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

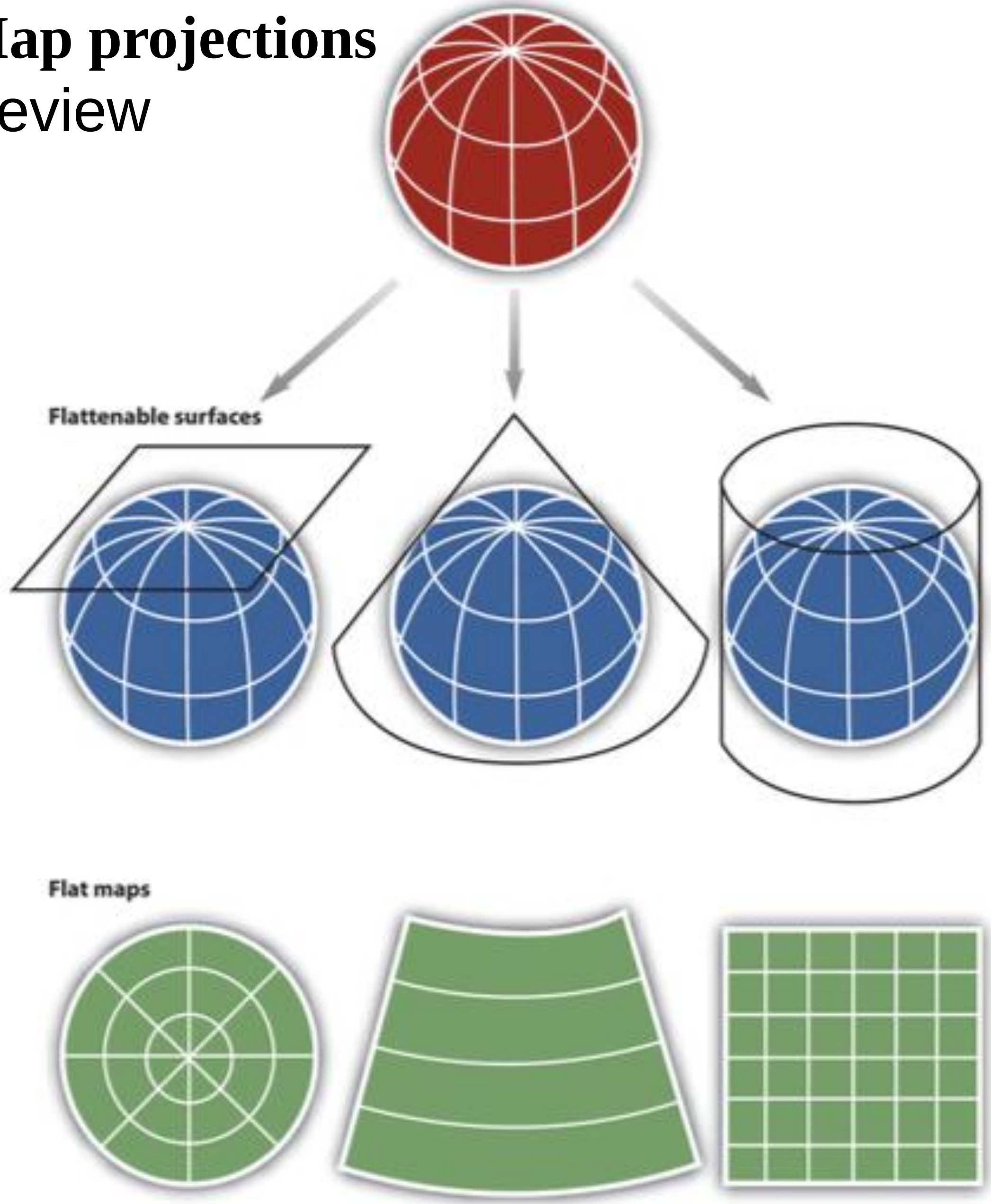
Digital mapping / GIS

= much easier to convert between projections

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

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

Map projections
Review



Major groups based on projection surface

Azimuthal, Conic, Cylindrical + Pseudo-cylindrical

Sub-groups based on projection orientation:
Azimuthal: polar, equatorial, oblique

Cylindrical: normal, transverse, oblique

Conic: normal

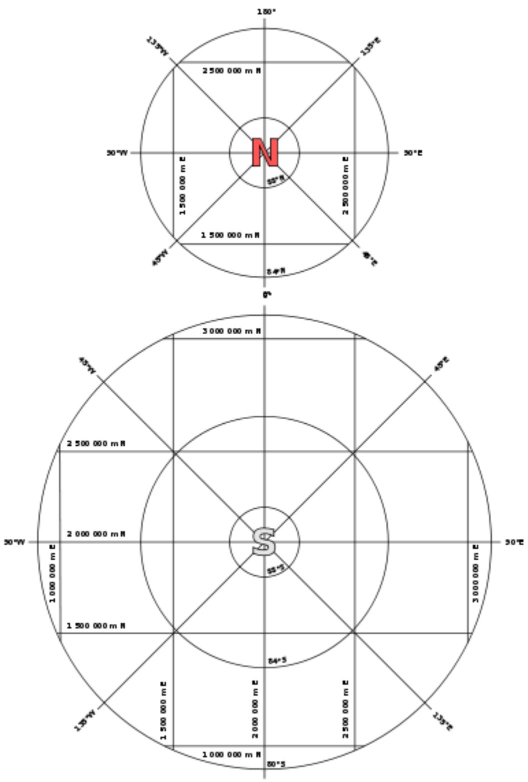
Pseudo-cylindrical: normal, oblique, interupted

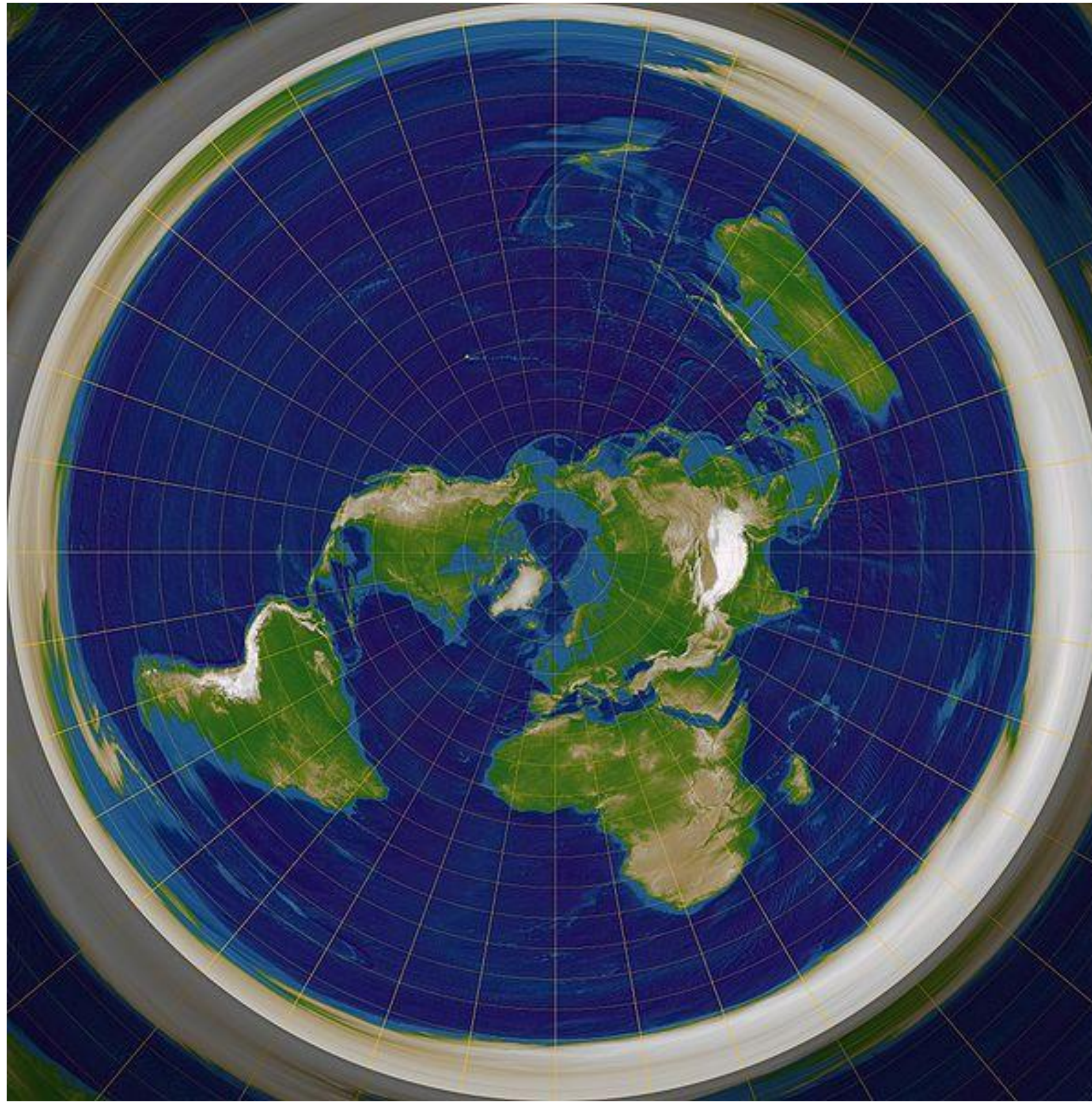
Properties : **area, shape** also distance, direction

1. Azimuthal

UTM is NOT used above 84N / 80S

Stereographic is used to map Polar regions (UPS) coordinates

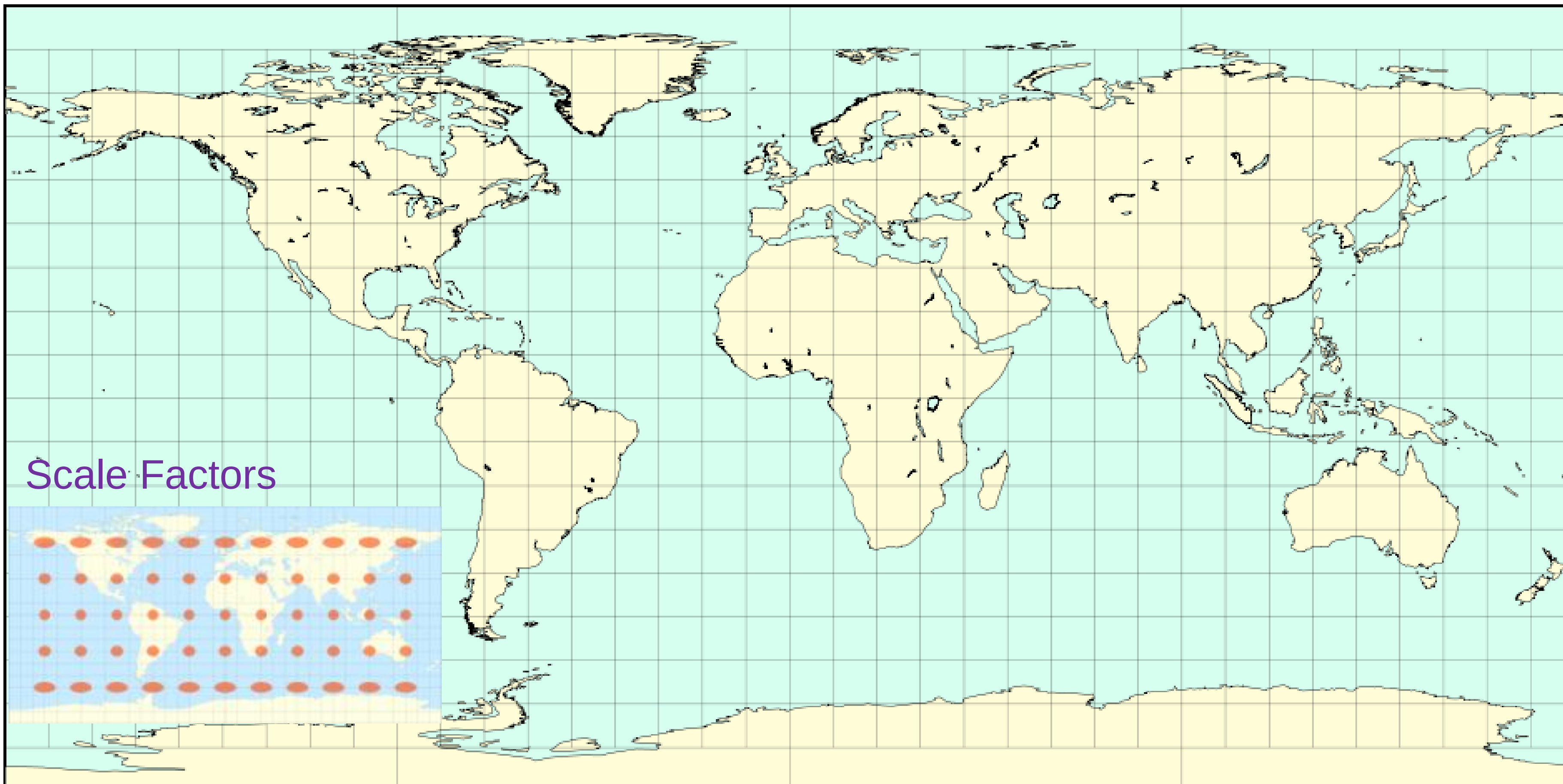




2. Cylindrical: Plate Carrée (‘square’) = equi-rectangular

[Eratosthenes 200BC]

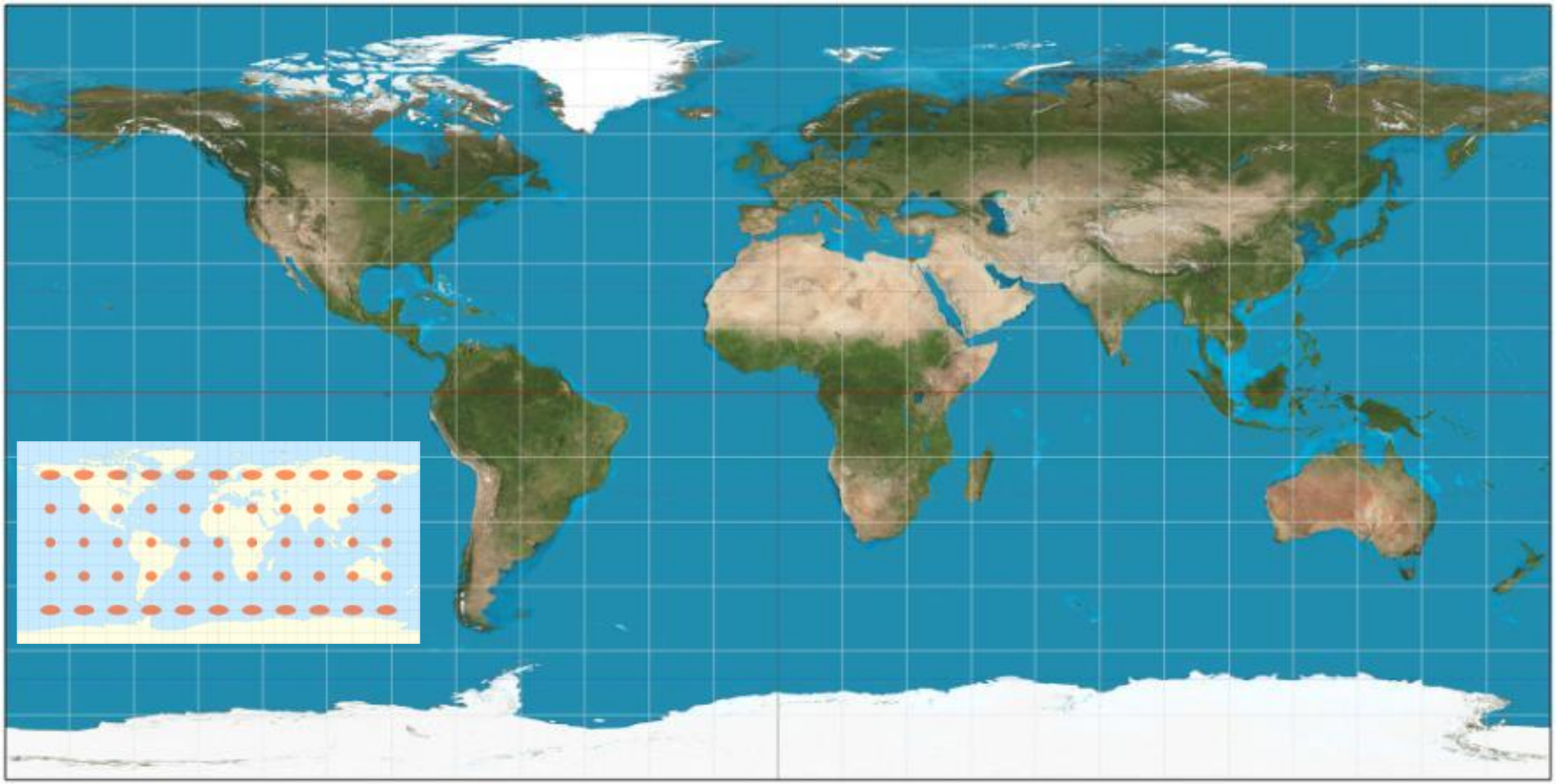
One degree is the same everywhere; easy to draw manually
Does NOT preserve shape or area;
it is **equidistant** …. From the equator north and south



= Digital / GIS: ‘Geographic’ or ‘unprojected’

One degree is the same everywhere

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 (between 84N and 80S)
Polar areas –Arctic and Antarctic use the **azimuthal stereographic projection** and Universal Polar Stereographic (UPS) coordinates

Some countries/regions modify the UTM system so it all fits in one ‘zone’ e.g.

Irish Transverse Mercator (ITM) System (2001)

Ireland: 5.5 -10.5°W

[UK: 5.7W - 1.7E]

And within one UTM zone Northings are reduced to a local base for 6 digits

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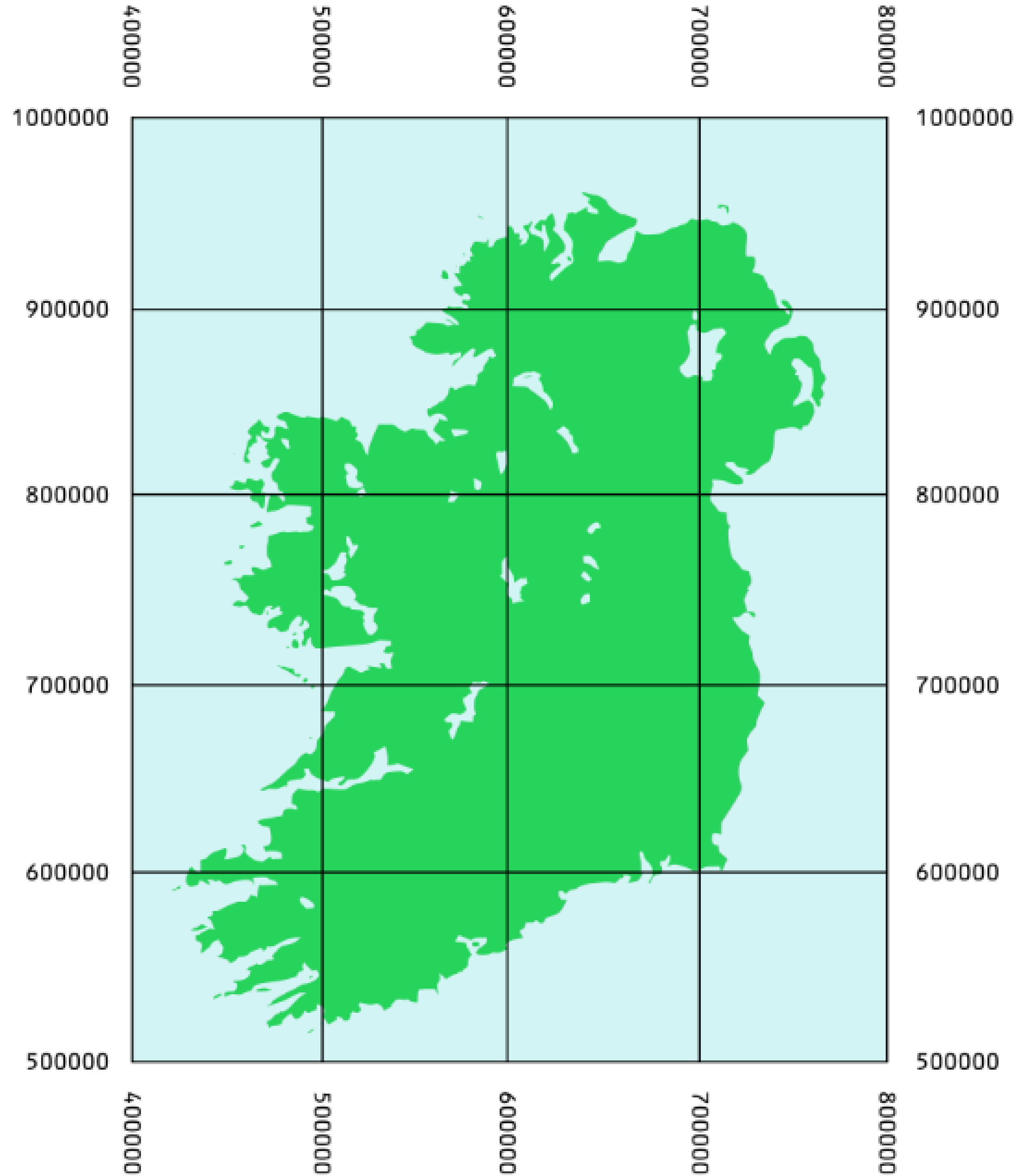
Alberta 10TM system

110° W to 120° W

centred on 115° W

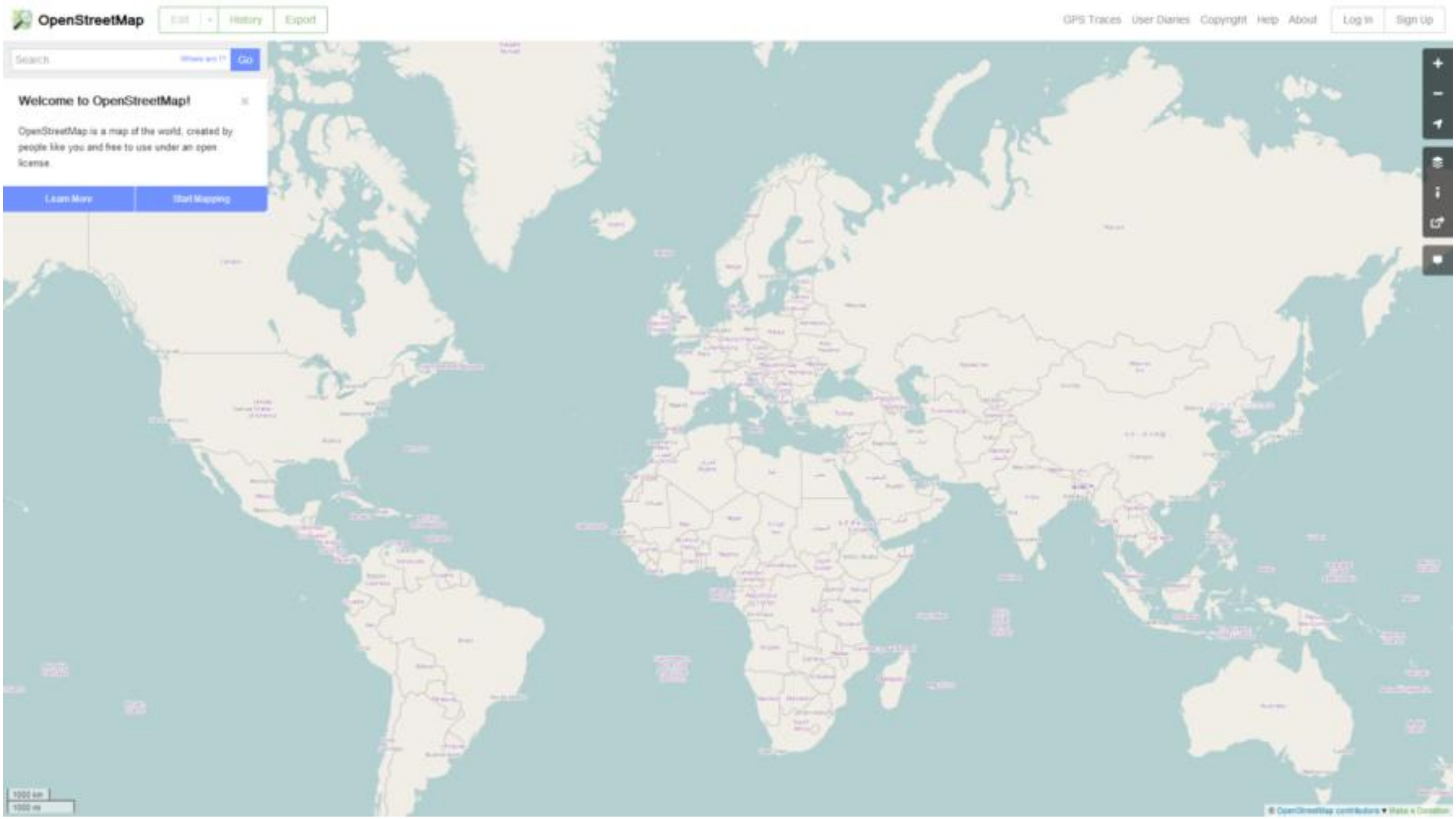
parts of UTM zones 11-12

11: 120-114W, 12: 114-108W



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

Gerhardt Mercator

Mercator still rules the world ….

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

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

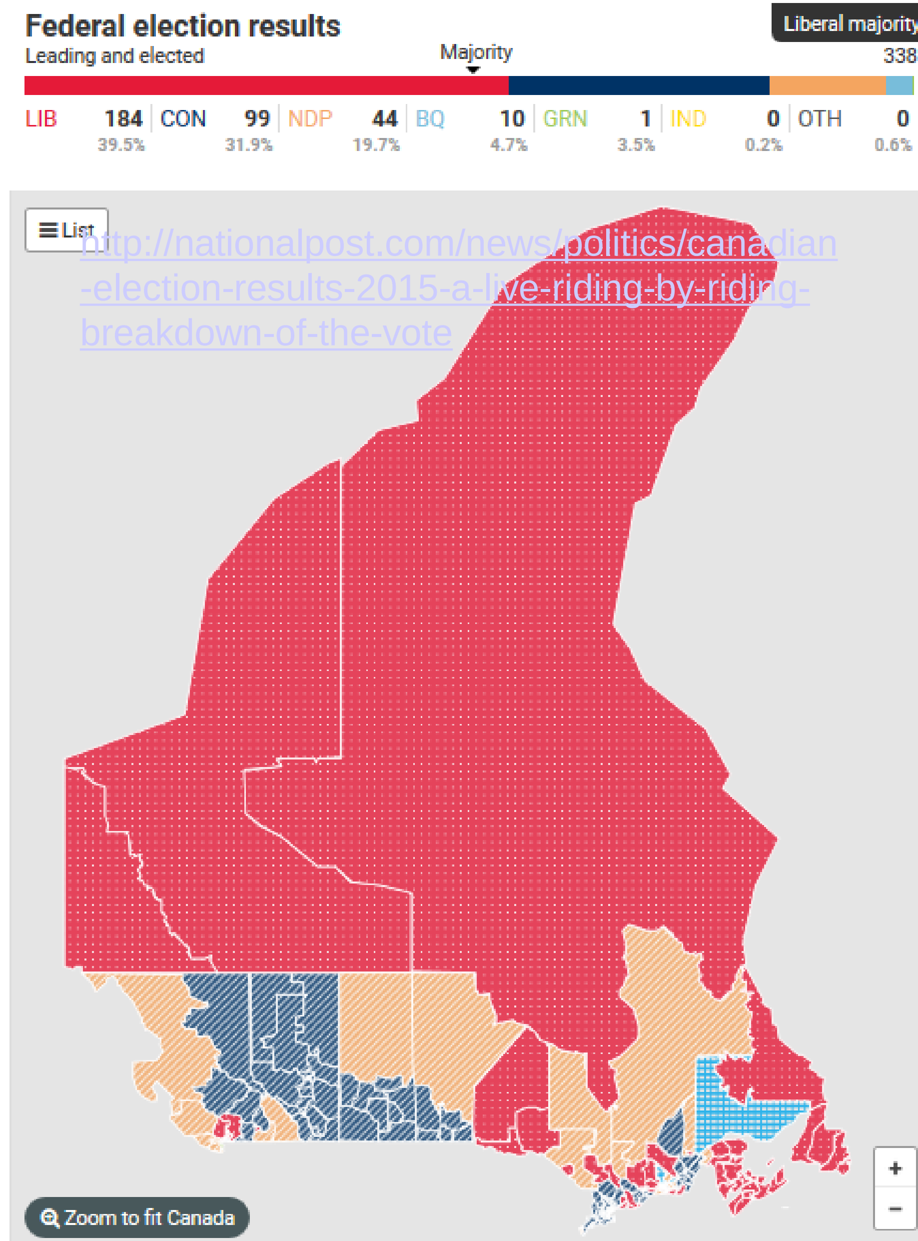
(there replaced by the Azimuthal Polar Stereographic)

