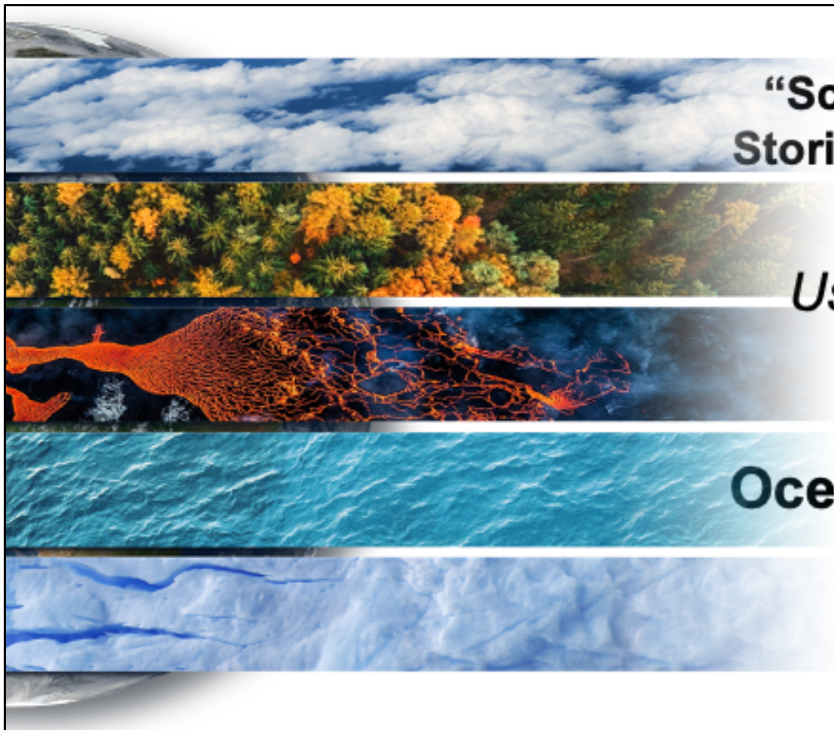
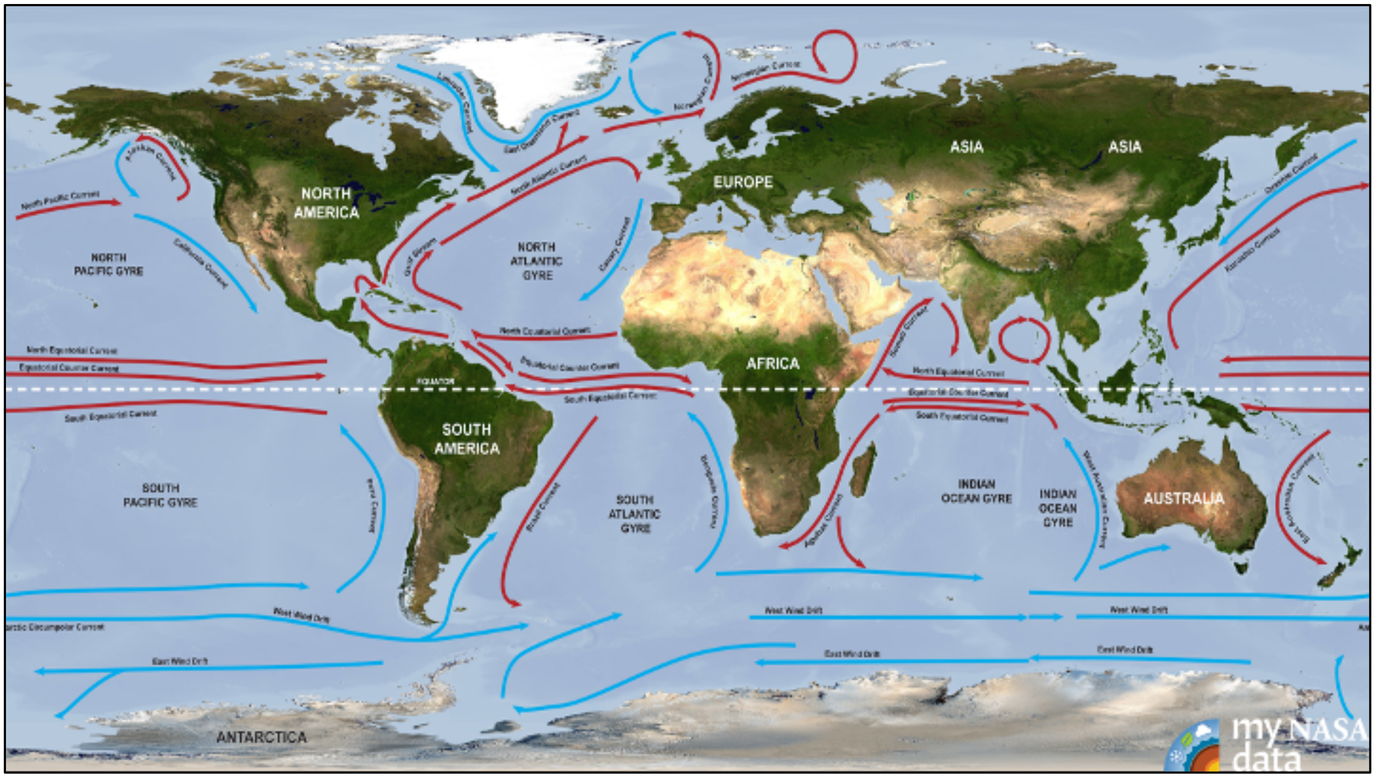


