

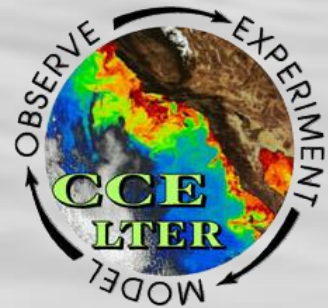
# State of the Ocean: 2014 – 2016: Persistent Marine Heat Wave Takes Hold

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[www.faralloninstitute.org](http://www.faralloninstitute.org)

Presentation to the Joint Sub-Committee on Fisheries and Aquaculture  
28 April 2016, State Capital, Sacramento , CA



**Over the past 3 years, we've observed unprecedented climate changes in the Pacific Ocean, with major impacts on California.**

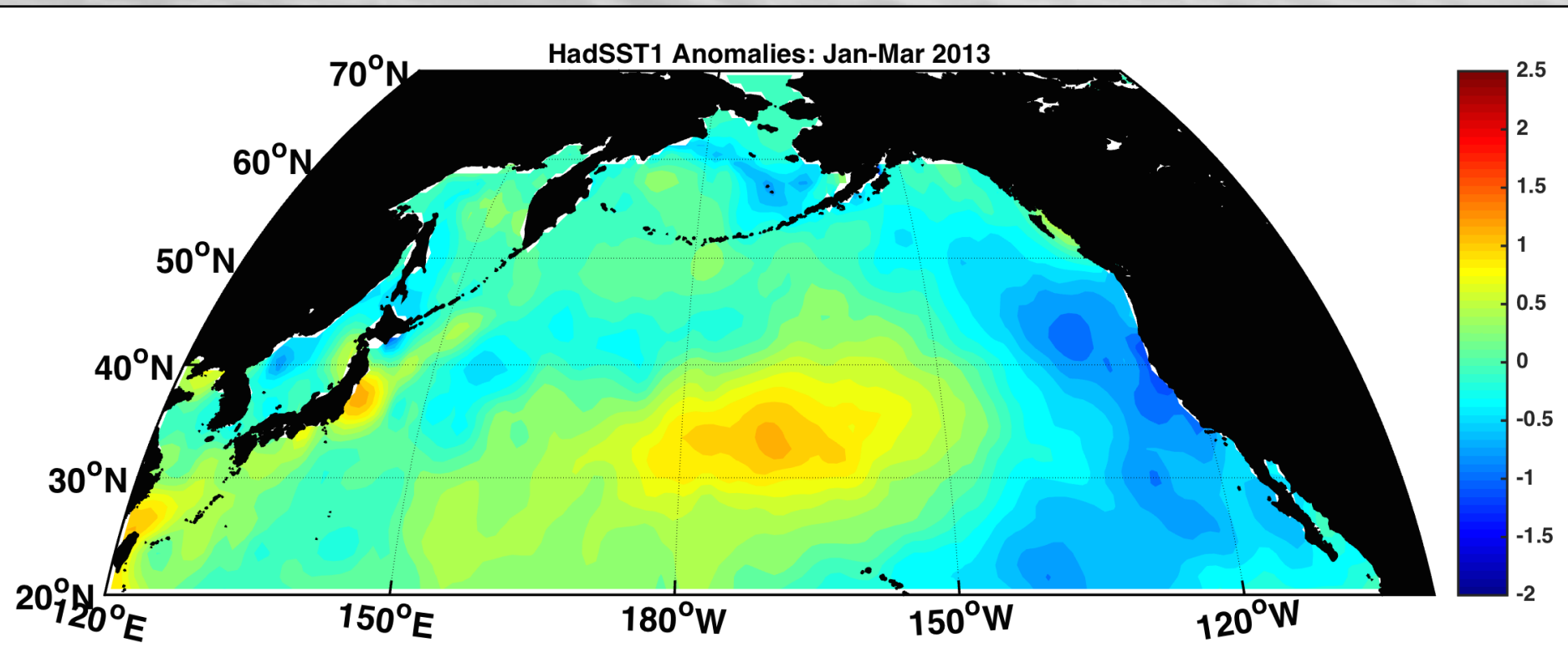
## **Talk Outline**

- 1) What happened (temperature patterns)**
- 2) Why it happened (atmospheric connections)**
- 3) Some consequences and what next?**

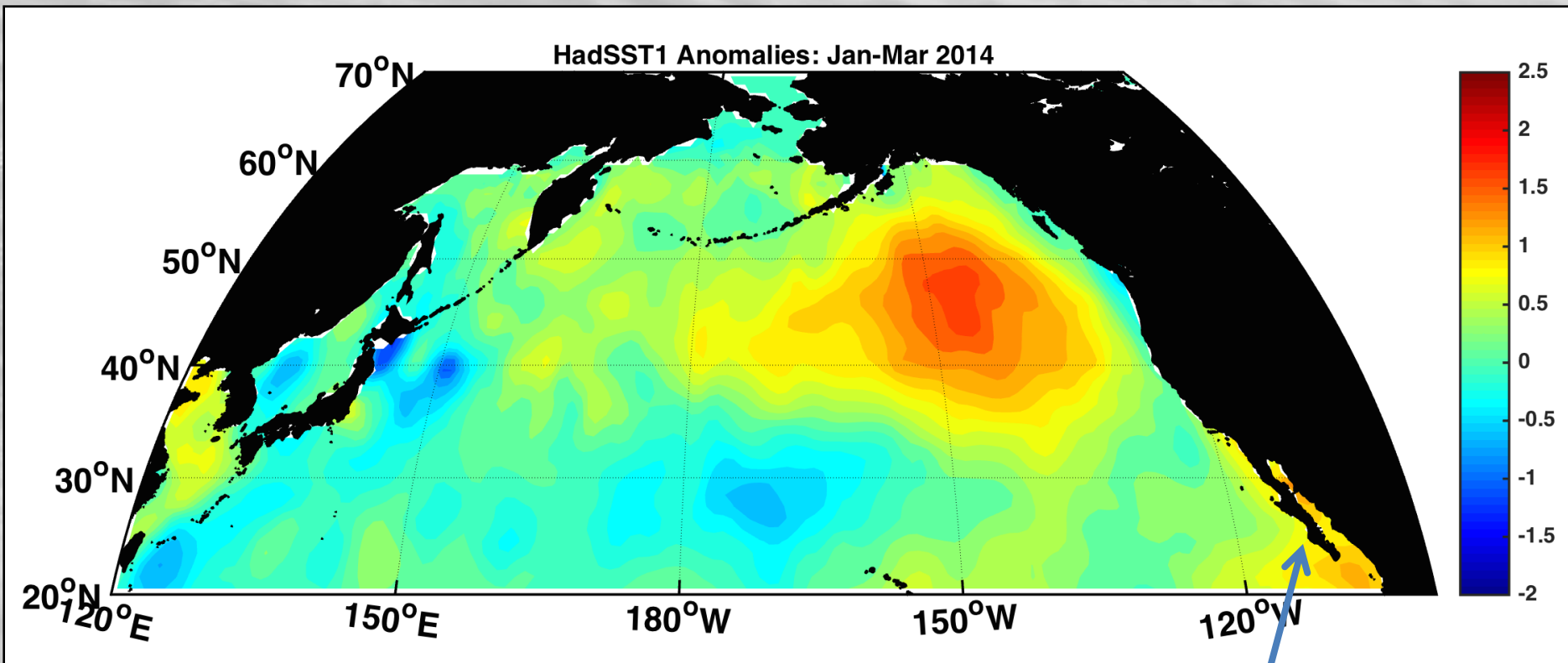
**What Happened?**

# Winter 2013: NE Pacific is Very Cold

(shown: temperature variation from average)



