



# ACCAP

Alaska Center for Climate  
Assessment and Policy

## Welcome to the ACCAP'S Alaska Climate Webinar Series

Tuesday, August 26, 2014

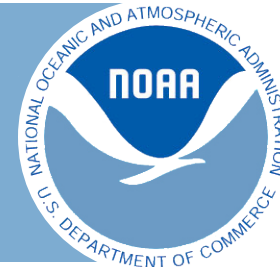
Webinar Moderated by:  
Tina Buxbaum



UAF is an AA/EO employer and educational institution.



UNITED STATES DEPARTMENT OF COMMERCE  
NATIONAL OCEANIC AND  
ATMOSPHERIC ADMINISTRATION



# El Nino and Alaska – Past, Present and Future

**Jon Gottschalck**

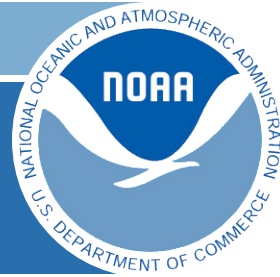
**Acting Chief, Operational Prediction Branch  
NWS / NCEP / Climate Prediction Center  
&**

**Rick Thoman**

**National Weather Service Alaska Region  
Climate Science and Services Manager**

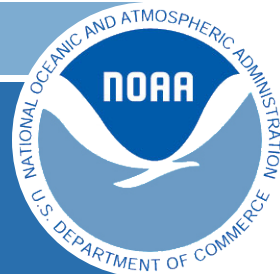


**Alaska Climate Webinar  
August 26, 2014**



# Outline

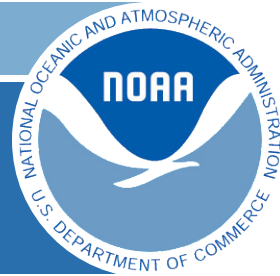
- Overview of the El Nino-Southern Oscillation (ENSO)
- How prospects for El Nino may impact large scale global circulation and temperature / precipitation patterns
- Current status and forecast of El Nino



# Outline

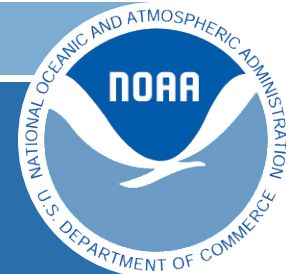
- **Overview of the El Nino-Southern Oscillation (ENSO)**
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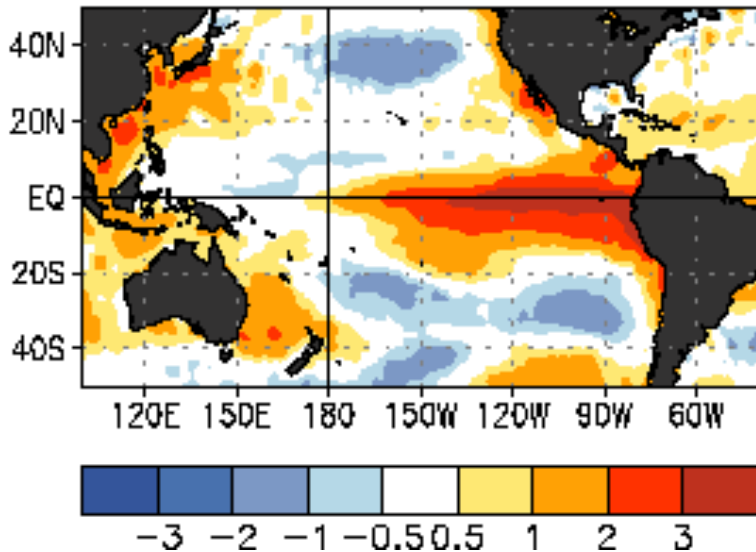
# ENSO Overview

- An irregular, naturally occurring cycle (every 2-7 years) of warm (El Nino) or cold (La Nina) conditions in the tropical Pacific Ocean.
- Ocean changes occur alongside changes in the tropical atmosphere circulation and rainfall
- On average, events last 9-12 months (La Niñas can persist longer) and peak in strength during N. Hemisphere winter

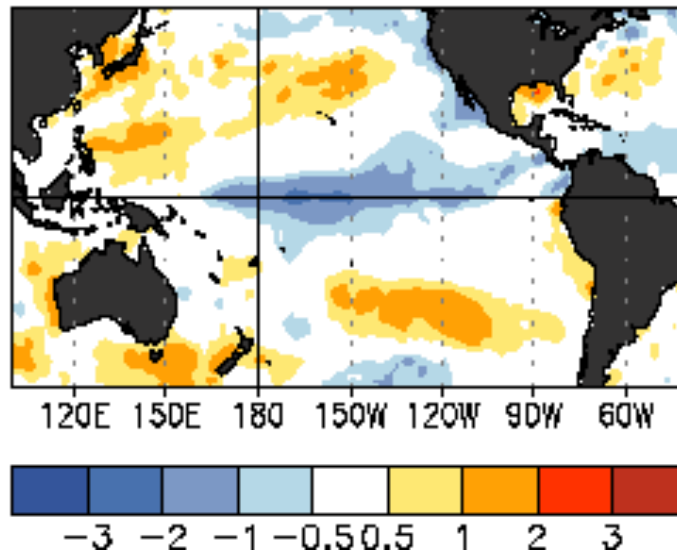


# Sea Surface Temperatures

## EL NIÑO Jan-Mar 1998

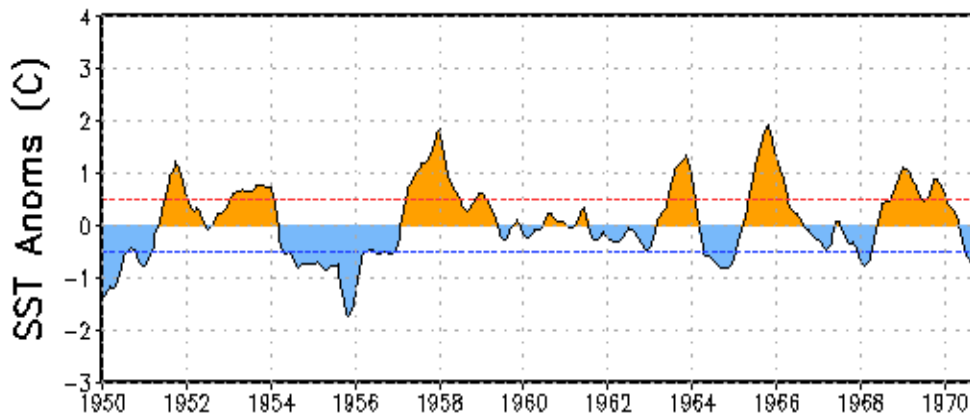


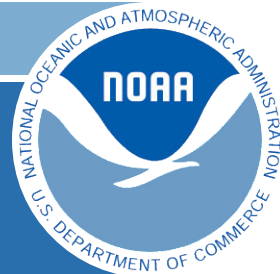
## LA NIÑA Jan-Mar 1989



**Red colors:**  
above average  
sea surface  
temps (SST)

**Blue colors:**  
below average  
sea surface  
temps (SST)





# Neutral conditions

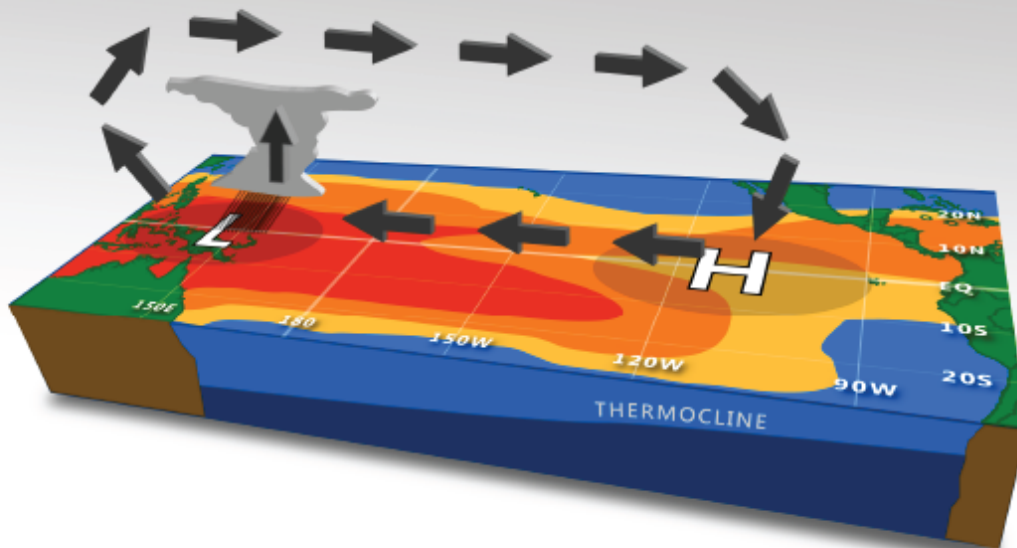
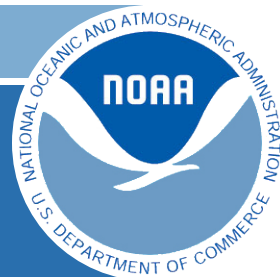


Figure 1  
NEUTRAL CONDITIONS

- Warm water heats the atmosphere and makes it rise
- Low-level trade winds blow towards warm water to fill the gap
- Subsiding air occurs in the eastern Pacific basin



# El Nino conditions

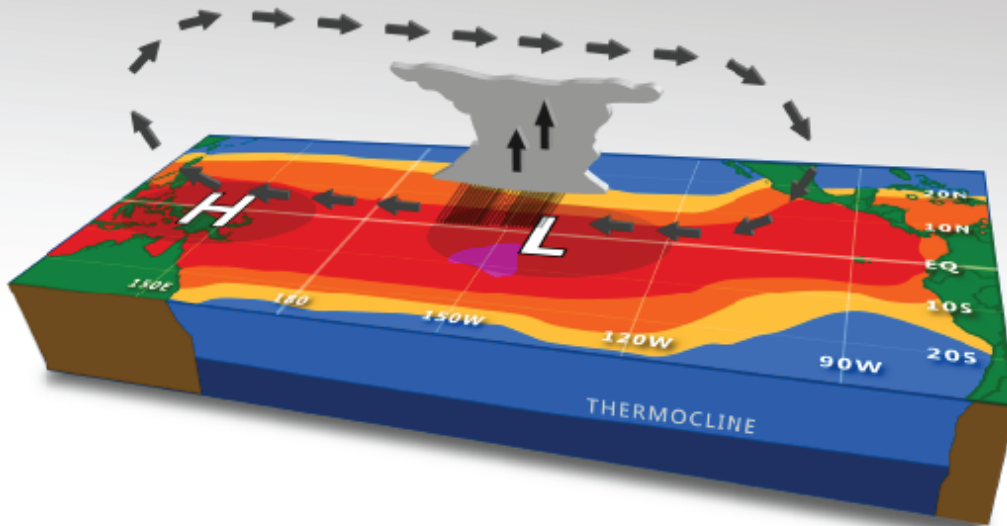
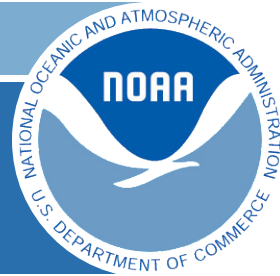


Figure 2  
EL NIÑO CONDITIONS

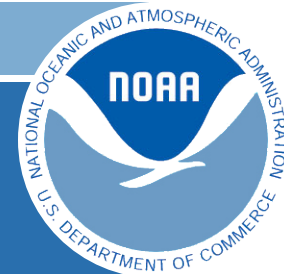
- Easterly trade winds weaken
- Thermocline deepens and the cold water upwelling decreases in the eastern Pacific
- Rainfall shifts eastward over the central and/or eastern Pacific Ocean
- Rainfall becomes suppressed over the far western Pacific/Indonesia





# Outline

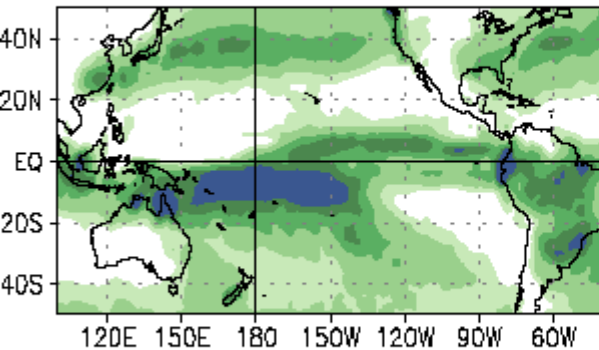
- Overview of the El Nino-Southern Oscillation (ENSO)
- **How prospects for El Nino may impact large scale global circulation and temperature / precipitation patterns**
- Current status and forecast of El Nino



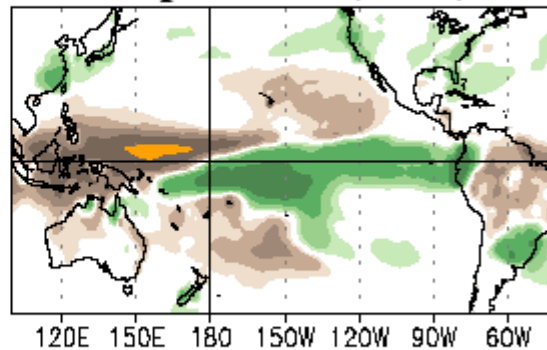
# Precipitation

## Jan-Mar 1998 Precipitation (mm)

Total



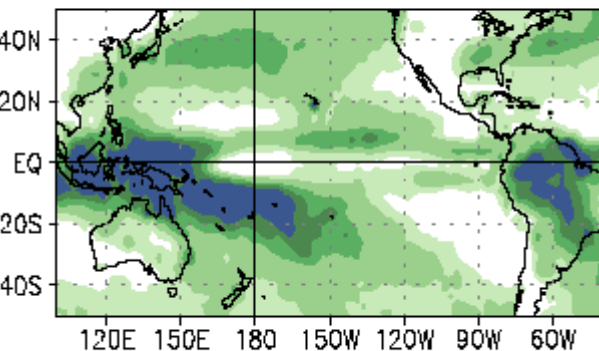
Departures (x100)



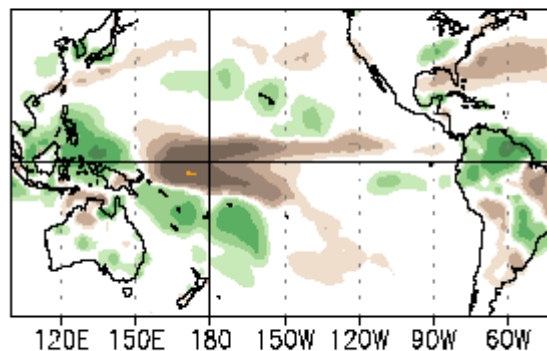
Enhanced rainfall occurs over warmer-than-average waters during El Niño

## Jan-Mar 1989 Precipitation (mm)

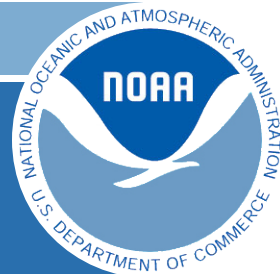
Total



Departures (x100)



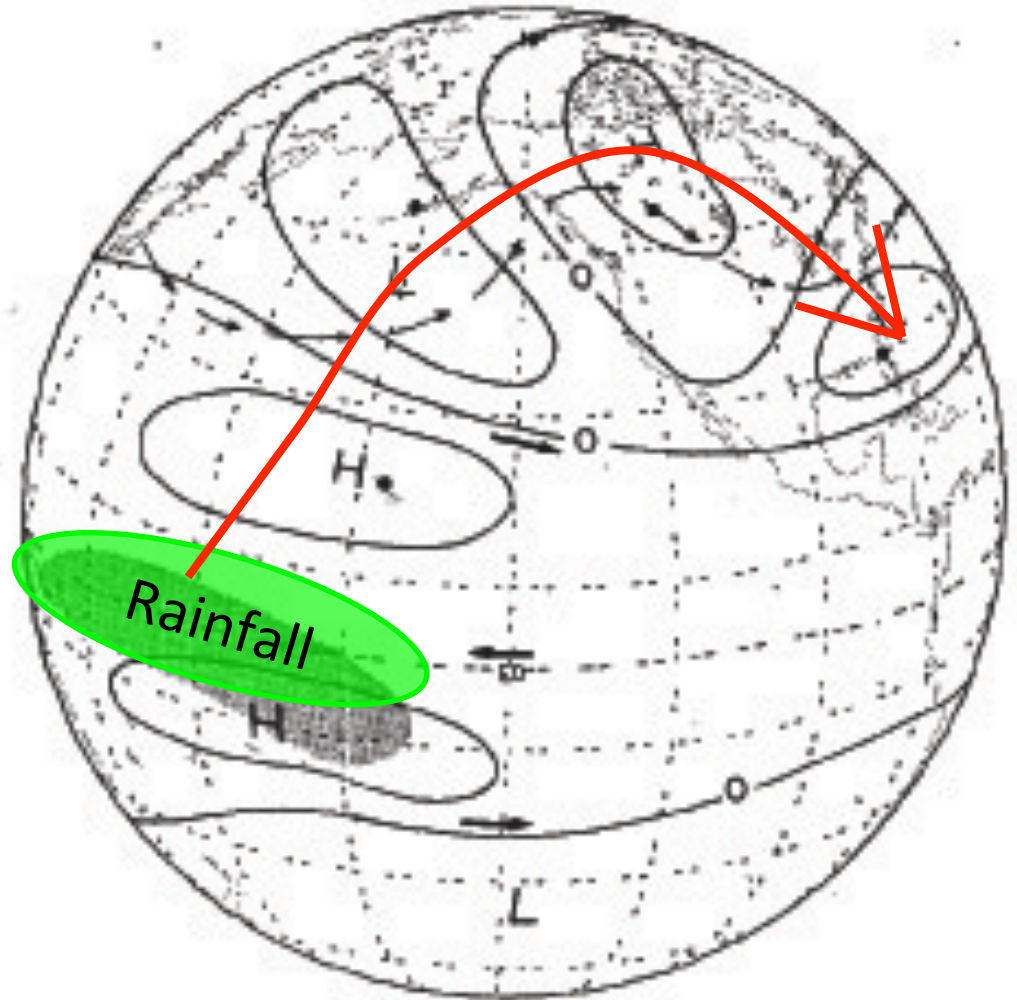
Reduced rainfall occurs over colder-than-average waters during La Niña



