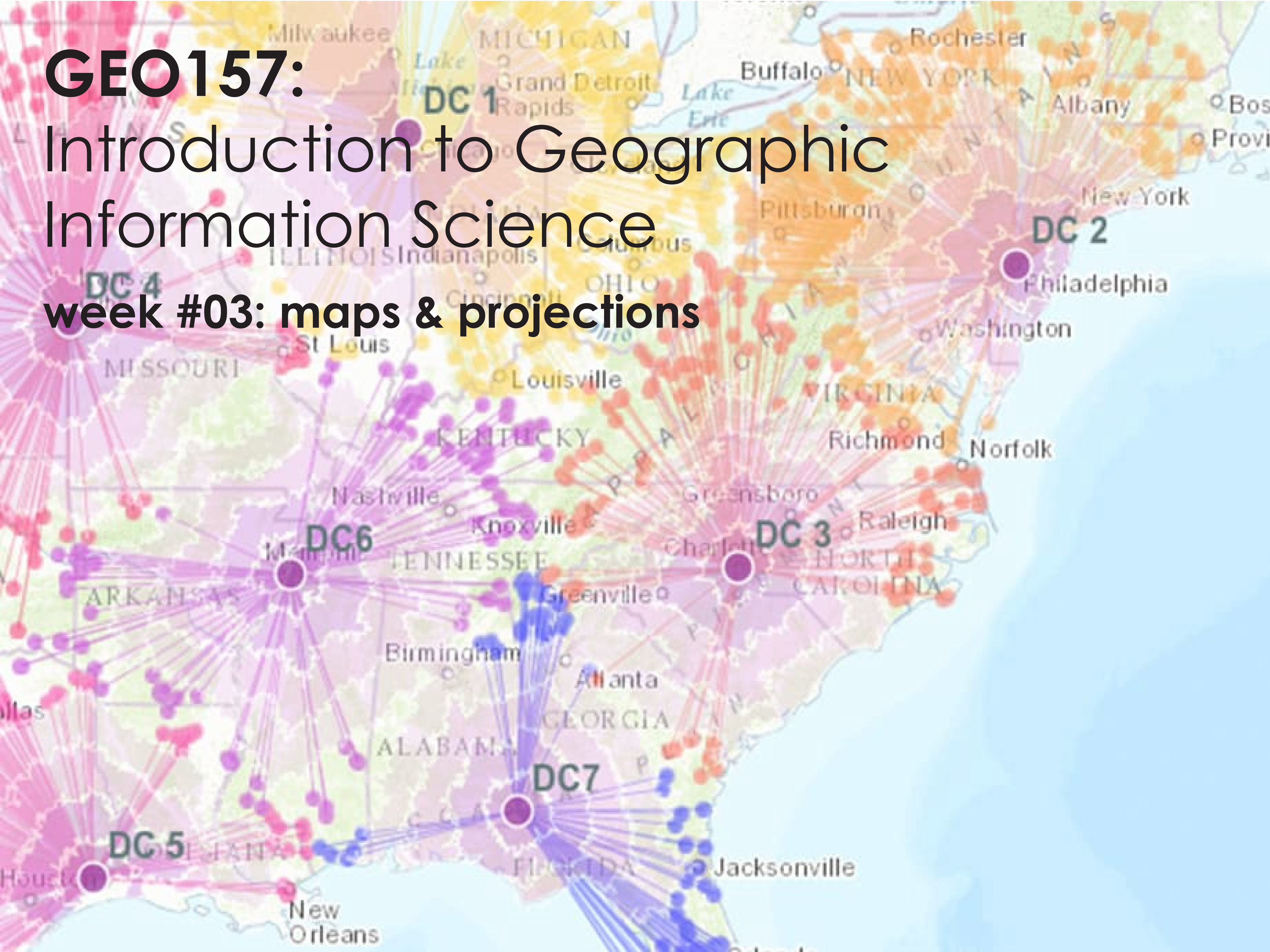
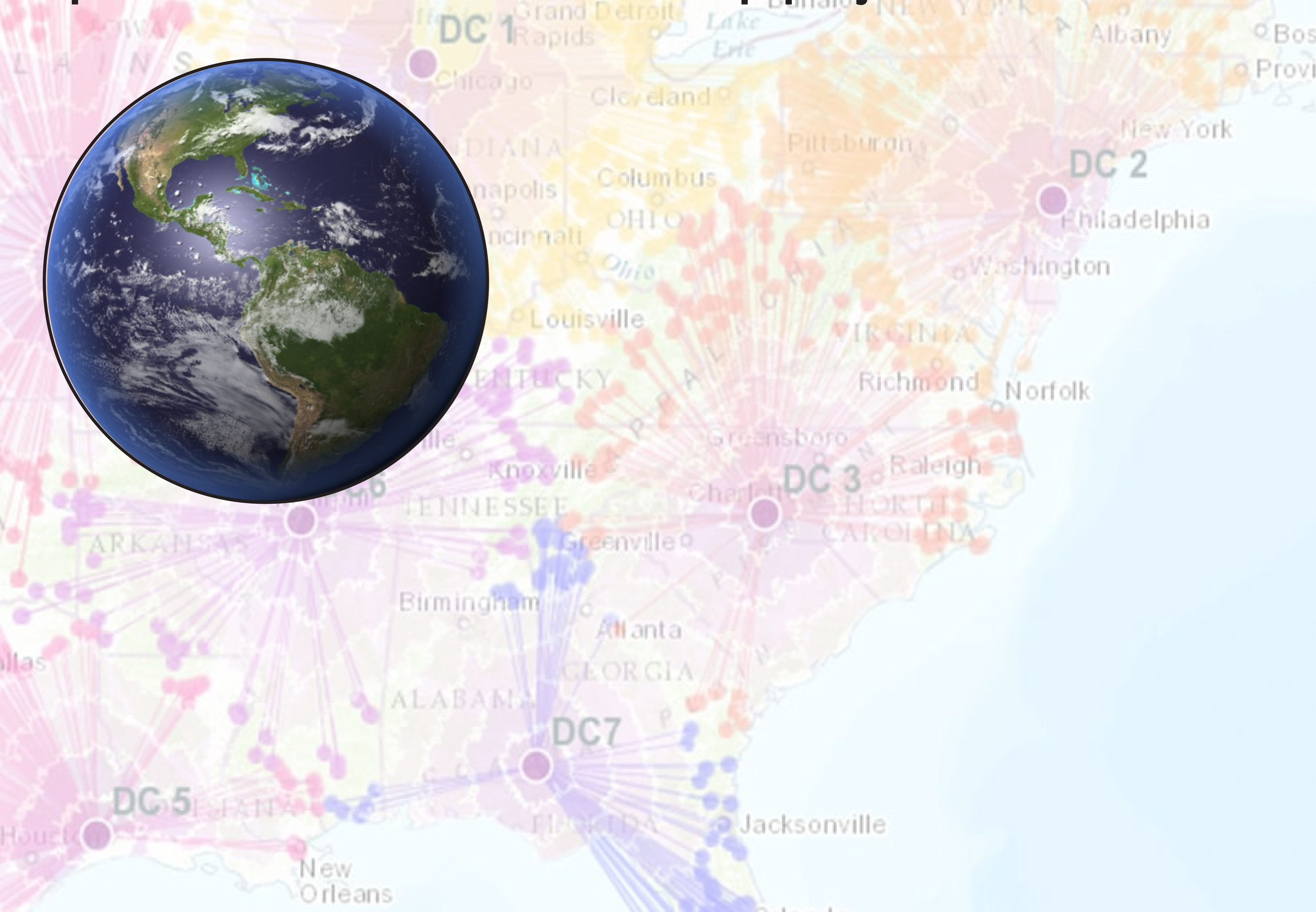
GEO157:

Introduction to Geographic Information Science

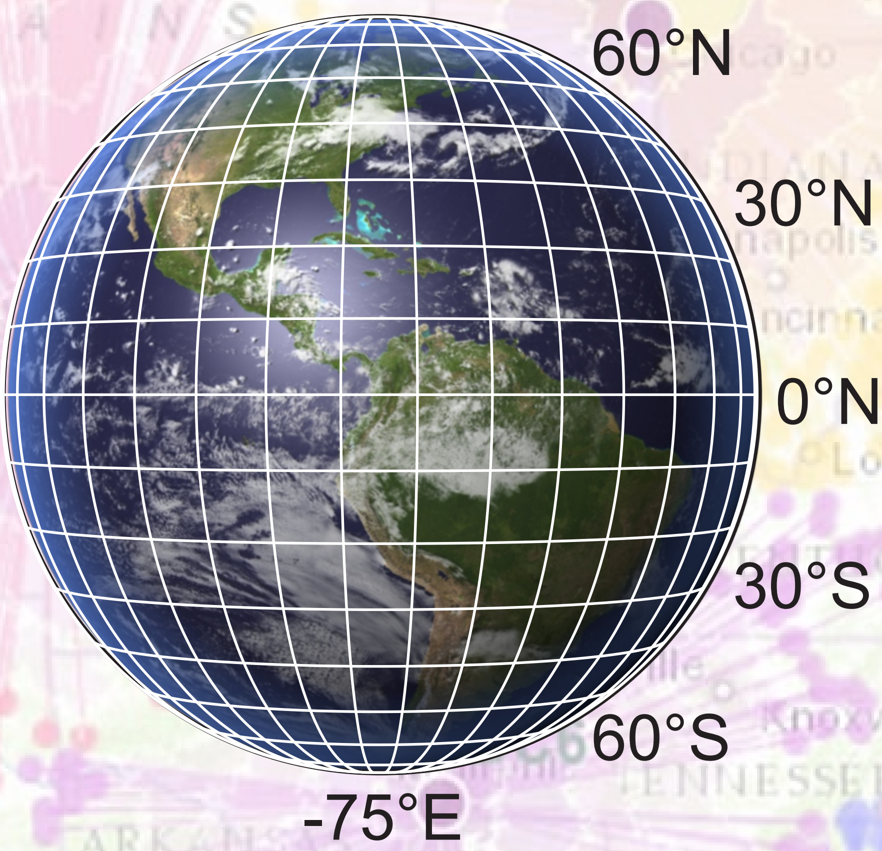
week #03: maps & projections



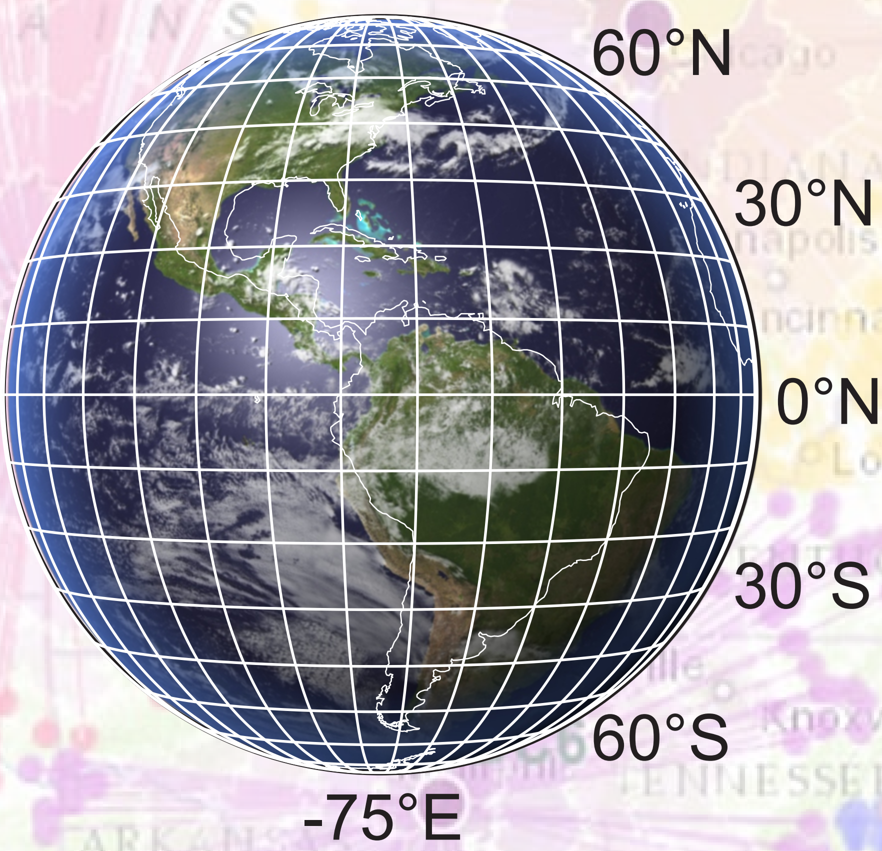
Spherical Coordinates and map projections