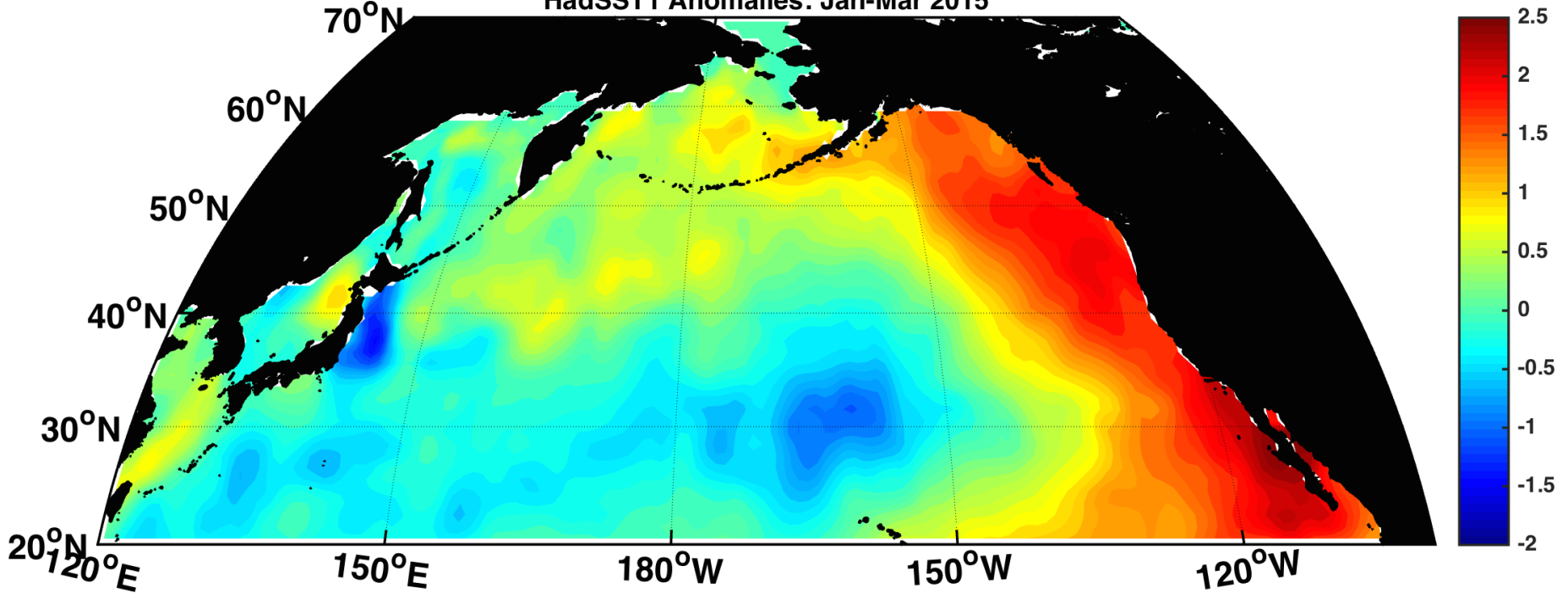
# Winter 2014: The 'Blob' Emerges



Note: Baja warming;  
harbinger of El Niño

# Winter 2015: NE Pacific is Very Warm

HadSST1 Anomalies: Jan-Mar 2015

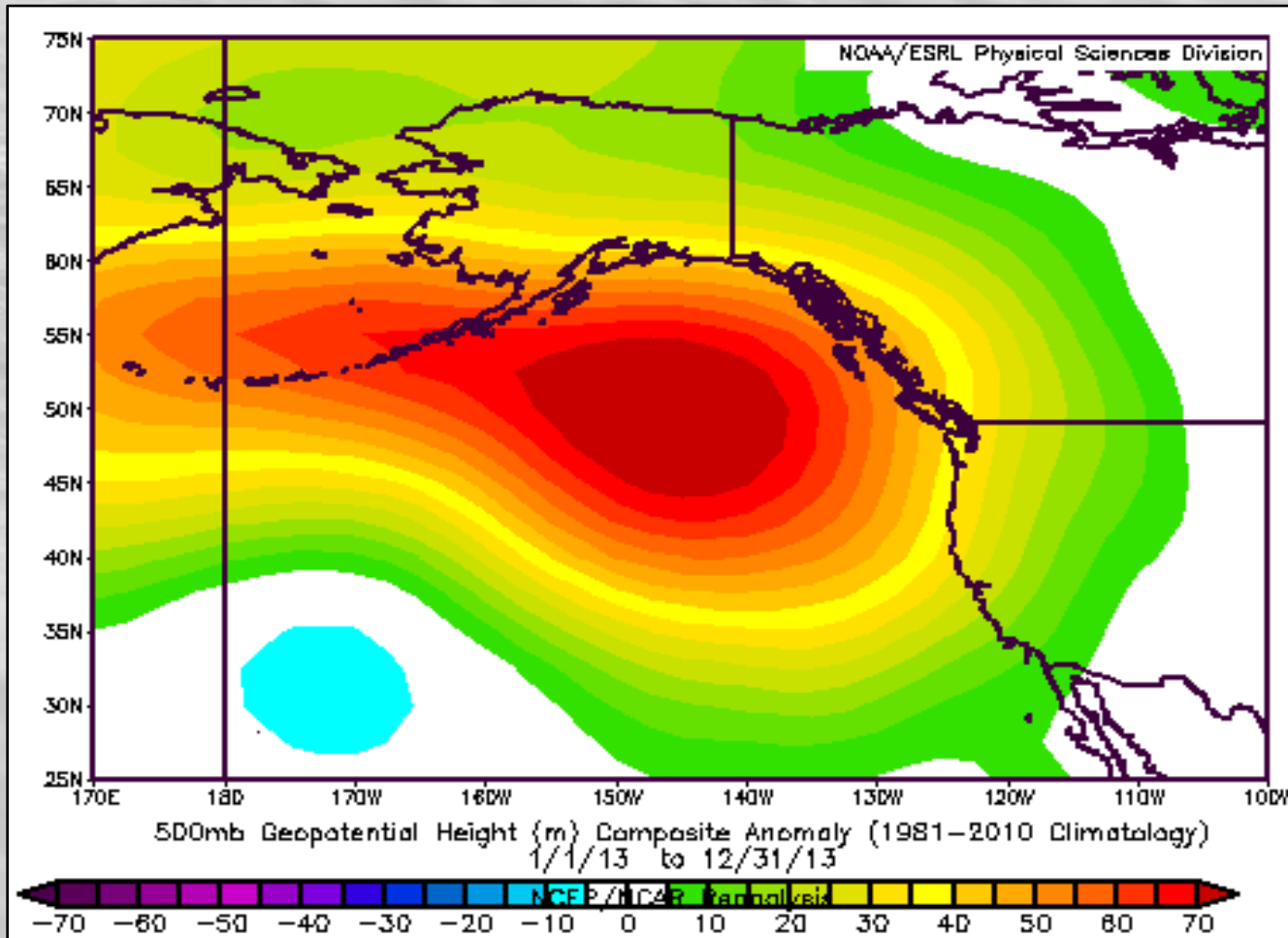


**Why Did This Happen?**

**2 reasons**

# 1. The Ridiculously Resilient Ridge (RRR)

North Pacific High shifted pole-ward, blocking storms, limiting cooling



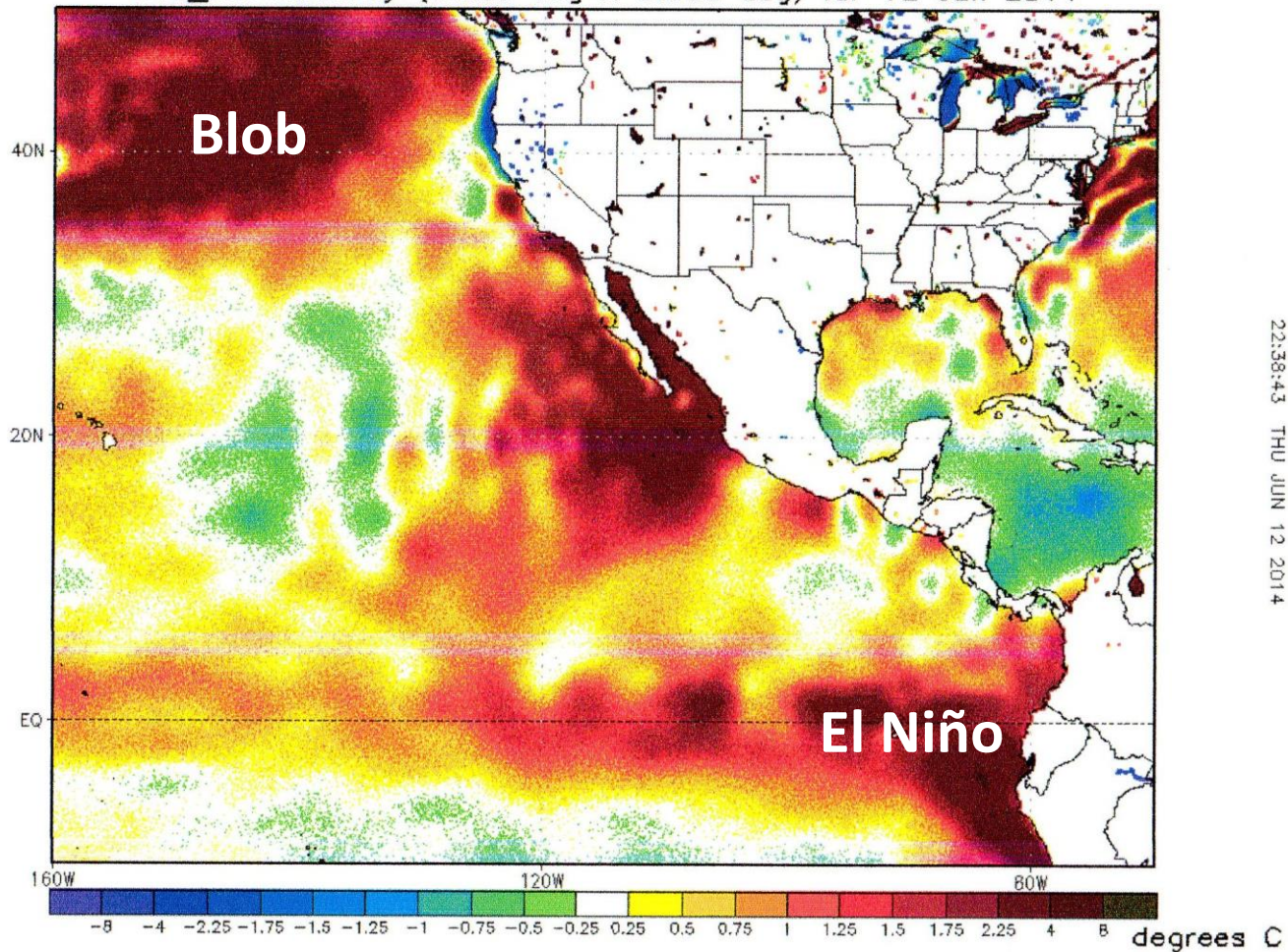
Notably, this blocking High also caused the drought in California (winters 2013-2015)



## 2. Mid-2014: The 'Blob' meets El Niño (a perfect 'climate storm')

NOAA/NWS/NCEP/EMC Marine Modeling and Analysis Branch Oper H.R.