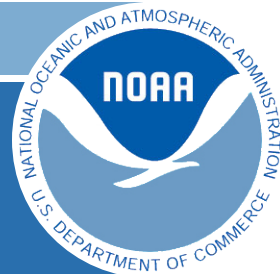
# Teleconnections

Tropical rainfall and so atmospheric heating can lead to “wavetrains” that can influence the global circulation (**red arc**)

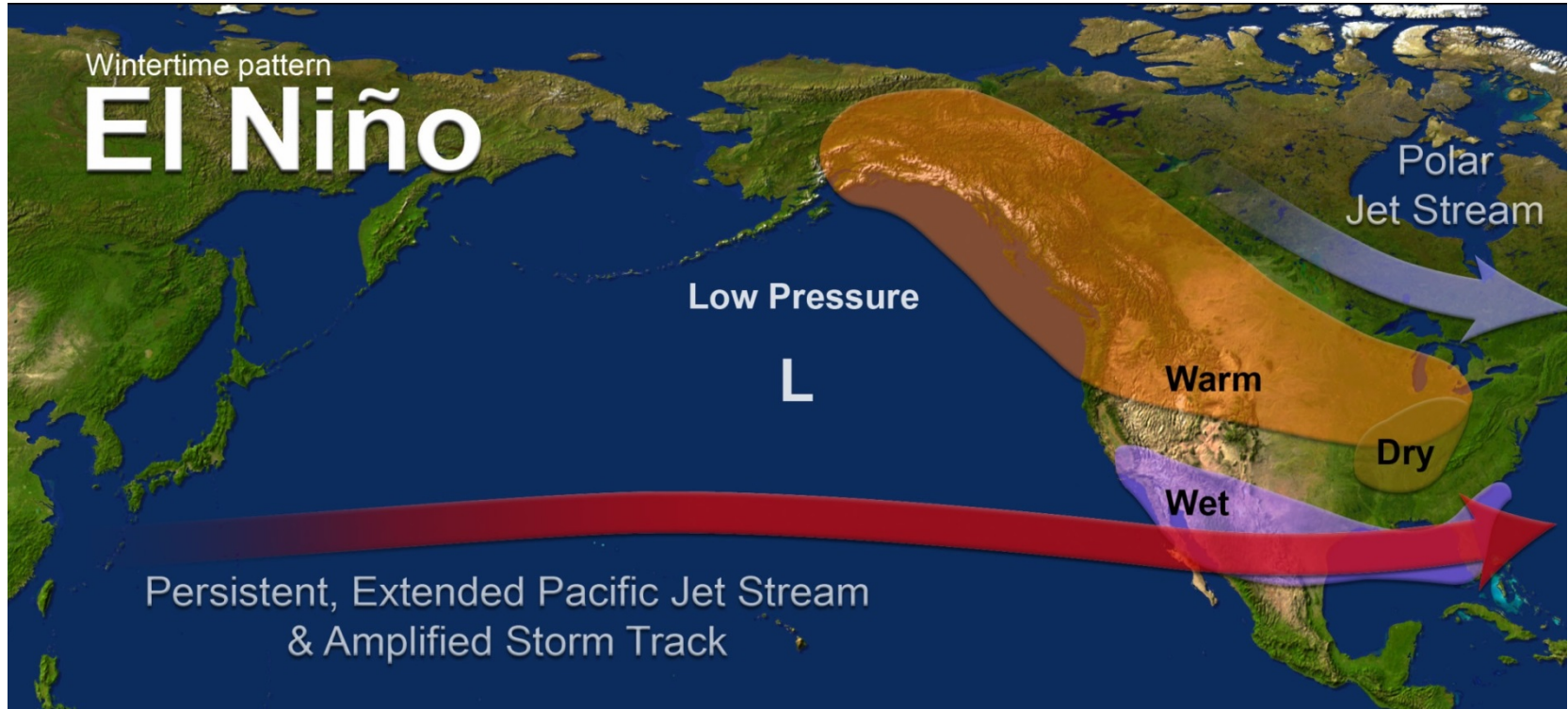
These “teleconnections” are why El Nino is important to the rest of the globe outside the Tropics, including Alaska



Schematic from Horel and Wallace (1981)

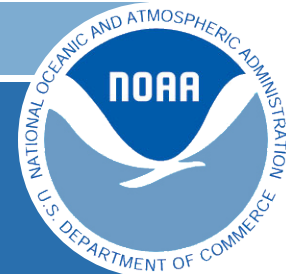


# Typical El Niño Pattern

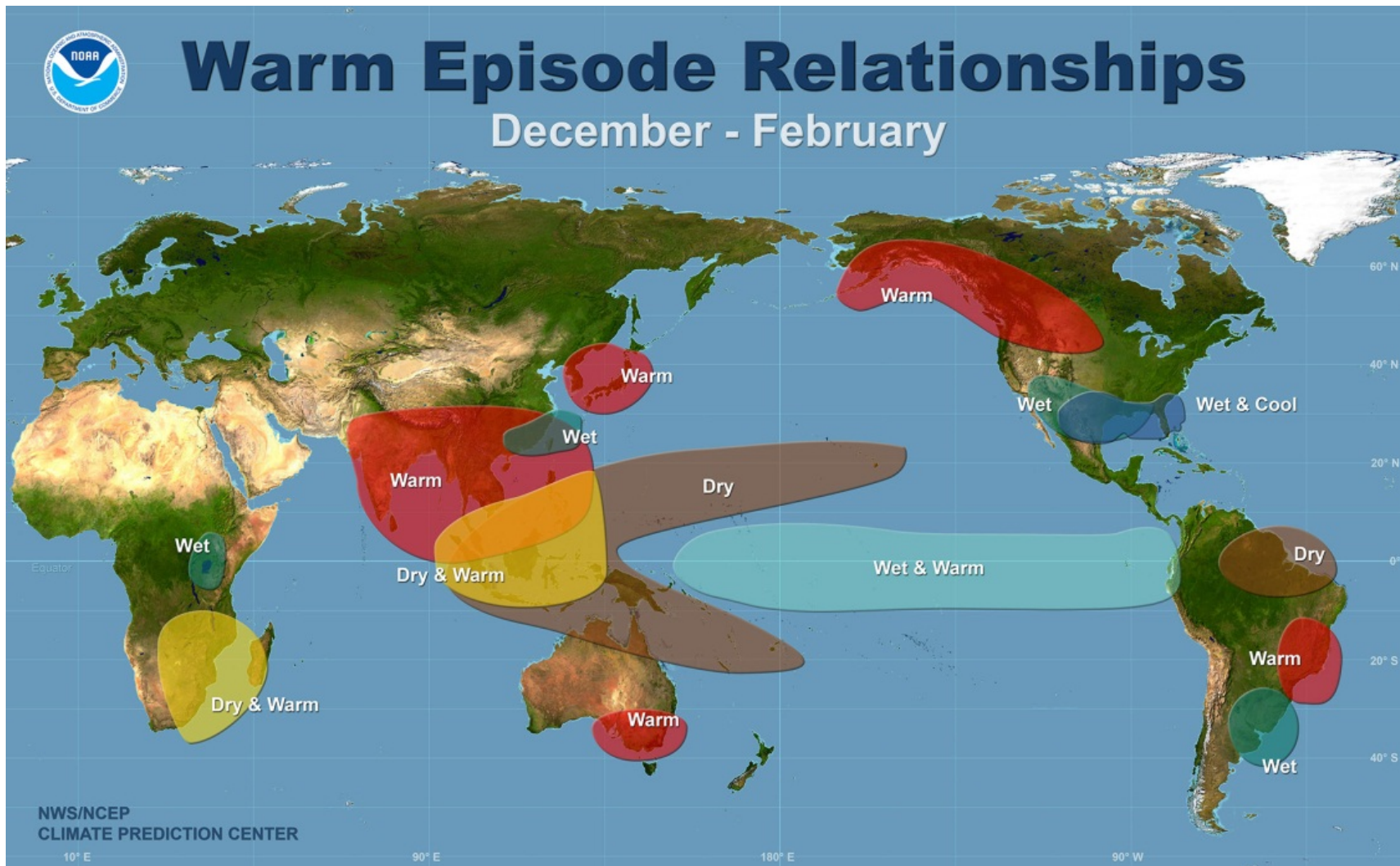


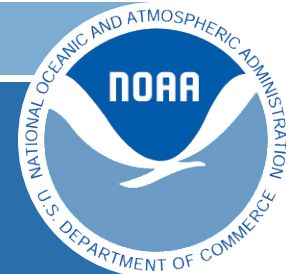
Jet stream over the Pacific and North America is stronger than average and shifted *equatorward*. Flow is more *zonal* than average from the central Pacific eastward across the U.S.





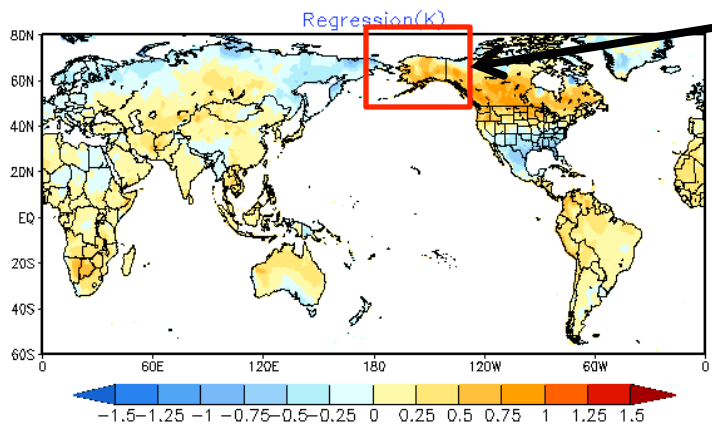
# Typical Global Impacts





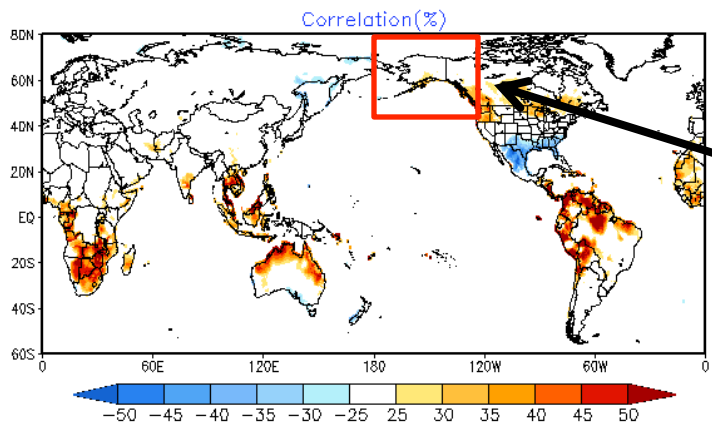
# Typical Global Impacts

ENSO Teleconnection: JFM Temp



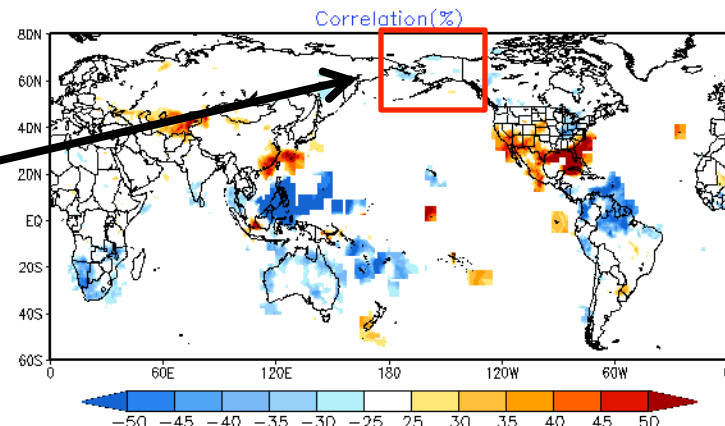
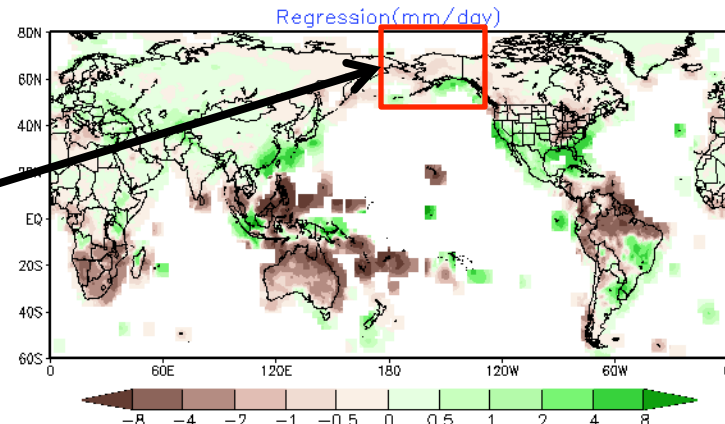
Warmer than Average

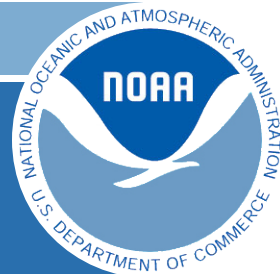
Wetter than average Southeast, drier than average northwest



Correlation is low indicating high uncertainty in this composite signal

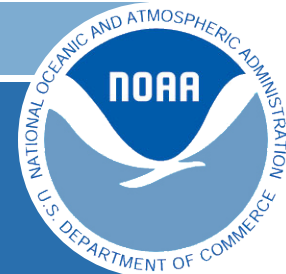
ENSO Teleconnection: JFM Precip





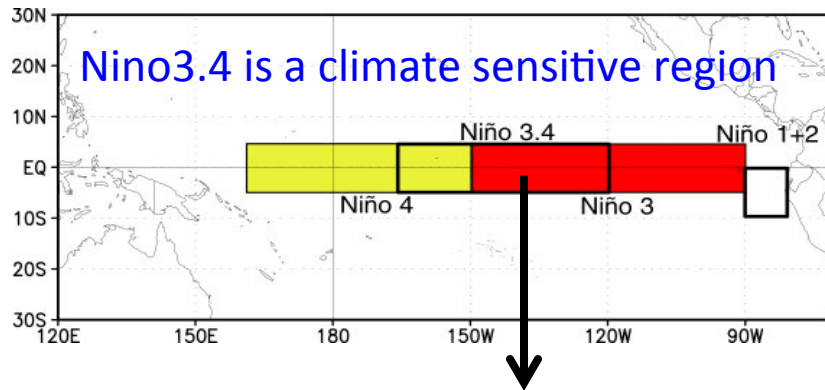
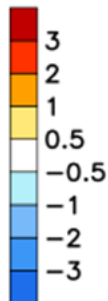
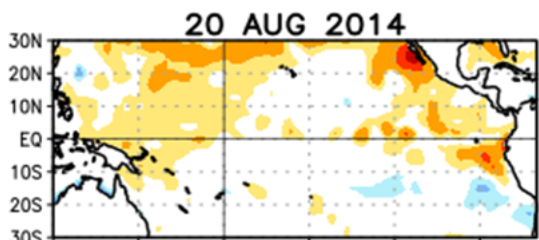
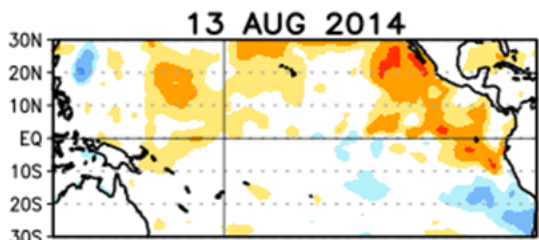
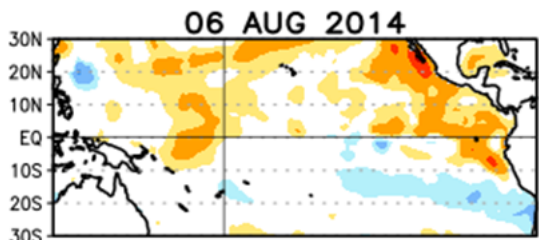
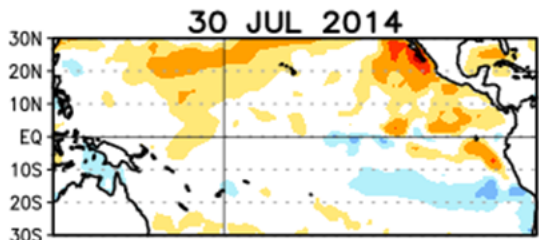
# Outline

- Overview of the El Nino-Southern Oscillation (ENSO)
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- **Current status and forecast of El Nino**

