

➤ Map Anatomy

- Maps and mapping are **essential components** of any and all geographic information systems (GISs).
- For instance, maps constitute **both the input and output** of a GIS.
- Hence a GIS utilizes many concepts and themes from **cartography**, the formal study of maps and mapping.
- Therefore, in order for us to become proficient with GISs, **we need to learn more about cartography, maps, and mapping.**

✓ Cartography:

- **The formal study of maps, mapping and map making.**



➤ Maps and Maps Types

- Maps are among the most compelling **forms of information** for several reasons.
- Maps are **artistic**.
- Maps are **scientific**.
- Maps **preserve history**.
- Maps **clarify**.
- Maps **reveal the invisible**.
- Maps **inform the future**.
- Maps **capture the imagination of people** around the world.
- **So what exactly is a map?**
- Like GISs, there are **probably just as many definitions** of maps as there are people who use and make them.
- **For starters, we can define a map simply as a representation of the world.**
- **The three types of maps** are the
 1. **reference map,**
 2. **the thematic map, and**
 3. **the dynamic map.**

Map Types, Scale, Coordinate Systems, and Map Projections

➤ Maps and Maps Types

1. Reference map

- The primary purpose of a reference map is to deliver **location information** to the map user.
- Geographic features and map elements on a reference map tend to be treated and **represented equally**.
- In other words, **no single aspect of a reference map takes precedent over any other aspect**.
- Moreover, reference maps generally **represent geographic reality accurately**.

- ✓ **Reference map:** The family of maps that are used to **locate features on the surface of the earth**.



❖ Political maps

Map Types, Scale, Coordinate Systems, and Map Projections

➤ Maps and Maps Types

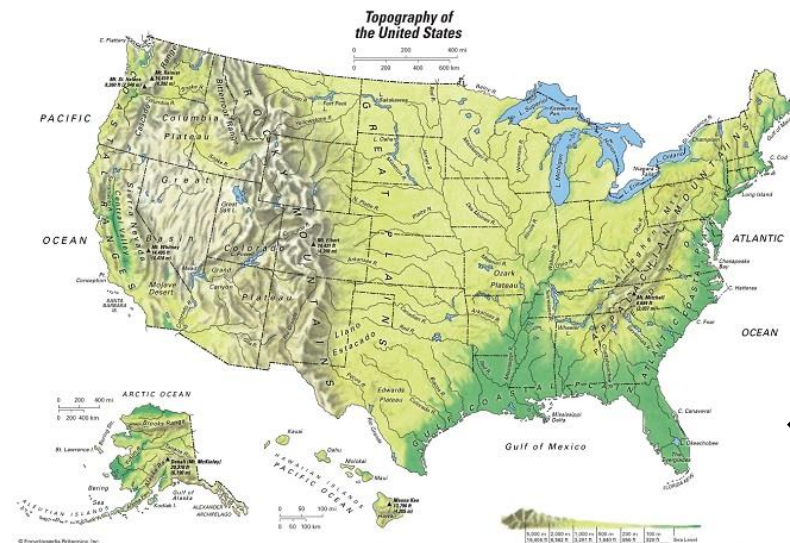
1. Reference map



❖ Physical maps



❖ Road maps



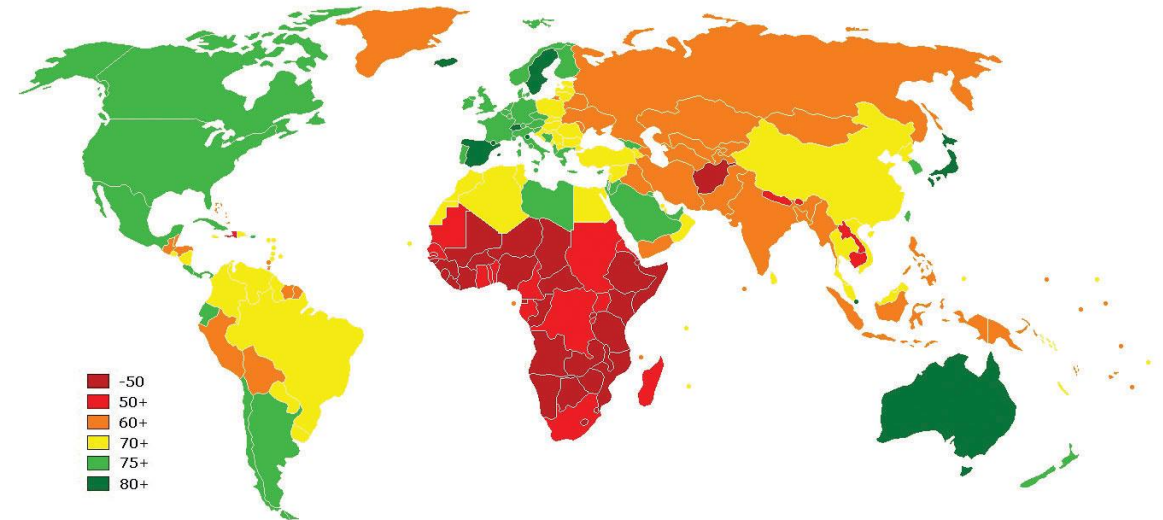
❖ Topographic maps

➤ Maps and Maps Types

2. Thematic map

- Contrasting the reference map are thematic maps.
- Thematic maps are concerned with a **particular theme or topic of interest**.
- ❑ While reference maps emphasize the location of geographic features, **thematic maps are more concerned with how things are distributed across space**.
- Such things are often abstract concepts such as **life expectancy around the world, per capita gross domestic product (GDP) in Europe, or literacy rates across India**.
- One of the strengths of mapping, and in particular of thematic mapping, is that **it can make such abstract and invisible concepts visible and comparable on a map**.

✓ **Thematic map:** The family of maps that are **about a particular topic or theme**.

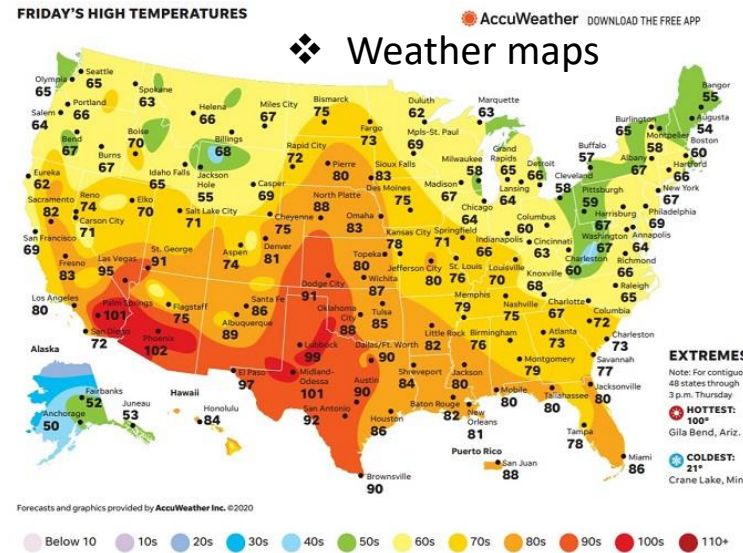
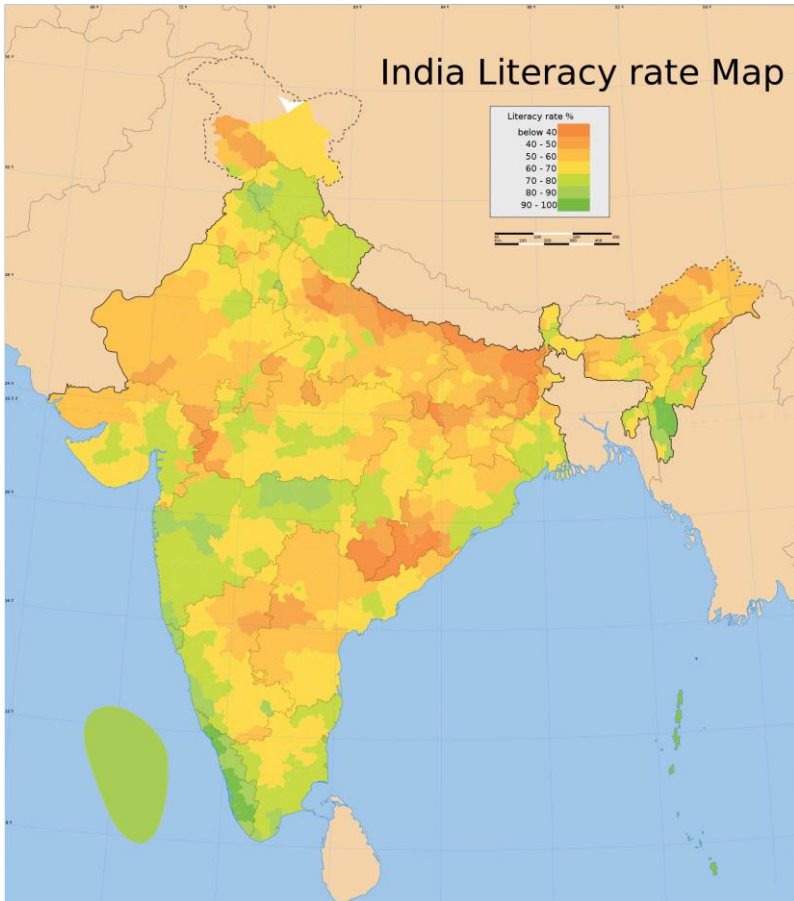


Map Types, Scale, Coordinate Systems, and Map Projections

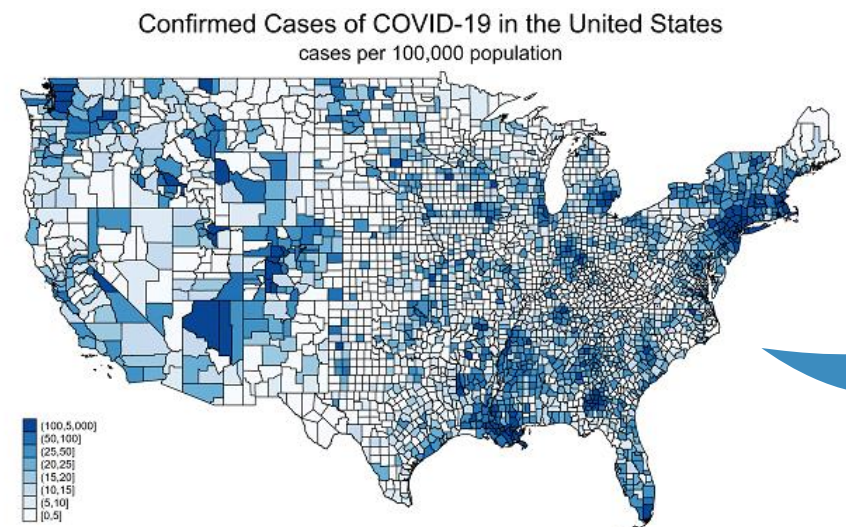
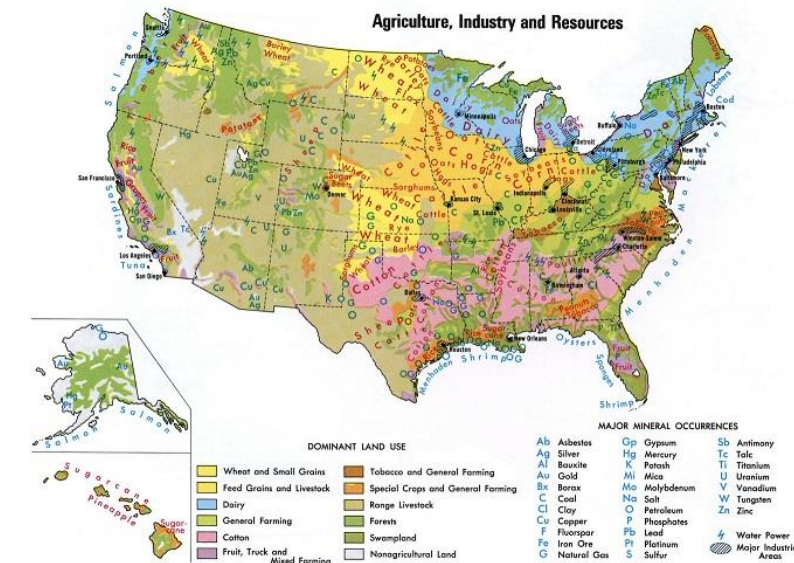


➤ Maps and Maps Types

2. Thematic map



❖ Resource maps



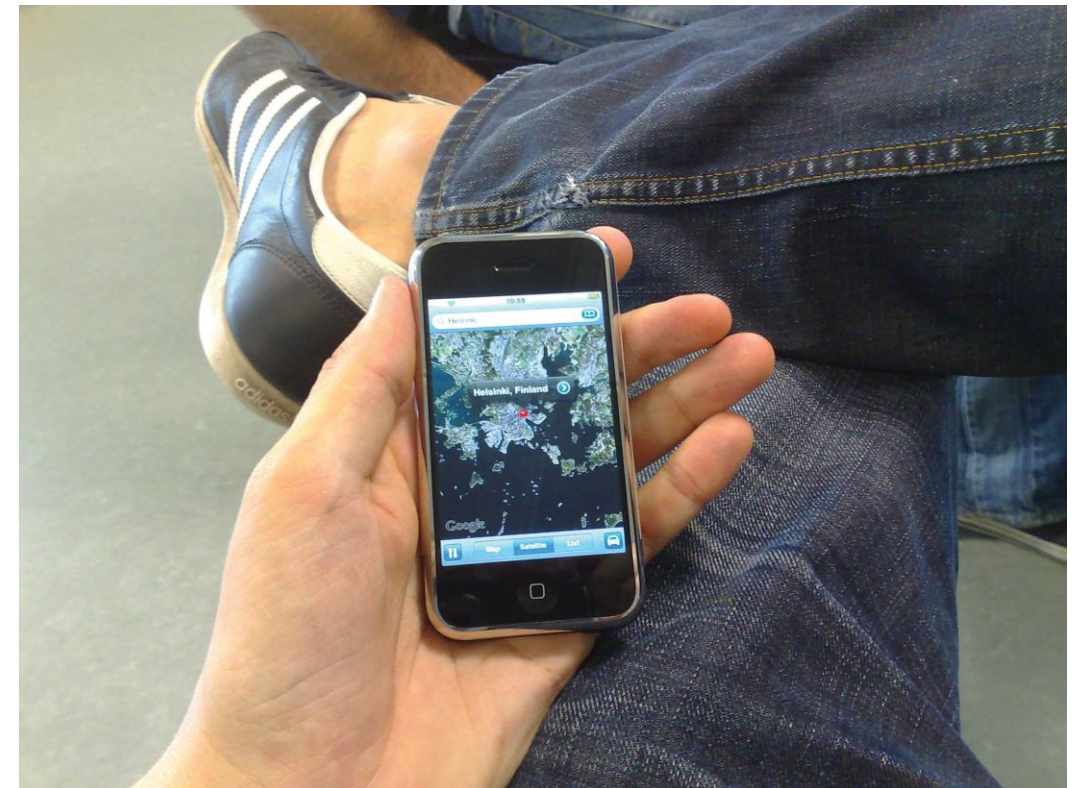
❖ **Choropleth maps** show colors in areas to communicate where a variable occurs in place. These maps can show the results of an **election**, the **spread of technology**, or the **ratio of cows to people**.

➤ Maps and Maps Types

3. Dynamic map

- Dynamic mapping refers more to **how maps are used and delivered to the map user today** (e.g., online, via mobile phone) than to the content of the map itself.
- **Both reference and thematic maps can be dynamic** in nature, and such maps are an integral component to any GIS.
- The key point about dynamic maps is that **more and more people**, not just GIS professionals, **have access to such maps.**

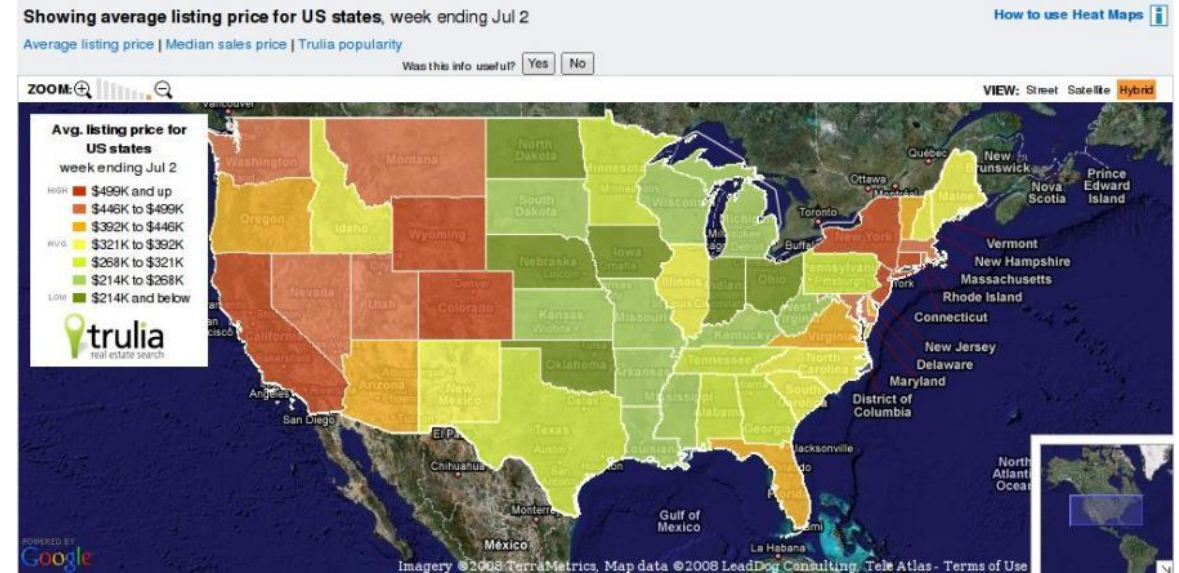
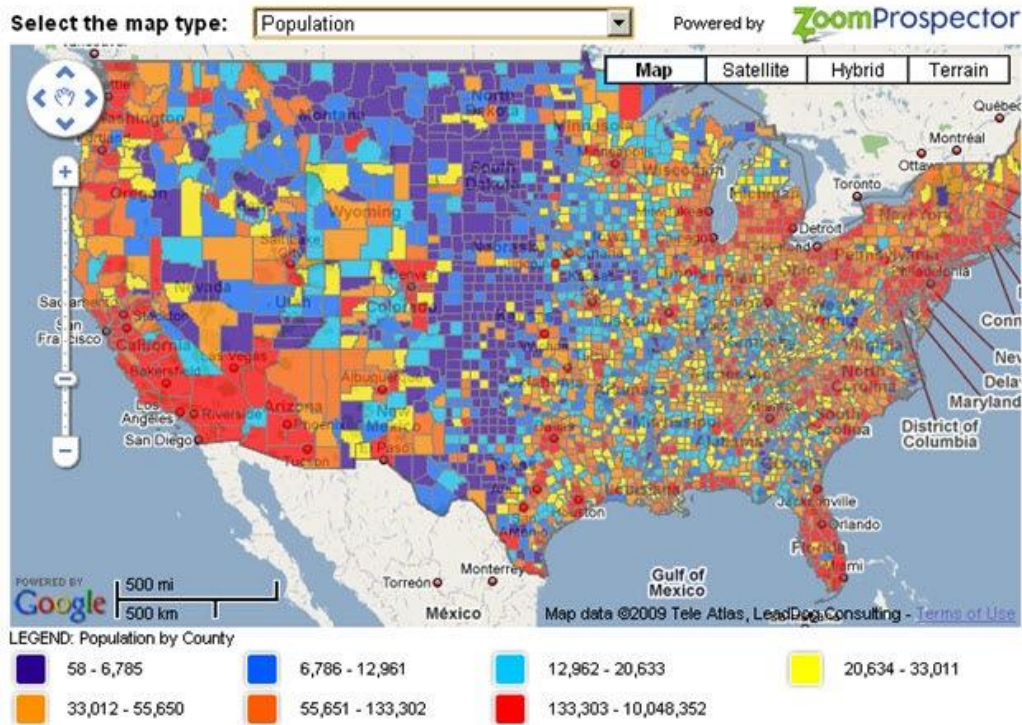
- ✓ **Dynamic map:** Interactive and changeable representations of the earth and its resident phenomena.



Map Types, Scale, Coordinate Systems, and Map Projections

➤ Maps and Maps Types

3. Dynamic map



Map Types, Scale, Coordinate Systems, and Map Projections



➤ Maps Scale

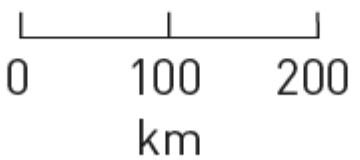
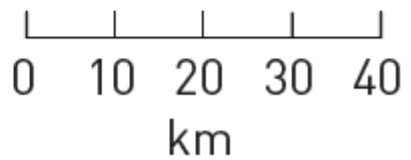
- The world is a big place...really big.
- One of the challenges behind mapping the world and its resident features, patterns, and processes is **reducing it to a manageable size**.
- **All maps reduce or shrink the world and its geographic features of interest by some factor.**
- Map scale refers to the factor of reduction **of the world so it fits on a map**.

☐ Scale can be expressed in one of three ways: as a **ratio scale**, a **verbal (nominal) scale** or a **graphical scale**.



✓ Map scale:

- The factor by which phenomena **on the surface of the earth are reduced in order to be shown on a map**.
- Scale gives an indication of **how much smaller than reality a map is**.
- Scale can be defined as the **ratio of a distance on the map to the corresponding distance on the ground**.

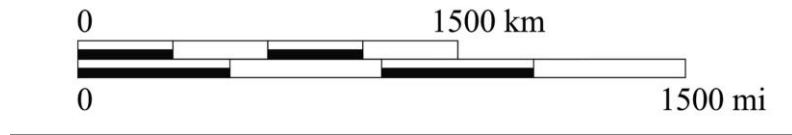
Ratio	1:5000	1:1,000,000
Verbal (nominal)	1 cm represents 50 m	1 cm represents 10 km
Graphical		

Map Types, Scale, Coordinate Systems, and Map Projections

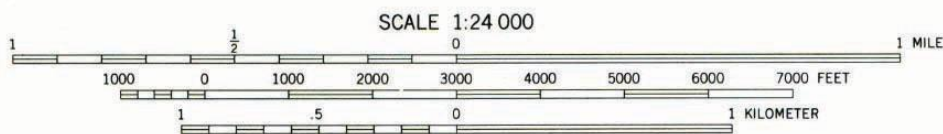
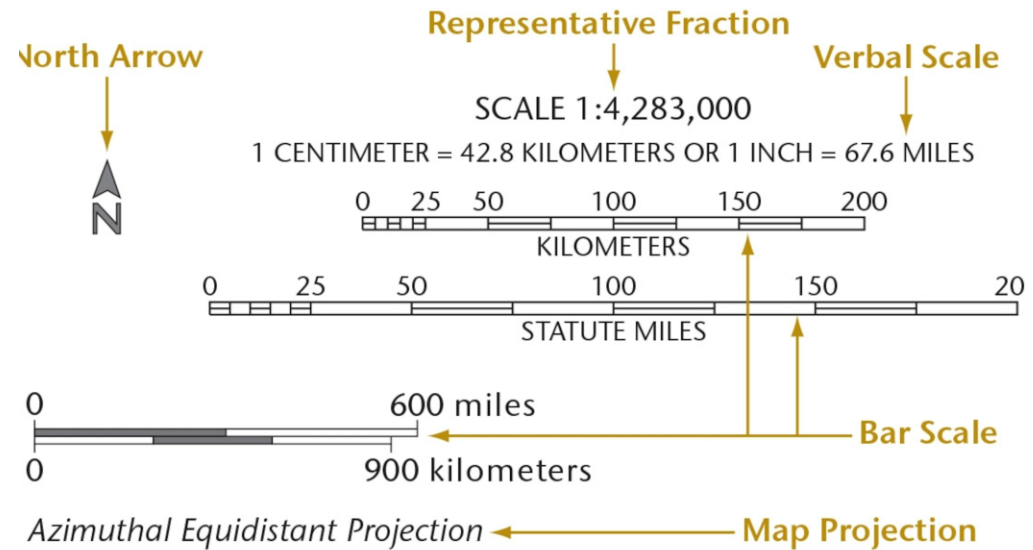
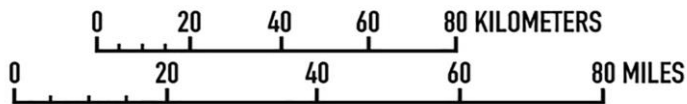


