The August 21, 2009 Chelsea, VT Flash Flood

Case Study and Radar Considerations

Eastern Region Flash Flood Conference
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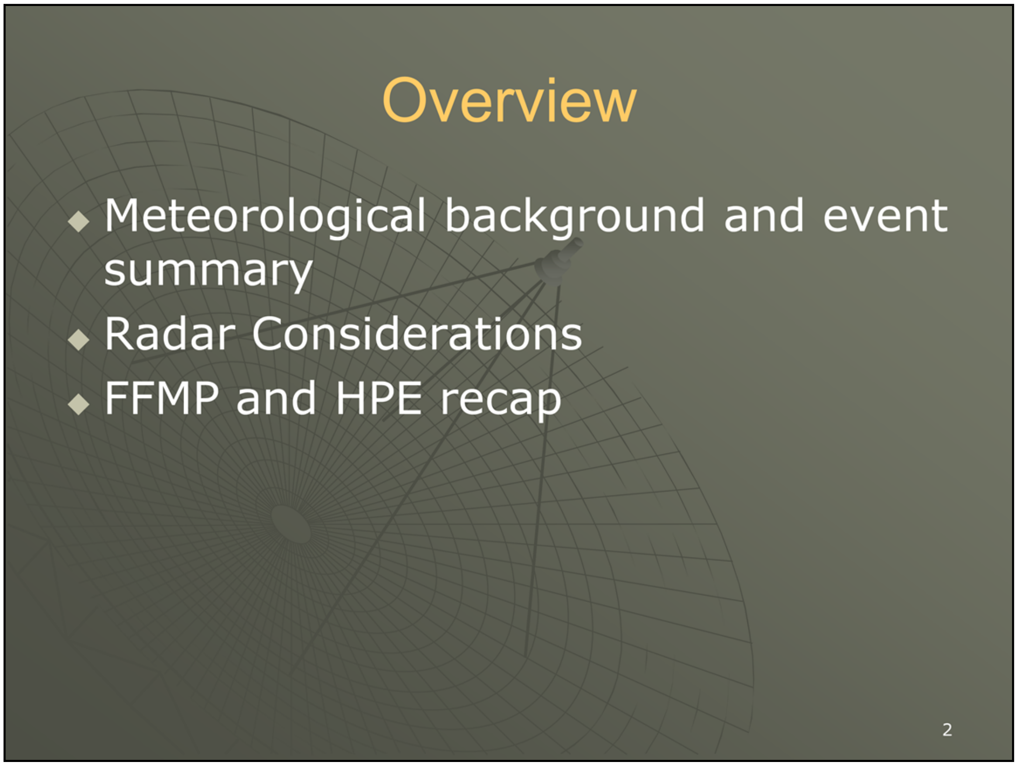
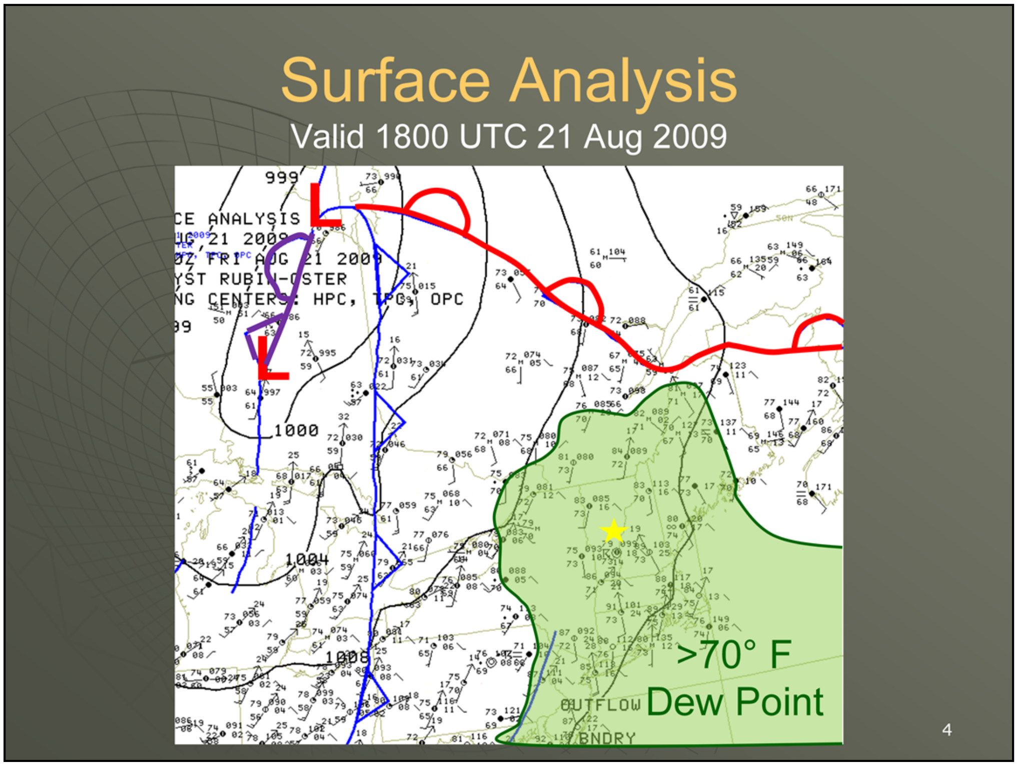


On August 21, 2009 heavy rainfall produced flash floods in portions of east central and southeast Vermont. A stalled frontal boundary provided a focus for convection, and deep subtropical moisture was in place. Precipitable water values were around 2 inches, roughly double the normal amount. Thunderstorms produced 4 inches of rain in 2 hours, and flooded Chelsea Village in Vermont. While flash flooding is not uncommon in Vermont, further study is warranted based on the geographic placement of the storms and the resulting radar sampling issues. We found that the High Resolution Precipitation Estimator (HPE) required further configuration to be fully effective in FFMP (Flash Flood Monitoring and Prediction). For offices in complex terrain, missing radar bin files derived from radar climatology should be optimized and included in FFMP processing. This presentation will examine the meteorological conditions leading up to the flash flood event, radar beam blockage issues, and range effects that created challenges for the warning process. A comparison of various radar products used as input to the Flash Flood Monitoring and Prediction (FFMP) will be presented.

