The Role of the Nocturnal Low-Level Jet in Convection Initiation on 2 June 2015

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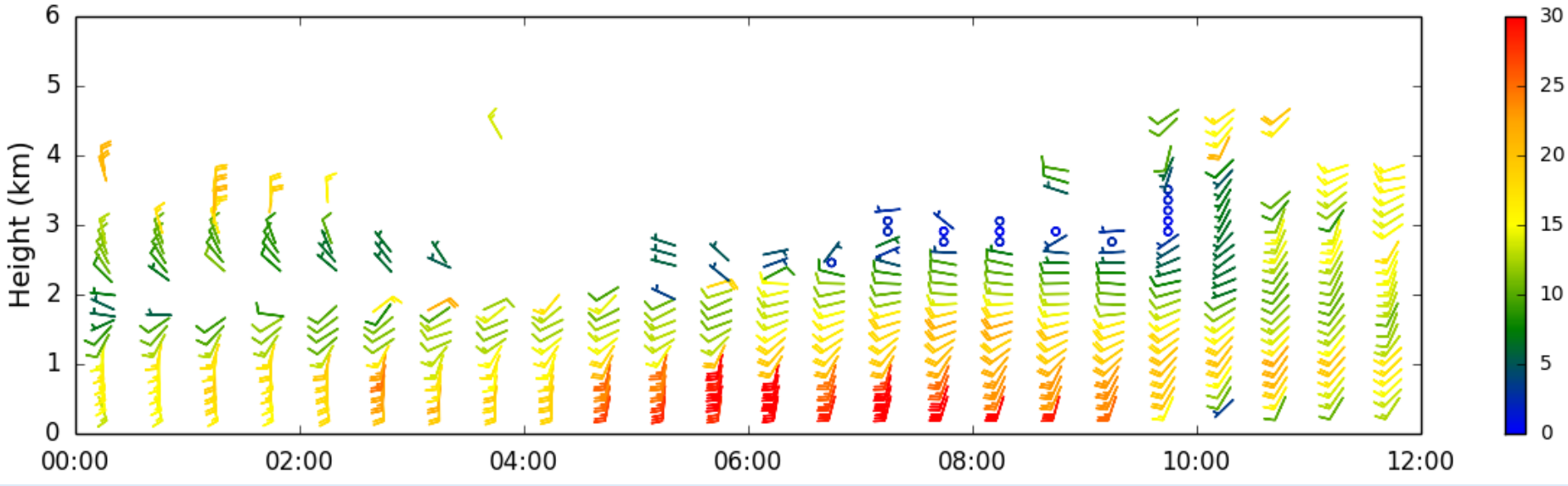


Background

- Many studies have found an association between boundary layer convergence and nocturnal convection
  - Pitchford and London 1962, Bonner 1966, Paegle and McLawhorn 1973, Wilson and Roberts 2006
- One region where boundary layer convergence is common is the northern edge of the LLJ wind speed maximum
- This region is favorable for MCC maintenance and CI due to convergence and thermodynamic support.
  - Maddox 1983, Astling et al. 1985, Trier et al. 1993, 2006, Tuttle and Davis 2006

Motivation

Preliminary PECAN Forecast Discussion for June 2nd

- A significant number of high-res models indicated CI after 06 UTC in a north-south line on the eastern edge of the LLJ
- Mechanism for the CI was unclear
- A case where CI occurs without a surface or 850 mb front, and not at the nose of the LLJ
- CI did occur!

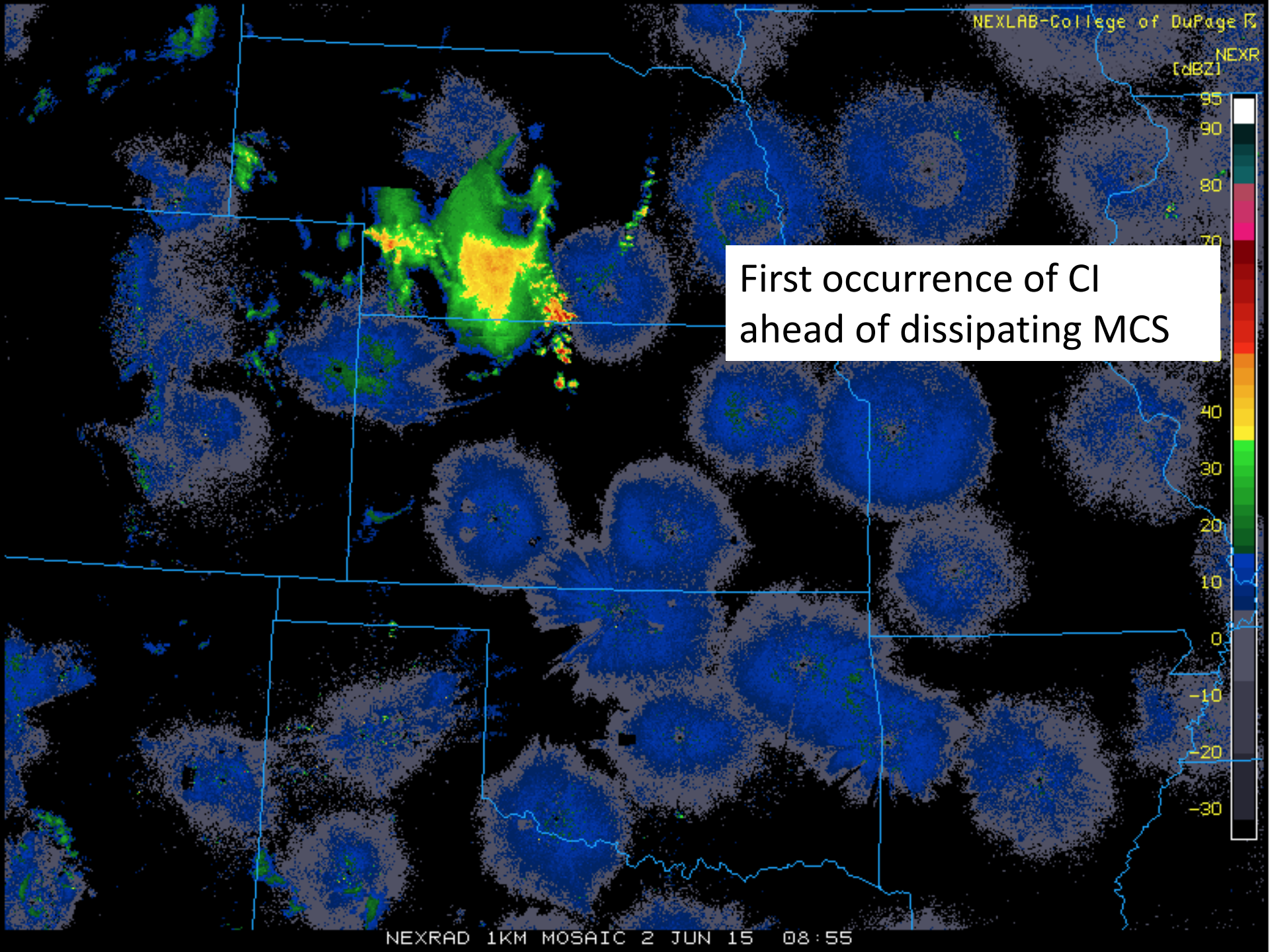
Motivation

- Is the CI mentioned in the forecast discussion caused by the LLJ?

- Bonner (1966) showed a case where the edges of the LLJ were convergent regions as well
  - In the early evening: convergence occurred on the western side
  - In the early morning: convergence occurred on the eastern side

- Is the convergence seen in Bonner (1966) occurring on this night?

Overview of June 2nd CI Case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First occurrence of CI
ahead of dissipating MCS
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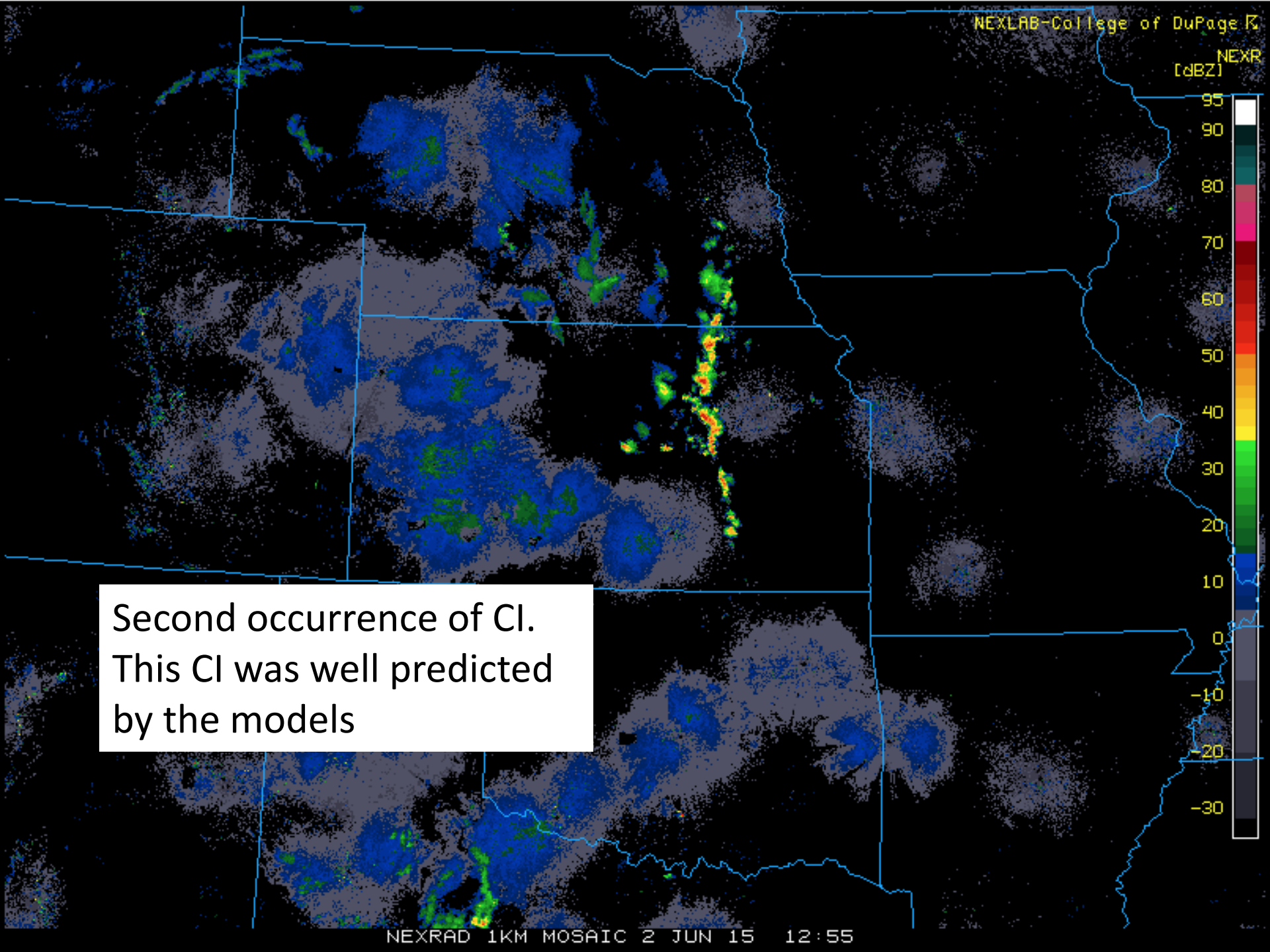
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Second occurrence of CI.
This CI was well predicted
by the models
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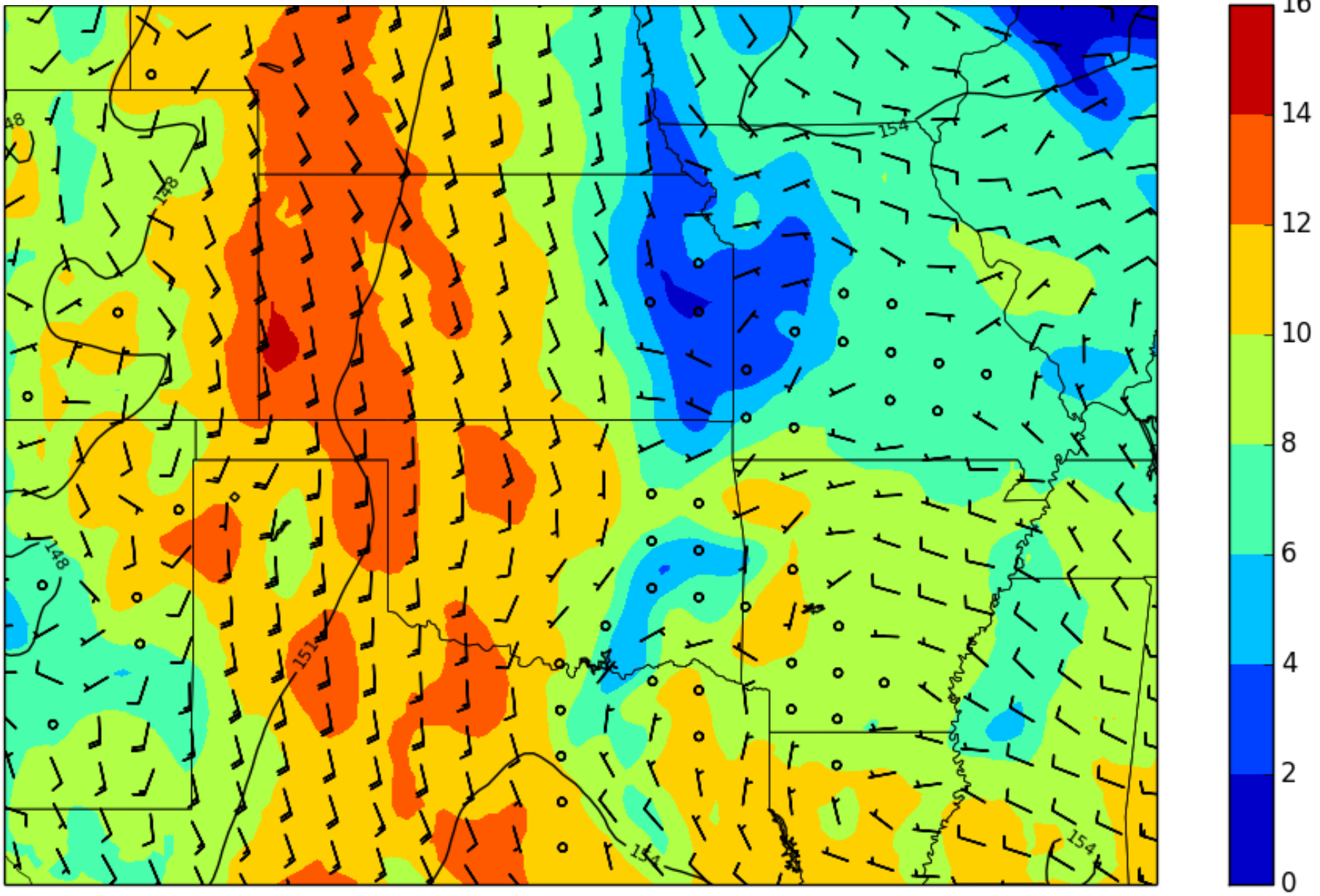
Synoptic Setup

