Ocean Properties and Climate: Spatio-temporal Trends

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Motivation and Objective

Objective: To see the correlation between various ocean data points including factors such as water temperature, water depth, latitude, time, and current heights.

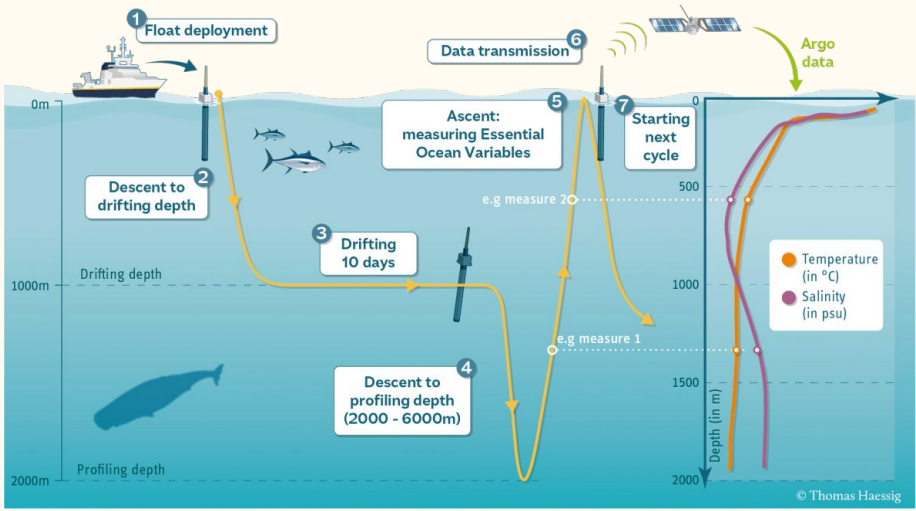
What we did:

- Analyzed the temporal trends of marine data such as sea surface temperature and salinity
- Attempted to find trends in the data (on both spatial and temporal scale) and explain them
- Recreate detailed gradient maps of ocean temperature and currents visualization of the high resolution data
- Explained the observations where disparities are present.

Dataset

- Our Datasets come from **Argo**, an international program that measures water properties through floats moving around the world.
- The dataset contains:
  - Longitude, latitude of floats
  - Time of measurement
  - Water temperature, pressure, salinity
  - More professional biology data (not used)
- Imported as Xarray.datasets or

  Pandas.dataframe



Methodology

- Firstly identify the correlation between different parameters and find the interesting pairs of parameters
- Plot simple correlations, identify interesting results and explain the reason
- Plot the ocean temperature and currents around the world for better explanation

What correlations are there between different pairs of parameters?

