spire | weather

Hackathon Challenge:
Spire Weather Route Forecast API

An Introduction to Weather Forecasts for Maritime Vessel Route Planning

Overview

Source: https://porteconomicsmanagement.org/pemp/contents/part1/interoceanic-passages/main-routing-alternatives-east-asia-northern-europe/

Modern society relies on shipping to move raw materials, component parts, and products all around the planet. There are many factors that ship owners must take into account when planning voyages: the customer's expected delivery time, the cost of fuel, the carbon footprint, canal fees, port conditions, weather, and more. Another important consideration is which routes other vessels take. Ships don't just take any route they want. They usually follow a well-known trajectory: https://www.vox.com/2016/4/25/11503152/shipping-routes-map

In this exercise, you will use the **Spire Weather Route Forecast API** to collect weather data (atmospheric and oceanographic) along your chosen shipping routes. You will build the routes yourself, coordinate by coordinate, with help from online sources like the one linked above. Try to make informed decisions about which route is best between two selected ports. Ask yourself questions like: How might the best route change depending on the season? How far can a vessel travel before needing to refuel? What are other factors and datasets that would be good to consider?

Requirements

- Internet access
- Command-line / terminal access
- The ability to run Python scripts
- A text editor for editing code
    - Sublime is one good option, but there are many others available: https://www.sublimetext.com/

Instructions

Part 1

Review the contents of the `data_request_examples/` directory.

This directory contains 3 example data requests using the Spire Weather Route Forecast API. All 3 examples make the same exact request, but they use different programming languages. There is one Python example, one JavaScript example, and one cURL example:

- `python_example_request.py`
- `javascript_example_request.js`
- `curl_example_request.sh`

The example request asks the API for 5 waypoints, where a waypoint is simply a combined data structure with Time, Latitude, and Longitude:

- The `"time"` field tells the API which time to return weather data for.
- The `"lat"` (latitude) and `"lon"` (longitude) fields tell the API which point-coordinate on Earth's surface to return the weather data for.

Please note that latitude and longitude values can be represented in different formats, but the API expects **decimal format,** like the example shows.

Part 2

Select one of the 3 examples to make a test API request.

Brief instructions for running the code are included at the top of each example file. Try running the code in your preferred programming language.

Verify that the JSON data in the response looks similar to **`example_api_response.json`**. You may receive an error response like this:

```
{ "message": "Requested waypoint times must be at most 10 days in the past" }
```

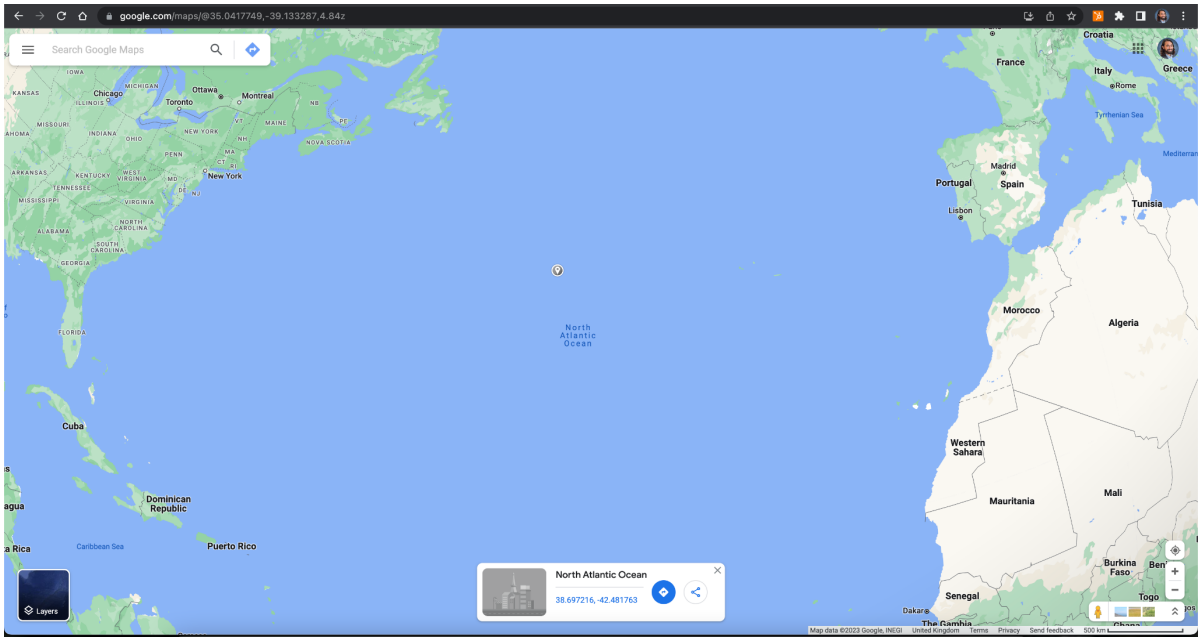
If you receive this error, you must change the date values for the `"time"` fields in the API request. In addition to the requirement for past times mentioned above, future times can only extend 15 days ahead or less. In other words, ***you must make sure that the `"time"` values are no more than 10 days in the past and no more than 15 days in the future.***

