

A photograph of a satellite in orbit around Earth. The satellite is positioned in the upper left quadrant, oriented diagonally. It features a large solar panel array with multiple rectangular panels, a cylindrical body with various equipment and instruments attached, and a prominent white cylindrical component at the bottom. The Earth is visible in the background, showing its blue oceans and white clouds from a high vantage point. The sun is visible in the upper right corner, casting light rays across the dark void of space.

# GIS Level 2: Introduction to Spatial Analysis

# OUTLINE

- Introduction to spatial analyses
- Use map projections & metadata to understand and transform spatial data
- Use different types of processing tools in software(s) to perform a multi-step analysis
- Exercise new knowledge with GIS software(s)

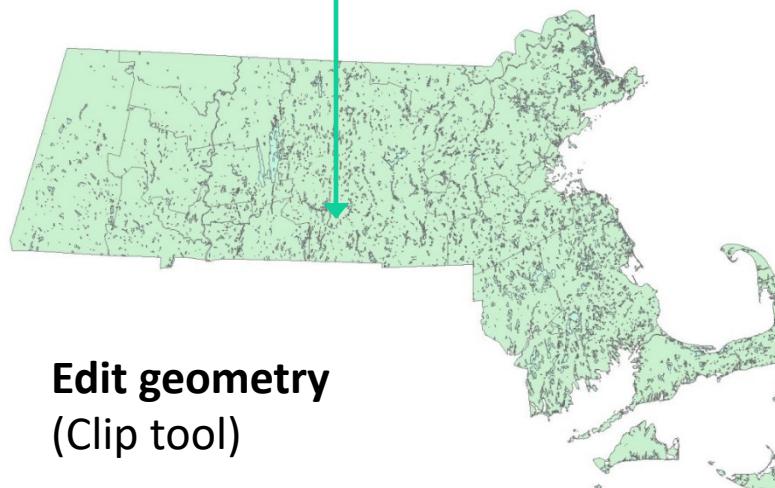
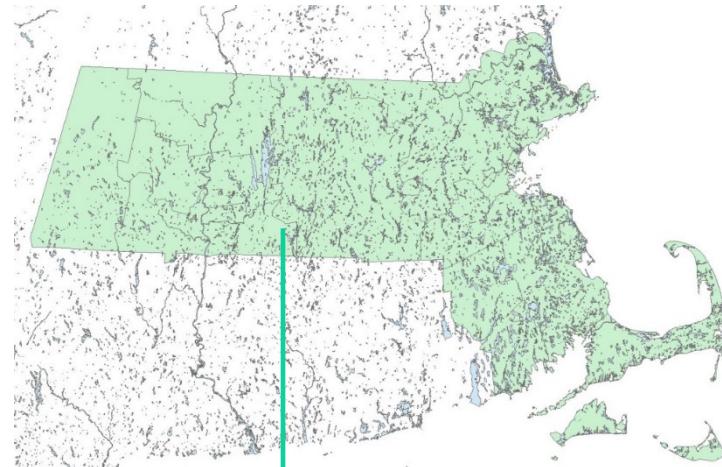
Introduction » Map Projections » Metadata » Processing Tools » Exercise



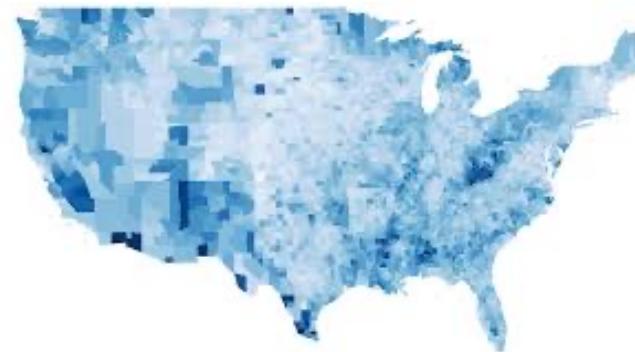
# INTRODUCTION TO SPATIAL ANALYSIS



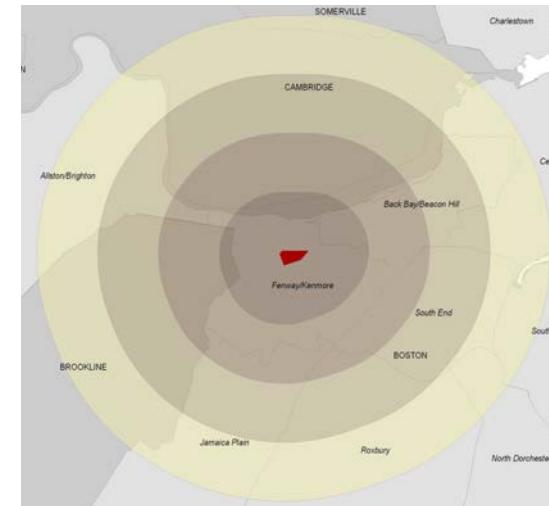
# What analyses can you do?



**Edit geometry**  
(Clip tool)



**Analyze values**  
(Vectors)  
(Rasters)



**Create data**  
(Buffer tool)

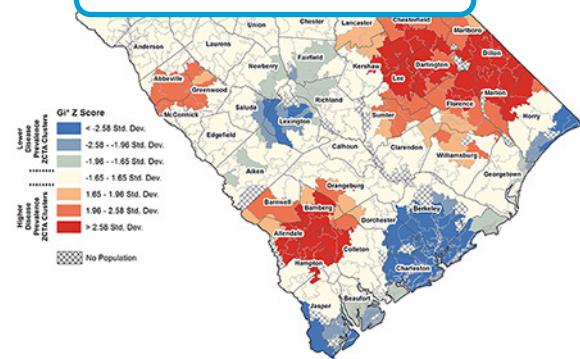
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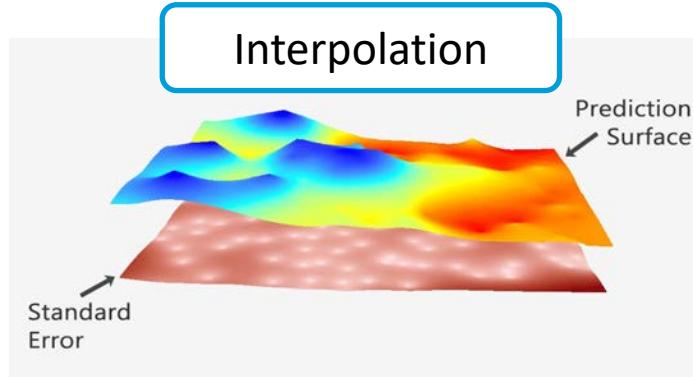


