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/

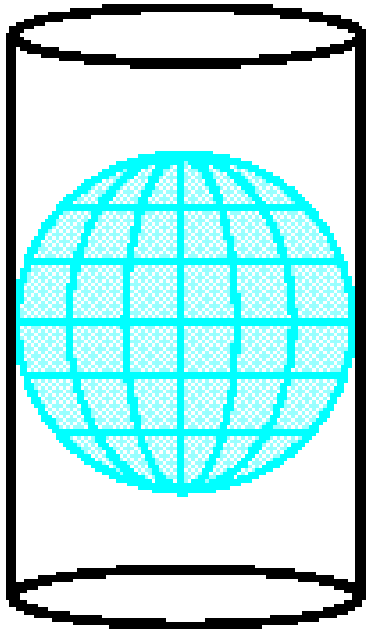
Click on the word **Earth** and change the projection

Map projections review– 3 + 1 major groups

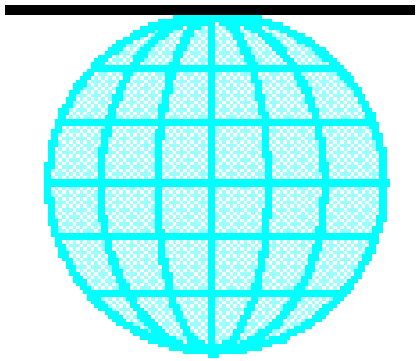
– based on projection surface

Azimuthal, Cylindrical, Conic, Pseudo-cylindrical

Conic



Cylindrical



Planar (azimuthal)

Plus **pseudo-cylindrical**: created mathematically based on cylindrical surface

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

Possible Properties : **area, shape**, distance

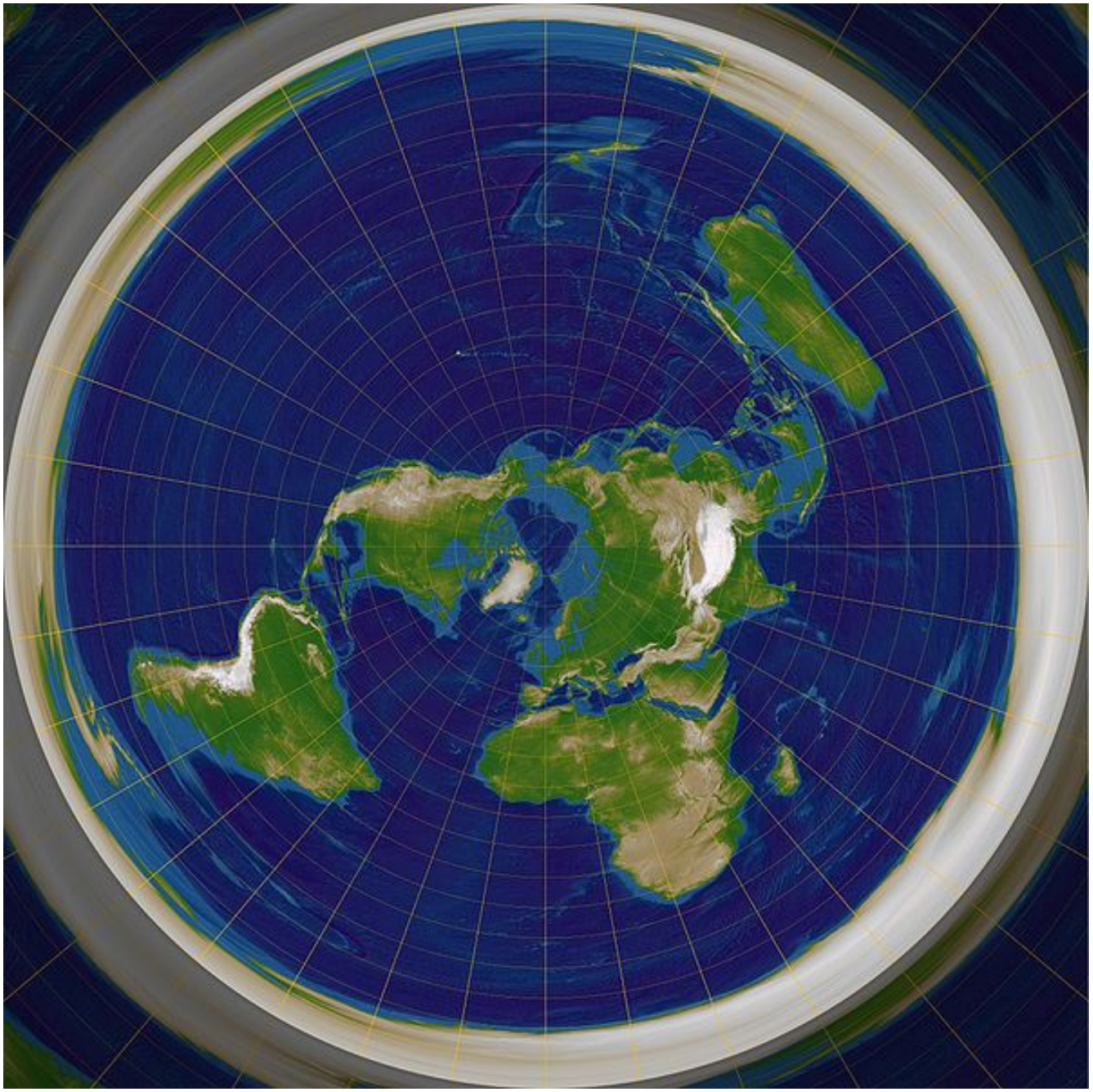
1. Azimuthal: perspective (August 2018) **Google Maps (when you zoom out)**

https://en.wikipedia.org/wiki/General_Perspective_projection

1. Azimuthal

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

Flat Earthers sort of use the Azimuthal Equidistant projection



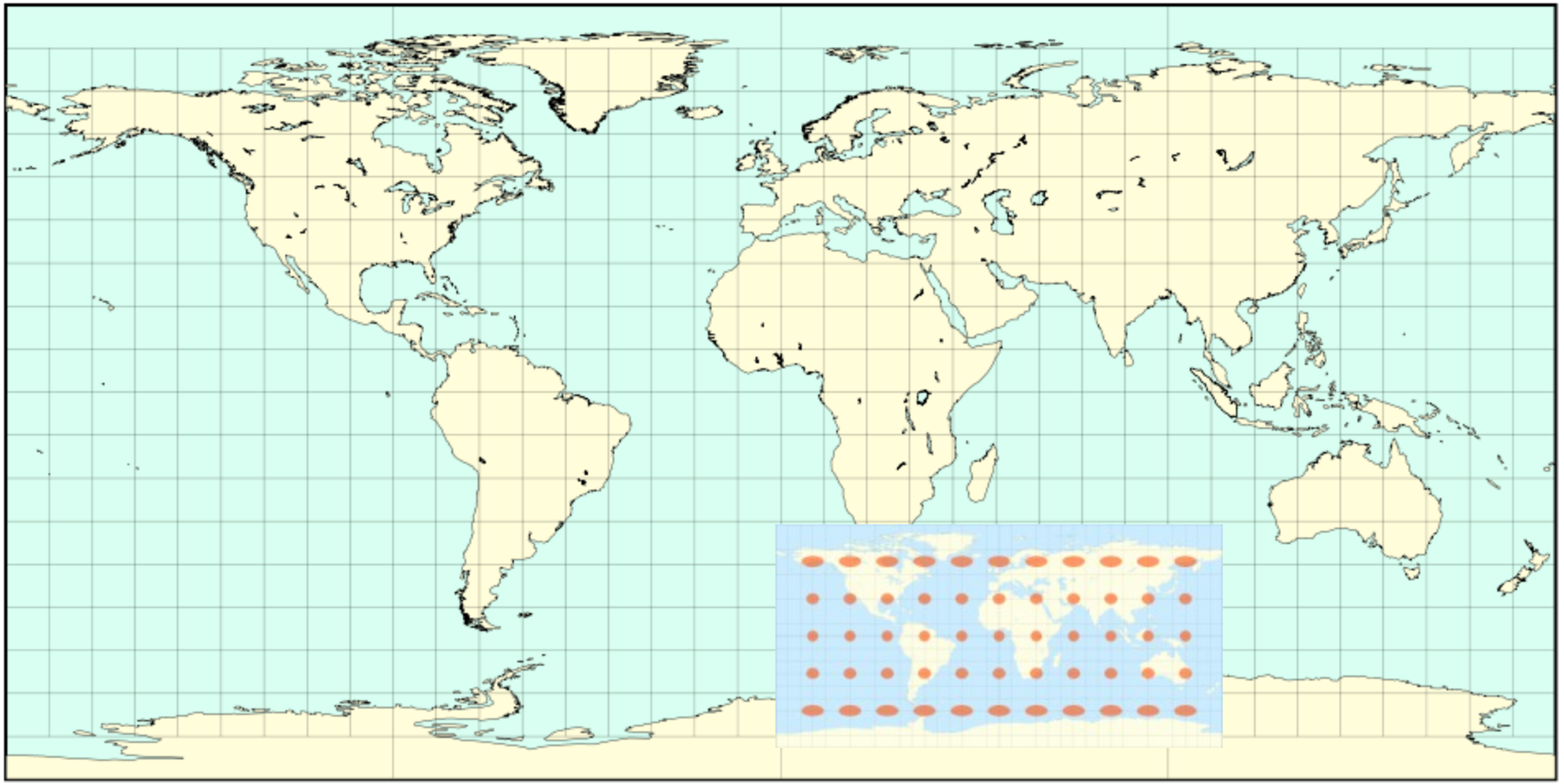
2. Cylindrical: Plate Carrée - equi-rectangular

[Eratosthenes 200BC and Marinus of Tyre, AD100]

One degree is the same everywhere; easy to draw manually

Does not preserve shape or area;

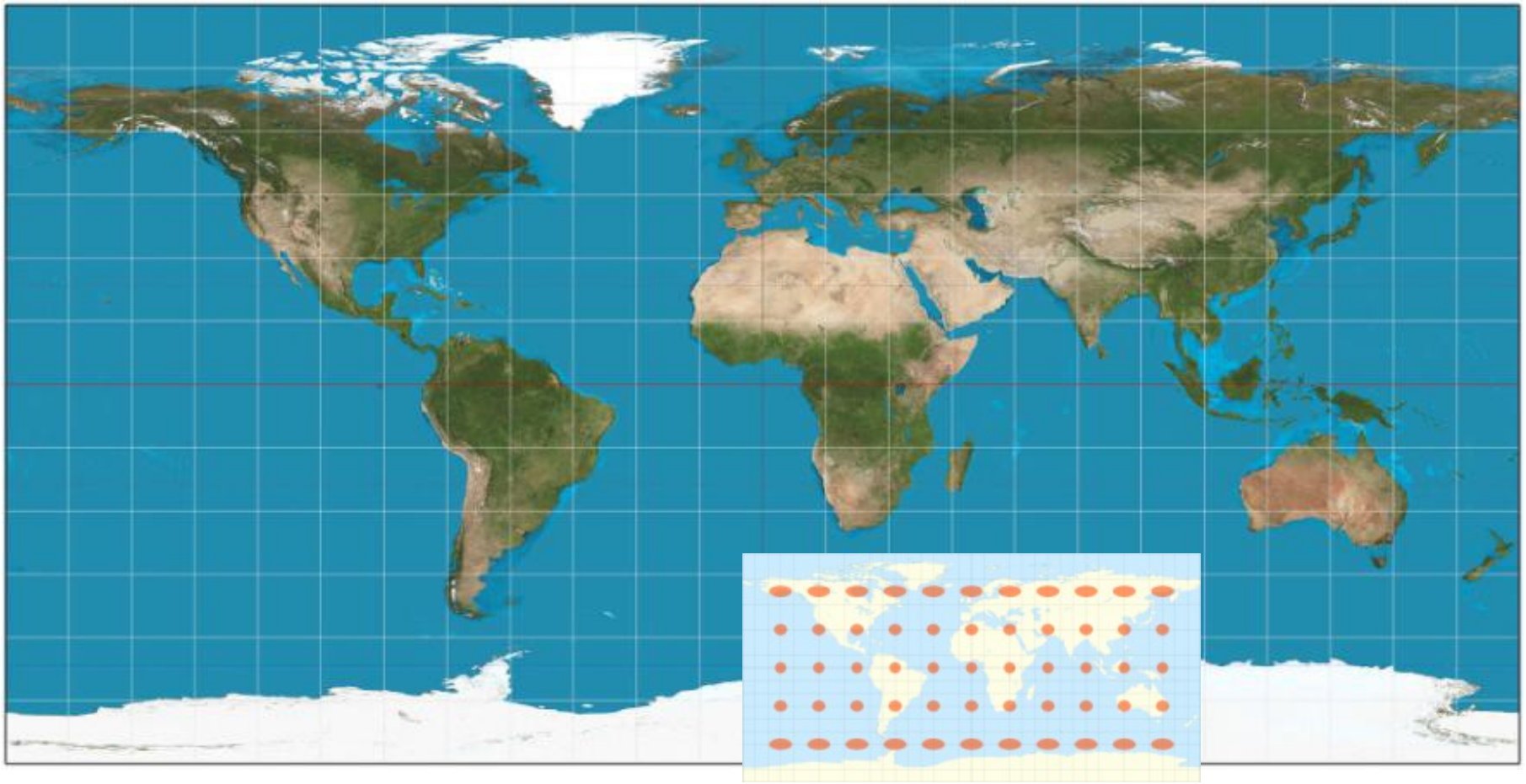
it is **equidistant** …. From the equator north and south



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)

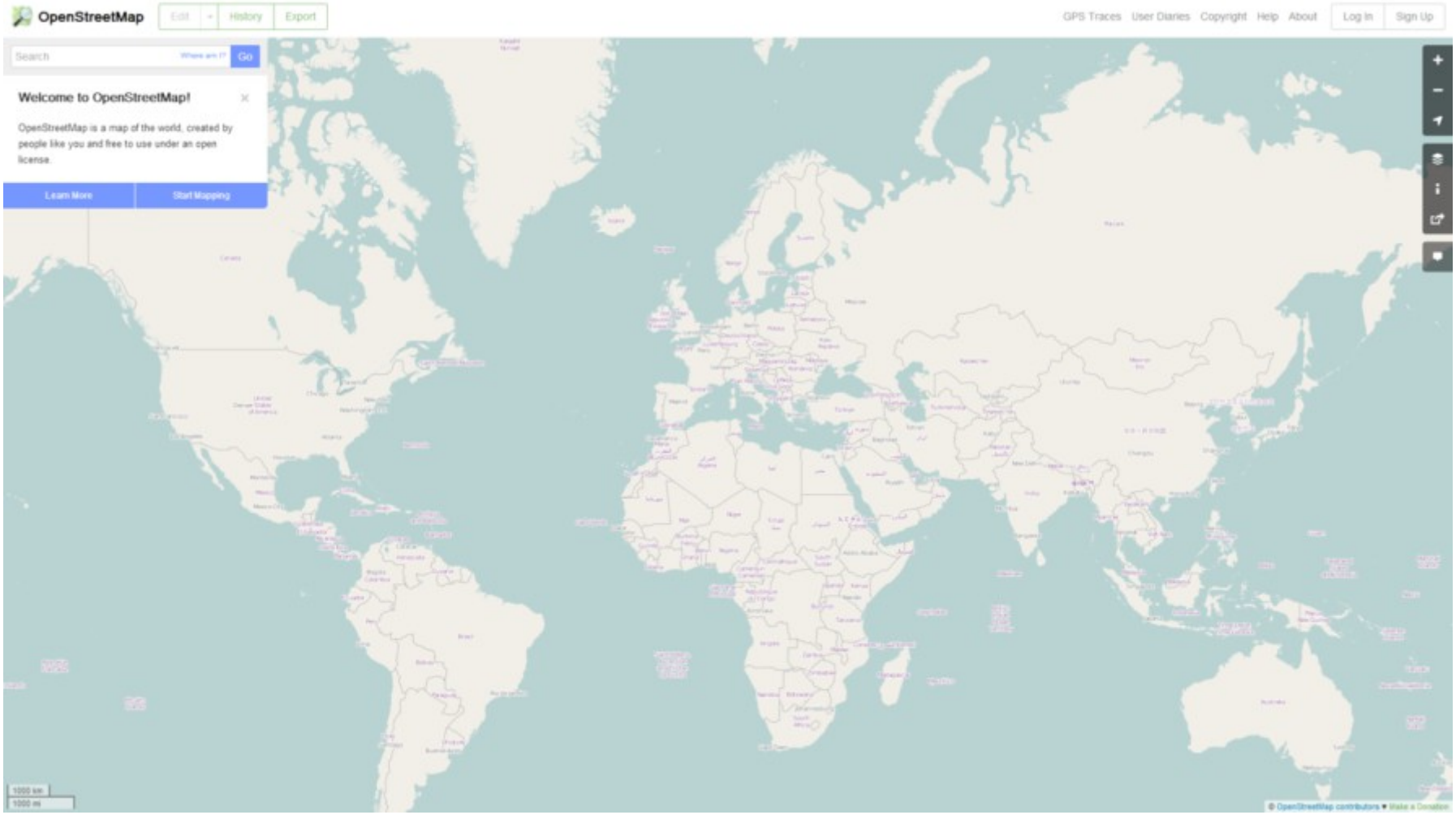
The TM projection is the basis for the (Universal) UTM system

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

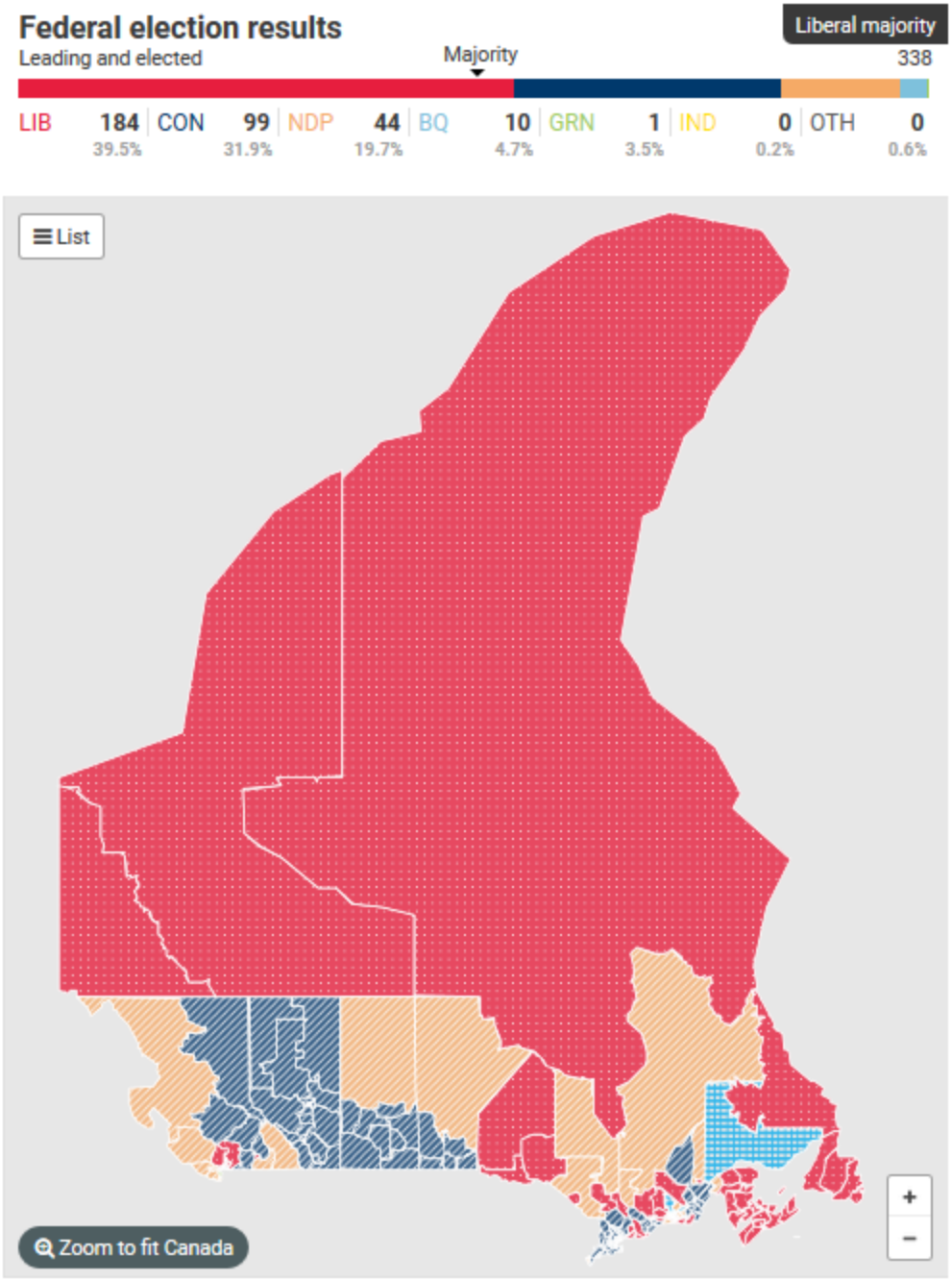
All web map servers use ‘Web Mercator’

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



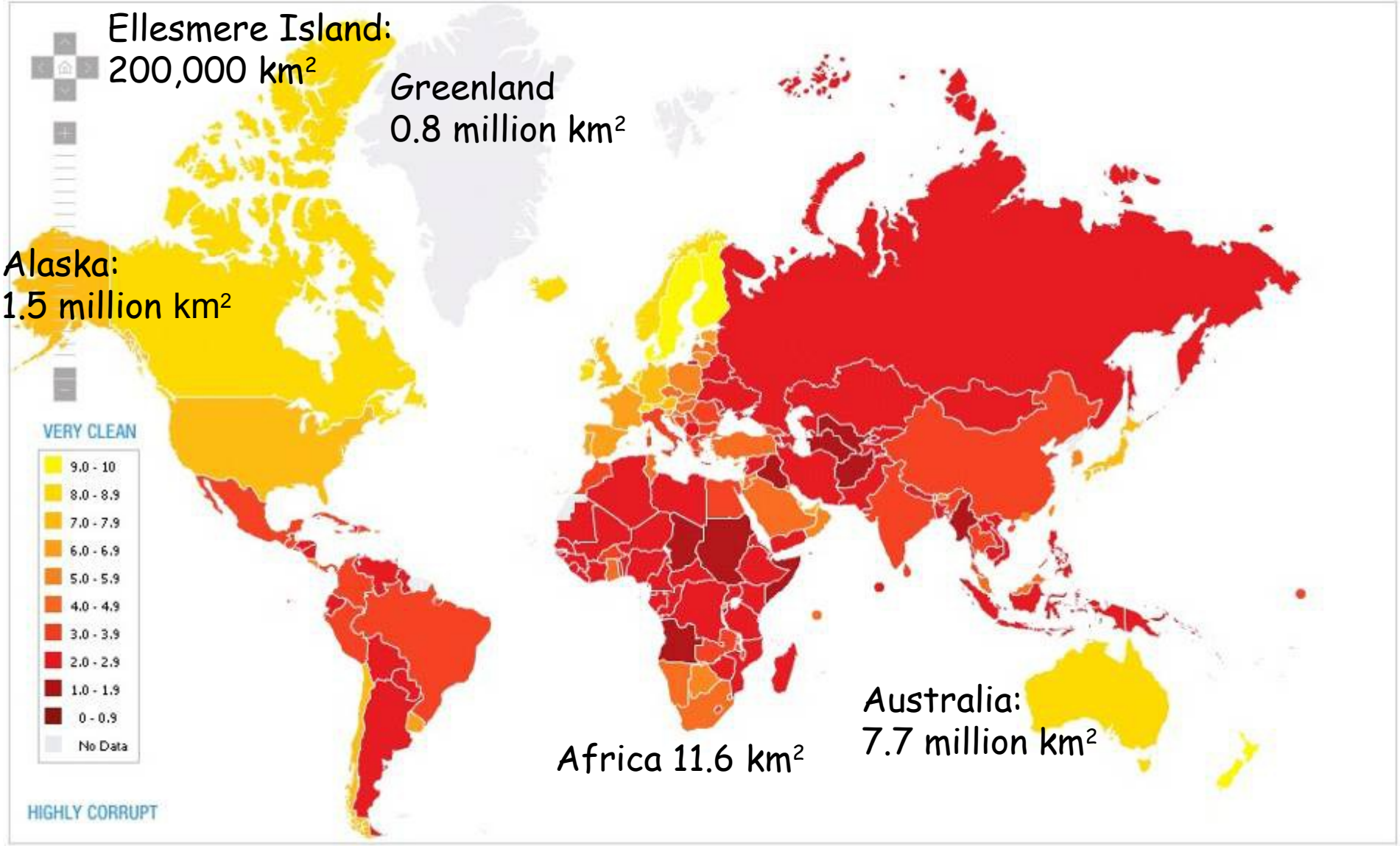
Actual areas: http://thetruesize.com

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



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

It isn't great for thematic maps



Misuse of Mercator projection: area distortion

Mercator still rules the world !

a. Mercator projection 1569

– navigation on lines of constant compass bearing

Gerhardt Mercator

b. Transverse Mercator (1779)

– minimum distortion on a line of longitude

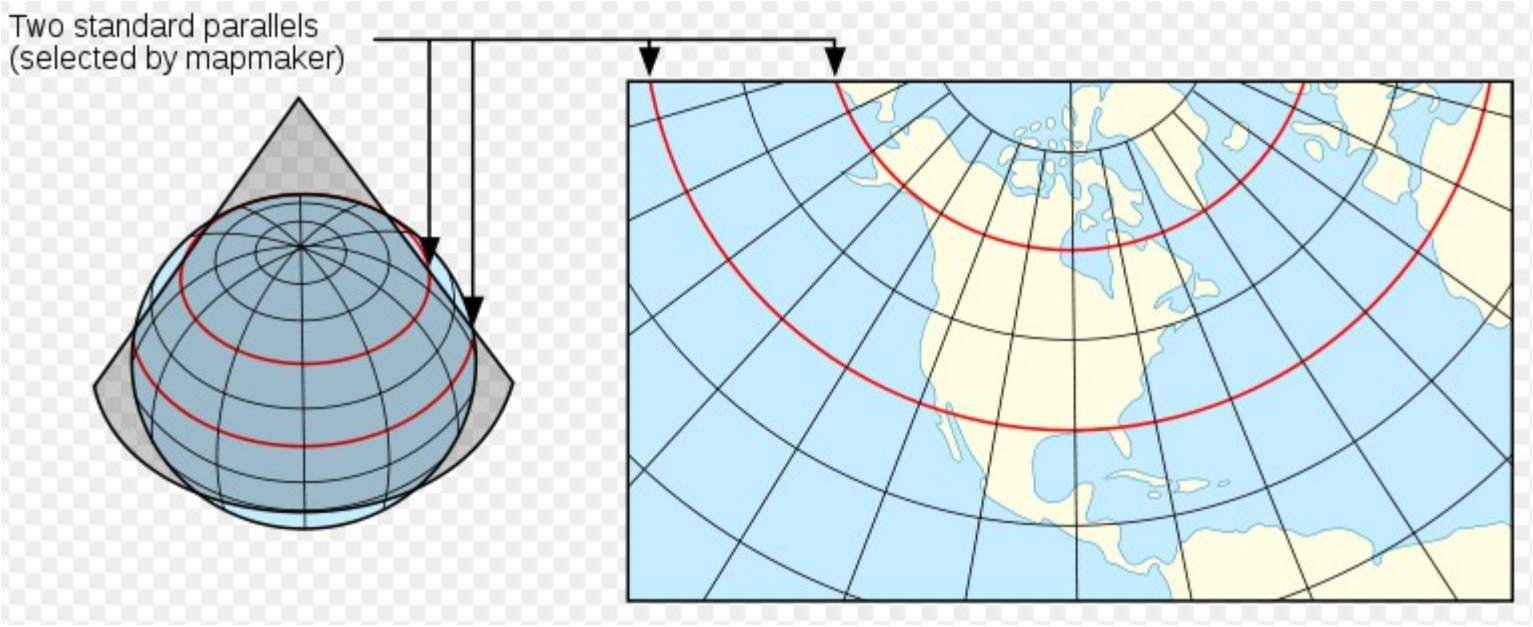
-the basis of UTM system for topographic mapping

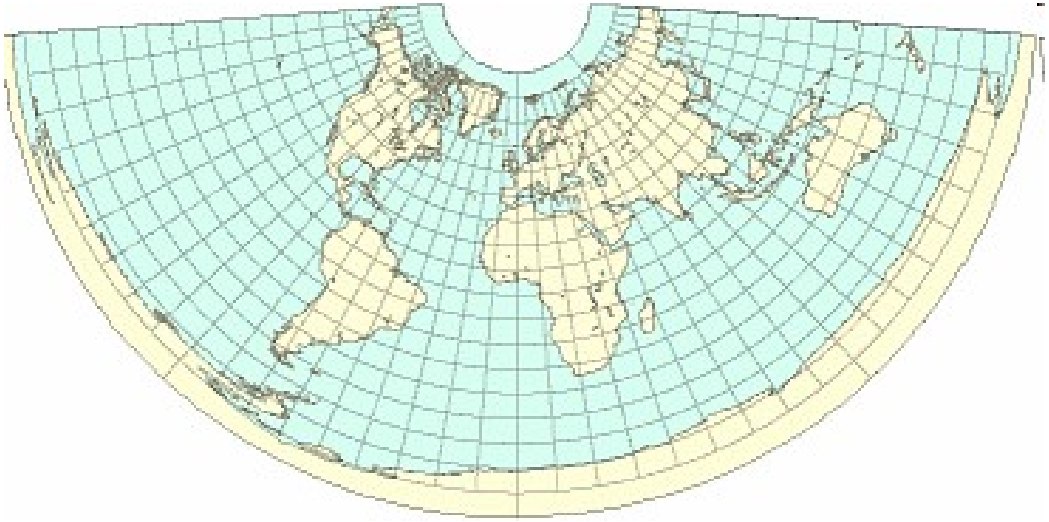
Adopted by Canada 1948 (so its not on pre-war maps) - Cuts off at 84°N

c. Web Mercator – for online world map viewers e.g. Google maps

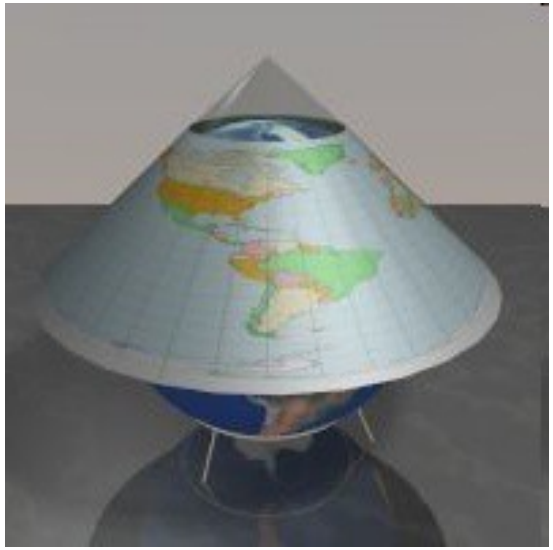
.. Cuts off at 85°N / S

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

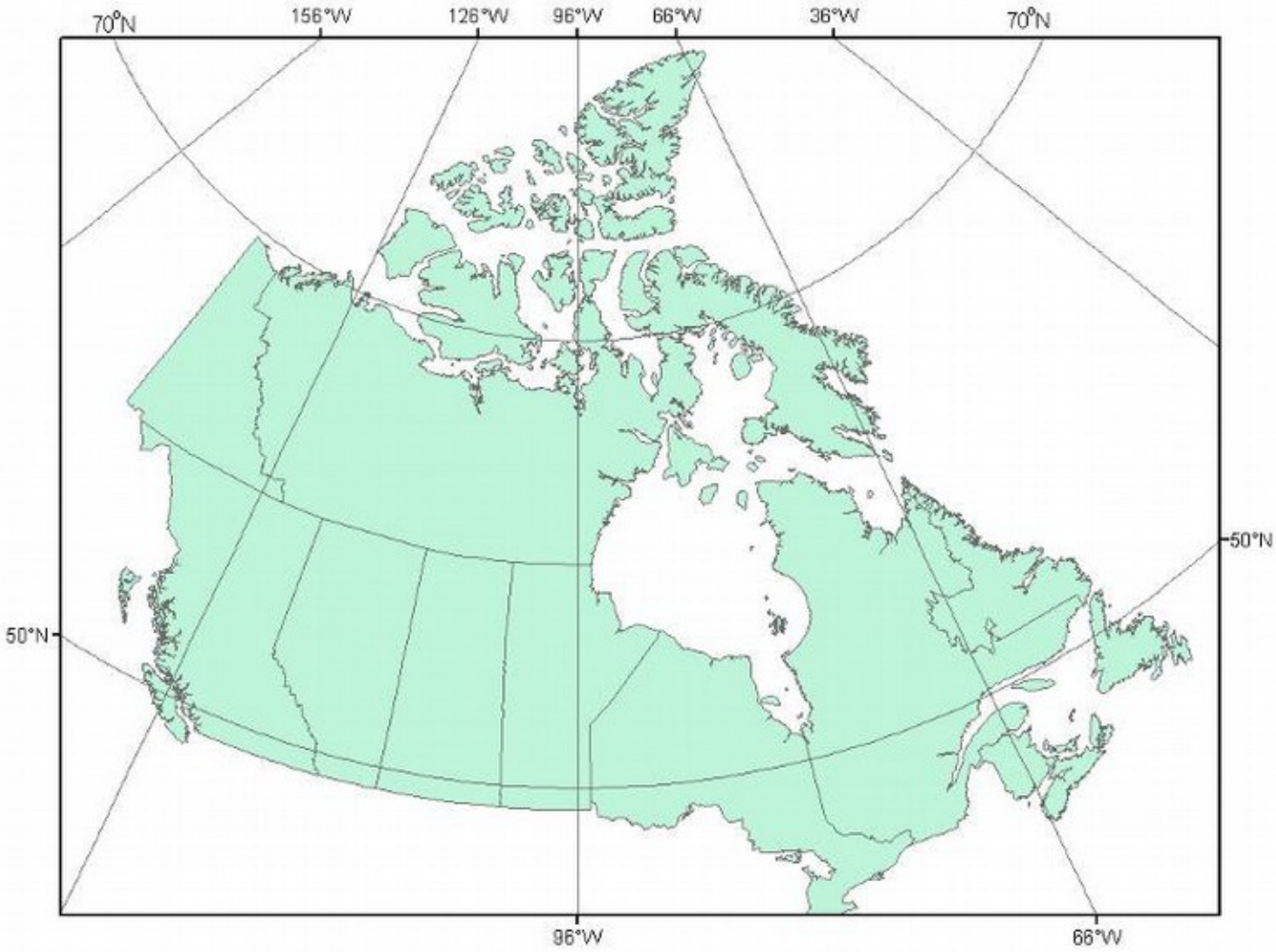
First Standard Parallel: 50 Second Standard Parallel: 70

Scale

Larger

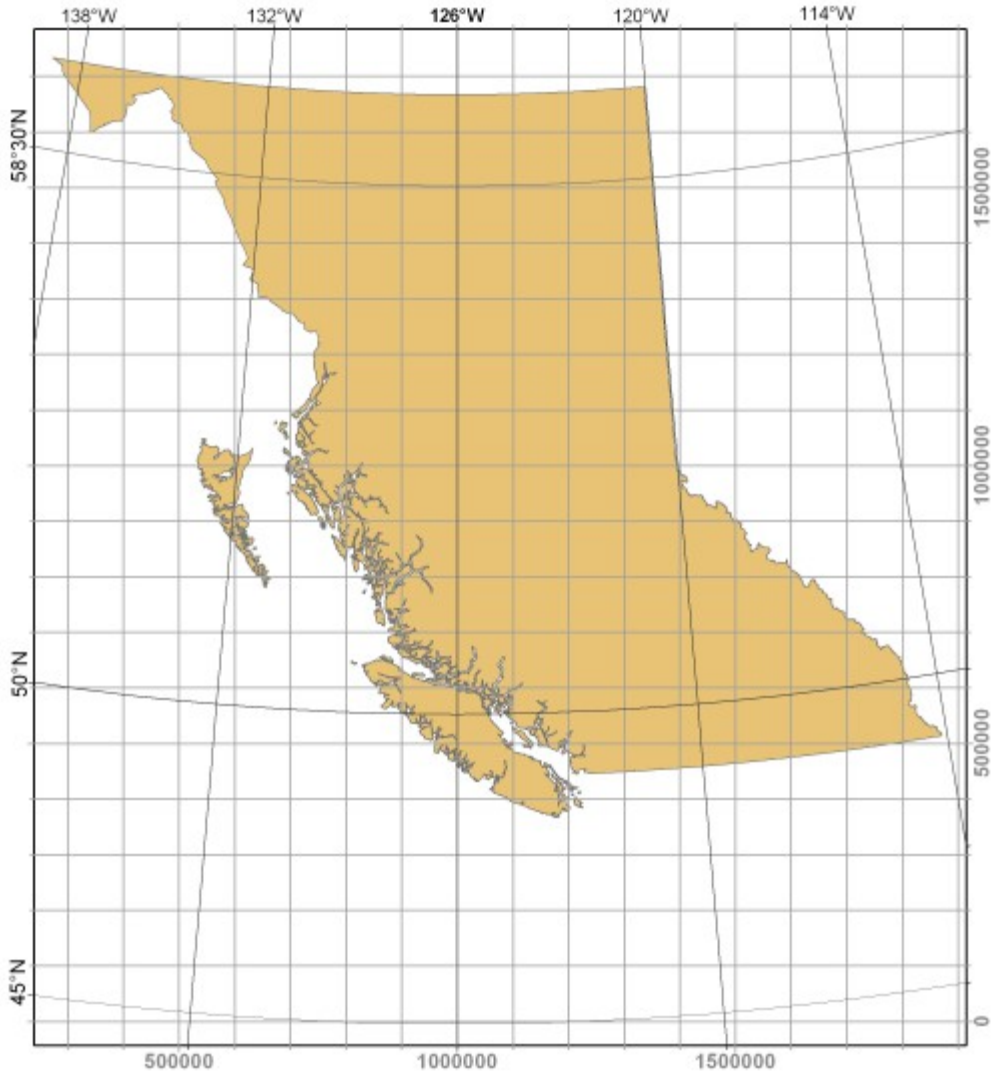
Smaller

Larger



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

BC Albers coordinate system



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

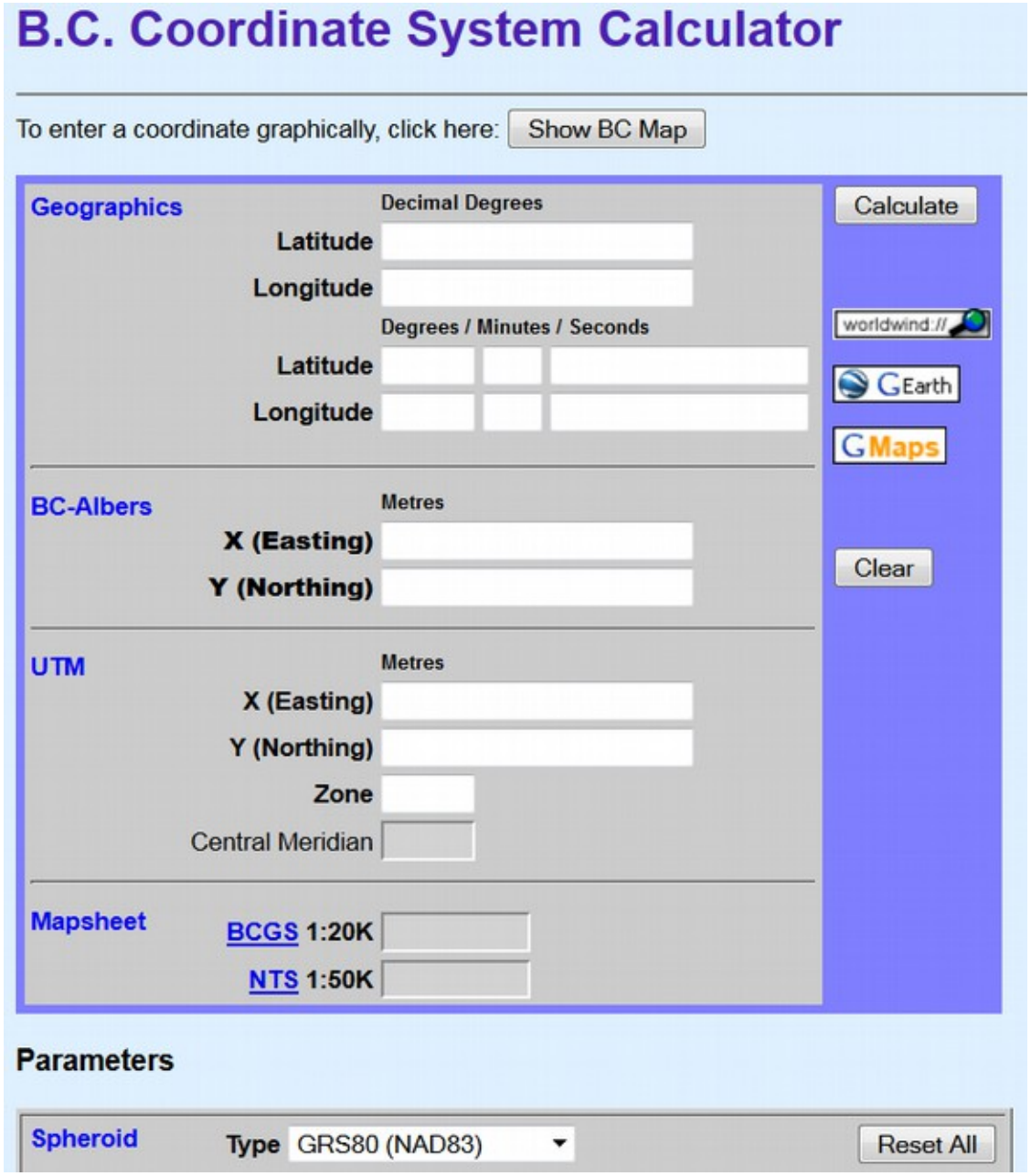
Standard lines = parallels at 50N / 58.5N

BC uses UTM for local areas

But Albers for the whole province

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

Note: only UTM has ‘zones’ ->



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

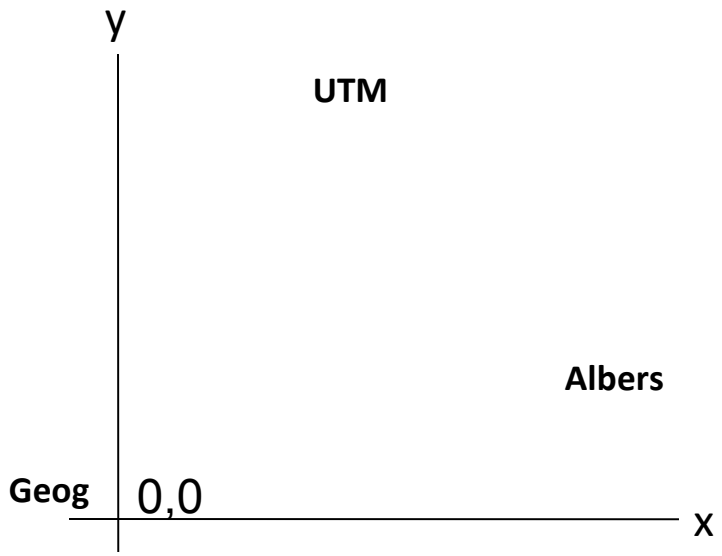
Multiple coordinate system layers

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)

