SPOTTER Trip Journal

By Marco A. Monrouzeau

Day 1: Monday, 29 May 2023

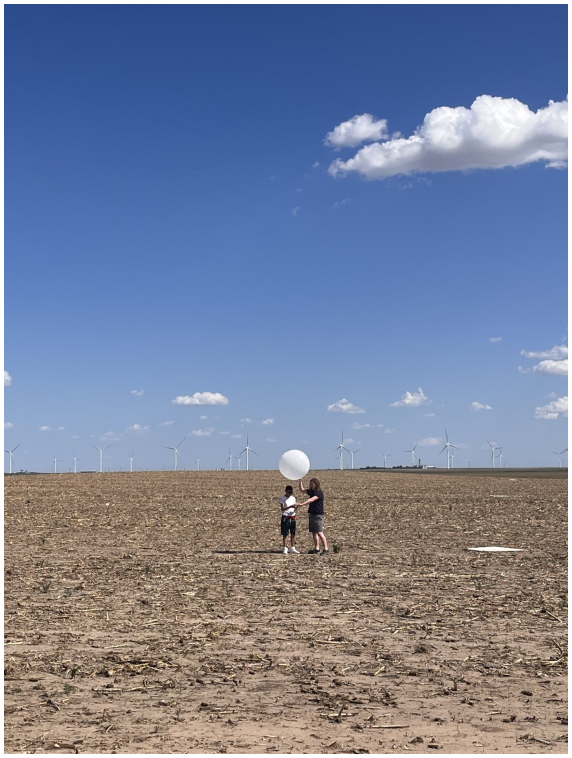
Forecast Overview:

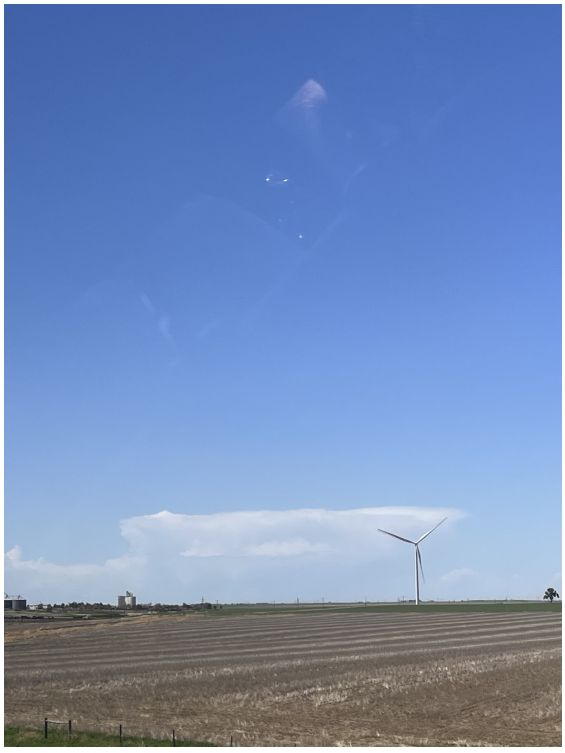
- Briefing discussed sections of good convective environments in southwest Nebraska. These turned out to be accurate as thunderstorms developed within that area. The terrain itself is not the best for chasing, thus the pursuit of these storms was not viable. Additionally, they were expected to have a high cloud base due to the deep mixing of the boundary layer pushing the LCL near the LFC at approximately 2 km.
- Also discussed, was choosing the Texas panhandle, which forecasted good levels of instability, decent shear, but a very shallow layer of moisture. Meaning storms would be possible but with a high cloud base (similar to the case of the Nebraska storms).
- Ultimately, the main factor that jeopardized storm development was the lack of sufficient directional shear due the weak flow induced by the rex block (high over low set up) in the Eastern U.S.
- We opted to head west to Colby, KS where we would have better options (either going north or south) to observe thunderstorms in the long run.

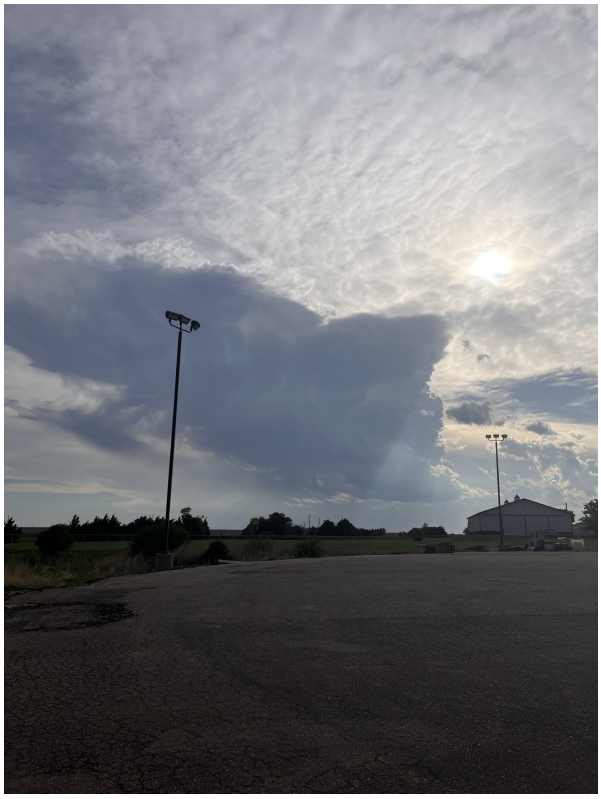
Noteworthy events:

- Around 2000 UTC cumulus congestus were observed northwest of I80 (southwestern part of Nebraska). These develop into thunderstorms with features including an anvil and overshooting top at around 2030 UTC.
- Between 2047 to 2100 UTC various dust devils were observed swirling across the field south of the Petro Dealer Oasis Travel Center in Colby. These were due to the strong heating and occasional gusts.
- A sounding, along with surface observations were taken at 2130 UTC. The surface observations showed a very dry surface layer.
- Between 2200 UTC and 2350 UTC, storms were trying to develop southwest and west of our location in Colby. These would break down due to entrainment and weak upper level shear, causing their updrafts to be choked.

Pictures:







Lessons Learned:

- The main issue today was that the weak shear and deep mixing boundary layer, along with entrainment, limited the development of thunderstorms in proximity to us. Thus, we are hoping that the mixing boundary layer shallows out to bring down cloud bases, that shear aloft increases (which does not seem to improve into Tuesday), and a more robust lifting mechanism.
- The forecast was correct in predicting how the lack of shear would diminish storm development, and also they did well in predicting the stronger development of storms in southwestern Nebraska.

Day 2: Tuesday, 30 May 2023

Forecast overview:

- During the briefing we discussed the set up for today which forecasted storm development near the border between eastern Colorado and western Kansas. We first looked at the 500 mb wind map and noticed an overall west- southwestern weak flow. This signaled that weak shear would be present (magnitude of winds seemed to be constant with height around 21 knots) thus leading to deep mixed boundary layer and

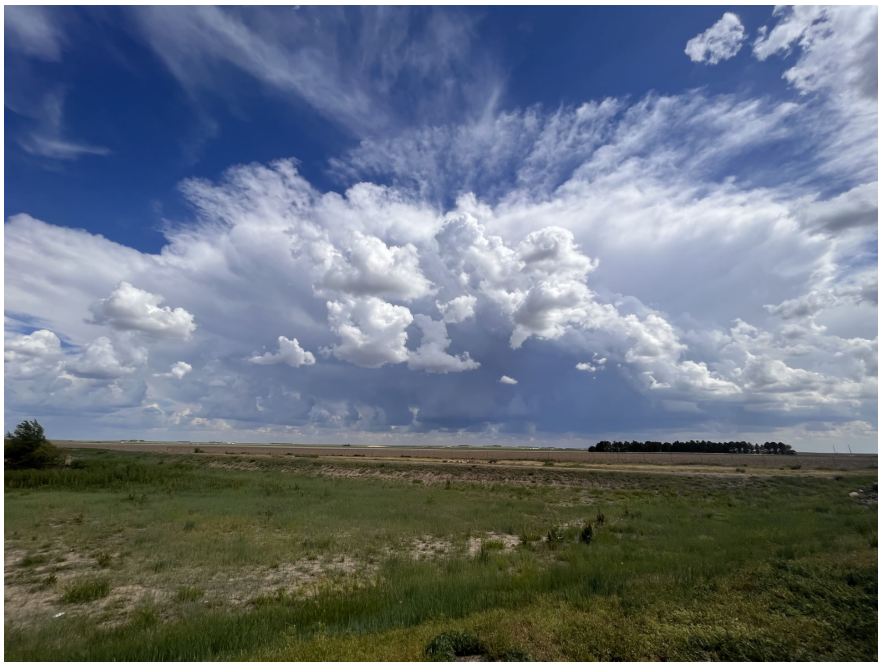
thunderstorm with a high cloud base (approx. 2 km). This was later evidenced by the storms that developed (most of the updraft bases were high based).

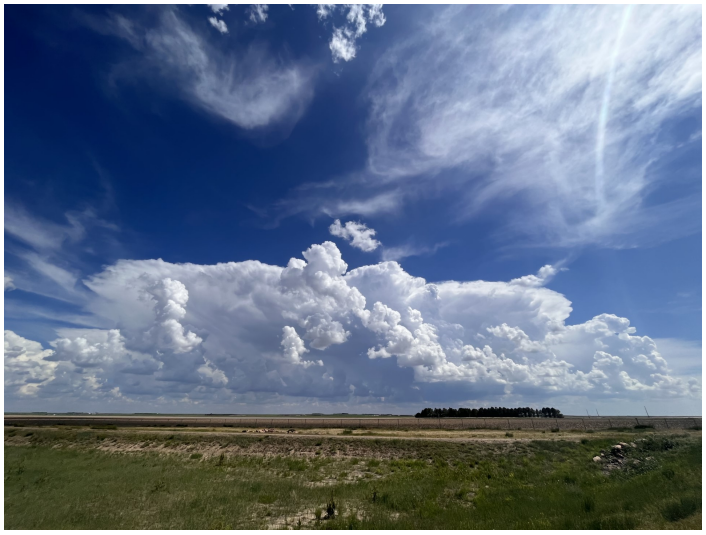
- Also observed using the 2 m AGL Dew Point, was dew points ranging between 45-55 degrees F throughout the eastern portion of Colorado, and portions of western Kansas, which is fairly more than compared to the dew point condition measured in Colby on Day 1.
- Looking at an 1800 UTC sounding, we found that there was a good amount of CAPE (approx. 2000), some CIN (approx. -27), but weak shear. Also looking at the hodograph we expected to see splitting storms, given the linear shape. An important feature found in the hodograph was that storms would be nearly stationary, or fairly slow moving.
- Finally, we looked at the Reflectivity UH>75. We noticed two points of interest, looking at the HRR and GFS models we noticed two areas where we found stationary storms, as expected from the motion predicted by the hodograph. One of these storm cells, which was consistently shown in different model runs, was near our current position in Burlington, Colorado. The other cell was located in the Texas Panhandle. We concluded that our best option was staying near Burlington.