“Scientifically-Interesting Stories with *My NASA Data*”

Using NASA Data To understand…

Ocean Circulation with Drifting Ducks (Intermediate)

Link to Scientifically-Interesting Story of Ocean Circulation on My NASA Data



Teacher Talking Points:
This NOAA image shows the relative temperatures (warm vs cold) and directions of currents in our global ocean. The warm surface waters are shown in red and cold bottom waters in blue. The arrows indicate the water's direction of movement. Transport through the whole cycle may take up to 1000 years.

Focus Questions:

1. What are ocean currents?
   Ocean currents are streams of water in the ocean that move together in a certain direction. These currents can be found both on the

surface of the ocean (Example: this map of currents) and deep within the ocean (Example: the thermohaline circulation).

1. Why are scientists interested in ocean currents? *Scientists study these currents because of what they carry. Ocean currents carry both objects that you can see, such as ships on the ocean and garbage dumped into the ocean, and things that you can't see, such as heat, which can warm or cool nearby land. Consider the following example on the next slides when a shipment or rubber duckies and other bath toys were accidently dropped into the ocean by a cargo ship...*

Image: Major ocean currents of the world
Image Credit: NOAA Science on a Sphere

Teacher Talking Points:

On January 10, 1992, a container ship was caught in a storm in the North Pacific Ocean. Some of the cargo was dropped overboard into the ocean, including containers of rubber bath toys. Eventually some of these toys ending up washing ashore, but where?

