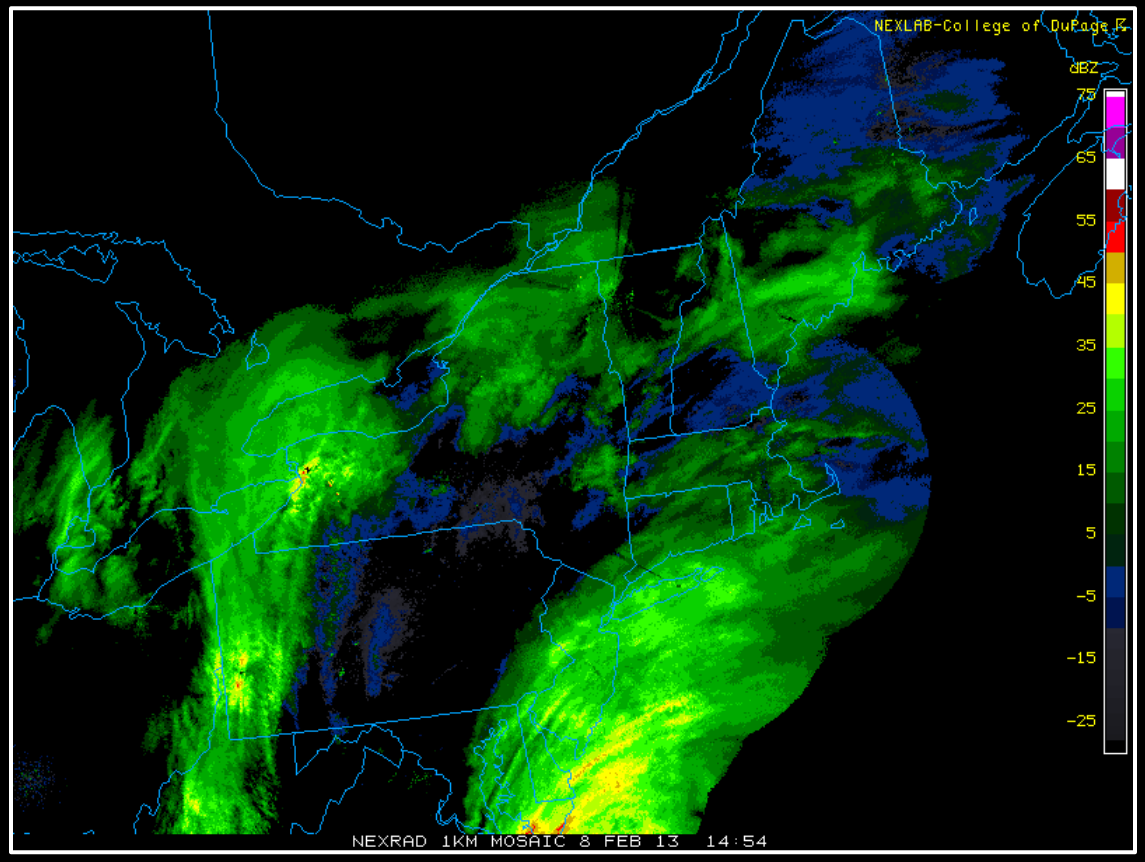
The Motion of Mesoscale Snowbands in Northeast U.S. Winter Storms



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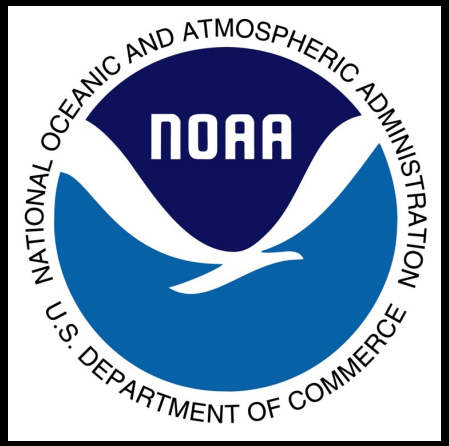
University at Albany

NWS Albany

Why this paper?

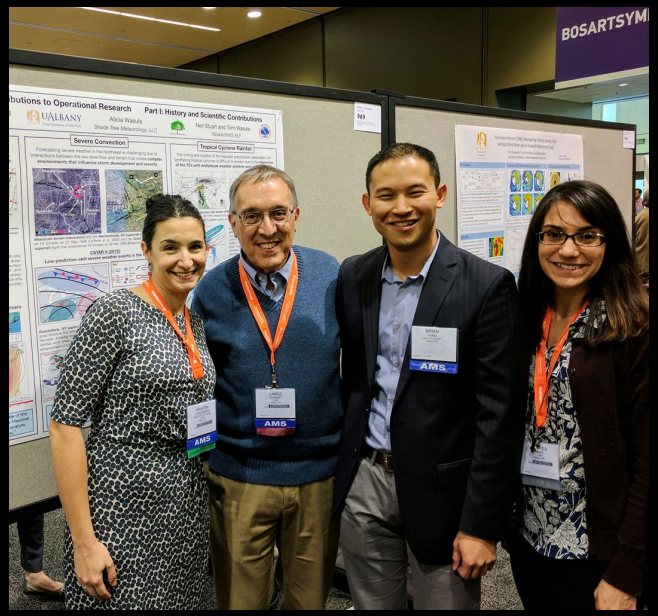
~ Part of the UAlbany/NWS Albany *Collaborative Science, Technology, and Applied Research (CSTAR)* Program

~ Grants funded by *NOAA* to *engage university* faculty and students in *applied research* of *interest* to operational *forecasters*



~ *Improve forecasts* by *applying scientific knowledge* to *operational products* and services

UAlbany–NWS Albany CSTAR Program



Why this paper?

FXUS61 KALY 112141
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
441 PM EST Fri Mar 11 2022

.NEAR TERM /THROUGH SATURDAY NIGHT/...
The question is where does a mesoscale snow band set-up with 1-2"/hr snow rates. The latest 12Z HREFS favors the Capital Region/northern Catskills/southern VT north and east in the late morning into the early evening. The latest NAM/HRRR would be from the Capital Region/southern VT and the eastern Catskills south and east. **Based on past CSTAR research, a dual jet structure within the northwest quadrant of the cyclone with strong 2D FGEN in the 850-700 hPa/700-500 hPA layers with some -EPV may support a "Pivoting band" of heavy snow.** The strong ascent from the band should tap into the favorable dendritic growth zone in some areas. We did increase snow amounts from the Capital Region south and east due to a more rapid cool down Saturday morning. This potential mesoscale snow band will impact the area late Saturday morning into the early/mid afternoon. The cyclone will pass south of the region from the Delmarva to near Cape Cod by 18Z/SAT based on the 12Z NAM/GFS. The EC/CMC are a little faster and northeast into the Gulf of Maine. We could be looking for a 6-9 hour period from 7 am to 4 pm Saturday with moderate to heavy snow. Some rain could curtail totals in the valley areas, and this forecast would unravel. Also, getting the snow to liquid ratios right is challenging. Going from low ones to average or higher ones.

NEAR TERM...Wasula

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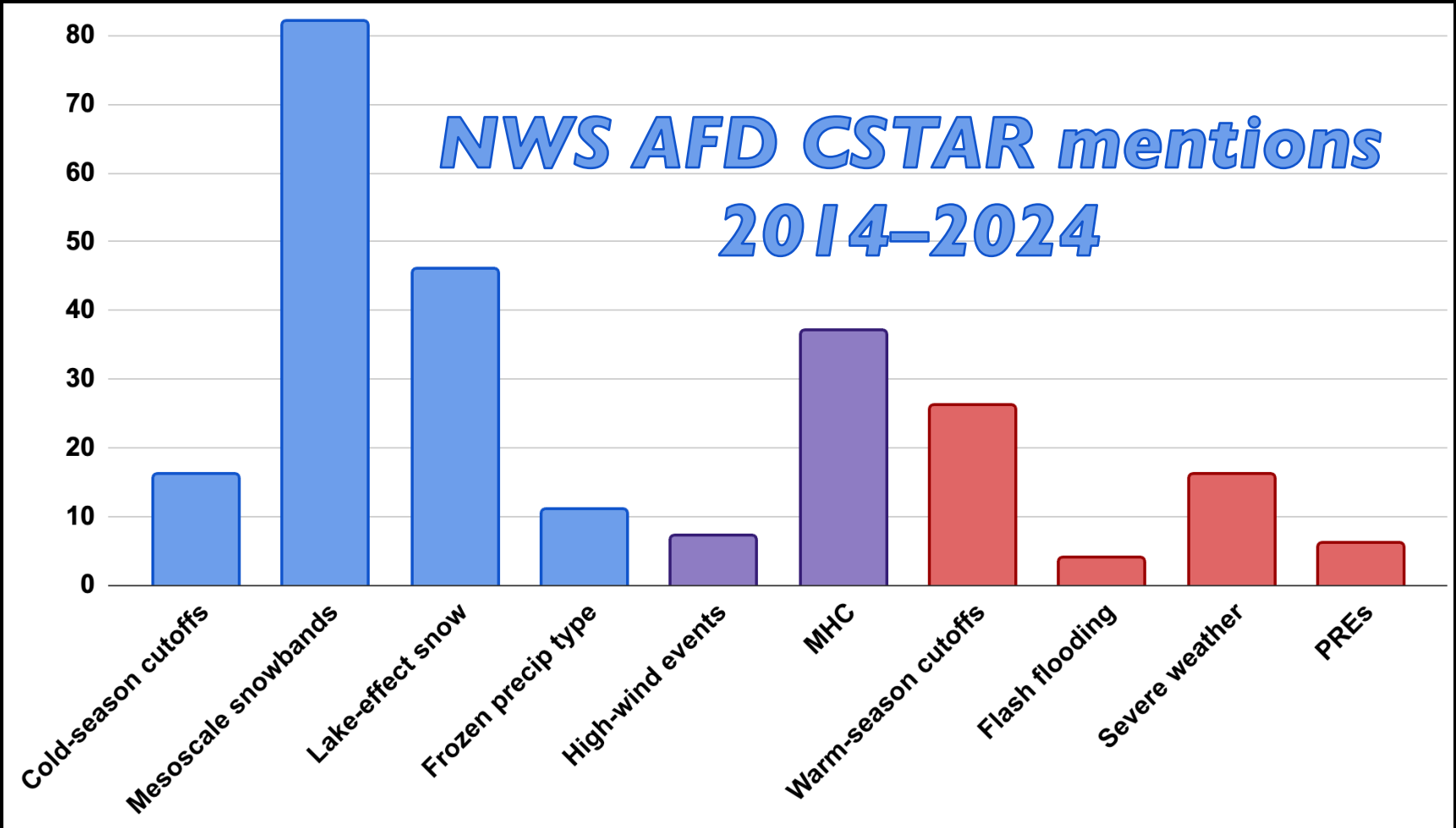

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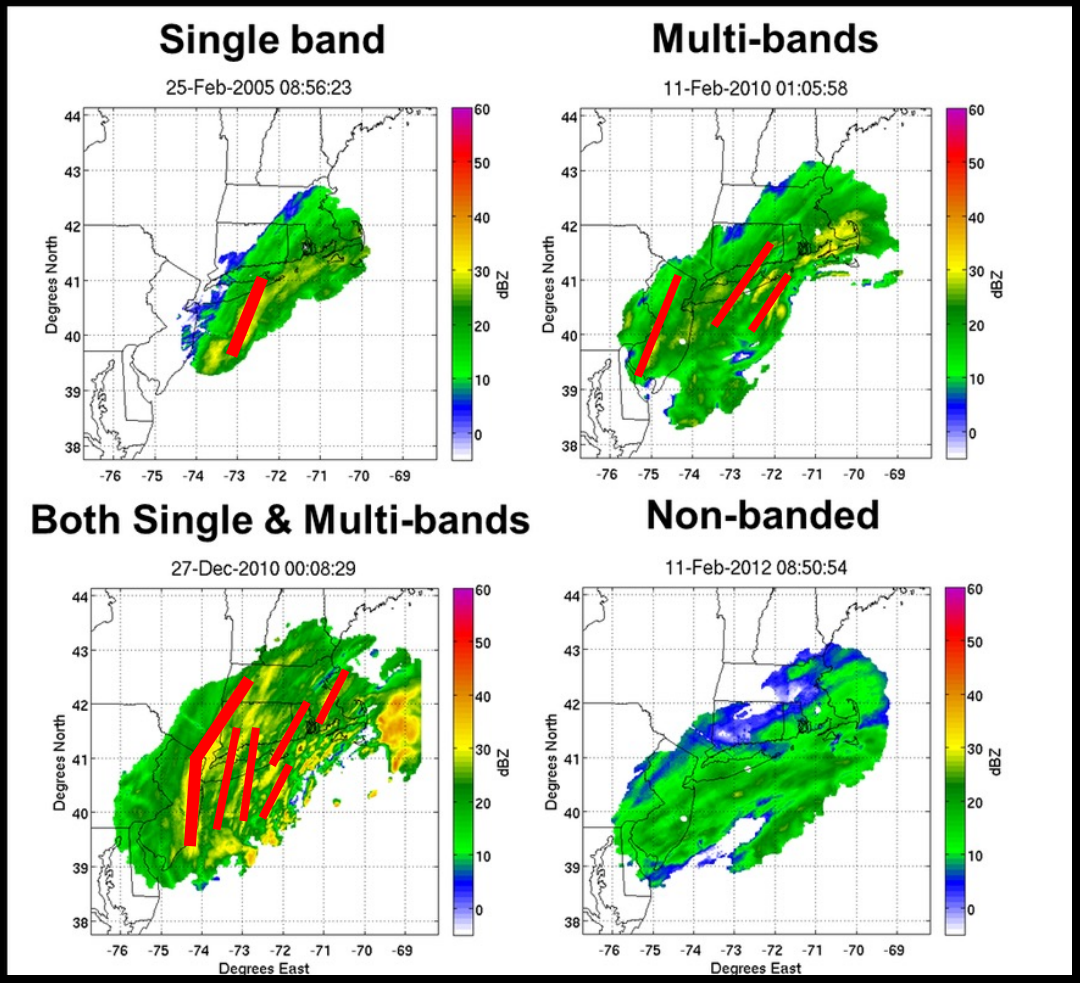
Why this paper?

~ Unique approach of *classifying bands by motion, instead of* ***structure*** *or cyclone-relative location*



Novak et al. (2004)
Ganetis et al. (2018)

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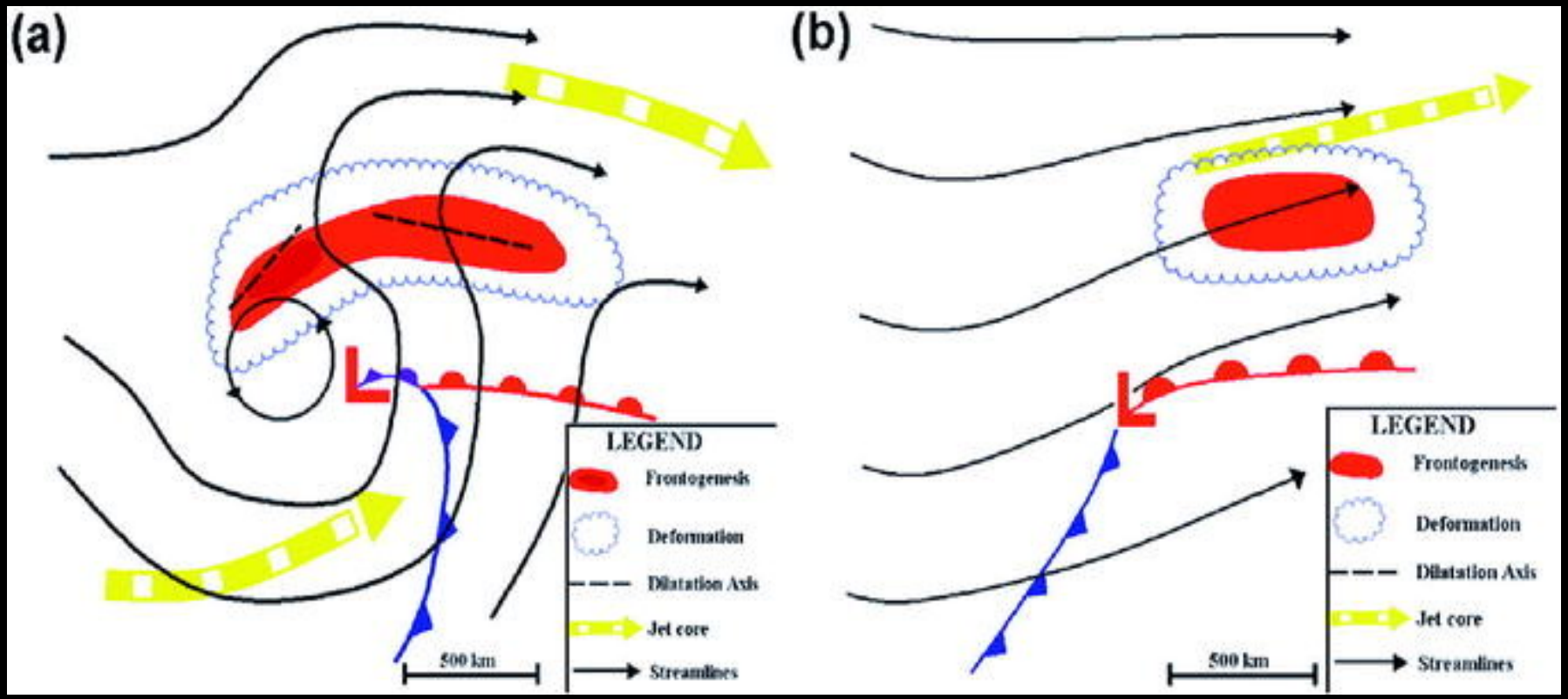

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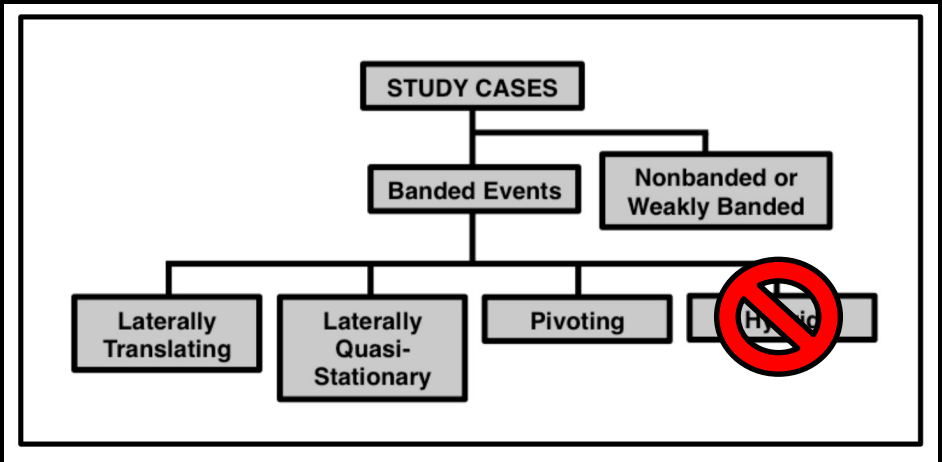
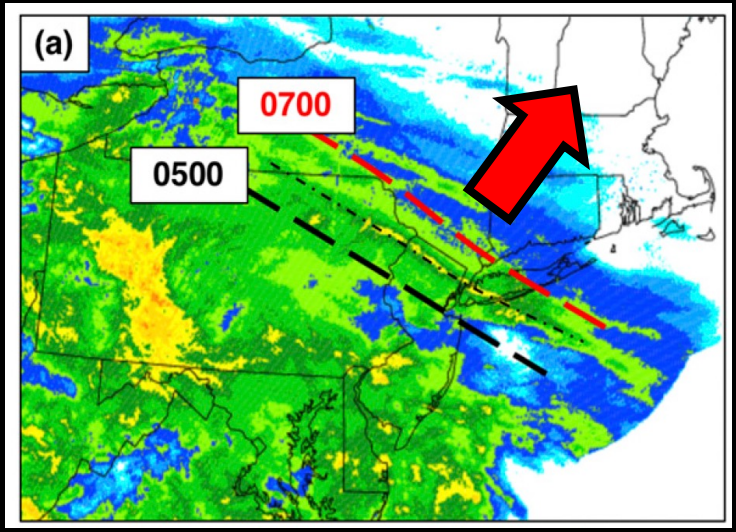
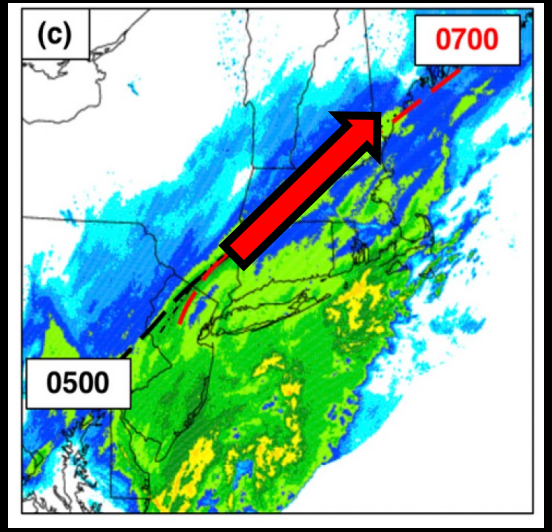
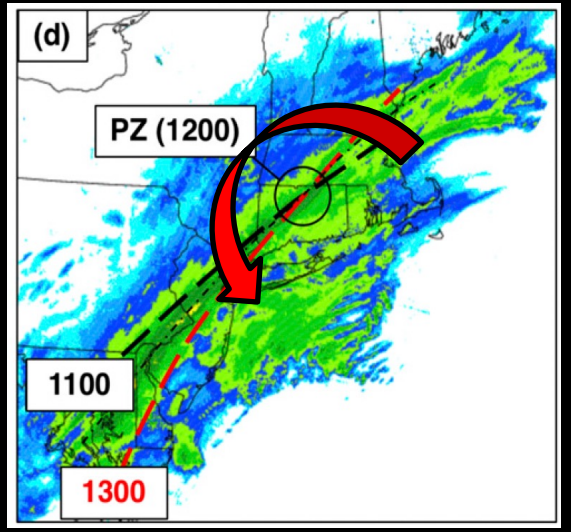
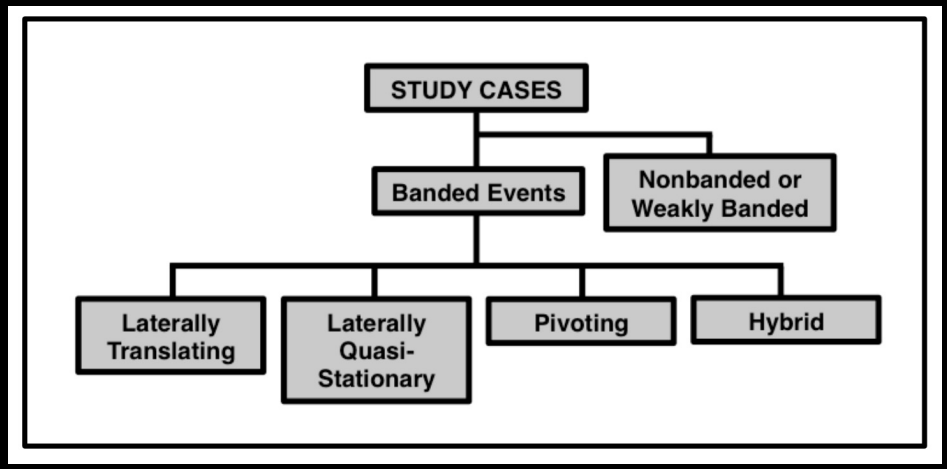
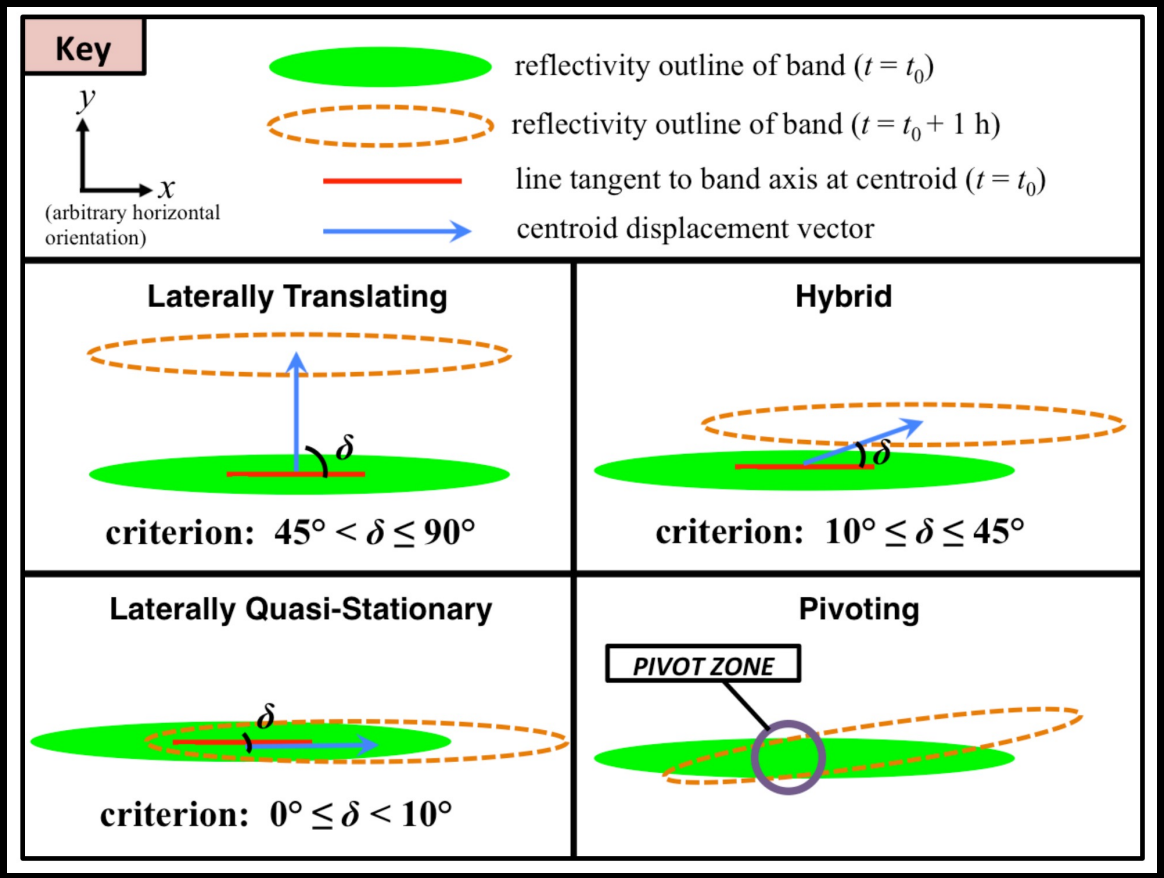


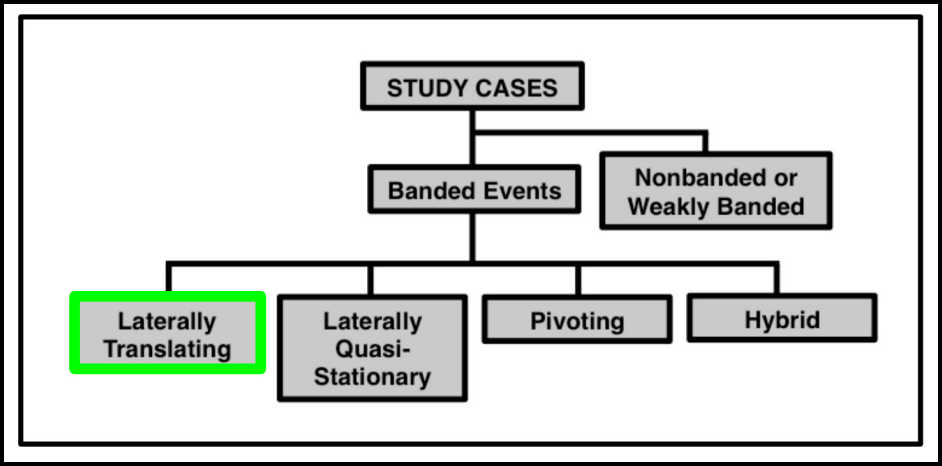


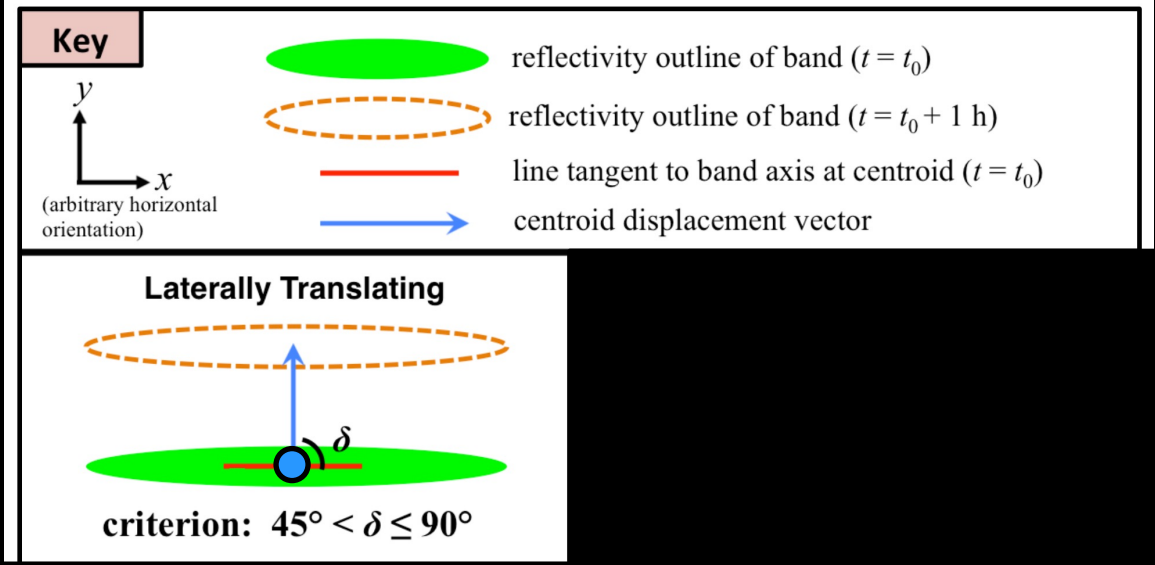





STUDY CASES
Banded Events
Nonbanded or Weakly Banded
Laterally Translating
Laterally Quasi-Stationary
Pivoting
Hybrid

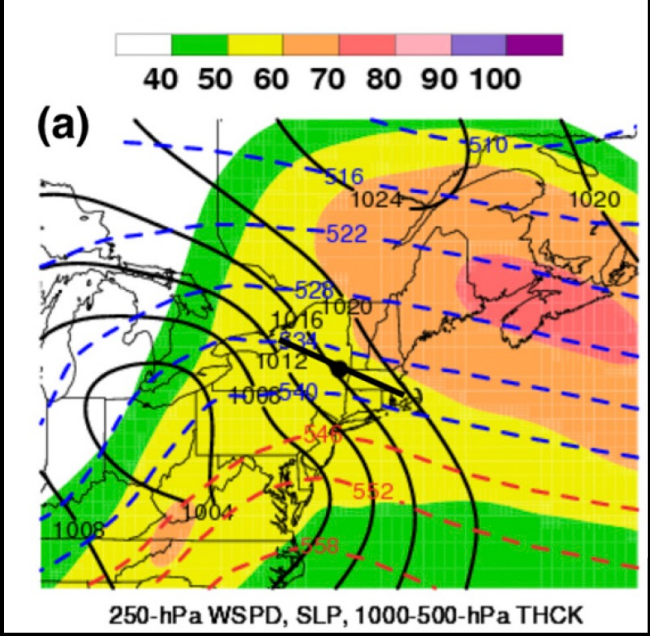

Key
reflectivity outline of band ($t = t_0$)
reflectivity outline of band ($t = t_0 + 1$ h)
line tangent to band axis at centroid ($t = t_0$)
centroid displacement vector
y
x
(arbitrary horizontal orientation)
Laterally Translating
δ
criterion: 45° < δ ≤ 90°
Hybrid
δ
criterion: 10° ≤ δ ≤ 45°
Laterally Quasi-Stationary
δ
criterion: 0° ≤ δ < 10°
Pivoting
PIVOT ZONE





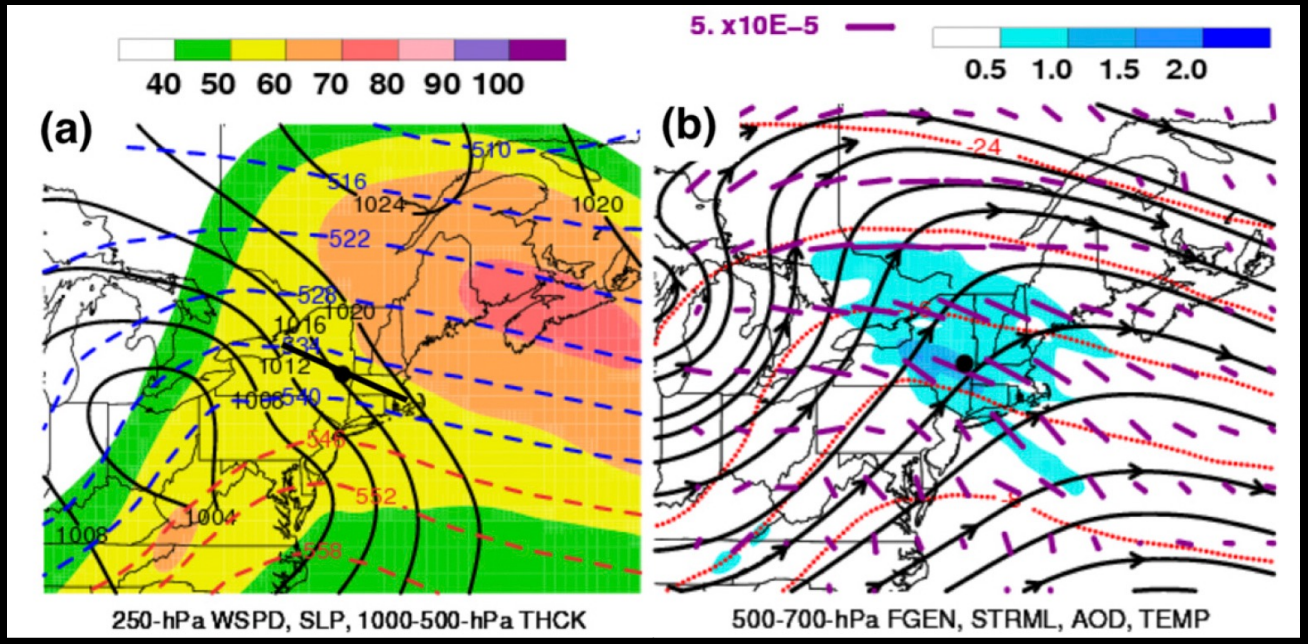
~ CFSR ***band-centroid composites*** of the synoptic environment to determine ***common features for forecasting***

Laterally translating snowbands



~ Band @ *ALB*, *ENE* of *cyclone* in *equatorward entrance region* of jet streak

