

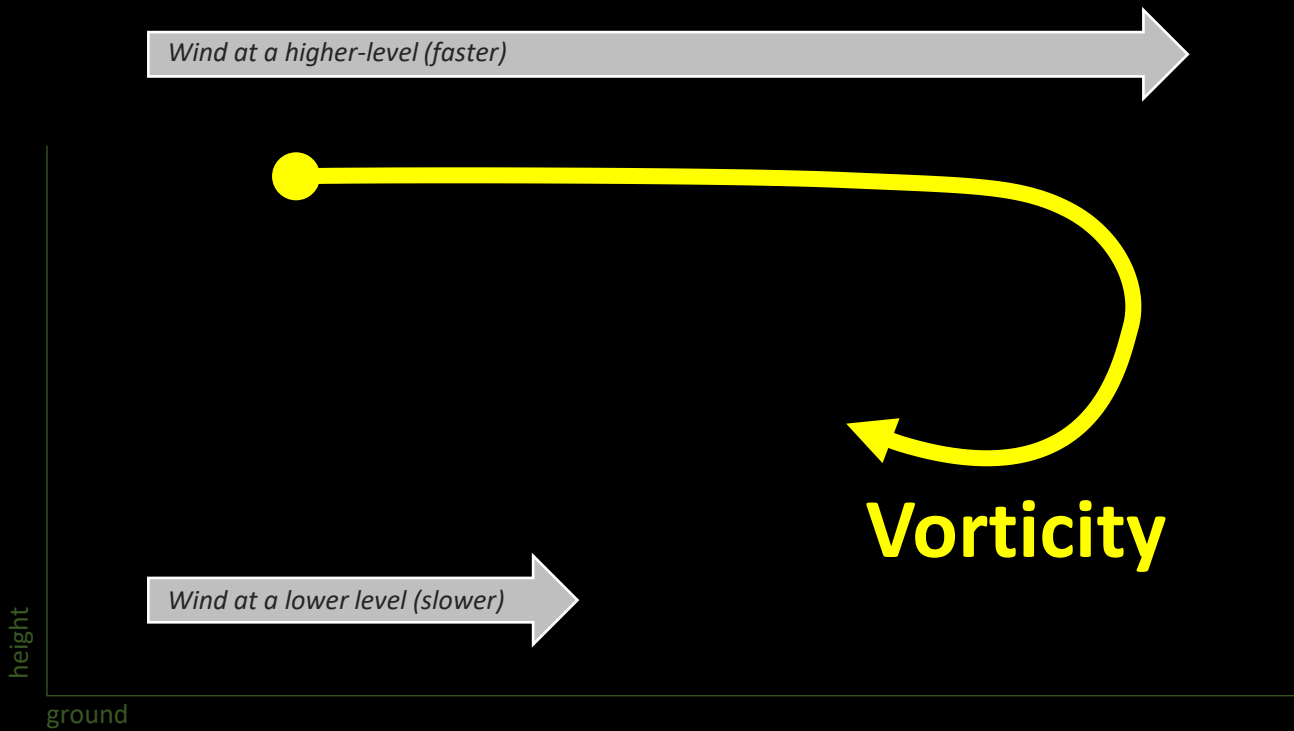
Surface Vorticity

It's formation and role in severe storm hazard formation & maintenance

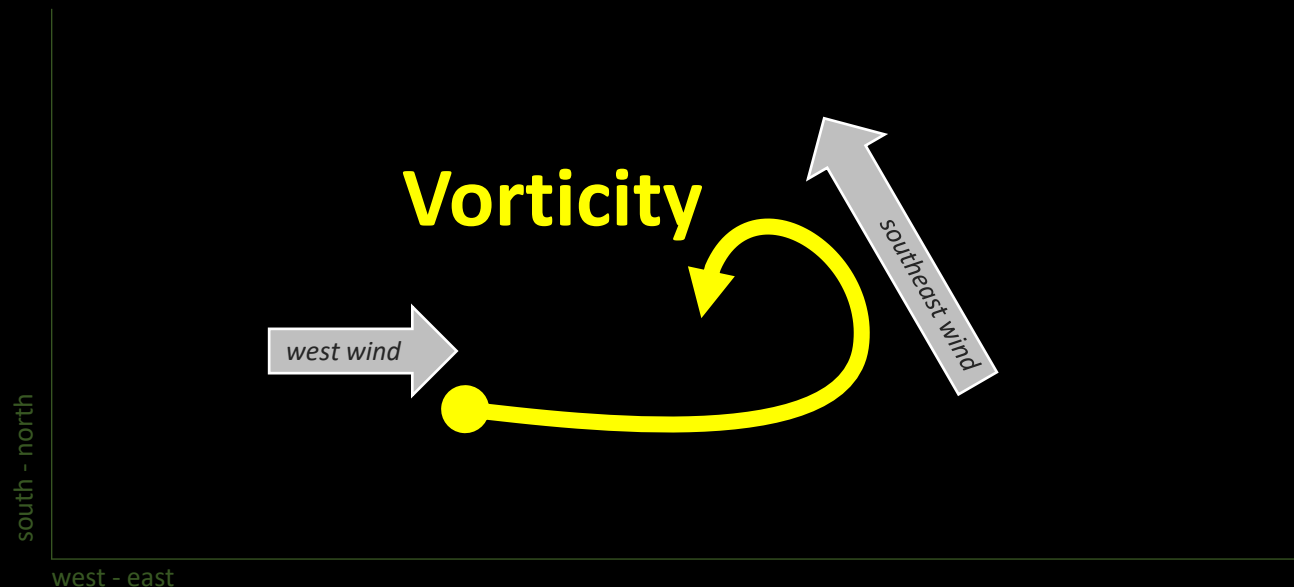


- I. Origins of vorticity**
- II. Sources of ambient surface vorticity**
- III. Storm-generated vorticity**
- IV. Role of surface vorticity**
- V. Forecasting Surface Vorticity**
- VI. Summary**

Origins of vorticity

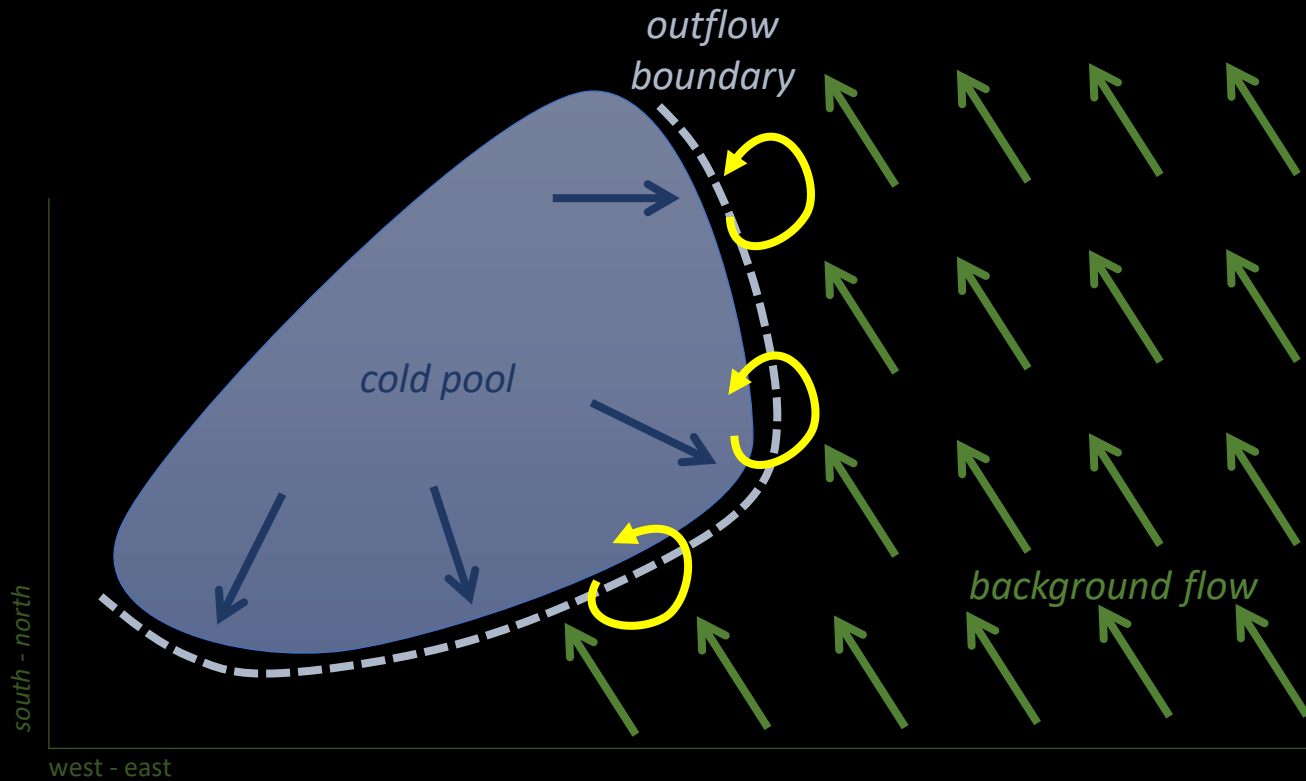


Vertical Wind Shear (differences in wind speed and/or direction at different levels) generates **horizontal** “tubes” or “sheets” of spinning air.

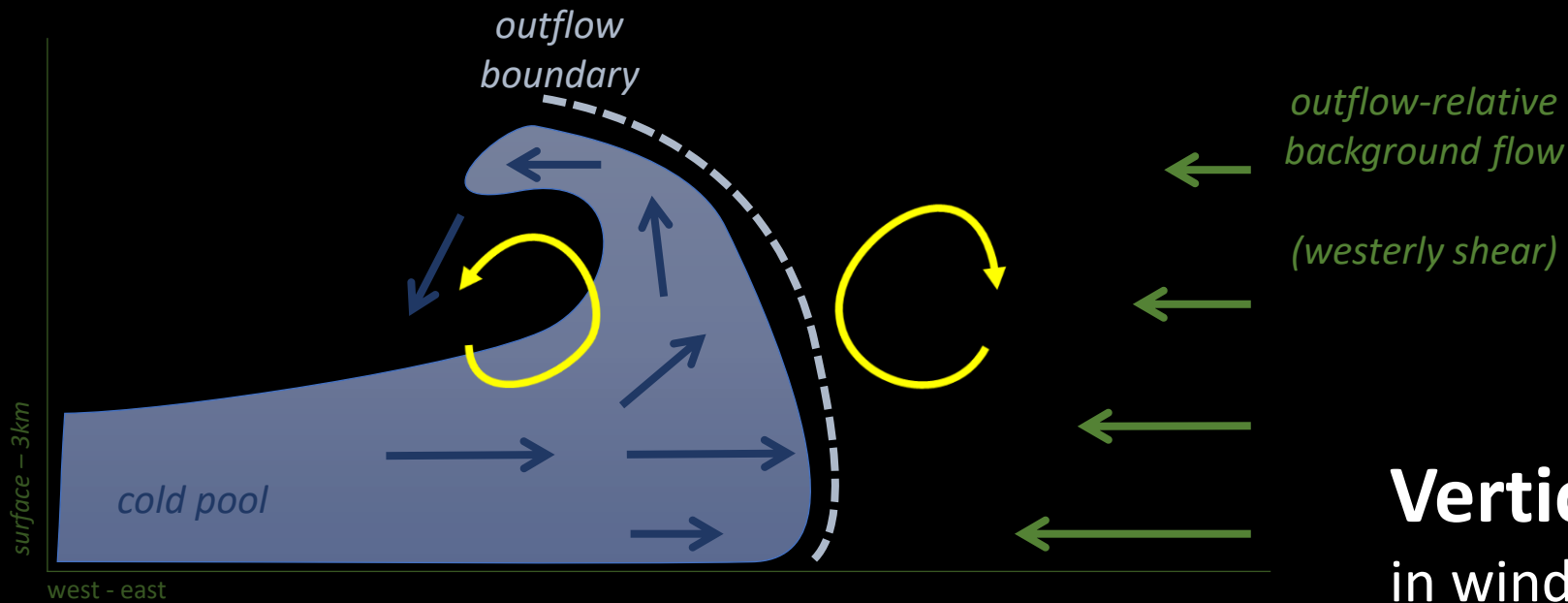


Horizontal Wind Shear (differences in wind speed and/or direction at the same level) generates **vertical** “tubes” or “sheets” of spinning air.

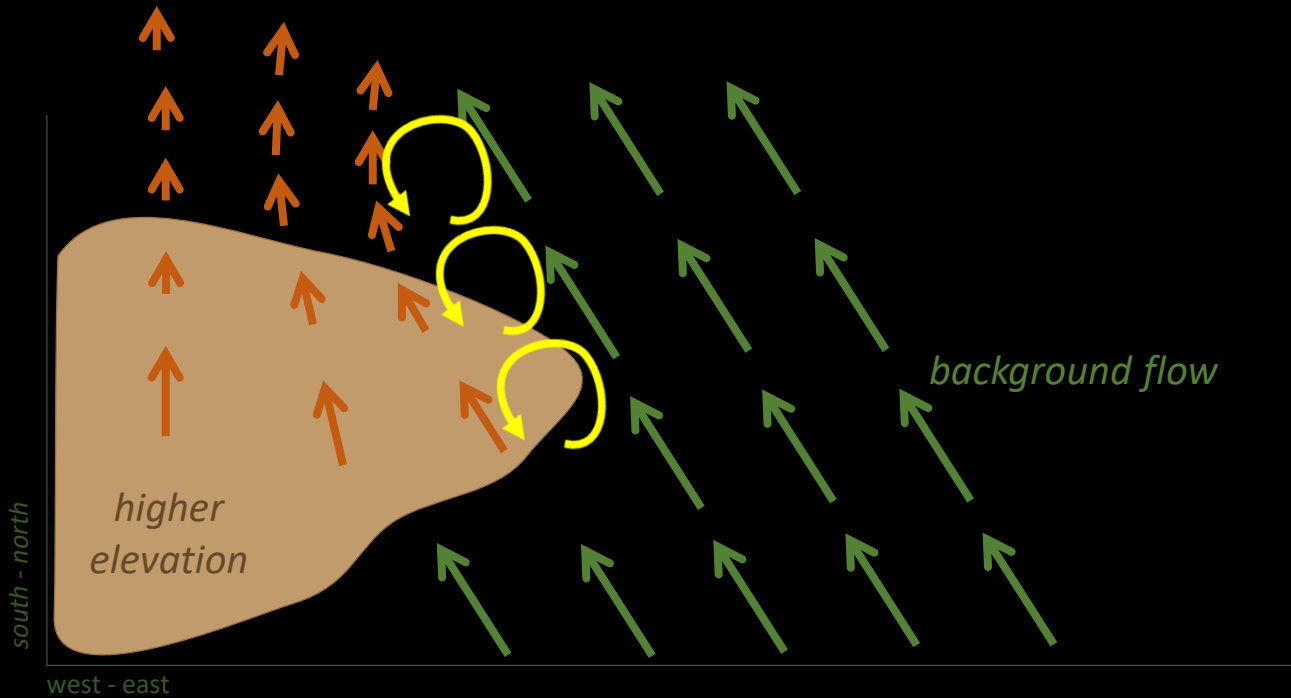
Sources of ambient surface vorticity



Horizontal Wind Shear
(differences in wind direction along boundaries) generates *horizontal shearing instability* which can lead to **vertical vorticity** along a boundary.

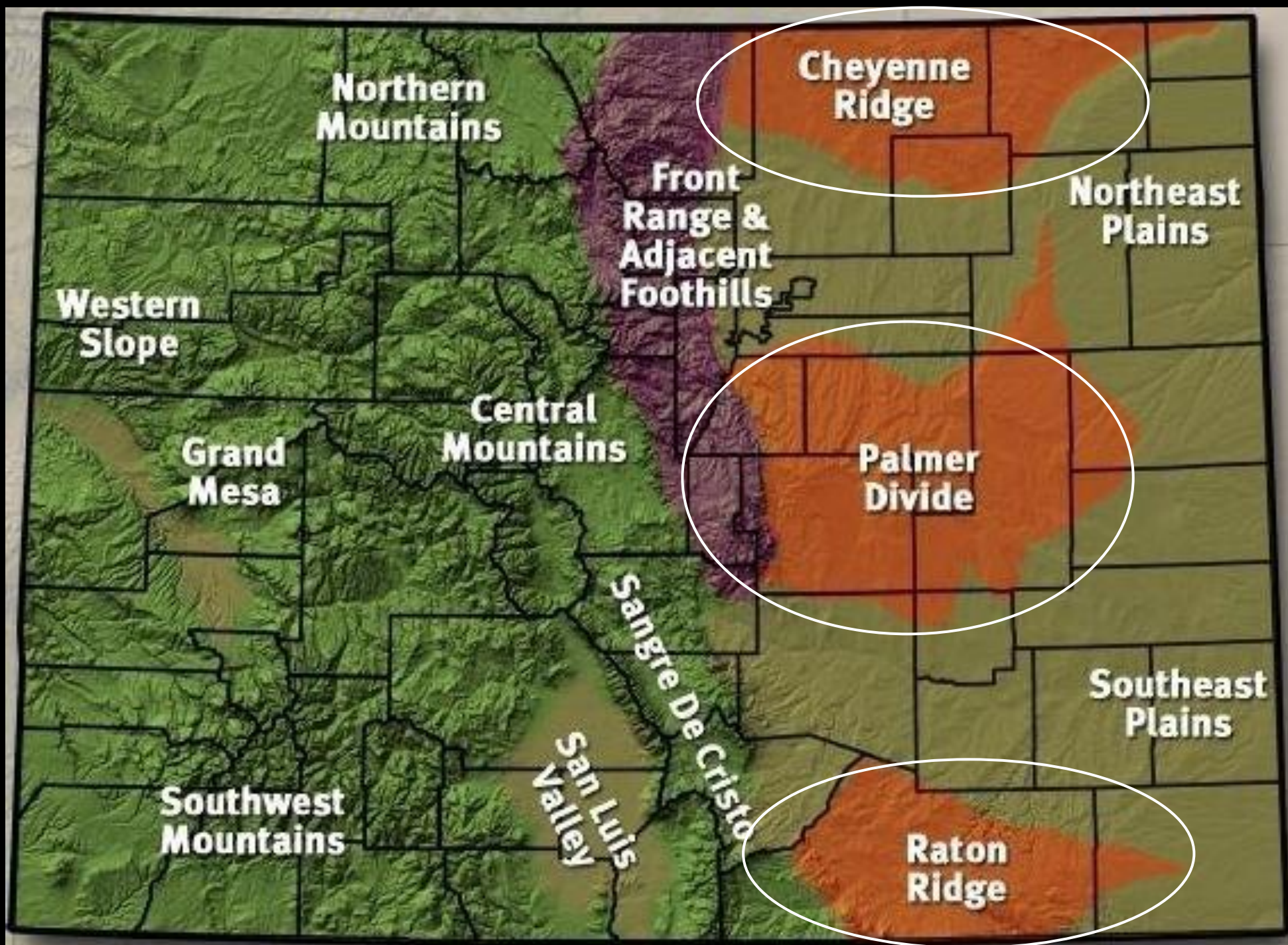


Vertical Wind Shear (differences in wind direction and/or speed along boundaries) generates **horizontal vorticity** along the leading edge of a boundary.

