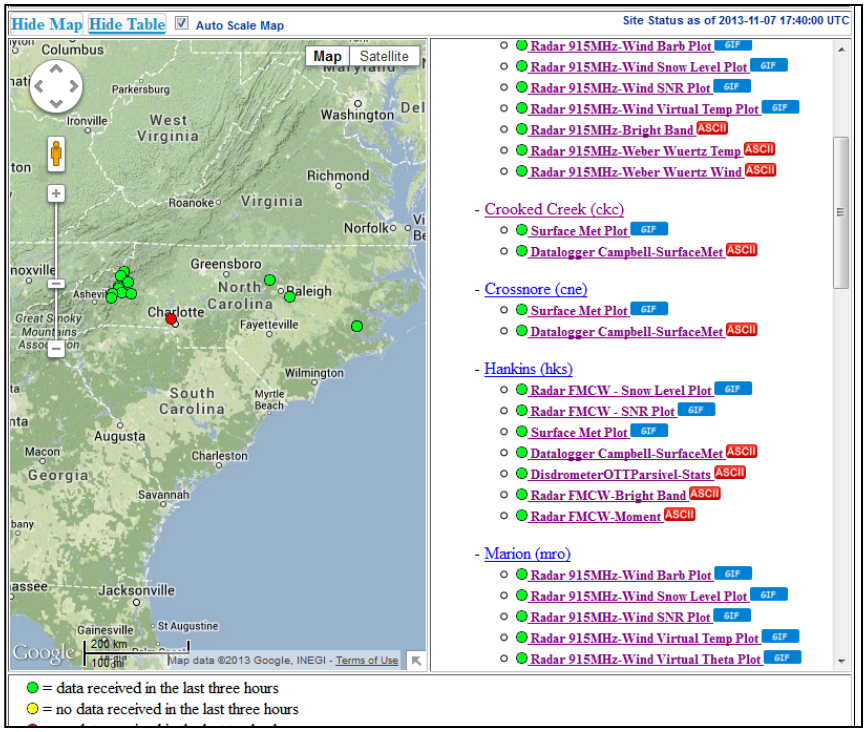
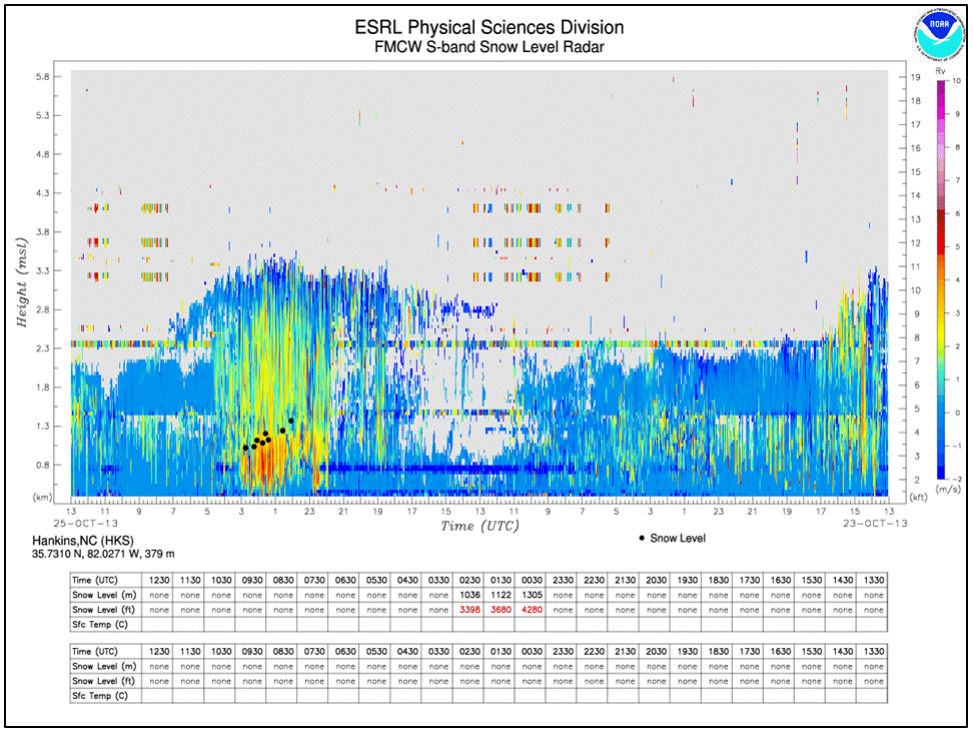
HMT-SEPS Observations and Forecast Utility Briefing and Discussion

Friday, 15 November 2013

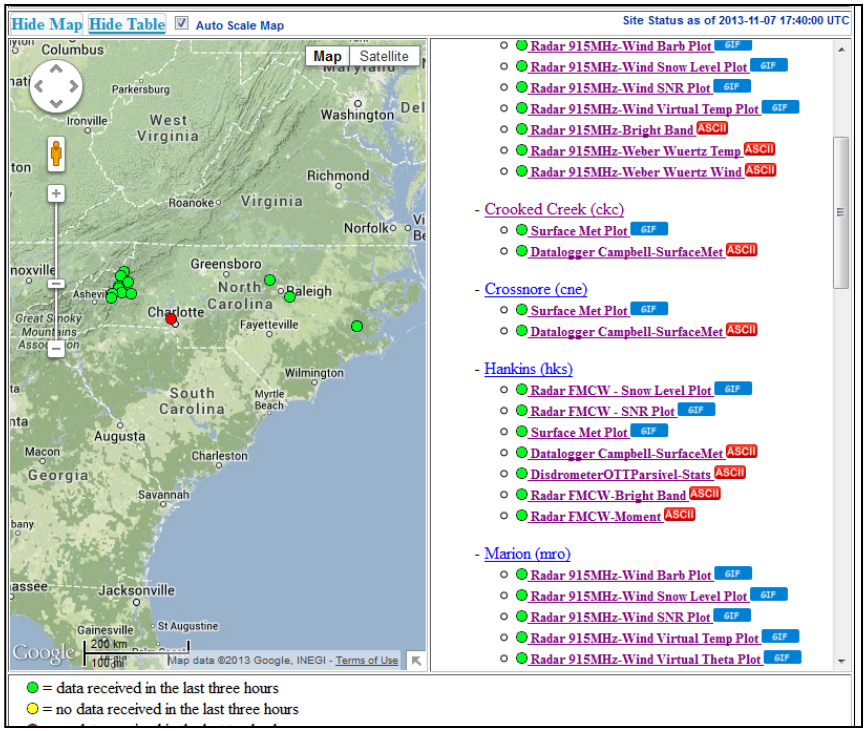
(Presentation being recorded and will be available for download)

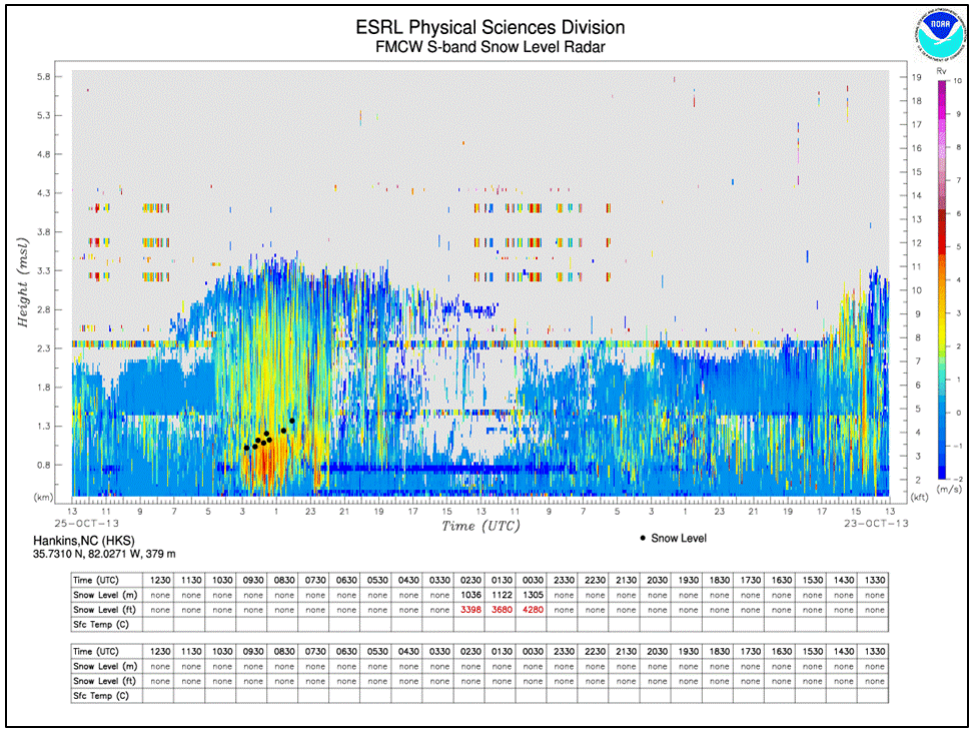




Outline

1. Introduction (Kelly Mahoney, Rob Cifelli)
2. Review of HMT observational platforms (Allen White)
3. WFO utility: Examples and suggestions (Dave Reynolds)
4. Examples of possibly-SE-relevant HMT research (Paul Neiman, Dave Kingsmill)
5. Discussion, Q&A





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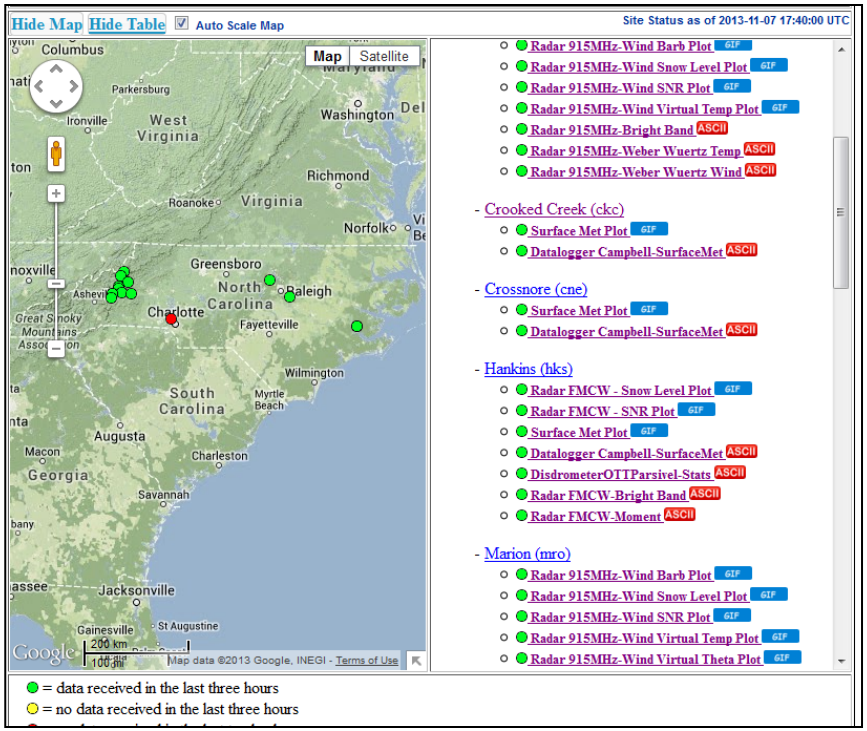
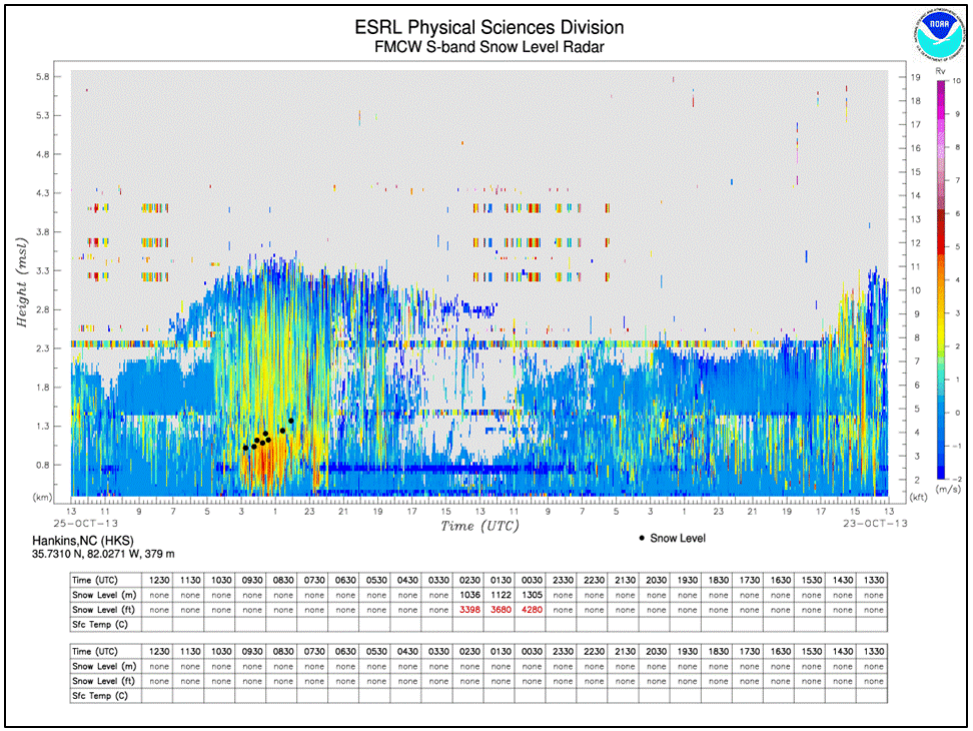




Update on HMT-SEPS NOAA Instrumentation

Dr. Allen White

Acting Chief, Water Cycle Branch

NOAA Physical Sciences Division

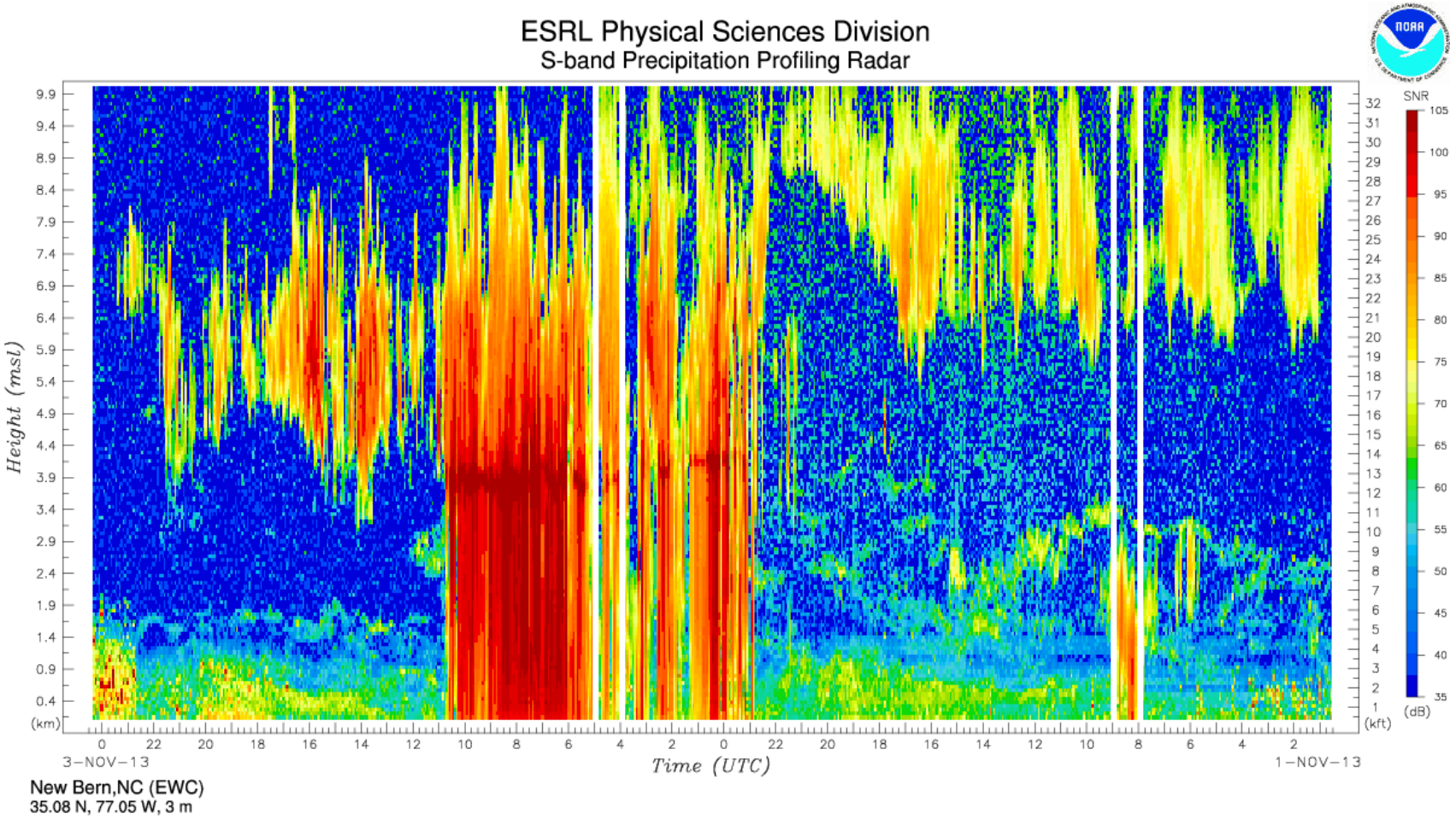
4 Types of Remote Sensing Radars

S-band (2875 MHz) Precipitation Profiling Radar (S-PROF)
Sites: New Bern and Old Fort
Vertically pointing pulsed Doppler radar
Measures vertical profiles of radar reflectivity (uncalibrated) and Doppler vertical velocity (reflectivity weighted), derived snow level

Radar reflectivity factor: $Z = \int D^6 N(D) dD$; $dBZ = 10\log(Z) + 180$

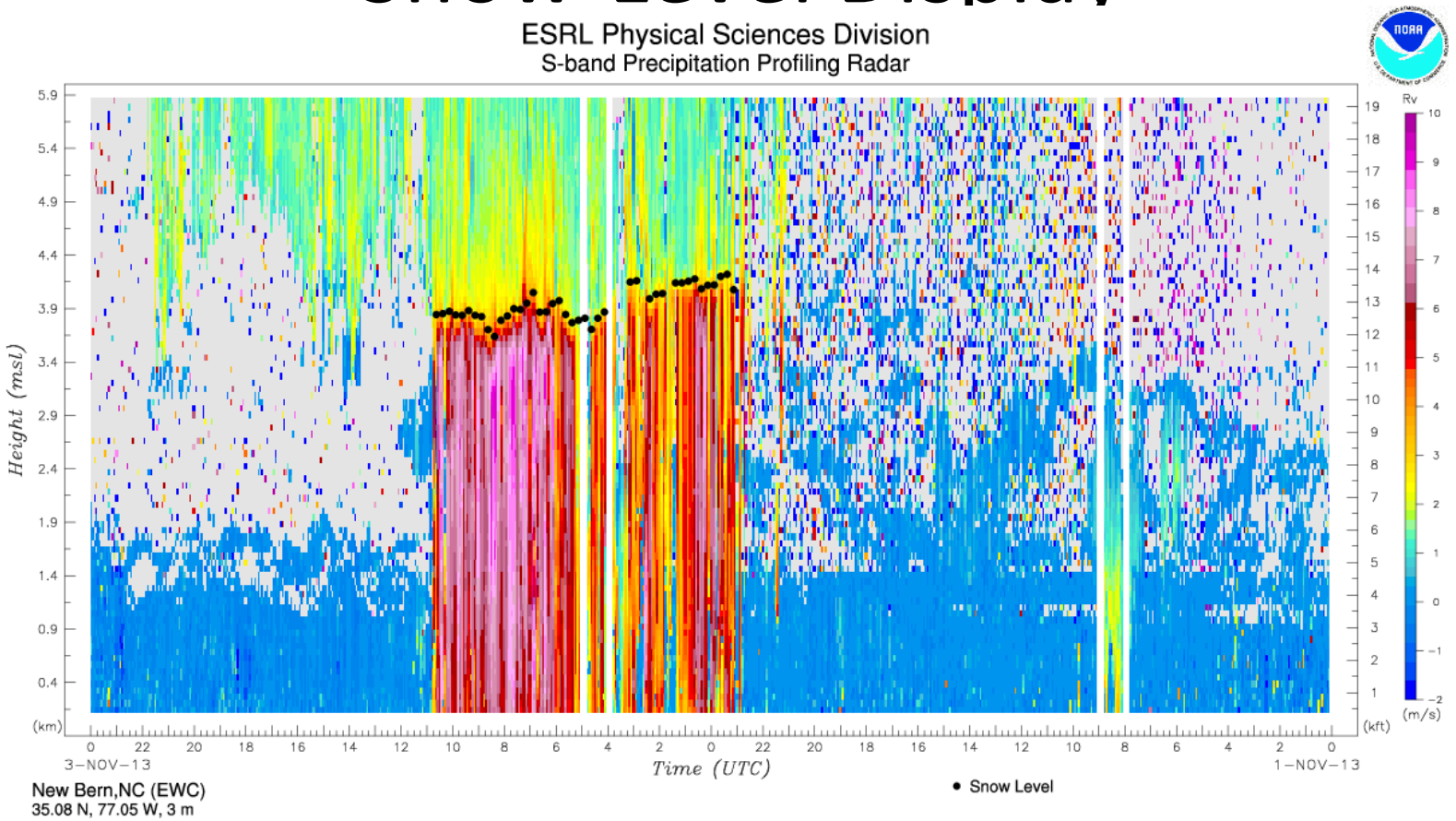
S-band (2875 MHz) FM-CW Snow-level Radar
Site: Hankins
Vertically pointing frequency-modulated, continuous-wave Doppler radar
Measures vertical profiles of radar reflectivity (uncalibrated) and Doppler vertical velocity (reflectivity weighted), derived snow level

S-PROF Radar Reflectivity Display



Note: NEXRAD-beam heights (up to two NEXRAD sites per image) can also be annotated on image products; these displays can be viewed on dedicated WFO displays without requiring forecaster interaction (auto-update mode.) We can follow-up with additional information for those interested.

