Analysis of Coral Reef Bleaching

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What is Coral Reef Bleaching?

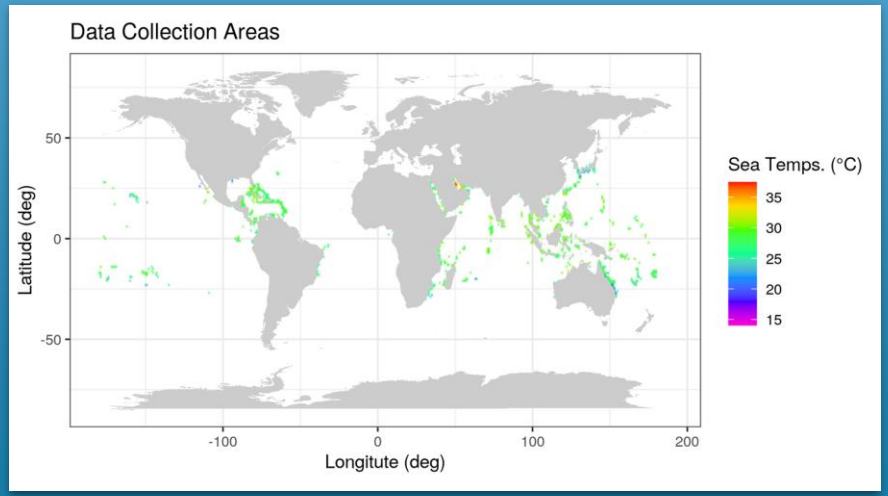
- Coral and algae are in a symbiotic relationship
- The corals emit ammonium -> nutrient for algae
- Algae undergo photosynthesis and emit nutrients back to the coral
- Rise is temperature throughout the global has caused stressful conditions for the coral
- In stressful conditions the coral expel the algae living on them

Why does Coral Reef Bleaching Matter?

- Coral bleaching deteriorates the entire reef ecosystems
- Thousands of marine animals depend on coral reefs for survival
  - Protection from predators
  - Food chain
- Coral reefs absorb the force of waves and storm surges, keeping coastal communities safe