# Specialized tools are used to quantify patterns & relationships in your data.

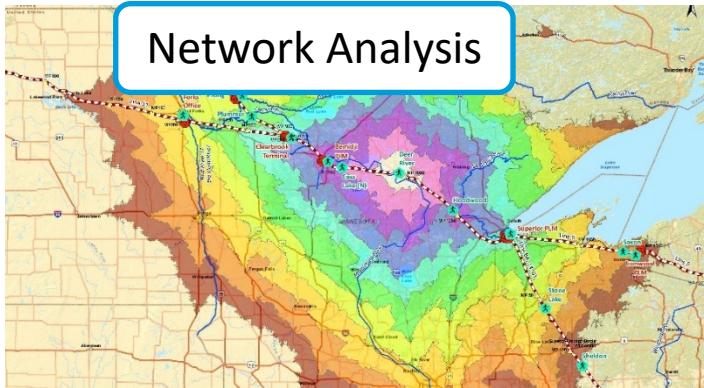
Spatial Statistics



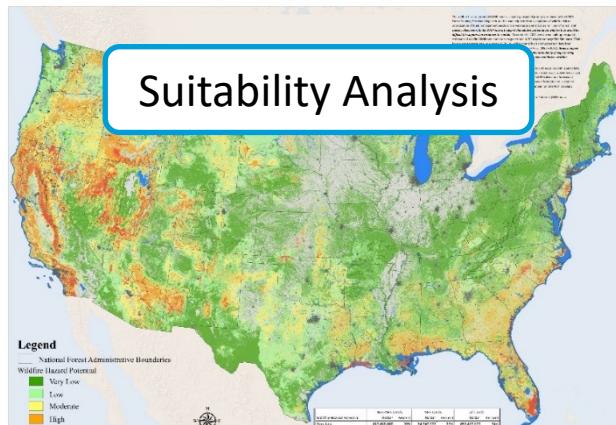
Interpolation



Network Analysis

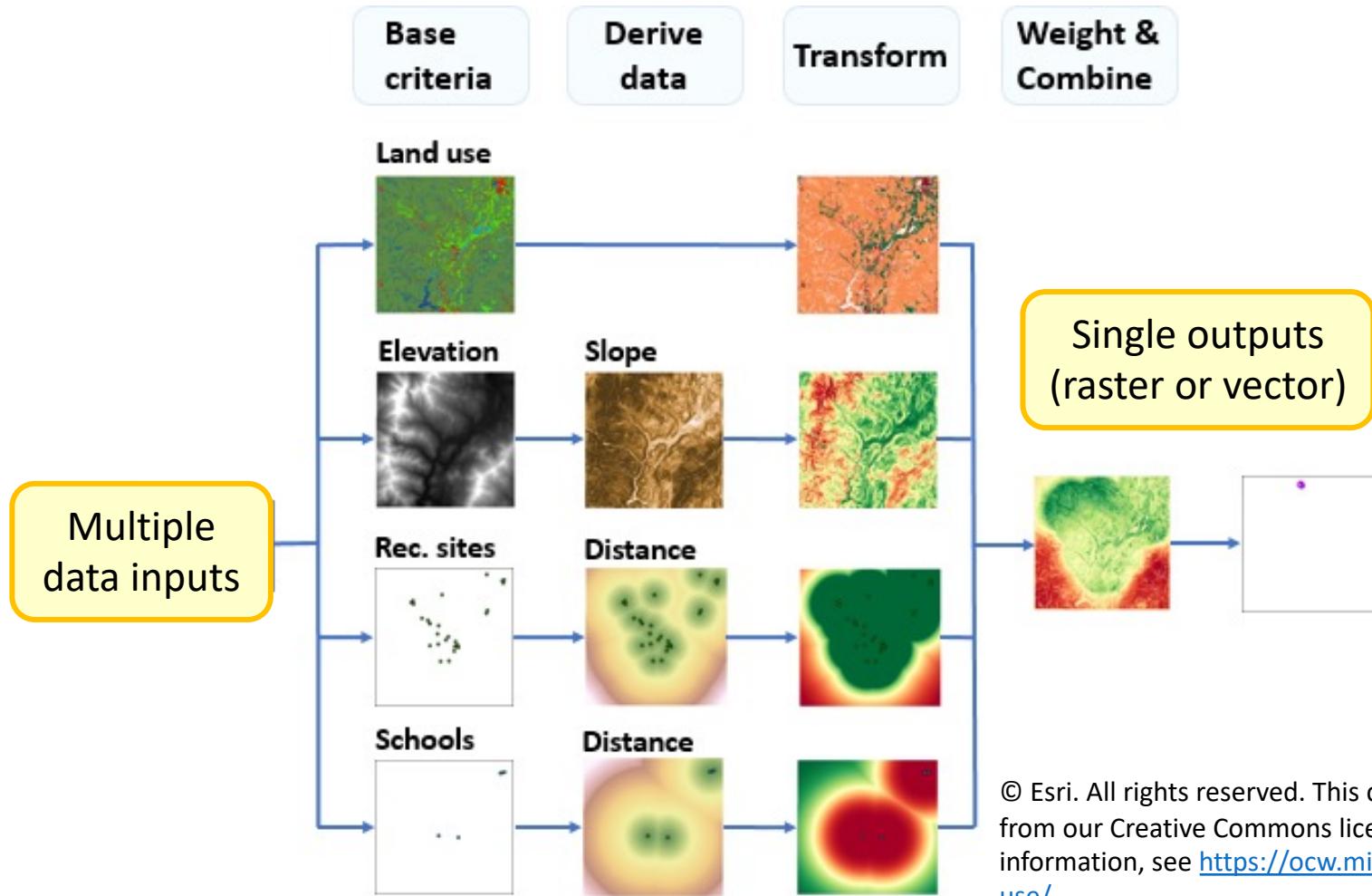


Suitability Analysis



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# Multiple tools are often used together.