- At 250 and 500 hPa winds were north-northwesterly over the PECAN domain
  - A trough was leaving the region and a ridge was building
  - No shortwaves or jet streaks were present
- At 850 hPa winds were southerly
  - A weak east-west temperature gradient at this height
  - Larger moisture values in western KS
- Surface winds were southeasterly in western KS and more easterly in eastern KS
  - Moisture gradient present at this height as well

00 UTC 850hPa Geopotential height, Specific Humidity (g kg^{-1}), Winds (Kts)

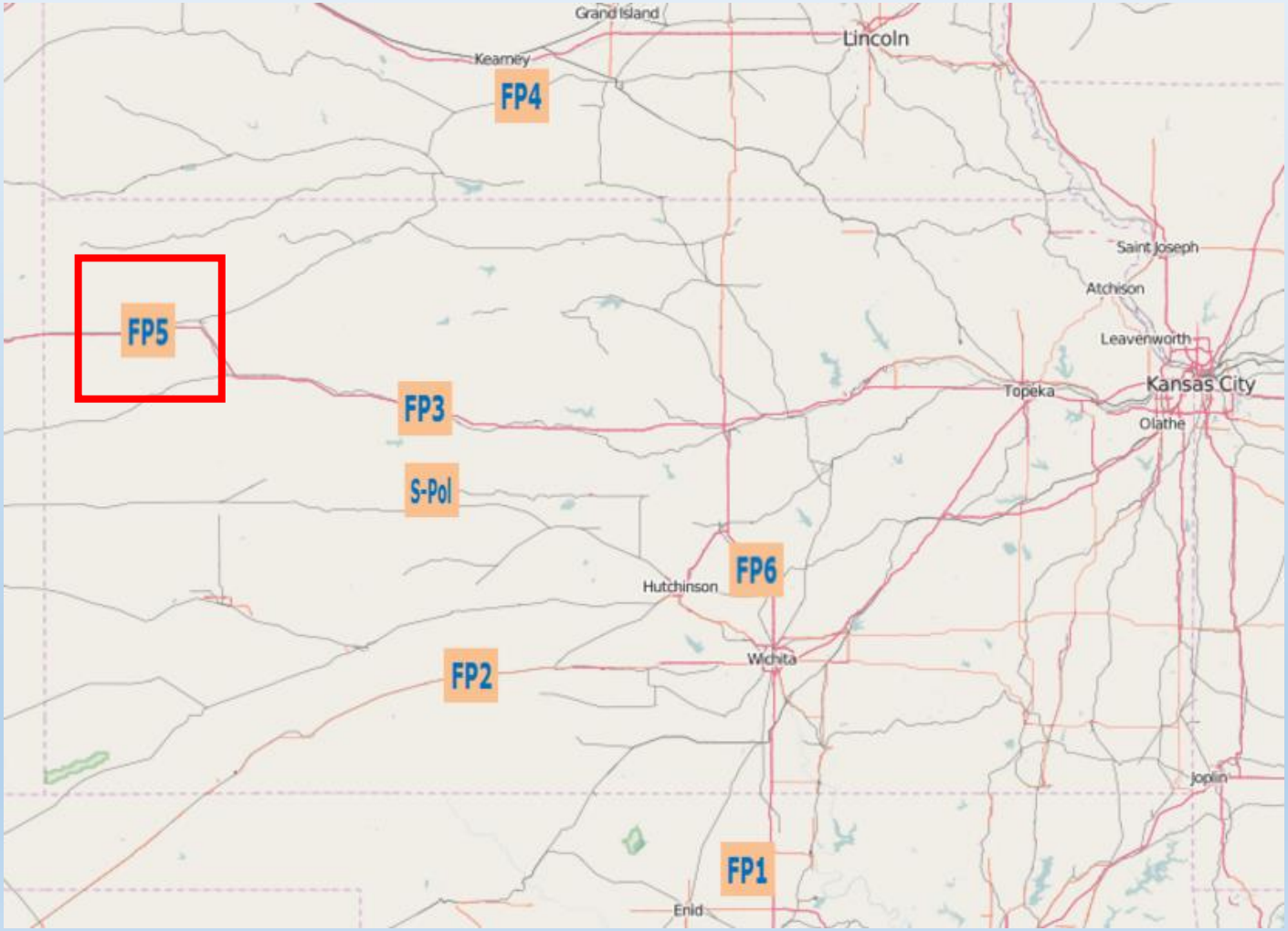


PECAN Observations of June 2nd

Observational Challenges

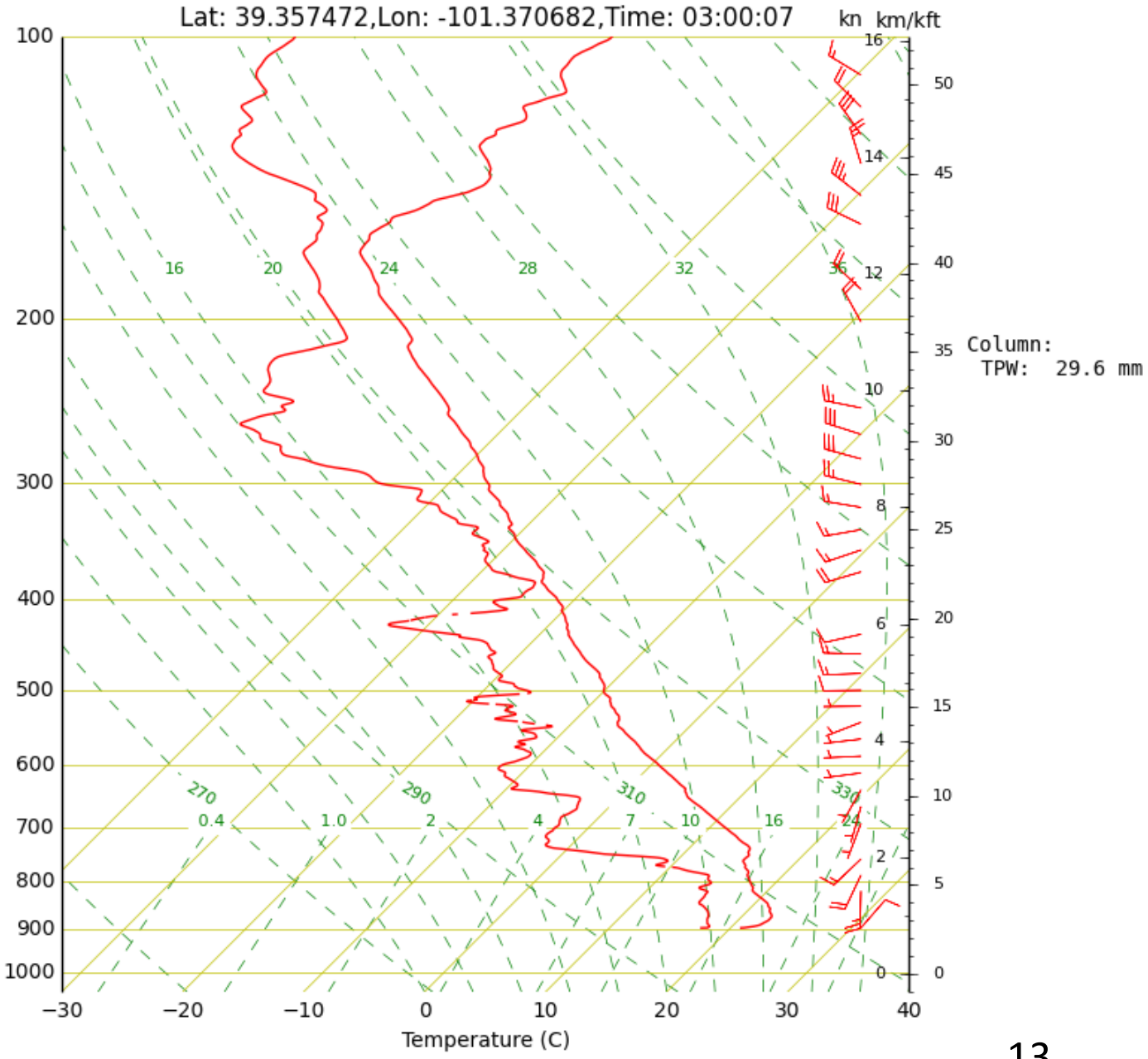
- Dry Run IOP occurred on this day and the IOP ended at 0500 UTC
- Early in PECAN some of the fixed PISA instruments were not functioning
- Only one radiosonde was launched at 0300 UTC at all Fixed PISA sites
- The mobile units were deployed in northwest KS

