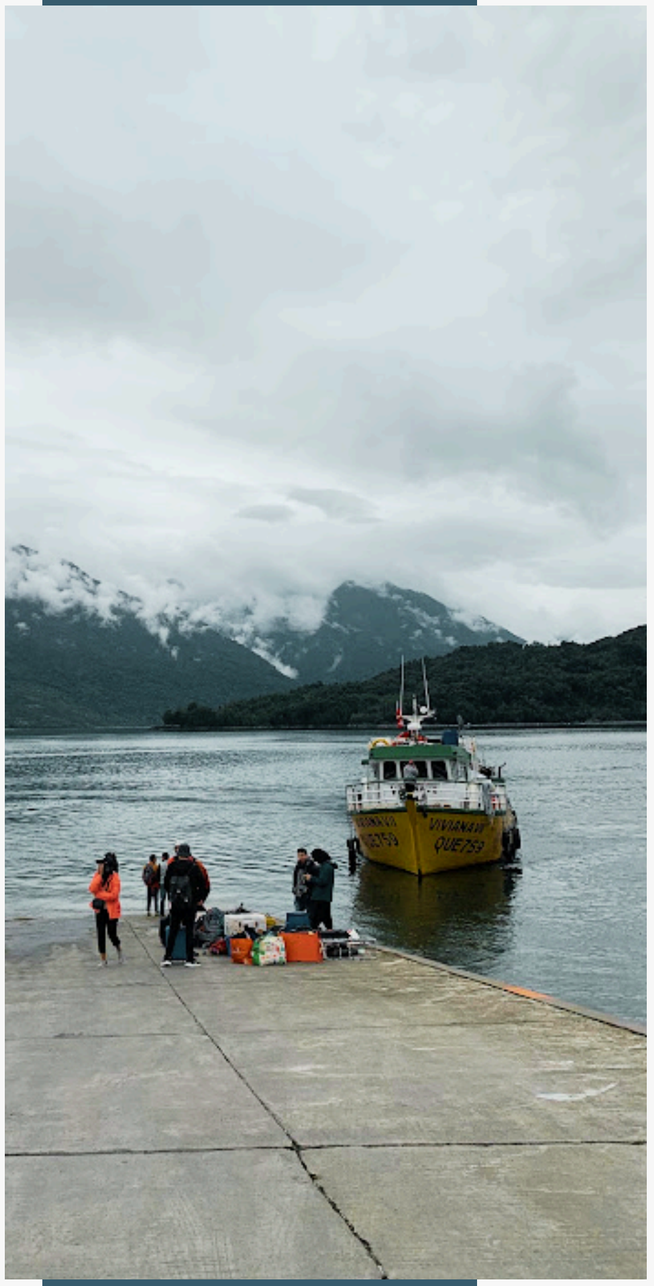
Studying Underwater Currents



Learning Goals

1. Explain why it is important and challenging to measure ocean transport, and describe a method oceanographers use to collect these measurements.
2. Apply the basic principles of neutrally buoyant ocean floats such that they can predict the impact of volume and mass change on the buoyancy of these objects.
3. Identify sources of error, both in the laboratory and the ocean, and consider design choices to mitigate these uncertainties.

Oceanography

Three main disciplines that rely on eachother

Biological

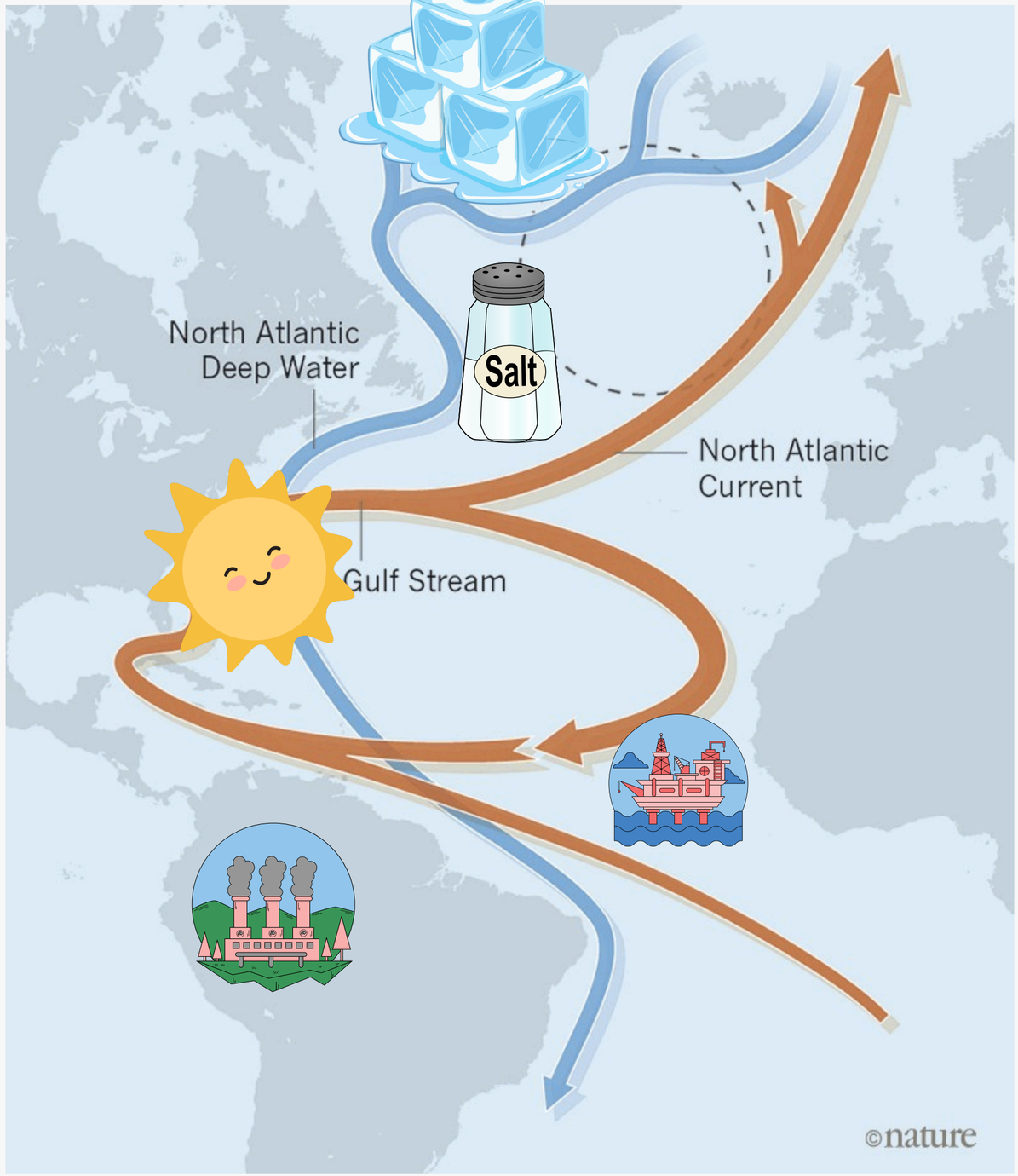
Interaction of living organisms and their environment.
*Not the same as marine biology