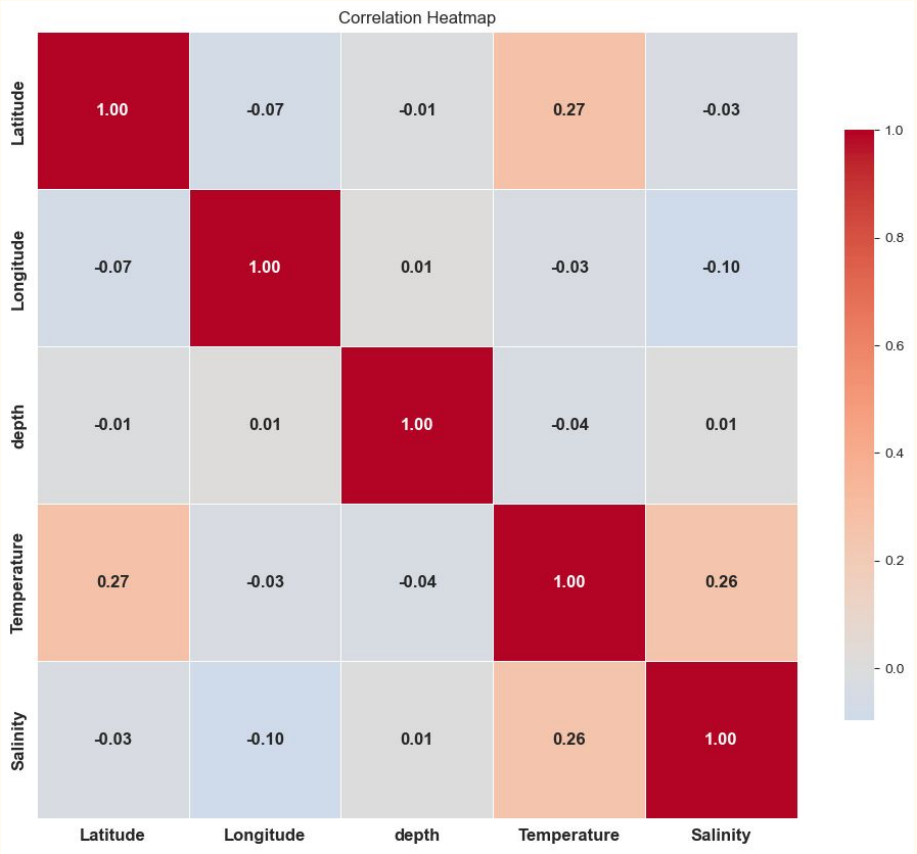
Correlation Heat Map

Notable correlations:

- Temperature vs. Salinity (not intuitive)
- Temperature vs. Latitude

Other properties to be analysis:

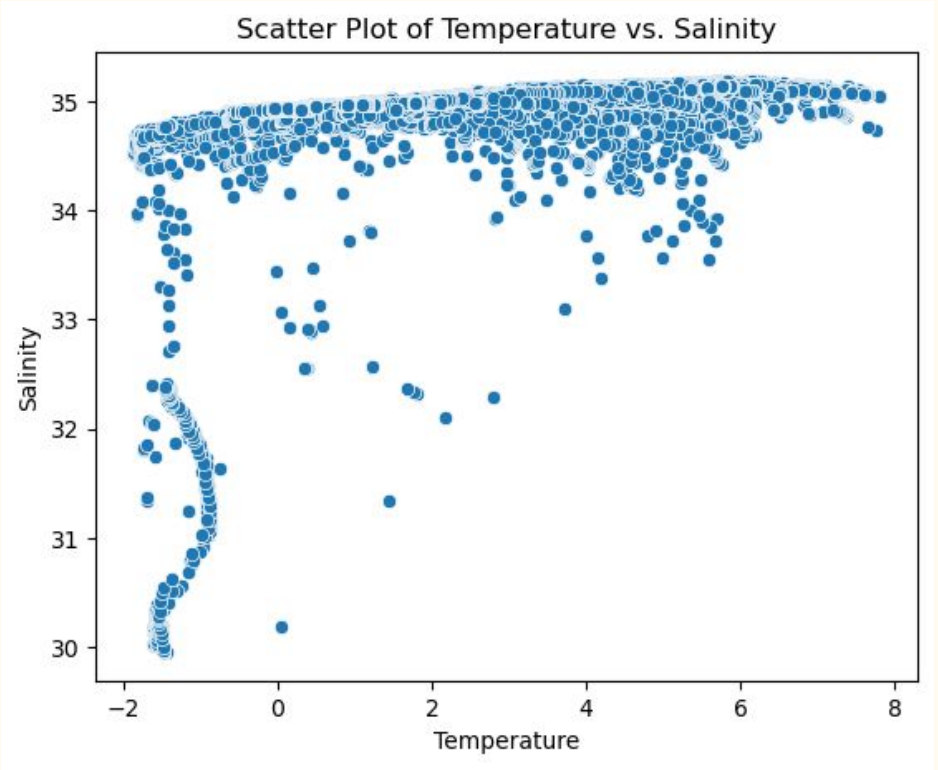
- Temperature vs. Time
- Temperature and around the world
- Currents around the world



What does Salinity have to do with Temperature?

Salinity vs Temperature

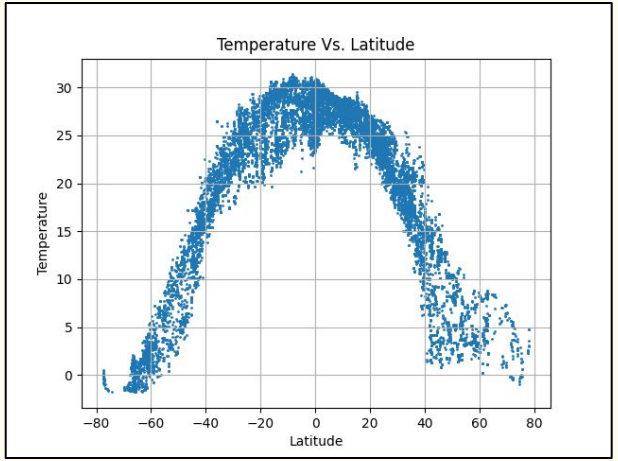
- The upper layer of the sea has higher temperature, so it evaporates faster.
- Due to limited mixing speed of water, the salinity of the sea surface rises.
- That's why higher Salinity are more related with higher temperature than low Salinity.