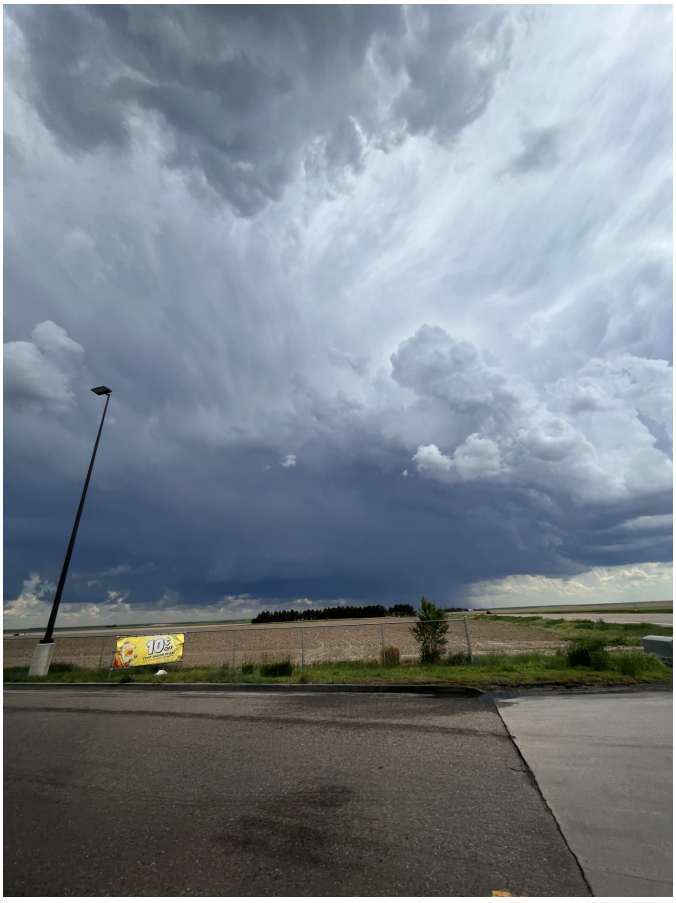
Noteworthy events:

- A sounding was launched at 1950 UTC to look at the pre-convective environment.
- At 2030 UTC cumulus clouds south of Burlington began initializing and getting clustered. There were visible “turkey-neck” updrafts getting entrained by dry air aloft.
- Around 2045 UTC the cumulus clouds started congeling and transitioned into cumulus congestus. These began producing several updrafts and reaching heights of about 9 km.
- At around 2140 UTC the storm intensified into a mature state with multiple updrafts and downdraft, leading us to start our chase. The storm produced copious rain and pea sized hail, along we cloud to ground and cloud to cloud lightning. Also, noticed two cold outflow boundaries, from the storm being chased and another storm further south converging into weaker updrafts. As expected these updraft bases were high and the outflow boundaries basically killed any further intensification.
- These “isolated” storm cells converged into a slow squall line moving west.

Pictures:







Lessons Learned:

- Today we saw in real time how storms develop, especially in areas that we forecasted to see them (from cumulus clouds to mature thunderstorms). We also saw how outflow boundaries behaved and interacted with developing storms (causing storms to “gust” out

and weaken) but we could have done a better job at anticipating this. Moreover, we saw how the lack of shear caused the LCL to remain higher in the boundary lawyer leading to high based storms in the vicinity.
- Overall we did a pretty good at predicting the motion and mode of the storms based on the skew T and hodograph data.

Day 3: Wednesday, 31 May 2023

Forecast overview:

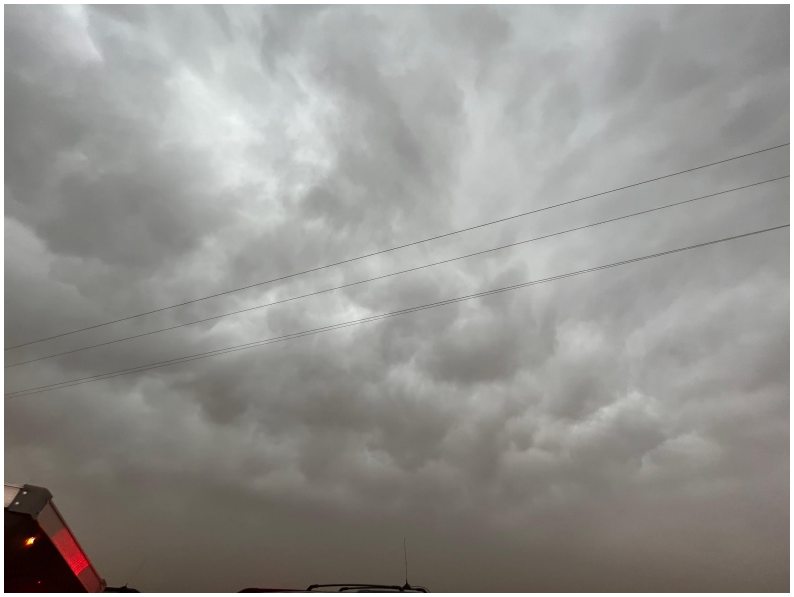
- There's a good amount of moisture present being brought from the Gulf by south easterly winds at lower levels.
- A fair amount of shear a loft
- Skew-T showed a good amount of CAPE (1500+) and CIN of -20, as well as lowering cloud bases (1 km) by a well mixed boundary layer.
- Hodograph shows that storm mode would most likely be splitting supercells.
- As the dryline retreated and more moisture moved in from the south easterly winds, storms were expected to initiate near their boundary.
- Storm expected to develop in eastern New Mexico based on the SPCs outlook.
- The storms cells were forecasted to merge and become a squall line as the evening rolled in.

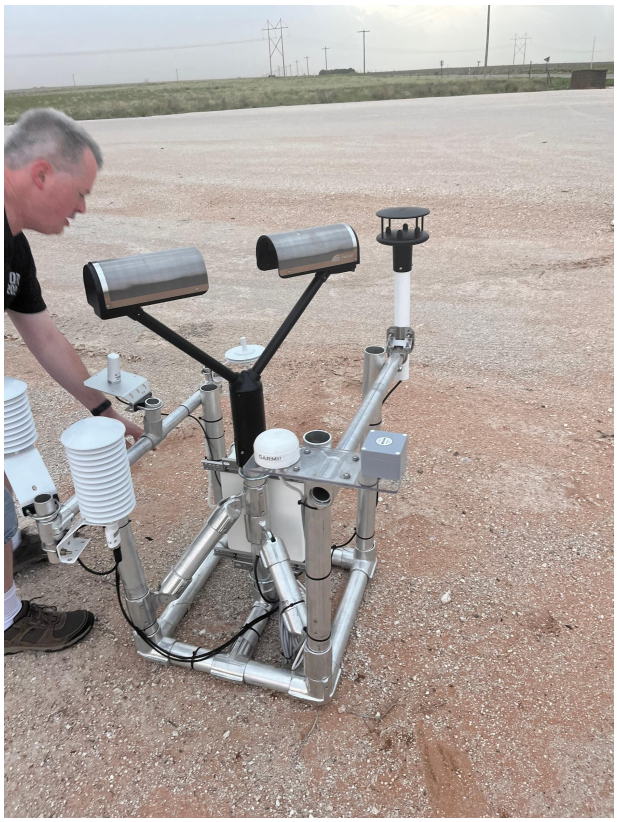
Noteworthy events:

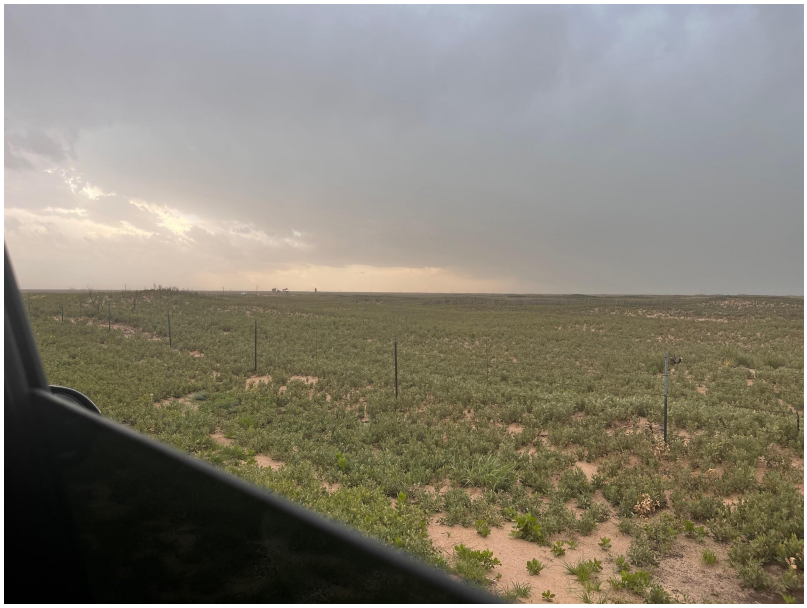
- Storms start to develop at 1600 UTC in northern New Mexico as they moved downslope the southern Rocky Mountains. These translated towards the northeast towards the Oklahoma and Texas Panhandle.
- As we moved south toward Clovis, New Mexico a second round of storms, many of them with a supercellular structure, developed around 2015 UTC. The storms had a mean motion towards the northeast, but some of these split into right and left movers as they matured. Specifically, a dominant supercell southwest of Dora, New Mexico split into a left mover and a more dominant right mover around 2105 UTC. Although we had a visual of the storm's anvil, dust blown from the southeasterly winds obscured the base of the storm and overall decreased visibility conditions. The more dominant right moving cell became tornadic, deduced from the noticeable hook echo, around 2141 UTC. At this point PIPS were deployed 3156 UTC on road 206. As we continued south, a storm to the south relative to the target storm clashed into it, ingesting it through its inflow, and therefore cutting off the circulation.
- As these cells merged, a new circulation (visible wall cloud) was observed about 15 miles southwest of 206, where we were stationed around 2220 UTC. This lasted about 15 minutes before being gusted out by a dominant outflow.

