



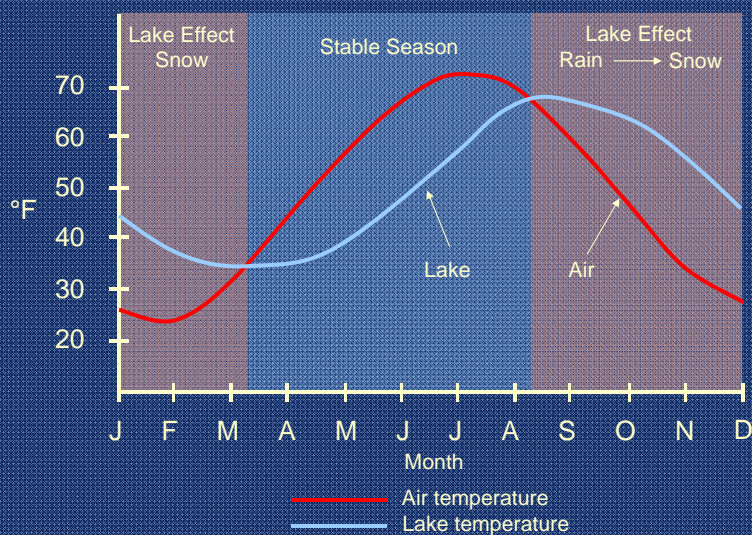
Snowfall Forecasting challenges in the Great Lakes

Jim Keysor - NWS Gaylord

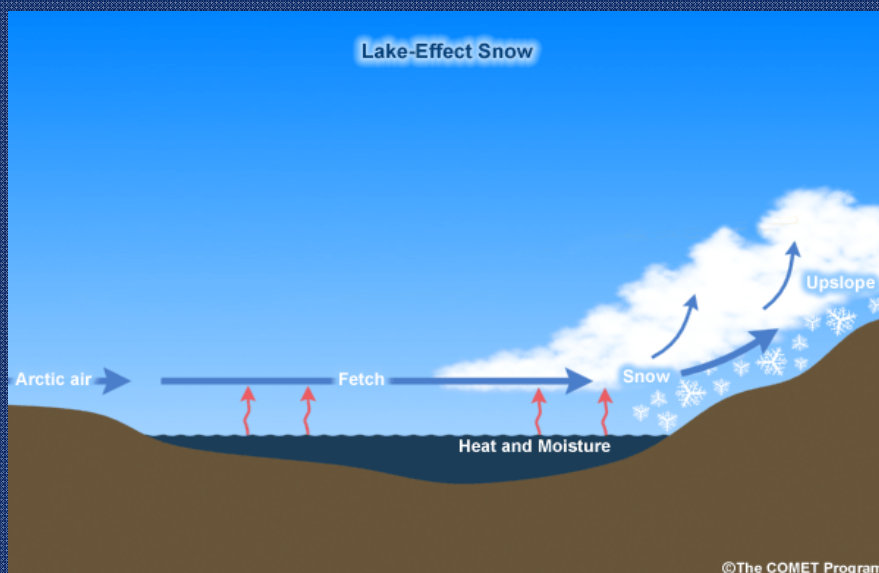
Presentation Outline Topics

- An overview of lake effect snow
- Forecast challenges
- Winter Weather tips
- Sneak peak at the upcoming winter

Mean Lake/Air Temperatures (for Lake Michigan)



How does lake effect snow form?



