FROST SCIENCE

DRIFTING SCIENCE

3rd - 5th Grade

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Overview

Students will explore global ocean surface currents by completing an investigation using real-world ocean drifter data. Students will analyze maps of ocean drifters to make observations about why they appear in some places more than others. Using the resources provided, they will then select a specific ocean drifter from an interactive map and predict where it may drift to, what currents it might be carried by, and where it might end up in a specific amount of time.

Classroom Time: 45 minutes

Objectives

By the end of this activity, students should be able to:

- Describe how moving water is a source of energy that can be used to move things, such as ocean drifters.
- Formulate questions about the connection between ocean currents and the use of ocean drifters and attempt reasonable answers to those questions using the resources provided.
- Keep records of their ocean drifter investigation, such as a map or graph.
- Understand how technology and other tools, such as ocean drifters, extend the ability of humans to observe various ocean characteristics.

Key Messages

- Ocean currents are the predictable, directed movement of water that flows in the ocean.
- A gyre is a large system of circulating ocean currents.
- An ocean drifter is an object launched into the ocean by scientists to collect data about ocean currents.

Background Information

Ocean Currents

Ocean currents are the predictable, directed movement of water that flows in the ocean. These currents can occur near or at the surface or much deeper within the ocean. Deep water currents are influenced by density differences between waters at different depths due to temperature and salinity. This process is known as thermohaline circulation. Surface currents are ocean currents on or at the surface. In contrast to the deep ocean currents that are driven by water temperature and salinity, surface currents are influenced by global wind systems, the shapes of coastlines, the topography of the seafloor and the rotation of the Earth. Surface currents play a key role in transferring heat from the tropics to the poles. The Gulf Stream is one such surface current which begins in the Gulf of Mexico and ends in the Norwegian Sea. As it moves along the Florida peninsula, it pulls warm water from the waters along Florida's east coast. This strong, warm water surface current keeps the climate of Florida warmer in the winter and cooler in the summer than other southeastern states. The Gulf Stream carries this warm water to western Europe, where it keeps the climate much warmer than it would be without the current.

Gyres

A gyre is a large system of circulating ocean currents. Though there are different types of gyres found around the world, the five major ones are known as subtropical gyres. Both the Pacific and Atlantic Ocean have a gyre located in their southern and northern regions. The fifth major gyre is in the Indian Ocean. As the wind directs the surface currents of these gyres, the land masses set "boundaries" and the rotation of the Earth deflects the direction of the currents.

Drifters

To learn more about currents, scientists deploy drifters into the ocean. Drifters are scientific tools that scientists use to study ocean currents. Drifters are often outfitted with transmitters that allow scientists to track where they are in the ocean at any given time. They may also carry instruments to collect data, such as water temperature and salinity, as they drift along in the ocean. Drifters can help scientists study how pollution moves around the ocean and create models of climate and weather patterns.

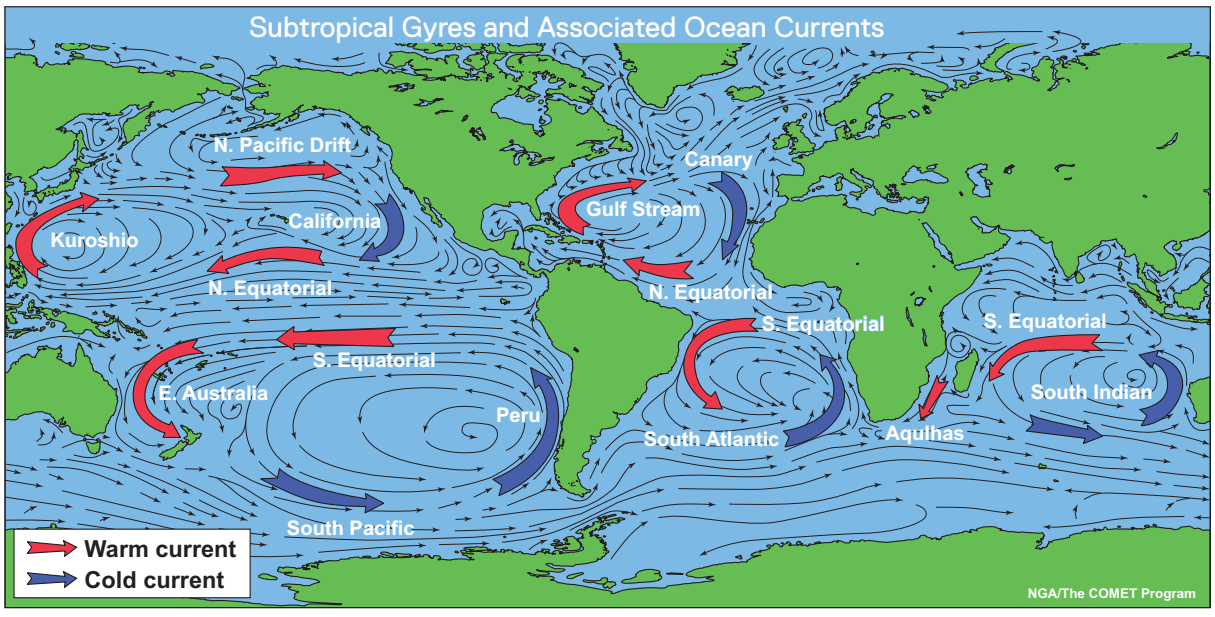

Image 1: Ocean Surface Currents; Ocean Blue Project

NOAA Global Drifter Program (GDP Array Map)

The National Oceanic and Atmospheric Administration (NOAA) satellite-tracks over 1,300 drifters around the world. Along with the scientific uses listed above, these drifters can help with weather forecasting, as they provide information about the atmospheric pressure above the ocean's surface in places where there are no permanent monitoring stations. This program is a part of NOAA's Global Ocean Observing System and the World Meteorological Organization, an agency of the United Nations. Scientists and governing bodies use this global observing system to monitor the ocean's role in our changing climate.

On the GDP Array map, you can change the colors of the dots and what the map shows by clicking "Map viewing options". The other map viewing options are:

- Buoy type which displays what the buoys are monitoring (sea surface temperature, atmospheric pressure and waves).
- Buoy drogue status which displays whether buoys are attached to a drogue or not. A drogue is a sea anchor which extends about 20 meters deep and is designed to move with near-surface currents.
- The map also shows us the number of deployed drifters. We can see GPS coordinates of each drifter by moving our mouse around.

Materials (per group)

- Pencil
- Colored pencils or markers
- Datasheet
- Drifter card example (for teacher)

Set-Up Procedure

On a projector screen, TV or Smart Board:
Open the Global Drifter Project on an internet browser

Activity Procedure

1. Ask students to imagine that they are a scientist who would like to study the ocean. Encourage them to think about a specific question they would like to answer.
    a. Encourage students to be specific. For example: If students say, "ocean currents", guide them to think deeper. What about ocean currents would they like to study? Some examples could be how fast ocean currents are or what creates ocean currents.
2. On the board or a large piece of paper/posterboard, create a list with the title "What do I want to know about the ocean?" and have students raise their hands to share something they would like to study about the ocean and how they would find that out. See some examples below:
    a. Temperature, how hot or cold the water is
    b. Salinity, how much salt is in the water
    c. Height of ocean waves
    d. Depth of the ocean
    e. Hurricane formation
3. Explain to students that we are going to be exploring the use of ocean drifters, which can be used to measure many different parameters in the ocean.
4. Pass out the Drifting Science datasheet.
5. Open the Global Drifter Project interactive map on a Smart Board or screen for all students to see.
    a. If all students are assigned laptops, you can also have them pull this up on their own computers and give them a chance to click around on it first before asking them this question.
6. Share with students that this is a global map of ocean drifters. Ask students if they can define what an ocean drifter is with the information provided.

