MAP PROJECTION SYSTEMS

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BACKGROUND

- Maps are flat (2-d), while the earth surfaces they represent are curved.
- Transforming three dimensional space onto a two dimensional map is called PROJECTION.
- A spheroid can't be flattened to a plane any more easily than a piece of orange peel can be flattened—it will rip. Representing the earth's surface in two dimensions causes distortion in the shape, area, distance, or direction of the data.

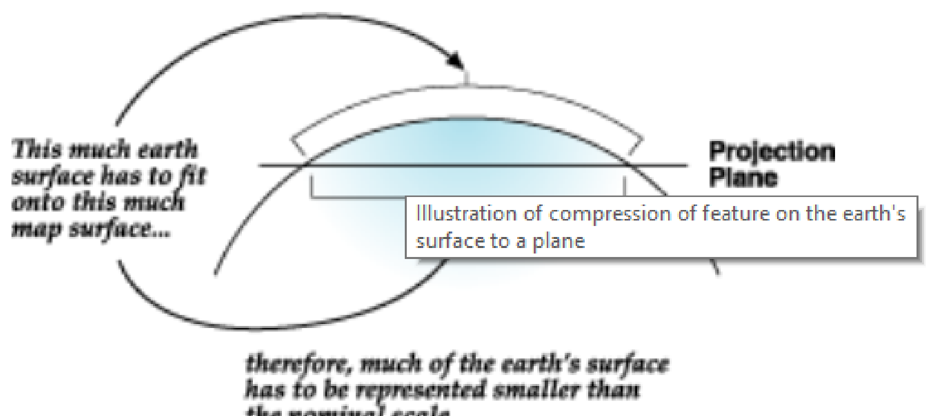
Ref: ARCGIS HELP

DISTORTIONS

- Different projections cause different types of distortions.
- Some projections are designed to minimize the distortion of one or two of the data's characteristics.
- A projection could maintain the area of a feature but alter its shape.

DISTORTION

The following diagram shows how three-dimensional features are compressed to fit onto a flat surface.



TYPES OF PROJECTIONS

Map projections are designed for specific purposes.

One map projection might be used for large-scale data in a limited area, while another is used for a small-scale map of the world.

Map projections designed for small-scale data are usually based on spherical rather than spheroidal geographic coordinate systems.

Types:

- Conformal projection`s
- Equal area projections
- Equidistant projections

CONFORMAL PROJECTIONS

- Conformal projections preserve **local shape**.
- To preserve individual angles describing the spatial relationships, a Conformal projection must show the perpendicular graticule lines intersecting at 90-degree angles on the map.
- A map projection accomplishes this by maintaining all angles.
- The drawback is that the area enclosed by a series of arcs may be greatly distorted in the process.
- No map projection can preserve shapes of larger regions.

EQUAL AREA PROJECTIONS

- Equal area projections preserve the **area** of displayed features.
- To do this, the other properties—shape, angle, and scale—are distorted.
- In Equal area projections, the meridians and parallels may not intersect at right angles.
- In some instances, especially maps of smaller regions, shapes are not obviously distorted, and distinguishing an Equal area projection from a Conformal projection is difficult unless documented or measured.

EQUIDISTANT PROJECTIONS

- Equidistant maps preserve the distances between certain points.
- Scale is not maintained correctly by any projection throughout an entire map.
- However, there are in most cases, one or more lines on a map along which scale is maintained correctly.
- Most Equidistant projections have one or more lines in which the length of the line on a map is the same length (at map scale) as the same line on the globe, regardless of whether it is a great or small circle, or straight or curved. Such distances are said to be true.
- For example, in the Sinusoidal projection, the equator and all parallels are their true lengths. In other Equidistant projections, the equator and all meridians are true. Still others (for example, Two-point Equidistant) show true scale between one or two points and every other point on the map.
- Keep in mind that no projection is equidistant to and from all points on a map.

