GEOG 204

LECTURE 3

Coordinate Systems

1

Coordinate systems

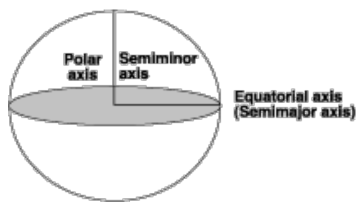
- Context/Backdrop
  - There is a need to know positions on the Earth's surface
  - The Earth is round
    - The nature of geographic information
      - Paper is an important medium
      - Rasters are inherently flat
  - Graticule of meridians and parallels on a spheroid

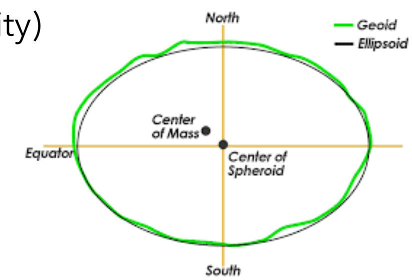
2

2

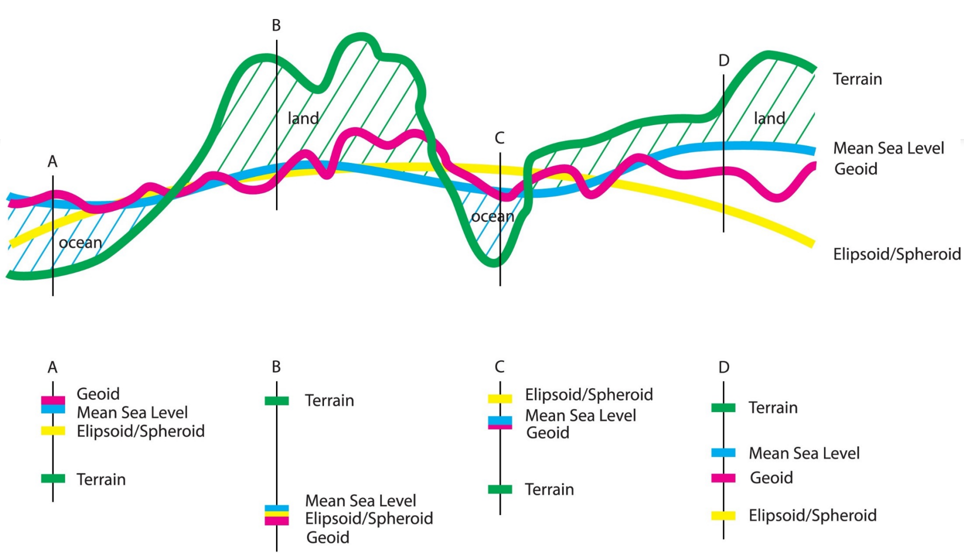
Surfaces to characterise the Earth's shape

- the Ellipsoid/Spheroid
- the Geoid (approximates earth's gravity)



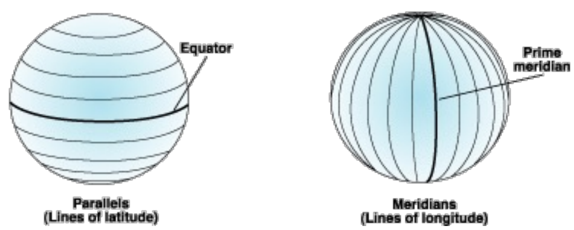


- the Mean Sea Level
  - Over oceans MSL = geoid; differ on landmass
- the Terrain



Coordinate Systems

- Assuming the Earth is spherical
  - Graticule of meridians and parallels on a spheroid



5

5

Coordinate Systems

- A coordinate system: a reference system used to represent the locations of geographic features
  - Allows geographic datasets to use common locations for integration
- Types of coordinate systems
  - Geographic coordinate systems
  - Projected coordinate systems