7. Next, just by looking at the webpage, ask students to describe some important characteristics of this map.
    a. The map is called GDP Array, which stands for "Global Drifter Project".
    b. We can see the date of the last update to the map.
    c. There are a bunch of different colored dots in the ocean. The dots represent the country that deployed the ocean drifter.
8. At this point they should understand that an ocean drifter is a tool that uses currents to move through the ocean.
9. Ask students to explain what an ocean current is and how a drifter might tell them more about ocean currents. Use some of the guided questions below:
    a. **Q:** What can ocean currents tell scientists about the ocean? A: How water moves around the ocean, how heat is distributed throughout the planet, they can make predictions about where garbage or oil spills may end up when it enters the ocean, and they can be used to help track storms and hurricanes.
    b. **Q:** What causes ocean currents? A: Ocean currents can be caused by wind (specifically surface currents), deep ocean currents are generally caused by the density differences caused by temperature and salinity differences, gravity and events like earthquakes.
10. Have students look at the GDP Array map and ask them to make observations about ocean currents based on the drifter map. Ask students the below guided questions for this discussion with the goal of them understanding ocean gyres and where they occur.
    a. **Q:** Are there drifters clustered anywhere? A: Drifters are clustered in between land masses. Allow students to think about why the drifters cluster there. While they share their thoughts, ask them to hold on to those ideas and apply them as they move through the activity.
    b. **Q:** Where do you see the most drifters clustered? Why might there be more drifters in that area than any others? A: Most of the drifters are clustered in the Pacific Ocean and Atlantic Ocean. Again, give students the chance to point out those areas where there are clusters, keeping in mind ocean currents and wind currents.
    c. Based on the map and where there are already drifters located, are there any areas you might deploy a drifter to learn more about that location?
11. Recall the questions that students answered about the locations of drifters as they viewed the drifter array. As students may have pointed out, there are drifters concentrated in between many of the continents in what are called gyres. Gyres are large systems of circulating ocean currents formed by global wind patterns, Earth's rotation and Earth's landmasses.
    a. They may have heard of the Great Pacific Garbage Patch which is located in the Northern Pacific Gyre.
12. Now that students know what a drifter is and where they may accumulate due to ocean and wind currents, explain that drifters often carry tools to study other aspects of the ocean such as temperature or salinity.
13. Briefly, turn back to the list they created with what they would like to study about the ocean. Ask what items were listed might be able to be studied with drifters.
14. Now that students are more acquainted with drifters and the GDP Array map, group them into pairs or small groups.
15. Each pair or group will select a drifter from the map and predict where the drifter will end up in one month, six months and a year from now.
    a. Tip: If this is too advanced for your students, do this as a class.
16. To do this:
    a. Have students click on the drifter to view information such as when it was deployed, when it last submitted location data and sea surface temperature data. They can click on this drifter ID card to make it larger and easier to see.

b. Ask students to also look at the two charts on the bottom. The first chart shows where the drifter is located on the map and the second chart shows the track the drifter has followed up until this point in time. This will be helpful to them when predicting where the drifter will move next.

c. Ask them to view the map of ocean currents on the back of their datasheet. Explain that this map will help them answer the questions on their datasheet as it shows ocean currents and the directions they move. Students should view this map to help them determine where their drifters may travel in the future and how it arrived in its current location.

17 When students finish their investigation, allow them some time to share their predictions with their classmates. Below are some guided questions to ask while they do so:

a. Where is the drifter currently located? When was it deployed? Has it moved much since it was deployed? What current do you think is responsible for moving the drifter to its current location?

b. Where do you predict the drifter will end up in a month? 6 months? A year?

c. What information did you use to predict where the drifter would end up? Is the drifter moving with the same current it previously used or do you predict that it ended up in a different current?

LESSON EXTENSION

Frost Science adopted a drifter from the Monterey Bay Aquarium Research Institute specifically for use during this lesson. Open the data sent to you by Frost Science and show students where this drifter is located and where it has been.

Repeat the steps from the previous portion of the lesson and have students predict where this drifter may end in a month, 6 months and 1 year. Either collect this information from your students or have them keep it in their folder/desk. As you continue to monitor this drifter throughout the school year, have students check their predictions to see how they match up with the real-time data provided by the drifter.

Cultural Relevancy

In Japan, the Pacific Ocean's Kuroshio Current supports a large fishing industry and is thus very economically important. No place in Japan is more than 100 miles from the sea. Not surprisingly, seafood is the main source of protein for the people who live there. The Kuroshio is one of the major ocean currents. It begins east of the Philippines and flows northeast past Taiwan and Japan. The water at the surface around this current is nutrient poor but the Kuroshio current transports a lot of nutrients within the subsurface layers from south to north, allowing many different types of fish to dwell within this region. Many of these Kuroshio species, such as skipjack, lobster and turban snails, are offered in traditional ceremonies at shrines within Japan.

