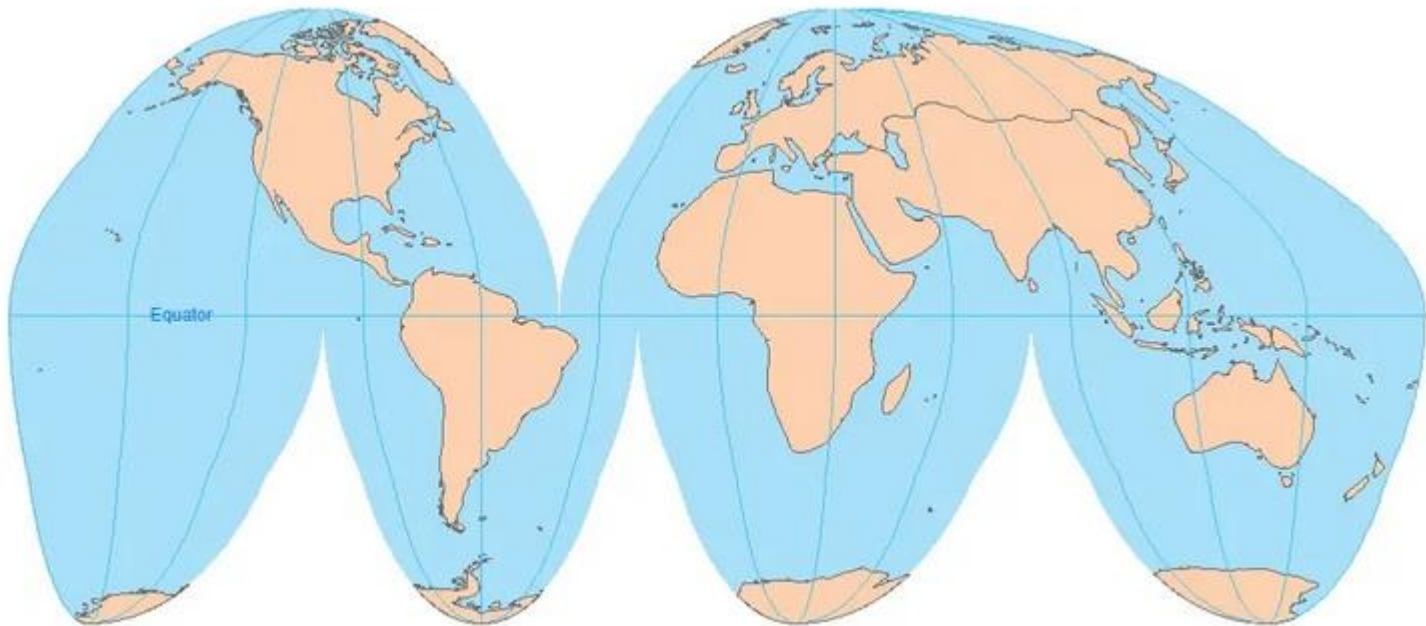


Review: Projections websites

<https://gisgeography.com/map-projections/>

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



https://imgur.com/t/science_and_tech/53iqEMC

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

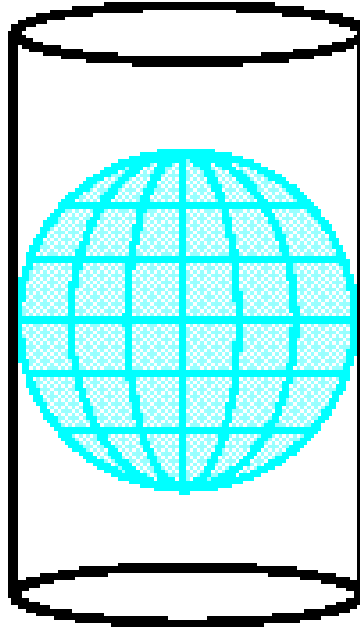
Map projections review- 3 + 1 major groups

- based on projection surface

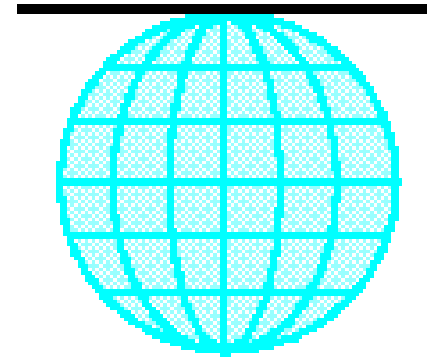
Azimuthal, Cylindrical, Conic, Pseudo-cylindrical



Conic



Cylindrical



Planar (azimuthal)

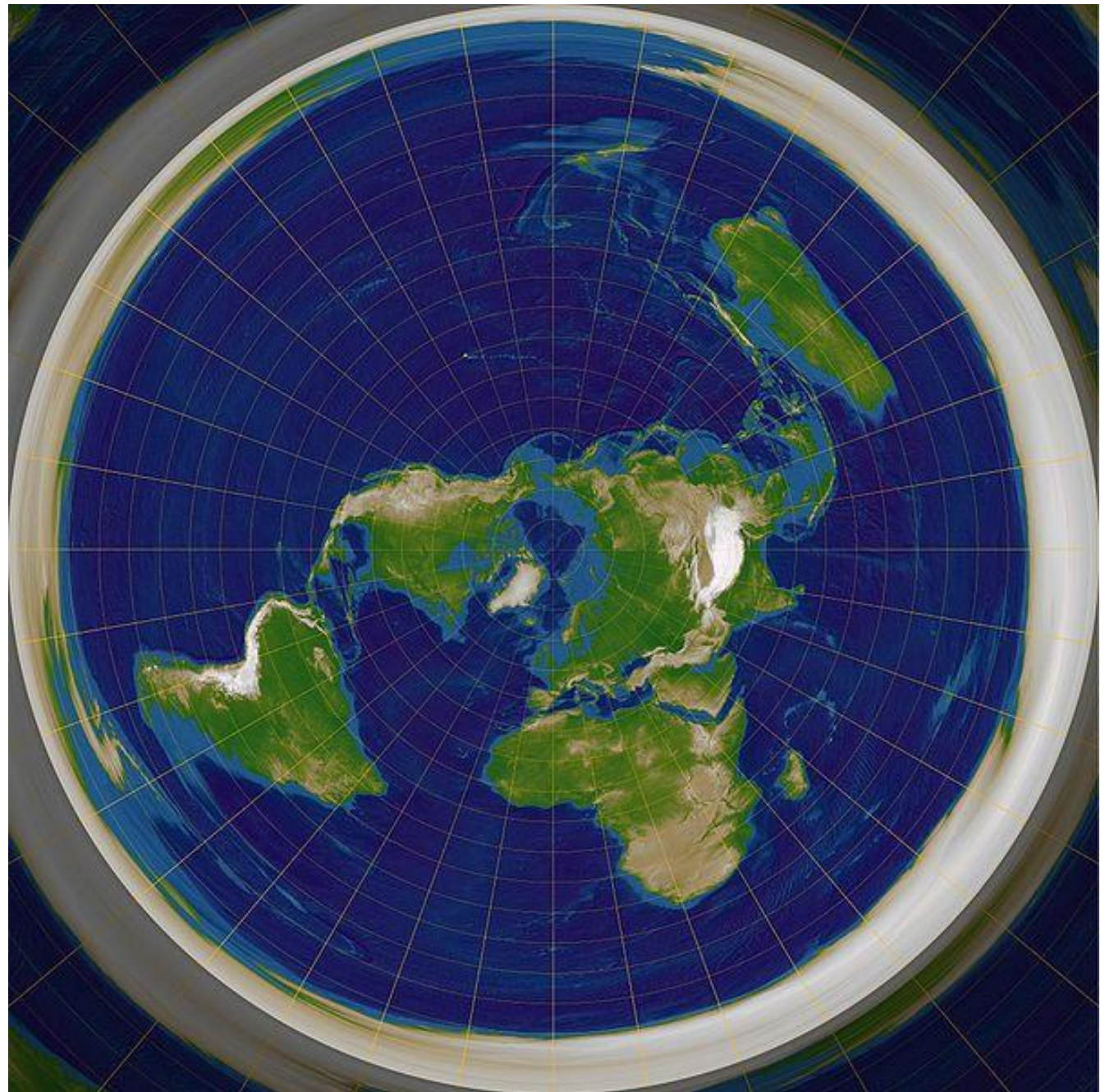
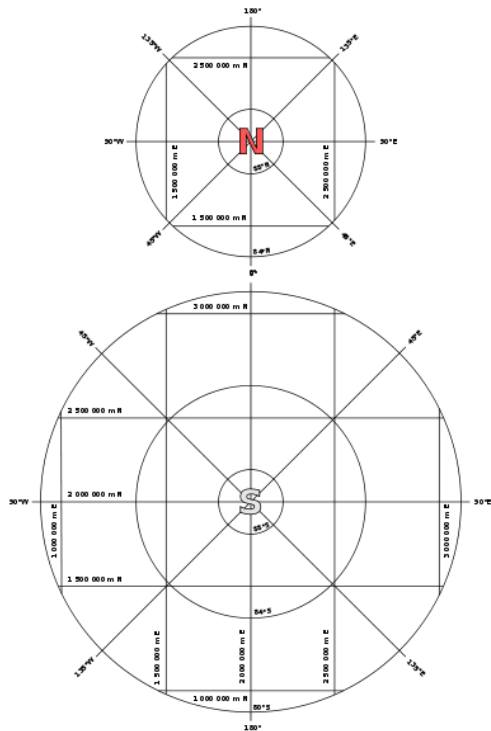
Plus **pseudo-cylindrical**: created mathematically based on cylindrical surface

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

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

1. Azimuthal

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



2. Cylindrical: Plate Carrée - equi-rectangular

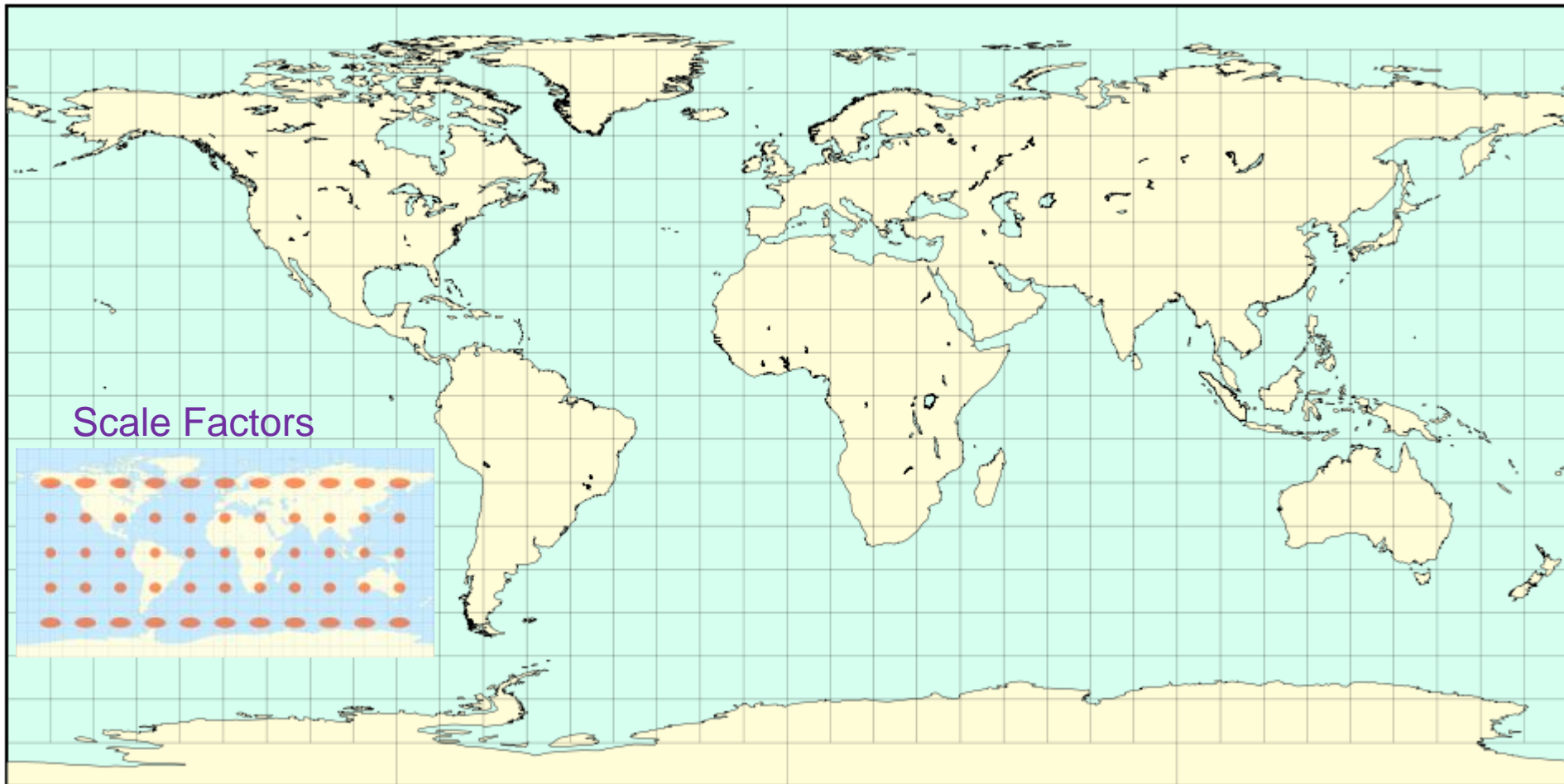
[Eratosthenes 200BC and Marinus of Tyre, AD100]



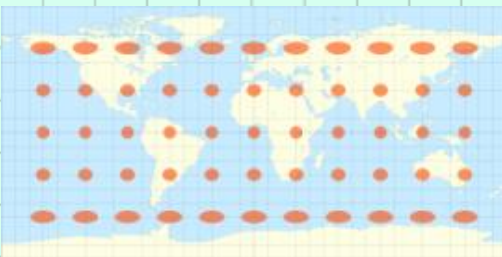
One degree is the same everywhere; easy to draw manually

Does NOT preserve shape or area;

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



Scale Factors

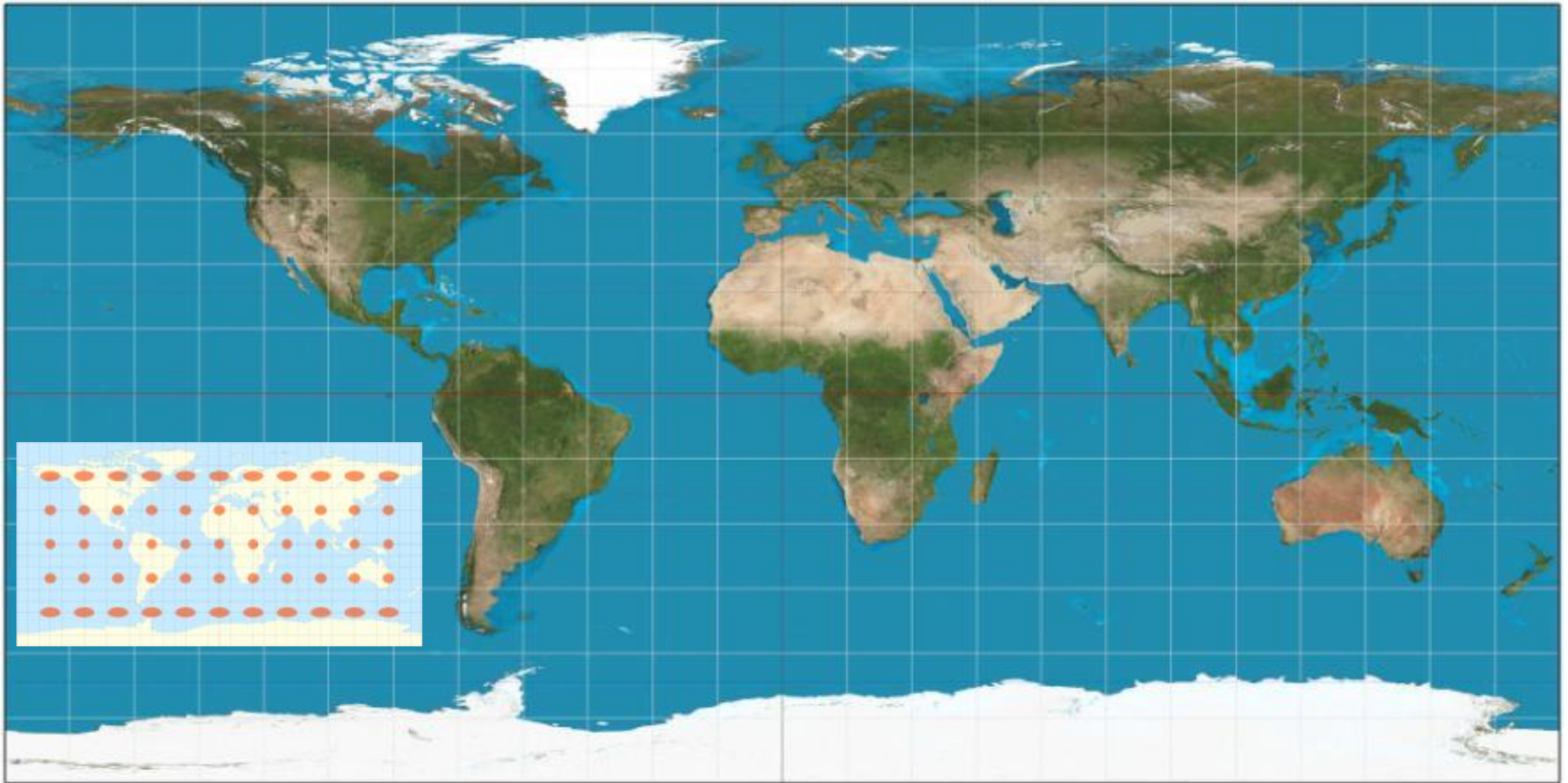


Digital / GIS: 'Geographic' or 'unprojected'

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

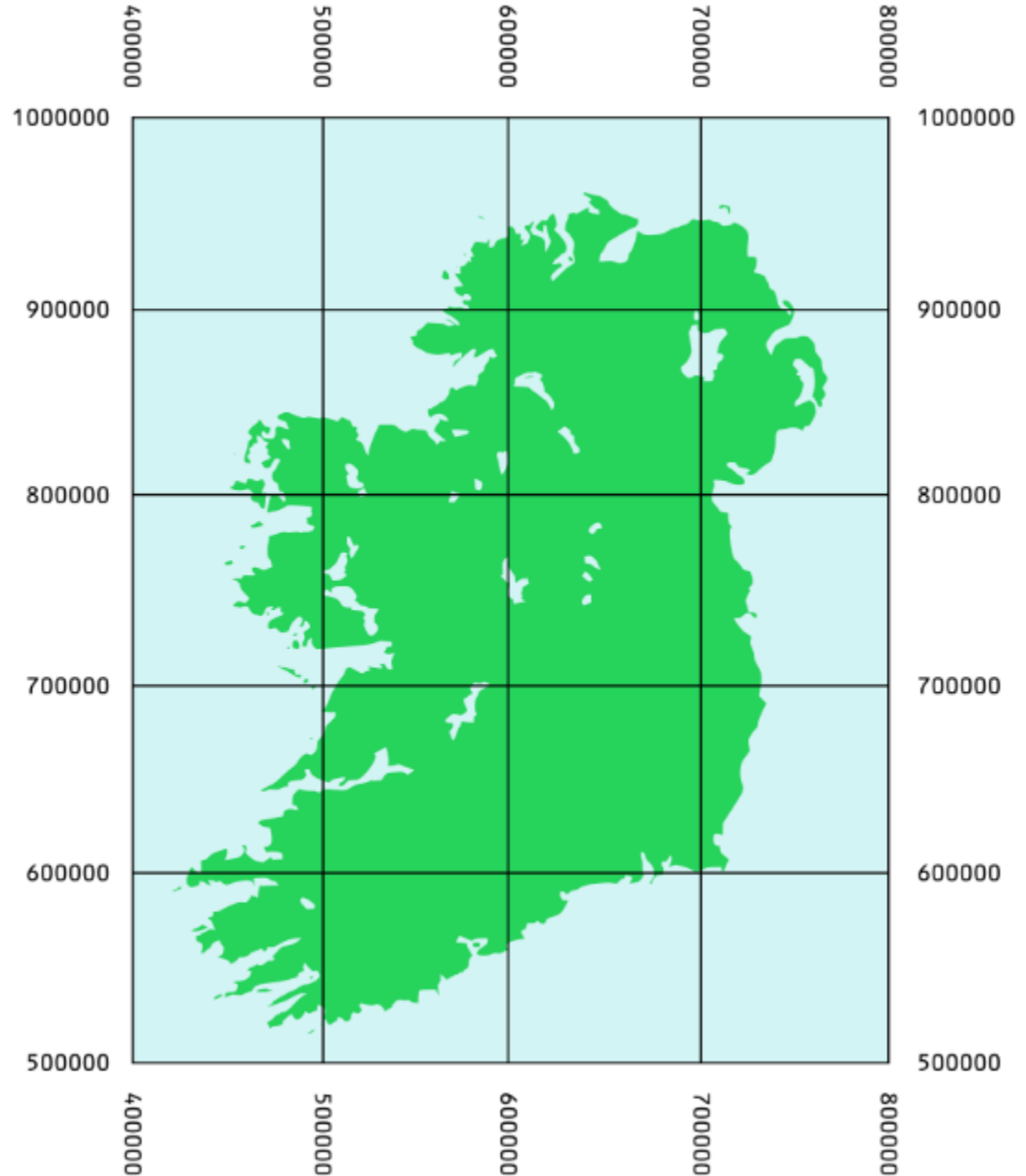
UTM is not a projection .. It is a system of 60 (similar) projections - each one centred on a UTM zone central meridian

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)

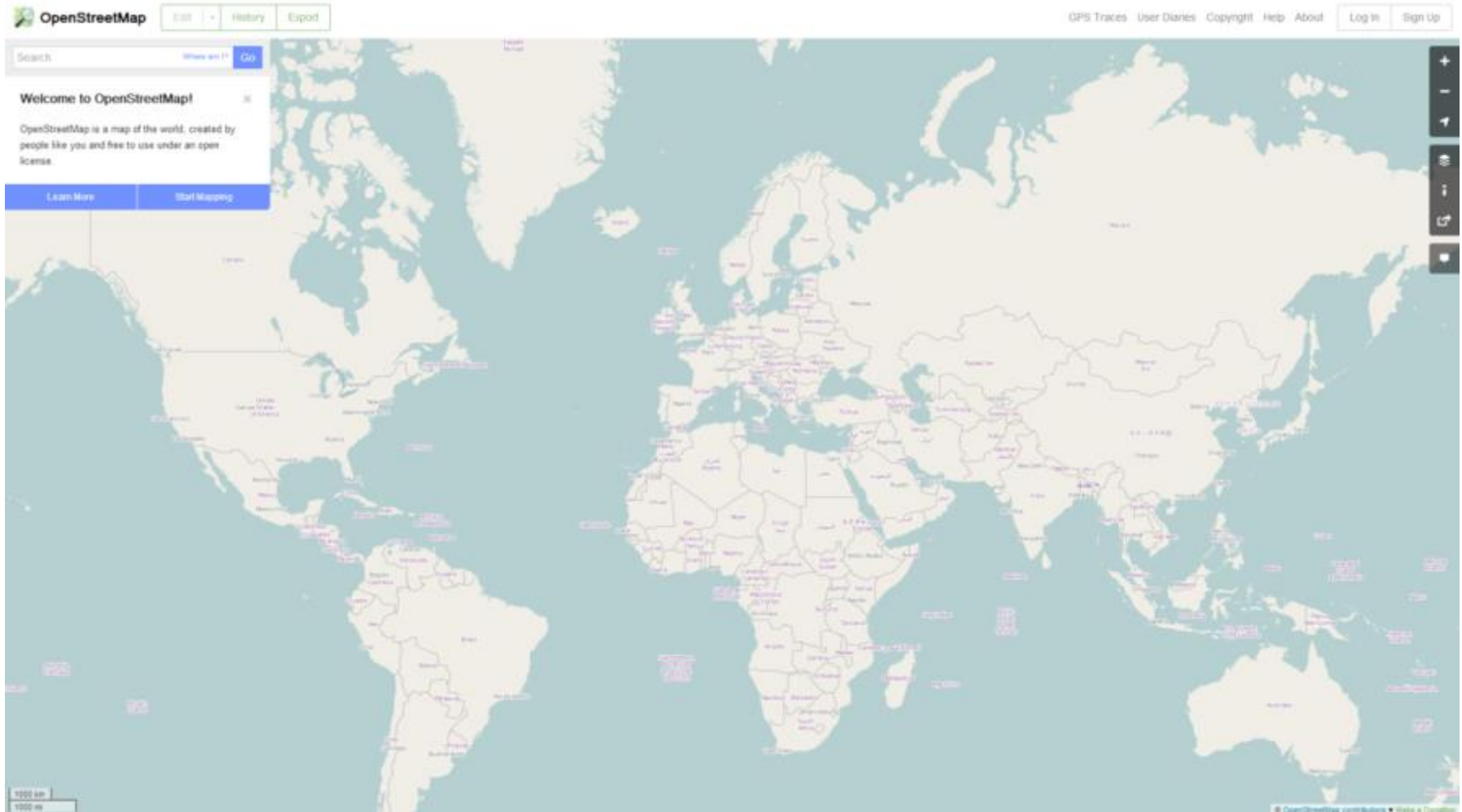
Ireland: 5.5 -10.5°W

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



All web map servers use 'Web Mercator'

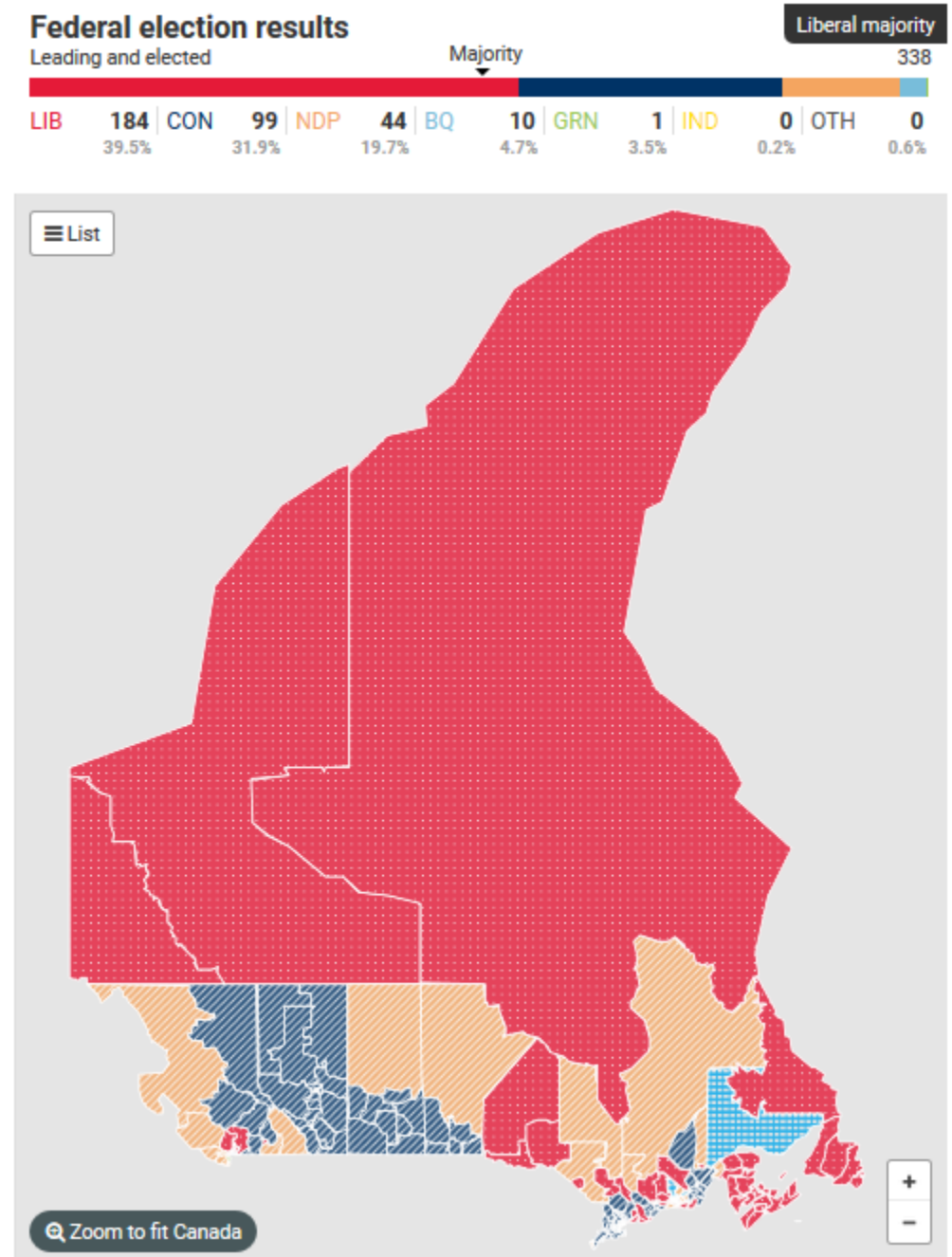
– conformal (shape-preserving) means less computing time when you zoom in:
Google maps, Bing maps, open street map etc..



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 !

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



Gerhardt Mercator

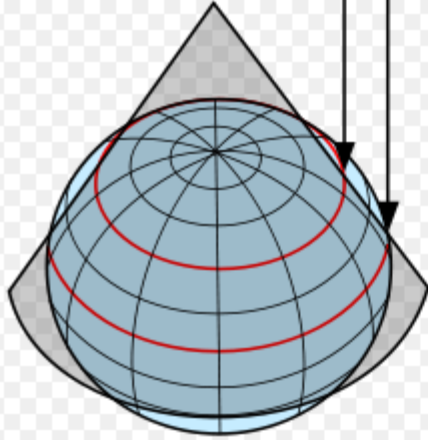
Adopted by Canada 1948 (so its not on pre-war maps) - Cuts off at 84°N

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)

Two standard parallels
(selected by mapmaker)



1500 / 1700s



Canada Albers (or Lambert) Equal Area Conic

Central Meridian: -96

Latitude Of Origin: 40

First Standard Parallel: 50

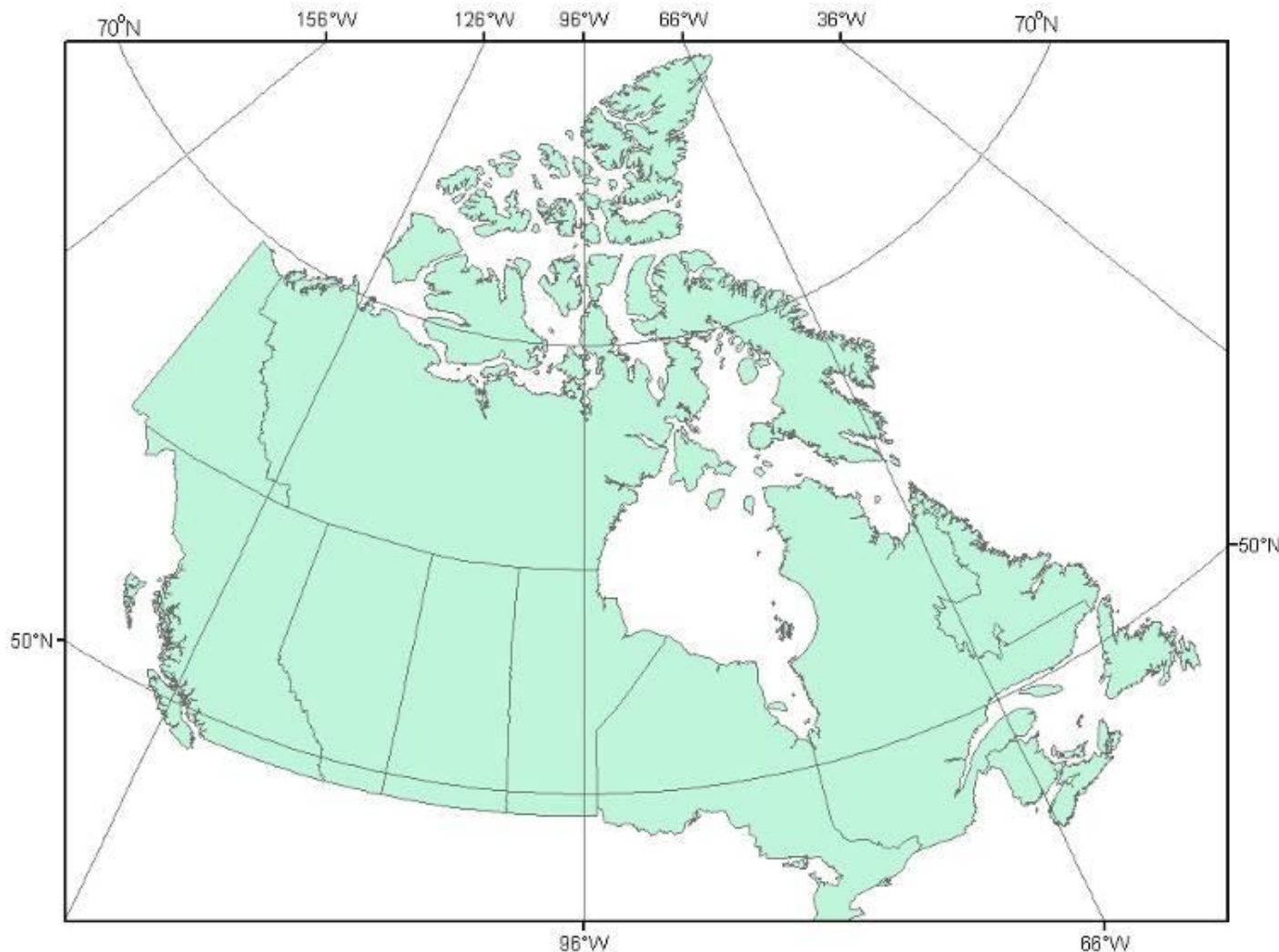
Second Standard Parallel: 70

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

➤ 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

B.C. Coordinate System Calculator

To enter a coordinate graphically, click here: [Show BC Map](#)

Geographics

Decimal Degrees

Latitude

Longitude

Degrees / Minutes / Seconds

Latitude

Longitude

[worldwind.//](#) 

 [GEarth](#)

 [GMaps](#)

BC-Albers

Metres

X (Easting)

Y (Northing)

UTM

Metres

X (Easting)

Y (Northing)

Zone

Central Meridian

Mapsheet

[BCGS](#) 1:20K

[NTS](#) 1:50K

Parameters

[Spheroid](#)

Type

**Note: only UTM
has 'zones' ->**

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

Multiple coordinate system layers

Georeferenced data can be recognised by the coordinates

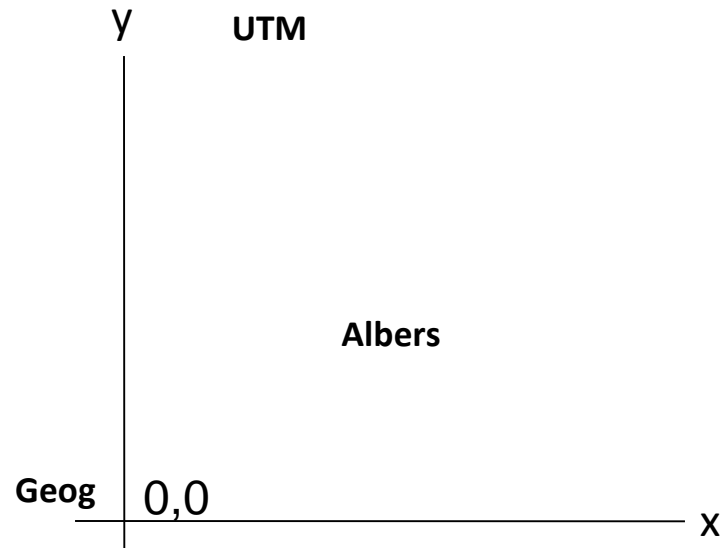
e.g. Prince George

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**' .. Only 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*)






















Map Properties: Map

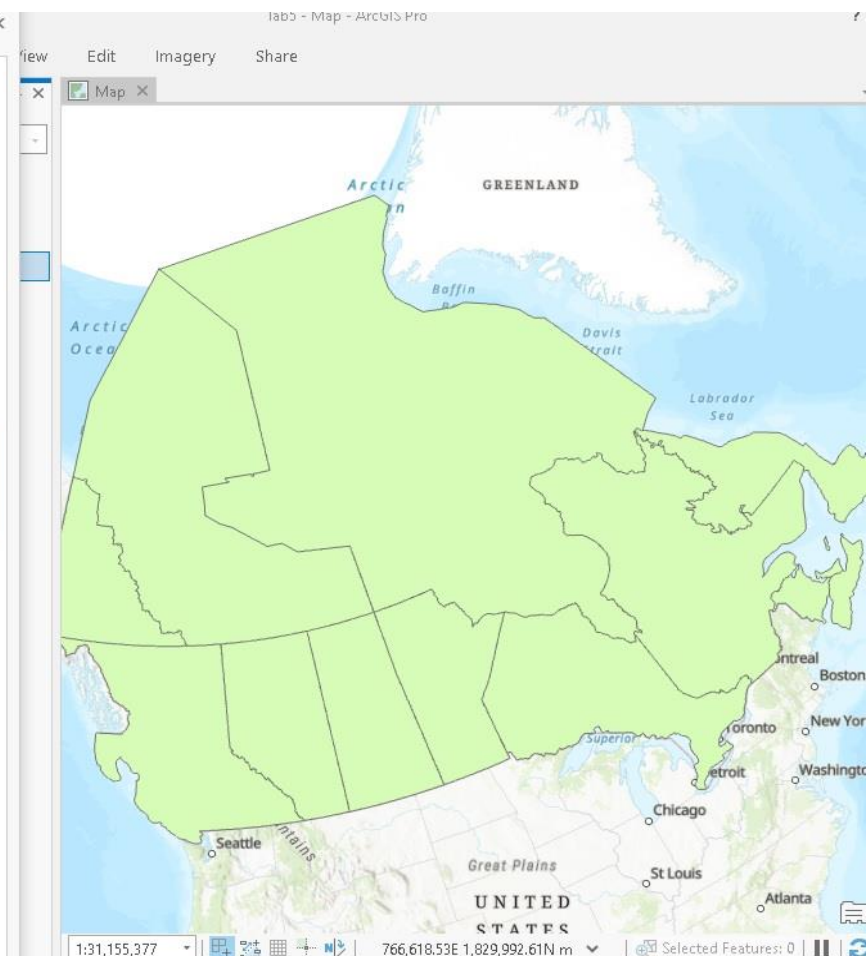
General
Extent
Clip Layers
Metadata
Coordinate Systems
Transformation
Illumination
Labels
Color Management

Select the Coordinate System to view the available options.


Current XY: **NAD 1983 BC Environment Albers** Details
Current Z: **<None>**

XY Coordinate Systems Available  

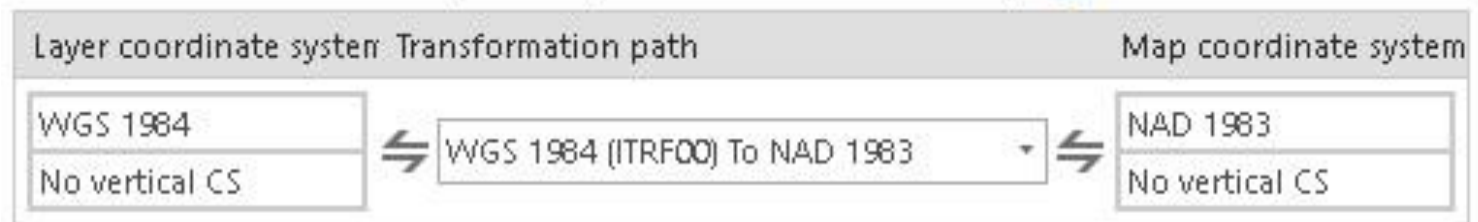
-  Eckert II (world)
-  Eckert III (world)
-  Eckert IV (world)
-  Eckert V (world)
-  Eckert VI (world)
-  Equal Earth (world)
-  Equal Earth (world) Americas
-  Equal Earth (world) Asia-Pacific
-  Equidistant Conic (world)
-  Equidistant Cylindrical (world)
-  Flat Polar Quatic (world)
-  Fuller (world)
-  GOES-16 East ABI Fixed Grid ITRF2008
-  Gall Stereographic (world)
-  Goode Homolosine (Land)
-  Goode Homolosine (Ocean)
-  Hammer-Aitoff (world)
-  Hotine (world)
-  Loximuthal (world)
-  Mercator (world)
-  Miller Cylindrical (world)



Layer and map

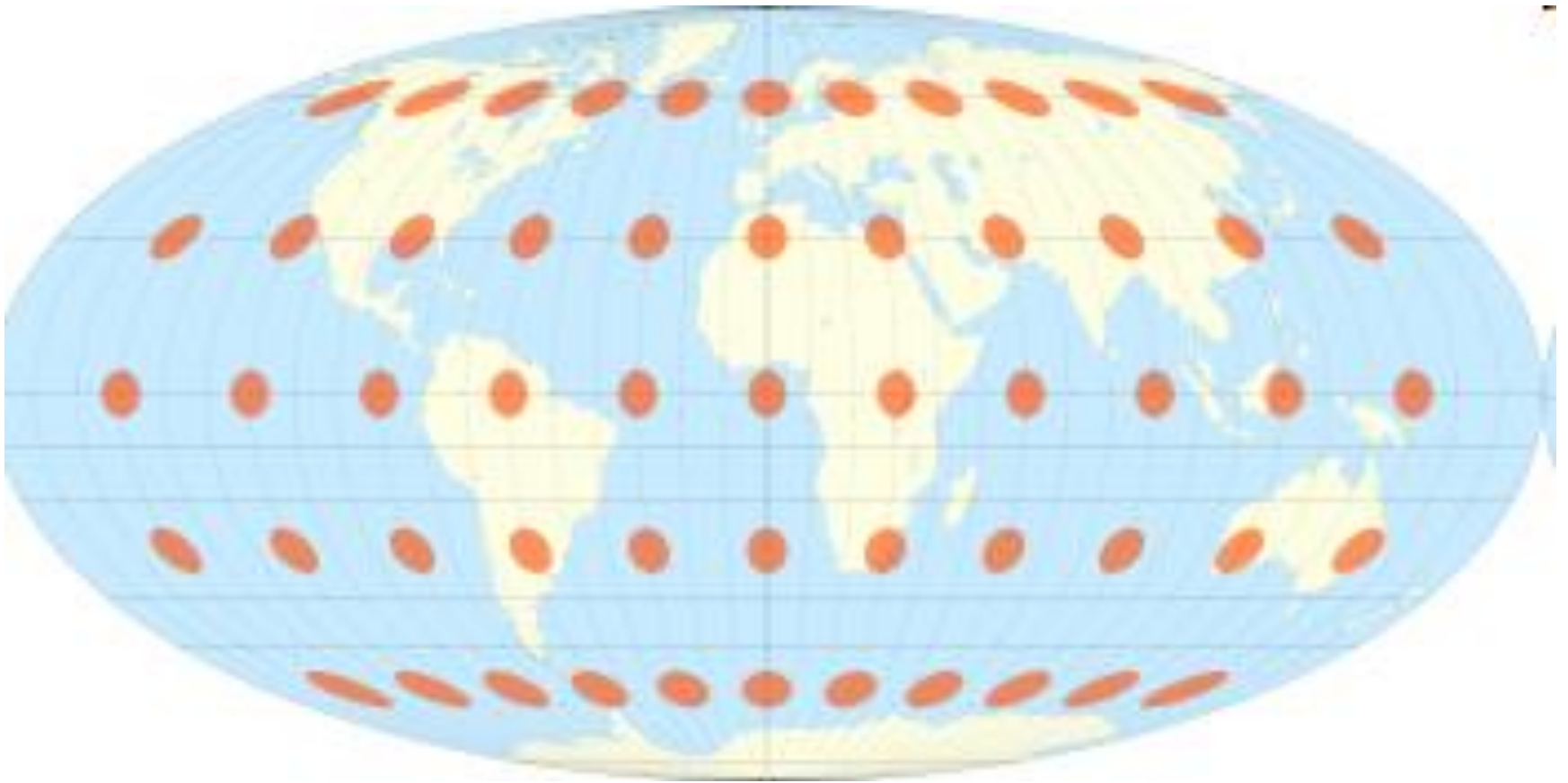
These transformations are required to position datasets in the map. 

Transform /
project



4. Pseudo-cylindrical projections

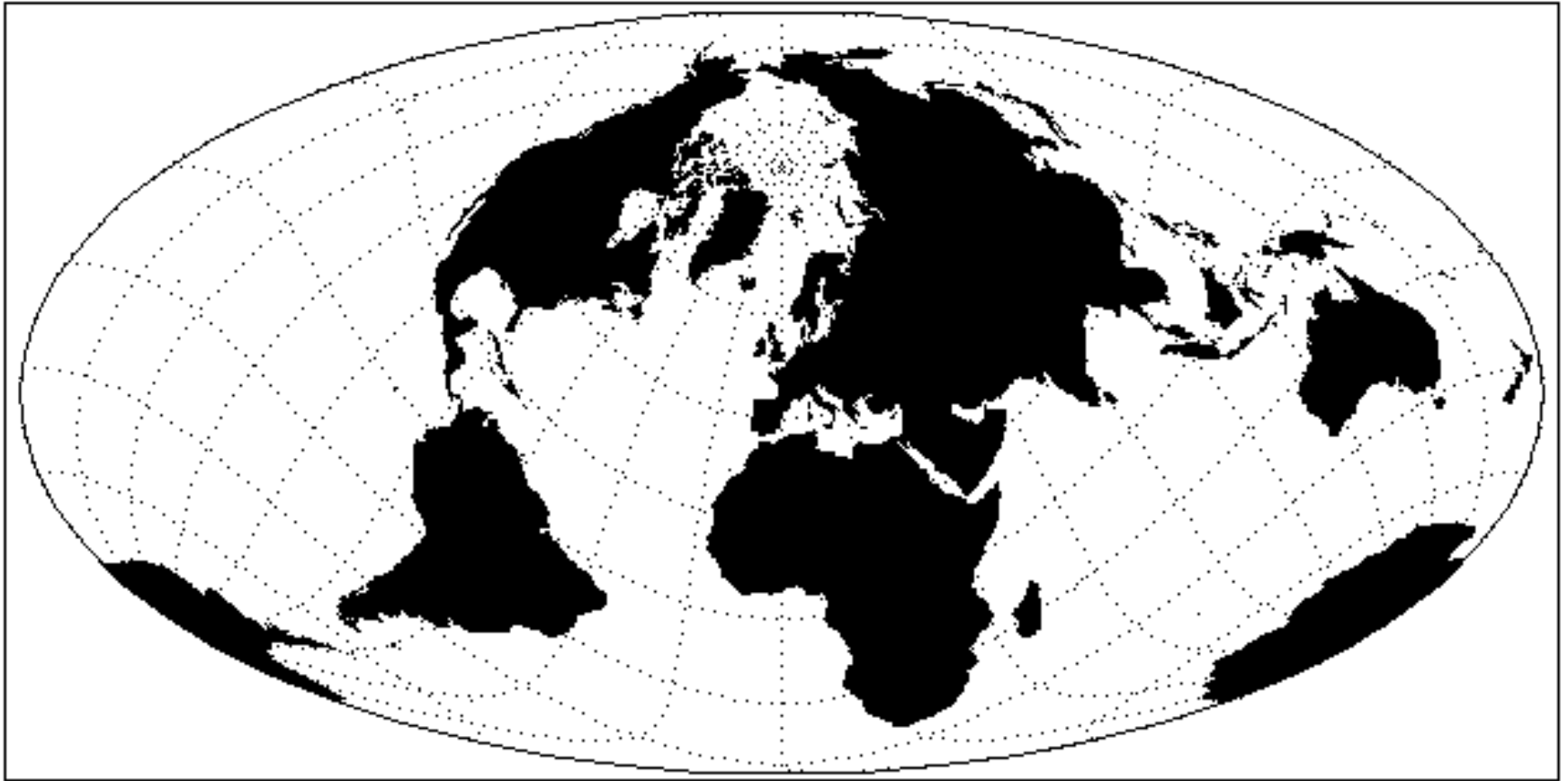
- show the whole world with least overall distortion (often equal-area)
- 19th century (and 20th) e.g. Mollweide (used in atlases etc.)



