INTRODUCTION

MAP PROJECTION

MAP IS AN PICTORIAL REPRESENTATION OF WHOLE EARTH SURFACE GRAPHICALLY DISPLAYED ON PLANAR SURFACE.

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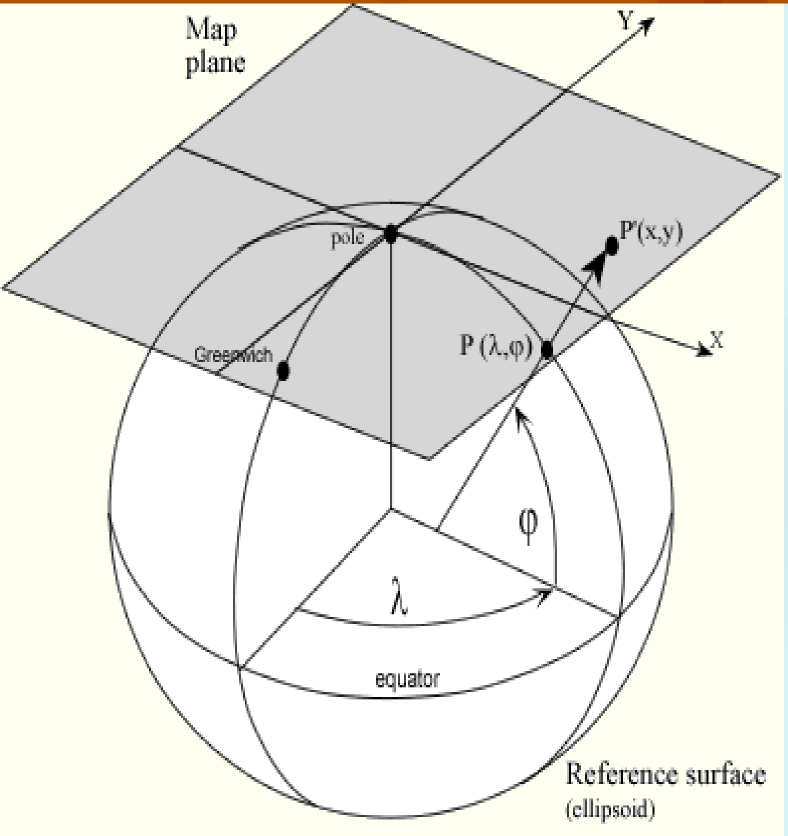
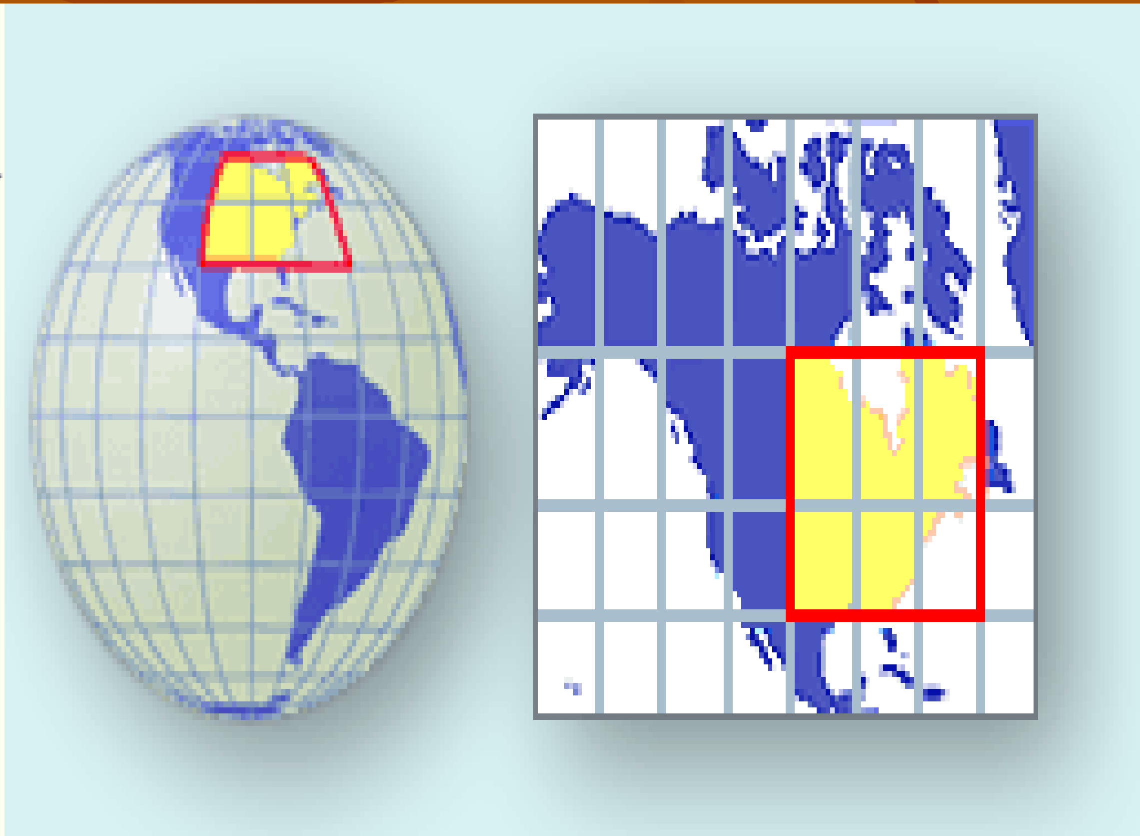
What is a Map Projection?