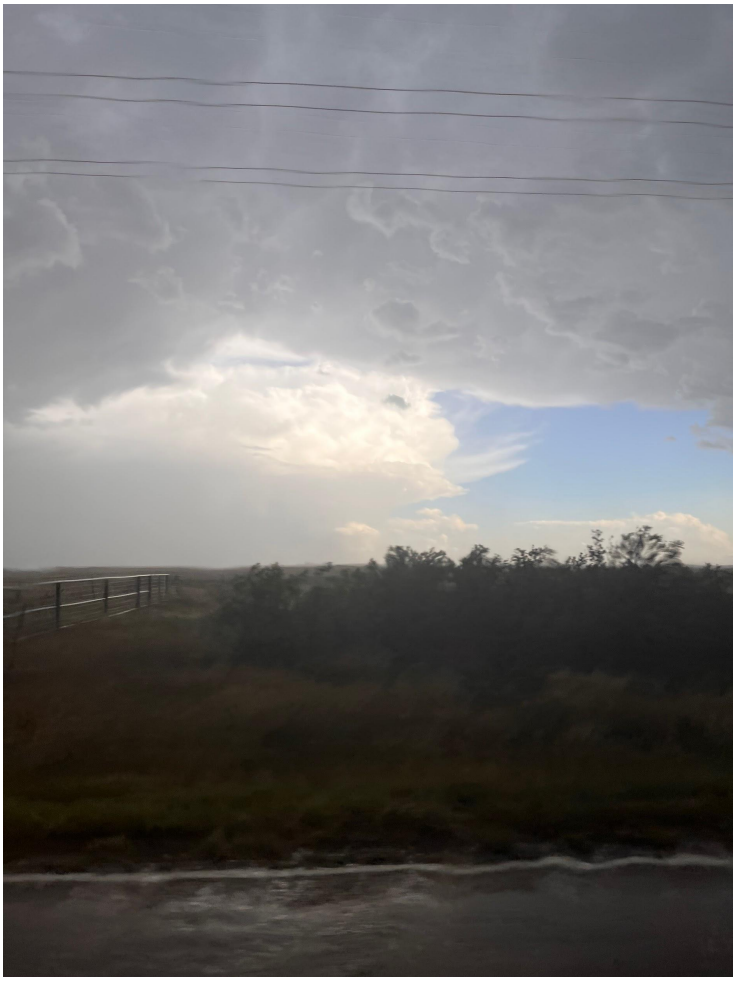
- After, the storm cells began to merge and become larger scale and transition into more of a squall line moving towards the northeast, similar to the first initial storm system.

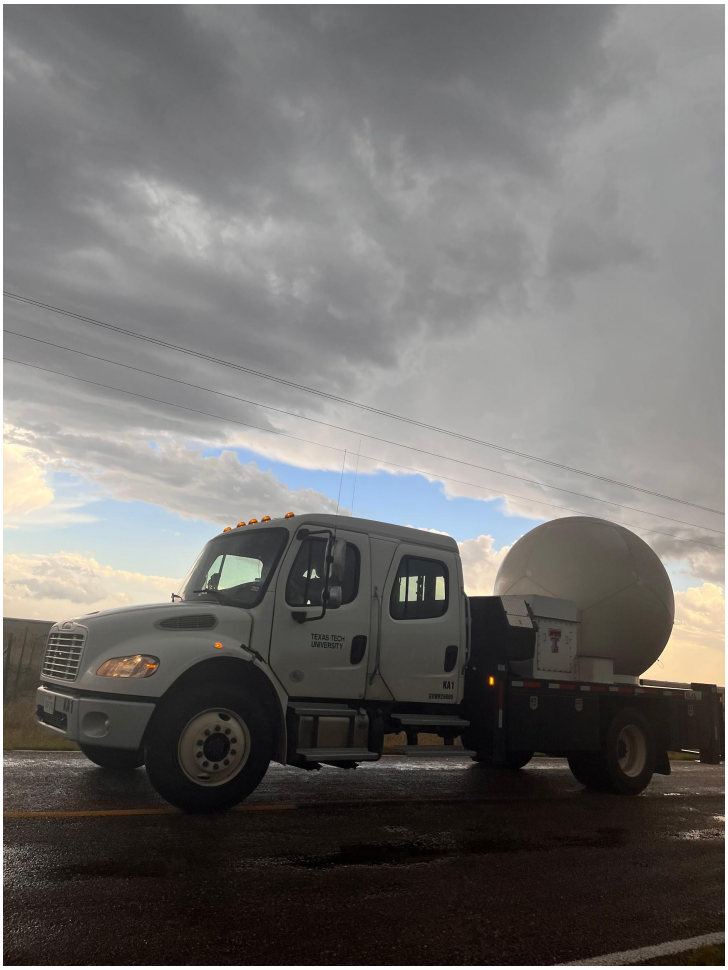
Pictures:











Lessons learned:

- I learned how supercells can interact with each other, and whether their mergers can be either destructive or constructive. The supercell that we targeted underwent a destructive interaction with another cell to its south, as the circulation was completely choked up and ingested the storm, as opposed to warm inflow which would have helped it strengthen otherwise. I also learned that tornadoes and supercells do not thrive when a set system of storms converges into an upper scale MCS or MCV, as opposed to set ups that allow for more isolated and discrete cells to develop. Moreover, in these upper scale systems, the storms begin to compete for the unstable environment, and end up weakening in that process.
- The forecast did well in predicting where the storms would initiate, as well as their mode.
- I think the forecast did not anticipate how quickly these storms ended up firing in an almost instantaneous manner due the capping being eroded by the morning squall line.
- We also learned how to pick a place to deploy the PIPS to get considerable data from the storms.

