

Places in the World whose Climates match with places in RUSSIA

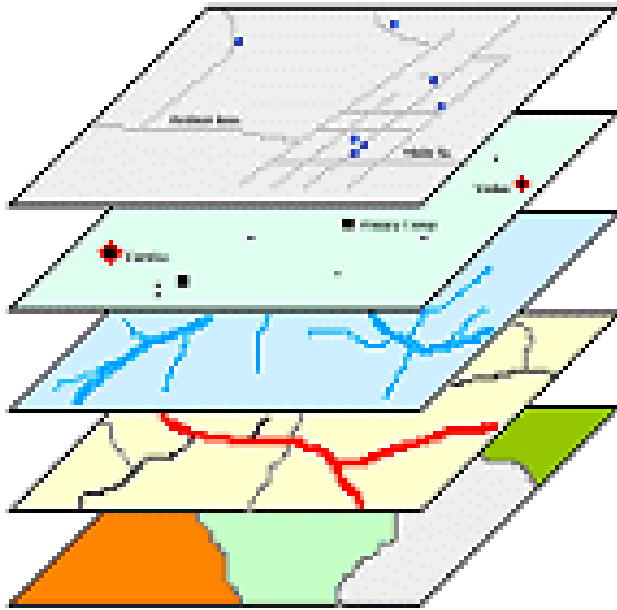
Thematic mapping: which city is most like Moscow ?



RED ZONE:
 CENTRAL-EAST ILLINOIS, USA
 CENTRAL INDIANA, USA
 CENTRAL & SOUTH OHIO, USA

LEGEND	
Good Match	The Average Monthly Temperatures & Koppen Classifications match best.
Special Mention	Koppen Classifications match very well, however the temperatures falling below -12.5°C (9.5°F) are ignored for the comparison.

Coordinate map systems and Georeferencing

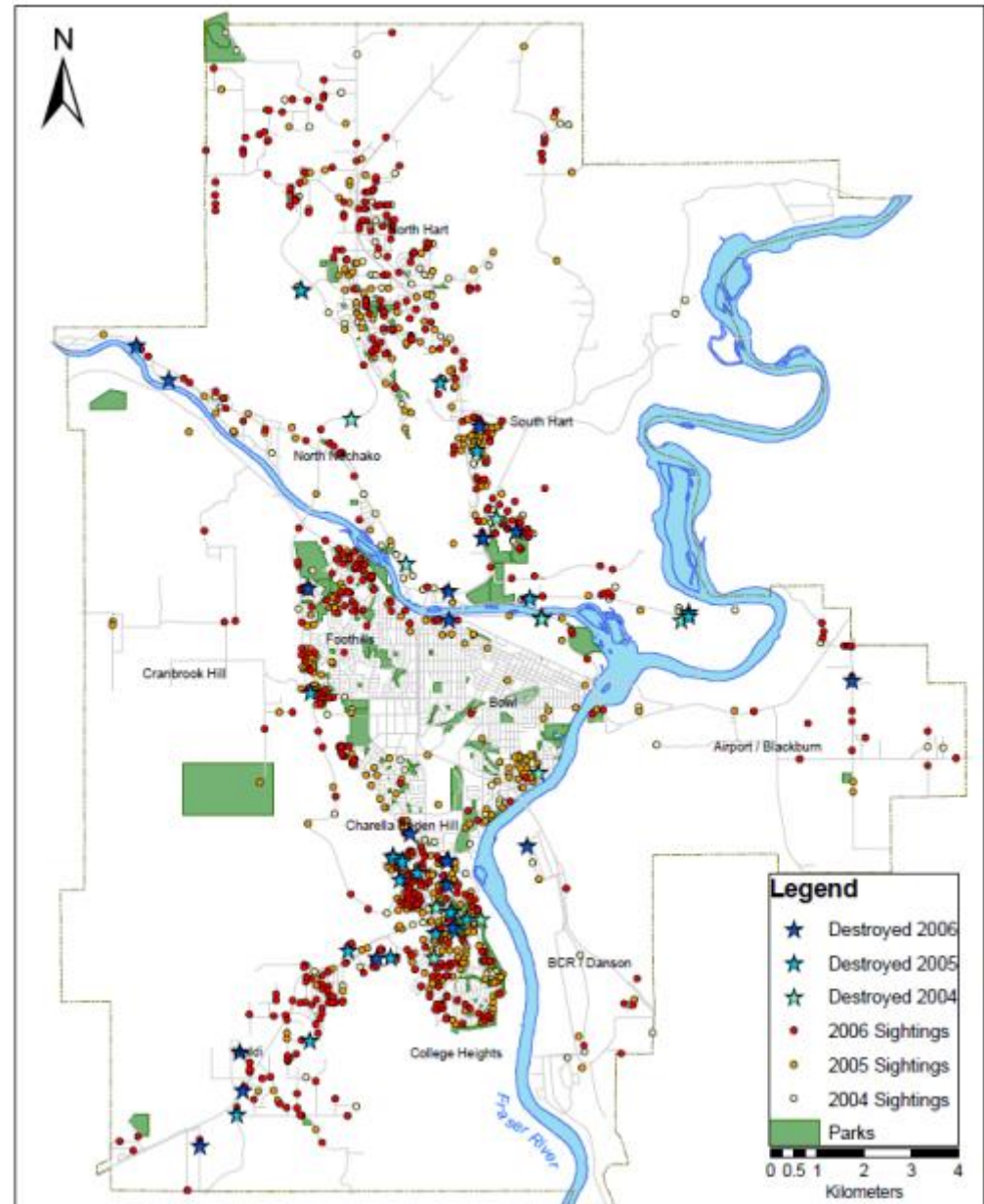


Registered map layers

digital mapping needs coordinates

- local for local mapping
- global for global datasets

Bear Sightings, Prince George 2004-2006



Registration vs Referencing

Registration:

-lining up the layers together

Georeferencing:

Linking layers to coordinates

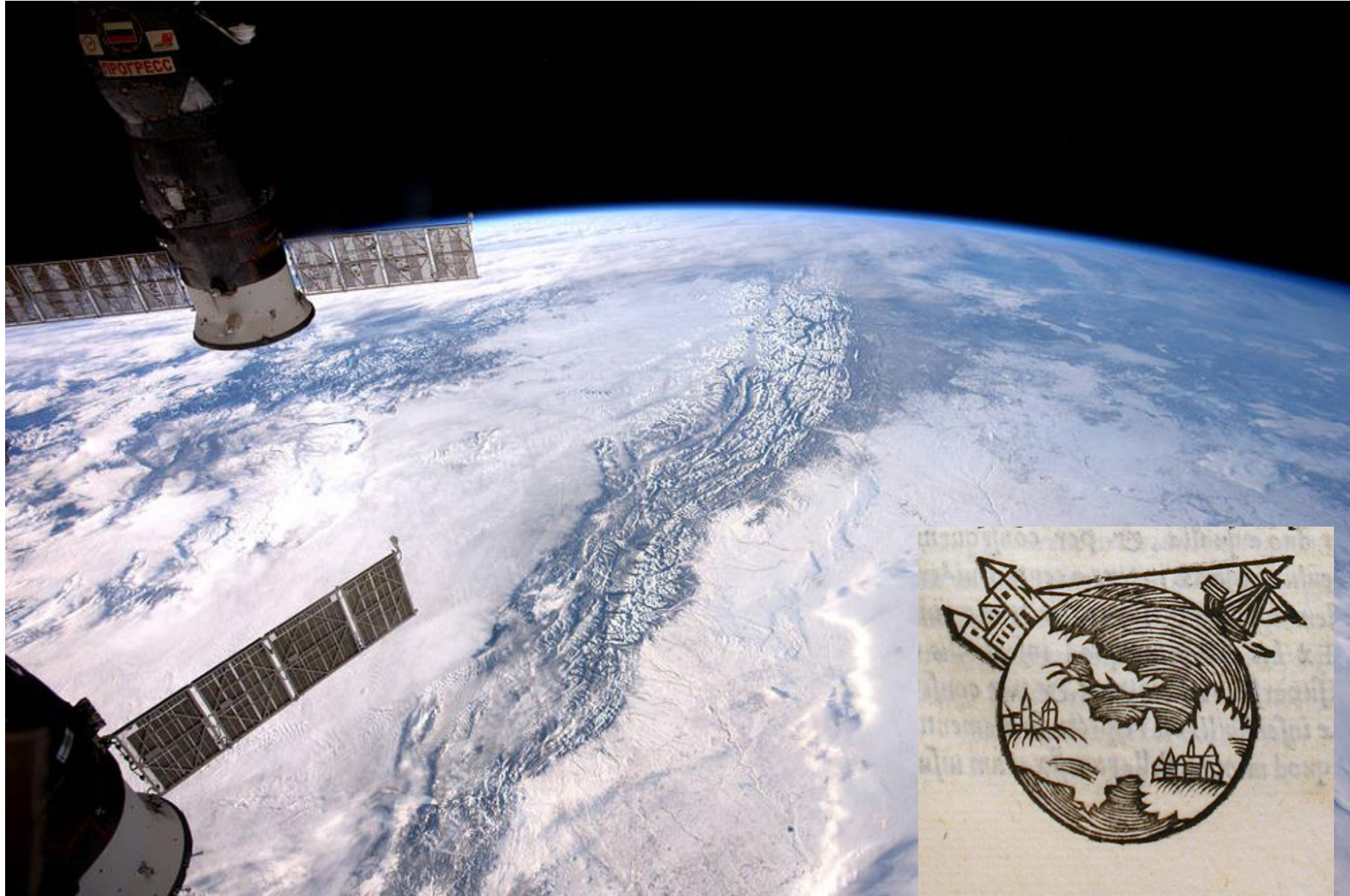


**Flat Earth options:— if only it was flat,
this would be a very short lecture**



The
FLAT EARTH
SOCIETY

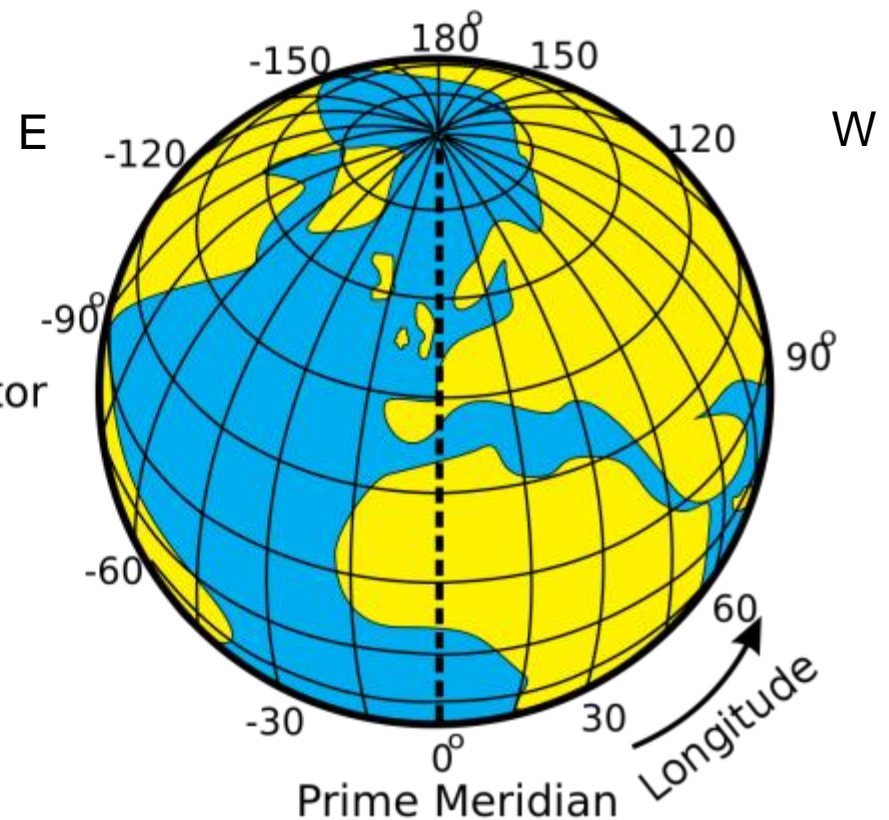
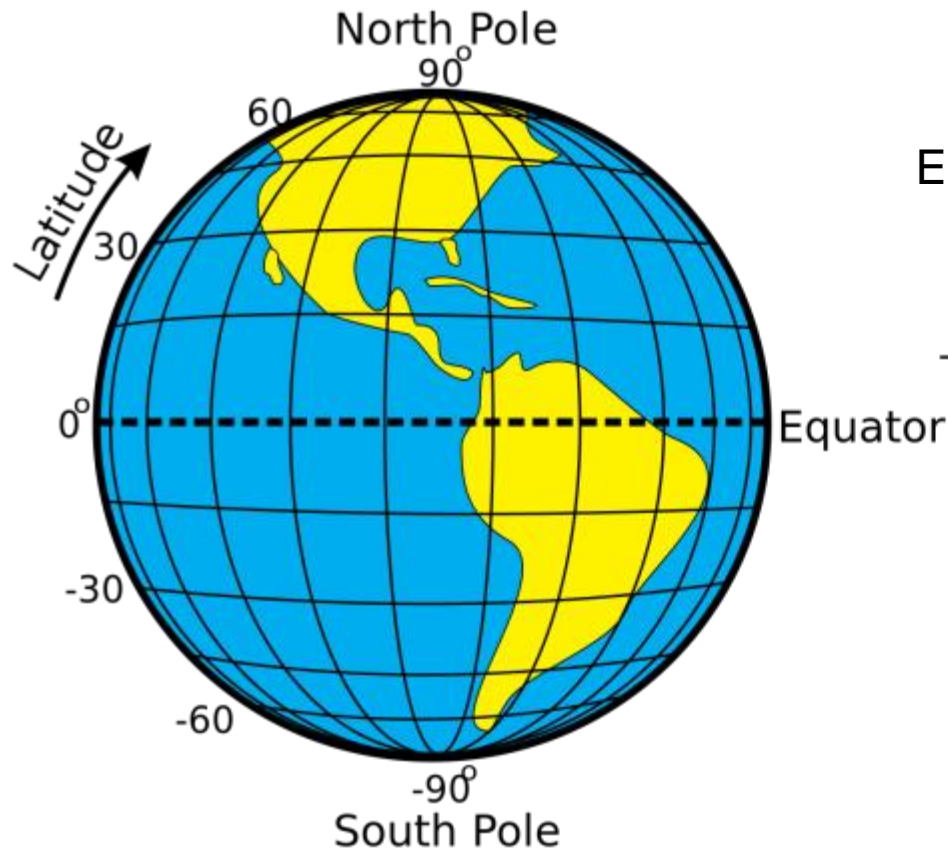
We're pretty sure the Earth is not 'flat': the Rockies from Space Station



Coordinate map systems

1. The Earth's Graticule: Latitude - Longitude

- The graticule is the imaginary grid of lines running east-west lines of latitude (parallels) and north-south lines of longitude (meridians)
- The system was first devised by Hipparchus (190-120 BC)



1a. 'Geographic Referencing'

We can identify locations by latitude, longitude

e.g. UNBC campus agora

In decimal degrees: 53.892381, -122.813699 (N, W)

See: <http://maps.google.ca> (right-click)

In degrees, minutes, seconds:

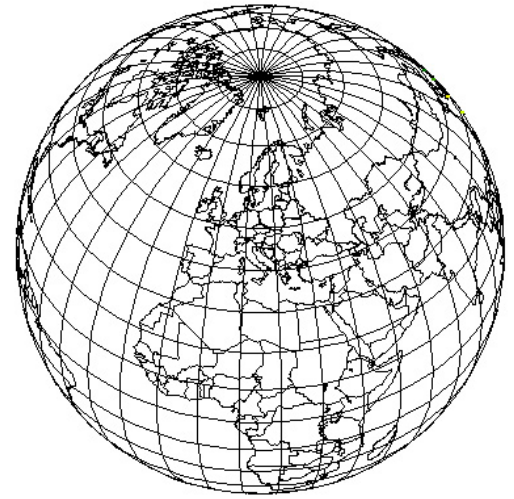
53° 53' 33" (N) 122° 48' 50" (W)

OR

In degrees and decimal minutes (e.g. GPS)

53° 53.543' N 122° 48.822' W

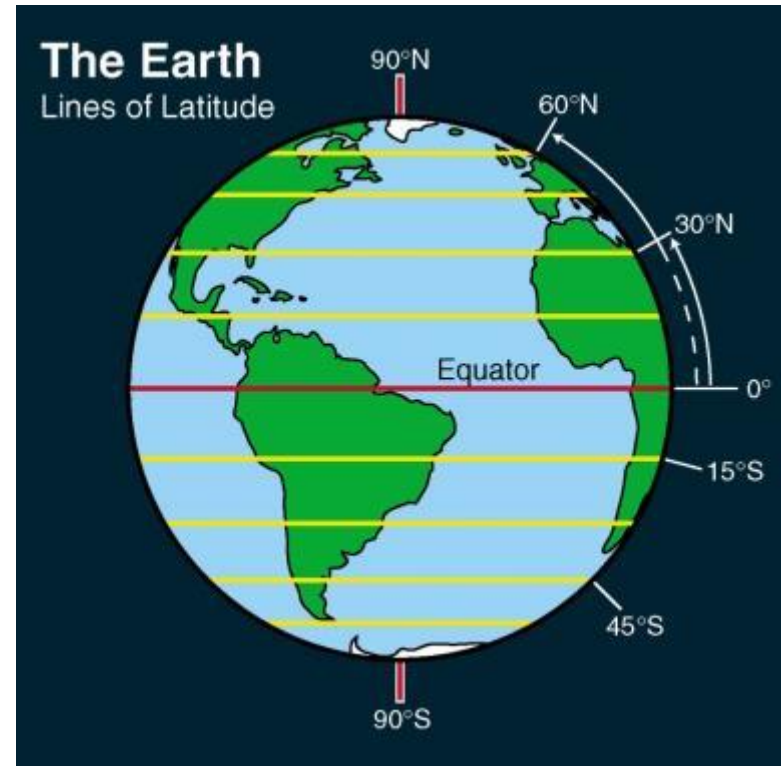
Latitude



- **Latitude** = the vertical angle from the centre of earth to the location
- e.g. Prince George is at 54°N
- Quesnel is at 53°N
- $[1^{\circ} = \sim 111\text{km}]$
- Latitude is 0 on the equator

'Sexagesimal system'

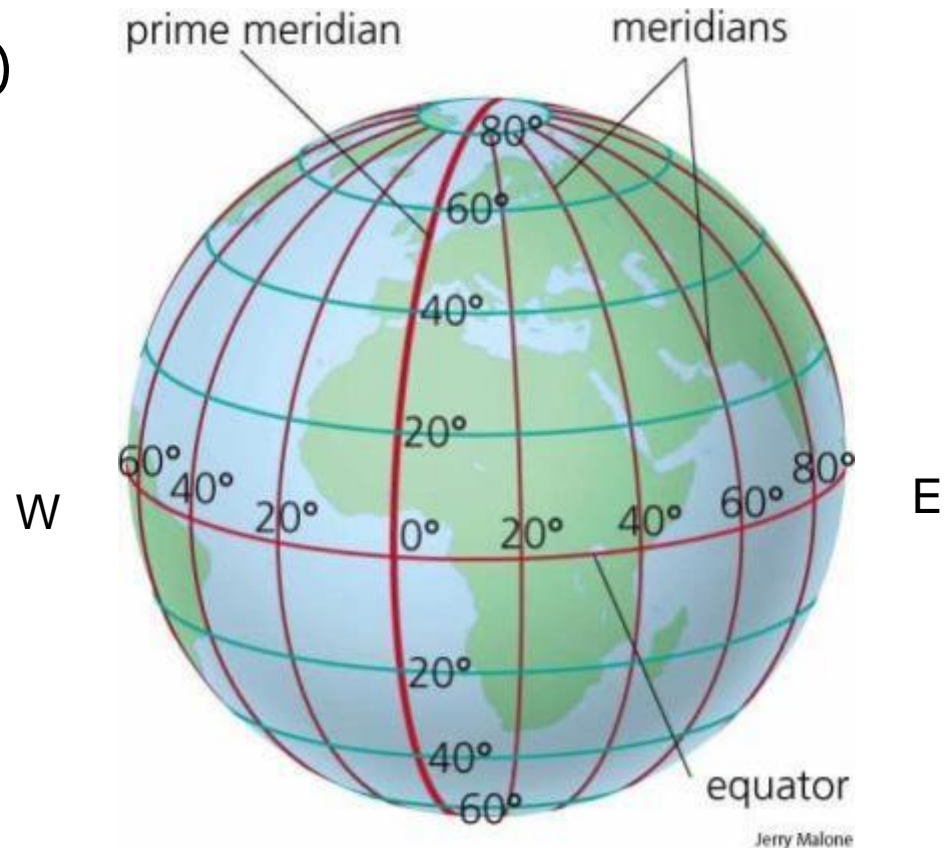
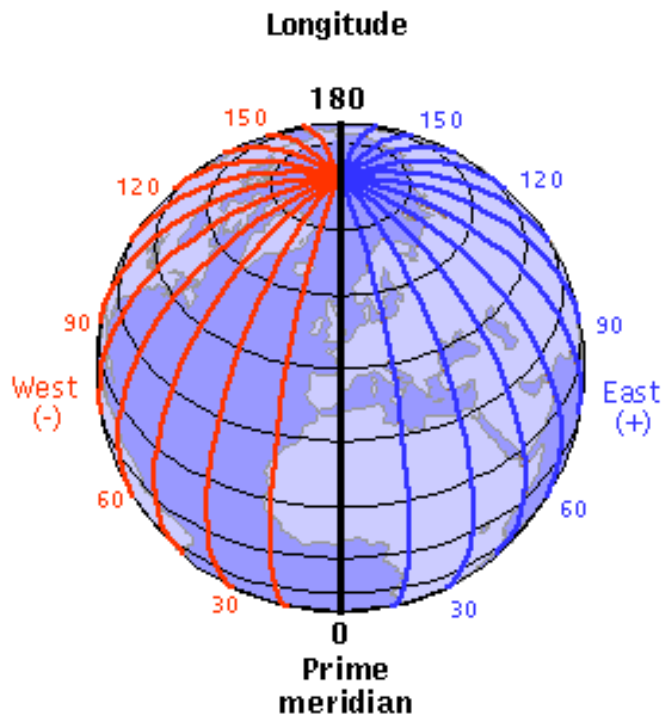
- 1 degree = 60' (minutes)
[1' = $\sim 2\text{km}$] ($111\text{km} / 60$)
- 1' = 60" (seconds)
[1" = $\sim 30\text{m}$] ($2\text{km} / 60$)



Longitude

Longitude = the angle formed between line from centre of earth to the (arbitrary) 'prime meridian' running through Greenwich, England and the local meridian. The 0 location is arbitrary (1884)

Longitude ranges from
0 to 180 W / 180 E (the same line)
Prince George = 123°W (-123)



The Greenwich Meridian

...where east meets west

Home

Interactive UK map

Interactive World map

Visit

Royal Observatory Greenwich

Latitude and Longitude

Airy Transit Circle (ATC)

WGS84 and the Greenwich Meridian

The Greenwich Meridian before the ATC

The Quest for Longitude

International Meridian Conference (1884)