Chemical

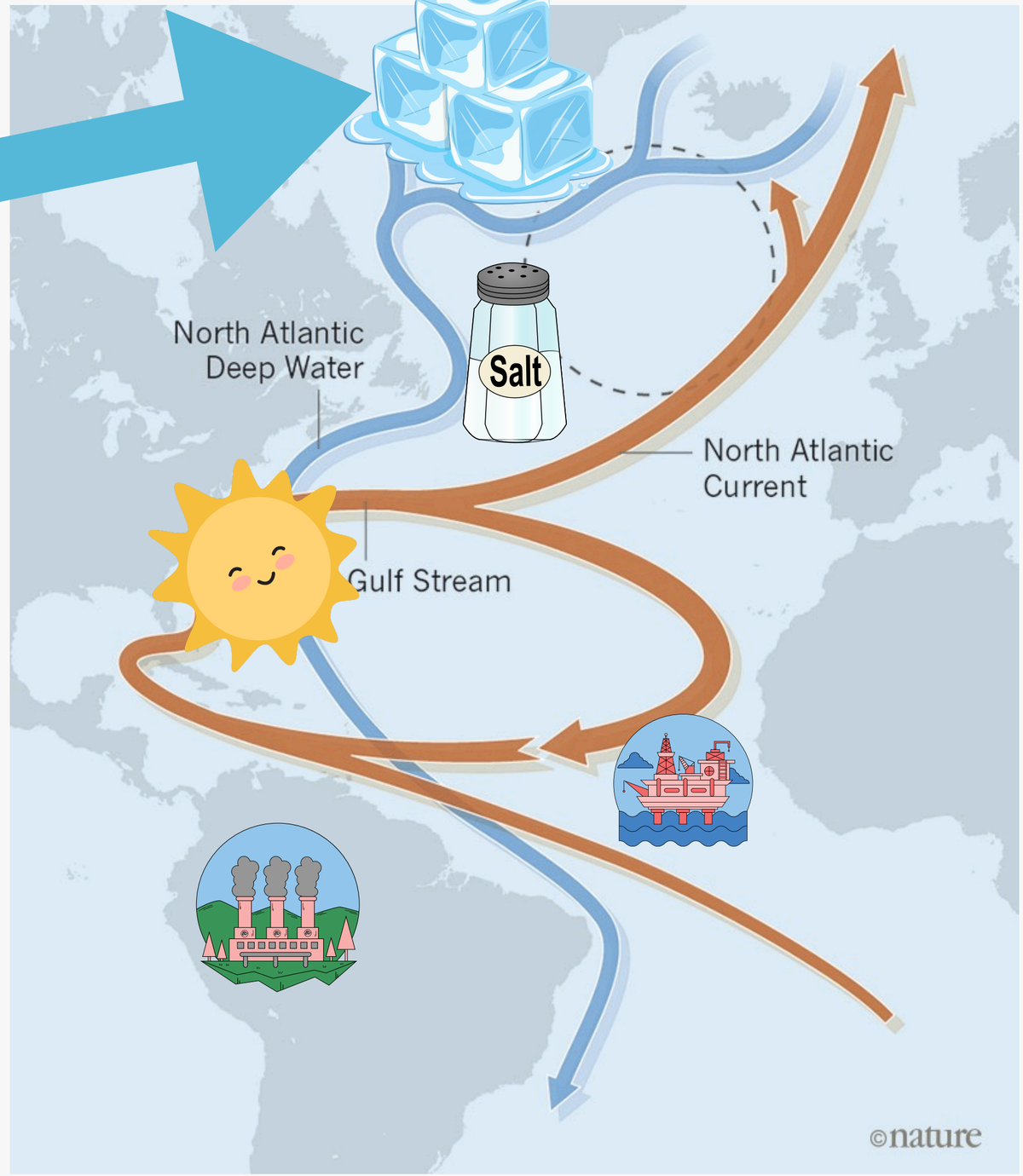
Processes that control the transport and cycling of chemicals and elements.

