

Investigation 1B

Mapping the Ocean

Objectives

Exploring the ocean relies on various methods to display scientific information. Map projections, two-dimensional representations of a three-dimensional planet, are common and convenient ways to portray Earth's surface. However, like all graphical models, maps have their limitations. Over great distances, flat maps distort Earth's surface because our planet is not flat.

In this investigation, we will:

- Investigate the ocean as a 3-D globe with Google Earth 3-D Viewer
- Examine the Earth from above as it rotates
- Identify and delineate the five major subdivisions of the world ocean

Mapping the Ocean

Most map projections are either considered conformal (all small features on Earth's surface retain their original shapes on the map) or equal-area (map portions of the same size everywhere on the map represent equal areas). The Mercator projection, which is used in Google Maps and most other mapping applications, is a conformal projection that is standard for marine navigation because it preserves angles even though it distorts the area near the poles.

Historically, map making has had constraints due to scale and/or orientation. A 2D model of a 3D object (Earth) has inherent limitations depending on its scale, orientation, and area. Prioritizing some features can restrict or distort others. The true relations of properties and locations can only be displayed on a map that approximates the actual shape of our planet. A globe is both conformal and equal area, eliminating the distortions introduced by flat maps. It also provides an authentic representation of spatial relationships in three dimensions. Globes are particularly useful for investigating the effects of Earth's rotation on currents, the interaction of lunar and solar gravitational forces with the ocean, and the impact of solar radiation on the ocean. Globes also have limits, displaying only half of the total surface at one time.

The increasing availability and sophistication of 3D models and related animations allow the viewer tremendous flexibility to analyze information virtually. The ability to zoom in, zoom out, rotate, and move forward or backward in time allows the viewer to seamlessly alternate between expansive global views and detailed local depictions.

Globes also have limits, displaying only half of the total surface at one time. However, computer models are often designed to zoom seamlessly between expansive global views and detailed local depictions. In this course, we utilize both flat maps and globes to investigate the global ocean and coastal areas.

We employ Google Earth to explore virtual 3-D perspectives, as seen in **Figure 1B-1**.

