

# Relationship Between Snow Extent and Mid-Latitude Storm Tracks From NARR Objectively Derived Storm Position and Snow Cover

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# Why do we care?

## • Forecasting

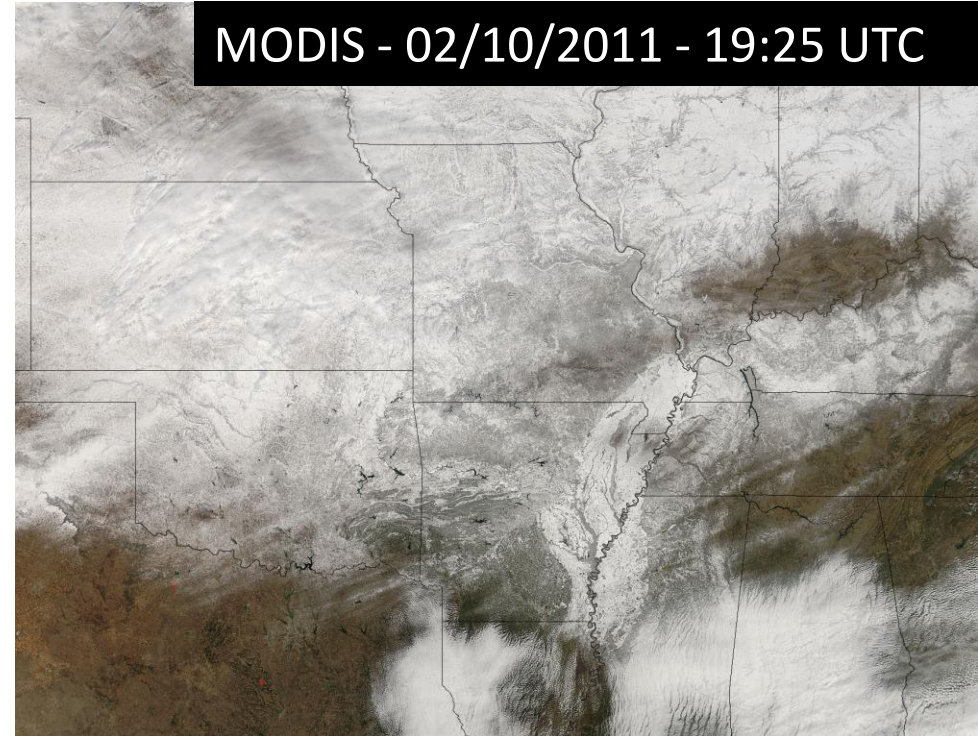
- “The **baroclinic zone** is a lot of times the place where storms will track. Repeated stormtracks will continue to move the snowcover slightly southward.”

- Eric Sorensen, WREX Weather Blog

- “Storms tend to ride along the southern edge of the snowpack where a natural **baroclinic zone** sets up.” - Henry Margusity, Accuweather

## • Climate

- “General features include a **poleward shift** in storm track location, increased storm intensity, but a decrease in total storm numbers “ IPCC (2007)



