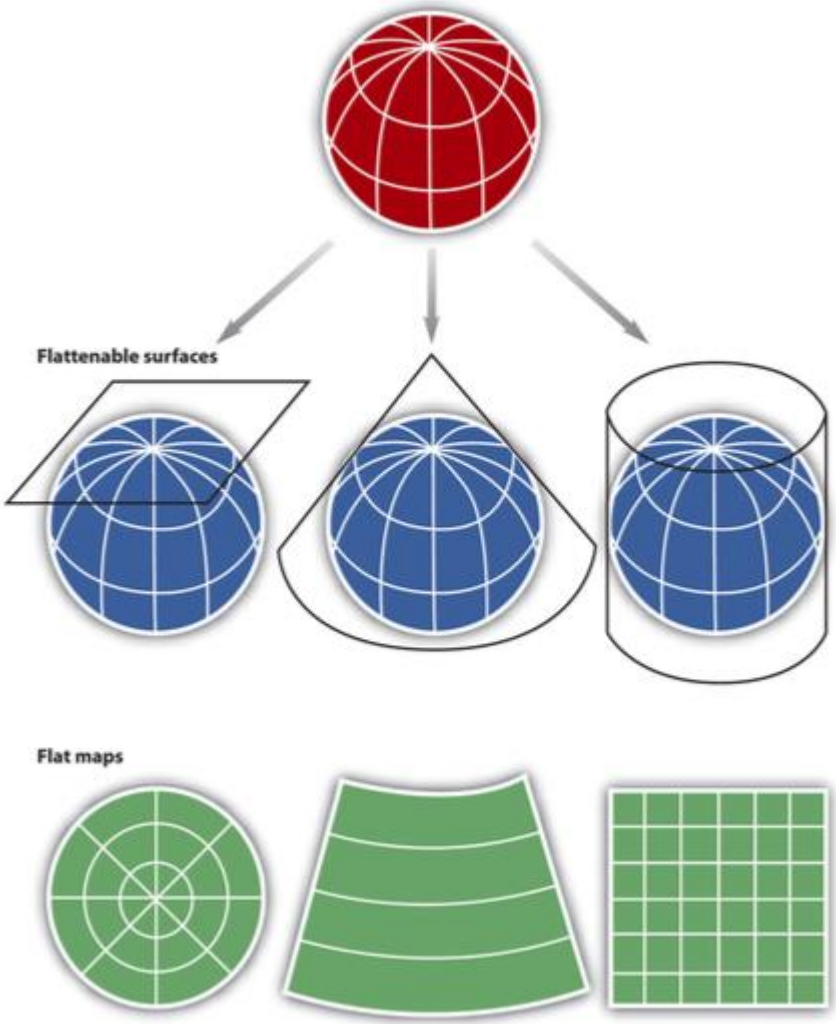
Map projections review– 3 + 1 major groups

- based on projection surface: **Azimuthal, Cylindrical, Conic,** Pseudo-cylindrical



Sub-groups based on projection orientation (**normal**, transverse, oblique)

Possible Properties : **area, shape**, distance, (direction)

Projections 2: GIS and digital mapping

Are projections 'old school' and irrelevant in the digital world ? NO

ArcGIS Pro supported projections:

https://pro.arcgis.com/en/pro-app/latest/help/mapping/properties/list-of-supported-map-projections.htm

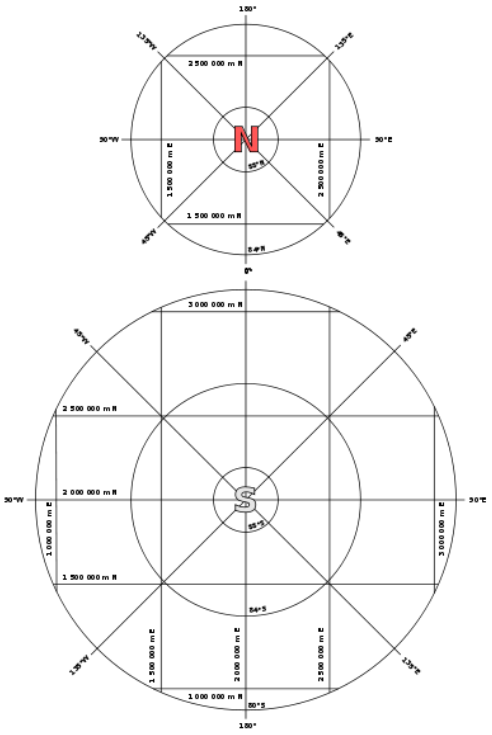
Digital mapping / GIS
= much easier to convert projections

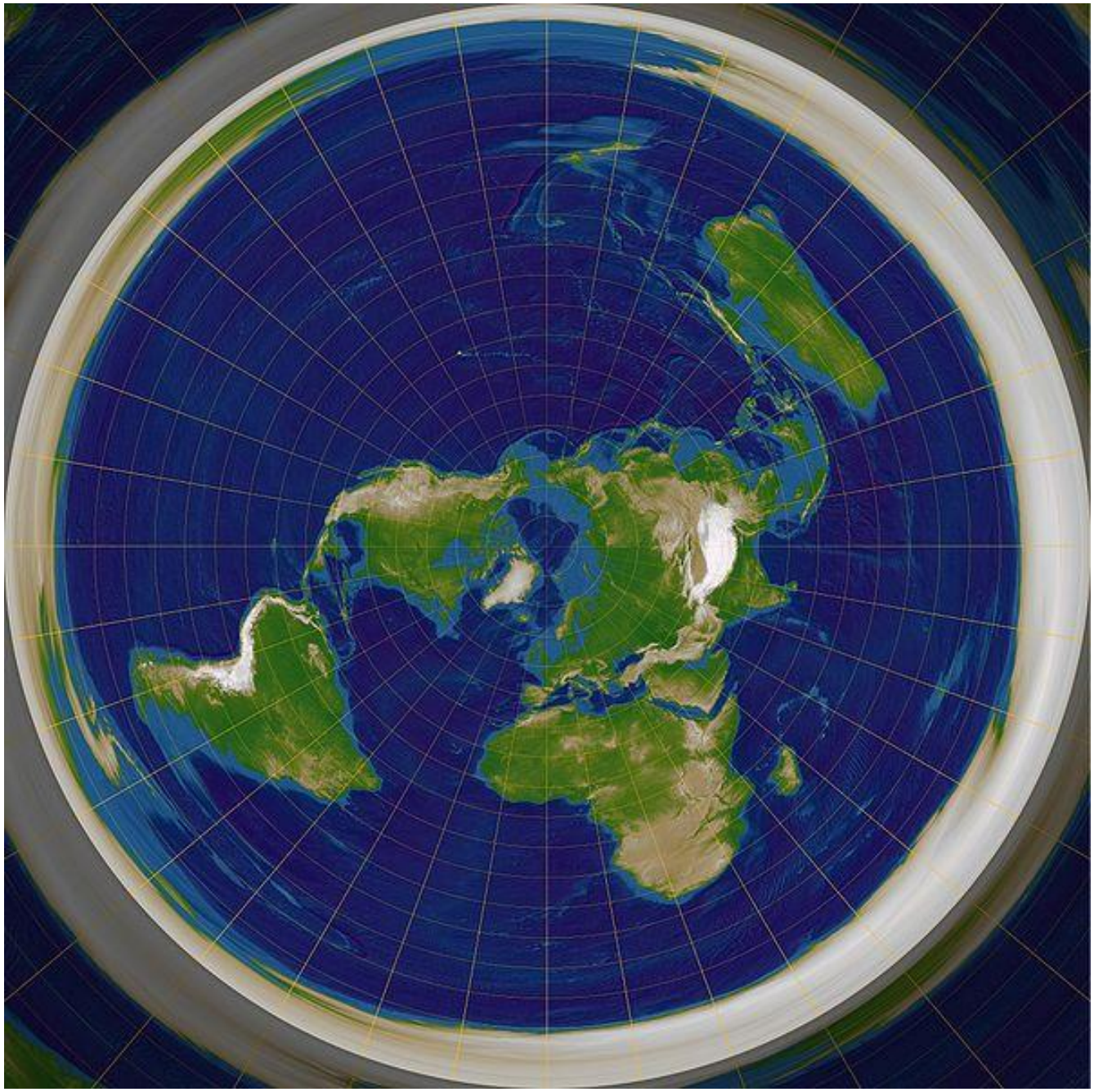
See also: https://earth.nullschool.net

Click on the word **Earth** and change the projection

1. Azimuthal

Stereographic is used to map Polar regions instead of UTM (cylindrical) – UPS coordinates





