SOUTH DAKOTA SCHOOL OF MINES & TECHNOLOGY

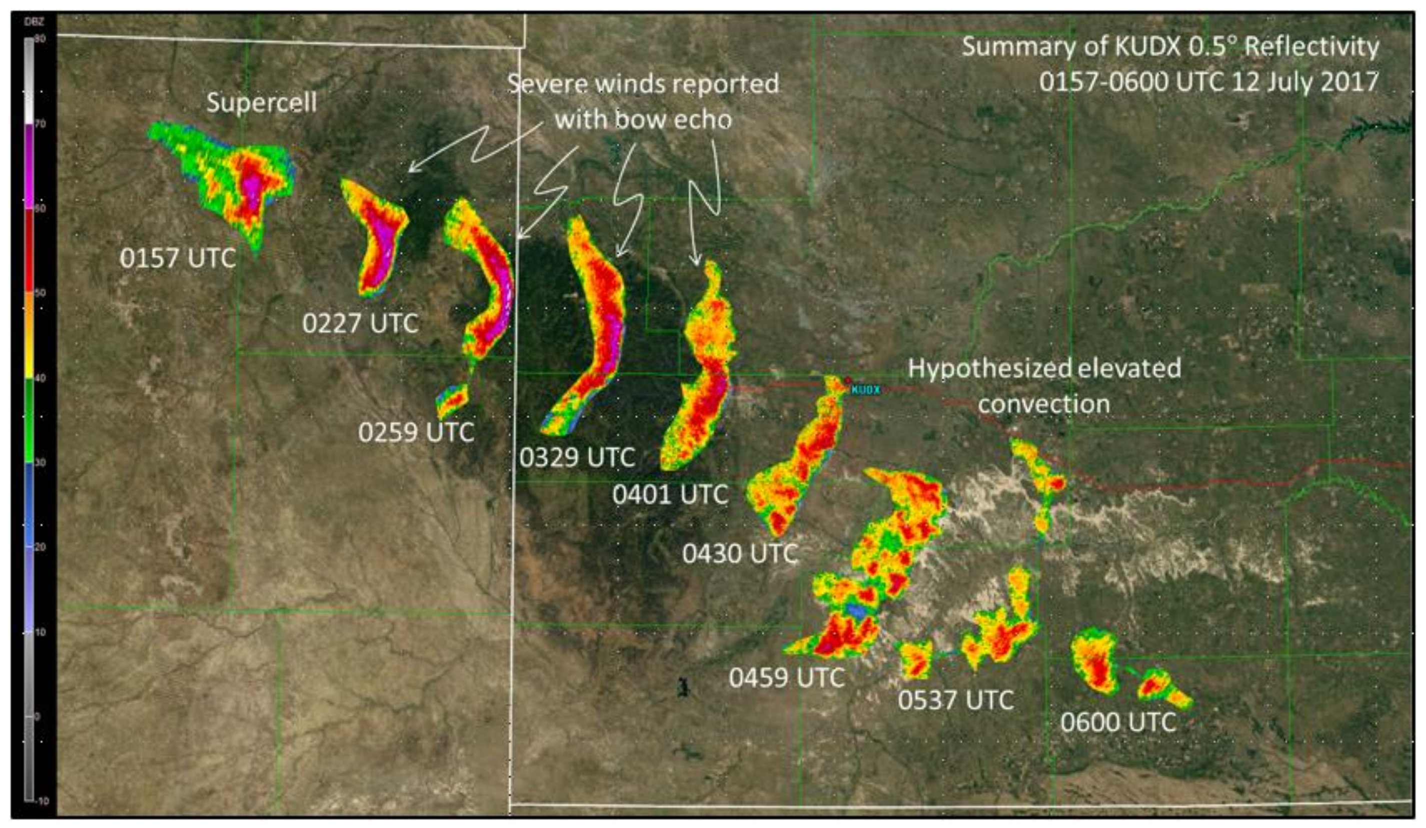
Observational Analysis of a Surface-Based Bow Echo Transitioning to Elevated Convection over Complex Terrain

Amanda Penning and Adam French

Atmospheric and Environmental Sciences Program, South Dakota School of Mines and Technology

