Sea Level Variation and Impacts

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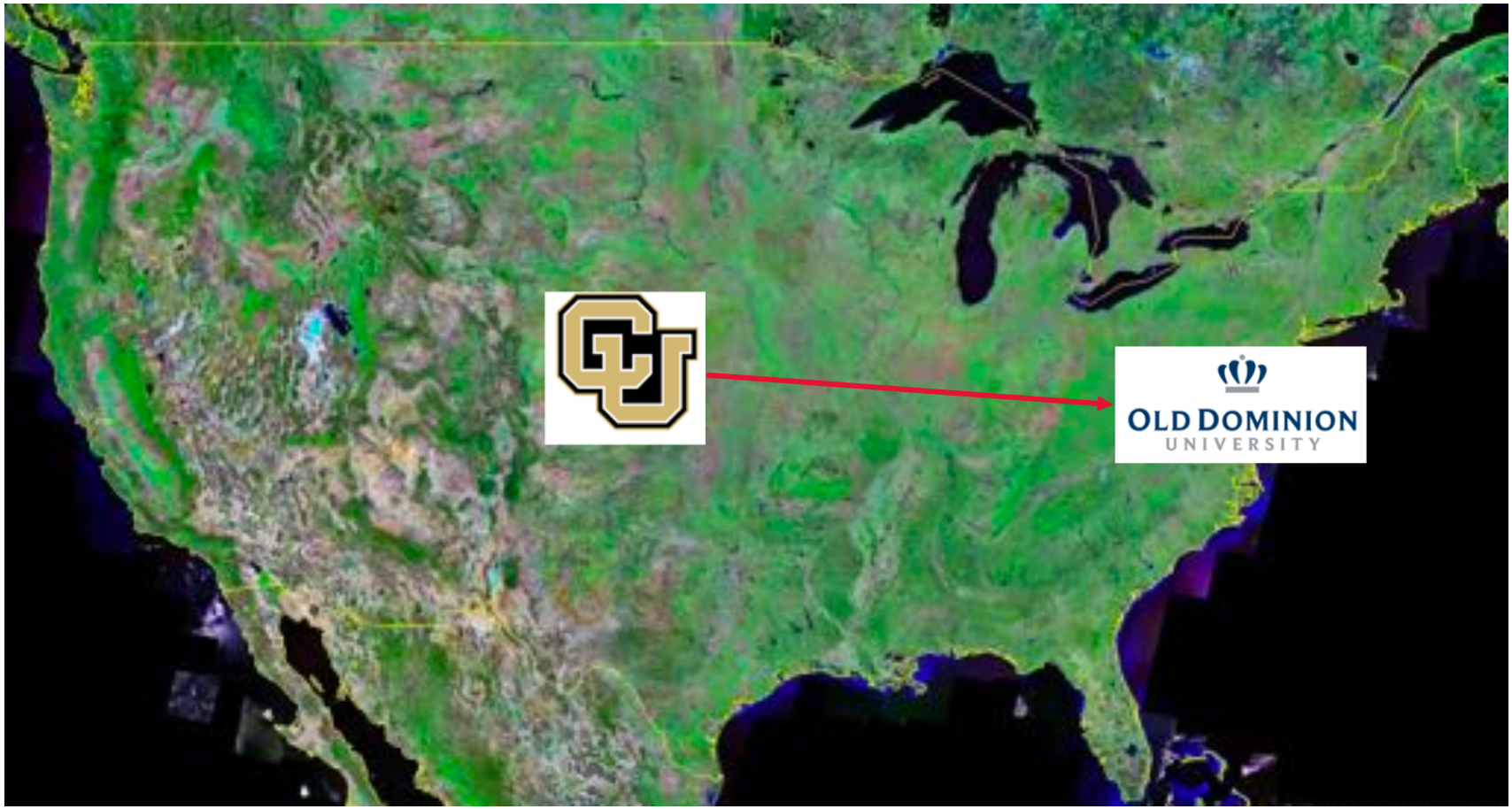
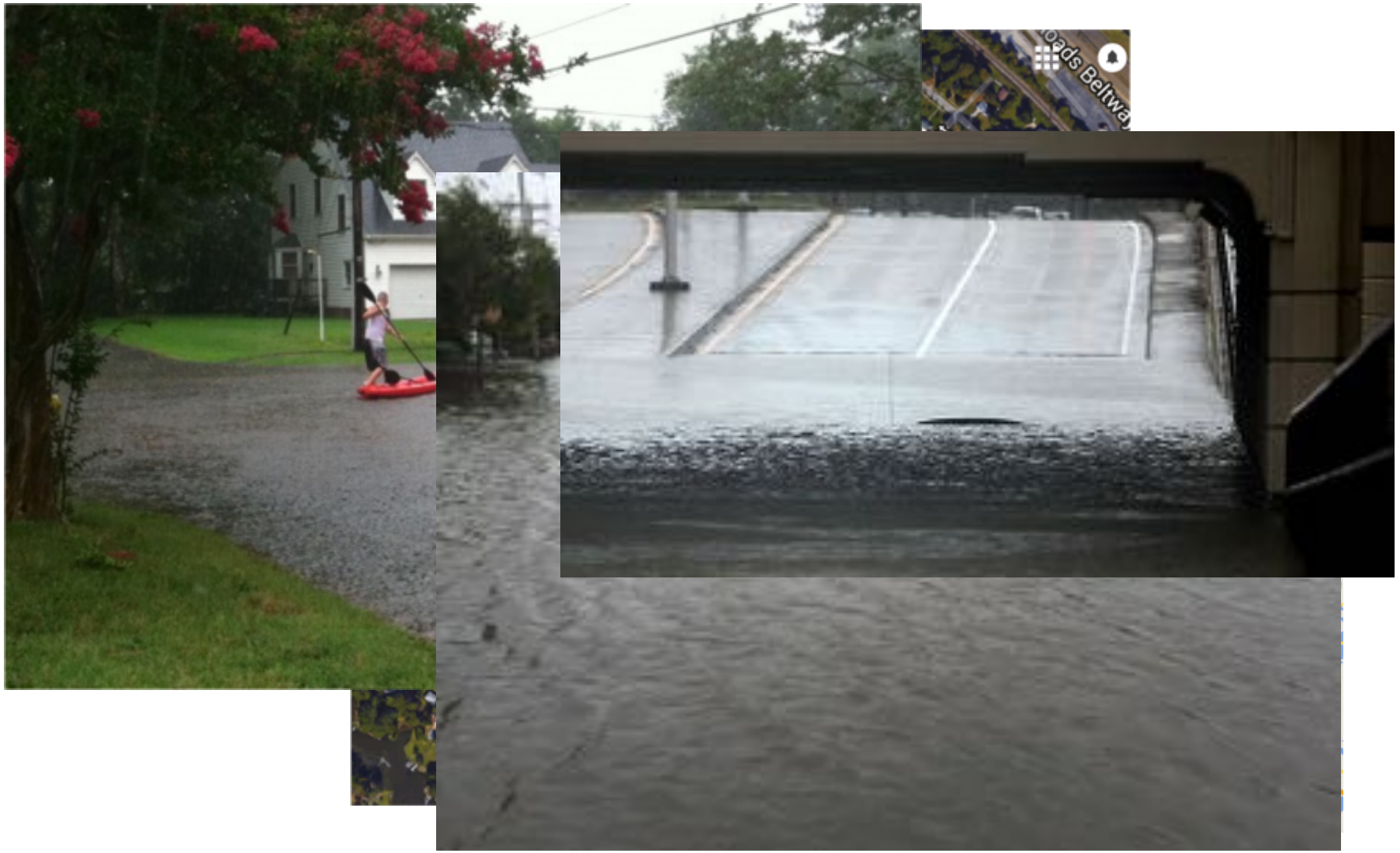
Path to JPL



