Salinity and Deep Ocean Currents

Overview

Ocean *currents* arise in several different ways. For example, wind pushes the water along the surface to form wind-driven currents. Over larger areas, circular wind patterns create hills and valleys on the ocean surface. In these areas, the balance between gravity and Earth's spin causes *geostrophic* currents to flow.

Deep ocean currents are caused by differences in water *temperature* and *salinity*. In this experiment, the students will *hypothesize* the cause of ocean currents and then develop a *model* to explain the role of *salinity* and *density* in deep ocean currents.

Concepts

- Salt water is more dense than fresh water, and is therefore heavier.
- When ocean water evaporates, the water becomes more dense because most of the salt remains in the water. In some regions of the ocean, circulation is based upon the mixing between more dense surface water and less dense layers of deeper water.

Materials

- 4 Baby food jars
- 2 Laminated index cards
- Table salt
- 2 Colors of food coloring
- Stir stick
- Dish pan (for spills)
- Towels
- Map of deep ocean currents
- Map of sea surface temperature
- Map of surface salinities

Preparation

It is important to do this activity before your students do it. This will give you a chance to see and work out any potential problems beforehand. Be sure that your jars have flat lips, and have the students add a lot of salt to the salt water jar.

Gather the supplies or send a supply list home with the students. Make sure that the students mark their names on anything they bring to class that will be returned home.

Set up one activity station for each group of four students. Provide each group with a check list of supplies and a copy of the setup procedures. Make sure that the students complete this activity over a tray or dish pan; it can be very messy.

Divide the class into groups of four. This allows for participation of all members. You may wish to assign each student in the group a job. One student could be the equipment and setup monitor. Another student could be the recorder. The third student could be the group spokesperson. The fourth student could be responsible for the clean-up of the activity.

PROCEDURE

Engagement

Display the maps of wind-driven ocean currents, sea surface temperature, and surface salinities of the oceans [Figs. 1, 2, 3]. Have the students look for relationships between sea surface temperature, salinity, and the locations of warm and cold currents. Ask the students to write a hypothesis that explains these relationships, if possible

Conduct the following experiment to learn more about the relationship between salinity and deep ocean currents.

Activity

1. Fill both baby food jars with water. Dissolve the salt in one of the jars and add blue food coloring. Make sure to mark the jar "Salt Water." Add a drop of red food coloring to the other jar and label it "Fresh Water."
2. Place a 3 x 5 index card on top of the salt water and carefully invert it. Place the salt water jar on top of the fresh water container and have someone carefully remove the card. Observe the results.
3. Use the second set of jars to repeat the experiment. This time, invert the fresh water jar over the salt water jar. Remove the card, and observe the results.
4. Take both sets of jars, turn horizontally, remove the card and observe the results.
5. Is salt water heavier or lighter (higher or lower in density) than fresh water? Make sure that you explain your answer in terms of the results that you obtained from your experiment. If evaporation causes surface water to be salty, where would you expect ocean water to be very dense? Does this correspond to where deep ocean currents originate? If not, can you explain why? Does the density of ocean water have any relationship to the temperature of ocean water?

Explanation

Thermohaline circulation is the name for currents that occur when colder, saltier water sinks and displaces water that is warmer and less dense. In this activity, you examined the relationship between salinity and deep ocean currents without changing the water's temperature.

In Earth's equatorial regions, surface ocean water becomes saltier as the water, but not the salt, evaporates. However, the water is still warm enough to keep it from sinking. Water that flows towards the poles begins to cool. In a few regions, especially in the North Atlantic, cold salty water can sink to the sea floor. It travels in the deep ocean back towards the equatorial regions and rises to replace water which is moving away at the surface. This whole cycle, called the *global conveyor belt*, is very important in regulating climate as it transports heat from the equatorial regions to polar regions of Earth. The full cycle can take a thousand years to complete.

EXTENSION

Have students compare the map of sea surface temperature to the map of surface salinity. They should also view the animation of the "global conveyor belt." Based on what they've learned from the animation and this activity, what combination of temperature and salinity favors the sinking of ocean water? Think about the parts of the ocean where cold salty ocean water tends to sink. Can fresh water from nearby land masses affect the salinity there? How might the influx of fresh water affect the "global conveyor belt?"

