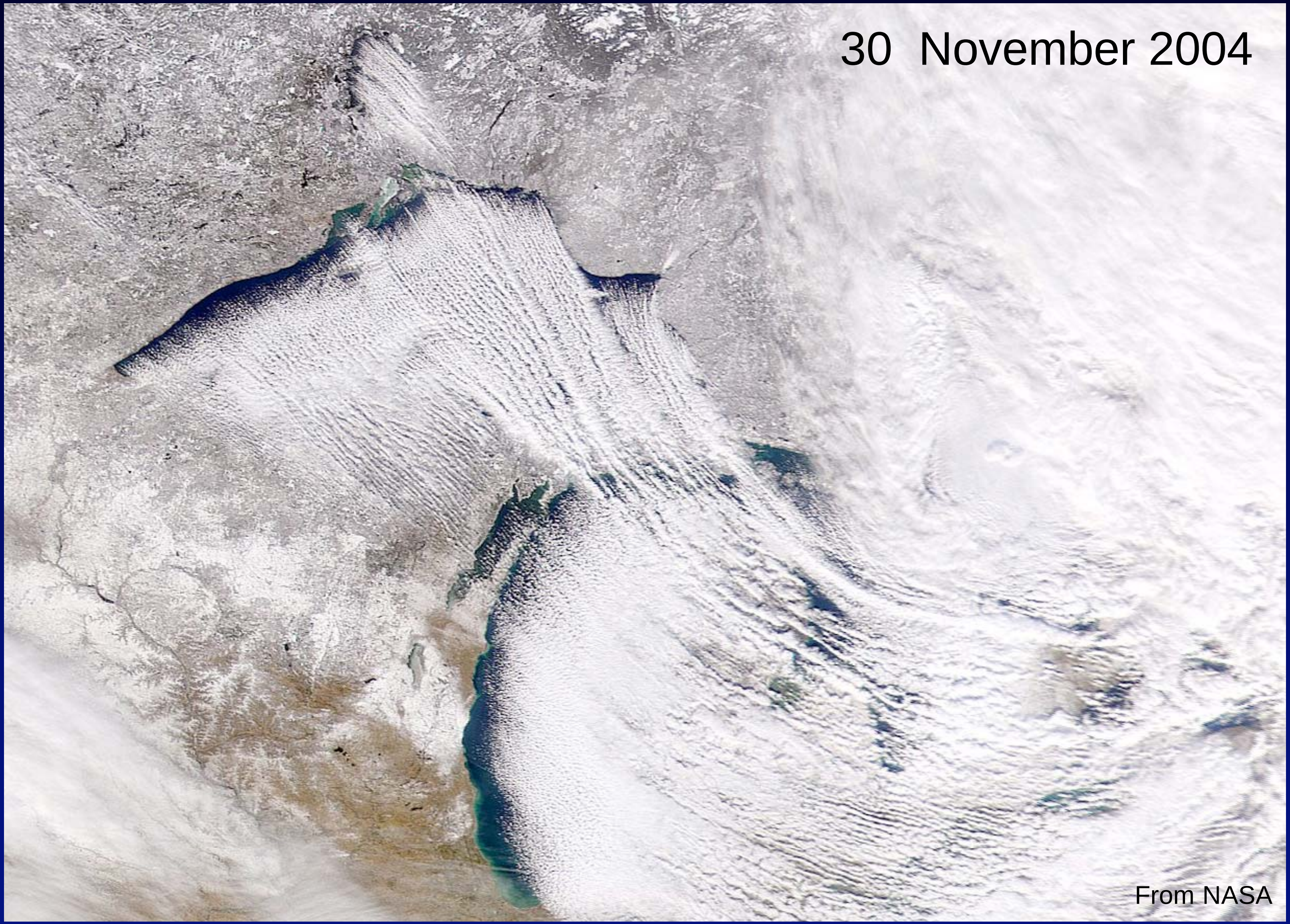
Lake-effect precipitation from the Great Salt Lake

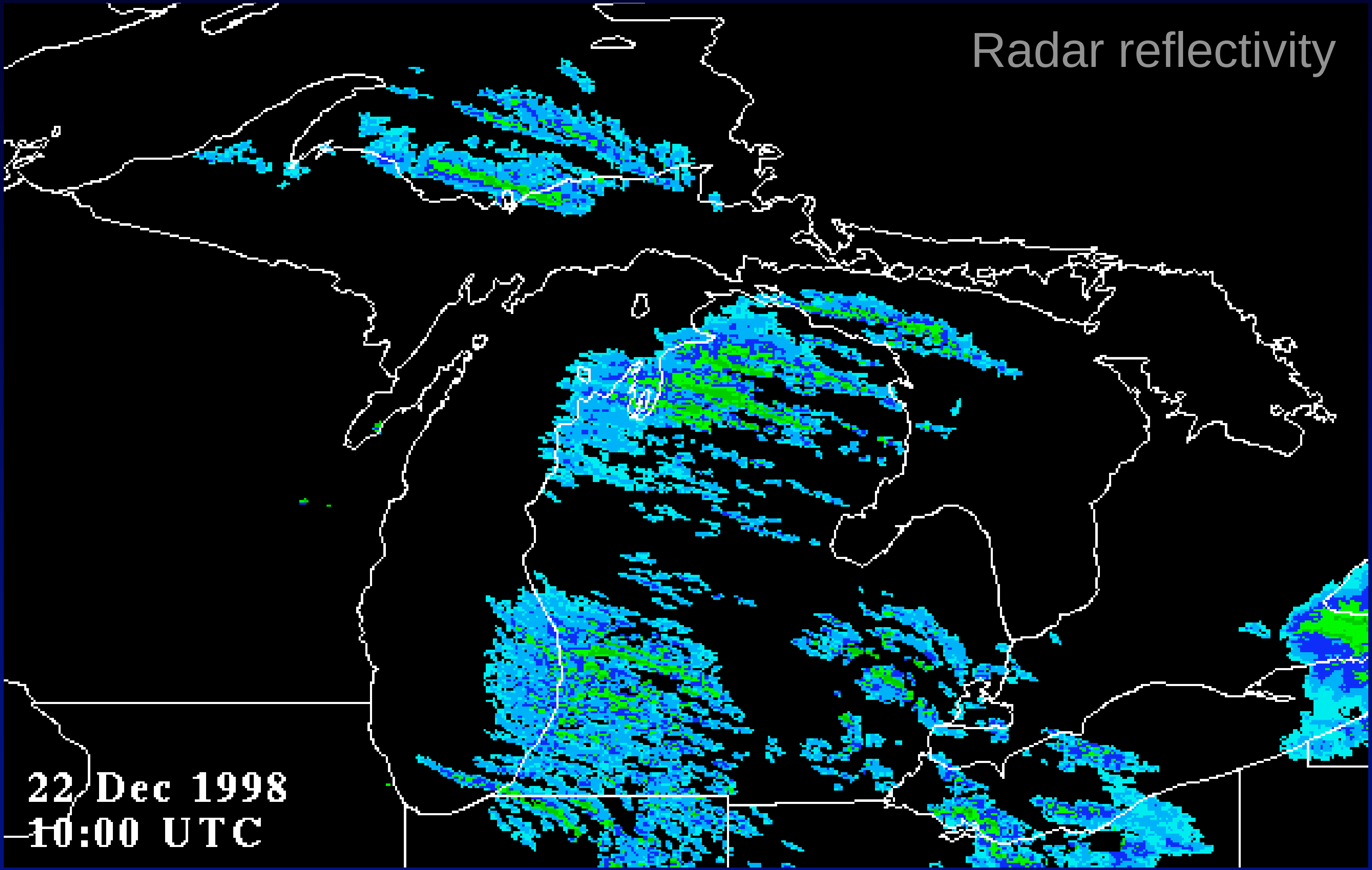
Jason Knievel

Material contributed by: Greg Byrd, Josh Hacker, Scott Halvorson, Daryl Onton, and Jim Steenburgh

