Climate Change and Sea Level Rise Impacts on Puget Sound

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Marine & Sediment Assessment Group

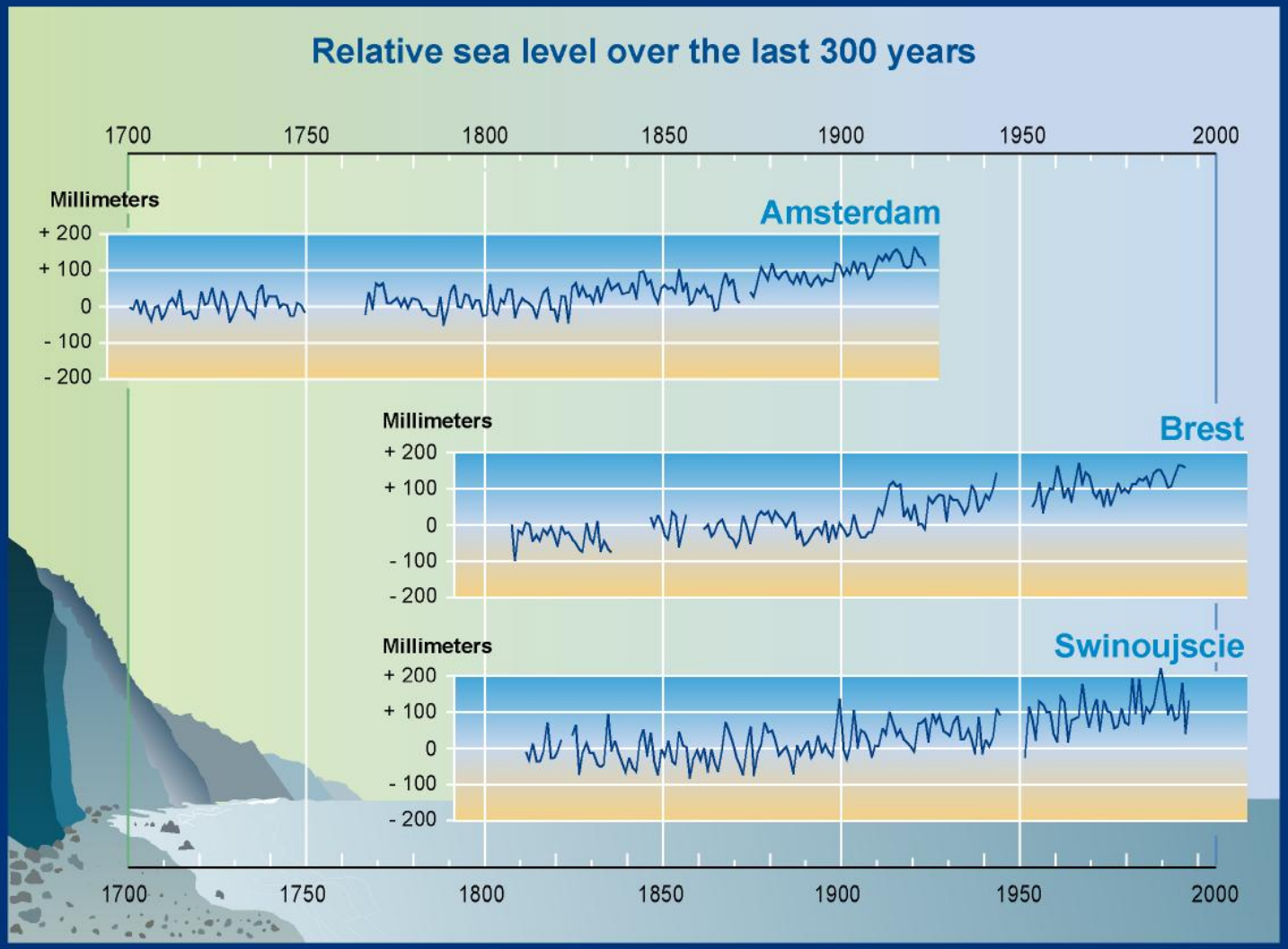
Water and Land Resources Division Science Seminar – November 29, 2005