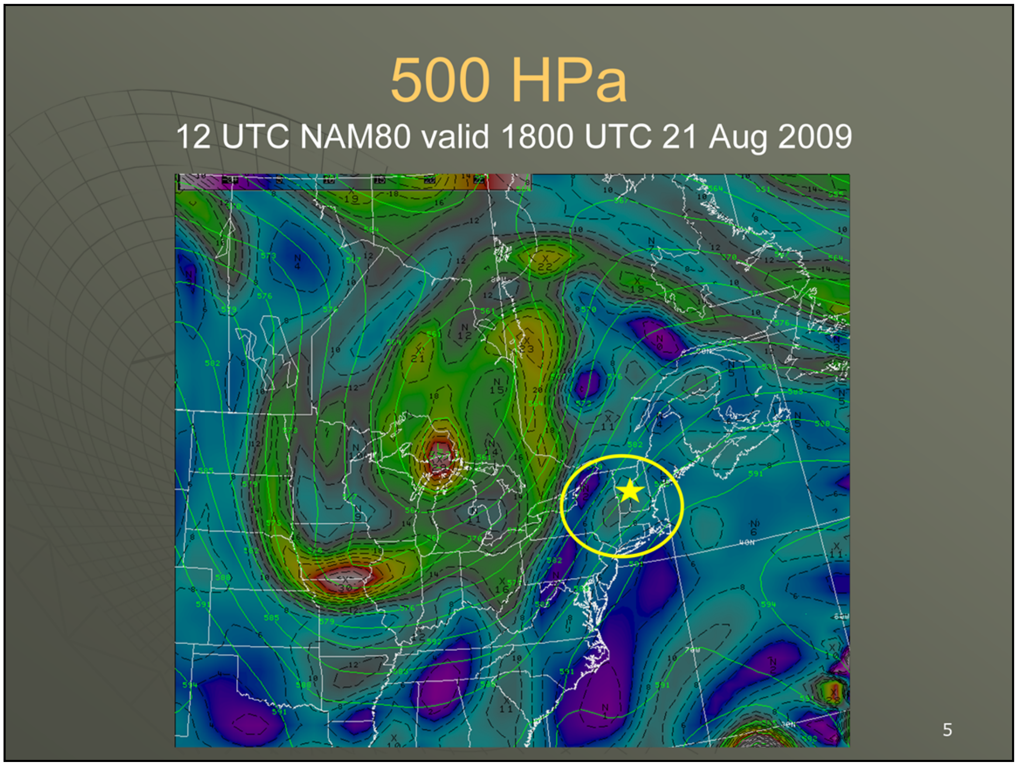
Chelsea Flash Flood

- 1st Branch White River
- Steep Terrain

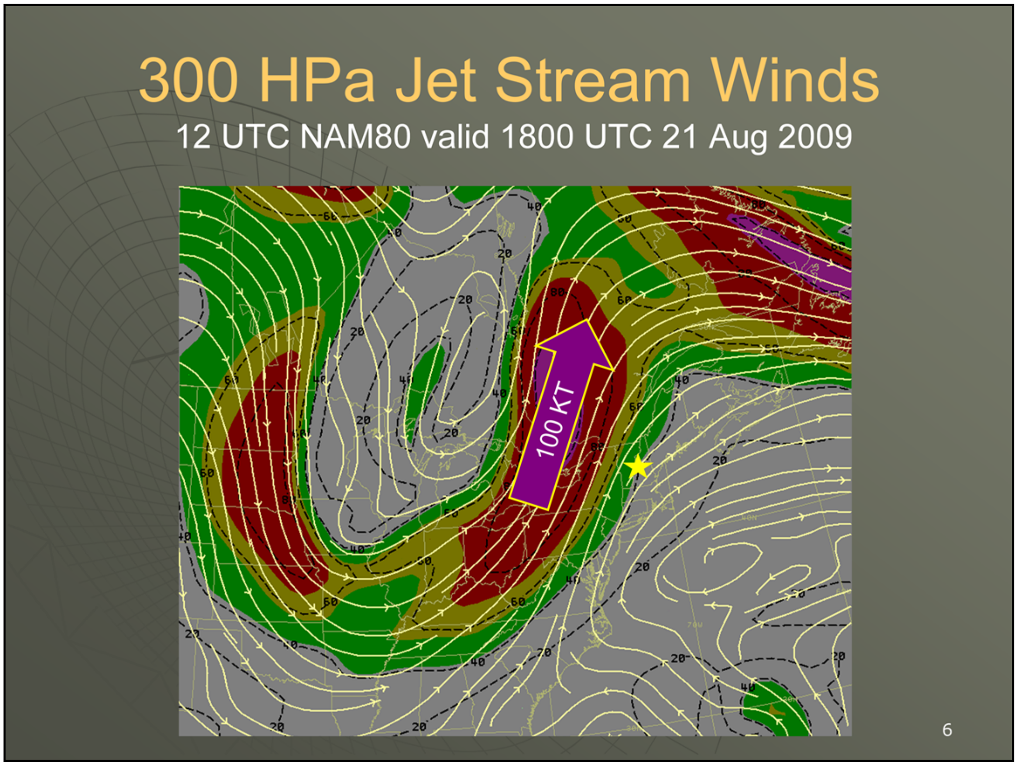
The village of Chelsea VT was the hardest hit of the flood event. Chelsea lies in the White River drainage along the First Branch of the White. The elevation of Chelsea is approximately 800 feet, sharply rising to 1500 to 2000 ft mountains in the surrounding area.



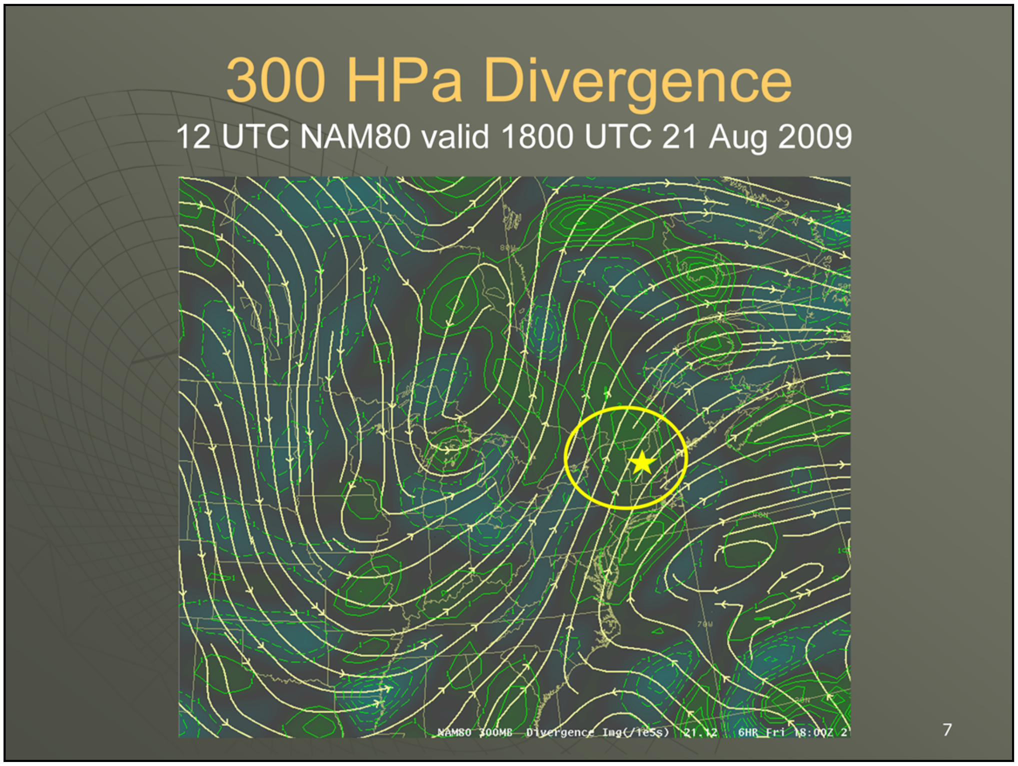
Surface analysis for 1800 UTC 21 Aug 2009. A warm front had lifted north of the region in to Quebec, with an occluded surface low to the northwest of the area and an approaching cold front moving through the great lakes region. Surface dewpoints across all of Vermont were in the low 70s.