Bright  
Cold  
Moist

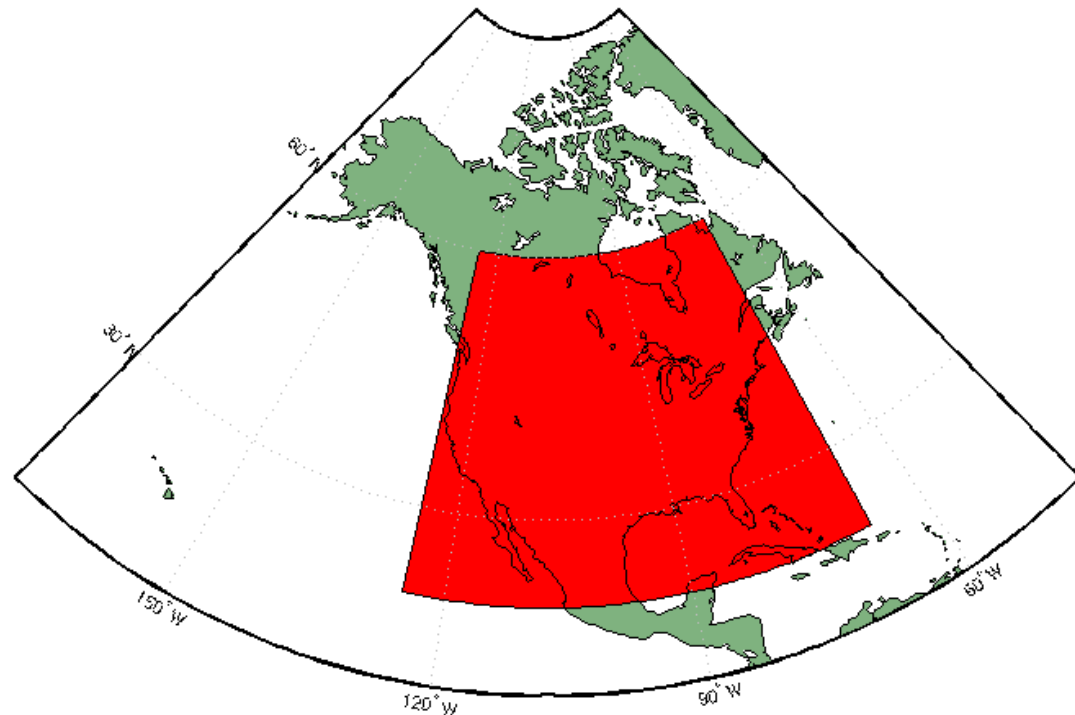
Dark  
Warm  
Dry

Snow

No Snow

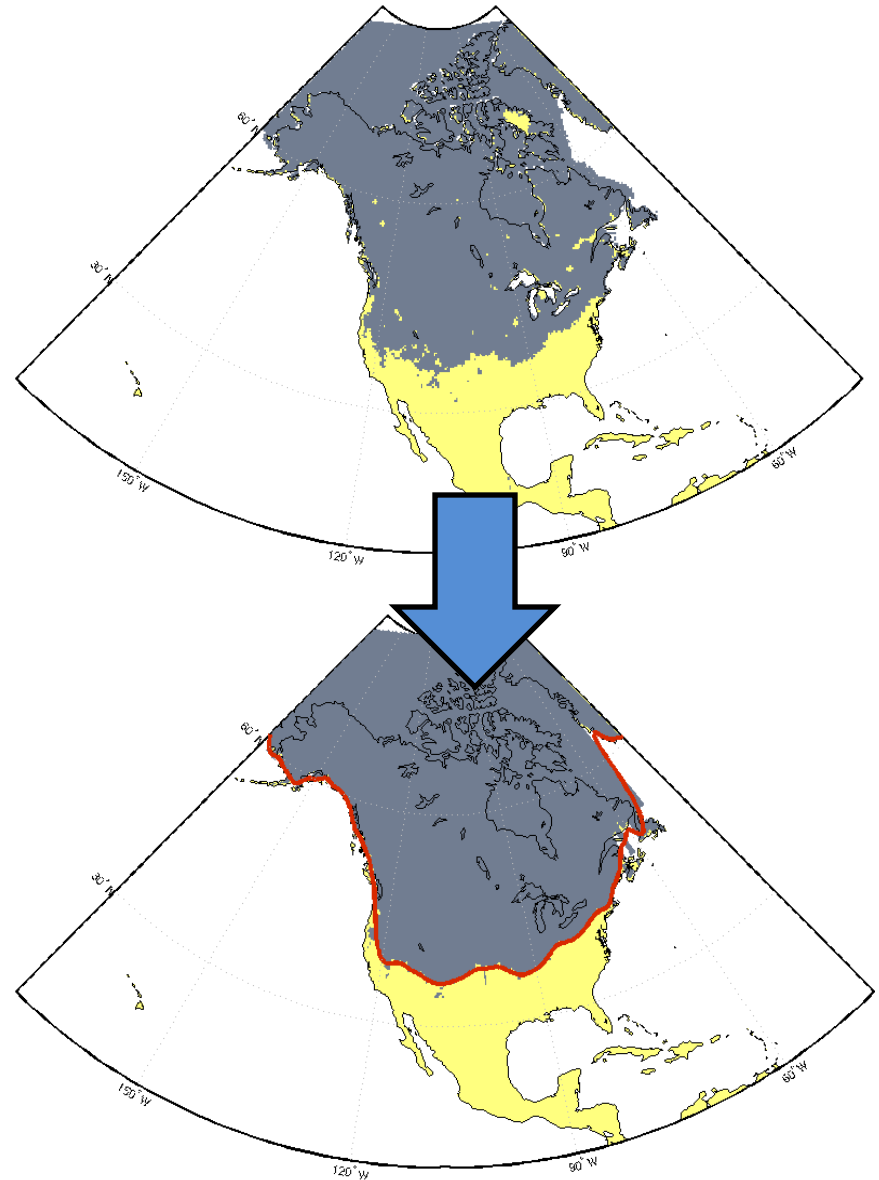
# Dataset and Domain

- North American Regional Reanalysis
  - Snow cover from U.S. Air Force analysis
- Snow extent produced at 0 UTC
- 1979-2010
- Study Domain
  - 20°N to 65°N
  - 125°W to 67°W



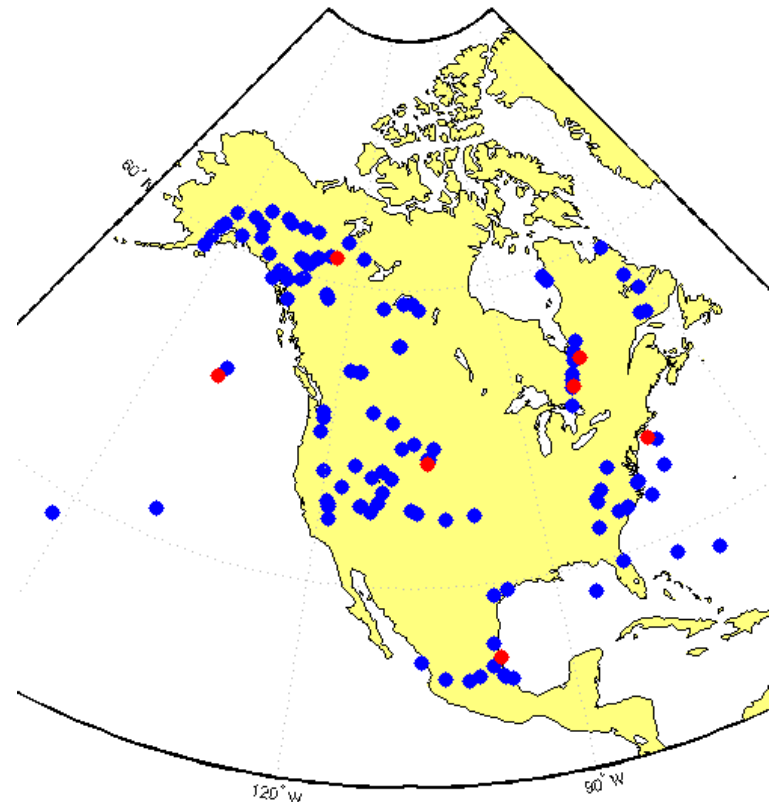
# Snow extent

1. Gaps filled in 0 UTC NARR categorical snow presence
2. Linearly interpolated to  $0.25^\circ$  grid
3. For each longitude, find  $2.5^\circ$  of consecutive snow cover from south to north
4. Smooth snow extent with  $2.5^\circ$  filter



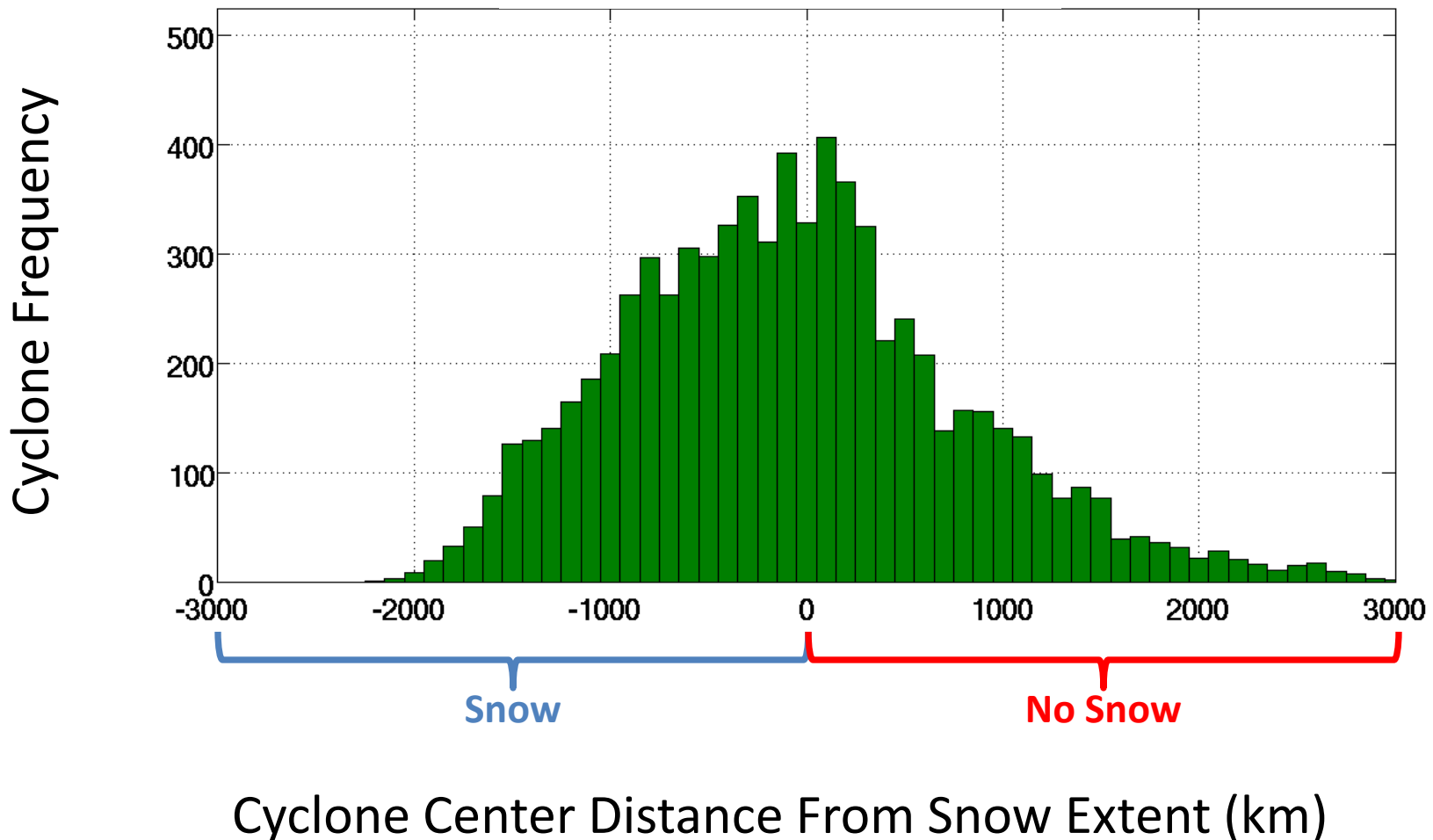
# Mid-latitude cyclone tracks

- Identification
  - Pressure minima located at fine ( $0.25^\circ$ ) and coarse ( $2.5^\circ$ ) resolution
  - Coarse minimum moved to nearest fine minimum
- Tracking
  - Nearest centers within 400 km are linked at three hour time steps
  - Center must move in six hours
  - Center may not backtrack
  - Center allowed to disappear for one time step
  - Storm must last at least a day



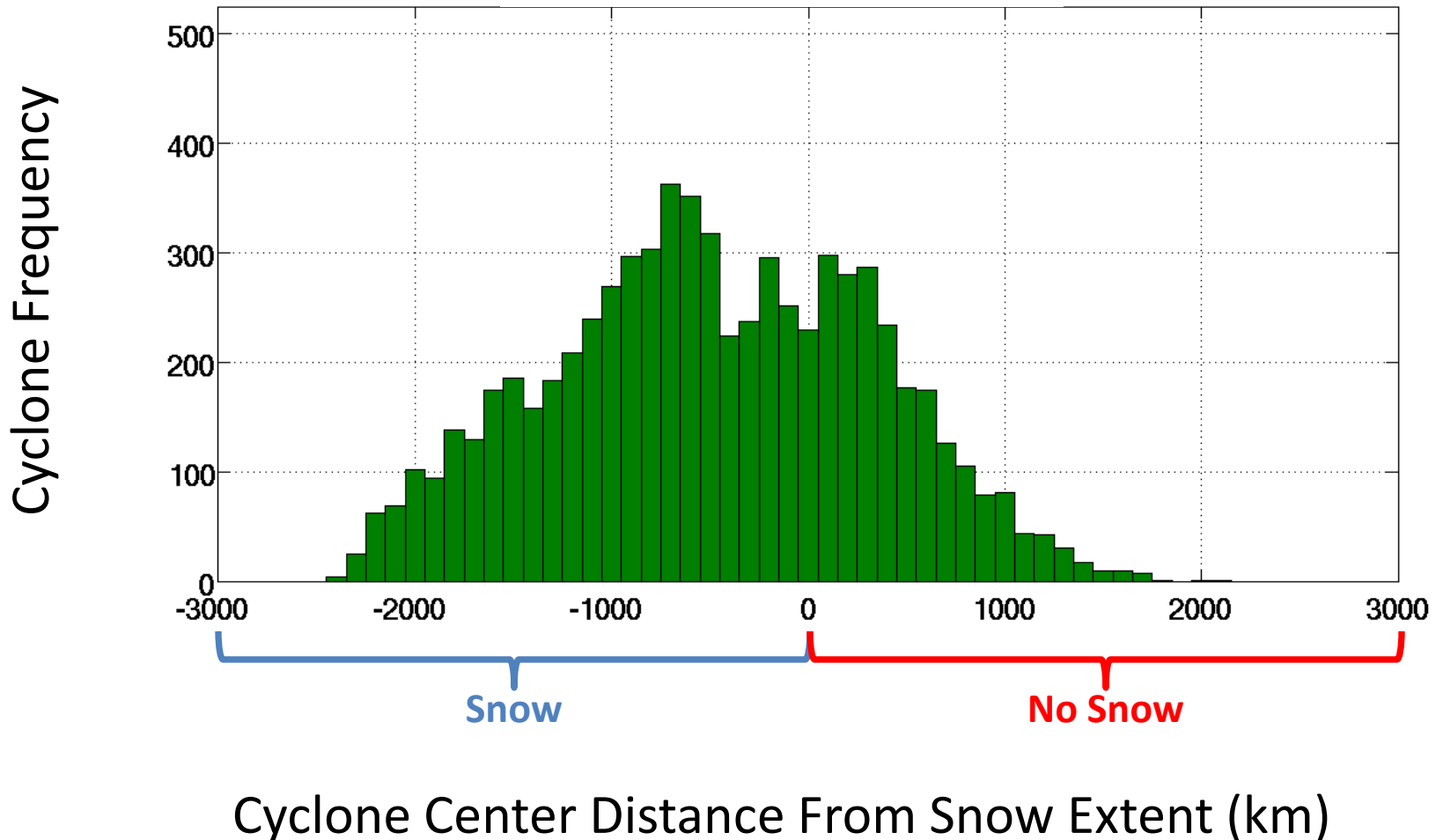
# Is there a relationship between snow extent and cyclone position?