RTG\_SST Anomaly (0.083 deg X 0.083 deg) for 12 Jun 2014



# Consequences

# Fall 2014 - Winter 2016: Seabird Die-Offs

~100,000 birds (northern California to Washington State): starvation



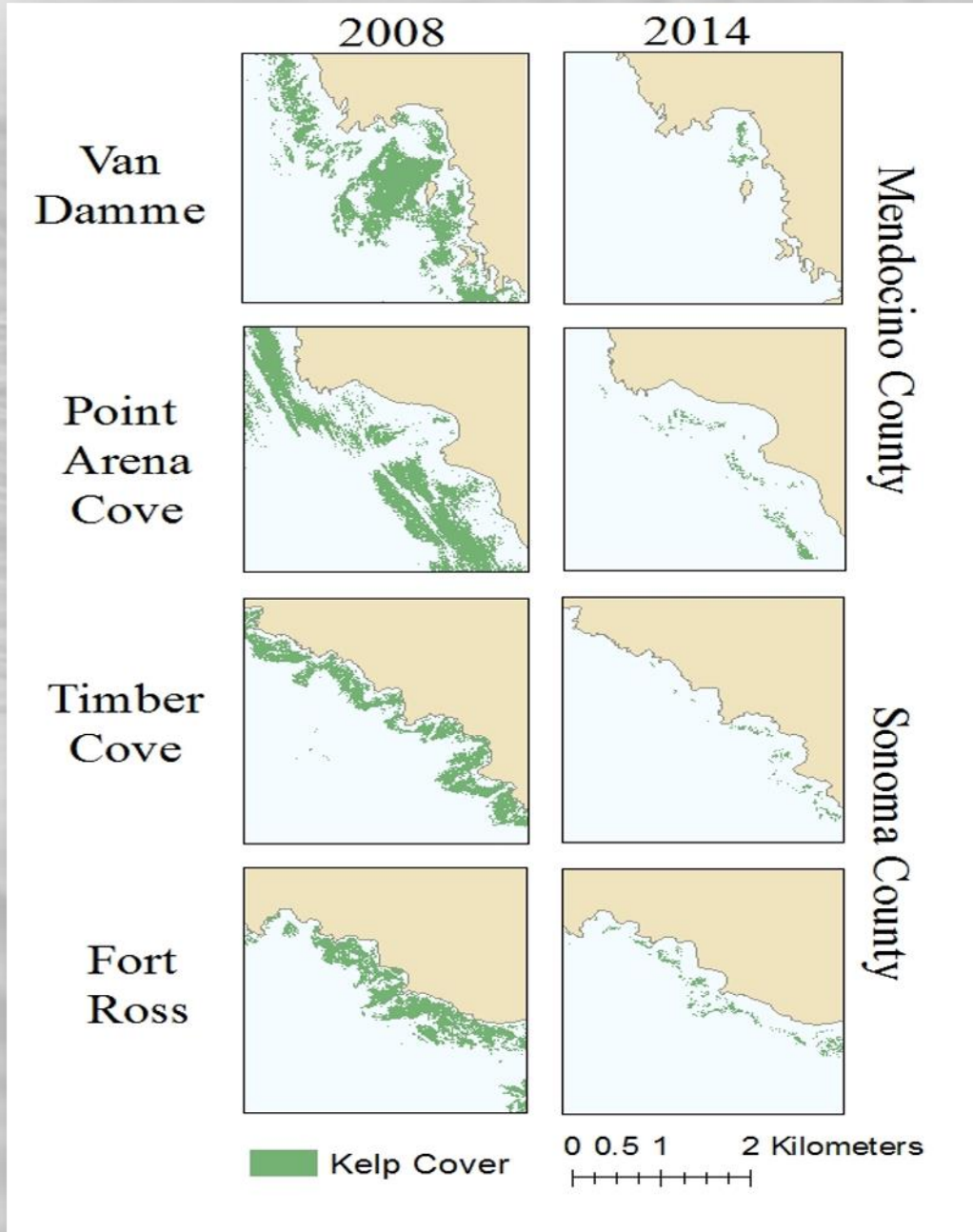
# More Tropical Species off California



**Cook's Petrel (from South Pacific)**

**Yellowfin Tuna**

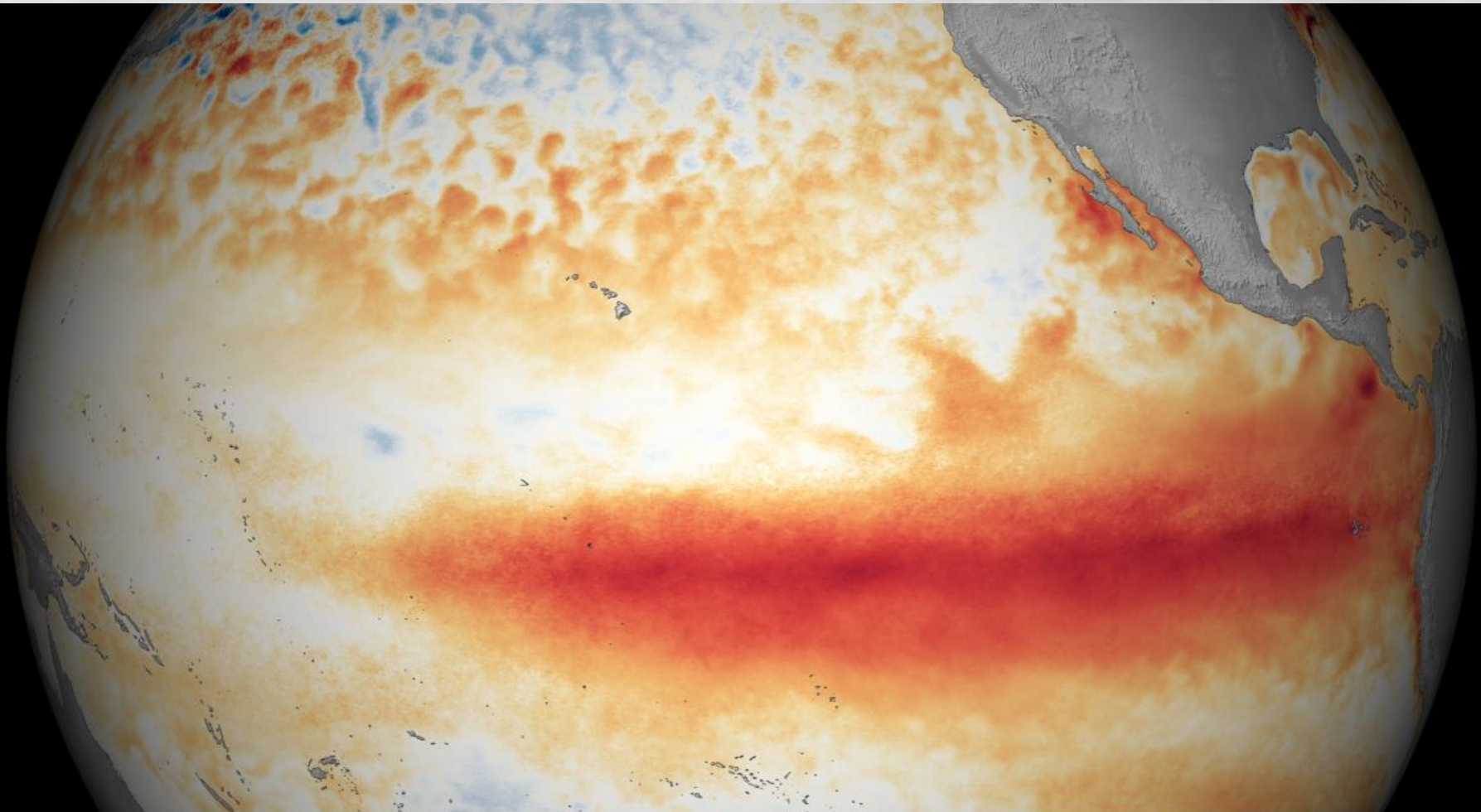
# Disappearance of Kelp in Northern California