Meridian Day (1984)

The Millennium

Millennium Tree Line (MTL)

Meridian Laser

Astronomers Royal

Telescopes used with Meridian Marks

Location

England
West Sussex

East Grinstead

S side of: B2110 (Lewes Road)

Distance (S) from Greenwich
39.39 Km: 24.48 miles

OS map details
OS Explorer: 135
OS grid ref
TQ 39945.37948
(539945,137948)

WGS84 lat/long
51.123729, -0.001647

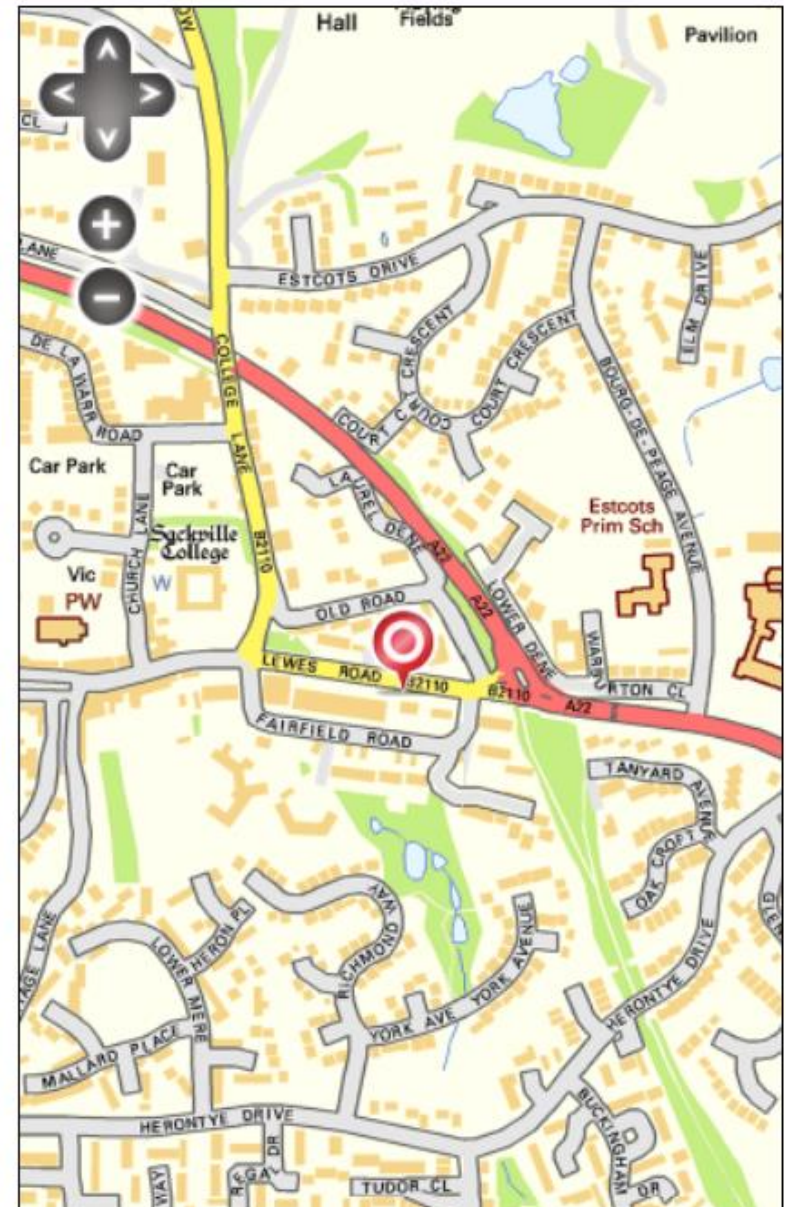
[Click here for images](#)

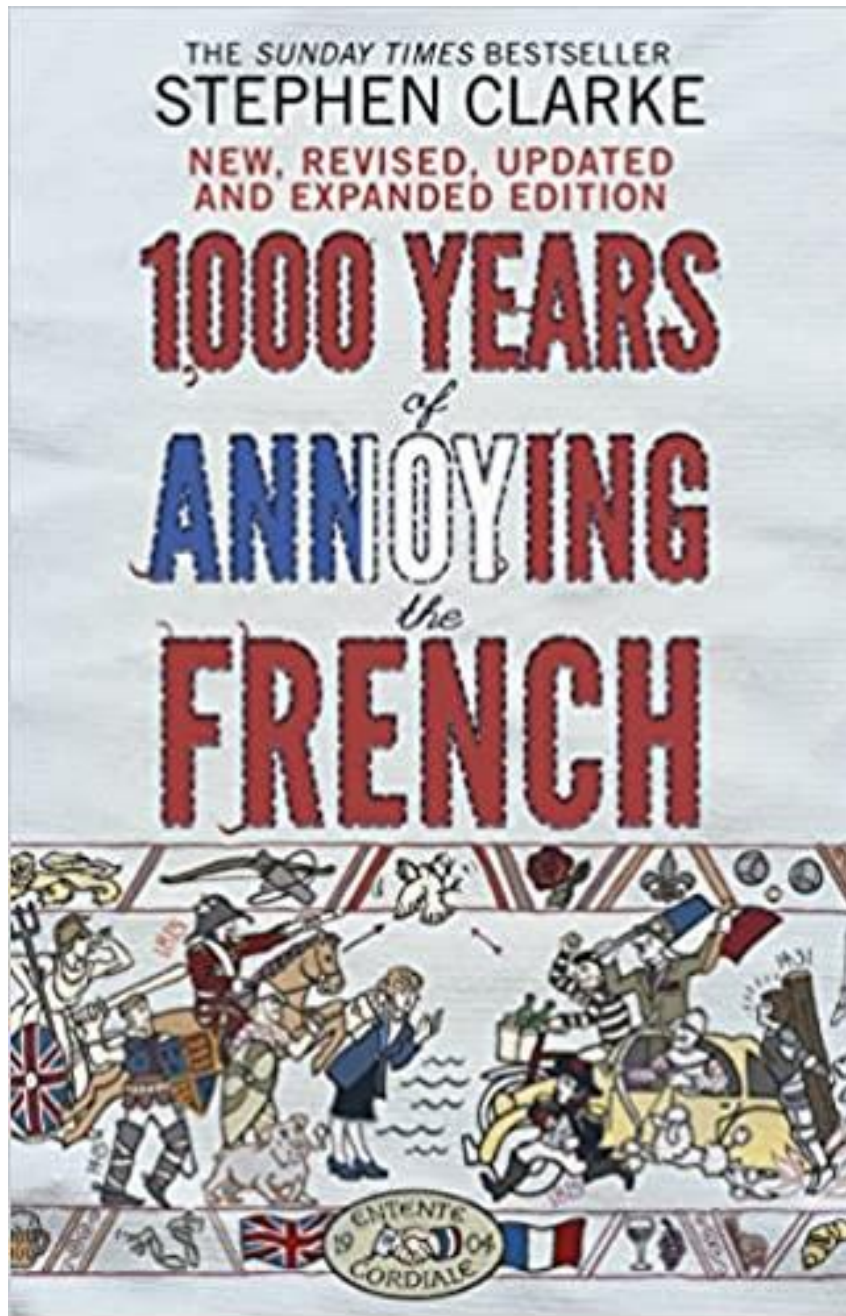
Type
Marker 'stone'

Marking date
2000

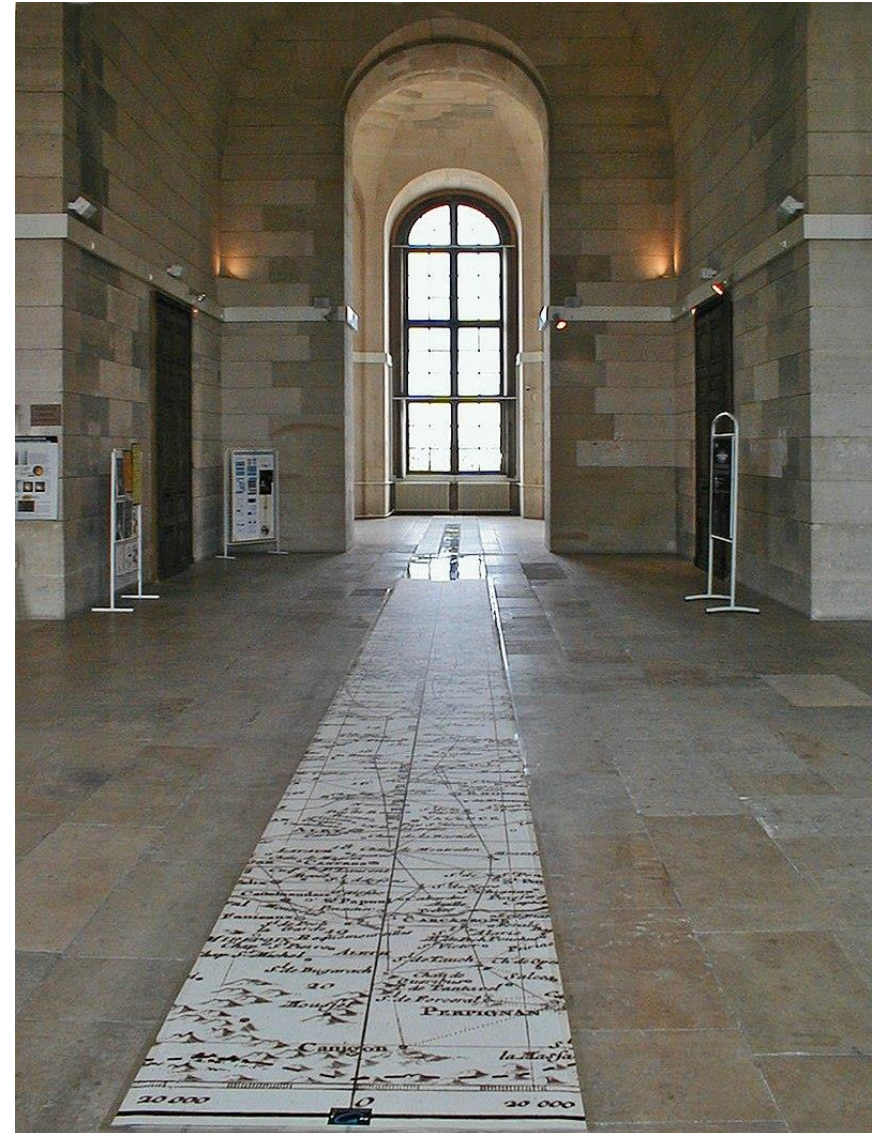
Access
Unrestricted

[Show satellite view](#)





Meridian Room (or Cassini Room) at the Paris Observatory, The Paris meridian is traced on the floor. Since 1634



'Geographic' referencing issues

a. Geographic is not decimal, it is 'sexagesimal' (= base 60)

1 degree = 60 minutes

1 minute = 60 seconds

Decimal degrees: $58^{\circ} 30'$ = 58.5 $30/60 = 0.5$

Decimal degrees: $58^{\circ} 36'$ = 58.6 $36/60 = 0.6$

Decimal degrees: $58^{\circ} 36' 36''$ = 58.61 $36/(60*60) = 0.01$

b. It is suitable for storing global datasets, but ...