Talk Outline

Sea Level Rise

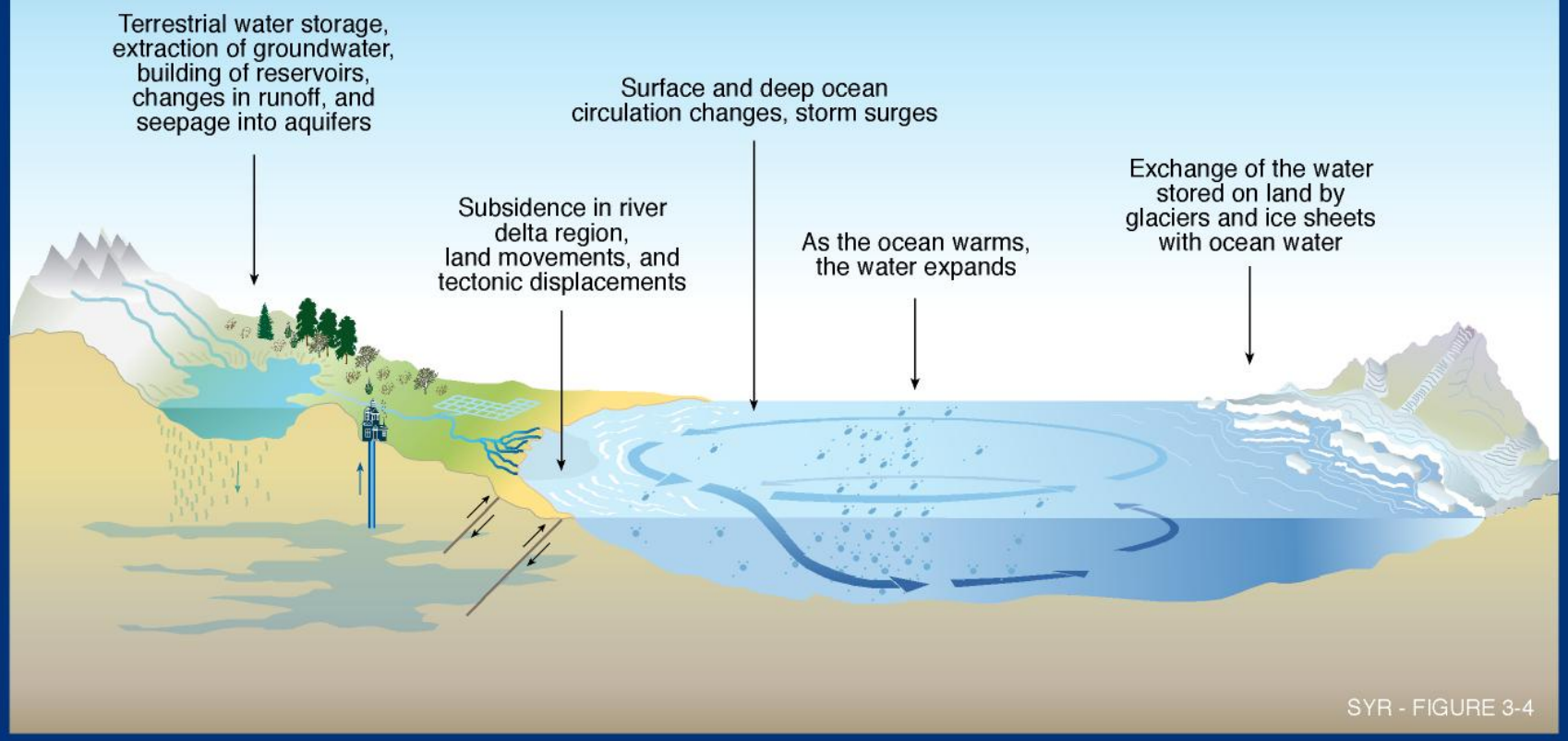
Water Quality

Implications for Marine Ecosystems



SYR - FIGURE 2-5

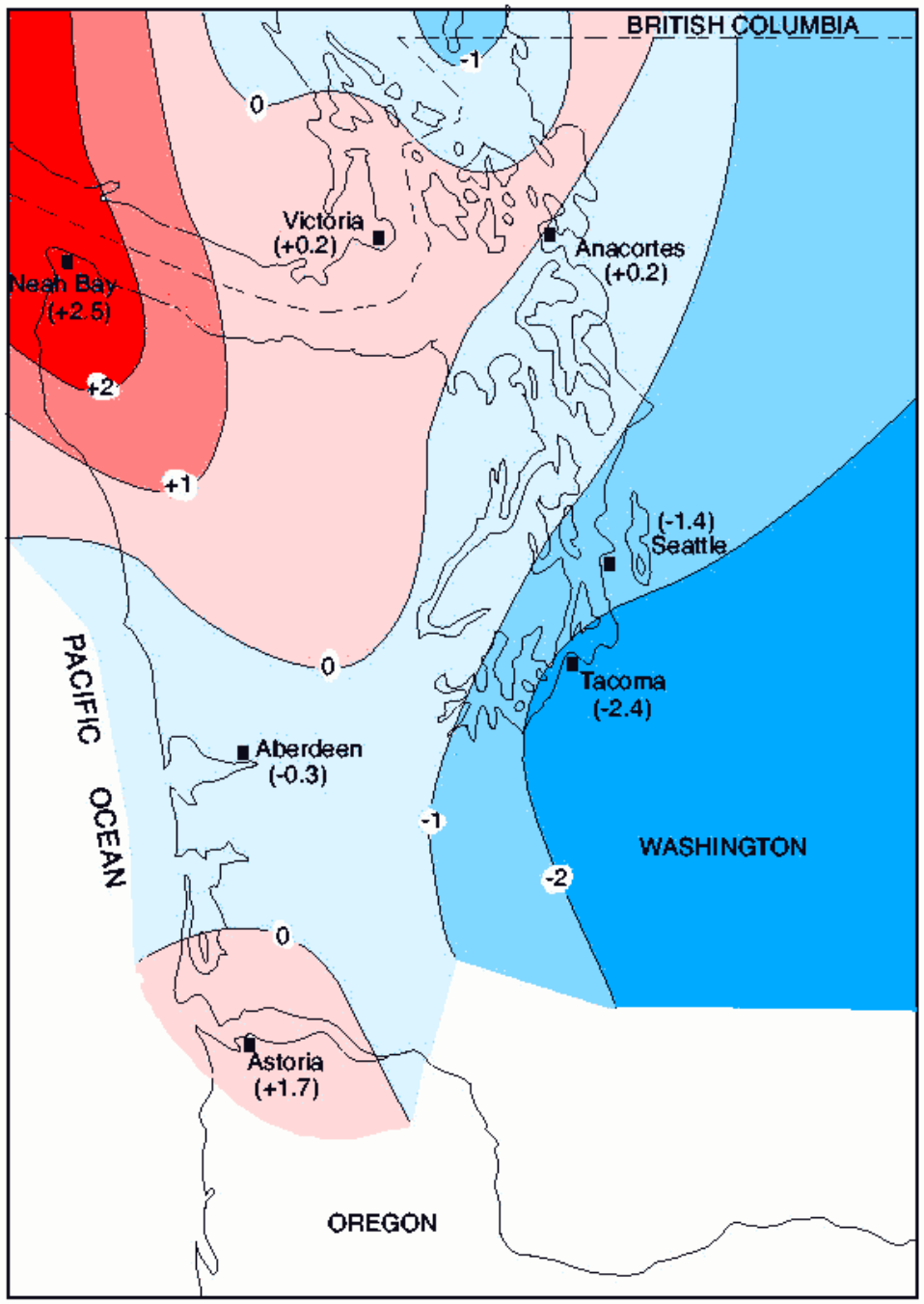
What causes the sea level to change?



Vertical Land Movement Rates in Western Washington

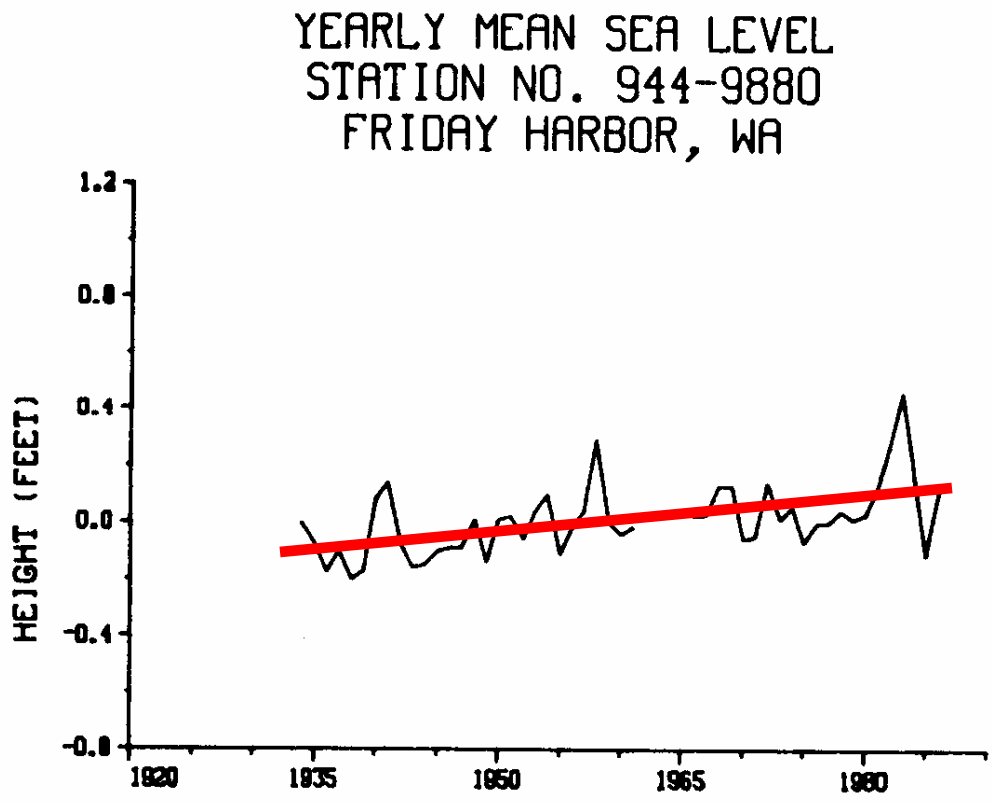
- Uplift occurs on northern outer coast and southern outer coast near Columbia River

- Subsidence occurs in most of Puget Sound and most of southern outer coast



Friday Harbor sea level trend

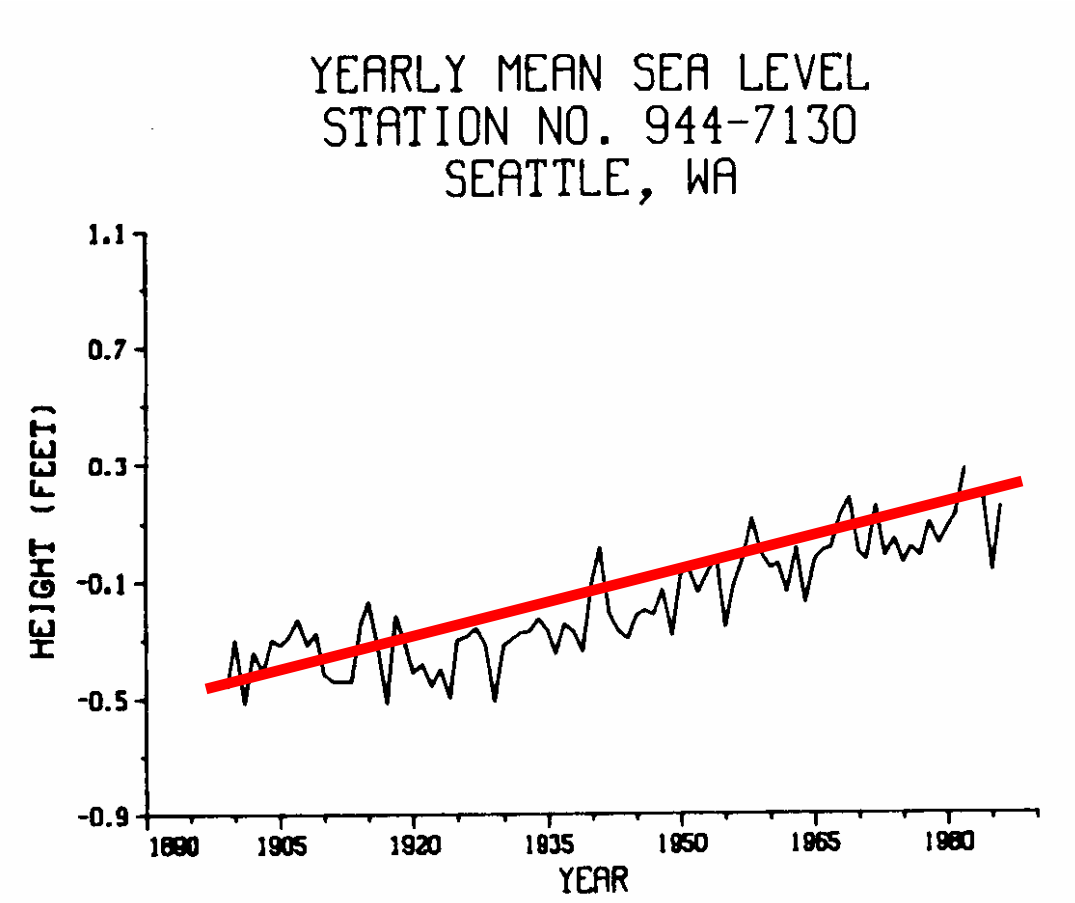
From 1935 to the present, water level at the Friday Harbor gauge has been rising at about the global average.