S-PROF Doppler Vertical Velocity and Snow-Level Display



Time (UTC)	2330	2230	2130	2030	1930	1830	1730	1630	1530	1430	1330	1230	1130	1030	0930	0830	0730	0630	0530	0430	0330	0230	0130	0030
Snow Level (m)	none	none	none	none	none	none	none	none	none	none	none	none	none	3853	3839	3746	3895	3908	3818	3810	4149	4035	4141	4137
Snow Level (ft)	none	none	none	none	none	none	none	none	none	none	none	none	none	12637	12591	12288	12775	12819	12523	12496	13608	13234	13582	13569
Sfc Temp (C)	16.59	17.68	18.84	19.60	20.38	20.05	19.13	18.21	17.83	17.52	17.28	17.75	18.42	18.62	18.59	18.75	19.73	21.41	21.73	21.50	21.56	21.71	21.66	21.70

Time (UTC)	2330	2230	2130	2030	1930	1830	1730	1630	1530	1430	1330	1230	1130	1030	0930	0830	0730	0630	0530	0430	0330	0230	0130	0030
Snow Level (m)	4161	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none
Snow Level (ft)	13648	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none
Sfc Temp (C)	22.29	22.95	24.12	25.12	25.63	25.56	24.95	24.49	24.08	23.04	22.23	21.62	20.79	20.22	19.86	20.43	22.38	22.00	21.65	21.23	20.88	20.82	20.54	20.80

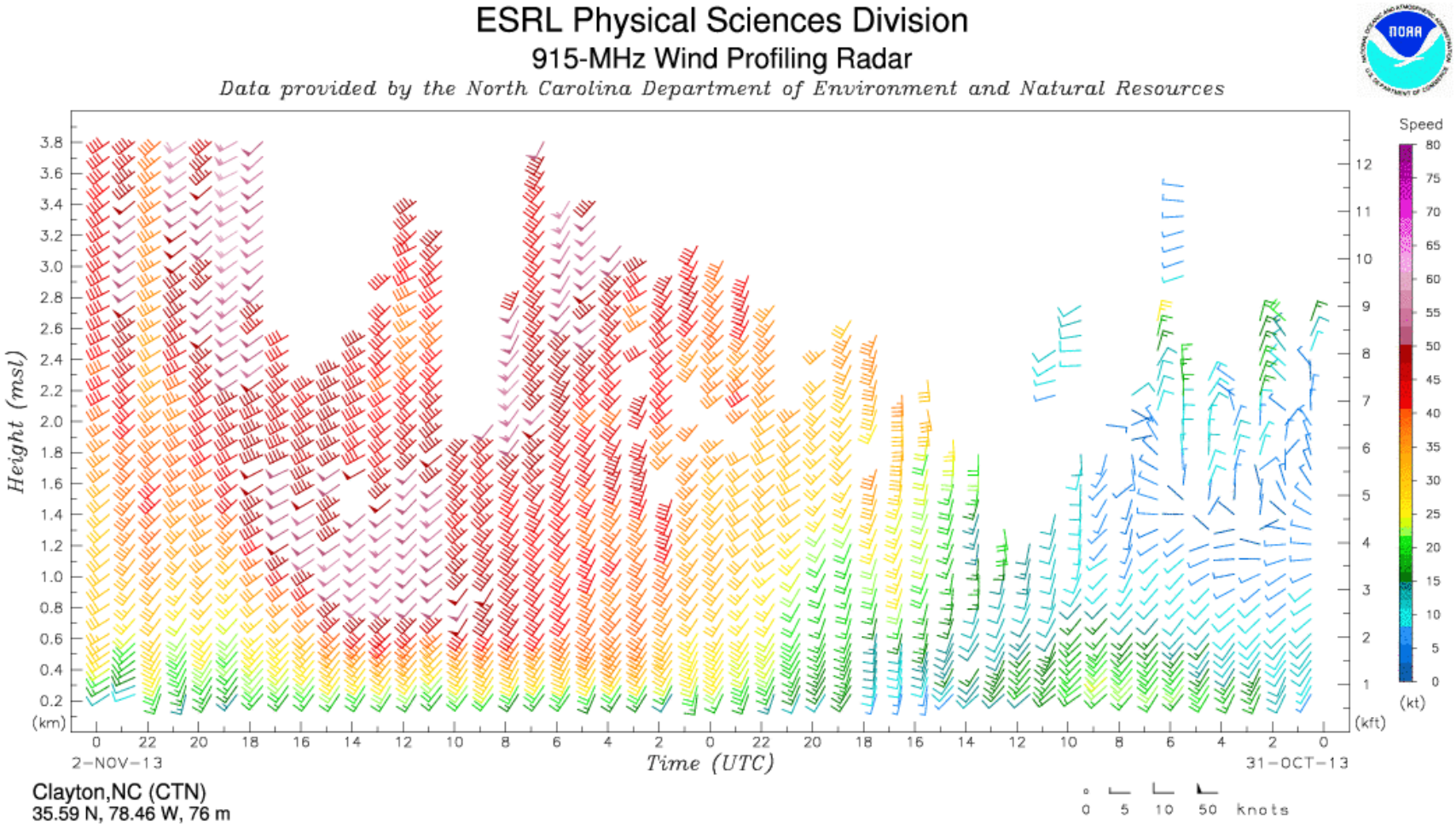
4 Types of Remote Sensing Radars

Scattering from clear-air turbulence in absence of precipitation

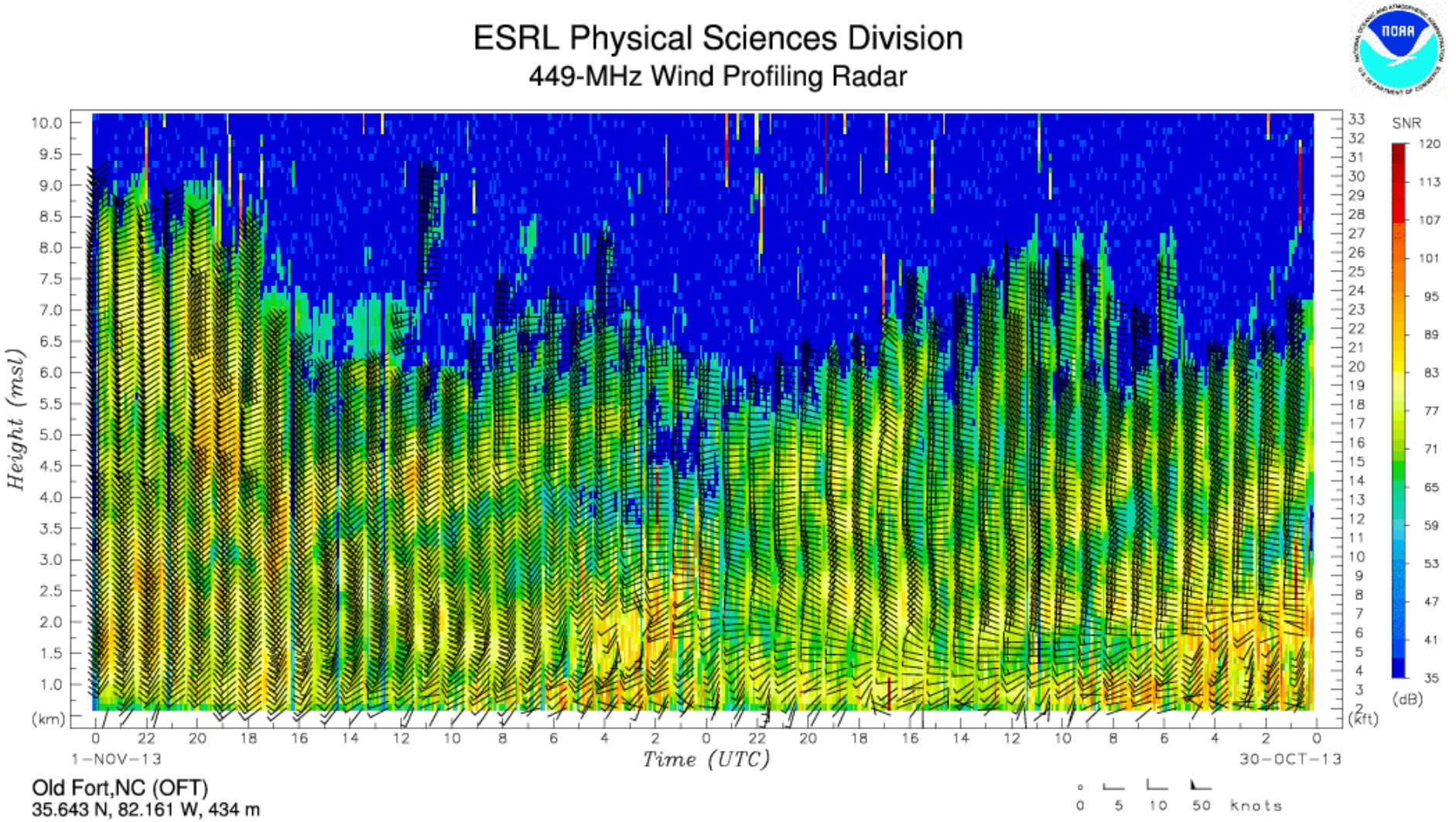
449-MHz Doppler Wind Profiler
Sites: New Bern and Old Fort
Vertically pointing pulsed Doppler radar
Measures vertical profiles of radar reflectivity (uncalibrated) and Doppler vertical velocity (reflectivity weighted) from which wind profiles are constructed
Three beam directions steered electronically to allow composition of vector wind

915-MHz Doppler Wind Profiler with RASS (RASS at Clayton and Marion only)
Sites: Charlotte, Clayton, Marion, Research Triangle Park
Measures vertical profiles of radar reflectivity (uncalibrated) and Doppler vertical velocity (reflectivity weighted) from which wind profiles are constructed
RASS transmits acoustic waves that are detected by the radar and converted into temperature profiles

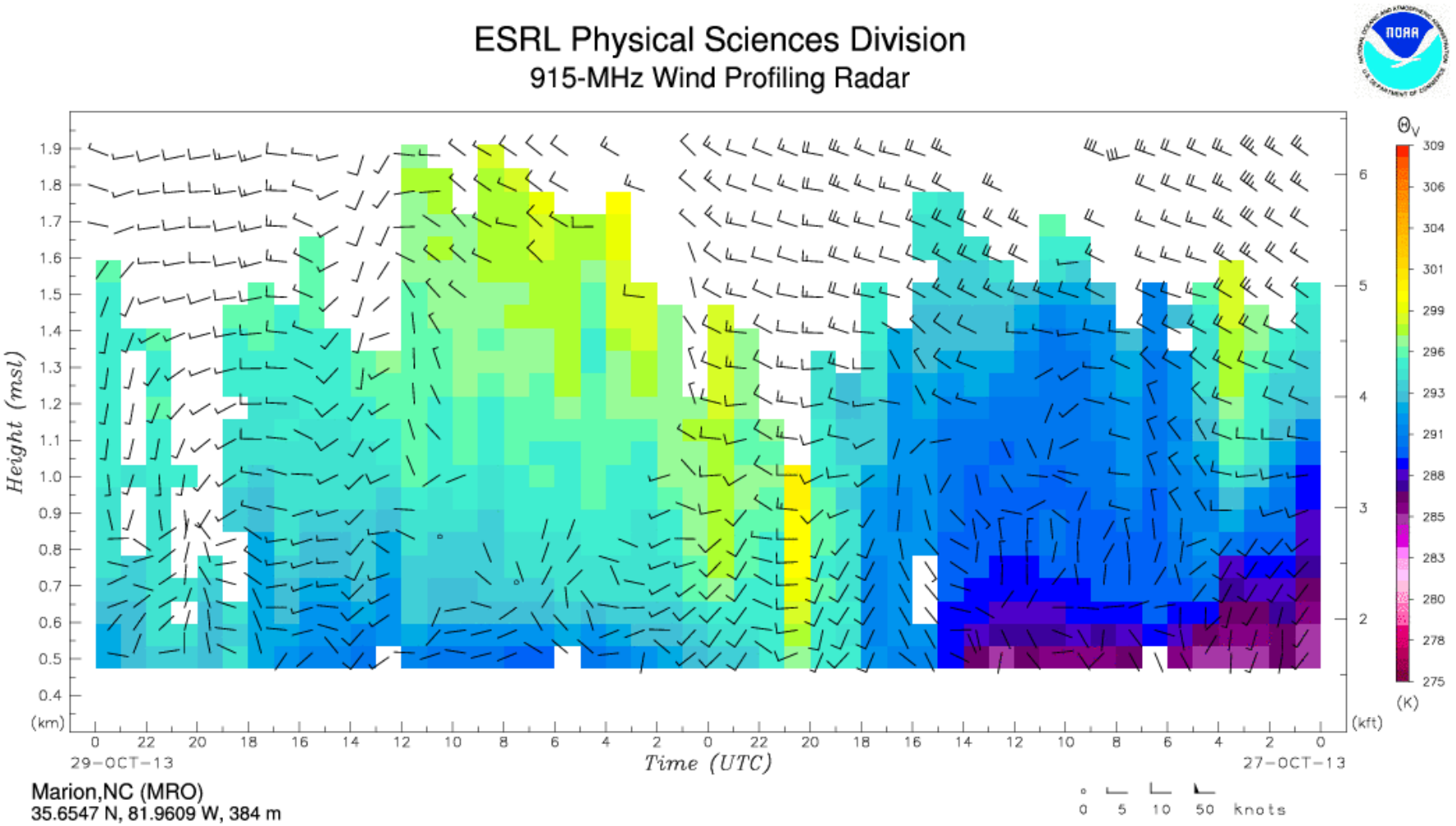
Color-Coded Wind Profile Display



Radar Reflectivity/Wind Profile Display



RASS Virtual Pot. Temperature Display

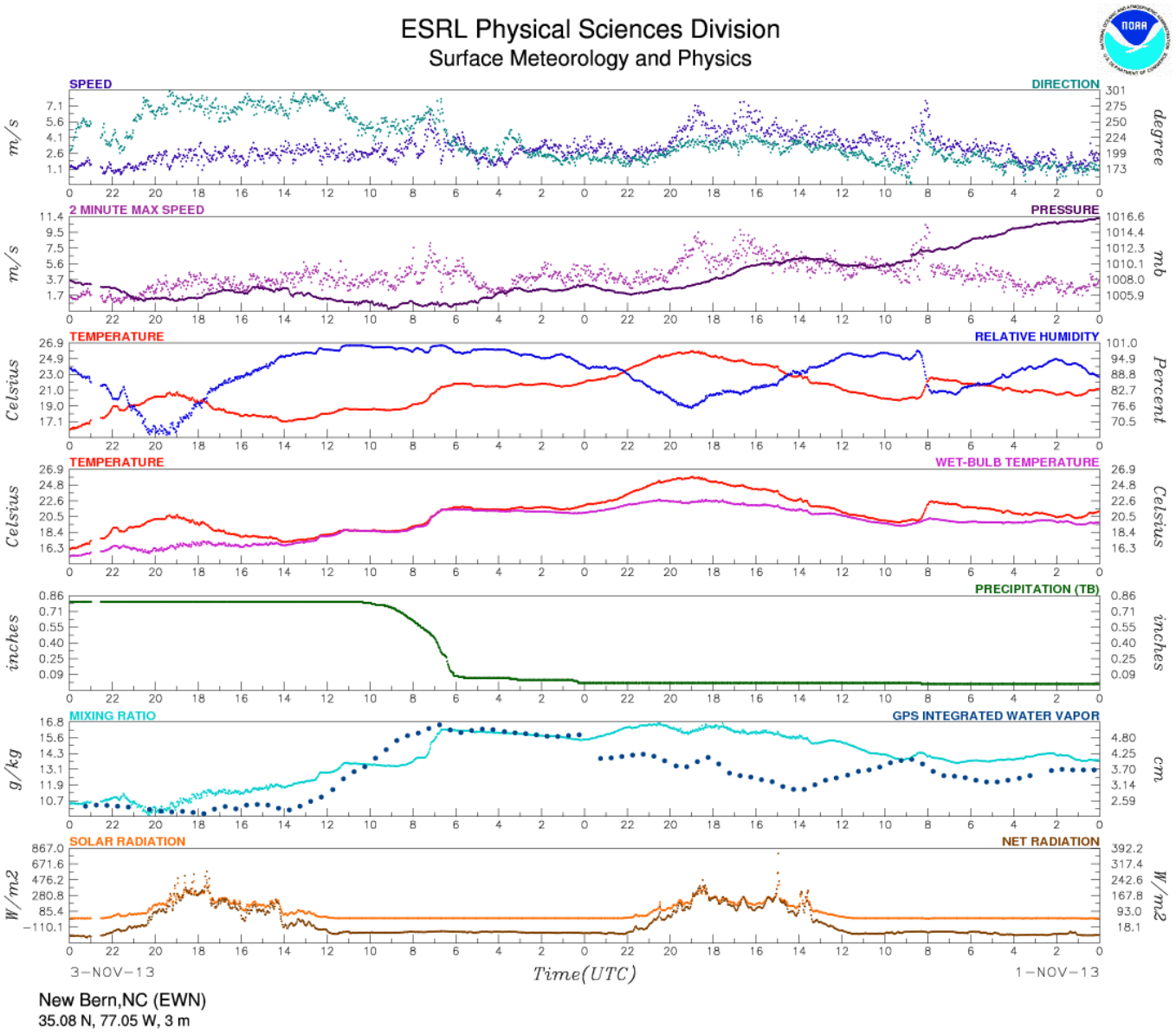


Surface Met. Stations

2-m Tripod Met. Station
Sites: Brindletown, Crooked Creek
Measures pressure, temperature, relative humidity, precipitation, soil moisture and temperature (5, 10, 20, 50, 100 cm depths)

