Mission Report
IOP#8
10-11 June 2015
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Mission: MCS_A (no broad severe winds expected).

Deployment Decisions: Forecast discussion at 3 pm suggested that a MCS would form in NE or NC Nebraska and propagate rather quickly to the east-northeast, reaching the north eastern part of the PECAN domain by 04 UTC. Several models indicated a southwest extension off the main MCS would form later in northwest or north central KS, move slower and exist within the PECAN domain during 03-06 UTC on 11 June. The forecast high probability region hedged towards the dominant MCS signal that would be along the eastern part of the domain by 04 UTC, near the position of the front, which was already north of I-80 at the time of the briefing.

Based on the forecast discussion, it seemed that the environment might produce a bow-and-arrow type of MCS, where warm-air advection by the low level jet over the southern edge of the cold pool would help initiate extensive convective activity to the SW of the main MCS. We decided to send the mobile armada to Salina and then up US Hwy 81. Periodic updates were given to the team. Around 00 UTC on 11 June, a decision was made to set up the radar hexagon centered to the east of York, NE. This decision was based on the fact that several attempts at CI had failed in north central KS well to the SW of the main MCS before this time. It was hypothesized that the large dew point depressions in the environment to the south of the front required sufficiently deep moisture convergence and the cold pool would be deeper farther north (Fig. 1).

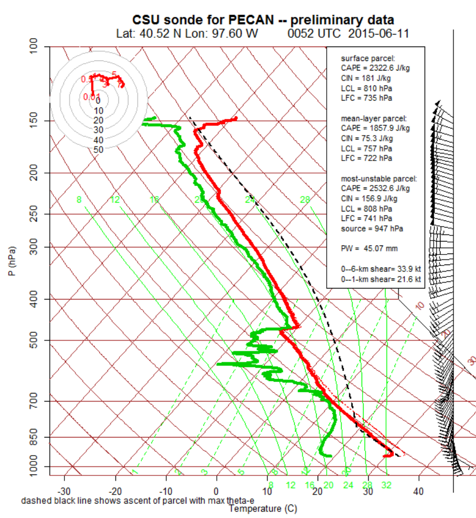

Fig. 1. SkewT-logP sounding from CSU MGAUS near Geneva, NE at 0052 UTC on 11 June 2015. Note the dry layer near the surface.

Two main regions of convection were expected to cross the mobile observing network. The first would be associated with the main MCS and was thought to be most likely to impact just the northern part of the network as it moved mostly east. For that reason, mobile PISA (MP) positions were selected from the central to the southern part of the domain, with the non-precipitation profiling systems located farther south, along the southern edge of the network. The second region of convection was expected to form in conjunction with the "arrow" part of the conceptual model and move towards the east-northeast later during the early night.

Given the driving distance from the Ops Center in Hays to the field site, several of the slower platforms were lagging the leading elements of the mobile armada. The faster elements were positioned along the northern part of the radar hexagon. The C-band radar baseline was chosen to be somewhat perpendicular to the expected propagation of convection from the southwest. The SPARC and CLAMPS systems were positioned along the southern end of the radar array near Milligan and Sutton, respectively. MIPS was deployed west of Seward, NE and MISS near York, NE (Fig. 2).