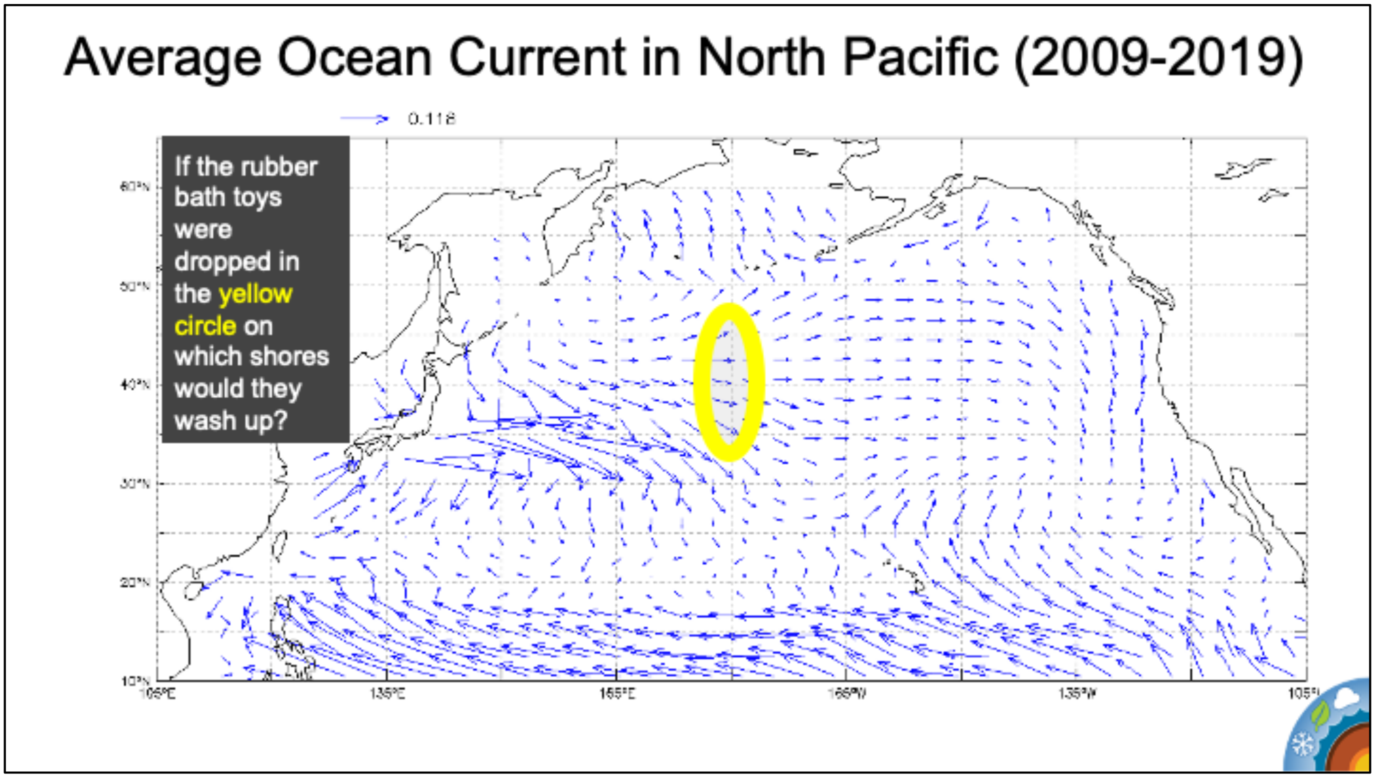
Image: Left: Rubber ducks, similar to the ones lost by the cargo ship in 1992. Right: Example of a cargo ship
Image credit: Jason Ahrns (ducks); NOAA Ocean Service (ship)

Focus Questions:

1. What do these deserts have in common?
2. What effect do you think the cold ocean water has on these deserts?
3. What effect does the current have on other parts of the Earth System?

Related Resources: Consider using the My NASA Data Map Cube and Question Sheet with this map. See link for details.

Image Credit: Earth System Data Explorer (To visualize Sea Surface Temperature in the Earth System Data Explorer, visit this link.)



Teachers Notes:

Map: Average surface ocean velocity vector from January 2009 to January 2019 over the North Pacific from the OSCAR surface ocean current velocity vector (Hydrosphere->All Data-> Sea Surface Properties->Surface Ocean Current Velocity Vector). The yellow circle represents the area where the container ship lost its shipment of rubber bath toys.