FP-5 Sounding

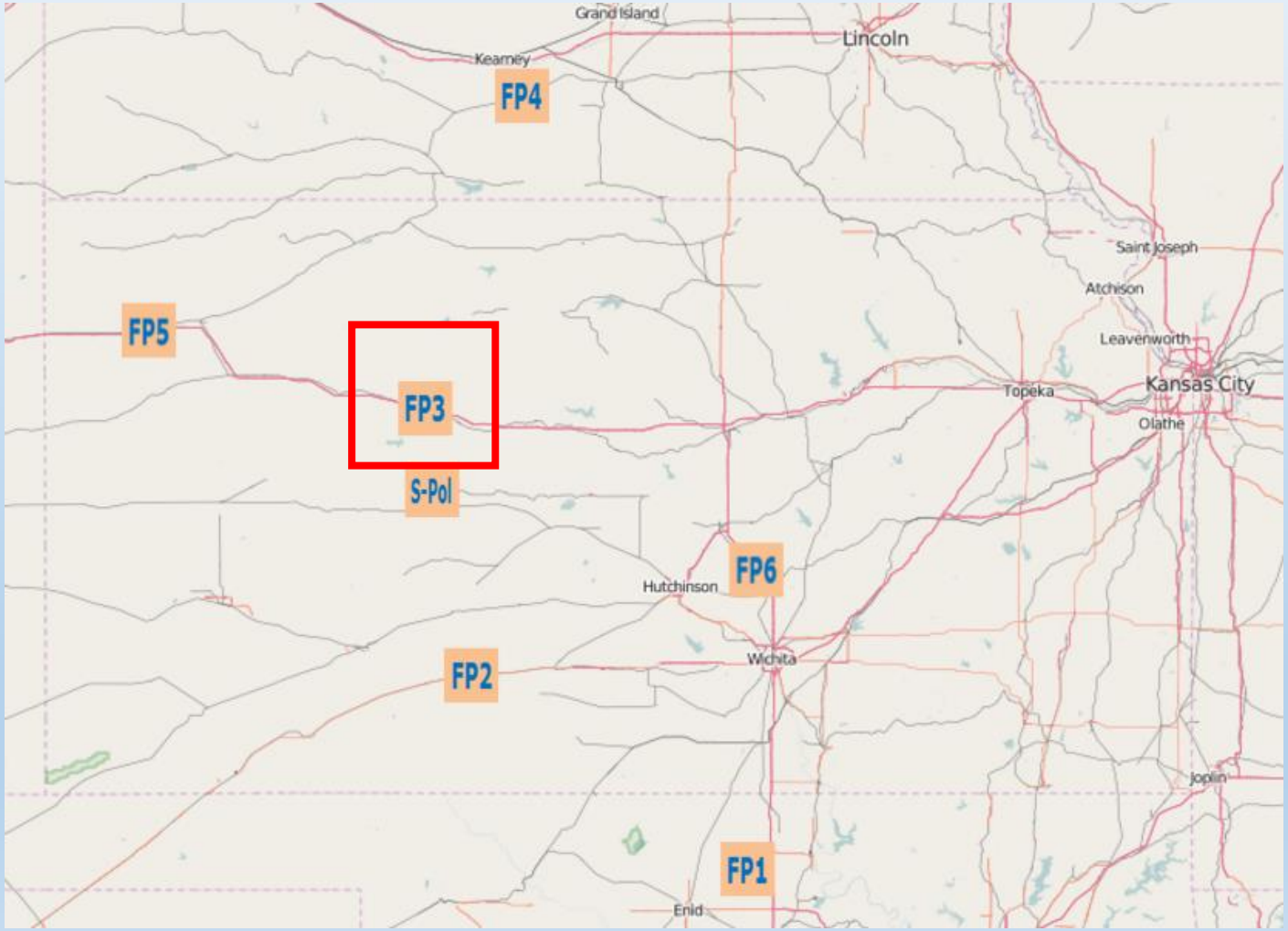


Moist layer extending up to 800 hPa

Boundary layer winds are veering with height



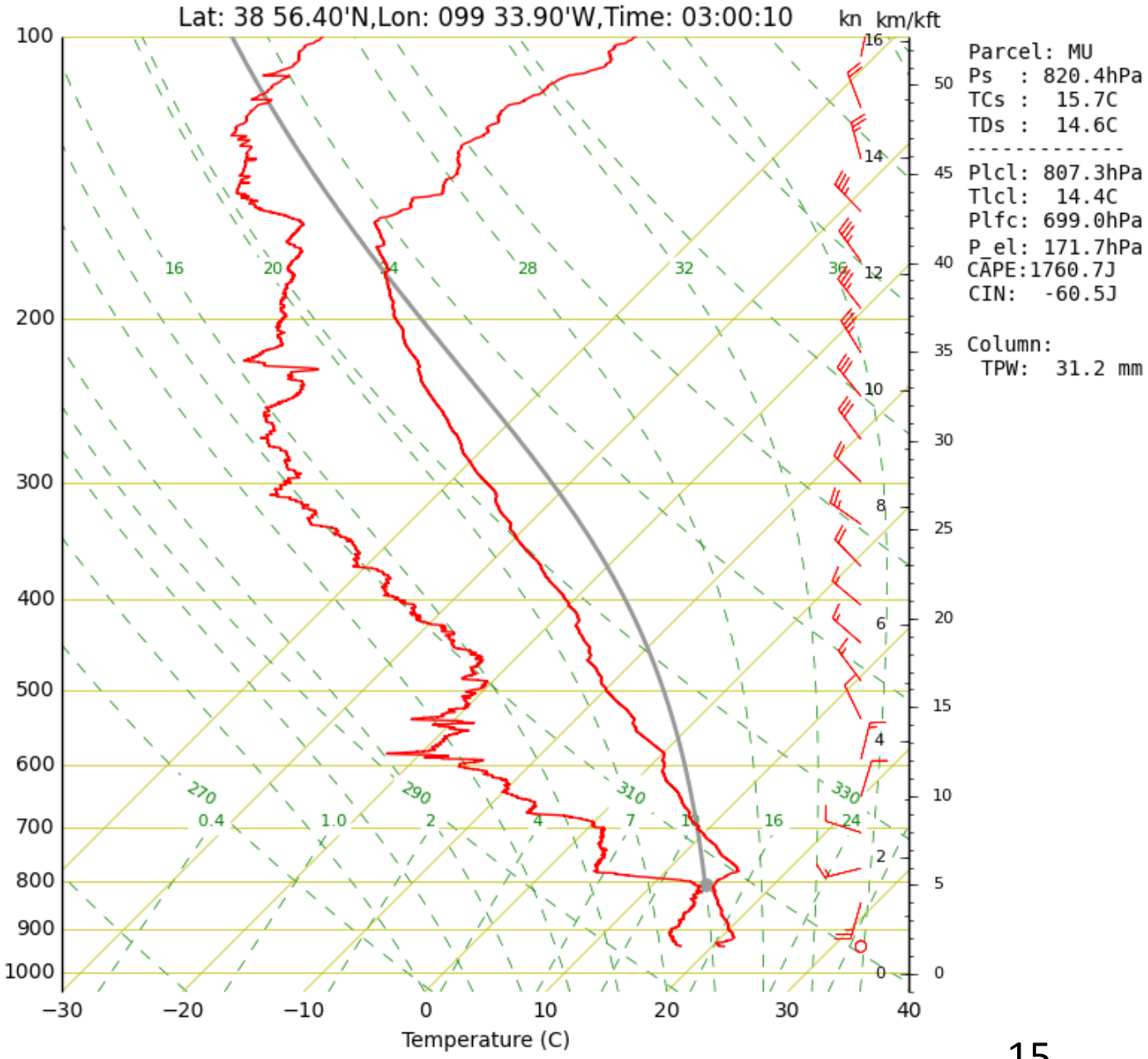
FP-3 Sounding



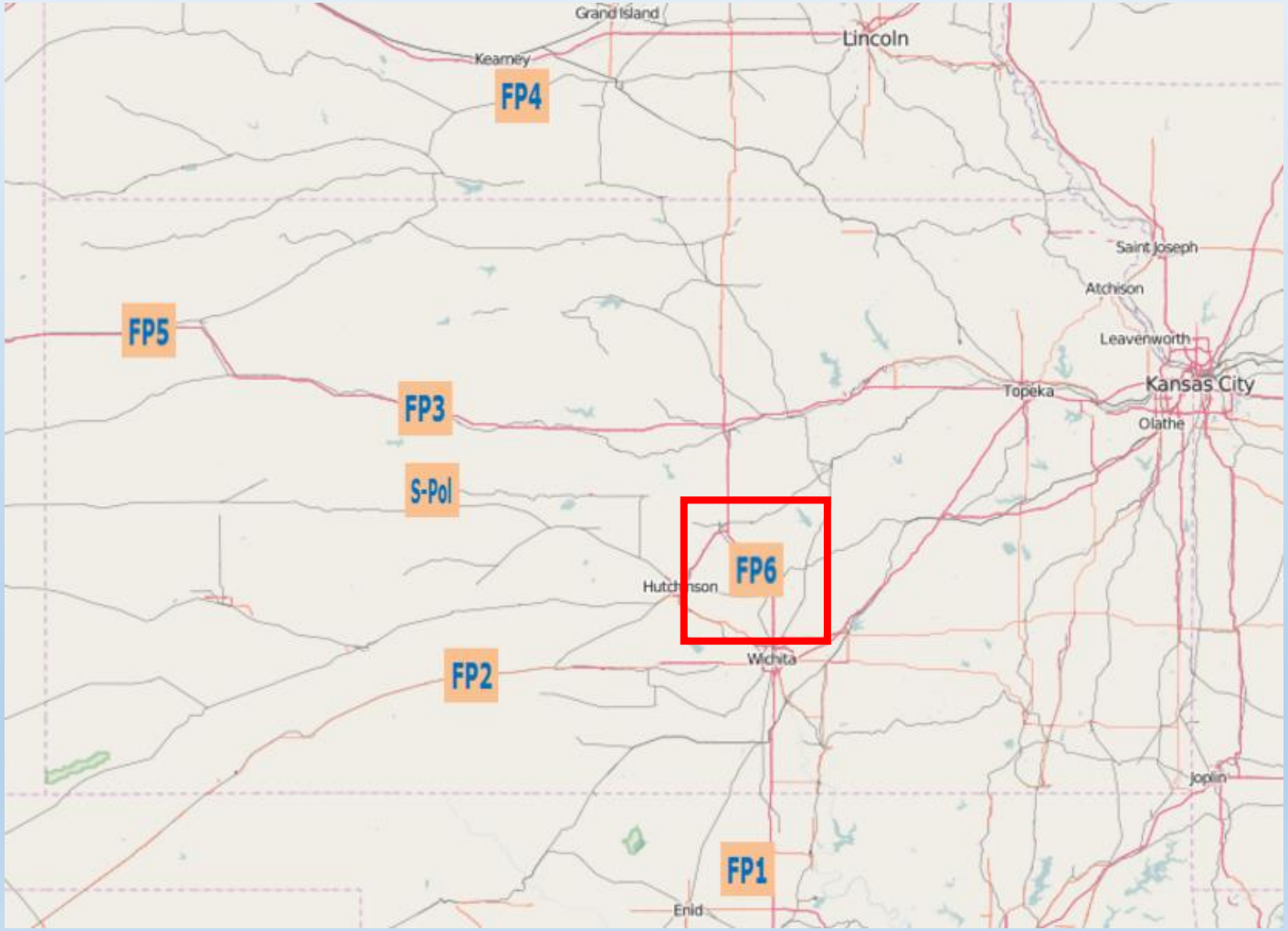
Boundary layer winds more veered at this location

More pronounced capping inversion

Nearly saturated at 800 hPa



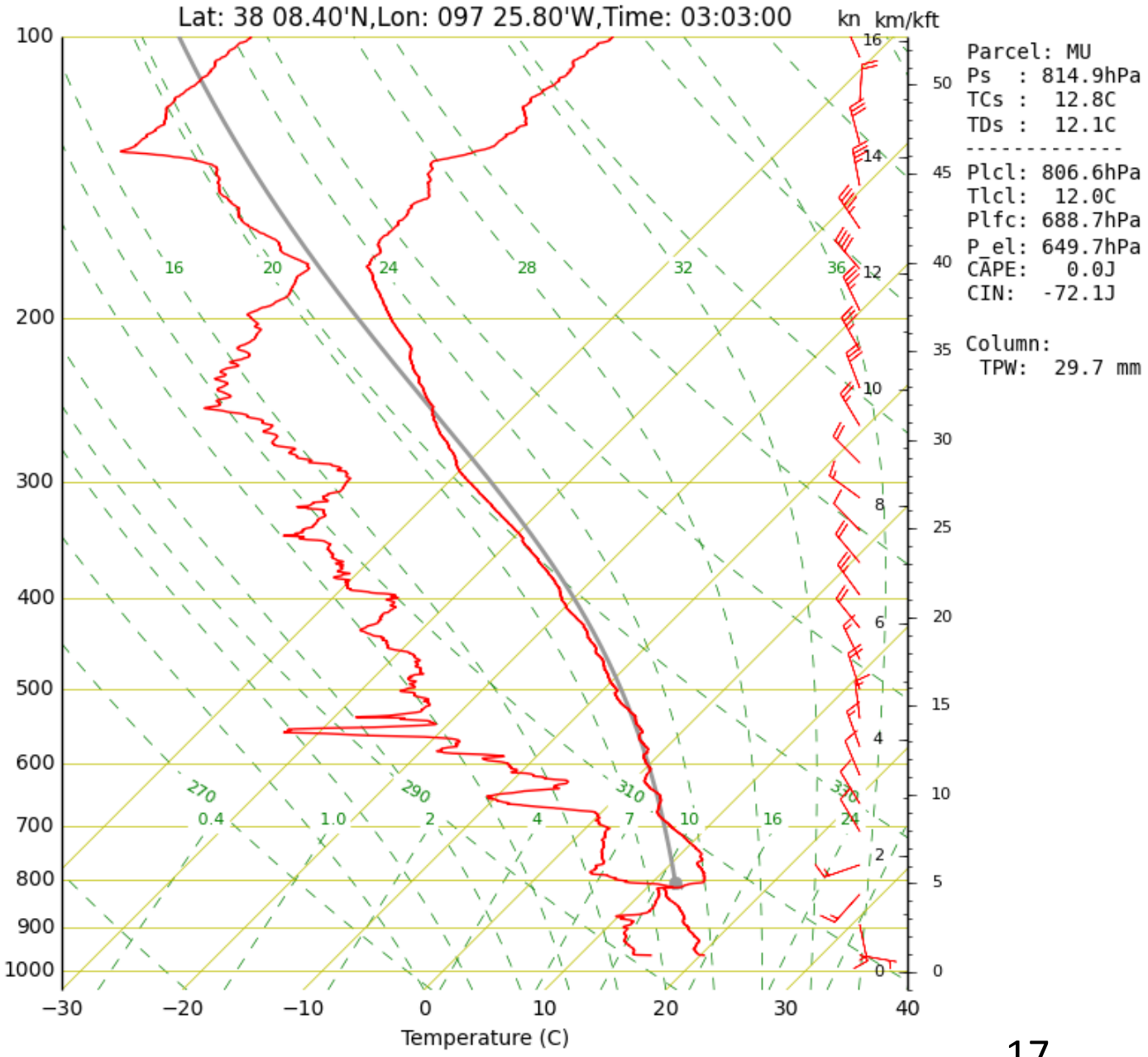
FP-6 Sounding



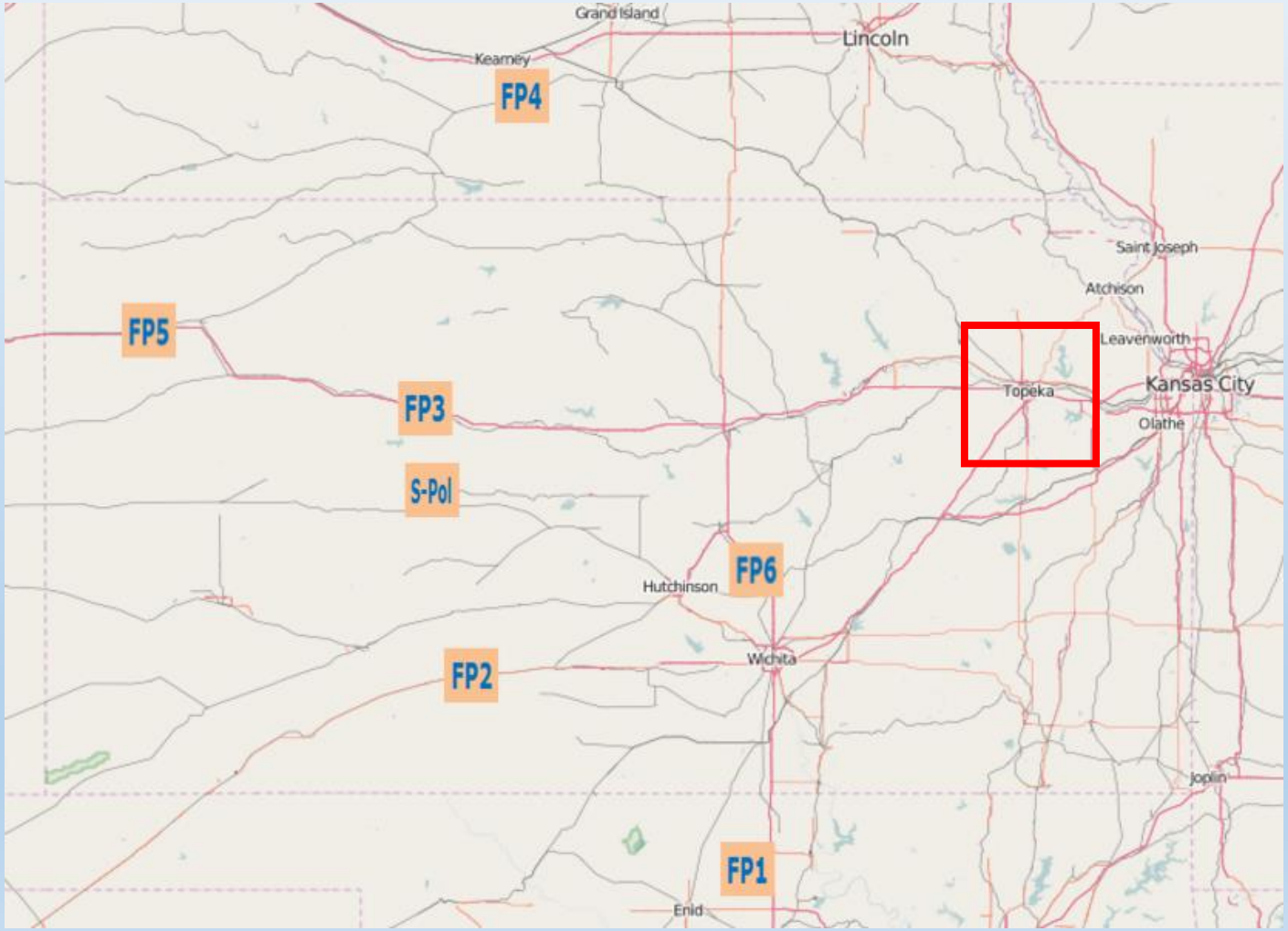
Boundary layer winds strongly veering with height