PROJECTION TYPES

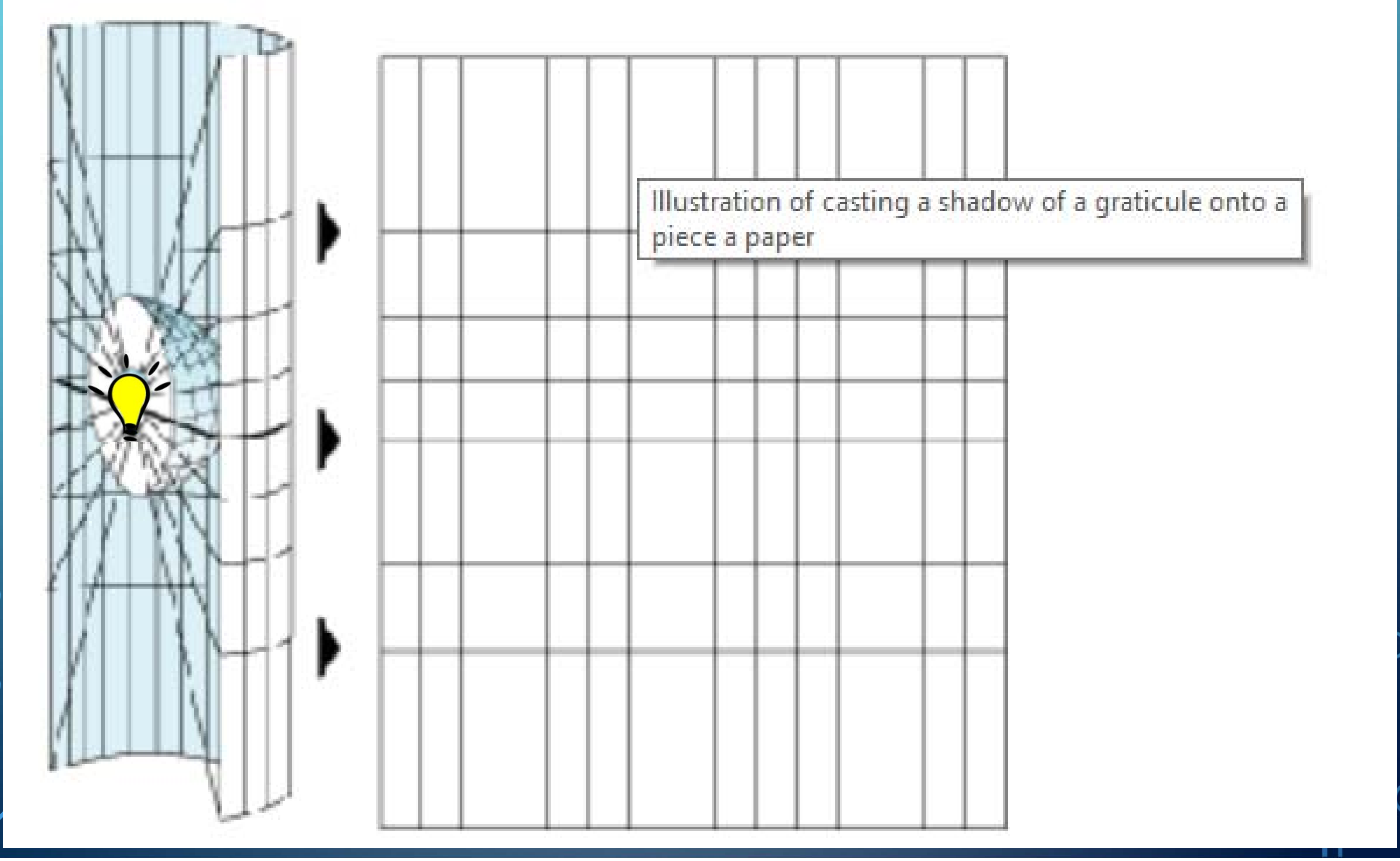
- Because maps are flat, some of the simplest projections are made onto geometric shapes **that can be flattened without stretching their surfaces.**
- These are called developable surfaces. Some common examples are:
  - cones,
  - cylinders, and
  - planes.