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 ..

Online map servers all 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 !!

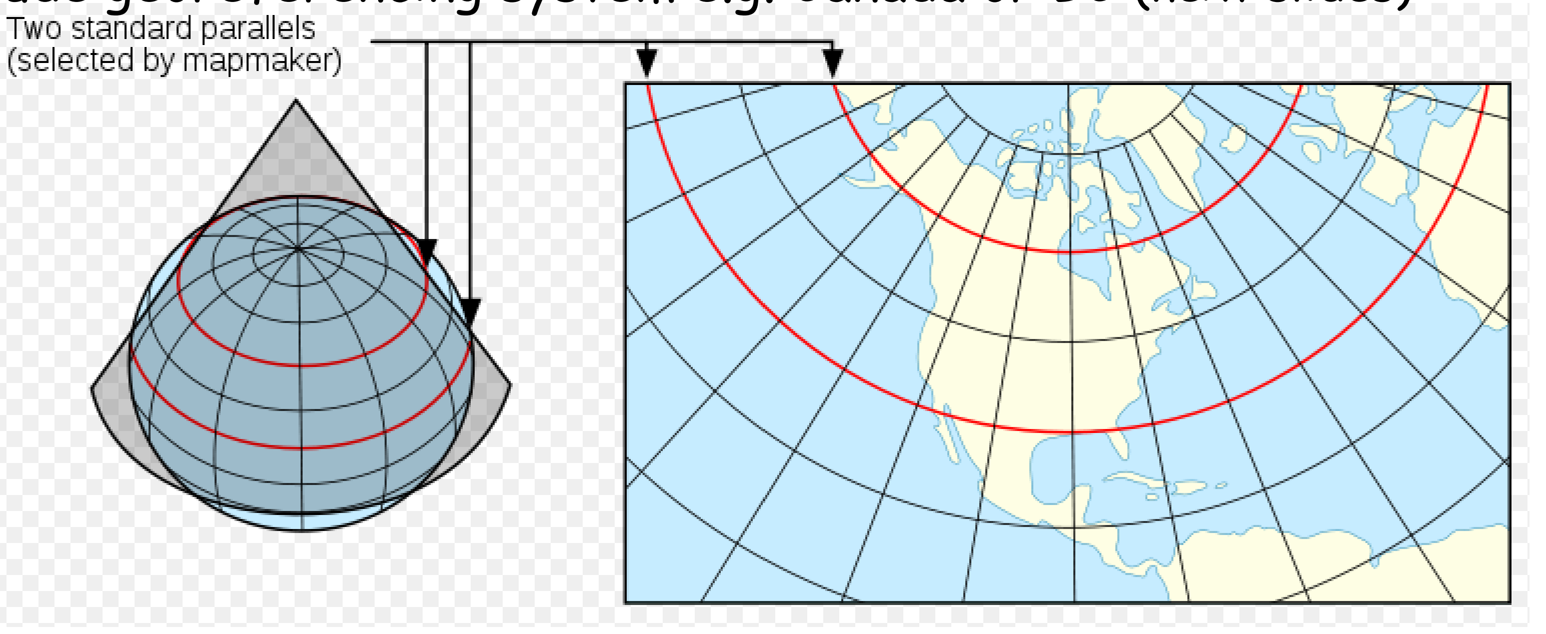


http://nationalpost.com/news/politics/canadian-election-results-2015-a-live-riding-by-riding-breakdown-of-the-vote

Canada – web Mercator

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

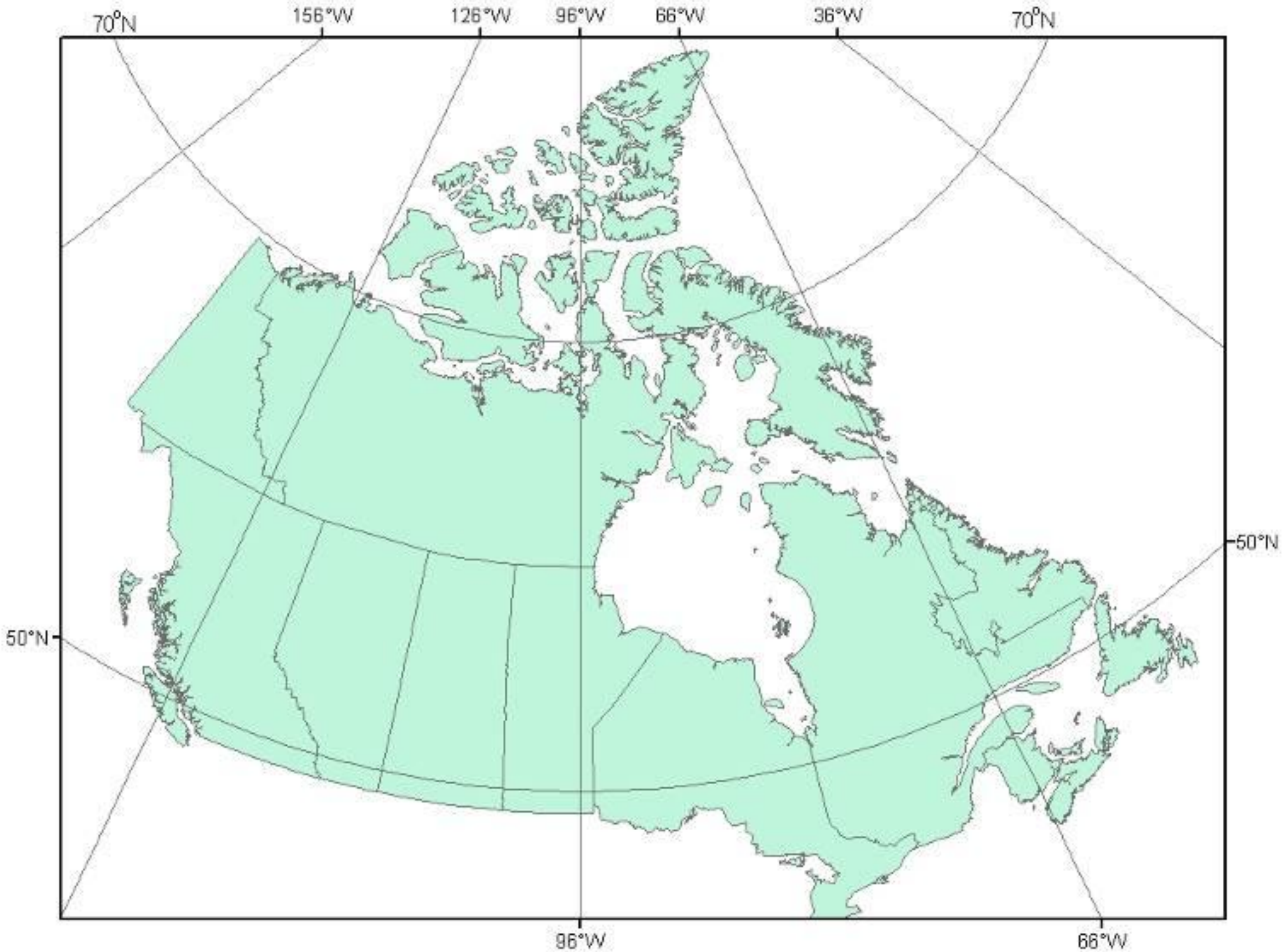
First Standard Parallel: 50   Second Standard Parallel: 70