6

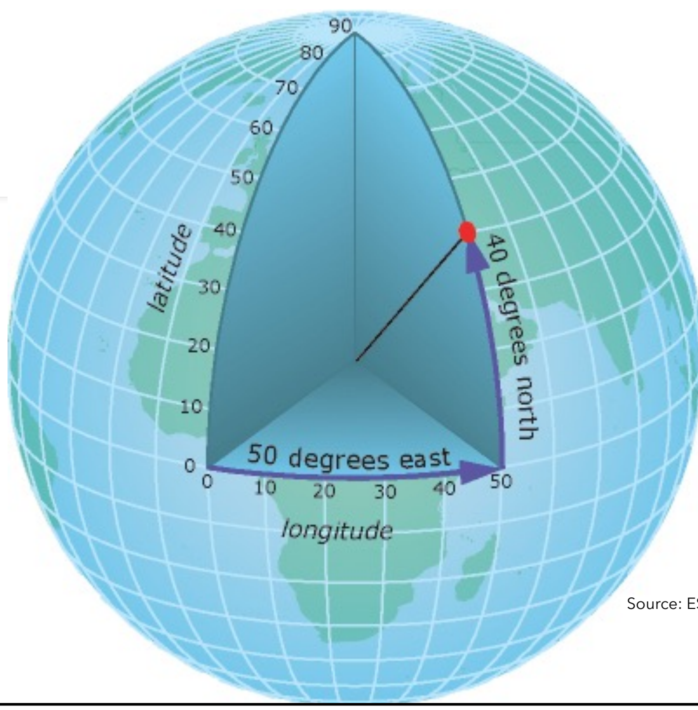
6

Geographic Coordinate Systems

- Global or spherical coordinate systems such as latitude-longitude.
  - Coordinates based upon "spherical" coordinates modified to account for the imperfect shape of the earth
  - The most commonly used coordinate system today is the **latitude**, **longitude**, and height system.
  - The **Prime Meridian** and the **Equator** are the reference planes used to define latitude and longitude.

7

7



Source: ESRI

8

8

Geographic Coordinate Systems

- Degree-Minute-Second
  - 1 deg = 60 min
  - 1 min = 60 sec
- Decimal Degrees
  - 62°52′30″= 62.875 °
- Range
  - Longitude: -180 to 180 (180W to 180E)
  - Latitude: -90 to 90 (90S to 90N)

9

9

Geographic Coordinate Systems

- "Null Island"
  - GIS fails to associate coordinates to a position and instead assigns [0,0] or [Null, Null]
- A long a meridian
  - 1° =~ 111 km, 1″ ~ 2 km, 1′ =~ 30metres
  - It is more complicated along the parallels because they get smaller towards the pole

10

10

Geographic Coordinate Systems

- A GCS includes
  - an angular unit of measure,
  - a prime meridian,
  - a datum

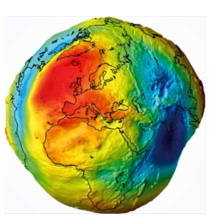
- The spheroid defines the size and shape of the earth model, while the datum connects the spheroid to the earth's surface.

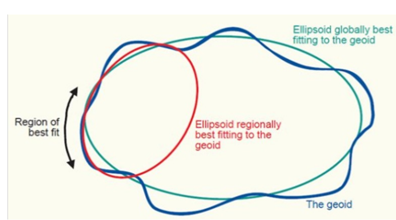
11

11

Datums

- A **datum**
  - Reference system which allows the location of latitudes and longitudes (and heights) to be identified onto the surface of the Earth
    - i.e. determine the position of the spheroid relative to the center of the earth.
      - GCS based on a spheroid
      - The Earth is not perfectly spherical