with negative values south and west of 0, 0

e.g. in a digital system, PG = 54, -123

c. The main issue with mapping with Longitude

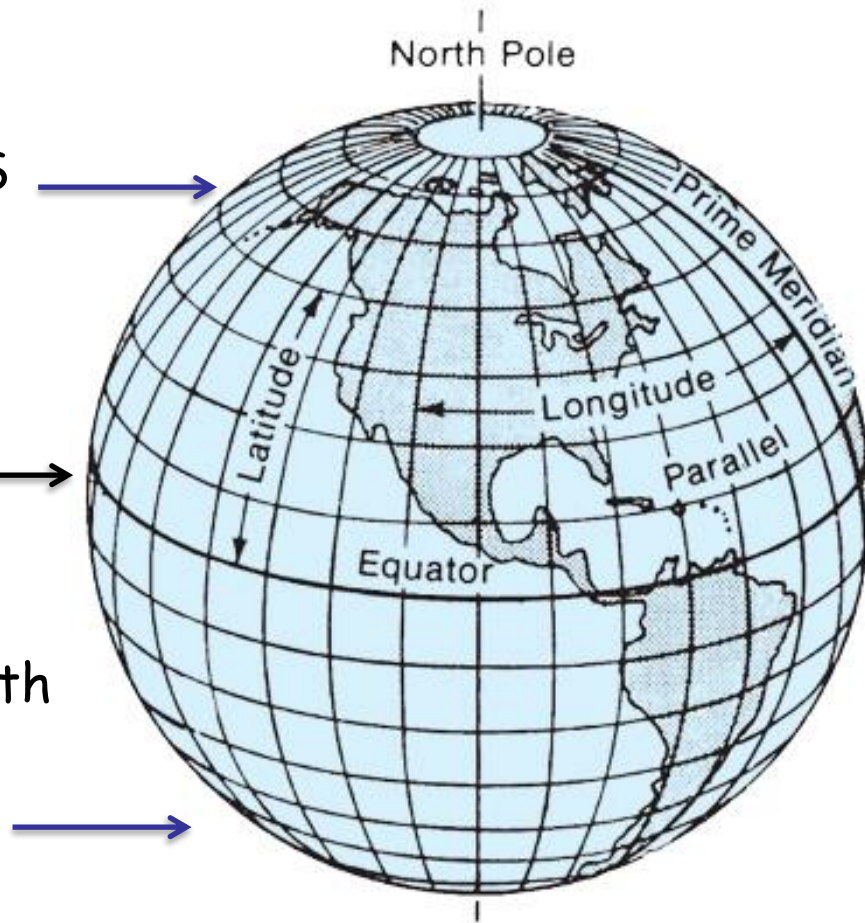
1 degree longitude varies widely from ~111 km at the equator to 0 km at poles

half the distance at 60 ° N/S

Equator

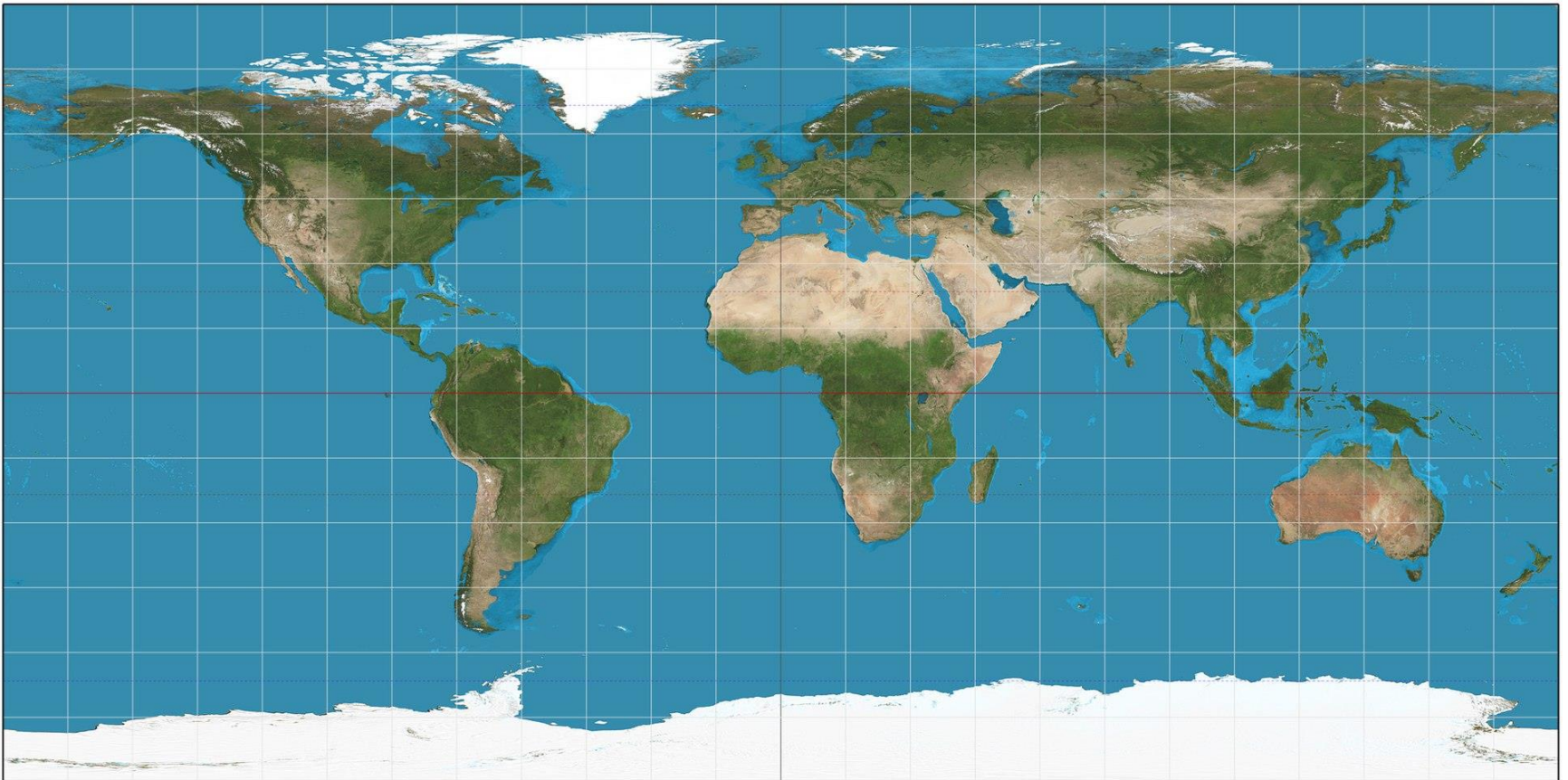
i.e. 1 degree has no fixed length

It is not rectangular



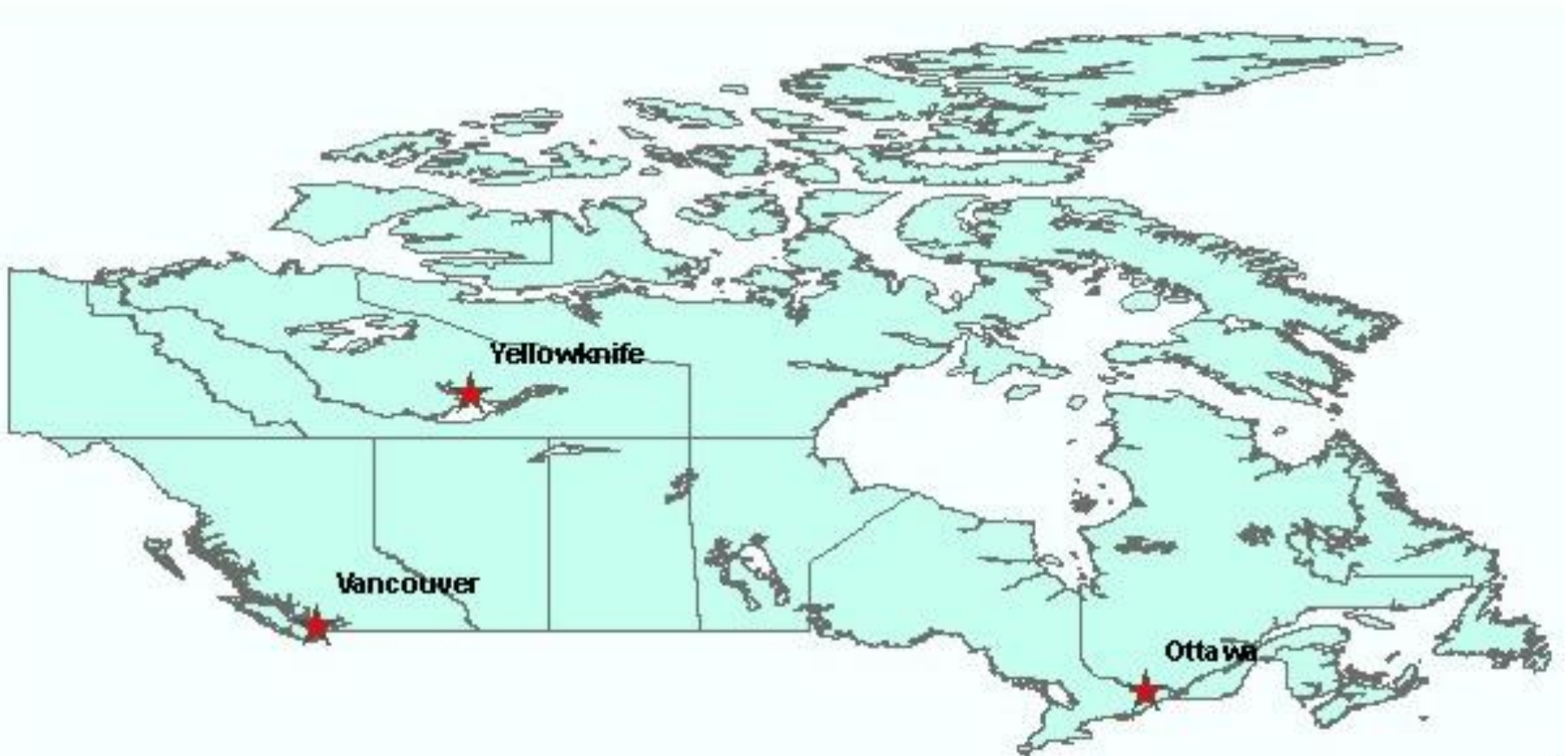
Equirectangular map display

... as if degrees of latitude and longitude were equal
E-W stretching away from the equator: 2x at 60° latitude



-1 degree longitude varies from 0 -> 111 km
-> East-west stretching away from equator
(as a degree is treated uniformly)