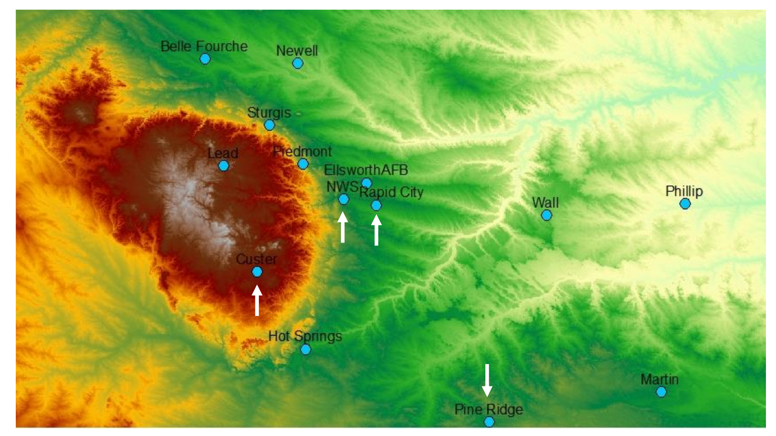
Introduction and overview

On the evening and overnight hours of 11 July 2017 (MDT) a bow echo developed and moved over the Black Hills of South Dakota. As the storm emerged east of the elevated terrain, it rapidly evolved into a less-organized cluster of thunderstorms. This evolution is consistent with the storm system evolving from surface-based to elevated convection.



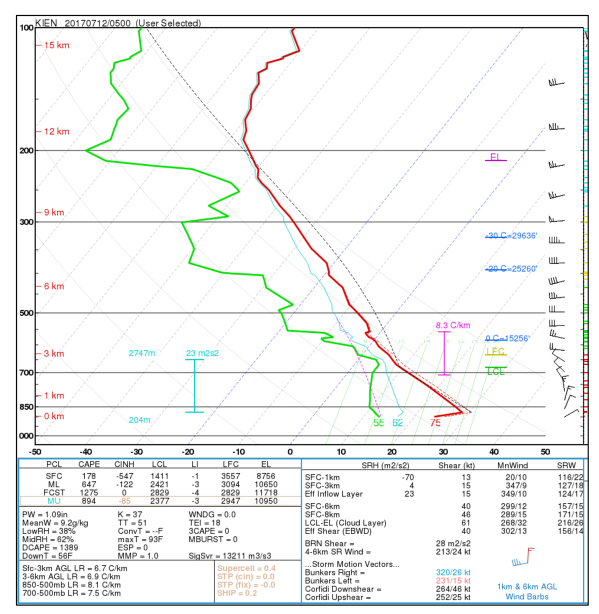
Given the timing of this evolution, ***this research seeks to determine whether moving from higher elevations to the surrounding plains influenced the change from surface-based to elevated convection in this case.*** *This poster will focus on documenting the transition from surface-based to elevated convection during the event.*

Data and methods

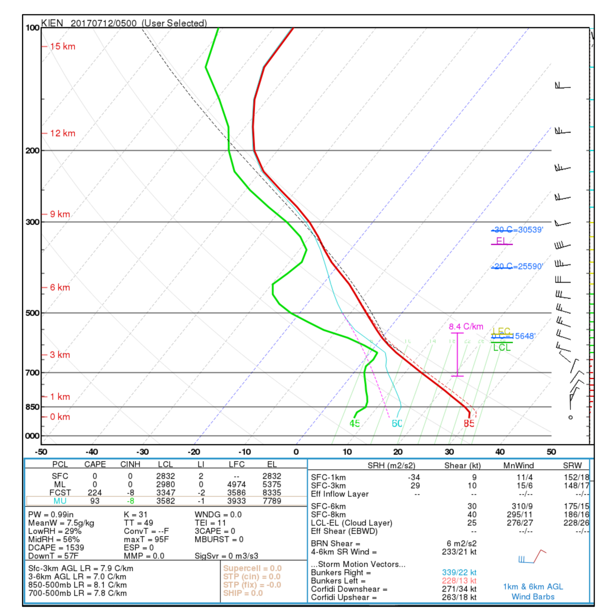


- Convective storm evolution detailed using radar data from KUDX WSR-88D
- Rapid City, SD sounding from 00Z 12 July 2017 provided initial environmental information
- Surface observations from region documented evolving pre-storm environment
- Rapid Refresh (RAP) model analysis fields help quantify mesoscale environment and stability profiles aloft

