Winter Outlook 2014-2015

Southeast Lower Michigan

December through February

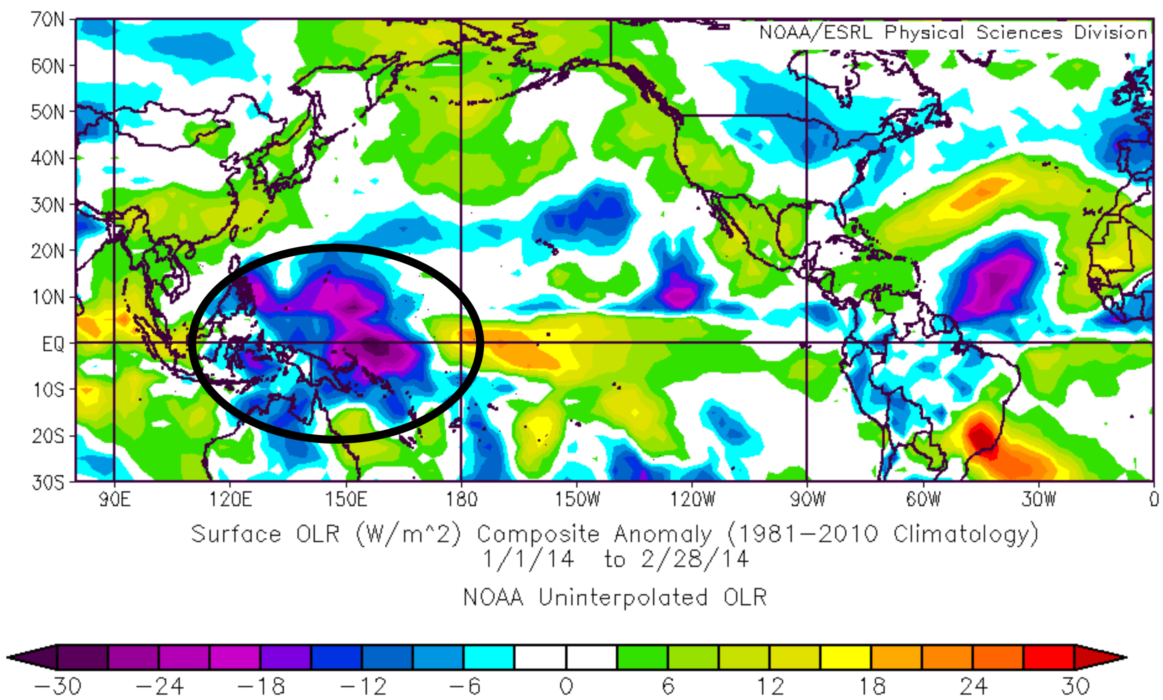
Slides 2-15: Forecast Reasoning
Slide 16: Winter Outlook for SE Michigan

Looking Back at Last Winter
Tropical Thunderstorm Activity

The location of thunderstorm activity (convection) in the tropics is usually approximated by using outgoing longwave radiation as a proxy.

During the heart of last winter, a large, organized, and persistent region of convection was present in the western basin of the Tropical Pacific.

Outgoing Longwave Radiation Anomaly



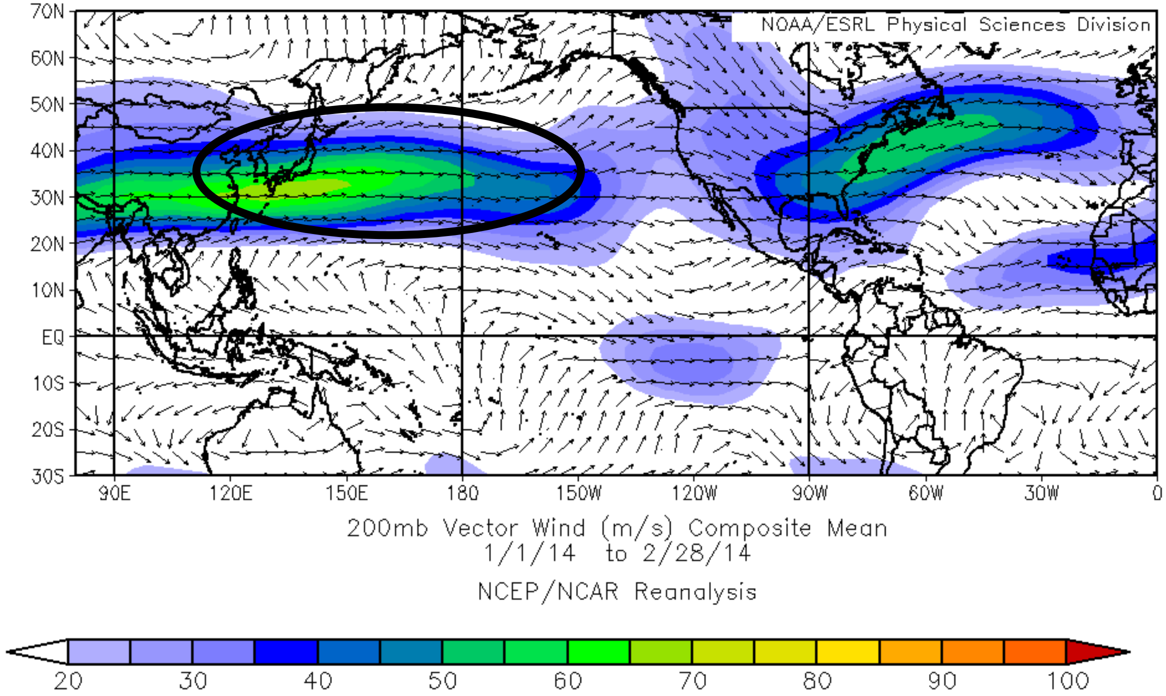
Looking Back at Last Winter

Jet Stream

The persistent tropical convection warmed the upper atmosphere in the surrounding region. The resulting upper-level mass gradient that helped to both maintain and strengthen the jet over the West Pacific.