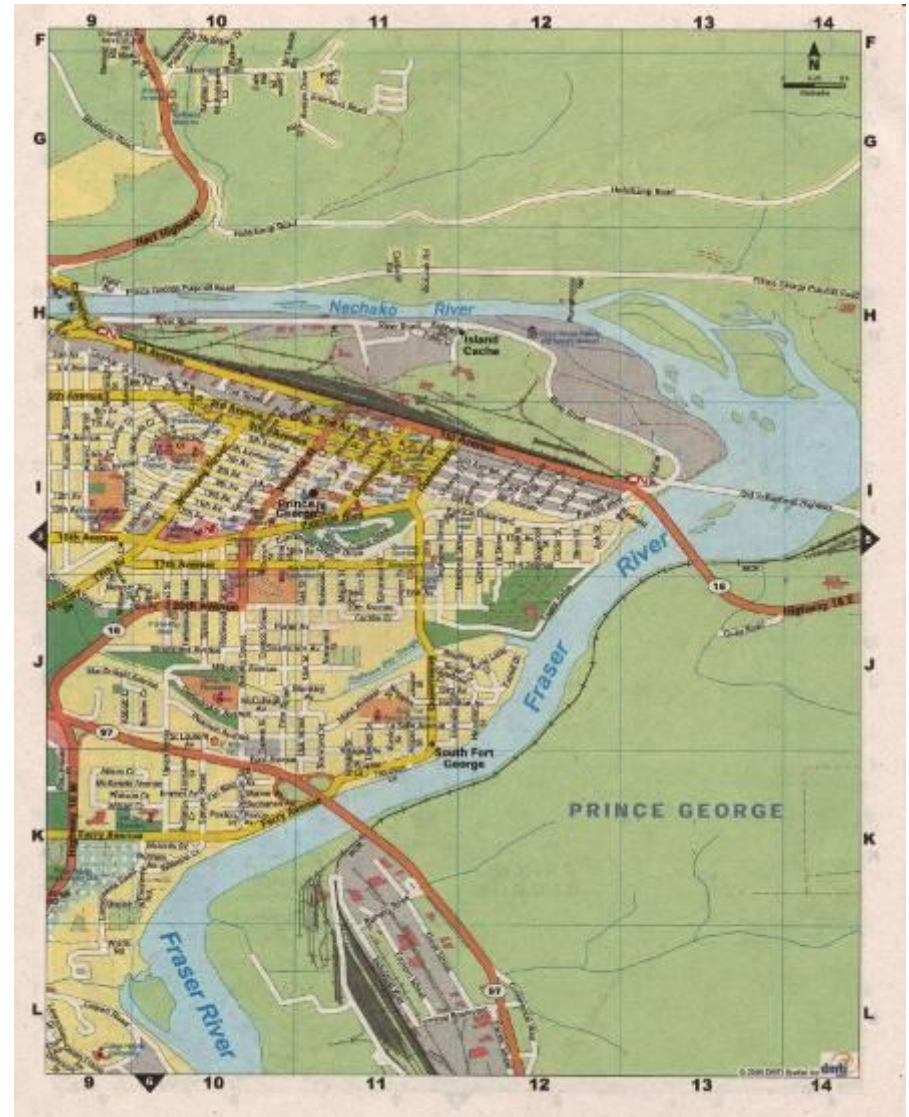
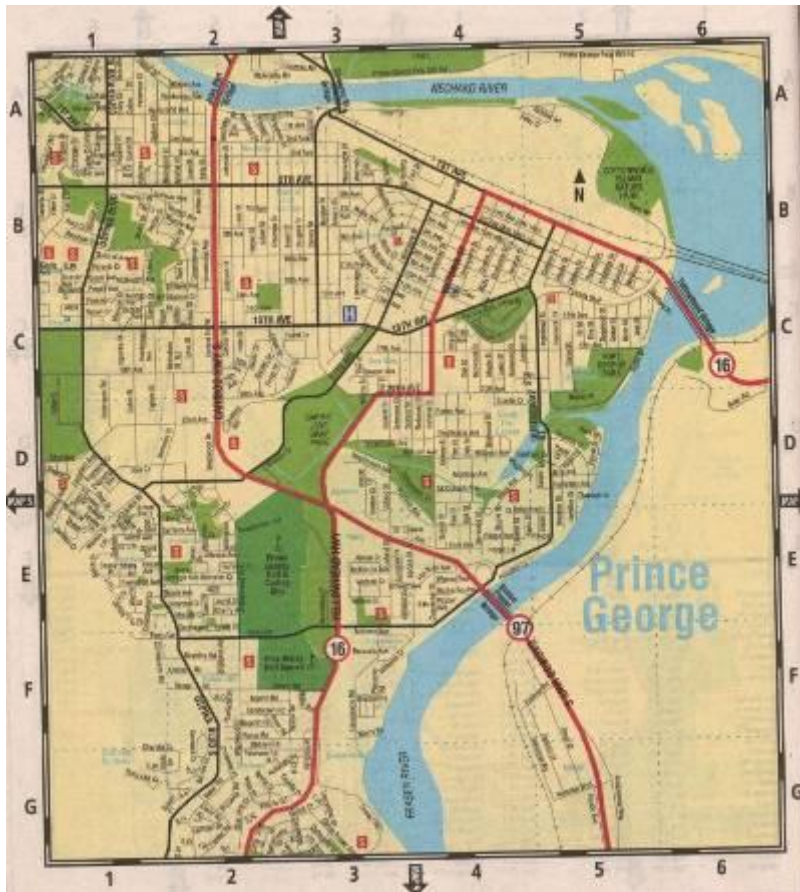
'geographic' is OK for data storage,
but not for display



Local example from the phone book

2007: scale is consistent

2008: horizontal scale is almost double



Latitude and Longitude

Length of One Degree of Longitude			Length of a Degree of Latitude		
Latitude	Kilometres	Miles	Latitude	Kilometres	Miles
0°	111.32	69.17	0°	110.57	68.71
10°	109.64	68.13	10°	110.61	68.73
20°	104.65	65.03	20°	110.70	68.79
30°	96.49	59.95	30°	110.85	68.88
40°	85.39	53.06	40°	111.04	68.99
50°	71.70	44.55	50°	111.23	69.12
60°	55.80	34.67	60°	111.41	69.23
70°	38.19	23.73	70°	111.56	69.32
80°	19.39	12.05	80°	111.66	69.38
90°	0.00	0.00	90°	111.69	69.40

45th Parallel
Halfway Between
Equator-North Pole



GEOLOGICAL MARKER

THIS SPOT IN SECTION 14, IN THE TOWN OF RIETBROCK, MARATHON COUNTY IS THE EXACT CENTER OF THE NORTHERN HALF OF THE WESTERN HEMISPHERE. IT IS HERE THAT THE 90TH MERIDIAN OF LONGITUDE BISECTS THE 45TH PARALLEL OF LATITUDE, MEANING IT IS EXACTLY HALFWAY BETWEEN THE NORTH POLE AND THE EQUATOR, AND IS A QUARTER OF THE WAY AROUND THE EARTH FROM GREENWICH, ENGLAND.

MARATHON COUNTY PARK COMMISSION

THIS MONUMENT IS ONLY A REPRESENTATION OF THE INTERSECTION OF THE 90TH MERIDIAN & THE 45TH PARALLEL. THE TRUE LOCATION IS N 75° 00' 00" E, 1.000.19' FROM THE CENTER OF THE MONUMENT.

THIS MONUMENT IS ONLY A REPRESENTATION OF THE INTERSECTION OF THE 90TH MERIDIAN & THE 45TH PARALLEL. THE TRUE LOCATION IS N 75° 00' 00" E, 1.000.19' FROM THE CENTER OF THE MONUMENT.

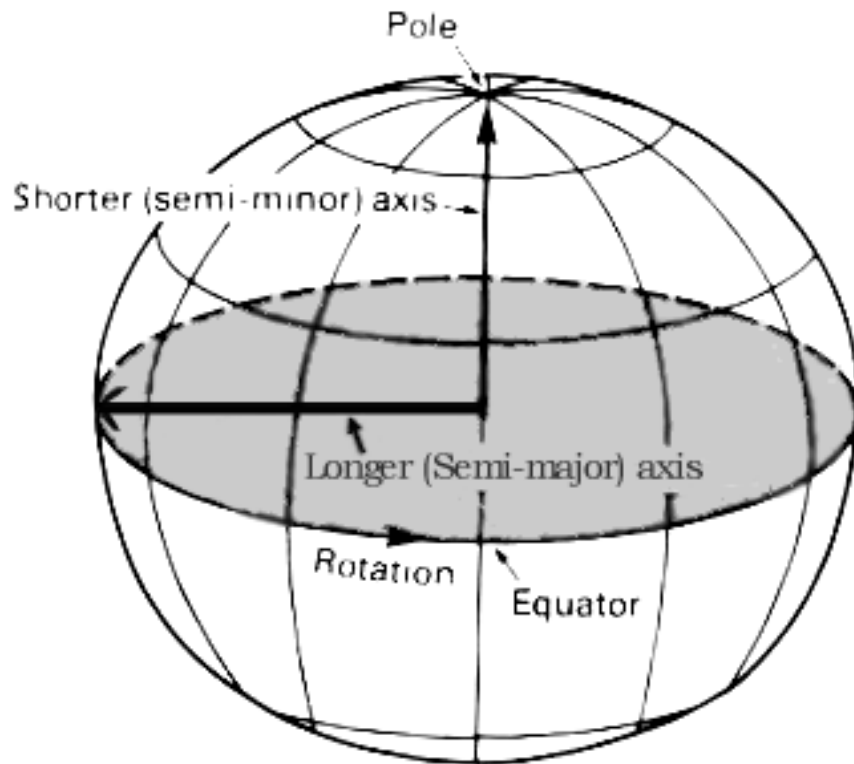


But is 45° North halfway ?

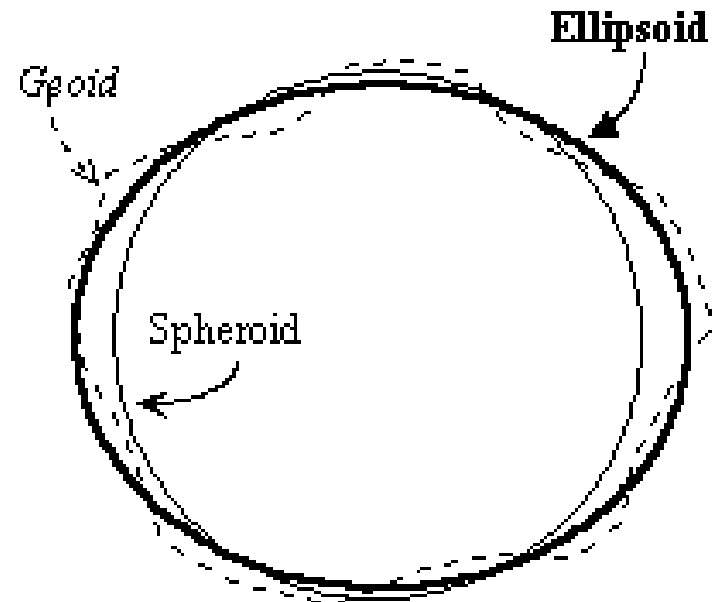
1b. The Geoid

Earth is not a perfect sphere, it is ellipsoidal ..

The difference between the length of the two axes = the amount of 'polar flattening' is about 1/300 (0.3%) and 1° latitude is slightly longer as you move away from the equator



An ellipsoid is formed by rotating an ellipse on its shorter axis

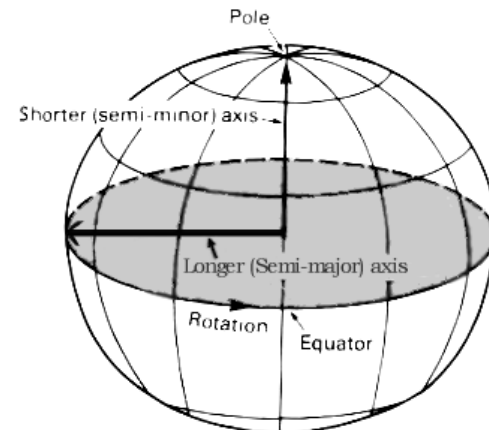


99.7% soccer ball
0.3% 'football'

Official Ellipsoids

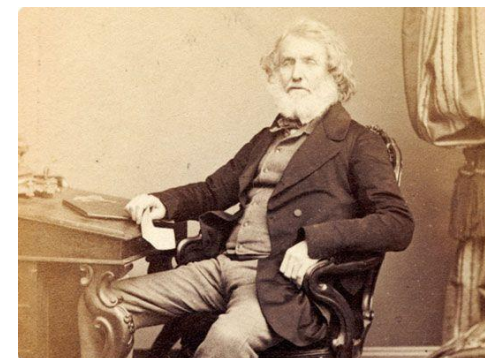
(part of the study of Geodesy)

(from J. Snyder, Map Projections--A Working Manual)



An ellipsoid is formed by rotating an ellipse on its shorter axis

Name	Date	Equatorial	Polar	Polar Flattening
		Radius <i>a</i> (metres)	Radius <i>b</i> (metres)	
WGS 84	1984	6,378,137	6,356,752	1/298
GRS 80	1980	6,378,137	6,356,752	1/298
WGS 72	1972	6,378,135	6,356,750	1/298
<hr/>				
International	1924	6,378,388	6,356,912	1/297
Clarke	1866	6,378,206	6,356,584	1/295
Everest	1830	6,377,276	6,356,075	1/301



Datums (do we need to know this?)