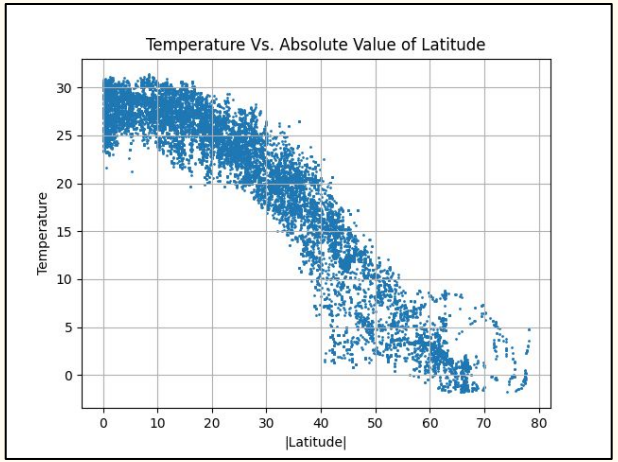


Easiest question: which part of the ocean is the warmest?

Temperature vs Latitude

- The peak temperature occurs closest to where the latitude is 0.
- Warmest temperatures occur near the equator which is true due to its tropical climate year-round.
- At higher latitudes, northern earth are slightly warmer than southern (e.g. 60 degrees north/south latitudes)
- Will go back later!

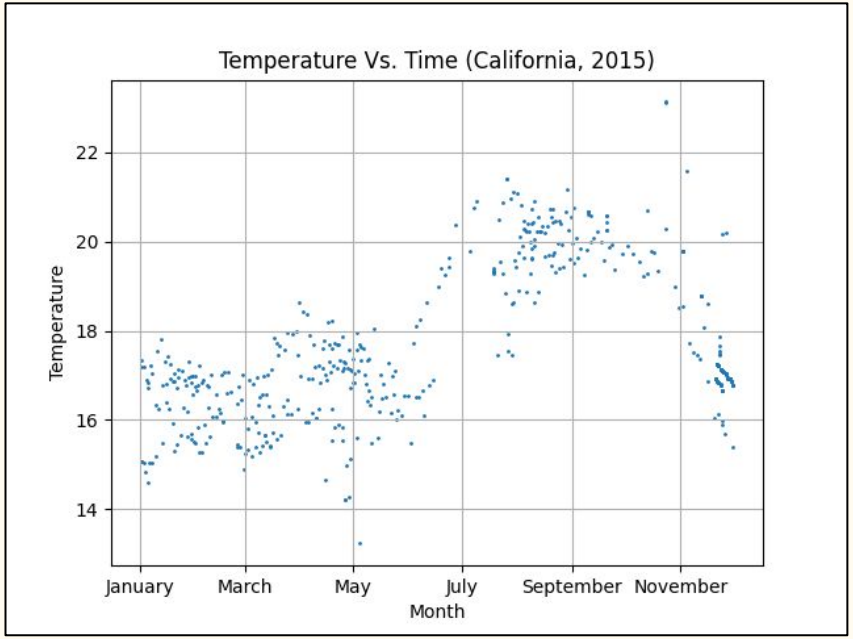




When will peak ocean temperatures occur over a year of time? Will it match with the four seasons?