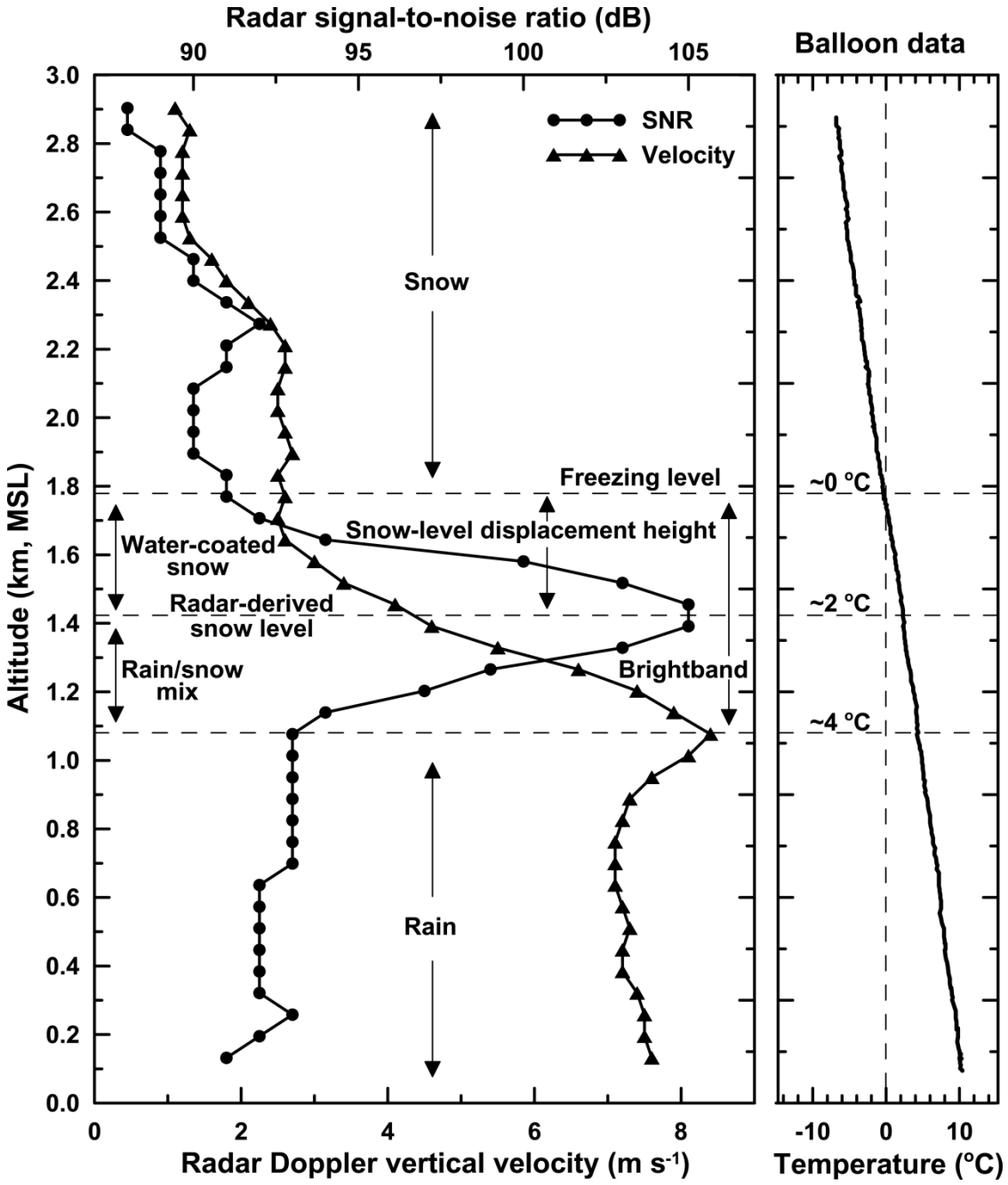
10-m Tower Met. Station
Sites: Crossnore, Hankins, Marion, New Bern, Old Fort, Spruce Pine, Table Rock, Woodlawn
Measures pressure, temperature, wet-bulb temperature, relative humidity, wind speed and direction, precipitation, soil moisture and temperature (5, 10, 20, 50, 100 cm depths), solar/net radiation (Marion, New Bern, and Old Fort only), integrated water vapor (New Bern and Old Fort only)

Surface Met. Display

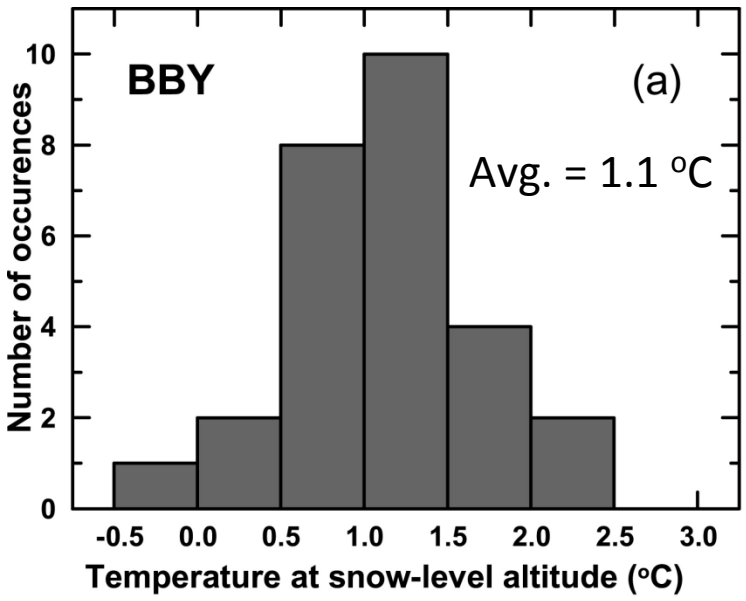


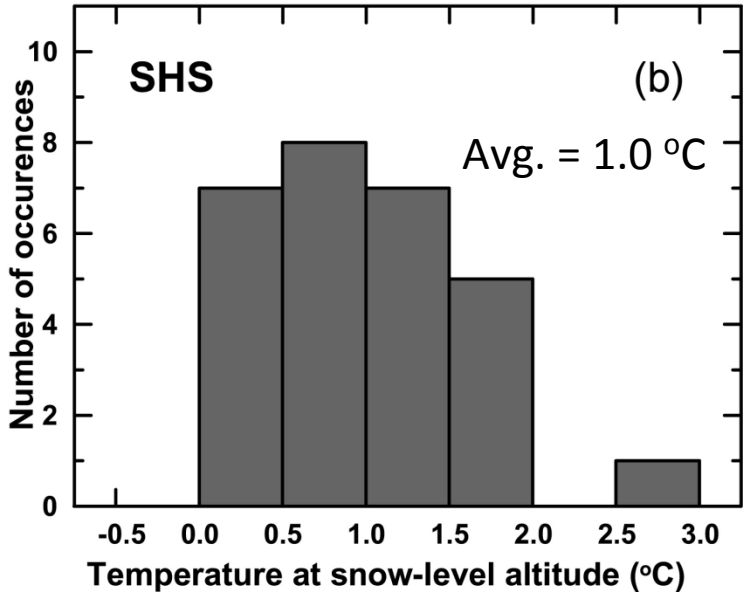
Snow-level Algorithm

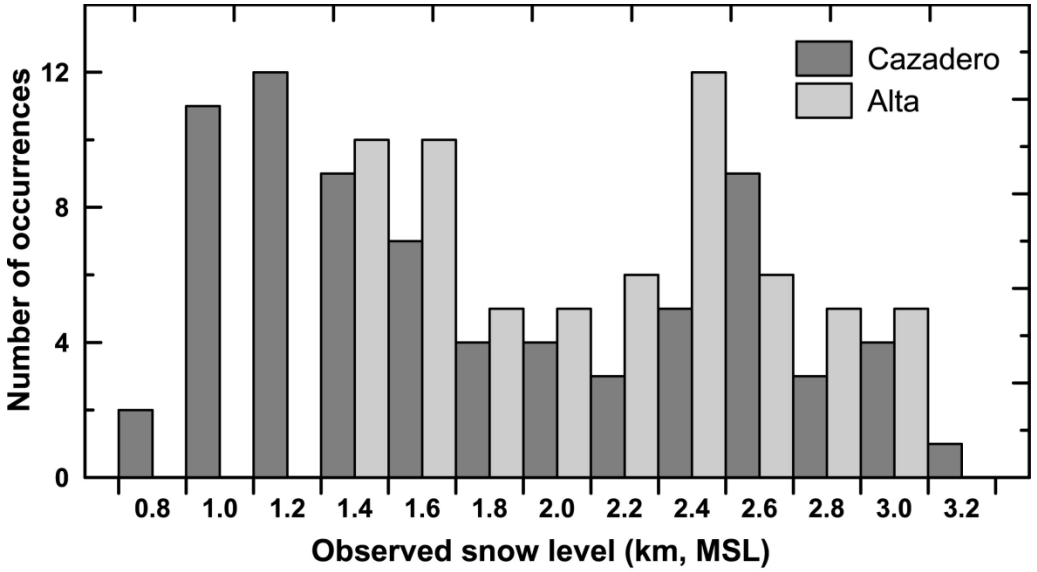
- Profiles of radar reflectivity and Doppler vertical velocity are both examined to determine whether a bright band is present.
- The snow level is calculated as the altitude of maximum radar reflectivity in the bright band.
- A simple consensus routine is used to average snow-level measurements within the 60-min. (wind profiler) 15-min. (S-PROF) averaging periods.
- The snow level will be lower in altitude and warmer than the freezing level. It is the altitude where snowflakes or aggregates obtain a wet surface through the melting process.

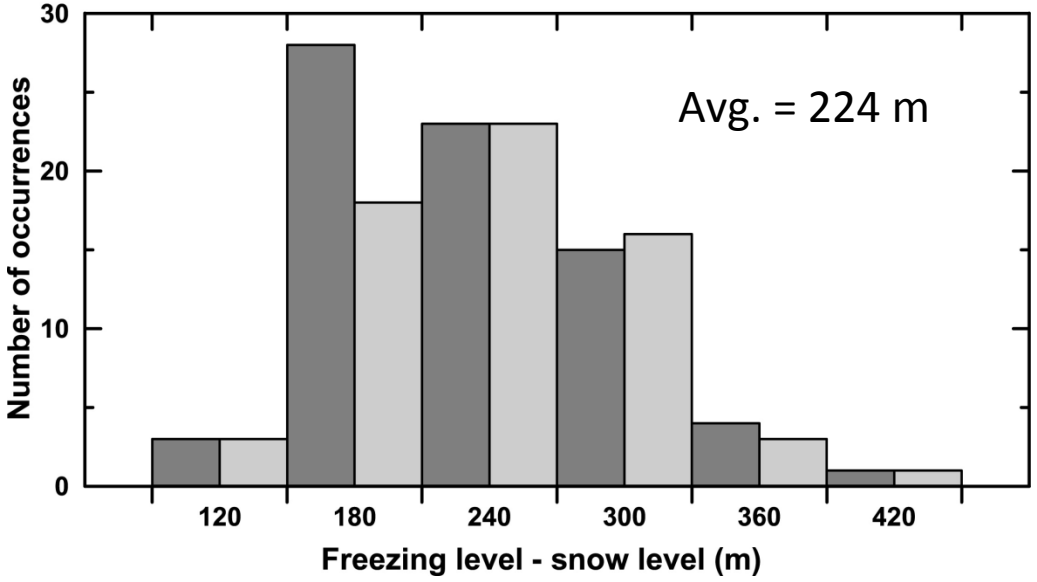


White et al. (2010), *J. Hydromet.*





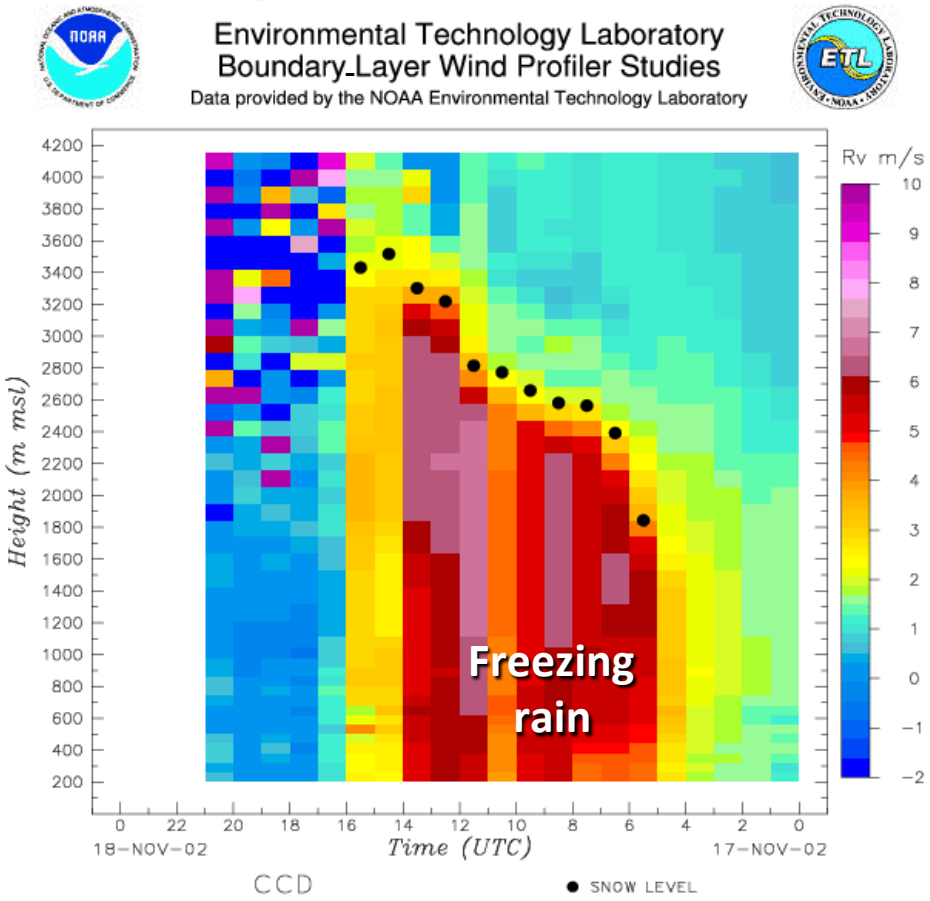




White et al. (2010), *J. Hydromet.*

Ice Detection, too

Snow-level image generated during a November 2002 ice storm that affected millions in the Northeast. The data shown here were collected at Concord, New Hampshire, on November 17. Note the relatively high snow level with sub-freezing temperatures occurring at the surface.



Time (UTC)	2330	2230	2130	2030	1930	1830	1730	1630	1530	1430	1330	1230
Snow Level (m)					none	none	none	none	3431	3517	3302	3219
Snow Level (ft)					none	none	none	none	11253	11535	10830	10558
Sfc Temp (C)					0.83	1.02	0.91	0.25	−0.01	−0.20	0.06	0.04

Time (UTC)	1130	1030	0930	0830	0730	0630	0530	0430	0330	0230	0130	0030
Snow Level (m)	2815	2773	2659	2581	2564	2392	1843	none	none	none	none	none
Snow Level (ft)	9233	9095	8721	8465	8409	7845	6045	none	none	none	none	none
Sfc Temp (C)	−0.11	−0.69	−1.91	−2.71	−2.91	−3.10	−3.19	−3.79	−4.07	−4.17	−3.94	−3.46

Below 0° C temps coded in blue font

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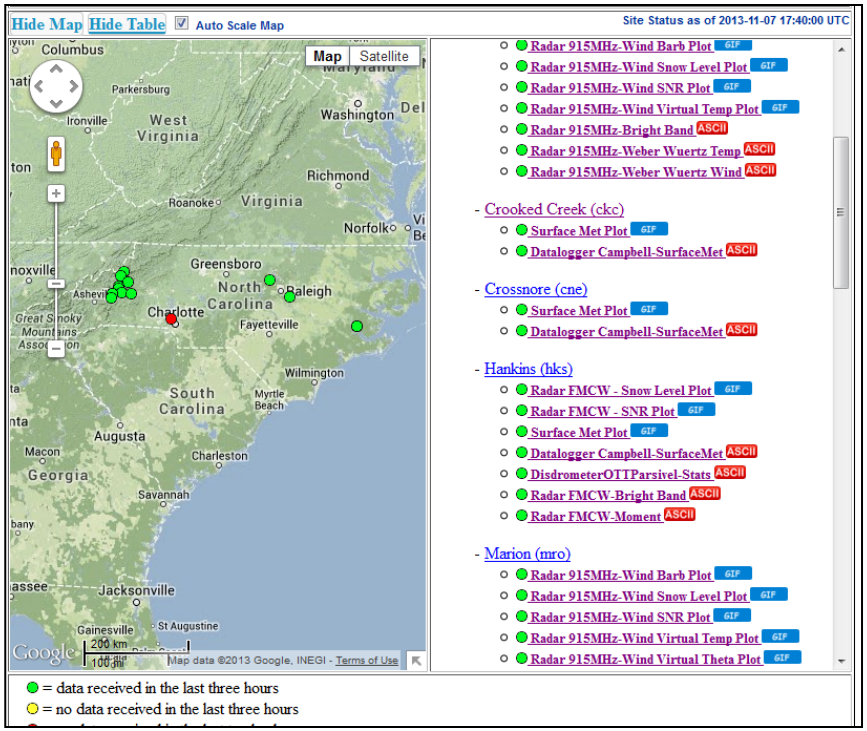
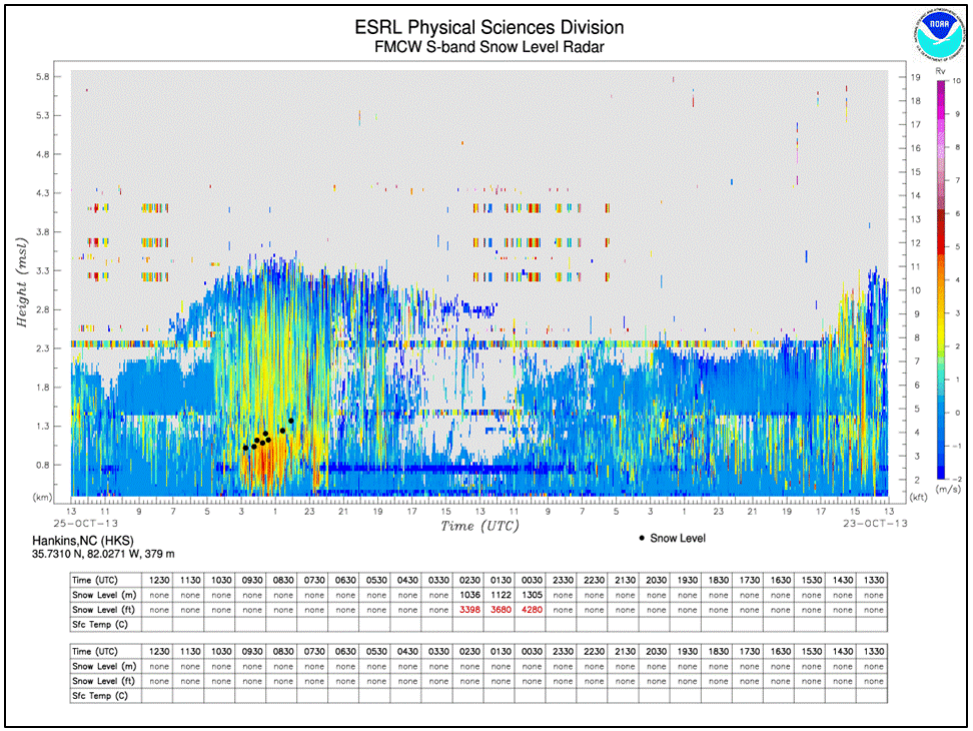
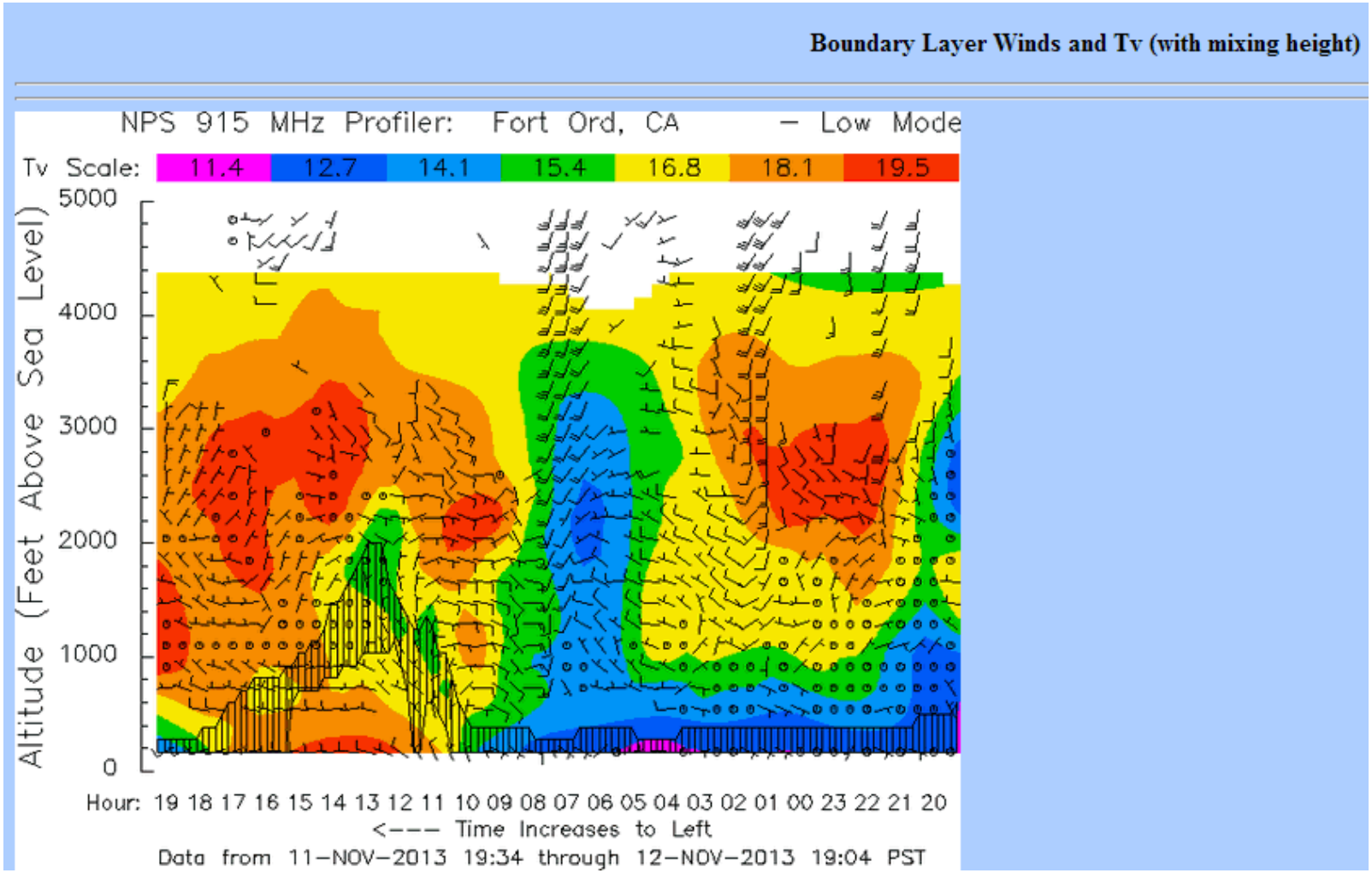


