

Day 5: Projecting Geographic Data

ArcGIS Pro Coordinate Systems

Goals: Explore map projections and scale in ArcGIS Pro

Deliverables: Screen grab of maps produced and compute distance calculations

Data: Download the data for this assignment: data-lab05.zip

Estimated Time: 30 minutes

Introduction:

The Lectures and reading provide the necessary background. We introduce unavoidable distortion when we flatten the Earth's curved surface onto a flat map. Different map projections represent the same points with different X and Y (or E and N) coordinate values. We cannot mix map projections in an analysis, so we often have to re-project some of our data layers.

Note that in the instructions below we often use the terms “map projection,” “projection,” and “coordinate system” interchangeably. A map projection is associated with a specific coordinate system, and to project data is to convert from one coordinate system to another.

The lab is composed of the following parts:

1. Get Started: Start ArcGIS Pro, set up project, insert a new map, add folder connection
2. Explore how distance may change due to coordinate system distortions

Part I: Get Started

A. COPY LAB01 DATA TO LOCAL DIRECTORY

- 1) Create a new folder for this lab in your personal directory: (e.g. C:\Users\jdoe\Downloads\Lab05).

We will refer to this directory as \$HOME, for the remainder of this document.

- 2) Copy contents of data-lab05.zip to \$HOME, the contents should be a folder: 'data-lab05'

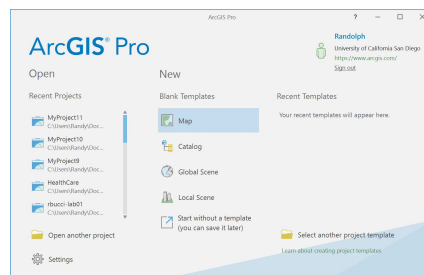
B. START ARCGIS PRO

- 1) Start ArcGIS Pro by clicking the Start button on the taskbar, and then, on the Start menu, click All Programs > ArcGIS > ArcGIS Pro > ArcGIS Pro.
- 2) Click Sign In.

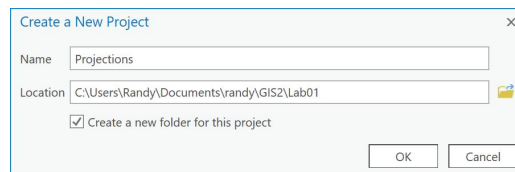
The application opens with the ArcGIS Pro dialog box.

C. CREATE A NEW PROJECT

- 1) To create a new project, click New ☐ Map.



- 2) Provide a New Project name: Projections

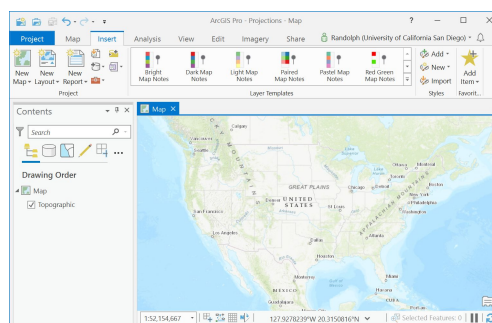


This creates a folder for ArcGIS to use as a working directory.

- 3) Browse to and select \$HOME as the location to save the new project folder.

\$HOME is wherever you want it to be (e.g. C:\Users\jdoe\Downloads\Lab05)

- 4) Click OK - Should see something like the following:



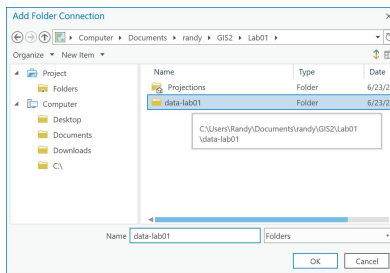
D. ADD FOLDER CONNECTION

On top of the basemap, you'll add a layer from the data that has been put together for this project and is stored on your computer. Adding a folder connection allows quick access to data for a project.

- 1) Open Catalog pane (View ☐ Catalog Pane), right-click Folders and click Add Folder Connection.



