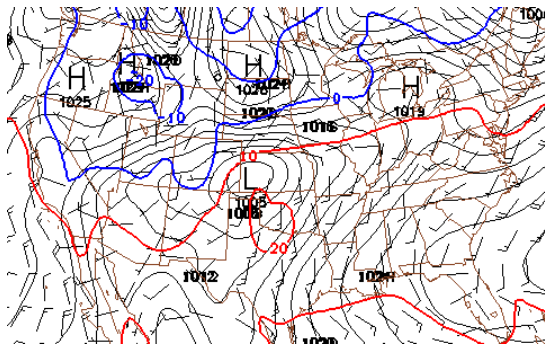


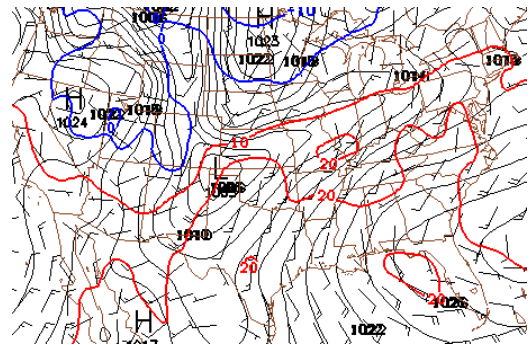
IOP-4 Summary of Operations
7 March 2009, 2200 UTC – 8 March 2009 2100 UTC

Authors: Rauber, Knupp, Brown

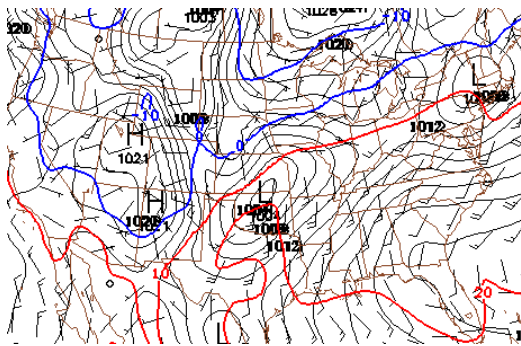
IOP-4 focused on a cyclone that developed in Southeast Colorado on 7 March at 0000 UTC. The center of the storm remained just north of the Oklahoma Panhandle for 12 hours through 1800 UTC 7 March (Fig. 1a,b), and then moved very slowly eastward, remaining just north of Oklahoma through 0600 UTC on 8 March. Throughout the 24 hour time period from 0600 UTC 7 March to 0600 UTC 8 March, a stationary front remained across central Kansas, Missouri, Illinois and Indiana, with a band of moderate to heavy rain located north of the warm front (Figs 1a-d, Fig.2a,b). The cyclone deepened and tracked rapidly northeastward along the frontal boundary between 0600 UTC and 1800 UTC, 08 March, with the central low pressure center arriving in central Illinois by 1800 UTC (Figs 1c, d). The storm continued eastward with the low pressure center over south-central Michigan by 0000 UTC 9 March.



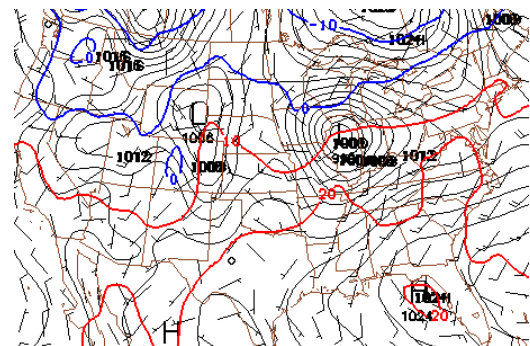
A. 7 Mar 09 0600 UTC Surf Pres/Temp



B. 7 Mar 09 1800 UTC Surf Press/Temp

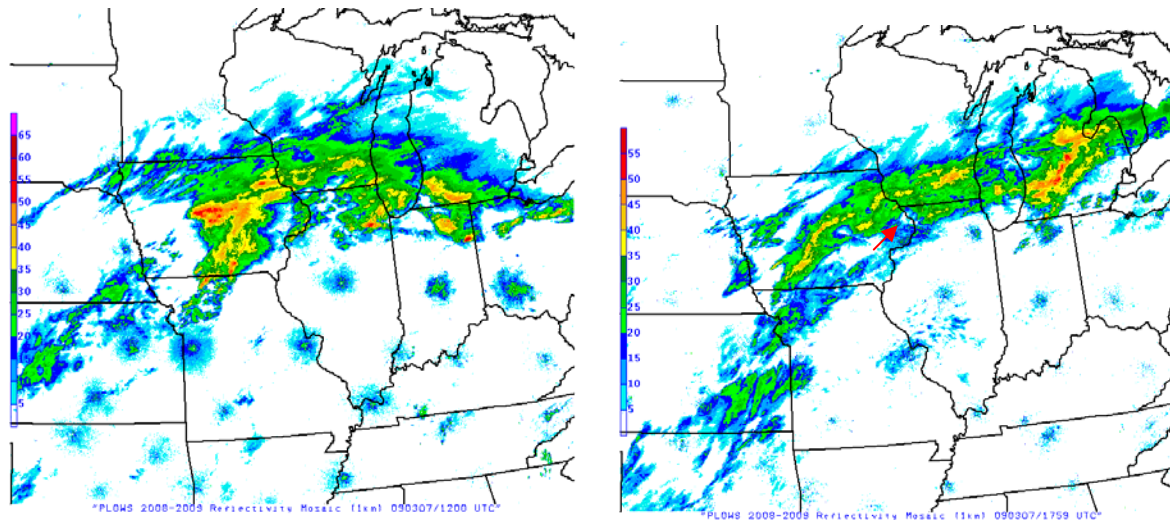


C. 8 Mar 09 0600 UTC Surf Pres/Temp



D. 8 Mar 09 1800 UTC Surf Press/Temp

Figure 1A-D Evolution of surface cyclone during IOP-4 from 0600 UTC 7 March-1800 UTC 8 March 2009.



Figs. 2a-b: Radar image showing rain north of the stationary front at 1200 and 1800 UTC, 7 March, prior to the start of operations at KDVN at 2100 UTC 7 March 09.

The forecast suggested that the best location to deploy would be LaCross, WI (KARX). All systems deployed to the KARX site on 6 March, arriving at 7 March around 0000 UTC, prior to the storm. After a night's rest, the 1500 UTC briefing indicated, based on the 1200 UTC run of the NAM, that operations were too far north. The decision was made to redeploy to Davenport, IA (KDVN). The MAX/MIPS arrived at the KDVN NNE site at 41°49' 47.8"N 90° 28' 16.6"W after driving across the rainband associated with the stationary front. The system was operational by 0000 UTC, 8 March. The MISS deployed to the KDVN SSW MISS site at 41° 37' 6.1"N 90° 47' 7.26"W. The MISS Profiler commenced operation at 2200 UTC 7 March, and soundings were launched beginning at 0000 UTC, 8 March.

