IOP-5 Summary of Operations
28 March 2009, 1900 UTC – 29 March 2009 1800 UTC

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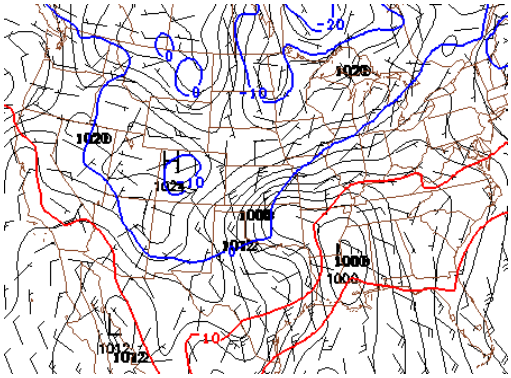
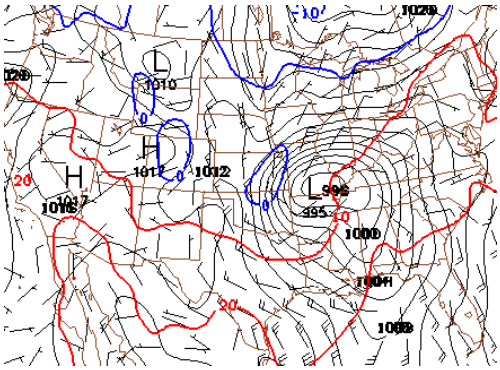
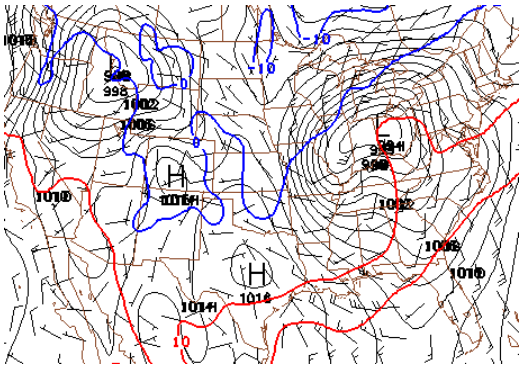
IOP-5 was associated with a strong cyclone that formed along the Gulf Coast between 0000 and 0600 UTC, March 28 and initially advanced northward along the Mississippi Valley through 1800 UTC, March 28, the approximate time that operations began (Fig. 1A, B). Aloft at 500 hPa, the surface cyclone was associated with a deep cutoff low that slowly propagated across Oklahoma during the same time period (Fig. 2A, B). During operations between 1800 UTC 28 March and 1800 29 March, the 500 hPa cutoff low propagated northeastward from eastern Oklahoma to northern Ohio (Fig. 2C, D). The center of the surface cyclone moved northeastward from southern Missouri into Ohio (Fig. 1C), where it split into two distinct centers, one which propagated northward over Lake Huron and the other which propagated eastward over Maryland (Fig. 1D).



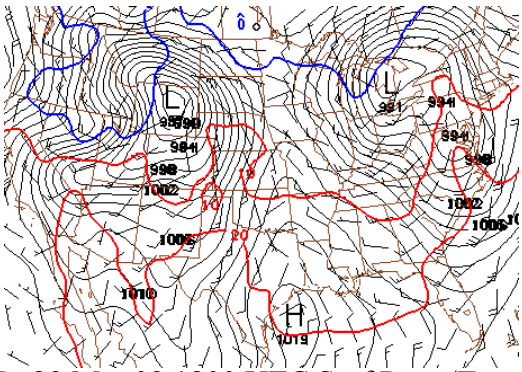
A. 28 Mar 09 0600 UTC Surf Pres/Temp



B. 28 Mar 09 1800 UTC Surf Press/Temp

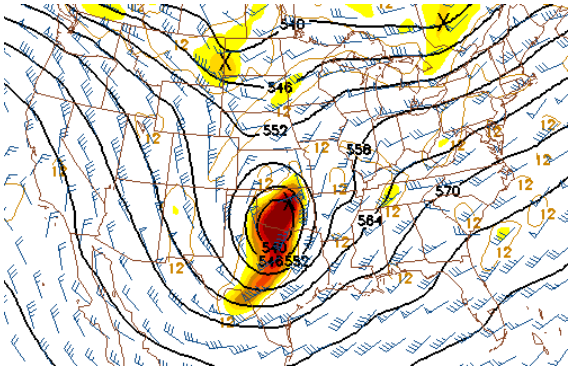


C. 29 Mar 09 0600 UTC Surf Pres/Temp

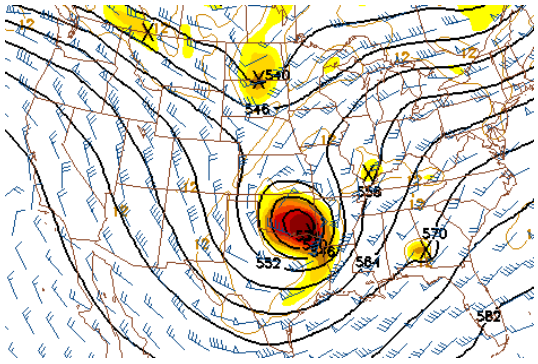


D. 29 Mar 09 1800 UTC Surf Press/Temp

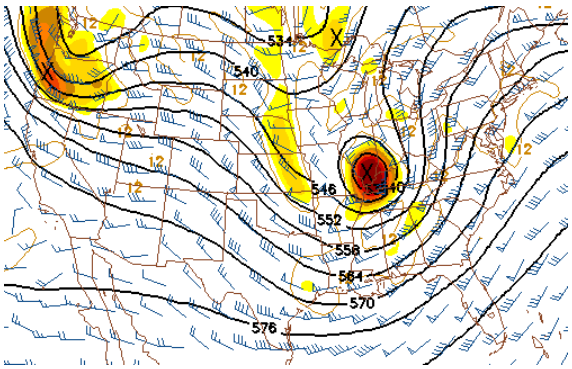
Figure 1A-D Evolution of surface cyclone during IOP-5 from 0600 UTC 28 March-0600 UTC 29 March 2009 1800 UTC.