Physical

Dynamics that govern the movement and mixing of seawater and its properties.



Care about the motion of the ocean (and how its changing)



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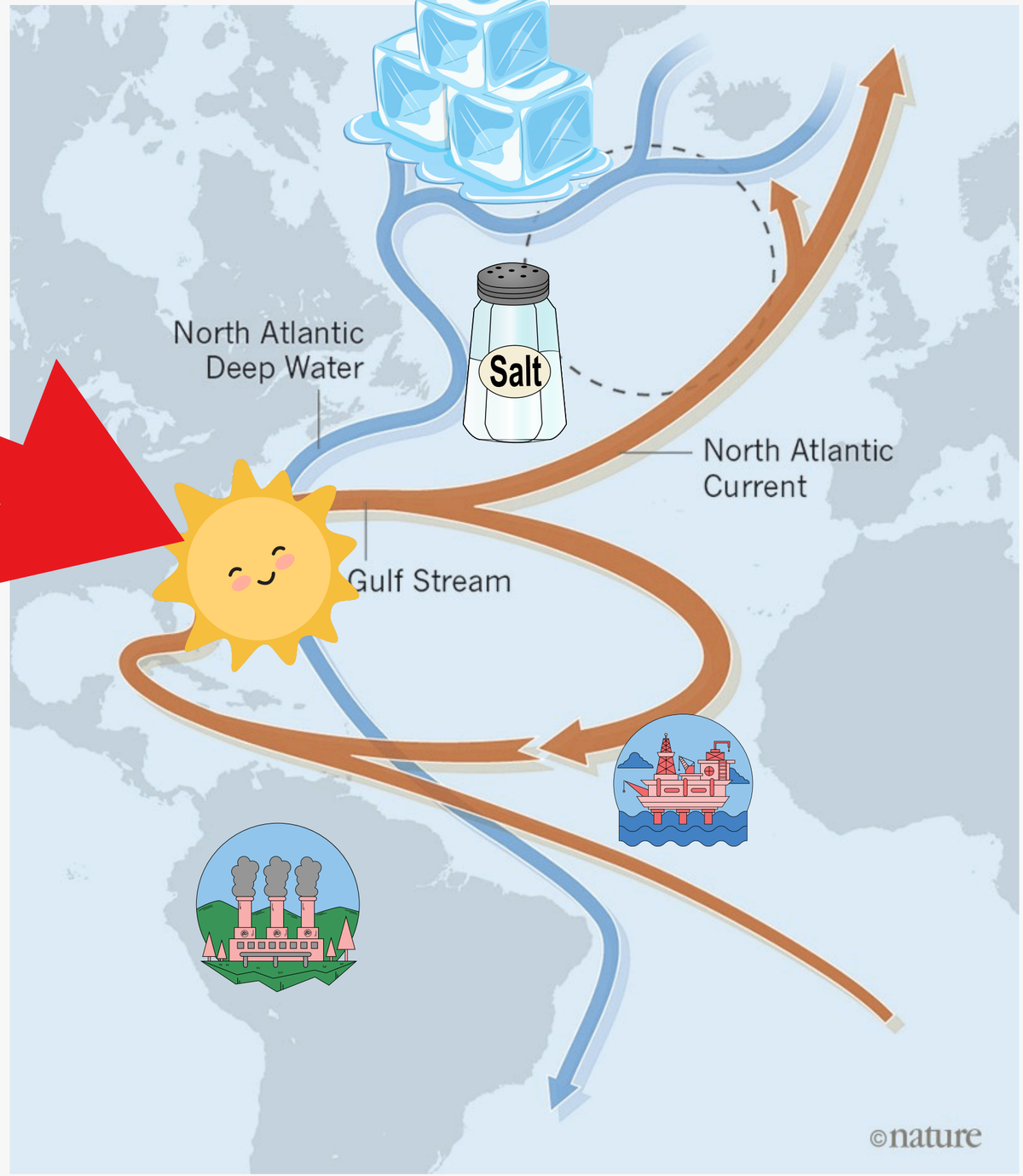

Care about the motion of the ocean (and how its changing)