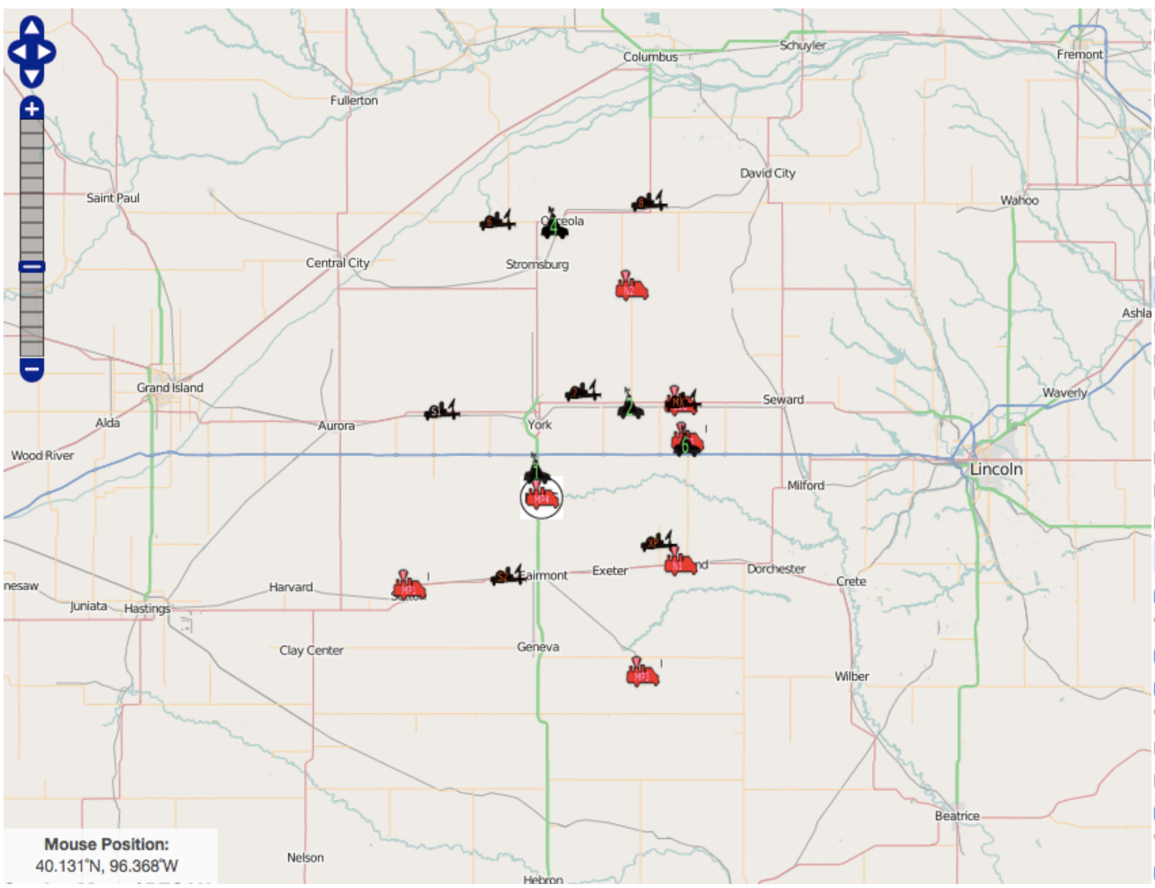

Fig. 2. Locations of the mobile armada during PECAN IOP #8 from 10-11 June 2015.

Site locations: Table 1 lists the locations of the mobile instruments. Note that RaXPOL was used in place of DoW6 as one of the nodes of the hexagon. Initially RaXPOL had set up at the same location as TWolf. Some data was collected there before moving the radar.

Table 1. List of deployable instrument locations. For the mobile radars, the closest database index location is also shown.

Platform	Latitude	Longitude	Comments
SR1	40.88697	-97.78856	
SR2	40.63071	-97.68805	
NOXP	40.68409	-97.34900	
MAX	40.90177	-97.2999	
DoW6	41.177220	-97.675108	
DoW7	40.915714	-97.502084	
DoW8	41.206507	-97.3679866	
RaxPol	down		
TWolf	did not participate		
MISS	40.85	-97.56	estimated
CLAMPS	40.60	-97.86	estimated
SPARC	40.51	-97.39	estimated
MIPS	40.90	-97.36	estimated
MG1	various		
MG2	various		
MG3	various		

Soundings: Requested soundings at 00, 03 and 06 UTC from the fixed PISAs. Later, we scrubbed the 06 UTC soundings as the system was well to the north and east of the fixed PISA sites. We requested 0300 and 0430 UTC soundings from the mobile PISAs. Almost all the soundings in the stratiform region terminated between 500-600 mb, near the freezing level. The MGAUS systems took 00 UTC soundings and launched about 10 soundings at various locations in and south of the mobile instrument array.

