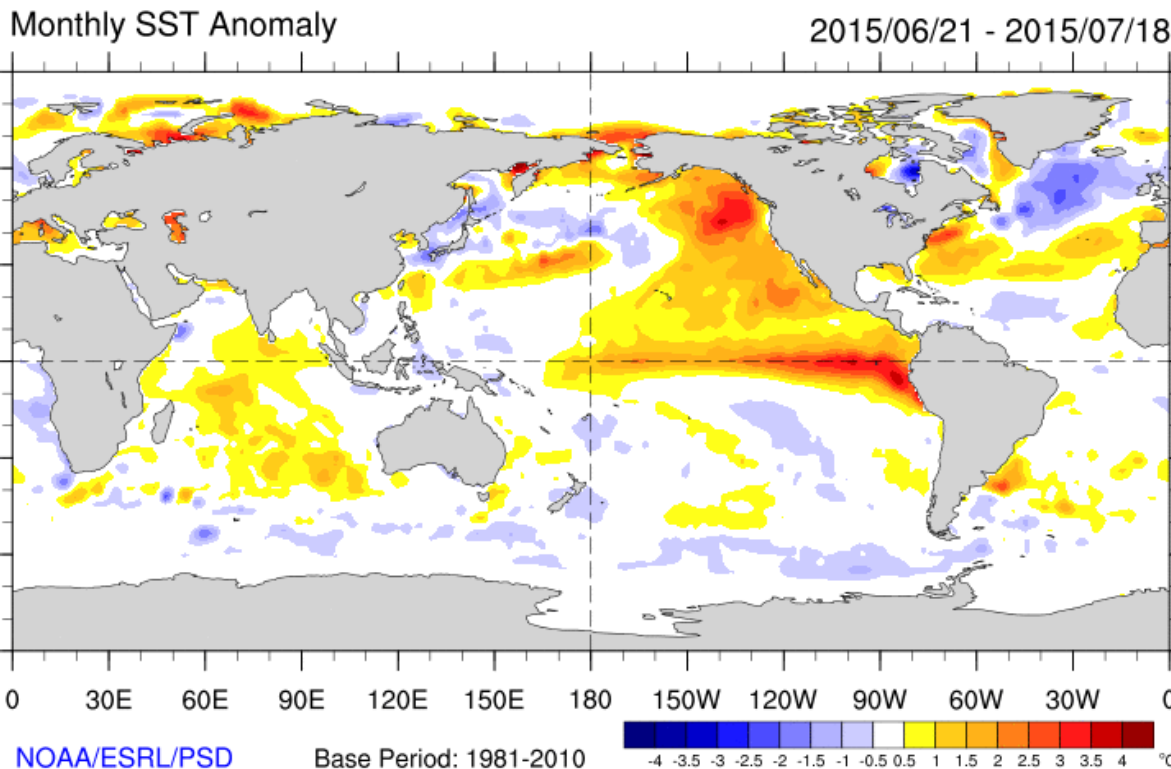


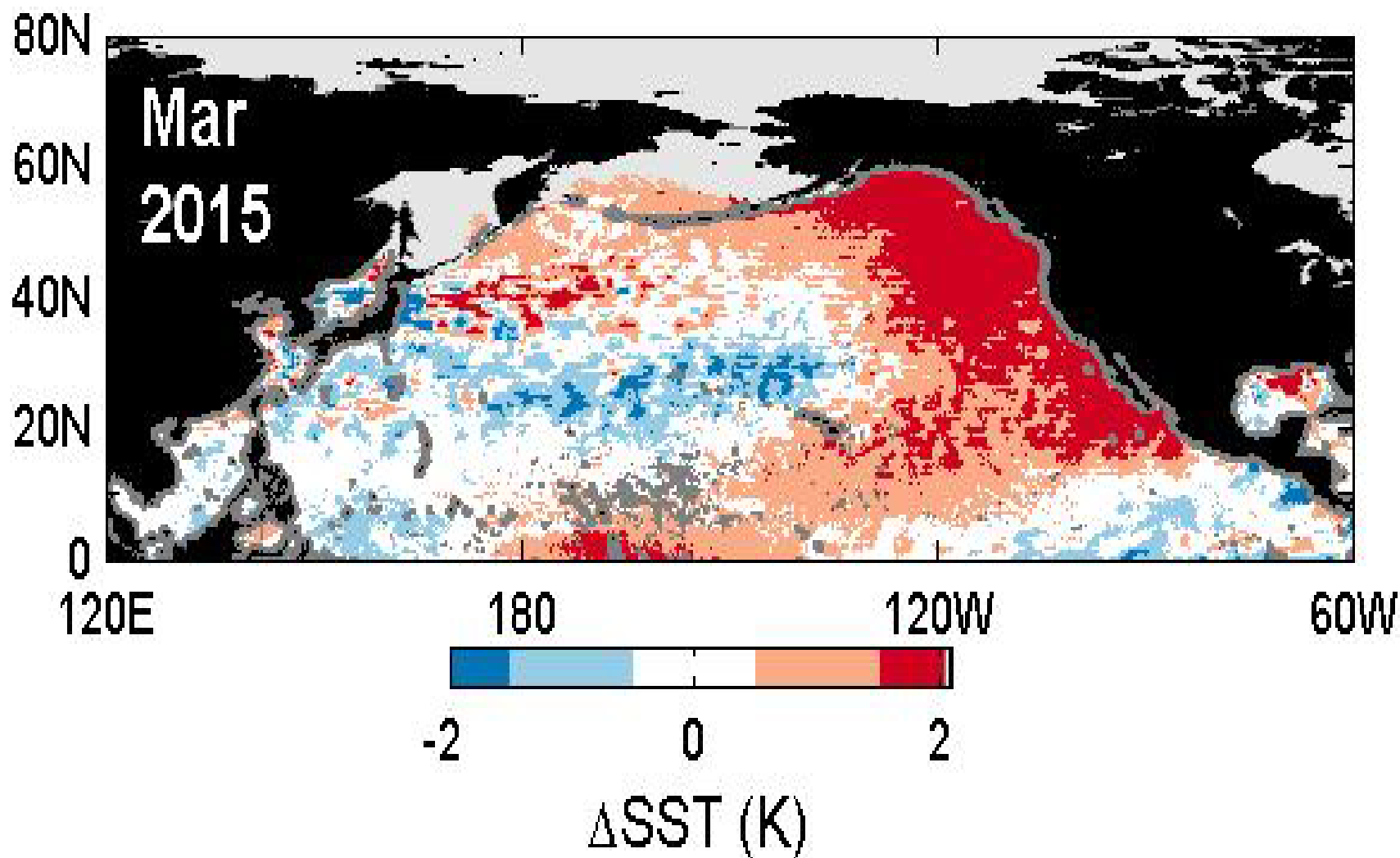
# The 2013-present Pacific SST anomaly

**Chelle L. Gentemann, Kyle Hilburn, Carl Mears**

[www.remss.com](http://www.remss.com)  
**GHR SST ESTEC 2015**



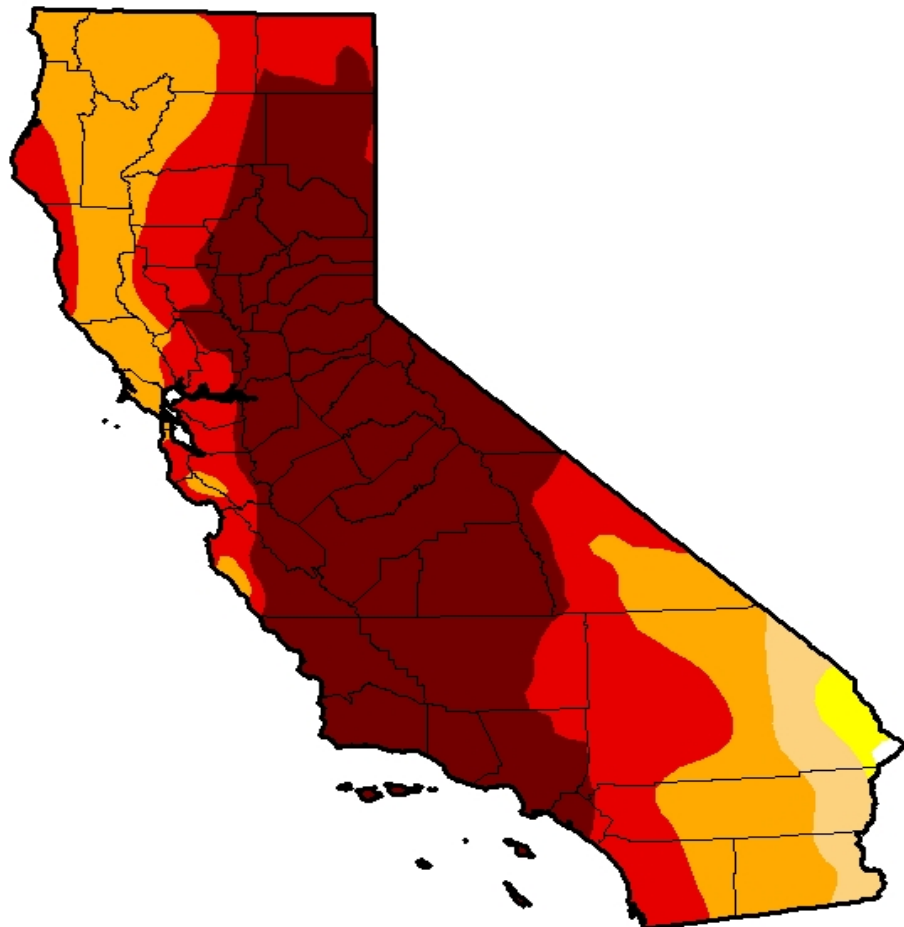
# SST anomaly



# 99.86% of California is experiencing drought

## U.S. Drought Monitor California

**July 14, 2015**  
(Released Thursday, Jul. 16, 2015)  
Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
<b>Current</b>	0.14	99.86	98.71	94.59	71.08	46.00
<b>Last Week</b> 7/7/2015	0.14	99.86	98.71	94.59	71.08	46.73
<b>3 Months Ago</b> 4/14/2015	0.14	99.86	98.11	93.44	66.60	44.32
<b>Start of Calendar Year</b> 12/31/2014	0.00	100.00	98.12	94.34	77.94	32.21
<b>Start of Water Year</b> 9/30/2014	0.00	100.00	100.00	95.04	81.92	58.41
<b>One Year Ago</b> 7/15/2014	0.00	100.00	100.00	100.00	81.85	36.49

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

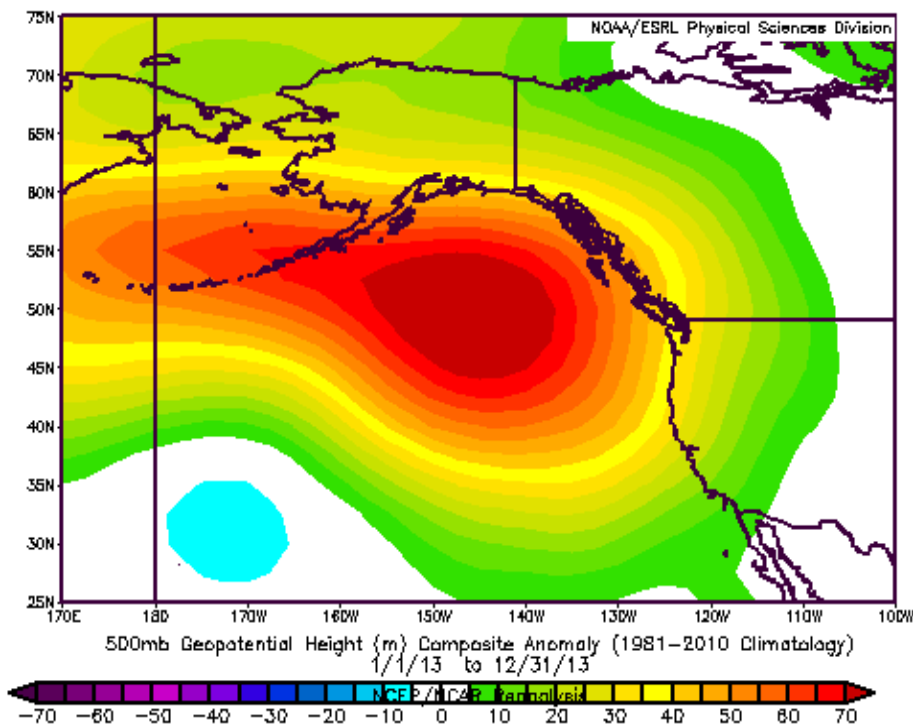
**Author:**  
David Simeral  
Western Regional Climate Center



<http://droughtmonitor.unl.edu/>

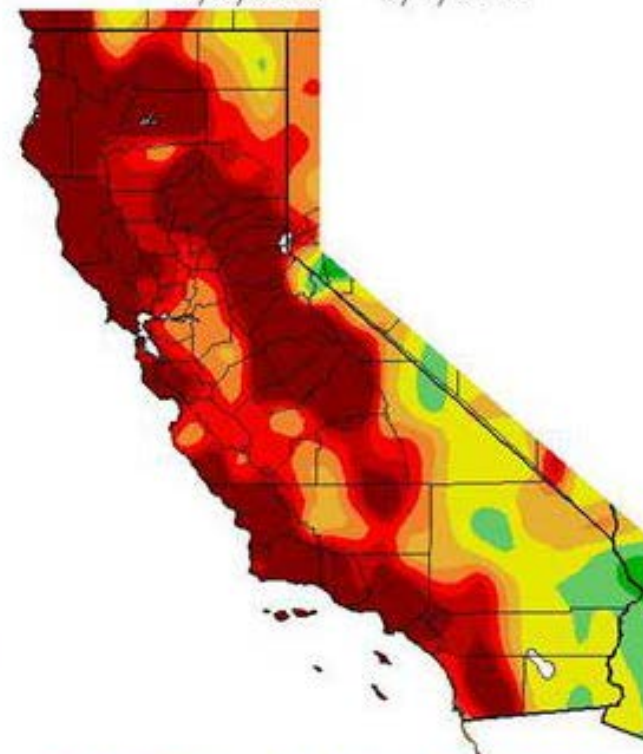
# 74.25% of the West is experiencing drought

# Why the drought?



**Ridiculously Resilient Ridge (RRR)**

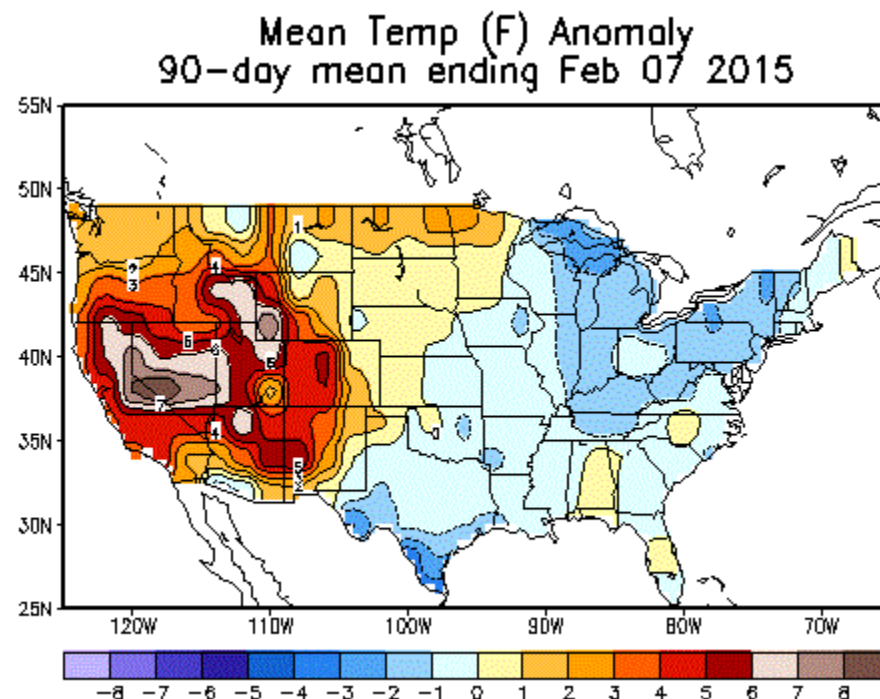
Precipitation Departure from Average (in.)  
3/2/2012 - 3/1/2015



Generated 3/02/2015 at WRCC using provisional data.  
NOAA Regional Climate Centers

