Sea Level Rise Projections

Gaining Insight with Predictive Analytics

Meet our team:

Ronda Hinz

Juliana Lima

Michael Bernstein

ANALYST AVENGERS

Beth Sequera

Mohamed Abdelsalam

Introduction

Shores Under Siege: The Perils of Rising Sea Levels in Coastal Communities

Global sea level rise is a critical environmental issue driven primarily by two major factors: thermal expansion and the melting of land-based ice.

As the Earth's climate warms, the ocean absorbs more heat, causing seawater to expand and accelerating ice-shelf calving in polar regions.

Nearly 40% of the U.S. population resides in coastal regions, making them particularly susceptible to the deleterious effects of rising sea levels.

Researchers predict that "*any further increase in the rate of sea level rise will lead to substantially larger, exponential changes in high-tide flooding*".[1]

We must gain a better understanding of the rate at which sea level is rising. In this analysis, we will establish a model for predicting mean sea level for the next century.

[1]NASA News & Features; https://sealevel.nasa.gov/news/264/why-seas-are-rising-faster-on-the-southeast-coast/; Date: June 6, 21023; Accessed: October 1, 2023

Data Details

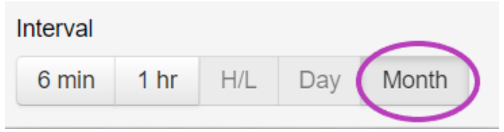
Source

- **Website:** Tides & Currents by NOAA
- **URL:** https://tidesandcurrents.noaa.gov/stations
- **Available Water Monitoring Stations:** 294

- **Criteria for Selection:**
  1. Must be coastal city
  2. Sea level data since 1923 (uninterrupted)
  3. Must include one target city from each region of the United States

Data Characteristics

- NOAA provides real-time water level information that is updated every 6 minutes though historical data is only available in 3 intervals.



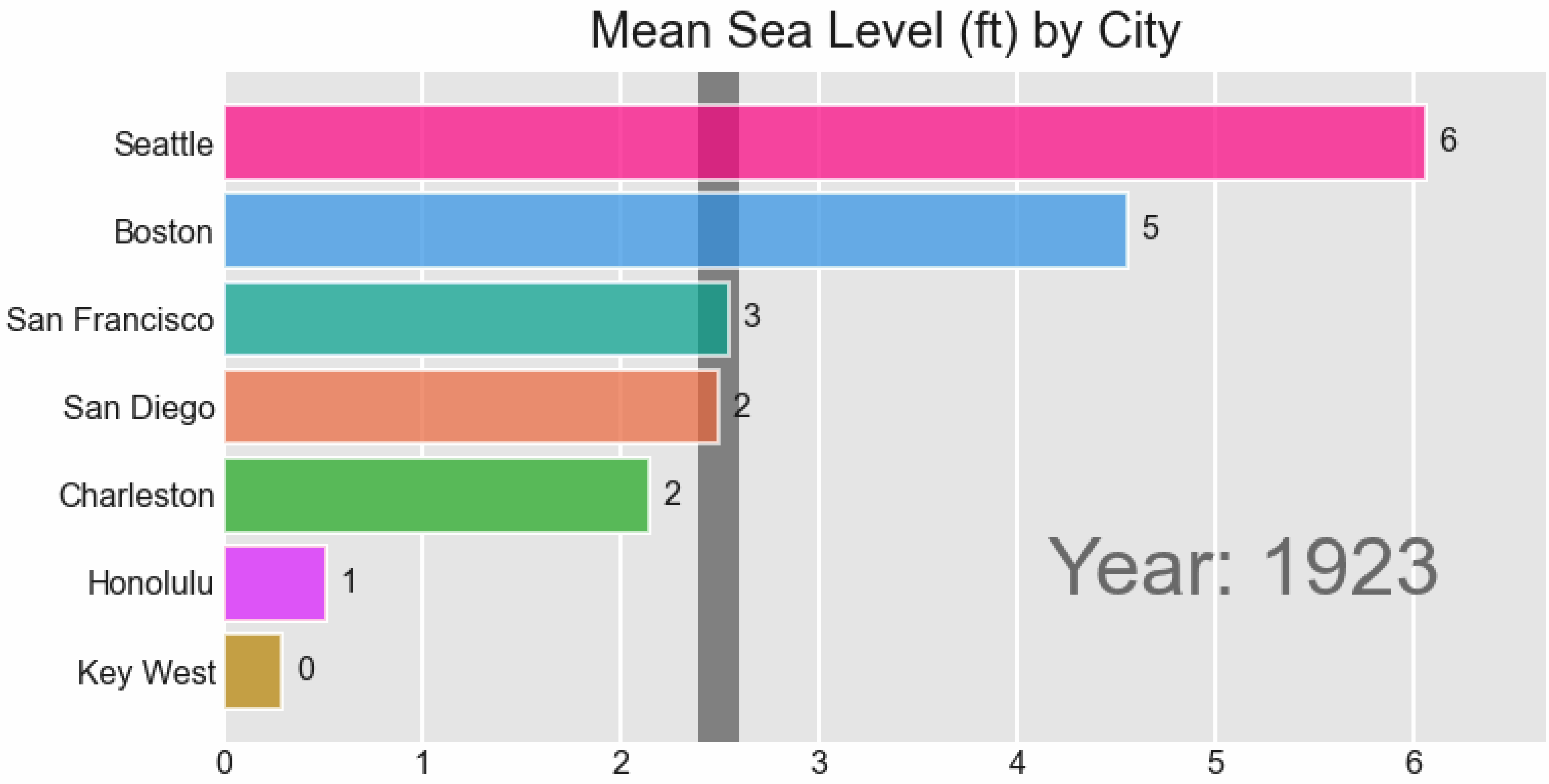
- We opted for water level data summarized by month for all 7 target cities.
- **Reason:** The timeline for this analysis spans 200 years. As such, mean values are sufficient.

