
UNITED STATES DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION


# El Nino and Alaska – Past, Present and Future

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**NWS / NCEP / Climate Prediction Center**

**Alaska Climate Webinar**

**October 10, 2023**

# 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)**
- How prospects for El Nino may impact large scale global circulation and temperature / precipitation patterns
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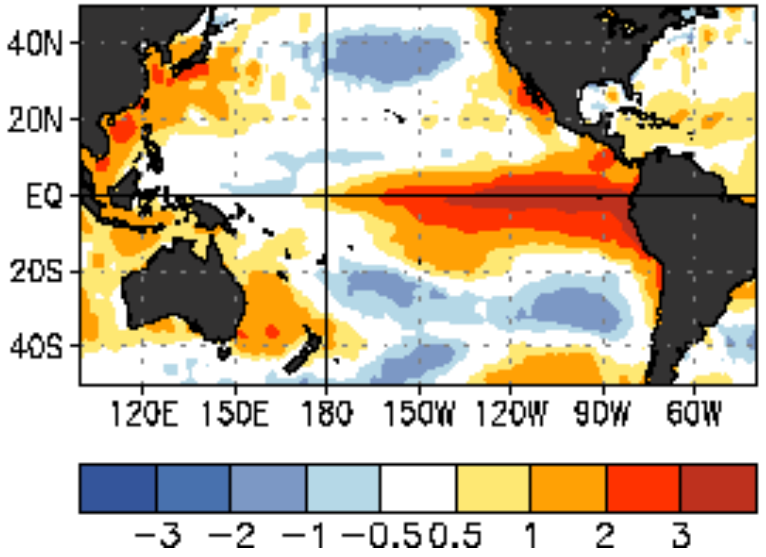
# ENSO Overview

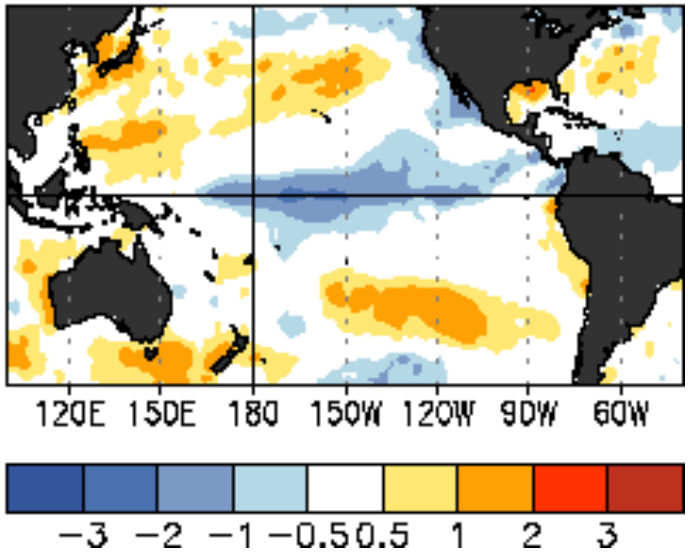
- An irregular, naturally occurring cycle (every 2-7 years) of warm (El Nino) or cold (La Nina) conditions in the tropical Pacific Ocean.
- Ocean changes occur alongside changes in the tropical atmosphere circulation and rainfall
- On average, events last 9-12 months (La Niñas can persist longer) and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

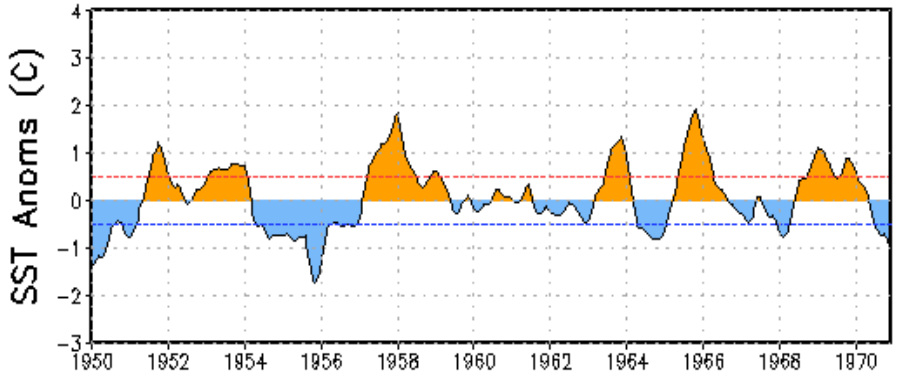
# Sea Surface Temperatures

**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

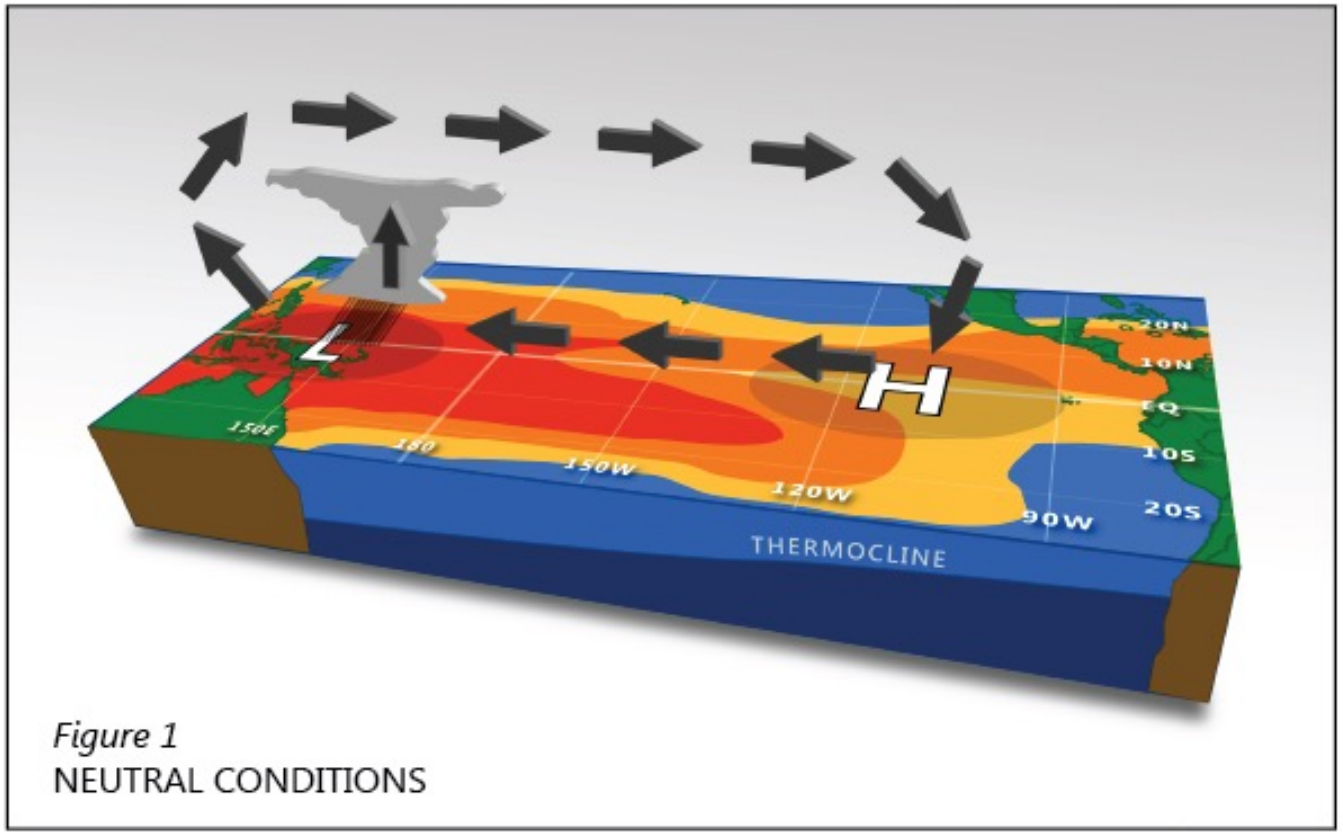



*Figure 1*
NEUTRAL CONDITIONS

- 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

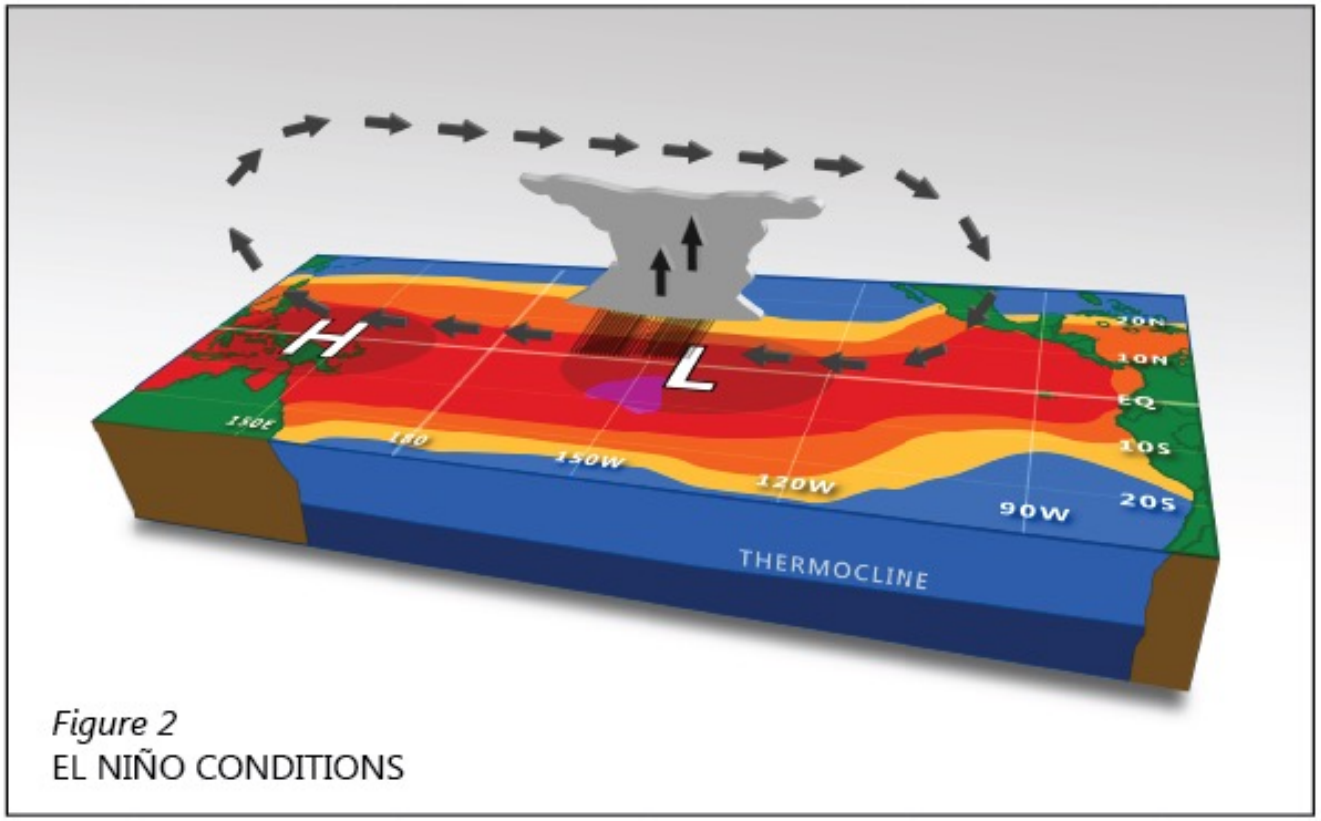


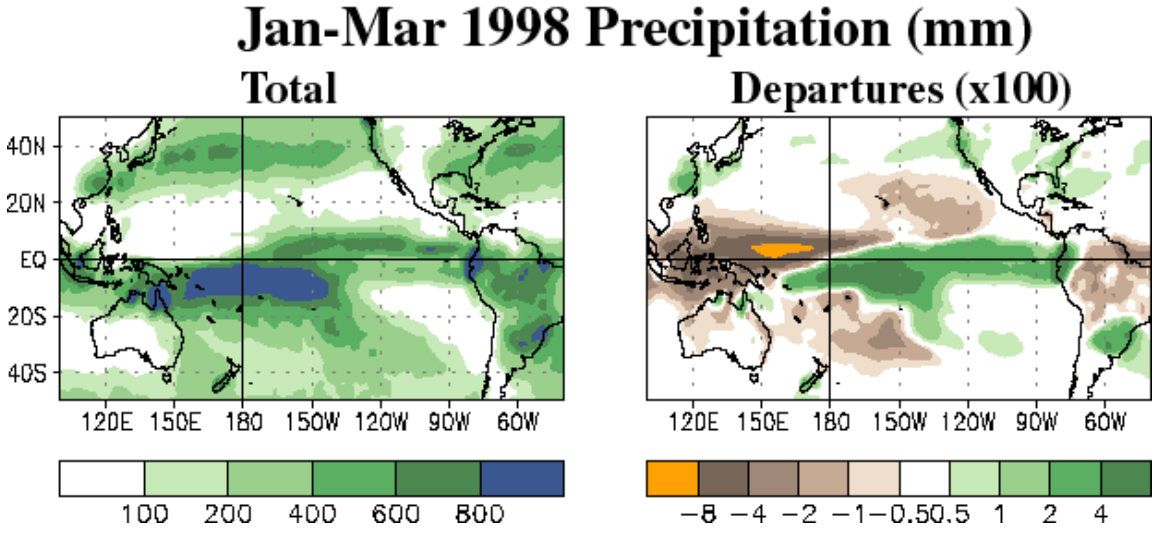

*Figure 2*
EL NIÑO CONDITIONS

- 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

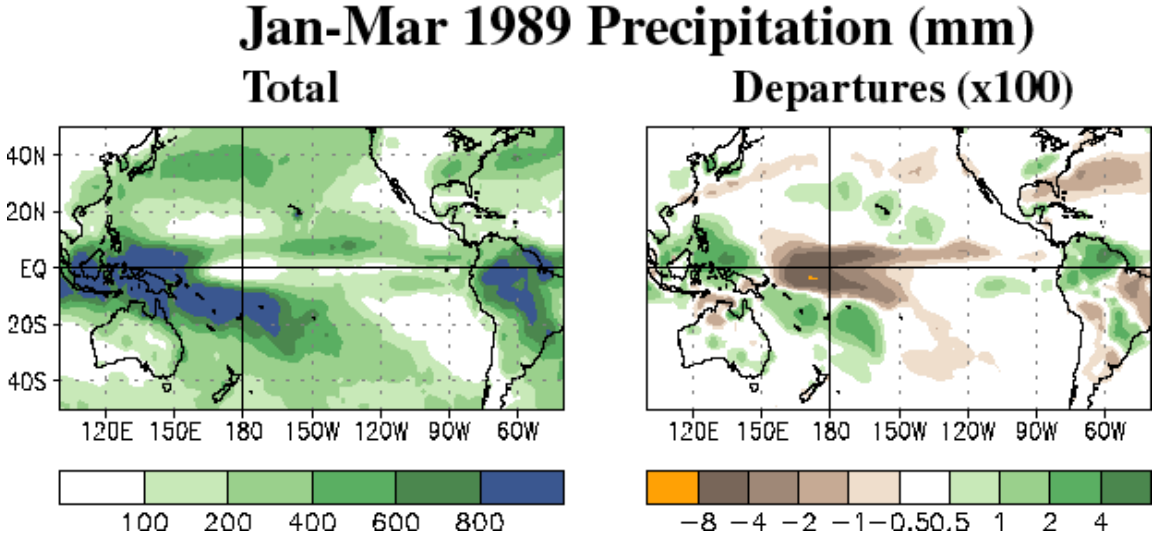
# Outline

- 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




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

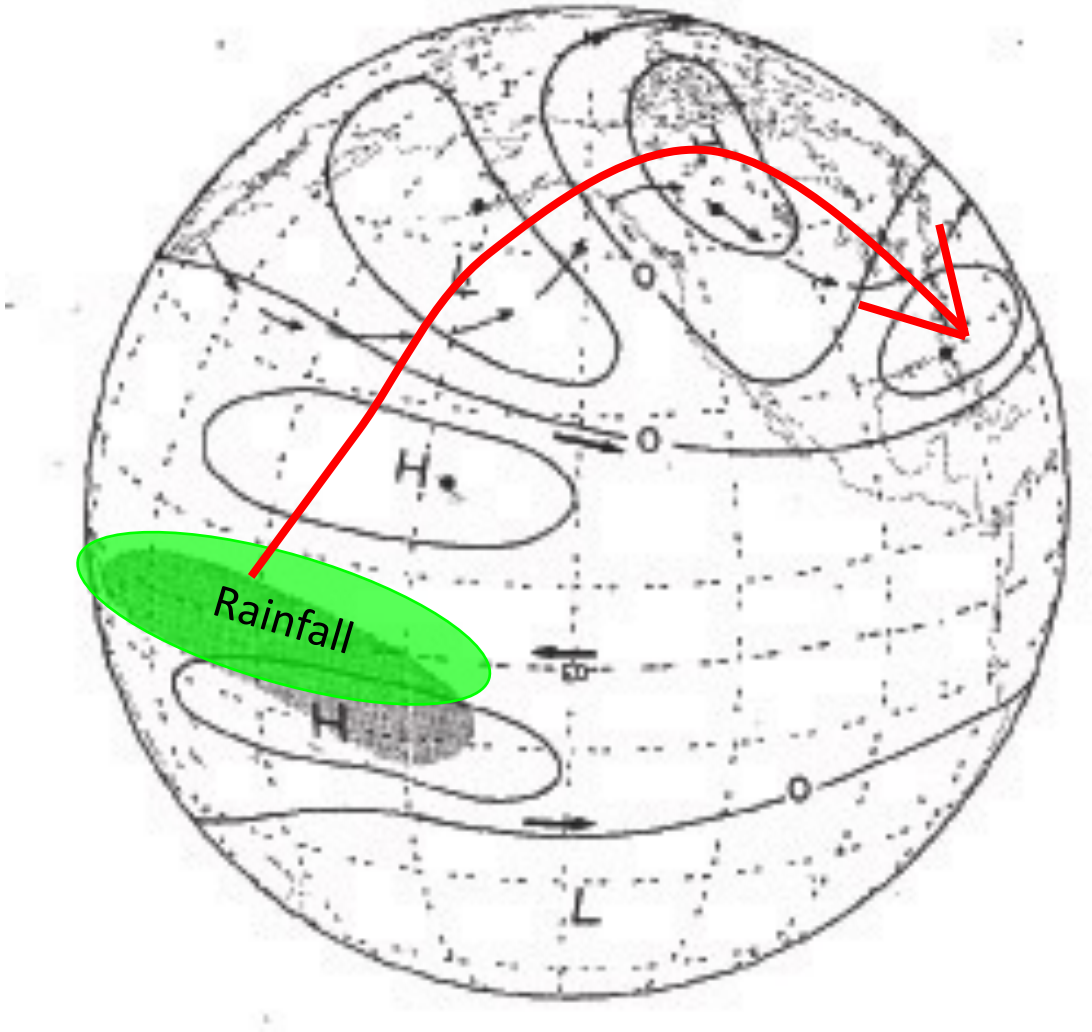



Reduced rainfall occurs over colder-than-average waters during La Niña

# Teleconnections

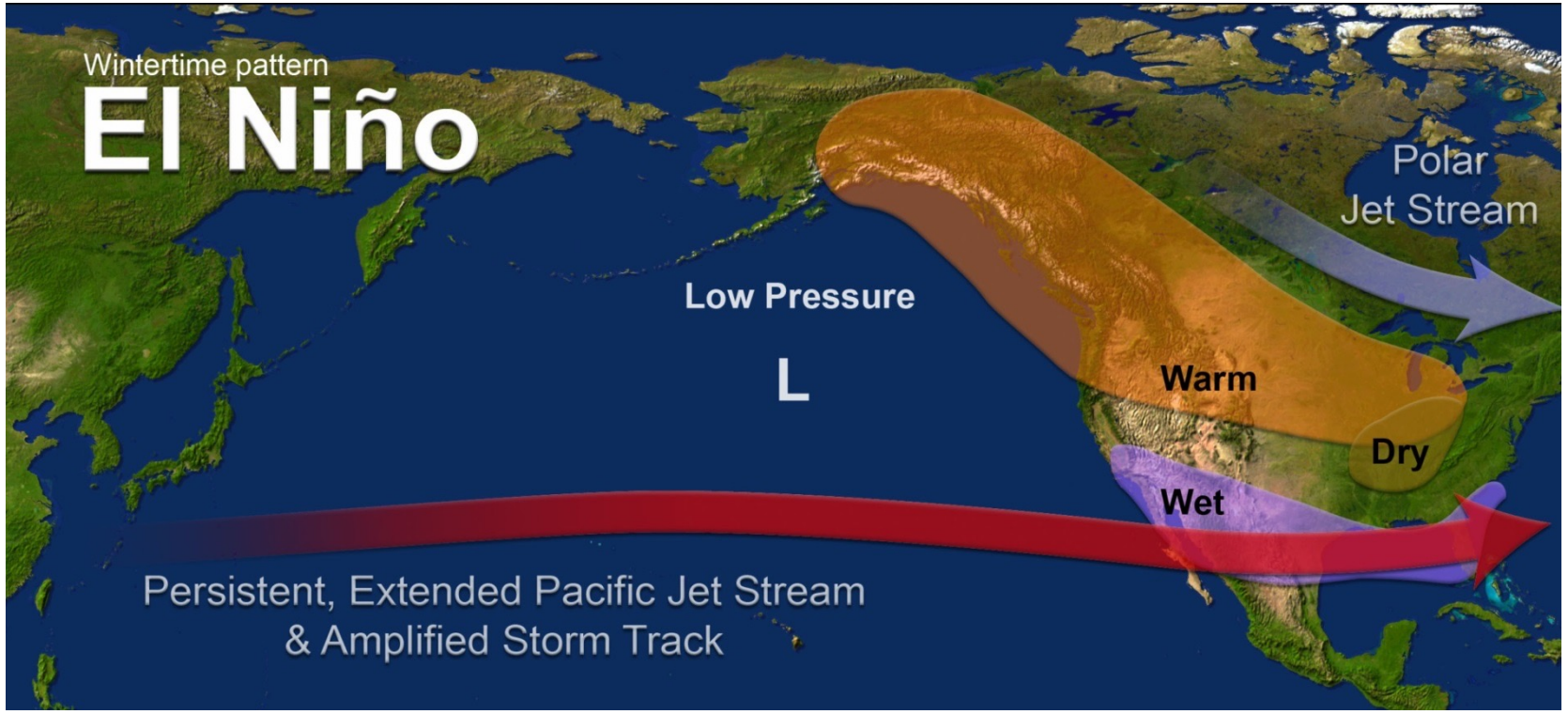
Tropical rainfall and so atmospheric heating can lead to “wavetrains” that can influence the global circulation (**red arc**)

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



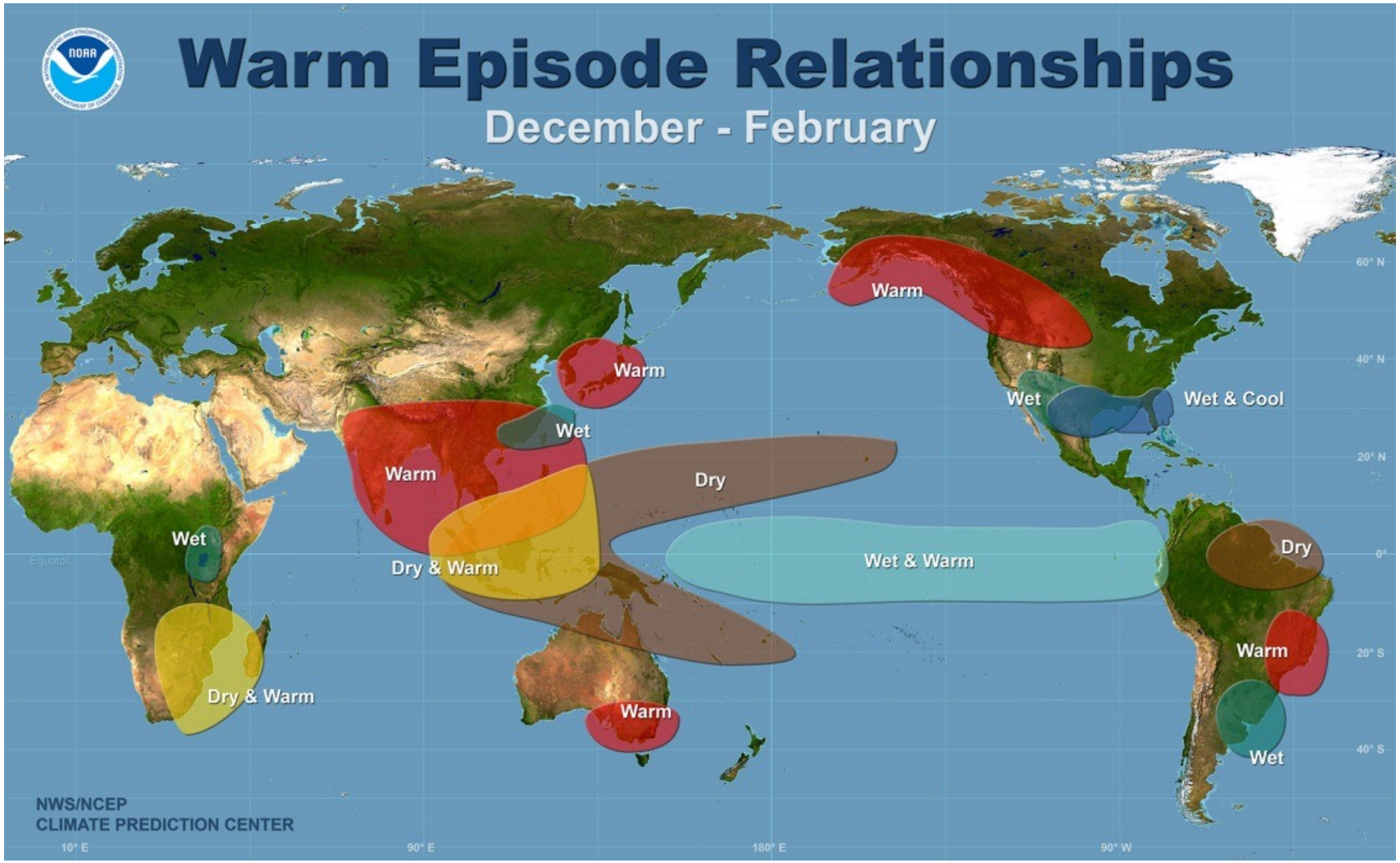

Schematic from Horel and Wallace (1981)

# Typical El Nino 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.

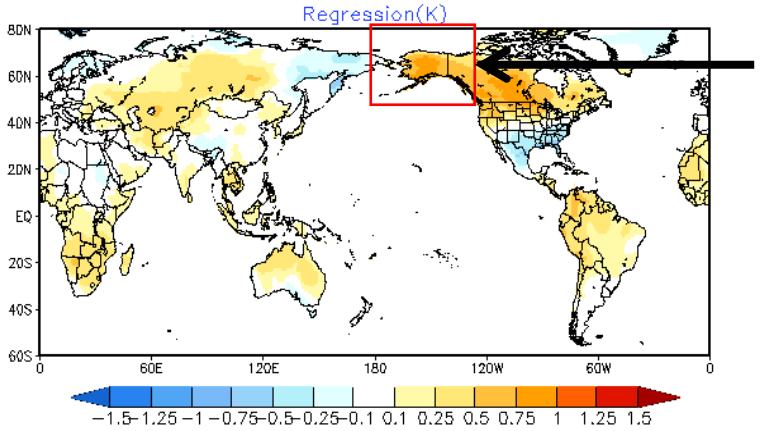
# Typical Global Impacts

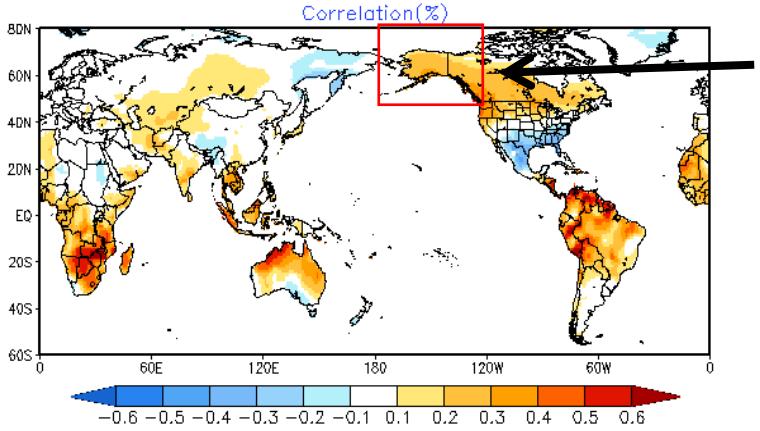


NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

# Typical Global Impacts

ENSO Teleconnection: JFM Temp



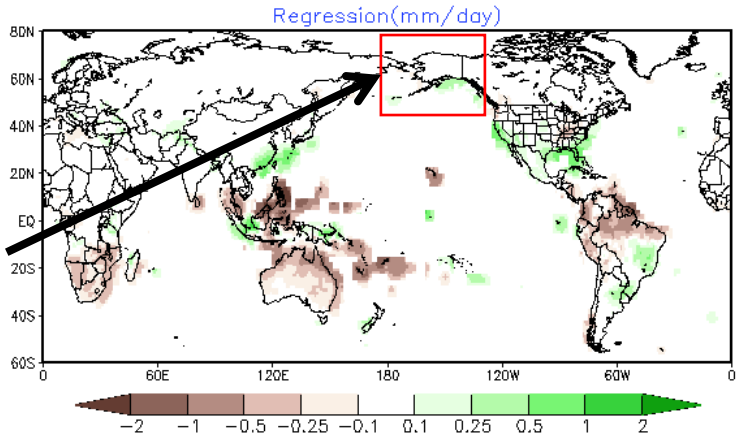

Warmer than Average

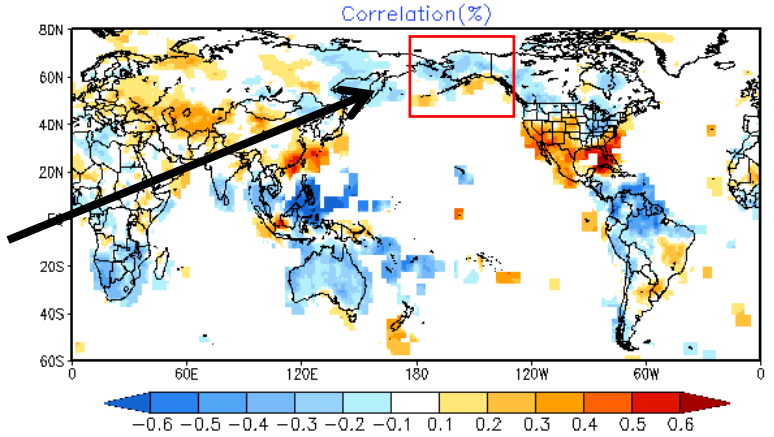
Wetter than average parts of South Coast. Weak signal across much of state.

Positive correlation

Negative correlation across Mainland. Positive correlation across parts of South Coast.

ENSO Teleconnection: JFM Precip



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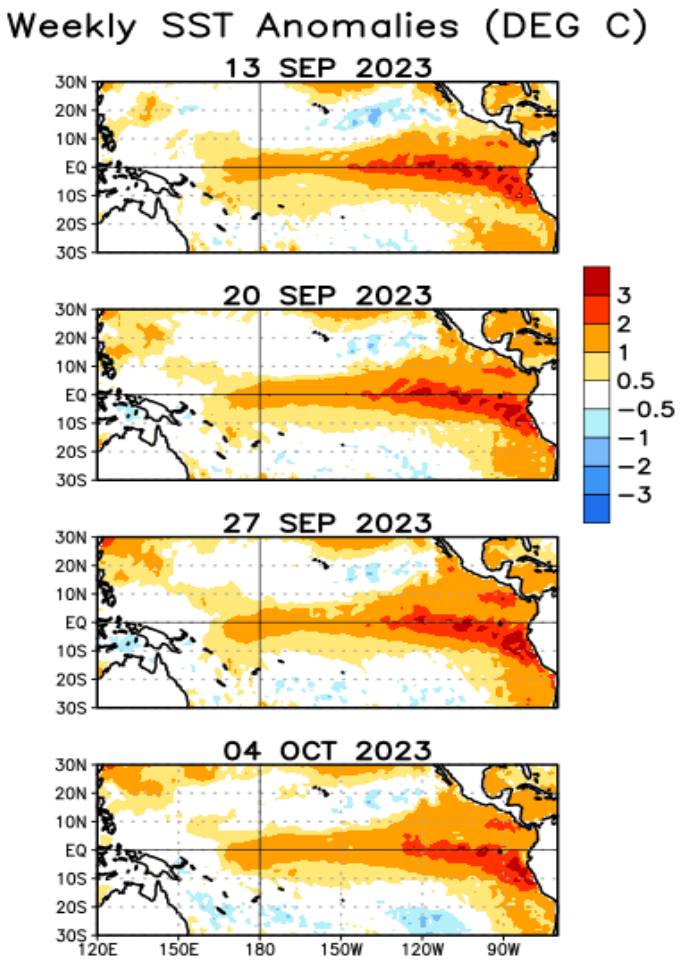
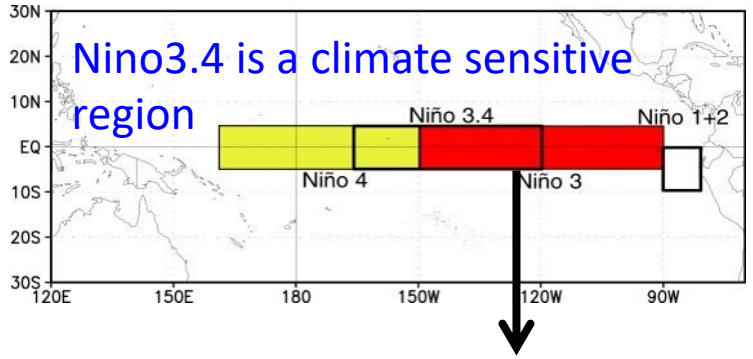
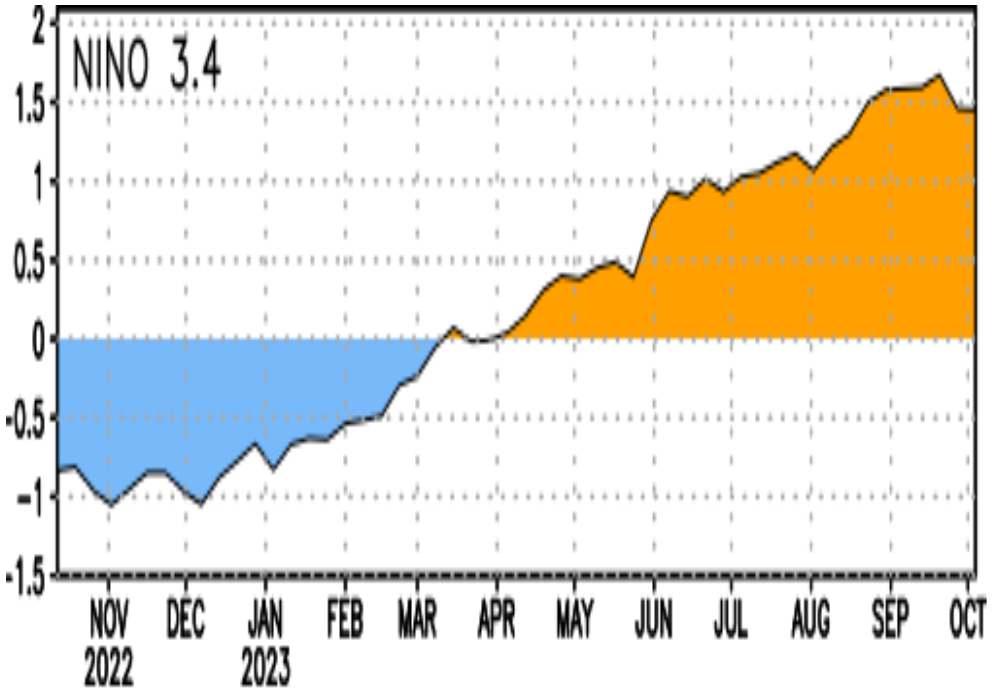
- **Current status and forecast of El Nino**

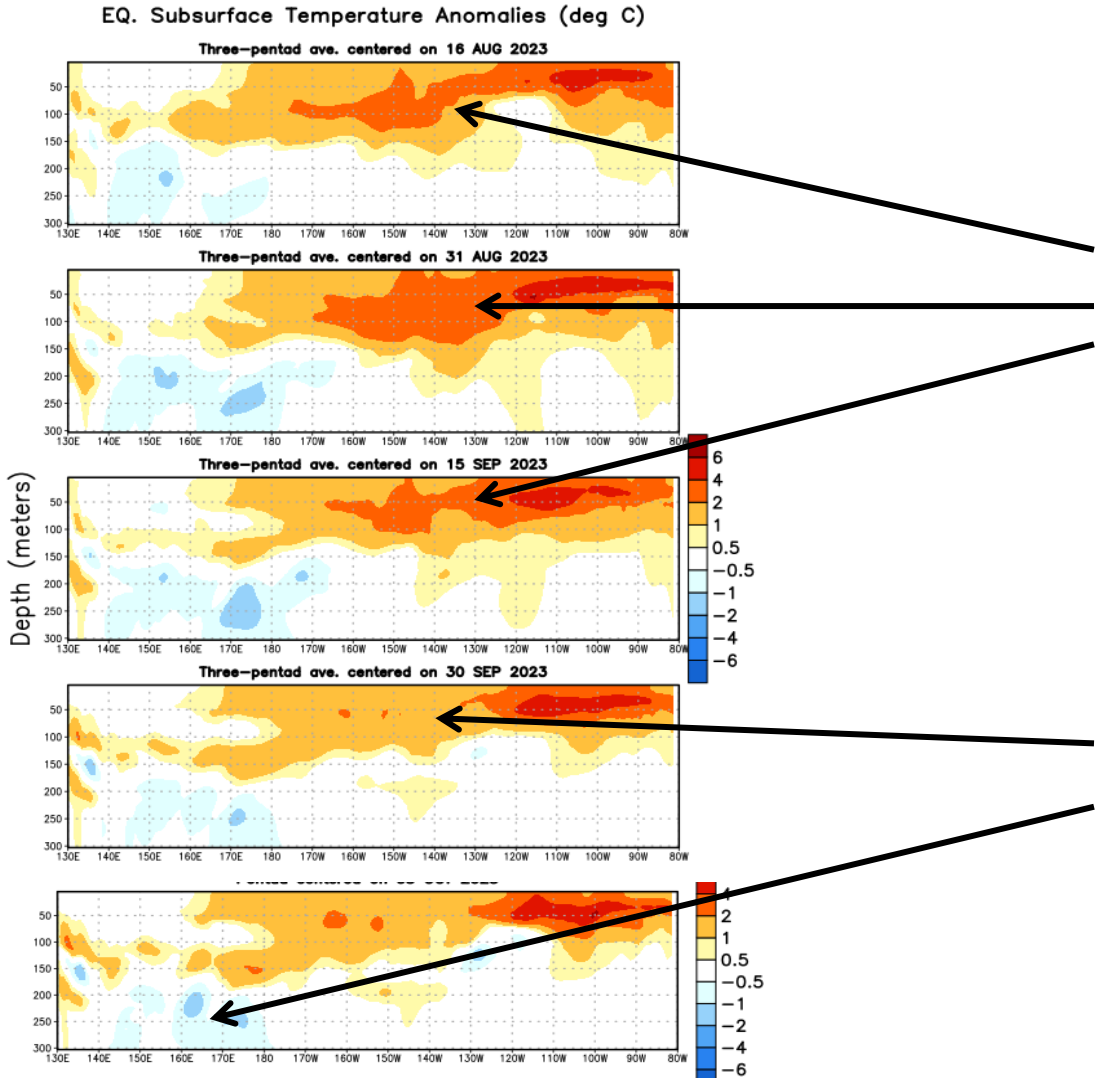
# Current SST conditions



# Ocean Temperatures at Depth

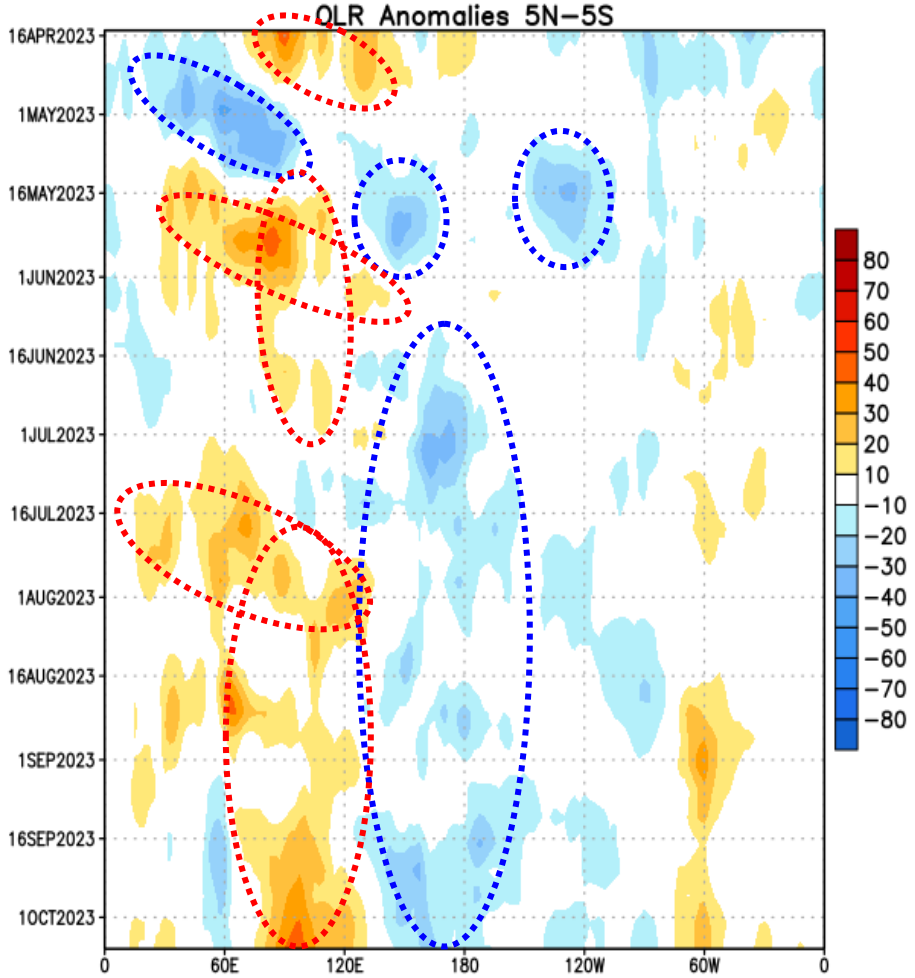


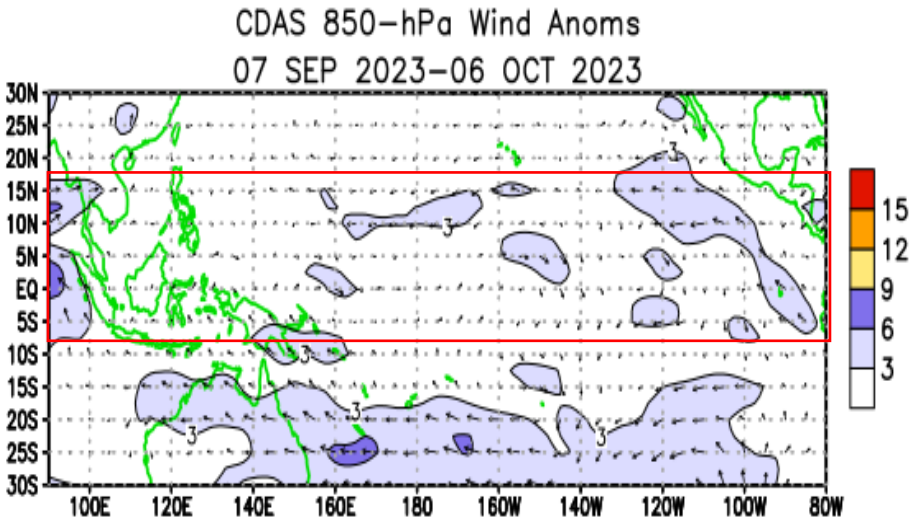

Positive subsurface temperature anomalies dominate most of the equatorial Pacific Ocean

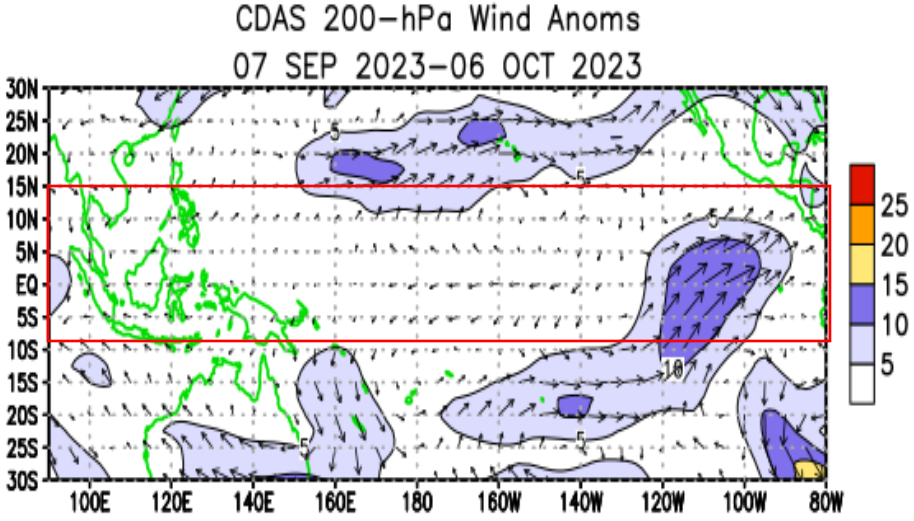
Positive subsurface temperature anomalies weakened in the western equatorial Pacific with negative anomalies emerging at depth

# Convection and Winds

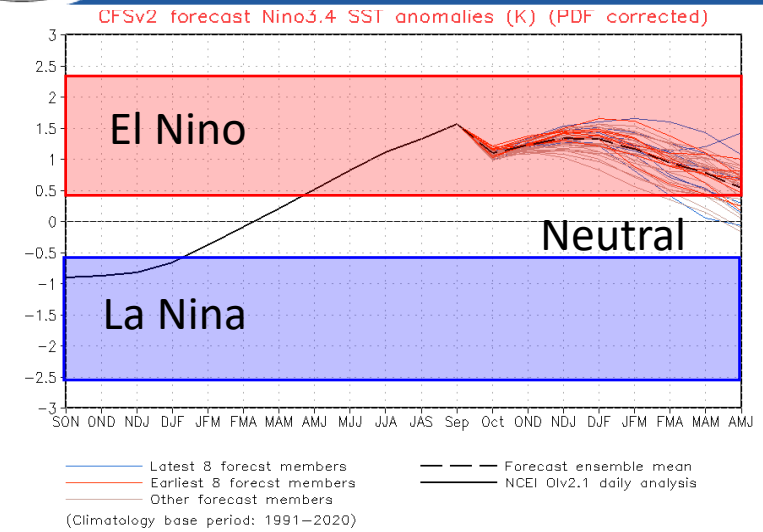
Tropical Pacific atmospheric anomalies are consistent with El Nino

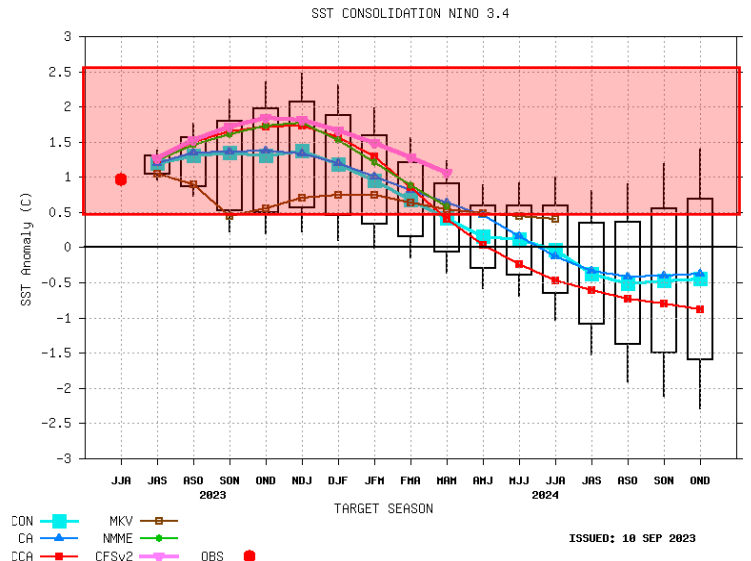


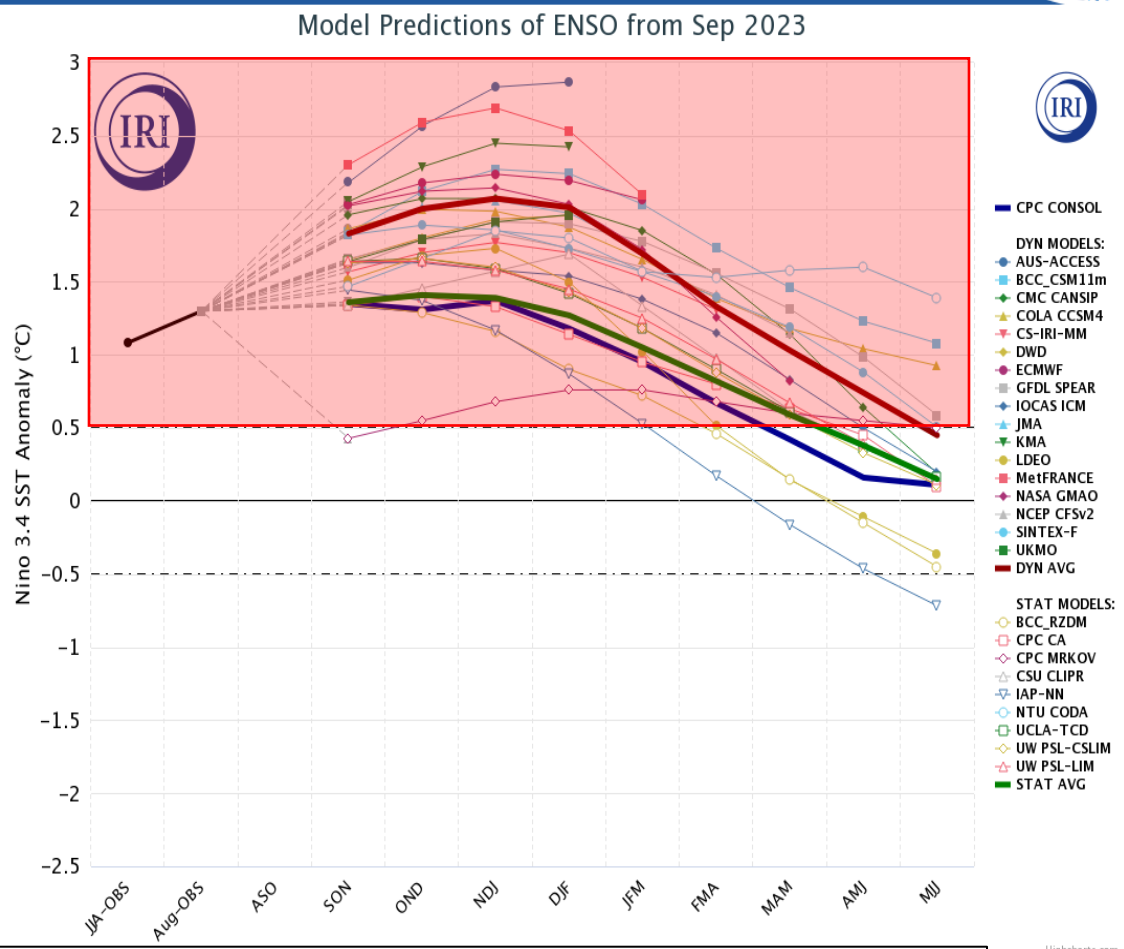



# ENSO Forecasts



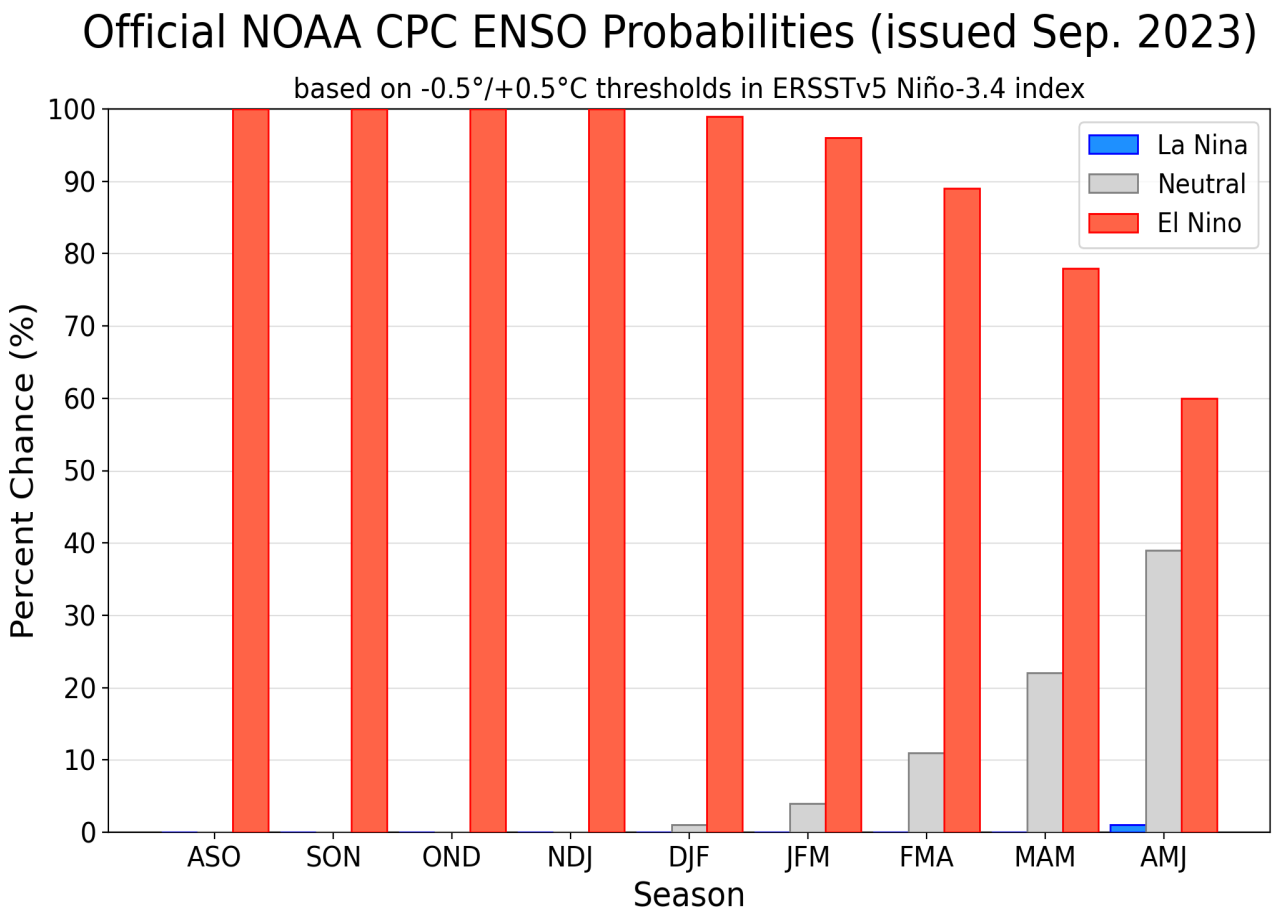




Forecasts for Nino3.4 favor a moderate to strong El Nino at the current time

# Official ENSO Outlook

<u>ENSO Alert System Status</u>: El Niño Advisory

The odds of El Niño exceed 95% through January-March 2024

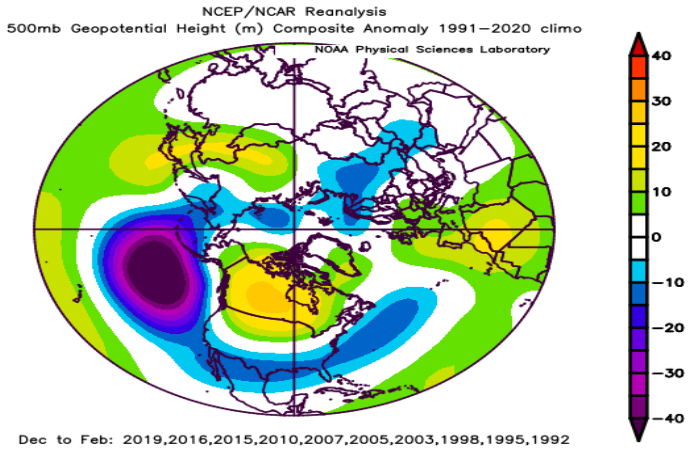


# El Niños
# The Past & the Future

- 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
  - Composites (averages of past El Niños)
  - CPC Outlooks for Autumn and Winter (for which El Niño is just one of several important factors)

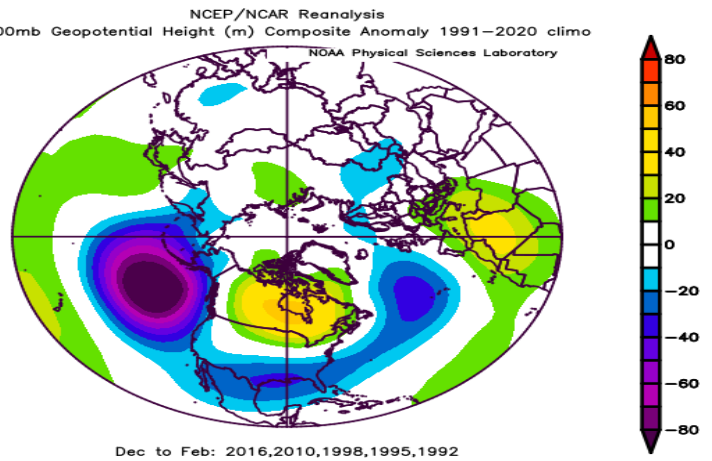
# December through February ENSO and Trend 500mb Anomalies

## El Niño All



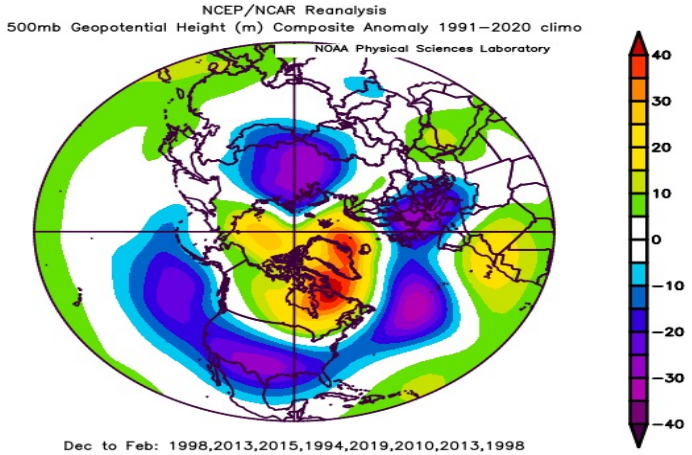

Dec to Feb: 2019,2016,2015,2010,2007,2005,2003,1998,1995,1992

## El Niño Moderate/Strong



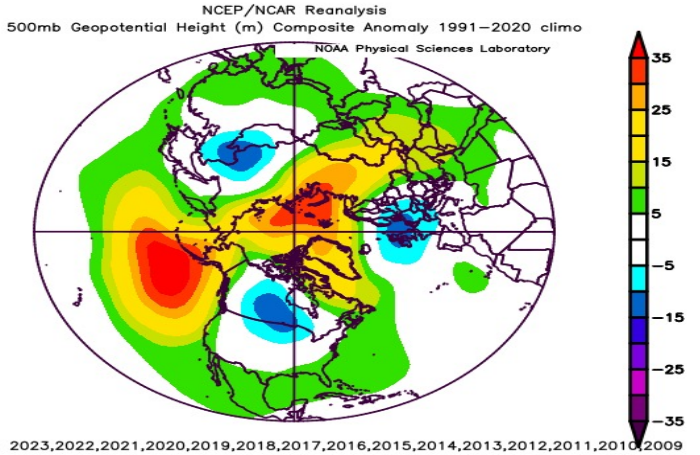

Dec to Feb: 2016,2010,1998,1995,1992

## ENSO Analogs (SST + EQ HEAT)




Dec to Feb: 1998,2013,2015,1994,2019,2010,2013,1998

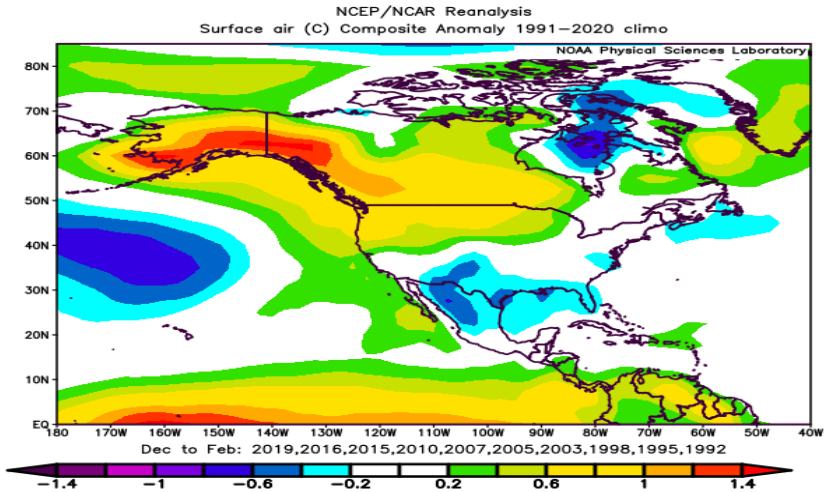
## Trends



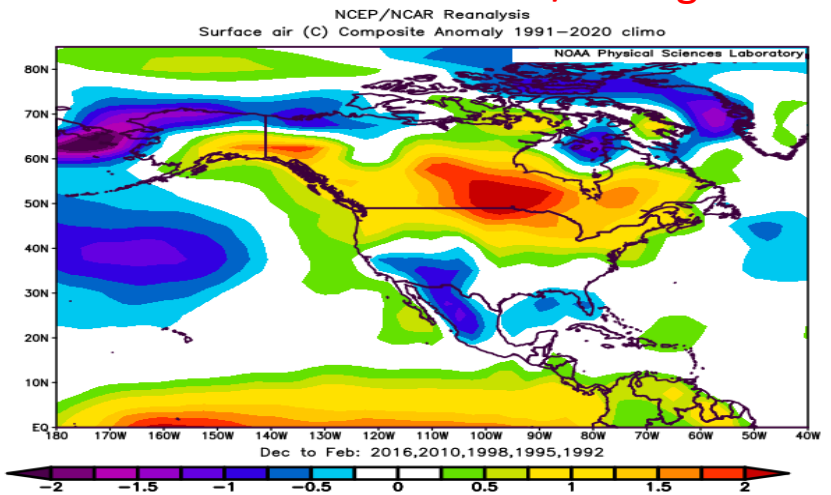

Dec to Feb: 2023,2022,2021,2020,2019,2018,2017,2016,2015,2014,2013,2012,2011,2010,2009

# December through February ENSO and Trend Temperature Anomalies

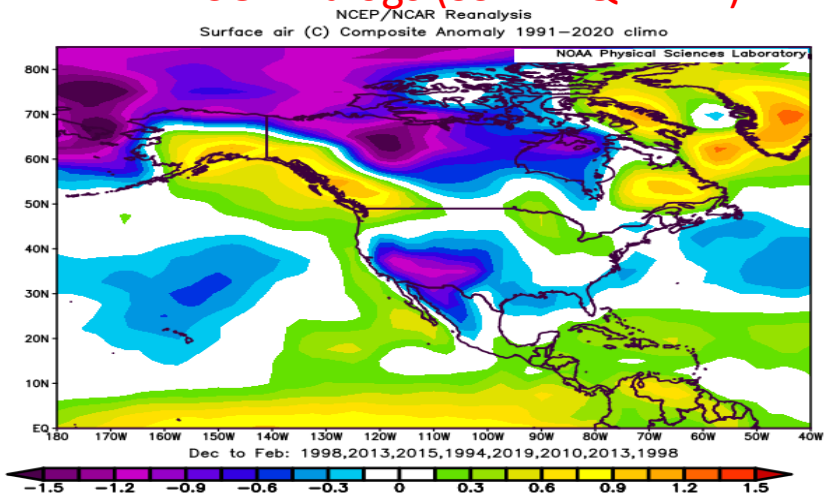
## El Niño All



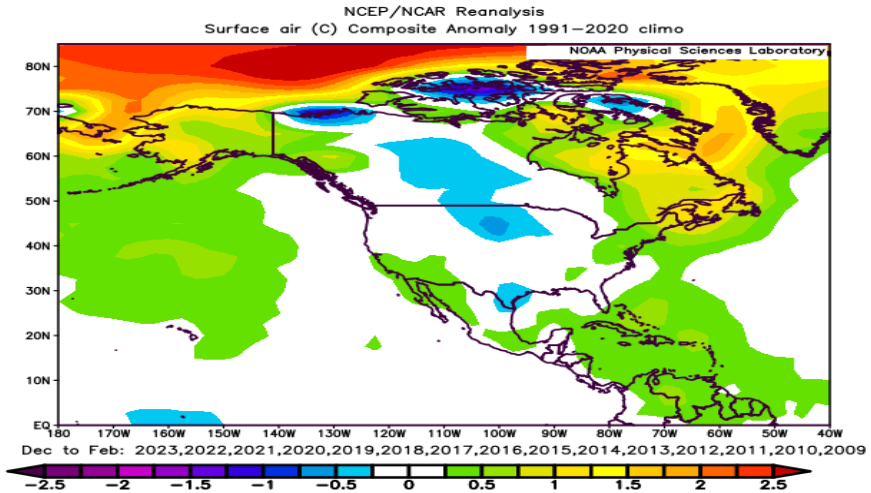

## El Niño Moderate/Strong




## ENSO Analogs (SST + EQ HEAT)

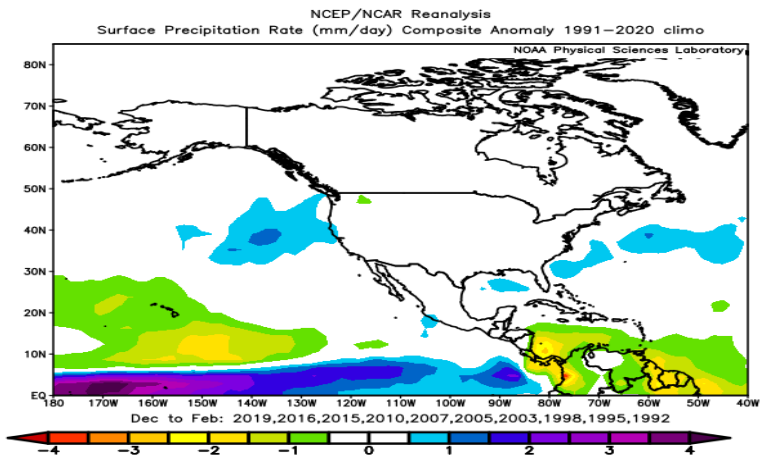



## Trends

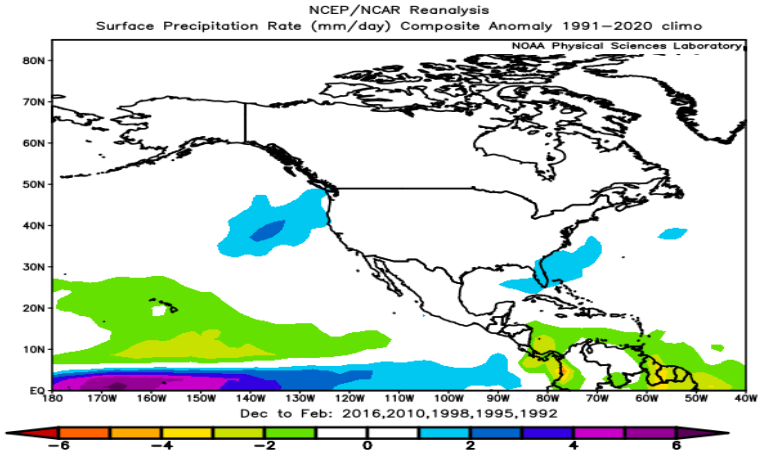


# December through February ENSO and Trend Precipitation Anomalies

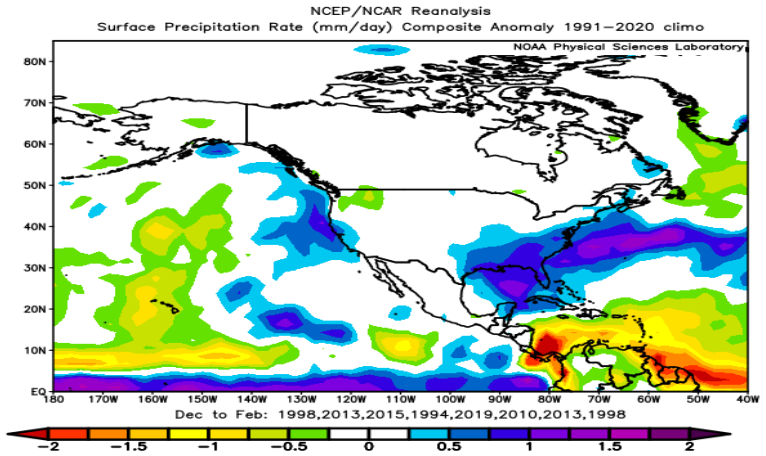
## El Niño All



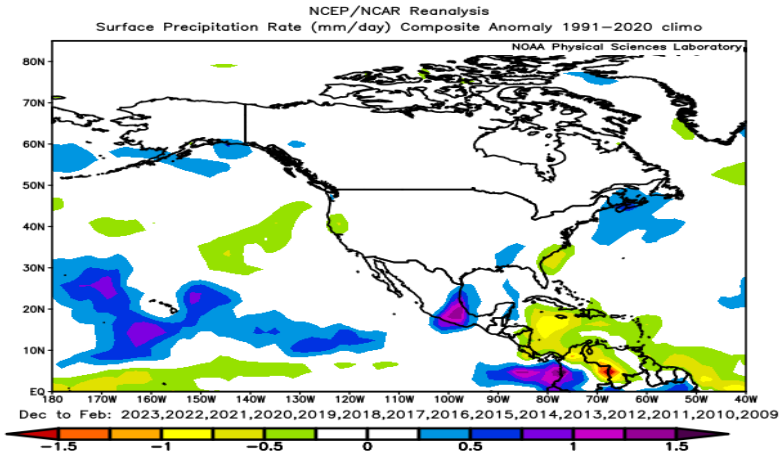

## El Niño Moderate/Strong

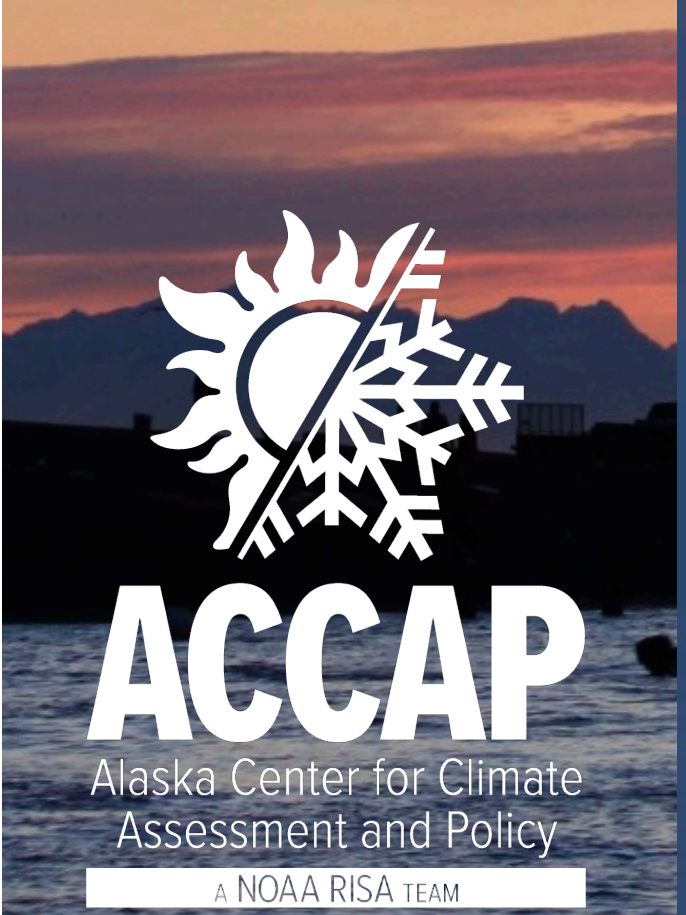



## ENSO Analogs (SST + EQ HEAT)




## Trends





ACCAP
Alaska Center for Climate Assessment and Policy
A NOAA RISA TEAM

# El Niño: Why it Matters for Alaska


Rick Thoman • Climate Specialist

*Alaska Center for Climate Assessment and Policy*
*@ International Arctic Research Center on the UAF Troth Yeddha' Campus*


UNIVERSITY OF ALASKA FAIRBANKS

International Arctic Research Center

# Presentation overview

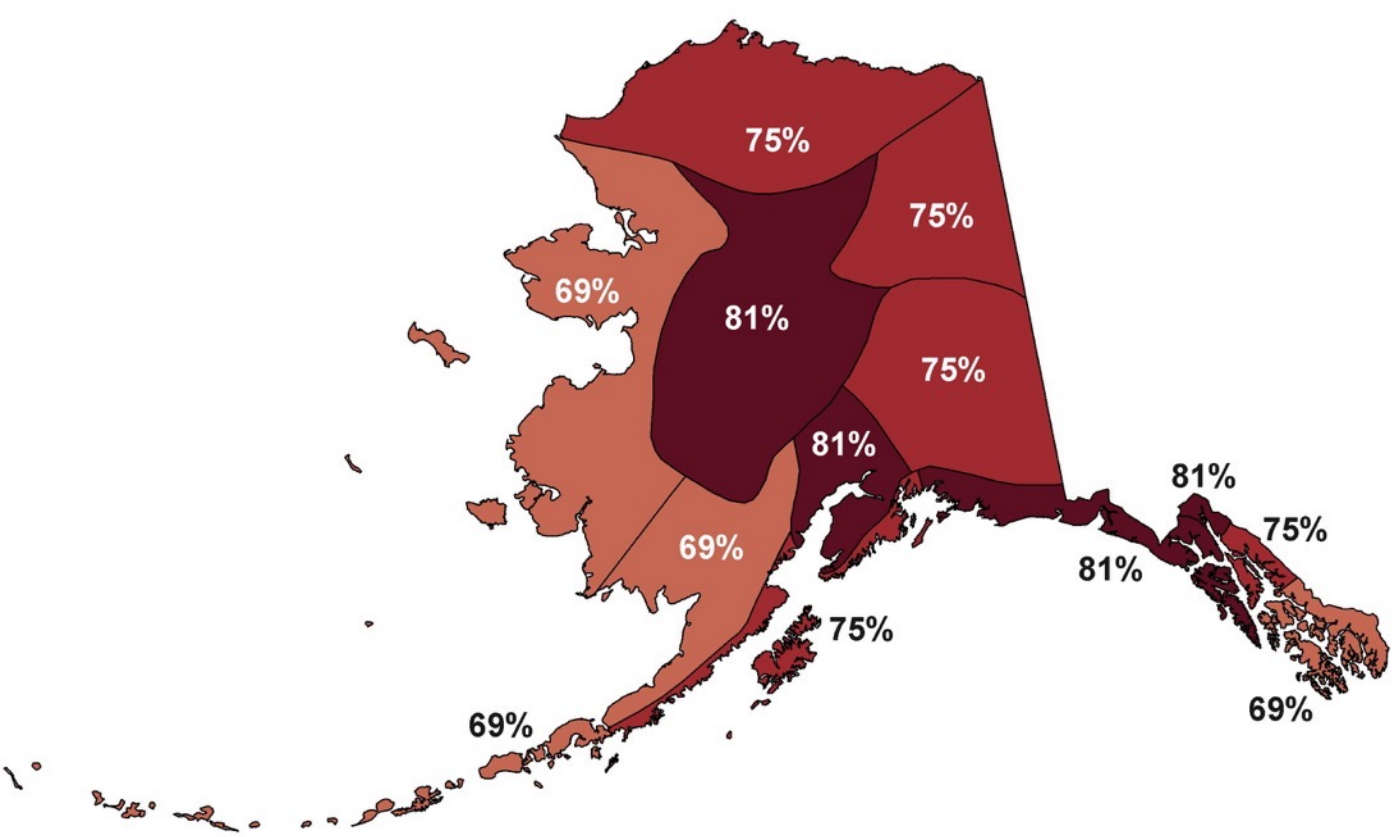
1. Past El Niños in Alaska
   a. Temperatures, Precipitation, Snow, Freezing Levels and Sea Ice
2. Interlude: Pacific Decadal Oscillation
3. CPC's Official Outlooks

# El Niño in Alaska Since 1976

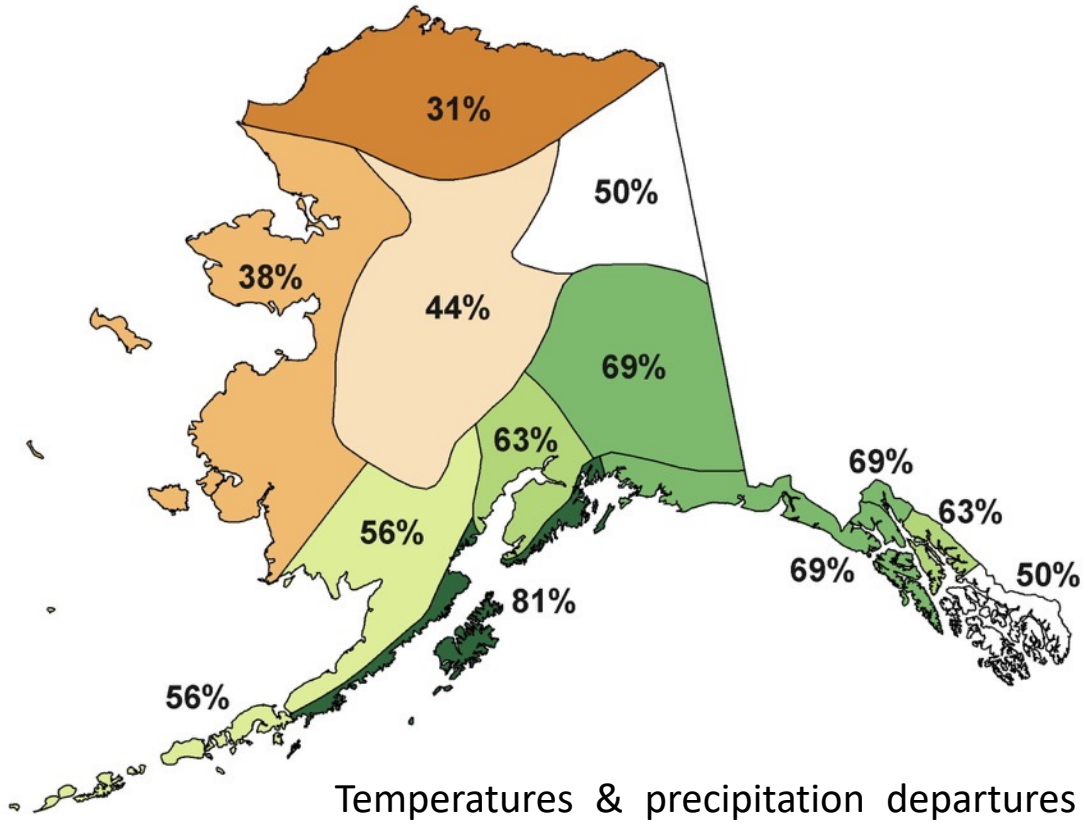
- 16 El Niño autumn-winters
  - 1976, 1977, 1979, 1982, 1986, 1987, 1991, 1994, 1997, 2002, 2004, 2006, 2009, 2014, 2015, 2018
- Dramatic changes past 50 years in ocean-atmosphere system
  - Dramatic loss/thinning of Arctic sea ice
  - Big changes in seasonality of ice near Alaska
  - Decreasing snow cover season length
  - Increasing global ocean surface temperatures

El Niño is an important component of Alaska seasonal climate but not the only one that matters

# October-December Temperature & Precipitation




**Percent of El Niños above normal**




Temperatures & precipitation departures from normal are relative to the 30-year normal effective at the time, e.g. 1977-78 relative to the 1941-70 normal, 2018-19 relative to the 1981-2010 normal.

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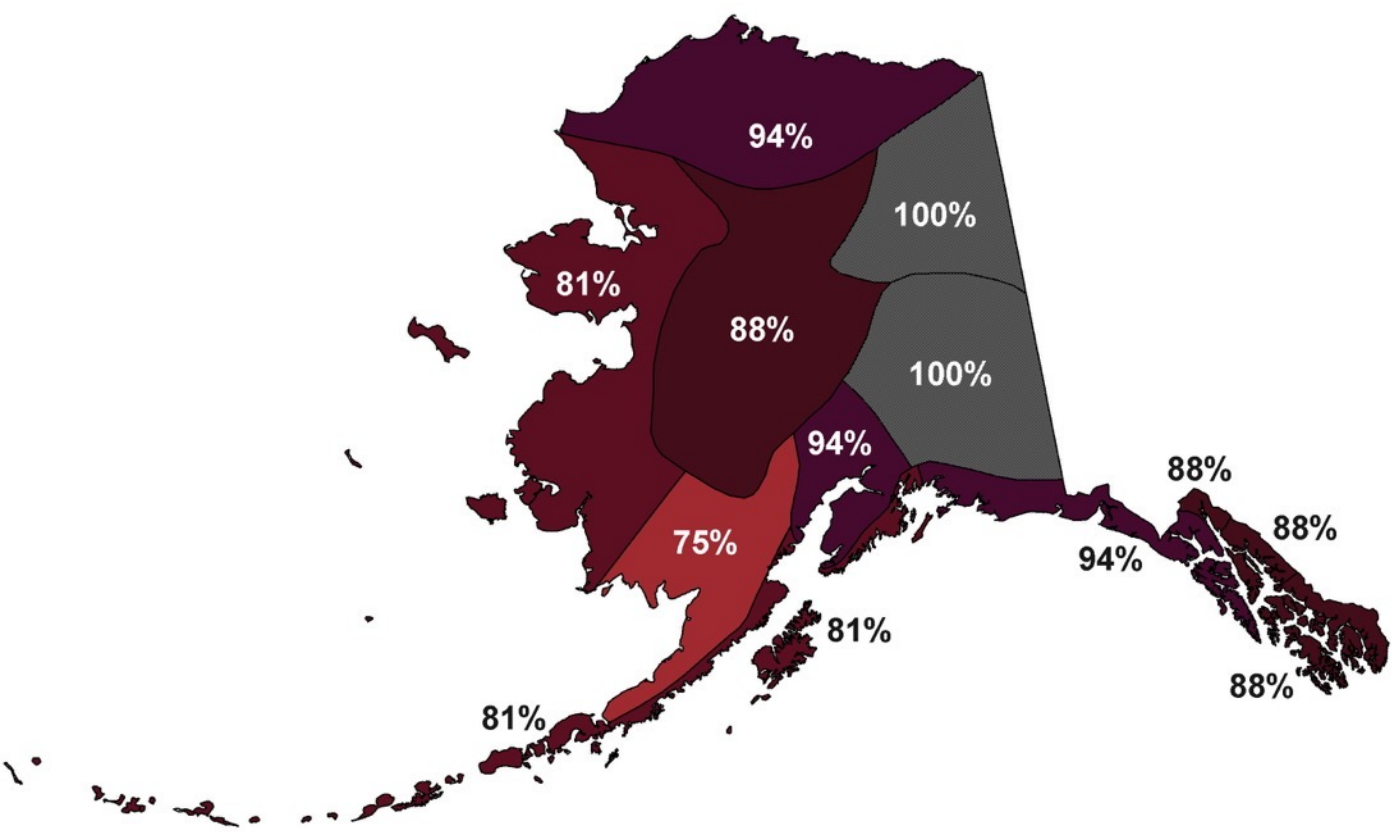
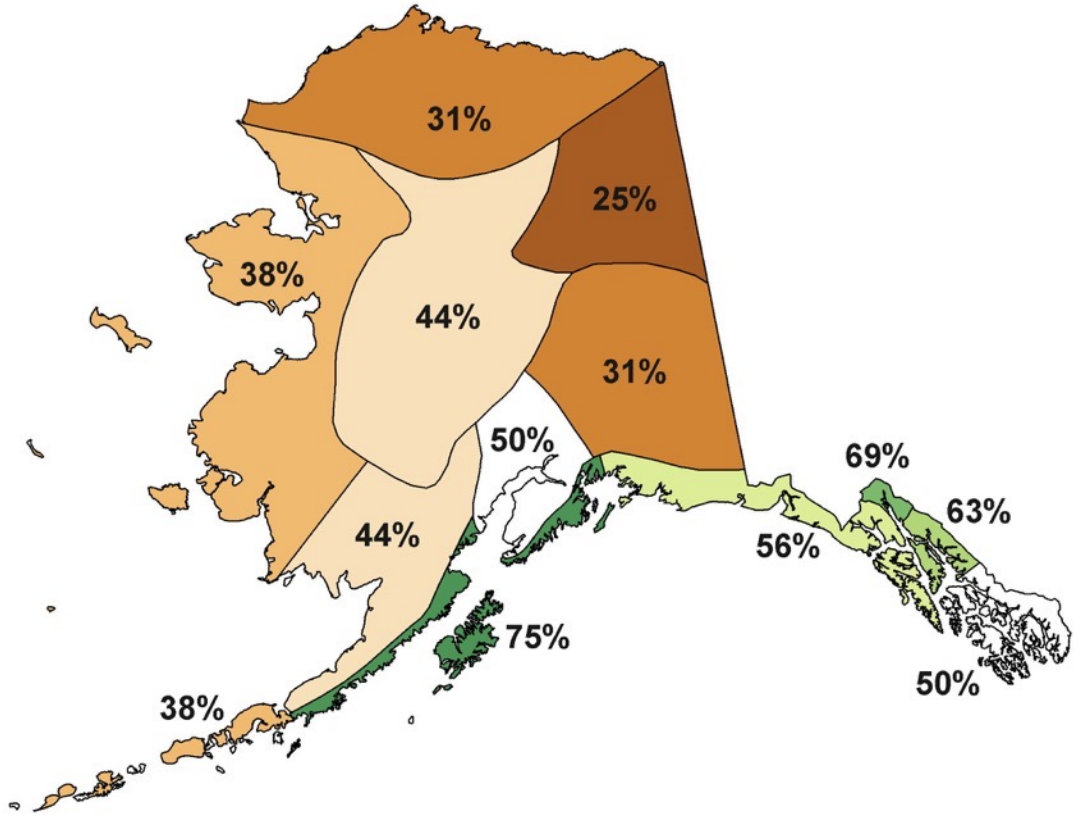
International Arctic Research Center

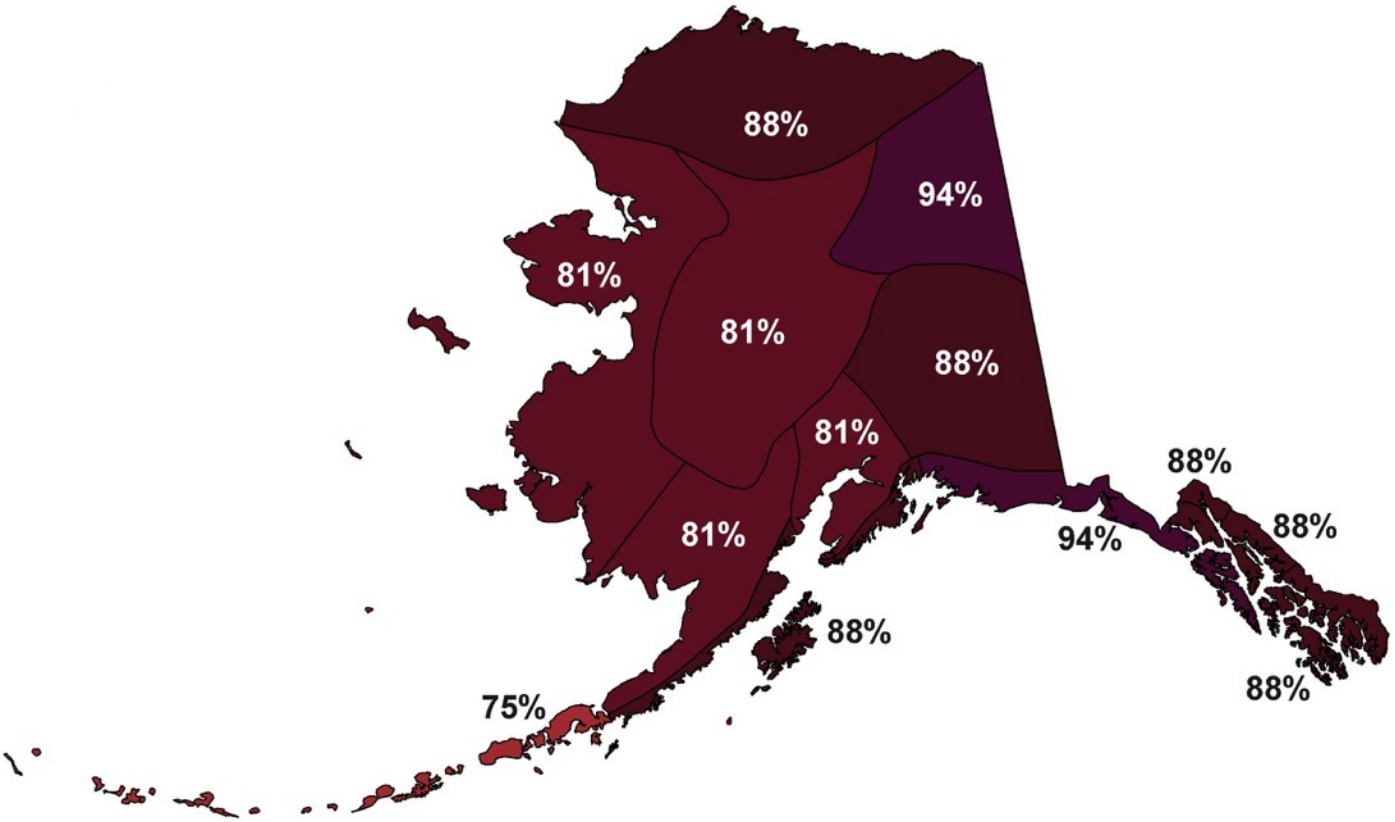
# December-February Temperature & Precipitation