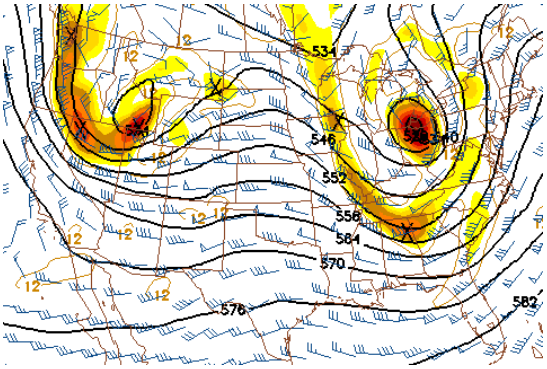
A. 28 Mar 09 0600 UTC 500 hPa heights/vort



B. 28 Mar 09 1800 UTC Heights/Vort



C. 29 Mar 09 0600 UTC 500 hPa heights/vort



D. 29 Mar 09 1800 UTC Heights/Vort

Figure 2A-D Evolution of the 500 hPa flow field during IOP-5 from 0600 UTC 28 March-0600 UTC 29 March 2009 1800 UTC.

The forecast suggested that the best location to deploy would be Joliet, IL (KLOT). All systems deployed to the KLOT site on 27 March, arriving at 27 March around 0000 UTC, prior to the storm. After a night's rest, the systems were deployed to the sites, with operations commencing at 1800 UTC for the Missouri Rawinsonde site and 1600 UTC for the MIPS/MAX site. The MAX/MIPS operated from the KLOT SSW site at 41°17' 31.5"N 88° 01' 58.2"W. The Missouri Rawinsonde group deployed to the Country Inn and Suites site off I-57 at Manteno, IL at 41° 14' 44.73"N, 87° 51' 12.96"W.

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 that varied as the storm passed the site), and vertically-pointing (moments, and time series during precipitation). The 915 MHz profiler ran continuously through the event. Rain fell through the warm frontal passage. Rain changed to sleet and snow during the passage of the trowal precipitation, with about 2 inches of total accumulation. Winds were exceptionally strong during the event, forcing the rawinsonde crew to have as many as 6 people coordinate a launch. Rawinsondes were discontinued from 0300 UTC, March 29 through 1000 UTC March 29 to allow the crew some rest since it was impossible to divide into shifts. This was the period when the site was under the dry slot of the storm. Sondes were launch after the leading edge of the dry slot arrived and before

the leading edge of the trowal moved over the site, so there was minimal loss of information associated with the break in continuity.

Figure 3 shows a national radar summary and water vapor satellite imagery at 1725 UTC 28 March 09, just after the start of operations. Note the position of the upper level front in Georgia, and the warm front and trowal of the cyclone extending from Indiana west and south to Oklahoma. The overall position of the leading edge of the dry slot extended across central Missouri eastward across the southern tip of Illinois, and southward across central Tennessee and central Alabama. Shortly before 2000 UTC 28 March, a new north-south band of convection developed along the cyclone's surface cold front near the Indiana-Illinois border. Over the next several hours (Figs. 5a,b, 6a,b) convection developed within the original dry slot and moved northward, the precipitation features within the original trowal region weakened and a completed new trowal-like region of precipitation developed parallel to, but south of the original trowal. In terms of precipitation structure, it appeared that a new cyclone regenerated within the circulation of the original cyclone.

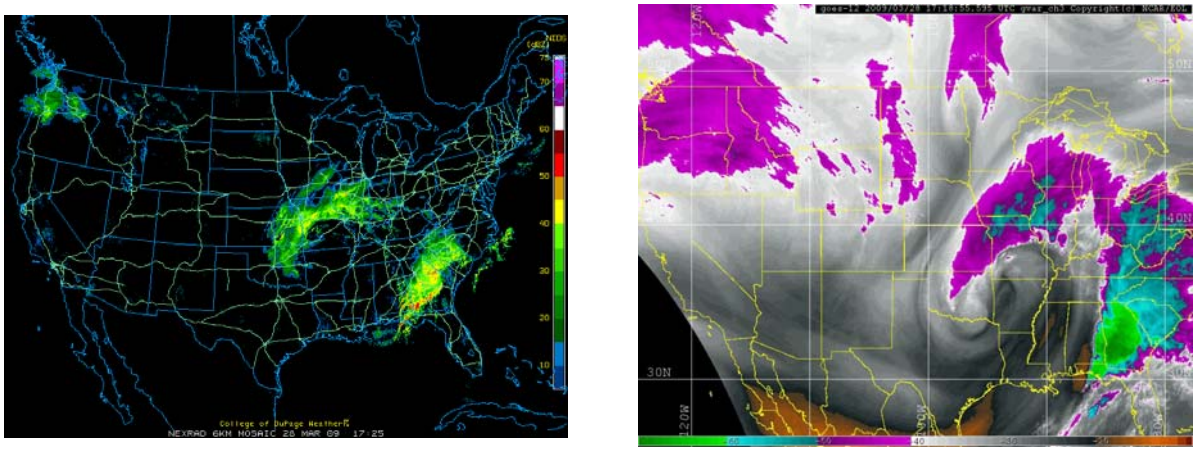


Fig. 3a, b: National radar summary and water vapor satellite imagery at 1725 UTC 28 March 09 just after the start of operations.