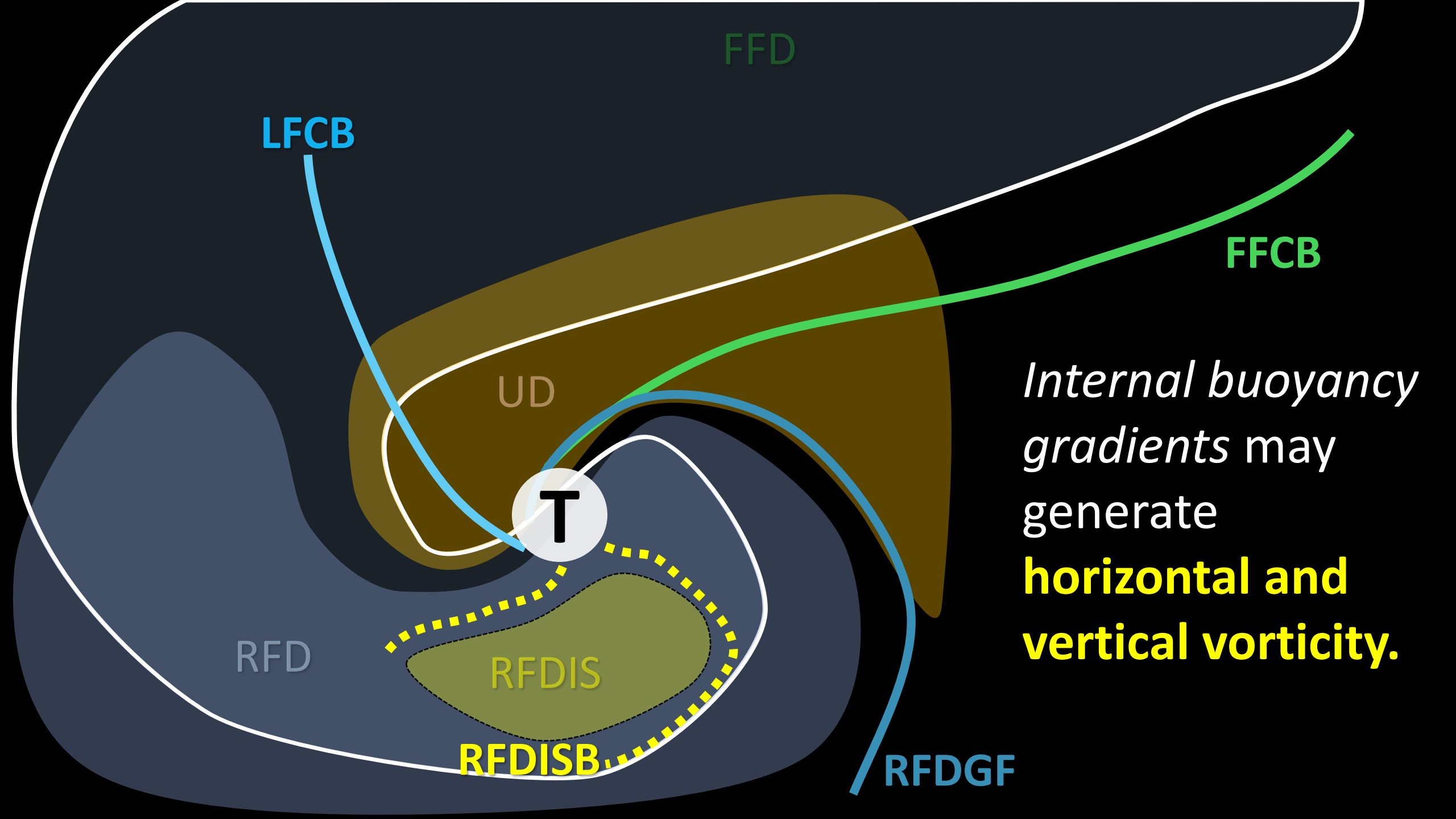


Example: The Palmer Divide of Colorado
(*Denver Convergence & Vorticity Zone*)

Terrain induced horizontal wind shear (differences in wind direction and/or speed due to elevation or frictional effects) generates **vertical vorticity** along and downwind of the terrain feature.



Storm-generated vorticity



FFD

LFCB

FFCB

UD

T

RFD

RFDIS

RFDISB

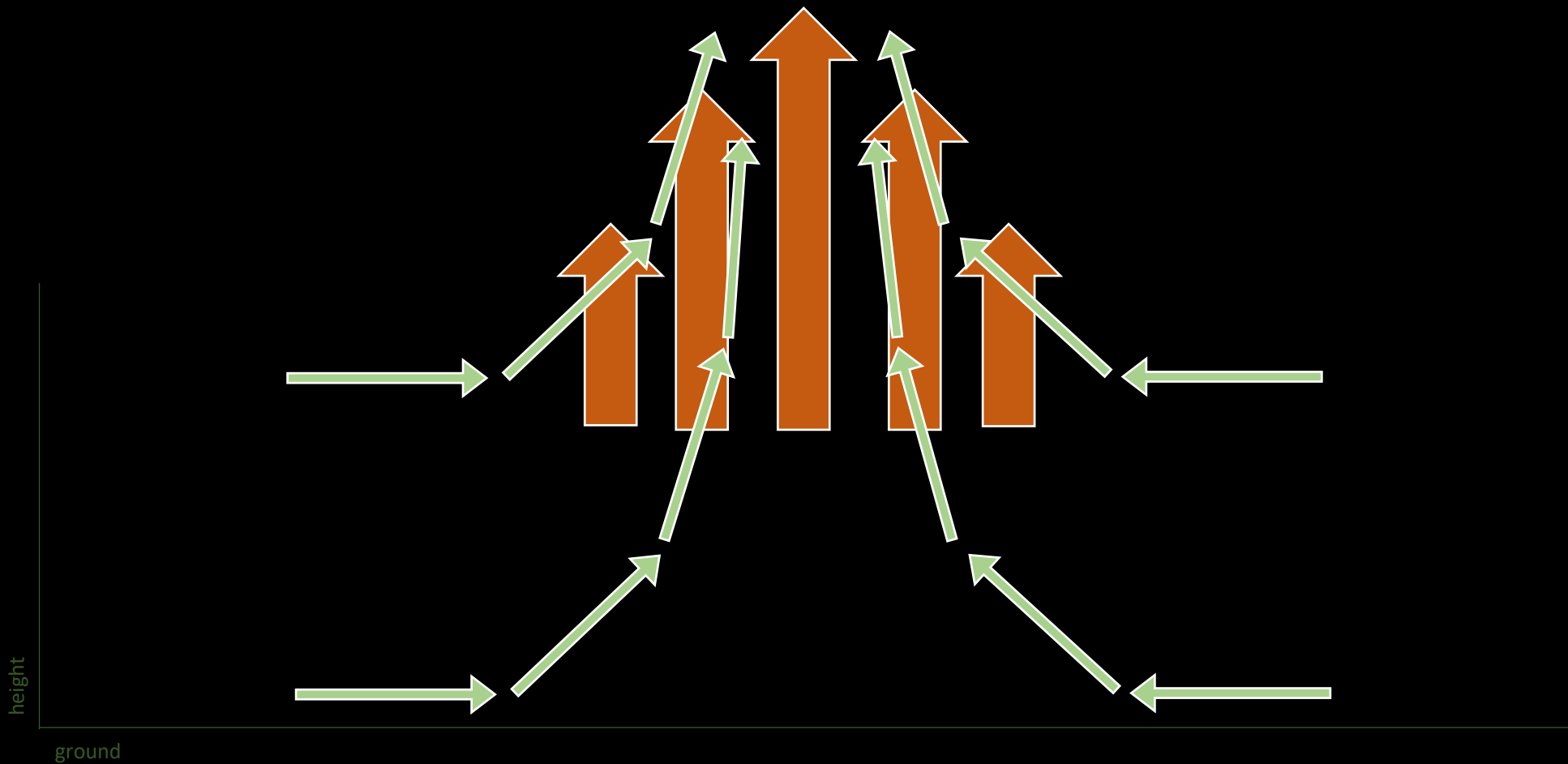
RFDGF

*Internal buoyancy
gradients may
generate
**horizontal and
vertical vorticity.***

The role of surface vorticity

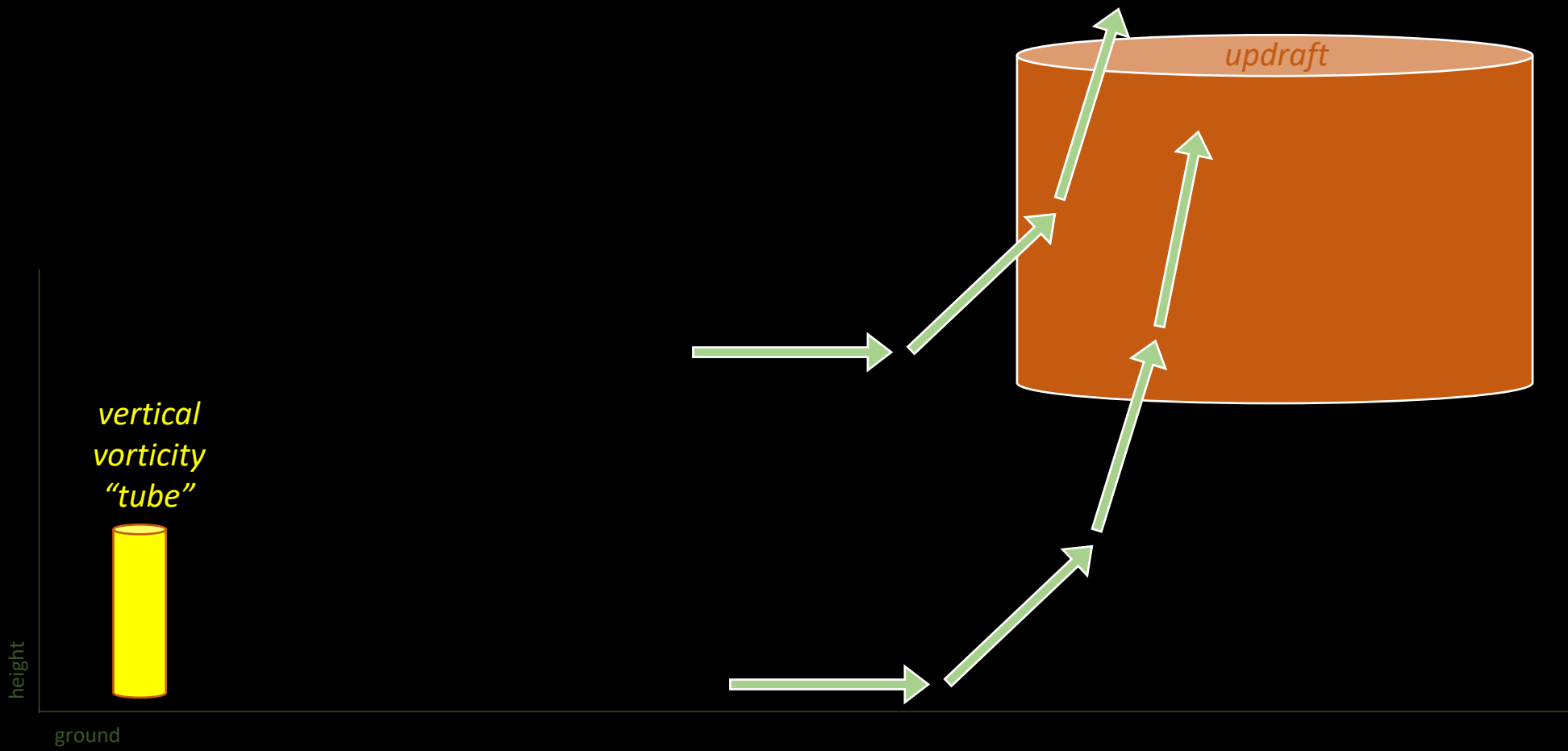
Ambient or storm-generated **vertical vorticity** near the ground can be important for near-ground rotation; and often is required for tornadogenesis (esp. for landspouts)

