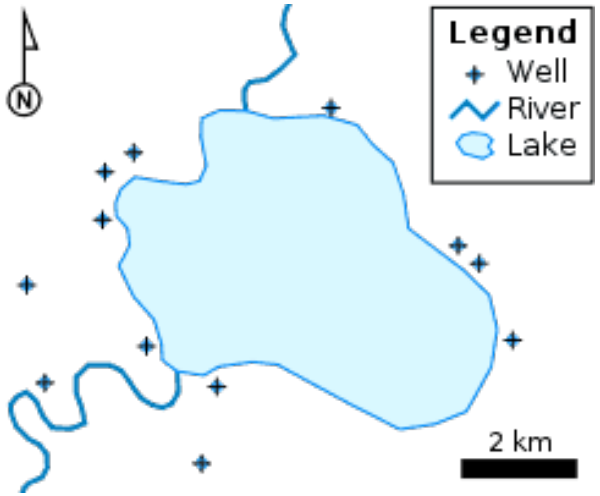
Introduction to Geospatial Analysis

Key Concepts

Spatial Data: Two main types of spatial data are **vector data** and **raster data**

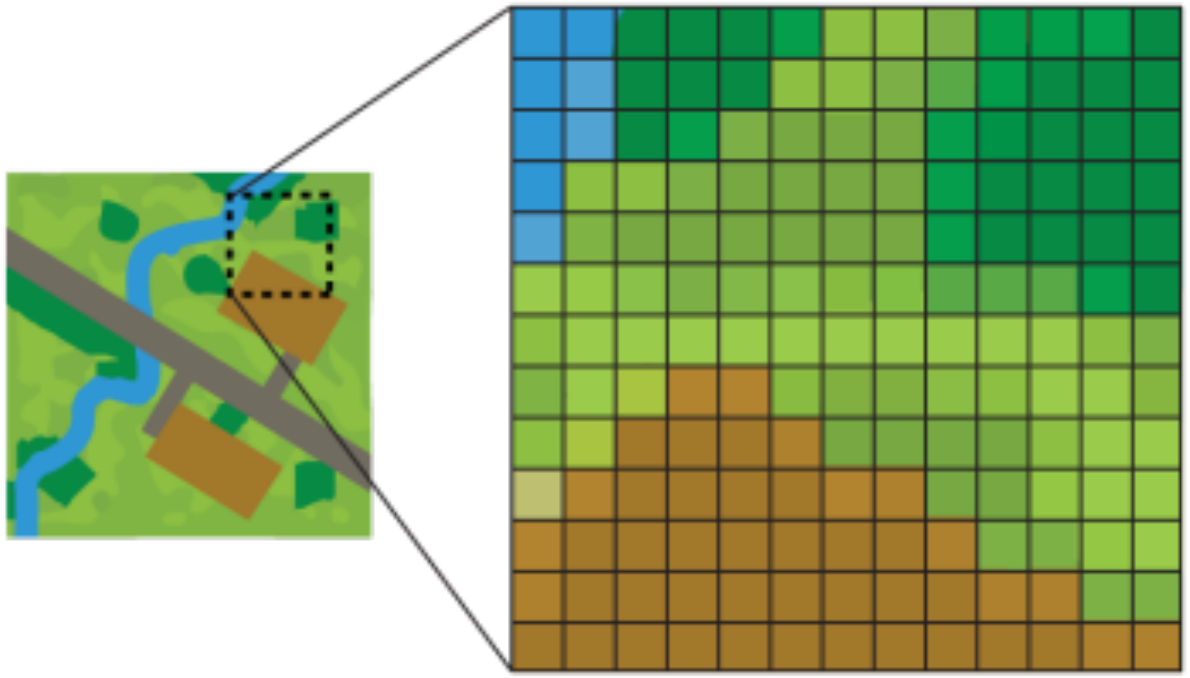
Vector Data

- Are points, lines, or polygons
- Common file formats include shapefiles (.shp) and geojsons (.geojson)
- Examples:
  - **Polygons** of countries
  - **Polylines** of roads
  - **Points** of households



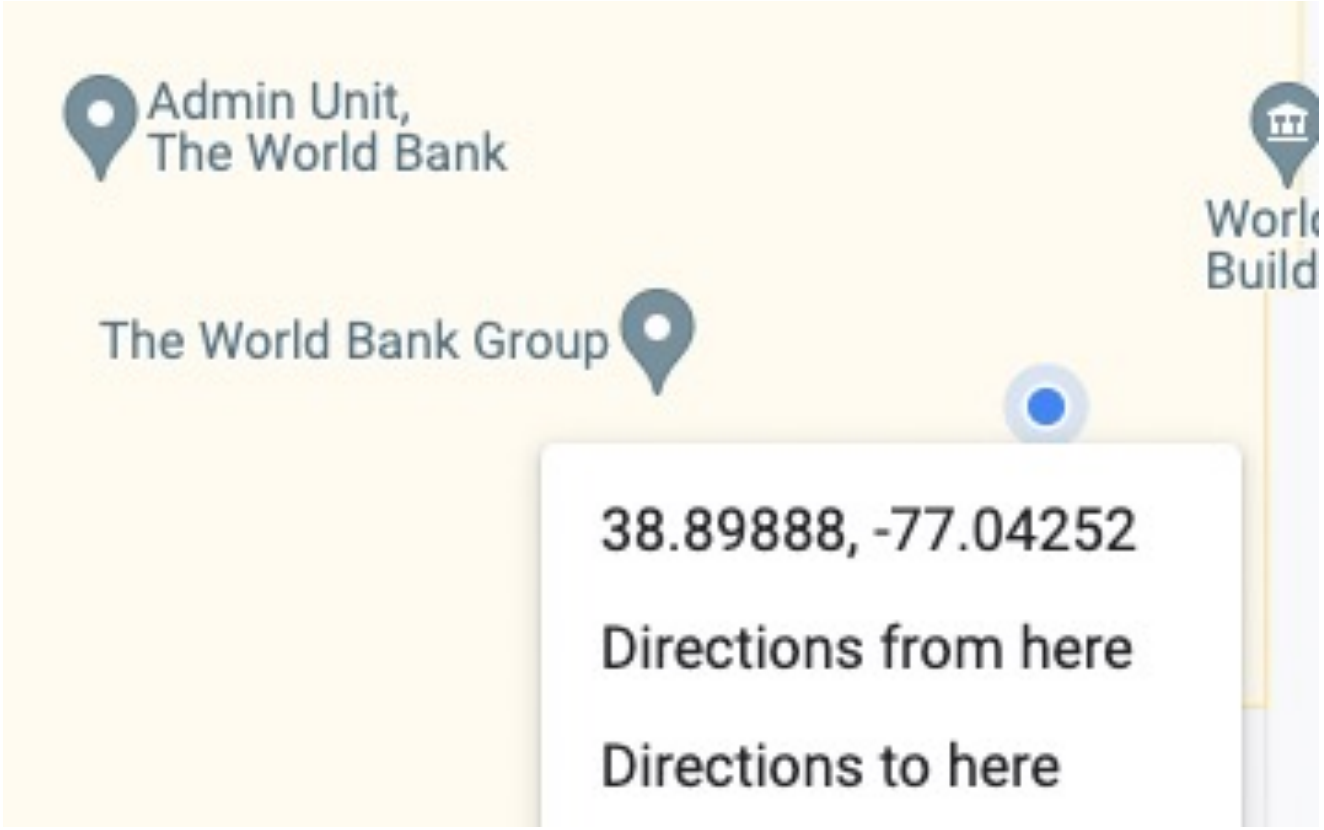
Raster Data

- Is a spatially referenced grid
- Common file format is a geotif (.tif)
- For example, satellite imagery comes in a raster format



Coordinate Reference Systems (CRS)

- Coordinate reference systems use pairs of numbers to define a location on the earth
- For example, the World Bank is at a latitude of 38.89 and a longitude of -77.04



Coordinate Reference Systems

There are many different coordinate reference systems, which can be grouped into **geographic** and **projected** coordinate reference systems. Geographic systems live on a sphere, while projected systems are “projected” onto a flat surface.