- 2) Browse to your \$HOME folder (e.g. C:\Users\randy\Downloads and select the data-lab05 folder. Then click OK.

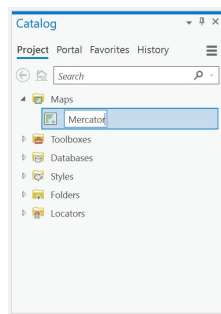


Selecting a folder adds a new folder connection to data-lab01 and provides quick-access to data.

E. ADD A SECOND MAP

Before adding a 2nd map, let's first rename the 1st map to: **Mercator**

- 1) Rename Map 1 to 'Mercator': From the Catalog Pane (View ☐ Catalog Pane), expand 'Maps', right-click on Map ☐ Rename

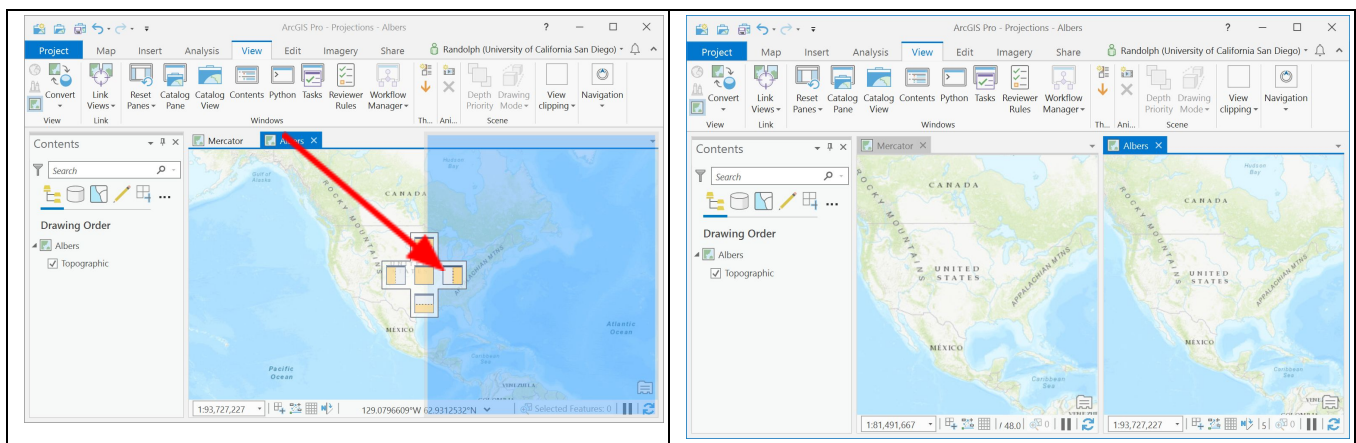


- 2) **Insert New Map: From Catalog Pane, right-click Maps ☐ New Map and rename it : 'Albers'**
- 3) **Close Catalog Pane**

F. REPOSITION THE MAPS SIDE-BY-SIDE

- 1) **Reposition Albers Map on the right side of the Mercator map by dragging the tab of the Albers to the right-center of the map.**
- 2) **On the View tab, click Link Views, and then on the drop-down menus, click Center and Scale**

When you release the map button, you'll have the two maps side-by-side. This will allow you to compare the two different map projections together.



- 3) **On the View tab, click Link Views, and then on the drop-down menus, click Center and Scale**

Now both Views are linked together, this is a useful feature when comparing datasets.

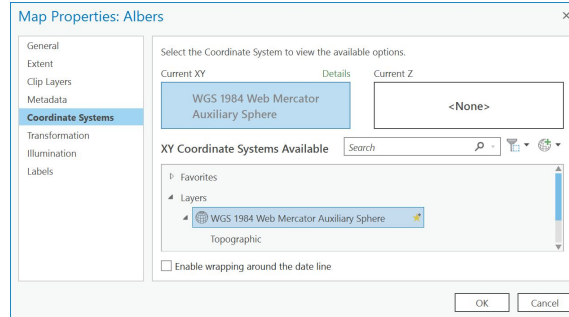
Part II: Observe How Distance May Change with a Map Projection

You will first add data layers to each of these maps and observe how on-the-fly projection works. Next, the measure tool will be utilized to explore Planar vs. Geodesic distances.

