

Advanced Structural Geology, Fall 2022

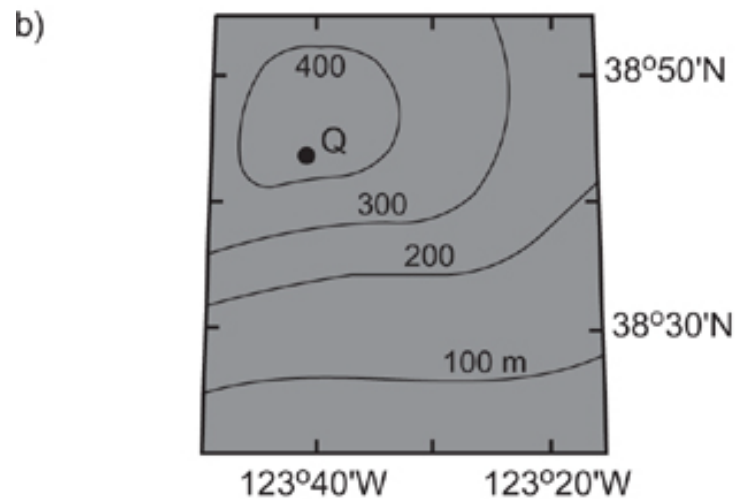
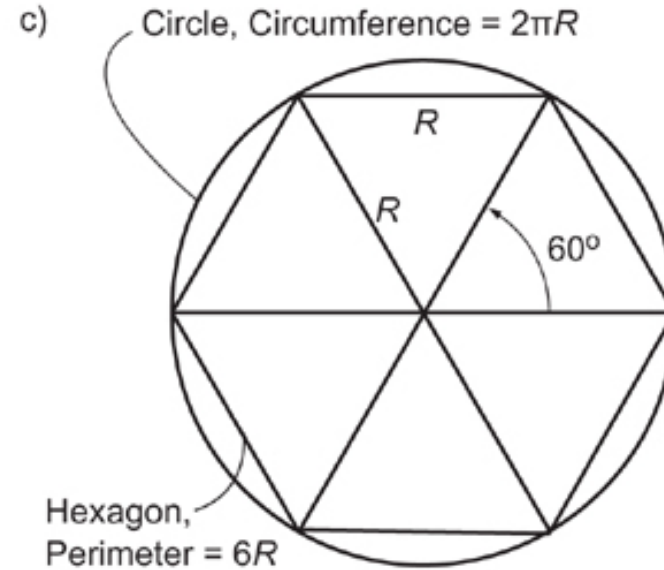
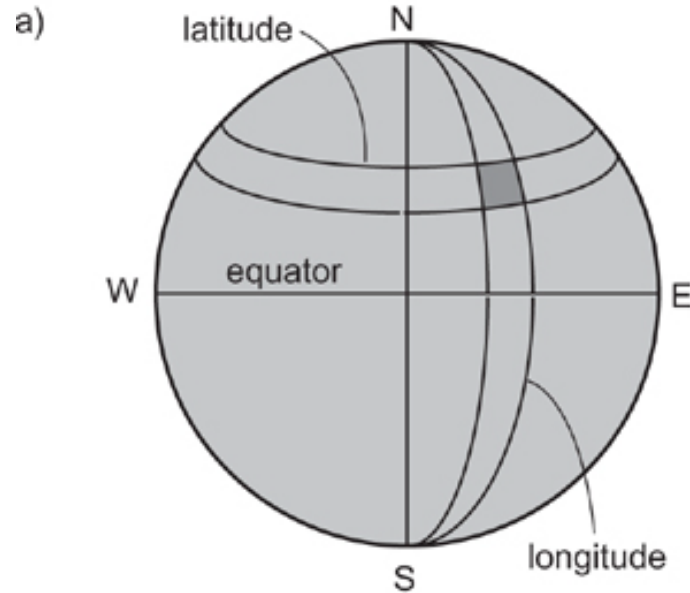
Coordinate systems and displacement/velocity vectors

Ramón Arrowsmith

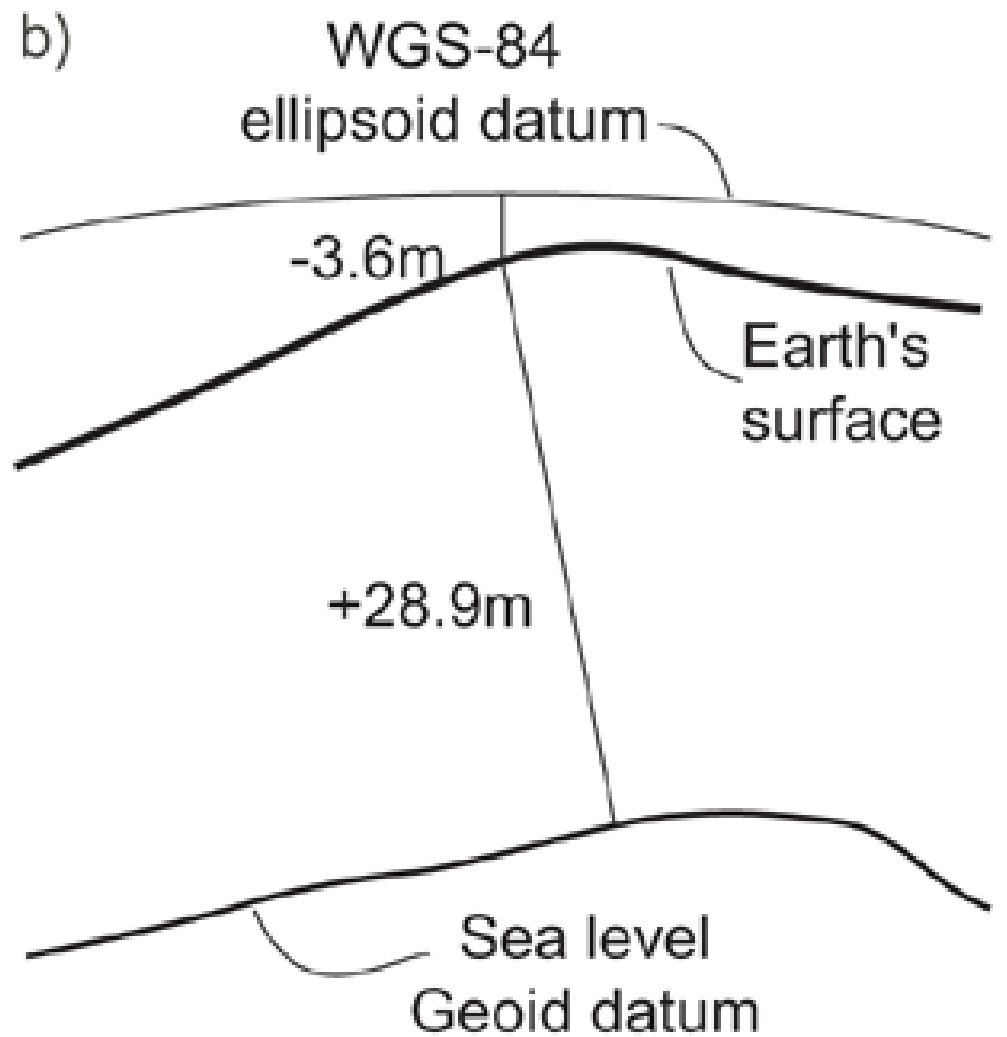
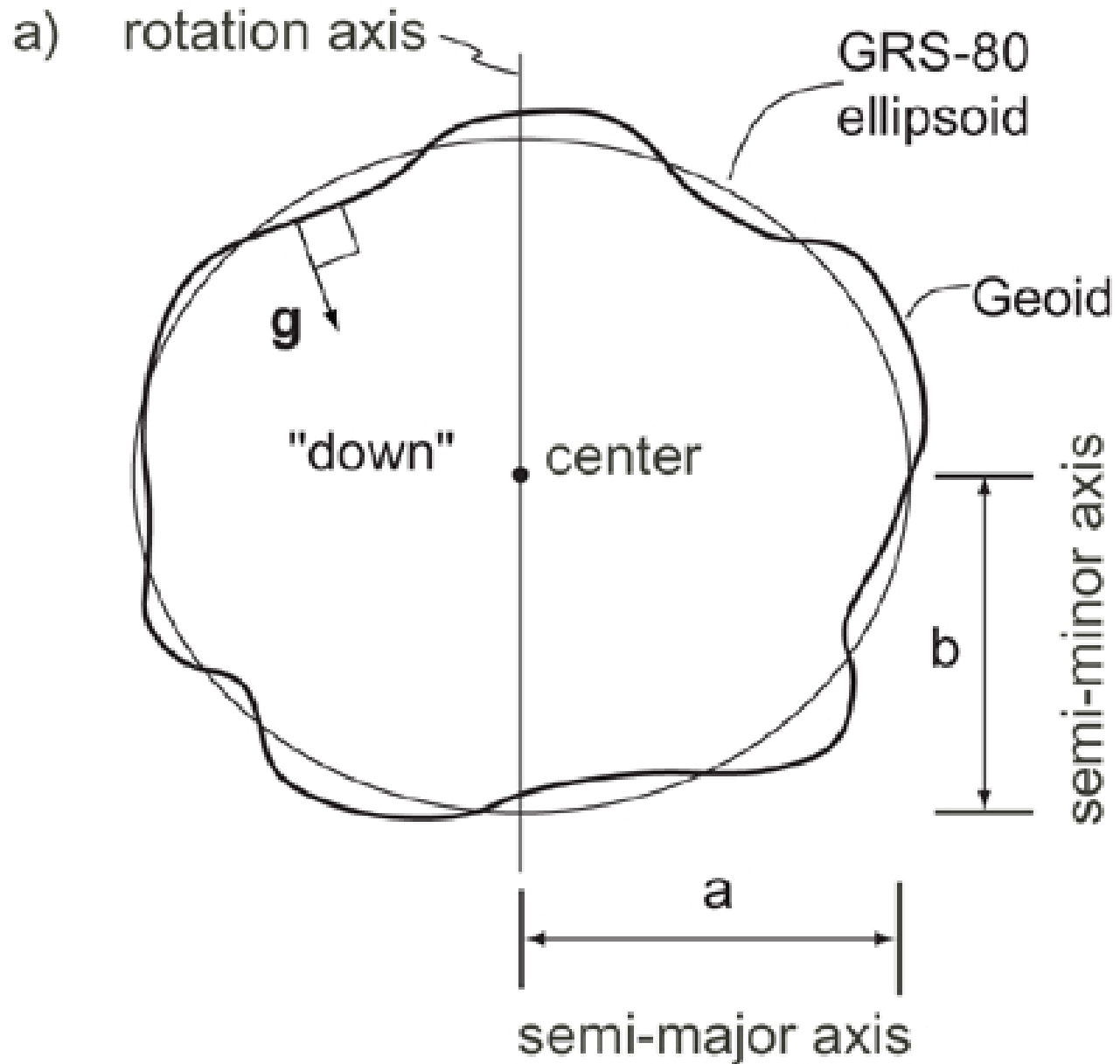
ramon.arrowsmith@asu.edu



Geographic Coordinates

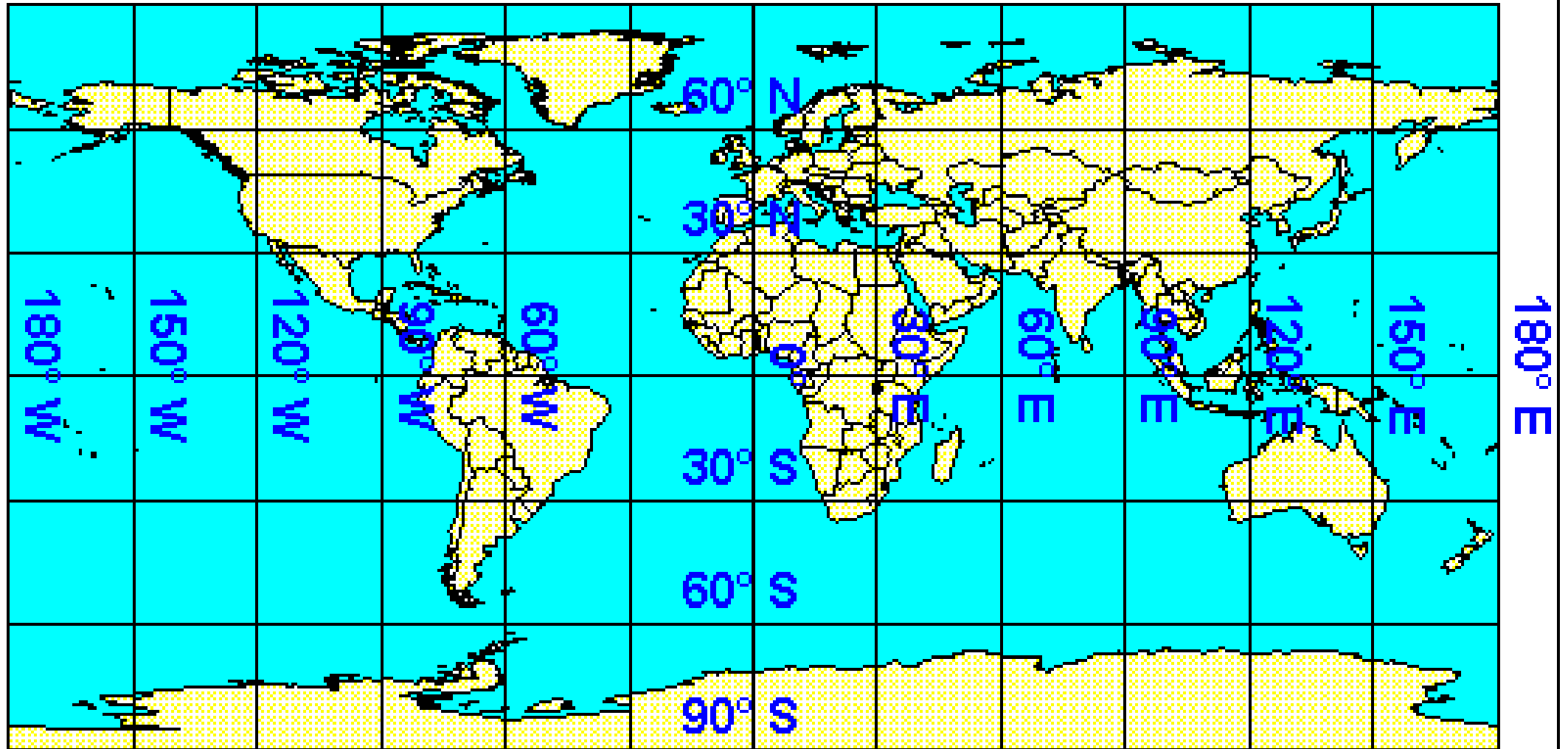


Location of Q
Latitude: 38° 45' N
Longitude: 123° 42' W
Elevation (MSL datum): 425 m



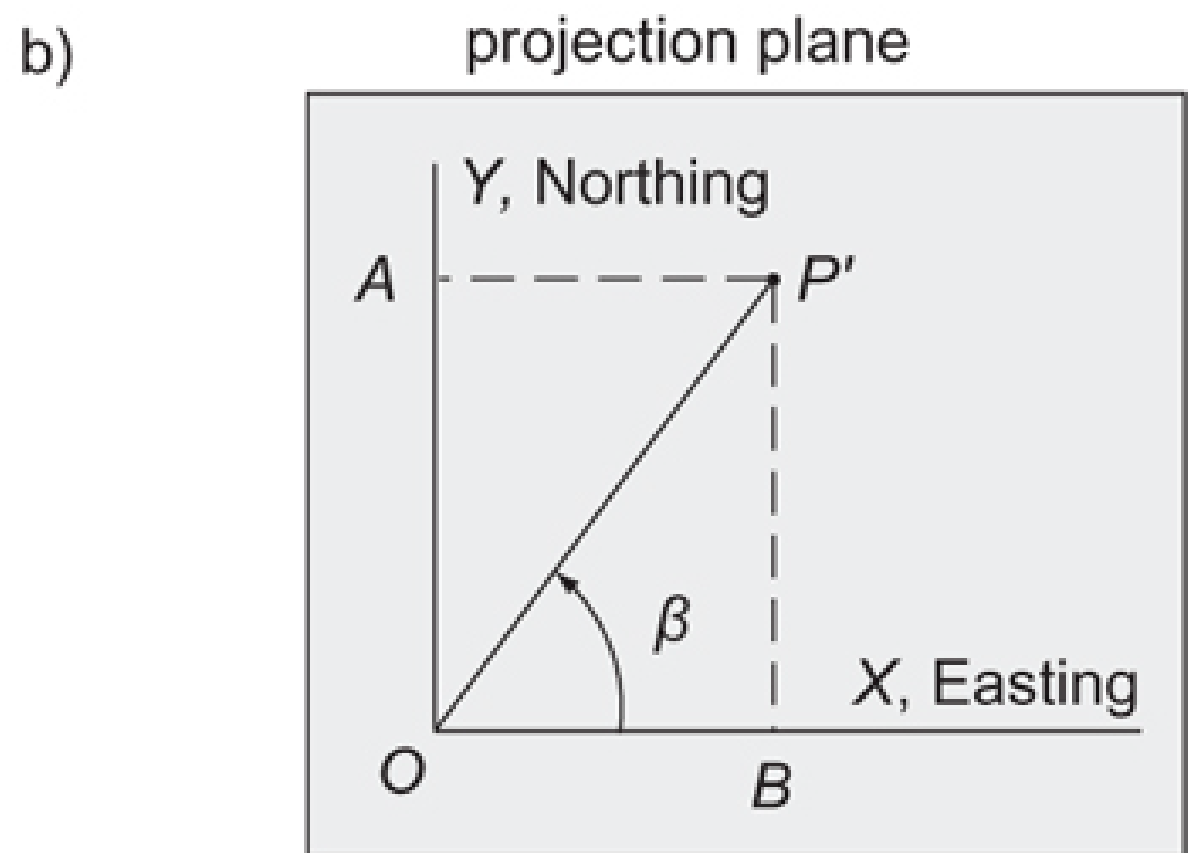
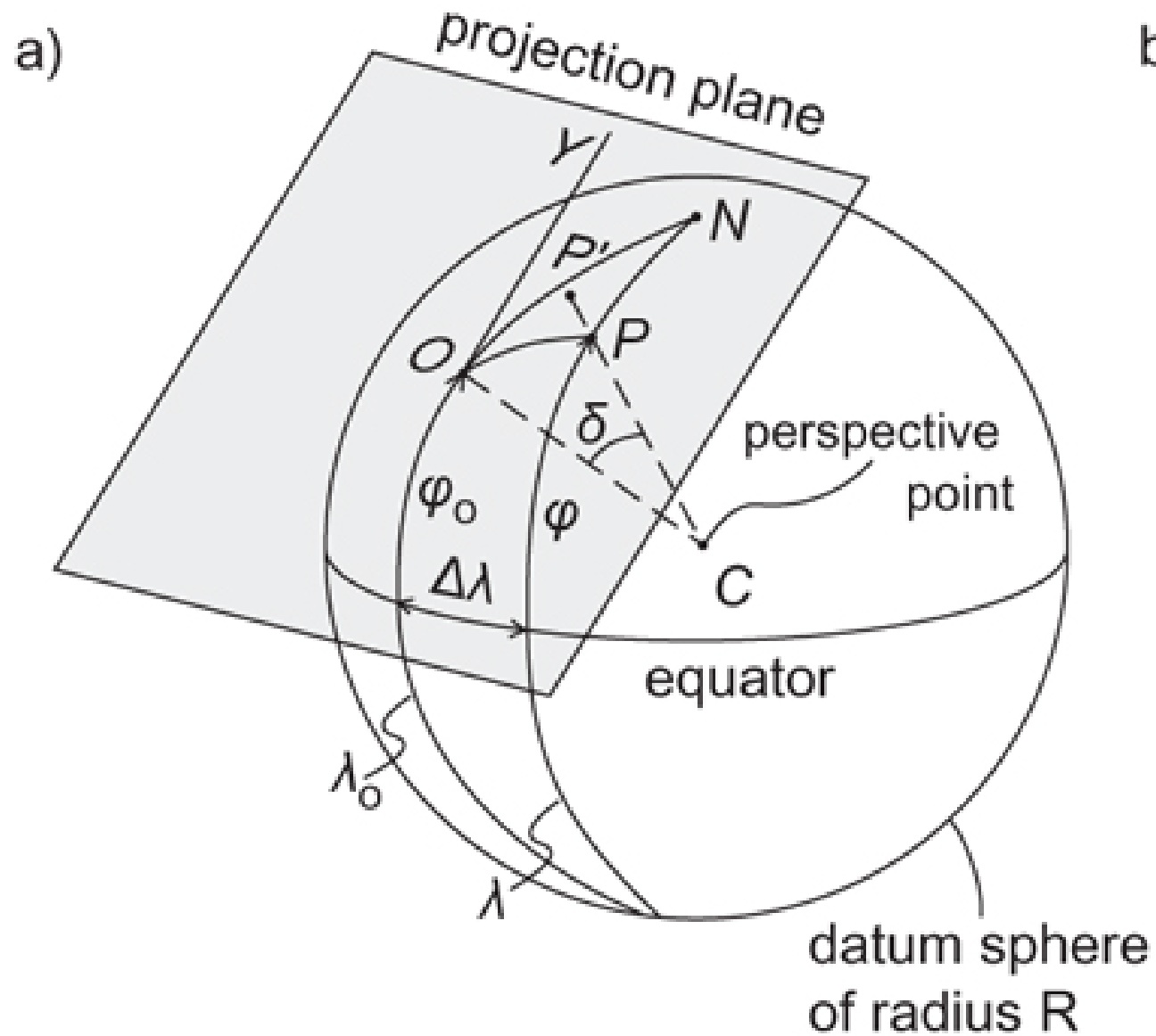
90° N

http://www.colorado.edu/geography/gcraft/notes/mapproj/mapproj_f.html



Unprojected Latitude and Longitude

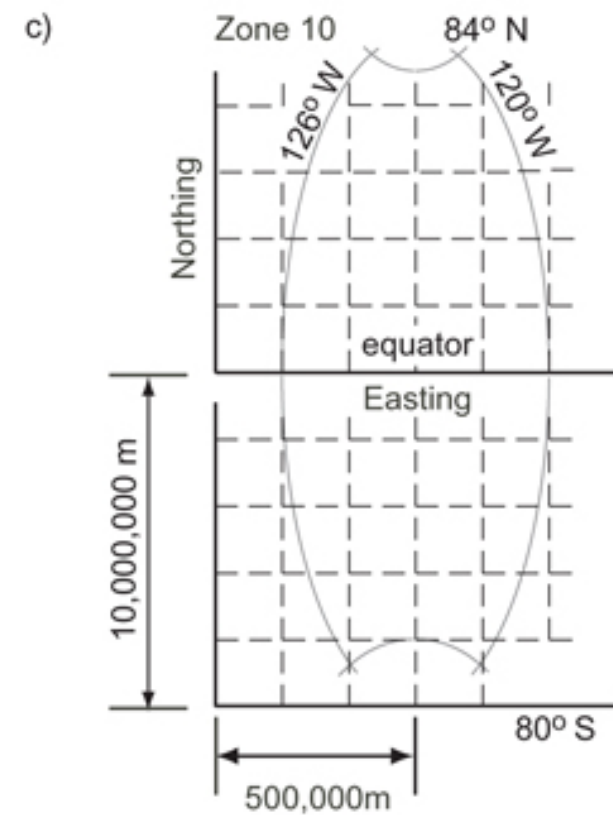
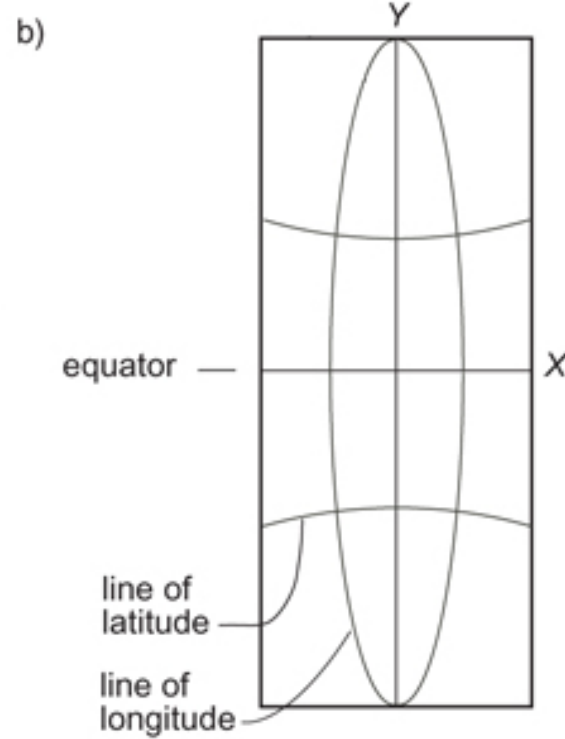
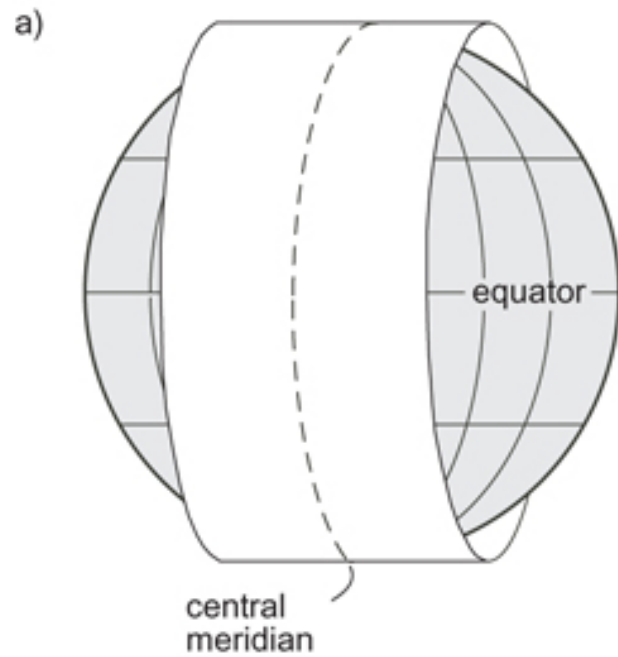
Scale, distance, area, and shape are all distorted with the distortion increasing toward the poles



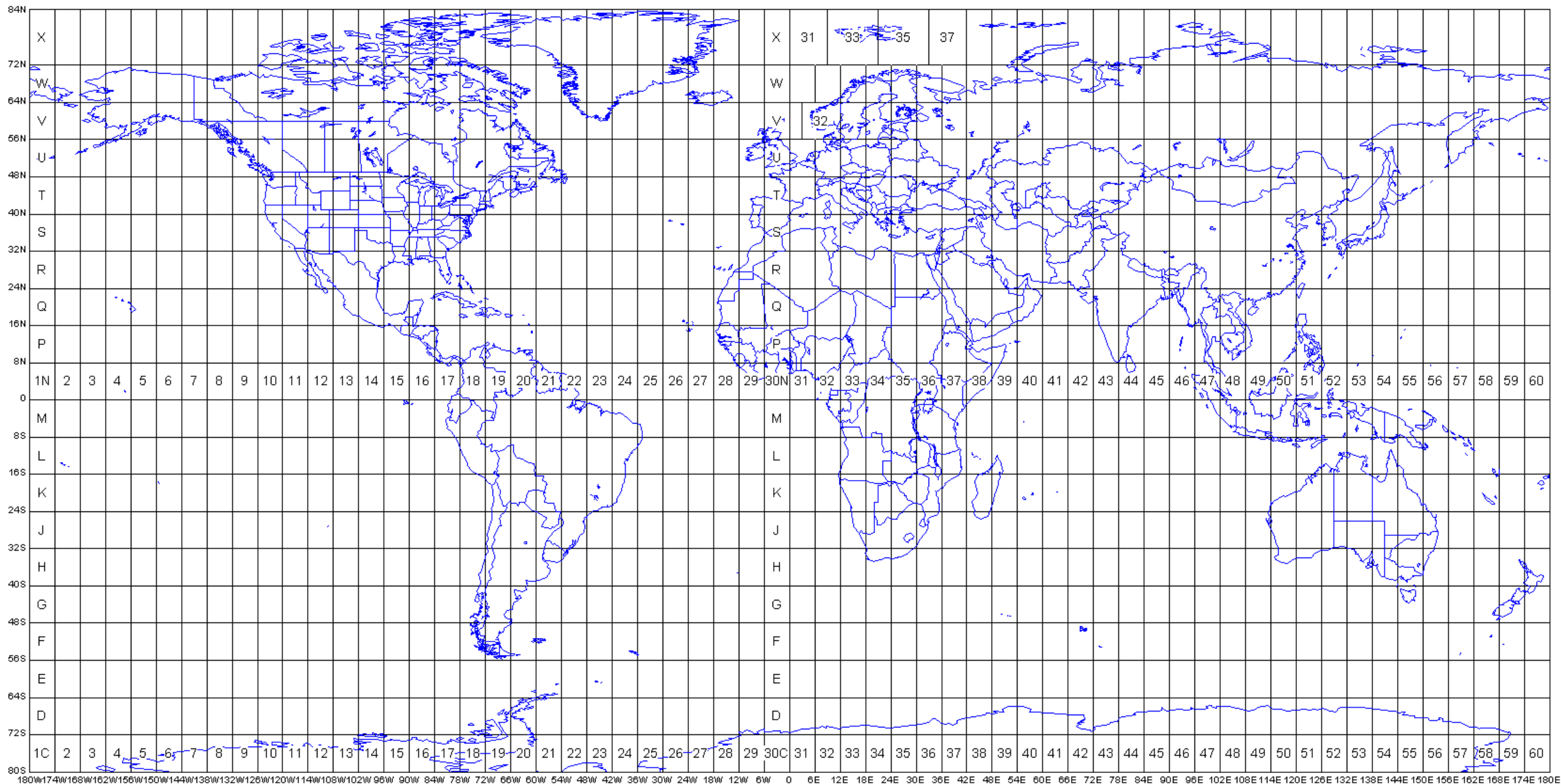


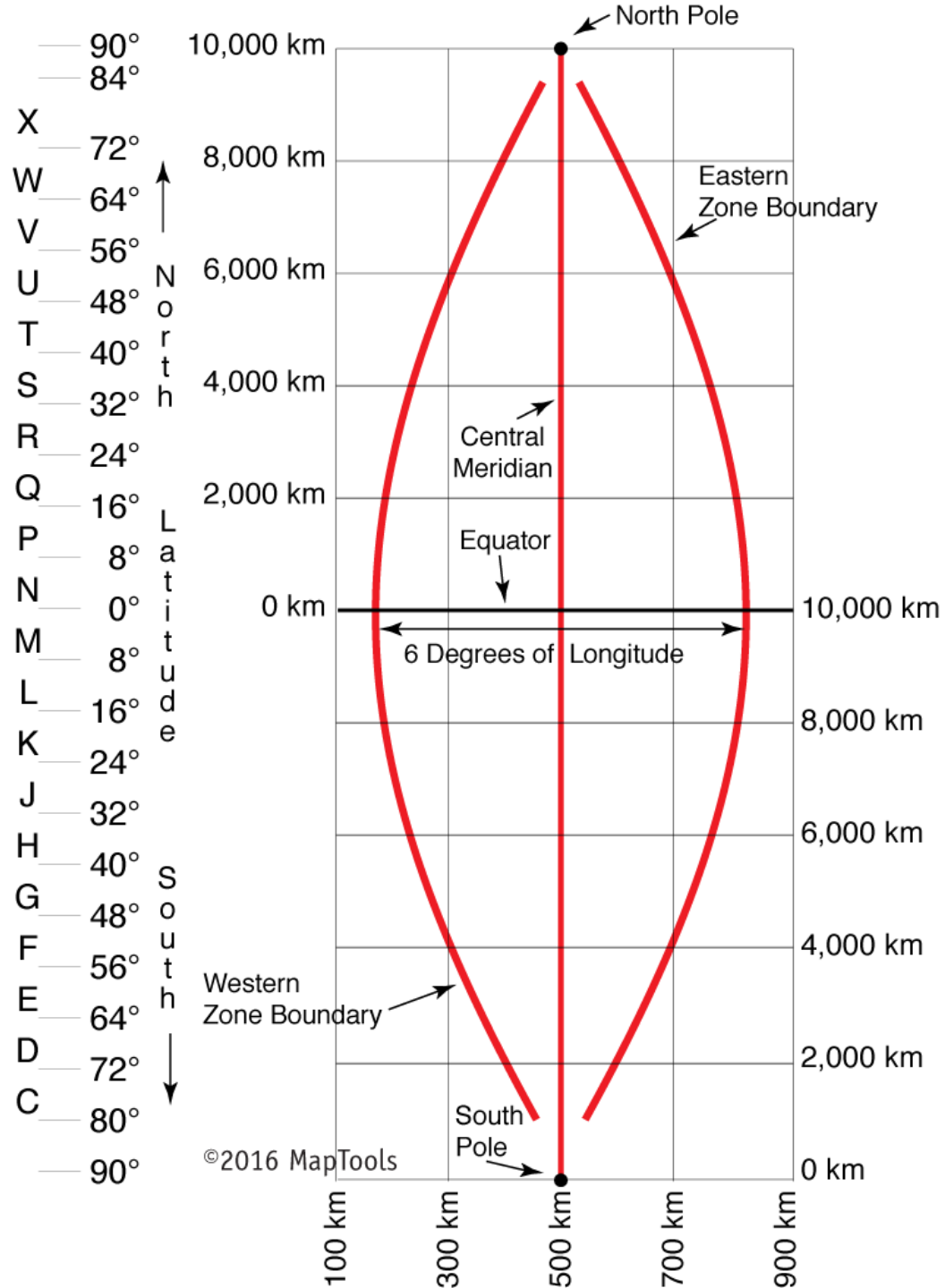
Mercator:

Used this projection in 1669 for a wall map of the world in 18 separate sheets



UTM zones of the world





Eastings

UTM easting coordinates are referenced to the center line of the zone known as the central meridian. The central meridian is assigned an easting value of 500,000 meters East. Since this 500,000m value is arbitrarily assigned, eastings are sometimes referred to as "false eastings"

Northings

UTM northing coordinates are measured relative to the equator

https://www.maptools.com/tutorials/grid_zone_details

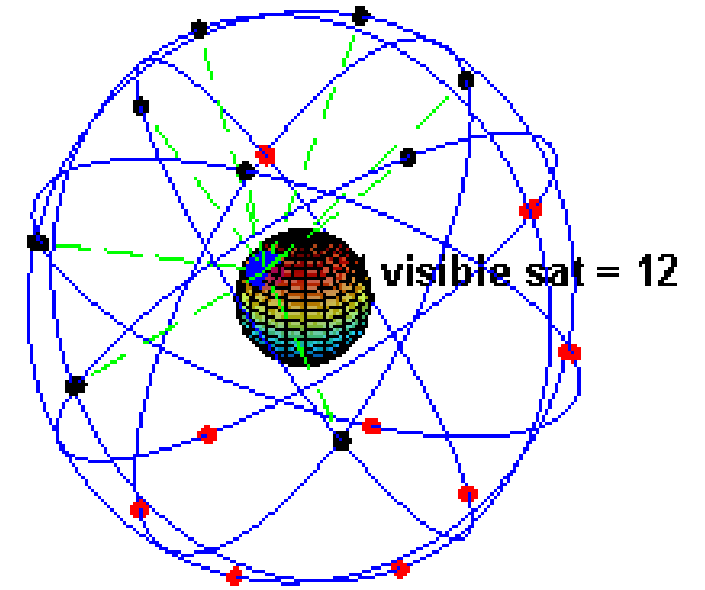
Global Positioning System Overview

GPS is made up of three components: a constellation of satellites, controllers on the ground, and users.

Satellite Segment

GPS satellites have some special characteristics:

- They are orbiting the Earth ~20,000 km above the Earth's surface. That means they orbit the Earth twice a day.
- They transmit coded signals for both civilians and military users.
- Originally GPS used two frequencies so that users could reduce the effects of the ionosphere. Recently GPS added a third frequency.
- They carry their own clocks so that they can keep synchronized with their ground controllers.
- The GPS signal also includes information about where the satellite is.
- Although initially designed for 24 satellites, the Global Positioning System currently has more than 30 satellites.

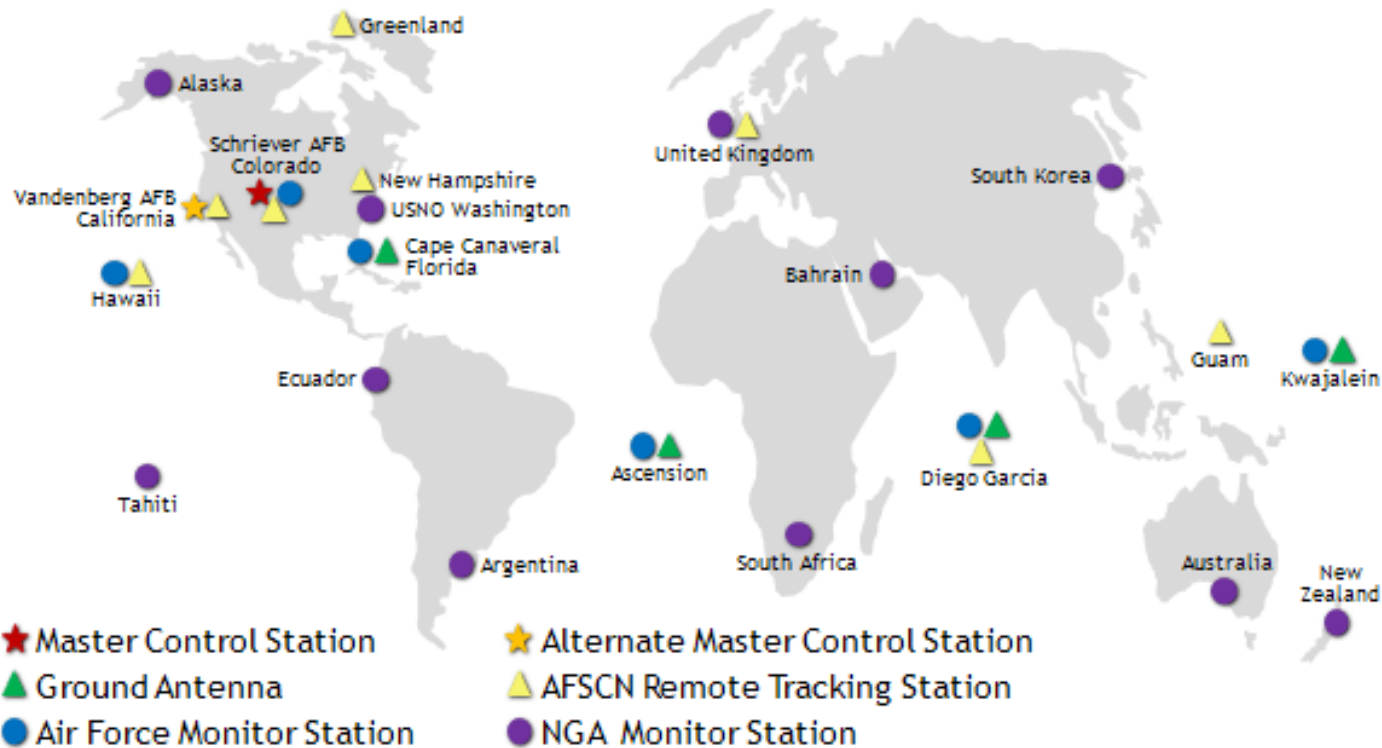


Global Positioning System Overview

GPS is made up of three components: a constellation of satellites, controllers on the ground, and users.