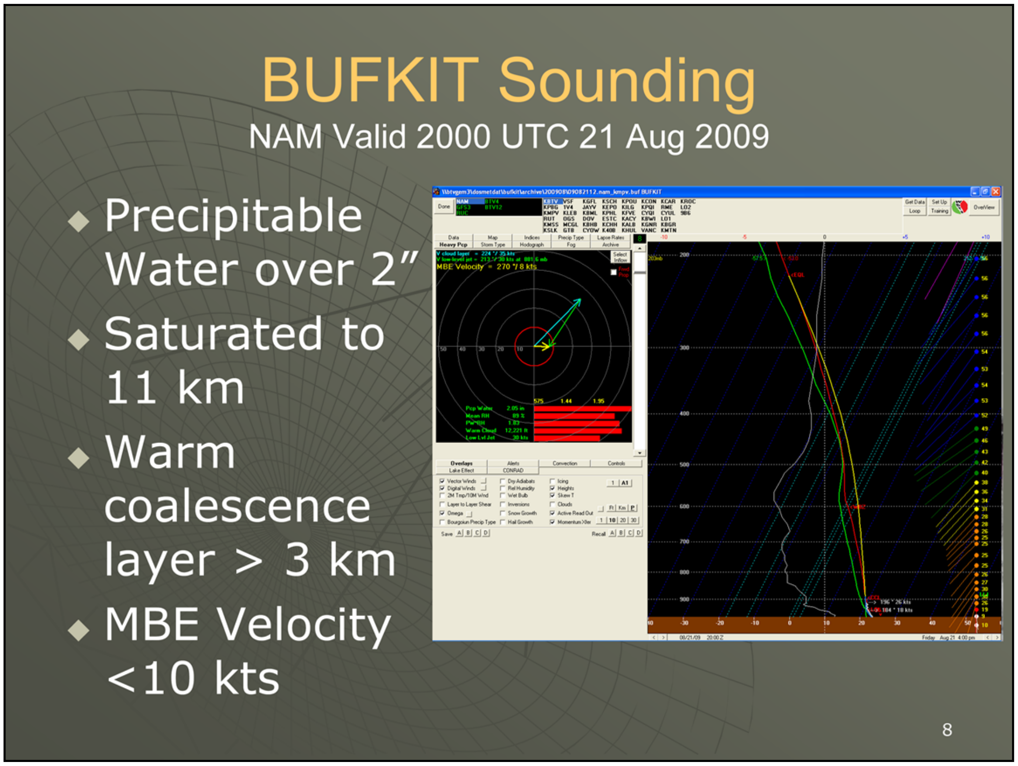
500 HPa height and vorticity from the 1200 UTC NAM80. A deep full latitude trough was situated to the west with a series of vigorous shortwave troughs moving through. Flow over Vermont was from the southwest and weakly diffluent. The NAM80 depicted a weak vort max moving over the area around 1800 UTC, which was at the beginning of the heavy rainfall. The GFS40 (not shown) also depicted a similar feature.



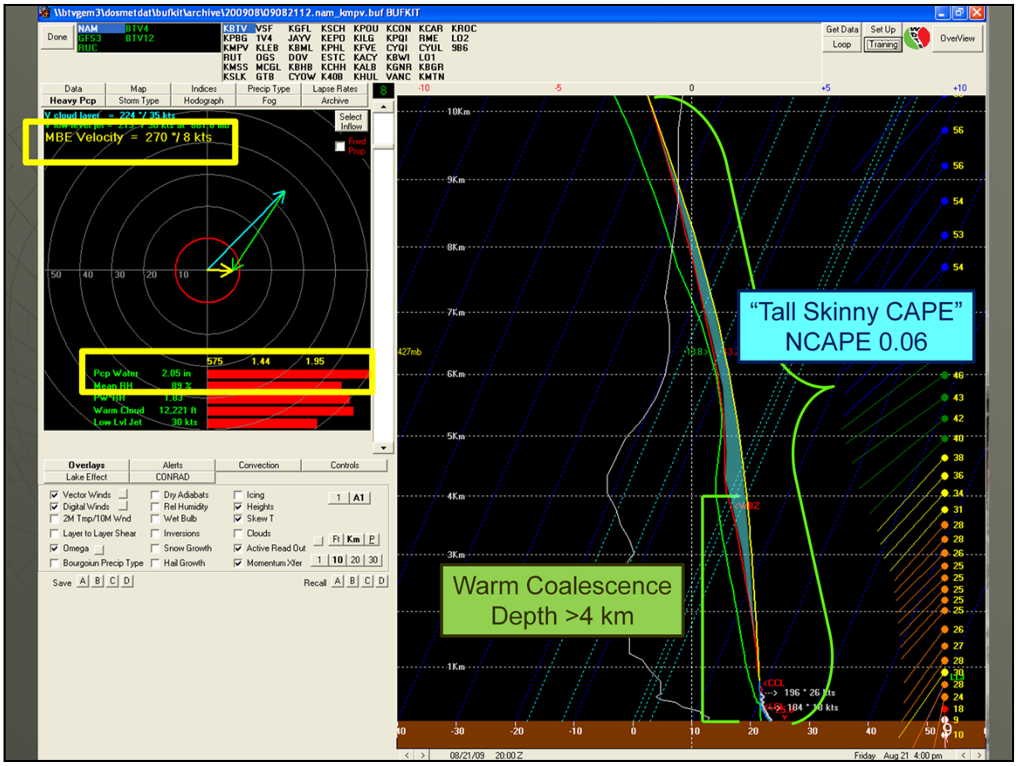
The NAM80 depicted a 100 kt jet max to the west of the region, although Vermont remained outside the favored right entrance and left exit regions of the jet. As with the 500 HPa flow, the 300 HPa flow was weakly diffluent over Vermont.

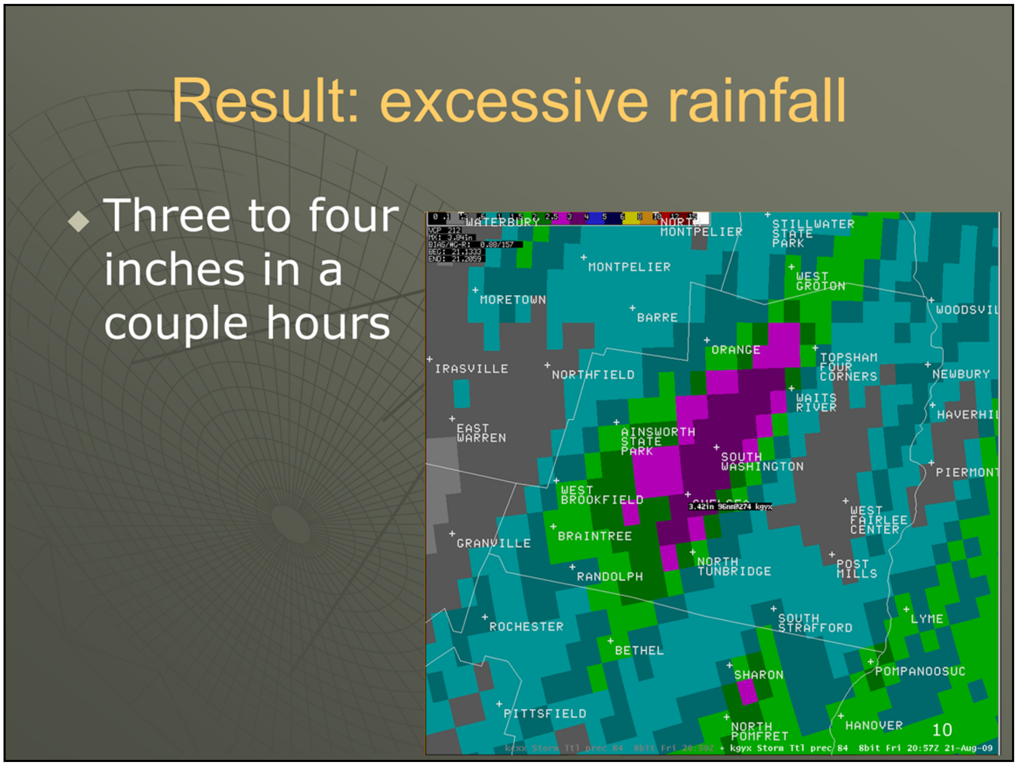


300 HPa divergence field from the NAM 80 indicates area of divergence associated with diffluent flow.



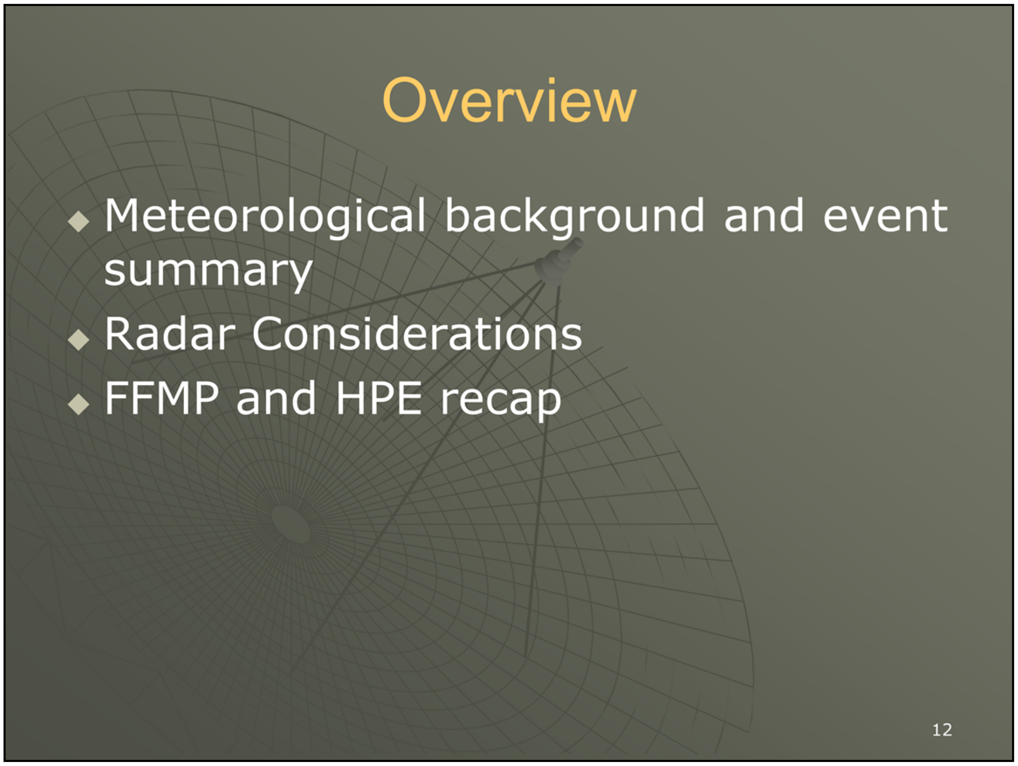
BUFKIT NAM forecast sounding valid 2000 UTC depicts heavy rain model forecast sounding with MBE velocity less than 10 kts, warm rain coalescence depth of almost 4 km, and a nearly saturated column from the surface through 11 km.


MBE Velocity = 270 °/ 8 kts
"Tall Skinny CAPE"
NCAPE 0.06
Warm Coalescence
Depth >4 km

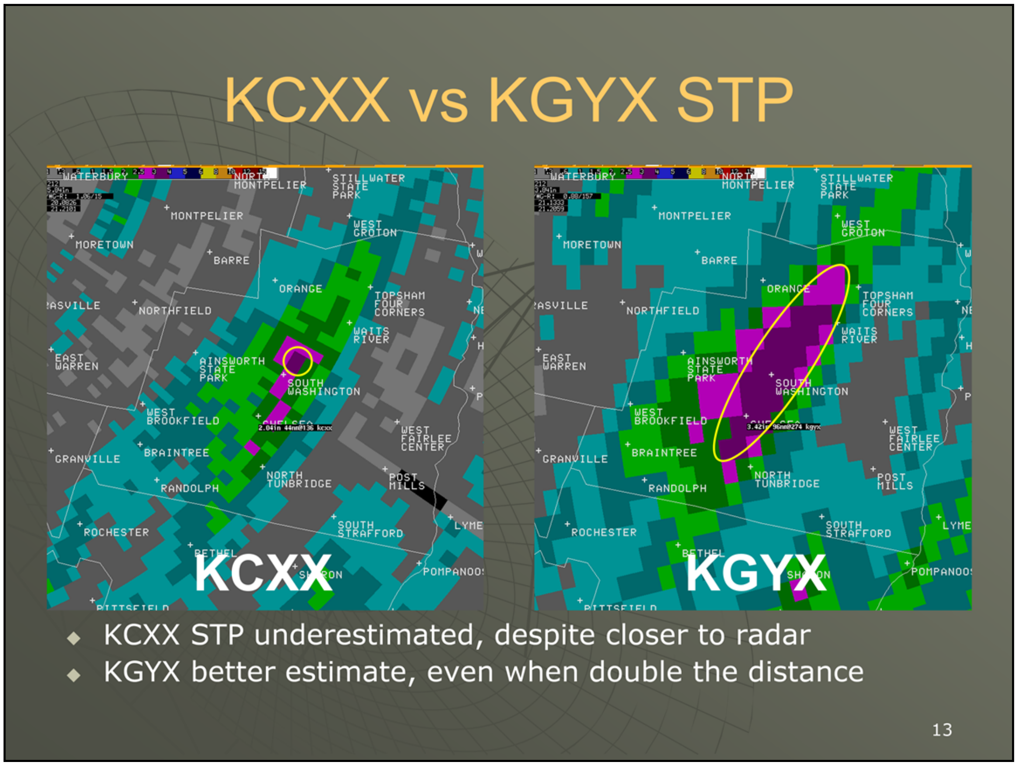


Storm Total Precipitation, for the Aug 21 2009 event, shows more representative precipitation estimates from KGYX than KCXX. Another example from the same event, not shown, similarly depicts better estimates from Albany's KENX radar than KCXX in southeast Vermont.

Flash Flooding in Chelsea



Moving on to Radar Considerations



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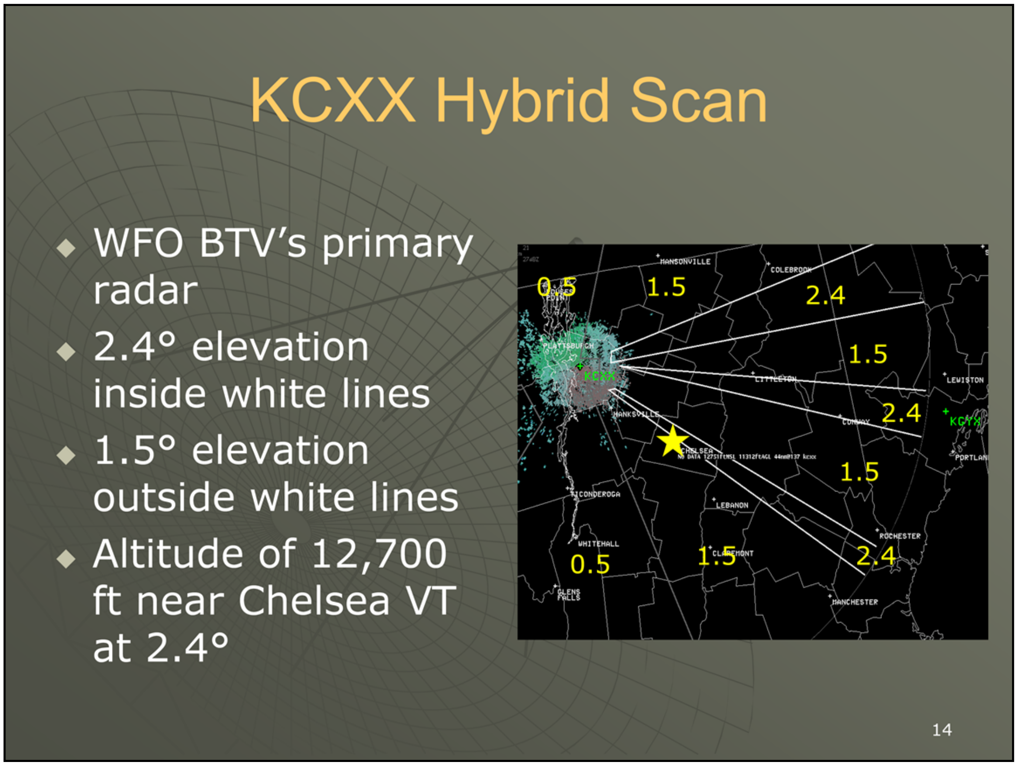
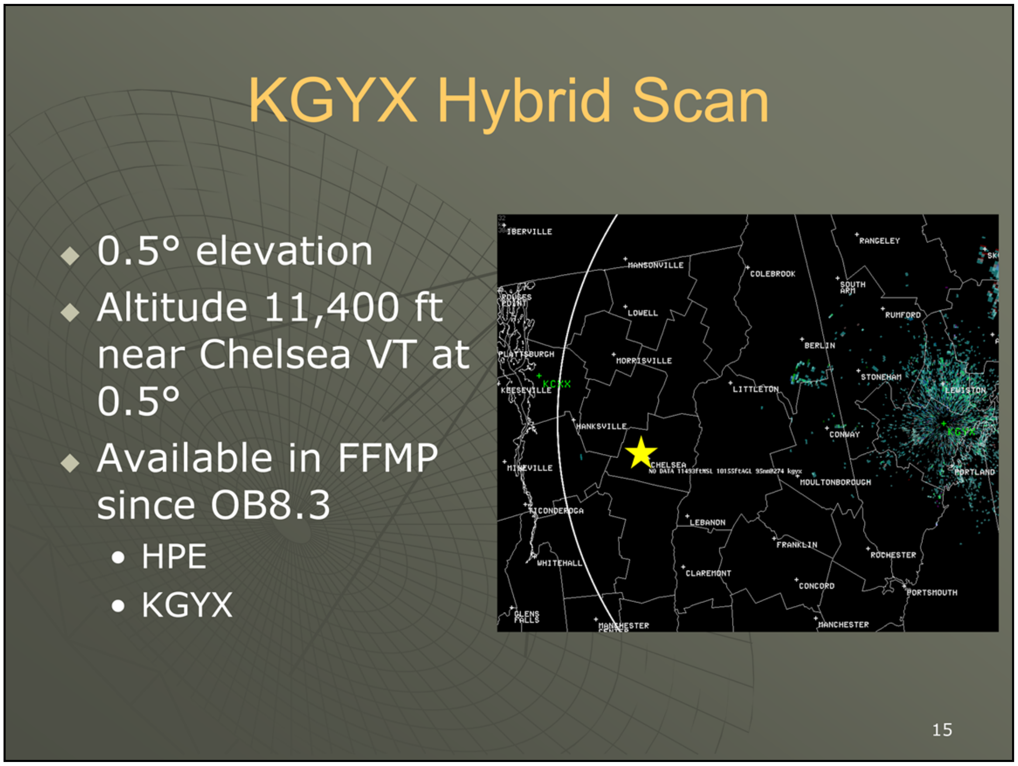
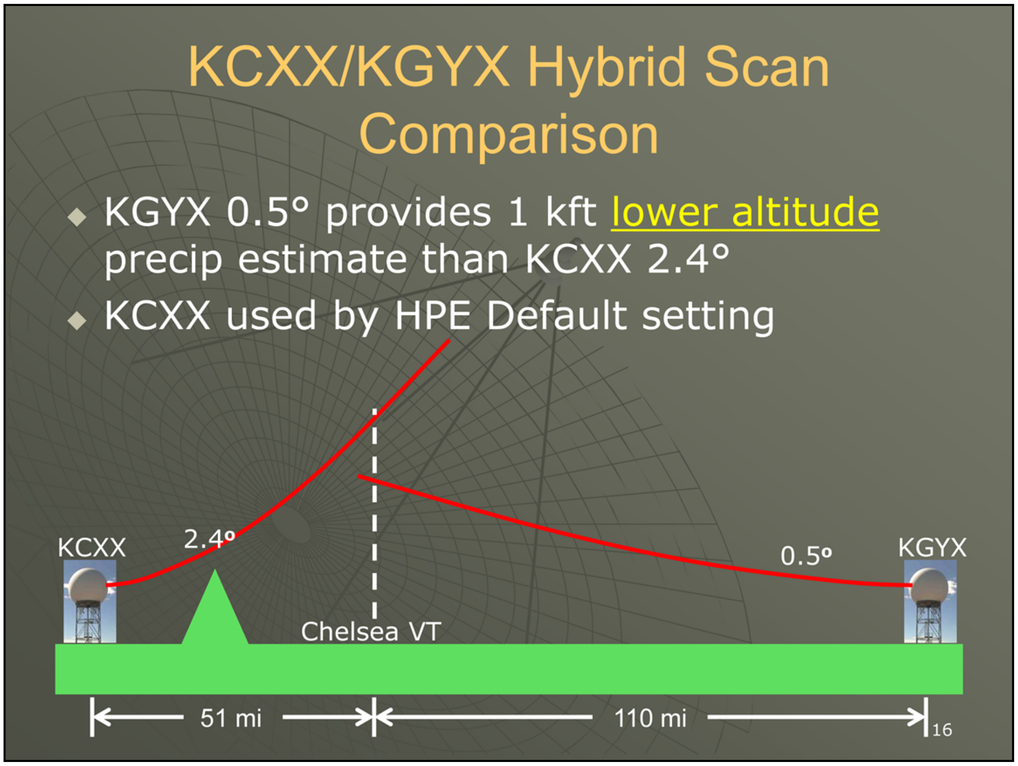


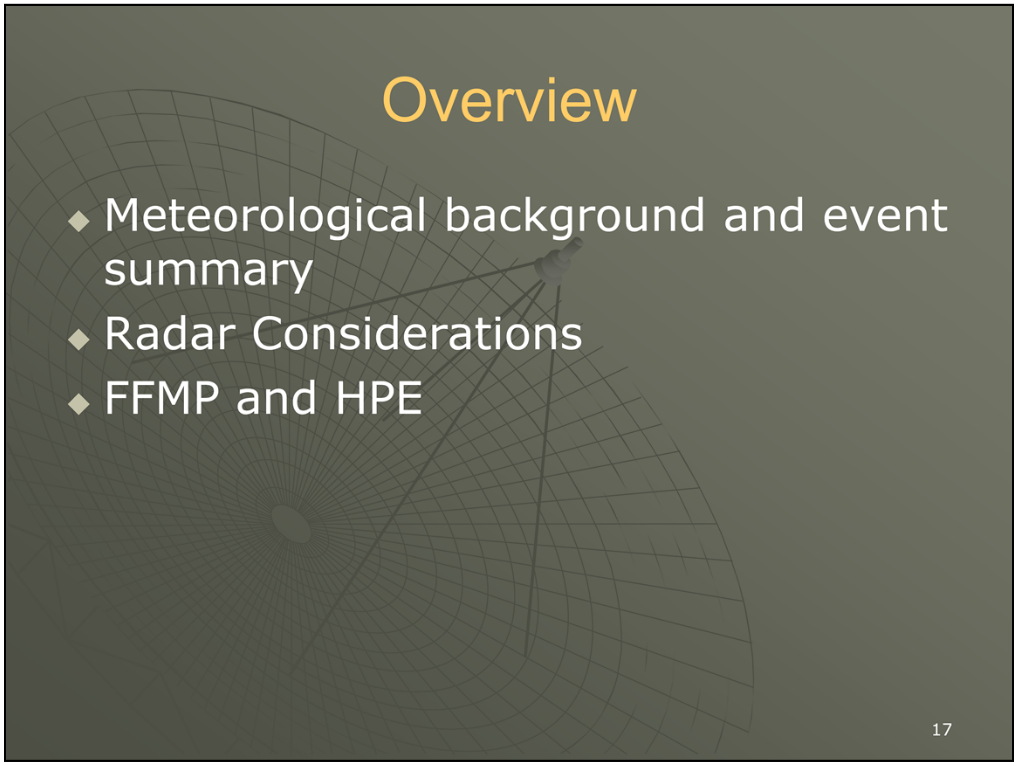
This graphic depicts the elevation angles used in the KCXX radar Hybrid Scan used in precipitation estimates. There is significant beam blockage east of the radar. Much of the state of Vermont is blocked at the 0.5 degree angle, forcing the use of 1.5 degrees where indicated. Inside the wedges delineated by the white lines, the radar beam is blocked at 1.5 degrees as well, forcing the use of 2.4 degree elevation. In some locations, such as Chelsea, the use of the 2.4 degree beam means radar sampling for precipitation is made at a very high altitude, despite being relatively close to the radar.



KGYX experiences no blockage to the west, and despite being much farther away than KCXX, it still samples at the lower elevation angle. However at this range the beam from KGYX is much wider as well, which may lead to underestimation due to beam filling issues. Even with beam filling problems it is still thought that KGYX offers a superior vantage point for eastern Vermont over KCXX.



This cross sectional graphic depicts the comparison of radar sampling over Chelsea VT from the 2.4 degree slice from KCXX versus the KGYX 0.5 degree KGYX.



Configuring and optimizing HPE for FFMP.

FFMP/HPE Recap

- With OB 8.3, FFMP became FFMPA
- High resolution Precip Estimator (HPE)
- Integrates data from multiple radars in one FFMP display
- How does HPE know what radar to use?

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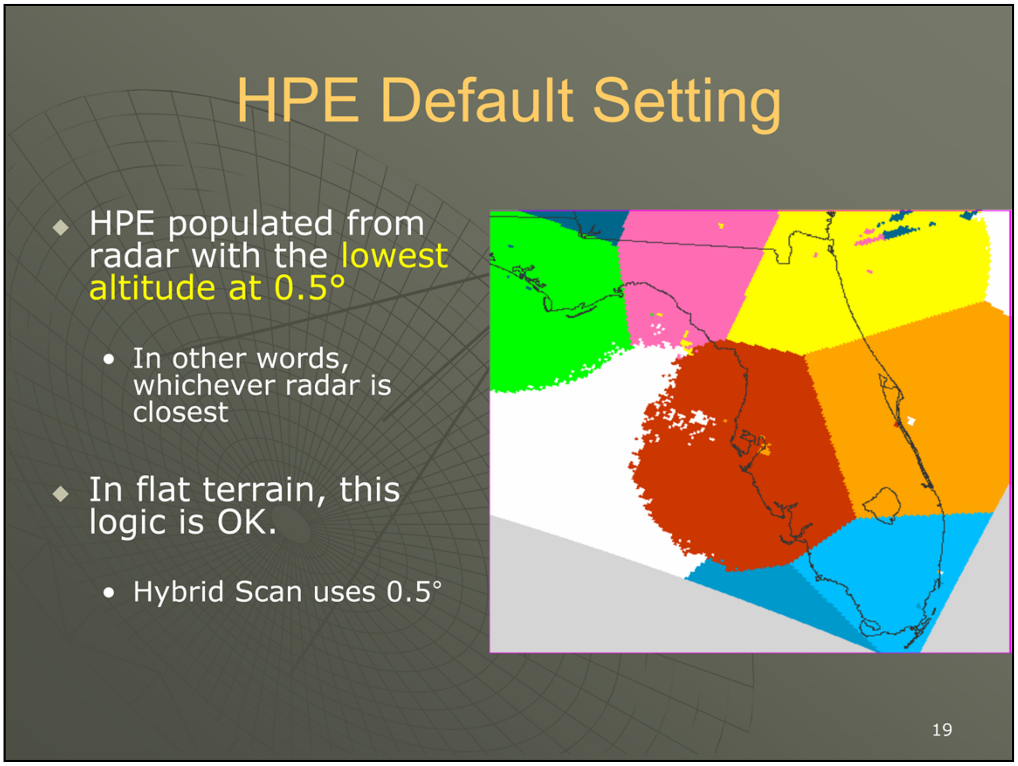
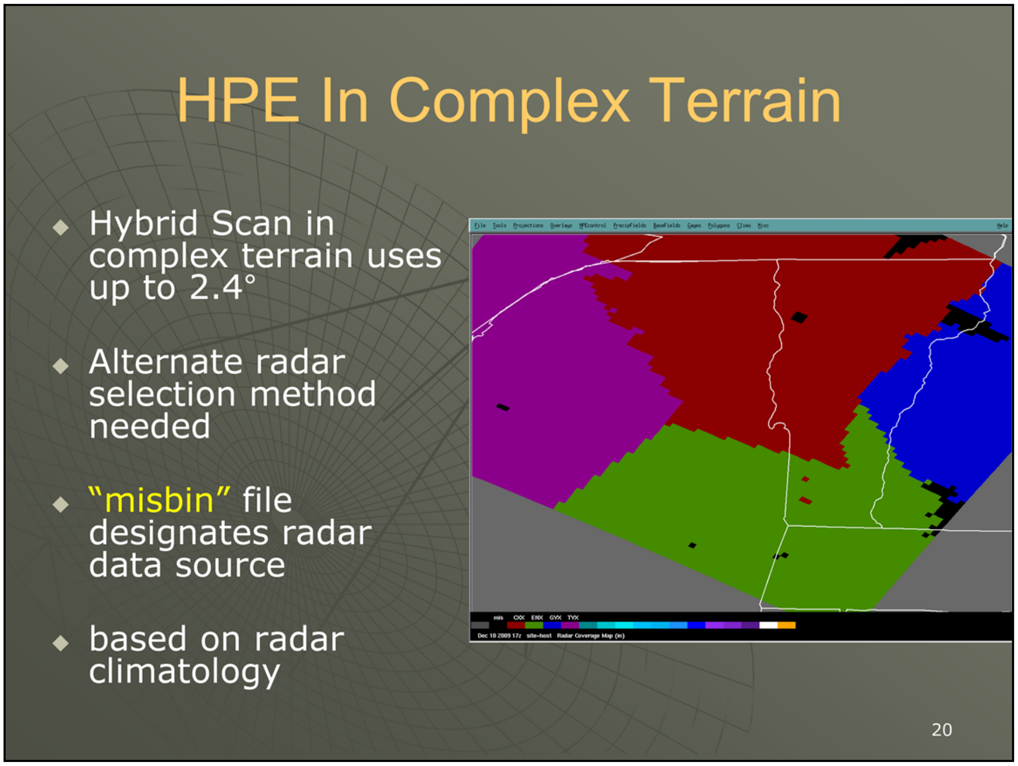