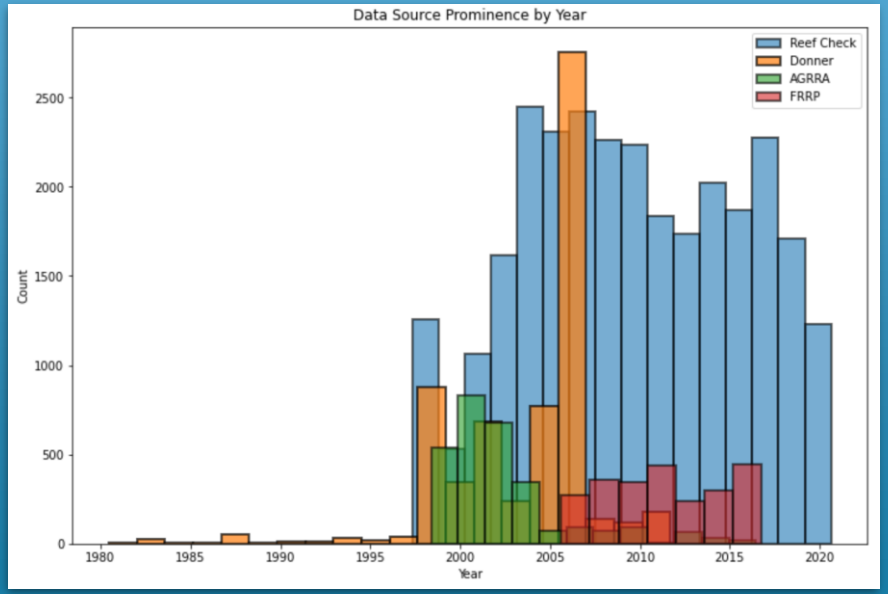
Introduction to Data

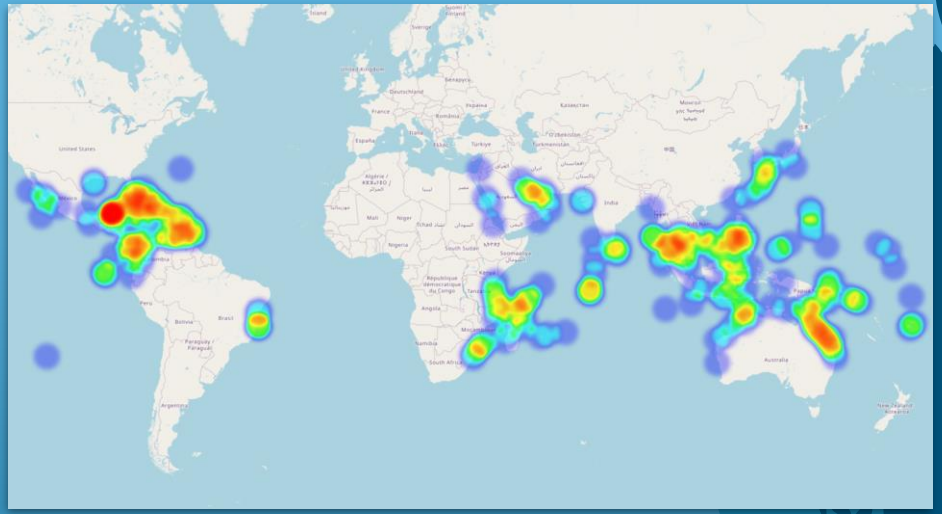
- 8 Ocean "Realms"
- Data collected from 1980-2020
- Temperature between 25-30 ℃
- Near Equator



Introduction to Data Cont.

- 4 main data sources
- Majority 1997-2020





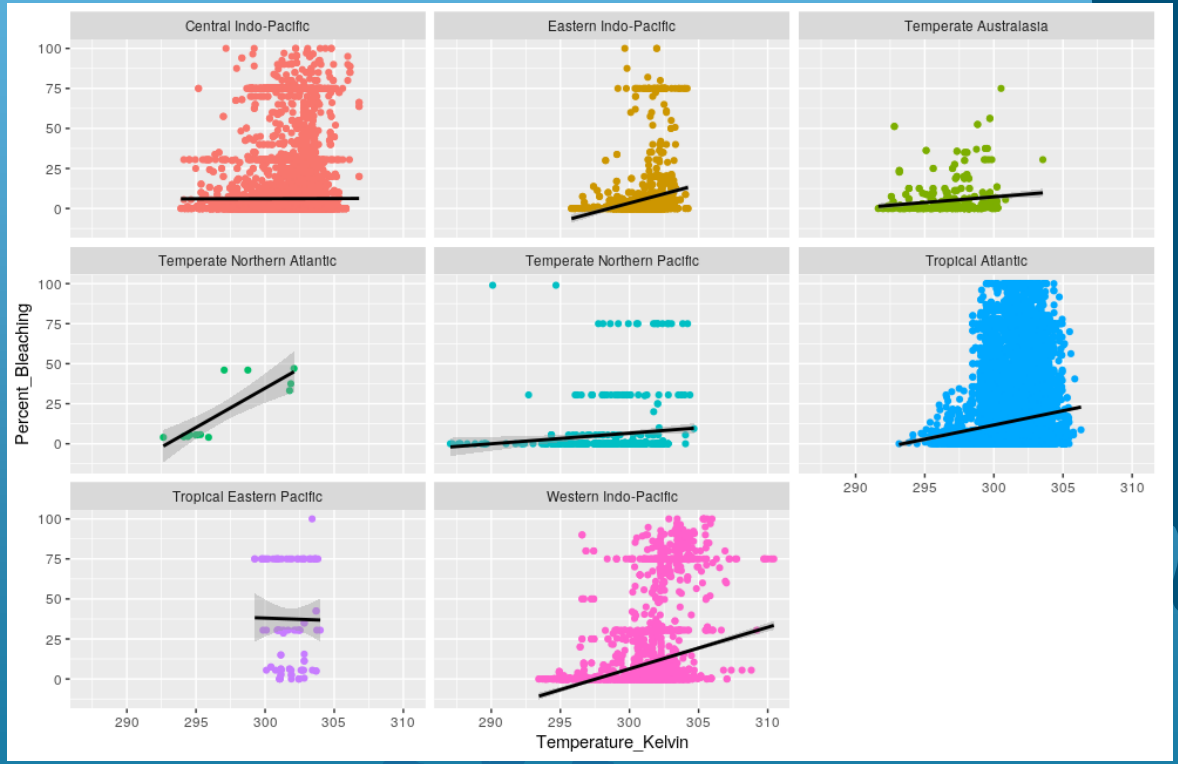
- Intense Bleaching concentrated in:
  - Caribbean, South China Sea, Tasmanian Sea

