Cartography

- Principles of design
- Sketch mapping
- Map datums
- Map projections
- Thematic Mapping:
  - Contour Lines
  - Isopleth and Choropleth maps
  - Some maps!
  - Introduction to critical cartography

Cartography is a complex combination of ART and SCIENCE

- design/production of maps by individuals or organizations
- scientific study of the technology of mapmaking and the effectiveness of maps as communication devices
- scholarly examination of societal role/impact of maps

A map is a representation of reality and needs at least some of the following:

- Graphic
- Scale
- Projection
- Symbolization

A map should be:

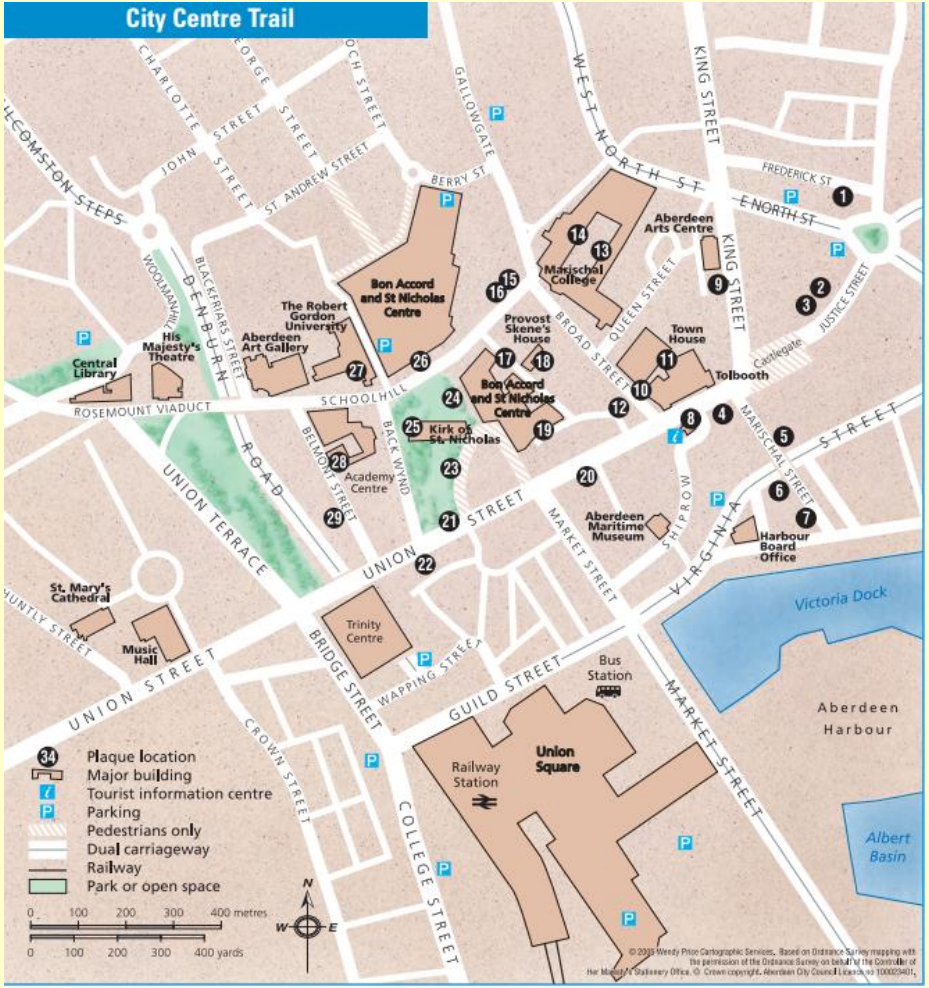
- Objective
- Legible
- Simple
- Balanced

Map design is dictated by:

1) The function of this map?
2) What needs to be depicted?

Sketch maps → selected and simplified details

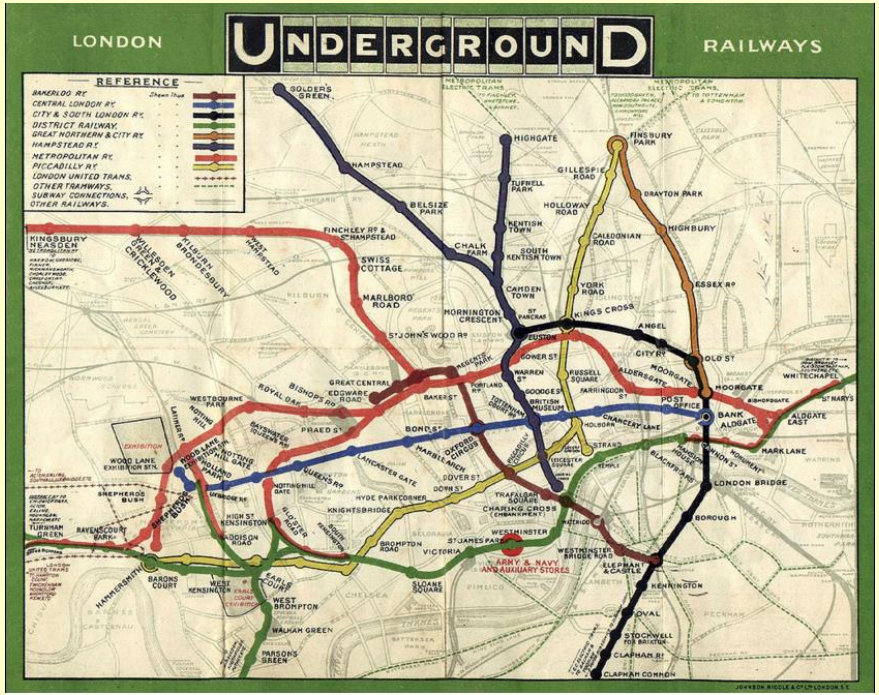
- Designed to show primary information only
- Navigation aided by key landmarks, no scale required



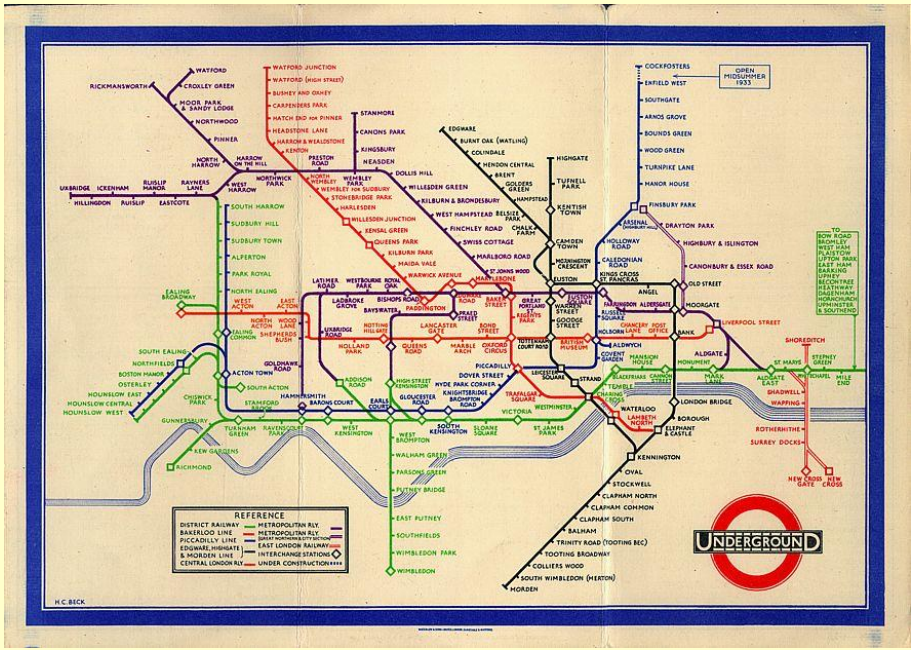
City of Aberdeen heritage trails guide www.aberdeencity.gov.uk/heritagetrails

Too much data can obscure the focus and function of the map!

Sometimes they don't even need a scale, or be spatially correct or include much information!

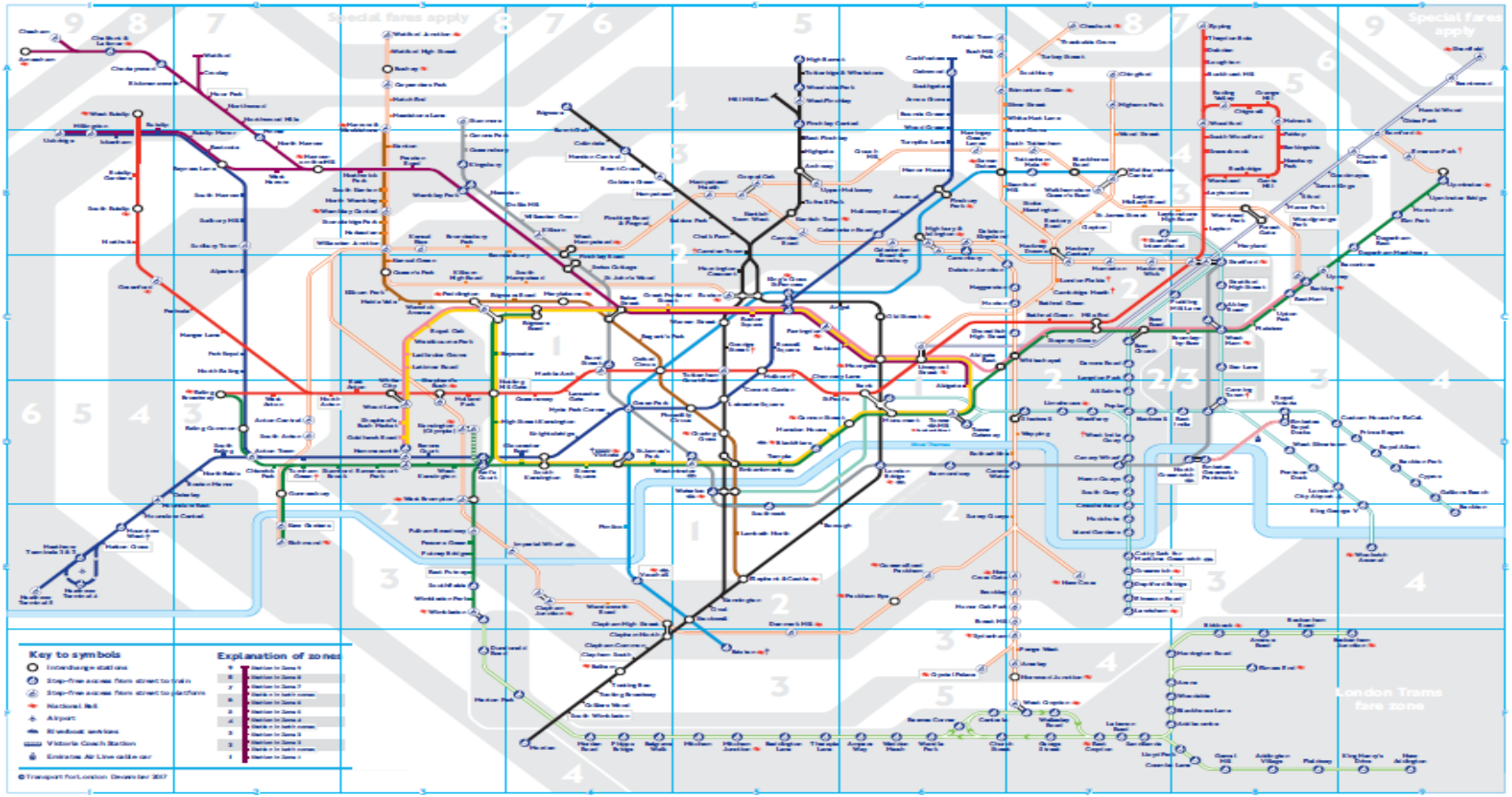


1909



1933

Tube map



MAYOR OF LONDON

tfl.gov.uk

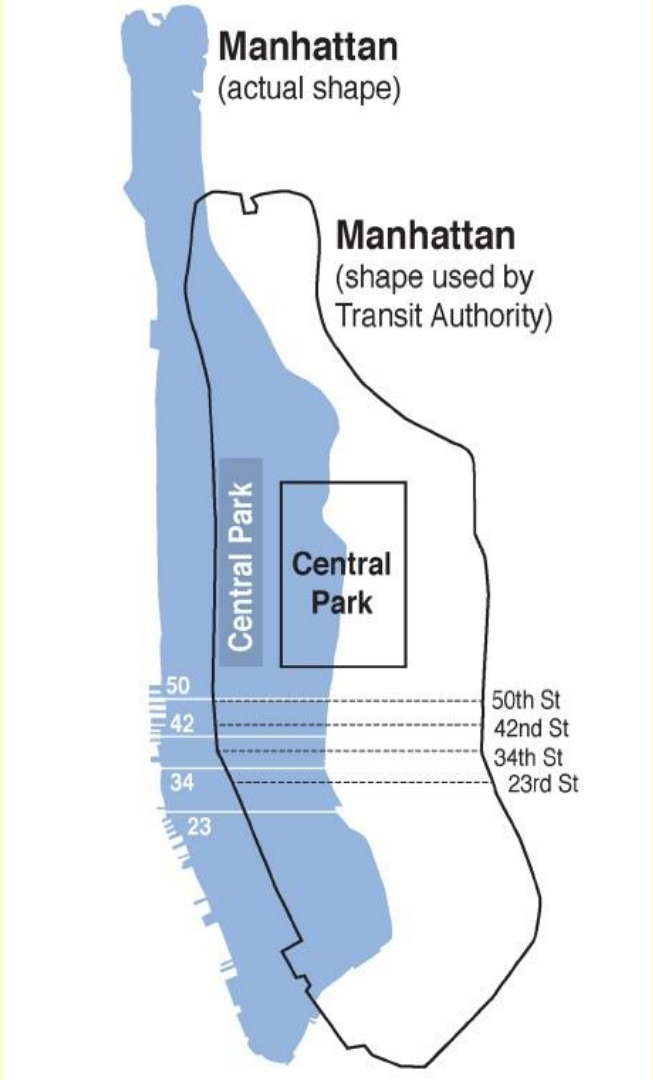
24 hour travel information
0343 222 1234*

Sign up for email updates
tfl.gov.uk/emailupdates

@TfLTravelAlerts

*Service and network changes may apply. See tfl.gov.uk/terms for details.

TRANSPORT FOR LONDON
EVERY JOURNEY MATTERS


Manhattan
(actual shape)
Manhattan
(shape used by
Transit Authority)
Central Park
Central
Park
50
42
34
23
50th St
42nd St
34th St
23rd St

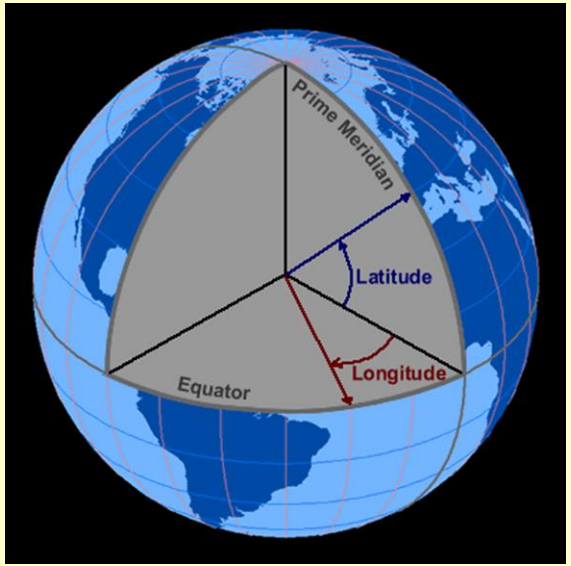

Metropolitan Transportation Authority
MTA New York City Subway
with bus, railroad, and ferry connections
THE BRONX
QUEENS
MANHATTAN
BROOKLYN
STATEN ISLAND
Subway Service Guide

When we need precision?

Position on a ‘Sphere’ – geographic coordinates

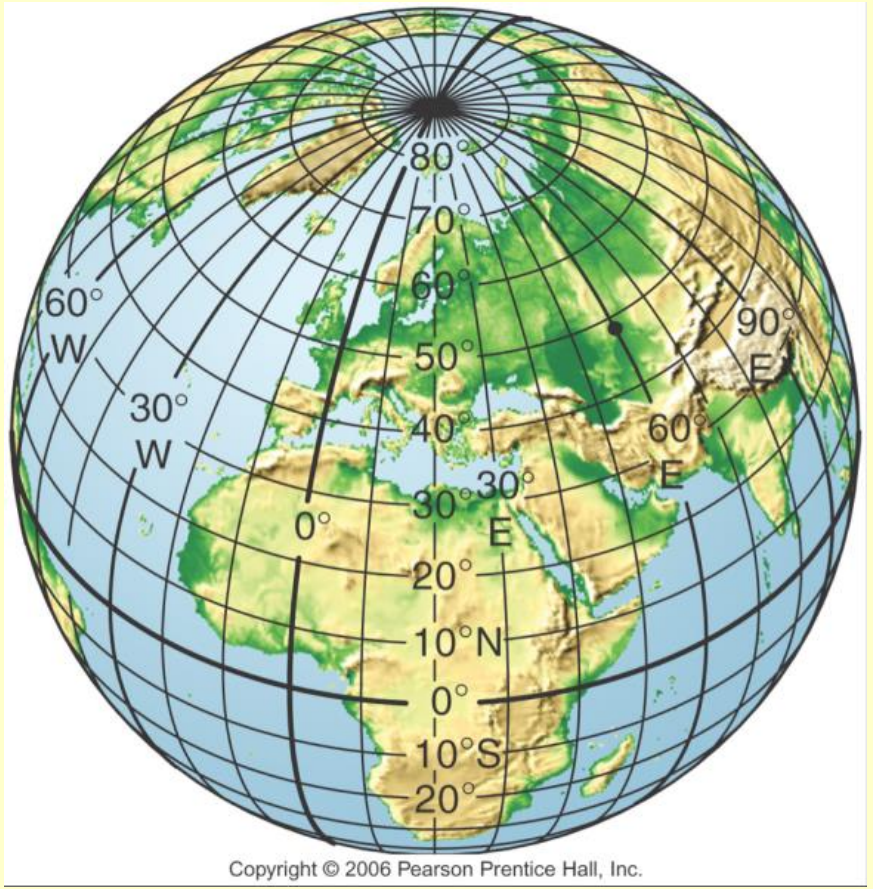
- Angle from equator (latitude)
- Angle from the prime meridian (longitude)

- Subdivisions (DMS notation)
  - 1° = 60 minutes
  - 1 minute = 60 seconds
  - Decimal degree or decimal second systems also common



Position on a ‘Sphere’ – geographic coordinates

- Position on Earth surface can be described with geographic coordinates
- Graticule - the mesh resulting from lines of latitude and longitude
- Distance between lines of longitude not constant
- No reference to depth/altitude at surface



Position on a ‘Sphere’ (Old Aberdeen)

Selected Location (Approximate)

Address: 81 High Street, Aberdeen, Aberdeen City AB24 3EH, UK
Latitude: 57.166178°
Longitude: -2.102415°
Accuracy: street_address
Status: 200

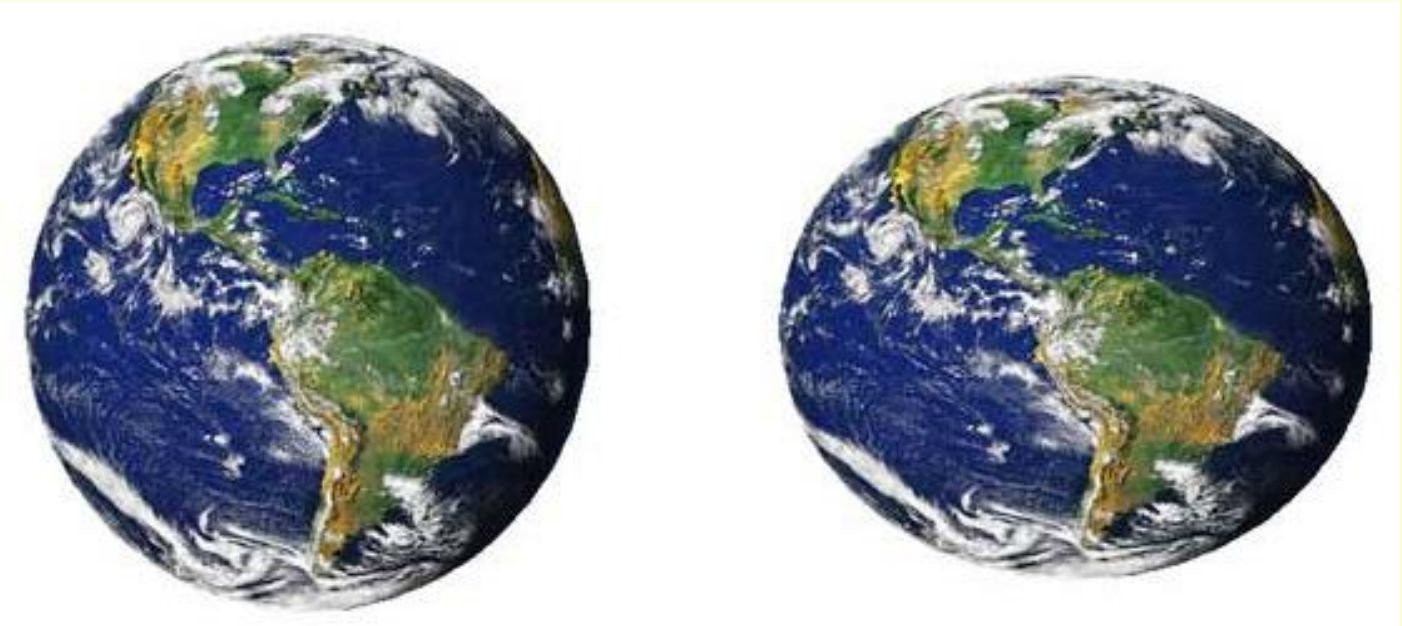
Map Coordinates of Selected Location

Latitude: N 57° 9' 58.6862"
Longitude: W 2° 6' 9.3604"
Latitude: N 57° 9.978104'
Longitude: W 2° 6.156006'
Latitude: 57.166302°
Longitude: -2.1026°

www.findlatitudeandlongitude.com

But the Earth is not a Sphere!

- It is more like an oblate spheroid



- The Earth's surface is irregular and cannot be exactly described mathematically

Geometric System

- A system to identify positions on the Earth

-> But how can we represent the Earth surface on a piece of paper or screen (i.e. in 2D)?

- Two issues: The earth is not a sphere and not flat

-> Need an approximation of its surface: **map datum** and a **map projection**

Geodesy

The science of accurately measuring and understanding three fundamental properties of the Earth.

1) its geometric shape

2) its orientation in space

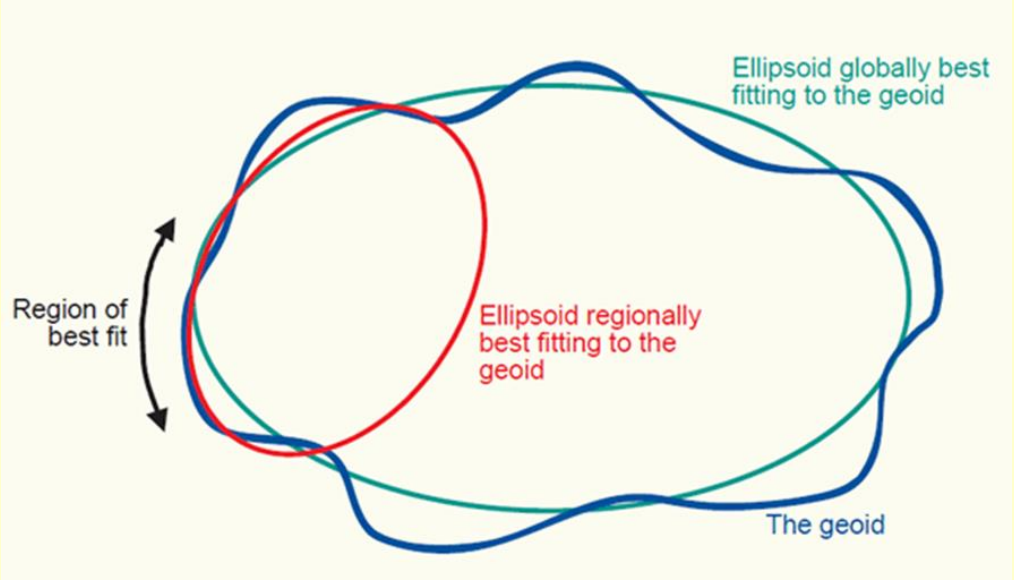
3) its gravity field

As well as the changes of these properties with time.

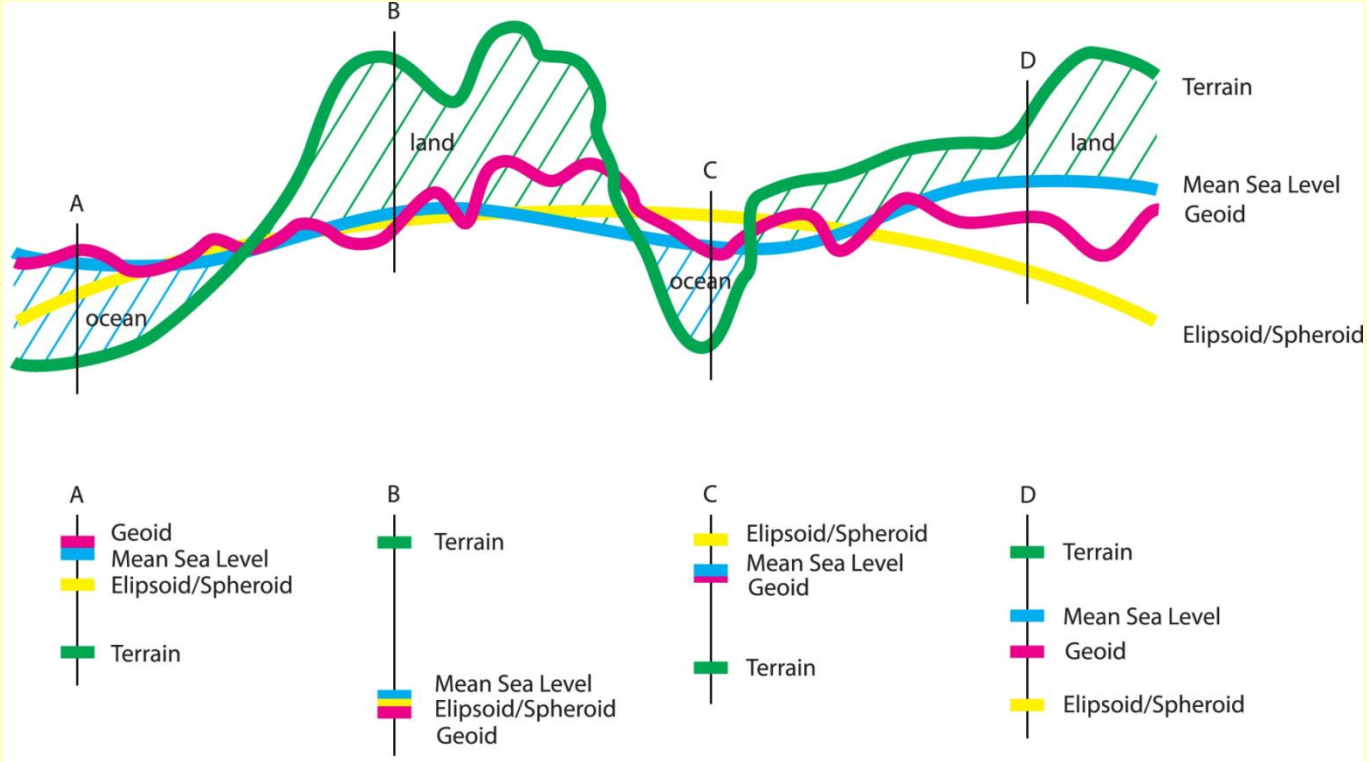
Geoid: imagined (hypothetical) solid figure whose surface corresponds to mean sea level (under the influence of the gravity and rotation of Earth alone)and its imagined extension under (or over in some cases) land areas

A Datum Defines:

- A reference ellipsoid which approximates the Earth's surface – globally or regionally
- The centre and orientation of this ellipsoid
- A coordinate system with a set of control or reference points

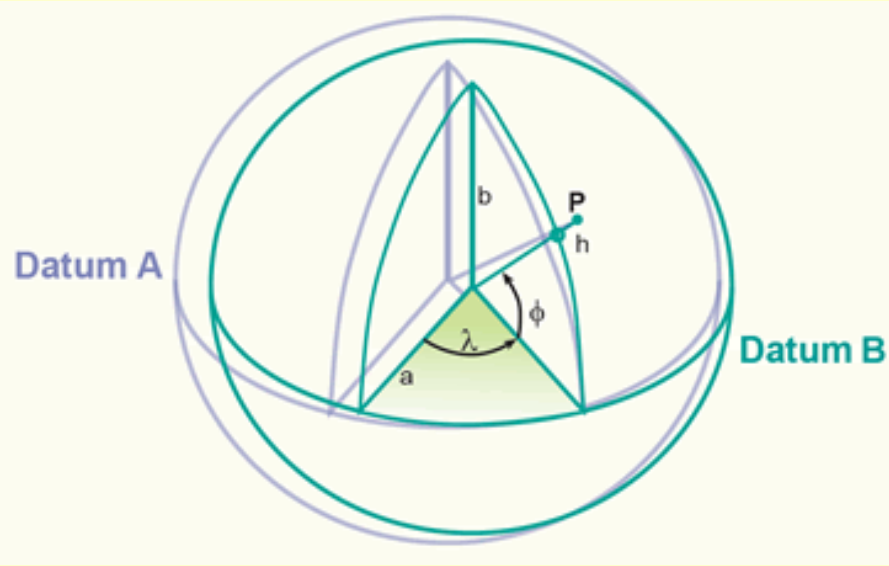


Heights relative to Mean Sea Level (Vertical Datum)



Datum Shift

A given position is only useful if you know the datum!



DATUM SHIFT: The distance between the same coordinates in two different datums– and it can be significant (up to a km)

Putting detail on - triangulation

- Method for accurately calculating an unknown point using points we already know!
- Trigonometry: rules of triangles to determine unknown points using known points and known angles
- Important technique for surveyors until rise of GPS in 1980s

Triangulation stations and benchmarks

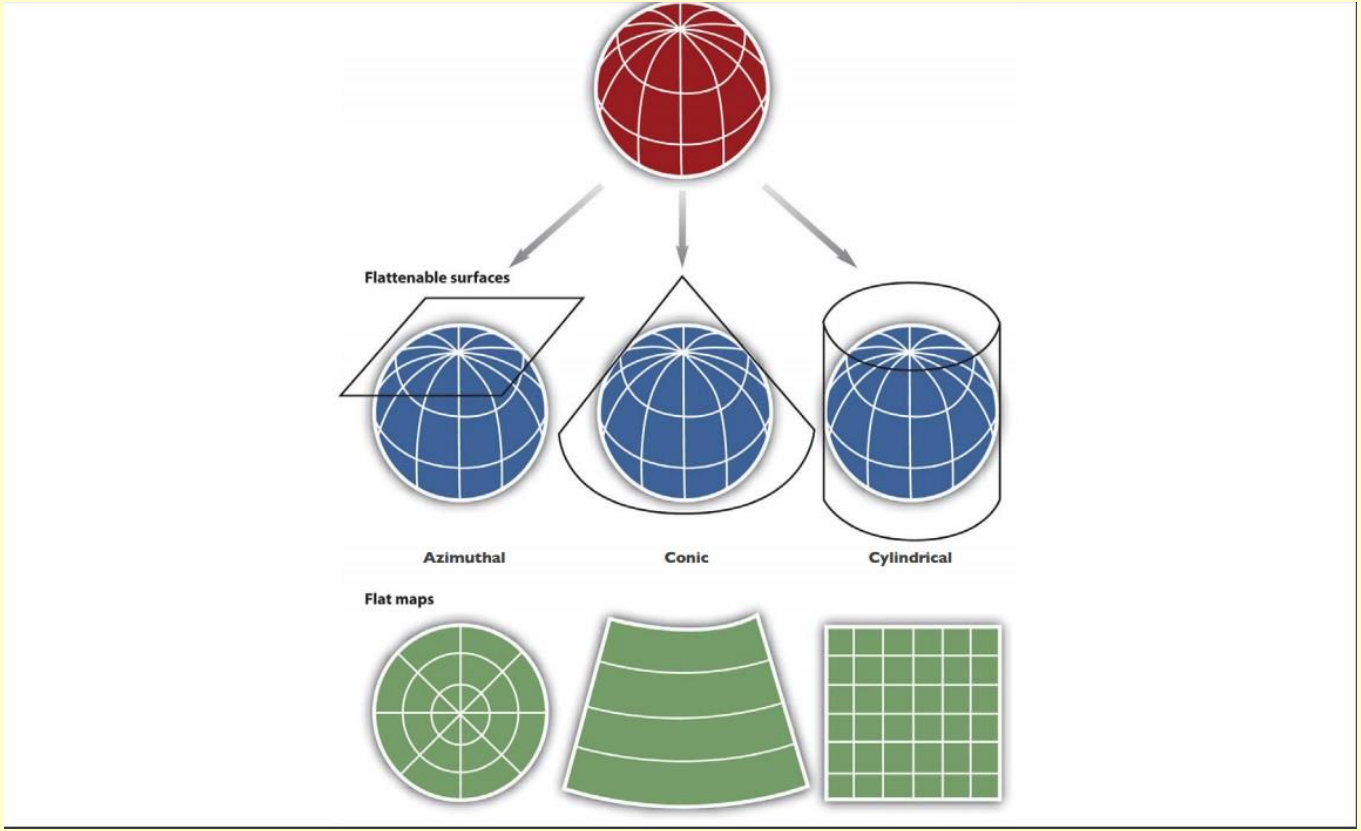
Markers of precisely known horizontal position (triangulation station) and vertical elevation (benchmark)

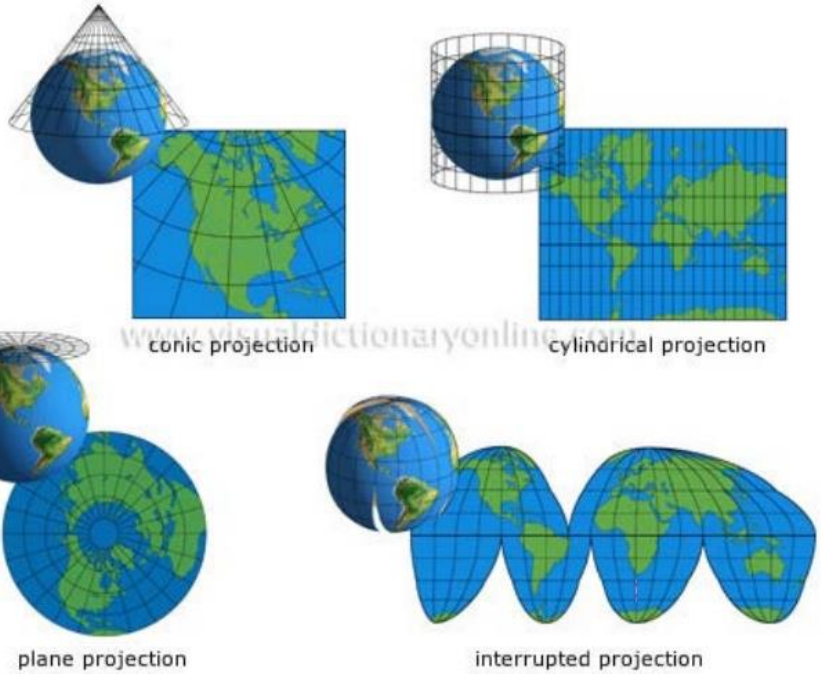
Projection ‘families’

