Exercise 2: Working with Projections

In this exercise, you will work with projections in ArcGIS at a variety of scales. The goal of this exercise is for you to gain an understanding and appreciation of how projections can be appropriately used and how they impact your maps.

Topics covered in this exercise include:

1. Determine the projection of your data layers in ArcGIS
2. Change the projection of your map in ArcGIS
3. Describe how projections may distort geometric properties
4. Discuss key criteria in determining an appropriate map projection

Step 1. Open a Map Project

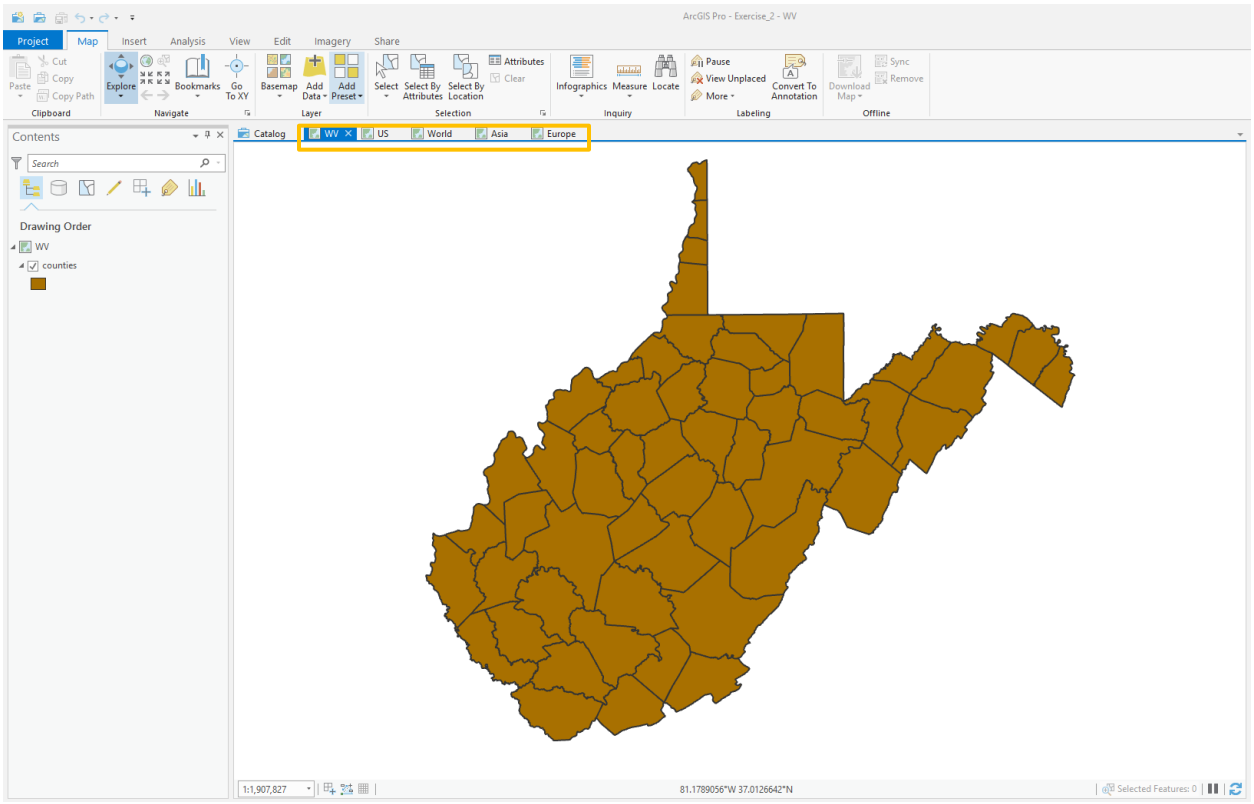
First, we need to download and open the **Exercise_2.aprx** file.

- Download the **Exercise_2** data from https://www.wvview.org/. All lab materials are available on the course webpage and linked to the exercise. You will need to extract the compressed files and save it to the location of your choosing.
- Open ArcGIS Pro. This can be done by navigating to All Apps followed by the ArcGIS Folder. Within the ArcGIS Folder, select ArcGIS Pro. Note that you can also use a Task Bar or Desktop shortcut if they are available on your machine.
- After ArcGIS Pro launches, select "Open another project."

- Navigate to the directory that houses the material for this course. The project files are in the **Exercise_2** folder where it was saved on your local machine.
- Select **Exercise_2.aprx**. Click OK to open the project.
- If necessary, navigate to the WV map.

Note: If you'd prefer, you can also just click on the **Exercise_2.aprx** file within the uncompressed folder directly to launch ArcGIS Pro.

This project contains a total of five maps: WV, US, World, Europe, and Asia. We will begin with the WV map. Each map is displayed in a different tab.