Temperature vs Time

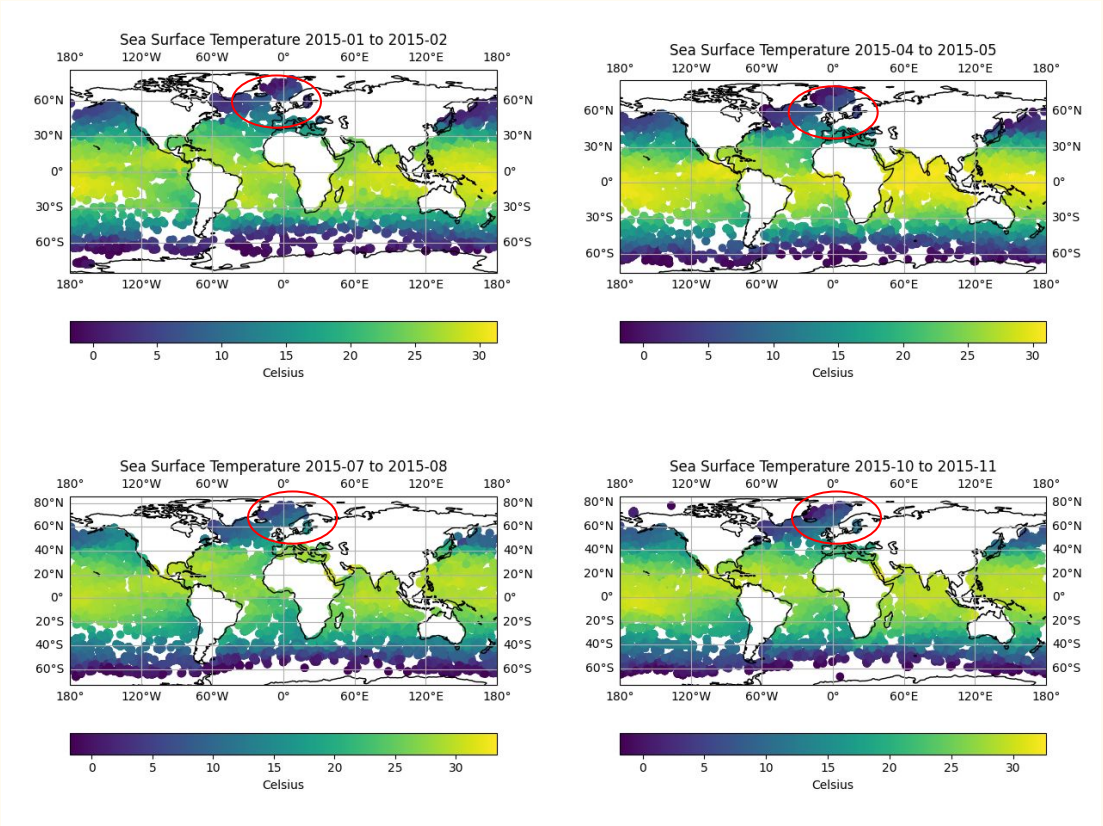
- Over the span of a year, the highest temperatures occurs around September
- Slightly behind the peak air temperature (July to August)
- Why?
- Heat transfer is slow!
- The temperature of the ocean at depth lags the Earth's atmosphere temperature by 15 days per 10 metres
- Similar for the lowest temperature



Anything else regarding ocean temperature is irregular and not intuitive?

Global Sea Surface Temperature

- Latitude dependence
- Season dependence (match with temperature vs time)
- Interesting region: Northern/Western Europe
- Keeping warm until November
- Warmer than same other places with same latitude
- North Atlantic current is warm and has strong influence in Winter!
- Currents matter!