How we get answers

Lagrangian Tracking

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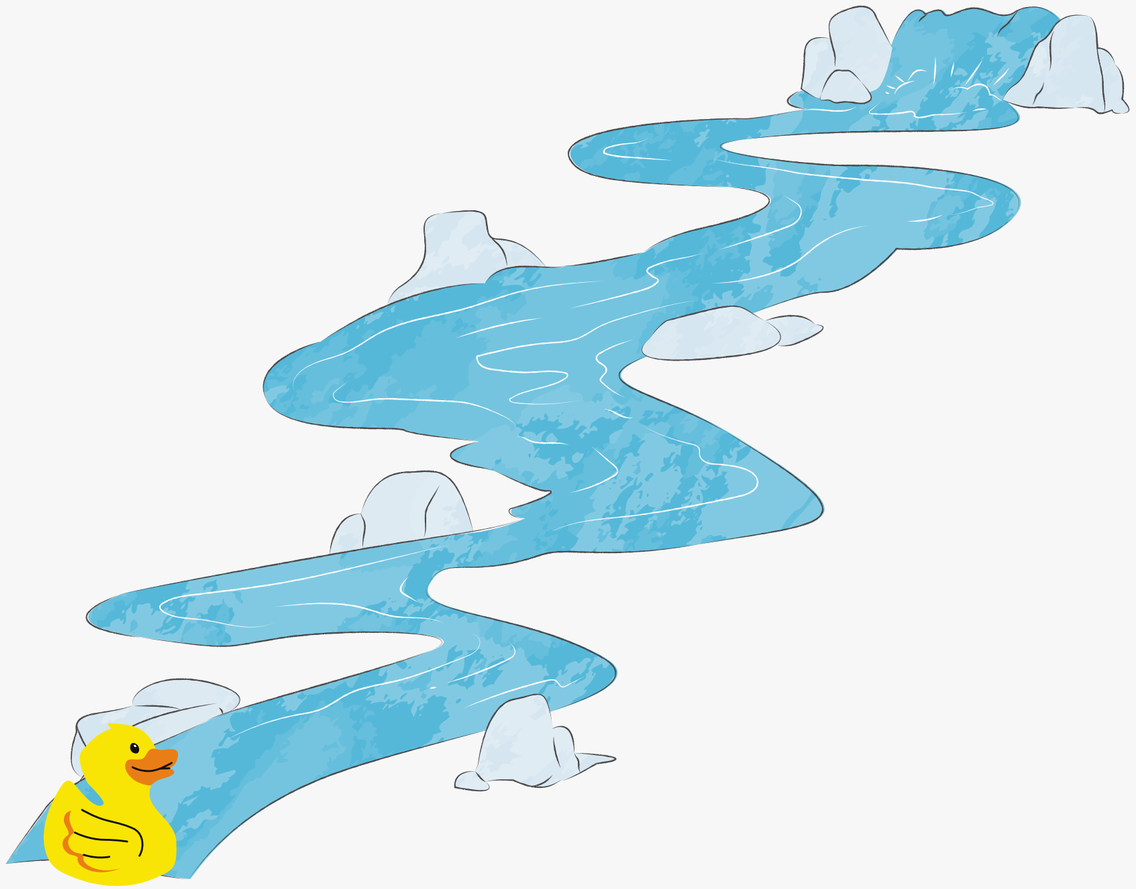
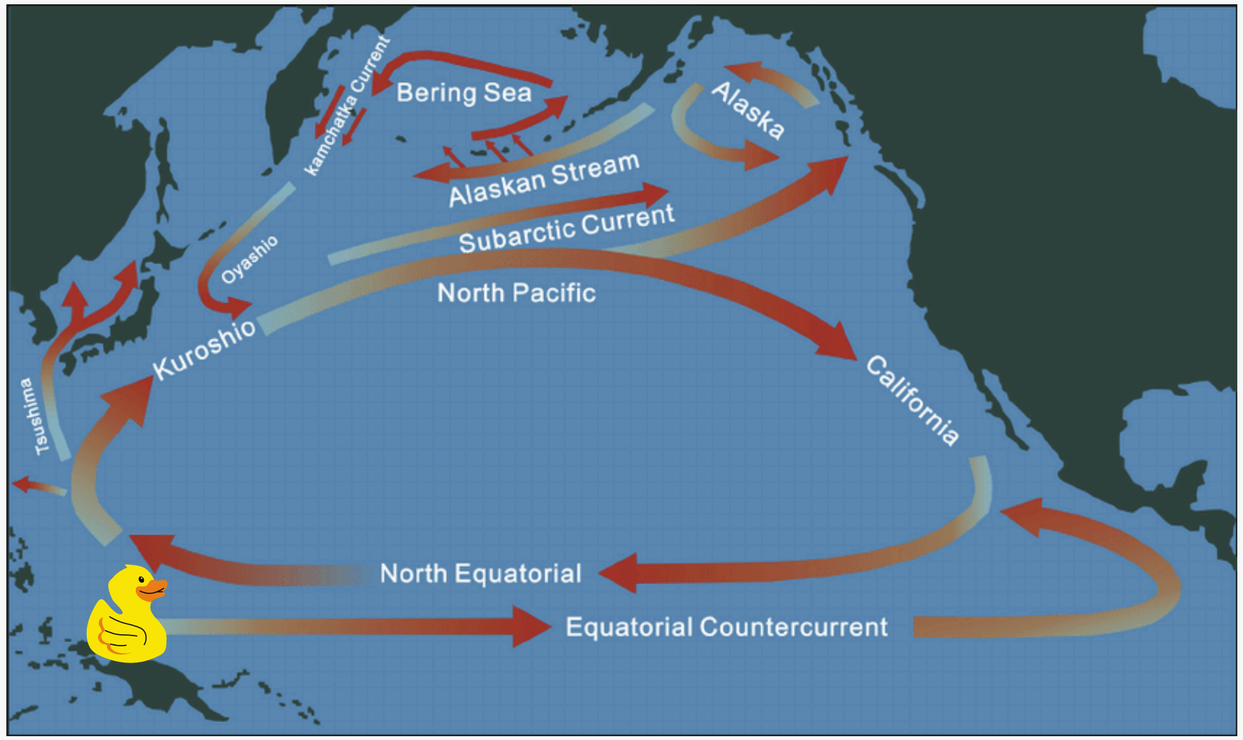
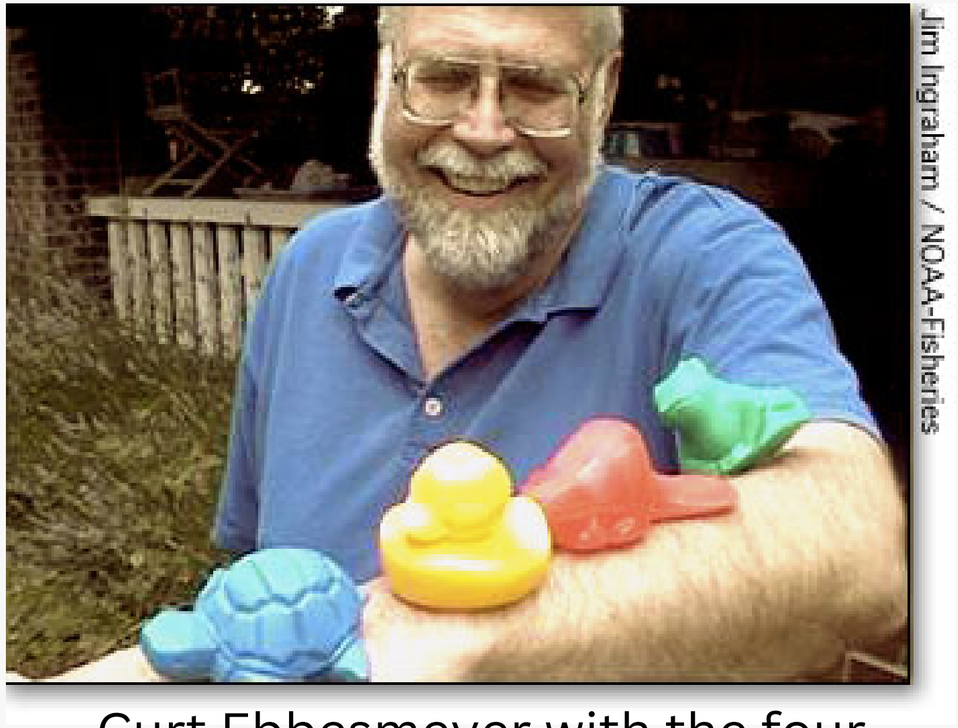
Lagrangian Tracking