The default setting for radar data used in HPE is for any given point, data is used from the radar with the lowest beam altitude at 0.5 degrees. This essentially uses data from the closest radar available. For flat terrain this logic is OK, as the radar hybrid scan uses the 0.5 degree slice, and it makes sense to use data from the closest radar. Problems begin if you are in complex terrain, and the hybrid scan used by your radar is using higher elevation data. In those cases, the decision for which radar to use is based on the height of the 0.5 degree slice, even though the hybrid scan does not use the 0.5 degree slice for that point.



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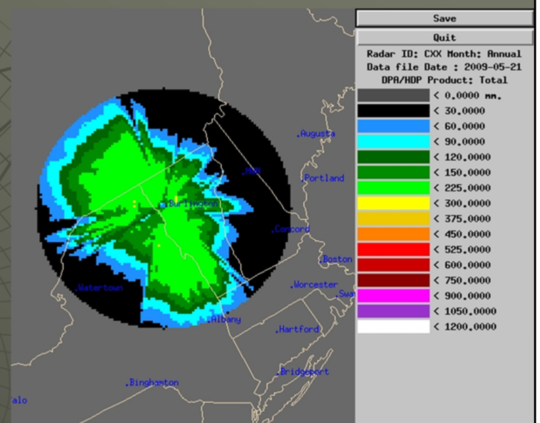
How misbin files are made

- RFC runs RadClim
- Radar Climatology identifies areas with degraded precip estimates
- misbin files created for each radar
  - 1 = good data bin
  - 0 = use someone else