King Air: The KingAir take-off time was pushed back to 9 pm, as the mobile instrument array was not expected to take many observations until about 02 UTC and the ferry time to the array was about 45 minutes. The aircraft launched and conducted a couple of race tracks to the sw of the mobile armada, mapping out the inflow air characteristics. By that time, significant convection had formed to the southwest of the main MCS. The outflow was producing a radar fine line that was propagating ahead of the convective line. The aircraft was directed to fly across the outflow boundary. The first two attempts resulted in terminated flight legs as new convection was surging out in narrow bands oriented perpendicular to the main convective band and to the outflow fine line. Later, the plane was directed towards a portion of the outflow boundary that was well ahead of active convection and where it was thought no new convection was likely to form in the immediate future. It was proposed that the plane fly across the outflow boundary as it surged to the southeast and track the feature to see if the outflow eventually would become a bore. Unfortunately, the aircraft encountered significant updrafts and strong turbulence that apparently disabled the two on-board power generators. The aircraft made an emergency landing in Salina, KS using manual flight controls and ATC guided approach. The aircraft landed safely and all crew and scientists were believed to be unharmed.

MCS Evolution: The forecast suggested that new convection would form in north central Kansas and become somewhat attached to the main MCS. The deployment was predicated on the hypothesis that this southwestward extension might be due to advection by the low-level jet as it was lifted over the southern edge of cold pool produced by the main MCS to the north. The system did not evolve as initially conceived.

Prior to about 01 UTC, most new convection that formed in the warm sector ahead of the main MCS was short-lived and weak. The exception was a small band of cells that formed along a distinct NW-SE oriented boundary, believed to be some kind of BL roll. The convection propagated with the roll feature, providing the deep moisture convergence necessary to sustain the convective cells. This feature produced an east-northeast moving outflow boundary that merged with the southeast surging outflow from the main MCS (Fig. 3).

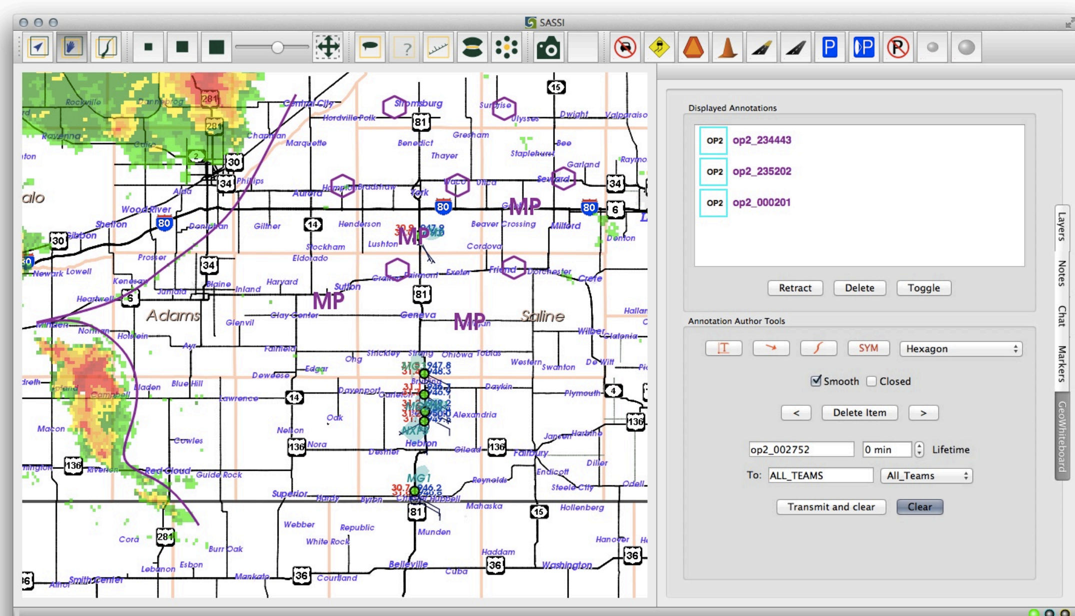

Fig. 3. SASSI display showing the location of the mobile armada and the outflow boundaries to the west and southwest of the instrument array.