Map Credit: My NASA Data Earth System Data Explorer

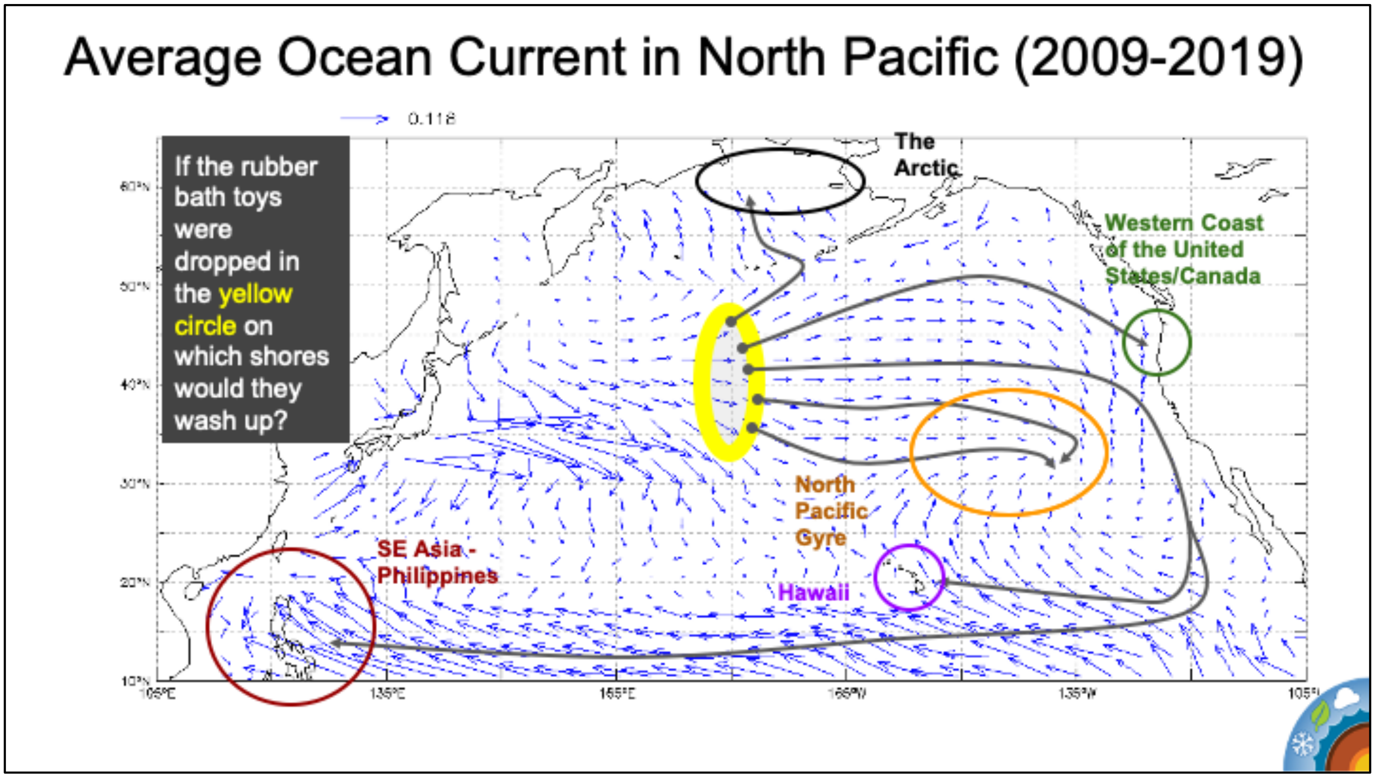
Focus Question:

If the rubber bath toys were dropped in the yellow circle on which shores would they wash up?

Instructions: Pick a point inside the yellow circle and draw a line following the directions of the arrows (Imagine that the arrows are pushing as you draw the line). Keep drawing the line until it runs into a shoreline or cannot be drawn further. Where does your line end up?

Additional Notes:

Scale: The units of these data are in meters per second. The arrows in the circle represent speed values of about 0.1 meters per second. This speed is about 10 times slower than the average person walks. If we assume that one of the ducks moves this speed straight towards the coast of western North America, it would take the duck around a year and a half to reach the coast.