Day 4: Thursday, 1 June 2023

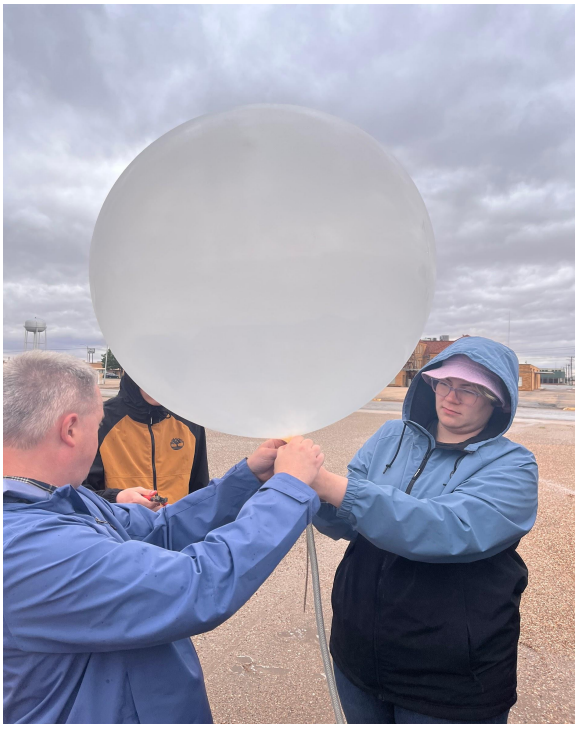
Forecast overview:

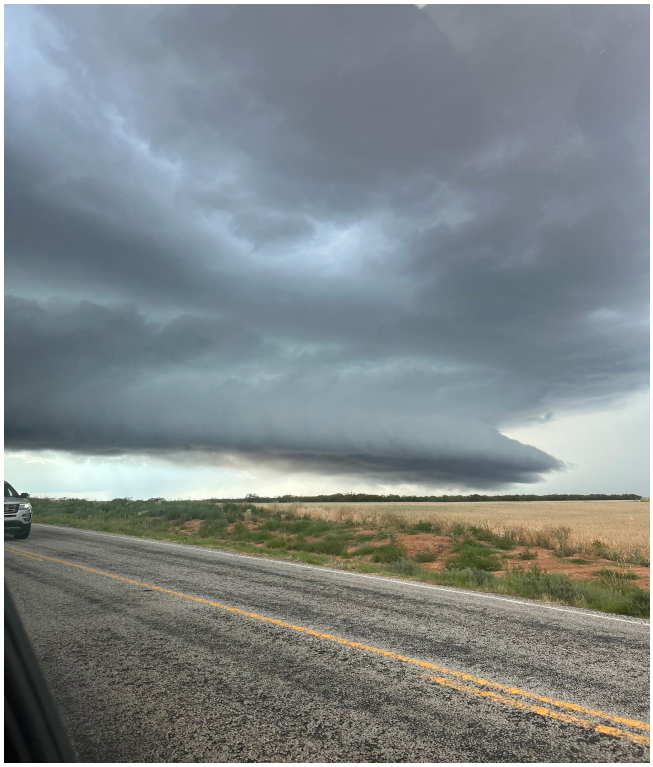
- Looking at the wind profile into the afternoon there seemed to be an increase in upper level flow into the afternoon. Meaning stronger shear was possible.
- The moisture levels were predicted to be high because of the early morning line of storms that went through. These storms would leave a pocket of stable air behind them but the development of an outflow boundary stationed just south of Lubbock, Texas coupled with warm air advected from the Gulf of Mexico were expected to aid the formation of storms along it.
- Unfortunately, although shear and moisture seemed to be present, low to moderate values of CAPE were expected, given that the morning stabilized the air north of that boundary.
- Regardless, the chance for supercell development was still possible along the boundary.
- Thus, it was concluded to head south of the boundary to Brownfield and/or Seminole and wait out to see what happened.

