WFO La Crosse: Seminar Series #9:

Frontogenesis and Banded Snow in an Upper Midwest Snowstorm: December 9th, 2003

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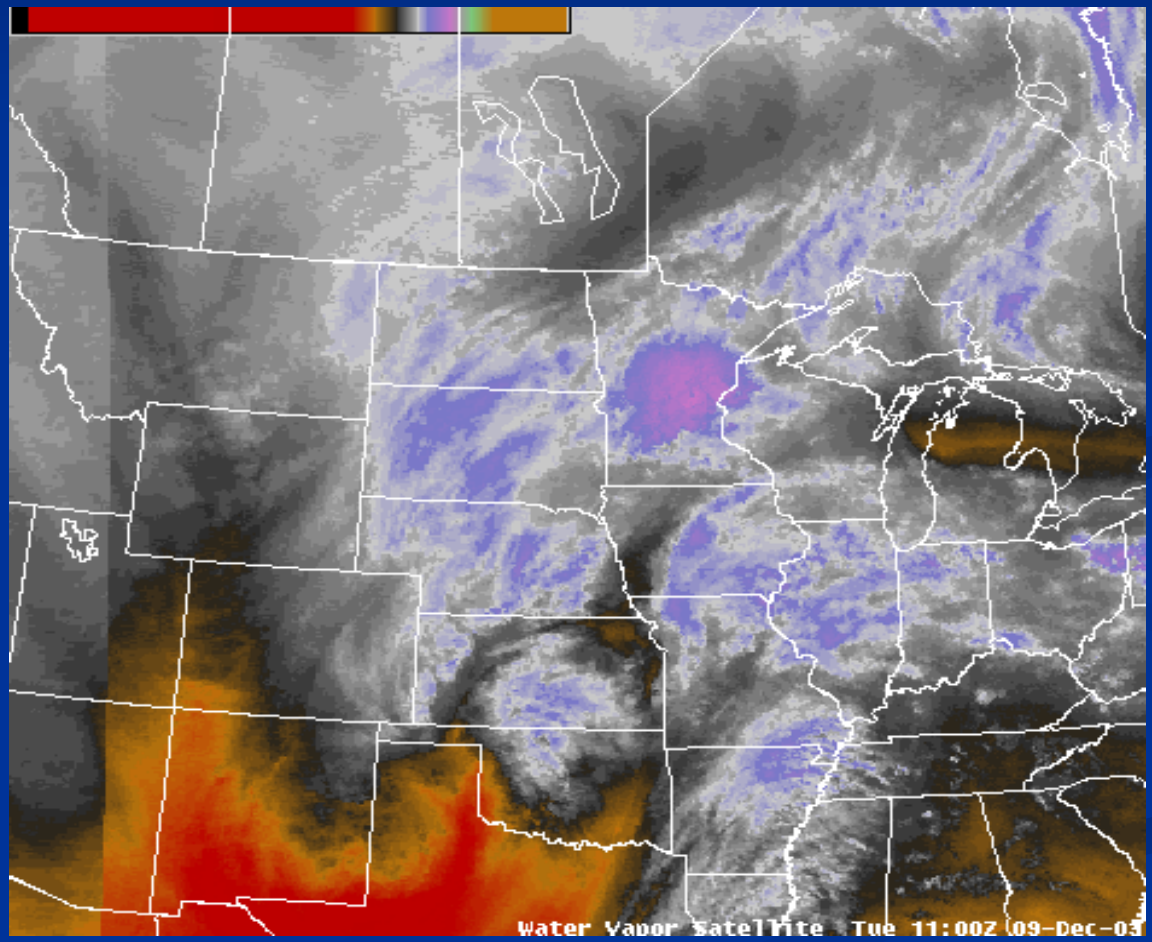
Case Study goals:

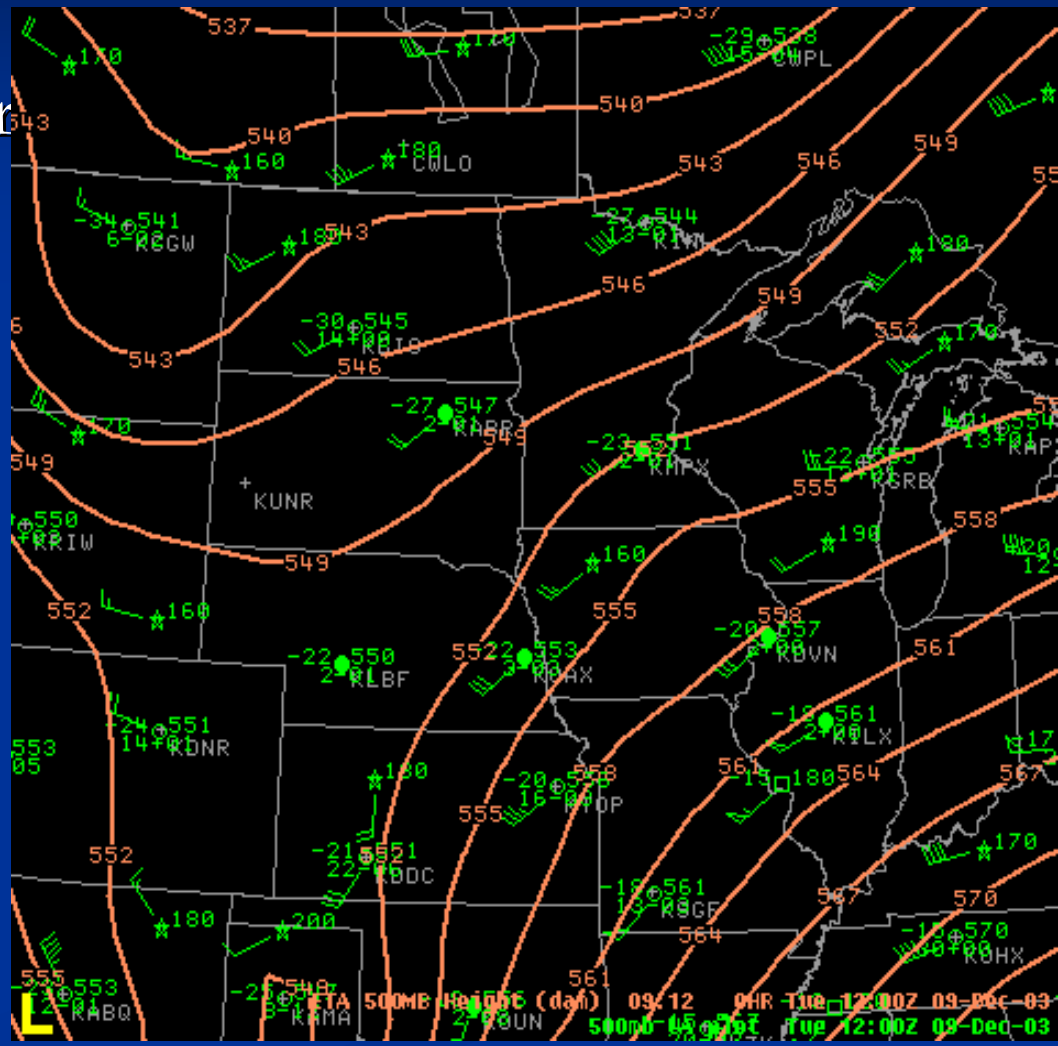
- Investigate the role of Fn vector convergence in producing a large, banded snowfall.
- Investigate the performance of the ETA model in forecasting Fn vector convergence in relation to the snow band.