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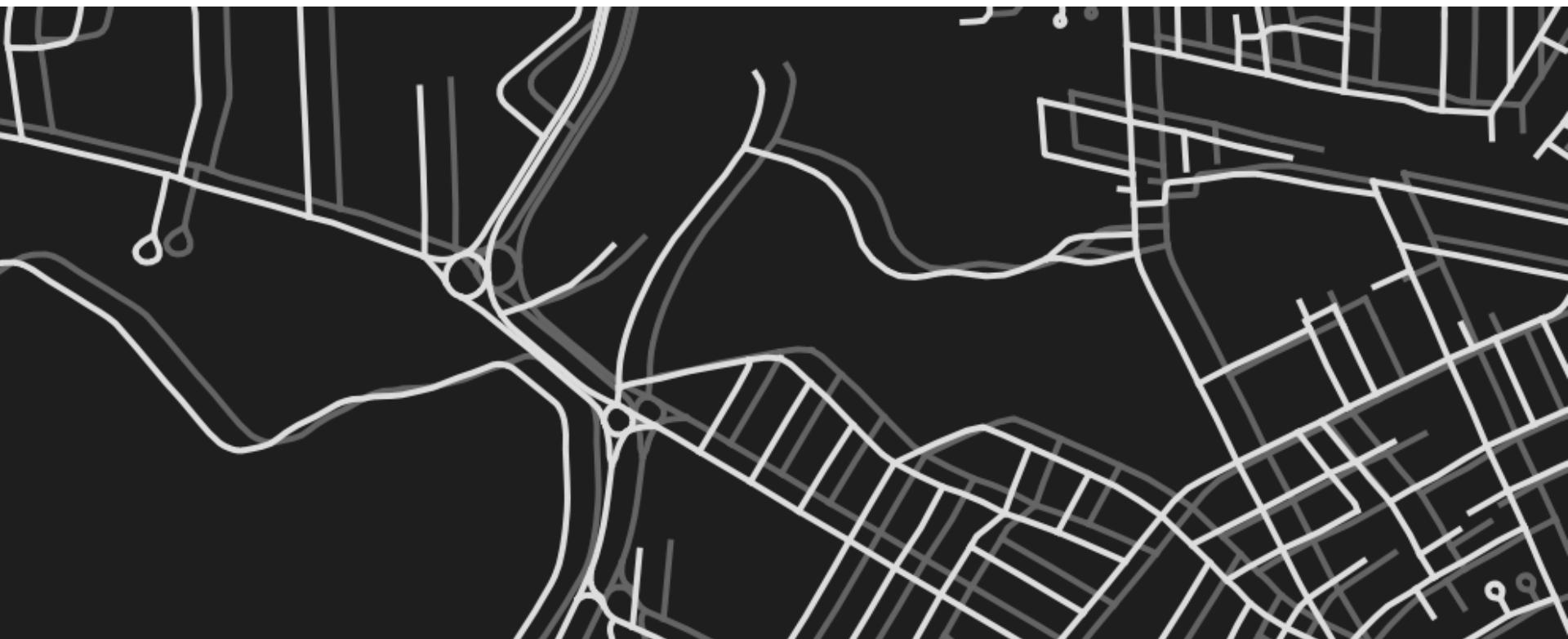
# **MAP PROJECTIONS:**

## **WHY DO WE CARE ABOUT THEM?**



If a coordinate system is wrong or missing,  
data will not display in the correct location.

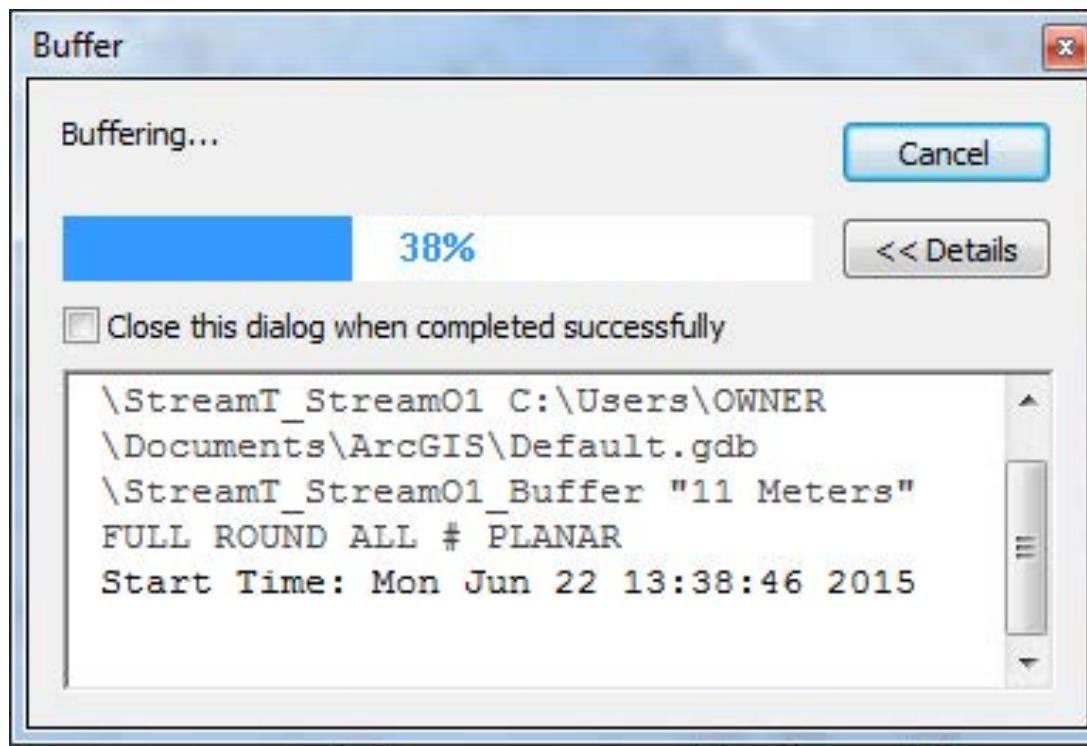
<https://ihatecoordinatesystems.com/>



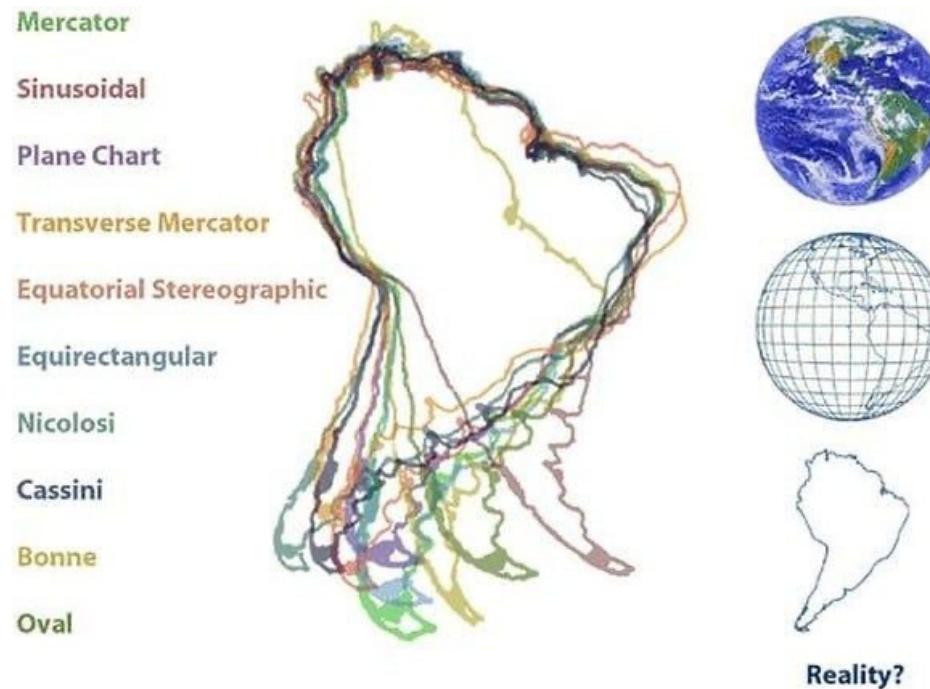
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Using the same projection for all the datasets in your project will lead to faster processing time.



Analysis tools that involve shape, area, direction, form, or distance calculations require data to be in a suitable **projected coordinate system**.

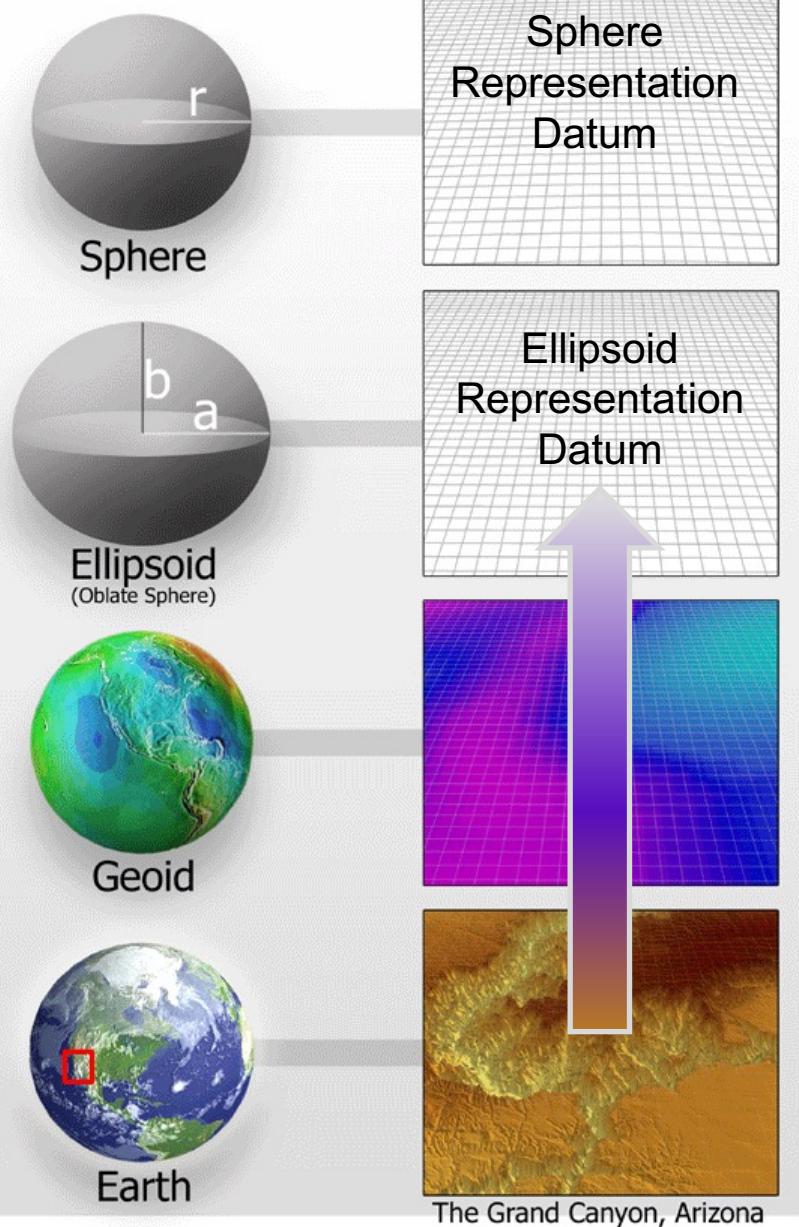


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# **MAP PROJECTIONS: WHAT ARE THEY?**

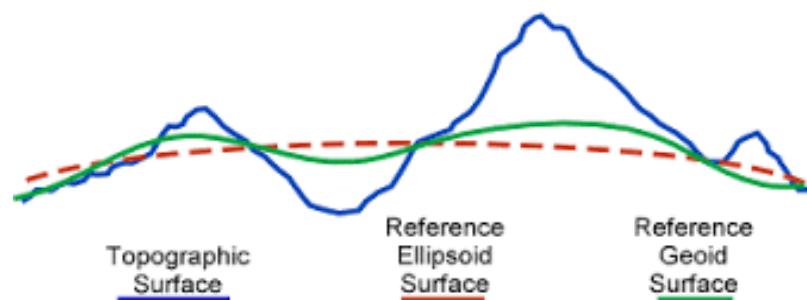




# A Geographic Coordinate System (GCS) consists of

- Datum
- Prime Meridian
- Angular Unit

A Datum is an idealized mathematical representation of the Earth.