2. Cylindrical: Plate Carrée - equi-rectangular

[Eratosthenes 200BC and Marinus of Tyre, AD100]

One degree is the same everywhere; easy to draw manually

Does NOT preserve shape or area;

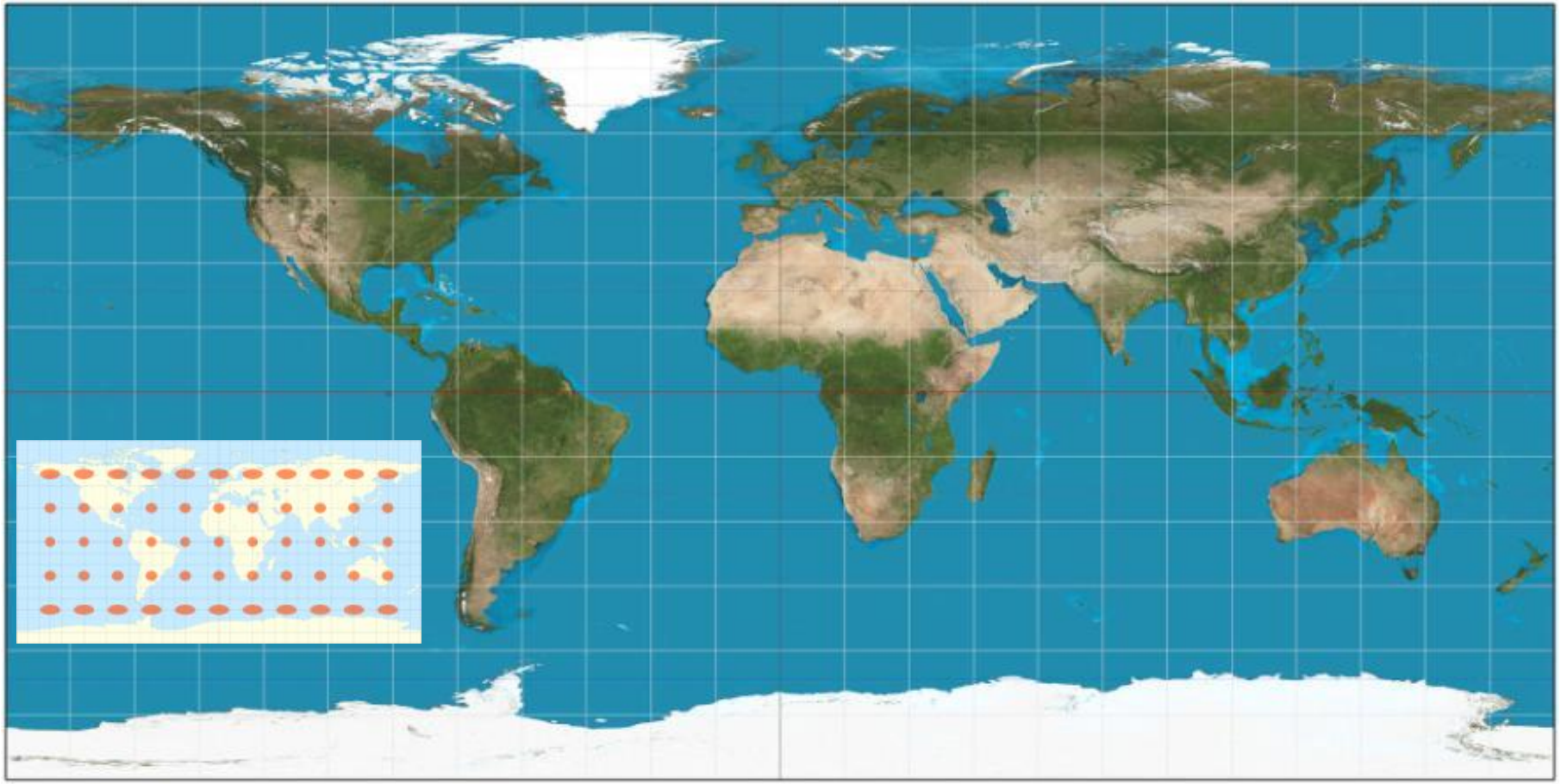
it is **equidistant** …. From the equator north and south

Scale Factors

Digital / GIS: ‘Geographic’ or ‘unprojected’

One degree is the same everywhere

common for data storage, but not for display due to E-W stretching
- DON’T leave your map data in Geographic …



Cylindrical Projections

Transverse Mercator (1772)

The TM projection is the basis for the (Universal) UTM system

UTM is not a projection .. It is a system of 60 (similar) projections – each one centred on a UTM zone central meridian

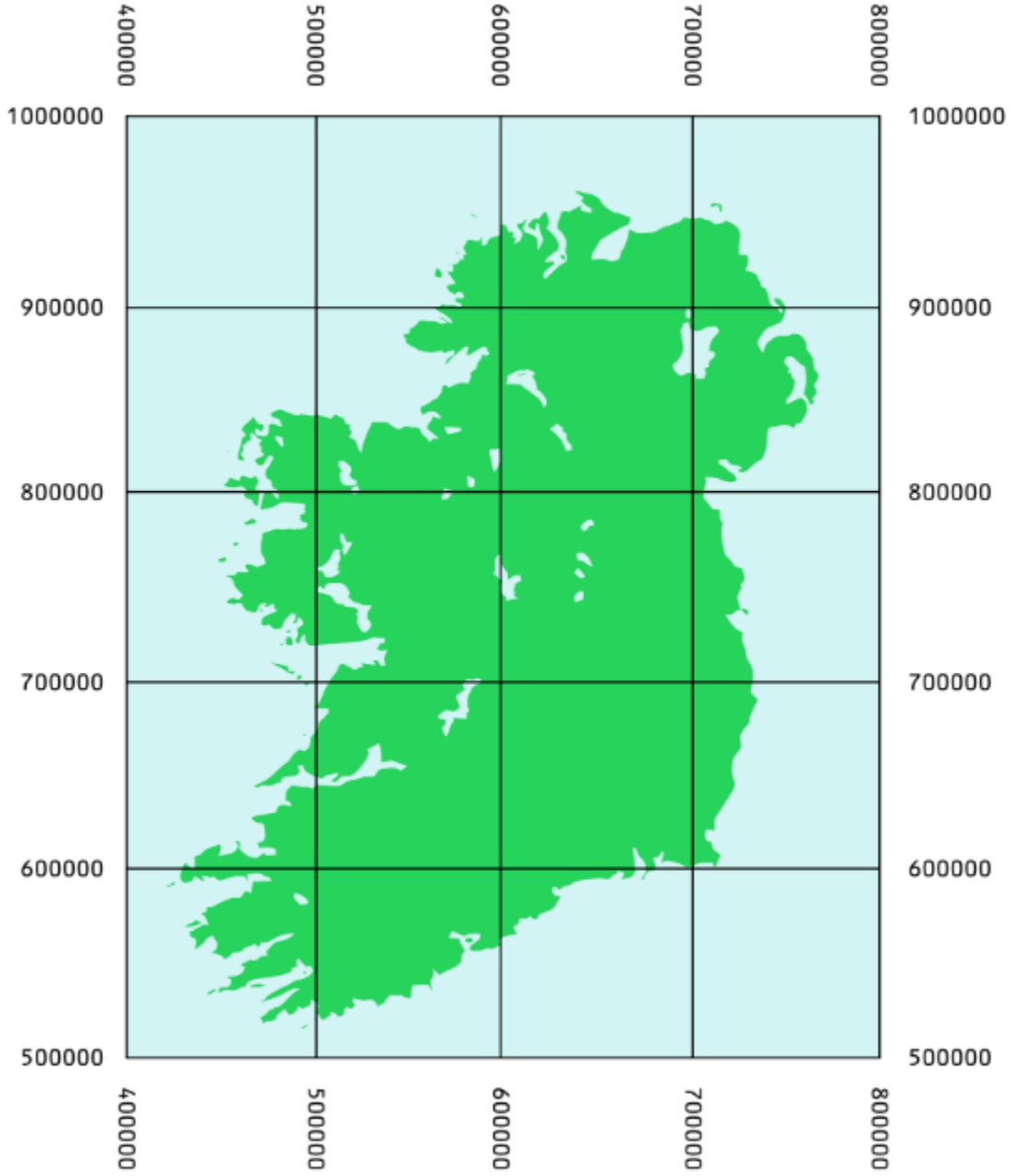
The UTM **system** consists of 60 TM projections (to 84N)
Polar areas –Arctic and Antarctic use the **azimuthal stereographic projection** and Universal Polar Stereographic (UPS) coordinates