Lake effect snow on satellite

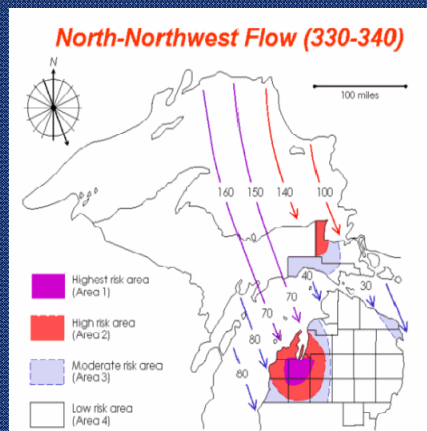


Snowfall forecast challenges

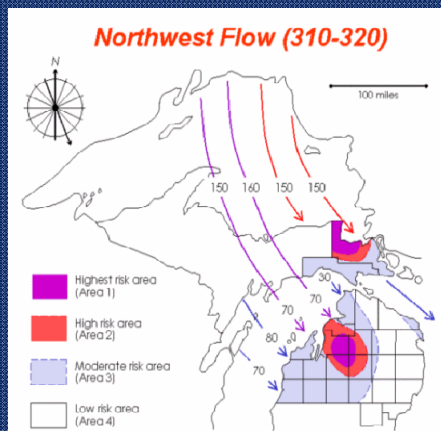


Challenge #1: Slight variations in wind direction

North-Northwest Flow

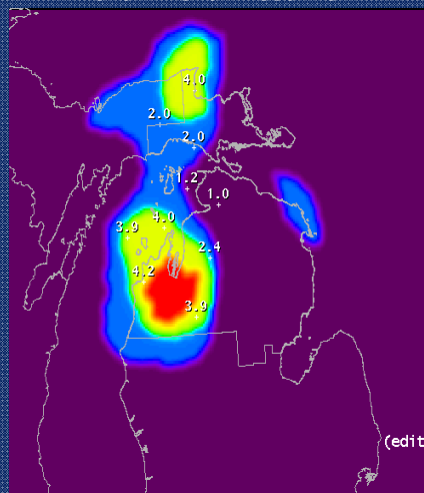


Northwest Flow

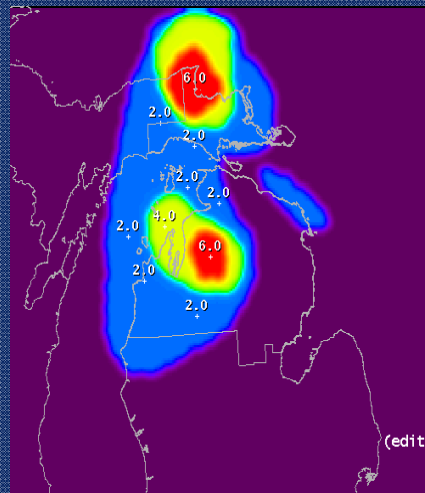


Challenge #1: Slight variations in wind direction

North-Northwest Flow



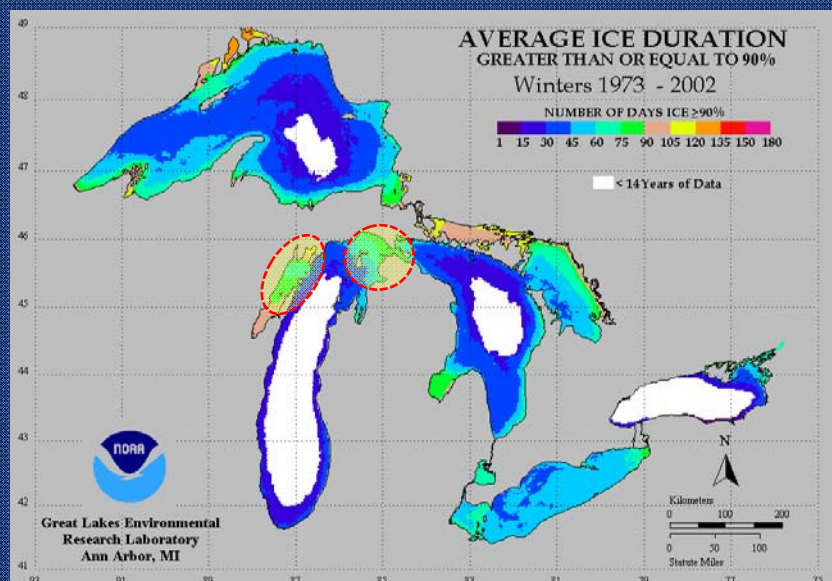
Northwest Flow



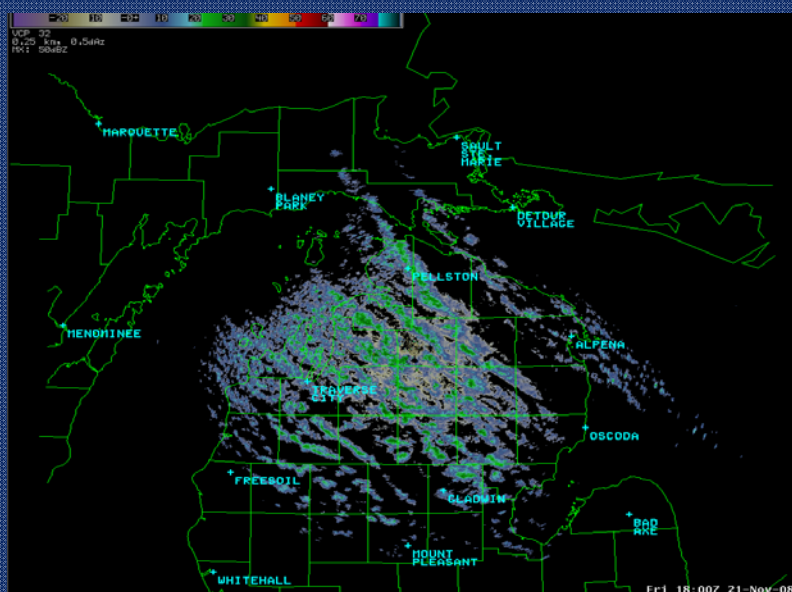
Challenge #2: Ice Cover



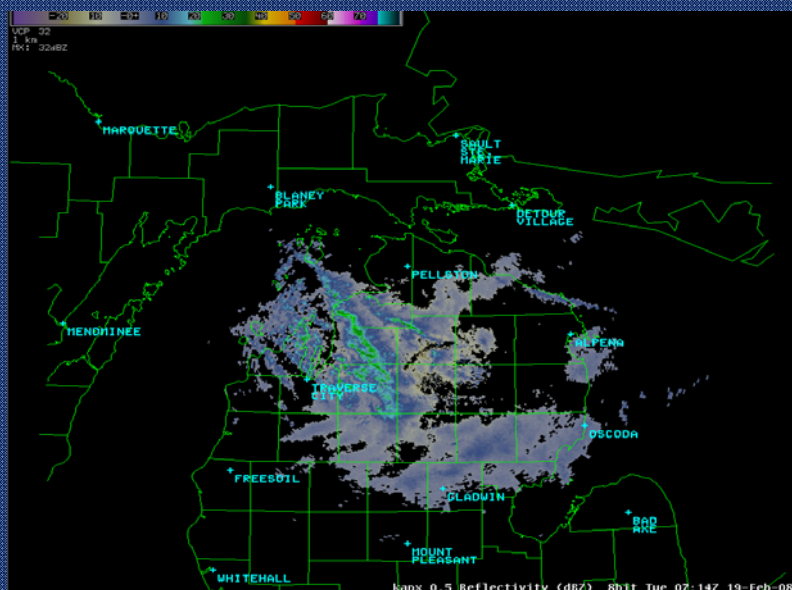