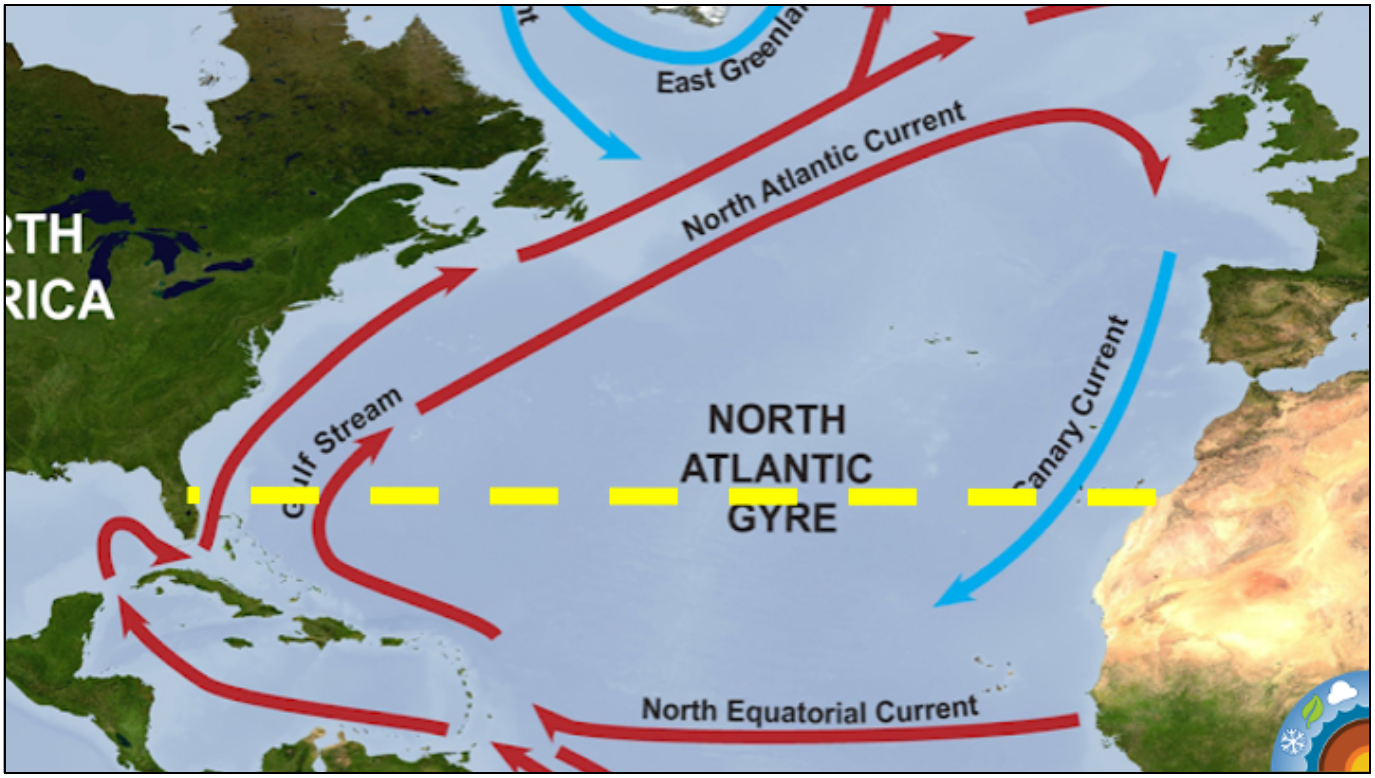
Same plot as previous plot, but annotated with some examples of possible pathways of where the rubber toys would go. The lines represent the path that any object that is floating on the surface of the ocean would take.

Teacher Talking Points:

Notice from the previous activity that some of the rubber toys would end up stuck in a circular pattern of currents. These circular patterns are called gyres. Gyres collect objects floating in the ocean at their center. Both items left in the ocean by humans and natural items collect in these gyres.