'Datum' = "a set of values that serve as a base for mapping"

a. North American Datum, NAD27 (1927) based on Clarke 1866

b. North American Datum, NAD83 based on GRS80/WGS 1984

-> NAD27 was the datum for mapping in most of the 20th century

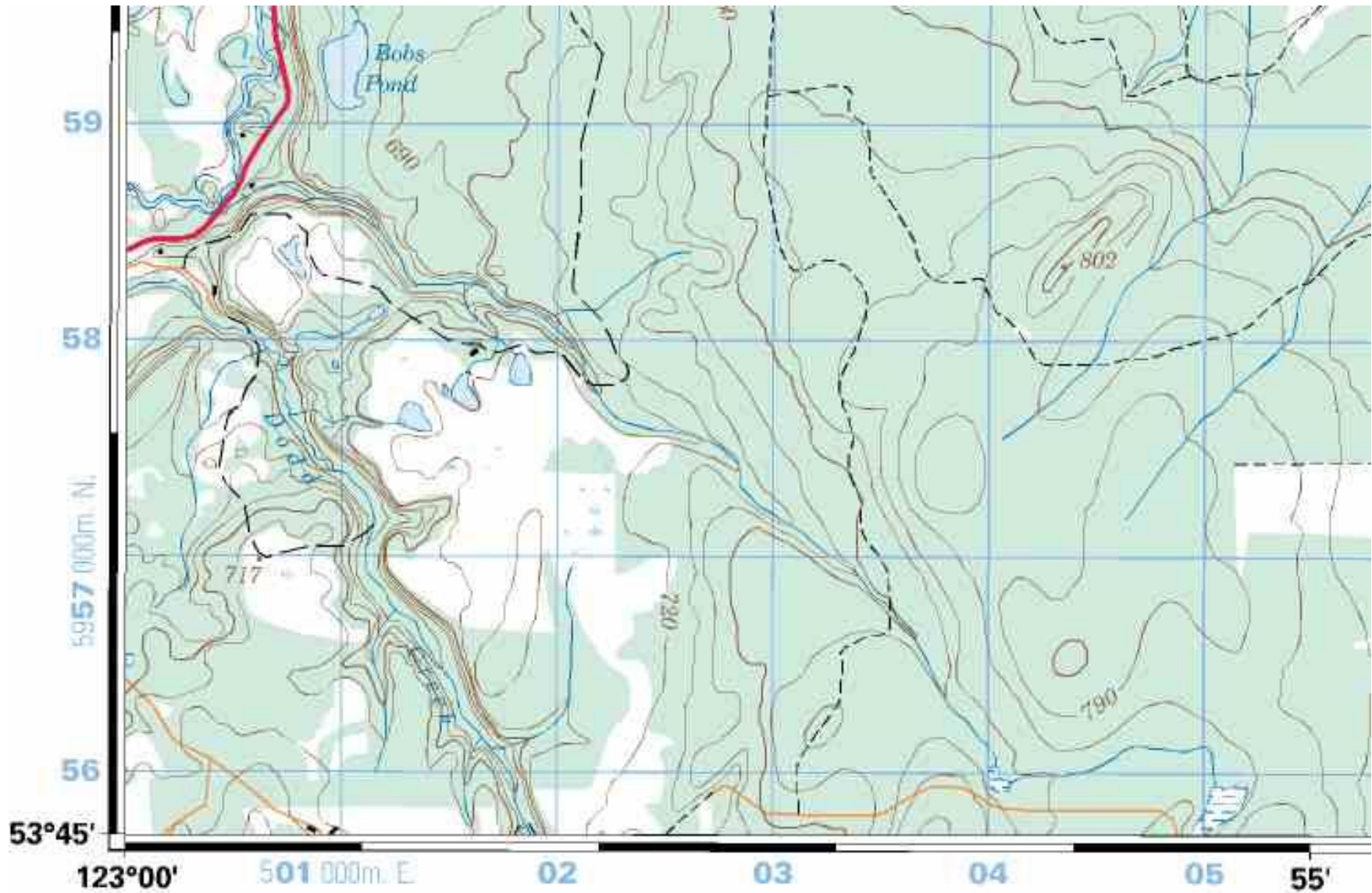
-> NAD83 is the current datum for digital mapping / GIS data

-> The two can differ by ~ **70 metres (x)** and **170 metres (y)**

New millennium: you can 'almost' forget about NAD27

but when UNBC opened in 1994, we still had a lot of NAD27 mapping

Lat/long coordinates given in black in degrees/minutes



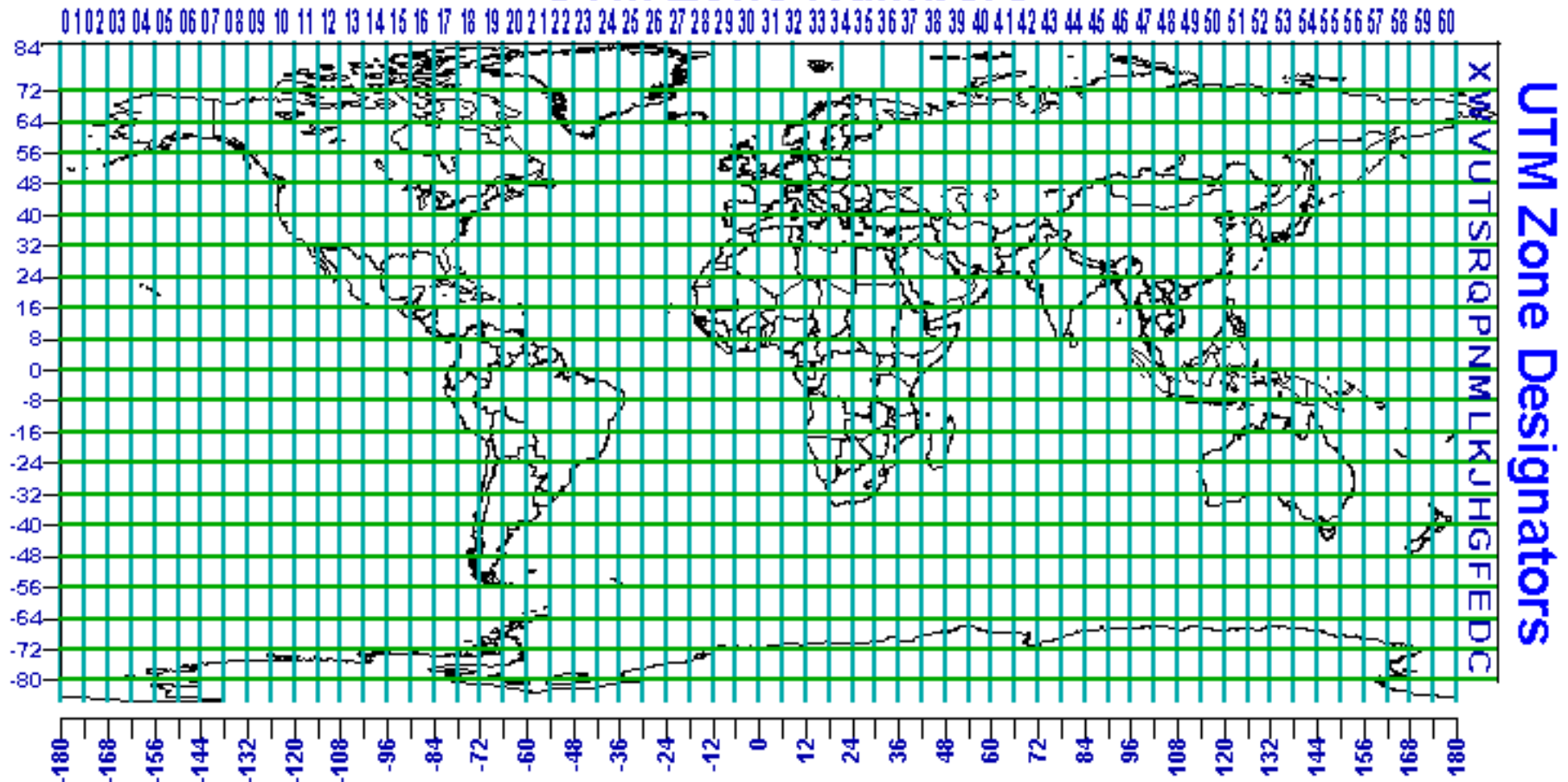
2. UTM map coordinates - a rectangular system

Universal Transverse Mercator (UTM) System

this bit is harder so pay attention ...

The world is divided into $60 \times 6^\circ$ longitude (vertical) strips numbered 1 - 60 from 180 degrees West to 180 degrees East

UTM Zone Numbers

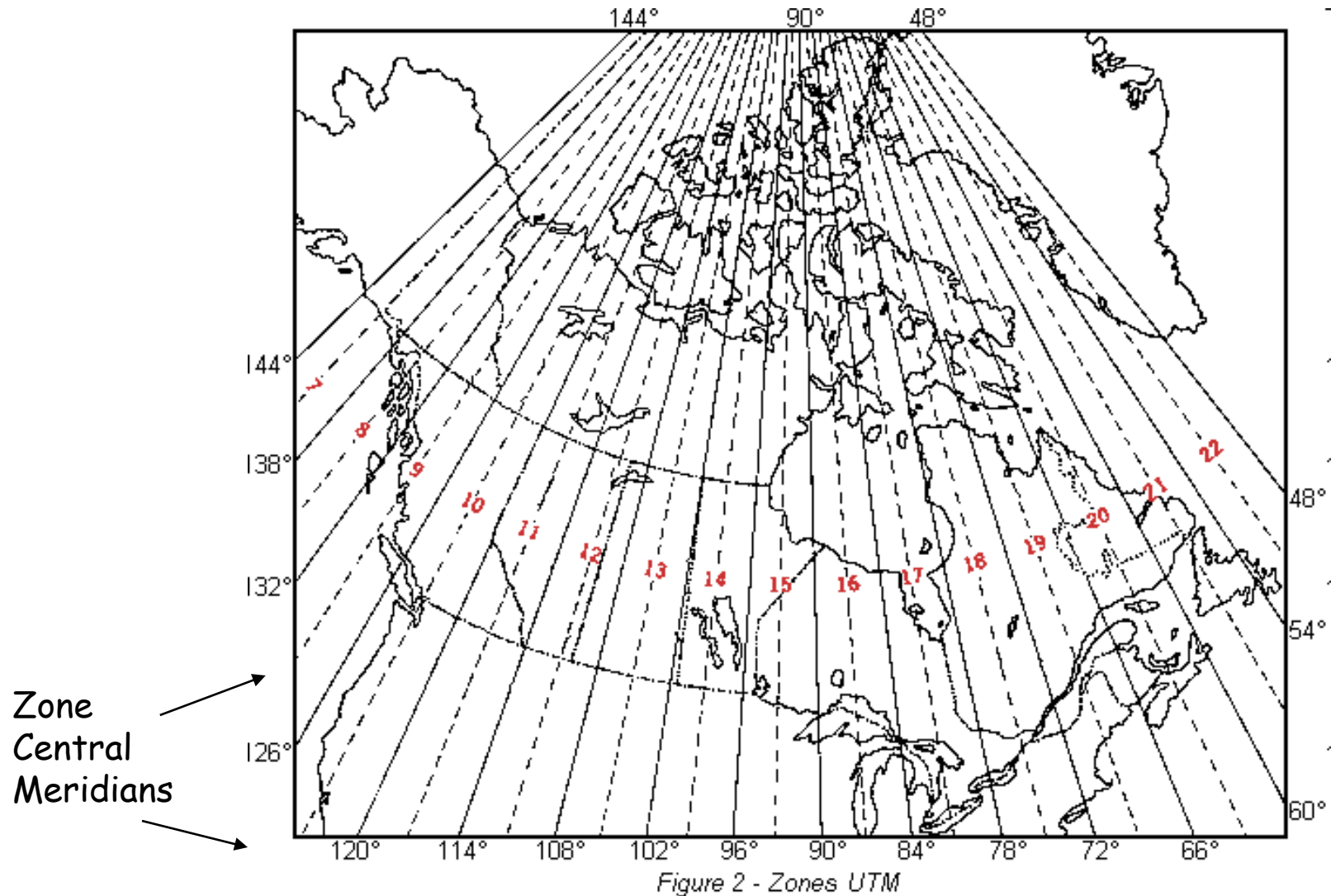


Universal Transverse Mercator (UTM) System

Peter H. Dana 9/7/94

either developed by United States Army Corps of Engineers or German Wehrmacht

Canada: UTM zones - adopted in 1947 for mapping



- the width of each zone varies from 666 km ($6 \times 111\text{km}$) at the equator ...to ~ 338 km (6×55.8 km) at 60° N/S, with a 'central meridian' in the middle