Irish Transverse Mercator (ITM) System (2001)

Ireland: 5.5 -10.5°W

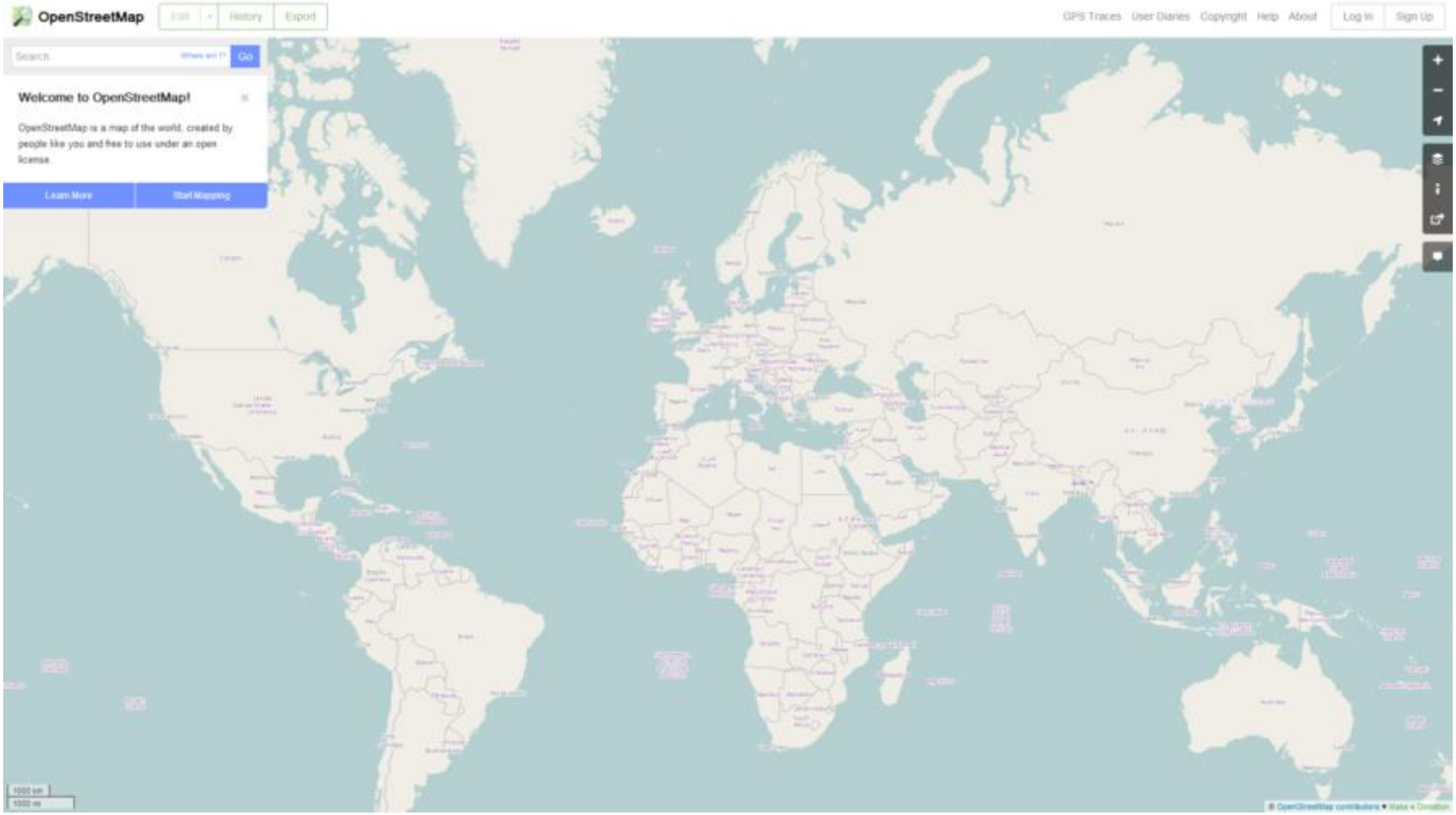
Within one UTM zone
Northings - reduced to a local base for 6 digits

Alberta uses a ‘10TM’ system:
110-120 W (across zones 11-12)
Central meridian = 115 W