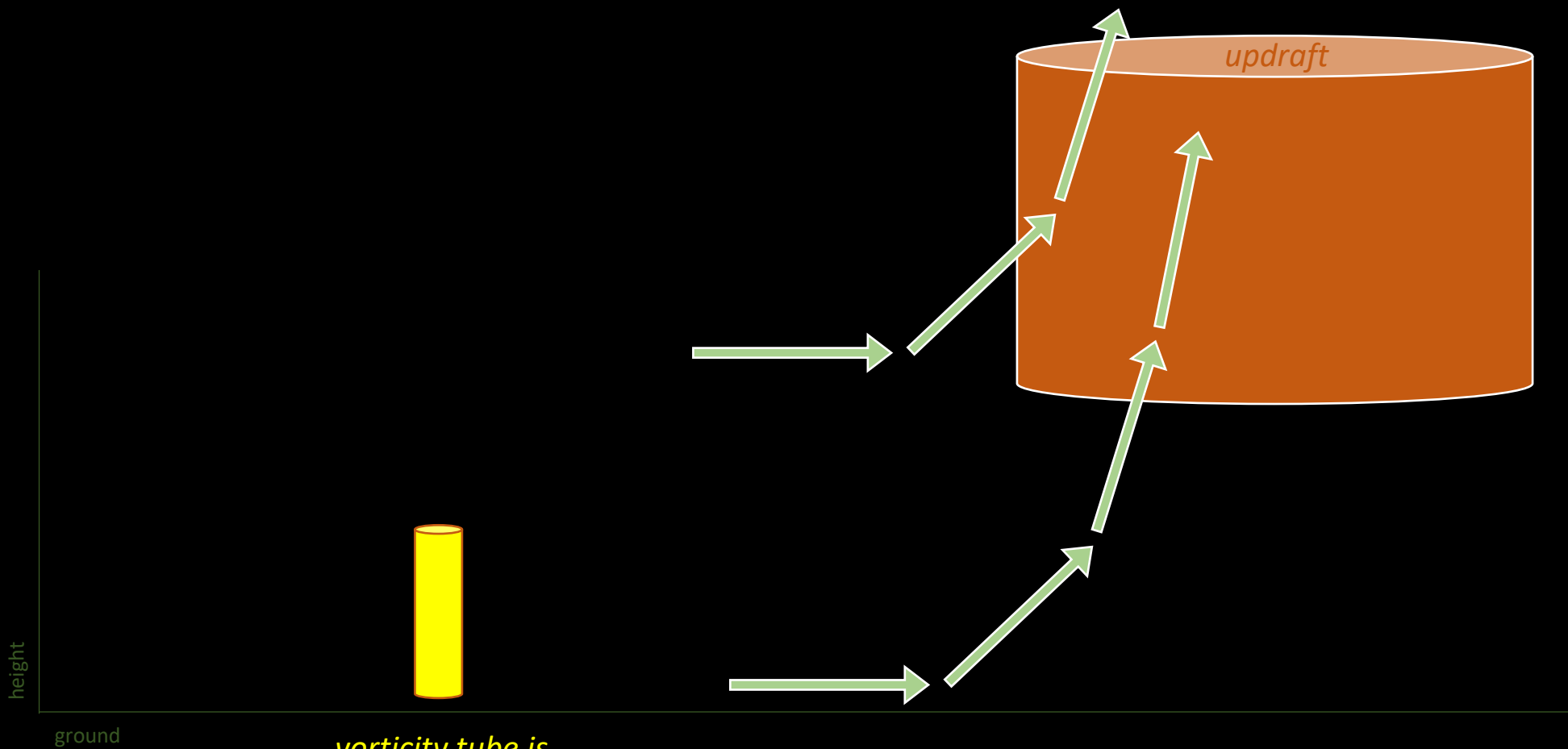
This is because vertical wind shear alone is (usually) not capable of generating rotation near the ground.



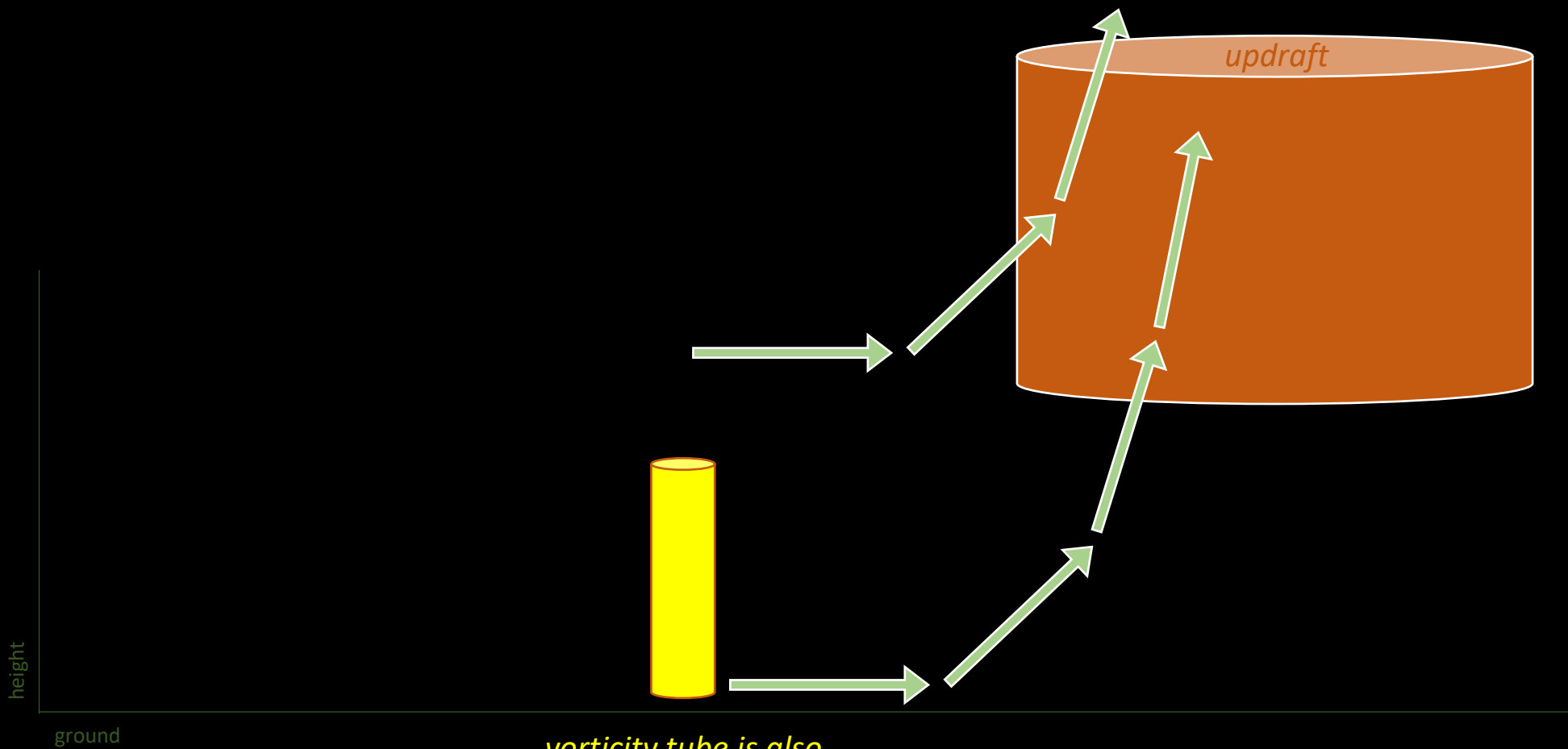
Because an updraft is accelerating air upwards, away from the ground, air around it must rush inward to fill the void.

This is *inflow*.

