

Present oceanic conditions in the North Pacific (And what next?)



**NOAA
FISHERIES**

Northwest

Southwest

Fisheries

Science

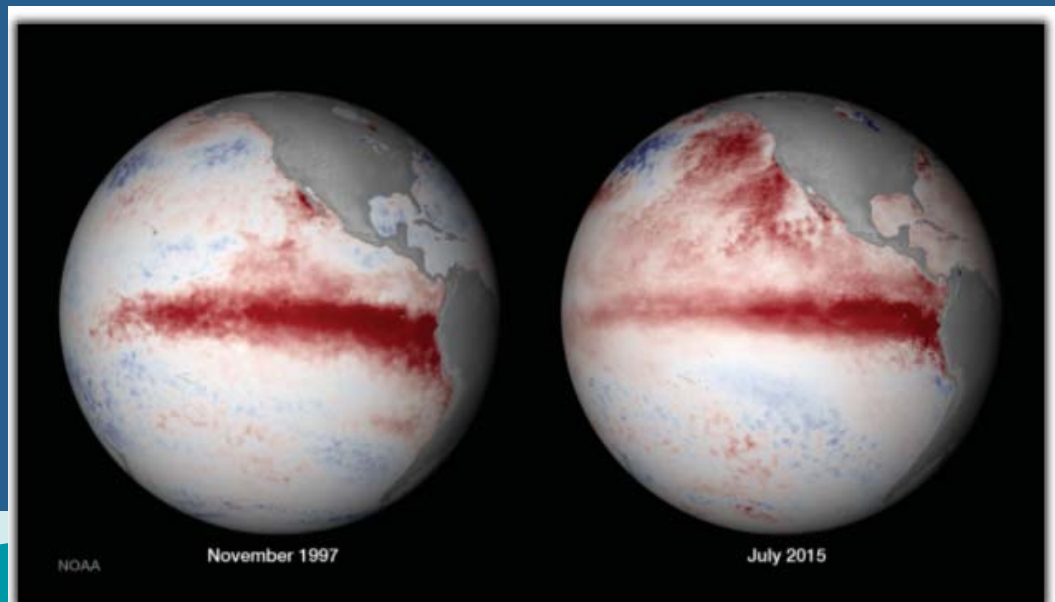
Centers

Thanks to: N. Mantua, S; Lindley,
S. Bograd, J. Field, B. Peterson,
L. Weitkamp, S. Busch and many
others for their input.

Cisco Werner
SWFSC

John Stein
NWFSC

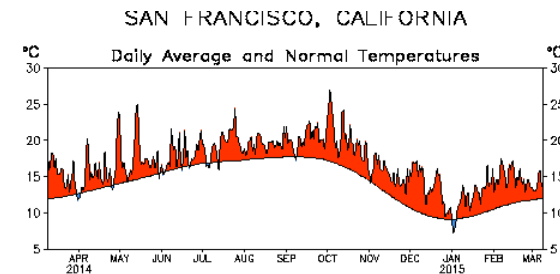
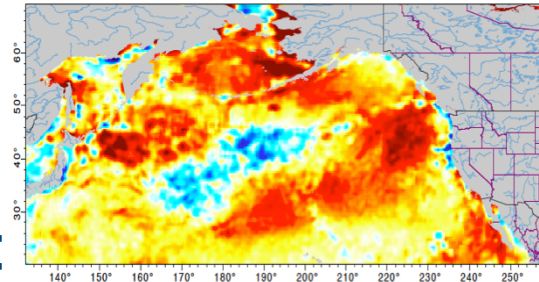
Pacific Fishery Management Council
11 September 2015
Sacramento



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Key points (1/3)

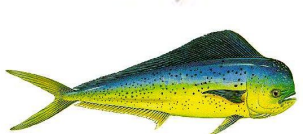
- For the past 3 years we have experienced record:
 - warm waters off the U.S. West Coast,
 - warm temperatures on land,
 - drought, and
 - low snowpack
 - We have witnessed unusual conditions in the ocean:
 - distributional shifts,
 - “non-native” spp.,
 - HABs
- that have impacted our fisheries and protected spp.



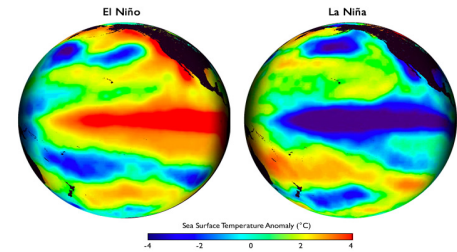
Dosidicus found in SaKe survey, Sept 2015, in Canadian waters

Key points (2/3)

- A “strong” El Niño (EN) is forecast for the Fall/Winter 2015/2016 (arrival to the California Current in Oct/Nov?)
- Associated with the EN we may see:
 - increases in storm/rain activity in So. California
 - low primary and secondary productivity
 - decreases in sea lion and bird populations
 - Increase presence of subtropical spp.
 - decreases in recruitment of “cold spp.” (rockfish)
 - improved recruitment for warm spp. (sardine)



Key points (3/3)

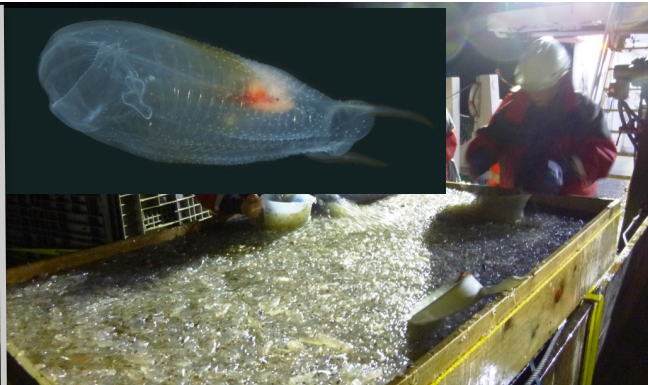


- Several of the past ENs followed by multi-year La Niña conditions
- Over the next 3-4 years (2015-2019) we *may* see a rich and complex series of events – covering a wide spectrum – in the North Pacific
- A possible EN/La Niña “seesaw” offers an important window to learn how our ecosystems and trust species will respond
- We need to gather data for immediate information and for improvement of future modeling capabilities. (IEAs...)

This past year we have observed a range of “unusual” sightings...



Shortbelly rockfish young, Pt. Sur



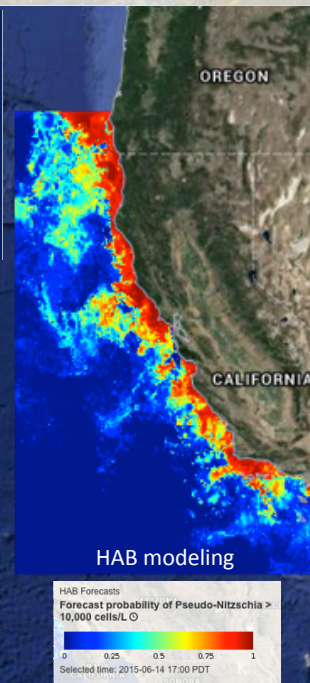
Salps and pyrosomes, Pt. Piedras Blancas



Pelagic red crabs, San Nicolas Isl.



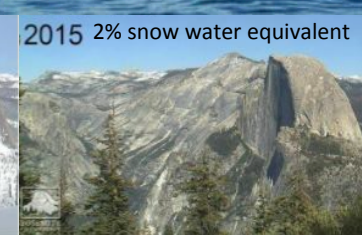
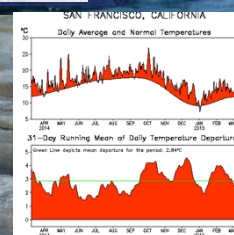
© Carl Sbarounis: bluefin tuna schools



False Killer Whales, 24 Feb 2015; Photo: M. Robbins



Photo: Sharon Melin, NOAA



2012

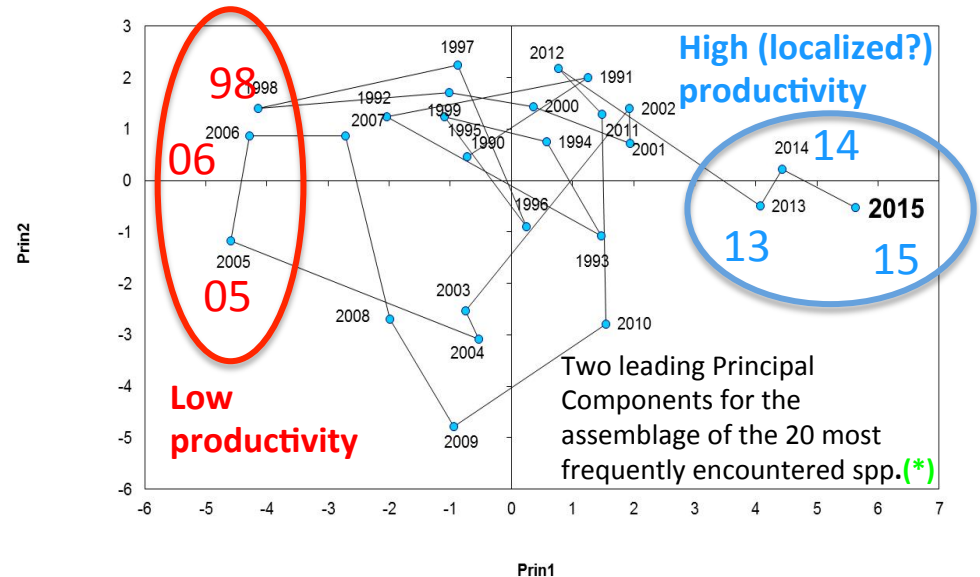
2015 2% snow water equivalent

Central CA ecosystem indicators for May/Jun 2015

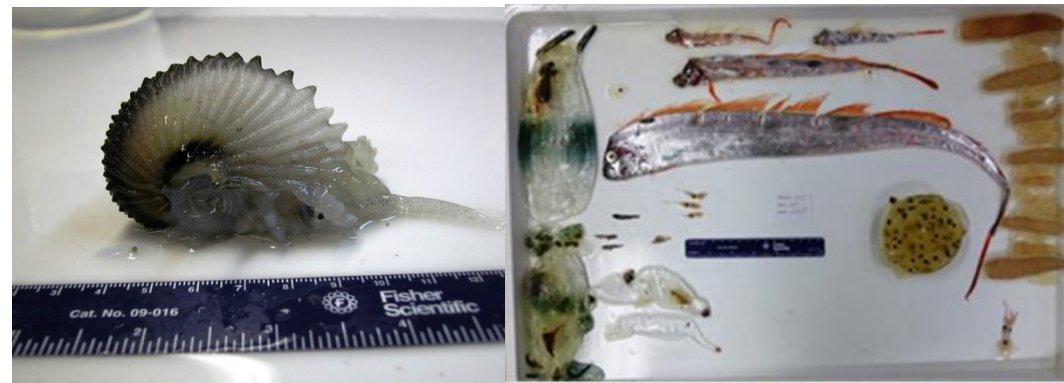
The 2015 data generally showed:

- (very) high catches of juvenile rockfish and Pacific sanddab in southern and northern California.
- Species (in high abundance) characteristic of 3 different states of the ecosystem
 - YOY groundfish-dominated catches,
 - pelagic-tunicate-dominated catches
 - subtropical species-dominated catches
- High productivity and transport of subarctic water -- YOY groundfish and of pelagic tunicates;
- High numbers of warm water species(**)

(**) Record high numbers of pelagic red crabs, California spiny lobster, phyllosoma, and two types of largely subtropical krill. Additionally, there were first time catches of the greater argonaut and the slender snipefish.