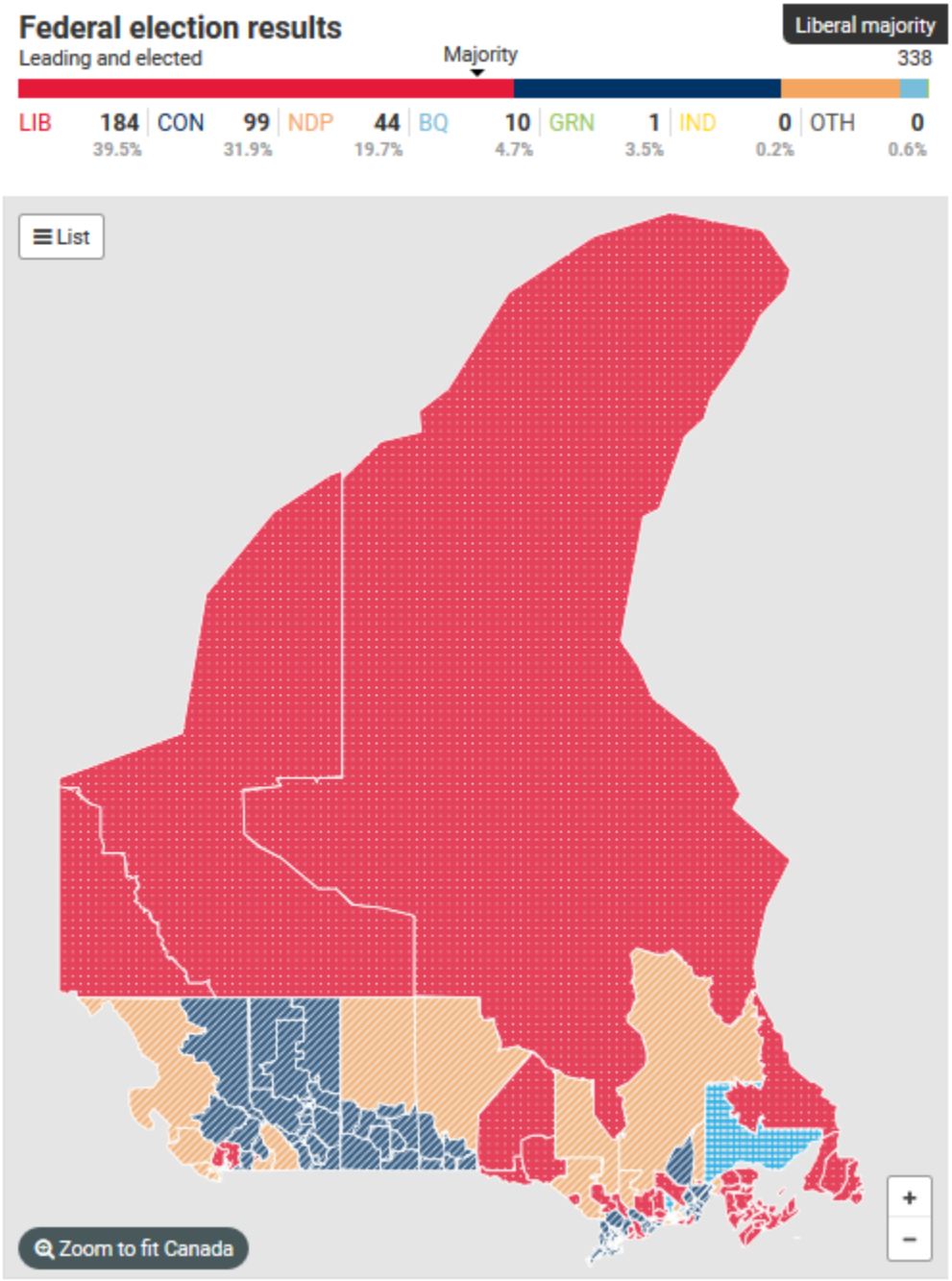
All web map servers use ‘Web Mercator’

– conformal (shape-preserving) means less computing time when you zoom in: Google maps, Bing maps, open street map etc..



Actual areas: http://thetruesize.com

Since Google 2005, web map servers use ‘Web Mercator’ a modified version of the original Mercator … but it can produce some ugly maps



http://nationalpost.com/news/politics/canadian-election-results-2015-a-live-riding-by-riding-breakdown-of-the-vote

Canada – web Mercator

Mercator still rules the world ….


Gerhardt Mercator

a. Mercator projection (1569)

– navigation on lines of constant compass bearing

b. Transverse Mercator (1779)

– minimum distortion on a line of longitude

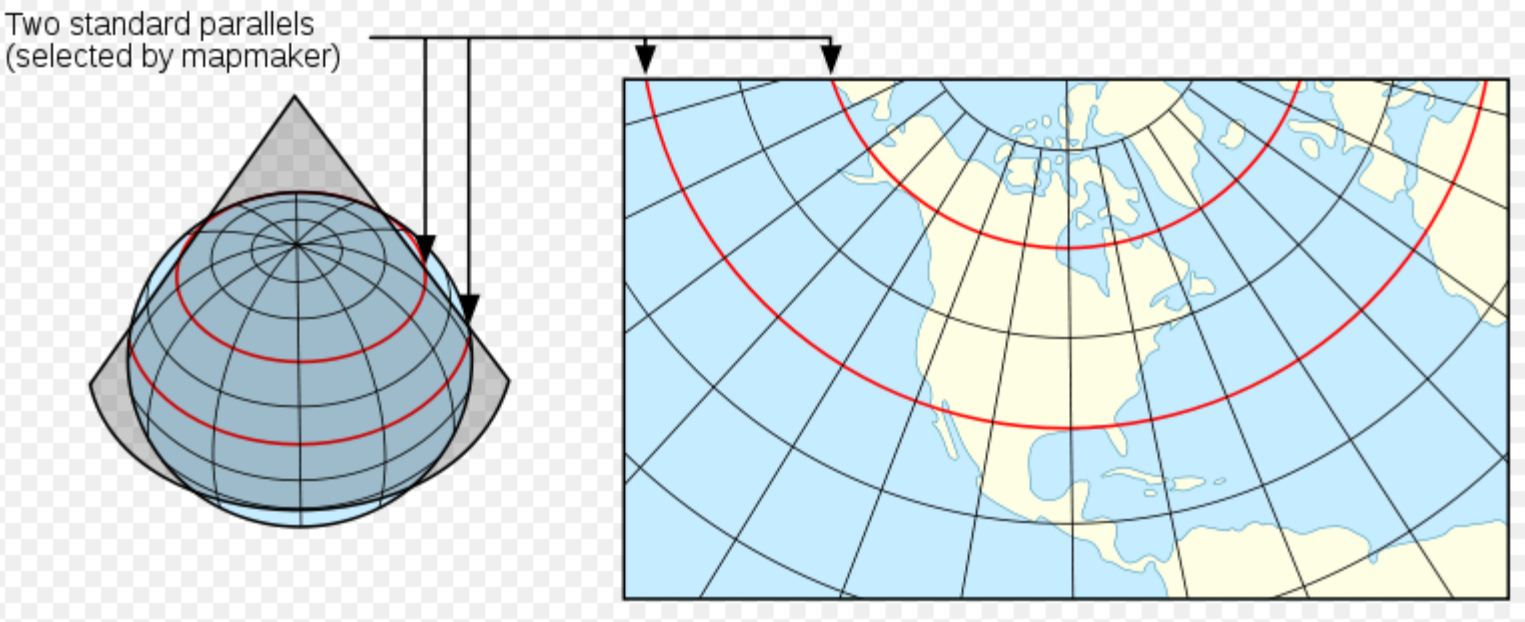
-the basis of UTM system for topographic mapping

Adopted by Canada 1948 (so its not on pre-war maps) - Cuts off at 84°N

c. Web Mercator (2005) – online world map viewers e.g. Google maps

.. Cuts off at 85°N / S; scale distortions not evident when you zoom in

3. **Conic projection with 2 standard parallels:** mid-latitude georeferencing system e.g. Canada or BC (next slides)