The MAX/MIPS was operational from 8 March 0000 UTC to 8 March 2200 UTC, except for a XX minute period from approximately 1700 to 1730 UTC when all systems had a power failure. Three scan types were used for the MAX during the event: VAD volume scans (elevations close to that of VCP 11), RHI scans (nominally normal to precipitation bands, in sectors ranging from 260°-330°), and vertically-pointing (moments and time series). The 915 MHz profiler ran continuously through the event, except for the brief power outage near 1700 UTC, as did other operating instruments. Rain fell through the period.

At the start of operations between 2200 UTC 7 March (Fig. 3) and 0000 UTC 8 March (Fig. 4), a scattered line of precipitation associated with the stationary front was located north of KDVN across Iowa and Nebraska, while a weak second line was along the upper level jet across Missouri and Oklahoma. Convection was erupting east of the low pressure center in Oklahoma. The MAX and MISS sites received light rain from the northern line, primarily from convective cells within the line. Convective cells from this line continued to pass the site through 0300 UTC (Fig. 5). By 0600 UTC, a broad area of stratiform precipitation with heavy bright band echo had developed over the site and

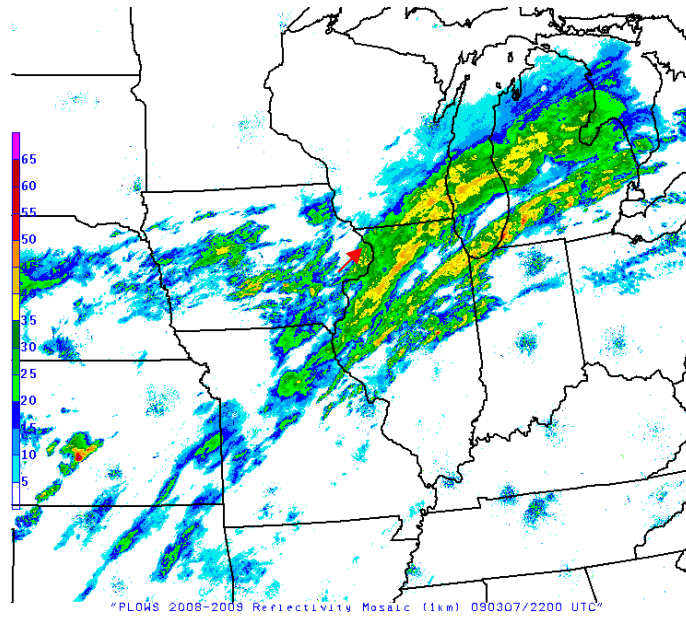


Figure 3: Composite reflectivity from WSR-88D radars at 2200 UTC, 7 March 09

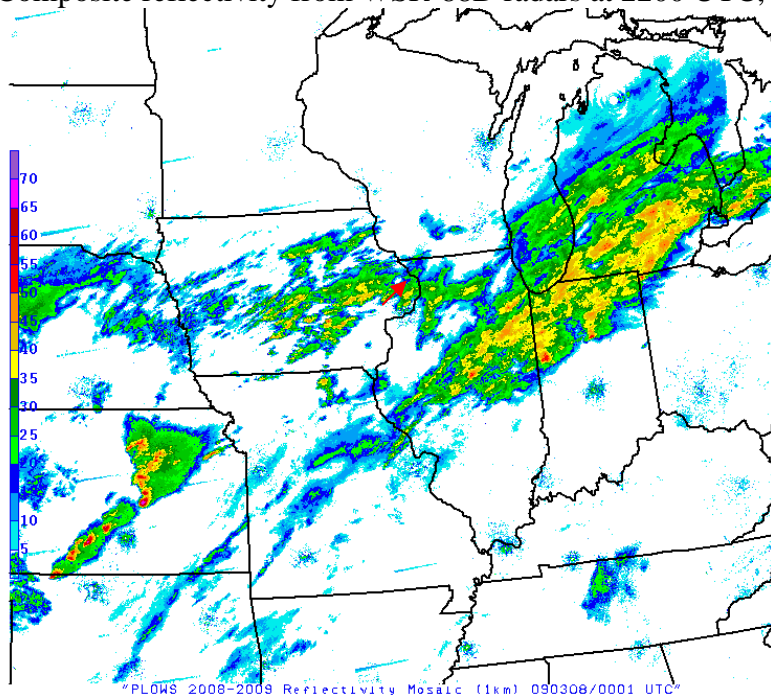


Figure 4: Composite reflectivity from WSR-88D radars at 0000 UTC, 8 March 09

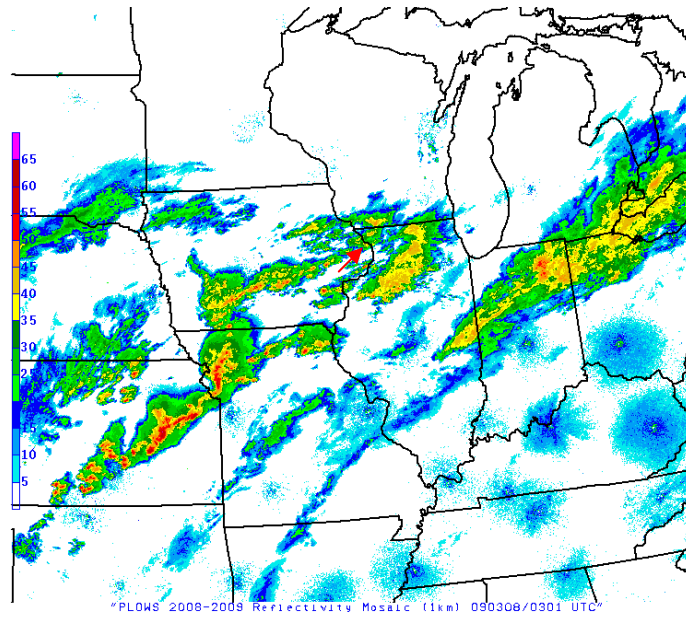


Figure 5: Composite reflectivity from WSR-88D radars at 0300 UTC, 8 March 09

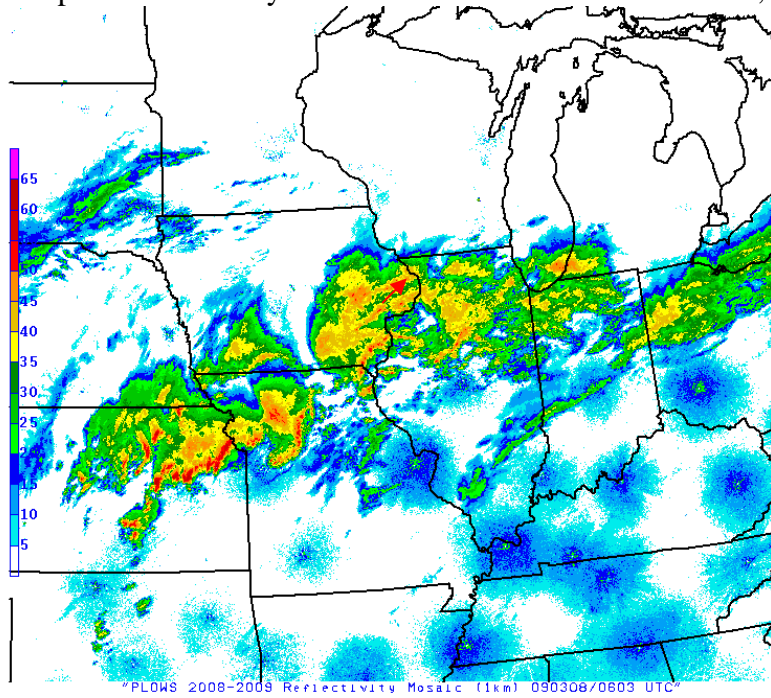


Figure 6: Composite reflectivity from WSR-88D radars at 0600 UTC, 8 March 09

along the line. Convective and stratiform rain was present all along the stationary front from central Kansas, across northern Missouri, southern Iowa and Northern Illinois.