Average days of >90% ice cover



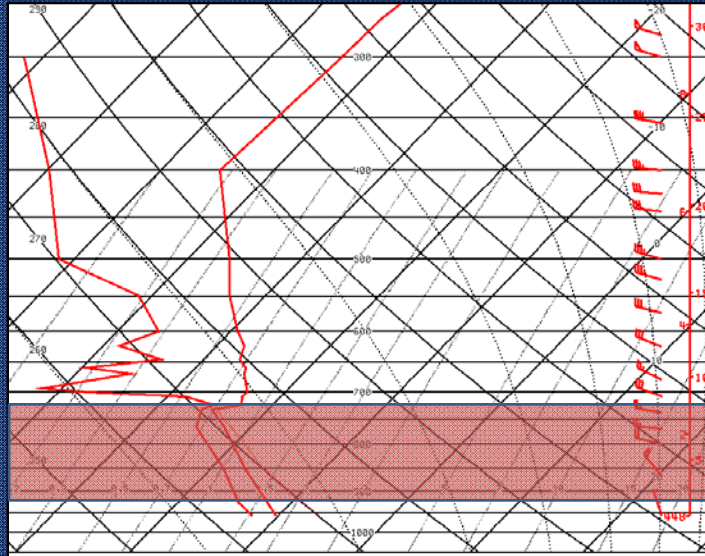
Northwest winds - No Ice cover



Northwest winds - Ice cover



Challenge #3: Snowflakes and temperatures



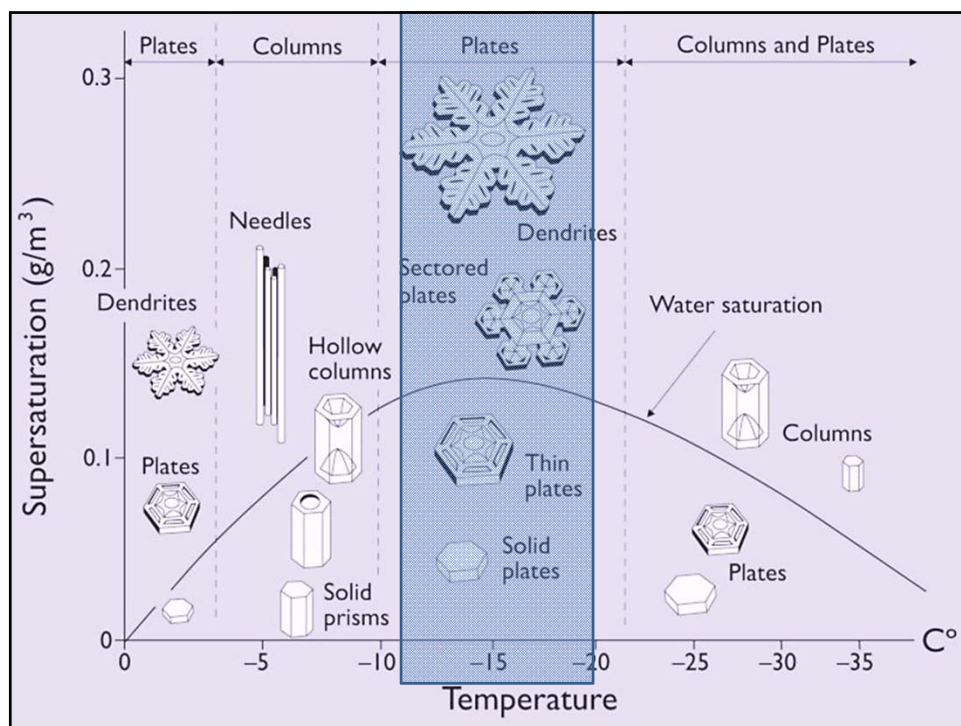
Temperatures aloft – the key



As temperatures aloft get colder, snowflakes become less dense (fluffier). Less dense snowflakes may accumulate more quickly.

But as temperatures around 5000 feet fall below -20 degrees Celsius, snowfall intensity and accumulation generally drops off as snowflake size gets smaller.