Temperature Data

- Global warming is driven by atmospheric temperature changes. **Why not include temperature data in the analysis?**

- **Reason:** Despite the undeniable connection between global warming and sea level rise, the relationship is complicated at best. Since regional temperatures at each target city have no direct impact on freshwater melt in polar regions, we have elected to omit this information.

Coastal Dynamics Spanning 1923-2023



Note: Perpendicular Bar = Mean Sea Level for each period/year displayed.

Mean Sea Level Predictions with Linear Regression Model

GOAL: Predict mean sea level for the next 100 years (2024-2123) in each of the target coastal cities by analyzing the previous 100 years (1923-2022) of sea level data using a linear regression model.

1st attempt: Station data grouped by month. Calculated mean sea level for each month. (Figure 1.)

- Result: Messy scatter plot with a low R-squared value for all cities. **R-squared ranged from 0.37 to 0.69.**

2nd attempt: Station data grouped by year. Calculated mean sea level for each year. (Figure 2.)

- Result: Data points are more tightly clustered around the regression line with significantly higher **R-squared values ranging from 0.64 to 0.89.**

Figure 1.

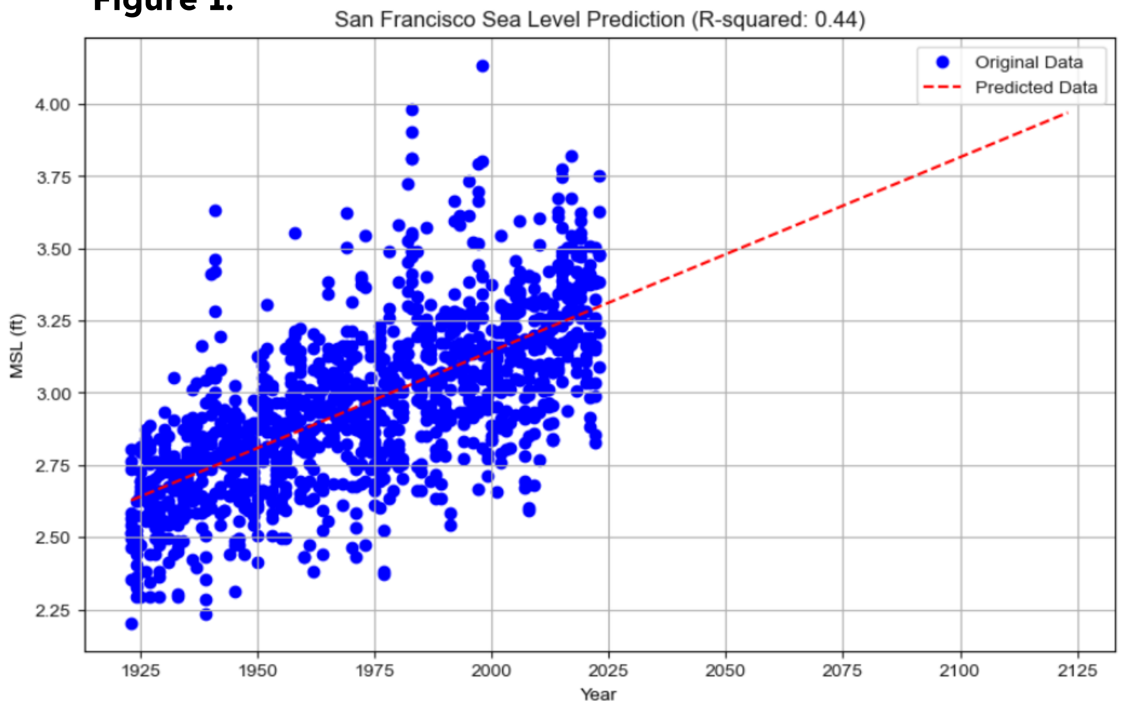
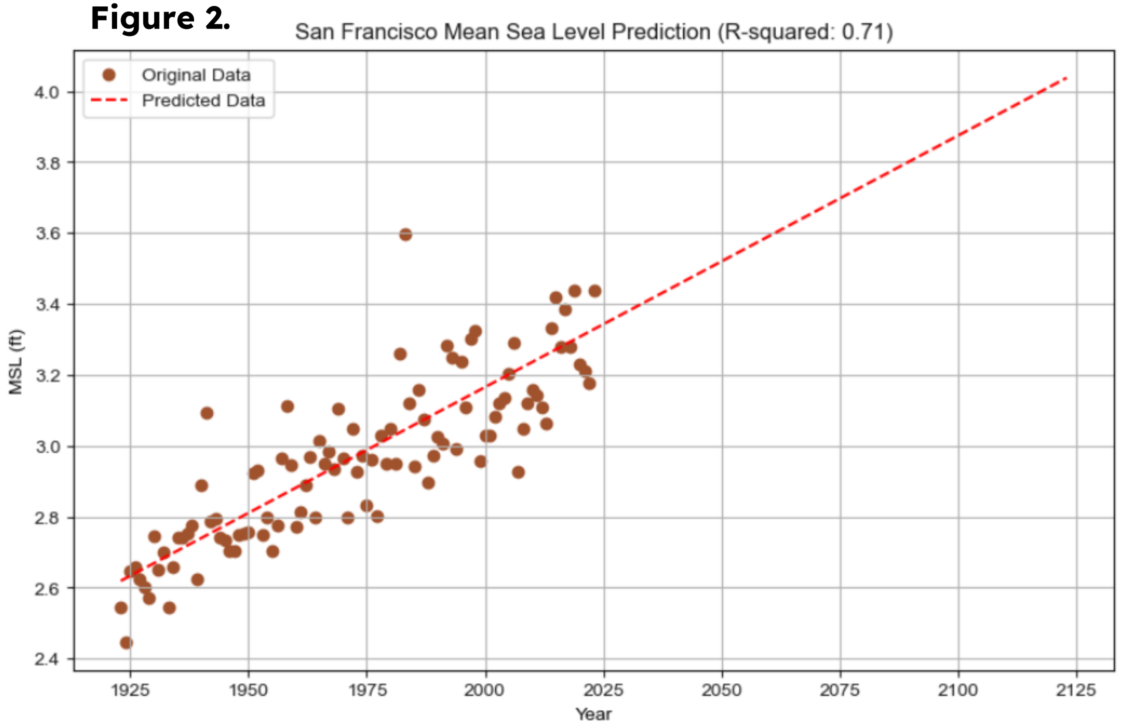