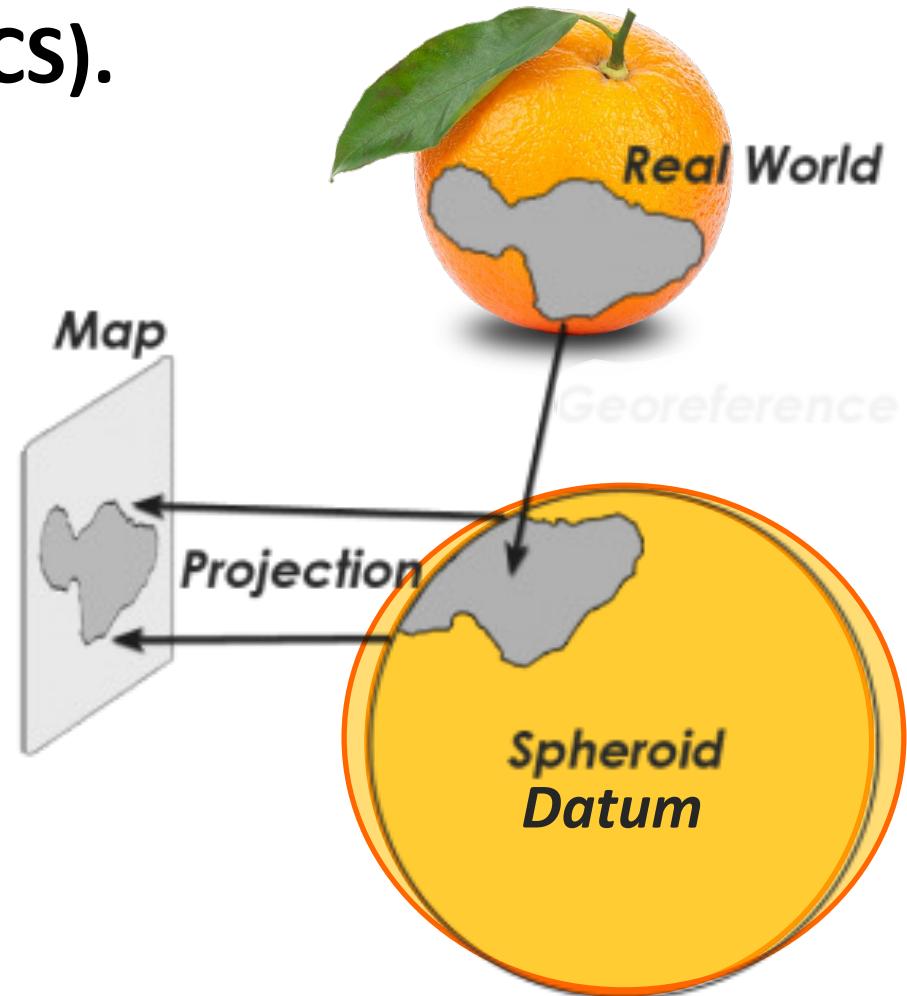


<http://desktop.arcgis.com/en/arcmap/latest/map/projections/what-are-map-projections.htm>

# A projection algorithm is applied to the GCS to create a Projected Coordinate System (PCS).

Imagine an orange as the Earth, and you want to be able to peel it in such a way as to lay the peel flat.

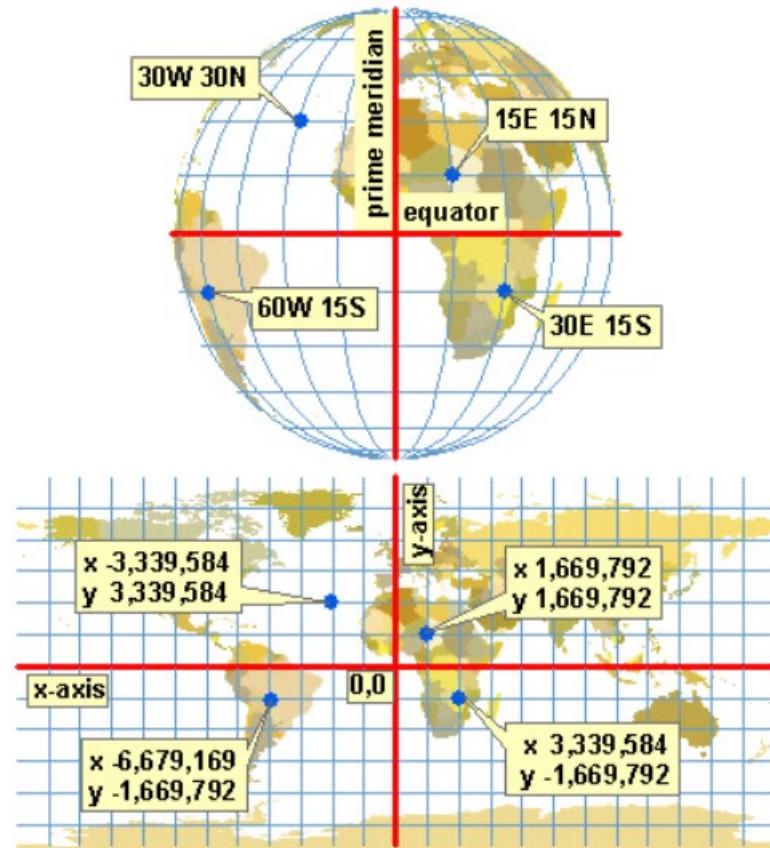
Similarly,  
**projection is a method by which cartographers translate a 3D globe (spheroid or ellipsoid) to a 2D map surface.**



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# A Projected Coordinate System consists of

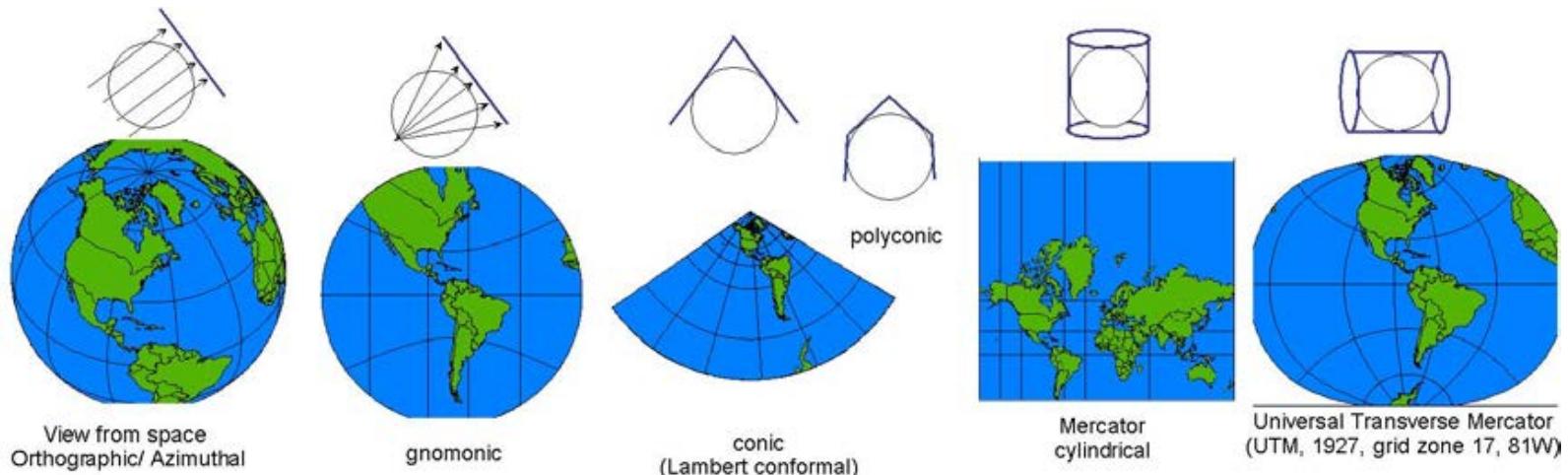
- Geographic Coordinate System
- Projection Algorithm
- Linear Unit
- Parameters that center the system on a certain location



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There are many different types of projections.  
Each have certain strengths and limitations  
in the following types of **distortions**:  
**shape, area, distance, direction**