PROJECTION TYPES

- The first step in projecting from one surface to another is creating one or more points of contact.
- Each contact is called a point (or line) of tangency.
- A planar projection is **tangential** to the globe at one point.
- Tangential cones and cylinders touch the globe along a line.
- If the projection surface intersects the globe instead of merely touching its surface, the resulting projection is a **secant** rather than a tangent case.
- Whether the contact is tangent or secant, the contact points or lines are significant because they define locations of zero distortion.
- Lines of true scale include the central meridian and standard parallels and are sometimes called standard lines.
- In general, distortion increases with the distance from the point of contact.

PROJECTION BY LIGHT AT CENTER OF EARTH ON A CYLINDER WRAPPING THE EARTH

In the graphic below, data near the poles is stretched.

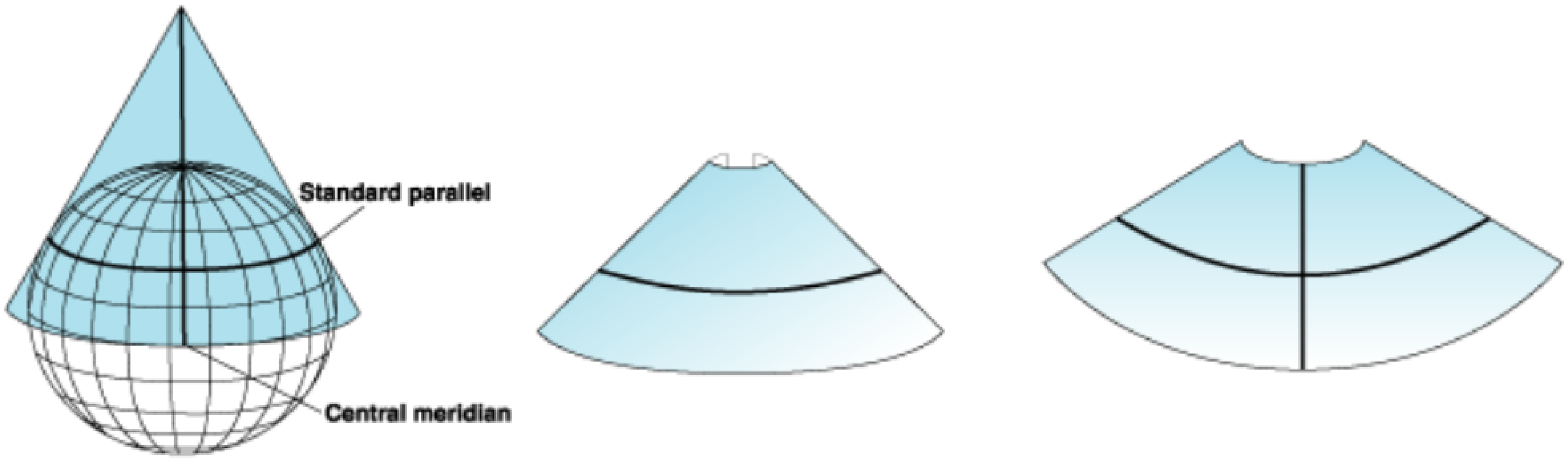


CONIC TANGENTIAL PROJECTION

Projection types illustrated

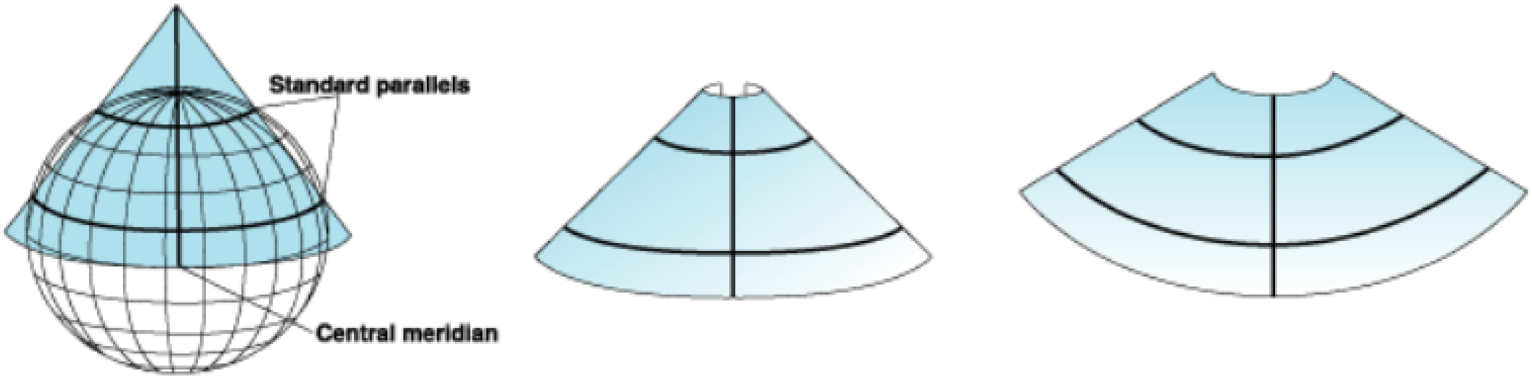
Each of the main projection types—conic, cylindrical, and planar—are illustrated below.

Conic (tangent)



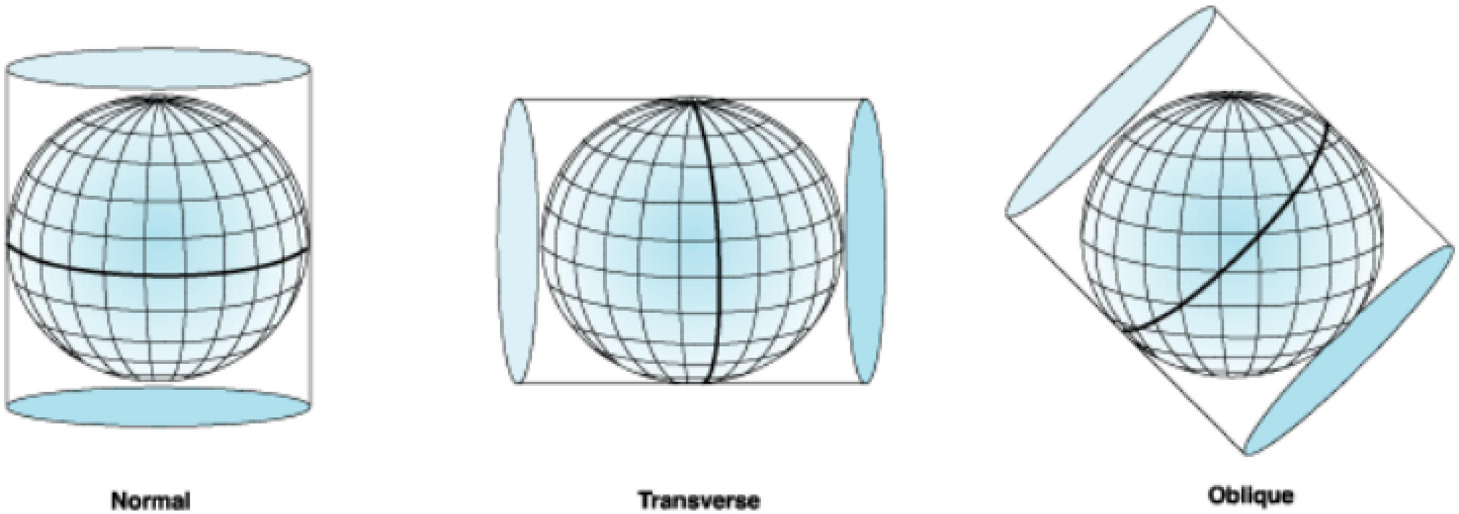
A cone is placed over a globe. The cone and globe meet along a latitude line. This is the standard parallel. The cone is cut along the line of longitude that is opposite the central meridian and flattened into a plane.