Control Segment

US Air Force has responsibility for the GPS system



Global Positioning System Overview

GPS is made up of three components: a constellation of satellites, controllers on the ground, and users.

Ground Segment

In order to access GPS, you need:

- An antenna to receive the satellite signals.
- A clock to time the satellite signals.
- Electronics to process the signals.
- A computer to calculate position.



geophysics



surveying



snow



precision farming

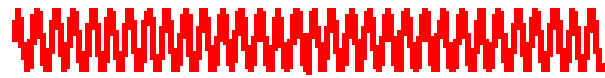


aircraft navigation



animal tracking

L1 CARRIER 1575.42 MHz



Coarse-acquisition code

C/A CODE 1.023MHz

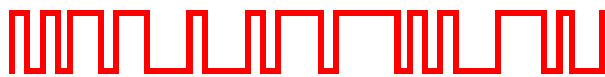


NAV/SYSTEM DATA 50 Hz

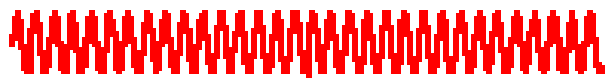


P-Code encrypted

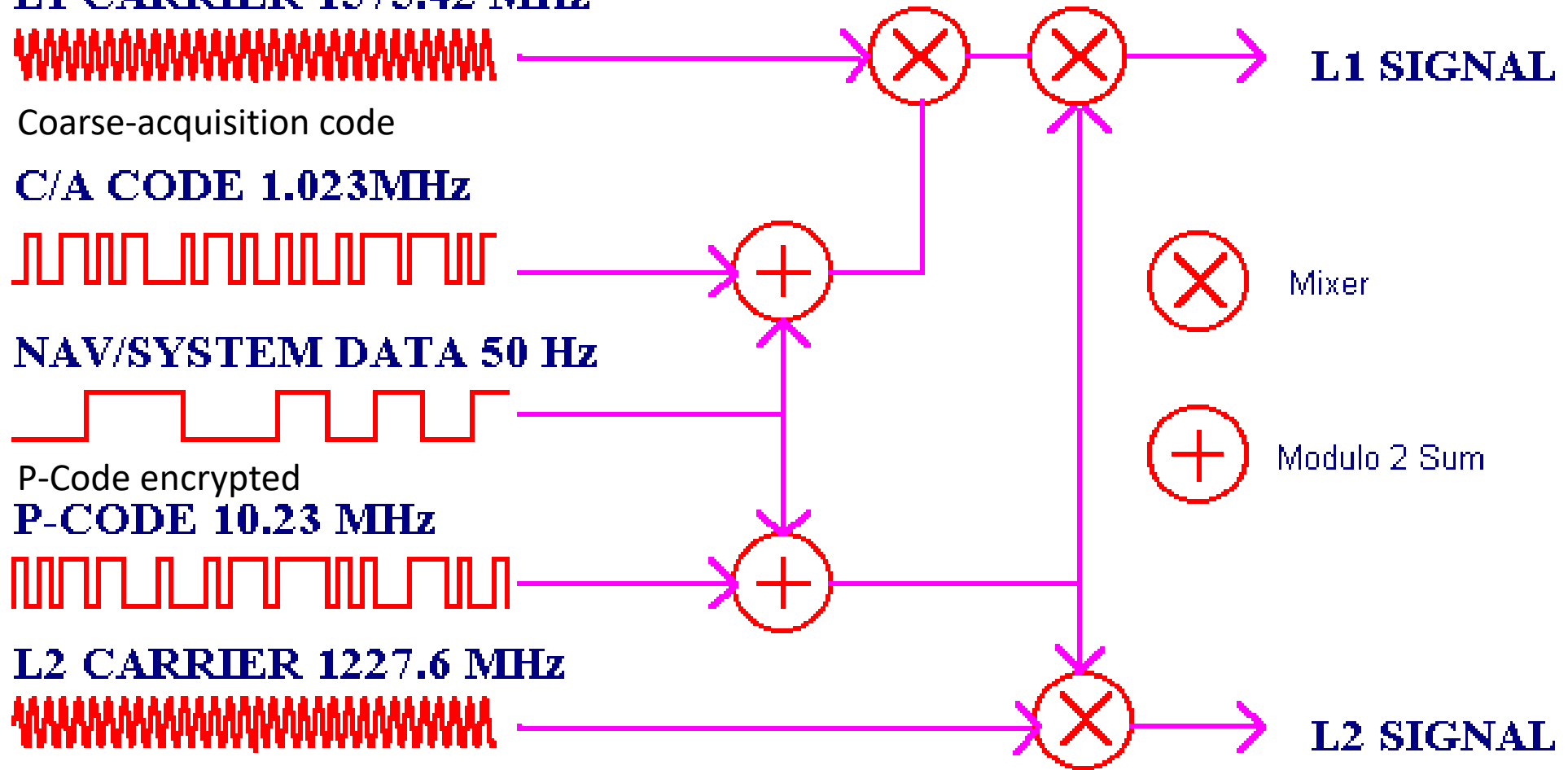
P-CODE 10.23 MHz



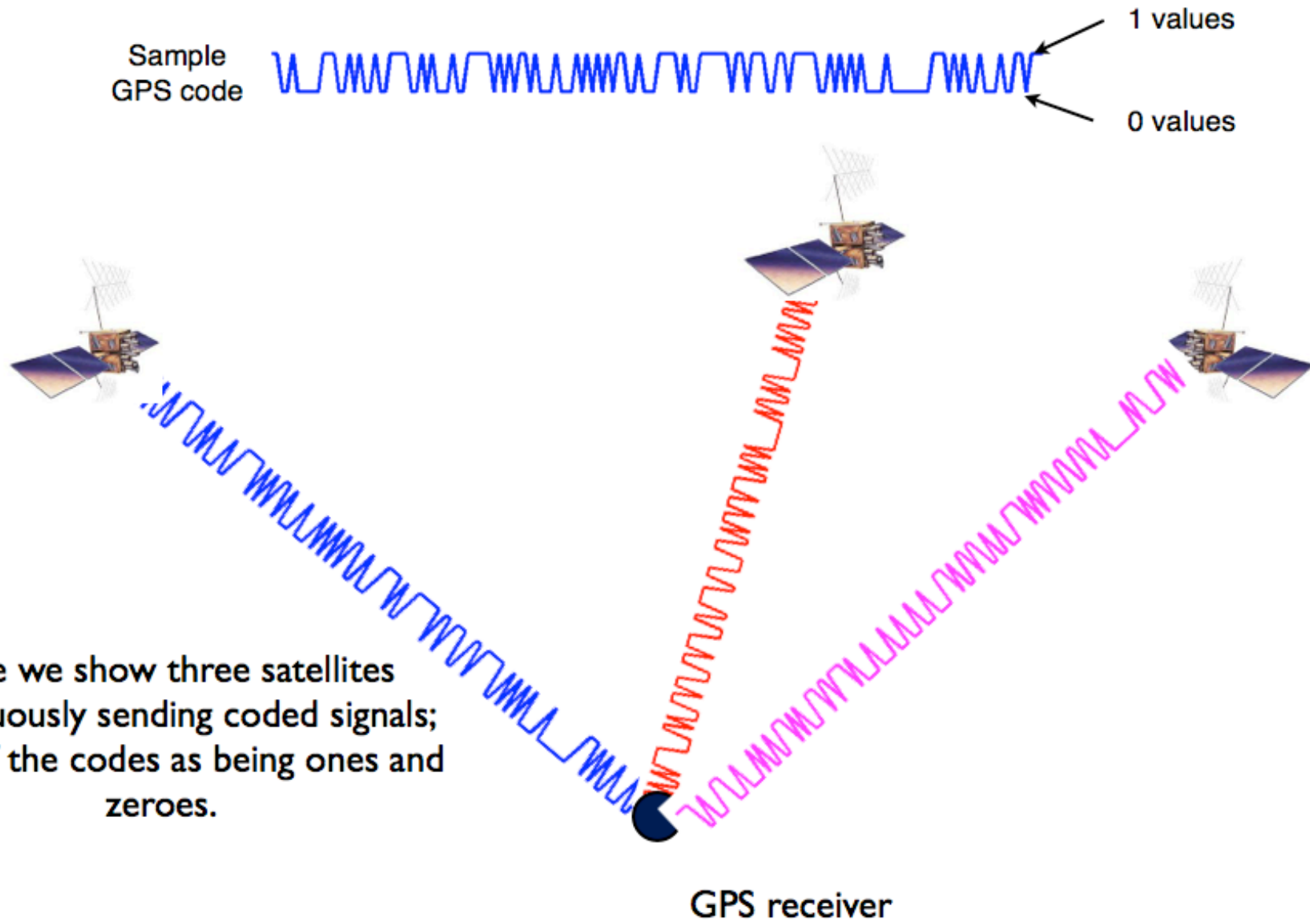
L2 CARRIER 1227.6 MHz



L1/L2 used in high precision geodesy

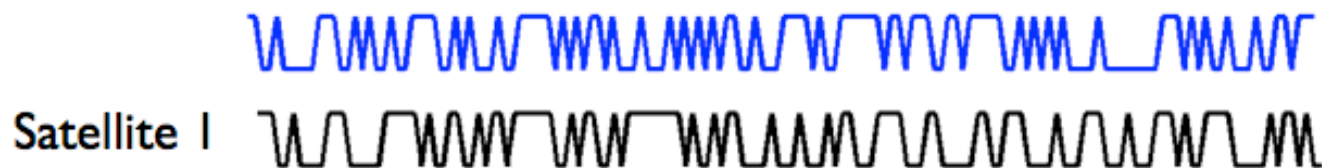


GPS SATELLITE SIGNALS



The receiver is going to try to decrypt each of the GPS signals separately.