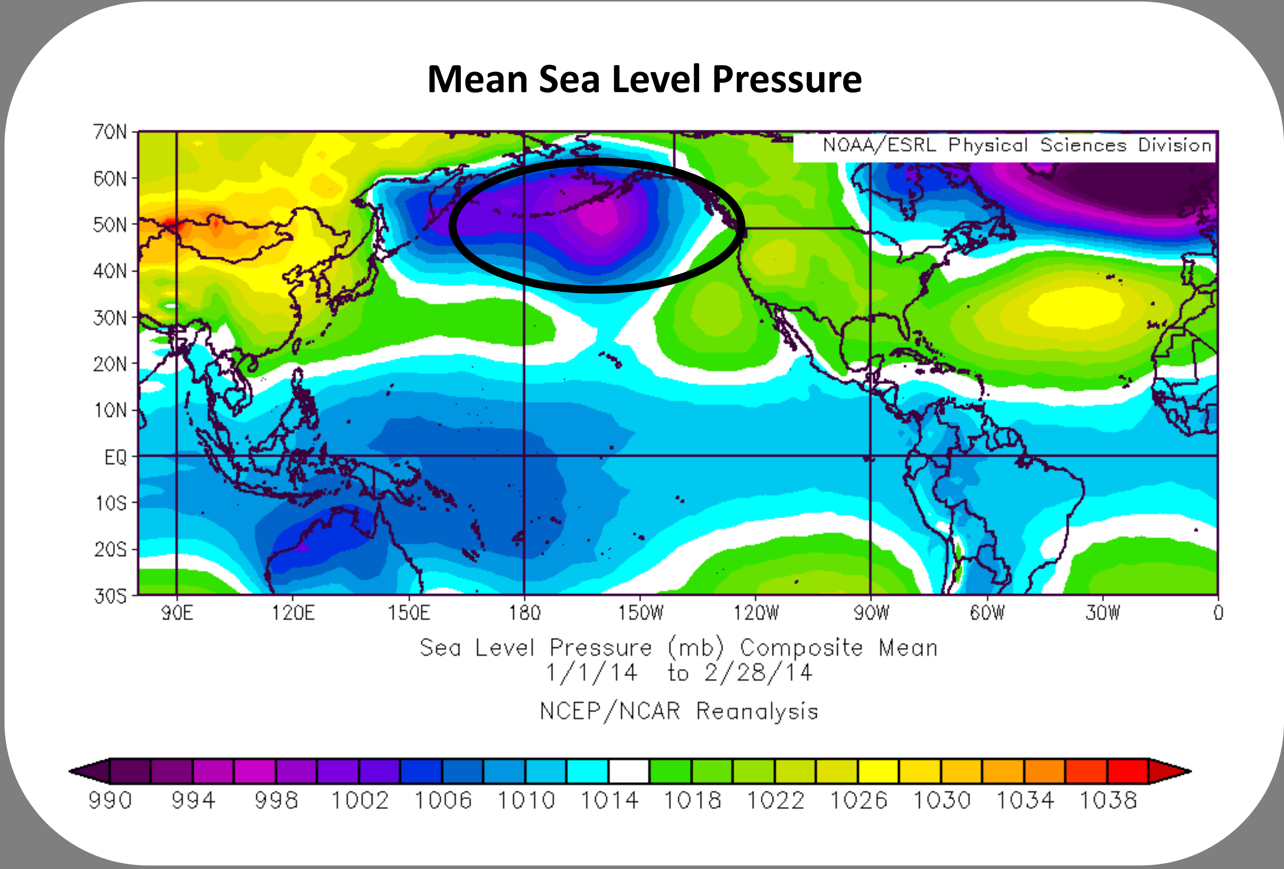
As the next 2 slides will show, this was likely a strong contributing factor to last year's severe winter.

Mean Wind at 200mb



Looking Back at Last Winter
Sea Level pressure

The persistent jet set up a favored region for cyclogenesis in the western Gulf of Alaska.