The cyclone's precipitation shield continued to develop between 0900 UTC (Fig. 7) and 1200 UTC (Fig. 8a) at which time the central low pressure was located over the Kansas-Missouri border (Fig. 8b). A "wrap around" shield of precipitation just started to develop. At 1500 UTC, the site was under a deep stratiform rain shield (Fig. 9). The MAX site remained in the warm sector rain shield until about 1710 UTC when the northern end of a narrow dry slot moved over the site (Fig. 10). Gravity wave features appeared in the profiler data at this time. The MAX radar was down during the dry slot passage due to a power failure, but recovered just as the western precipitation shield approached. A very narrow band with dark cloud base and a bore-like pressure jump passed the radar during the passage of the wrap-around clouds and precipitation. The central core of the low aloft approached the site between 1900-2000 UTC (Figs. 11,12), moving directly over the site by 2100 UTC (Fig. 13) as the rain and clouds in the vicinity of the low weakened considerably. Banding developed in the wrap around over central Wisconsin during this time, well north of our site.

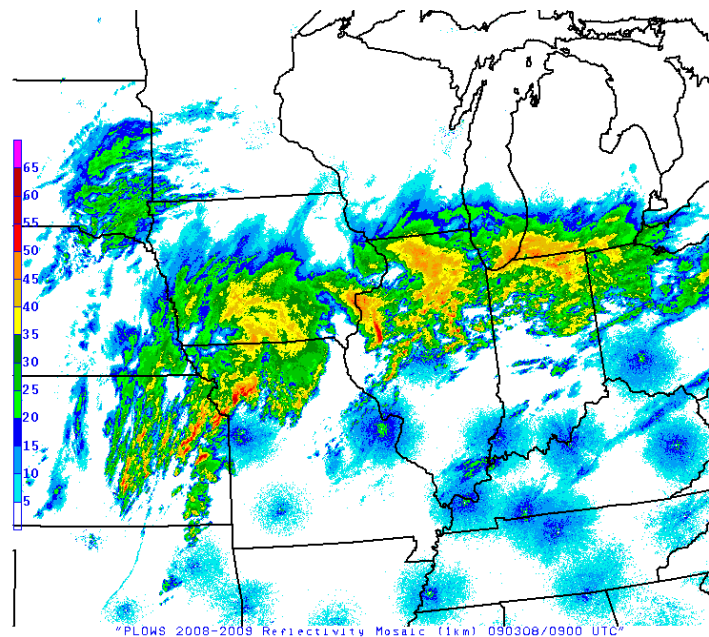


Figure 7: Composite reflectivity from WSR-88D radars at 0900 UTC, 8 March 09

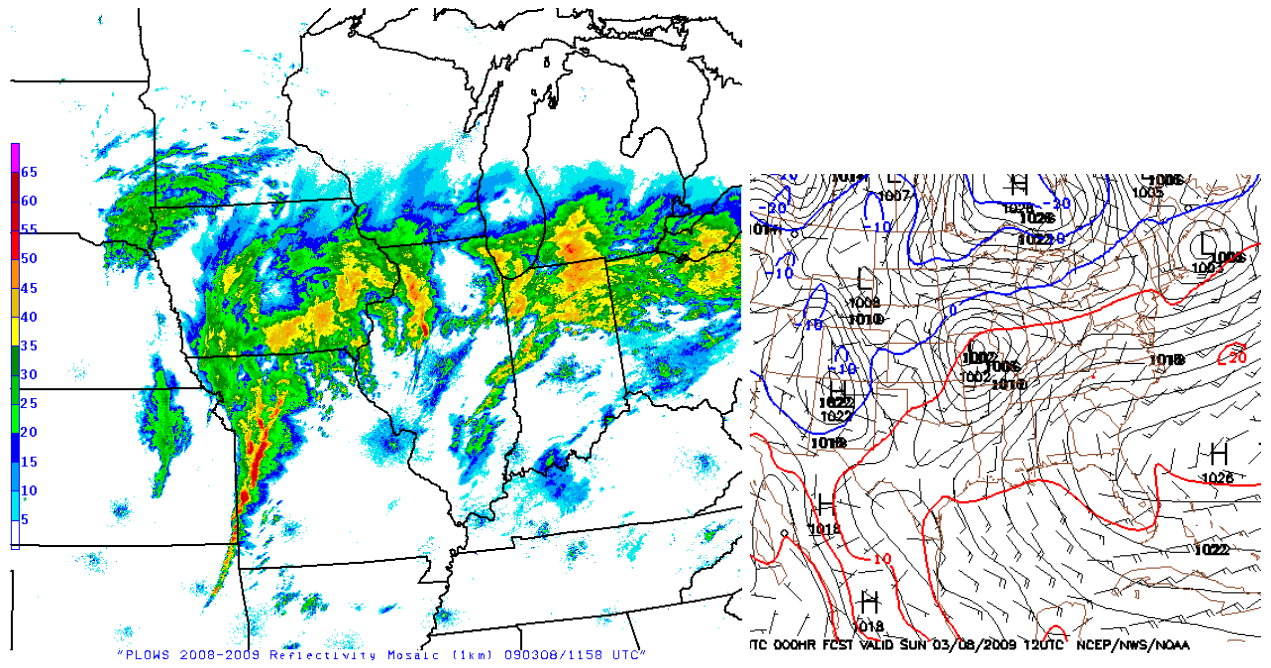


Figure 8a,b: Composite reflectivity from WSR-88D radars at 1200 UTC, 8 March 09 and surface pressure and temperature at 1200 UTC