Lyles et al. (1988)

Seattle sea level trend

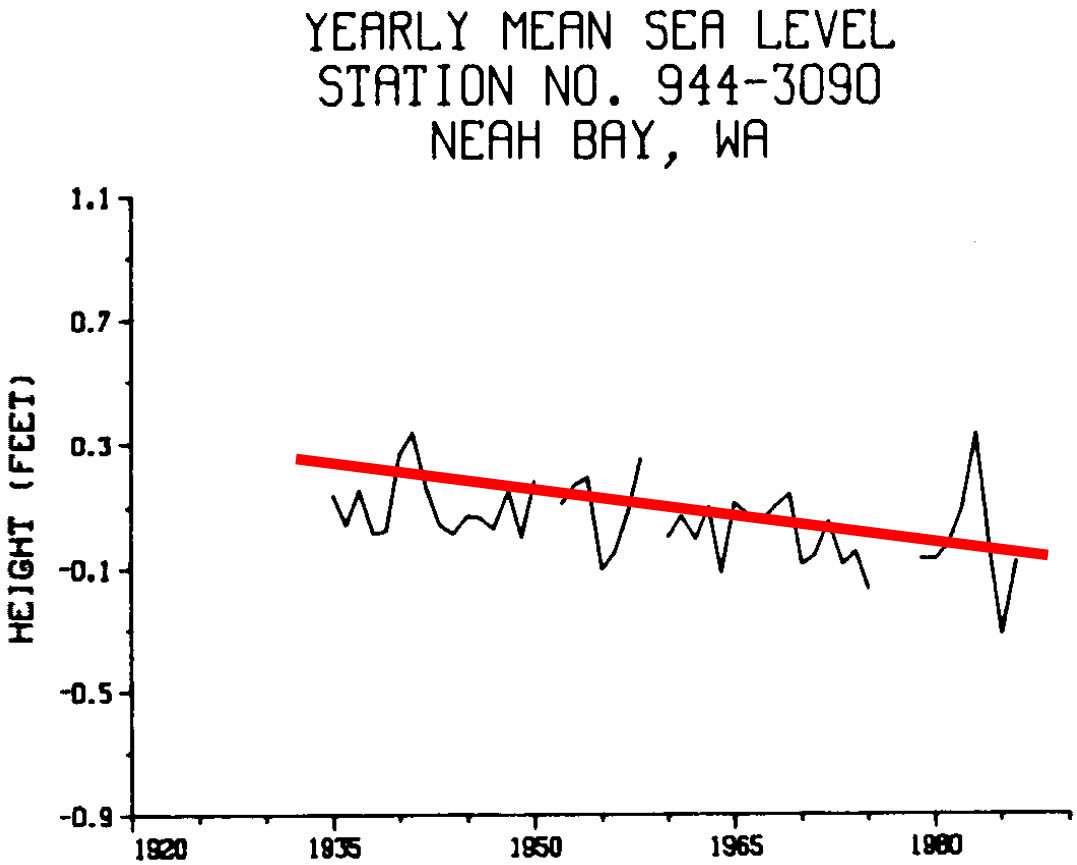
From 1900 to the present, water level at the Seattle gauge has been rising at about 2X the global average.



Lyles et al. (1988)

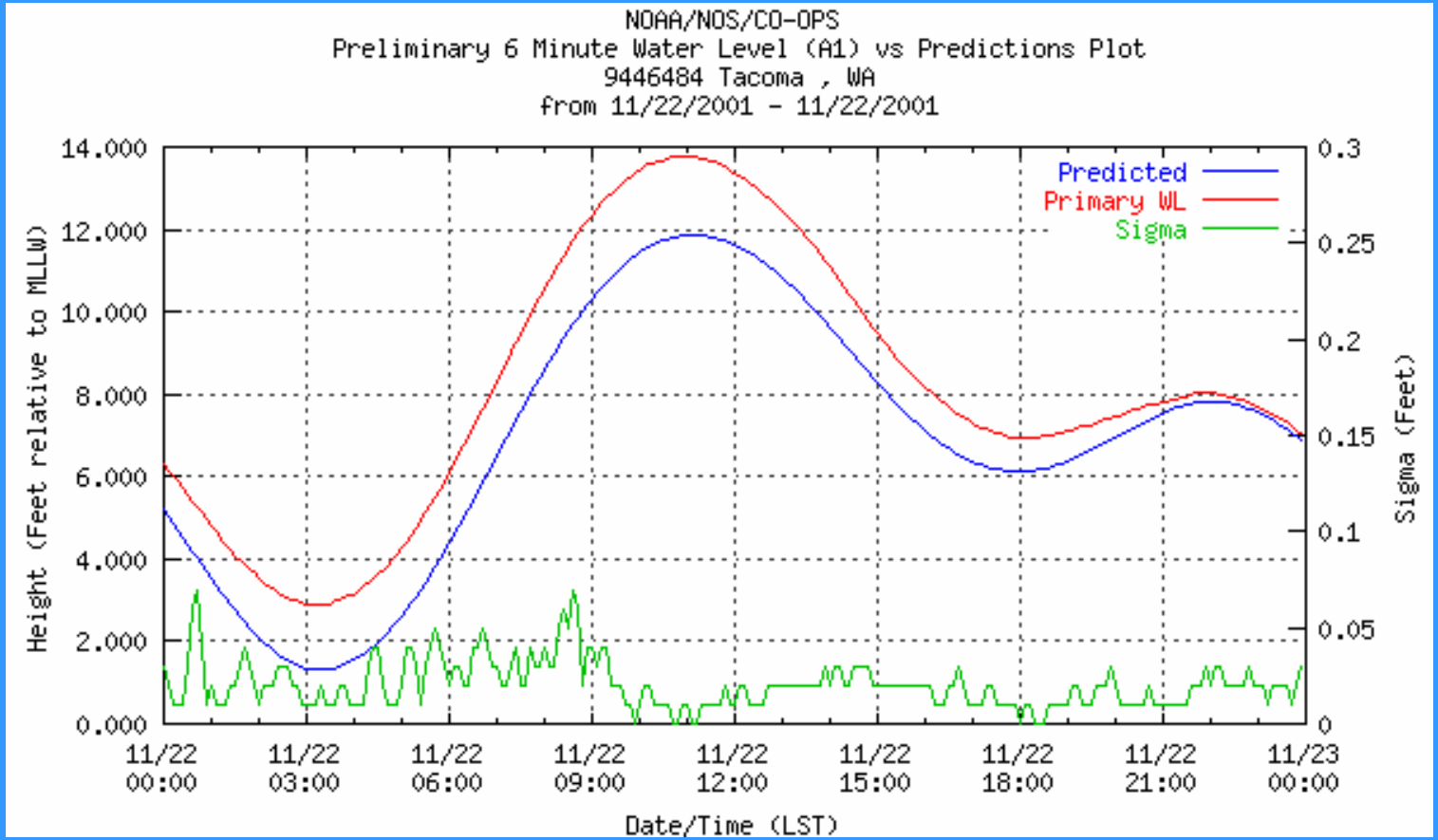
Neah Bay sea level trend

From 1935 to the present, water level at the Neah Bay gauge has been trending down.