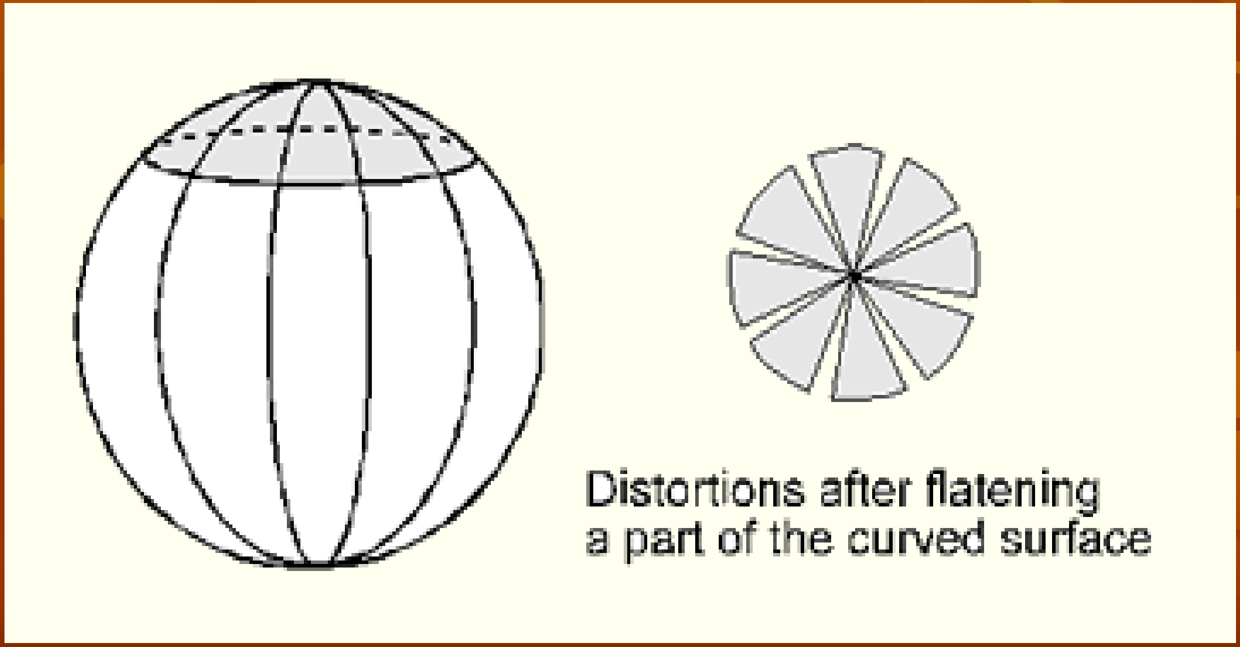
A map projection is a way to represent the curved surface of the Earth on the flat surface of a map.