Dendrite Snowflake

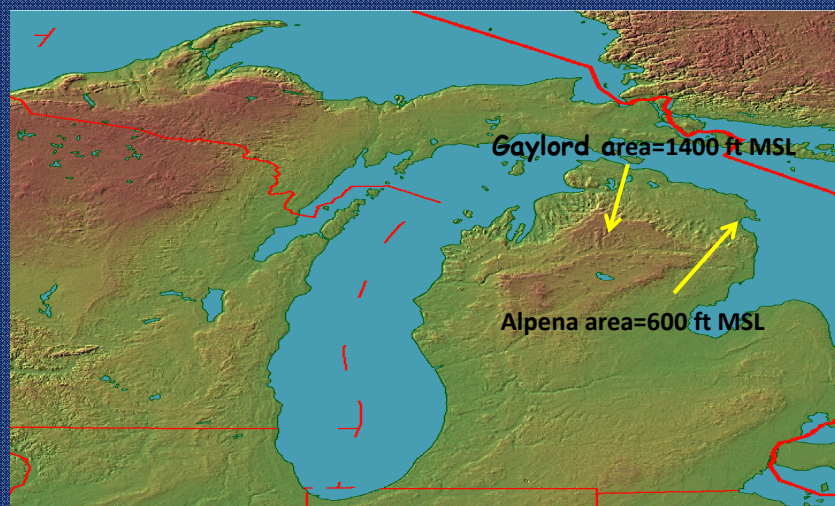


Column Snowflake

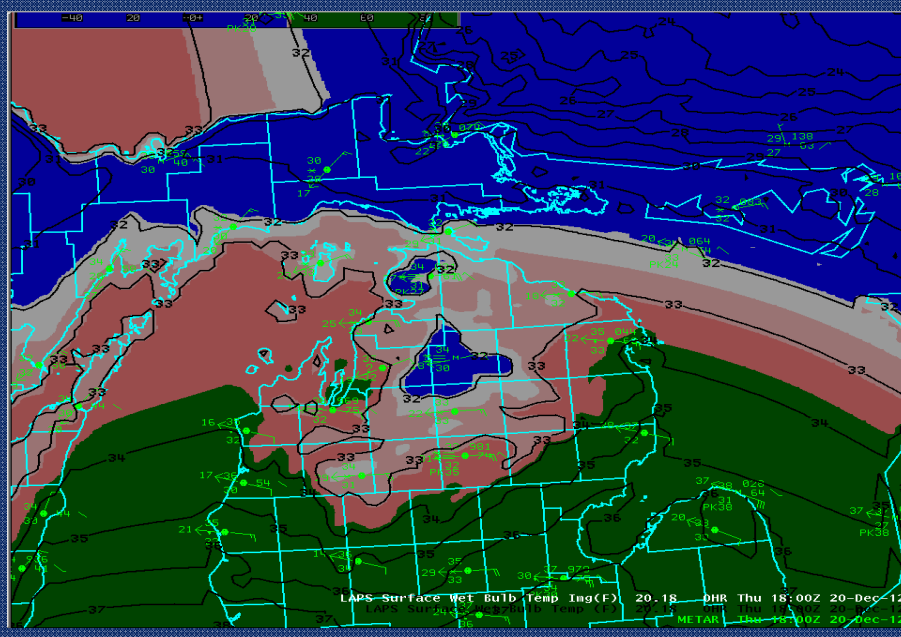


Challenge #4: Elevation

During snow events, temperatures drop approximately 1 degree Fahrenheit for every 300 foot rise in elevation



December 20-21, 2012 Snowstorm



December 20-21, 2012 Snowstorm

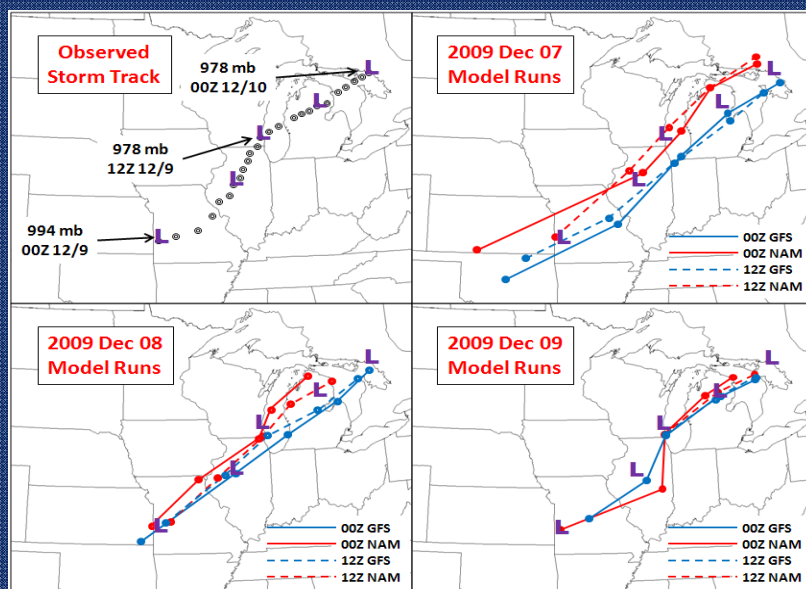
Gaylord Observations Elevation 1400 feet

9:53 AM	32.0 °F	24.2 °F	30.0 °F	92%	29.74 in	0.5 mi	East	9.2 mph	20.7 mph	0.04 in	Fog , Snow	Snow
10:53 AM	32.0 °F	23.6 °F	30.9 °F	96%	29.71 in	0.2 mi	East	10.4 mph	19.6 mph	0.07 in	Fog , Snow	Snow
11:53 AM	32.0 °F	24.2 °F	30.9 °F	96%	29.64 in	0.2 mi	East	9.2 mph	25.3 mph	0.11 in	Fog , Snow	Snow
12:36 PM	33.8 °F	24.8 °F	30.2 °F	87%	29.52 in	0.5 mi	East	12.7 mph	20.7 mph	0.04 in	Fog , Snow	Snow
1:31 PM	32.0 °F	22.5 °F	30.2 °F	93%	29.44 in	0.2 mi	East	12.7 mph	24.2 mph	0.03 in	Fog , Snow	Snow
1:53 PM	32.0 °F	20.8 °F	30.9 °F	96%	29.43 in	-	East	17.3 mph	31.1 mph	0.05 in	Snow	Snow