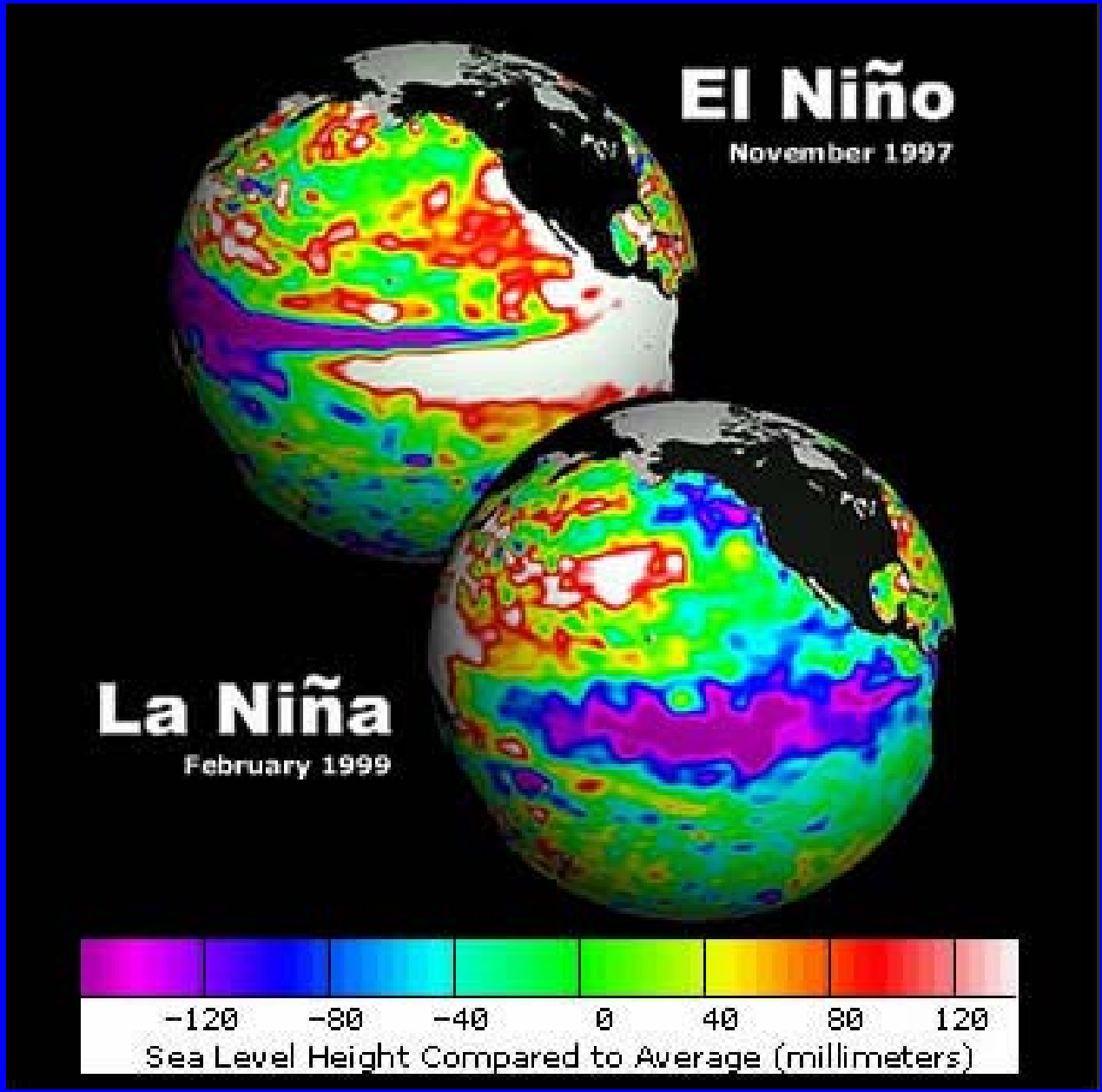


Lyles et al. (1988)

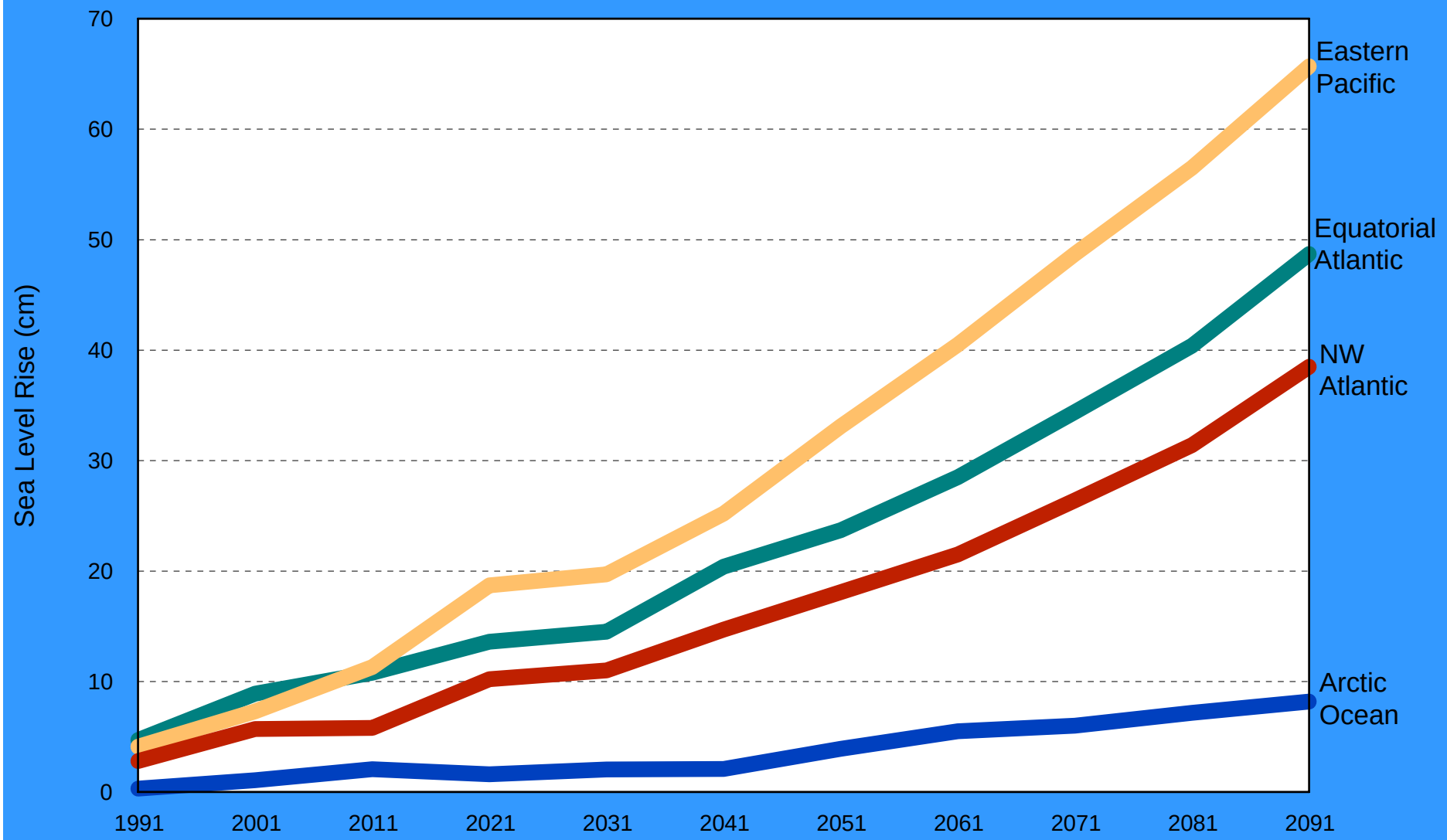
Barometric Pressure Effects



Short term low pressure cells allow water level to rise: up to 2.0 ft on 22 Nov 2001 at Tacoma


