GEOG 205 Course update:

Quiz 3: Map projections .. I hope to post it on Moodle later today or weekend

Lecture Friday 15 March: 'Projects' … will be posted online (no in-class lecture !)

Projects lecture will give examples of past projects, guide for 'easy data' and tips on what to do / not to do; please review the lecture slides before your lab section

It will be posted by Monday evening (after March 11 lecture)
Project grading scheme and guide will also be posted
Announcement on Moodle when posted

Remaining labs: Important to attend next week's lab to get help finding project data

Lab week 9: data download

Lab 10: design/styling
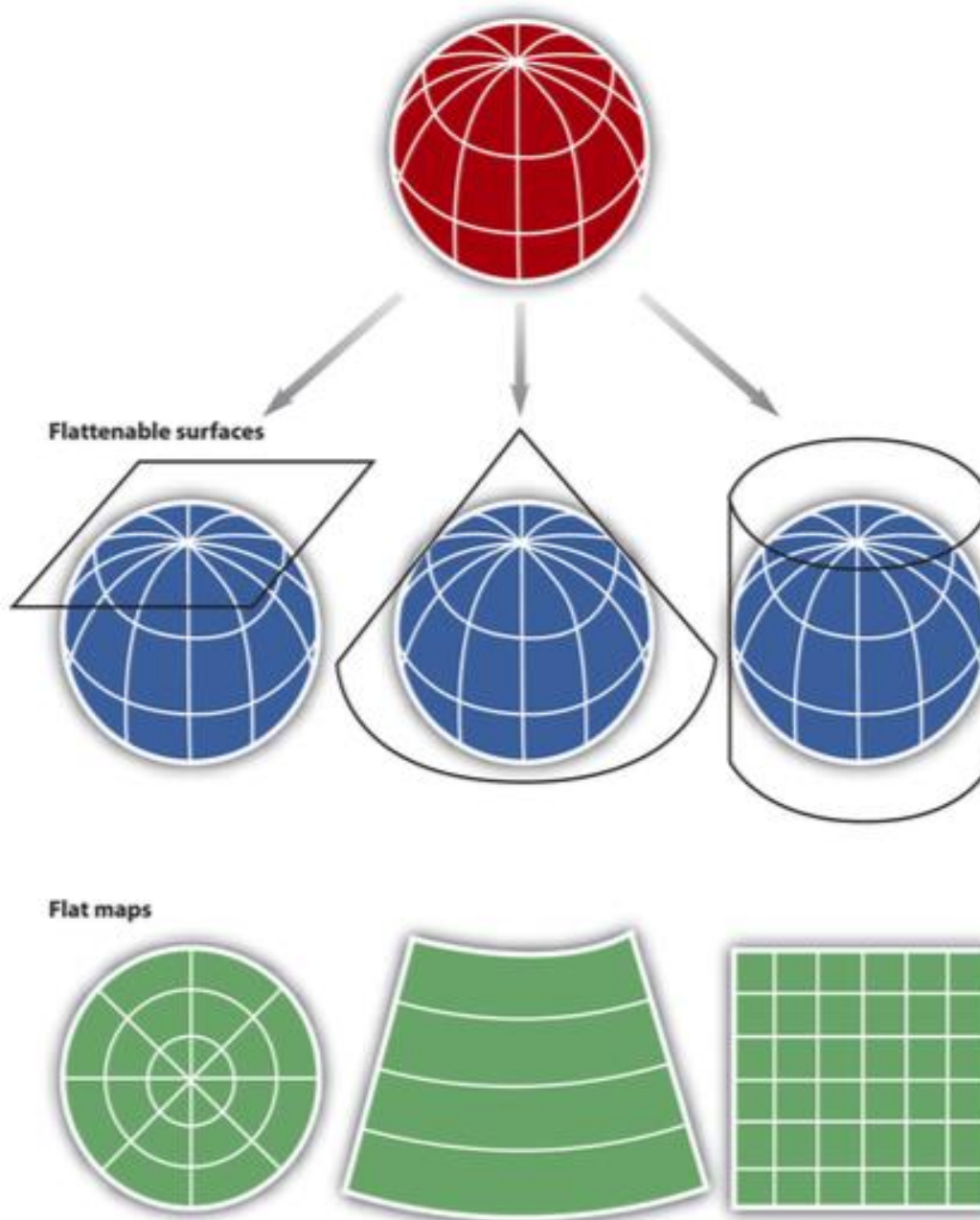
Lab 11: Completion/write-up

Map projections

3 + 1 major groups

–projection surface

Azimuthal, Conic, Cylindrical + Pseudo-cylindrical

Flattenable surfaces

Sub-groups based on projection orientation normal/polar, transverse/equatorial oblique