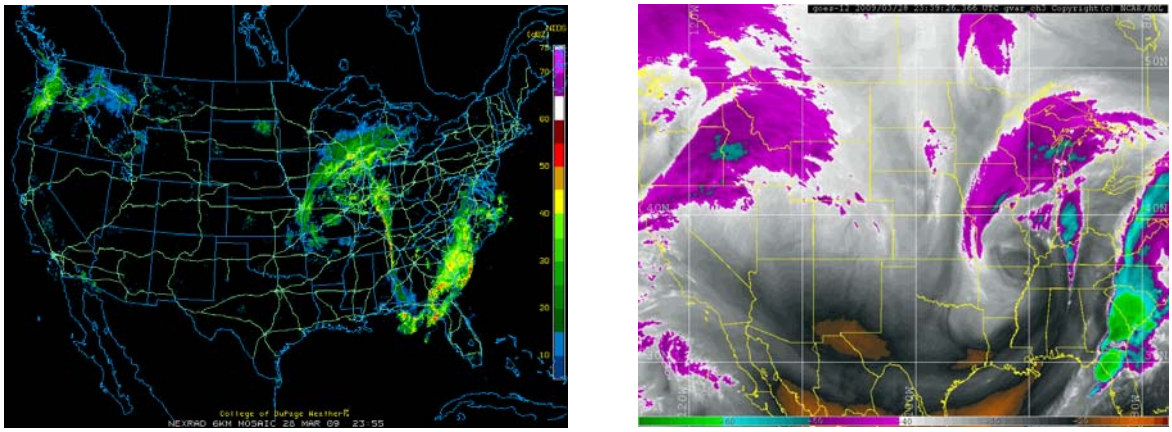


Fig. 4a, b: National radar summary and water vapor satellite imagery at 2355 UTC 28 March 09.

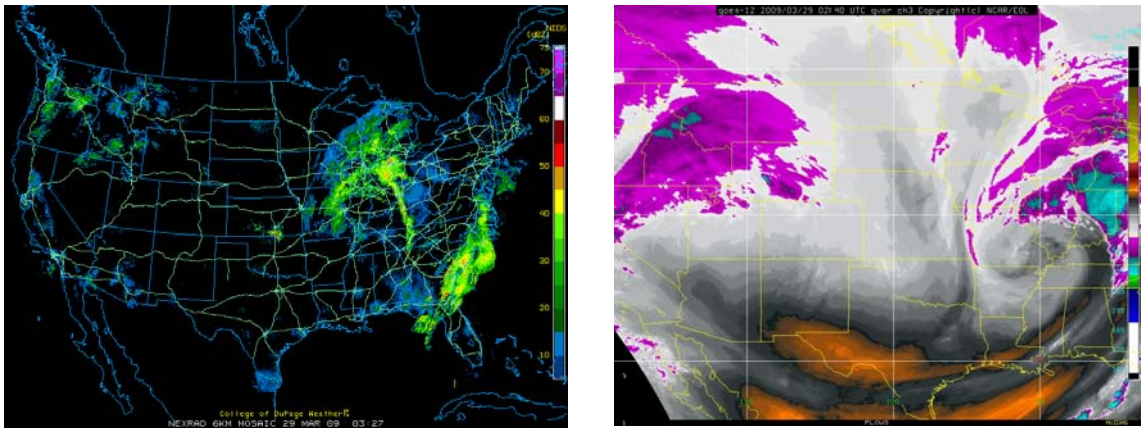


Fig. 5a, b: National radar summary and water vapor satellite imagery at 0257 UTC 29 March 09.

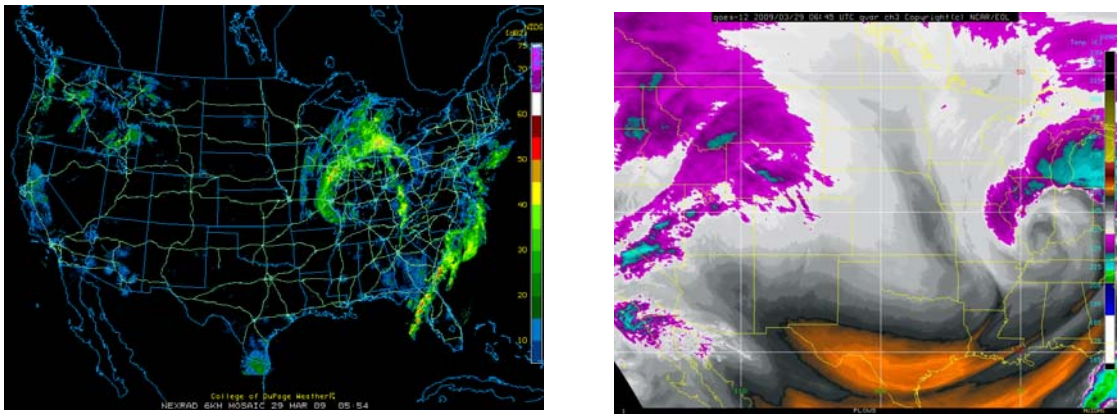
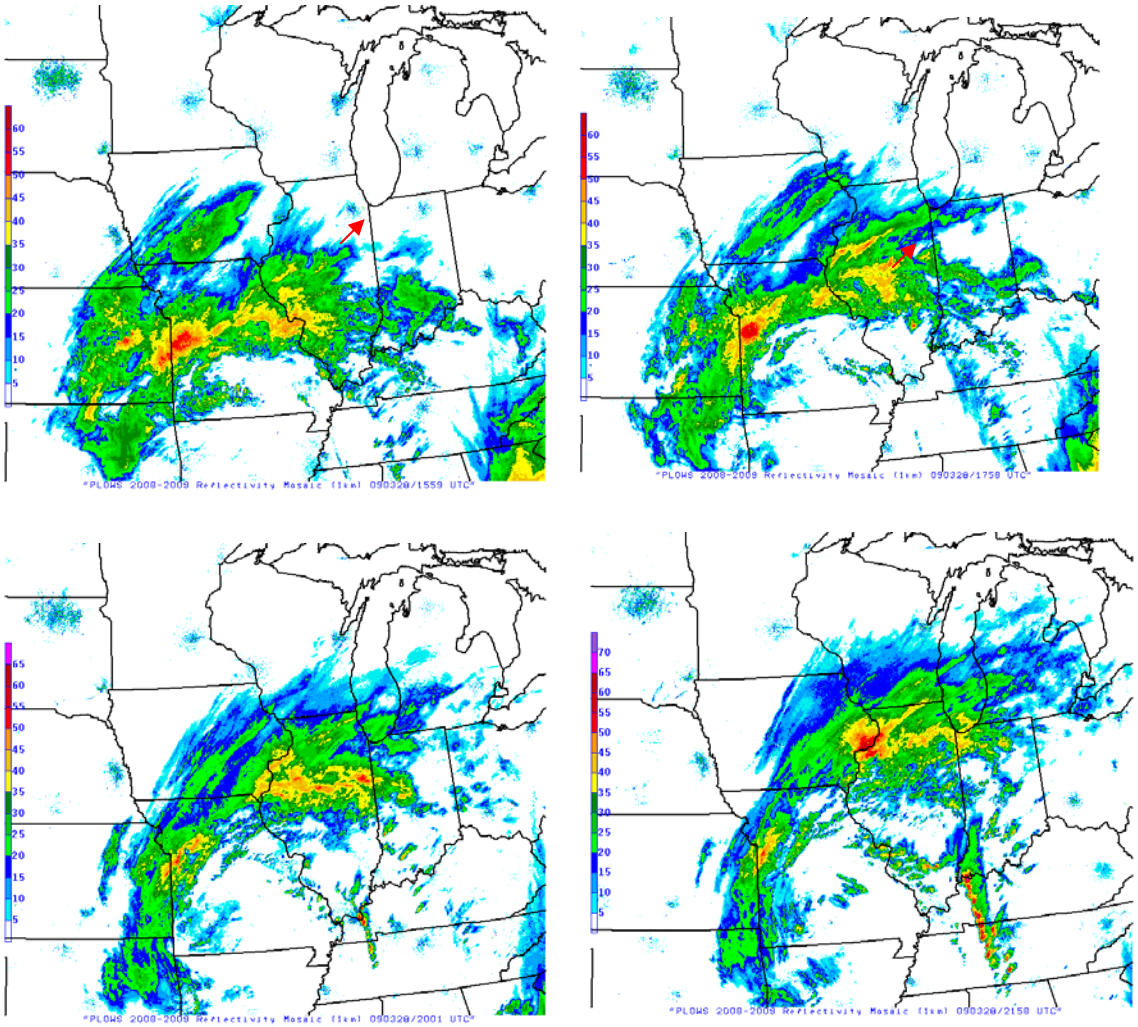