Examples of lake-effect precipitation

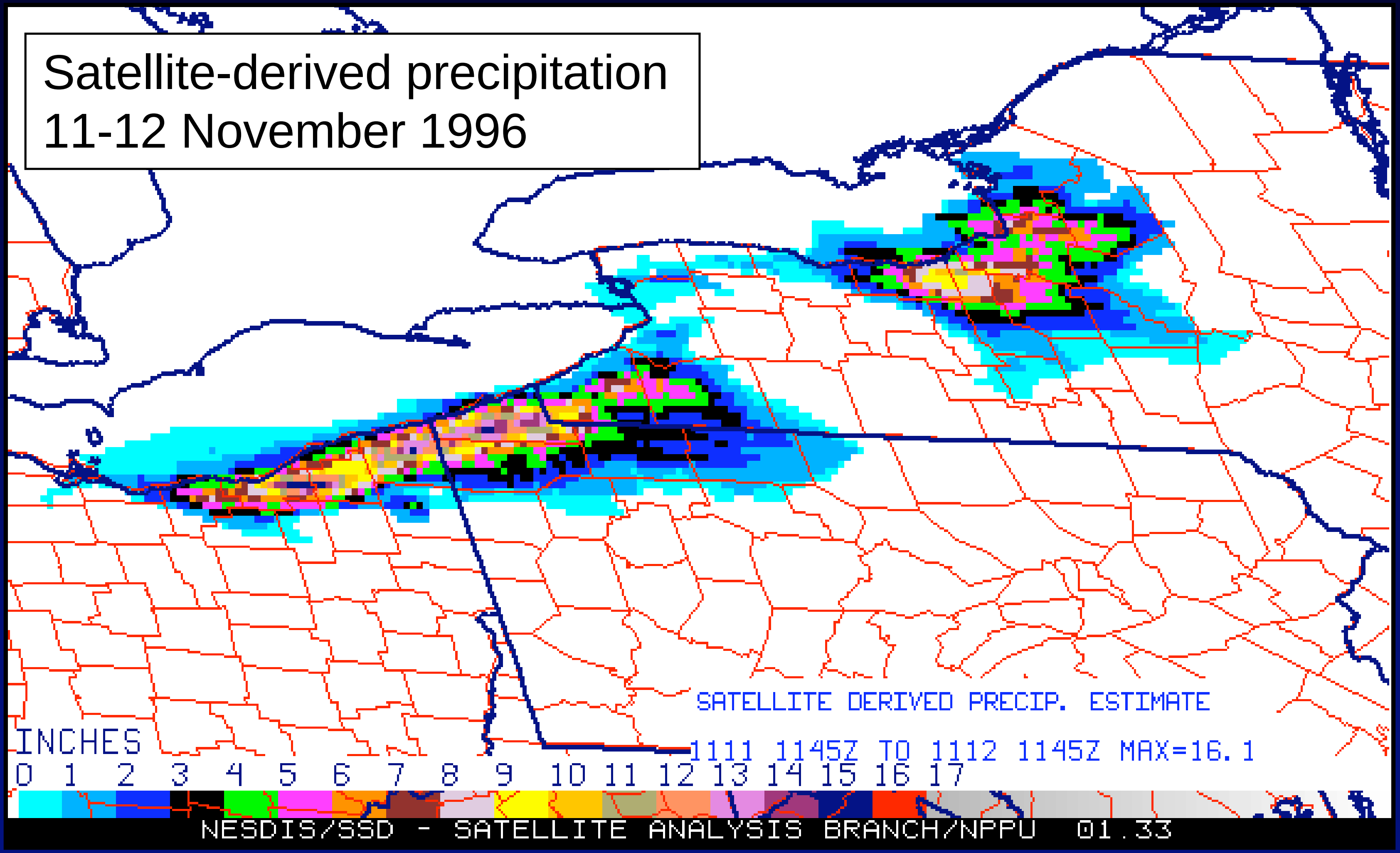


Examples of lake-effect precipitation



From U of Wyoming

Examples of lake-effect precipitation

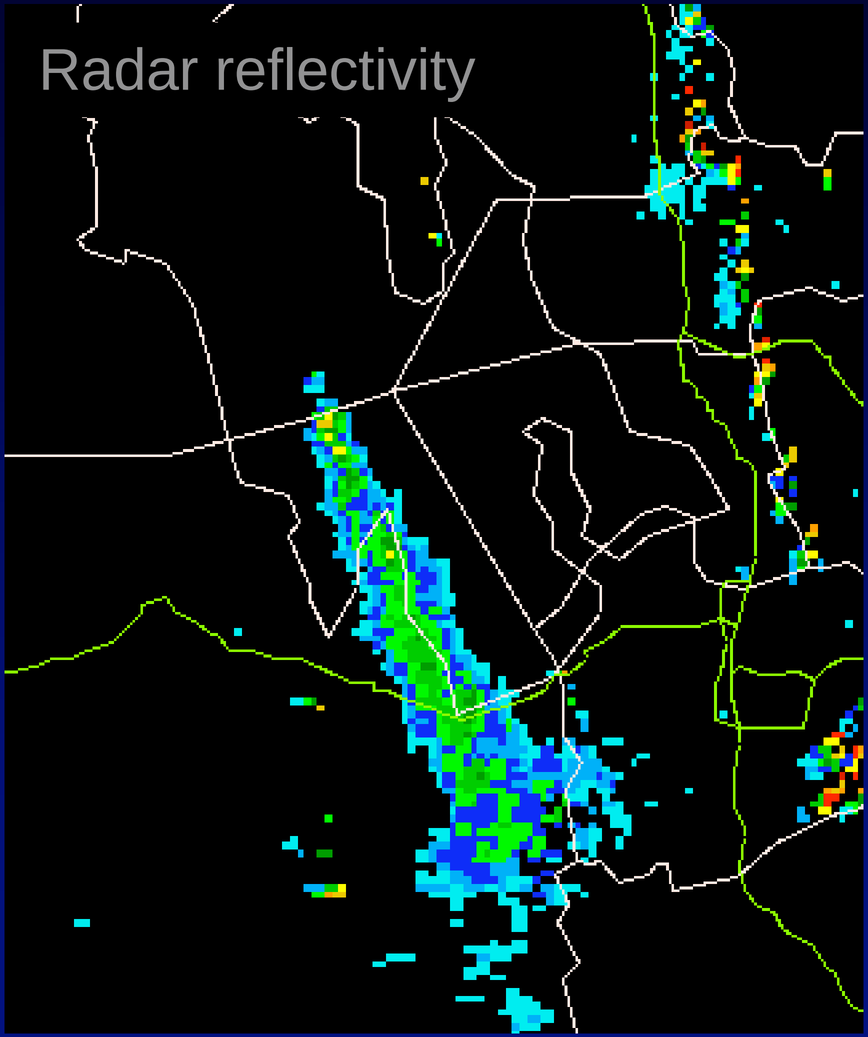


From NWS Buffalo

Locations of lake-effect-type precipitation

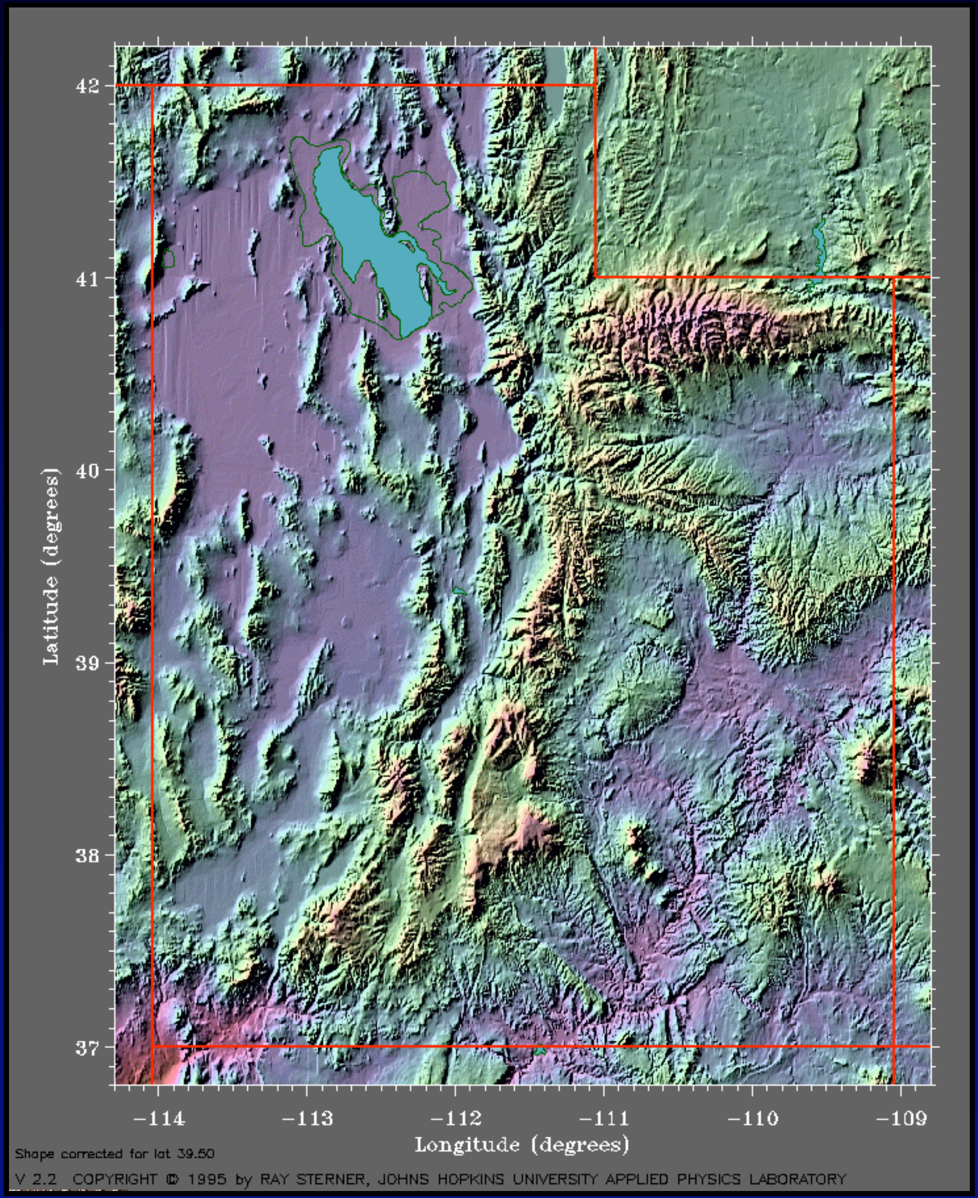
- Great Lakes
- Finger Lakes, NY
- Chesapeake, Delaware, and Massachusetts Bays
- Gulf Stream
- Sea of Japan
- Great Salt Lake (GSL)

Lake effect precipitation from the GSL



From Jim Steenburgh

GSL and surroundings

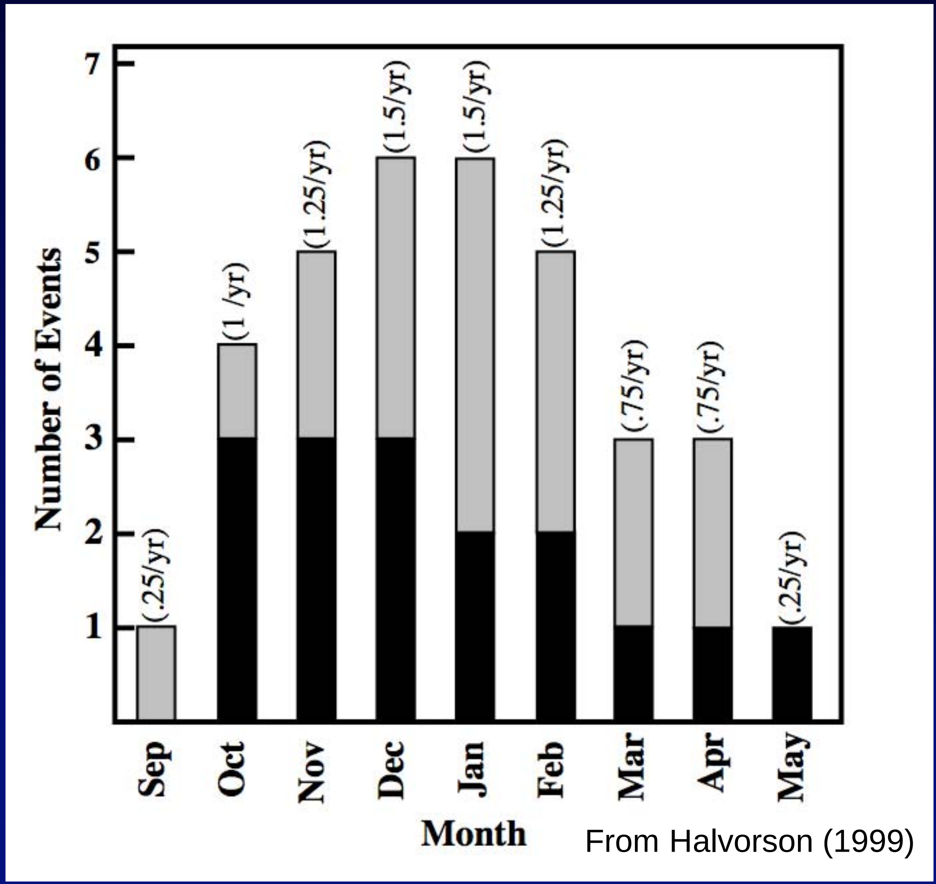


From siteatlas.com

Lake-effect precipitation by month

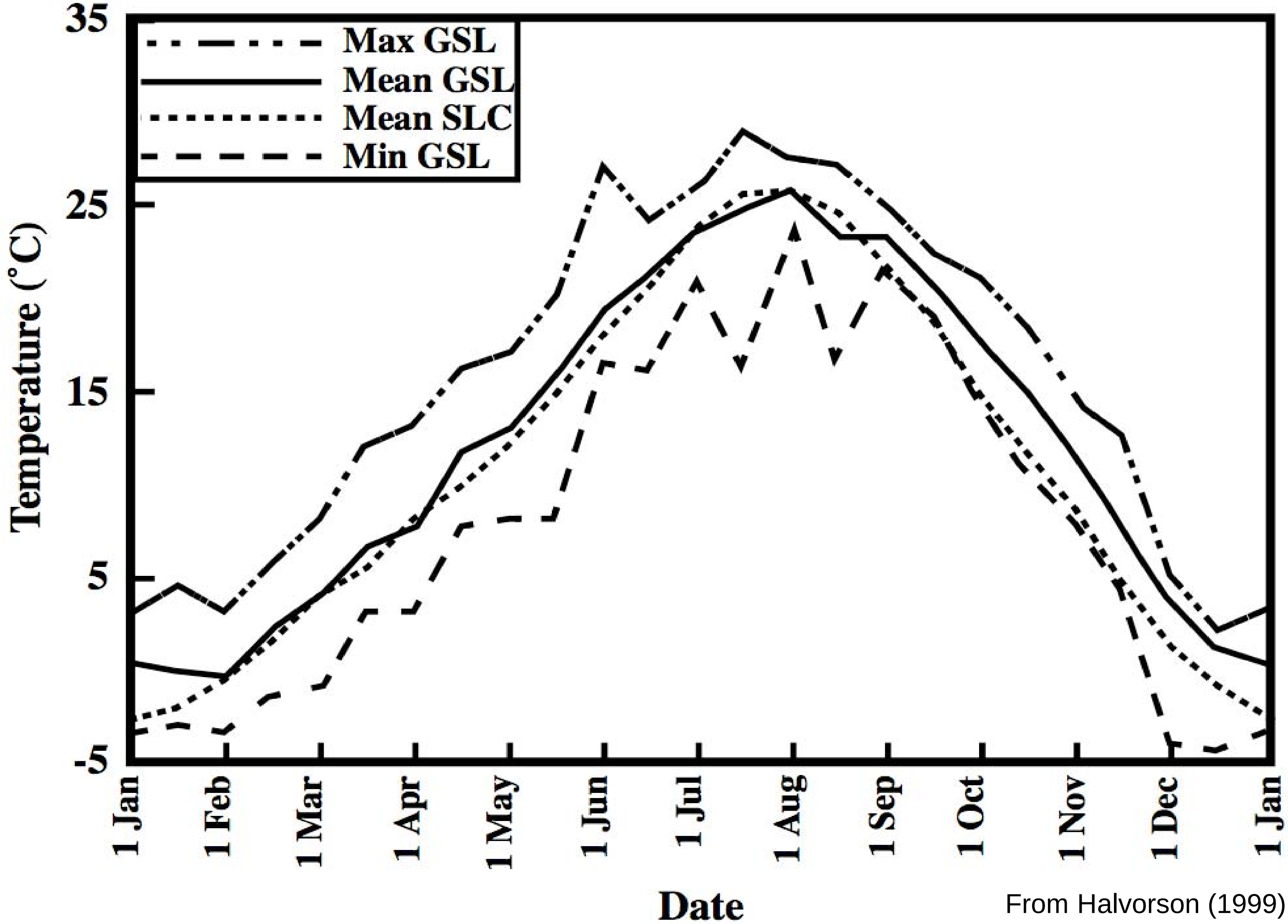
- L-E precipitation occurs during all the cool/cold months
- Most distinct L-E precipitation occurs during autumn and early winter