The outflow from the main MCS also surged further north, where the cold pool was deeper, leading to rapid propagation of the system into the radar hexagon by 0130 UTC (Fig. 4). Meanwhile, the convection started to fill in towards the southwest along the main MCS convective band. This later resulted in less than optimal deployments for the mobile PISAs,. Also note the scattered new cells that developed in the warm sector well ahead of the main MCS convective line.

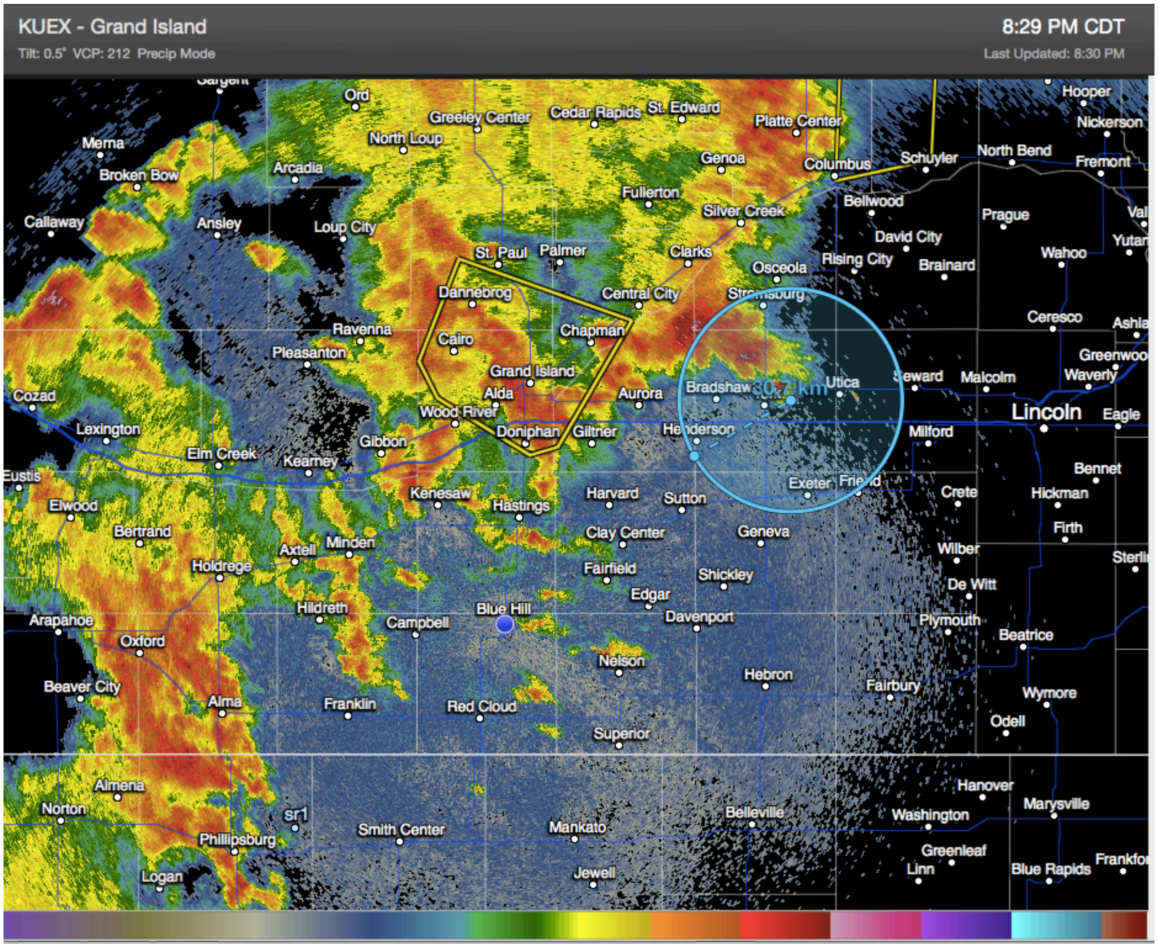

Fig. 4. Radarscope display of the 0.5 deg elevation PPI form the Grand Island, NE WSR-88D at 0129 UTC on 11 June 2015. The circle encompasses the approximate location of the radar hexagon.