Even more pronounced capping inversion

Less moisture, but saturated at 800 hPa

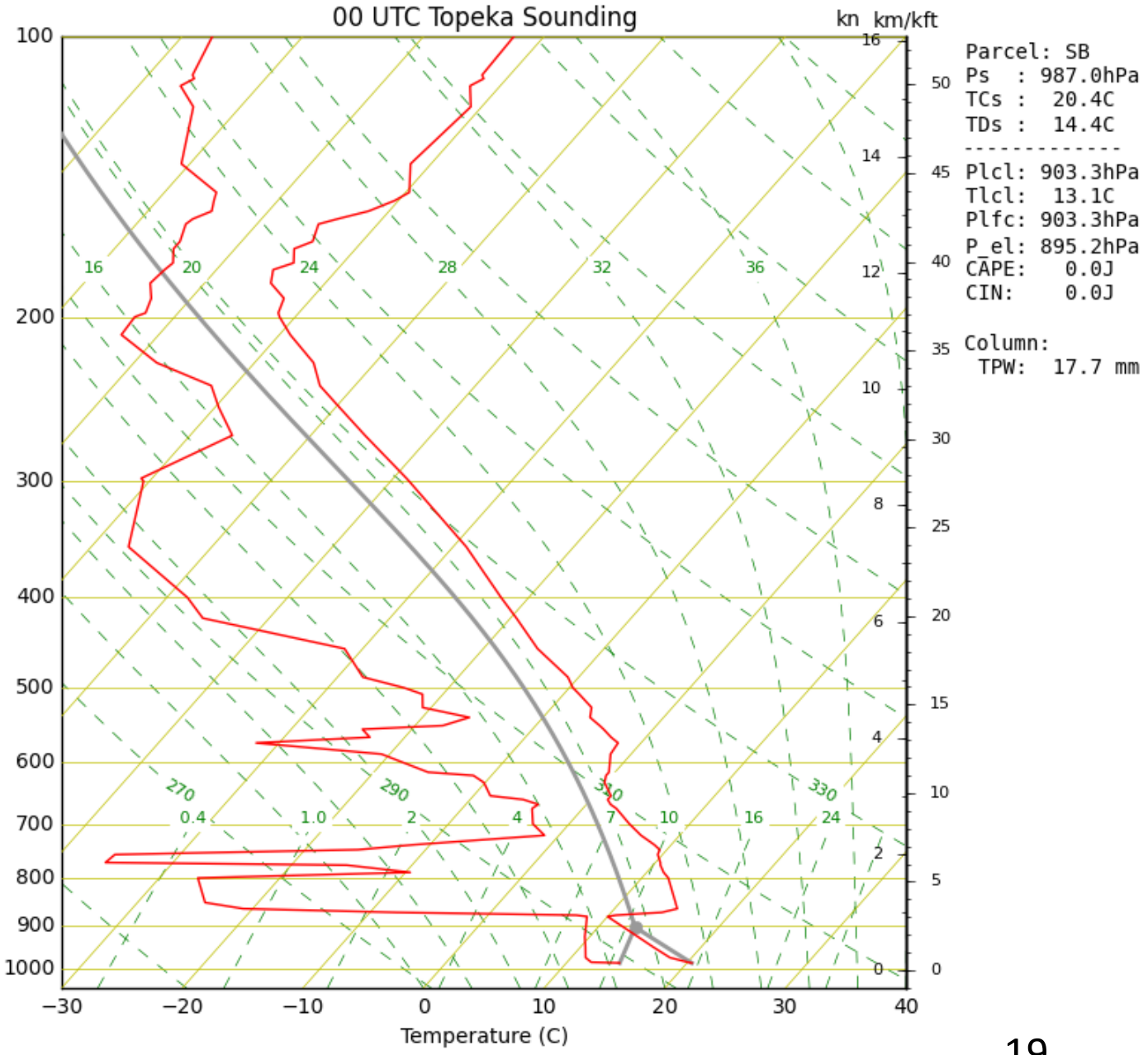


Topeka Soundings (00 and 12 UTC)



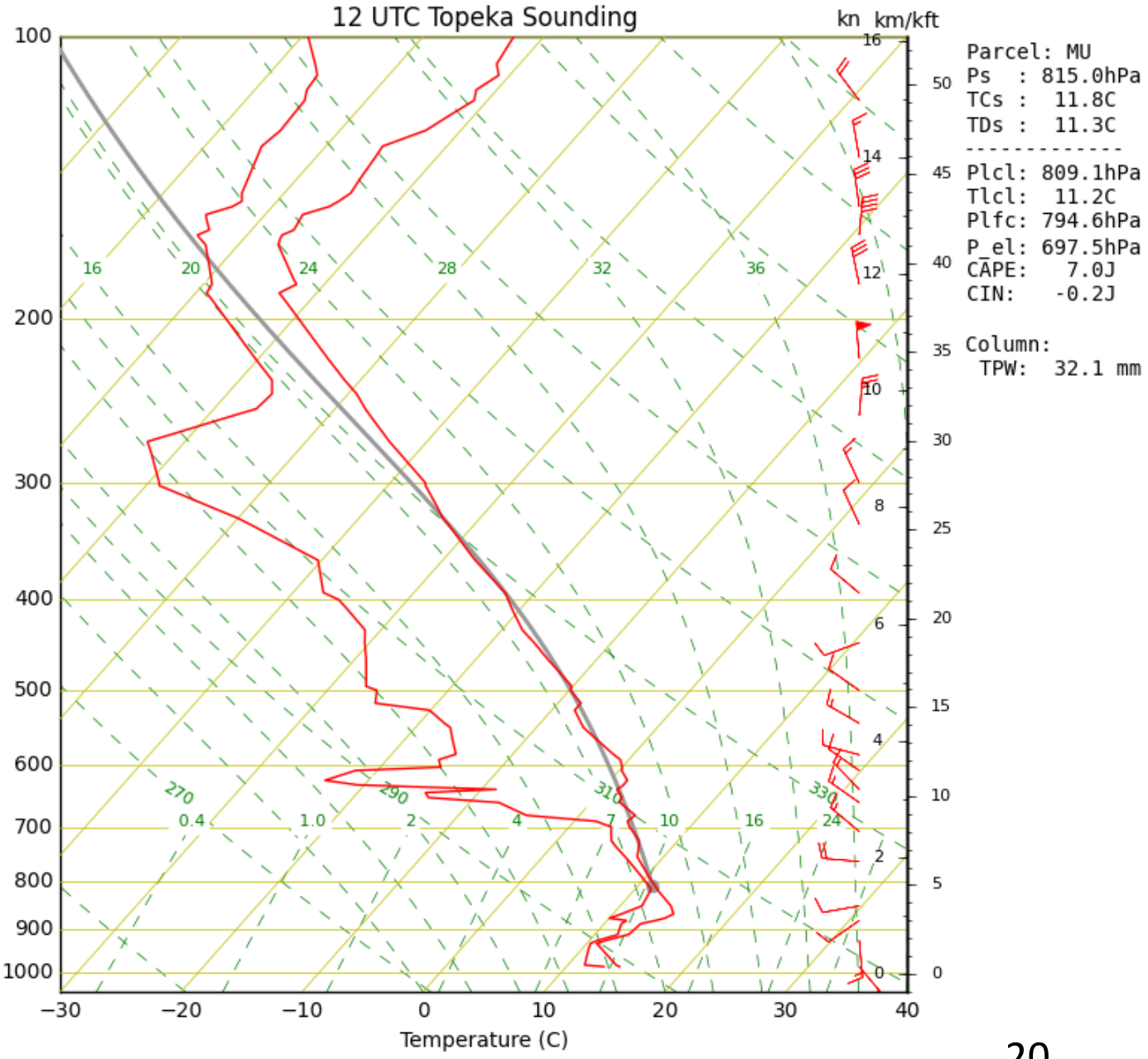
Strong inversion

Very dry layer from 875 to 700 hPa



Inversion still present at the same temperature as 00 UTC

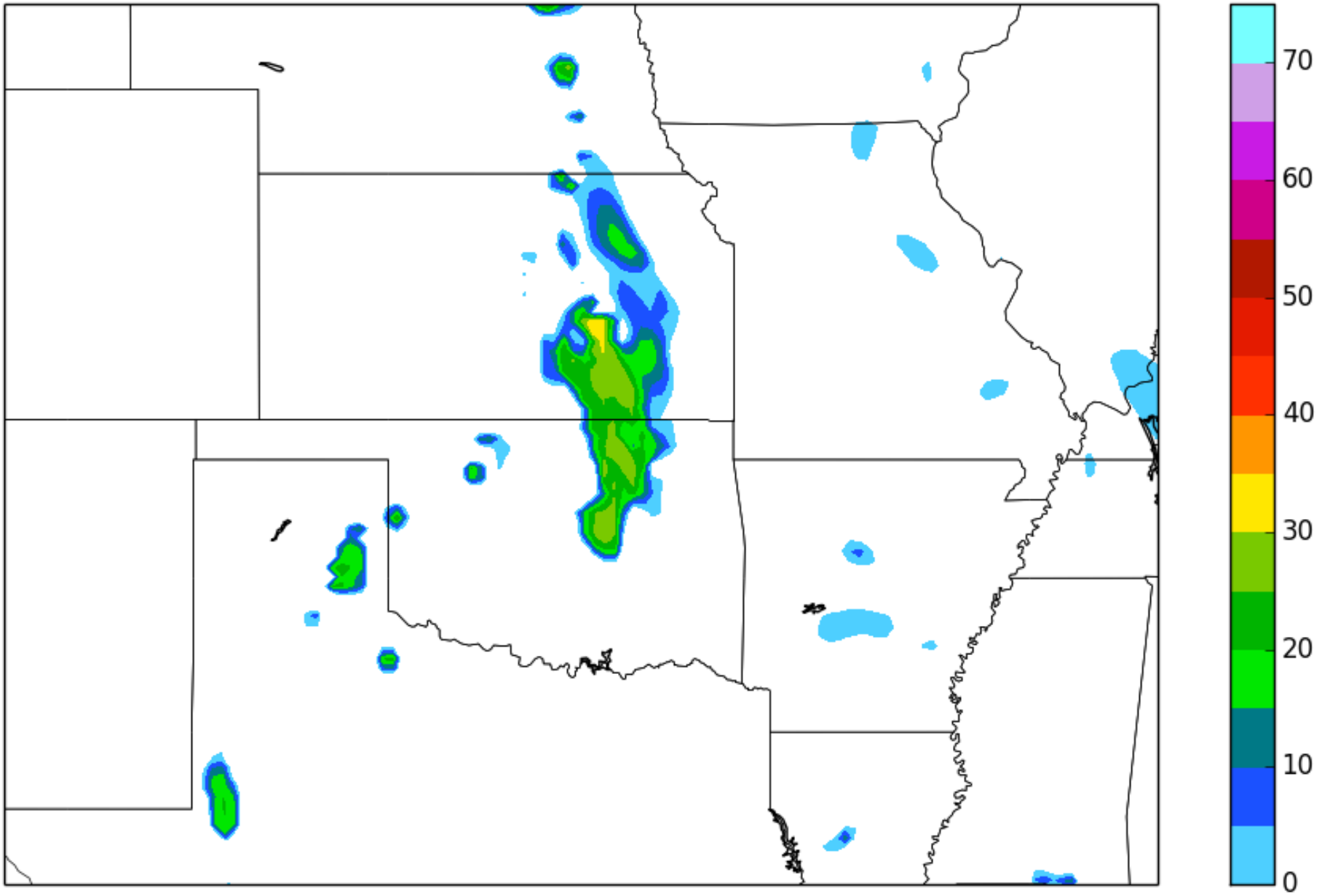
Region above inversion has cooled and is saturated at 800 hPa



Model Analysis

- A convenient starting point for identifying the CI mechanism
- The 00 UTC RAP forecast was used
  - Wilson and Roberts (2006) showed the elevated convergence that caused CI was able to be resolved on larger scale grids (used RUC10)
- This forecast had an over amplified signal for CI in eastern part of the PECAN domain
- This forecast failed to predict the MCS that developed over western KS
  - Seen as a benefit for examining the LLJ as an initiation source