➤ Maps Scale

BAR SCALE

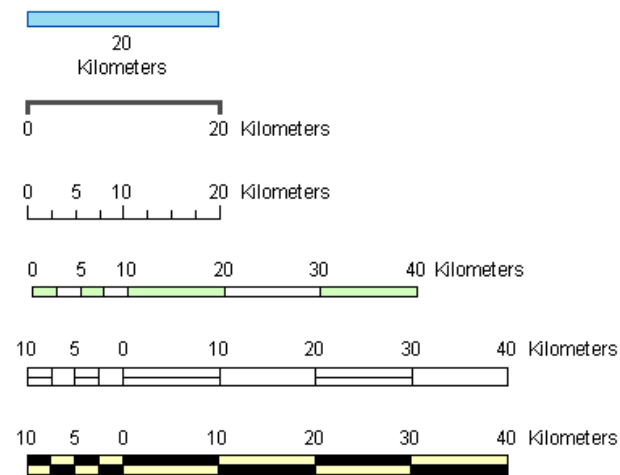


LINE SCALE



CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, P.O. BOX 25286, DENVER, COLORADO 80225
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST



Map Types, Scale, Coordinate Systems, and Map Projections

➤ Maps Scale

Large Scale vs. Small Scale

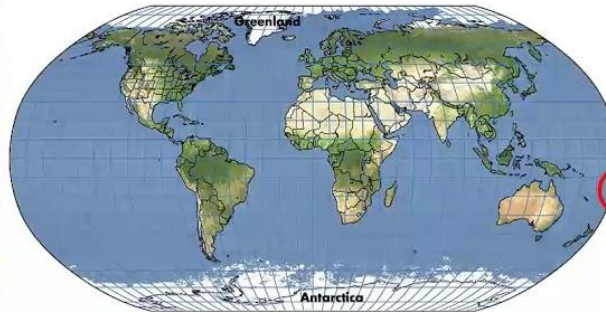
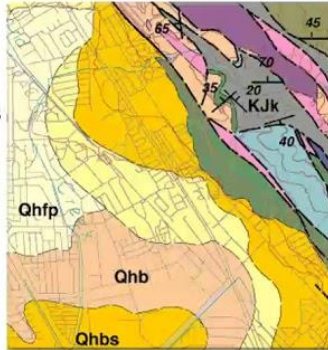
- Large scale – large amount of detail; can only show small area
- Small scale – small amount of detail; can show a large area

Large Scale

Verbal Scale
1 inch = 0.25 miles

Fractional Scale
1:16,000

Bar Scale
0 Miles 0.4

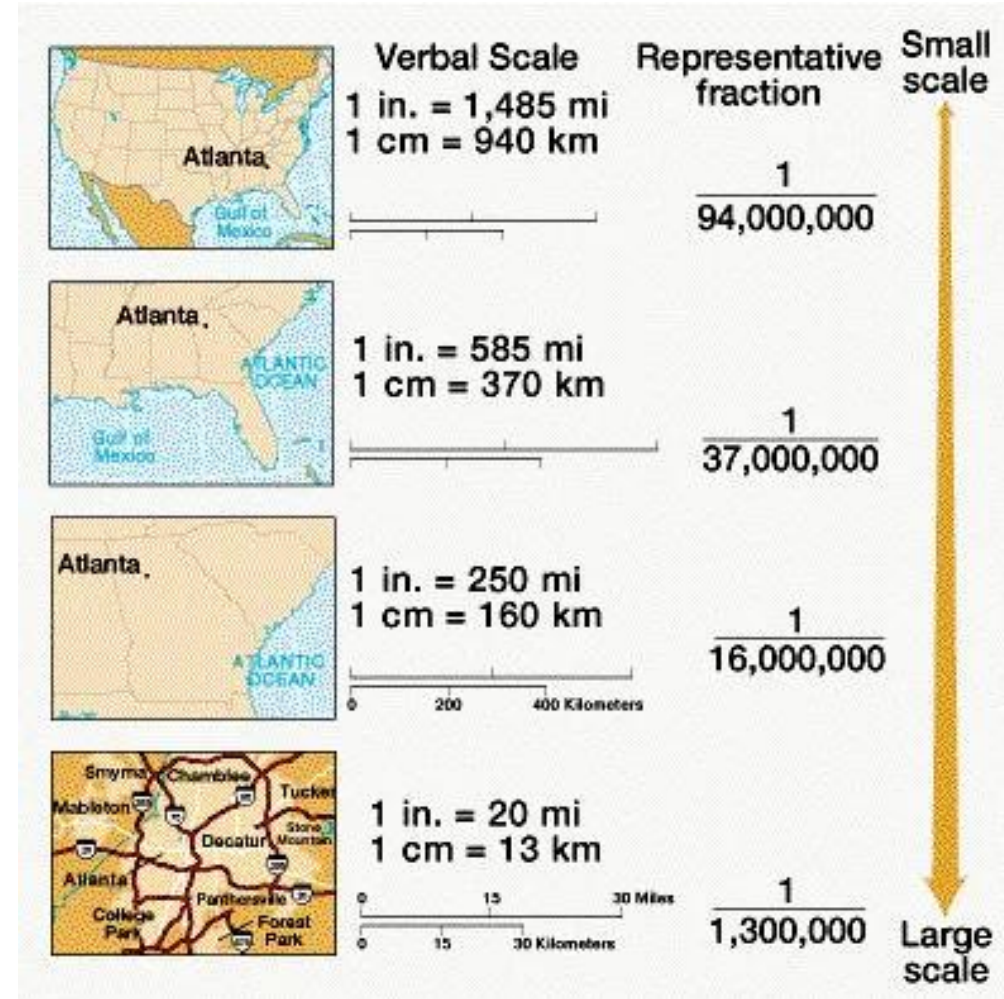


Small Scale

Verbal Scale
1 inch = 3000 mile

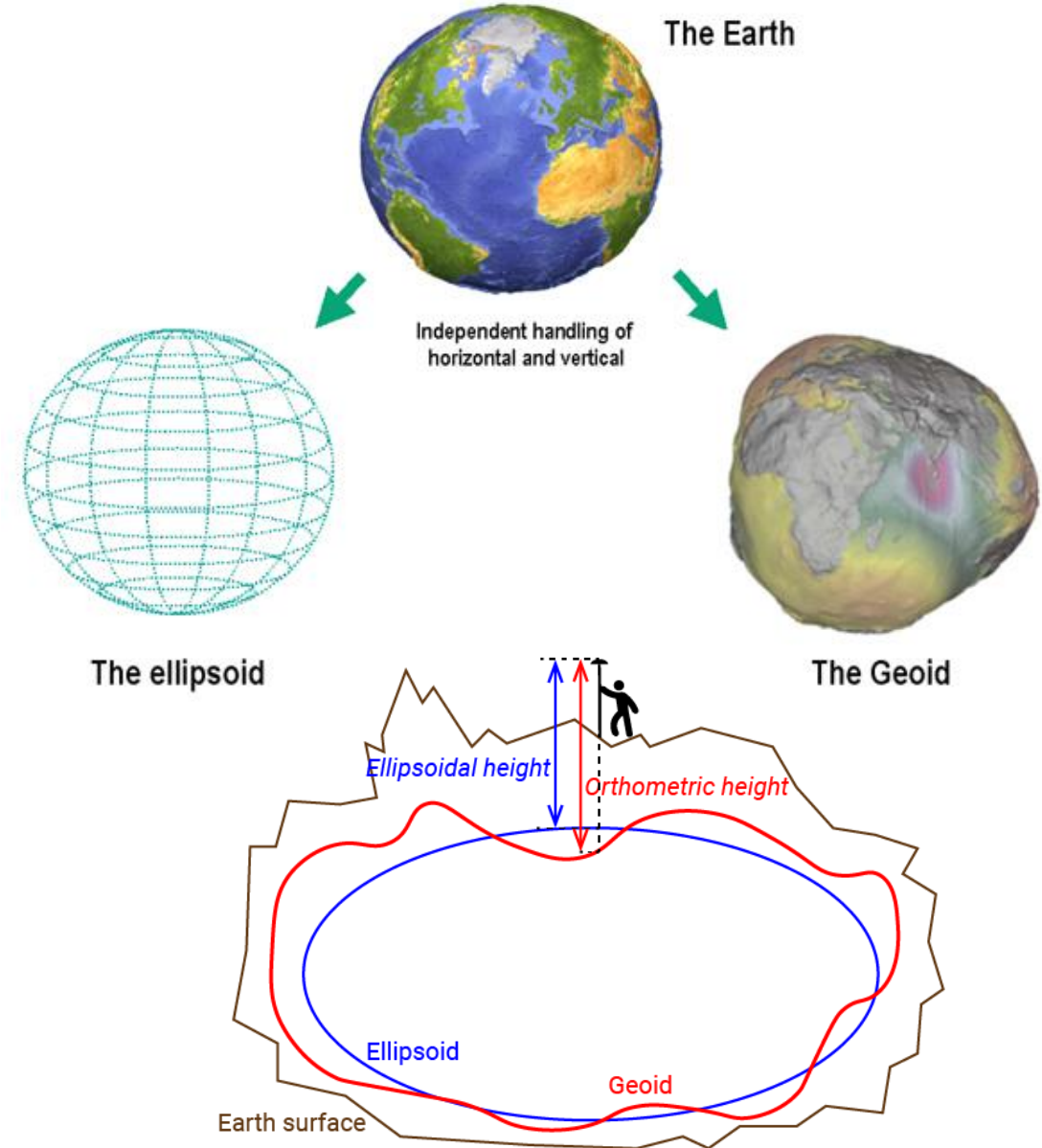
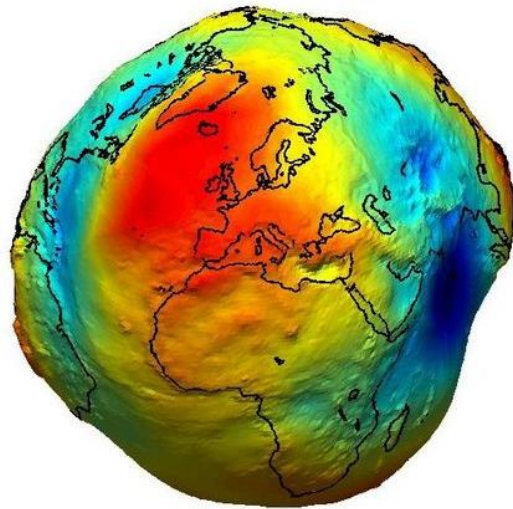
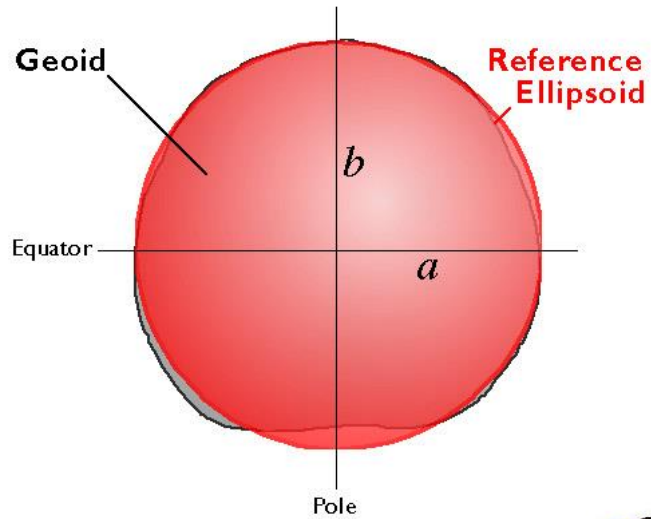
Fractional Scale
1:190,000,000

Bar Scale
0 Miles 5000



Map Types, Scale, Coordinate Systems, and Map Projections

➤ Coordinate Systems

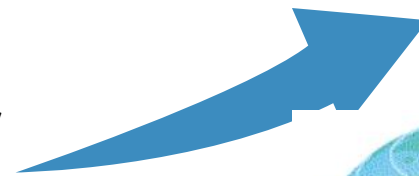


Map Types, Scale, Coordinate Systems, and Map Projections

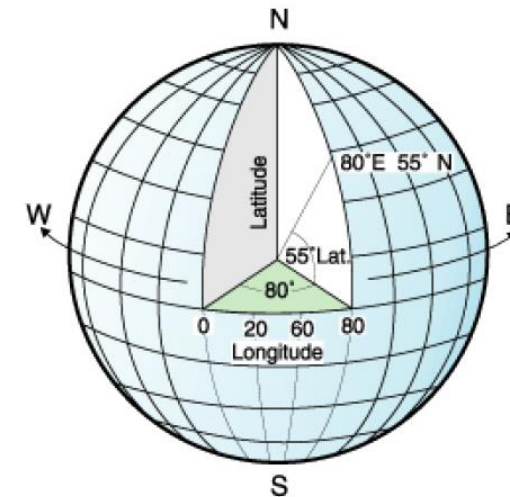
➤ Coordinate Systems

1. Geographic Coordinate System (GCS)

- Just as all maps have a map scale, **all maps have locations**, too.
- Coordinate systems are frameworks that are used to **define unique positions**.
- For instance, in geometry we use **x (horizontal) and y (vertical) coordinates to define points** on a twodimensional plane.
- The coordinate system that is most commonly used to define locations on the **three-dimensional earth is called the geographic coordinate system (GCS)**, and it is based on a sphere or spheroid.