Data from Sep 1994 - May 1998



18 marginal cases in gray
16 distinct cases in black

Climate of GSL temperature

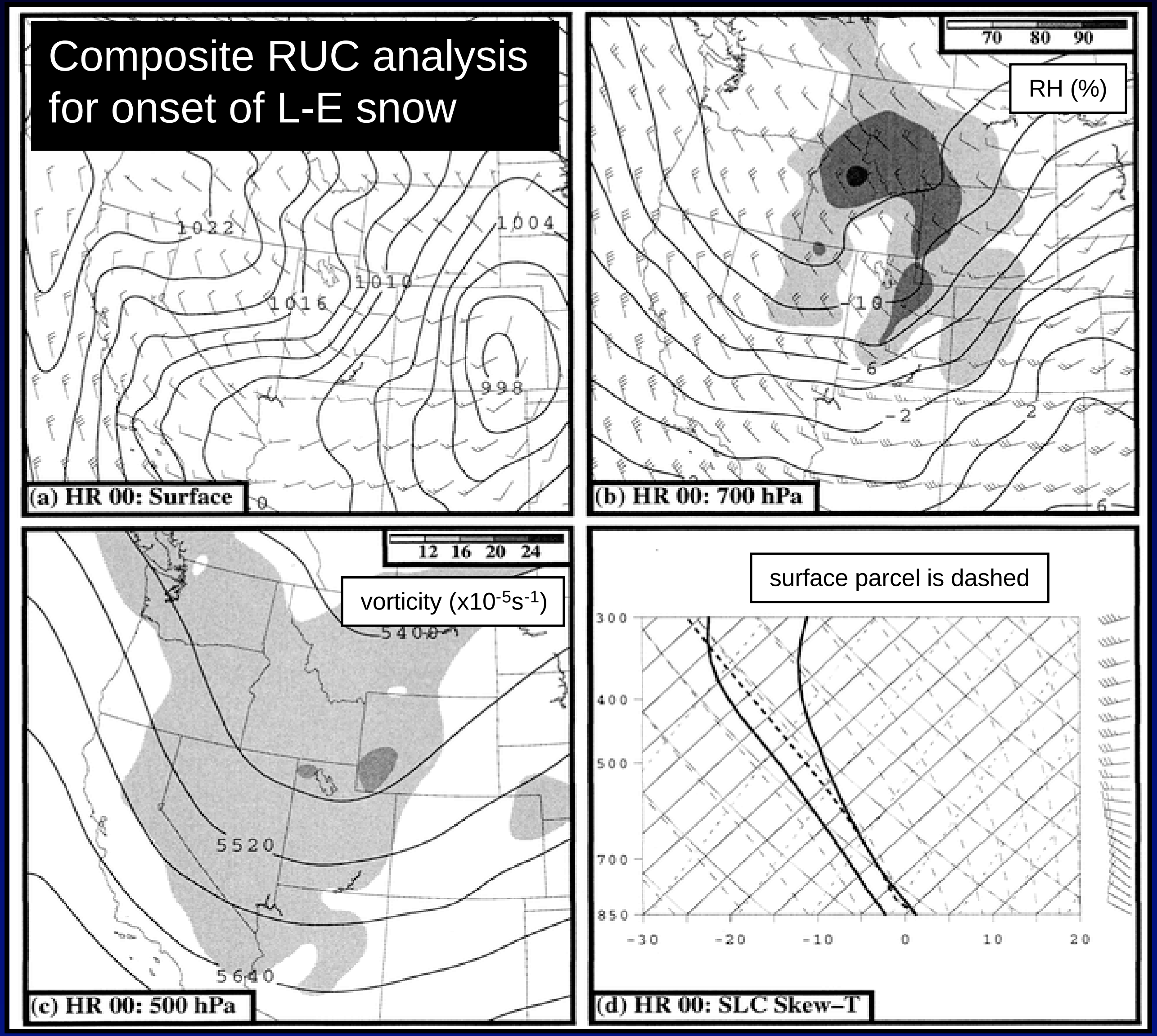


From Halvorson (1999)

Significance of salinity and size of GSL

- Lake-effect precipitation can occur over most of the year
  - Lake does not freeze
  - Lake temperature responds quickly to forcing
- Upstream, extant moisture may be important in many cases
  - Moisture from lake is limited

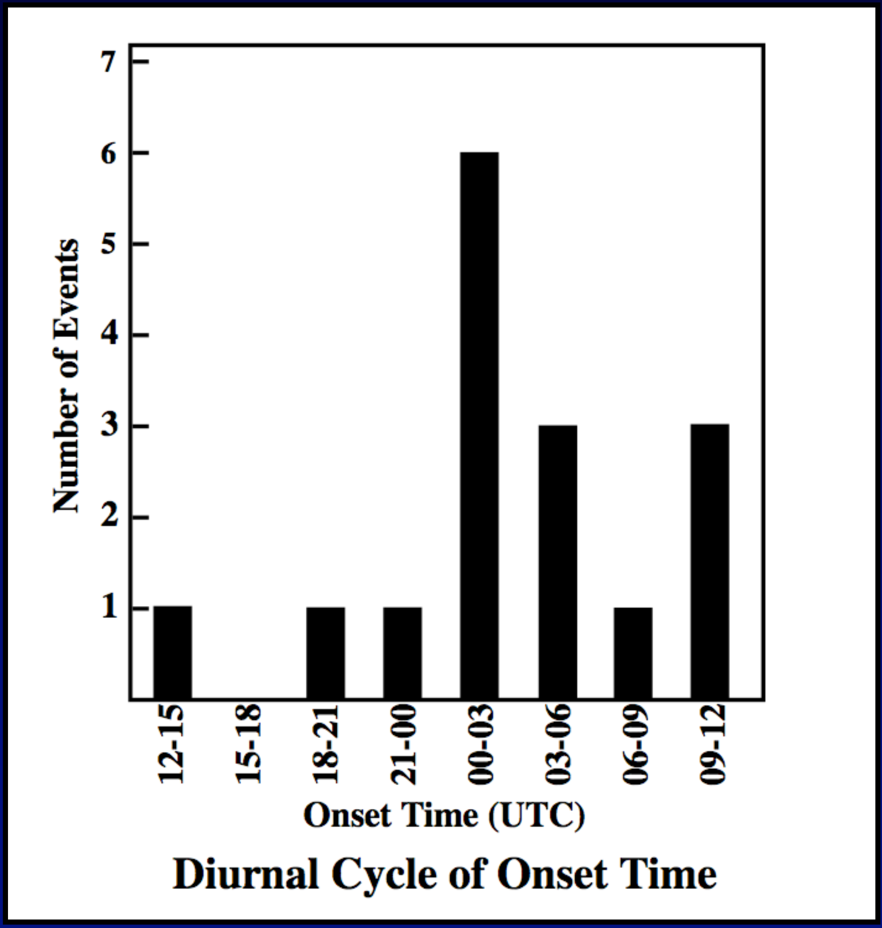
Synoptic setting



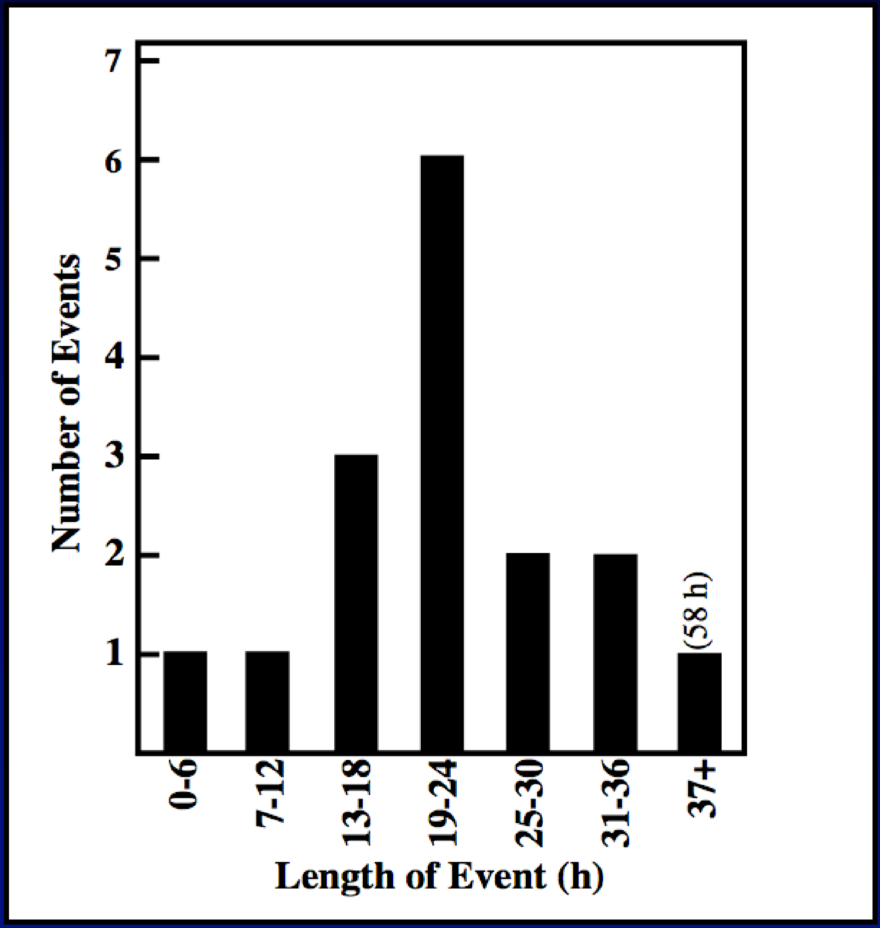
From Steenburgh et al. (2000)

Timing and duration of snows

- Most episodes start and night and last 12-36 h



From Halvorson (1999)

