Composite Analysis of Conceptual Models for Significant Snowstorms in the Lower Ohio Valley

- 81 cases of 2+ inches classified from 1980-2010 over/near central Kentucky and southern Indiana
- 5 main synoptic patterns/types identified
- Composites average out (lessen) values of individual events, but patterns are very good

NWS Louisville and Saint Louis University

Type 1 (1A/1B)

Number: **9 (1A), 24 (1B), 33 (Total)** **Name:** **Broad SW Flow Aloft**

Surface:

1A: Weak low/front west of NWS Louisville's county warning area (CWA defined as central Kentucky and south-central Indiana); southeast-southeast (S-SE) winds; CWA in "warm sector" on back side of arctic air mass

1B: Weak low/front south (S) or southwest (SW) of CWA; east/northeast (E/NE) winds; CWA in cold sector of system

850 mb:

In exit region of 850 mb jet and moisture transport vectors; low-level jet (LLJ) centered over TN and lower Mississippi (MS) Valley; moderate-to-strong warm advection into KY

500 mb:

Broad, strong SW flow over Ohio (OH) Valley with mean trough axis over central or SW U.S.

300 mb:

Strong jet core oriented west-to-east (W-E) or southwest-to-northeast (SW-NE) over Great Lakes; CWA in anticyclonic right entrance region of jet which enhances upper-level divergence (DIV) and LLJ/850-700 mb frontogenesis

Isentropic:

SW flow and moderate-to-strong ascent and upward moisture transport focused from lower MS Valley to lower OH Valley and into CWA

Frontogenesis:

Significant 850-700 mb frontogenesis over central/western KY/TN, southeastern MO, northern AR

Type 2

Number: 23 **Name: Deep Trough Aloft**

Surface:

Stronger low over TN Valley/Gulf States than Type 1; front extends northward into NWS Louisville CWA or just SE of CWA; can be large temperature difference across CWA with cold/snow on western/ northern side

850 mb:

Closed low S or W of CWA; thermal ridge axis and exit region of low-level jet (LLJ) extending into KY; moderate-to-strong warm advection into CWA

500 mb:

Deep trough over central U.S.; S or SW flow over OH Valley; embedded shortwaves ahead of mean trough at times enhance precipitation over OH Valley

300 mb:

Jet core oriented S-N or SW-NE east of trough axis and over or near CWA

Isentropic:

South flow and strong ascent/upward moisture transport from central Gulf States north into CWA

Frontogenesis:

Strong, deep-layered frontogenesis axis over or near CWA, associated at times with deformation, which enhances mesoscale banded precipitation

Type 3

Number: 10 **Name: Closed Low Aloft (East Coast Storm)**

Surface:

Strong low over southeastern U.S. to near East Coast with N or NE flow over CWA (heaviest snow often in eastern/northeastern CWA or just east of CWA in deformation zone/comma head)

850 mb:

Strong, closed low over TN Valley or southeastern U.S. with E or NE flow across CWA bringing warm advection from the E or NE (reflection of TROWAL)

500 mb:

Deep trough or closed low over southeastern U.S. or Carolinas with strong vorticity max rounding base of trough

300 mb:

Jet core oriented S-N or SW-NE over southeastern U.S. and mid Atlantic states with col (trough axis) over mid MS Valley; snow to left of jet core in isotach gradient/deformation/comma head

Isentropic:

Strong ascent/moisture transport over eastern halves of KY/TN, Appalachians, and southeastern U.S.

Frontogenesis:

Strong, deep-layered frontogenesis axis over eastern halves of KY/TN and in WV

Type 4

Number: 6 **Name: Polar Vortex over Northern States**

Surface:

Weak low in Great Lakes area with trailing arctic cold front across OH Valley; precipitation usually is along or just behind arctic front

850 mb:

Average west (W) flow (SW to WNW) over CWA south of low over Great Lakes; colder at 850 mb than most other types; weak/modest warm advection over top of arctic air at surface

500 mb:

Polar vortex/closed low over northern Plains or Great Lakes with significant vorticity max south of vortex; W to SW flow across OH Valley

300 mb:

Cyclonically-curved jet core in base of trough over TN Valley to S of CWA; CWA on cyclonic shear side of jet

Isentropic:

Low center over Great Lakes; near neutral pressure advection over CWA; weak ascent

Frontogenesis:

Weak frontogenesis over central KY compared to other types; confined to below 700 mb

Type 5

Number: 9 **Name: Clipper System**

Surface:

Weak low and cold front NW, W, or SW of CWA; position of low crucial to temperatures, precipitation type and location (more northern track takes snow N/E of CWA with warmer air over CWA)

850 mb:

Open trough axis or weak low to W of CWA with W to SW flow over area often in exit region of low-level wind max; 850 temperatures variable depending on location/track of system

500 mb:

Digging shortwave trough W or NW of CWA within W to NW flow aloft

300 mb:

Cyclonically-curved jet core S and W of CWA diving SE; CWA on cyclonic side of jet; little or no precipitation (and warmer temperatures) along and S of jet core

Isentropic:

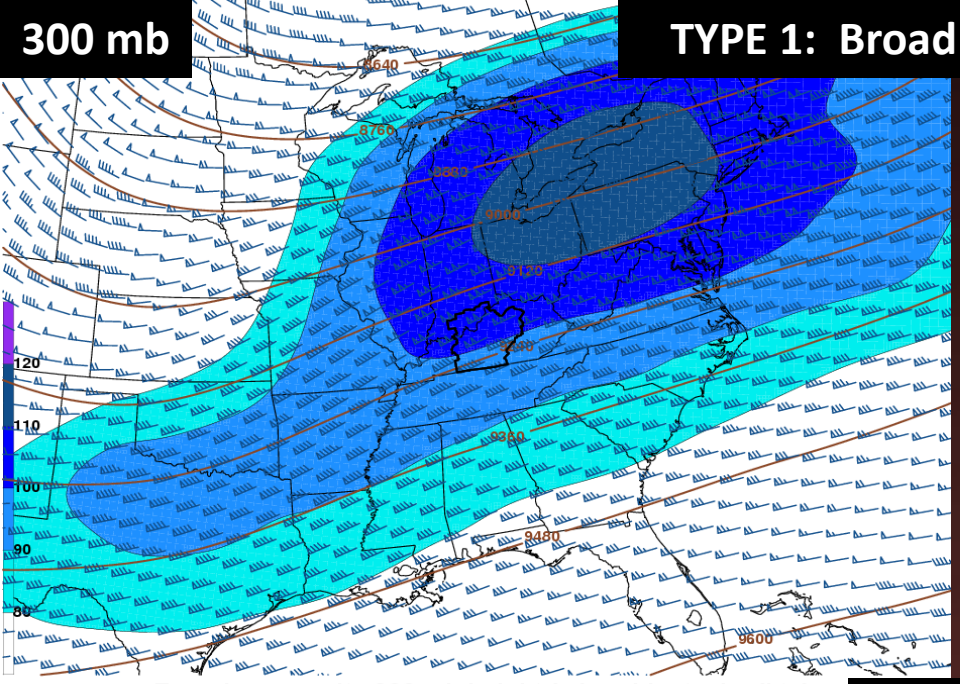
Weak-to-moderate ascent and upward moisture transport in and W of OH Valley just ahead of shortwave trough

Frontogenesis:

Weak 850 frontogenesis over/near CWA; frontogenesis generally is shallow and weak

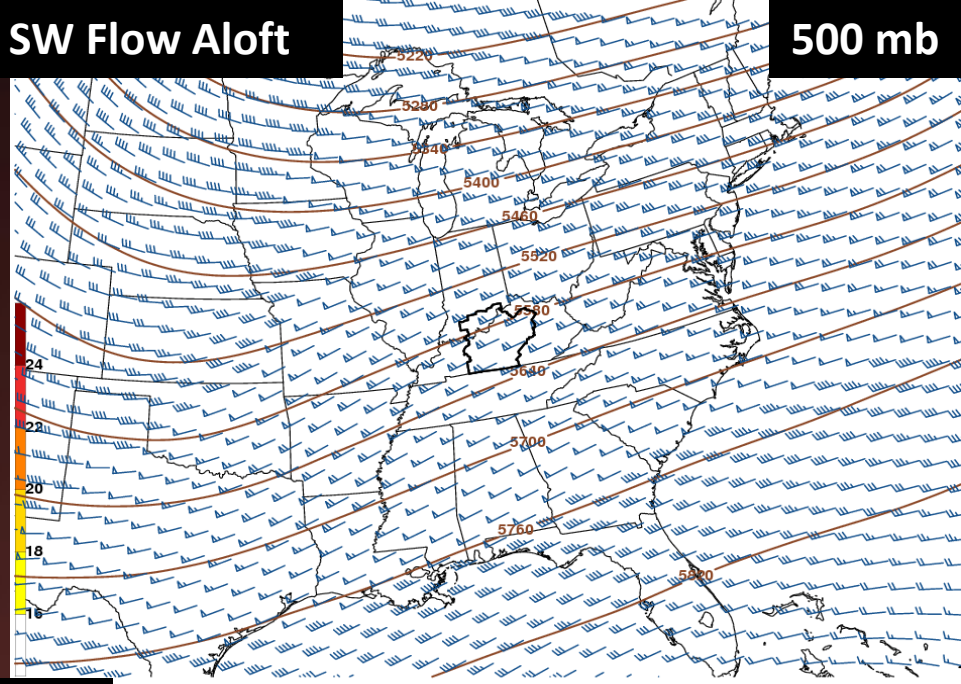
TYPE 1: Broad SW Flow Aloft

300 mb



Type 1 composite 300 mb height (m) and isotachs (kts)

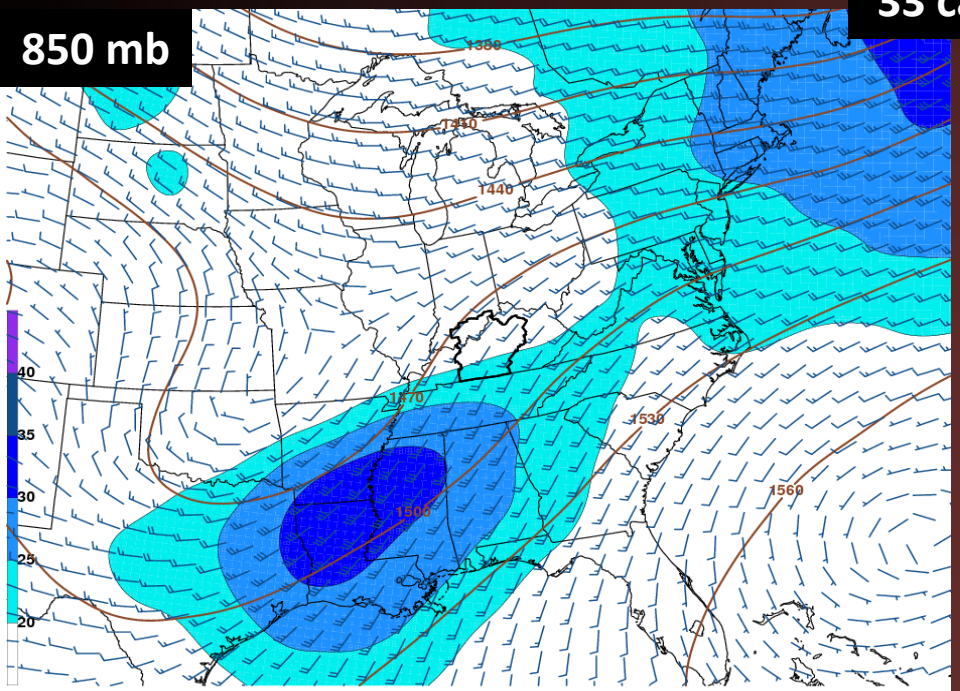
500 mb



Type 1 composite 500 mb height (m) and isotachs (kts)

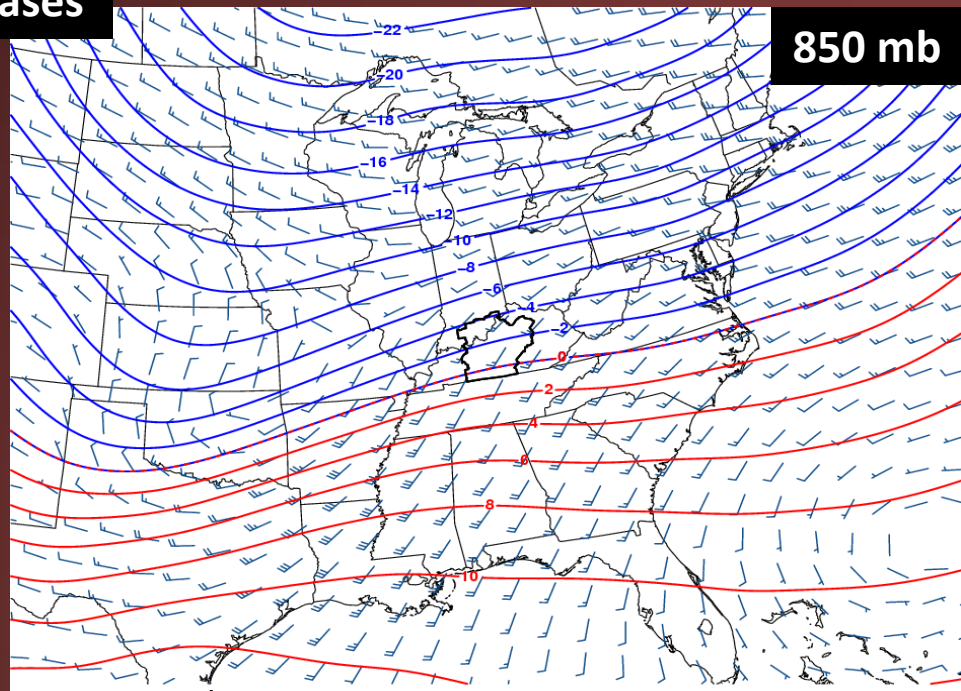
33 cases

850 mb



Type 1 composite 850 mb heights (m) and isotachs (kts)

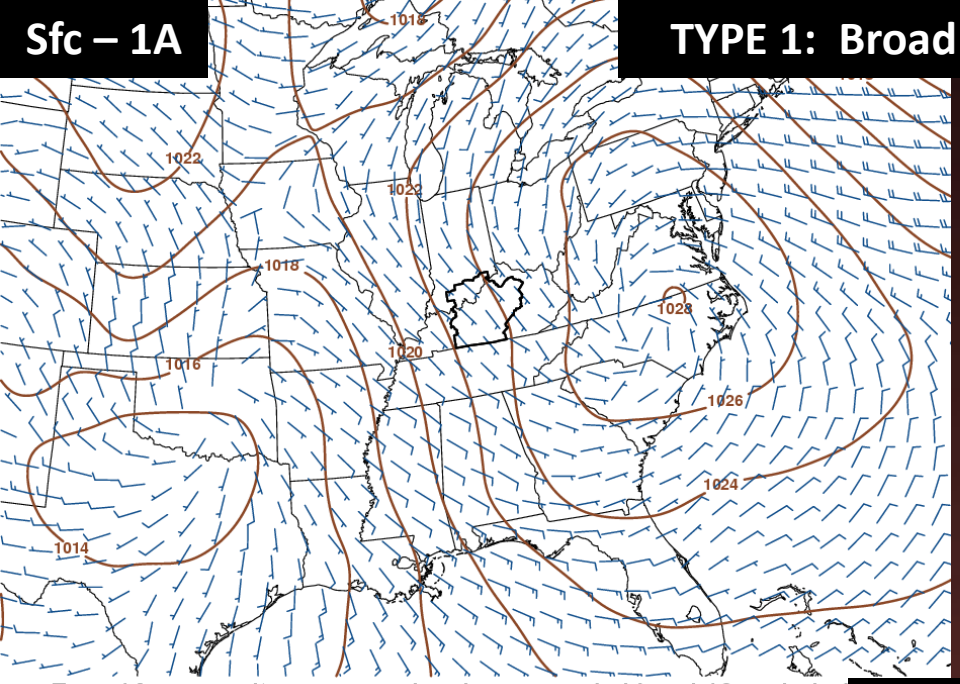
850 mb



Type 1 composite 850 mb temperatures (C) and wind (kts)

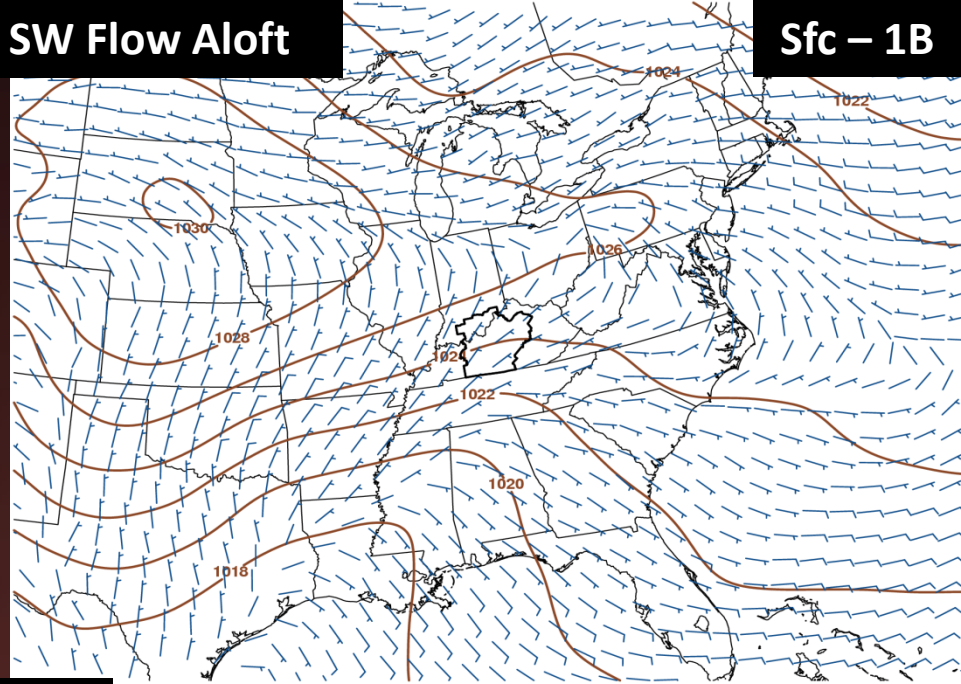
TYPE 1: Broad SW Flow Aloft

Sfc – 1A



Type 1A composite mean sea level pressure (mb) and 10m winds (

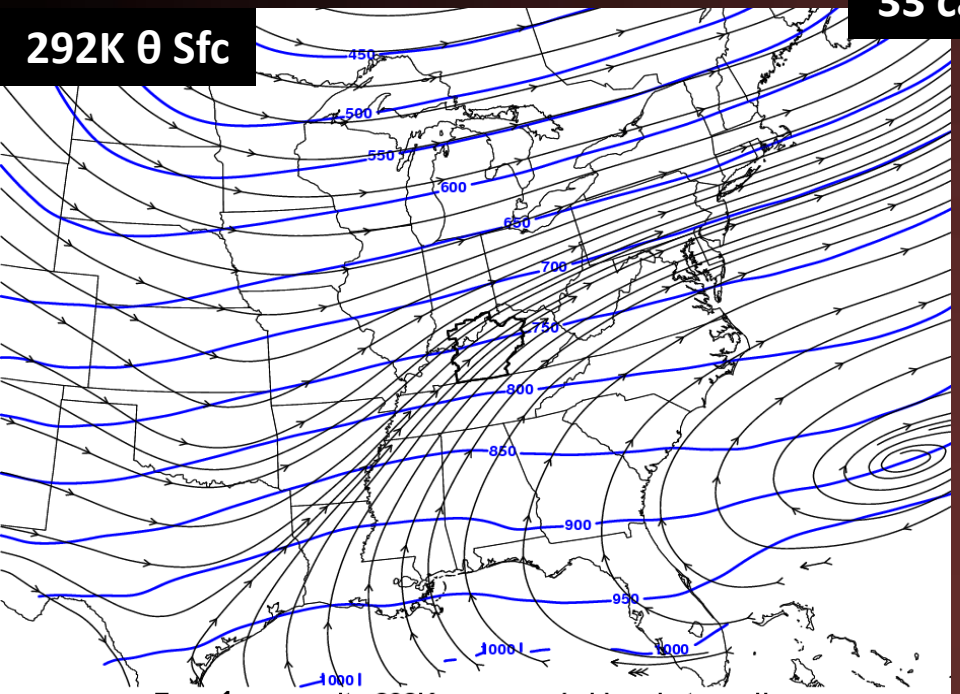
Sfc – 1B



1B composite mean sea level pressure (mb) and 10 m winds (kts)

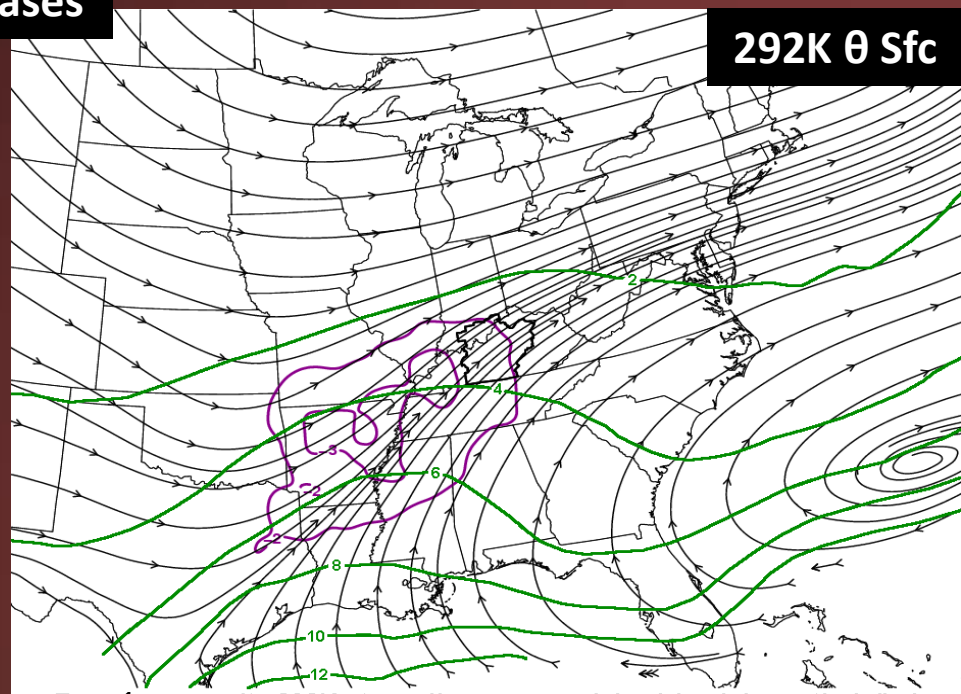
33 cases

292K θ Sfc



Type 1 composite 292K pressure (mb) and streamlines

292K θ Sfc

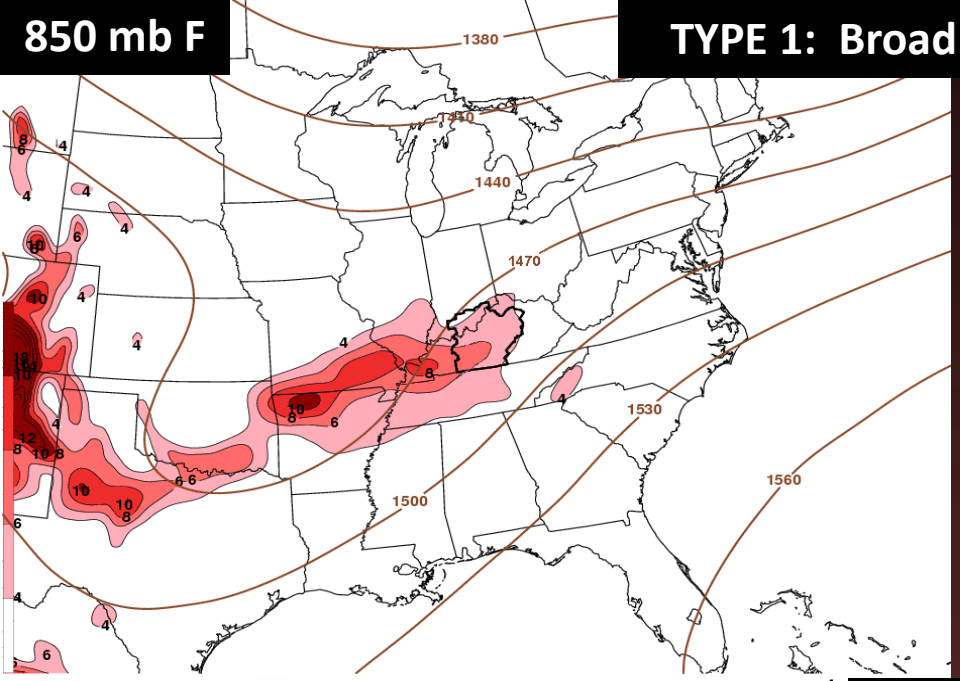


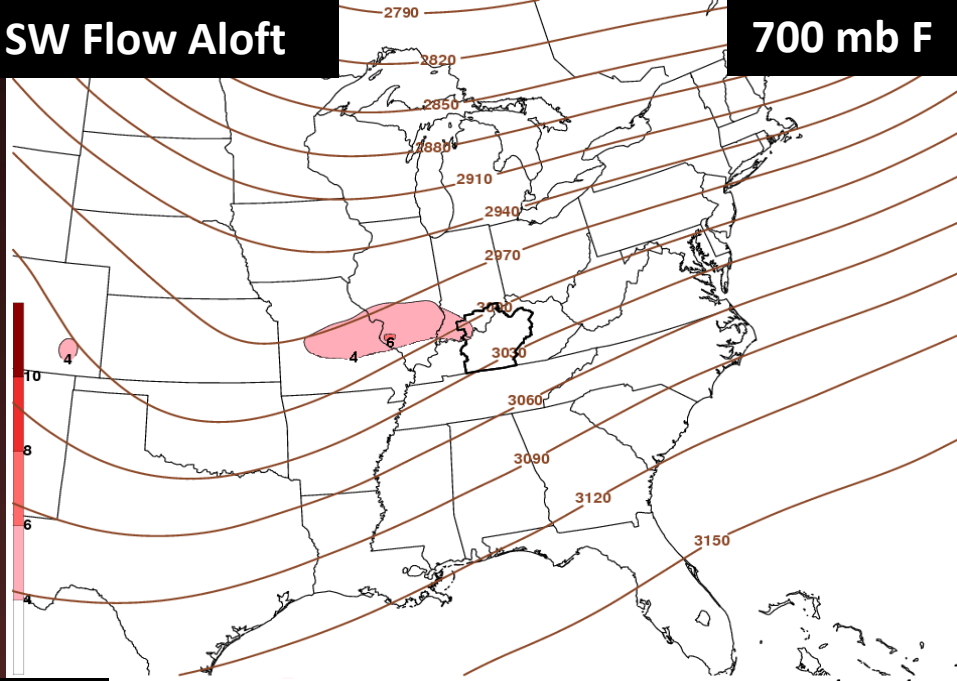
Type 1 composite 292K streamlines, omega (ubar/s), mixing ratio (g/kg)

TYPE 1: Broad SW Flow Aloft

850 mb F

700 mb F

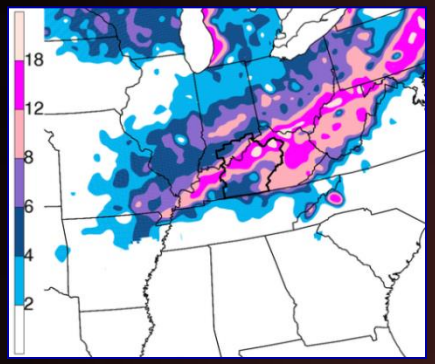


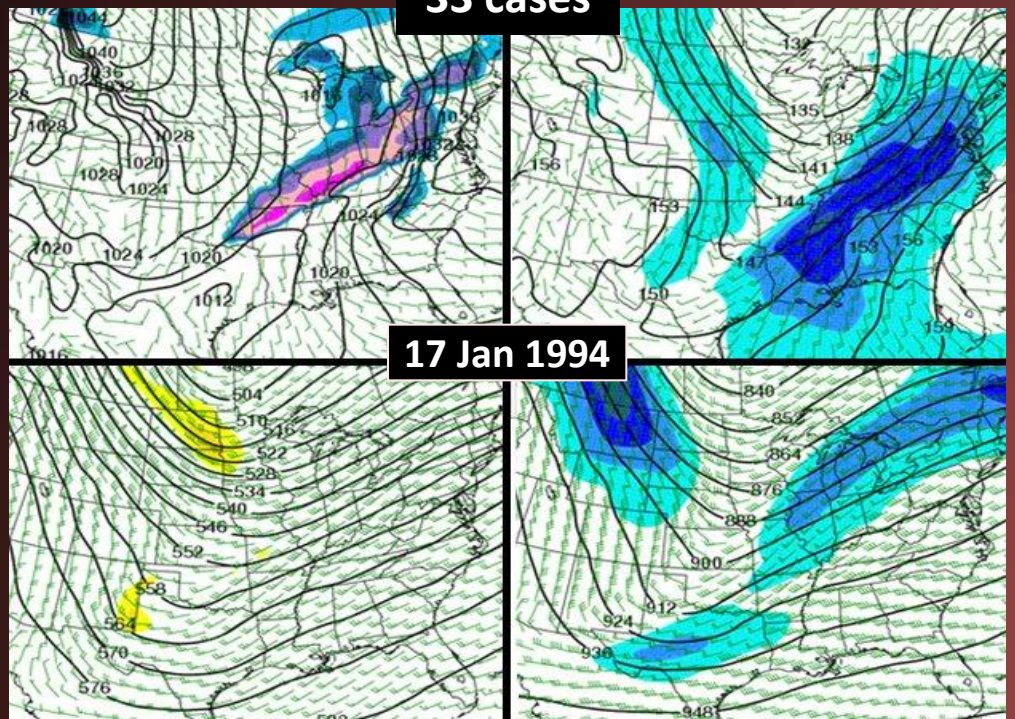


Type 1 composite 850 mb height (m) and frontogenesis (K 100 km^{-1} 3

1 composite 700 mb height (m) and frontogenesis (K 100 km^{-1} 3 hr^{-1})

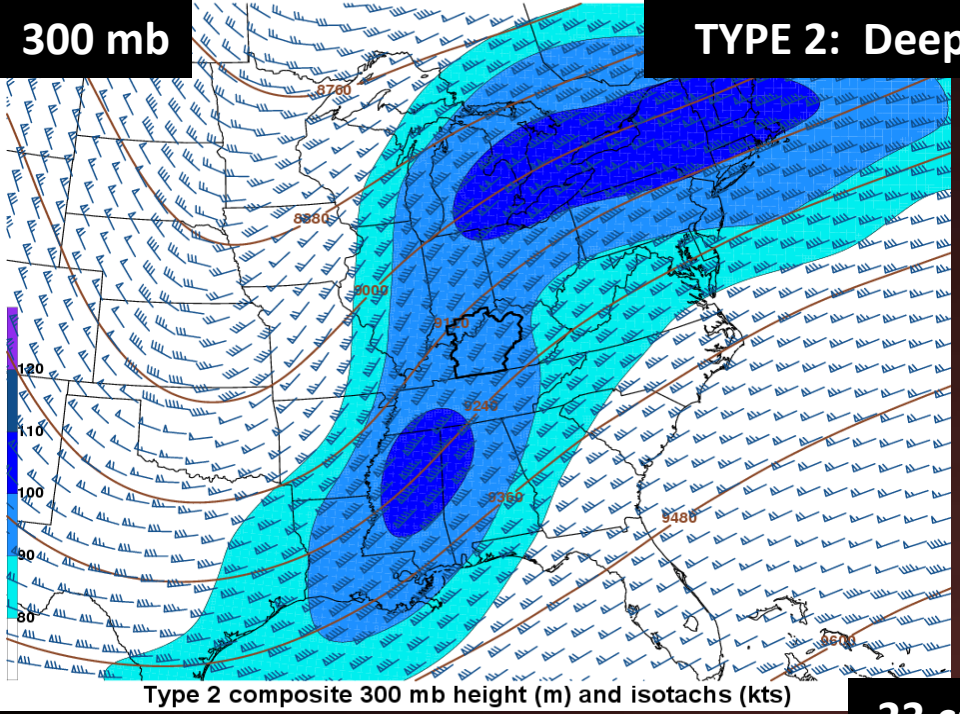
33 cases



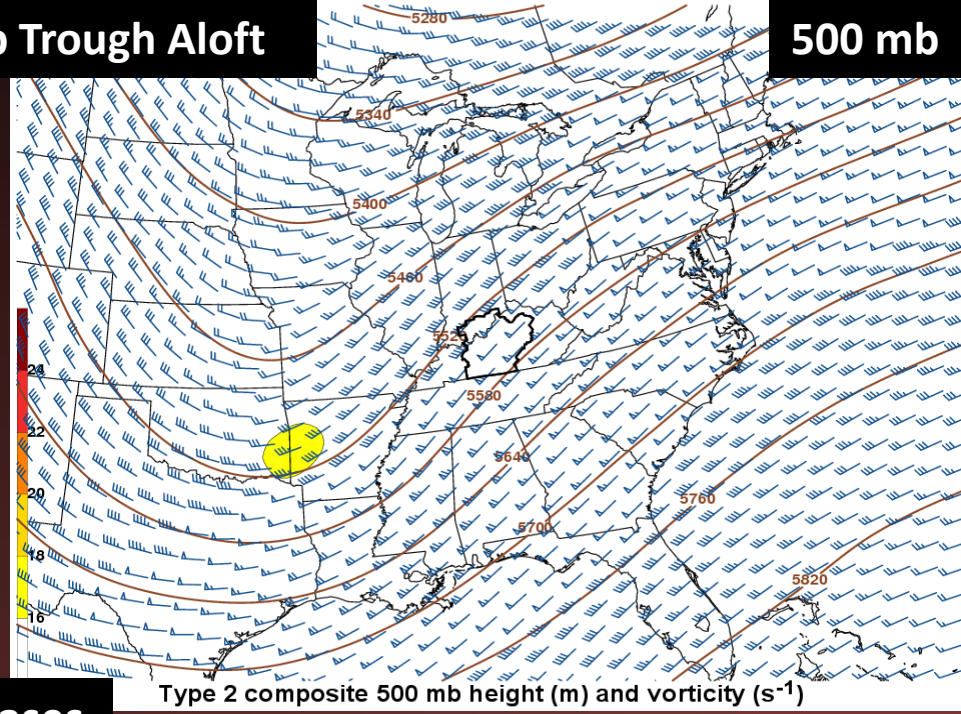


17 Jan 1994

TYPE 2: Deep Trough Aloft

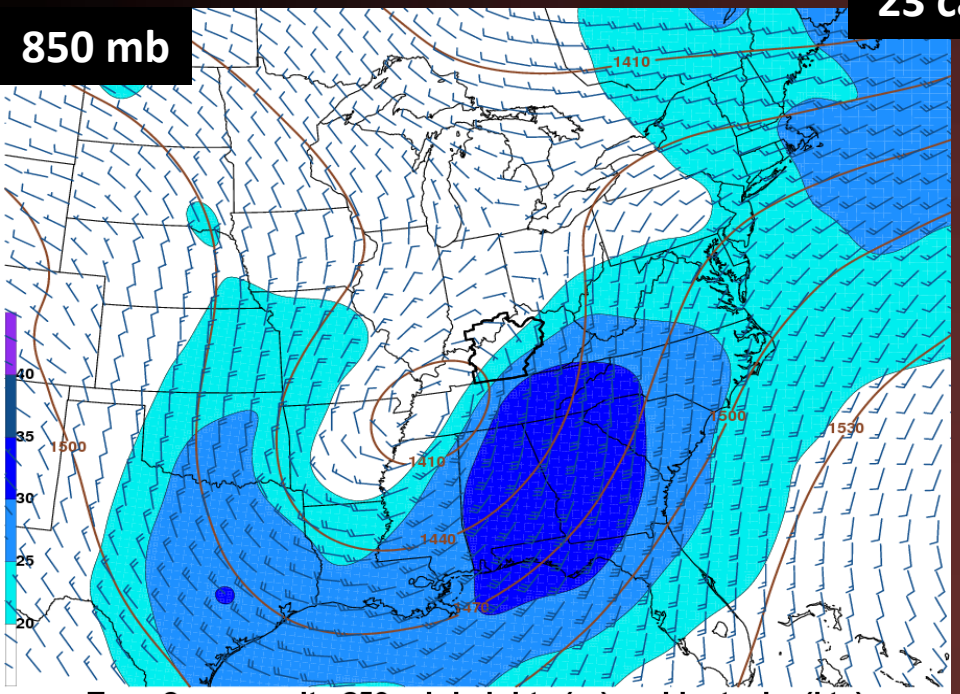


Type 2 composite 300 mb height (m) and isotachs (kts)

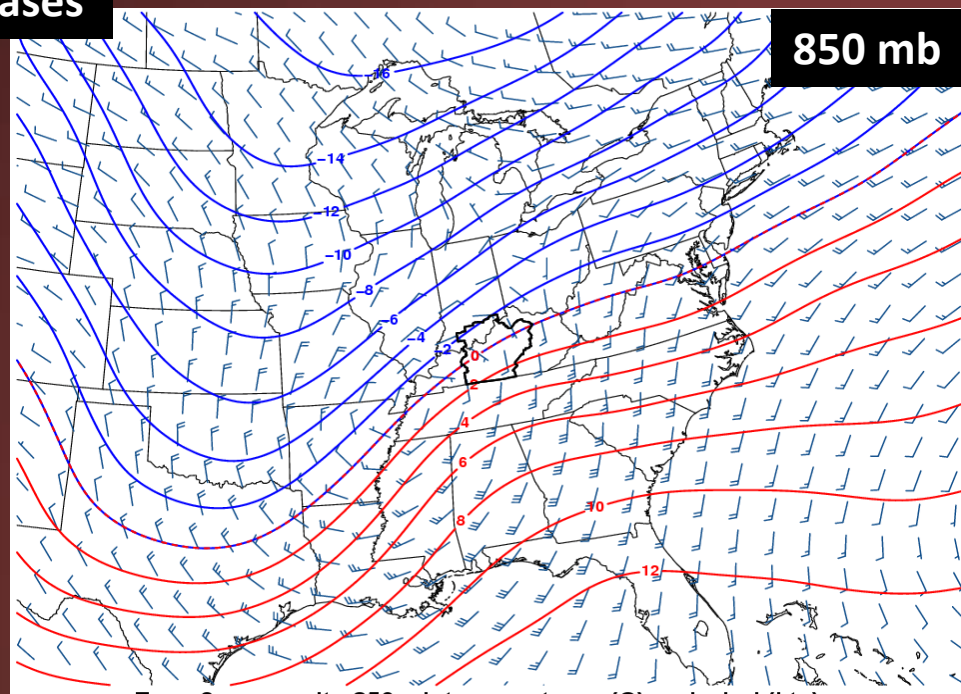


Type 2 composite 500 mb height (m) and vorticity (s^{-1})

23 cases



Type 2 composite 850 mb heights (m) and isotachs (kts)

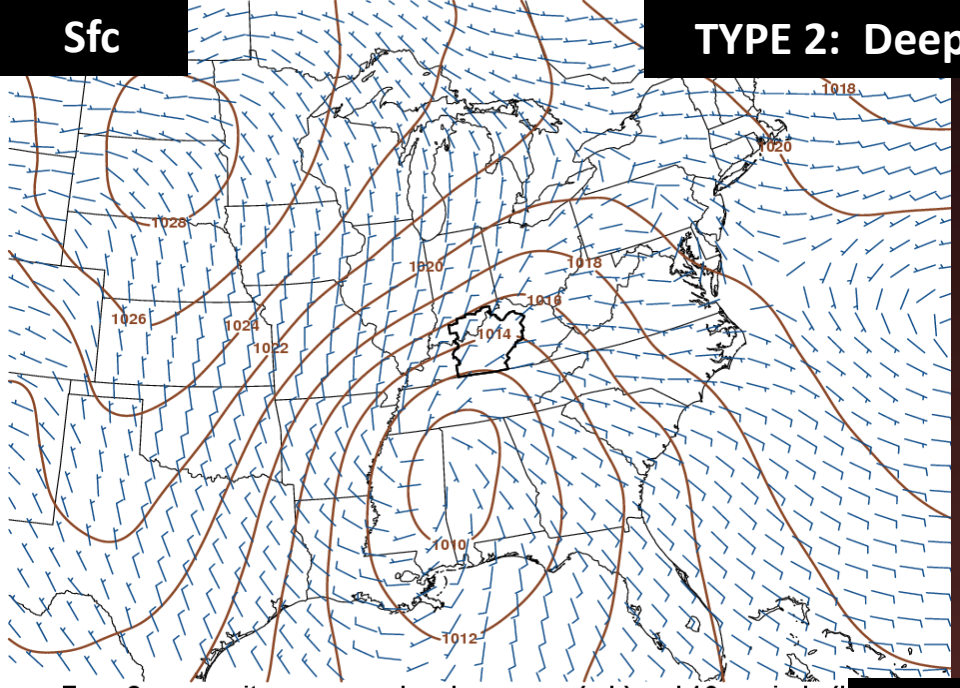


Type 2 composite 850 mb temperatures (C) and wind (kts)

TYPE 2: Deep Trough Aloft

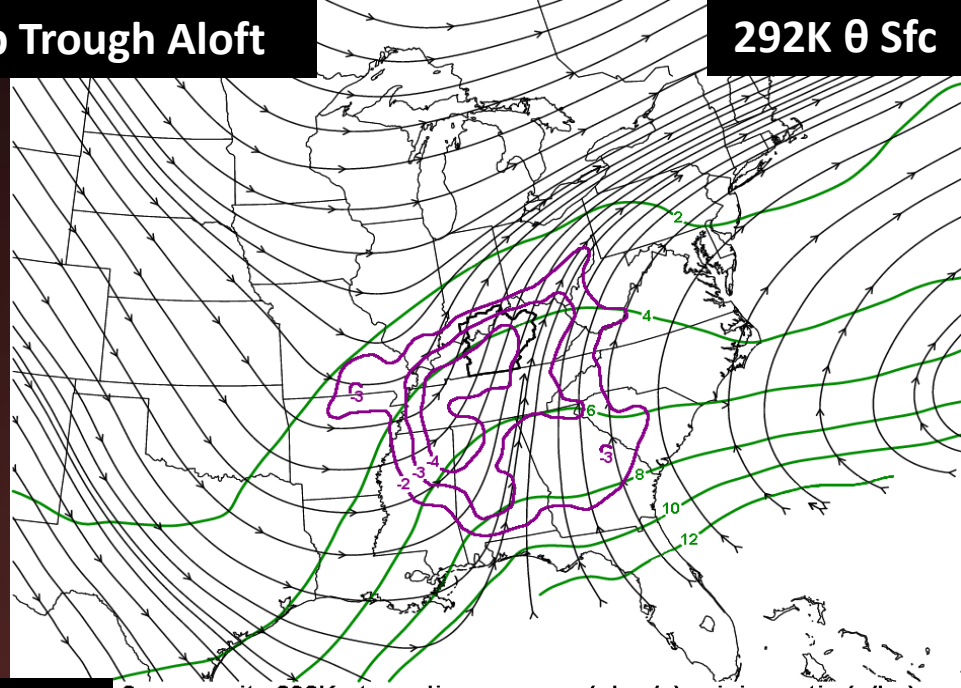
33 cases

Sfc



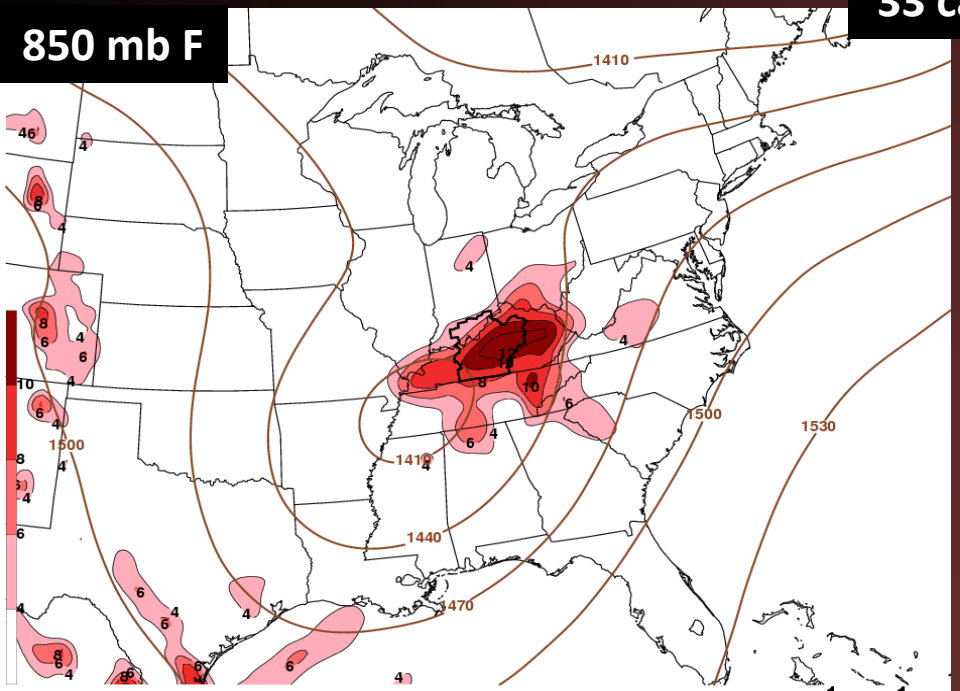
Type 2 composite mean sea level pressure (mb) and 10 m winds (K

292K θ Sfc



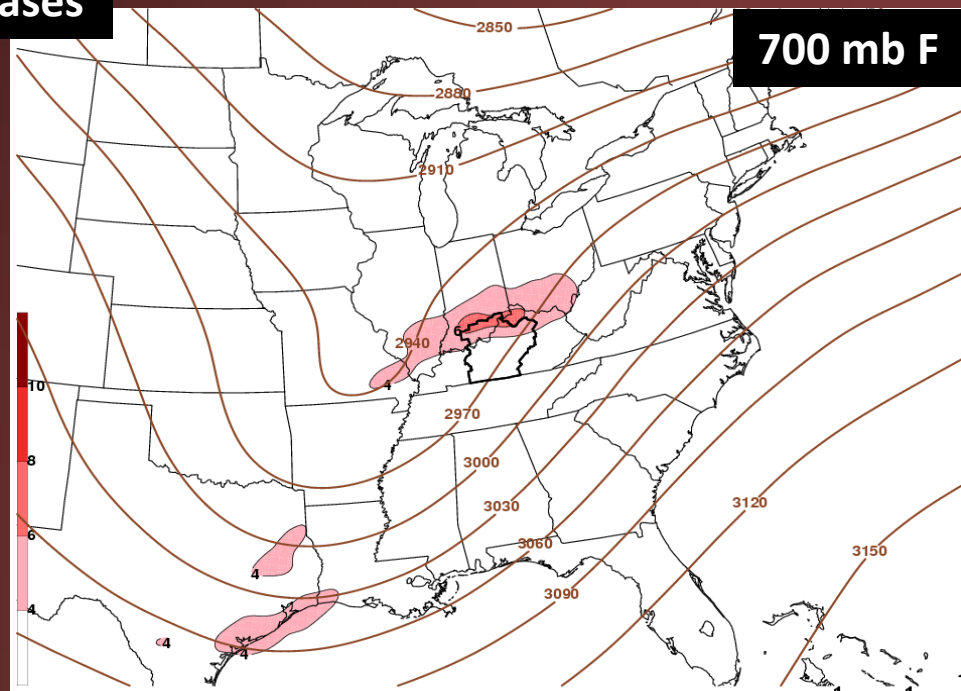
2 composite 292K streamlines, omega (ubar/s), mixing ratio (g/kg)

850 mb F



Type 2 composite 850 mb height (m) and frontogenesis (K 100 km^{-1} 3 hr^{-1})

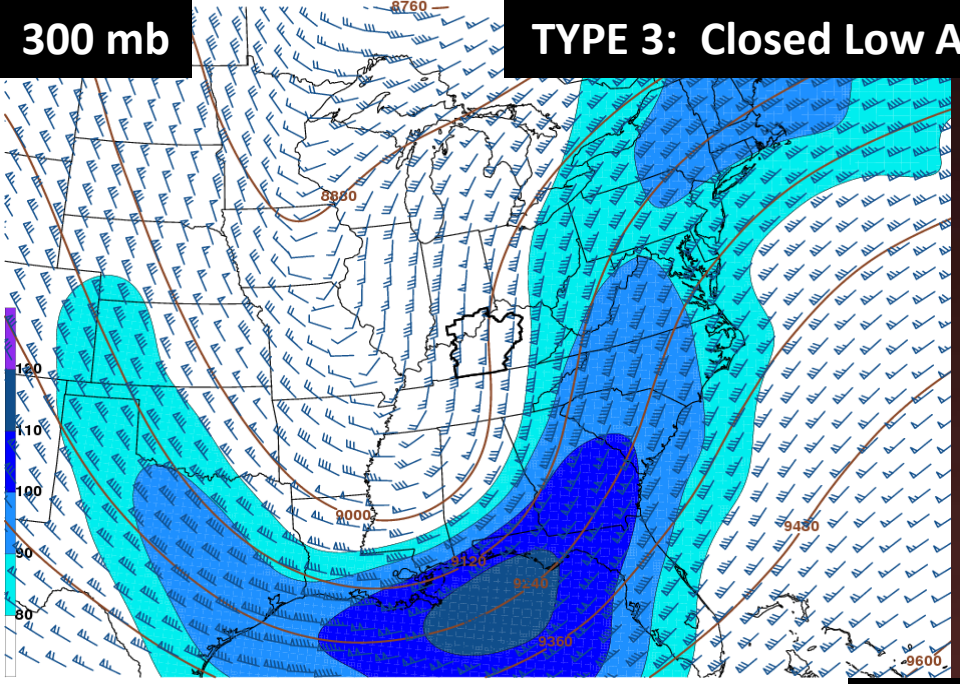
700 mb F



Type 2 composite 700 mb height (m) and frontogenesis (K 100 km^{-1} 3 hr^{-1})

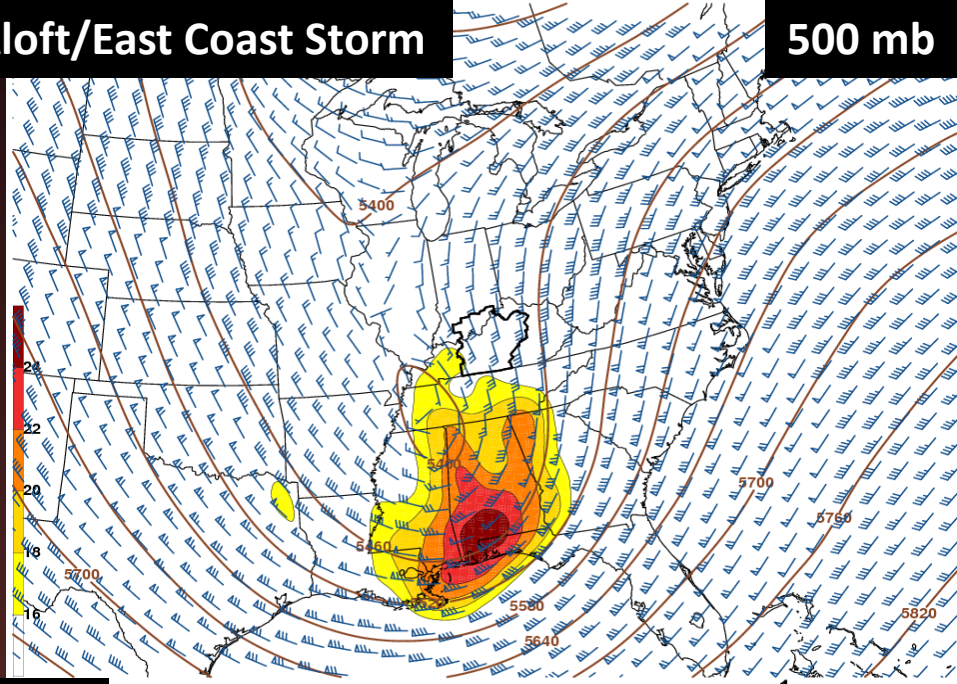
TYPE 3: Closed Low Aloft/East Coast Storm

300 mb



Type 3 composite 300 mb height (m) and isotachs (kts)

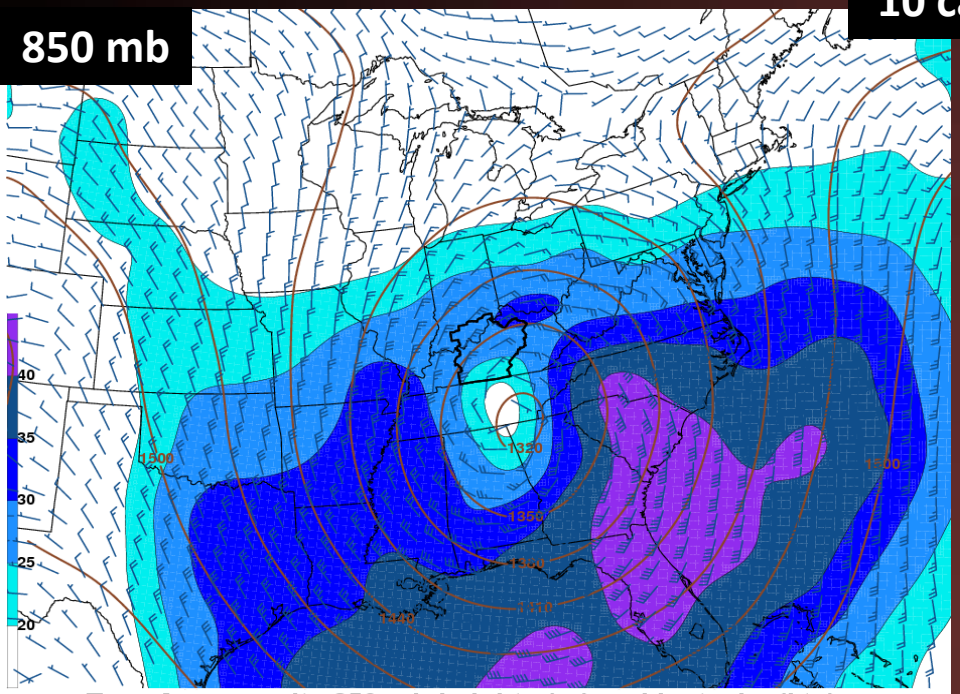
500 mb



Type 3 composite 500 mb height (m) and vorticity (s^{-1})

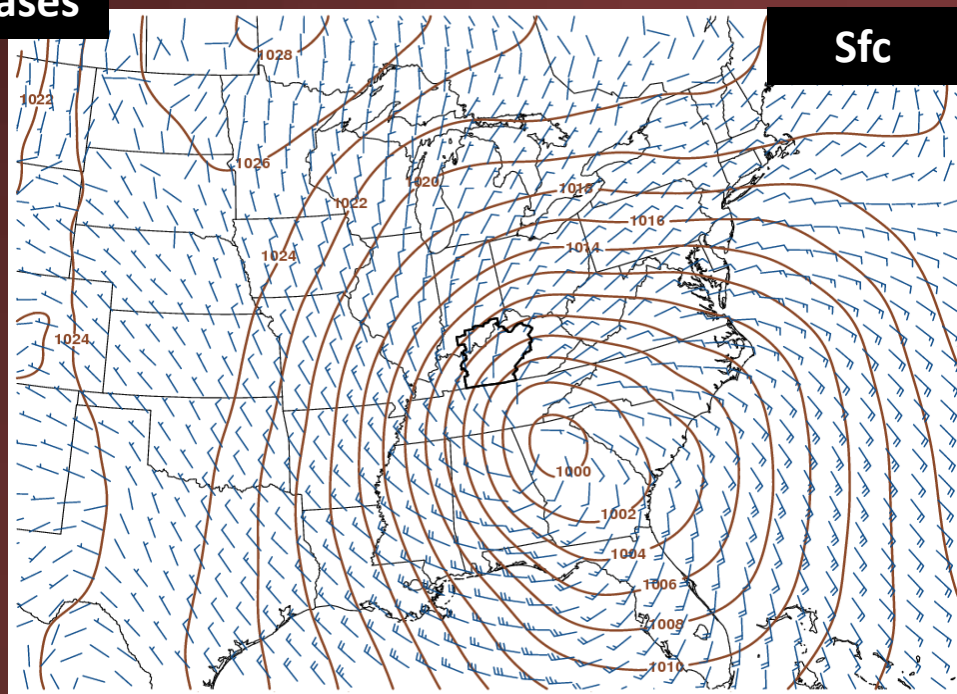
10 cases

850 mb



Type 3 composite 850 mb heights (m) and isotachs (kts)

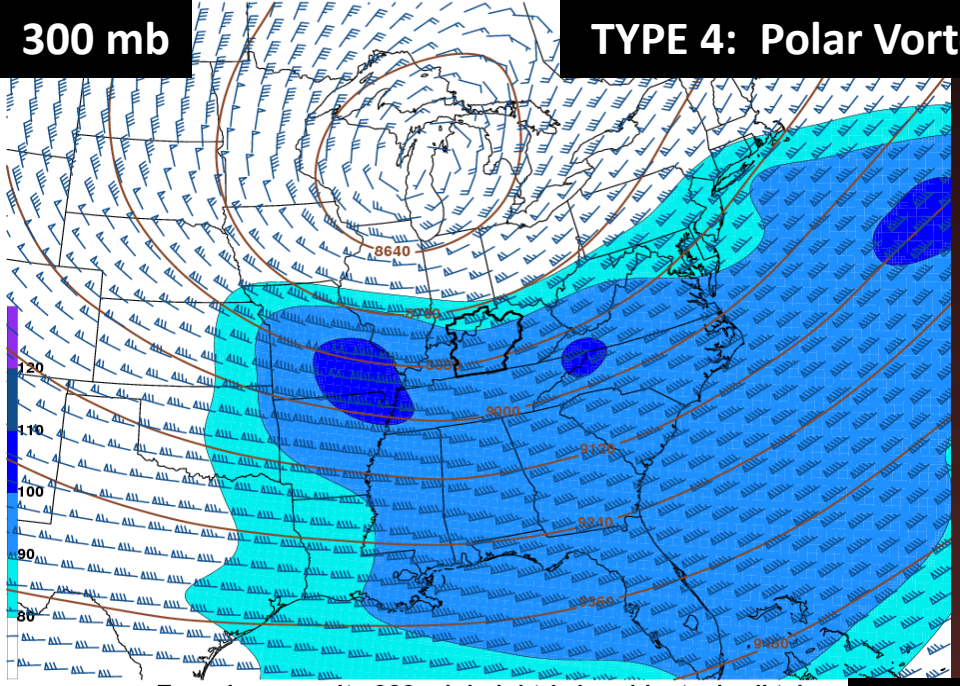
Sfc



Type 3 composite mean sea level pressure (mb) and 10 m winds (kts)

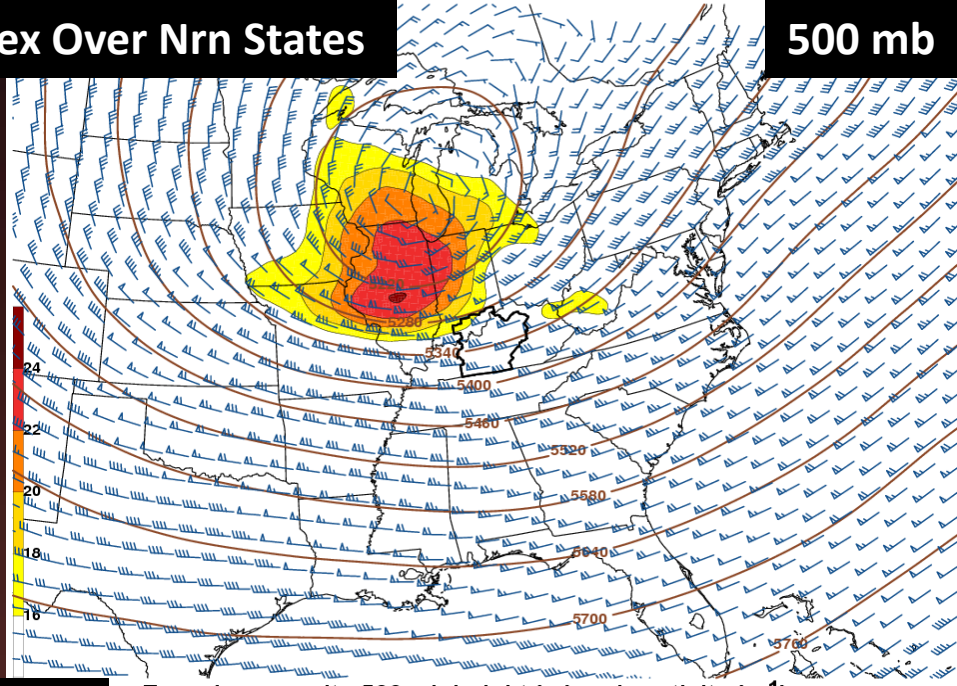
TYPE 4: Polar Vortex Over Nrn States

300 mb



Type 4 composite 300 mb height (m) and isotachs (kts)

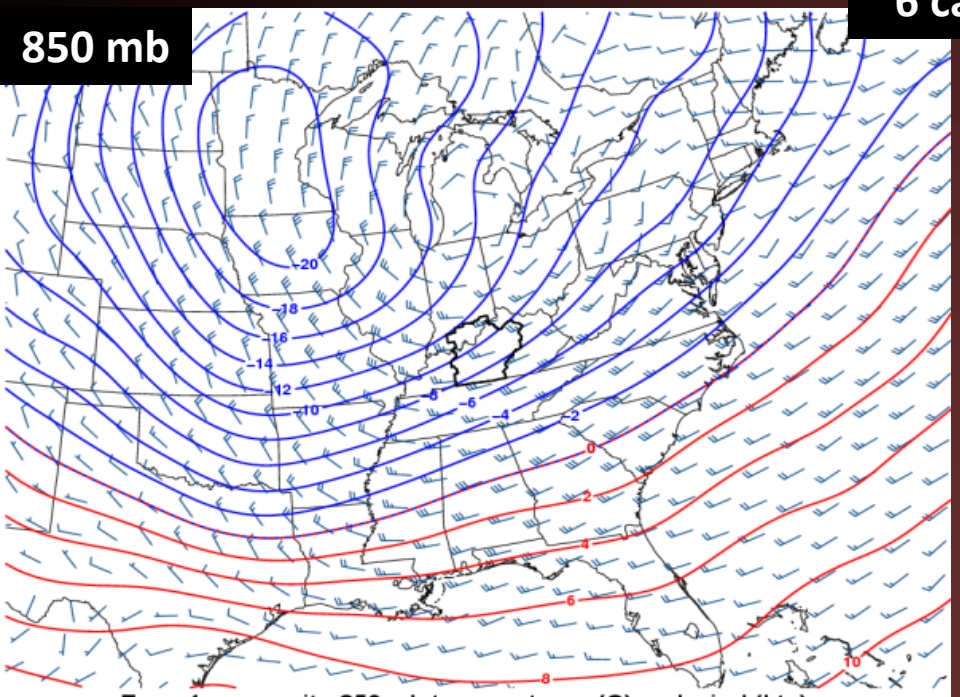
500 mb



Type 4 composite 500 mb height (m) and vorticity (s^{-1})

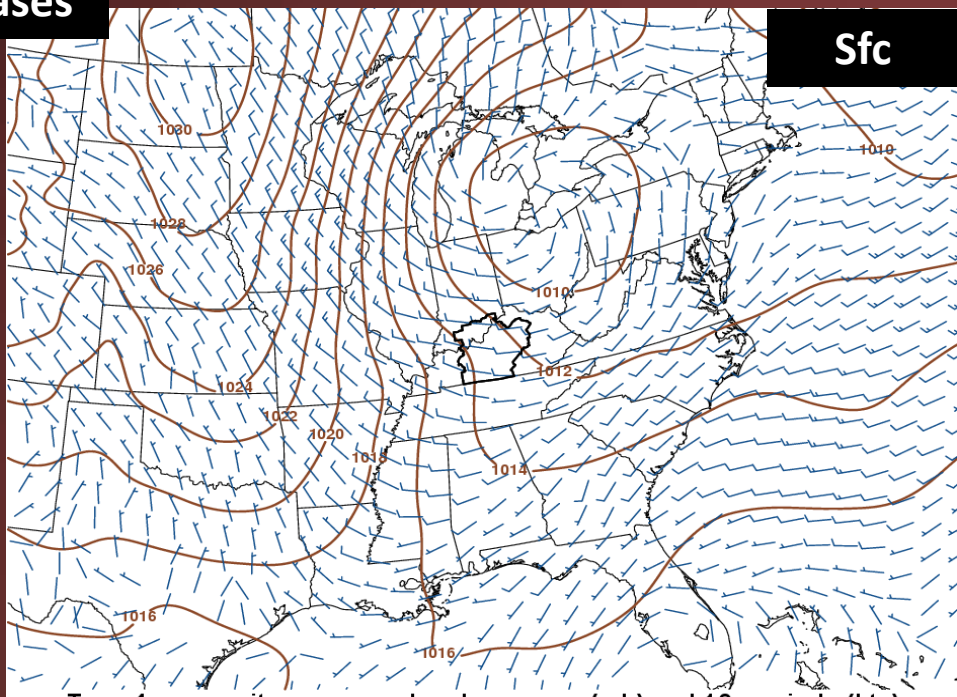
6 cases

850 mb



Type 4 composite 850 mb temperatures (C) and wind (kts)