Geographic (Sphere)

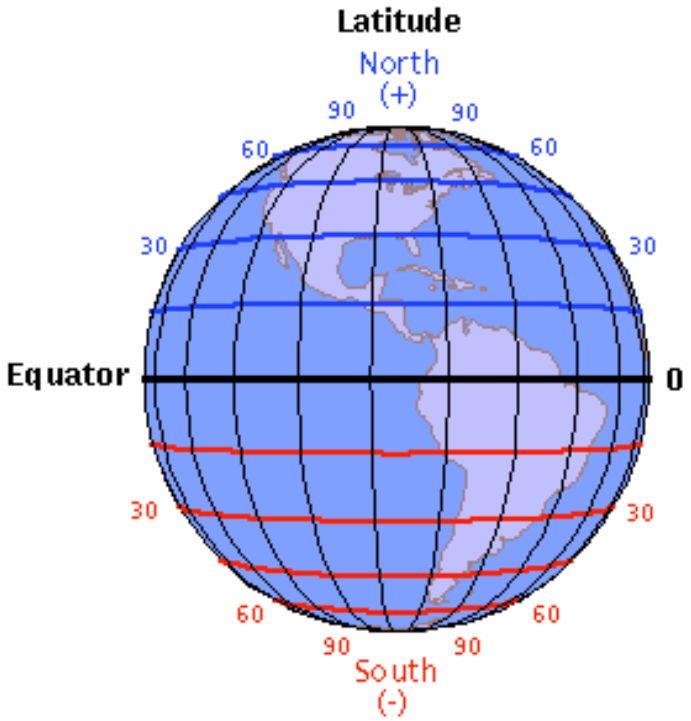
Projected (Flat)

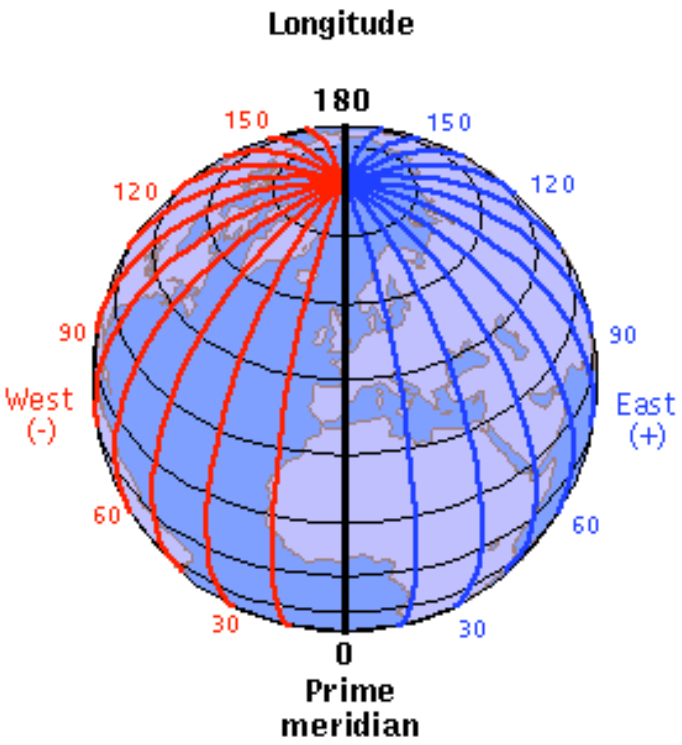
Geographic Coordinate Systems

Units: Defined by latitude and longitude, which measure angles and units are typically in decimal degrees. (Eg, angle is latitude from the equator).

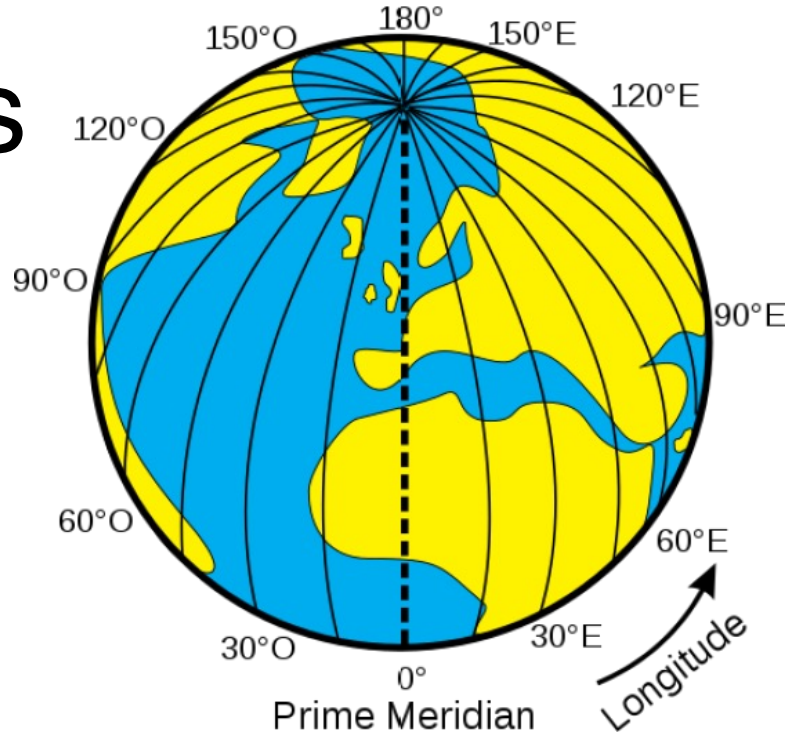
Latitude & Longitude: On a grid X = longitude, Y = latitude.