Part 3

Add some additional waypoints to the example route.

Using the example code you selected in Part 2 above, copy and paste an existing waypoint to add a new waypoint to the route. Make sure to follow the exact structure used in the example, or your code might return errors. Then:

- Open Google Maps in a web browser: https://www.google.com/maps
- Click somewhere in the ocean
- You should see a popup box with some numbers at the bottom.
    - In this example, the popup box numbers are:
        - `38.697216, -42.481763`



- The numbers in the popup box are the latitude and longitude values for that point-coordinate in decimal format, which is exactly what the API expects!
- The first value is the latitude, and the second value is the longitude.

Now that you have the location information for the point where you want to get weather data, you can edit the new waypoint in the route API request like so:

- Replace the `"lat"` value of your new waypoint with your selected latitude
- Replace the `"lon"` value of your new waypoint with your selected longitude
- Replace the `"time"` value of your new waypoint with a new time that follows the time rules described in Part 2.

Repeat the above steps as many times as you'd like to generate more waypoints along the route.

Now, you can make the API request like you did in Part 2, now with the new waypoint(s) added.

Finally, verify that the JSON response includes the coordinates you expect.
Note: this is sometimes easiest if you copy/paste the JSON response into a text editor where you can use a "search" feature for the expected number values.

Part 4

Convert the JSON data response to CSV format for analysis.

Replace the contents of **spire_weather_api_response.json** with the JSON response of your new API request using text copy/paste in your text editor.

Run the Python script **convert_spire_json_to_csv.py** which will convert **spire_weather_api_response.json** into a CSV file called **my_output.csv**. The script will put the new output CSV file inside of the **csv_output/** directory.
The script can be run from the terminal command-line using:

```
python convert_spire_json_to_csv.py
```

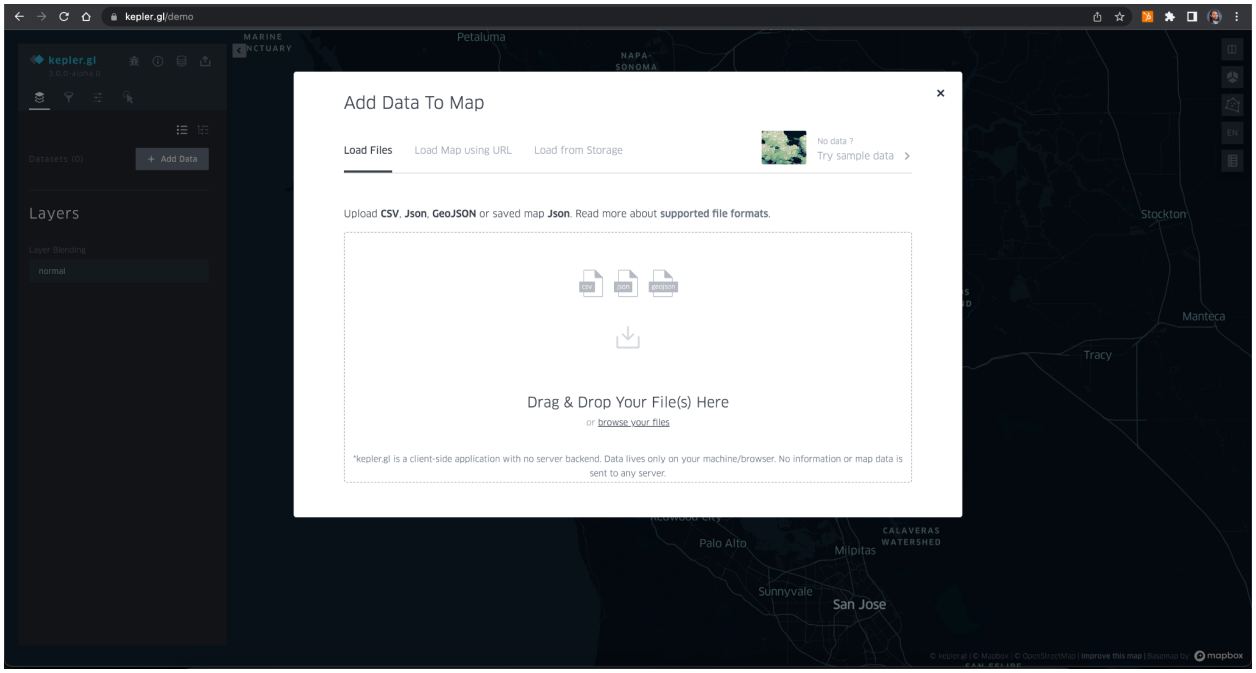
Verify that a file called **my_output.csv** appeared in the **csv_output/** directory.
Compare **my_output.csv** to the **example_output.csv** and consider how the responses are similar and different.