Fig. 6a, b: National radar summary and water vapor satellite imagery at ~0600 UTC 29 March 09.

Details of the radar reflectivity evolution and the SNR field from the 915 MHz profiler during IOP-5 appear on Figs. 7a-d, 8, 9a-d, 10 and 11a-f. Between 1600-1900 UTC, clouds producing elevated radar echoes passed over the site. Bands of convection within the warm frontal region of precipitation moved across the site over the next several hours. Note the development of the new line of precipitation north-south along the cyclone's surface cold front near the Illinois-Indiana border at 2000 UTC and the development of dry slot convection over southern Illinois at 2200 UTC. The convection organized into several bands that moved across the MAX site through about 0600 UTC 29 March. By this time, a completed new trowal feature had developed, with the precipitation in the older trowal feature dissipating. The "new trowal" moved across the site between 0800 and 1800 UTC, with 4 distinct bands of precipitation passing over the site at 0900, 1130, 1330 and 1630 UTC. These bands had tops around 5 km, compared to the earlier convection which topped at 7-8 km. The changeover from rain to snow occurred around 1000 UTC. Figure 12 shows the complete profiler record for SNR, Velocity and Spectral Width. The velocities at the tops of the convection were strong, while the velocities at the top of the trowal bands were not pronounced.



Figs. 7a-d: Radar images showing rain over the warm front as it moved across the MAX/MIPS site at 1600, 1800, 2000 and 2200 UTC, 28 March 09.