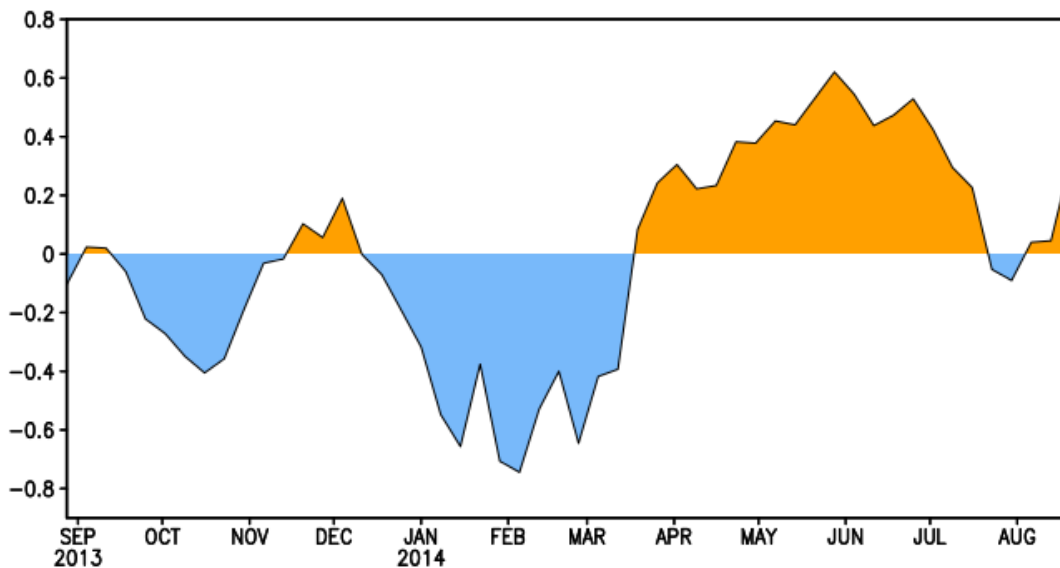


# Current SST conditions

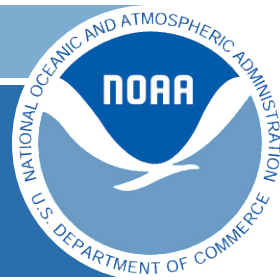
## Weekly SST Anomalies (DEG C)



SST Anomalies (°C)  
Niño 3.4



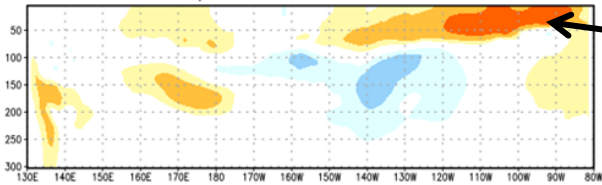




# Ocean Temperatures at Depth

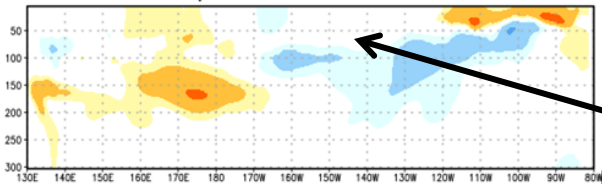
EQ. Subsurface Temperature Anomalies (deg C)

Three-pentad ave. centered on 02 JUL 2014



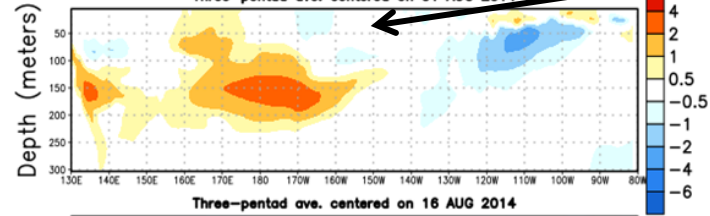
Strong warming in the eastern Pacific during late Spring associated with a downwelling oceanic Kelvin wave

Three-pentad ave. centered on 17 JUL 2014



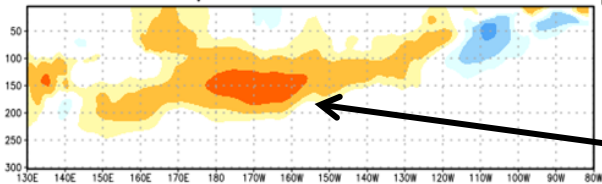
Upwelling component of this Kelvin wave resulted in cooling of ocean temperatures in the central Pacific during the second half of July

Three-pentad ave. centered on 01 AUG 2014

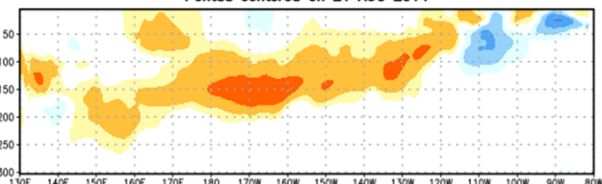


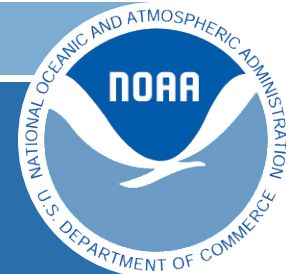
Warming at depth is once again evident during August across much of the Pacific basin.

Three-pentad ave. centered on 16 AUG 2014



Pentad centered on 21 AUG 2014

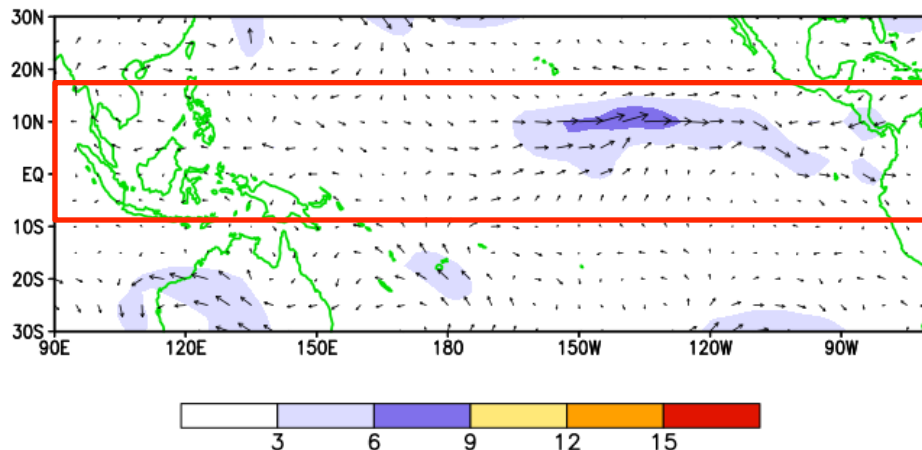




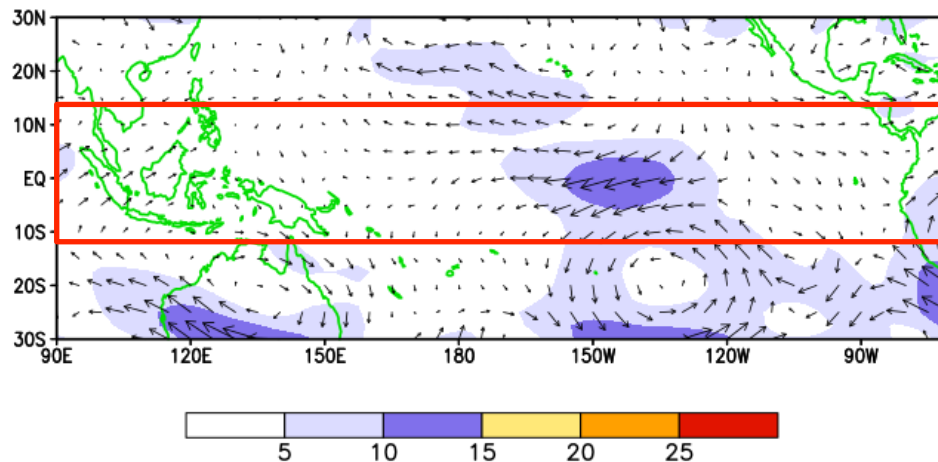
# Convection and Winds

Atmospheric coupling to the ocean has been difficult to achieve to date

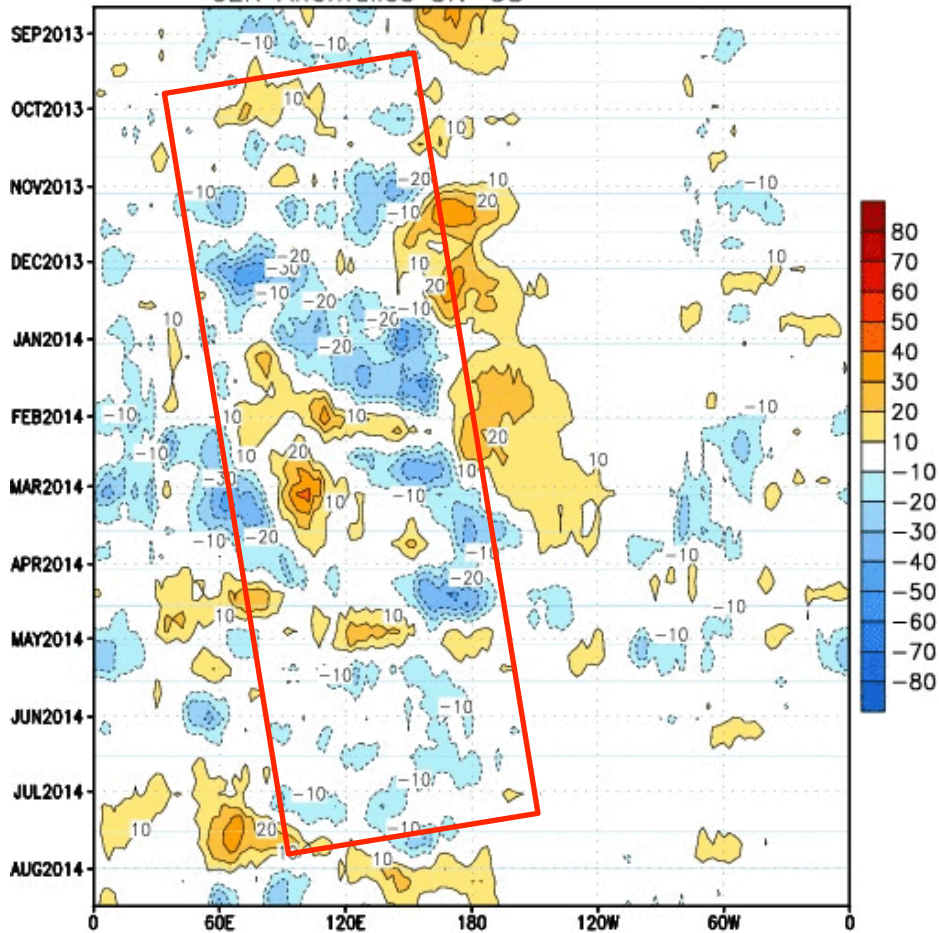
CDAS 850-hPa Wind Anomalies (m/s)  
24 JUL 2014–22 AUG 2014

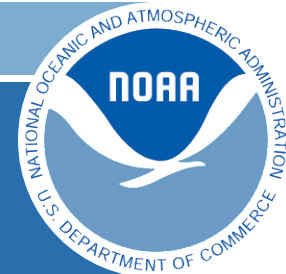


CDAS 200-hPa Wind Anomalies m/s  
30-Day Average for 24 JUL 2014–22 AUG 2014



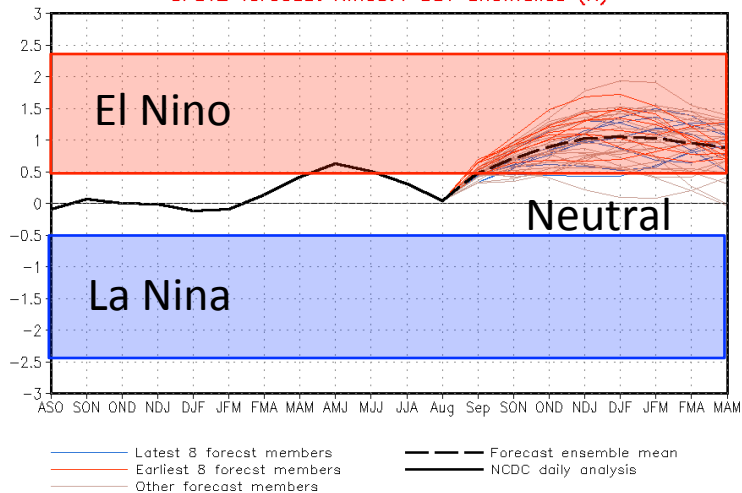
OLR Anomalies 5N–5S



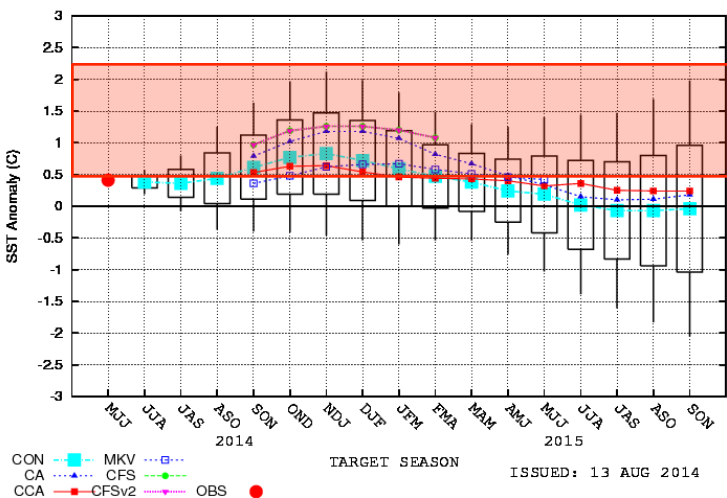


# ENSO Forecasts

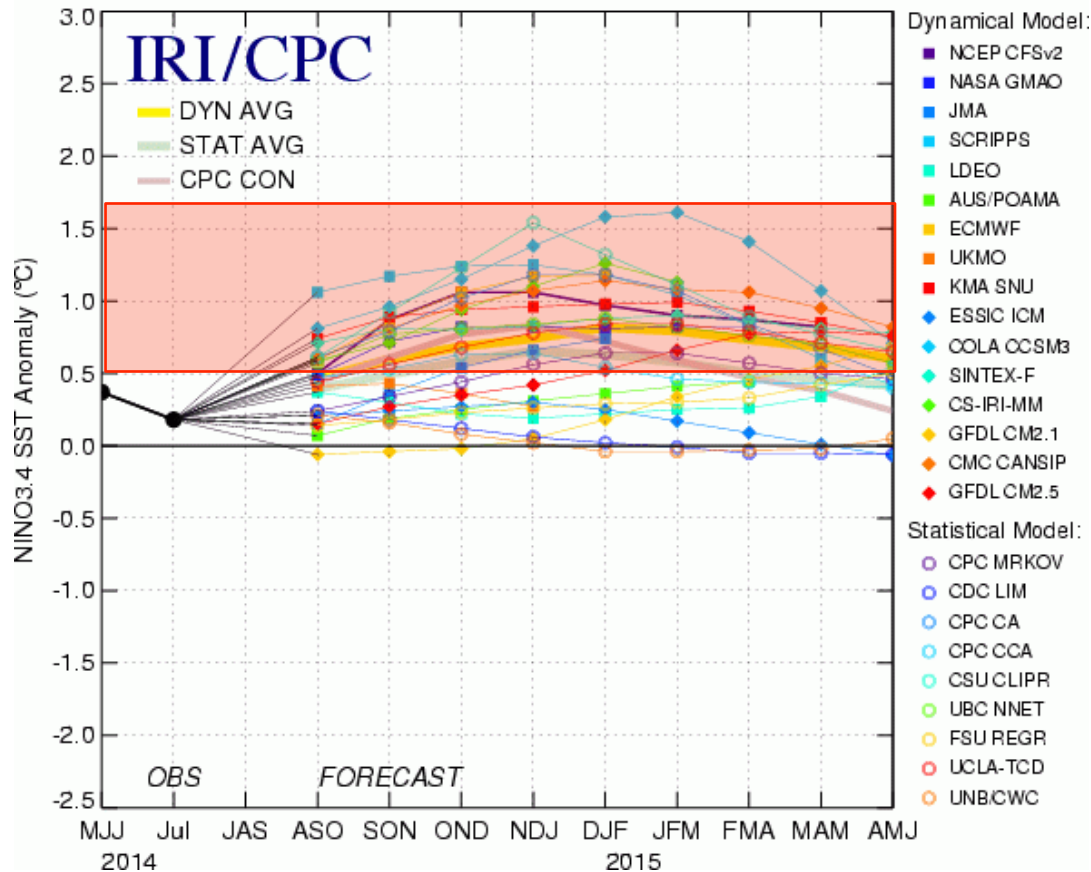
CFSv2 forecast Nino3.4 SST anomalies (K)