# AND warm temperatures

- California & Washington have had their warmest winter on record





# AND warm temperatures



- MODIS data showing the Sierra snow pack in July 2, 2011 and Jun 24, 2014



**Starving sea birds  
Washing up on shore  
Unprecedented mortality**

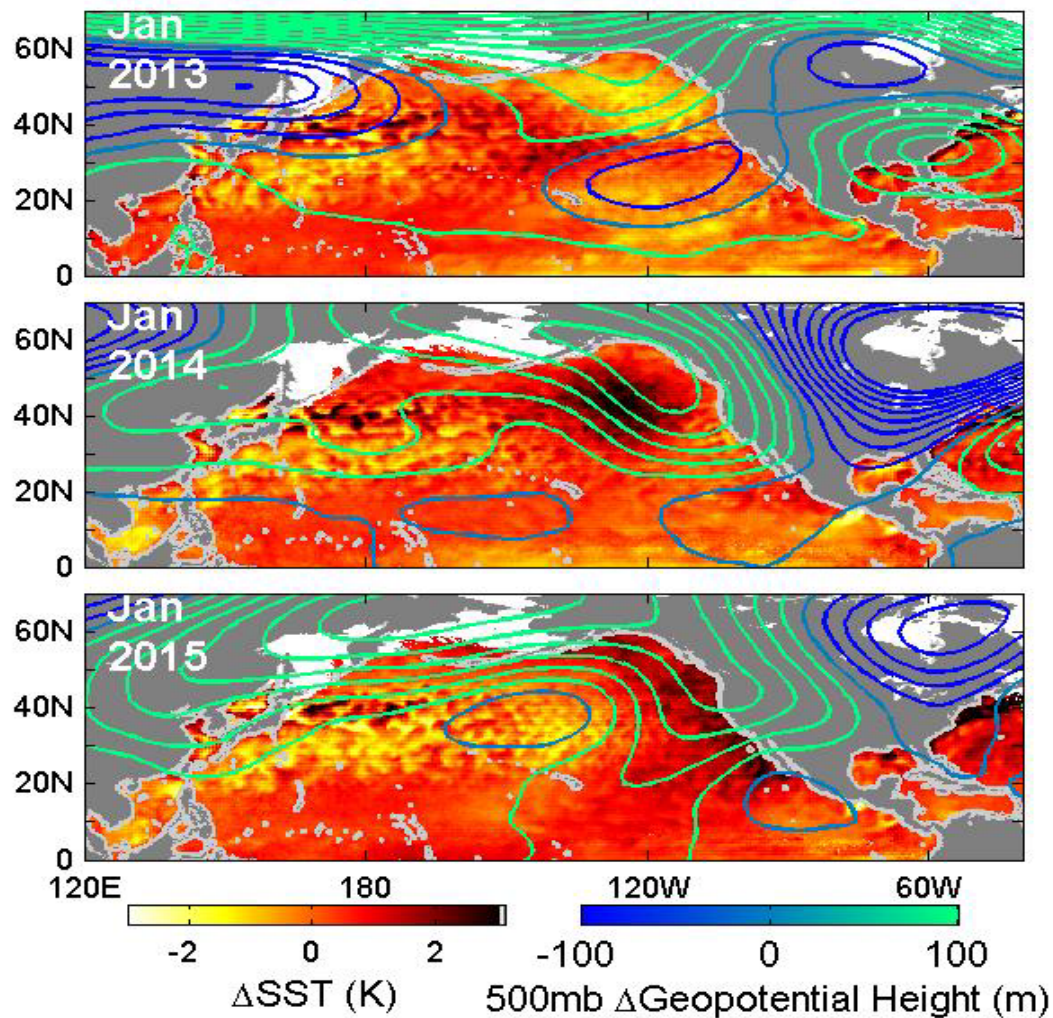


**Starving sea lion pups  
Washing up on shore 3<sup>rd</sup>  
year in a row, 50% mortality**





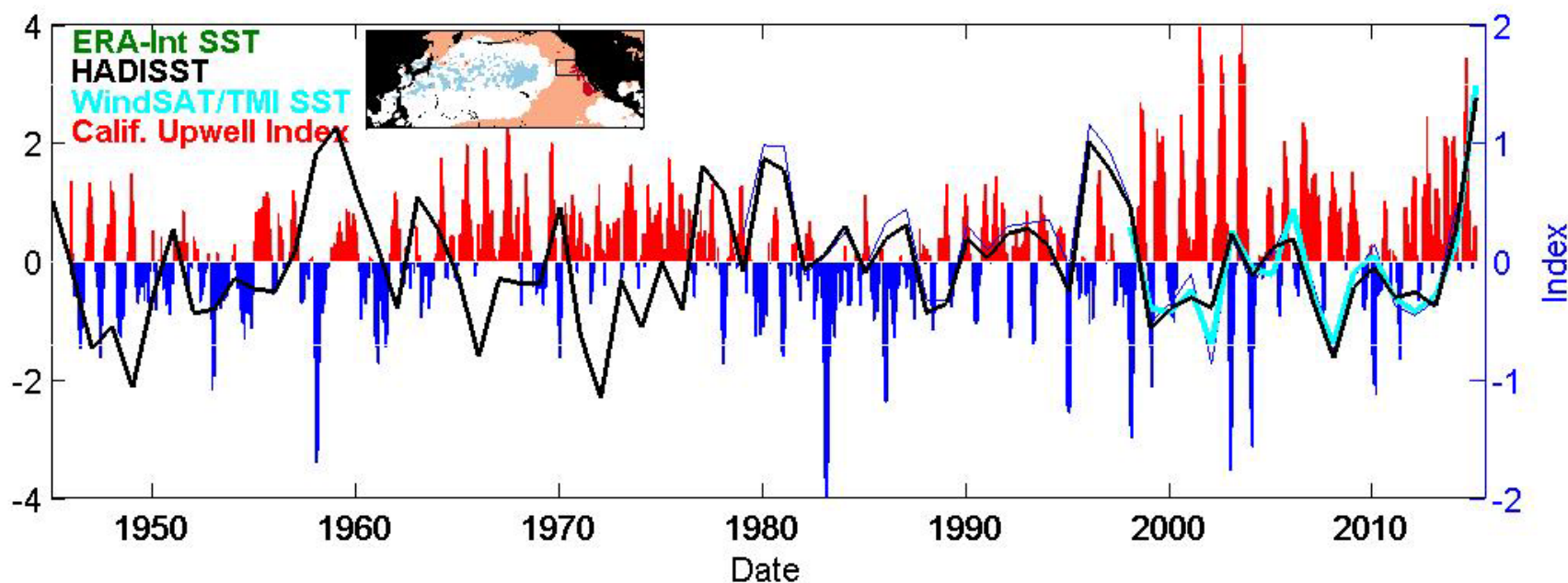
# Air-Sea & Sea-Air



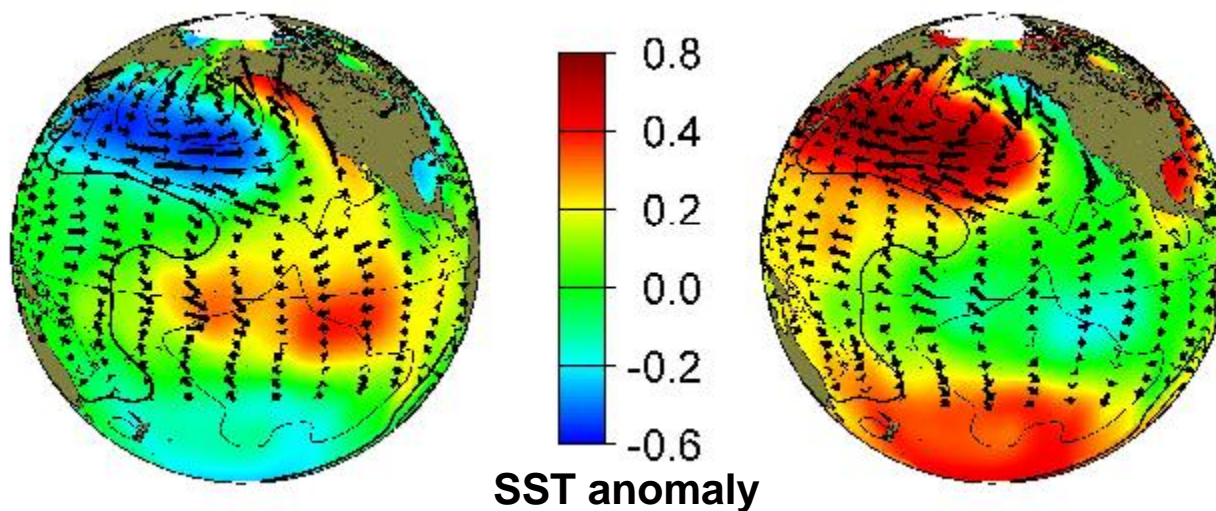


# Is it upwelling?

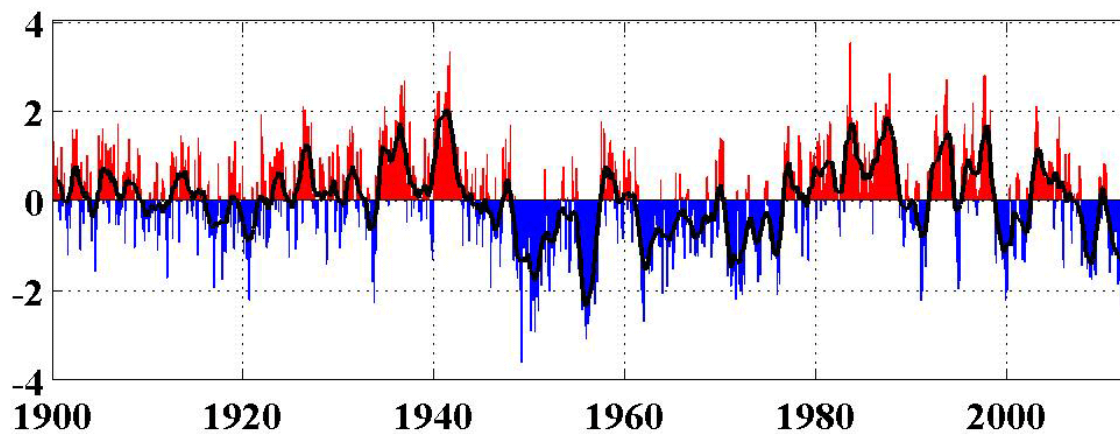
- It has been suggested that decreased upwelling has caused the SST anomaly
  - Over a much larger area than upwelling normally impacts
  - Upwelling index (based on wind/pressure) shows a POSITIVE anomaly



# Is it the PDO?



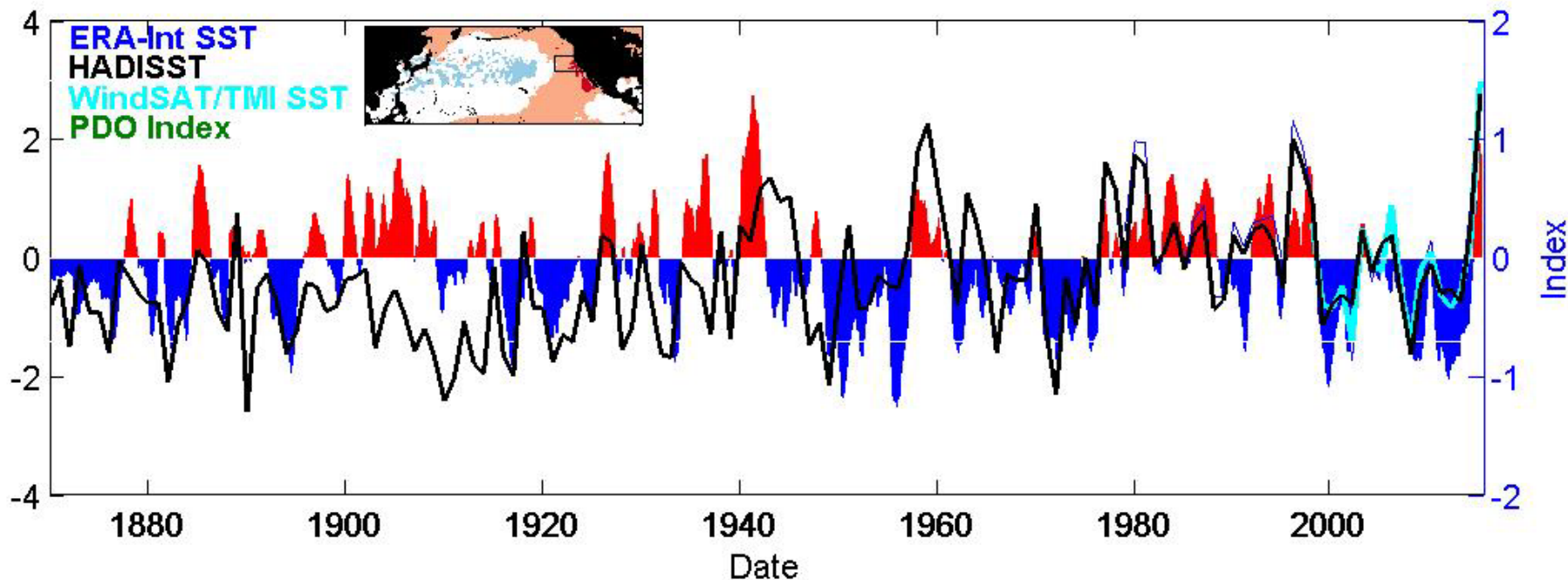
monthly values for the PDO index: 1900-2013



