Synoptic-Dynamic Interactions That Contributed to the Evolution of the Historic Cold Air Outbreak of 1985

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6 May 2016

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Overview

- Background
- Data and Methodology
- Synoptic Overview
- Case Study of Synoptic Interactions
- Discussion and Conclusions

Motivation

- 19-21 January 1985, a major CAO impacted the central and eastern US.

  -Resulted in at least 86 deaths.

  -At least 3 billion dollars of citrus lost in Florida (Rogers and Rohli 1991).

  -Forced the cancellation of all of President Reagan's outdoor inaugural festivities.

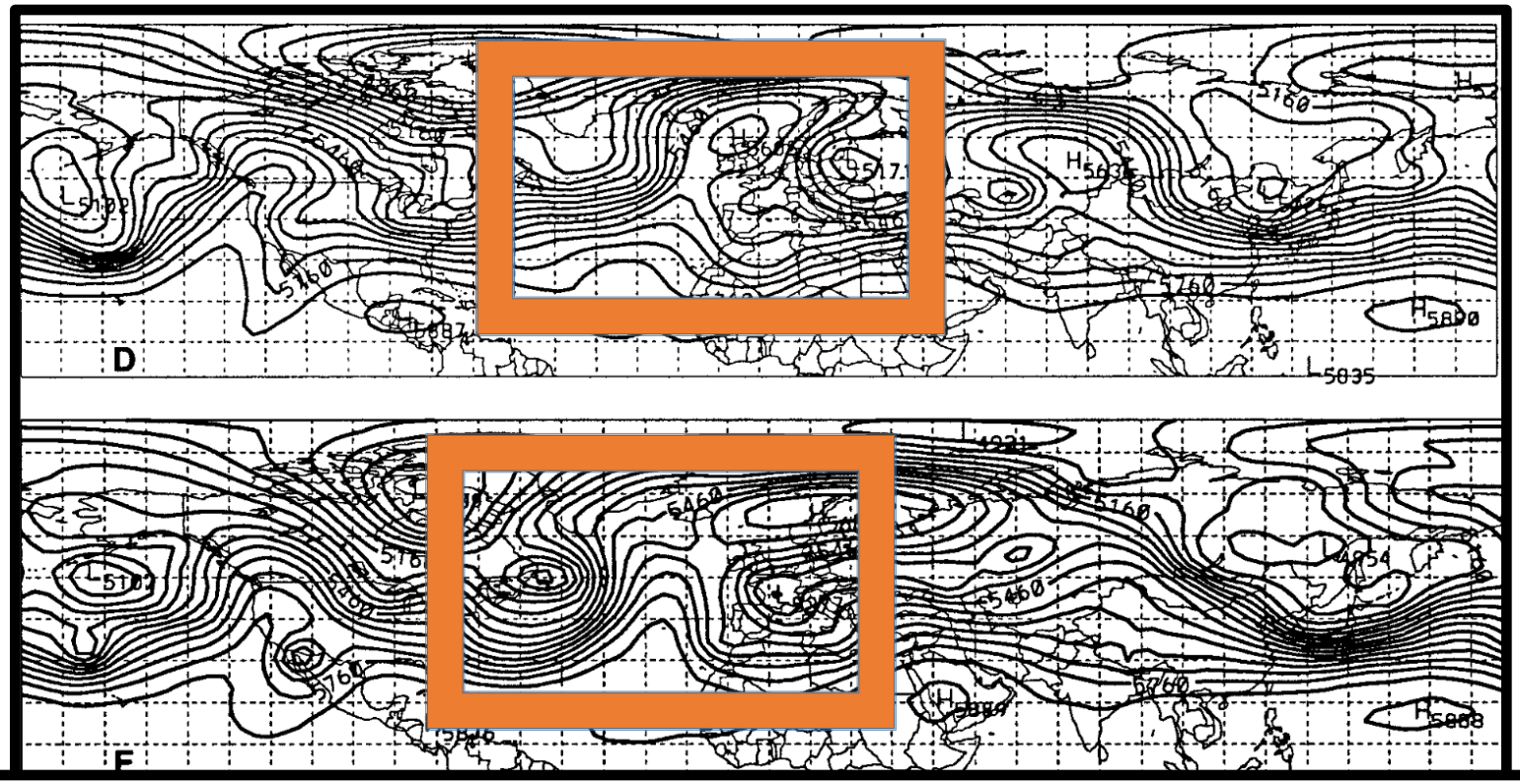
- Thus, the devastating impacts of this CAO warrant an exploration.

Previous Work

- Colucci and Baumhefner (1998, 1999):

  -Showed that this CAO occurred during a perturbed flow regime.

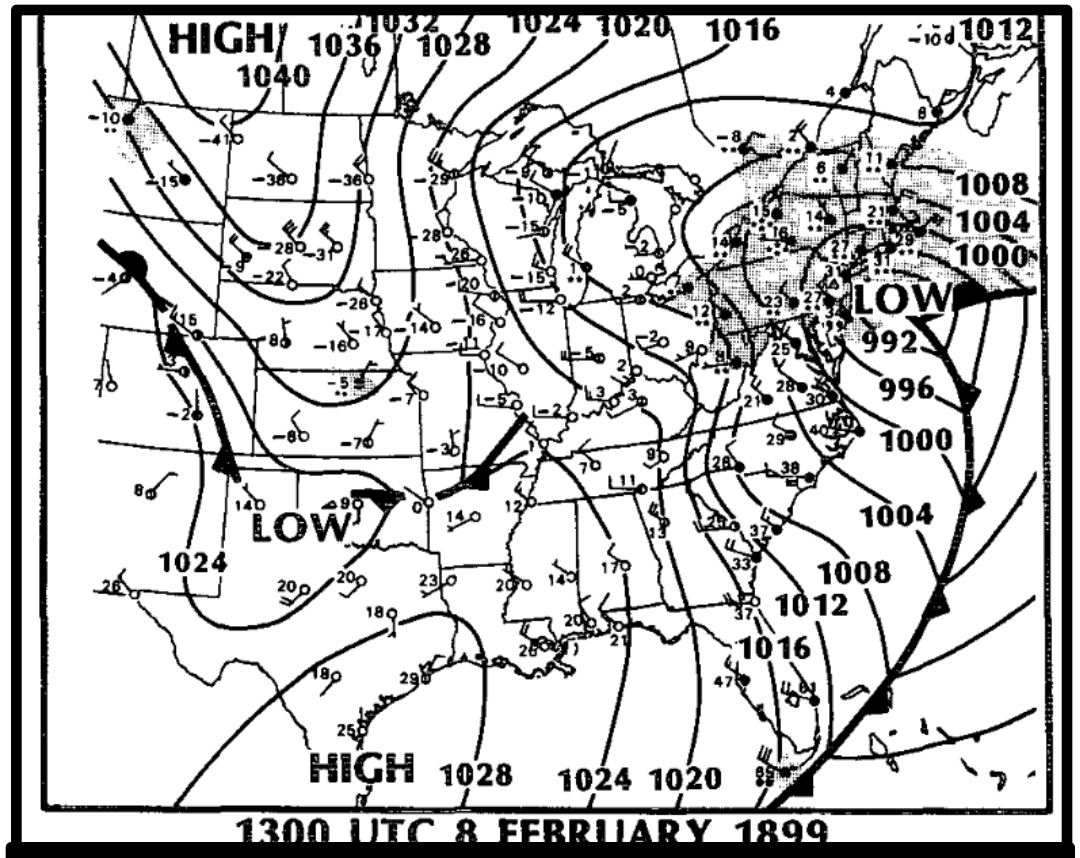
  -Preceded by a 500 hPa North Atlantic block that collapsed, coincident with Shapiro et. al (1987) observation of polar vortex.



Analyzed 500 hPa geopotential heights at 12 January (top) and 14 January 1985 (bottom). From Colucci and Baumhefner (1998).

Previous Work (Continued)

- Konrad and Colucci (1989):
  - -Showed that intense CAOs were associated with a polar anticyclone.
  - -Often accompanied by a downstream low-pressure system.
  - -Low-pressure system assists with cold-air advection.
  - -Agrees with previous case studies such as Kocin et. al (1988).



Surface analysis and station observations from 1300 UTC 8 February 1899. Courtesy of Kocin et. al (1988).

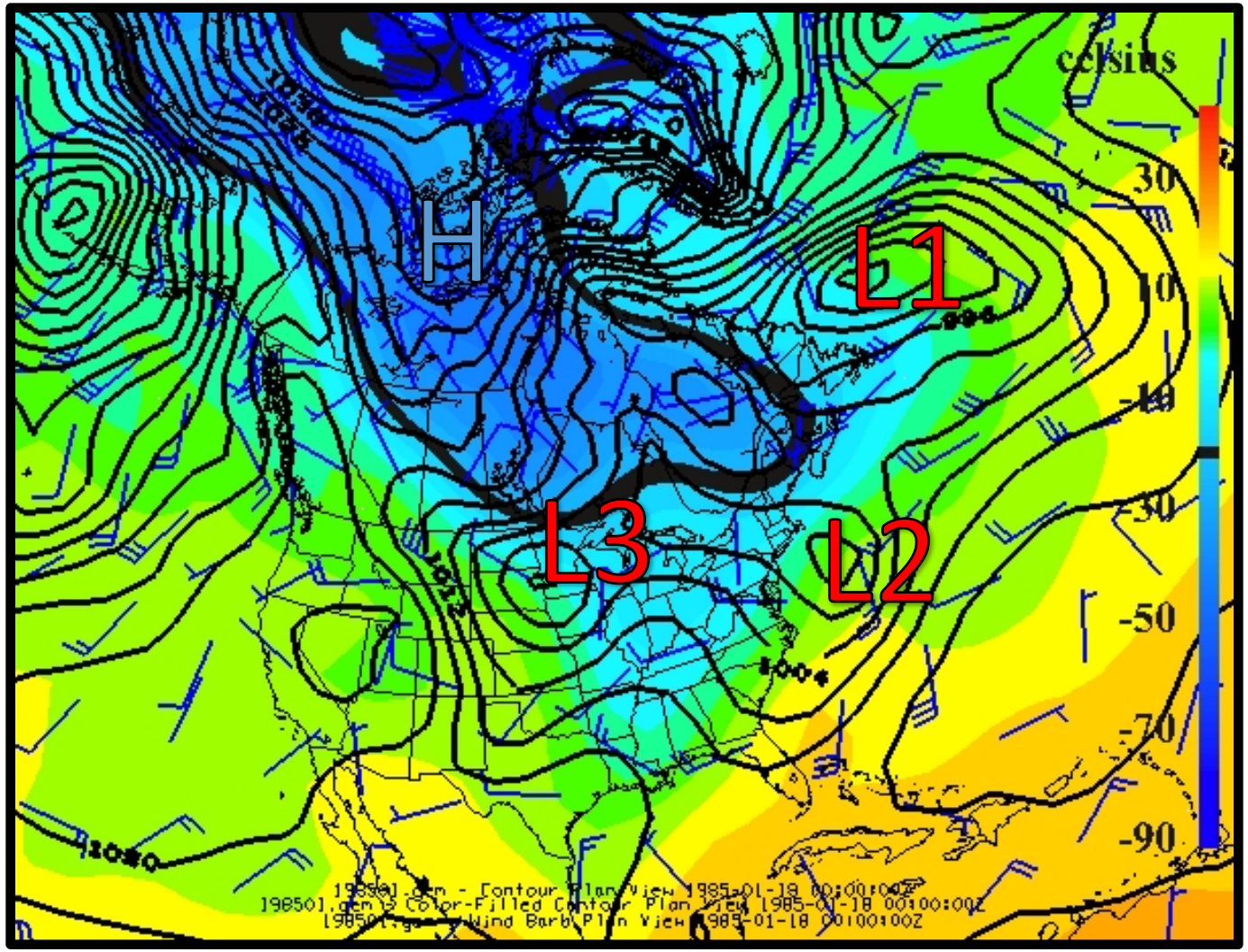
What interactions at upper and lower levels served to produce the January 1985 CAO?

Data and Methodology

- Data: 2.5x2.5 degree NCEP-NCAR Reanalysis Dataset (Kalnay et. al. 1996). available on 17 isobaric levels.
- The period studied was 0000 UTC 18-20 January at 24-hour intervals.
- Pressure, temperature, geopotential, potential vorticity (PV), winds, and divergence at the 250-, 500-, 850-hPa and surface levels.

Synoptic Overview

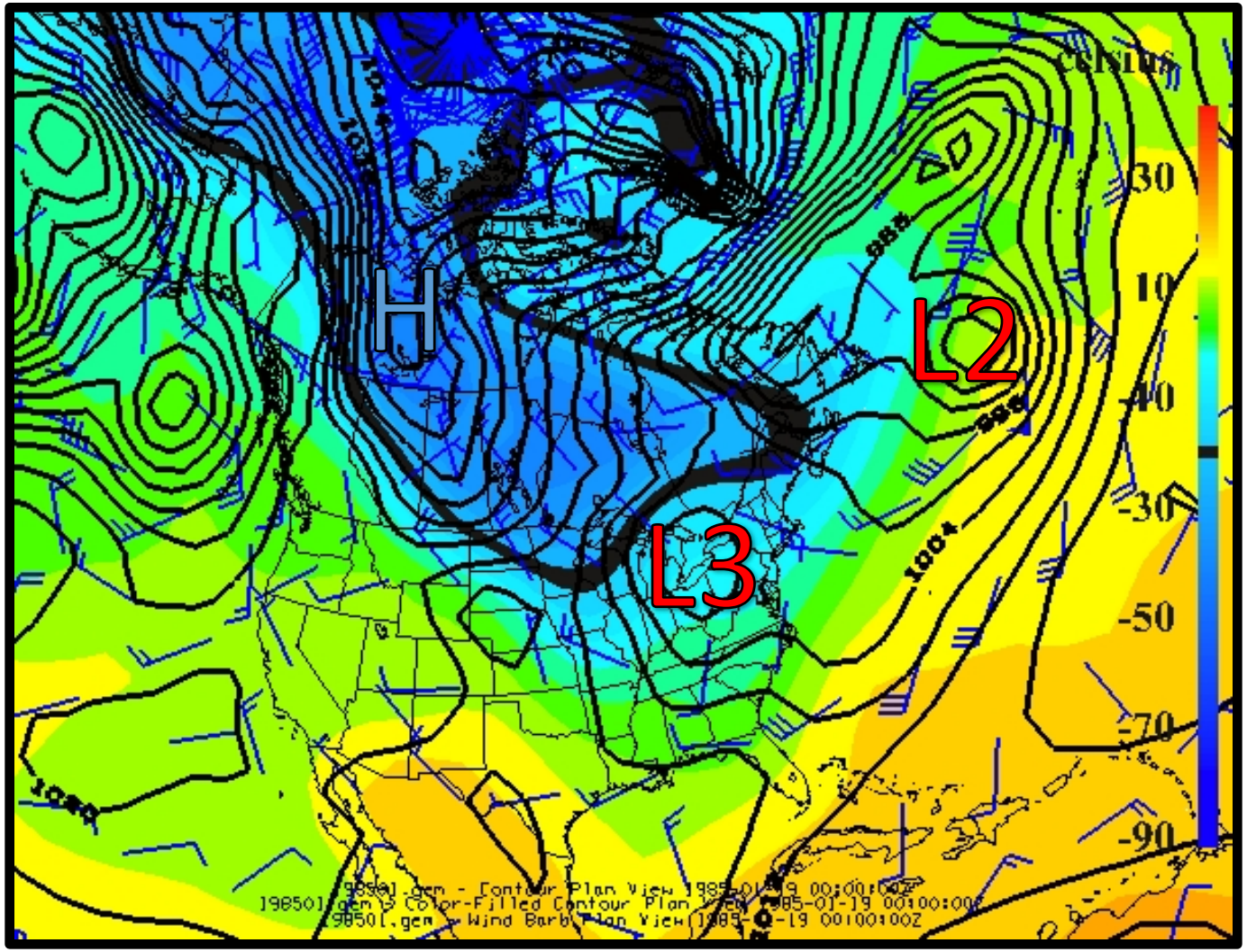
0000 UTC 18 January 1985



Sfc wind barbs, mean sea-level pressure (black contours, every 4 hPa), surface temperatures (fills), **-18 degree Celsius line (bolded black line).** Boundary between green and teal denotes 0 degree Celsius line.

Synoptic Overview

0000 UTC 19 January 1985



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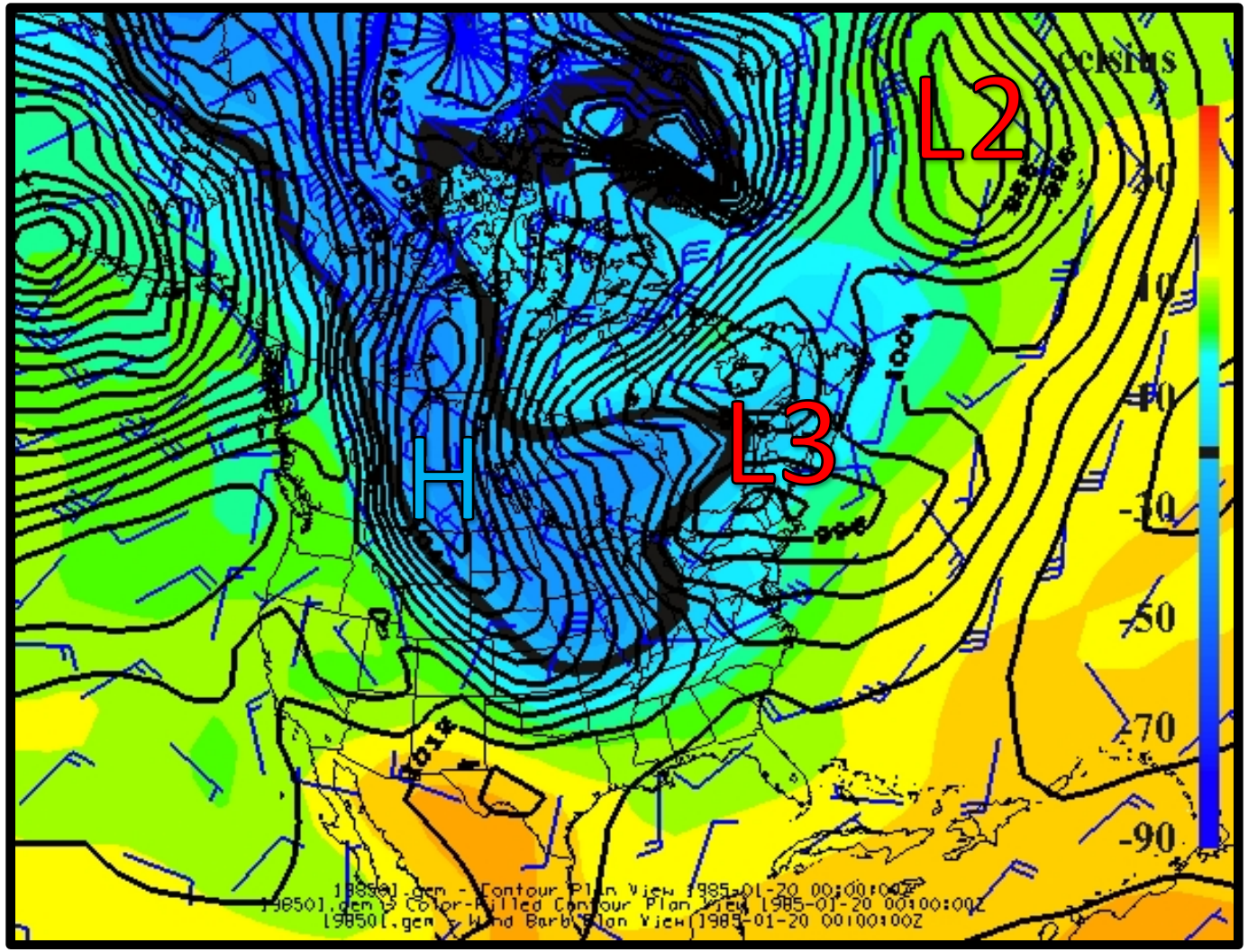
Synoptic Overview

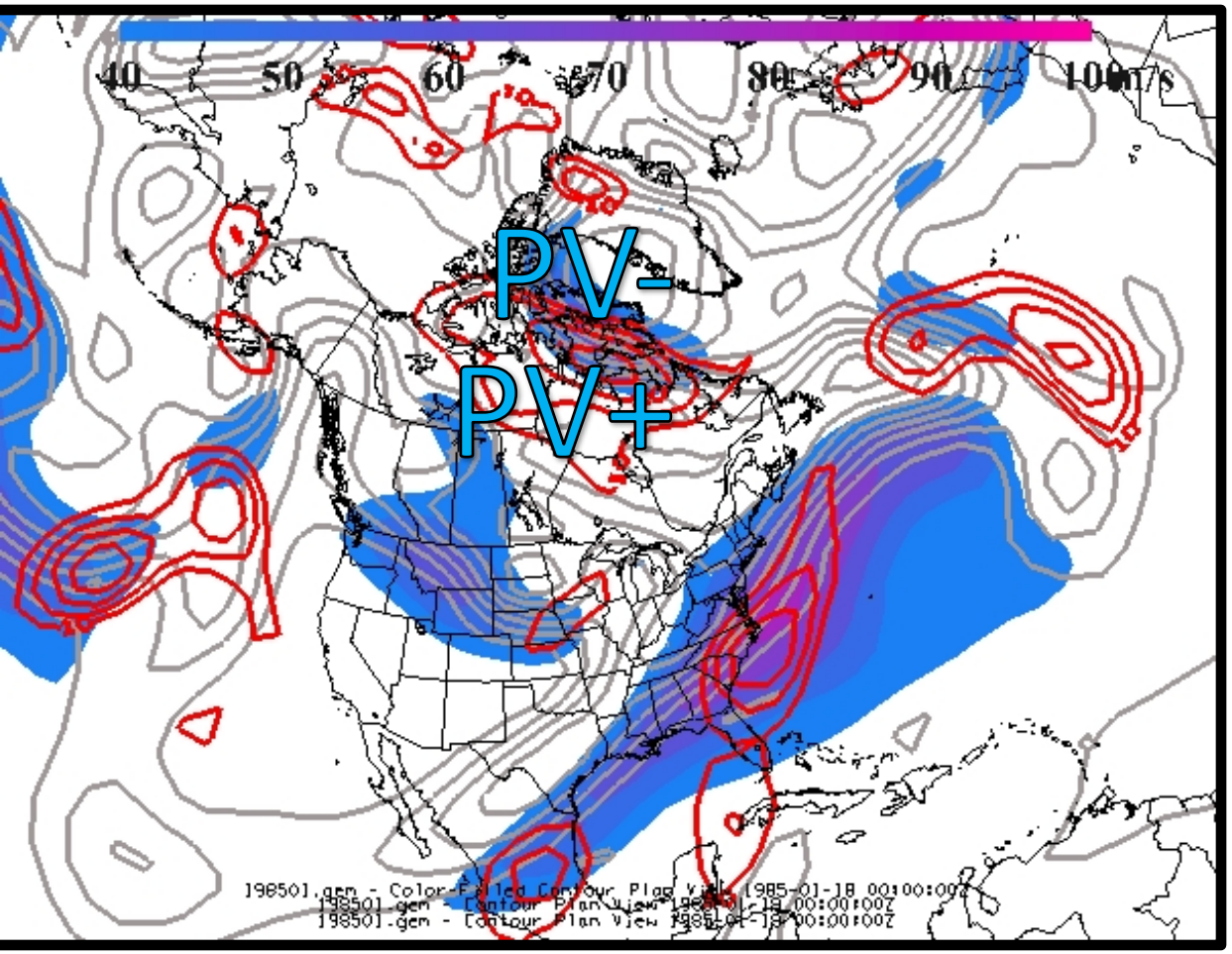
0000 UTC 20 January 1985

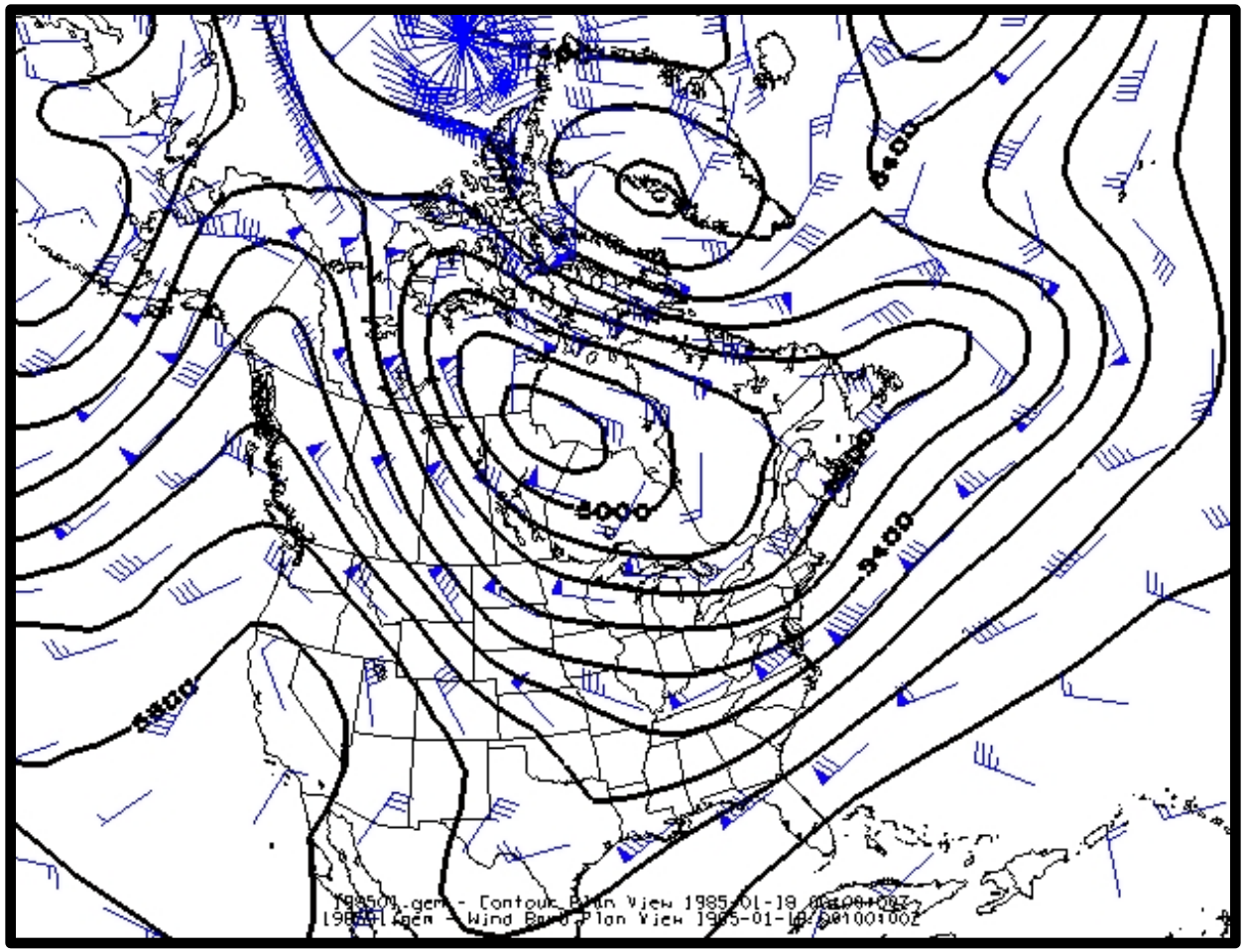


Sfc wind barbs, mean sea-level pressure (black contours, every 4 hPa), sfc temperatures (fills), **-18 degree Celsius line (bolded black line).** Boundary between green and teal denotes the 0 degree Celsius line.

Upper-Tropospheric Dynamics

0000 UTC 18 January 1985



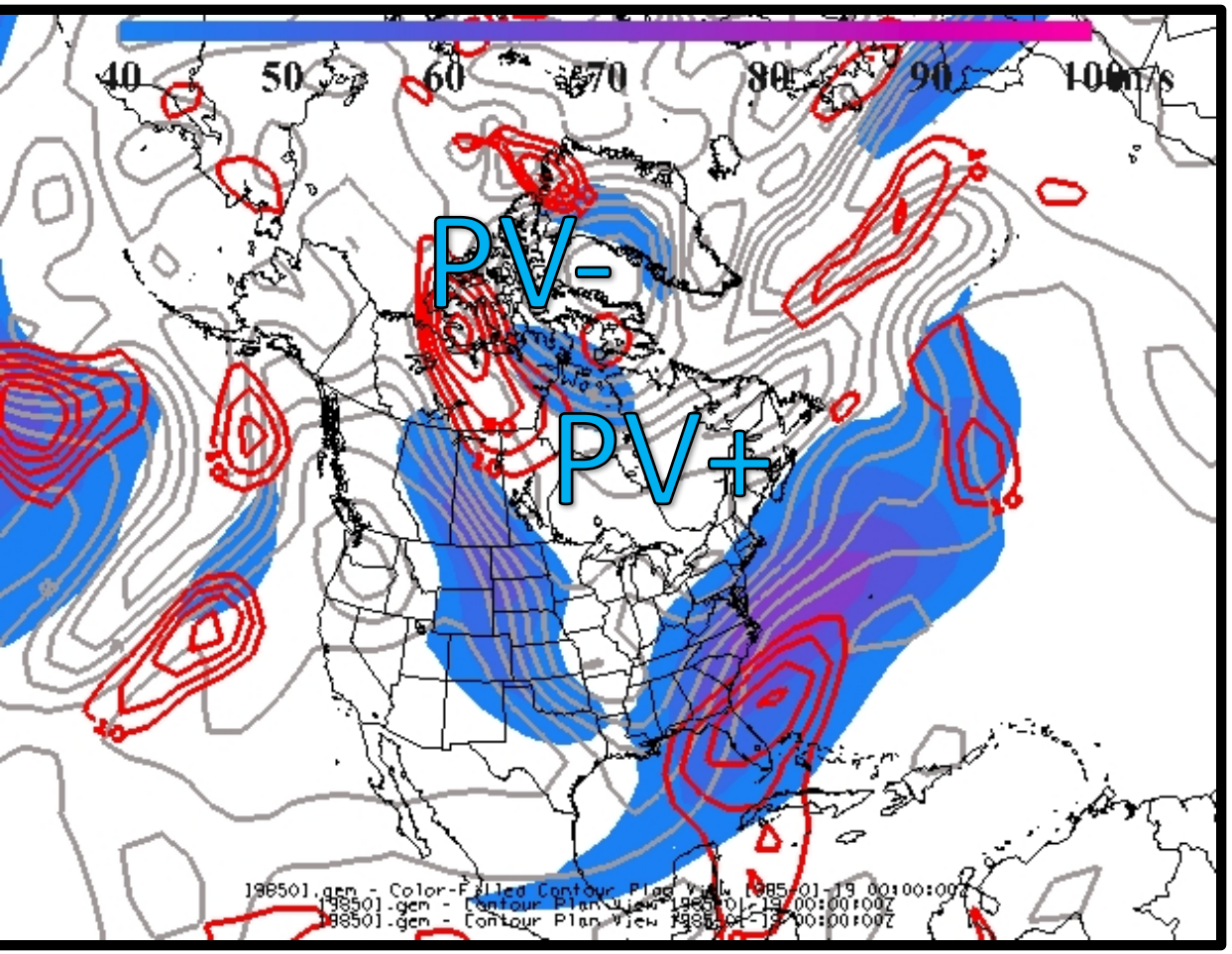


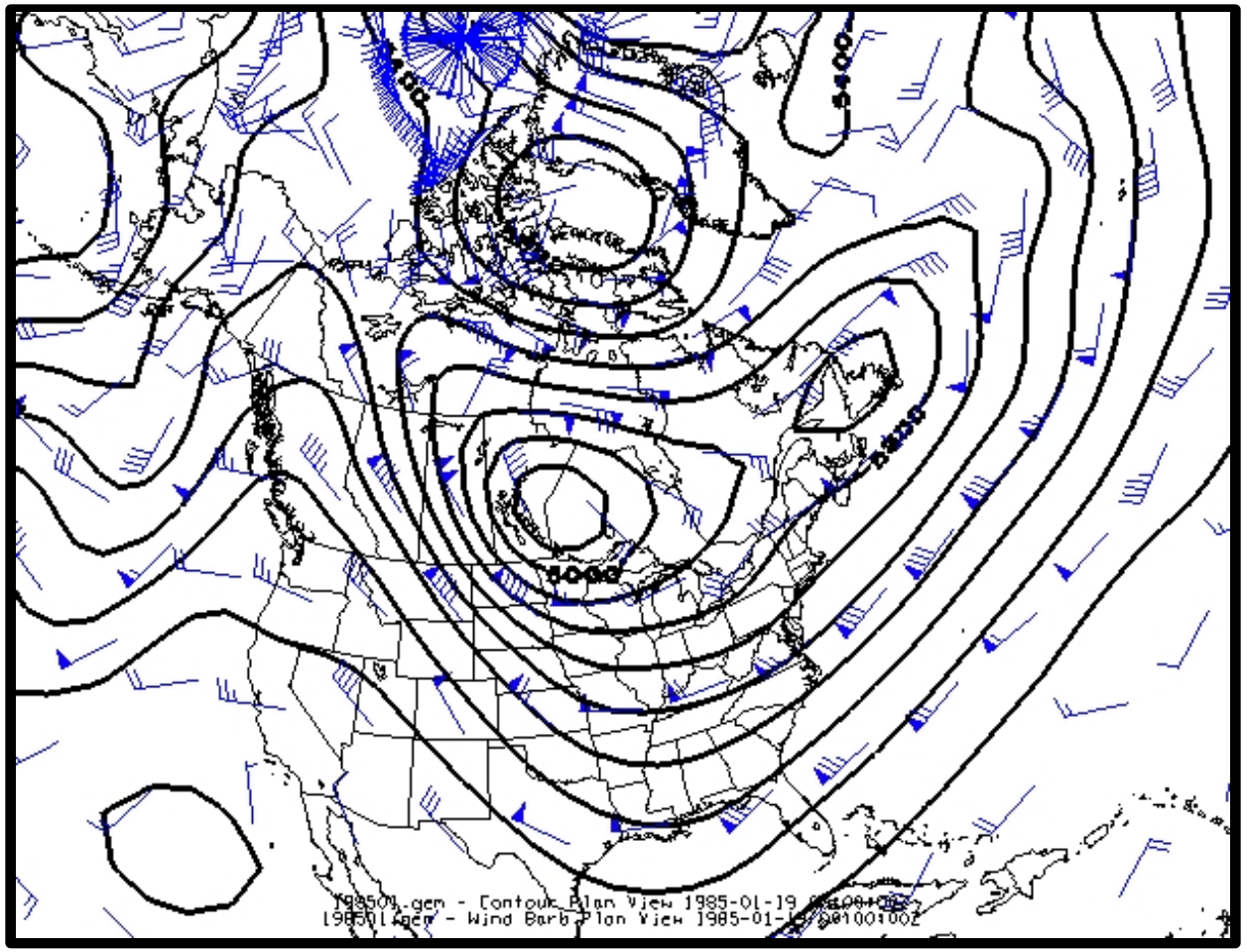
300-200 hPa PV (gray contours, contoured every 1.5 PVU), 250-hPa divergence (red, contoured every 10e-5 s^{-1}), 250-hPa isotachs (fills).