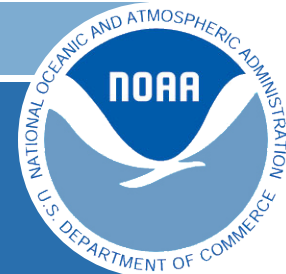
SST CONSOLIDATION NINO 3.4



Mid-Aug 2014 Plume of Model ENSO Predictions



Forecasts for Nino3.4 most likely favor a weak El Niño at the current time

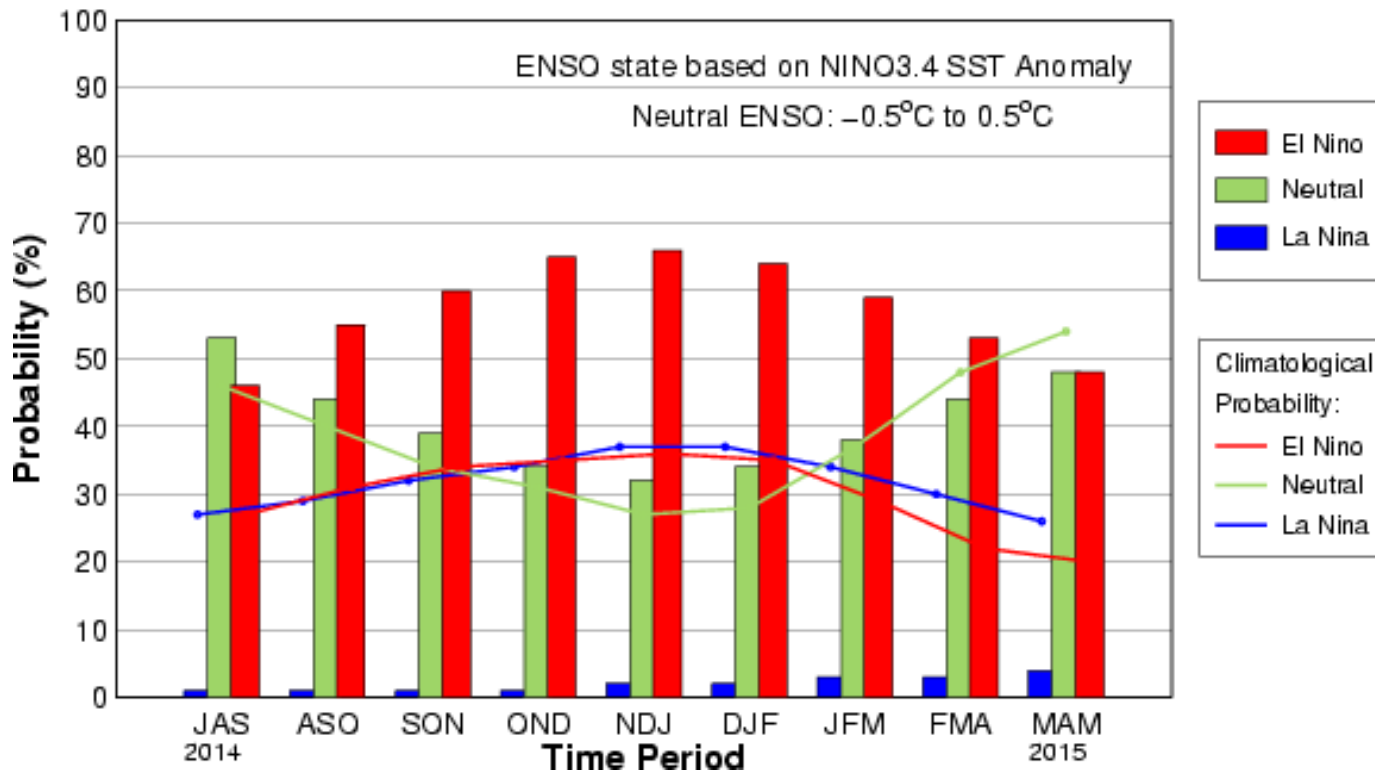


# Official ENSO Outlook

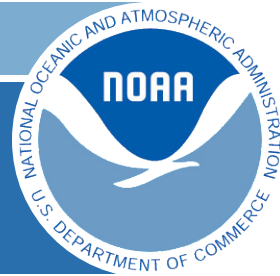
## ENSO Alert System Status: El Nino Watch

The odds of El Niño are about 65% during the fall and early winter

Early-Aug CPC/IRI Consensus Probabilistic ENSO Forecast

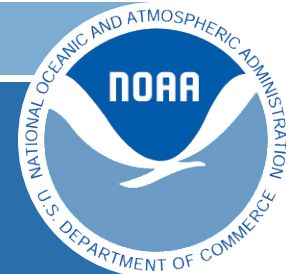






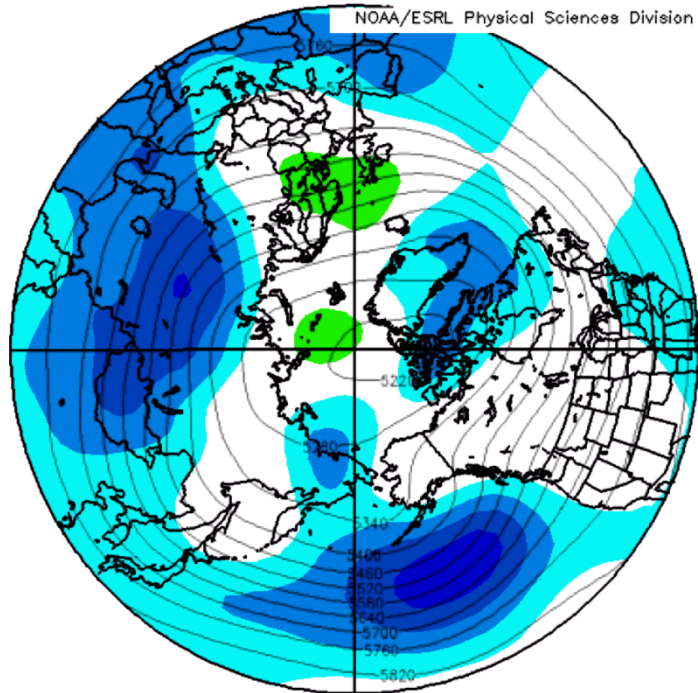
# Alaska and El Niños The Past & the Future

- Past El Niño events as forecast tool
  - Not all El Niños are equal
    - Actual sea surface temperatures and large scale response have changed in the past 60 years
  - Event frequency analysis during El Niños
  - Composites (averages of past El Niños)
  - CPC Outlooks for Autumn and Winter (for which El Niño is just one of several important factors)



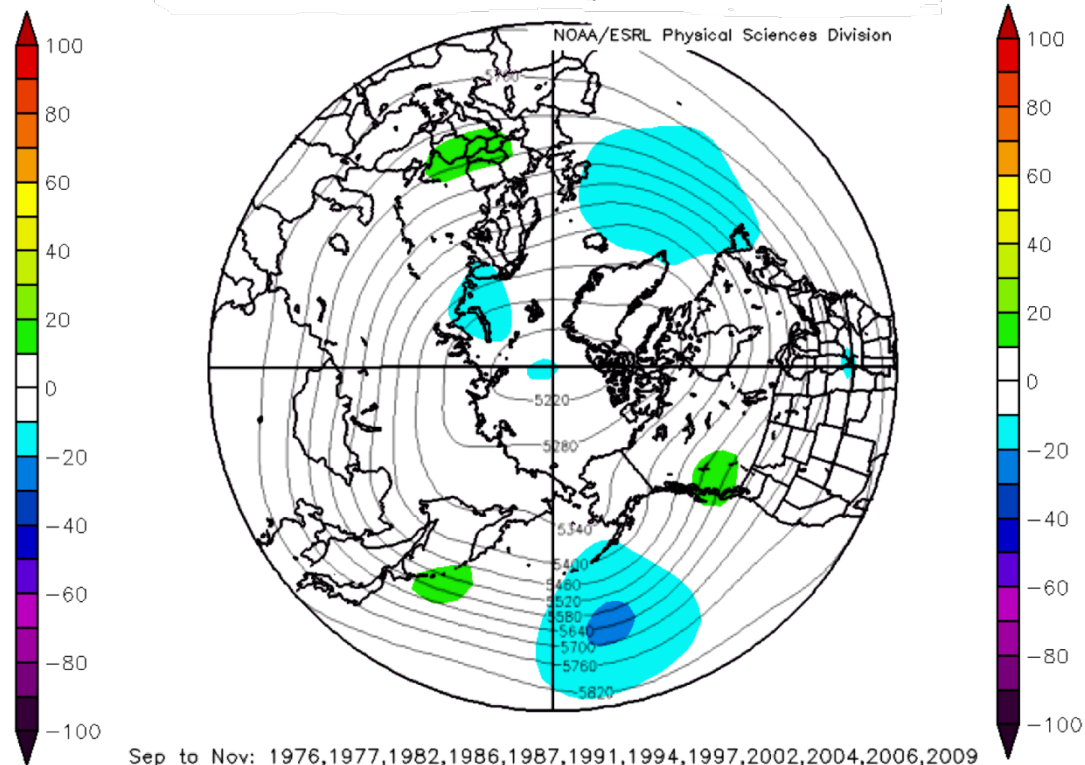
# September through November El Niño 500mb Heights and Anomalies

NCEP/NCAR Reanalysis

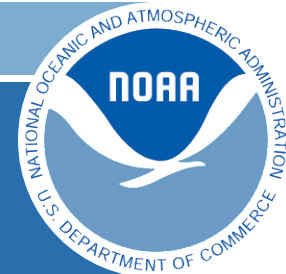


Sep to Nov: 1951,1953,1957,1958,1963,1965,1968,1969,1972

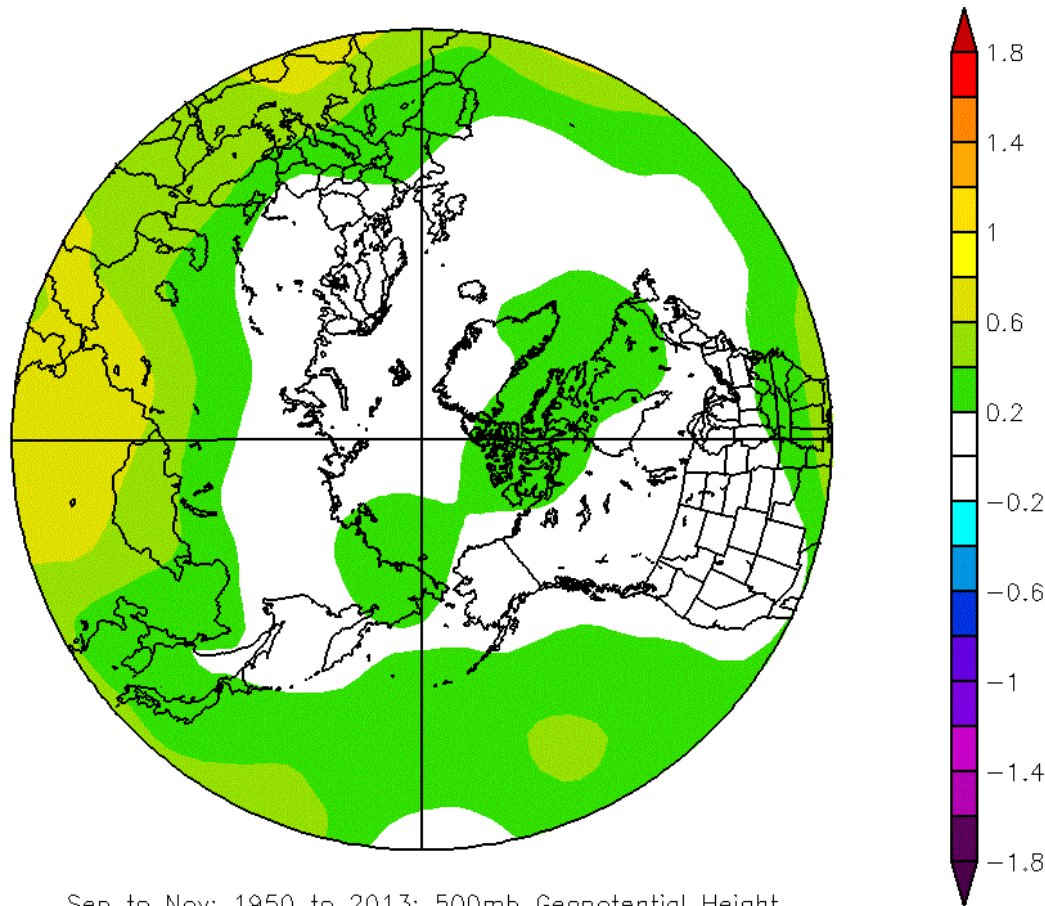
NCEP/NCAR Reanalysis



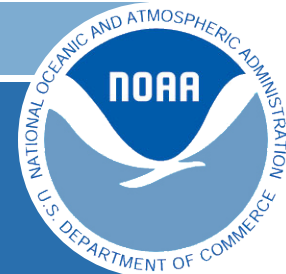
Sep to Nov: 1976,1977,1982,1986,1987,1991,1994,1997,2002,2004,2006,2009



# September through November 500mb Height Trends: 1950 to 2013

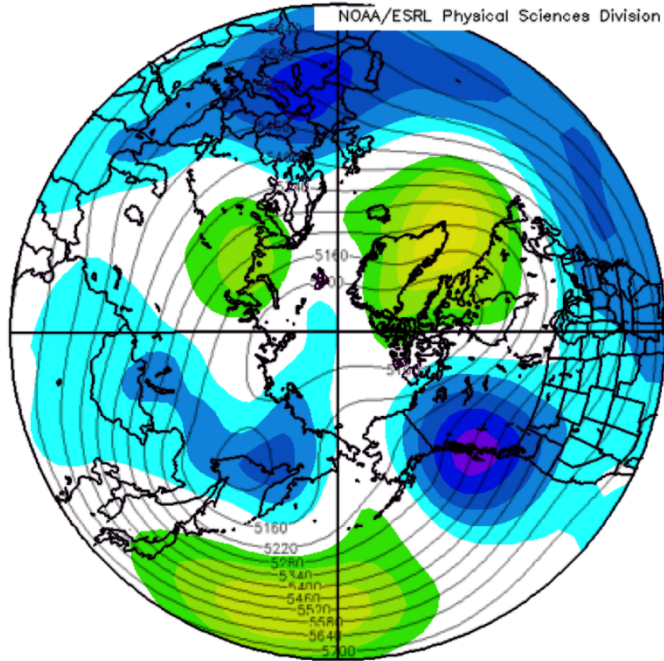


Sep to Nov: 1950 to 2013: 500mb Geopotential Height  
Seasonal Correlation w/ Sep to Nov Trend  
NCEP/NCAR Reanalysis



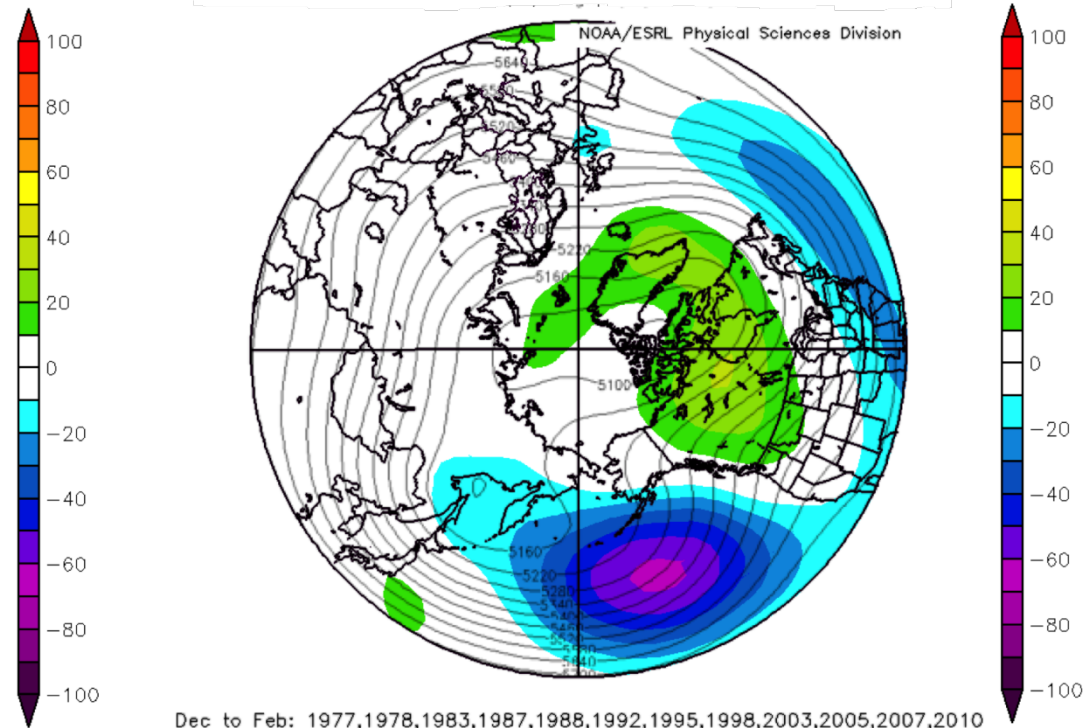
# December through February El Niño 500mb Heights and Anomalies

NCEP/NCAR Reanalysis



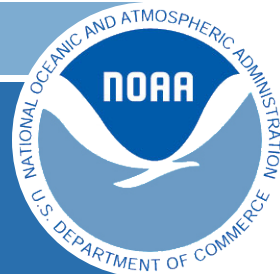
Dec to Feb: 1952,1953,1954,1958,1959,1964,1966,1969,1970,1973

