Estimating the effect of climate change on global and local sea level rise

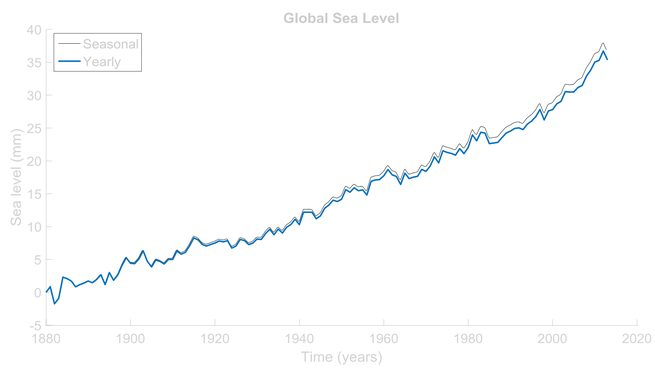
Mala Alahmadi[1], Jan Kolmas[2]
[1]Stanford University, Civil and Environmental Engineering, [2]Stanford University, Aeronautics & Astronautics

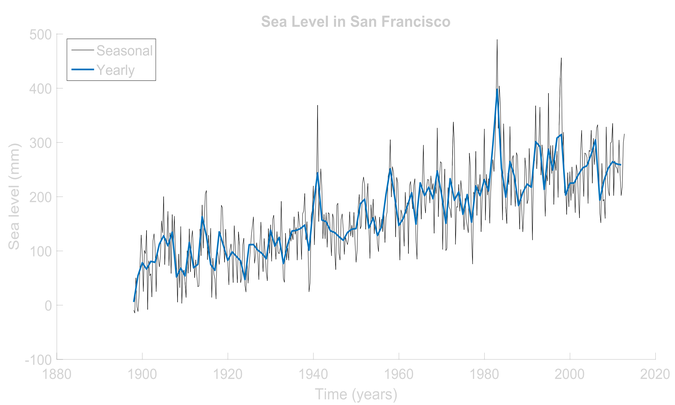
ABSTRACT

In this CS 229 final project, we apply several machine learning algorithms and error analysis methods to predict the local sea level rise in the San Francisco Bay and global sea level rise based on recorded local and global atmospheric conditions in years 1900 to 2013

BACKGROUND

A critical consequence of global warming is the melting of glaciers and associated sea level rise. This aspect of climate change is critical to predict, as almost half of the world's population lives in coastal regions. Knowing how much the levels will rise can inform governments and other interested entities in disaster prevention, real estate evaluation and public safety.





OBJECTIVES

- Use machine learning methods to predict local (San Francisco Bay) and global sea level until 2020
- Evaluate the suitability of various algorithms for this problem
- Learn about new algorithms by applying them in this project

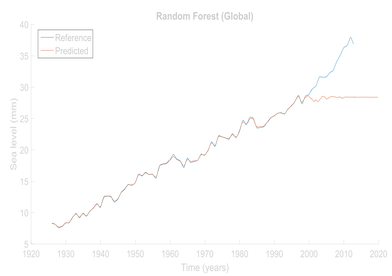
DATA

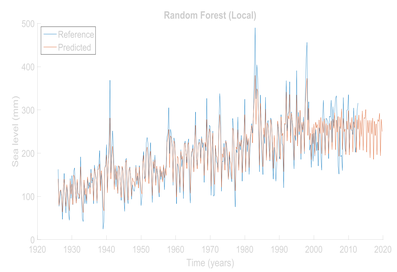
Features for local sea level rise prediction	Features for global sea level rise prediction
Global CO_2	Global CO_2
Global Population	Global Population
Local Precipitation	Global Land-Ocean Temperature Index
Local Temperature	Global Snow Melt
Global Snow Melt	

- A span of time was selected, offset into the past to pick the features listed above from. For example, the prediction of sea level in 2020 would depend on data from years 2008-2013.
- Three methods were used to predict the sea level: Neural networks, support vector regression and random forest.
- The performance of machine learning algorithms under various conditions was done using cross validation on the latest 15% of the dataset, which was left out from the training.