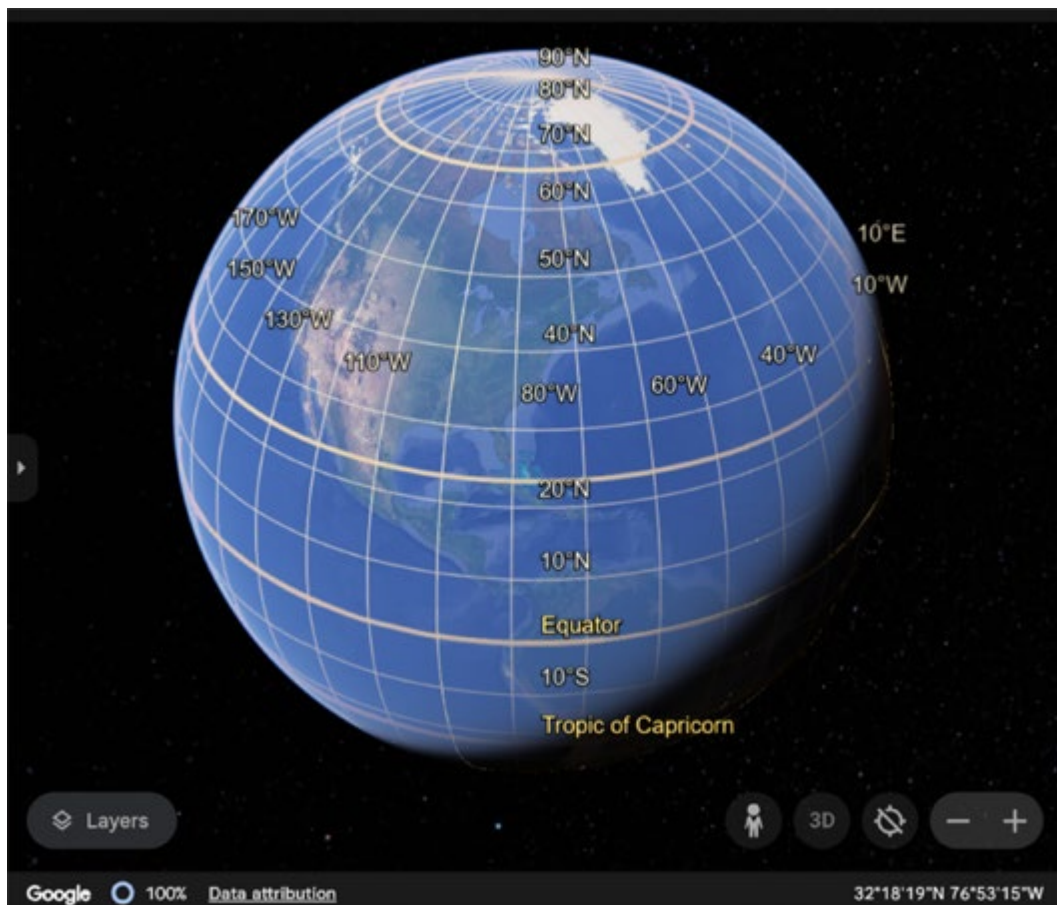


Figure 1B-1. Sample Google Earth 3-D Viewer image demonstrating a global view. [Google Earth, [Link 1B-1](#)]

1. Note the positions of Greenland and the U.S. in Figure 1B-1 as seen from the Google Earth 3-D Viewer. The depictions of these locations can be assumed to be _____.
 - a. conformal
 - b. equal-area
 - c. both conformal and equal area
 - d. neither conformal nor equal area

2. As seen in Google Earth, Greenland is _____ the U.S.
 - a. much larger than
 - b. much smaller than
 - c. about the same size as

For an overview of map projections, go to [Link 1B-2](#).

Earth's Rotation

In addition to manipulating the Earth by size, resolution, and perspective, digital viewers allow for animation. Observing Earth's rotation in 3-D visualizations is especially important for the Earth system sciences, especially when investigating how Earth's rotation impacts the sense of motion at different

latitudes.

To view Earth as seen from high above the equator, the North Pole, and the South Pole, click [Link 1B-3](#). The video begins centered on the white line of the equator with 40% of the rotating Earth's total surface visible. The other white lines are the Tropic of Cancer at 23.5°N and the Tropic of Capricorn at 23.5°S. Later, the Arctic Circle (67.5°N) and the Antarctic Circle (67.5°S) come into view. Start, stop, and re-start the video by using the control panel that appears on the screen.

3. From above the equator, Earth's rotation is causing any objects on the equator to move toward the east _____.
 - a. while curving to the right
 - b. while curving to the left
 - c. in a straight line

After observing Earth from above the equator, the video transitions to directly above the North Pole. From this vantage point, the Arctic Circle is represented by a concentric circle with the North Pole at its center.

4. As viewed from above the North Pole, any objects on Earth's surface (except directly at the North Pole) are carried in a _____ path by Earth's rotation.
 - a. diagonal
 - b. circular
 - c. straight
5. The sense of Earth's rotation from this view is _____ around the North Pole as seen from above.
 - a. counterclockwise
 - b. clockwise

The video transitions southward, passing over the equator to arrive at a point directly above the South Pole. The South Pole is positioned in the center of the circle representing the Antarctic Circle.

6. As viewed from above the South Pole, any objects on Earth's surface (except directly at the pole) are carried in a _____ path by Earth's rotation.
 - a. diagonal
 - b. circular
 - c. straight
7. Earth's rotation from this vantage point is _____.
 - a. counterclockwise
 - b. clockwise

As the course proceeds, you will learn that Earth's rotation has an immense impact on the circulation of the ocean.