NCEP/NCAR Reanalysis

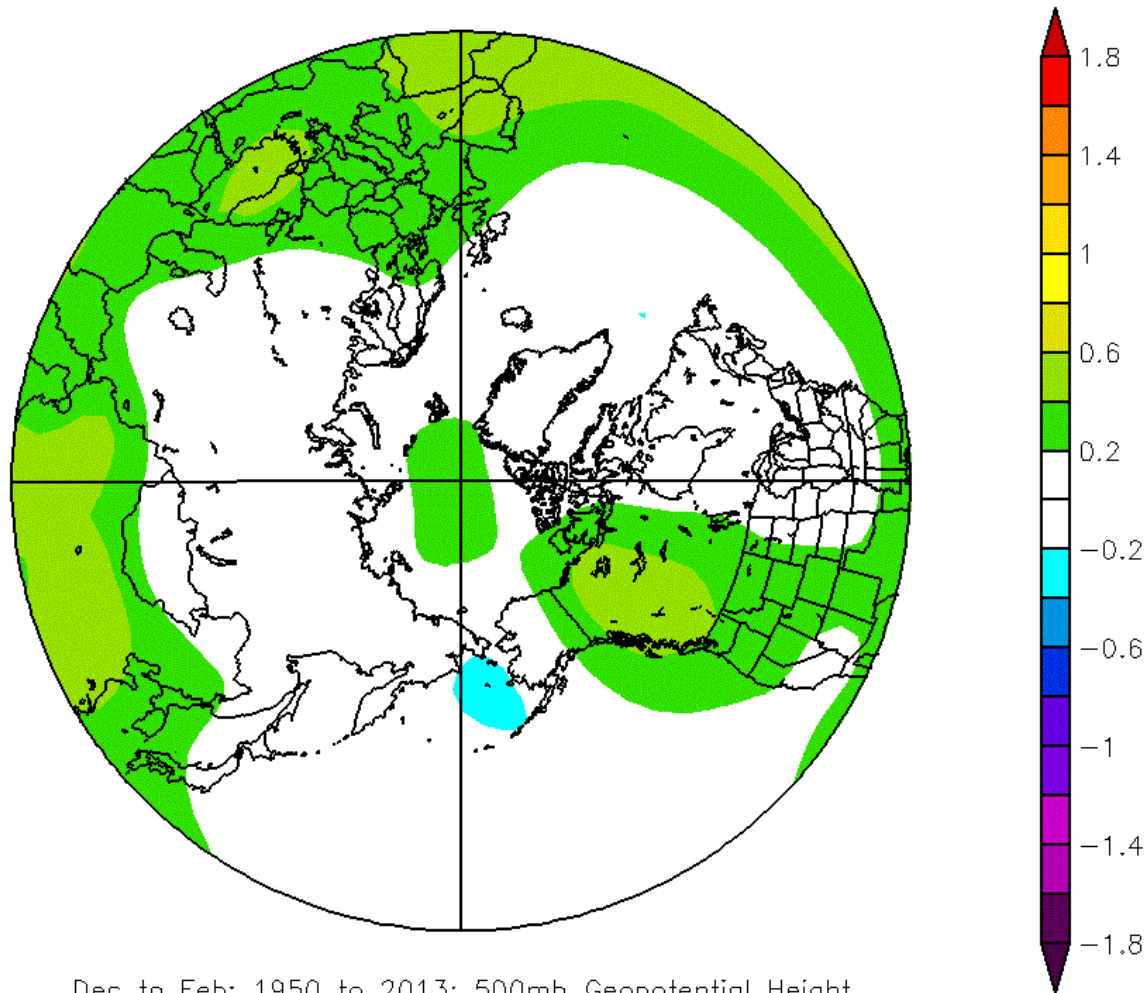


Dec to Feb: 1977,1978,1983,1987,1988,1992,1995,1998,2003,2005,2007,2010



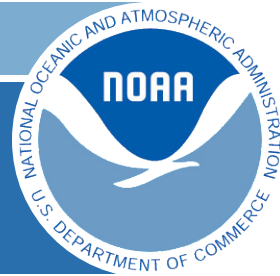


# December through February 500mb Height Trends: 1949-50 to 2012-13



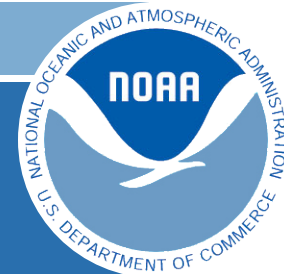
Dec to Feb: 1950 to 2013: 500mb Geopotential Height  
Seasonal Correlation w/ Dec to Feb Trend  
NCEP/NCAR Reanalysis





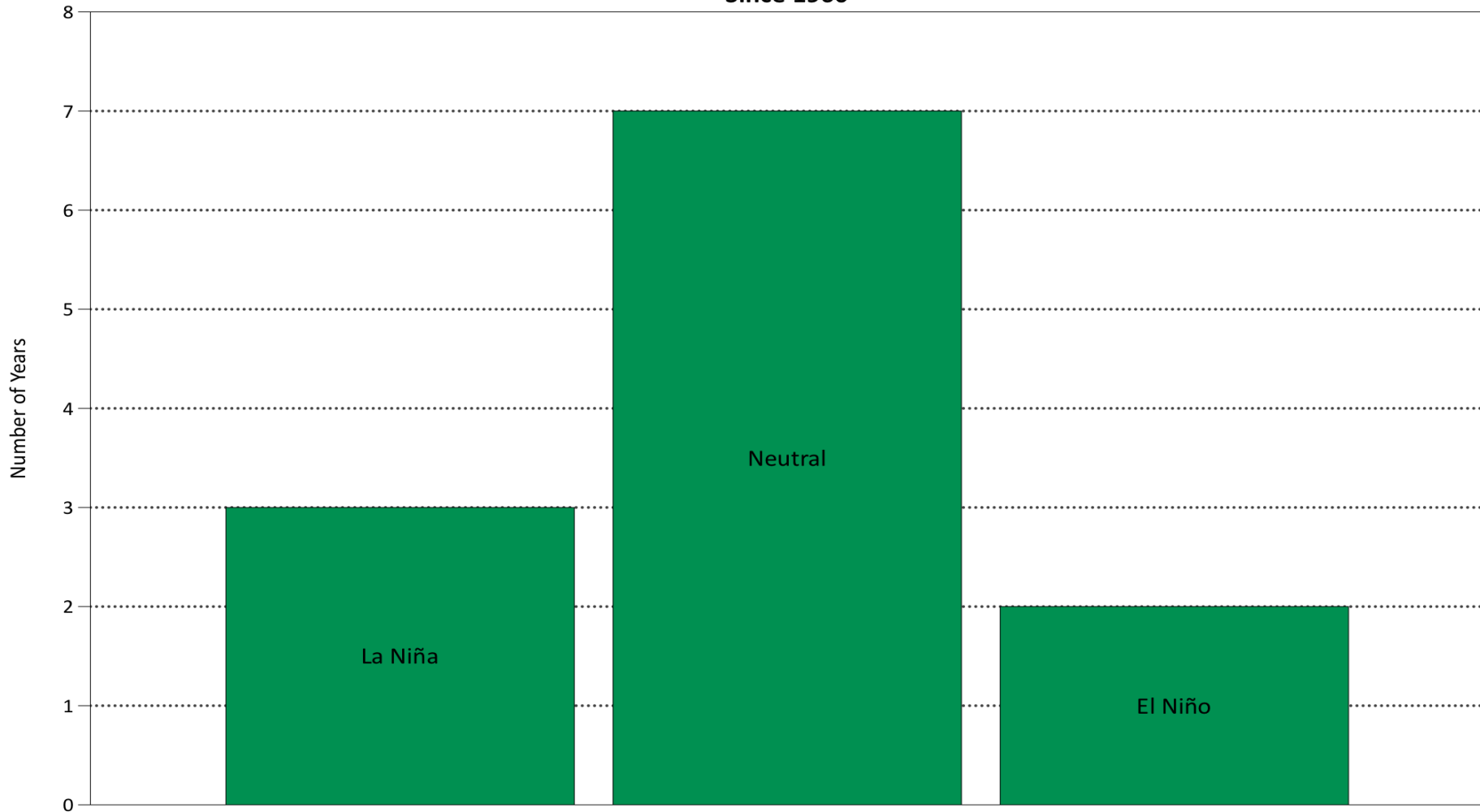
# Bering/Chukchi Sea Storms

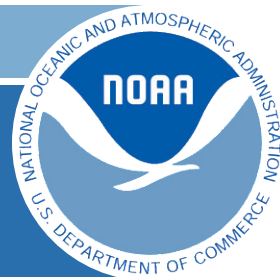
- Do storms that produce significant coastal flooding occur more frequently during a particular ENSO phase?
- How do the frequency of storms vary by ENSO phase?



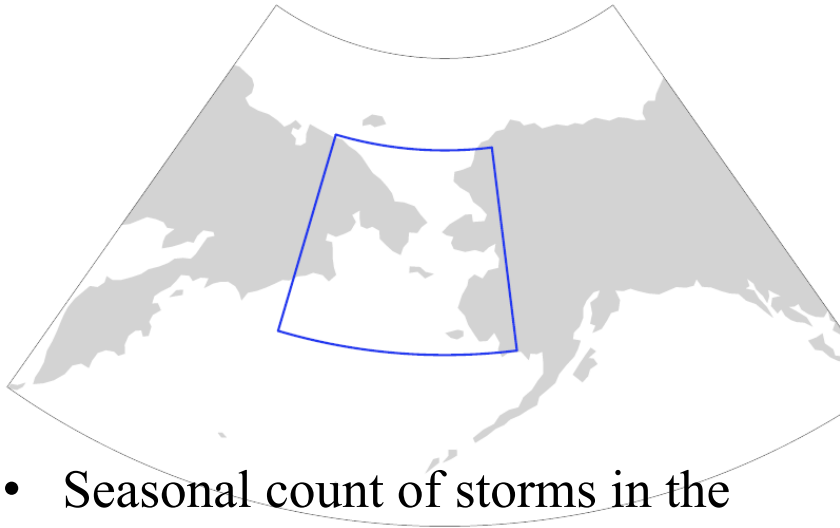
# Significant Bering/Chukchi Coastal Floods

Significant Bering/Chukchi Sea Storm Years by ENSO Phase Since 1960



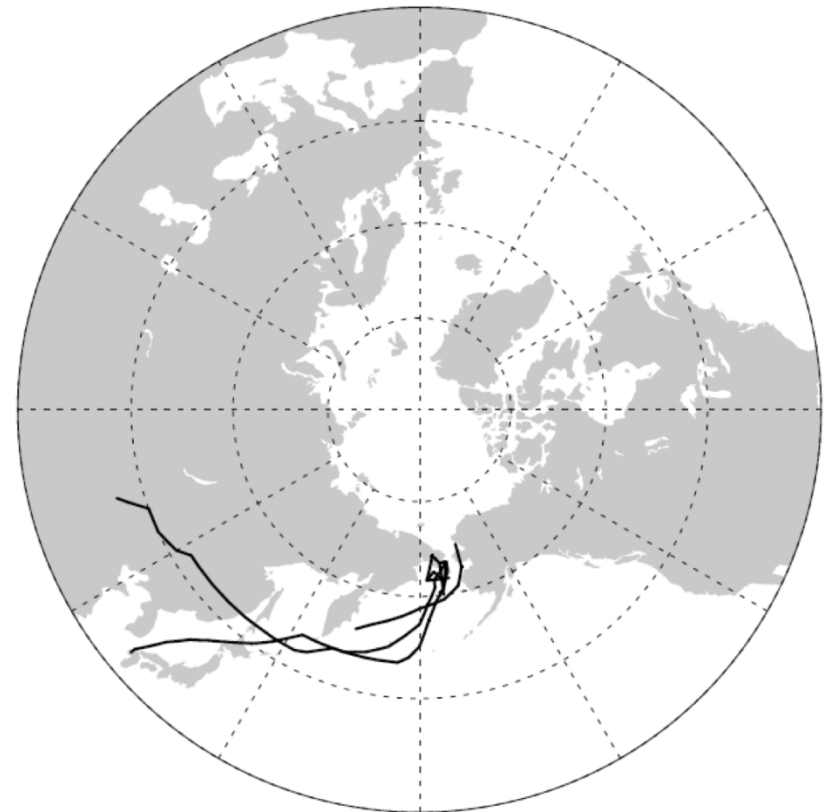


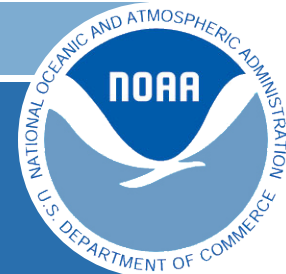
# Bering/Chukchi Sea Storminess



- Seasonal count of storms in the central and northern Bering and southern Chukchi seas that had a minimum pressure  $\leq 988$ mb (in the region)
- Zhang et al 2004's storm track/intensity algorithm on NCEP/NCAR reanalysis data

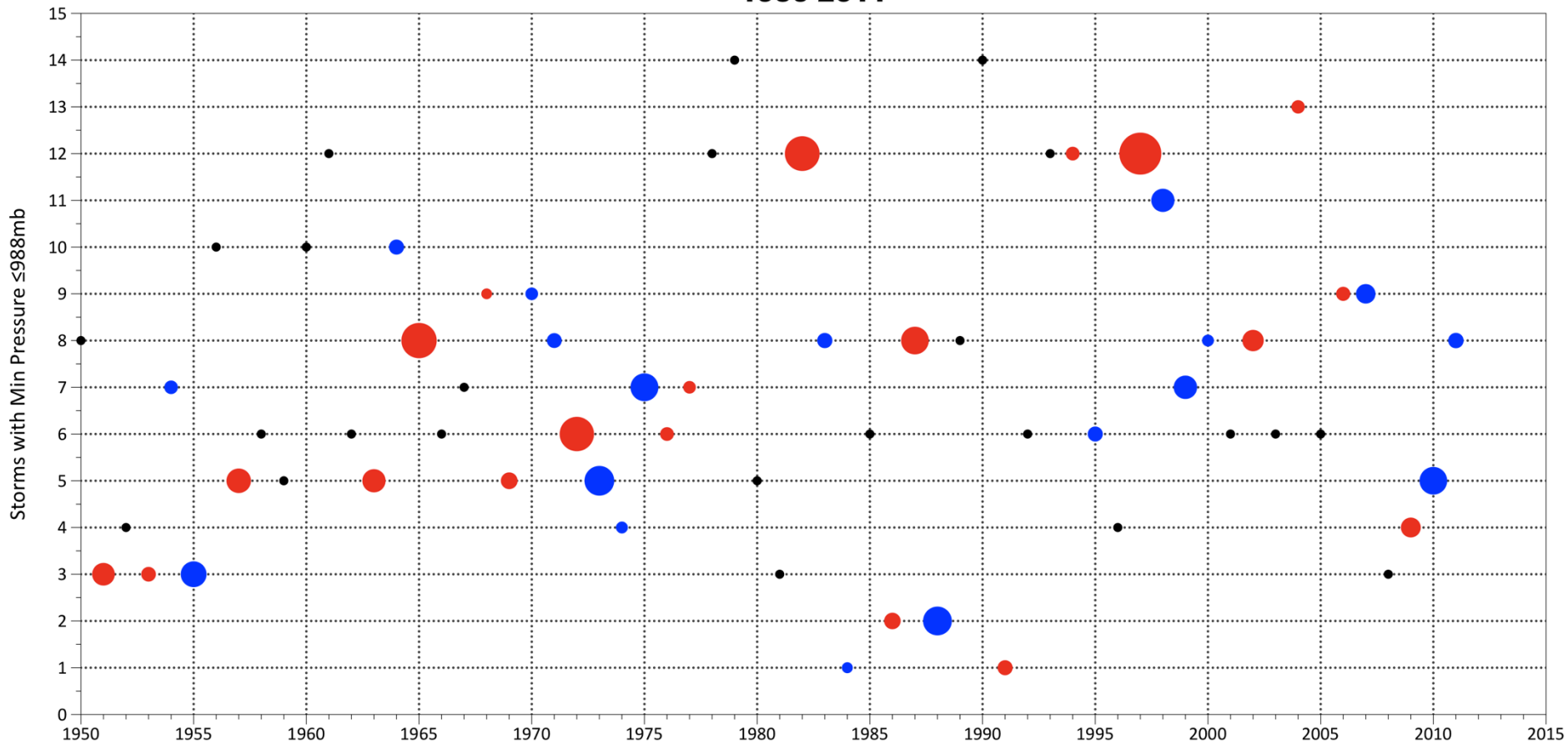
2005 Sept 1 - Nov 30 MSLP < 988mb Tracks Into Box



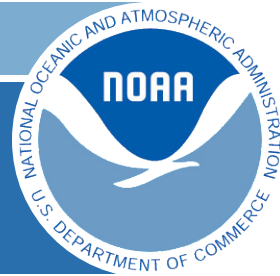


# Moderate to Strong Bering/Chukchi Sea Storms

**Bering Sea Storm Counts by ENSO Phase  
September-November  
1950-2011**

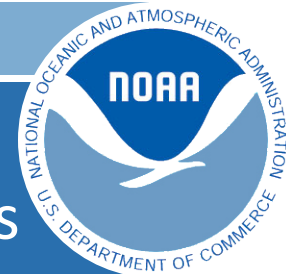




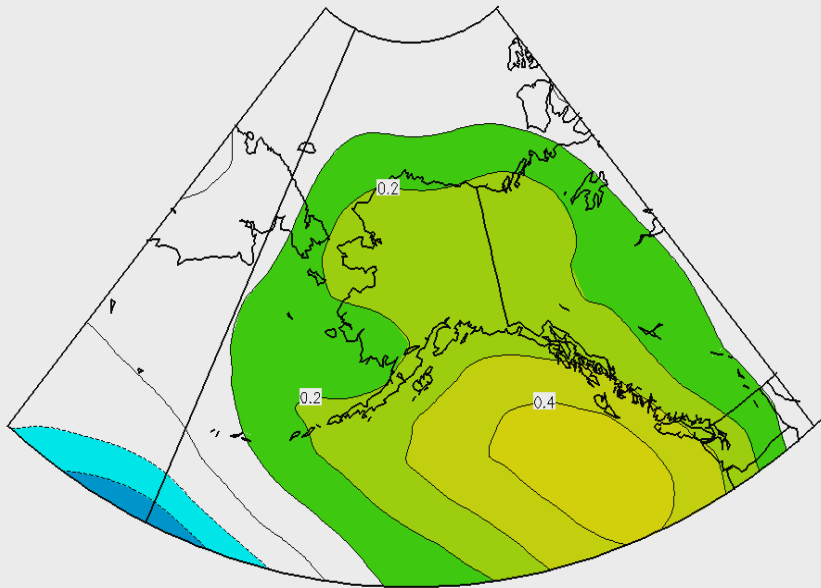


# El Niño Composites and Alaska

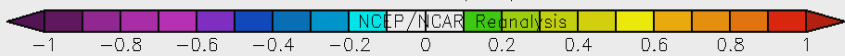
- Composting at varying scales
  - Regional: Northwest North America and northeast Pacific (NCAR/NCEP reanalysis 1948-present)
  - Higher Resolution Regional
    - ERA-Interim dynamically downscale reanalysis (20km, USGS Alaska Climate Science Center and UAF/SNAP, 1980-2013)
  - Point Based (individual stations)



