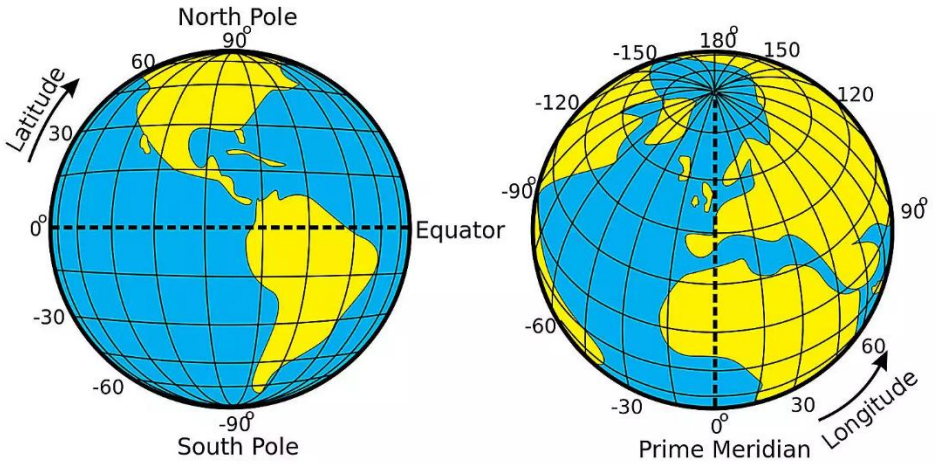
Comprehensive Research on UTM Coordinate System

Geographic coordinate systems provide the essential framework for pinpointing any location on Earth. This document explores the fundamentals of latitude, longitude, and the Universal Transverse Mercator (UTM) system, enabling precise and accurate location identification.

Outline:

Overview of Latitude & Longitude Coordinate System

- Latitude and Longitude is the oldest and most widely used system.
- Lines of Latitude run parallel to one another & never intersect.
- Lines of longitude intersect at the North & South Poles.

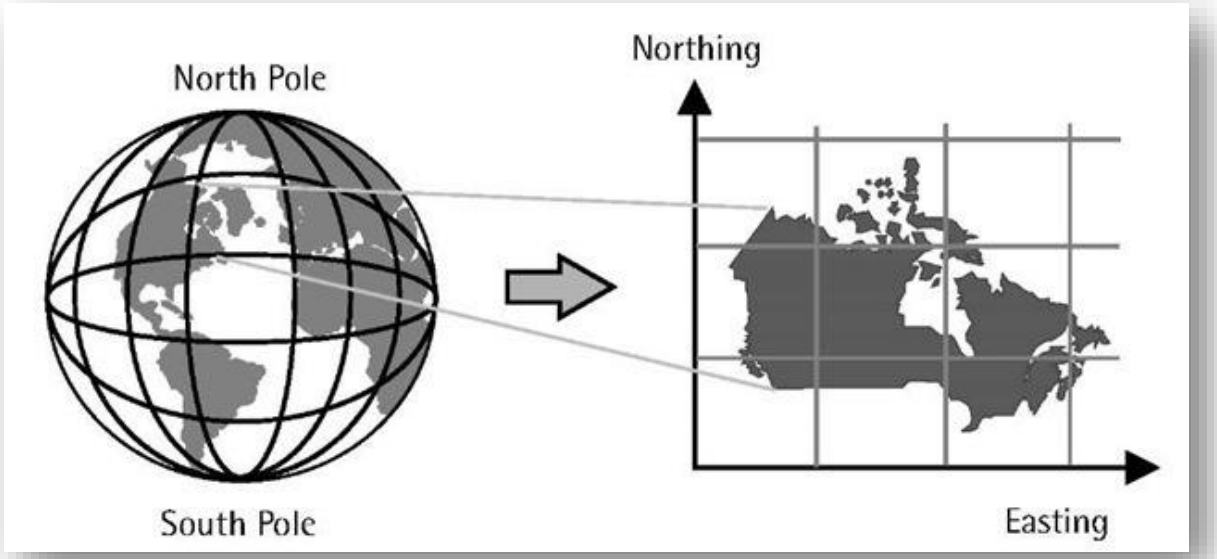


Note: Lat/Lon is good for ships & airplanes traveling long distances, but UTM is better for land navigation.

Understanding the UTM Coordinate System

a) What is the UTM Coordinate system:

- UTM = Universal Transverse Mercator.
- Metric based system created by US Army in the 1940s.
- UTM zones use a transverse Mercator projection to approximate the curved surface of the Earth with a flat, rectangular grid.
- Simply, we can think of it as a huge grid of 1-meter squares laid over the entire map of the earth.



Important Note:

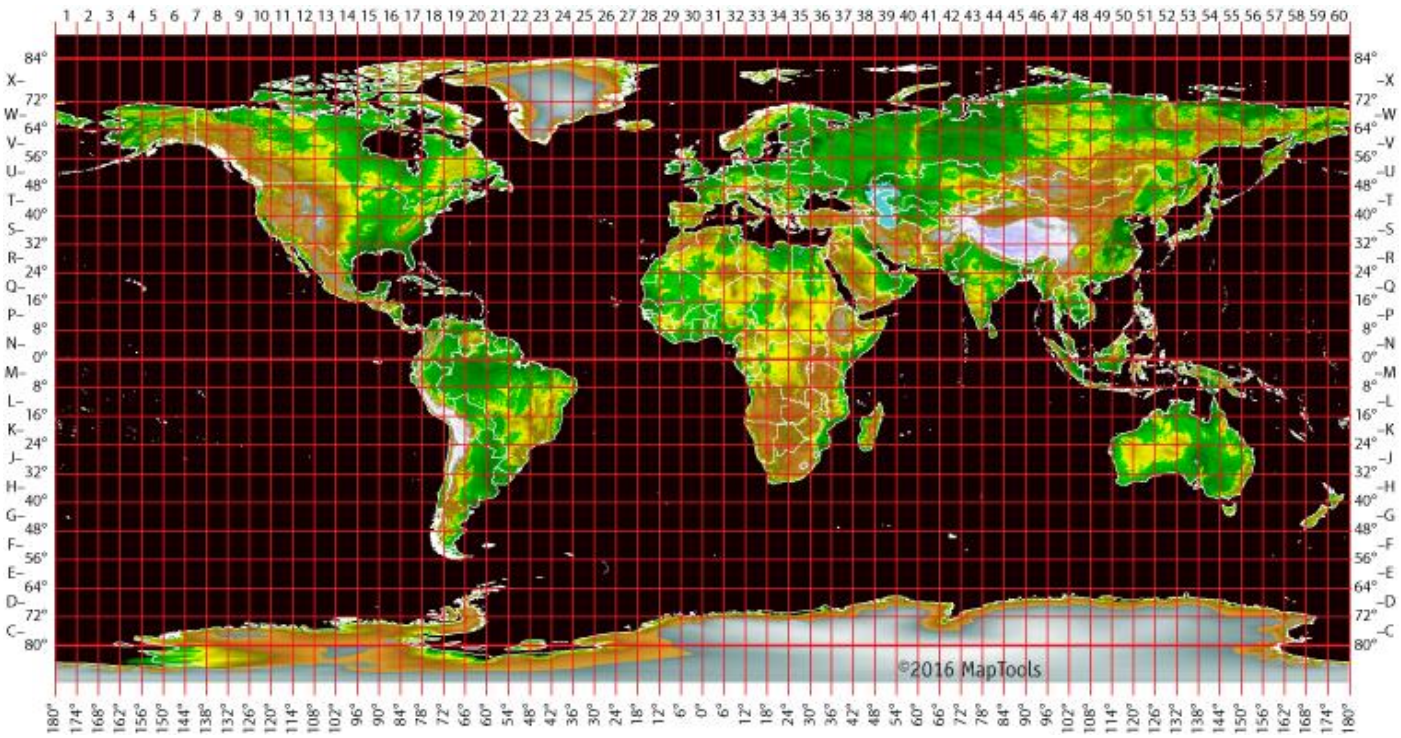
LONGITUDE DIVISION

The UTM coordinate system divides the Earth into 60 zones, with each zone being 6 degrees of longitude wide. These zones are numbered 1 through 60, starting at the international date line, which is at longitude 180°, and proceeding east. For example, Zone 1 extends from 180° West to 174° West and is centred on 177° West.