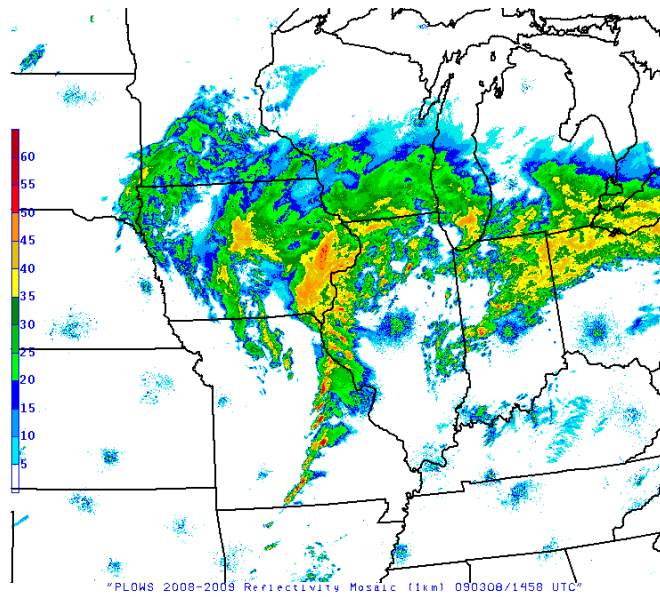


Figure 9: Surf Pres/Temp at 1500 UTC, 8 March 09

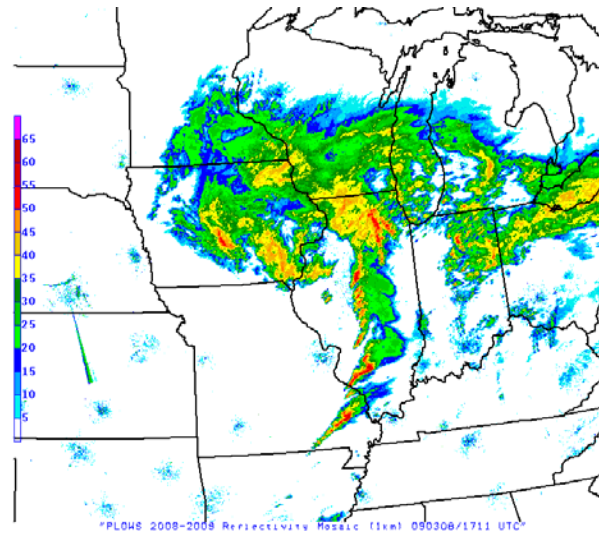


Figure 10: Surf Pres/Temp at 1710 UTC, 8 March 09

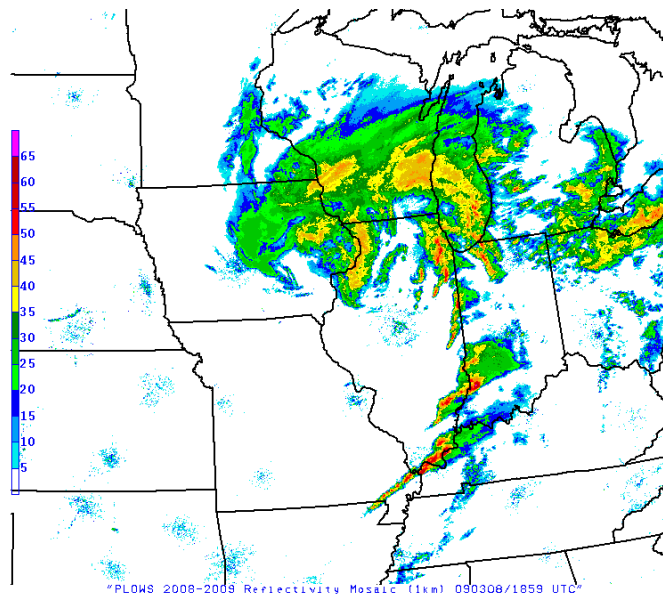


Figure 11: Surf Pres/Temp at 1900 UTC, 8 March 09

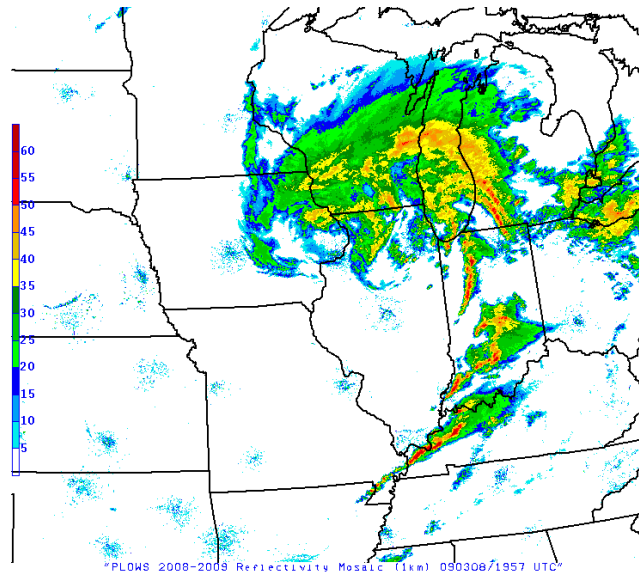


Figure 12: Surf Pres/Temp at 2000 UTC, 8 March 09

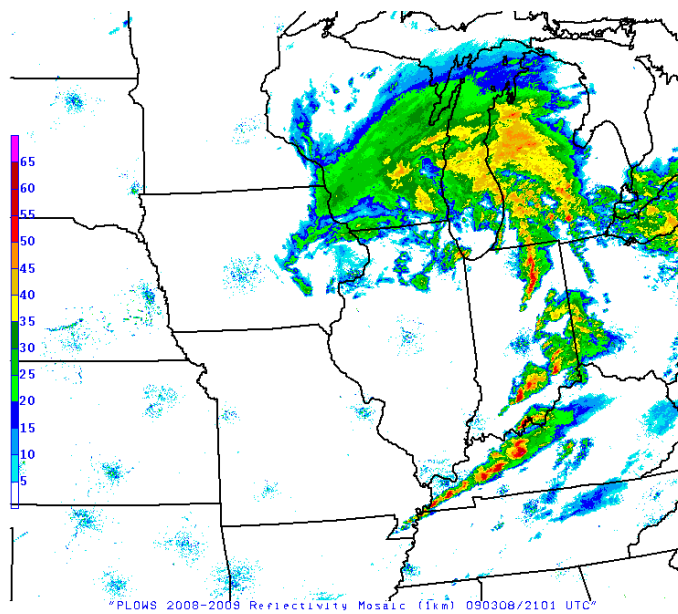


Figure 13: Surf Pres/Temp at 2100 UTC, 8 March 09

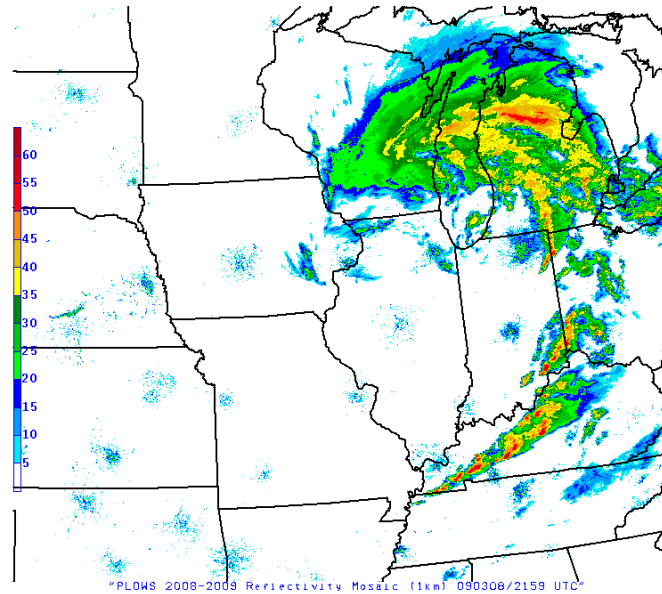


Figure 14: Surf Pres/Temp at 2200 UTC, 8 March 09

Figure 15a shows the SNR profile collected by the 915 MHz Profiler at the MIPS site. The SNR shows a series of deeper bands separated by gaps. It was unclear whether these are true banded features or individual cells passing over the radar. Lightning was observed occasionally prior to 1200 UTC, 8 March. No thunder or lightning was obvious after that. An interesting point is that these banded features were not as obvious on RHI scans taken at the MAX site, which generally showed deep stratiform clouds. The same type of