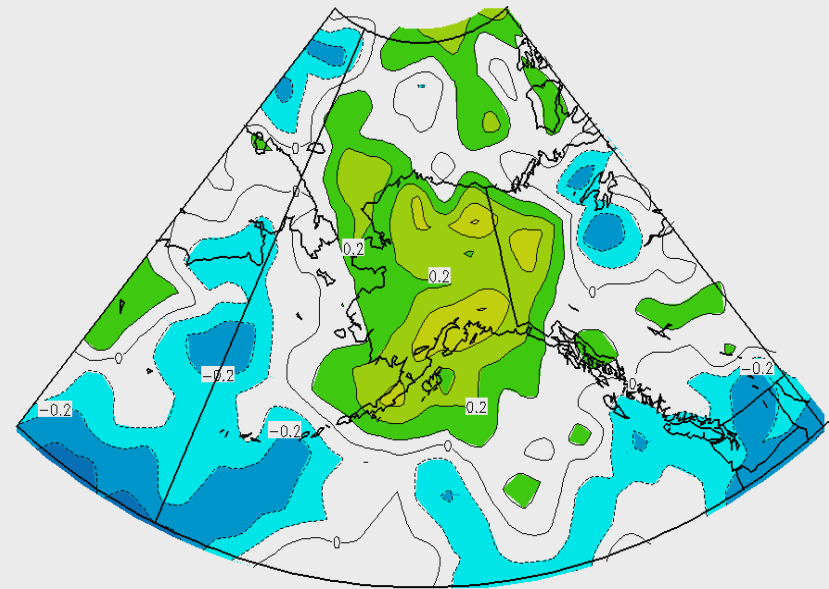
# September through November 1950-2013 ENSO Temperature & Precipitation Correlations



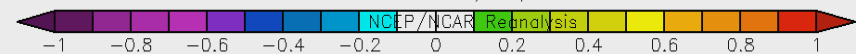
Sep to Nov: 1950 to 2013: 925mb Air Temperature  
Seasonal Correlation w/ Sep to Nov Niño3.4

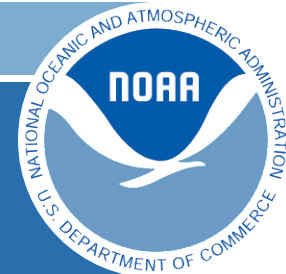


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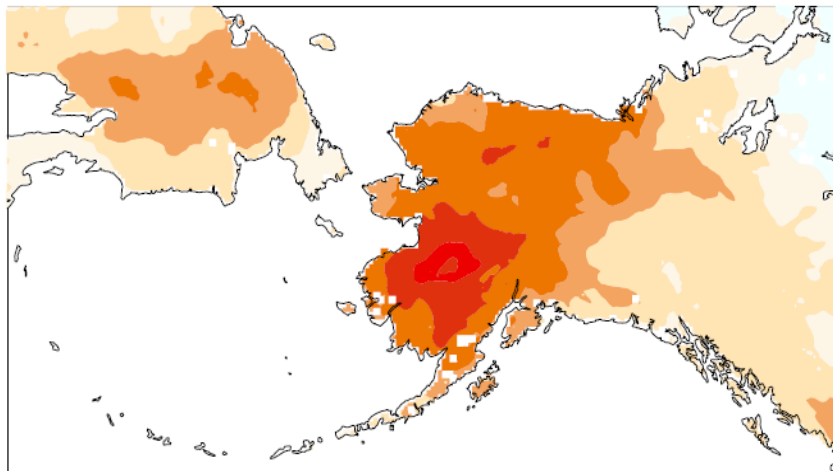


Sep to Nov: 1950 to 2013: Surface Precipitation Rate  
Seasonal Correlation w/ Sep to Nov Niño3.4

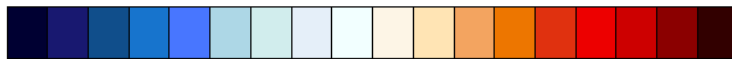




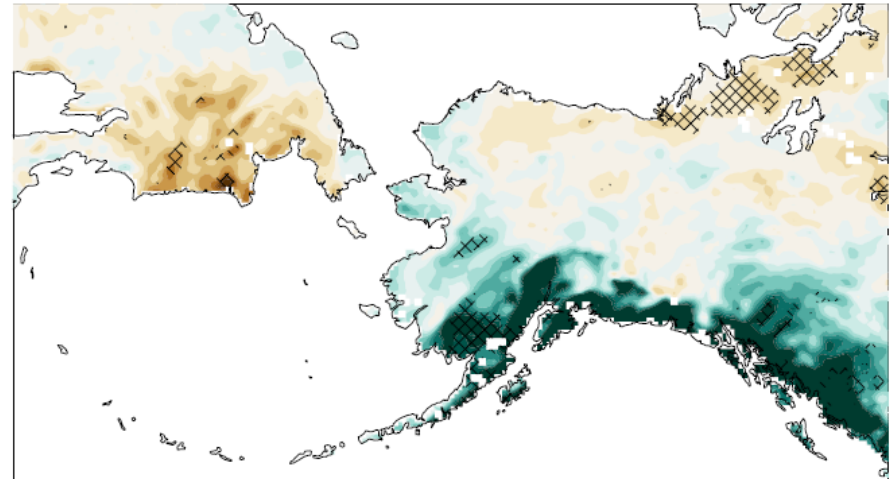
# September through November, 1980-2013 Weak & Moderate El Niños



Mean Temp Departure (°C, 1981-2010)



-1.6 -1.4 -1.2 -1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6

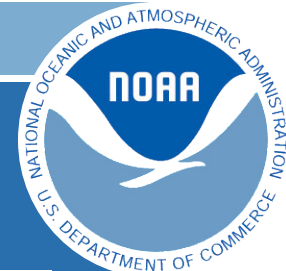


Mean Pcpn Departure (mm, 1981-2010)

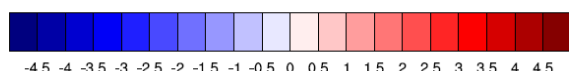
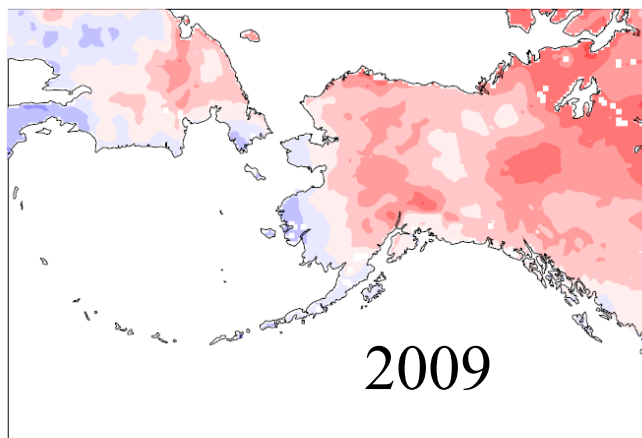
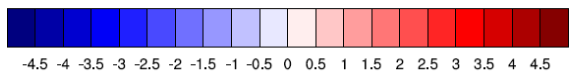
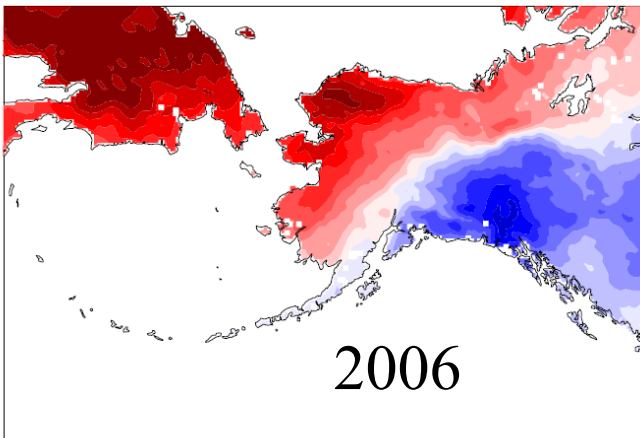
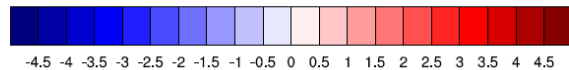
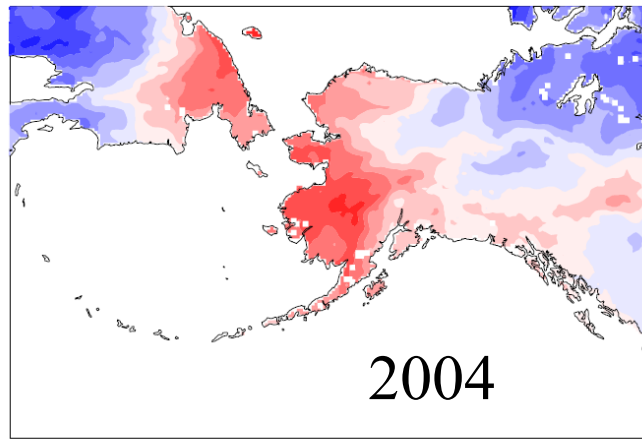
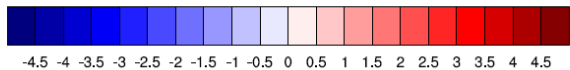
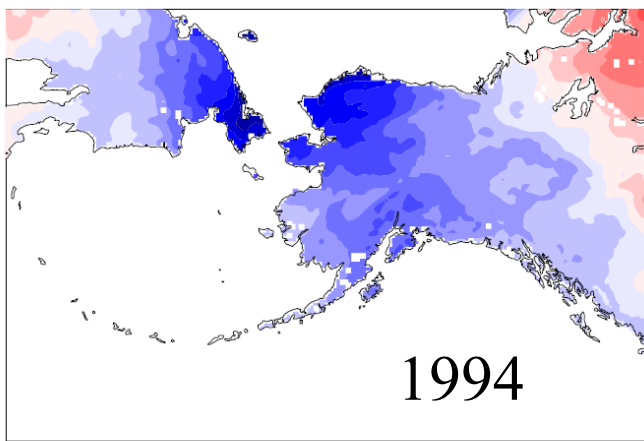


-16 -14 -12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12 14 16

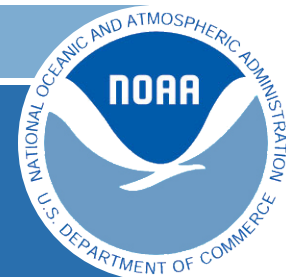
1986, 1987, 1991, 1994, 2002, 2004, 2006, 2009



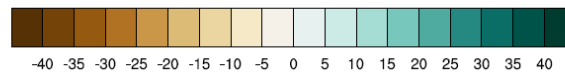
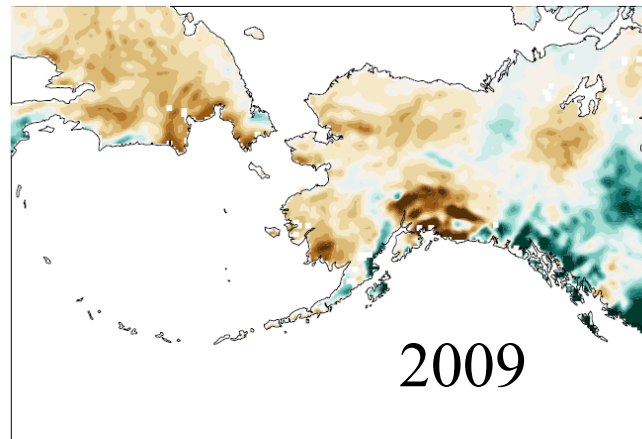
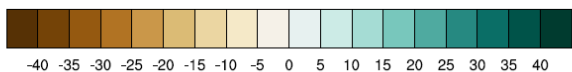
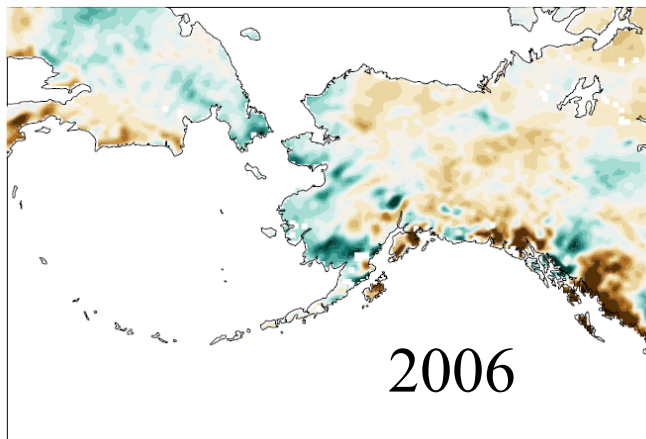
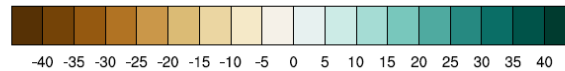
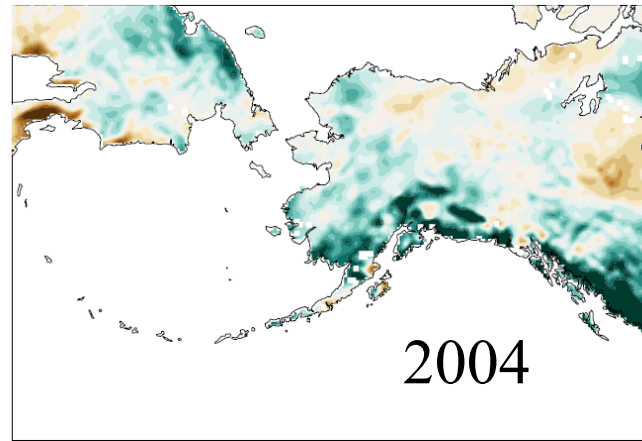
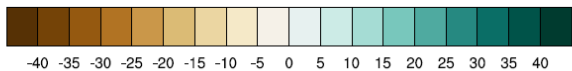
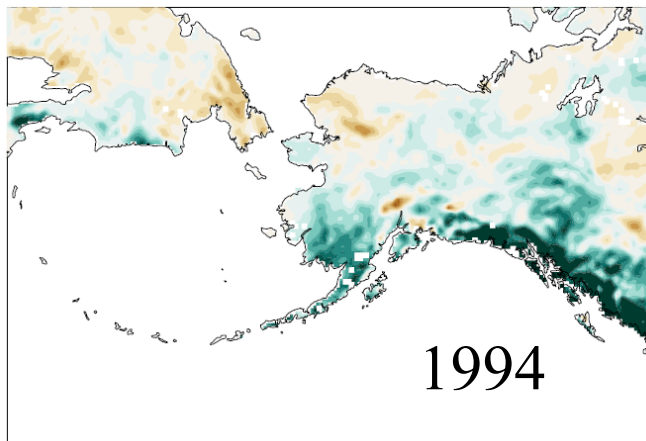
# Recent Weak El Niños Autumn Temperature Departures

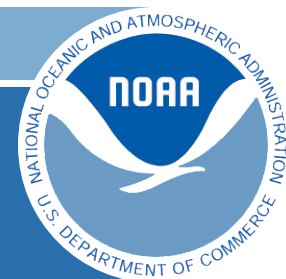






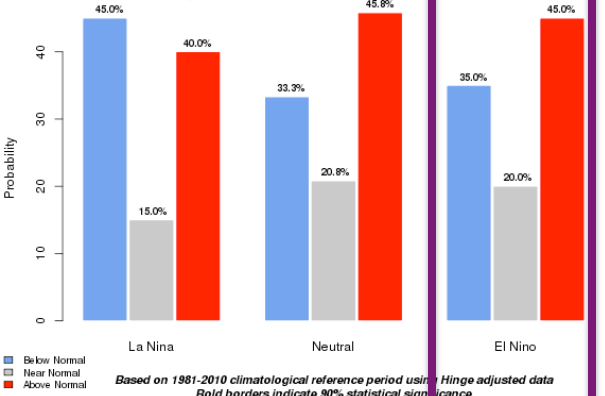
# Recent Weak El Niños Autumn Precipitation Departures



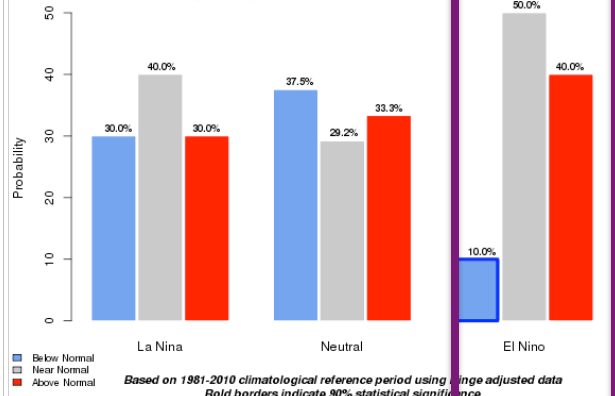


# September through November 1950-2013

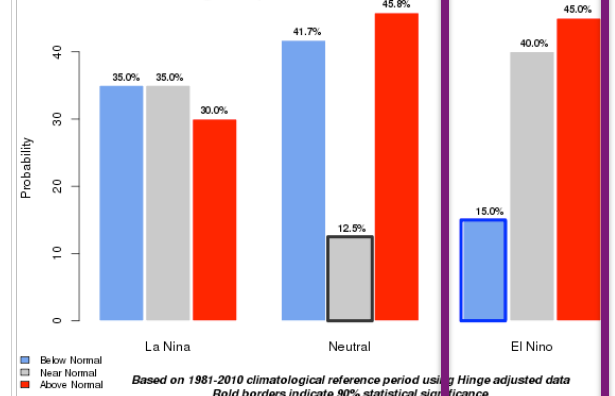
ENSO Probability Distribution [1950-2013] of September-October-November Average Temperature for COOP Station ID #504100