1500 / 1700s

Canada Albers (or Lambert) Equal Area Conic

Central Meridian: -96 Latitude Of Origin: 40

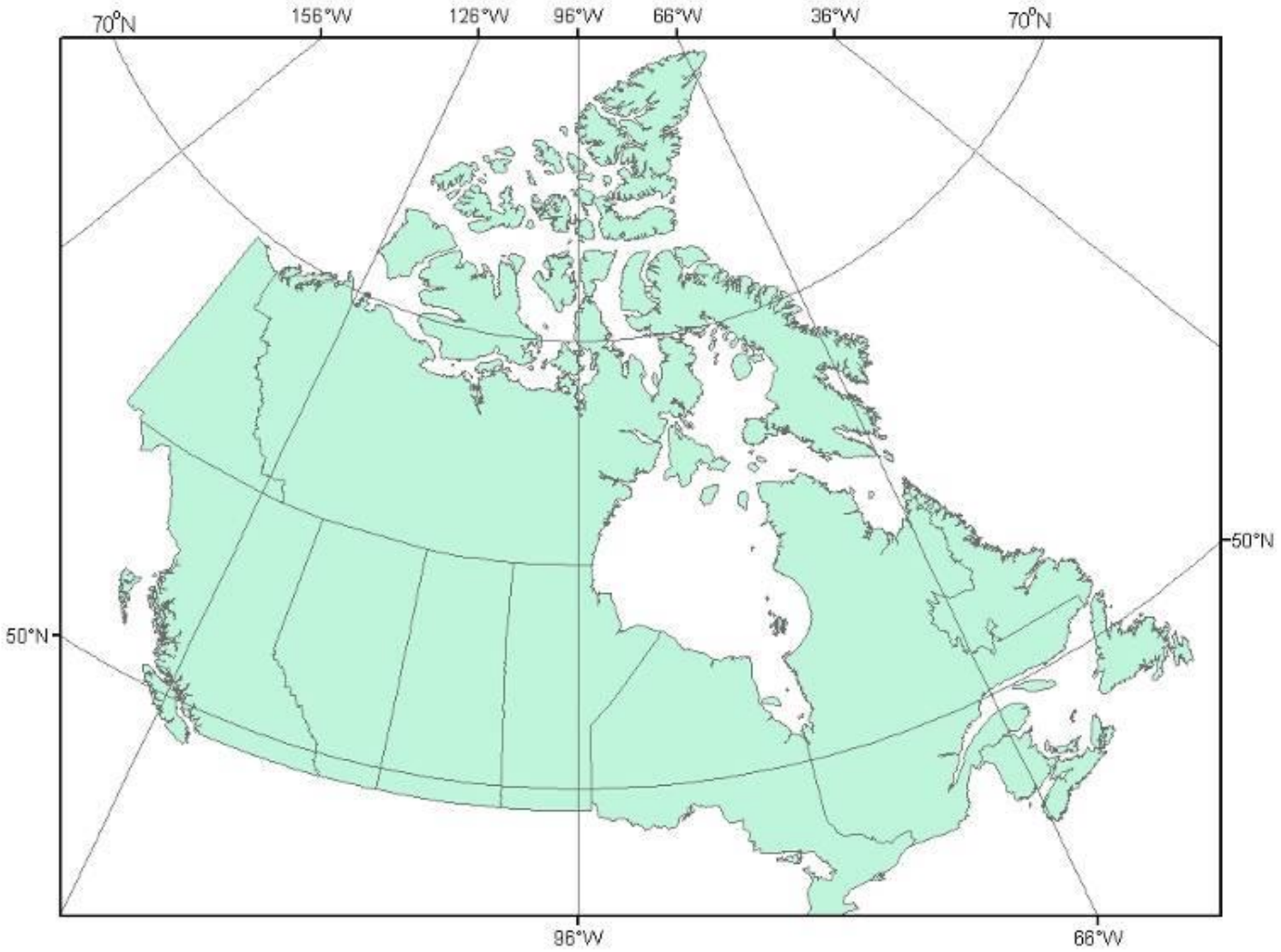
First Standard Parallel: 50 Second Standard Parallel: 70

Scale

Larger

Smaller

Larger



Download NTDB data using Geographic, Lambert ... or Web Mercator (2019)

BC Albers coordinate system

Standard lines = parallels at 50N / 58.5N

BC uses UTM for local areas

But Albers for the whole province

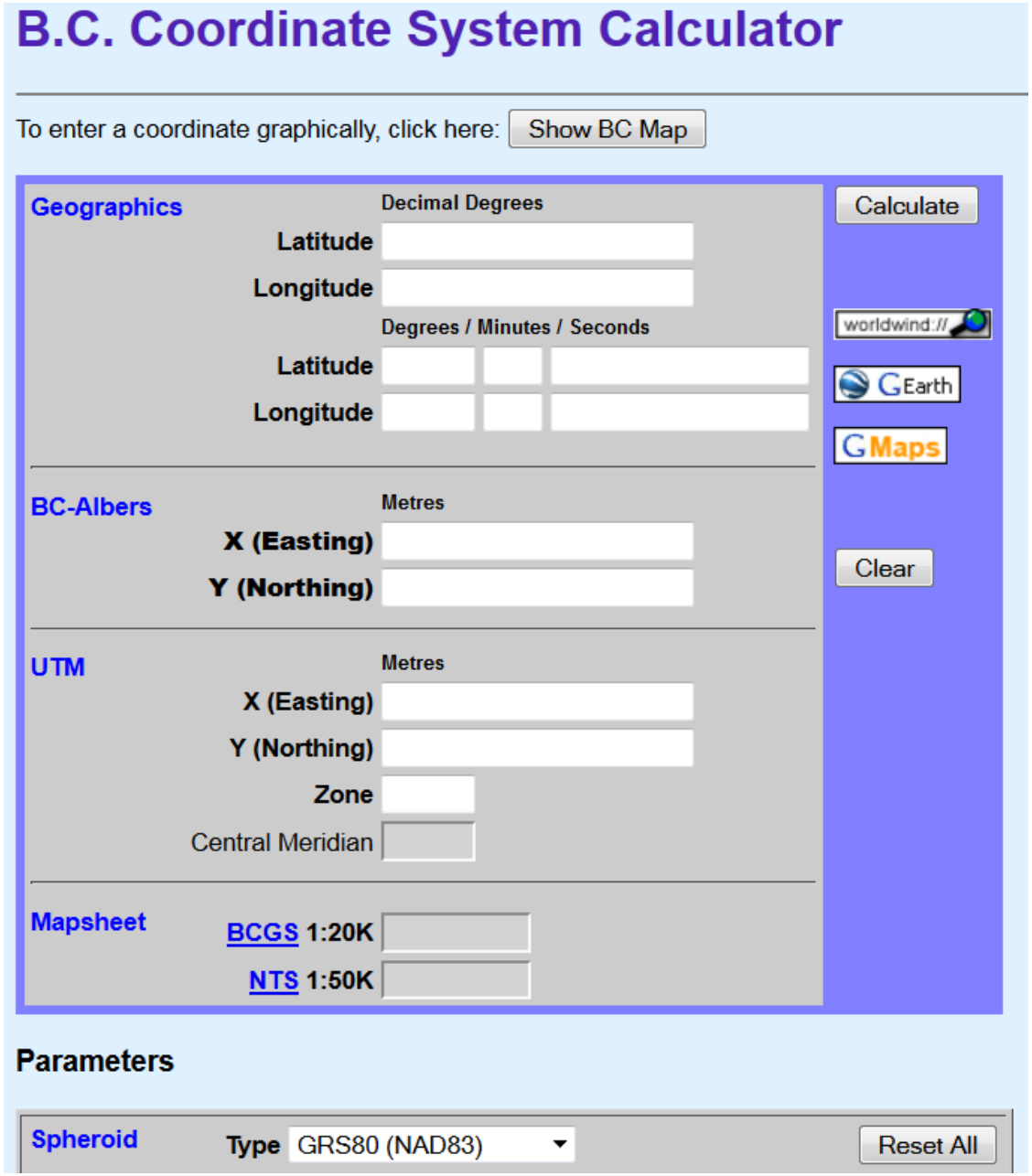
Note: distortion is less between the 2 parallels than outside them

- BC: 50 and 58.5 N
- Yukon: 61.67 and 68 N
- Alaska: 55 and 65 N
- Hawaii: 8 and 18 N

British Columbia Albers Equal Area Conic
Central meridian: -126.0 Degrees West longitude
Latitude of projection origin: 45.0 Degrees North latitude

