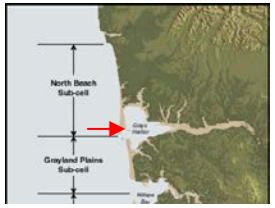
Grays Harbor County Coastal Futures Project



Project Overview:

1. Project Objectives
2. Motivation/Background
3. Existing GHC Context
4. Setting Expectations

Grays Harbor County Coastal Futures Project

Objectives: Develop a **'Knowledge to Action Network'** consisting of a **collaborative team** of stakeholders, researchers, and outreach specialists who will **co-produce knowledge** to inform climate-resilient strategies in **Grays Harbor County**.

Grays Harbor County Coastal Futures Project

Objectives: **Collaboratively develop** the information and tools necessary to **envision future scenarios**, **assess impacts and vulnerability** associated with climate change driven erosion and flood hazards, and quantitatively evaluate a **range of adaptation strategies**.

Harden the coastline?

Grays Harbor County Coastal Futures Project

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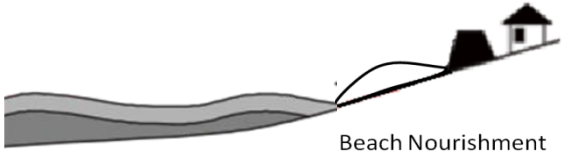
Harden the coastline?



Nourish the coastline?

Grays Harbor County Coastal Futures Project

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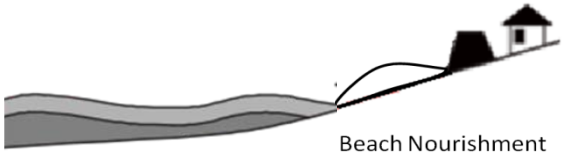
Harden the coastline?



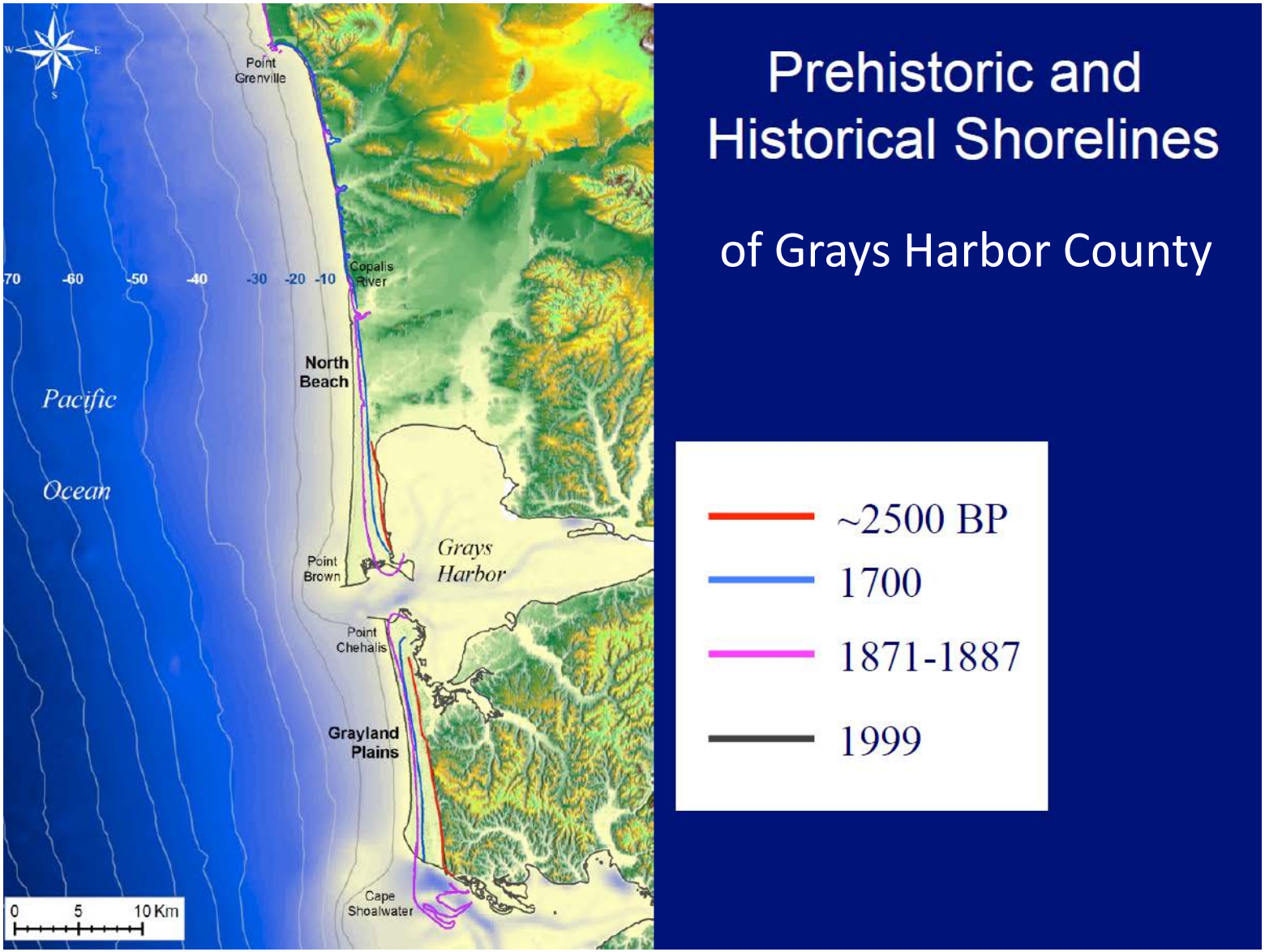
Nourish the coastline?

Retreat from the coast?

Questions about Adaptation Planning?

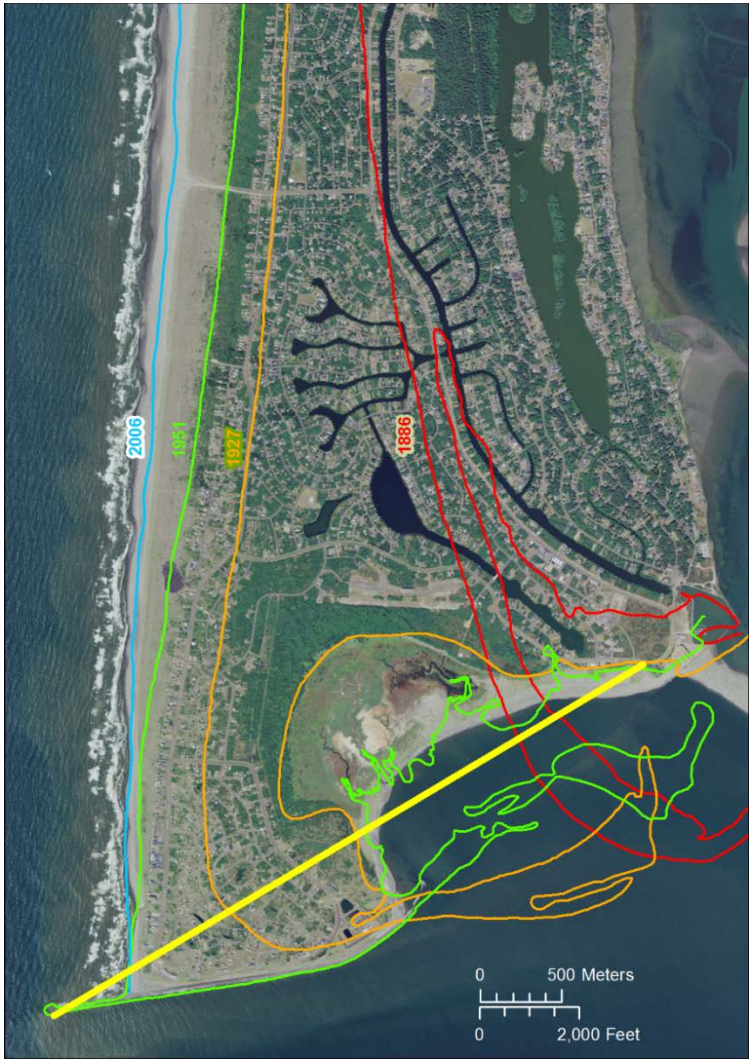
1. Can implementing adaptation measures change how coastal flooding and erosion impact the things we care about?
2. **Can we characterize that change?**
3. How does the implementation of adaptation policies alter development? How much will it cost?
4. **Which drivers (human and physical) cause the greatest variation in landscape metrics?**
5. When will homeowners need backshore protection structures (riprap) to protect their property?
6. **What extent of the beach is accessible now and in the future?**
7. What is the feasibility of implementing various adaptation measures?

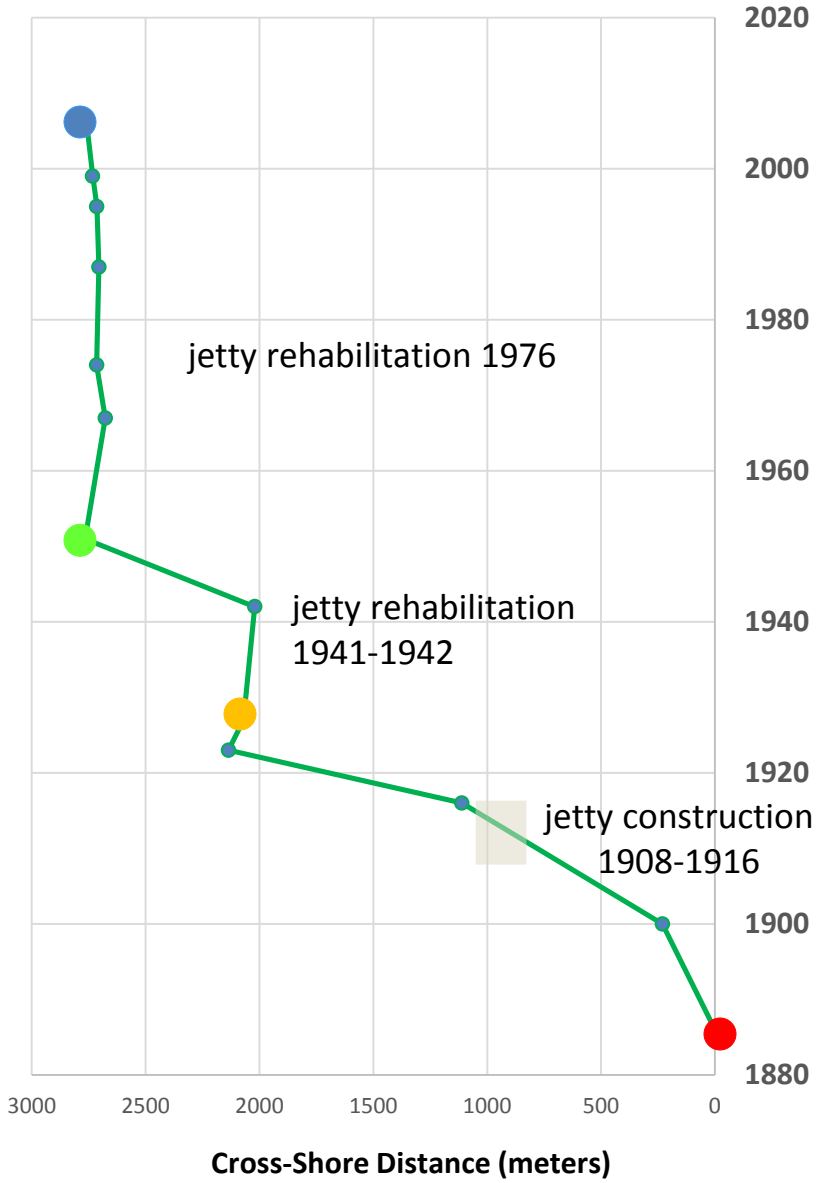
Grays Harbor County Coastal Futures Project



Courtesy George Kaminsky, WA DOE

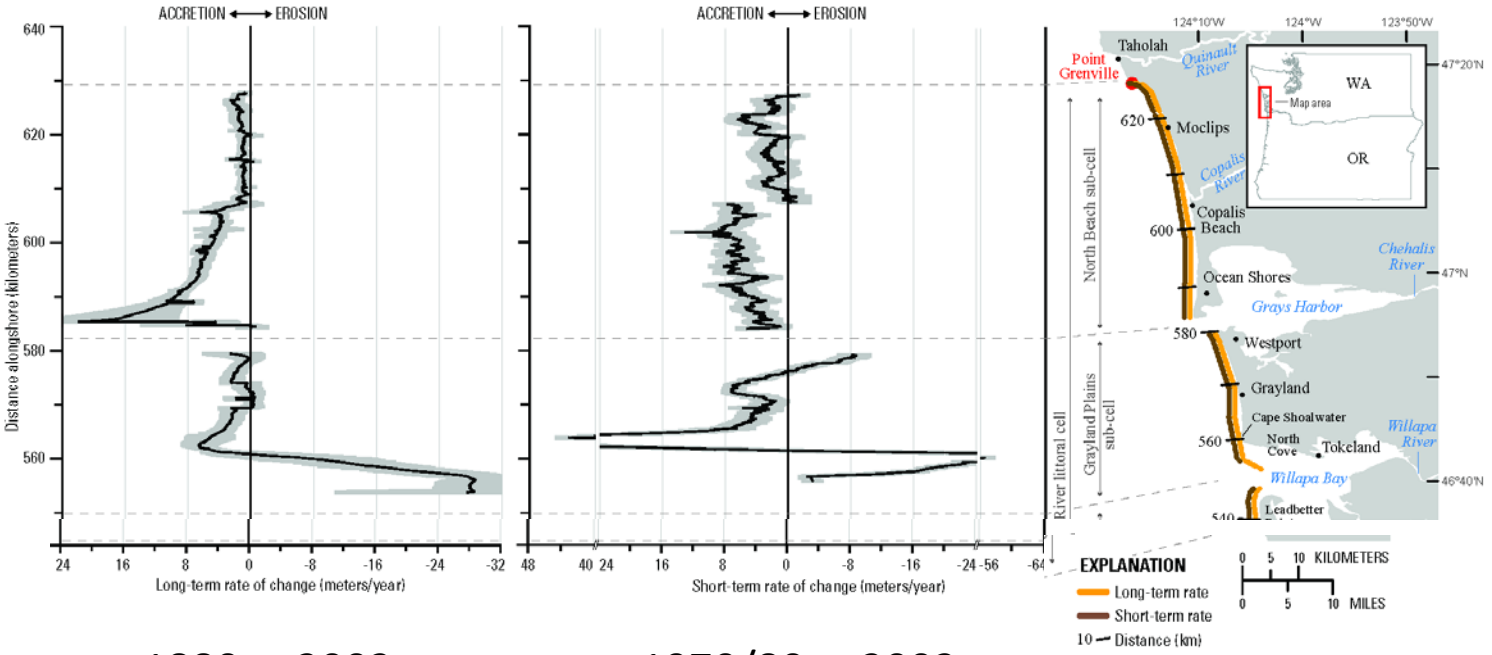
Grays Harbor County Coastal Futures Project





Courtesy George Kaminsky, WA DOE

Historical Shoreline Change Analysis



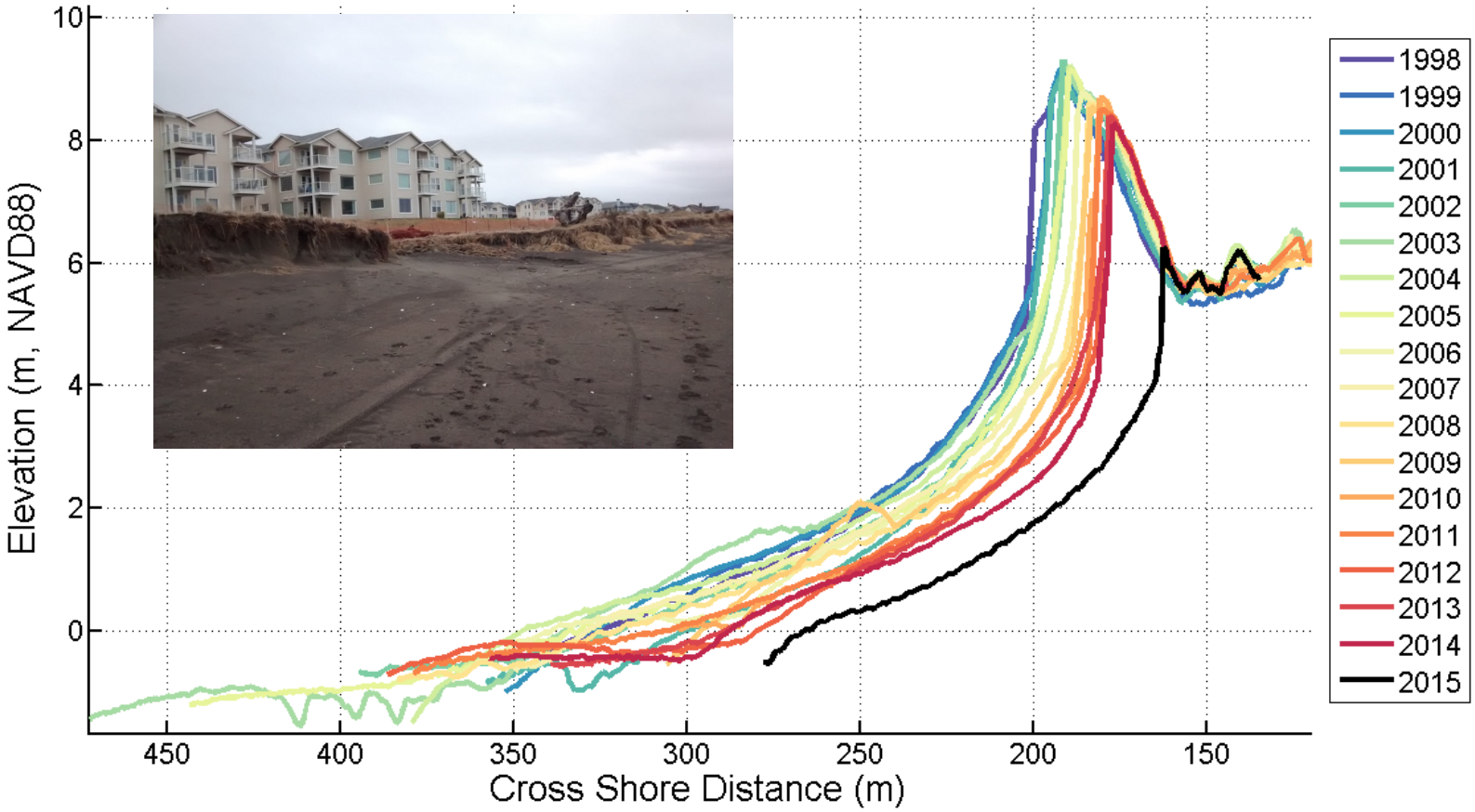
1880s - 2002

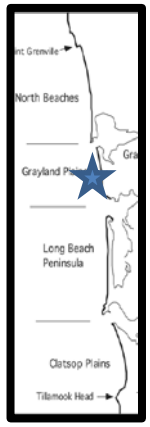
1970/80s - 2002

Ruggiero et al., 2013

Grays Harbor County Coastal Futures Project

Beach Monitoring Data

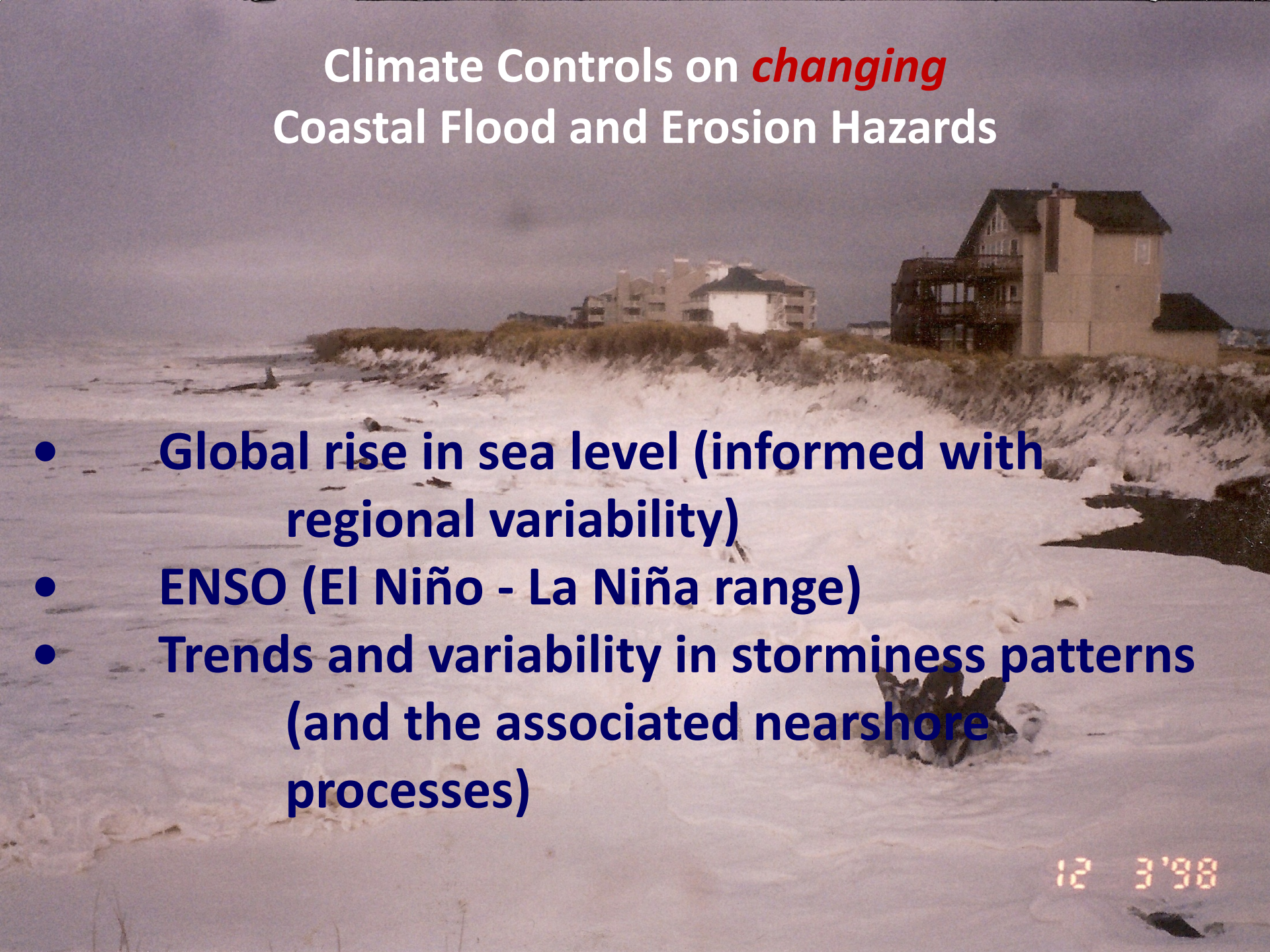




Courtesy George Kaminsky, WA DOE
Dave Michaelson, USACE

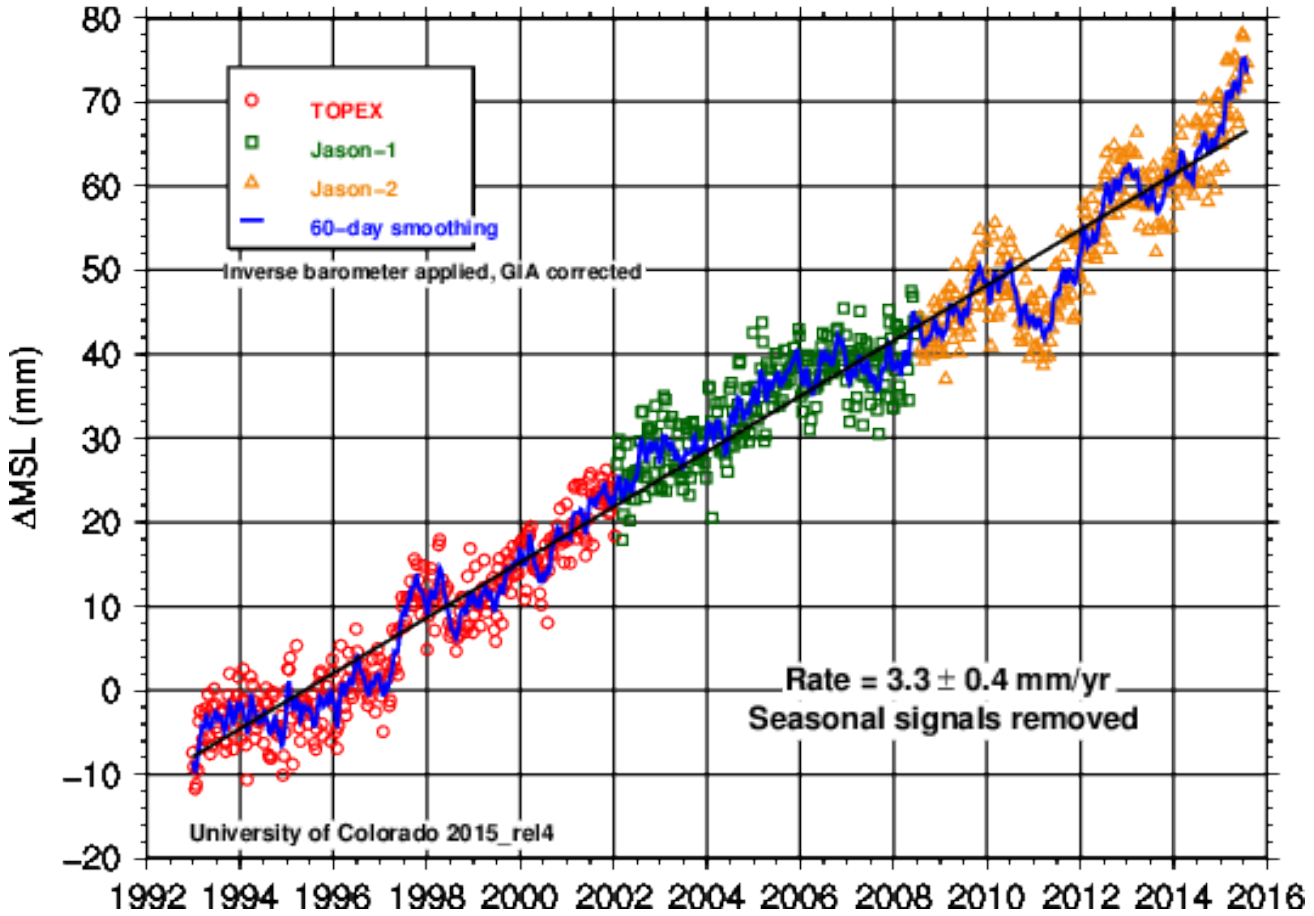
