Module 2: Mapping
Topic 1 Content: Map Projections Notes

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Today, everyone knows that the Earth is round. In fact, it is a sphere. If you wanted to study the Earth, you could examine a spherical model of the Earth called a globe. Although a globe is an accurate representation of the Earth, it is not practical for everyday use. A globe cannot fit in a book, and it is not very portable.

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Maps are portable globes. A map is a representation of the spherical Earth on a flat surface. The Earth is a three-dimensional sphere, but it is difficult to show accurately on a two-dimensional flat surface like a map.

Translating from a three-dimensional sphere to a two-dimensional map leads to distortion in the shapes and sizes of continents and bodies of water. Distortion is a change or inaccuracy in the size, shape, or location of places on a map. All maps have distortion to varying degrees, depending on the projection method used, and the intent of the map maker, known as a cartographer.

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Over the centuries, cartographers have developed methods to show the Earth on a flat surface. These methods are called map projections. How did ancient cartographers make map projections?

Imagine that you have a clear glass globe with the landmasses painted on it. Then, put a light inside the globe. Next, wrap a large paper around the globe to form a cylinder. Now, trace the landmasses on the paper. In 1569, this is how the Flemish geographer Gerardus Mercator made the first practical map projection, known as the Mercator projection. In his map, there was very little distortion near where the paper was closest to the globe. As the distance between the surface of the globe and the paper cylinder increased, so did the amount of distortion.

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Think for a moment about travel in 1569. By whom do you think Mercator intended his map to be used? If you said sailors, you would be correct! The Mercator projection was developed especially for sailors. Take a moment to view Gerardus Mercator's projection from 1569.

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Shown here is a modern version of Mercator's projection. Although there is distortion of landmasses, especially nearer the poles, the Mercator projection does have two very helpful features. Take a look at the lines of latitude and longitude. Do you notice how the lines are perpendicular to each other? The lines form a grid. The Mercator projection also preserves accurate compass directions. Features like a grid and accurate compass directions make the Mercator projection useful for navigation.

Now take a look at the Mercator projection and this globe of the Earth. Compare the appearance of Greenland at the top and Antarctica at the bottom. What is different? You may notice that when using the Mercator projection, Greenland and Antarctica look much larger than they do on the globe. This is because the projection distorts the shape and size of these landmasses. On the Mercator projection, Greenland seems to be the same size as Africa, while in fact, Africa is about fourteen times larger than Greenland. Similarly, Antarctica spreads across the entire bottom of the Mercator projection, but it is only the fifth largest landmass.

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Cartographers have made many attempts to improve upon Mercator's projection. The Robinson projection is an attempt to balance projection errors. While it does have size, shape, and direction errors, it minimizes the distortion. As a result, the Robinson projection is commonly used in textbooks and atlases. Notice the Robinson projection's oval shape and its curved lines of longitude compared to the Mercator projection's rectangular shape and straight lines of longitude.

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Suppose that you wanted to fly east from Norfolk, Virginia to Bangalore, India. Which route would your plane fly? If you said, "straight across the Atlantic Ocean," you would be incorrect. How can this be? You know that the Earth is a sphere, and you know that all maps have distortion. Sometimes, what seems obvious on a map is not the whole truth. Due to the curvature of the Earth, the shortest possible route from Norfolk, Virginia to Bangalore, India actually crosses over Iceland. This is called the great circle route. In fact, it would be a much longer journey if you were to fly “straight” across the Atlantic Ocean and Africa, although on this map, it would appear to be the most direct possible route.

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To understand the great circle route, you can plot your flight from Norfolk, Virginia to Bangalore, India on a map called a polar, or conic, projection. The polar projection is a map that shows the Earth as if you were viewing it from space. In fact, this is the exact same route depicted on the previous projection. If you were to trace both routes, you would cross the same points, including directly overtop the small country of Iceland. On a polar projection, you see great circle routes as they are, whereas in other projections these flight route arcs appear greatly exaggerated. The polar projection shows accurate distance and direction, so it is commonly used by pilots. What do you think is the weakness of this projection? It only shows half of the Earth at a time. These maps are generally used for mapping small areas that require a great deal of accuracy, like in weather or road maps.