Geometric shape of paper (flat surface!) that the spheroid is projected on

These can be:

- Planar/azimuthal
- Conic
- Cylindrical

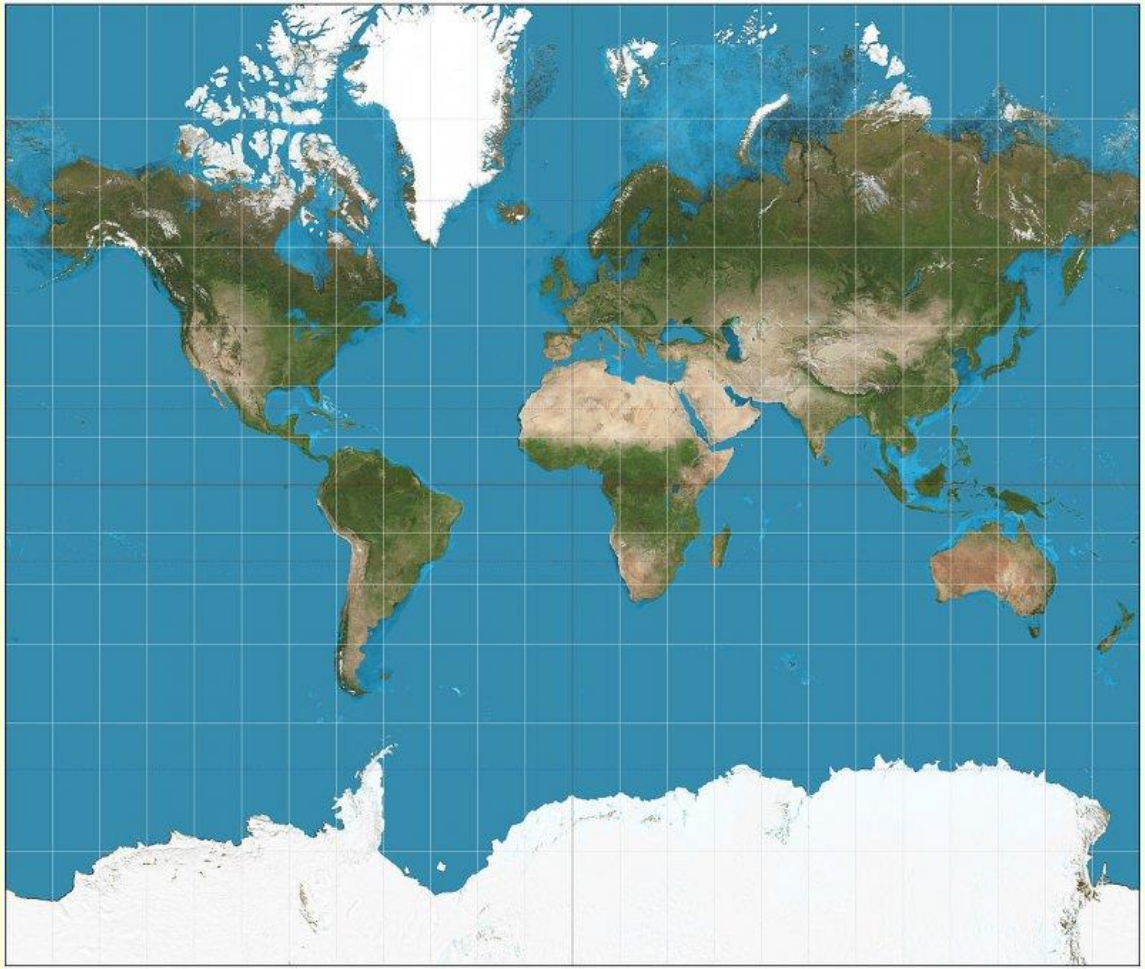



conic projection
cylindrical projection
plane projection
interrupted projection

Many different map projections (usually named after its inventor)

Most well-known projection?

Mercator Projection (1569)!

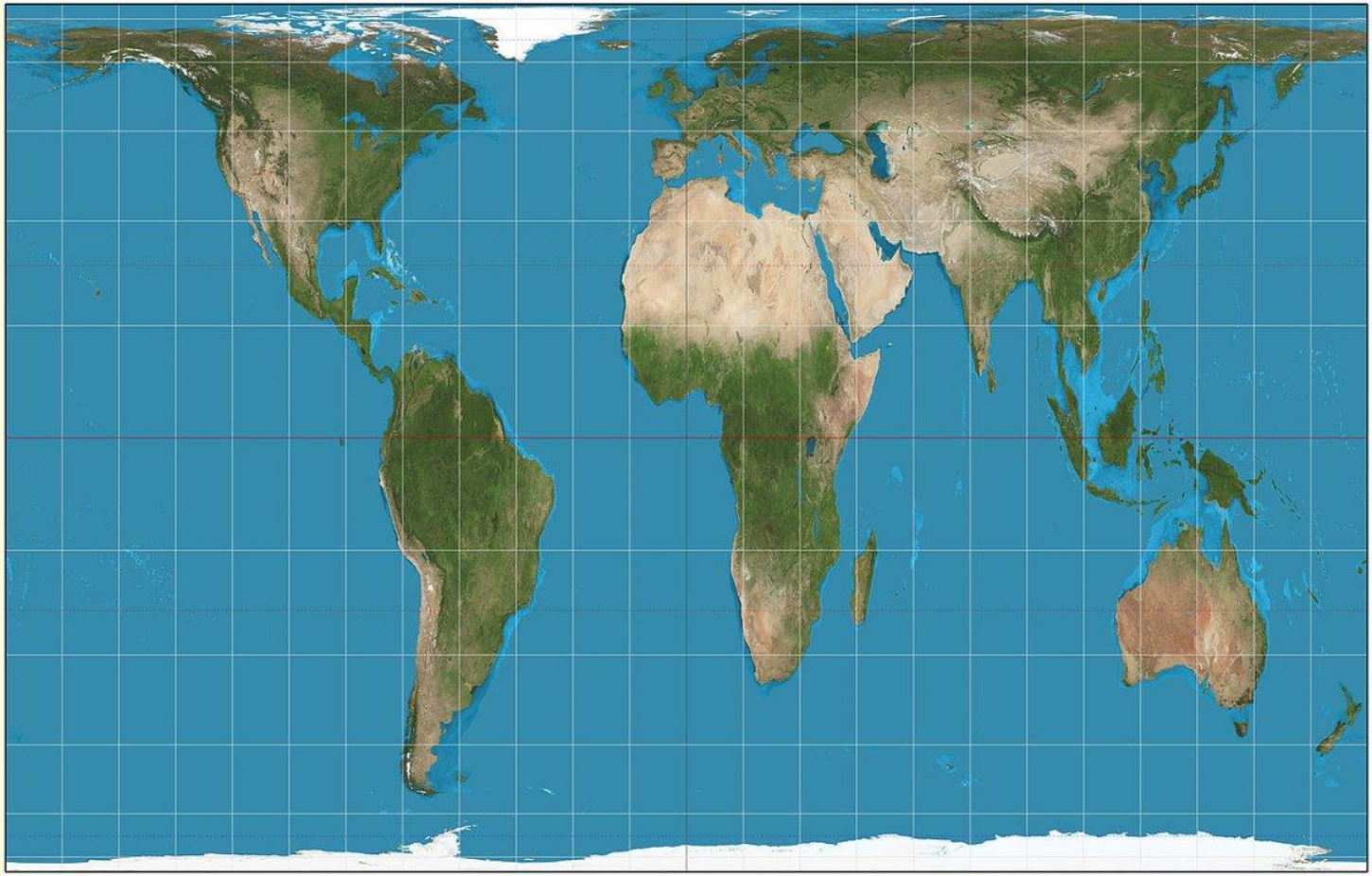


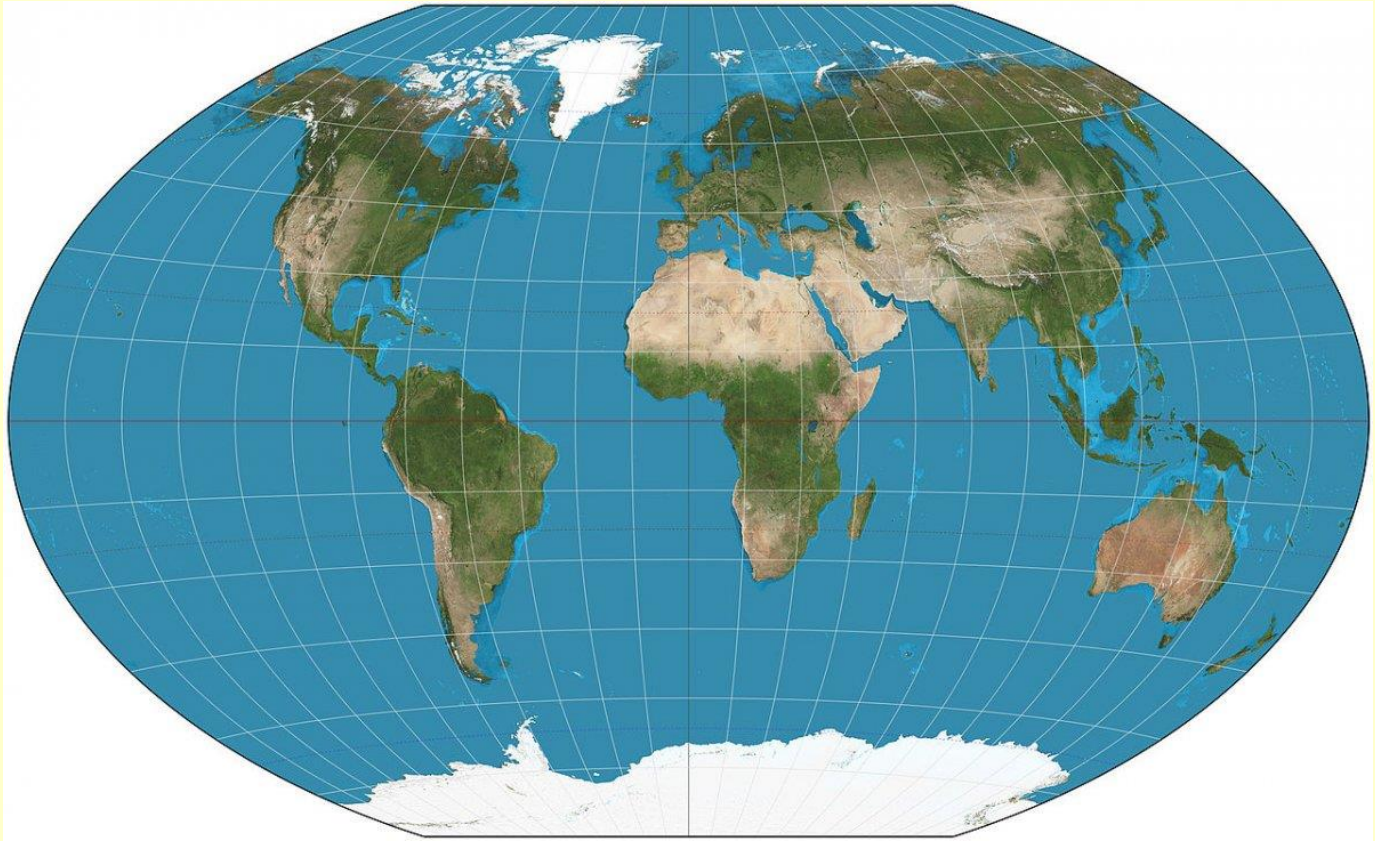
Mercator Projection

- Designed for navigation
- Preserves direction bearing
- Forms of this projection used by Google, other online data sources!