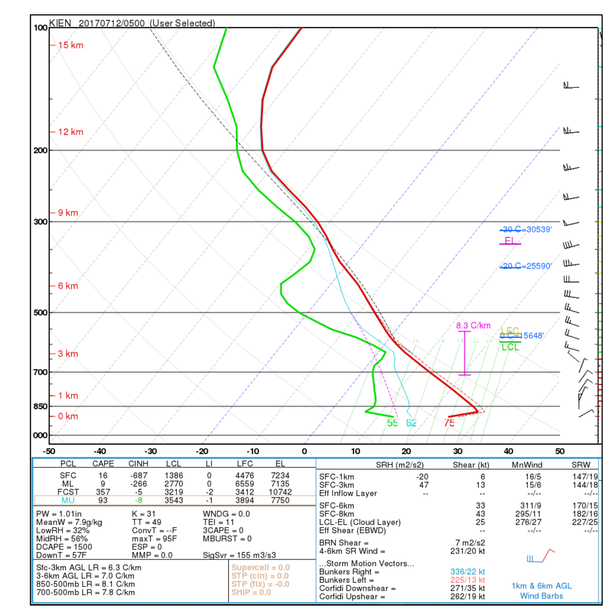
Assessing static stability in the near-storm environment



Observed 00 UTC KUNR sounding, adjusted for surface conditions near storm at 0500Z.

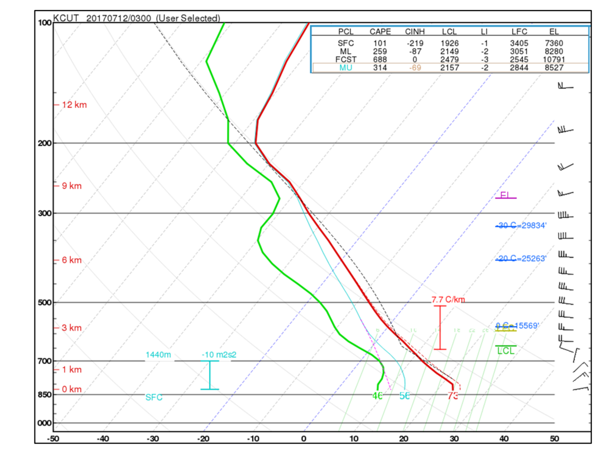


Rapid Refresh (RAP) model analysis proximity sounding from 0500Z.

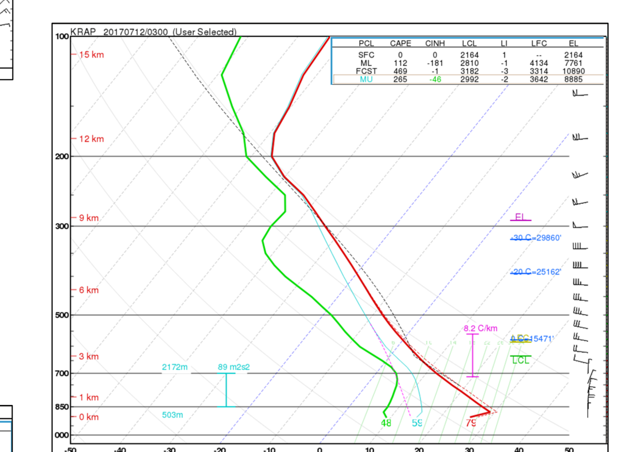


Combination of RAP model analysis sounding and observed surface conditions for 0500Z.