**What Next?**

# El Niño: January 2016

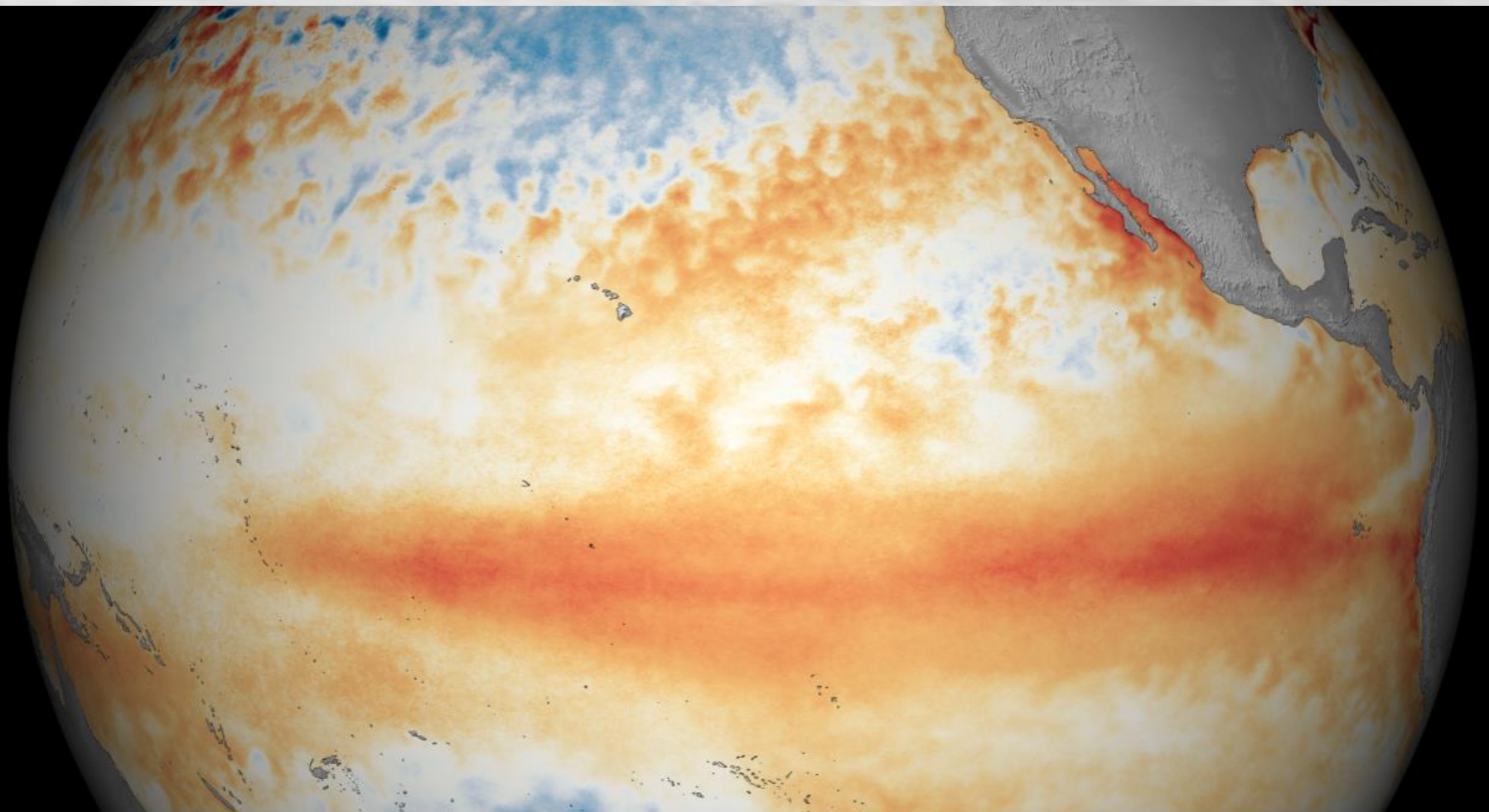


January 2016  
compared to 1981-2010



Climate.gov/NNVL  
Data: Geo-Polar SST

# Waning El Niño: March 2016



March 2016  
compared to 1981-2010

Difference from average temperature (°F)



Climate.gov/NNVL  
Data: Geo-Polar SST



# Summary

1. **'Blob' warmed California from the north (mid-2014)**
2. **El Niño warmed California from the south (mid-2015)**
3. **Result: Persistent marine heat wave: from mid-2014 to mid-2016 ('perfect storm' of warming events)**
4. **Collapse of coastal food chains (mass mortality of seabirds) and habitats; 'tropicalization' of ecosystem**
5. **Reversal of conditions is expected (good news)**