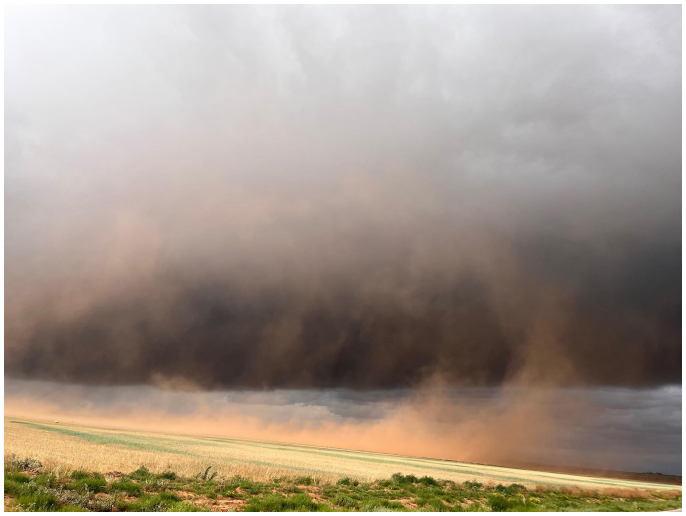
Noteworthy events:

- At 1720 UTC we launched a radiosonde to get a grasp of the atmospheric conditions as that first line of storms retreated northeast and to find out if there would be a positive trend toward a convective environment later in the day. Note: It was easy to tell where the LCL was because this was the level at which the balloon disappeared into the clouds.
- At around 1925 UTC, a second radiosonde was launched to measure the pre-convective environment further south of the boundary, where convection was already visible to the southeast.
- As we drove down highway 180 we noticed some deep convection towards the east, with other cells starting to develop behind the main convective cell. These formed along the boundary that we initially forecasted them to form from.
- Turning into highway 87, we observed a developing wall cloud, but it weakened in time due to it being more outflow dominant (note this would be a trend).
- As we followed our main target storm east, we kept an eye on the weakening wall cloud to our southeast.
- Approaching the target cell, a lot of dust began to be picked up by the outflow and gust front from the storm. This would produce at least 2 visible gustnadoes. Another wall cloud began to form as the cloud base of the updraft lowered.
- After watching it move on its east-north easterly track over us, the storm encountered stable air, which completely cut off the wall cloud from the updraft, thus leading to a more shelf like structure, and ultimately its decay. As two other cells (a southern cell and northern cell (e.i. the same that produced the initial wall cloud)) approached the stable air and suffered the safe fate.

Pictures:







Lessons learned:

- In this case, we learned how stable air can cut off the connection between the updraft and wall cloud, which was the main cause of the weakening and decay of the storms. This pocket of stable air seemed to have had a bigger impacted than what was initially forecasted. It was also unknown why more storms did not develop west of the boundary. On the other hand we saw how storms can develop along a boundary line driven by the outflow from a previous system and a gradient in wind speed and direction, coupled with changes in moisture content as a result of that outflow.
- Although these were more isolated supercells, as opposed to the day before, it was interesting to see how volatile their development was as a result of varying conditions in stability across a short distance and time.

Day 5: Friday, 1 June 2023

Forecast overview:

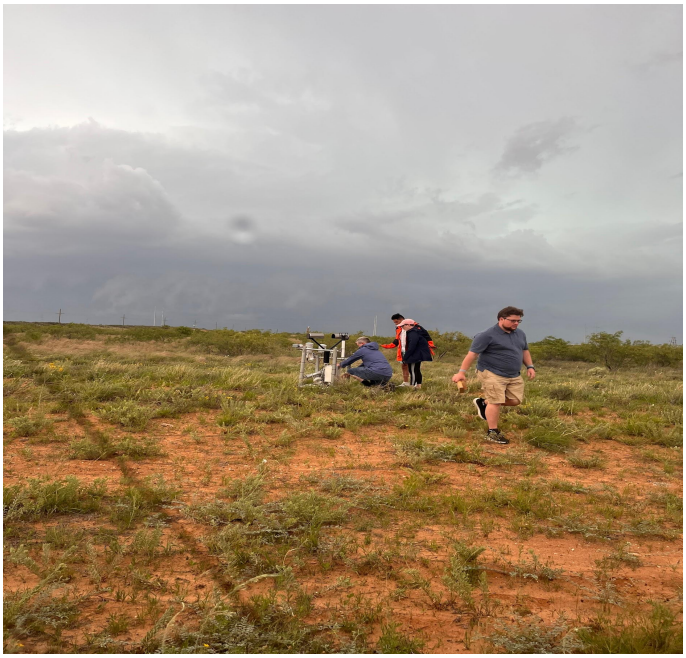
- Looking at the surface based CAPE, there was a notable increase in CAPE in the early afternoon hours ranging from ~2000- ~3000. This was observed just south of Lubbock, TX.
- Dew points were in the upper 60s indicated high moisture levels in western Texas, thus good ‘fuel’ for storms to develop and last for a longer period.
- Bulk shear vector from 0-6 km looked fairly strong with winds a loft in the mid 50s knots but weaker winds near the surface. A closer look at the hodograph, suggested a good chance for discrete supercells to develop (semicircle shape).
- These parameters suggest that there was enough instability for the development of supercell mode of storms around 2000 UTC.