(*) Juvenile rockfish, market squid, juvenile Pacific sanddab, euphausiids, Pacific sardine, northern anchovy, Pacific hake, speckled sanddab, rex sole, lingcod, adult Pacific hake, octopus, sergestid shrimp, gobies, plainfin midshipman, and a variety of mesopelagic species.



(Data and analysis from J. Field and K. Sakuma)

West Coast Harmful Algal Bloom (Pseudo-nitzschia)

TUESDAY, JUNE 16, 2015

The Seattle Times

WINNER OF 10 PULITZER PRIZES

1.6 million readers

Toxic algae bloom might be largest ever

SHELLFISH HARVESTS SHUT DOWN
High temperatures suspected

Marine biotoxins
Marine biotoxins are produced by microscopic algae. Unlike the bacteria or viruses that can also contaminate shellfish, biotoxins are not destroyed by cooking or freezing. Also, harmful algal blooms usually don't color the water.

The three biotoxins of concern in Washington are:

- **Paralytic shellfish poisoning.** Symptoms include tingling in lips, arms and legs, followed by trouble breathing and paralysis. Can be fatal.
- **Domoic acid poisoning,** also called amnesic shellfish poisoning. Caused by *Pseudo-nitzschia* diatoms, symptoms include vomiting, nausea,

By SANDI DOUGHTON
Seattle Times science reporter

A team of federal biologists set out from Oregon Monday to survey what could be the largest toxic algae bloom ever recorded off the West Coast.

The effects stretch from Central California to British Columbia, and possibly as far north as Alaska. Dangerous levels of the natural toxin domoic acid have shut down recreational and commercial shellfish harvests in Washington, Oregon and California this spring, including the lucrative Dungeness crab fishery off Washington's southern coast and the state's popular razor-clam season.

At the same time, two other types of toxins rarely seen in combination are turning up in shellfish in Puget Sound and along the Washington coast, said Vera Trainer, manager of the Marine Microbes and Toxins Programs at the Northwest Fisheries Science Center in Seattle.

"The fact that we're seeing multiple toxins at the same time, we're seeing high levels of domoic acid, and we're seeing a coastwide bloom — those are indications that this is unprecedented," Trainer said.

Scientists suspect this year's unusually high temperatures are playing a role, along with "the blob" — a vast pool of unusually warm water that blossomed in the northeastern Pacific late last year. The blob has morphed since then, but offshore waters are still about two degrees warmer than normal, said University of Washington climate scientist Nick Bond, who coined the blob nickname.

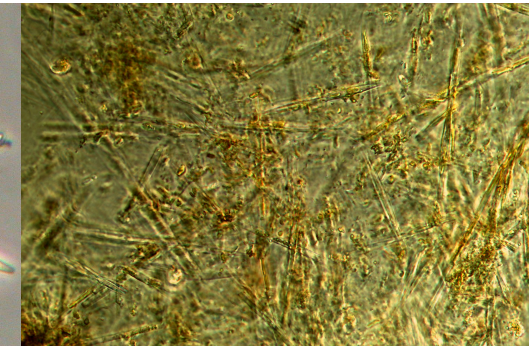
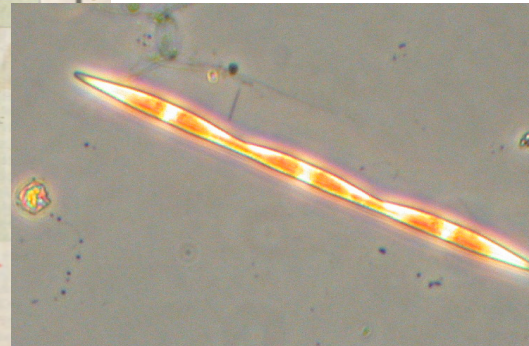
Closures of Puget Sound beaches frequently change. Check State Department of Health for latest conditions: doh.wa.gov

Closed for all recreational shellfish harvesting including clams, geoduck, scallops, mussels, oysters, snails and other invertebrates

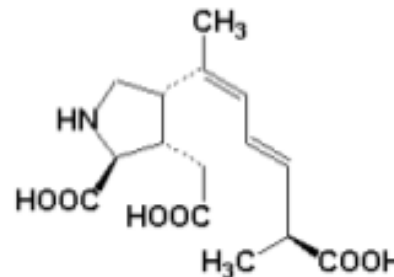
The state of California closes beaches to recreational mussel harvesting every year in the spring and summer

The California Department of Public Health is advising consumers to not eat recreationally harvested mussels, clams, anchovy, sardines, or the internal organs of crab from Monterey and Santa Cruz counties due to dangerous levels of domoic acid.

- Breadth – Channel Islands to Aleutian Islands
- Length – Longest lasting (mos)
- Levels – Highest toxin concentrations ever measured in anchovies
- “Super” *Pseudo-nitzschia* – large chains, chloroplasts bulging



Domoic acid



Clogged Bongo nets –
June 25, 2015 Sta. Barbara Channel

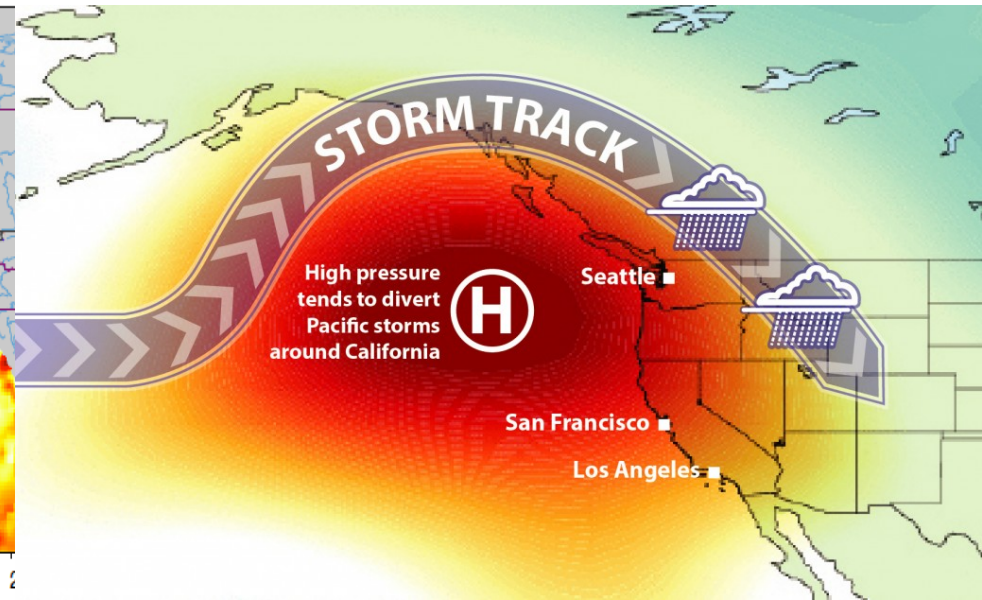
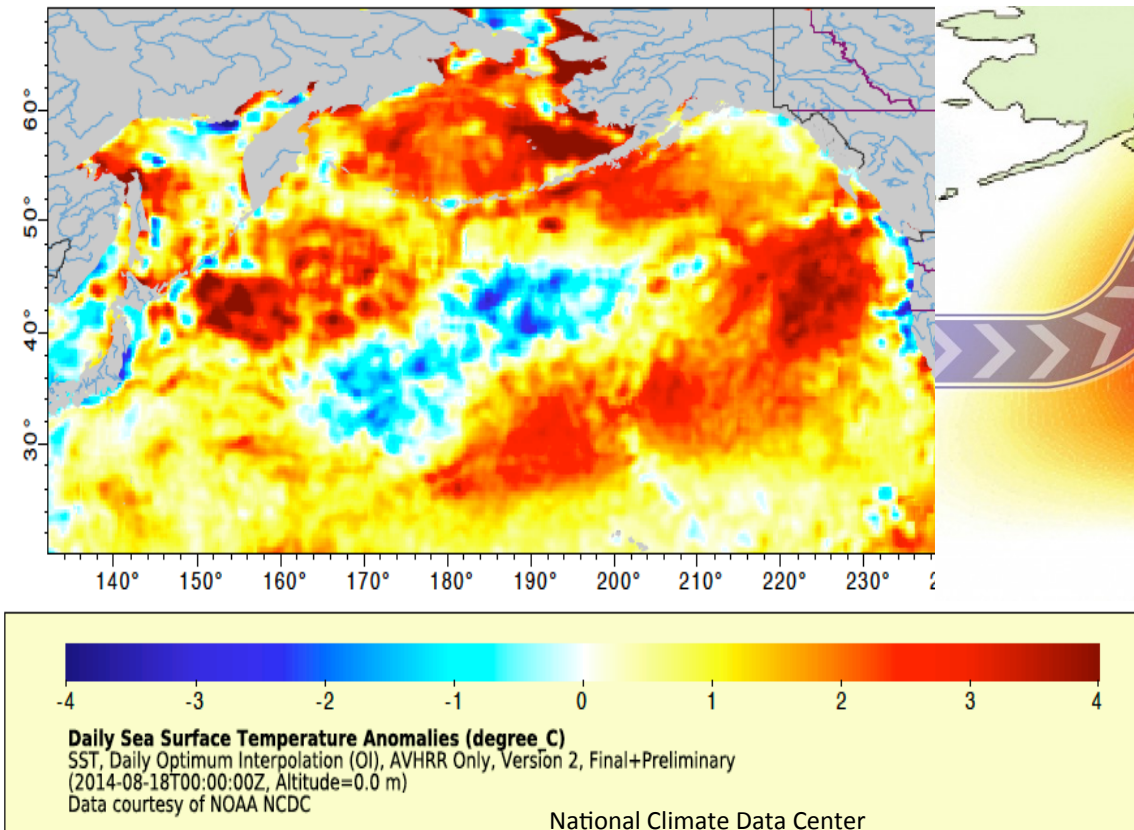
What's causing all these conditions?

Have we seen them before?

What next?