How we get answers

Lagrangian Tracking



Curt Ebbesmeyer with the four types of toys that fell overboard

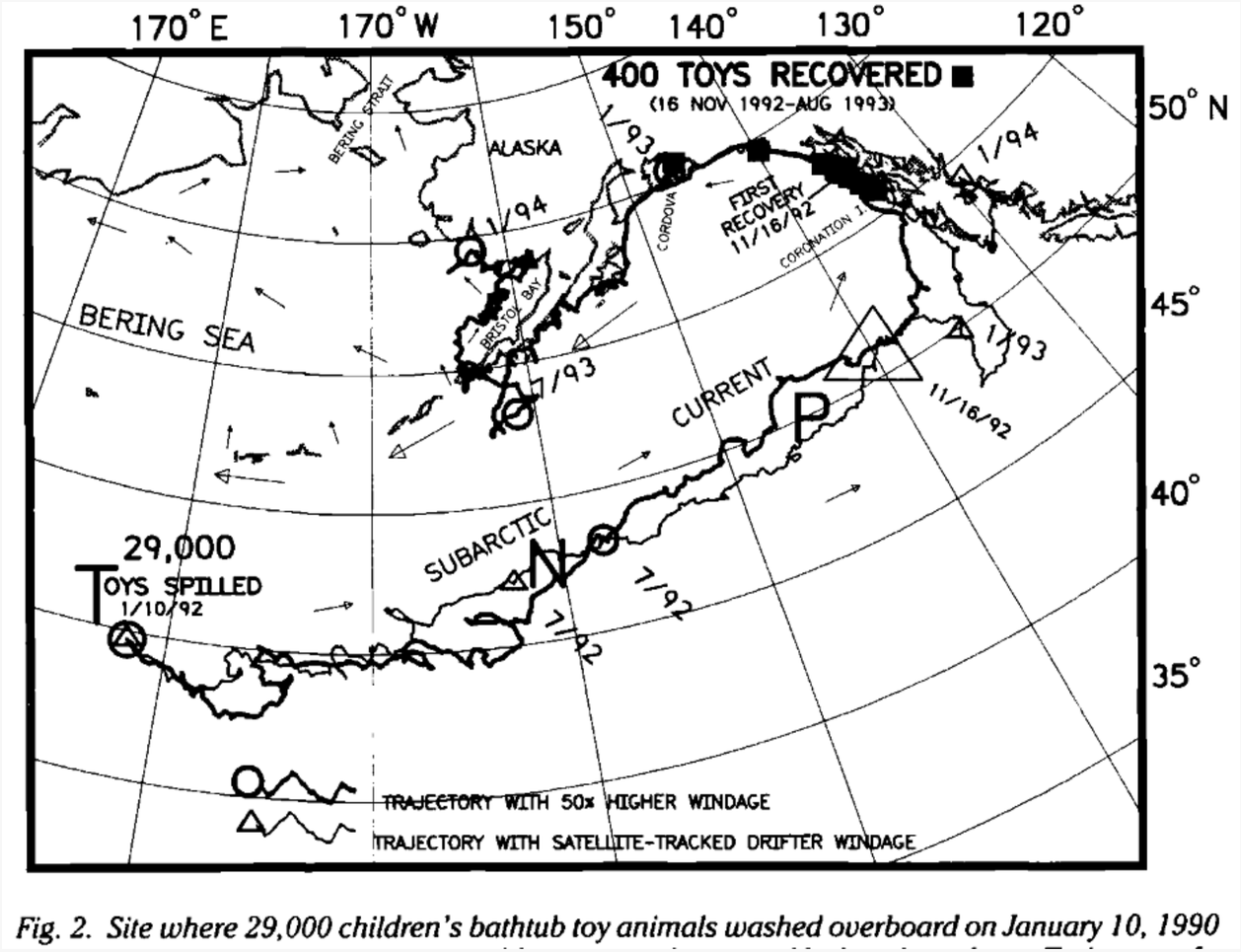
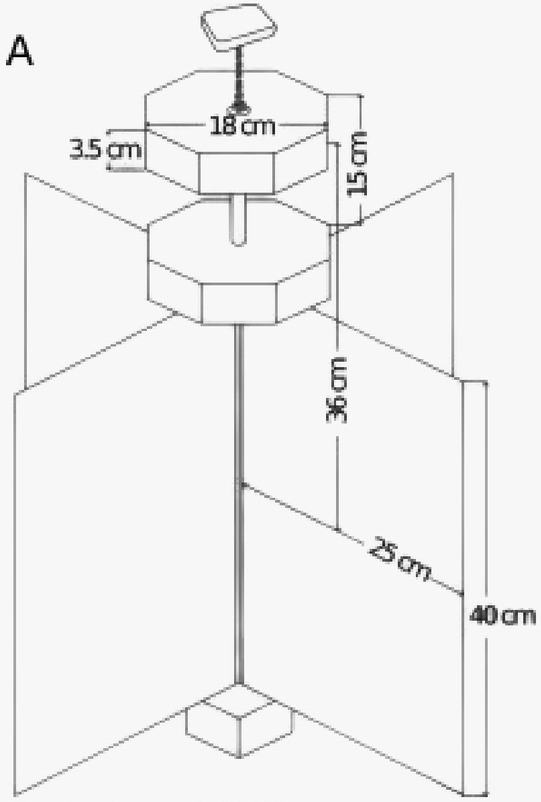


