

# Environmental Controls on Banded Versus Cellular Organization of Mesoscale Snow Squalls in Western South Dakota

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## What is a Snow Squall?

A fast moving, intense, localized snowfall accompanied by gusty winds, dropping temperatures and low visibility.

## Why do They Matter?

Snow squalls can be hazardous for road travel. The sudden nature of these systems can surprise drivers and lead to rapidly changing road conditions.



1/2 mile later

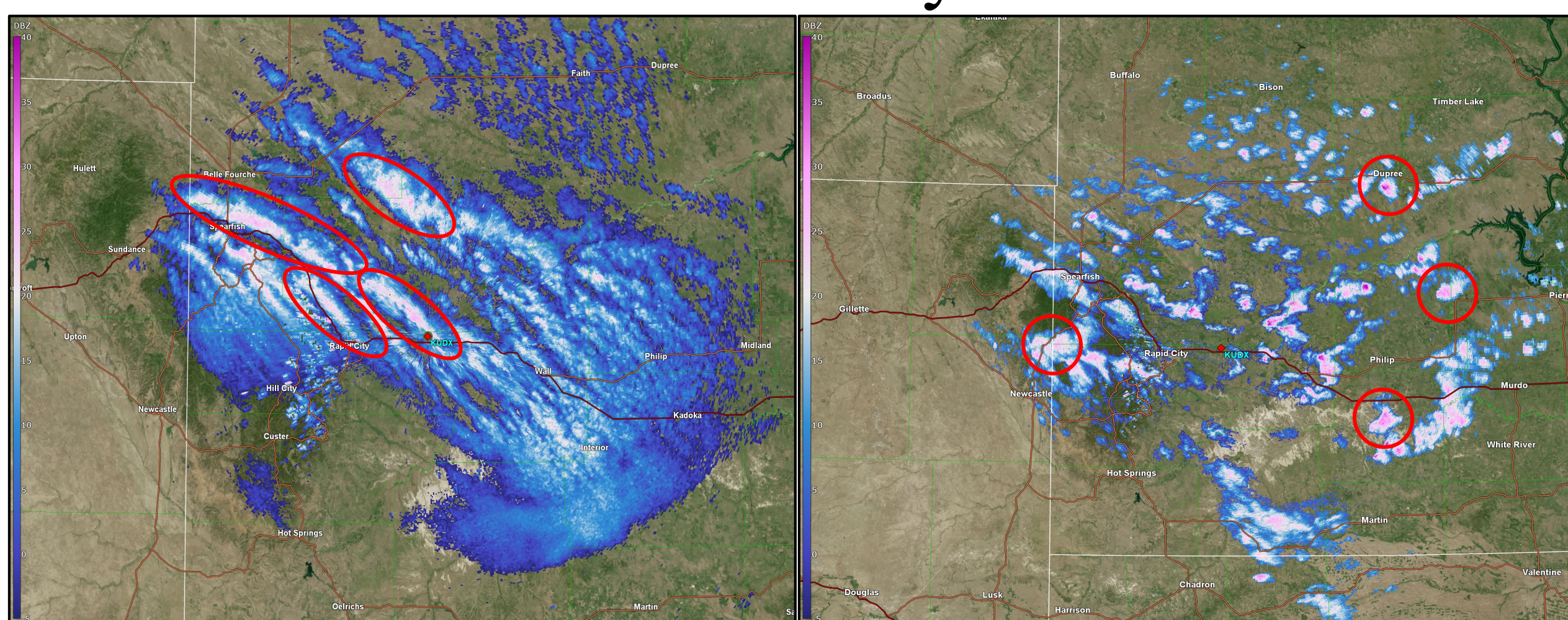
## Research Goals

- Determine radar signatures unique to banded and cellular snow squalls.
- Identify environmental conditions that may differentiate between these two modes.
- Determine which mode of snow squall is more impactful.