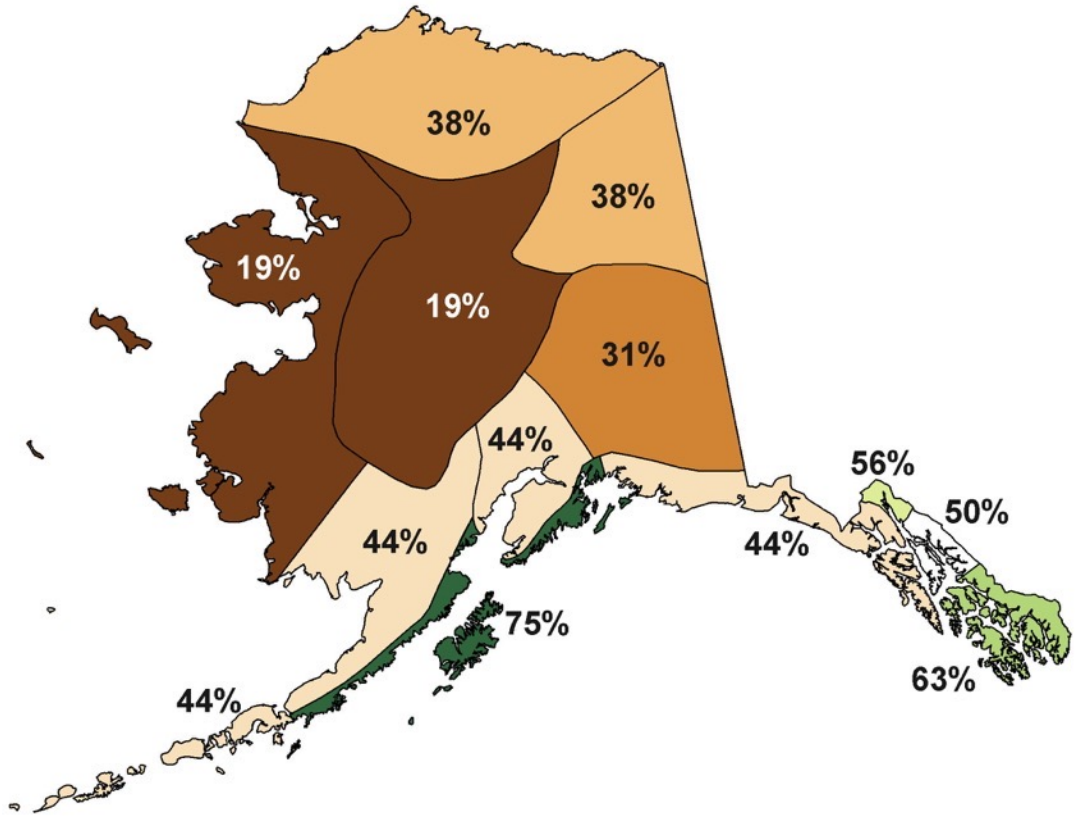



**Percent of El Niños above normal**

# February-April Temperature & Precipitation




**Percent of El Niños above normal**

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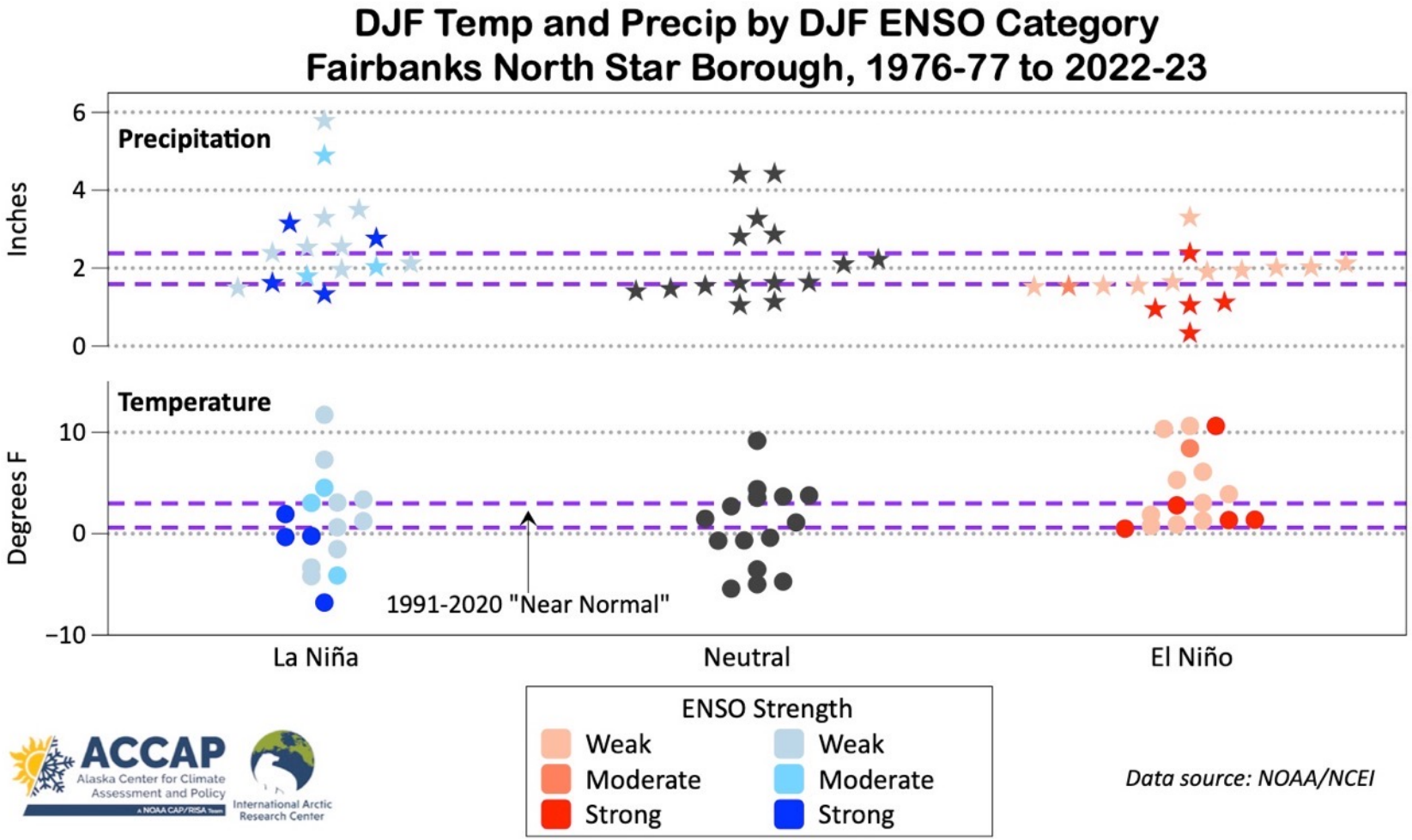
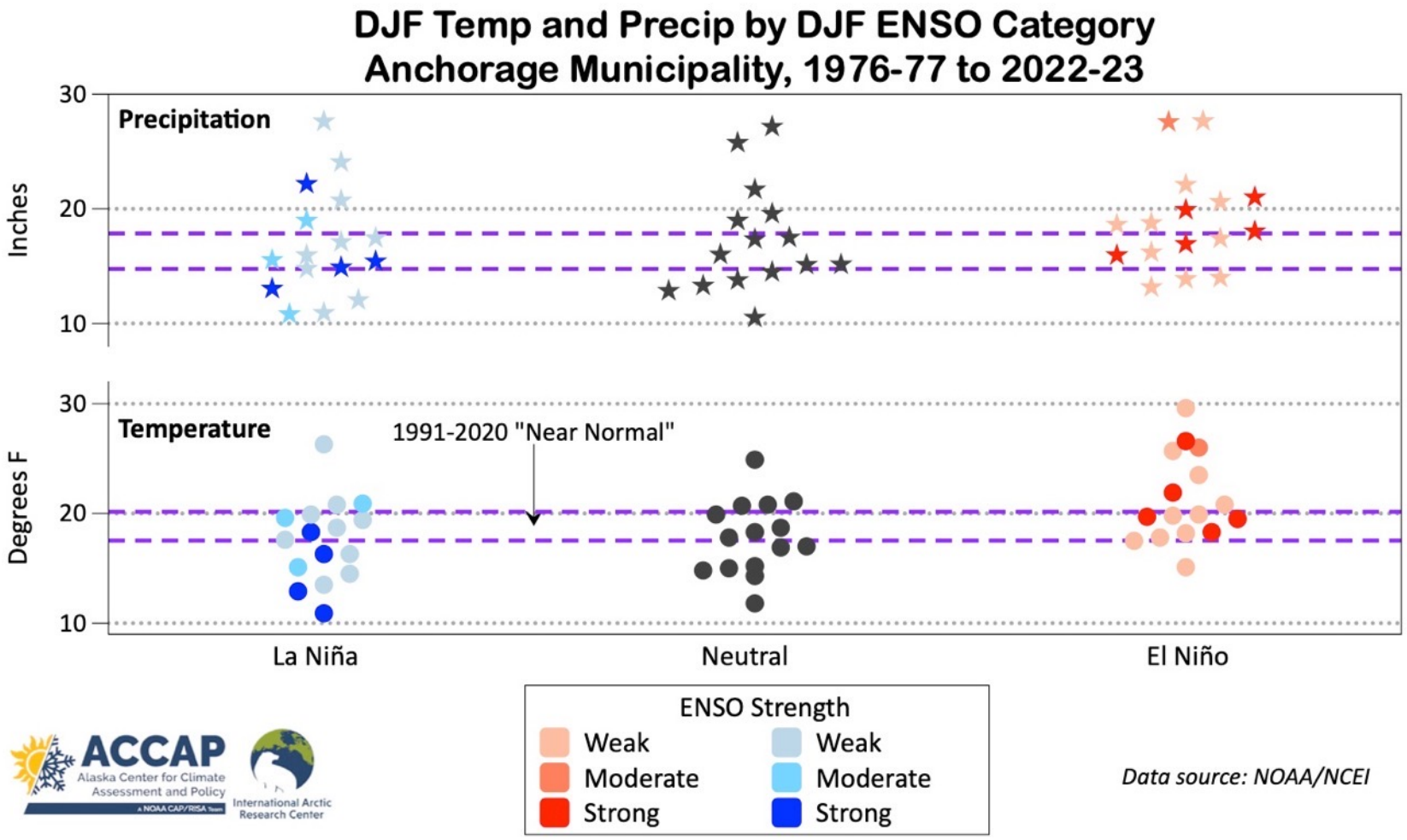
International Arctic Research Center