# Causes/Impacts 2014 Warm Anomaly in NE Pacific (Bond, 2015)

- Strongly positive temperature anomalies developed in the NE Pacific Ocean during the boreal winter of 2013-14. Based on a mixed layer temperature budget, **these anomalies were caused by lower than normal rates of the loss of heat from the ocean to the atmosphere, and of relatively weak cold advection in the upper ocean.**
- Both of these mechanisms can be attributed to an unusually strong and persistent weather pattern featuring much higher than normal sea level pressure over the waters of interest. This anomaly was the greatest observed in this region since at least the 1980s. The region of warm SST anomalies subsequently expanded and reached coastal waters in spring and summer 2014.

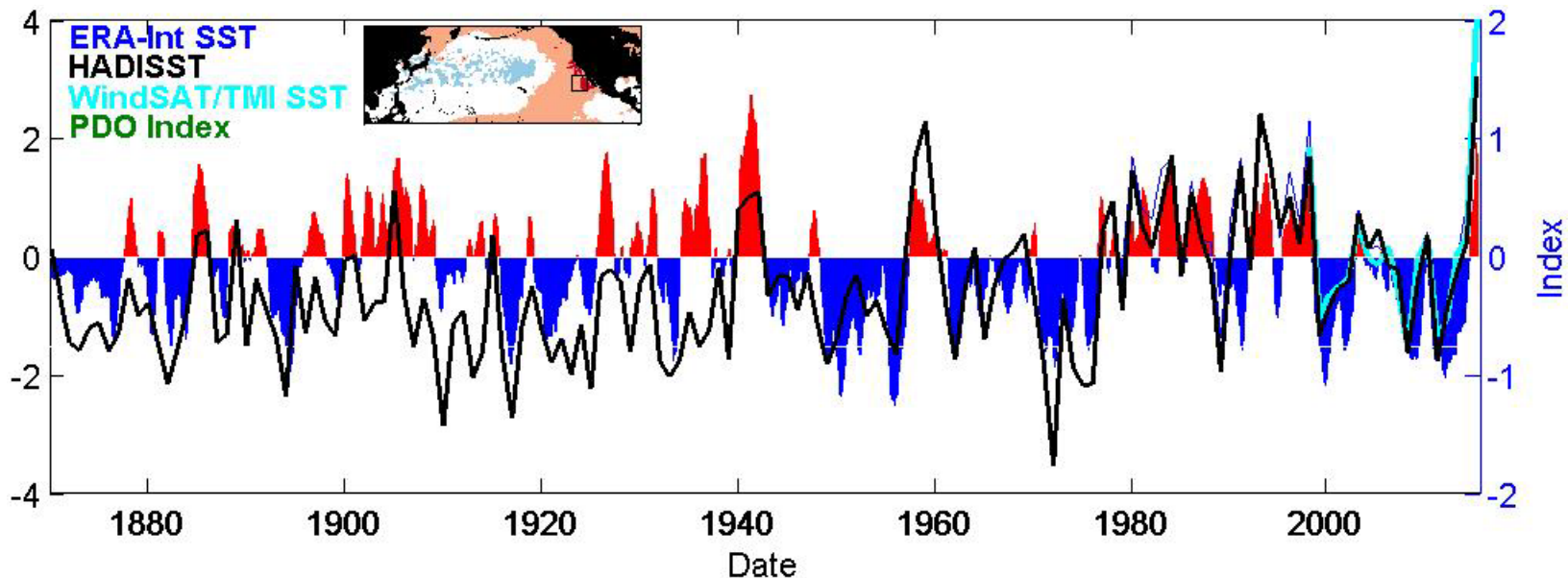
# Record warm temperatures with record warm SST anomaly



- Super PDO 1940, SST anomaly < current
- Large PDO in 80s, with positive SST anomalies
- Largest SST anomalies 2015, 1958, 1998