Alpena Observations Elevation 600 feet

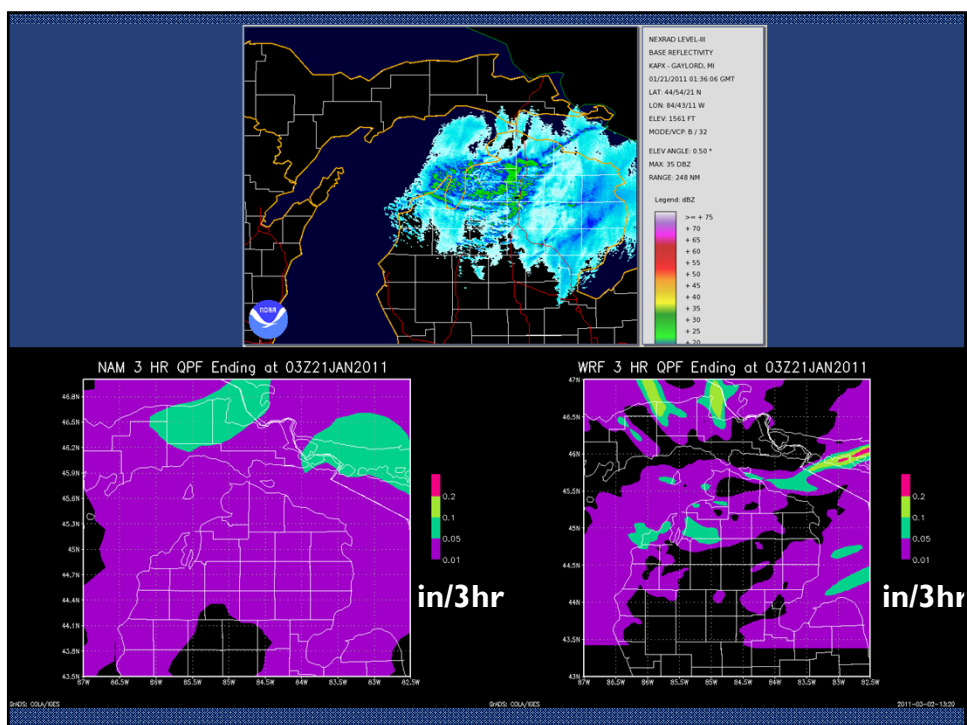
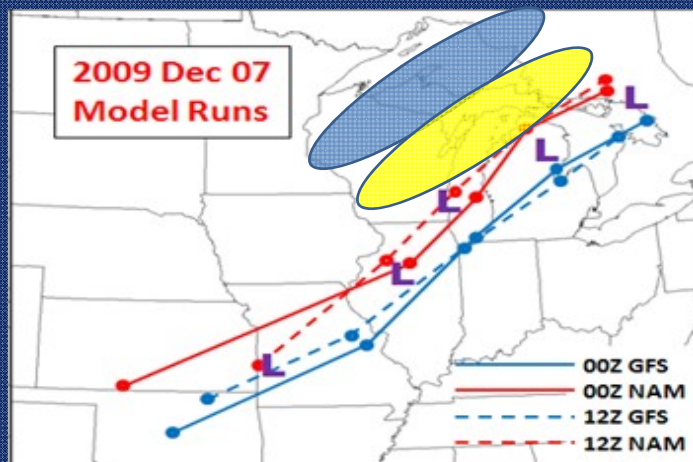
10:54 AM	35.1 °F	24.5 °F	33.1 °F	92%	29.80 in	5.0 mi	ESE	18.4 mph	27.6 mph	0.00 in	Rain	Light Rain
11:11 AM	35.6 °F	24.8 °F	33.8 °F	93%	29.76 in	2.0 mi	ESE	19.6 mph	33.4 mph	0.03 in	Rain , Snow	Light Rain
11:17 AM	33.8 °F	22.8 °F	33.8 °F	100%	29.76 in	1.5 mi	ESE	18.4 mph	31.1 mph	0.05 in	Rain , Snow	Light Rain
11:38 AM	33.8 °F	23.2 °F	32.0 °F	93%	29.74 in	0.8 mi	ESE	17.3 mph	31.1 mph	0.09 in	Snow	Light Snow
11:48 AM	33.8 °F	23.5 °F	32.0 °F	93%	29.73 in	0.2 mi	ESE	16.1 mph	25.3 mph	0.12 in	Fog , Snow	Heavy Snow
11:54 AM	33.1 °F	21.9 °F	30.9 °F	92%	29.74 in	0.2 mi	ESE	18.4 mph	27.6 mph	0.14 in	Fog , Snow	Heavy Snow
12:06 PM	33.8 °F	22.8 °F	32.0 °F	93%	29.70 in	0.5 mi	ESE	18.4 mph	25.3 mph	0.03 in	Fog , Snow	Snow
12:22 PM	33.8 °F	24.8 °F	32.0 °F	93%	29.68 in	2.5 mi	East	12.7 mph	23.0 mph	0.04 in	Snow	Light Snow
12:26 PM	33.8 °F	24.8 °F	32.0 °F	93%	29.67 in	5.0 mi	East	12.7 mph	23.0 mph	0.04 in	Snow	Light Snow
12:47 PM	35.6 °F	25.2 °F	33.8 °F	93%	29.65 in	8.0 mi	East	18.4 mph	26.5 mph	0.04 in		Overcast
12:54 PM	36.1 °F	24.8 °F	33.1 °F	92%	29.66 in	8.0 mi	East	17.3 mph	25.3 mph	0.04 in	Rain	Light Rain