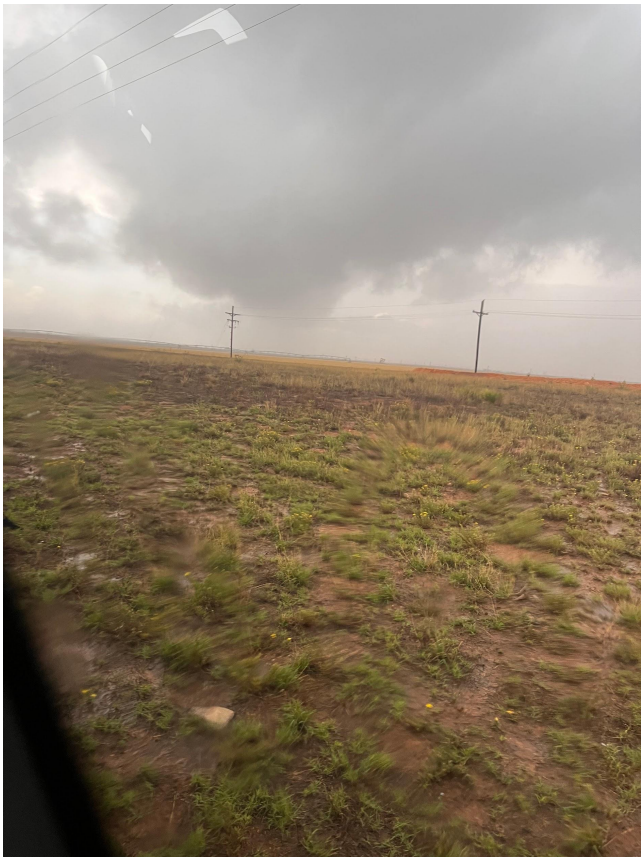
- These storms were then expected to congeal into a squall line in the evening, so we need to catch these storms in their early development process before the transition to that occurred.
- For this reason, we decided to drive south to Seminole, Texas, where these storms were expected to occur according to Reflectivity UH>75.
- The SPC also placed an enhanced risk for severe storms within the Lubbock and Seminole areas, which agreed with what was said in the forecast.
- The forecast was fairly accurate in predicting the area that storms would develop, as well as the mode of storms (supercells and then squall line) based on the conditions present in the preconvective environment. The only slight discrepancy was that the storms began to form earlier than expected at around 1700 UTC.

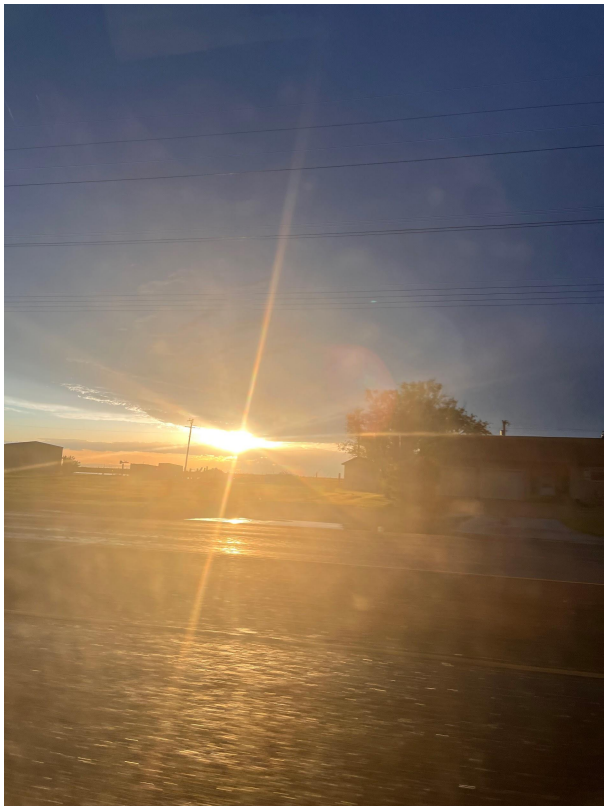
Noteworthy events:

- Our first target was a supercell that developed at approximately 1650 UTC and produced a confirmed tornado at around 1720 UTC. The storm was also tornado warned around this time. We were unable to get a visual of the tornado itself because heavy rain and hail obscured it (rain wrapped). Though, it was impressive to see a vibrant green near the core of the storm indicating that heavy hail was present.
- At one point near 1735 this storm had 3 circulations present at once as result of another storm merging, but they became outflow dominant and were “gusted out” unable to produce anymore tornadoes.
- In 1820 UTC a second supercell began to develop south of the original target cell. We got in position east-northeast of it to deploy PIPS. We ultimately deployed 2 PIPS, one at 1842 UTC and another further south 1852 UTC.
- As we drove away to wait for this storm to pass, we experienced heavy rain and pea sized hail at around 1920 UTC. At this same time the PIPs recorded winds between 15 m/s to 25 m/s according to Prof. Dawson’s account.
- On our ride back to Oklahoma City, we encountered the squall line that developed from the original storm cells we chased. It was interesting to see very low level clouds (the tops of windmills were obscured by these) and later on fog in the western region of the squall line. As we began to enter the stratiform region CC type of lightning occasionally lit up the overhead clouds. As we continued on we encountered heavier rain as we approached the core of the storms at around 0000 UTC. We were inside of this storm for most of our drive back since we both were moved in the same northeasterly fashion.

Pictures:







Lessons learned:

- It is important to keep an eye on satellite and radar imagery so we understand when CI begins. The storms developed a lot quicker than what was forecasted in the morning leading us to scramble to get the Seminole in time. But thanks to the satellite and radar imagery we were able to act fast and get to the storms before they congealed into the squall line.
- Something that the forecast did well on this particular day was predicting the tornadic cell near Fort Stockton, TX. And also the QLCS that we drove through on our way to OKC.