Grays Harbor County Coastal Futures Project

Climate Controls on *changing* Coastal Flood and Erosion Hazards

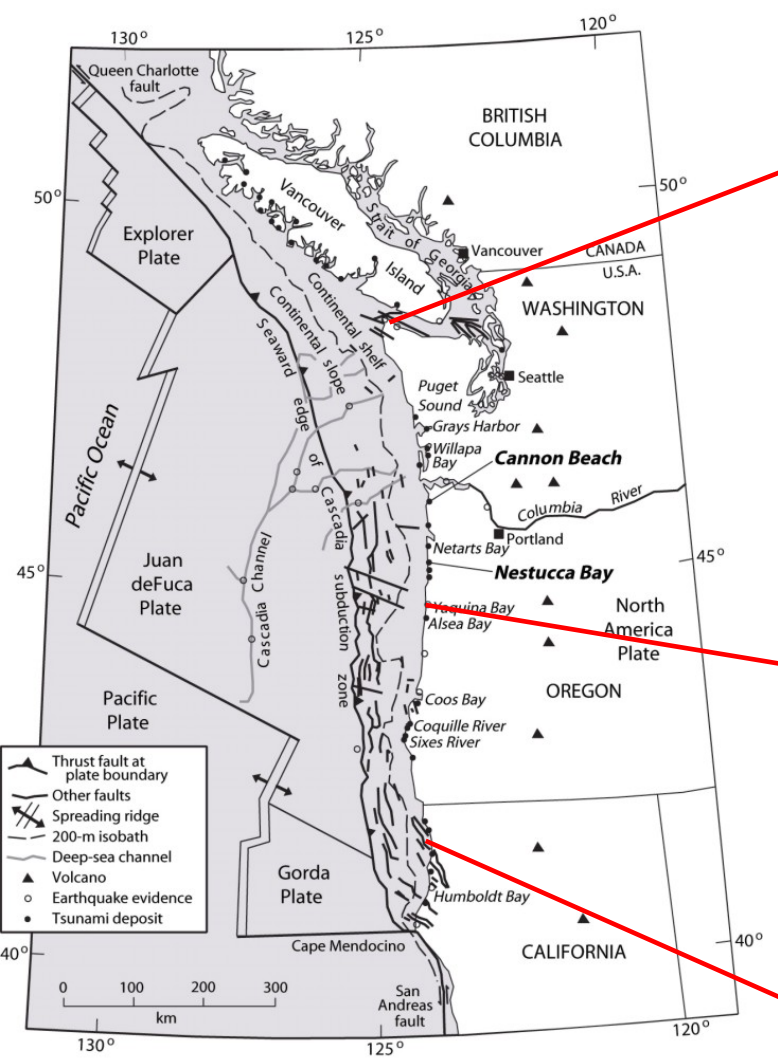


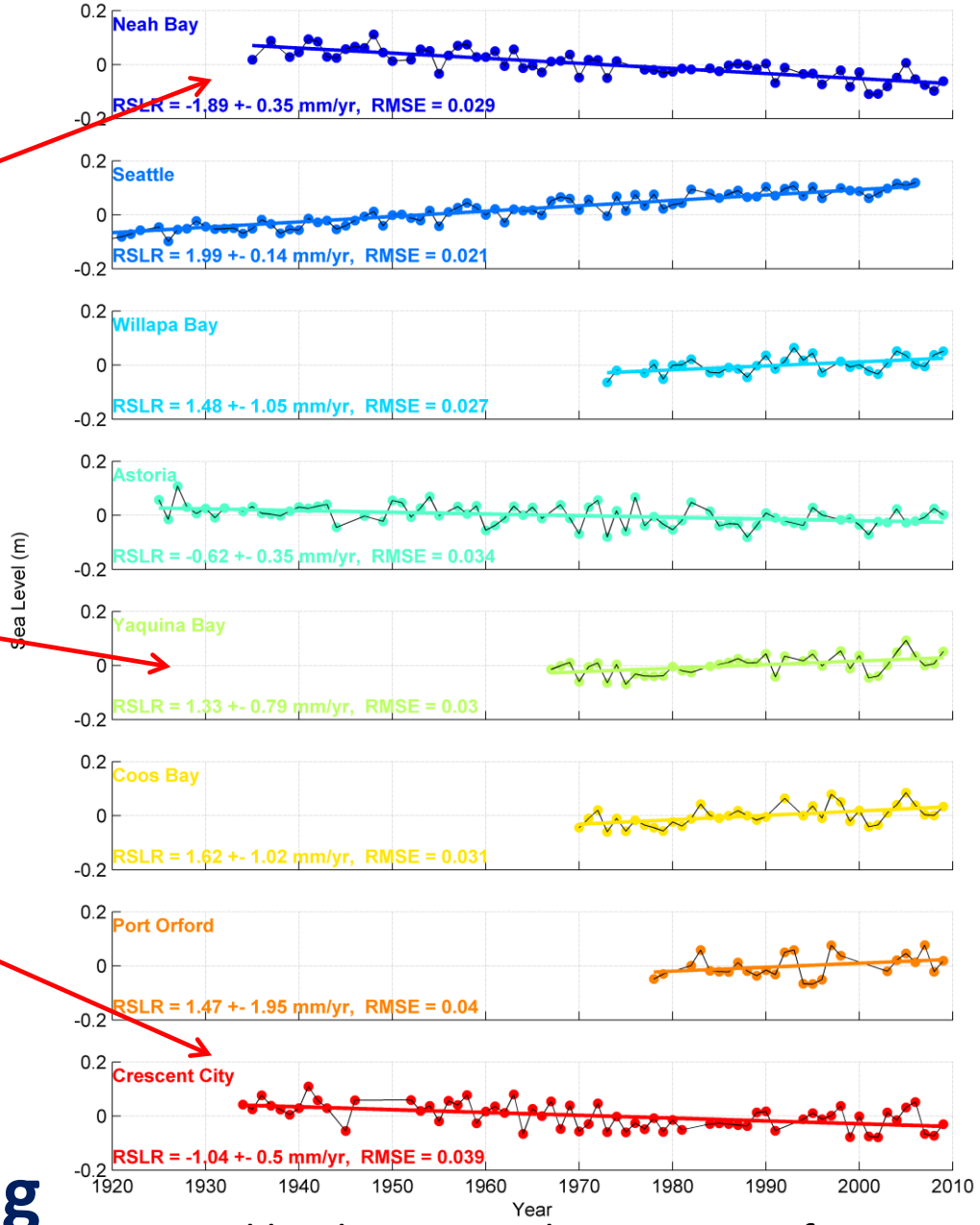
- Global rise in sea level (informed with regional variability)
- ENSO (El Niño - La Niña range)
- Trends and variability in storminess patterns (and the associated nearshore processes)