November



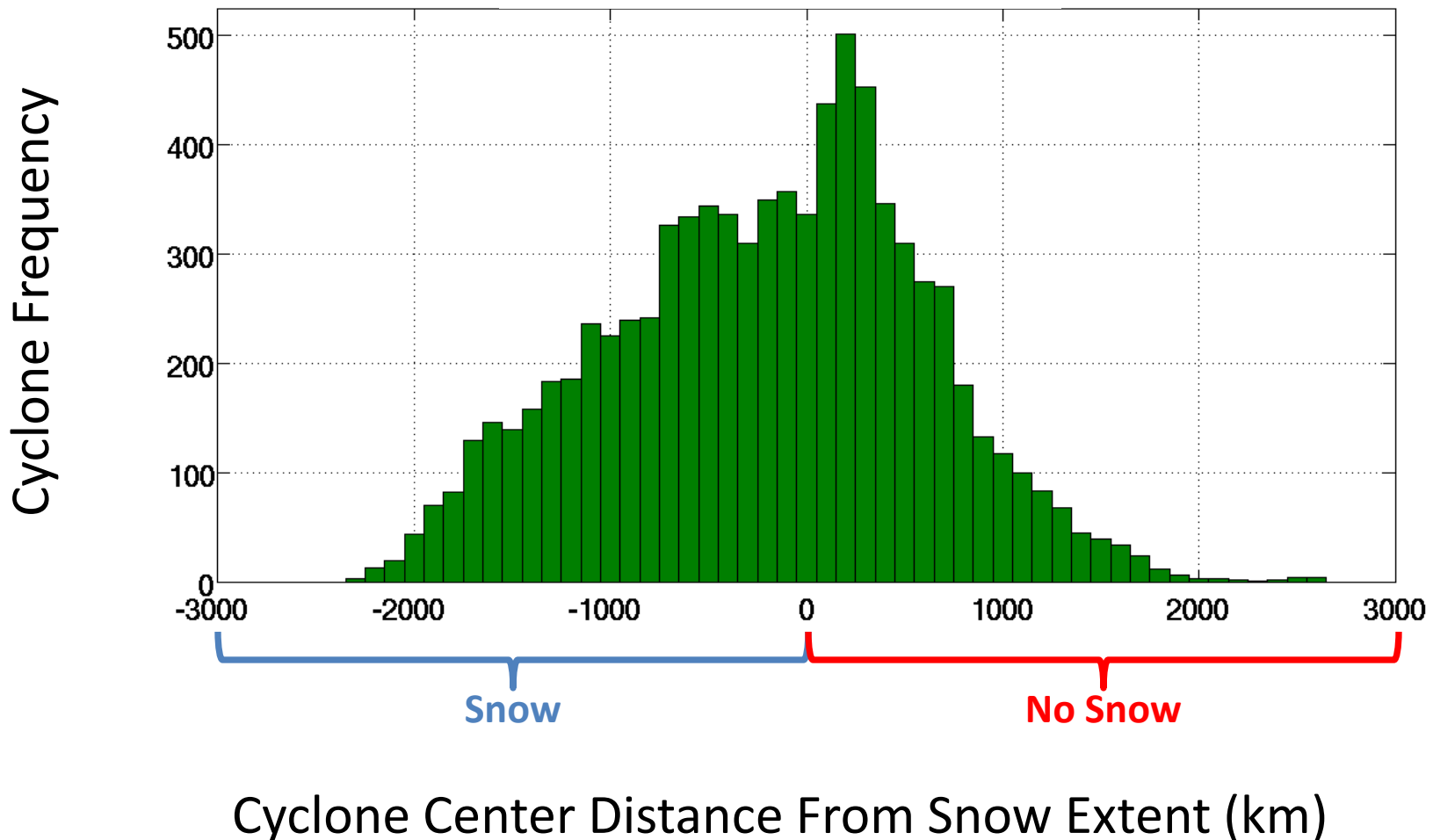
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January



# Is there a relationship between snow extent and cyclone position?

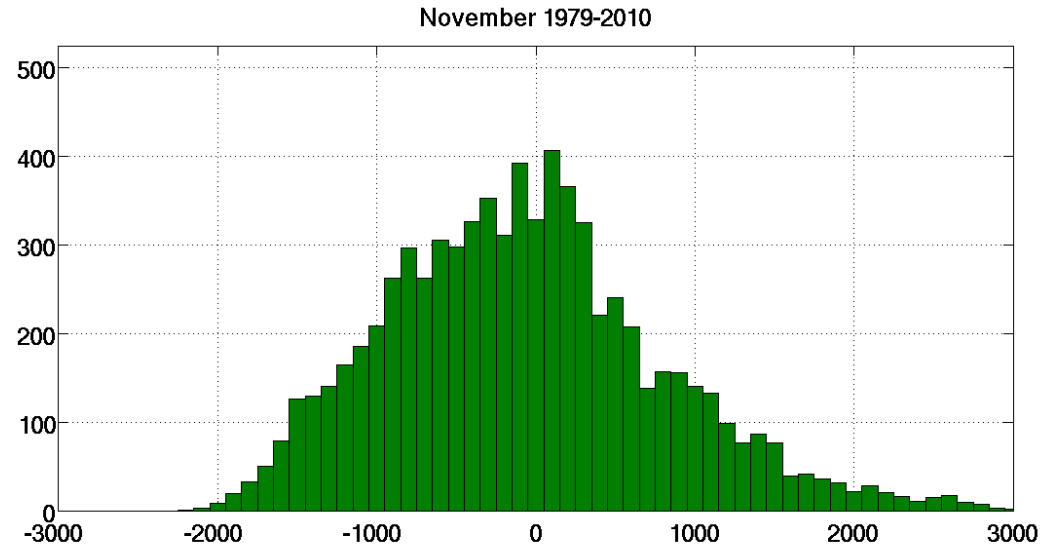
March





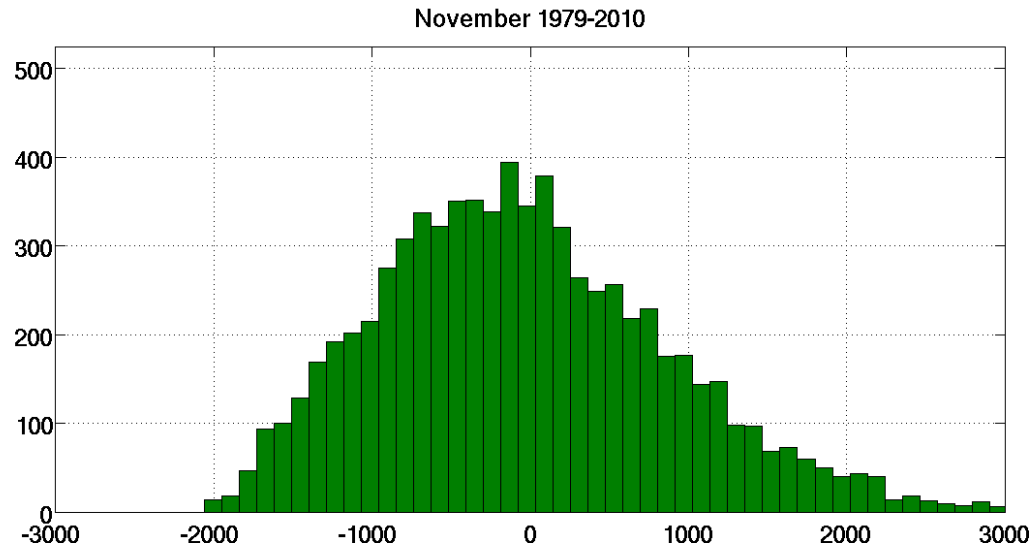
# Is there a lagged relationship?

