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OS52B-0512: Physics-informed Machine Learning for Estimation of Spatially-distributed Sea Level Rise Rates and their Associated High Tide Flooding

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Abstract

In the past few decades, sea level rise (SLR) has been used as one of the most reliable proxies for evincing climate change impacts and significantly contributed to elevated coastal high-water levels around the globe. High tide flooding (HTF) has become more frequent along the U.S. coasts, and it is expected to become more frequent in the following decades. Thus, having an improved estimate of SLR along the coast is crucial for flood hazard mitigation and adaptation planning. There is a lack of a comprehensive framework that provides SLR and HTF flooding statistics at a reasonable spatial resolution that complements current point-based (tide gauge) estimations. To fill this gap, we developed a machine learning algorithm to extract the spatially distributed SLR and HTF thresholds using inputs from observational data. The outcome of this physics-informed machine learning methodology is SLR and HTF estimates under projected SLR by the mid-21st century

Background

High tide flooding (a.k.a. sunny day flooding or nuisance flooding) is the flooding brought on by tides.

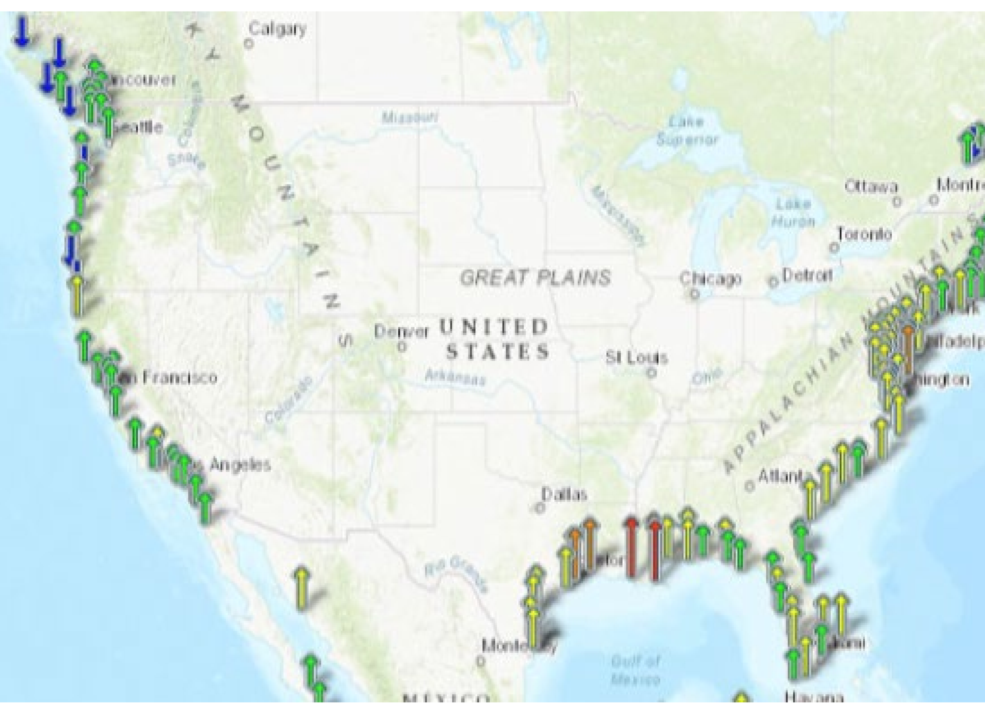
SLR is the main driver of HTF which has increased its frequency over time.

The day-to-day life of people in coastal areas will be affected by SLR, and its associated HTF.