Gall-Peters Projection

- Sought to correct distortions of Mercator
- Relative size of places more accurate
- Still distorted in other ways





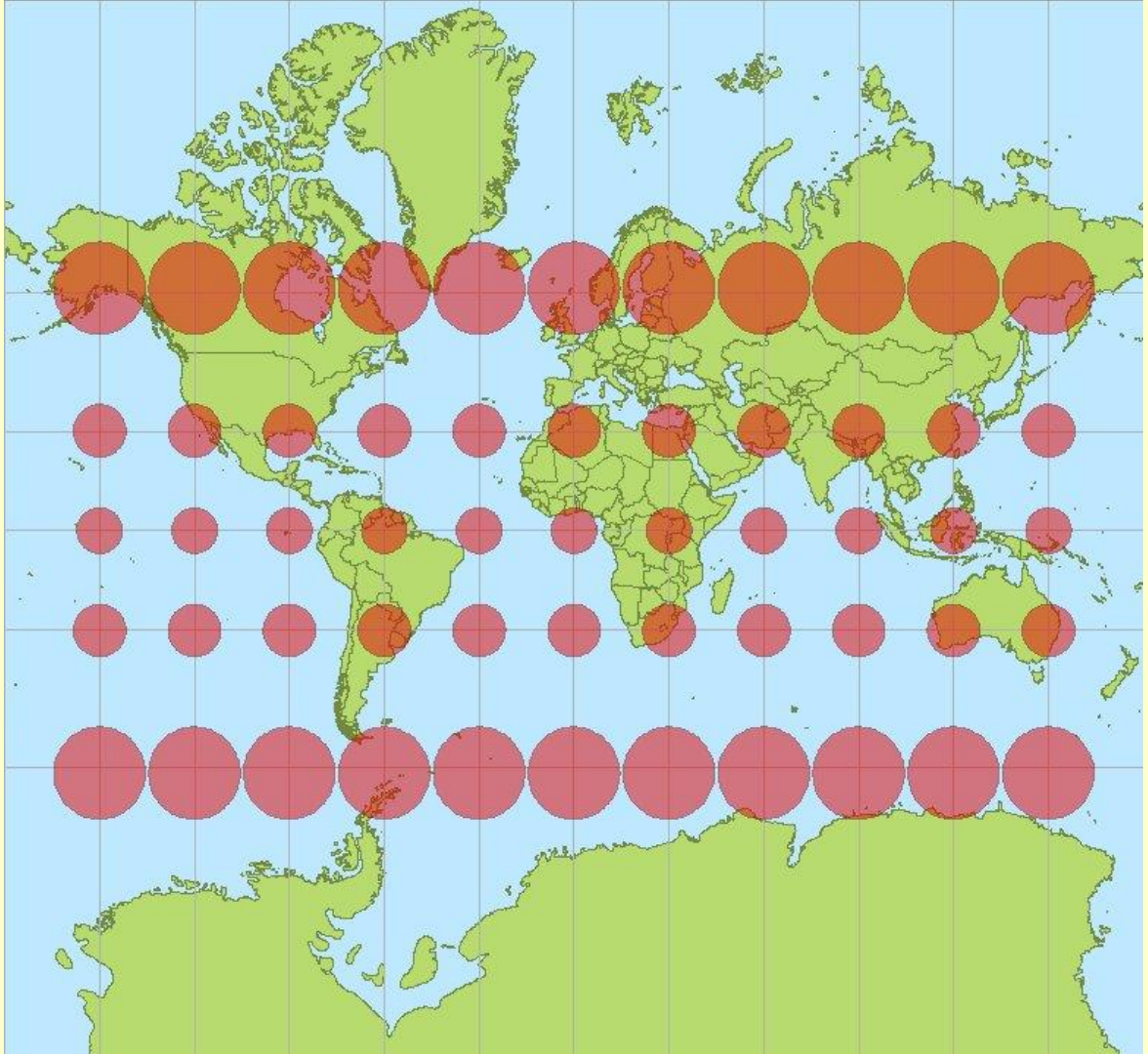
Winkel tripel projection (1921)

- Less distortion
- Standard map of National Geographic Society
- Often standard in schools

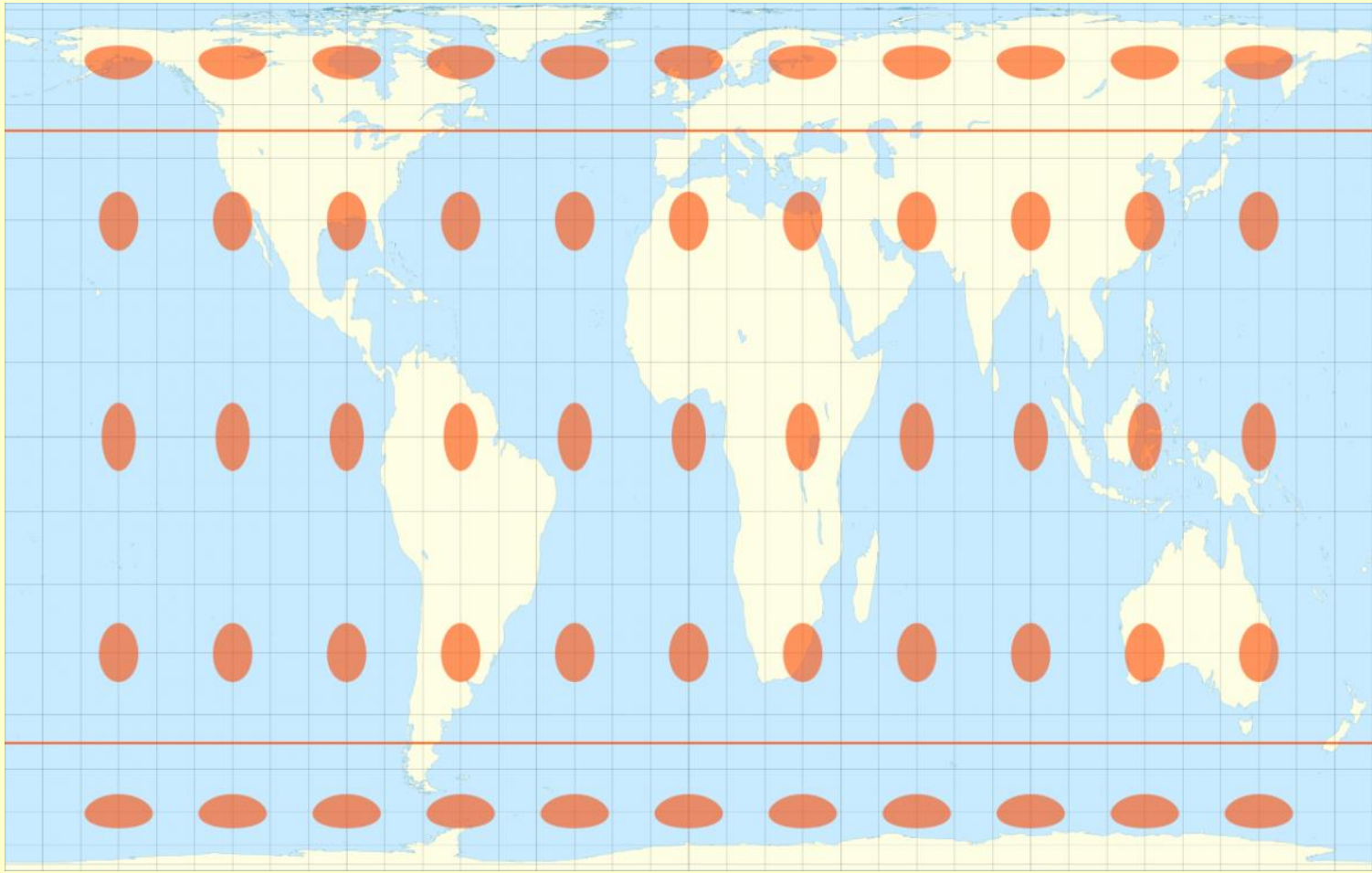
Tissot’s Indicatrix:

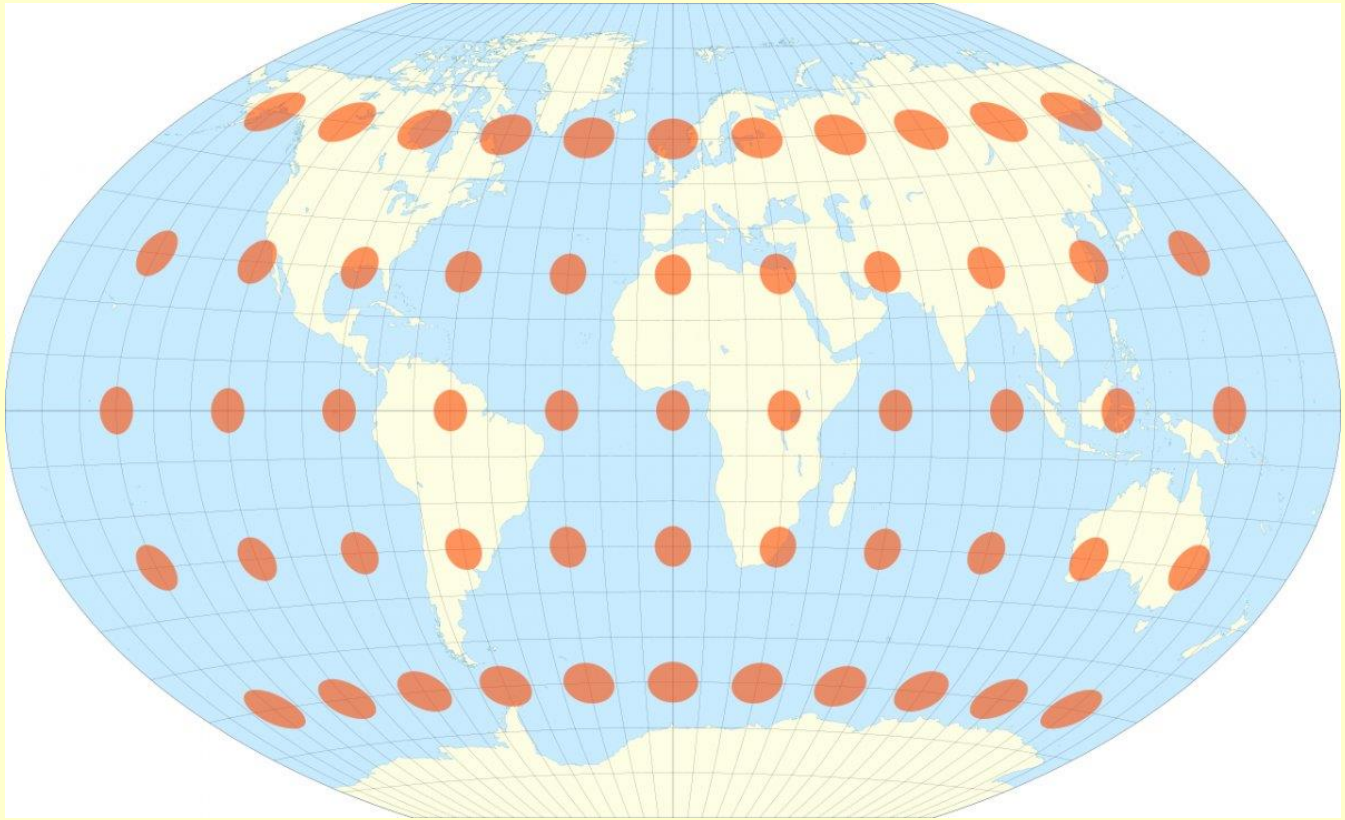
Geometric equation showing distortion on maps

(Mercator Projection)



