

Projected Climate Change Impacts to the San Francisco Bay-Delta Ecosystem and Region

BAECCC Climate Smart Workshop
November 29, 2012

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Special Thanks to:

Dan Cayan (USGS)

Mike Dettinger (USGS)

John Takekawa (USGS)

Mike Casazza (USGS)

Patrick Barnard (USGS)

Doug Marcy (NOAA)

Jeff Burgett (USFWS)

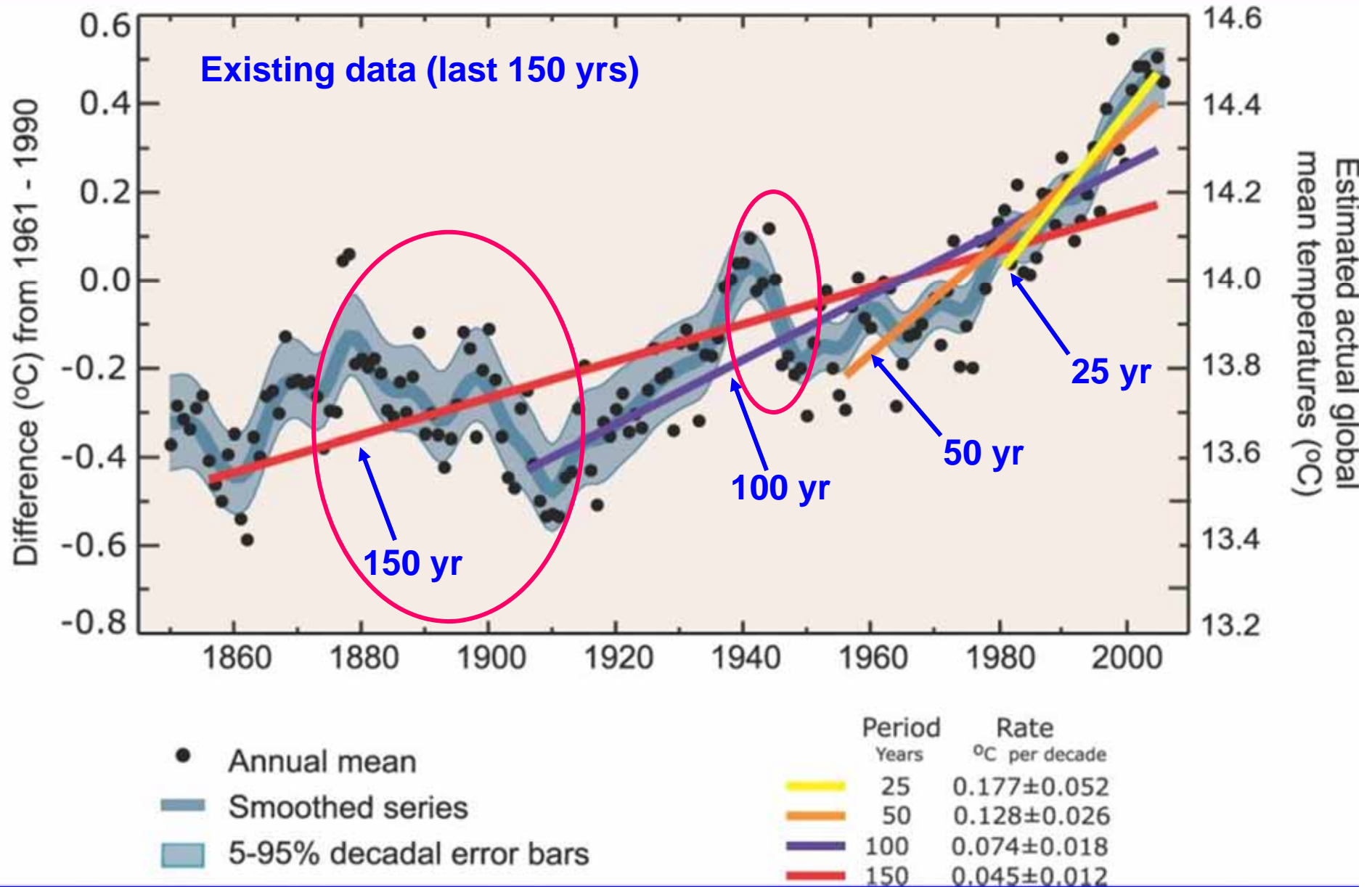
Mendel Stewart (USFWS)

Ellie Cohen (PRBO-Conservation Science)

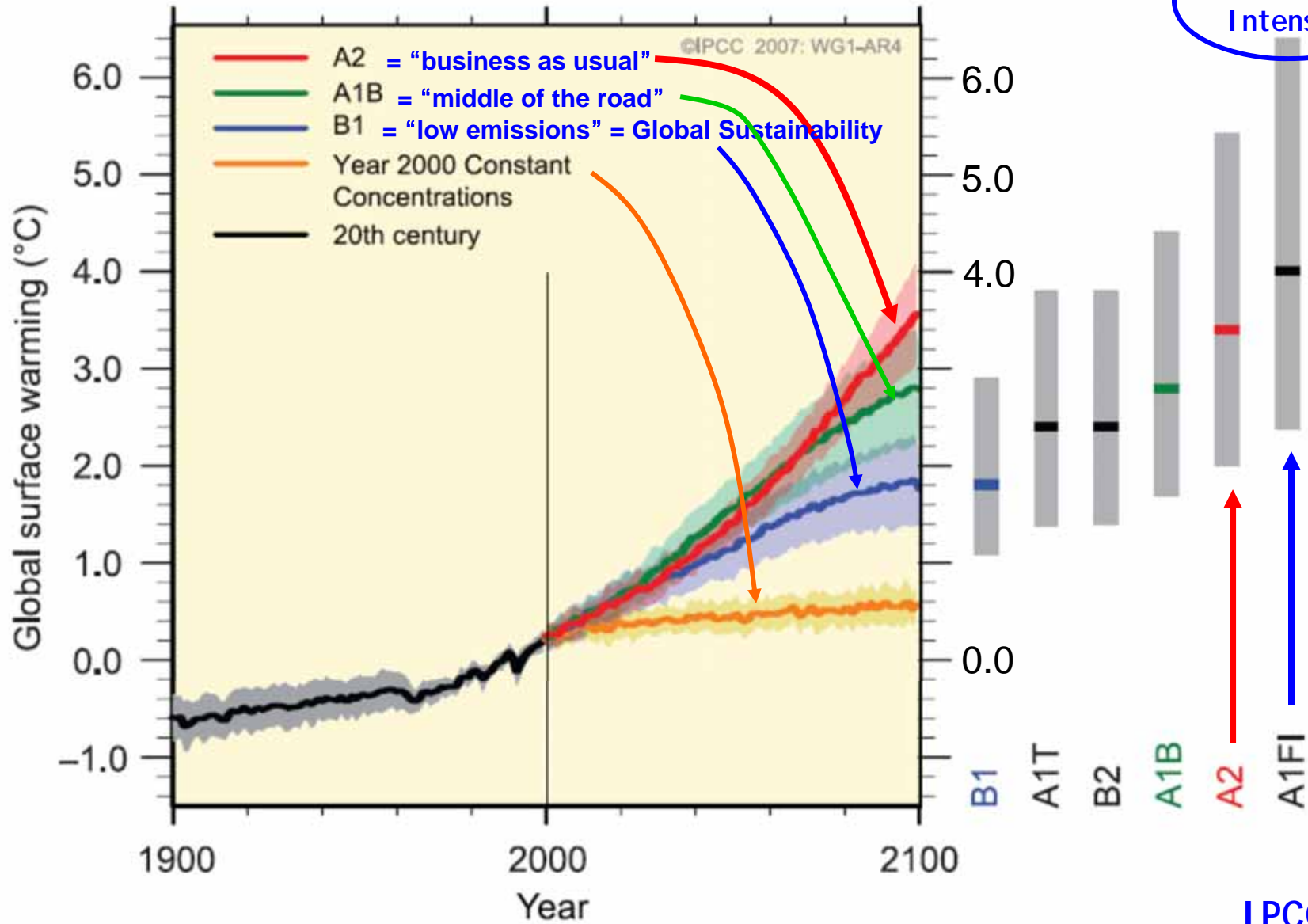
Josh Collins (San Francisco Estuary Institute)