Note: CSV data files simply consist of columns and rows. They can be opened directly inside of Microsoft Excel or Google Sheets. They can also be opened with free online tools for further data visualization and analysis.

Part 5

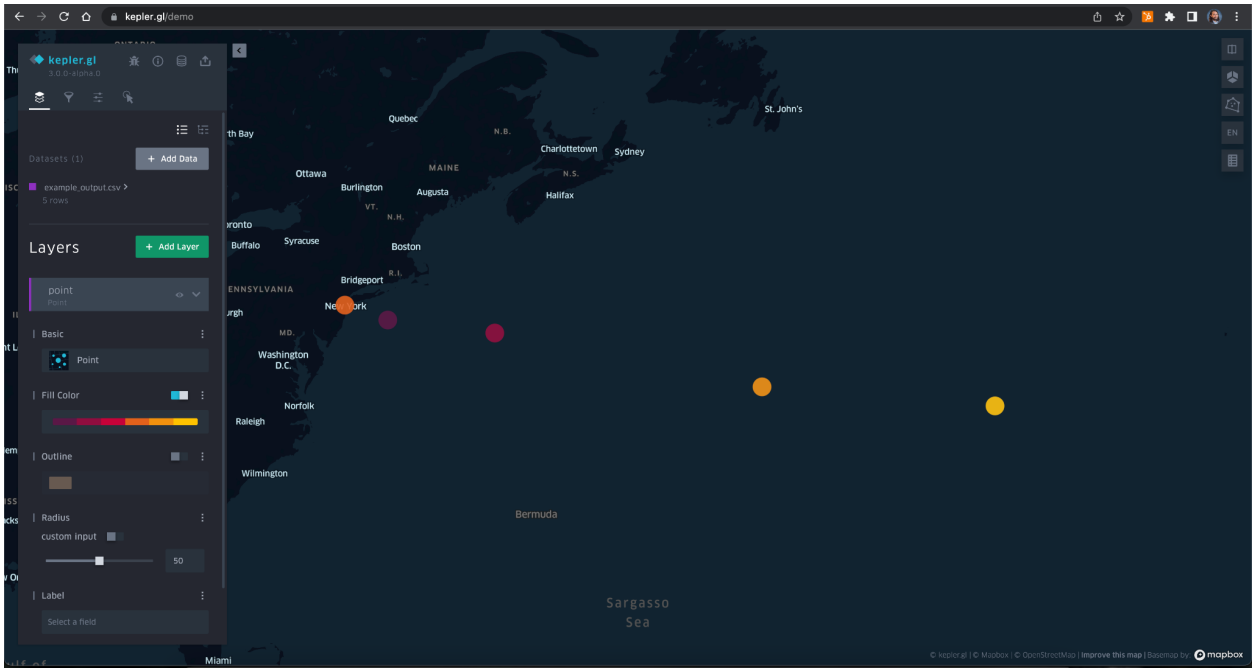
Visualize your CSV weather data.