500-hPa wind barbs, 500-hPa geopotential heights(black contours, every 100 meters).

Upper-Tropospheric Dynamics

0000 UTC 19 January 1985





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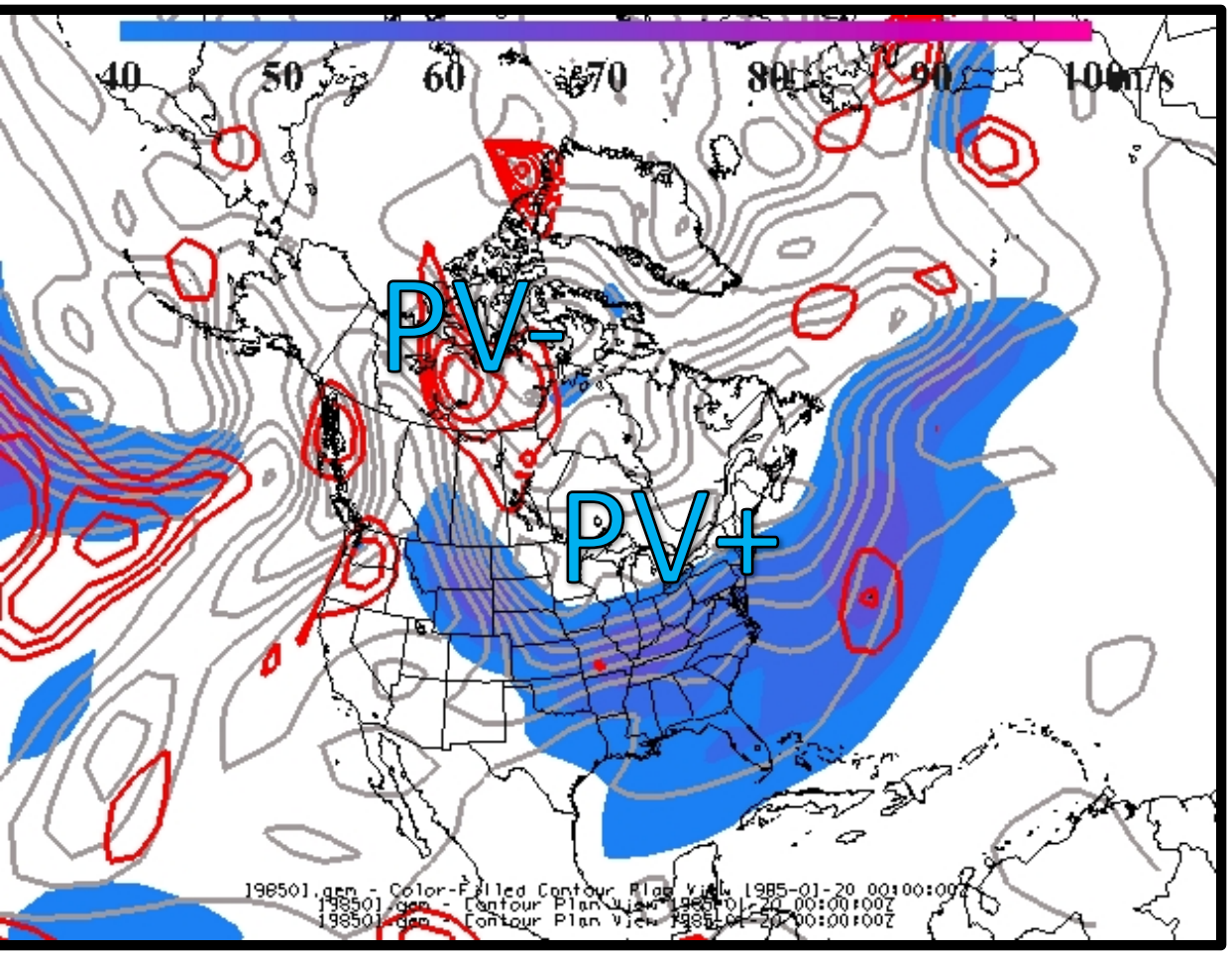
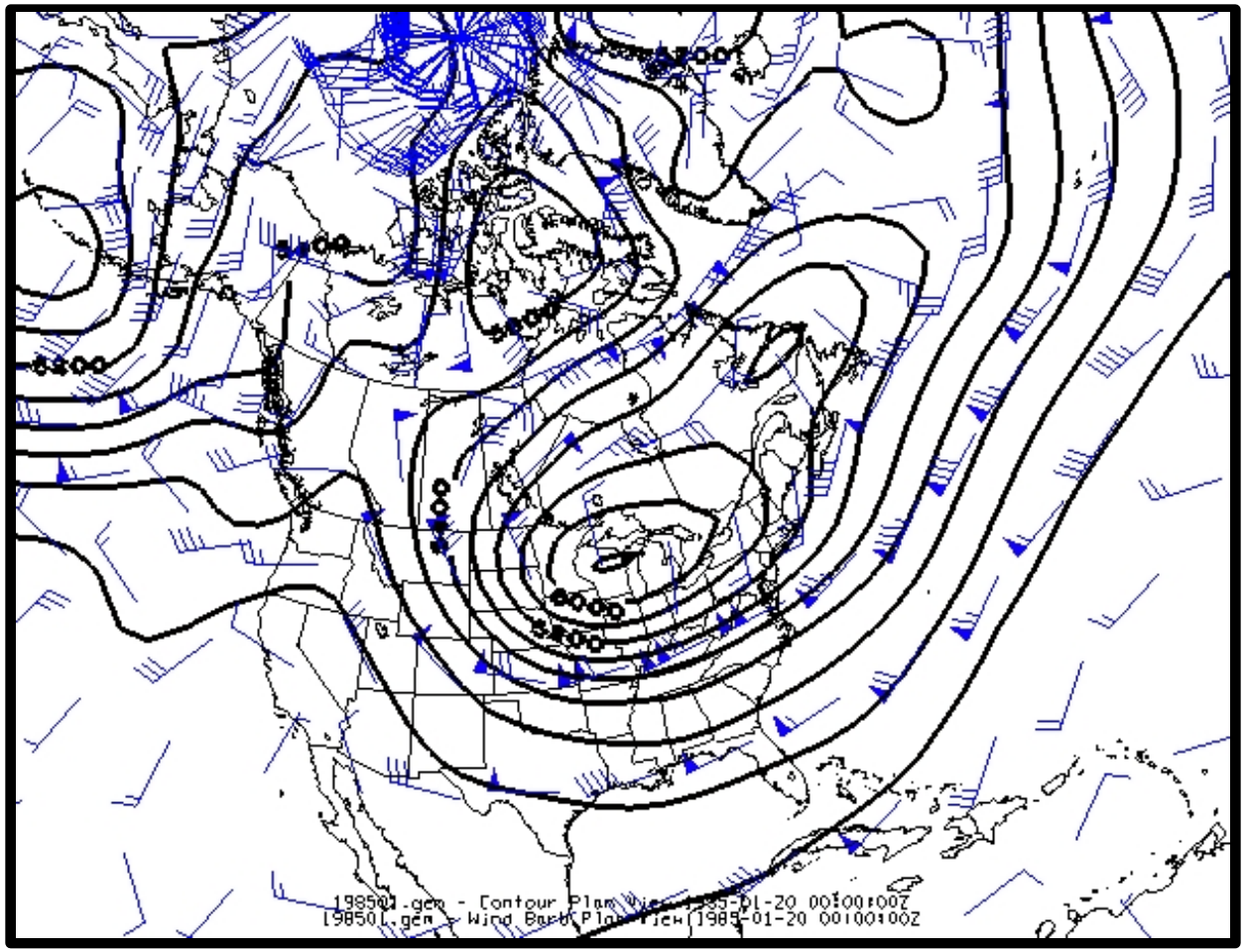
Upper-Tropospheric Dynamics

