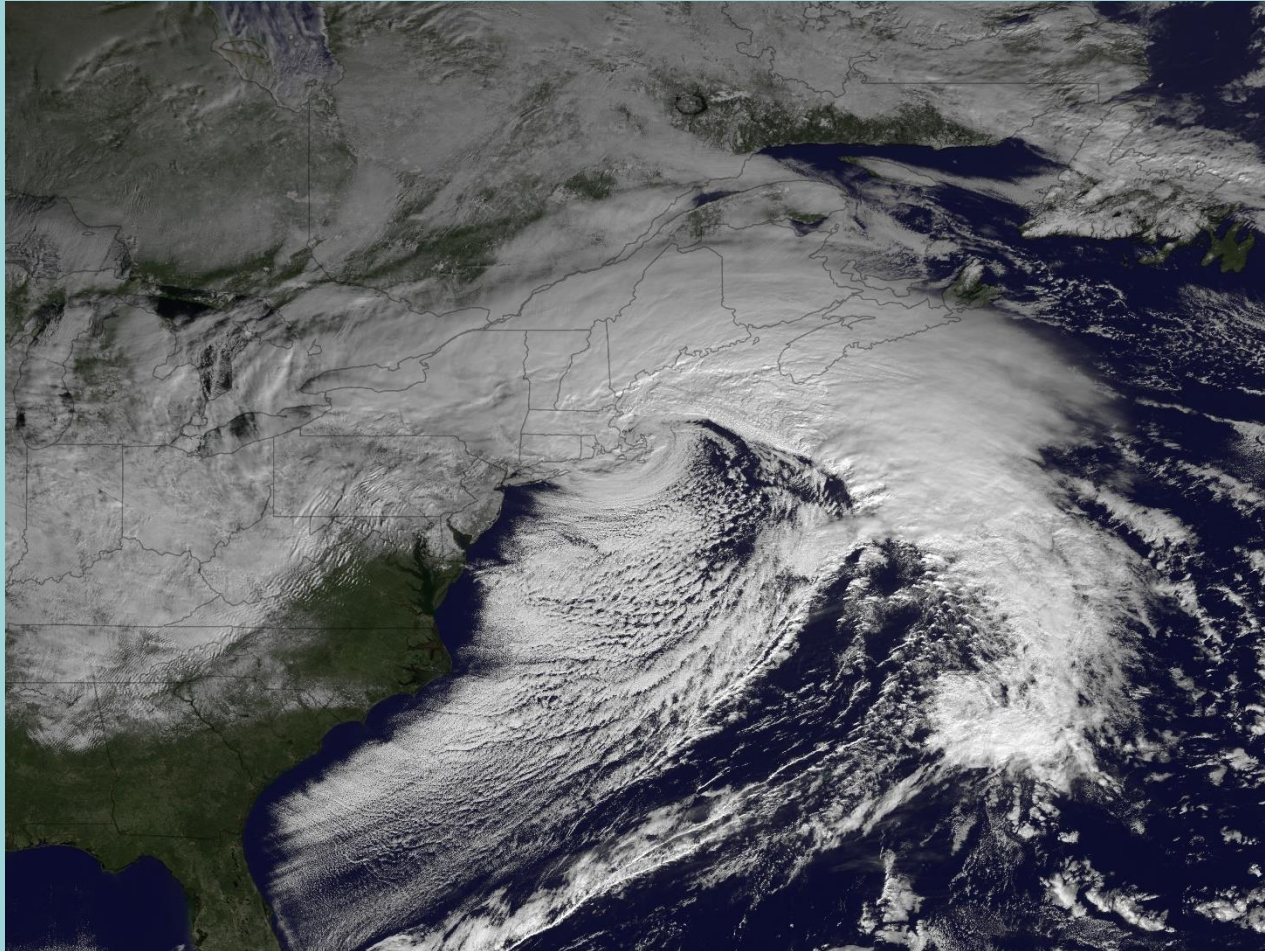


# Satellites, Weather and Climate Module ??:

## *Polar Vortex*



# Polar Vortex

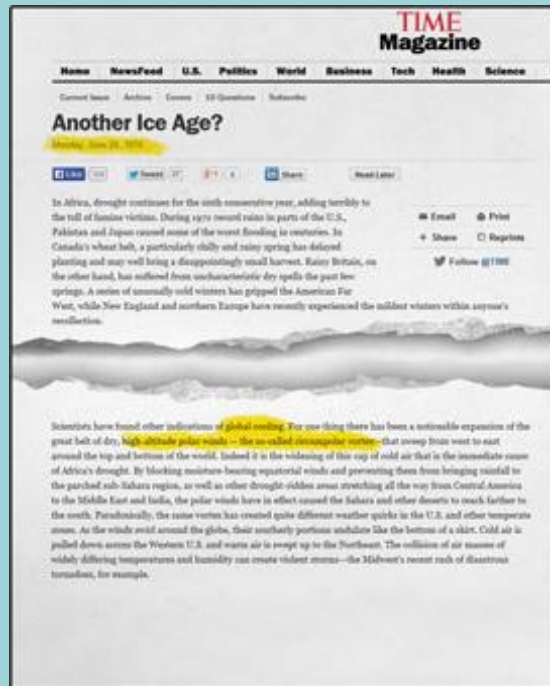
- AKA Circumpolar Vortex
- Science or Hype ?
- Will there be one this year ?



# Today's objectives

- Pre and Post exams
- What is the Polar Vortex (PV)
- Images of January 2014 PV
- Review Jet Streams
- Polar Vortex and the General Circulation
  - How Arctic and Mid-Latitude weather may be linked
- General group discussion – analyze current jet stream
  - student(s) research on circumpolar vortex science vs hype

# What a difference a few years makes



**Time Magazine, 1974:  
"Global Cooling" Causes  
"Circumpolar Vortex."**



**Time Magazine, 2014:  
"Global Warming" Causes  
"Polar Vortex."**

**Do we understand the science behind these terms ?**

<http://www.climatedepot.com/2014/01/07/time-magazine-goes-both-ways-on-the-polar-vortex-in-1974-time-mag-blamed-the-cold-polar-vortex-on-global-cooling-in-2014-time-magazine-blames-the-cold-polar-vortex-on-global-warming/> ?



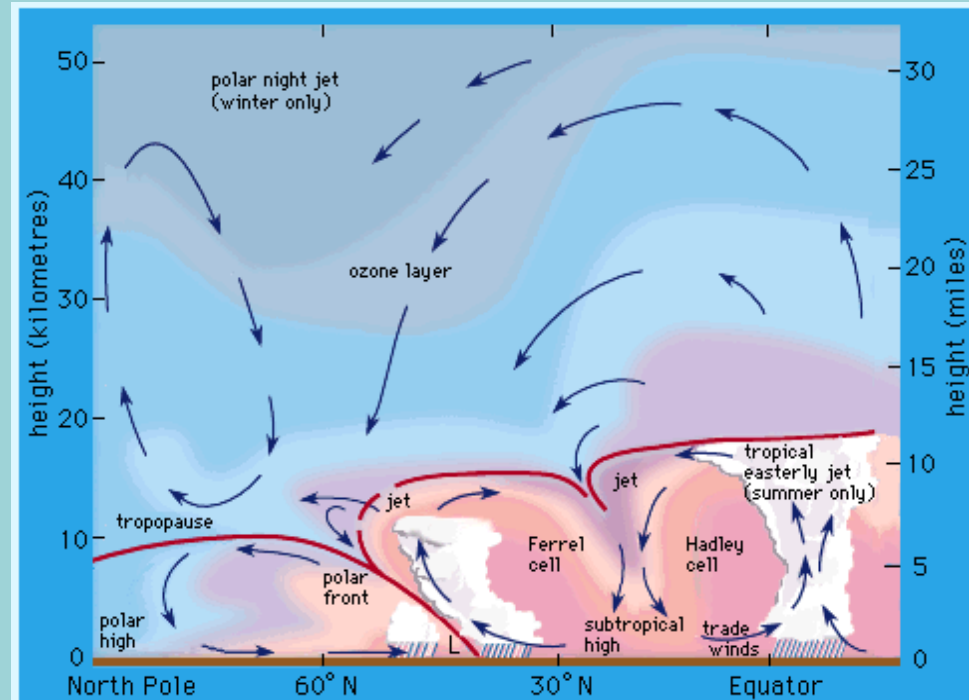
# What is the *POLAR VORTEX* ??

*In words...from the AMS Glossary of Weather and Climate pg 173...*

- *"The Polar Vortex (or circumpolar vortex)*
- *is a large cyclonic westerly circulation (west to east)*
- *in the middle and upper troposphere (aloft)*
- *centered generally in the polar regions*
- *in the Northern Hemisphere (NH) it has two centers in the mean, one near Baffin Island and another over northeast Siberia.*
- *The associated cyclonic wind system comprises the westerlies of the middle latitudes."*

# Circumpolar Vortex Is a **Normal** Part of the General Circulation

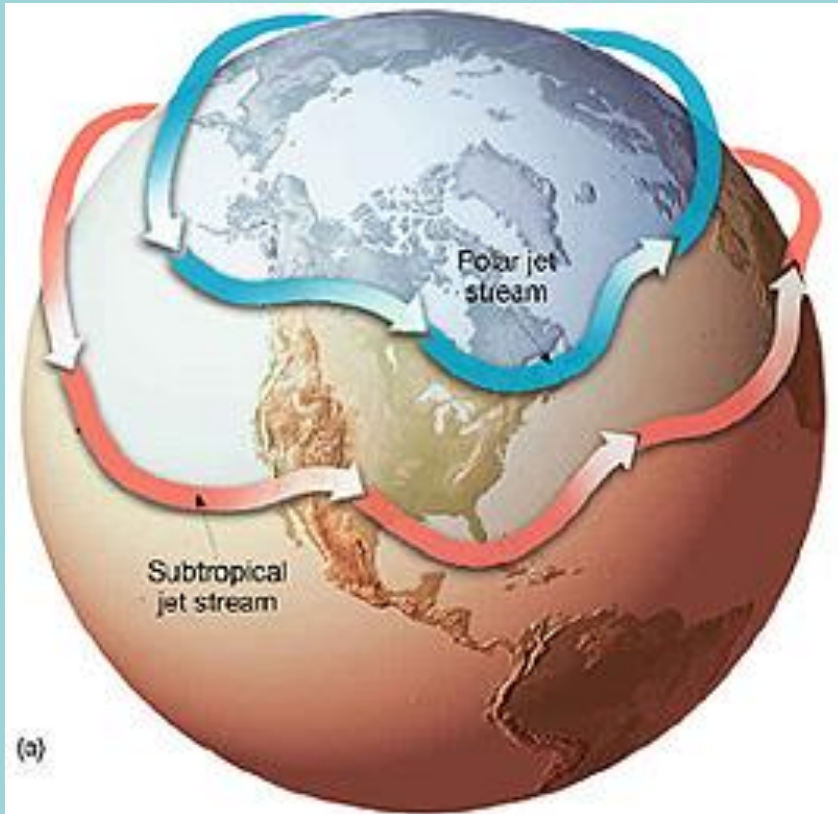
- Low level cold dense air sinks (long polar nights) creating **surface high pressure and low pressure aloft (cyclonic flow)**.
- **Stratospheric warming also supports low pressure aloft (warm air rises)**.
- Think of the polar vortex as encompassing the region of the hemisphere's cold air, bounded by the polar jet stream.
- View the Pole as the **general** axis of the vortex. However, **the vortex is not perfectly round, varies from year to year and meanders, and has more than one center**. It is most pronounced in the winter.



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- **Why do you think it is most pronounced in winter ???**

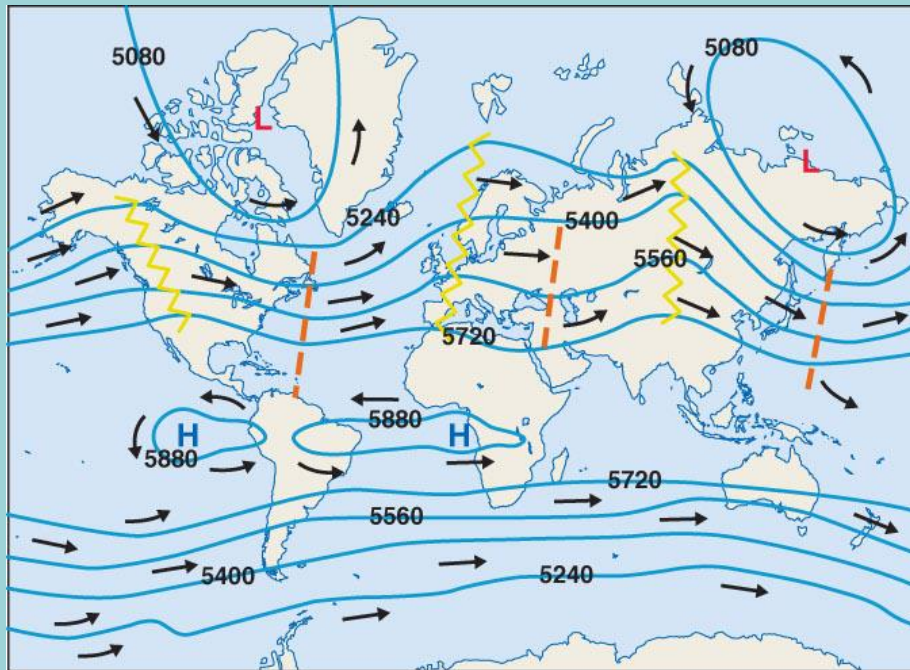
# Polar Frontal and Jet theory



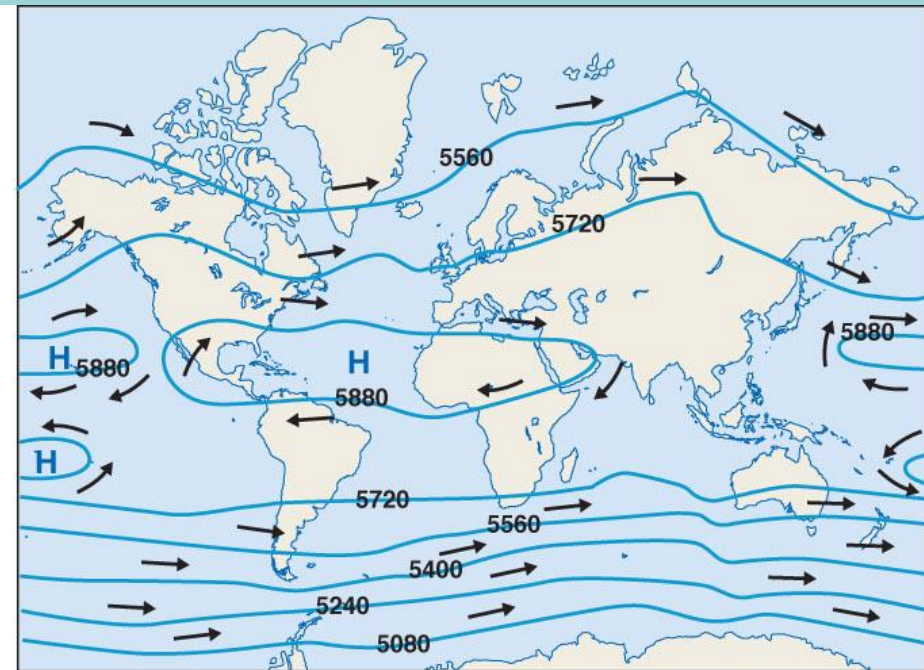
- The return westerlies (relatively mild) clash with polar easterlies and result in rising air.
- Air moving north has more **angular momentum** and combined with density discontinuity (***temperature differences***) creates polar jet
- In a broad sense, the polar jet keeps the PV confined in arctic region

# Upper Level Polar Vortex surrounded by Polar Jet

Mean 500mb flow – Jan and July



January

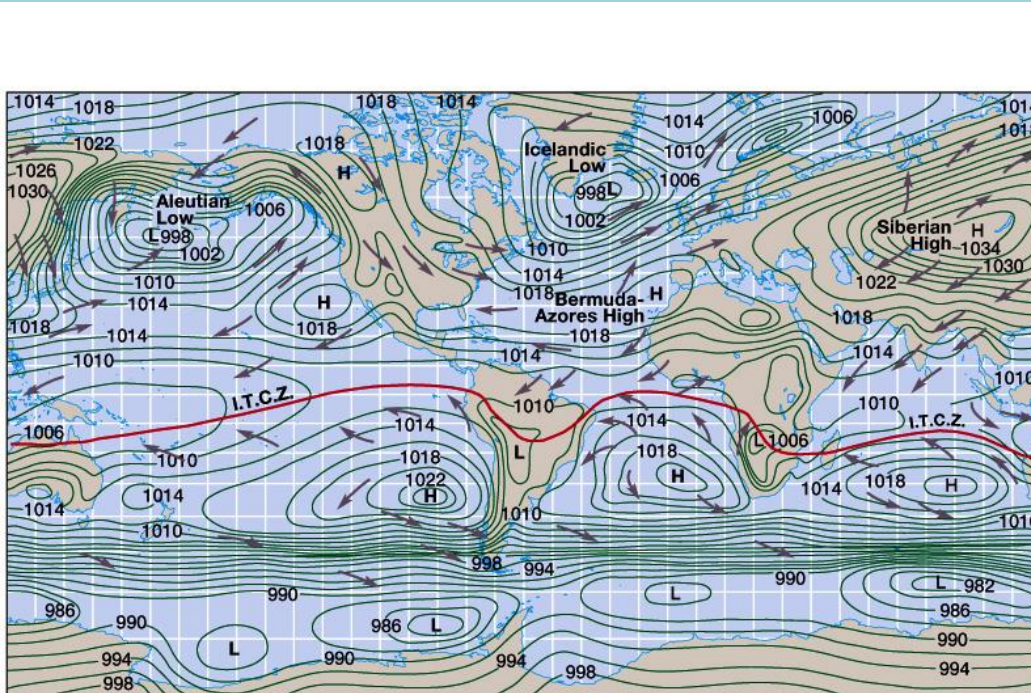


July



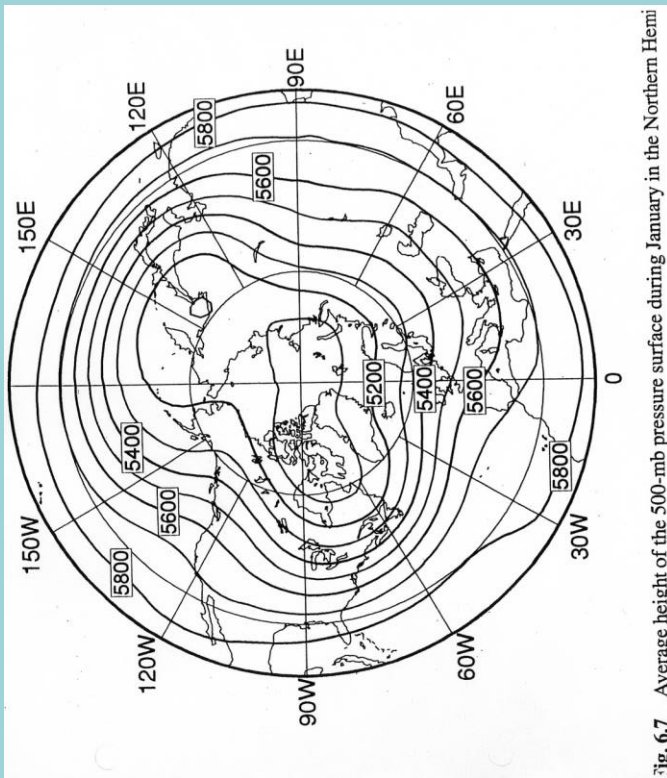
# In words - **Average** Northern Hemisphere Winter Semi-permanent Circulation features

- Areas of surface HIGH Pressure over:
  - Eastern Siberia
  - Beaufort Sea
  - North American High
- Areas of surface LOW Pressure:
  - Aleutian Low
  - Icelandic Low

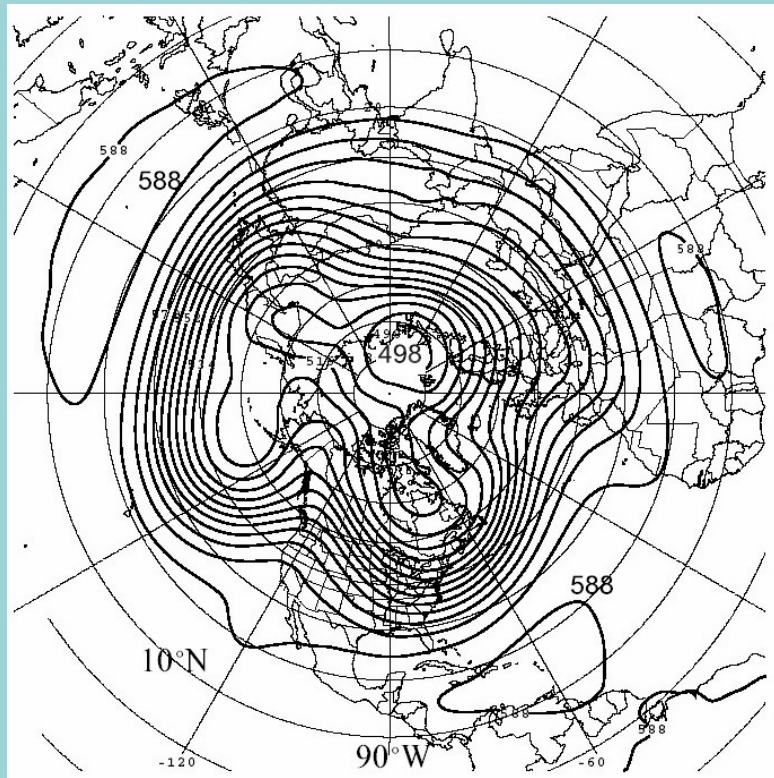


# Average and Actual 500mb Polar Vortex

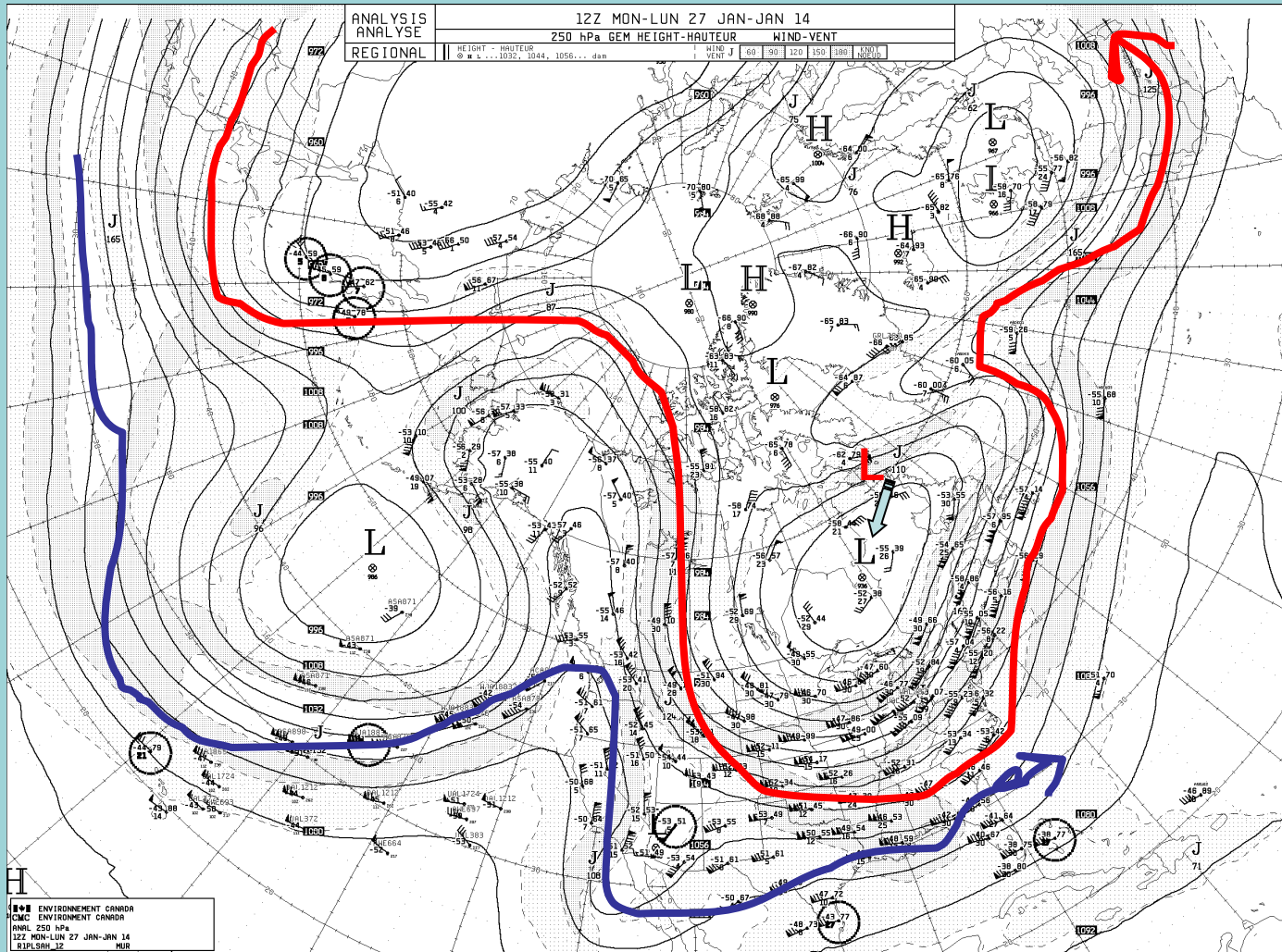
Long term Average January 500mb



January 2003 MEAN 500 mb pattern



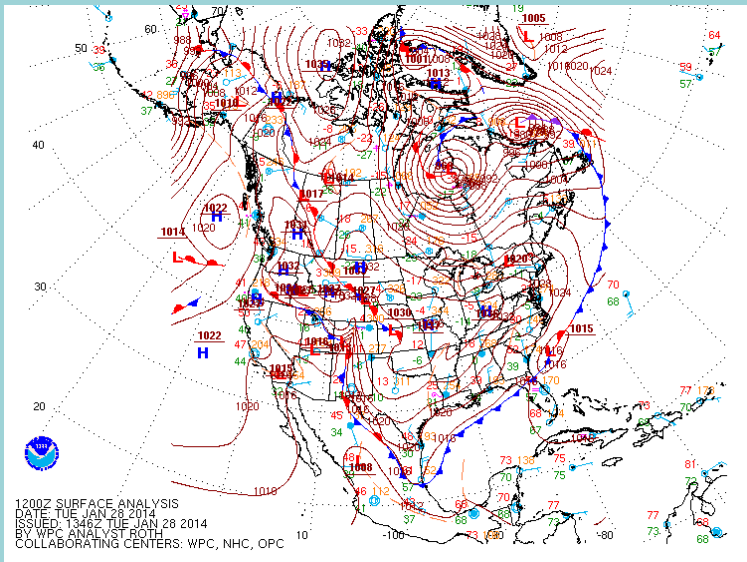
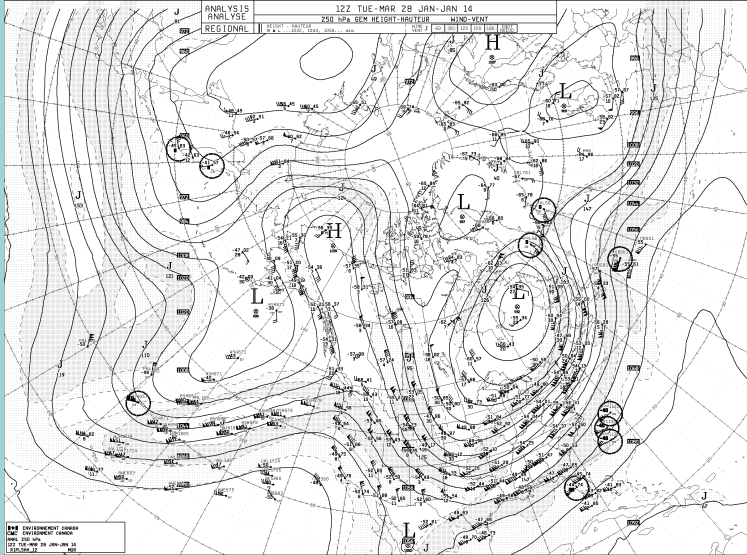
# 250mb 12z Mon Jan 27 2014



PV shifted west and south with long wave trough across North America and ridge off west coast of NA – **NOTE HOW THIS IMPACTS AIR TRAJECTORY???**



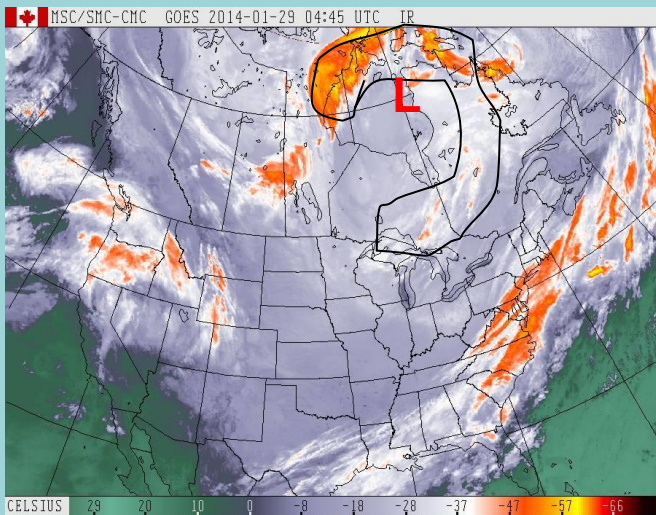
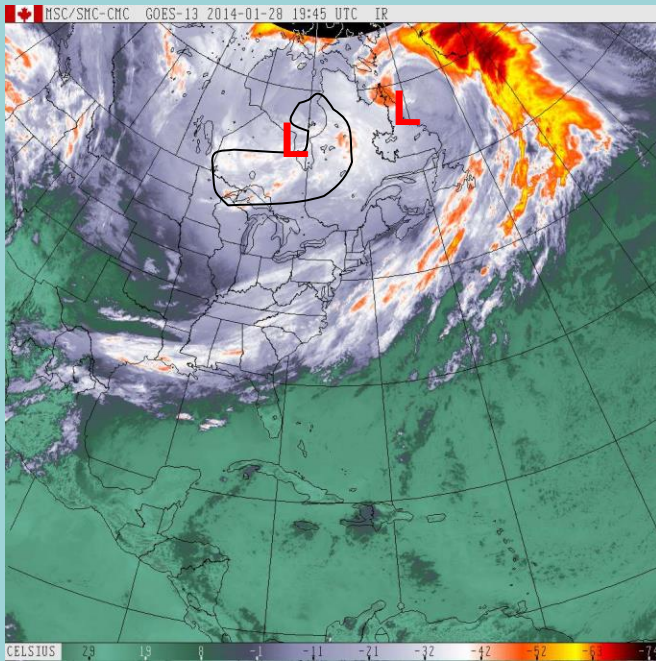
# Tue -- 28 Jan 2014



- 250mb chart top and surface map bottom
- LOW pressure over Canada shifted further west and south of normal PV position
- Note Icelandic Low ???



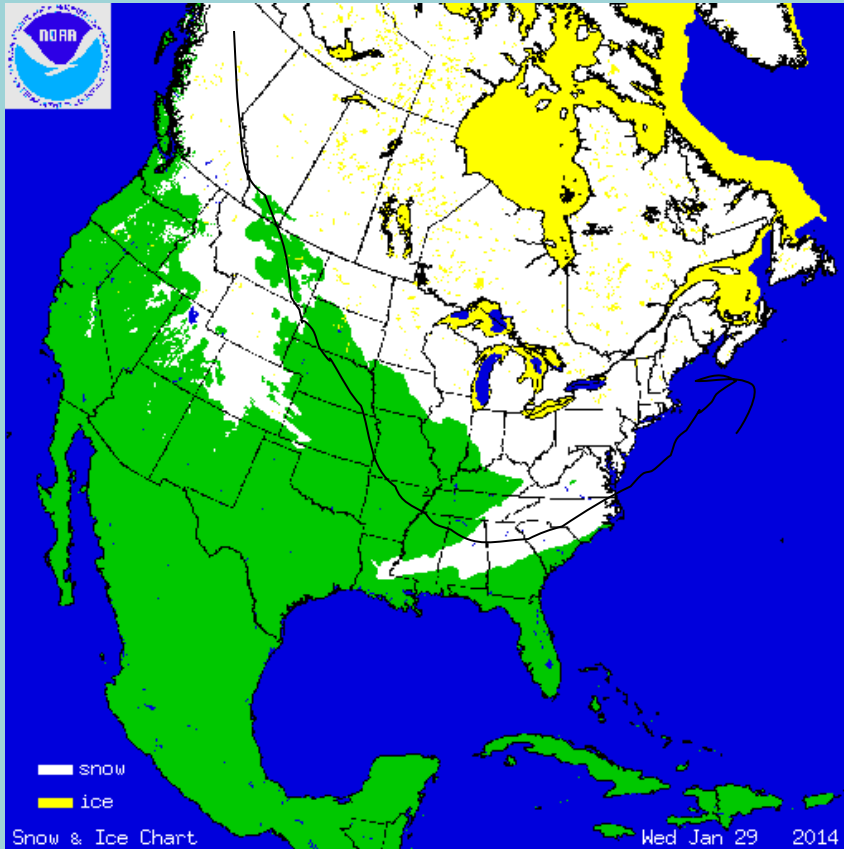
# IR Satellite



- 2014 Jan 28 (top) and Jan 29 (bottom) IR imagery
- Satellite imagery suggests PV slowly moving northeast to more normal position

# -PV changes and impacts this year-

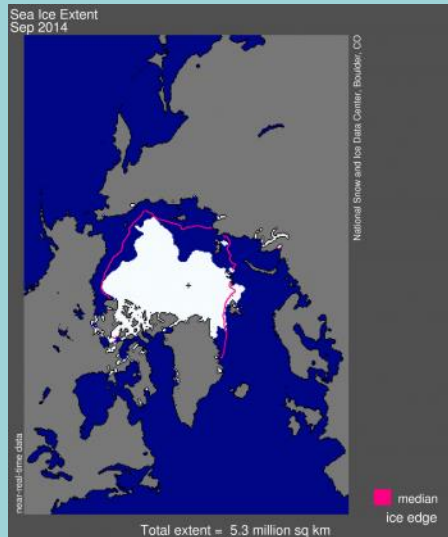
Cold Central and Eastern US with snow in the south



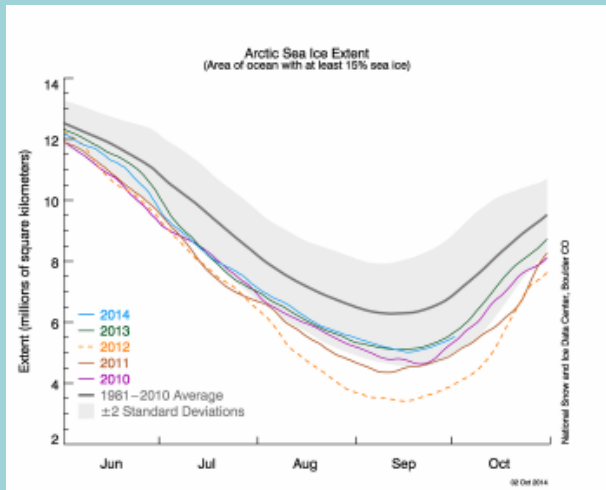
- Storm tracks further south in NA (polar front boundary)
- Cold air further south in eastern US
- West coast High Pressure ridge and lack of snow in Sierra Nevada's

# **Changes in the Arctic and possible Mid-Latitude connections Arctic**

# Arctic Sea Ice below average but not as bad as recent two years



- This years the seasonal daily minimum ice was the 6th lowest in the satellite record (1978)
- Arctic sea ice has started its seasonal cycle of growth.
- One notable feature this year compared to last year is that ice that is 1 to 2 years old persisted north and east of the East Siberian Sea. This likely helped limit the loss of ice above the record low monthly average for September that occurred in 2012.

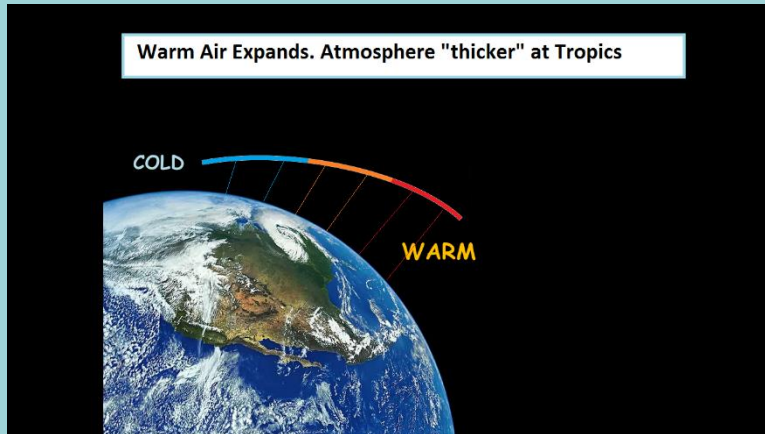




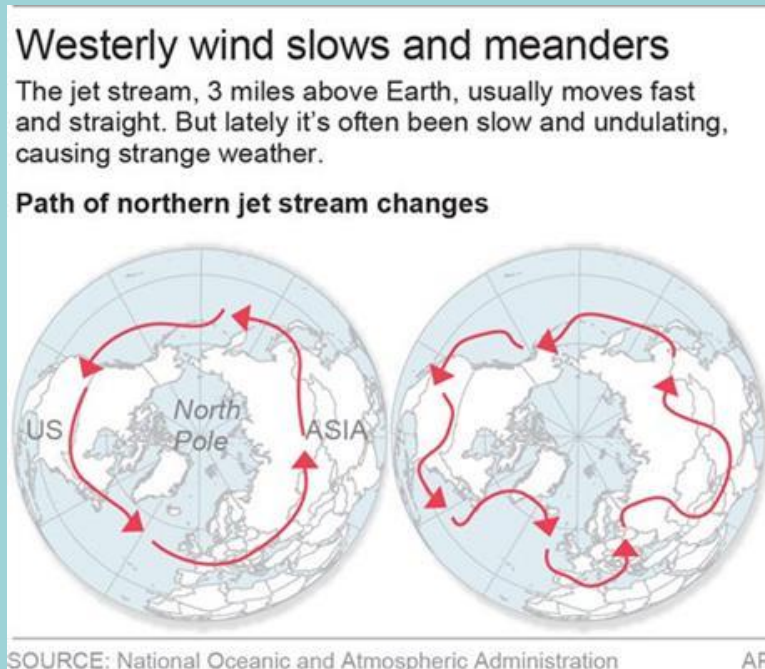
Dr. Jennifer Francis' study

Arctic sea ice vs Jet Stream meandering

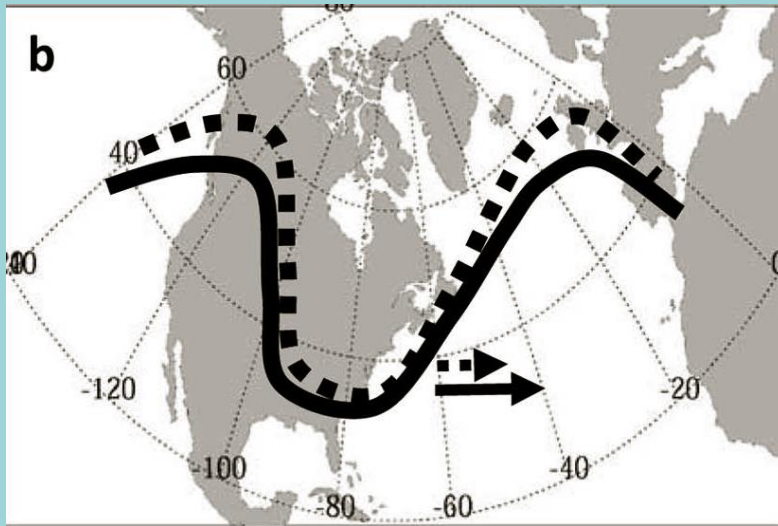
# Strong versus weak Polar Vortex



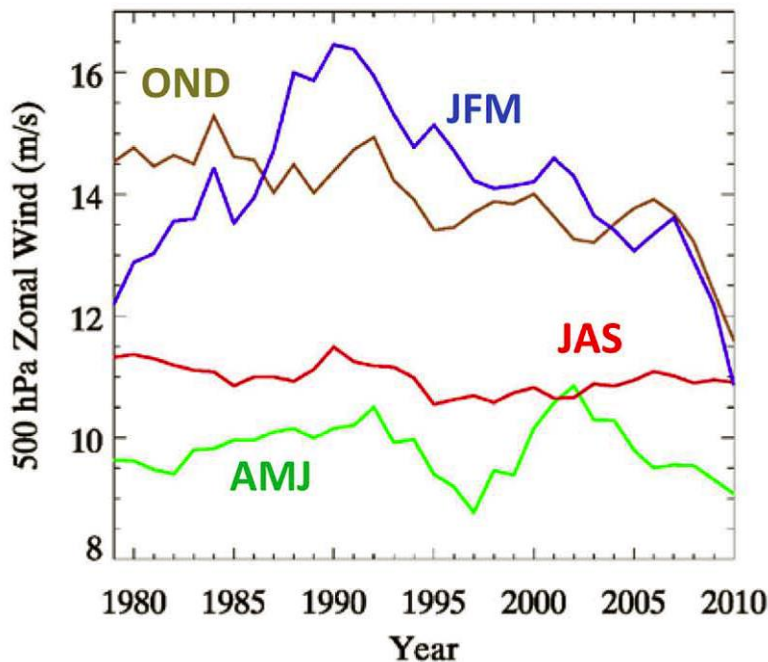
- The tropopause is higher in the tropics and lower at the poles.
- This slope helps maintain the polar jet
- If the slope decreases (due to poles warming) it could disrupt/weaken the jet
- Weaker Polar Vortex = Meandering Jet and Polar Vortex movement



# Study of arctic sea ice and General Circulation

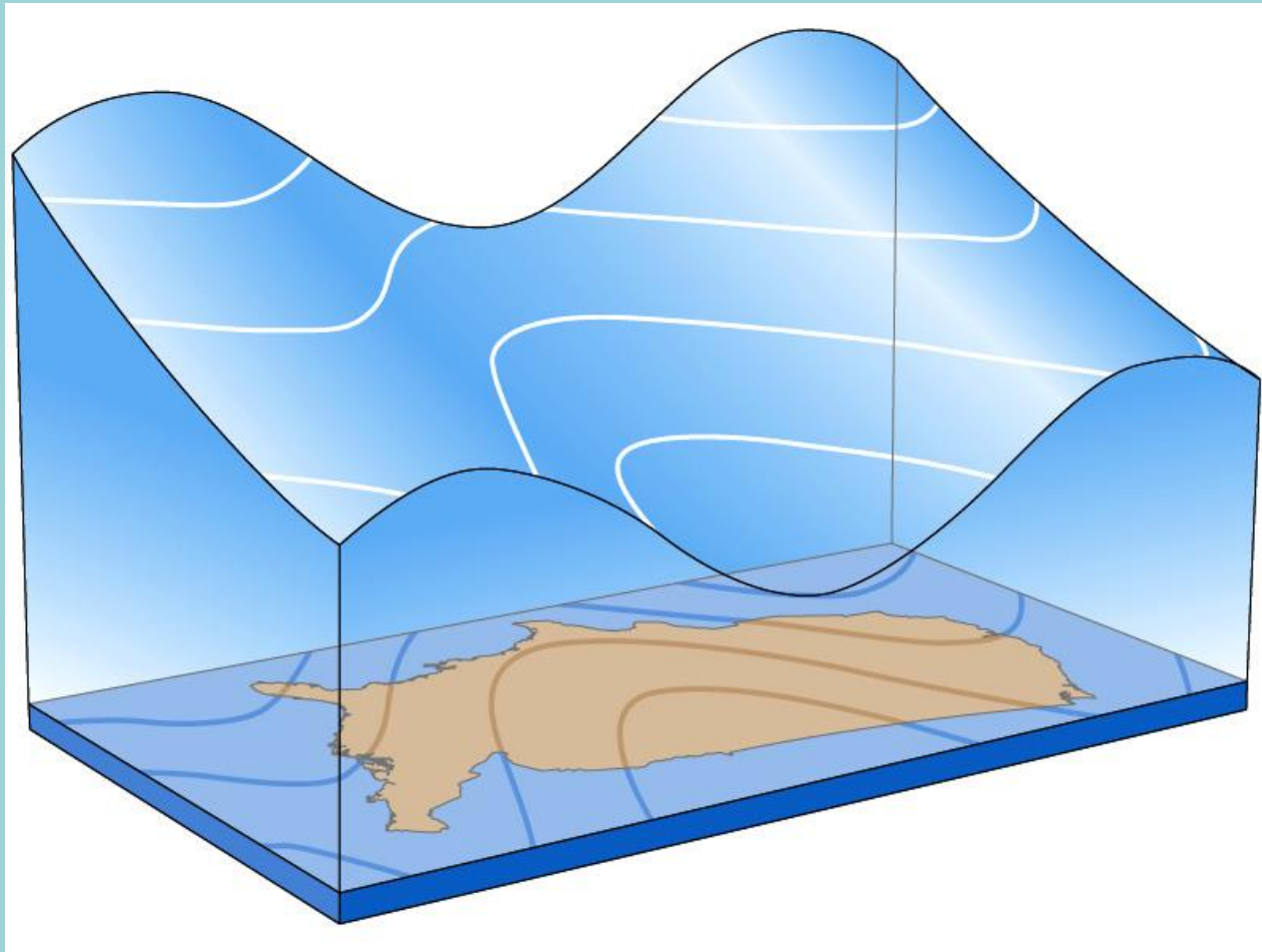


- Top ... projected higher amplitude ridges (dashed) bring warmer air to Arctic region, while **increased amplitude mean slower moving troughs with persistent weather patterns**



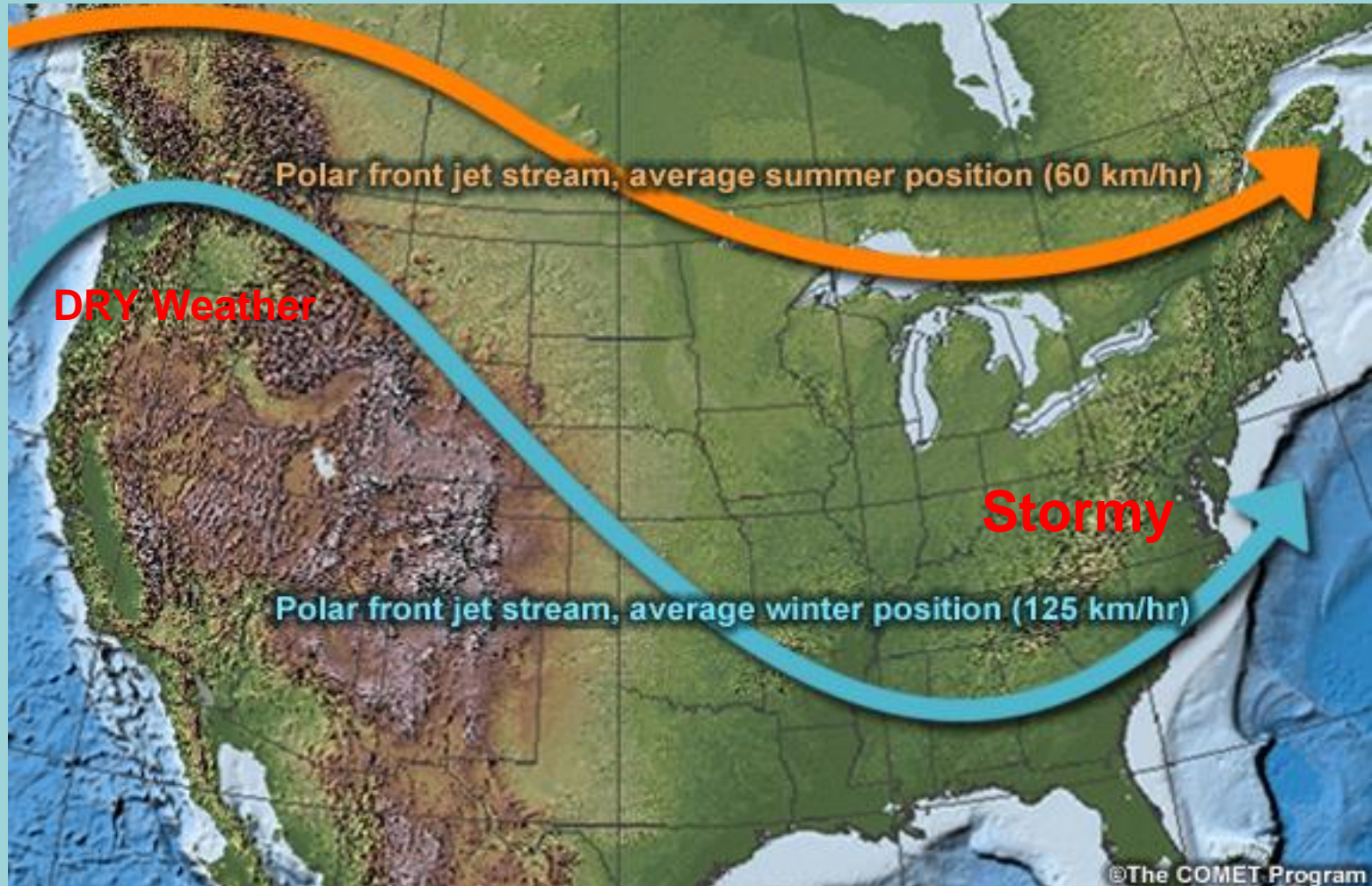
- **Bottom decreasing thermal gradient may be cause for decrease in zonal winds aloft especially during Fall Months (winter is more variable) since 1990.**

# Upper level Ridges and Troughs profile

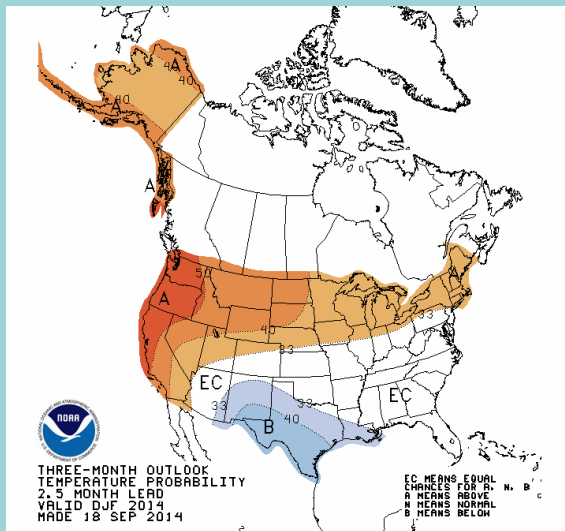




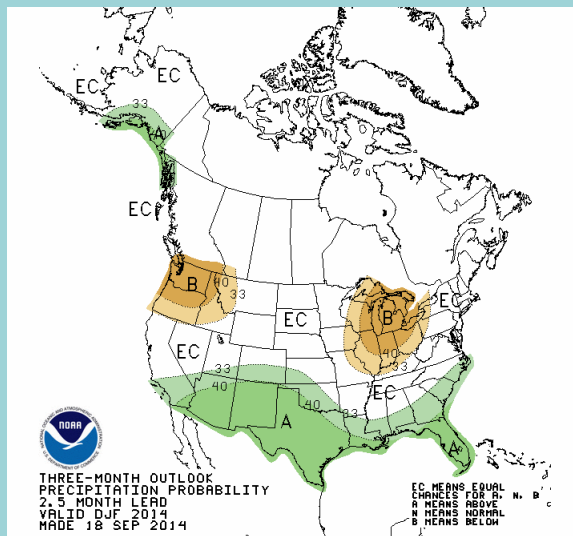
# Rough guide associating surface weather with 500mb pattern



# Winter Forecast Dec 2014-Feb 2015



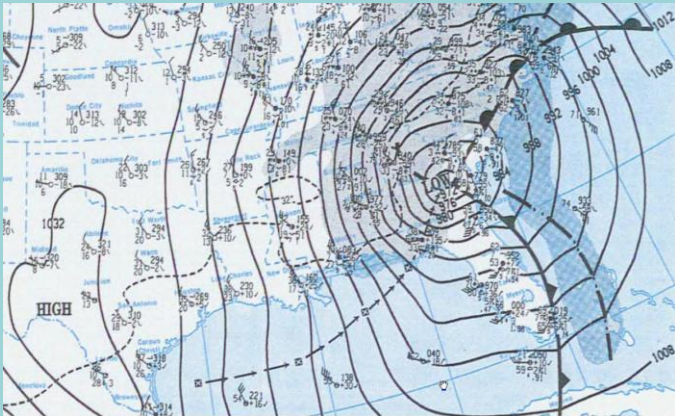
- Temperature forecast above normal northern States
- Drought continues in far west
- Cold Bay and St Paul, Ak for the period July – August - September 2014 warmest since records began in the 1940s.
- Weak El Nino expected winter of 2014-2015



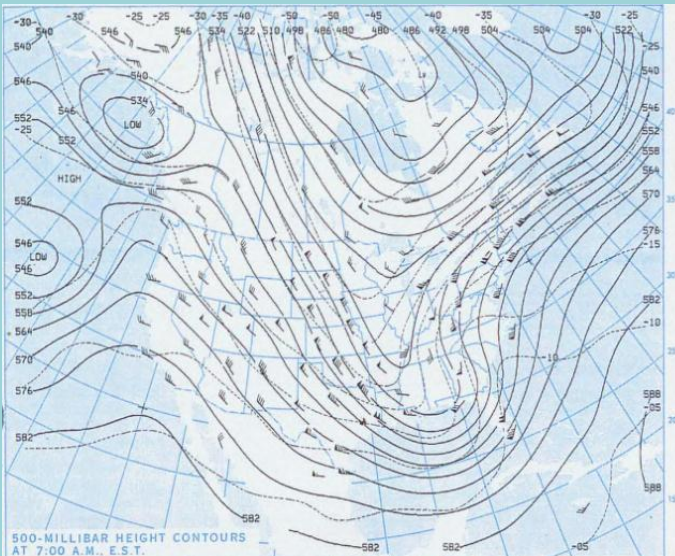
# Locating Jet Stream and Polar Vortex



# March 13, 1993 1200UTC



Surface Analysis March 13, 1993 1200UTC  
NOAA NWS



500MB Analysis March 13, 1993 1200UTC  
NOAA NWS

- Circumpolar Vortex centered over Baffin Island
- Longitudinal trough from Hudson Bay to Gulf of Mexico
- Storm system not true extension of polar vortex, but originated from Pacific

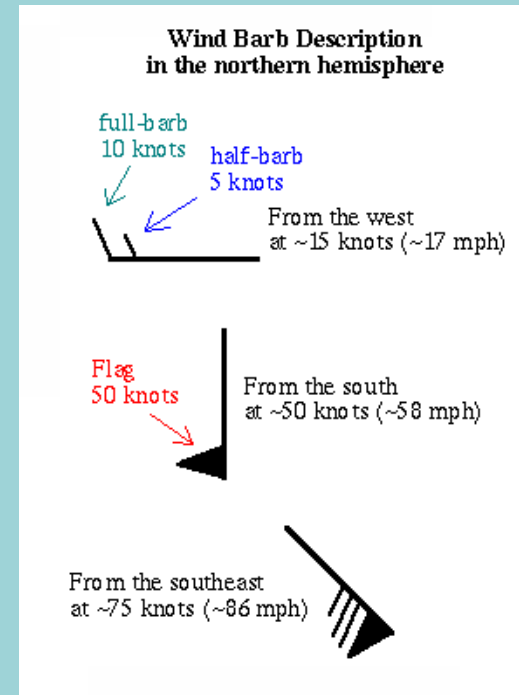
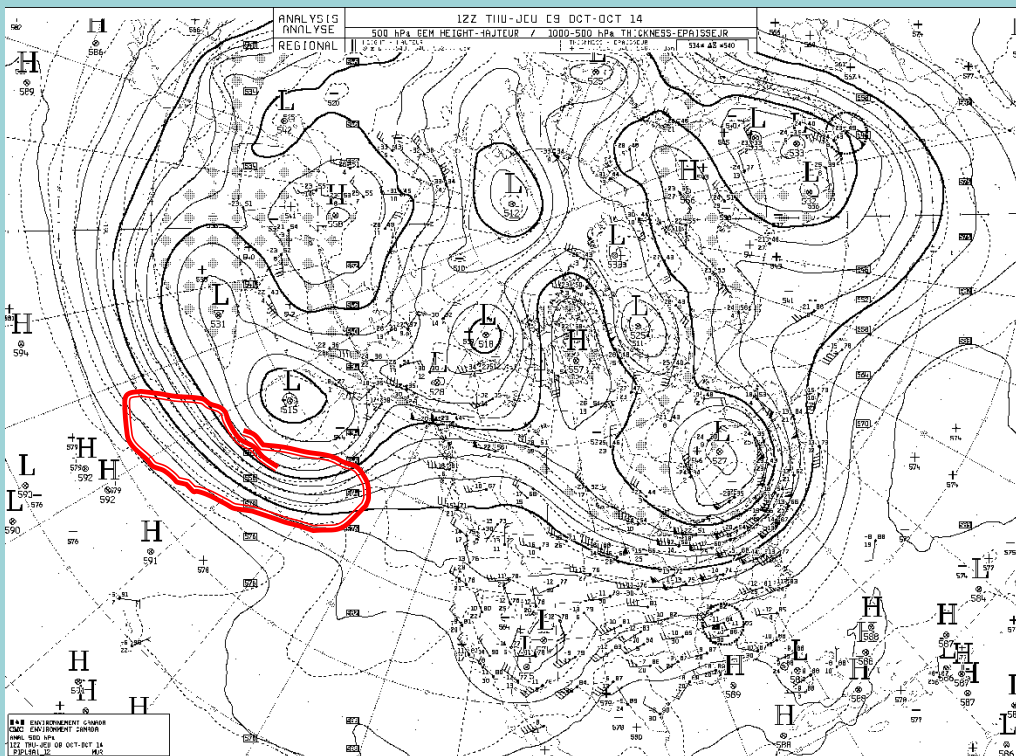
Both figures  
[http://www.erh.noaa.gov/gsp/localdat/cases/2013/Review\\_Marc\\_h1993\\_Superstorm.pdf](http://www.erh.noaa.gov/gsp/localdat/cases/2013/Review_Marc_h1993_Superstorm.pdf)