126W = 1,000,000 Eastings
45N = 0 Northings

Note: only UTM has ‘zones’ ->



http://tsusiatsoftware.net/coordSys/CoordinateSystemCalculator.html

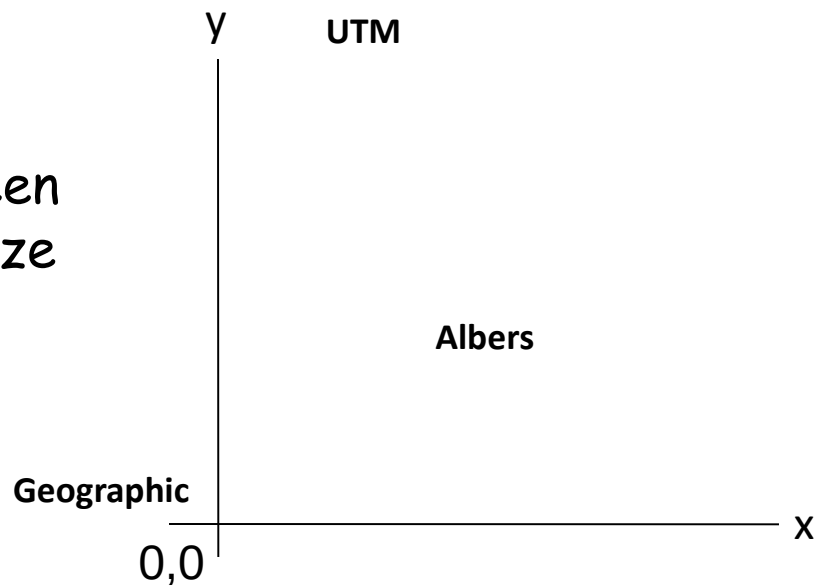
Multiple coordinate system layers

Georeferenced data can be recognised by the coordinates

e.g. Prince George

Geographic:	**-123.0**	**54.0**
UTM zone 10:	**512,000**	**5,972,000**
BC Albers:	**1,200,000**	**1,000,000**

Where these would plot onscreen
-- if software does not recognize projections ? (pre-2000)



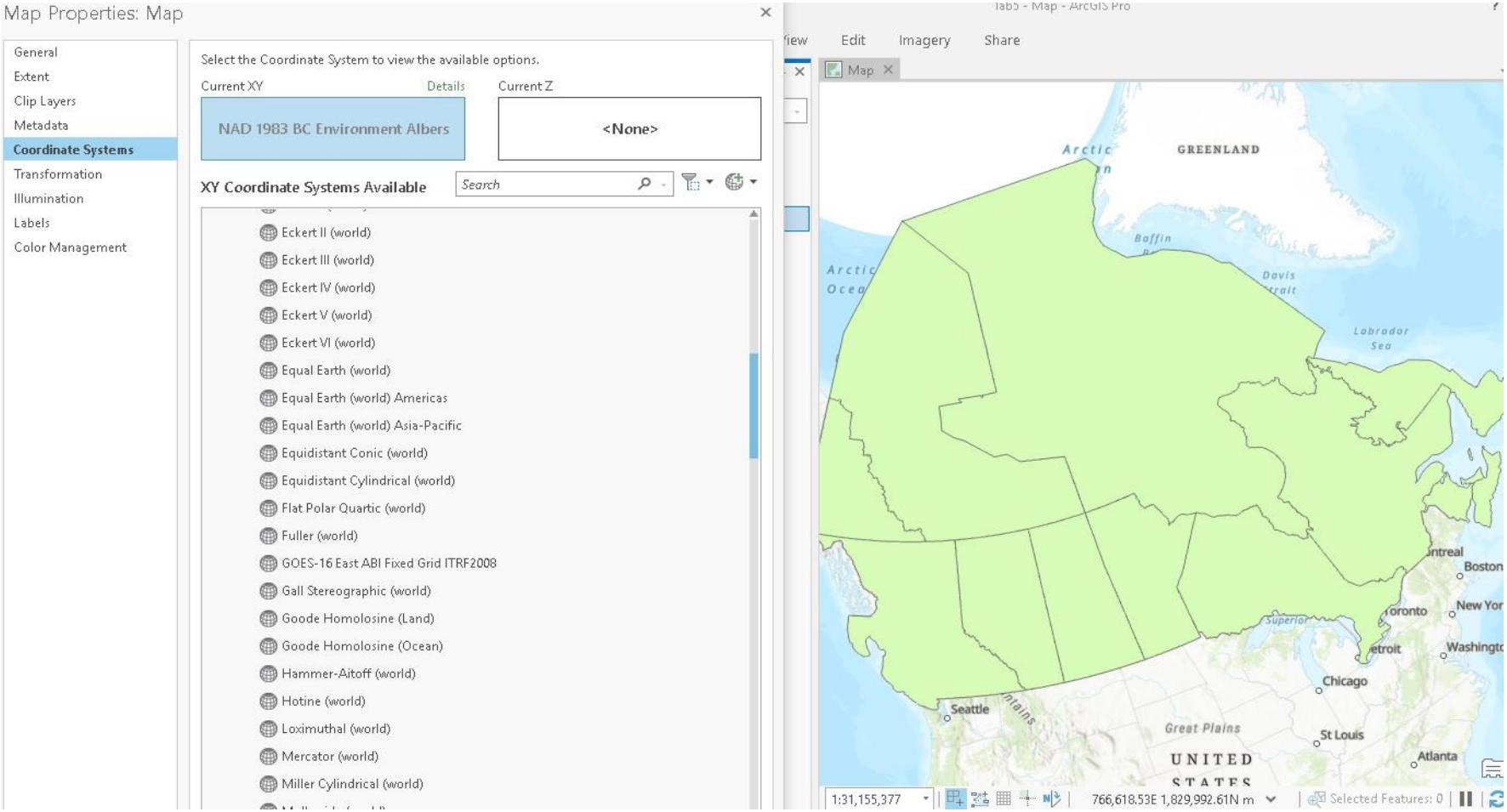
- The Data Frame / Map display takes on the coordinate system of the first layer

Multiple different coordinate systems can be displayed together **'on the fly'** .. But only if properly 'defined'

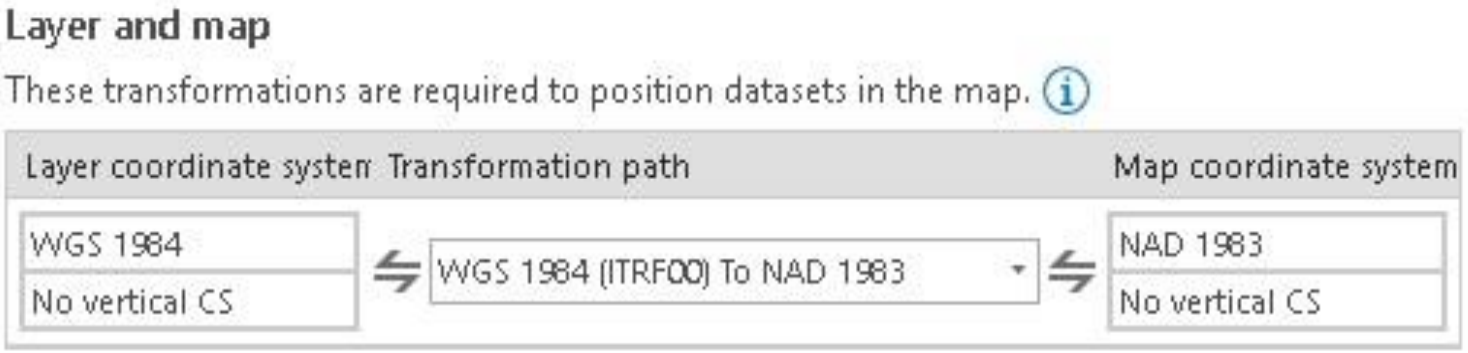
Project define tool: edits the metadata to properly 'label' the coordinate system
… creates a file named **.prj** *(e.g. roads.prj)*

