Investigation 1A

Maps In Action

Helpful Tips

- *Click on Figures for a larger image, which can be printed or edited*
- *Learn about the online reader's capabilities*
- *Bookmark Ocean Studies Maps & Links, a collection of helpful links for this course and afterward*
- *For assistance with the colors on the Figures, use the free Visolve software*

Objectives

The ocean covers almost 71% of Earth's surface to an average depth of about 4300 m (14,000 ft.), making the Earth truly an ocean planet. Working with cartographers, early mariners created the first maps of the vast ocean as they crossed it to find food, trade, and expand their communities. Those early maps have evolved in accuracy and detail over time, and it is important to understand the benefits and limitations of different ways of representing the ocean.

The most accurate way to represent Earth, 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.

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

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

Click on the image to open it in a new tab or window.

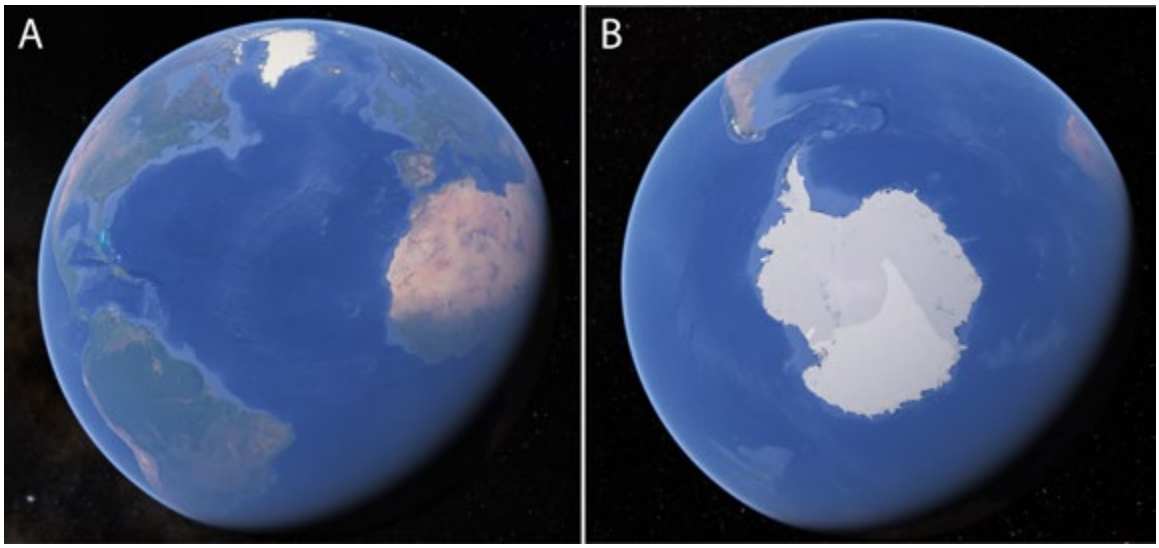

Figure 1A-1. The Google Earth globe centered on (A) the North Atlantic Ocean and (B) Antarctica and the Southern Ocean shows the extent of the ocean compared to the continents. [Google Earth]

1. As shown in Figure 1A-1, on a globe, you can see _____ Earth at one time.

    a. all of
    b. close to half of
    c. one-quarter of

2. As seen in Figure 1A-1, Greenland is _____ South America.

    a. much larger than
    b. much smaller than
    c. about the same size as

As discussed in Chapter 1 of *Introduction to Ocean Science*, map projections aim to represent a spherical object on a flat surface. These projections aim to conserve Earth's features in one of four ways:

- *Equidistant projections* preserve the distances between points. However, these maps only preserve distance from the center of the map rather than from any point on the map to another.
- *Azimuthal projections* preserve the direction between two points by showing great circle paths, the shortest route between two points on Earth, as straight lines. These maps, too, only show accurate paths from the center of the map to the location.
- *Equal-area projections* preserve the area of each feature but distort the shapes, making the sizes of continents and oceans comparable but the shapes often unrecognizable.
- *Conformal projections* preserve the shapes of the oceans and land masses but distort the areas and distances, keeping the familiar shapes but are not very useful for navigation.

As a general rule, distortions get worse near the edges of the map. To create a world map that is useful for many applications, many projections compromise on all of the properties to spread the distortions of each feature more evenly. This means that there is no location on the map that is not distorted at all but also none that is unrecognizable.

We will now observe a map that focuses on the ocean rather than land, like most common projections. **Figure 1A-2** is based on the *Spilhaus projection*, which shows the world on a square with the world ocean as its focus. This map projection is a compromise. It doesn't fully preserve any specific properties, but it is helpful for viewing the ocean, as the most distortion happens in the center of the continents, which are cut off in this version.

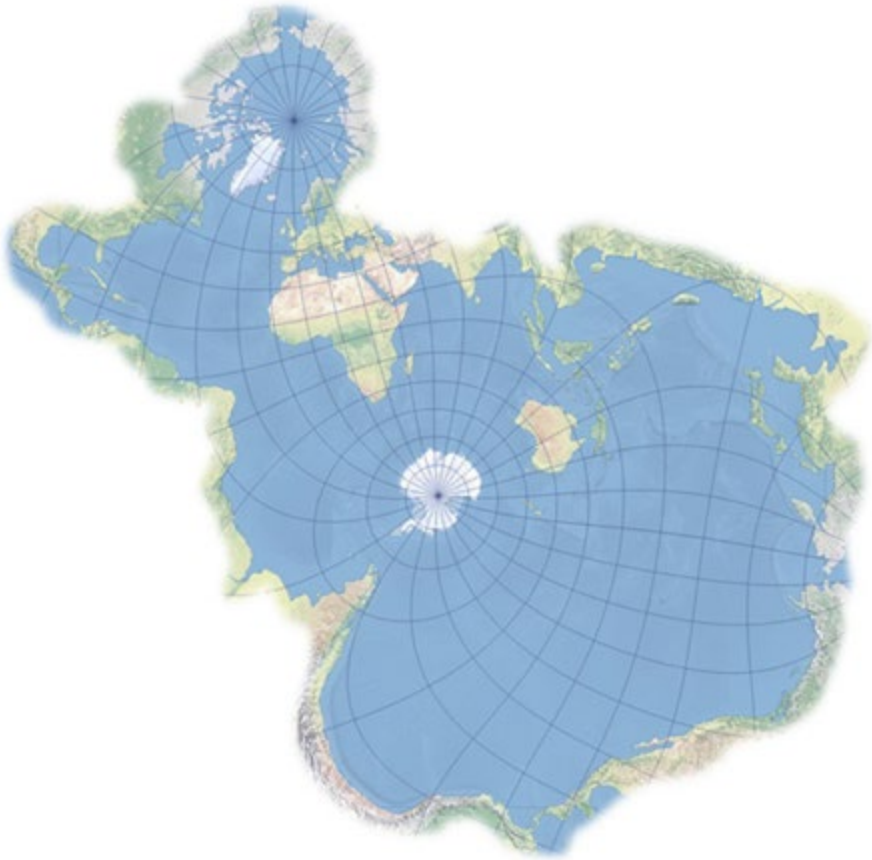

Figure 1A-2. A cropped version of the Spilhaus projection world map focuses on the oceans rather than the continents. The angles and areas between the latitude and longitude lines show distortion. [ESRI]

3. The Spilhaus projection is centered on _____.

    a. Africa
    b. Antarctica
    c. Eurasia
    d. North America

4. In addition to the continent in the center, _____ are recognizable, which means the other continents are very distorted around the edges of the map.

    a. Africa and Australia
    b. Australia and Eurasia
    c. Eurasia and South America
    d. South America and Antarctica

5. This projection shows clearly that the ocean is _____.

    a. continuous
    b. split into 2 completely isolated segments
    c. split into 4 completely isolated segments
    d. split into 5 completely isolated segments

Ocean Basins

Continents and other land barriers separate the ocean 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.

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.

In **Figure 1A-3**, the oceans are labeled and the divisions are drawn as dark blue lines on the Robinson projection.

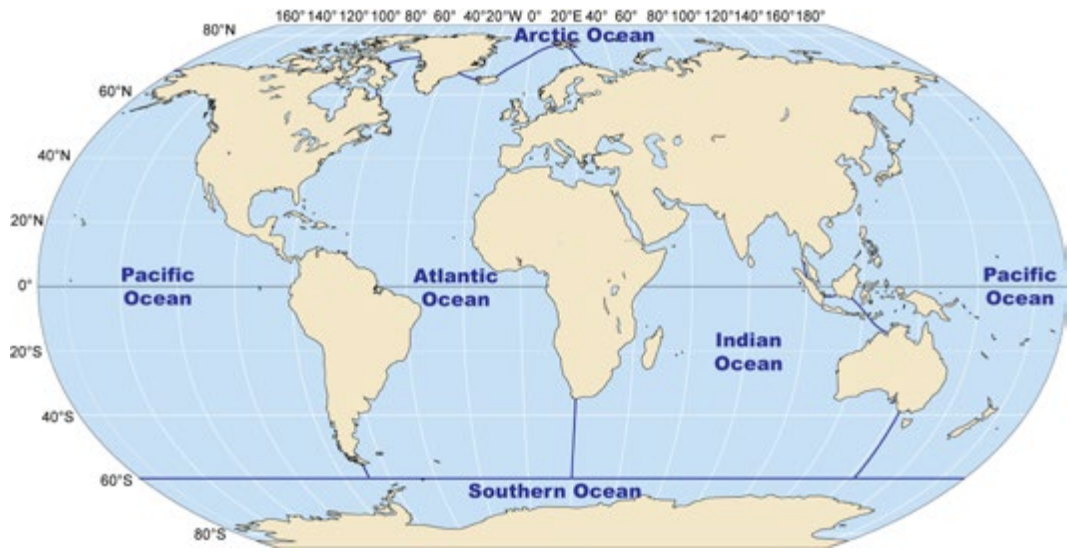

Figure 1A-3. A Robinson projection world map, with the boundaries between the major ocean basins delineated, highlights the natural divisions between these basins.

6. Figure 1A-3 shows that most oceans are bounded primarily by _____.

    a. lines of longitude
    b. lines of latitude
    c. continents

7. In contrast, the _____ Ocean surrounds Antarctica and is bounded completely by_____.

    a. Arctic ... North America
    b. Atlantic ... the equator

c. Pacific ... 140°E longitude
d. Southern ... 60°S latitude

8. Figure 1A-3 shows that the _____ Ocean has the largest area, wrapping from the left side of the projection around to the right.

   a. Arctic
   b. Atlantic
   c. Indian
   d. Pacific

9. The next largest ocean is the _____, stretching from the far north to the far south.

   a. Arctic
   b. Atlantic
   c. Indian
   d. Pacific

10. From the map, you can see that the Indian Ocean is located mostly in the _____ Hemisphere.

    a. Northern
    b. 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

Learning about the ocean involves many methods for displaying scientific and geographic information, including the use of flat map projections and globes. A digital globe provides both conformal and equal area views, allowing us to navigate from place to place and zoom from global to local views. Some map projections are more useful than others, depending on the location and information displayed. An equal-area map is more useful when trying to maintain area, but it distorts shapes and distances. Conformal maps are more appropriate when trying to maintain the shapes and distances on the map. No map projection is perfect, so each application must consider these factors. The world ocean is continuous across the planet; however, when viewing even very different map projections, it is clear there are also distinct ocean basins, which are the Atlantic, Pacific, Indian, Arctic, and Southern Oceans.

References

Figure 1A-1 – Google Earth, 2025: Google Earth. Accessed 2 April 2025, https://earth.google.com/.

Figure 1A-2 – Šavrič, B., D. Burrows, and M. Kennedy, 2020: The Spilhaus World Ocean Map in a Square. ArcGIS, accessed 2 April 2025, https://storymaps.arcgis.com/stories/756bcae18d304a1eac140f19f-4d5cb3d.