Analyzing the Atmospheric Conditions that Caused Two Unexpected Tornado Events

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Objectives

On May 25, 2016 and July 7, 2016, two tornadic storms occurred near Chapman, Kansas and Eureka, Kansas. Neither of these tornadic storms was forecast to occur by the National Oceanic and Atmospheric Administration's (NOAA) Storm Prediction Center (SPC). In this research project, data from several online sources were analyzed to identify the atmospheric conditions around the times and near the concerned areas where the tornadoes spawned. Identifying and understanding the causes of these tornadoes will help future meteorologists better predict possible tornadoes in the future.

Testing Approach

- Collect meteorological maps with weather data
- Contour regions of similar temperature, pressure, and dew-point temperature at the surface (see Figure 1)
- Determine location of dry lines (region separating moist and dry air), cold and warm fronts (air mass boundaries), low and high pressure regions
- Compare meteorological maps as time progresses

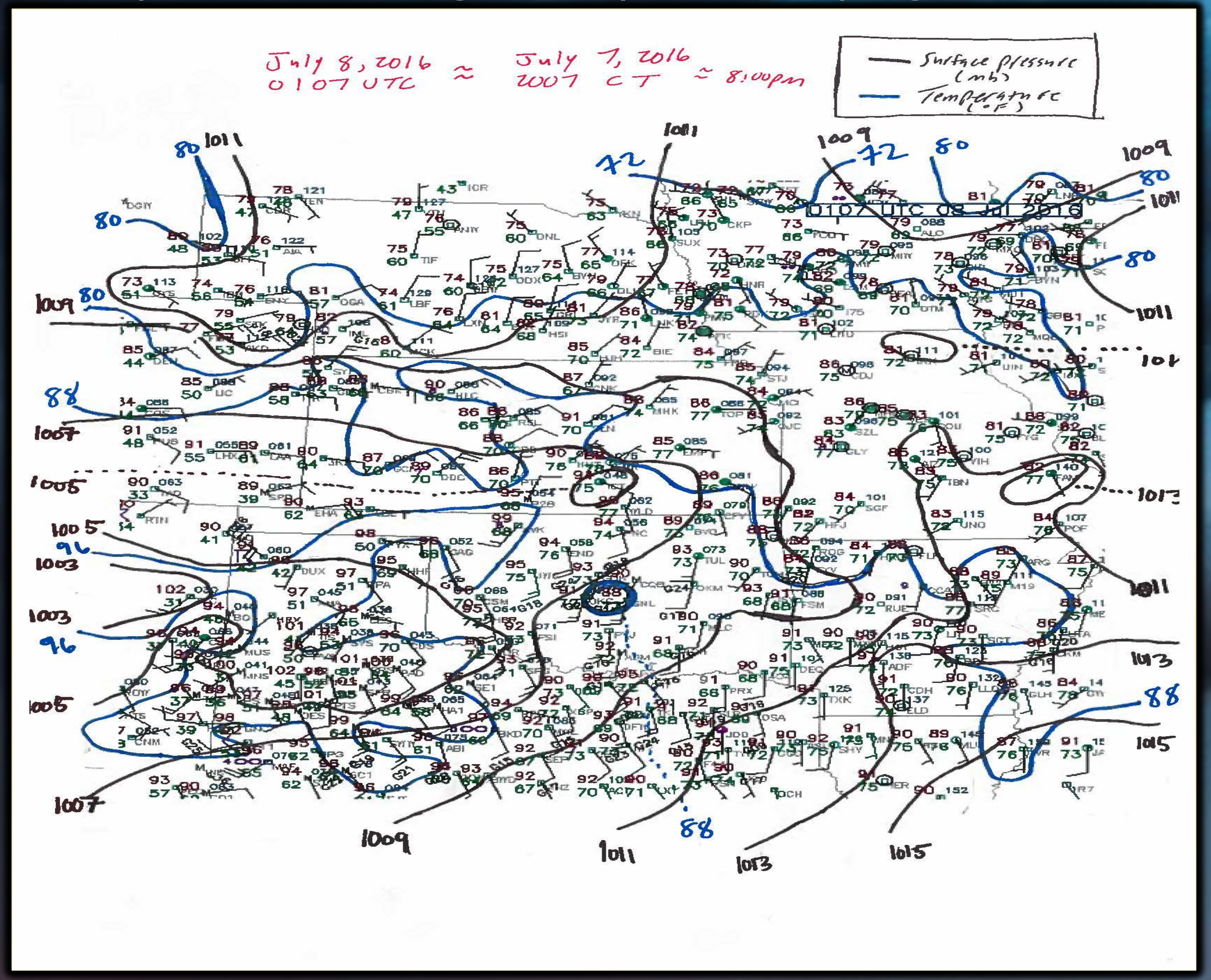

Figure 1. Sample map with isobar (pressure) and isothermal (temperature) contour lines drawn for July 8, 2016 0100 UTC

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Chapman Tornado

May 25, 2016 Atmospheric conditions:

- Low pressure in south-central KS based on wind vectors(See Figure 3A)
- Cold front west of low pressure region moving southwestward
- Warm front East of Low Pressure region moving northeastward
- Dry line south of low pressure region extending into TX
- Atmosphere showing high instability
- Strong changes in wind speed and direction with increasing altitude(vertical wind sheer)
- Atmosphere in the region was very moist

All variables came together to provide an environment conductive to the development of a severe thunderstorm.