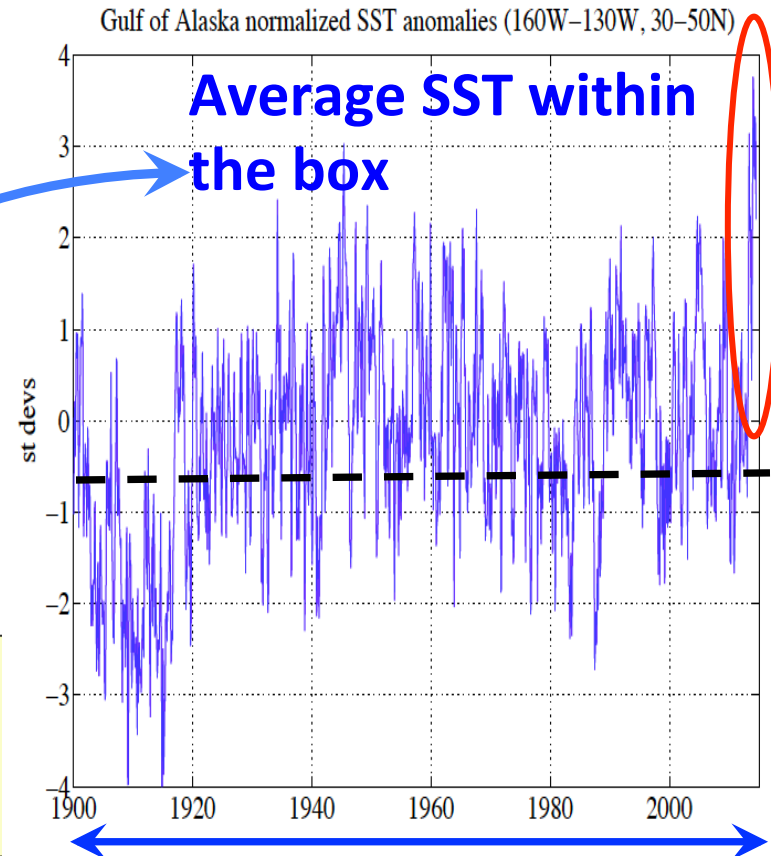
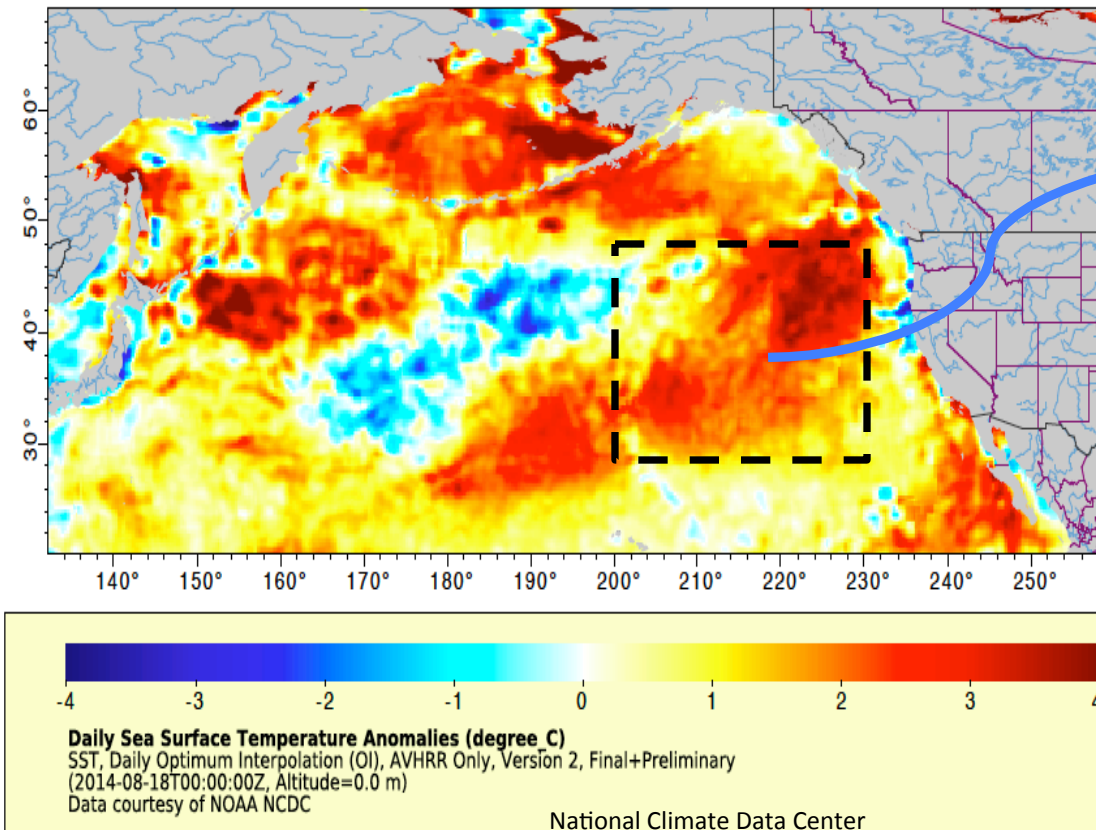
The Blob: A prominent mass of positive temperature anomalies, attributed to strongly positive anomalies in SLP (*the Ridiculously Resilient Ridge*), which served to suppress the loss of heat from the ocean to the atmosphere. The ‘extra heat’ persisted through the summer of 2014.



(Bond et al. 2014; GRL, doi:
10.1002/2015GL063306

**Daily SST anomaly (18 Aug 2014) relative to the 30-year
(1982-2010) climatology**

The Blob: A prominent mass of positive temperature anomalies, attributed to strongly positive anomalies in SLP (*the Ridiculously Resilient Ridge*), which served to suppress the loss of heat from the ocean to the atmosphere. The 'extra heat' persisted through the summer of 2014.



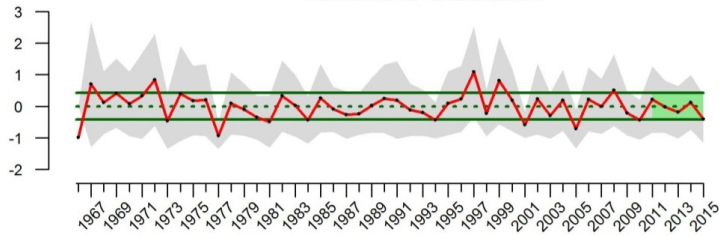
Daily SST anomaly (18 Aug 2014) relative to the 30-year (1982-2010) climatology

The 100+ year time series of Sea Surface Temperature in the eastern Pacific shows this is the warmest

Snow water equivalent (SWE)

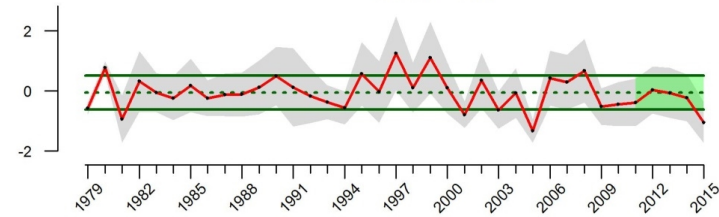
20 Feb SWE Anomaly

Columbia Glaciated



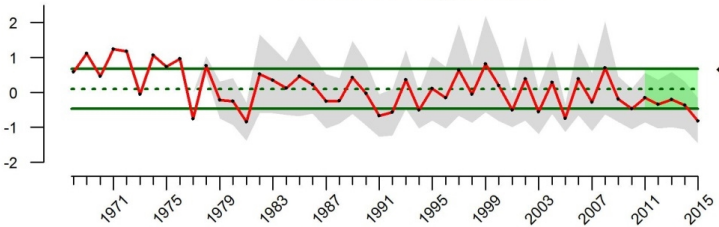
20 Feb SWE Anomaly

Salish Sea



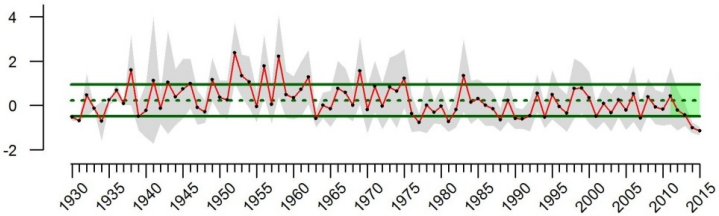
20 Feb SWE Anomaly

Columbia Unglaciati



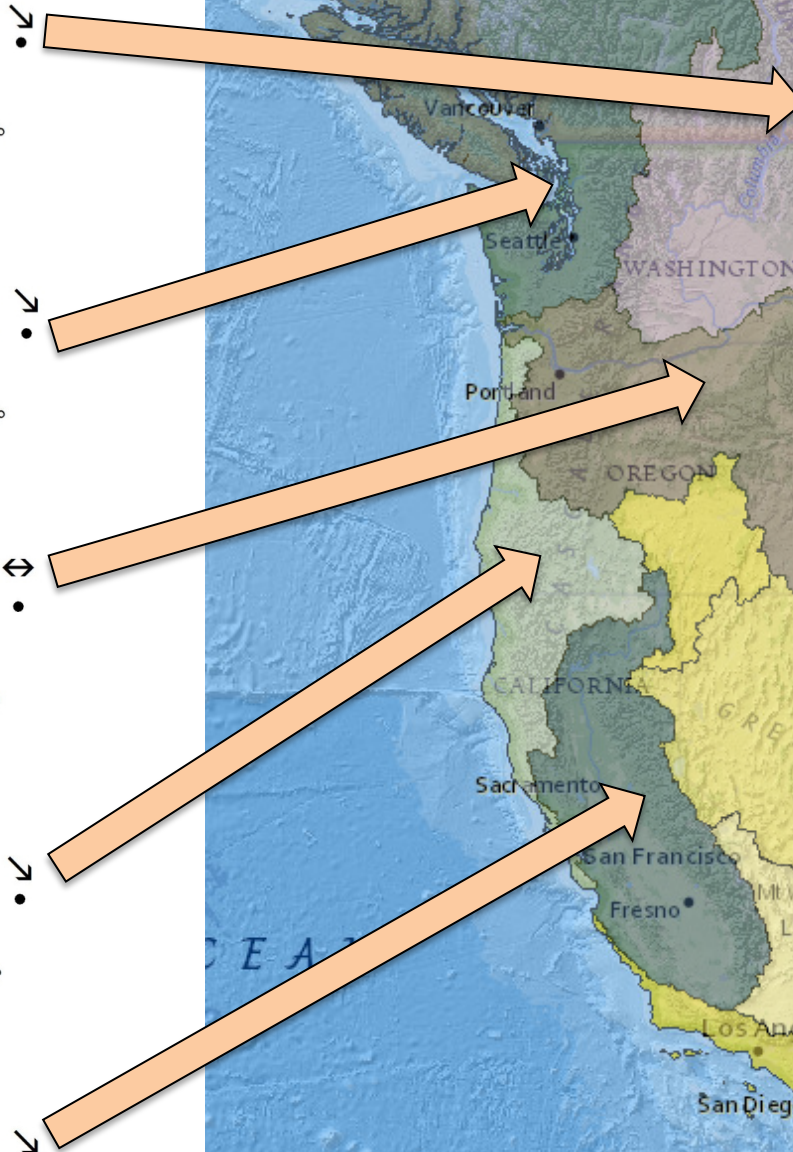
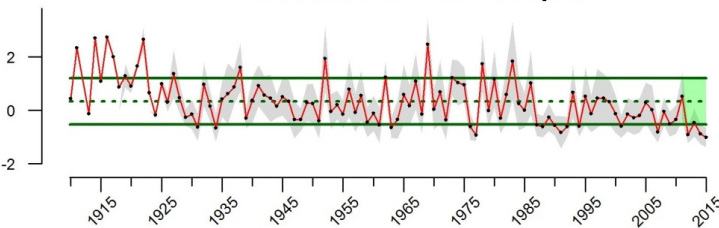
20 Feb SWE Anomaly