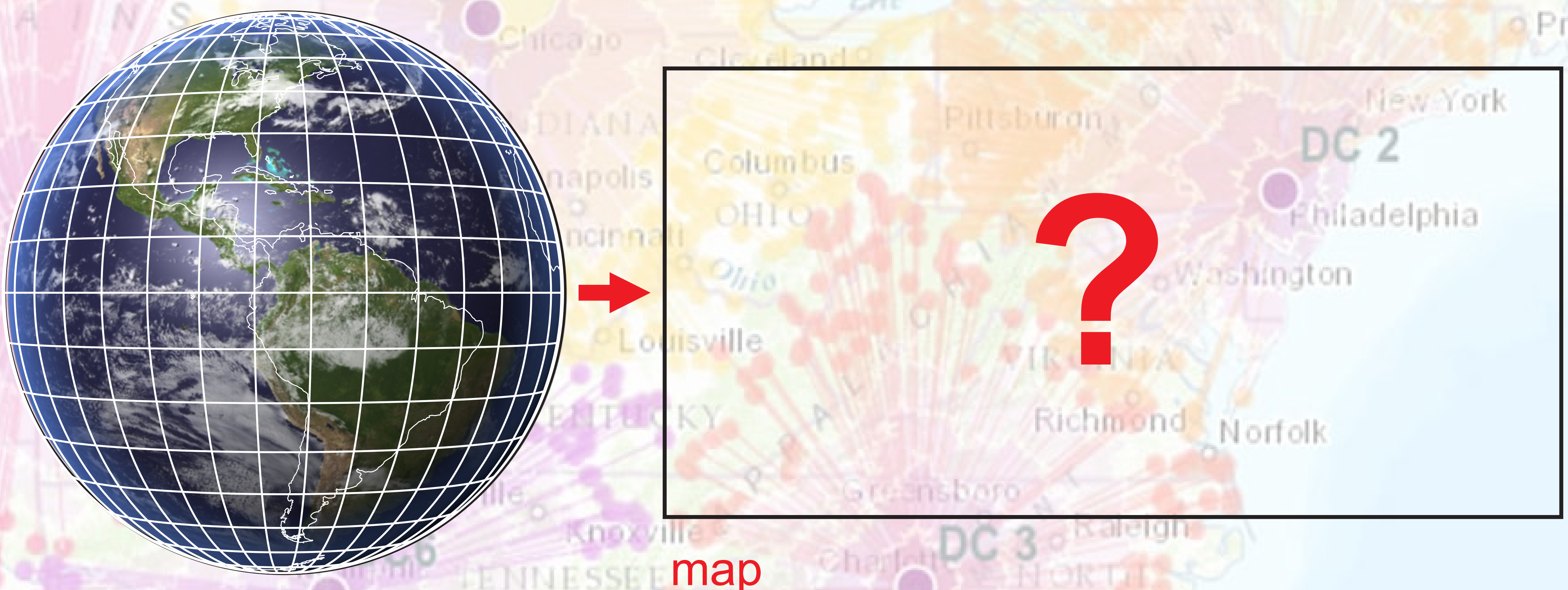
Spherical Coordinates and map projections



Spherical Coordinates and map projections



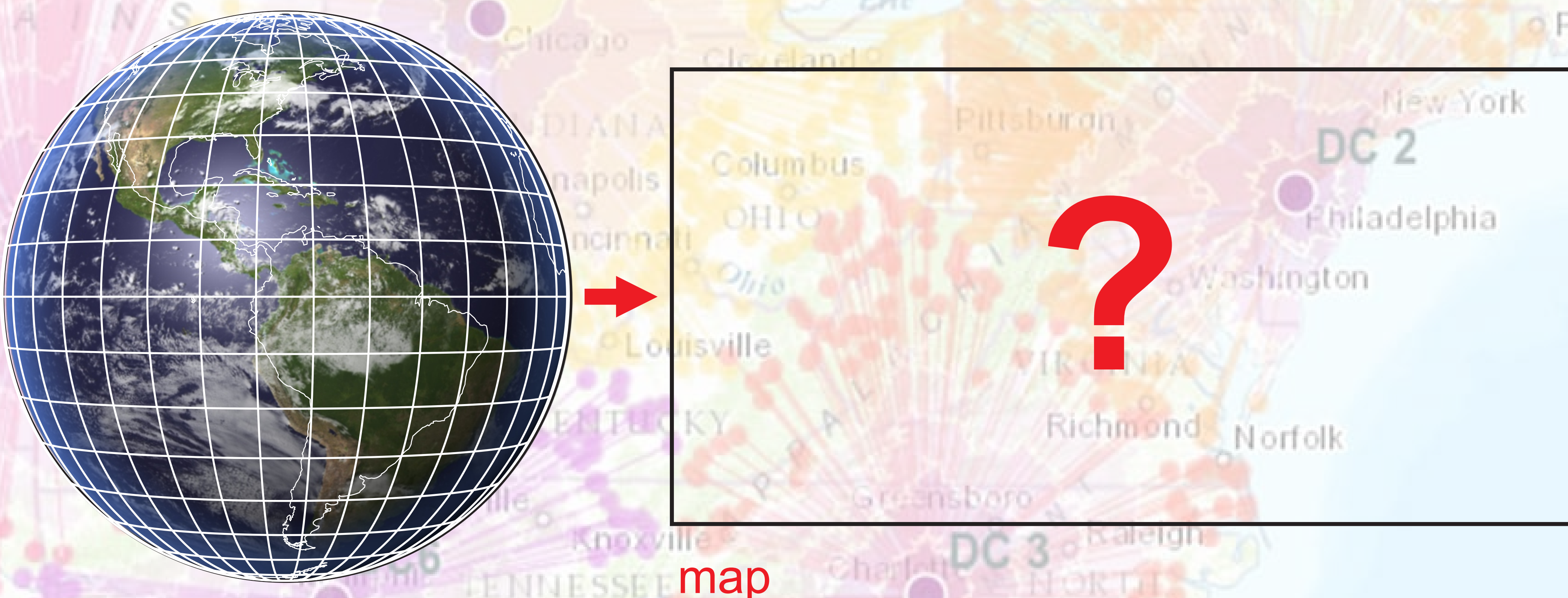
Spherical Coordinates and map projections



Map projections: transforming the spherical Earth into two dimensions.

Why?

Spherical Coordinates and map projections



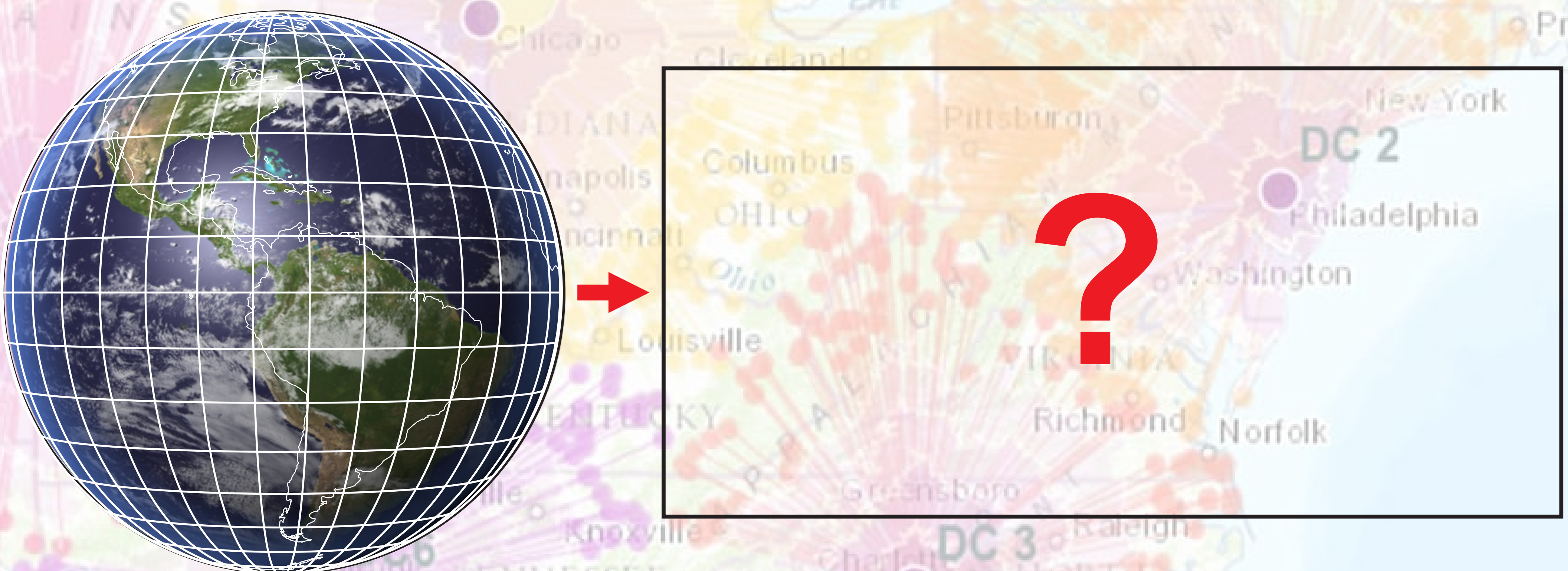
Map projections: transforming the spherical Earth into two dimensions.

Why?

It is easier to carry around a map than a globe(!)

Globes are best representations of the Earth, but only available at small scales.

Spherical Coordinates and map projections



The chosen features and their representation, and scale of a map, all depend on its purpose. This also goes for map projections.