Could global warming and associated melting of polar ice affect “the global conveyor belt”?

Links to Related CD Activities, Images, and Movies

Map of *Geostrophic currents*
Map of *Wind-driven ocean currents*
Image of *Sea surface temperature*
Image of *Surface salinity of the oceans*
Image of *Global conveyor belt*
Animation of *Global conveyor belt*
Activity *Temperature and Deep Ocean Circulation*

Vocabulary

current *density* *displacement*
geostrophic *hypothesis* *model*
salinity *temperature* *thermohaline circulation*
wind-driven current

Source

Adapted from Kolb, James A. Marine Science Center. Marine Science project: For Sea. p. 88 - 90.

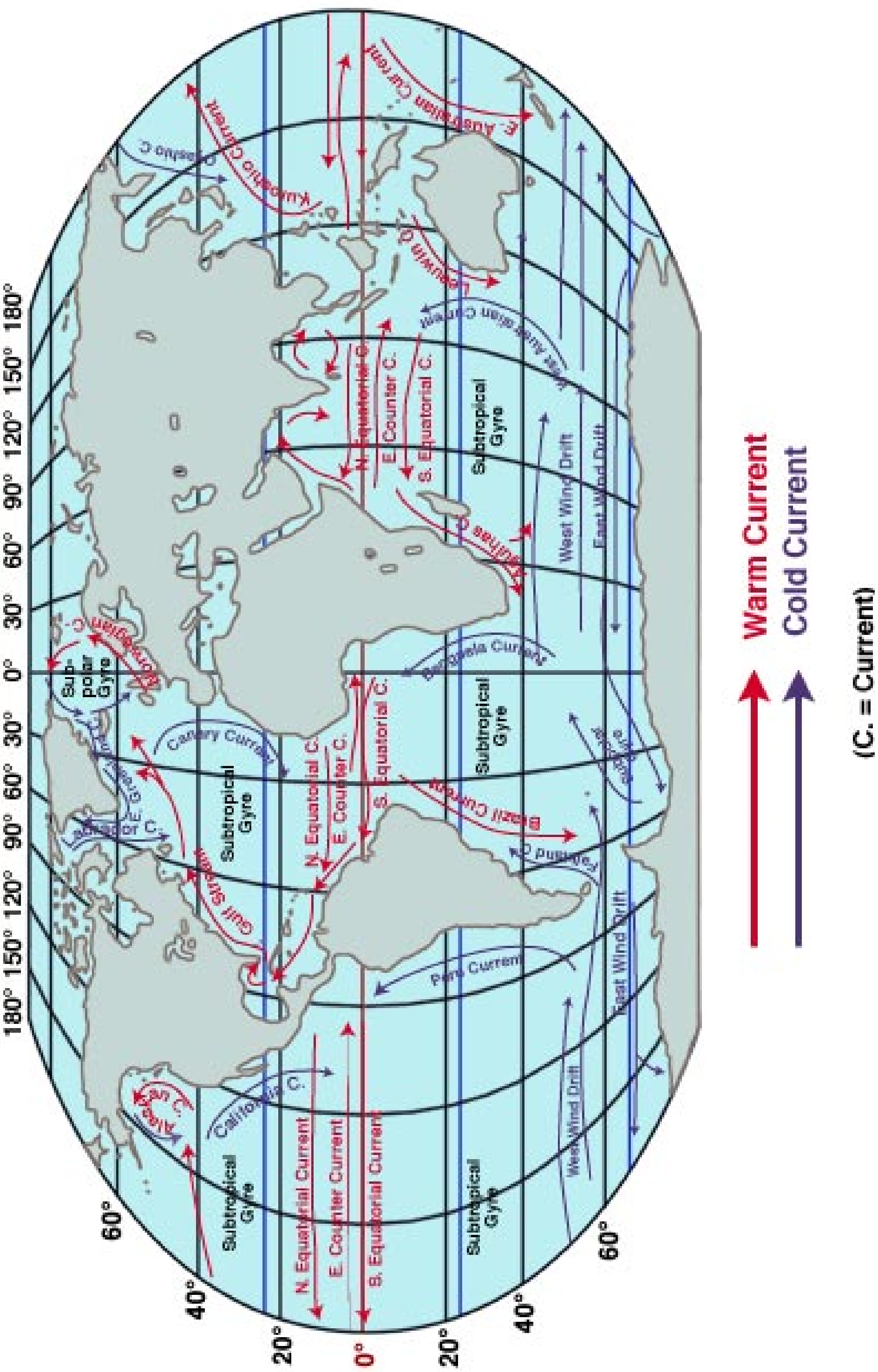

Figure 1. Wind-driven surface current.

