Name______________________________________

Thermohaline Circulation

Background Information:
1. The sun warms the Earth’s surface, which controls global currents and climate, keeping the earth habitable.
2. The ocean is one continuous body of water with global currents that interact, with water surrounding all landforms.

The oceans are the major surface feature of Earth, covering about two thirds of the planet. Because water gains and loses heat much more slowly than air or land, oceans are the most important factor influencing global and regional climates. One way oceans affect climate is by transporting heat from equatorial towards Polar Regions and giving off heat in latitudes that receive less direct sunlight. Oceans also affect climate by absorbing and releasing huge amounts of carbon dioxide, one of the most important heat-trapping gases in the atmosphere.

A current is defined as a large mass of continuously moving oceanic water (Greene, 1998). Surface ocean currents are mainly wind-driven and occur in all of the world’s oceans. Surface ocean currents move to the right/clockwise in the Northern Hemisphere and to the left/counterclockwise in the Southern Hemisphere because of the Coriolis Effect.

The currents eventually come into contact with the continents that redirect them, creating giant oceanic current circles known as gyres. Vertical (up and down) and ocean bottom currents are mainly caused by density differences caused by changes in temperature and salinity.

Starting in Polar Regions, cold, salty waters sink to the ocean bottom and move toward the opposite poles where they again surface. Vertical upwelling (The rising of cold water from the deeper areas of the ocean to the surface.) currents can also be caused by winds “blowing off” a coastline. The displaced waters are replaced by underlying bottom waters.
**Purpose:** To observe the processes that cause thermohaline circulation.

**Materials:**

| 2 beakers | Cold water | Warm water colored red | Ice cubes colored green |

**Procedure:**

1. Fill the beaker $\frac{1}{2}$ full of cold water.
2. **Gently** place a green ice cube in the water. Wait for the water to stop moving and observe.
3. Record your observations in writing and with a diagram.
4. Fill another beaker $\frac{1}{4}$ full of warm, red water. (1-2 drops of food coloring)
5. **Gently** pour the water down the inside edge of the beaker. Don’t disturb the rest of the water.
6. Record your observations in writing and with a diagram.

**Data and Observations:**
This investigation models how cold surface temperatures in Polar Regions can increase water density, causing it to sink. In these far northern regions, sinking water is replaced at the surface by water from warmer regions, a process which pulls relatively warm water at the surface in the North Atlantic Ocean toward the cold polar latitudes. As the warm water moves toward these areas, much of its heat is lost and is carried to northern Europe by the atmosphere, warming the climate there.

An important factor influencing sinking is the salinity of the water. Salt increases the density, or mass per unit volume, of water. The warm water transported to high latitudes in the North Atlantic is very salty since it comes from the warm regions near the equator where evaporation removes much water vapor.

The very cold, salty water is dense so it sinks and flows slowly (over the course of about 1000 years) at depth around the globe as part of what is called the “ocean conveyor” The density-driven circulation of ocean water caused by differences in temperature and salinity is called thermohaline circulation. Draw your investigation set-up in the box to the right, then label where modeling of sinking and warm water replacement occur in the model.

Questions and Conclusions:

1. Was the colored water moving away from the ice cube colder or warmer than the water in the glass? Why?

2. Was the warm colored water that was added to the glass colder or warmer than the water already in the glass? Why?

3. Where is floating ice found in the ocean? Why?

4. Where is cold water found? Why?

5. Where would cold water flow in the ocean? Why?

6. Where would you expect to find the warmest waters in the ocean? Why?

7. Where would warm moving water flow in the ocean? Why?

8. Which direction would cold water move in the ocean?

9. Which direction would warm water move in the ocean?