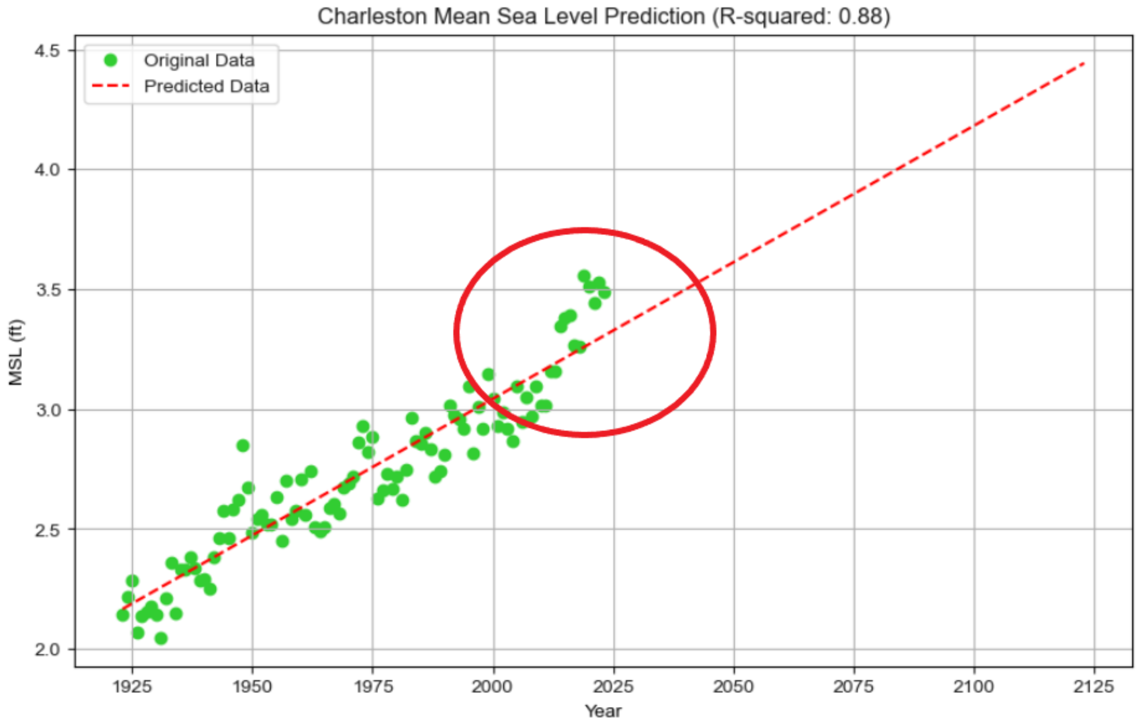
Figure 2.