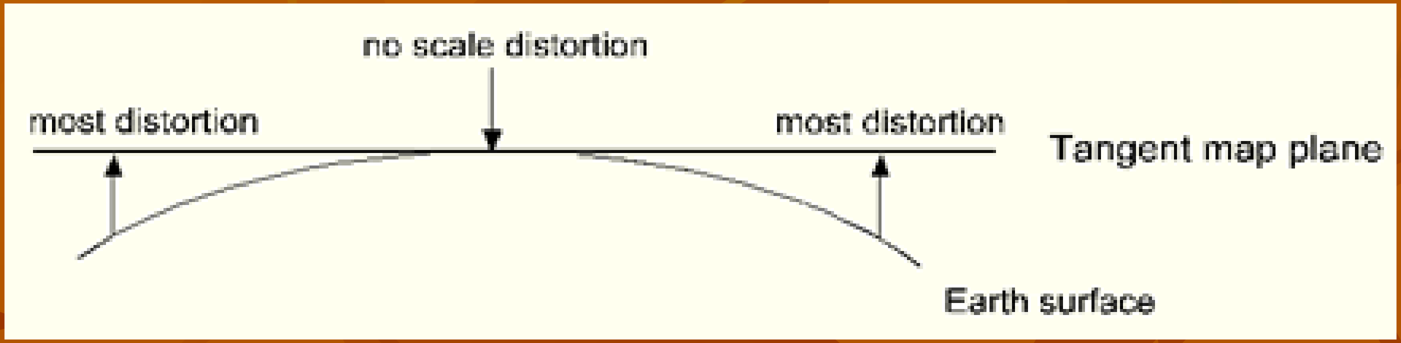




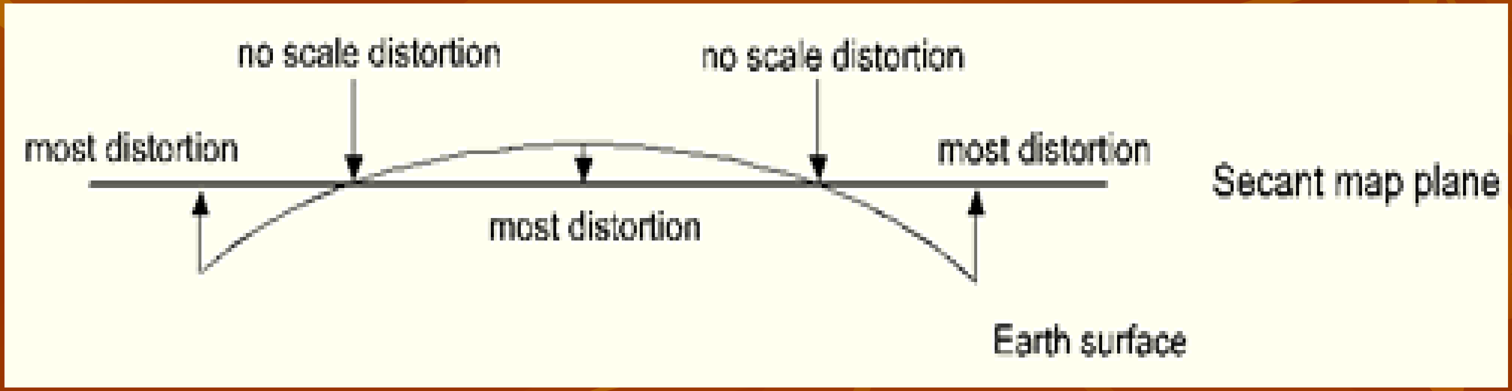
Scale distortions on a Map

- The transformation from the curved reference surface of the earth to the flat plane of the map is never completely successful.





- The distortions increase as the distance from the central point of the projection increases. Placing the map plane so that it intersects the reference surface will reduce and mean out the scale errors.



SCALE DISTORTION

can be shown on a map by a scale factor.

A scale factor is smaller than 1 indicates that the scale is smaller than the **nominal scale**, the scale given on the map.

A scale factor is larger than one indicates that the scale is larger than the nominal scale.

Properties of Map Projections

- Areas are everywhere correctly represented .
- All distances are correctly represented.
- All directions on the map are the same as on Earth.
- All angles are correctly represented.
- The shape of any area is correctly represented
- It is, unfortunately, impossible to have all these properties together in one map projection .

The process of transferring information from the Earth to a map causes every projection to distort at least one aspect of the real world –

- shape,
- area,
- distance, or
- direction.

Classification

- **property** (*equivalence*, *equidistance*, *conformality*),
- **class** (*azimuthal*, *cylindrical*, *conical*).
- **aspect** (*normal*, *transverse*, *oblique*).

CLASSIFICATION

1. According to the geometric construction: -

   * Conical map projection.