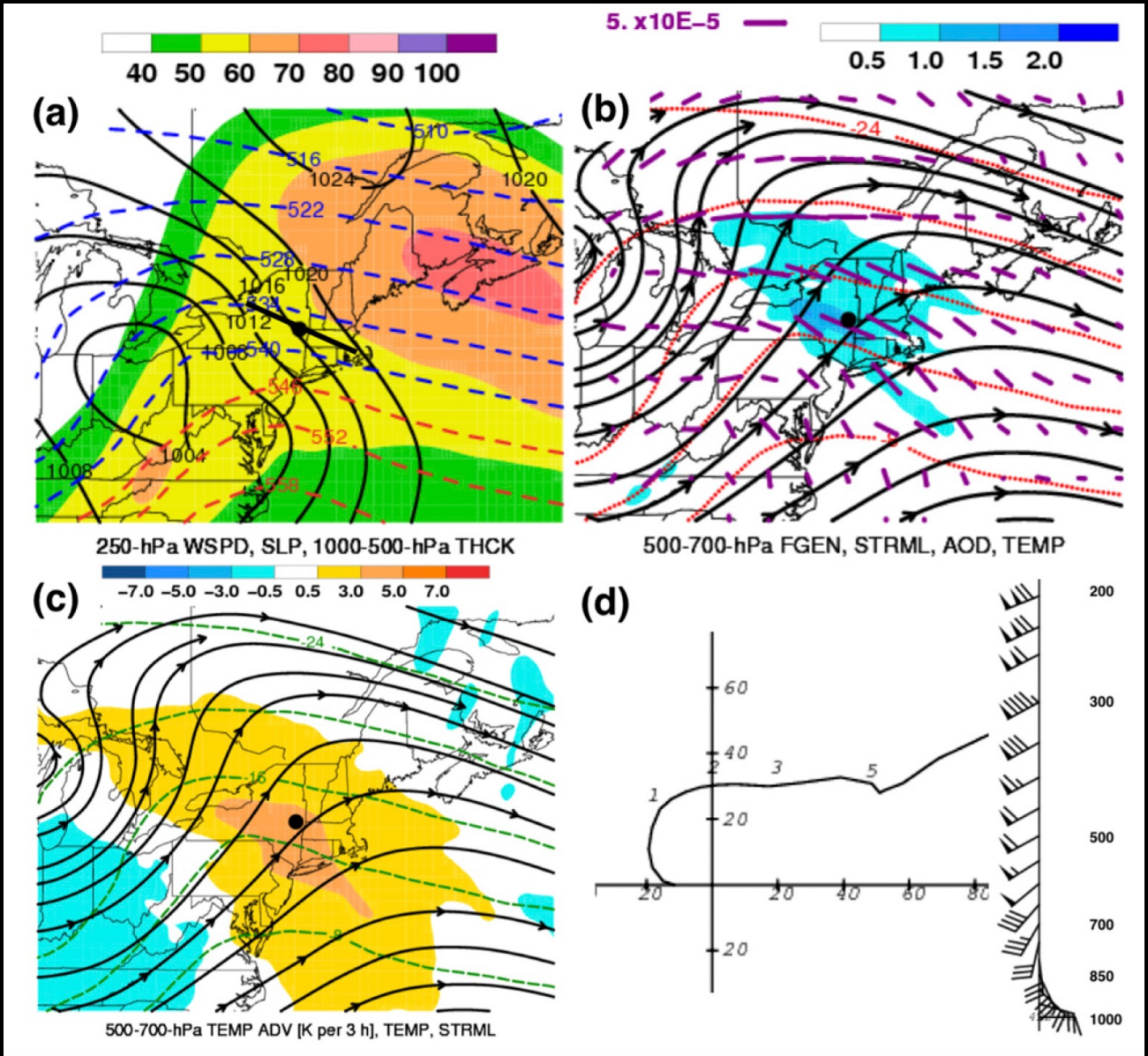
Laterally translating snowbands



~ *Midlevel frontogenesis* max at band centroid

~ *Diffluent SW flow* with *axis of dilatation parallel* to *isotherms*

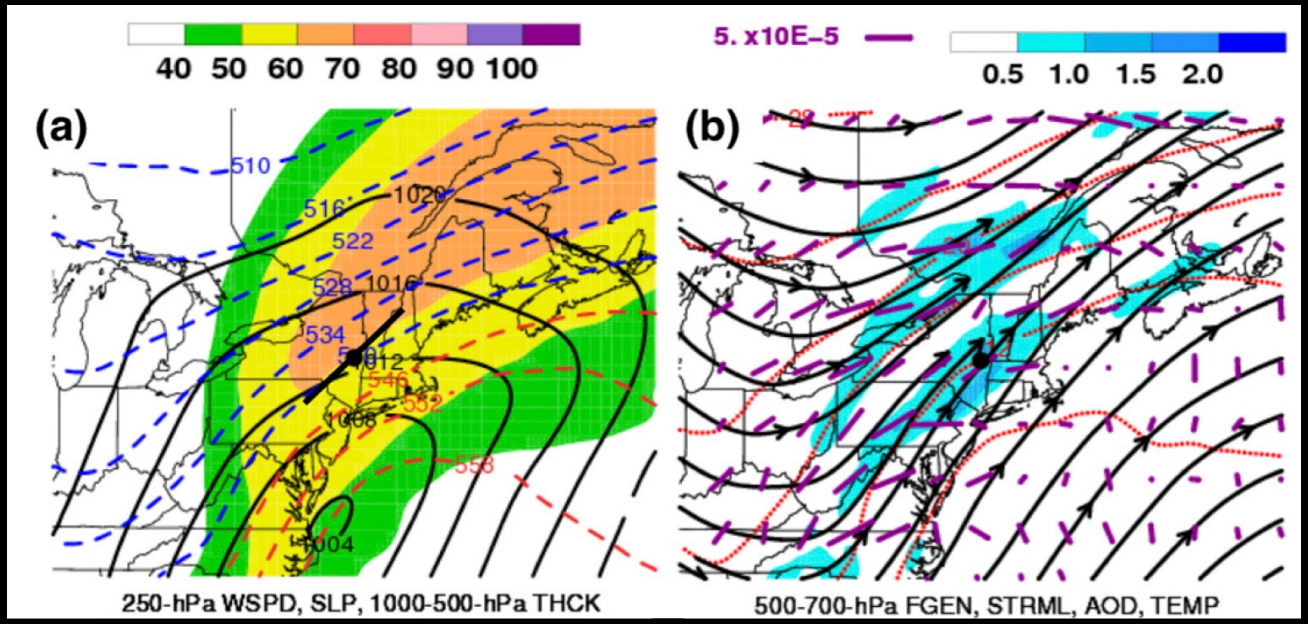
Laterally translating snowbands



~ *Warm air advection* max aligned with band

~ *Veering hodograph* with height

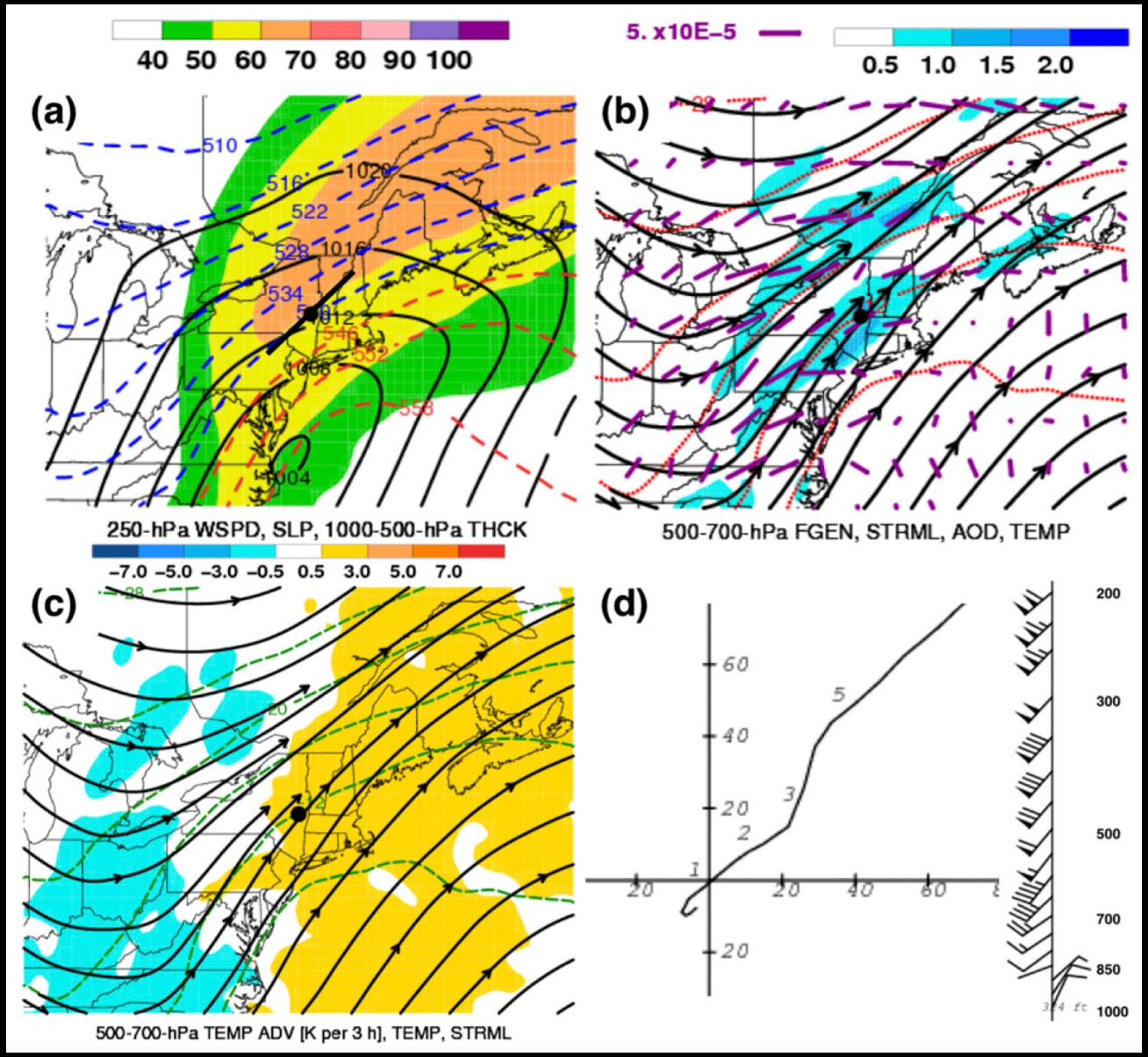
Laterally quasi-stationary snowbands



~ Band *NNE* of *cyclone* in *equatorward entrance region* of jet

~ ***Confluent*** *SW flow* with *axis of dilatation* *parallel* to *isotherms*

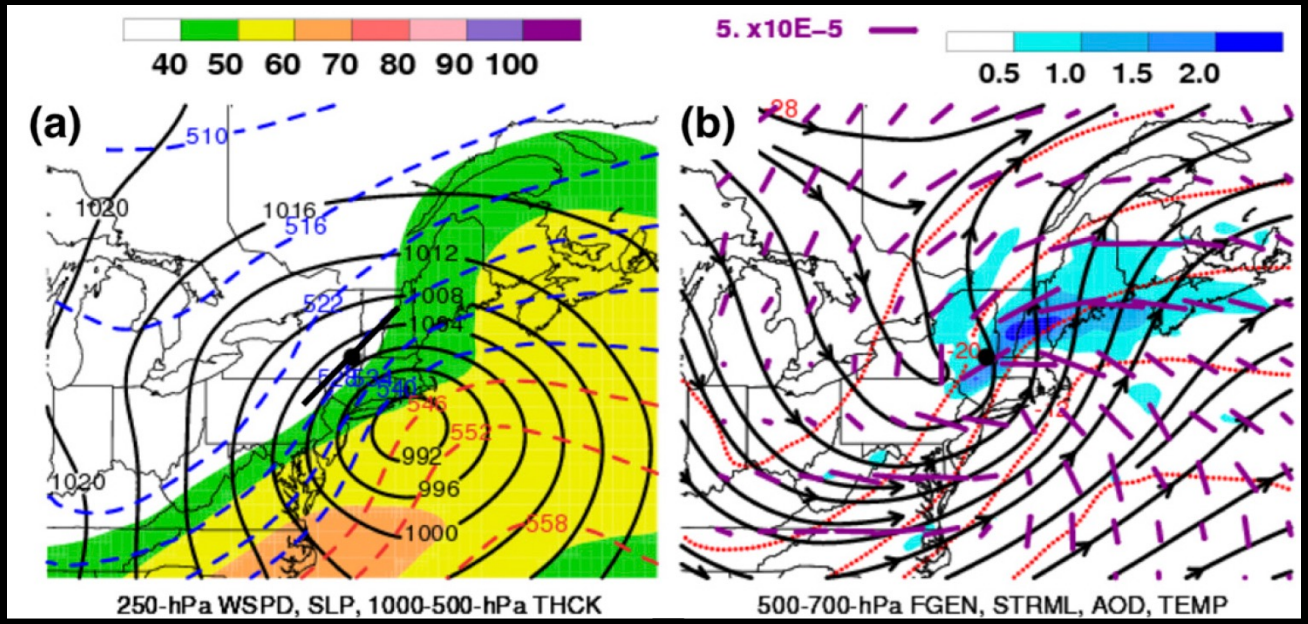
Laterally quasi-stationary snowbands