Milwaukee
MICHIGAN
Rochester
Buffalo
NEW YORK
Albany
Grand Rapids
Detroit
Lake Erie
DC 1
DC 2
DC 4
DC 5
New York
Philadelphia
Washington
Norfolk
Raleigh
Jacksonville
New Orleans
NORTH AMERICA
CENTRAL AMERICA
SOUTH AMERICA

Spherical Coordinates and map projections

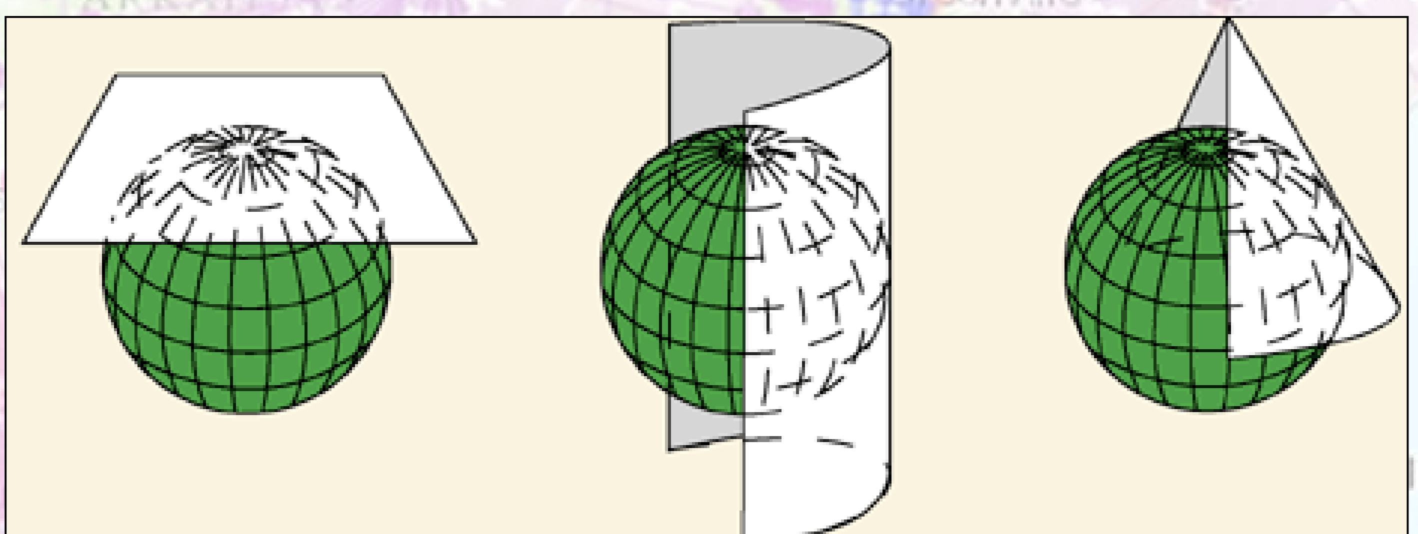
Projections are useful, but introduce errors into spatial data.

Choose projection type either to preserve:

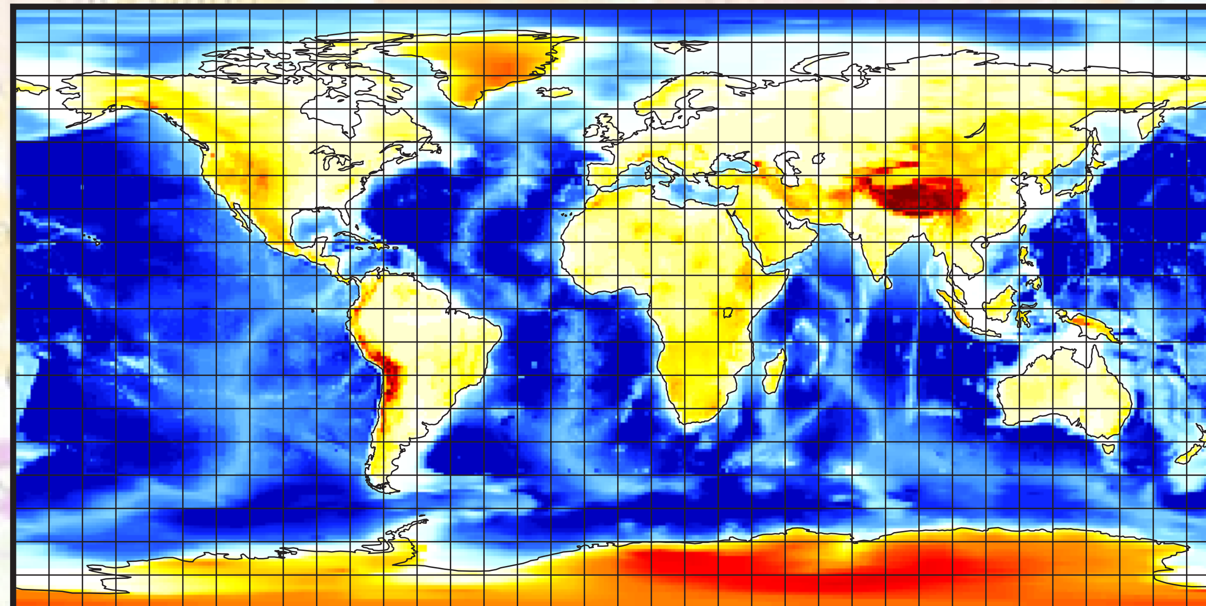
(a) distances between spatial entities (distorting directions),

(b) shape of entities (distorting areas).

Different projections are used to best display the information you would like to emphasize (key to a GIS!).



Spherical Coordinates and map projections

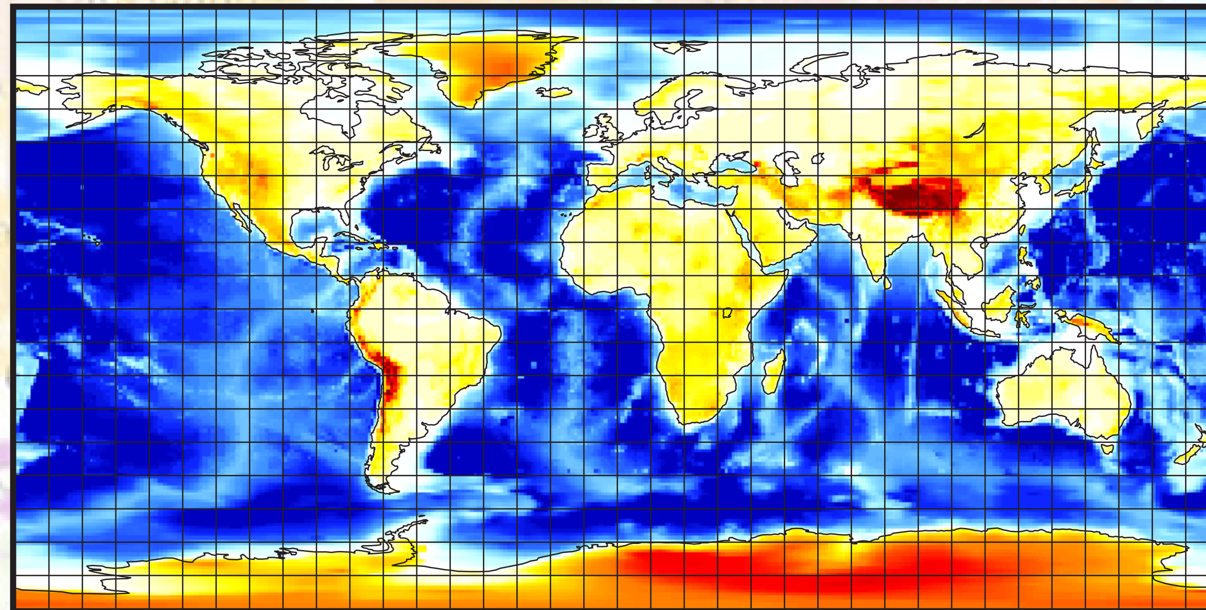


Equirectangular

The **Equirectangular** projection (also called the equidistant cylindrical projection) maps meridians to vertical straight lines of constant spacing (for meridional intervals of constant spacing), and circles of latitude to horizontal straight lines of constant spacing (for constant intervals of parallels).

Problems?

Spherical Coordinates and map projections



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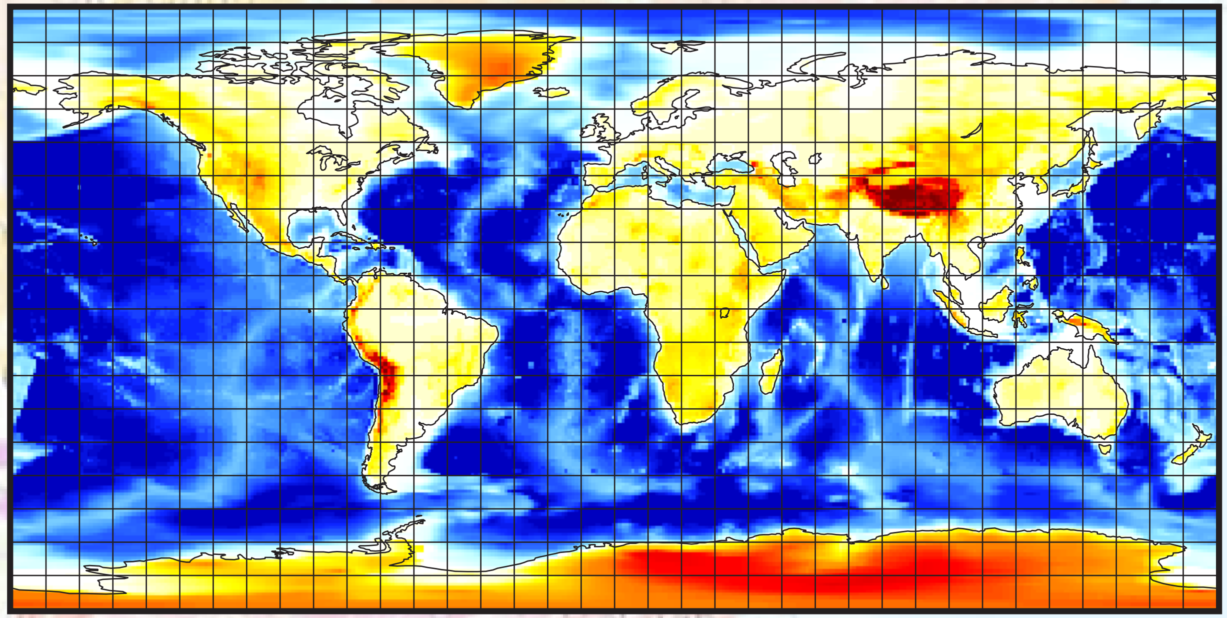
A conformal map projection is one in which any angle on Earth is preserved in the image of the projection.

Advantages?