Fig. 2. Site where 29,000 children's bathtub toy animals washed overboard on January 10, 1990

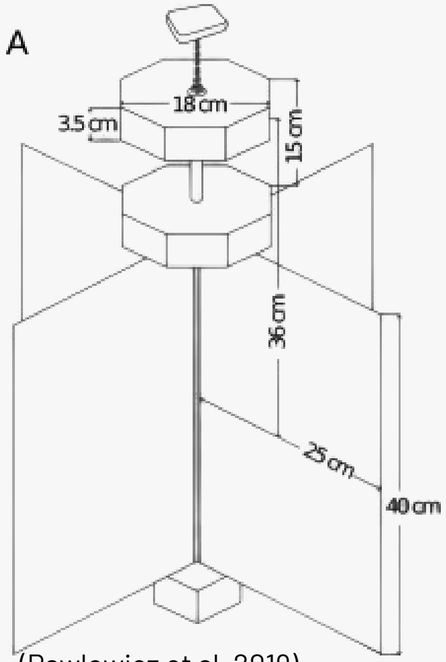
(Ebbesmeyer & Ingraham, 1994)

Surface Drifter



(Pawlowicz et al. 2019)

Sub-surface float



(Pawlowicz et al. 2019)

Considerations when Making Lagrangian Measurements

- What depth are you measuring at? How can you get/keep your drifter at this depth?
- What factors may affect the movement of your drifter? Are these all things you want to measure? If no, how do you minimise measuring these?
- How is the location and time recorded?
- Do you need to collect your drifter after its "done" following a track?
- What's your budget?