Zero Day Lag



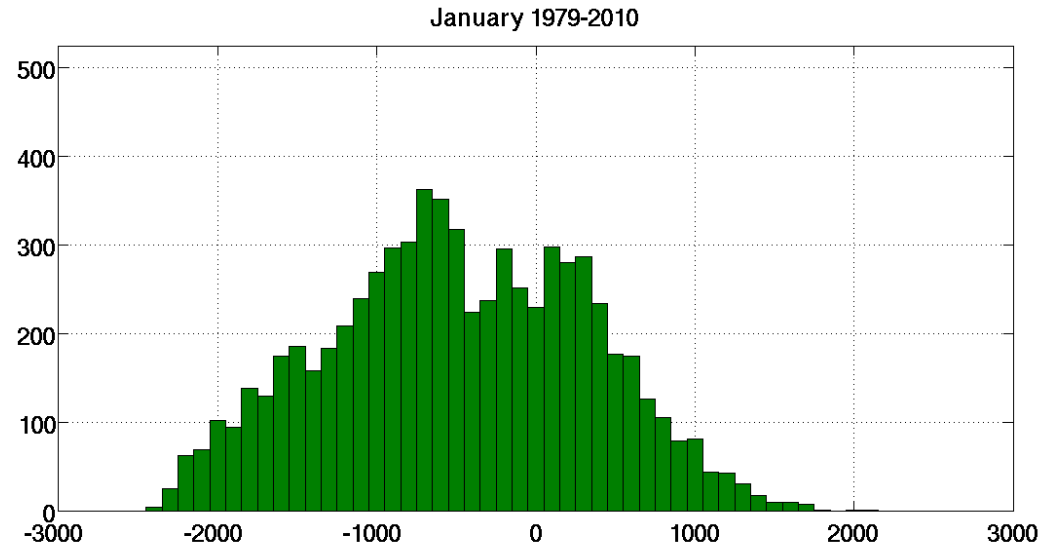
November

Two Day Lag  
(snow leads)



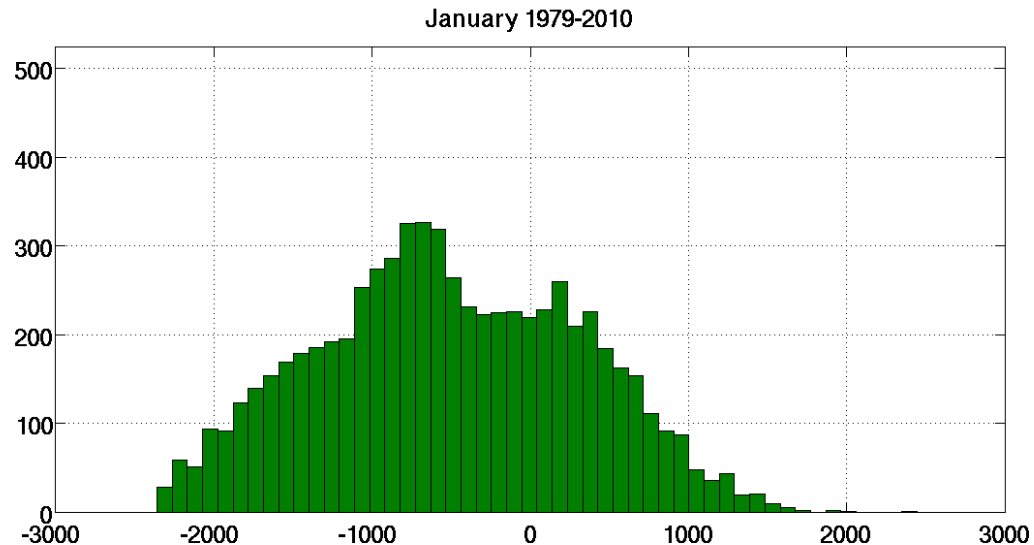
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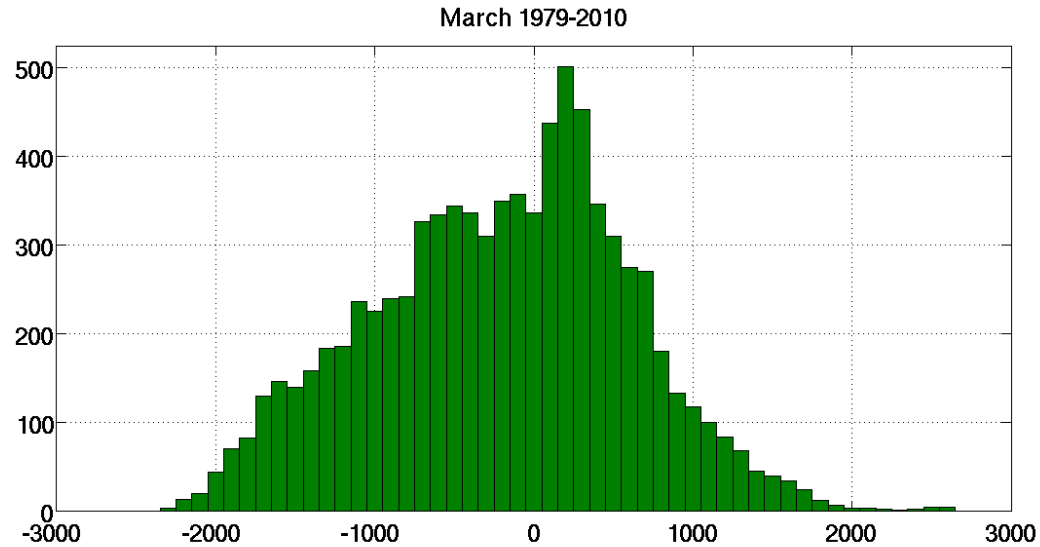
January