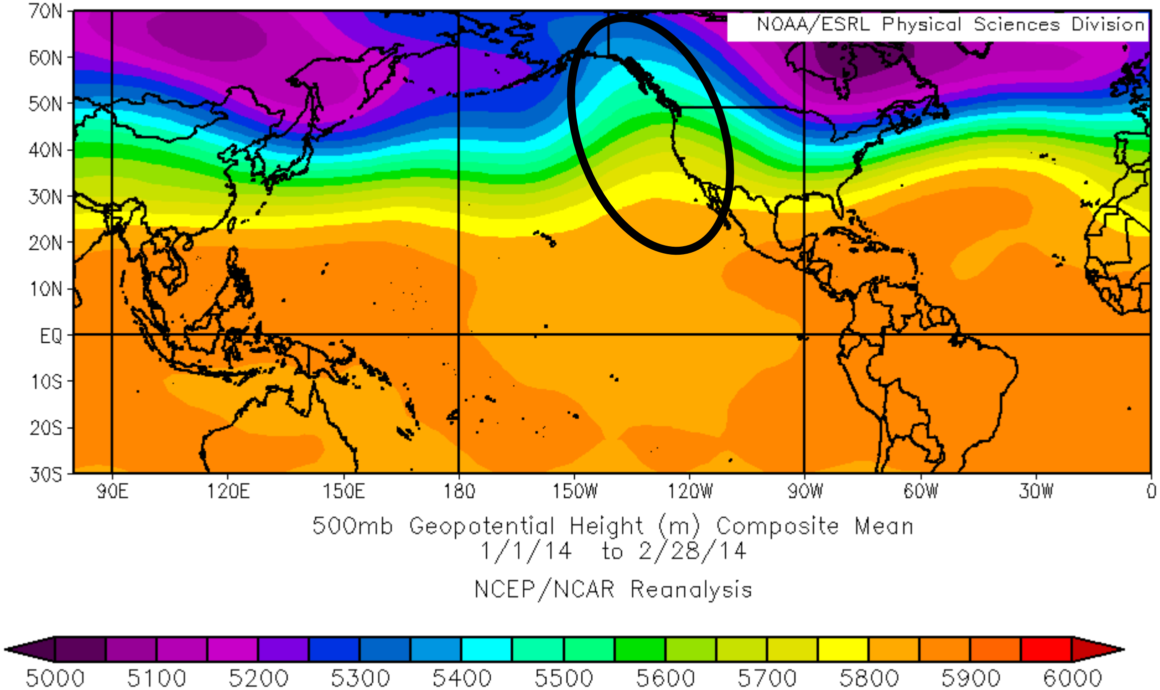
Looking Back at Last Winter
Mid-Atmospheric Flow Pattern

The development of mid-latitude cyclones, or cyclogenesis, results in ridge amplification downstream.

Thus, frequent cyclogenesis over the same region resulted in nearly continuous maintenance of the downstream ridge over western North America.

This helped to set the stage for nearly continuous cold in the eastern United States.

Mean Geopotential Heights at 500mb

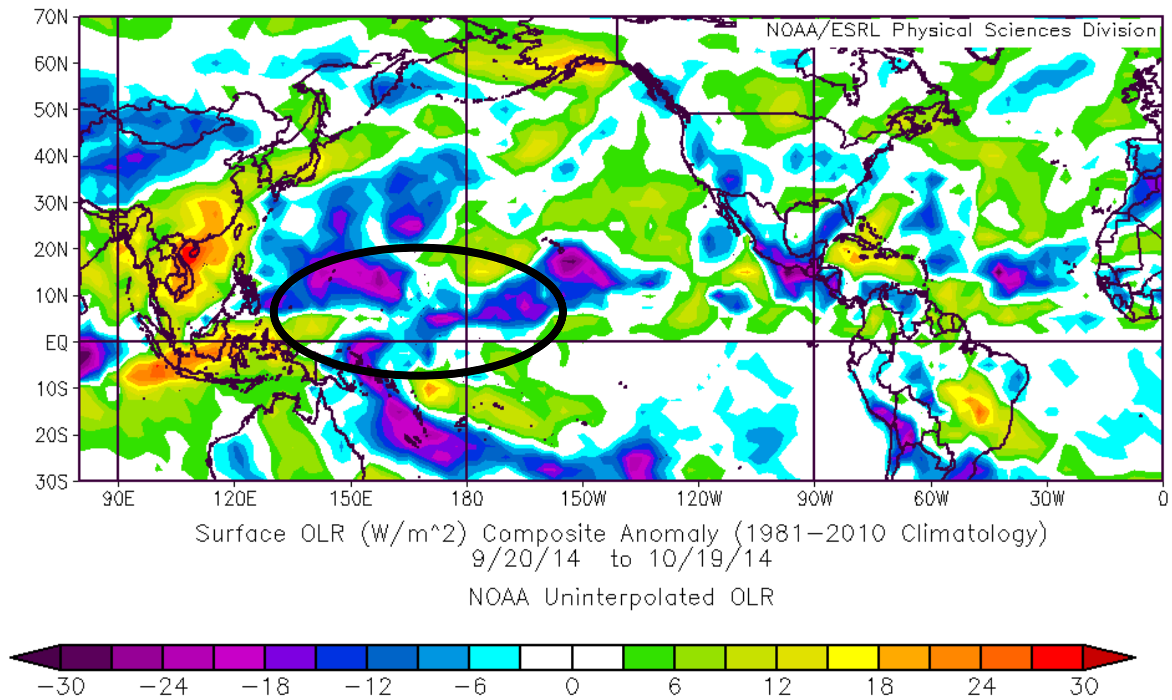


Current Conditions
Tropical Thunderstorm Activity

As of late October 2014, tropical convection remains primarily focused over the western Pacific. It has shown some eastward expansion just north of the equator, but is not particularly organized.