Hypotheses

1. Bleaching percent will increase as water temperature increases
2. Coral that is closer to the shore will experience more bleaching than coral further from the shore
3. Bleaching percent will decrease as turbidity increases
4. Bleaching percent will decrease as cyclone frequency increases

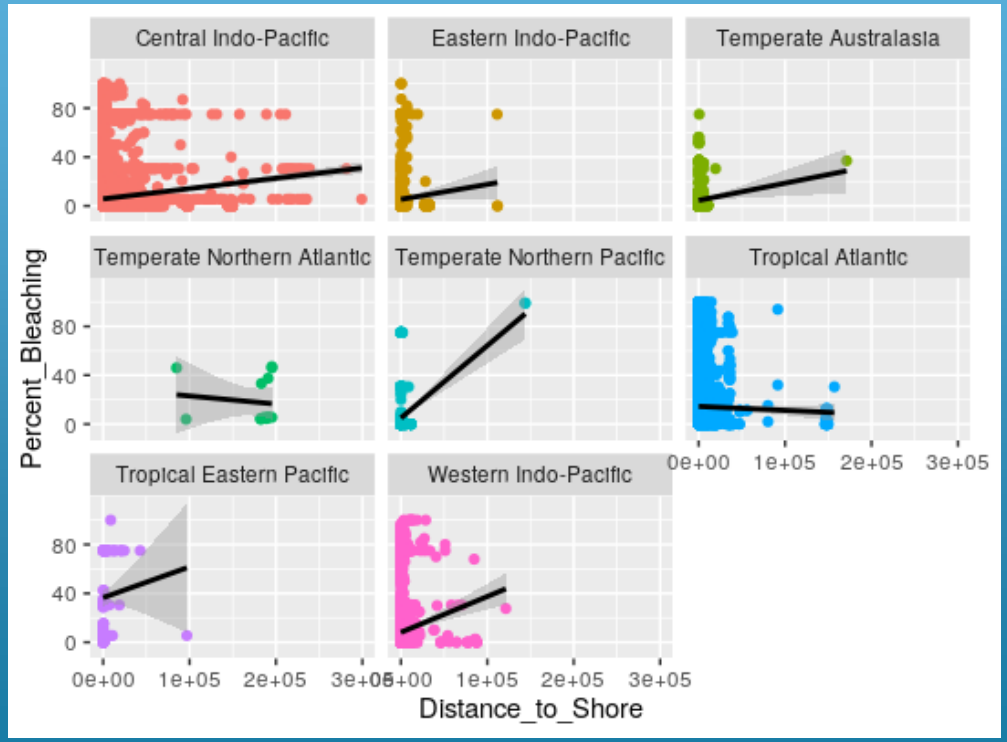
Bleaching Percent vs. Temperature

- Correlation strength depends on the ocean realm
- General positive trend for most ocean realm



