Predicting Changes in Glacier Mass & Sea Level

E. Culverhouse, R. Dupont, S. Morgan, L. Woodul

The Goal

Create a model with high accuracy in predicting the change in glacier mass and sea level over time

And answer:

- ❖ How is the change in global average temperature affecting average glacier mass and sea level change? What changes can be predicted for the near future based on historical data?
- ❖ Does change of greenhouse gas emissions in the Earth's atmosphere affect average glacier mass and sea level change?

Project Overview

Collect & Clean

Find, clean & merge historical climate data

Models

Create models to run data through and decide on most effective model

Data Projection

Project future data of variables ranging from 2020-2050

Statistical Analysis

Finding correlations between data

Visualizations

Create Tableau dashboard

Our Dashboard

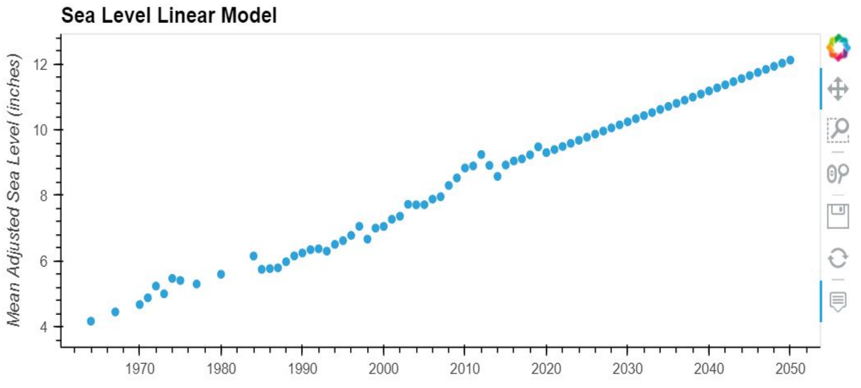
Models

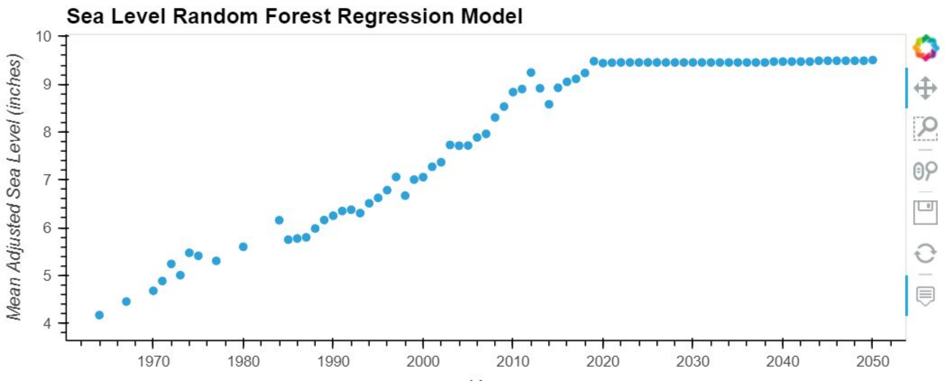
Random Forest Regression		Linear Regression
- Generally High Accuracy - Handles Outliers Better - Not sensitive to missing Data - Can overfit easily	VS	- The more linear the data the better it performs - Easy & Simple to implement - Fast Training - Assumes normal distribution