Oregon and Northern California Coastal



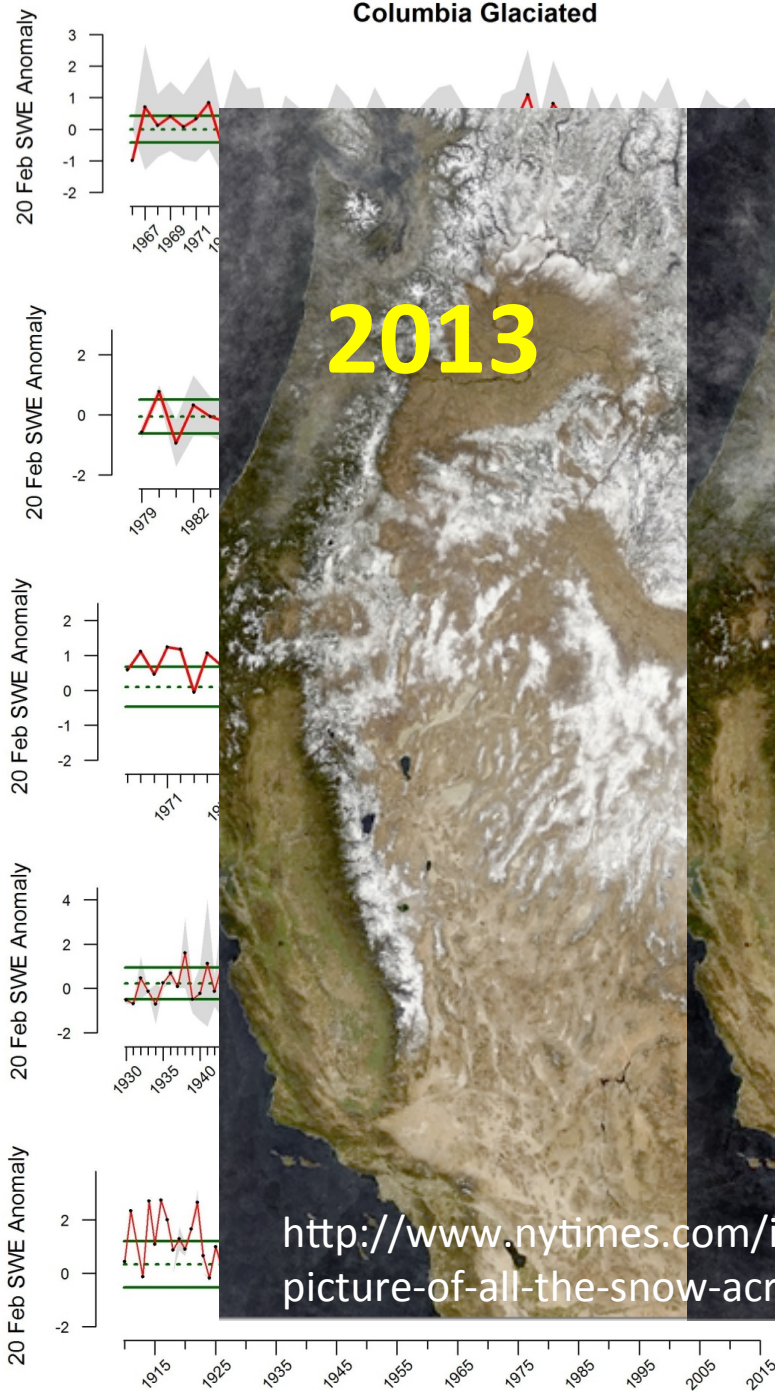
20 Feb SWE Anomaly

Sacramento - San Joaquin



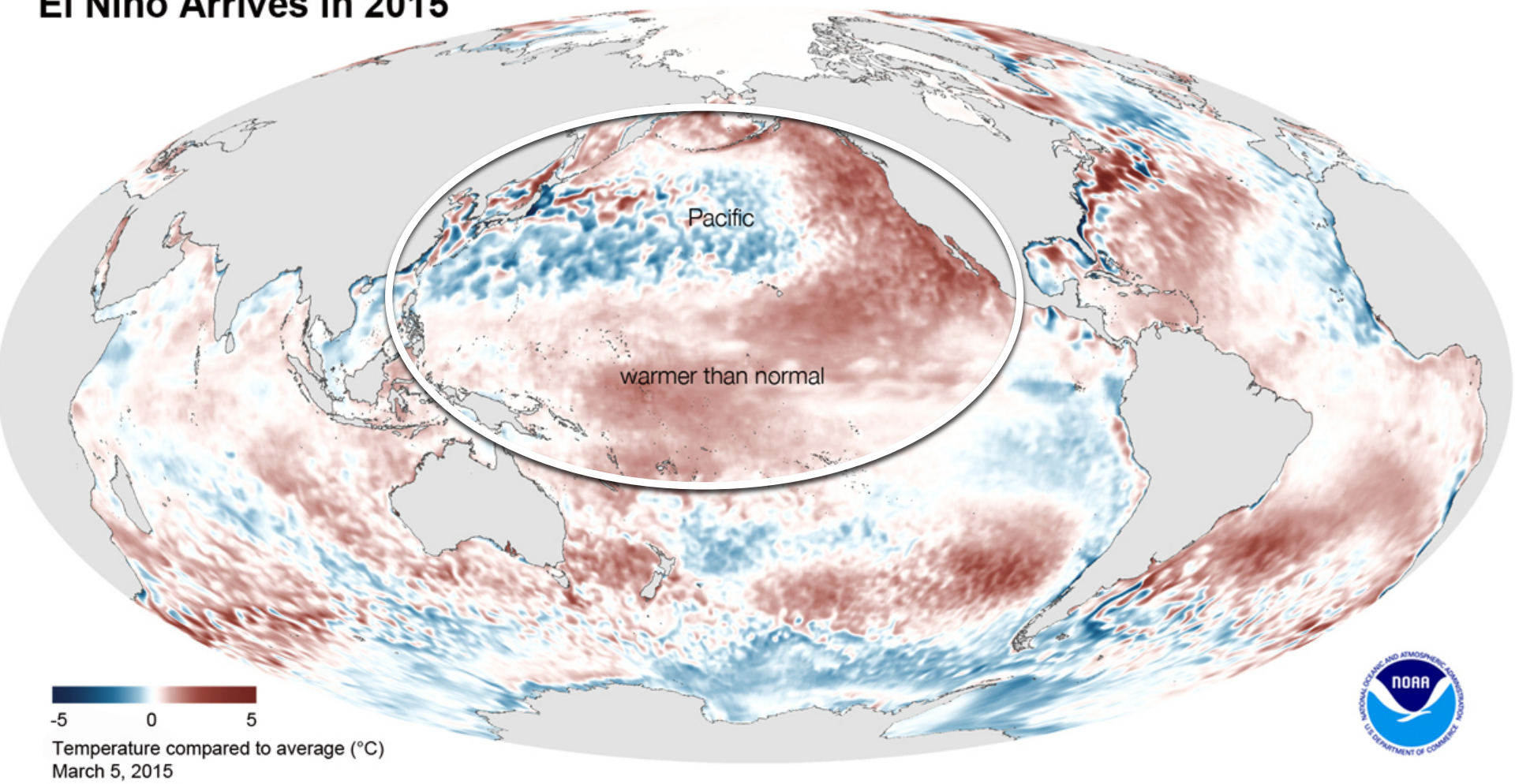
Columbia Glaciated

Snow water equivalent (SWE)



http://www.nytimes.com/interactive/2015/03/05/us/one-giant-picture-of-all-the-snow-across-the-us.html?smid=tw-share&_r=0

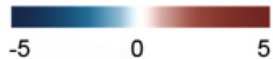
El Niño Arrives in 2015



El Niño Arrives in 2015

Sept 7, 2015 update: There is a greater than 90% chance that El Niño will continue through the Northern Hemisphere winter 2015-16, and around an 85% chance it will last into early spring 2016. All multi-model averages suggest that Niño 3.4 will be above $+1.5^{\circ}\text{C}$ (a “strong” El Niño) during late 2015 into early 2016.