A. CHECK DEFAULT COORDINATE INFORMATION

The default coordinate system used by ArcGIS Pro is similar to that used by Google Earth and other mapping applications, to find out what it is do the following:

- 1) **Activate the 'Albers' Map.**
- 2) **In the Contents pane, right-click Albers and click Properties > Coordinate System**

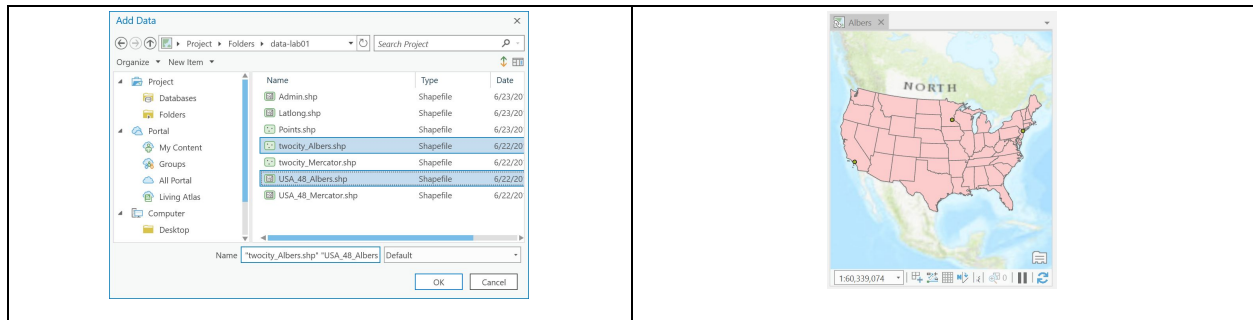


The default coordinate system is: **WGS 1984 Web Mercator**

B. ADD DATA TO ALBERS MAP AND CHECK PROJECTION

Add the layers `twocity_Albers.shp`, and `USA_48_Albers.shp` from Lab01 data folder (e.g. Lab01/data-lab01). There are several ways to add data layers to a map. If you need help, see the ArcGIS Quick Start Tutorial: [Add Data to Project](#)

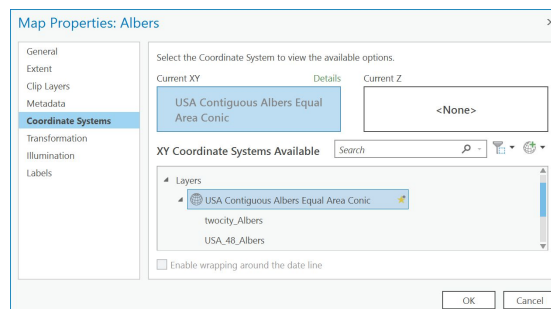
1) Map > Add Data > Project > Folders > data-lab01



You have added two new layers to the Albers Map, now re-check the Coordinate System information.

2) In the Contents pane, right-click Albers and click Properties > Coordinate System

You will see ArcGIS Pro has performed an On-The-Fly projection where the map has adopted the coordinate system of the added data layers. The new coordinate system is: **Albers Equal Area Conic**



Any layers added from this point on, will be converted (projected) by software into the same coordinate systems.

C. ALBERS: MEASURE DISTANCE BETWEEN LOS ANGELES AND NEW YORK

Before making distance measurements, please refer to the ArcGIS Pro Documentation on the [Measure Tool](#)

1) Activate the Map tab

2) Left-click on the Measure Tool to enable it, and set Distance Units to Miles, and Mode to Planar.

3) Left-click once on Los Angeles, then move the mouse to New York and double left-click on New York.

The distance between the two cities is displayed in a drop-down window. Your measured distance should be approximately 2,440 miles.

4) Set the mode to Geodesic and make the measurement again.