LATITUDE DIVISION

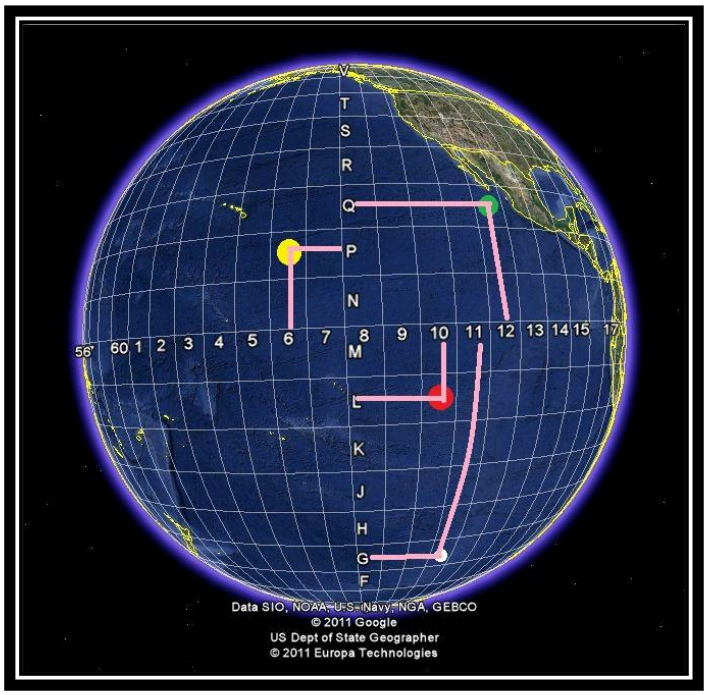
Each UTM zone is further divided into horizontal bands spanning 8 degrees of latitude. These bands are lettered from south to north, starting at 80° South with the letter "C" and ending with the letter "X" at 84° North. The letters "I" and "O" are skipped to avoid confusion with the numbers one and zero. The band lettered "X" spans 12° of latitude.

Fig: ***Universal Transverse Mercator (UTM) System***



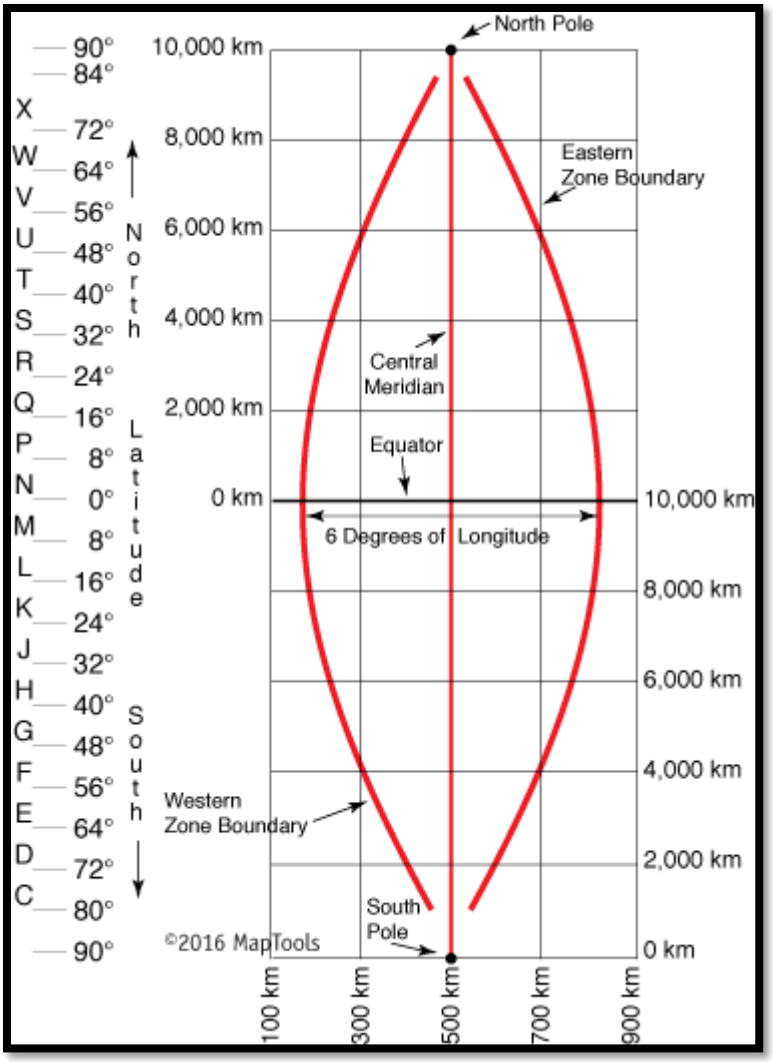
b) The Significance of Zones:

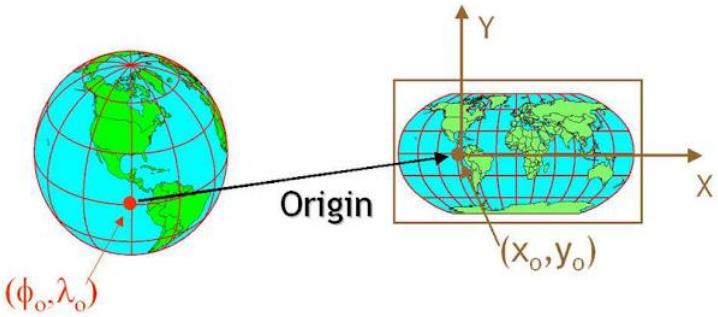
- The zone increases a number moving around the globe.
- While it's not a perfect representation of the Earth's curvature, it provides a highly accurate and practical means of location referencing.
- The UTM zones are widest at the Equator and narrow as they approach the pole.
- In UTM coordinates, some values work for both sides of the equator. To avoid mix-ups, we include a letter to say if it's north or south.



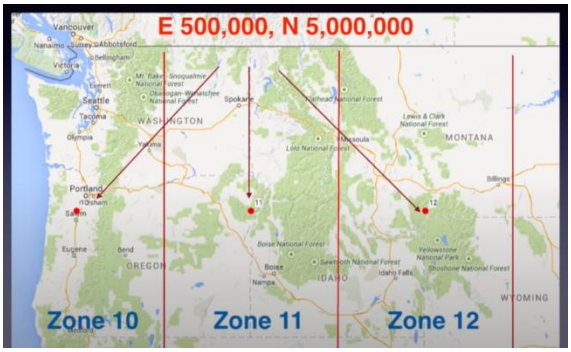
c) The Significance of Eastings & Northings:

Fig: **Eastings and Northings within a zone**





- A UTM grid zone is like a tall rectangle, about 20,000 km tall (up and down) and only about 700 km wide (side to side).
- So, the exact same coordinates repeat in every UTM zone.



- Therefore, specifying the correct zone (number & letter) is essential for accurate location identification.
- The point of origin for each UTM zone is the intersection of the zone's central meridian & the equator.
- To avoid dealing with negative numbers, this central meridian has a value of 500,000 metres (500 km). For example, an Easting coordinate of 450,000 metres means that is 50 kilometres west of this central meridian.
- In the northern hemisphere, Northing values begin at 0 at the equator and increase as we move north.
- In the southern hemisphere, Northing values start at 10 million metres at the equator and decrease as we move south.

- In the UTM system, Easting is the "X" coordinate & Northing is the "Y" coordinate and the origin is : the intersection of the zone's central meridian & the equator.
- In UTM, the origin (0,0) of the XY coordinates corresponds to the lower left corner of the tall skinny 1 metre grid.

Working with UTM Coordinates

a) How to read coordinates from a map:

UTM Coordinates are always given in a specific order: Z-E-N Zone, Easting and Northing.

- Zone - one of the 60 tall skinny rectangles.
- Easting - the “X” coordinate
- Northing - the “Y” coordinate