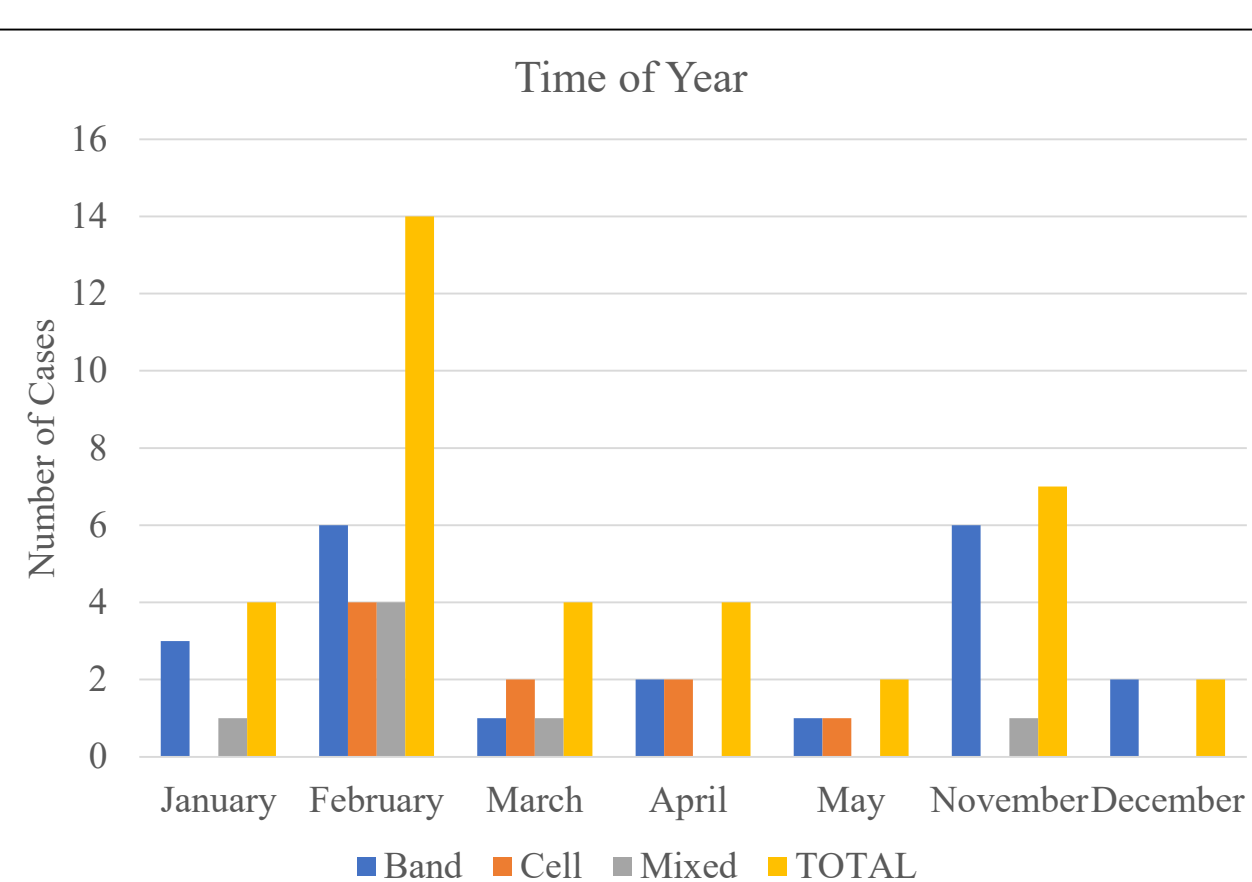
## Methods

- Identified cases using ASOS observations following the Banacos et al. (2014) criteria for snow squalls from January 2012 to December 2017.
- Used WSR-88D radar data to verify that snow squalls were not part of a synoptic-scale system, and grouped them by three subsets; bands, cells and mixed.
- Characterized the environment using observations and RAP model analysis data.

## Radar Analysis



Radar reflectivity factor (dBZ shaded as shown), for example cases of banded and cellular classifications. Note that the maximum value of reflectivity plotted is 50 dBZ.



Identified 21 Band, 10 Cells, and 6 Mixed cases.

