CHAPTER 2 COORDINATE SYSTEMS

Coordinate System

Two map layers are not going to register spatially unless they are based on the same coordinate system.

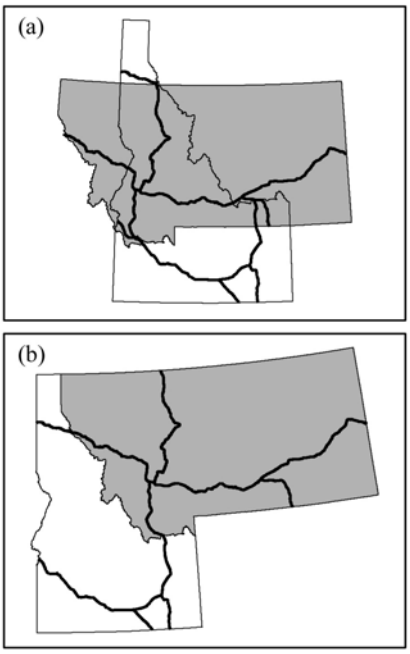

Figure 2.1
The top map shows the road networks in Idaho and Montana based on different coordinate systems. The bottom map shows the road networks based on the same coordinate system.

Geographic Coordinate System

- The geographic coordinate system is the location reference system for spatial features on the Earth's surface.
- The geographic coordinate system is defined by longitude and latitude.

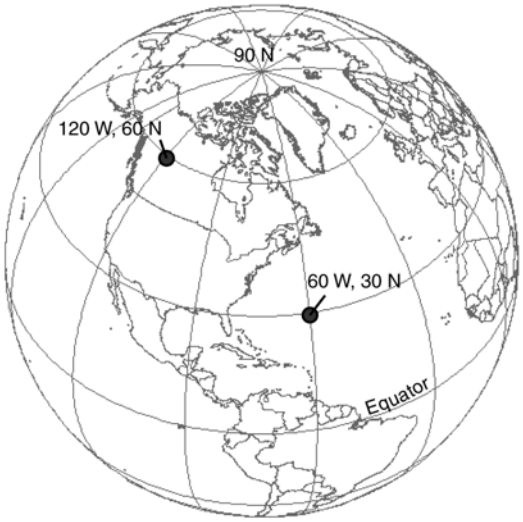

Figure 2.2
The geographic coordinate system.

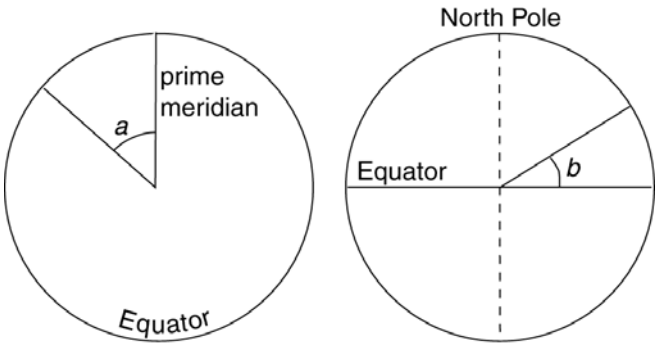

Figure 2.3
A longitude reading is represented by *a* on the left, and a latitude reading is represented by *b* on the right. Both longitude and latitude readings are angular measures.

Approximation of the Earth

- The simplest model is a sphere, which is typically used in discussing map projections.
- The Earth is not a perfect sphere: the Earth is wider along the equator than between the poles. Therefore a better approximation to the shape of the Earth is a *spheroid*, also called *ellipsoid***,** an ellipse rotated about its minor axis.

