Impacts of Sea Level Rise and Winter Storm Activity on Coastal California

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COASTAL IMPACTS

- Sea cliff retreat and beach erosion
- Inundation of lowlands and coastal wetlands
- Storm surge related flooding
- Saltwater intrusion into estuaries and freshwater aquifers

Most of the damage caused by sea level variability occurs during episodes of concurrent

Extreme Sea Levels and Extreme Wave Heights

Public Facilities At Risk

California Coastal Records Project (x4)

Sea Level Variability

- Global Mean Sea Level Rise
- Tides
- Interdecadal SLH variability and El Nino related changes
- Storms: includes wind-forced surge as well as the inverse barometer effect caused by sea level pressure changes
- Waves (not included in the tide gauge record)

GLOBAL "COASTAL" SEA LEVEL RISE

- Steric (thermal expansion from warming of the world's oceans)
  ~ 3 - 6 cm/century (Levitus et al.)

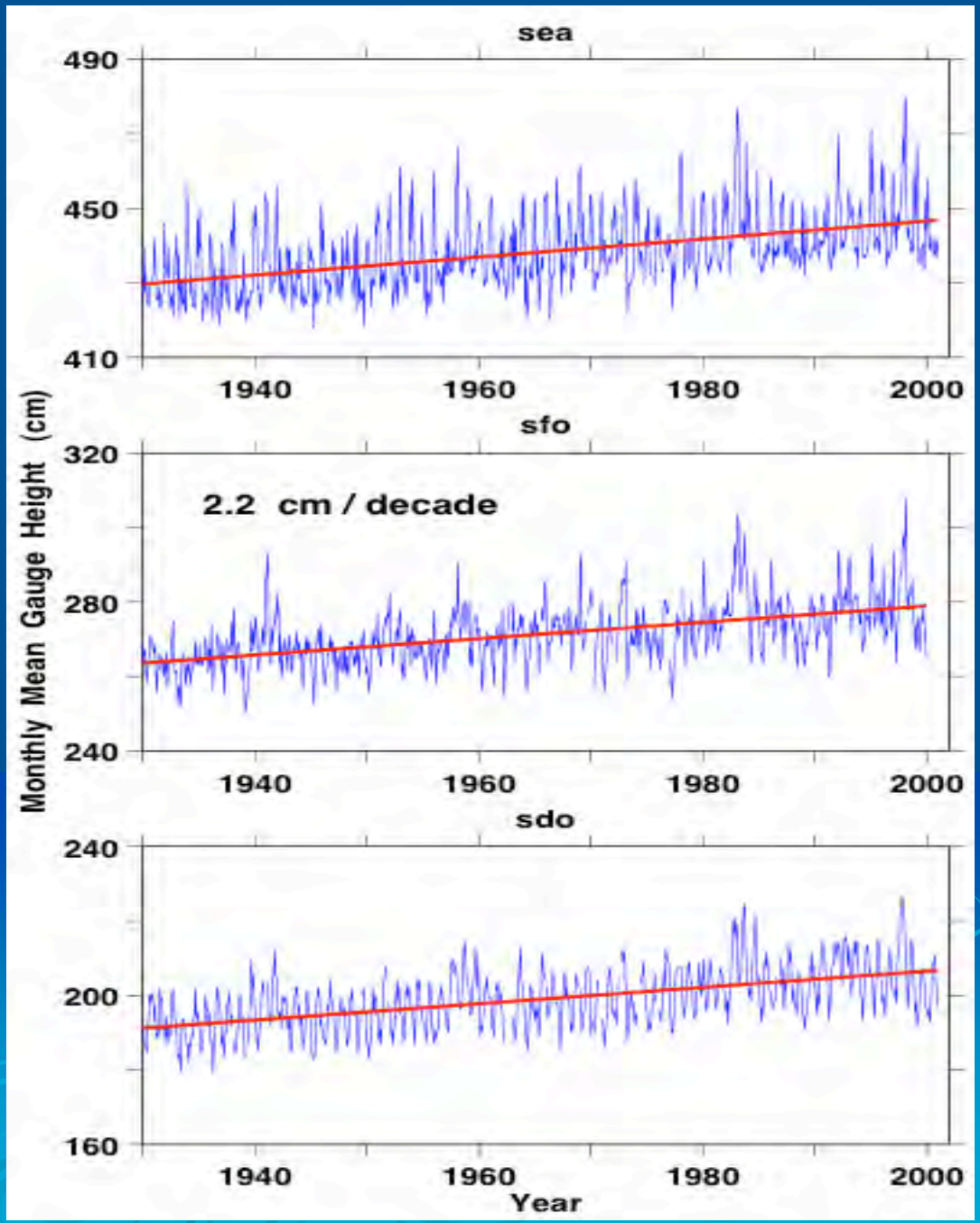
- Eustatic (added water from melting glaciers and ice caps)
  ~ 6 cm/century (IPCC)

Global MSL rise: ~ 10 - 20 cm / century

Well established trends in average sea level rise along the West Coast

Long period variability most prominent at San Francisco (SFO)

Increases tend to persist for several years



GREATEST COASTAL IMPACTS

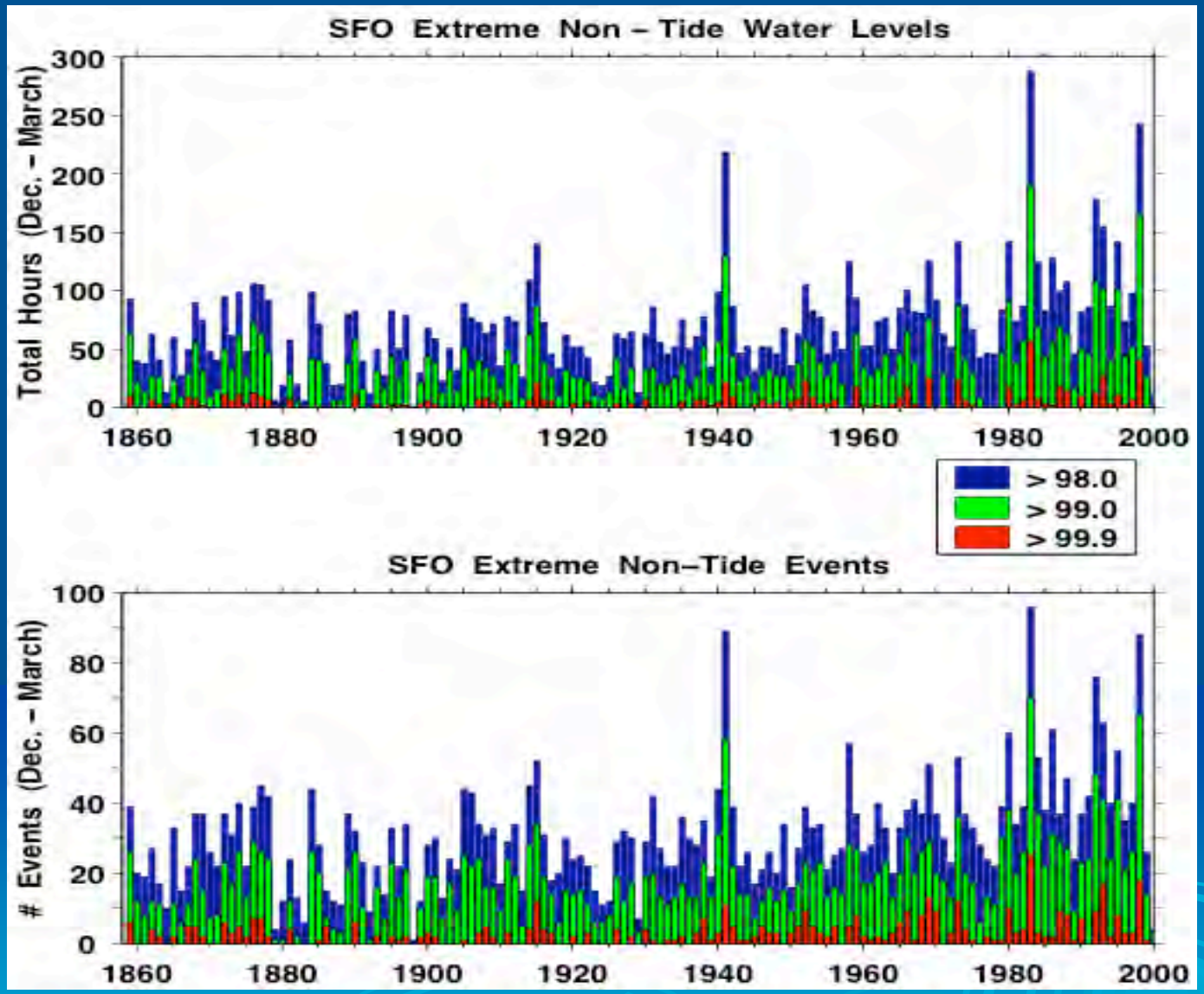
"High" High-Tide

in conjunction with

Extreme Storm - Forced Sea Levels

Extreme Surge + Extreme Waves during High Tide

Storm - Forced Sea Levels



Increasing frequency and duration of Extremes

Ocean Beach , February 1983

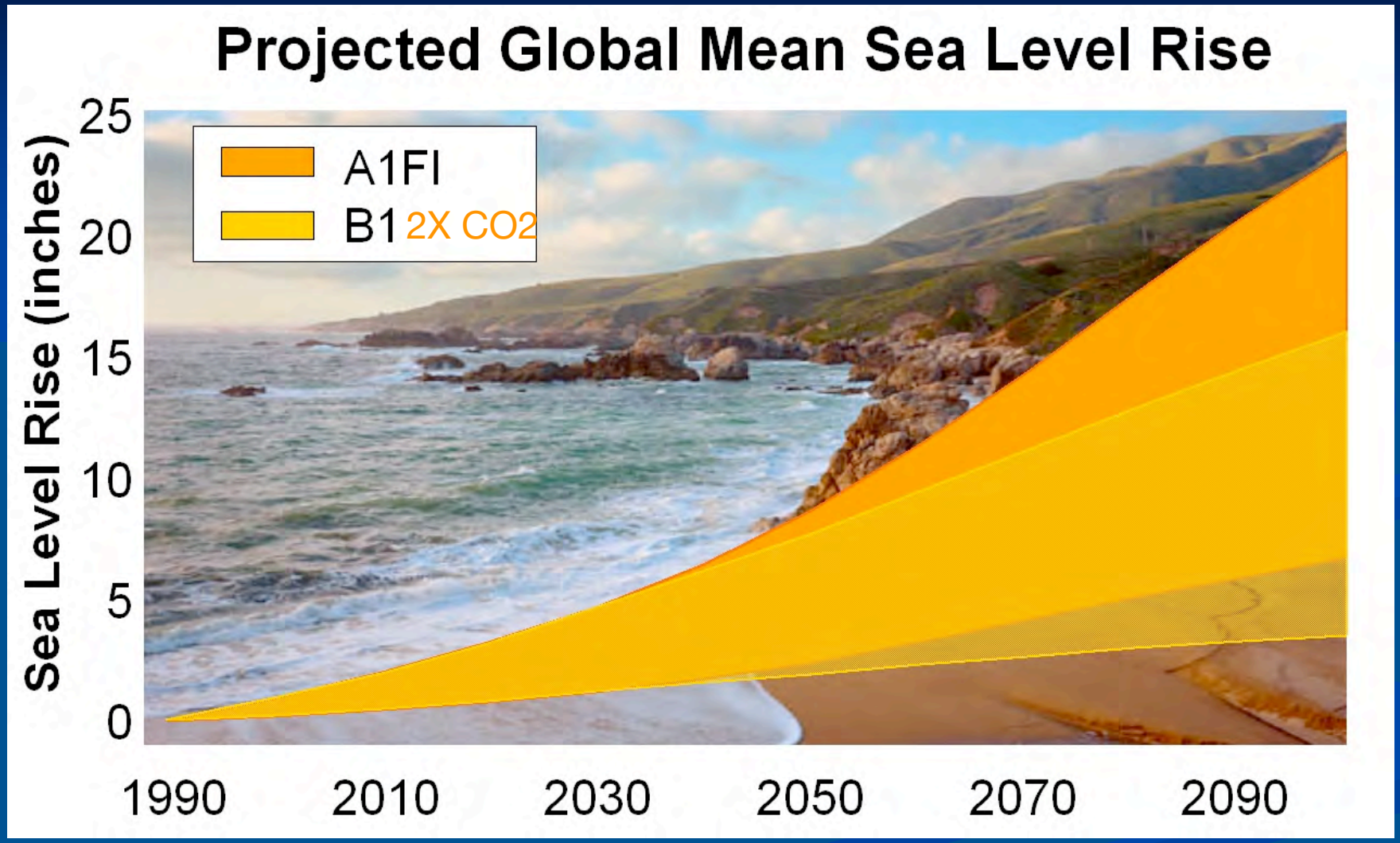
Extreme storm-forced sea levels
and waves during an extreme tide

HISTORIC WAVE CLIMATE VARIABILITY

- NOAA Buoy data: 1981 - 2005
- Inversion of Seismic data (U.C. Berkeley archives, 1931-1981) for Wave Heights

Extending the winter wave record an additional 50 years --> more reliable extreme wave statistics, e.g. 100 yr events, for model constraints

Increased Emission Scenarios: Thermal Expansion Only



Ice melting increase expected to have similar magnitude

Modeling Approach:
Coastal Sea Level Impacts Group

Astronomical Tide

+

Weather
(wind, atm press
at tide gage stations)
From climate GCM

+

Waves
From buoys,
seismics, and
wave model

+

Short & Long
Period Sea Level
Height Variability,
From climate GCM
and tide gauge data

+

Sea Level Rise
(climate model or
other estimates)

--> **Sea Level Extreme events and statistics**

ECONOMIC COSTS

- Loss of expenditures and consumer's surplus associated with beach closures
- Loss of expenditures and consumer's surplus associated with beach narrowing and shrinking
- Economic cost of increased beach renourishment requirements (replacing beach sand)

Is coastal California ready to plan for the impacts of SLR?