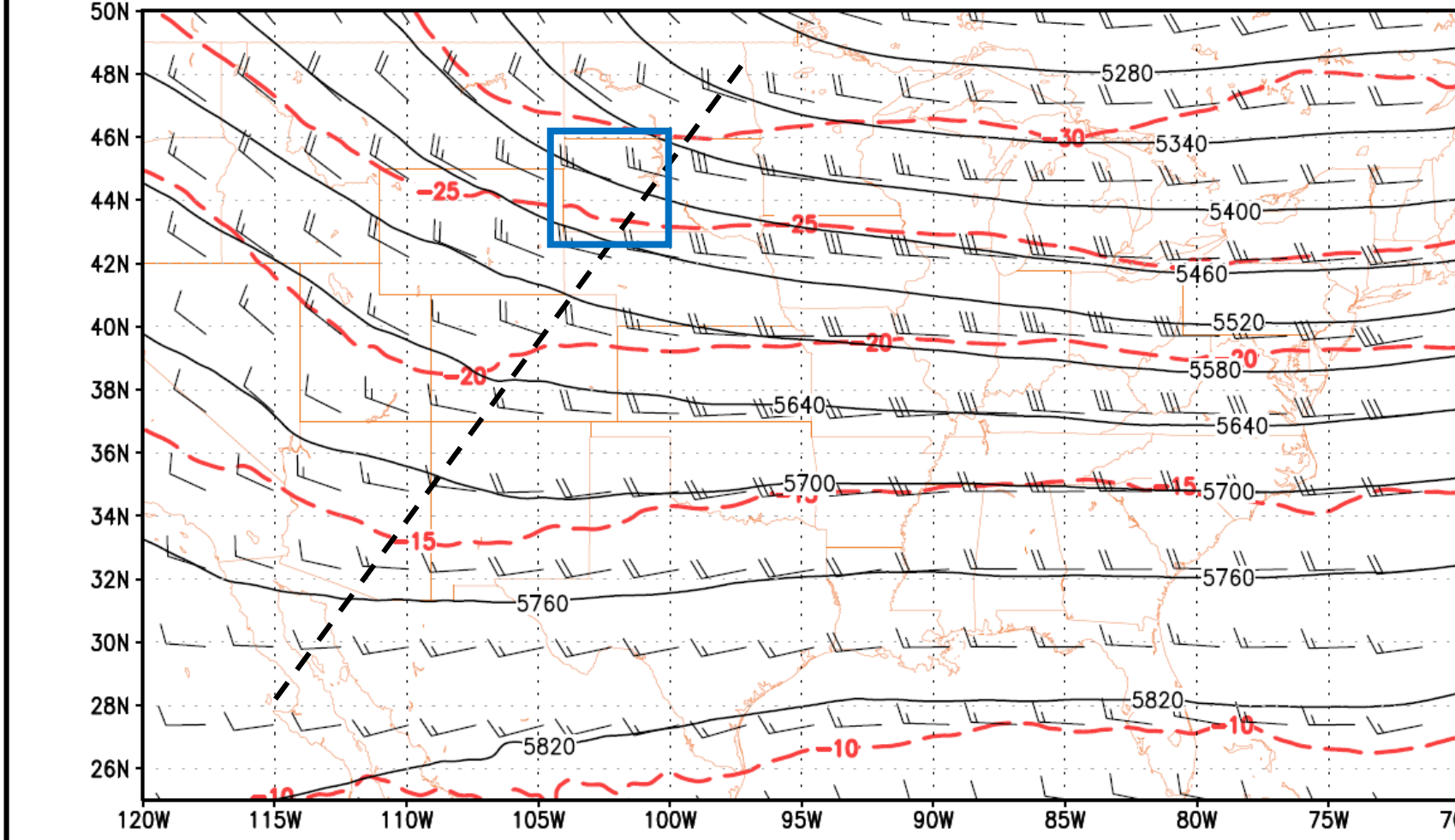
**Bands** tended to have *faster storm motion* and orientate long-axis parallel to the surface to 500 hPa shear vector. There is higher band activity during the *colder months*.

**Cells** tended to have *higher reflectivity* values but *moved slower*. There is higher cell activity during the *warmer months*.