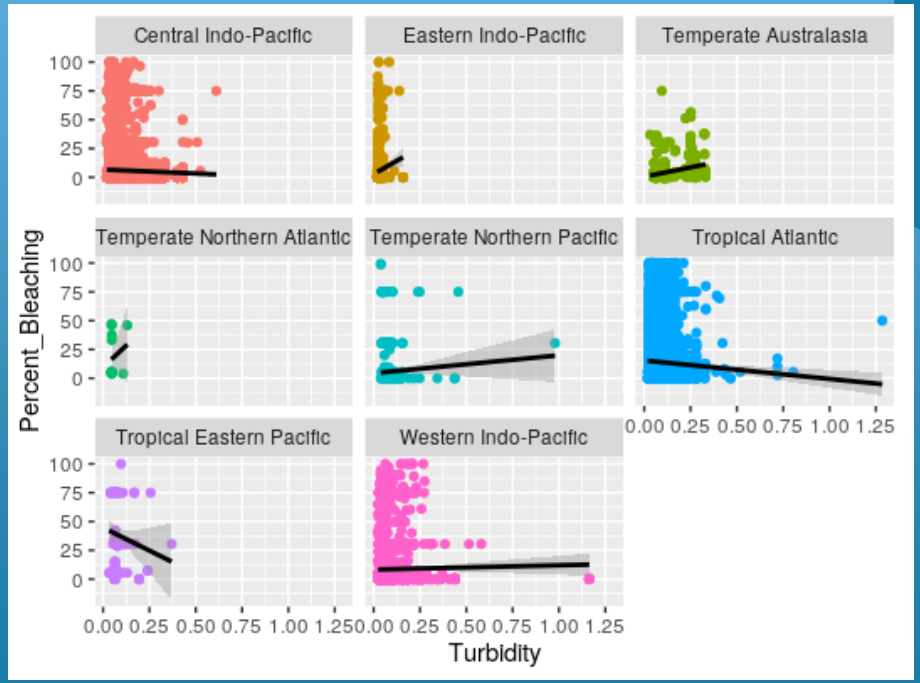
Bleaching Percent vs. Distance to Shore

- Distance to shore slightly positively correlates with bleaching percent
- Farther away from the shore, water tends to be warmer in the summer months



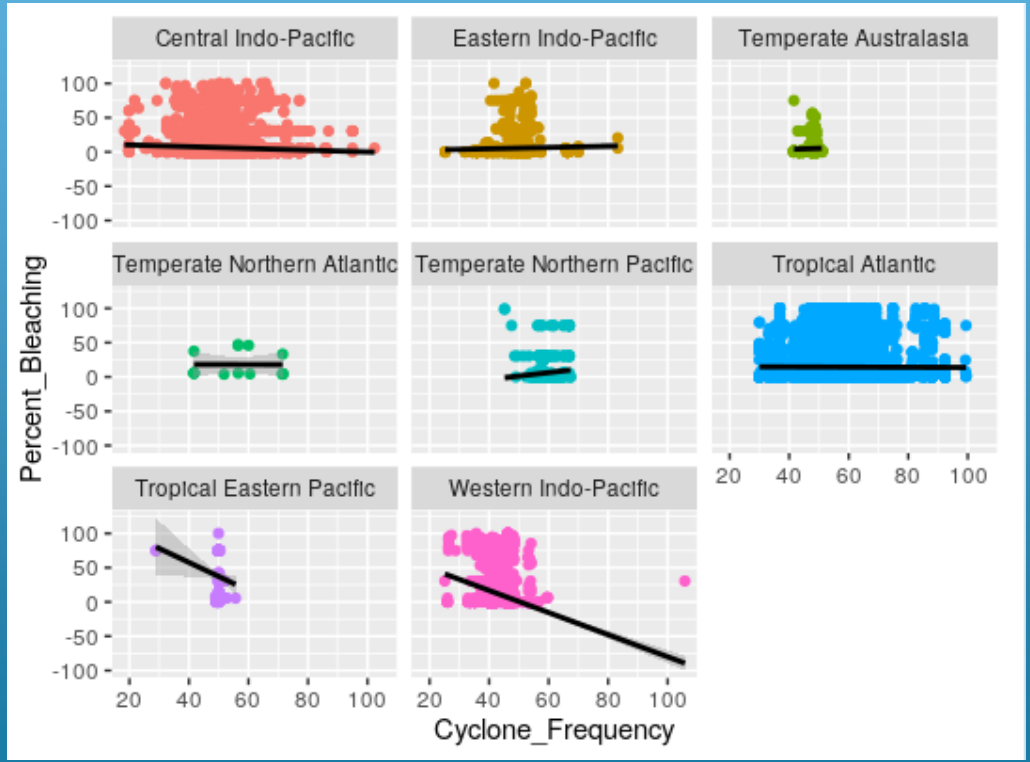
Bleaching Percent vs. Turbidity

- Turbidity shows a negative correlation with the bleaching percentage.
- Turbidity is the relative clarity of a liquid measured by the amount of light scattered by the water when light is passed through.
- A high turbidity rating means a large number of suspended sediments in the water sample, making it more harmful for aquatic life.