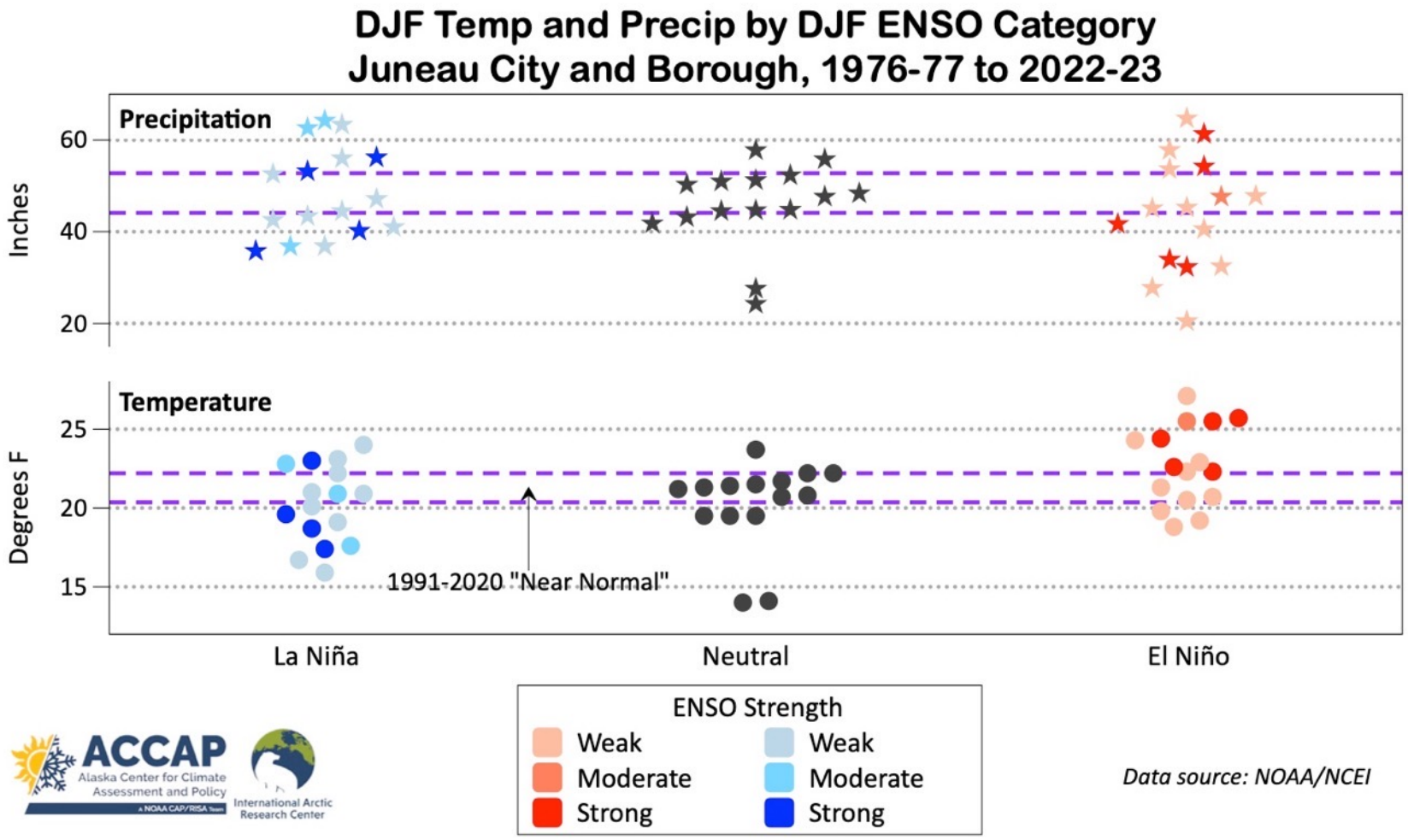
# Fairbanks North Star Borough



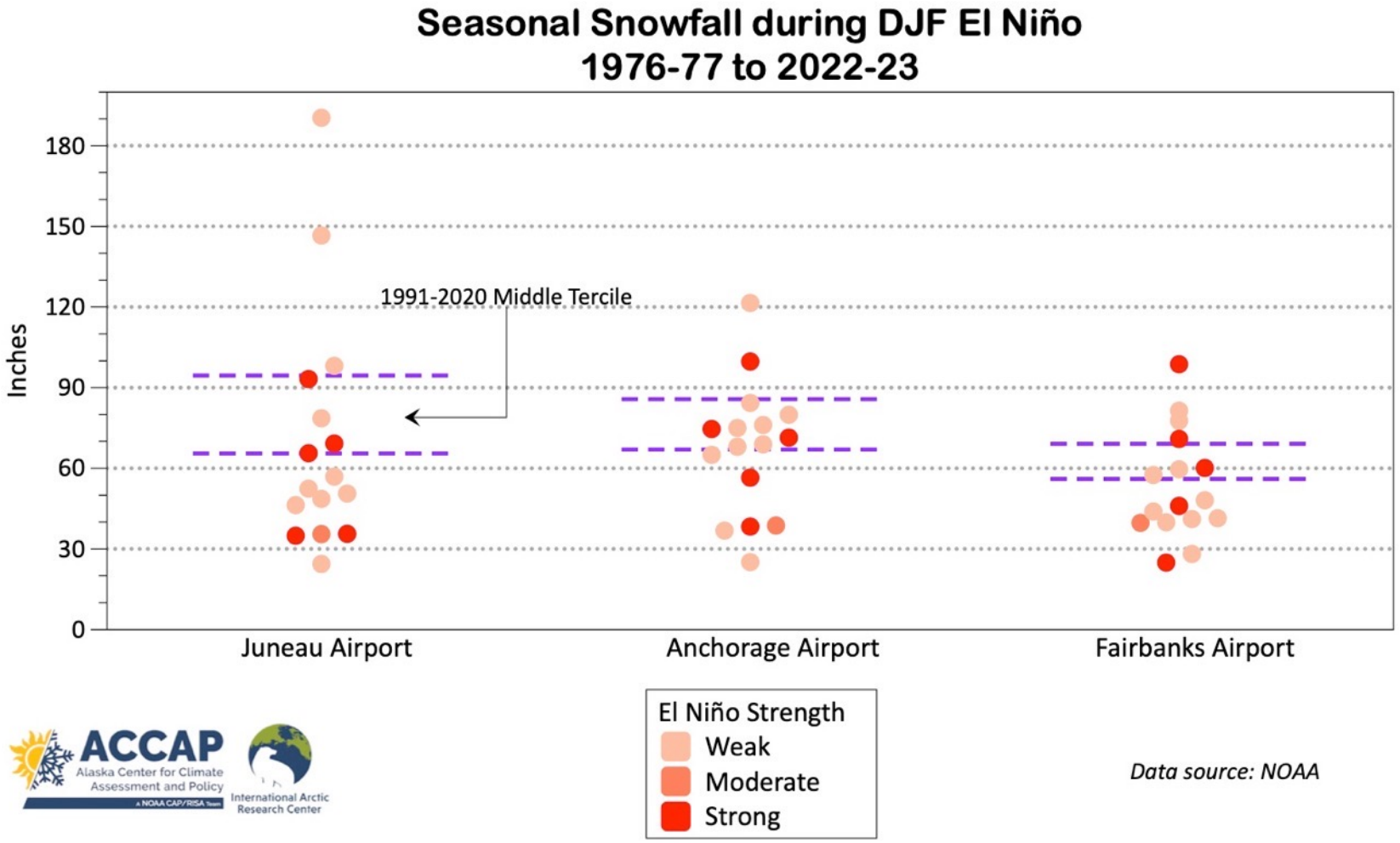
# Anchorage Municipality



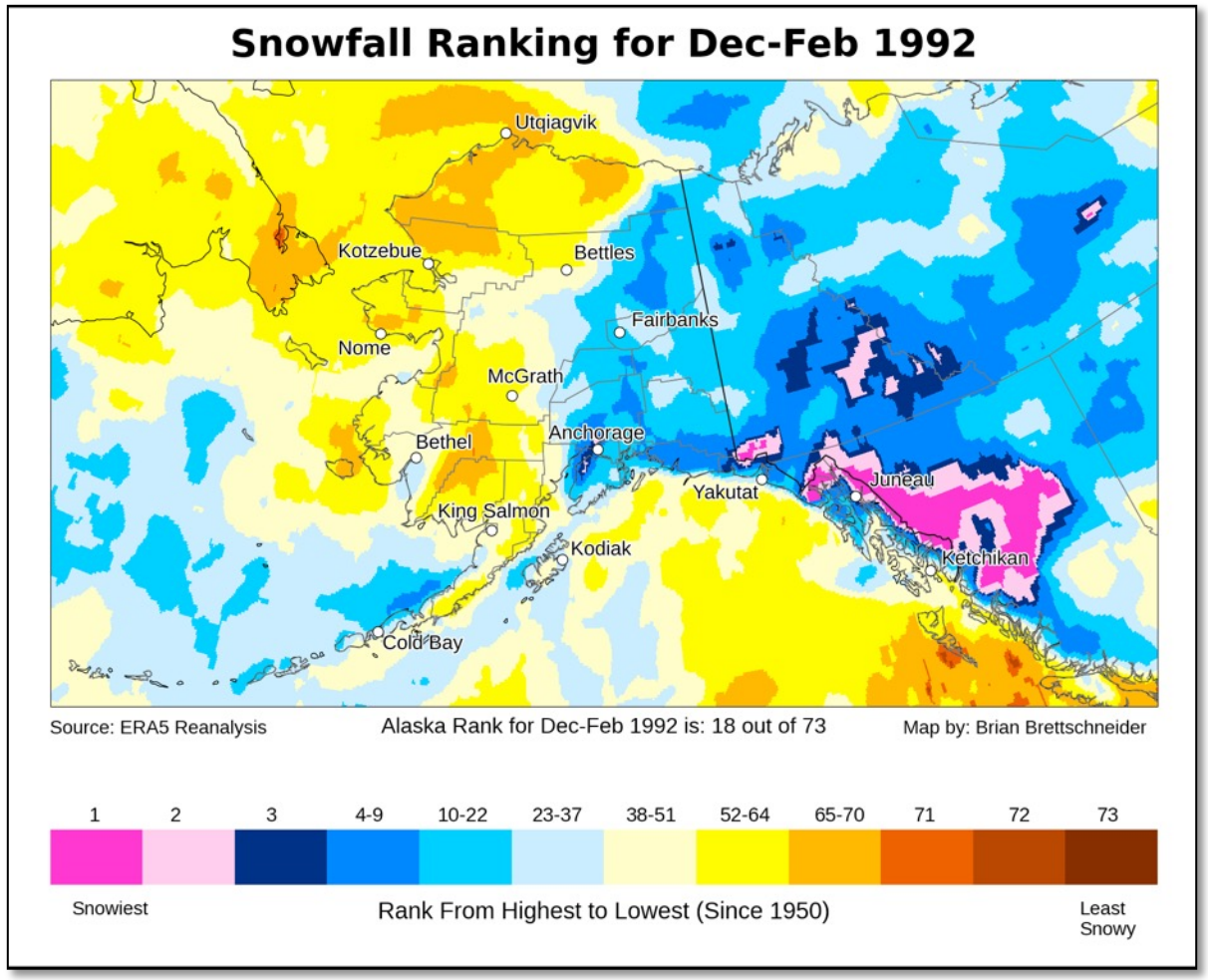
# Juneau City and Borough

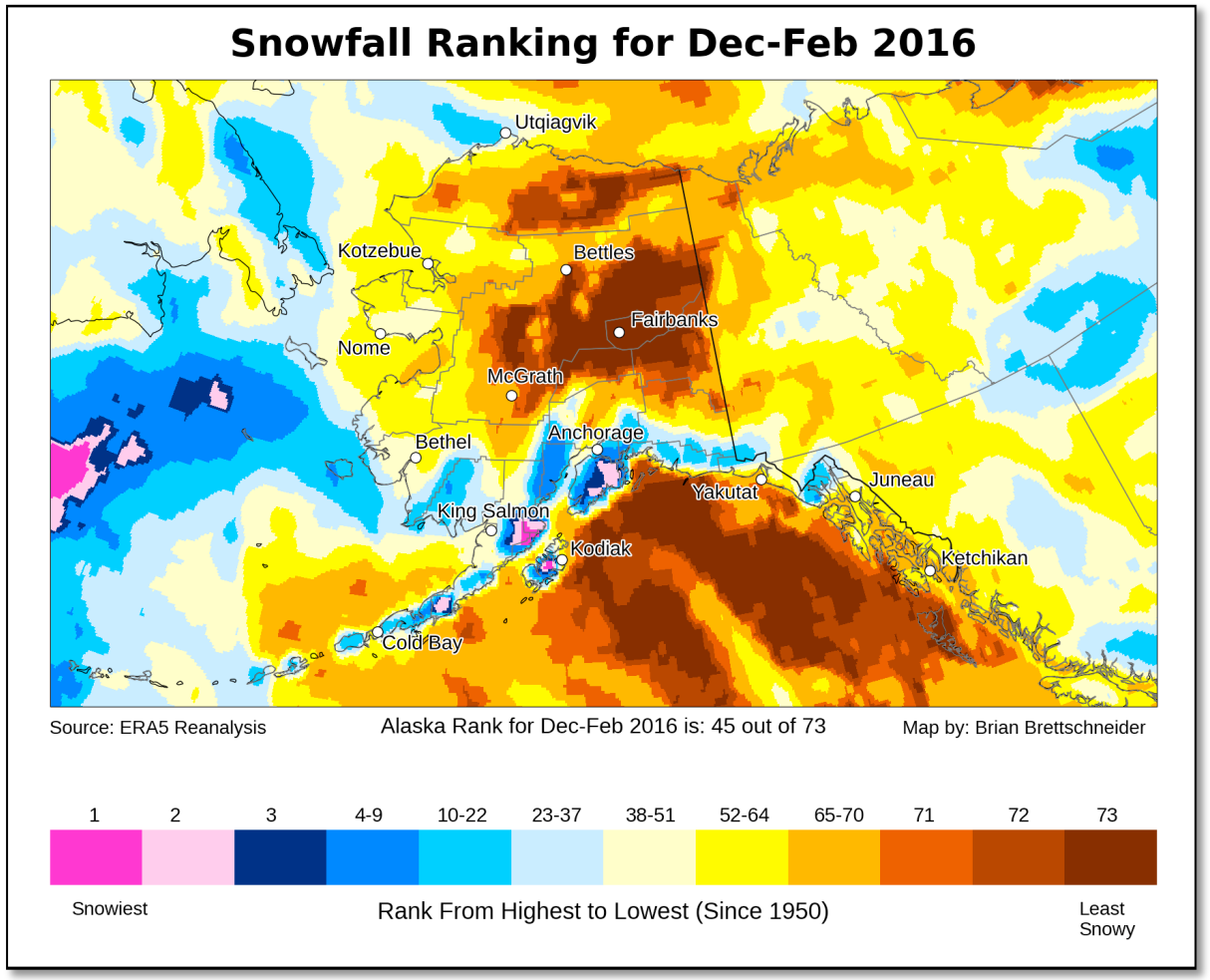


# Snowfall During El Niño

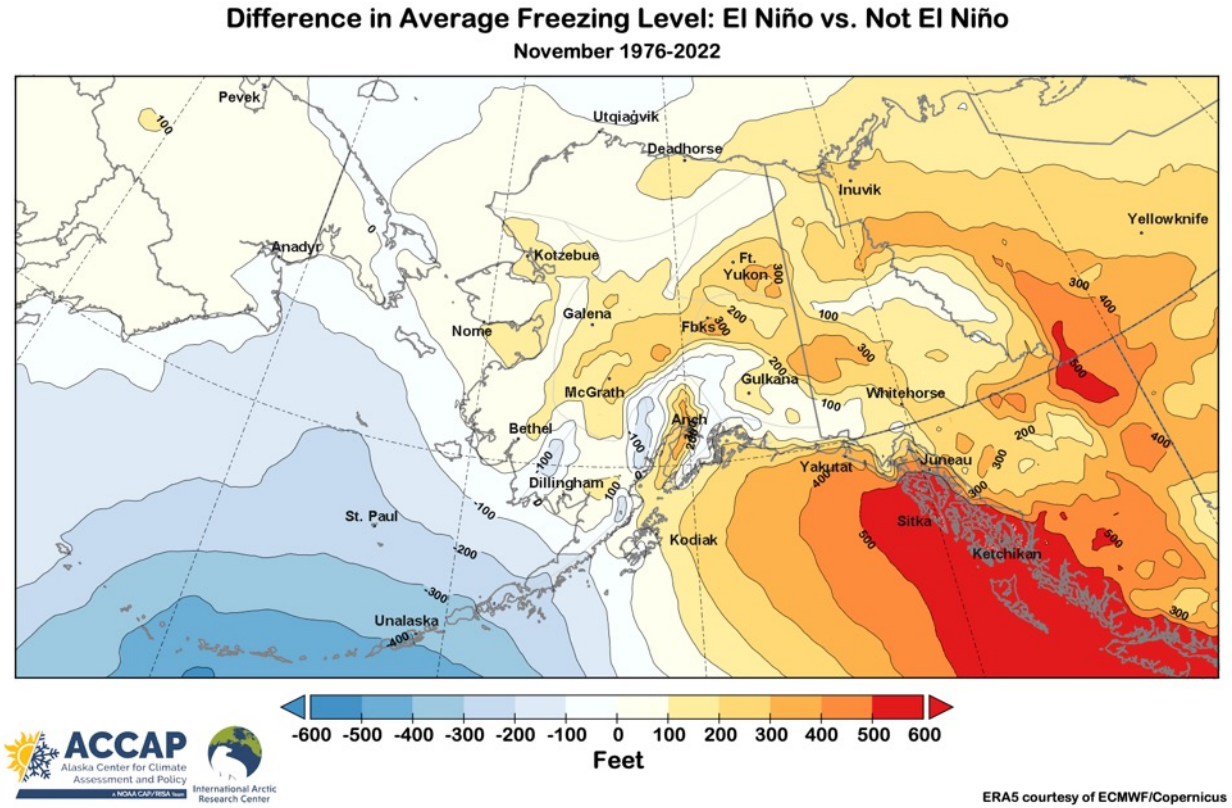


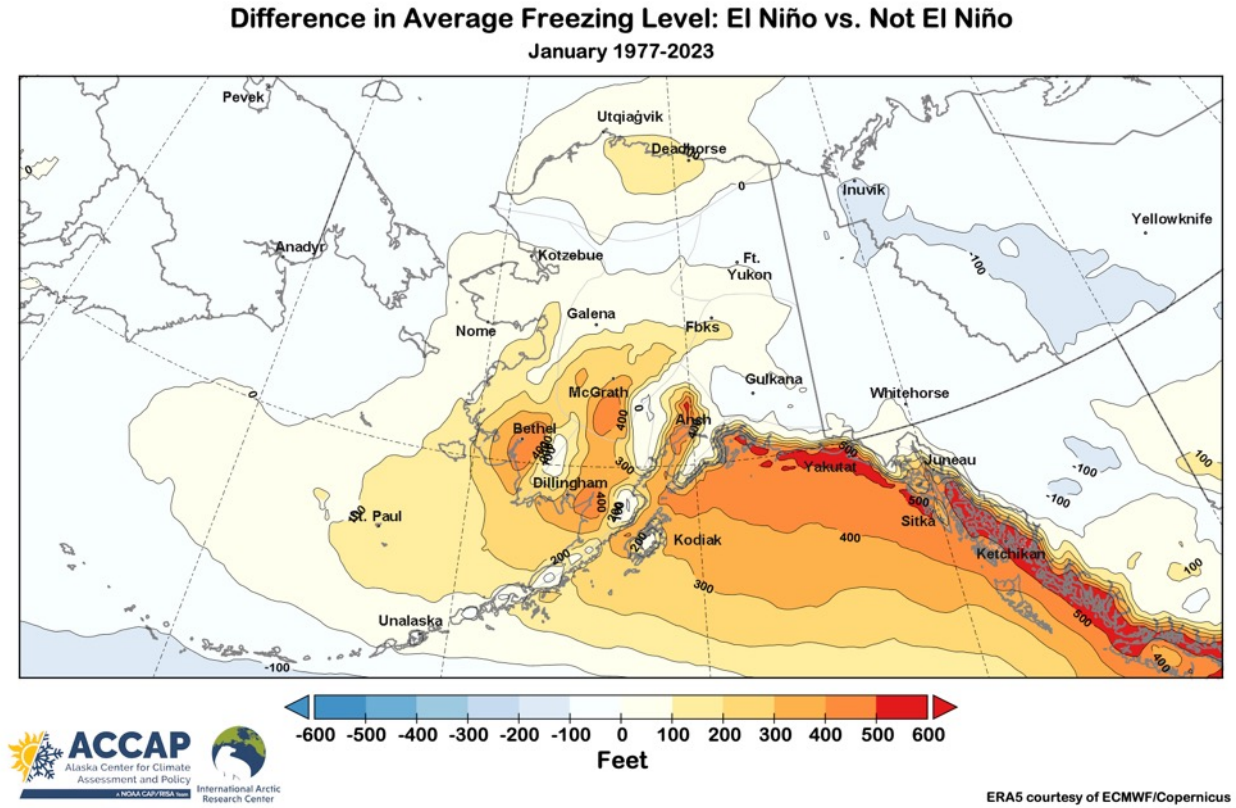
# Snow during El Niño Winters



# Freezing Level During El Niño

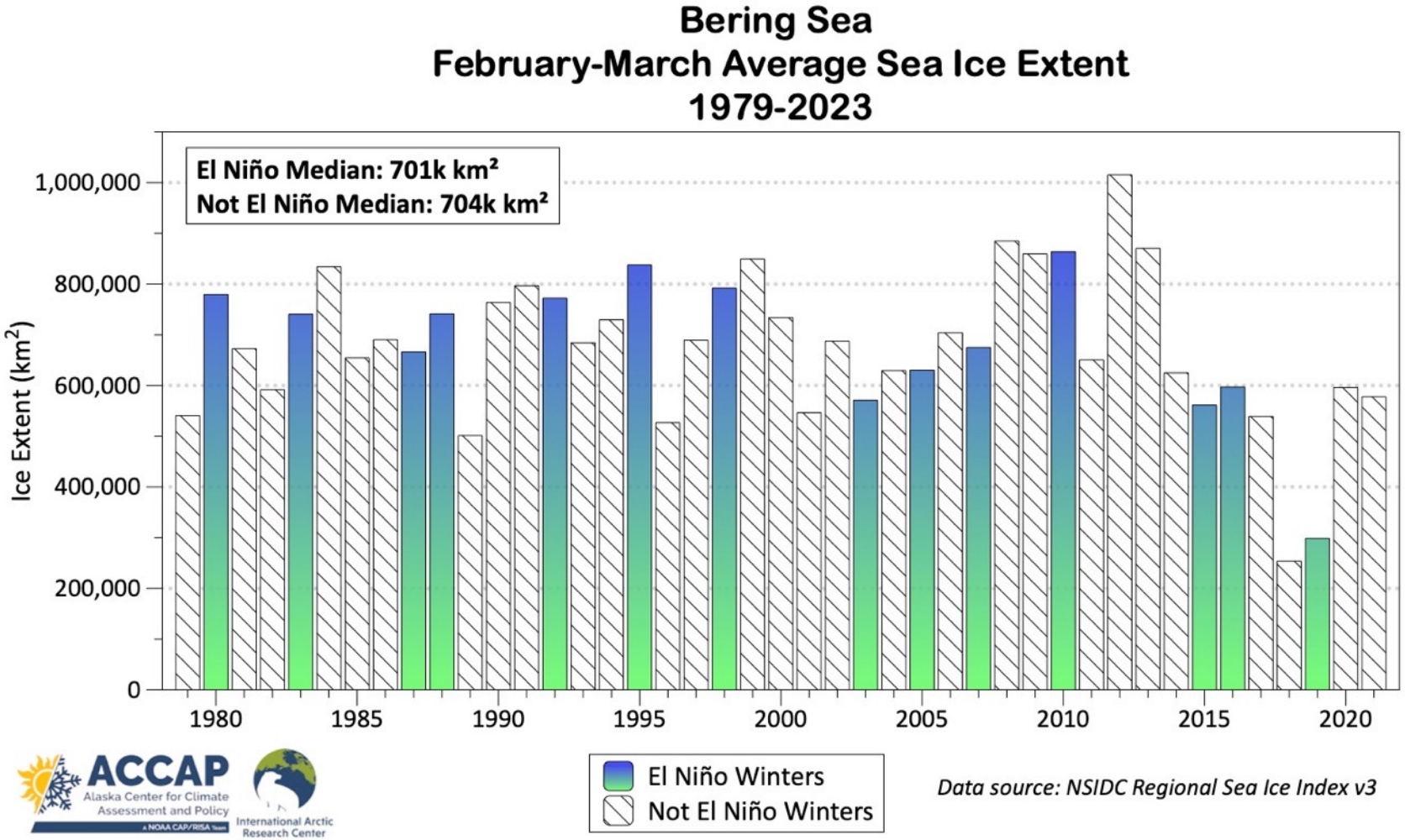



**November**

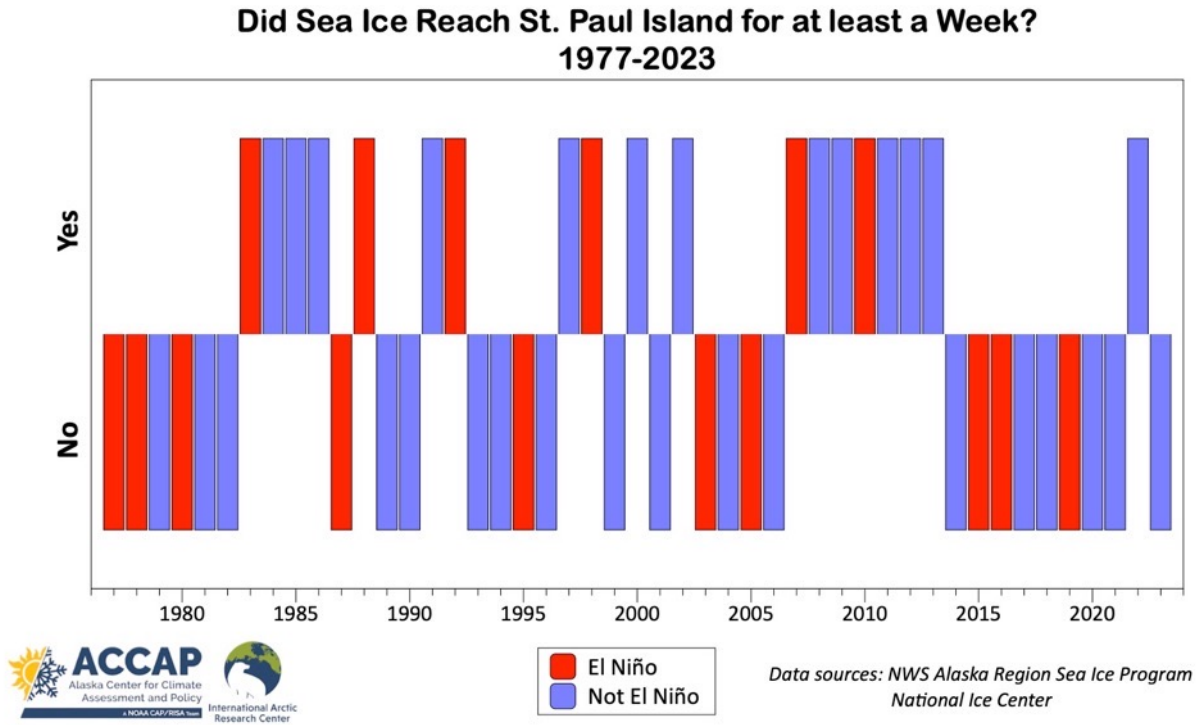
**January**

# Bering Sea Late Winter Sea Ice Extent



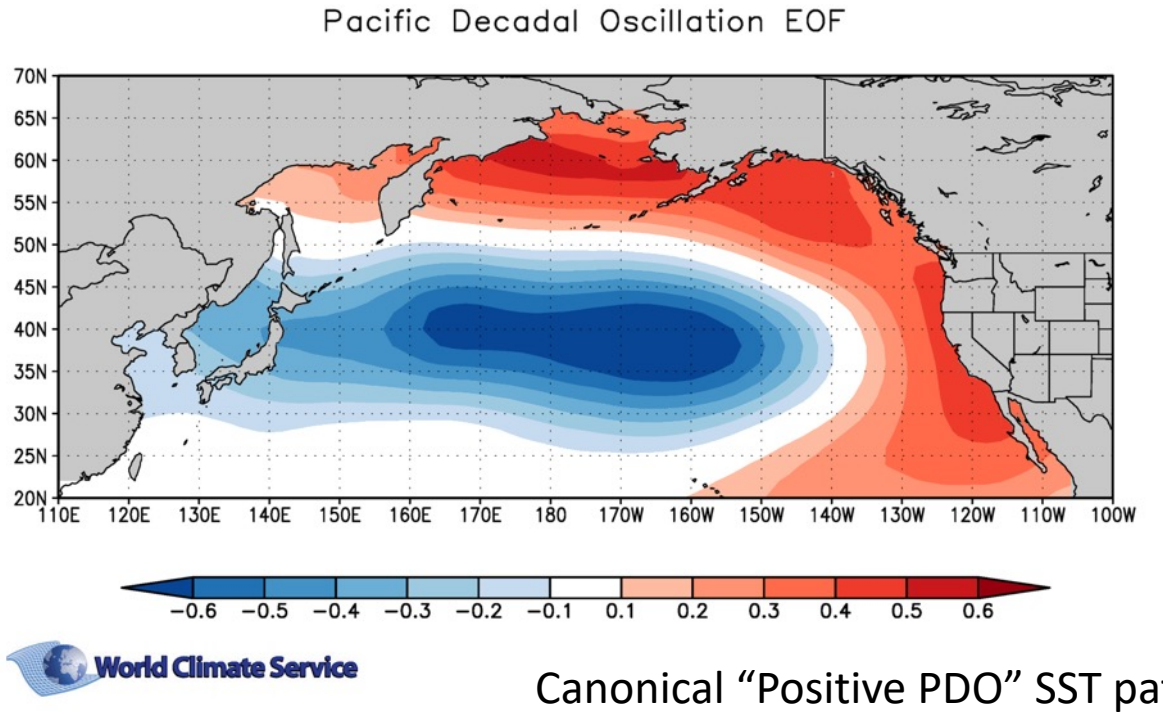
# Late Winter/Spring Ice to St. Paul

- No significant correlation between El Niño and sea ice reaching St. Paul
- Years with ice to St. Paul
  - 32 percent during El Niño winter
- Years without ice to St. Paul
  - 35 percent during El Niño winter



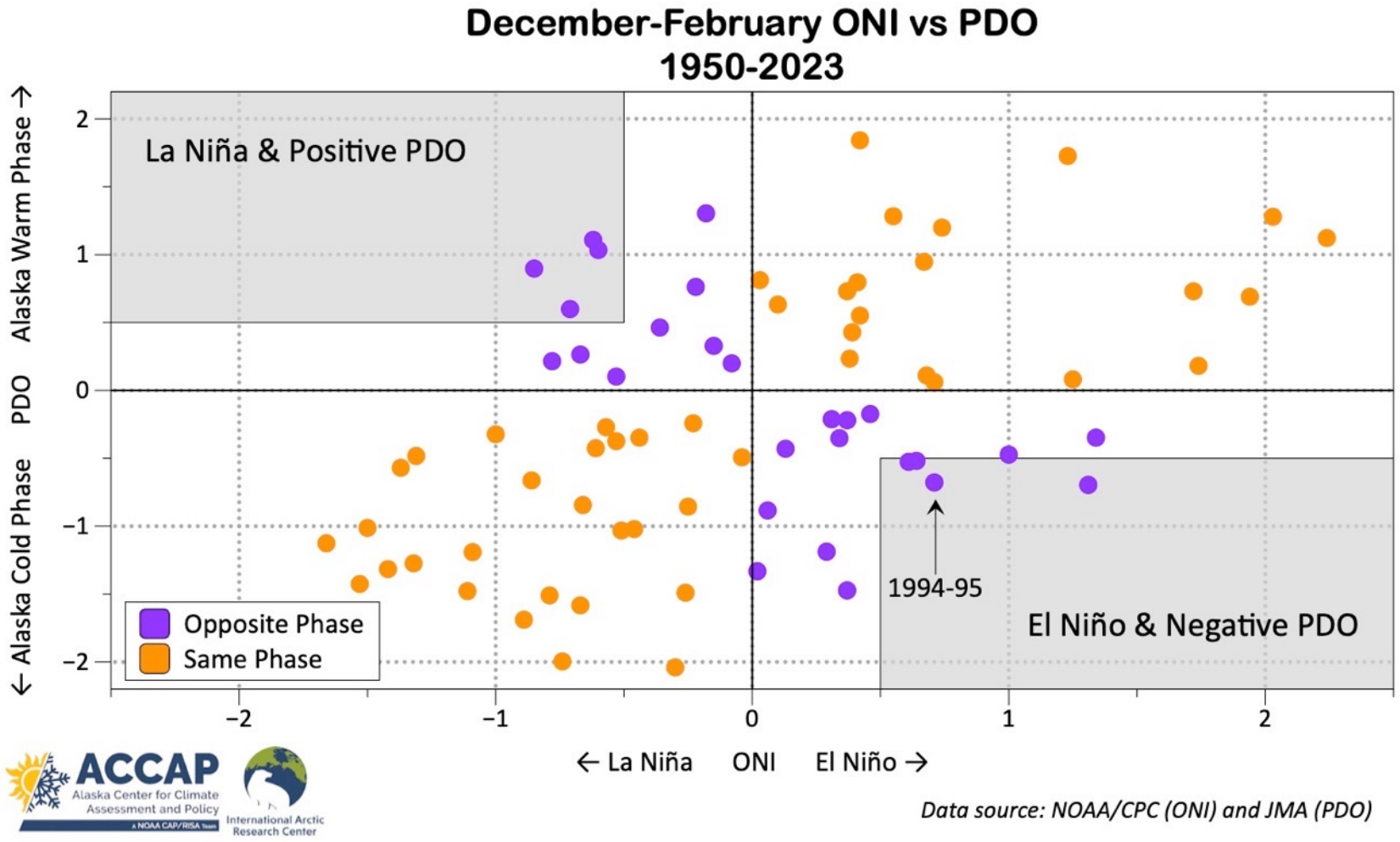
# What is the Pacific Decadal Oscillation?

- Pattern of sea surface temperatures departures in the “north” Pacific Ocean
- Times scales years to decades
- Originally uncovered in1997 salmon return studies
- Does not appear to be independent of other scale drivers