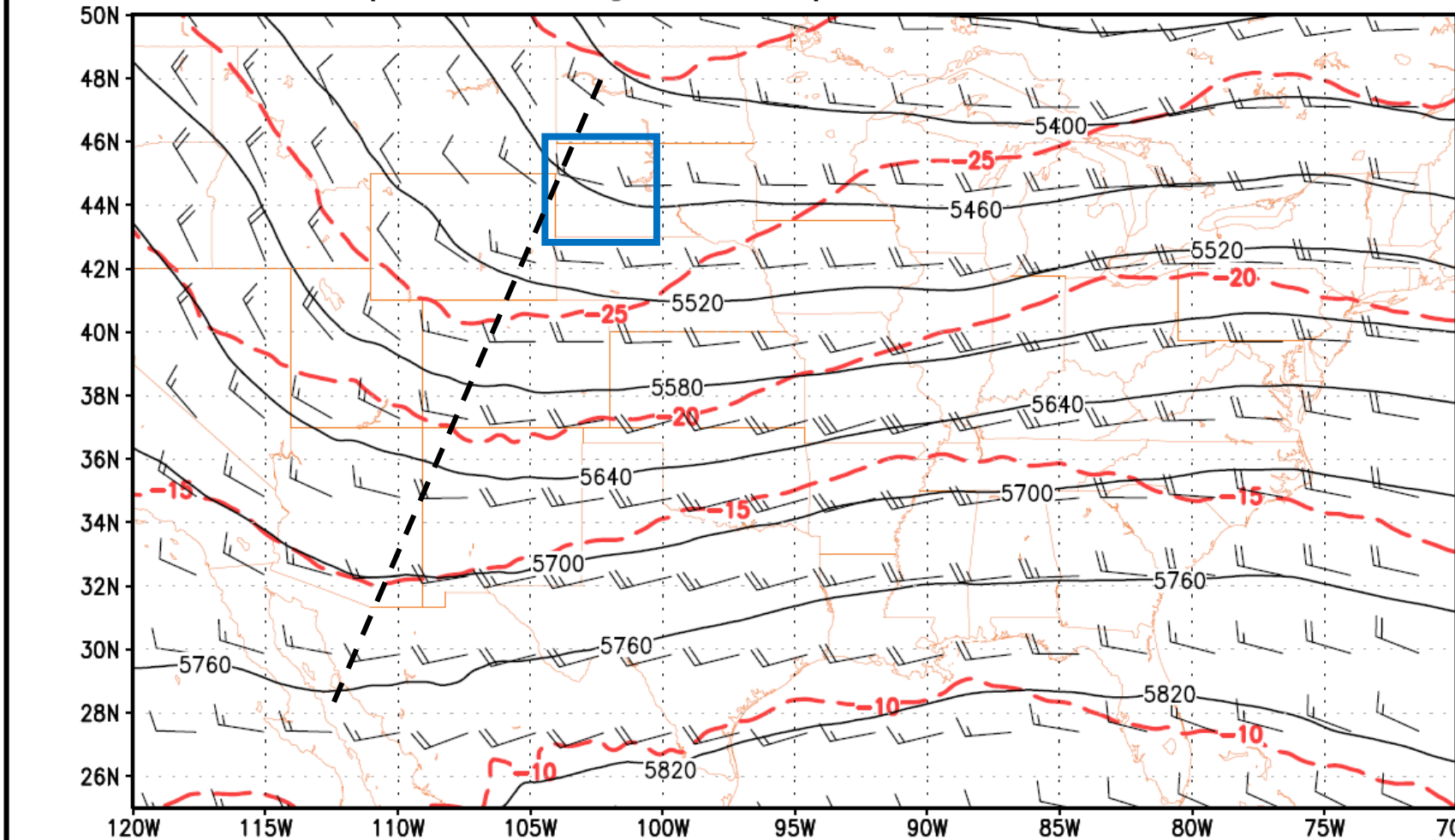
**Both Modes:** Activity peaked in the late afternoon and evening hours.