El Niño
November 1997
La Niña
February 1999
-120
-80
-40
0
40
80
120
Sea Level Height Compared to Average (millimeters)

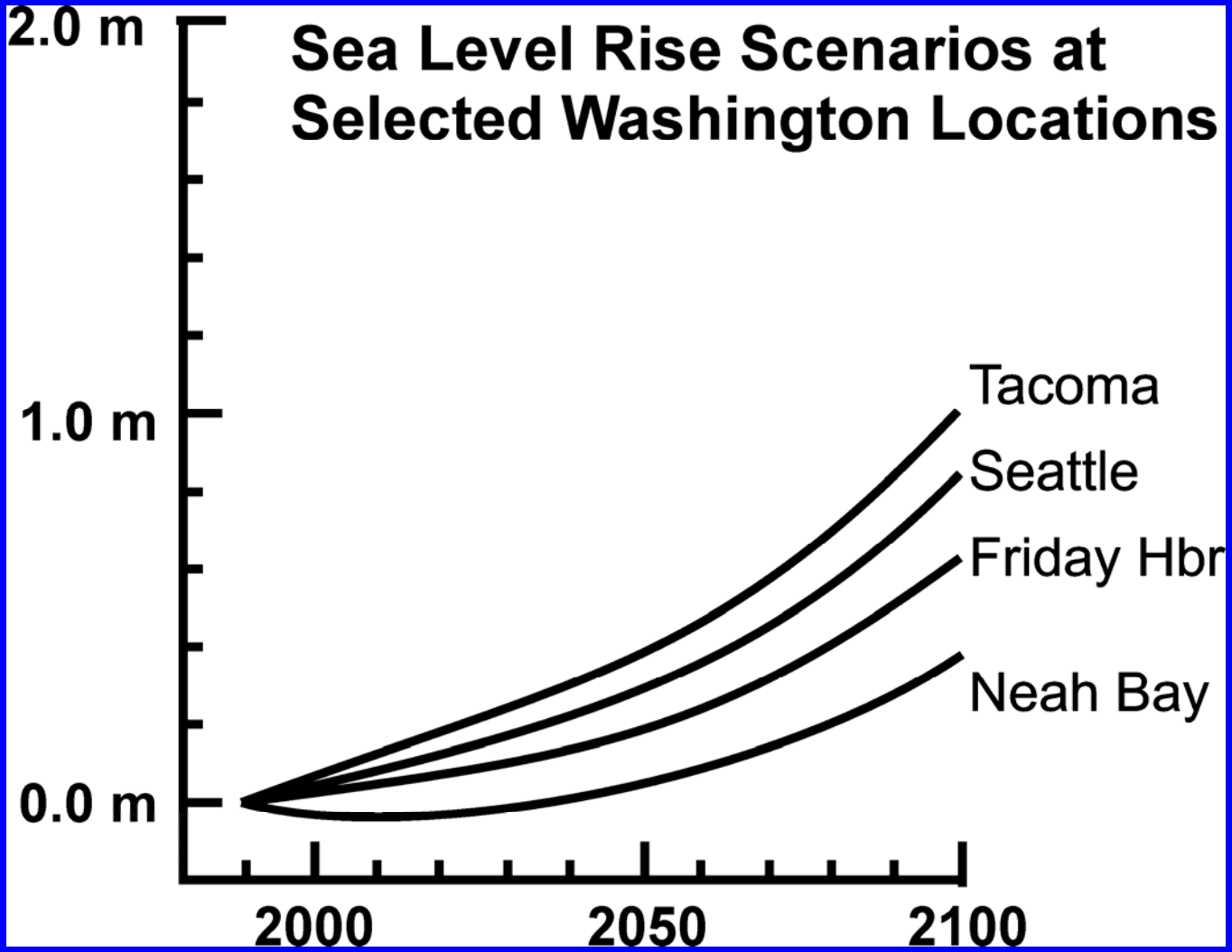
Regional Changes in Sea Level



Source: Canadian Climate Change Model

Local Sea Level Rise Scenarios

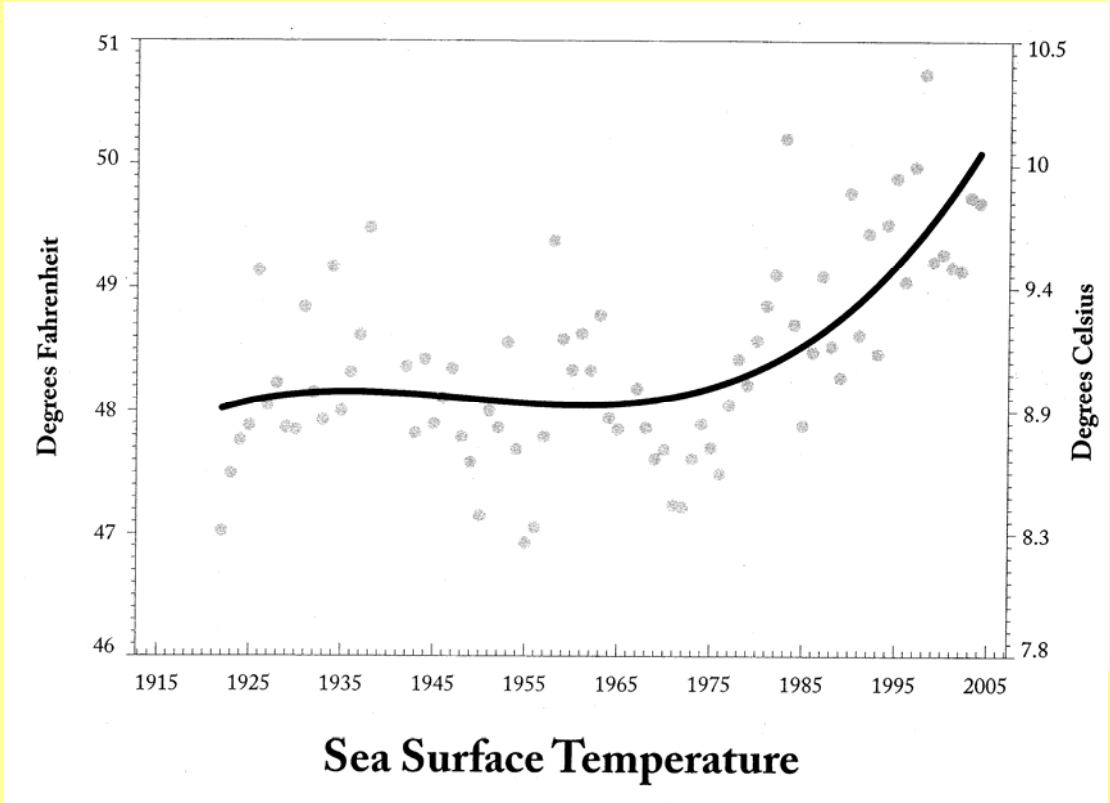
Canning (1991)



Effects and Implications of Sea Level Rise

- Inundation of low-lying coastal areas
- Increased coastal flooding
- Increased rates of coastal erosion
- Loss of coastal wetlands
- Changes in tidal prism and salinity of embayments
- Rise in coastal water table
- Changes in stormwater/wastewater outfall hydraulics