- Sometimes represented as (longitude, latitude).
- Also has become convention to report them in alphabetical order: (latitude, longitude) — such as in Google Maps.
- Valid range of latitude: -90 to 90
- Valid range of longitude: -180 to 180
- {Tip} Latitude sounds (and looks!) like latter.





Geographic Coordinate Systems



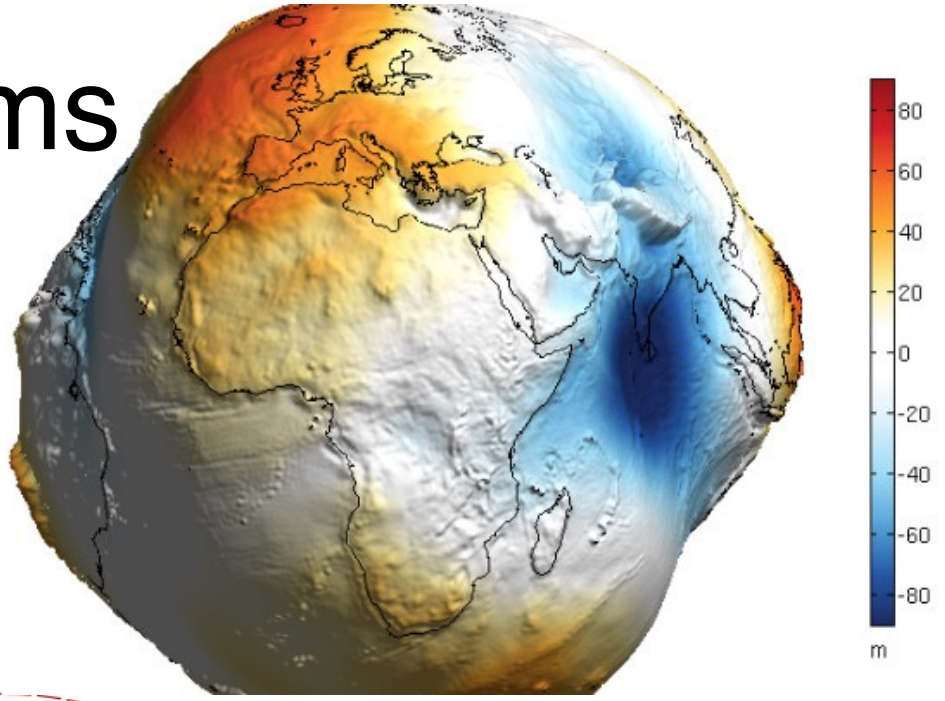
Distance on a sphere

- At the equator (latitude = 0), a 1 decimal degree longitude distance is about 111km; towards the poles (latitude = -90 or 90), a 1 decimal degree longitude distance converges to 0 km.

- We must be careful (ie, use algorithms that account for a spherical earth) to calculate distances! The distance along a sphere is referred to as a great circle distance.

- Options for spherical distance calculations
  - Formulas such as haversine distance
  - s2 (Google library for working with spherical geometries)