## Synoptic and Surface Conditions

500hPa Composite Height, Temperature and Wind, Band Cases



500hPa Composite Height, Temperature and Wind, Cell Cases

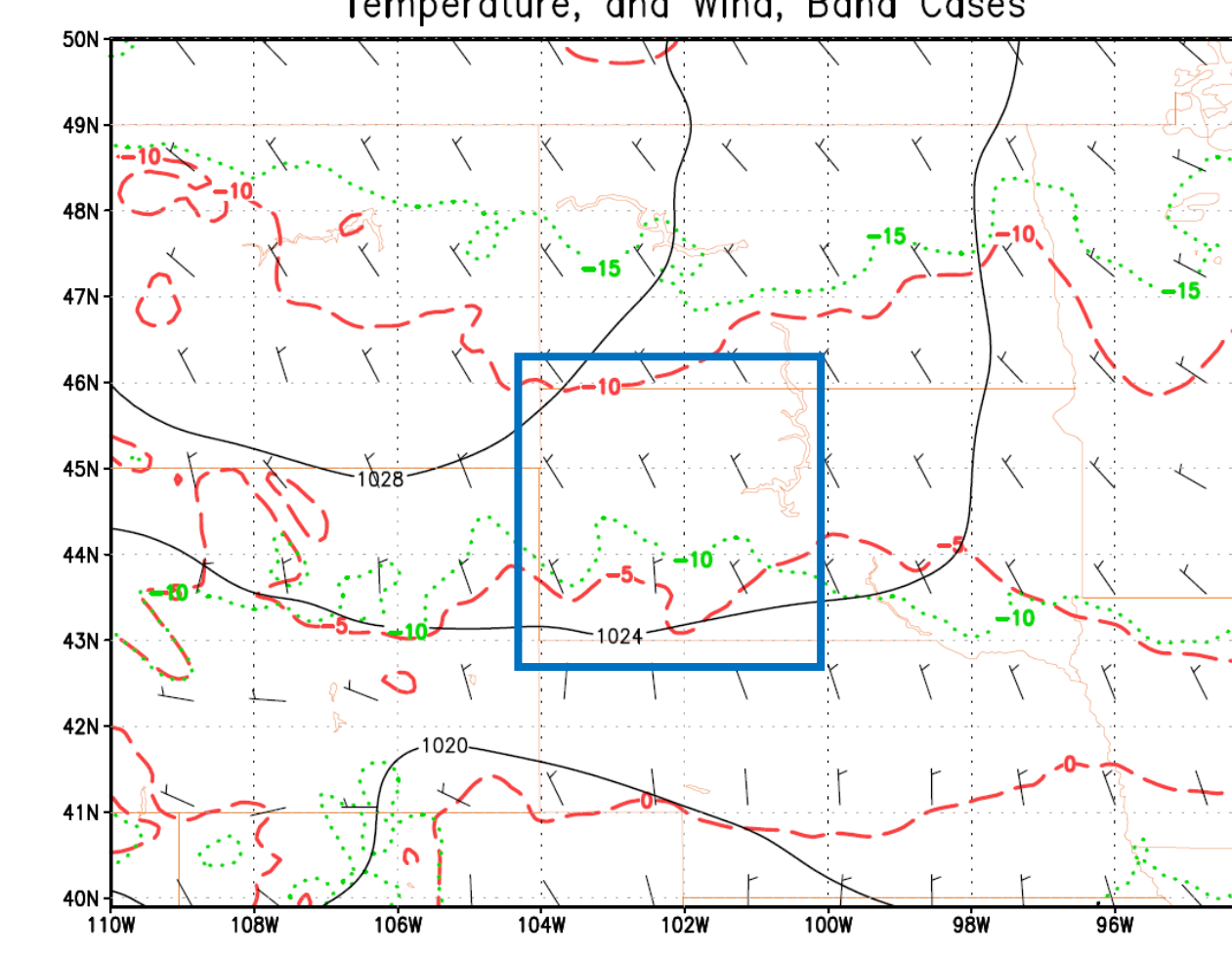


500-hPa height (m, contours), temperature (°C, dashed red contours), and wind barbs (m s<sup>-1</sup>, half barb=5, full barb=10).