Within 30 minutes, three keys aspects of the developing convective system became apparent (Fig. 5). First, the unexpected surge and southwestern extension of convection along the main MCS band produced a region of strong convective activity that immediately inundated the MIPS, MISS and SPARC sites. Secondly, the farther southwest scattered convection ahead of the main MCS intensified and congealed, producing a NW-SE oriented convective band that was perpendicular to the outflow orientation and to the orientation of the main MCS band. Lastly, a severe-wind producing, well organized convective line segment had formed farther southwest along the lone from Smith Center, NE to Elm Creek, NE. It was believed that severe-wind producing feature would continue to propagate east-northeast and become the main target of interest.

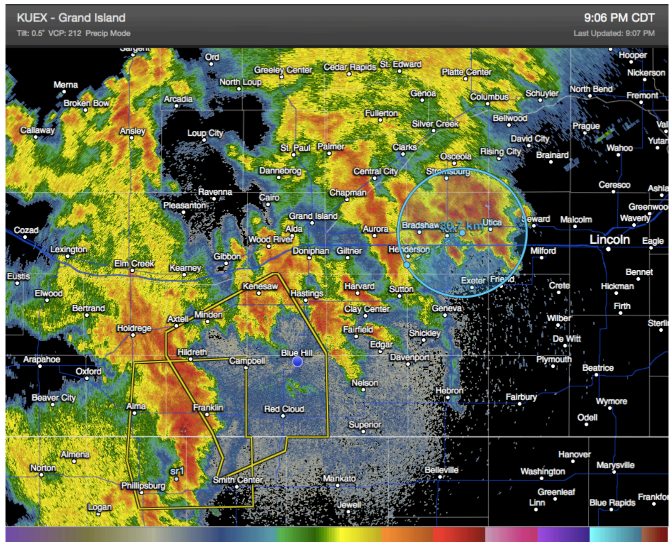

Fig. 4. Radar reflectivity at 0.5° elevation from the 88D radar near Grande Island, NE taken at 0206 UTC on 11 June 2015. The circle approximately encompasses the mobile radar hexagon.

Another half-hour later, new convective activity formed and congealed quickly in the region between the severe-wind producing convective line and the convection within the hexagon (Fig. 5). Several new cells were forming in lines ("fingers") perpendicular to the outflow boundary, causing wavelike patterns of extended convection to the southeast. Of particular interest was the north-south oriented outflow to the west of Geneva, NE. This feature propagated overhead the SPARC location and was observed by Doppler lidar (Fig. 6). A ~ 7 m/s updraft from about 500-1200 m was observed associated with this feature.