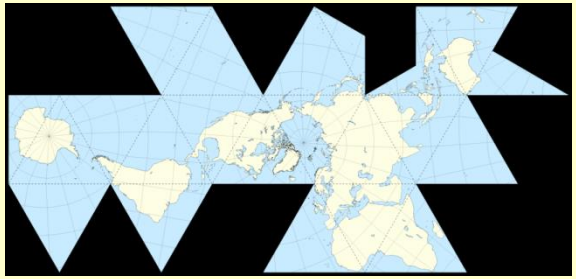
Gall-Peters Projection



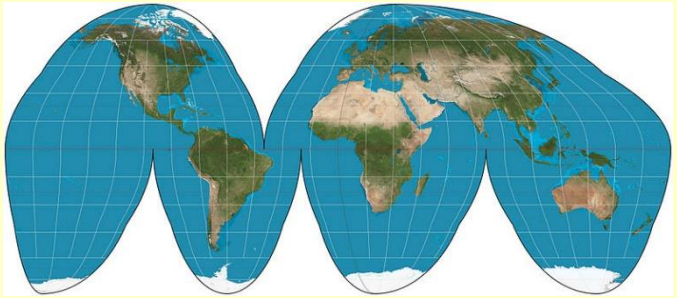


Winkel tripel projection

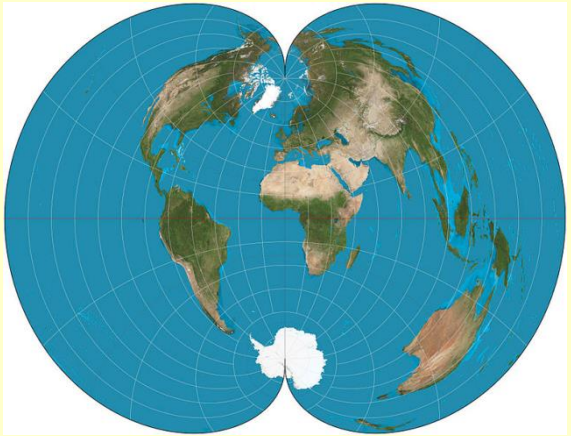
There are many other map projections:



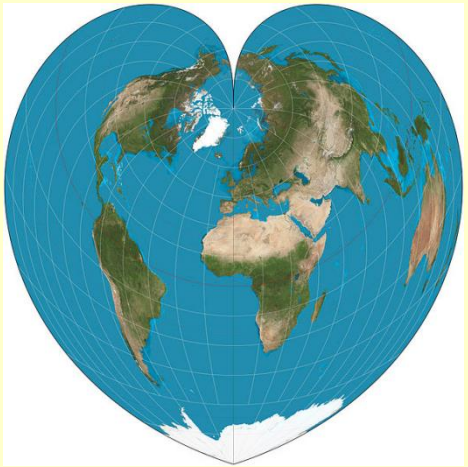
Dymaxion/Fuller Projection



Goode projection



American polyconic projection



Werner projection

Thematic mapping

‘maps which depict information on a particular topic…

may be physical, statistical, measured, or interpreted, and sometimes requires specialist knowledge by the map user’

(definition according to Intergovernmental Committee on Surveying and Mapping, Australia)

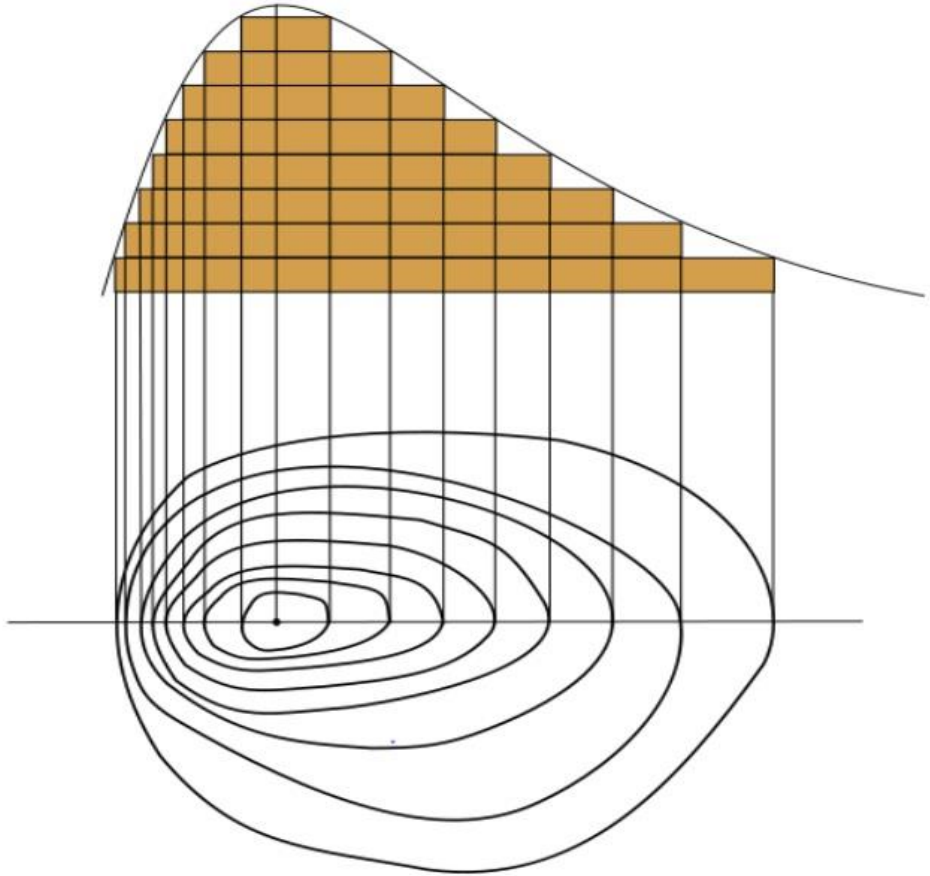
Some examples of many types of maps:

contour line?

a line on a map joining points of equal height above or below sea level

*the change in elevation between one contour line and the next is called the **contour interval***

It is a type of isopleth map



Isopleth maps (*iso* – greek 'equal')

a line drawn on a map through all points having the same value of some measurable quantity