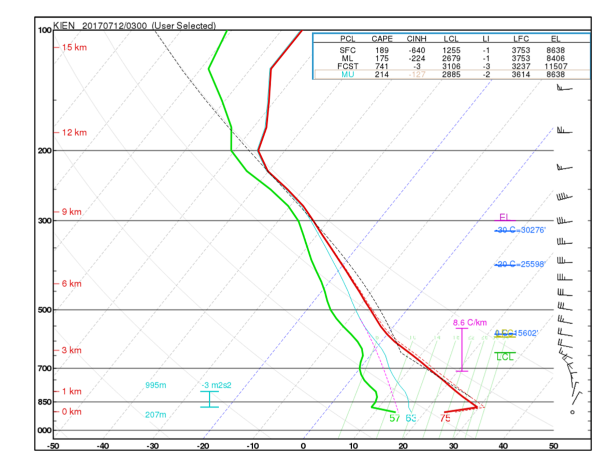
Stronger stable layer over plains



0300Z hybrid observation from Custer, SD (elev. 1707 m)
Surface-based CAPE of 101 J/kg
Surface-based CIN of -219 J/kg
Most unstable CAPE of 314 J/kg
Most unstable CIN of -69 J/kg



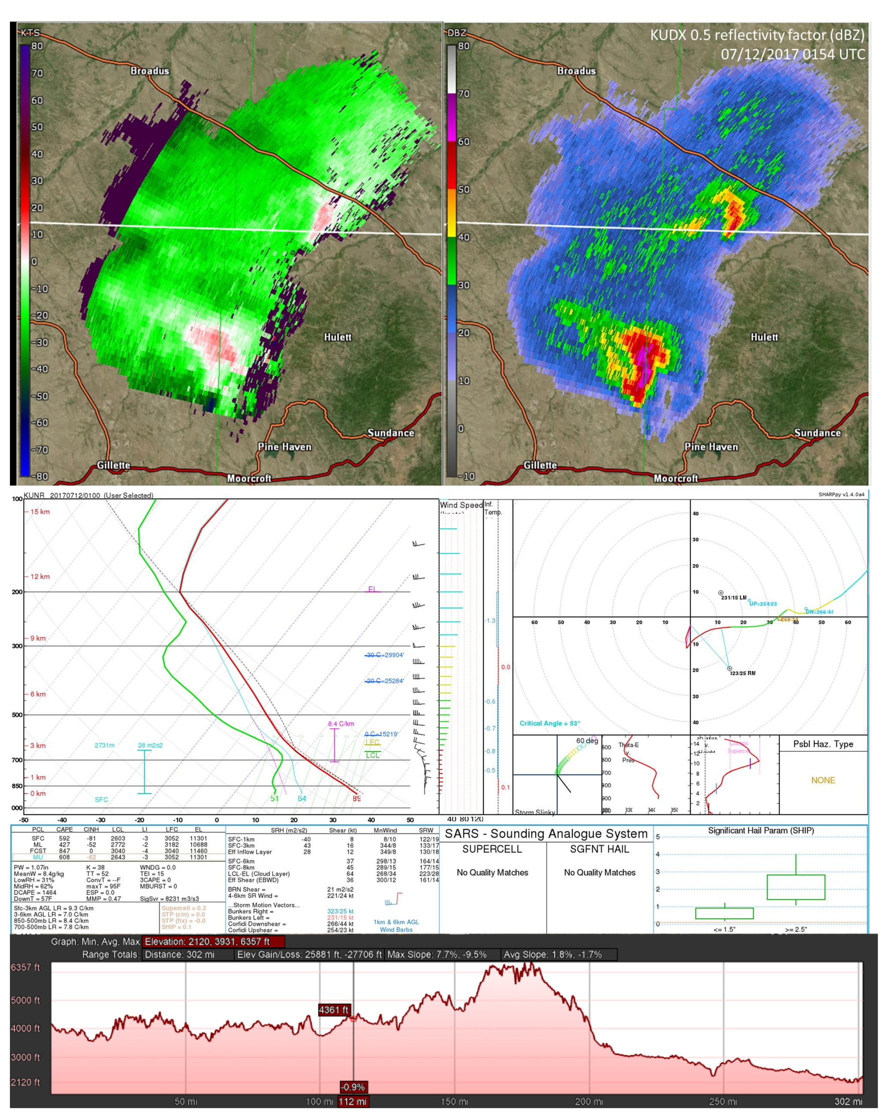
0300Z hybrid observation from Rapid City, SD (elev. 976 m)
Surface-based CAPE of 0 J/kg
Most unstable CAPE of 265 J/kg
Most unstable CIN of -46 J/kg