1200 UTC RAP Composite Reflectivity



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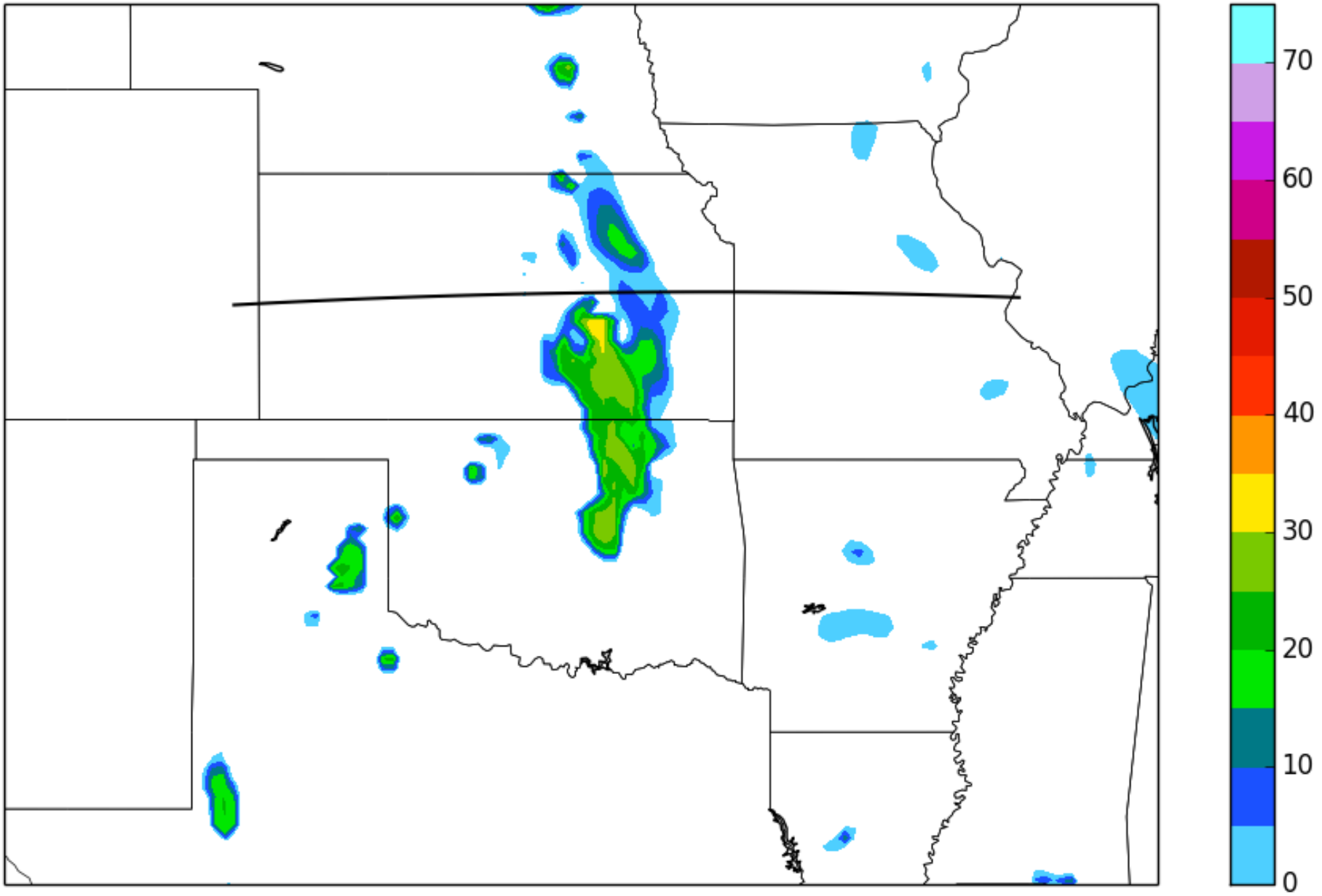
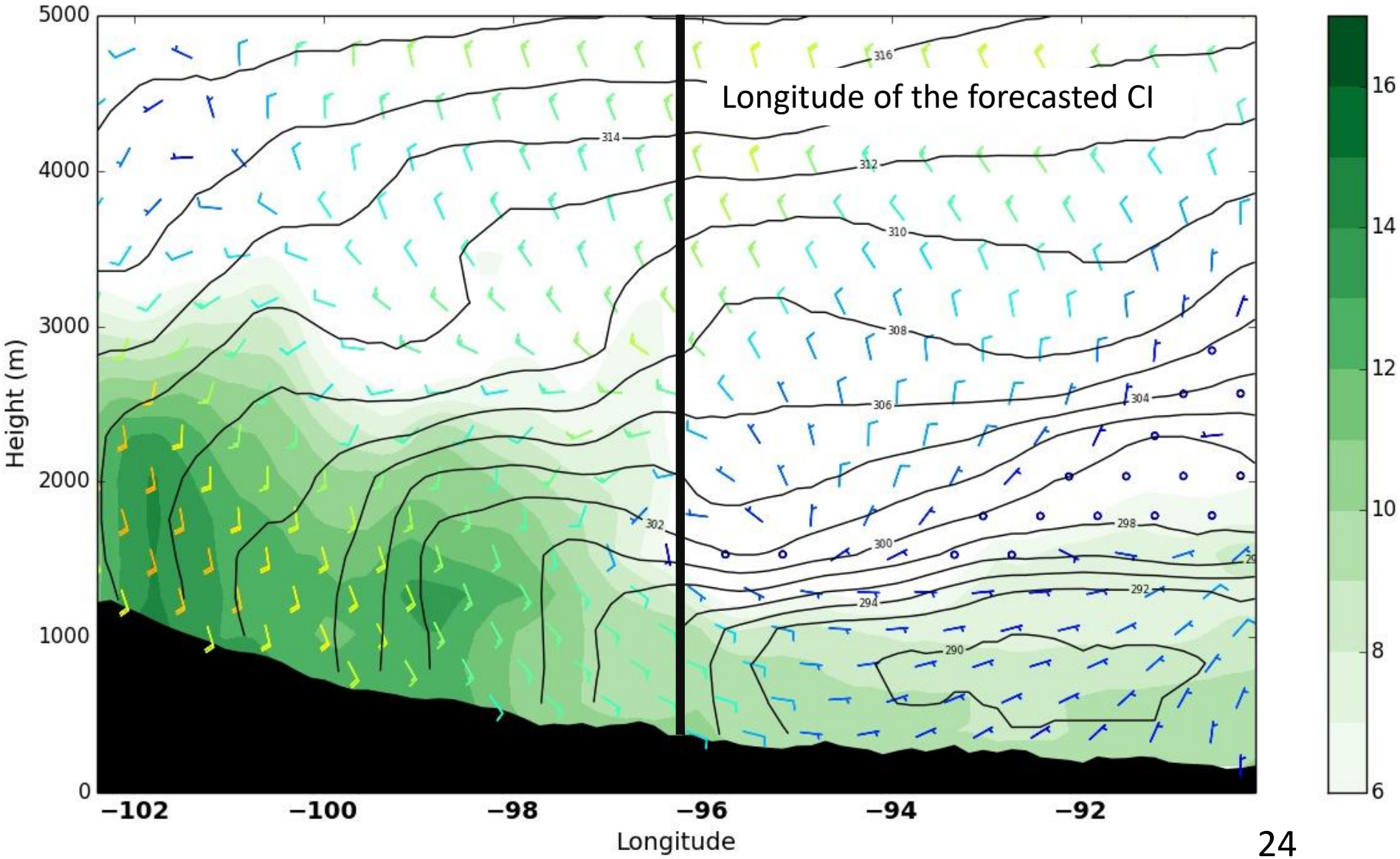


Potential Temperature, Winds (kts), Specific Humidity > 6 g kg^{-1}



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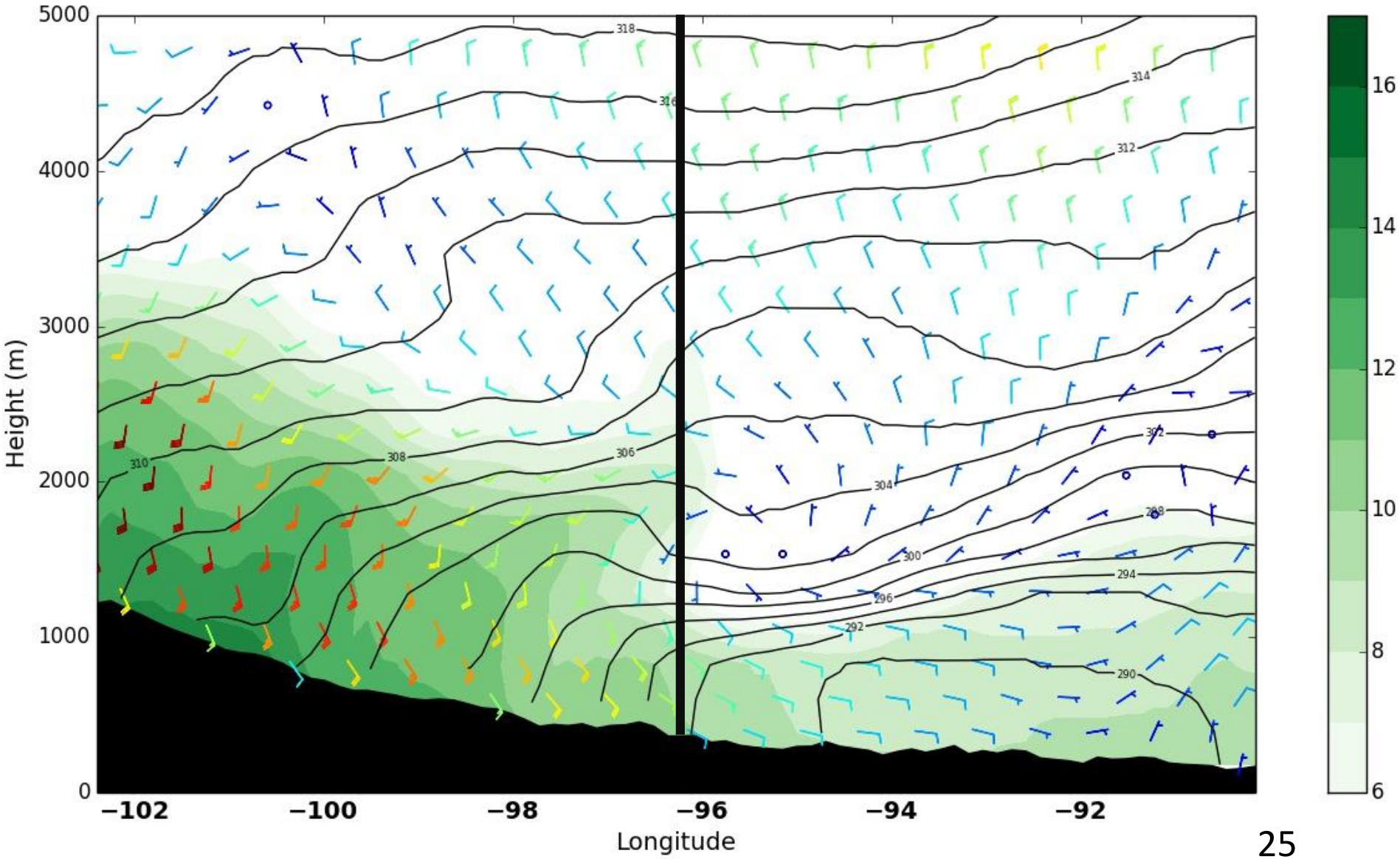

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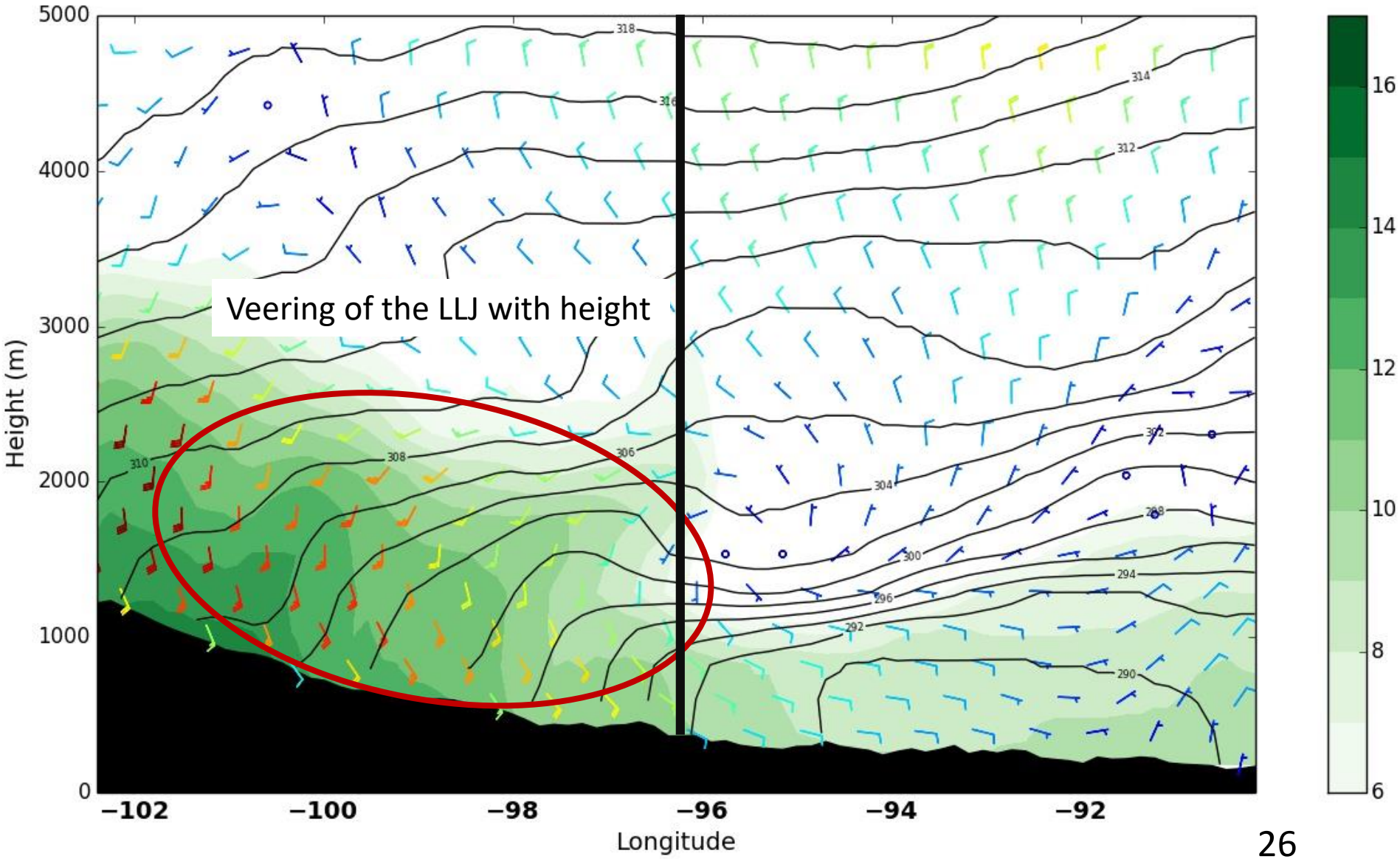

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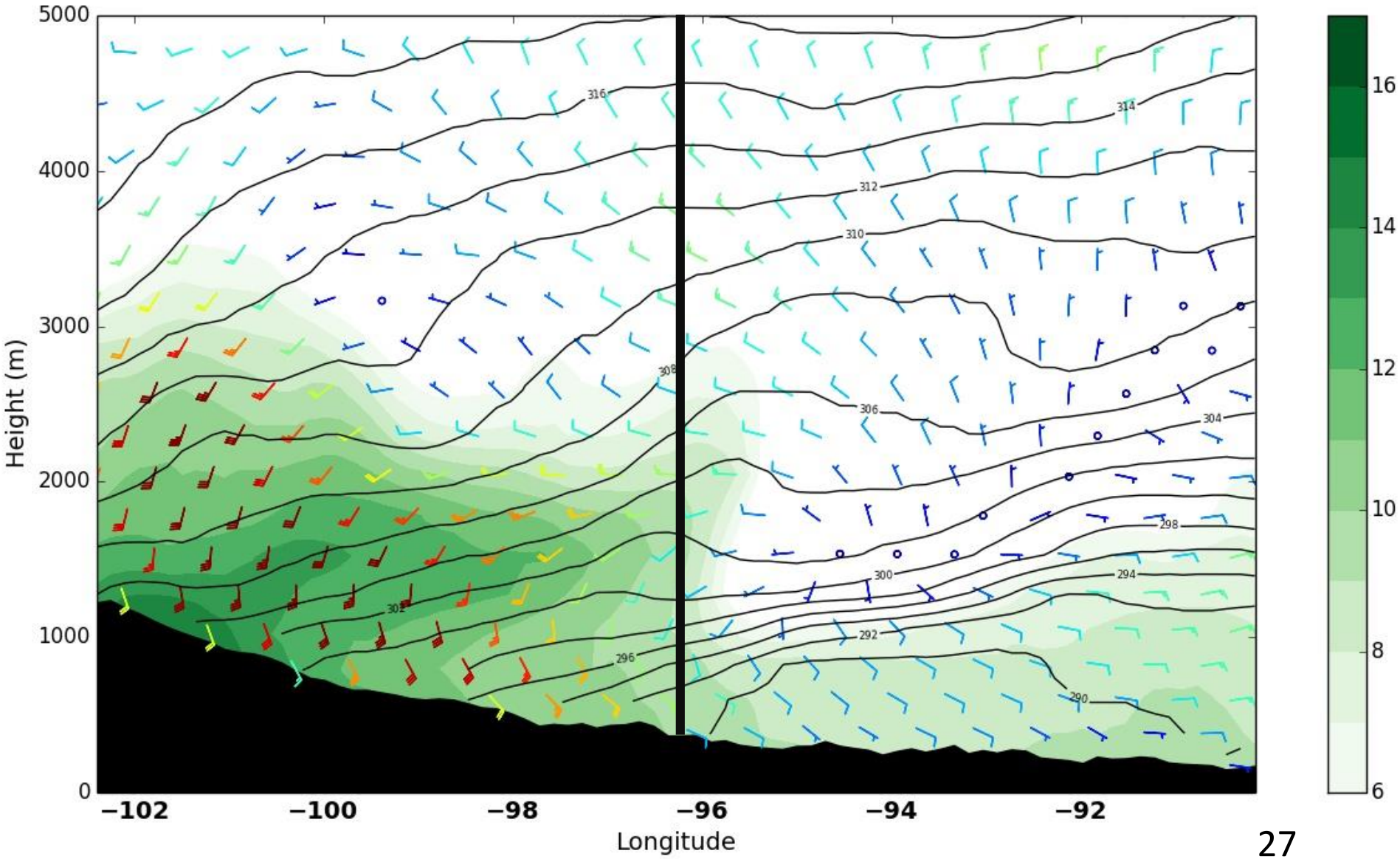