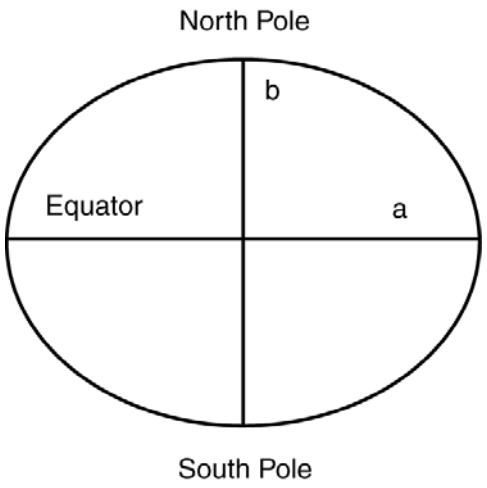

Figure 2.4
The flattening is based on the difference between the semimajor axis *a* and the semiminor axis *b*.

Datum

- A *datum* is a mathematical model of the Earth, which serves as the reference or base for calculating the geographic coordinates of a location.
- A shift of the datum will result in the shift of positions of points.

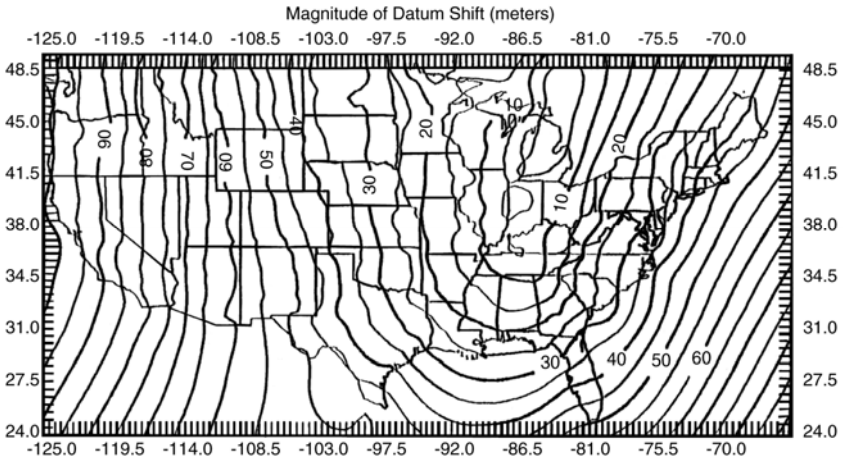

Figure 2.5
The isolines show the magnitudes of the horizontal shift from NAD27 to NAD83 in meters. See text for the definition of the horizontal shift. (By permission of the National Geodetic Survey)

Map Projection

- A map projection is a systematic arrangement of parallels and meridians on a plane surface.
- Cartographers group map projections by the preserved property into conformal, equal area or equivalent, equidistant, and azimuthal or true direction.
- Cartographers also use a geometric object (a cylinder, cone, or plane) and a globe (i.e., a sphere) to illustrate how to construct a map projection.

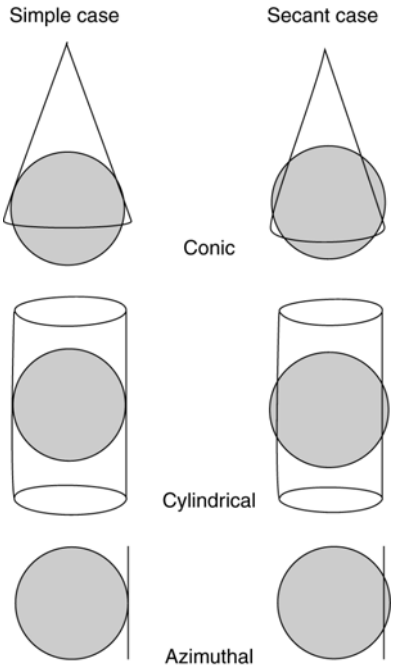

Figure 2.6
Case and projection.