Spherical Coordinates and map projections



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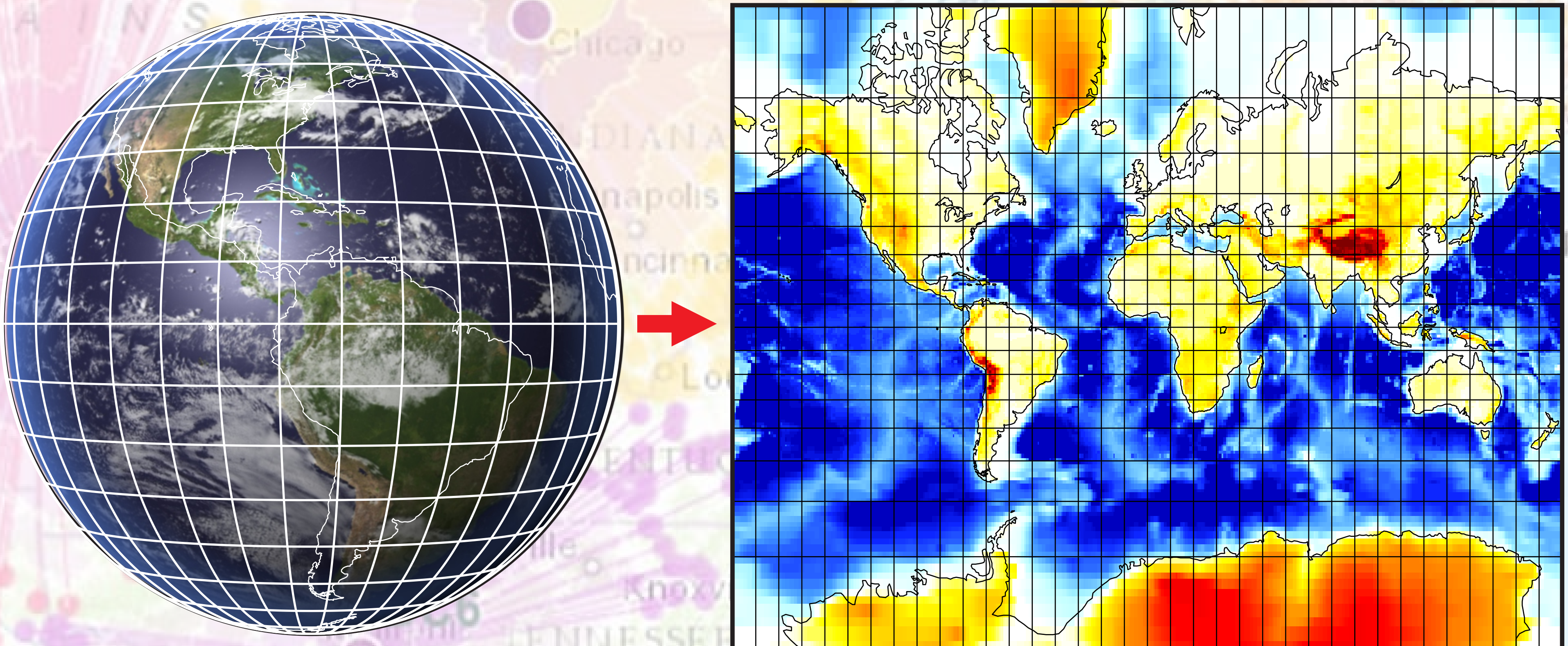
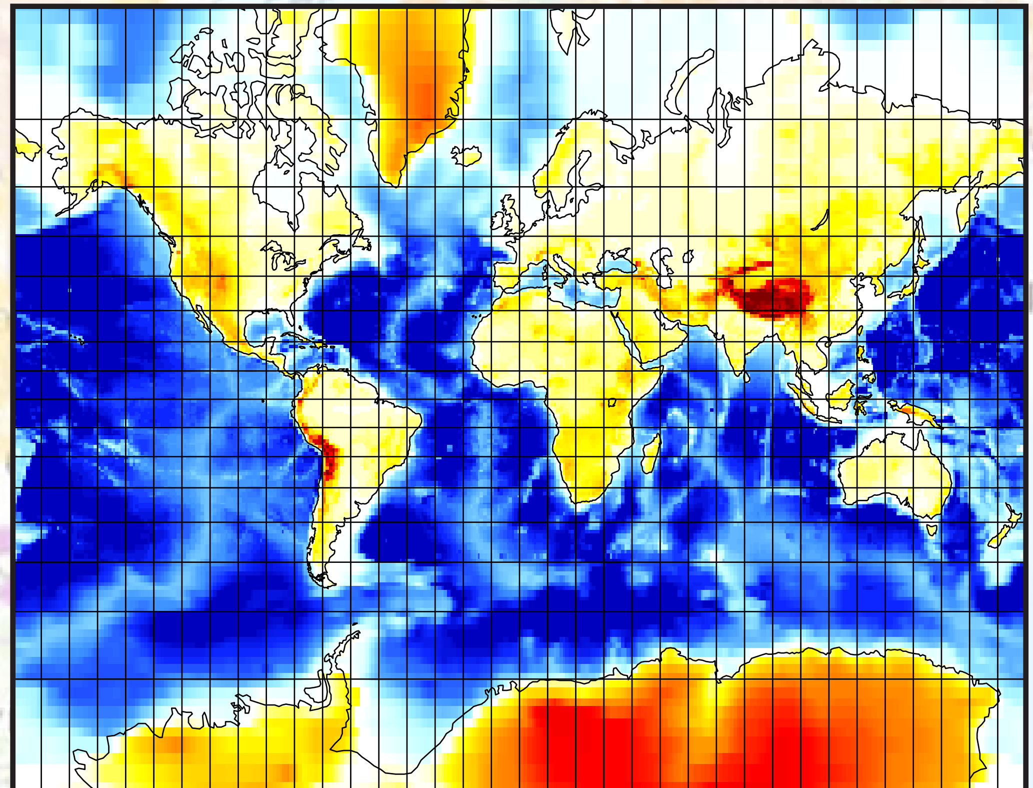
Spherical Coordinates and map projections

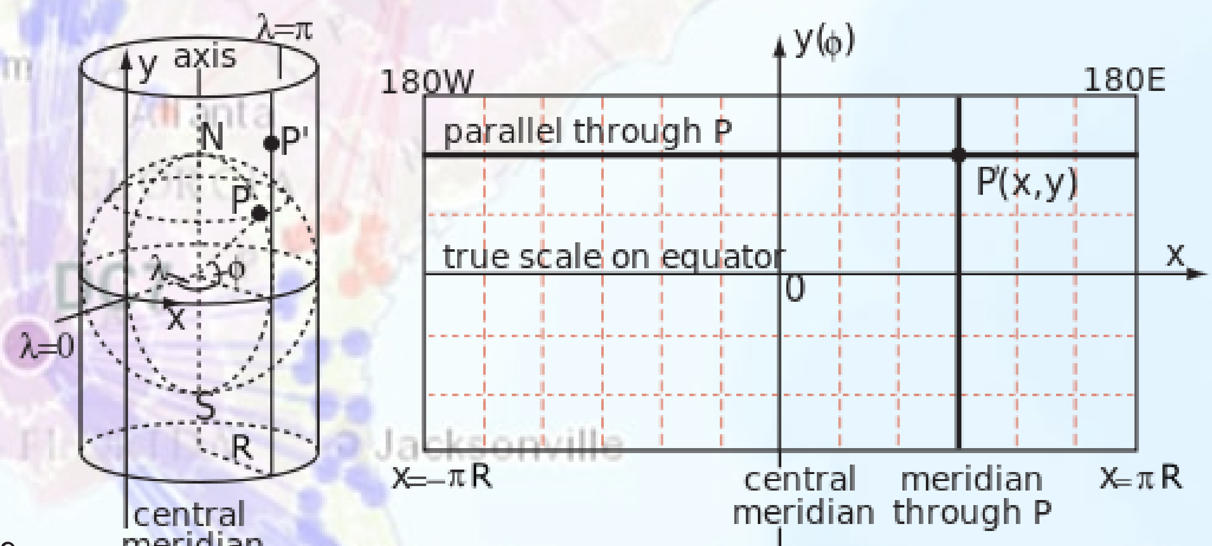


The **Mercator** projection is a 16th century cylindrical map projection used for nautical purposes because of its ability to represent lines of constant course as straight segments that conserve the angles with the meridians. Although the linear scale is equal in all directions around any point, thus preserving the angles and the shapes of small objects (which makes the projection conformal), the Mercator projection distorts the size of objects as the latitude increases from the Equator to the poles, where the (latitude and longitude) scale becomes infinite.

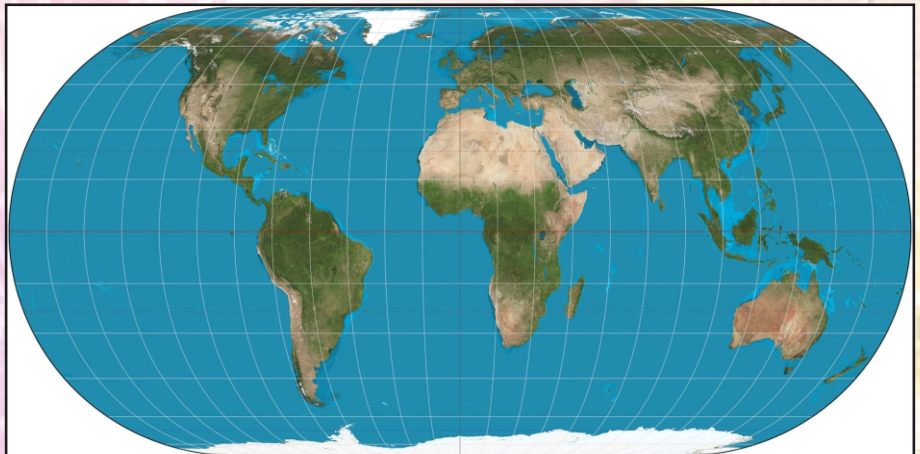
Spherical Coordinates and map projections



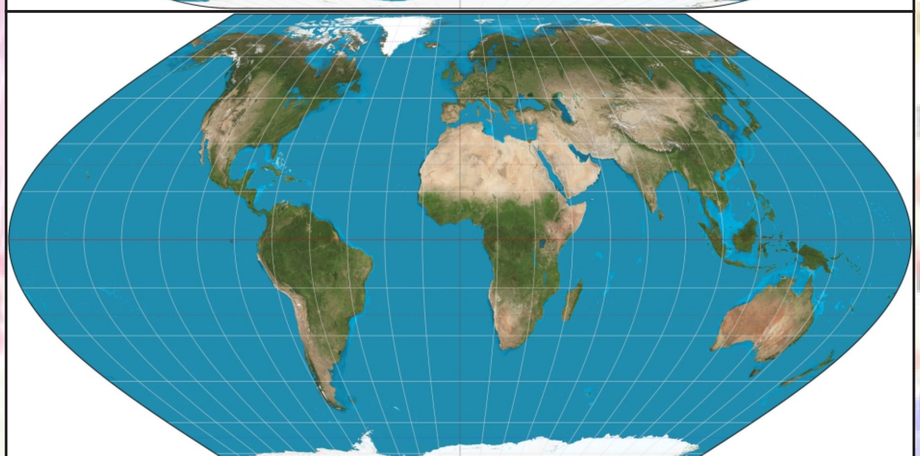
Mercator



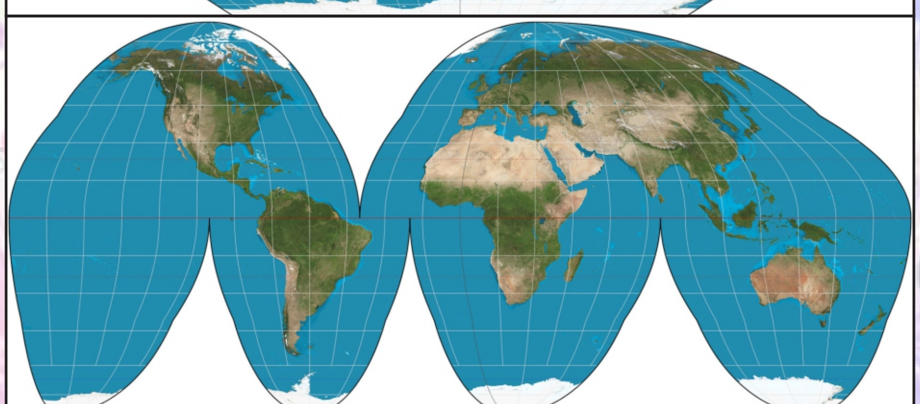
Spherical Coordinates and map projections