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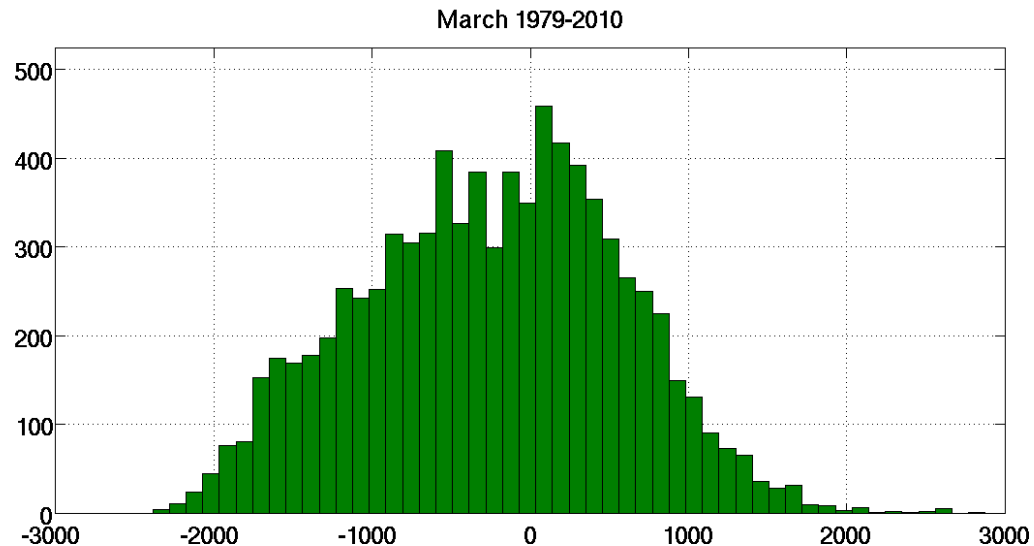
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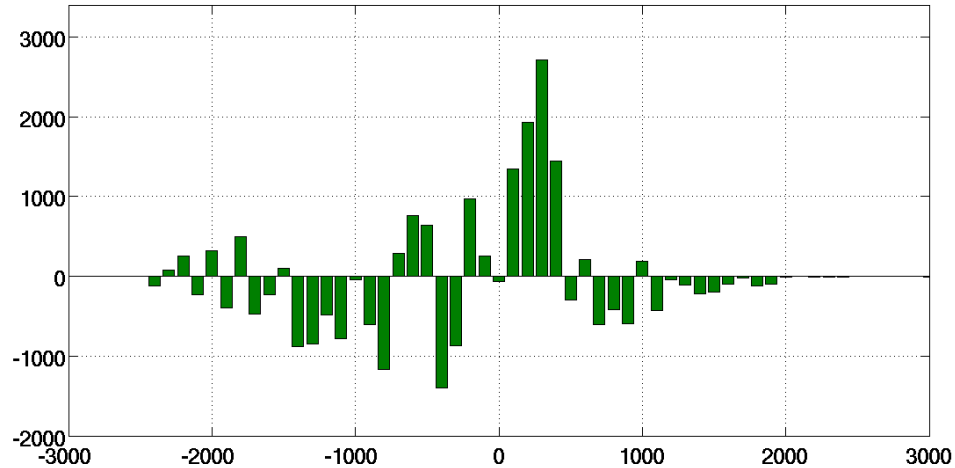
March

Two Day Lag  
(snow leads)

