Learning Objective: Influence of Oceans on Weather and Climate

NGSS Standard: MS-ESS2.D-3 - The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents.

Objective:
Students will be able to:

1. Describe how the movement of ocean currents affects weather and climate.
2. Define Wind and describe the conditions that contribute to it.
3. Explain how local interactions between climate factors determine regional climates.
4. Explain how Earth's rotation causes ocean and atmospheric currents to curve due to the Coriolis effect.

Time Required: 90 minutes

Materials Needed:

- Teacher computer with internet access and projector
- Student computers/laptop/tablet with internet access (preferably one per student but at least enough for small groups of 3 -4 students)
- Lazy Susan rotating table
- Aluminum pie pan
- Food coloring
- Paper cup
- Pushpin
- Crushed ice
- Ocean Currents handout (attached)

Teacher Preparation:

- Create Playlist 1, a 20-minute playlist in Legends of Learning with the following game found in the Influence of Oceans on Weather and Climate learning objective:
  - *Ocean Frenzy*
- Create Playlist 2, a 30-minute playlist in Legends of Learning with the following game found in the Influence of Oceans on Weather and Climate learning objective:
  - *Ocean Momentum*
- Set up steps a-b of the Coriolis Effect Lazy Susan demonstration (see the Elaborate section of the lesson plan)
- Have Appendix A and Appendix B available to display on projector

Engage: 10 minutes

1) The teacher will play the video "NASA - The Ocean: A Driving Force for Weather and Climate" https://www.youtube.com/watch?v=6vgvTeuoDWY&t=15s
2) The students will take notes on the information described in the video in their science journal

a. Explain how a low-pressure system can turn into a tropical cyclone (hurricane). Describe the factors that contribute to the formation of a hurricane.
    a. ***Tropical cyclones (hurricanes) form over areas of low pressure and, if the system(s) are large enough, and there is enough warm, moist air, then the system becomes a tropical storm/cyclone. For a hurricane to form, there must be a low pressure system(s) over warm a body of water, as well as enough heat and humidity.***
b. How does the Coriolis Effect determine both air and water currents?
    a. ***The Coriolis Effect is caused by the Earth's rotation from west to east. Without this rotation, winds, and currents, would go from north to south in a straight line. The Coriolis Effect causes a deflection of wind to the 'right' in the Northern Hemisphere and to the 'left' in the Southern Hemisphere. **Note** At the Equator, there is little to no Coriolis Effect. The Coriolis Effect causes a deflection of Ocean currents in a similar manner to the winds.***

3) Teacher will discuss student responses as a whole class.

Explore: 20 minutes

1) Students will sign in to Legends of Learning and enter your teacher code.
1) Launch Playlist 1 to your students.
2) Students will complete *Ocean Frenzy* as the teacher assists students as needed. Stopping game play to address the questions asked in the game may be needed.

Explain: 15 minutes

1) Teacher will display Appendix A on the projector.
2) Teacher will lead a discussion using the following questions:
    a. London is much further North than New York City, but has a similar climate. What is one possible cause of this?
        a. ***The Gulf Stream brings warm water from the Caribbean and brings it to England. This helps to moderate the climate.***
    b. Using the currents on the sheet, list three locations that should experience consistently warm temperatures and tropical climates.
        a. **Brazil, Eastern Equatorial Africa, New Guinea, Southern India, Hawaii/Pacific Islands, North East Australia.**
    c. Using the currents on the sheet, list three locations that should experience consistently cool/cold temperatures and polar climates.
        a. **Greenland, Eastern Russia, Antarctica, Southern Argentina/Chile.**
    d. Hypothesize what may happen if the Brazil Current stopped running.
        a. ***If the Brazil Current stopped, the climate of Equatorial South America would be greatly effected. Temperatures would most likely drop and the rainforests of the area would be destroyed, as the Brazil Current is a constant supply of warm, moist air. In addition, this would have a ripple effect and affect other currents of all oceans.***

Elaborate: 15 minutes

1) Teacher will display any of the images from Appendix B on the projector and explain the diagrams briefly.