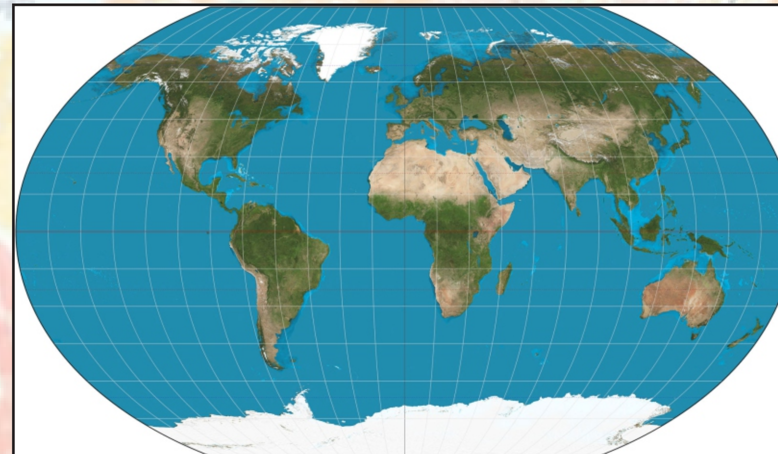
Eckert IV



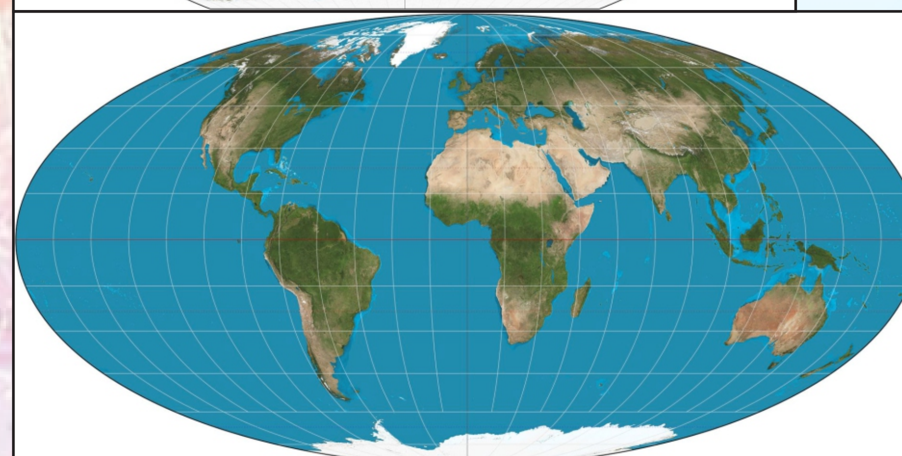
Eckert VI



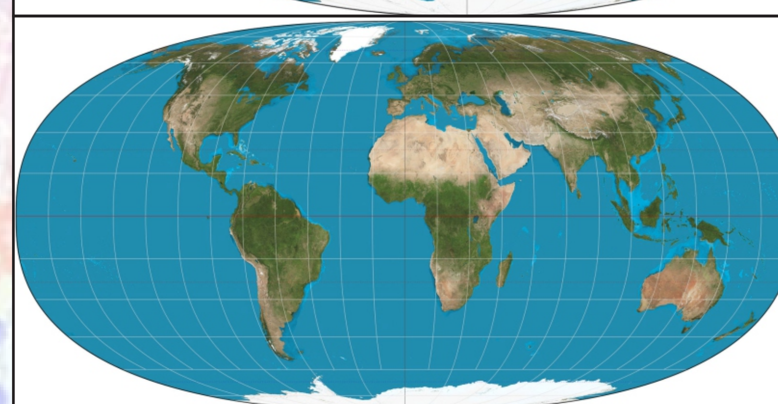
Goode homolosine



Kavrayskiy VII

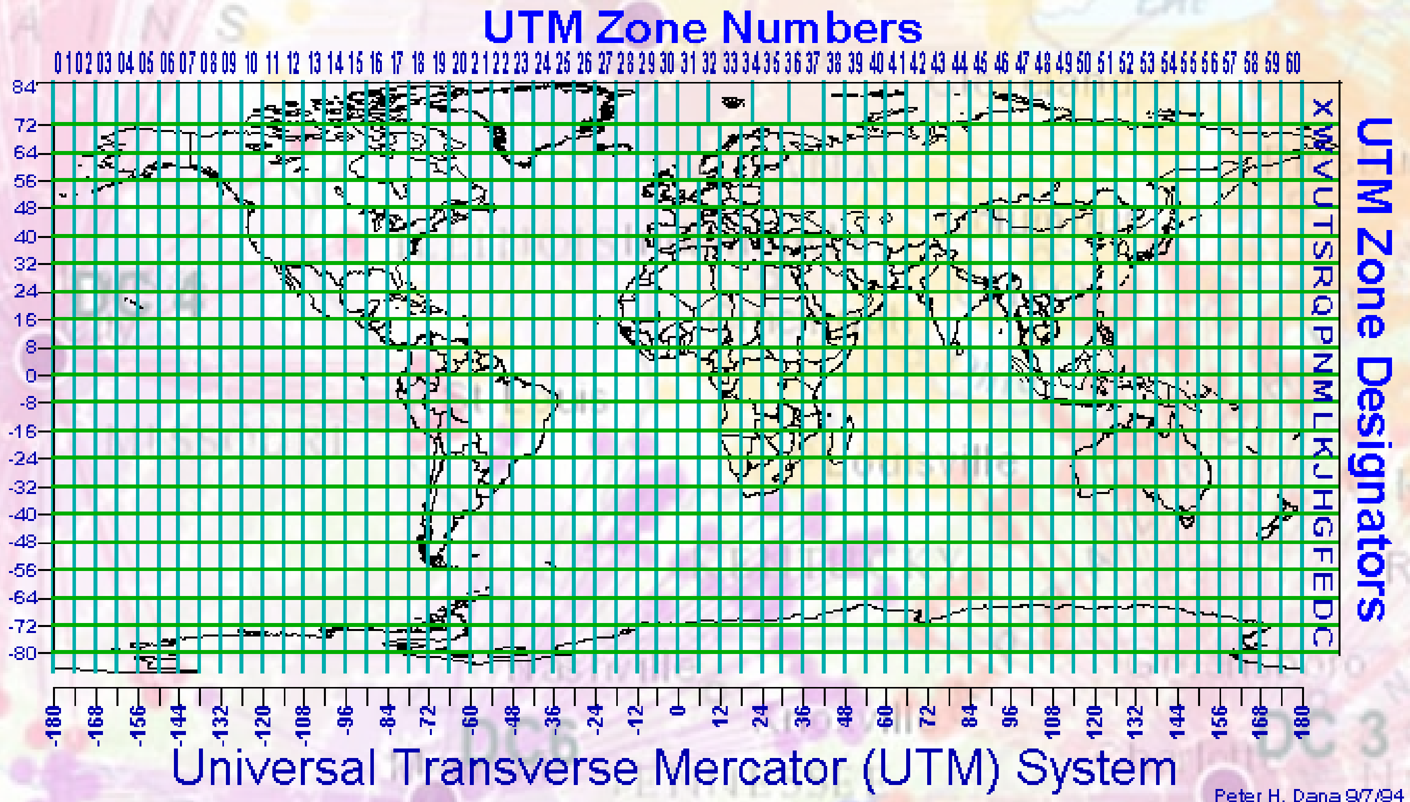


Mollweide



Tobler hyperelliptical

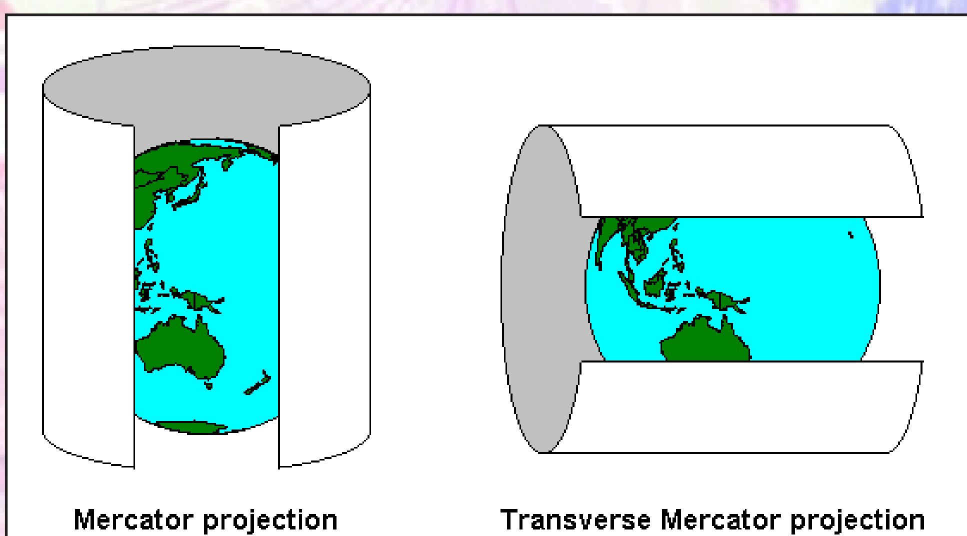
Universal Transverse Mercator (UTM)



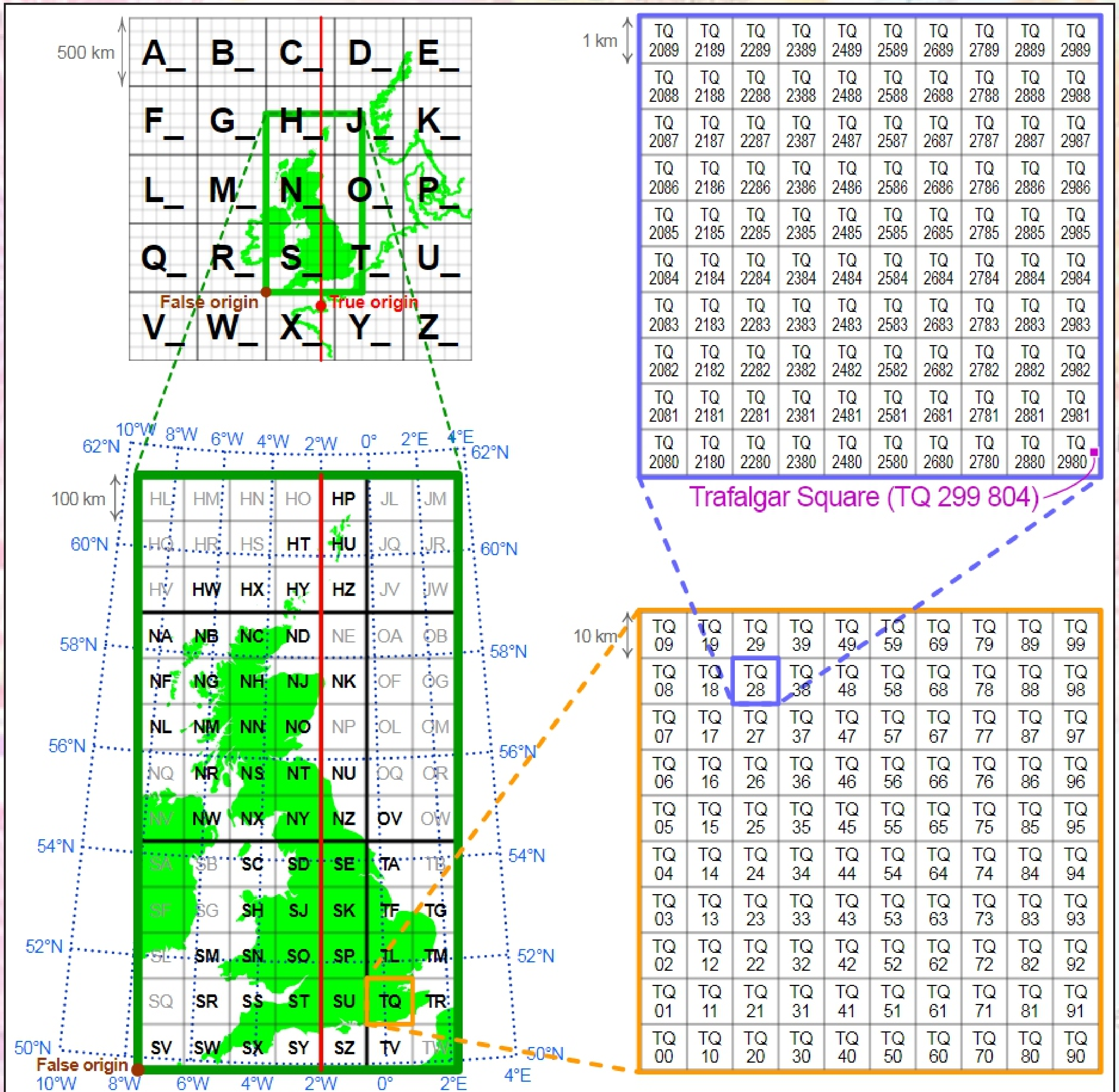
The globe is divided up into "zones" – sixty zones, 6 degrees wide, each of which is based on Transverse Mercator projection.