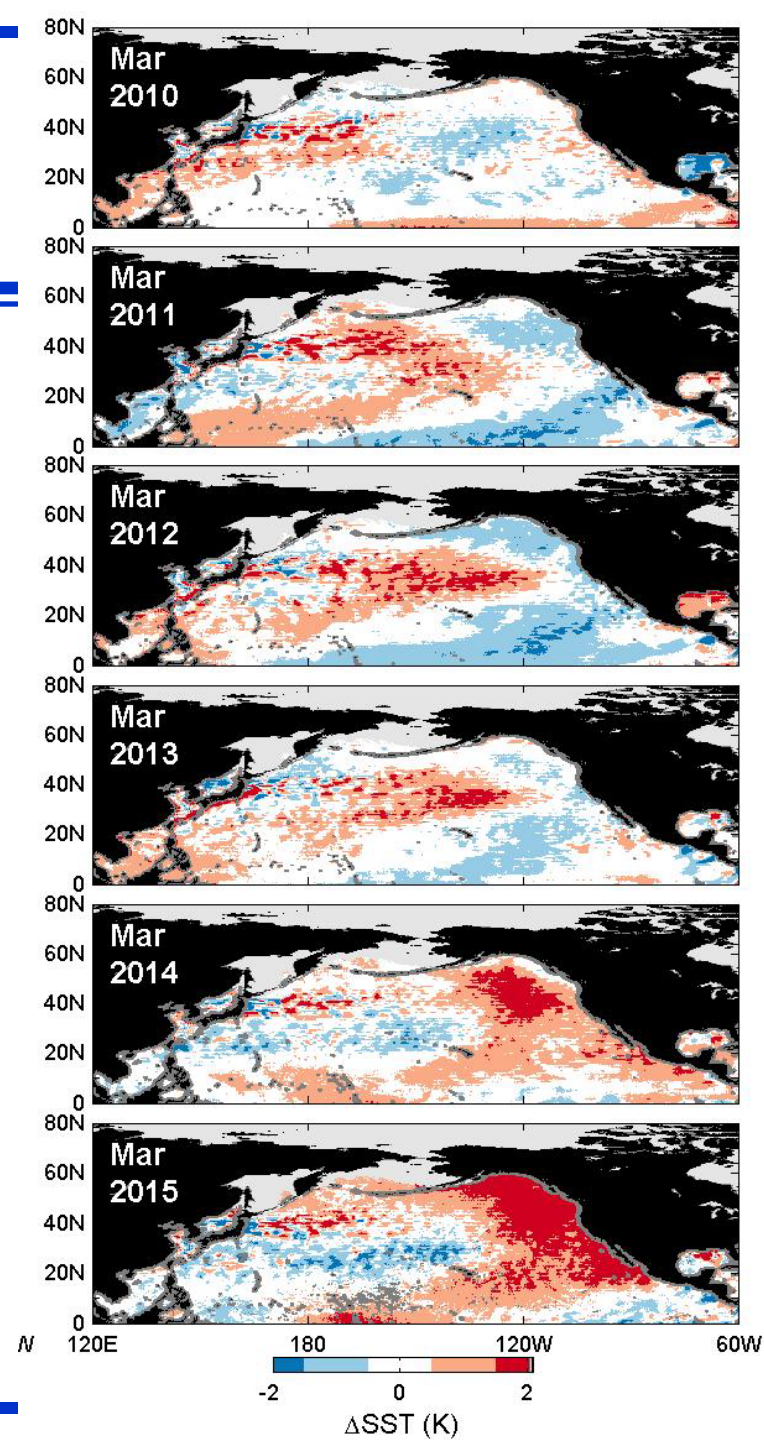


# Consistent result

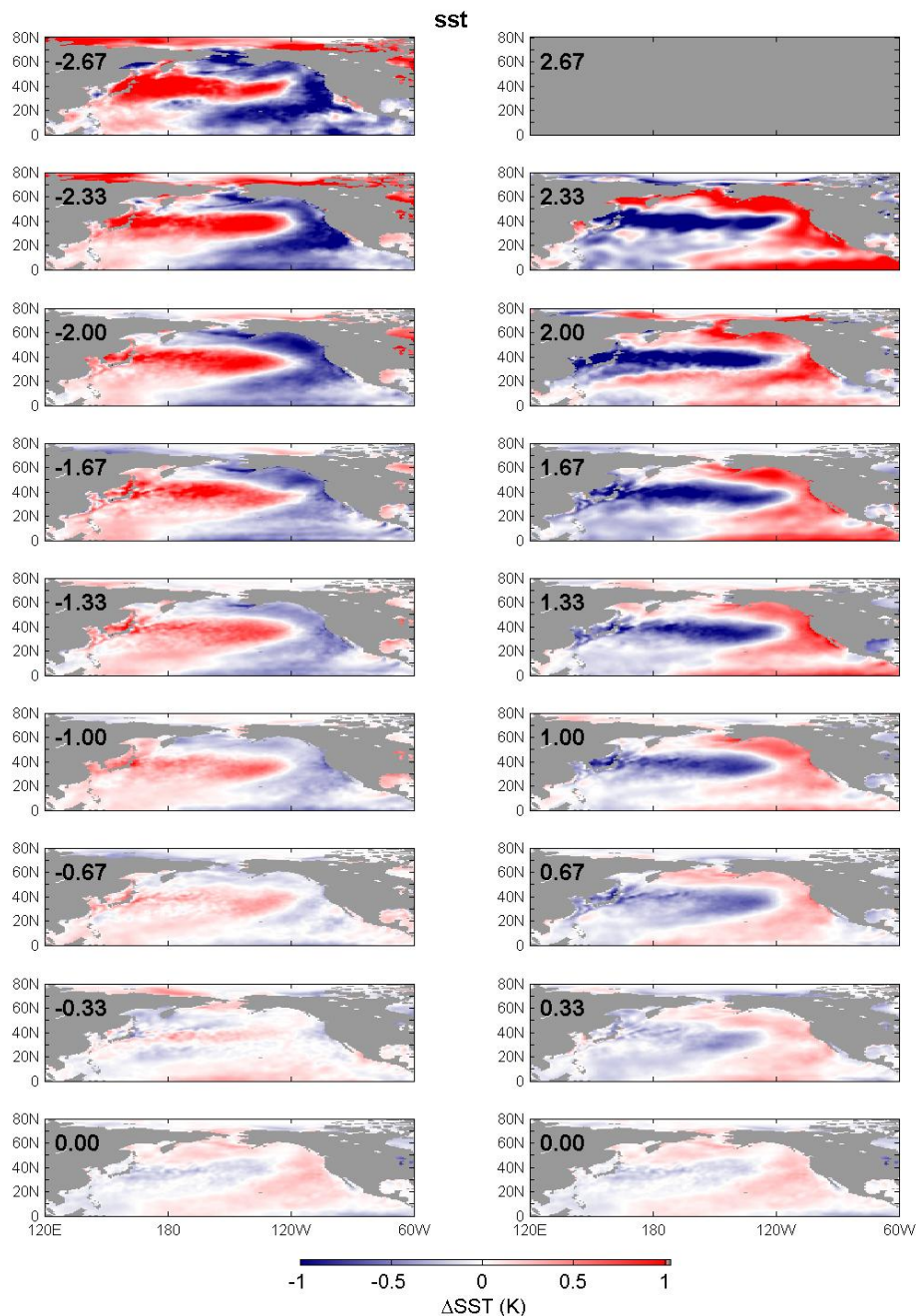


- Why super PDO in 1940 so different than later PDO anomalies
- Are we in 1958 PDO or 1980 PDO (start of decade long positive anomalies)

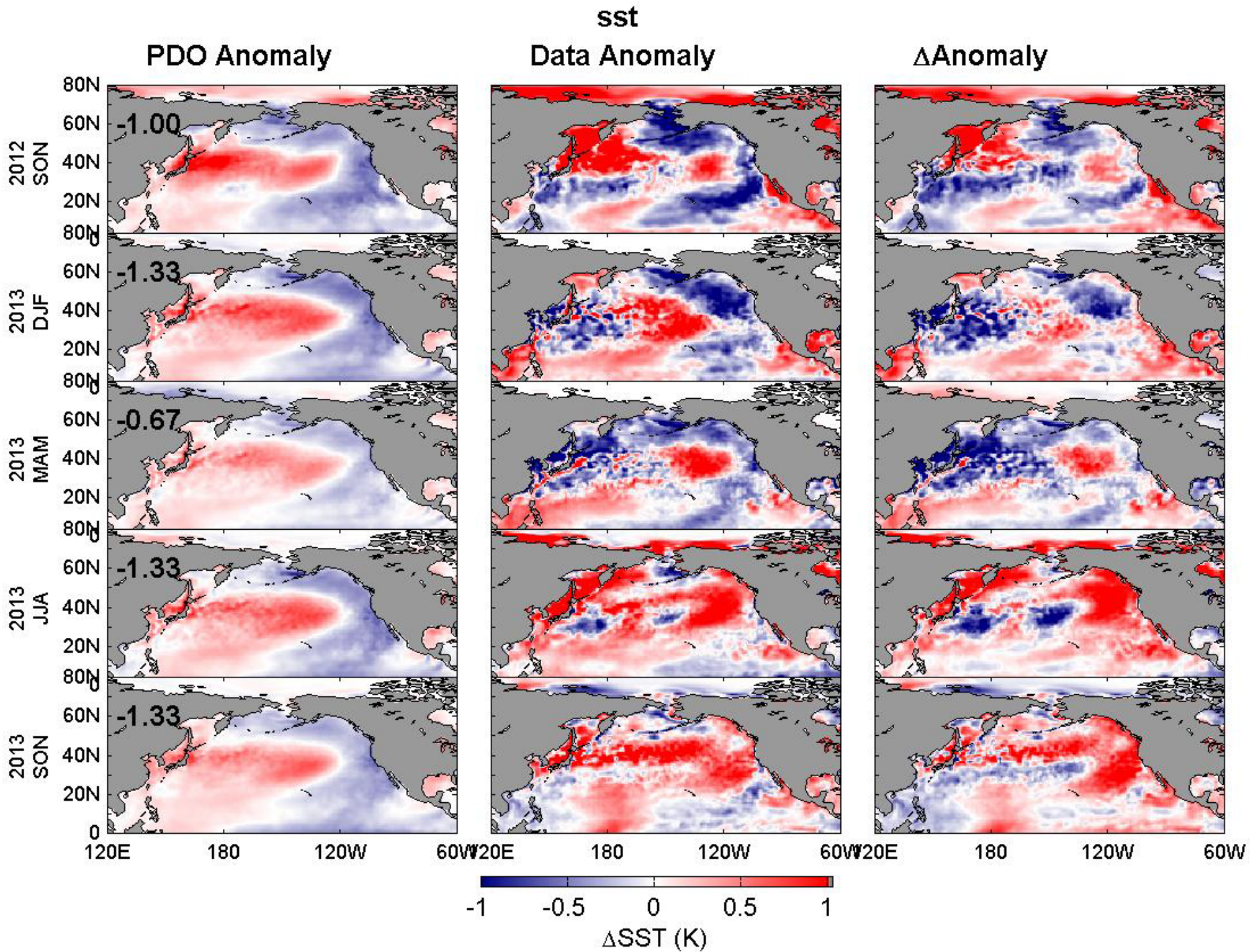
- Blob first identified  
Nov/Dec 2013
- Well developed in 2014  
when PDO still negative



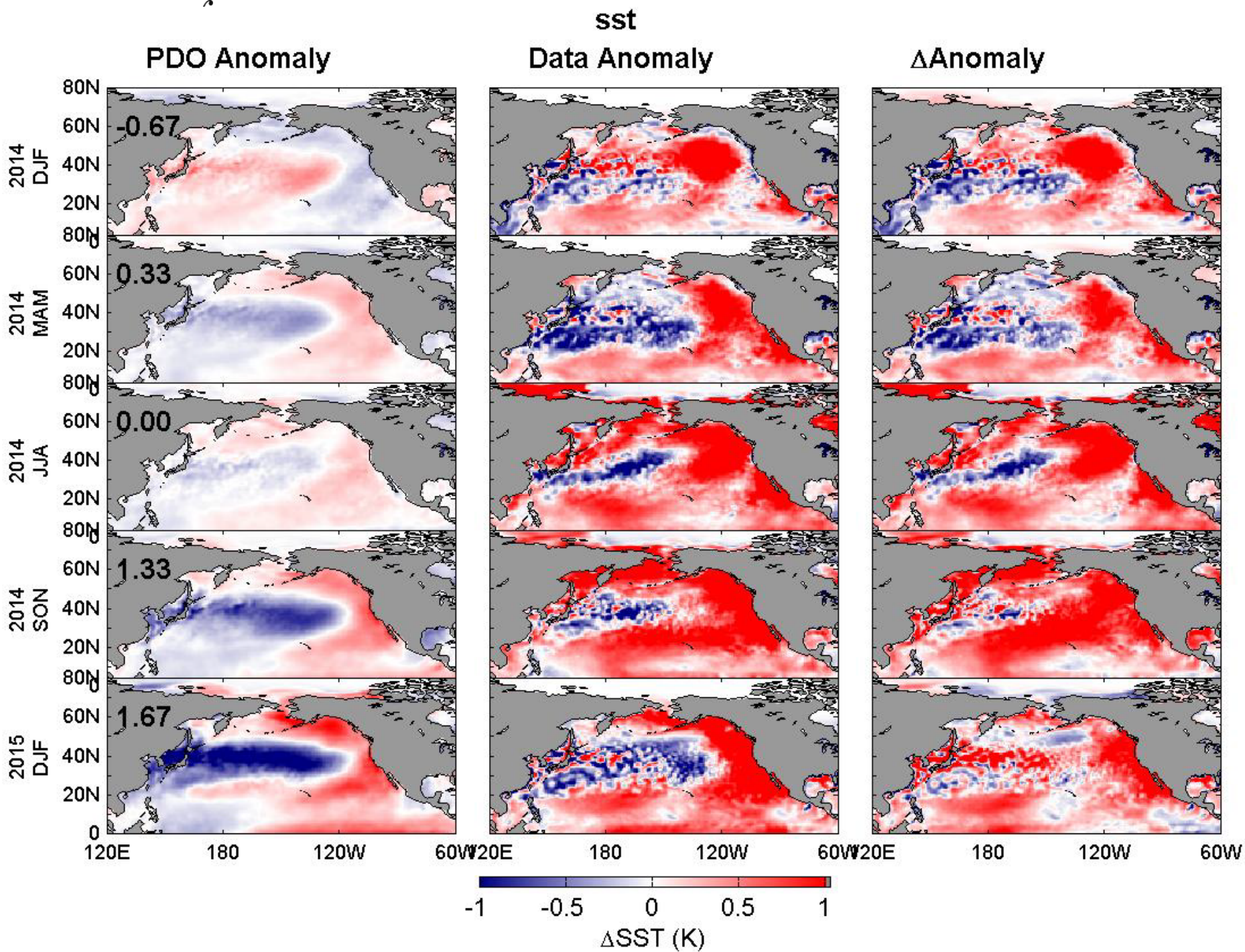
- Using HADISST looked at SST patterns for different PDO values to find average PDO pattern in SST for different PDO strengths