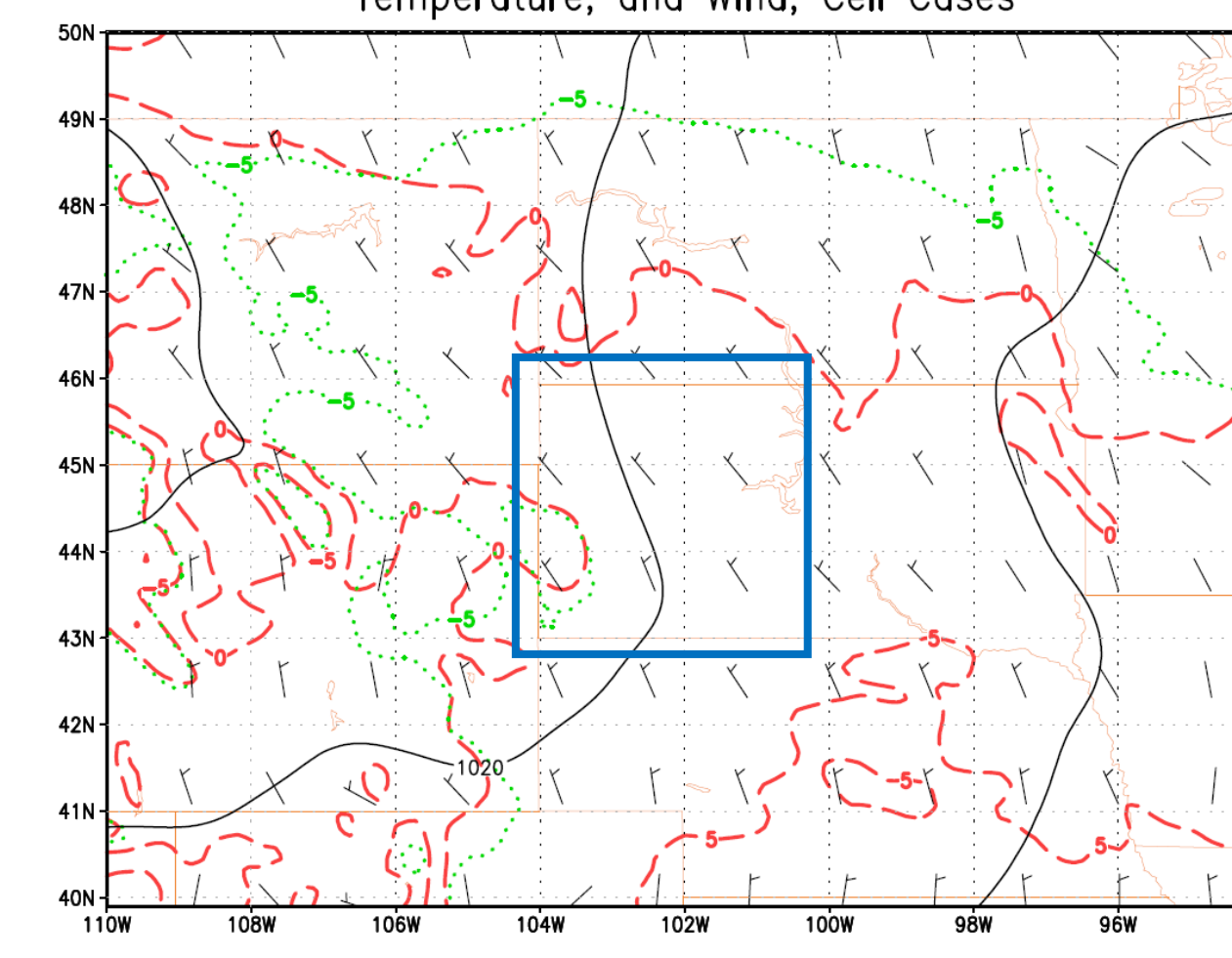
**Bands**

**Cells**

Composite Surface Sea Level Pressure, Dew Point Temperature, Temperature, and Wind, Band Cases