0000 UTC 20 January 1985



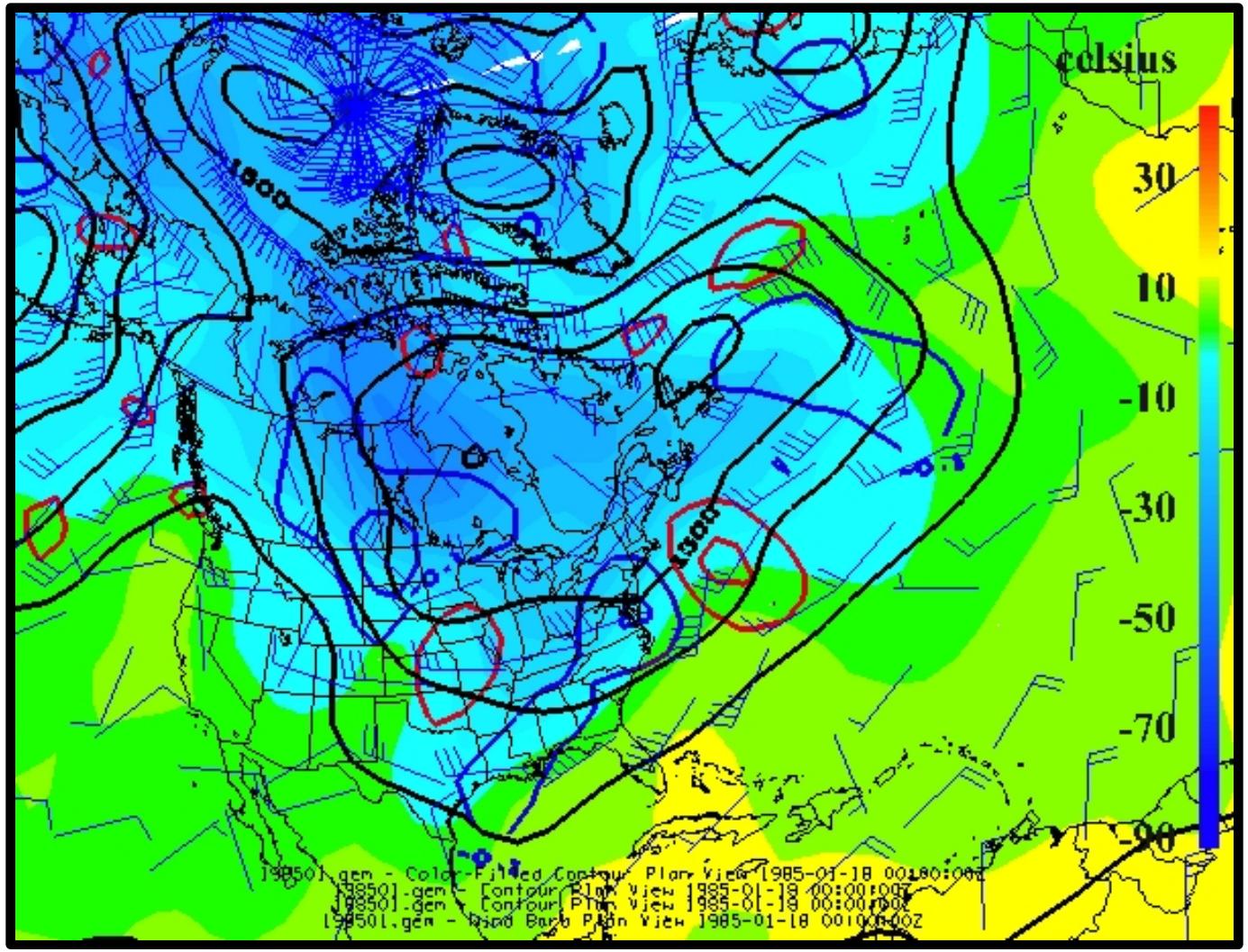


300-200 hPa PV (gray contours, contoured every 1.5 PVU), 200-hPa divergence (red, contoured every 10e-5 s^{-1}), 200-hPa isotachs (fills).

500 hPa wind barbs, 500 hPa geopotential heights(black contours, every 100 meters).