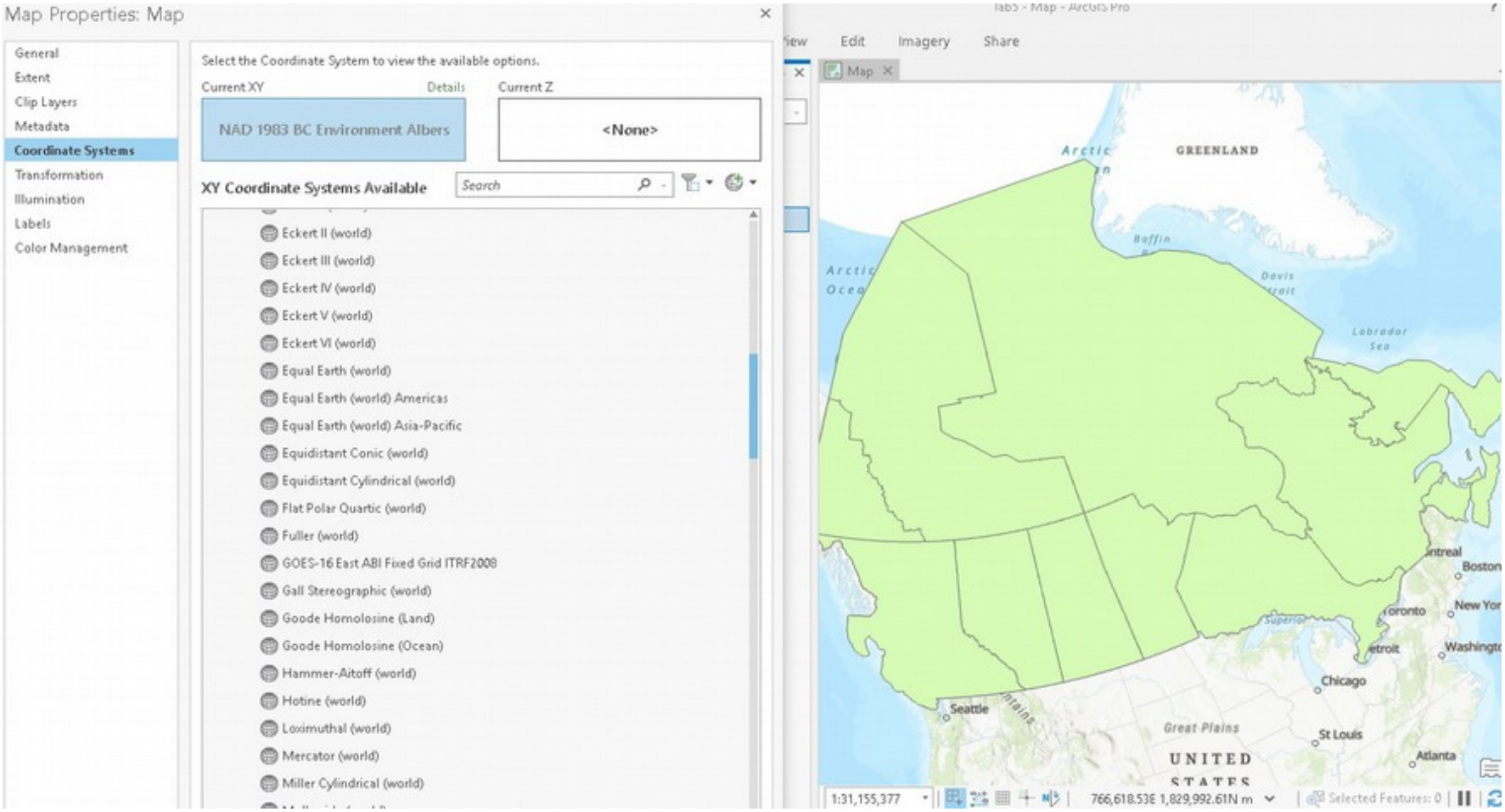


- The Data Frame (display) takes on the coordinate system of the first layer loaded

Multiple different coordinate systems can be displayed together (since ~2000)
'on the fly' .. if they are properly defined

Project define tool: edits the metadata to properly 'label' the coordinate system

... creates a file named **.prj** *(e.g. roads.prj)*



Transform / project

Layer and map

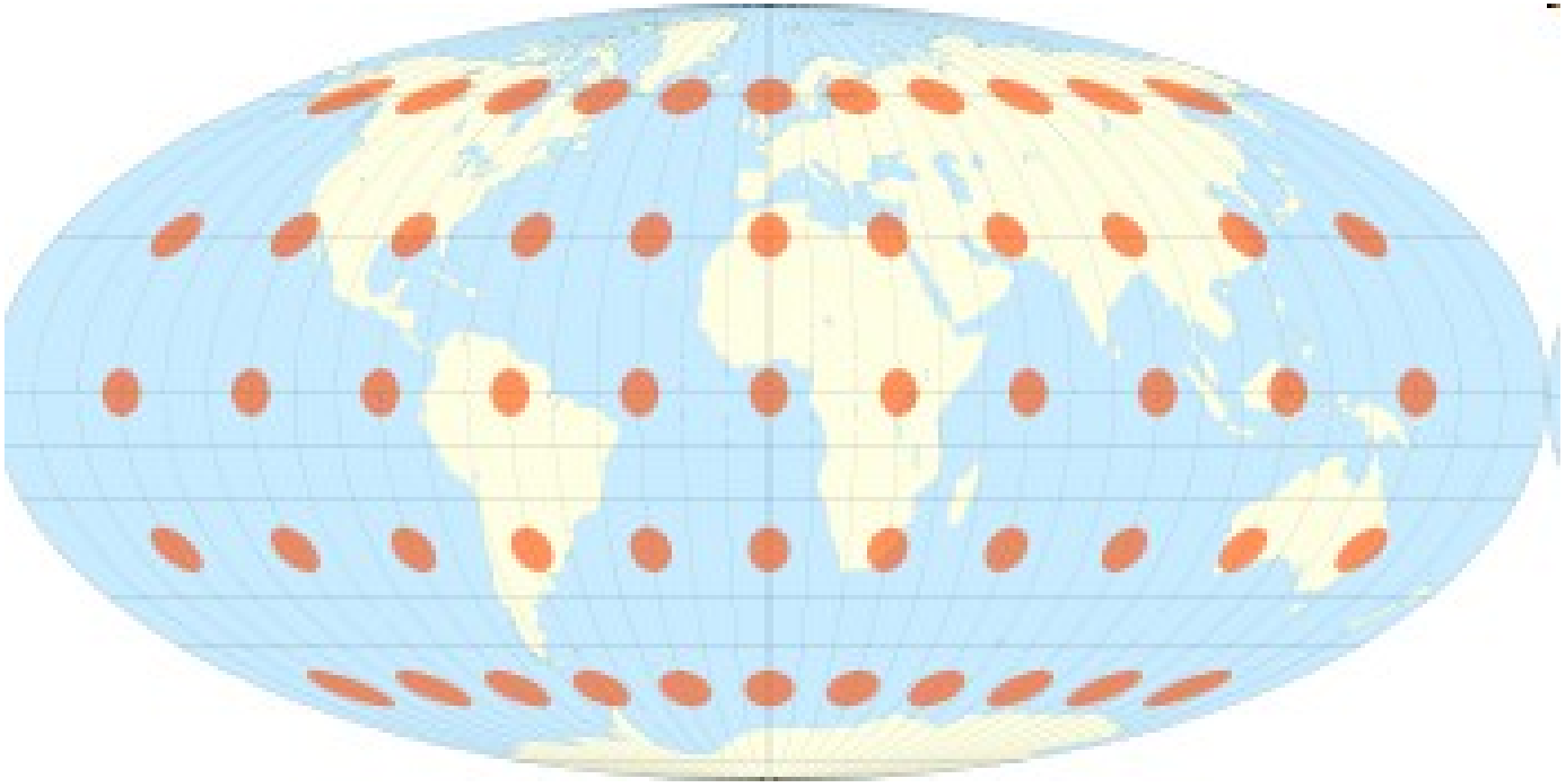
These transformations are required to position datasets in the map.

Layer coordinate system	Transformation path	Map coordinate system
WGS 1984 No vertical CS	WGS 1984 (ITRF00) To NAD 1983	NAD 1983 No vertical CS

4. Pseudo-cylindrical projections

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

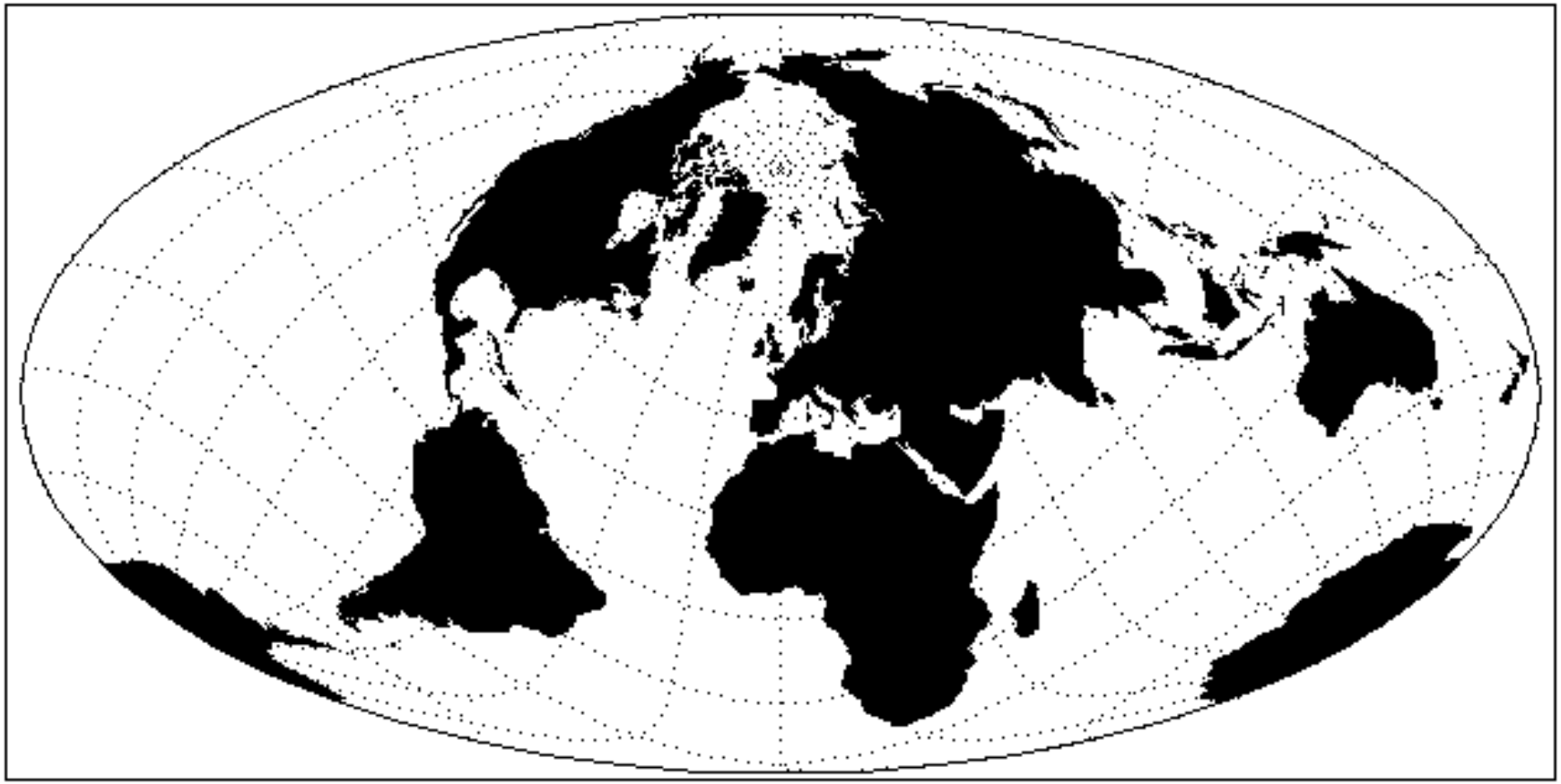
-19th century (and 20th) e.g. Mollweide (used in atlases etc.)