Cartography: layers can remain in their 'native' projection

Analysis: usually, layers must be reprojected to match



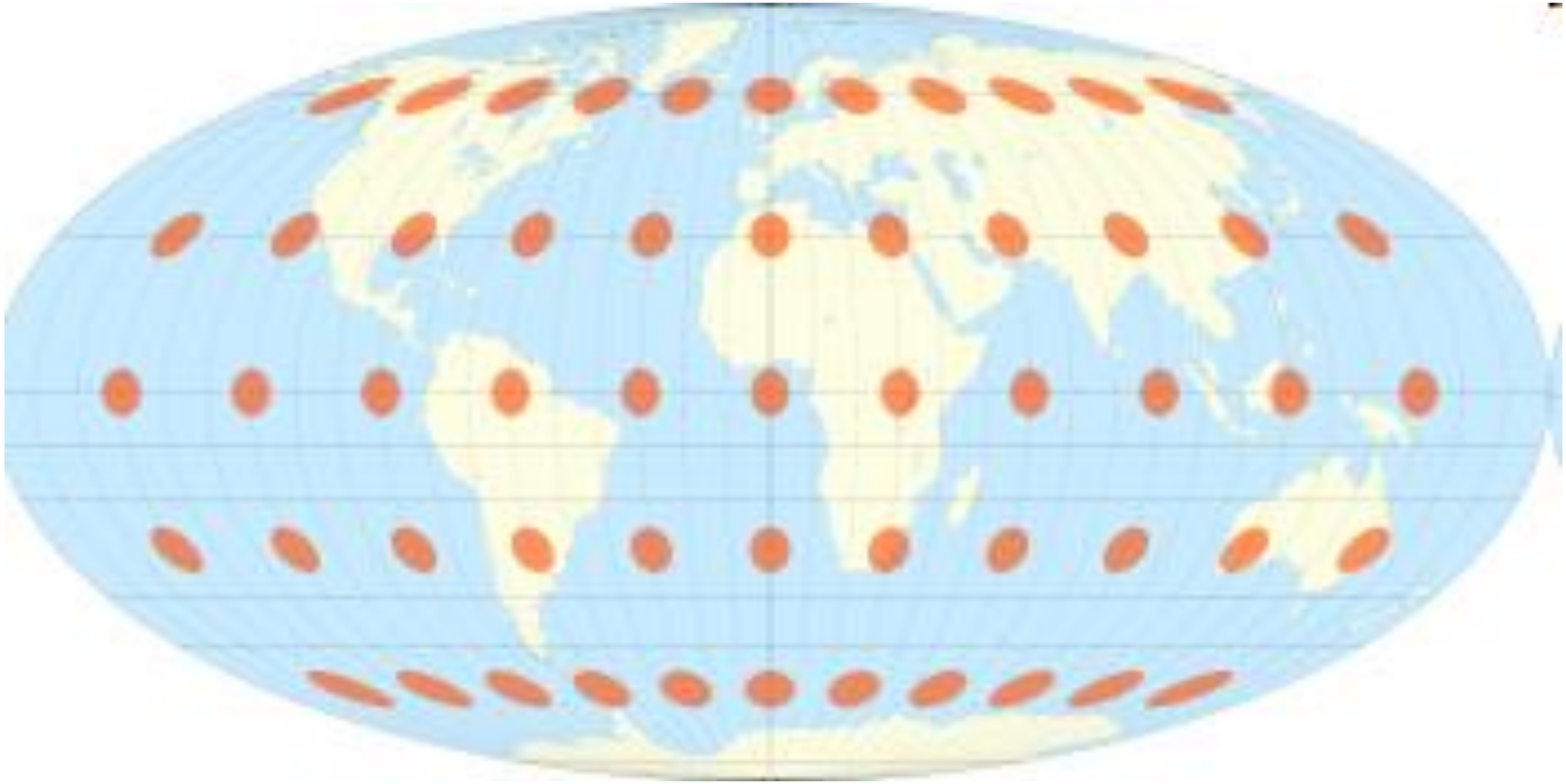
Transform / project



4. Pseudo-cylindrical projections

-show the whole world with least overall distortion (often equal-area)

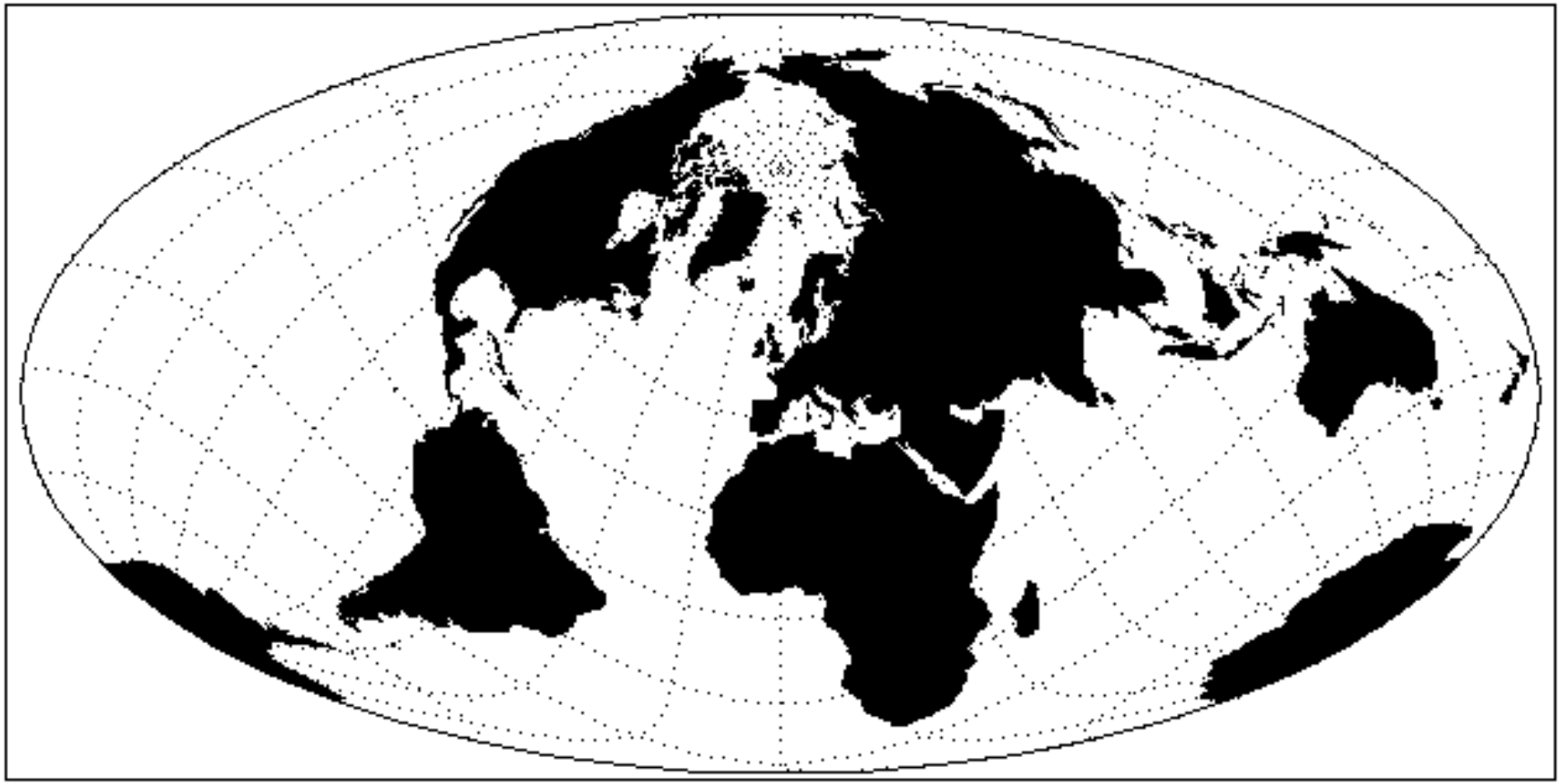
-19th century (and 20th) e.g. Mollweide (used in atlases etc.)