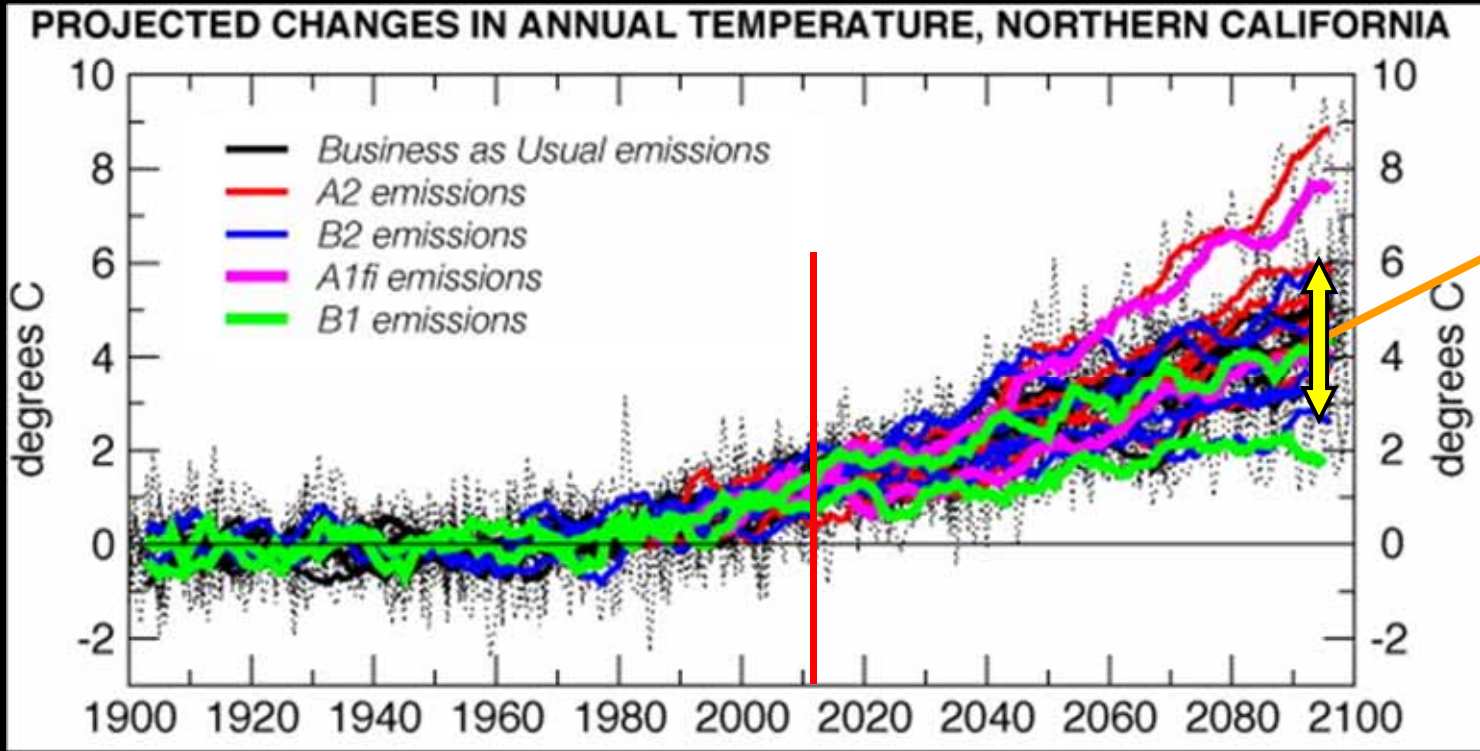


Rate of temperature change is increasing



MULTI-MODEL AVERAGES AND ASSESSED RANGES FOR SURFACE WARMING

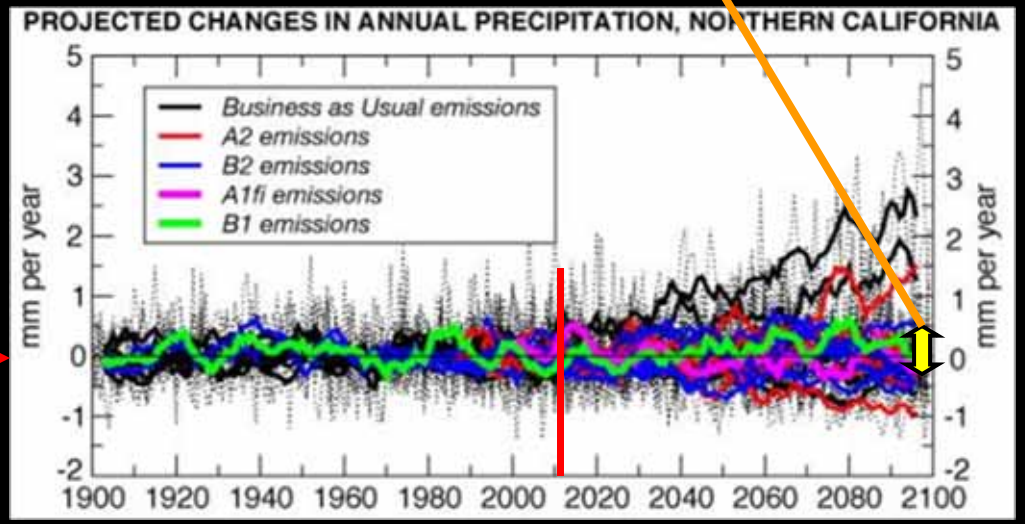




19 of 23 in this range

Strong consensus for warming

Large uncertainty with precipitation

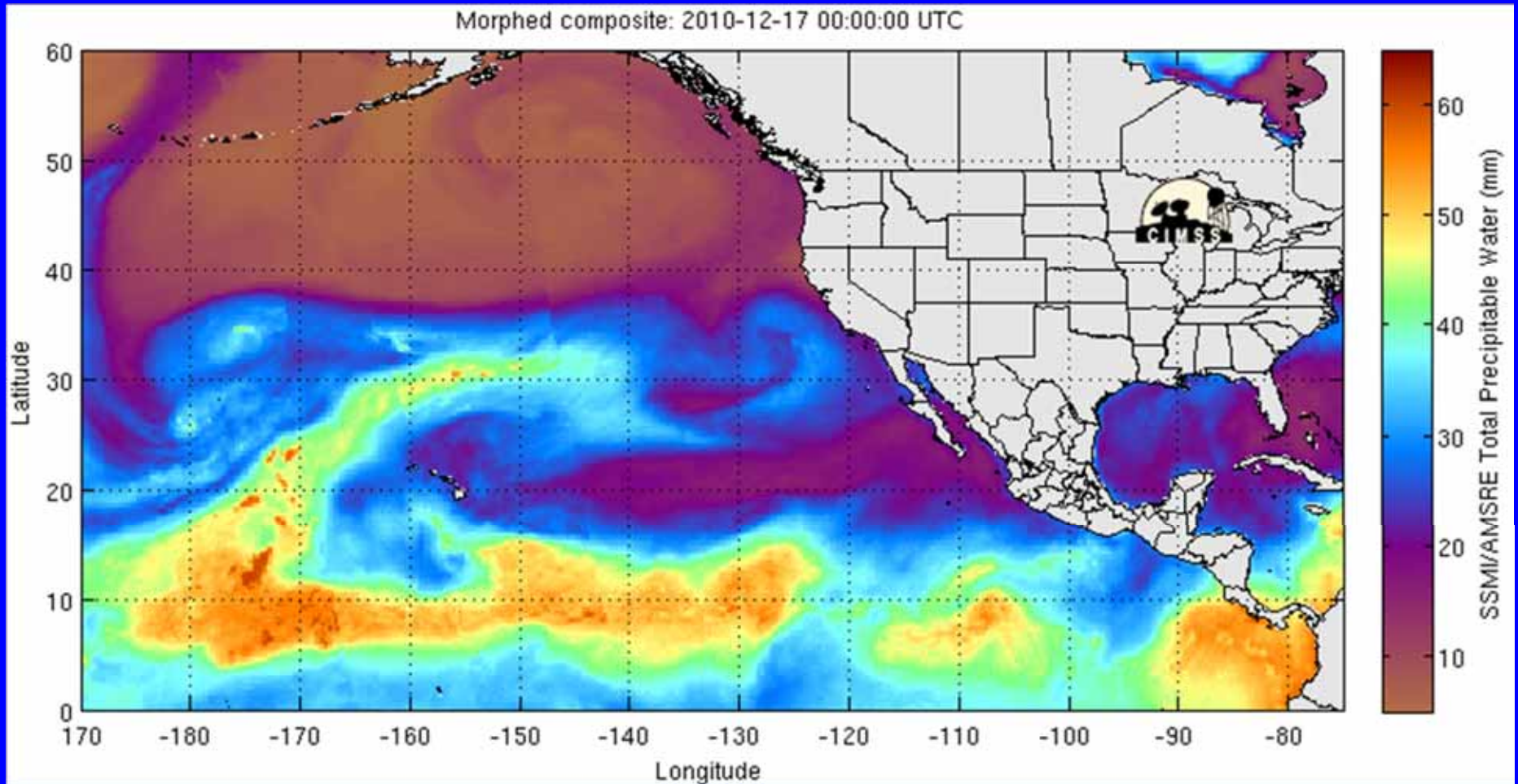


Dettinger, 2005; Hidalgo et al, 2008

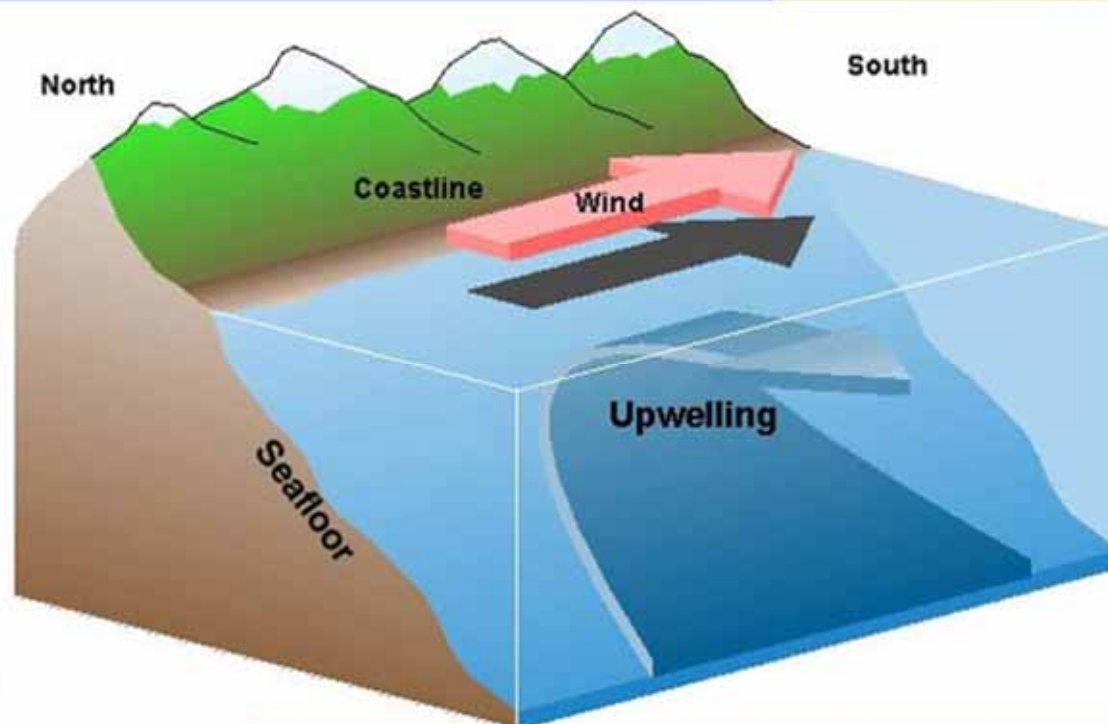
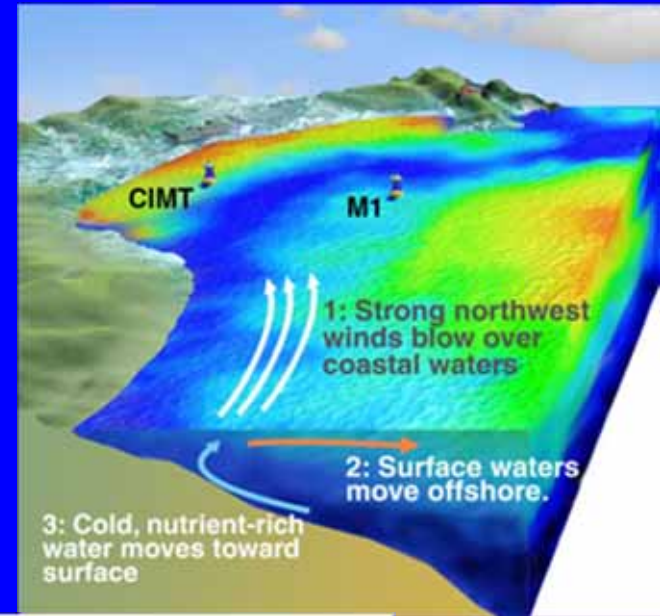
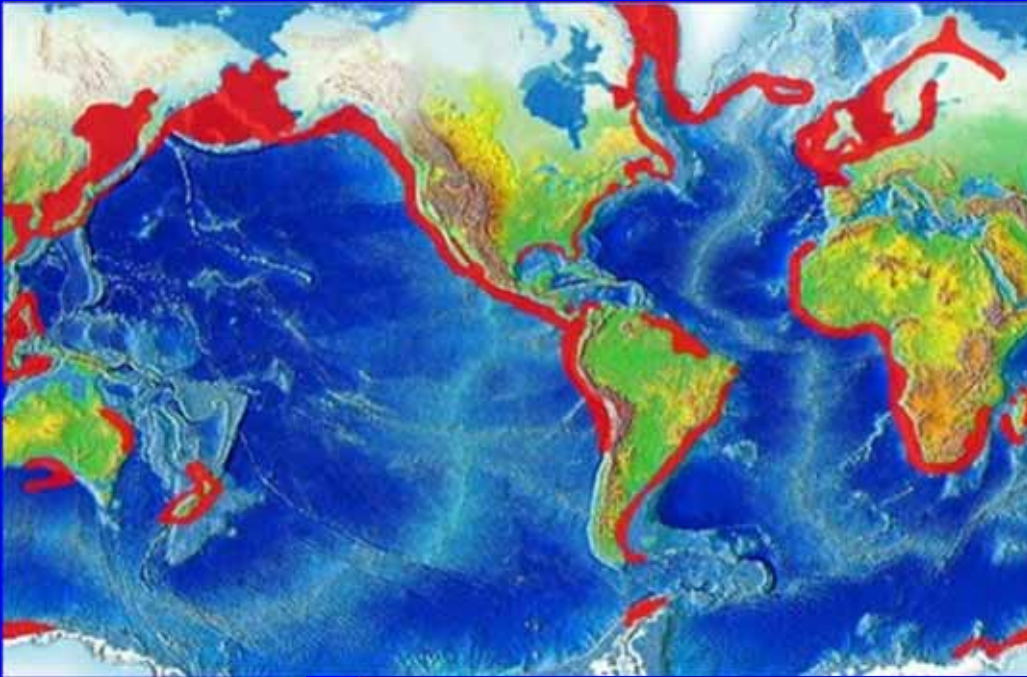
Atmospheric Rivers

SUPER STORM
December 17-22, 2010

26 inches of rain in coastal CA
17 feet of snow in the Sierra

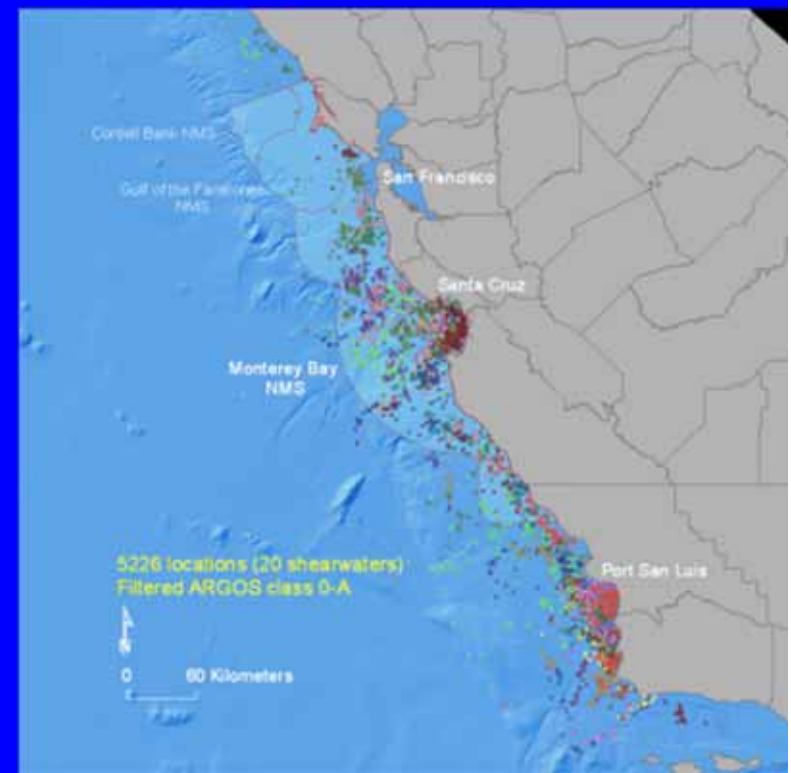
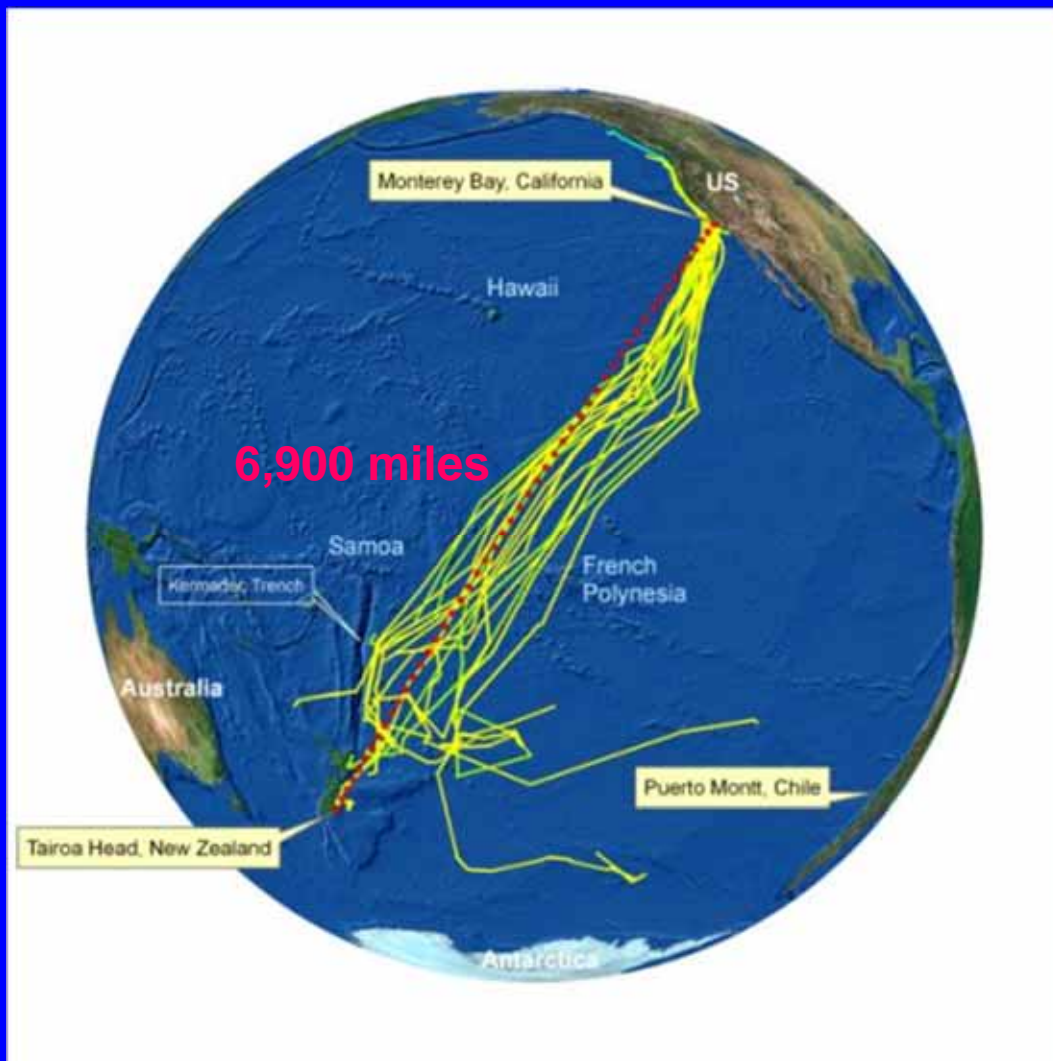


EL NIÑO & UPWELLING

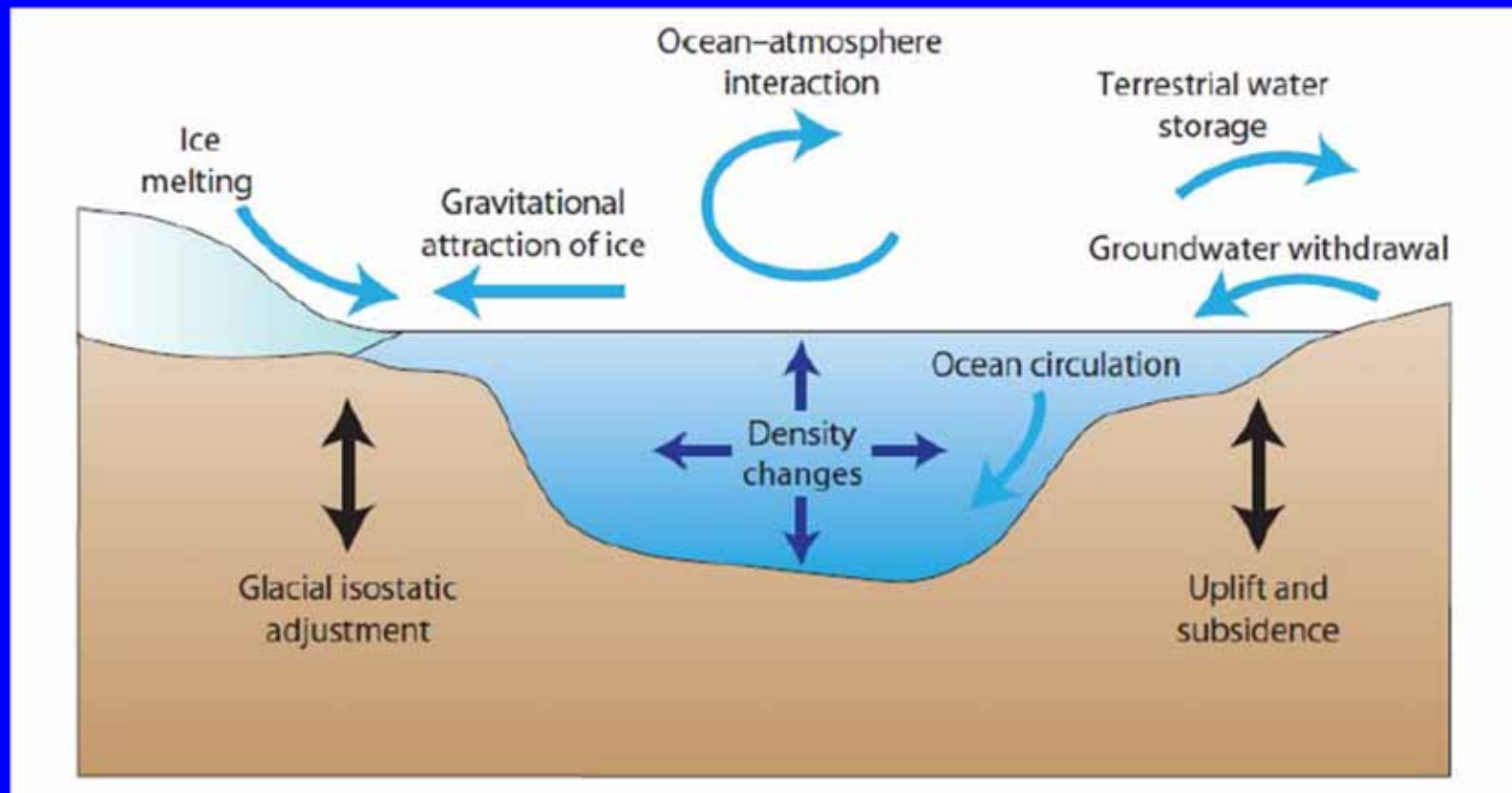


El Niño
slows
upwelling

Movements and trans-Pacific migration of the Sooty Shearwater (*Puffinus griseus*)



SEA LEVEL RISE

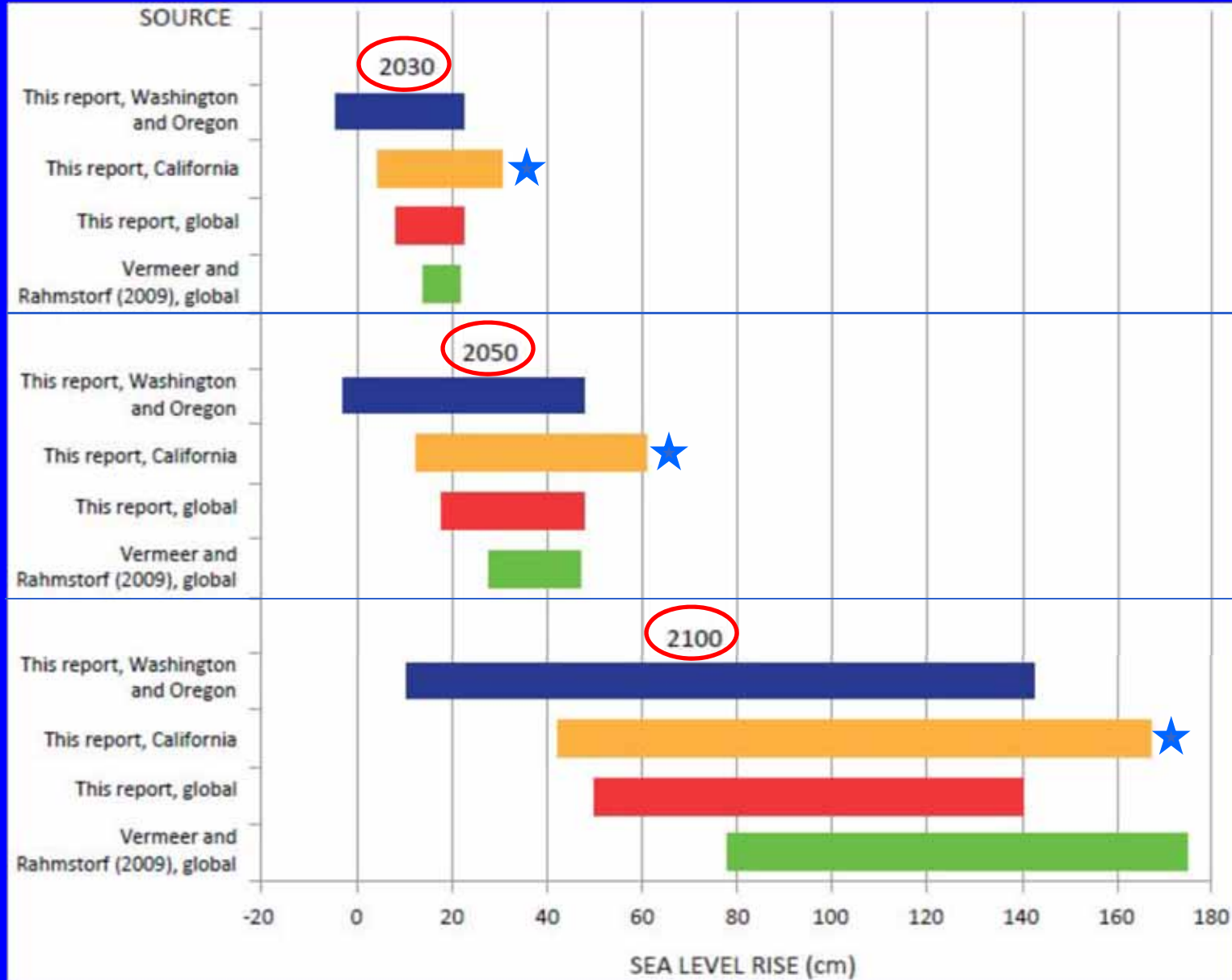


About 50% from expansion...

About 50% from melting of glaciers & ice caps ...

NRC: 2012

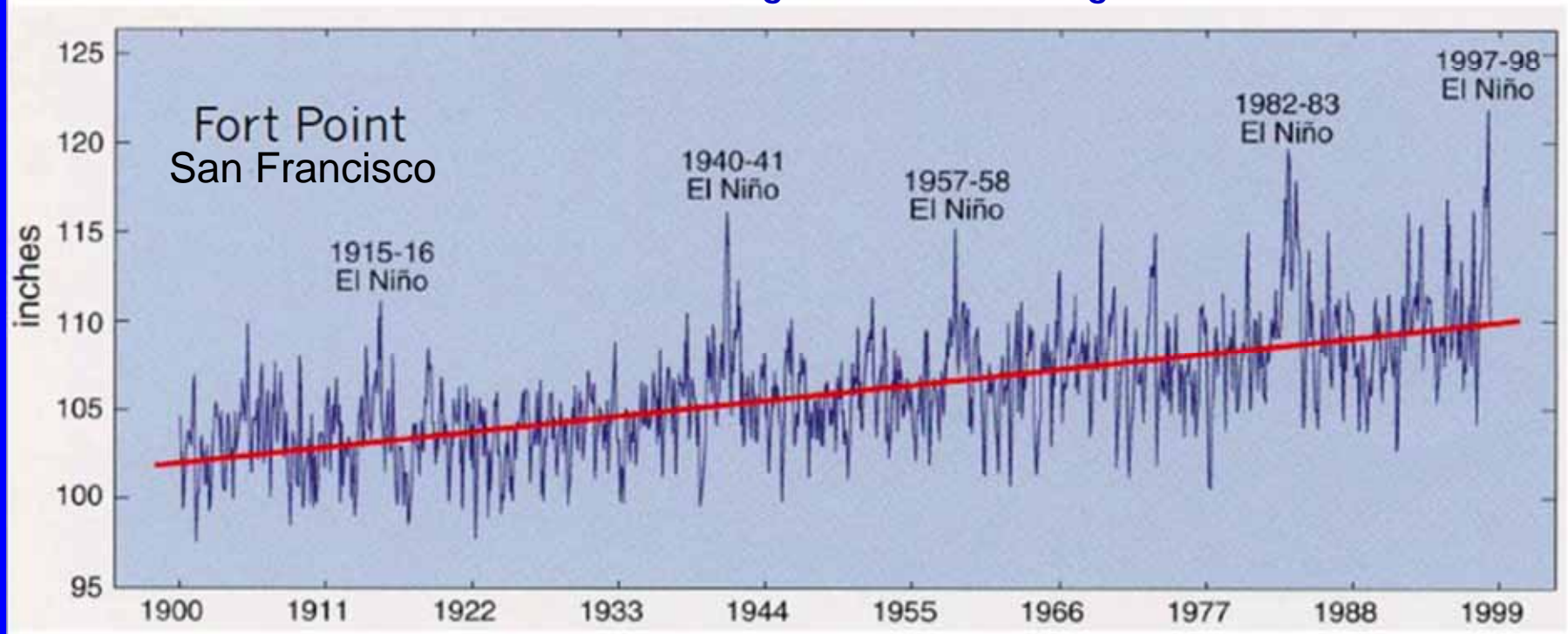
Estimates of future Sea Level Rise



El Niño Events Affect Sea Level

Local sea level rises during warm climate phases like El Niño, and falls during cool climate phases like La Niña

~ 10 inches higher than average



Think about it....



Sea level rise will further erode existing levees and inundate low elevation areas unprotected by levees.



Past
1849

Present

*With levee construction
and development*

2100

Will the Future Be This ??



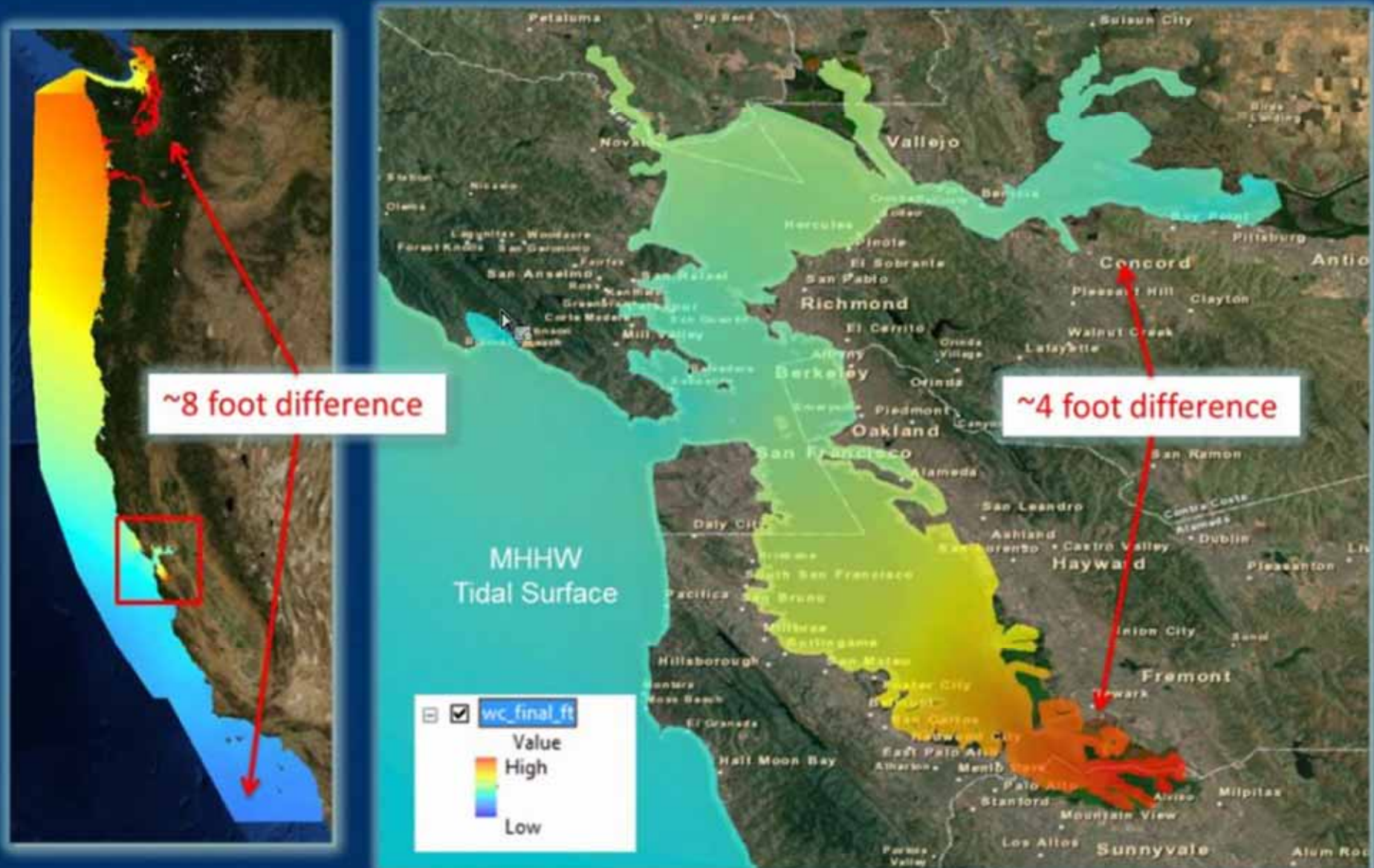
West Coast Trends

- California sea level rise up to 1.6 m by 2100
- Winter wave height increasing ~1-3 cm/yr
- Extreme wave height increasing ~10 cm/yr
- Wave surge increasing, especially in the north...
- Increase in magnitude and frequency of storms



- Sources: IPCC (2007)
- Allan and Komar (2006, Journ of Coastal Res),
- Climate Progress – June 2009
- NRC - 2012

The Ocean Is Not a Flat Surface (especially in bays and estuaries)

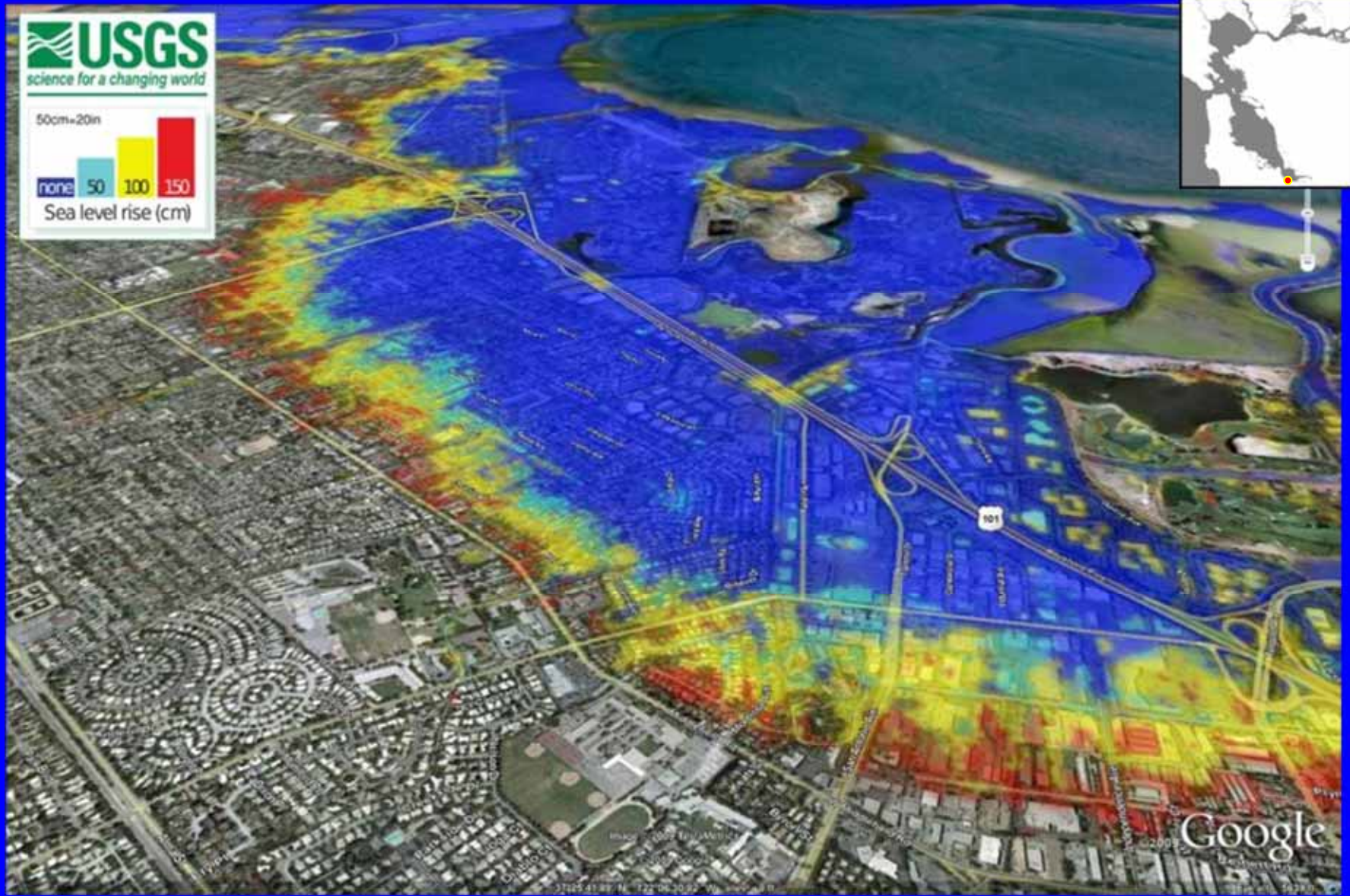


South Bay: Projections (infrastructure)

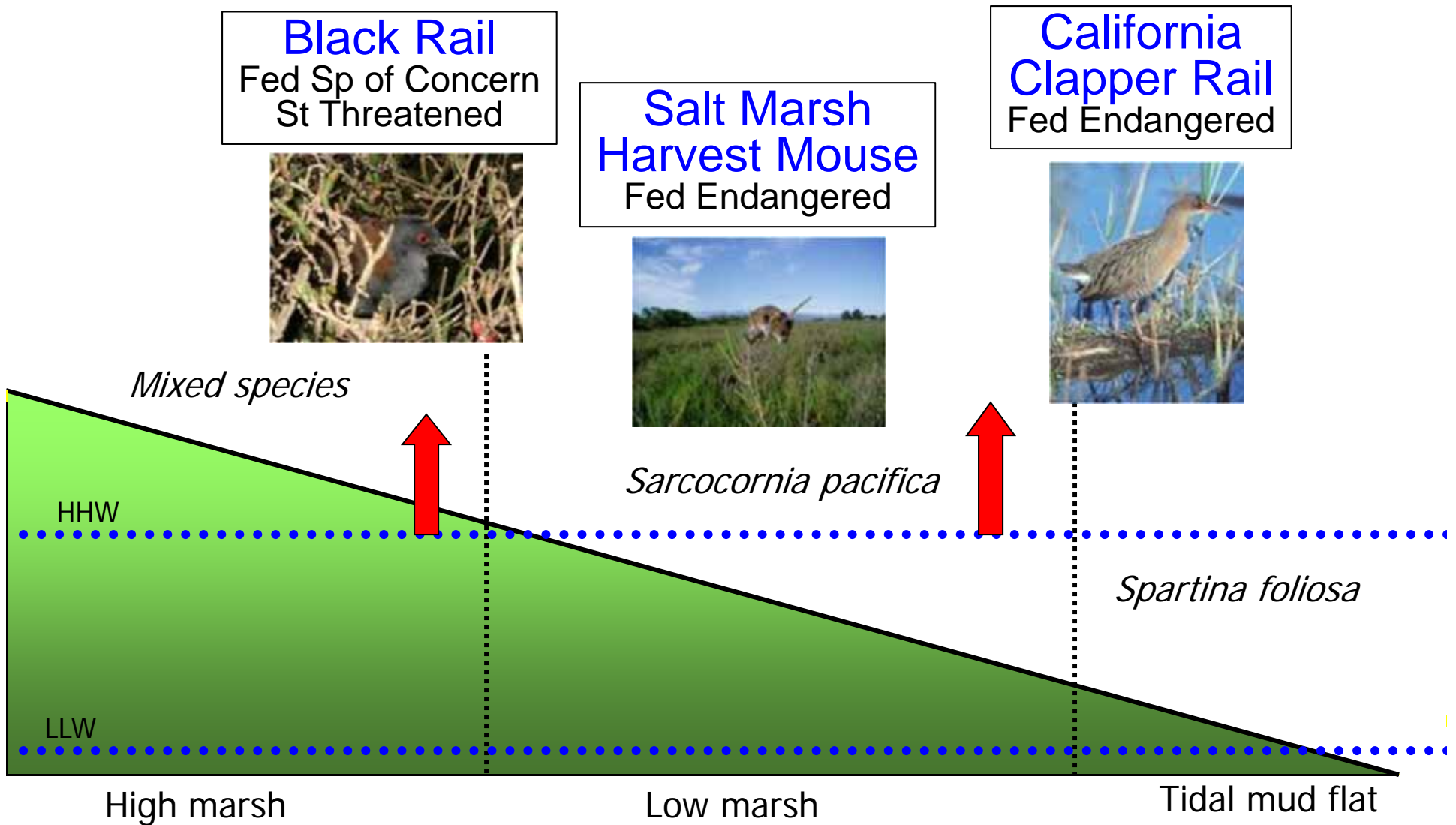


South Bay: Projections

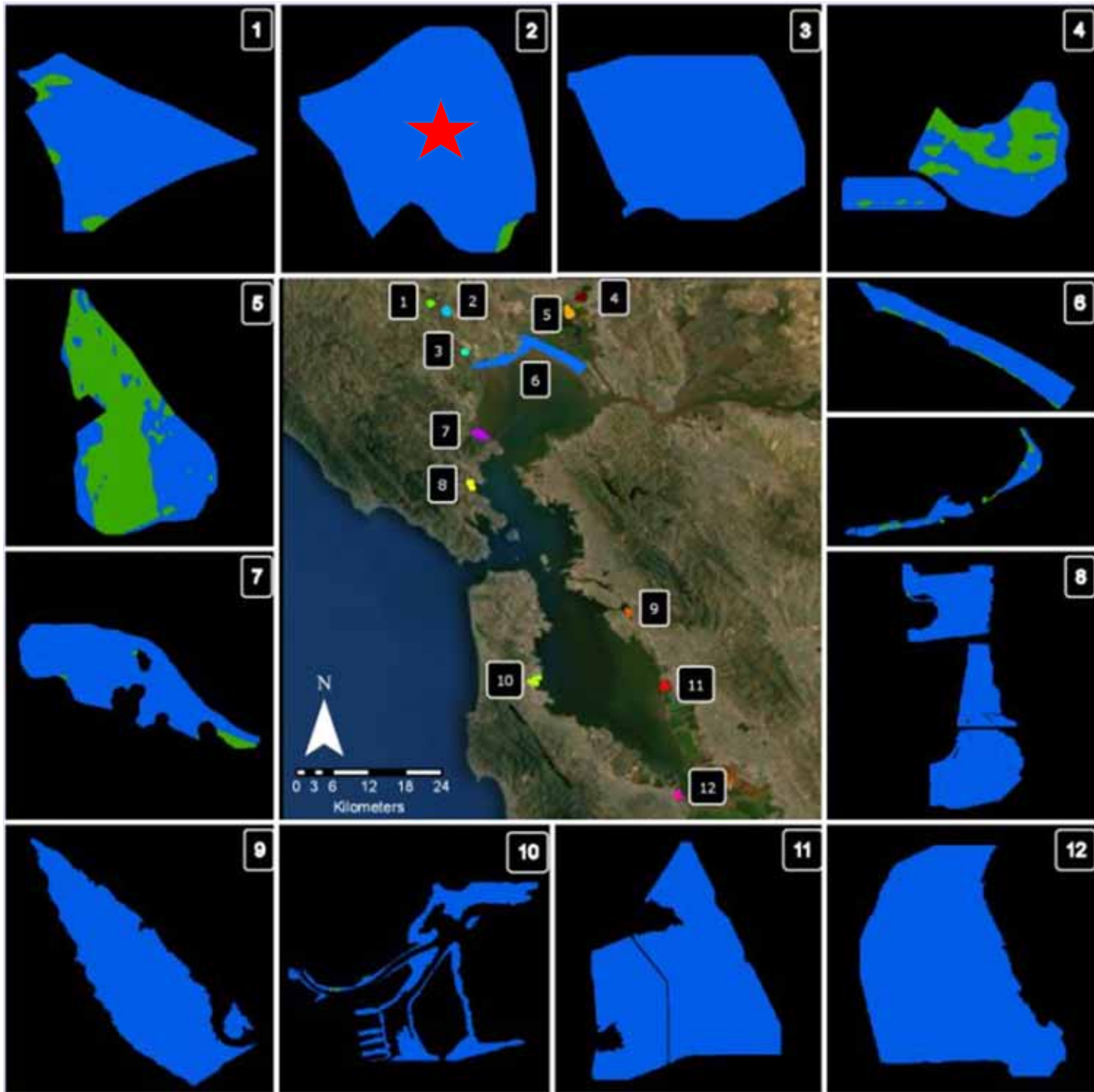
100 yr Storm Surge +



Relative positions of three marsh-dependent species.