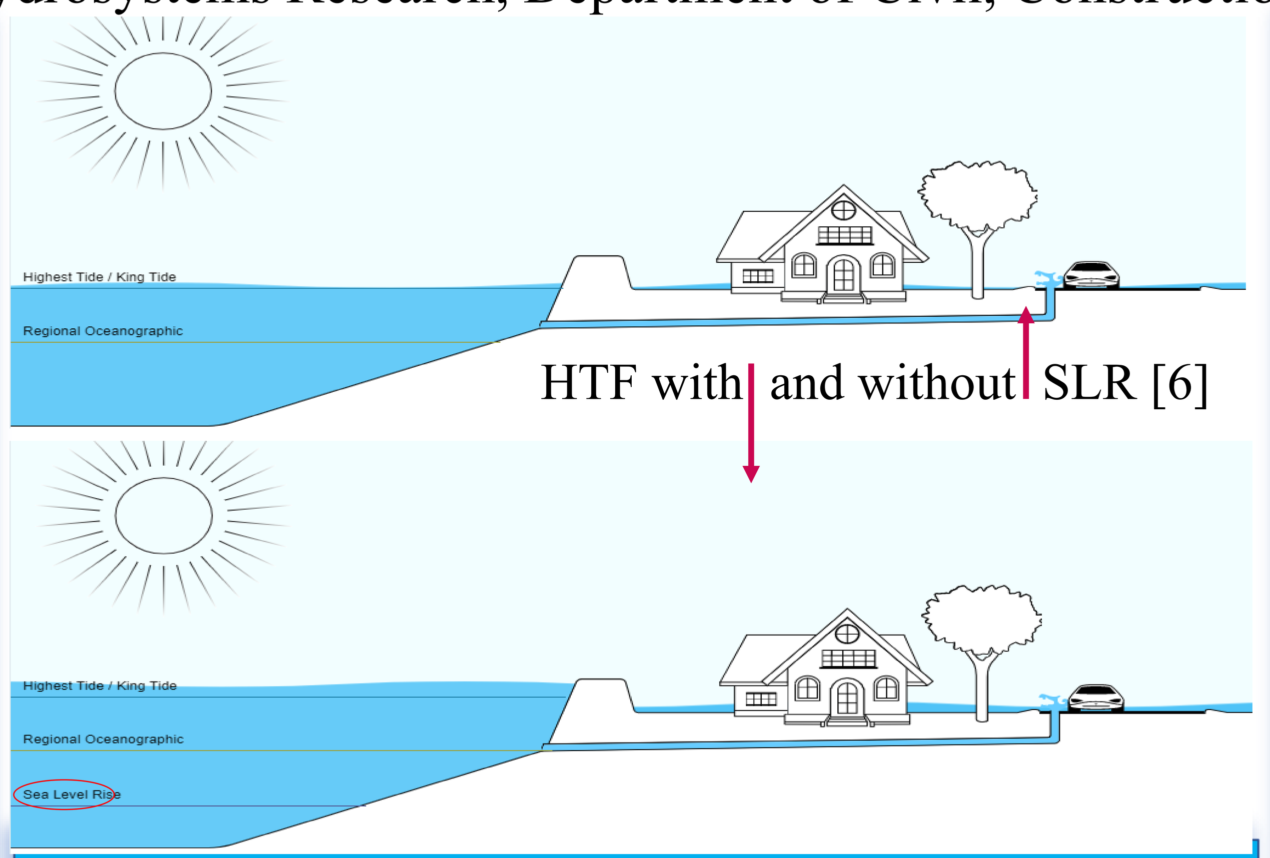
HTF thresholds are obtained and reported by NOAA based on local flood incident reports. Tide gauges provide accurate sea level information for coastal research.

The geographical scarcity and uneven distribution of tide gauges that provide crucial information for SLR and HTF analysis pose a challenge to reliable estimates of nuisance flooding.

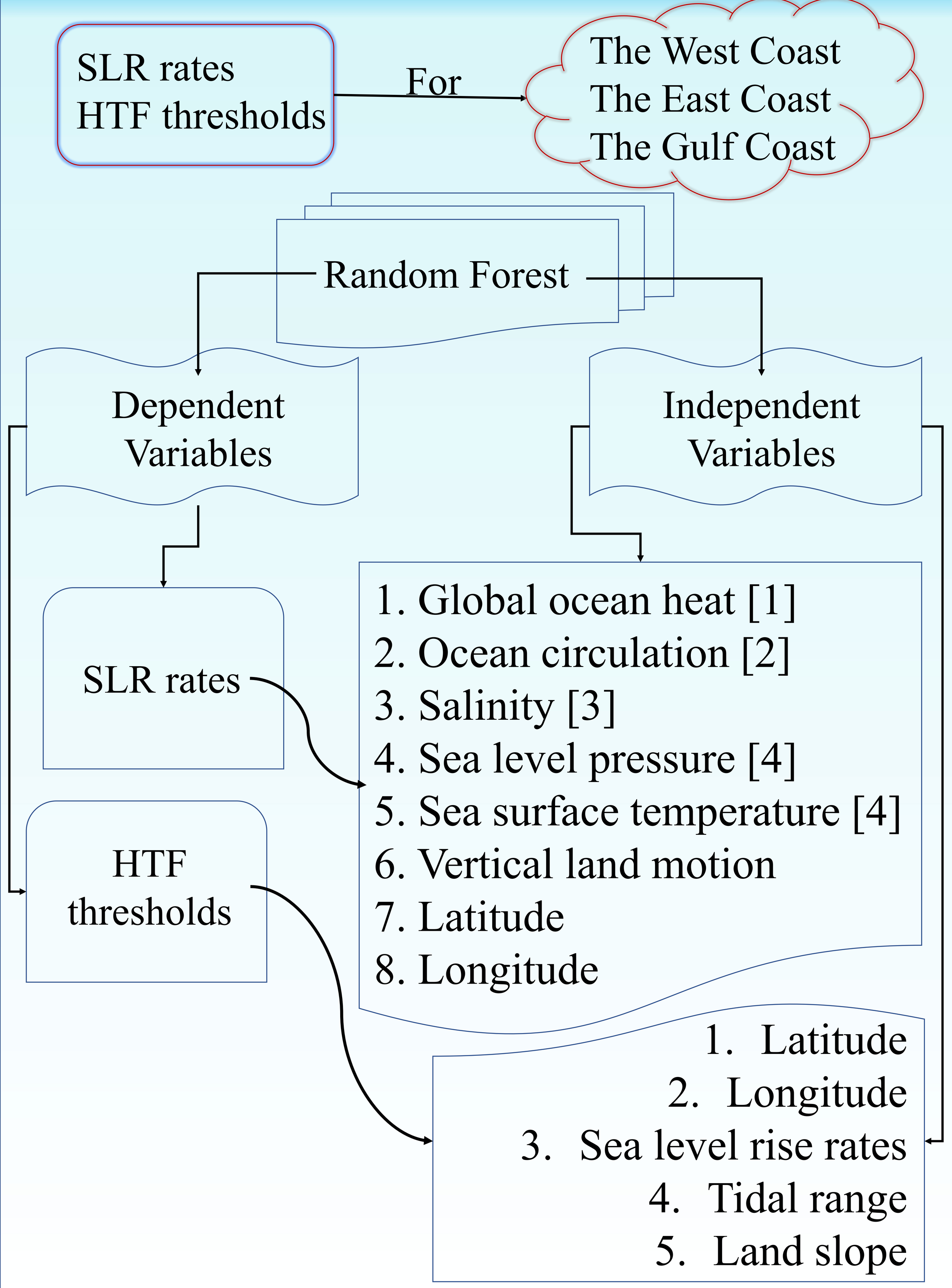
Hence, a strong incentive motivates researchers to achieve HTF thresholds and SLR rates in different regions.