http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/

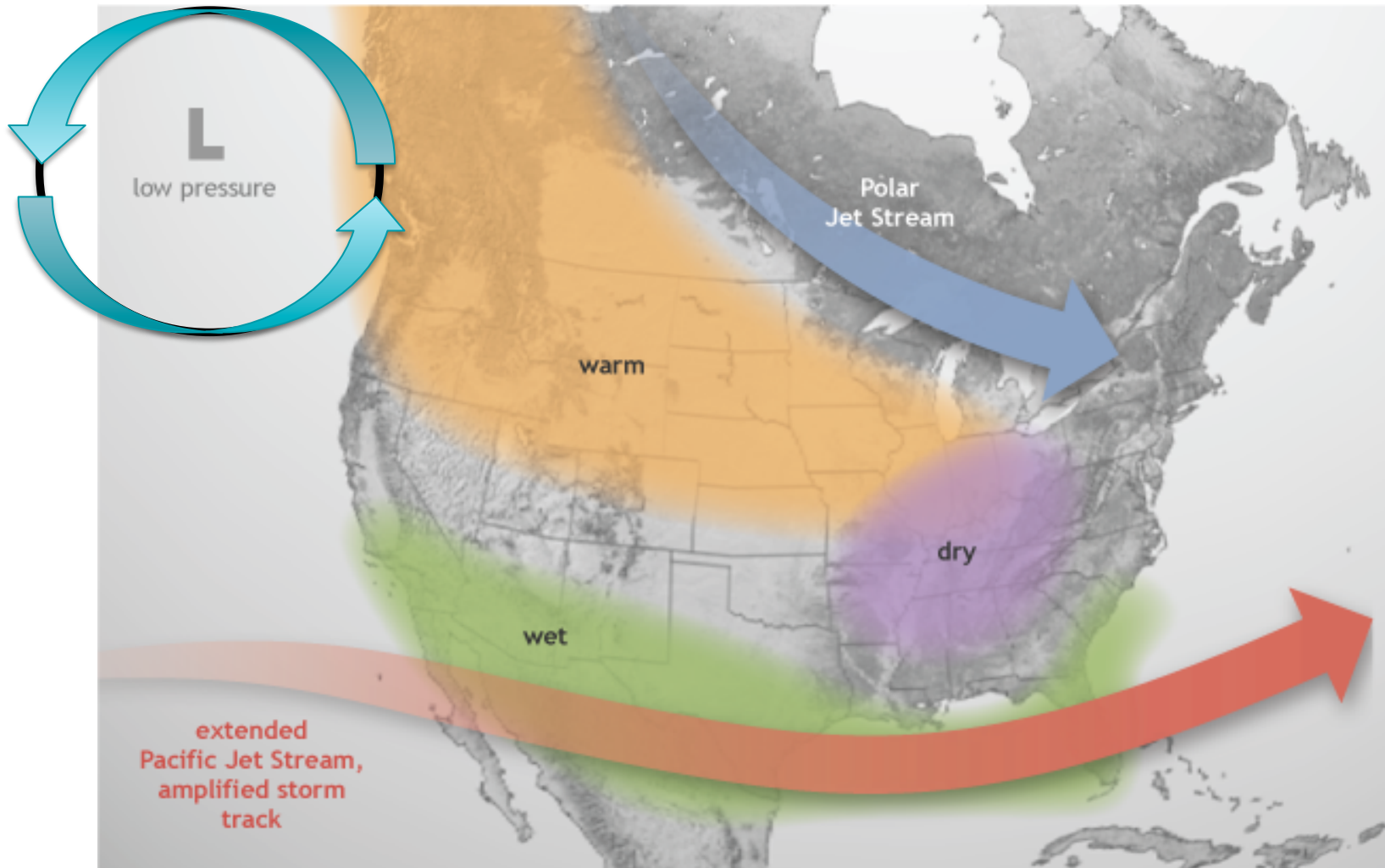


Temperature compared to average ($^{\circ}\text{C}$)
March 5, 2015



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Wintertime El Niño pattern

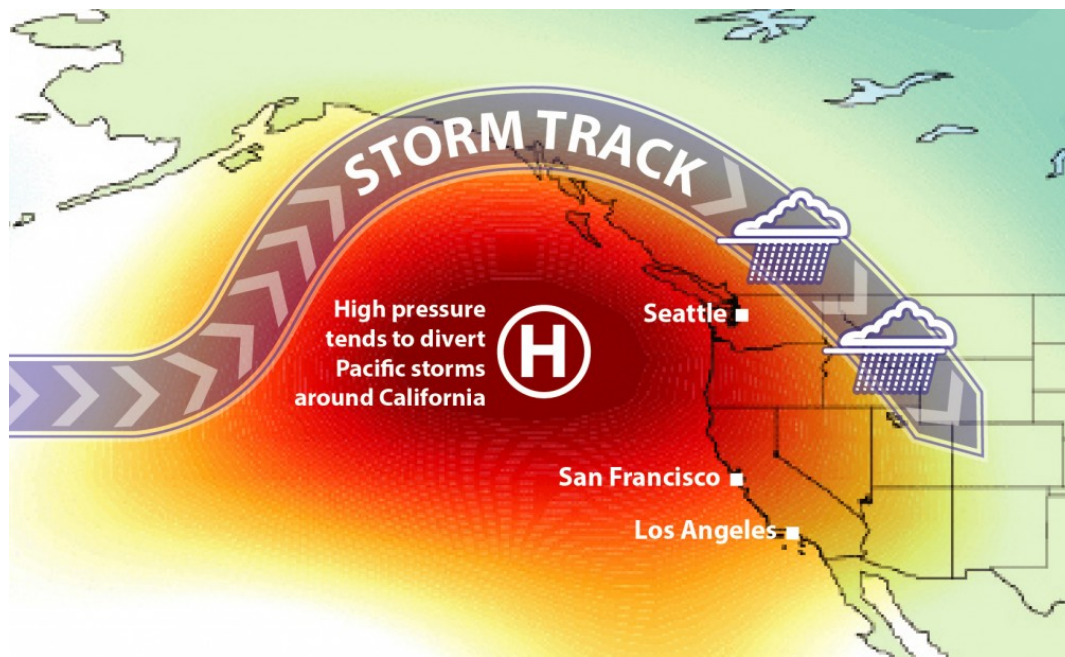


NOAA Climate.gov

<https://www.climate.gov/news-features/blogs/enso/june-el-ni%C3%B1o-update-damn-torpedoes-full-speed-ahead>



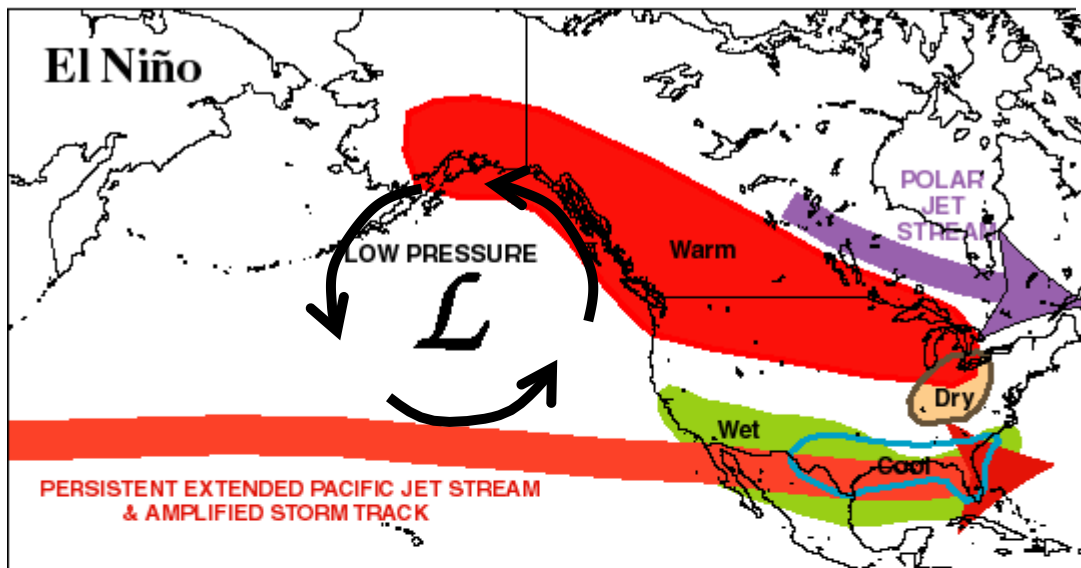
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What happens when 'the blob' meets Godzilla El Niño? Climate chaos and more hot, dry weather for B.C.



JOHN COLEBOURN AND DAAN FUMANO, POSTMEDIA NEWS | August 19, 2015 1:59 PM ET
More from Postmedia News



Fall (2015) we could see:

- the “blob” cool down on the offshore side where winds intensify, but
- off the U.S. West Coast ocean temperatures would rise under the influence of the southerly winds.

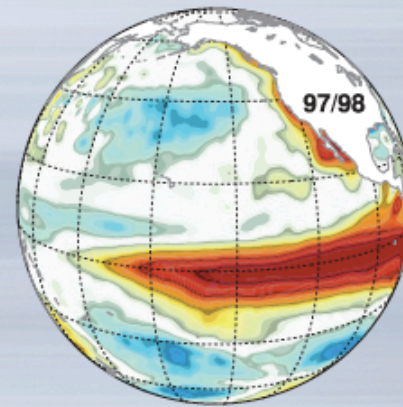
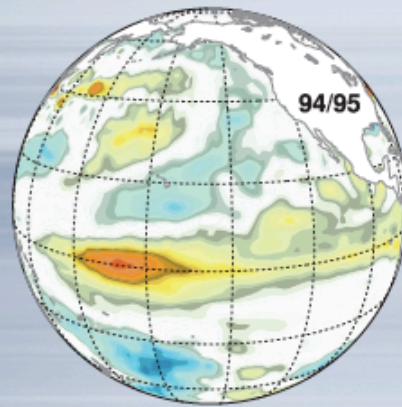
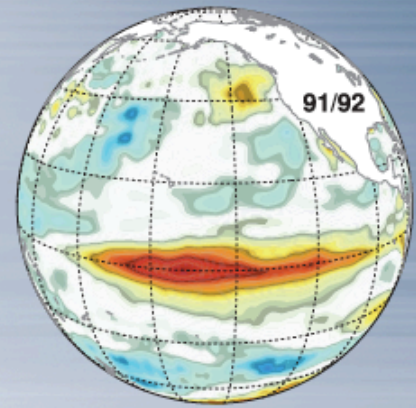
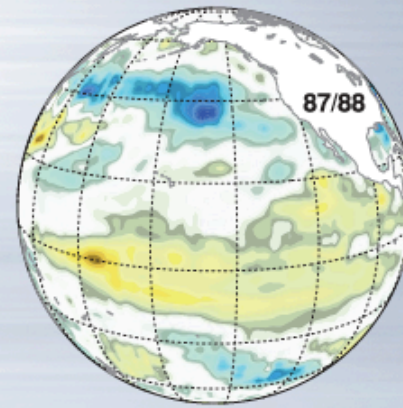
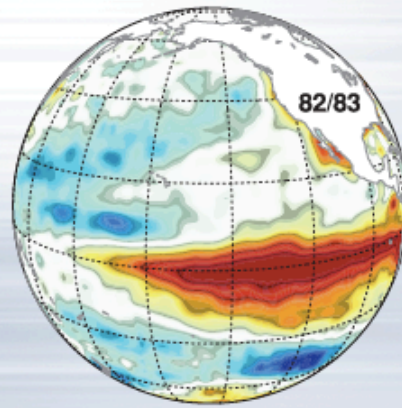
With El Niño, the persistence of the low pressure in the GOA may last through the entire fall and winter.



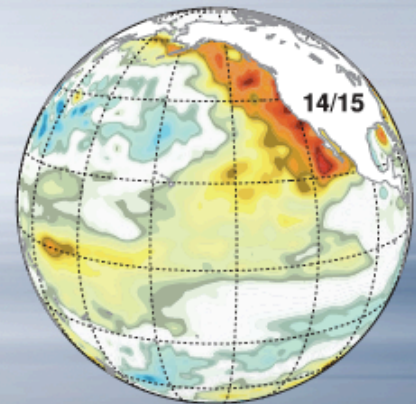
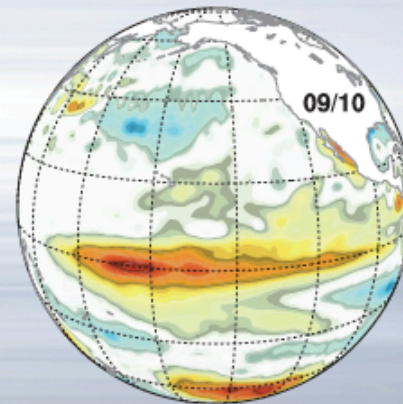
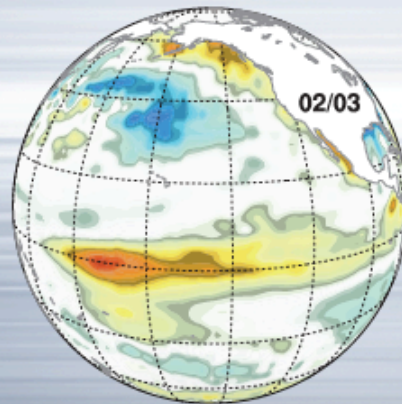
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But what will
the 2015-2016
El Niño look
like?

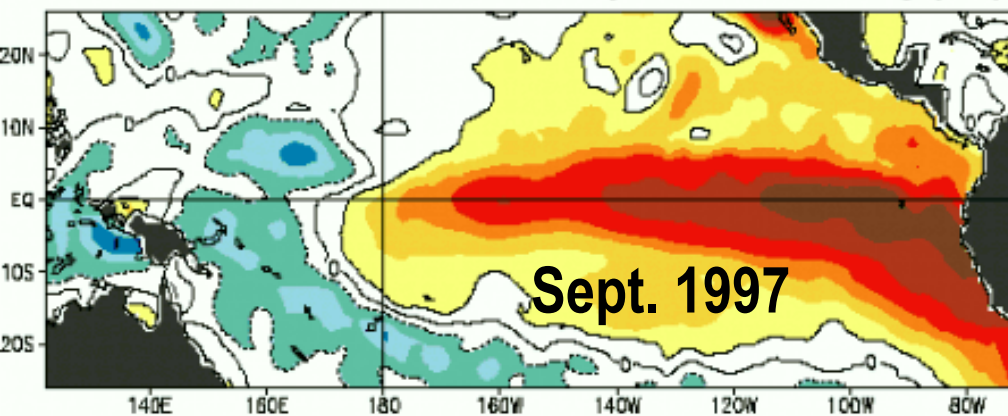
(*i.e.*, not all
El Niños are
the same.)