   * Cylindrical map projection.

   * Perspective map projection.

   * Azimuthal map projection.

According to the spatial properties :

i) Conformal projection : -

* Mercator map projection.

* Transverse mercator map projection.

* Lamberts conformal conical map projection.

* Stereographic conformal map projection.

ii) Equal-area projection :

* Albers equal area map projection.
* Lamberts equal area map projection.
* Cylindrical equal area map projection.
* Sinusoidal map projection.
* Mollweides map projection.
* Goode's map projection.
* Azimuthal equal area map projection.

iii) Azimuthal map projection :

* Azimuthal equidistant map projection.

* Orthographic map projection.

* Gnomonic map projection.

iv) Other systems of map projection :

* Plane chart map projection.

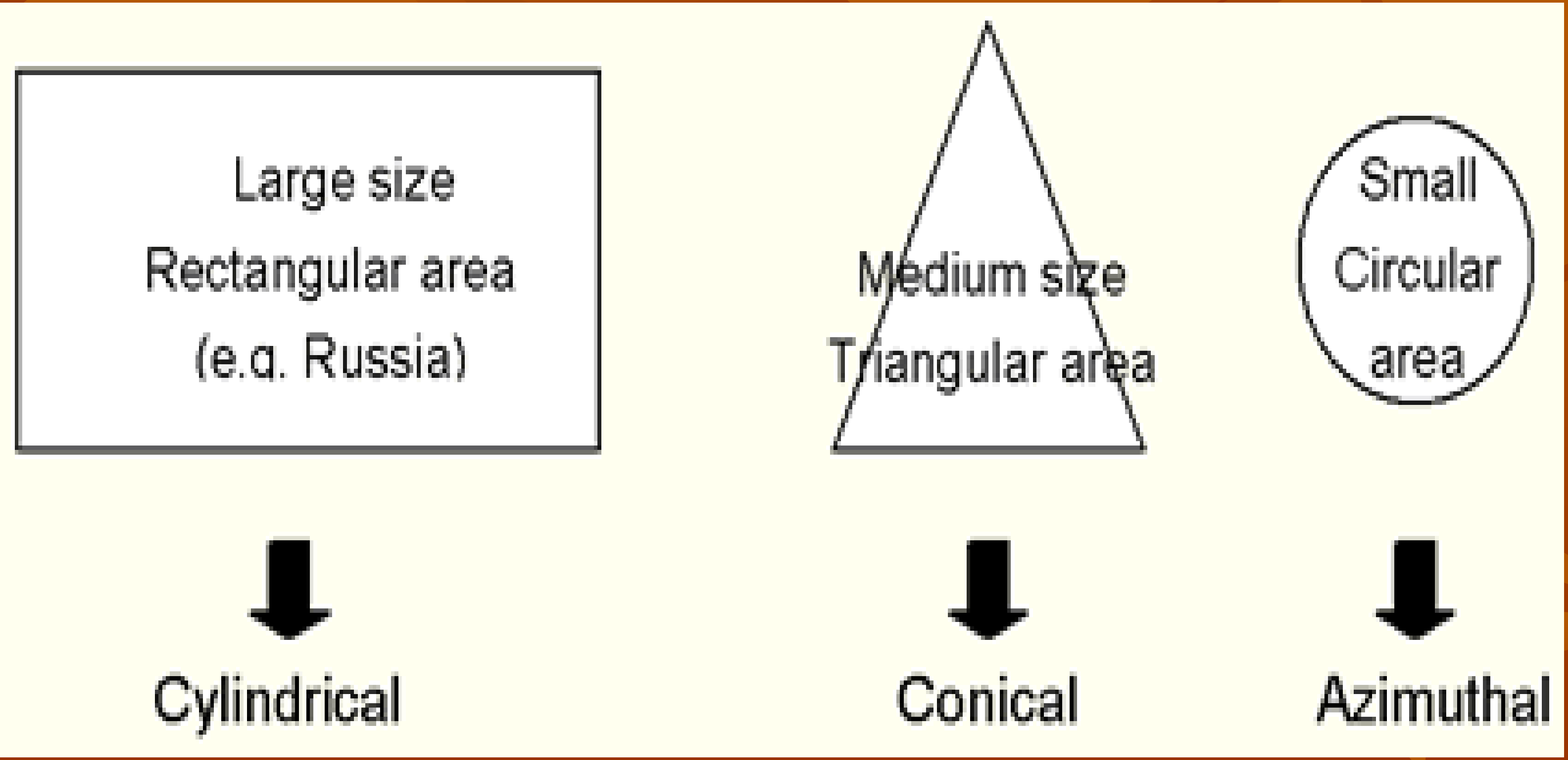
* Polyconic map projection.

* Space oblique mercator map projection.

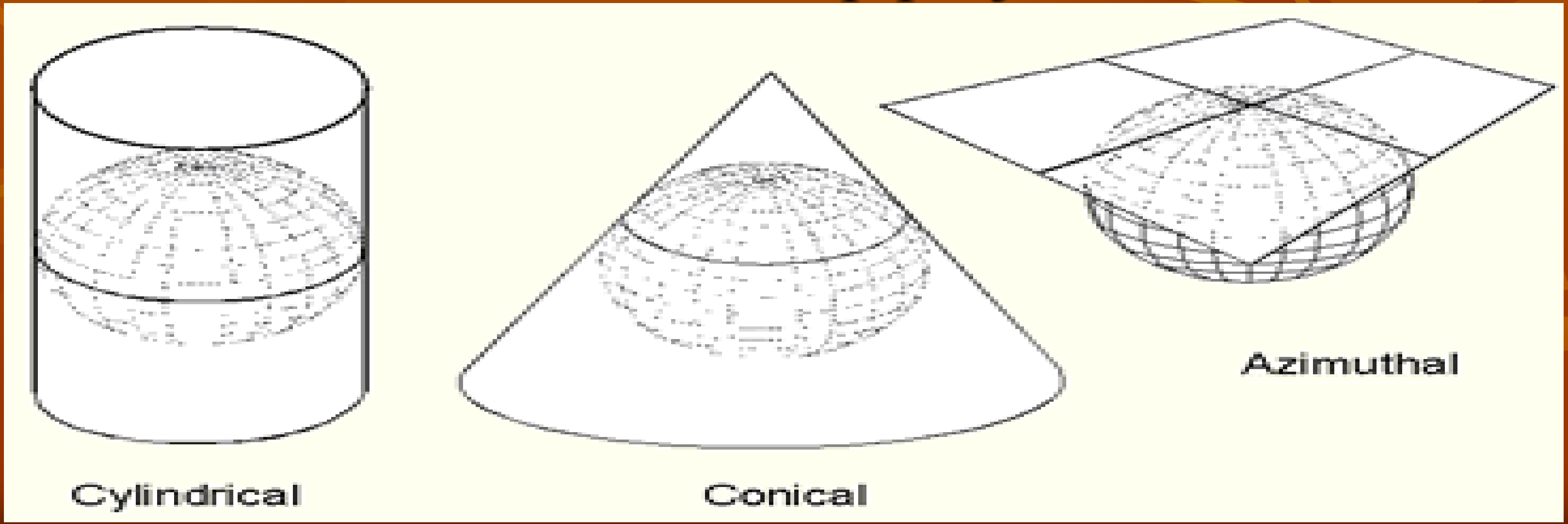
Selecting a suitable Map Projection

- Shape and Size of the area.
- Position of the area.
- Purpose of the map.

The choice of the **class** of a map projection should be made on the basis of the ***shape and size of the geographical area*** to be mapped.