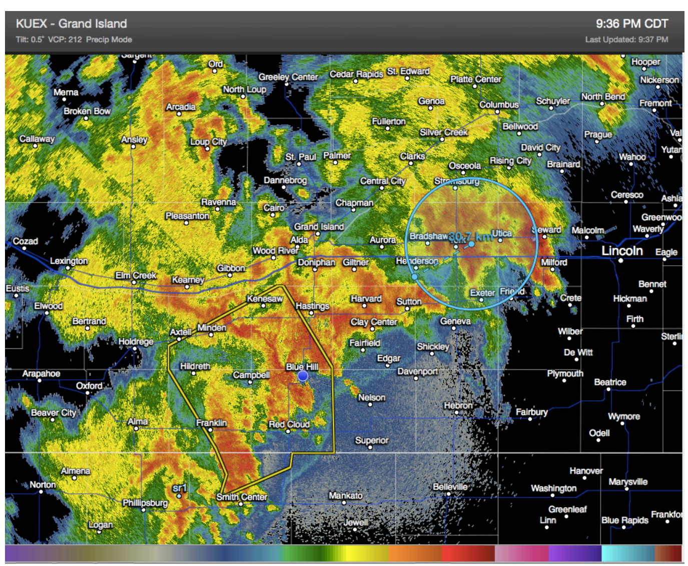

Fig. 5. Radar reflectivity at 0.5° elevation from the 88D radar near Grande Island, NE taken at 0236 UTC on 11 June 2015. The circle approximately encompasses the mobile radar hexagon.

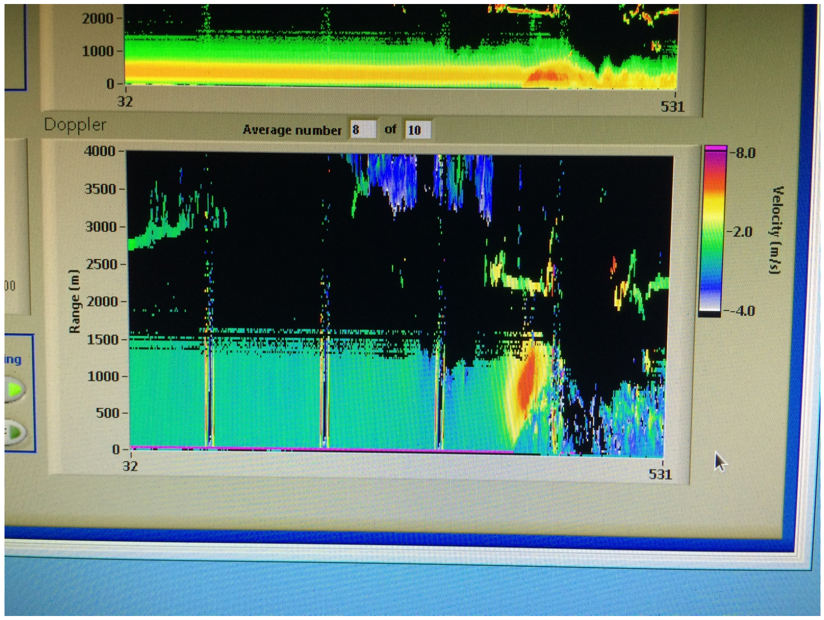

Fig. 6. Doppler lidar image from SPARC near Milligan, NE showing the vertical motion associated with an outflow from the main MCS that was observed during 10-11 June 2015.

By 03 UTC, several well-defined fingers of convective activity had developed from the outflow that surged southeast from the main MCS (Fig. 7). Note also the marked radar fine line that was passing through Superior, NE at this time. The aircraft was directed across this boundary where it encountered severe turbulence that resulted in the need for an emergency landing.