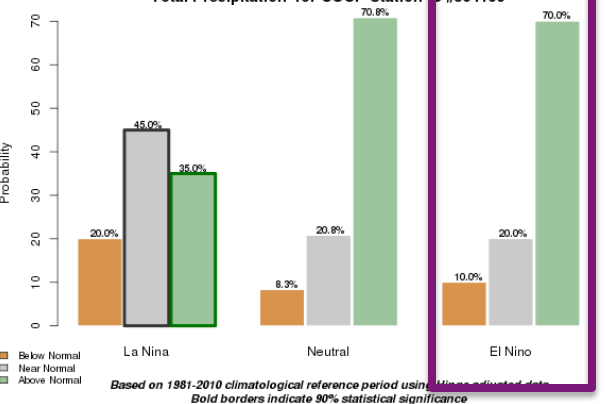
ENSO Probability Distribution [1950-2013] of September-October-November Average Temperature for COOP Station ID #500280



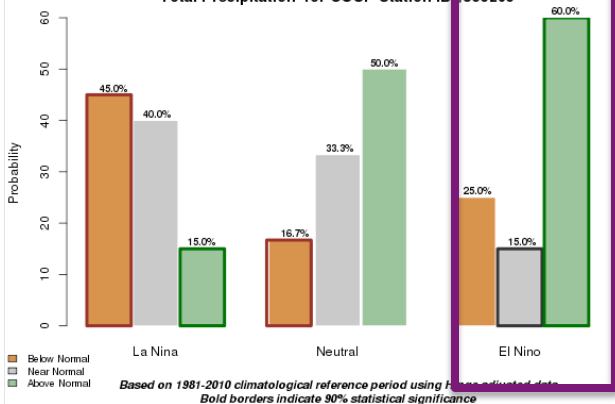
ENSO Probability Distribution [1950-2013] of September-October-November Average Temperature for COOP Station ID #502968



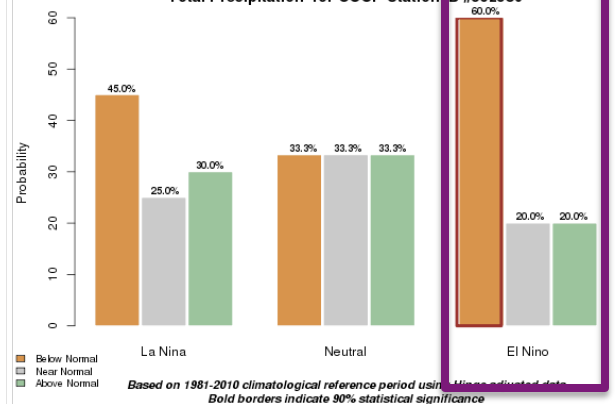
ENSO Probability Distribution [1950-2013] of September-October-November Total Precipitation for COOP Station ID #504100



ENSO Probability Distribution [1950-2013] of September-October-November Total Precipitation for COOP Station ID #500280



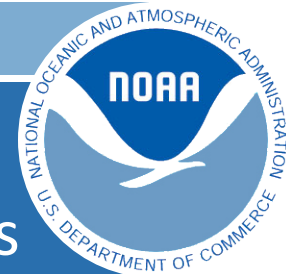
ENSO Probability Distribution [1950-2013] of September-October-November Total Precipitation for COOP Station ID #502968



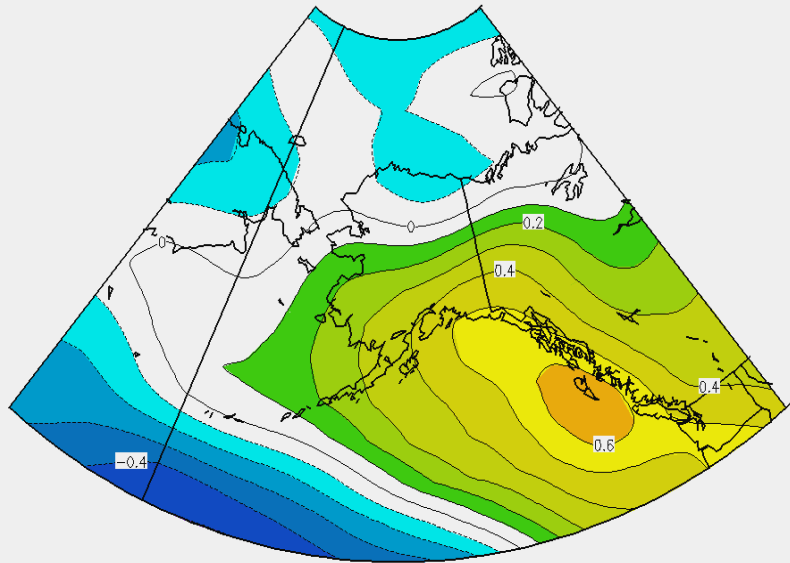
Juneau Airport

Anchorage Airport

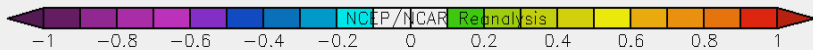
Fairbanks Airport



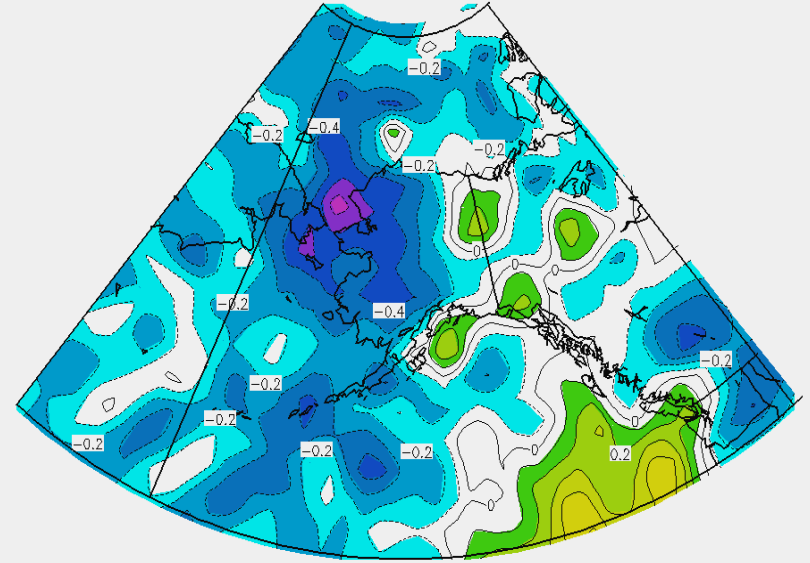
# December through February 1977-2014 ENSO Temperature & Precipitation Correlations



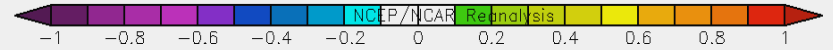
Dec to Feb: 1977 to 2014: 925mb Air Temperature  
Seasonal Correlation w/ Dec to Feb Nino3.4



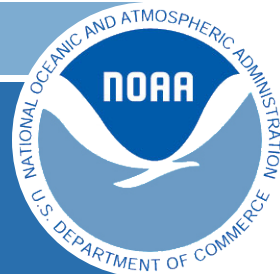
NOAA/ESRL Physical Sciences Division



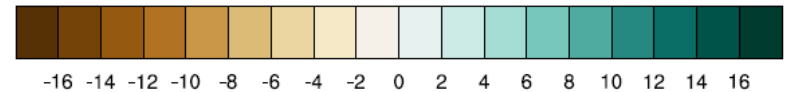
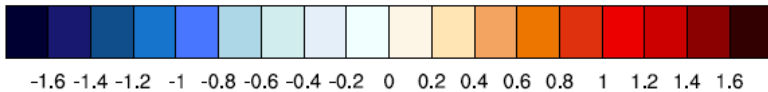
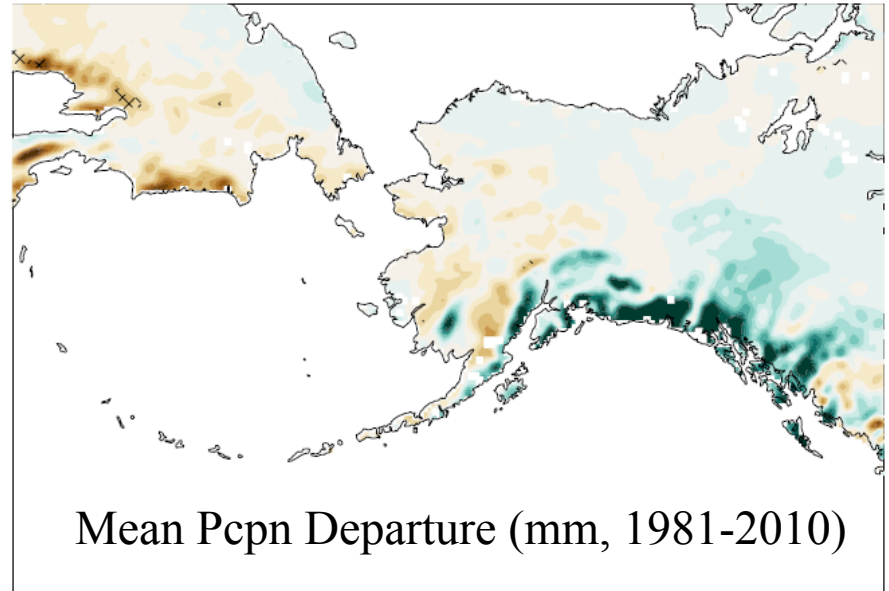
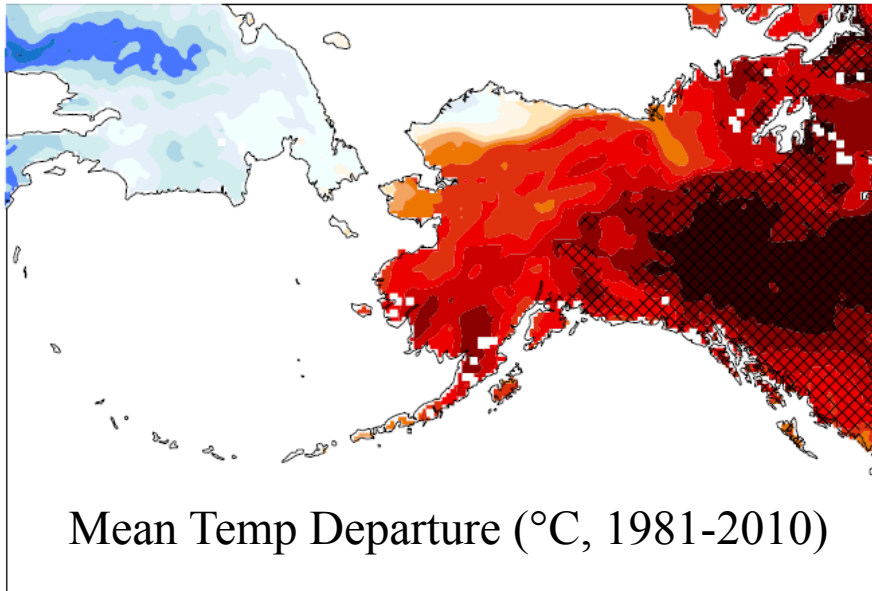
Dec to Feb: 1977 to 2014: Surface Precipitation Rate  
Seasonal Correlation w/ Dec to Feb Nino3.4



NOAA/ESRL Physical Sciences Division

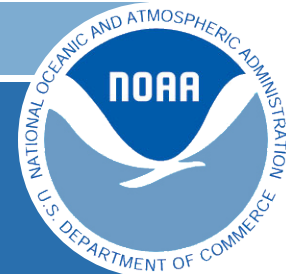


# December through February, 1980-2013 Weak & Moderate El Niños

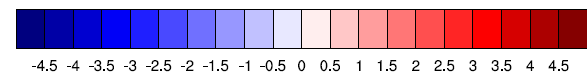
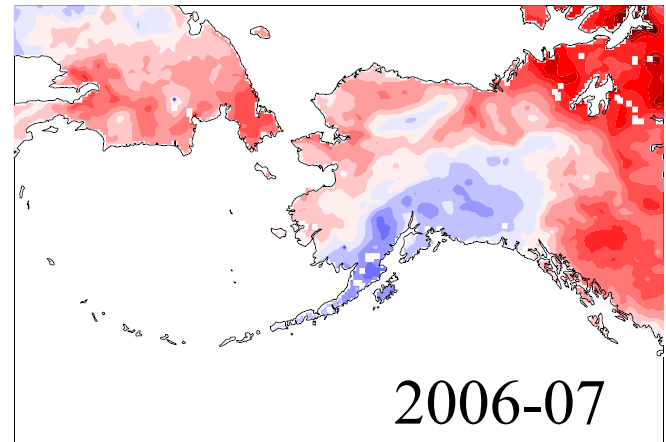
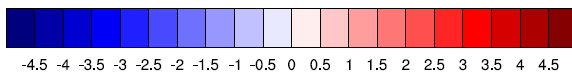
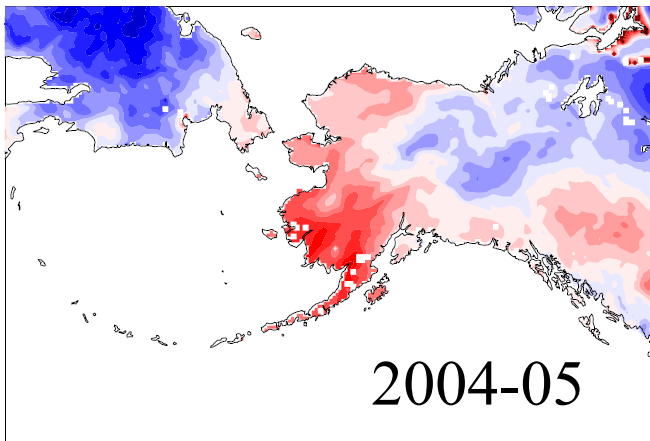
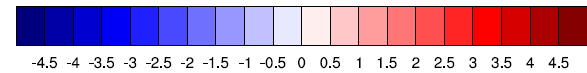
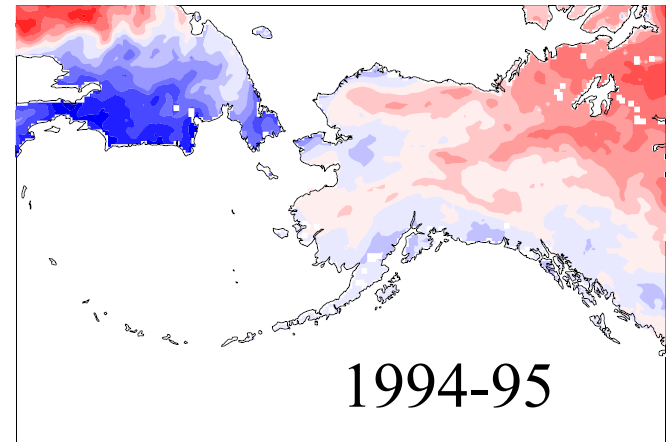
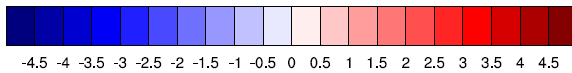
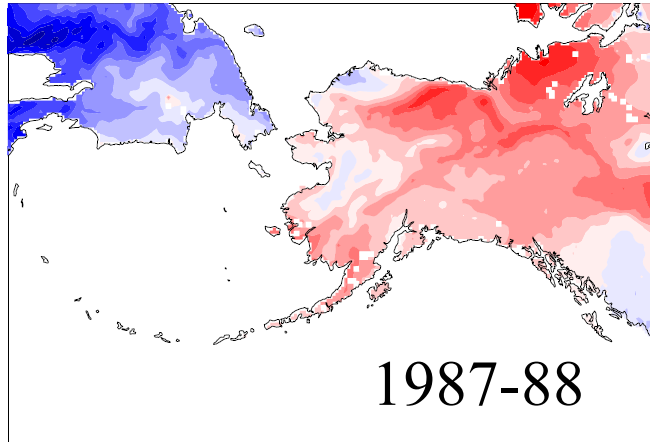


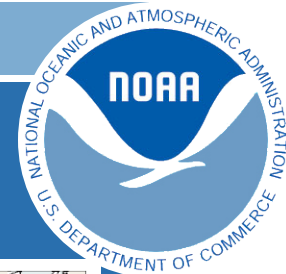
1986-87, 1987-88, 1991-92, 1994-95, 2002-03, 2004-05, 2006-07, 2009-10