barometric pressure ***(isobar)***

temperature ***(isotherm)***

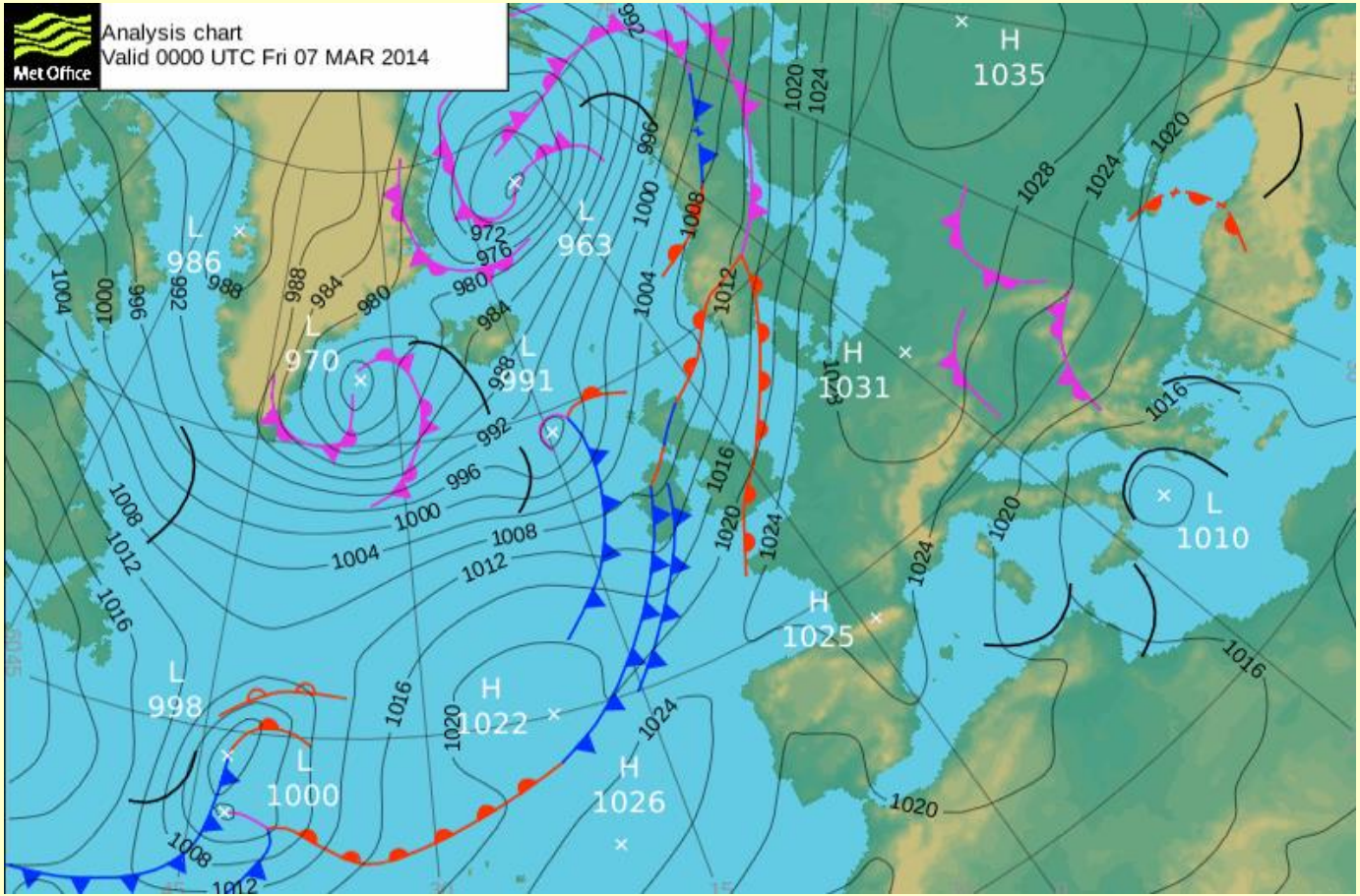
precipitation ***(isohyet)***

humidity ***(isohume)***

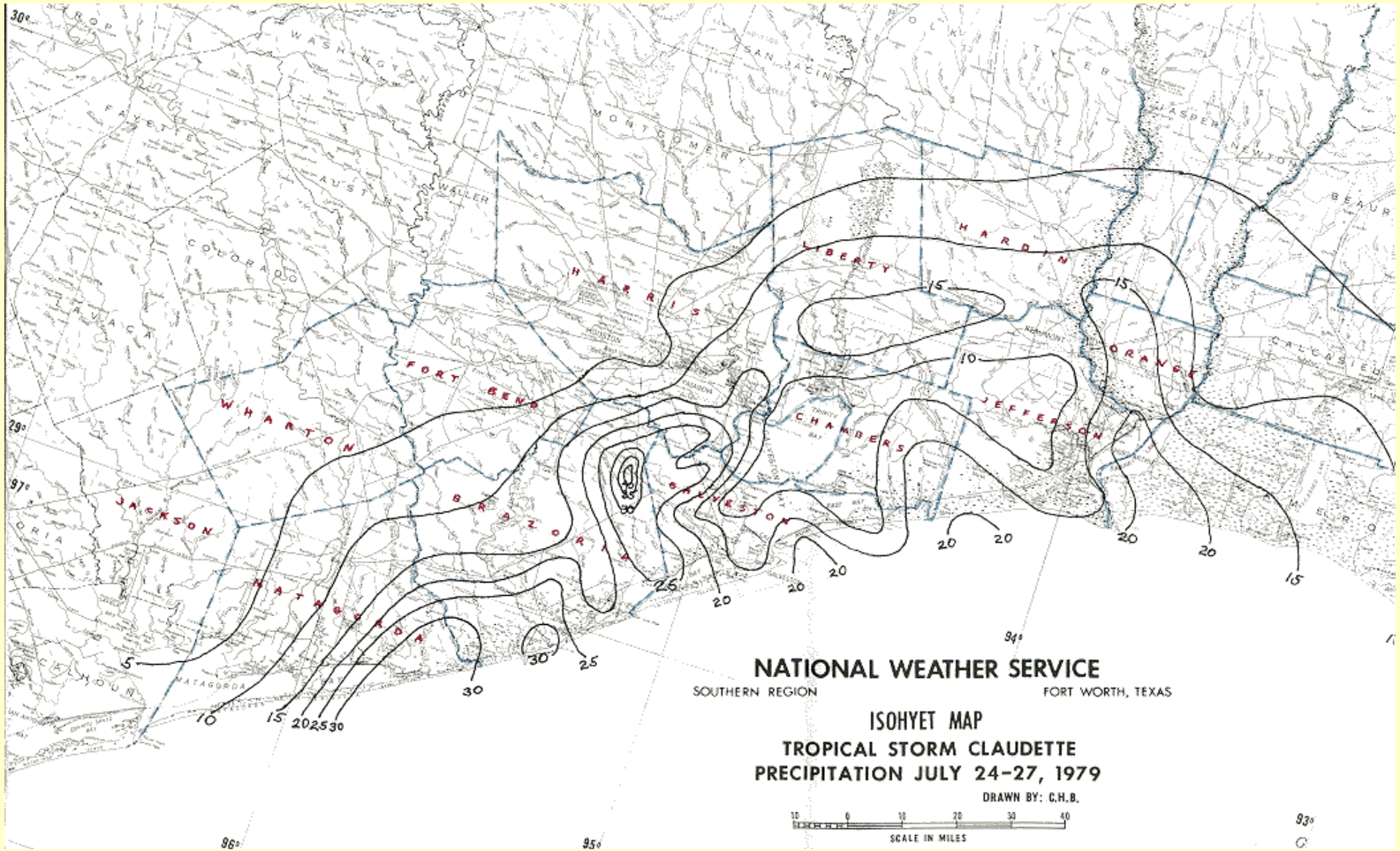
wind ***(isotach)***

elevation ***(contour)***

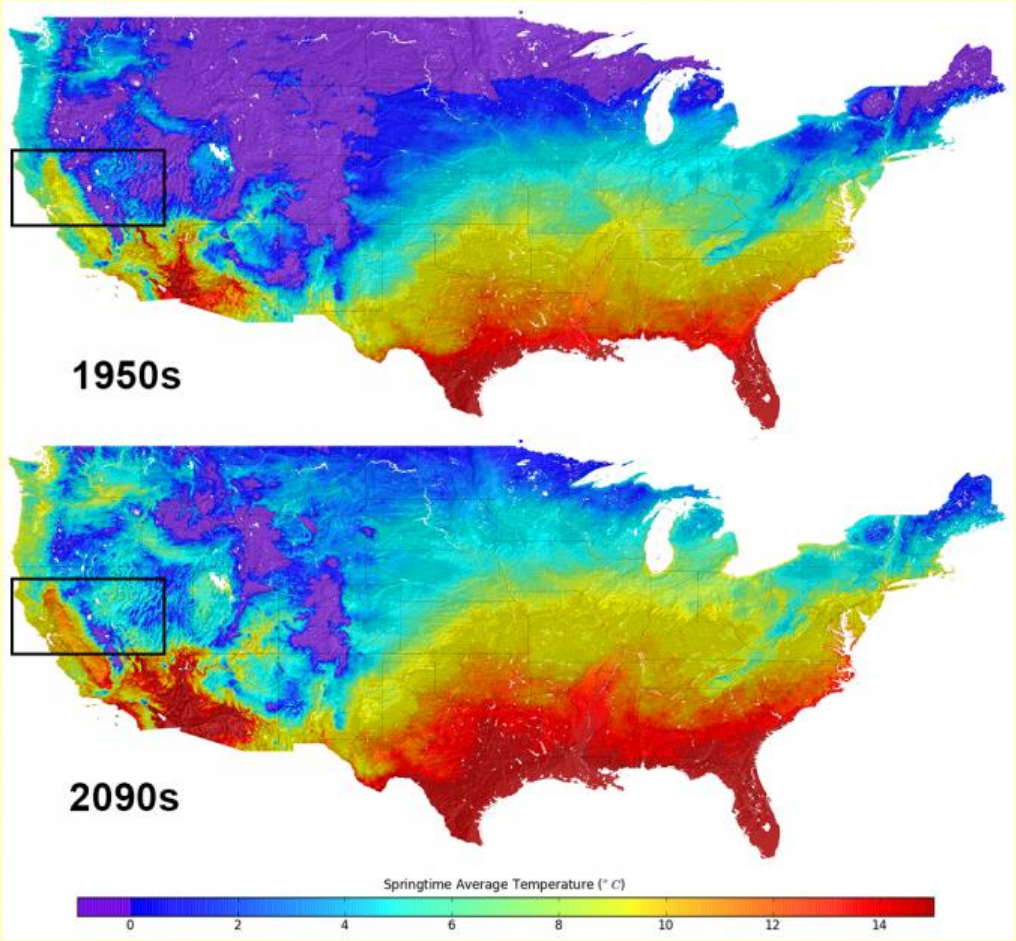
sediment thickness ***(isopach)***


Met Office
Analysis chart
Valid 0000 UTC Fri 07 MAR 2014
H
1035
L
986
L
963
L
970
L
991
H
1031
L
1010
H
1025
L
998
H
1022
L
1000
H
1026

Met Office.



US National Oceanic and Atmospheric Administration, isohyetal map showing points of equal precipitation,



NASA. Climate change modelled. Maps depicting average temperatures in the US in the 1950s and projected for 2090.

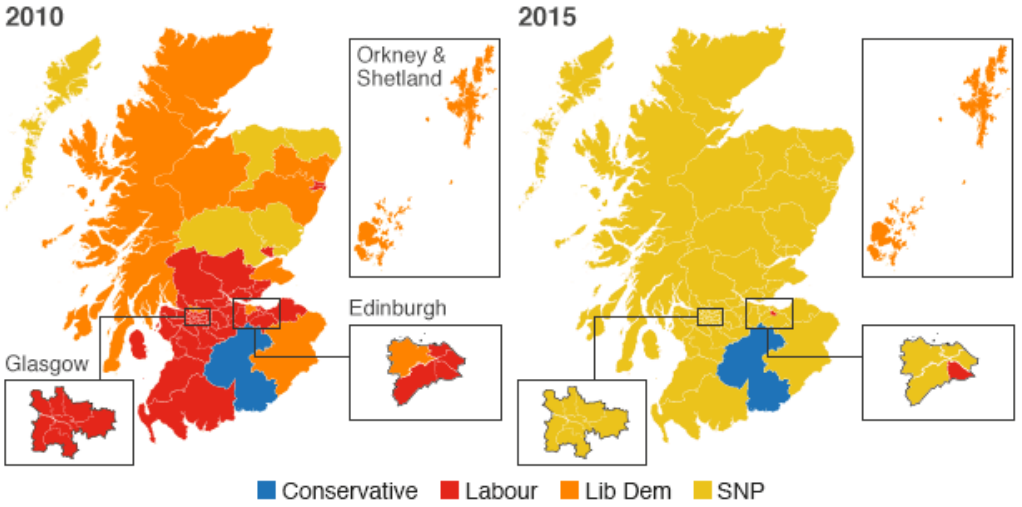
choropleth map

- *depicts a statistical variable that differs between* ***discrete predefined areas or regions****.*
- *utilises shading or patterning in proportion to the measurement*
- they give a false impression of abrupt change at the boundaries of shaded units

examples include:

- Population density
- Per-capita income
- Census data

General election results



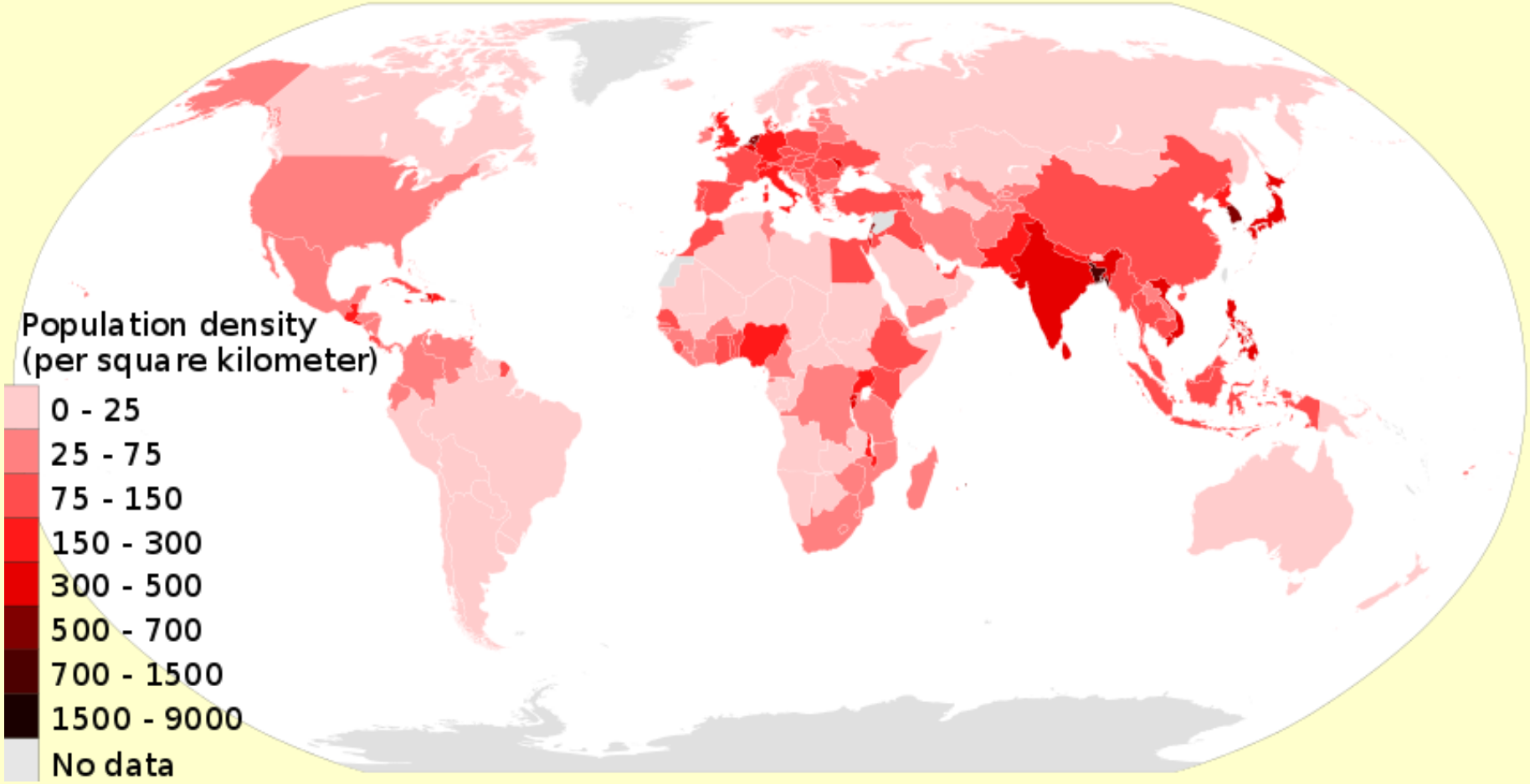
Party	Seats
Lab	41
LD	11
SNP	6
Con	1

Party	Seats
SNP	56
Lab	1
Con	1
LD	1

Party	Share
Lab	42.0%
SNP	19.9%
LD	18.9%
Con	16.7%
Oth	2.5%

Party	Share
SNP	50.0%
Lab	24.3%
Con	14.9%
LD	7.5%
Oth	2.9%

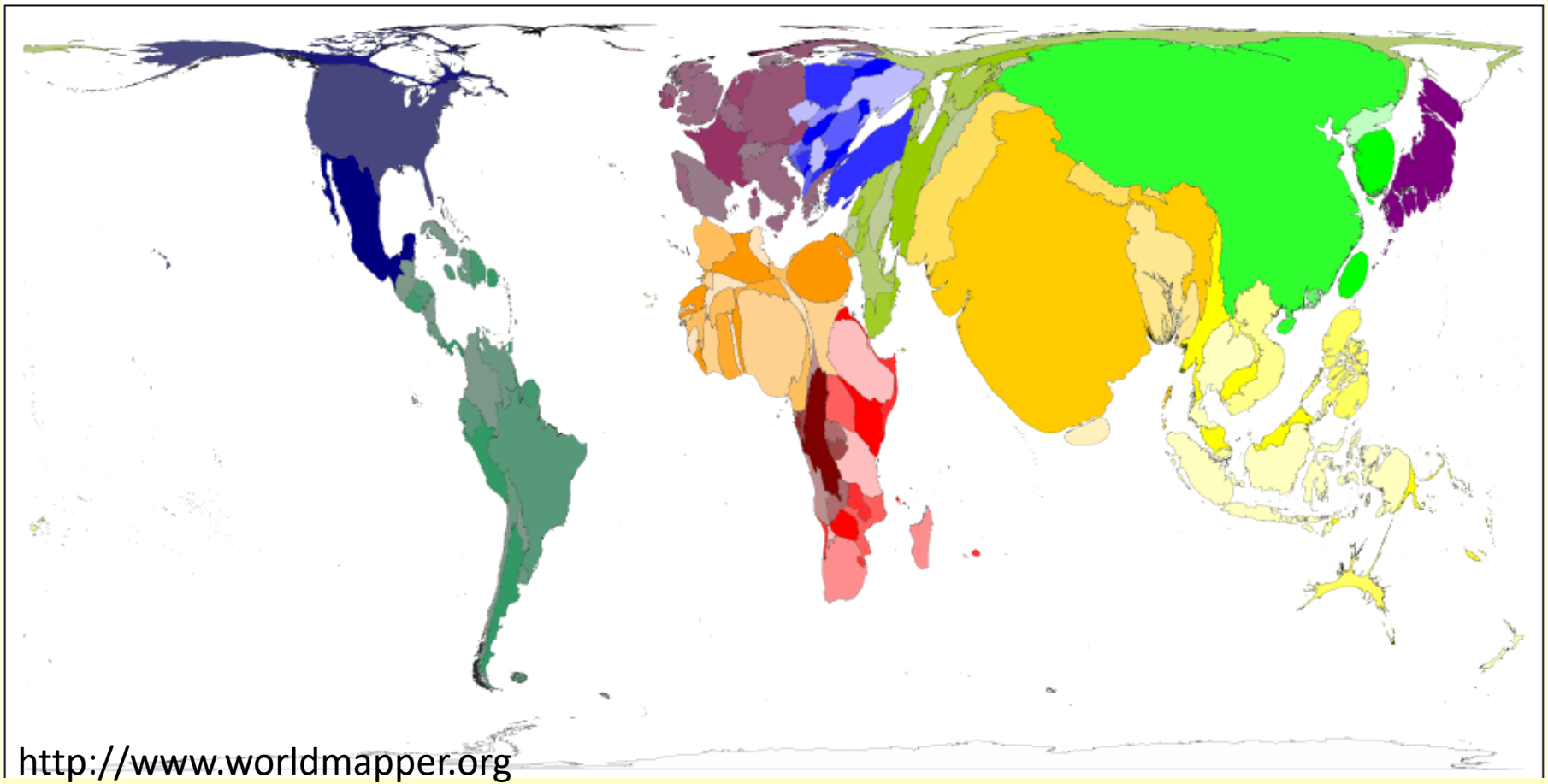
bbc.co.uk


Population density
(per square kilometer)
0 - 25
25 - 75
75 - 150
150 - 300
300 - 500
500 - 700
700 - 1500
1500 - 9000
No data

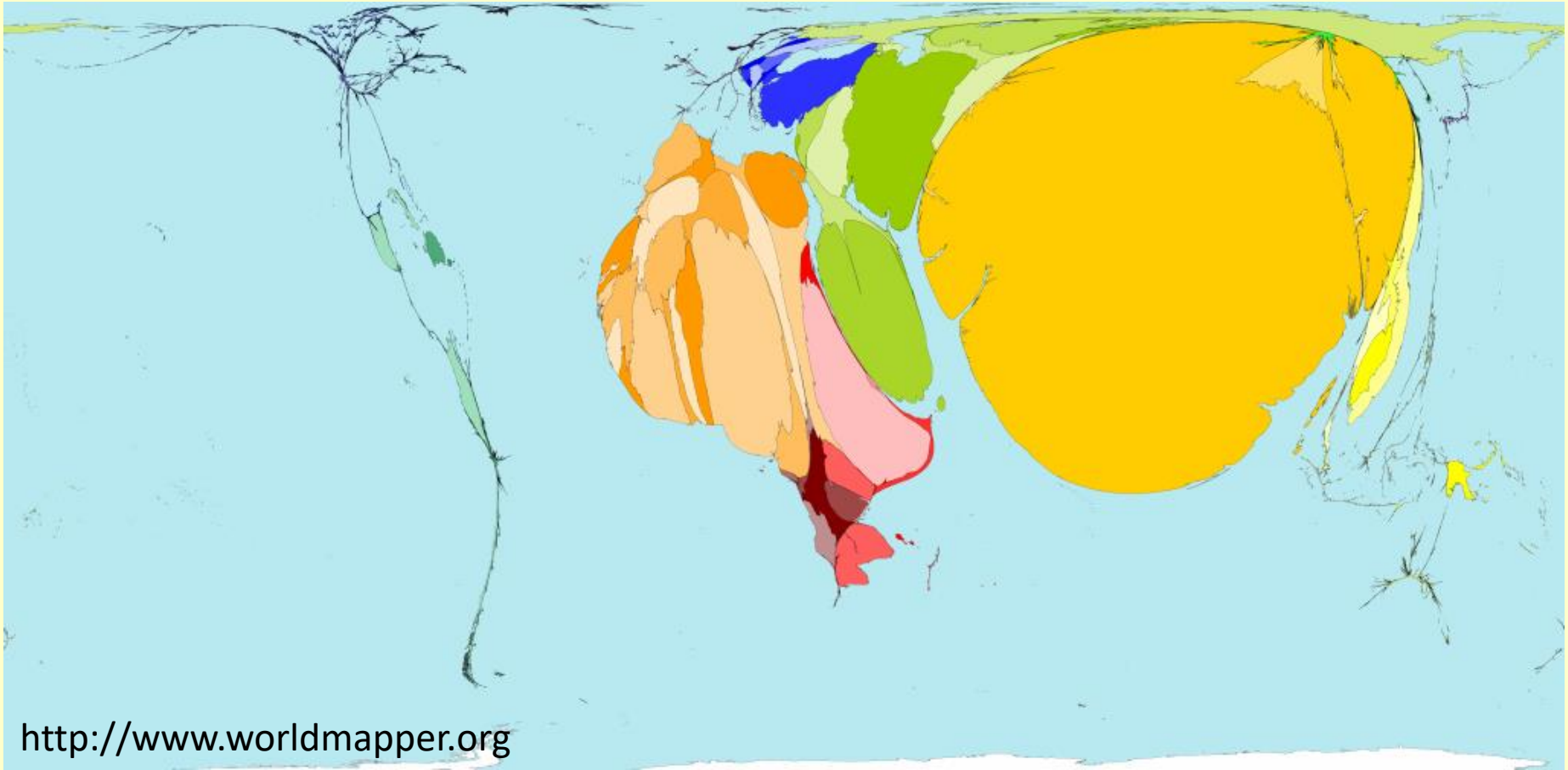
- *There are lots of interesting approaches to utilise space vs other data to display information.*

- *Some examples:*

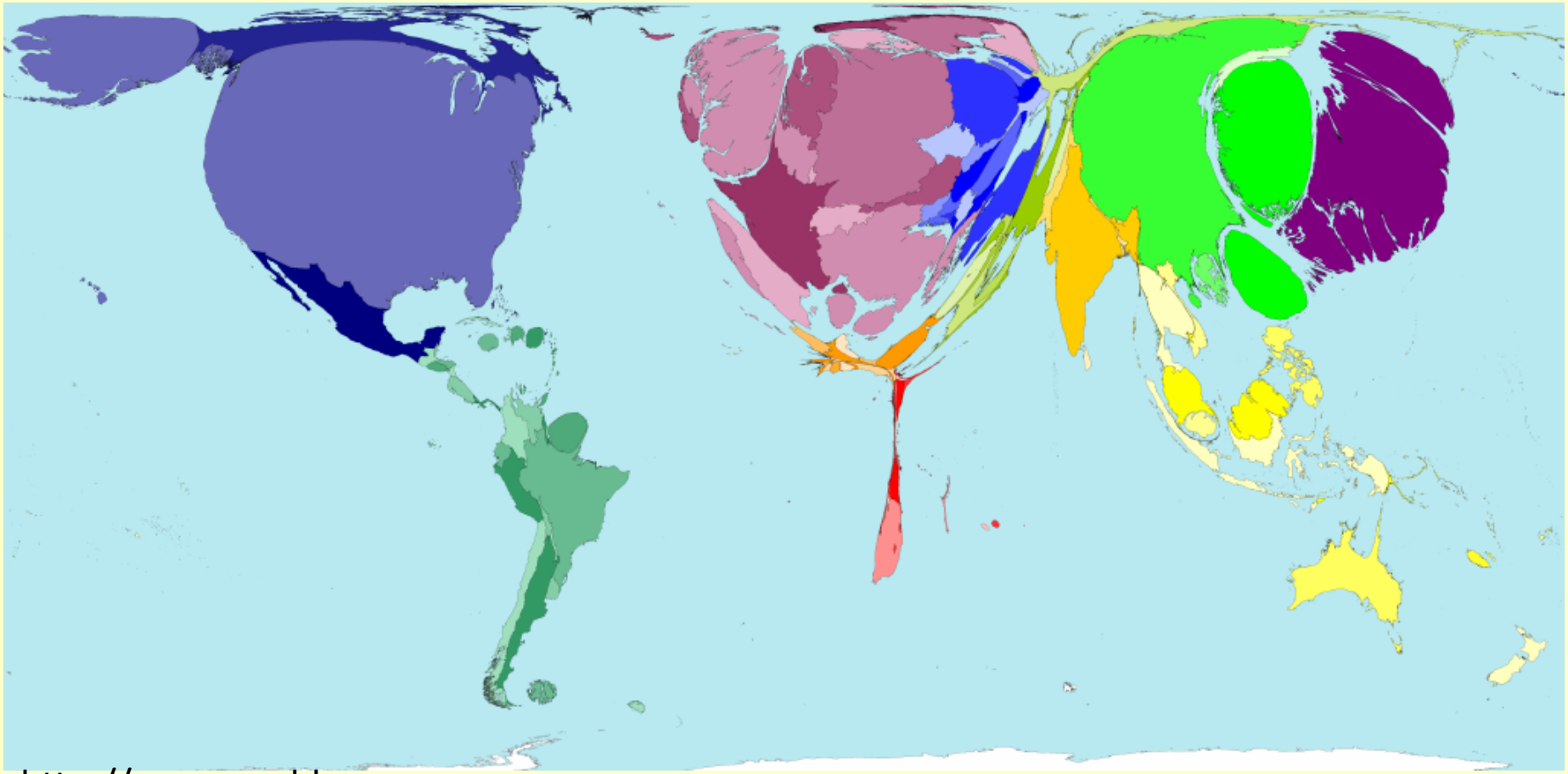
The size of each territory shows the relative proportion of the world's population living there



Territory size is proportional the world distribution of the excess male over female enrolment in primary education



Territory size shows the proportion of worldwide Internet users who lived there in 2002



http://www.worldmapper.org

Conclusions:

- Map needs to be fit for purpose!
- What co-ordinates and datums?
- What data do you wish to display dictates what is most suitable: isopleth vs choropleth
- Spatial representations are extremely important for very many applications!

Some Resources:

- Dieter Rams, Ten principles for good design: www.vitsoe.com/gb/about/good-design
- Ordnance Survey Design: www.ordnancesurvey.co.uk/resources/carto-design
- Map projections: http://www.businessinsider.com/mercator-projection-v-gall-peters-projection-2013-12?IR=T
- Mapping the Mountains, Jim Niehues: http://anotherescape.com/stories/mapping-the-mountains
- http://www.businessinsider.com/mercator-projection-v-gall-peters-projection-2013-12?IR=T
- http://uk.mathworks.com/help/map/the-three-main-families-of-map-projections.html?s_tid=gn_loc_drop
- http://uk.businessinsider.com/map-overlays-comparing-size-2013-12?r=US&IR=T
- https://www.ordnancesurvey.co.uk/resources/carto-design/
- http://www.worldmapper.org
- Dorling, D, Newman, M and Barford, A. (2010) The Atlas of the Real World: Mapping the way we live.
- Crampton, J. (2010) Mapping: A Critical Introduction to Cartography and GIS.