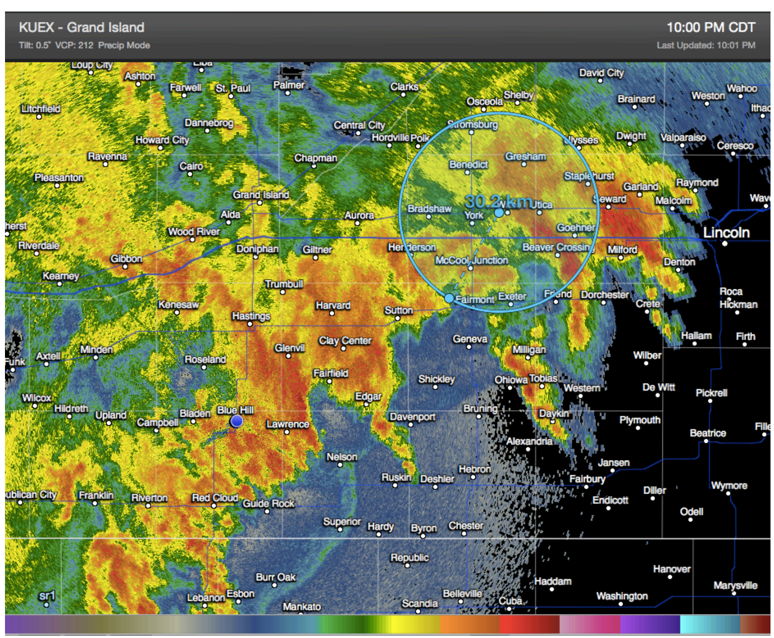

Fig. 7. Radar reflectivity at 0.5° elevation from the 88D radar near Grande Island, NE taken at 0300 UTC on 11 June 2015. The circle approximately encompasses the mobile radar hexagon.

The rapid development of new convection along the surging outflow resulted in a convective region with relatively little trailing low-level stratiform precipitation. Indeed, discussion was held regarding strategies for the how the NOAA P-3 flight would be conducted for such an event as this one. One suggestion was that the aircraft take-off would have needed to be delayed until at least 03 UTC.

With time, stratiform rain did develop (Fig. 8). Fortuitously, the radar hexagon was well placed at the junction between the main MCS that was able to generate an extensive region of stratiform rain and the more north-south oriented convection with little stratiform rain that had developed in response to the southeastward surging outflow. Unexpectedly, this convective line extended farther southwestward down to Hays, KS. Also evident at around 04 UTC was that an incipient mesoscale convectively-generated vortex (MCV) was developing along the southern end of the stratiform region. This feature was propagating towards the radar array.

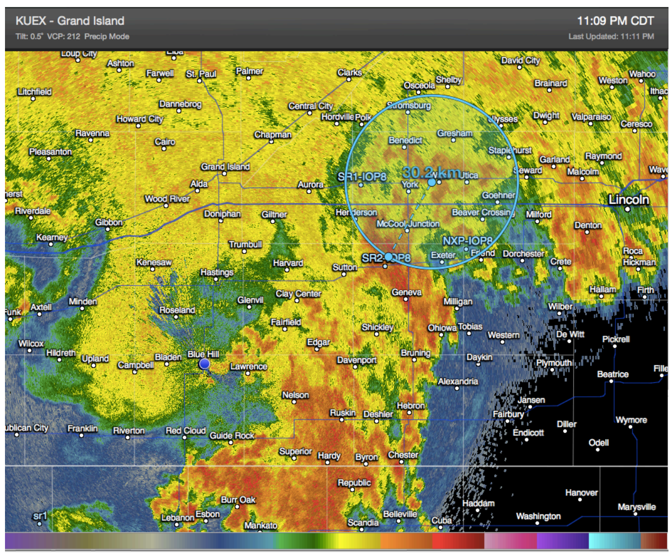

Fig. 8. Radar reflectivity at 0.5° elevation from the 88D radar near Grande Island, NE taken at 0400 UTC on 11 June 2015. The circle approximately encompasses the mobile radar hexagon.

By 05 UTC, the last of the convective fingers had propagated through the radar hexagon and the MCV feature was moving into the far southwestern part of the network. The radars continued to operate to about 0130 UTC to sample this feature as it moved into and through the array. Operations were terminated at 0130 UTC. Mobile teams secured hotel rooms in nearby cities.

Summary: This was a successful MCS_A mission. Initially, it was believed that the system would form a bow-and-arrow MCS structure, with new convection developing in response to the low-level jet rising above the cold pool generated by the main MCS in north central and northeastern NE. Instead, several convective "fingers" developed in the inflow region and merged with convection that developed along the surging outflow from the main MCS. Several of these convective bands moved northeastward through the mobile instrument array. Later, an extensive stratiform region as sampled, with evidence of an incipient MCV forming as the stratiform rain traversed the mobile radar network. The aircraft encountered unexpected strong turbulence traversing the outflow that had developed well ahead of active convection, resulting in an emergency landing in Salina, KS.

This is a good case for examining several wave-like bands of elevated convection that formed perpendicular to the main outflow boundary and to the orientation of the main MCS convective region.