Figure 2. Photograph of the EF4 Chapman, KS tornado on May 25, 2016; photograph by Scott Landolt

EF3 damage noted at 7:10 pm local on May 25, 2016

- A second storm formed behind (west of) the isolated storm
- Second storm began to be absorbed by the first storm
- Second storm produced a left-moving split that moved north before second storm merged with first storm (see Figure 3B)

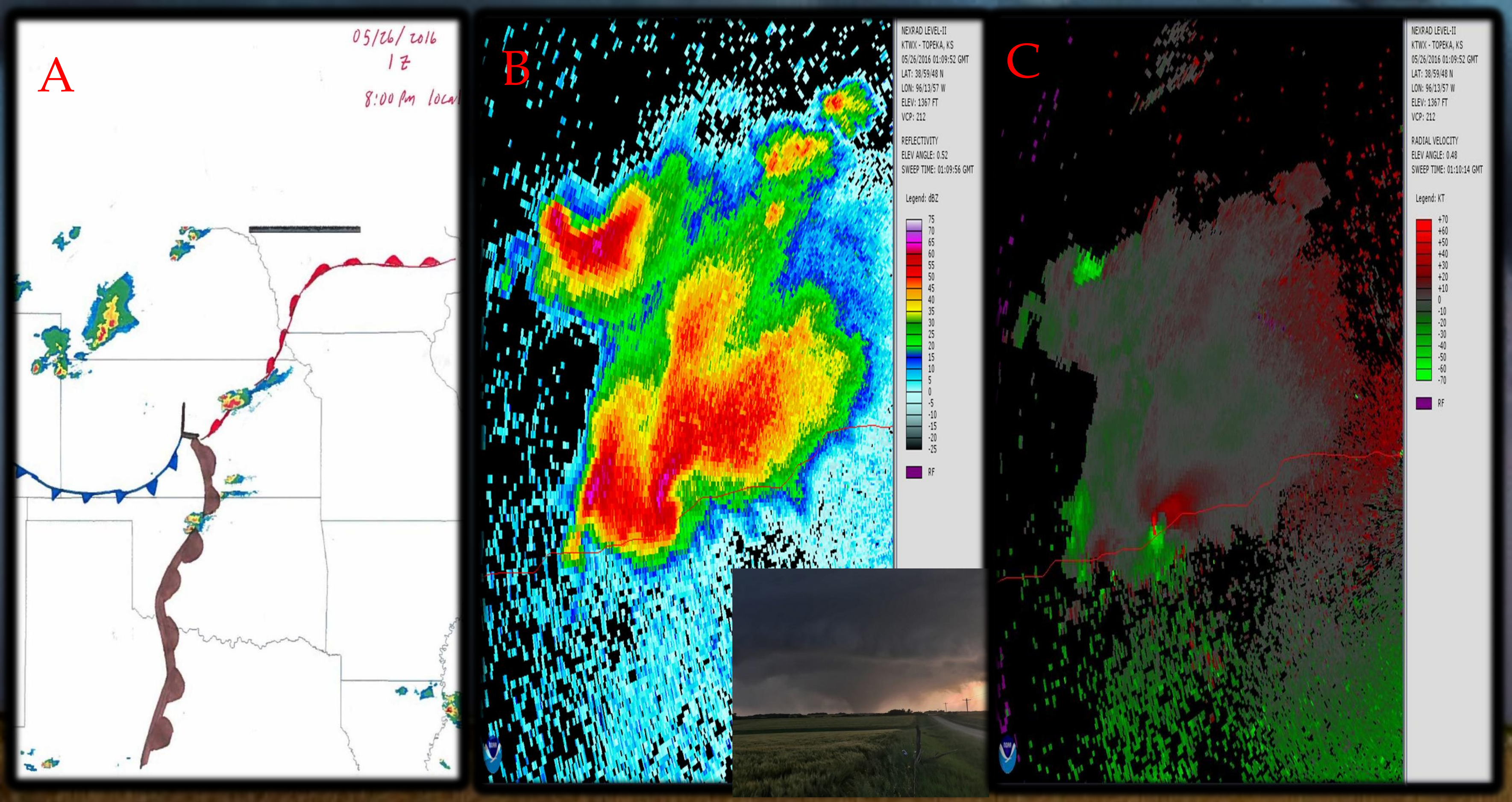

Figure 3. Images showing air mass boundaries at 0100 UTC (A) and Radar image of the storm splitting at 0110 UTC(B) with a photograph of the tornado at the same time , and Radial Velocity showing winds moving away from (red) and toward (green) Topeka, KS on 05/26/16 (C). Image C shows a region in the southwestern edge of the storm where there is rotation at the hook echo. Photograph in image B was photographed by Scott Landolt