2) The teacher will demonstrate the Lazy Susan Coriolis effect lab by using this procedure:
    a. Place the pie pan on the Lazy Susan and fill with water to within 1-2 cm from the top.
    b. Using a pushpin, put four small pinholes around the side of the cup, approximately 1 cm from the base of the paper cup.
    c. Fill the cup ½ to 2/3 full of crushed ice.
    d. Place the cup in the center of the pie pan.
    e. Begin to turn the Lazy Susan in a counterclockwise direction to simulate the Earth's rotation. Be sure to keep the platform rotating slowly and constantly.
    f. Have as student add several drops of food coloring to the cup.
    g. Have another student add a small amount of water to the cup.
    h. Students will observe what they see happening in the pan and write their observations in their science journal.
    i. Stop the spinning of the Lazy Susan allow students time to observe.
    j. Students will write their observations in their science journal.
3) Students will answer the following questions in their journals.
    a. Describe the motion of the food coloring as it came out of the cup when the Lazy Susan was spinning.
        a. The food coloring should move to the right in a circular motion.
            i. Reference: https://www.youtube.com/watch?v=bhwYZJT5Fwg
    b. How does this motion demonstrate the Coriolis effect?
        a. This shows how the rotation of the Earth deflects the direction of the wind and water in the Northern Hemisphere (deflection to the right).

Evaluate: 30 minutes

1) Launch Playlist 2 for students.
2) Students will play *Ocean Momentum* and be assessed on their ability to answer the questions provided in the game correctly.
3) Teacher will analyze student results to determine what concepts need to be a focus for reteaching.

Possible Extension Activity:

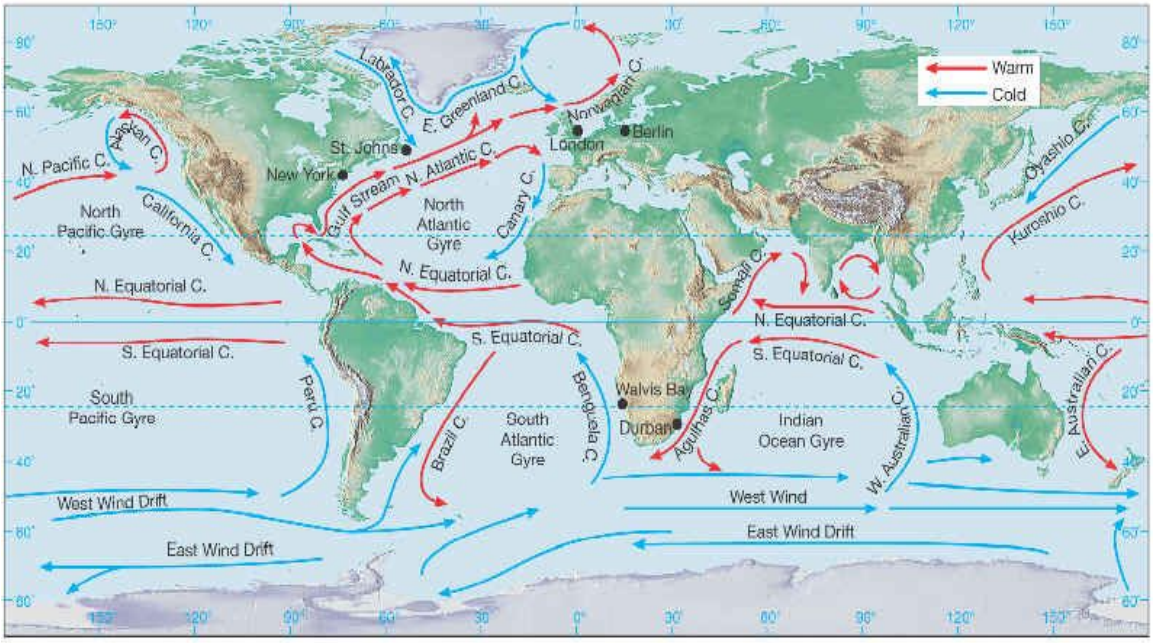
1) Completing the lab "Ocean Currents: Modeling the 'Global Conveyor Belt' in Your Kitchen"
   https://www.sciencebuddies.org/science-fair-projects/project_ideas/OceanSci_p012.shtml#summary
   To save time and money, the teacher could demonstrate this lab in front of the class.

Additional Lesson Strategies:

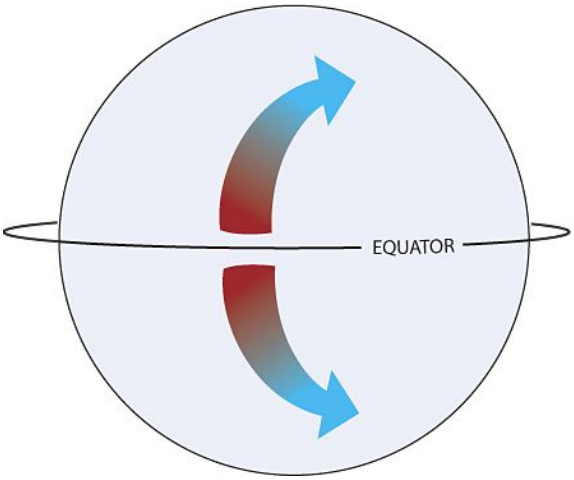
- To use Legends for additional instruction, create a custom playlist with an instructional game and pre and post assessment.
- To use Legends for a quick formative assessment, create a 5-question assessment in a playlist.