Scenario: Loop of Water Vapor Satellite Imagery



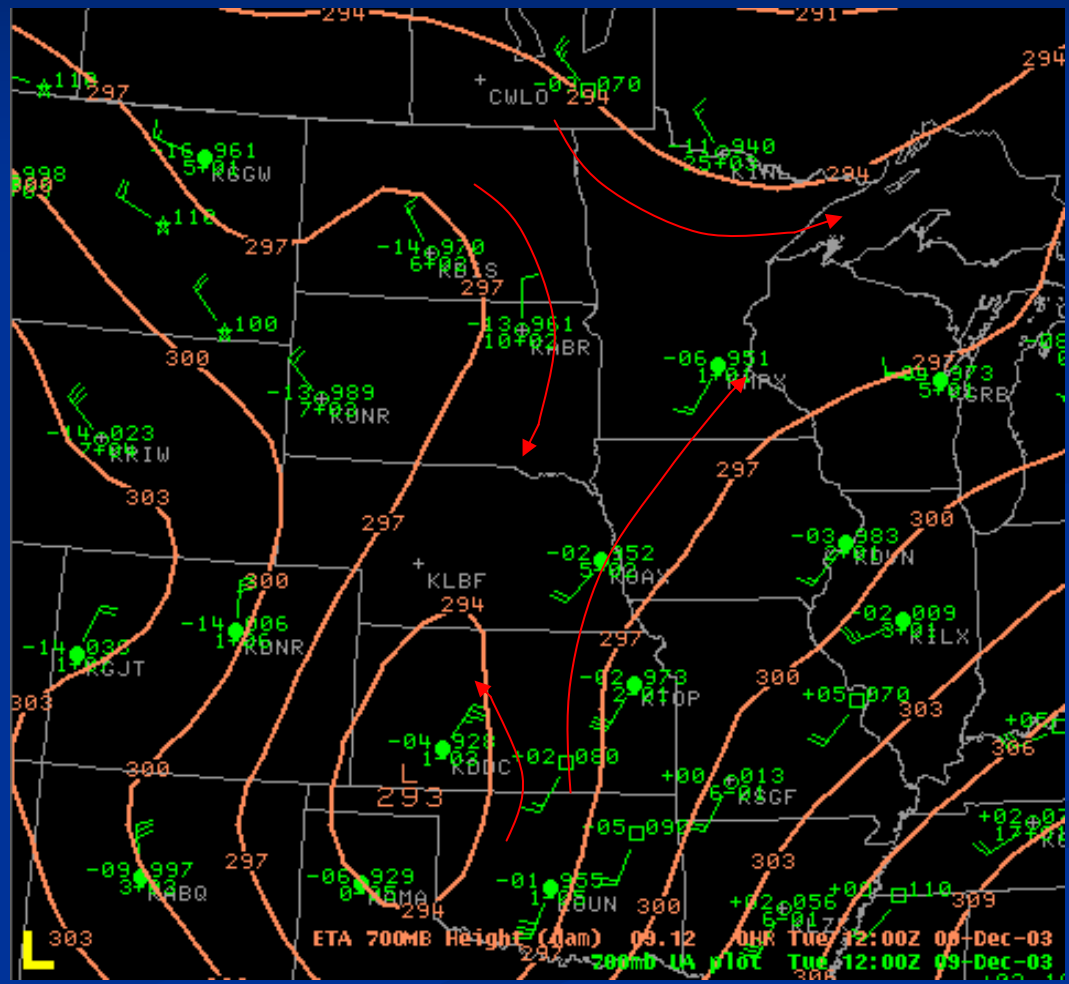
Scenario continue…

- 12z Dec 9th 500mb upper air pattern: Shortwave trough digging in over eastern Montana and eastern Wyoming.

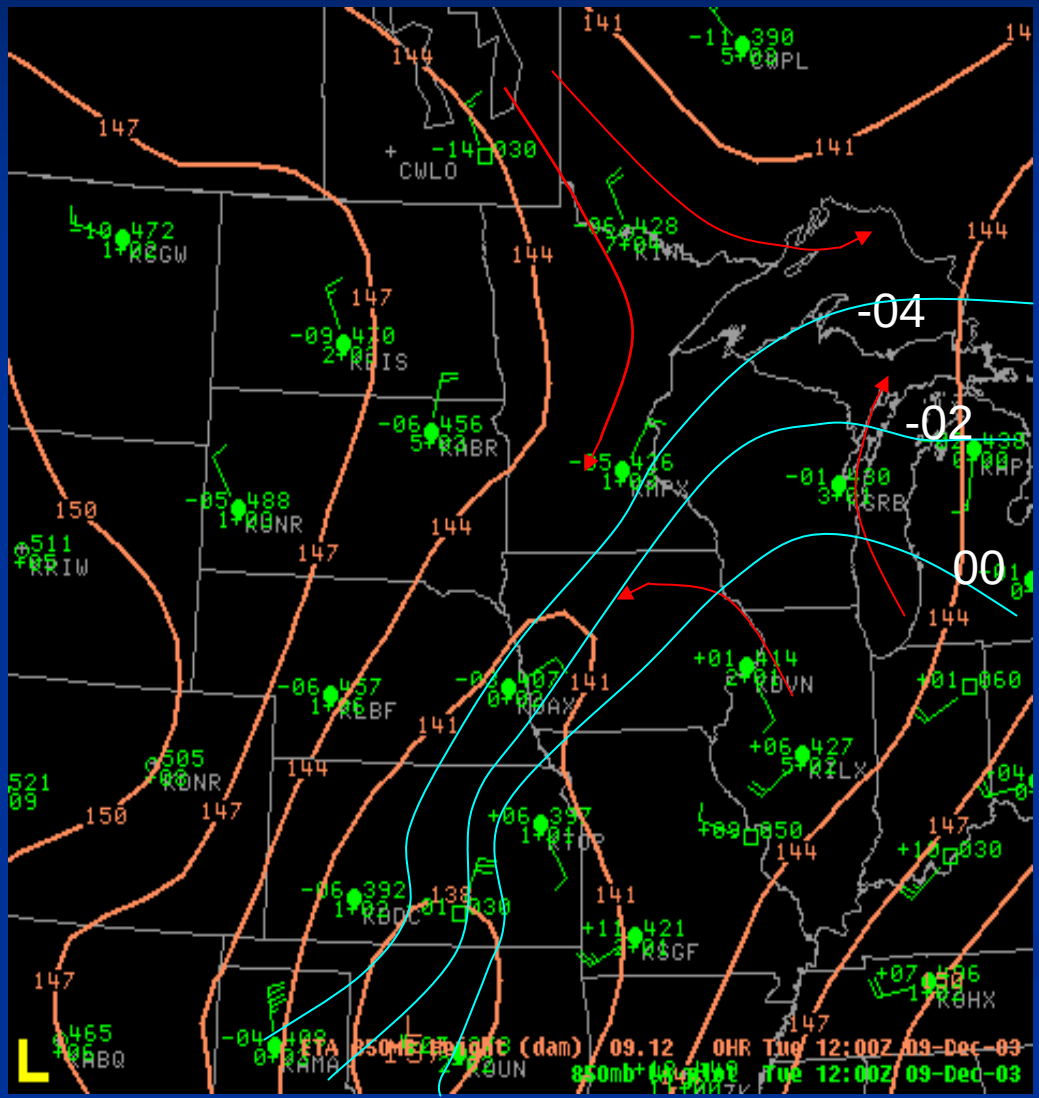


12z Dec 9th 700mb upper air pattern

- A weak deformation zone over northern and central MN.
- Tightening of temperature gradient over central MN and southeastern SD (-13 deg C at ABR and -6 deg C at MSP).

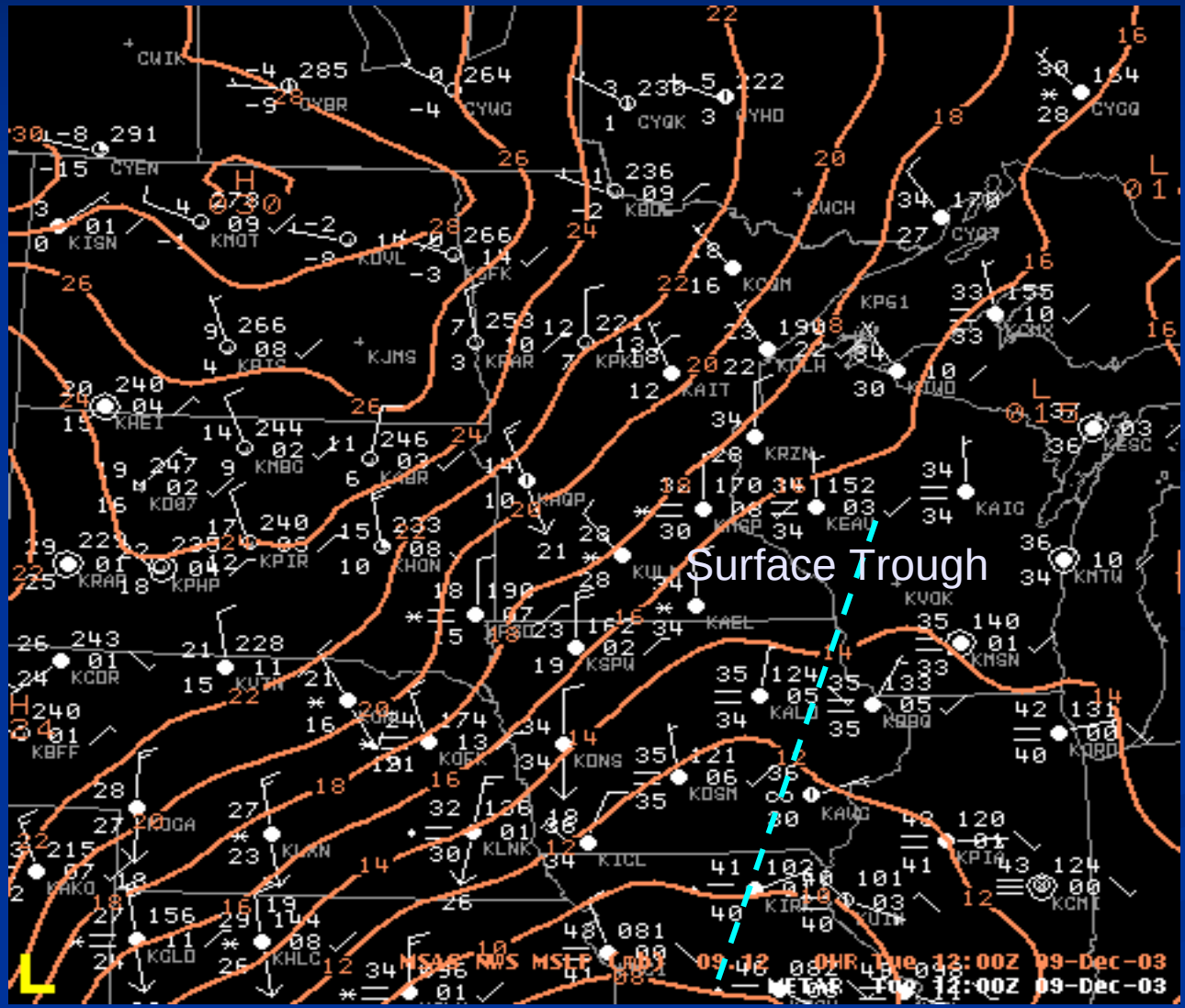


12z Dec 9th 850mb upper air pattern



- Weak deformation zone over western Wisconsin and into northeast Iowa.
- Temperature gradient tightening over western WI and northeast IA (-5 deg C at MSP and +1 deg C at DVN).