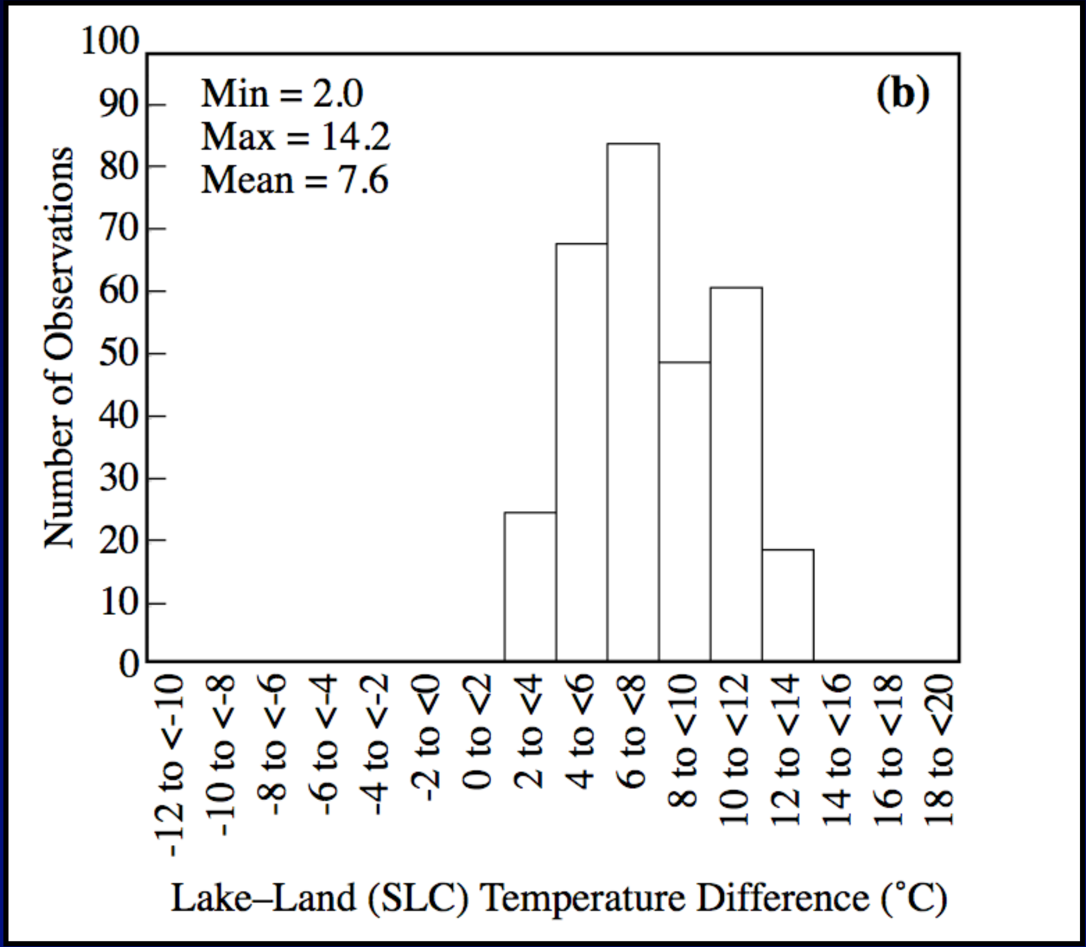


From Halvorson (1999)

Mesoscale enhancement by land breeze

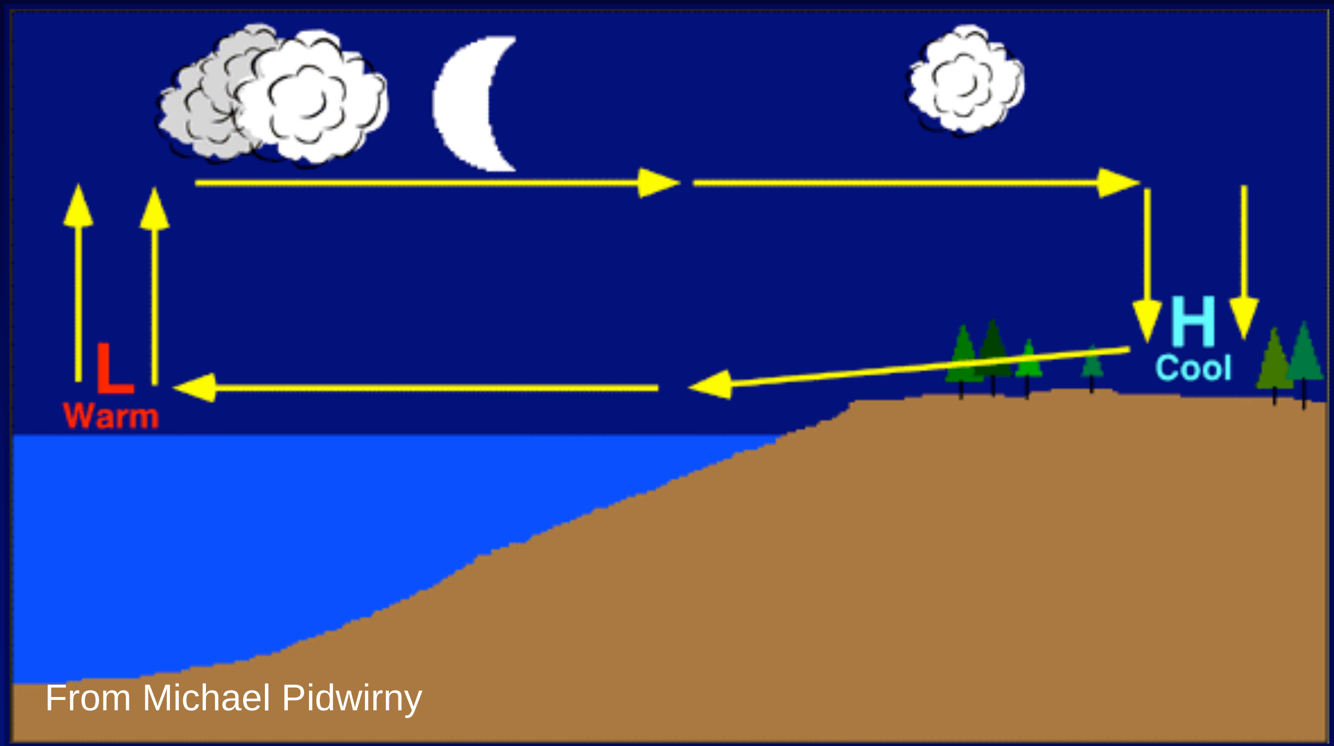
- Warmer water drives a land breeze

T_{lake}–T_{land} during lake-effect snows



From Halvorson (1999)