The Geodesic distance should be approximately 2,460 miles. A difference of 20 miles from the Planar measurement.

E. ADD DATA TO MERCATOR MAP AND CHECK PROJECTION

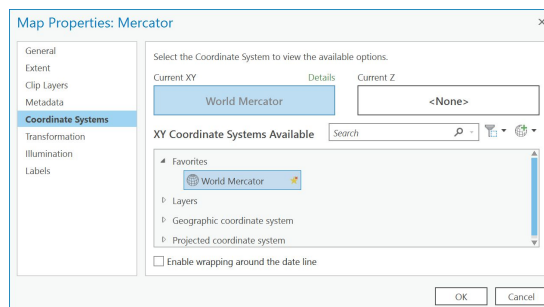
Add the layers twocity_Mercator.shp, and USA_48_Mercator.shp from Lab01 data folder (e.g. Lab01/data-lab01).

1) Activate the 'Mercator' Map

2) Add the data layers: twocity_Mercator.shp and USA_Mercator.shp

3) Check Coordinate System

The new layer has slightly different coordinate system than the default. The Coordinate System is now: World Mercator.



F. MERCATOR: MEASURE DISTANCE BETWEEN LOS ANGELES AND NEW YORK

You will now re-measure distances using the Mercator Projection.

1) Activate the Mercator Map

2) Activate the Map tab

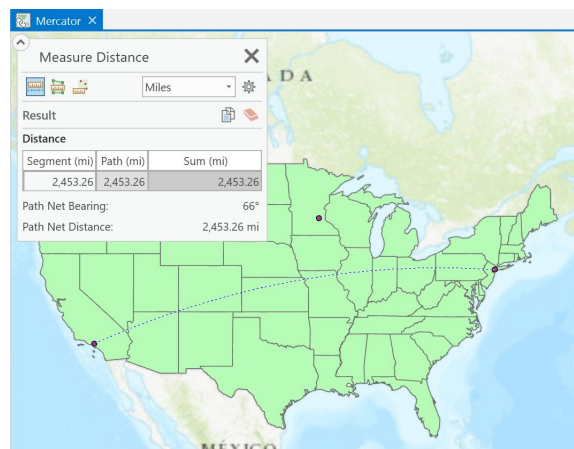
3) Left-click on the Measure Tool  to enable it, and set Distance Units to Miles, and Mode to Planar.

4) Left-click once on Los Angeles, then move the mouse to New York and double left-click on New York.

The re-measured distance should be approximately 3,127 miles.

5) Set the mode to Geodesic and make the measurement again.

The Geodesic distance should be approximately 2,450 miles. A difference of 677 miles from the Planar measurement! When stretching the measure tool in Geodesic mode, you should see the measurement line start to curve.



The on the “ground distance”, or **planar distance**, between LA and NY is actually 2,444 miles. The difference in measurements between the “Albers” and “Mercator” is due to unavoidable distortion caused when we stretch measurements from the curved Earth surface to a flat map surface. Notice that the distortion is different for different projections.

Under the Geodesic option, the calculations approximate as close as possible the true distance measurement on the surface of the earth. The Loxodromic and Great Elliptical options are only slightly different than the Geodesic differences, but are approximately equal to the Geodesic distance in this application. The big difference is with the planar method, which assumes both projections are good approximations of a Cartesian surface. You can see, with the almost 700 mile error, that a Cartesian measurement assumption can be substantially wrong.

G. ADDITIONAL MEASUREMENTS

There is a 3rd point in the shapefiles of each map representing the city of Minneapolis, Minnesota.

Compute the missing distance measurements in the table below:

	Mercator Distances (mi)	Albers Distances (mi)
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Distance (miles)	Planar	Geodesic	Planar	Geodesic
Los Angeles to Minneapolis	?	1510	1503	?
Minneapolis to New York	1400	?	?	1030

E. EXPORT SCRENGRAB

You will be asked to paste a screengrab showing the two Maps: Mercator and Albers. Similar to below:

