

This help guide will describe how to define a coordinate reference system (*Define Projection*) and how to project data from one coordinate reference system to another coordinate system (*Project*).

Some terms

Geographic Coordinate System (GCS): A GCS locates objects on the curved surface of the earth based on a mathematical approximation of the Earth's shape (known as a spheroid) and a datum (see below). A GCS is a grid made up of horizontal lines of latitude (also known as parallels) and vertical lines of longitude (also known as meridians.) The coordinates of a particular location are expressed in degrees, minutes, and seconds (DMS) or as decimal degrees (DD).

Datum: A datum is the origin of the GCS to which all other points refer. Different datums are more or less appropriate depending on which region of the Earth is being mapped. In North America, NAD27 and NAD83 are commonly used datums; WGS84 is commonly used for maps with a world-wide extent.

Projected Coordinate System (PCS): A PCS "projects" objects from the curved surface of the Earth onto a flat map using a map projection. No projection can represent all of a map's features with complete accuracy; some distortion of shape, area, distance, and/or direction will occur. This distortion is especially noticeable with small-scale maps (maps that show a large area.) Distortion can be minimized by choosing a projection that is appropriate to the area being shown and the intended use of the map.

Why define a coordinate reference system or a projection?

All the layers (raster and/or vector) in your map must have the same geographic coordinate system (GCS) and datum in order to display correctly. If you have several map layers in the Table of Contents in ArcMap and one layer does not display properly with your other layers (for example, it displays far away from the other layers), you may have a problem with geographic coordinate systems and/or datums. You must ensure that all the datasets you add to your map have defined GCSs and datums that match one another.

A map need not have a PCS to display properly in ArcGIS. Many available datasets are unprojected (i.e. they have no defined projected coordinate system [PCS]). If you add unprojected data or data with a PCS to an existing map that has a different PCS, ArcGIS can adjust the new data's PCS on the fly. Please note that if you are planning on doing any kind of measurement (distance, area, etc.) you need to ensure that your map has a defined, appropriate PCS.

How do I know whether my data has defined a coordinate system or a projection?

There are several ways to determine the coordinate system / projection of your data:

1. In ArcMap or ArcCatalog open the properties of the data and select the **Source** tab (Right click> **Properties** > **Source**). If your data has a coordinate reference system

- (e.g. GCS_North_American_1983) or a projection defined (e.g. UTM_NAD83_Zone17N) it will be displayed in the Data Source window.
2. If the Source Tab window says *Unknown Units* use *My Computer* to go to the directory where the data is located and look for a .prj file. This is a text file that describes the coordinate system or projection. Open this text document with *Notepad* or *Word Pad*.
 3. Look at the metadata. Metadata includes any documentation you have for your data.

How to define a coordinate system / projection and how to re-project data

You can define a coordinate system for data with missing or incorrect projection information using the following options:

1. Geodatabase feature dataset, feature class, or raster dataset: using the **Define Projection** tool in the **Data Management** toolbox
2. Shapefile: using the **Define Projection** tool in the **Data Management** toolbox
3. ArcInfo Coverage: using the **Define Projection** tool in the **Coverage** toolbox

Please note that the **Define Projection** tool does not actually change any geometry, it only labels the dataset with the correct information. You must know the correct map projection before using this tool.

If you have a dataset with a GCS but no PCS, or you want to change the map projection, you can project the data using the following tools:

1. Geodatabase feature dataset, feature class, or raster dataset: using the **Project** tool or **Project Raster** tool in the **Data Management** toolbox
2. Shapefile: using the **Project** tool in the **Data Management** toolbox
3. ArcInfo Coverage: using the **Project** tool in the **Coverage** toolbox

Using the *Define Projection* Tool

Follow these steps to define a dataset's projection as *Universal Transverse Mercator, North American Datum 1983, UTM Zone 17 North*.

1. Open **ArcToolbox** and expand **Data Management Tools** and **Projections and Transformations**.
2. Double click the **Define Projection** tool.
3. In the first drop-down box, select the layer whose projection you want to define.
4. Click the icon to the right of the **Coordinate System** box.
5. In the **Spatial Reference Properties** window make sure the **XY Coordinate System** tab is selected.
6. Expand **Projected Coordinate Systems** > **UTM** > **NAD 1983**. Click on **NAD 1983 UTM Zone 17N** and click **OK**.
7. Click **OK**.

Using the *Project* Tool

The **Project** tool changes the coordinate system of your input data or feature class to a new output dataset or feature class with the newly defined geographic or projected coordinate system including the datum and spheroid (if applicable.)

If you have shapefile or a raster with a Geographic Coordinate System (GSC_North_American_1983 with a Datum –D_North_American_1983) you can project the data to a projection such as NAD 1983 UTM Zone 17N. This is a good projection for North America.

1. Open **ArcToolbox** and expand **Data Management Tools** and **Projections and Transformations**.
2. Expand the **Feature** folder if your data to be projected is vector and the **Raster** folder if your data is raster (grid).
3. Double-click the **Project** tool to open it.
4. For **Input Dataset or Feature Class** use the drop-down button to select the dataset or click and drag the dataset from the Table of Contents in *ArcMap* or *ArcCatalog*.
5. If the dataset has a defined Input Coordinate System it will display as greyed out.
6. For the **Output Coordinate System** click the button to the right.
7. In the **Spatial Reference Properties** window make sure the **XY Coordinate System** tab is selected.
8. Expand **Projected Coordinate Systems > UTM > NAD 1983**. Click on **NAD 1983 UTM Zone 17N** and click **OK**. Click **OK** again to run the tool.
9. The new projected dataset or feature class will be added automatically to your map.