Mesoscale enhancement by land breeze

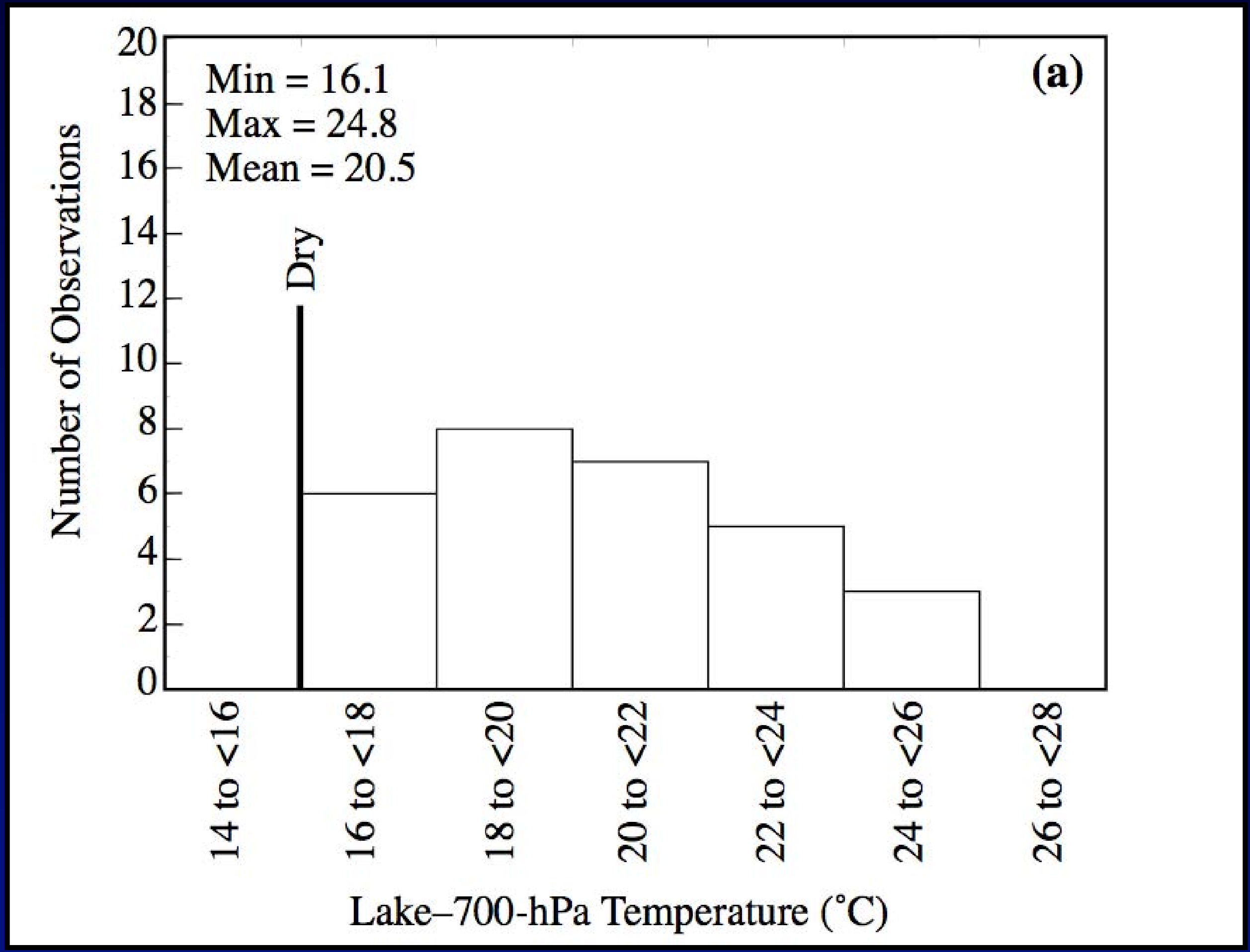


From Michael Pidwirny

- Frequent nocturnal onsets may be from enhanced forced ascent due to convergence over the GSL from land breezes

Role of static instability

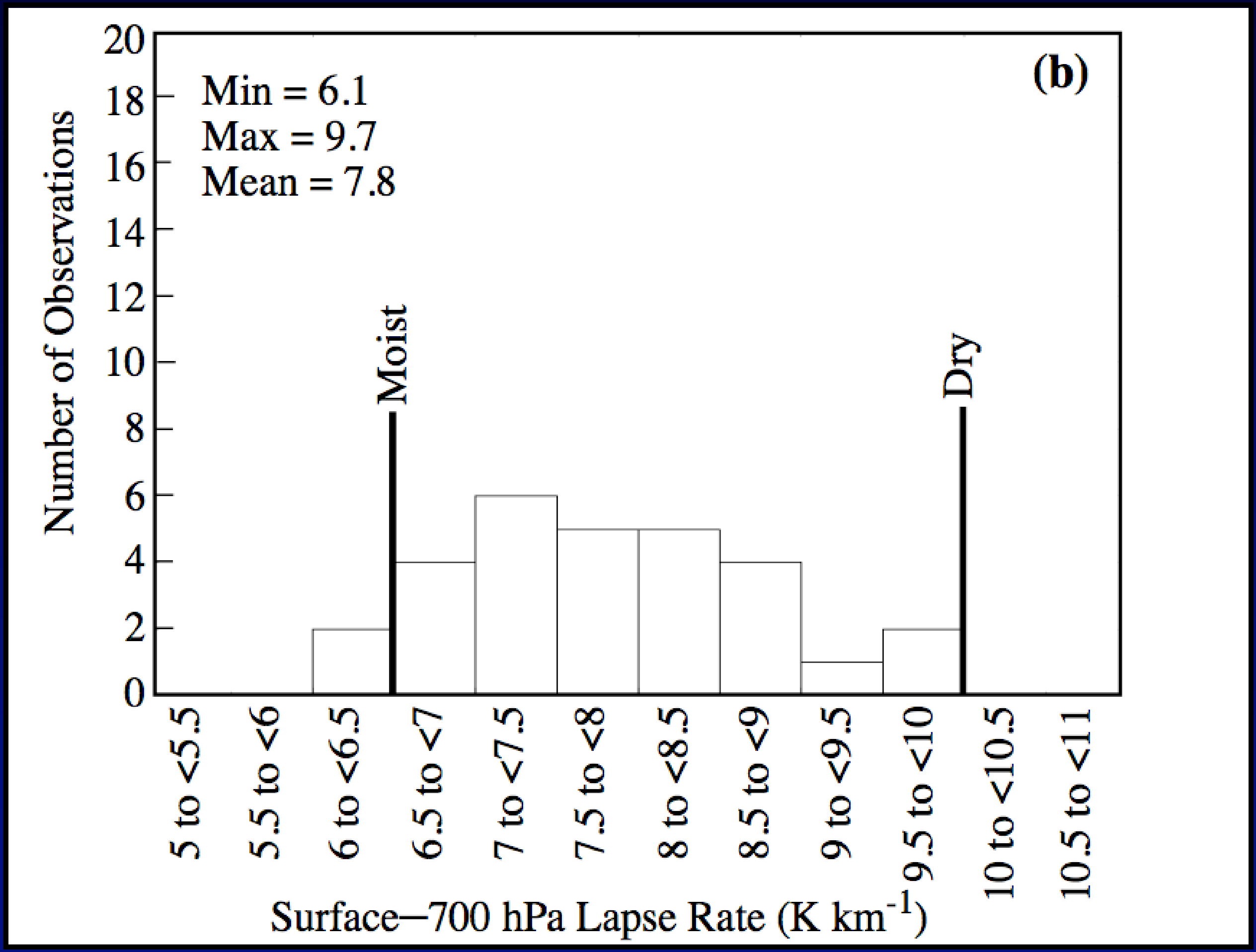
T_{lake}–T_{700} during lake-effect snows



From Halvorson (1999)

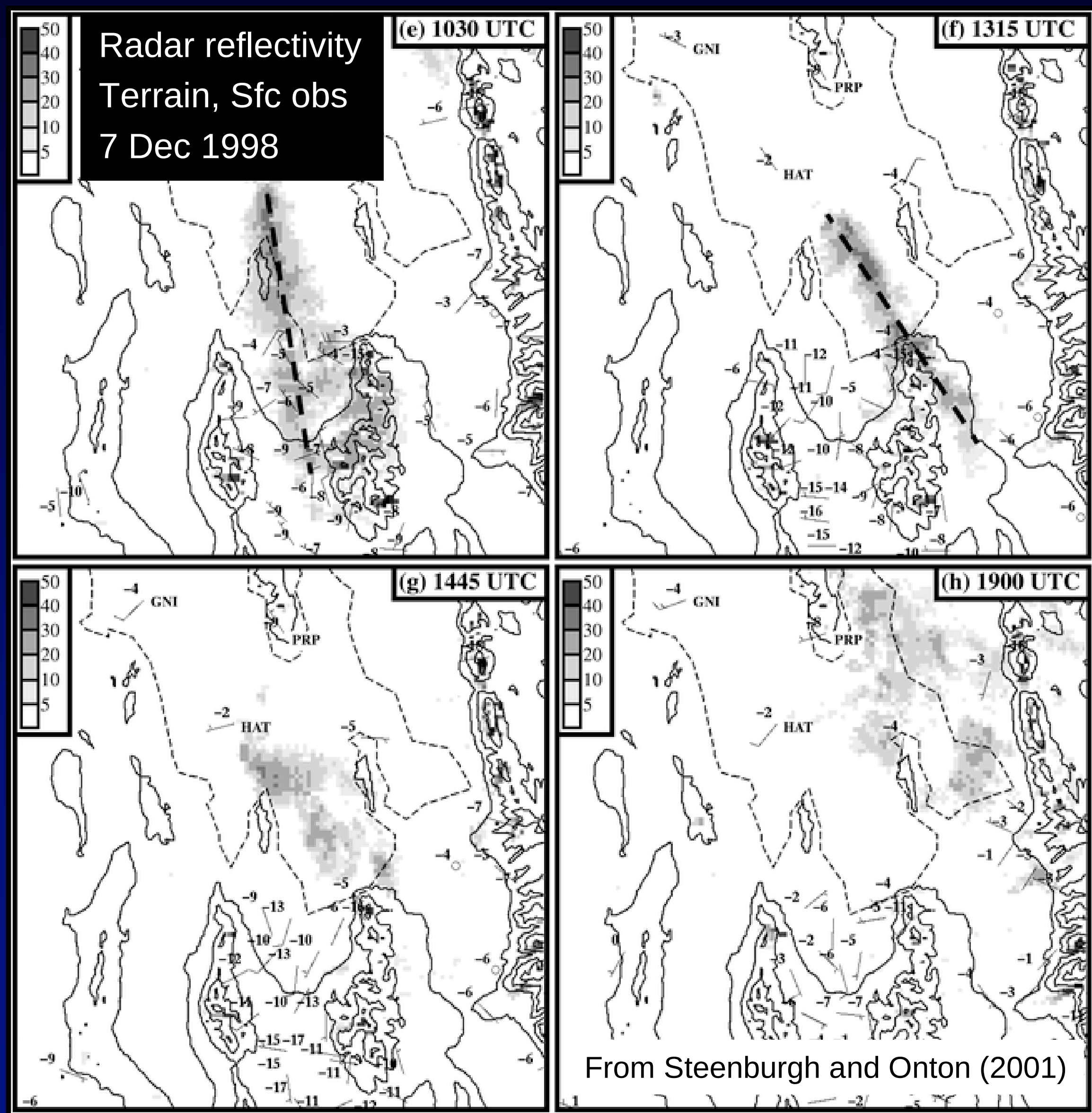
Role of static instability

T_{sfc}–T_{700} lapse rate during lake-effect snows



From Halvorson (1999)