**FACES
— of —
ENSO**



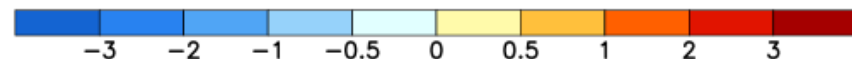
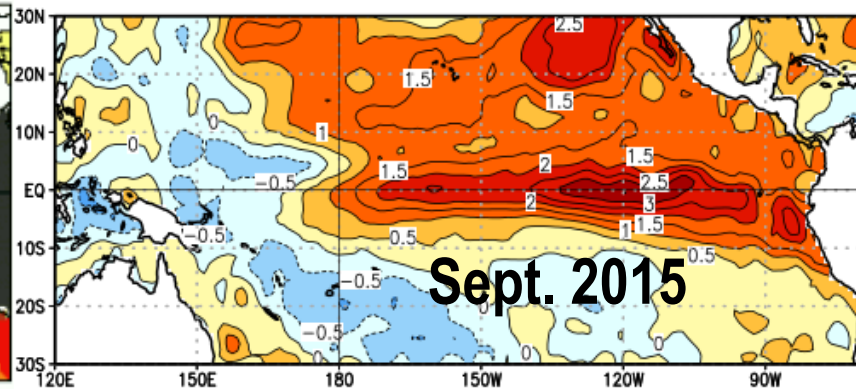
Observed Sea Surface Temperature Anomaly (°C)



7-day average centered on 17 September 1997

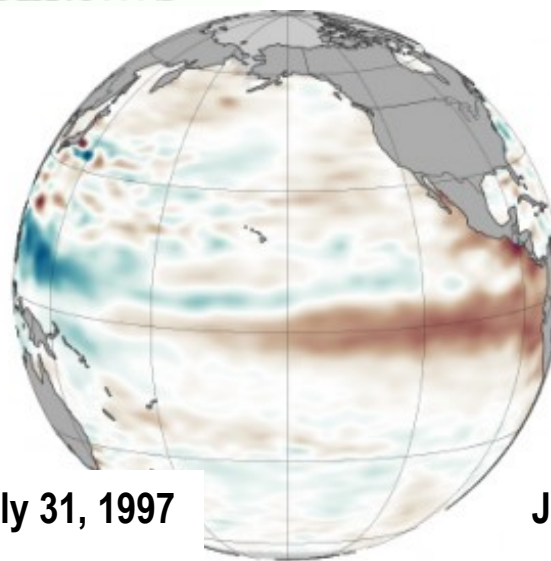
Climate Prediction Center/NCEP/NWS

Average SST Anomalies 9 AUG 2015 – 5 SEP 2015

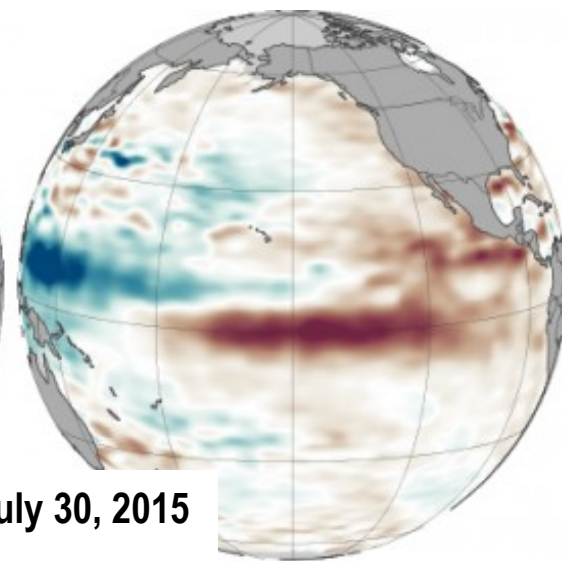


- 2015-16 could look like 1997-98
- But its evolution is still a projection

July 31, 1997

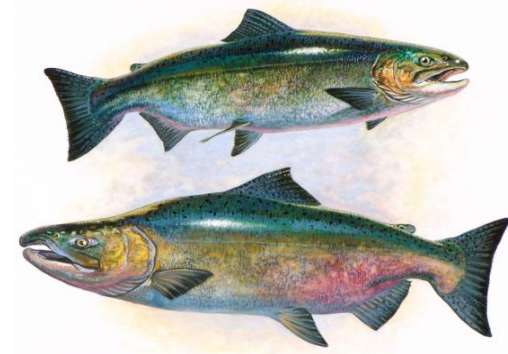


July 30, 2015

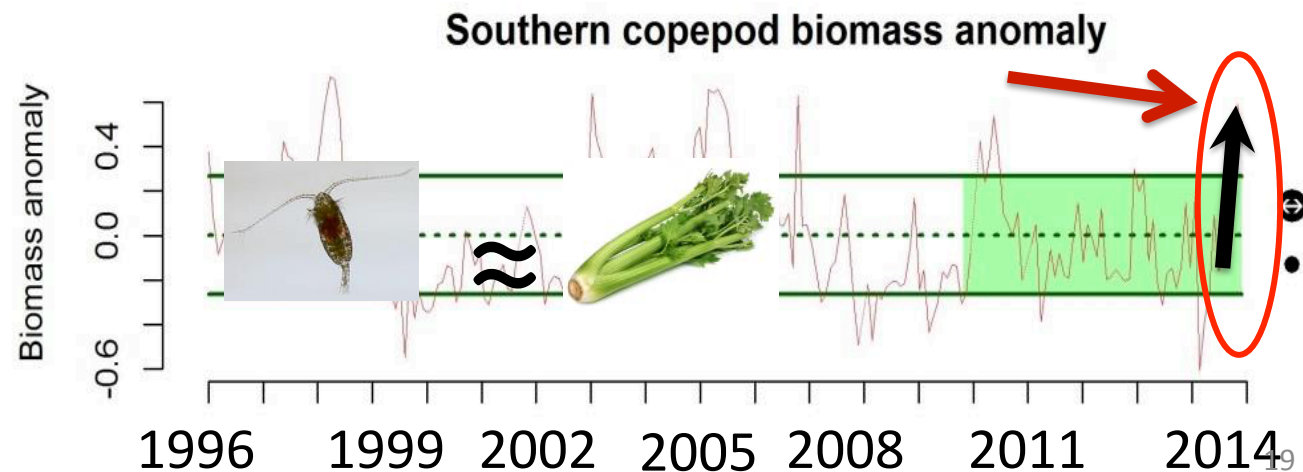
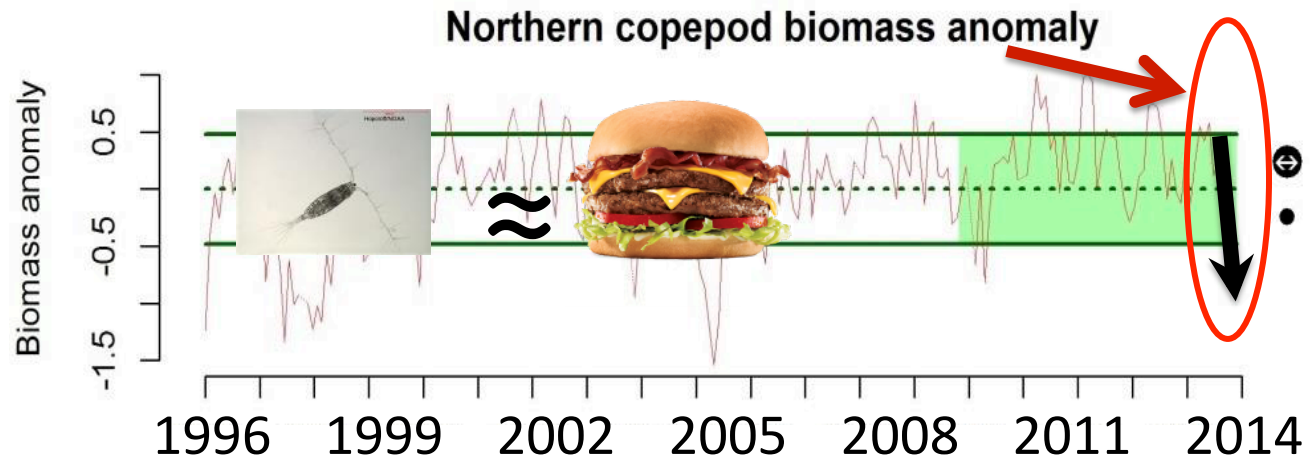


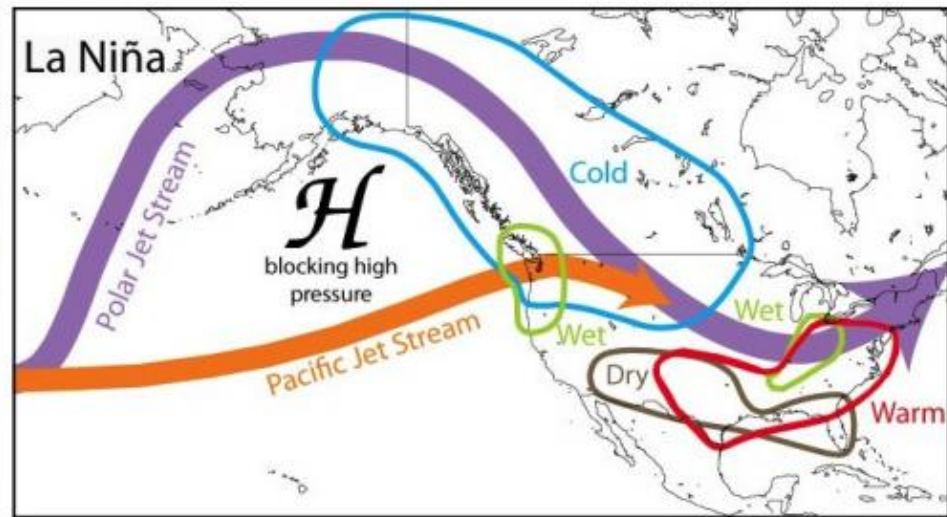
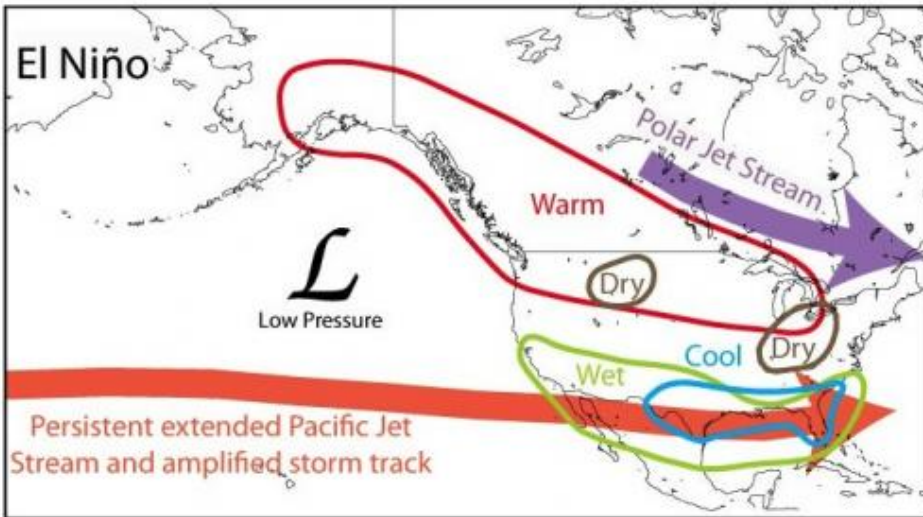
El Niño's Effects on Salmon in the California Current

Bodes ill for west coast salmon marine growth and survival



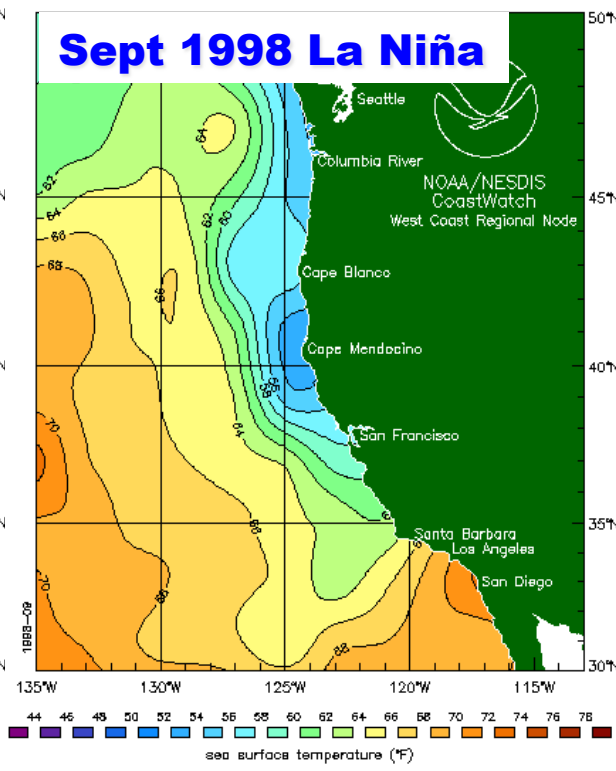
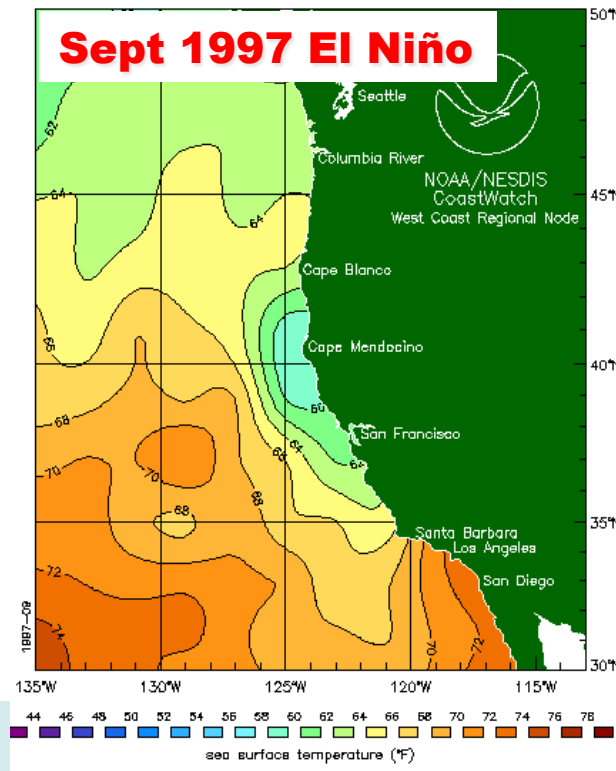
- “Northern” copepods rich in lipids support fish production
- Northern copepods associated with cooler waters in the California Current
- But, a major shift occurred in late 2014





What about after
the **El Niño**? ...

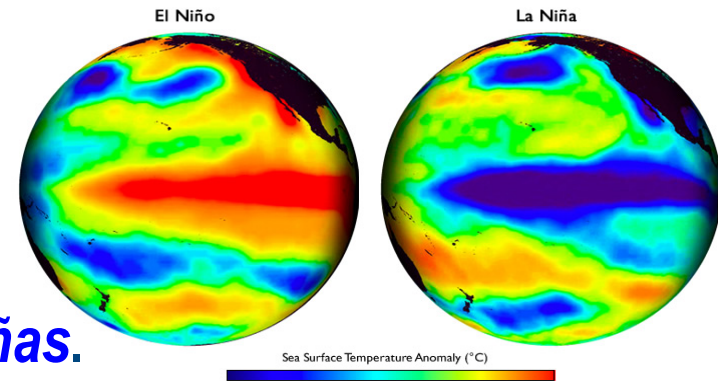
A seesaw to
La Niña?



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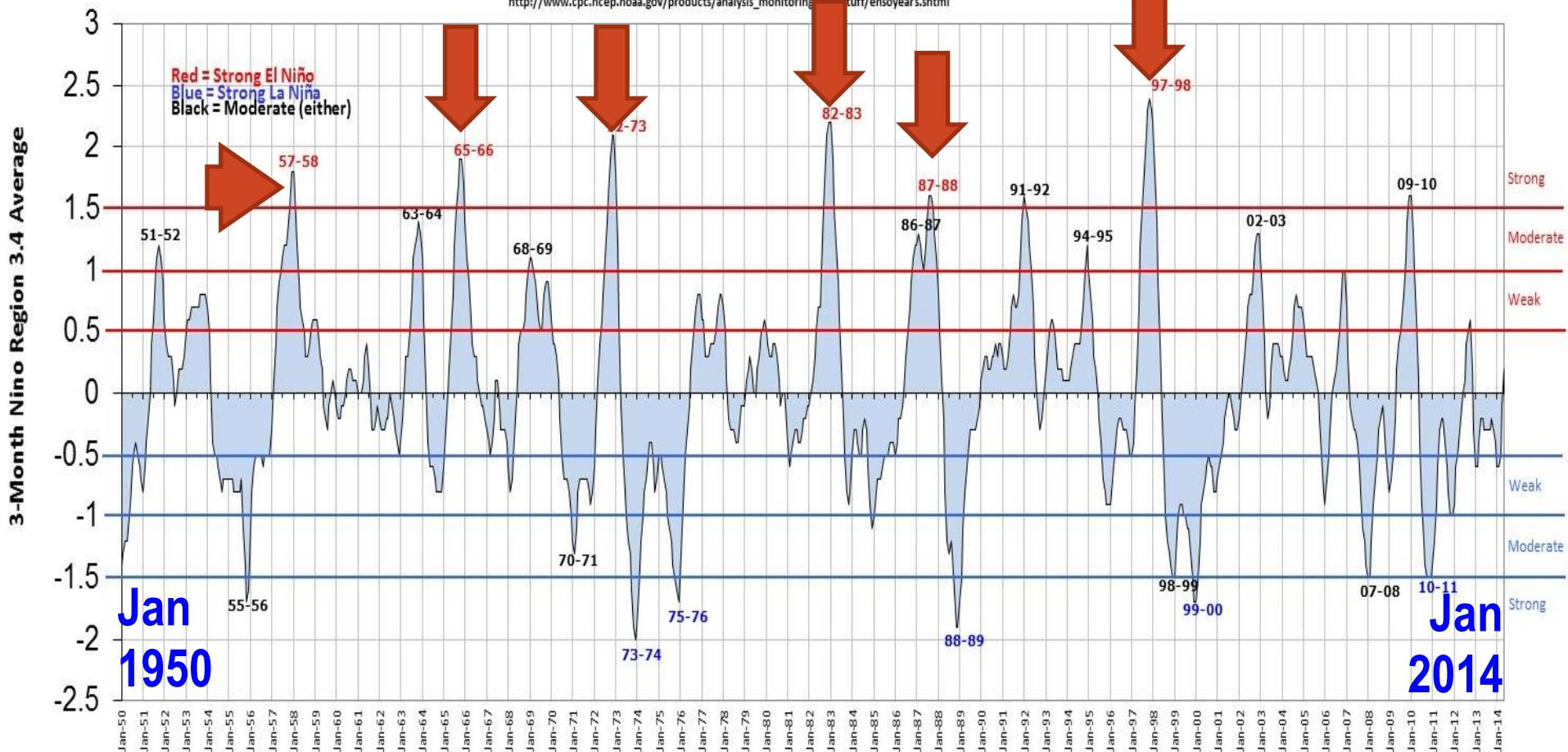
History since 1950 of El Niño - La Niña occurrences

Six “strong” and eight “moderate” *El Niños*
And five “strong” and four “moderate” *La Niñas*.



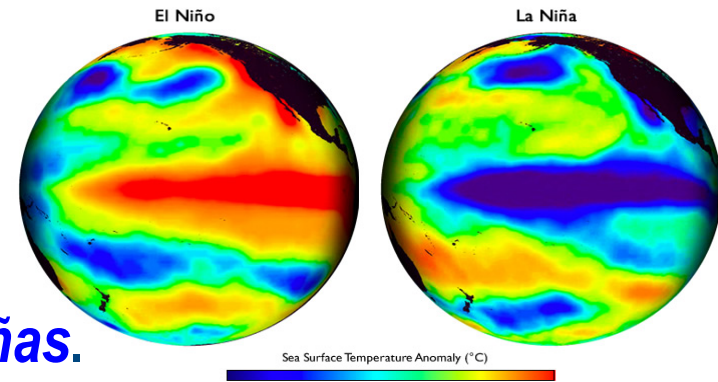
Oceanic Niño Index (ONI)