Norfolk, VA



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Lessons Learned

1. Sea level rise is a problem now (chronic, low level flooding is among the biggest problems).

2. Planning efforts are underway and money is being spent.

3. There is a diverse set of stakeholders undertaking these efforts.

4. Their needs, in terms of sea level information, are equally diverse.

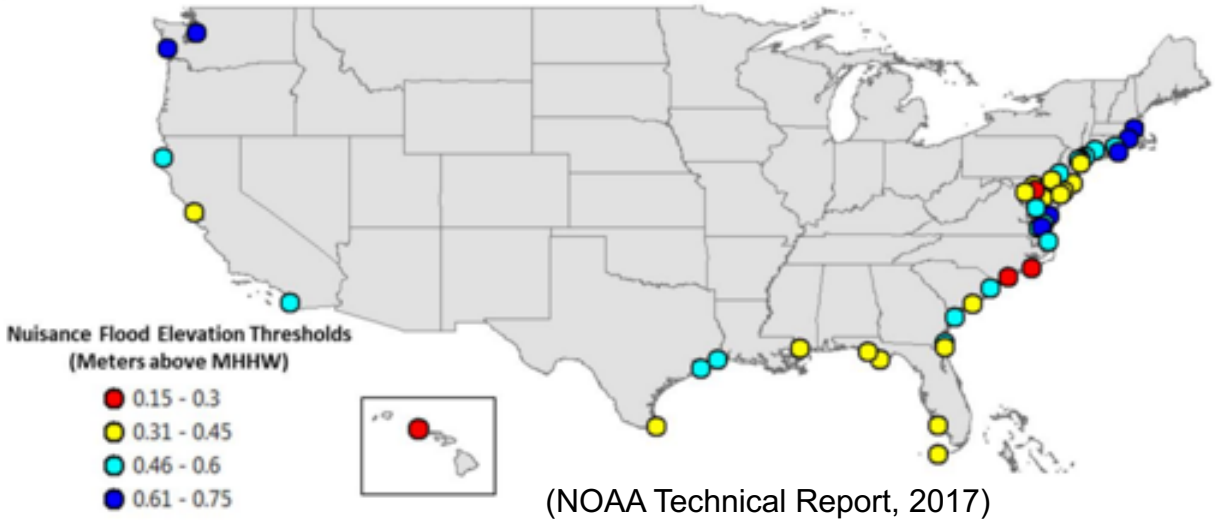
Naval Facilities in Hampton Roads

Timescales of Variability

Physical Process	Spatial Scale			Temporal Scale	Potential Magnitude (yearly)
	Global	Regional	Local		
Wind Waves (e.g., dynamical effects, runup)			X	seconds to minutes	<10 m
Tsunami		X	X	minutes to hours	<10s of m
Storm Surge (e.g., tropical storms or nor'easters)		X	X	minutes to days	<15 m
Tides			X	hours	<15 m
Seasonal Cycles		X	X	months	<0.5 m
Ocean/Atmospheric Variability (e.g., ENSO response)		X	X	months to years	<0.5 m
Ocean Eddies, Planetary Waves		X	X	months to years	<0.5 m
Ocean Gyre and Over-turning Variability (e.g., PDO response)		X	X	years to decades	<0.5 m
Land Ice Melt/Discharge	X	X	X	years to centuries	millimeters to centimeters
Thermal Expansion	X	X	X	years to centuries	millimeters to centimeters
Vertical Land Motion		X	X	minutes to centuries	millimeters to centimeters

(NOAA Technical Report, 2017)

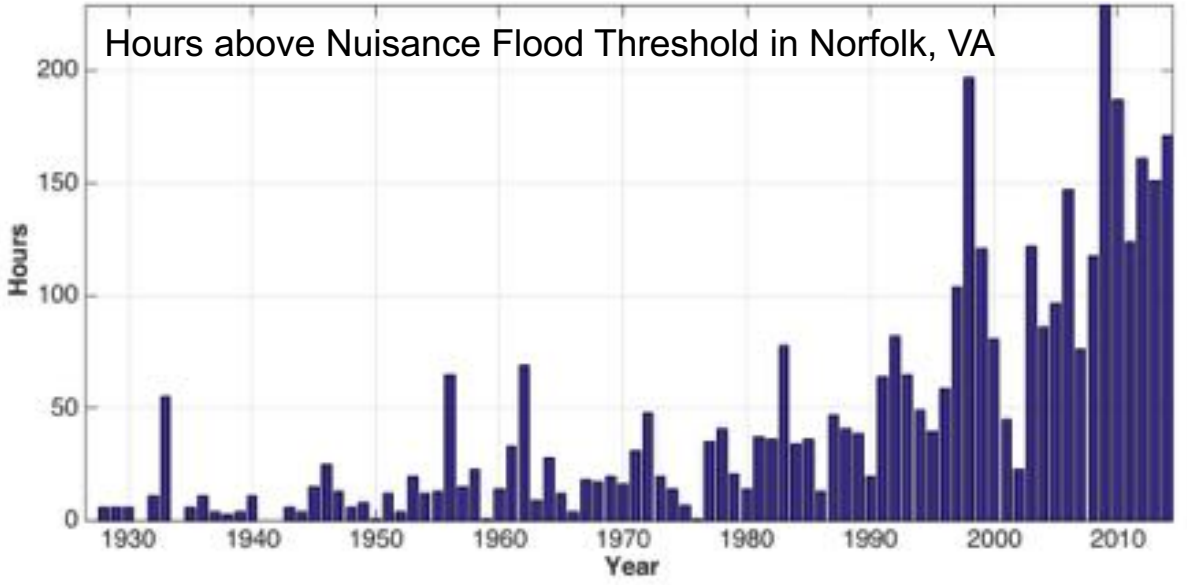
High Tide Flooding



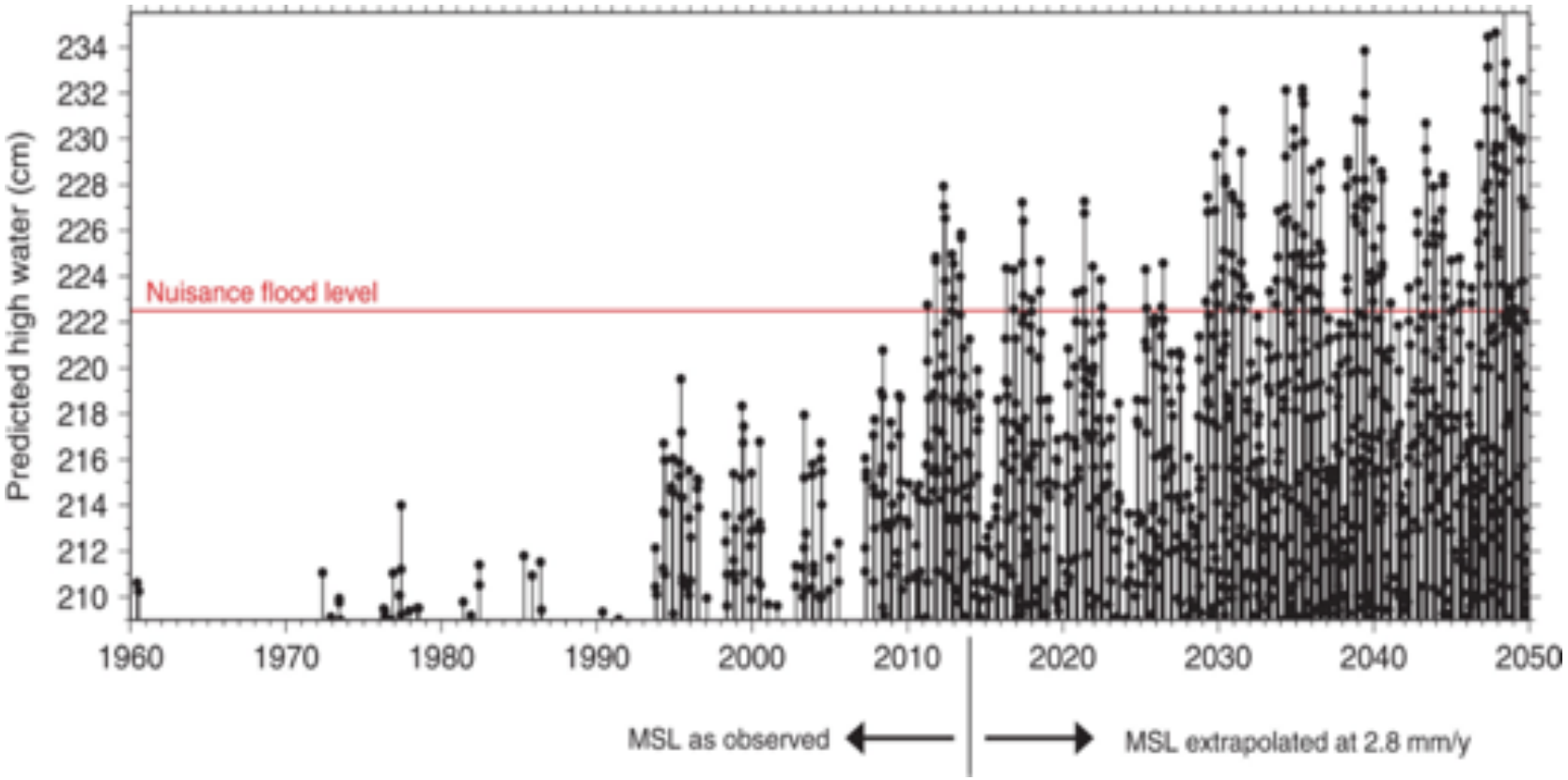
(NOAA Technical Report, 2017)

High tide or “nuisance” flooding occurs when water exceeds MHHW + an additional threshold.

Due to ongoing sea level rise, this threshold has been reduced dramatically → wide range of sea level variability can close this gap.



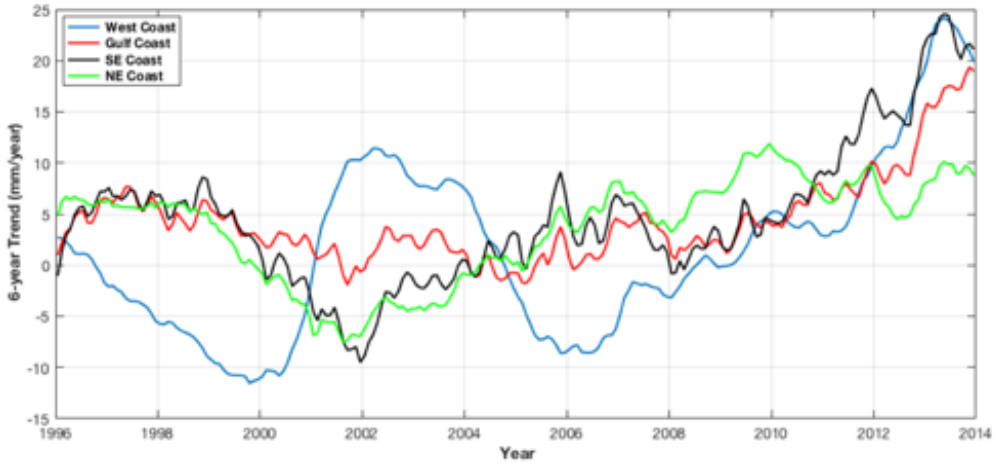
High Tide Flooding



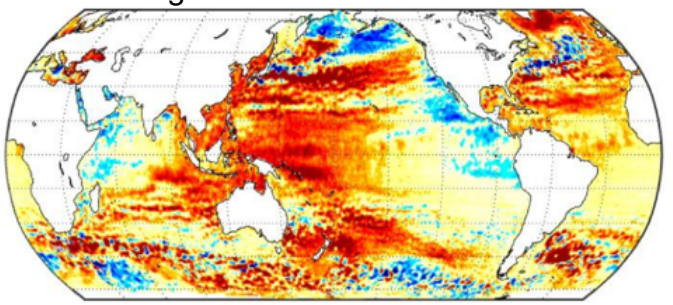
Predicted high tides at Boston near or exceeding the “nuisance flood” level of 68 cm above mean higher high water (Ray, 2016).

Interannual/Decadal Sea Level Variability

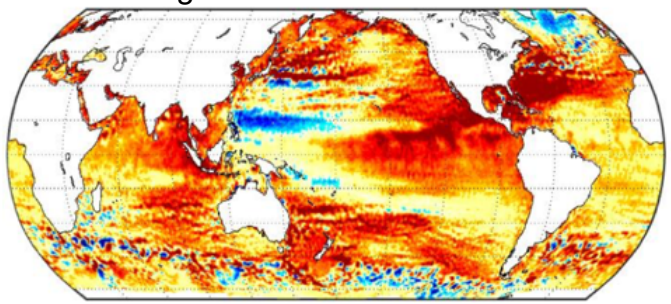
- Recent focus has been placed on interannual and decadal sea level variability and the role in coastal flooding.
- Satellite altimeter record is now reaching the length that it is possible to separate and extract decadal variability → possible to quantify the contribution.



Regional Trends: 1993-2005



Regional Trends: 2006-2018



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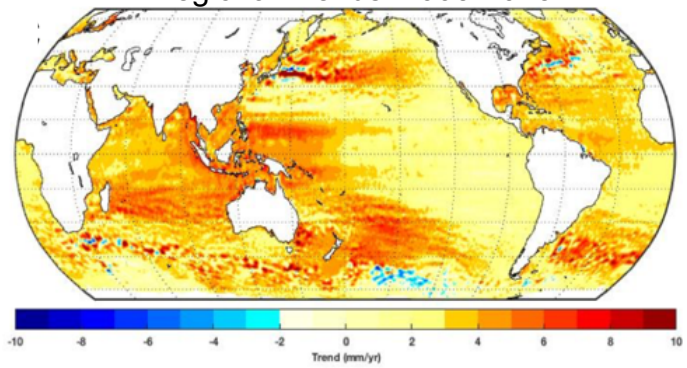

(Hamlington et al, 2019)