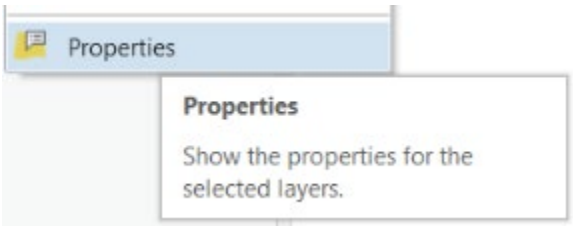


Step 2. Exploring Layer Datum and Projection Information

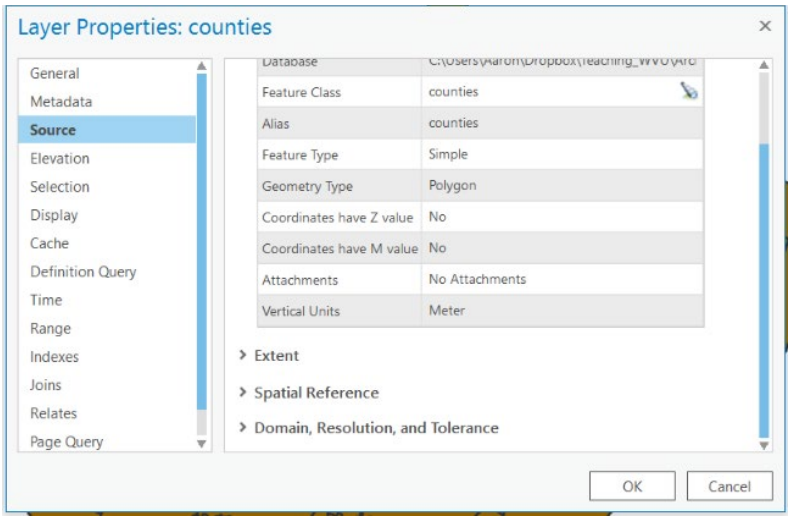
The WV map only includes one layer, **counties**. Layers in a map commonly have a datum defined and maybe a map projection to which the coordinates are referenced. This may be different from the map. Note that ArcGIS allows for projection-on-the-fly, in which data layers can be re-projected in memory so that they draw at the correct location relative to a map projection. This is a nice feature, as it allows you to load data that have different datum and/or projections defined into the same map space.

Here, we will investigate the projection information for the **counties** layer.

- ☐ Right-click on the counties layer in the table of contents. Select Properties (it should be at the bottom of the window).



- ☐ In the Layers Properties Window, navigate to the Source options.
- ☐ Within the Source options, expand the Spatial Reference information.



This provides information about the Projected and Geographic coordinate systems used for this data layer. Use this information to answer the following questions.

Question 1. What is the projected coordinate system for this layer? (2 Points)

Question 2. What is the geographic coordinate system for this layer? (2 Points)

Question 3. In what length units are the measurements specified? (2 Points)

Question 4. What is the value for the false easting, with units? (2 Points)

Question 5. What is the value for the false northing, with units? (2 Points)

Question 6. What datum is used? (2 Points)

Question 7. Would this projection be appropriate for a map that shows the entire globe? Why or why not? (4 Points)

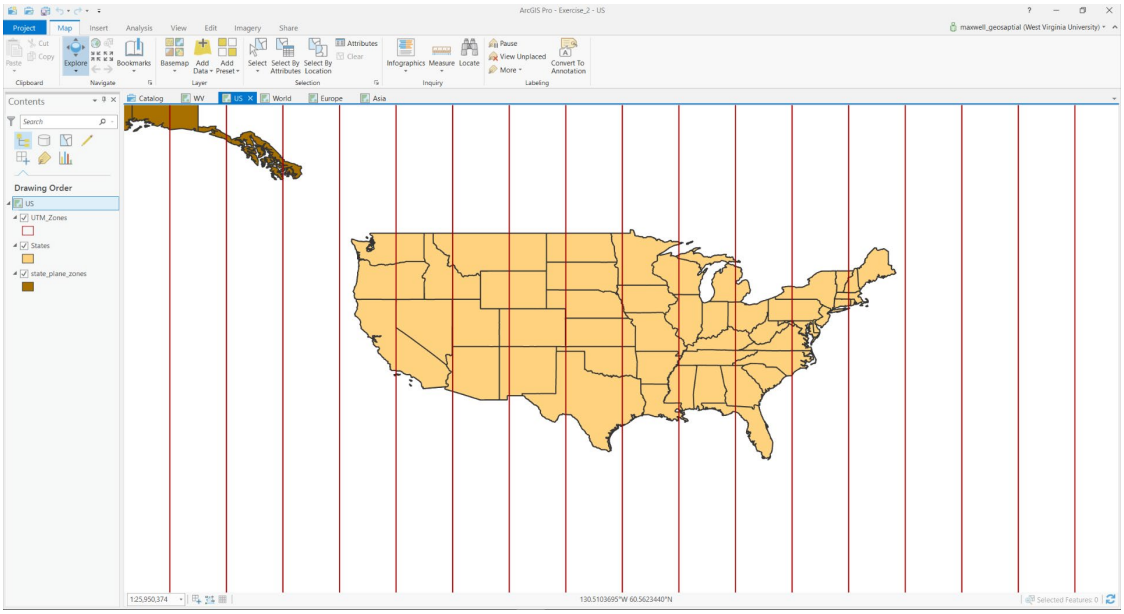
You can use this menu to investigate spatial reference information for any geospatial layer.