Global Mean Sea-level Rise (1993-2015)



http://sealevel.colorado.edu/files/2015_rel4/sl_ns_global.png

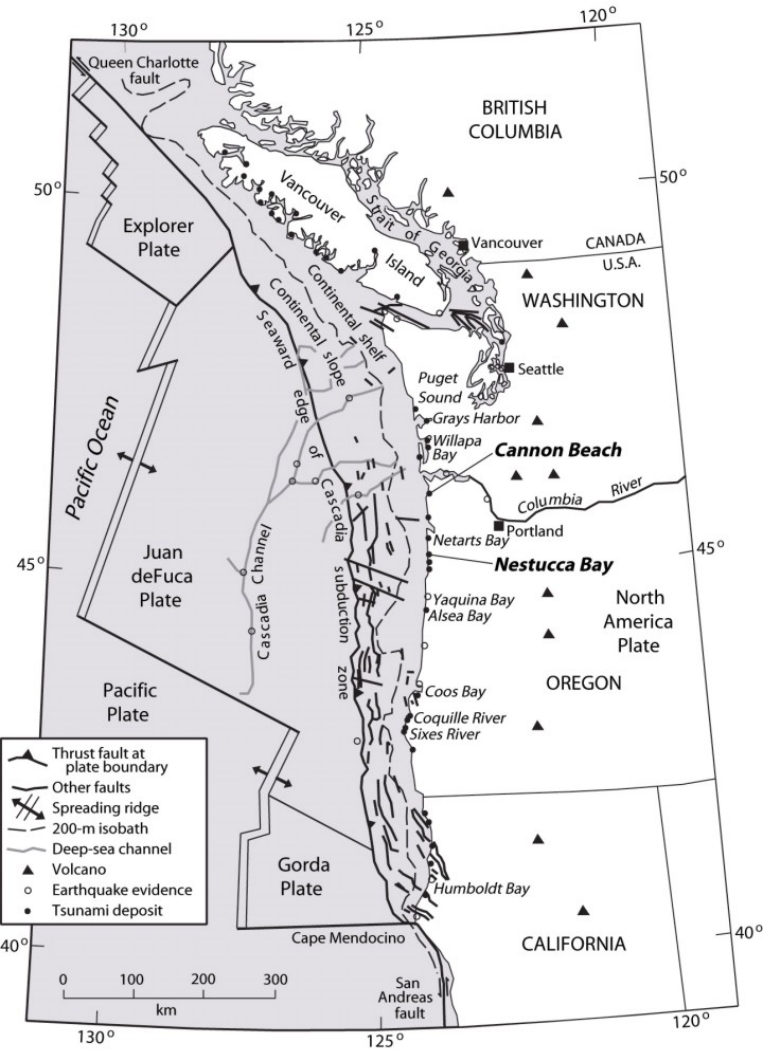




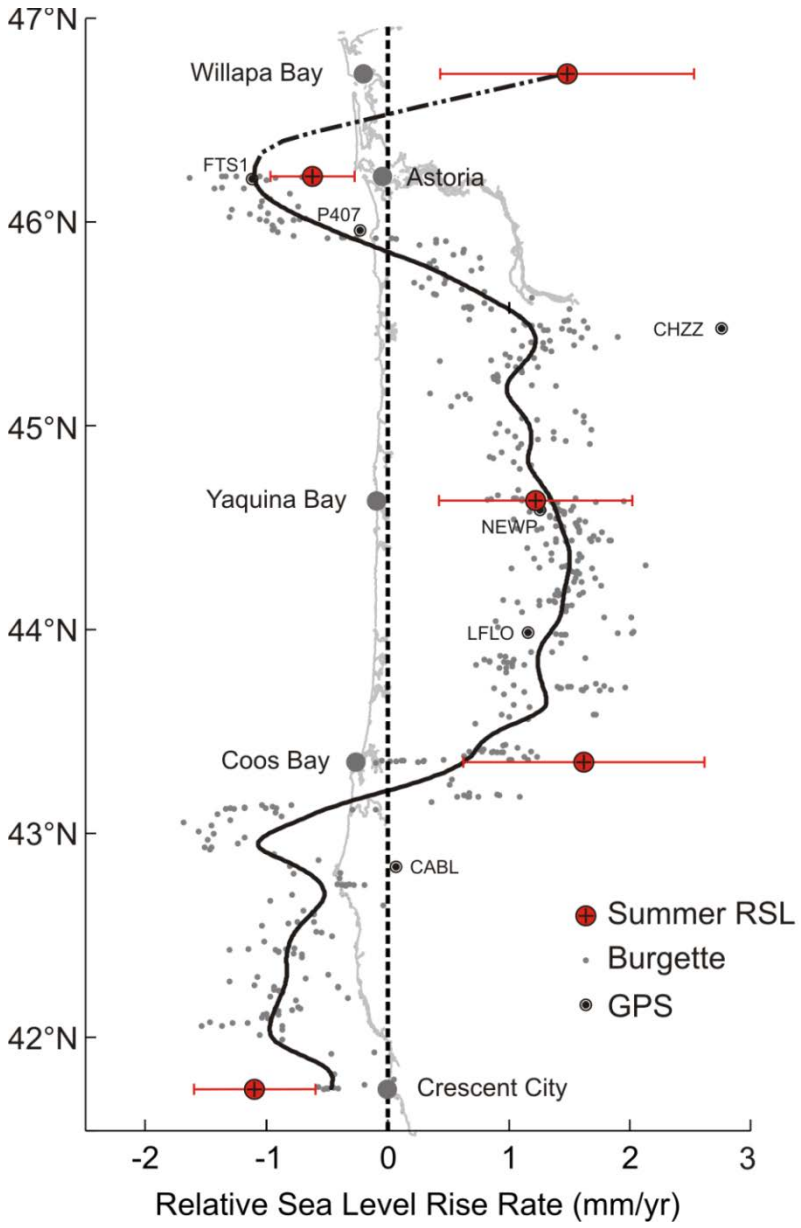
Geological and Hydrodynamic Setting of the PNW

Vertical land motions alter impacts of **SLR**

Komar, Allan, and Ruggiero, 2011



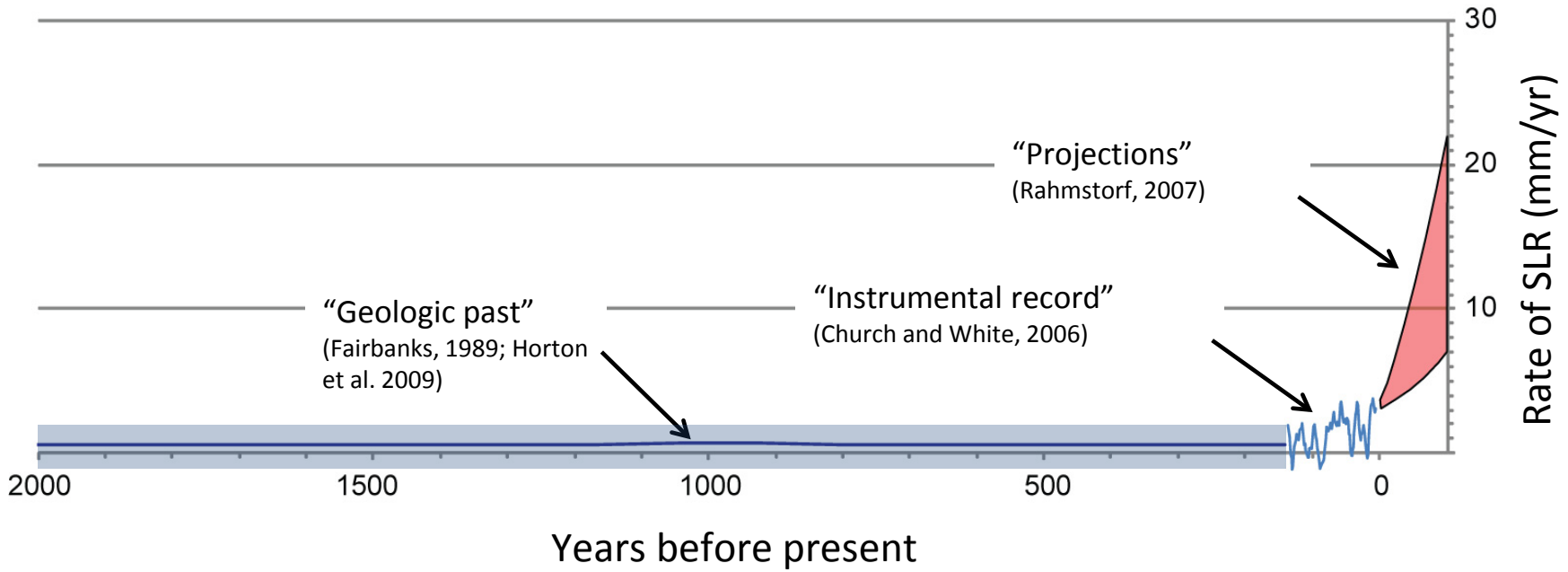
Geological and Hydrodynamic Setting of the PNW