Open Kepler in a web browser: https://kepler.gl/demo
Kepler is a free online visualization tool for putting data on maps.

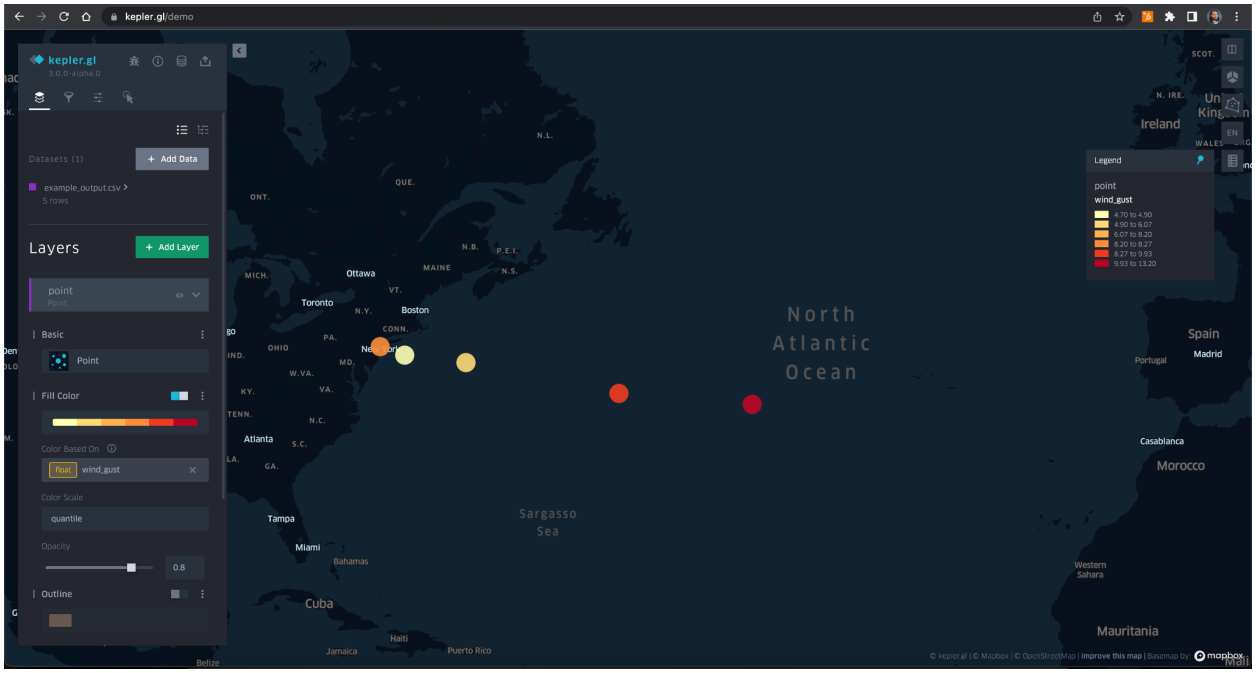


Drag your CSV data file into the "Drag & Drop" section of the Kepler webpage.
A map should load with your waypoint coordinates visualized.

On the left side of the page, under "Layers", you should see an item called "point".
This is the visualization configuration for your waypoint coordinates.
Click the down arrow to expand the configuration options.
Increase the Radius from the default of 10 to something higher (e.g. 50) to more easily see the visualized points.