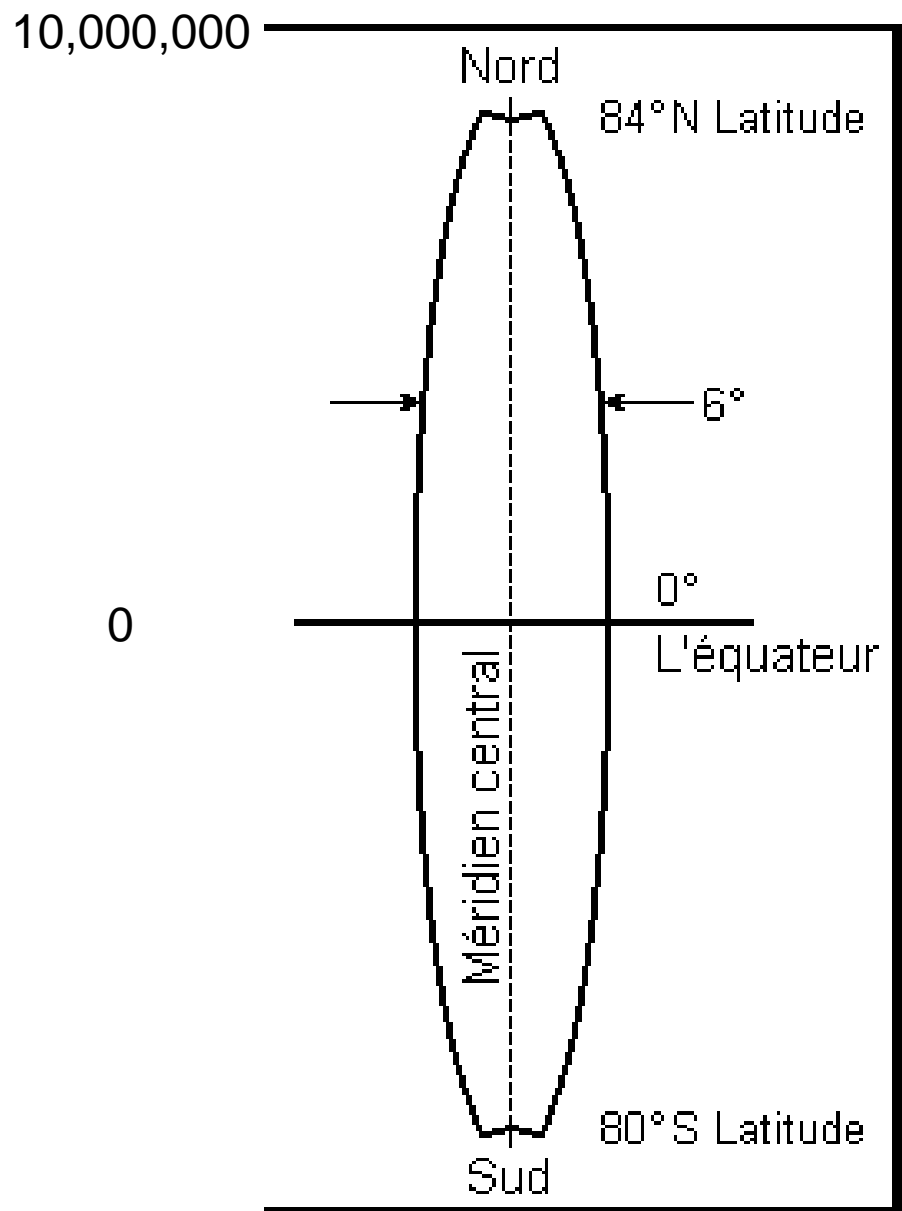


Figure 1 - Zone UTM

UTM coordinates

are in metres

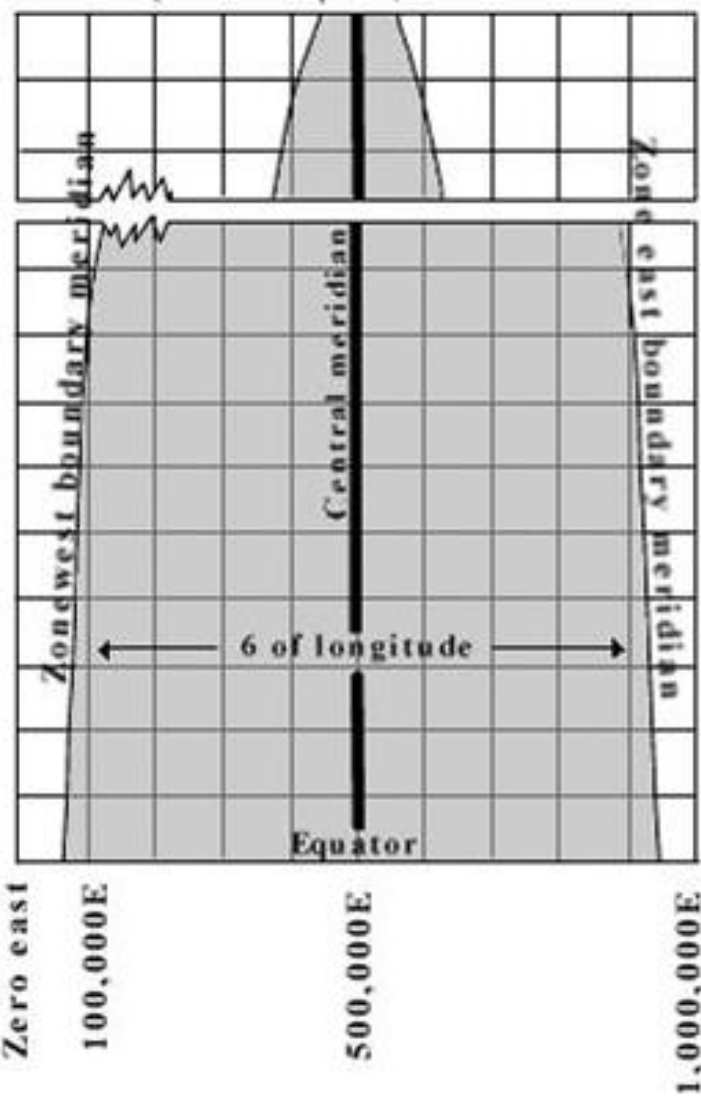
Within each zone ...

The 'Y' coordinate
Northings (N):

measured from the Equator
(0) - to the north pole
(10,000,000) ... in metres
[this is the metric system]

e.g. UNBC ~ 5,972,000

9,200,000 N



100,000 N

Zero north

Zero east

100,000E

500,000E

1,000,000E

UTM coordinates

The 'x' coordinate

- this is the hardest part ...