Eureka Tornado

July 7, 2016 Atmospheric Conditions:

- Moist atmosphere
- Strong Vertical wind sheer
- Instable atmosphere
- Low pressure region in southern KS
- Moist air moving northeastward from Texas (warm front)
- Southwestward moving wind from northeastern Kansas (cold front)

Figure 4. Photograph of the Eureka, Kansas tornado on July 7, 2016; photographer unknown

- The atmosphere in KS was unstable with the sounding from Topeka, KS showing a CAPE value of 2819 J/Kg. Higher CAPE values (>2000) indicate very unstable environments
- The cold air mass (cold front) in Figure 5A is moving southwest into KS from the northeast. As it passes the warm front near the low pressure region in central KS, the denser cold air lifts the warm air, providing a focus to initiate convection.
- Vertical wind sheer gives the storm the vorticity for a tornado to occur.

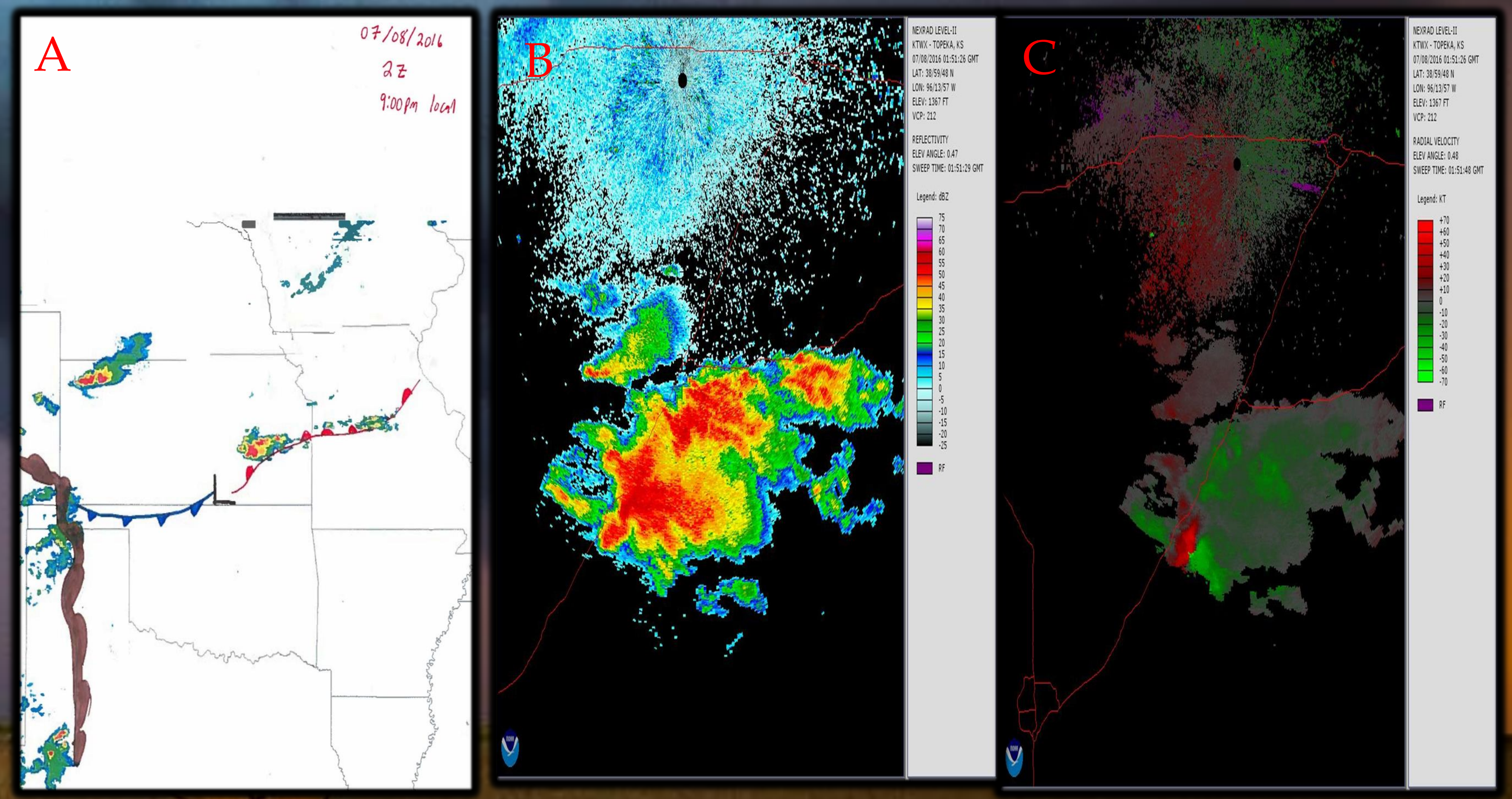

Figure 5. Images showing air mass boundaries at 0200 UTC (A), a radar image of the storm at 0151 UTC (B), and the corresponding radial velocity of the winds at 0151 UTC (C) on 07/08/2016