~ *Weak, diffuse warm air advection*

~ *Straight hodograph* above the boundary layer

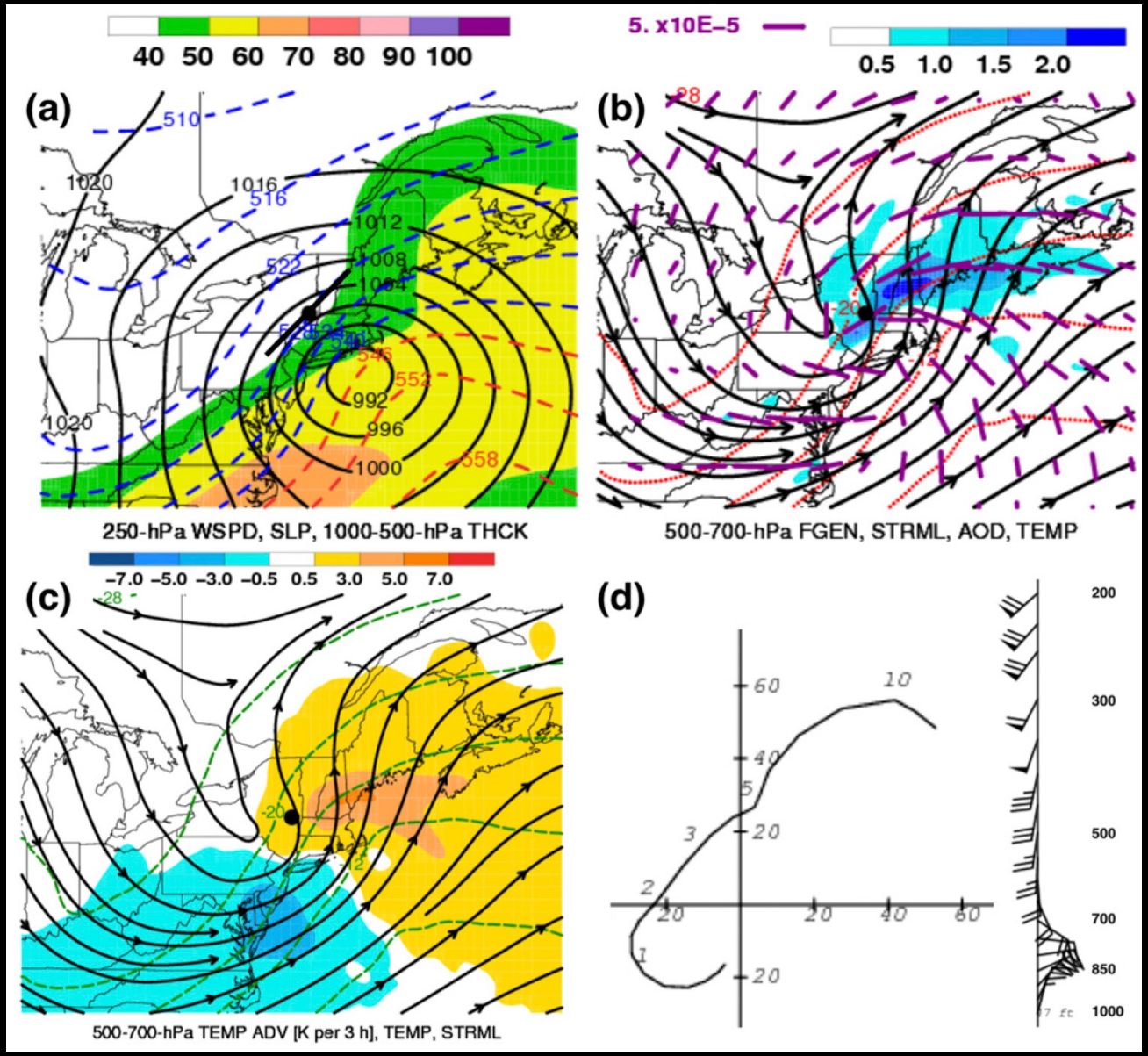
Pivoting snowbands



~ Band *NW* of *cyclone* in *poleward exit region* of jet

~ *Diffluent S flow* with *frontogenesis not maximized at band* centroid

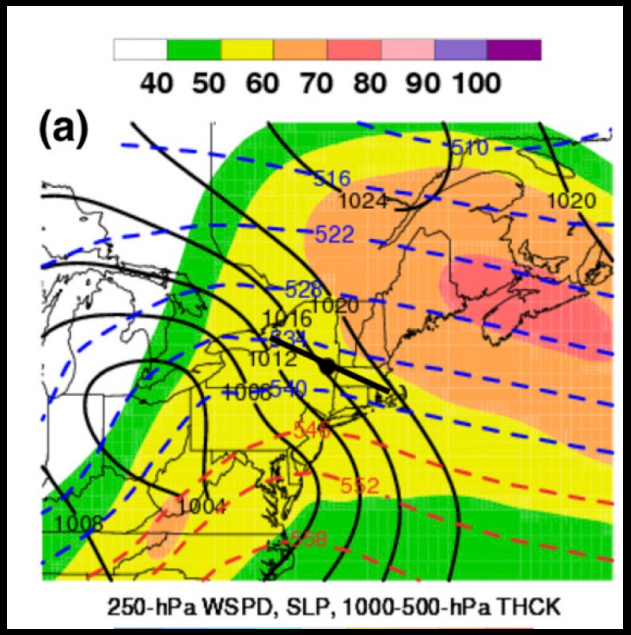
Pivoting snowbands

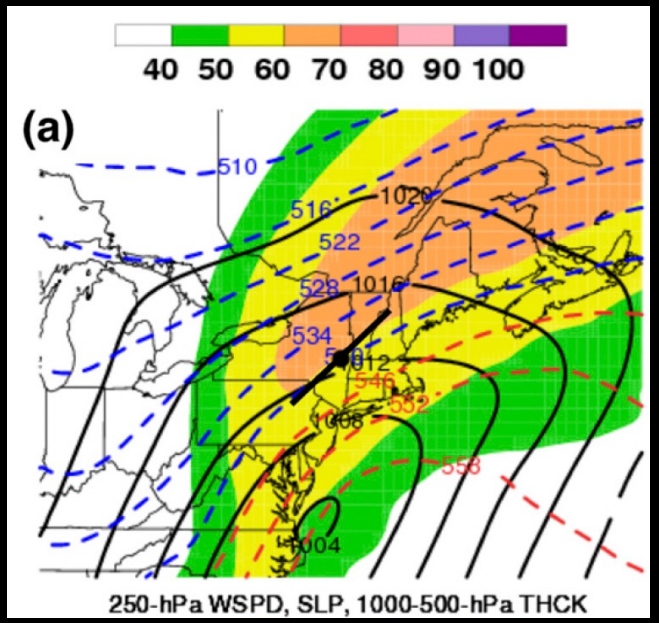


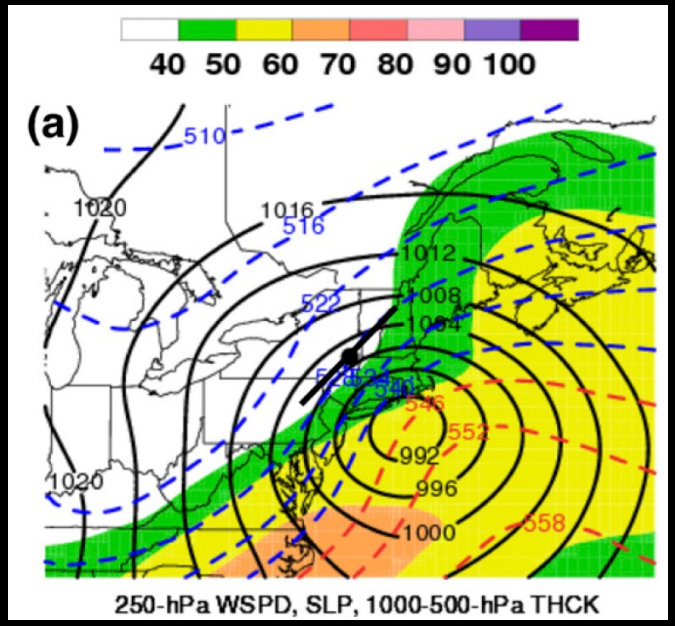
~ *Warm air advection max east of band*

~ *Sharply-veering hodograph* with height

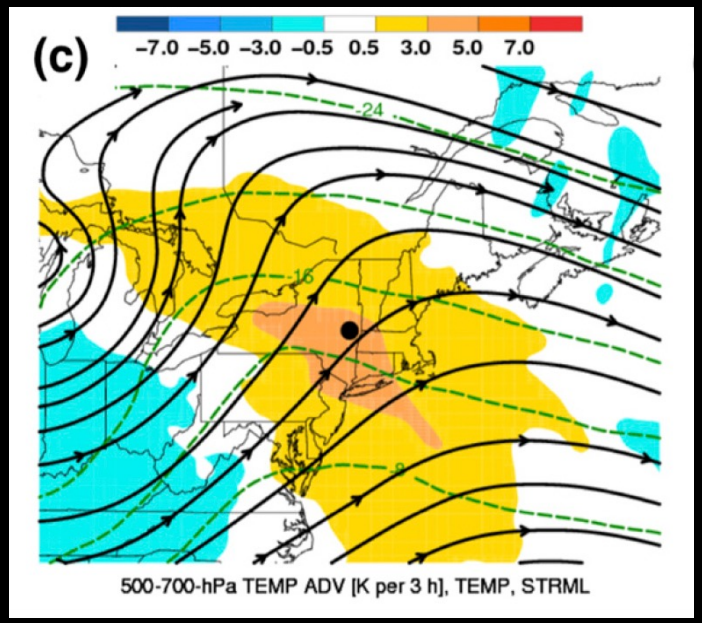
Surface cyclone & jet position

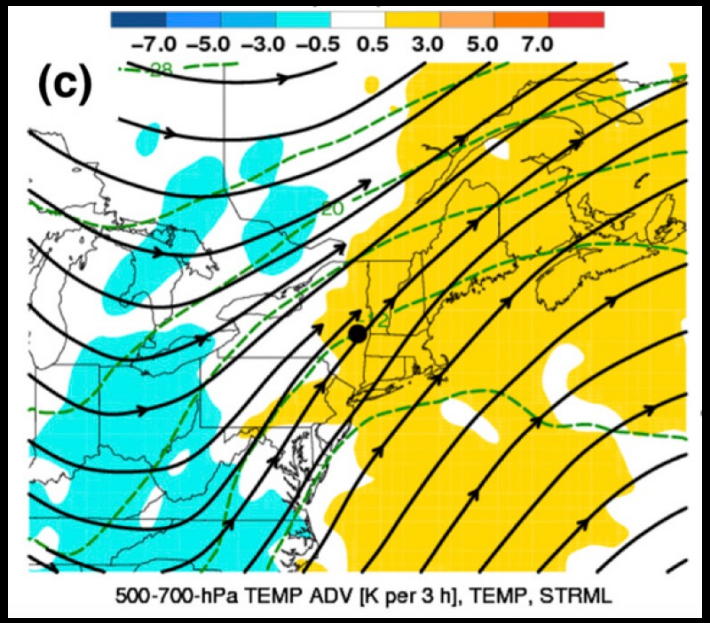


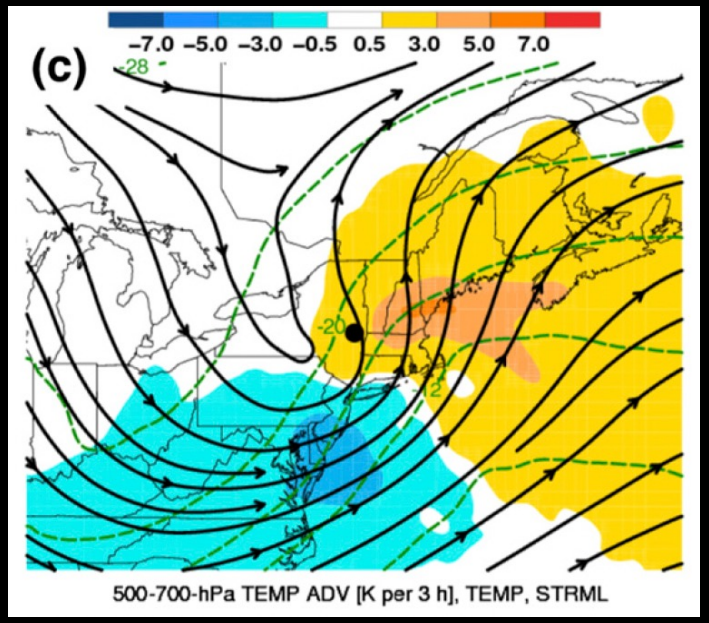