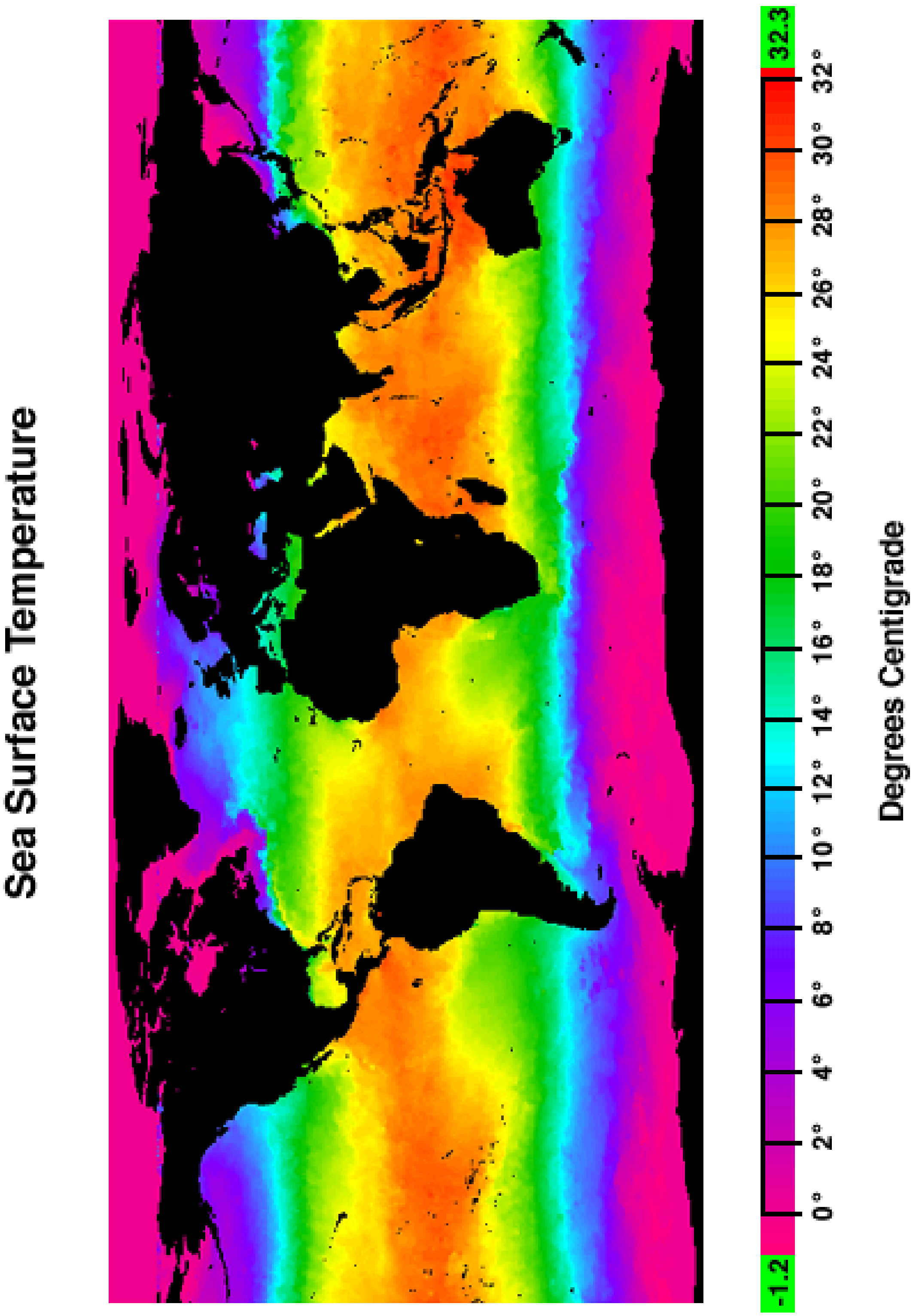
Sea Surface Temperature
-1.2
0°
2°
4°
6°
8°
10°
12°
14°
16°
18°
20°
22°
24°
26°
28°
30°
32°
32.3
Degrees Centigrade

Figure 2.