Tide gauges for extracting SLR rates



Methodology

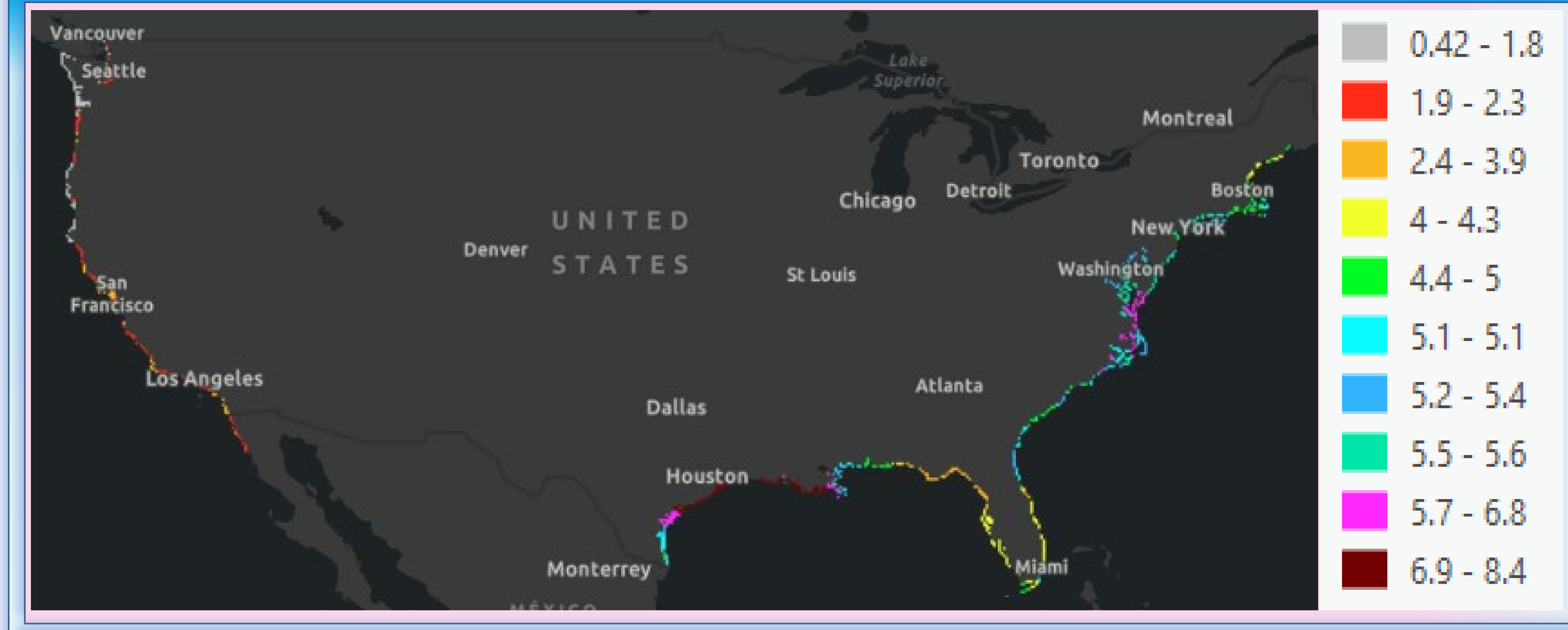


Results

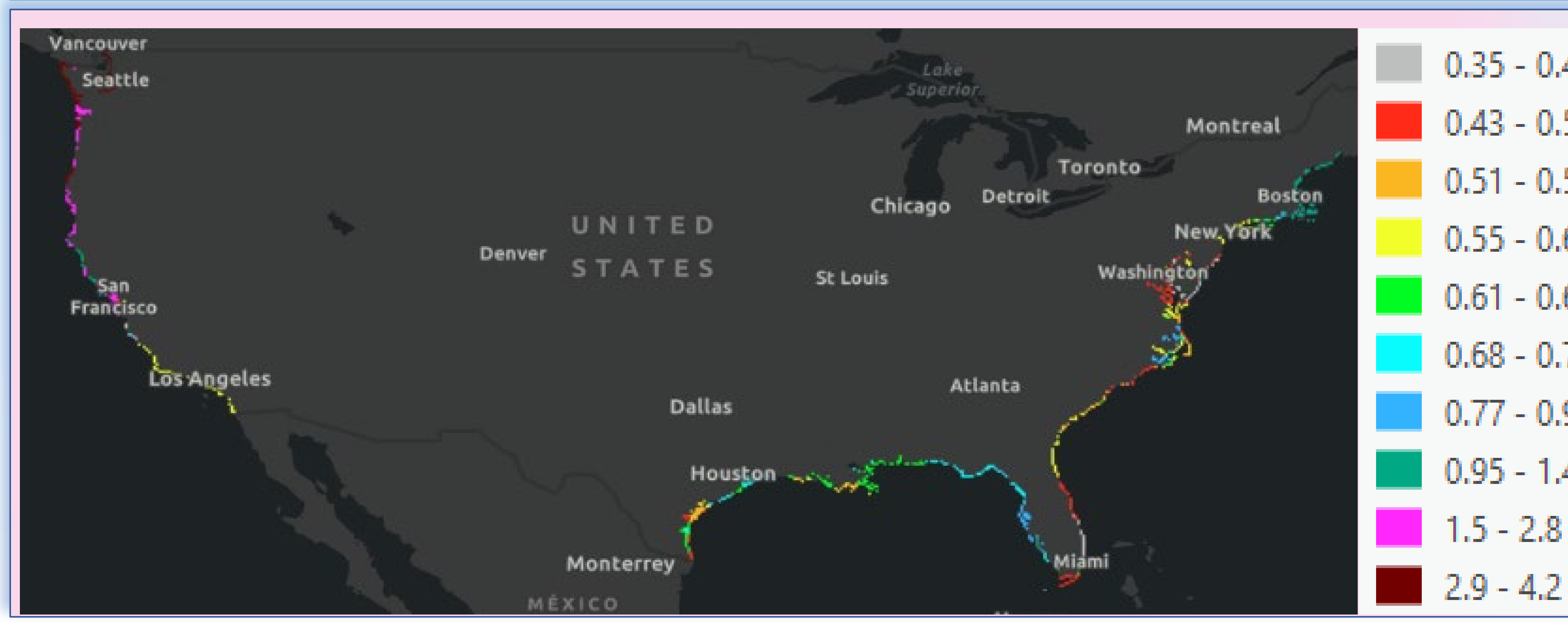
Evaluation metrics of each process and each region

	SLR Model			HTF Model		
	West Coast	Gulf Coast	East Coast	West Coast	Gulf Coast	East Coast
MAE	0.2	0.32	0.08	0.2	0.051	0.054
R Squared	0.86	0.94	0.9	0.96	0.88	0.8
NSE	0.86	0.94	0.9	0.96	0.88	0.8
KGE	0.79	0.9	0.86	0.9	0.82	0.84

Results



Spatially distributed SLR rates (mm/year) along the CONUS coastlines



Spatially distributed HTF thresholds (m above MMHW) along the CONUS coastlines

Conclusion

- We here aim to fill in the gaps for SLR and HTF thresholding information in areas without observational tide gauges at their close proximity.
- Based on our preliminary analysis results the Gulf, East, and West coasts of the United States should be trained on different models because they possess a wide range of different characteristics that contribute to the flooding dynamics.
- Supported with reasonable evaluation metrics, we achieved a spatially distributed map for both SLR rates and HTF thresholds along the CONUS coastlines.

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Acknowledgment

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