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# Coordinate Systems Characteristics

## Geographic

- 3D spherical/spheroidal surface defines locations
- Units: degrees (angular)
- Lengths, angles, and areas change with distance away from equator

## Projected

- 2D flat/planar surface defines locations
- Units: ft, m, miles, etc. (linear)
- Lengths, angles, and areas constant across the two dimensions



# Coordinate Systems Summary

1. Data often start in a geographic coordinate system.
2. They are projected into a projected coordinate system.
3. The projection depends on the data location and analyses

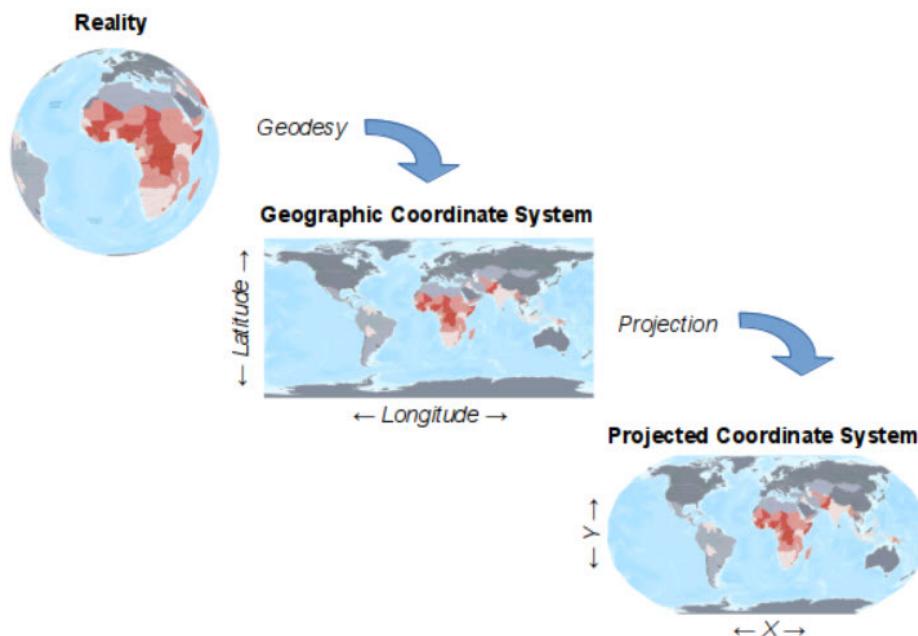


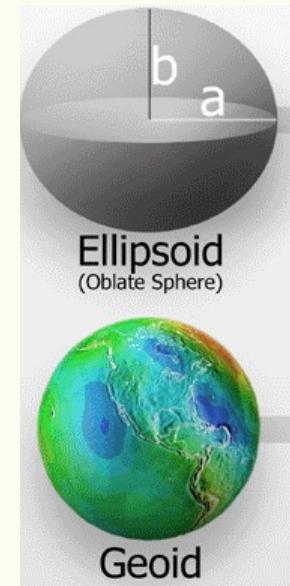
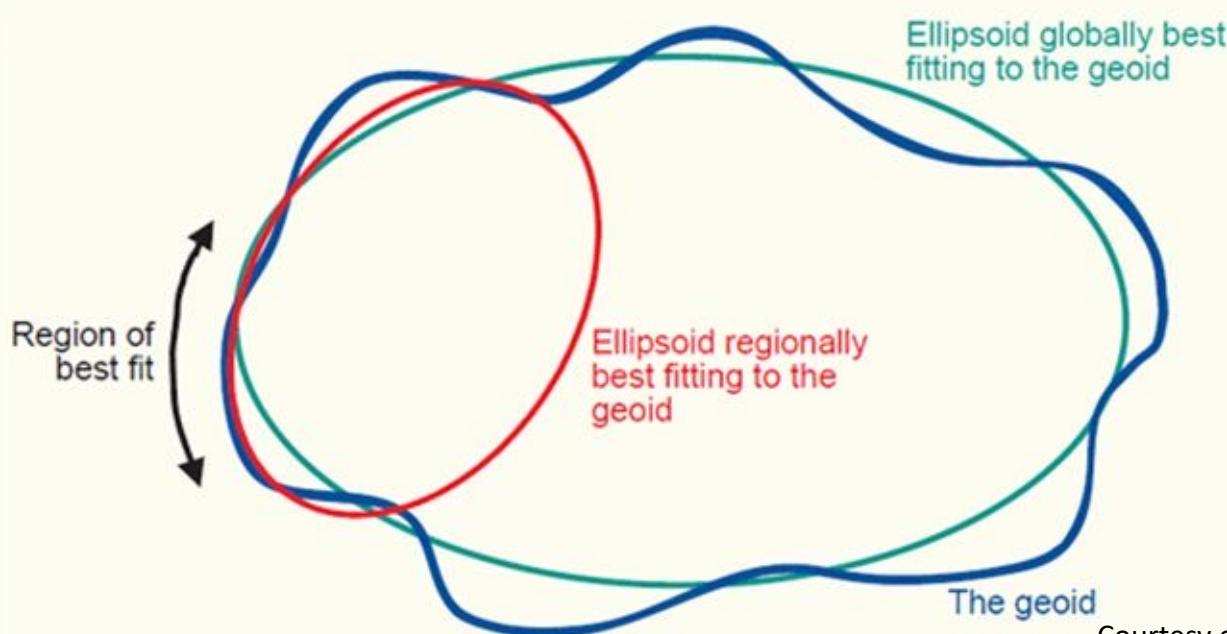
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# Commonly Encountered Systems

## Geographic Coordinate System

- NAD83 (North American Datum) – best fitting ellipsoid for North America
- WGS1984 (World Geodetic System) – best fitting ellipsoid for the globe/world



Courtesy of NOAA. Image is in the public domain.