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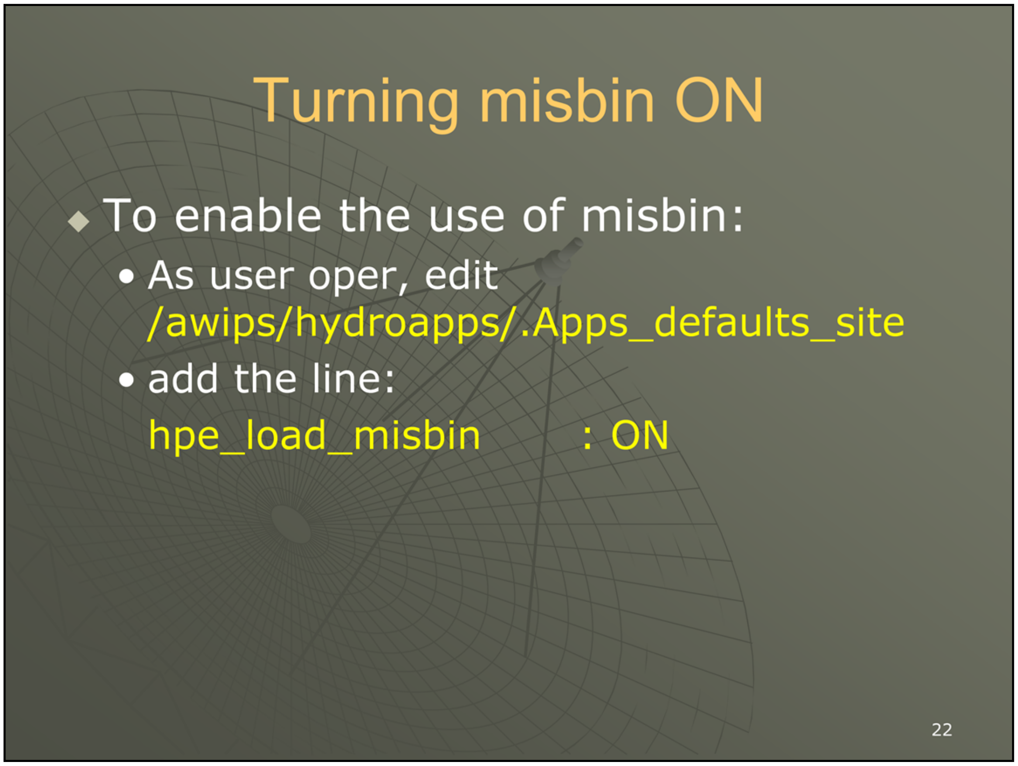
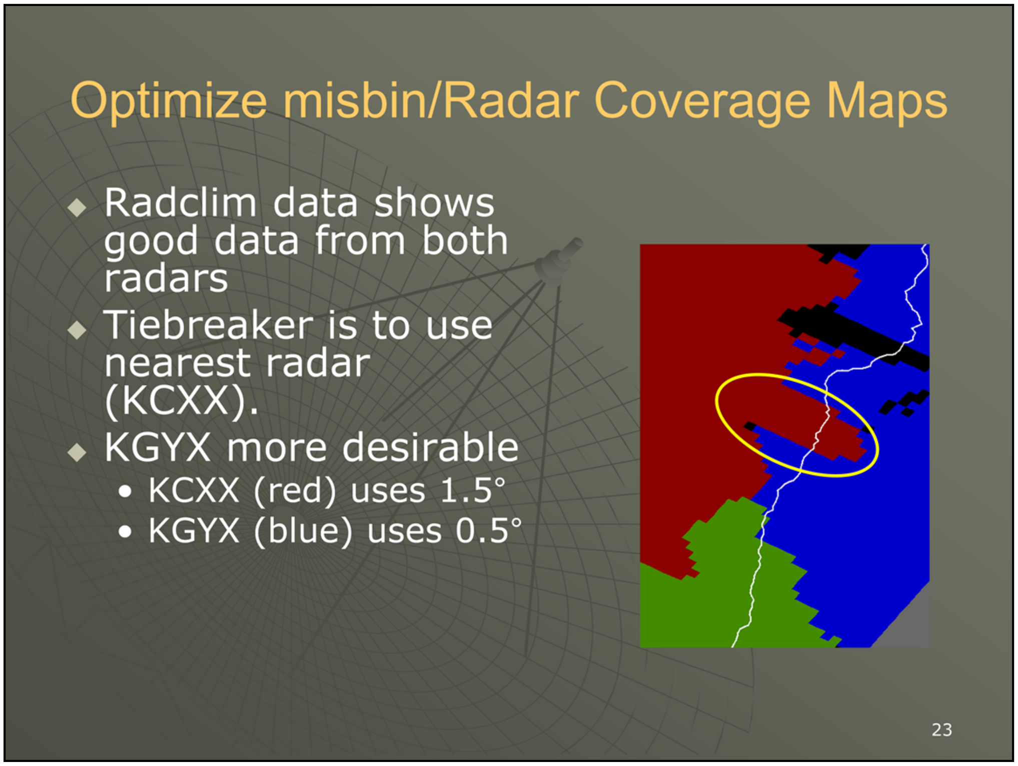
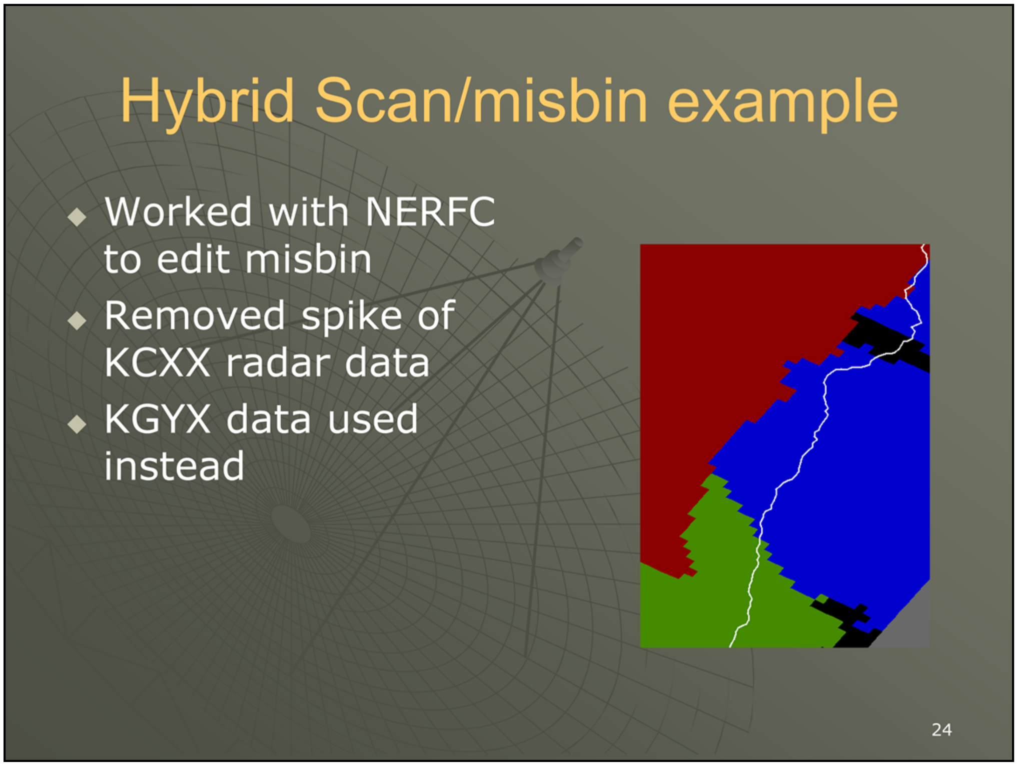
NWS Hydrology lab has an ongoing project to objectively define radar data "quality" through an automated process of analyzing DPAs and a reference precip field - this would take out the subjectivity. This will be reported out within a year (by Oct 2010).



Only change the token in .Apps_default_site



The next two slides show examples of optimization of the HPE radar coverage map based on the misbin files. The default maps show the KCXX radar coverage in red, KGYX in blue, and KENX in green. In the circled area, there is a spike of KCXX radar coverage all the way to the Vermont/New Hampshire border. Although the RADCLIM program indicated this is acceptable data, we preferred to use KGYX radar data in the circled area. The reason: KGYX hybrid scan uses the 0.5 degree slice, while the KCXX hybrid scan uses 1.5 and 2.4 degree elevations.



Working with NERFC to re-run the misbin generation program, the coverage from the KGYX radar was extended west, and KGYX is now used in the Connecticut River Valley when HPE is loaded in FFMP. A significant area of missing data still exists (upper right, black area), where beam blockage for KGYX (Mount Washington) and KCXX (Mount Mansfield) prevents good sampling. Rather than give the forecasters bad data and a falls sense of security, we chose to leave this field missing. When HPE is used in FFMP, basins in the missing data area will be blank, and the basin table will show “M” for those basins.

Suggested Actions for Service Hydrologists in Eastern Region

- If complex terrain & hybrid scan uses elevations above 0.5, consider turning on the misbin token!
  - misbin token off:
    - HPE Data choice will be based on altitude of 0.5° elevation
    - Hybrid scan may be using higher elevation
  - misbin token on:
    - Check Radar Coverage Field in MPE Editor.
    - Optimize radar selection working with RFC
    - Note missing data areas
      - may degrade FFMP estimates if basins partially missing
      - Entire basin may be set to missing if no radar data available

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Summary

- Meteorological precursor conditions in place for flash flooding
- Radar sampling issues complicated heavy rainfall identification
- Localization of misbin parameters should help FFMP operations for 2010 convective season.

Summary

- Misbin token determines radar data used in FFMP HPE field.
- Default setting is misbin=off.
  - Precip estimates used from the radar with the lowest altitude at 0.5°.
  - Limitation: for complex terrain, 0.5° logic overlooks Hybrid Scan, beam blockage, other precip estimate degradation

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Summary

- For misbin token set to ON
  - In HPE, for each bin, decision for which radar's precip estimates is based on misbin files for each radar
  - For overlapping radars
    - misbin file for both has "1" in same HPE bin
    - 0.5° rule determines radar used.

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Acknowledgements

- David Riley, WHFS Support
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- Jeff Ouellet, NERFC


Questions?