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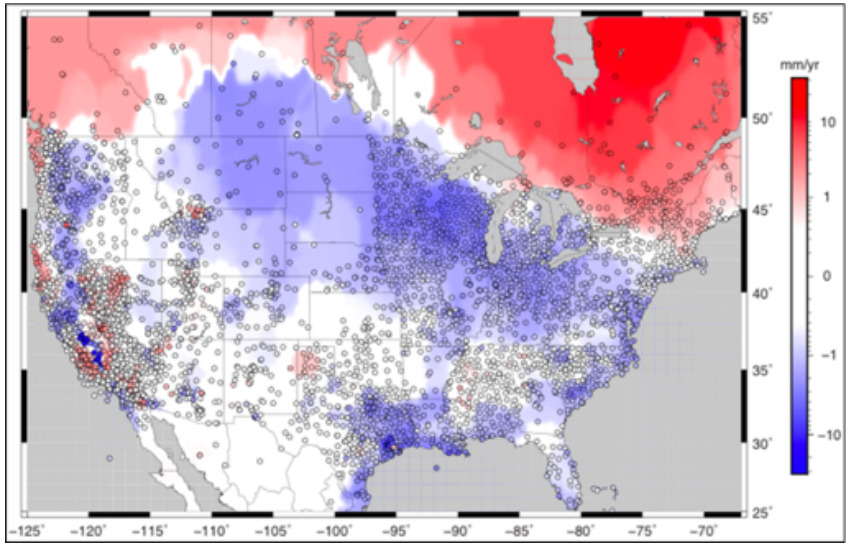
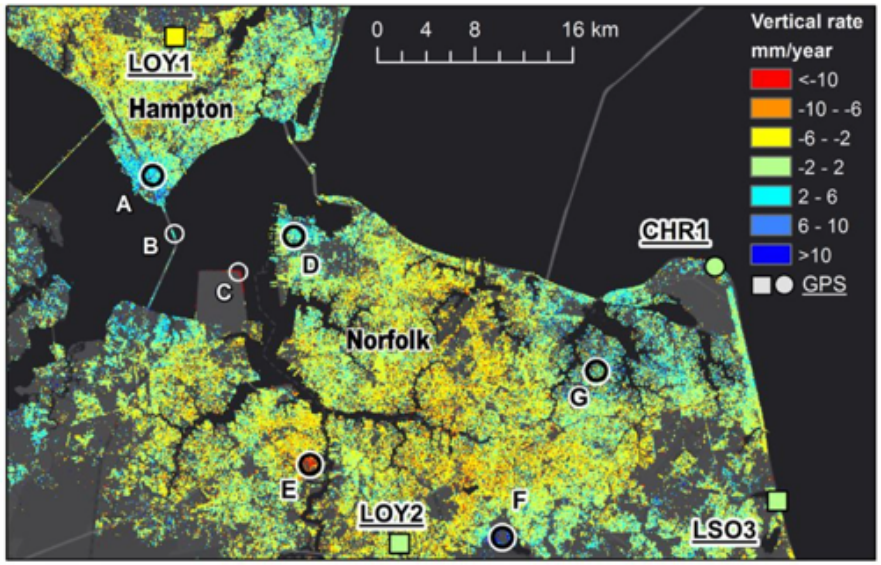
Vertical Land Motion

- Rates of uplift or subsidence can be very large in coastal areas, and vary over short distances.



Vertical land motion rates for United States from GPS (Hammond, 2016).



Vertical land motion rates in Hampton Roads from InSAR, 2007-2011 (Bekaert et al., 2018).

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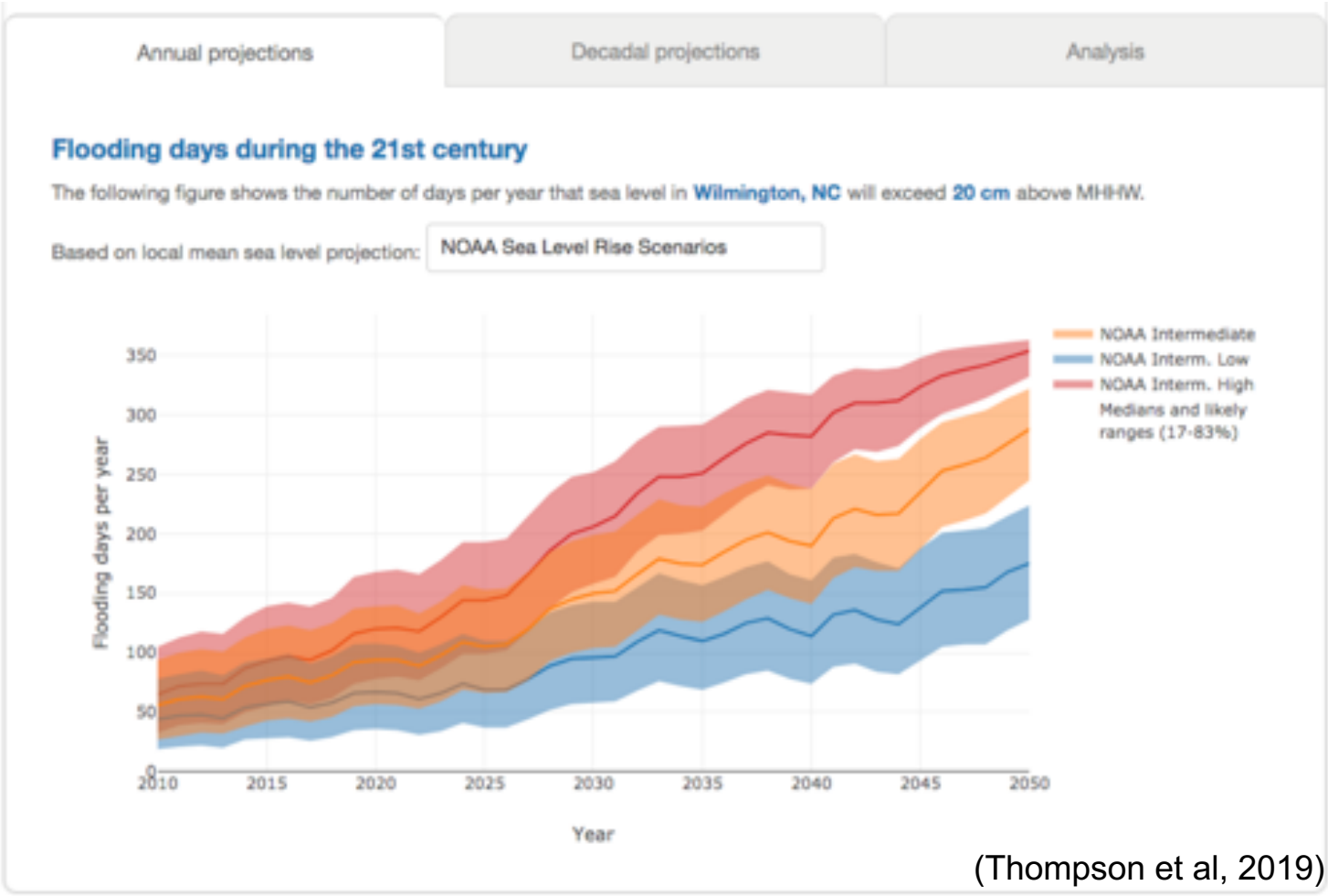
Combining the Timescales of Variability