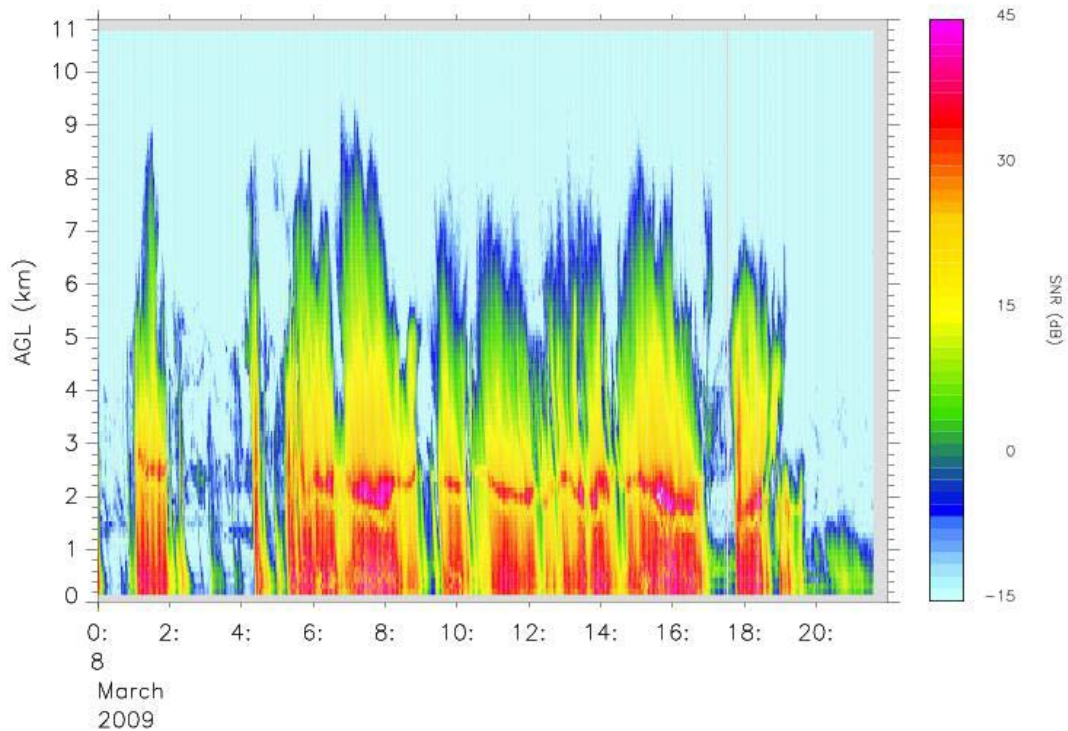


Fig. 15a: SNR from the MIPS 915 MHz profiler from 0000 UTC-2200 UTC 8 March 09.

features appeared on the MISS 915 MHz profiler SNR (Fig. 16c). The maximum velocities near cloud top (Fig. 15b, Fig 16d) were consistent with stratiform rain, except at the leading edge of the wrap around west of the dry slot, where strong upward velocities were evident.

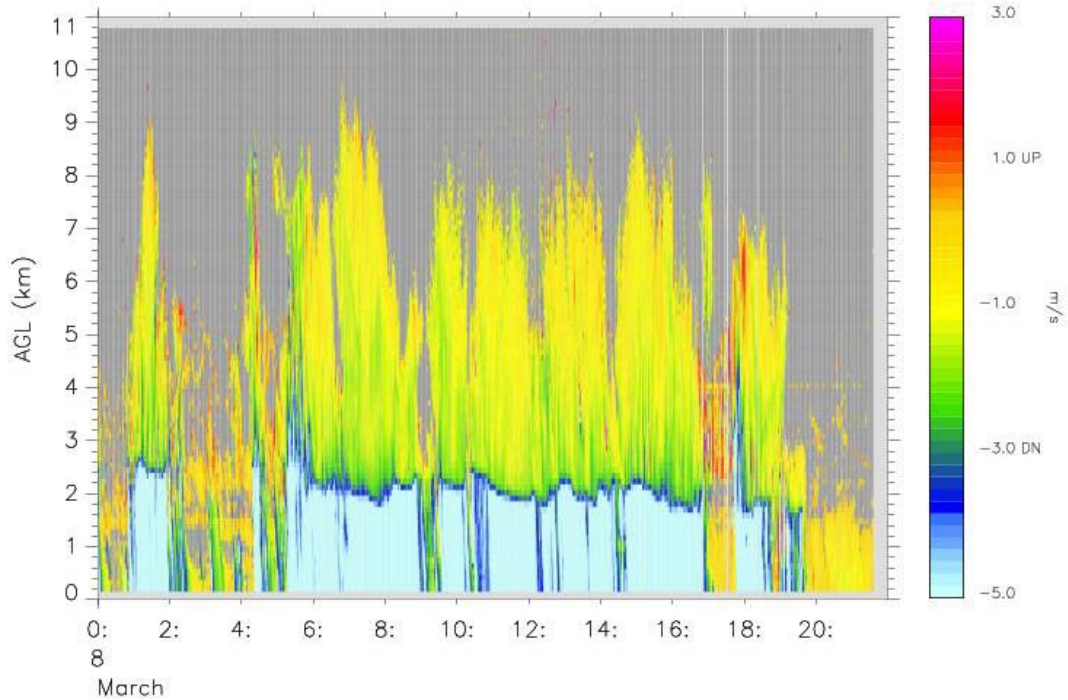


Fig. 15b: W from the MIPS 915 MHz profiler from 0000 UTC-2200 UTC 8 March 09.