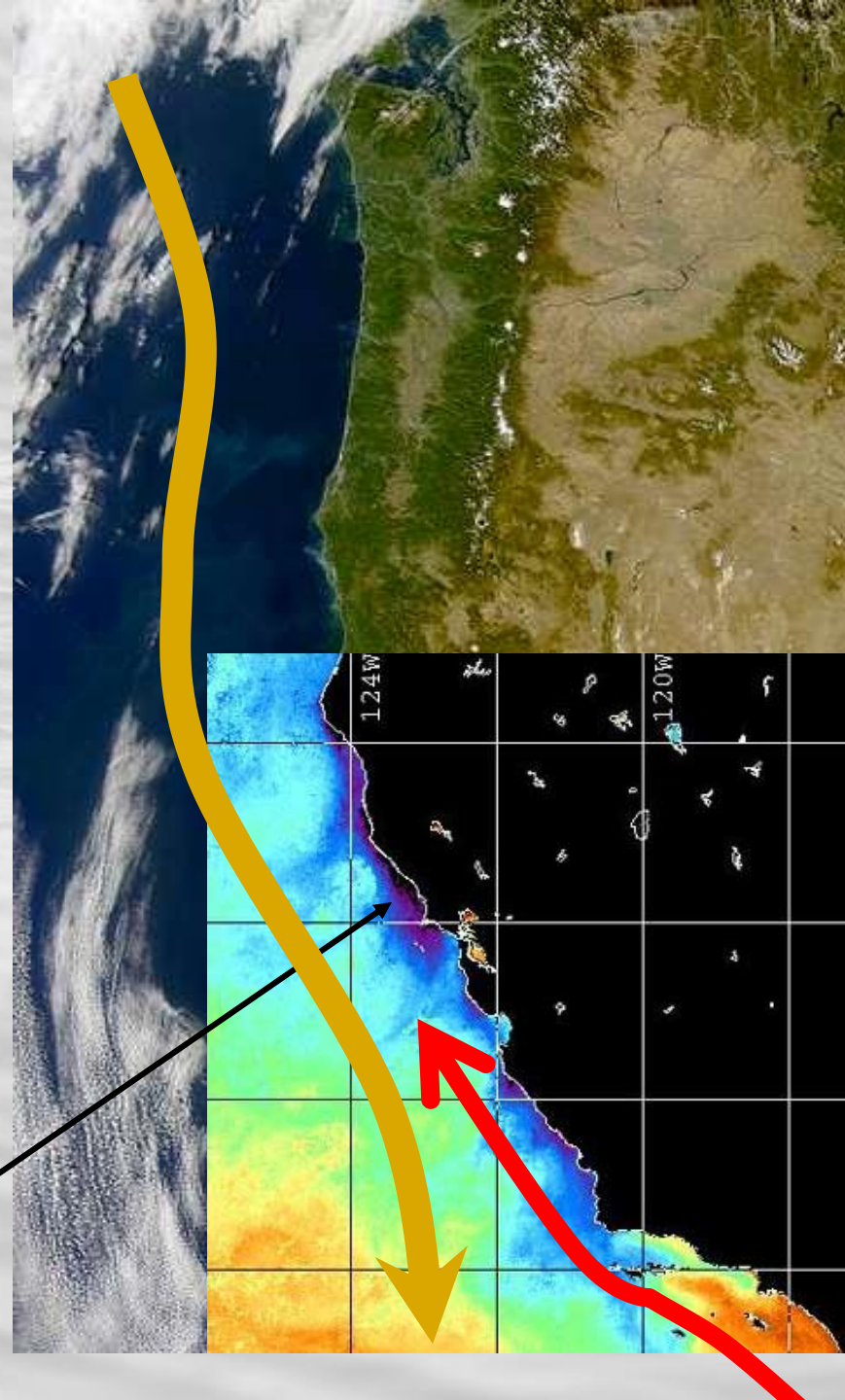
# Crash Course in California Oceanography

- (1) *California Current* – offshore “river in the sea” – brings waters from the north into California
- (2) *California Undercurrent* – nearshore – waters from the tropics into California

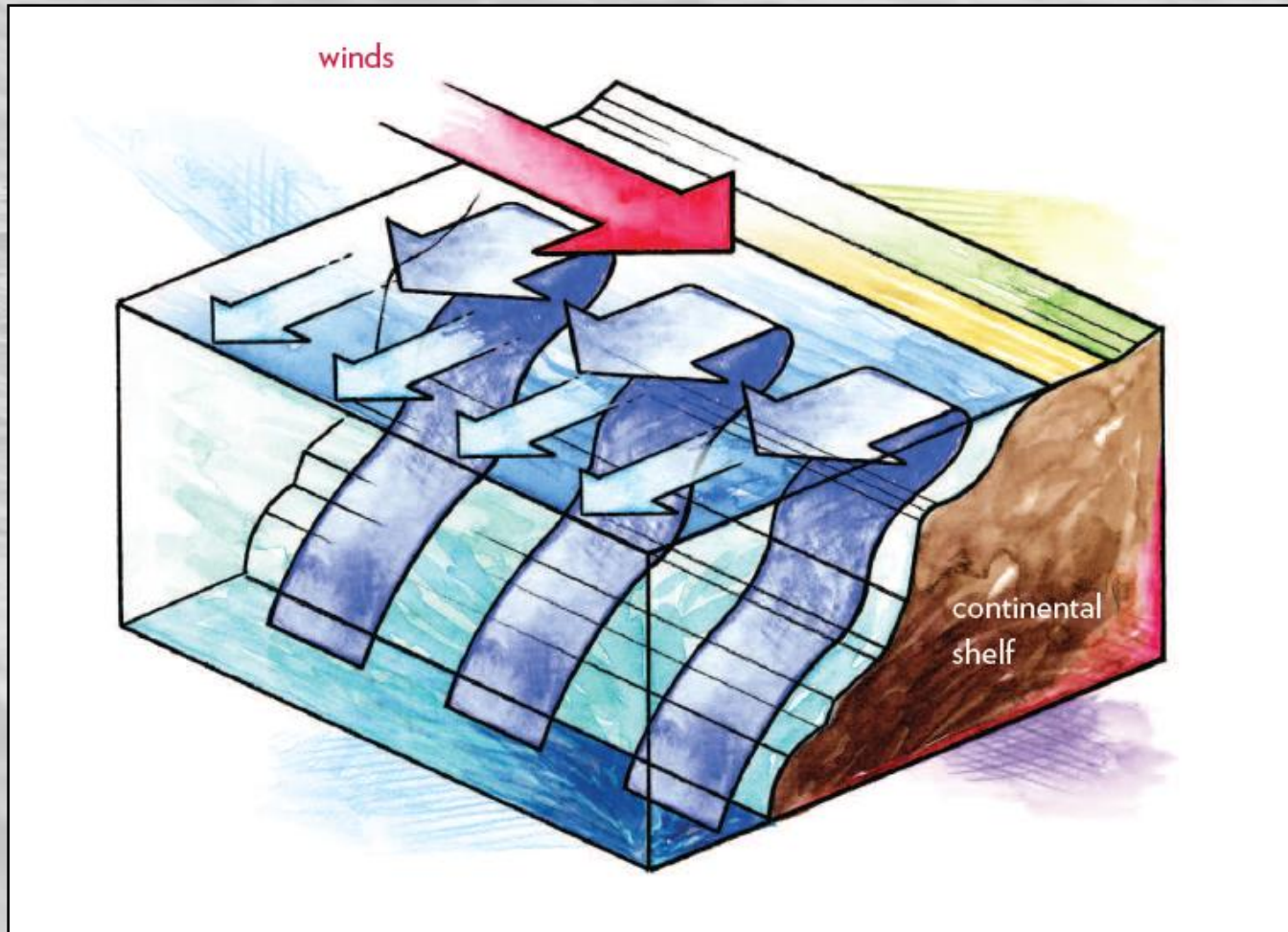
\* these are effects from outside CA that affect the local environment!