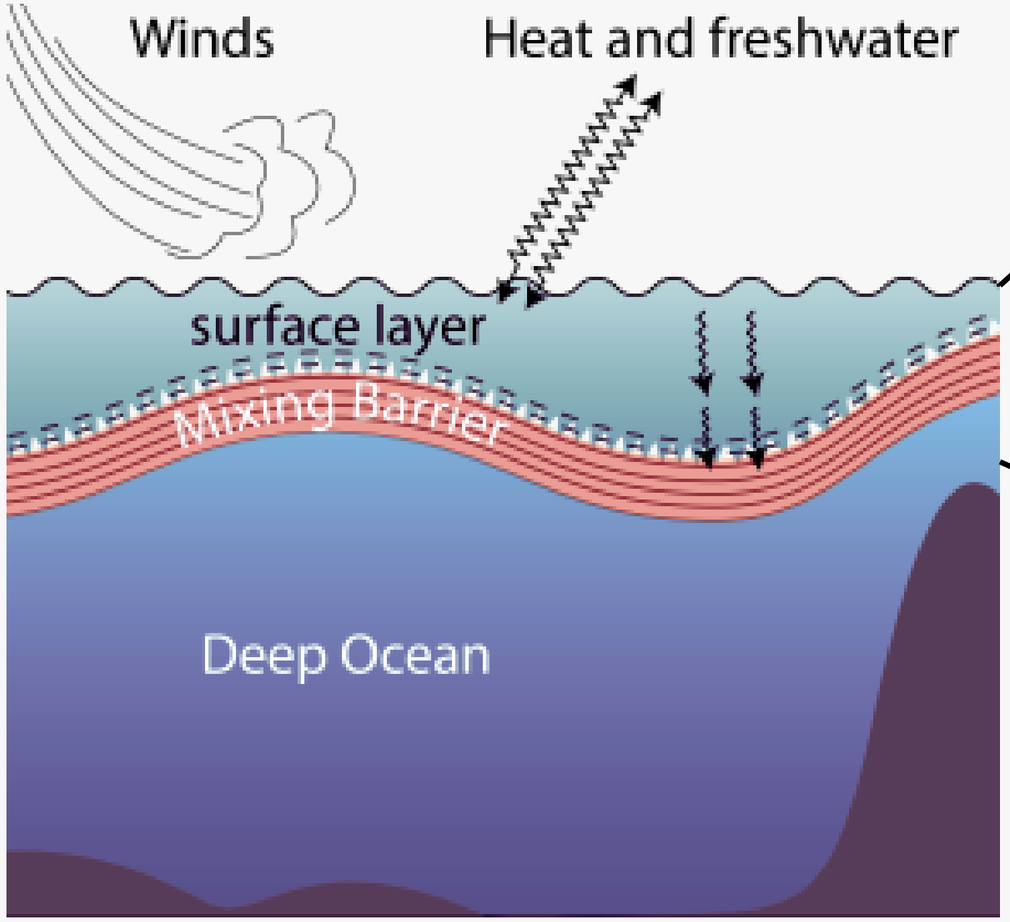
Your Challenge

Prototyping a sub-surface drifter

Overview

Ocean Layers

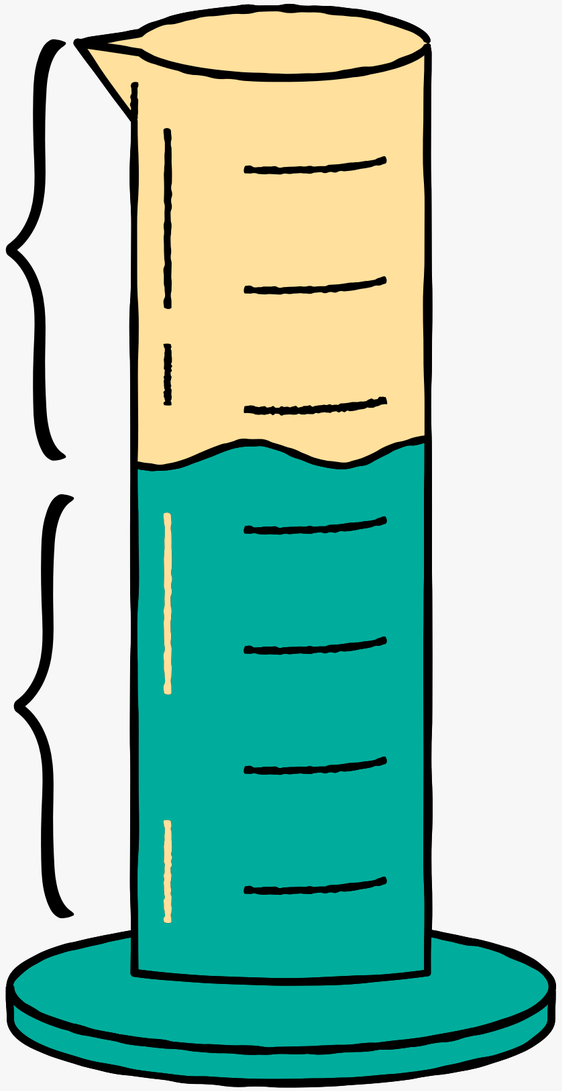
****Stratification** = the separation of ocean into vertical layers based on their density.
(warm/fresh water sits on top of cold/salty water)



Jean-Baptiste Sallée, 2021

Surface mixed layer (oil)

Deep ocean (water)



Overview

Depth targeting

Neutral buoyancy - to target a depth the drifter must have a weight equal to the weight of the fluids its displacing

$$F_{gravity} = F_{buoyancy}$$

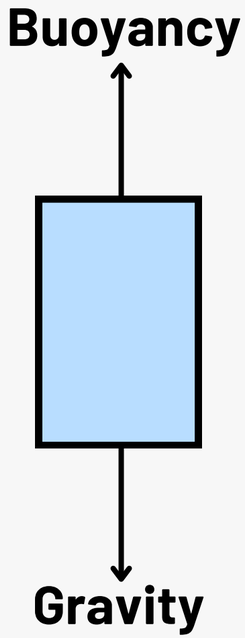
$$m_{drifter} g = V_o \rho_o g + V_w \rho_w g$$