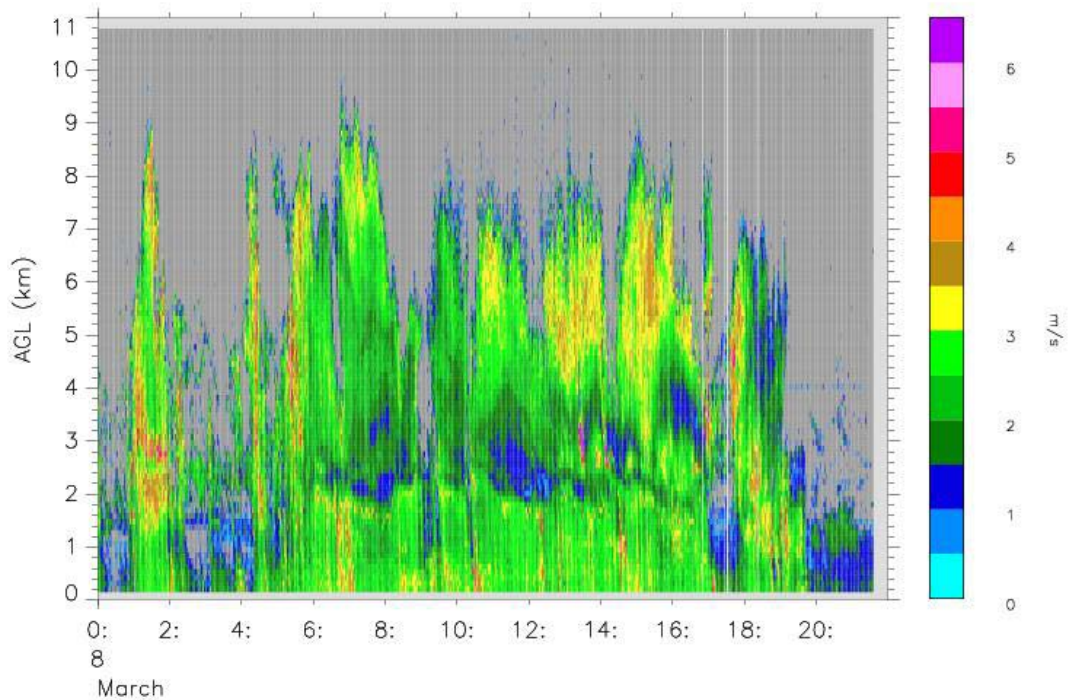


Fig. 15c: Spectral Width from the MIPS 915 MHz profiler from 0000 UTC-2200 UTC 8 March 09.

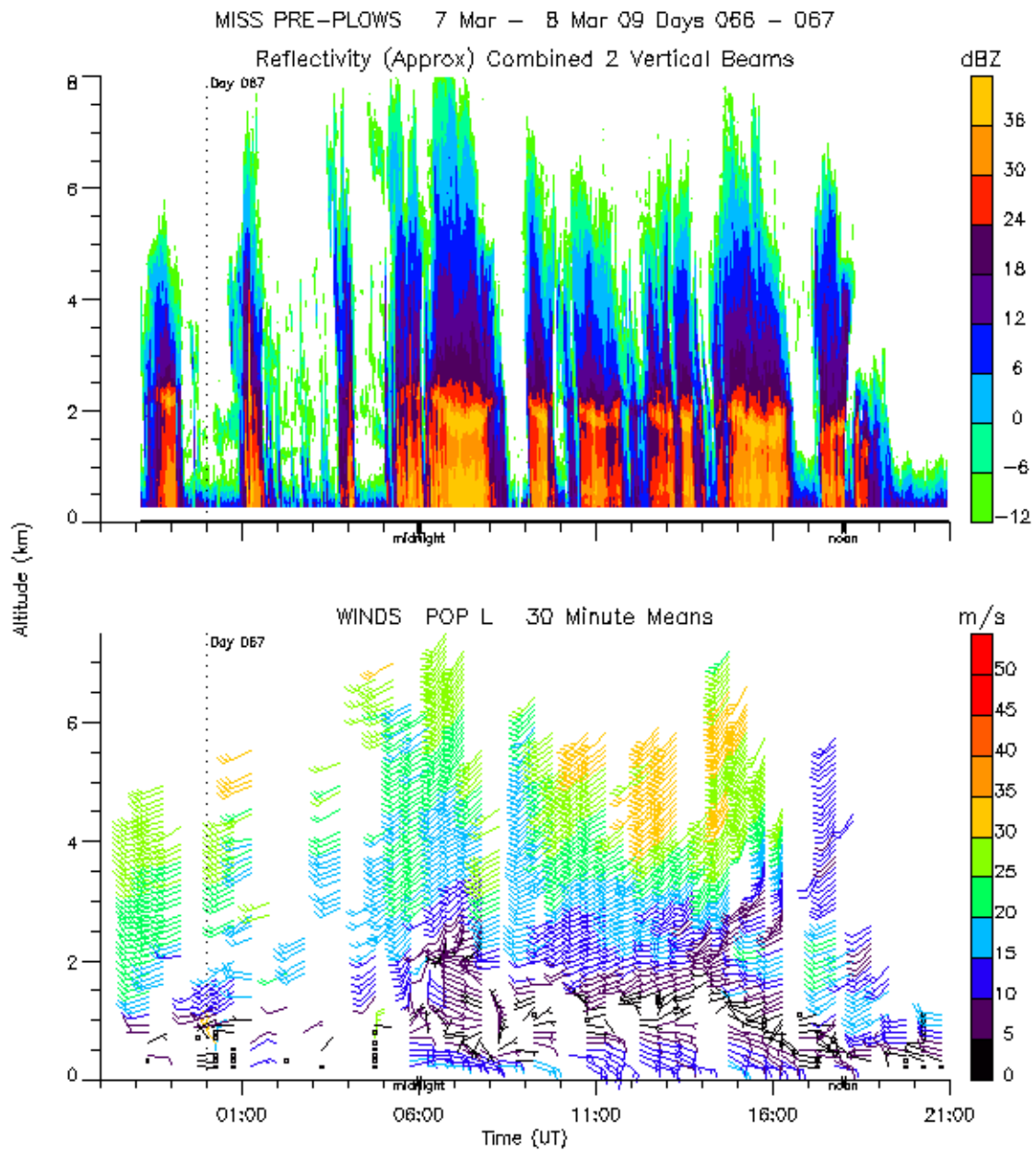


Fig. 16a,b: Reflectivity and winds from the MISS 915 MHz profiler from 2200 UTC, 7 March-2100 UTC 8 March 09.