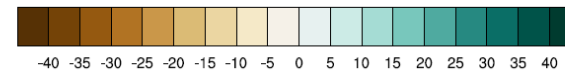
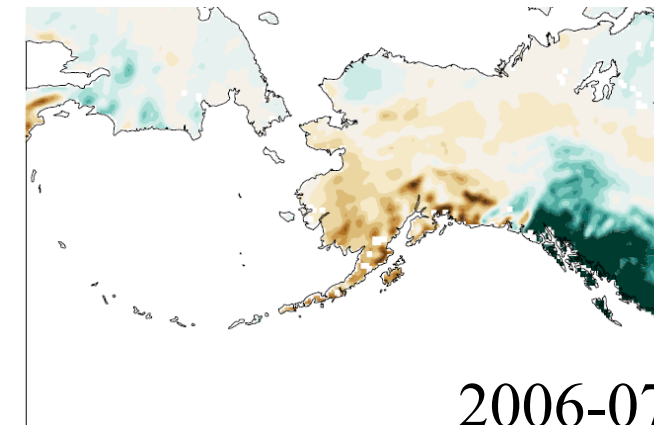
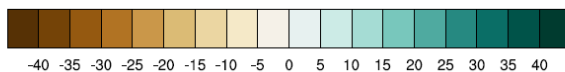
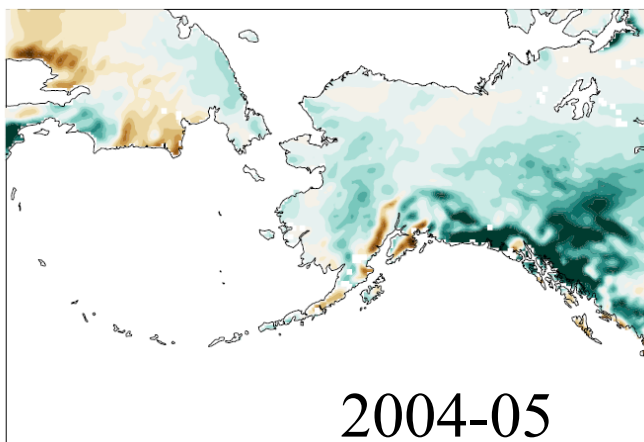
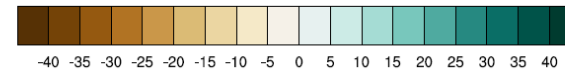
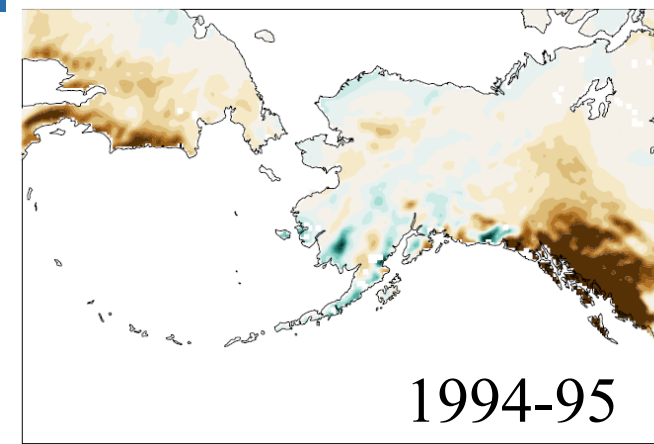
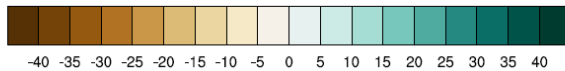
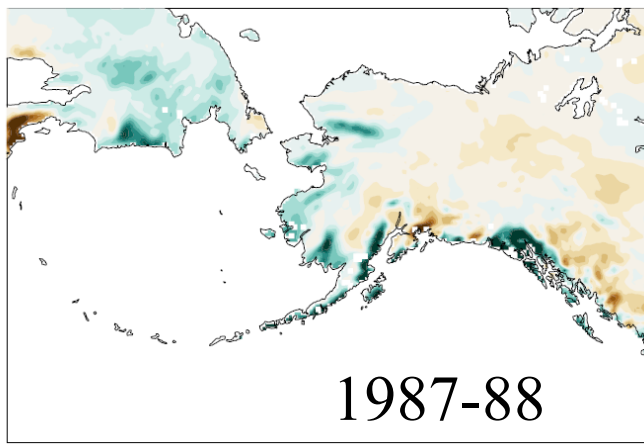


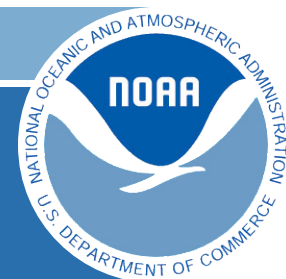
# Recent Weak-Moderate El Niños Winter Temperature Departures





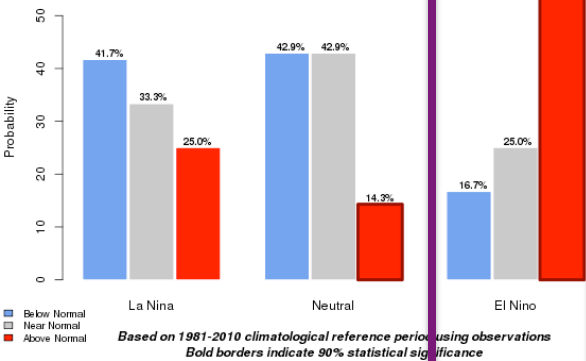
# Recent Weak-Moderate El Niños Winter Precipitation Departures



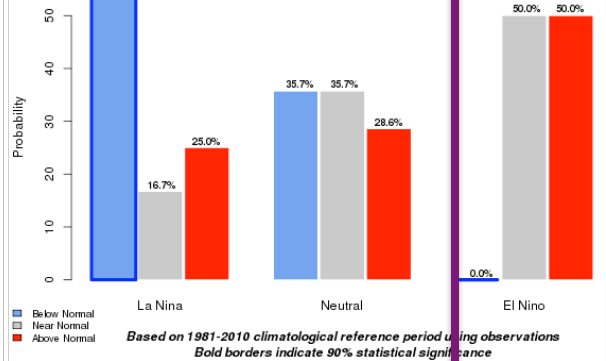


# December through February 1976-77 to 2013-14

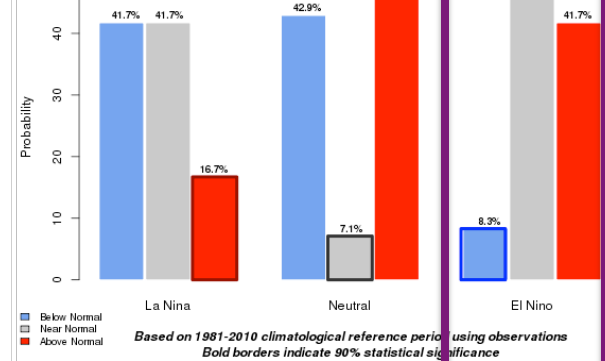
ENSO Probability Distribution [1976-2013] of December-January-February Average Temperature for COOP Station ID #504100



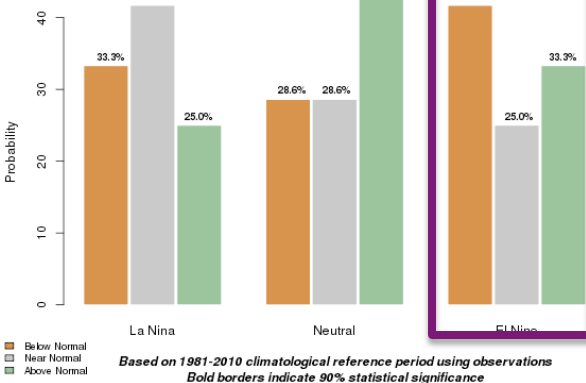
ENSO Probability Distribution [1976-2013] of December-January-February Average Temperature for COOP Station ID #500280



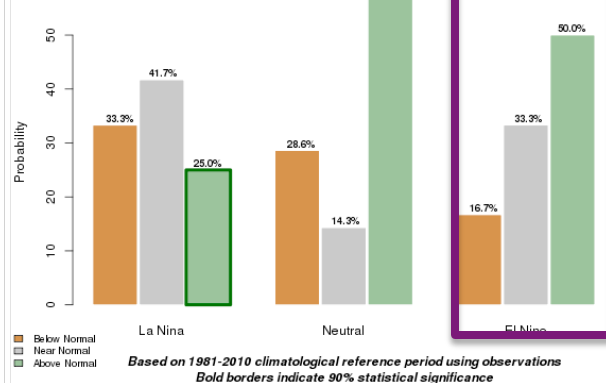
ENSO Probability Distribution [1976-2013] of December-January-February Average Temperature for COOP Station ID #502968



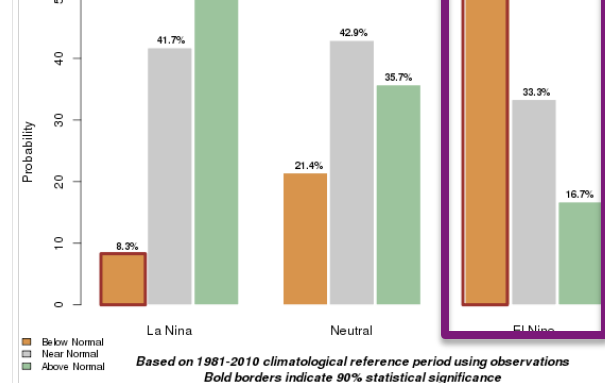
ENSO Probability Distribution [1976-2013] of December-January-February Total Precipitation for COOP Station ID #504100



ENSO Probability Distribution [1976-2013] of December-January-February Total Precipitation for COOP Station ID #500280



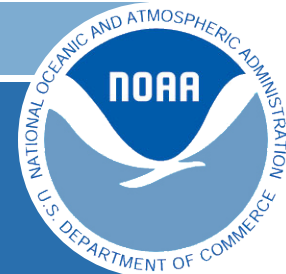
ENSO Probability Distribution [1976-2013] of December-January-February Total Precipitation for COOP Station ID #502968



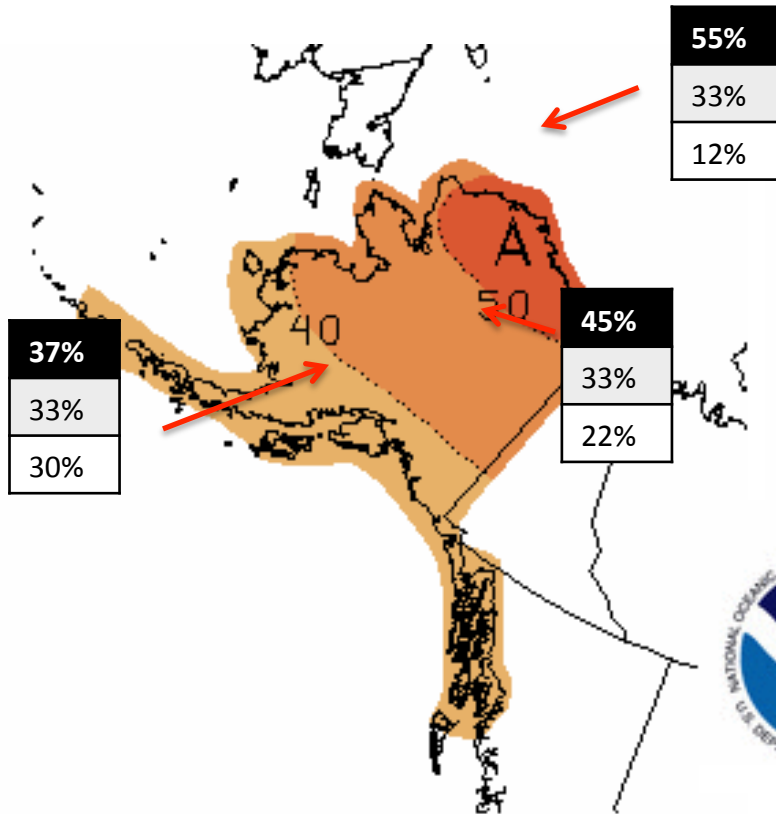
Juneau Airport

Anchorage Airport

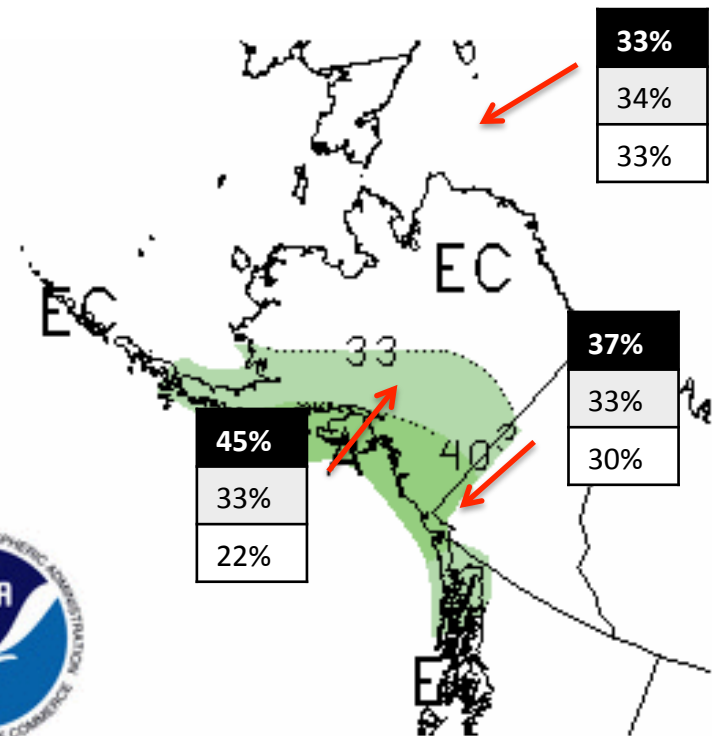
Fairbanks Airport



# CPC Outlook September through November

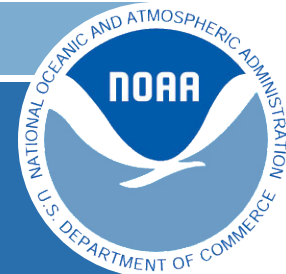


THREE-MONTH OUTLOOK  
TEMPERATURE PROBABILITY  
0.5 MONTH LEAD  
VALID SON 2014  
MADE 21 AUG 2014

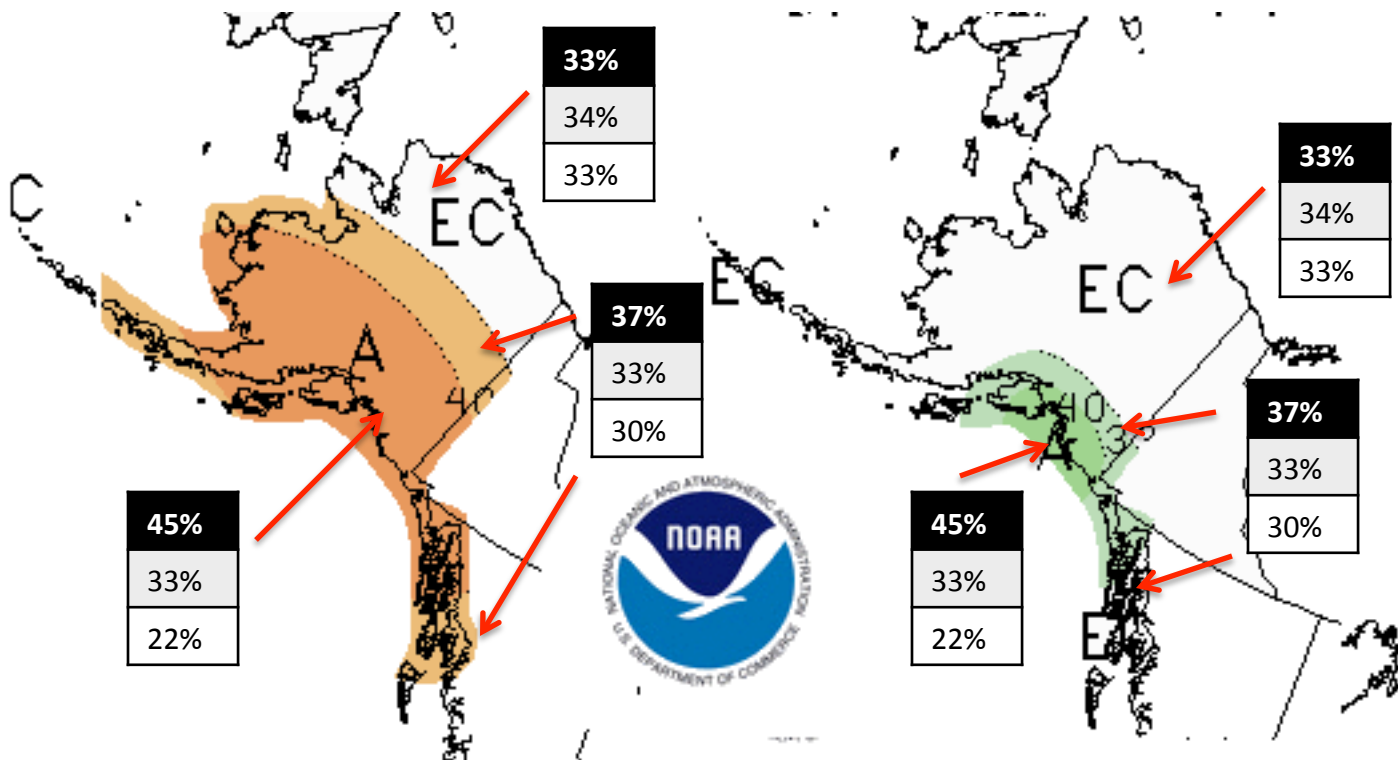


THREE-MONTH OUTLOOK  
PRECIPITATION PROBABILITY  
0.5 MONTH LEAD  
VALID SON 2014  
MADE 21 AUG 2014





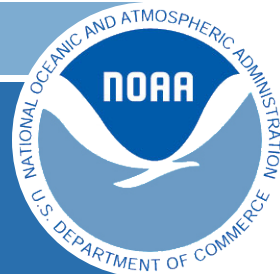
# CPC Outlook December through February



THREE-MONTH OUTLOOK  
 TEMPERATURE PROBABILITY  
 3.5 MONTH LEAD  
 VALID DJF 2014  
 MADE 21 AUG 2014

THREE-MONTH OUTLOOK  
 PRECIPITATION PROBABILITY  
 3.5 MONTH LEAD  
 VALID DJF 2014  
 MADE 21 AUG 2014





# Questions and Comments

Thank you for your attention

Feel free to contact us anytime via e-mail if you have comments or questions.

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Rick Thoman

[richard.thoman@noaa.gov](mailto:richard.thoman@noaa.gov)