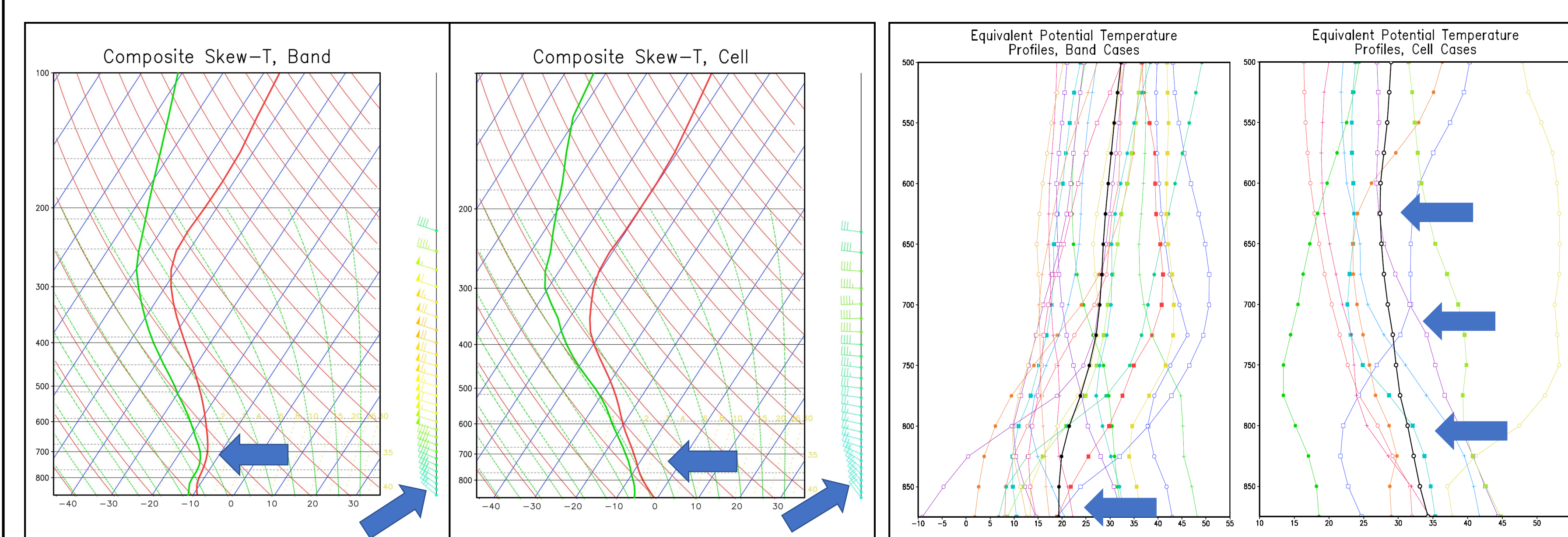


Composite Surface Sea Level Pressure, Dew Point Temperature, Temperature, and Wind, Cell Cases

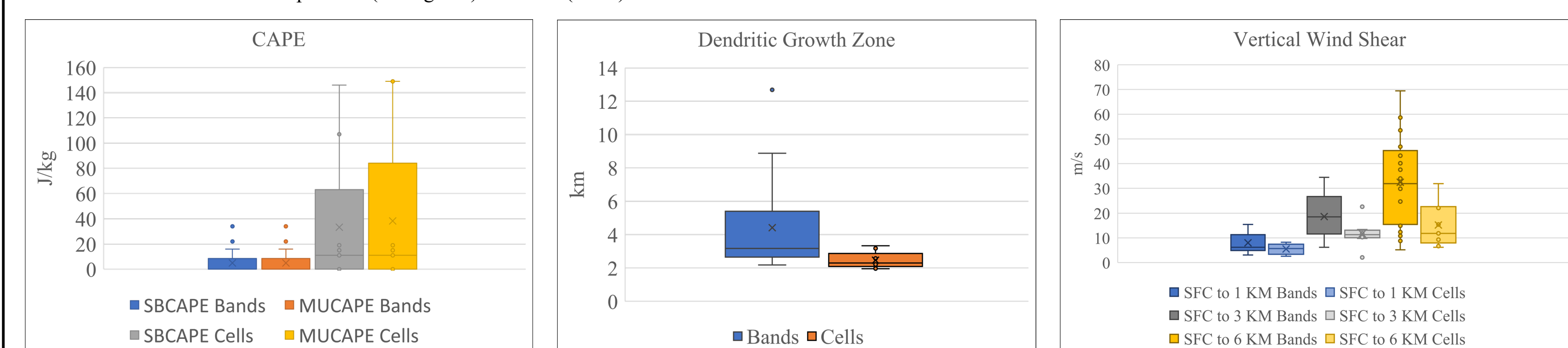


Mean sea level pressure (hPa, solid black contours), dewpoint temperature (°C, small dashed green contours), temperature (°C, dashed red contours), and wind barbs (m s<sup>-1</sup>, half barb=5, full barb=10).

## Vertical Profiles



Skew-T log-P diagrams showing composite profiles of temperature (solid red) dew point temperature (solid green) and wind (barbs). Vertical profiles of equivalent potential temperature. Individual cases are the colored lines, and the bold black line is the composite.

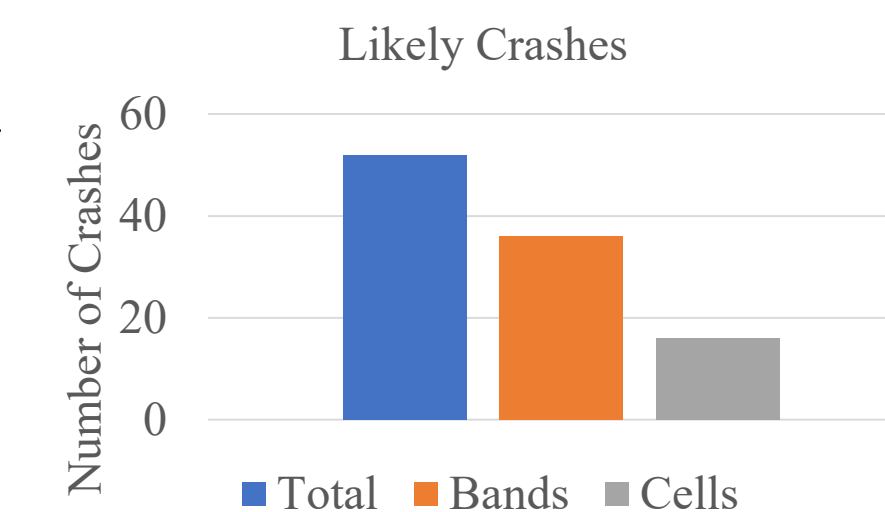


**Bands** tended to occur in environments with *smaller instability*, but *larger vertical wind shear*. Surface-based instability tended to be shallow, and some cases the unstable layer was elevated. Bands saw a large range of dendritic growth zones but were generally deeper than cells.