Scale

Larger

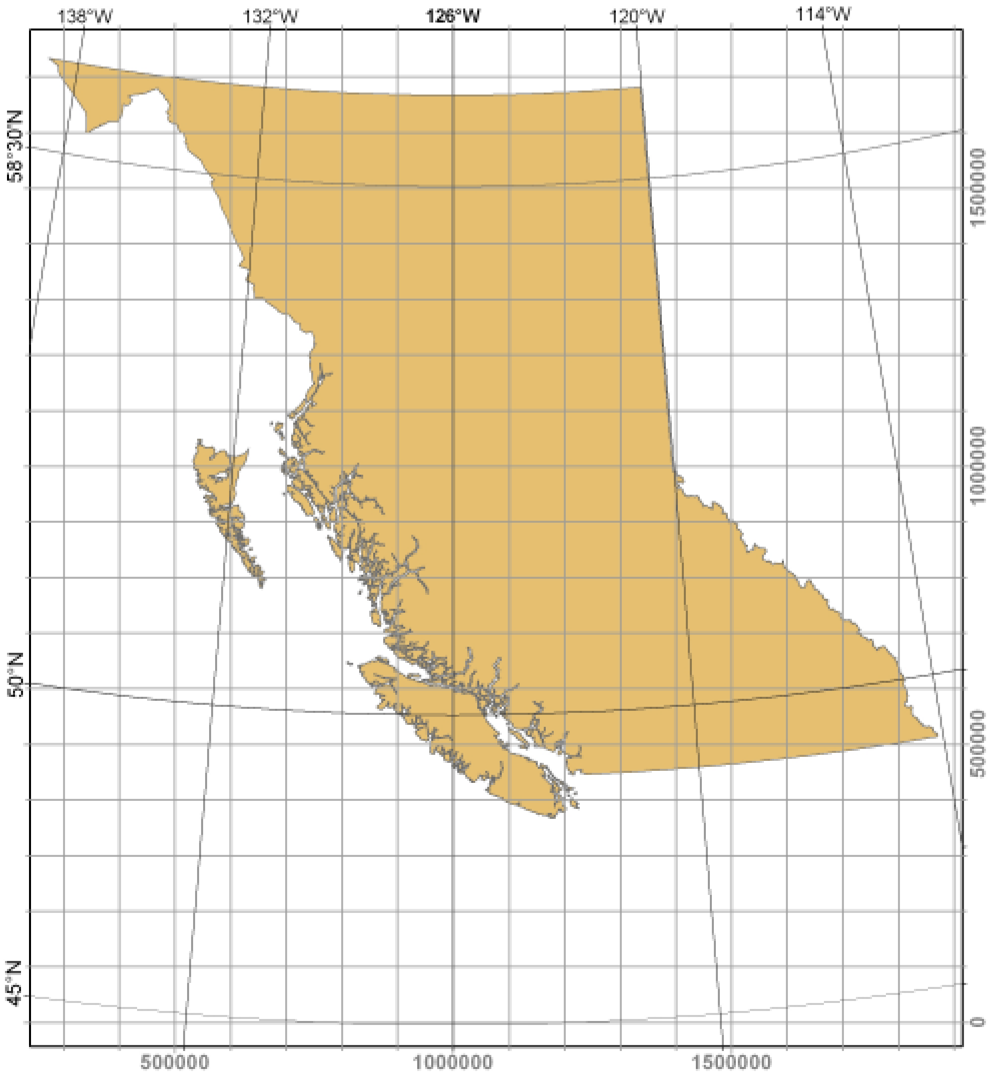
Slightly
Smaller

Larger



Download NTDB data using Geographic, UTM, 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

Multiple coordinate system layers

Georeferenced data can often be recognised by the coordinates

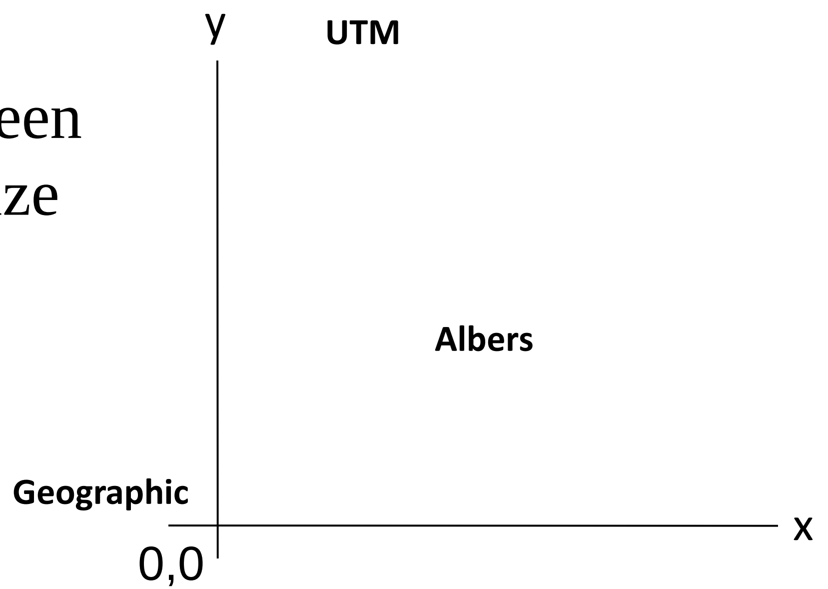
e.g. Prince George

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)



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

Multiple coordinate systems can be displayed together since 2000

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

You might have to do this if your project layers (hopefully not)

'Project define' tool**:** edits the metadata 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'