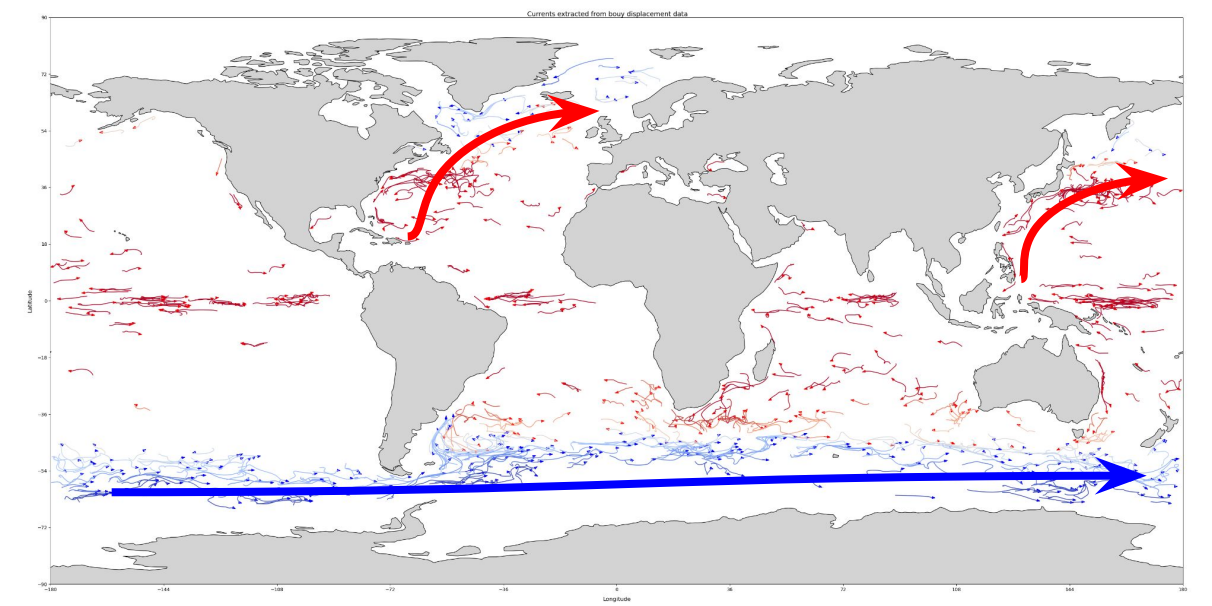
Can we use currents to explain the non-intuitive temperature observations?

How to find currents

- Consider the routes of single floats: must move along currents
- Identify those floats with most obvious movements
- Using Bezier curve to approximate its trajectory, which could represent the currents
- Temperature being measured can reflect whether the current is warm or cold

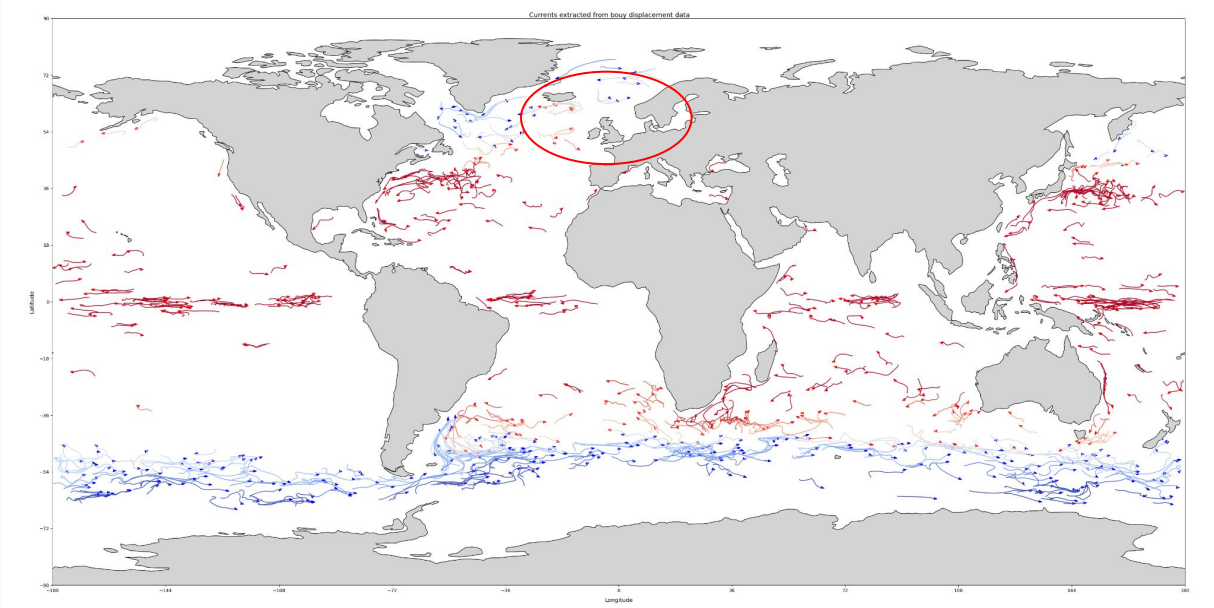
Currents explains a lot...

