Influences of the Lake Champlain Valley on Freezing Rain Events at Burlington, Vermont

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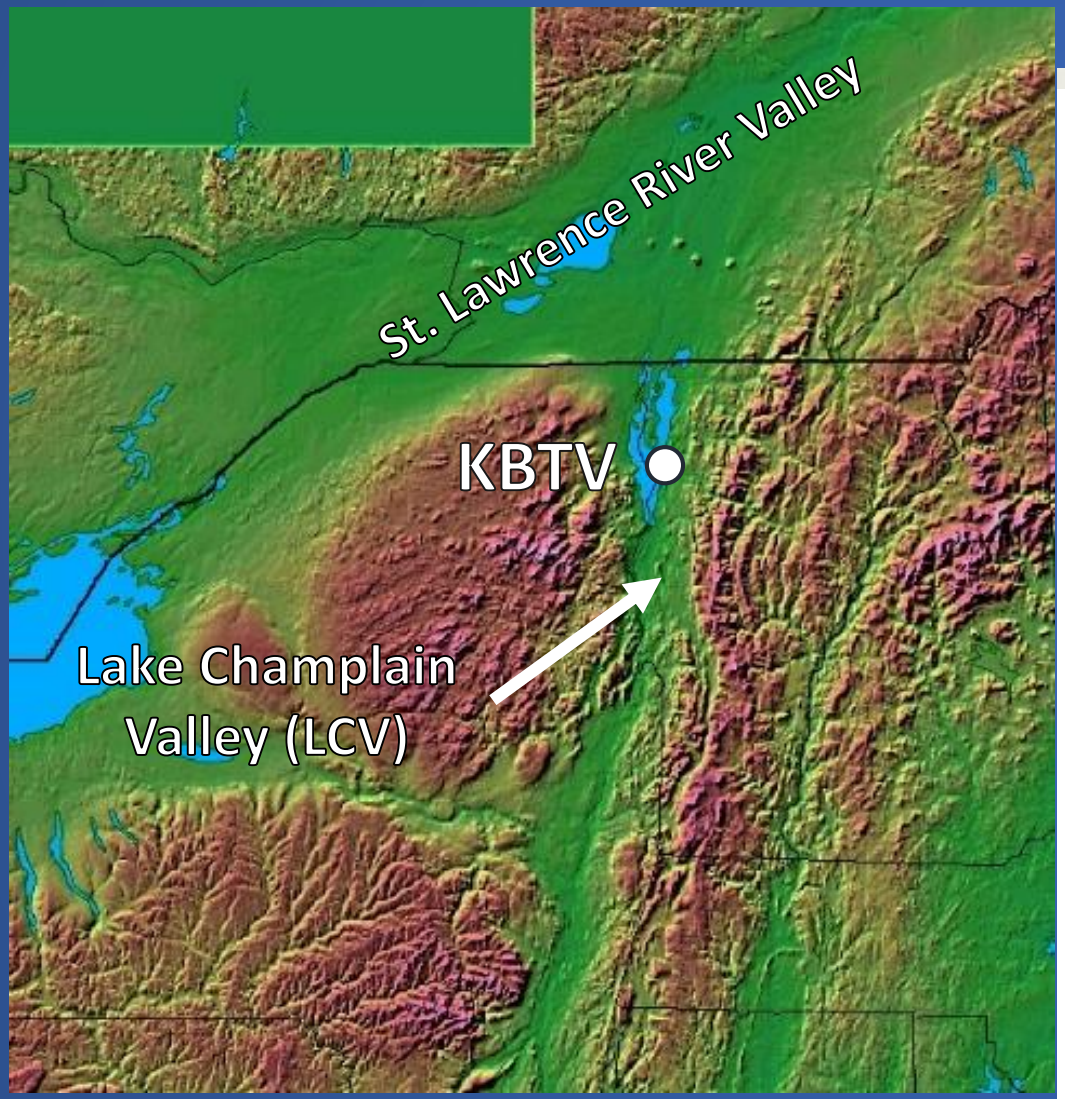
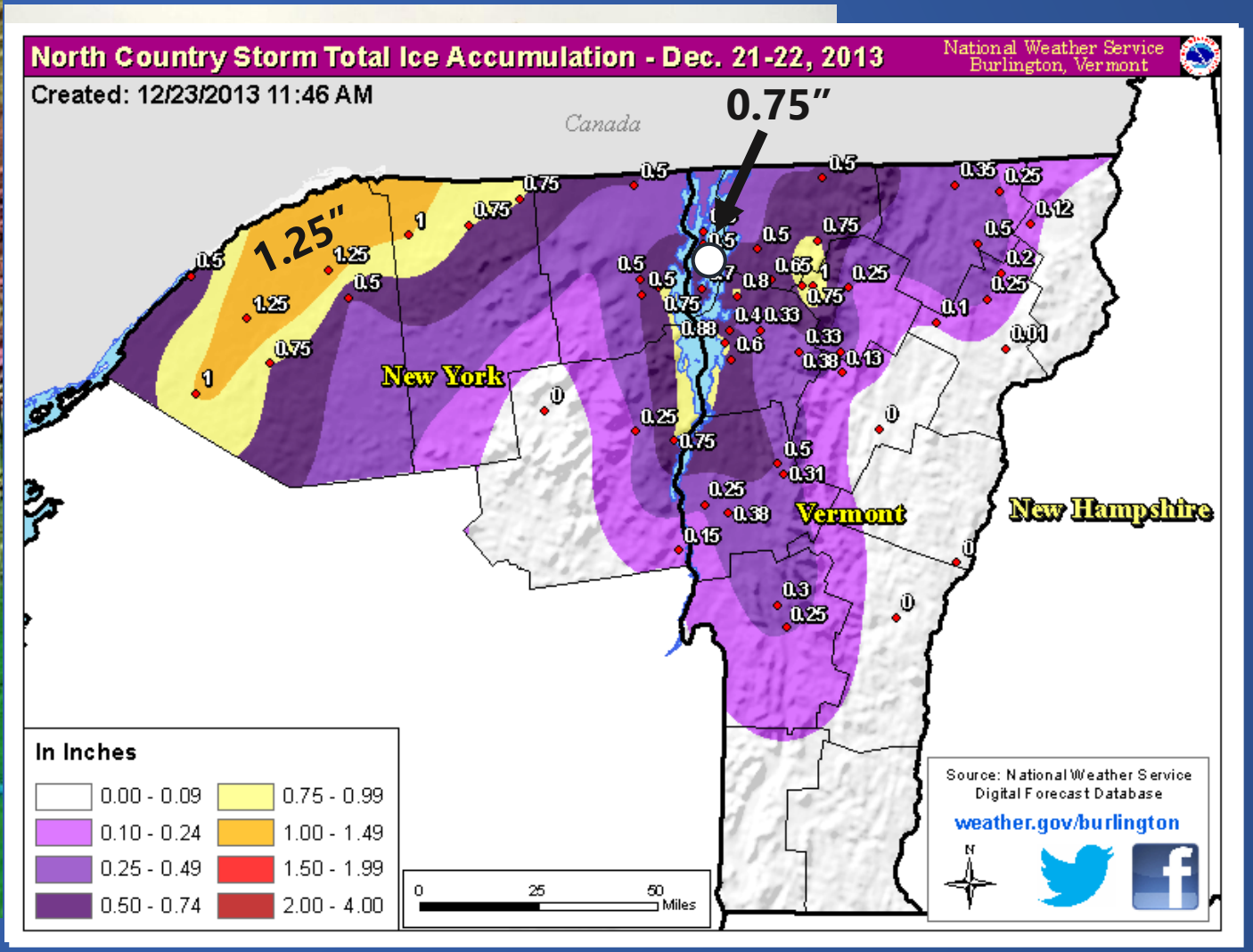
Burlington, VT (KBTV) has a history of severe ice storms…



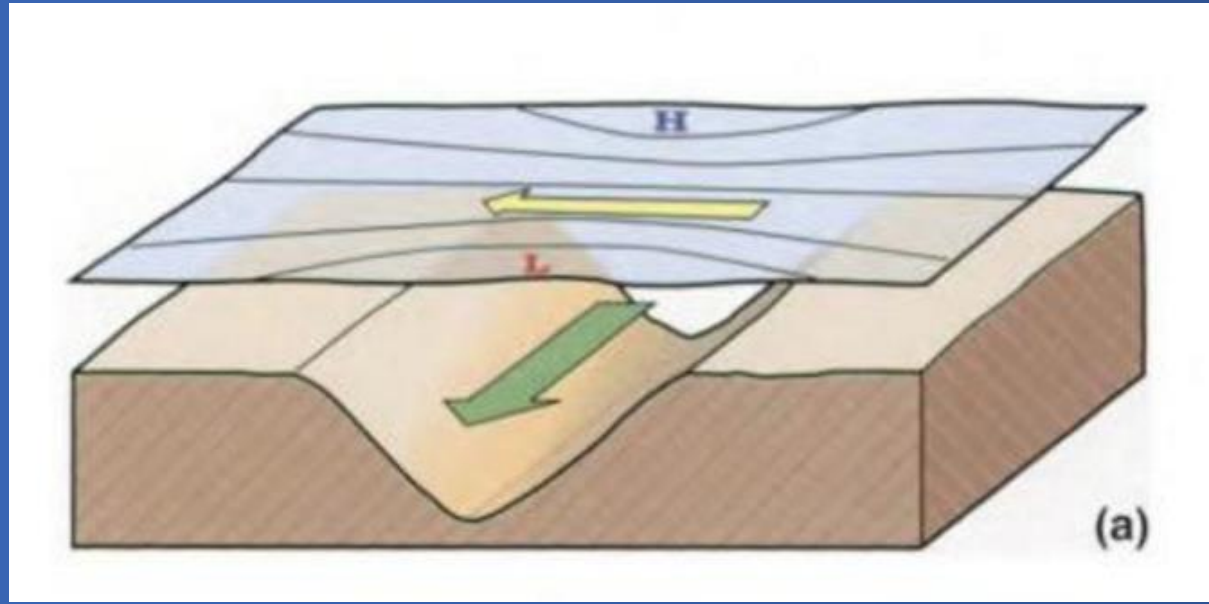


Valleys can channel cold surface air equatorward

- Pressure-driven channeling: winds in valley flow in direction of along-valley pressure gradient

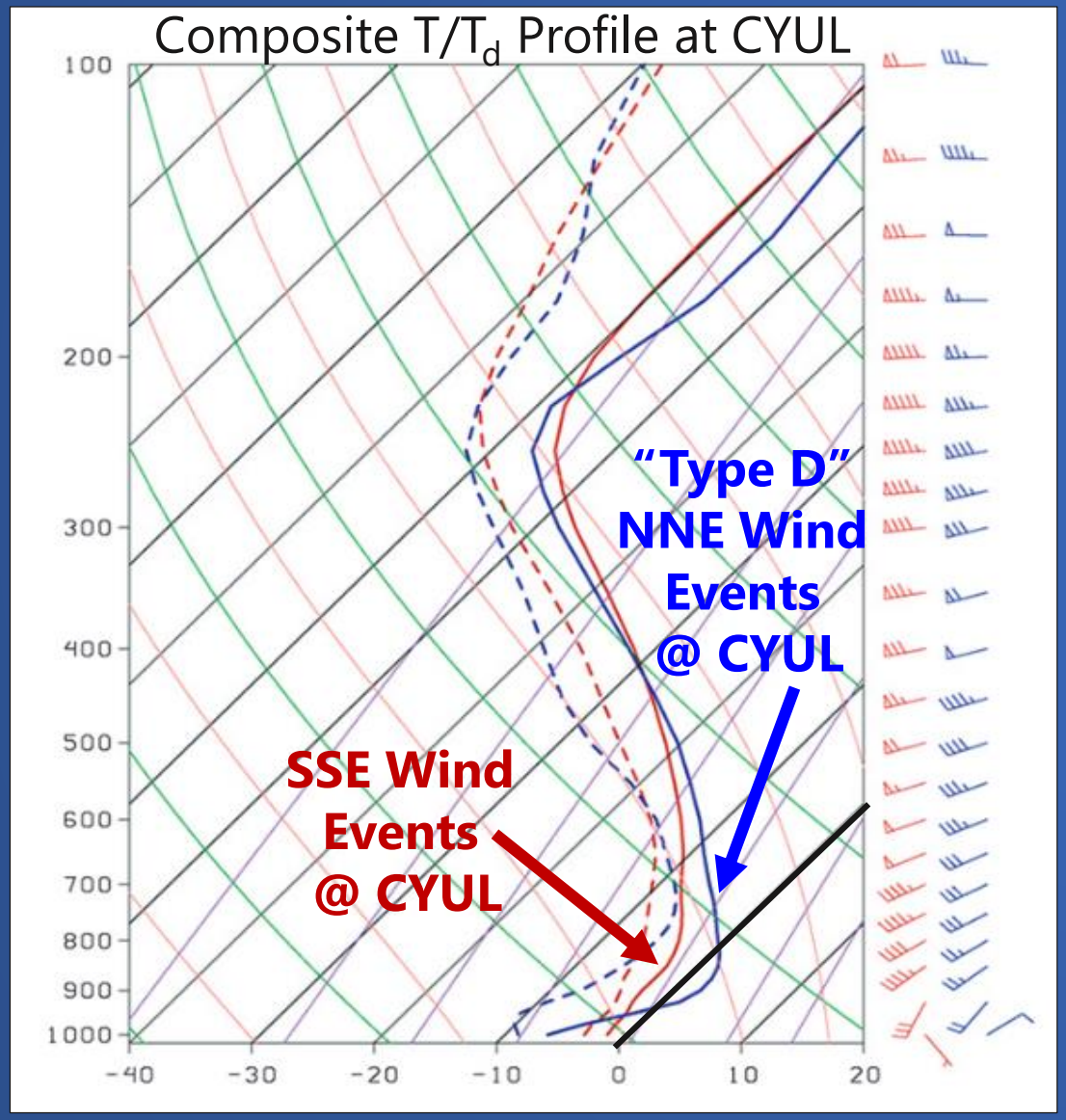
- Can support (i.e.) NE sfc. winds, southerly aloft
  - CAA at surface, WAA aloft
  - Maintains cold/warm layers

Pressure-Driven Channeling



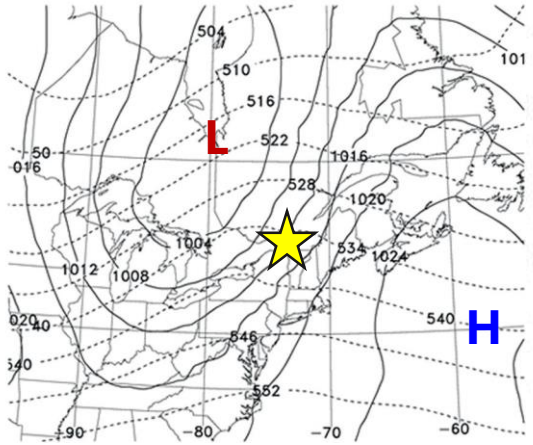
(Whiteman 2000)

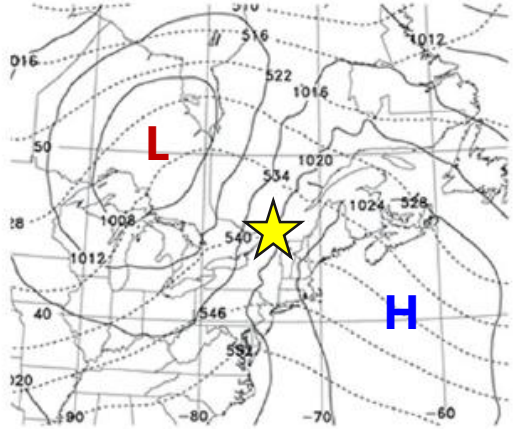
Valleys can channel cold surface air equatorward



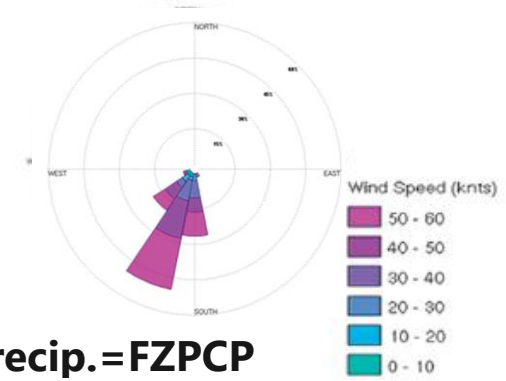
Wind Event Types at CYUL

MSLP / 1000-500mb thickness



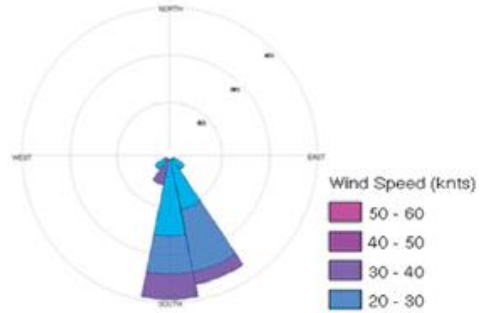


Surface Geostrophic Wind



2% precip.=FZPCP

SSE Surface Winds @ CYUL



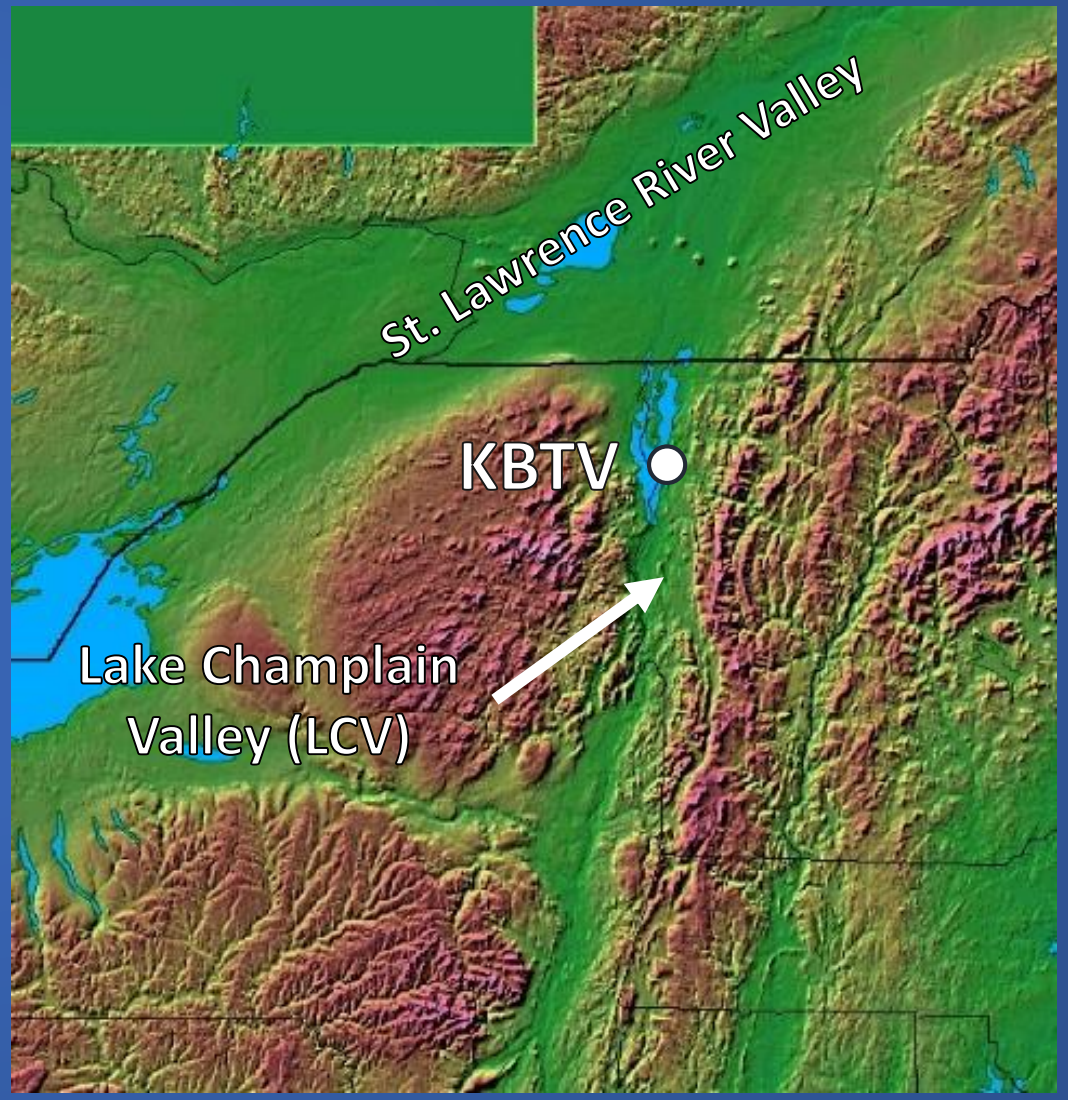
48% precip.=FZPCP

NNE Surface Winds @ CYUL

Razy et al. (2012, JAMC)

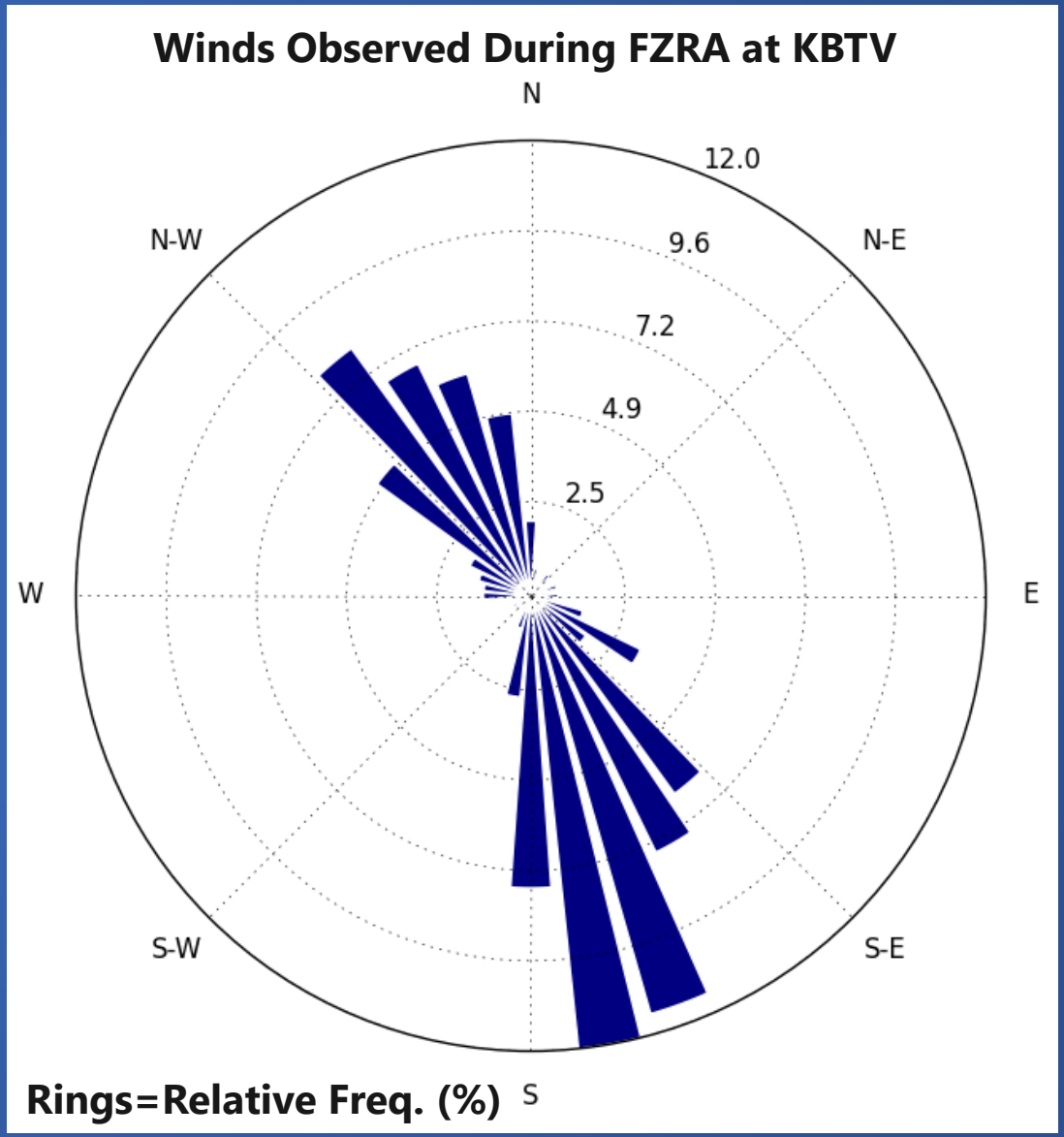
Pressure-Driven Channeling at KBTV

- Resulted in sfc. CAA in Lake Champlain Valley (LCV) during 1998 Ice Storm
  - Without orographic channeling: virtually no FZRA at KBTV during '98 storm (Roebber and Gyakum 2003)
- How does the LCV modulate severe FZRA events at KBTV?



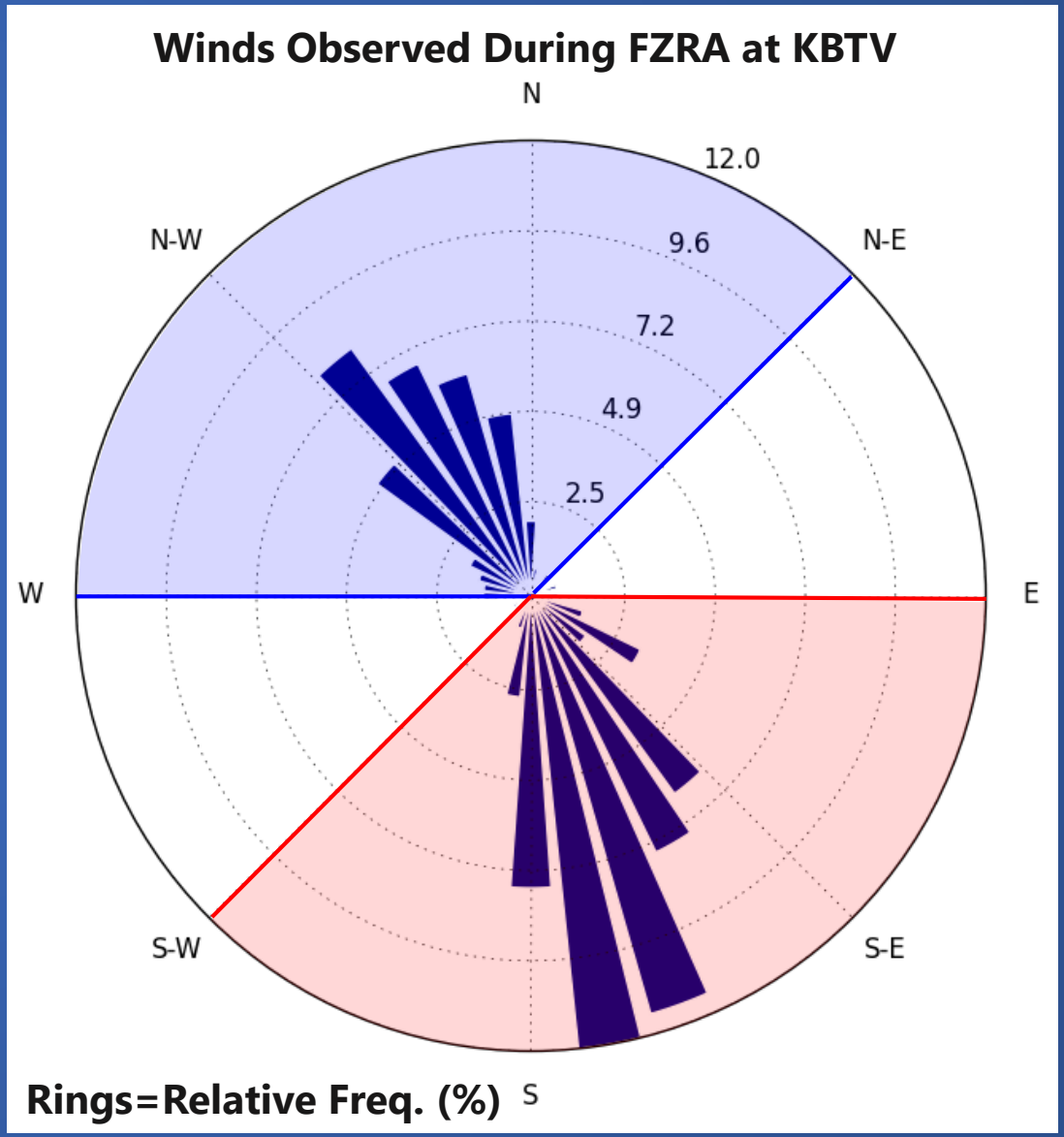
Freezing Rain Climatology at KBTV

- 1973-2014 Surface Obs.
- Median Annual FZRA:
  - 14.0 h/yr ; 5.0 d/yr
- Event Duration:
  - Number of hours separated by <6 h each of different/no precip.
  - Longest: Jan 1998 (33 h); Dec 2013 (17 h); Mar 1984 (13 h)
- Long-Duration:
  - 6+ hrs FZRA

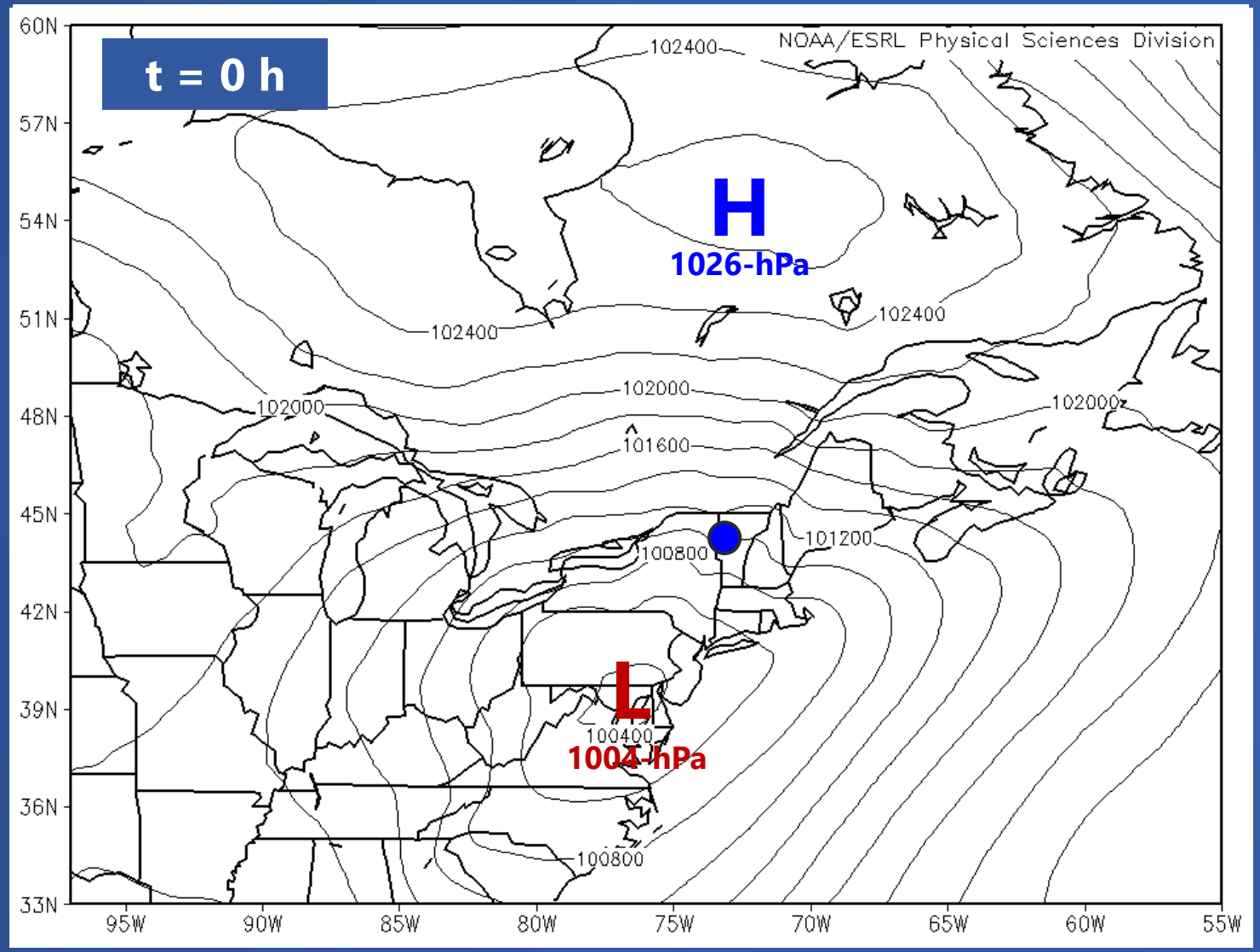


Two Categories of Severe Freezing Rain Events

- Two categories, each 135° range of wind directions: NNW, SSE
- NNW/SSE *Events*: All FZRA obs. must have winds within ranges
- 13 long-duration NNW events
  - Median: 9 h Max: 17 h
- 13 long-duration SSE events
  - Median: 7 h Max: 10 h

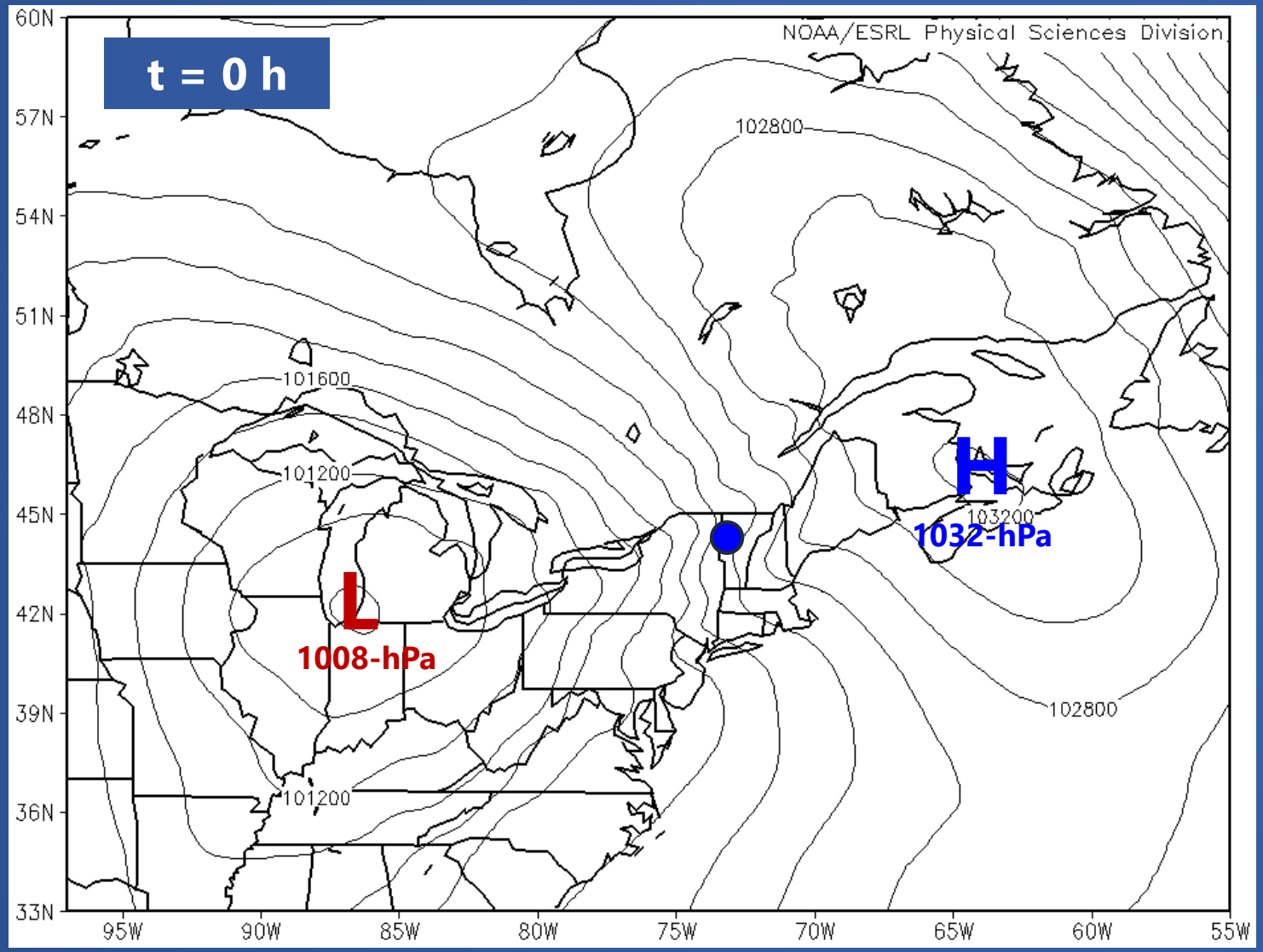


NNW Long-Duration Events – Synoptic Composites



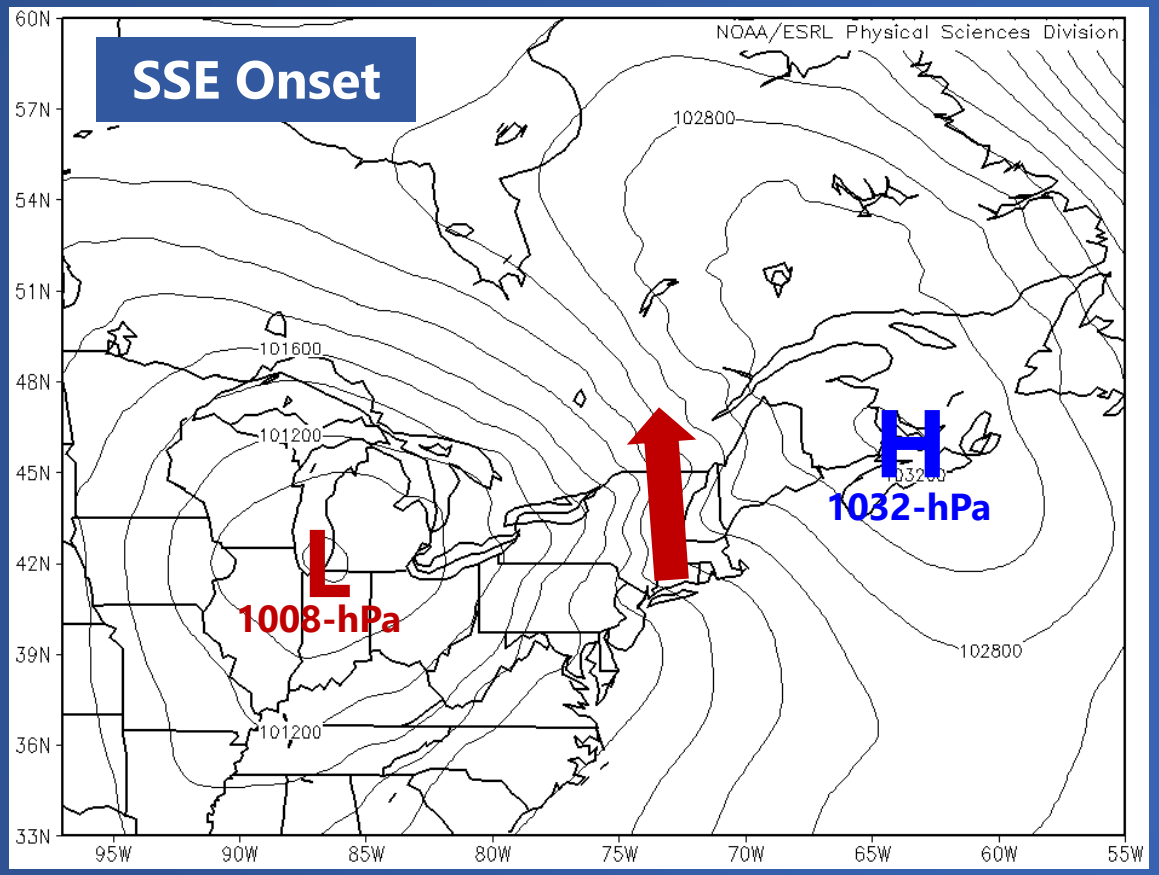
- NARR MSLP composite for **12 NNW** long-duration events
- KBTV = Blue Dot

SSE Long-Duration Events – Synoptic Composites

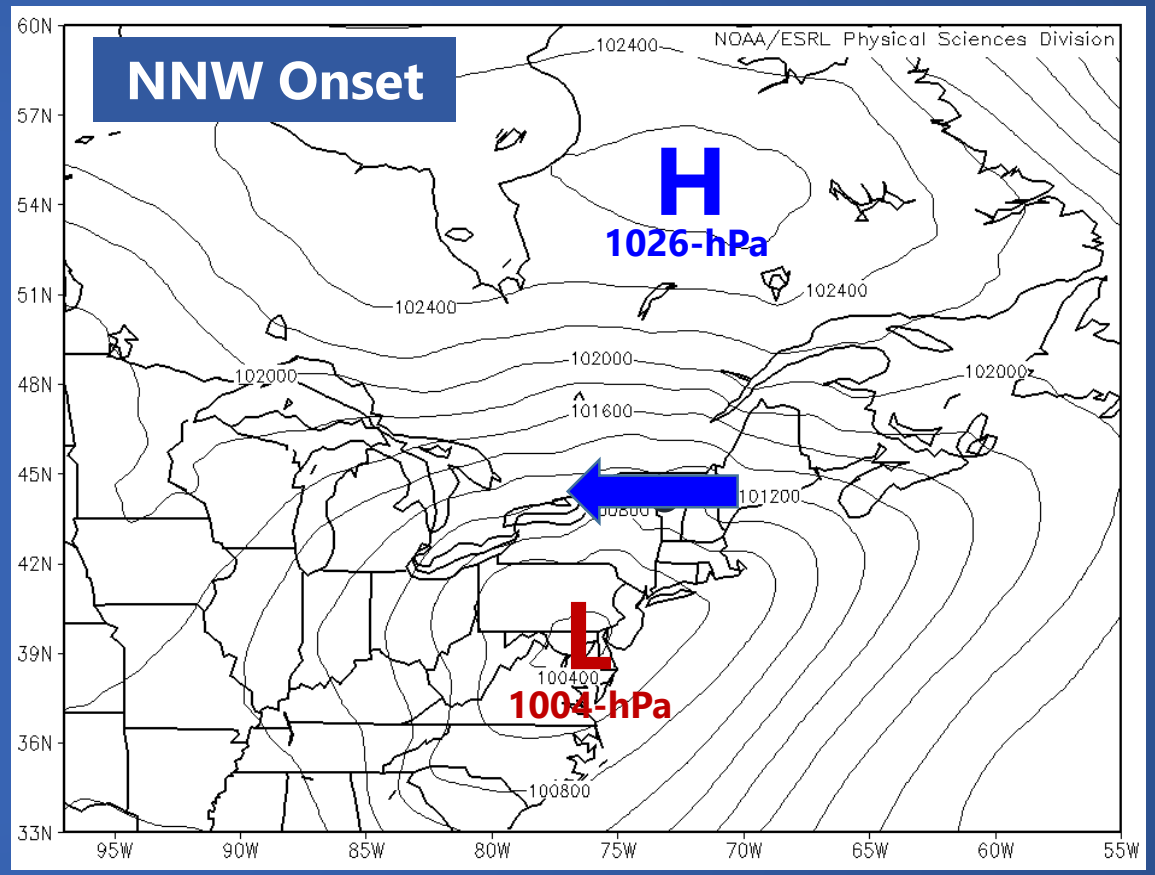


- NARR MSLP composite for **10 SSE** long-duration events
- KBTV = Blue Dot

Synoptic vs. Observed Surface Flow at Event Onset

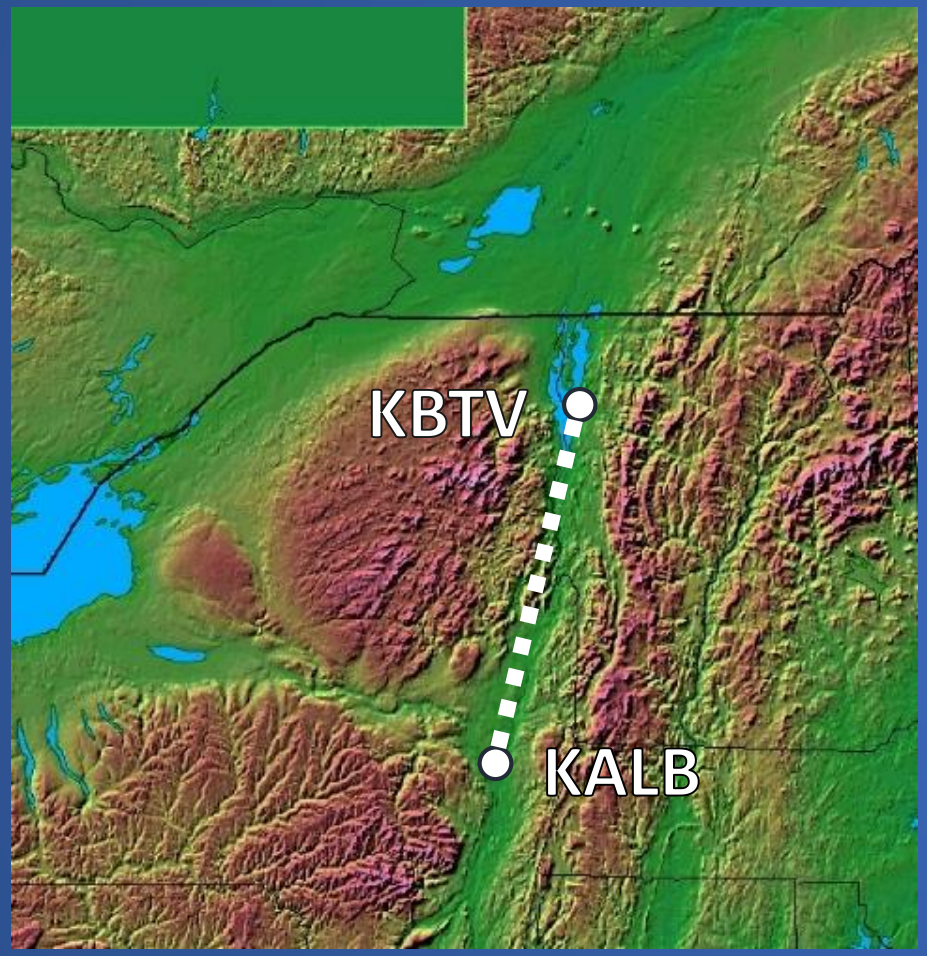


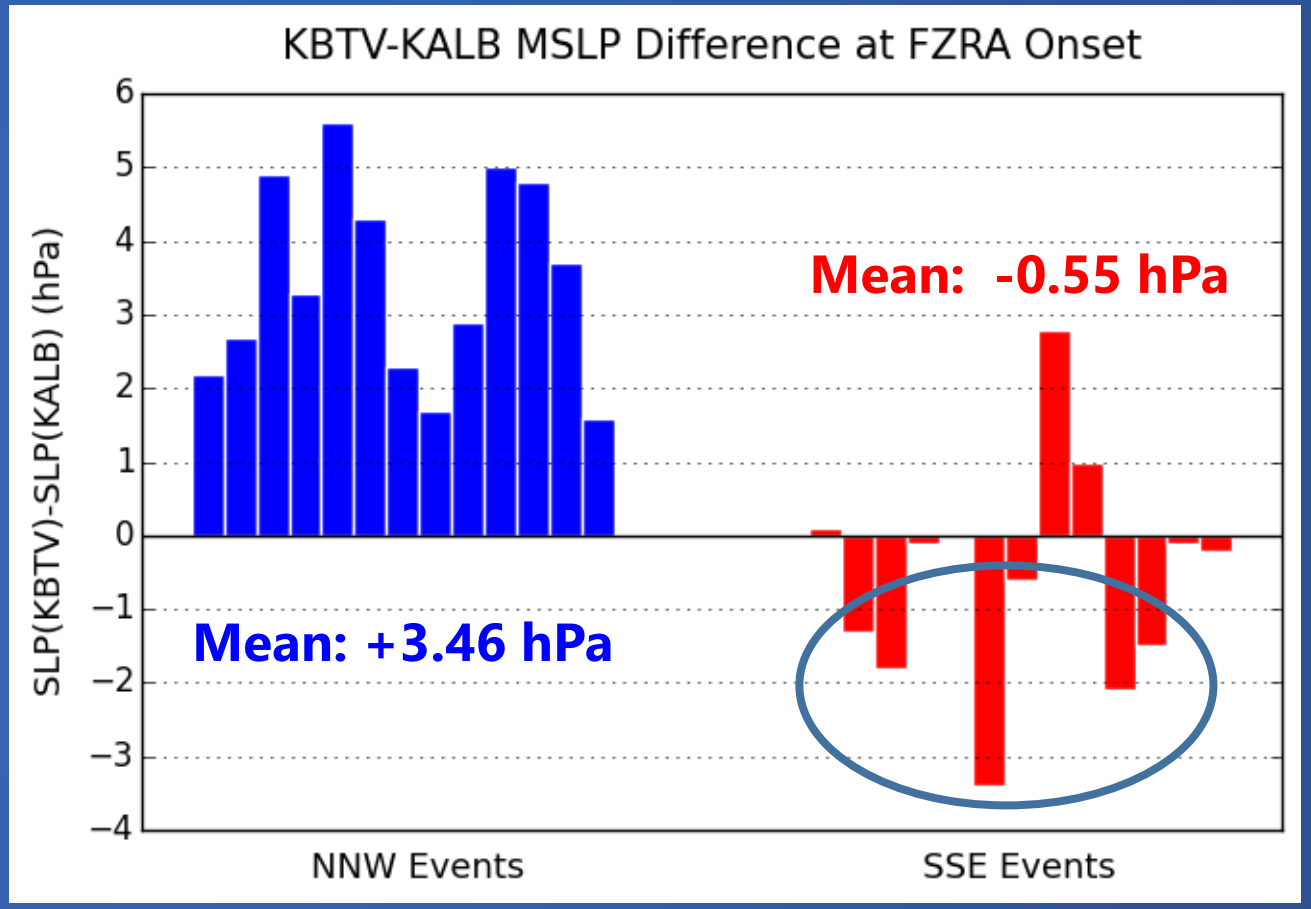
- Southerly geostrophic sfc. winds at KBTV
- Approx. agreement with SSE observed



- Easterly geostrophic sfc. winds (not NNW)
- PGF points north → south (down LCV)
- Pressure-driven channeling supported

LCV Pressure Gradient at Event Onset

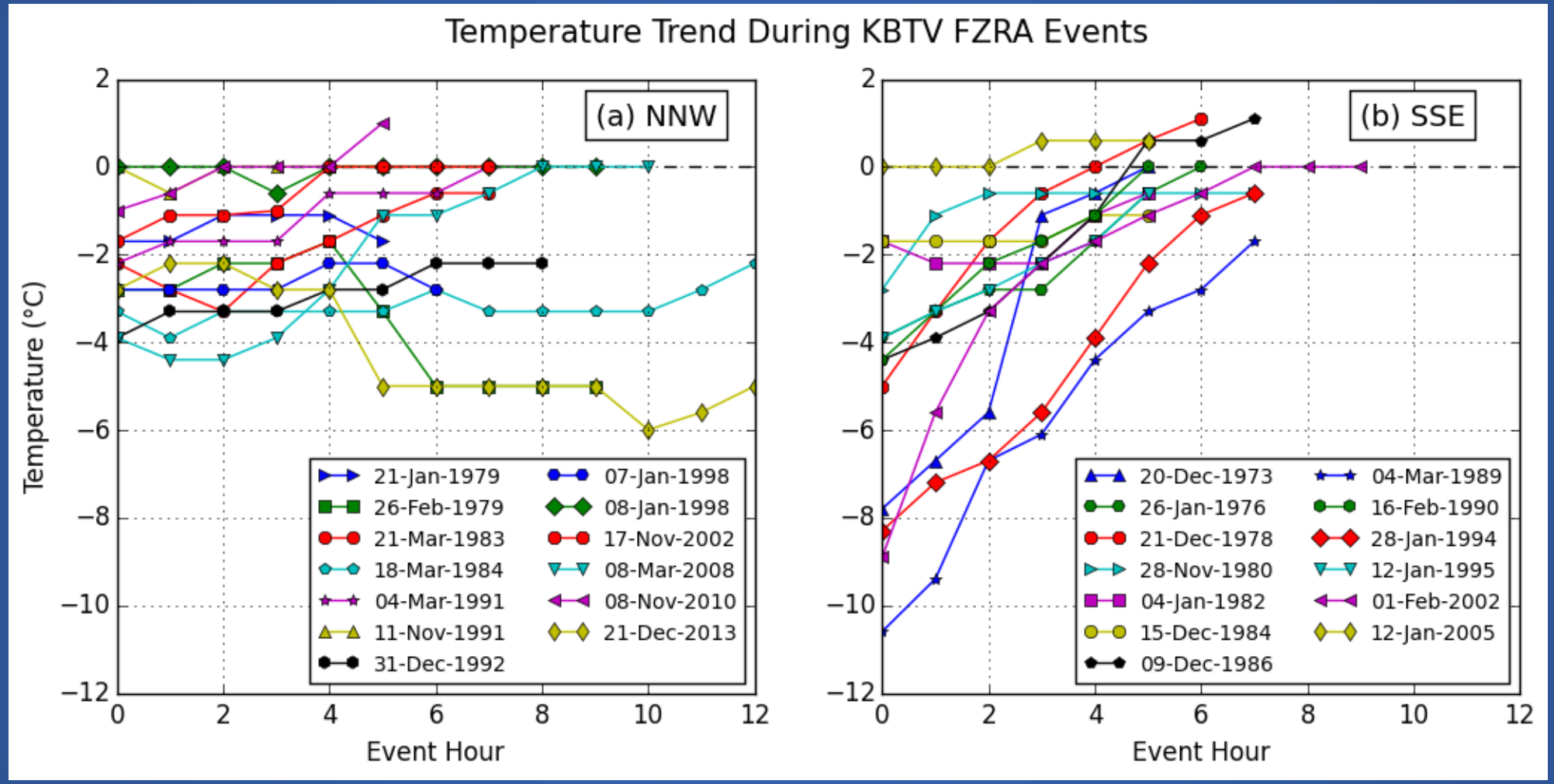




Pressure-Driven Channeling → NNW winds

No channeling, poss. PDC-enhanced SSE Winds

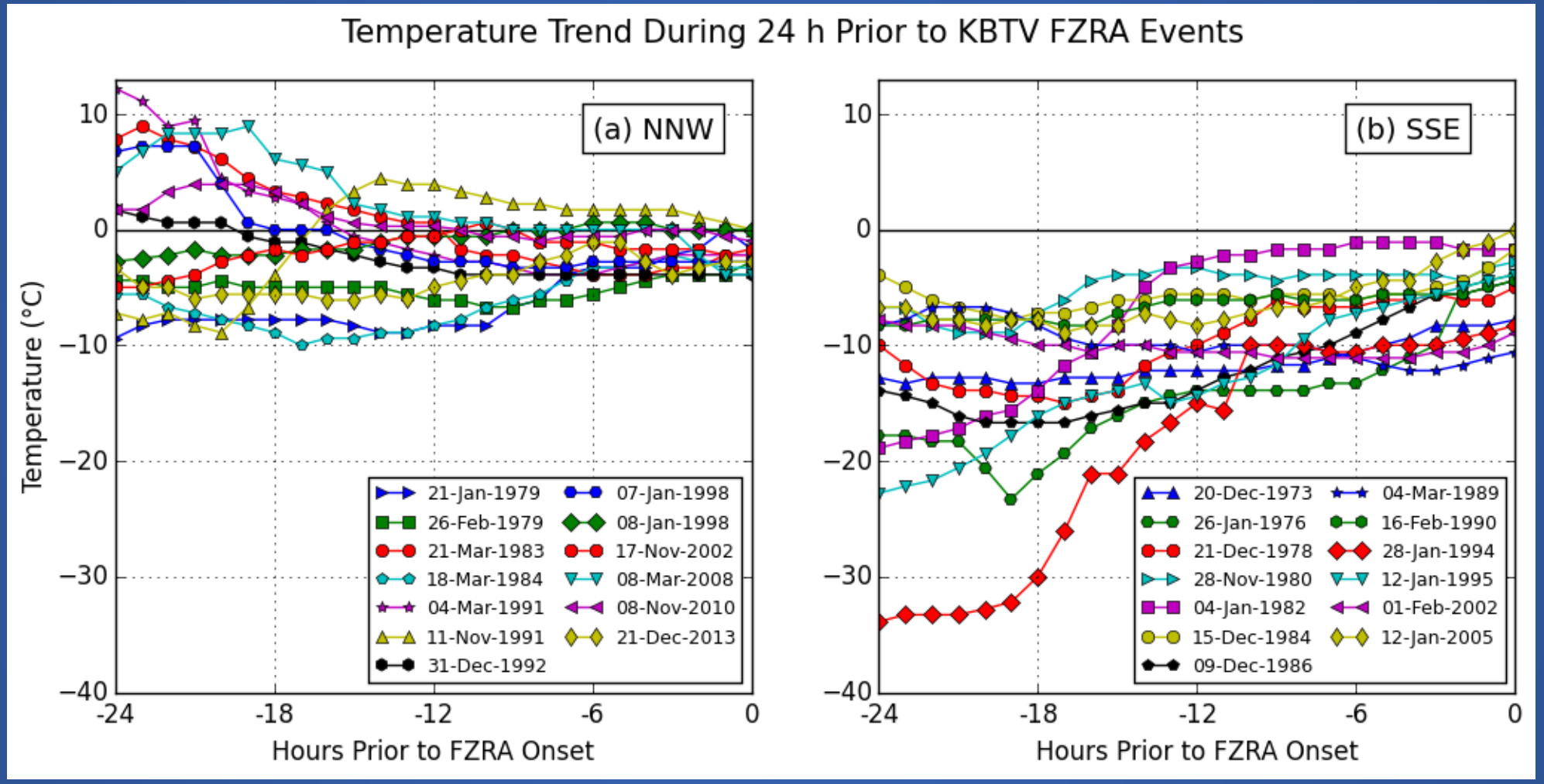
NNW-channeled winds maintain below-0°C temps…



Mean Onset T: **-2.2°C**
Mean T 1 h after event ends: **-1.2°C**

Mean Onset T: **-4.9°C**
Mean T 1 h after event ends: **+0.7°C**

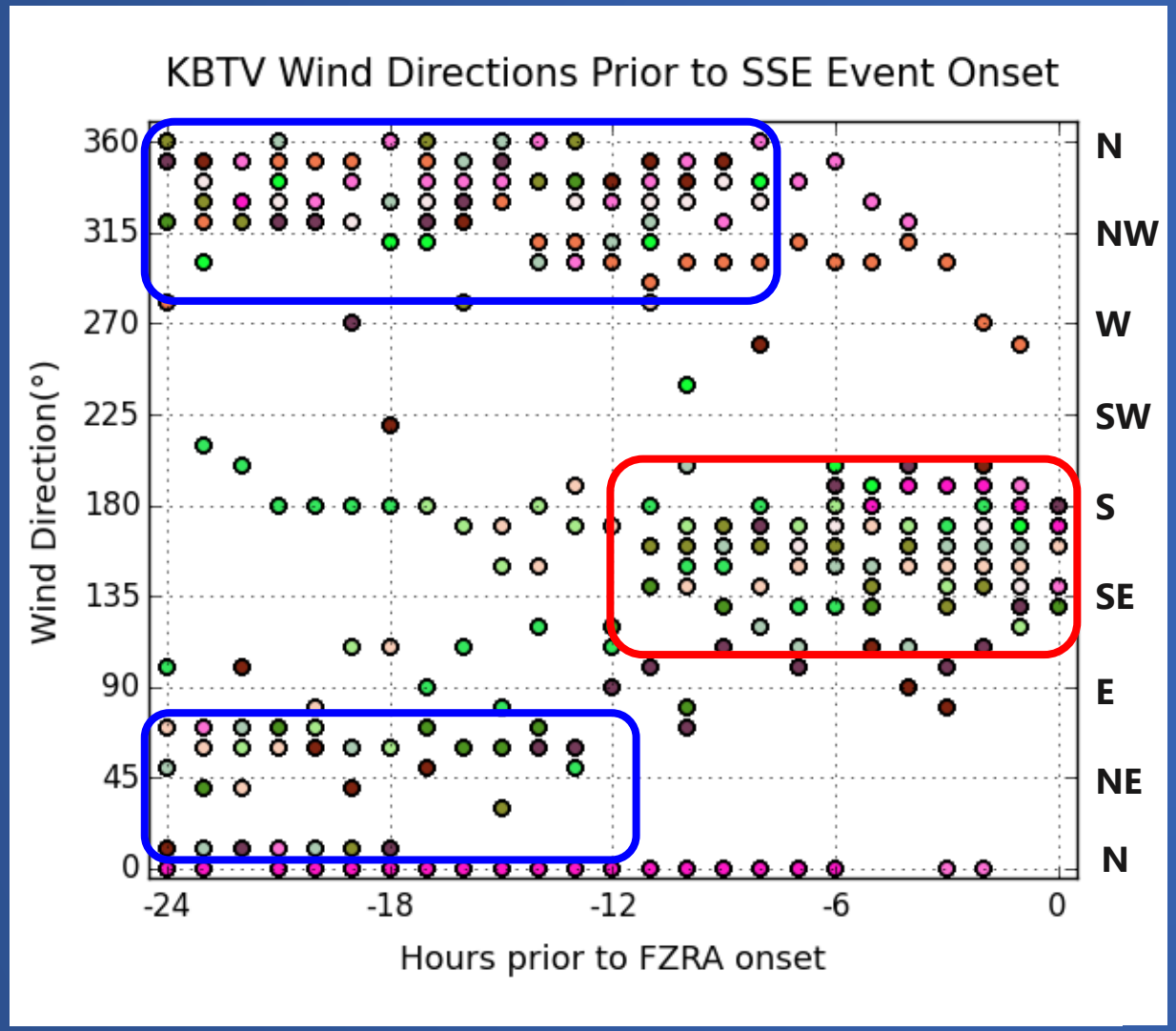
Precursor air masses differ between event types

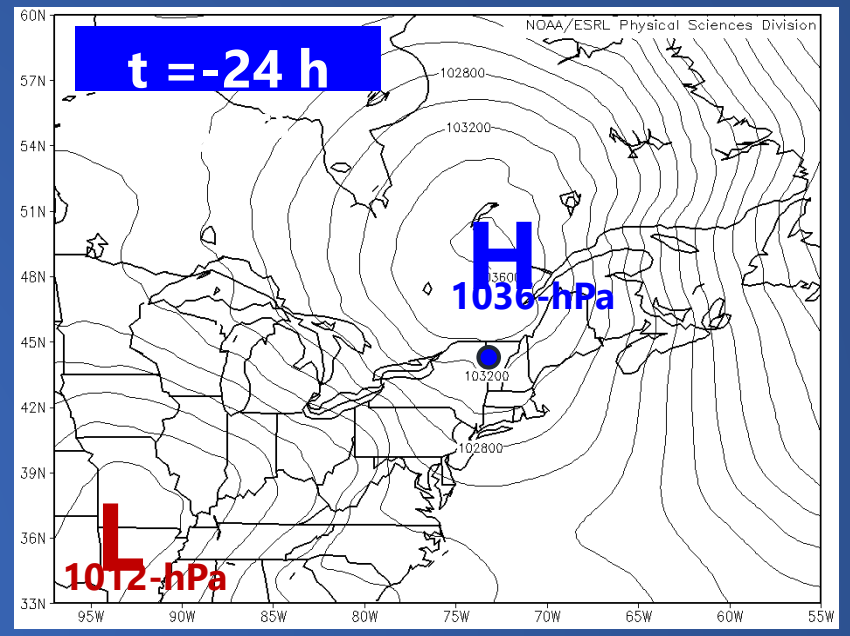


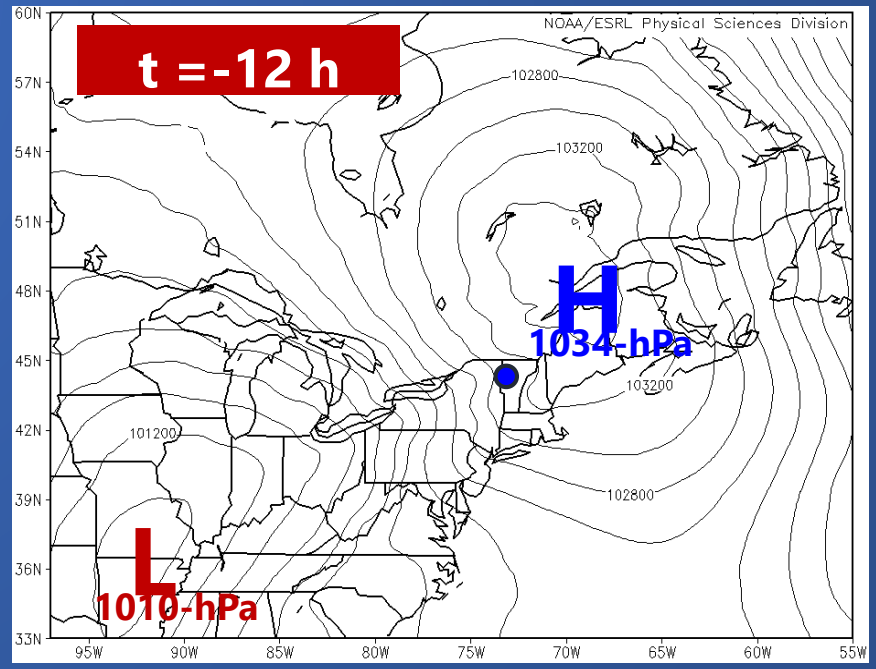
Mean Onset T: **-2.2°C**
Mean T during 24h Prior to Onset: **-0.2°C**

Mean Onset T: **-4.9°C**
Mean T during 24h Prior to Onset: **-10.2°C**

Prior to SSE onset, LCV channels cold air



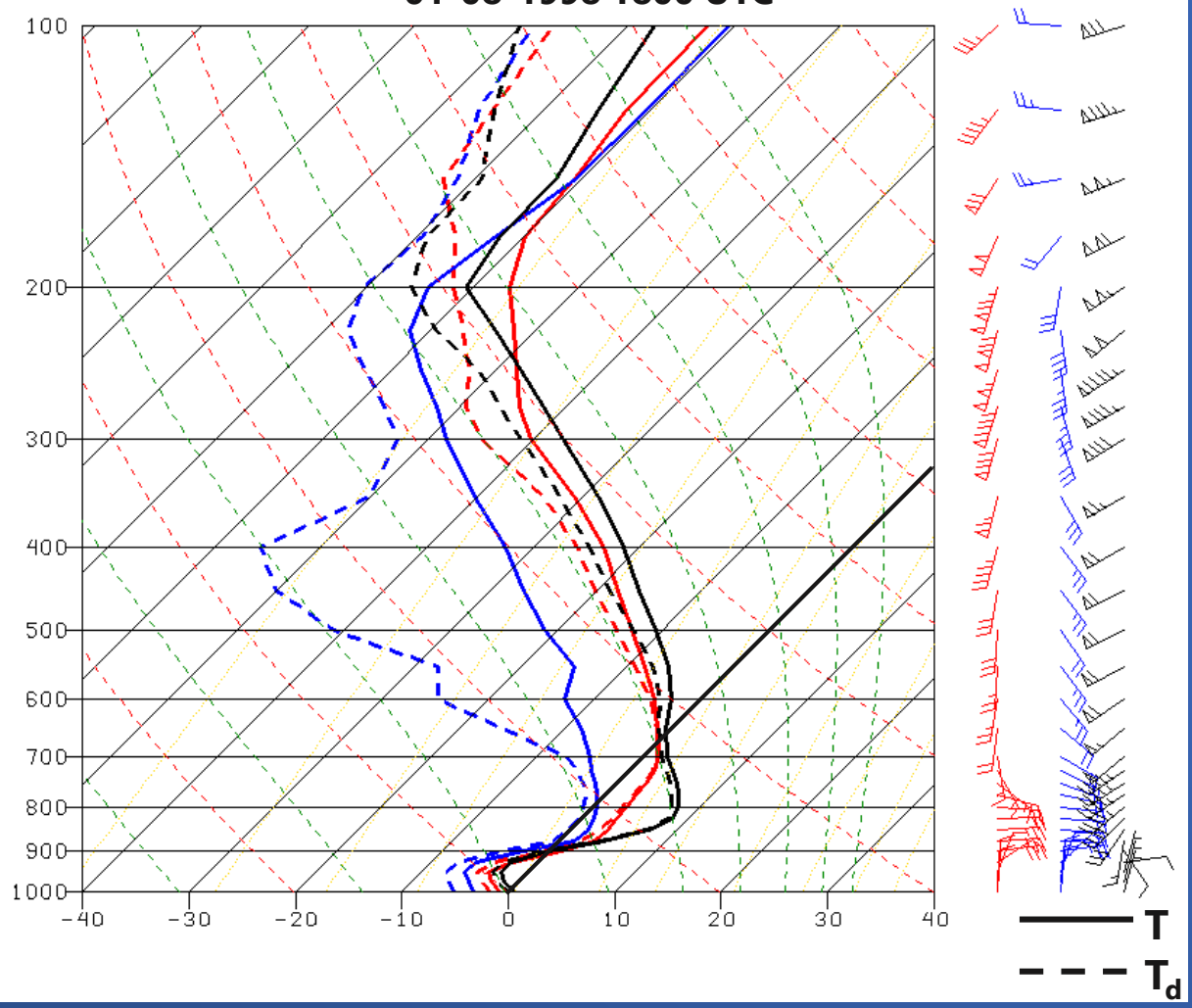




KBTV NARR Soundings at Onset

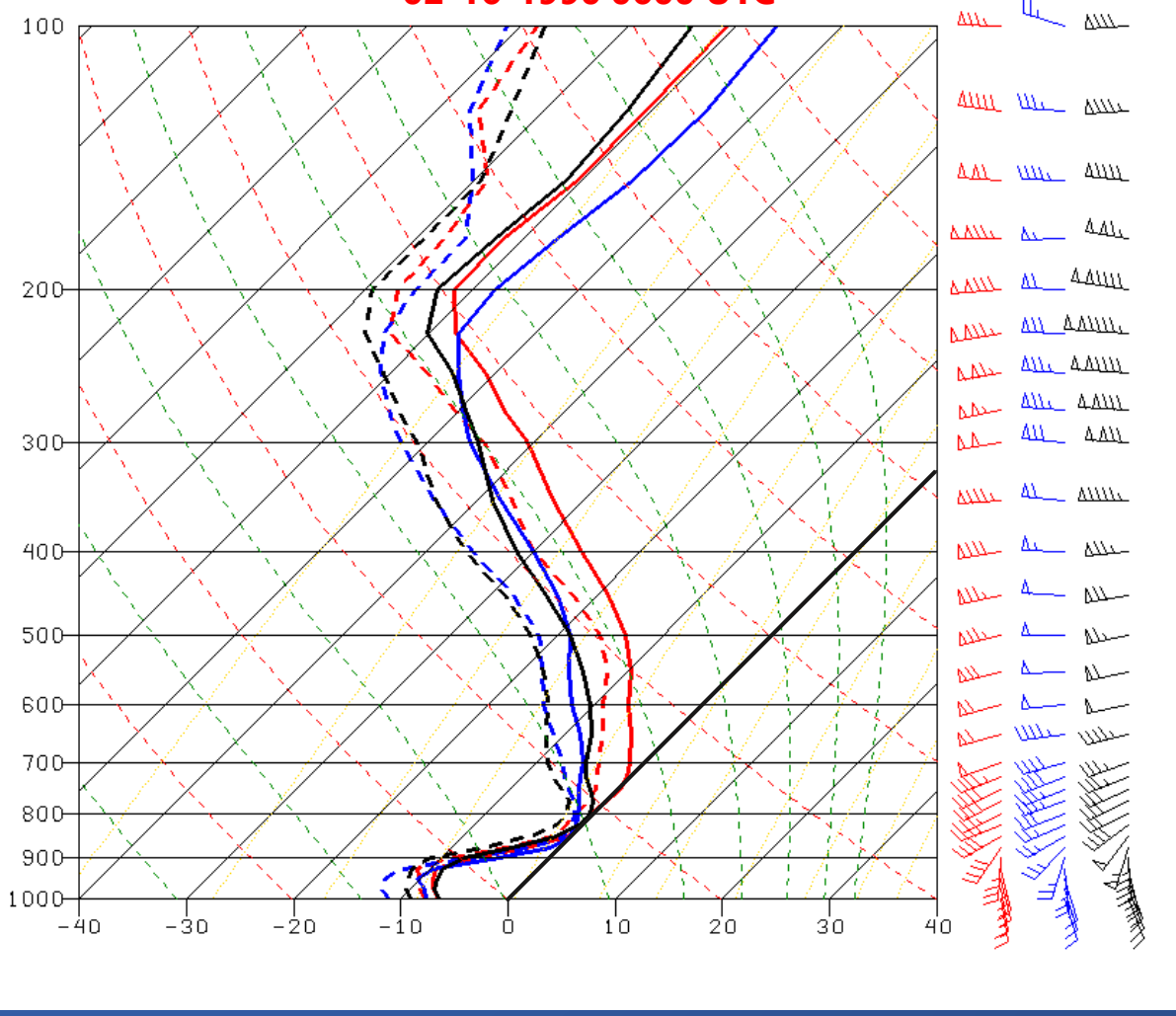
NNW

03-19-1984 0000 UTC
11-11-1991 0900 UTC
01-08-1998 1800 UTC

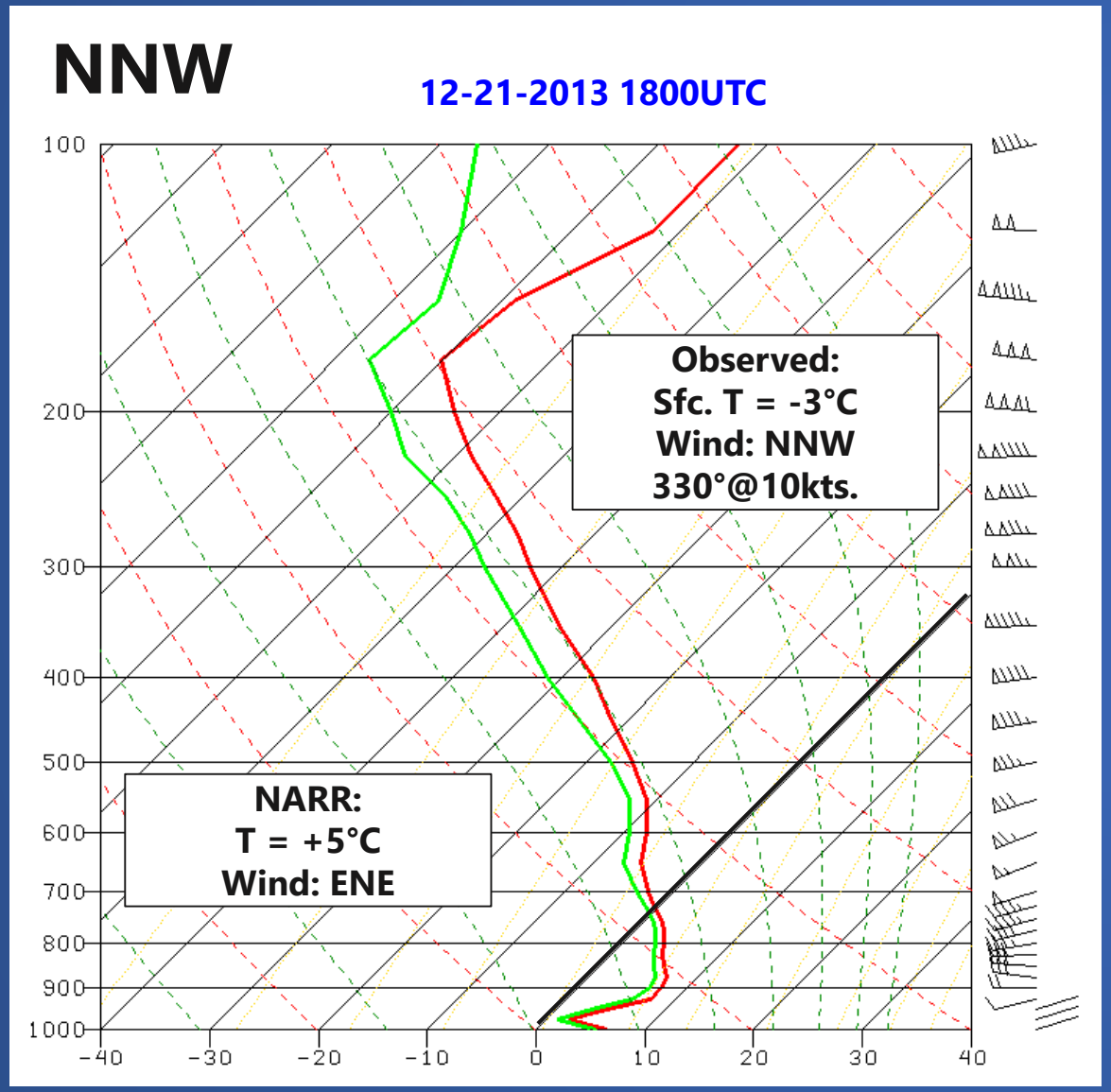


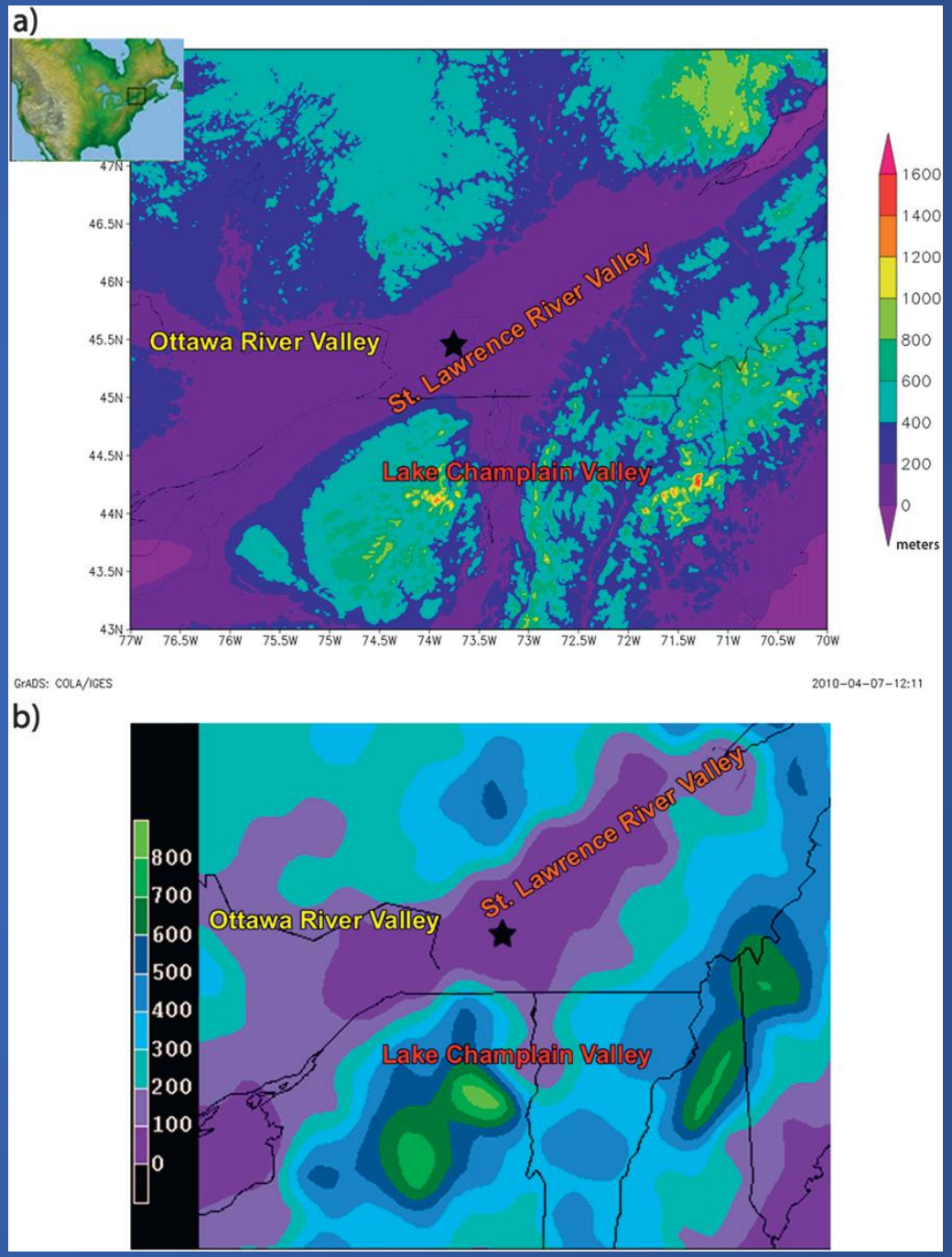
SSE

12-09-1986 1800 UTC
03-04-1989 1800 UTC
02-16-1990 0600 UTC



Channeling and NARR/Models

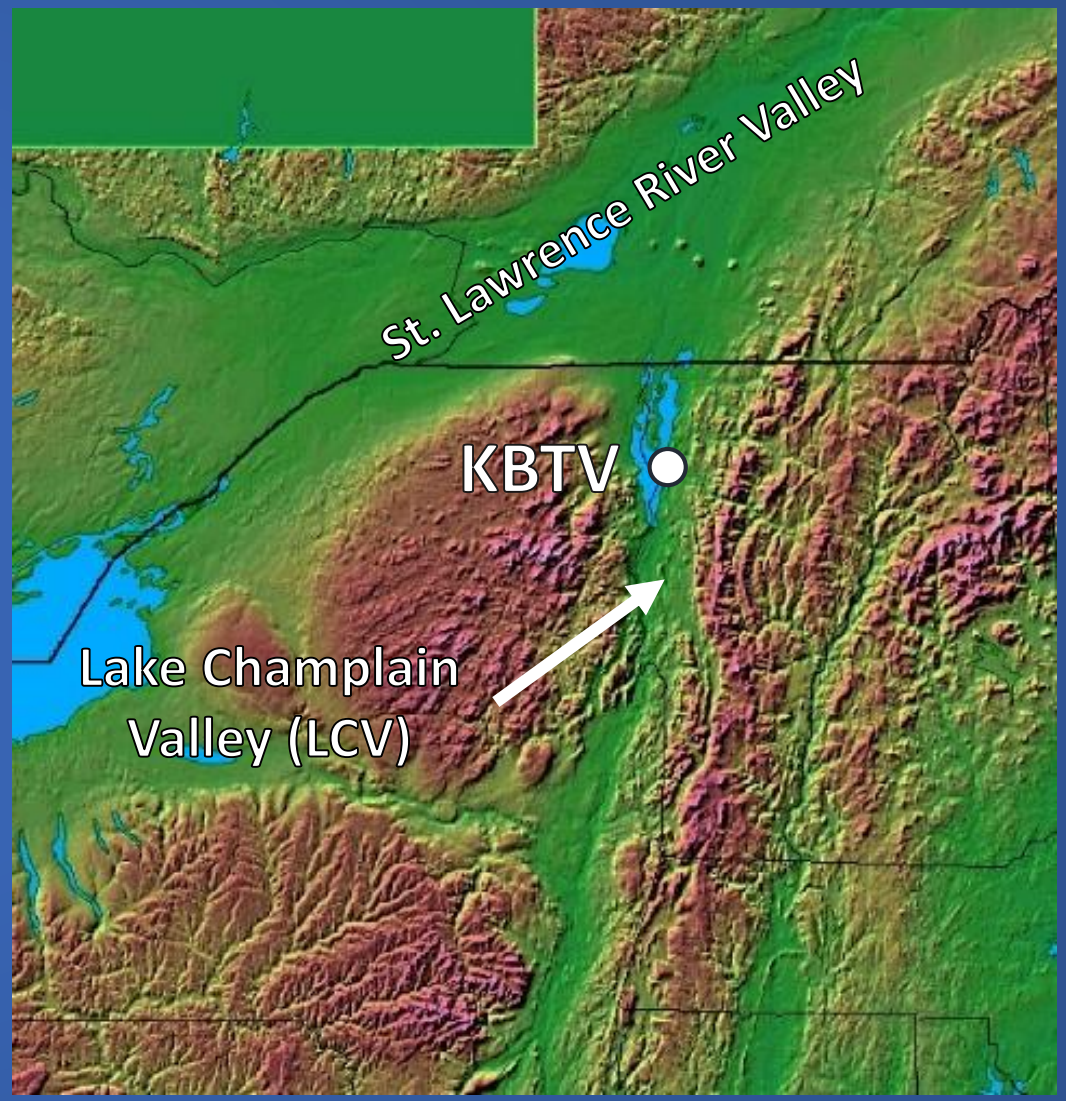




Razy et al. (2012, JAMC)

Summary

- FZRA occurs at KBTV with NNW *and* SSE winds
  - 2 different synoptic settings
- LCV is vital in channeling NNW winds during NNW events
  - Cold air advection offsets warming due to latent heat release→ very long duration events
- Pressure-driven channeling down LCV helps advect cold air southward prior to SSE events
  - Otherwise, too warm at onset



List of NNW and SSE Long-Duration Events

NNW Events		SSE Events	
Onset	Duration (Hours)	Start	Duration (Hours)
1900 UTC 21 Jan 1979	6	**1700 UTC 20 Dec 1973**	6
2000 UTC 26 Feb 1979	10	**0800 UTC 26 Jan 1976**	7
1600 UTC 21 Mar 1983	8	**0500 UTC 21 Dec 1978**	7
2300 UTC 18 Mar 1984	13	**0800 UTC 28 Nov 1980**	8
0300 UTC 04 Mar 1991	9	**0800 UTC 04 Jan 1982**	6
0800 UTC 11 Nov 1991	6	**0800 UTC 15 Dec 1984**	6
0100 UTC 31 Dec 1992	9	**1900 UTC 09 Dec 1986**	8
1254 UTC 07 Jan 1998	7	**1700 UTC 04 Mar 1989**	8
1754 UTC 08 Jan 1998	10	**0500 UTC 16 Feb 1990**	6
1154 UTC 17 Nov 2002	8	**0800 UTC 28 Jan 1994**	8
1554 UTC 08 Mar 2008	11	**1000 UTC 12 Jan 1995**	6
1449 UTC 08 Nov 2010	6	**0454 UTC 01 Feb 2002**	10
1801 UTC 21 Dec 2013	17	**1854 UTC 12 Jan 2005**	6