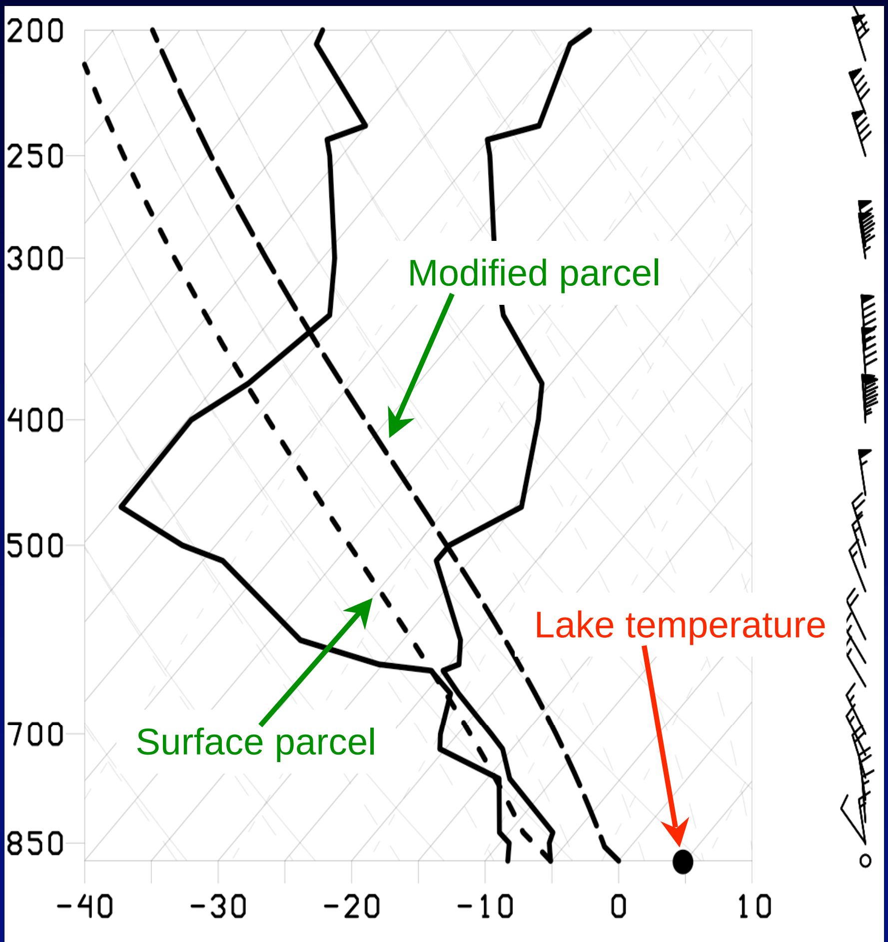
Wind direction and banding



From Steenburgh and Onton (2001)

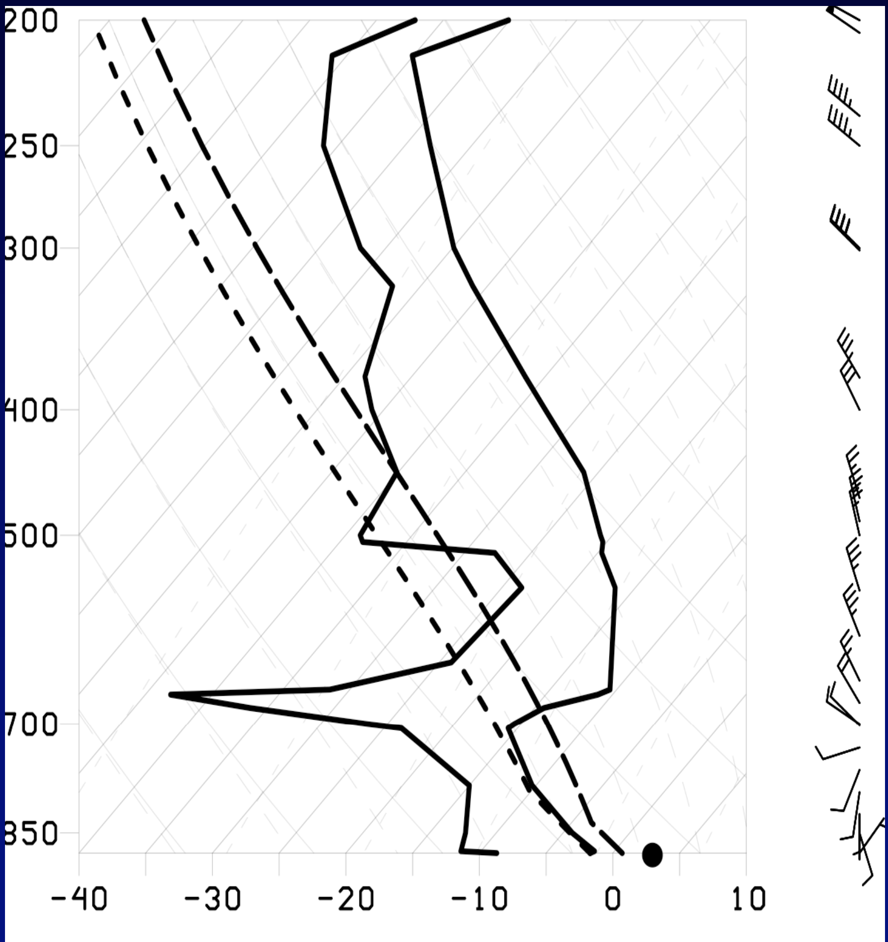
Wind direction and banding

1200 UTC 7 Dec 1998



From Onton (2000)

0000 UTC 8 Dec 1998



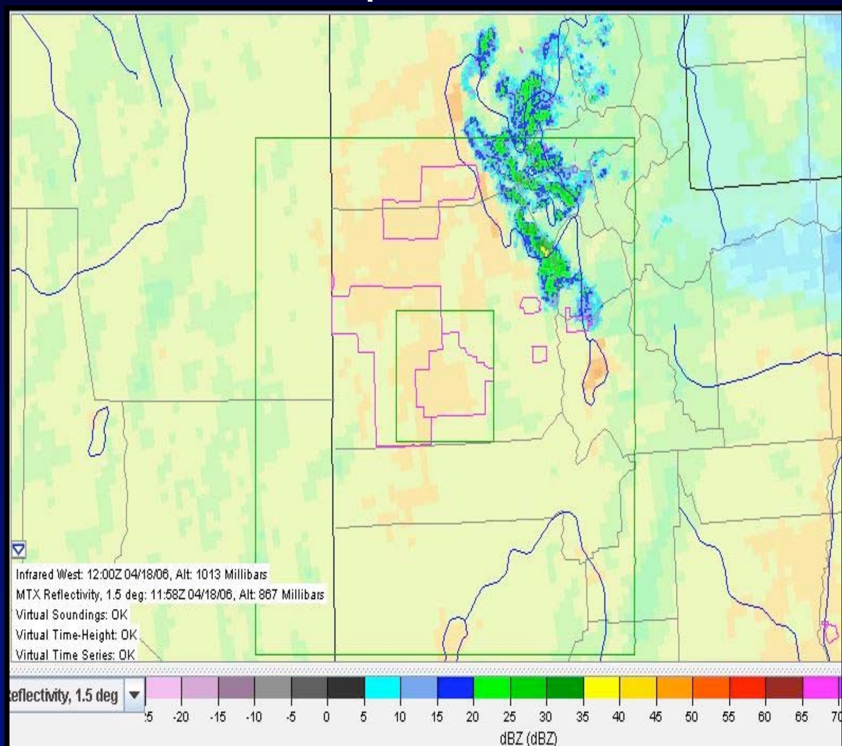
From Onton (2000)

Summary of ingredients

- Instability: Cold air over warm water to produce conditional or absolute instability
- Lift: Convergence, mountains, other mechanisms for lifting parcels to level of free convection
- Moisture: Supply of water for latent heating and precipitation
- Wind direction and lack of shear: Indicator of precipitation location and banding
- Persistence and intensity of these conditions