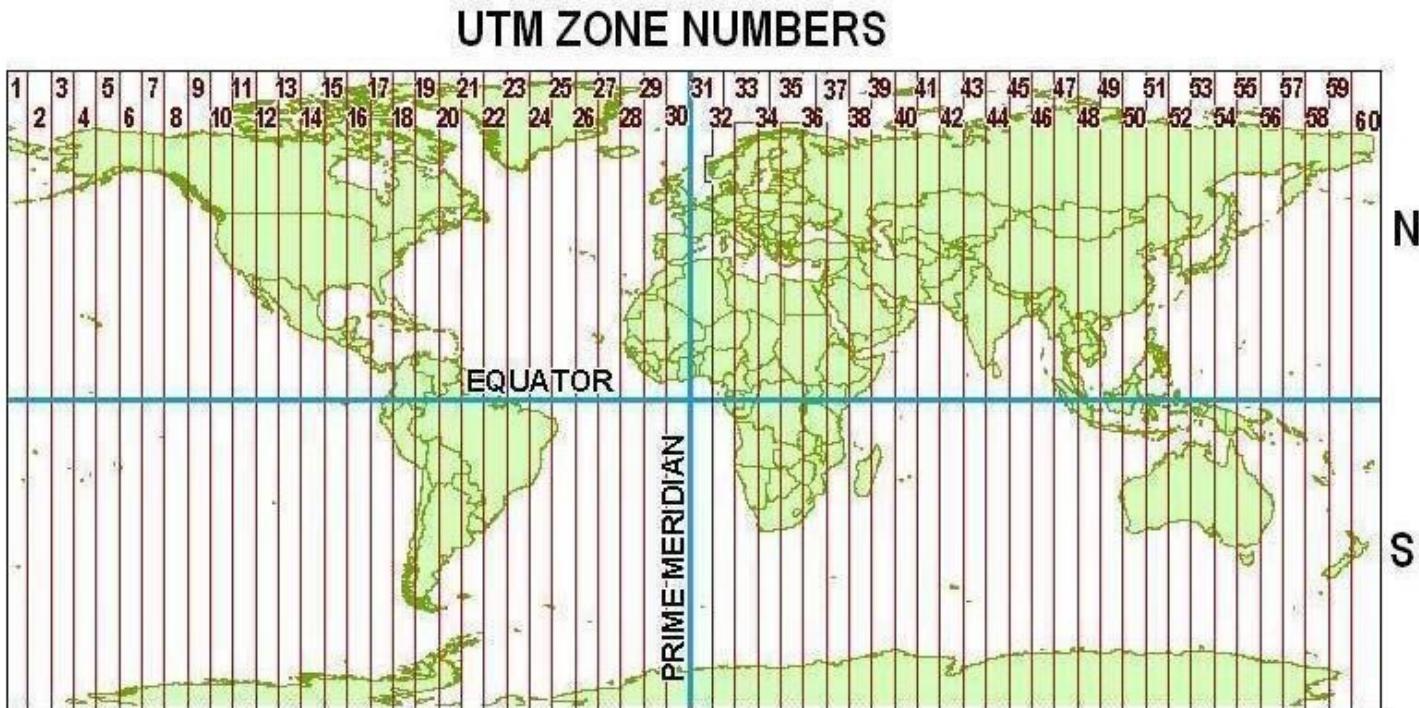
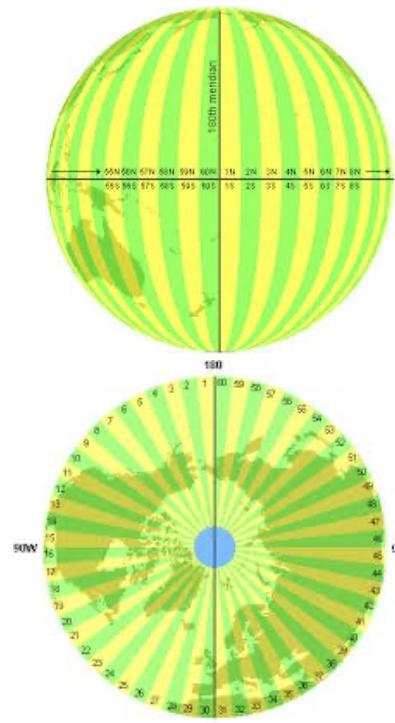
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# Commonly Encountered Systems

## Projected Coordinate System

- UTM (Universal Transverse Mercator) – often best for large regions

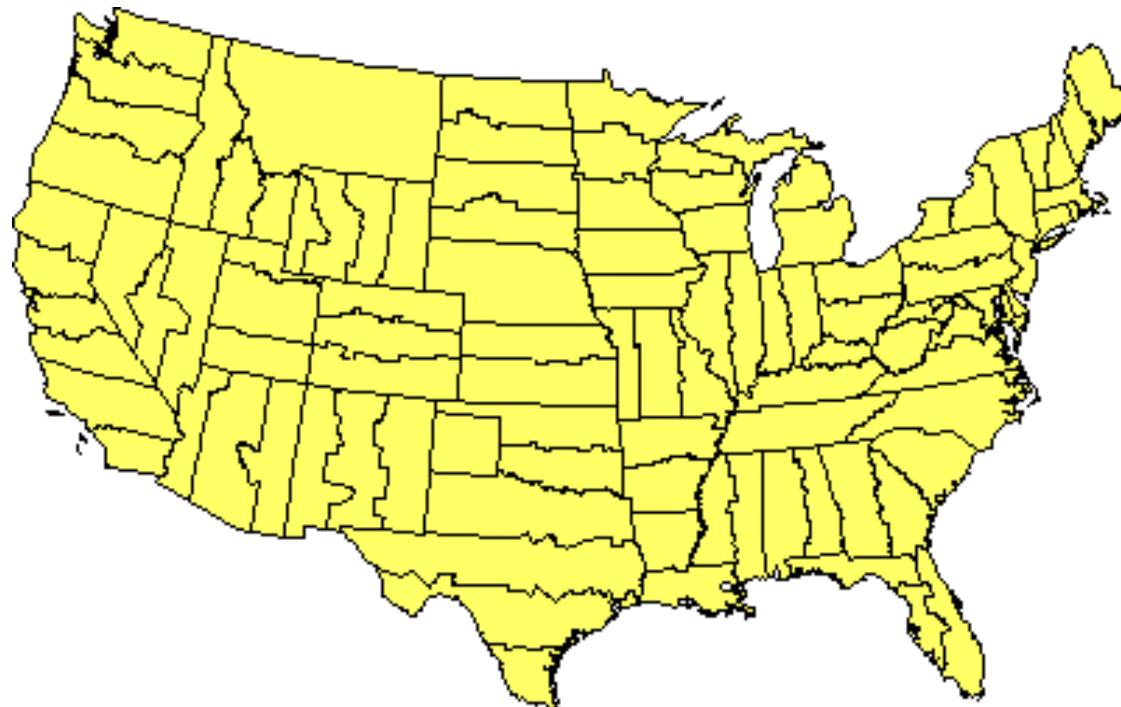


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# Commonly Encountered Systems

## Projected Coordinate System

- USA State Plane Systems – have been optimized per state, see updates [here](#).



# Tips on selecting a Projected Coordinate System

- **Based on your project's analyses:**
  - Preserve **area** with equal-area projections
  - Preserve **shape** with conformal projections
  - Preserve **direction** with azimuthal projections
  - Preserve **distance** with equidistant projections
  - Other projections compromise on the distortions
  - (Usually you stick with one, but can re-project)



# Tips on selecting a Projected Coordinate System

- **Based on your project's location:**

## Size

- Locally, the US has ‘state plane systems’
- Regionally, UTM is often a good option
- World, World Mercator (EPSG: 3857)

## Region

- To map tropical regions, use a cylindrical projection 
- To map middle latitudes, use a conic projection 
- To map a polar region, use an azimuthal projection 

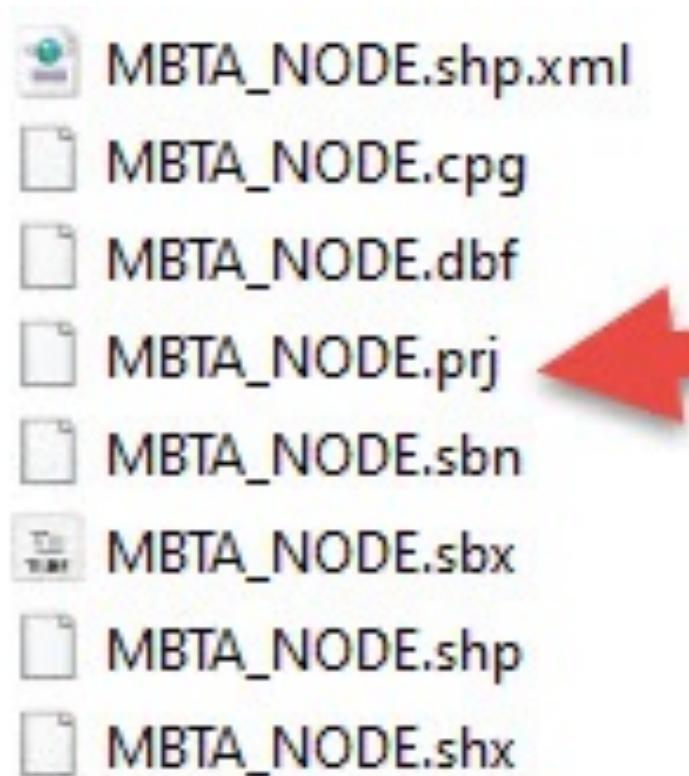


# **MAP PROJECTIONS:**

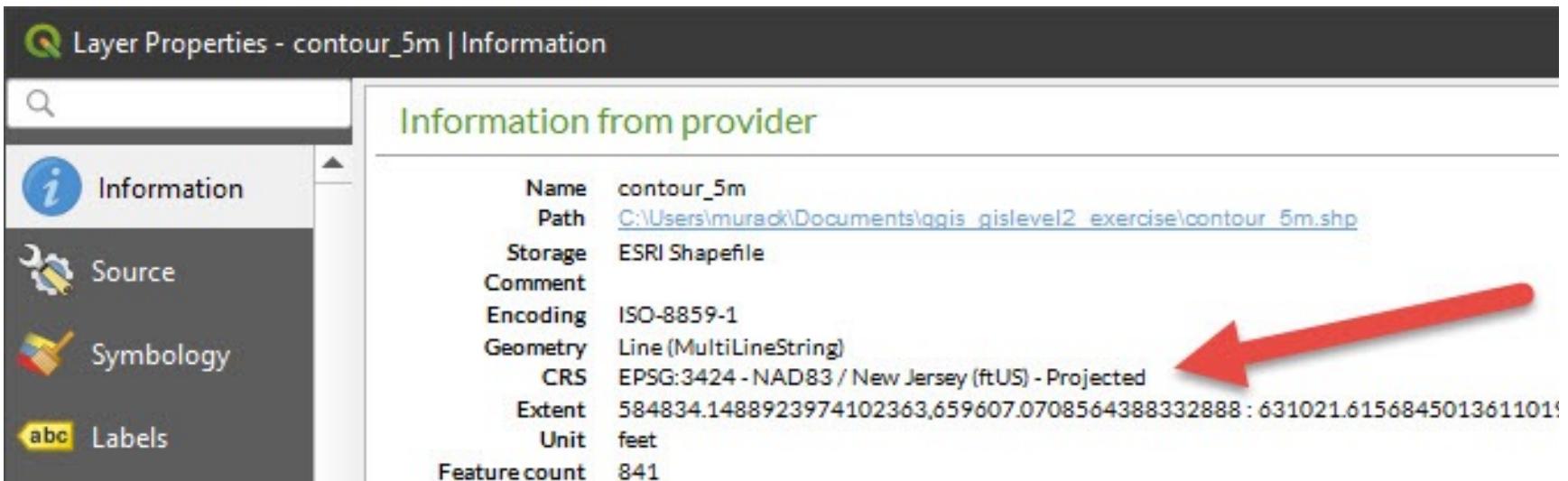
## **HOW DO YOU KNOW THE COORDINATE SYSTEM OF YOUR DATA?**



Option 1: Look for a .prj (projection) file within the files that make up the “shapefile” and then...



Option 1 continued: Open the file in QGIS or ArcGIS and examine the data layer information.



The screenshot shows the 'Layer Properties - contour\_5m | Information' dialog in QGIS. On the left is a sidebar with icons for Information, Source, Symbology, and Labels. The main area is titled 'Information from provider' and contains the following data:

Name	contour_5m
Path	<a href="C:\Users\murack\Documents\qgis_gislevel2_exercise\contour_5m.shp">C:\Users\murack\Documents\qgis_gislevel2_exercise\contour_5m.shp</a>
Storage	ESRI Shapefile
Comment	
Encoding	ISO-8859-1
Geometry	Line (MultiLineString)
CRS	EPSG:3424 - NAD83 / New Jersey (ftUS) - Projected
Extent	584834.1488923974102363,659607.0708564388332888 : 631021.615684501361101
Unit	feet
Feature count	841

A red arrow points to the CRS field.

**Note:** ESRI products (ArcGIS Desktop and ArcGIS Pro) refer to geographic & projected coordinate systems with names while QGIS uses EPSG codes:  
NAD 1983 StatePlane New Jersey FIPS 2900 (US Feet) versus EPSG: 3424



# Option 2: Consult the metadata

## ⊖ Spatial Reference Information

### Horizontal Coordinate System Definition

Geographic Coordinate Units	Decimal degrees
Latitude Resolution	0.000000
Longitude Resolution	0.000000

Horizontal Datum Name	D_WGS_1984
Ellipsoid Name	WGS_1984
Semi-major Axis	6378137.000000
Denominator of Flattening Ratio	298.257224

Geographic  
Coordinate  
System in  
WGS84

## ⊕ Entity and Attribute Information

## ⊕ Distribution Information