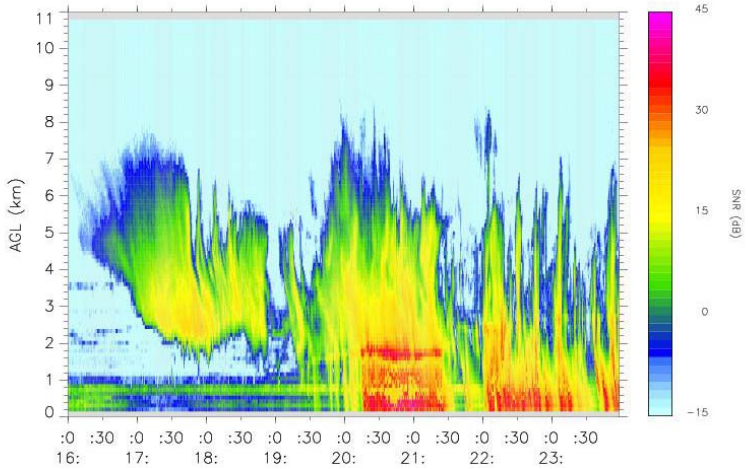
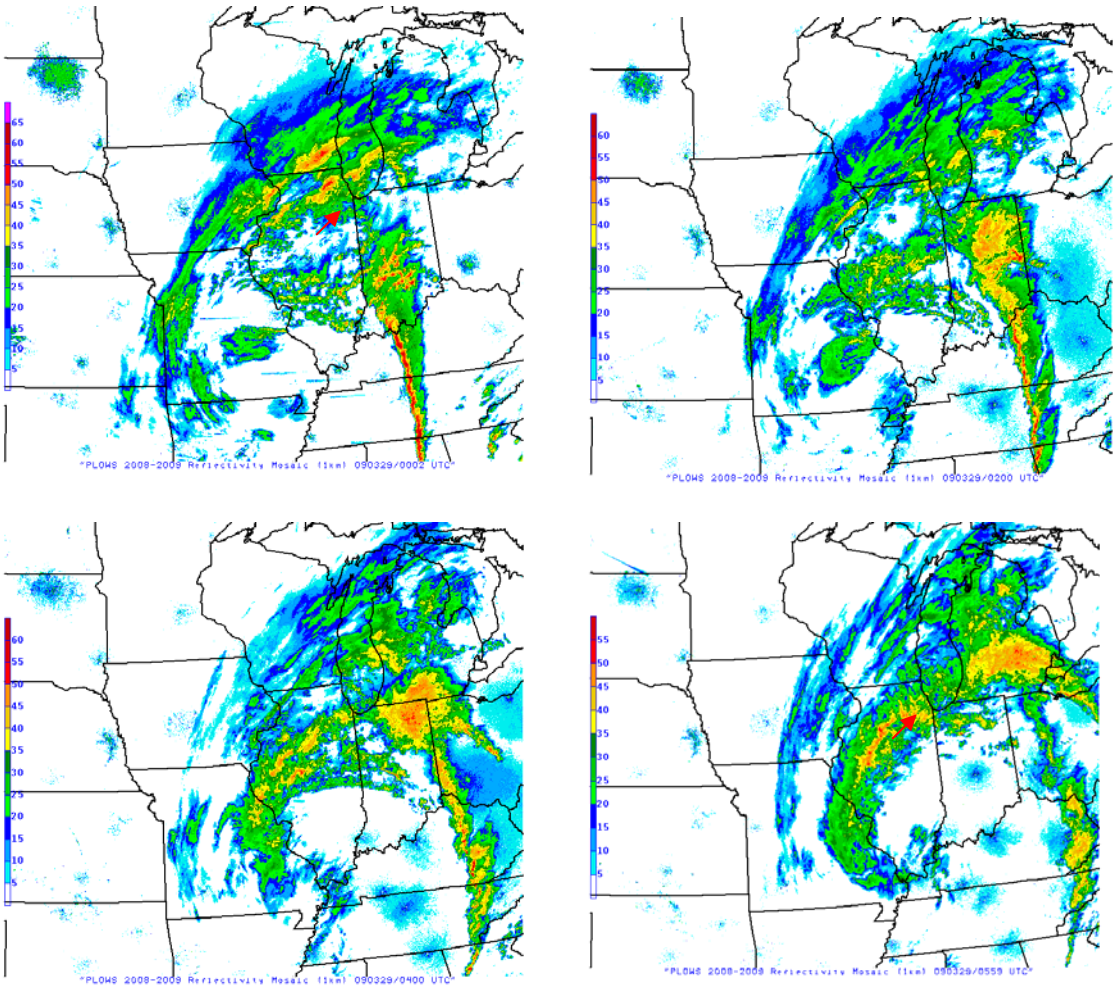


Fig. 8: The MIPS 915 MHz Profiler SNR for the period 1600 UTC 28 March 09-0000 UTC 29 March 2009.



Figs. 9a-d: Radar images showing rain over the warm front as it moved across the MAX/MIPS site at 0000, 0200, 0400 and 0600 UTC, 29 March 09.