Conic (secant)



A cone is placed over a globe but cuts through the surface. The cone and globe meet along two latitude lines. These are the standard parallels. The cone is cut along the line of longitude that is opposite the central meridian and flattened into a plane.

Cylindrical aspects

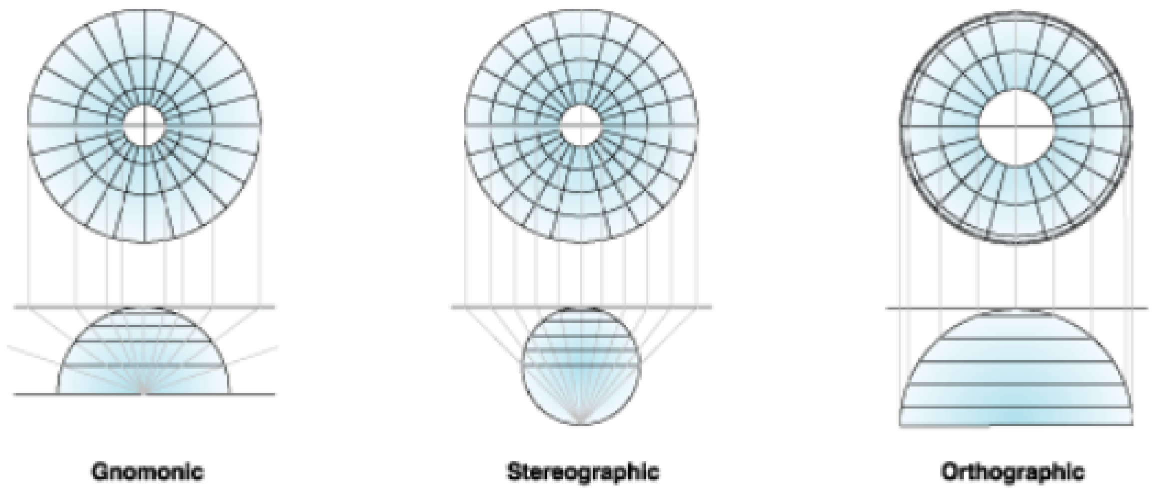


A cylinder is placed over a globe. The cylinder can touch the globe along a line of latitude (normal case), a line of longitude (transverse case), or another line (oblique case).

Planar aspects

A plane is placed over a globe. The plane can touch the globe at the pole (polar case), the equator (equatorial case), or another line (oblique case).

Polar aspect (different perspectives)

