UNDERSTANDING WEATHER HELPS IN STORM CHASING – STORM CHASING HELPS UNDERSTAND WEATHER: A WIN-WIN SITUATION

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1. INTRODUCTION

Textbooks, lectures, slides, and videos have been the tools instructors have traditionally used in weather courses in the past. While adequate when combined with passion and good teaching, they lack the dynamism of an actual experience. This gap has been filled at the **W**eather **A**nalysis **L**aboratory for **T**eaching and **E**ducational **R**esources (WALTER) at Minnesota State University, Mankato where instructors and students have incorporated storm chasing into their advanced weather courses. Initiatives were given for participating students to equip two vehicles that would serve as self-contained mobile weather labs for forecasting, nowcasting, and as a means of using and comparing digital media in field-experience conditions. This paper focuses on a chase day (May 12th, 2004) where classroom-learning experiences were tested in the field and contrasted against in-situ forecast-evaluations. A learning experience that was an enhancement to both the classroom and simple field observations!

2. CHASE DAY SETUP

May 12th, 2004 provided the opportunity to utilize forecasting abilities, cutting edge technology, and experience to intercept a low-pressure center that had not yet formed. A 965-kilometer (600 miles) venture to southern Kansas would place the chase team in position. The weather charts showed an upper level trough over the Rockies with a developing short wave in eastern Kansas extending southward to the Texas and Louisiana border. A cold front associated with the main upper trough extended from a low-pressure center in Minnesota to the Oklahoma and Northern Texas Panhandles (Figure 1). The chase team's focus was on a low-pressure center forecasted to develop and deepen along the boundary in southern Colorado, which would allow the boundary to retreat northward into western Kansas where a potential target for severe weather, was Dodge City, KS. Forecast models gave dew points in the mid to upper 60's ahead of the cold front. With daytime heating and mixing, cape values were anticipated to soar to 2000 - 3000 J/KG by mid afternoon. The cold front would act as the triggering mechanism in western Kansas. The strongest instability and shear values were favored to be across Kansas where 40 - 50 KTS of 0-6 KM shear was anticipated. Any discrete storms that could erode the cap would rapidly become supercellular with very large hail and damaging winds expected. Isolated tornadoes would also be a concern with the amount of low-level shear available.

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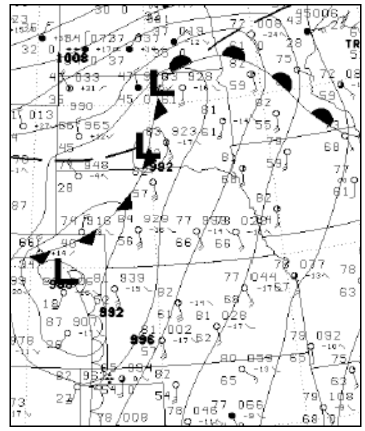

Figure 1: May 12th, 2004: OO:OO Z surface analysis chart.

2.1 *Cellular Technology*

The 2004 chase season charted new territory as two additional technological tools allowed for constant data retrieval on the road. One of these tools, the Third Generation (3G) Universal Mobile Telephony System (UMTS), is a digital cellular system that provided significantly higher data transfer speeds than previous models. In addition, more reliable connections were available for accessing data from the Internet. Typical connection speeds of 14.4 kbps were available throughout the Great Plains with even higher download speeds near large cities or Interstate highways. Internet browsing was made possible while traveling 90 KPH (55 MPH) southward on Highway 183 while keeping an eye on meso scale ingredients near Dodge City, KS. The hourly updates of the RUC analysis, together with high-resolution visible satellite images, and Storm Prediction Center (SPC) Products, it was decided that Dodge City, KS was too far north for any supercell development.

2.2 *Forecast Update*

At 3:23PM, Mesoscale Discussion 670 was issued by the SPC. It called for thunderstorm development to occur with the surface analysis chart now showing the cold front extending from northeast Kansas to southwest Kansas just south of Dodge City, KS. Strong convergence was beginning to occur between Dodge City, KS, Medicine Lodge, KS, and Gauge, OK. The air mass was becoming increasingly unstable across the warm sector with mid level capes ranging from 2000 - 4000 J/KG. The sounding from 18:00Z was still showing a persistent strong cap over southwestern Kansas. Daytime heating and convergence along the cold front was predicted to weaken the cap allowing for storm initiation. The 18:00Z RUC and ETA model runs were in agreement with rapid development occurring along the cold front in southern Kamas by 00:00Z. The focus was on a surface low as it rode the front into a favorable environment of deep layer shear (O-6 KM) and strong low-level shear (0-1 KM) in southern Kansas. At 4:00PM, the chase team was heading towards Cold Water, KS. (Figure 2)