Varying rates of uplift are reflected in RSLR

Komar, Allan, and Ruggiero, 2011.
after Burgette et al. 2009

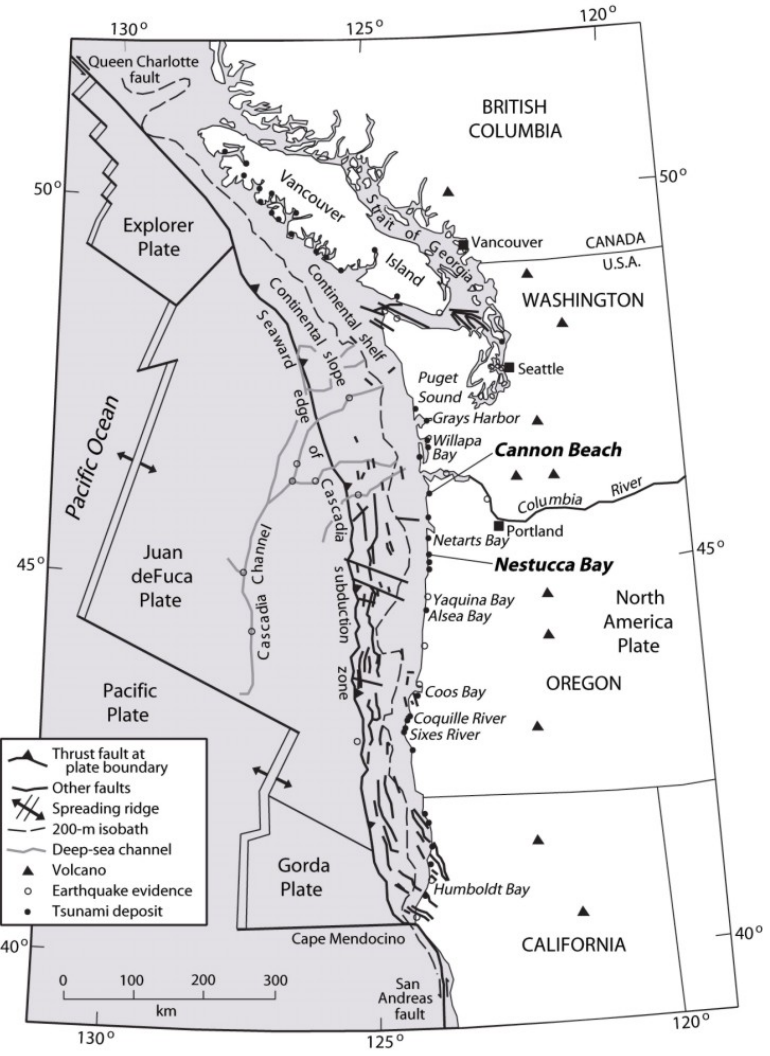
Past, present, and potential future rates of sea-level rise



- Wide range of SLR_{2100} estimates
  - 0.18-0.59 m (IPCC, 2007)
  - Up to 2.0 m (Pfeffer et al., 2008)
  - 0.5-1.4 m (Rahmstorf, 2007; 2010)
  - 0.2-2.0 m (National Climate Assessment, 2012)
  - .2-1.4 m (NRC Committee on SLR, 2012)
  - .3 - .98 m (IPCC, 2013)

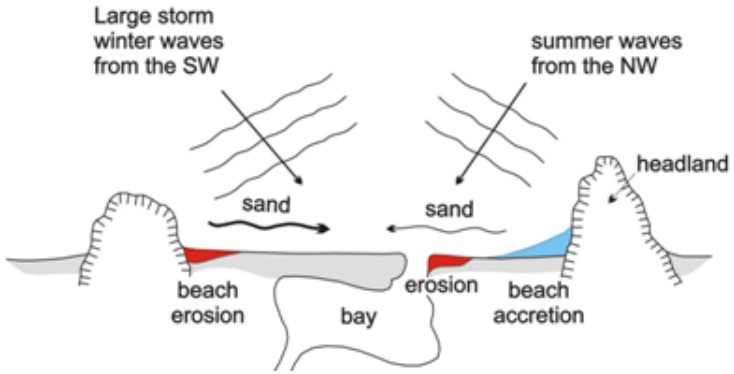
Uncertainty is increasing!

From Thieler et al., 2009



Geological and Hydrodynamic Setting of the PNW

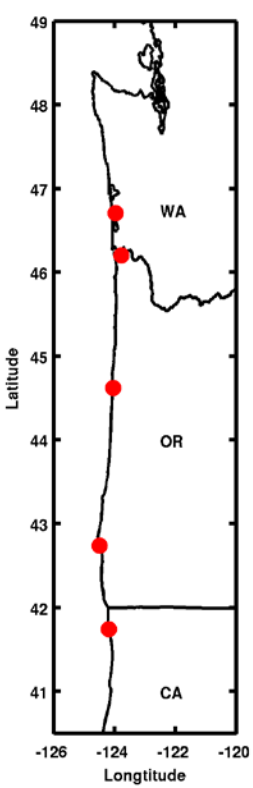
- **High water levels (10s of cms)**
- **Larger than typical wave heights**
- **Anomalous wave approach angles**
- Enhanced longshore and cross-shore sediment transport
- Hot-spot erosion

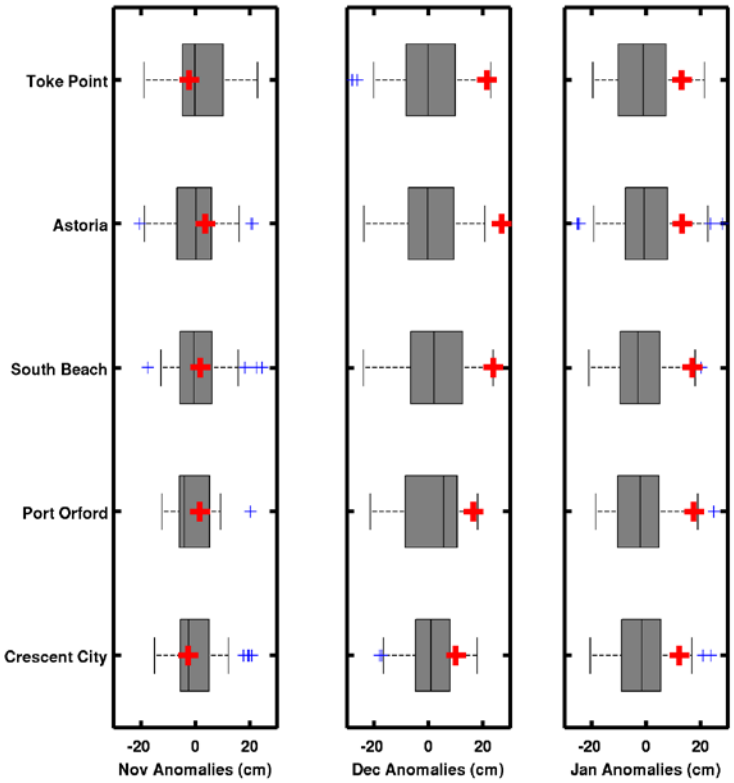


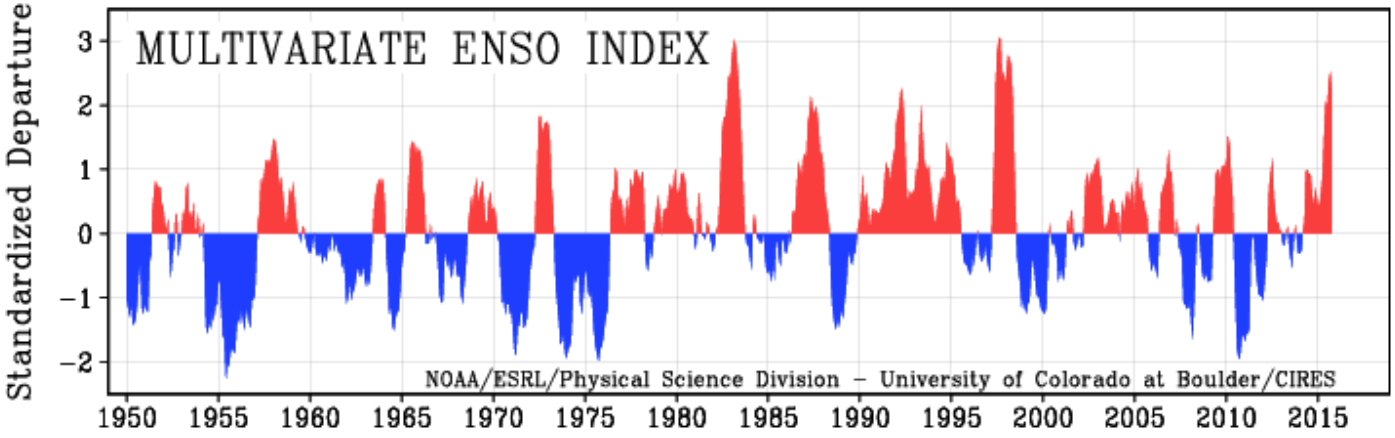
During **El Niños** the PNW effectively experiences decades worth of SLR for months

El Niños impact on the US West Coast

2015-2016 Event







North Beach

Grayland

Long Beach

Netarts

Agate Beach

South Beach

Grays Harbor County is not alone!

Some Preliminary Observations from the 2015/2016 El Niño

- PNW beaches generally appear to be lowering during the El Niño in response to elevated wave conditions and water levels
- Scarping and dune retreat has occurred in many locations
- While beach/surf zone slope has generally decreased on PNW beaches (serving to dissipate wave energy further from the beach face), the dune toe has also lowered such that the threshold for impacting the backshore is lower than at the start of the winter
- Elevated wave conditions and sea level anomalies persist – thus further coastal change this winter is highly likely

Future frequency and magnitude of El Niños?

More, less, no change from present-day??

nature climate change

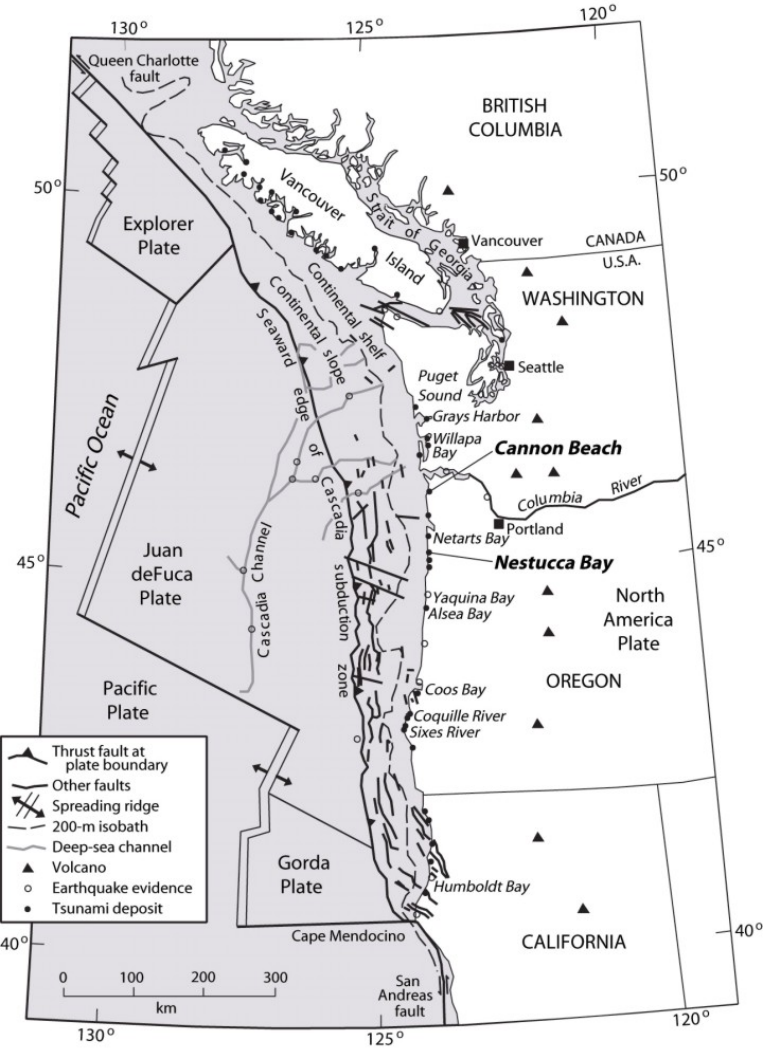
LETTERS

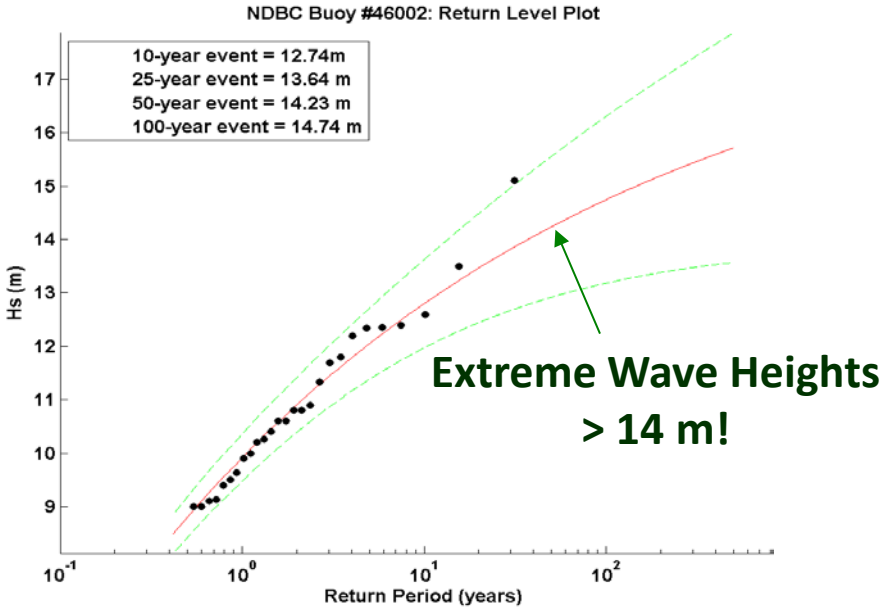
PUBLISHED ONLINE: 19 JANUARY 2014 | DOI: 10.1038/NCLIMATE2100

Increasing frequency of extreme El Niño events due to greenhouse warming

Wenju Cai[1,2*], Simon Borlace[1], Matthieu Lengaigne[3], Peter van Rensch[1], Mat Collins[4], Gabriel Vecchi[5], Axel Timmermann[6], Agus Santoso[7], Michael J. McPhaden[8], Lixin Wu[2], Matthew H. England[7], Guojian Wang[1,2], Eric Guilyardi[3,9] and Fei-Fei Jin[10]

Major ENSO events may double in frequency

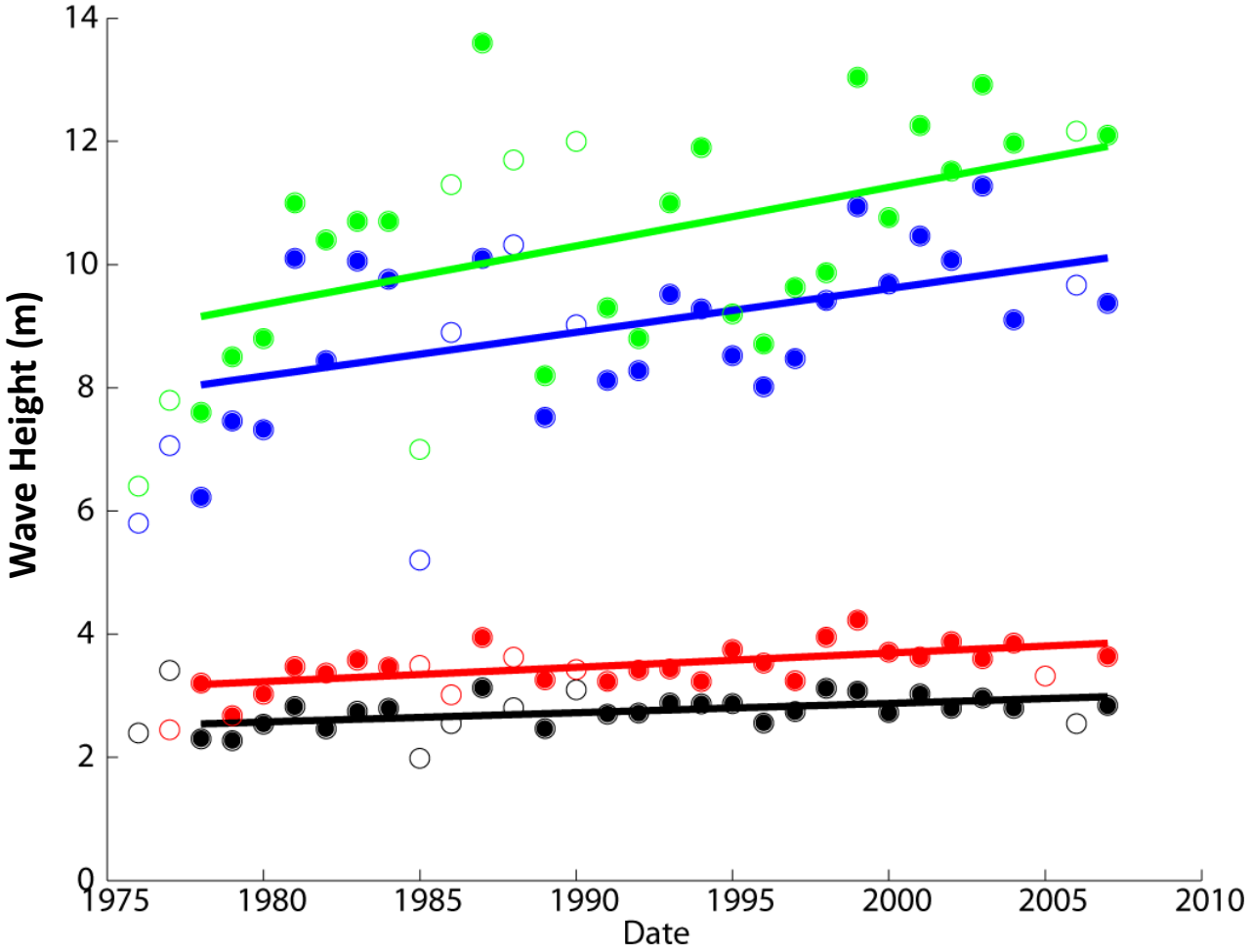




Geological and Hydrodynamic Setting of the PNW

One of the most intense **wave climates** in the world

Increasing PNW wave heights



Annual Max
+9.5 cm/yr

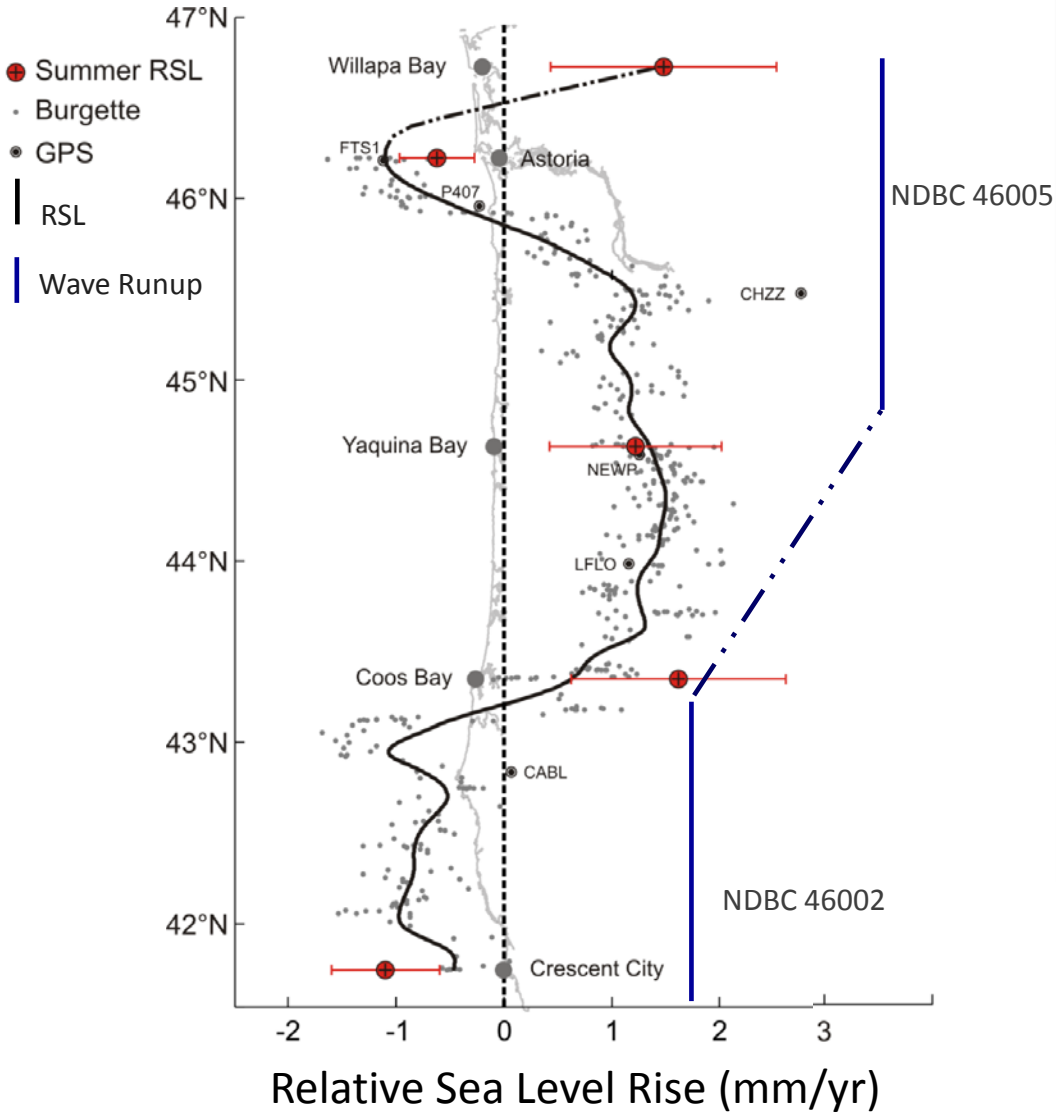
Avg. 5 Largest
+7.1 cm/yr

Winter Mean
+ 2.3 cm/yr

Annual Mean
+ 1.5 cm/yr

Ruggiero et al., 2010; after Allan and Komar, 2000; 2006

Between ~ 1980 and 2010 *changing* wave heights caused more impact than *changing* sea level over much of the PNW coast!



Ruggiero, 2013

Envisioning Coastal Futures

Climate

Policy

Alternative Futures Analysis:

Explore how complex coupled natural and human systems dynamically respond to varying adaptation strategies and driving forces.

Washington Coastal Policy: A Quick Review

- **Federal** – Coastal Zone Management Act (1972)
  - Implemented through existing state laws – Washington's Shoreline Management Act
  - 2006 updates included consideration of sea-level rise due to global warming

- **State** –Shoreline Management Act (1971)
  - WA Dept. of Ecology adopts shoreline management guidelines in 1972
  - No explicit references to sea level rise, but does allow consideration through policies of best available information (WAC173-26-201)

- **County/Local –** Several planning tools, regulatory mechanisms
  - Local governments are responsible for developing and amending Shoreline Master Programs, Comprehensive Plans, Critical Areas Ordinances, Hazards Mitigation Plans, Flood Management Plans, Ecosystem Recovery Plans, etc.

Approach of **Climate Impacts Research Consortium**

- Collaborative networks **co-producing knowledge** for climate-resilient strategies.

- Developing frameworks for **interactively envisioning alternative future scenarios**.

- Synthesizing and integrating state-of-the-art science into **decision support**.

Quick Survey and Break!