Geographic Coordinate Systems

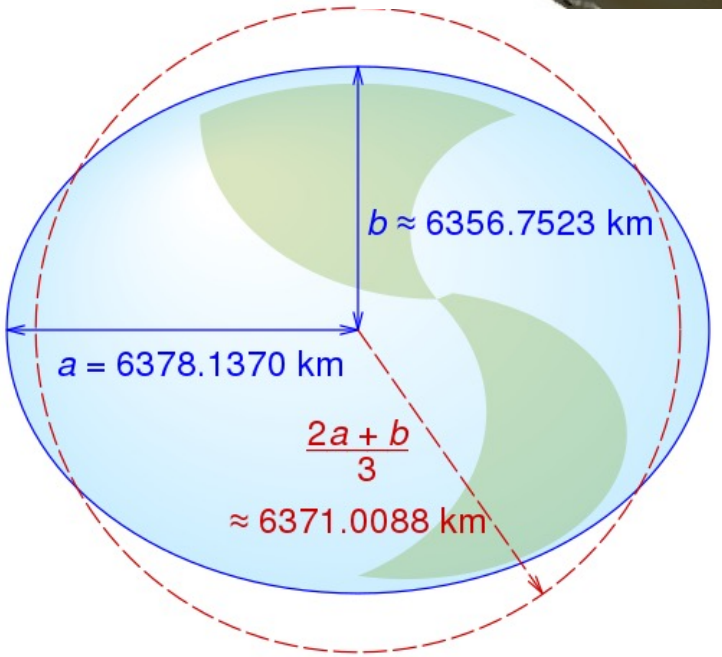


Datums

- **Is the earth flat?** No!
- **Is the earth a sphere?** No!
- **Is the earth a lumpy ellipsoid?** Yes!

The earth is a lumpy ellipsoid, a bit flattened at the poles.

- A datum is a model of the earth that is used in mapping. One of the most common datums is WGS 84, which is used by the Global Positional System (GPS).
- A datum is a reference ellipsoid that approximates the shape of the earth.
- Other datums exist, and the latitude and longitude values for a specific location will be different depending on the datum.



Projected Coordinate Systems

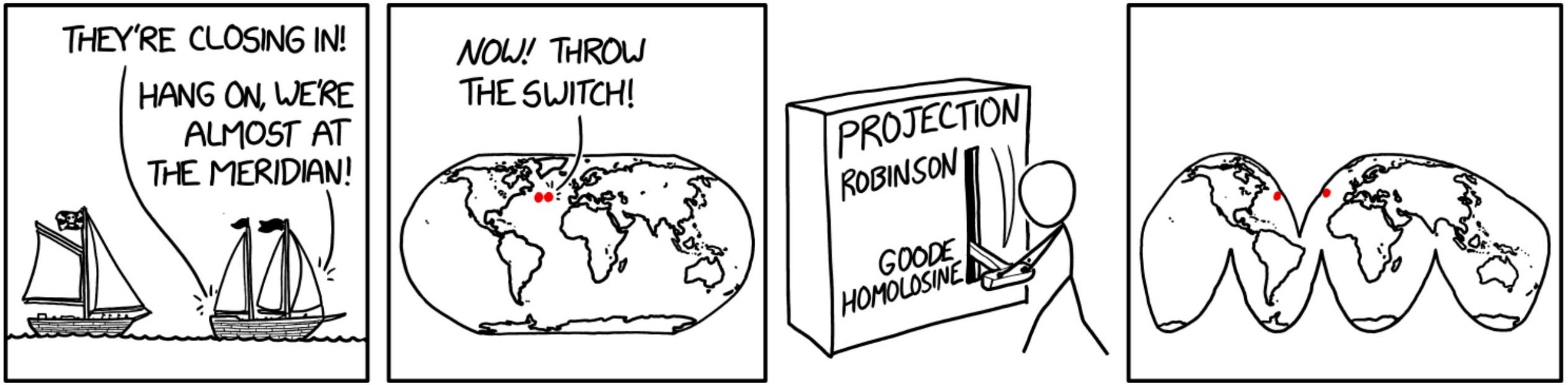
Projected coordinate systems project spatial data from a 3D to 2D surface.

Distortions: Projections will distort some combination of distance, area, shape or direction. Different projections can minimize distorting some aspect at the expense of others.

Units: When projected, points are represented as “northings” and “eastings.” Values are often represented in meters, where northings/eastings are the meter distance from some reference point. Consequently, values can be very large!

Click here to see why Toby & CJ are confused (hint: projections!)

Projected Coordinate Systems



Coordinate Reference Systems

Whenever have spatial data, need to know which coordinate reference system (CRS) the data is in.

- You wouldn't say "I am 5 away"
- You would say "I am 5 [miles / kilometers / minutes / hours] away" (units!)
- Similarly, a "complete" way to describe location would be: I am at 6.51 latitude, 3.52 longitude using the WGS 84 CRS