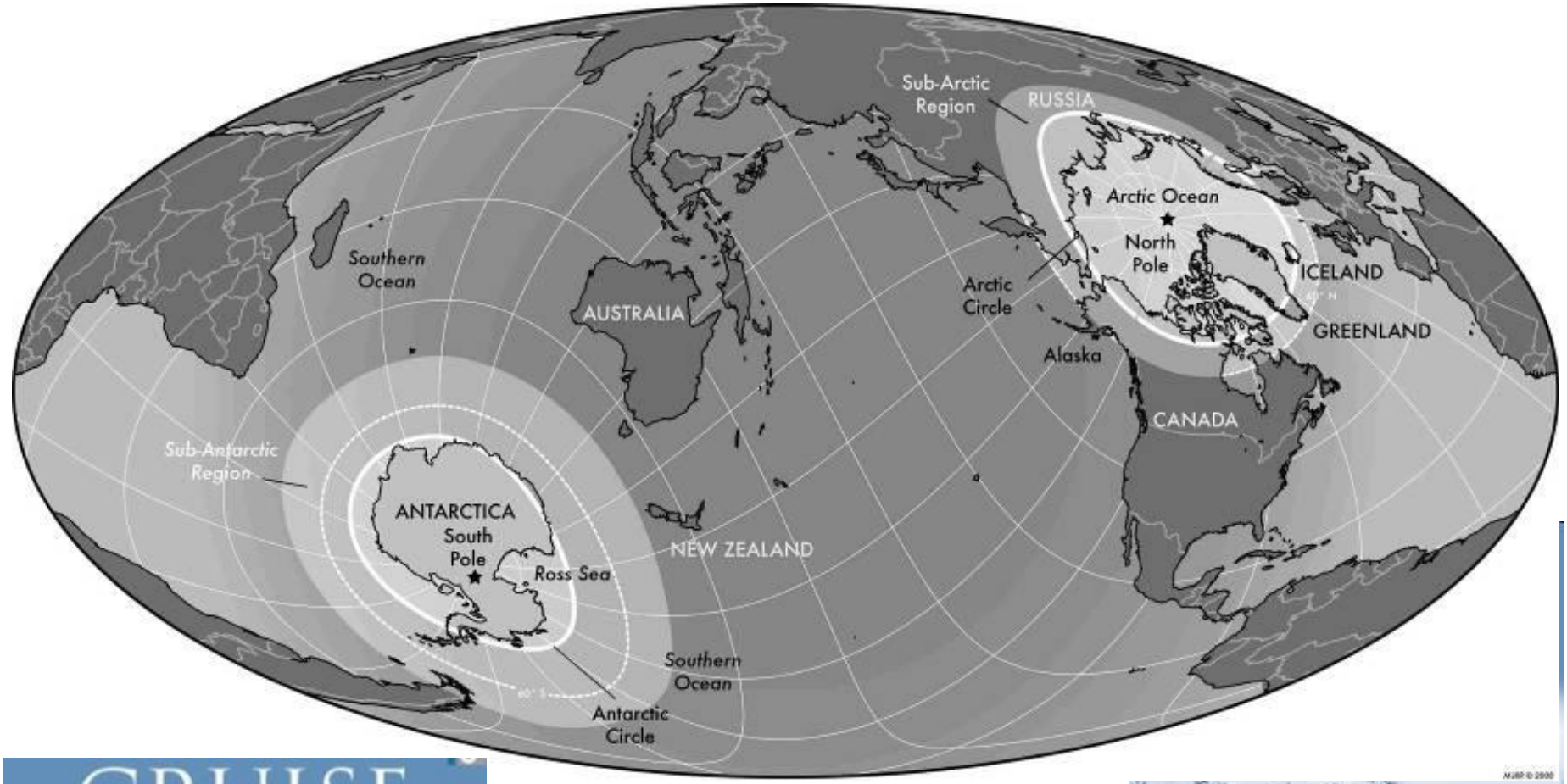
Tissot's Indicatrix of distortion

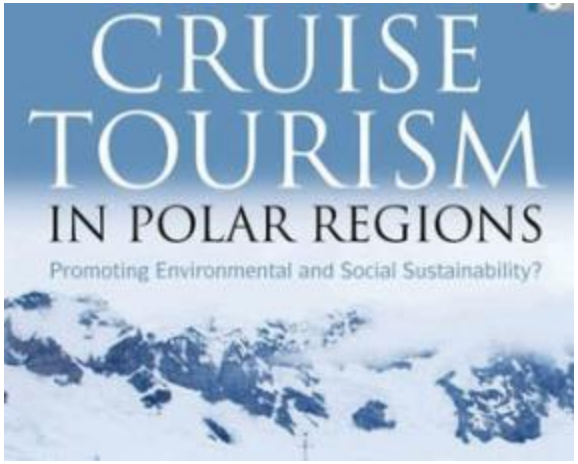
Oblique Mollweide

(obliques are used sparingly, rarely made manually)

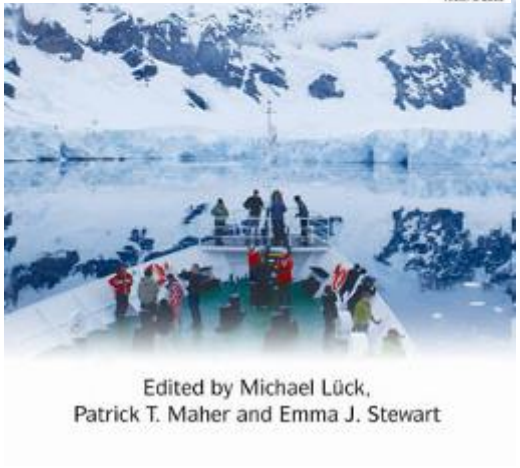


GIS and digital cartography have enabled easy generation of many projections





Clever use of oblique Mollweide to show both poles – UNBC co-author



Summary – use of projections

By 'developable surface' / geographic area

1. Azimuthal: polar areas (polar orientation)
   Oblique: centre on specific location

2. Cylindrical: equatorial areas (normal orientation)
   Transverse: centre on a meridian (longitude) e.g. Chile

3. Conic: mid-latitudes
   Standard lines selectable

4. Pseudo-cylindrical: whole globe – least overall distortion
   Oblique: e.g. can show both polar areas

Summary – use/application of projections

By feature preservation / purpose

a. Conformal: navigation (shape)

b. Equal-area: global thematic distributions (area)

c. Equidistant: measuring distances from a point

d. Azimuthal: directions from a point (the centre)

Map projections supported in ArcGIS Pro

https://storymaps.arcgis.com/stories/ea0519db9c184d7e84387924c84b703f

6 minute projections video: https://www.youtube.com/watch?v=kIID5FDi2JQ

Quiz 3: coming via Moodle this evening or Friday, due Wednesday 11.59pm