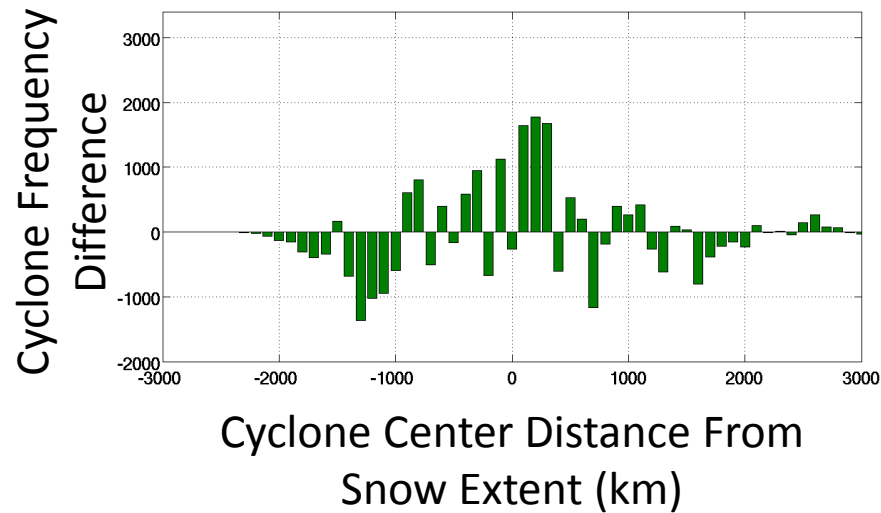


# How robust is the result?

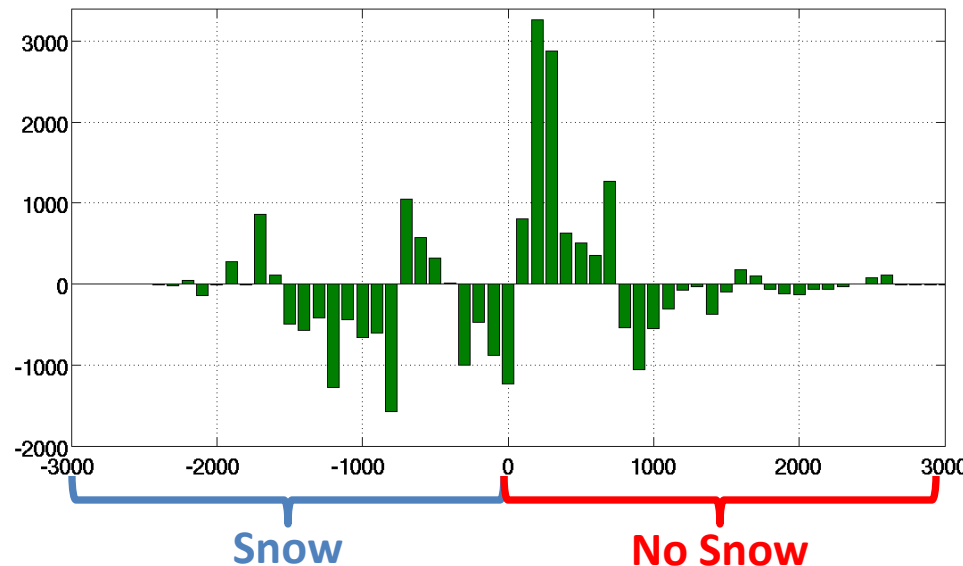
January



November

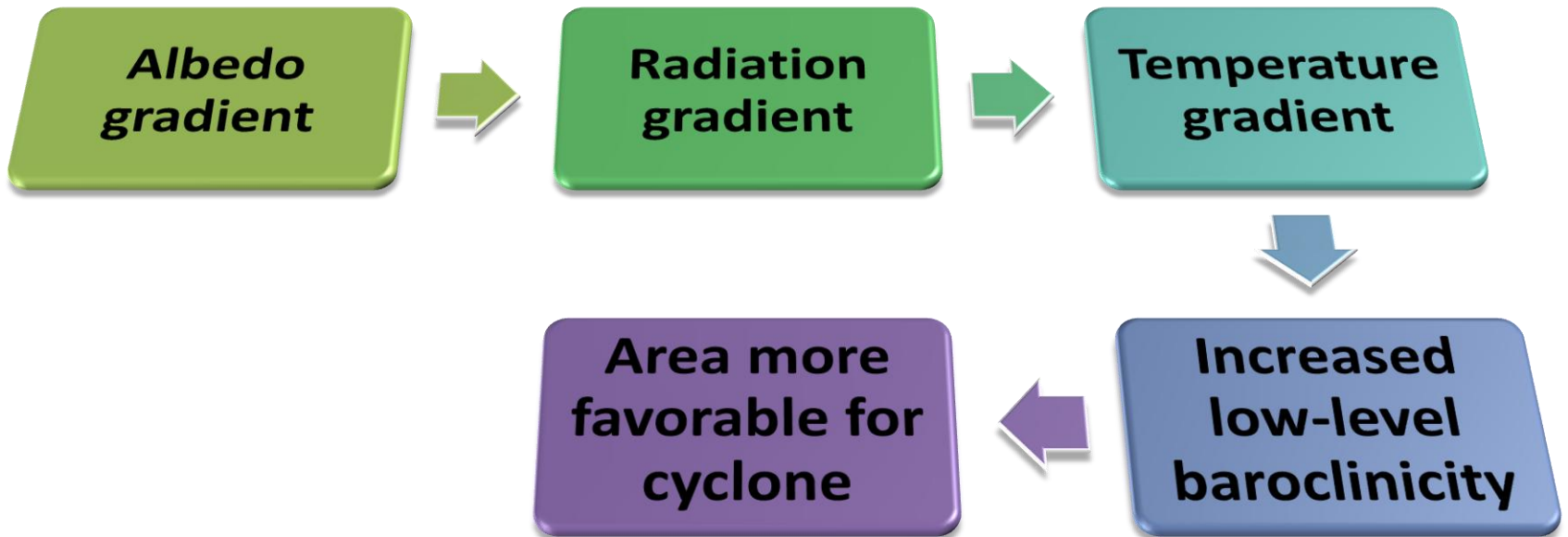
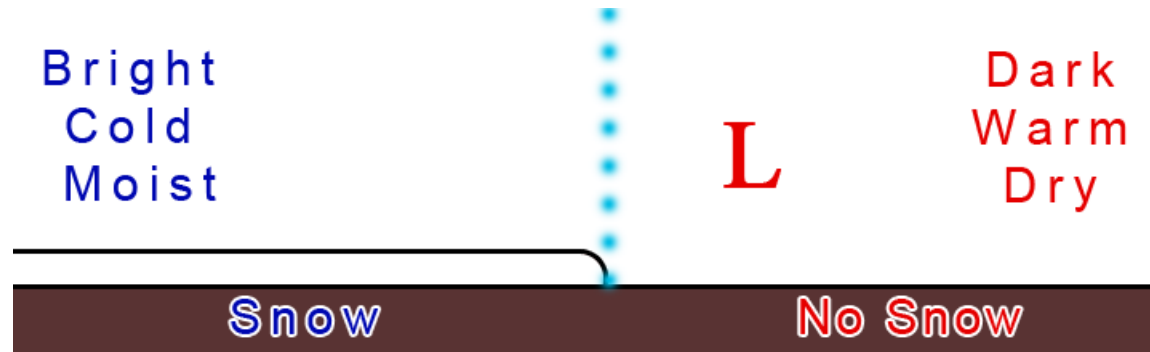


March

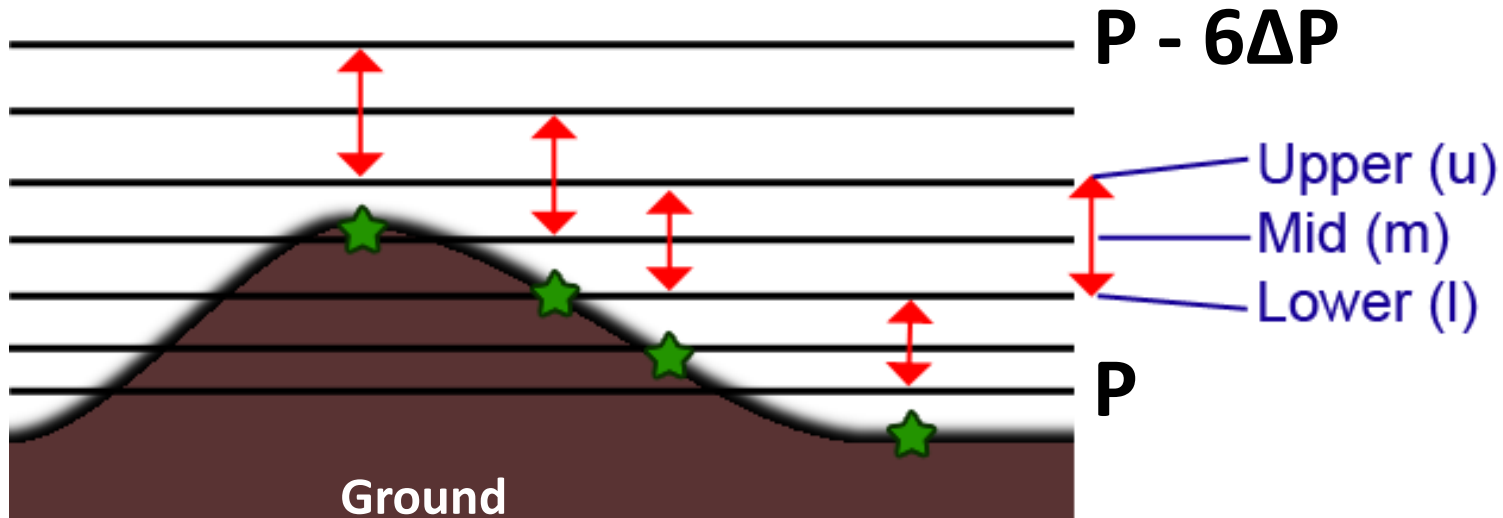


Sum of the difference between the distribution for the actual year and all other years.