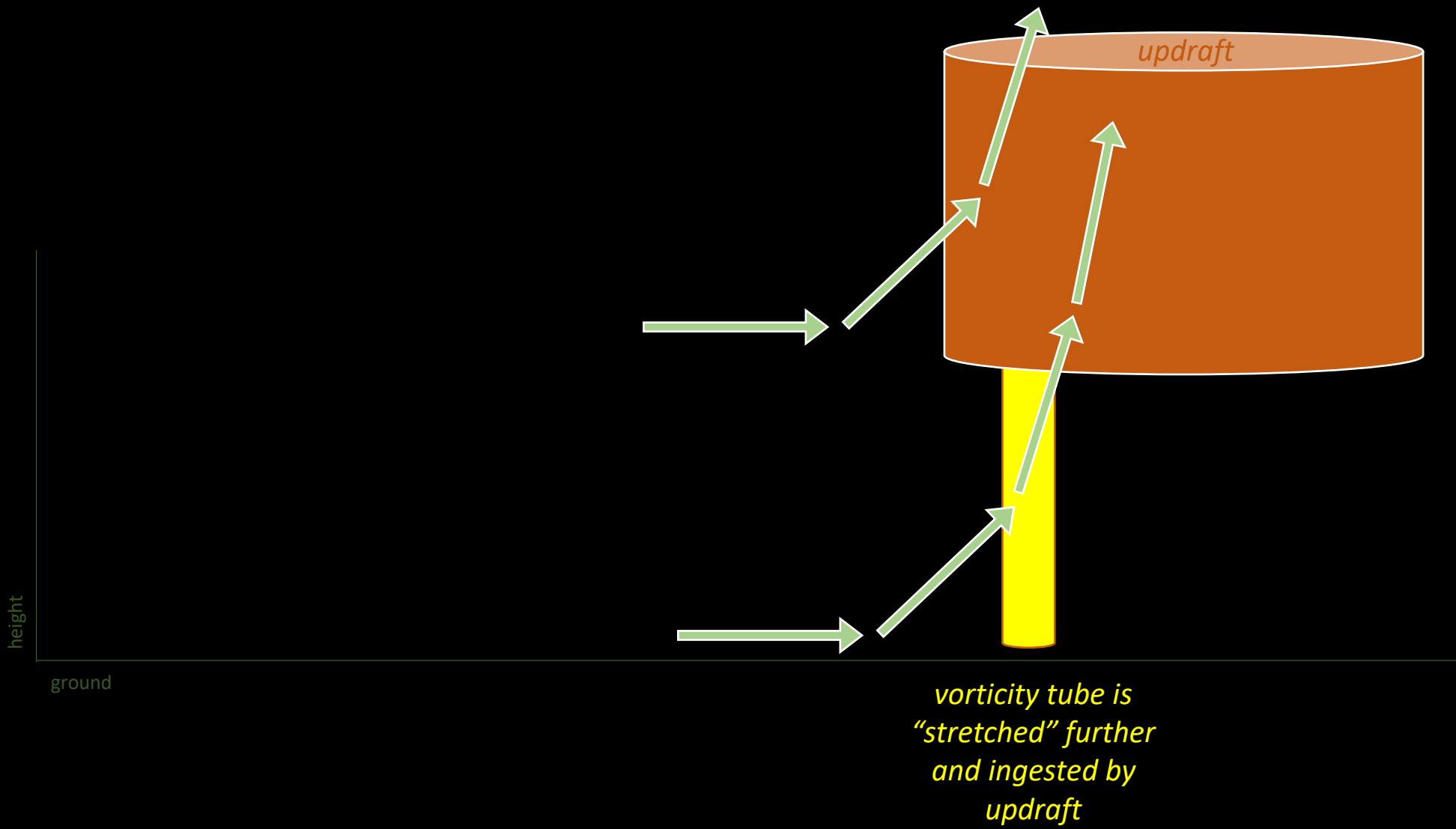




*vorticity tube is
advected toward
updraft by inflow*

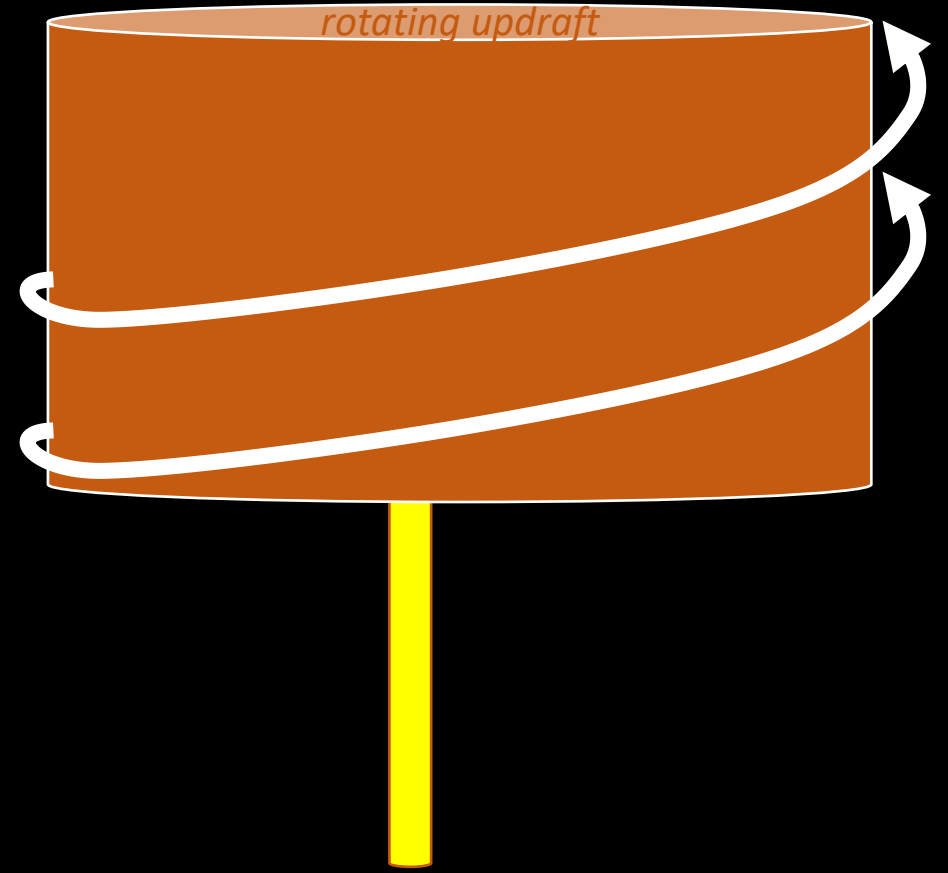


*vorticity tube is also
being "stretched",
thus the vorticity
strengthens*



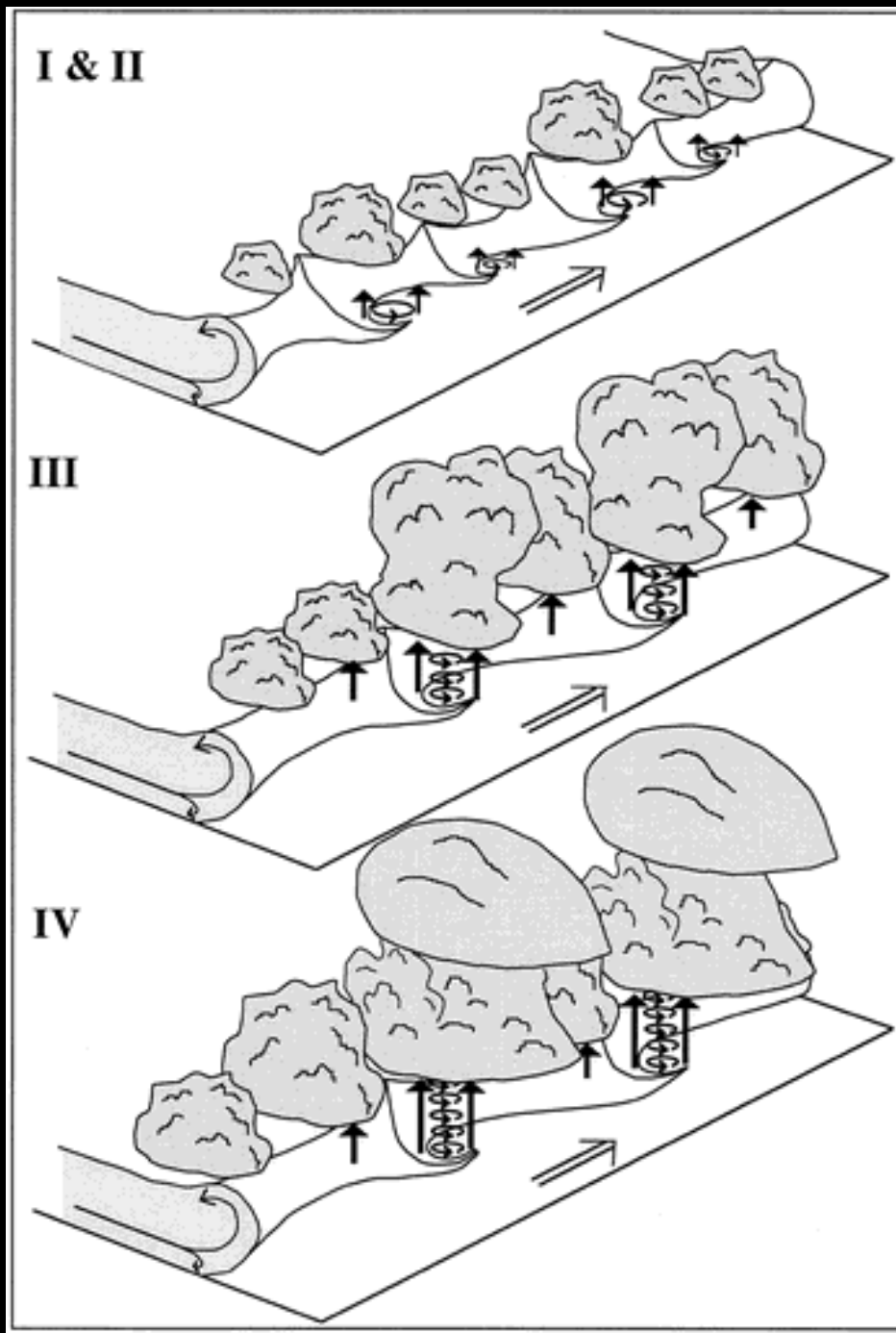
height

ground



*stretching continues,
updraft acquires rotation*

*If stretching is sufficient,
vortex may become
tornadic*



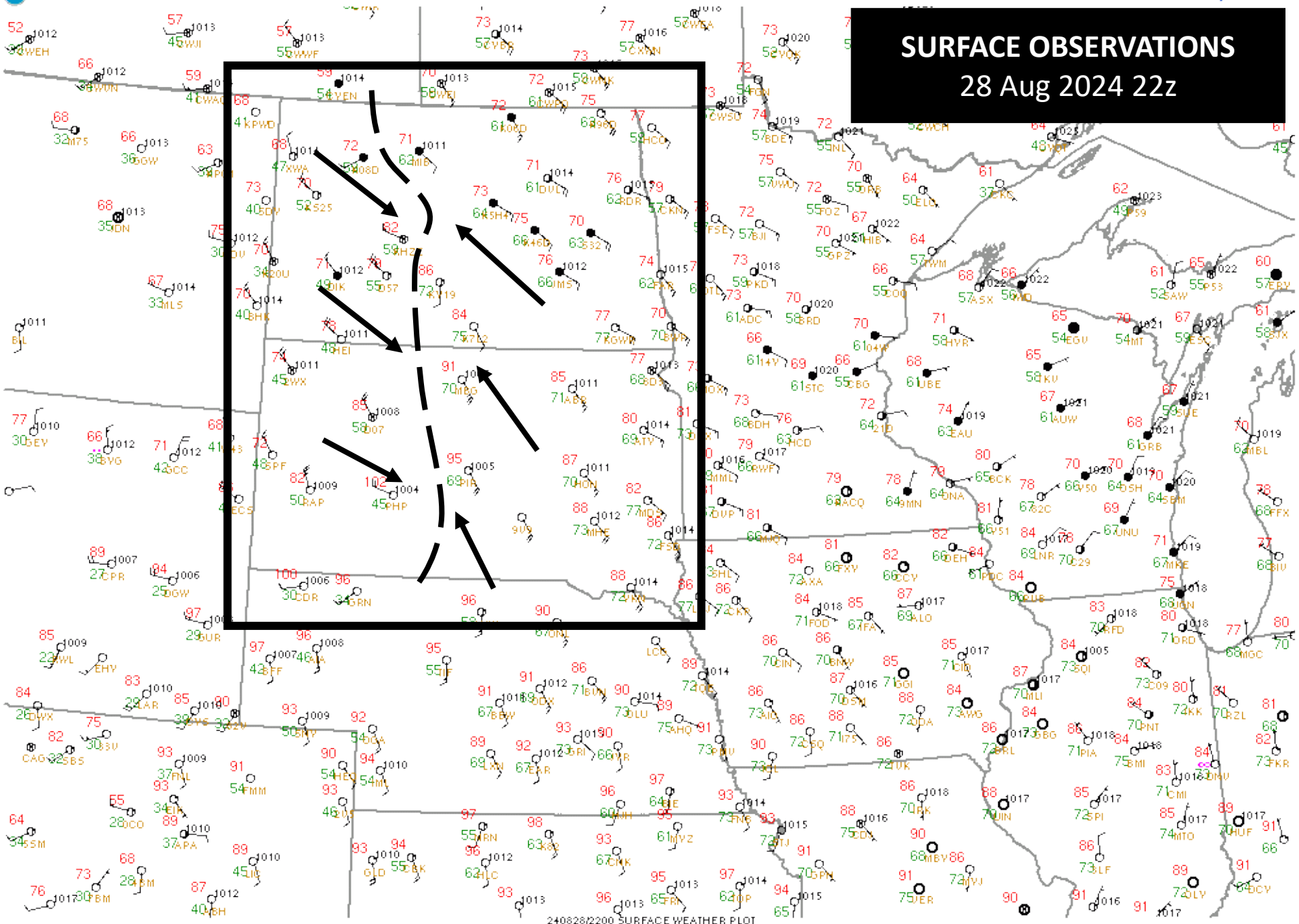
Ambient **vertical vorticity** can also have a role in *facilitating convection initiation*.

As vorticity increases, the nearby surface air is forced to converge near the vortex's center. If air converges near the ground, it must rise. As a vortex grows stronger, convergence and vertical motion (as well as the depth of the vertical motion) may increase.

(from Lee and Wilhelmson, 1997)