Step 3. Changing Map Projections

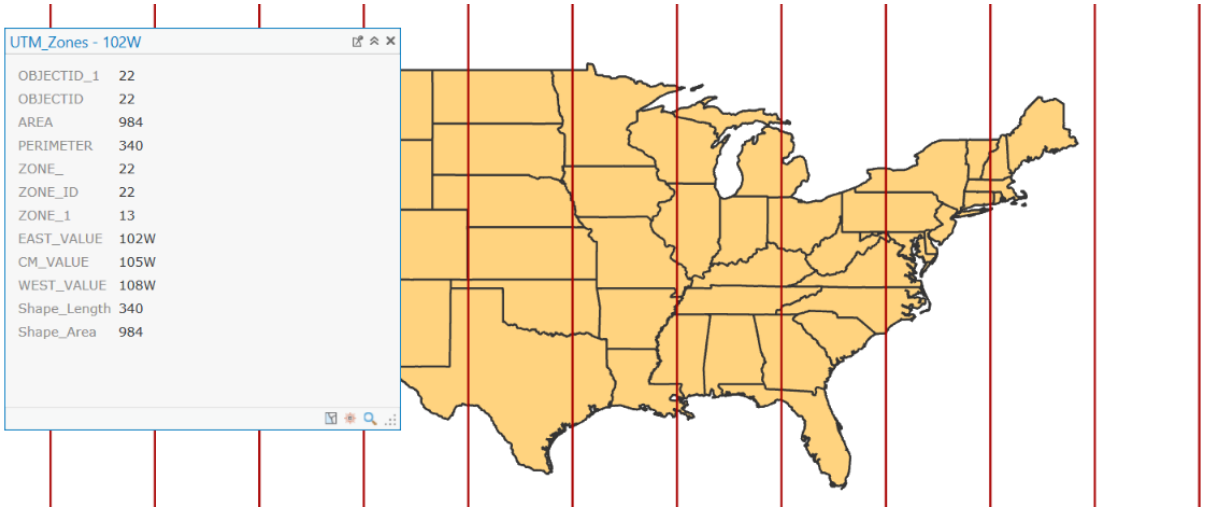
Although each data layer is assigned either a projected coordinate system or a geographic coordinate system, the spatial reference for a data layer can be transformed. So, you can view the map space or map layouts in different projections as ArcGIS Pro can apply these transformations on-the-fly, or in memory. Here, we will explore changing the projection of a map. We will

now work with the US map. Before we change the projection, we will explore the UTM zones and State Plane Coordinate Systems.

- Navigate to the US Map.



The regions on the map that are separated by vertical red lines represent different UTM zones. If you click within a zone, information about the zone will be displayed.



The zone number is listed in the "Zone_1" field. Use this information to answer the following questions.

Question 8. In what UTM zone is Nevada located? (2 Points)

Question 9. In what UTM zone is most of West Virginia located? (2 Points)

Question 10. Does the zone number increase as you move east or west across the United States? (2 Points)

Question 11. Based on the lecture material, what developable surface is used in the UTM system (plane, cone, or cylinder)? (2 Points)

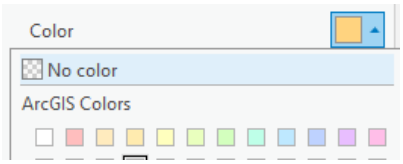
You will now investigate the state plane coordinate systems.

- Turn off the **UTM_Zones** by un-checking it in the Contents Pane.
- Let us make the **States** layer only have an outline by changing the symbology as we did in exercise 1.

Recap:

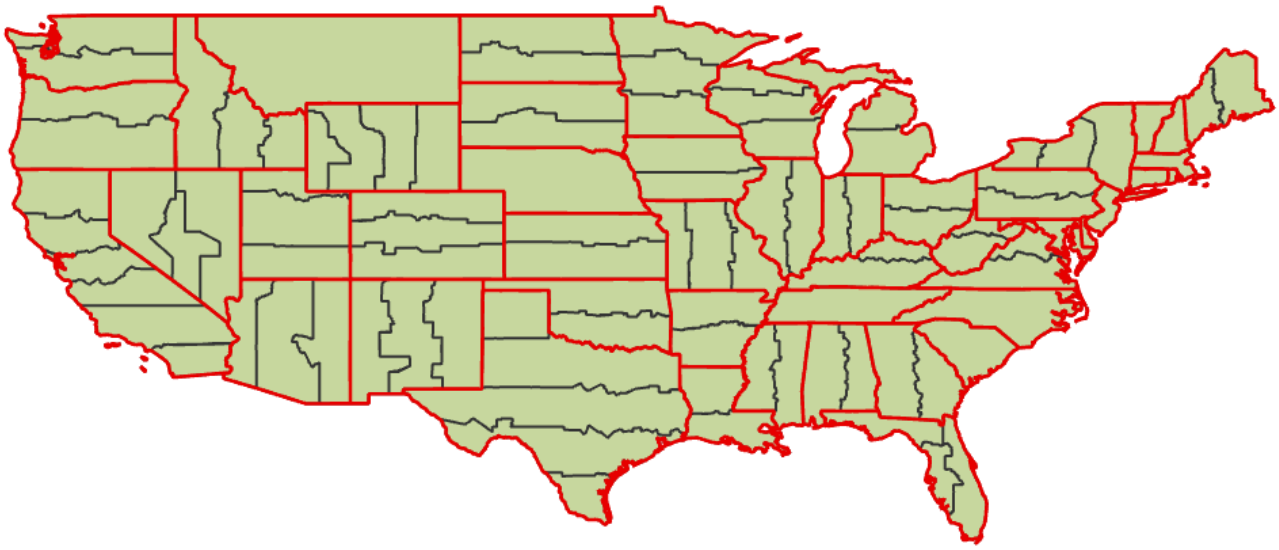
- Double-click on the polygon symbology for **States** in the Contents Pane.
- Click on Properties in the Symbology Window.

- Click on the Symbol Options (looks like a brush).
- Change the Color to "No Color".



- Change the Outline Color, and Outline Width to settings you feel are appropriate.
- Click Apply to accept the changes.

- You should now see the state plane systems within each state.



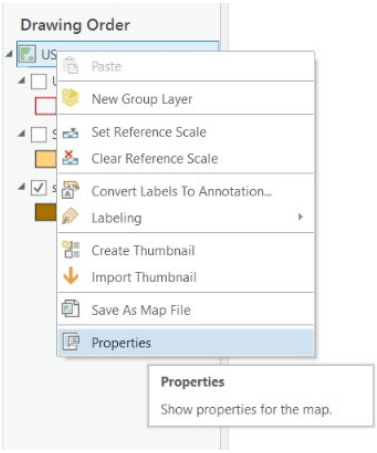
Question 12. How many state plane systems does West Virginia have? (2 Points)

Question 13. How many state plane systems does Texas have? (2 Points)

Question 14. Would it be appropriate to project all of Texas into one of its state plane systems to produce a map of the entire state? Why or why not? (2 Points)

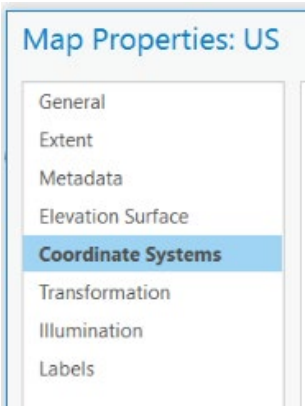
Now, you will change the projection for this map. Before we begin, let's turn off all of the layers except the **States** layer.

- Make sure that the **States** layer is displayed. Make sure that it is checked on in the Contents Pane.
- Make sure that the **UTM_Zones** and **state_plane_zones** layers are not displayed. Make sure that they are un-checked in the Contents Pane.



Now, you are ready to change the projection.

- In the Contents Pane, right-click US. In the menu that is activated, select Properties.
- In the Map Properties window, navigate to Coordinate Systems.

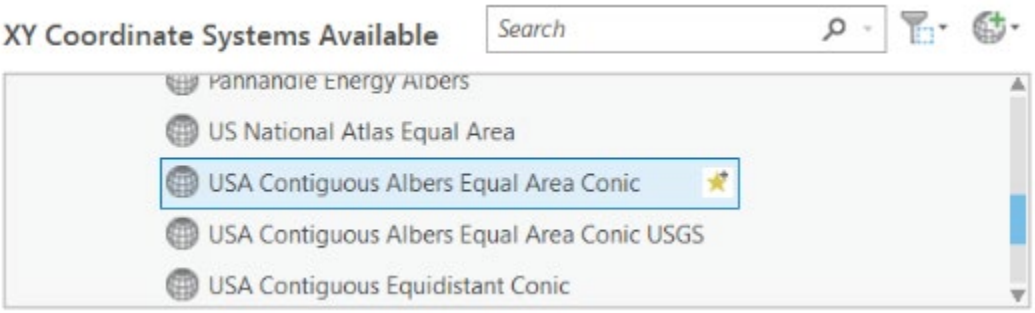


Question 15. Is the map currently in a projected or geographic coordinate system? (2 Points)

We will now change the projection to an Albers Equal Area Conic projection.