Each zone is segmented into 20 latitude bands – each latitude band is 8 degrees high and denoted by letter.

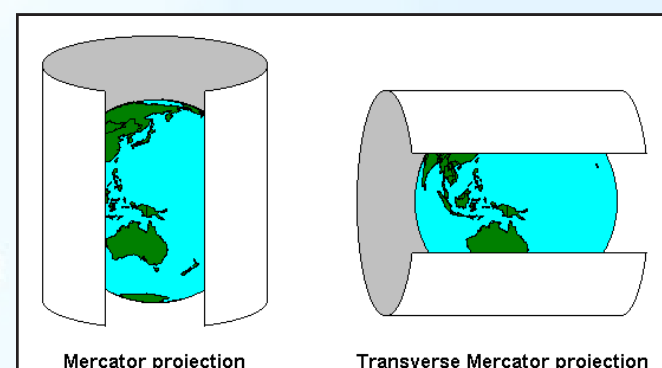
(System changes at Poles.)



Universal Transverse Mercator (UTM)

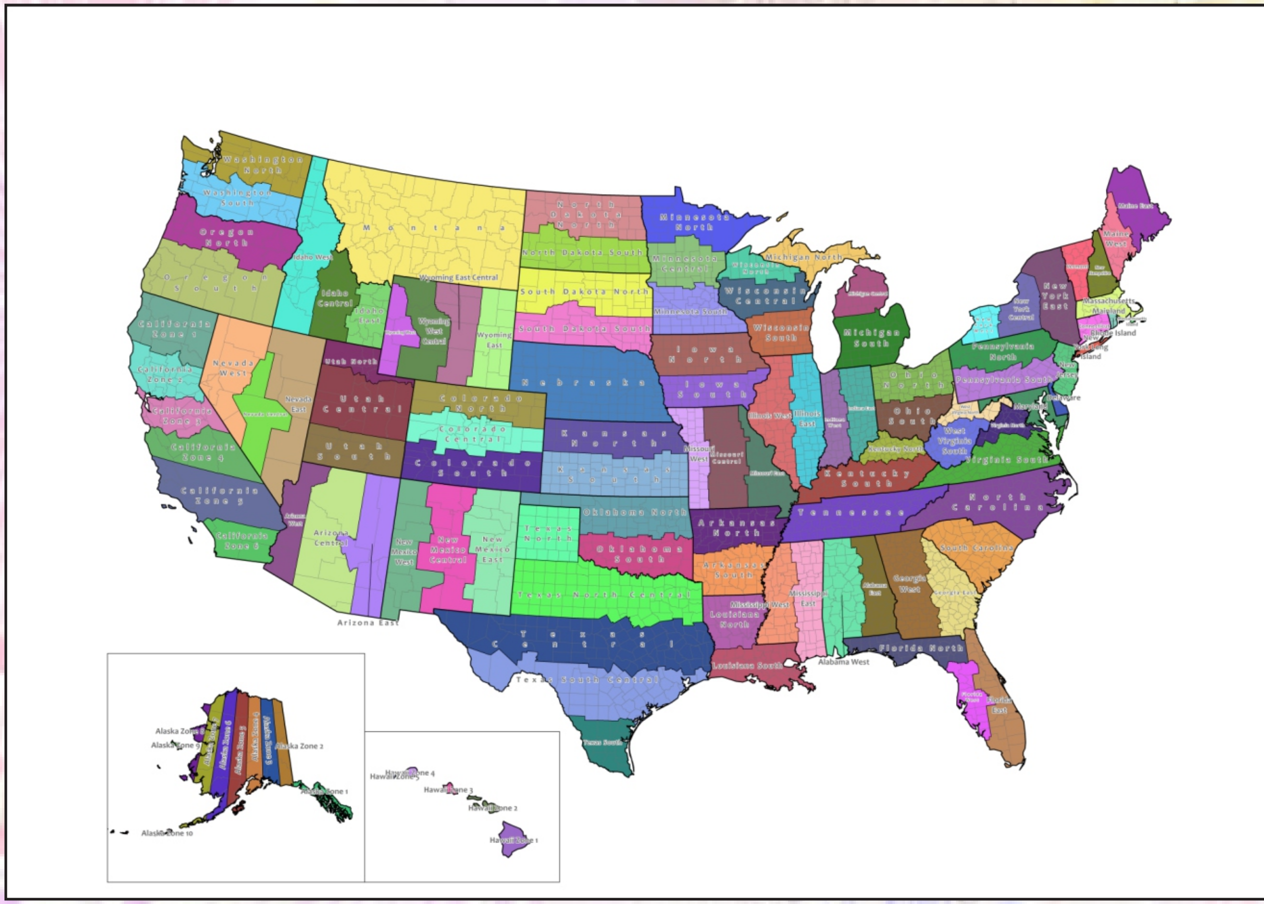


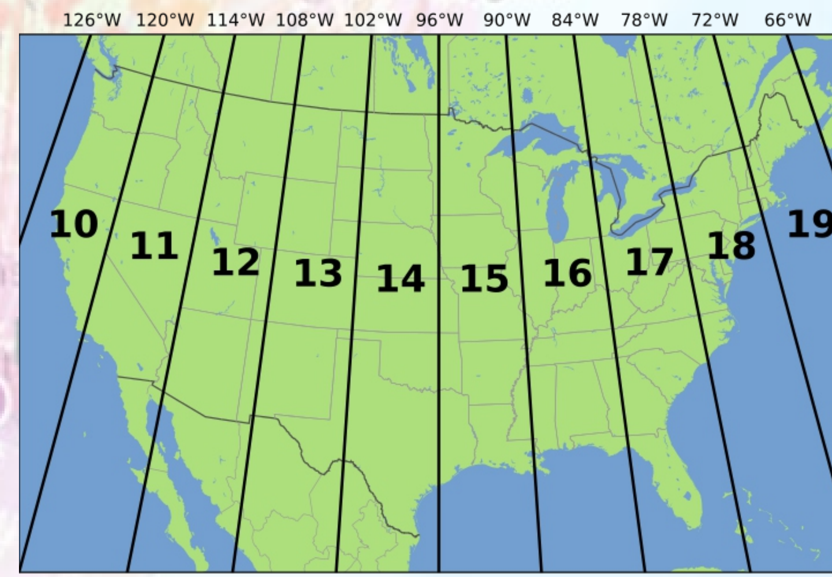
British maps adopt a Transverse Mercator projection with an origin (the "true" origin) at 49° N, 2° W (an offshore point in the English Channel which lies between the island of Jersey and the French port of St. Malo). A (the) National Grid is placed with a new false origin to eliminate negative numbers, creating a 700 km by 1300 km grid. This false origin is located south-west of the Isles of Scilly.



Universal Transverse Mercator (UTM)

State Plane Coordinate System





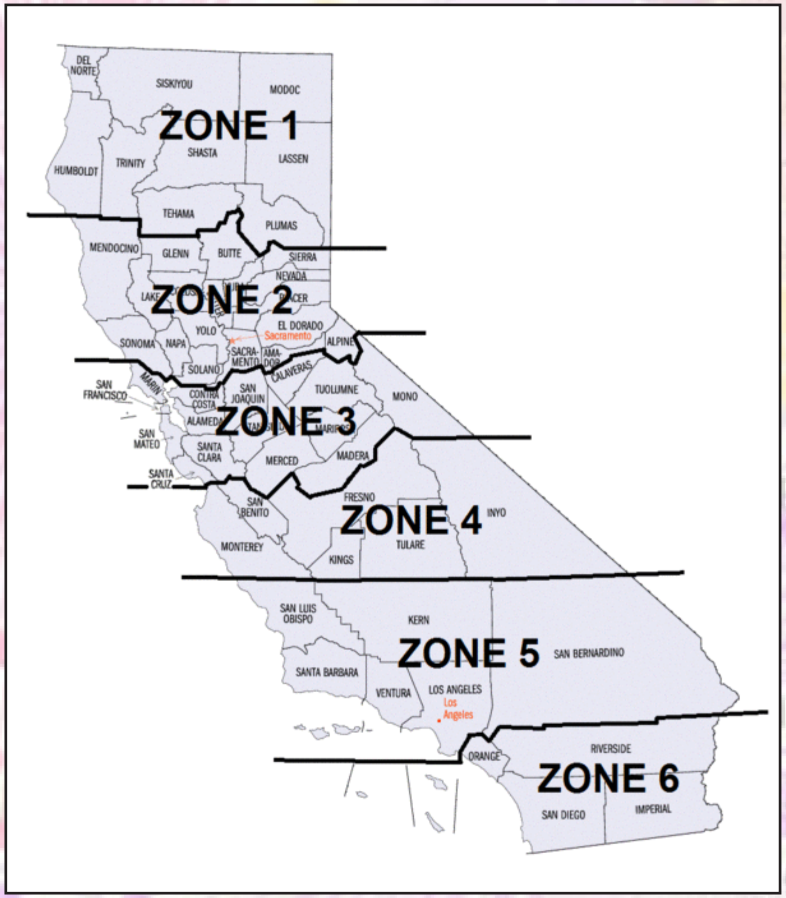
Divides the U.S. into
a hundred or more distinct grid surfaces (Zones).

Used for local surveying and engineering applications, but isn't used if crossing state lines.

Number of zones in a state is usually determined by area the state covers.

Universal Transverse Mercator (UTM)

State Plane Coordinate System



California: Zones drawn along county boundaries.

Most state plane zones are based on either a transverse Mercator projection or a Lambert conformal conic projection. The choice between the two map projections is based on the shape of the state and its zones. States that are long in the east–west direction are typically divided into zones that are also long east–west. These zones use the Lambert conformal conic projection, because it is good at maintaining accuracy along an east–west axis, due to the projection cone intersecting the earth's surface along two lines of latitude. Zones that are long in the north–south direction use the Transverse Mercator projection because it is better at maintaining accuracy along a north–south axis, due to the circumference of the projection cylinder being oriented along a meridian of longitude.

Universal Transverse Mercator (UTM)

When to / why use Spherical or Rectangular Coordinate Systems?