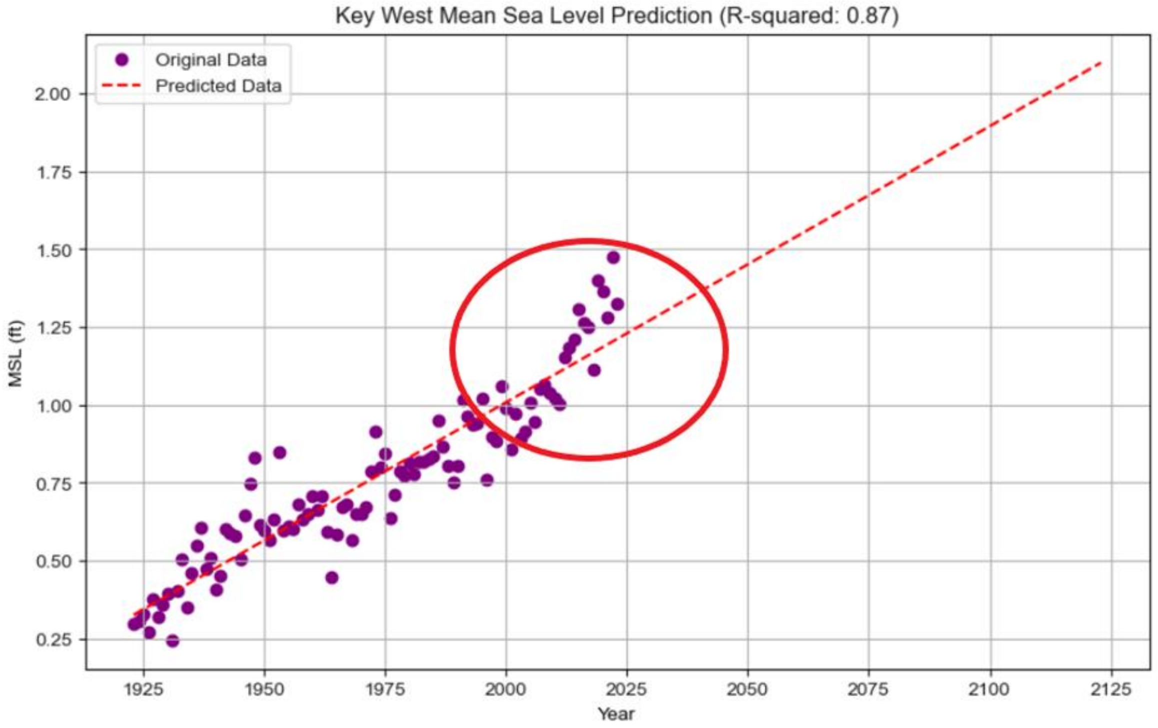


Mean Sea Level Predictions with Linear Regression Model

According to a 2017 report from NOAA: “Although the sea level has risen by 6.5 inches since 1950, nearly half of it (3 inches) has occurred in just the last 20 years.”

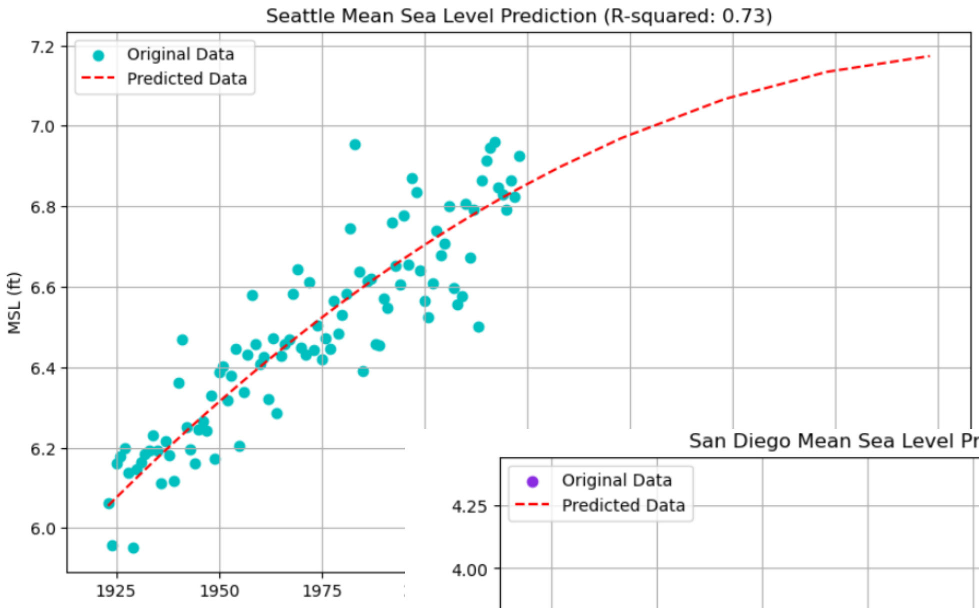
While this accelerated rate of sea level rise is captured in the scatter plots (see examples below), the linear regression model is ill-suited for capturing nonlinear trends of this nature. We would need to fit the data to a polynomial regression model to capture the dynamics of this dataset.

