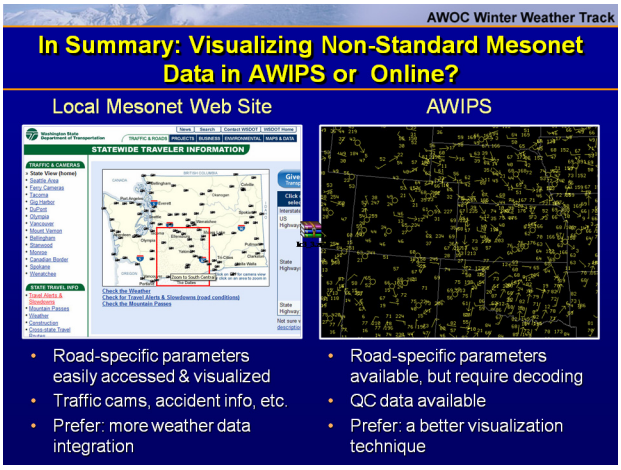


27. Quiz #3

Instructor Notes: Please take a moment to complete the quiz question shown.

Student Notes:

28. Summary

Instructor Notes: After all of this discussion, the end result is that there isn't one best way for NWS forecasters to view local mesonet data. [show web site text] Mesonet web sites offer easy access to their data and often visualize the data well. For DOT sites, they often include data unavailable on AWIPS: traffic cameras, accident & construction info, etc. The downside to these web sites is that there is very limited integration of their data with other weather data that's available. [show AWIPS text] AWIPS, on the other hand, provides access to these data, but it's not very easy to access some of the information. If the data you are interested in shows up in the super sampling readout, then you're in good shape. Otherwise, you either can see the data you need or are using a sub-standard visualization (aka: the raw readout) just so you can access the parameters you want. On the plus side, though, is the MADIS QC data readout. Most data providers don't make this information available on their web sites and it can be very helpful in interpreting surface data for meso-to-microscale phenomena.

Student Notes: