SOUTH FLORIDA WATER MANAGEMENT DISTRICT

An Overview of Global and Regional Sea-Level Rise Projections

Jayantha Obeysekera, Ph.D. ('Obey')

Chief Modeler

So. Fl. Water Management District

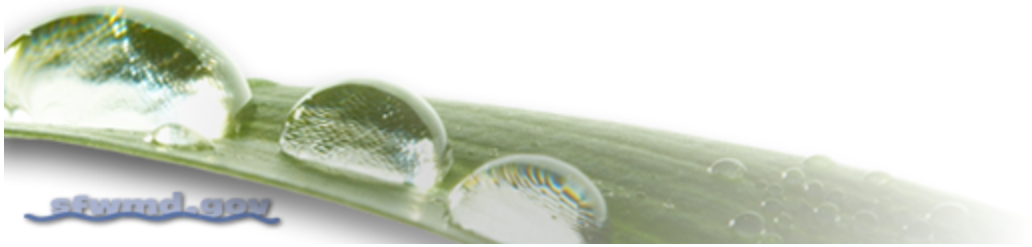
sfwmd.gov

GEER 2015
April 20-23, Coral Springs, Florida

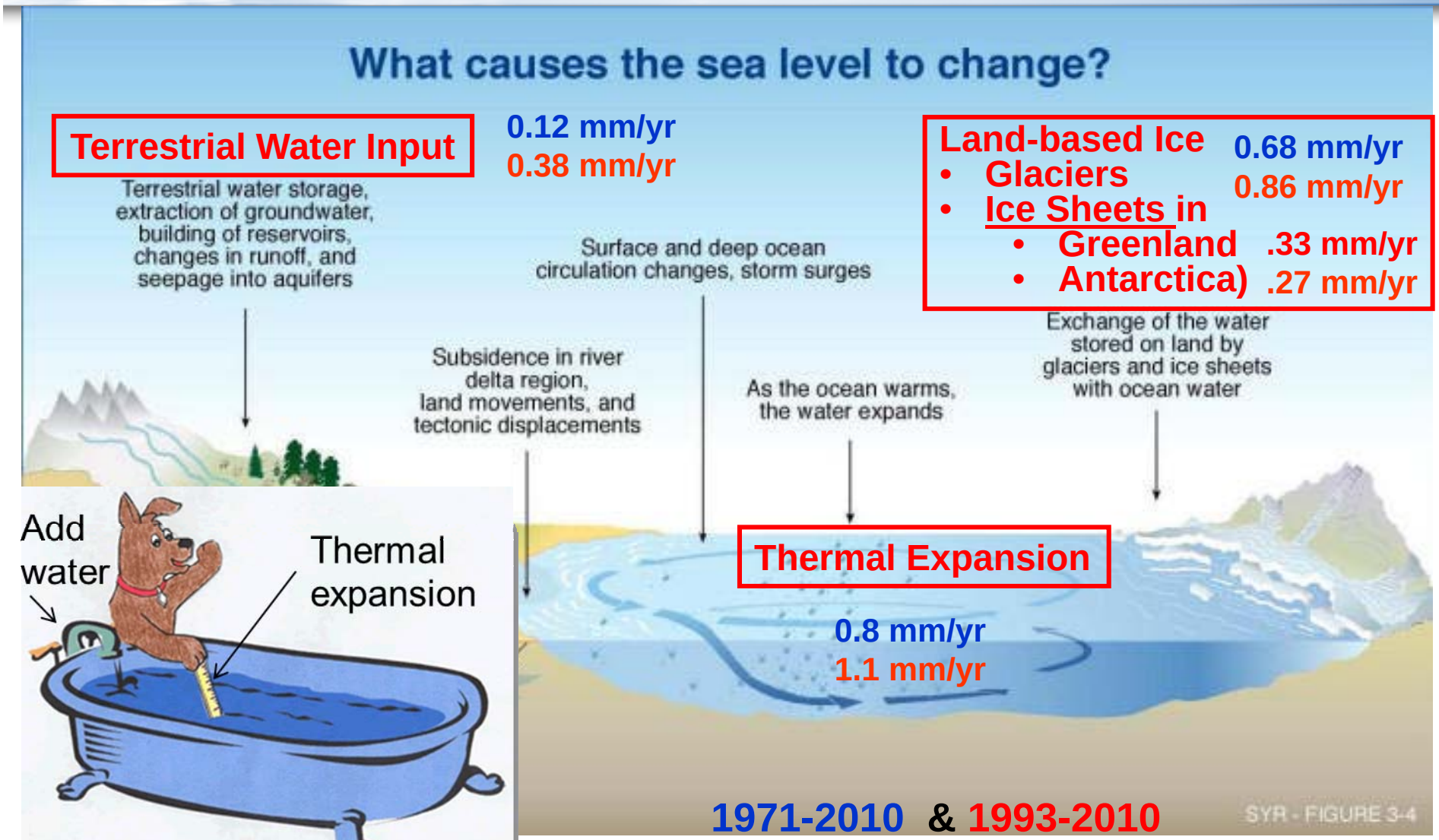
sfwmd.gov

Outline

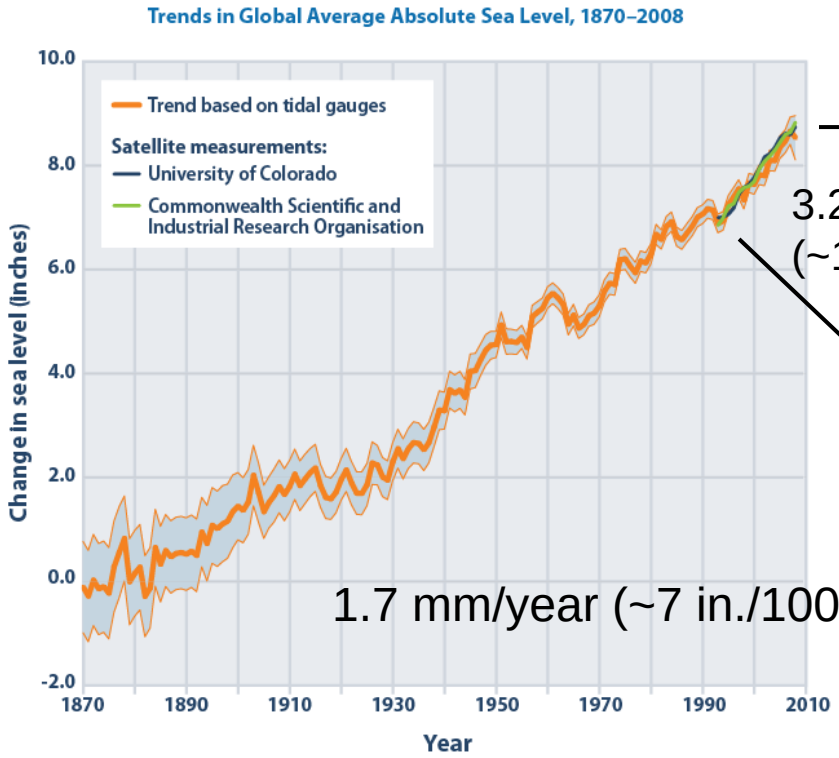
- Global Mean Sea Level
- Regional Sea Levels
- Sea Level Extremes (time permitting!)



Sources of Sea Level Rise (Global)



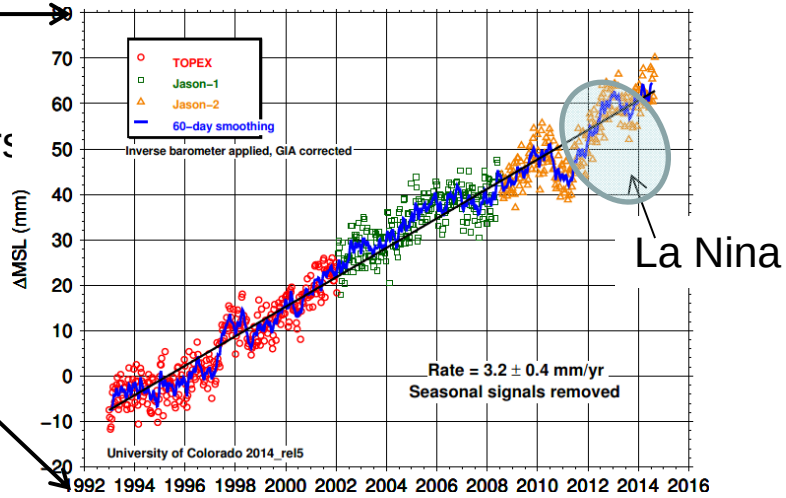
Global Average Sea Level Rise



Data sources:
- CSIRO (Commonwealth Scientific and Industrial Research Organisation). 2009. Sea level rise. Accessed November 2009. http://www.cmar.csiro.au/sealevel.
- University of Colorado at Boulder. 2009. Sea level change: 2009 release #2. http://sealevel.colorado.edu.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climatechange/science/indicators.

3.2 mm/year
(~13 in/100 yrs

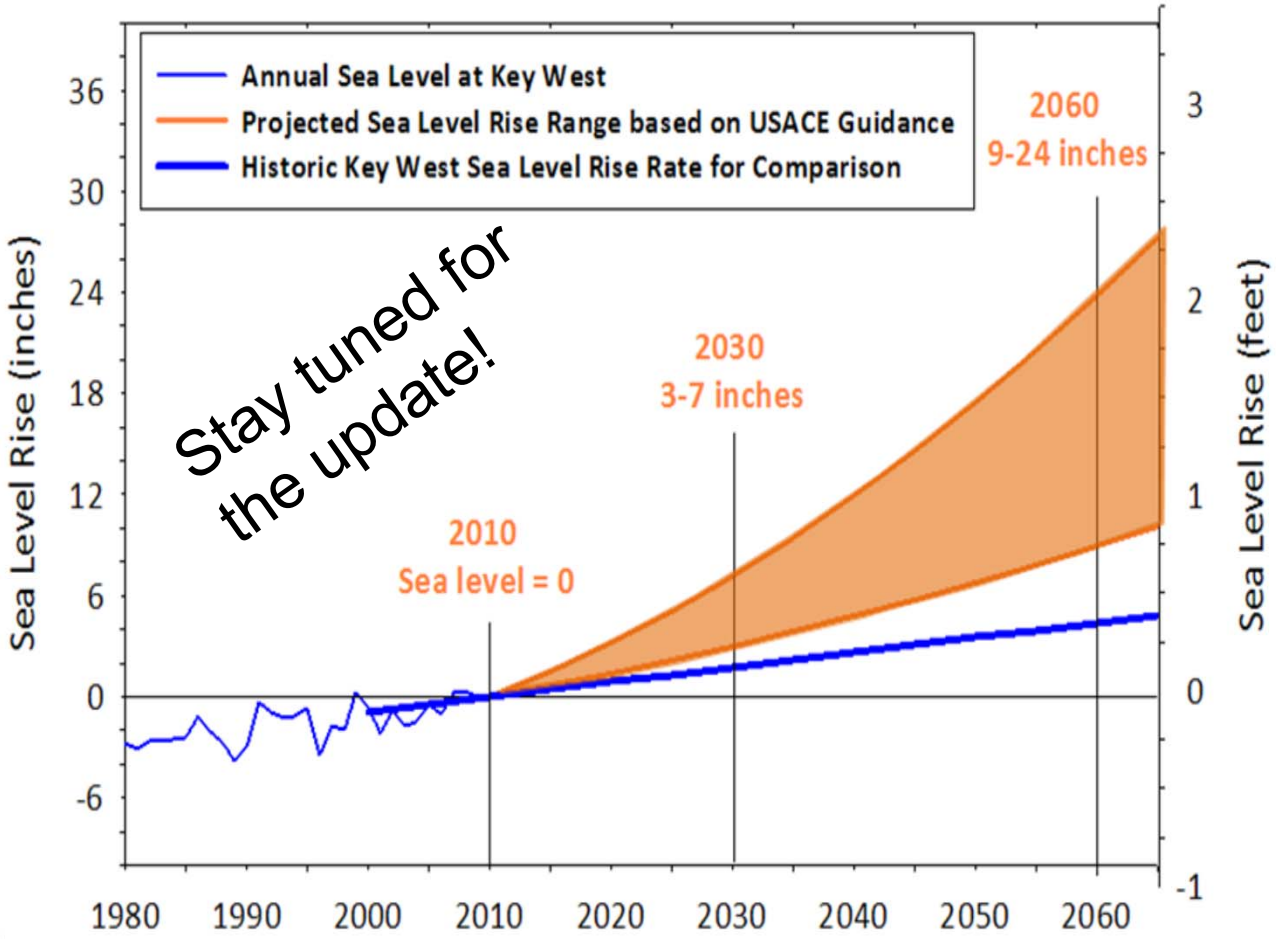


La Nina

- Increase in the rate to > 3 mm/yr is of significant concern for coastal regions

More closer to home: Projections for South Florida

SOUTHEAST FLORIDA REGIONAL COMPACT CLIMATE CHANGE



Recent Global Mean Sea Level Projections

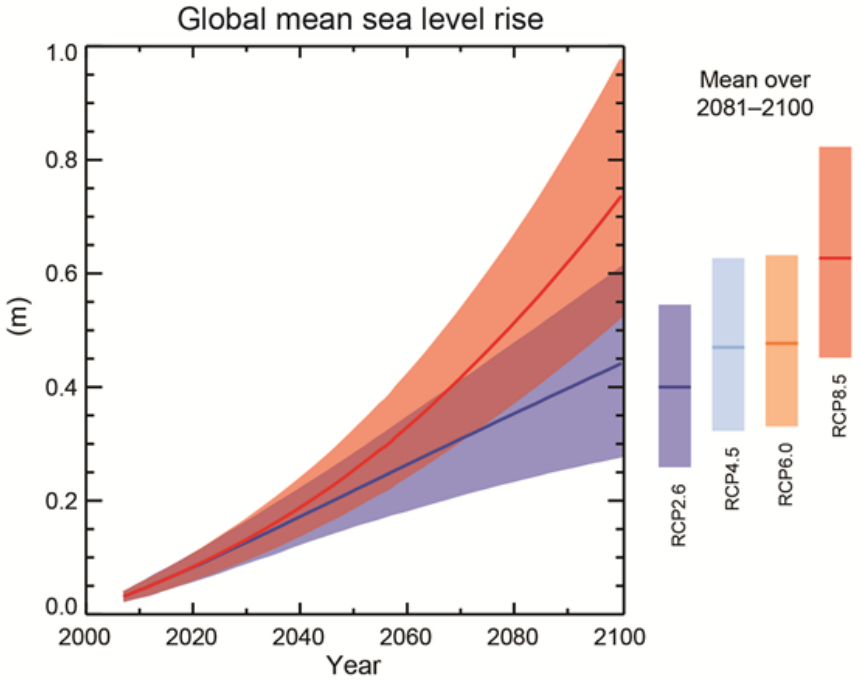
- Update to USACE guidance
- Sea Level Rise projections from IPCC Assessment Report V (AR5)
- NOAA scenario projections (NOAA 2012) developed NCA, 2014
- National Research Council (NRC 2012) projections for West coast of the United States
- Sea Level Rise projections issued for state-level planning. These include the states of Maryland, Massachusetts, and New York
- Probabilistic Projections that have become available recently in the literature (Kopp et. al. 2014; Jevrejeva et al. 2014)

IPCC (AR5) GMSL Projections (m)

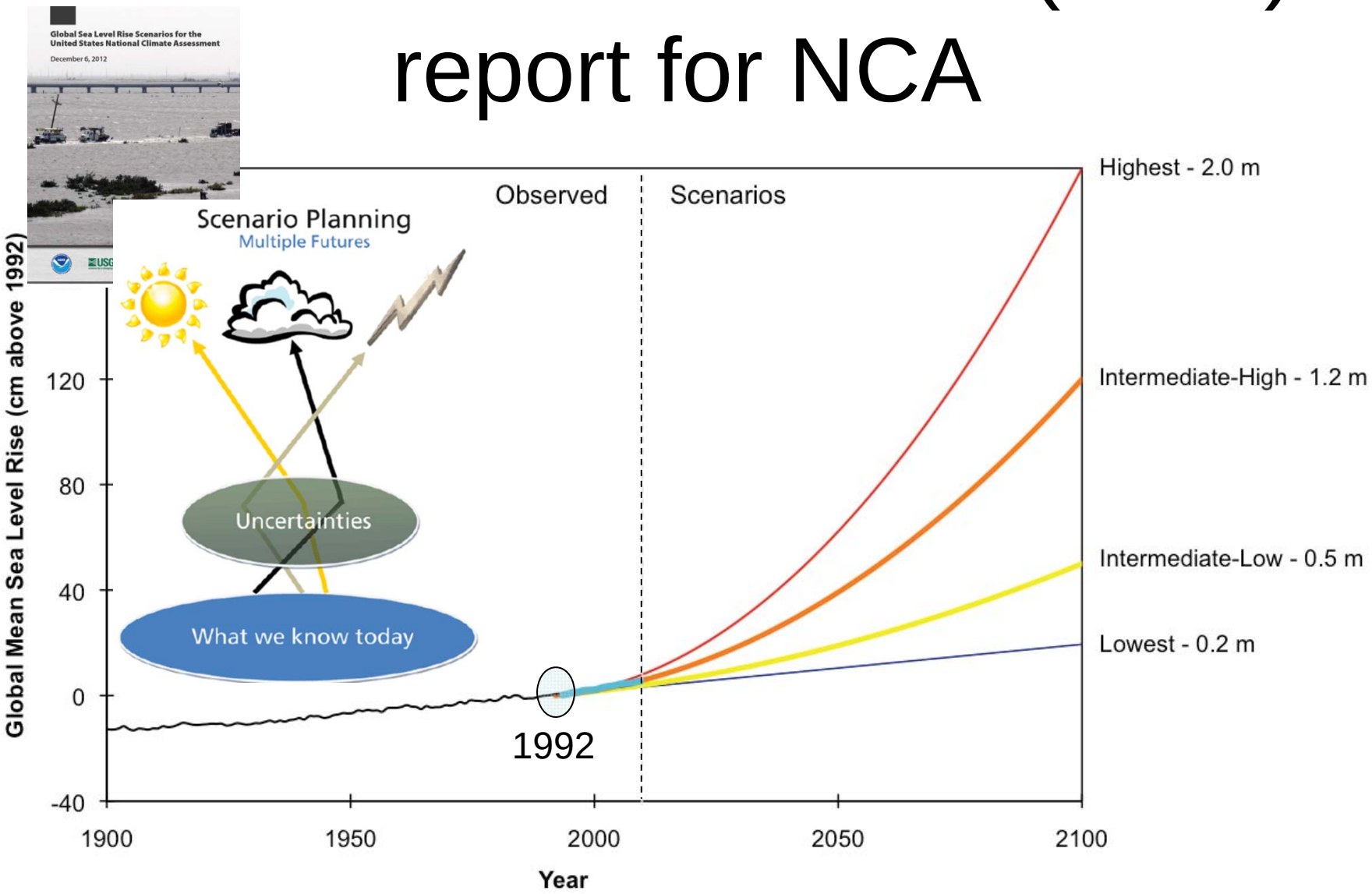
Year	RCP2.6	RCP8.5
2030	0.13 [0.09–0.16]	0.13 [0.10–0.16]
2060	0.26 [0.18–0.34]	0.33 [0.24–0.42]
2100	0.43 [0.28–0.60]	0.73 [0.53–0.97]

“The IPCC’s global mean sea-level scenarios do not necessarily provide the right information for coastal decision-making and risk management”

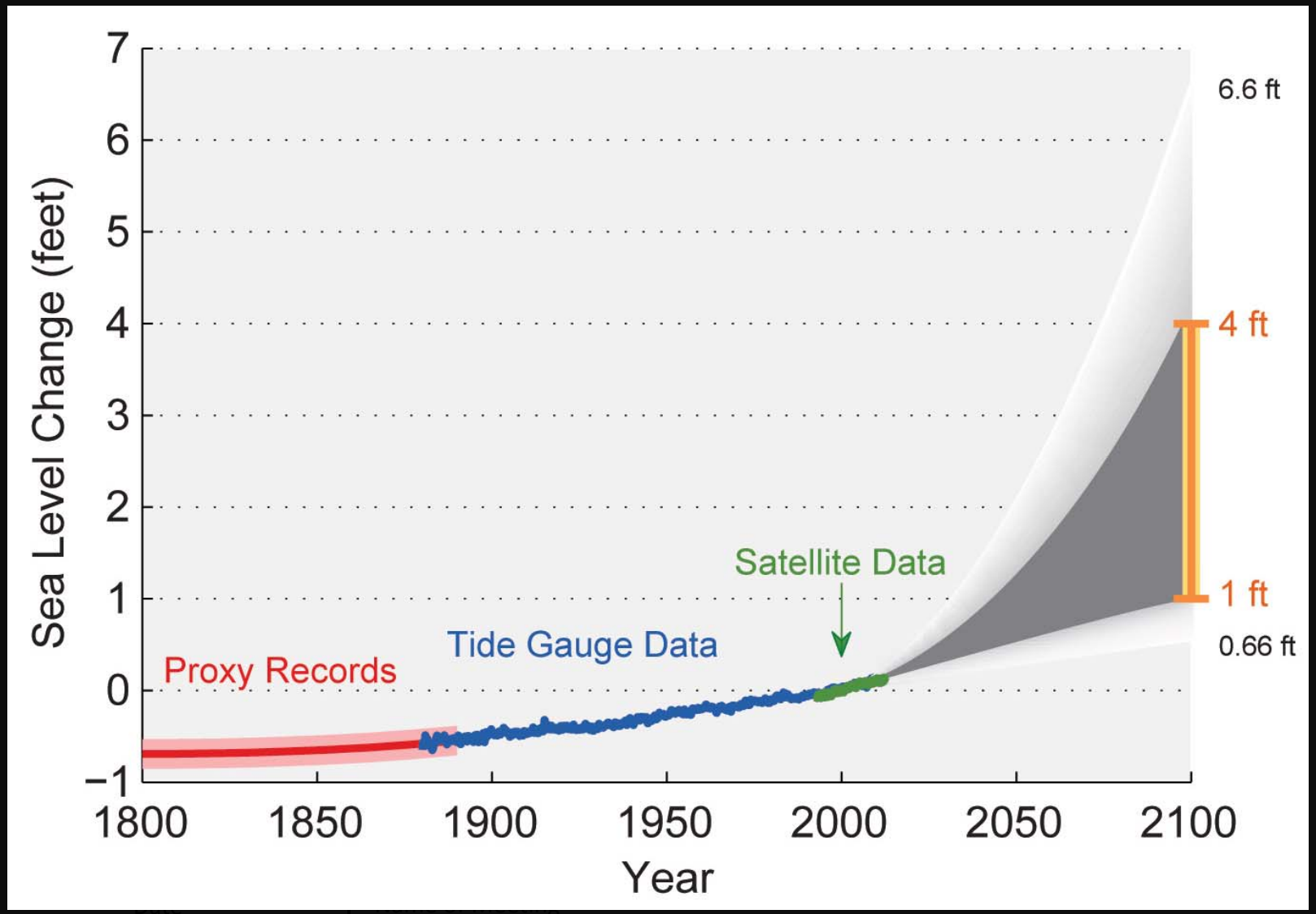
Hinkel et al., (2015), Nature Climate Change



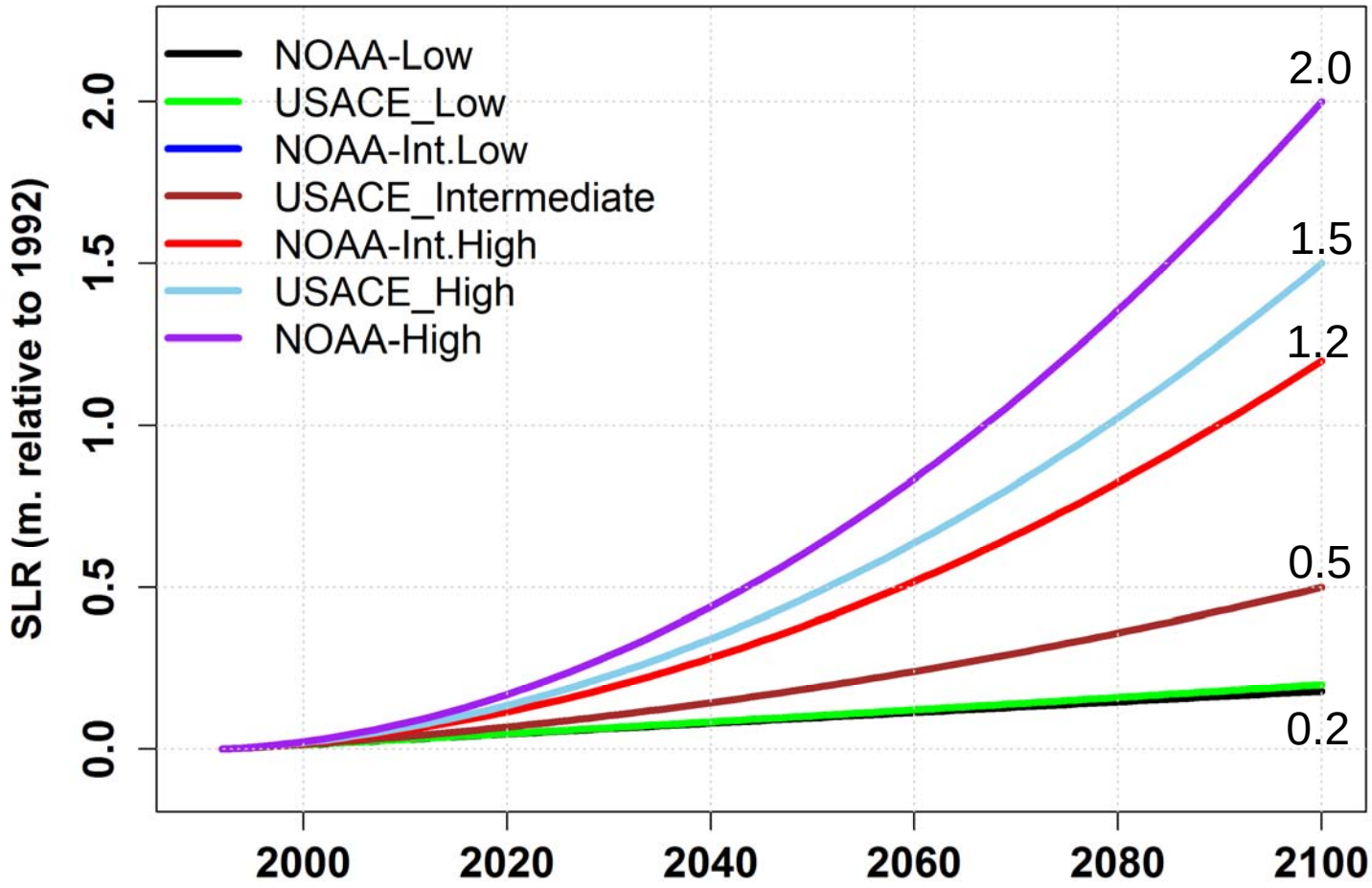
Sea Level Rise: NOAA (2012) report for NCA



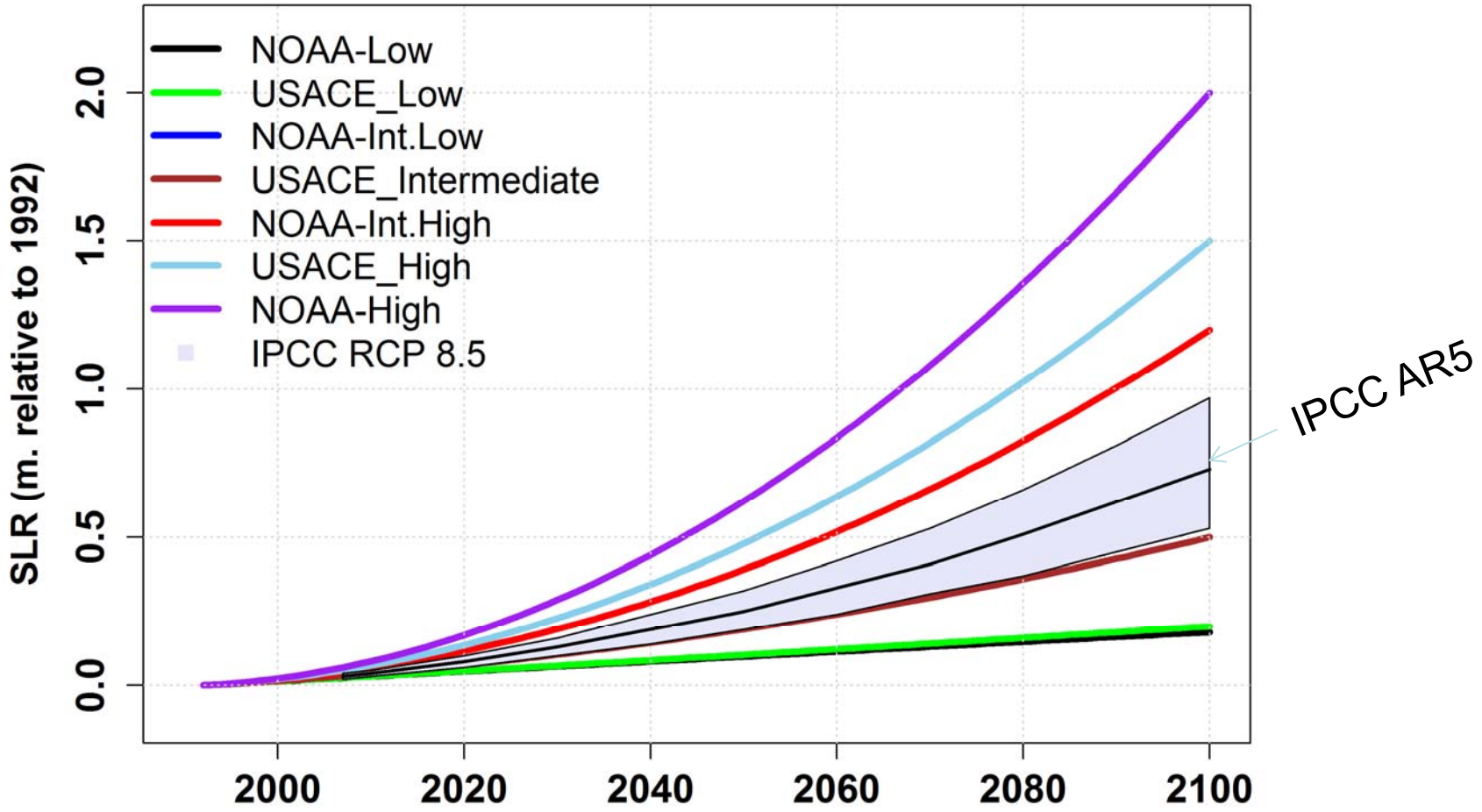
Past and Projected Changes in Global Sea Level (NCA 2014 report)



Comparison of GMSL Projections

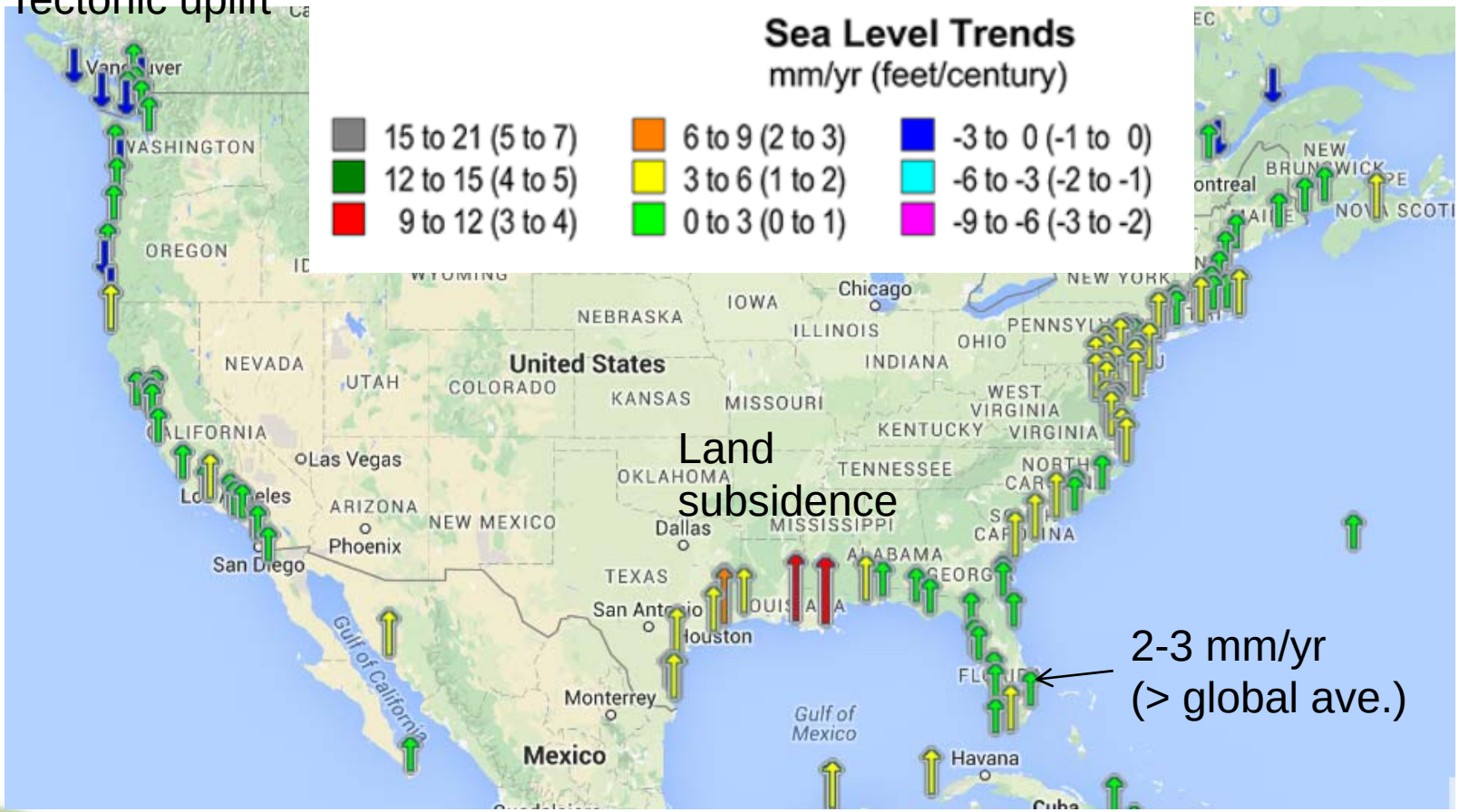


Comparison (cont.)

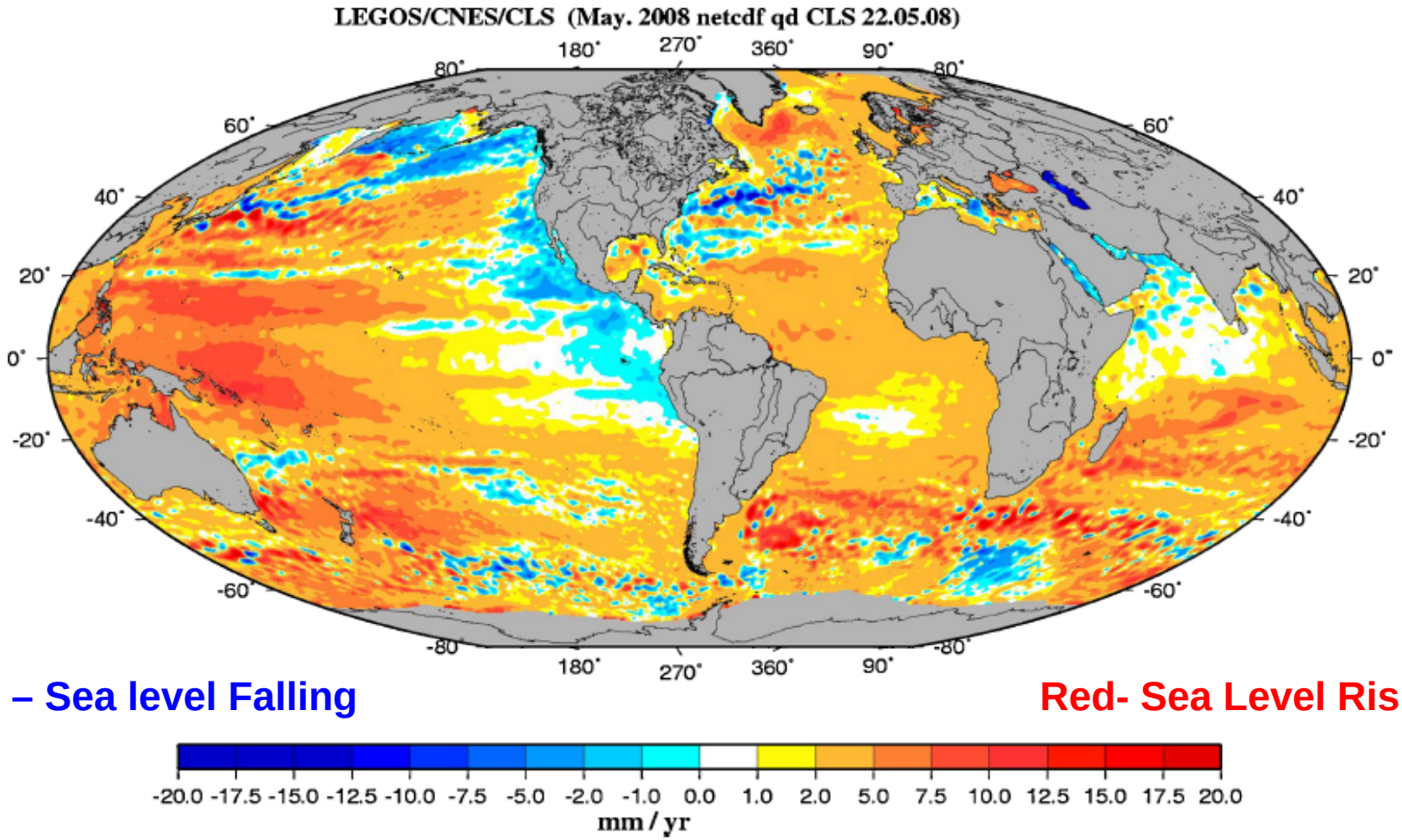


Sea Level Rise rates in the US

Tectonic uplift



Sea Level Rise is not uniform (why?)