- (3) Coastal headlands – sites of coastal “*upwelling*” – mixing of cold waters from the deep into the surface layer

e.g., Pt. Arena/Pt. Reyes Upwelling Cell



# “Upwelling” is Incredibly Important: Controls T, Nutrients, Oxygen, pH (acidification)



**But, it operates on waters brought in by currents**

# 2016-2017: Predicted La Niña=Return to Colder

2015-2016: Strong El Niño

2014-2015: The 'Blob'

2013-2014: Record Upwelling

**2012-2013:**

**2011-2012:**

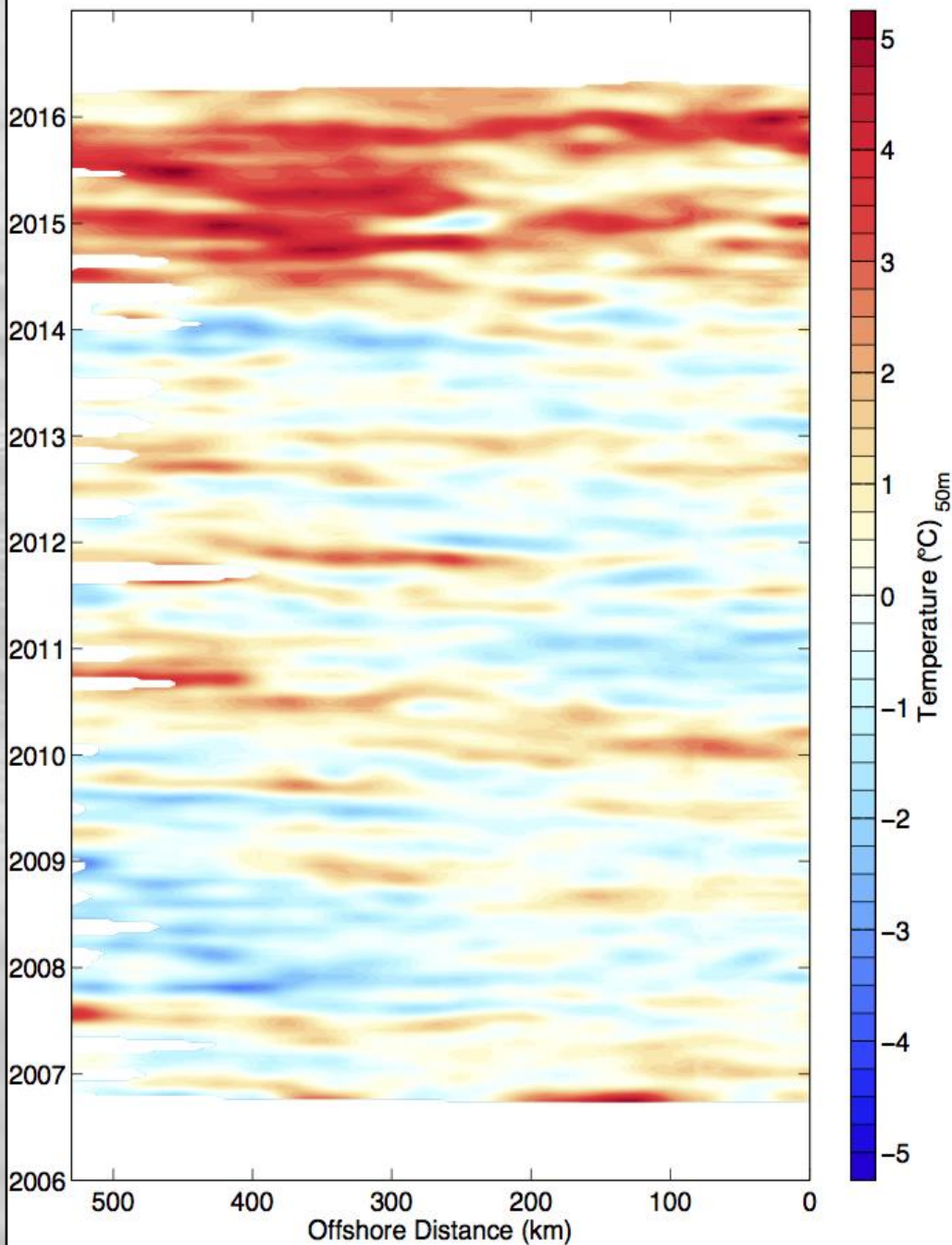
**2010-2011:**

**2009-2010: Weak El Niño**

**2008-2009: Strong Upwelling**

**2007-2008: Moderate Upwelling**

**2006-2007: La Nada**



# Global Ocean Temperature Anomalies, February

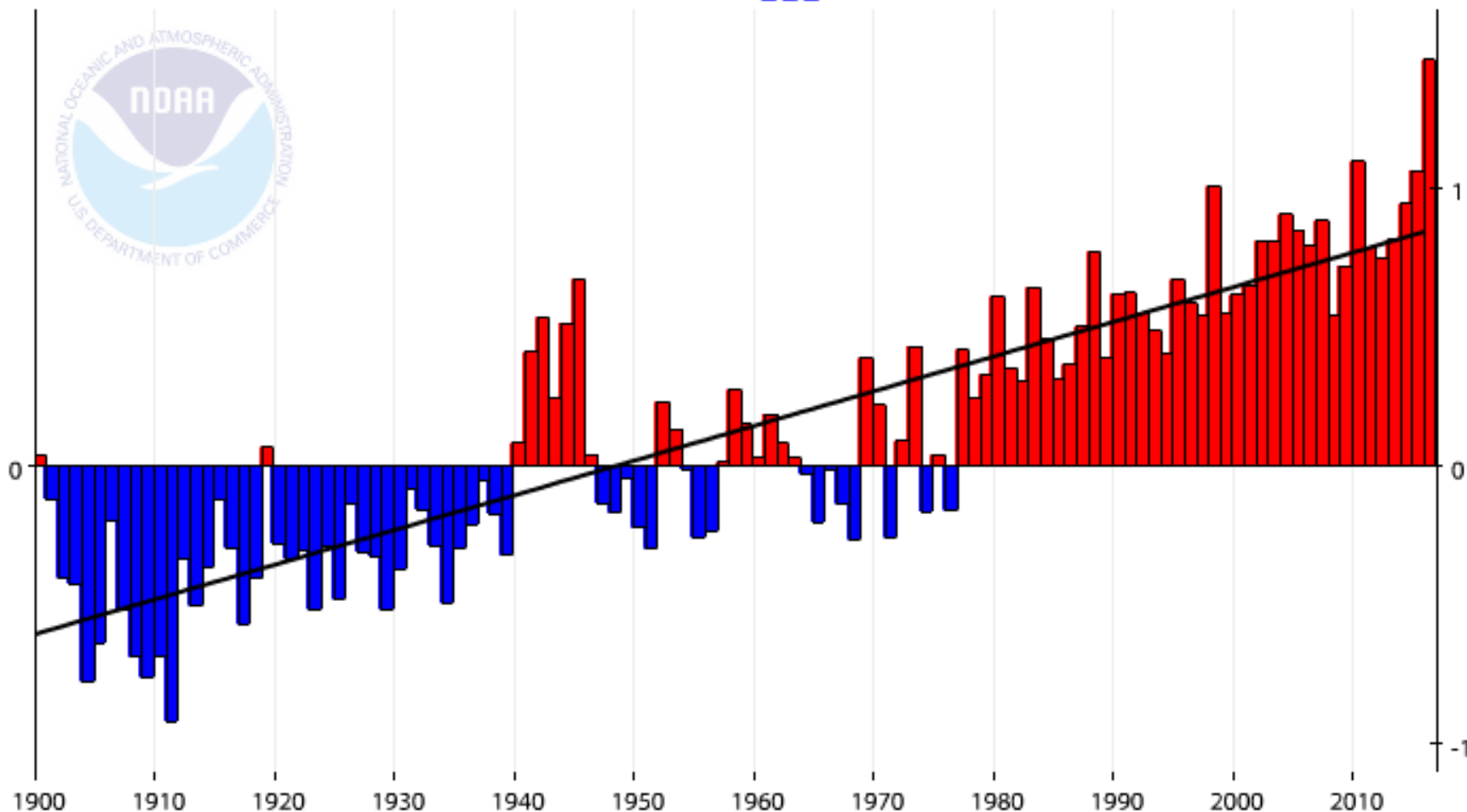