Eastings (E) for each zone

- based on the zone

Central Meridian at 500,000

the easting value increases to the east, but not > 1,000,000

the easting value decreases to the west but not below zero

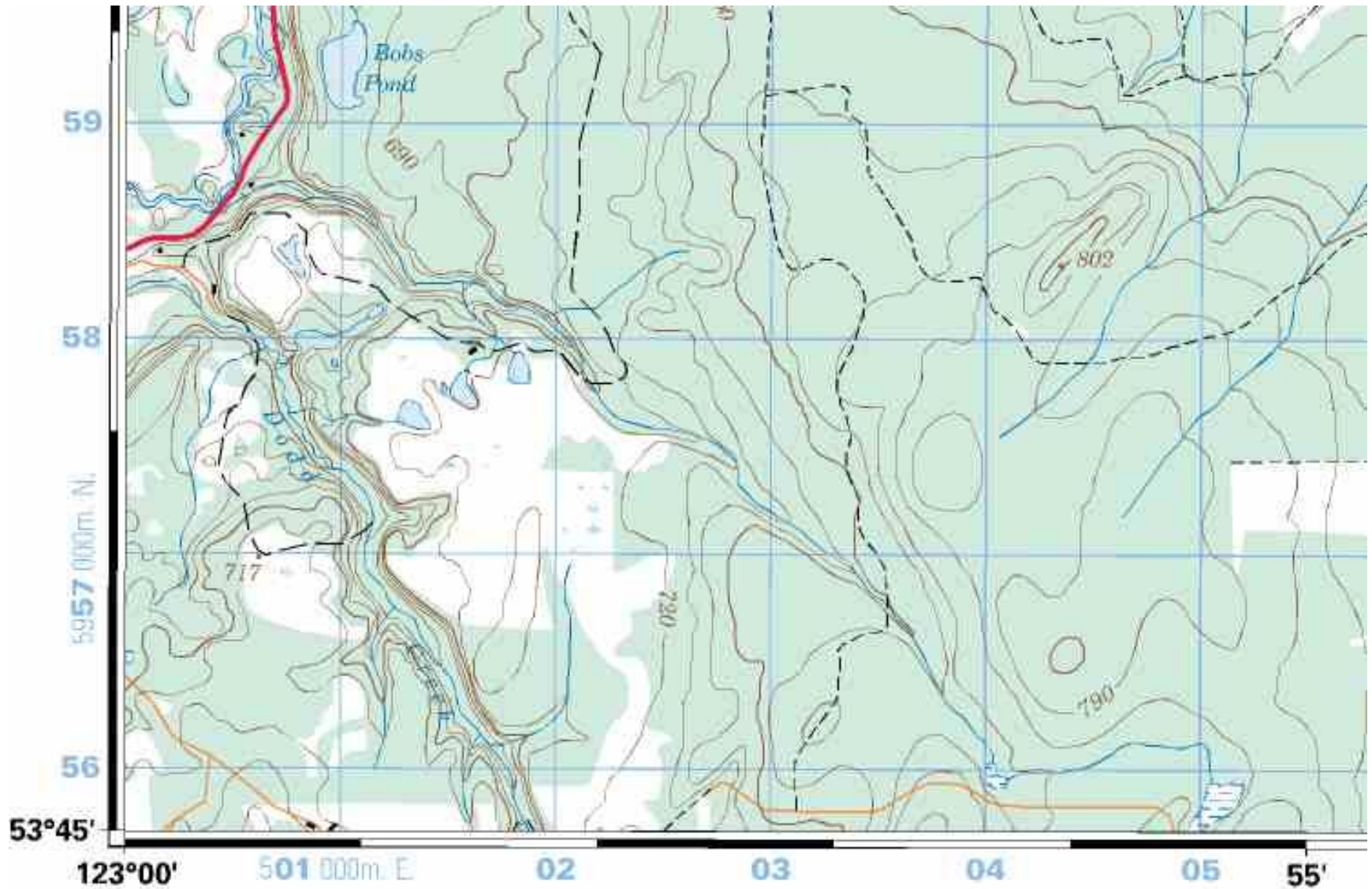
e.g. UNBC ~ 512,000

BC range= ~300,000-700,000

Zone must also be given as Coordinates repeat for each zone

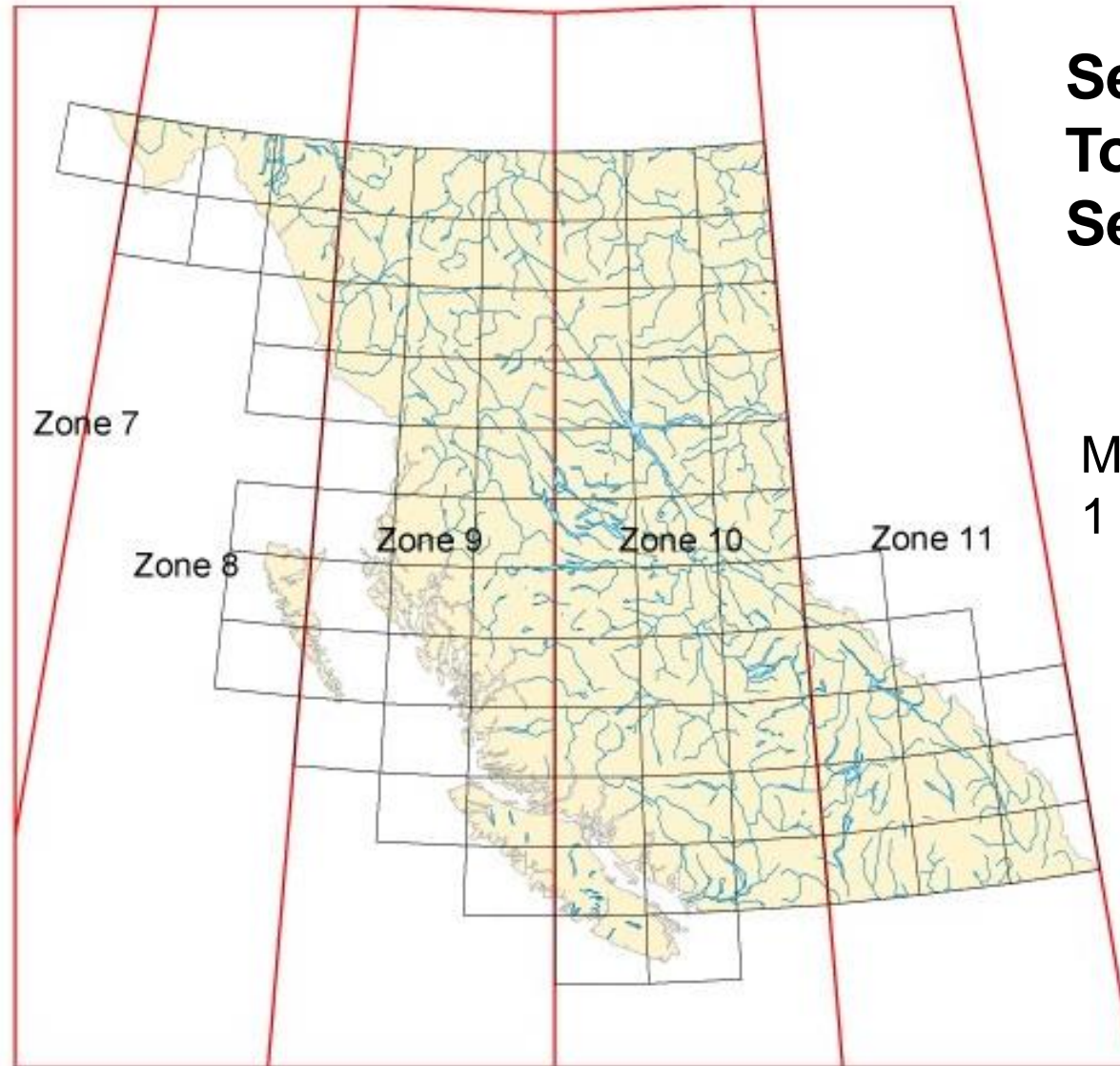
Grrrr ... who came up with this crazy scheme !?

Canadian topographic mapping includes UTM and lat/long coordinates
Blue grid squares in this map are 1000m = 1km



UTM : Eastings are 6-digit, Northings are 7-digit (in Canada)

BC: UTM zones



**See google earth:
Tools-> options
Select UTM**

Many provinces fit into
1 (or 2) UTM zones

How to deal with multiple UTM zones: Eastings switch from ~700,000 at the west edge of one zone to ~300,000 at the east edge of the next zone

BC Albers coordinate system



BC uses UTM for local areas

Albers for the whole province
As with UTM, also in metres

Unlike UTM, eastings and northings are often both 7-digit,
Or both 6-digit or one of each.

Developed by provincial ministry
Forestry/Geomatics in Smithers

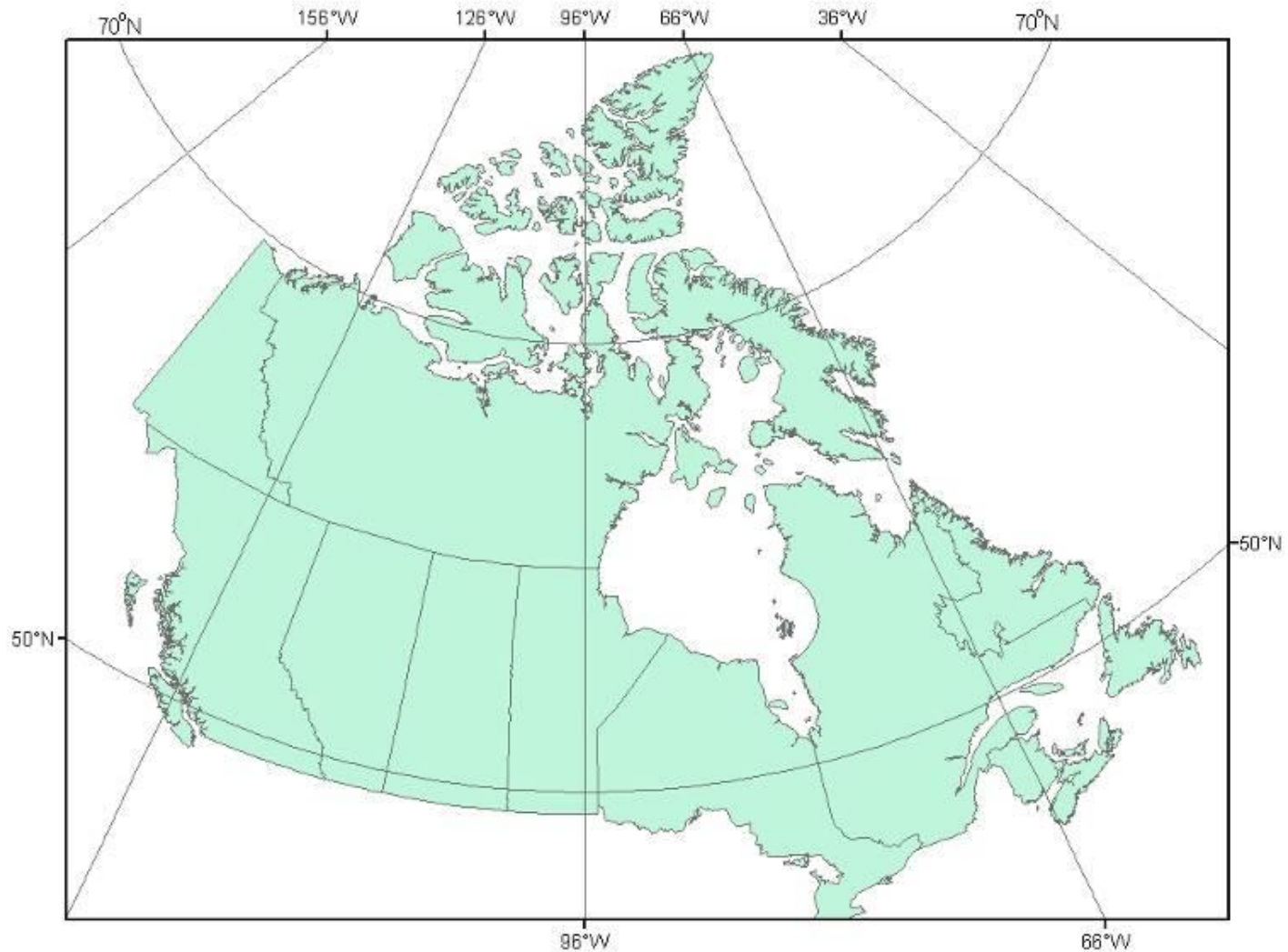
British Columbia Albers Equal Area Conic
Central meridian: -126.0 Degrees West longitude
Latitude of projection origin: 45.0 Degrees North latitude



126°W = 1,000,000 Eastings
45°N = 0 Northings

Canada Albers Equal Area Conic

Central Meridian: -96 Latitude Of Origin: 40



Download Canada map data using Geographic, Albers, UTM ... or Web Mercator (2019)

Summary: BC mapping coordinates

Could be one of:

1. Geographic - lat. / long. - global reference
2. UTM - zones 7-11 - local /regional mapping
3. BC Albers - BC provincial data
4. Canada Albers - Federal data

Why is it important - because we 'import' data from different sources .. and they need to line up

It makes more sense here : - view these at home or in lab

PGMAP: <https://pgmap.princegeorge.ca/Html5Viewer/index.html?viewer=PGMap>

UTM coordinates - or lat/long + web Mercator

BC IMAP: <http://maps.gov.bc.ca/ess/hm/imap4m/>

UTM, Lat/long and Albers

Google Earth: Lat/long and UTM

Natural Resources Canada and BC Forestry– UTM grid

<https://www.nrcan.gc.ca/earth-sciences/geography/topographic-information/maps/9779>

UTM coordinates quiz on Moodle - today or Monday, due one week later

PGMap viewer

The screenshot displays the PGMap viewer interface. At the top, there is a toolbar with icons for various functions: Identify, Pan, Print, Share, Export, Upload Data, Add Layers, Google Street View, Initial View, Distance, Area, Edit, Open Data (Download Data), City of PG Website, and PGMap Tutorial Videos. Below the toolbar, the main map area shows a topographic map of Prince George, BC, with a blue dashed line outlining the city boundary. The map includes labels for Reid Lake, Miworth, Shady Valley, Foreman, Nechako River, and Telachick. On the left side, there is a 'Layers' panel with a search bar and a list of layers: ADMINISTRATIVE BOUNDARIES (checked), CADASTRE (checked), CITY SERVICES, COMMUNITY INFORMATION, DEMOGRAPHICS, ECOLOGY, EMERGENCY MANAGEMENT, HYDROGRAPHY, LAND USE PLANNING, MAP GRID AND SURVEY, OCP 8383, 2011, and PARKS. At the bottom, there is a status bar showing the coordinate system (Nad83 UTM Zone 10N), coordinates (X: 535793.84287, Y: 5971578.41561), a scale bar (0 to 4km), and the text 'City of Prince George | Esri, Buckhorn'.

<https://pgmap.princegeorge.ca/Html5Viewer/index.html?viewer=PGMap>

The last 3 words on coordinates

<https://what3words.com>



Earth surface (510m km²) is divided into (57 trillion) 3x3m squares, each coded by 3 unique word combination

Canadian rescue services:

<https://what3words.com/news/emergency/three-words-to-tell-canadian-emergency-services-exactly-where-you-are>

Lonely Planet

<https://venturebeat.com/mobile/lonely-planet-adopts-what3words-geocoded-navigation-system-to-find-places-using-just-3-words/>