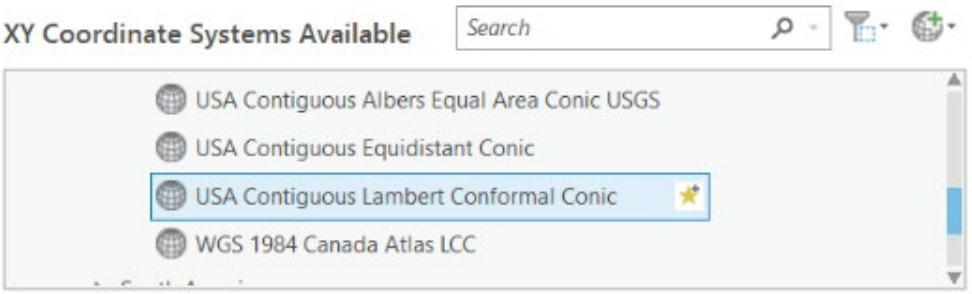
- Within the Coordinate Systems window, expand the Projected Coordinate Systems list. Expand the Continental list. Expand the North America list.

- From the North America list, select USA Contiguous Albers Equal Area Conic.
- Click OK to change the projection of the map.



The map should now be projected to an Albers Equal Area Conic projection. The shape of the United States should change to reflect the projection.

- Change the projection to Lambert Conformal Conic (use USA Contiguous Conformal Conic). This can also be found in the North America folder.



Question 16. What is one similarity between the Albers and Lambert projections for the contiguous United States? (4 Points)

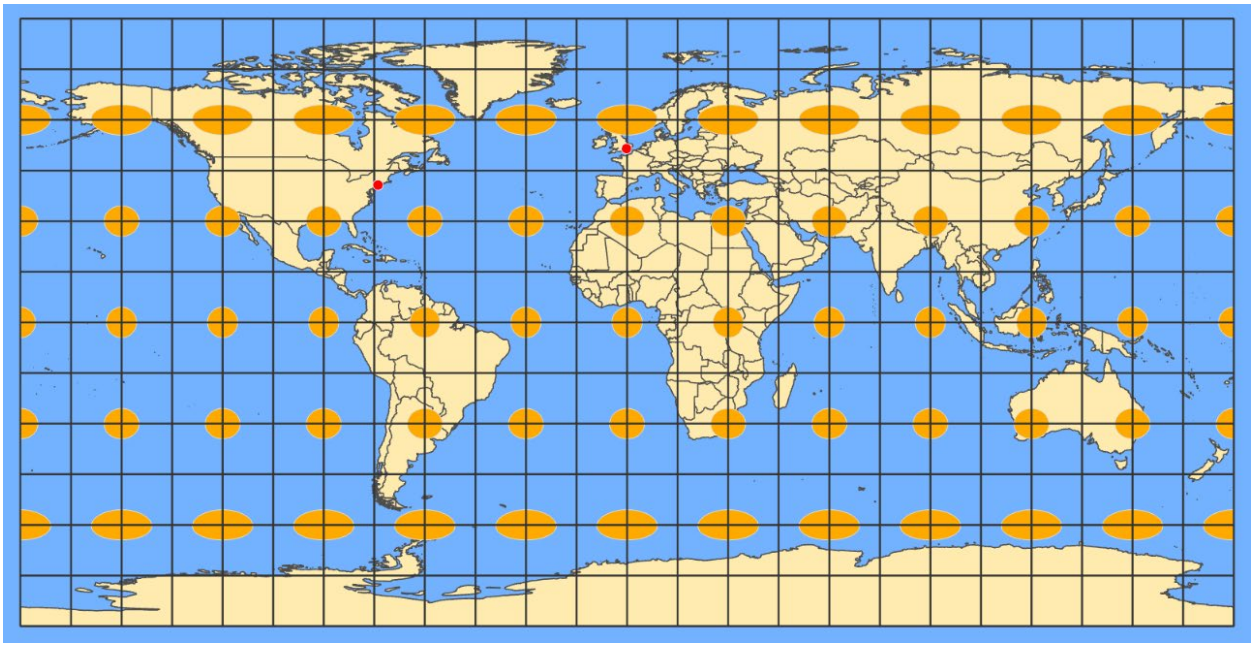
Question 17. What is one difference between the Albers and Lambert projections for the contiguous United States? (4 Points)

Question 18. What property (distance, direction, area, shape) are conformal projections designed to maintain? (2 Points)

Step 4. Investigating World Projections

Now, you will explore some global projections. We commonly see more distortions for global scale maps as we are transforming the entire curved surface of the Earth to a flat surface.

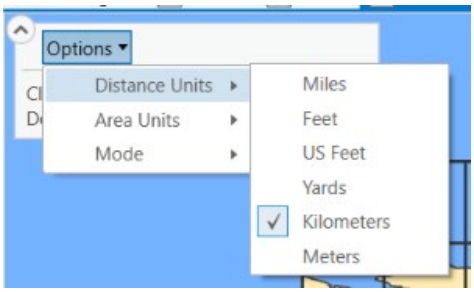
- Navigate to the World Map.