Challenge #5: Computer models

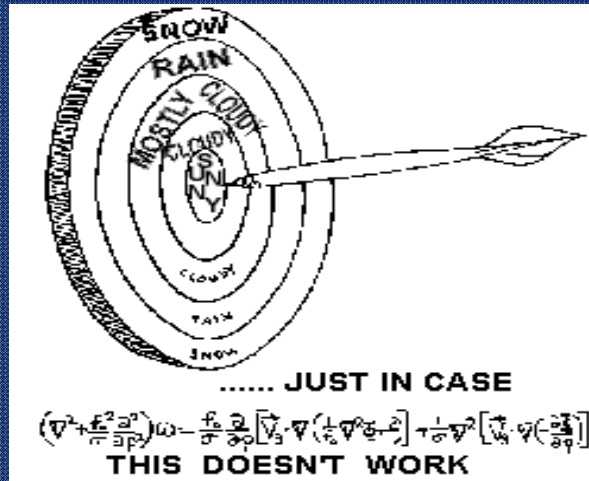


Why is storm track important?

Heaviest snow normally falls 150 to 200 miles to the left of the surface low track



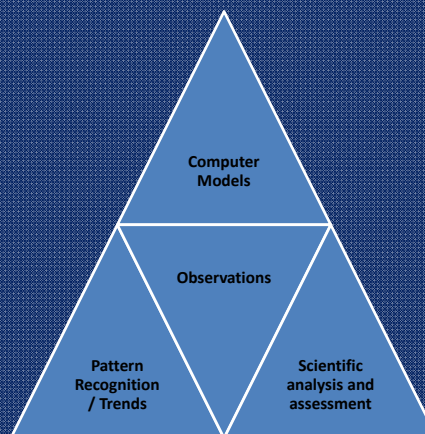
With all of these challenges...How do meteorologists put the forecast together?



With all of these challenges...How do meteorologists put the forecast together?

Creating a Forecast: Like putting a puzzle together

- Current observations
- Various computer models
- Pattern recognition
- Forecaster expert analysis and assessment