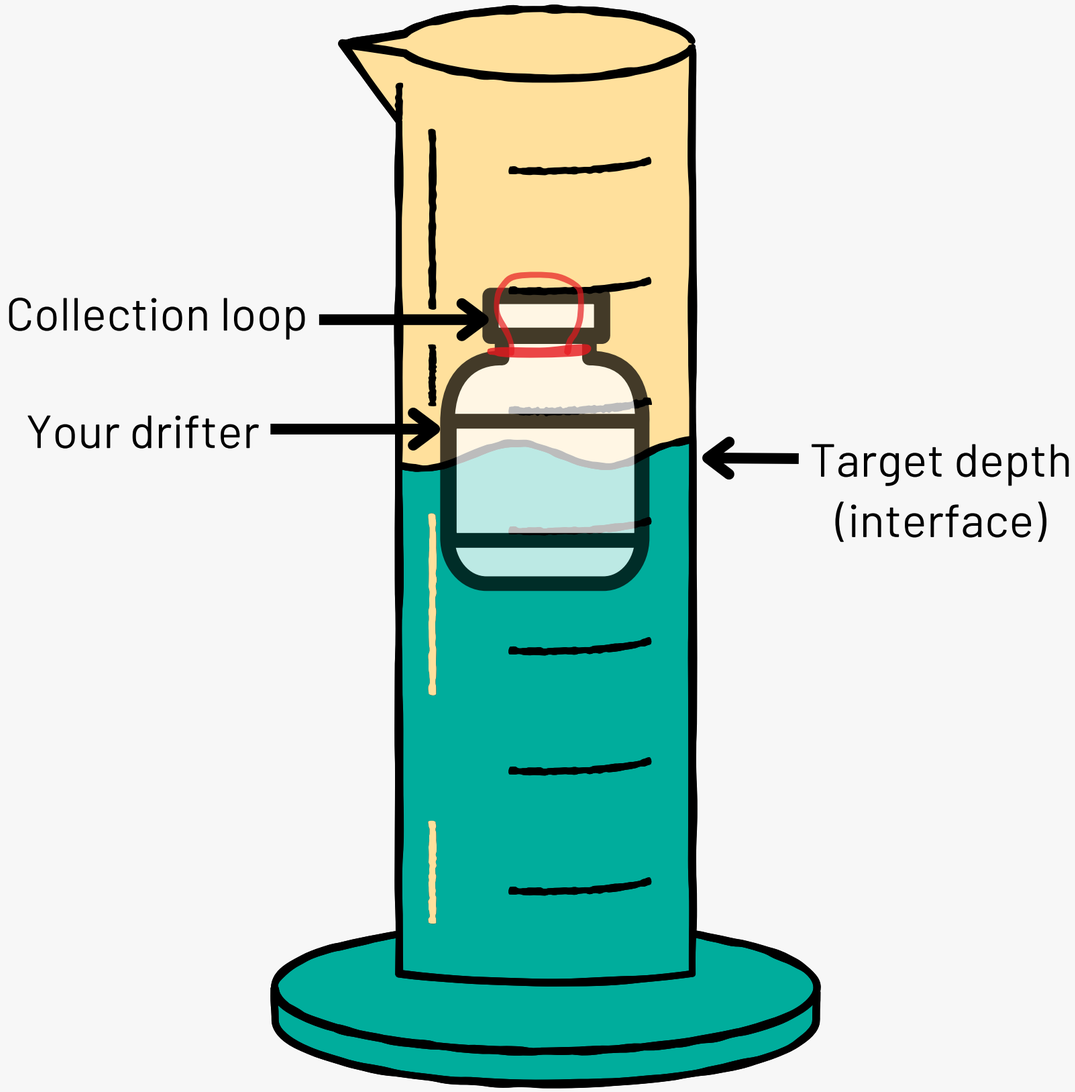
mass

gravity

volume

density



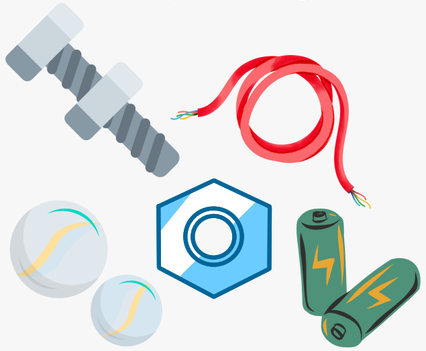


Materials

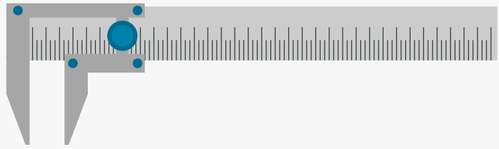
Laptop or calculator- to calculate volumes and densities

Drifter casing (nalgene sample bottle)

Bits and bobs (for drifter weight and collection loop design)

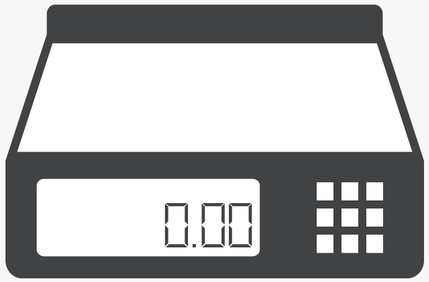


Calipers



Thermometer

Scale



Materials

Research budget! - these items have costs (marked on materials table) make your design as low cost as you can

Laptop or calculator- to calculate volumes and densities

Drifter casing (nalgene sample bottle)

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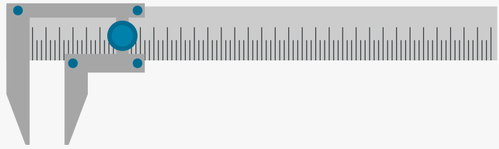
Calipers



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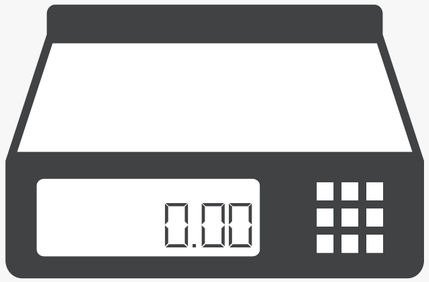

Time to test!

1. Use the code or calculator intructions to find the mass necessary to have it rest half in water, half in oil.
2. Make a float of the calculated mass (with a **collection loop** to get it out of the cylinder!).