Flat maps

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
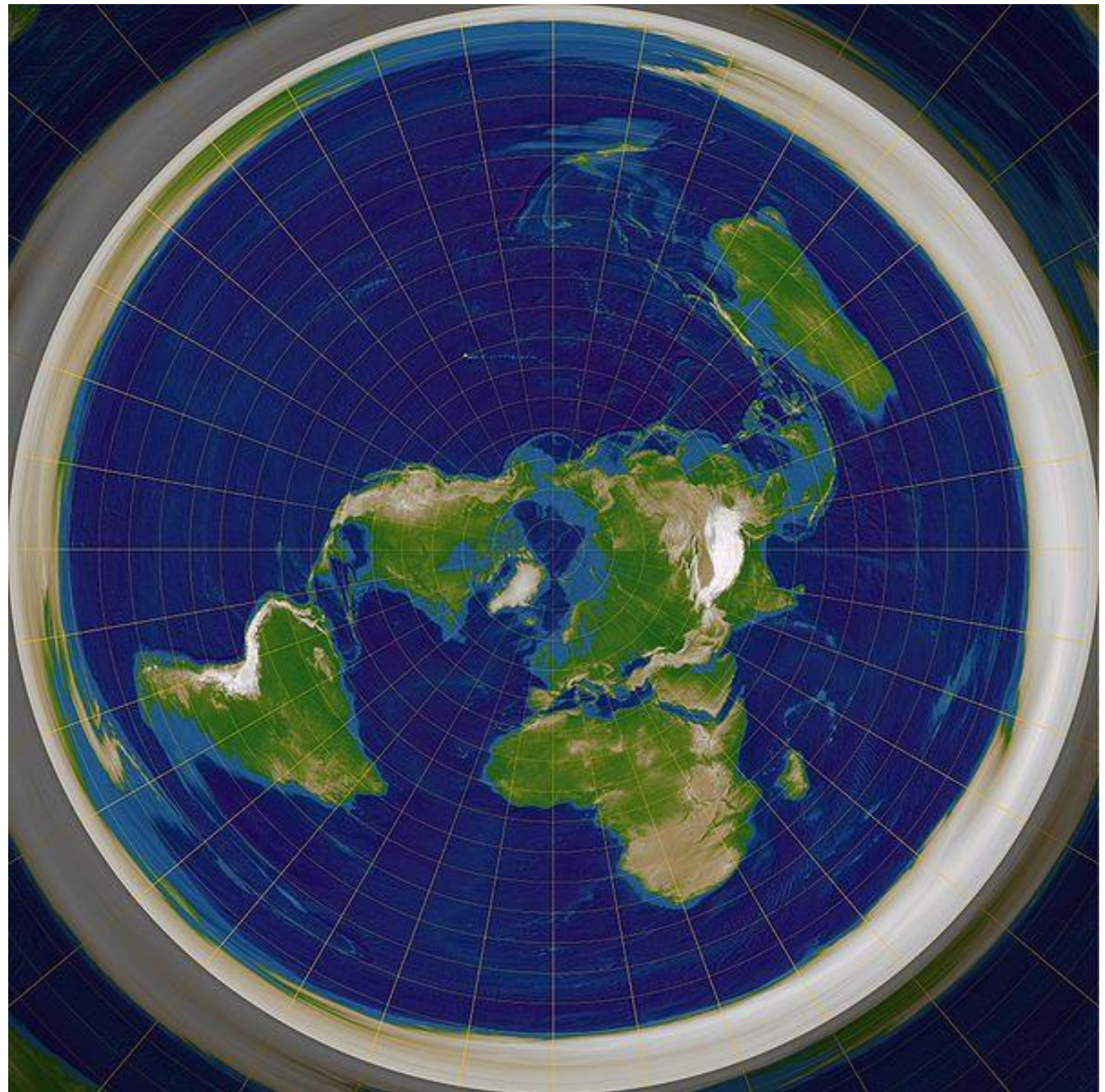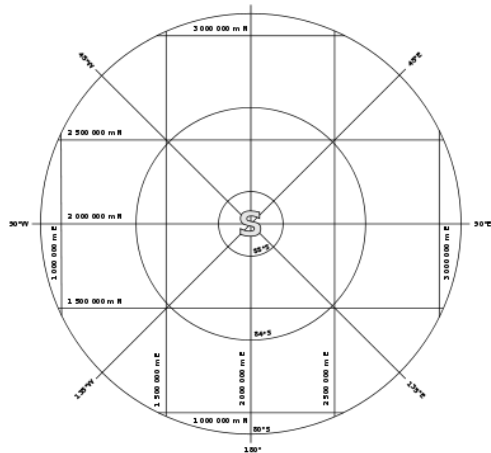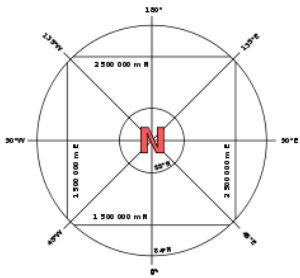
Digital mapping / GIS
   = much easier to convert between projections

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 > 84N and 80S

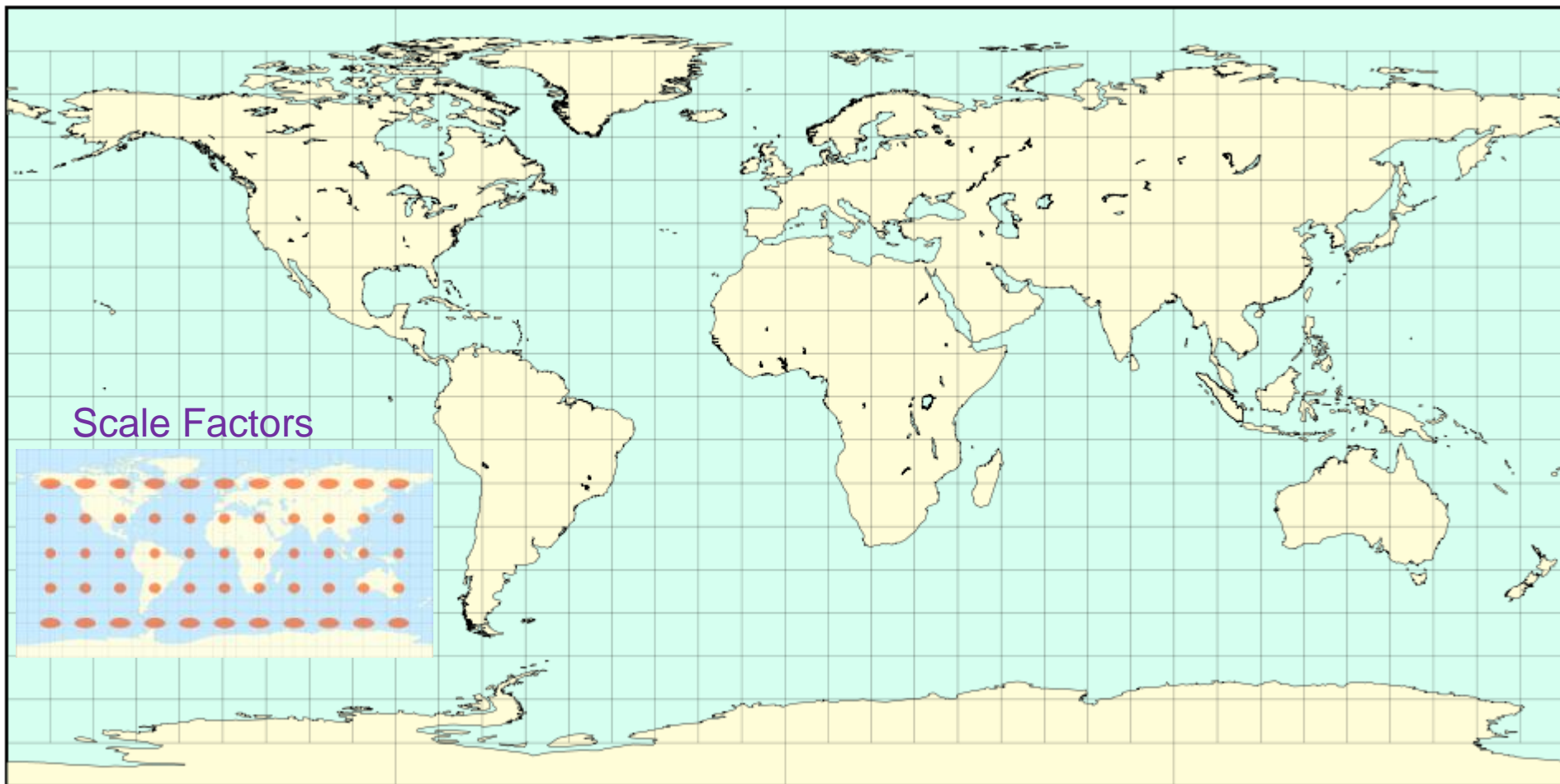# 2. Cylindrical: Plate Carrée ('square') = equi-rectangular

[Eratosthenes 200BC and Marinus of Tyre, AD100]

One degree is the same everywhere; easy to draw manually
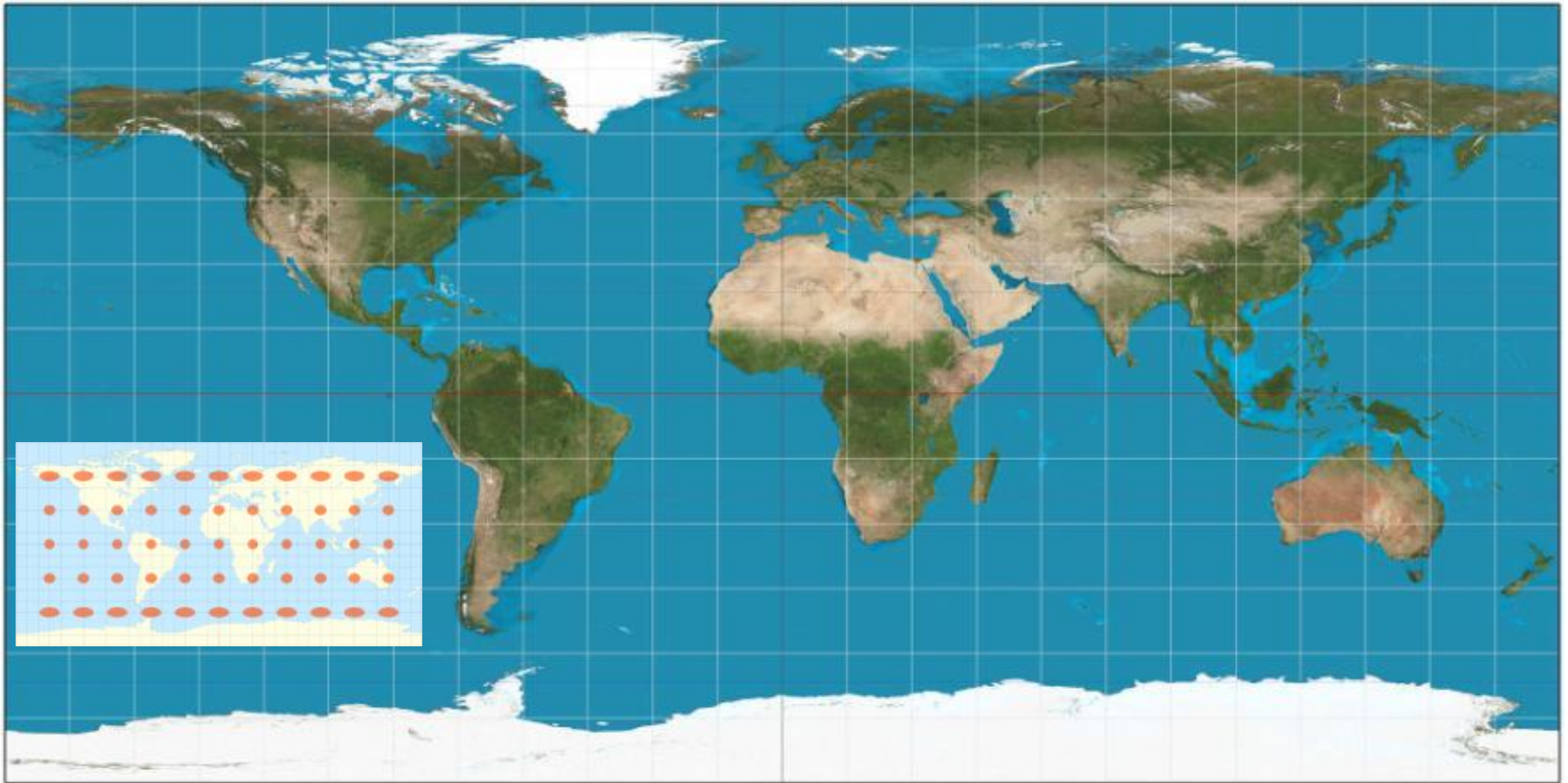
Does NOT preserve shape or area;

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

Scale Factors

Digital / GIS: 'Geographic' or 'unprojected'

One degree is the same everywhere

Most 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 (one) 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
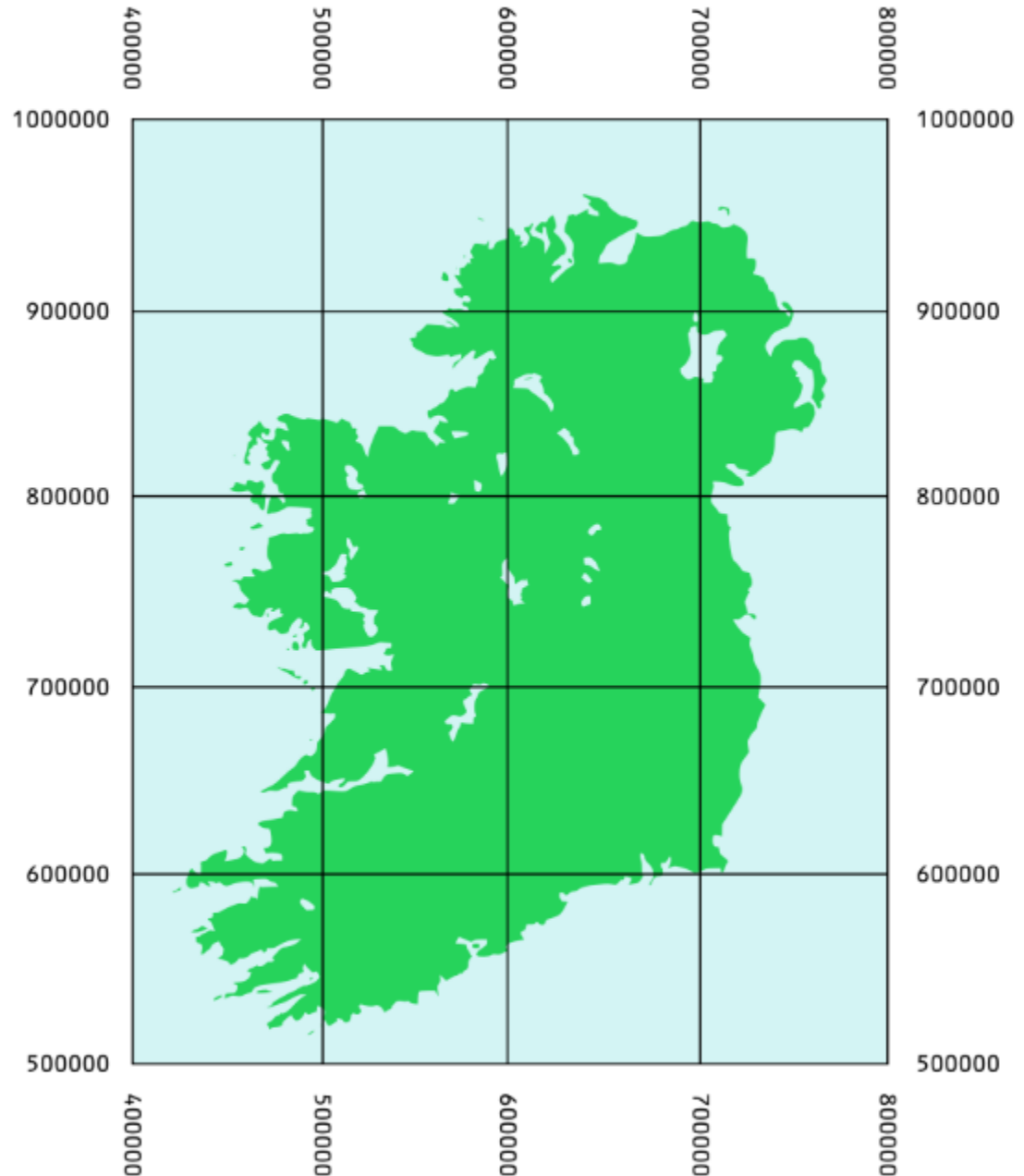
Irish Transverse Mercator (ITM) System (2001)

Ireland: 5.5 -10.5°W

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

Alberta 10TM system

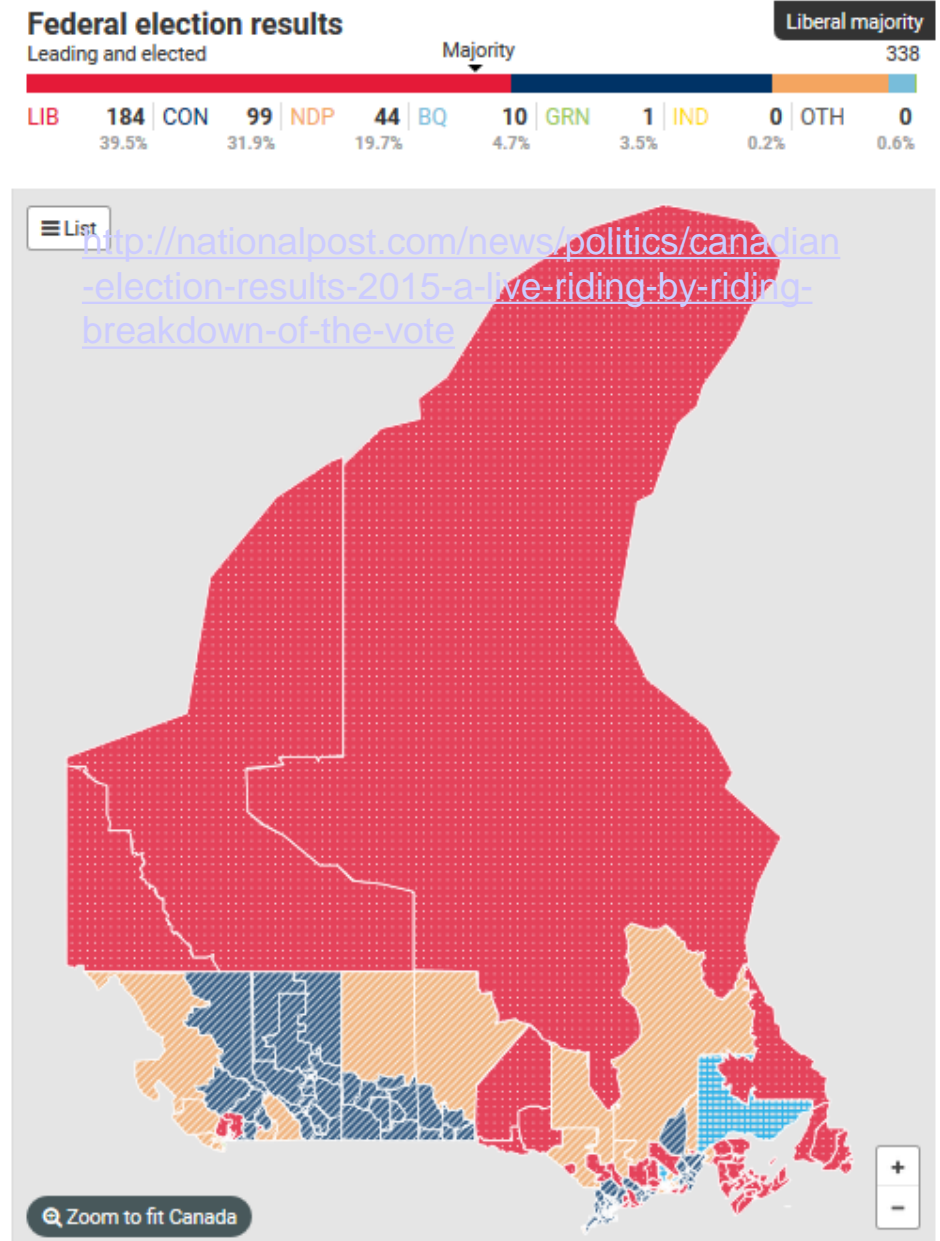110° W to 120° W
  centred on 115° W
parts of UTM zones 11-12

Online map servers use 'Web' Mercator

Since Google 2005, web map servers use 'Web Mercator' a modified version of the original Mercator … but it can produce some hideous thematic maps !!