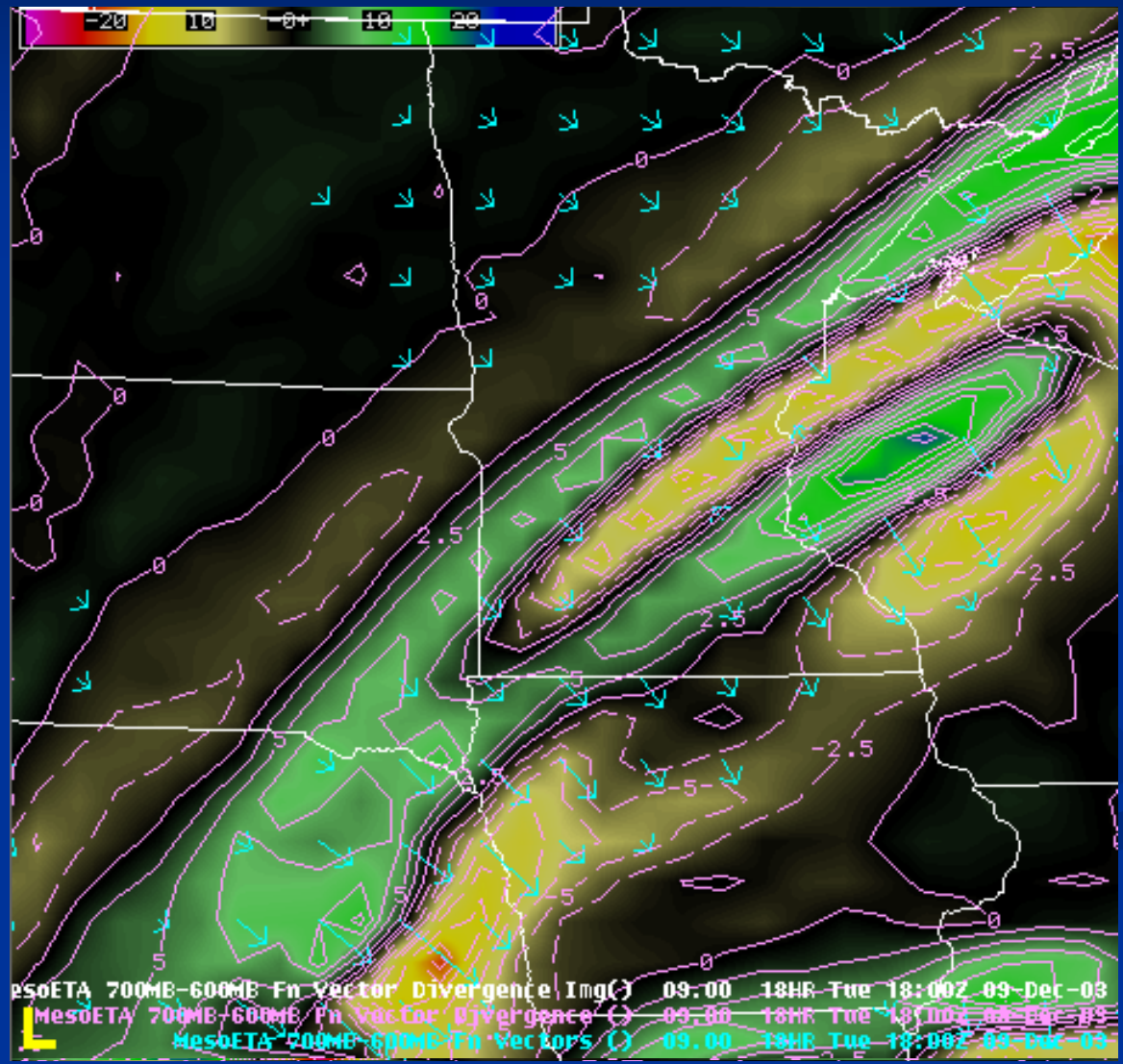
12z Surface map overlaid with MSAS MSL



- Surface trough extending northeast from Low pressure in southern Missouri into eastern Iowa and southwestern Wisconsin.
- Snow falling across southwest MN and southeast SD.

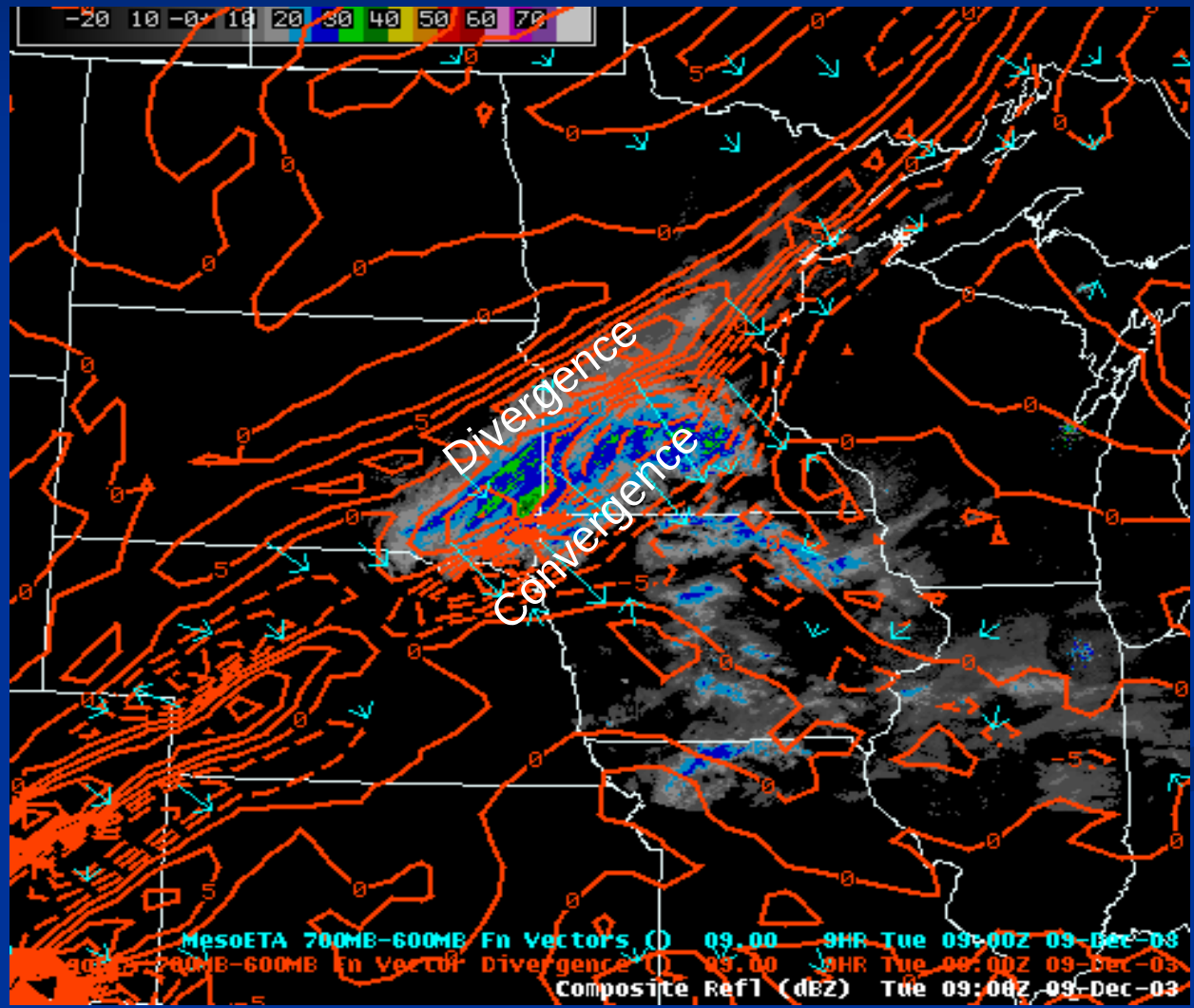
ETA 6 hour to 18 hour forecast of the 700-600mb layer Fn vector

- Important: Notice at 06z the isotherms are parallel to the Fn vector convergence.
- Also, note the strong Fn vector convergence over southwest and central Minnesota and how it moves northeast over central Minnesota.