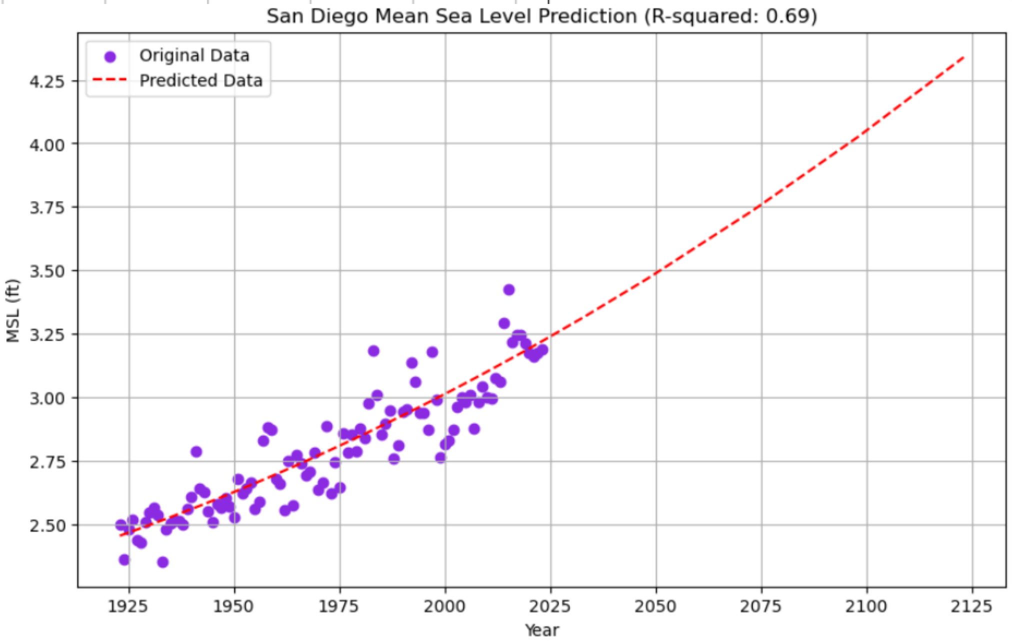


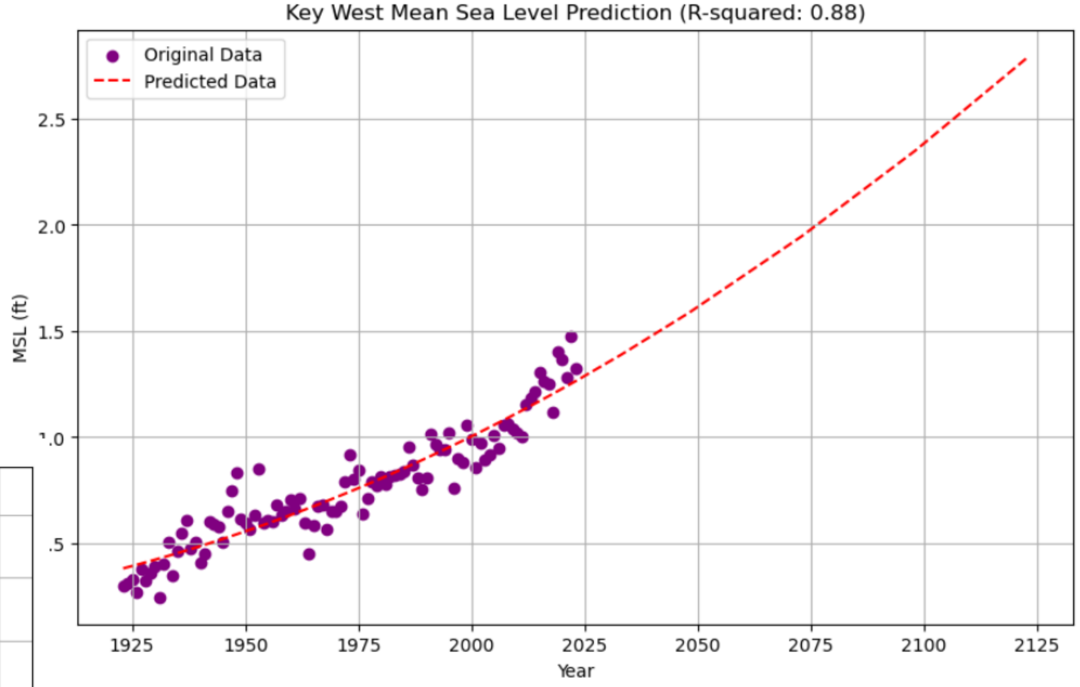


Mean Sea Level Predictions with Polynomial Regression Model

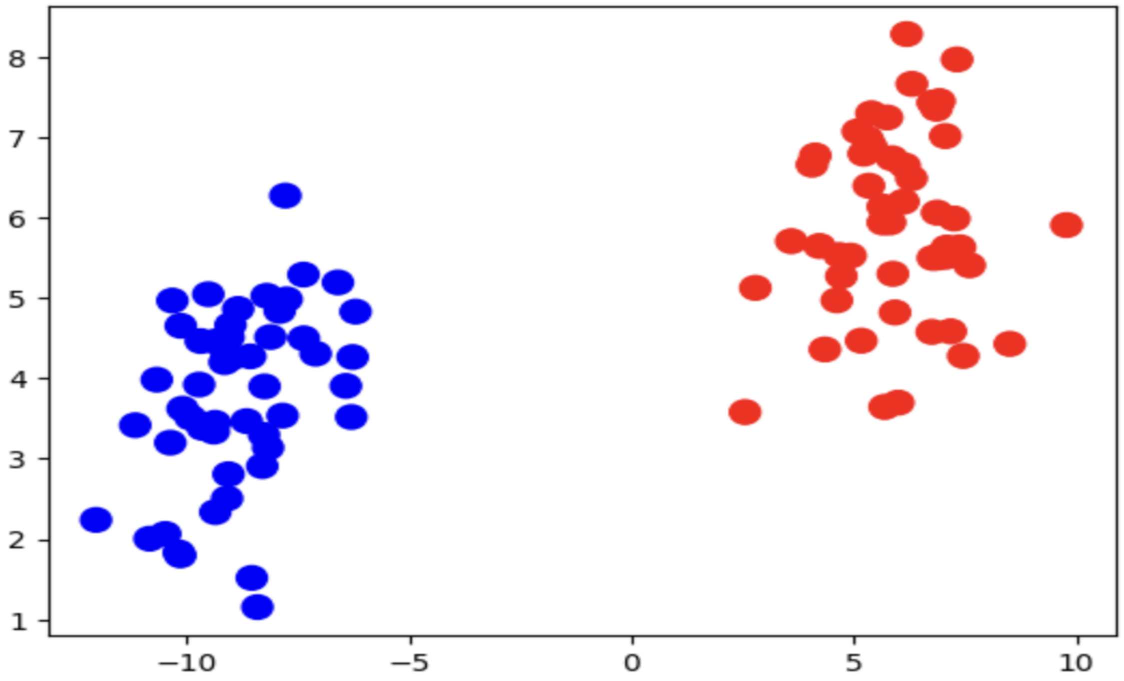
With the polynomial regression model (degree = 3), we are finally able to visualize the dynamic nature of sea level rise at each of our target cities.







Neural Model




```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense (Dense)               (None, 5)                 15

 dense_1 (Dense)             (None, 1)                 6

=================================================================
Total params: 21 (84.00 Byte)
Trainable params: 21 (84.00 Byte)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

```python
# Calculating the model accuracy and loss
model_loss, model_accuracy = nn_model.evaluate(X_test_scaled, y_test, verbose=2)
print(f'Loss: {model_loss}, Accuracy {model_accuracy}')
```