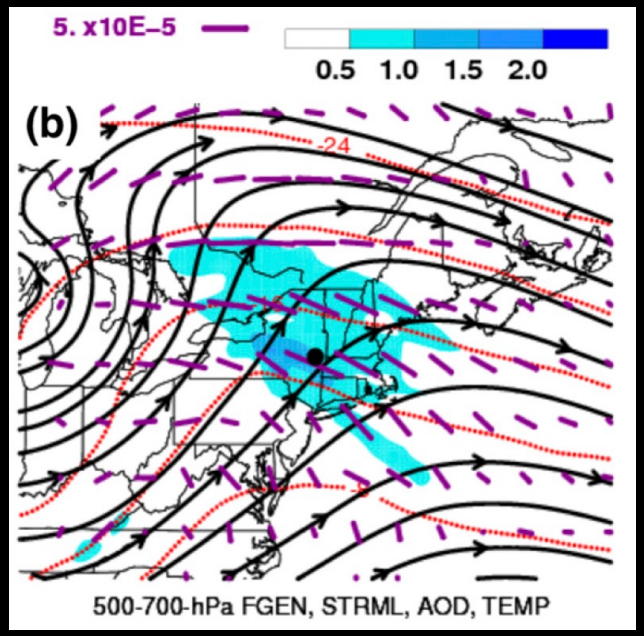
Trough position & temp. advection

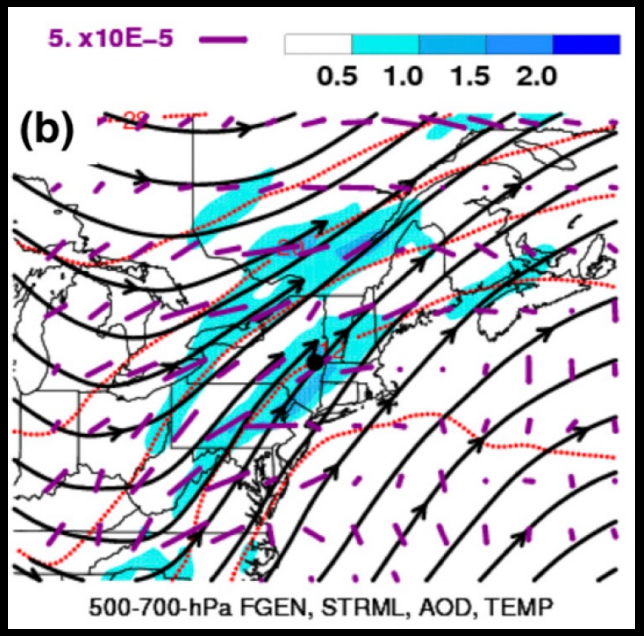


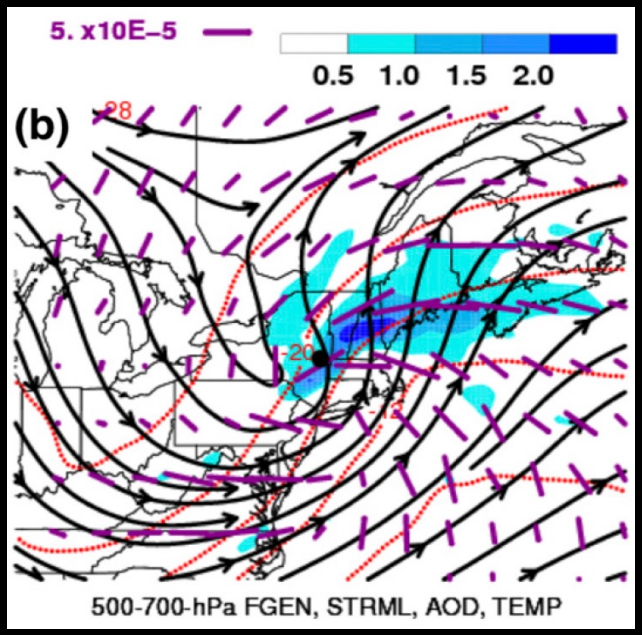




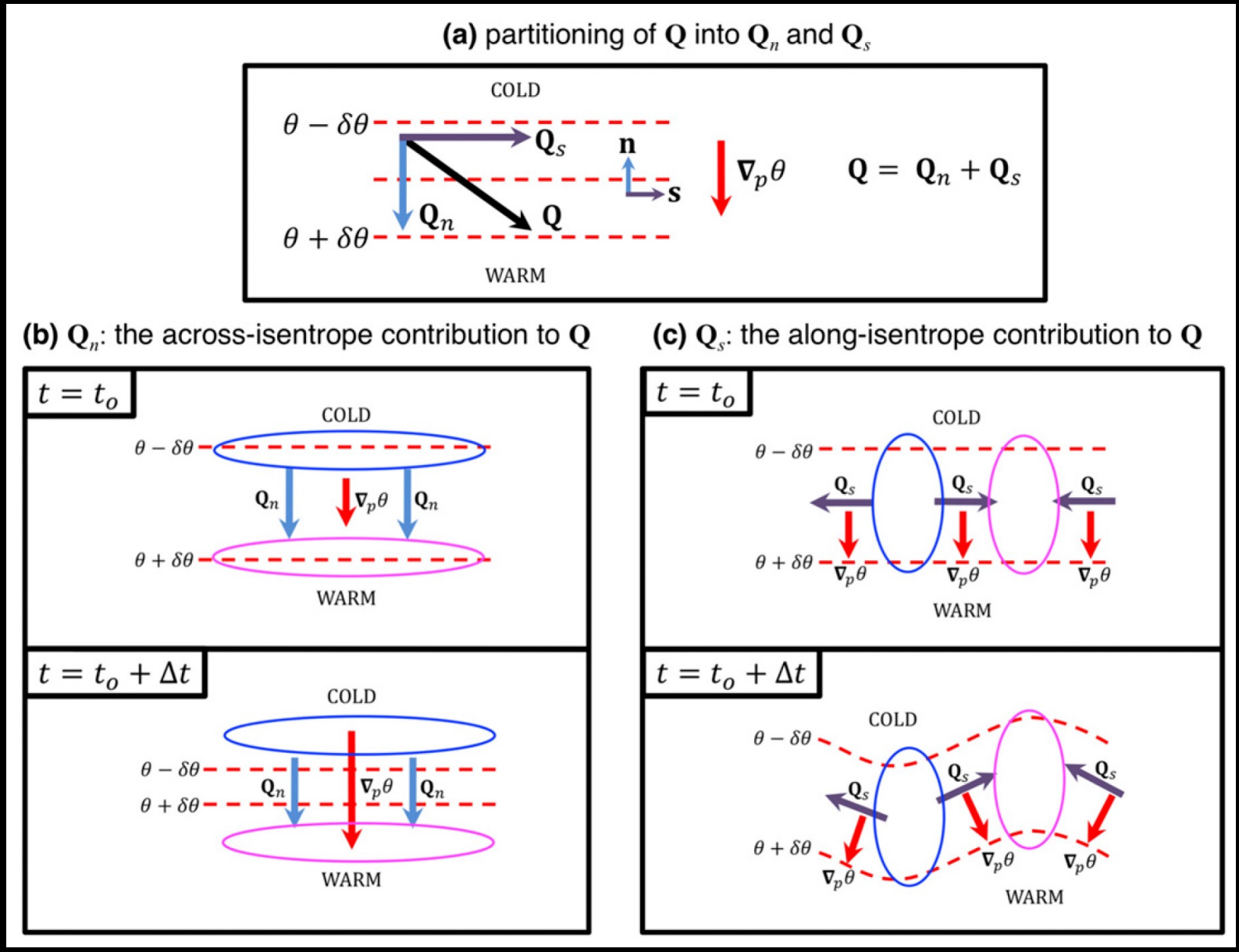
Trough position & frontogenesis







Q vector frontogenesis



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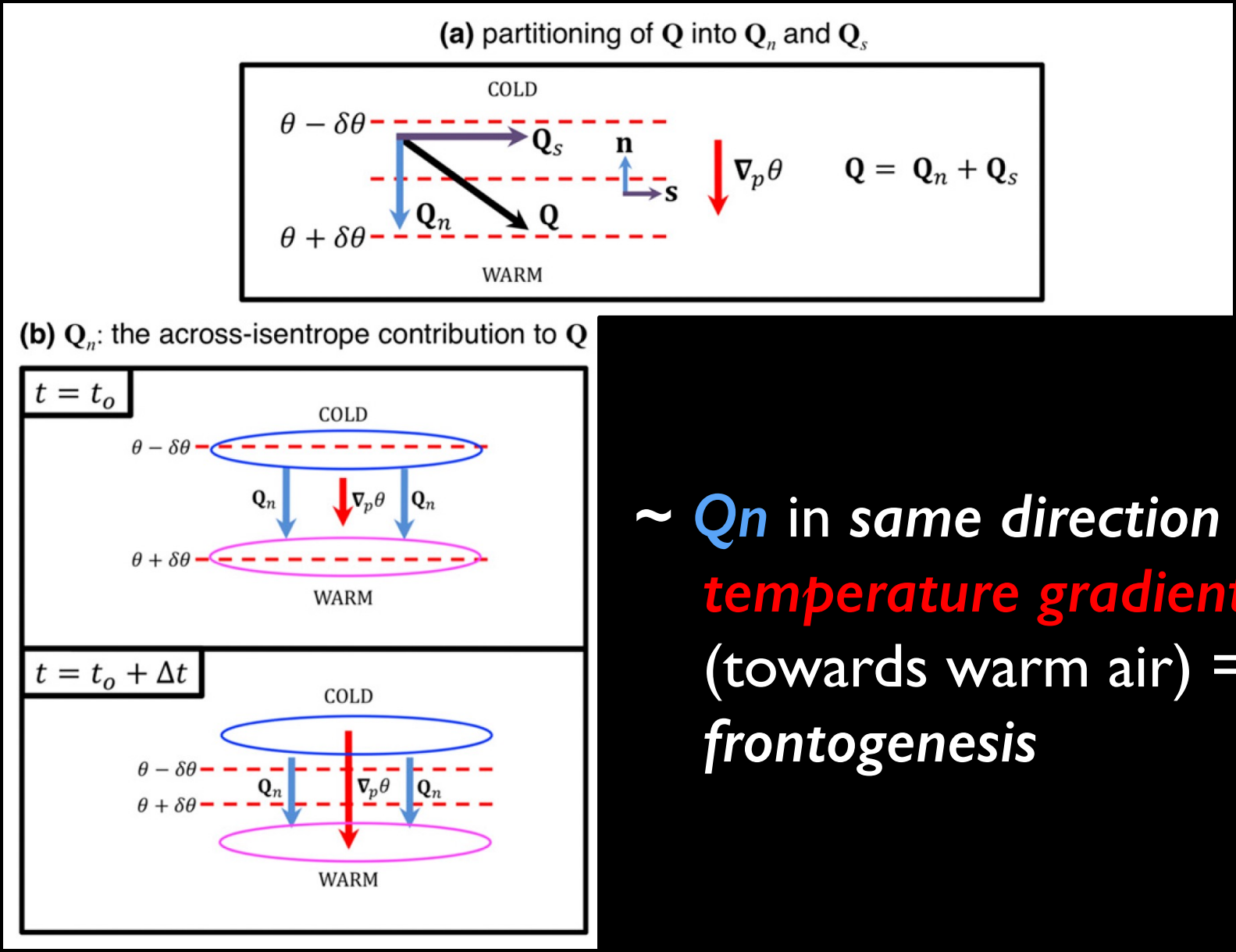
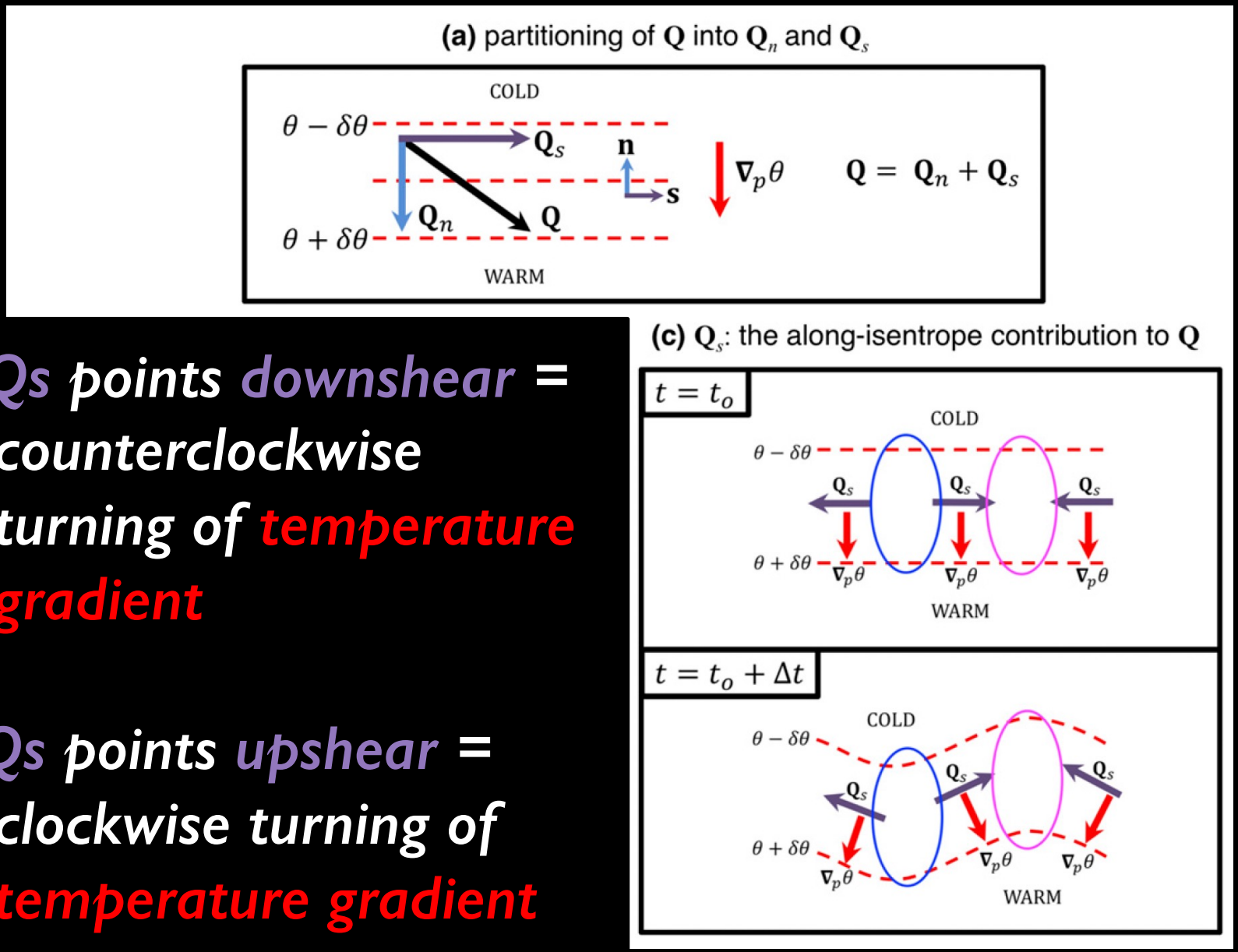


~ *Qn* in *same direction* as *temperature gradient* (towards warm air) = *frontogenesis*

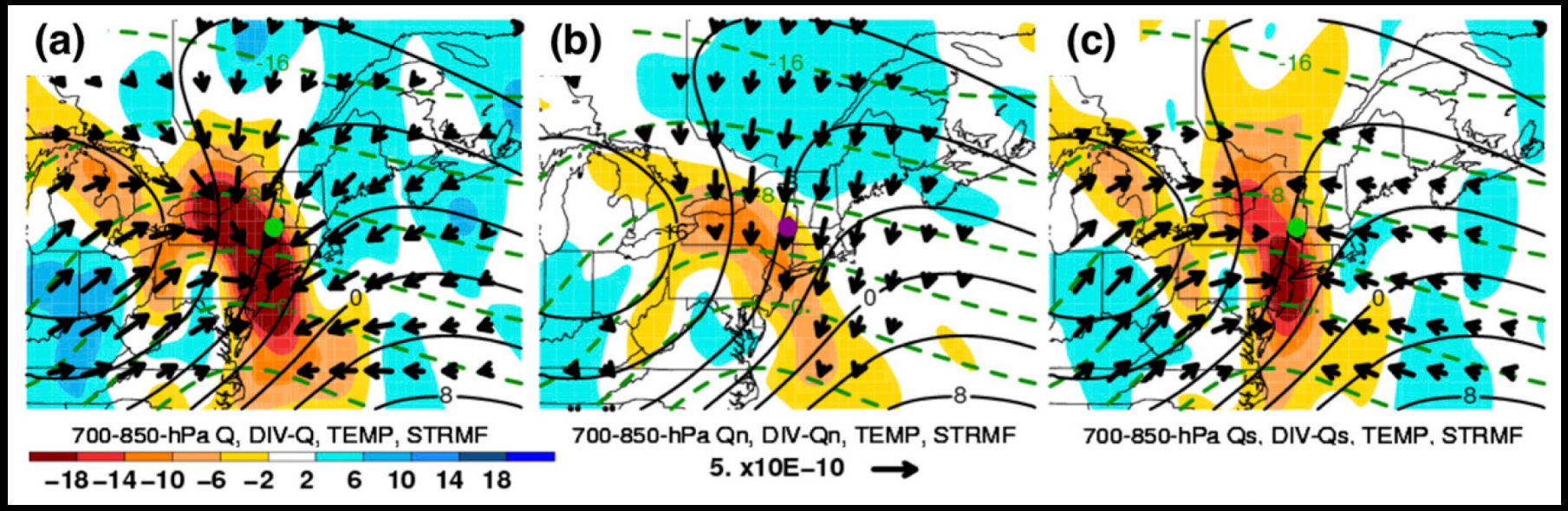
Q vector frontogenesis



~ *Qs points downshear = counterclockwise turning of temperature gradient*