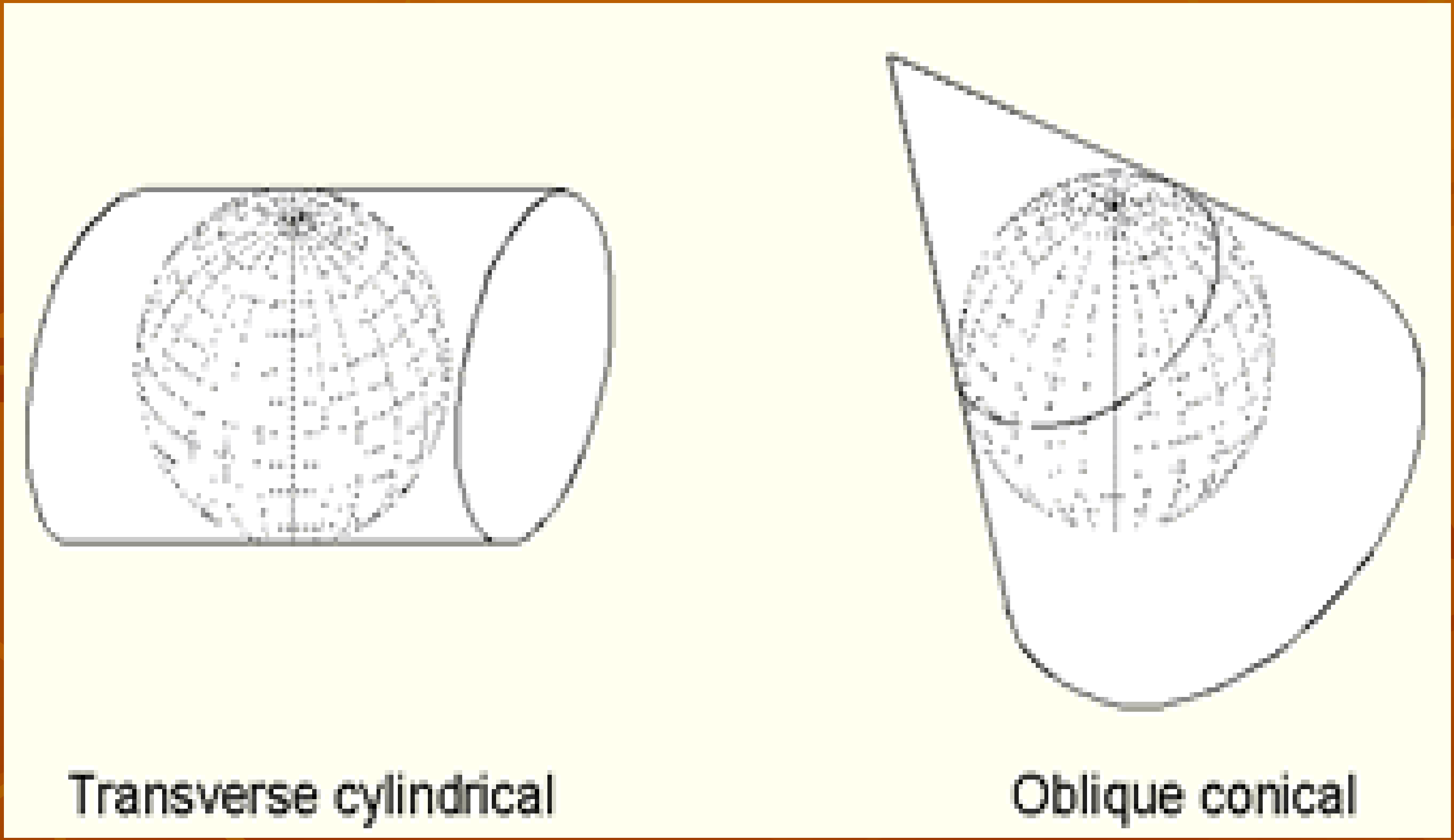


- The earth's surface projected on a map wrapped around the globe as a cylinder produces the **cylindrical** map projection.
- Projected on a map formed into a cone gives a **conical map** projection.
- When projected on a planar map it produces an **azimuthal** or ***zenithal*** map projections.