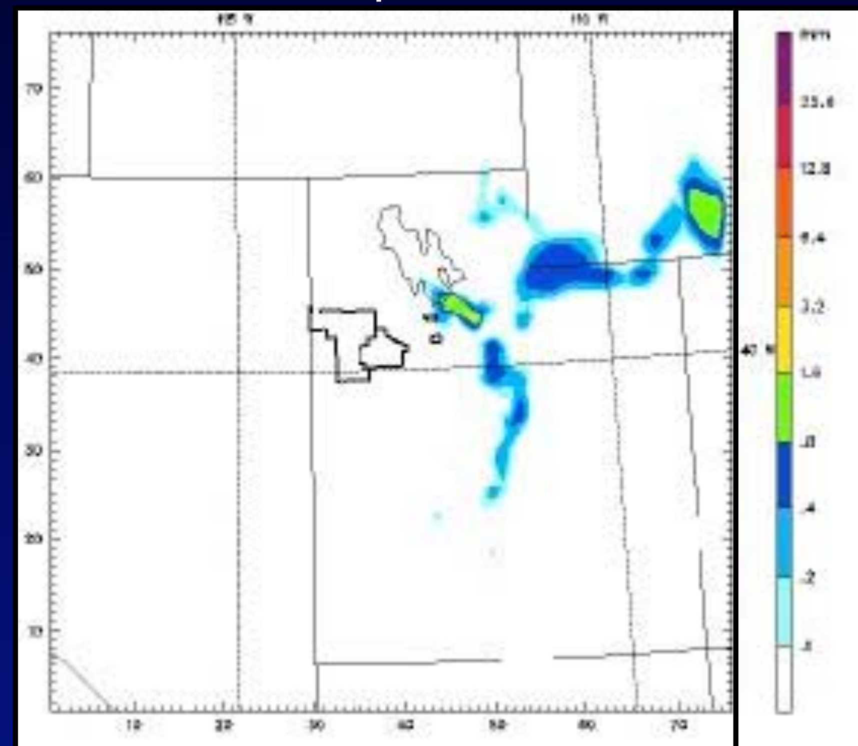
Lake-effect precipitation and RTFDDA

1200 UTC 18 Apr 2006 Obs



From Carissa Edgar

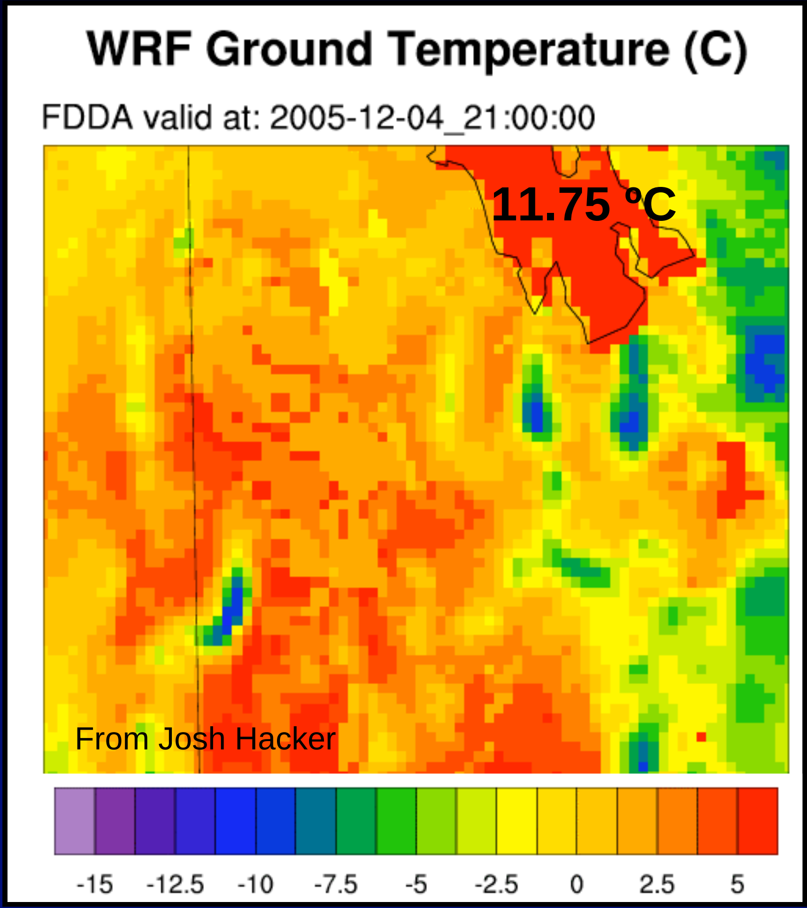
1200 UTC 18 Apr 2006 WRF

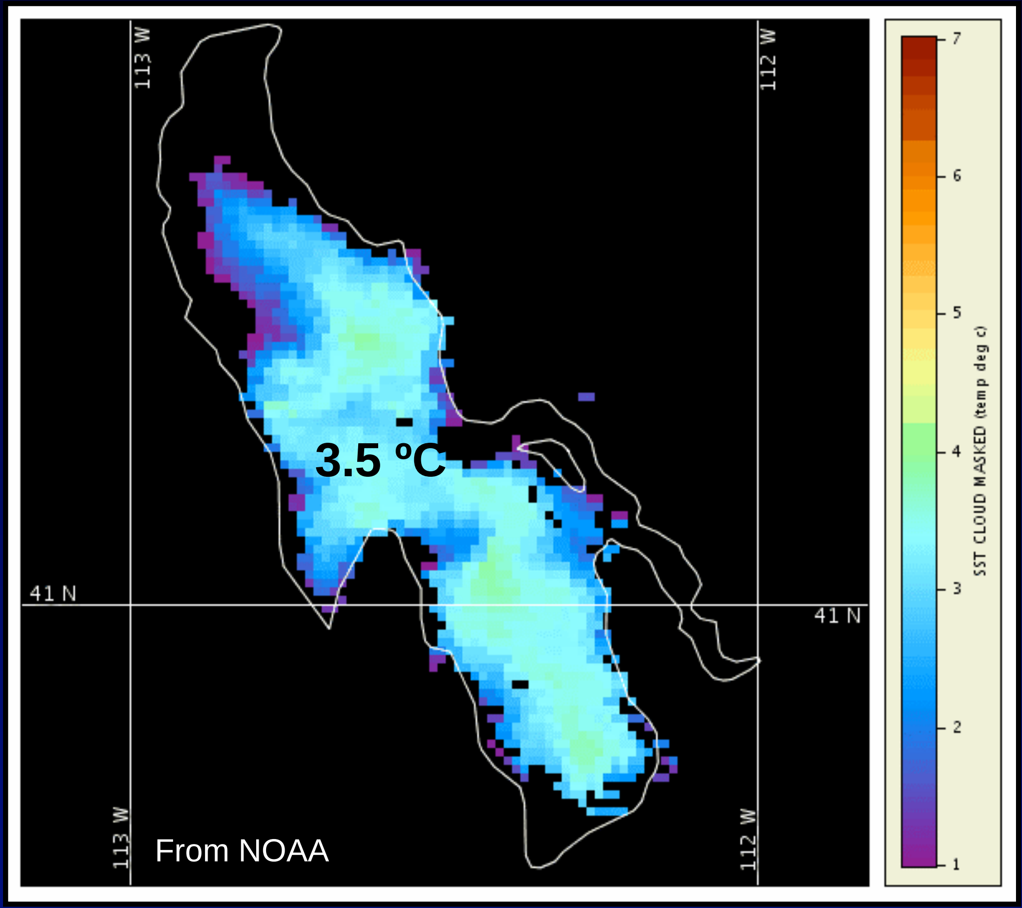


From Carissa Edgar

- RTFDDA is capable of realistically predicting lake-effect precipitation

Importance of lake temperature in RTFDDA





- RTFDDA is also capable of *over*-predicting lake-effect precipitation

Additional reading

- Carpenter, D. M., 1993: The lake effect of the Great Salt Lake: Overview and forecast problems. *Wea. Forecasting,* **8,** 181–193.
- Halvorson, S. F., 1999: Climatology of lake-effect snowstorms of the Great Salt Lake. M. S. thesis, Dept. of Meteorology, University of Utah, 78 pp.
- Onton, D. J., 2000: An observational and numerical modeling investigation of Great Salt Lake effect snow. Ph. D. dissertation, Dept. of Meteorology, University of Utah, 131 pp.
- Steenburgh, W. J., S. F. Halvorson, and D. J. Onton, 2000: Climatology of lake-effect snowstorms of the Great Salt Lake. *Mon. Wea. Rev.* , **128,** 709–727.
- Steenburgh, W. J., and D. J. Onton, 2001: Multiscale analysis of the 7 December 1998 Great Salt Lake-effect snowstorm. *Mon. Wea. Rev.,* **129,** 1296–1317.