Sea Surface Temperature at Race Rocks

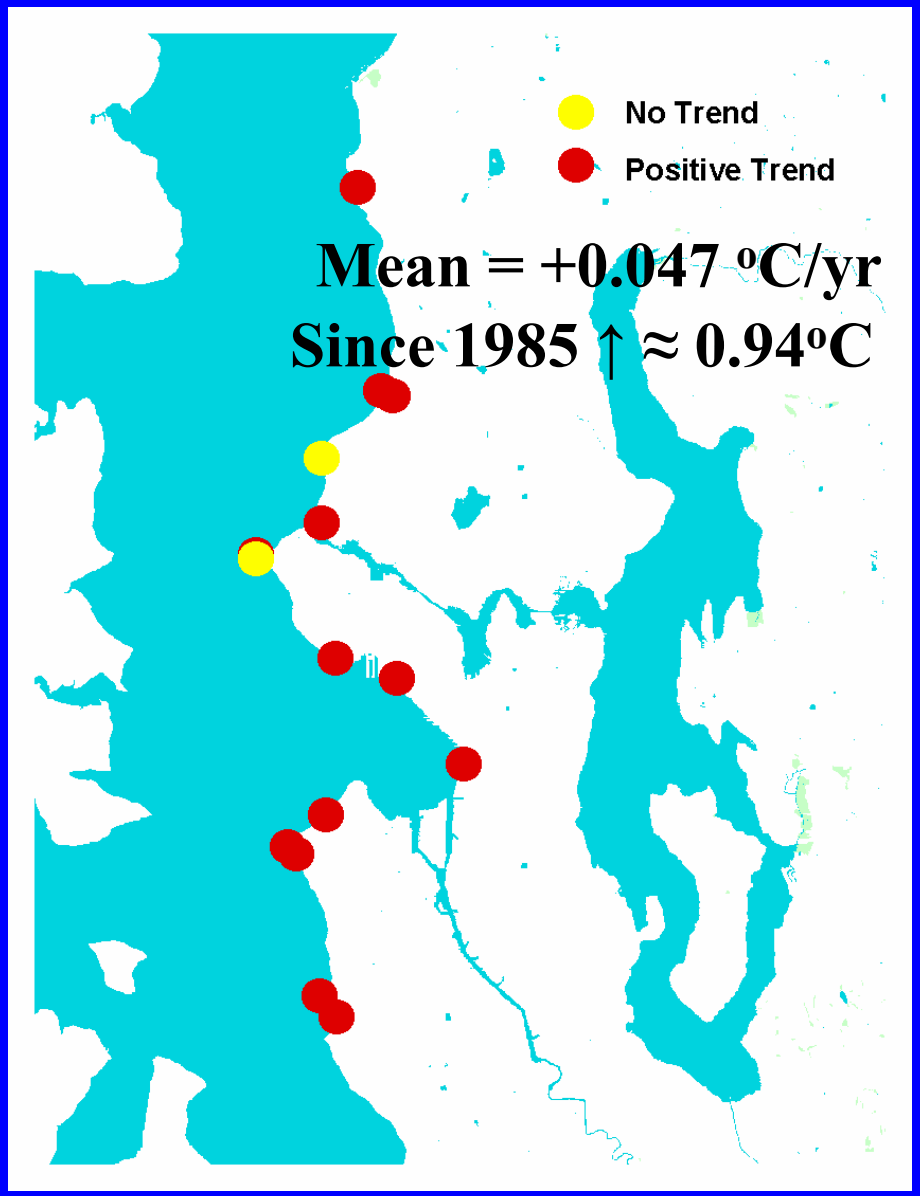


Long-term warming trend of 1.7°F (0.9°C) since 1921 and 1.8°F (1.0°C) since 1950.

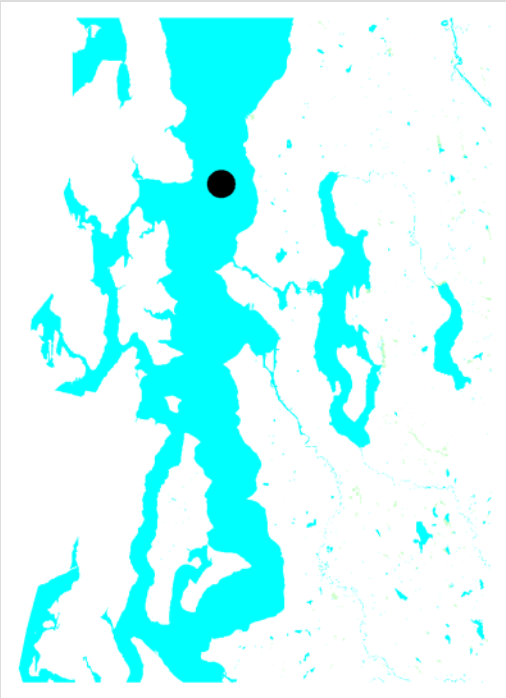
Since 1985 ↑ ≈ 0.85°C

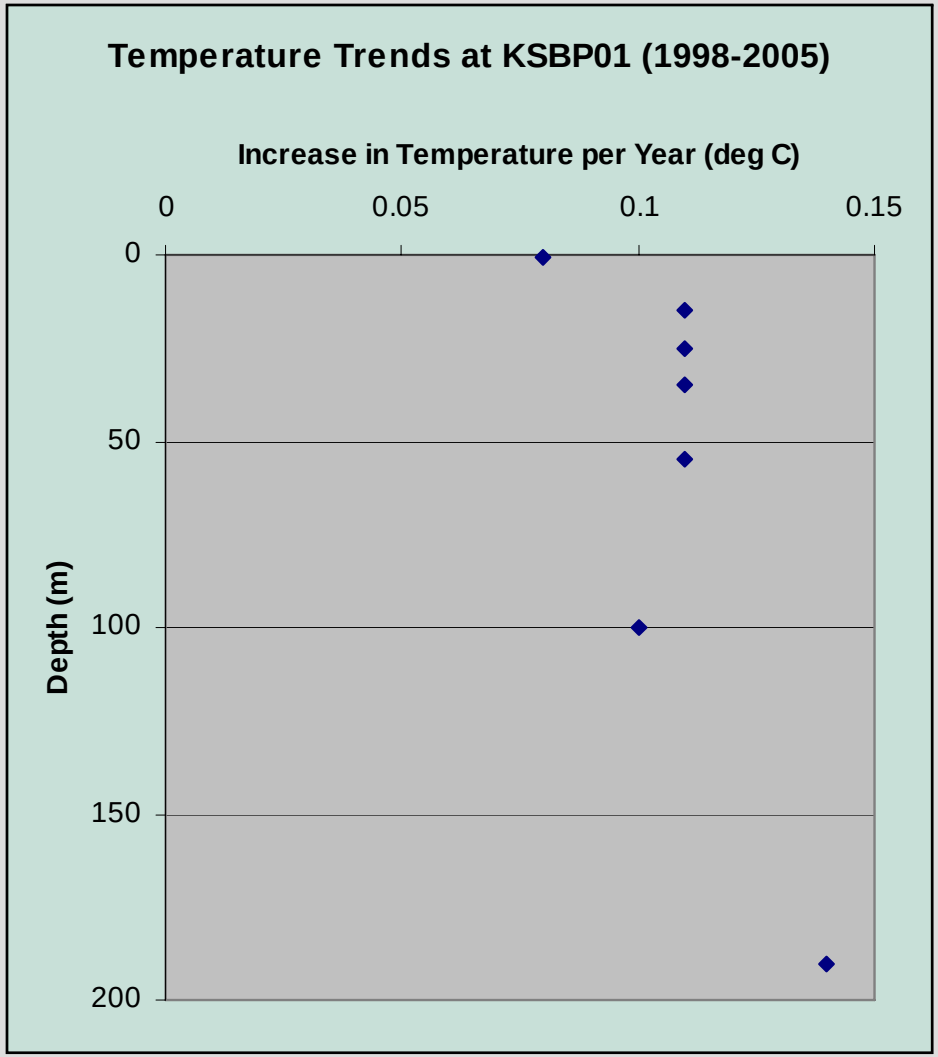
From Snover et al. 2005

Preliminary Temperature Trends at King County Beach Sites (1985-present)



Preliminary Temperature Trends Offshore (1998-present)