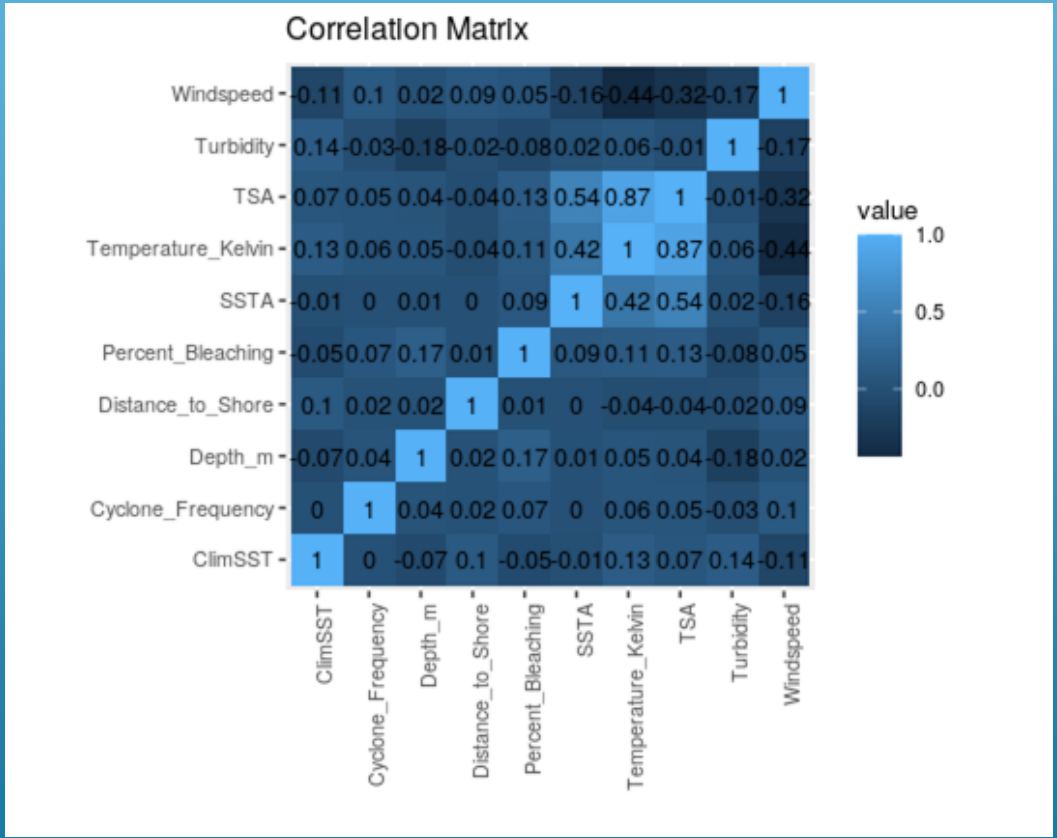


Bleaching Percent vs. Cyclone frequency

- Cyclone frequency was neutrally correlated in some regions, and negatively correlated in others, such as the Western Indo-Pacific to percent bleaching
- Cyclone frequency can also increase turbidity



Correlation Matrix



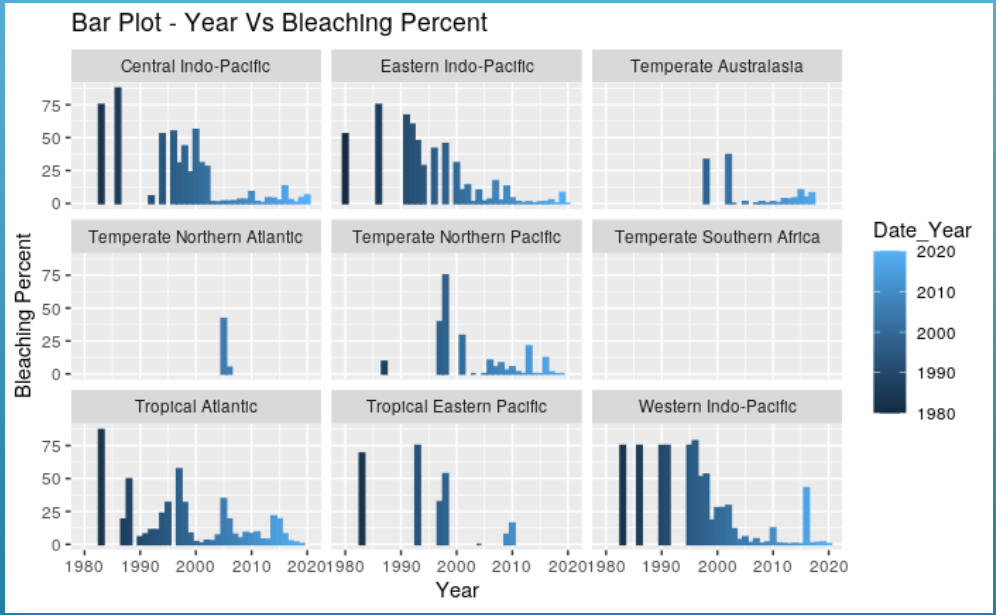
Correlation Matrix

- Percent bleaching is positively correlated with depth (m), total survey area (TSA), temperature (Kelvin), sea surface temperature anomaly (SSTA), Cyclone frequency, wind speed and distance to shore in this order (i.e. Depth (m) is maximum and Distance to Shore is minimum).

- Percent Bleaching is negatively correlated with Turbidity and climatological Sea Surface temperature.

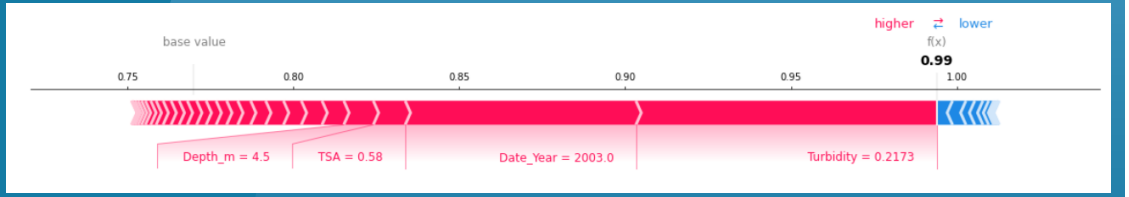
Bleaching Percent vs. Year

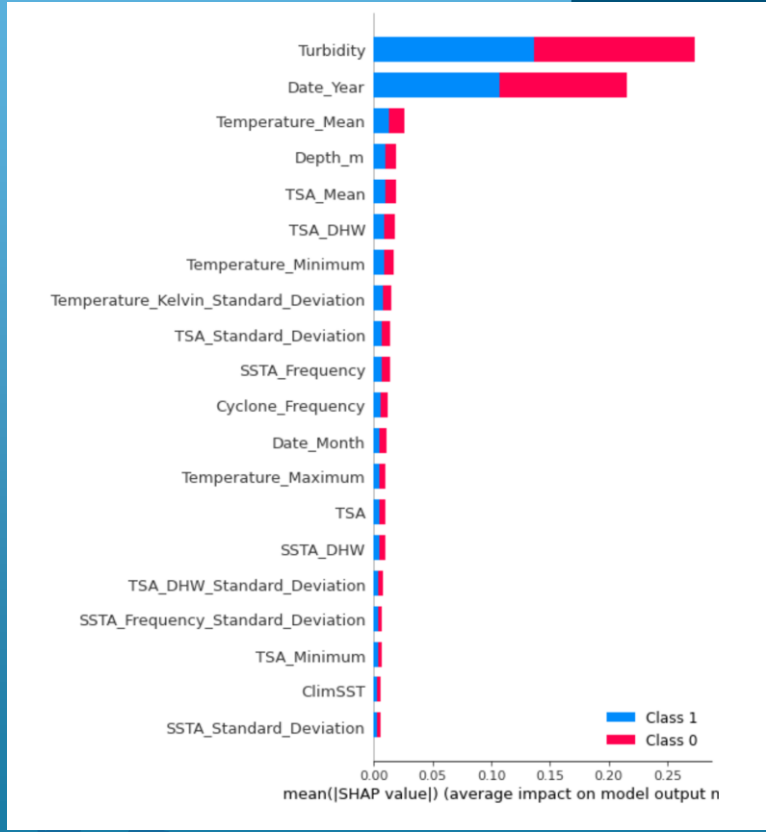
- Looking at the correlation matrix we decided to plot the bleaching percentage vs the year
- We can see that bleaching percentage over the years has gone down regardless of the location
- A possible source of error is that the corals that have been analyzed have died and have been bleached to their maximum capacity



SHAP Plots for Bleaching Percent

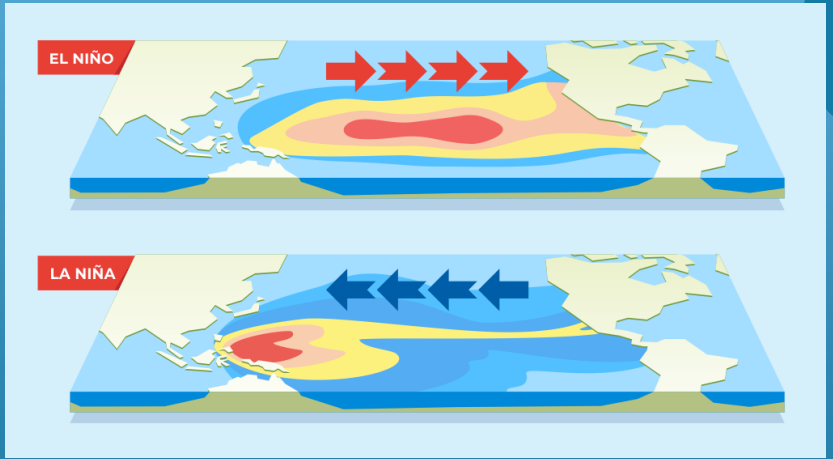
- Random Forest classifier
- Turbidity and Year