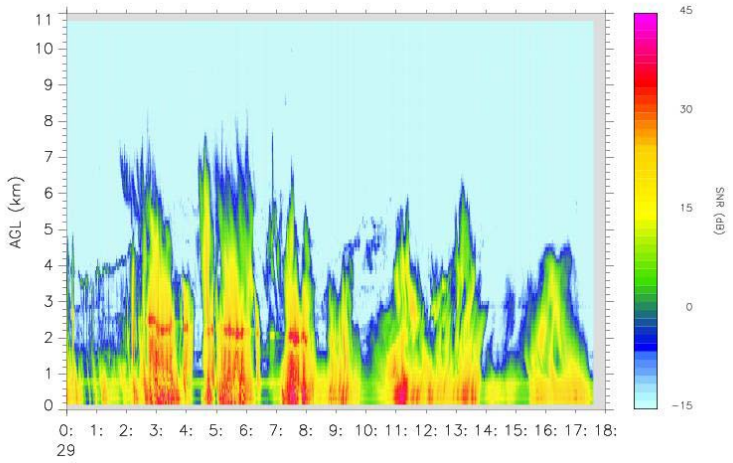
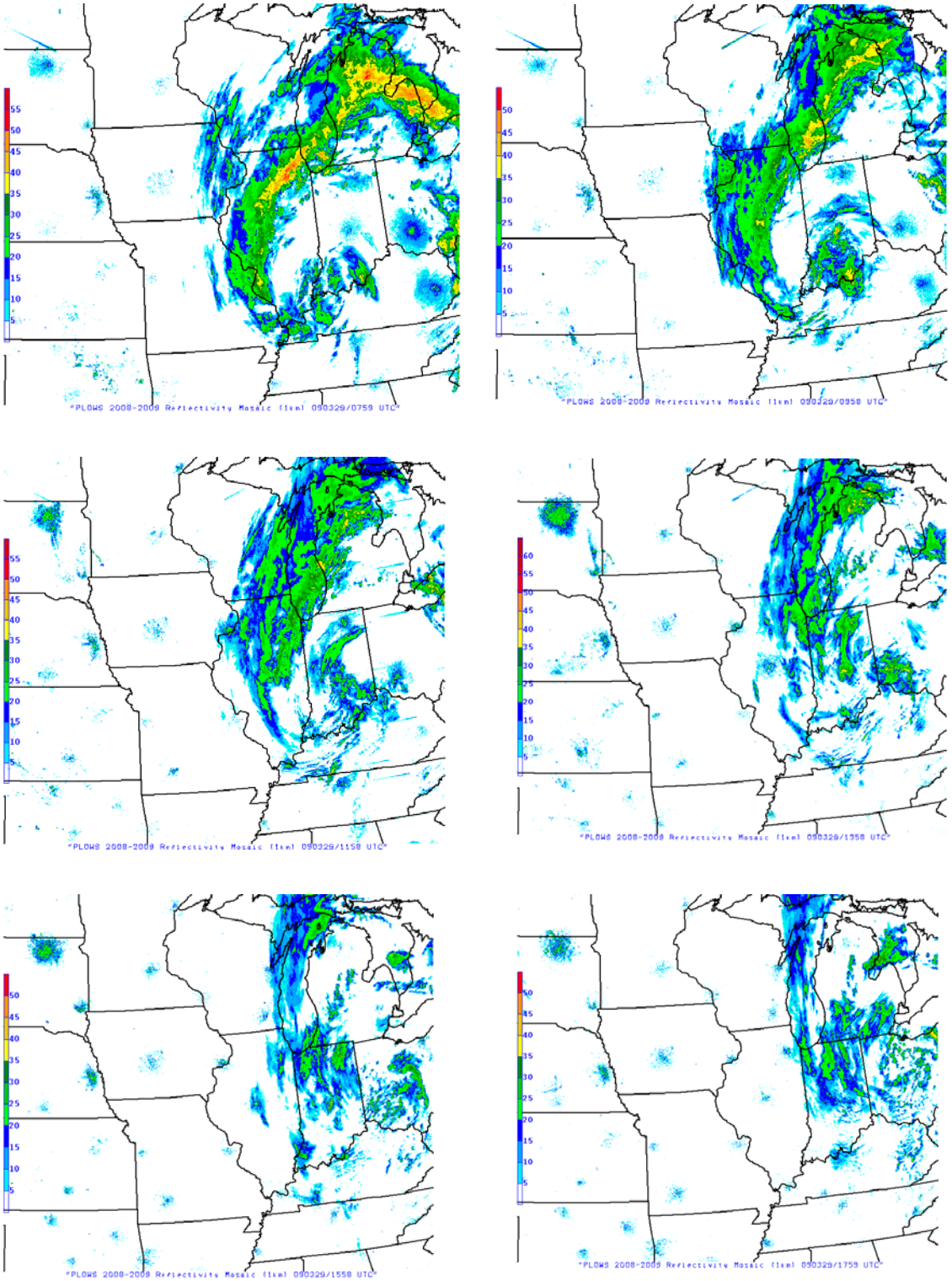
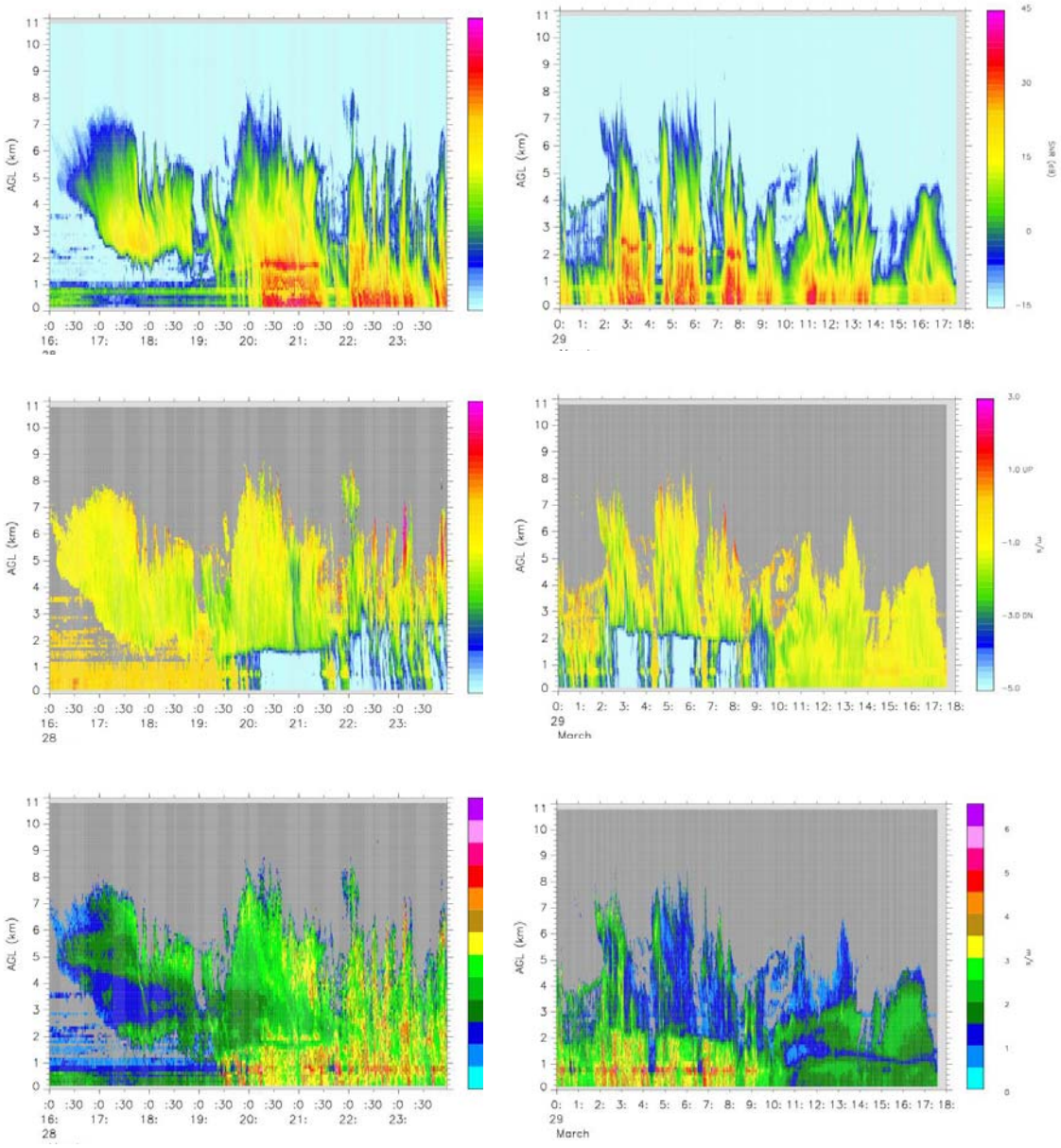


Fig. 10: The MIPS 915 MHz Profiler SNR for the period 0000-1800 UTC 29 March 2009.