Projections can also be described in terms of their aspect

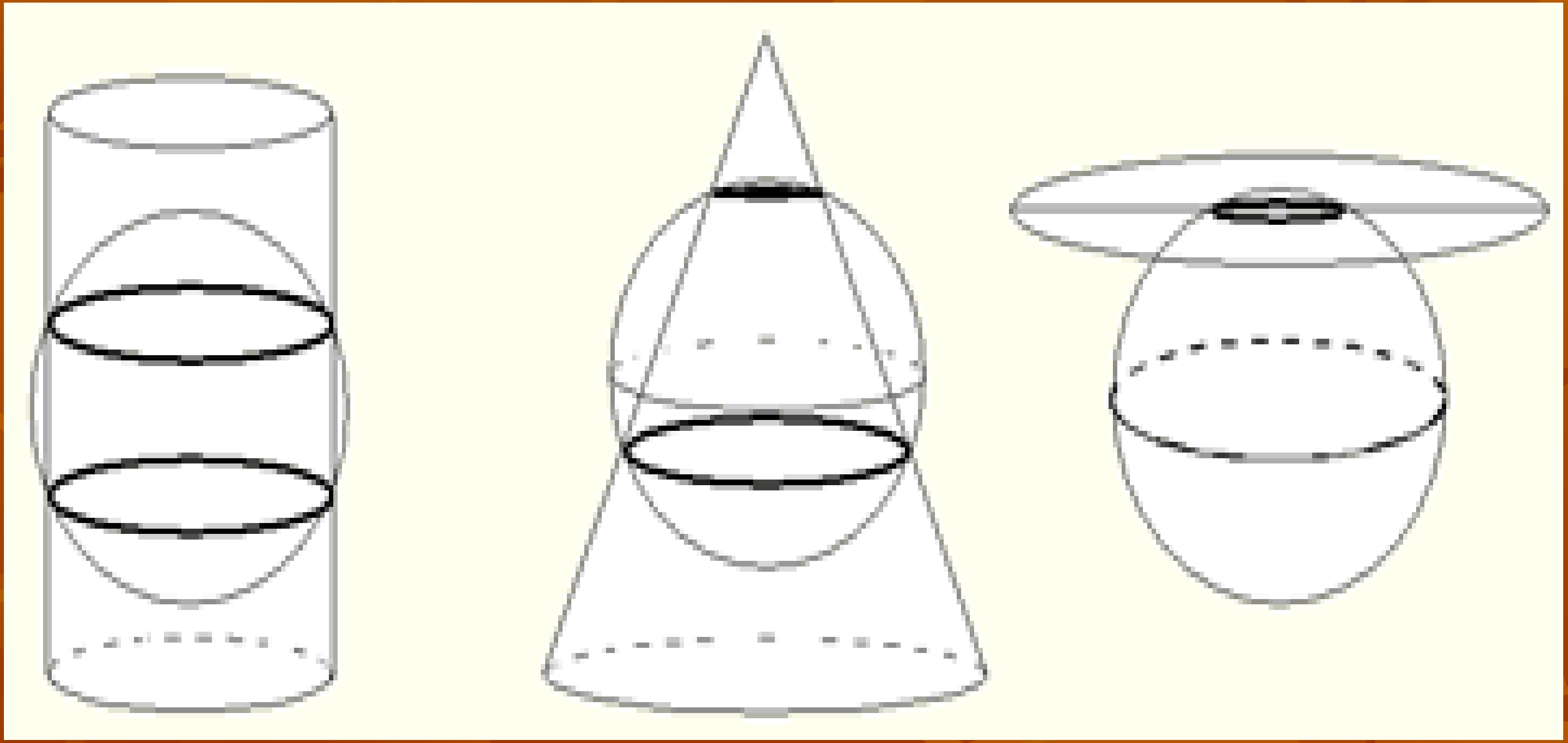
- The three possible aspects of a map projection are **normal**, **transverse** and **oblique**.
- In a normal projection, the main orientation of the projection surface is parallel to the earth's axis .
- A transverse projection has its main orientation perpendicular to the earth's axis.



A transverse cylindrical and an oblique conical map projection. Both are tangent to the reference surface

- The terms *polar*, *oblique* and *equatorial* are also used. In a polar azimuthal projection the projection surface is tangent or secant at the pole.
- In a equatorial azimuthal or equatorial cylindrical projection, the projection surface is tangent or secant at the equator.
- In an oblique projection the projection surface is tangent or secant anywhere else.

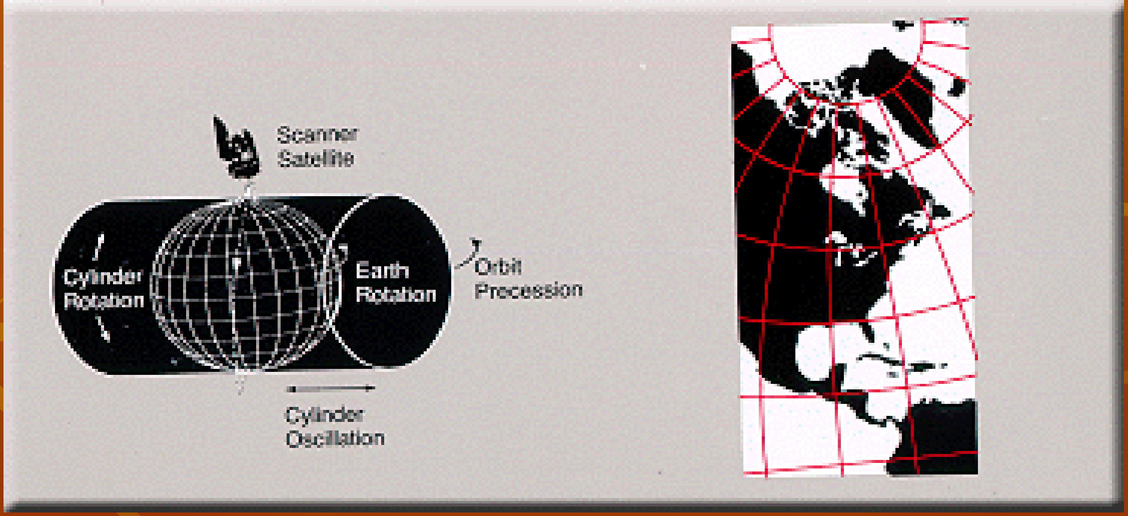
- A map projection can be tangent to the globe, meaning that it is positioned so that the projection surface just touches the globe. Alternatively, it can be secant to the globe, meaning that the projection surface intersects the globe.