12

12

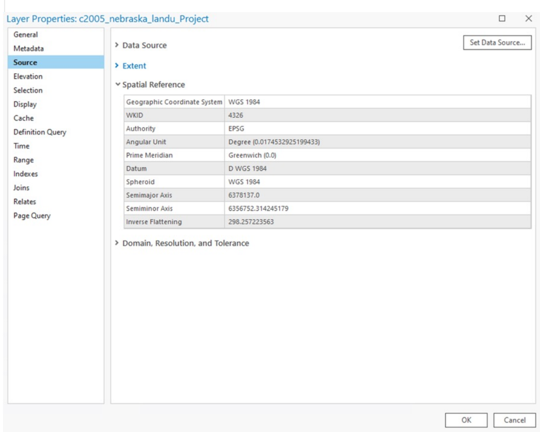
Datum

- To project Earth to a flat plane we must choose an ellipsoid or spheroid to represent the Earth's surface.
- Choosing an ellipsoid implies selecting a horizontal datum for the projected map.
- Hundreds of datums have been created
- Reference ellipsoids are usually defined by semi-major (equatorial radius) and flattening (the relationship between equatorial and polar radii).

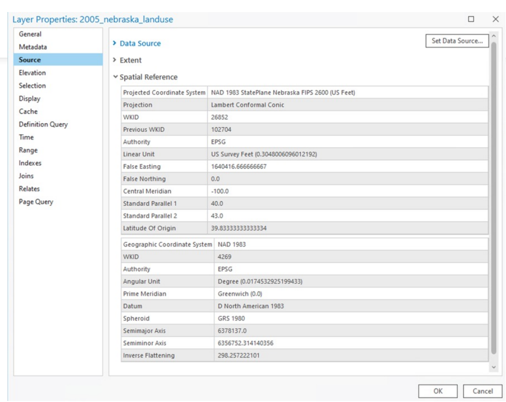
13

13

Datum



A Geographic Coordinate System
WGS1984



A Projected Coordinate System,
North American Datum, State Plane Projection

14

14

Selected Reference Ellipsoids

Clarke 1866 Datum (NAD27)

World Geodetic System 1984 (North American Datum 1983 (NAD83))

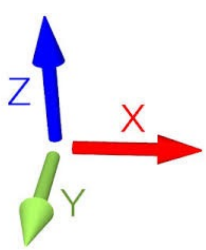
Ellipse	Semi-Major Axis (meters)	1/Flattening
Airy 1830	6377563.396	299.3249646
Bessel 1841	6377397.155	299.1528128
Clarke 1866	6378206.4	294.9786982
Clarke 1880	6378249.145	293.465
Everest 1830	6377276.345	300.8017
Fischer 1960 (Mercury)	6378166.0	298.3
Fischer 1968	6378150.0	298.3
G R S 1967	6378160.0	298.247167427
G R S 1975	6378140.0	298.257
G R S 1980	6378137.0	298.257222101
Hough 1956	6378270.0	297.0
International	6378388.0	297.0
Krassovsky 1940	6378245.0	298.3
South American 1969	6378160.0	298.25
WGS 60	6378165.0	298.3
WGS 66	6378145.0	298.25
WGS 72	6378135.0	298.26
WGS 84	6378137.0	298.257223563