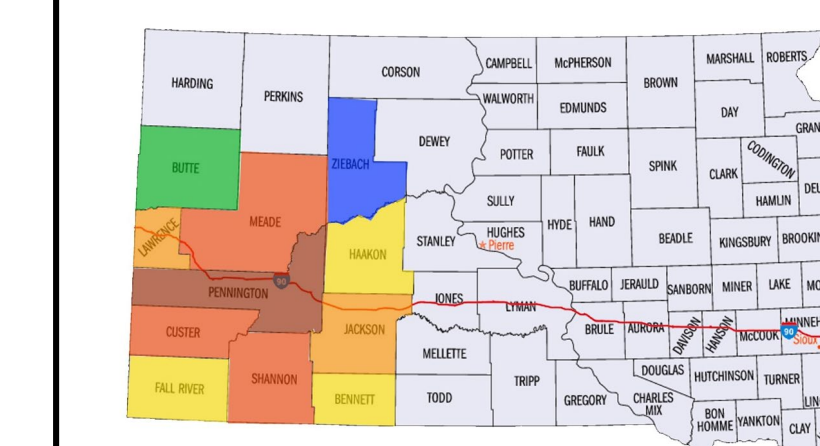
**Cells** tended to occur in environments with *larger instability*, but *smaller vertical wind shear*. Instability tended to be surface-based and unstable layers were often deeper than those associated with bands, while the dendritic growth zone was shallower.

## Motor Vehicular Crashes

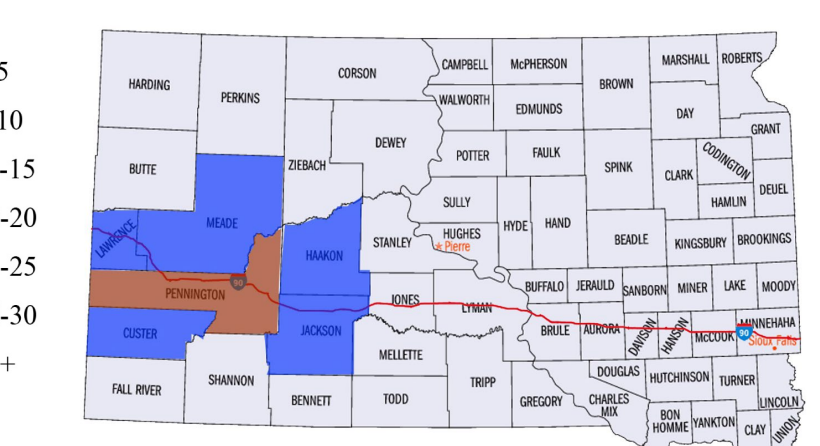
- 22 cases with crash data
  - 12 Banded
  - 7 Cellular
  - 3 Mixed



Total Number of Events per County



Total Number of Crashes per County



- More crashes correlated with banded snow squall events than cellular snow squall events
- Higher number of crashes around the Black Hills and in Pennington County (highest populated county)
- Limited data precluded definitive conclusions on impacts

## Summary

### Bands:

- Occur in **colder months**
- **High shear** but more **stable environment**
- **Deeper** dendritic growth zone

### Cells:

- Occur in **warmer months**
- **Low shear** but more **unstable environments**
- Slightly **more moisture**

### Both Modes:

- Activity peaks in the late afternoon and evening
- Same average visibilities

## Future Work

- The Snow Squall Parameter did not perform well with banded cases. Test for regional sensitivity.
- Expand the number of cases examined, potentially using a radar-based case selection.
- Investigate cases that transition from one mode to the other.
- Sub-categorize banded features based on length and width.
- Investigate potential topographical influences.

Archived ASOS, NEXRAD, RAP and storm event data were retrieved from online archives maintained by NCEI. Plots were created using GrADS. I would like to acknowledge Dr. William Capehart, Dr. Darren Clabo, Dr. Kyle Caudle, Krystal Kossen, Michael Montalbano, Christopher Woody, Brian Roberts, and Patrick Kozak for assistance in coding and helpful discussions regarding this work.