```
1/1 - 0s - loss: 0.2007 - accuracy: 0.9500 - 70ms/epoch - 70ms/step
Loss: 0.20070961117744446, Accuracy 0.949999988079071
```

Mean Sea Level for Target Cities (combined)
(1923-2023)

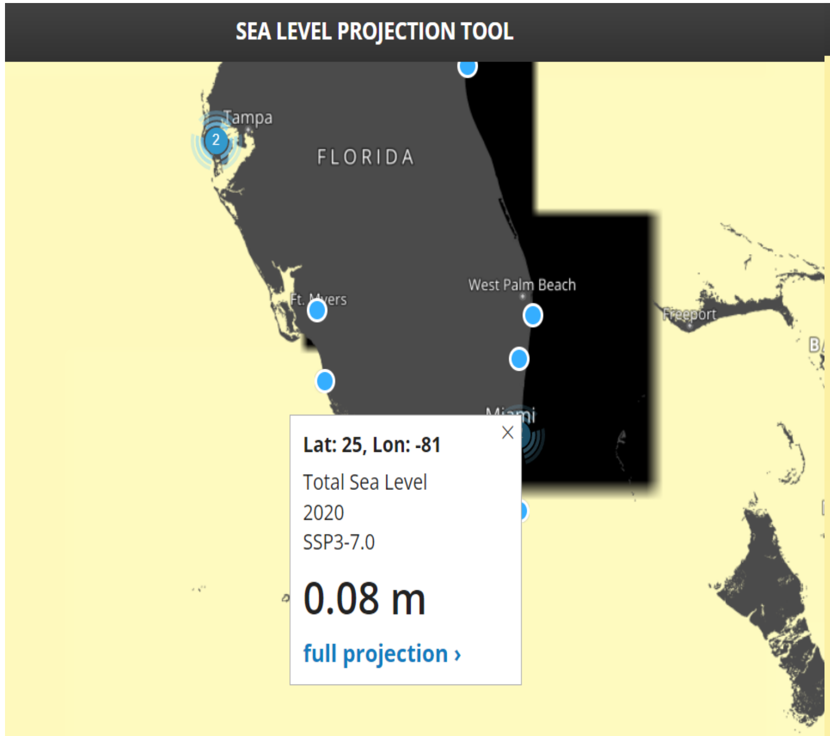
YEAR:	
2013	Mean Coastal Sea Level 10 years ago: 2.96 ft
1998	Mean Coastal Sea Level 25 years ago: 3.80 ft
1973	Mean Coastal Sea Level 50 years ago: 3.36 ft
1948	Mean Coastal Sea Level 75 years ago: 2.84 ft
1923	Mean Coastal Sea Level 100 years ago: 2.51 ft

Sea Level Predictions for Target Cities (combined)
(2023-2123)

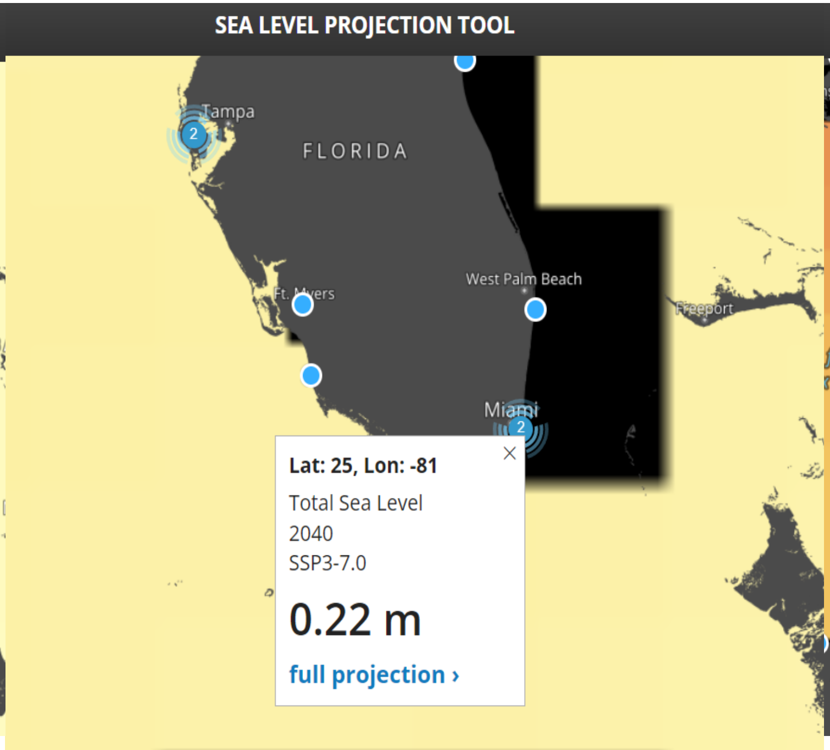
YEAR:	
2033	Predicted Mean Coastal Sea Level in 10 years: 3.57 ft
2048	Predicted Mean Coastal Sea Level in 25 years: 3.69 ft
2073	Predicted Mean Coastal Sea Level in 50 years: 3.89 ft
2098	Predicted Mean Coastal Sea Level in 75 years: 4.10 ft
2123	Predicted Mean Coastal Sea Level in 100 years: 4.30 ft
	Mean Absolute Error on Test Data: 1.57 ft

Sea Level Projections for Miami

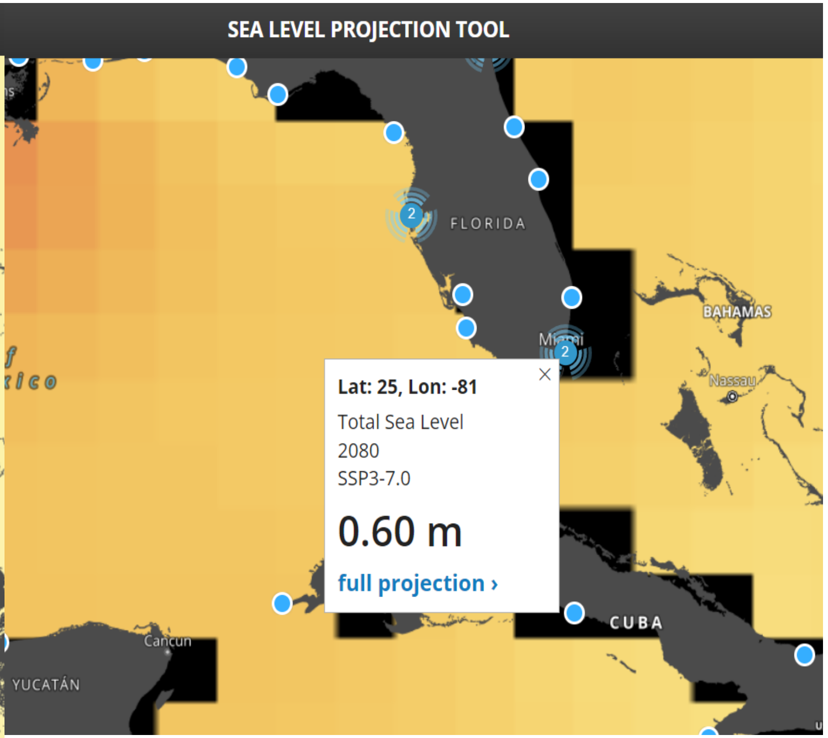
2020



2040



2080



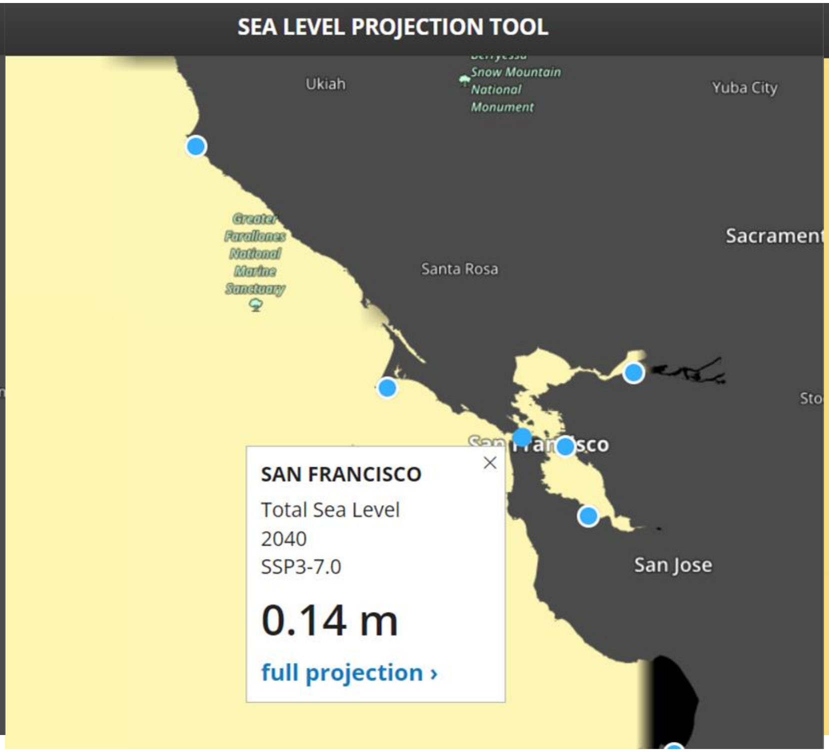
"IPCC AR6 Sea-Level Projection Tool. Retrieved from https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool." Accessed: September 29th, 2023

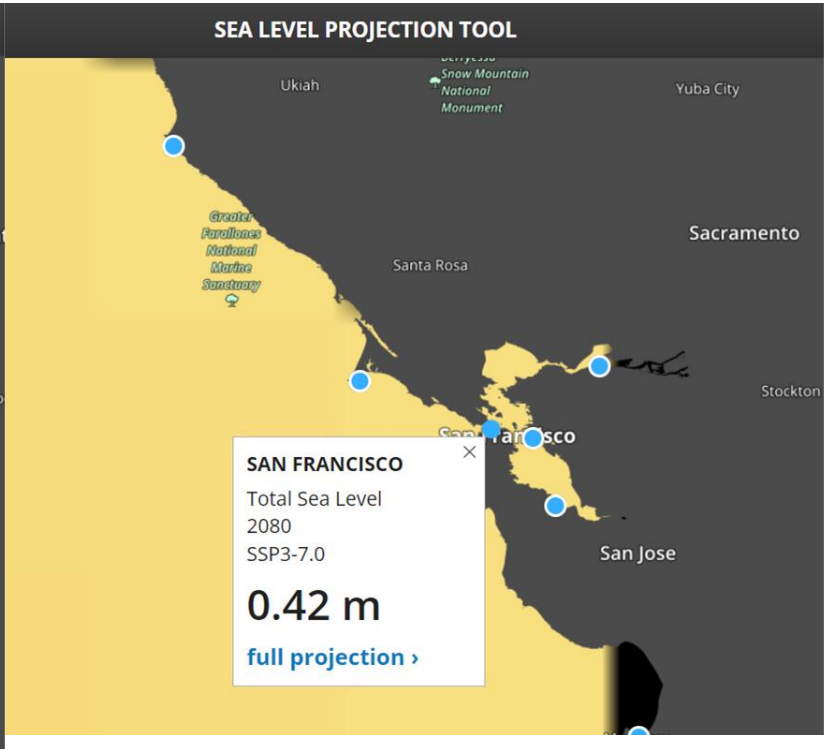
Sea Level Projections for SF

2020

2040

2080





Source: https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool

Thank You