We will begin by measuring the distance between New York and London, shown on this map as red points.

- Use the Measuring Tool to measure the distance between New York and London. This tool can be found in the Inquiry area of the Map Tab.

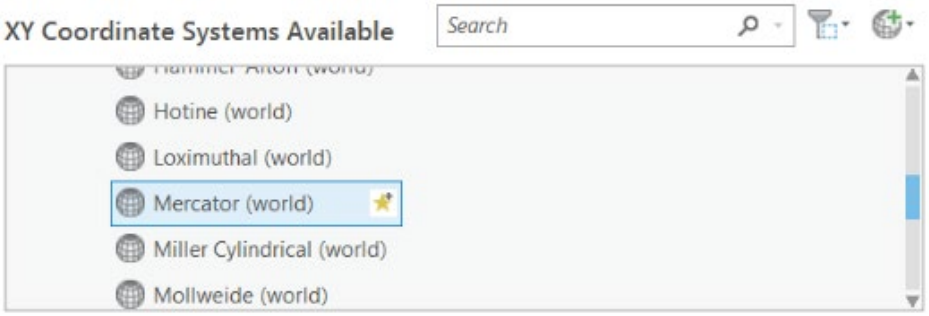
- In the tool options, change the distance units to kilometers.



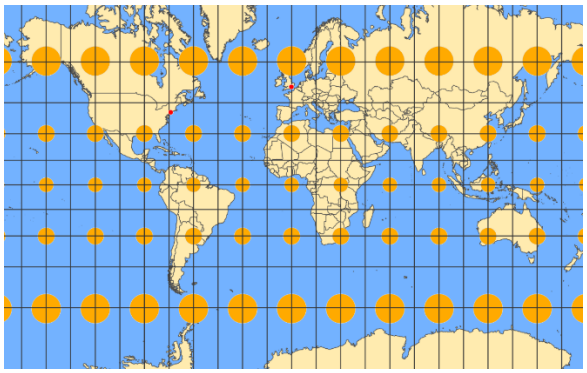
Question 19. What was the reported distance in kilometers between New York and London? (2 Points)

Now, you will change the projection for this global map to a Mercator projection.

- Right-click on World in the Contents Pane. Select Properties.
- In the Map Properties window, navigate to Coordinate System.
- Use the Mercator (world) projection. This can be found under Projected Coordinate Systems and in the World list.



- Click OK to change the projection.



Question 20. What developable surface is used by the Mercator projection (plane, cone, or cylinder)? (2 Points)

Note that if there are no projection distortions, the Tissot Ellipse (Tissot Indicatrix), shown on the map in orange, will all be the same size (relative to each other) and shape (perfect circles). Use the Tissot Ellipses to answer the following questions.

Question 21. Does the Mercator projection distort size? (2 Points)

Question 22. Does the Mercator projection distort shape? (2 Points)

- Now, change the projection to Mollweide (world). This projection is also in the World list under Projected Coordinate Systems.

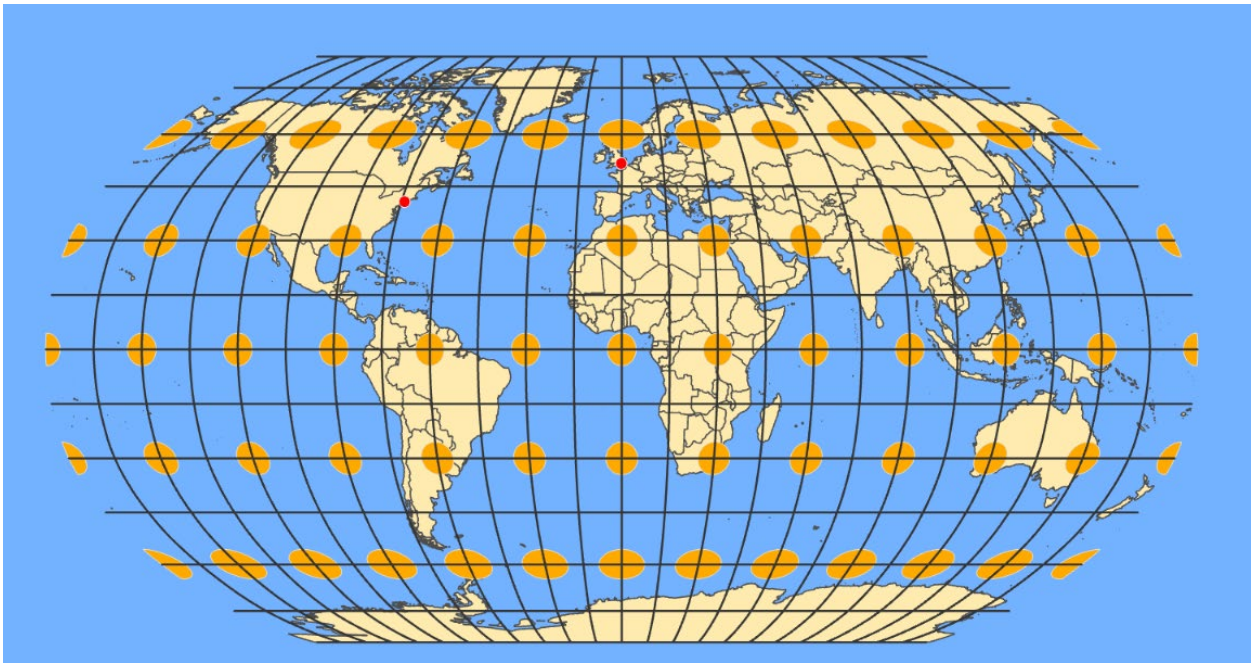
Question 23. Does the Mollweide projection distort size? (2 Points)

Question 24. Does the Mollweide projection distort shape? (2 Points)

As you can see from these examples, different projections distort different properties. This is one of the primary considerations when choosing a projection for your map. What properties do you wish to maintain and which can be distorted?

Some projections attempt to strike a balance between distortions. One example is the Robinson Projection.

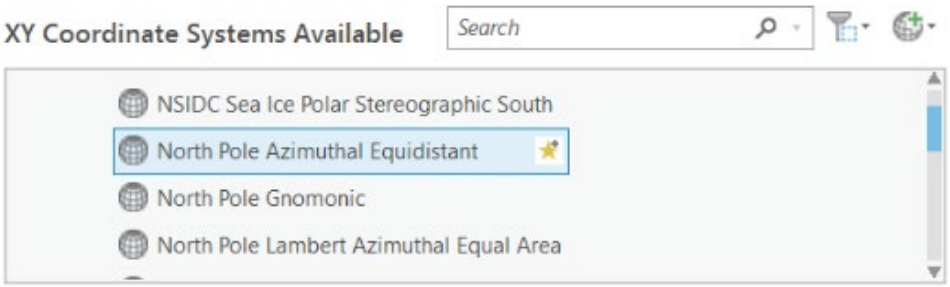
- Change the projection to Robinson (world). This projection is also in the World list under Projected Coordinate Systems.

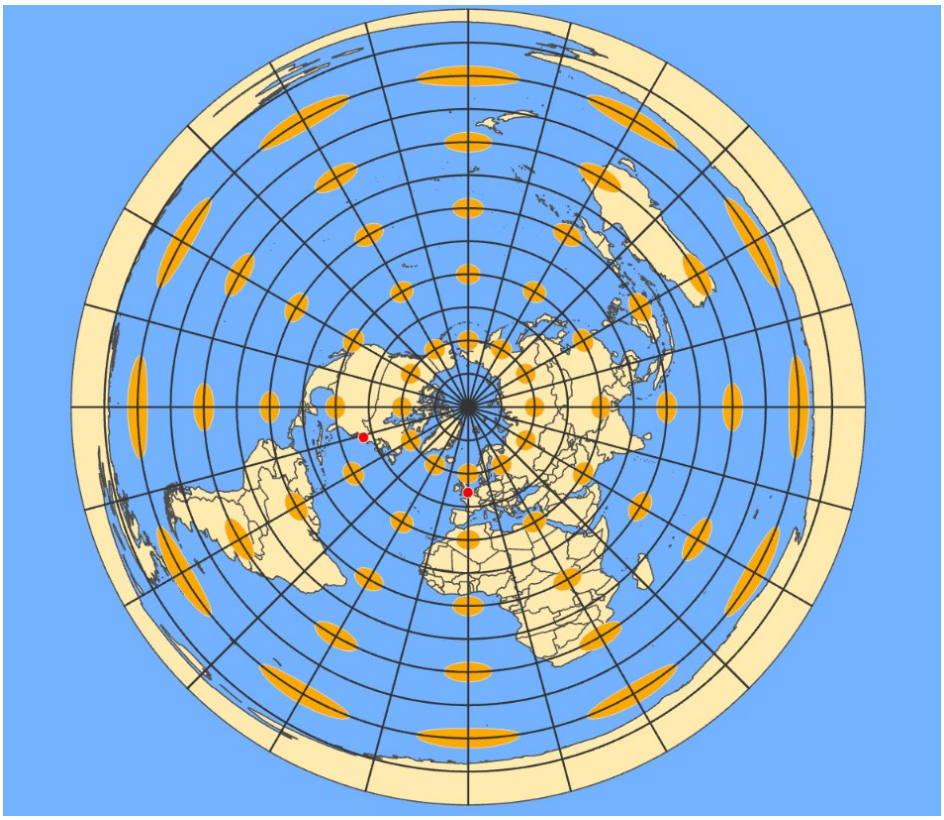


Note that the Robinson Projection distorts both size and shape, but attempts to balance out the distortions.

Before we move on, let's investigate a polar projection.