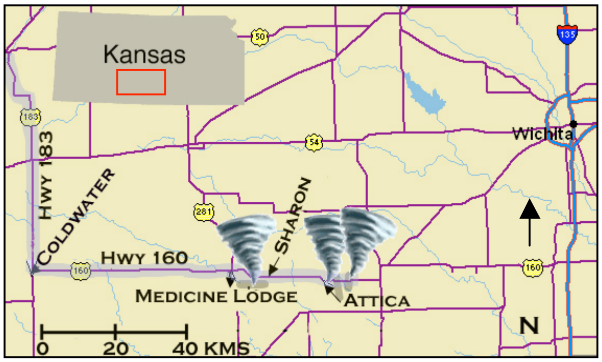

Figure 2: This is a location map of where chase events took place. Highway 160 from Medicine Lodge, through Sharon to Attica were where the tornado touchdowns were seen.

2.3 XM Mobile Threat Net

Clear blue skies overhead established a band of 4500 J/KG, while helicity values of 300 extended from the Oklahoma border into southern Kansas. The chase team was situated north of explosive development near Coldwater, KS. A changeover to a nowcasting mode required use of the second new technological tool, Mobile Threat Net (MTN). With a compact in-lab receiver, an external antenna, and a laptop, it was possible to receive a continuous feed of near real time data by S-Band satellite transmissions from XM Satellites. The MTN software is able to combine a limited number of weather products with Geographic Information System (GIS) and Global Positioning System (GPS) data sources. Integration of these allowed for a precise location of the chase team's position in relation to any convective activity and meso scale weather features (Figure 3 & 4). MTN indicated two cells exploding north and south of Highway 160 with movement toward the north – northeast. It was discovered that MTN had its flaws – like any newly released technology. The radar images could not clearly distinguish storm signatures (e.g. Hook Echo, V-Notch, Inflow Notch, etc.), with only seven intensity levels used for precipitation depiction. Radar imagery was further degraded by using an overly smooth contouring routine, which created TV-like radar pictures. This was marginally compensated for by their wind-shear detection algorithm (a gate to gate shear), which did enable a location to be pinned within the cell.

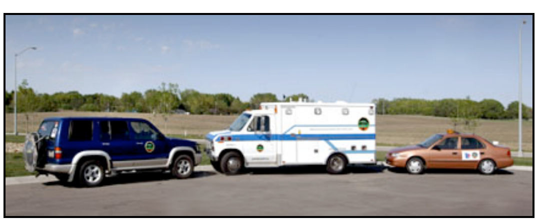

Figure 3: The student's chase vehicle equipped with data acquisition devices and a mounted weather station **(right)** collaborates resources with the Multi-community Environmental Storm Observatory (MESO) chase vehicles in southern Kansas.

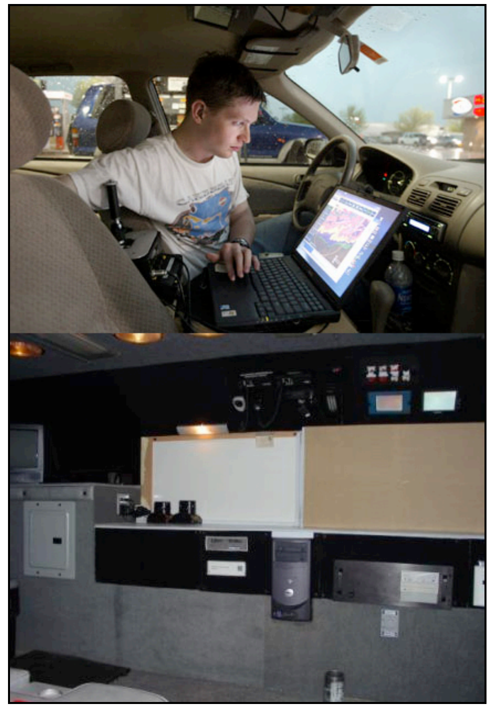

Figure 4: Inside the student-equipped chase vehicle **(Top);** and the MESO vehicle **(Bottom).;** showing laptop and desktop computers connected with cellular, GPS, and XM MTN technologies giving a sophisticated mobile forecasting capability in the field.