http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml



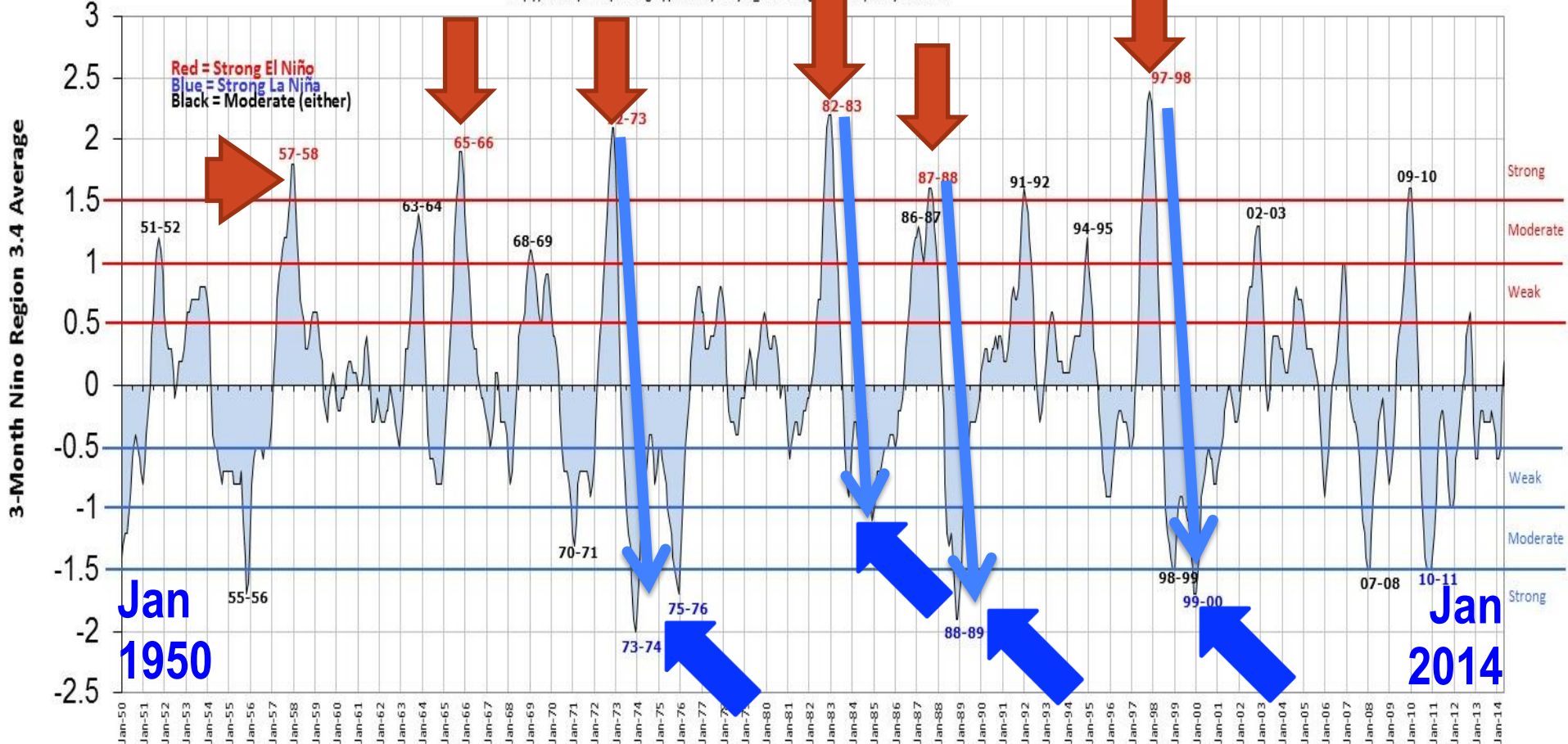
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So far, we can say that...

Fall/Winter of 2015/2016: we are likely to experience a significant El Niño. It may “dissipate” the blob. It will have implications to our fisheries and protected species.

Within a great deal of uncertainty/extrapolation:

Summer/Fall 2016: several of the past El Niños have been followed by multi-year La Niña conditions (including the 1982/83 and 1997/98 extreme El Niño events).

Next 3 - 4 years (2015-2019): we may see a rich and complex series of events – covering a wide spectrum – in the North Pacific.

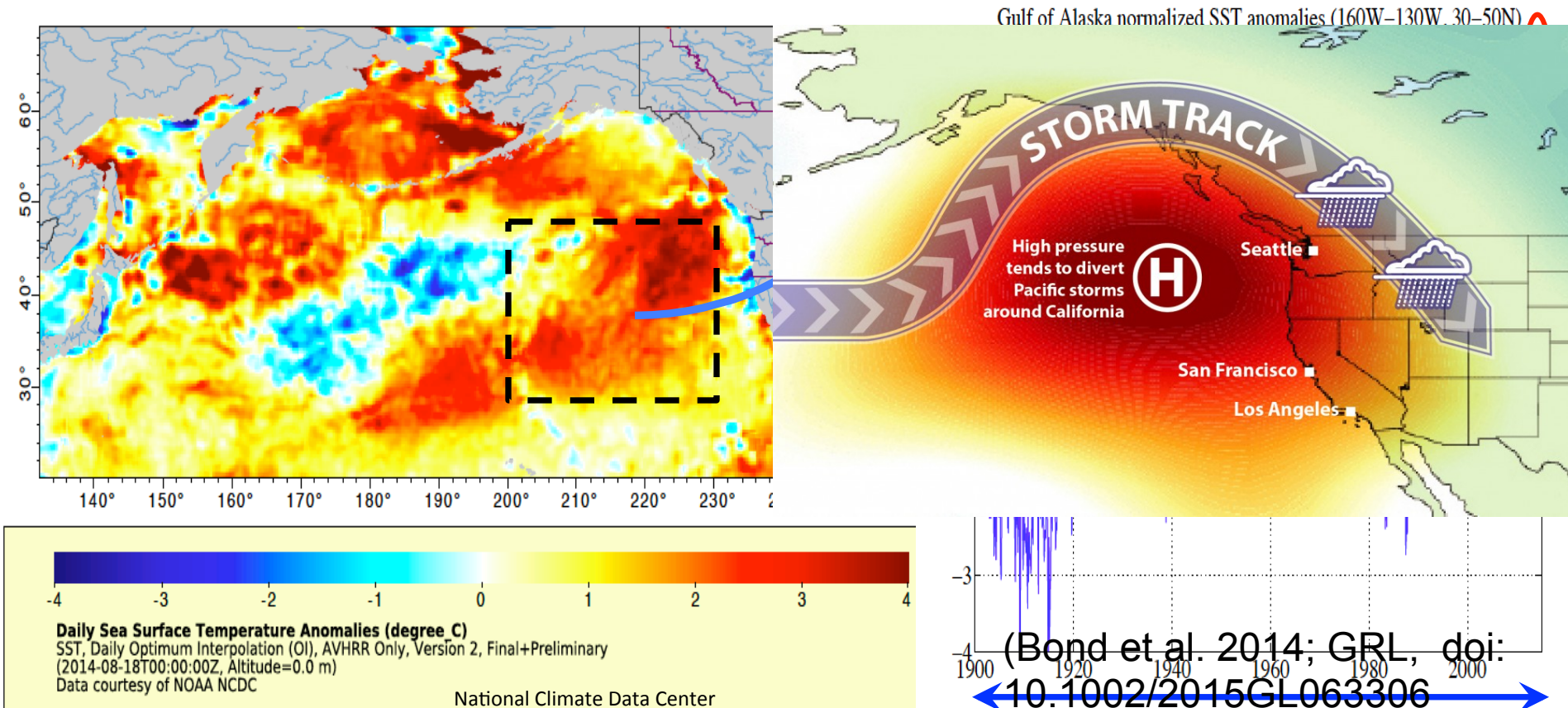
Questions?



“Animated slides”



The Blob: A prominent mass of positive temperature anomalies, attributed to strongly positive anomalies in SLP (*the Ridiculously Resilient Ridge*), which served to suppress the loss of heat from the ocean to the atmosphere. The ‘extra heat’ persisted through the summer of 2014.

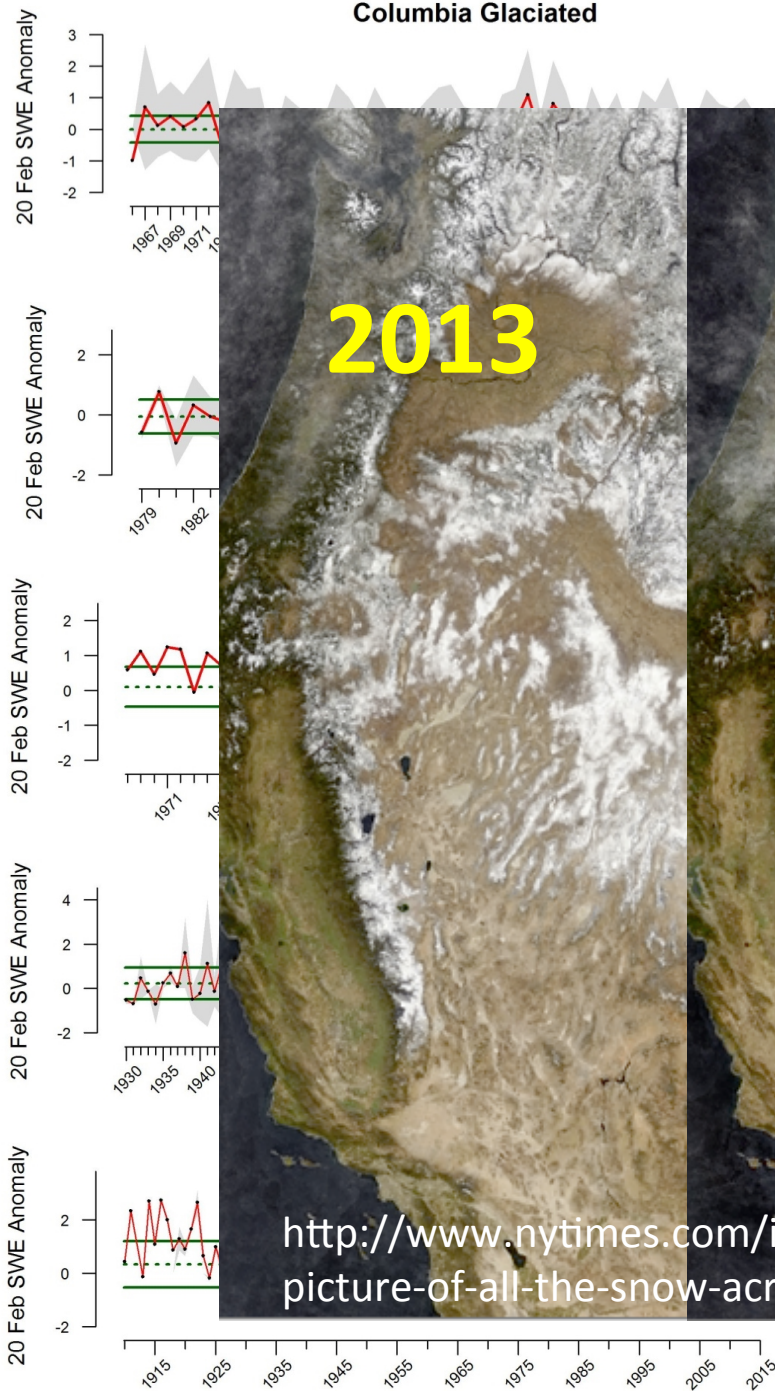


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Snow water equivalent (SWE)



2013

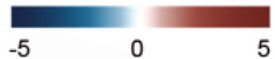
2014

2015

http://www.nytimes.com/interactive/2015/03/05/us/one-giant-picture-of-all-the-snow-across-the-us.html?smid=tw-share&_r=0

El Niño Arrives in 2015

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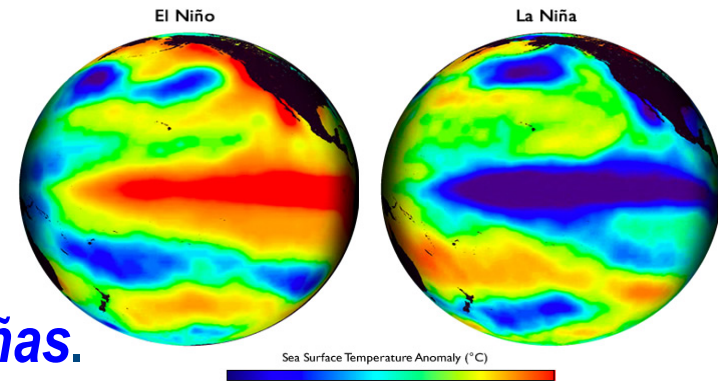
Temperature compared to average ($^{\circ}\text{C}$)
March 5, 2015



NOAA FISHERIES

History since 1950 of El Niño - La Niña occurrences

Six “strong” and eight “moderate” *El Niños*
And five “strong” and four “moderate” *La Niñas*.



Oceanic Niño Index (ONI)

http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml