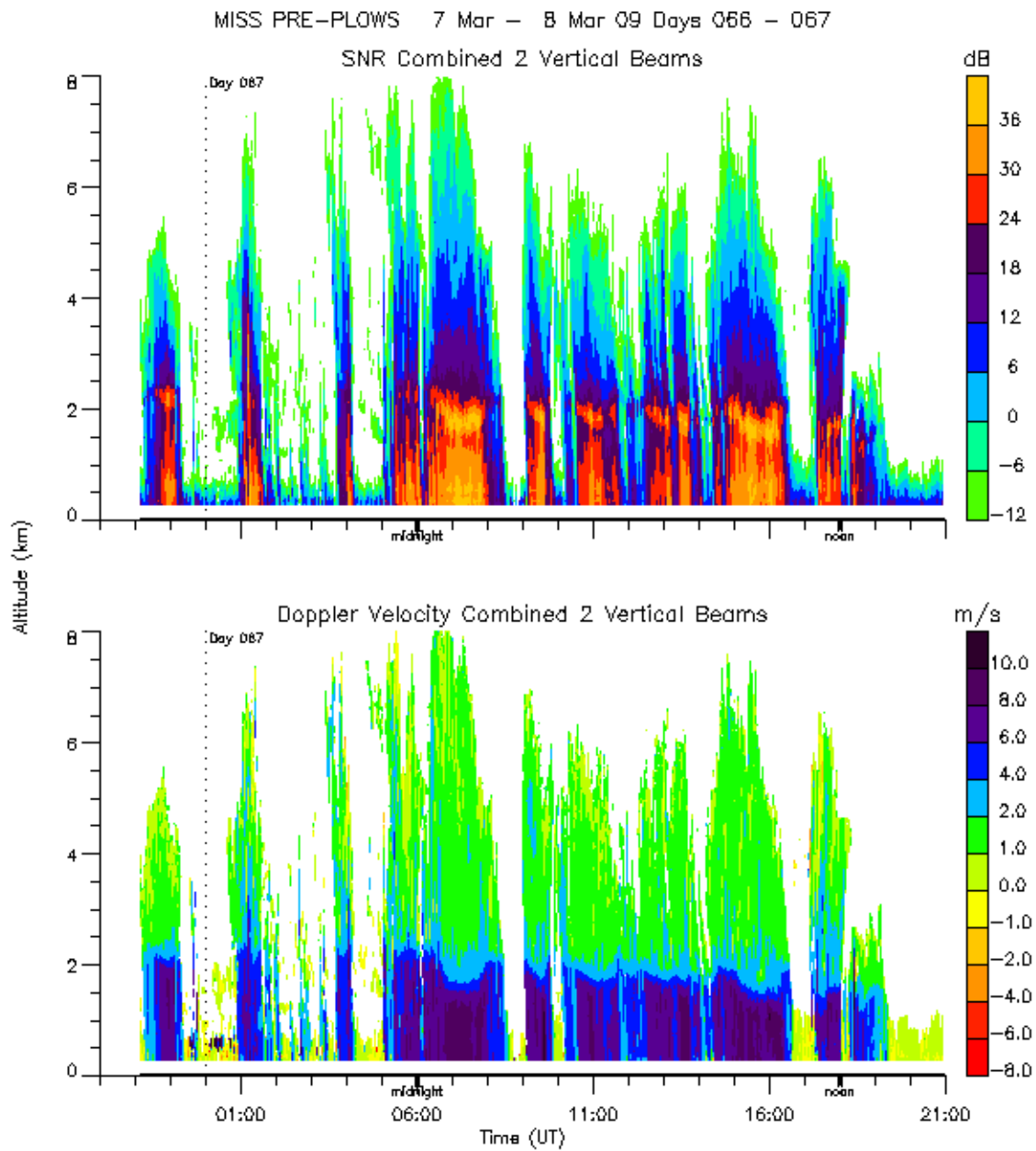


Fig. 16c,d: SNR and W from the MISS 915 MHz profiler from 2200 UTC 7 March-2100 UTC 8 March 09.

MISS Radiosonde Flights

Launch History - 11 launches, indicated by release time.

00:05 UTC (19:05 CDT)

01:58 UTC (20:58 CDT)

03:57 UTC (22:57 CDT)

05:57 UTC (00:57 CDT)

07:57 UTC (02:57 CDT)

10:01 UTC (05:01 CDT)

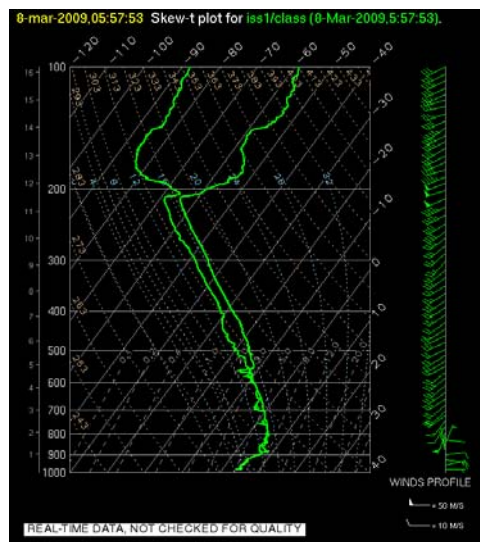
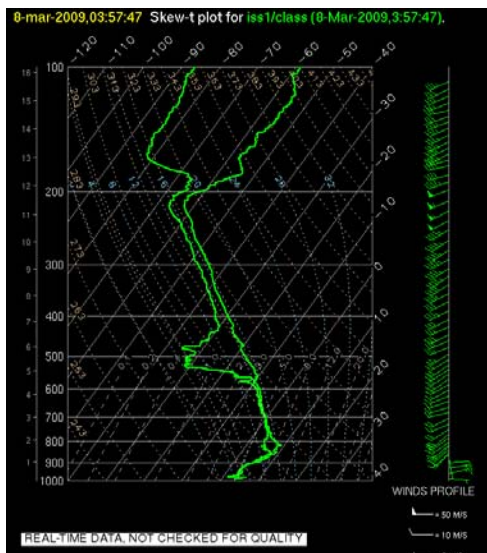
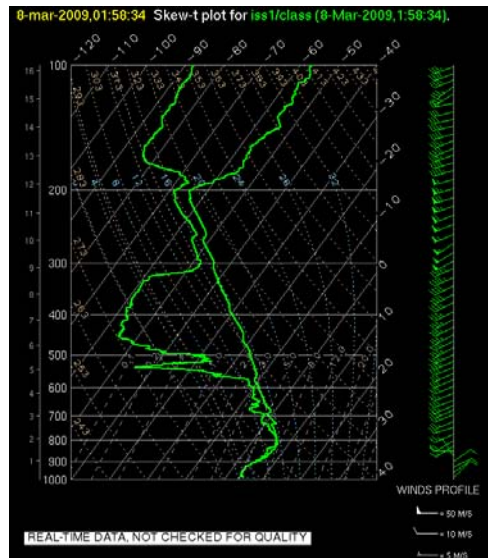
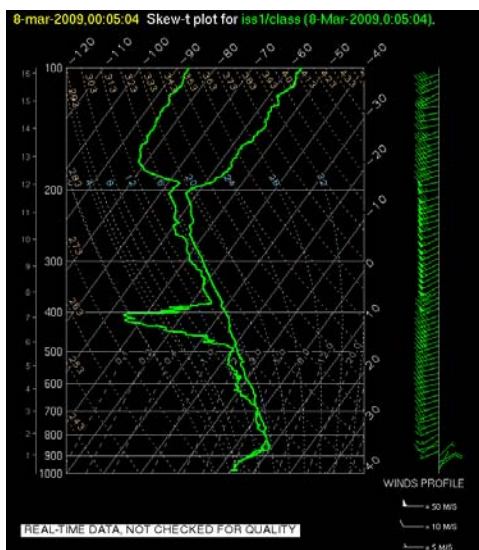
11:58 UTC (06:58 CDT)