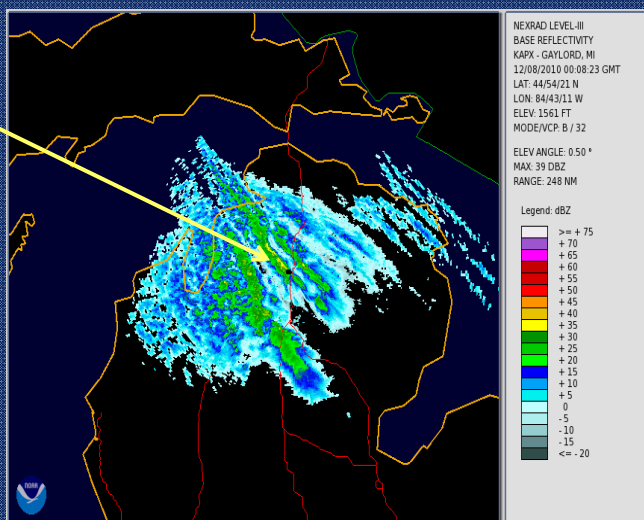
A few winter weather tips



Snowfall intensity and radar

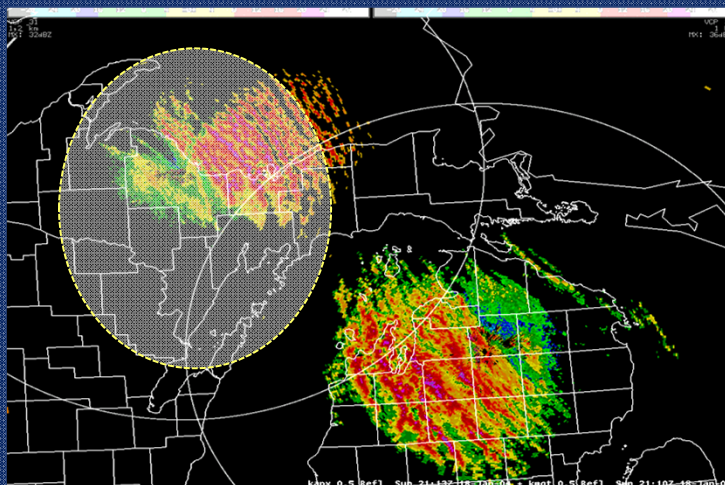
www.weather.gov/gaylord

28 dBZ or
higher returns =
1"+ / hour snow



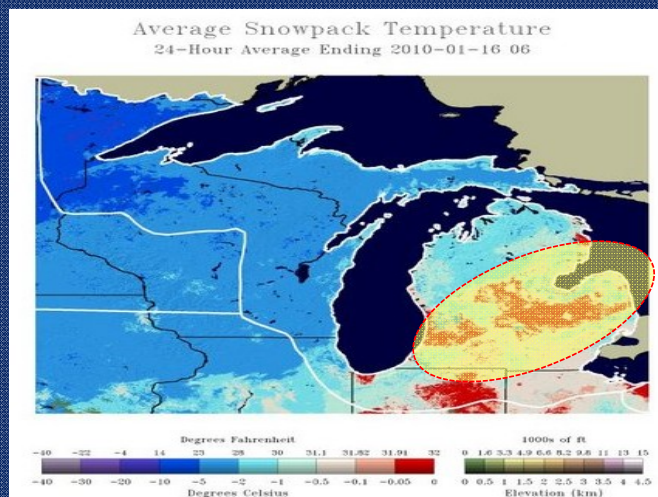
Wind direction changes – look upstream

www.weather.gov/gaylord



Snowpack Temperatures

See how quickly the snow may melt



<http://www.nohrsc.noaa.gov/nsa/>

Weather alerts on your phones

<http://inws.wrh.noaa.gov/>

Home My Alerts News FAQ About Login Register

iNWS - Interactive NWS
National Weather Service Mobile Decision Support Services (MDSS)

iNWS MOBILE ALERTING
Receive customized text message and e-mail alerts for National Weather Service products that you care about.

Welcome.
InteractiveNWS (iNWS) is the home of new mobile and desktop innovations of the National Weather Service. This application suite allows NWS partners to receive National Weather Service products in new and innovative ways, such as text messaging and mobile-enabled webpages. iNWS strives to fulfill our mission of protecting life and property by using new technology to reach out to our customers.

Recent News.
[iNWS fix implemented at 1910z today to mitigate warnings being sent to neighboring counties](#)
[New iNWS Terms of Use Are In Effect](#)
[Text Message Alerts Unlocked for All iNWS Users](#)
[New Version of the iNWS Web Page Released](#)
[All Advisories, Watches and Warnings Restored to iNWS Text Message Alerts](#)

Note: If you are receiving alerts, but never signed up for them, they may be coming from a new FEMA public system called the Wireless Emergency Alerts (WEA). More information can be found at <http://fema.gov/ema>.

iNWS is an experimental service intended for NWS core partners, including emergency managers, community leaders and other government agencies only. You are encouraged to complete a [short survey](#) on iNWS. See the [iNWS Service Description Document](#) for more information.

Weather alerts on your phones

<http://inws.wrh.noaa.gov/>

When creating an iNWS Alerts alert area, what types of NWS products fall into each weather category?

Severe - Severe Weather, Tornado (SVR, SVS, TOR, WCN)
 Winter Weather - Blizzard, Snow, Winter Storm, Winter Weather, Ice Storm, Avalanche (WSW, AVA, AVW, SAB)
 Hydrology - Flash Flood, Flood, Areal Flood (FFA, FFS, FFW, FLS, FLW)
 Fire Weather - Red Flag, Rangeland Fire Danger (RFW, RFD)
 Marine Weather - Lake Wind, Marine, Small Craft, Hazardous Seas (CWF, MWS, NSH, GLF, SMW, OFF, MWW)
 Coastal Hazards - Tsunami, Coastal Flooding, High Surf (CFW, LSH, TSU)
 Tropical Weather - Hurricane, Tropical Storm, Hurricane Winds (HLS, TCM, TCP, TCV)
 Aviation - Aviation Weather Warnings (AWW)
 Non-Precipitation - High Wind, Fog, Frost, Freeze, Dust (NPW, ASA)
 Civil Emergency - 911 Outage, Evacuation, HazMat, Nuclear, Volcano (CAE, CDQ, CEM, EQW, EVI, FRW, HMW, LAE, etc.)
 Other - Special Weather Statement (SPS)

Winter Weather Briefing Page

www.weather.gov/gaylord

The screenshot shows the NWS Gaylord website interface. On the left is a blue sidebar with various weather-related links. The main content area includes a map of the Traverse City, MI area, a 'Latest Conditions in Traverse City, MI' section showing a temperature of 19°F and 'Light Snow', and a 'Choose Your Front Page City' dropdown. A yellow banner with the text 'Winter Weather Briefing Page' is prominently displayed. A red circle highlights the 'Winter Weather Briefing Page' link in the sidebar. At the bottom, there is a 'CoCoRaHS' logo and a call to action to report rainfall and snowfall.