El Niño-Southern Oscillation (ENSO) cycle

- Major Pacific Ocean climate pattern affecting weather worldwide
- El Niño/La Niña: 2 opposing phases breaking normal conditions
  - El Niño: warmer ocean temps
  - La Niña: cooler ocean temps

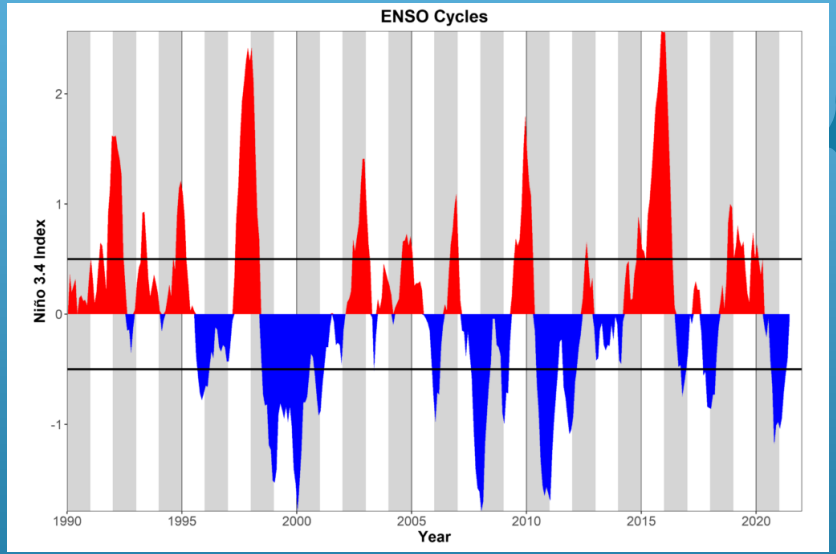


https://youngzine.org/news/climate-science/la-ni%C3%B1a-back-scientists-say

ENSO Study Method

- EN/LN cycles last up to 2 years, happen every 2-7 years

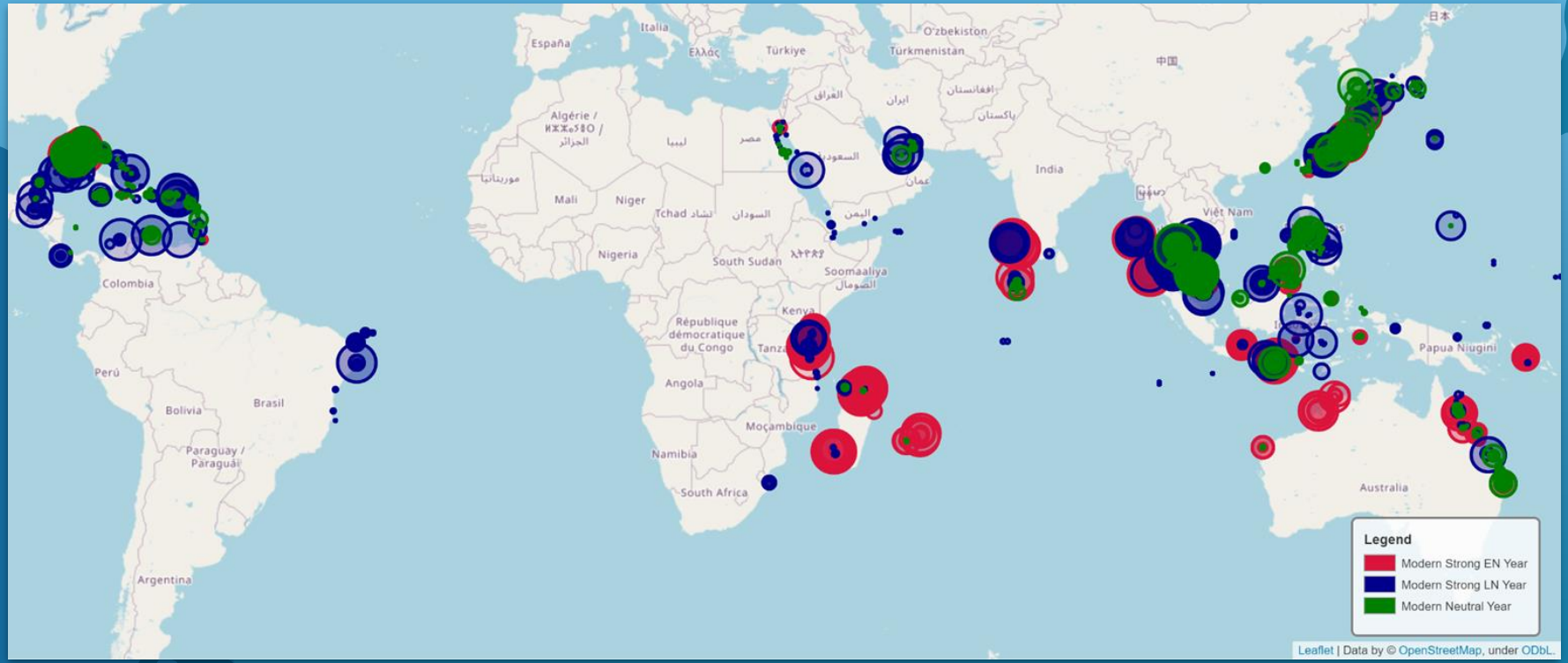
- Split dataset into strong EN/LN, neutral years
  - Past (1996-2004)
  - More Recent (2007-2020)