Lower-Tropospheric Dynamics

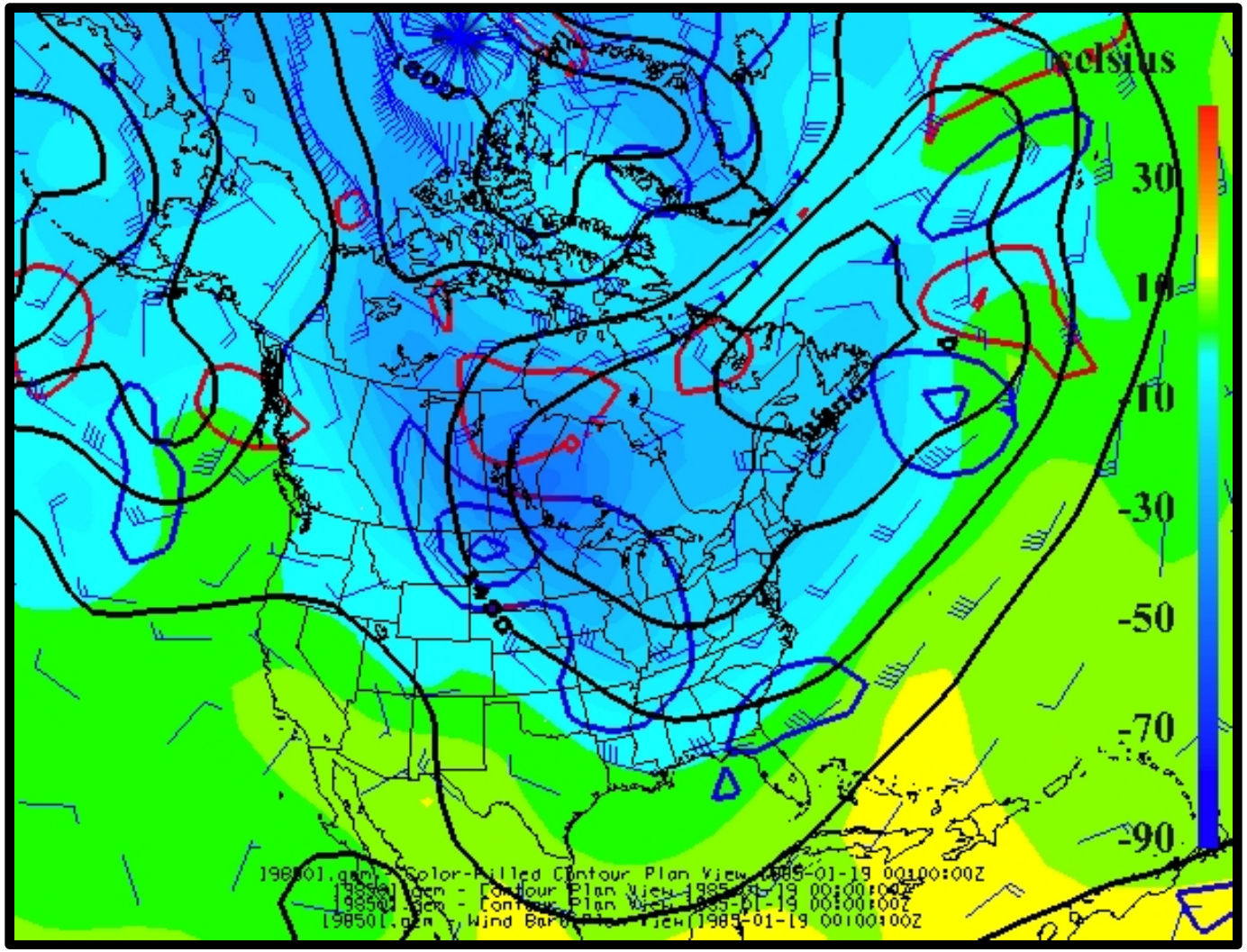
0000 UTC 18 January 1985



850-hPa Wind barbs, 850-hPa geopotential heights (black contours, every 4 hPa), 850-hPa temperatures (fills), Cold-Air Advection, Warm Air Advection (contoured every 0.5 Celsius S^{-1}).

Lower-Tropospheric Dynamics

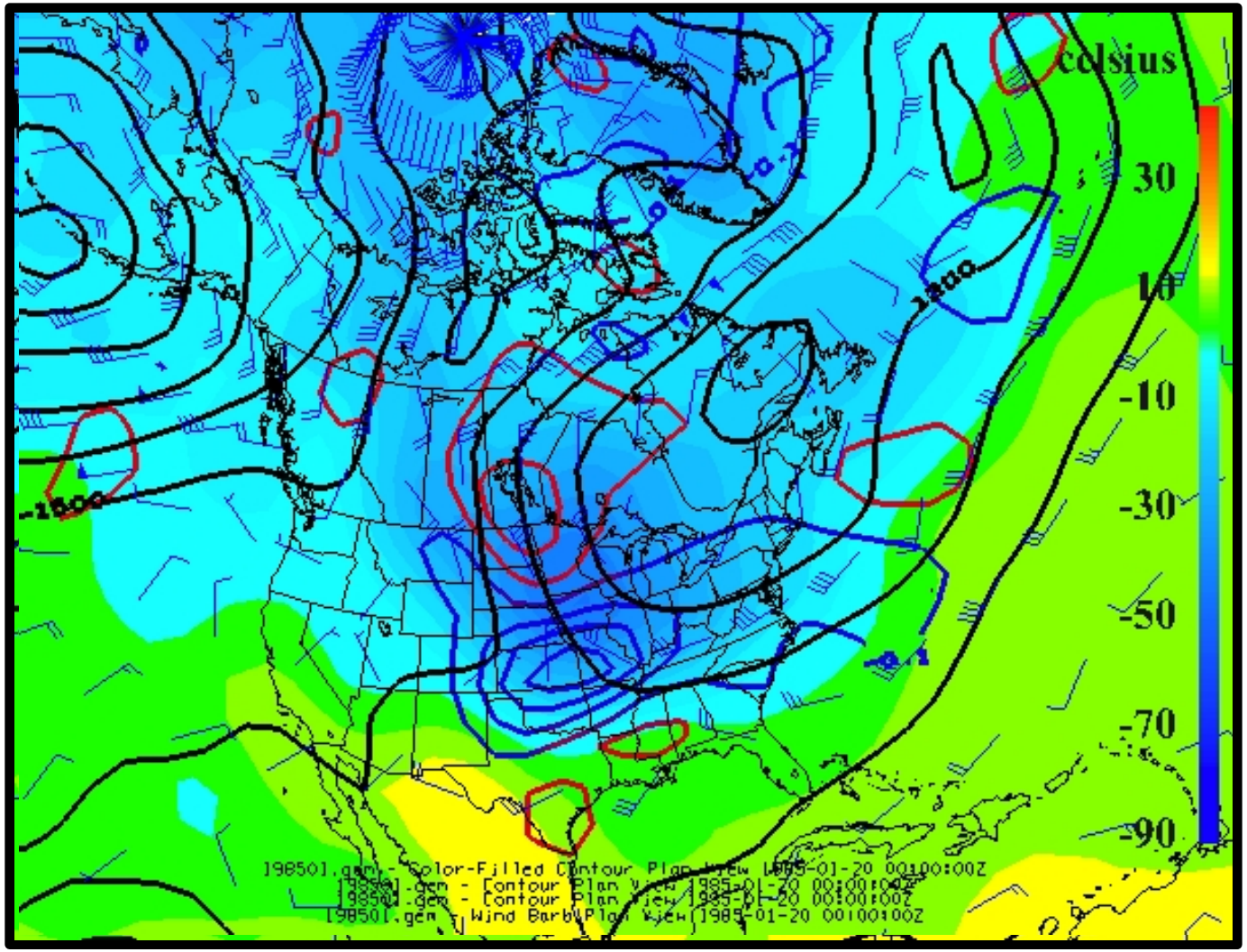
0000 UTC 19 January 1985



850-hPA Wind barbs, 850-hPa geopotential heights (black contours, every 4 hPa), 850-hPa temperatures (fills), Cold-Air Advection, Warm Air Advection (contoured every 0.5 Celsius S^{-1}

Lower-Tropospheric Dynamics

0000 UTC 20 January 1985



850-hPA Wind barbs, 850-hPa geopotential heights (black contours, every 4 hPa), 850-hPa temperatures (fills), Cold-Air Advection, Warm Air Advection (contoured every 0.5 Celsius $s^{-1)}$

Discussion and Conclusions

- Upper-tropospheric analysis reveals that the demise of the North Atlantic block was accelerated through upper-tropospheric divergent outflow associated with a strong jet and ongoing surface convection.

- This forced a PV minimum/geopotential height maximum into the Arctic. This feature coupled with a ridge over the North Pacific placed elevated geopotential heights over the pole, unifying the separate features seen by Shapiro (1987) and Colucci and Baumhefner (1998, 1999).

- The resulting interaction severed a portion of the polar vortex.

Discussion and Conclusions

- 850-hPa analysis reveals simultaneous fracture of cold pool associated with migration of warm air/positive geopotential height anomaly collocated with upper-level features.

- Development of large cyclonic flow feature over Quebec and Nova Scotia, associated with vigorous cyclonic activity.

- Cyclonic flow at lower levels enhanced the cold-air advection associated with the polar anticyclone.

- This strengthened the transport of polar air into the Great Lakes and northeast US, agreeing with Konrad and Colucci (1989), and Kocin et. al(1988).