The Bering Strait is another notable place where ocean currents have important cultural meaning. The Bering Strait lies between the Arctic and Pacific Oceans and is the only marine gateway between the two. The Indigenous people who live in this area rely heavily on marine mammals to feed their communities. Ocean currents can influence the food found within the ocean, like Kuroshio current does in Japan, but they also influence the movement of sea ice. Many of the marine mammals hunted by these Indigenous groups are ice-associated mammals such as walruses and ringed, bearded, spotted and ribbon seals. These mammals use the sea ice to pup, rest, mate and escape from whales and other predators. Knowledge of these currents can help these Indigenous communities locate where these animals may be or where they might end up when hurt or lost. These groups also use the currents to help them to forecast the weather when out hunting on the ice. Knowledge of how currents move the ice and predict the changing of the weather has been passed down from older generations to younger ones to maintain unique and living bodies of traditional knowledge.

The Polynesian people are another group to whom the ocean is incredibly important. Polynesian people

were skilled navigators who used the stars to find their way around. They were also very observant of the ocean and its movement as they sailed around the Pacific in dugout voyaging canoes. They shared their knowledge orally and from the stick charts they made. Stick charts not only included where islands were located but included curved fibers to indicate the direction of currents, waves and wind patterns. Some native Polynesians today still use these traditional wayfinding methods.

Formative Assessment

To evaluate learning and identify any misconceptions, struggles and leaning gaps, include the following formative assessment at the end of the lesson. Focused listing is a practice that asks students to list as many concepts, facts and ideas as they can recall from the prior instruction. Have students label the top of a blank sheet of paper 'Ocean Drifters and Currents'. Give them a couple of minutes to write as many words, phrases or facts as they can that recall what they learned from the drifting science lesson. This can be completed individually or in small groups. When assessing these focused lists, look for similarities between the lists, noting what is missing from the lists that are critical to understanding the concepts presented to them in the lesson and what students could readily recall.

Notes/Safety Considerations

For the lesson extension, the deployment of the drifter can take up to four months depending on the availability of expeditions. Frost Science will reach out to you with more information once the drifter has been deployed and you can begin tracking.

Additional Resources

- Global Drifter Program - https://www.aoml.noaa.gov/phod/gdp/interactive/drifter_array.html
- Ocean Current Simulator - https://earth.nullschool.net/
- Ocean Currents - https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-currents
- Japan's Kuroshio Current - https://eos.org/editors-vox/the-kuroshio-current-artery-of-life

Florida Next Generation Science Standards

3rd Grade

SC.3.N.1.1 Raise questions about the natural world, investigate them individually and in teams through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.
SC.3.N.1.3 Keep records as appropriate, such as pictorial, written, or simple charts and graphs, of investigations conducted.

4th Grade

SC.4.E.6.5 Investigate how technology and tools help to extend the ability of humans to observe very small things and very large things.
SC.4.P.10.4 Describe how moving water and air are sources of energy and can be used to move things.
SC.4.N.1.1 Raise questions about the natural world, use appropriate reference materials that support understanding to obtain information (identifying the source), conduct both individual and team investigations through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.
C.4.N.1.4 Attempt reasonable answers to scientific questions and cite evidence to support.

5th Grade

SC.35.CS-CP.1.3 Identify, research and collect data set on a topic, issue, problem or question using age-appropriate technologies.
SC.35.CS-CP.3.2 Gather, organize and analyze information from digital resources.

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3rd-5th grade

Investigator Name _____

1. Where is the ocean drifter you chose currently located? _____

2. Place an X on the map above to represent the starting location of your ocean drifter.
   - Use a marker to plot where you think your drifter will be in 1 month.
   - Use a different color marker to plot where you think your drifter will be in 6 months.
   - Use a third color marker to plot where you think your drifter will be in 1 year.

3. Use the ocean current map to answer the following: What current or currents do you hypothesize your drifter will follow as it moves throughout the ocean?