- North half of the earth has some significant warm currents (North Pacific/Atlantic current) while the south half has some significant cold currents (Antarctic Circumpolar Current)
- Somehow explains why northern ocean are sometimes warmer

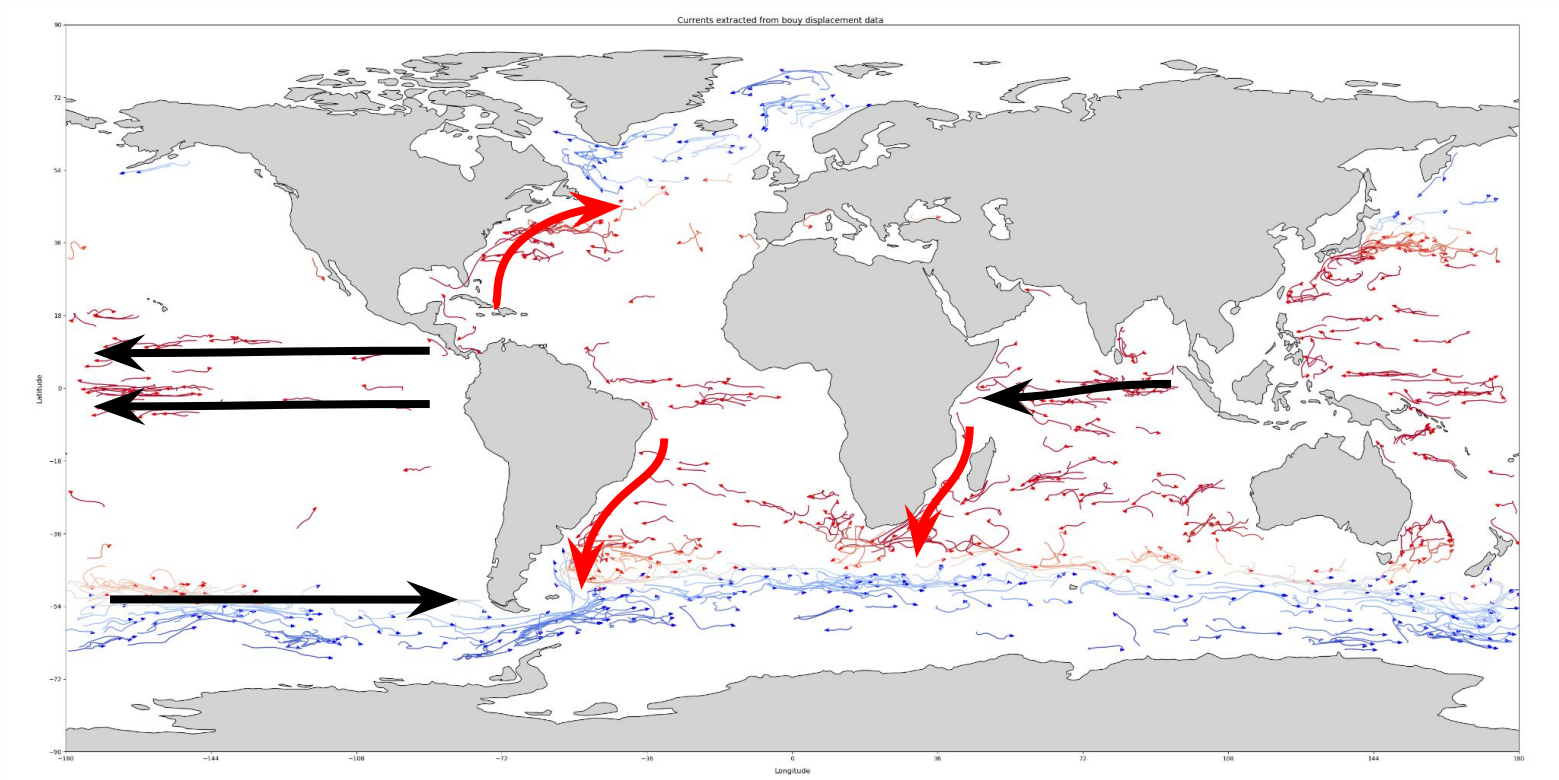


Currents explain a lot...

- North atlantic current keeps moving to the Northern/Western Europe, which explains the high temperatures at ocean around Europe
- Plotted currents matches with the scientific facts!
- To be shown in next page



Currents (January to June)



https://zh.wikipedia.org/wiki/File:Corrientes-oceanicas.png

Currents (July to December)