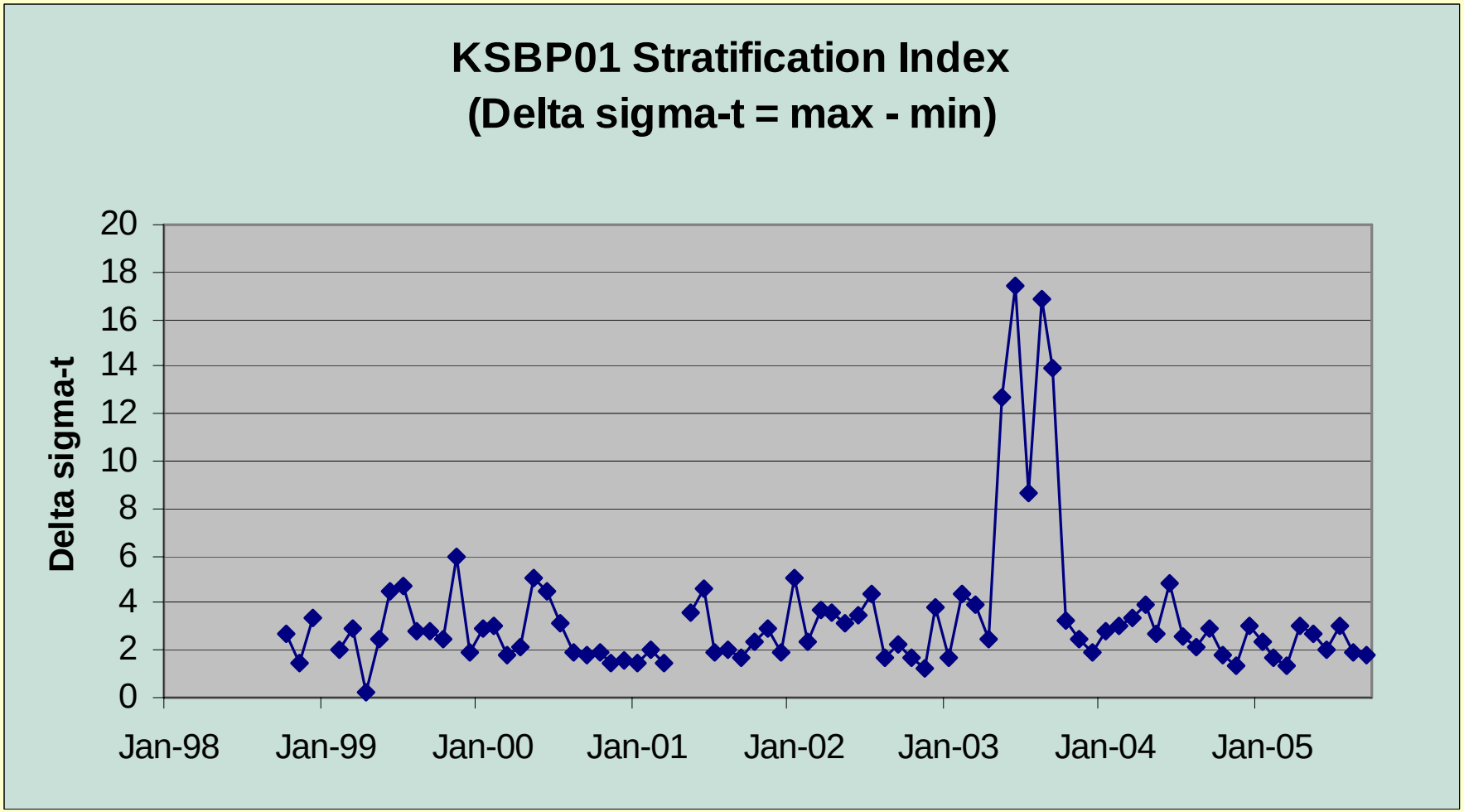
Other Parameters Currently Under Study for Trends

- Salinity – Positive trends observed at beach and offshore sites
- Dissolved Oxygen – No trends observed offshore
- Nutrients
- Fecal Coliform/Pollutants

Stratification Index

High ΔSigma-t = Strongly Stratified Water Column

Low ΔSigma-t = Weakly Stratified Water Column



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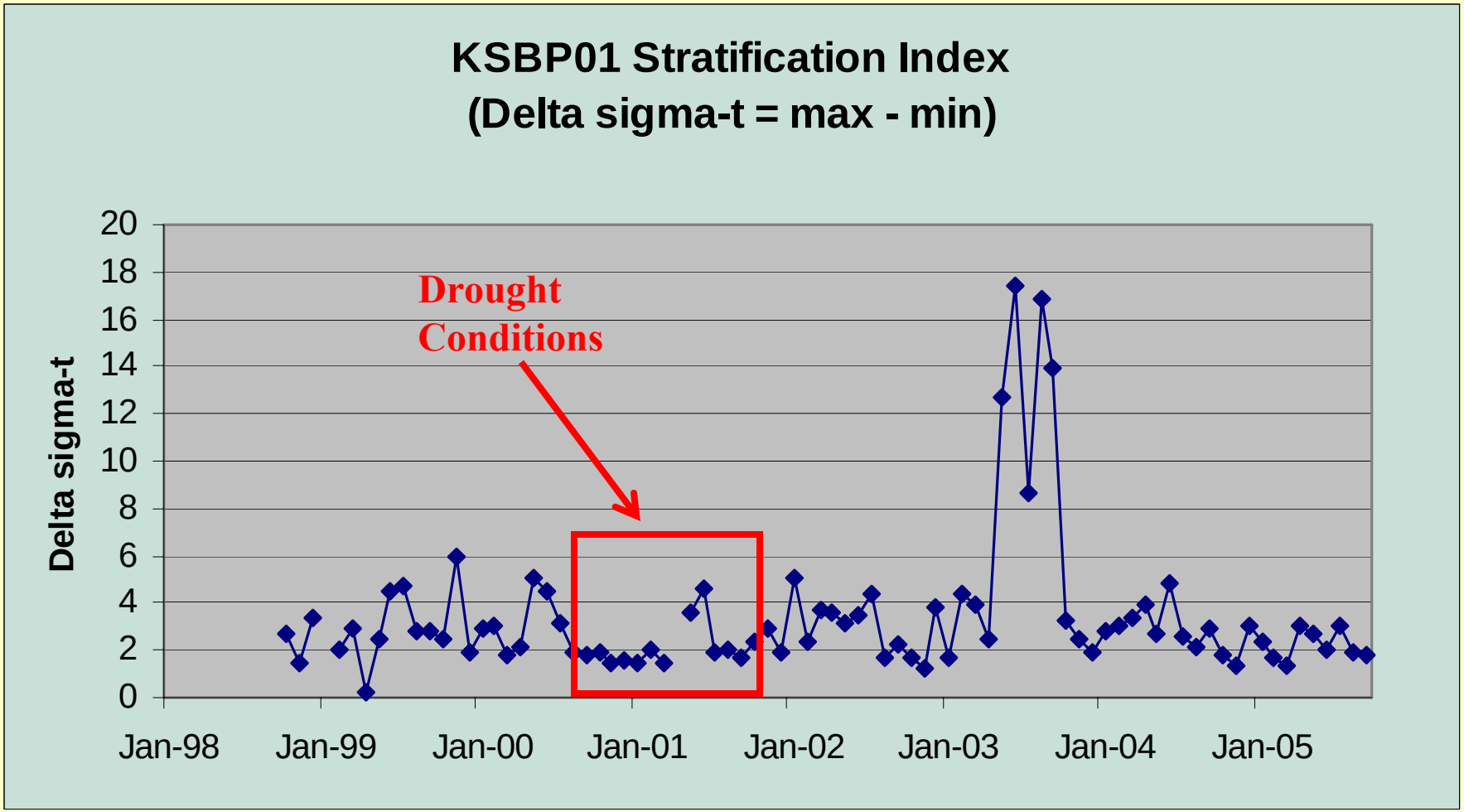