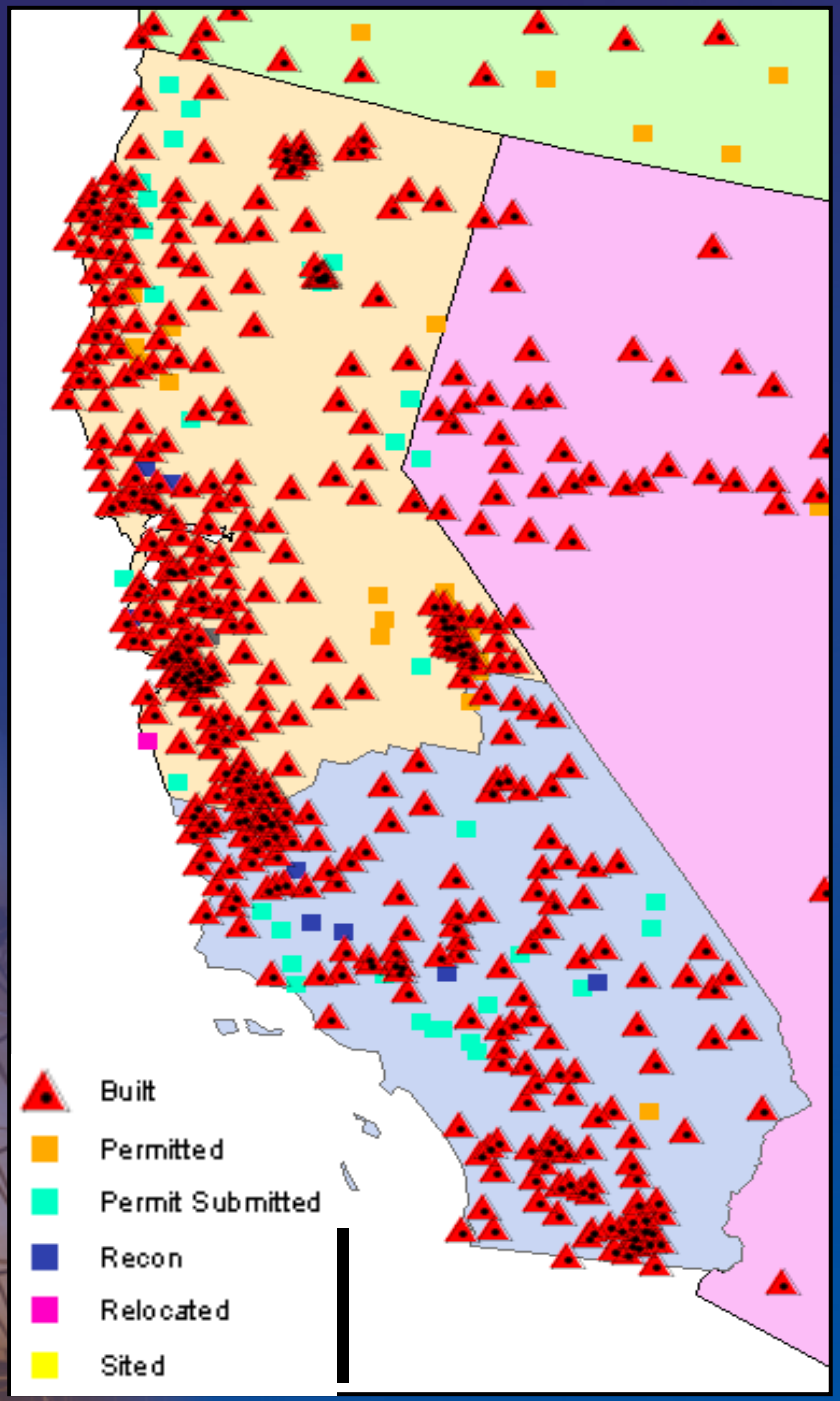


Used for Ft Ord Control Burns for Smoke Management



Instrument Function

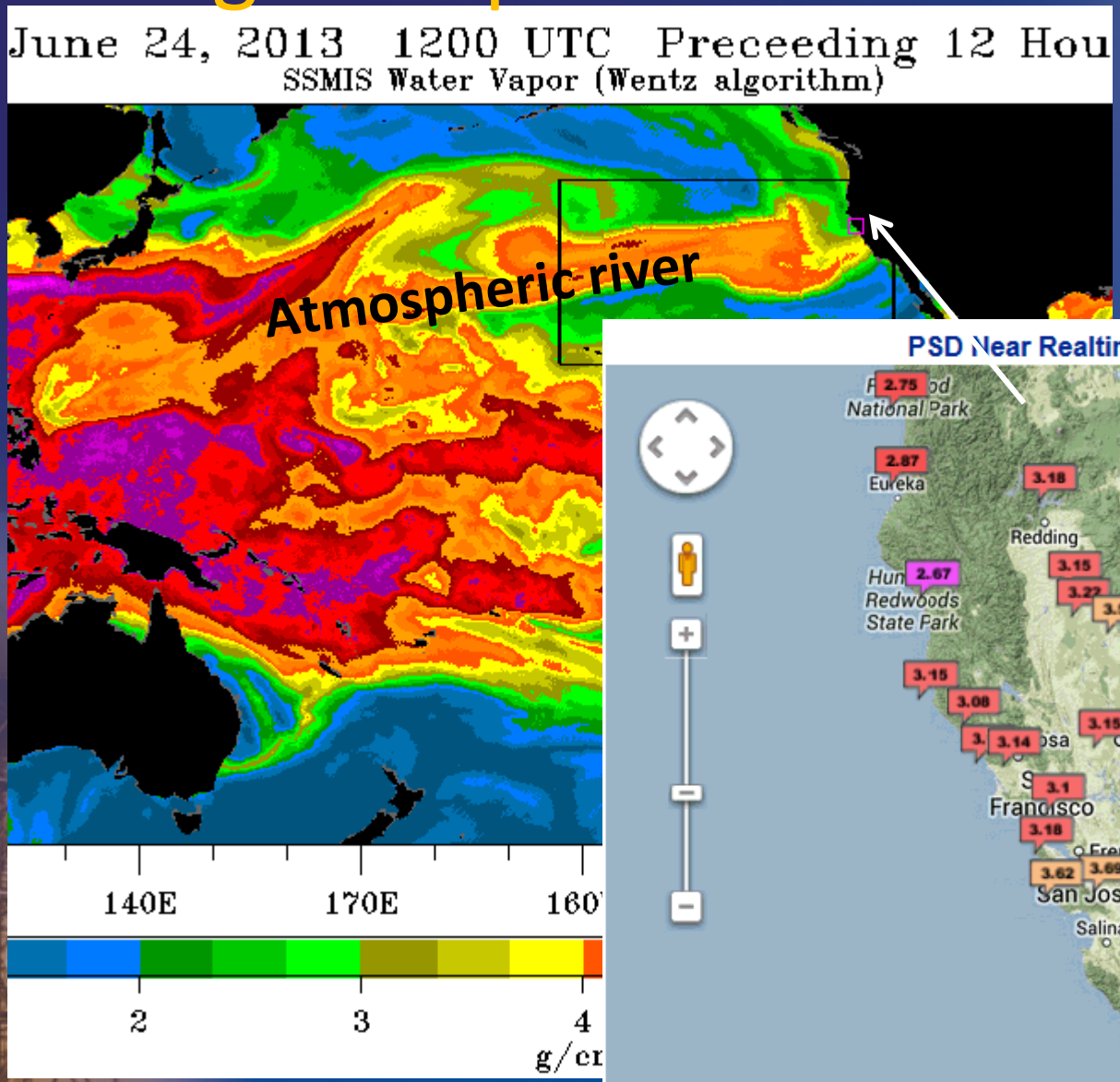
- **Land-based GPS sensor** – measure the fuel (water vapor content) carried by the winds as the storm makes landfall.
- **Wind Profilers** – measure the rate at which the fuel is being supplied to generate heavy rain (fuel rate)
- **Snow level radar (S-band profilers)–** measure the depth of the atmosphere warmer than freezing. Deeper this layer more moisture is available and the higher the elevation snow will fall in the mtns. Higher snow level more runoff will occur.
- **Soil Moisture Sensor** - measure the moisture content of the soil and calibrate that to field capacity to determine runoff potential.



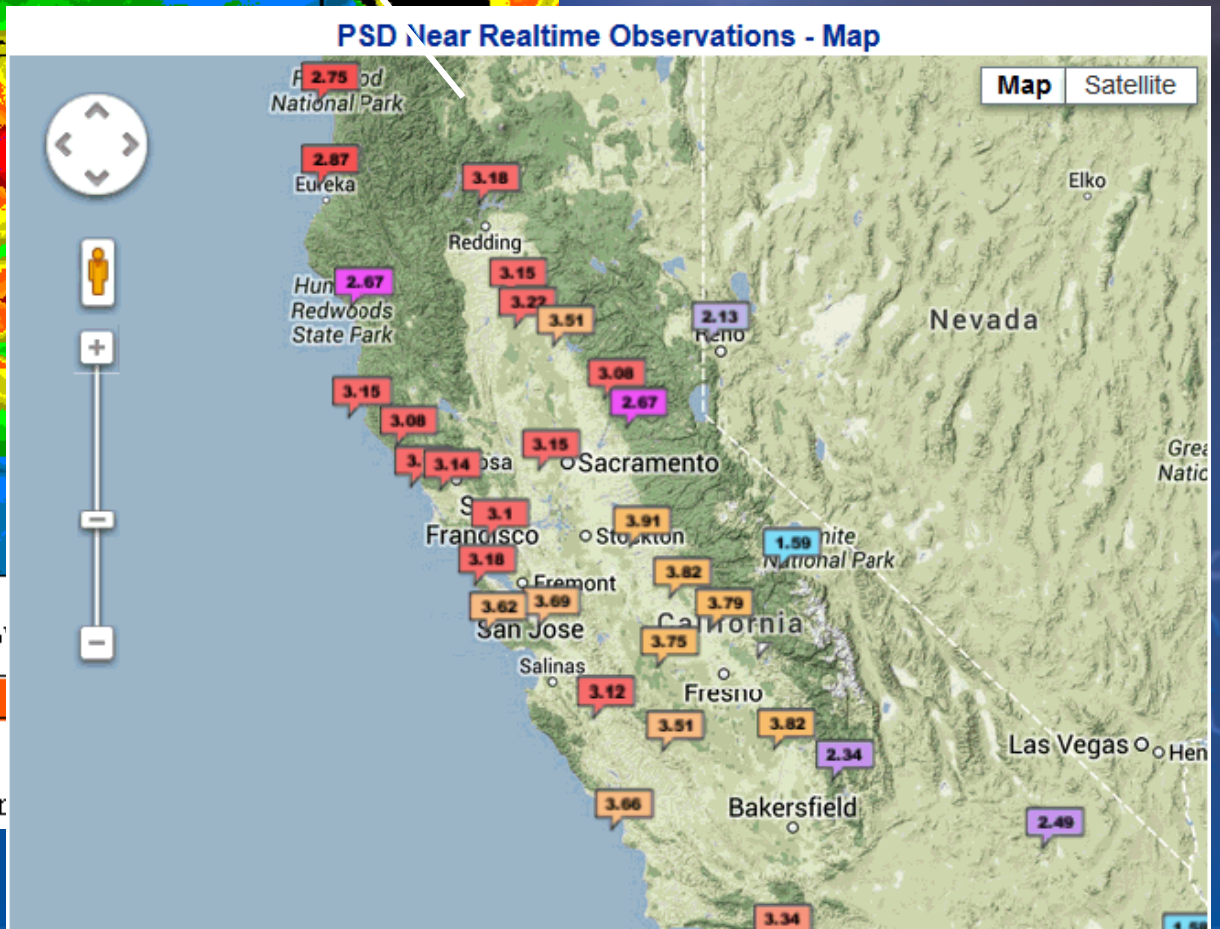
Tier 1: GPS receivers of opportunity

- NSF/UNAVCO Plate Boundary Observatory (PBO) network of GPS receivers for primarily geodetic applications
- **Installing surface temperature and pressure sensors at existing GPS receiver sites will allow the network to map out the horizontal distribution of vertically integrated water vapor (IWV)**
- Energy industry (electricity distribution) benefits because GPS receivers are used by Space Weather Center to monitor geomagnetic storms

Google Map IWV from GPS Met Stations

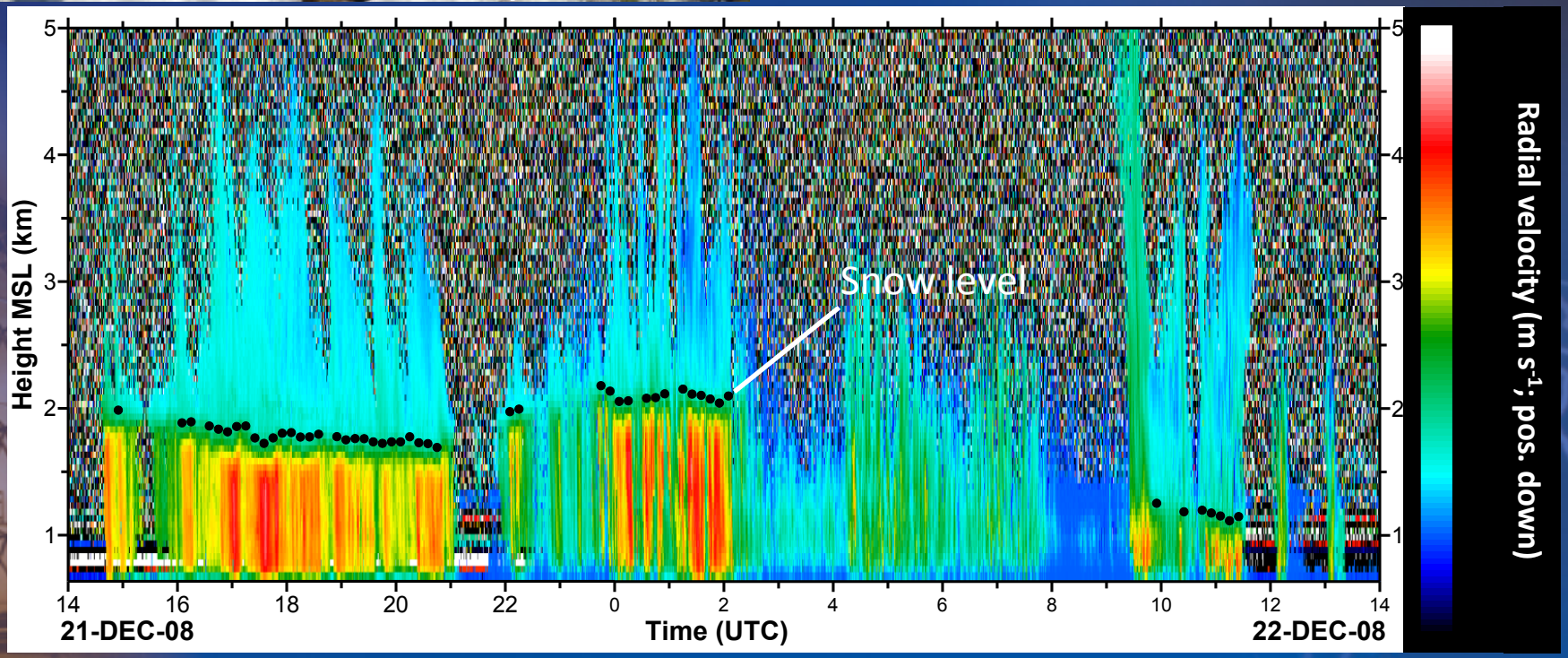


Water vapor observations onshore fills gap in satellite observations

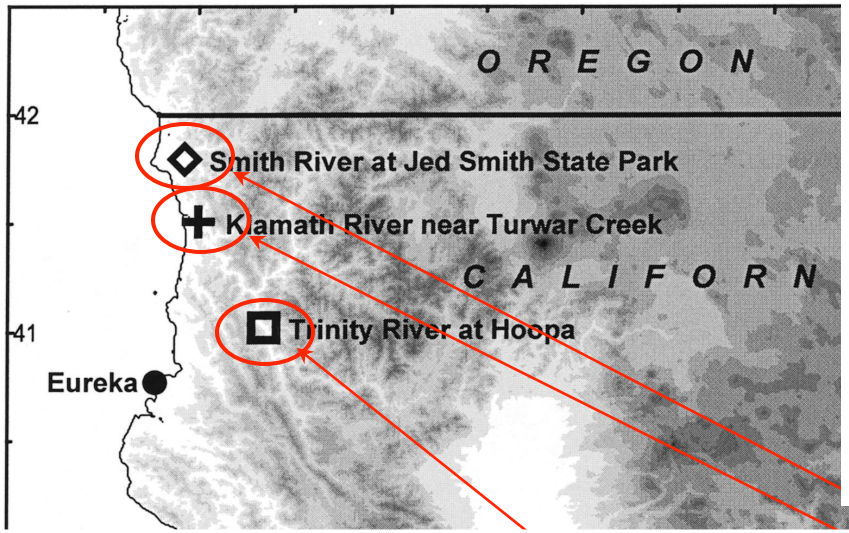


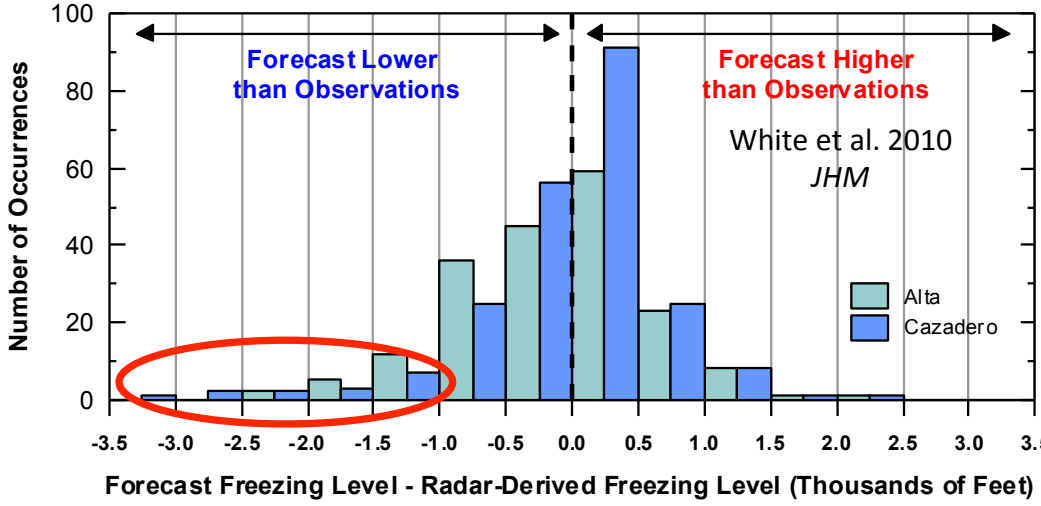
Tier 1: Snow level radars

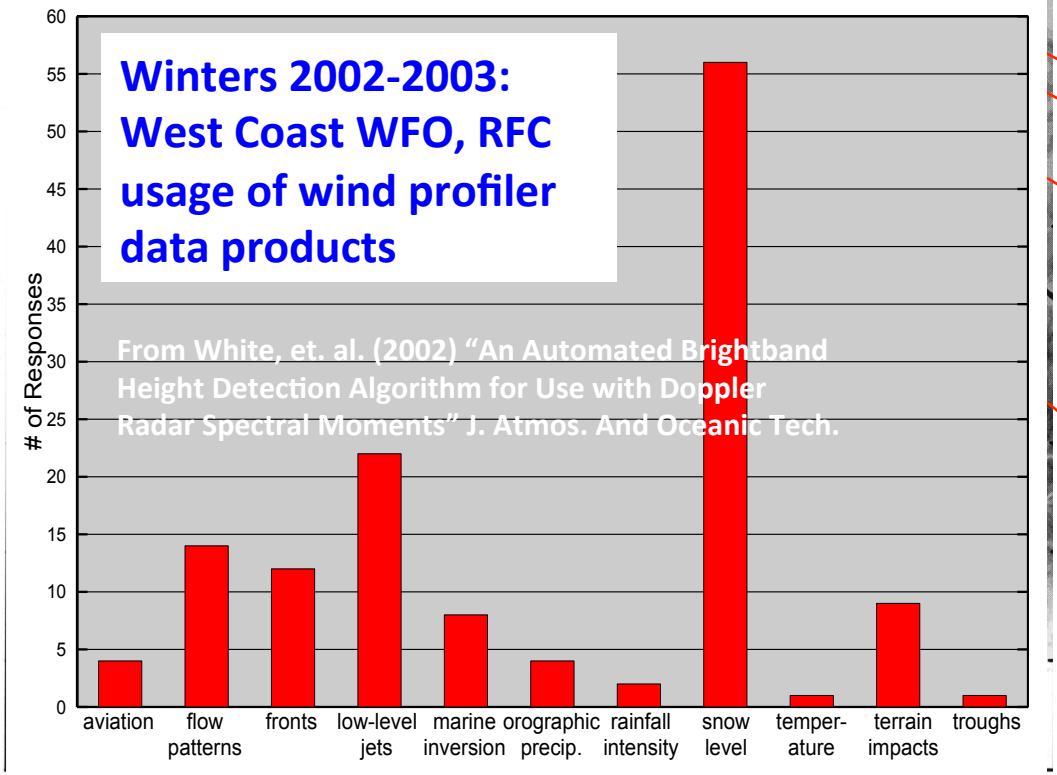
- Provides proxy snow-level height during precipitation events
- Utilizes proven FMCW technology to substantially lower cost
- **Uses the patented ESRL automated snow-level detection algorithm proven in nationwide field experiments**
- Less than 8’ diameter footprint
- Low-power requiring minimal infrastructure