- ✓ **Coordinate Systems:** Frameworks used to **determine position on the surface of the earth**.
- ✓ **The three-dimensional coordinate system** commonly used to define locations on the earth's surface.



Map Types, Scale, Coordinate Systems, and Map Projections

➤ Coordinate Systems

1. Geographic Coordinate System (GCS)

- Note that latitude and longitude can be expressed in **degrees-minutes-seconds (DMS)** or in **decimal degrees (DD)**.
- When using decimal degrees, **latitudes above the equator and longitudes east of the prime meridian are positive**, and **latitudes below the equator and longitudes west of the prime meridian are negative**.



Nominal location	Absolute location (DMS)	Absolute location (DD)
Los Angeles, US	34° 3' North, 118° 15' West	+34.05, -118.25
Mumbai, India	18° 58' North, 72° 49' East	+18.975, +72.8258

Nominal location	Absolute location (DMS)	Absolute location (DD)
Sydney, Australia	33° 51' South, 151° 12' East	-33.859, 151.211
Sao Paulo, Brazil	23° 33' South, 46° 38' West	-23.550, -46.634

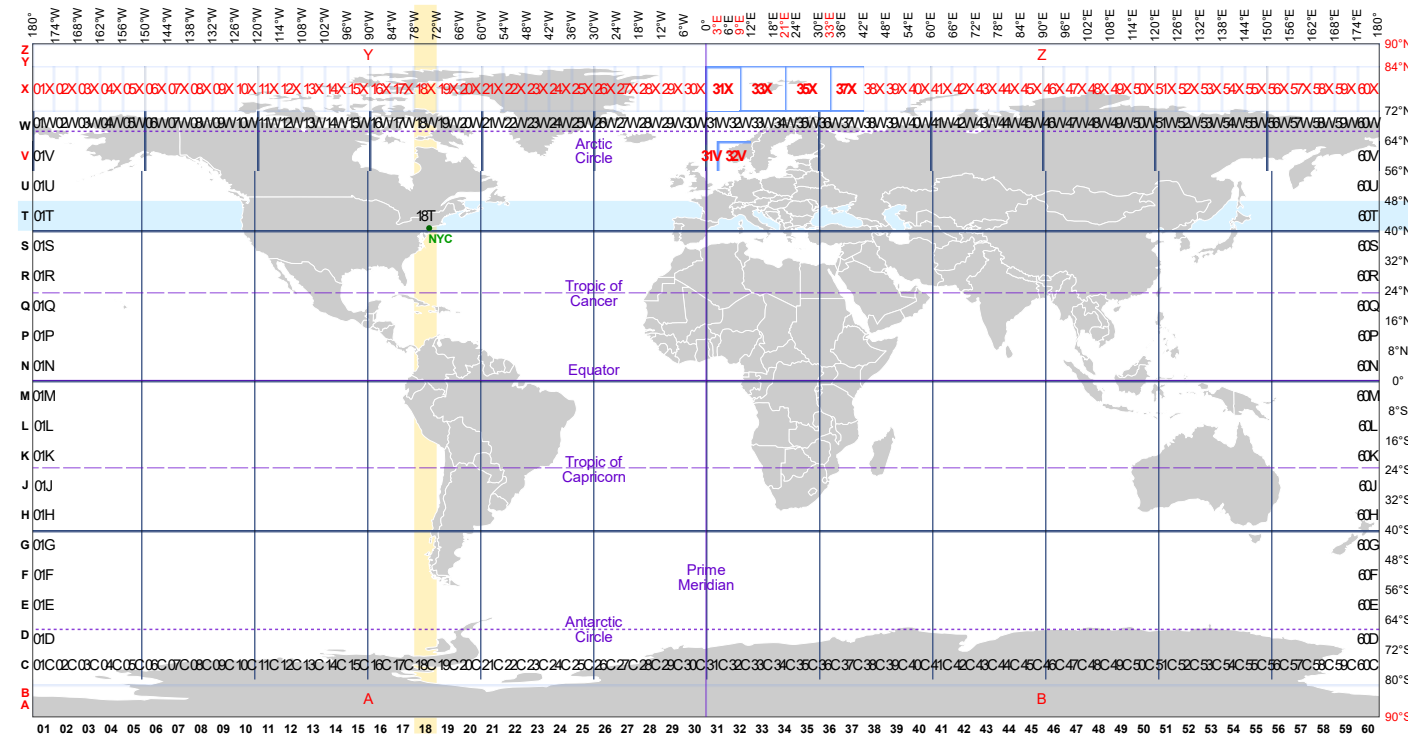
Map Types, Scale, Coordinate Systems, and Map Projections

➤ Coordinate Systems

2. Universal Transverse Mercator (UTM) Coordinate System

- The Universal Transverse Mercator (UTM) is a map projection system for **assigning coordinates to locations on the surface of the Earth**.
- Like the traditional method of latitude and longitude, it is a horizontal position representation, which means it **ignores altitude and treats the earth as a perfect ellipsoid**.
- However, it differs from global latitude/longitude in that it **divides earth into 60 zones** and projects each to the plane as a basis for its coordinates.
- Specifying a location means specifying the zone and the **x, y coordinate in that plane**.

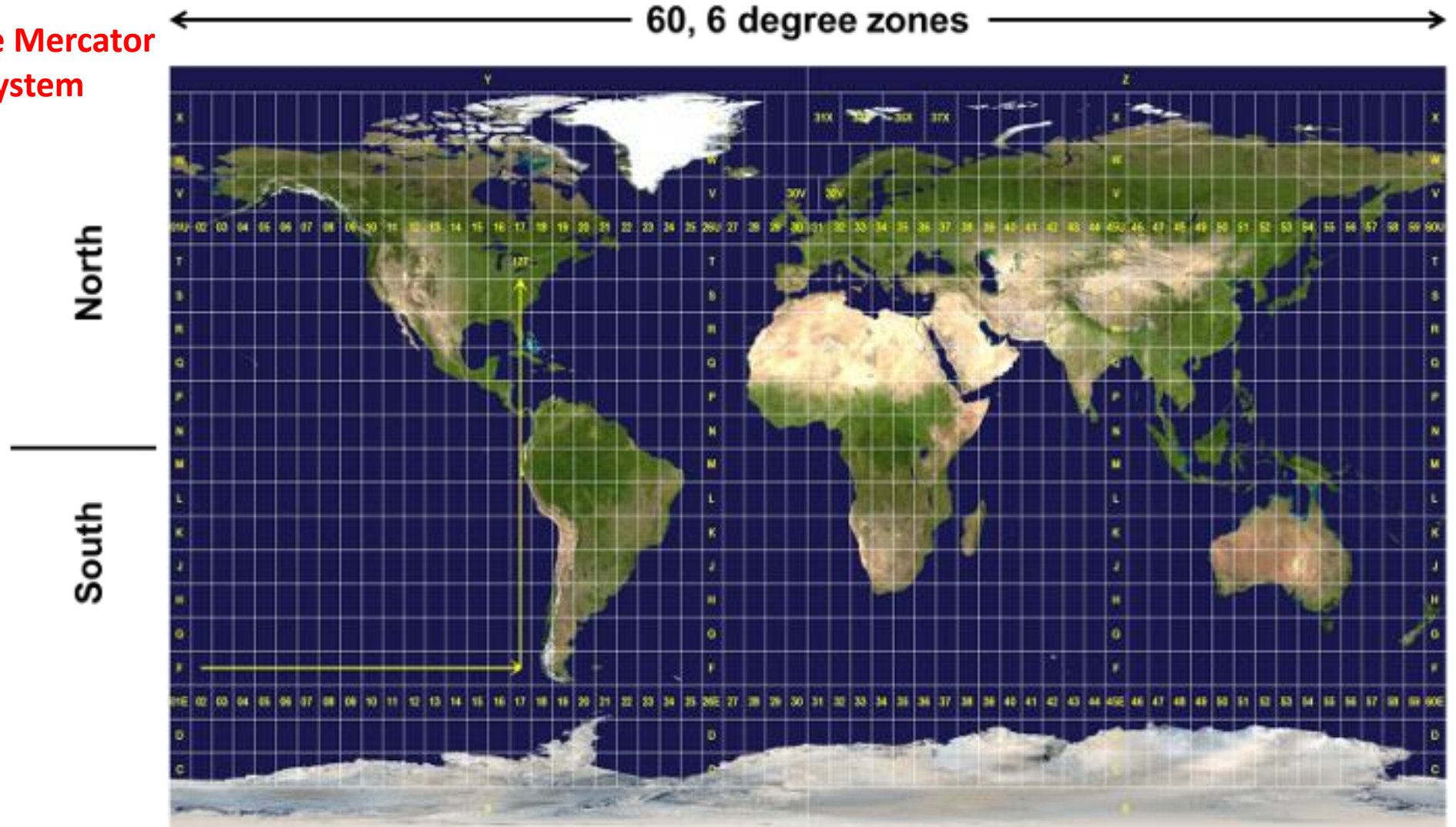
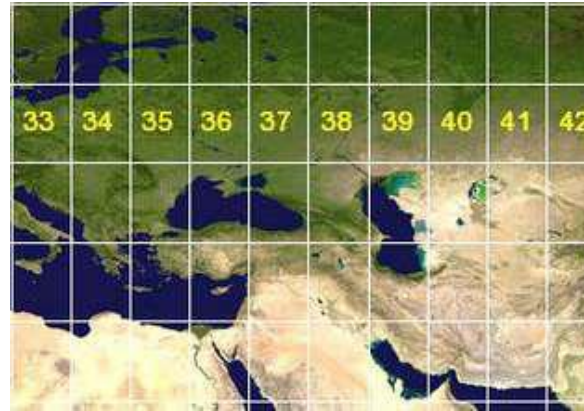
☐ Most zones in UTM span 6 degrees of longitude, and each has a designated central meridian



Map Types, Scale, Coordinate Systems, and Map Projections

➤ Coordinate Systems

2. Universal Transverse Mercator (UTM) Coordinate System

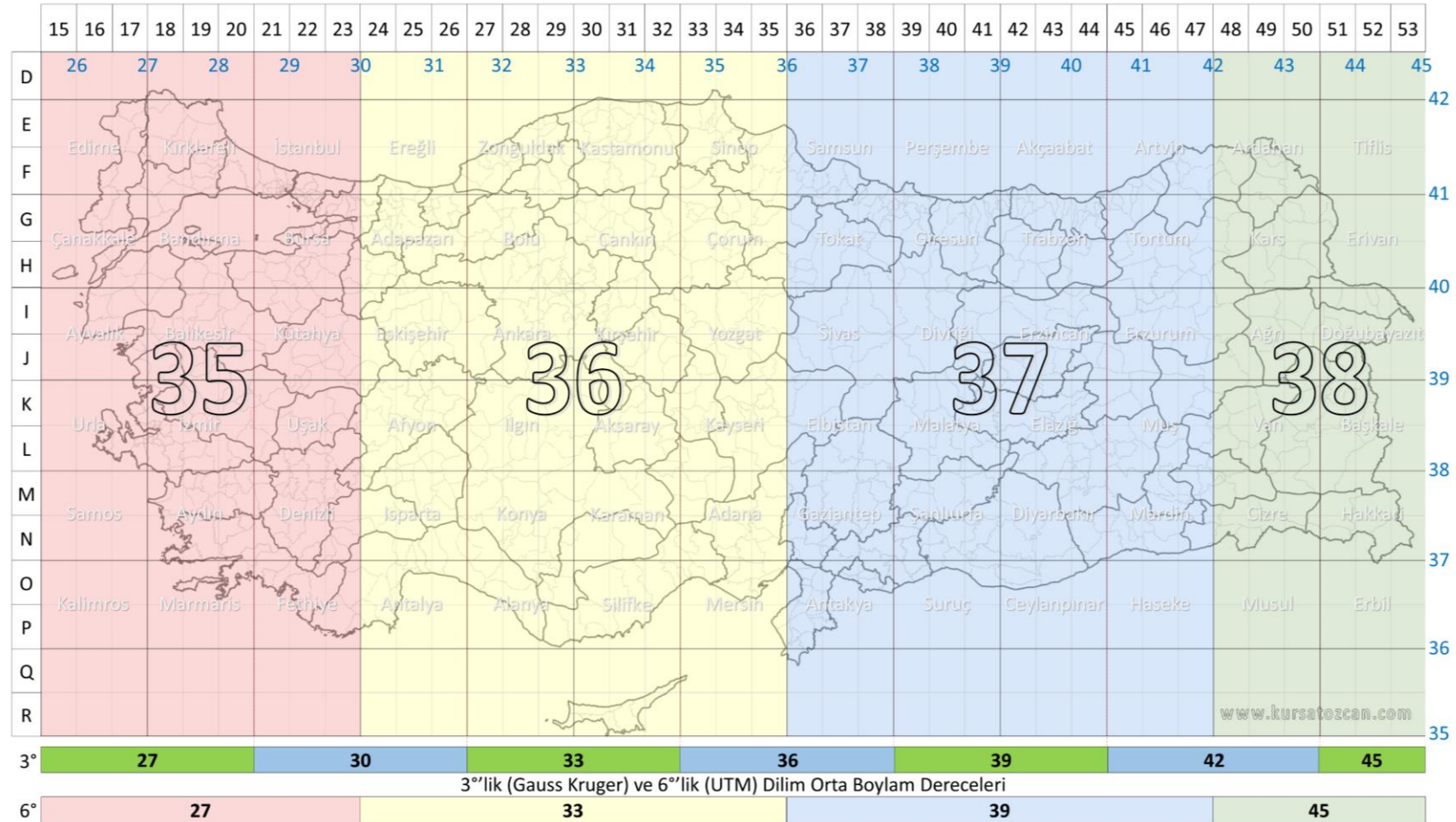


➤ Coordinate Systems

2. Universal Transverse Mercator (UTM) Coordinate System

- Turkey falls within the **35, 36, 37, and 38 zones** in the UTM system and the **S and T bands**.
- The **central meridians** corresponding to these slices are at **27°, 33°, 39°, and 45°** meridians.

TÜRKİYE PAFTA BÖLÜMLEMESİ



Map Types, Scale, Coordinate Systems, and Map Projections

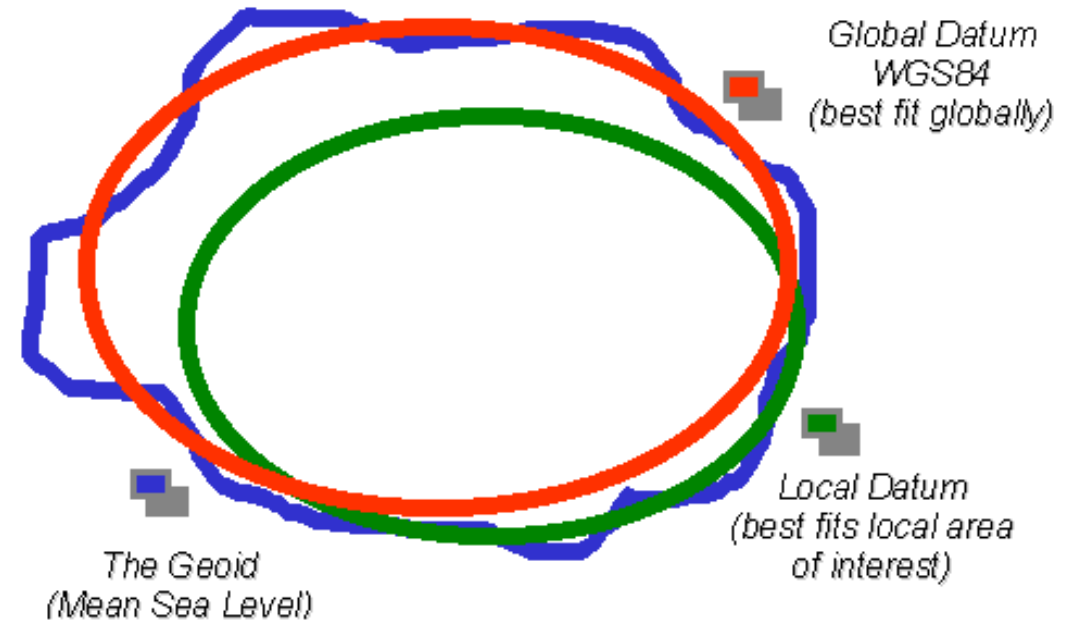


➤ Coordinate Systems

○ DATUM

- When we want to map things like mountains, rivers, streets, and buildings, **we need to define how the lines of latitude and longitude will be oriented and positioned on the sphere.**
- **A datum serves this purpose** and specifies exactly the orientation and origins of the lines of latitude and longitude relative to the center of the earth or spheroid.

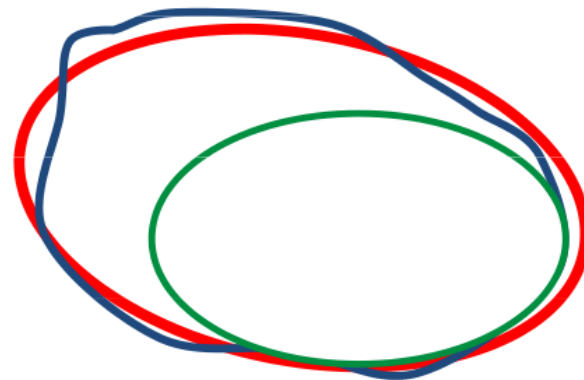
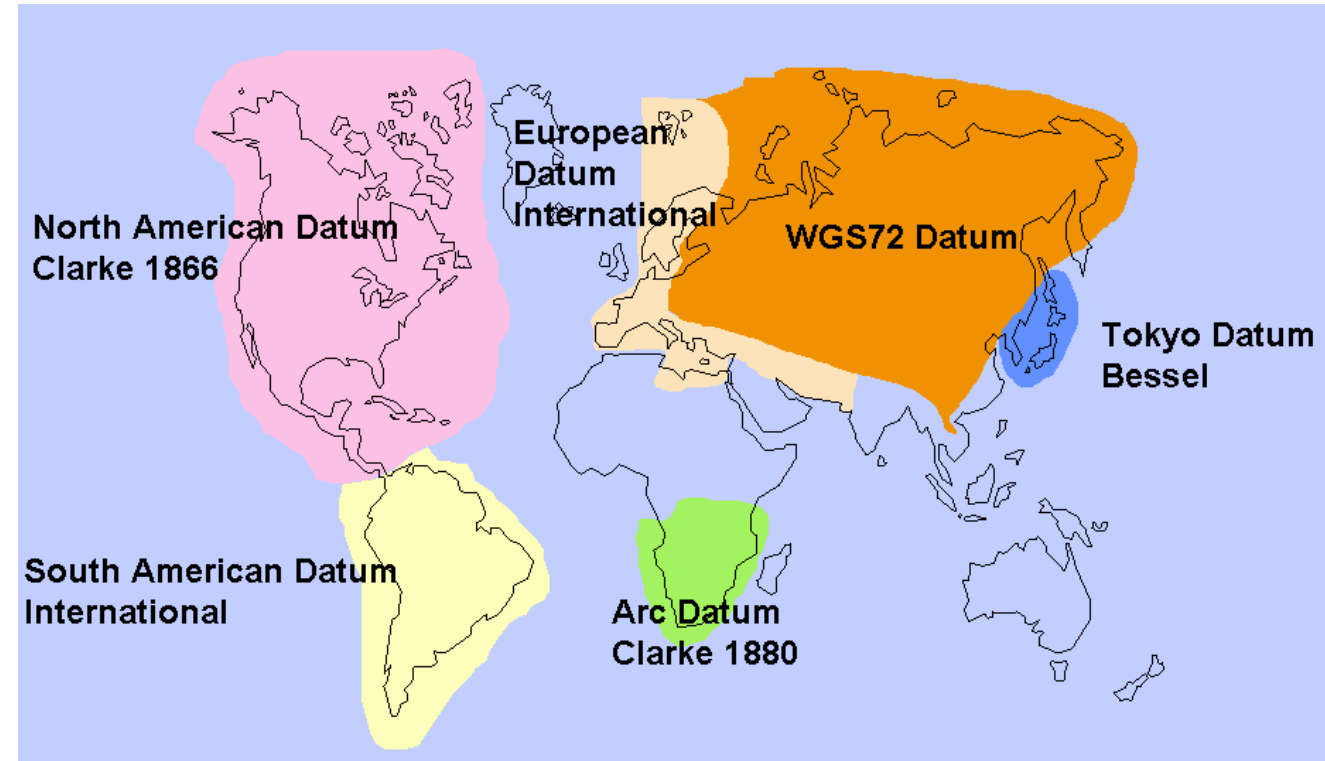
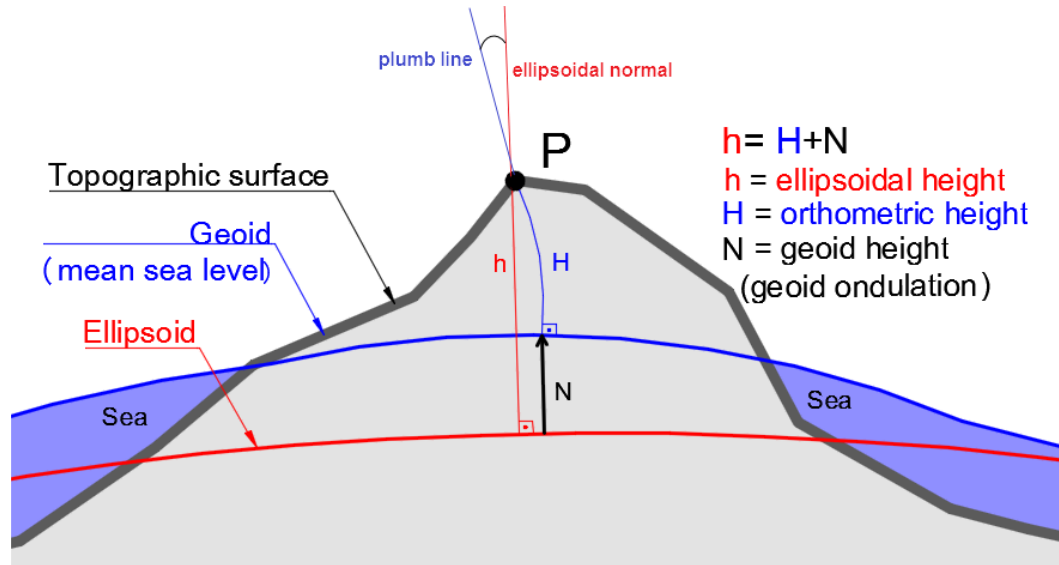
- **The global WGS84 datum** (i.e., World Geodetic System of 1984) **uses the center of the earth** as the origin of the GCS and is **used for defining locations across the globe.**



Map Types, Scale, Coordinate Systems, and Map Projections

➤ Coordinate Systems

○ DATUM



The Geoid
(Mean Sea level)

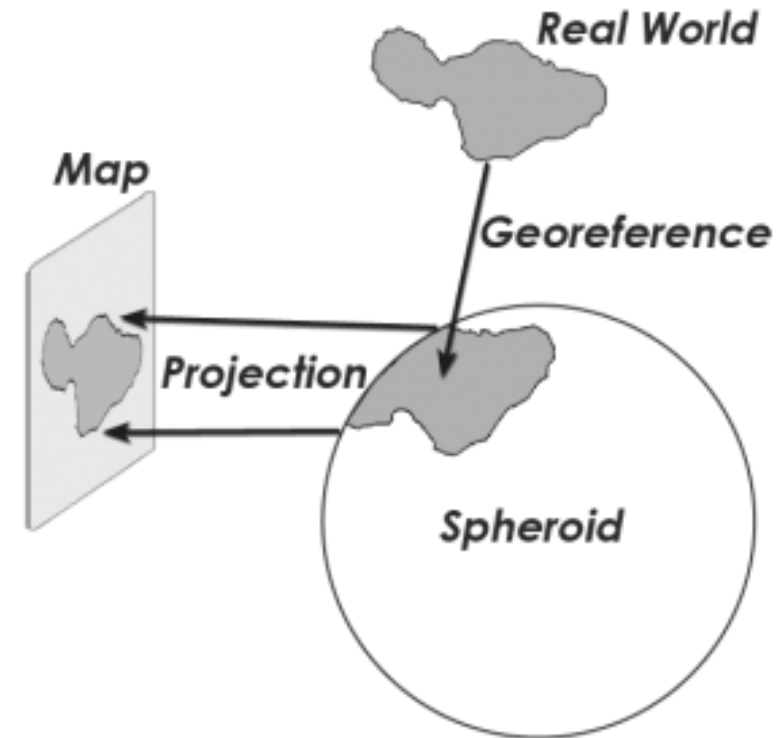
Local Datum
(best fits on a Local Area)

Global Datum (e.g., WGS84)
(best fit globally)

➤ Map Projections

- Previously we noted that the **earth is really big**.
- **Not only is it big, but it is a big round spherical shape called a spheroid.**
- **A globe is a very common and very good representation** of the three-dimensional, spheroid earth.
- One of the problems with globes, however, is that **they are not very portable** (i.e., you cannot fold a globe and put it in your pocket), and their small scale makes **them of limited practical use** (i.e., geographic detail is sacrificed).
- **To overcome these issues;**
 - ❑ **Enter the map projection.**

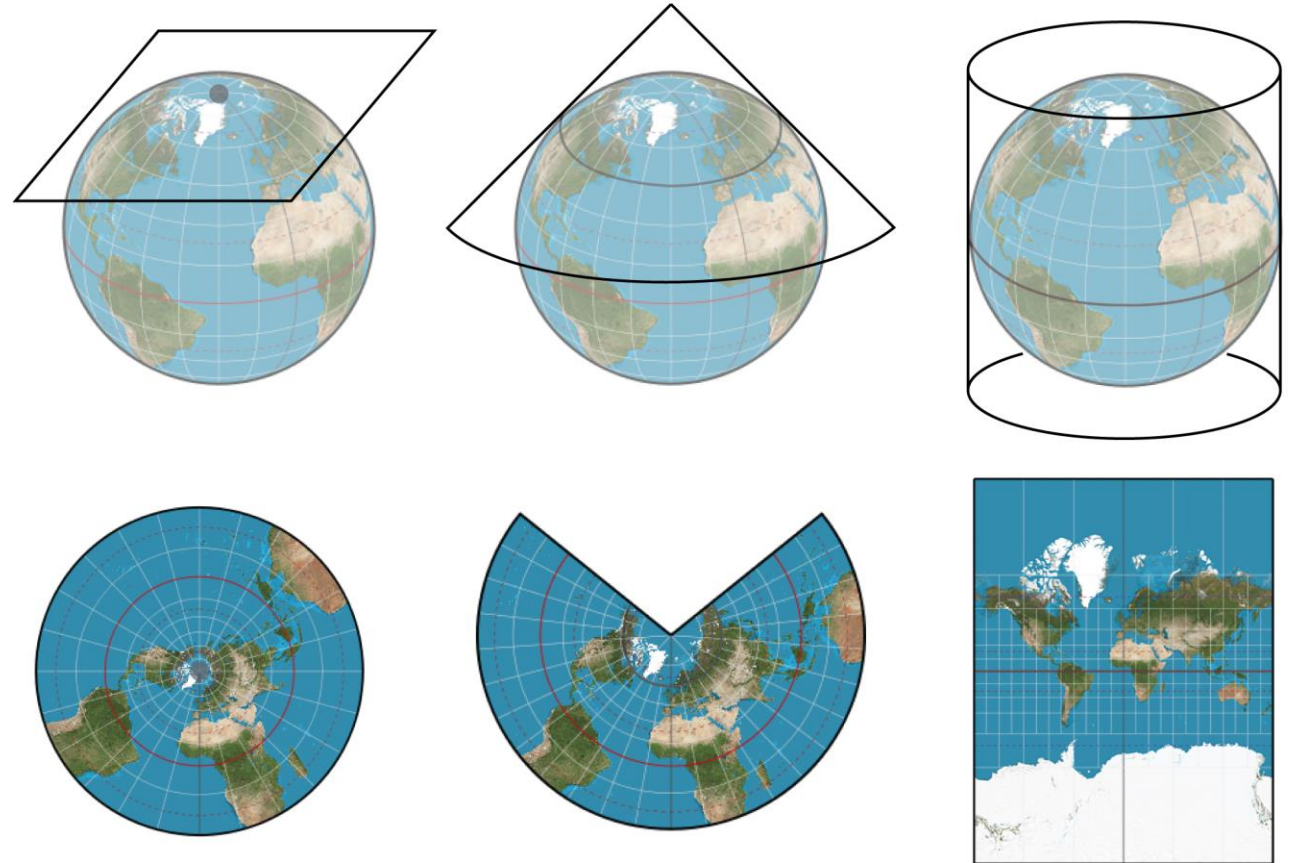
- ❑ **Map Projections:** The mathematical formulae used to transform locations from a three-dimensional, **spherical coordinate system to a two-dimensional planar system.**



Map Types, Scale, Coordinate Systems, and Map Projections

➤ Map Projections

- Map projection refer to the methods and procedures that are used to transform the spherical **three-dimensional earth into two-dimensional planar surfaces**.
- Specifically, map projections are mathematical formulas that are used to translate **latitude and longitude on the surface of the earth to x and y coordinates on a plane**.
- Since there are an infinite number of ways this translation can be performed, **there are an infinite number of map projections**.



➤ Map Projections

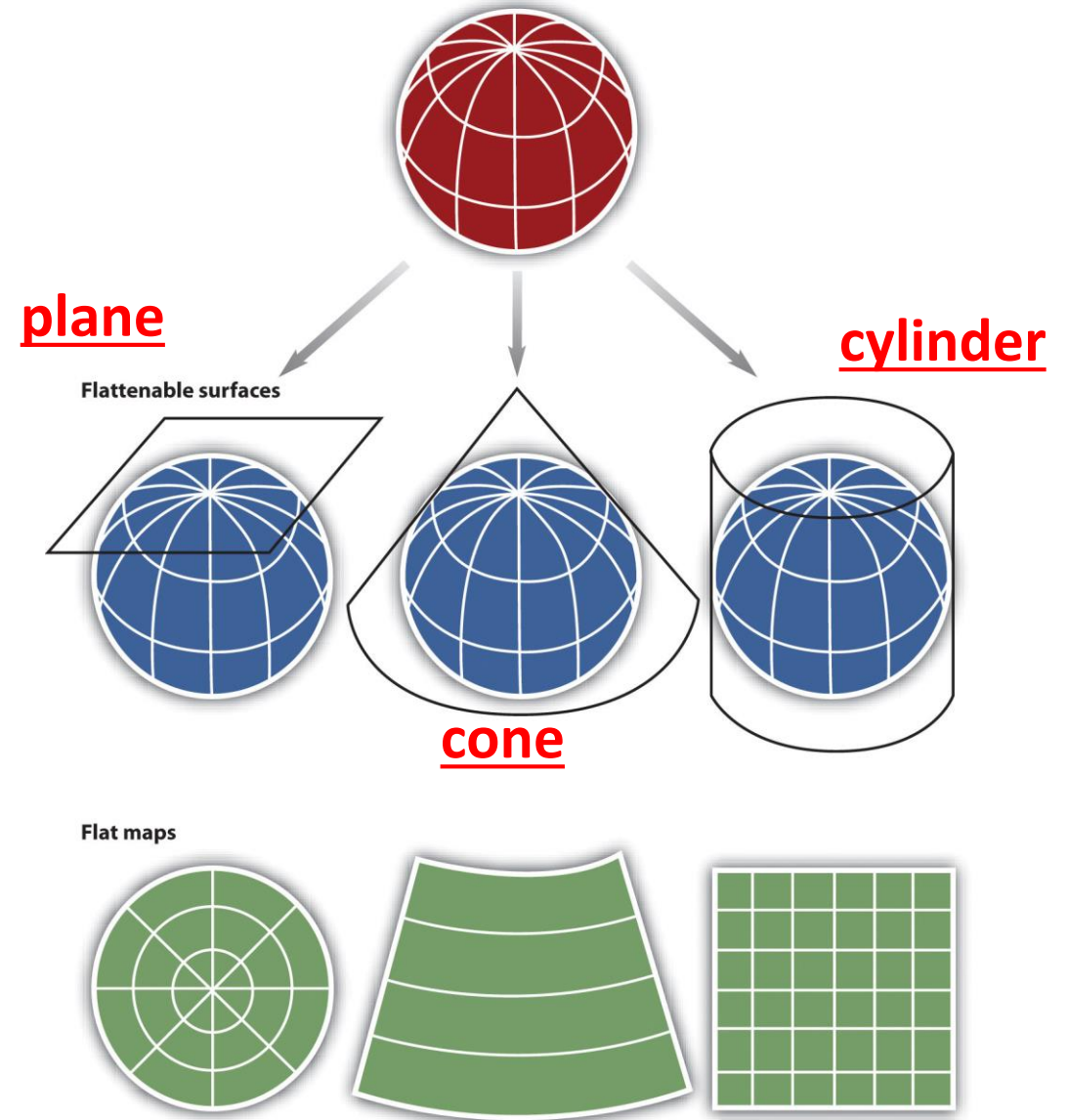
- To illustrate the concept of a map projection, **imagine that we place a light bulb in the center of a translucent globe.**
- **On the globe are outlines of the continents and the lines of longitude and latitude called the graticule.**
- **When we turn the light bulb on, the outline of the continents and the graticule will be “projected” as shadows on the wall, ceiling, or any other nearby surface.**
- **This is what is meant by map “projection.”**



Map Types, Scale, Coordinate Systems, and Map Projections

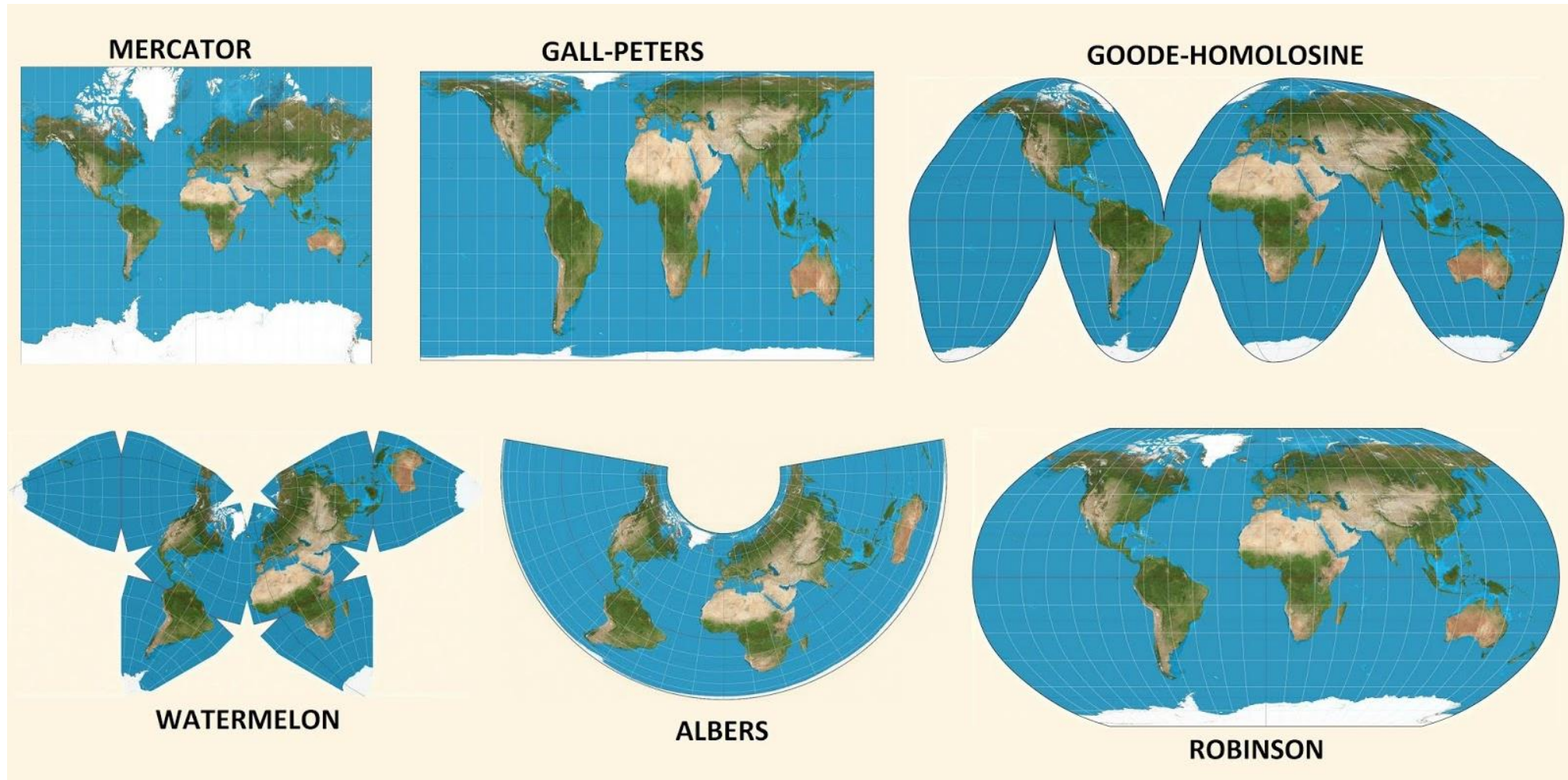
➤ Map Projections

- Within the realm of maps and mapping, **there are three surfaces used for map projections.**
- These surfaces are the **plane**, the **cylinder**, and the **cone**.
- Note that during the projection process, **we can situate each surface in any number of ways.**
- For example, **surfaces can be tangential to the globe along the equator or poles**, **they can pass through or intersect the surface**, and they can be oriented at any number of angles.



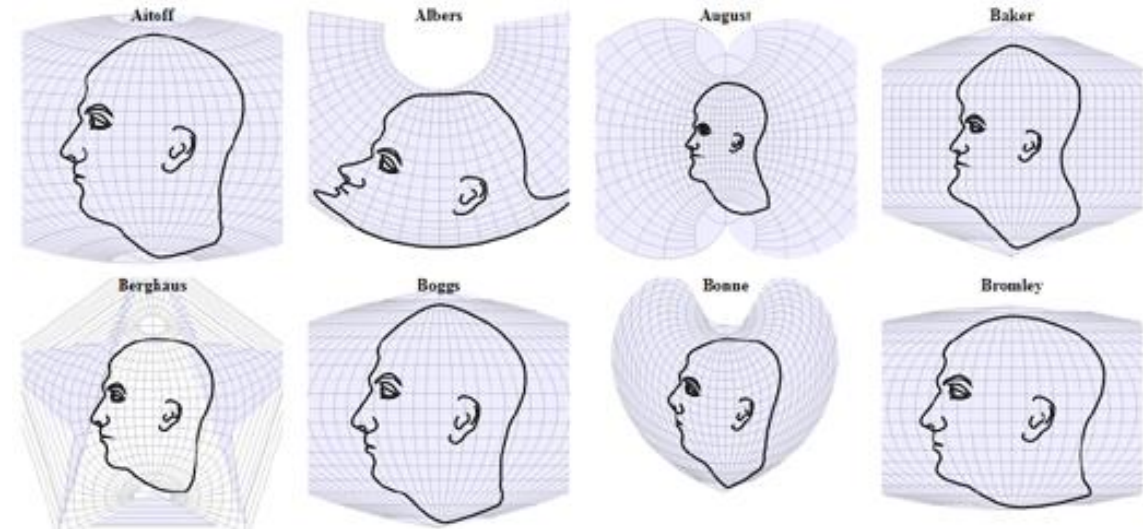
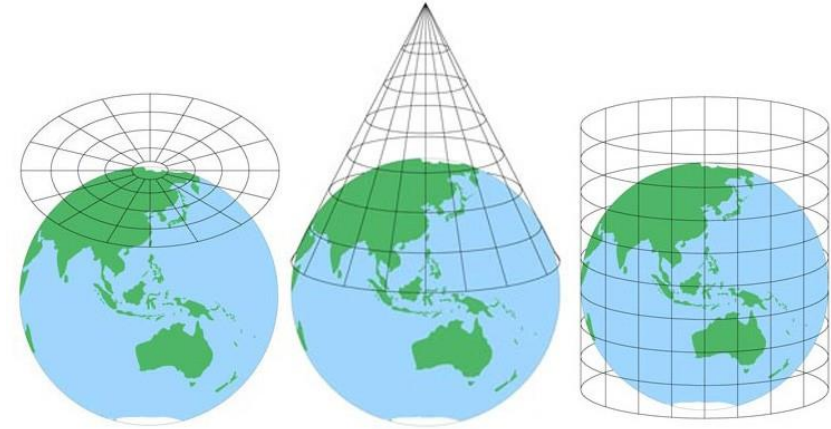
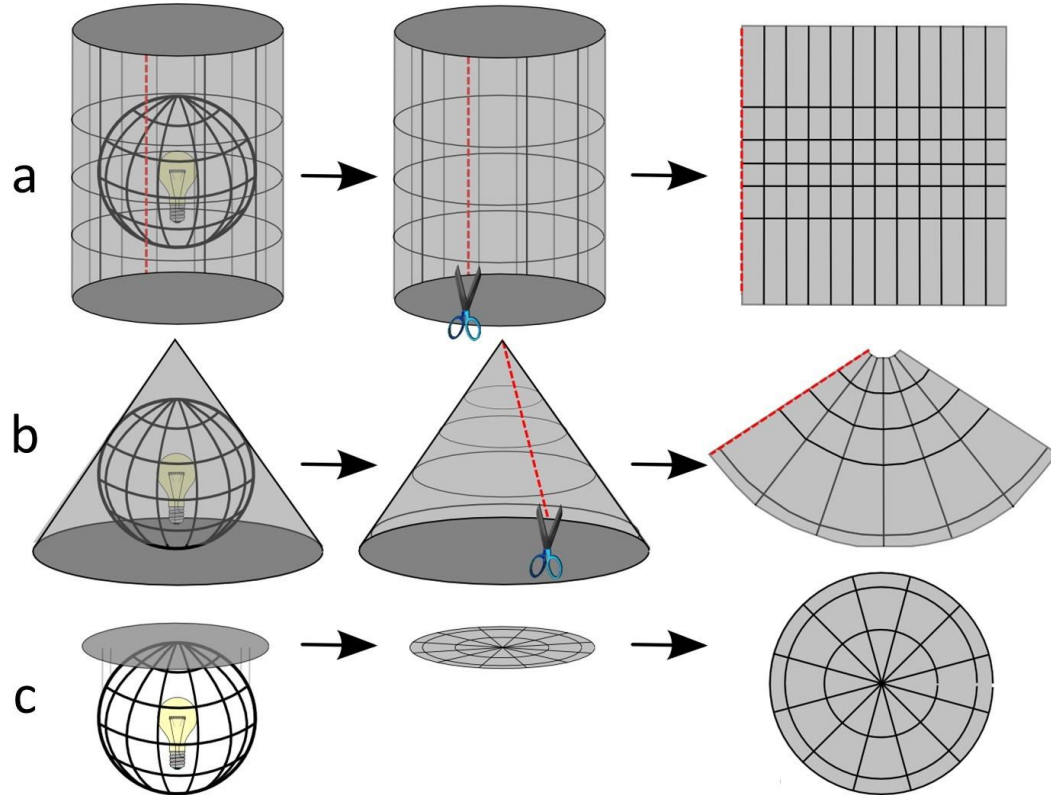
Map Types, Scale, Coordinate Systems, and Map Projections

➤ Map Projections



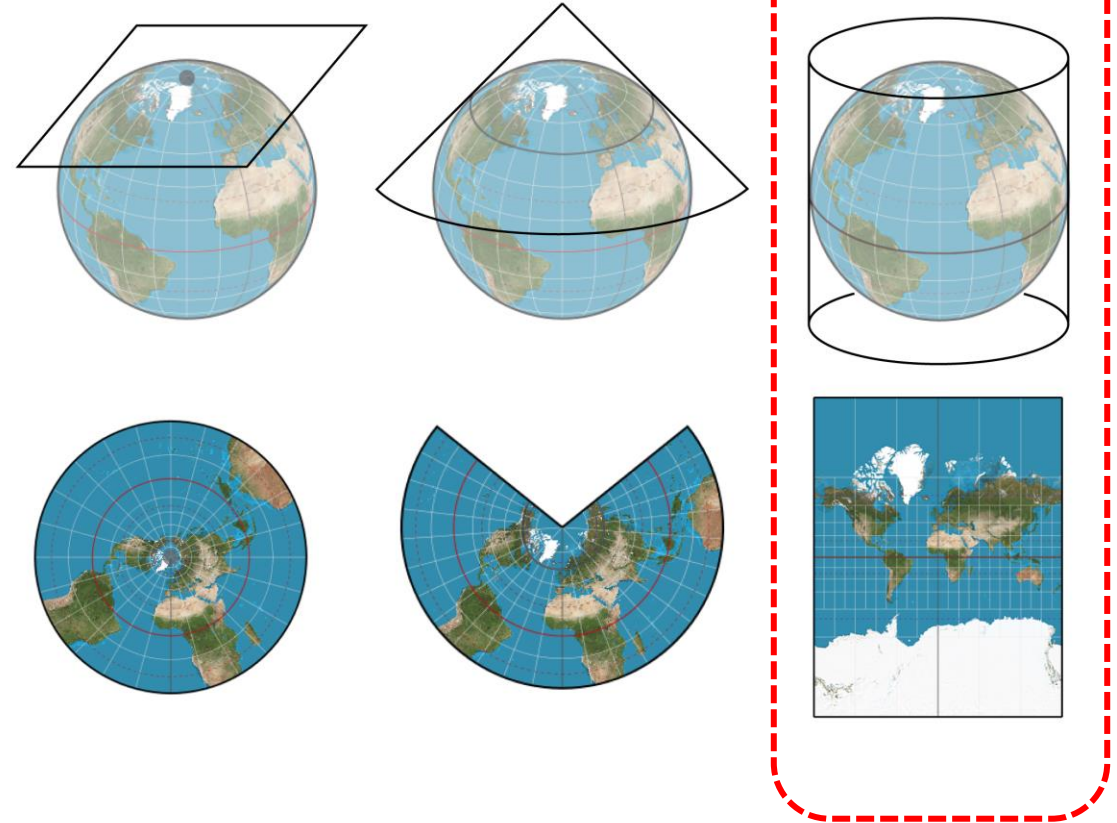
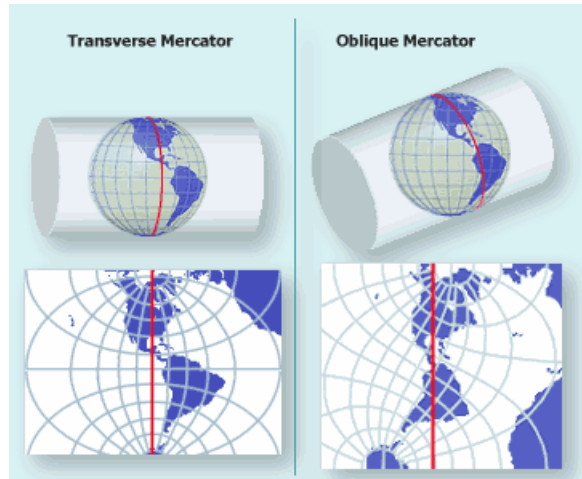
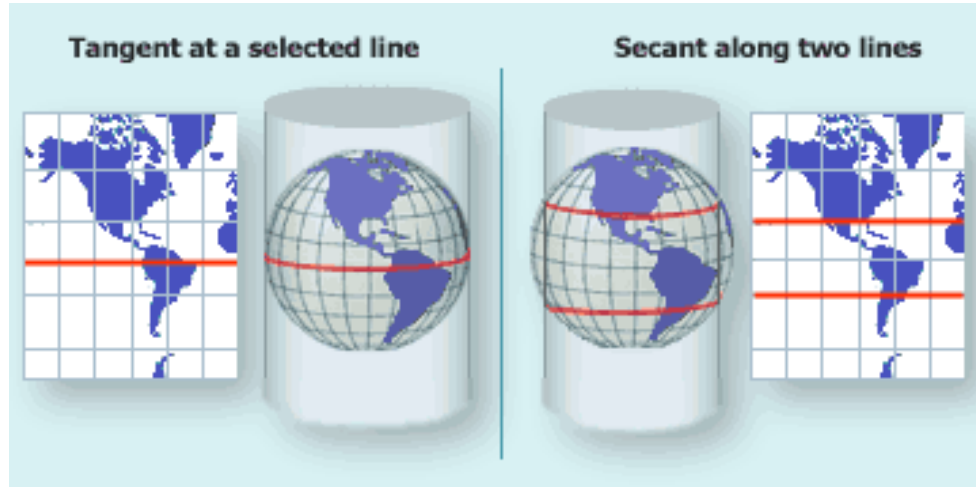
Map Types, Scale, Coordinate Systems, and Map Projections

➤ Map Projections



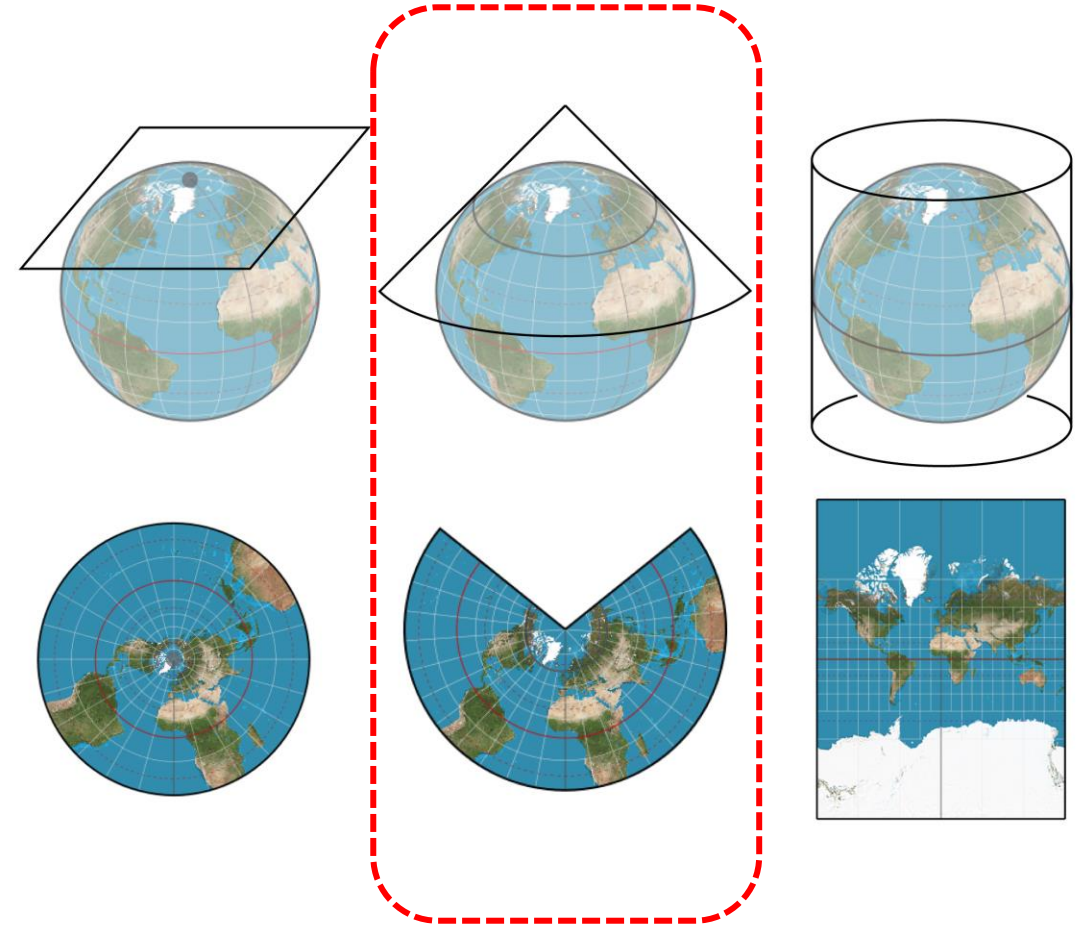
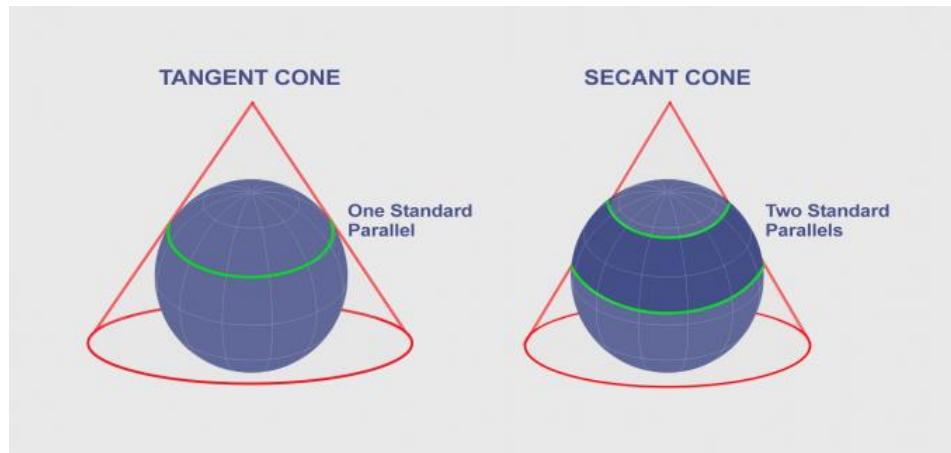
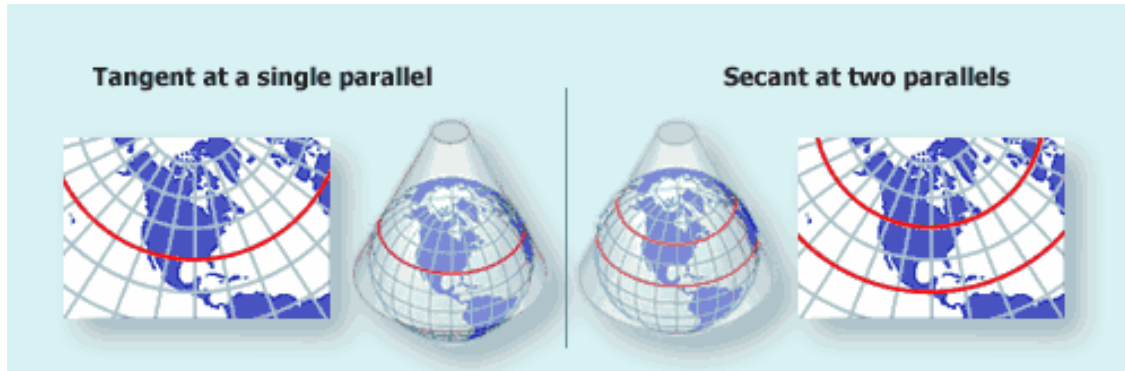
➤ Map Projections

1. Cylindrical (cylinder) projection



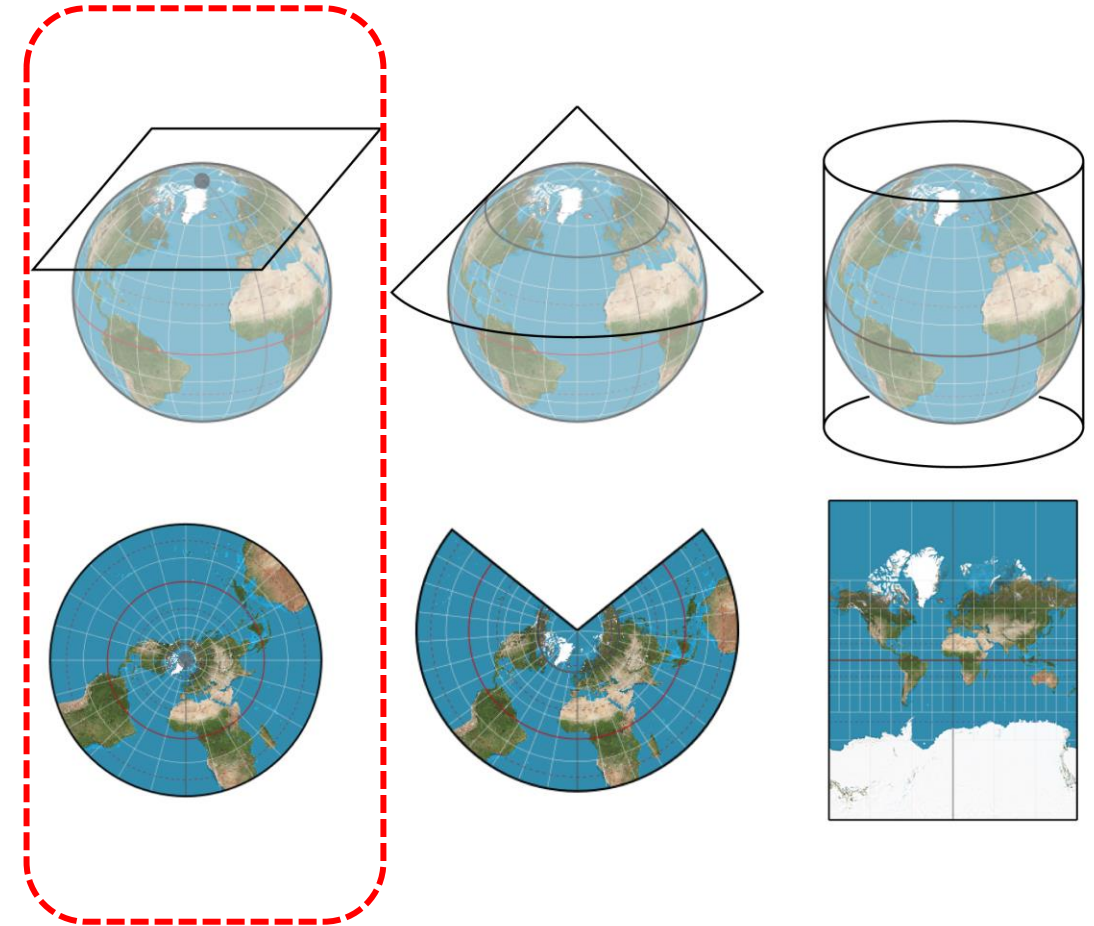
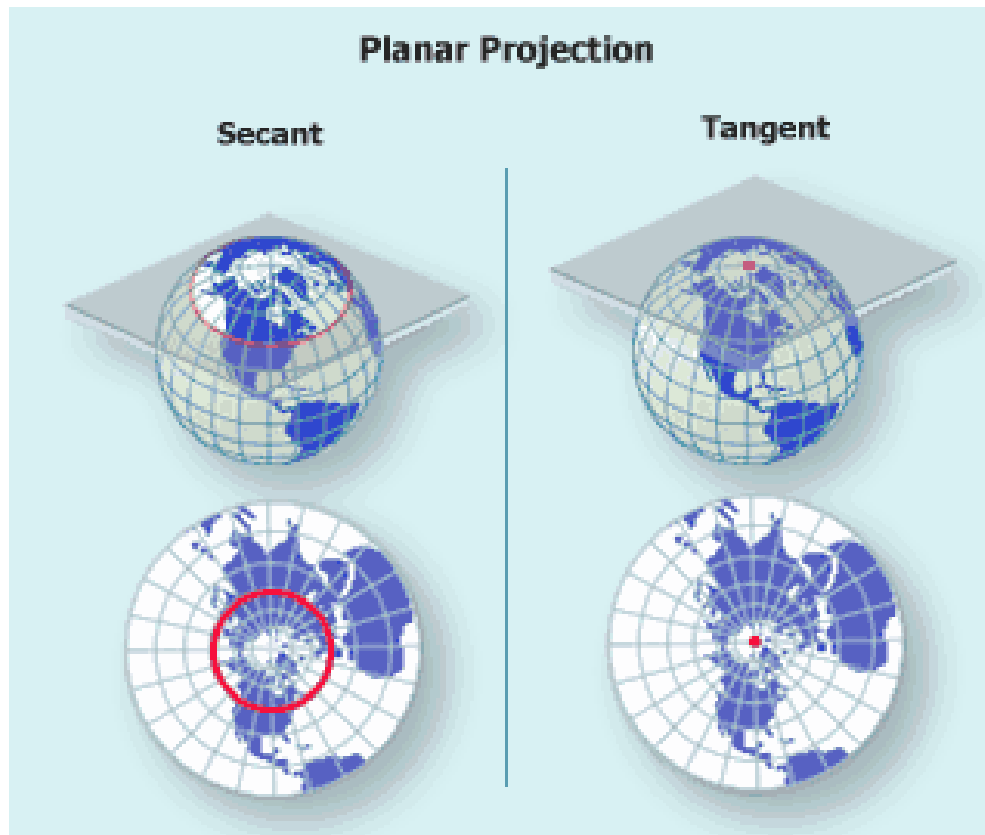
➤ Map Projections

2. Conical (conic) projection



➤ Map Projections

1. Planar (plane) projection



- Burrough, P. A., McDonnell, R. A., & Lloyd, C. D. (2015). Principles of geographical information systems. Oxford university press.
- Turođlu, H. (2016). Cođrafi Bilgi Sistemlerinin Temel Esasları. İstanbul: Çantay Yayınları.
- Campbell, J. E., & Shin, M. (2011). Essentials of geographic information systems. [https://www. saylor. org/books/](https://www.saylor.org/books/).
- Ocak, F., Sert, S., Ünsal Ö. (2012). ArcGIS 10.1 for Desktop. Esri Bilgi Sistemleri Mühendislik ve Eğitim Ltd. Şti. Ankara.
- <https://101gis.com/reference-map-vs-thematic-map/>
- <https://mapscatalogonline.blogspot.com/2018/04/large-scale-map-vs-small-scale-map.html>
- <http://geokov.com/education/map-projection.aspx>