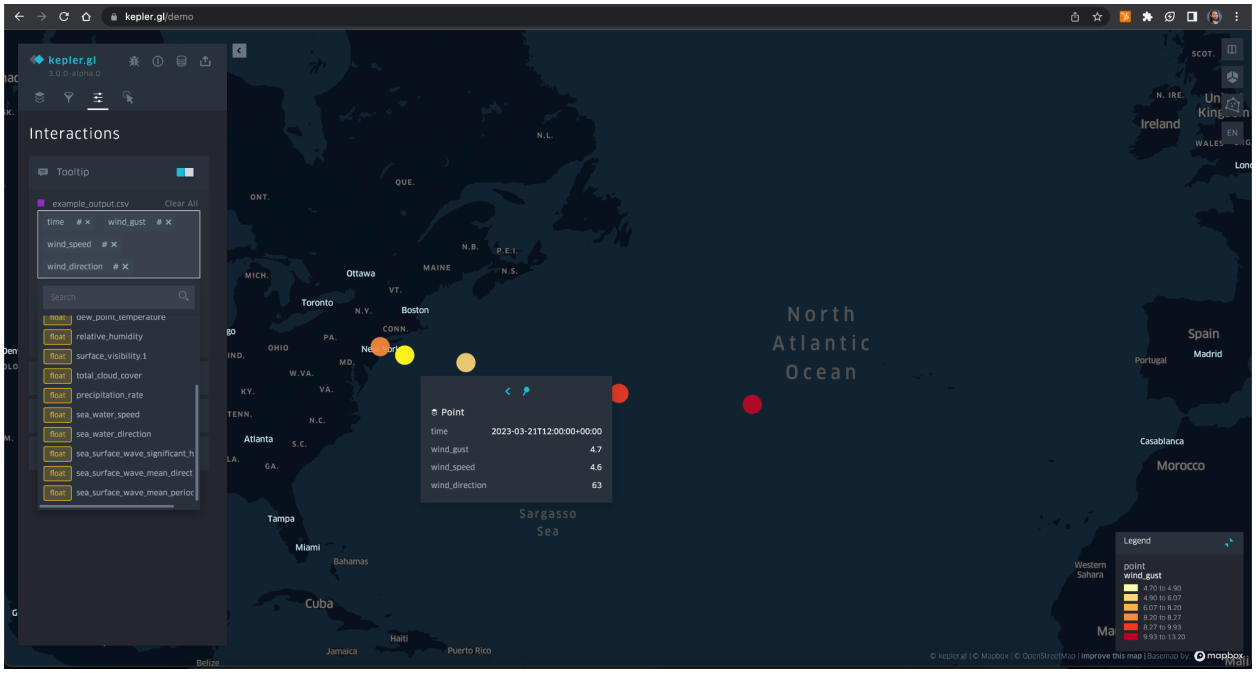


Next to the "Fill Color" option, click the three vertical dots button.
Here, you can click on the color bar to change the color scheme.
You can also change the weather field that is being visualized, which in this example is `"wind_gust"`. *Note: by default, the API returns data in metric units. Check the data descriptions at the end of this PDF to see which units apply to each data field.*