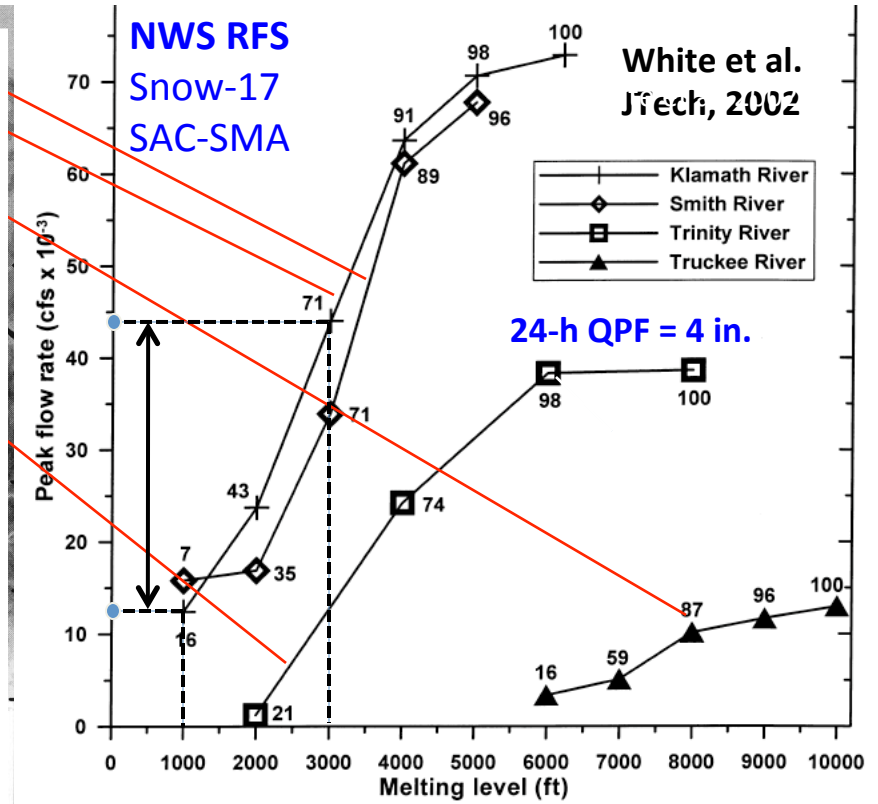


HMT Snow Level Research Results



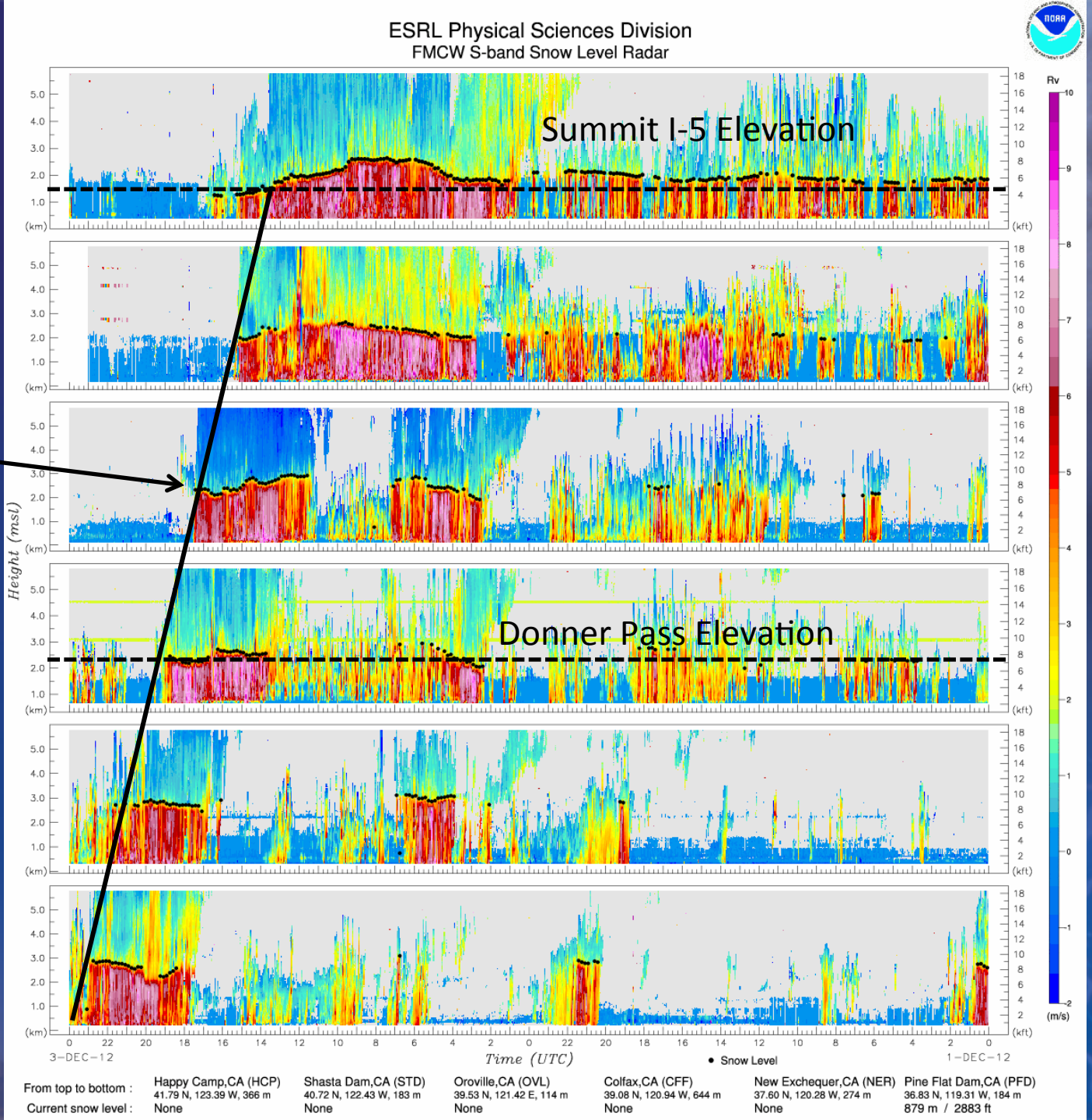




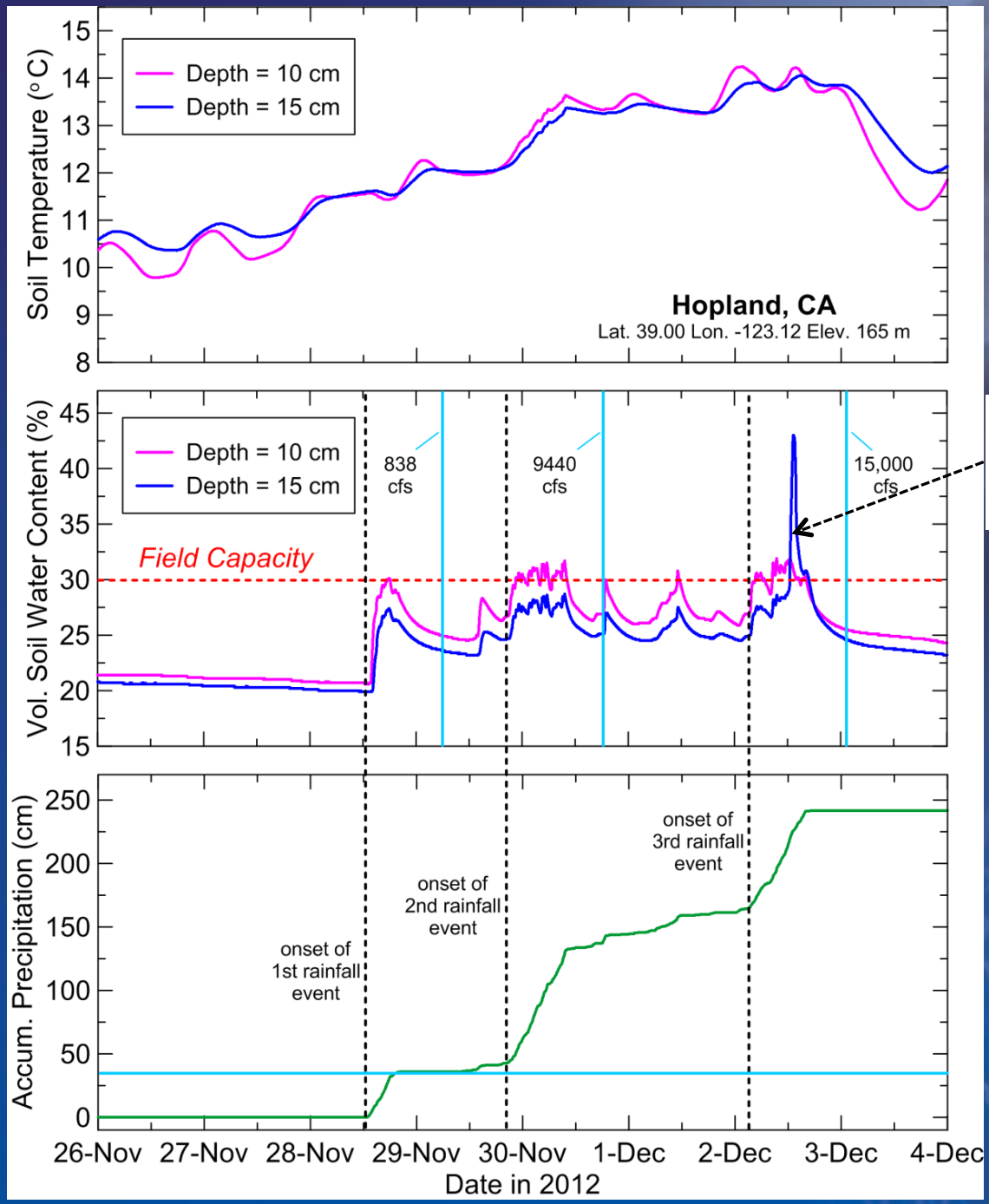


1-2 Dec 2012

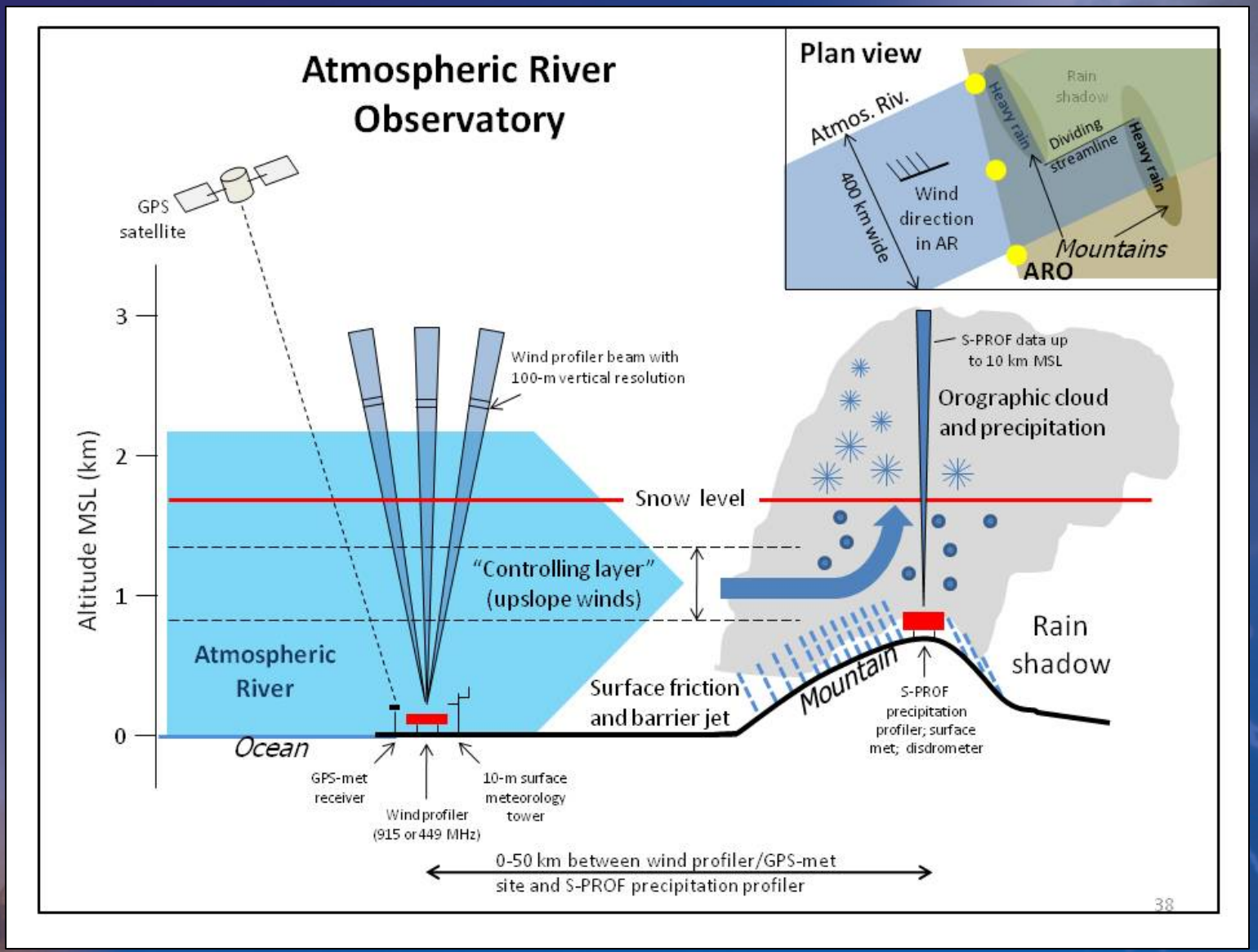
~21 kt motion allows 3 to 12 hrs lead time of front and cessation of heavy rain



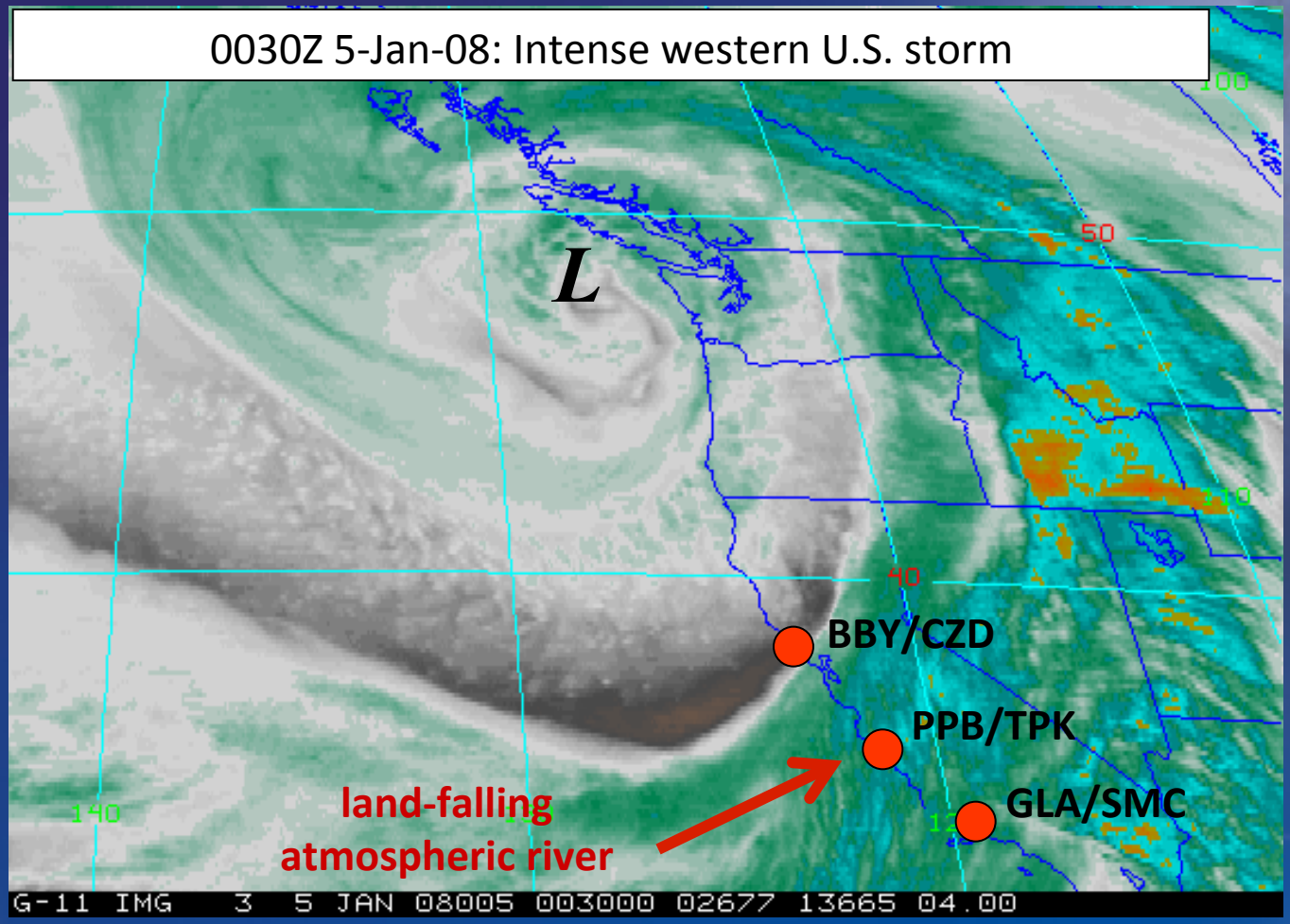
- Russian River was impacted by three separate precipitation events within a five day period in late Nov. to early Dec. 2012.
- Peaks in Russian River stream flow were observed each time the observed precipitation rate and amount kept the 10 cm soil at field capacity for a period longer than 3 h.
- The 15,000 cfs flow peak that occurred early on 3 Dec. was 0.42 m below flood stage for this location.