$$RSLR(r,t) = HF(r,t) + IC(r,t) + AN(r,t) + LM(r,t)$$



(Thompson et al, 2019)

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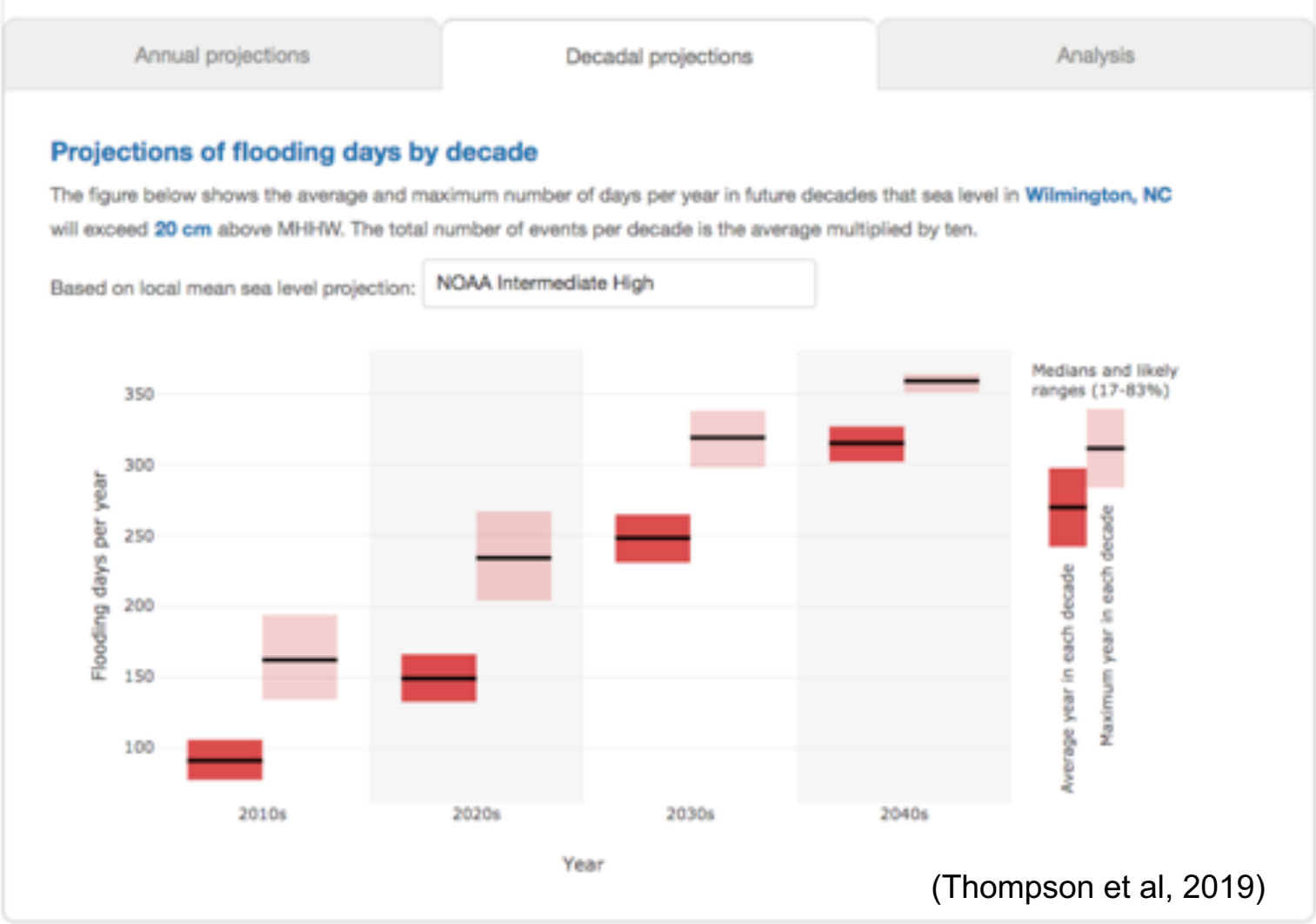
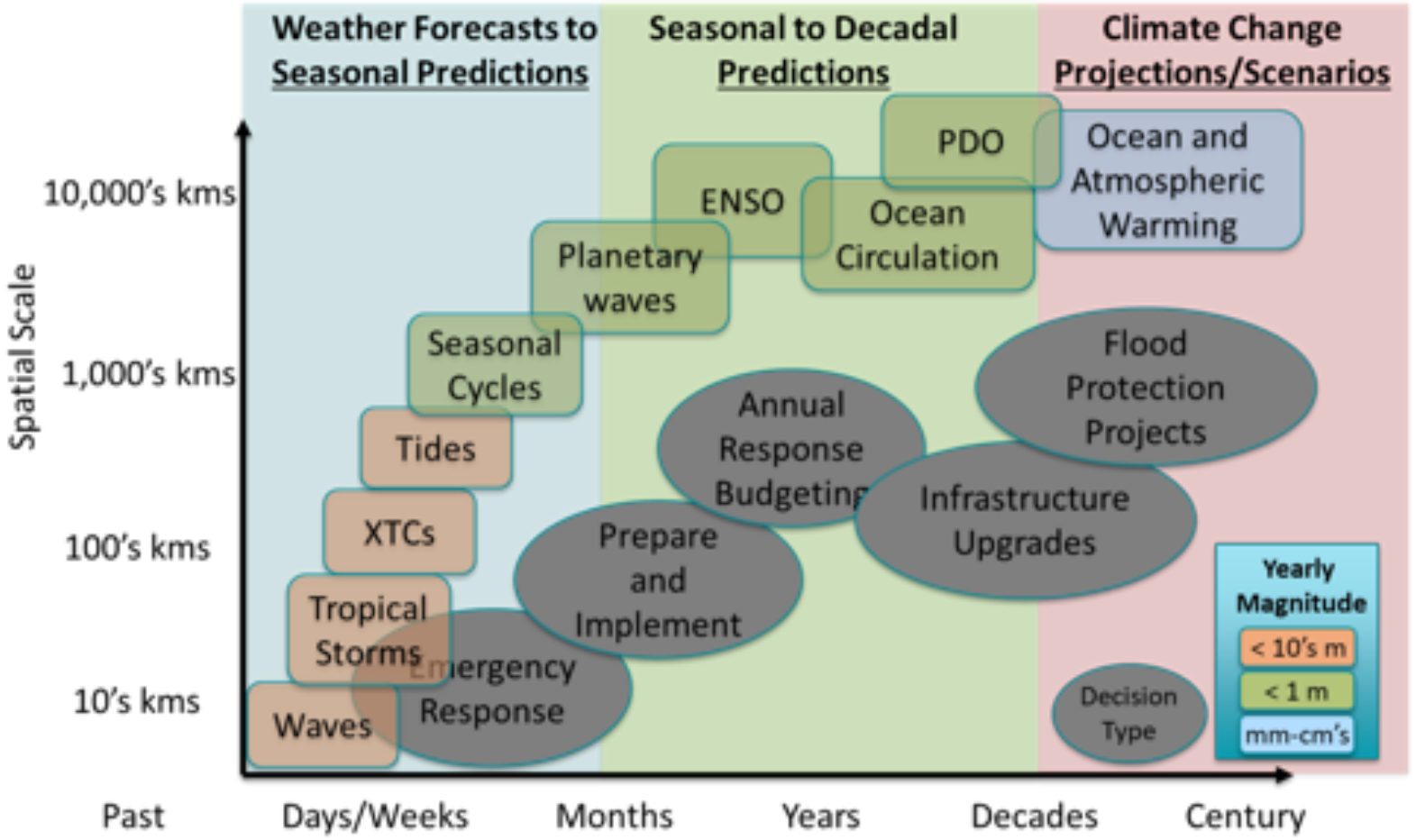


(Thompson et al, 2019)

Coastal Flood Decisions and Weather and Climate Information Needs Across Time and Space



(Sweet, NOAA, 2019)

User Needs

The current user needs can be stated as follows:

1. What is current flood risk at current sea levels?
2. How is this likely to change in the coming season, years or decades?

These user needs then drive science needs:

1. Improved projections of long-term regional relative sea level rise.
2. Predictions of seasonal to multi-decadal variability and its contribution to regional sea level change.
3. Estimates of contemporary rates and prediction of future rates of vertical land motion at high spatial resolution.

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