# Why is there a relationship?



# Low-level baroclinicity



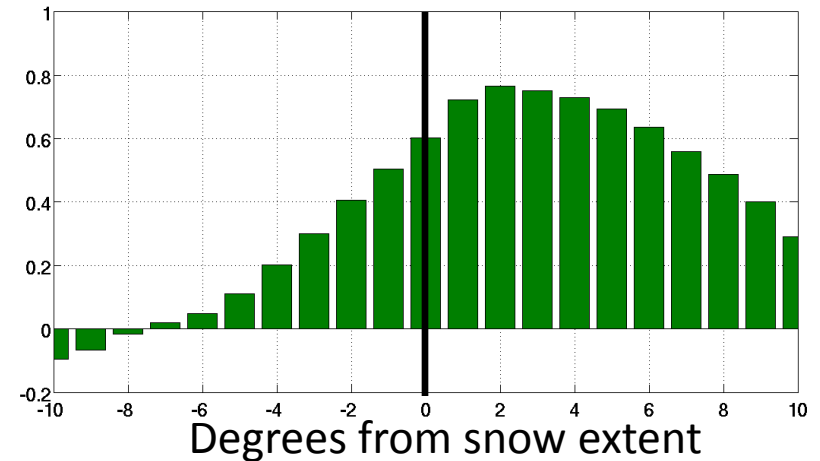
$$\sigma_{BI} = 0.31 \frac{f}{\sqrt{\frac{g}{\Theta_m} \frac{\Theta_u - \Theta_l}{\Phi_u - \Phi_l}}} \left| \frac{V_u - V_l}{\Phi_u - \Phi_l} \right|$$

(based off of Lindzen and Farrell, 1980)

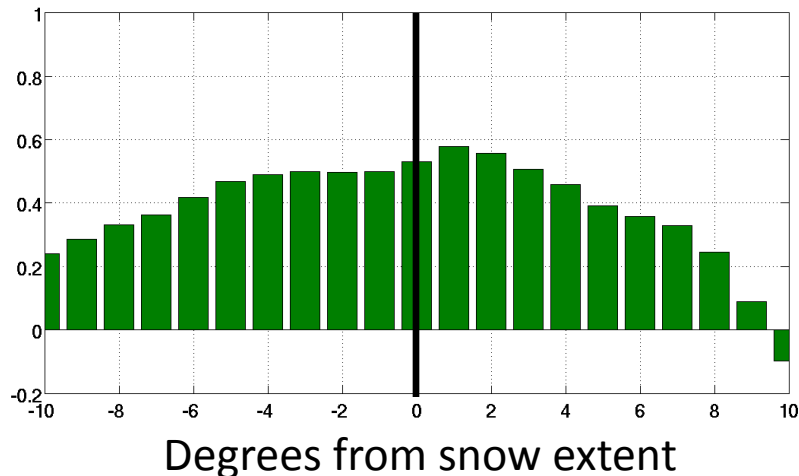
# Is there enhanced low-level baroclinicity?

- Normalized low-level baroclinicity in  $1^\circ$  bins from  $-20^\circ$  to  $+20^\circ$  around snow extent

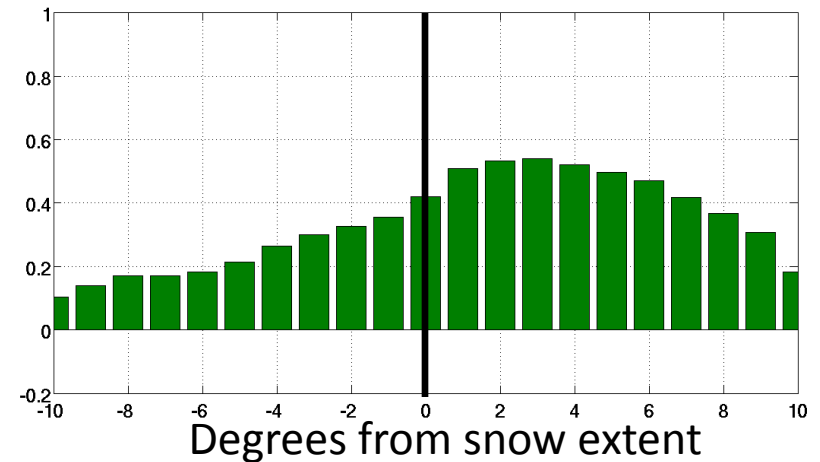
November



January

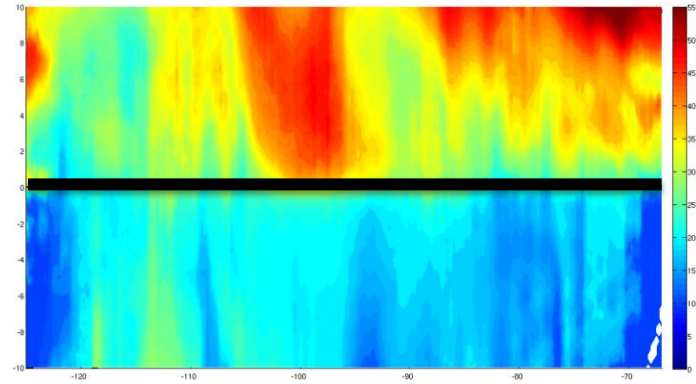


March



# Maybe it is something else?

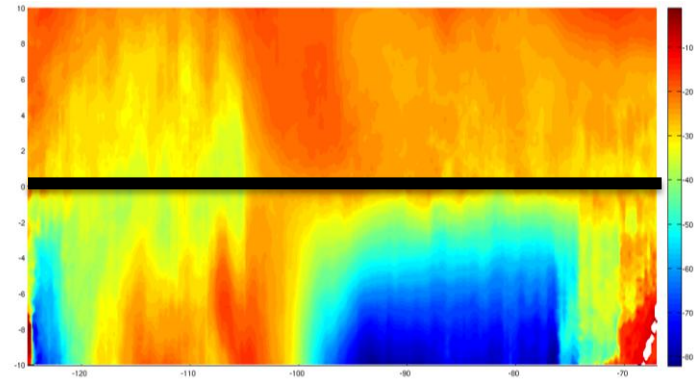
Albedo



North

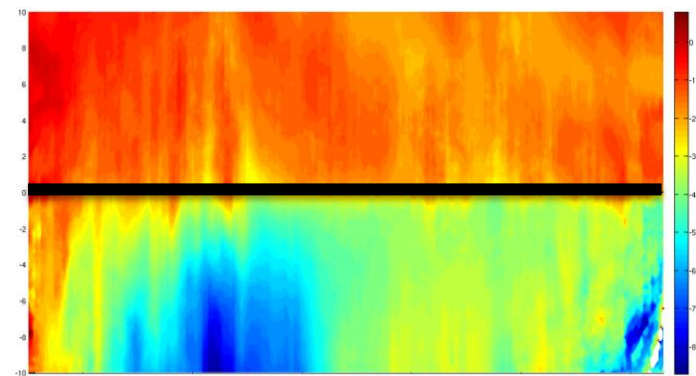
Latent  
Heat Flux

Snow



South

Sensible  
Heat Flux



125°W

67°W



# Questions?

- Enhanced cyclone frequency 100-300km south of the snow extent
- Maybe low-level baroclinicity is not the reason?
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  - <http://flux.aos.wisc.edu>