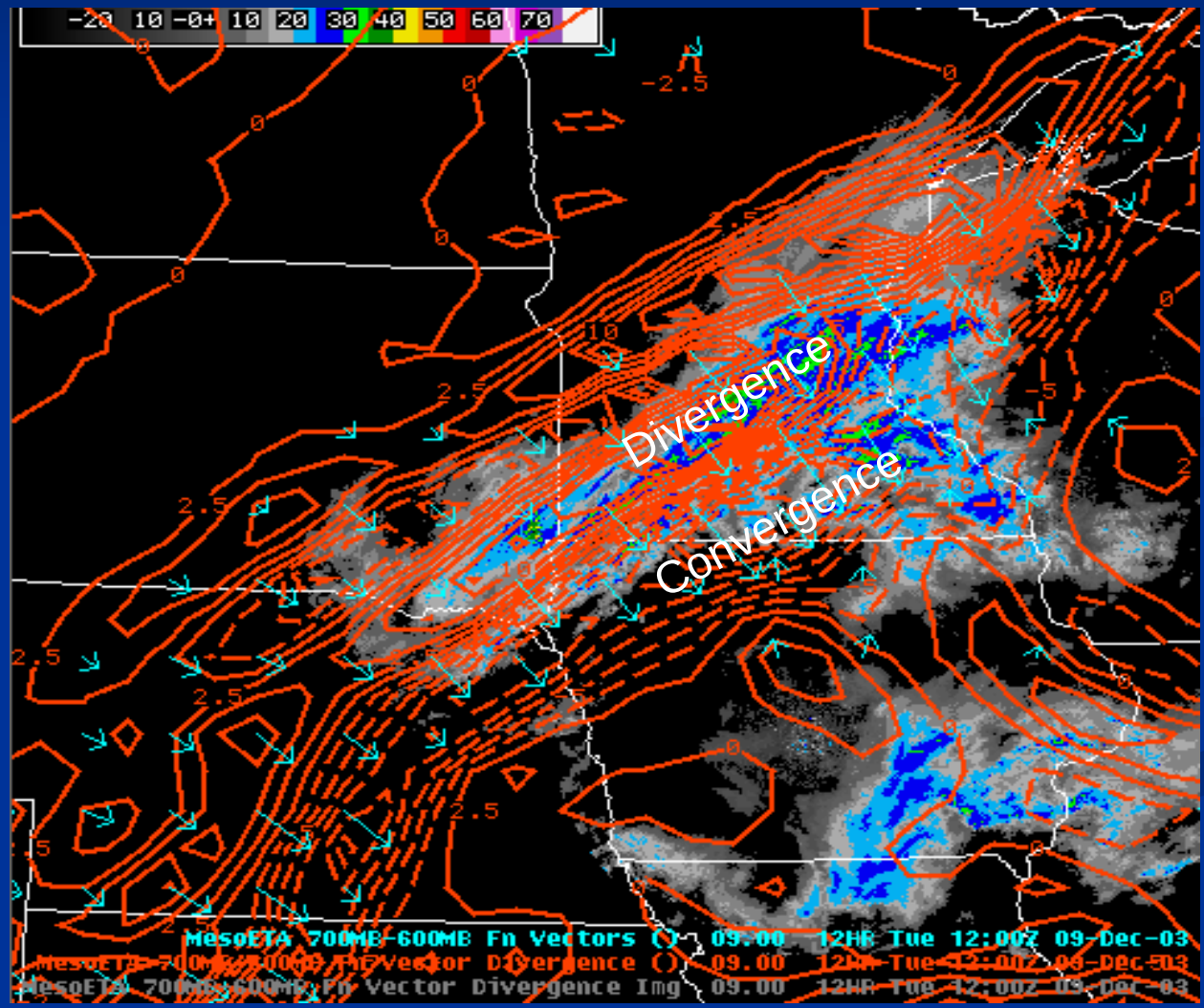
Radar Mosaic and ETA Fn vector convergence at 9z

- Look at how well the Fn vector convergence match up in relation to the snow falling over southeast SD and into southwest MN.
- Also, notice the strong gradient between the convergence and divergence of the Fn vector and location of where the snow is occurring.

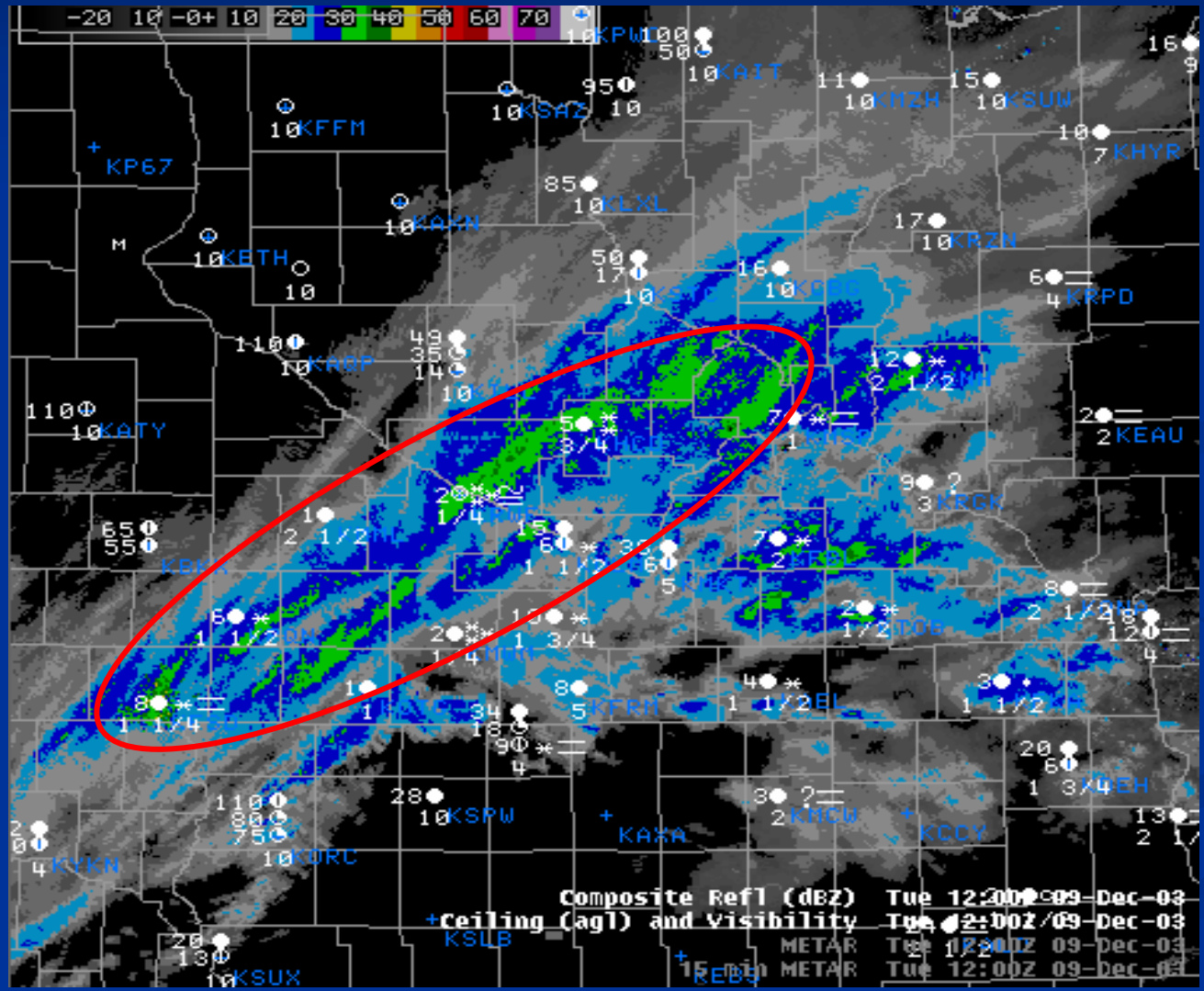


Mosaic radar and ETA Fn vector convergence at 12z

- Three hours later: The Fn vector convergence continue to match up well with the snow band at 12z.