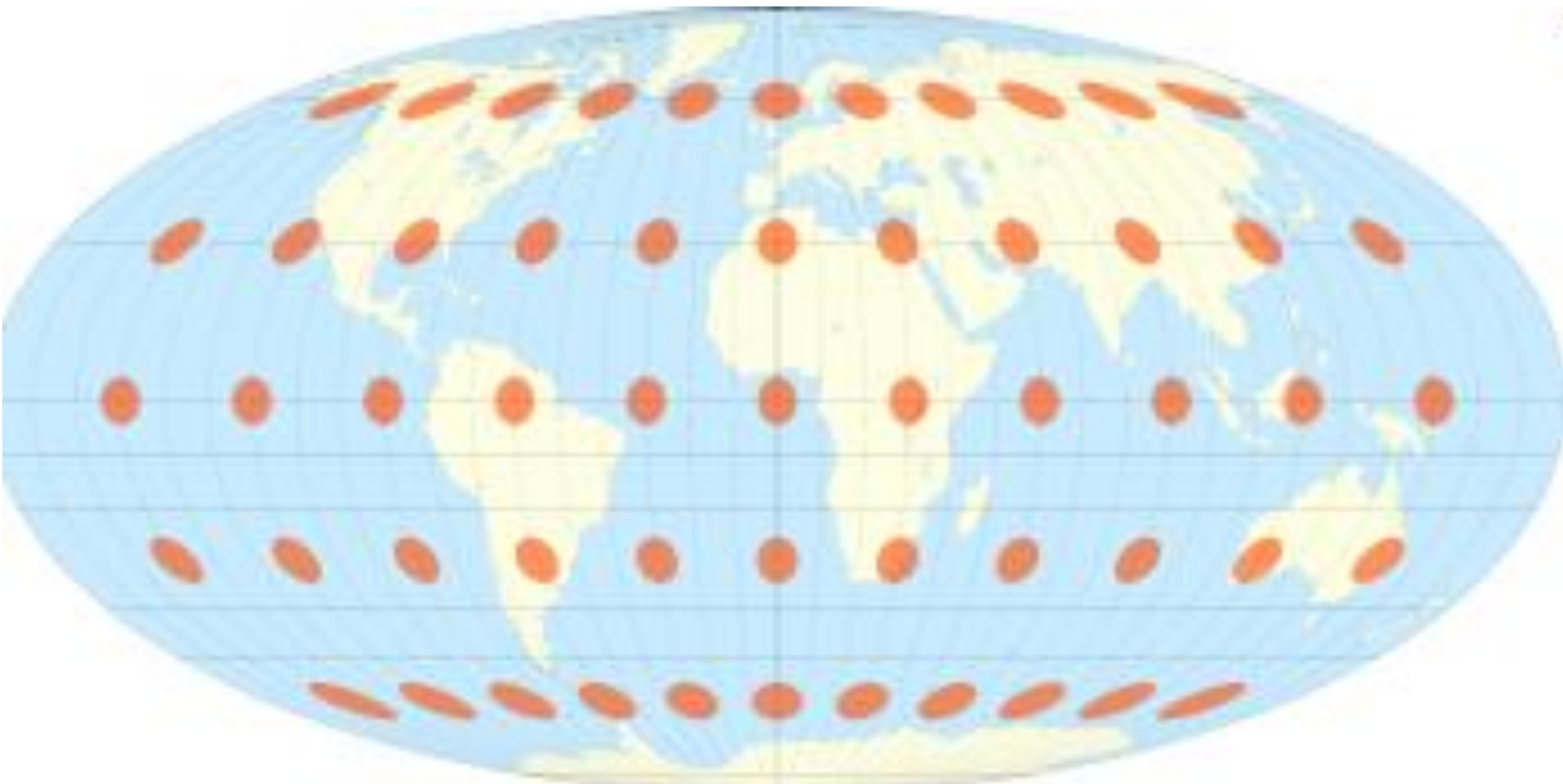
But to do 'analysis' e.g. hillshade, overlay, buffer, clip ..

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)

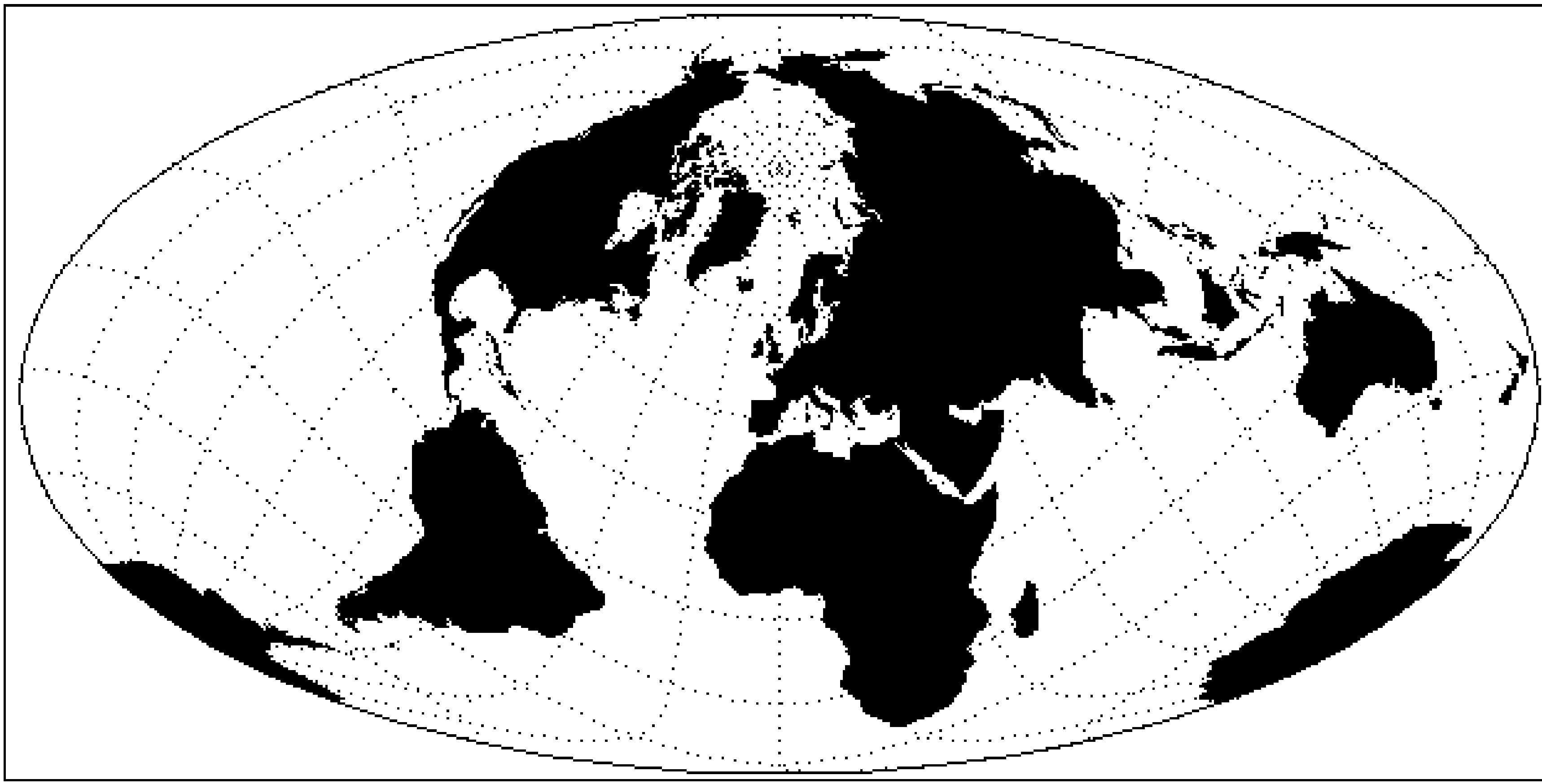
-19th century (and 20th)   e.g. Mollweide (used in atlases etc.)