Figs. 11a-f: Radar images showing rain within the trowal region as it moved across the MAX/MIPS site at 0800, 1000, 1200,1400, 1600, and 1800 UTC, 29 March 09.



Figs. 12a-b: Radar images showing the passage of the warm frontal region at 2000 and 2200 UTC, 28 March 09.

Missouri Radiosonde Flights

The University of Missouri flew 11 flights over 12 hours. Most were successful flights, although there were some instances of ascent from a saturated layer into a dry layer above. **Of note**: The first sounding was a failure immediately after launch due to a faulty connection on the ground station. A second sounding developed a bad pressure sensor, but the temperature and elevation data appear to be fine, so pressure should be retrievable.

Radiosonde Flight Log

Flight 1 – 28 March 2009 – 1749 UTC

Lost immediately after launch. Cause was a loose connection on the ground station antenna. **No data**.

Flight 2 – 28 March 2009 – 1803 UTC (Fig. 13a)

14 minutes from launch to launch may be a record for us. Flight 2 was put up in response to the loss of Flight 1, and a desire to obtain an 18Z sounding.

Flight 3 – 28 March 2009 – 1948 UTC (Fig. 13b)

Flight 4 – 28 March 2009 – 2133 UTC (Fig. 13c)

Flight 5 – 28 March 2009 – 2332 UTC (Fig. 13d)

Flight 6 – 29 March 2009 – 0125 UTC (Fig. 13e)

Evidence of sensor freezing and/or evaporation issues between 650-600 mb.

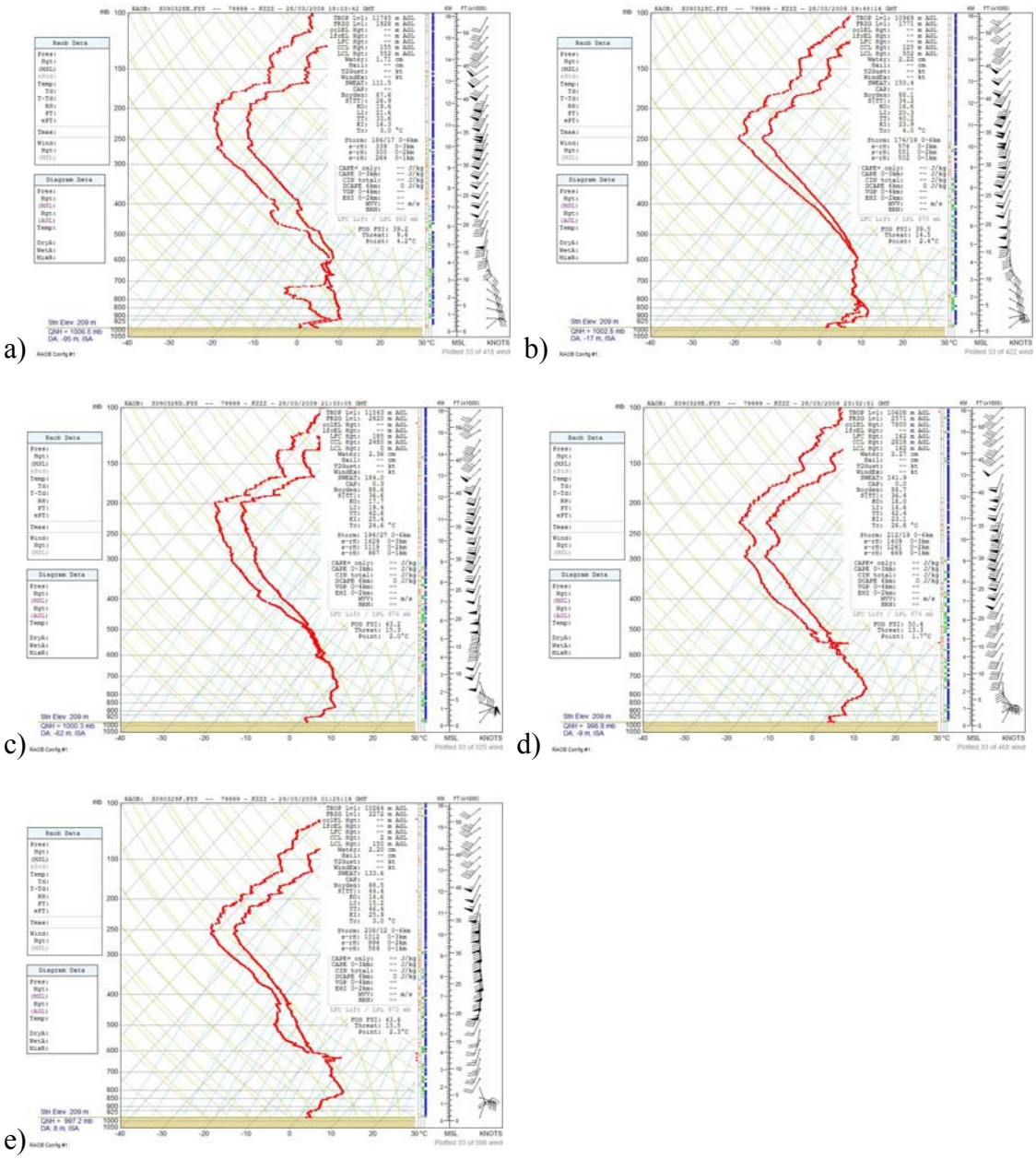


Figure 13. Radiosonde flights from Manteno, IL (41.2455 N, 87.8536 W, 209 m MSL), for 28 March 2009 at a) 1803 UTC, b) 1948 UTC, c) 2133 UTC, d) 2332 UTC, and 29 March 2009 at e) 0125 UTC.