- Changing correlation with Alaska climate



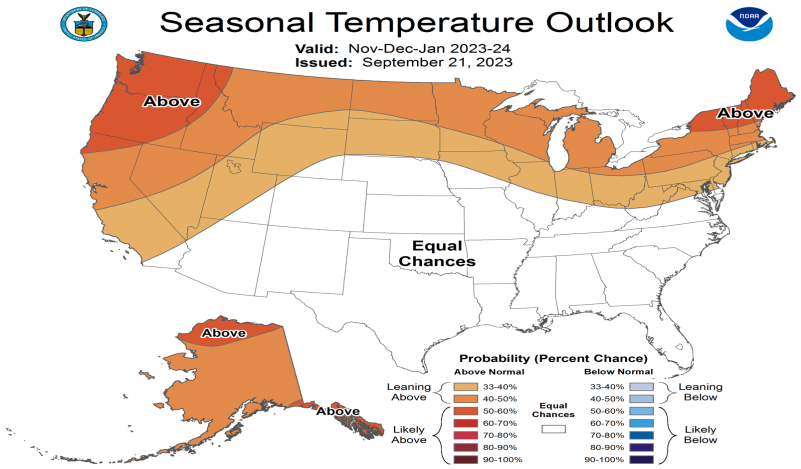

Canonical “Positive PDO” SST pattern

# ENSO vs PDO

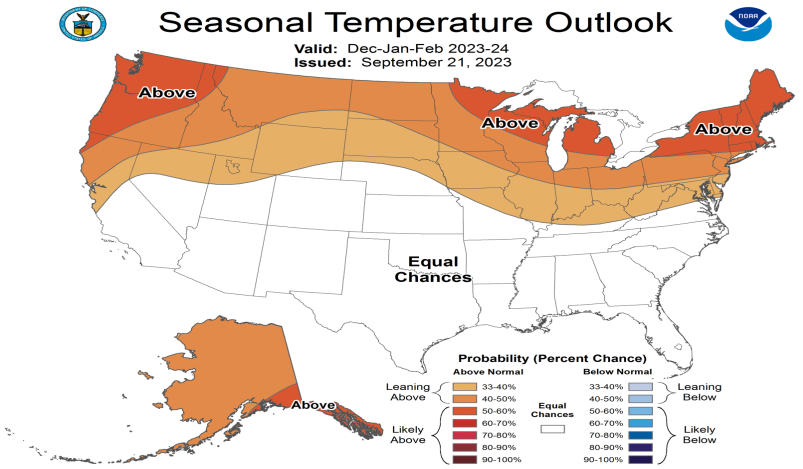

December-February ONI vs PDO
1950-2023
La Niña & Positive PDO
El Niño & Negative PDO
1994-95
Opposite Phase
Same Phase
← Alaska Cold Phase PDO Alaska Warm Phase →
← La Niña ONI El Niño →
2
1
0
−1
−2
−2
−1
0
1
2
ACCAP
Alaska Center for Climate Assessment and Policy
A NOAA CAP/RISA Team
International Arctic Research Center
Data source: NOAA/CPC (ONI) and JMA (PDO)

# CPC Temperature Outlooks Issued September 2023

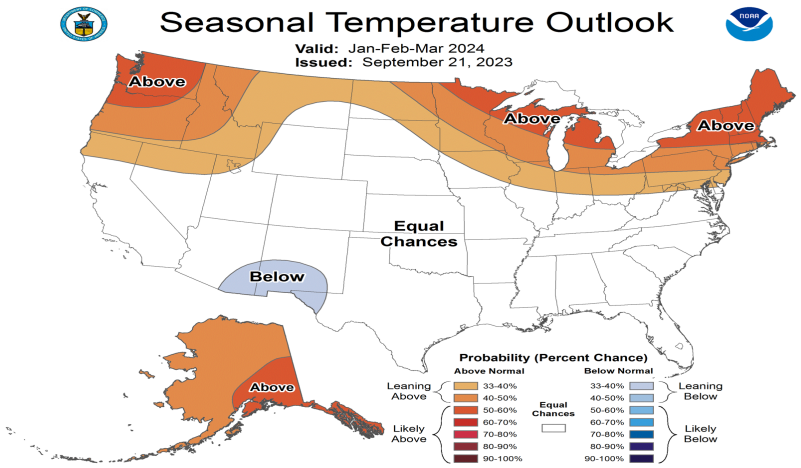
## Nov-Dec-Jan 2023-24



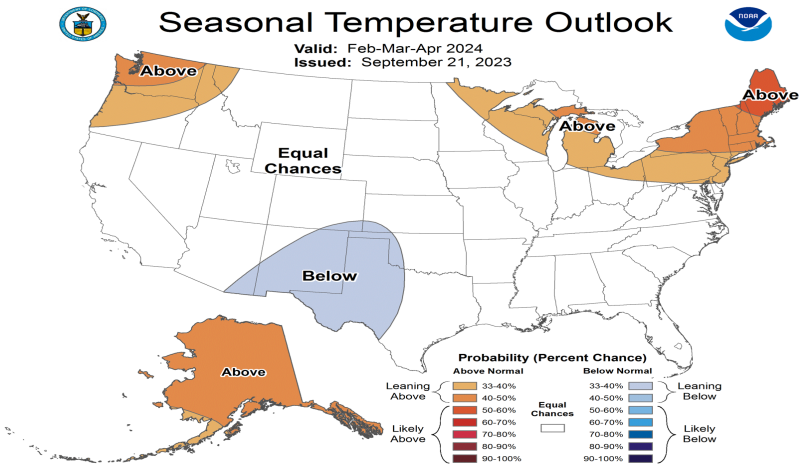

## Dec-Jan-Feb 2023-24




## Jan-Feb-Mar 2024

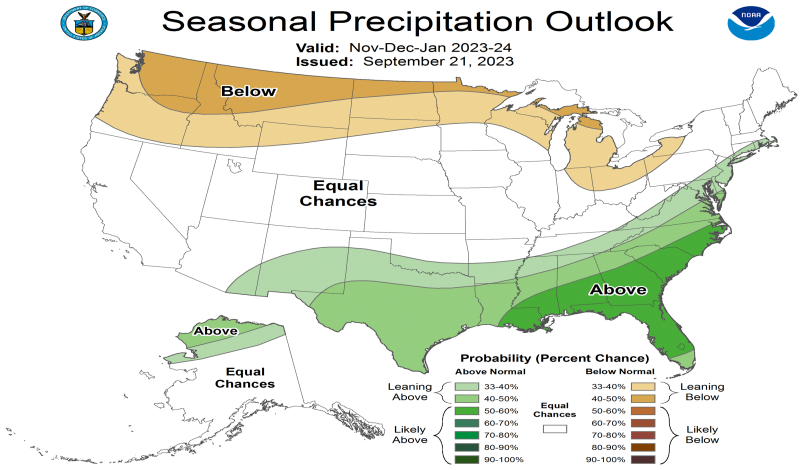



## Feb-Mar-Apr 2024

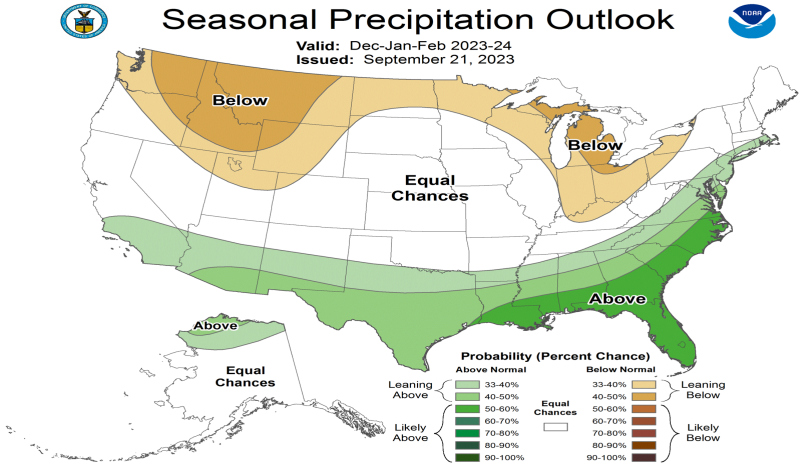


# CPC Precipitation Outlooks Issued September 2023

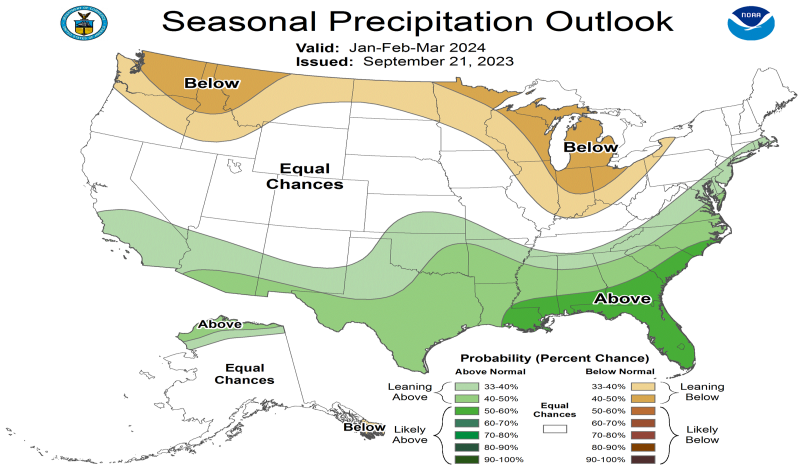
## Nov-Dec-Jan 2023-24



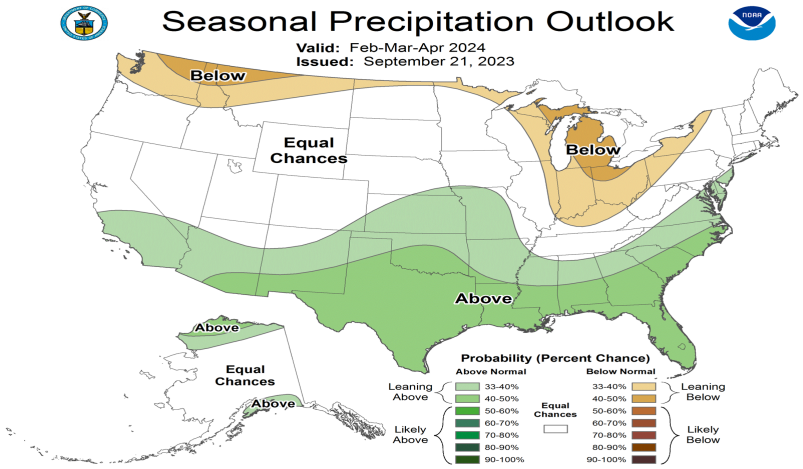

## Dec-Jan-Feb 2023-24




## Jan-Feb-Mar 2024




## Feb-Mar-Apr 2024



# Basi’
# Thank you
# Quyanaq
# Gunalchéesh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