_____

_____

4. Where did your drifter end up in 1 month? _____

5. Where did your drifter end up in 6 months? _____

6. Where did your drifter end up in 1 year? _____

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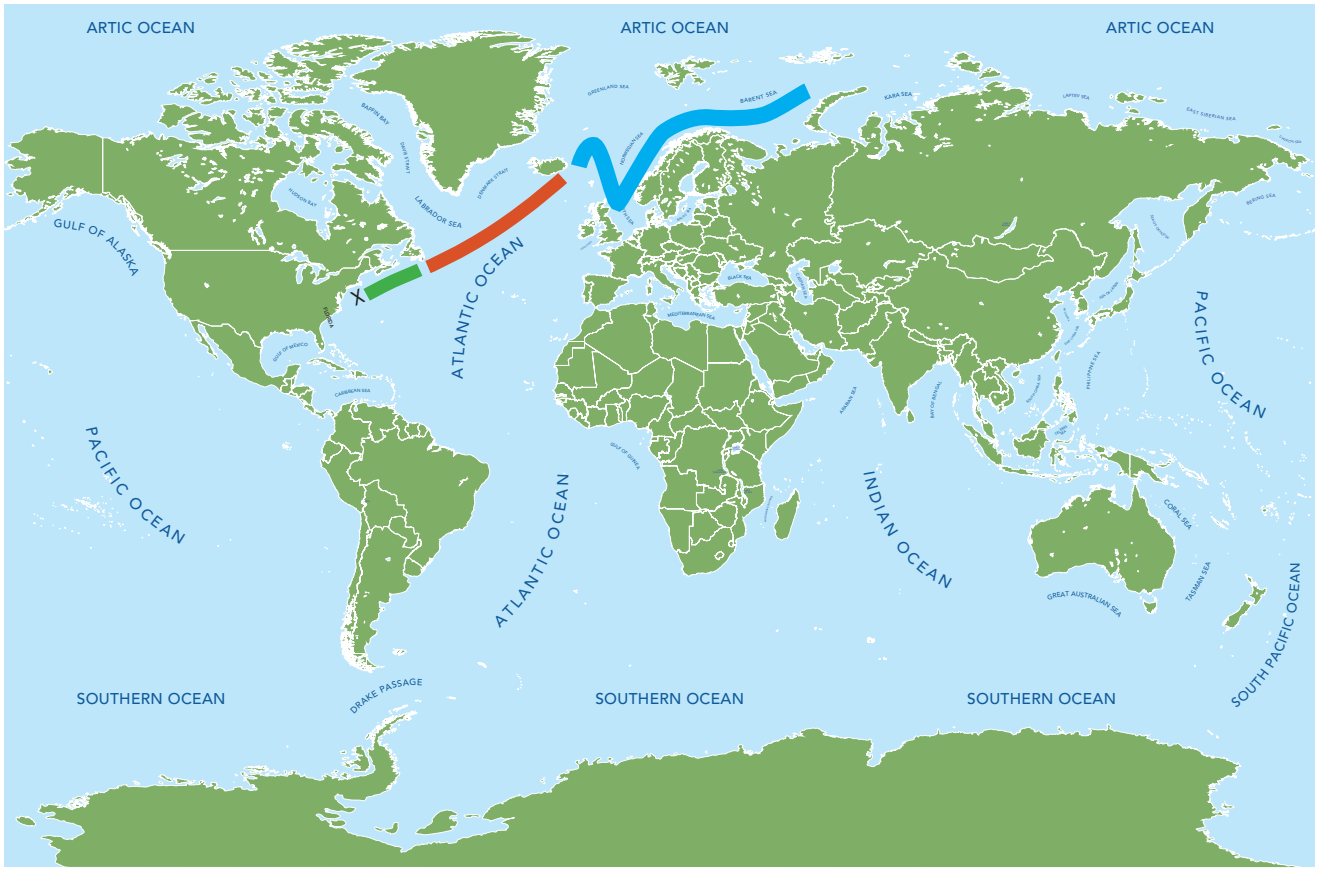
3rd-5th grade

Investigator Name _____



1. Where is the ocean drifter you chose currently located? *In the Atlantic Ocean off the coast of North Carolina*

2. Place an X on the map above to represent the starting location of your ocean drifter.
   - Use a marker to plot where you think your drifter will be in 1 month.
   - Use a different color marker to plot where you think your drifter will be in 6 months.
   - Use a third color marker to plot where you think your drifter will be in 1 year.