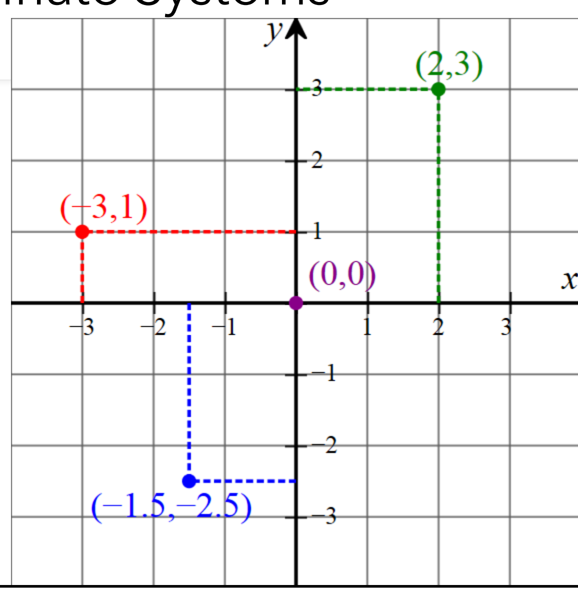
Peter H. Dana 9/1/94

15

Projected Coordinate Systems

- Ordered Pairs
- Units
- X: East/West
- Y: North/South
- Z: Elevation



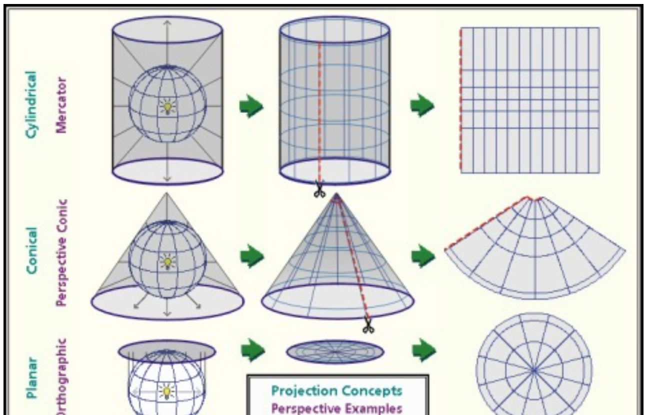


16

16

Major Projection Surfaces

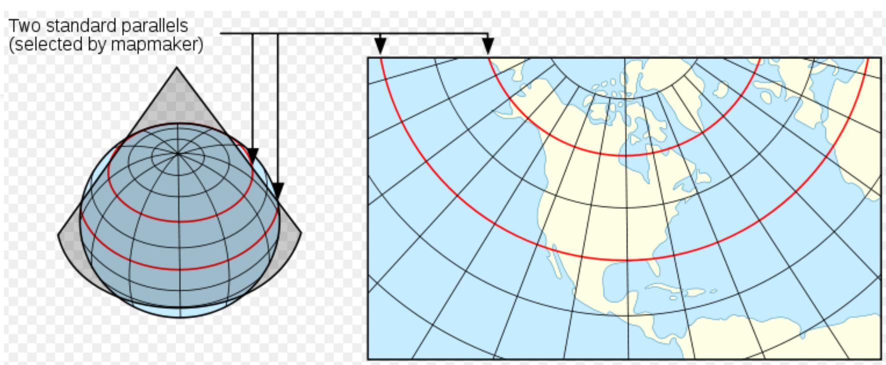
- Cylindrical, Conical, Planar
- World, regional, local



http://www.gihdatatutorials.net/basics-of-coordinate-systems.html

17

Albers (conic) projection



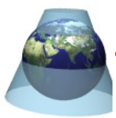
Albers Canada: http://en.wikipedia.org/wiki/Albers_projection

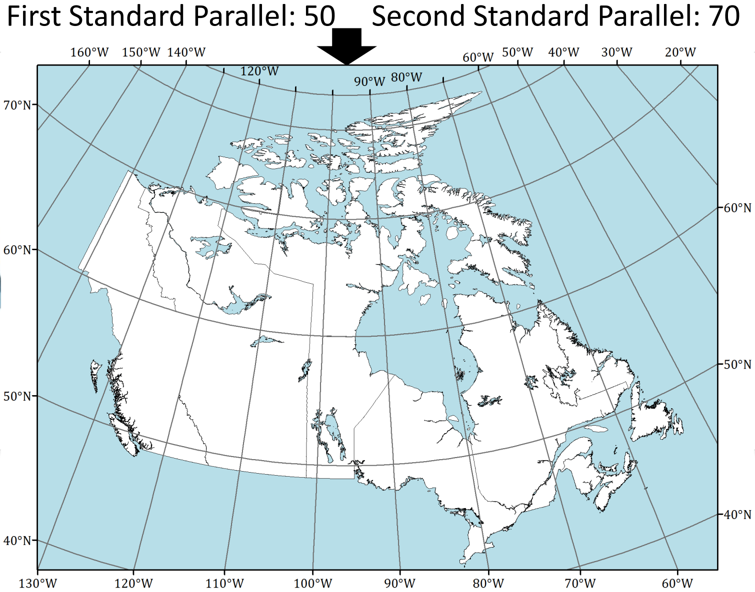
18

Canada Albers Equal Area Conic:

Central Meridian: -96 Latitude Of Origin: 40

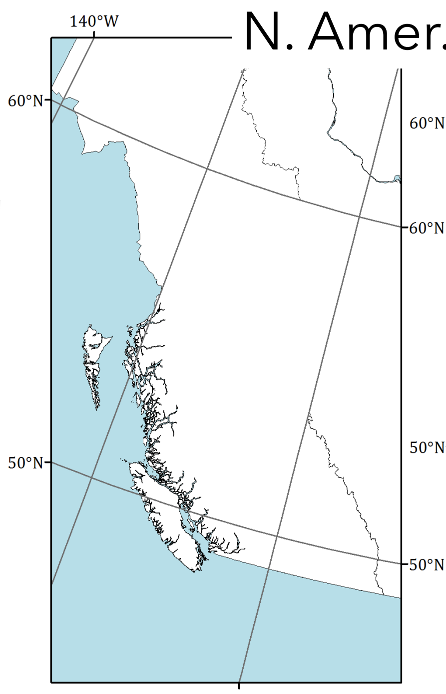
First Standard Parallel: 50 Second Standard Parallel: 70

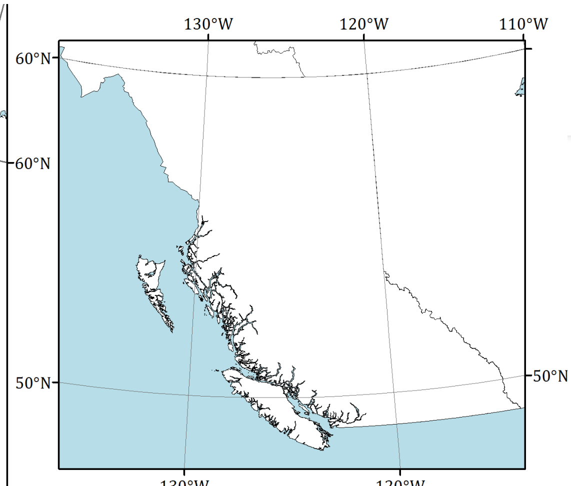




19

N. Amer. vs BC Albers





Central meridian: 126° W **Latitude of origin: 45N**

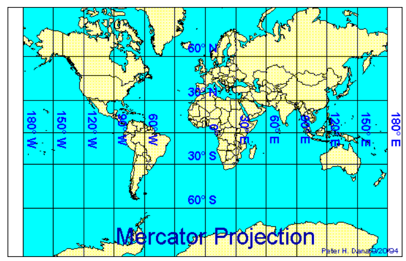
First Standard Parallel: 50°N **False northing: 0**

2nd Standard Parallel: 58:30 **False easting: 1,000,000**

20

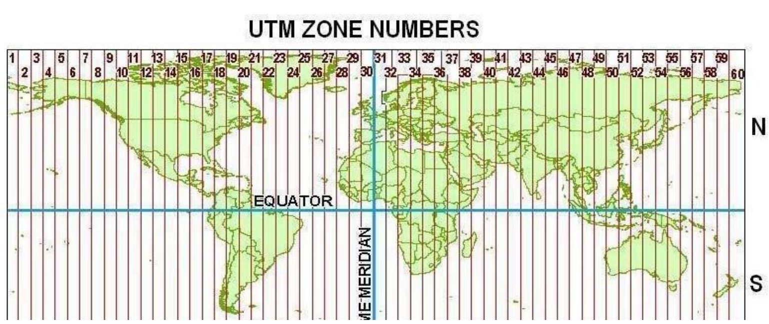
Transverse Mercator Projection

- Straight meridians and parallels intersect at right angles. Scale is true at the equator or at two standard parallels equidistant from the equator.
- Requires:
  - Standard Parallels
  - Central Meridian
  - Latitude of Origin
  - False Easting and Northing