Federal election results
Leading and elected

Majority

Liberal majority
338

LIB	CON	NDP	BQ	GRN	IND	OTH	
184	**99**	**44**	**10**	**1**		**0**	**0**
39.5%	31.9%	19.7%	4.7%	3.5%		0.2%	0.6%

≡ List

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

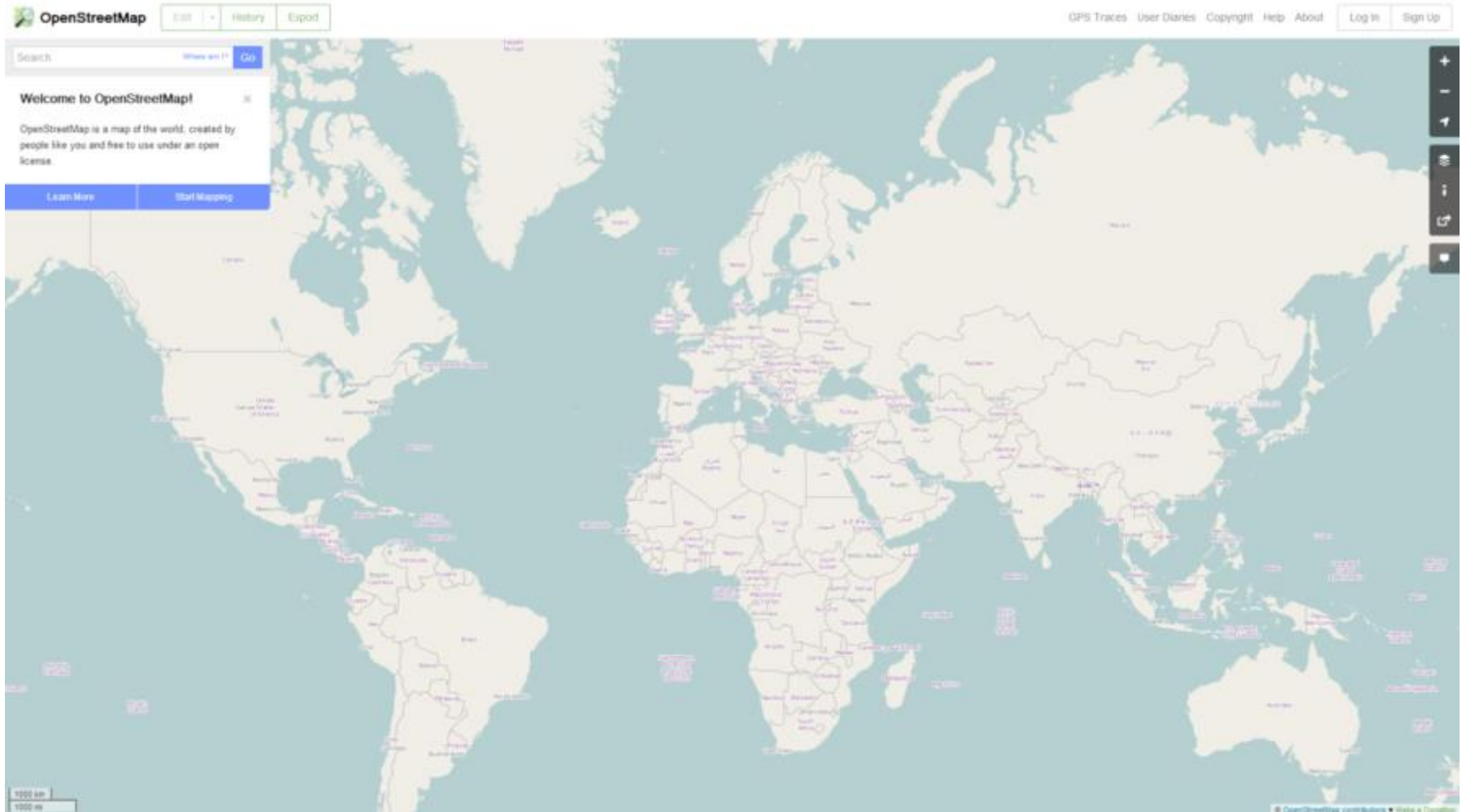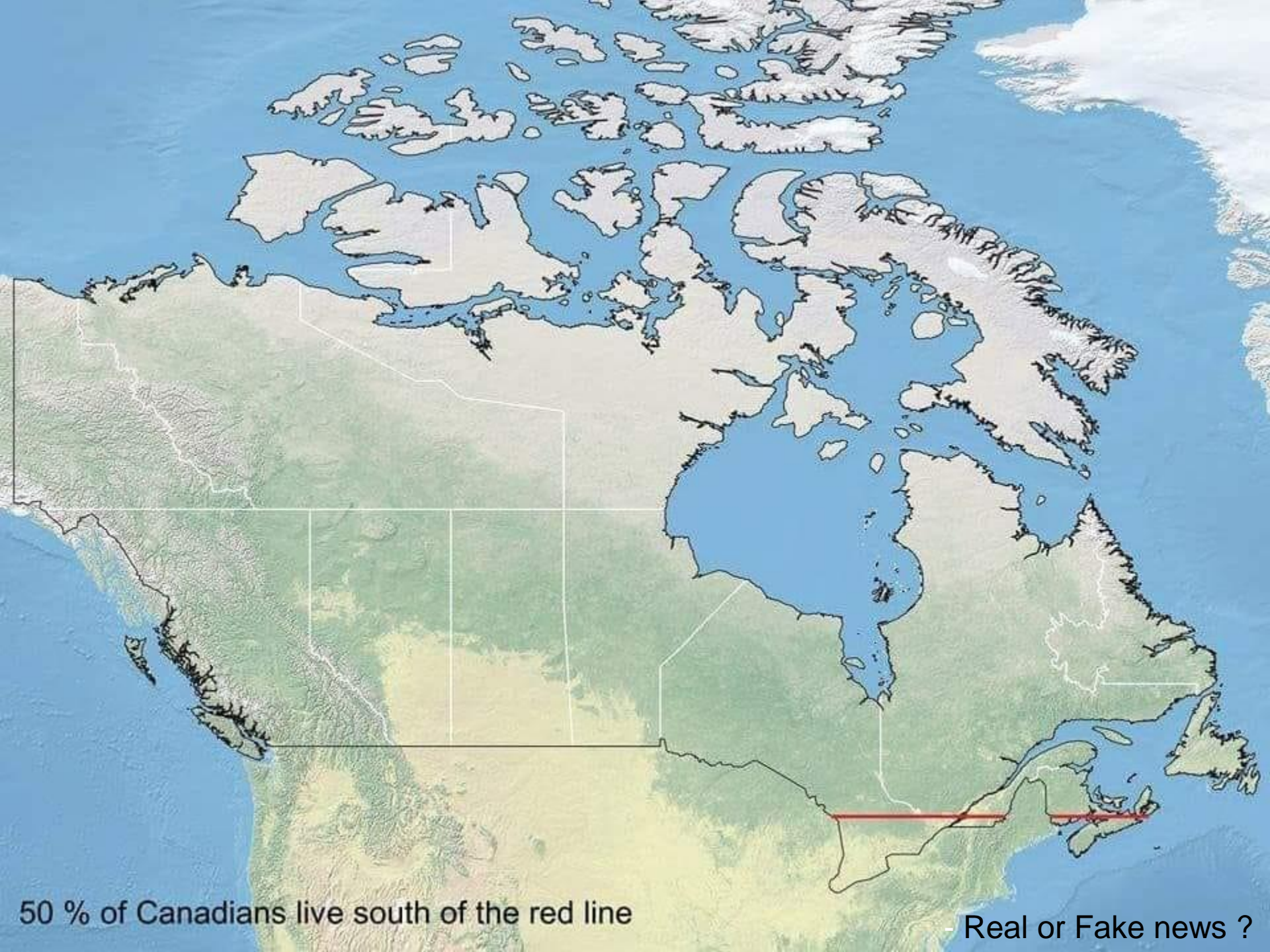Zoom to fit Canada

83N

75N

60N

50N

Canada – web Mercator

Online 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

50 % of Canadians live south of the red line

- Real or Fake news ?

Mercator still rules the world ….

Gerhardt Mercator

a. Mercator projection (1569)
– navigation on lines of constant compass bearing

b. Transverse Mercator (1772)
– minimum distortion on a line of longitude

-the basis of the UTM system for topographic mapping
-> Refined by Gauss-Krüger (1882) for the ellipsoid (after Lambert's spherical)

Adopted by Canada 1948 (so its not on pre-war maps) - cuts off at 84°N
(there replaced by the Azimuthal Polar Stereographic)