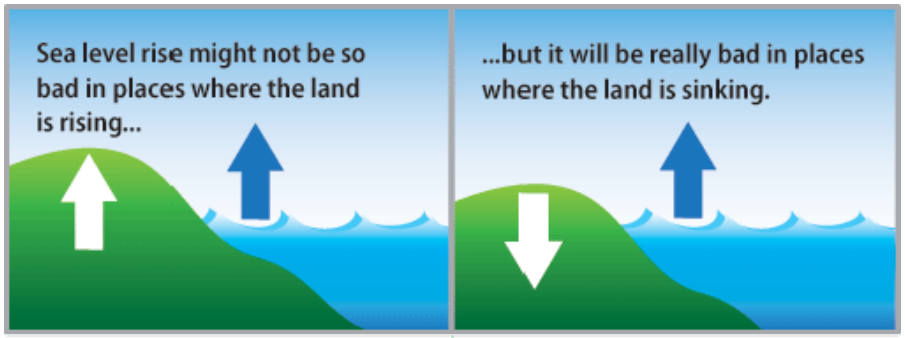


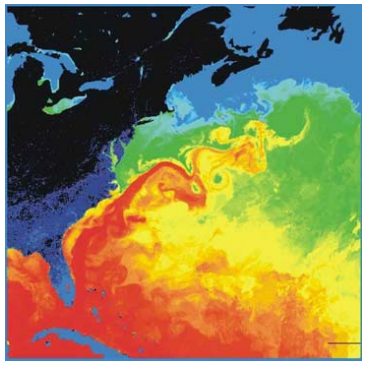
Blue – Sea level Falling

Red- Sea Level Rising

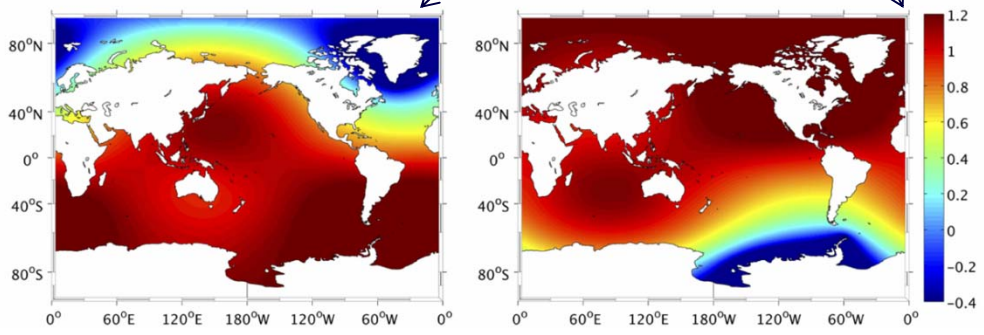
Source of Regional Variation in Sea Level Relative to Land

- Land subsidence or uplift, Post Glacial Rebound
- Variations in Ocean Currents (e.g. Gulf stream)
- Gravitational and rotational effects of land ice redistribution (more complex)





Ice melt effect
- Greenland
- Antarctica



Combining Components of Sea Level Rise

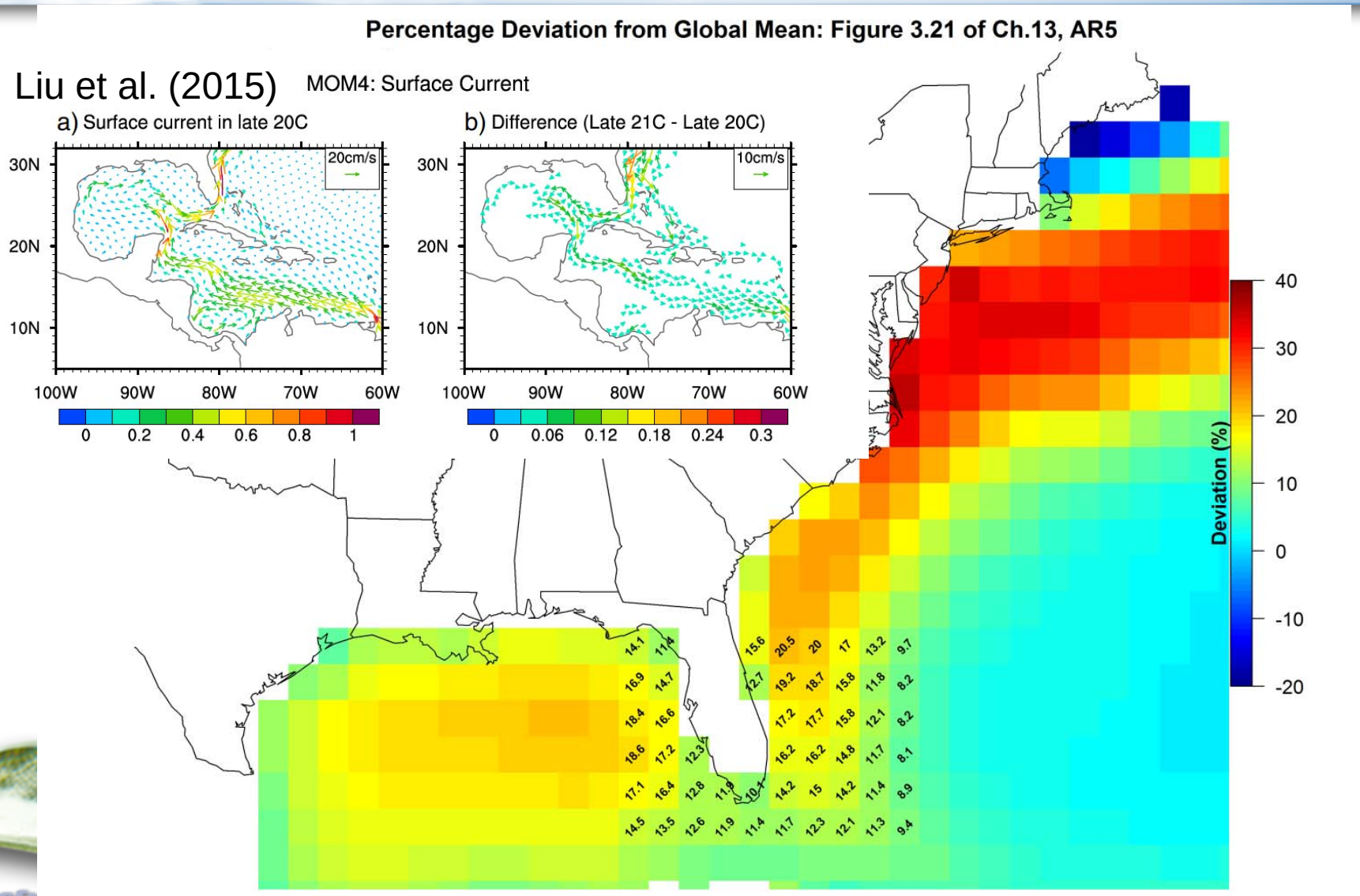
- Change in Relative Sea Level (RSL)*:

$$\Delta RSL = \Delta SL_G + \Delta SL_{VLM} + \Delta SL_{RM} + \Delta SL_{RG}$$

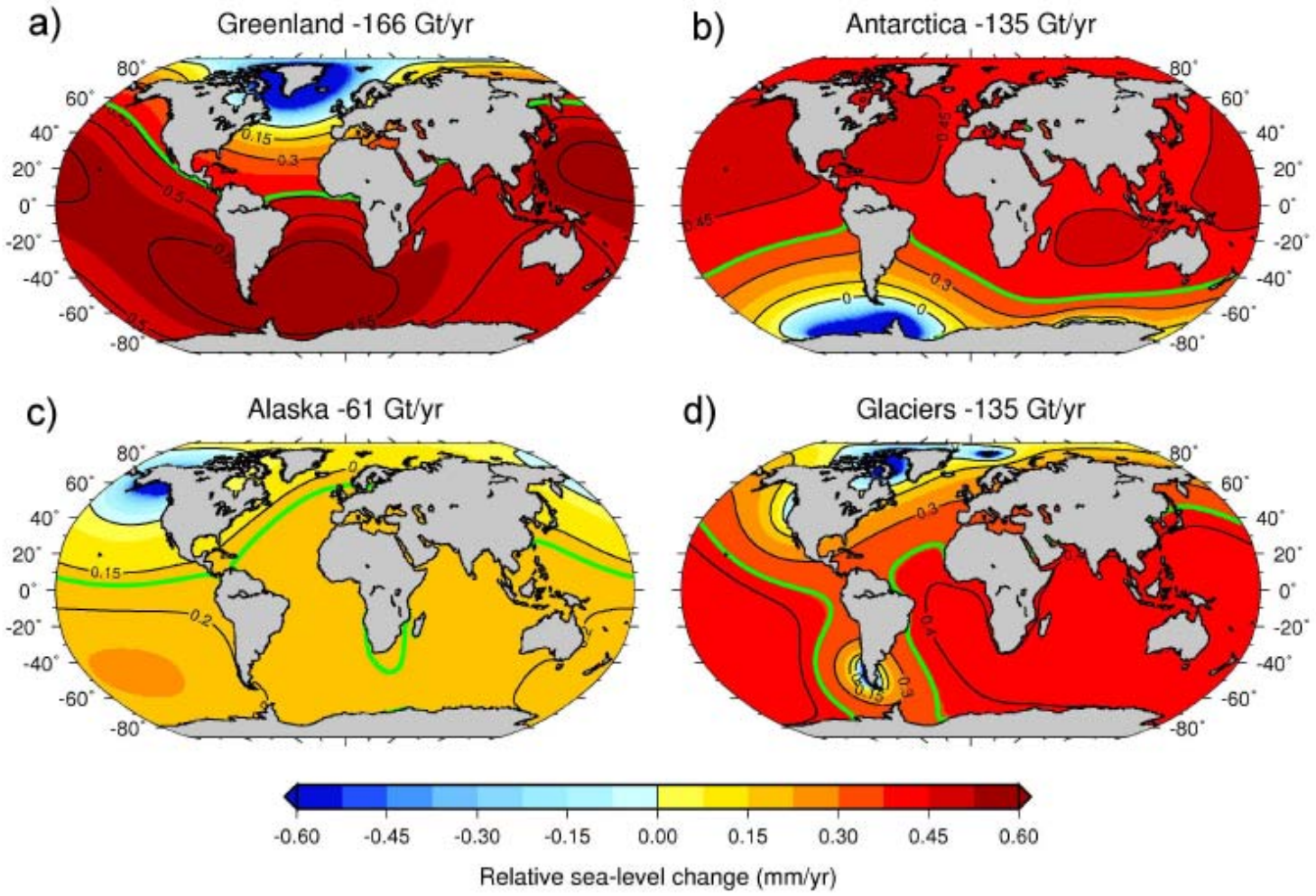
- ΔSL_G: Global Mean
- ΔSL_{VLM}: Local: f(Uplift/ Subsidence, GIA)
- ΔSL_{RM}: Dynamic Sea Level f(meteo-oceanographic Factors)
- ΔSL_{RG}: Ice sheet fingerprint f(Changes in Earth's gravitational Field)