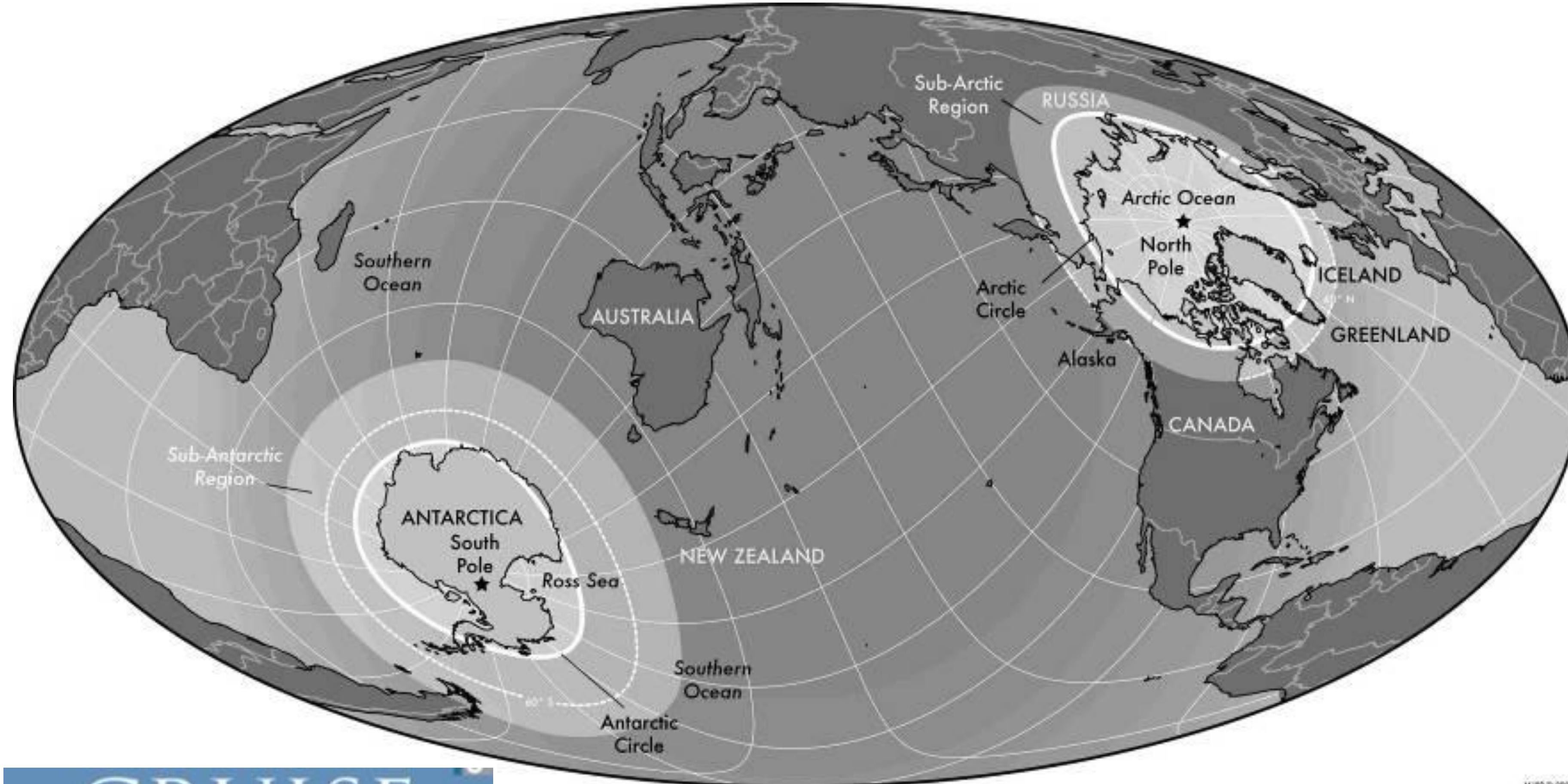
Tissot's Indicatrix of distortion

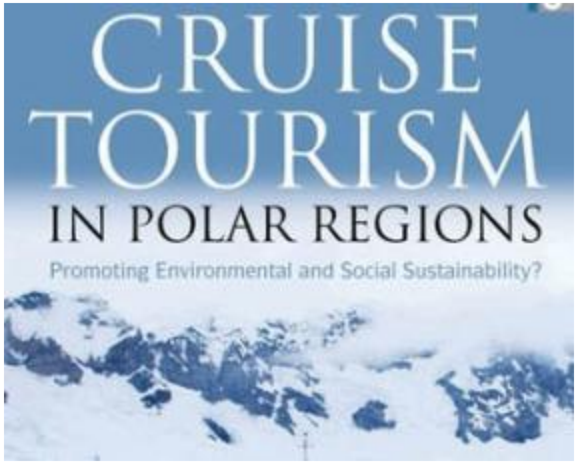
Oblique Mollweide

(obliques are used sparingly, rarely made manually)

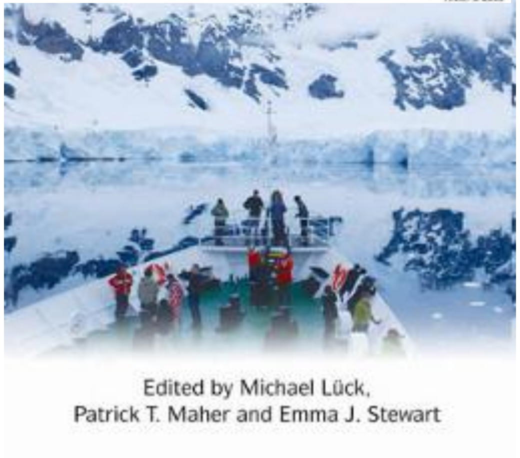


GIS and digital cartography have enabled easy generation of many projections





Clever use of oblique Mollweide (equal-area) to show both poles: UNBC co-author



Summary – use of projections

grouped 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

excellent 6-minute video on projections: may make some things clearer

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

March 13: GEOG 205 Course update: quiz and projects

Quiz 3: Map projections .. will be posted shortly after this class; due Wednesday

Labs next week, and remaining labs – Projects
I will post some 2024 examples on the webpages by the weekend, with guidelines

Lecture on Tuesday: 'Projects'
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

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

Lab week 9: data download

Lab 10: design/styling

Lab 11: Completion/write-up