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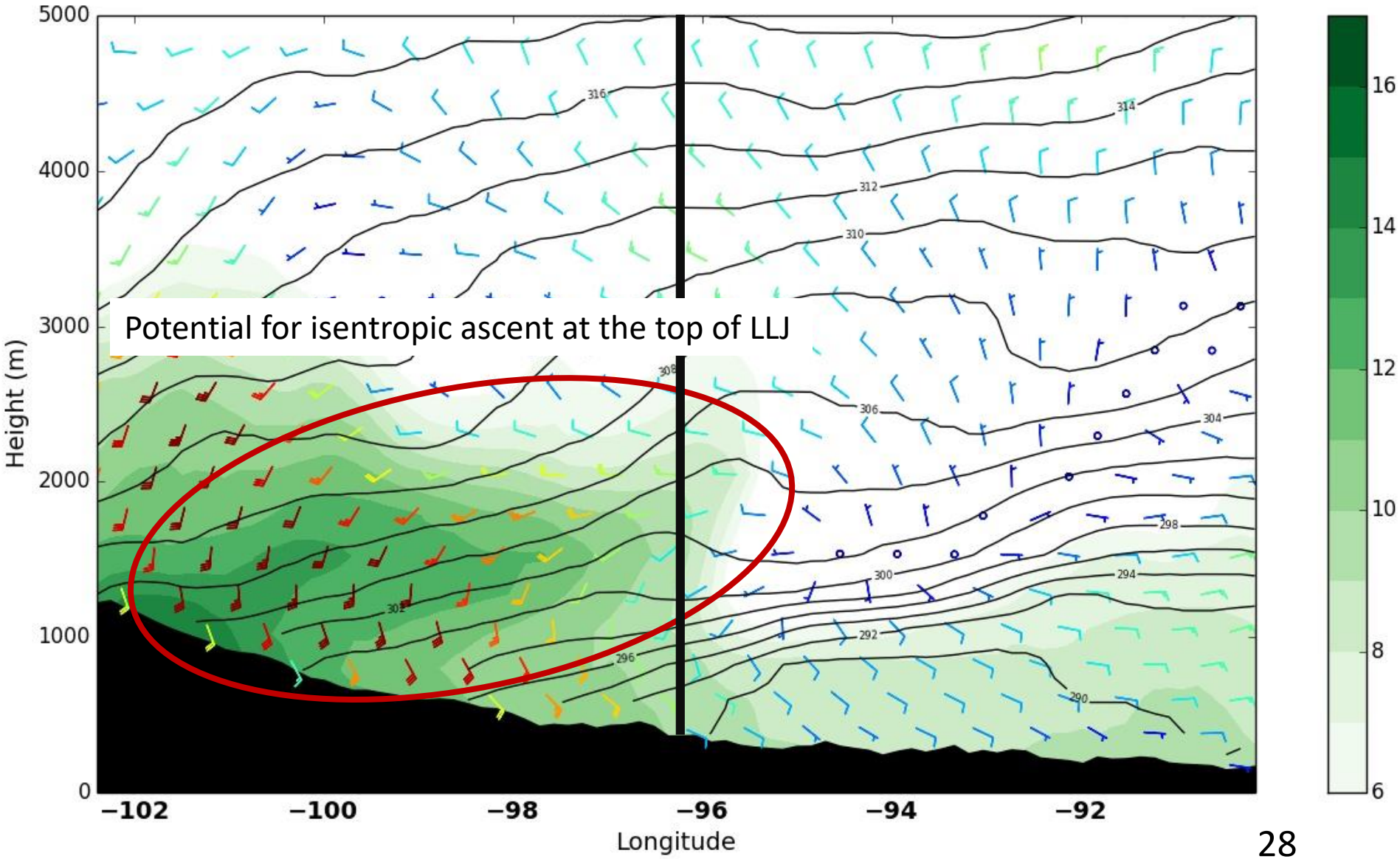

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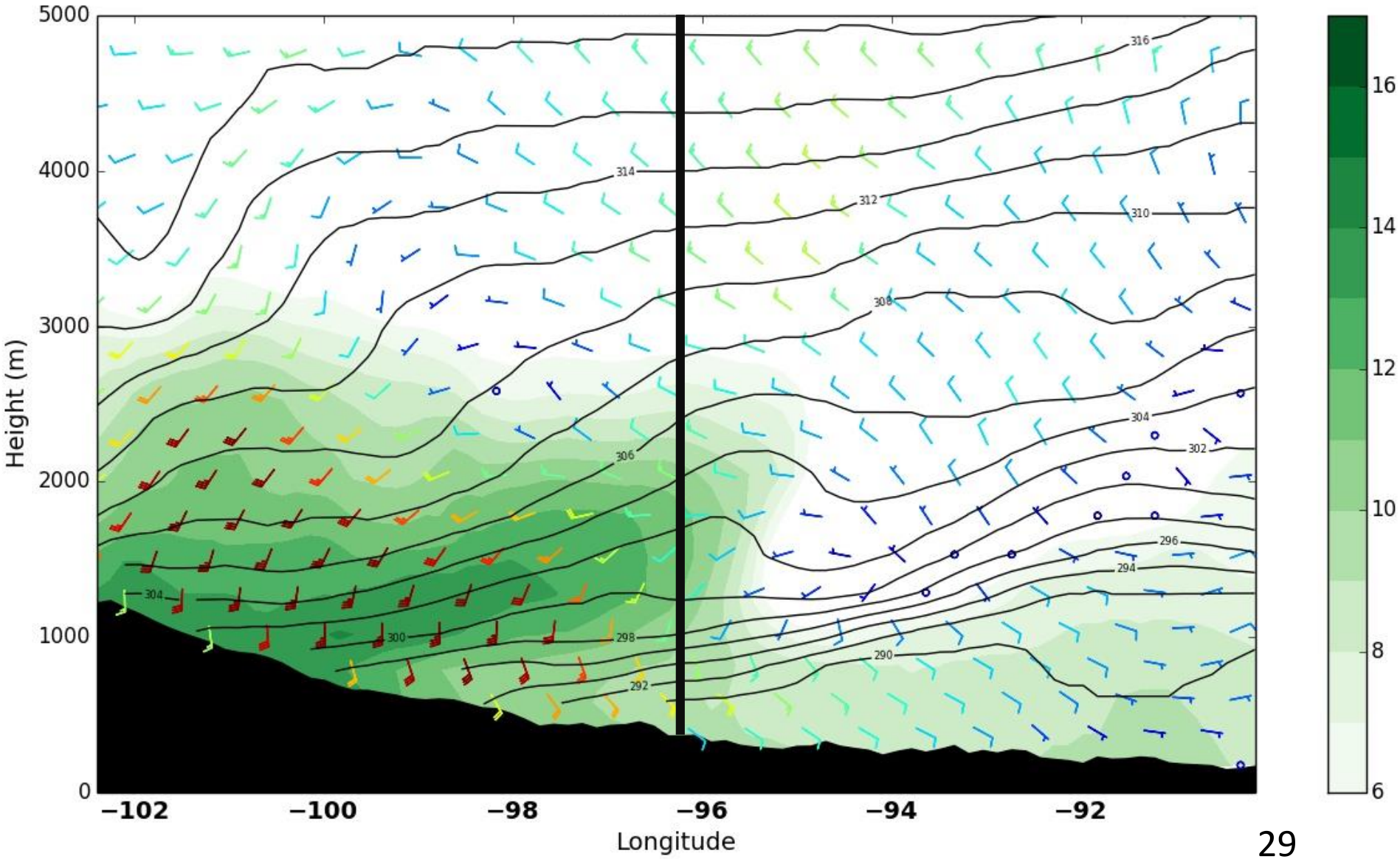

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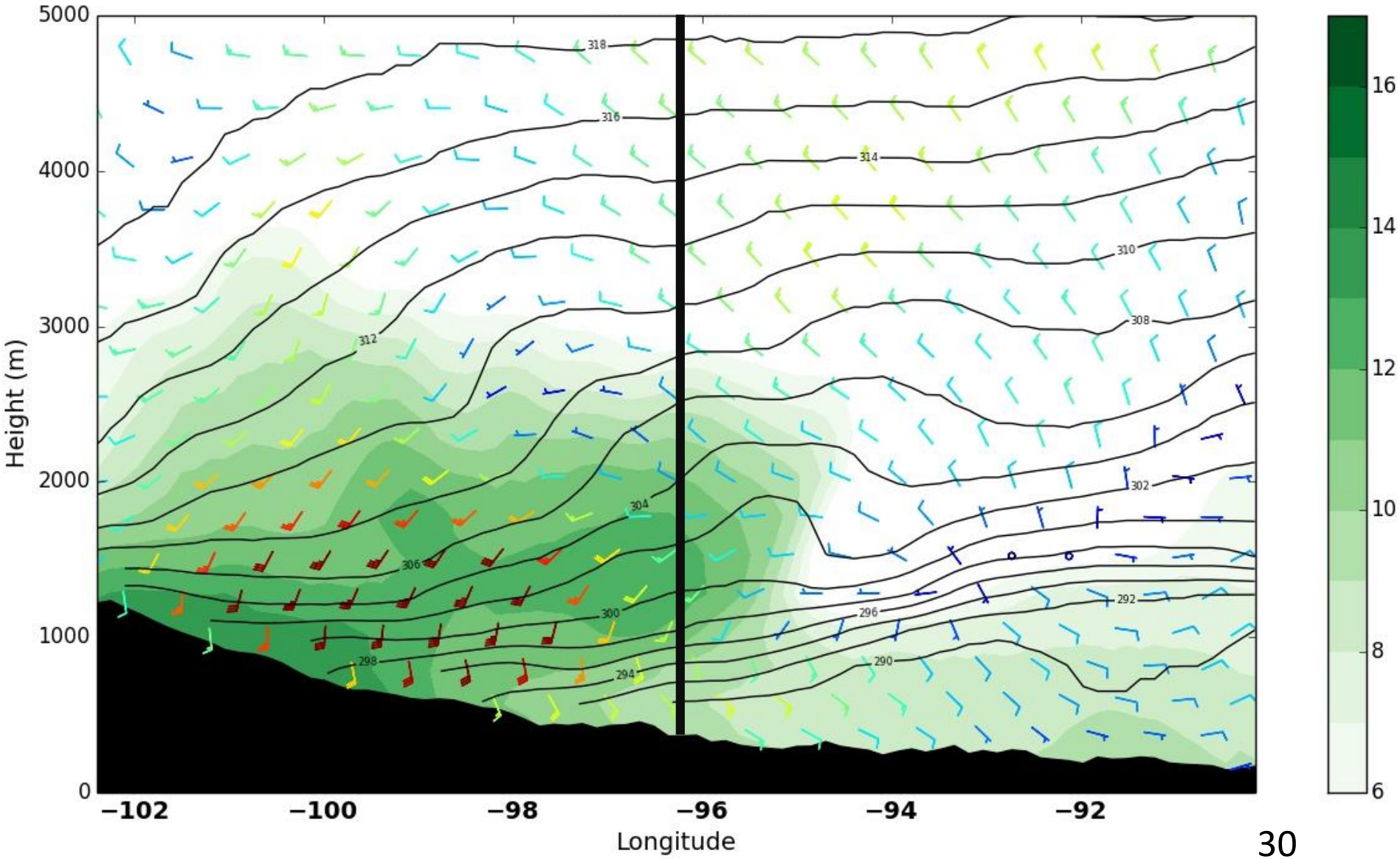
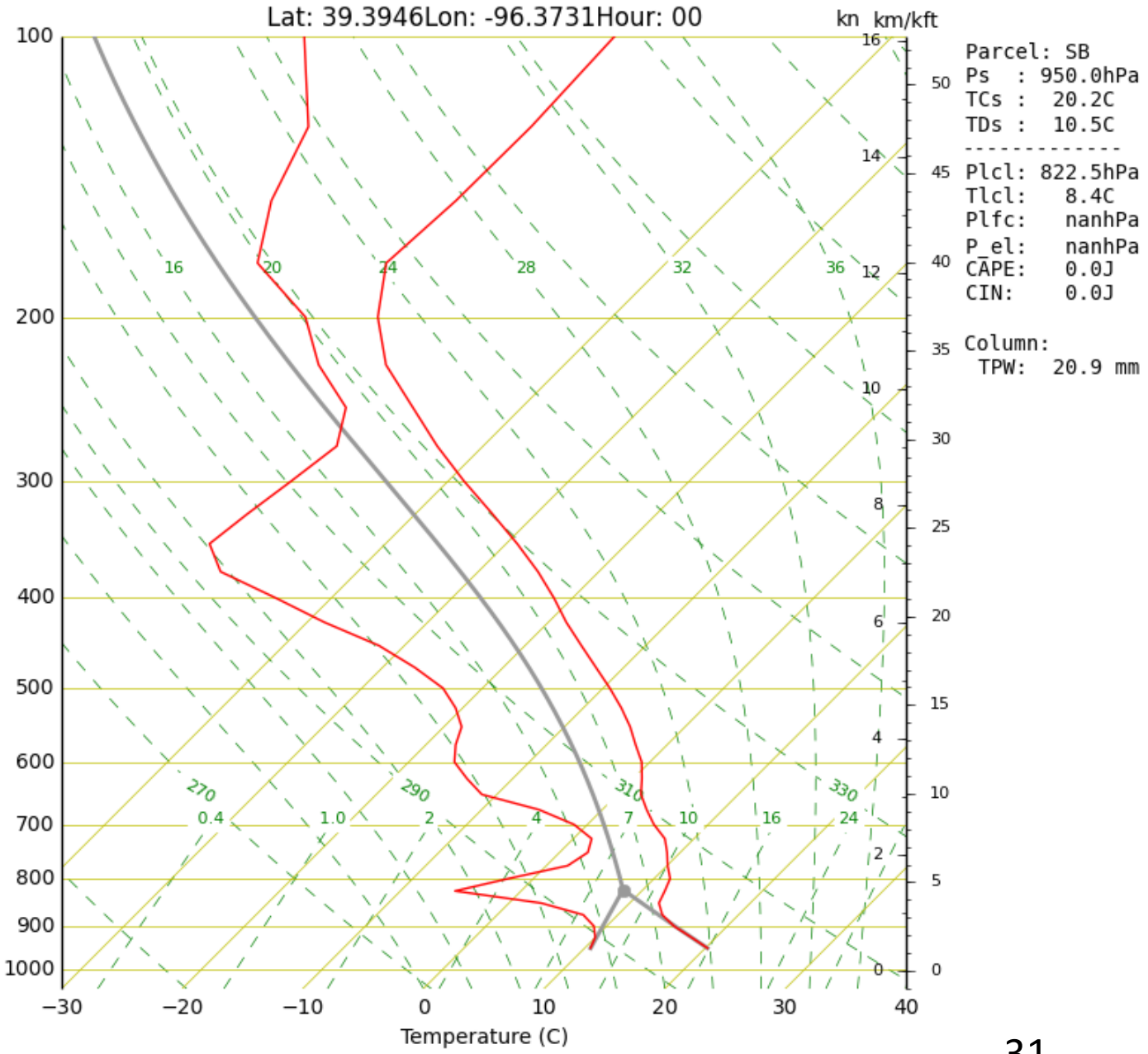
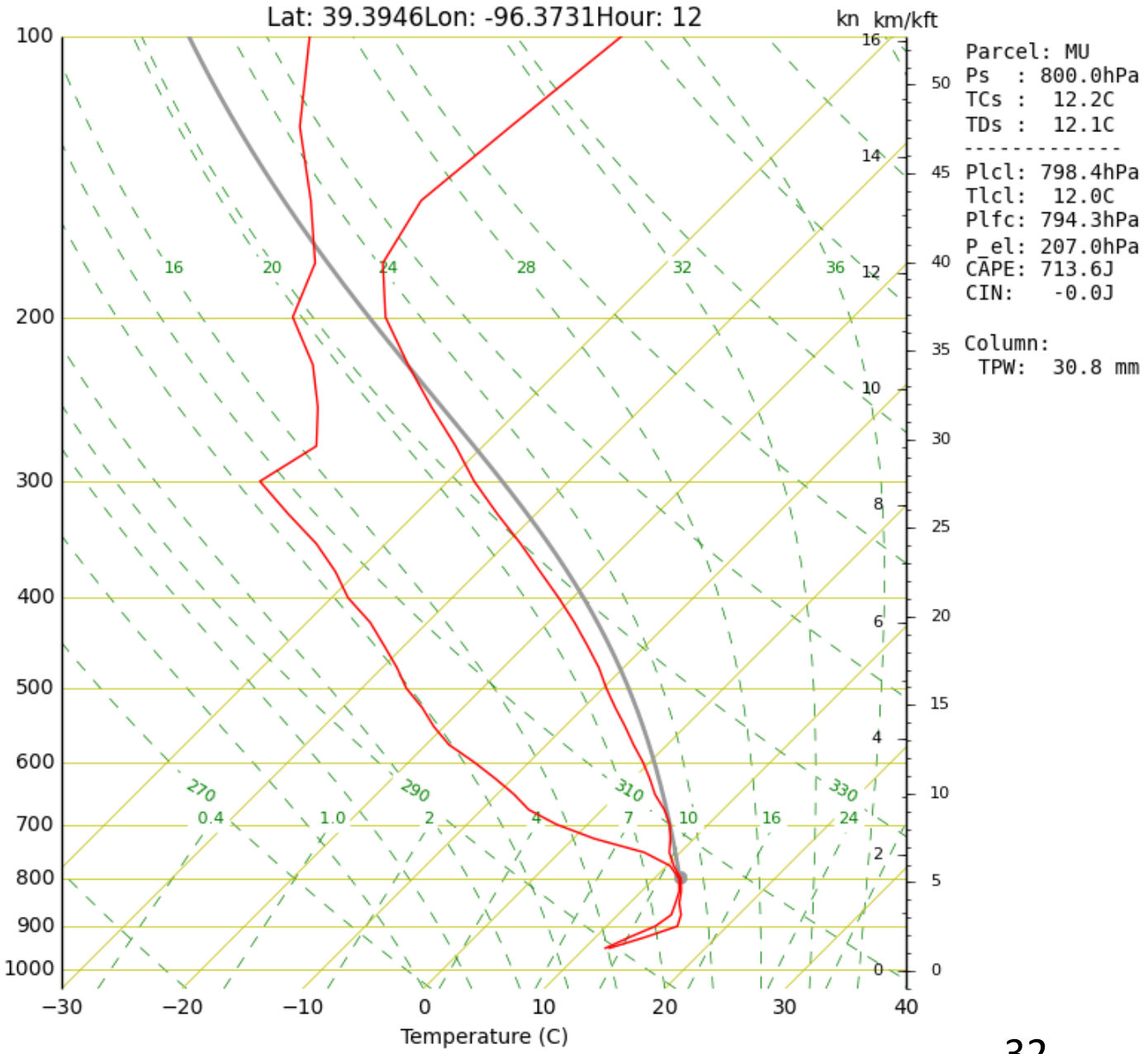