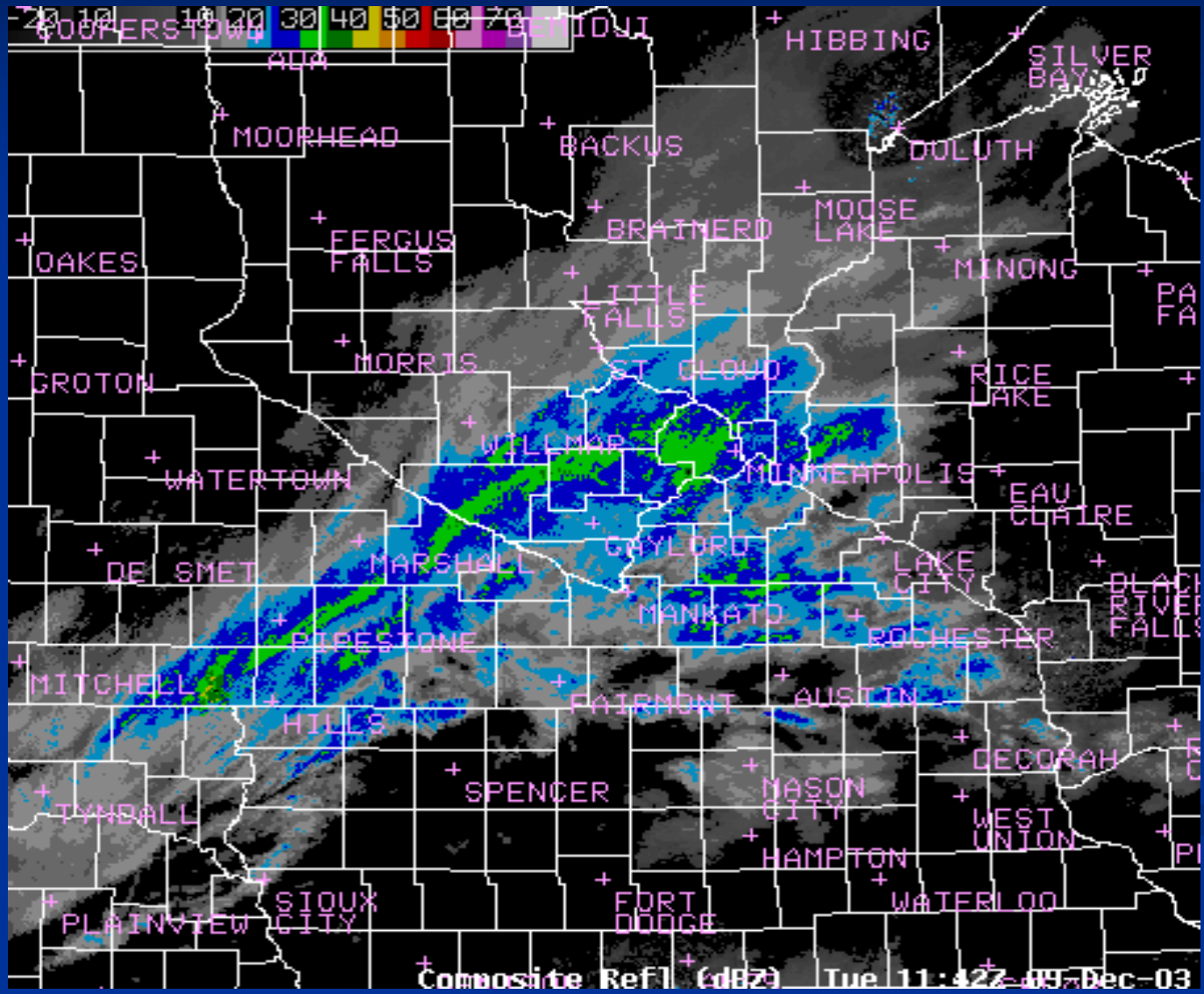


12z Surface observations and Mosaic radar

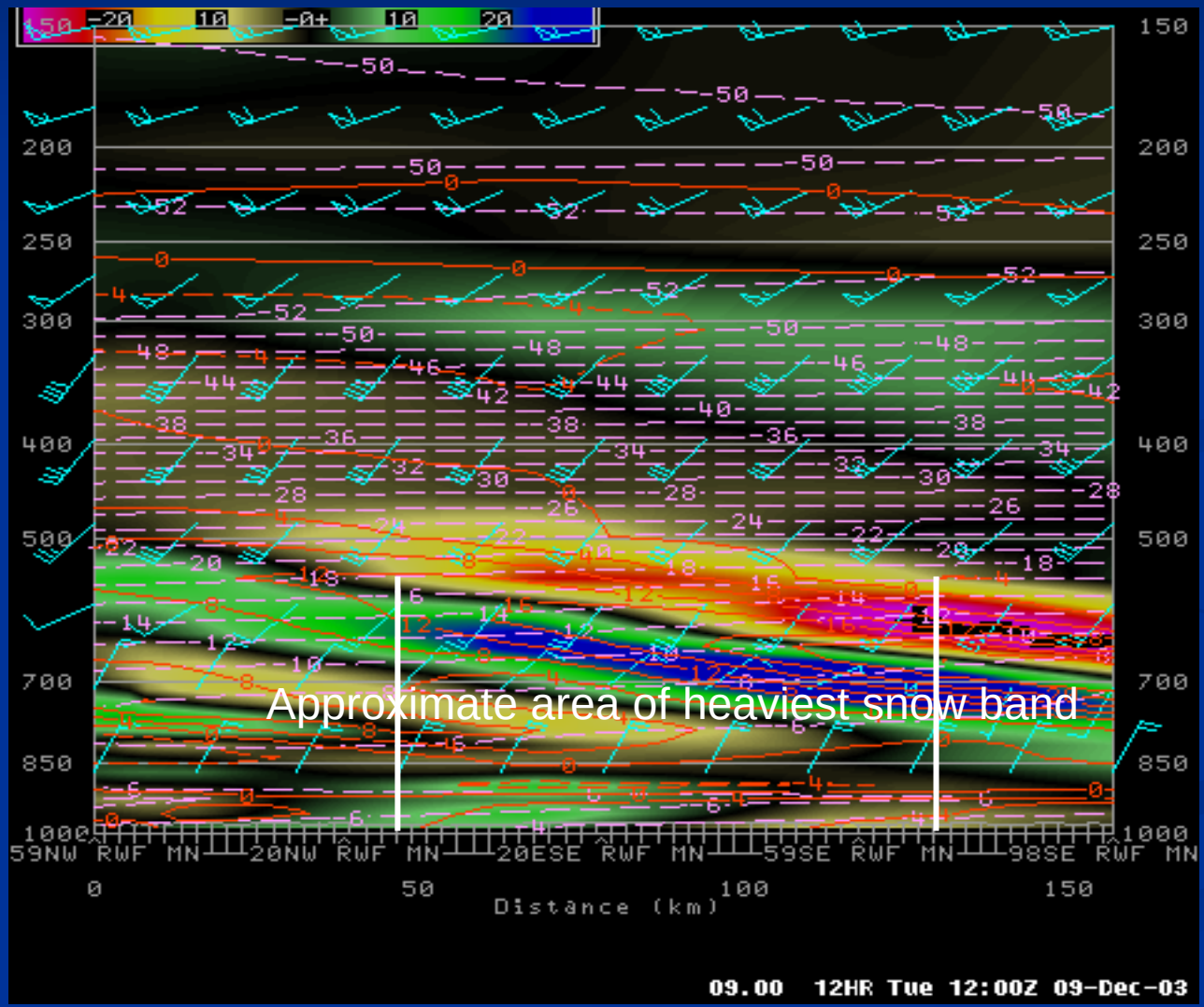


Area circled in red: Notice the visibilities range from a ¼ mile to 1 ½ miles in the heaviest snow band across southwest and central Minnesota.

Loop of Mosaic radar over southwest and central Minnesota on December 9th around 12z