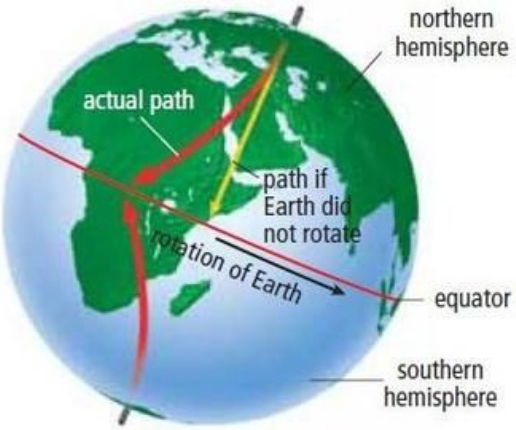
- To use Legends for a student-directed experience, create a targeted freeplay playlist.
- Encourage students to play on their own at home in Legends of Learning: Awakening for a student-driven experience including avatars, battling, and quests all centered around topics they are covering in class.

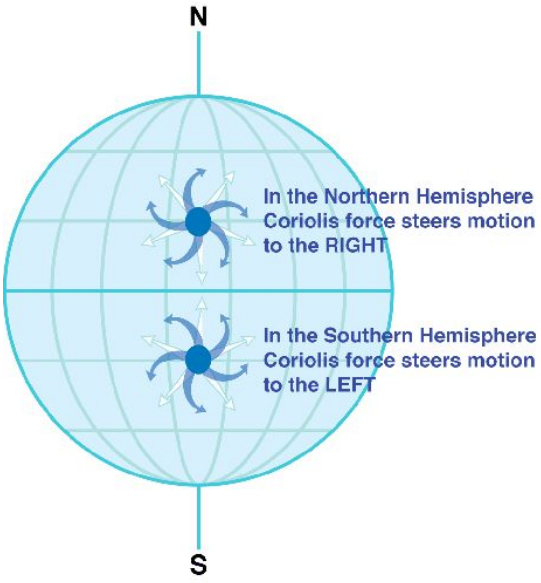
Appendix A. – Ocean Currents

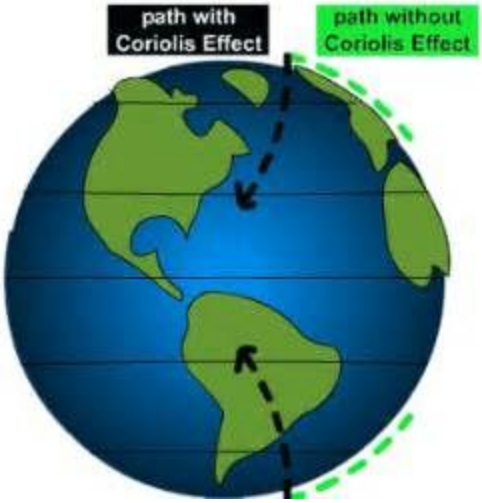


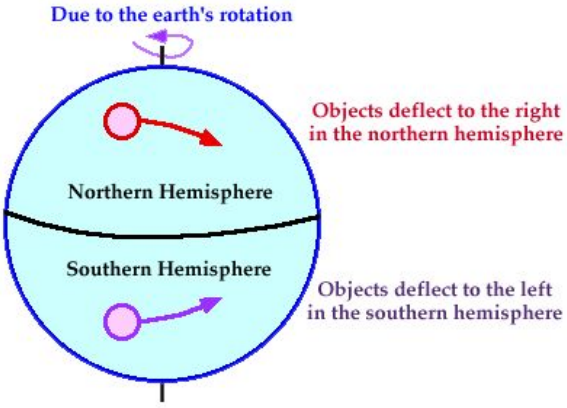
Appendix B. – The Coriolis effect causes circulating air to curve to the side.


EQUATOR


northern hemisphere
actual path
path if Earth did not rotate
rotation of Earth
equator
southern hemisphere


N
In the Northern Hemisphere Coriolis force steers motion to the RIGHT
In the Southern Hemisphere Coriolis force steers motion to the LEFT
S


path with Coriolis Effect
path without Coriolis Effect


Due to the earth's rotation
Objects deflect to the right in the northern hemisphere
Northern Hemisphere
Southern Hemisphere
Objects deflect to the left in the southern hemisphere