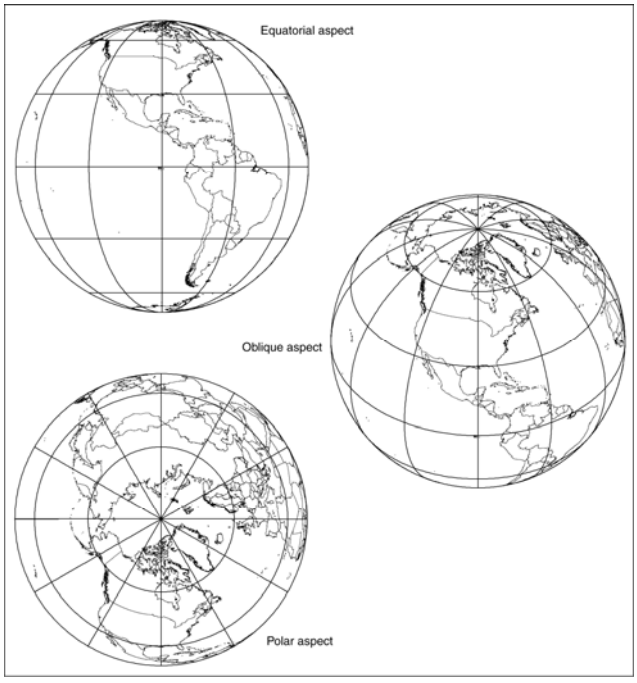

Figure 2.7
Aspect and projection.

Map Projection Parameters

Map projection parameters include standard lines (standard parallels and standard meridians), principal scale, scale factor, central lines, false easting, and false northing.

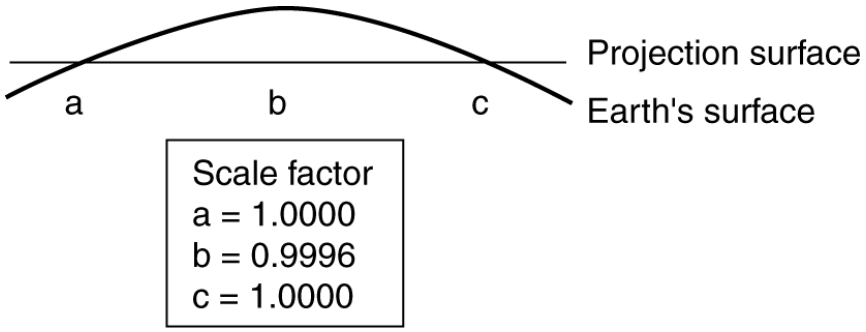

Figure 2.8
The central meridian in this secant case transverse Mercator projection has a scale factor of 0.9996. The two standard lines on either side of the central meridian have a scale factor of 1.0.

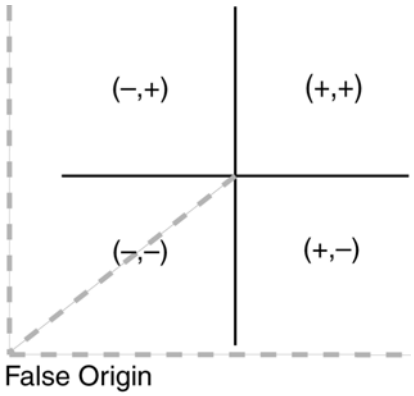

Figure 2.9
The central parallel and the central meridian divide a map projection into four quadrants. Points within the NE quadrant have positive *x*- and *y*-coordinates, points within the NW quadrant have negative *x*-coordinates and positive *y*-coordinates, points within the SE quadrant have positive *x*-coordinates and negative *y*-coordinates, and points within the SW quadrant have negative *x*- and *y*-coordinates. The purpose of having a false origin is to place all points within the NE quadrant.

Commonly Used Map Projections

1. Transverse Mercator
2. Lambert conformal conic
3. Albers equal-area conic
4. Equidistant conic

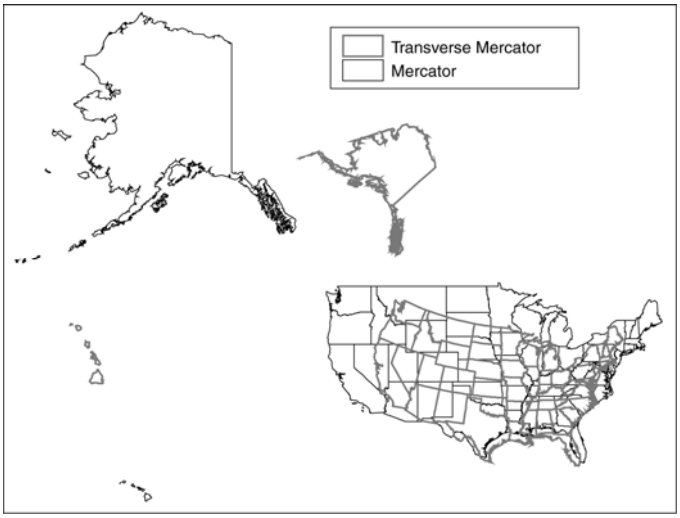

Figure 2.10
The Mercator and the transverse Mercator projection of the United States. For both projections, the central meridian is 90°W and the latitude of true scale is the equator.

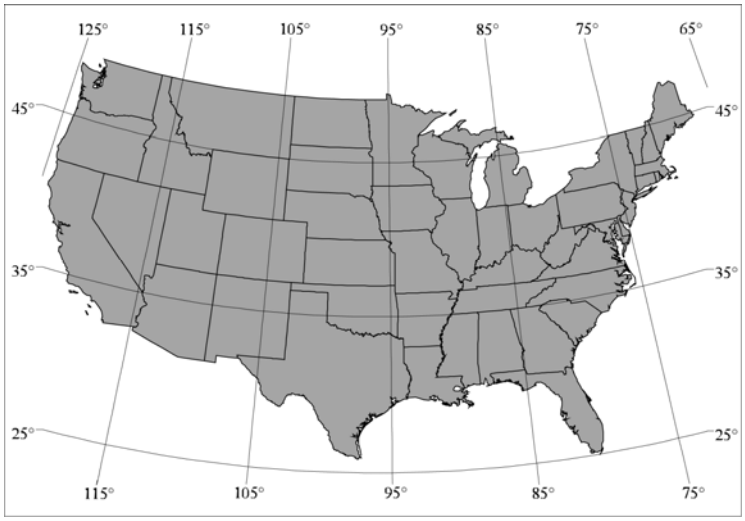

Figure 2.11
The Lambert conformal conic projection of the conterminous United States. The central meridian is 96°W, the two standard parallels are 33°N and 45°N, and the latitude of projection's origin is 39°N.

Projected Coordinate Systems

1. The Universal Transverse Mercator (UTM) grid system
2. The Universal Polar Stereographic (UPS) grid system
3. The Public Land Survey System (PLSS)

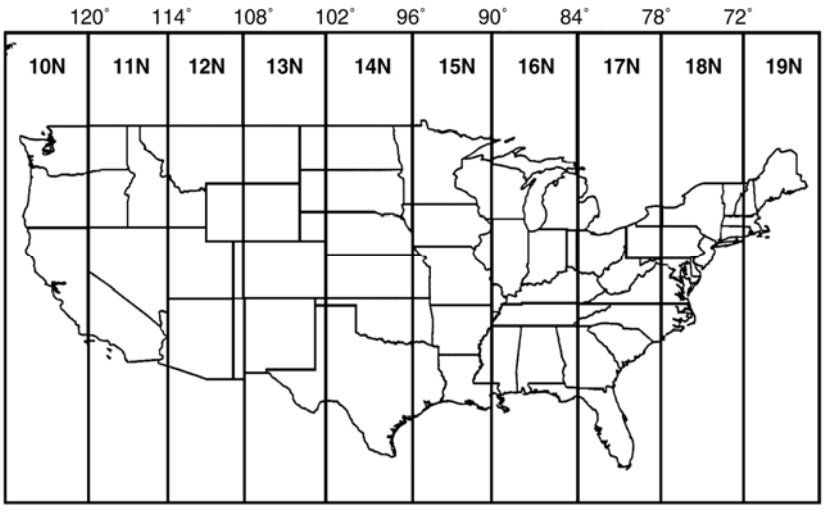

Figure 2.12
UTM zones range from zone 10N to 19N in the conterminous United States.