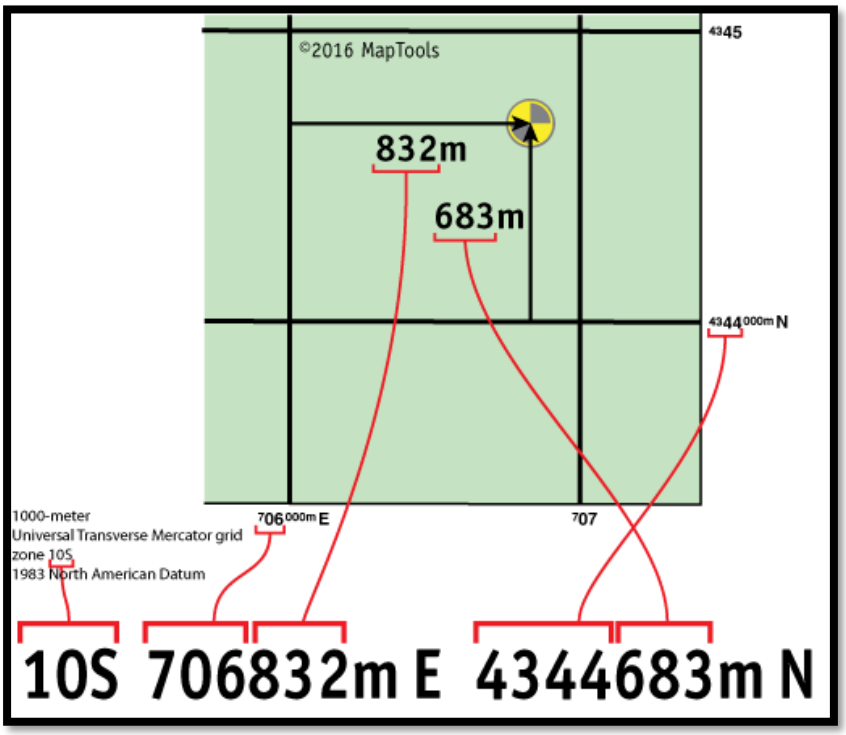


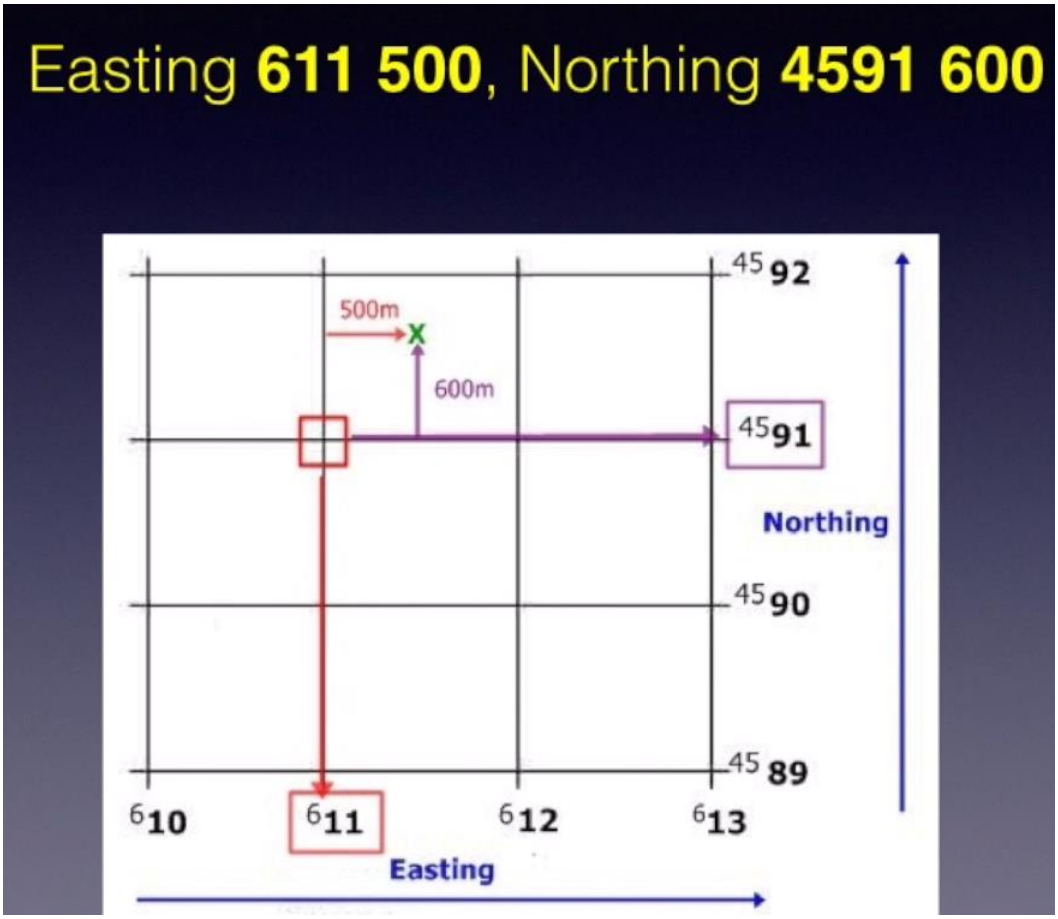
Fig: **The map with grid lines spaced every kilometre or 1000 meters**

PRACTICE - 1 Finding the coordinates with simplified map.

