GCS & PCS

Geographic Coordinate Systems

&

Projected Coordinate Systems

*****Most of this material is <u>lifted</u> (directly, word-for-word) from 6th Edition of <u>Chang</u> text, with some material from <u>Jensen</u> & <u>Jensen</u> (with additional material from the web – see links)*****

Geospatial data are geographically referenced (“georeferenced”) using a **geographic coordinate system** (gcs, like lat/lon); when displayed on maps, typically based on **projected coordinate system** (pcs).

Projection displays Earth’s spherical surface as a plane surface.

The **geographic coordinate system** is the location reference system for spatial features on Earth's surface (lat/lon).

The angular measures of latitude and longitude may be expressed in **degrees-minutes-seconds (DMS)** or **decimal degrees (DD)**.

A model that approximates the shape and size of Earth is a **spheroid** or **ellipsoid**.

The **geoid** is an even closer approximation of Earth. It has an irregular shape representing undulations in mean sea level that are derived from irregularities in the density of Earth (used to measuring elevation).

Geodesy is the science concerned with determining the size and shape of the Earth and the location of points upon its surface.

A **datum** is a mathematical model of Earth, which serves as the reference or base for calculating the geographic coordinates of a location (for GIS purposes, datum is interchangeable with spheroid).

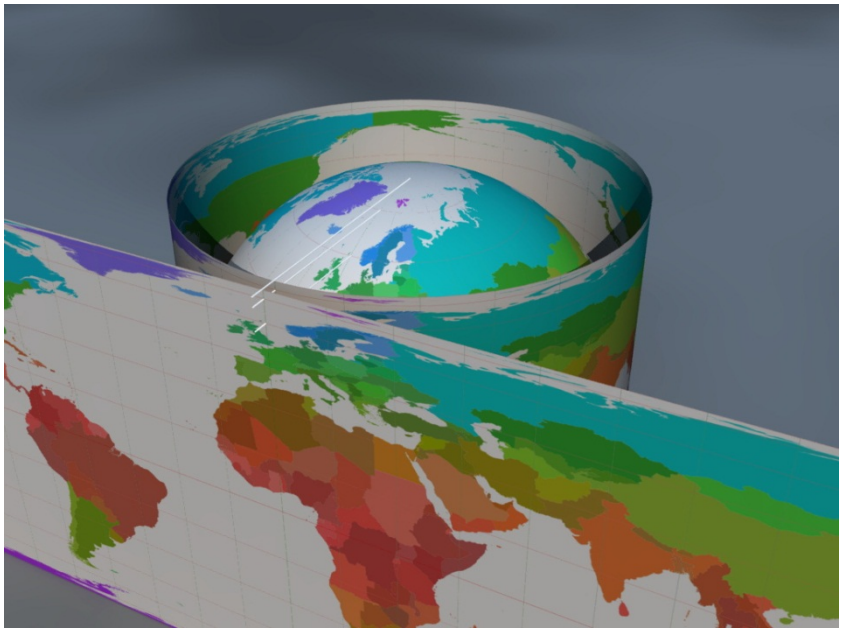
NAD27 (North American Datum of 1927) is frequently used in the United States (with its origin in Meades Ranch, Kansas).

NAD83 is based on measurements made by Doppler satellite observations (representing a shift from a local to a geocentric datum).

Significance of datums to you? Positions of points can shift horizontally anywhere from 10 to 100 meters!

A **map projection** transforms Earth's surface, typically based on a spheroid in GIS, to a plane. The outcome of this transformation process is a **map projection**: a systematic arrangement of parallels and meridians on a plane surface representing the geographic coordinate system *(can skip pcs, but then have to use globe instead of flat surface, and lat/lon instead of plane coordinates which can lead to less accurate distance measurements).*

An image that depicts how a cylindrical projection is created:



http://en.wikipedia.org/wiki/File:Cilinderprojectie-constructie.jpg

The transformation from Earth's surface to a flat surface always involves **distortion**, and no map projection is perfect. Every map projection preserves certain spatial properties while sacrificing other properties. There are four classes of projections based on their "preserved" property: **conformal**, **equal area/equivalent**, **equidistant** and **azimuthal/true direction**.

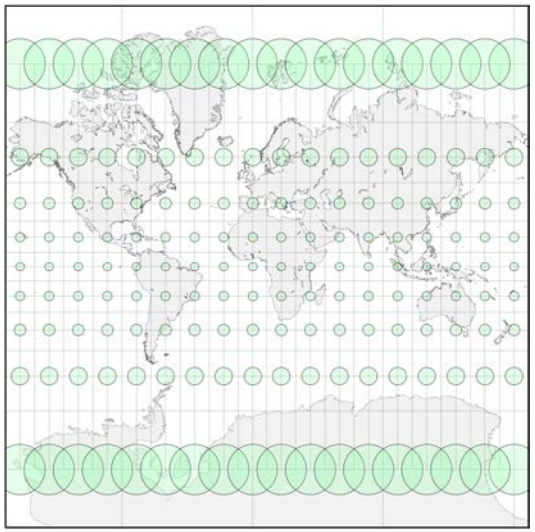
Conformal preserves shape; **equivalent** preserves relative area; **equidistant** maintains consistency of scale along certain lines; **azimuthal** retains accurate direction (conformal and equivalent are mutually exclusive; you can’t have both on the same map!).

Map projections can also be grouped by their projection surfaces (the geometric object onto which the globe is projected); they are **conic**, **cylindrical** and **azimuthal** (or **planar**).

These can be simple (tangency along one line or one point) or secant (tangent along two lines or two points). Tangent lines are called **standard** lines, and have no distortion. Distortion increases as we move away from tangency.

As a heads-up to those of you that intend to do further work with GIS, you'll want to be familiar with transverse Mercator, Lambert conformal conic, Albers equal-area conic, and Web Mercator (used by Google Earth, based on Earth as a sphere instead of a spheroid; simplifies calculations, but not good for accuracy or numerical analysis… therefore, re-project before importing to GIS).

A visual expression of distortion - Tissot's *Indicatrix*. An example of the distortion exhibited by the Mercator



http://www.progonos.com/furuti/MapProj/Dither/CartProp/Distort/distort.html

A **projected coordinate system** is built on a map projection. Common systems include you'll encounter are **UTM** (Universal Transverse Mercator), and **SPC** (State Plane Coordinates).

The coordinates based on these systems are often termed “real-world coordinates”. You will use these systems when mapping at larger scales (1:24,000 or larger), where you need detailed calculations and positioning. A helpful link re: coordinate systems and projections: (http://geology.isu.edu/geostac/Field_Exercise/topomaps/grid_sys.htm).