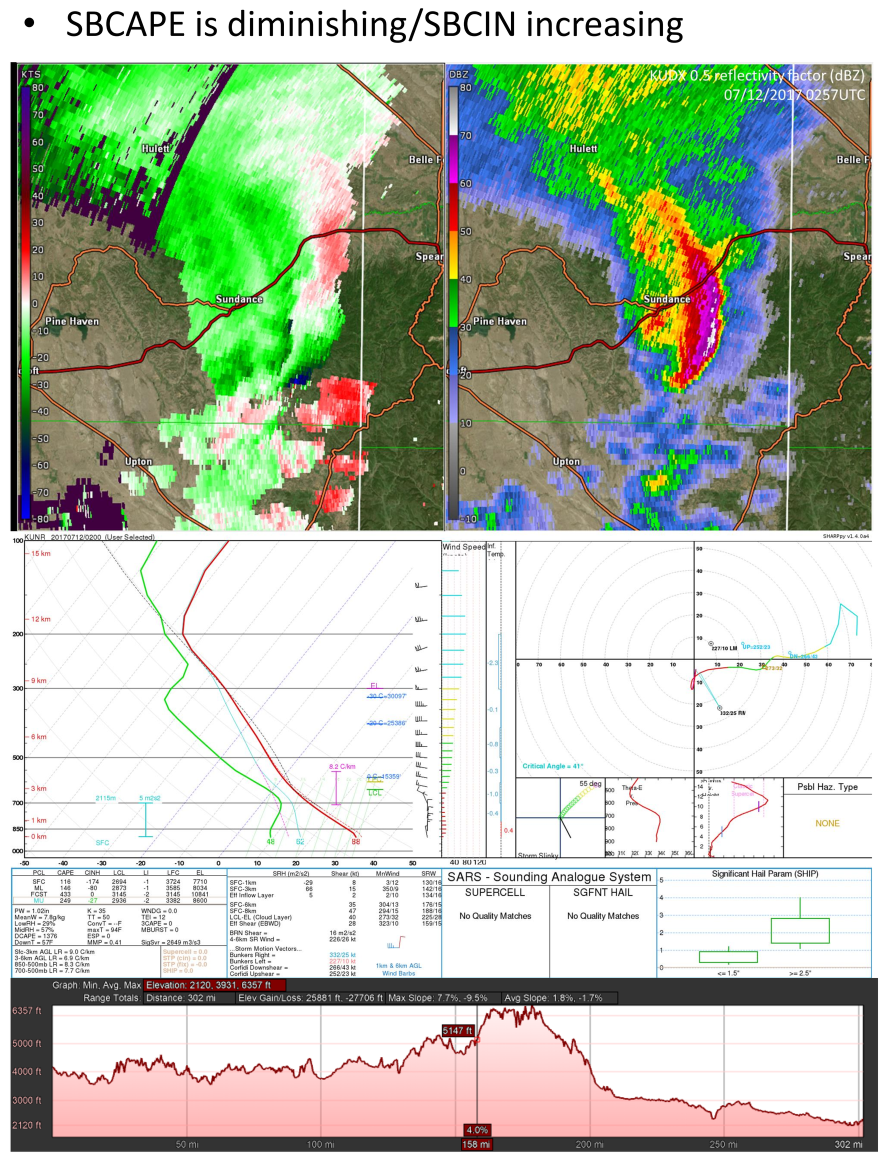
0300Z hybrid observation from Pine Ridge, SD (elev. 1016 m)
Surface-based CAPE of 189 J/kg
Surface-based CIN of -640 J/kg
Most unstable CAPE of 214 J/kg
Most unstable CIN of -127 J/kg