Salt Marsh Elevation Gradient



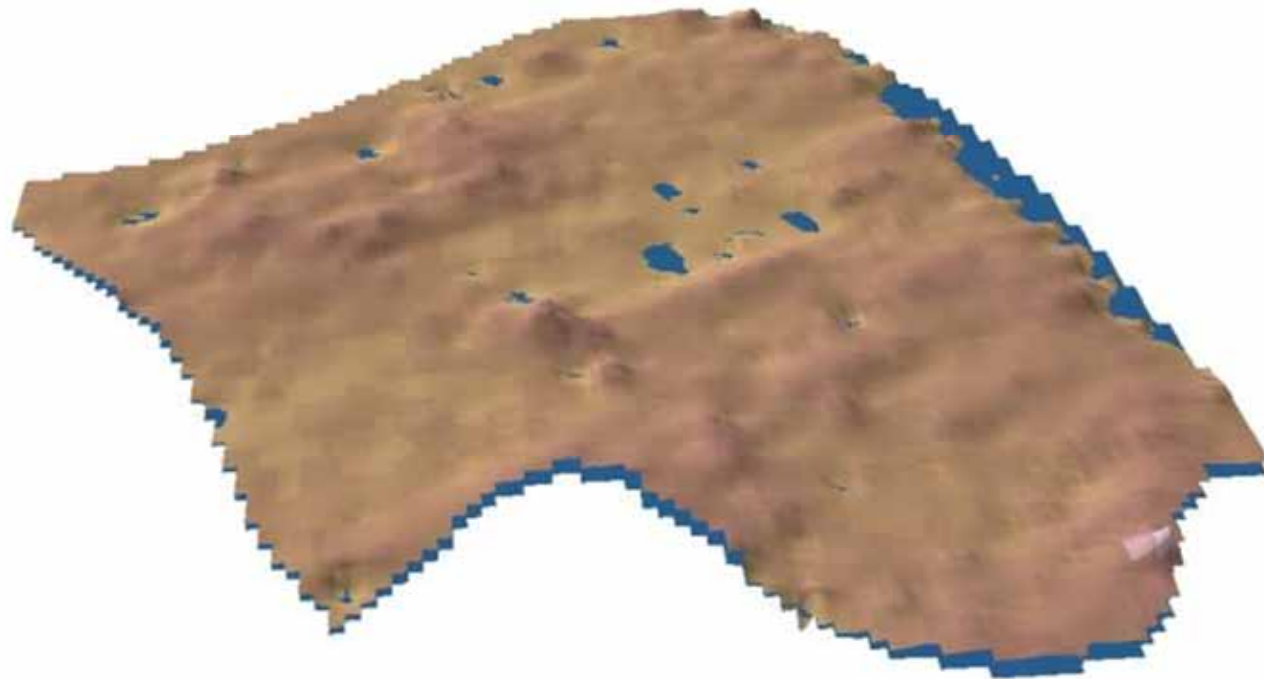
San Francisco Bay Area Salt Marshes

Inundation at Mean Higher High Water

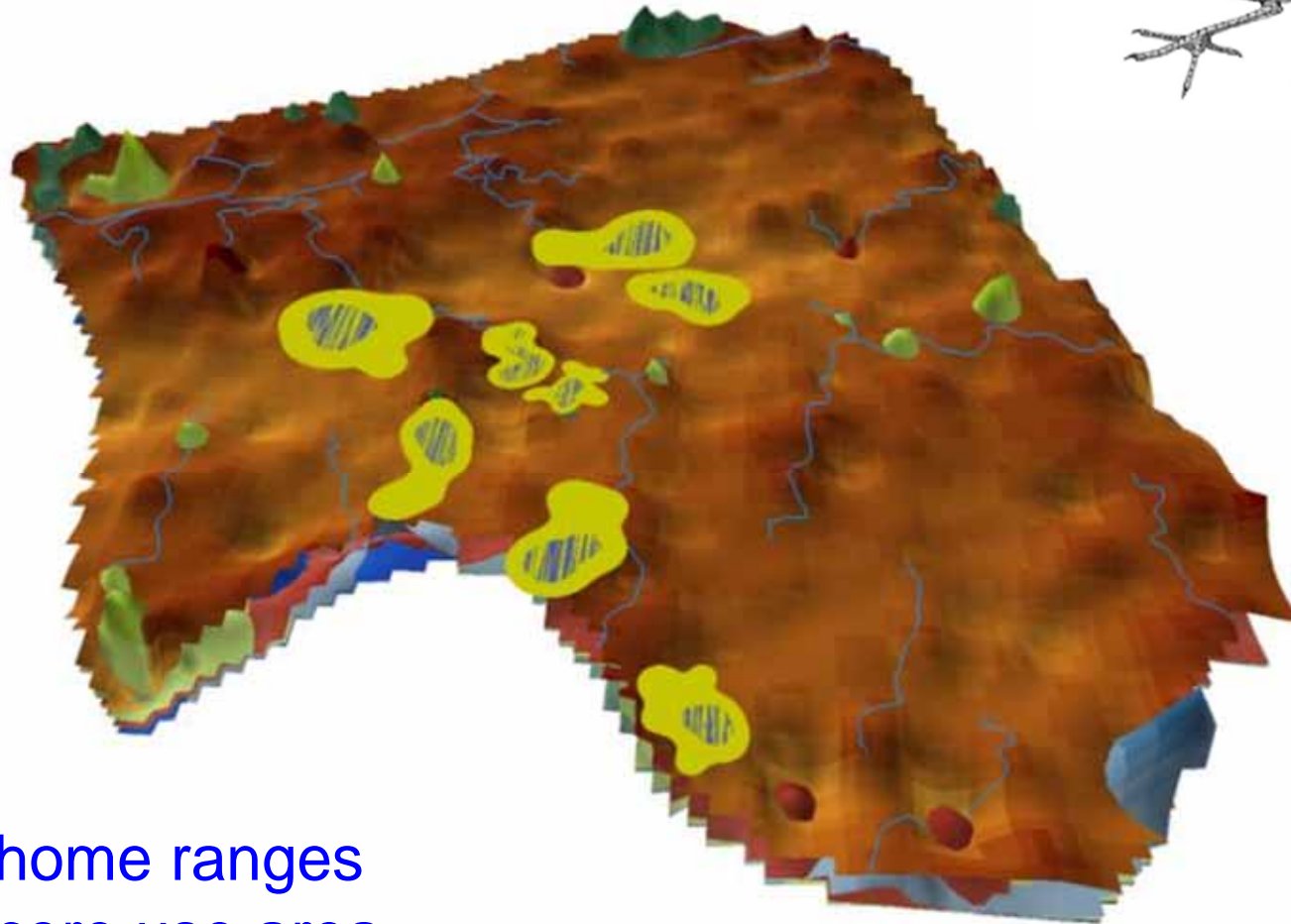
1	Gambonini	95.7%
2	Petaluma	99.1%
3	Black John	100%
4	Fagan	70%
5	Coon Island	38%
6	SPB NWR	93%
7	China Camp	97%
8	Corte Madera	99.8%
9	Arrowhead	100%
10	Colma	99.5%
11	Cogswell	100%
12	Laumeister	100%



**Petaluma Tidal Marsh
water level = 1.75 m**



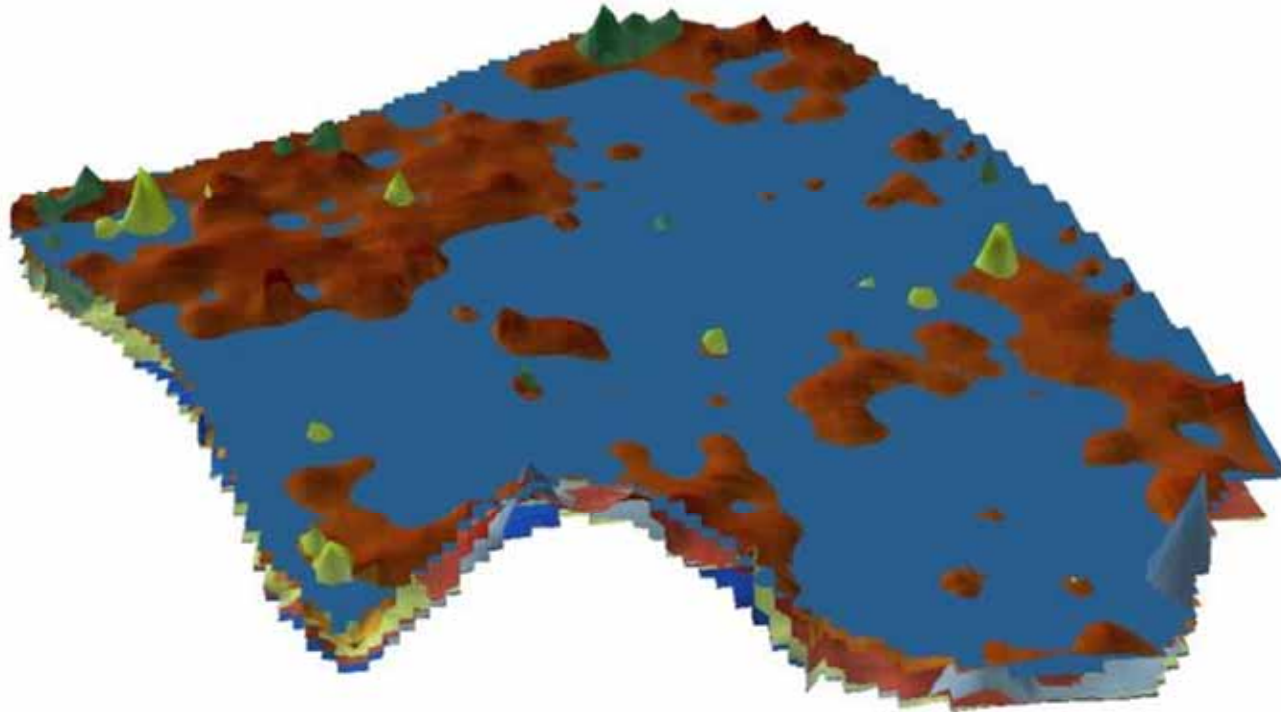
Petaluma Tidal Marsh California Black Rail



0.59 ha home ranges
0.14 ha core use area

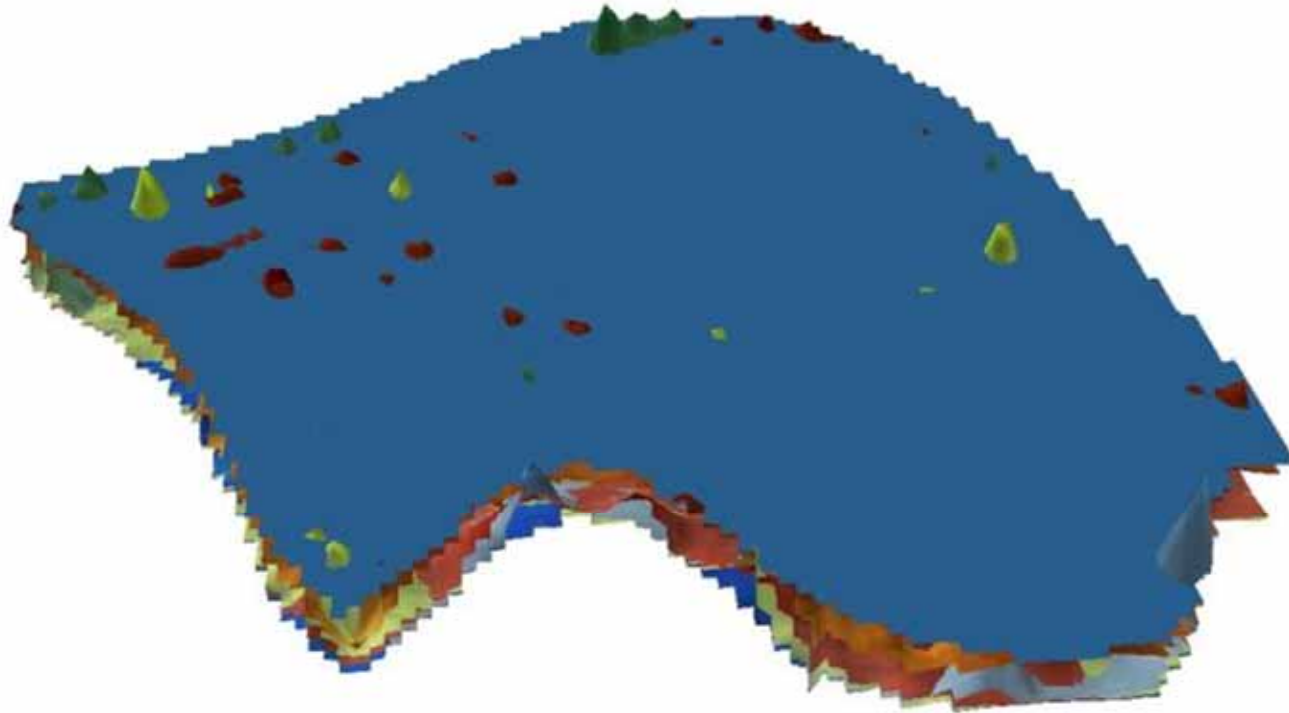
(Tsao et al. 2009, Condor 111:599-610)