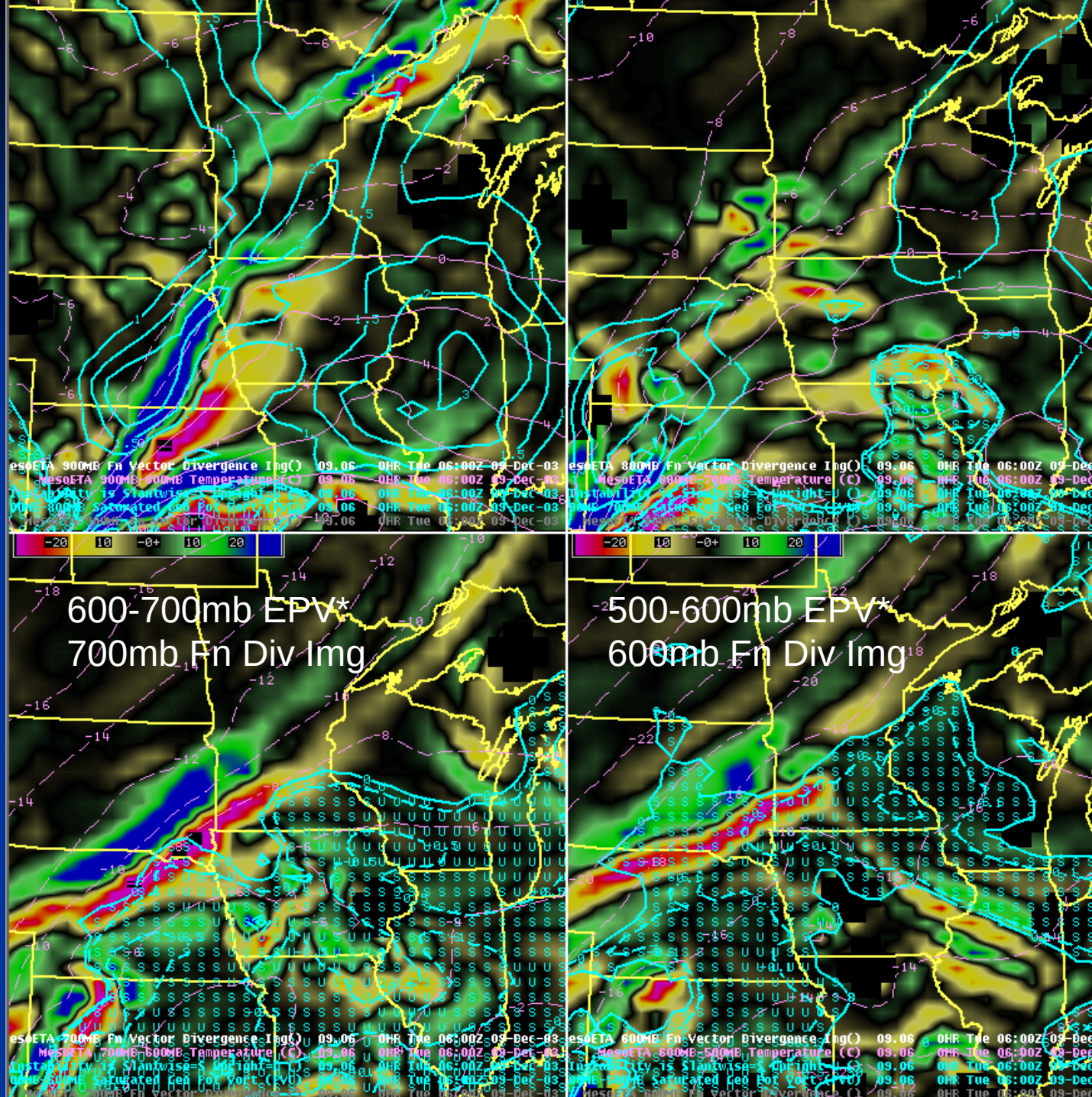


12 hour ETA Cross section at 12z

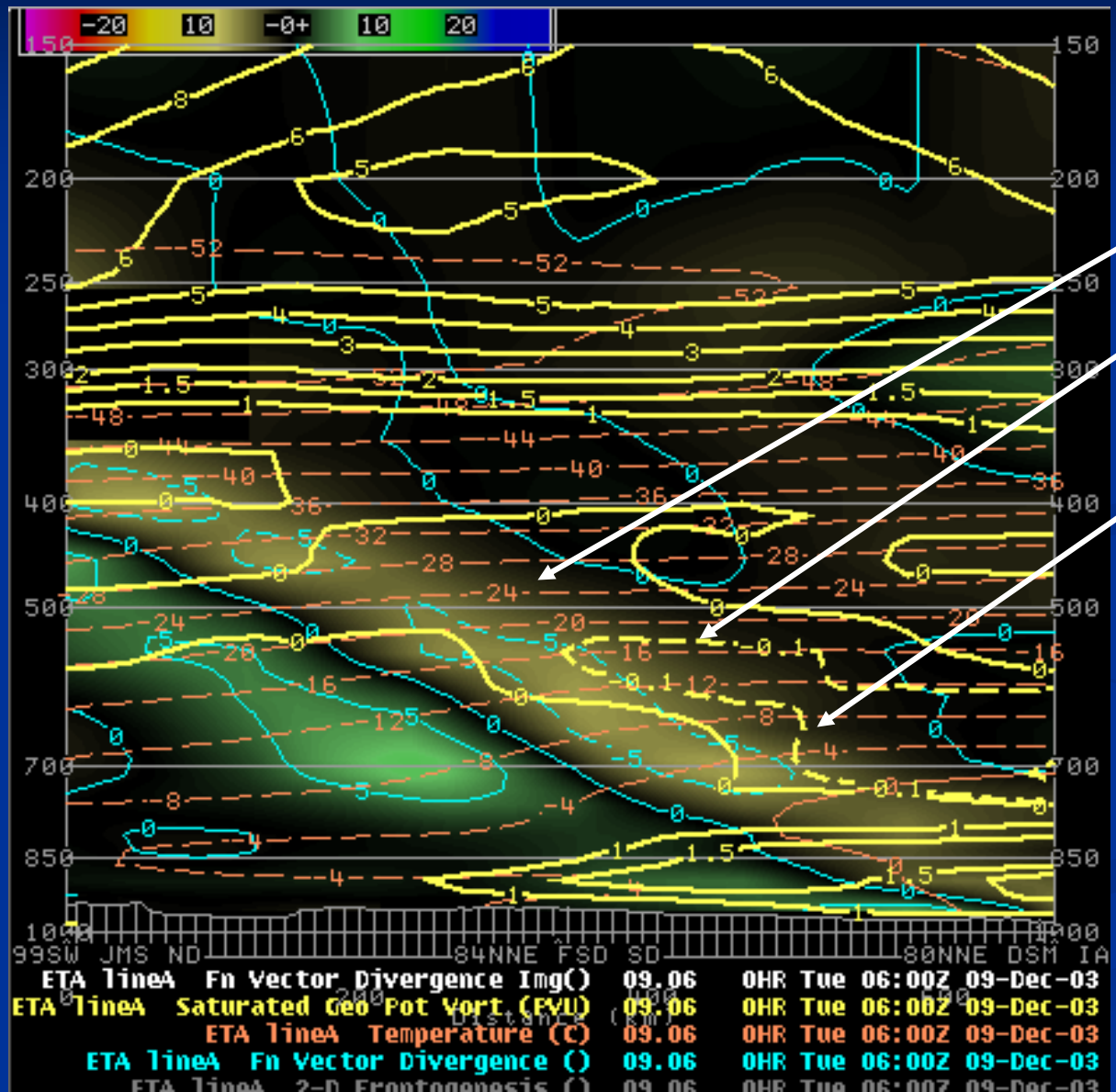


- Notice the Fn vector convergence between 700-600mb layer lines up where the snowfall band set up.
- Also note the wind field and the 2-D Frontogenesis sloping upward toward colder air.

- Big Three

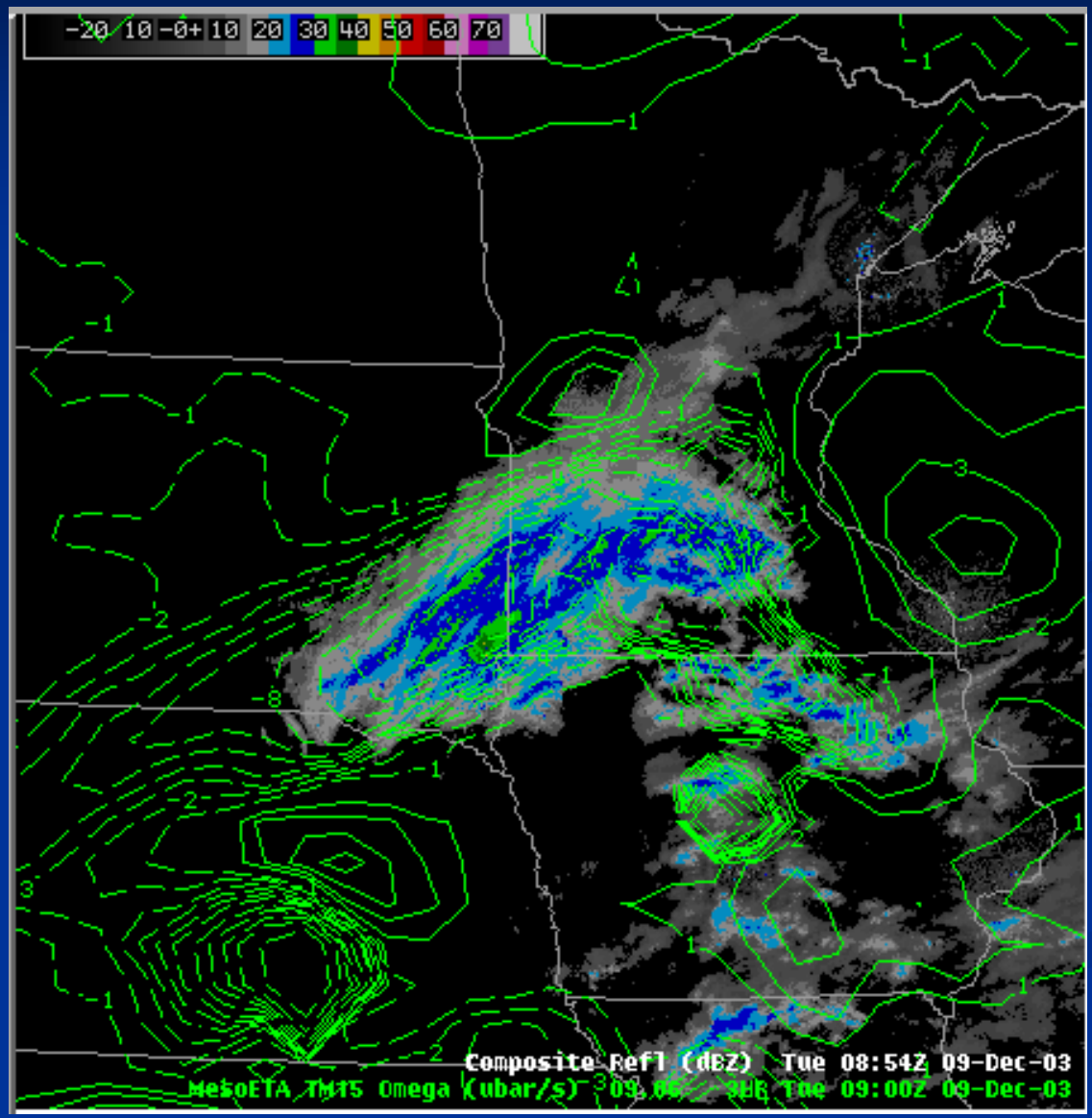


EPV* and Fn in cross-section



- Unstable EPV*
  - 200 mb deep or more.
  - Co-located right over frontogenesis region.

Vertical Motion at -15C?