Its evolution over the course of winter will be important and will potentially be influenced by the development of a weak el Nino – more on that later.

Outgoing Longwave Radiation Anomaly



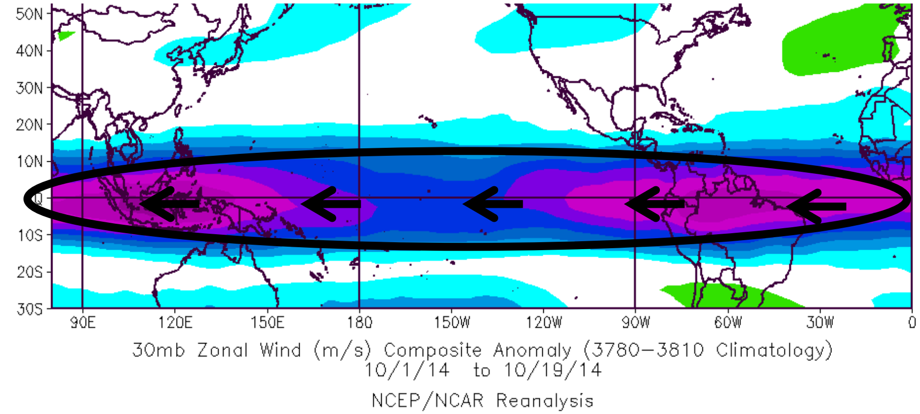
Current Conditions

Strengthening easterlies in the tropical stratosphere

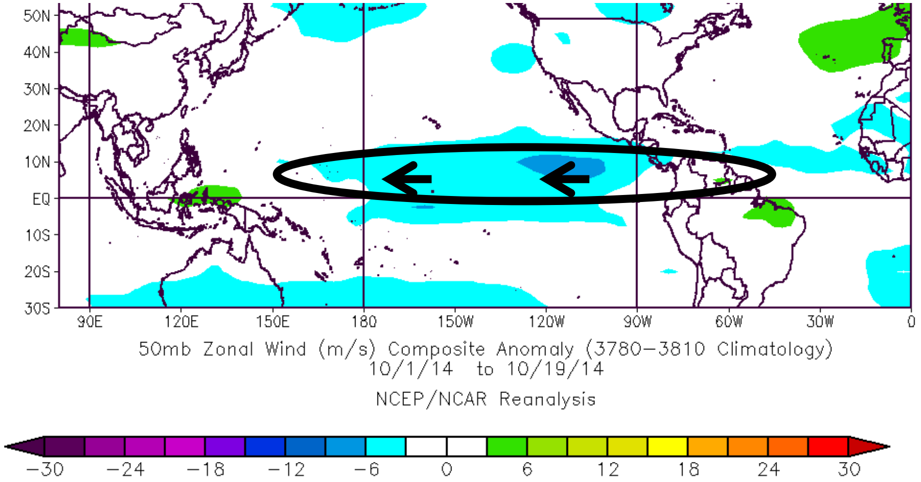
Winds in the lower stratosphere have significant implications for the global distribution of atmospheric energy. They are highly predictable as they oscillate between westerly and easterly, and they are an important consideration for seasonal outlooks.

Easterly winds have developed high in the tropical stratosphere (top). They will eventually propagate down to the lower stratosphere (bottom). Although they have not reached the lower stratosphere in any significant capacity just yet, they will by the onset of winter.