2.4 *Nowcasting*

The northern mature cell showed the highest dBZ values with an ample amount of shear detected on the southwestern quadrant of the storm where large hail and tornadic development was visible to the north. However, the developing cell to the south of Highway 160 provided a classic textbook setup. After superimposing the wind profile data onto the radar imagery, it appeared likely that the southern cell would rob the warm moist inflow from the northern cell and would ultimately become the single dominant cell (Figure 5). A couple miles east of Medicine Lodge, KS on Highway 160, attention was drawn to a well-defined rear flank downdraft notch where rotation was becoming increasingly visible, but lacking any kind of wall cloud. After a short time, a funnel took shape and slowly descended to the ground with a dust column enveloping a debris cloud. While dodging hail, ranging in size from 2.5 to 9.0 centimeters (1.0 to 3.5 inches) in diameter, a semi-transparent tornado formed that had very slow westward movement south of Highway 160 between Sharon and Medicine Lodge, KS. (Figures 2 & 6) As this tornado roped out, under the arc of an intense rainbow, a large debris cloud formed due east of the system.

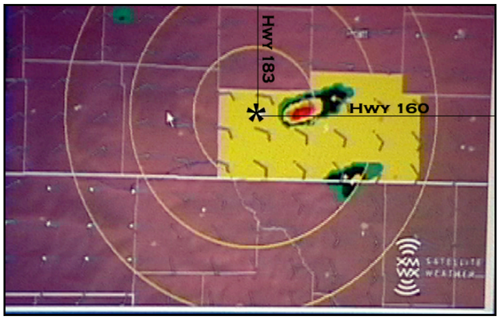

Figure 5: At 5:04 PM, radar imagery with superimposed surface wind barbs from MTN shows the team's position (star) at the intersection of Highways 183/160 in the community of Coldwater, KS.

Figure 6: Hail ranging to the size of baseballs was encountered near a tornado between Sharon and Medicine Lodge, south of Highway 160.

3. TORNADO HITS ATTICA, KS

Mobile Threat Net and radio reports confirmed a damaging tornado was ripping though the community of Attica, KS with significant damage occurring. Further storm chasing was halted as the team went to render aid to the victims on the eastern side of Attica, who had been impacted by the full brunt of the tornado. For such circumstances, the chase fleet carries two full trauma packs, and other disaster and first aid supplies. Contact was made with the local Fire Department and Emergency Management crew and the team helped with the search and rescue efforts that subsequently occurred.

Figure 7. A direct hit is taken in eastern Attica, KS by this ghostly white tornado seen by the chase team in pursuit on Highway 160.

3.1 *Radar versus Reality*

Pulling up to a destroyed home in eastern Attica with ragged cloud bases to the north and east, MTN showed the main tornadic storm to be intensifying as it moved northeastward towards Harper, KS. The chase team was caught off guard as a surface vortex materialized a few hundred yards away under a nonrotating cloud base. MTN depicted the heaviest shear core existing five miles east of the team's location. Only light rainfall was shown on MTN around the Attica area. The chase team and Emergency Response Crews were forced to cease all operations momentarily as the short-lived touchdown posed a life-threatening situation. (Figure 7)

3.2 *New Development*

Another discrete cell flared up to the southwest of the Attica area. Although small in comparison to its dominant partner to the north, it showed an intense precipitation core with frequent lightning being detected by MTN. The path projection plotted the cell towards Attica. Within minutes, hailstones up to golf ball size inundated around the mobile labs. A clear slot was spotted as the hail shaft proceeded to move northeastward. Visual rotation was occurring on the underside with numerous transition zones of redeveloping wall clouds occurring. One wall cloud produced a near touchdown within 0.40 KM (0.25 miles) of our location before it roped out as quickly as it had developed. (Figure 7)

Figure 7: The surface induced vortex that unexpectedly developed below the non-rotating cloud base **(left).** The funnel cloud, on the outskirts of Attica,, that in fact never made a touchdown **(right).**

4. CONCLUSIONS:

This was one of several field studies undertaken by students during the 2004 chase season. Success and failures contributed to a real-life environment where students were able to assess the outcome of their time sensitive decisions and interpretation skills using forecast models and meso scale observations. There were clear limitations when using the near real-time data where processing and transmission timing could not constantly agree with the in-situ observations. Undoubtedly, student's understanding of meteorological processes, usually perceived in a two-dimensional environment, was opened up to a comparison in three-dimensional reality. A bridge was built to connect textbook theories with real life events. The realization was quick - that severe weather events rarely occur as clearly or as organized as textbook examples show.

5. REFERENCES AND ACKNOWLEDGMENTS

Poulsen, Henrik Kaare. 2002. Cellular Phone Systems. http://3g.cellular.phonecall.net/

Photography courtesy of Allan Detrich: www.allandetrich.com

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