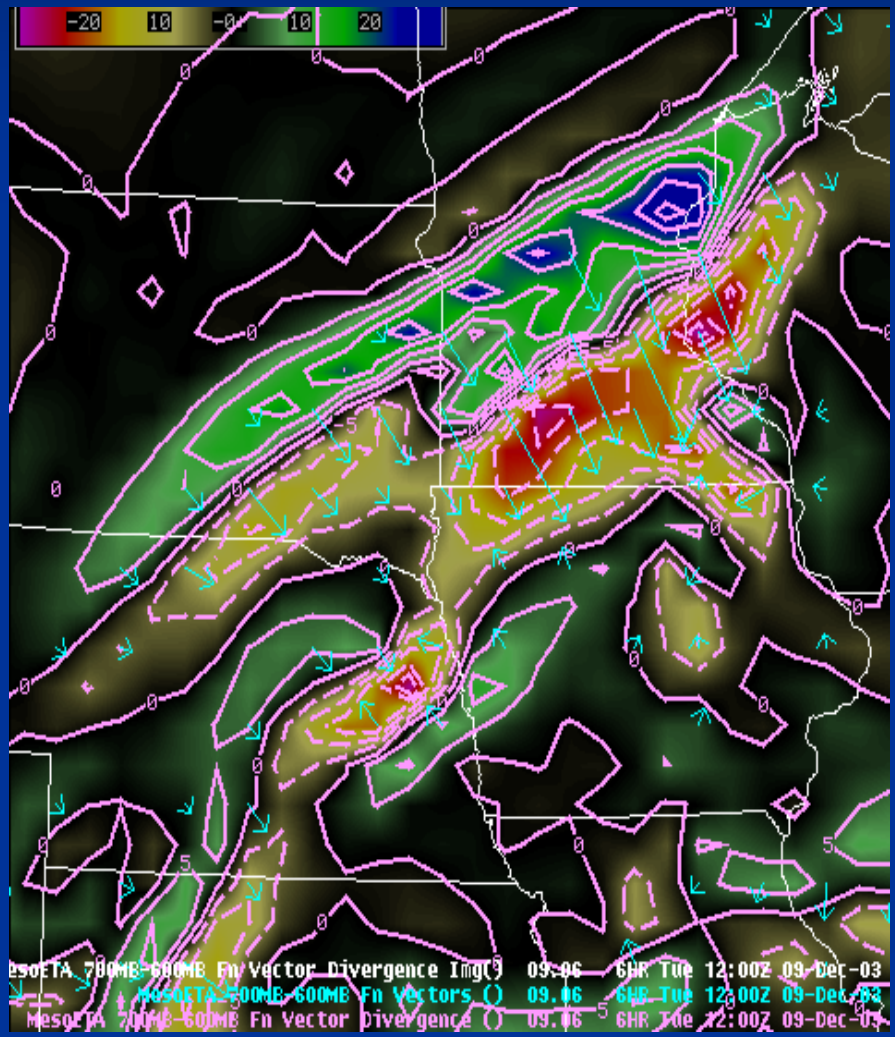


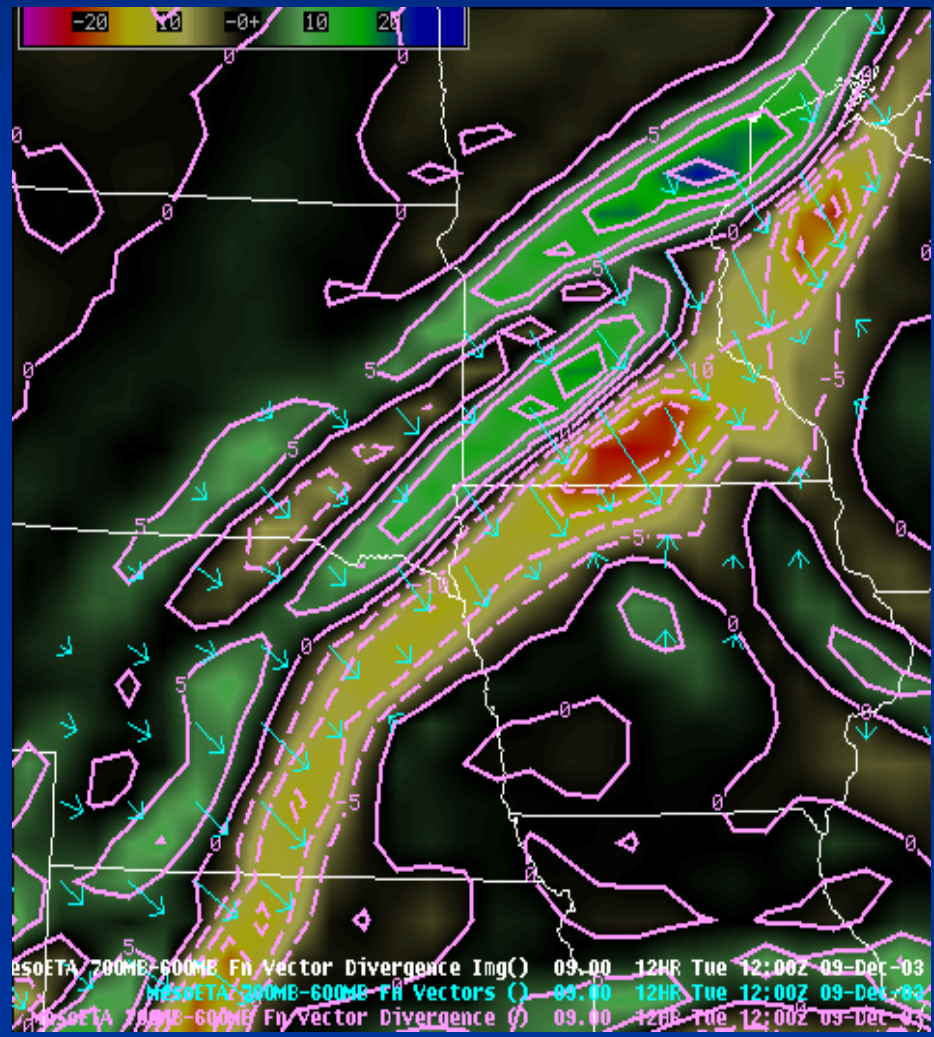
- Good vertical motion signal at -15C favors dendritic crystal growth.

How well did the MesoETA model do over the last four model runs of the Fn vector and divergence?

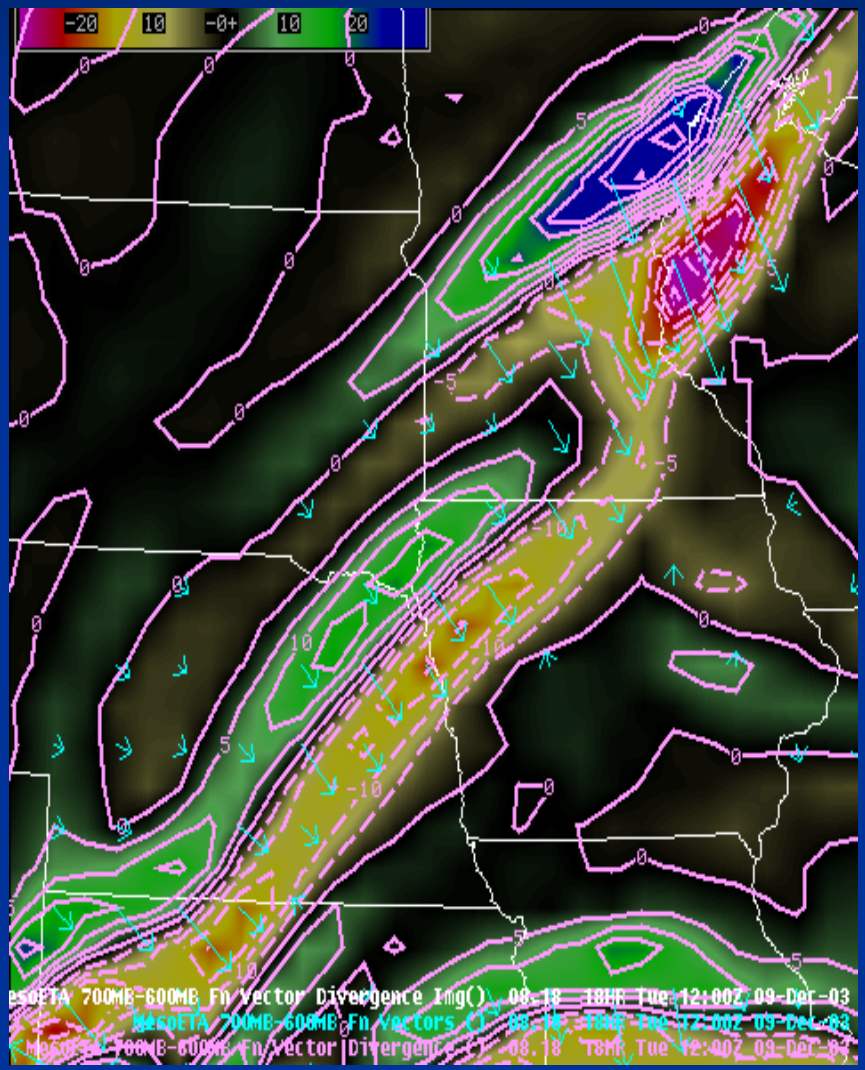
- Next two slides show the ETA dprog/dt 6 to 24 hour forecast of the 700-600mb layer Fn vector convergence at 12z December 9th over the snowfall band.
- Notice how the ETA forecasts the 700-600mb layer Fn vector convergence at the 6, 12, 18 and 24 hour time frame.