- Change the projection to North Pole Azimuthal Equidistant. This projection is in the Polar list under Projected Coordinate Systems.





This projection maintains distance from the North Pole to other locations on the globe.

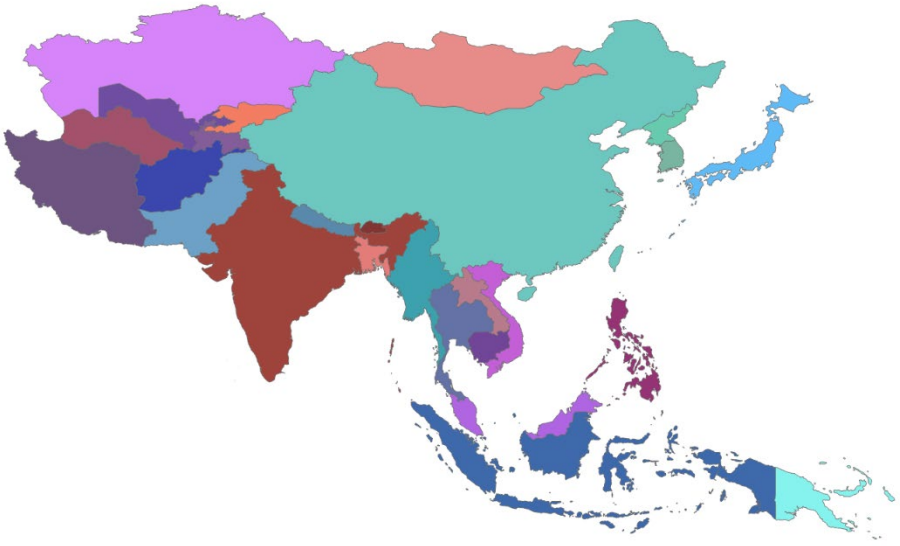
Take the time to experiment with some different map projections for projecting the entire globe. Projections designed for global maps are in the World list under Projected Coordinate Systems.

Question 25. Of the projections that were investigated above and the ones you experimented with on your own, which did you prefer for a global map and why? (4 Points)

Step 5. Continental Scale Projections for Asia

We will now explore projections designed for Asia.

- Navigate to the Asia Map.



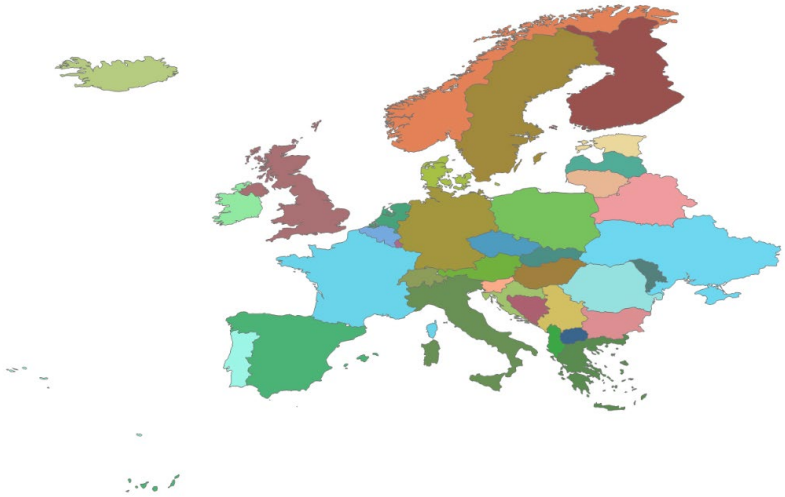
Projections that would be appropriate for Asia can be found in the Asia list under Continental and Projected Coordinate Systems. Experiment with the available projections to answer the question below.

Question 26. Name a projection that would be appropriate if you were interested in maintaining the relative shape of the countries. How do you know that this projection maintains shape? (4 Points)

Step 6. Continental Scale Projections for Europe

We will now explore projections designed for Europe.

- Navigate to the Europe Map.



Projections that would be appropriate for Europe can be found in the Europe list under Continental and Projected Coordinate systems. Experiment with the available projections to answer the question below.

Question 27. Name a projection that would be appropriate if you were interested in maintaining the relative size of the countries. How do you know that this projection maintains relative size? (4 Points)

Step 7. A Note or Re-projecting a Layer

In this exercise, you experimented with changing the projection of maps. Note that this process re-projects the data on-the-fly and changes the projection of the screen display. It does not change the actual projection associated with the data layer. If you wanted to save a copy of a data layer with a different projection applied, this can be done using the **Project Tool**. This tool can be found in the Projections and Transformations subtoolbox within the Data Management Toolbox. This tool will create a copy of a data layer with a new projection. If you are going to perform spatial analysis, as we will do in later labs, it is generally a good idea to have all of the data layers in the same projection. So, you could use this tool to pre-process your data. However, this is not always necessary. For example, here we were simply viewing the data, so re-projecting the data layers to a new projection was not necessary.

END OF EXERCISE