Evolution of convective system and static stability

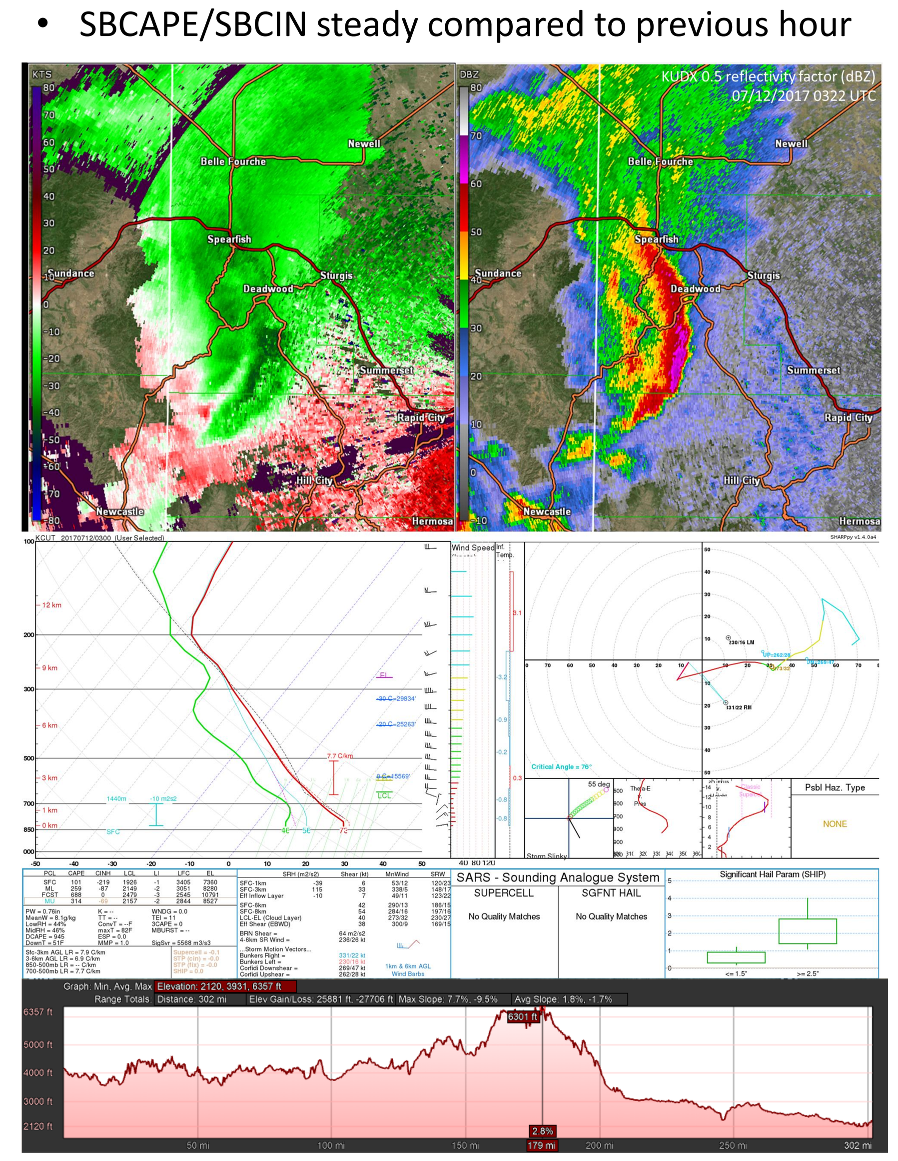
- Initial supercell forms in north-central WY
- 592 J/kg of SBCAPE; -81 J/kg of SBCIN