You can help us as well

The best warning information from the NWS occurs when we get real time snowfall/icing reports

The kinds of information we need:

Snowfall accumulations (especially overnight hours)
Intense snow bands (1" + per hour snowfall rates)
Icing on roads or power lines

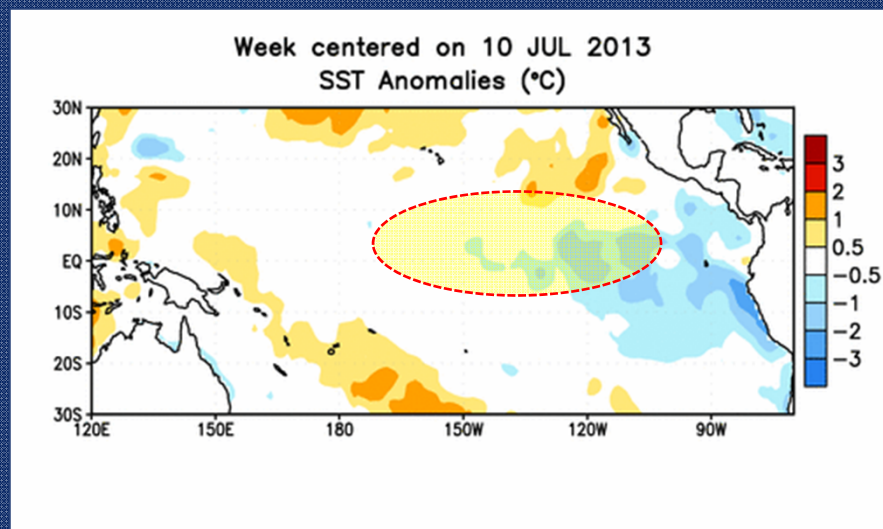
Anytime you can provide the NWS with current condition information, it is appreciated and helpful to the warning process

NWS Gaylord **989-732-9306** (24 hour direct forecaster number)

What about this upcoming winter?



First we look to the Pacific Ocean



Pacific Niño 3.4 SST Outlook

- Most models predict ENSO-neutral (-0.5°C to $+0.5^{\circ}\text{C}$) continuing through Northern Hemisphere spring 2014.

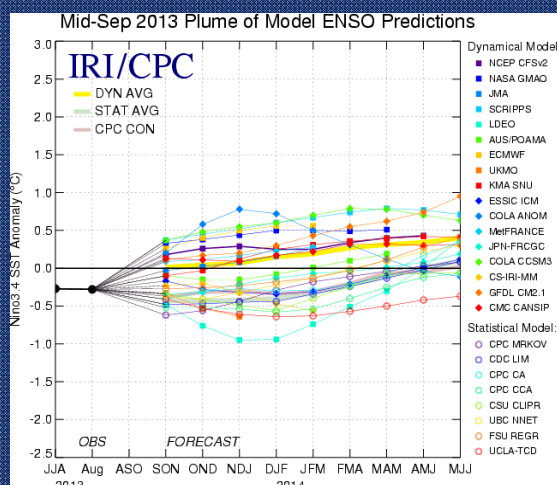
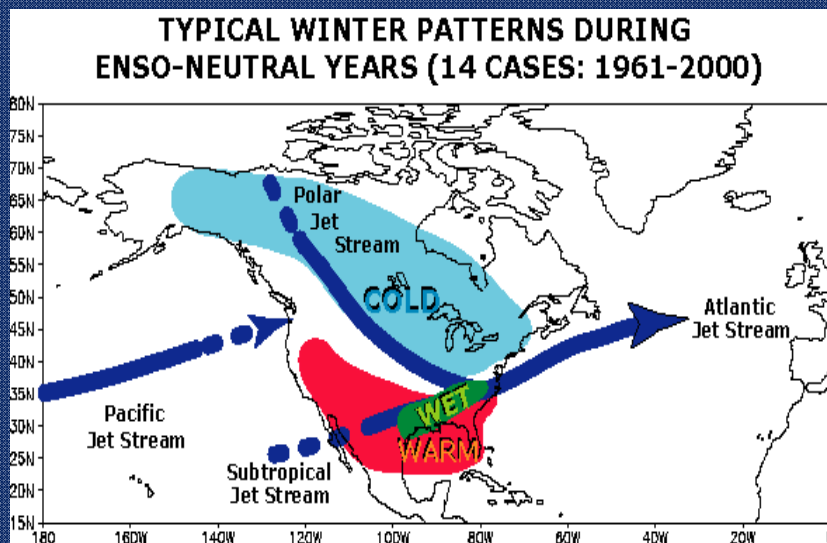
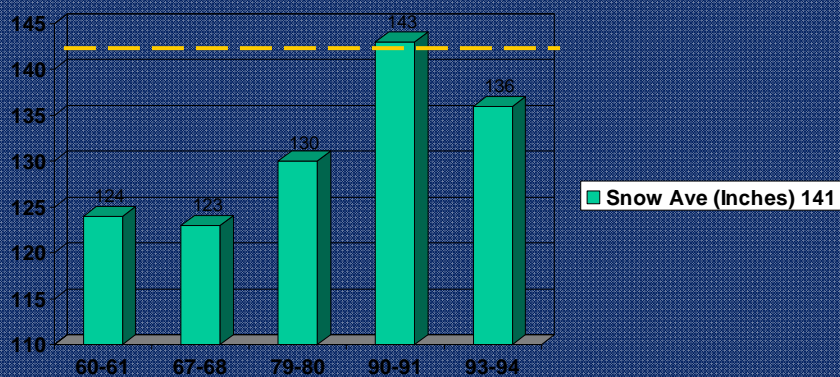


Figure provided by the International Research Institute (IRI) for Climate and Society (updated 18 September 2013).

Typical Neutral Winter Patterns



Gaylord Snowfall during ENSO Neutral Conditions



Questions???

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NWS Gaylord

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james.keysor@noaa.gov
www.weather.gov/gaylord