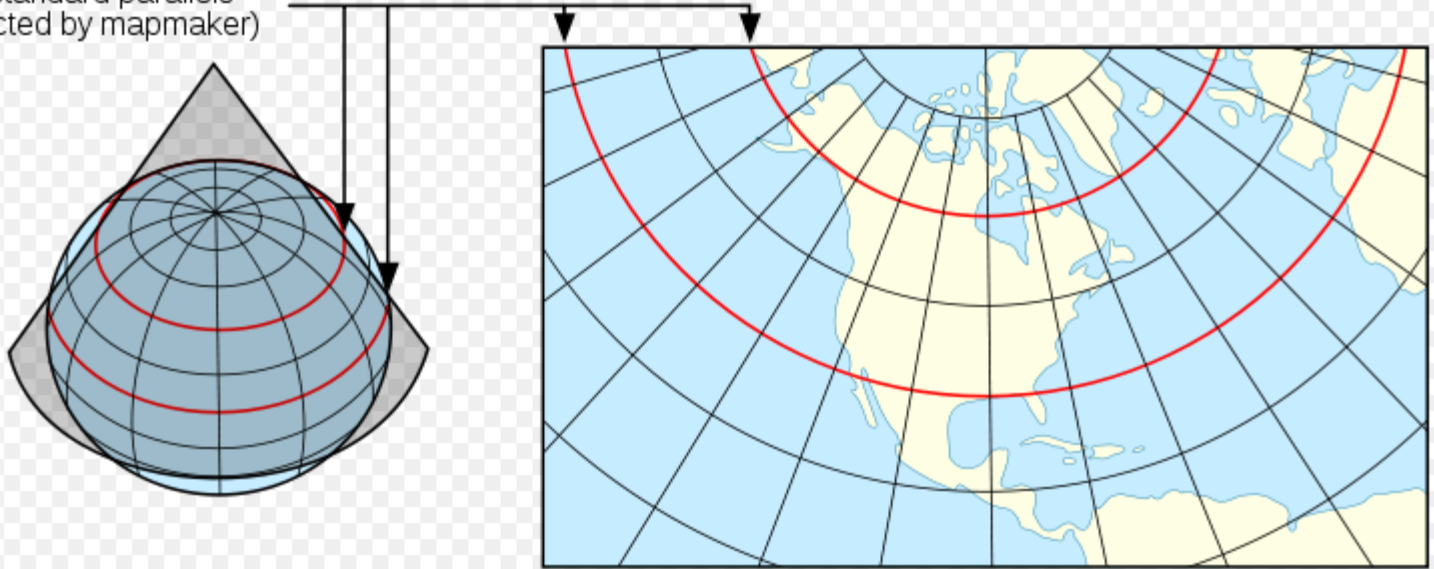## c. Web Mercator (2005) **– online world map viewers** e.g. Google maps
.. Cuts off at 85°N / S; scale distortions not evident when you zoom in ..

3. Conic projection with 2 standard parallels:

mid-latitude georeferencing system e.g. Canada or BC (next slides)

Lambert, 1772

Canada Albers (or Lambert) Equal Area Conic

Central Meridian: -96   Latitude Of Origin: 40
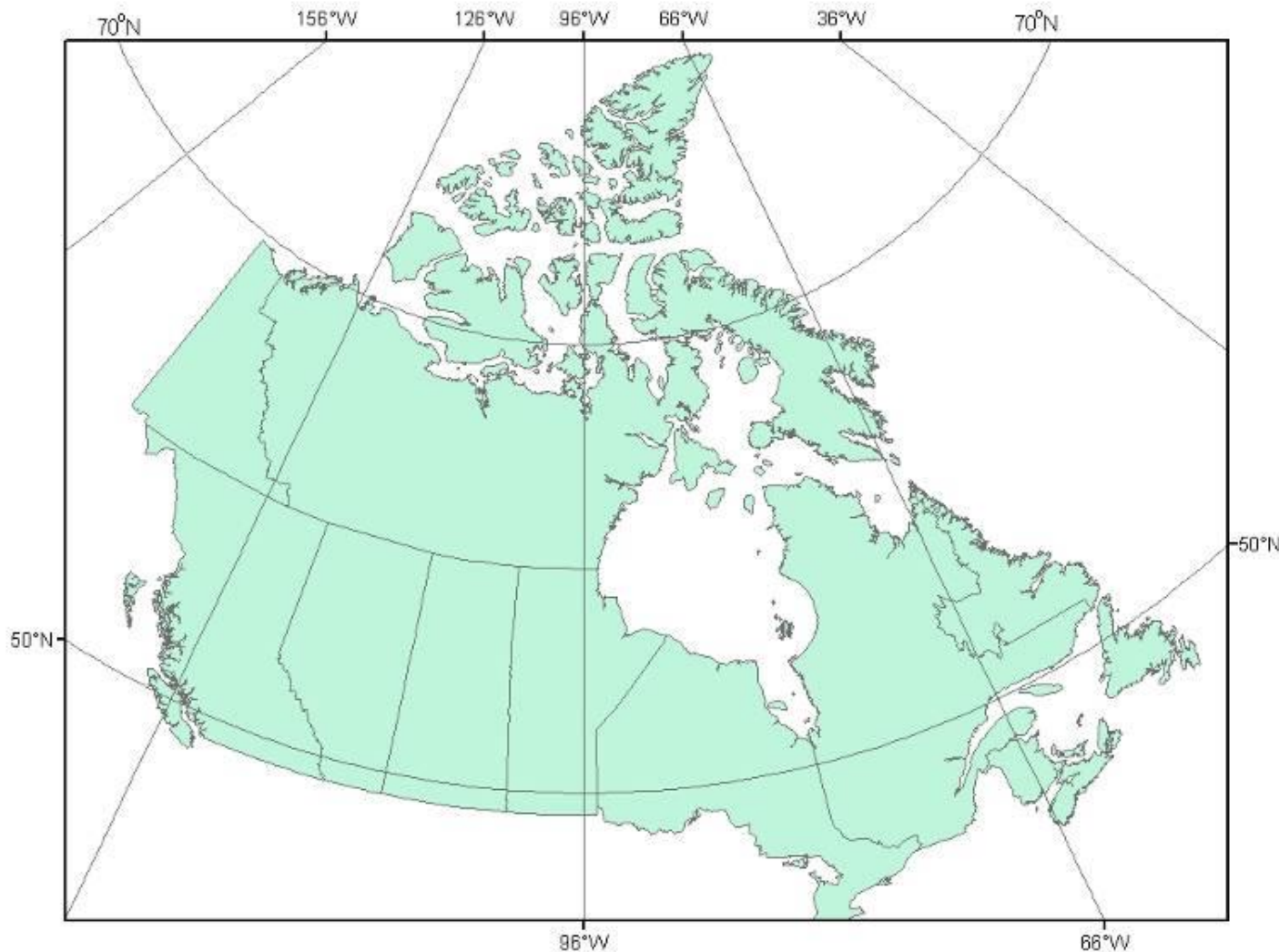## First Standard Parallel: 50   Second Standard Parallel: 70

Scale

Larger

Slightly
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

126ºW = 1,000,000 Eastings
45ºN =   0 Northings

Note: only UTM has 'zones' ->

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

Multiple coordinate system layers

Georeferenced data can often be recognised by the coordinates

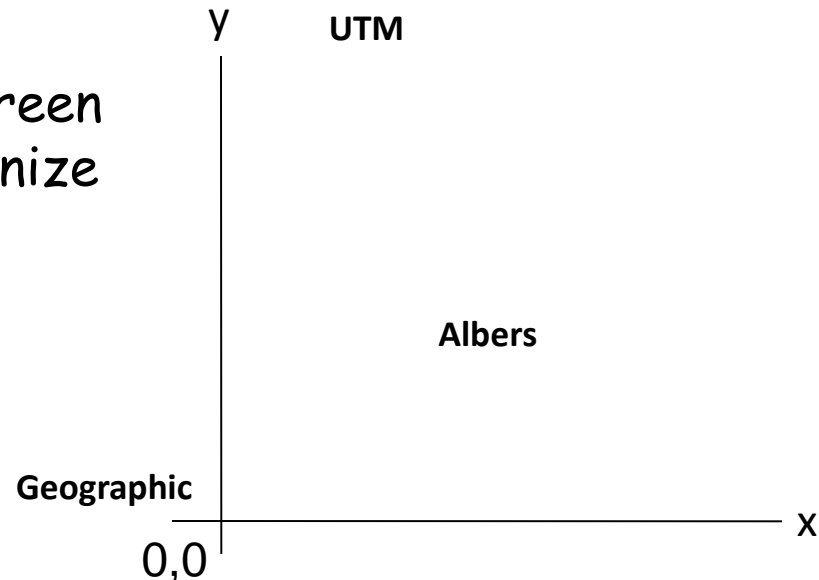e.g. Prince George

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
different projections ?
(pre-2000)

y   UTM

Albers

Geographic

0,0   X

- The **Data Frame / Map display** takes on the coordinate system of the <u>first layer</u> loaded

Multiple coordinate systems can be displayed together <small>since 2000</small>

… 'on the fly' .. But only if they are properly 'defined'

Project define tool**:** edits the <u>metadata</u> to properly 'label' the coordinate system … creates a file named **.prj** *(e.g. roads.prj)*
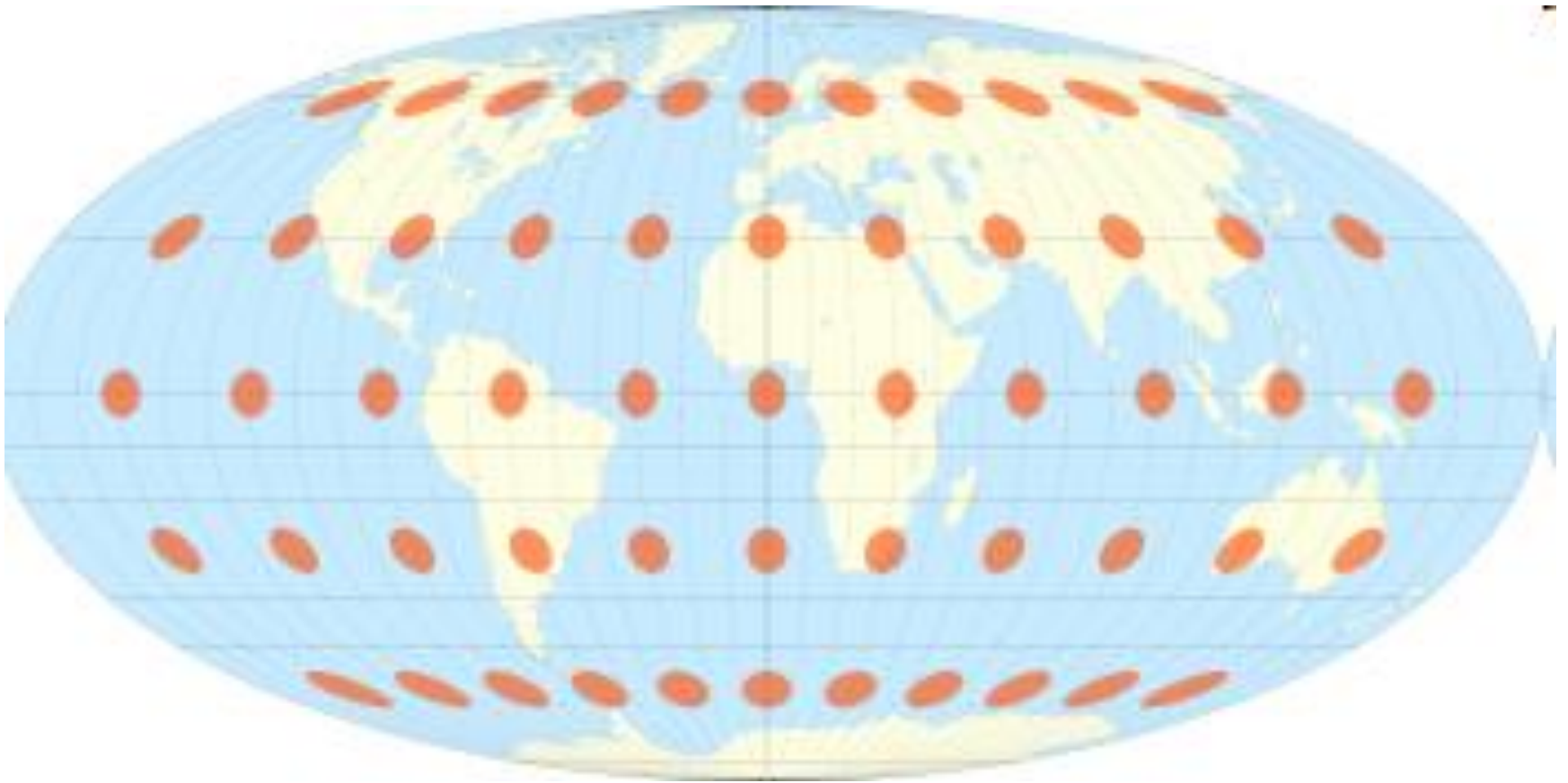
it does not 'project' the data, it only updates the 'metadata'

But to do 'analysis' e.g. hillshade, overlay, buffer, clip ..

Layers should be in the same projection (and not 'geographic')
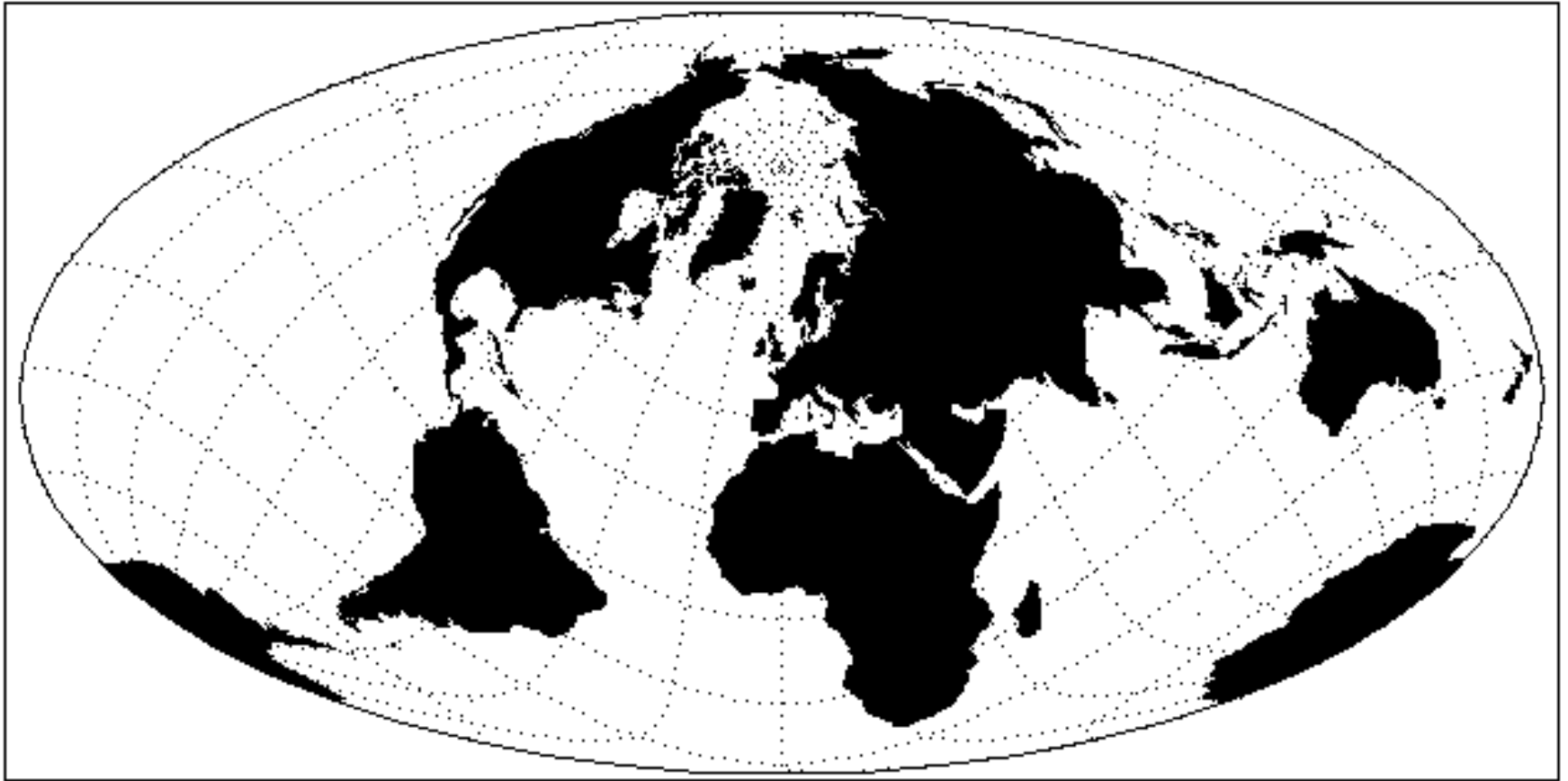
4. Pseudo-cylindrical projections