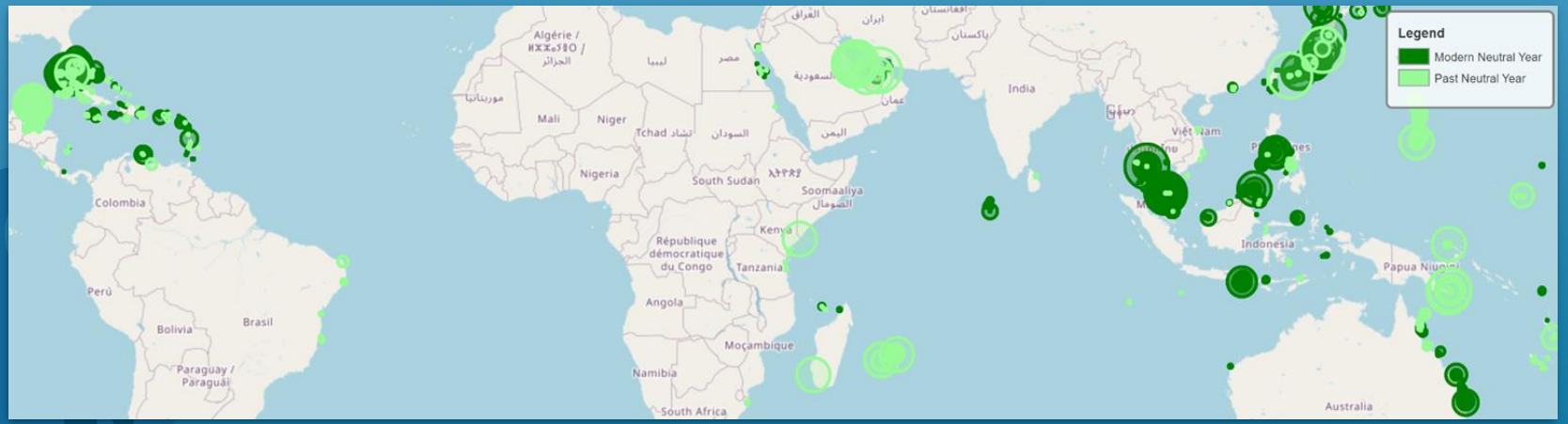
https://www.worldclimateservice.com/2021/08/25/what-is-el-nino/

Bleaching is Historically Cyclical

Bleaching Events are Becoming More Common



Corals Don't Have Time to R



Limitations

- Data was collected from coral reefs even if coral had died
  - - Bleaching percent decreased over the years
- Very little data from 1980-1997

Conclusion

- Temperature and distance to shoreline seem to be directly correlated to bleaching percent for most Ocean Realms
- Turbidity is negatively correlated to the bleaching percentage
- Bleaching follows ESNO cycles but is becoming more common across all phases

Questions?

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