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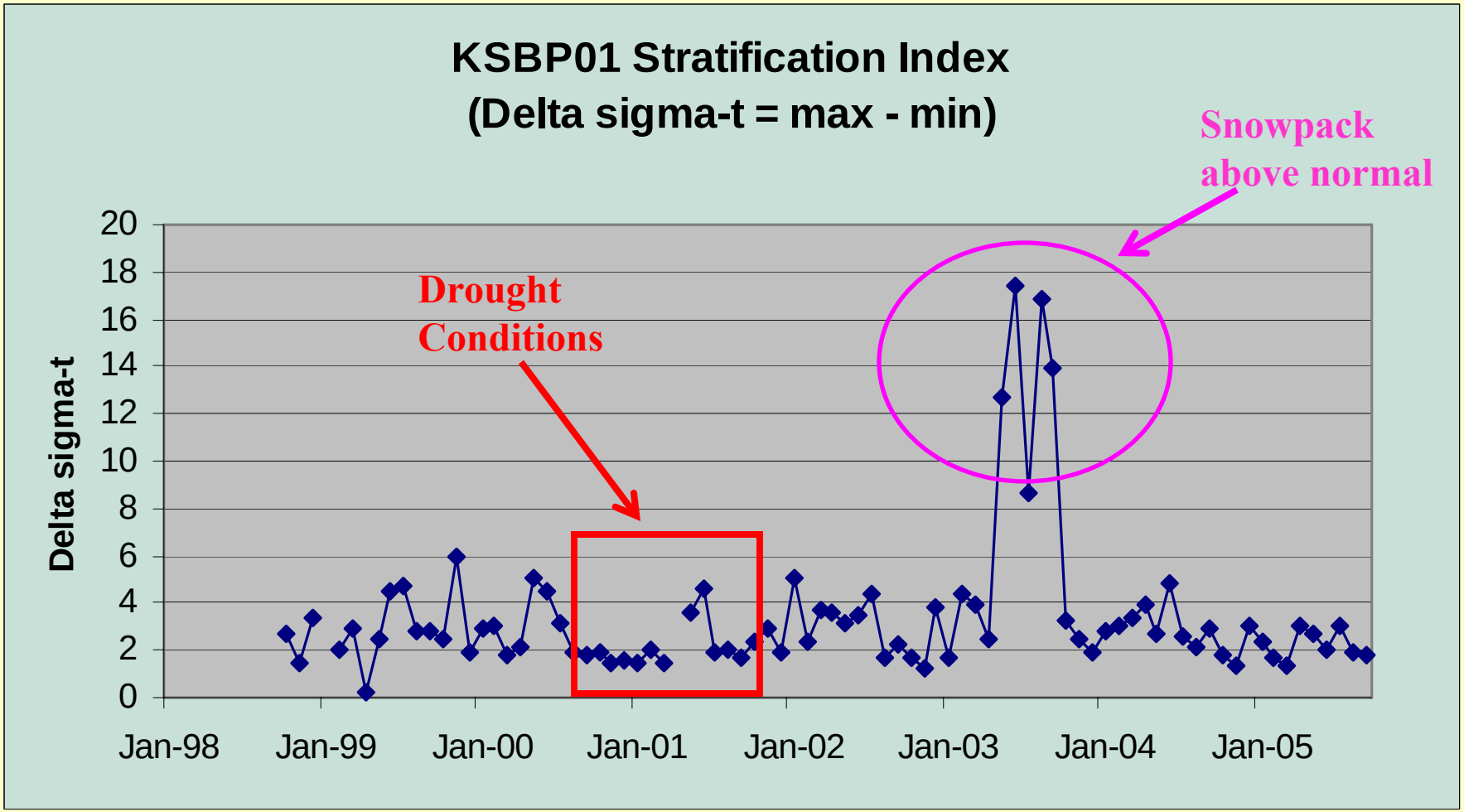

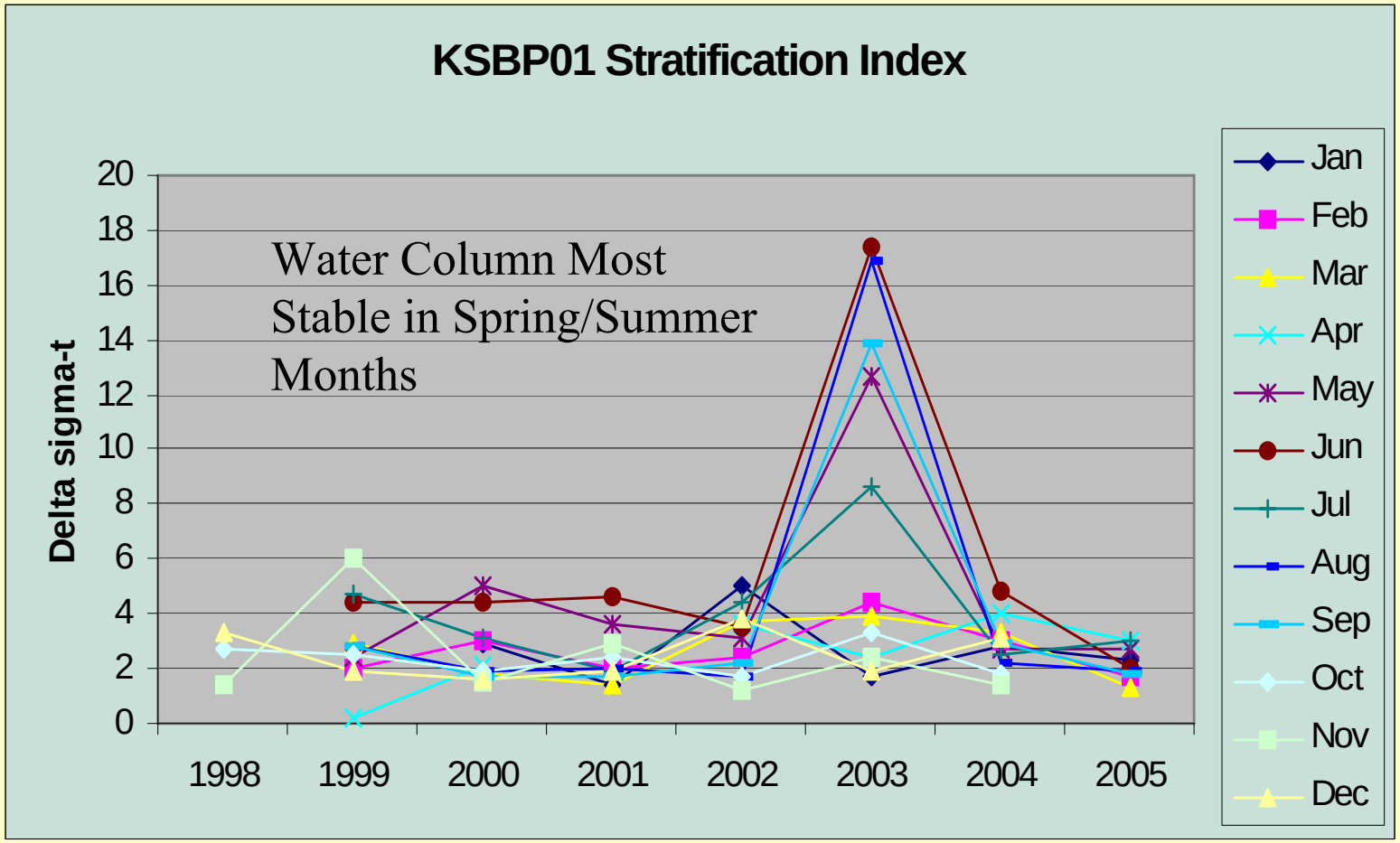

Newton et al. 2003 – Weak stratification → More sluggish circulation → Increased residence time of water in Puget Sound

<u>Implications for ecosystem-level processes!</u>

↓ precip (snowpack) → ↑ surf salinity → ↓ stratification

1) Either: low DO less likely (↑ mixing rates) OR
   low DO more likely (↑ residence time)

2) Changes in the timing and/or intensity of phytoplankton blooms could result in a mismatch of PP blooms with zooplankton emergence → possible impact on trophic transfer and biota recruitment success

3) Decreased circulation would increase residence time of contaminants and pollutants in Puget Sound.

4) Implications for transport/retention of planktonic larvae & ichthyoplankton.

Recommendations

More baseline and environmental variability data

Monitoring focused on long-term

Characterization of physical, chemical & biological processes and the connections between them

Engagement of public interest

Acknowledgements

- Douglas Canning, Ecology
- Eric Grossman, Western Coastal and Marine Geology Program, USGS, Santa Cruz, CA
- Tom Georgianna, WLRD