UTM (Universal Transverse Mercator) and State Plane (SPCS) provide constant scale relationship:

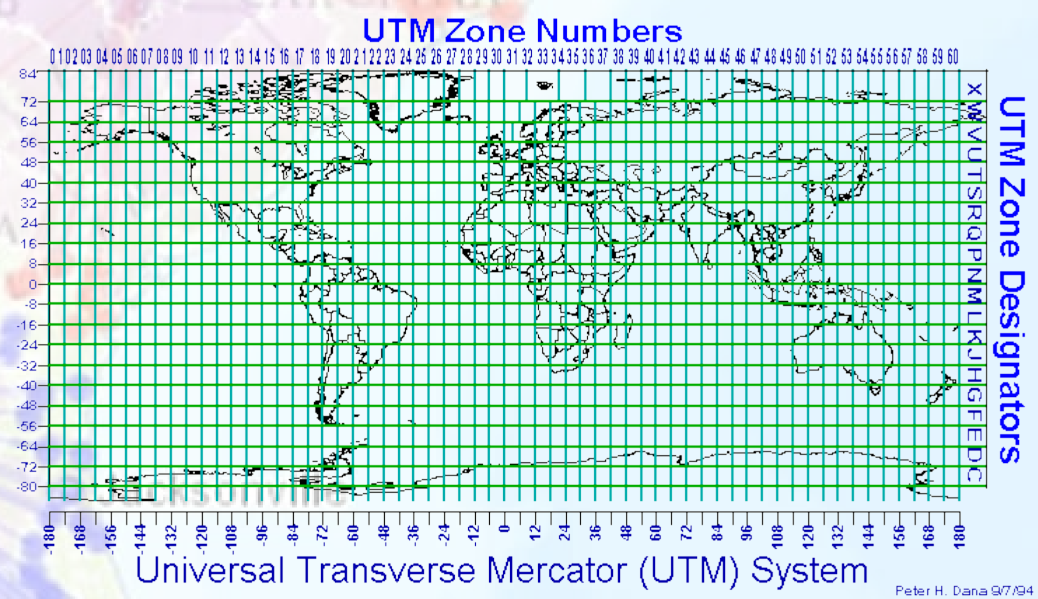
- SPCS: 1:10,000
- UTM: 6x8 deg grid

Latitude and Longitude: distance covered by a degree of longitude differs as you move towards the poles.

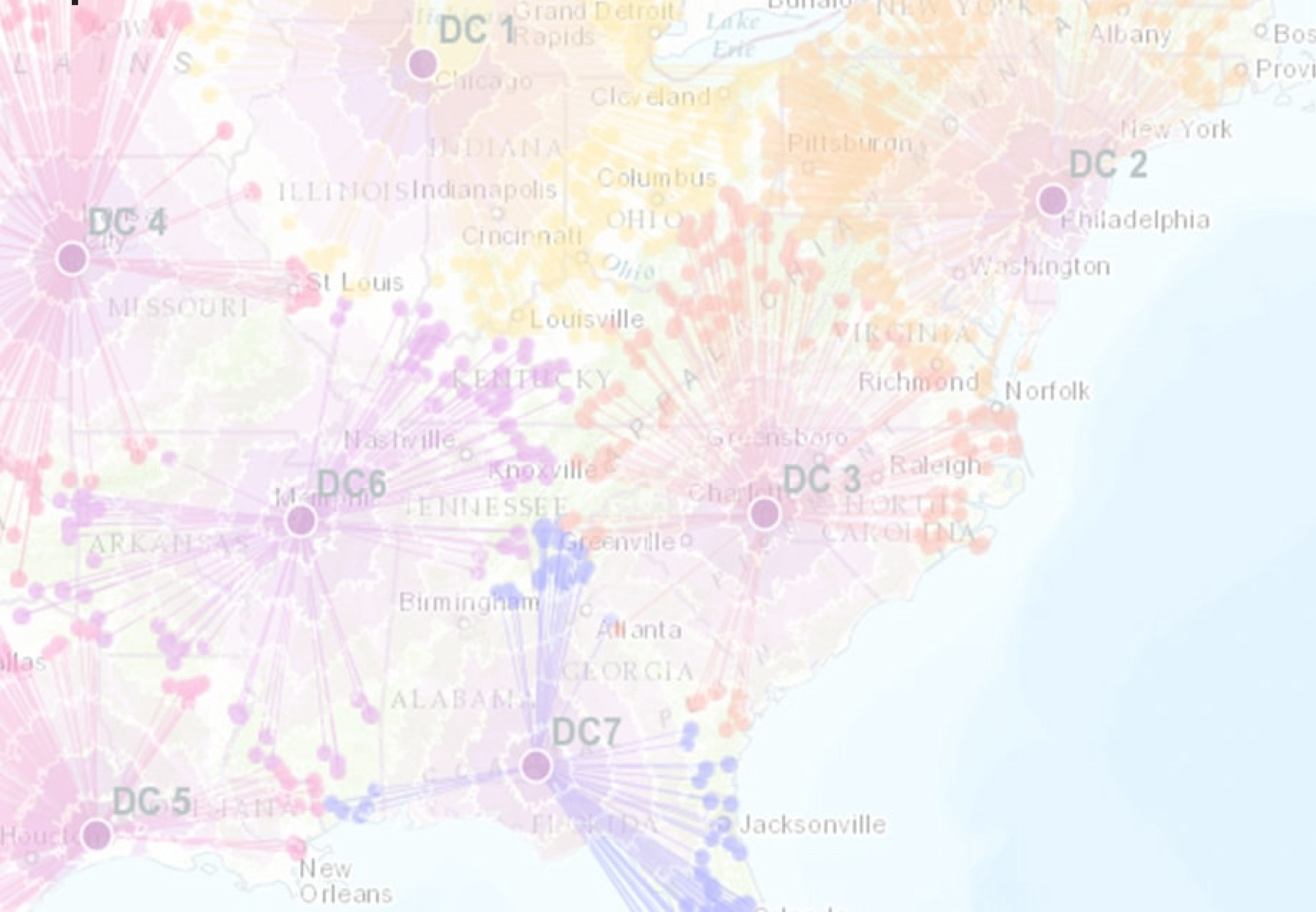
No negative numbers for UTM and SPCS and decimal based coordinates (base-10 metric vs base-60 coordinate system).

Consider area of map?

- Long distances -> Lat/Lon
- Short distances -> UTM, SPCS



Spherical Coordinates and *datums*



Spherical Coordinates and *datums*

Coordinate systems are relative to the center of Earth and use a height system relative to the surface of the Earth.

This poses two immediate problems:

– Where is the center of the Earth?
– What is the shape of the Earth?

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Spherical Coordinates and *datums*

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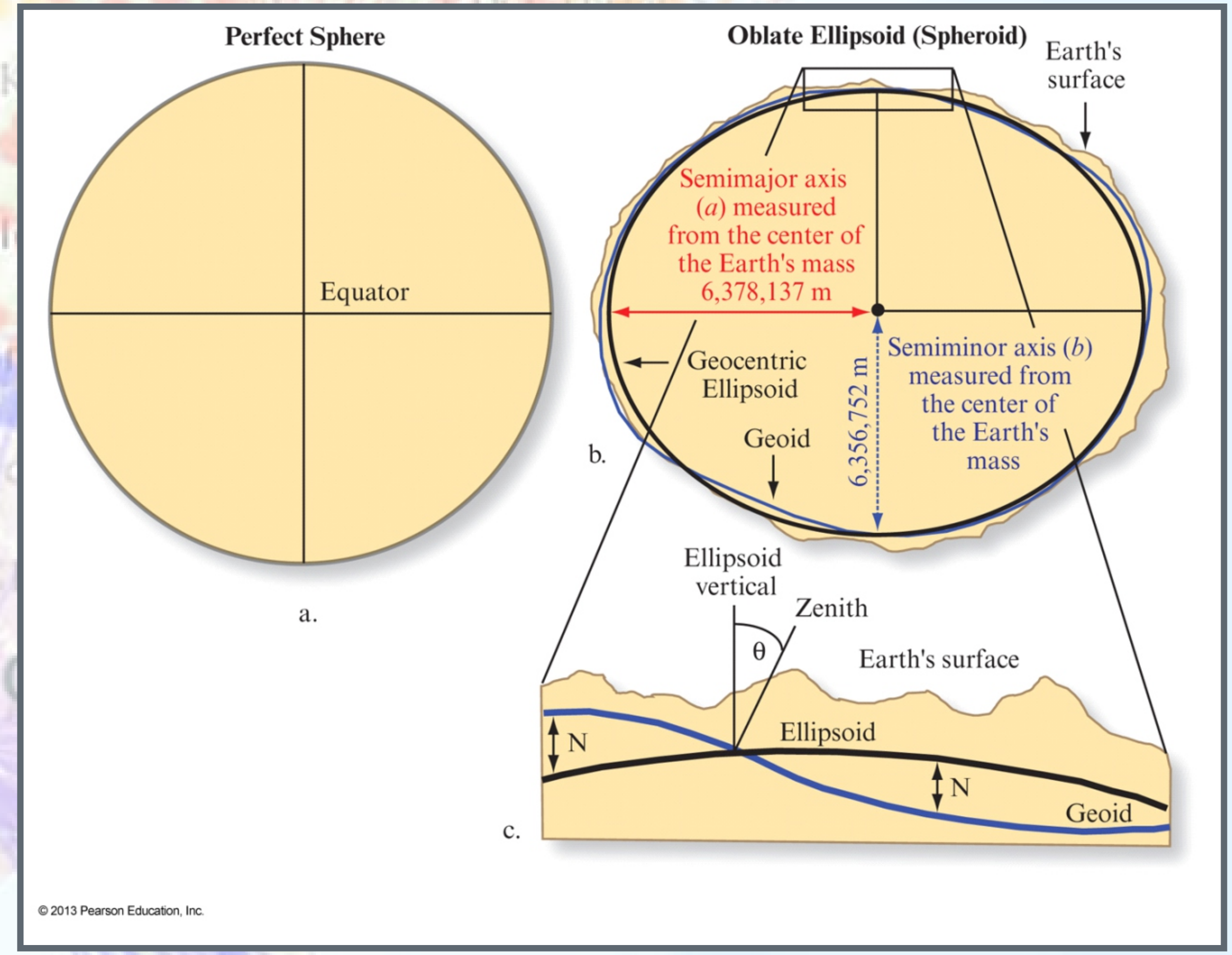
- Where is the center of the Earth?
- What is the shape of the Earth?

We define the surface of Earth at mean sea level (Geoid).

Since this is not very practical to work with as a model, an ellipsoid is used for approximation (WGS84).