*As suggested in Nicholls et al., 2011

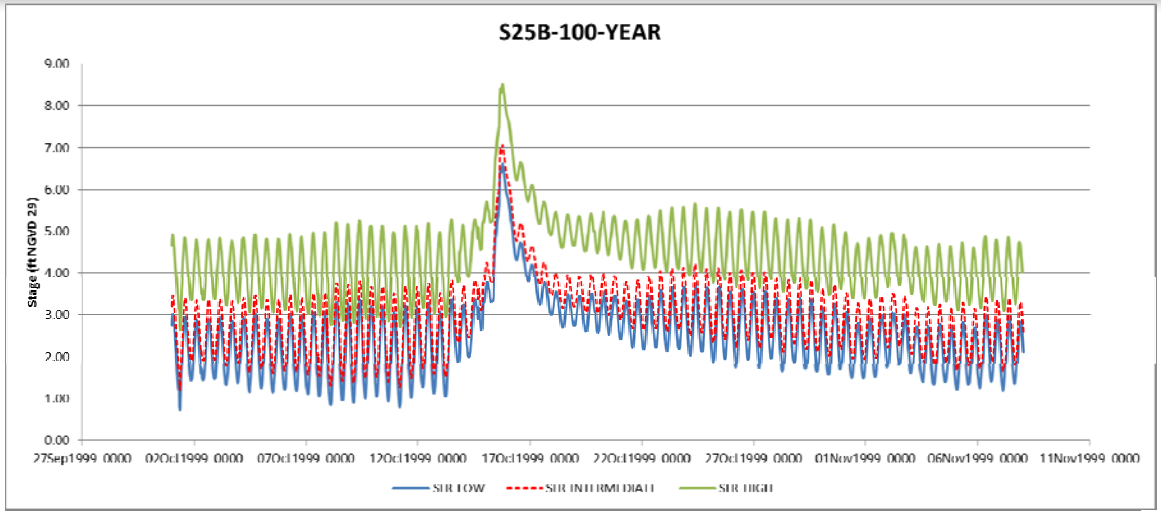
Dynamic Sea Level Adjustment



Gravitational and earth rotational effect of ice mass losses

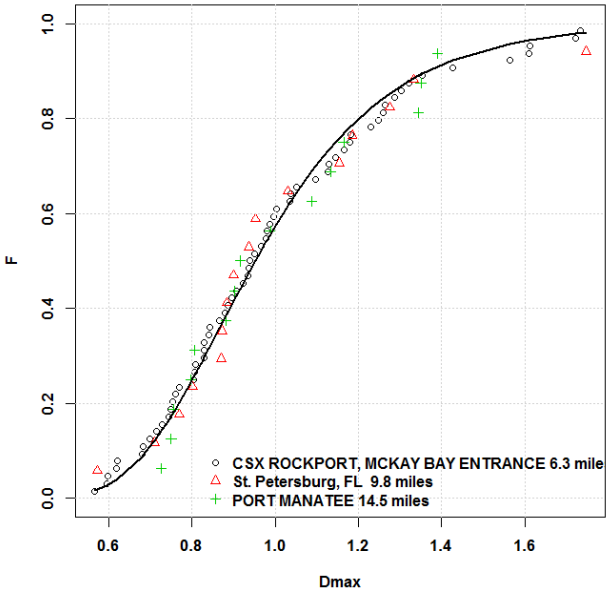


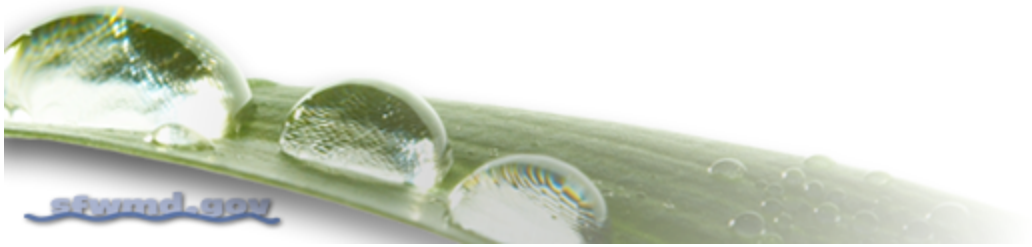
Predicting future extreme sea levels



Extreme value modeling at a single site

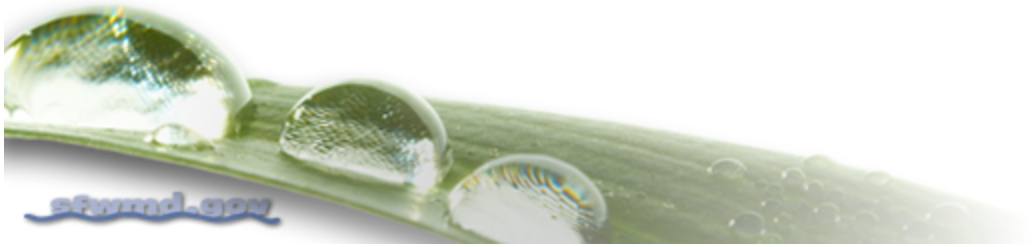
Regional Frequency Analysis (use data at multiple locations)