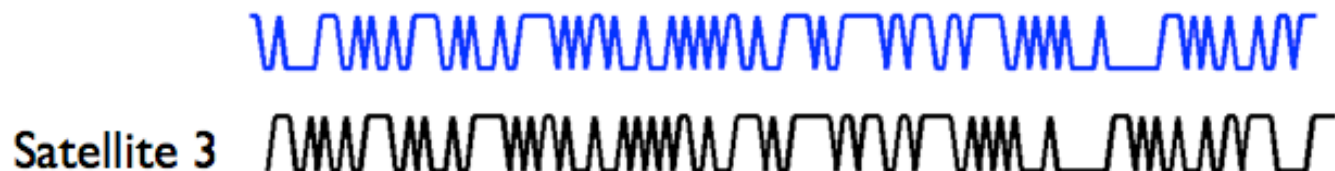
Here the receiver compares the blue coded signal to all the known codes.



it isn't this one.



it isn't this one either

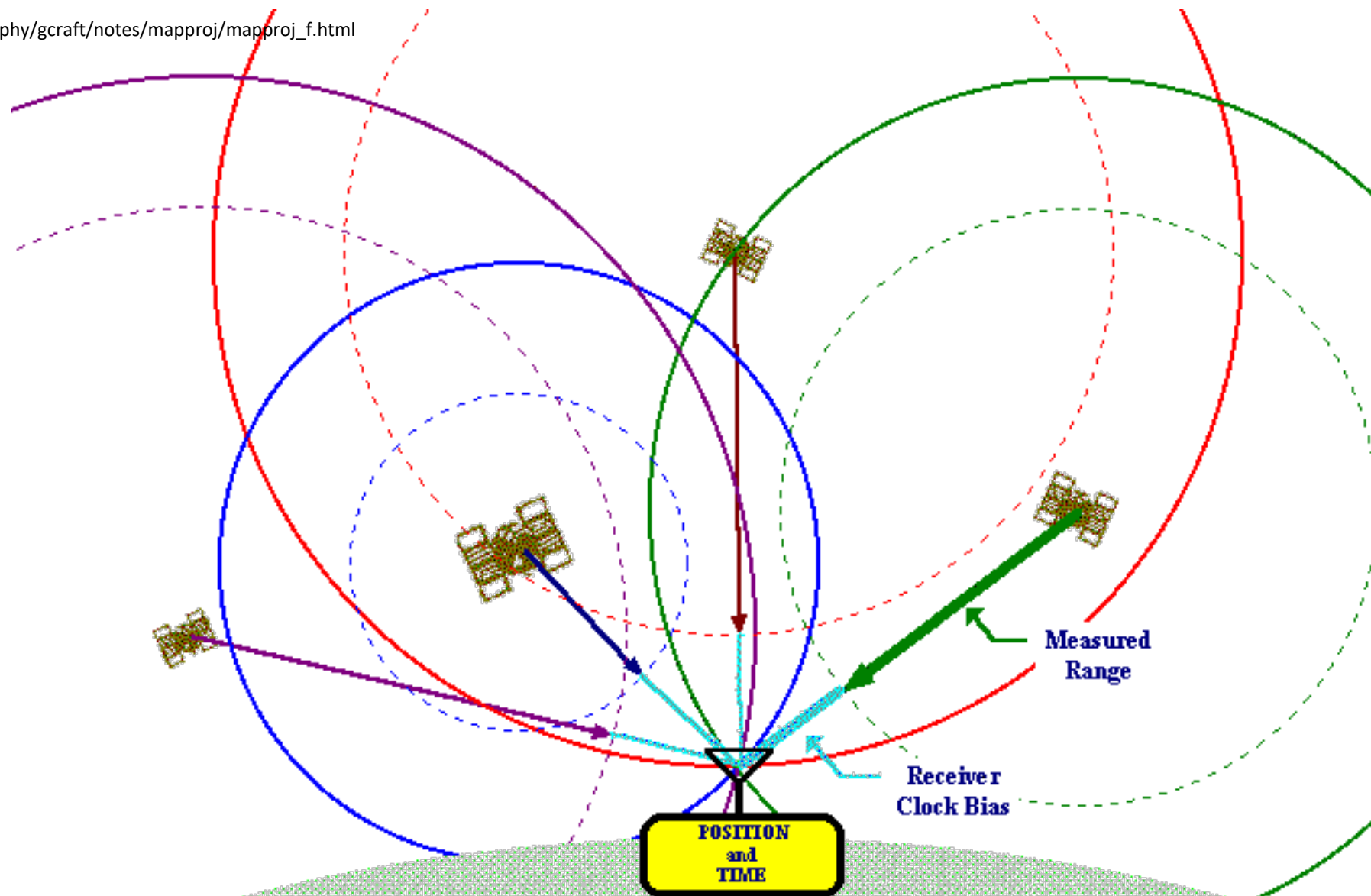


at first this one looks
wrong too

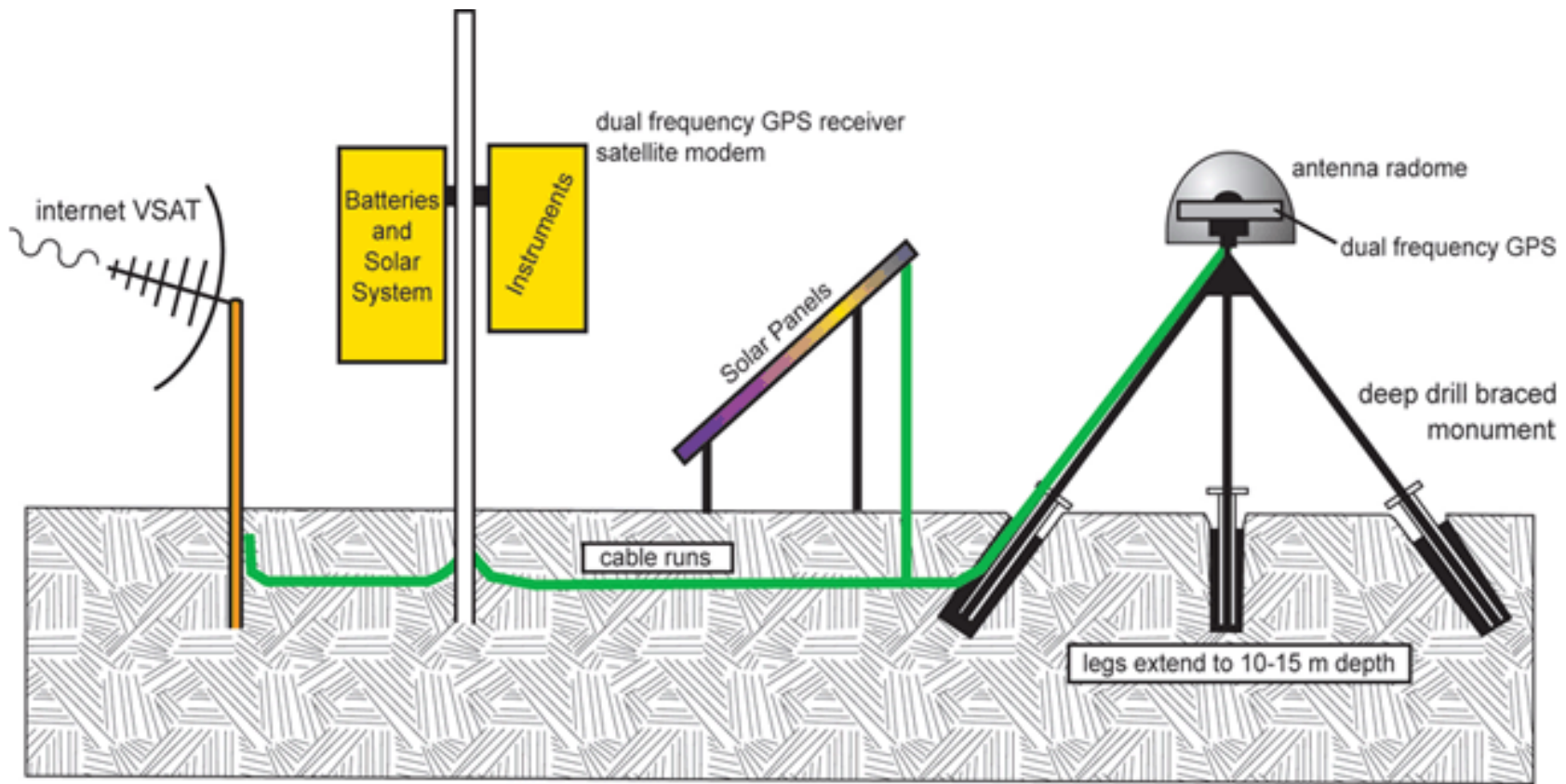


but then we can see that
they are identical, but shifted
by 10

It is this time shift the receiver uses to figure out how far away the satellite 3 is from the receiver - and how big the radius is for that sphere.