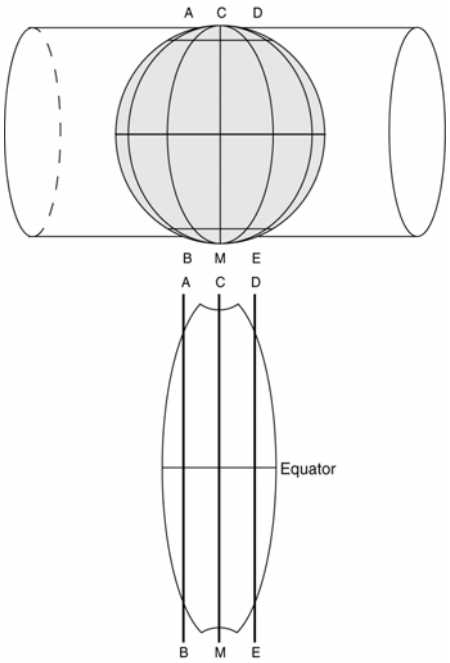

Figure 2.13
A UTM zone represents a secant case transverse Mercator projection. CM is the central meridian, and AB and DE are the standard meridians. The standard meridians are placed 180 kilometers west and east of the central meridian. Each UTM zone covers 6° of longitude and extends from 84°N to 80°S. The size and shape of the UTM zone are exaggerated for illustration purposes.

Figure 2.14
SPC83 zones in the conterminous United States. The thinner lines are county boundaries, and the gray lines are state boundaries.

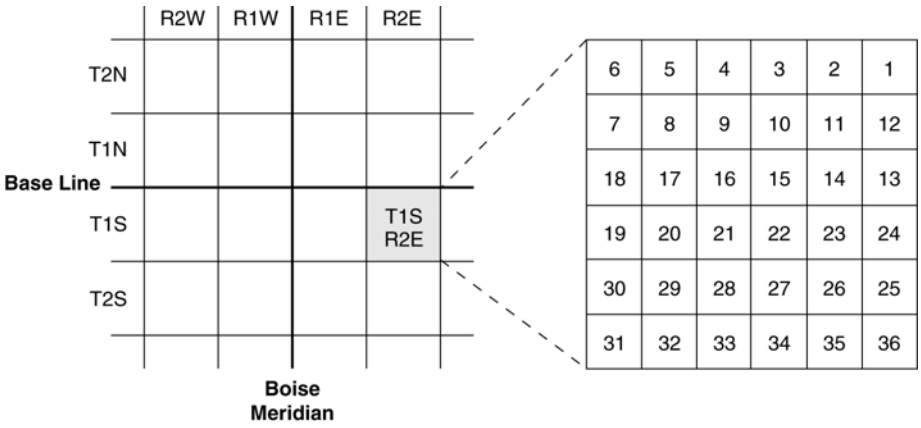

Figure 2.15
The shaded survey township has the designation of T1S, R2E. T1S means that the survey township is south of the base line by one unit. R2E means that the survey township is east of the Boise (principal) meridian by 2 units. Each survey township is divided into 36 sections. Each section measures 1 mile by 1 mile and has a numeric designation.

	Predefined	**Custom**
Geographic	NAD27, NAD83 (1986)	Datum transformation
Projected	UTM, State Plane	IDTM

Table 2.1 A classification of coordinate systems in GIS packages

National Geodetic Survey: Nadcon
http://www.ngs.noaa.gov/TOOLS/Nadcon/Nadcon.html
Bureau of Land Management: Geographic Coordinate Data Base
http://www.blm.gov/gcdb/
National Geodetic Survey
http://www.ngs.noaa.gov/CORS/cors-data.html
Geospatial One-stop
http://geodata.gov/
Geodesy for the Layman by R. K. Burkard
http://www.ngs.noaa.gov/PUBS_LIB/Geodesy4Layman/TR80003A.HTM#ZZ0/
Department of Defense World Geodetic System 1984: Its Definition and Relationships with Local Geodetic Systems
http://earth-info.nga.mil/GandG/
NGS BenchMark Database
http://www.ngs.noaa.gov/cgi-bin/datasheet.prl?Type=DATASHEETS