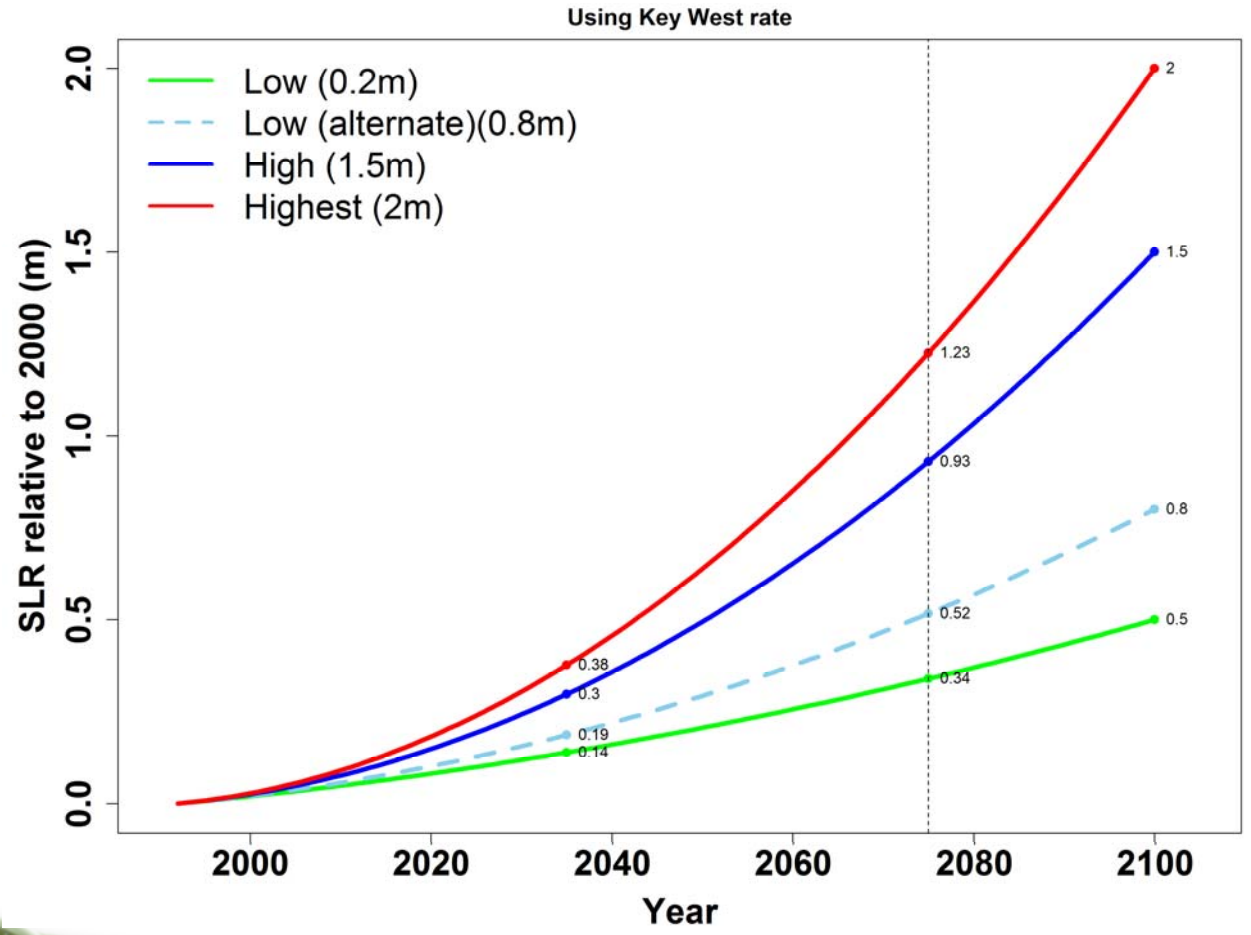


For South Florida Sea Level Rise is a bigger concern in the near future

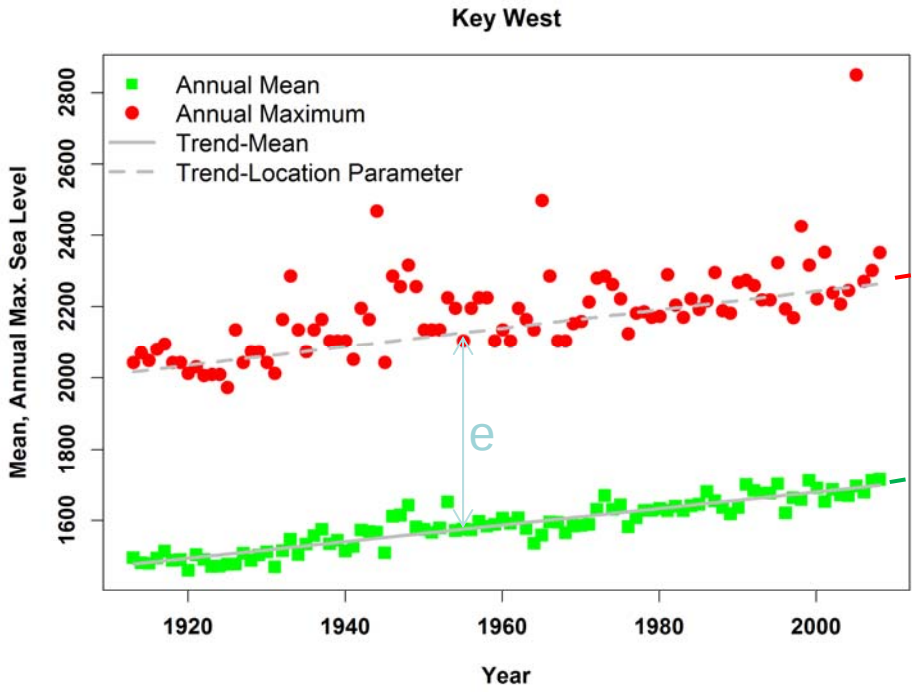
Extra slides

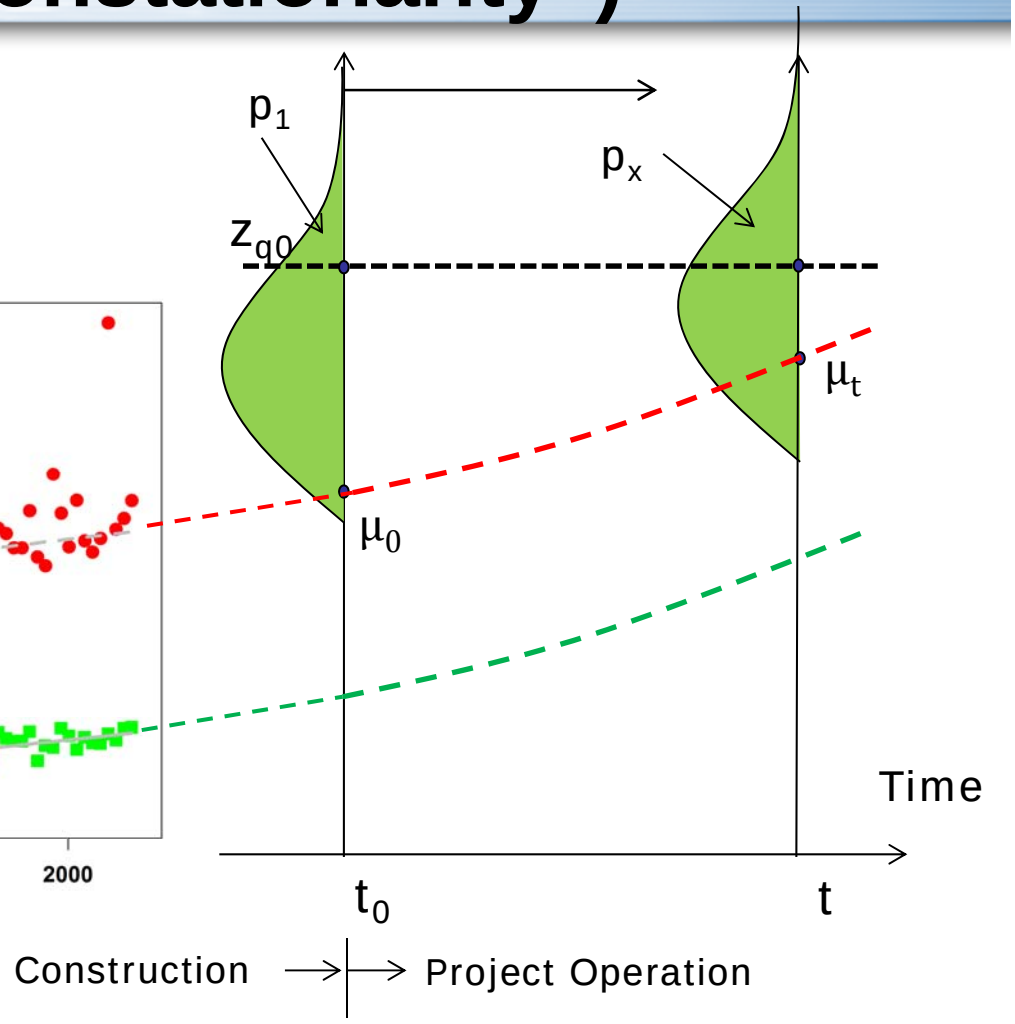


Potential options for scenarios



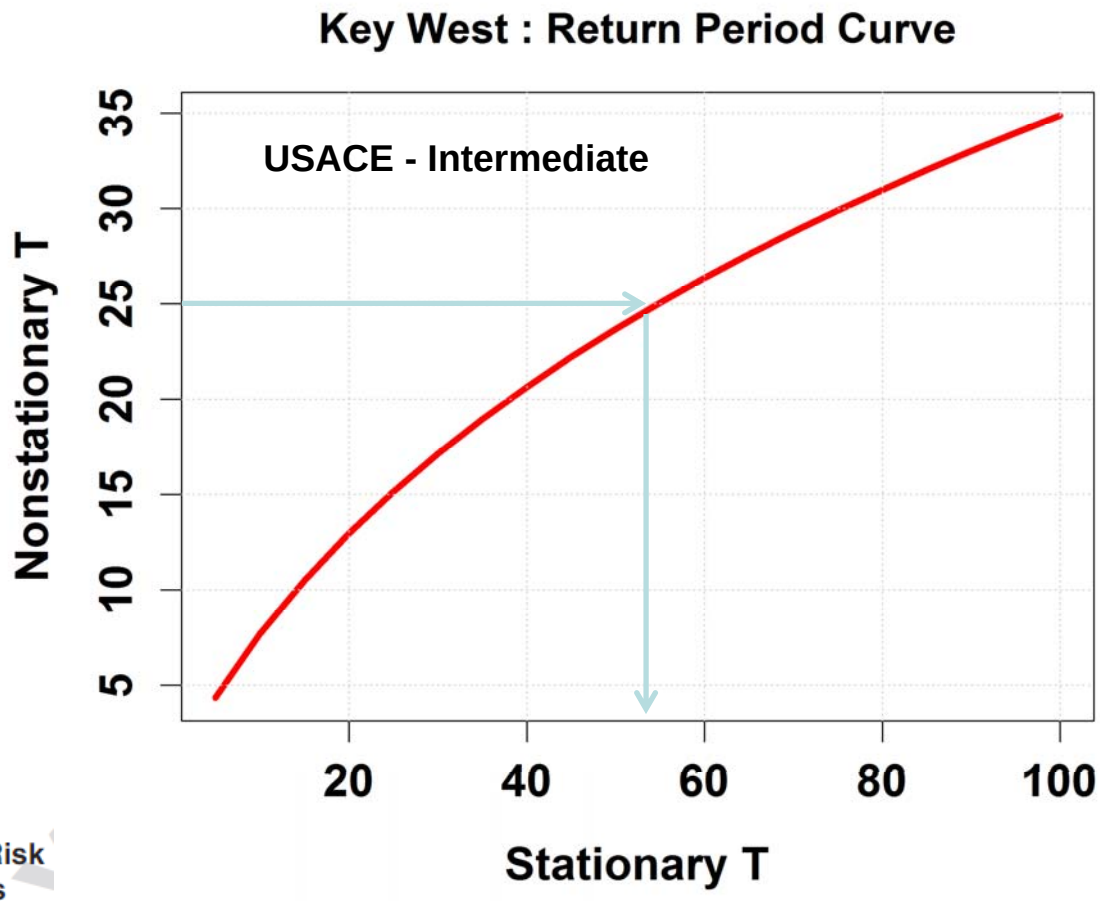
Concept of Return Period in Extremes: Paradigm Shift ("Nonstationarity")





Return Period Change – A new paradigm for floods and sea level rise

$$T = E[X] = 1 + \sum_{x=1}^{\infty} \prod_{t=1}^{x} (1 - p_t)$$



Revisiting the Concepts of Return Period and Risk for Nonstationary Hydrologic Extreme Events

Jose D. Salas, M.ASCE[1]; and Jayantha Obeysekera, M.ASCE[2]