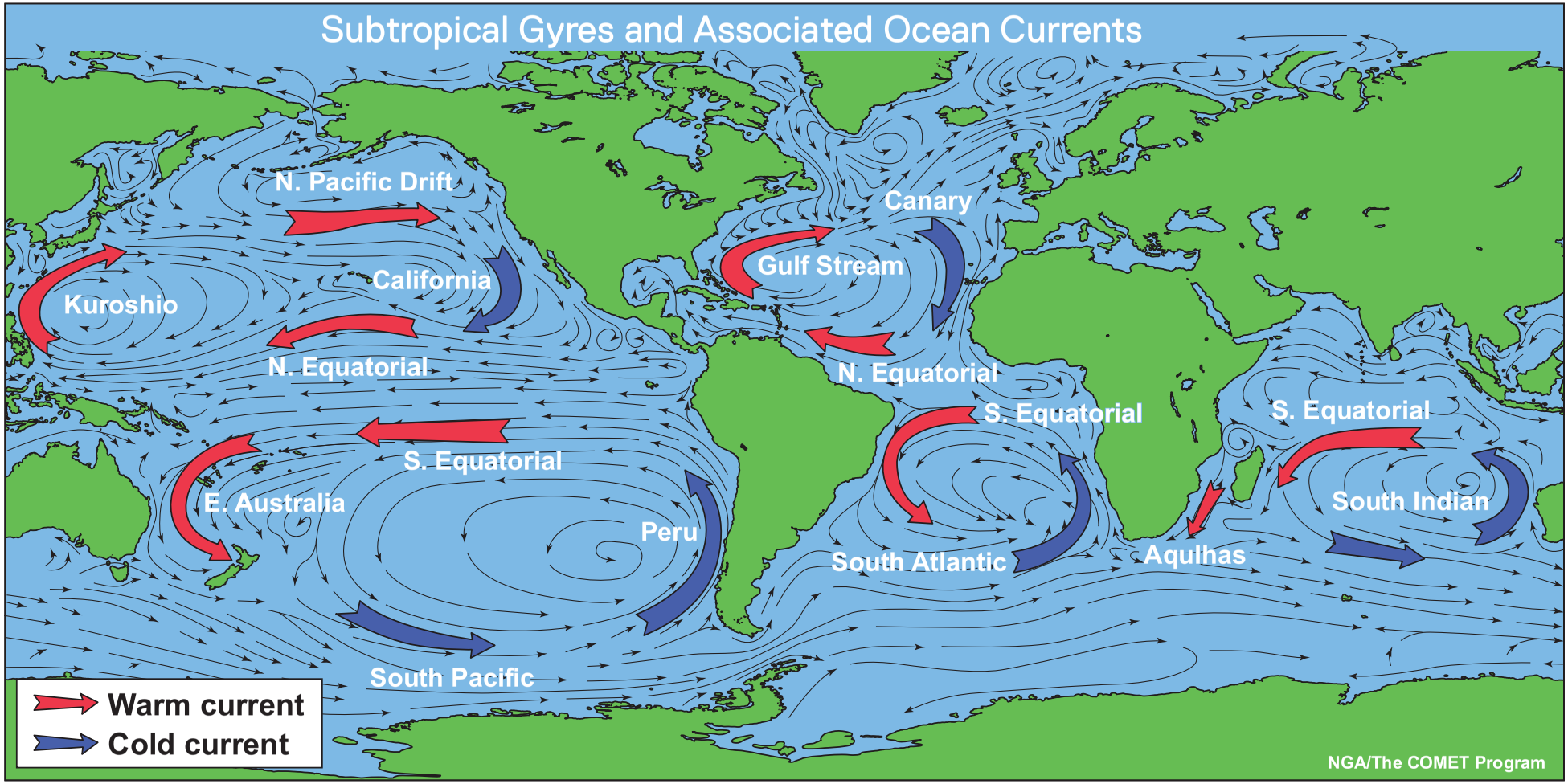
3. Use the ocean current map to answer the following: What current or currents do you hypothesize your drifter will follow as it moves throughout the ocean?