~ *Qs points upshear = clockwise turning of temperature gradient*

Laterally translating snowbands

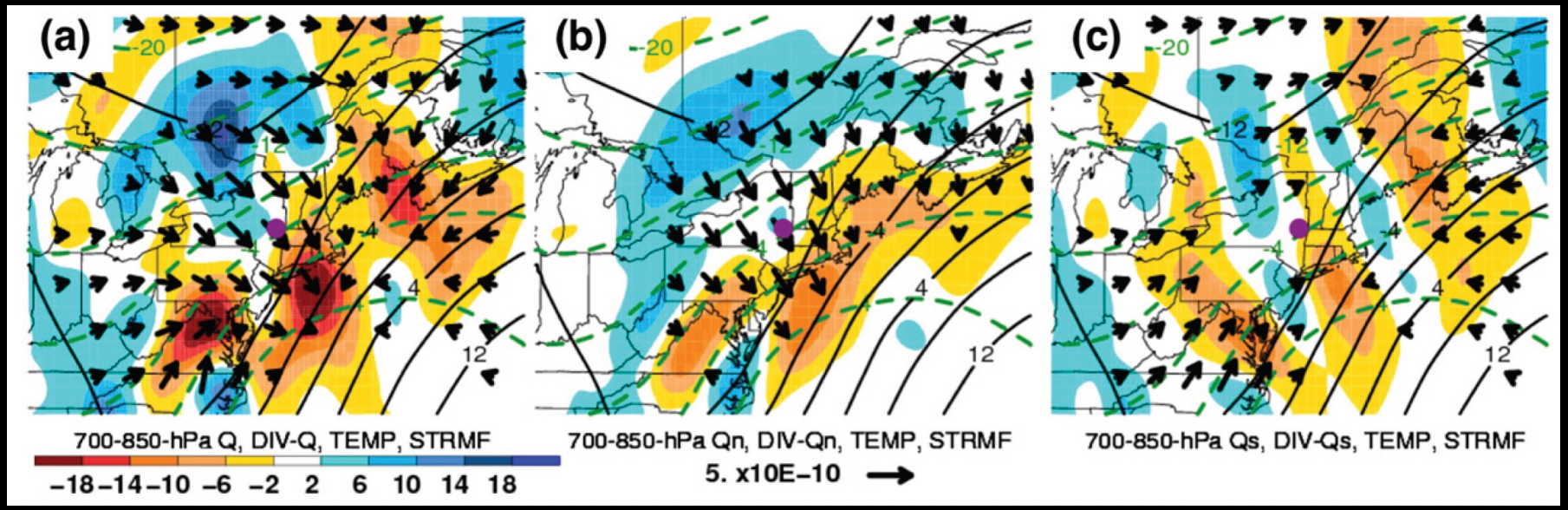


~ Strong *Q vector convergence* along *band axis*

~ *Qn* vectors are uniformly *pointing towards warmer air* indicating *frontogenesis*

~ *Qs vectors* are *small at the band*, so *little rotation* of the *temperature gradient*

Laterally quasi-stationary snowbands

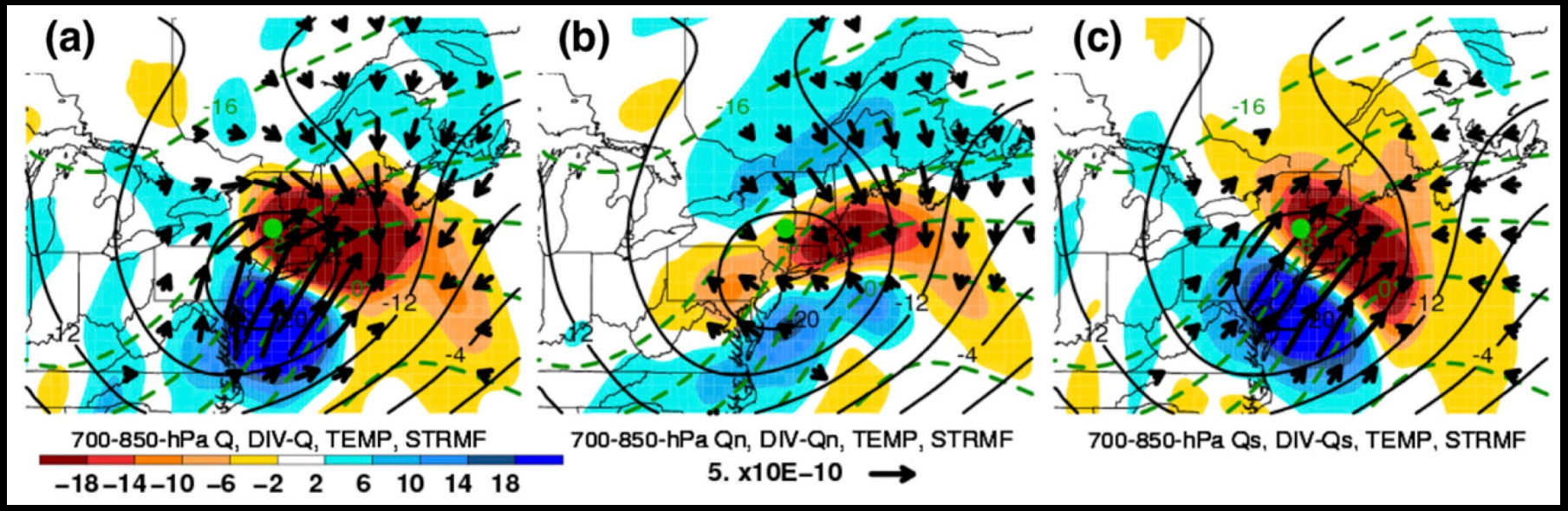


~ *Q vector convergence* ***displaced*** *southeast* of band

~ *Qn* indicates *frontogenesis*, ***but*** again *southeast* of the band

~ *Qs* is *very small* at the *band*, so *no rotation* of the *temperature gradient*