Zonal Wind Anomaly at 30mb



Zonal Wind Anomaly at 50mb

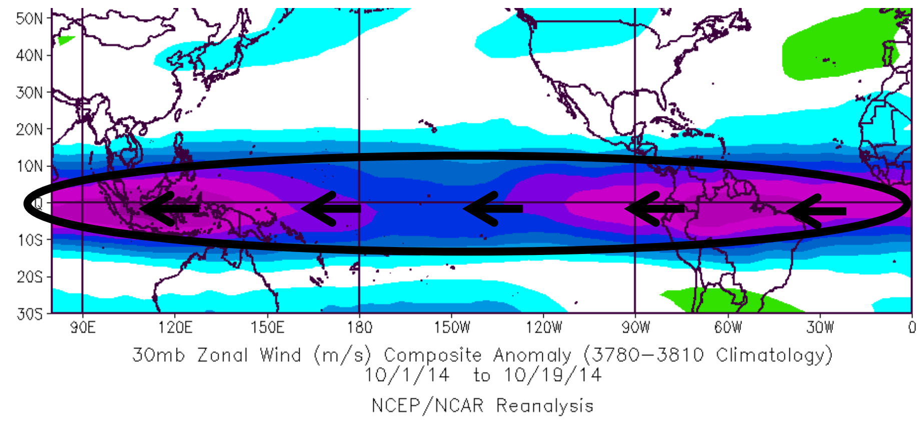


Current Conditions
Strengthening easterlies in the tropical stratosphere

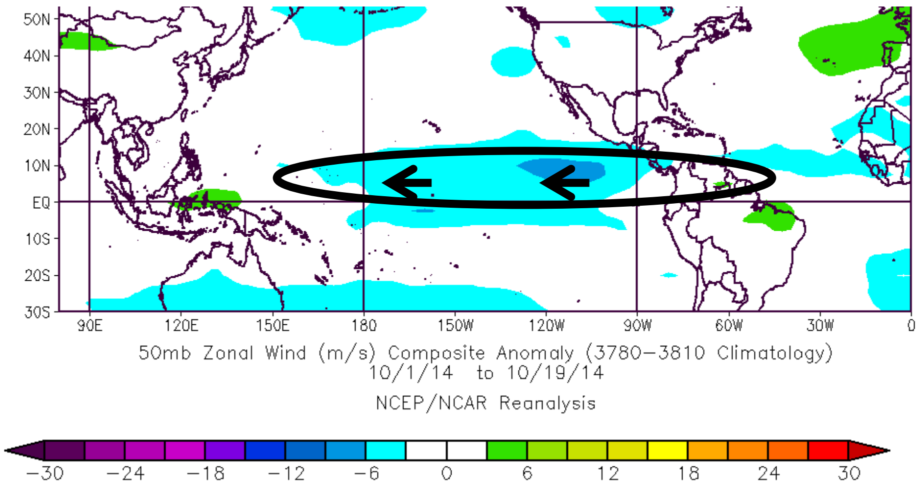
Per [Baldwin et al. (2001)](), the easterly phase (right), is significant because the dynamics associated with it result in more atmospheric wave energy being directed poleward. The convergence of these waves results in a net deceleration of the polar jet, thereby offering a contribution toward a weaker polar vortex.

For this reason, the easterly phase has physical ties to southward displacements of the polar jet (i.e. –[NAO]()), which favors colder weather over the eastern U.S., including the Great Lakes.

Zonal Wind Anomaly at 30mb



Zonal Wind Anomaly at 50mb



Current Conditions
High-Latitude Snow Cover

High-latitude snow cover plays a key role in the manufacturing of cold arctic airmasses, and therefore has a direct influence on the intensity of cold air outbreaks in the Great Lakes. Snow cover is currently above average, mainly in Siberia.

Northern Hemisphere Snow Cover

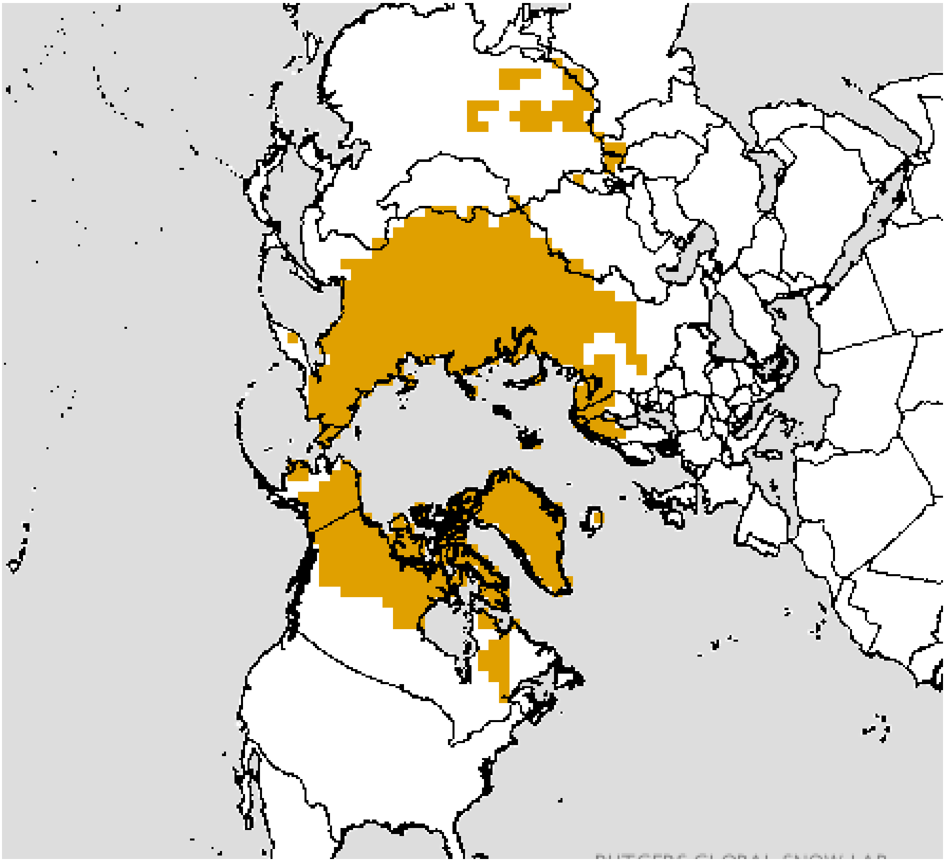


Image courtesy of Rutgers University [Global Snow Lab]

Current Conditions
High-Latitude Snow Cover

In addition, recently published research by Cohen et al. (2014) describes a tie between the pressure patterns caused by vast Autumnal snow cover in Siberia and the resultant strengthening of the jet stream.

The strengthening jet causes increased upward energy flux into the polar stratosphere which can weaken the polar vortex.

It is therefore believed to be a skillful predictor for the arctic oscillation, an index that is used as a proxy for the strength of the polar vortex for a given winter.

Per these findings, the likelihood for a negative Arctic Oscillation (e.g. weakened polar vortex) this winter is higher than normal.