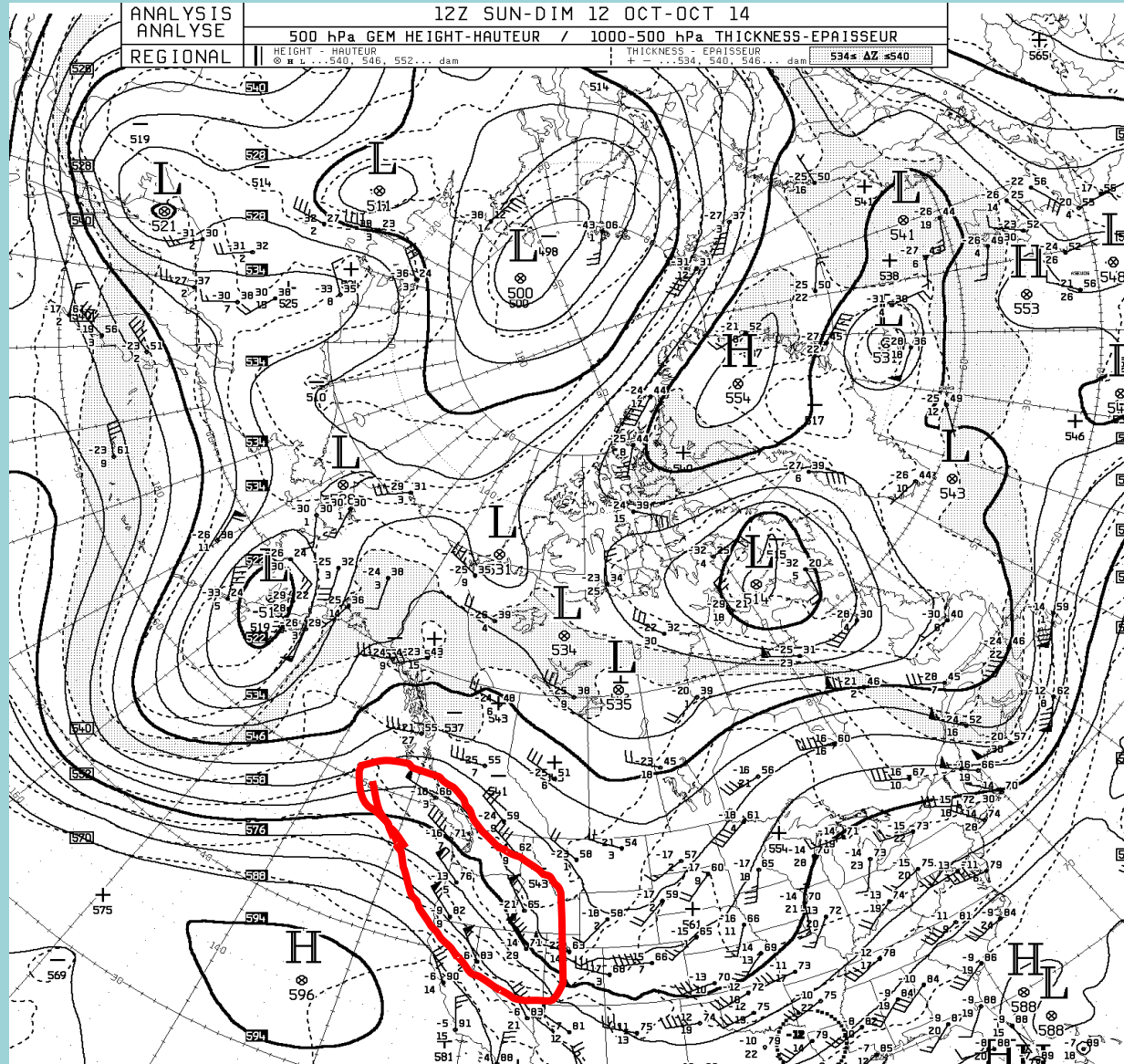
# Developing weather system this week – not the polar vortex –

1200 UTC Oct 9 2014 Thurs

- Not much happening in western US. We need to wait for Pacific energy to move inland

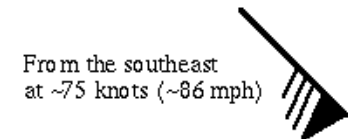
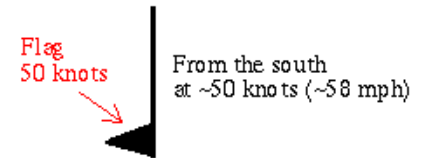
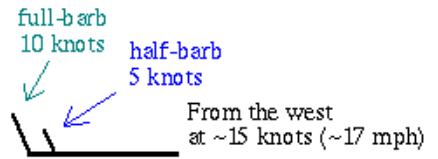


# Evolving upper level pattern Sunday Oct 12 --- 12UTC

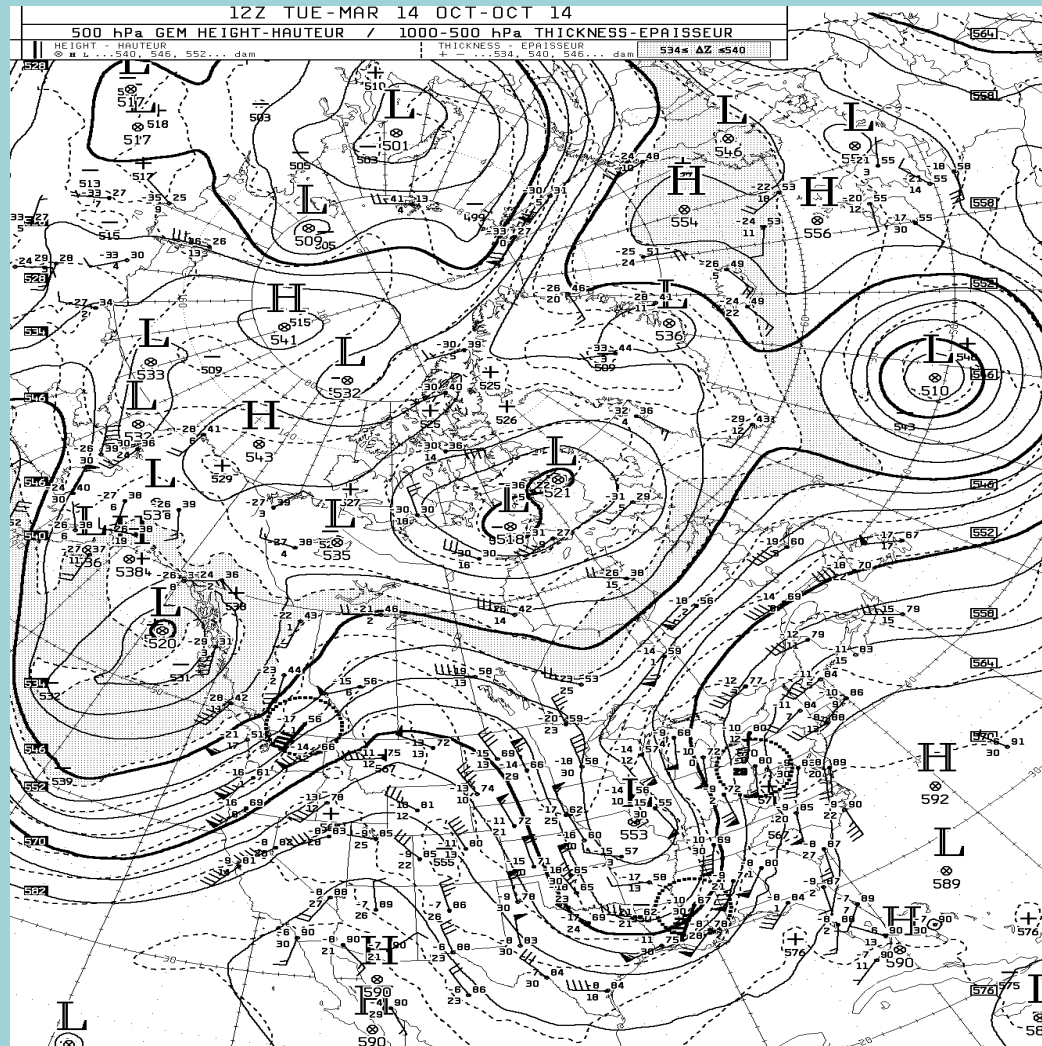


## Wind barb key

### Wind Barb Description in the northern hemisphere



# Tuesday October 14, 2014 500mb



1. Sketch in rough location of polar jet using a solid line or arrows
2. Locate the possible Polar Vortex center(s)
3. What type of weather would you expect in Wyoming at this time
4. What type of weather would you expect in Indiana at this time.

# Conclusion

The years ahead will be exciting for ***research climatologists and those who teach climate science***

- The polar Vortex is not new...but is it at the mercy of natural and human induced climate changes???
- These changes could impact storm tracks which are related to precipitation and temperature
- ***Climate is a system of intricate feedbacks*** of ice – soil moisture – oceans - incoming vs reflected insolation – Greenhouse gas balances just to name a few
- **What happens in the Arctic doesn't necessarily stay there.** The tropics – mid-latitudes – and polar regions are all teleconnected.



# The End