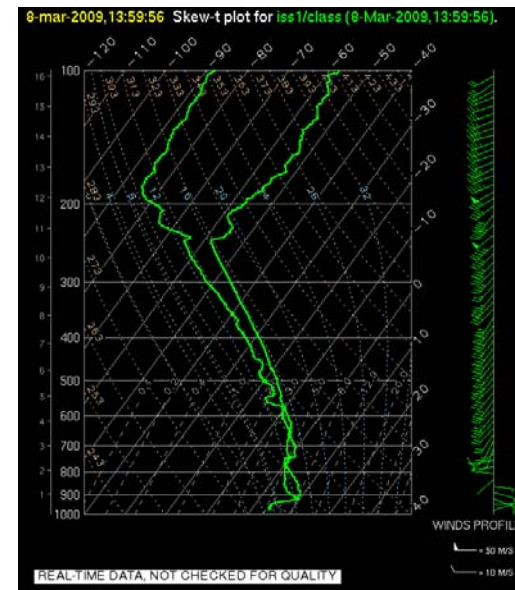
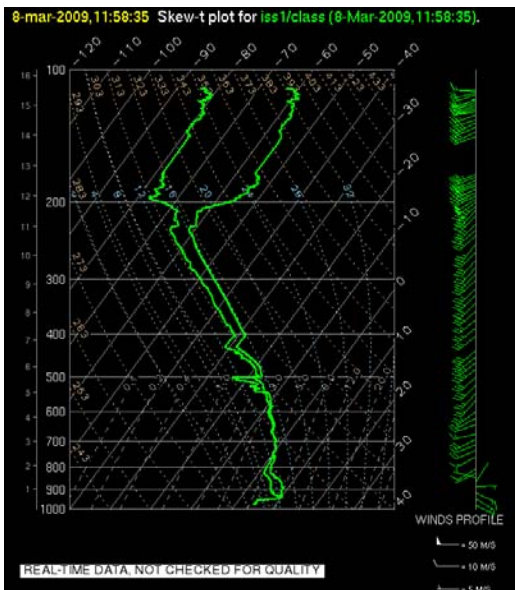
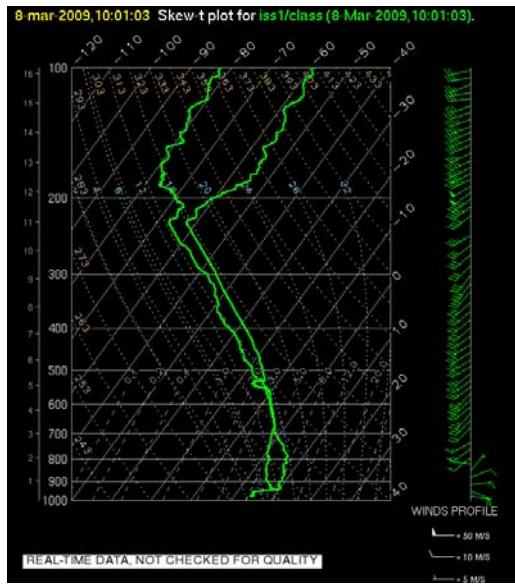
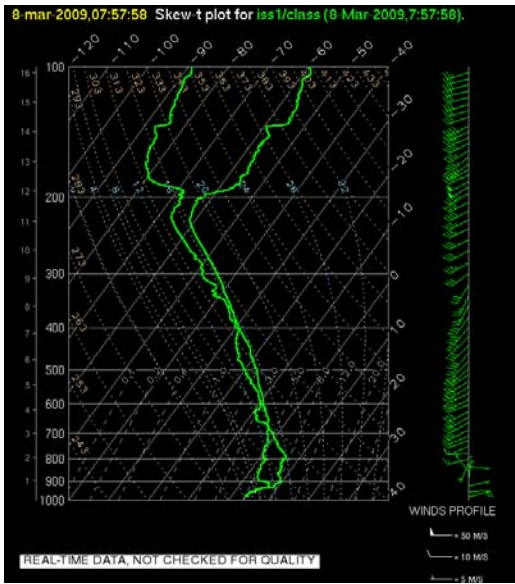
13:59 UTC (08:59 CDT)

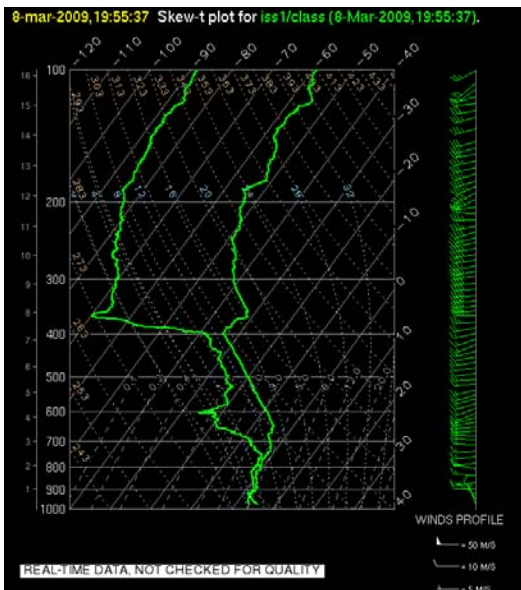
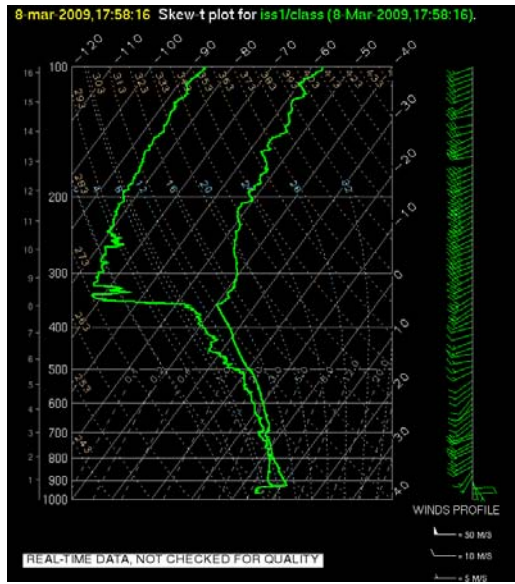
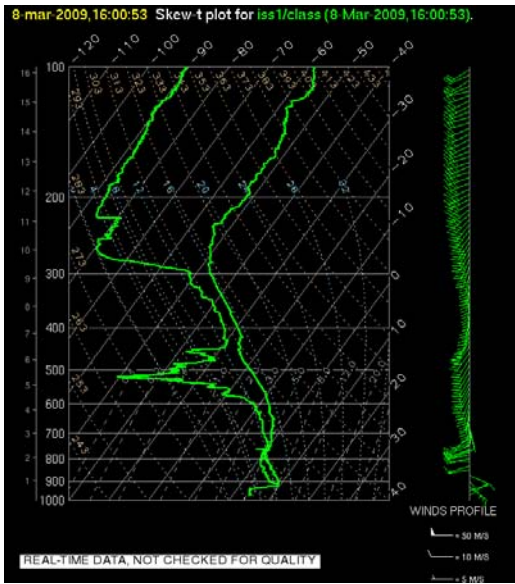
16:00 UTC (11:00 CDT)

17:58 UTC (12:58 CDT)

19:55 UTC (14:55 CDT)







KEY ISSUES

Site selection: The constraint of being 30 km from a WSR-88D left little options to target the best time and location, which would have been between KARX and KMKX or even as far north as Green Bay. We should consider the possibility of siting away from the WSR-88Ds if the option of being close to one is non-optimal, as it was during this event.

The dirt road siting option was non-optimal in this type of event which featured heavy rain. The road was chewed up in the region where cars had to pass the MAX-MIPS vehicles.

The NWS shift change lead to readjustments in the VCP-11 scans. It is important to call after each shift to remind the NWS of PLOWS operations.