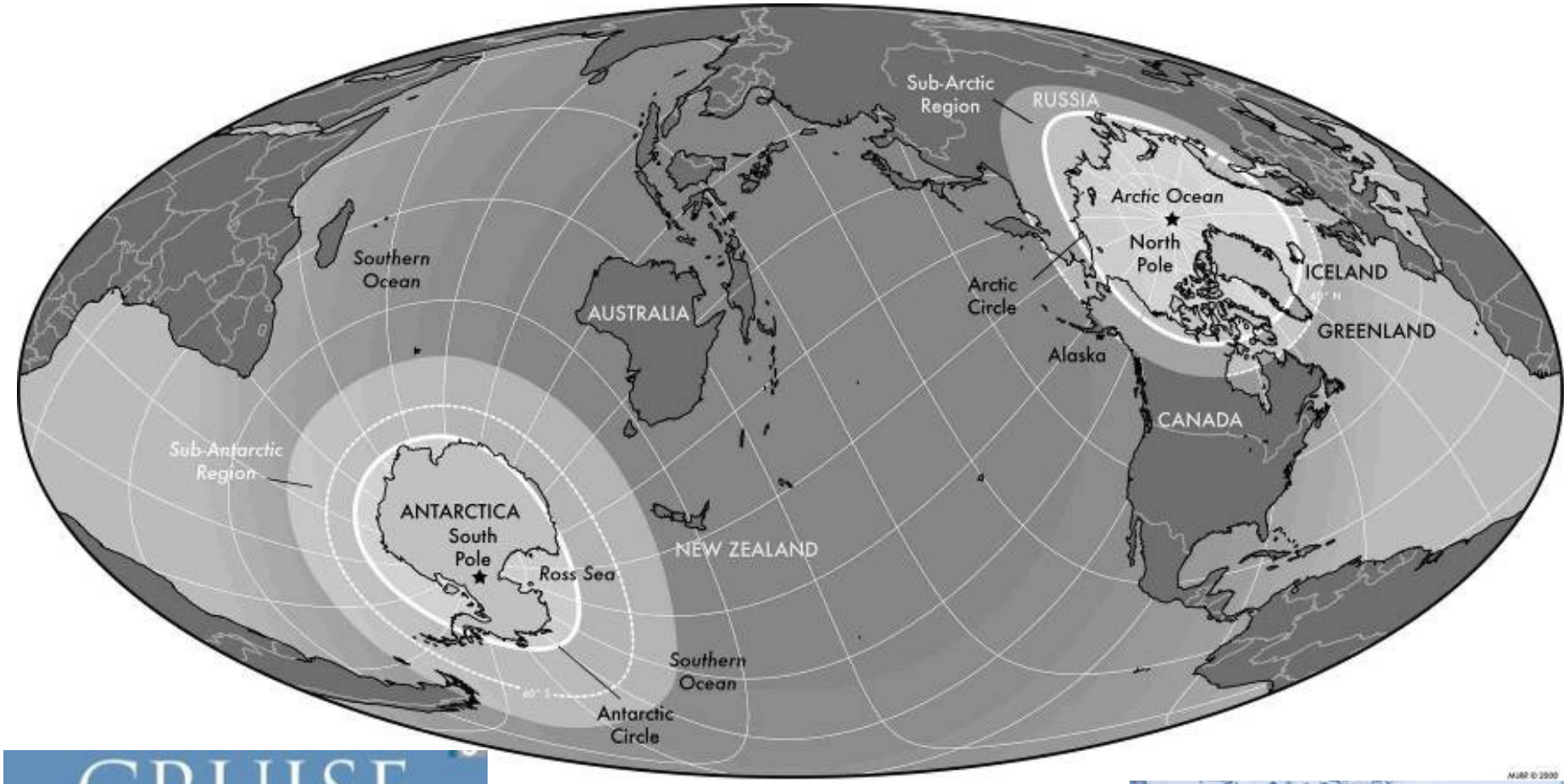
Tissot's Indicatrix of distortion

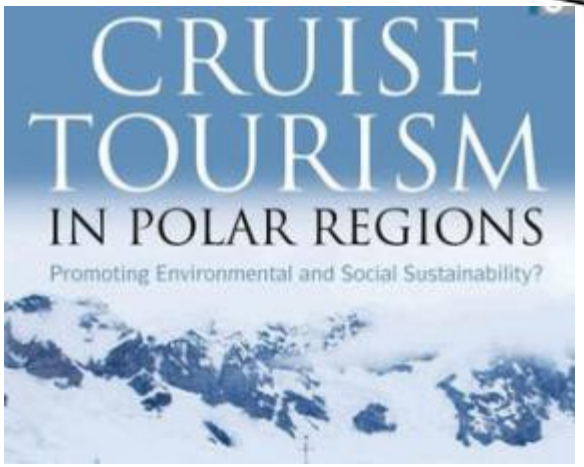
Oblique Mollweide

(obliques are used sparingly, rarely made manually)

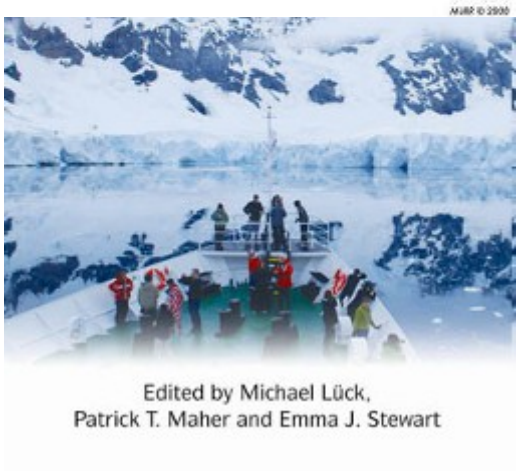


GIS and digital cartography have enabled easy generation of many projections





Clever digital use of oblique Mollweide to show both poles



Summary – use of projections

By feature preservation / purpose

a. Conformal: navigation (shape)

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

c. Equidistant: measuring distances from a point

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)

3. Conic: mid-latitudes
   Standard lines selectable

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

Map projections supported in ArcGIS Pro

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

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