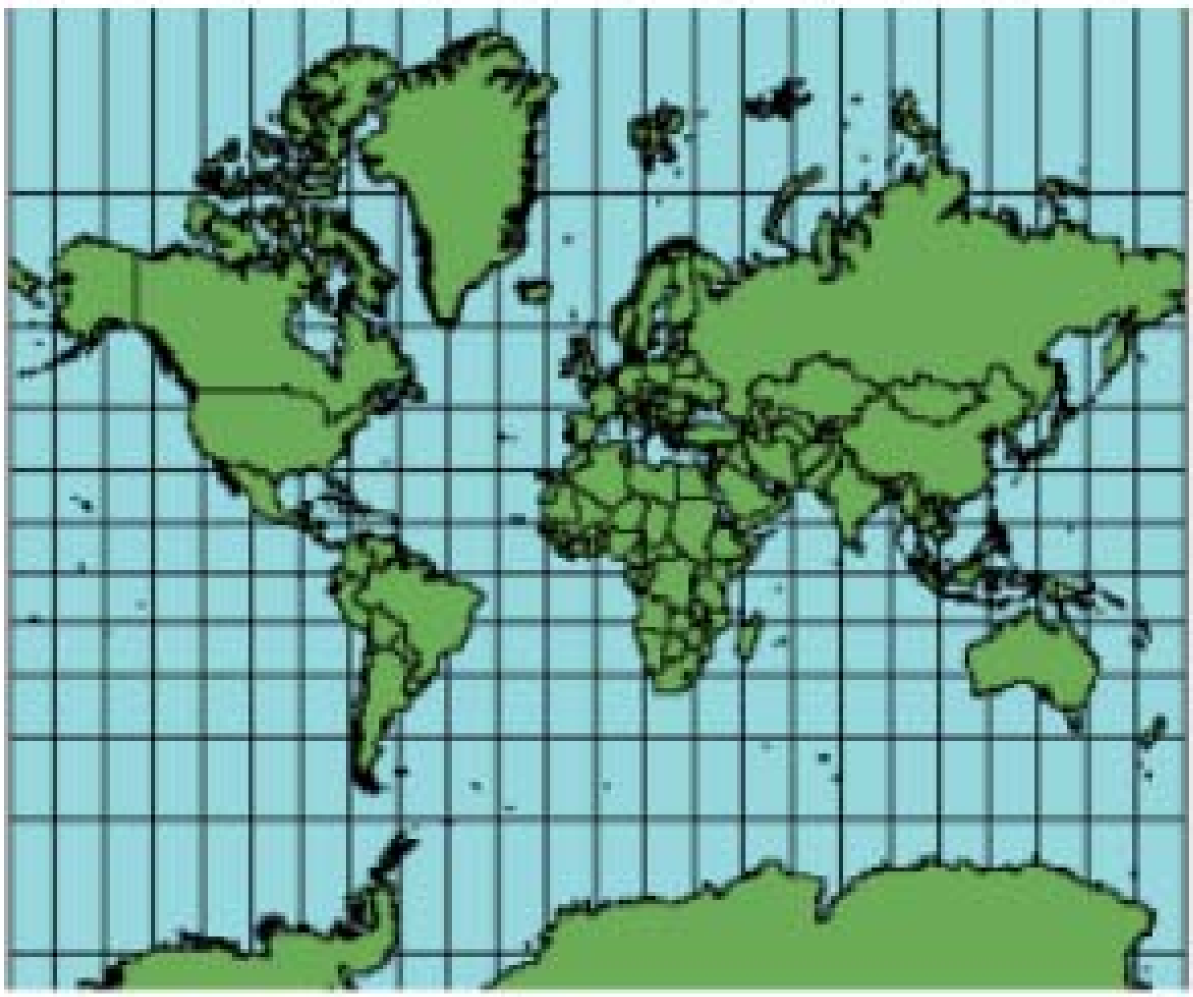


Azimuthal, or planar projections can have different perspective points. The gnomonic projection's point is at the center of the globe. The opposite side of the globe from the point of contact is used for a stereographic projection. The perspective point for an orthographic projection is at infinity.

MERCATOR

- **The Mercator projection is a <u>cylindrical</u> map projection presented by the Flemish geographer and cartographer Gerardus Mercator in 1569**
- Although the linear scale is equal in all directions around any point, thus preserving the angles and the shapes of small objects (which makes the projection conformal).
- <u>The Mercator projection distorts the size of objects as the latitude increases from the Equator to the poles, where the scale becomes infinite.</u>
- So, for example, landmasses such as Greenland and Antarctica appear much larger than they actually are relative to land masses near the equator, such as Central Africa

MERCATOR



THE UNIVERSAL TRANSVERSE MERCATOR (UTM) SYSTEM

- The Universal Transverse Mercator (UTM) system is a specialized application of the transverse Mercator projection.
- The globe is divided into 60 north and south zones, each spanning 6° of longitude. Each zone has its own central meridian. Zones 1N and 1S start at 180° W.
- The limits of each zone are 84° N and 80° S, with the division between north and south zones occurring at the equator.
- The polar regions use the Universal Polar Stereographic coordinate system.
- The origin for each zone is its central meridian and the equator.
- To eliminate negative coordinates, the coordinate system alters the coordinate values at the origin. The value given to the central meridian is the false easting, and the value assigned to the equator is the false northing.
- A false easting of 500,000 meters is applied. A north zone has a false northing of zero, while a south zone has a false northing of 10,000,000 meters.

UTM

Projection method

- Cylindrical projection.