Northern Hemisphere Snow Cover

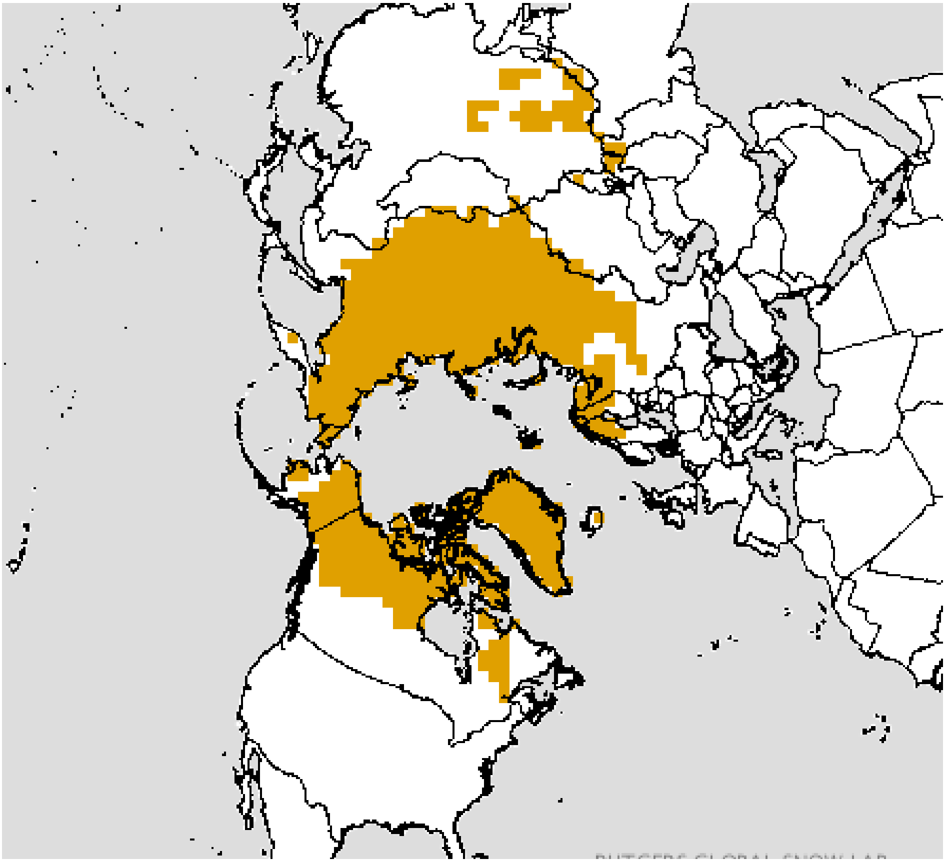
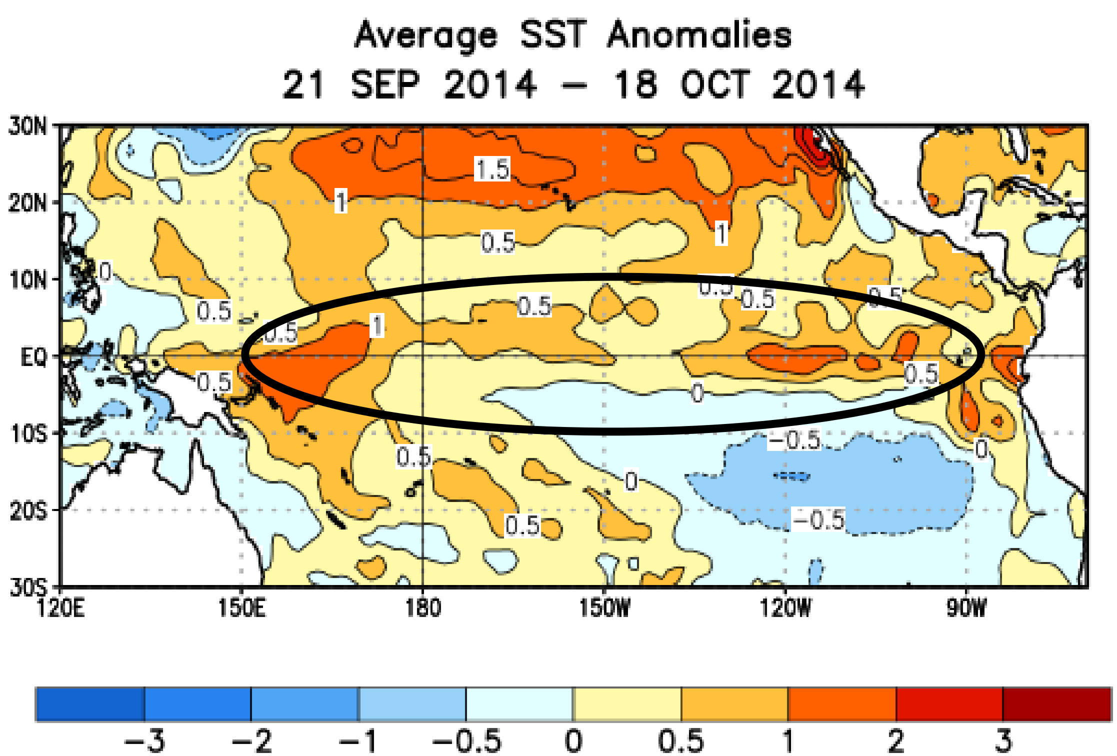


Image courtesy of Rutgers University Global Snow Lab

ENSO Outlook
Changes to expect

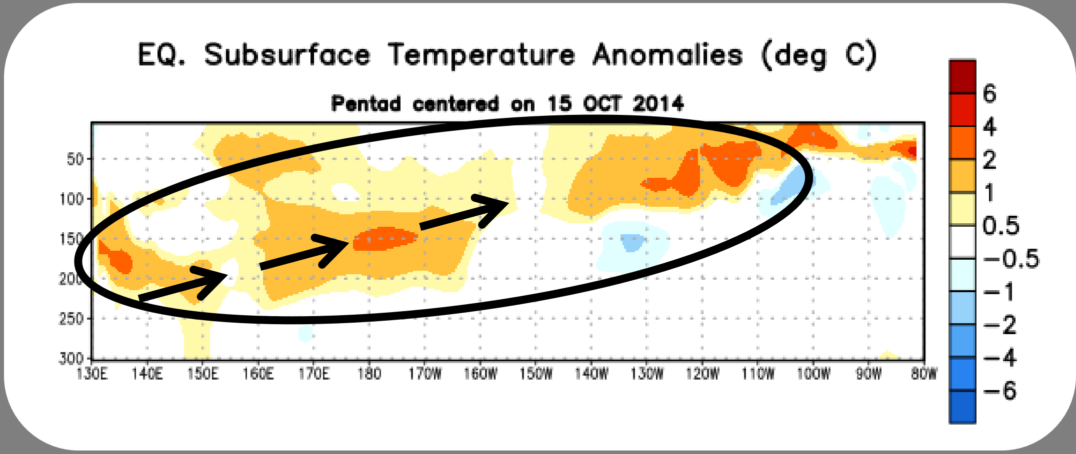
Current sea surface temperature anomalies are positive across the Equatorial Pacific. This is an important feature to note, because warm SSTs are supportive of enhanced tropical convection which, as noted several slides back, can have significant effects on our weather in the mid-latitudes.

There appears to be support for tropical convection to continue to migrate eastward with time.



ENSO Outlook
Changes to expect

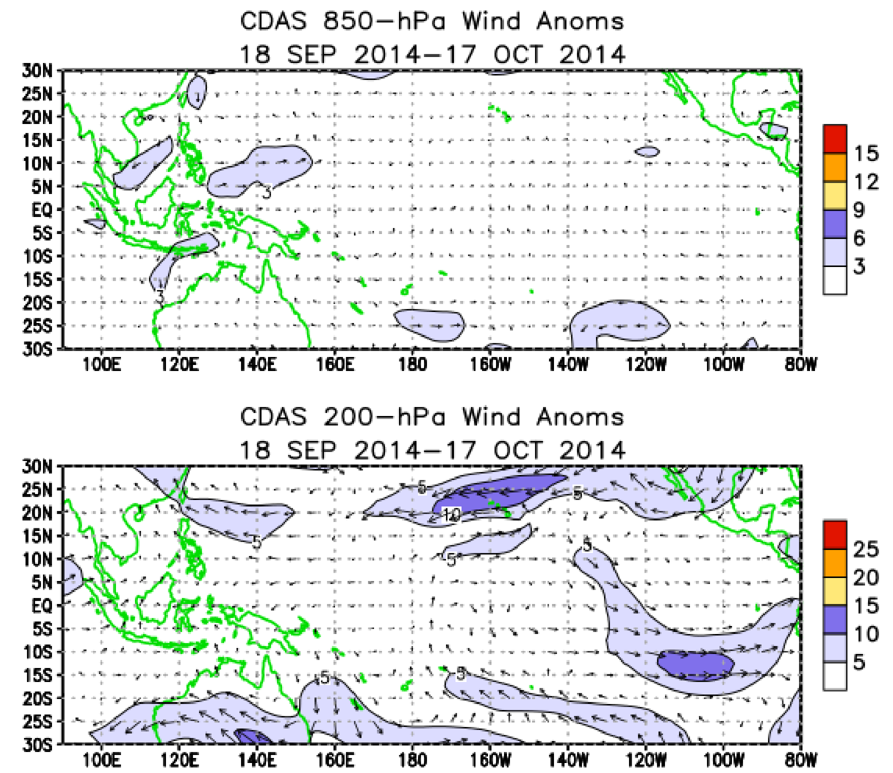
Subsurface temperature anomalies indicate continued support for the existing warm sea surface temperature anomalies. This increases confidence that warm SSTs will persist and potentially have an influence during the cold season.



ENSO Outlook
Changes to expect

Both low-level westerly winds and upper level easterly winds are near normal in the tropics. This indicates that while SSTs are warm, the effect on the Walker Circulation has been minimal thus far. This is confirmed by the latest weakly positive MEI value of 0.500.

Given the expectation for persistent positive-neutral or perhaps weak el Nino conditions to develop, the Walker Circulation should eventually undergo mild weakening while the influence of convection migrating eastward should increase with time.