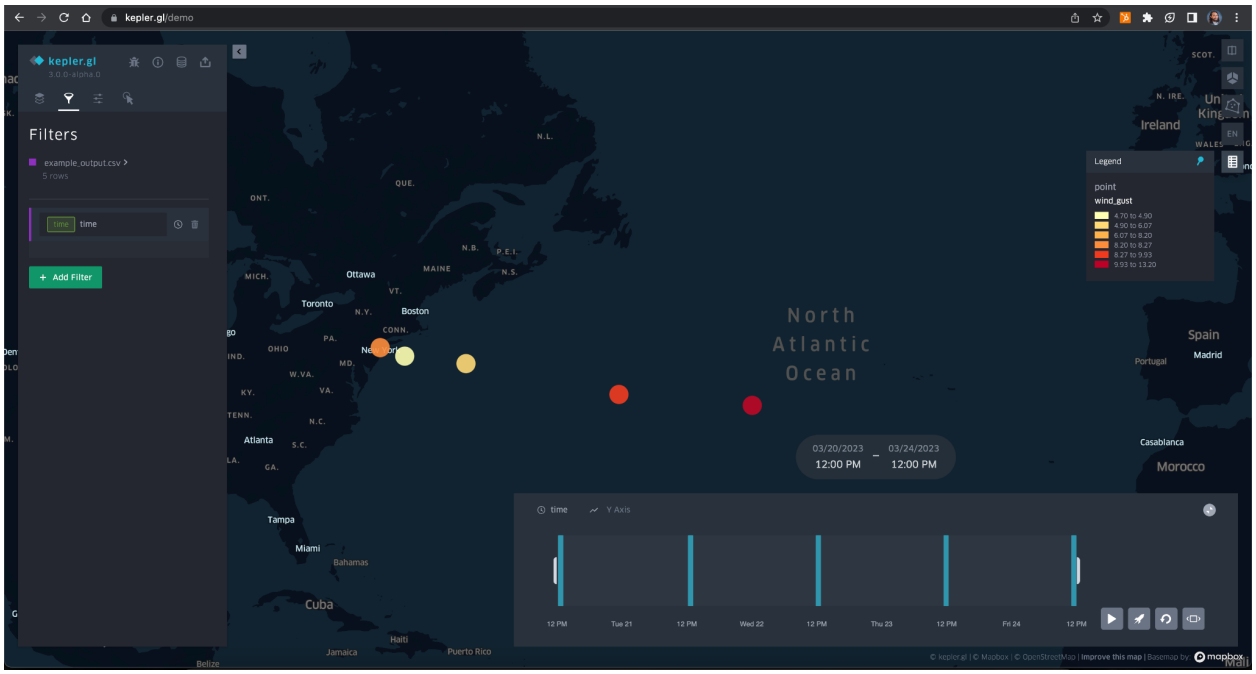


In the top right corner of the page, the bottom icon in the stack toggles the legend.

Clicking on one of the visualized points will display some of the weather data for that waypoint. The fields that are shown in the popup tooltip box can be configured using the options on the left panel. *Note: click the icon with three sliders.*



Using the left configuration panel, you can also create filters for the data based on data fields. *Note: click the filter icon next to the icon with the three sliders.*



One especially interesting field to filter with is `"time"`, which will generate a range

slider that you can use to scroll through time or even animate ship movement by pressing the play button.

Part 6

Apply your new knowledge to make weather-informed decisions.

If you've made it this far, ***Congratulations!***
You can now check the weather along a ship's future voyage.

Use the internet to search for popular shipping routes between major ports.
Use the skills you've learned to request weather data along these routes.
Check different weather fields (e.g. wave height, wind speed) to see if any segments of the route have "bad weather".

As a bonus:

- Try to understand what "bad weather" means for a ship at sea. When are waves considered too high? When are winds considered too strong? *Note: the answers will vary depending on different ship types and cargos.*
- Try to make the `"time"` values of your waypoints as realistic as possible. To do this, you will need to use the ship's average speed. This will also depend on the type of ship you select to investigate.

Thank you!

Thank you for your effort and participation.
Hopefully you've learned a few things along your voyage.
This document and the starter code were prepared by:

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If you liked this exercise and want to learn more, or if you have any questions about maritime weather, please feel free to email and we'll gladly share more information.

Weather Data Descriptions and Units

Basic Bundle (basic)

Field Name	Vertical Level	Description	Units
Temperature	2 meters AGL	Air temperature at standard observation height (2 meters above the surface)	K
Relative humidity	2 meters AGL	The fractional ratio of the partial pressure of water vapor to the equilibrium vapor pressure at a given temperature expressed as a percentage	%
Dewpoint temperature	2 meters AGL	Temperature at which a parcel of air cooled at constant pressure and specific humidity reaches saturation	K
Wind speed	10 meters AGL	Wind speed at 10 meters above ground level	m/s
Wind direction	10 meters AGL	Wind direction at 10 meters above ground level	Degrees
Wind gust speed	10 meters AGL	Instantaneous wind gust (speed) at 10 meters above ground level	m/s
Mean sea-level pressure	Sea level	Air pressure adjusted to mean sea level	Pa
Precipitation Rate	Surface	The instantaneous rate of precipitation valid at the top of each hour	mm/s
Accumulated precipitation	Surface	The total **accumulated** (liquid) precipitation occurring since the beginning of the forecast. Read more about working with accumulated fields.	mm kg/m^2
Maximum temperature	2 meters AGL	Maximum air temperature in the previous six hours	K
Minimum temperature	2 meters AGL	Minimum air temperature in the previous six hours	K

Cloud Cover	Whole atmosphere	The percentage of the sky covered by clouds	%
Visibility	Surface	The horizontal visibility	m

Maritime Bundle (maritime)

Field Name	Vertical Level	Description	Units
Sea Surface Temperature	Sea level	The temperature of the ocean surface	K
Sea Water Speed	Sea level	The speed of the ocean currents	m/s
Sea Water Direction	Sea level	The direction of the ocean currents	Degrees
Significant Wave Height	Sea level	Wave heights of combined swell and wind waves	m
Mean Wave Direction	Sea level	Mean wave direction of combined swell and wind waves	Degrees
Mean Wave Period	Sea level	Mean wave period of combined swell and wind waves	Seconds
Ocean Salinity	Sea level	The amount of dissolved salts that are present in water.	kg/kg