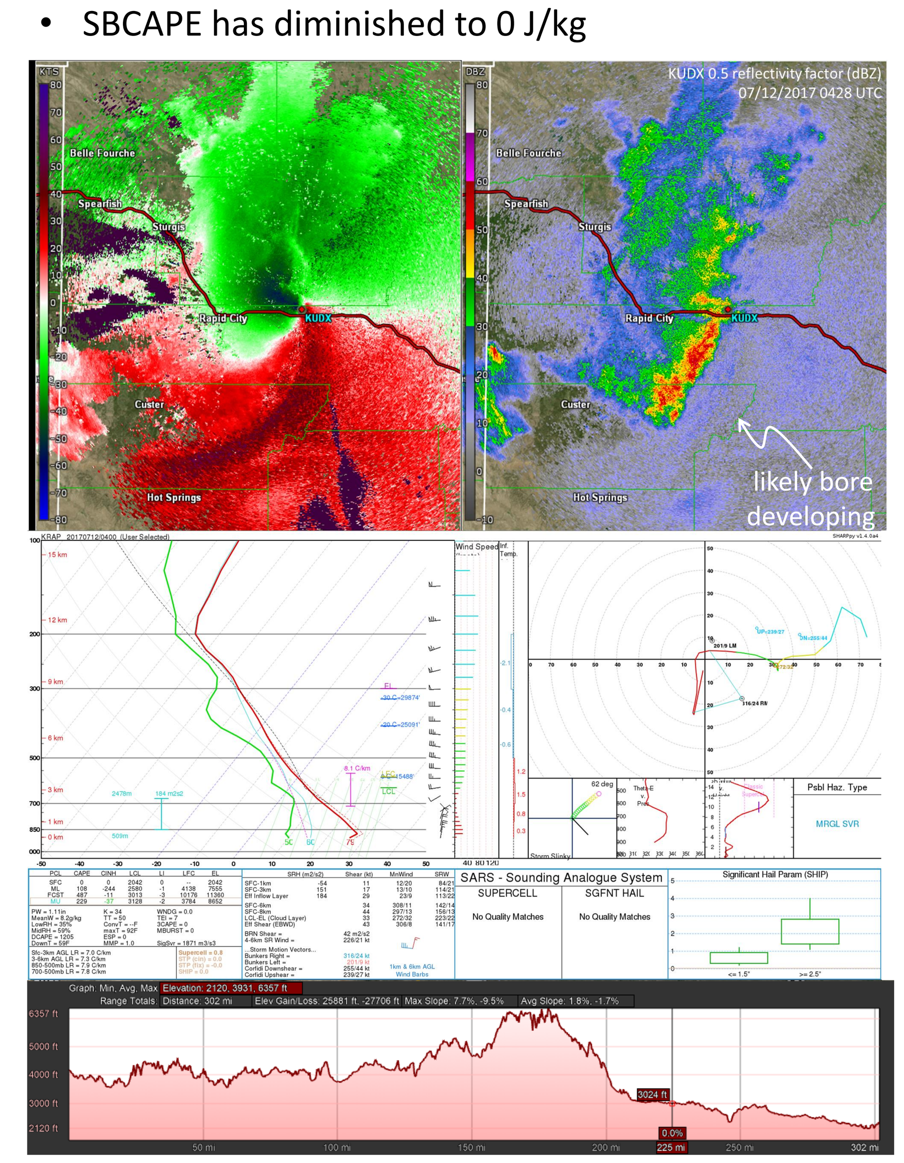
- Bow echo approaches western slopes of Black Hills, severe-criteria winds reported.
- SBCAPE is diminishing/SBCIN increasing



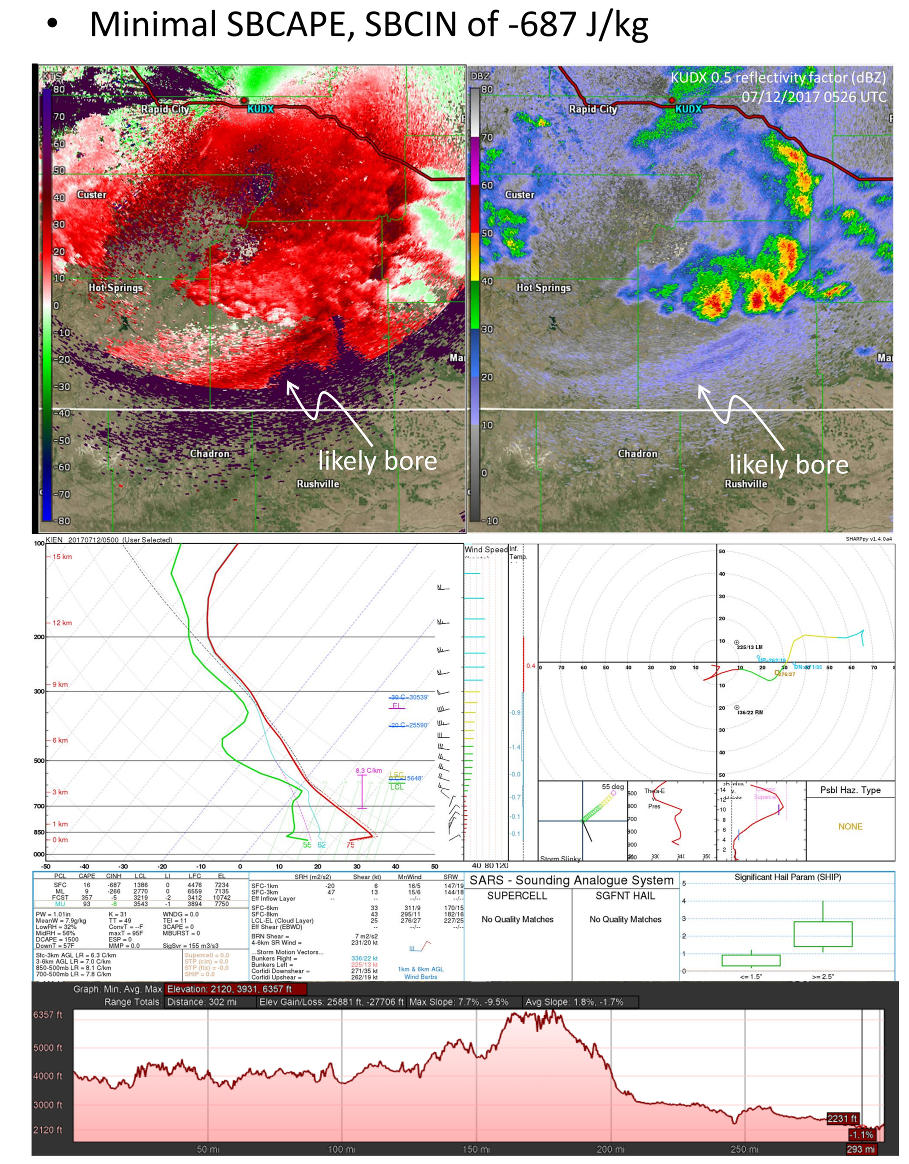
- Bow echo over the highest terrain of Black Hills, severe-criteria winds reported.
- SBCAPE/SBCIN steady compared to previous hour



- Storm moving to lower elevation east of Rapid City, rapidly losing bow echo structure.
- SBCAPE has diminished to 0 J/kg



- Storm continues evolving into a multicell cluster
- Bore evident as double radar fine line structure
- Minimal SBCAPE, SBCIN of -687 J/kg



Summary of initial findings

- The observed CAPE/shear profiles were marginal for supercells and bow echoes.
- Relatively large CIN was present throughout the event, although it was at a minimum early on suggesting that the initial storms were surface-based.
- Evolution from bow echo to convective cluster coincided with SBCAPE trending to zero and SBCIN becoming very large, supporting the hypothesis that the storms indeed became elevated east of the Black Hills.
- The transition to elevated convection is further supported by radar observations of a bore-like feature moving away from the active convection east of the Black Hills.
- Comparing soundings by elevation revealed stronger CIN over the plains, with less CIN over the Black Hills – suggesting that the storm likely encountered increasing low-level stability as it moved off of the Black Hills to lower elevations.

Future work

The next phase of this study will involve running simulations using the Weather Research and Forecasting (WRF) model to examine cold pool properties and more directly test the hypothesis that the underlying topography affected the evolution to elevated convection. In particular we seek to examine how possible thinning of the cold pool over the Black Hills may have influenced the rapid transition to elevated convection over the plains.

Acknowledgements: Archived radar data and RAP model analyses were retrieved from archives maintained by NCEI. Archived surface and upper air observations were accessed from archives maintained by MesoWest and the University of Wyoming, respectively. Sounding data were analyzed using the SHARPpy sounding analysis package. Elevation profiles created using Google Earth Pro.