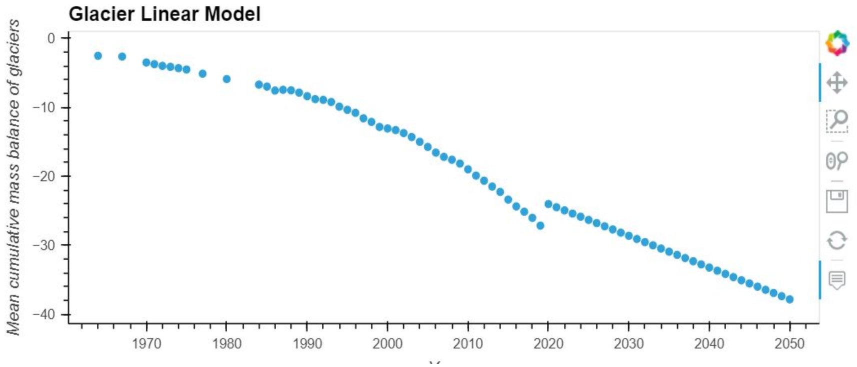
Statistical Analysis

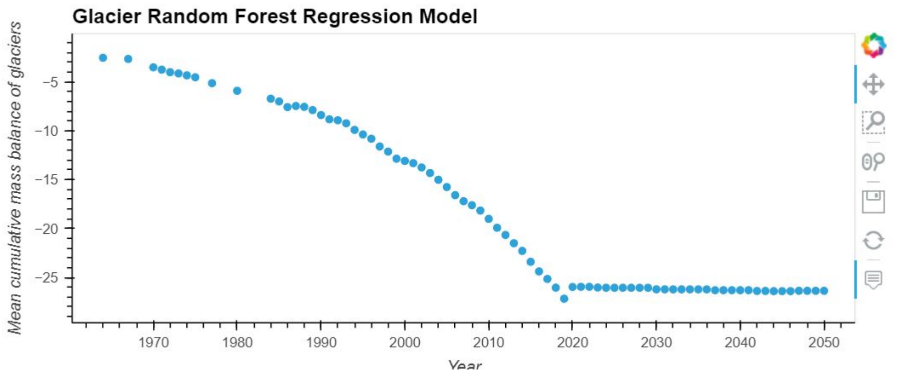
- Both Glaciers models had high accuracy scores with the Linear Regression Model at 0.996 and the Random Forest Regression at 0.993
- Both Sea Level models had high accuracy scores with the Linear Regression Model at 0.980 and the Random Forest Regression at 0.966
- Used both models due to high accuracy scores seen in Glacier & Sea Level
- Linear Model projected well continuing a Strong Linear Relationship all the way through 2050 showing Glaciers lose over 10 more cumulative mass balance & Sea Level rising almost 3 more inches in that span
- Cumulative Mass is the size of the Glaciers compared to their size in 1956 in meters of water equivalent
- Random Forest Regression wound up having some unforeseen limitations

Graph Analysis









Data Wrangling & Cleanup

- Our data was collected from the US Environmental Protection Agency's Climate Change Indicators.
- We selected data that was prima facie related to glacier melt and sea level change
  - The atmospheric concentration of the three major greenhouse gases (carbon dioxide, methane, nitrous oxide)
  - The annual precipitation anomaly, based on the 1901-2000 average
  - The temperature anomalies of the Earth's surface and the sea surface, based on the 1901-2000 and the 1971-2000 averages, respectively
- We went through each of the candidate features for our training dataset and checked how well each feature correlated with our models' targets, the Sea Level Anomaly and the Mean Cumulative Mass Balance of Glaciers.
- We found a high degree of correlation for all of our candidate features except for the annual precipitation anomaly, which did not have a statistically significant correlation with either target.

Projections

- Once we had the Linear Regression and Random Forest Regression models trained, we needed to create a feature set to feed to the models to create the 2020-2050 projections for the sea level change and the mean cumulative mass balance of glaciers.
- We used linear regression models to project the greenhouse gas emissions, assuming that their concentrations would continue to increase at their current rates.
- We also created linear regression models using the greenhouse gas concentration data as features to predict the earth and sea surface temperatures.

Projections cont.

- We then projected the temperature changes by inputting our greenhouse gas projections into our temperature models, then added the temperature predictions onto the projection data set with the gas concentrations.
- It was this base set of prediction data that we fed into both of our sea level models to to create a linear regression prediction and a random forest prediction. These predictions were each added to copies of our projection data set, and both were fed into our two glacier models to generate our final predictions.

Limitations

- Models
- Merging data, missing years
- Data wrangling, sites/sources
- Data set on the smaller size
- Finding existing geospatial data
- Creating mapping data from predictions

Conclusion

- We were successful in creating a model with a high accuracy in the prediction of future data
- From results from our model & statistical analysis:
  - Greenhouse gasses concentration increase does have correlation in the decrease in average glacier mass and increase in sea level
  - Global average temperature change does have correlation in the decrease in average glacier mass and increase in sea level

Sources

- Environmental Protection Agency. (n.d.). EPA. https://www.epa.gov/ : Data collection source
- GLIMS Consortium, 2005. GLIMS Glacier Database, Version 1. Boulder Colorado, USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. DOI: https://doi.org/10.7265/N5V98602 [6/23]. https://nsidc.org/data/glims/data : Glacier map data
- USGS.gov | Science for a changing world. (2023, June 11). https://www.usgs.gov/ : Glacier information

Thank you Matthew & Reza!!!