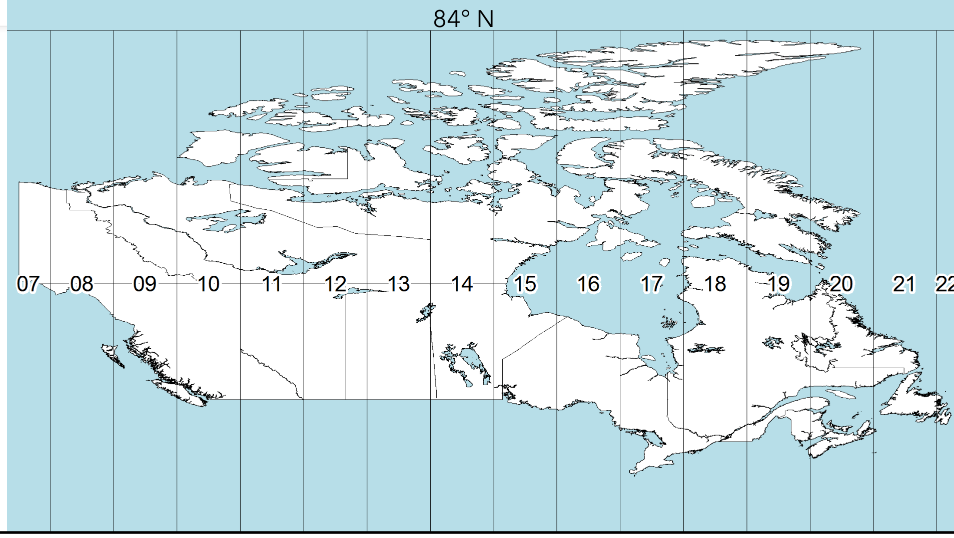


Universal Transverse Mercator

- 60 slices, 60 meridians (we are in 10N, **126°W**)
- Units: Meters
- Standard for field navigation (no world maps)
- <u>Conformal</u>
- Key purpose: horizontal position (no Z value)