Petaluma Tidal Marsh
water level = 2.35 m
90% inundated



**Petaluma Tidal Marsh
water level = 2.5 m
>99% inundated**

**What will happen
with Sea Level Rise?**

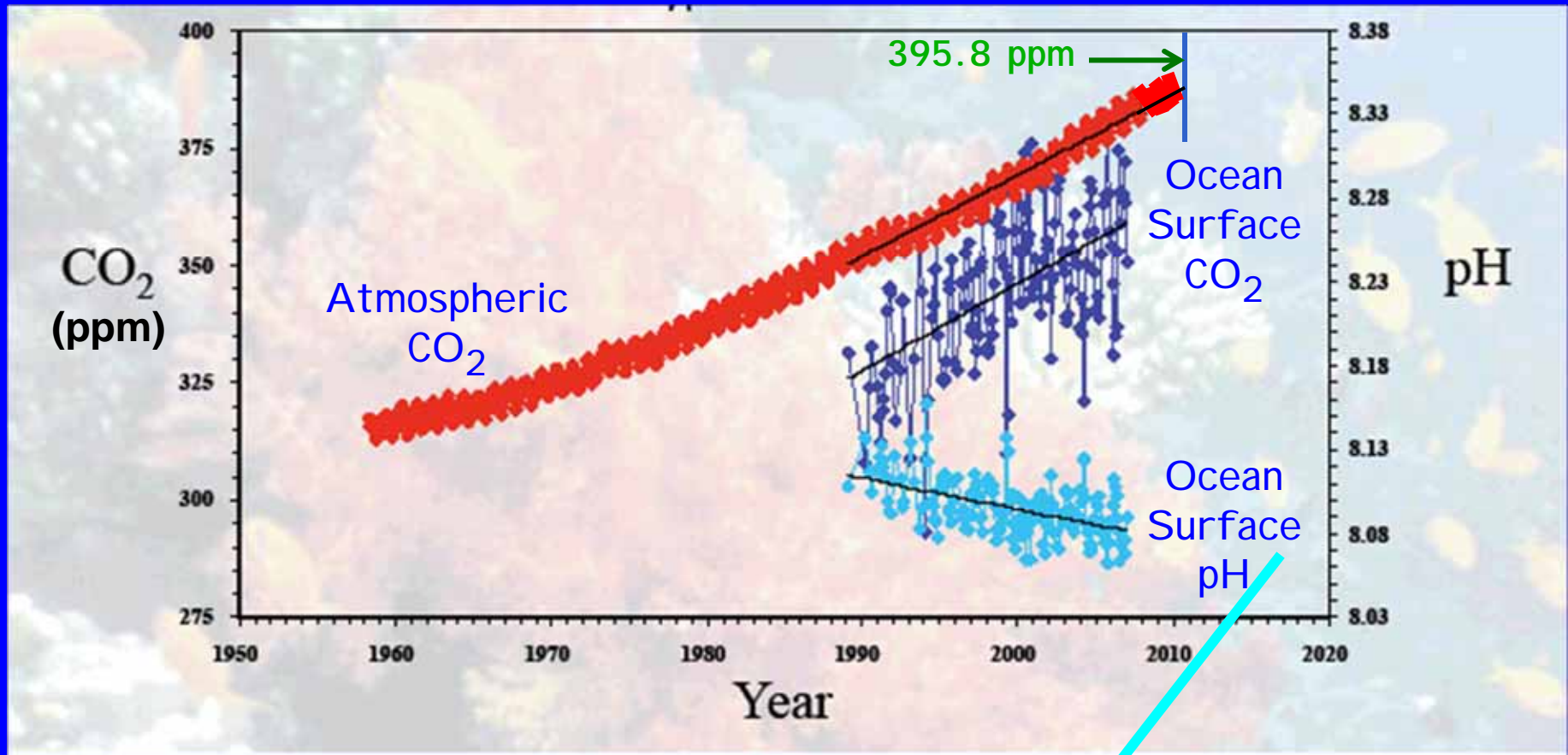




Ocean Acidification:

The ocean absorbs $\sim\frac{1}{4}$ of global C emissions.

Inverse relationship between Atmospheric CO_2 and Ocean pH.

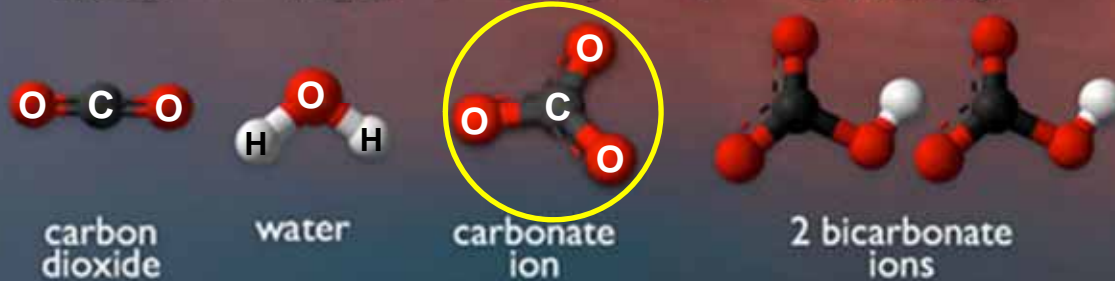
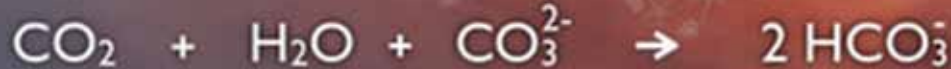


Decreased pH lowers the saturation of CaCO_3 in seawater.

OCEAN ACIDIFICATION

HOW WILL CHANGES IN OCEAN CHEMISTRY AFFECT MARINE LIFE?

CO₂ absorbed from the atmosphere



consumption of carbonate ions impedes calcification

Since ~ 1850, the pH of the oceans has decreased by ~ 0.1 pH units (= 30% increase in acidity).

By the end of this century, it is predicted that the ocean surface will be more acidic than it has been in 400 M yrs.



Climate Change will happen in the face of
and in concert with all of the other
stressors that already exist in the
Bay-Delta ... including:

Contaminants: Mercury, Selenium, Pesticides, PCBs,
PBDEs, Pharmaceuticals, other emerging contaminants

Invasive Species: New species ~ every 14 weeks

Land Use Change/Development:

Computational
Assessments of
Scenarios of
Change in the
a
Delta
Ecosystem

<http://cascade.wr.usgs.gov/index.shtm>

Global
Climate
Models



Downscaled
To Region



Watershed
Model



Delta
Model



CASCaDE I

New downscaled scenarios: A product of
SF Bay PES & CASCaDE projects:



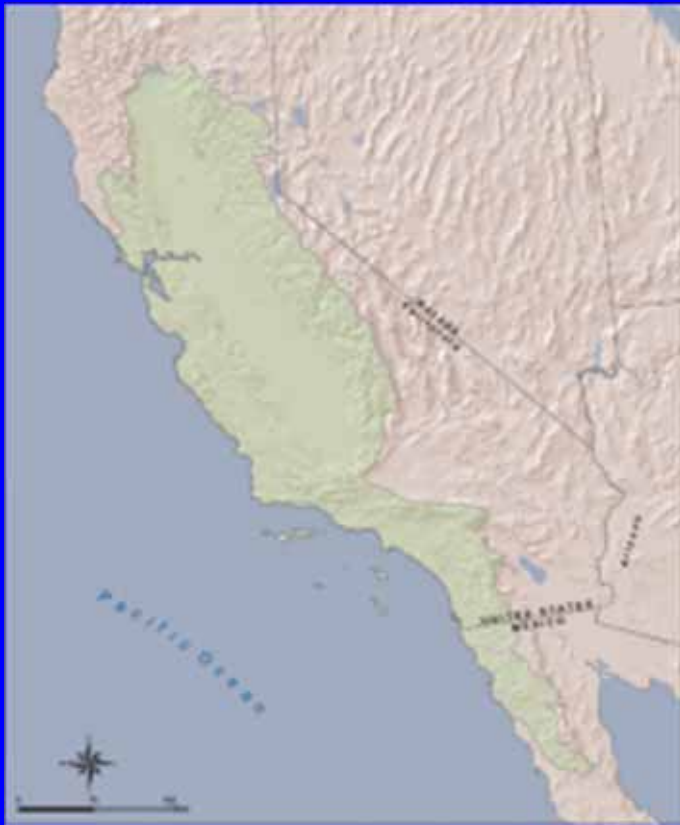
Computational
Assessments of
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Delta
Ecosystem

CASCaDE II





California Landscape Conservation Cooperative



Funded ~ 35 conservation projects over the past 3 yrs; 13 involved studies the Bay-Delta region.

www.CaliforniaLCC.org



Global Warming ?

Definitive Scientific Data...

The END ???

Positive proof of global warming.



**18th
Century**

1900

1950

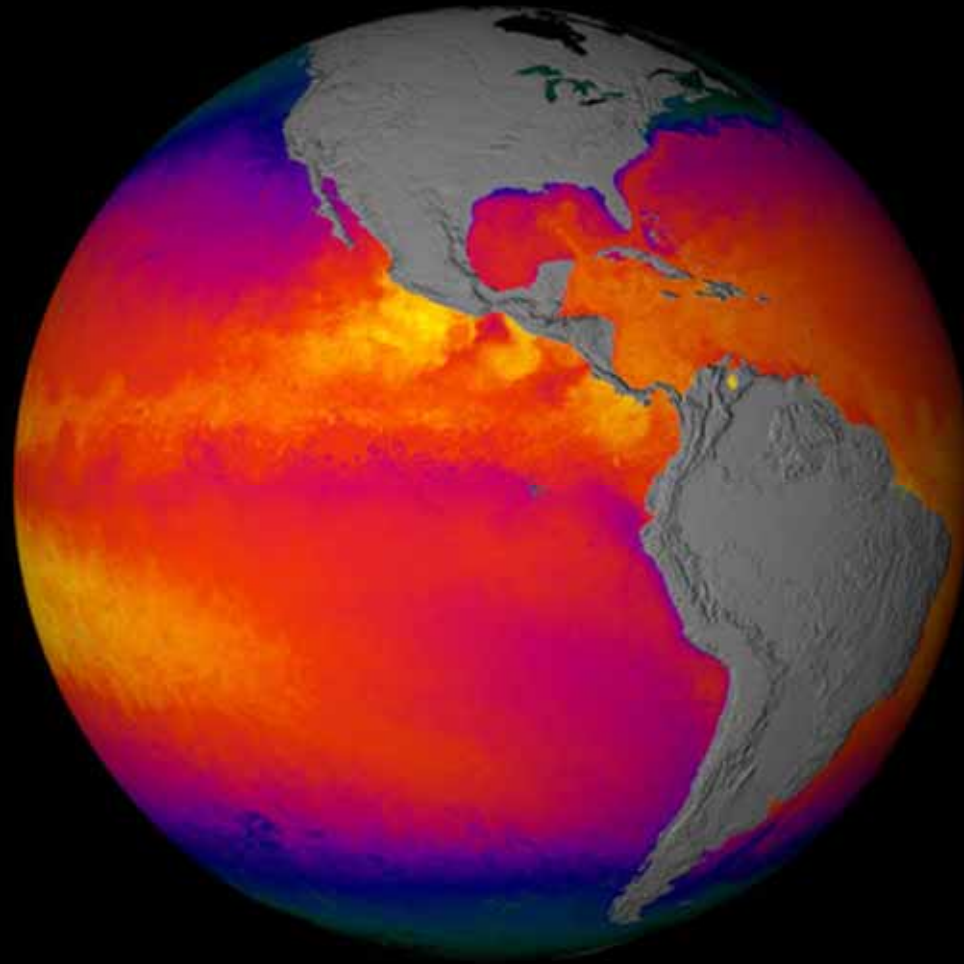
1970

1980

1990

2006

Think Cool



Thank You.....