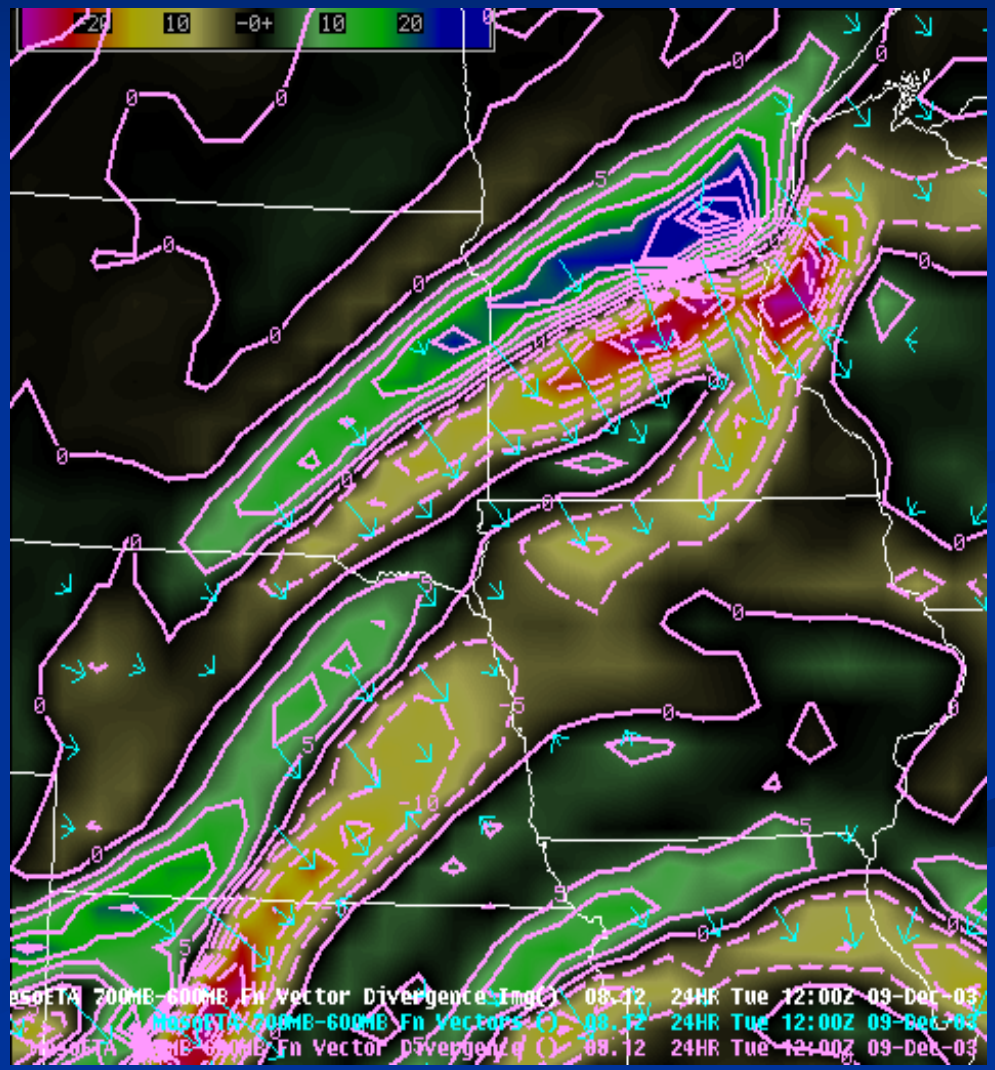
The ETA 6 and 12 hour forecast of Fn vector convergence at 12z Dec 9th





18 and 24 hour Forecast

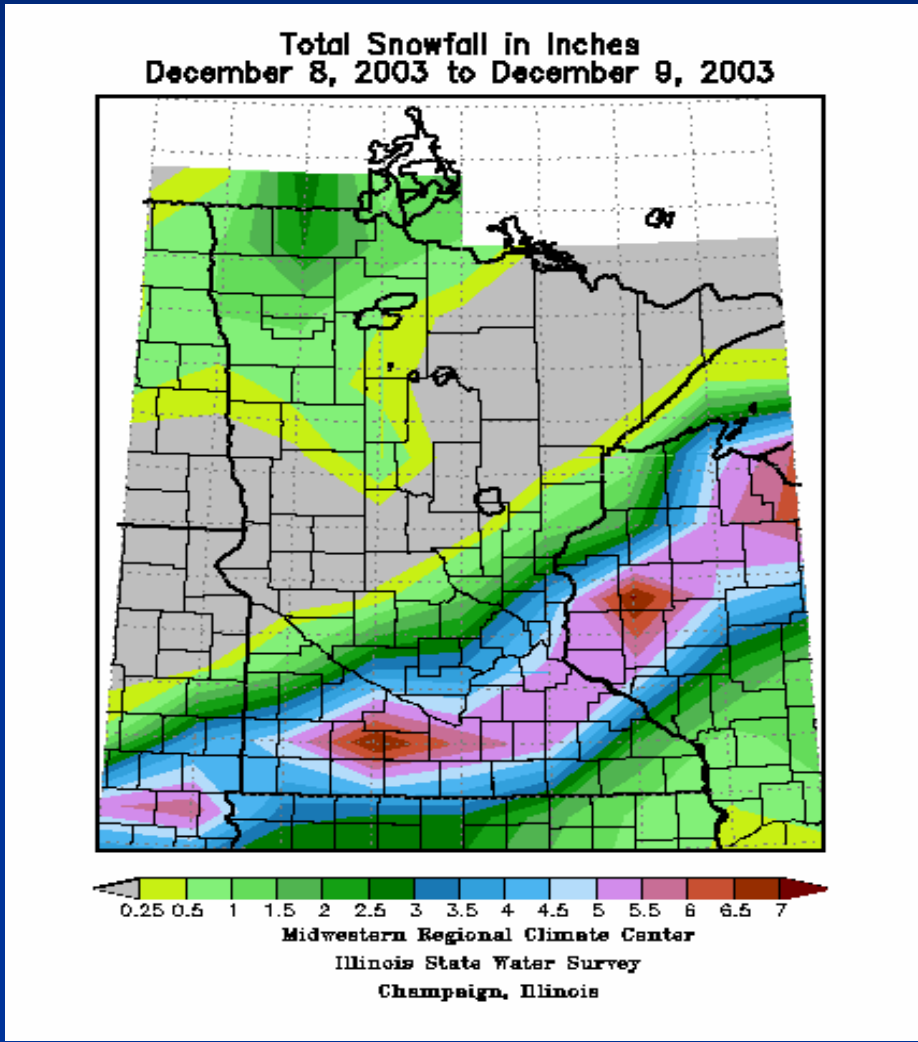




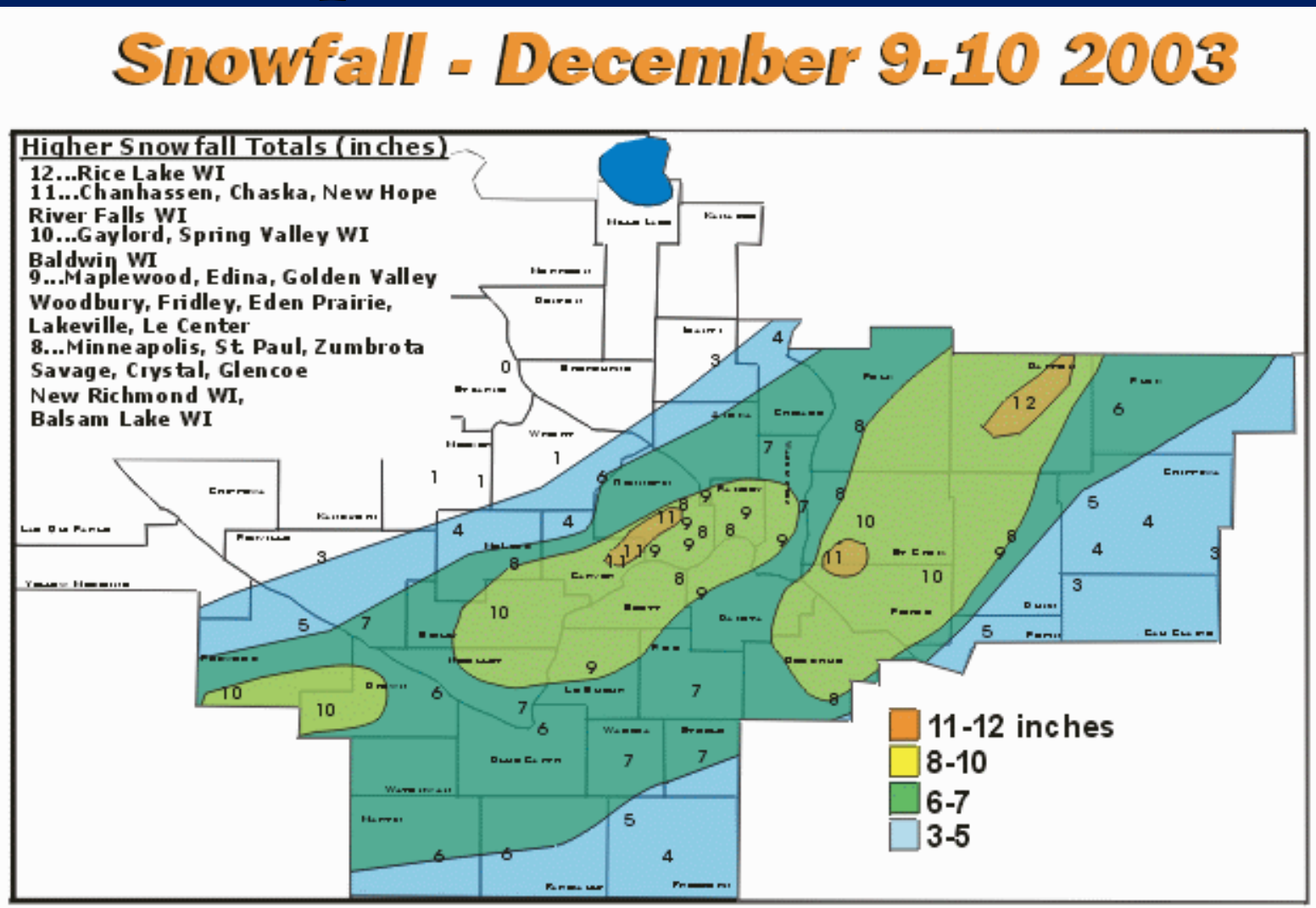
MesoETA 6 to 24 hour forecast

- The previous four model runs of the MesoETA showed consistency in forecasting the Fn vector convergence in relation to the snowfall band that occurred over southwest and central Minnesota.

Map of snowfall totals



Map of snowfall totals



Conclusion:

- Banded snowfall over southwest and central Minnesota coincided with the Fn vector convergence at the 700-600mb layer.
- Important note: Radar loop indicated snowfall parallel to isotherms and Fn vector convergence. This is a good indication of a prolonged snow event.
- Previous model runs of the ETA model run showed good Fn vector convergence at 700-600mb layer.