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

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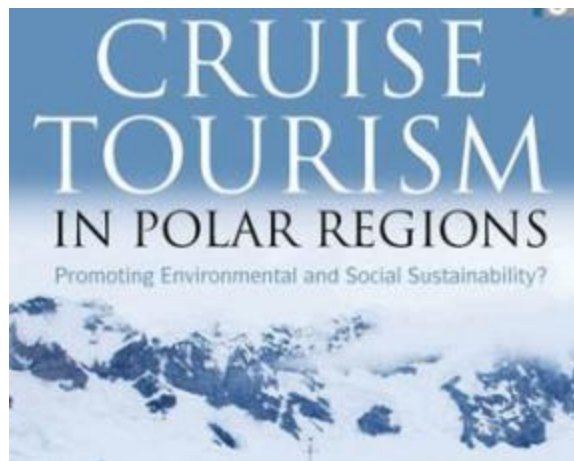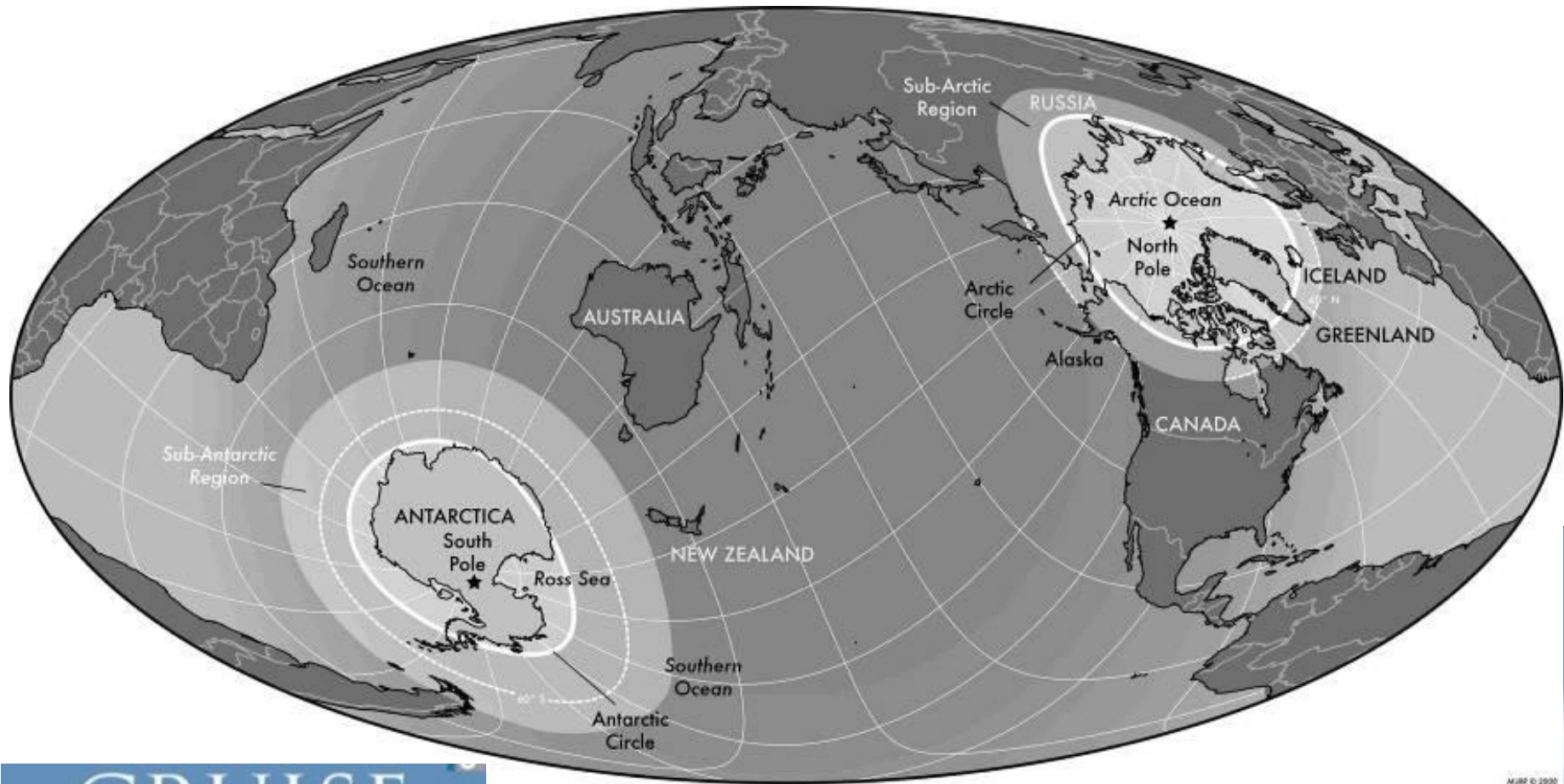

Tissot's Indicatrix of distortion

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 (equal-area) to show both poles: UNBC co-author

Summary – use of projections

By 'developable surface' / geographic area
    = 'where does the surface touch the globe'

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, usually 2 for least distortion

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 / line

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

Map projections supported in ArcGIS Pro

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

Nice 6-minute video on projections:
if we don't get time to see it in class, get a coffee / ale and watch it at home

https://www.youtube.com/watch?v=kIID5FDi2JQ

Quiz 3: coming via Moodle later today / weekend, due next Thursday