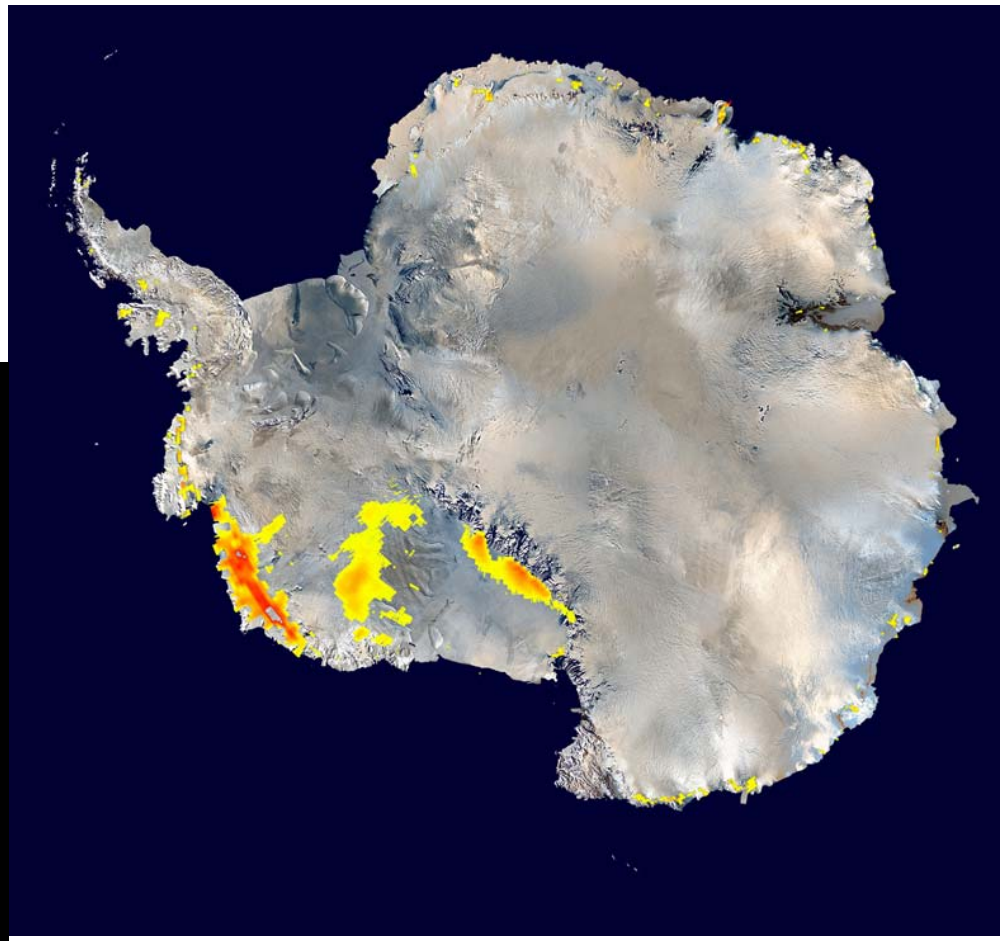
Quantifying the Uncertainty of Design Floods under Nonstationary Conditions

Jayantha Obeysekera, M.ASCE[1]; and Jose D. Salas, M.ASCE[2]

Why should Arctic and Antarctic Regions Matter to us?

(~ 2 million sq.km.)

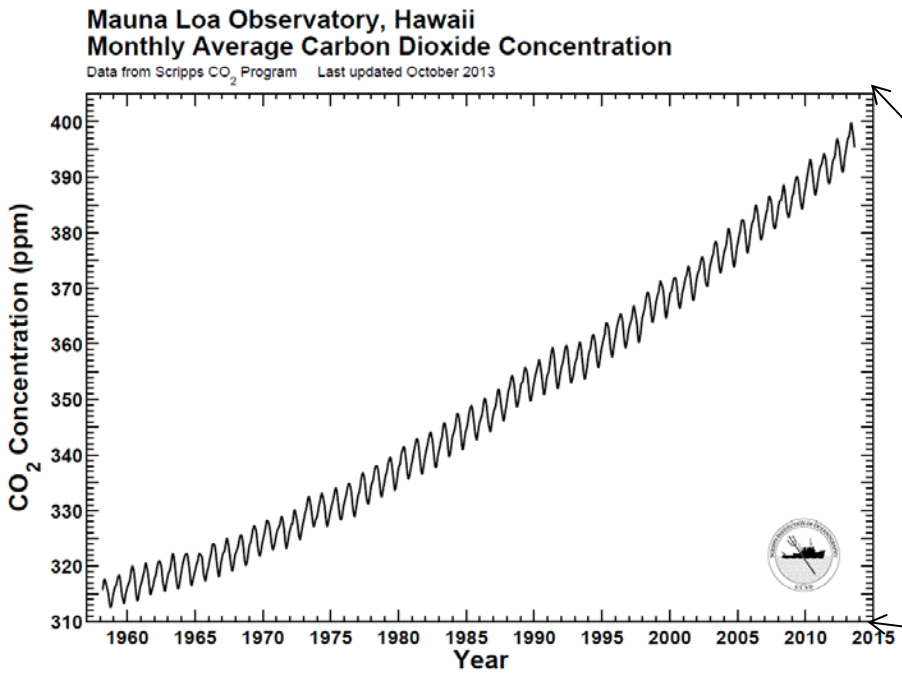
(~5.4 million sq. km.)

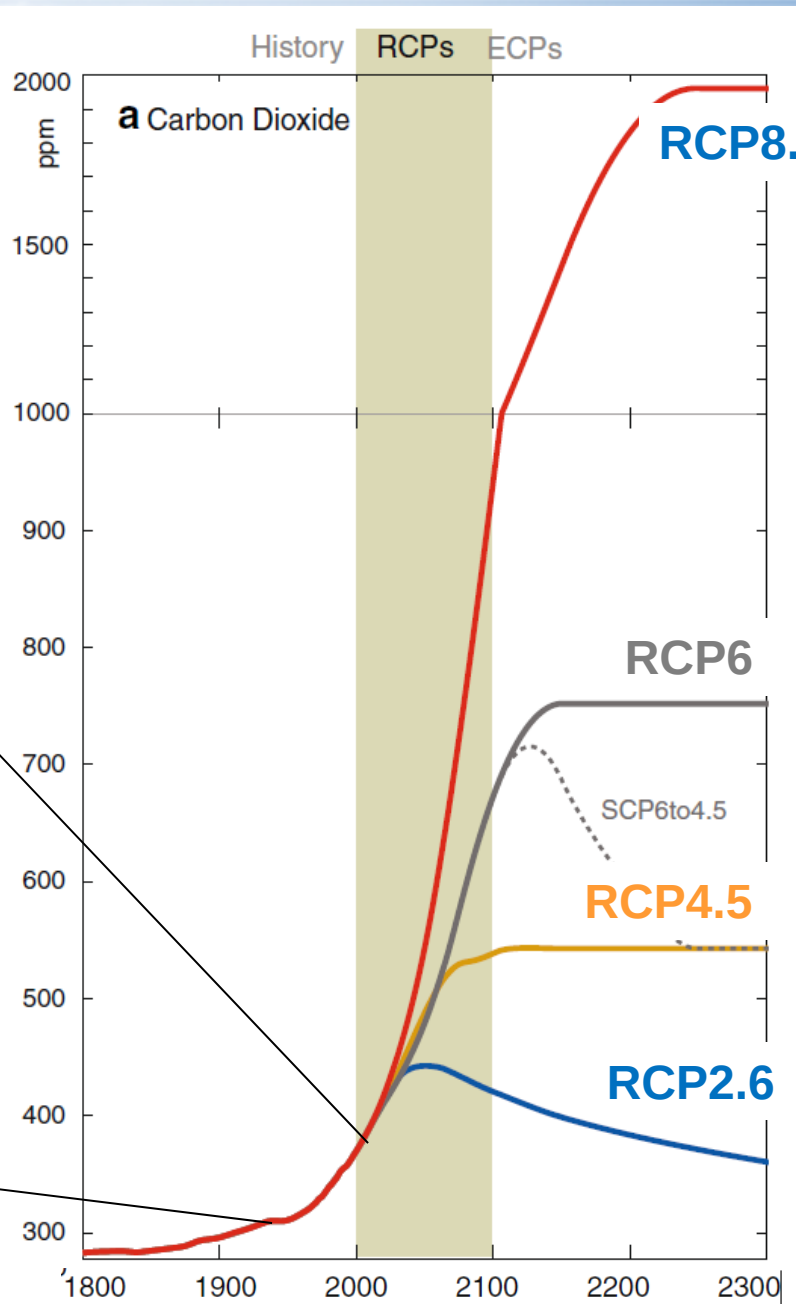


Glaciers retreating

AR5: Representative Concentration Pathways

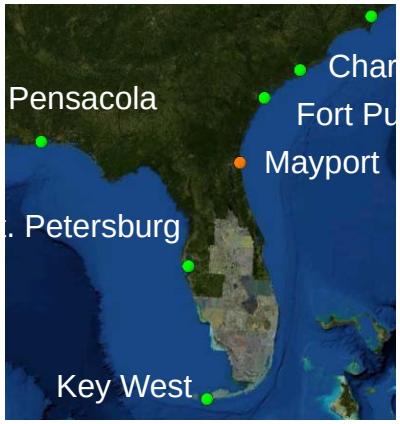
New IPCC (AR5) Approach for Greenhouse Gas Scenarios*

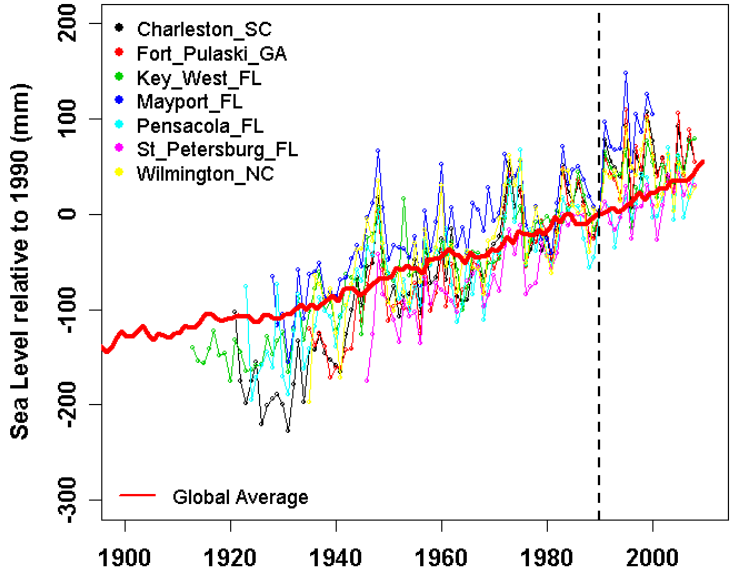




Meinshausen et al. 2011

Rising Seas – Around Florida





- **Relative Sea Level (height above a local datum) depends on:**
  - **Global Mean Sea Level**
  - **Vertical Land Movement (uplift/subsidence)**
  - **Regional Variability**

Global SLR Projections for 2100- Considerably spread