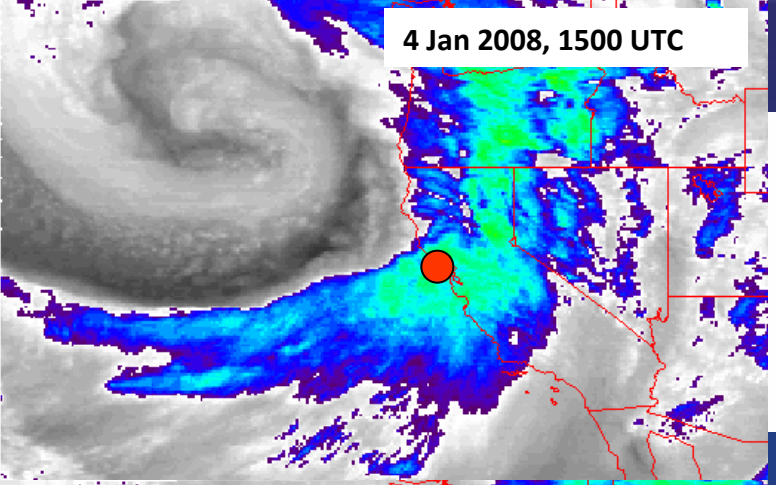
Atmospheric River Observatories to Fill Largest Single Monitoring Gap

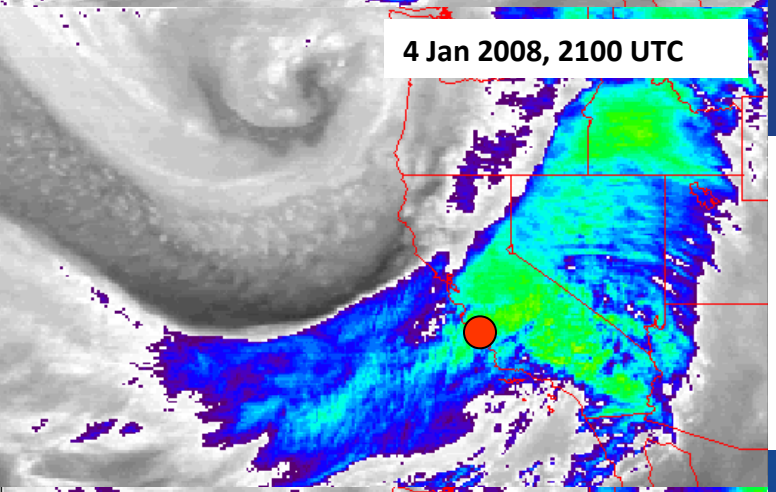


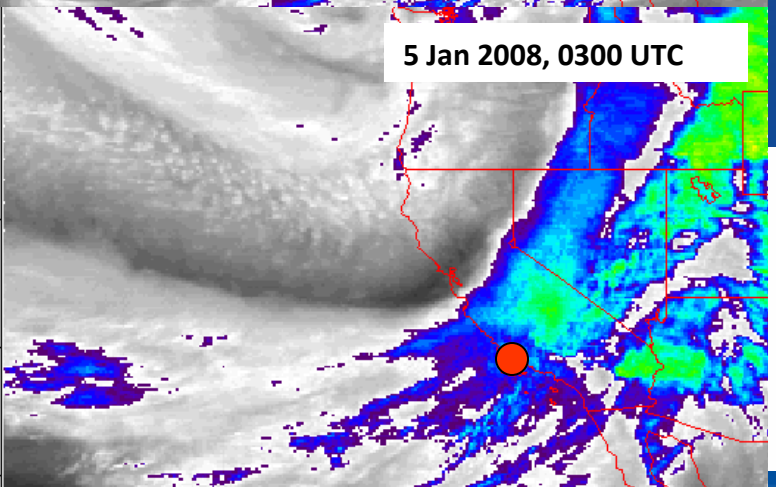
Prototype forecast tool tested at 3 CA couplets during NOAA's HMTs



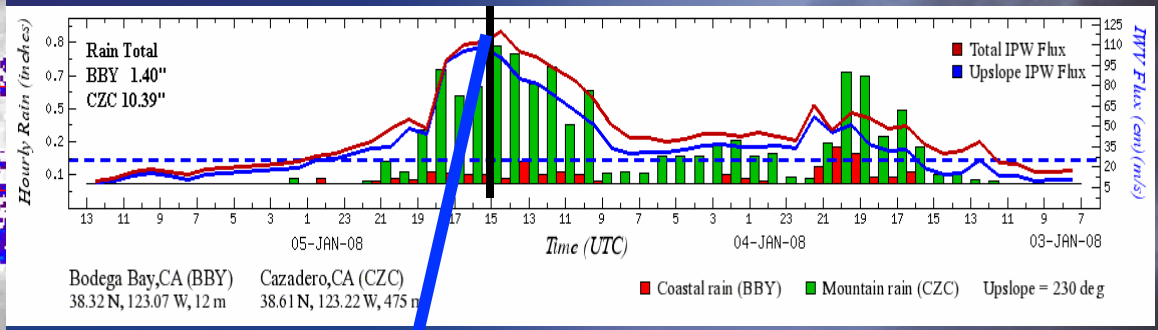
Couplet	**Coast** (*profiler, GPS, rain gauge*):	**Mountains** (*rain gauge*):
North:	Bodega Bay (BBY; 12 m MSL)	Cazadero (CZD; 475 m MSL)
Central:	Piedras Blancas (PPB; 11 m MSL)	Three Peaks (TPK; 1021 m MSL)
South:	Goleta (GLA; 3 m MSL)	San Marcos Pass (SMC; 701 m MSL)



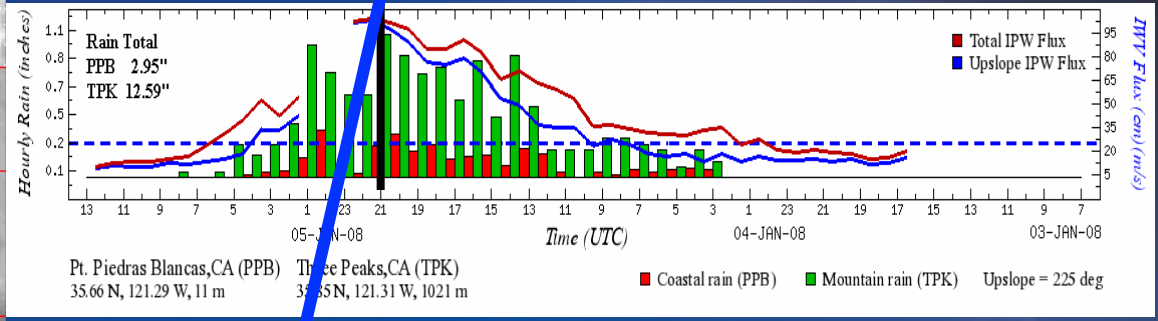




Time of max AR bulk flux at BBY: 1500 UTC 4 Jan

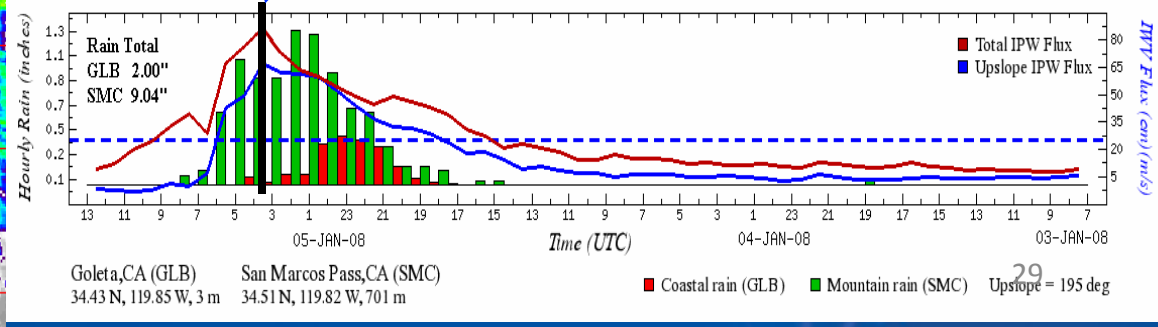


Time of max AR bulk flux at PPB: 2100 UTC 4 Jan



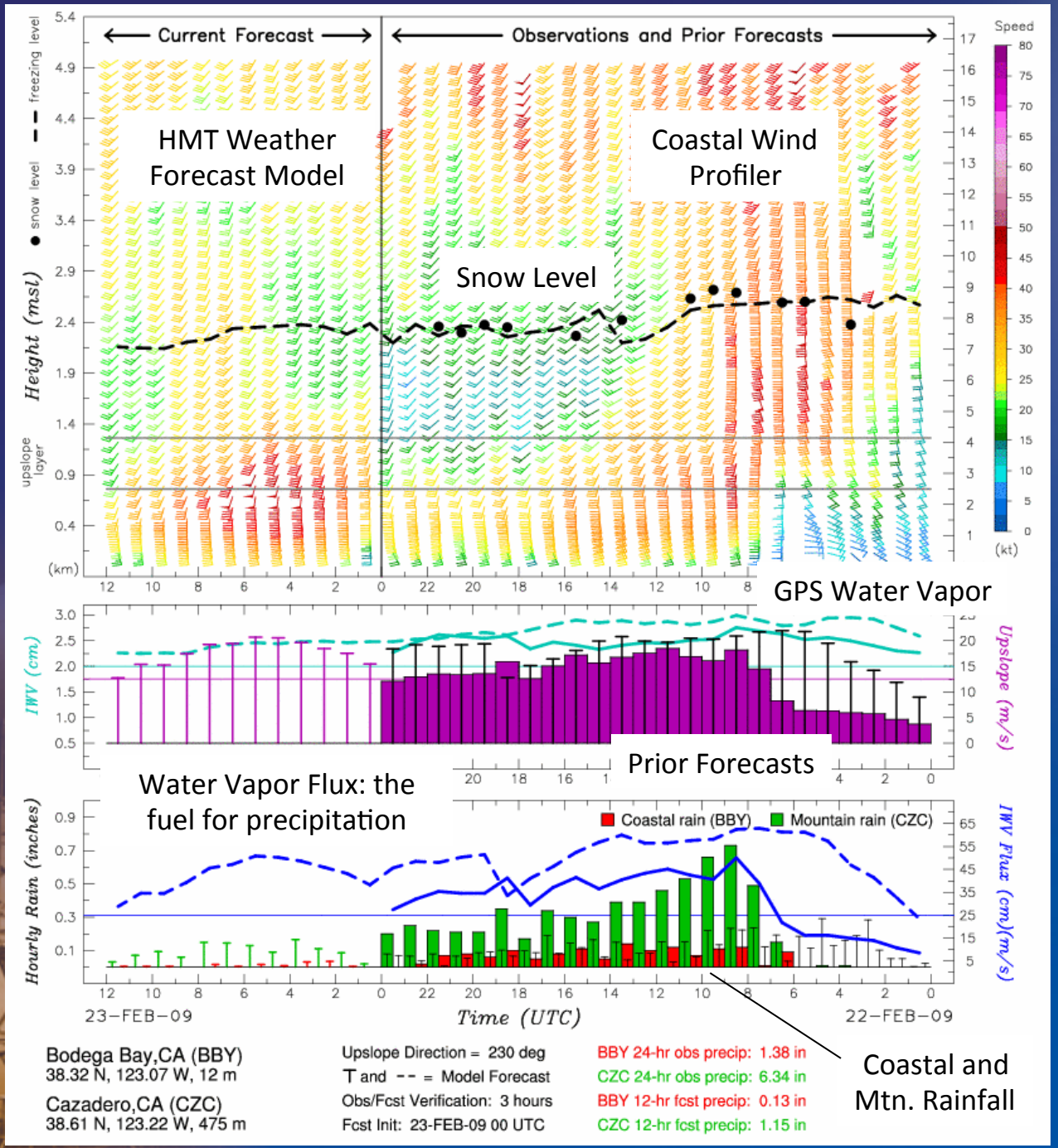
AR Propagation: ~12 m s^{-1}.
½-day lead time for SoCal

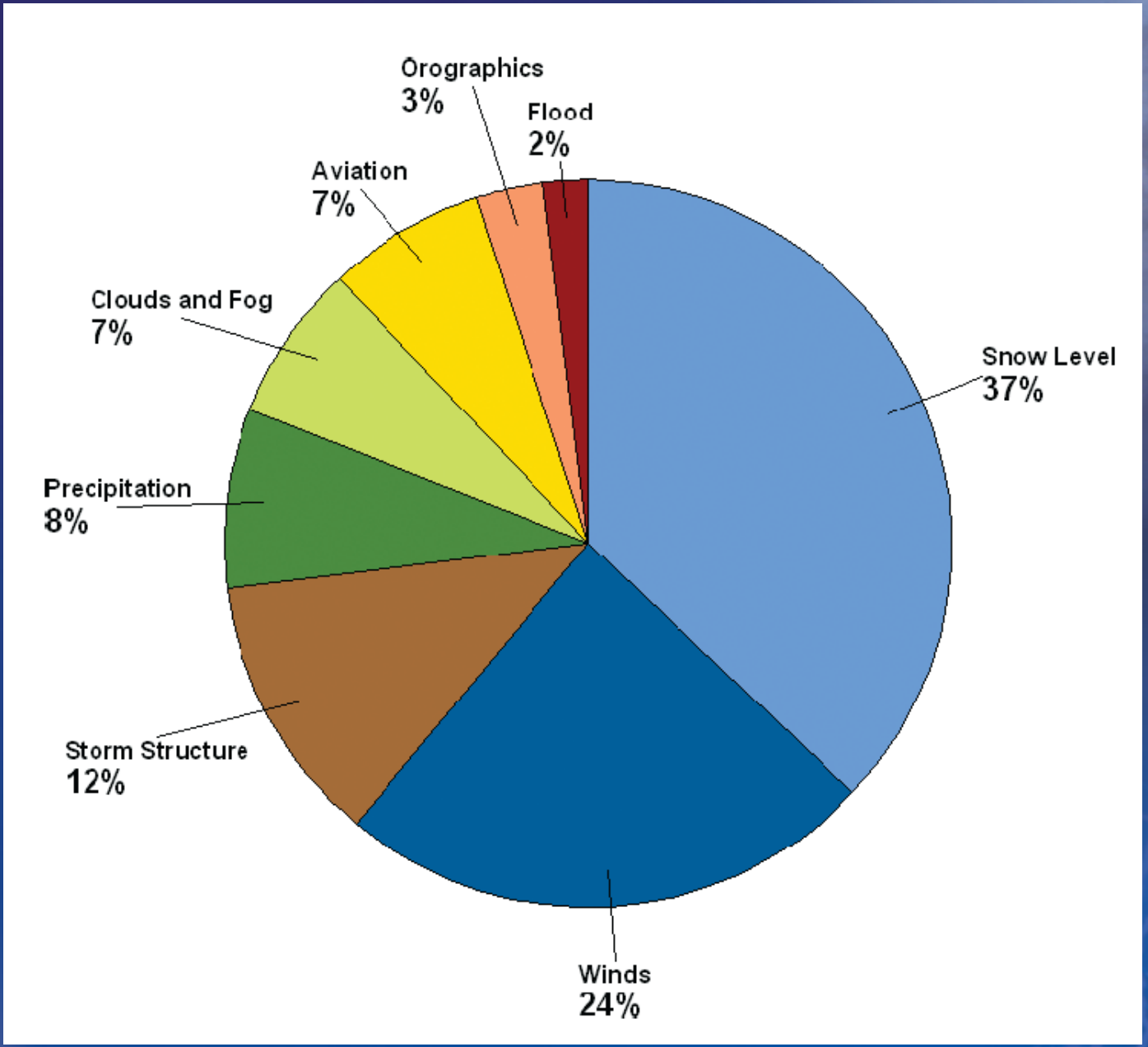
Time of max AR bulk flux at GLA: 0300 UTC 5 Jan



ESRL's Real-time Upslope Water Vapor Flux Tool Display

2009 NOAA Bronze Medal awarded to OAR/NWS team "for innovative contributions to the development of the Coastal Atmospheric River Monitoring and Early Warning System [i.e., upslope water vapor flux tool]."





Weather forecast applications for which ARO data products were quoted in 59 individual Area Forecast Discussions issued by the Seattle Weather Forecast Office

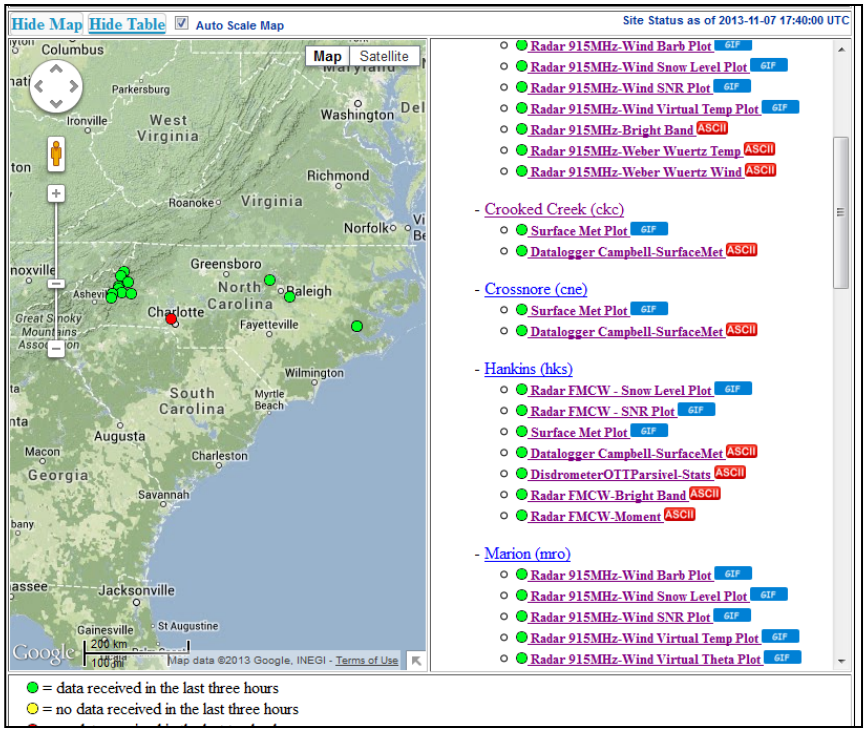
Benefit of Expanded Observation Networks Recent Past and Near Future

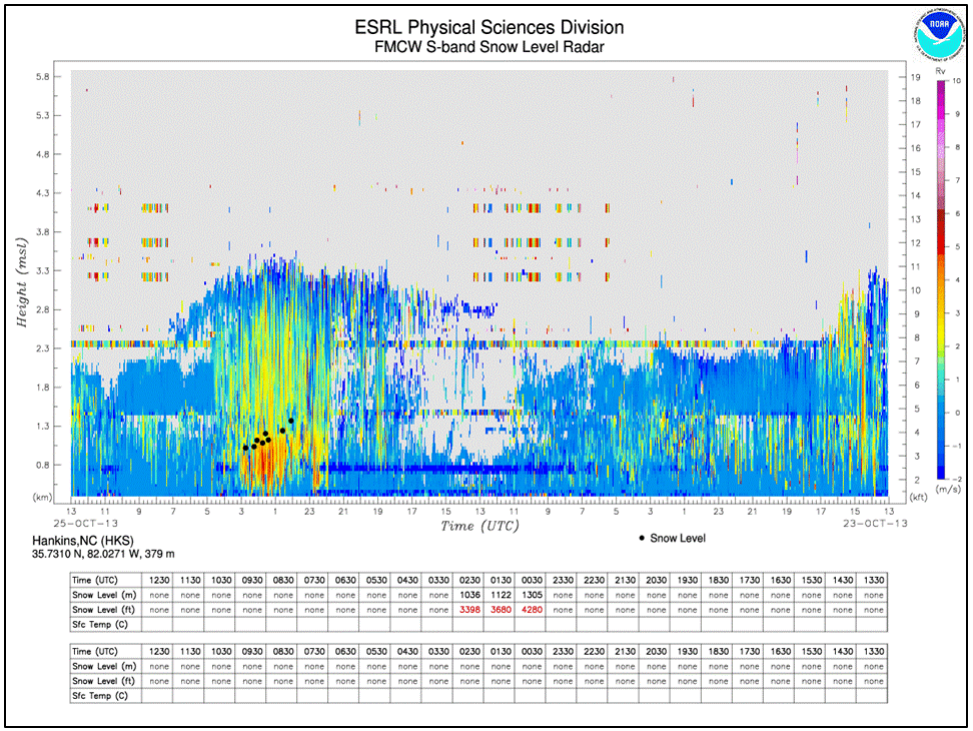
- Allowed us to begin a climate record of land-falling AR magnitude, duration, relationship to flooding, seasonality.
- Allowed us to define the spatial and temporal resolution needed to monitor extreme rainfall events
- Allowed us to define the critical observations that we need to properly model extreme events - gaps
- Test beds have provided the scientific credibility needed to bridge the research to operations gap - Sustainability – not just a research project…
- Expand capability to all areas in the west.

Outline

1. Introduction (Kelly Mahoney, Rob Cifelli)
2. Review of HMT observational platforms (Allen White)
3. WFO utility: Examples and suggestions (Dave Reynolds)
4. **Examples of possibly-SE-relevant HMT research (Paul Neiman, Dave Kingsmill)**
5. Discussion

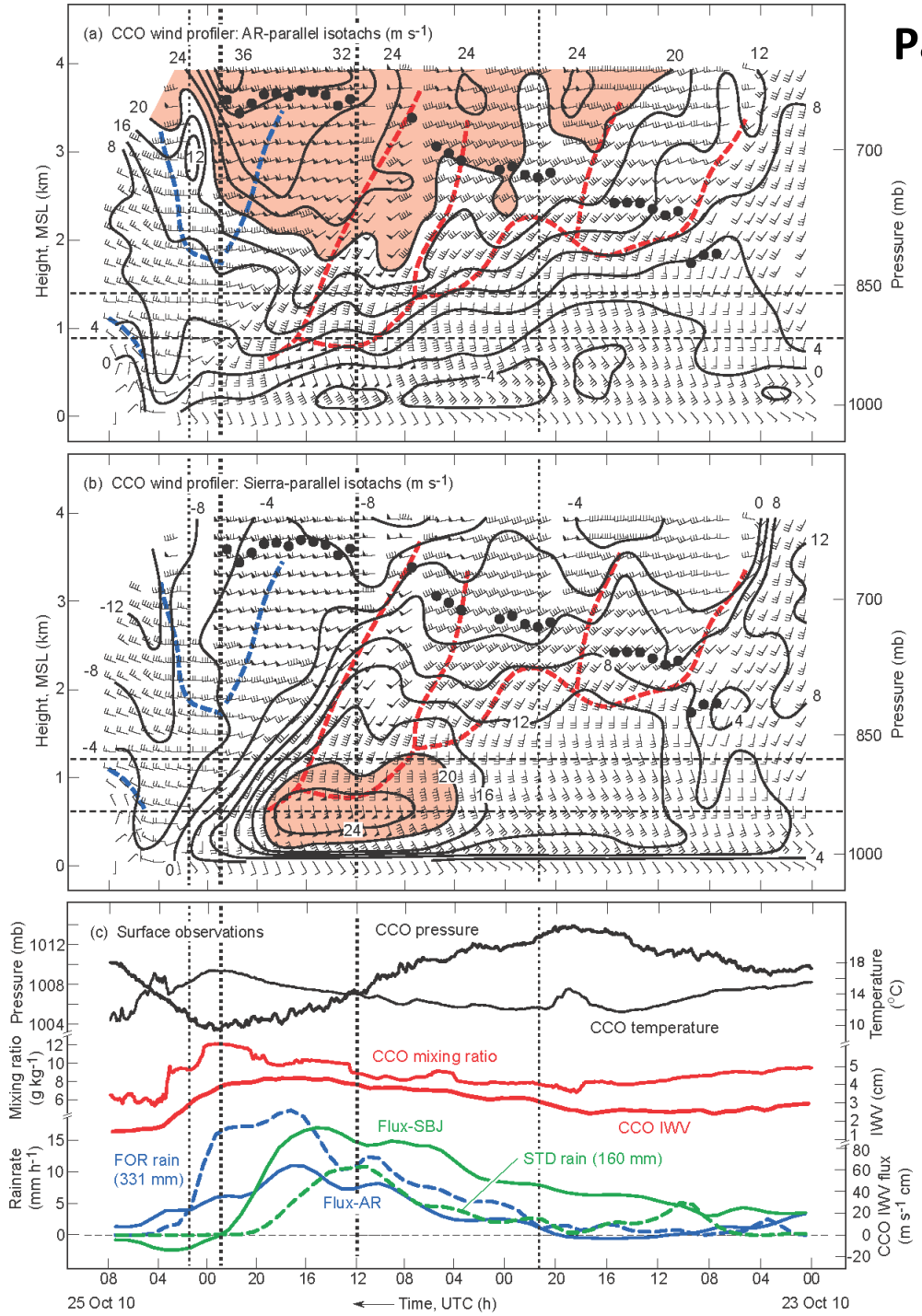
   → *including insight from Dan Gottas, Tim Coleman on potential forecast displays, tools*





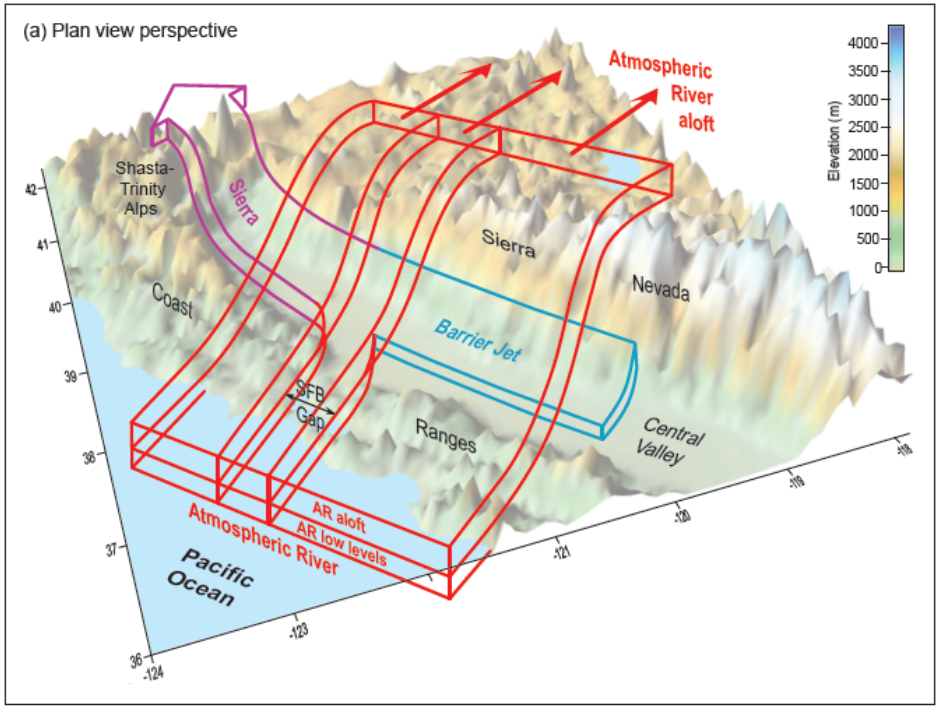
Paul Neiman: Examples of utility of wind profiler measurements

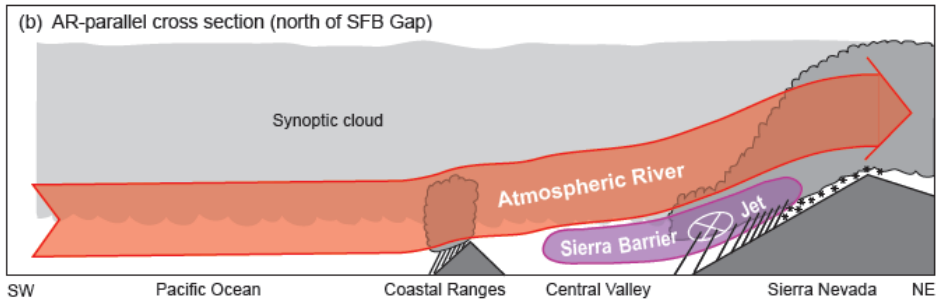
- Wind profiler and GPS data and analyses from Chico, CA during the landfall of an intense atmospheric river (AR) and temporally coincident Sierra barrier jet (SBJ)
- Shows IWV flux results in context of orographic precip generated by both the AR and SBJ
- Also shows summary geostrophic thermal advection diagnostics (red and blue dashed lines denote axes of maximum warm advection and cold advection, respectively).
- Possible important terrain-forced analogy: SBJ as it might relate to cold-air damming (occur due to very similar -- if not the same -- physical processes)

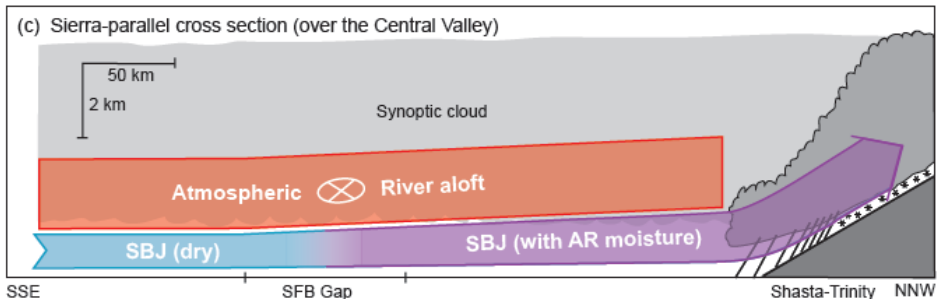


Detailed figure caption: Time series of observations from CCO and nearby precipitation gauges between 0000 UTC 23 October and 0800 UTC 25 October 2010, with time increasing from right to left to portray the advection of transient synoptic features from west to east. The thin (thick) vertical dotted lines mark the outer temporal bounds of IWV >3 (>4) cm. (a) Time-height section of hourly averaged wind profiles (flags and barbs are as in Fig. 4), AR-parallel isotachs (m s^{-1}, directed from 250°), brightband melting-level heights (bold black dots), and axes of maximum thermal wind-derived (i.e., geostrophic) warm and cold advection [(red and blue dashed lines, respectively]. Every wind profile and every other range gate is plotted. (b) The same as panel (a), except for Sierra-parallel isotachs (m s^{-1}, directed from 160°). The horizontal thin dashed lines in (a) and (b) show the vertical bounds for the AR and SBJ orographic controlling layers, respectively. (c) Time series of surface pressure (hPa; thick black), surface temperature (°C; thin black), surface water vapor mixing ratio (g kg^{-1}; thin red), IWV (cm; thick red), the upslope IWV flux in the orographic controlling layer for the AR-component (blue solid; Flux-SBJ: from 250°, 0.9-1.4 km MSL) and SBJ-component (blue dashed; Flux-SBJ: from 160°, 0.6-1.2 km MSL) of the flow at CCO, and time series of hourly rainrate (mm h^{-1}) at FOR (blue dashed) and STD (green dashed). Storm-total precipitation (mm) is given in parentheses for each site.

Paul Neiman: Sierra Barrier Jet & Cold air damming analogy







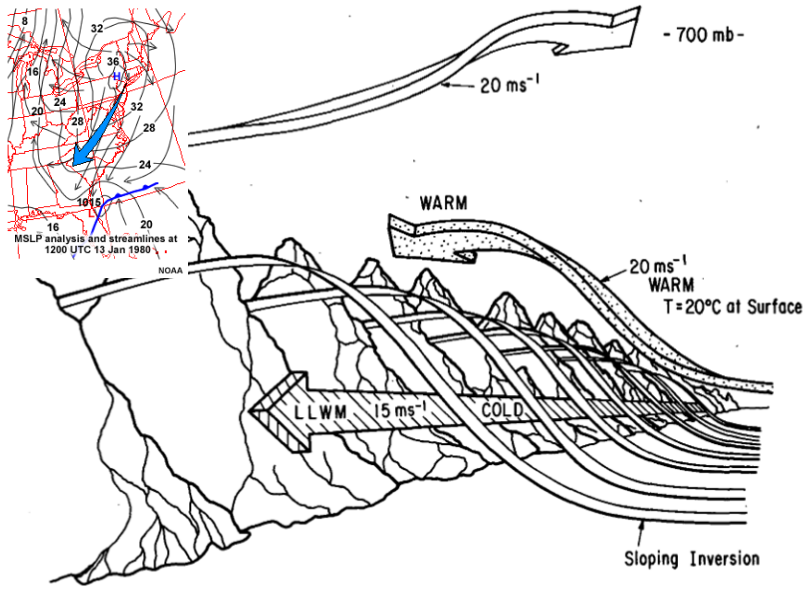
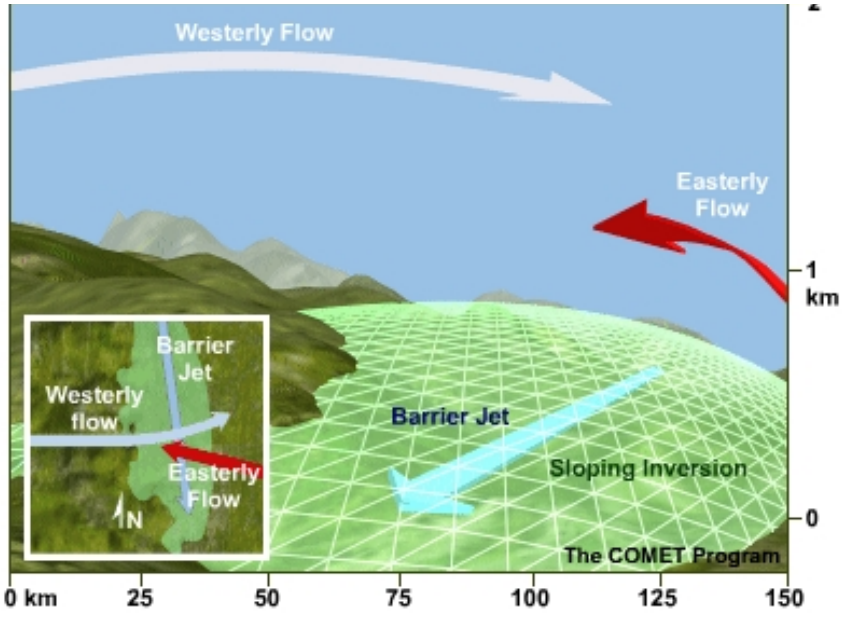


FIG. 22. Conceptual model of the cold-air damming region as it existed at 1200 UTC 22 March 1985. Note the strong low-level wind maximum (LLWM) within the cold dome, the easterly (or southeasterly) flow just above the cold dome associated with strong warm advection into the warm air above the dome, the sloping inversion of the cold dome top, and the southerly and southwesterly winds above 700 mb associated with the advancing short-wave trough west of the Appalachians.

Bell and Bosart (1988)



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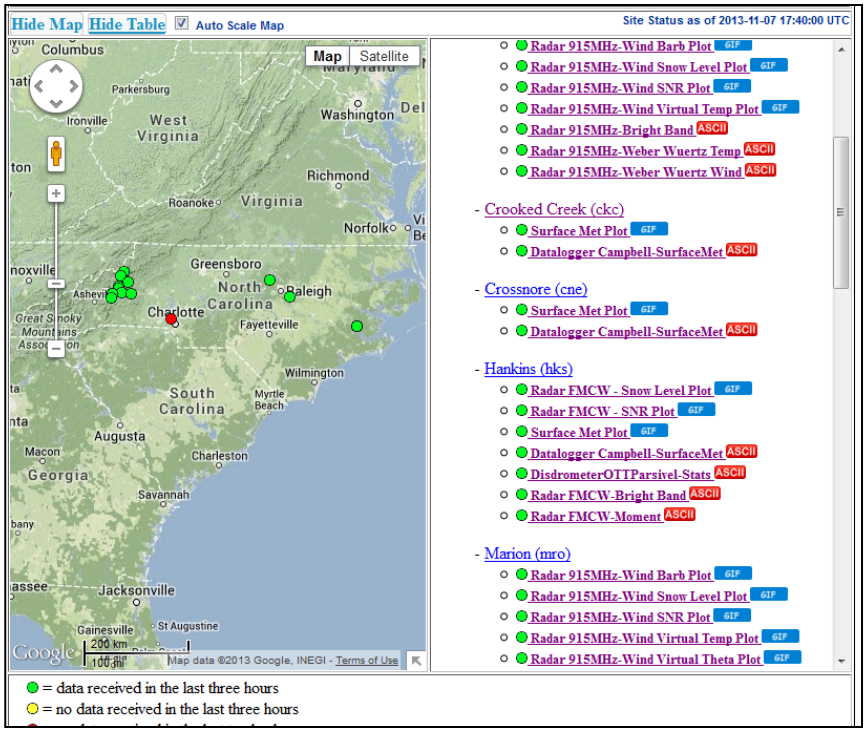
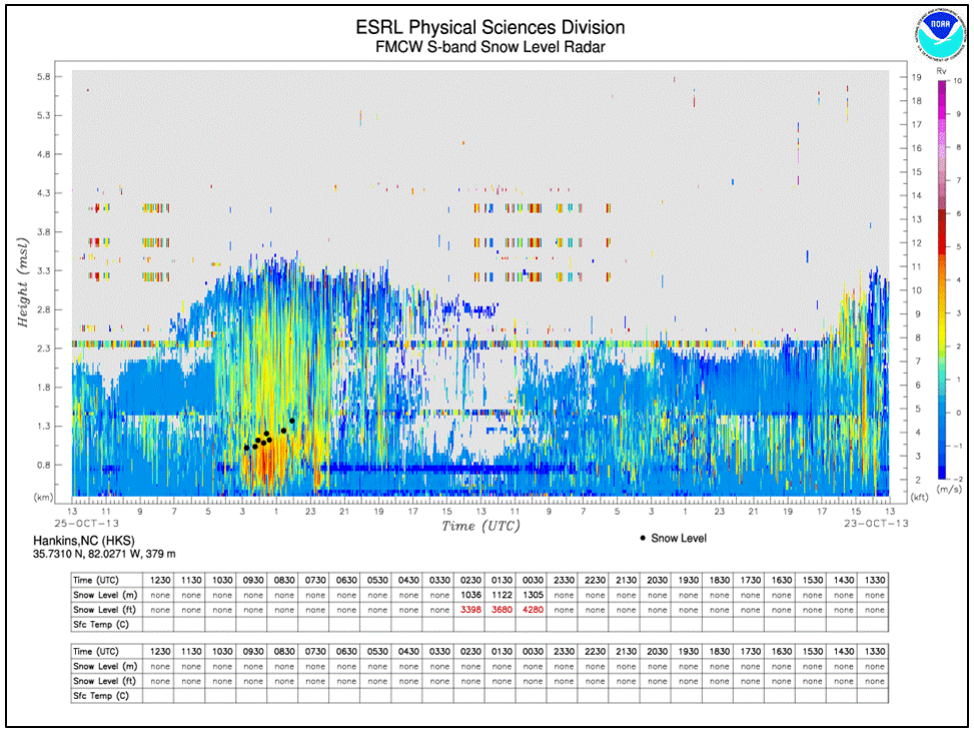




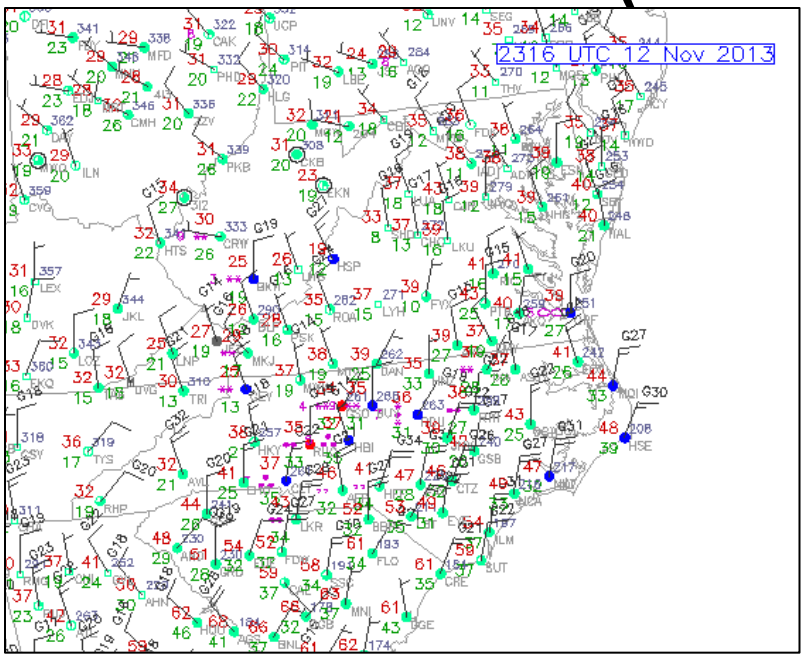
Contact information

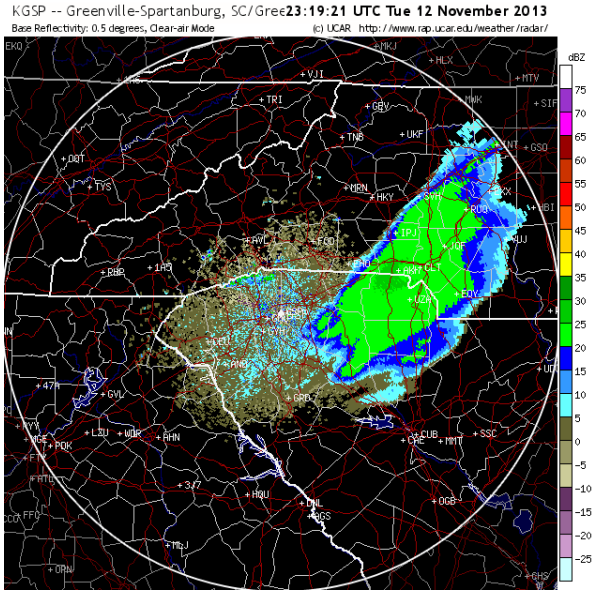
- Facebook: https://www.facebook.com/NOAAHMTSoutheast (frequent updates, news interactive sharing between community members)
- Webpage: http://hmt.noaa.gov/field_programs/hmt-se/ (background information, science plan, documentation)