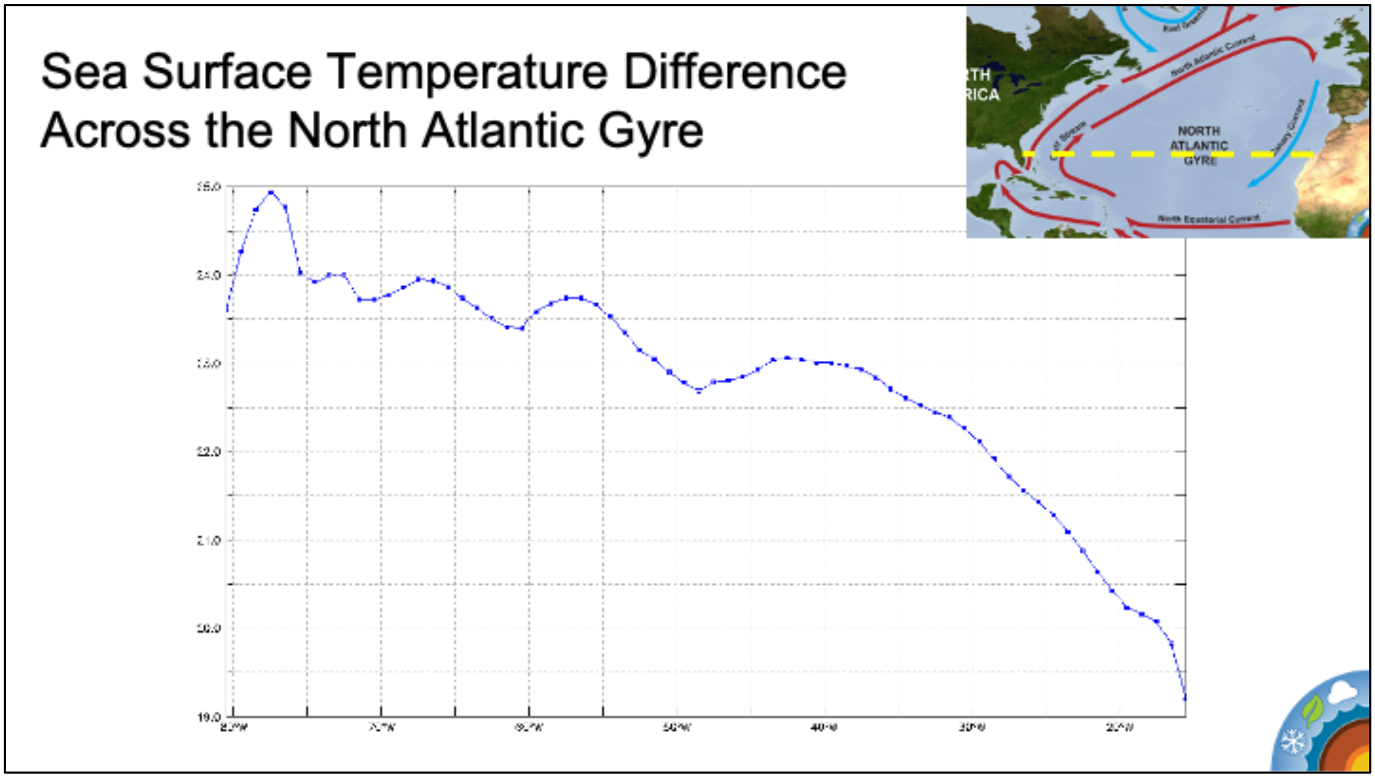
Top image: Sargassum seaweed floating in the North Atlantic gyre. This seaweed floats in large patches at the center of the gyre.
Image credit: NOAA Ocean Service

Bottom image: A collection of plastics found in the Great Pacific Garbage Patch.
Image credit: Pixnio



Teacher Talking Points:
Gyres are also important in the Earth system because they transport heat. Warm water moves towards the poles on the west side of the gyres. Cooler water from higher latitudes moves towards the Equator on the east side of the gyres.

Image: Subset of ocean current map zoomed in on the North Atlantic gyre.
Image Credit: NOAA Science on a Sphere



Teacher Talking Points:

Here is evidence of the sea surface temperature difference across the North Atlantic Gyre. The blue line on the graph shows the sea surface temperature from the west to east side of the North Atlantic Gyre in January 2020, along the yellow line on the previous slide.

Focus Questions:

1. At what latitudes do you observe the warmer temperatures? *Notice the warmer sea surface temperatures in the west, and the cooler sea surface temperatures in the east. The warmest temperatures are found around 78°W longitude*

and decline as we move East.

2. Identify the currents that are connected with the 78°W warm spike and the cool temperatures found at 20°W. *The warmer sea surface temperatures are part of the warm Gulf Stream current. The cooler sea surface temperatures in the east are part of the cool Canary current off of the coast of Africa.*

Graph: Average Monthly Sea Surface Temperature in January 2020 in the Atlantic Ocean at 28 degrees North latitude.
Graph Credit: My NASA Data Earth System Data Explorer (Link from the Earth System Data Explorer)

Scale: The temperature difference between the water in the Gulf Stream and the Canary current is almost 6 degrees Celsius (25 degrees Celsius vs. 19 degrees Celsius). This is the difference between a water temperature that is typically found in competition Olympic swimming pools and water that can be too cold to swim in for long periods of time (National Center for Cold Water Safety).

Extra fact: The amount of water vapor that air holds is related to its temperature. Consider air the same temperature as the ocean surface at the Gulf Stream and the Canary Current. The air over the Gulf Stream would hold 44% more water vapor than the air over the Canary Current.