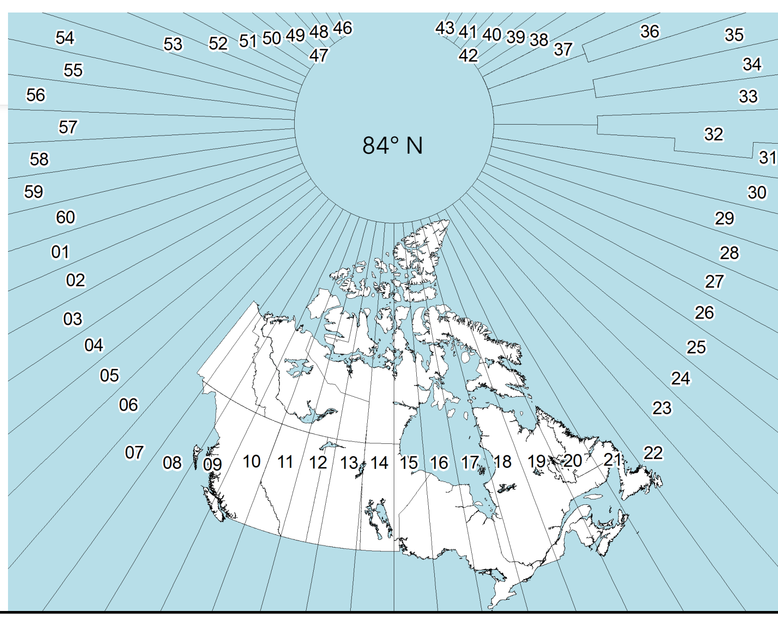


UTM Zones in Geographic Projection



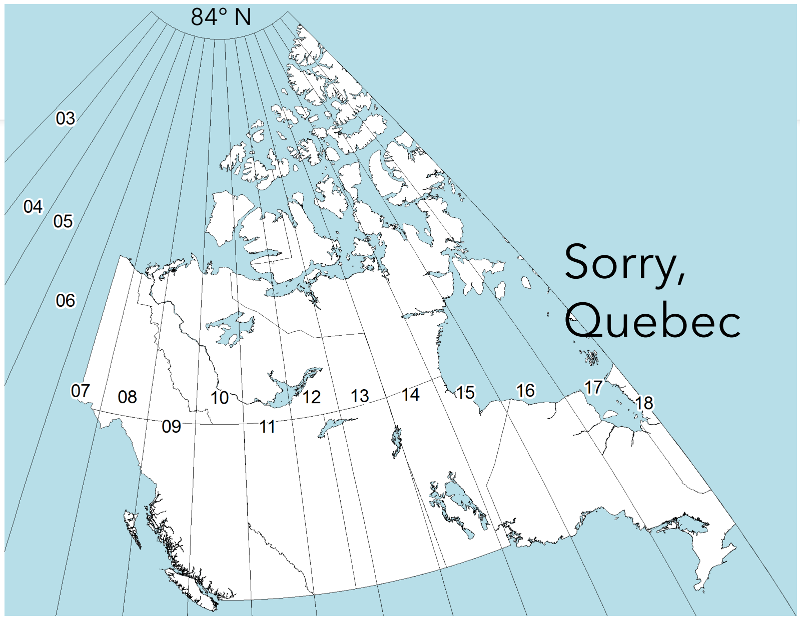
23

UTM Zones in Canada Albers



24

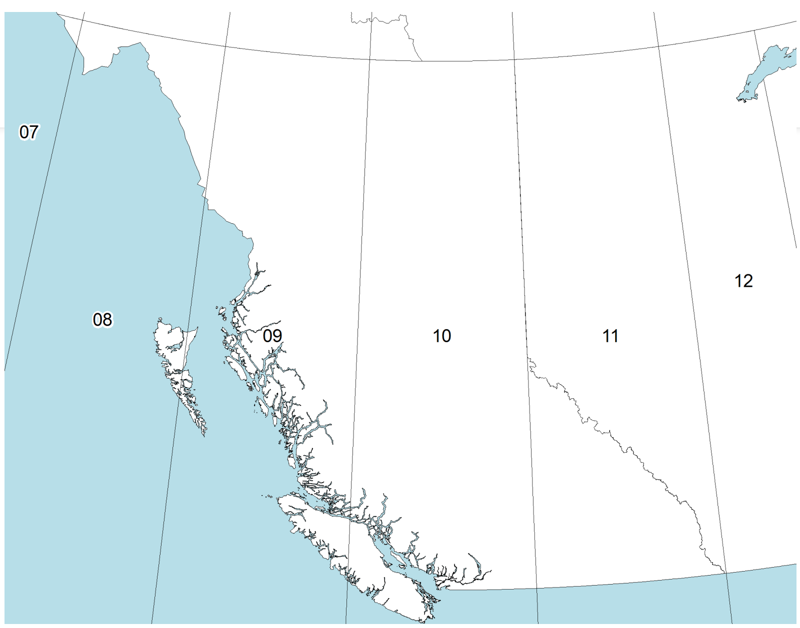
Canada According to UTM 10N



Sorry,
Quebec

25

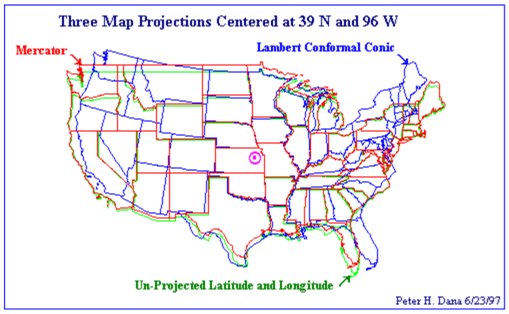
BC According to UTM 10N



26

Projection on the Fly

- First layer defines coordinate system
  - May be changed manually (lab)
- All subsequent layers "projected on the fly"
- Same in ArcGIS, QGIS, Manifold, etc.
- Imagine displaying in 3 projections…



27

Summary

- Never display in unprojected coordinates
- Local projections often the best
  - Most issues/debates surround world maps
- Know the major projection shapes/classes
- UTM for horizontal position

28