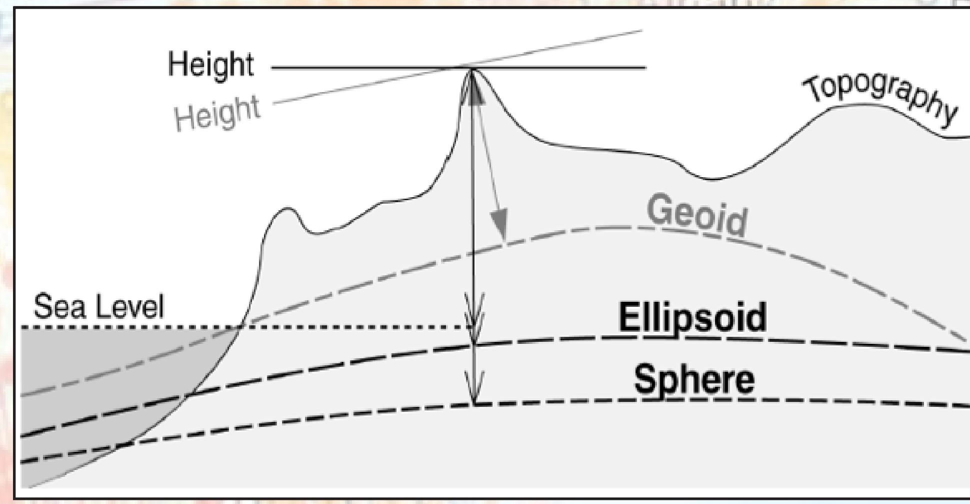
Spherical Coordinates and *datums*

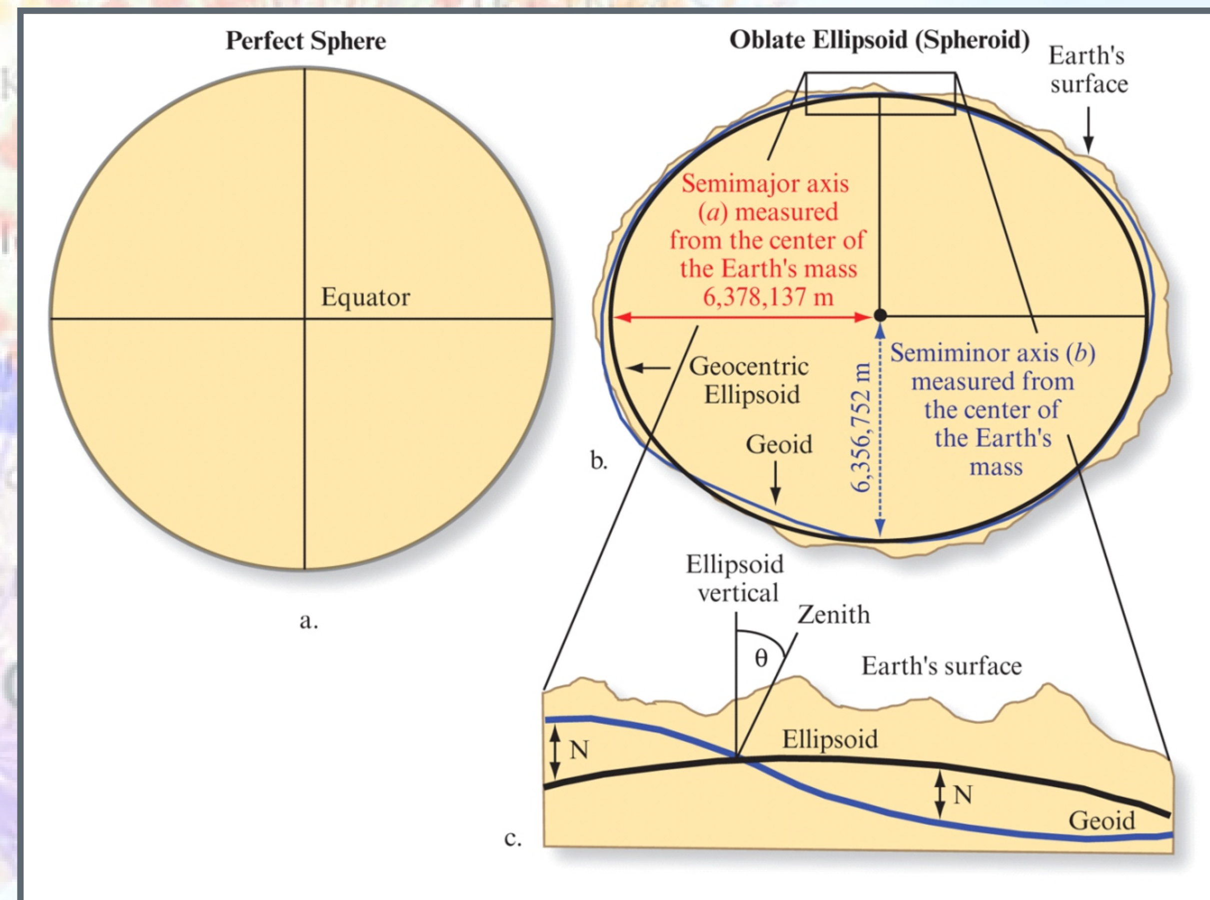
The center and orientation of the ellipsoid is called the datum.

Points on the ground are fixed to the ellipsoid to define the datum.

This is a problem because continental drift moves the points on the ground that are used to define the points on the ellipsoid.

This is why the name of a datum usually have a year, referring to the position of those points January 1st of that year (e.g. NAD27, NAD83).





Spherical Coordinates and map projections

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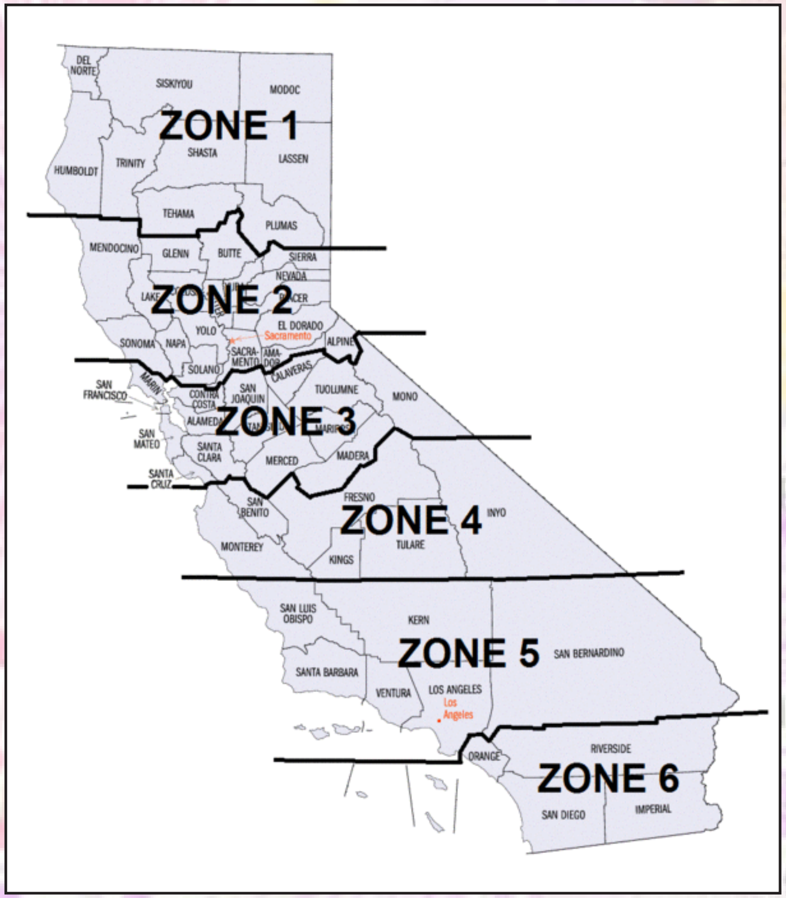

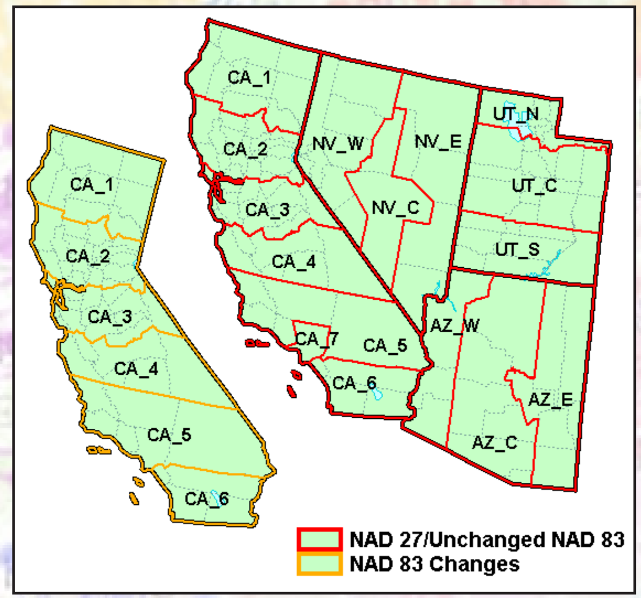

Units of feet (NAD27) or meters (NAD83).

California changed from 7 zones to 6 with NAD27 to NAD83.

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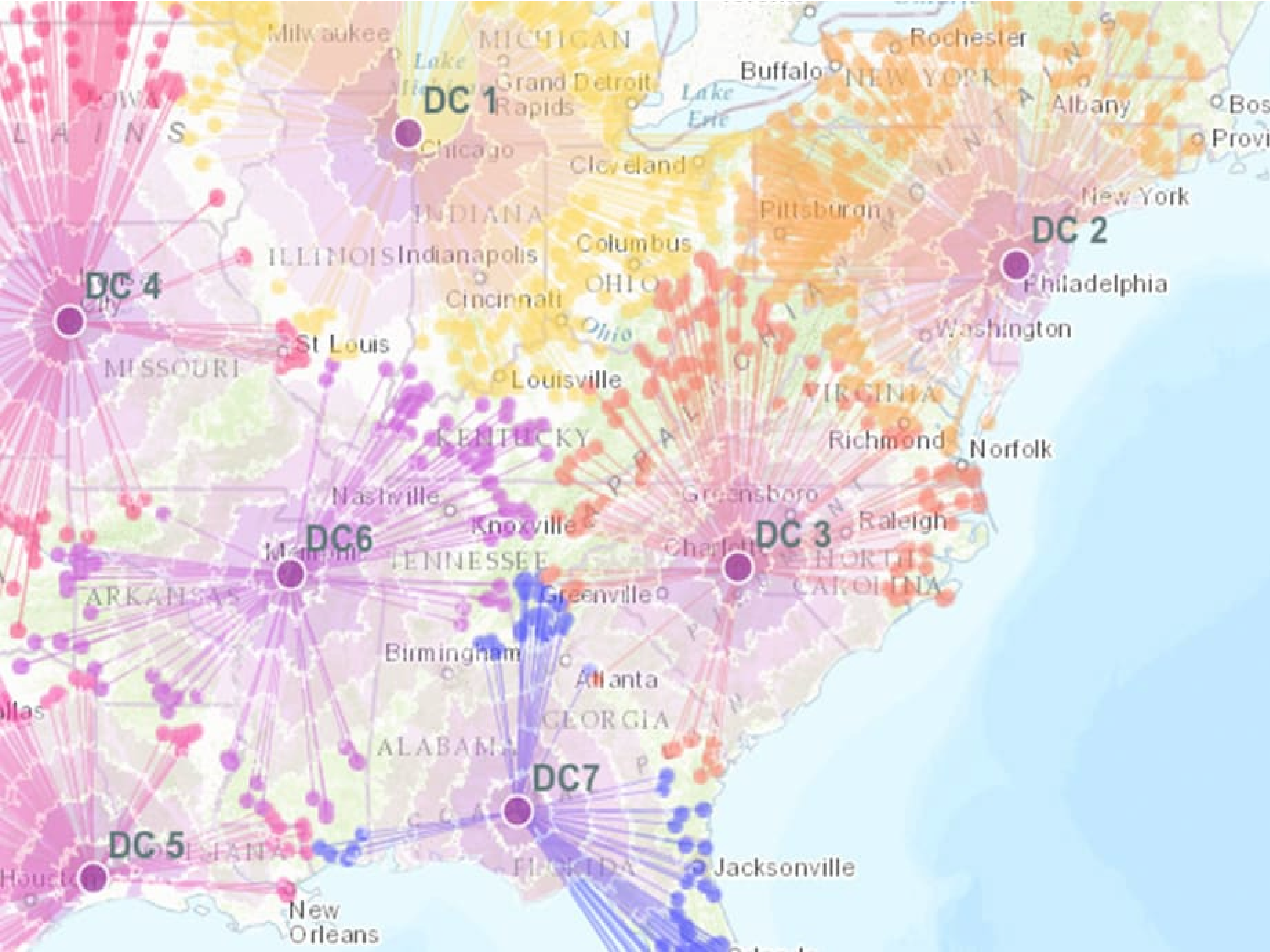
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Milwaukee
MICHIGAN
Grand Rapids
Detroit
Chicago
Cleveland
Buffalo
Rochester
NEW YORK
Albany
Boston
Providence
New York
Pittsburgh
DC 2
Philadelphia
Washington
Columbus
OHIO
Indianapolis
ILLINOIS
INDIANA
Cincinnati
St Louis
MISSOURI
Louisville
KENTUCKY
VIRGINIA
Richmond
Norfolk
Greensboro
Raleigh
Charlotte
NORTH CAROLINA
Nashville
Knoxville
TENNESSEE
Memphis
ARKANSAS
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PLAINS
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