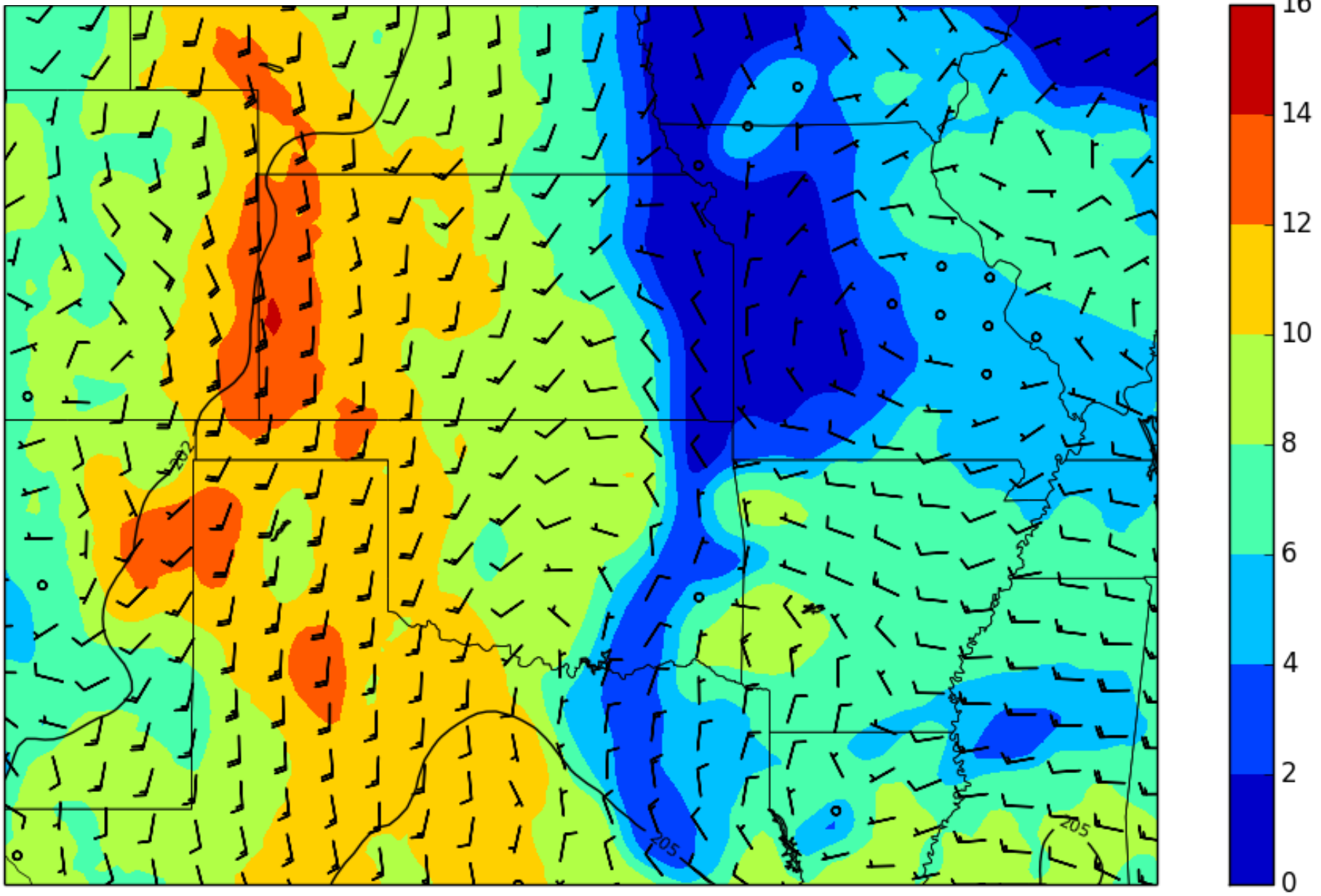
RAP Model Sounding at CI location



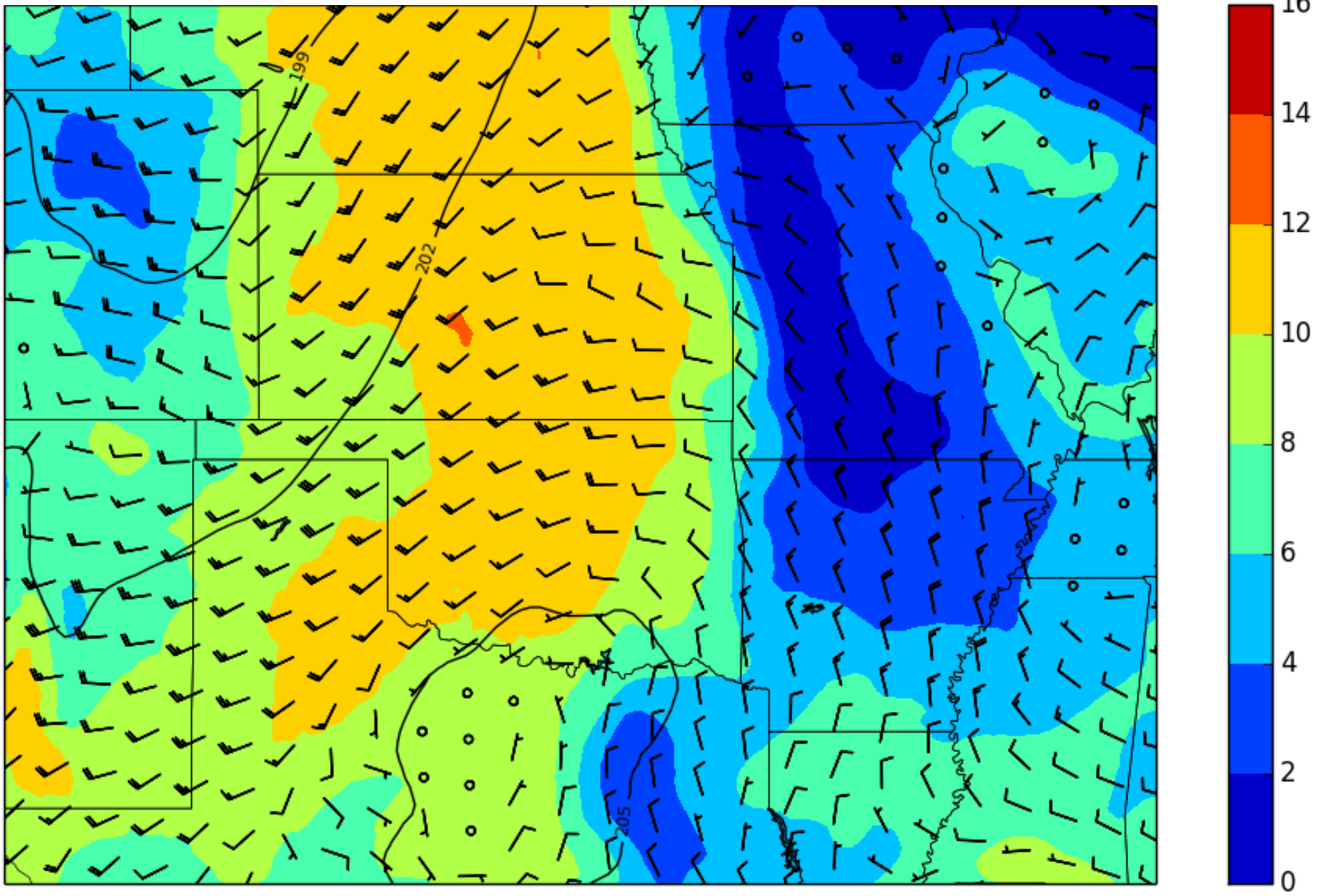
RAP Model Sounding at CI location



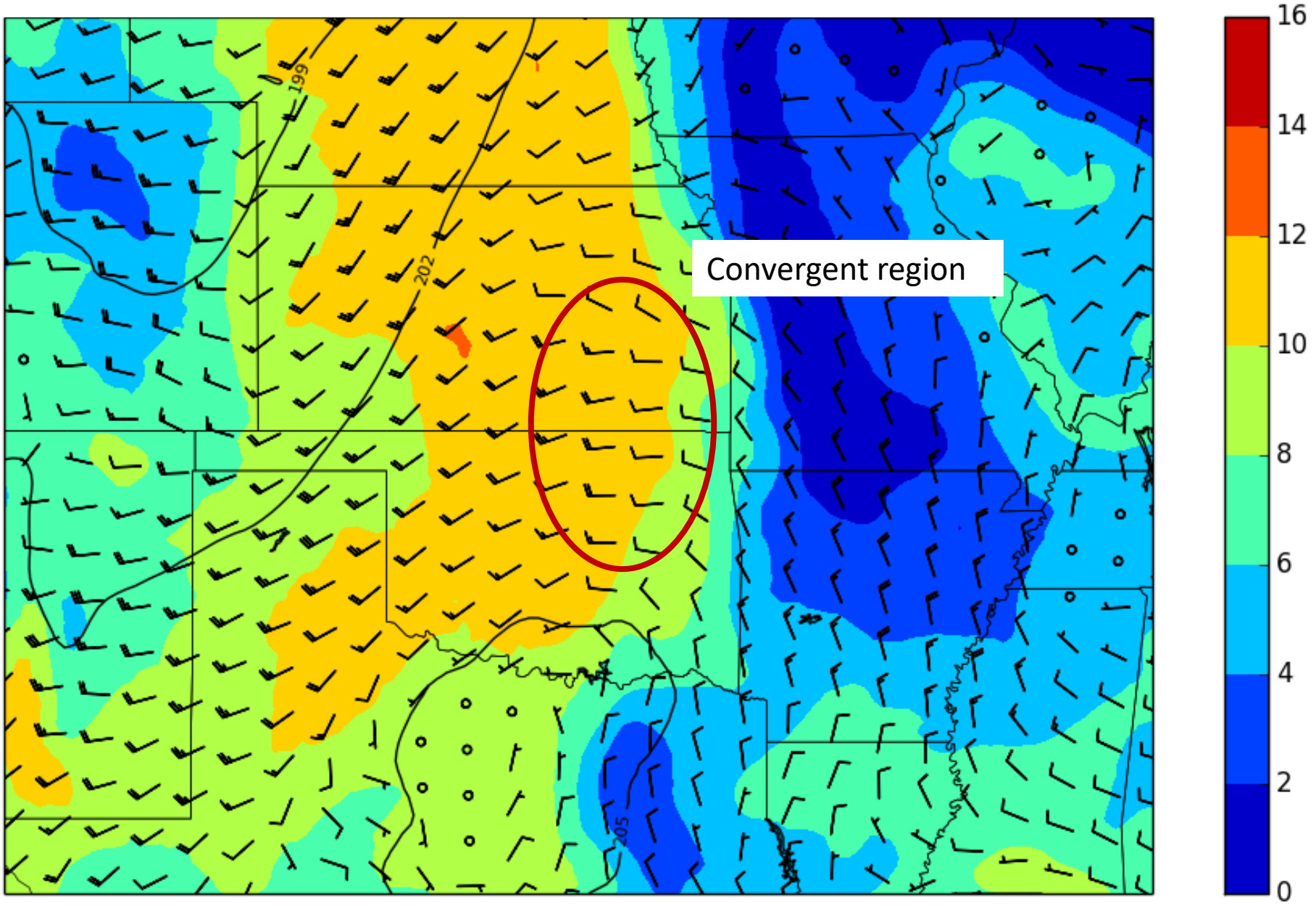
00 UTC 800hPa Geopotential height, Specific Humidity (g kg^{-1}), Winds (Kts)



12 UTC 800hPa Geopotential height, Specific Humidity (g kg^{-1}), Winds (Kts)



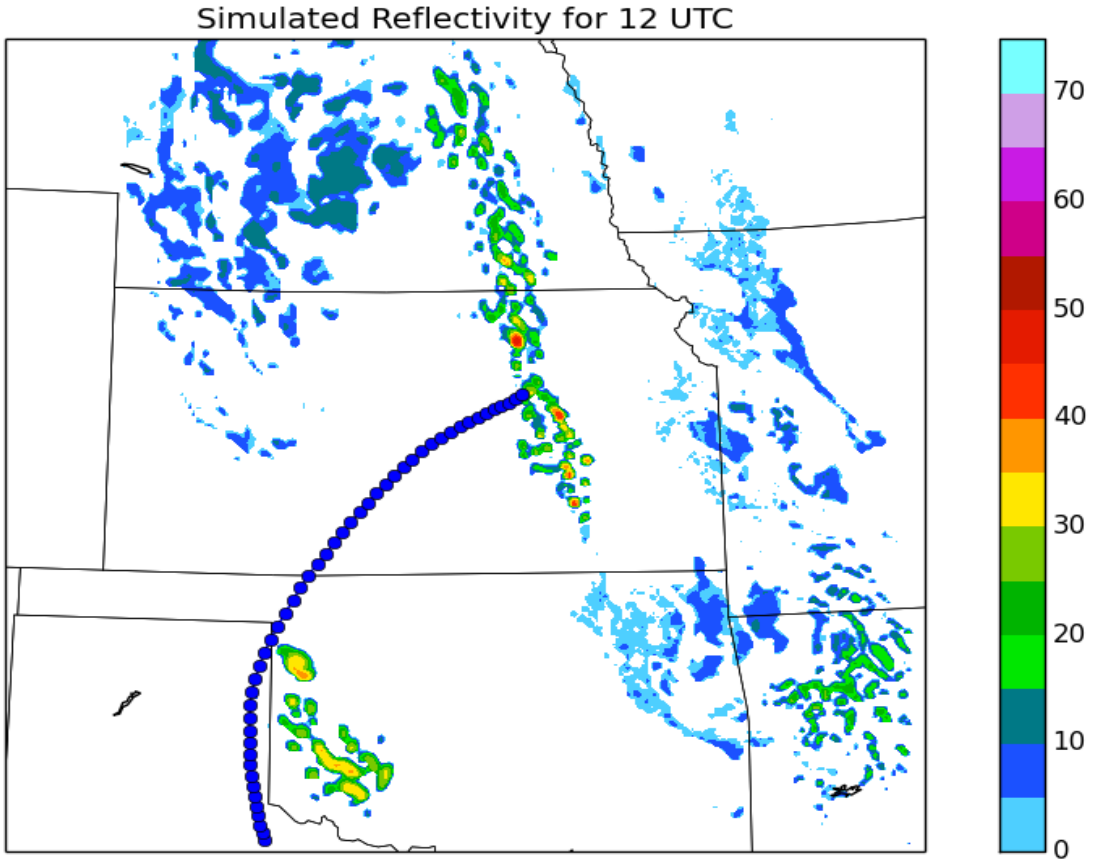
12 UTC 800hPa Geopotential height, Specific Humidity (g kg^{-1}), Winds (Kts)

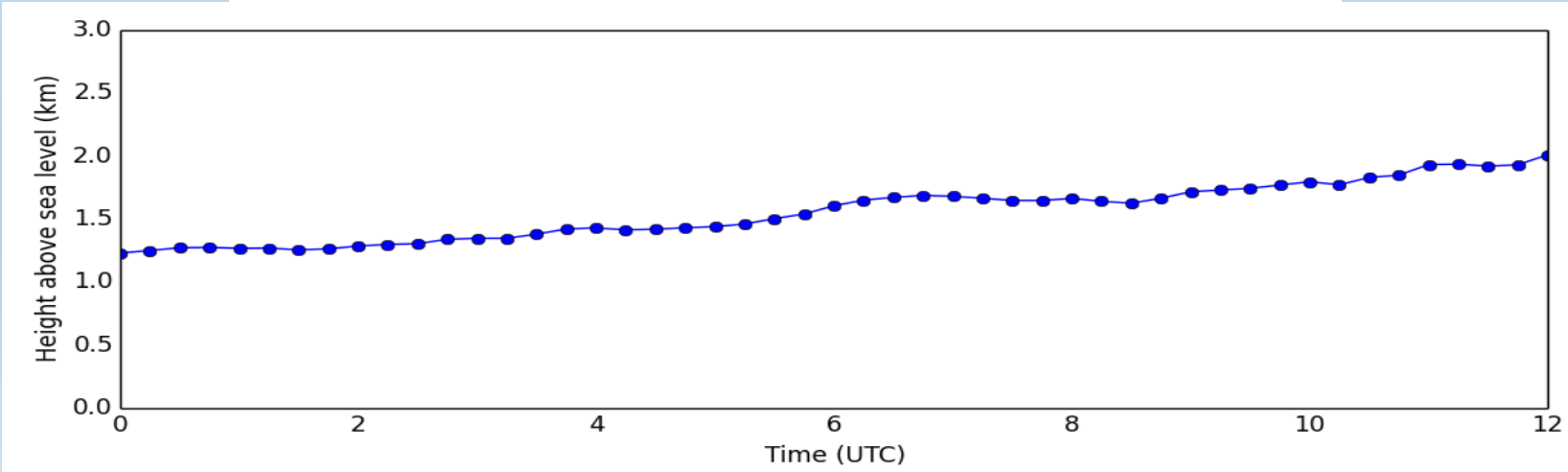


Conclusions

- CI occurred in the early morning hours in a north-south line on 2 June 2015
- The LLJ that developed on this night strongly veered with altitude and time
- The RAP forecasted for moisture in western KS to be advected across the jet axis.
  - Topeka soundings do show an increase in moisture in eastern KS in the early morning
- In models and observations, the inversion height in eastern KS was below the inversion height in western KS.
  - Persistent eastward moisture advection occurred above the inversion in eastern KS, where there was little CIN for a saturated parcel.
- The convergence due to the heterogeneous LLJ and slight isentropic ascent caused subtle lift that initiated the convection

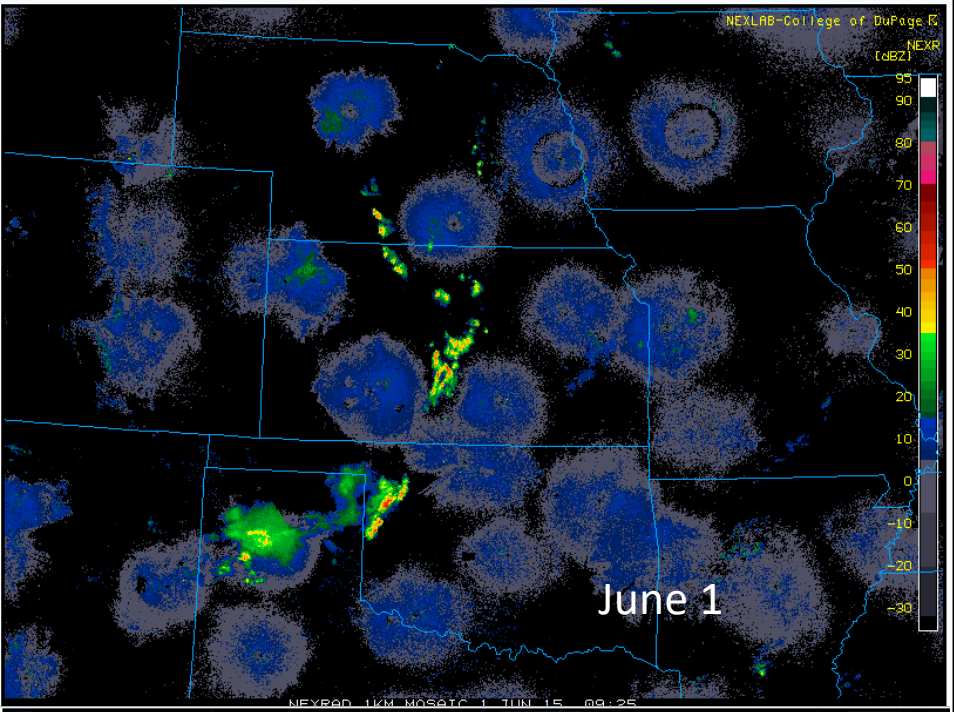
More recently began to study this case with WRF (Still very much in progress)





Future Work

- Examine the other days where this mechanism appears to occur
  - June 1st , June 3rd (out of the domain), July 5, and possibly more
- Incorporate more of the PECAN observations into the analysis
- Study how these strongly veering with height LLJs occur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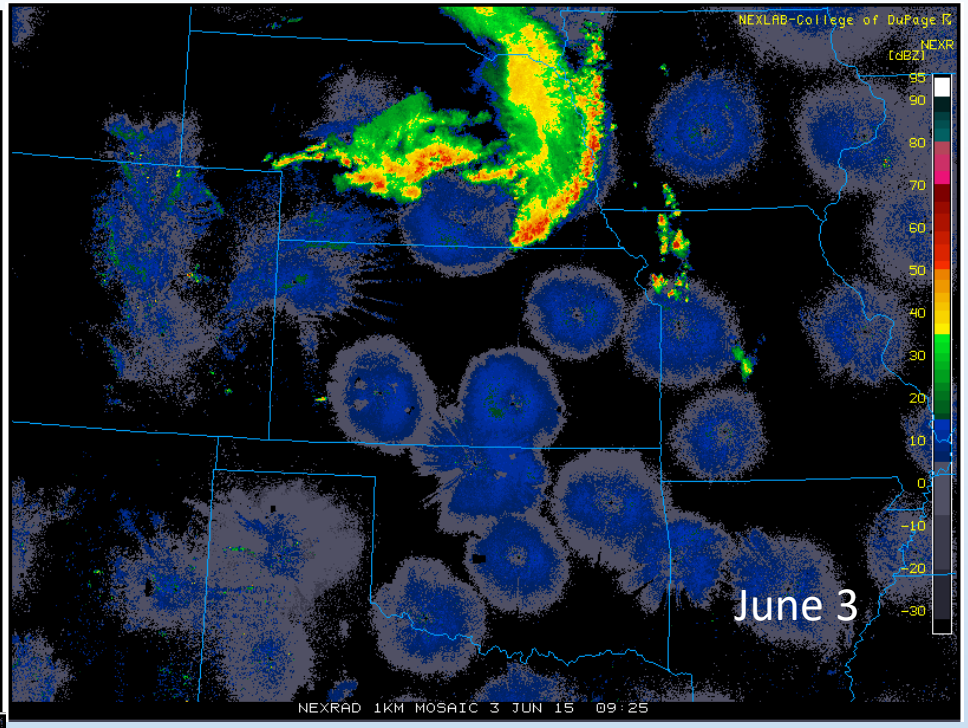
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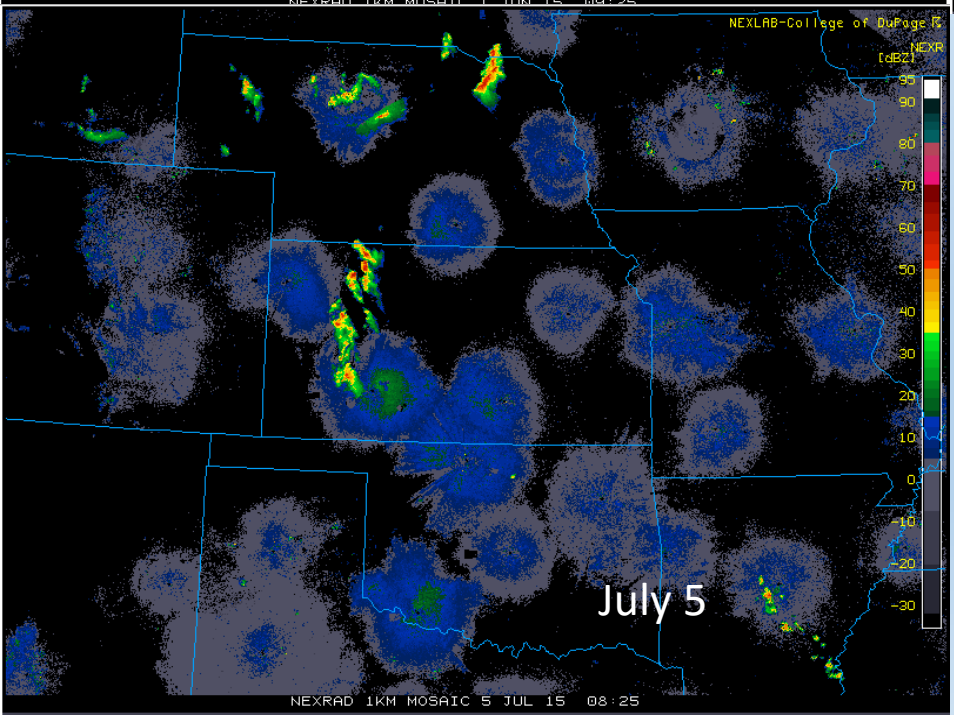
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Questions?