Pivoting snowbands

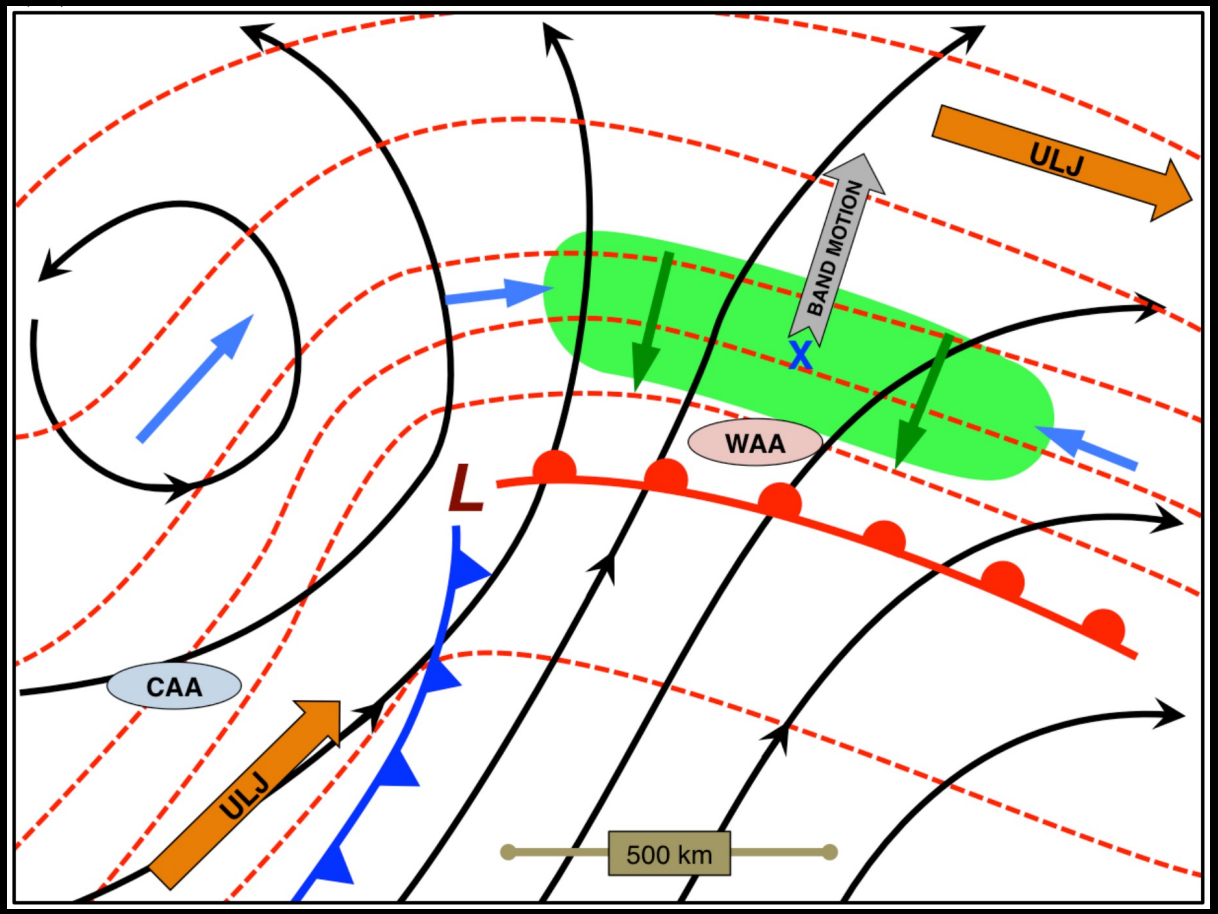


~ *Q vector convergence* max *east* of the band, with *divergence south*

~ *Qn* indicates *frontogenesis along* the *band axis*

~ *Qs* is *large* and *downshear* in the pivot zone, so *temperature gradient rotates counterclockwise*

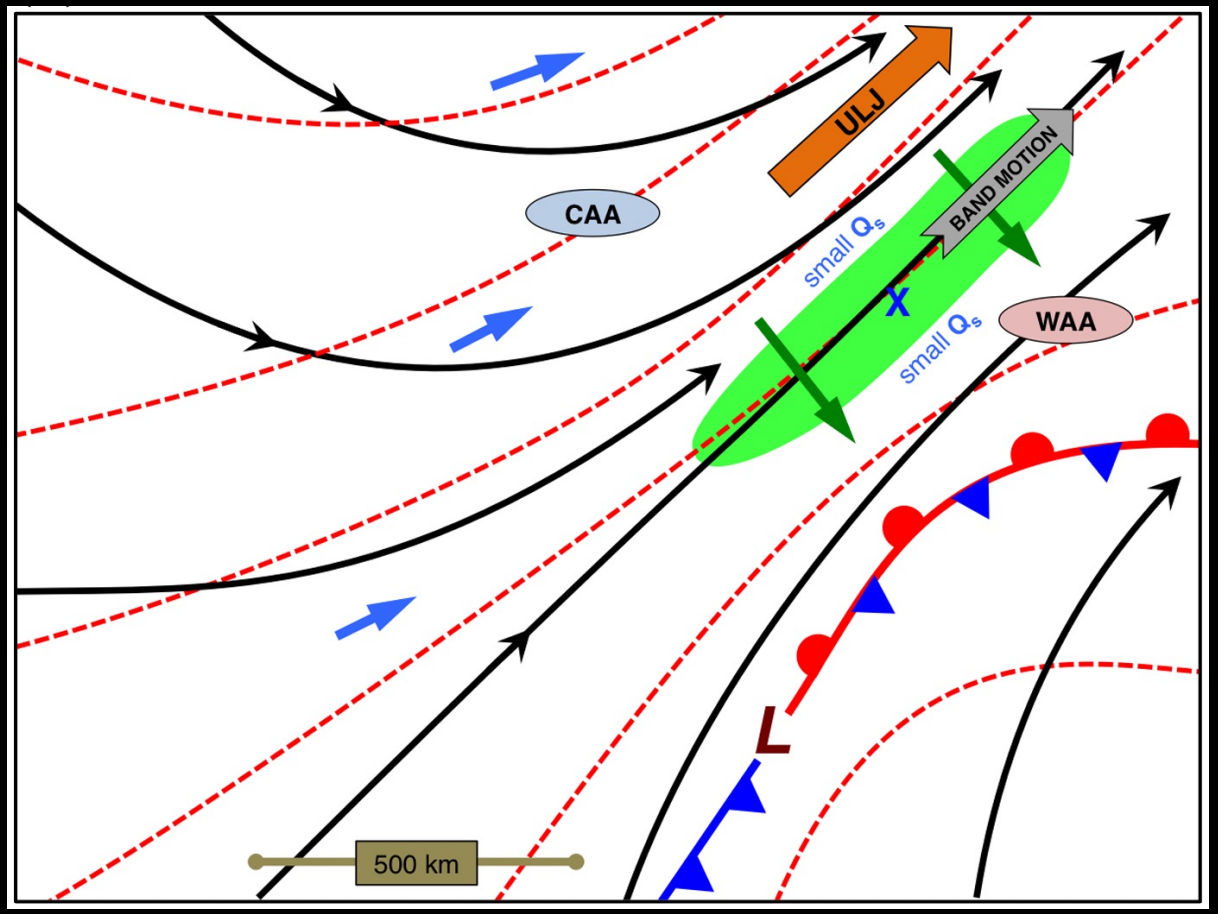
Laterally translating snowbands



Key

- 1000–500-hPa thickness isopleth
- 850–700-hPa streamline
- 850–700-hPa frontogenesis
- WAA — 850–700-hPa warm advection maximum
- CAA — 850–700-hPa cold advection maximum
- 850–700-hPa Q_n vector
- 850–700-hPa Q_s vector
- ULJ — upper-level jet core
- X — hodograph location

Laterally quasi-stationary snowbands



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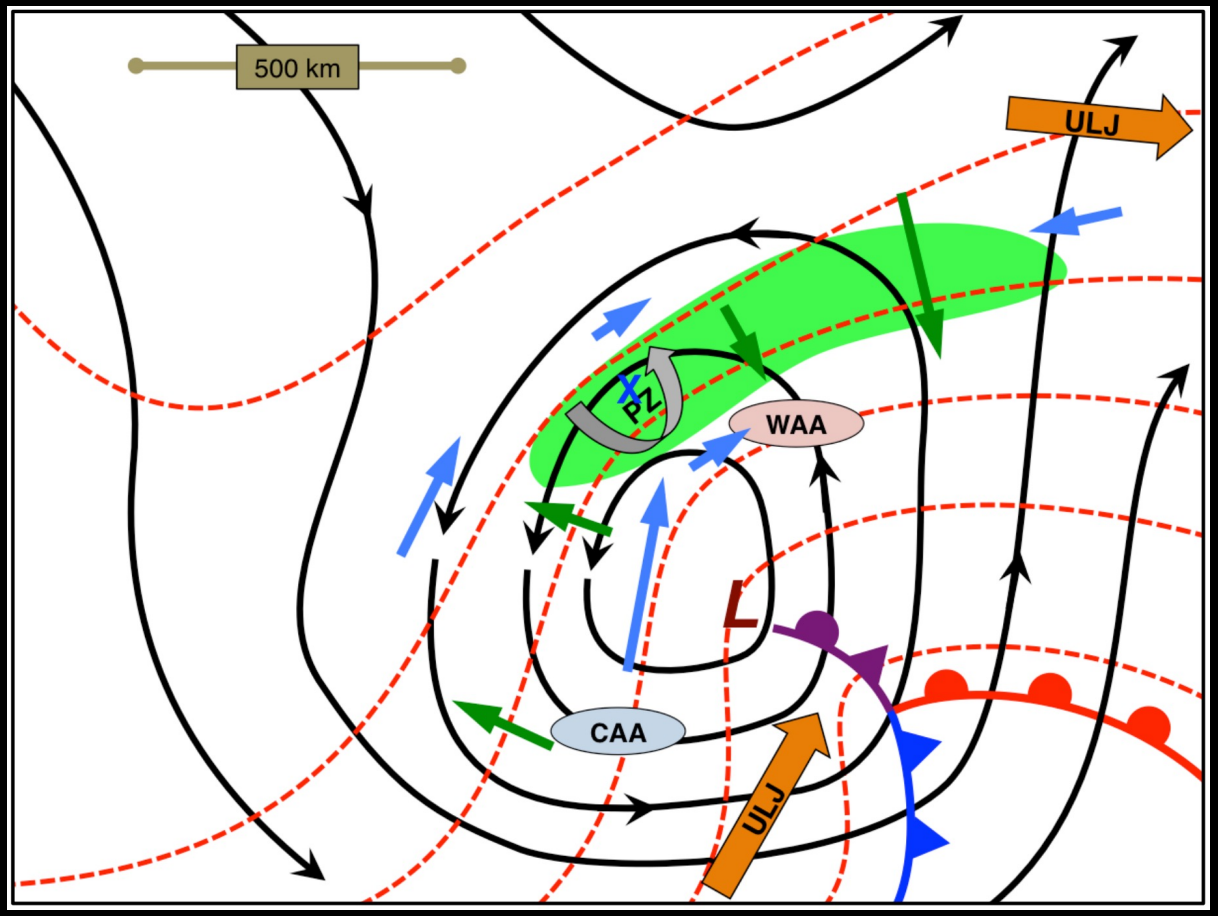

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