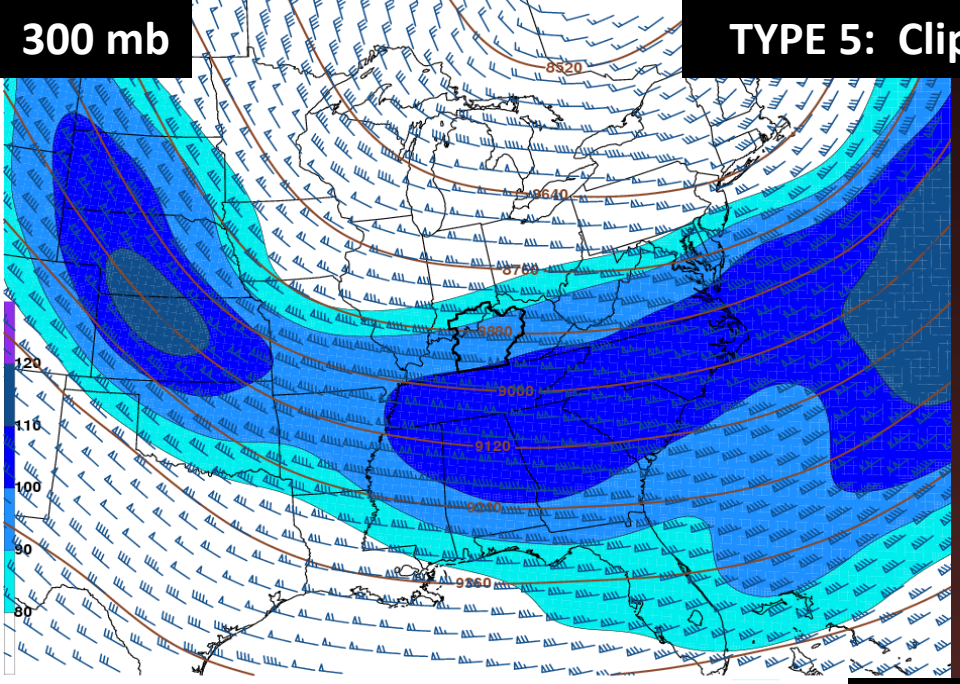
Sfc



Type 4 composite mean sea level pressure (mb) and 10 m winds (kts)

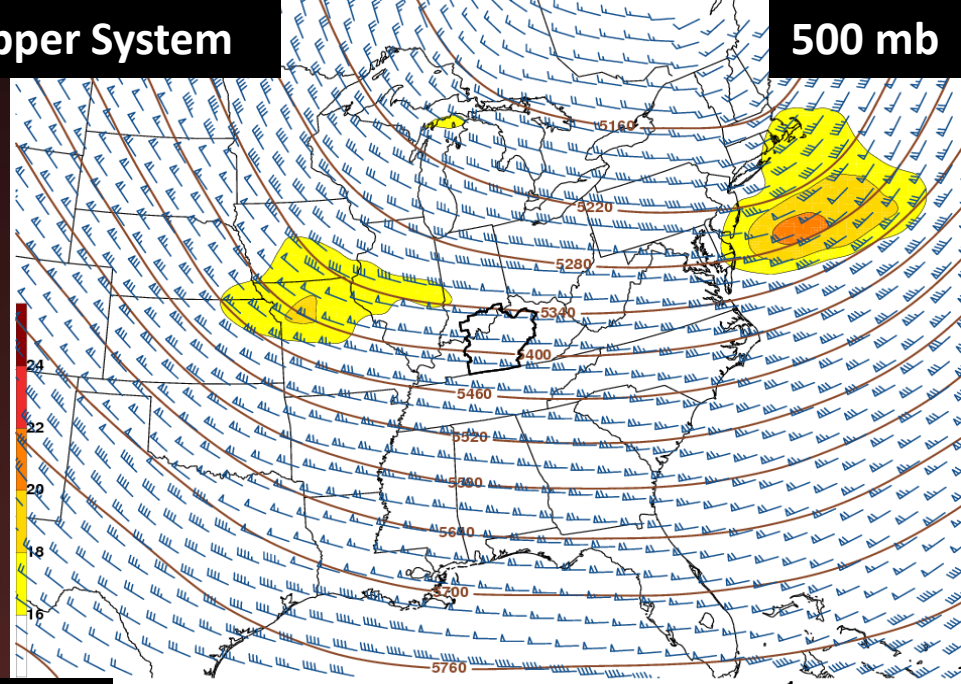
TYPE 5: Clipper System

300 mb



Type 5 composite 300 mb height (m) and isotachs (kts)

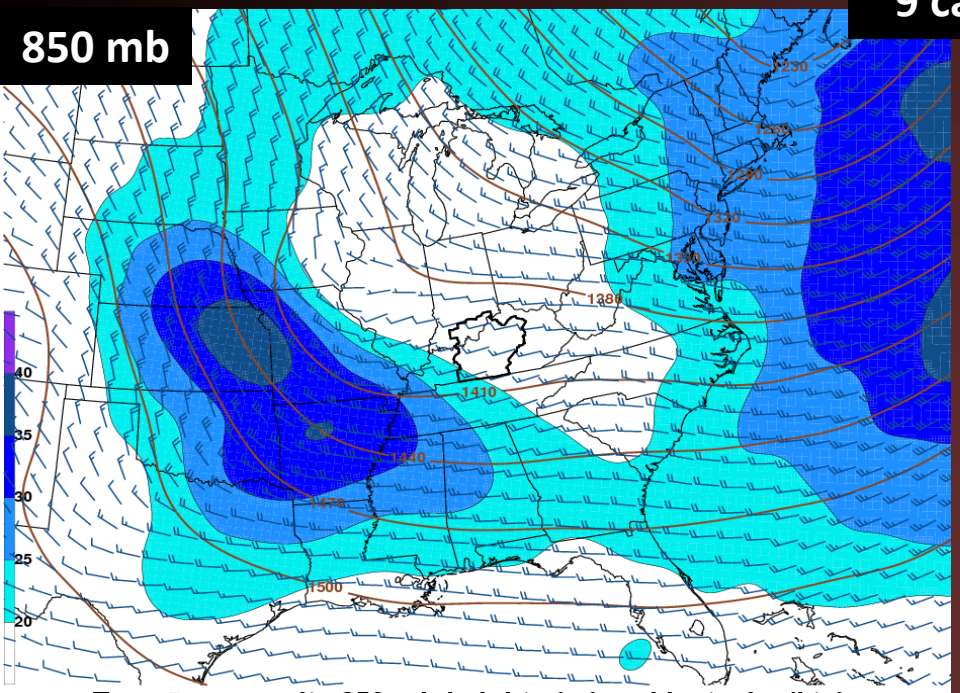
500 mb



Type 5 composite 500 mb height (m) and vorticity (s^{-1})

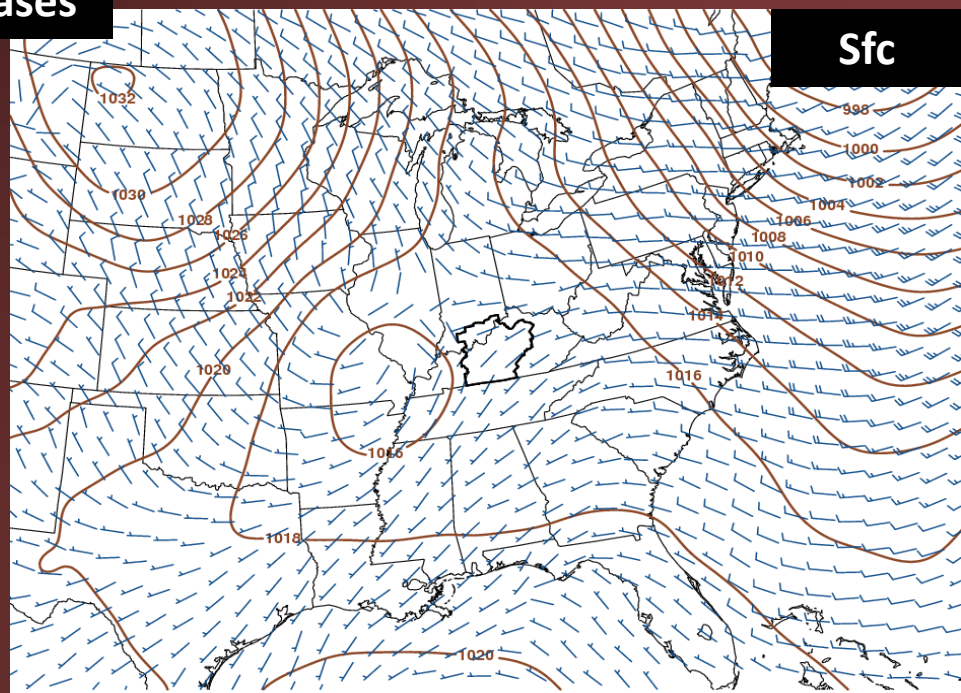
9 cases

850 mb



Type 5 composite 850 mb heights (m) and isotachs (kts)

Sfc



Type 5 composite mean sea level pressure (mb) and 10 m winds (kts)