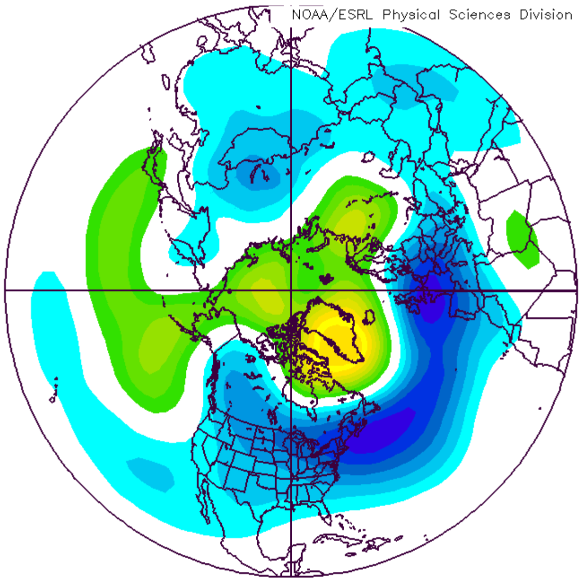


Similar Past Years
Positive-Neutral or Weak el Ninos

Positive-neutral or weak el Nino conditions are likely to be present through winter. A composite plot (right) of years featuring similar tropical forcing revealed a strong signal for above normal heights across the polar regions as well as a strong signal for a southward displaced jet over the eastern United States and Atlantic Ocean (commonly referred to as a "negative NAO", where NAO stands for "North Atlantic Oscillation"). NOTE: This is only one method of considering one factor. The map at right is not an explicit forecast or expectation.

This is a common symptom of a weakened polar vortex (commonly described by AO, where AO stands for "Arctic Oscillation"), and is favorable for infiltration of cold air into Southeast Michigan. The signal in the composite at right was strongest in January and weakest in December.

500mb Composite Anomaly



Winter Outlook for Southeast Michigan
Summary

Numerous factors are in place to prevent a warmer-than-normal winter in Southeast Michigan. Heights across the polar regions are presently above normal and the Arctic oscillation index has generally been negative for 2014, an indication of a weak polar vortex.

This atmospheric state is one will be reinforced by developing stratospheric easterlies. These winds result in wave energy being directed poleward such that the polar vortex is further weakened. In addition, positive-neutral or weak el Nino conditions are likely to be present through the winter season.

A composite plot of years featuring similar tropical forcing revealed a strong signal for above normal heights across the polar regions as well as a strong signal for a southward displaced jet over the eastern United States and Atlantic Ocean.

Thus, there appears to be sufficient evidence to expect a weaker-than-normal polar vortex. This will favor a southward displaced jet over Southeast Michigan and colder-than-normal temperatures, especially January into February. However, it is worth noting that such a jet configuration commonly sends bigger snowstorms east of our area.

Winter Outlook for Southeast Michigan

Colder and drier (and not as cold or as snowy as last winter)

Temperature Trends

Cold anomalies are forecast to be greatest during the latter half of winter due to increasing northwest flow over Southeast Michigan. The strongest signal for southward displacement of the jet stream is January into February while the weakest is in December. Given that many of the factors discussed are only just beginning to take shape, December temperatures are more likely to be within normal ranges.

December: Near normal
January: Colder than normal
February: Slightly colder than normal

Precipitation/Snowfall Trends

The previously described pattern will be one that favors deflection of the most significant snowstorms to our south and/or east. Thus, conditions are expected to evolve into a drier-than-normal pattern. However, even an active clipper pattern, though dry, can result in normal snowfall amounts.

December through February: Near normal snowfall

Winter Trivia for Southeast Michigan

Coldest temperature: **Tri-Cities: -23F** (Feb 1918), **Flint: -25F** (Jan 1976), **Detroit: -21F** (Jan 1984)
Coldest month: **Tri-Citie**s: **9.4F** (Jan 1912), **Flint: 10.9F** (Jan 1977), **Detroit: 12.2F** (Feb 1875)

Coldest winter: **Tri-Cities**: **15.7F** (1962-63), **Flint: 16.7F** (1976-77), **Detroit: 18.8F** (1903-04)
Warmest winter: **Tri-Cities: 33.3F** (1931-32), **Flint: 32.2F** (1982-83), **Detroit: 36.9F** (1881-82)

Snowiest month: **Tri-Cities: 39.3"** (Feb 1908), **Flint: 32.9"** (Jan 2014), **Detroit: 39.1"** (Jan 2014)
Snowiest year: **Tri-Cities: 87.2"** (1966-67), **Flint: 82.9"** (1974-75), **Detroit: 94.9"** (2013-14)
Least snowy year: **Tri-Cities: 7.8"** (1941-42), **Flint: 10.9"** (1921-22), **Detroit: 13.4"** (1936-37)

Heaviest snow storms: **Tri-Cities: 23.8**" (January 26-27, 1967), **Flint: 22.7**" (January 26-27, 1967), **Detroit: 24.5**" (April 6, 1886)

Average first measureable snowfall: **Tri-Cities:** Nov 15th , **Flint:** Nov 16th, **Detroit:** Nov 17th
Average first 1+": **Tri-Cities:** Nov 26th , **Flint:** Nov 29th, **Detroit:** Nov 30th
Average first 3+" snowfall: **Tri-Cities:** Dec 27th , **Flint:** Dec 29th, **Detroit:** Dec 26th

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