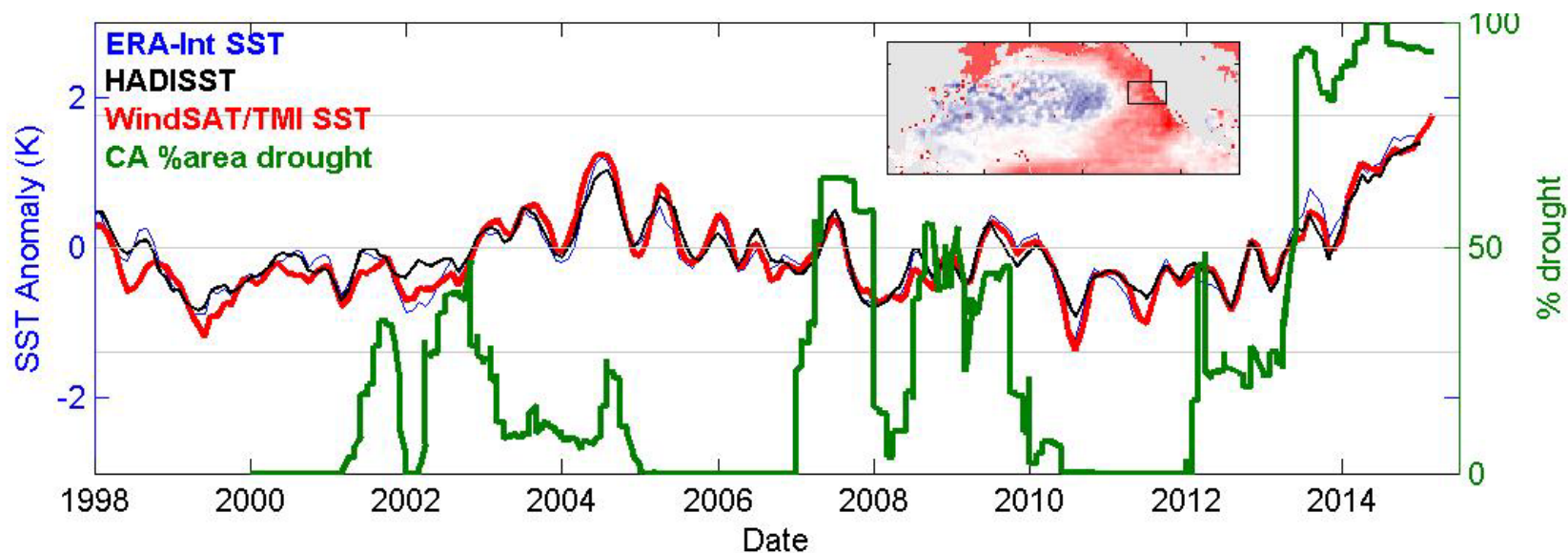


# SST anomaly

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- Can the Bond (2015) explanation explain all the SST anomaly that developed and expanded in 2014/5?
- Still atmospheric affect or advection now

# SST and CA drought





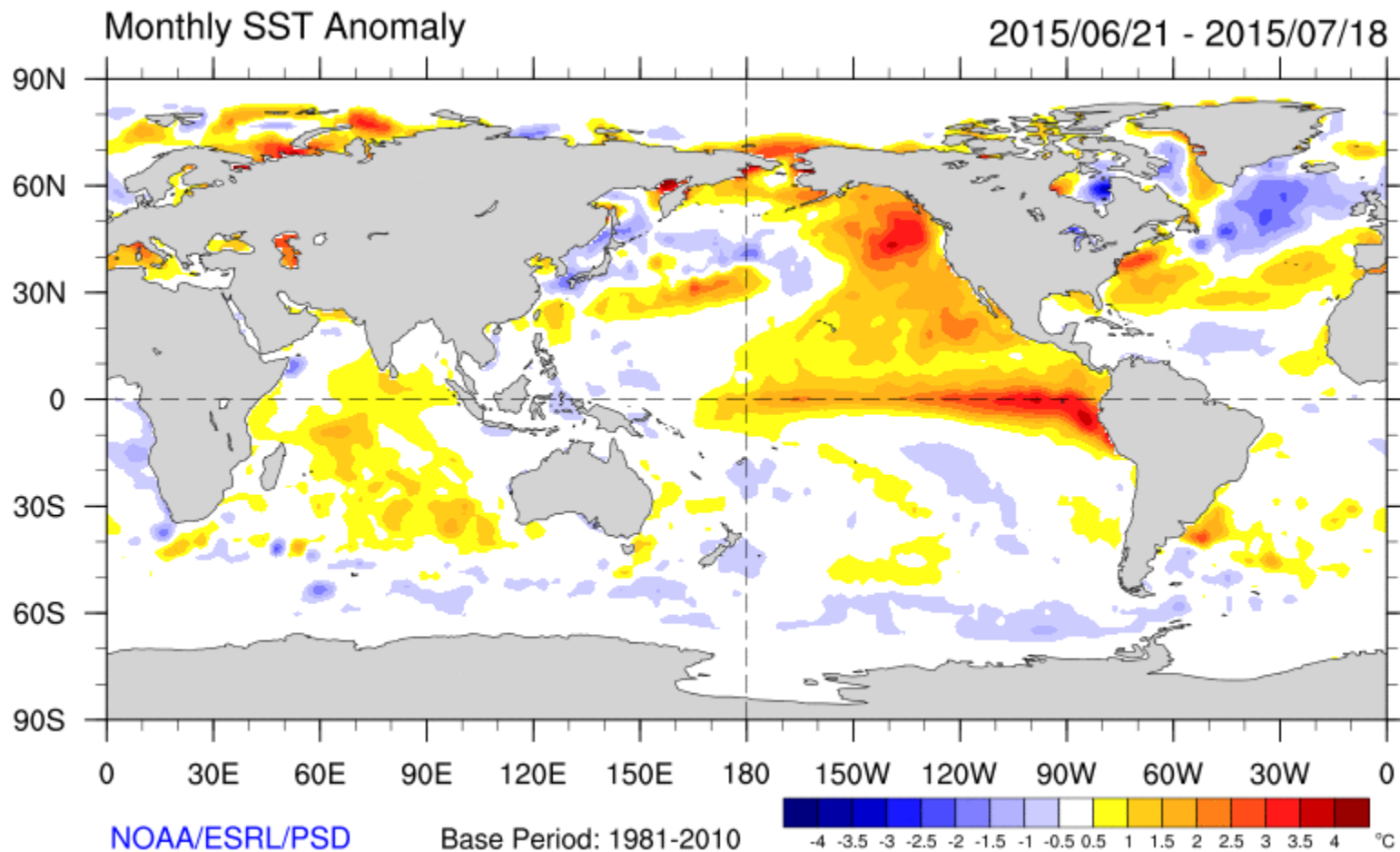
# PDO PDSI

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- Correlation between PDO and PDSI, but the physical mechanism is not the anomalous SSTs but the anomalous atmospheric conditions
- 2015 Super winter on East Coast linked to warmer SSTs in NE Pacific (Hartman,2015)



# ENSO/PDO





# Our Savior???

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- Media hype
- Will blocking ridge re-establish and block the ENSO storms?
  - The recent persistence and duration of the RRR is unprecedented and not well understood
- If the ridge doesn't form, the winter should be very warm and very wet a bad combination for flooding



# Impacts

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- Earlier 9%-36% mandatory cuts
- Now mandatory 25% cut
  - 50% environmental
  - 40% agriculture (use steady, economics increase)
  - 10% urban (use steady, pop increase)
- Does the NE SST anomaly stabilize the atmospheric ridge (positive feedback cycle)?
- What is the future?





# extra

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# Box model

- We consider the heating of a volume bounded by 40 °N and 50 °N, 150 °W and 135 °W, and the air-sea interface to the depth where the density is 0.03 kg m<sup>-3</sup> greater than at the surface for the upper and lower boundary. The depth defined by the bottom boundary condition here is often referred to as the “mixed layer depth”, above which the waters are generally mixed and similar in properties to those found at the sea surface. We use a density-based definition for the mixed layer to account for the potential effects of salinity on the stratification. The value of 0.03 kg m<sup>-3</sup> is based on inspection of density profiles from GODAS for the region of interest and is consistent with a definition used by de Boyer Montegut et al. [2004]. **Temperature of the water in this box can be changed due to air-sea heat exchanges across the top surface (i.e. net surface heat fluxes), heat exchanges across the east, west, north, and south sides of the box (i.e. horizontal advection), and heat exchanges across the bottom boundary (i.e. vertical advection and mixing).**



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**Local cooling of 5.5 °C from October 2013 to February 2014 was about 30% lower than the mean, and the smallest magnitude in this record extending back to 1980. The net surface heat fluxes caused about 2 °C of cooling in 2013-14 versus a normal value of about 3 °C over the 4 month period.**

The net effect of the heat exchange at the base of the mixed layer, often termed entrainment and here estimated as a residual, was close to normal.

**The horizontal advection term was near zero; this term generally accounts for about 1 °C cooling.**

**The large interannual temperature anomaly thus appears to be due to a combination of anomalous advection and reduced surface heat loss.**