Ocean Basins

Although the ocean is continuous, continents and other land barriers separate it into three expansive

deep-water basins that extend northward from the ocean-dominated area surrounding Antarctica. This geographical confinement is among the reasons why the world ocean is divided into the Arctic, Atlantic, Indian, Pacific, and Southern Oceans.

To locate the boundaries of major ocean basins, go to *The World Ocean* at [Link 1B-4](#).

8. Each ocean basin is shaded in light blue in the Area maps of the ocean at the top. The _____ Ocean borders the fewest other ocean basins, while the _____ Ocean completely surrounds a continent.
- Southern ... Pacific
 - Arctic ... Southern
 - Pacific ... Indian
 - Indian ... Atlantic

9. Scroll down and click on "Pacific Ocean" in the left menu. The globe alongside now displays the Pacific Ocean, nearly covering _____ of the visible globe.
- all
 - three quarters
 - one half
 - one quarter

You can click through the photos using the arrow button on the right. Hover over the "i" in the top left of each image for more information.

10. Under the Bathymetry section for the Pacific Ocean, read about its depth. The Pacific Ocean has the deepest mean depth, at 4080 m (2.5 mi.). At _____, the Challenger Deep in the Mariana Trench is the deepest location on Earth.
- 7432 m (4.62 mi.)
 - 8605 m (5.35 mi.)
 - 10,924 m (6.79 mi.)
 - 12,432 m (7.72 mi.)
11. Scroll down to the Climate section. The El Niño Southern Oscillation occurs in the _____ Pacific.
- North
 - South
 - equatorial
12. Scroll down to the Atlantic Ocean. Among the waterways that are part of the Atlantic Ocean, listed in the Includes section, are the Caribbean Sea and _____.
- Bering Strait
 - Mediterranean Sea
 - Red Sea
 - Greenland Sea

13. Scroll down to the Indian Ocean. From the map, you can see that the Indian Ocean is located most-

ly in the _____ Hemisphere.

- a. Northern
- b. Southern

14. In the Climate section, the Indian Ocean _____ monsoon occurs from December to April, and the _____ monsoon takes place from June to October.

- a. northeast ... southeast
- b. northeast ... southwest
- c. northwest ... southeast
- d. northwest ... southwest

The Southern Ocean is not universally recognized, but the U.S. and many other countries consider it an ocean basin because it is distinct, bounded by land to the south with a well-defined current of water to the north, and is a unique ecological region.

15. Scroll down to the Southern Ocean. In the Area section, the Southern Ocean extends from Antarctica to _____.

- a. 60°N
- b. 30°N
- c. 30°S
- d. 60°S

16. During the winter, sea ice freezes furthest north on the _____ side of the Southern Ocean. Keep in mind that north is equatorward in the Southern Hemisphere.

- a. Pacific
- b. Atlantic

17. Review the Climate section for each ocean. All of them have tropical cyclones, also called hurricanes or typhoons, except the _____.

- a. Arctic and Atlantic
- b. Arctic and Southern
- c. Indian and Southern
- d. Pacific and Indian

18. Close the information section to easily compare the area of each ocean. The _____ Ocean is the largest.

- a. Arctic
- b. Atlantic
- c. Pacific
- d. Southern

The five major ocean basin locations, expanses, and boundaries define how they interact with each other, the ocean at large, and the hydrosphere, atmosphere, biosphere, and lithosphere.

Summary

Exploring the ocean relies on various methods for displaying scientific information, including the use of flat map projections and globes. A digital globe provides both conformal and equal area views while enabling us to move from place to place and zoom from global to local views. The world ocean can be divided into five major basins, the Atlantic, Pacific, Indian, Arctic, and Southern Oceans.

References

Figure 1B-1 – Google Earth, 2023: Google Earth. Accessed 17 October 2023, <https://earth.google.com/>.