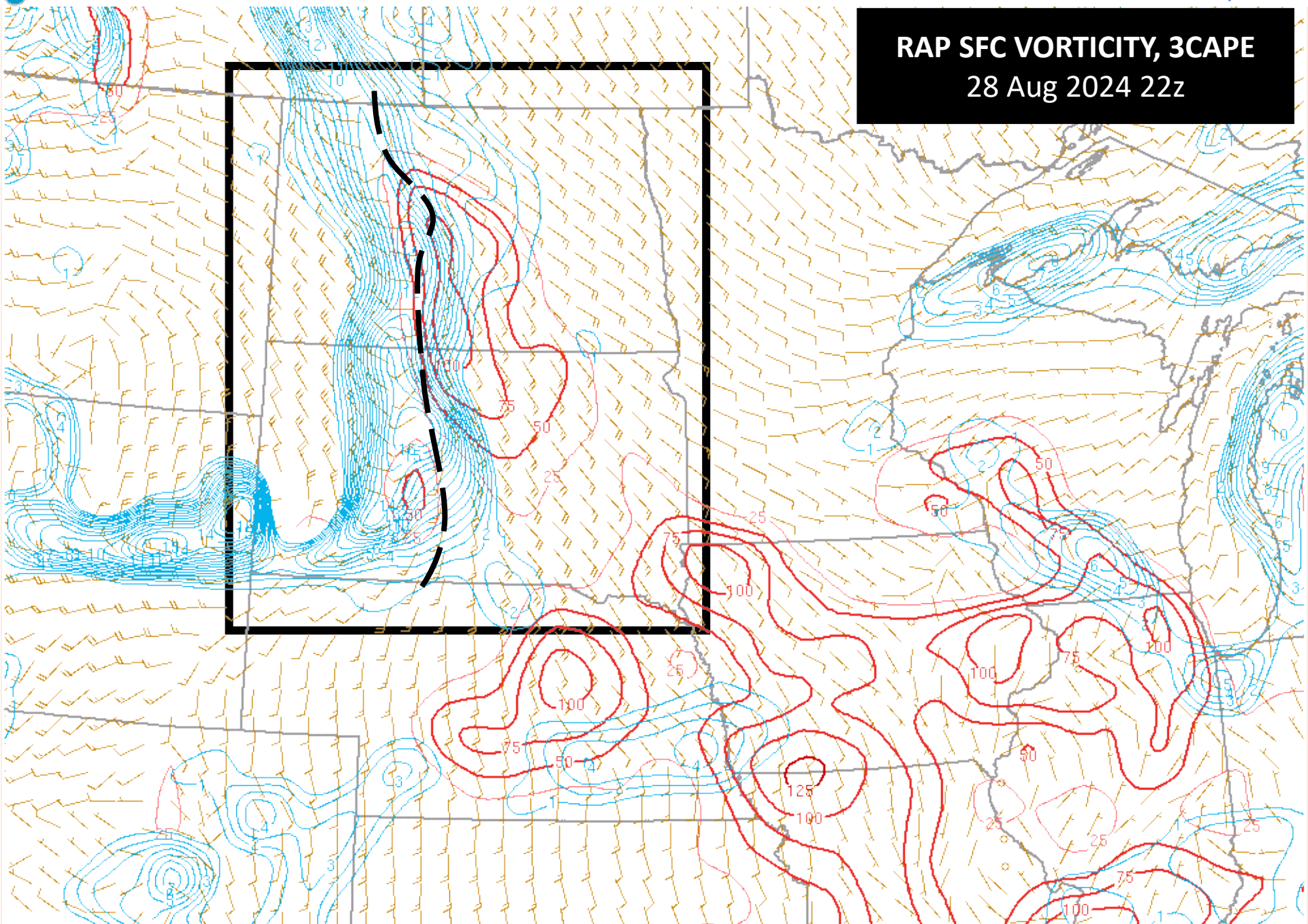
SURFACE OBSERVATIONS

28 Aug 2024 22z

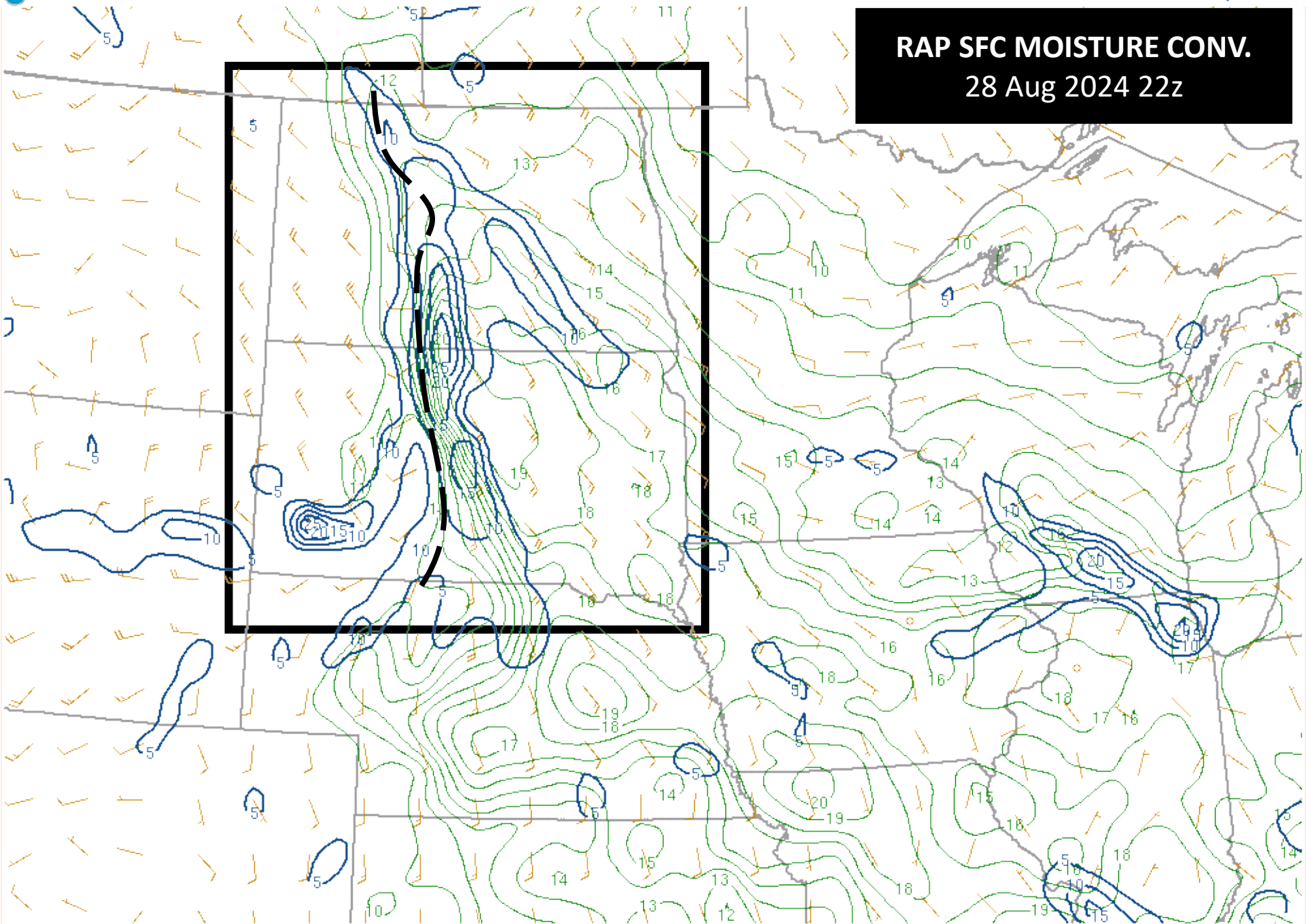


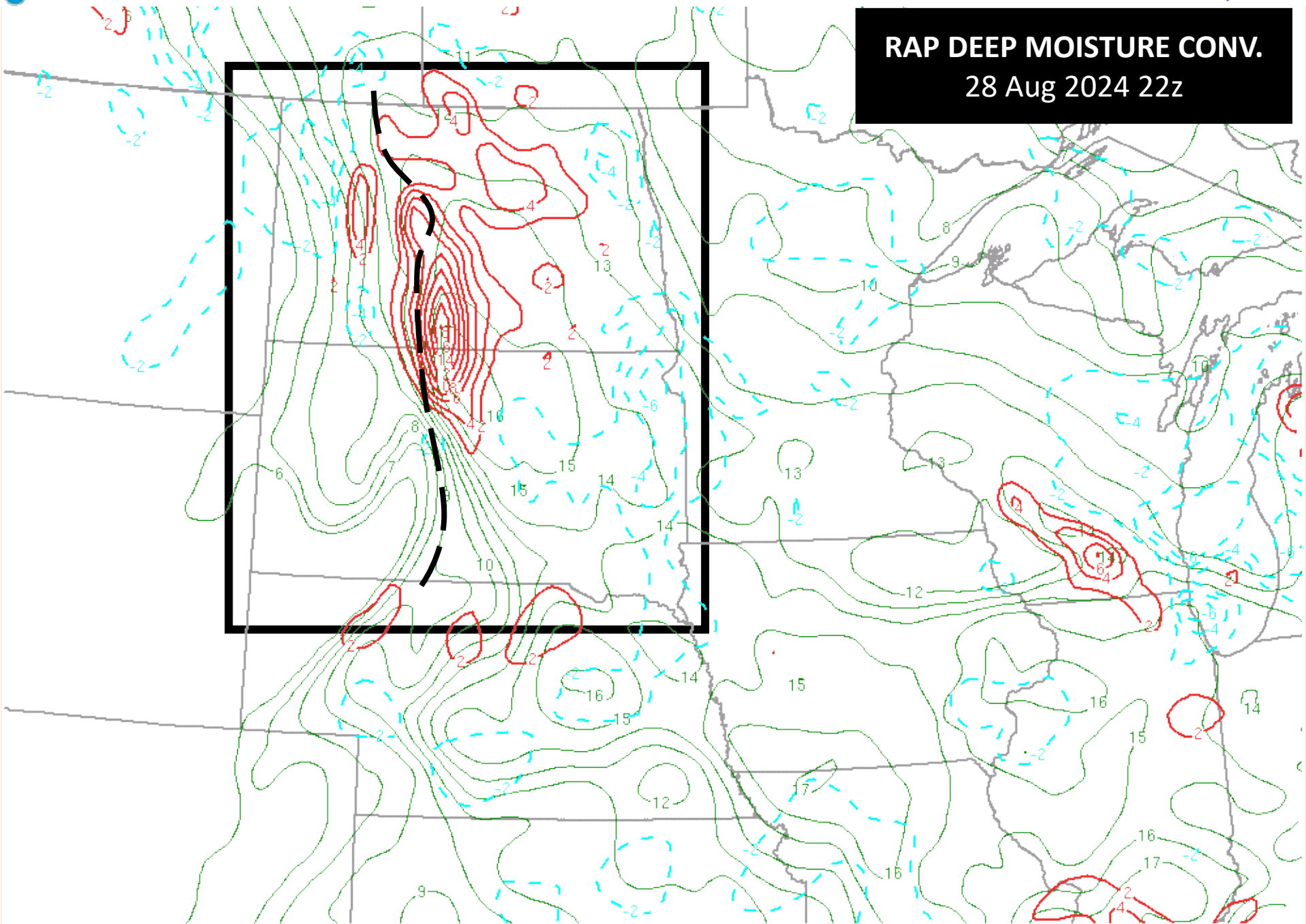
RAP SFC VORTICITY, 3CAPE

28 Aug 2024 22z



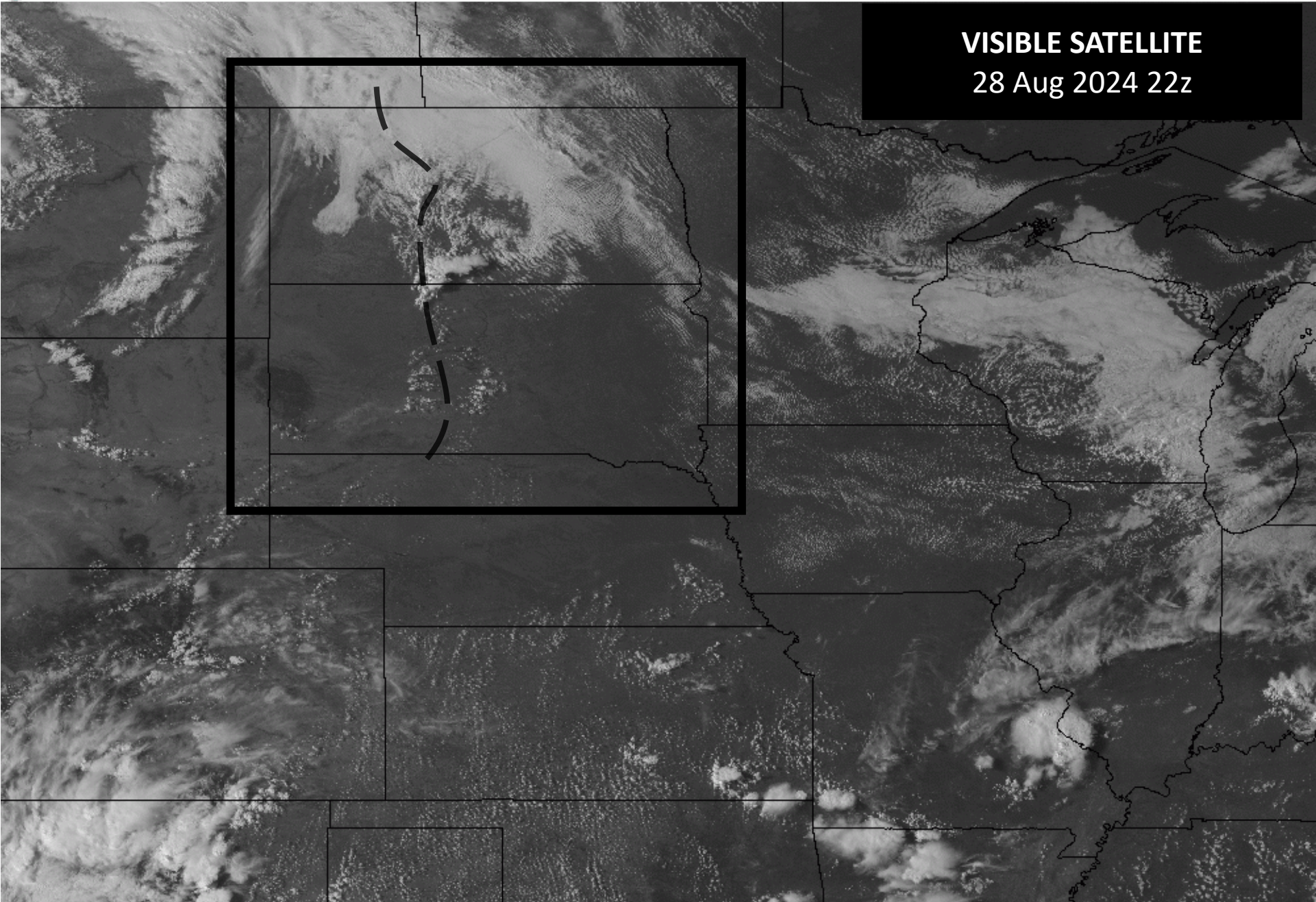
RAP SFC MOISTURE CONV. 28 Aug 2024 22z



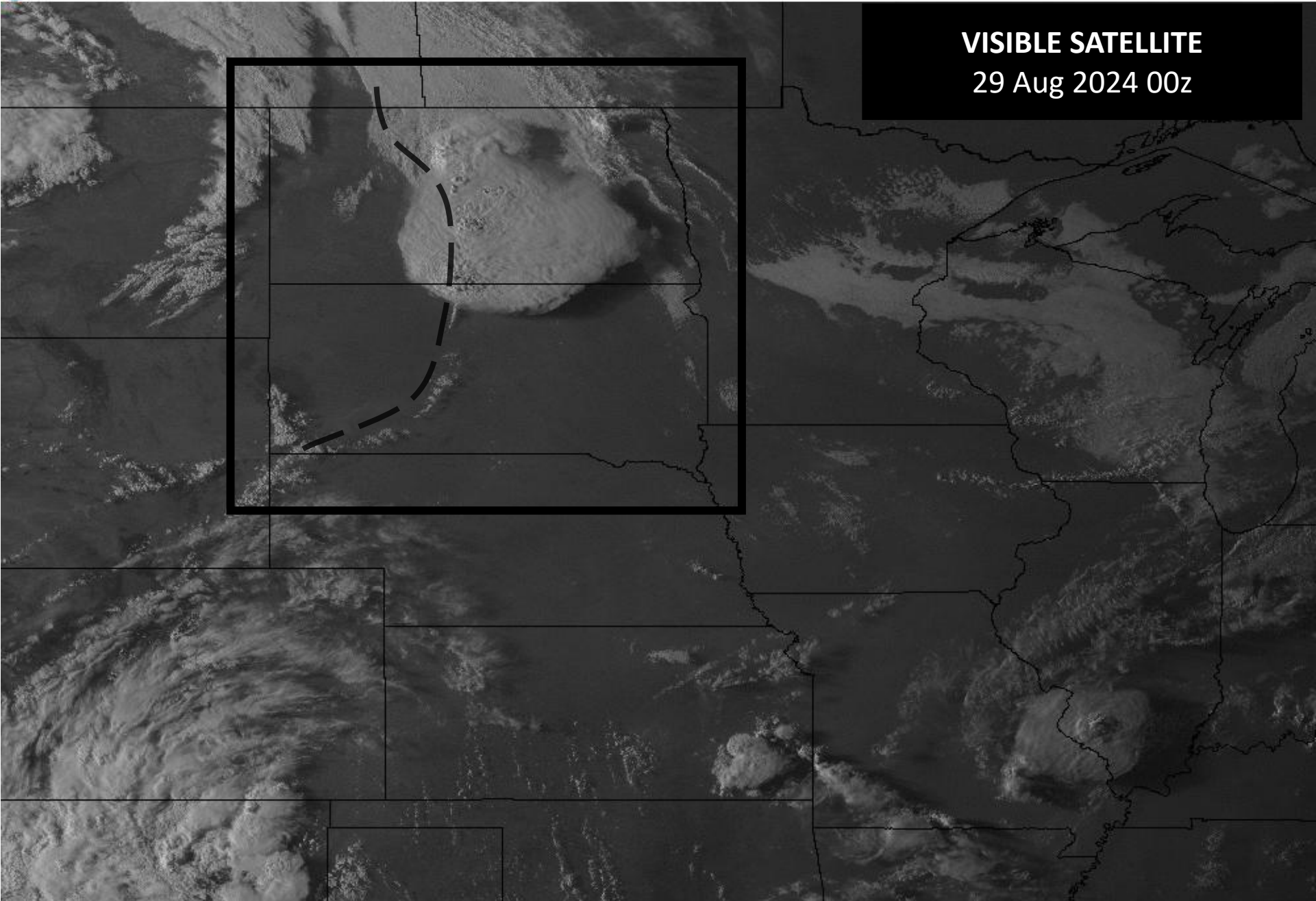
RAP DEEP MOISTURE CONV.
28 Aug 2024 22z

240828/2200 Deep layer mstr flux cvgnc and 100 mb mean mixing ratio

VISIBLE SATELLITE
28 Aug 2024 22z

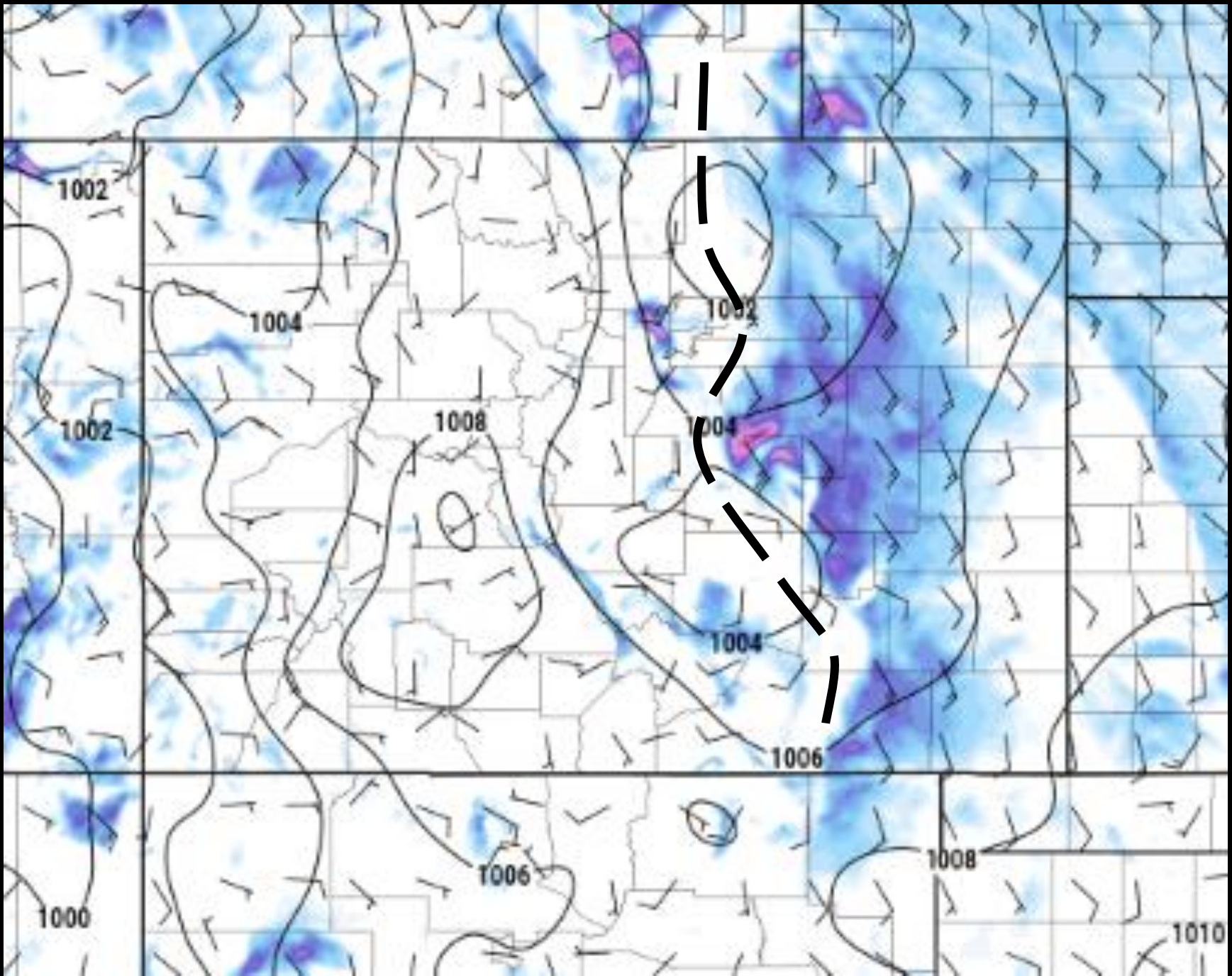


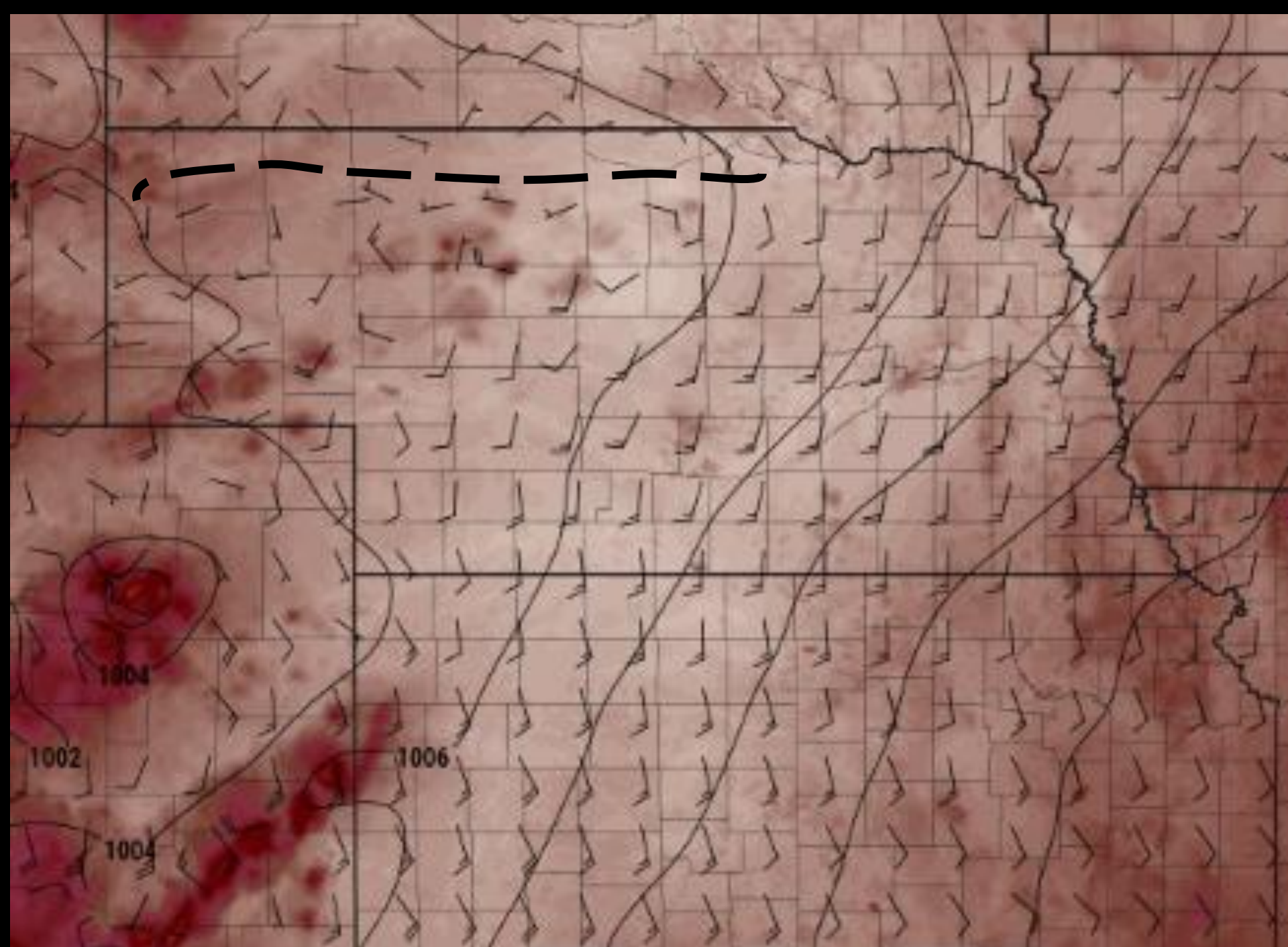
VISIBLE SATELLITE
29 Aug 2024 00z





Forecasting Surface Vorticity





Summary

Surface Vorticity may be generated...

1. Along the leading edge of fronts and boundaries

- *E.g., cold fronts, drylines, outflows, lake/sea breezes, differential heating boundaries*

2. Near terrain gradients

- *E.g., the Palmer Divide and Raton Mesa of Colorado, the Llano Estacado and Caprock of west Texas, the Missouri Plateau and Coteau des Prairies of the Dakotas/Minnesota, the Cheyenne Ridge of Colorado/Wyoming*

3. Along internal storm boundaries

- *E.g., through both baroclinic and barotropic processes along the FFCB, LFCB, RFGF and other internal momentum boundaries*

To forecast **Surface Vorticity**...

1. Look for boundaries

- *with wind shifts!*

2. Look for wind speed gradients along terrain features

- *slower flow west of stronger flow along or downstream of terrain gradients*

3. Forecast the development and movement of outflow boundaries

- *satellite and radar are best for this*

So.... is **Surface Vorticity** a cheat code?

While it is important in the facilitation of near-ground rotation (a requirement of tornadogenesis) ***you still need a storm that is capable of using it!***

Storm behavior is *not* a function of surface vorticity. If other components of the set up *do not favor the right storm mode*, then a storm may be *unable to sufficiently utilize* all aspects of it's nearby environment, including surface vorticity.

Questions?