— 1900-2016 Trend  
+0.07°C/Decade



Temperature Anomalies



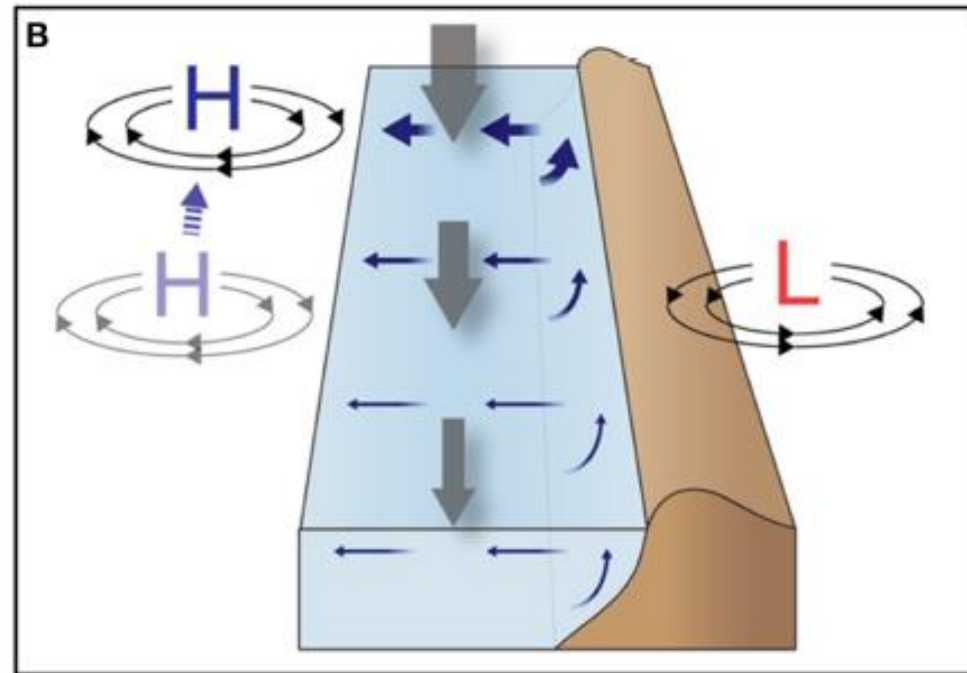
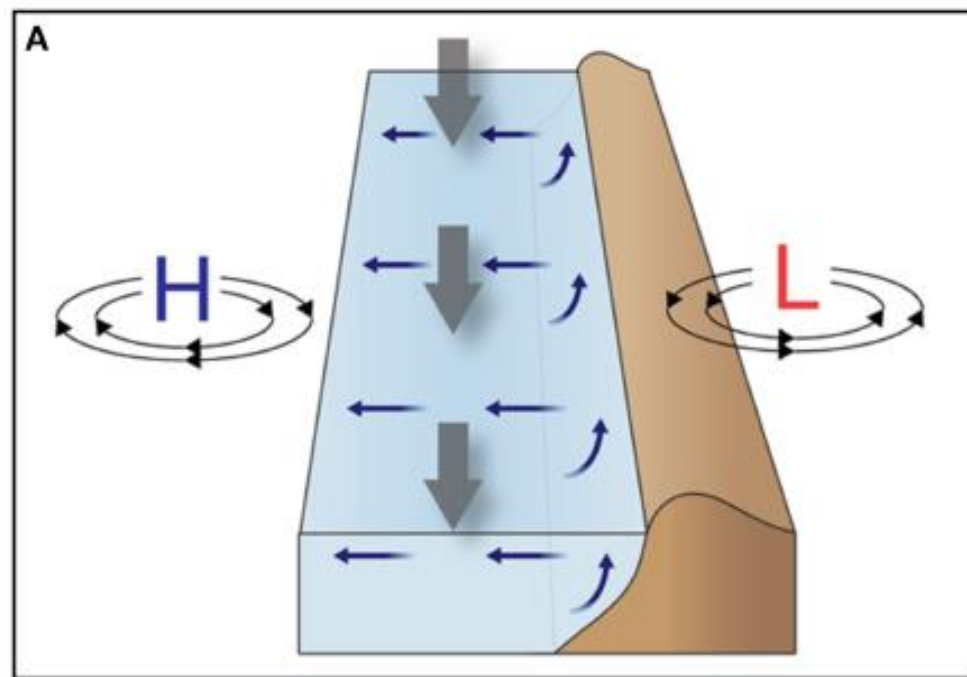
Anomaly (°C)



Anomaly (°F)

**Prediction from  
IPCC models:  
Poleward shift of  
high pressure  
systems**

**Observed here  
and off South  
Africa (similar  
system)**



# Canaries of California's marine environment



**pelican**



**cormorant**



**murre ("CA penguin")**

# What Caused The 'Blob' to Form?

-- NP High and storm tracks:  
normally, winter storms cause cooling in the North Pacific