Flight 7 – 29 March 2009 – 0922 UTC (Fig. 14a)

Evidence of sensor freezing and/or evaporation issues between 625-600 mb.

Flight 8 – 29 March 2009 – 1125 UTC (Fig. 14b)

Evidence of sensor freezing and/or evaporation issues near ~ 600 mb.

Flight 9 – 29 March 2009 – 1322 UTC (Fig. 14c)

Flight 10 – 29 March 2009 – 1528 UTC (Fig. 14d)

Problem with pressure sensor on this flight---becomes grossly evident above ~700 mb. Still, other data (GPS height is independent of on-board pressure sensor) suggest that the balloon hit 22 km level within 1 hour and 23 minutes of flight time (with a temp of -58°C). In the figure show, vertical scale is greatly compressed above ~ 700 mb.

Drying is evident in this sounding.

Flight 11 – 29 March 2009 – 1726 UTC (Fig. 14e)

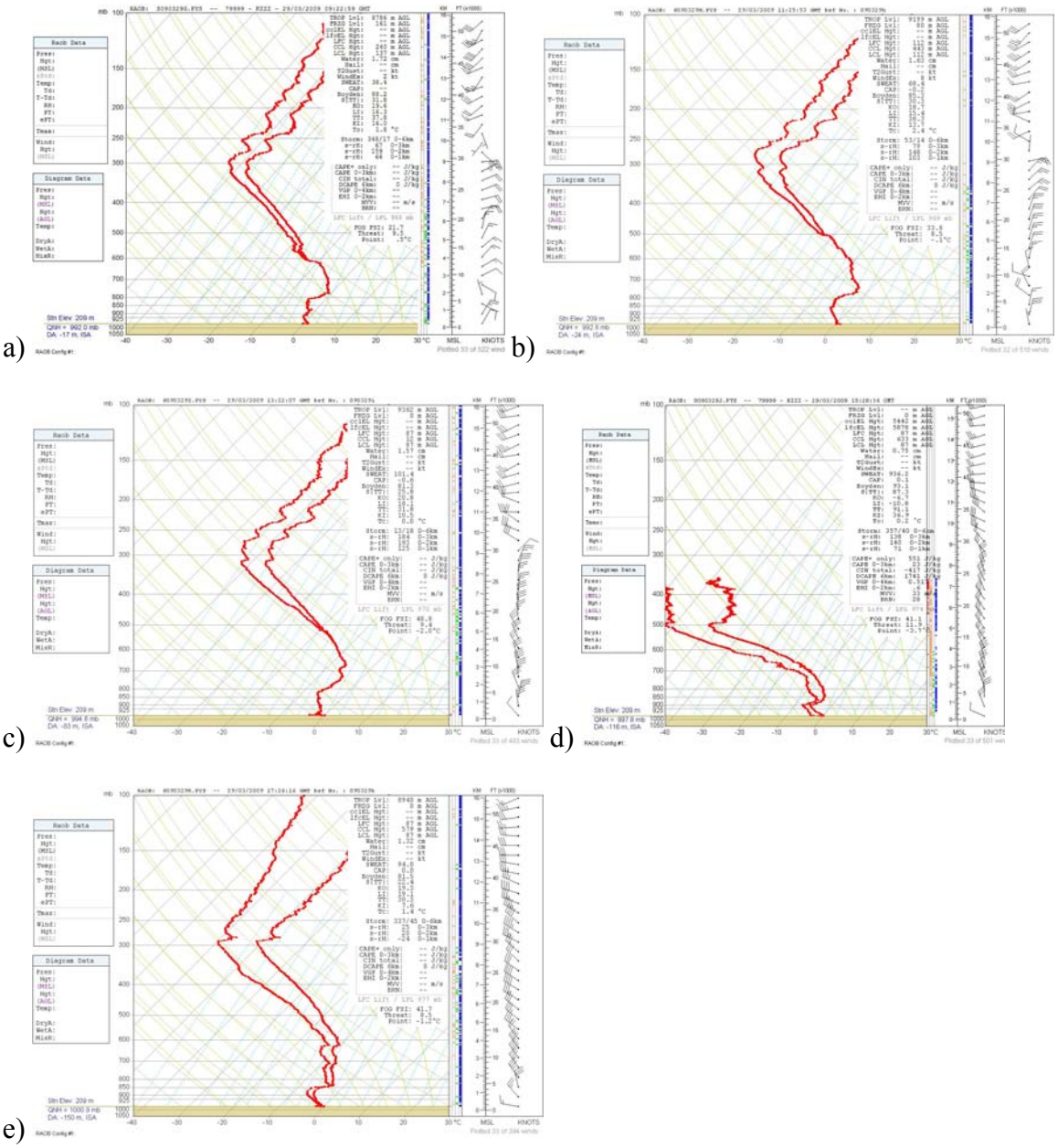


Figure 14. Radiosonde flights from Manteno, IL (41.2455 N, 87.8536 W, 209 m MSL), for 29 March 2009 at a) 0922 UTC, b) 1125 UTC, c) 1322 UTC, d) 1528 UTC, and e) 1726 UTC.

KEY ISSUES

Site selection: The constraint of being 30 km from a WSR-88D again compromised the best position which would have been further west. No major problems were noted at the MIPS/MAX site.

The strong winds and cold weather led to difficultly in balloon releases at the rawinsonde site, so that the entire staff had to participate in the launches. This lead to fatigue for the staff. We will need to think about this next year when it comes to staffing the MISS site and the Missouri site if funds become available for them to participate.