Surface Salinities of the Oceans (‰)

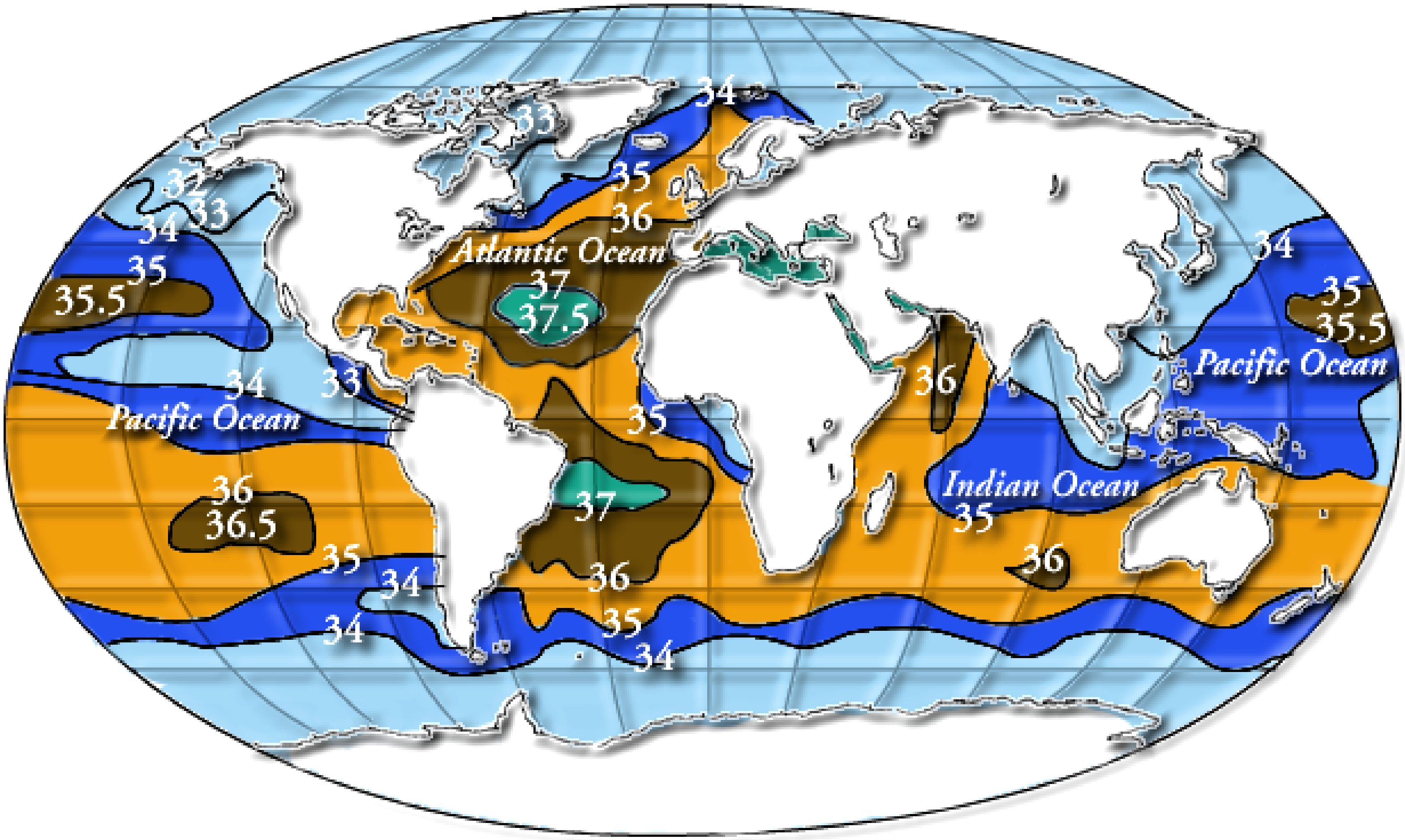

Figure 3.