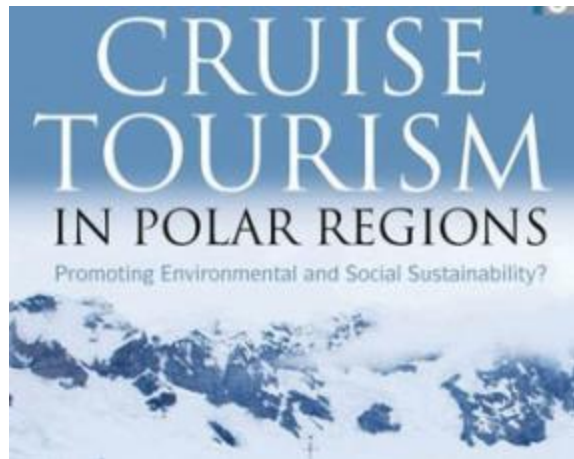
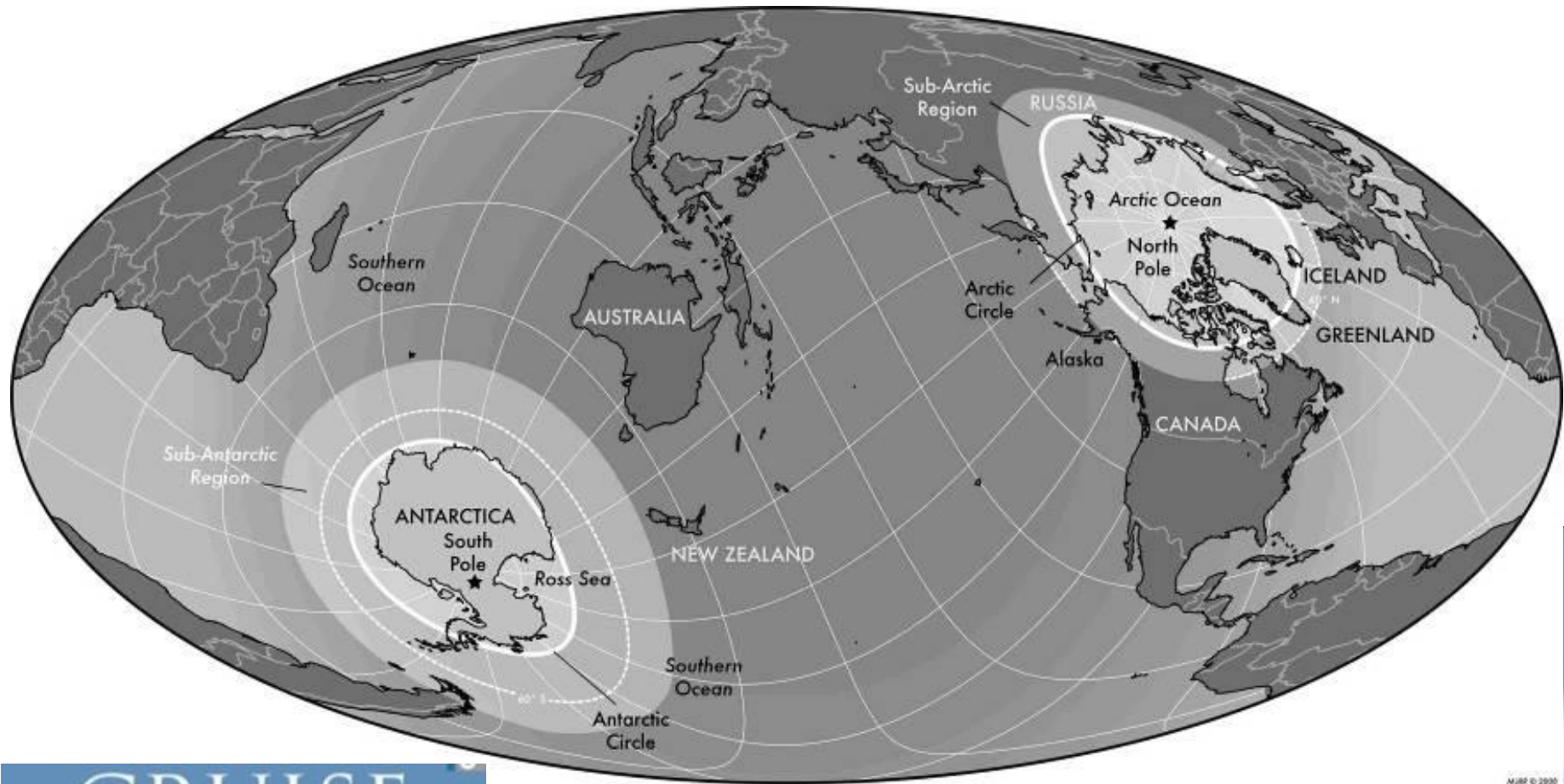
Tissot's Indicatrix of distortion

Oblique Mollweide

(obliques are used sparingly, rarely made manually)



GIS and digital cartography have enabled easy generation of many projections



Clever digital use of oblique Mollweide to show both poles



Edited by Michael Lück,
Patrick T. Maher and Emma J. Stewart

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: 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=klID5FDi2JQ>