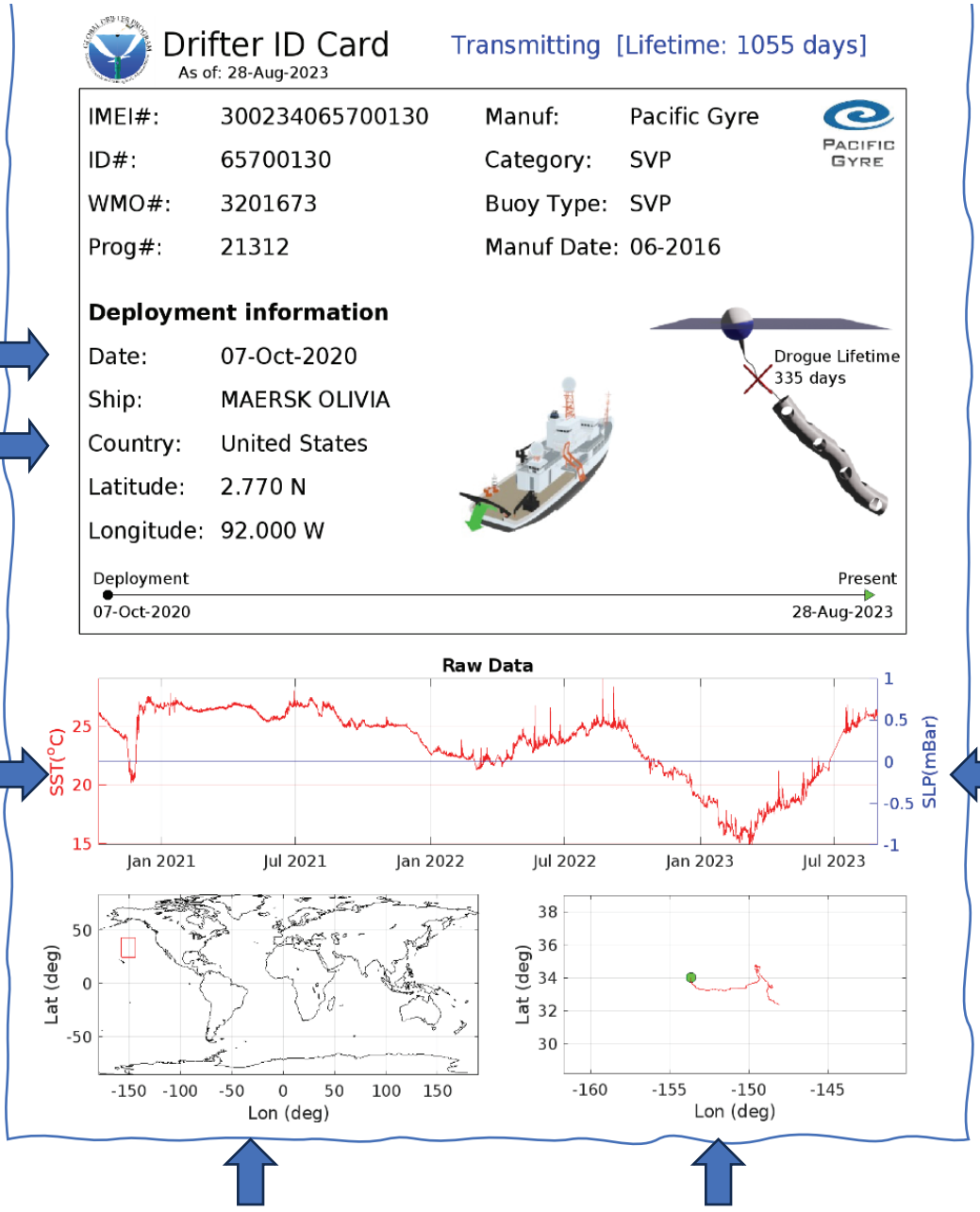
   The Gulf Stream

4. Where did your drifter end up in 1 month? *up the east coast in the North Atlantic*

5. Where did your drifter end up in 6 months? *Near the United Kingdom, still in the North Atlantic*

6. Where did your drifter end up in 1 year? *in the Arctic Ocean past Finland nearing Russia*





Date of release

Country of deployment

Sea surface temperature in Celsius

Sea-level pressure in millibars

Map showing where in the world drifter is located

Map showing the track the drifter has taken up until the most recent ping

IMEI# – 15-digit identification number unique to a specific buoy/drifter.

ID# – Preprogrammed into each transmitter inside of the drifter. The number is sent with each data message to differentiate between other transmitters.

WMO# – assigned after the deployment region is identified. It is used to reference data placed onto the Global Telecommunications System (GTS) for public distribution and archiving.

GTS – a communications network consisting of a real-time exchange of meteorological data from weather stations, satellites, buoys, etc.

SVP – Surface velocity program drifter which tracks currents at depths of 2 to 50 meters.

DRIFTING SCIENCE

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PHILLIP & PATRICIA FROST MUSEUM OF SCIENCE
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