To find: *What are the coordinates of point X marked in green? "Remember, the printed Grid is 1 kilometre. Easting & Northing coordinates are often abbreviated on a map by dropping the last three digits & the numbers showing the kilometres are often printed in bold as we see in figure."*

- First look to the left of our point & find the closest easting line (here it is 611).
- Second look below the point & find the closest northing line (here it is 4591).
- This gives us the coordinates of the lower left corner of a 1-kilometre square that contains point X. So, we're within a few hundred meters of where we want to go.
- Now estimate the location of point next to the nearest 100 metres (it might help to imagine a grid of 100 metre squares covering the 1-kilometre square that contains the point).
- Now looking at point X, we see that it's just about midway between the 611 & the 612 easting lines. Since these easting lines are 1000 meters apart, 1/2 * 1000 = 500 metres.
- Estimating the northing, it looks like the point X is just a little bit above the midway between the 4591 & the 4592 northing lines. Since these northing lines are 5,000 metres apart, a little above the midway makes it about 600 meters.
- So, the final estimated coordinates are 611 500 easting & 4591 600 northing.

Fig: Simplified Map Image

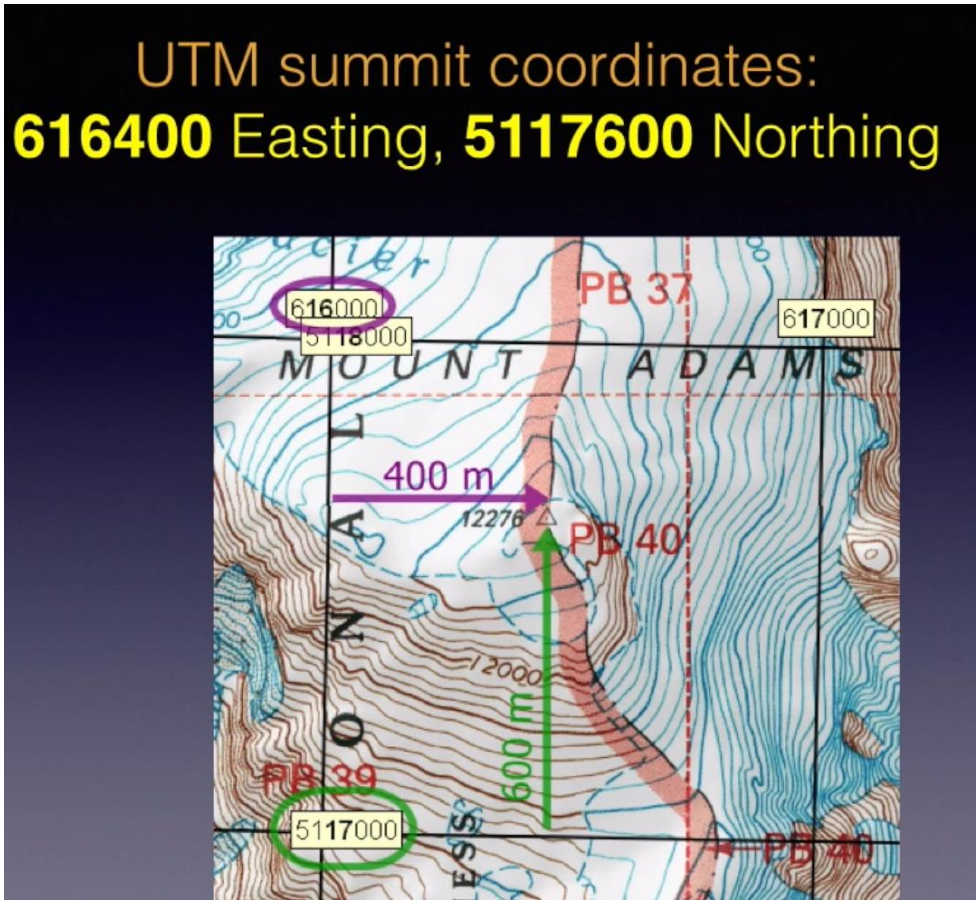


PRACTICE – 2 *Finding* the coordinates with Real map.

To find: *What are the coordinates for the summit of Mount Adams?*

- First look to the left of the summit and find the closest easting line, then we estimate the distance from that line to the summit to the nearest 100 metres. Here it is about 400 metres.
- Second look below the summit and find the closest northing line, then we estimate the distance from that northing line to the summit to the nearest 100 meters. Here it is about 600 meters.
- Therefore, the estimated position for the summit accurate to about +/- 100 meters.

Fig: **Real Map Image**



Conclusion

I've successfully gained a deep understanding of the UTM coordinate system, including its fundamentals and the significance of zones. This knowledge empowers me to make well-informed decisions in upcoming projects, ensuring the selection of the most suitable coordinate system for accurate predictions. My documentation stands as a valuable resource for future data analysis endeavours.

Note: this information taken from online1,online2 resources.