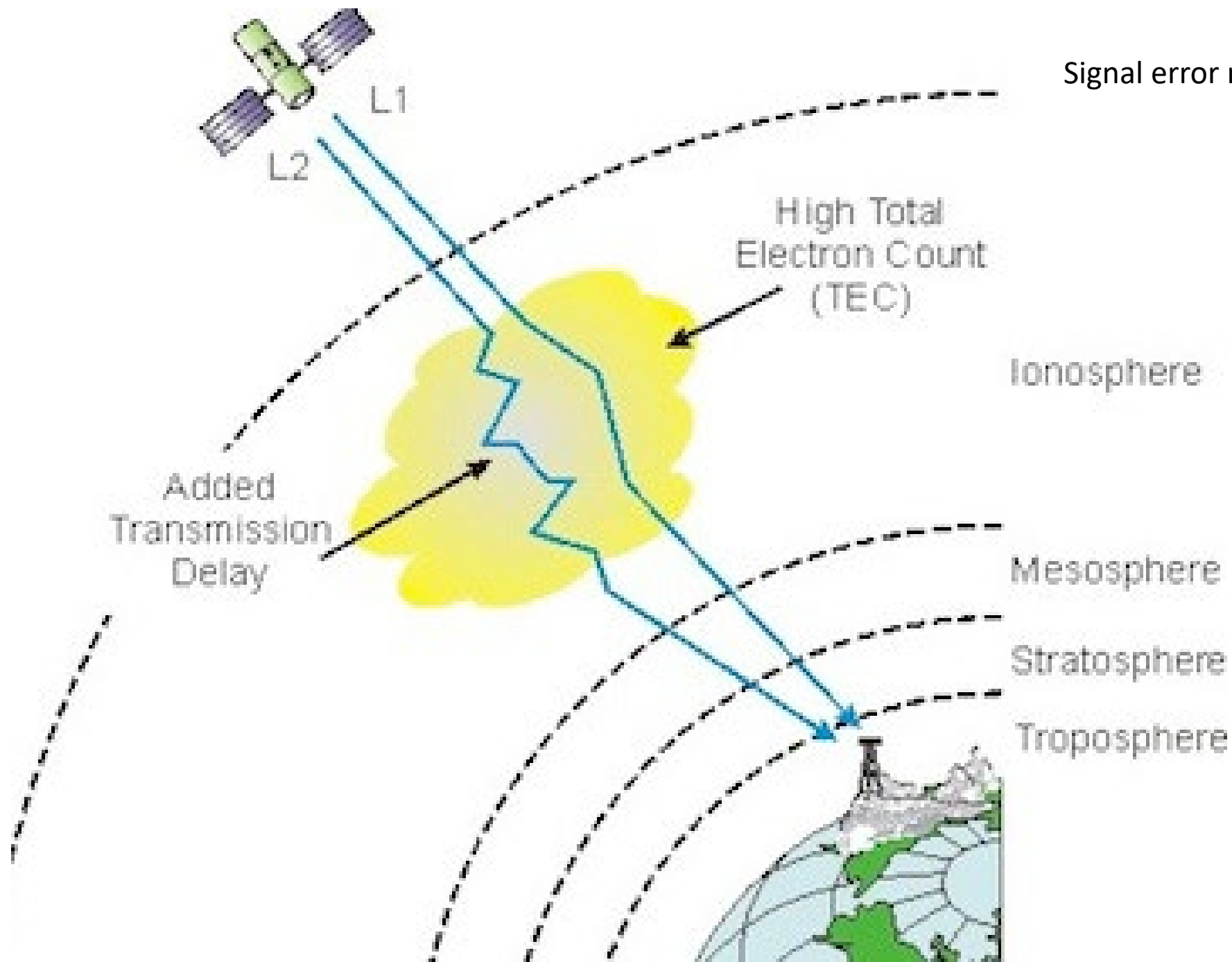
The GPS Navigation Solution
The estimated ranges to each satellite intersect within a small region when the receiver clock bias is correctly estimated and added to each measured relative range.



Network of the Americas permanent GPS station

<https://spotlight.unavco.org/how-gps-works/gps-basics/gps-and-geosciences.html>

Signal error mostly comes from the Ionosphere

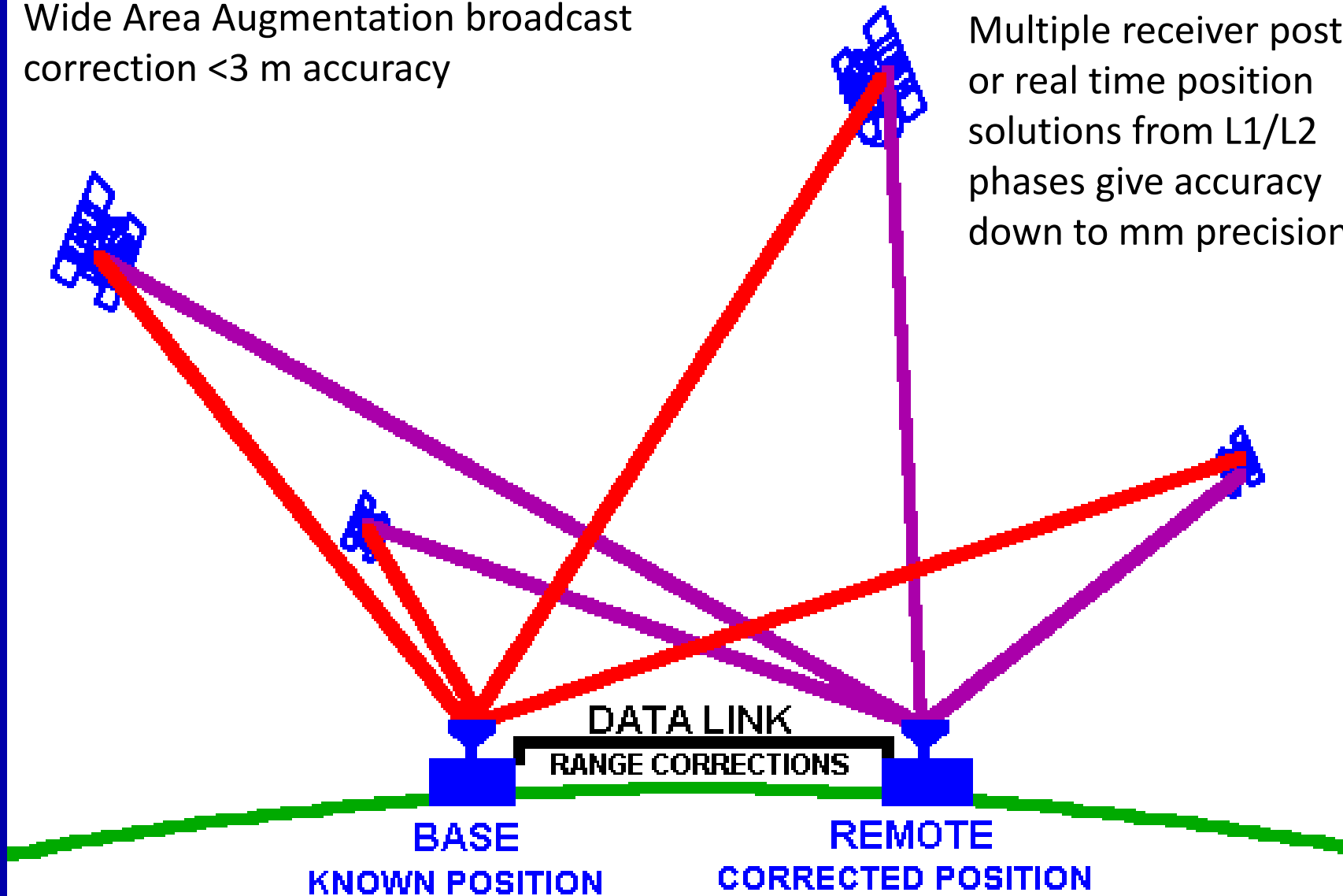


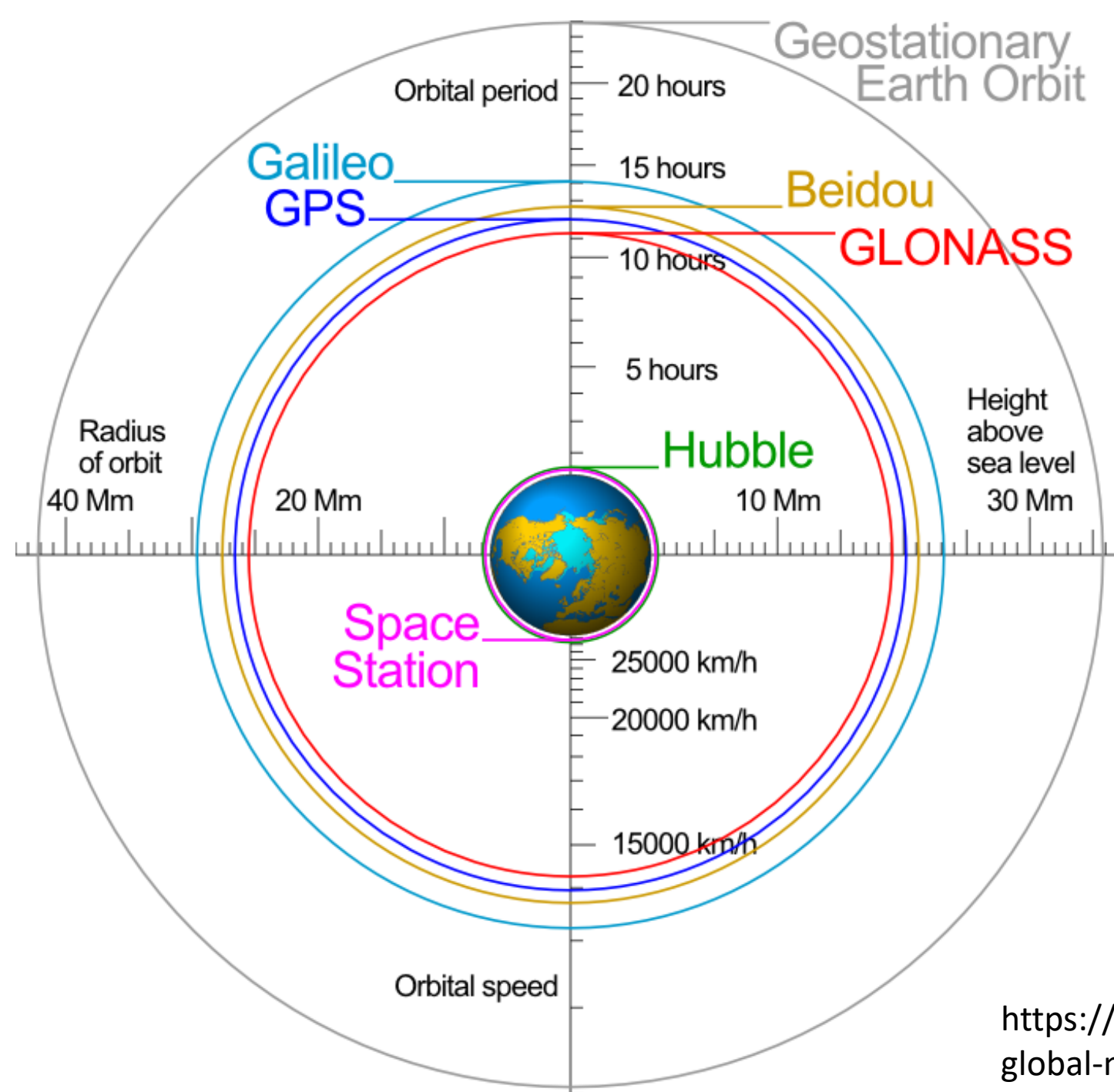
DIFFERENTIAL GPS POSITIONING

Wide Area Augmentation broadcast
correction <3 m accuracy

Multiple receiver post
or real time position
solutions from L1/L2
phases give accuracy
down to mm precision

Real time kinematic positioning

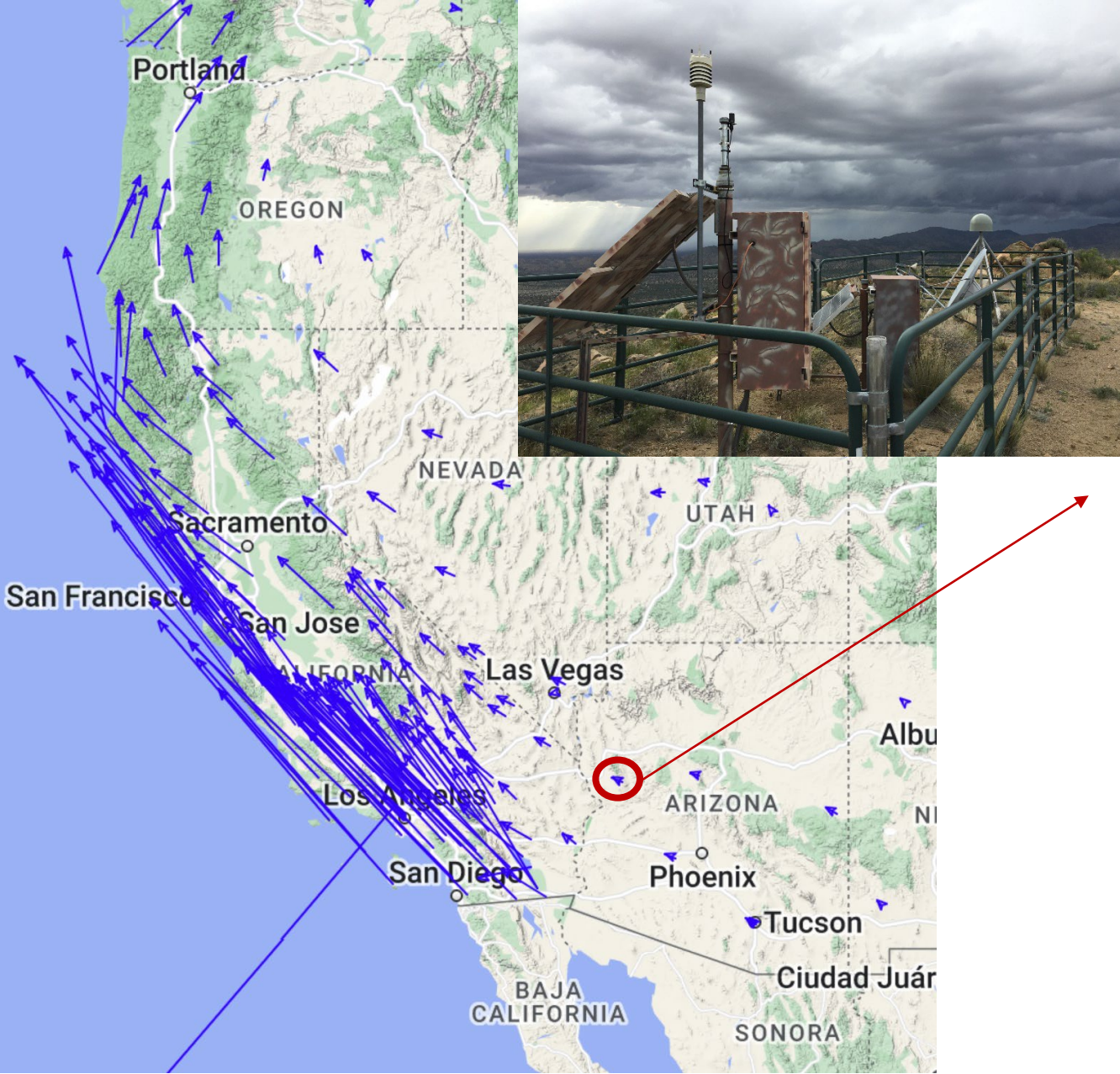




Global Navigation Satellite Systems (GNSS) is the term used to describe satellite navigation systems. This includes GPS, GLONASS (the Russian system), Beidou (the Chinese system), and GALILEO (the system being developed by the European Union).

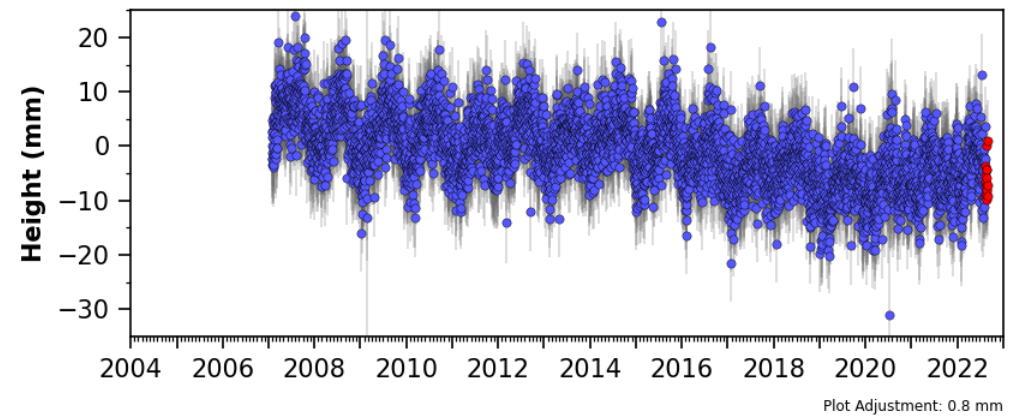
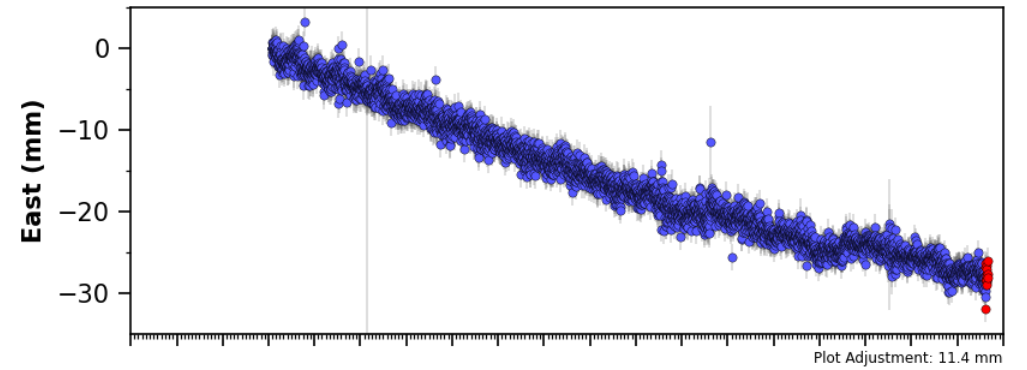
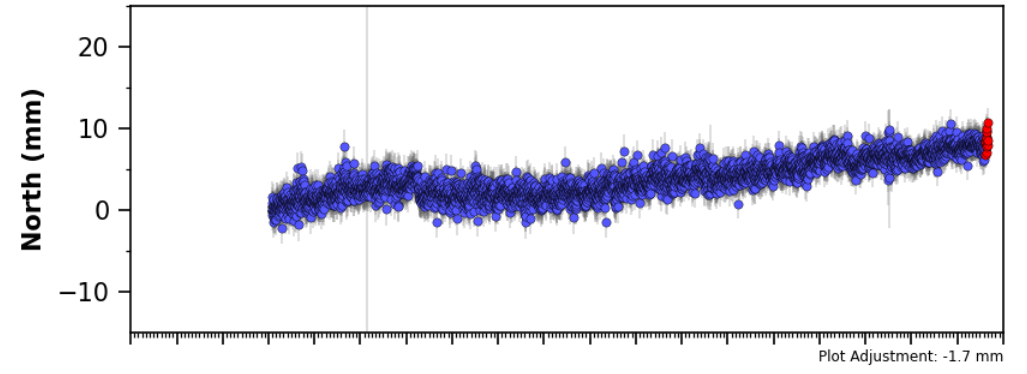
Each constellation has slightly different designs. For example, they are at different altitudes, and thus have different orbital periods. Secondly, they use different frequencies, although all are L-band.

<https://spotlight.unavco.org/how-gps-works/gps-basics/gnss-global-navigation-satellite-systems.html>



P010 (AubreyPeakAZ2007) NAM14

Processed Daily Position Time Series



● Final solution ● Rapid solution — Std. Dev.

Source file: P010.cwu.nam14.pos Last epoch plotted: 2022-08-29 12:00:00