RANDOM FOREST

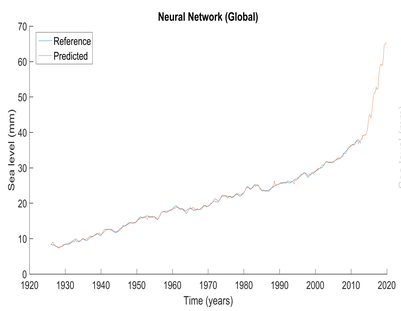
- Random forest algorithm overfits the training set but outputs a reasonable prediction.

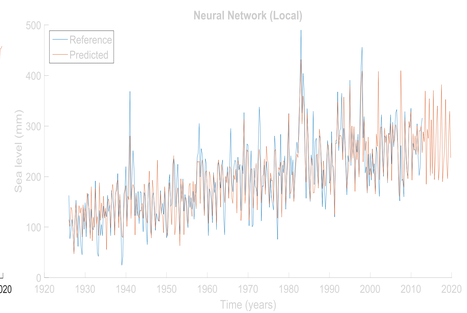




NEURAL NETWORK

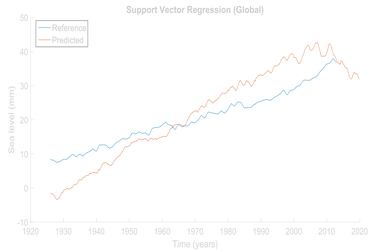
- A feed-forward, two-layer neural network with size 5 of the hidden layer was used
- Does not overfit, does a good job on the cross-validation and presents a believable prediction with seasonal variations.

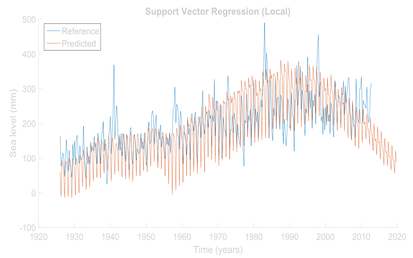




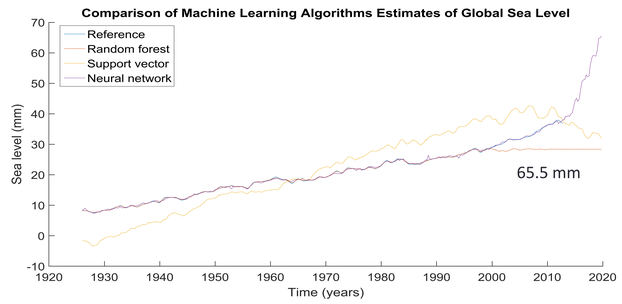
SUPPORT VECTOR REGRESSION

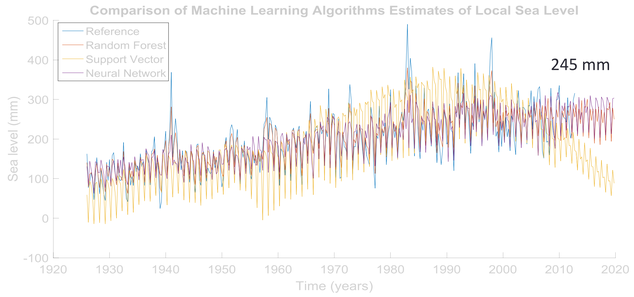
- On a monthly and seasonal basis, the support vector regression algorithm matches well the sub-year variations, but has a significant negative bias compared to the reference.





CONCLUSIONS





		Global Sea Level Rise		Local Sea Level Rise	
		Random Forest	Neural Network	Random Forest	Neural Network
RMSE (mm)	Seasonal	5.6	0.25	45	27
	Yearly	5.5	0.48	29	26
Percent Training Error (%)	Seasonal	0.39	1.2	7.9	16
	Yearly	1.4	3.6	6.9	17
Percent Test Error (%)	Seasonal	15	**0.85**	14	**8.0**
	Yearly	15	1.1	8.9	8.1

- Sea level in San Francisco is expected to be dominated by seasonal variations rather than by a yearly trend between 2015 and 2020
- Neural network appears to be the most suitable learning algorithm for this case.