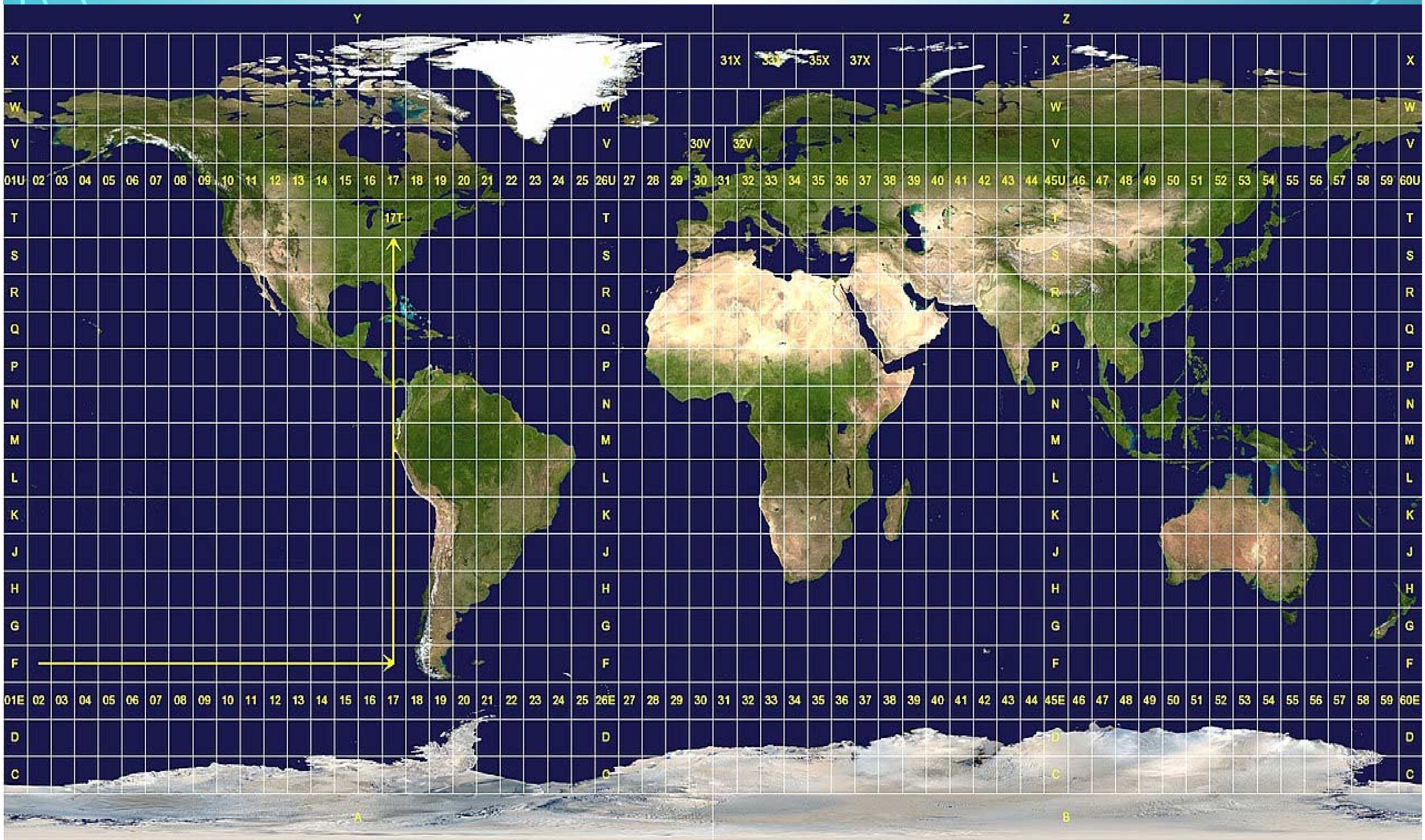
Lines of contact

- Two lines parallel to and approximately 180 km to each side of the central meridian of the UTM zone

Linear graticules

- The central meridian and the equator

UTM ZONES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THANKS