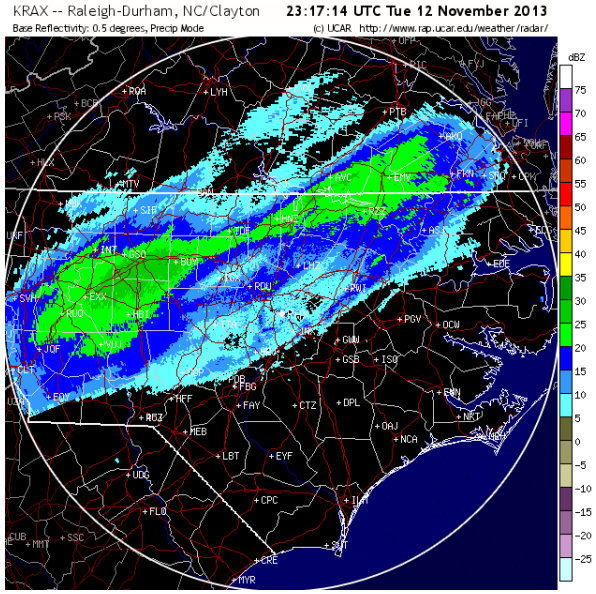
- Project manager: Rob Cifelli (rob.cifelli@noaa.gov)
- Lead Scientist: Kelly Mahoney (kelly.mahoney@noaa.gov)
- Data, observations: Allen White (allen.b.white@noaa.gov)
- WFO/R2O: Dave Reynolds (David.Reynolds@noaa.gov)
- HMT-West research examples: (Paul.J.Neiman@noaa.gov, David.Kingsmill@noaa.gov)
- Displays, webpage:
  - Tim Coleman (timothy.coleman@noaa.gov)
  - Dan Gottas (daniel.gottas@noaa.gov)

Extra slides

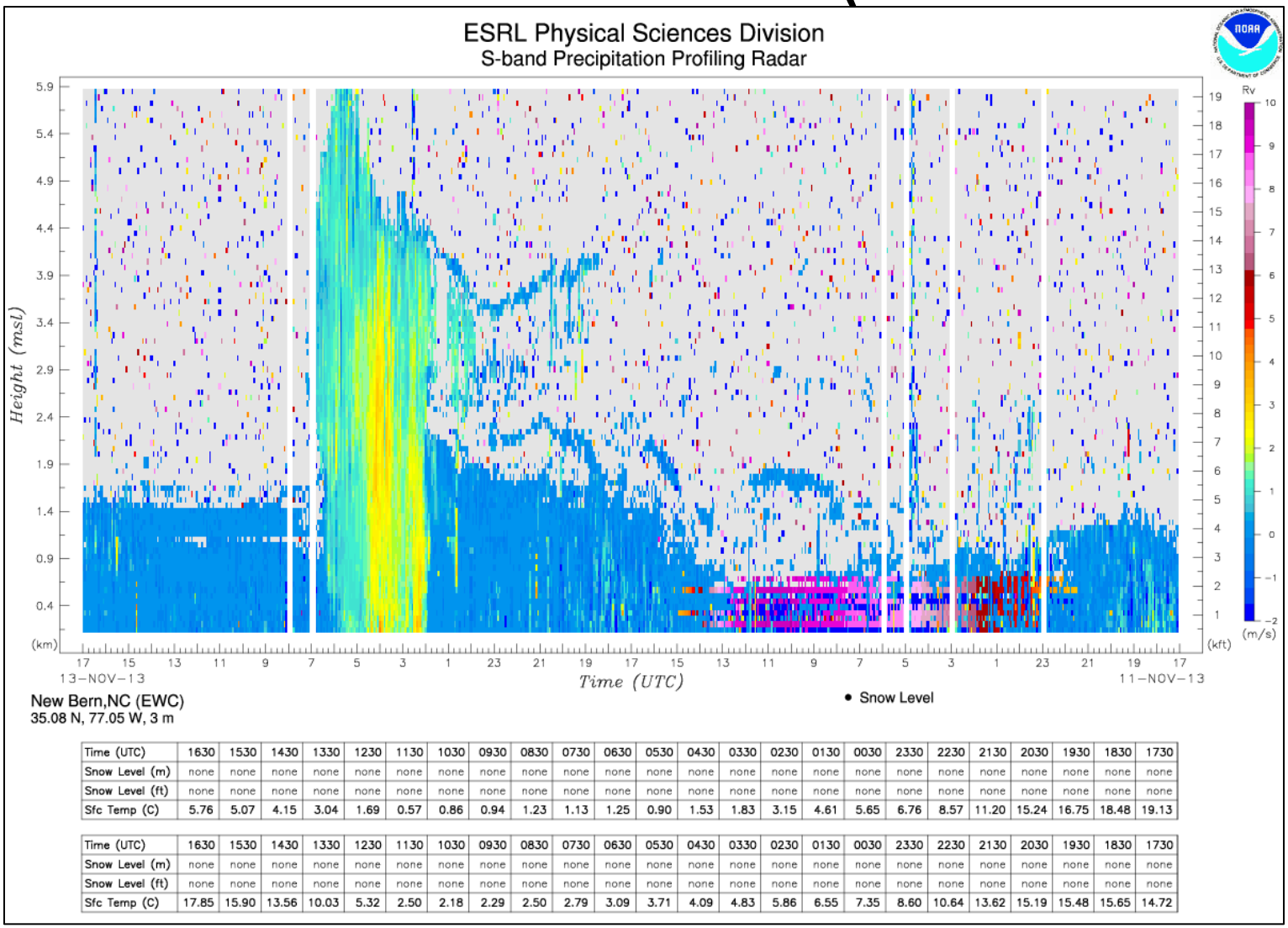
This week's snow event (12 Nov 2013)







This week's snow event (12 Nov 2013)



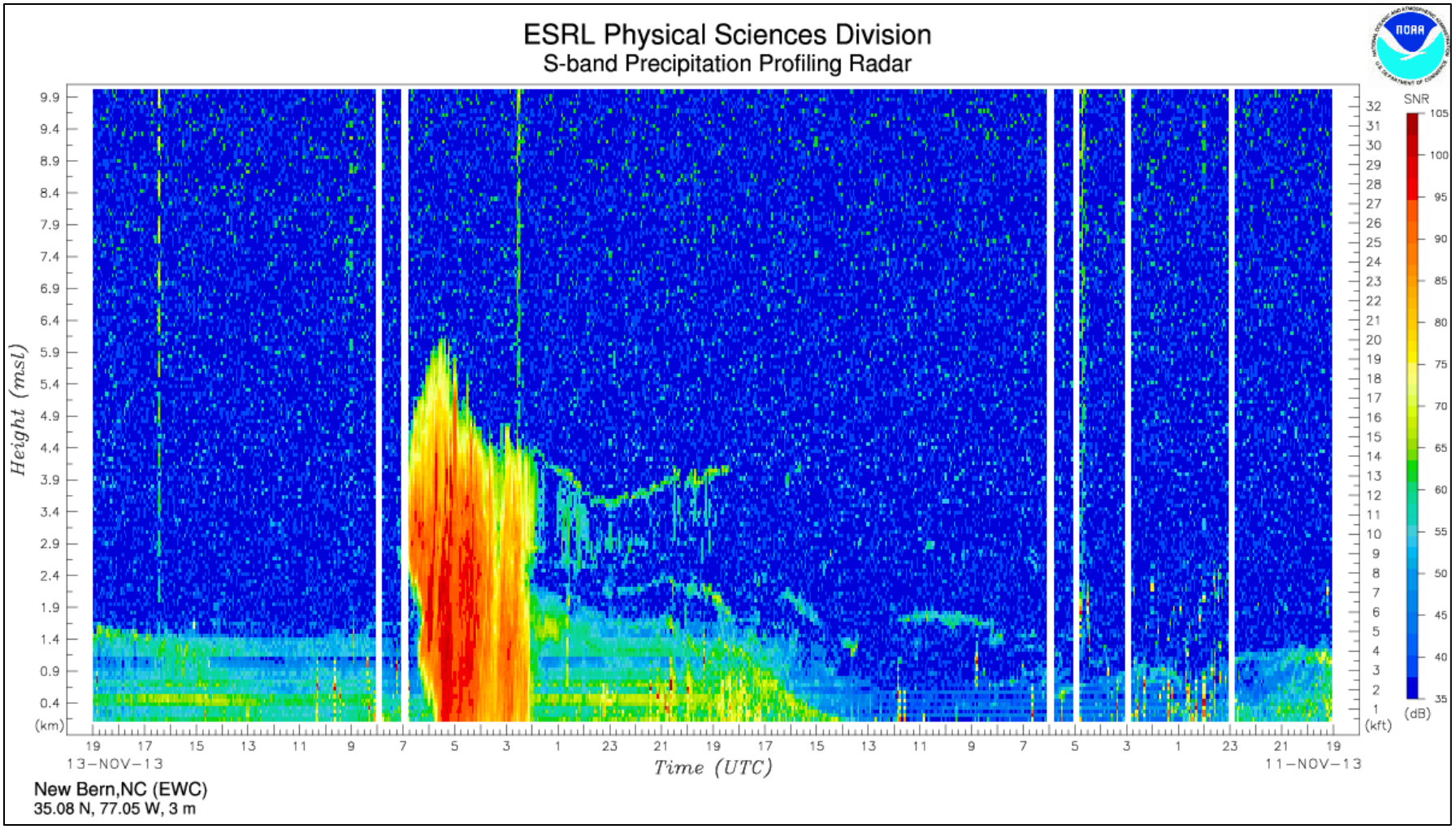
Time (UTC)	1630	1530	1430	1330	1230	1130	1030	0930	0830	0730	0630	0530	0430	0330	0230	0130	0030	2330	2230	2130	2030	1930	1830	1730
Snow Level (m)	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none
Snow Level (ft)	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none
Sfc Temp (C)	5.76	5.07	4.15	3.04	1.69	0.57	0.86	0.94	1.23	1.13	1.25	0.90	1.53	1.83	3.15	4.61	5.65	6.76	8.57	11.20	15.24	16.75	18.48	19.13

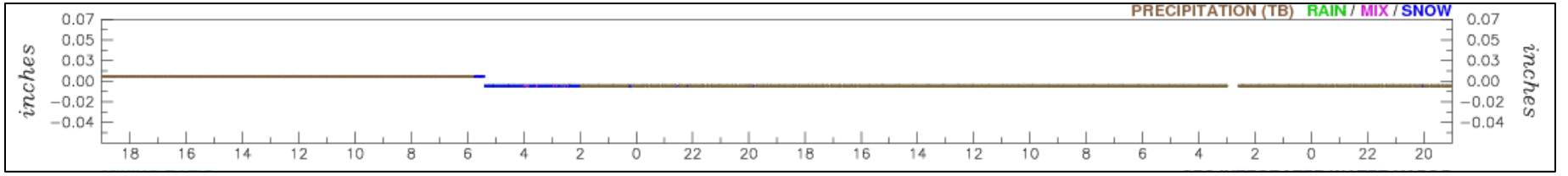
Time (UTC)	1630	1530	1430	1330	1230	1130	1030	0930	0830	0730	0630	0530	0430	0330	0230	0130	0030	2330	2230	2130	2030	1930	1830	1730
Snow Level (m)	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none
Snow Level (ft)	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none
Sfc Temp (C)	17.85	15.90	13.56	10.03	5.32	2.50	2.18	2.29	2.50	2.79	3.09	3.71	4.09	4.83	5.86	6.55	7.35	8.60	10.64	13.62	15.19	15.48	15.65	14.72

Questions from WFOs RAH and MHX:

- How to interpret the higher velocities at around 04 UTC in the 5-10 kft range?
- Disdrometer data is in ascii format and I couldn't make heads or tails from it. Is there a decoder or some plot that could be developed for the 0-08 UTC period that could tell me what the disdrometer was "seeing"?
- We had snow last night and thought we could use the S-band to look at the freezing level aloft. But it wasn't as simple to find as we'd thought it would be?

This week's snow event (12 Nov 2013)





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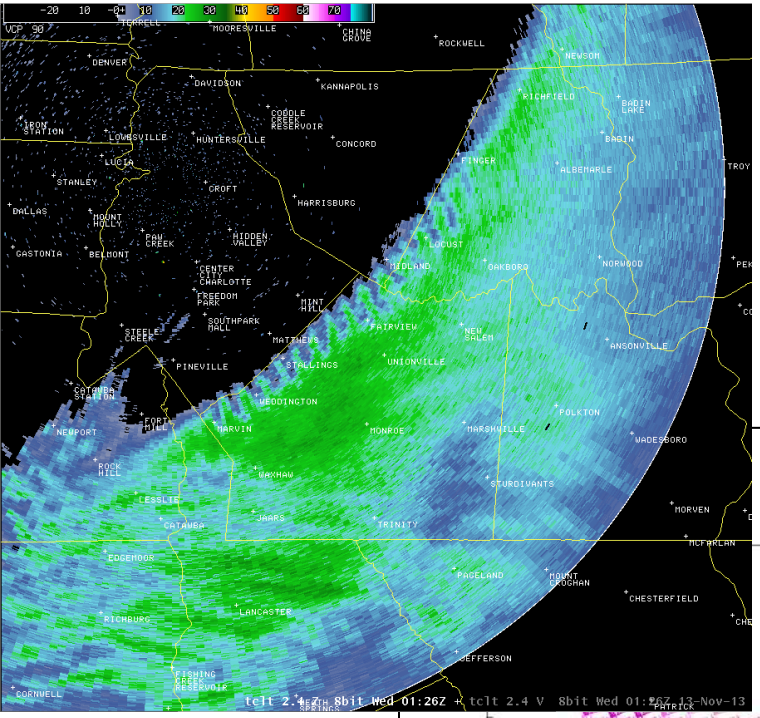
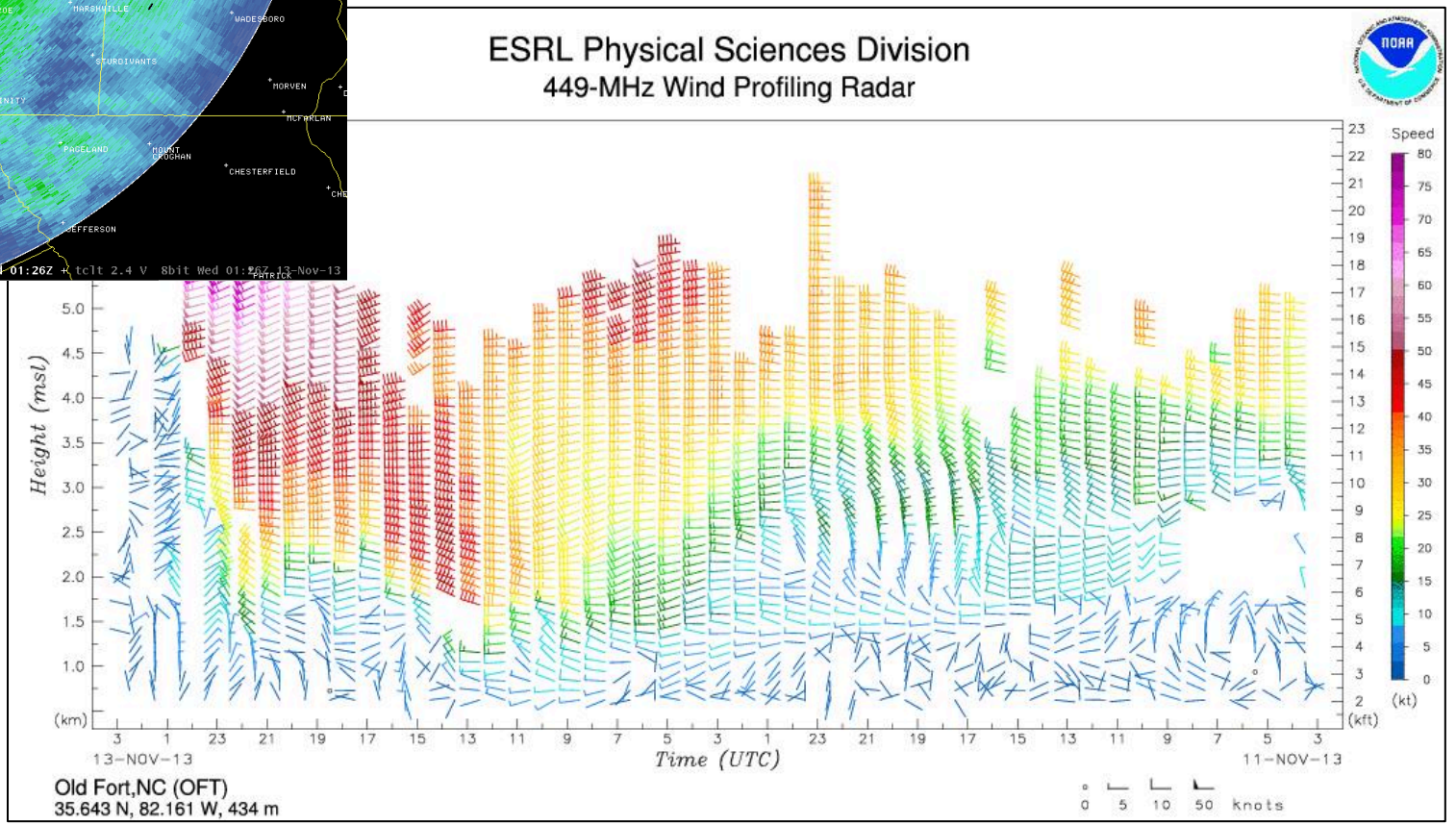
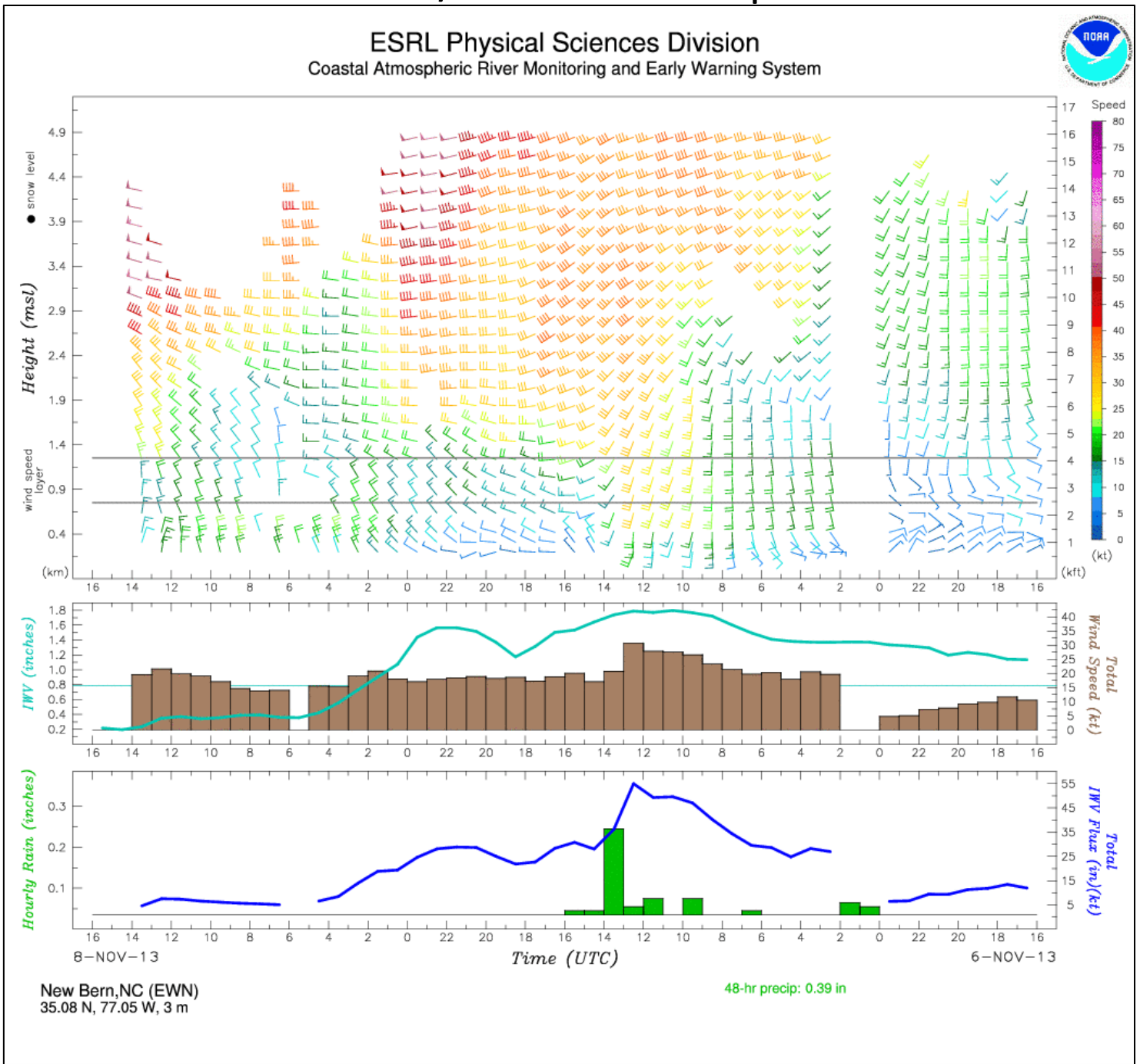


- Gravity wave formation on the back edge of snow band?



ARO/Flux tool example