Three normal secant projections: cylindrical, conical and azimuthal.

CYLINDRICAL PROJECTION

The projection in which meridian are mapped to equally spaced vertical lines and circle of latitude (parallels) are mapped to horizontal lines.



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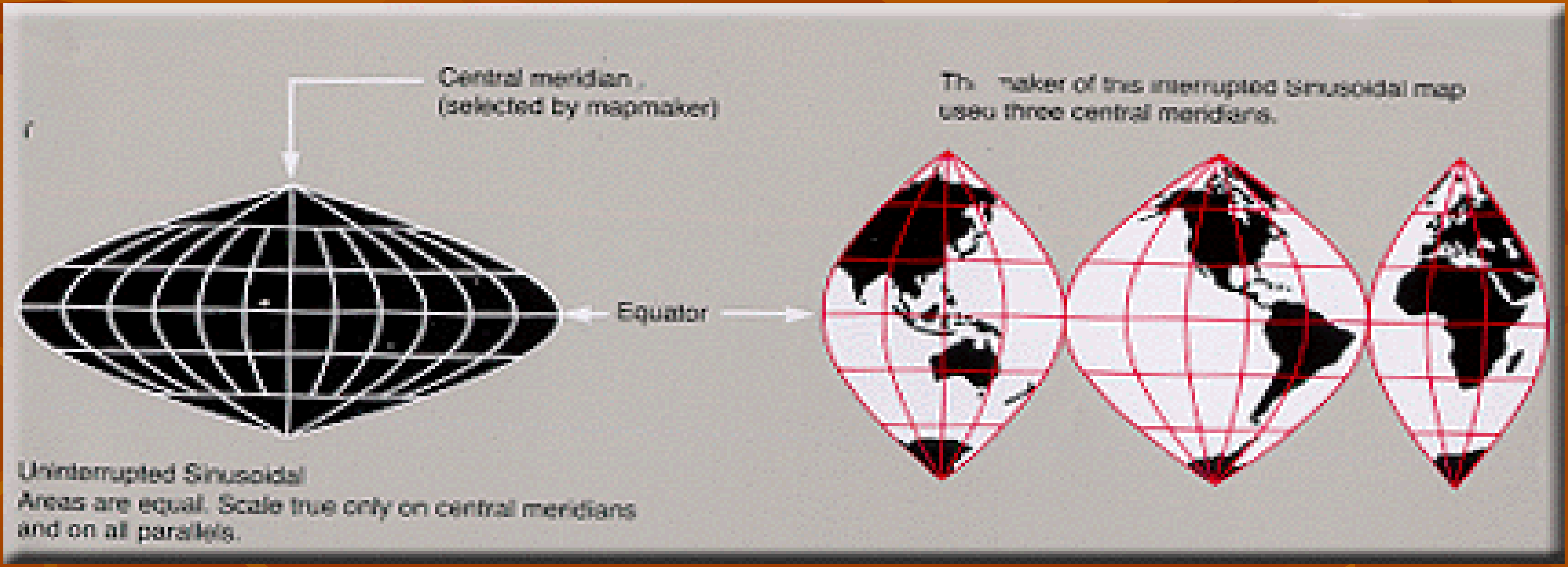
A map projection where the Earth's surface is projected onto a tangent or secant cylinder, which is then cut lengthwise and laid flat.

- On equator distortion is less but near the poles it is more.
- East-west stretching away from the equator.

PSEUDO CYLINDRICAL

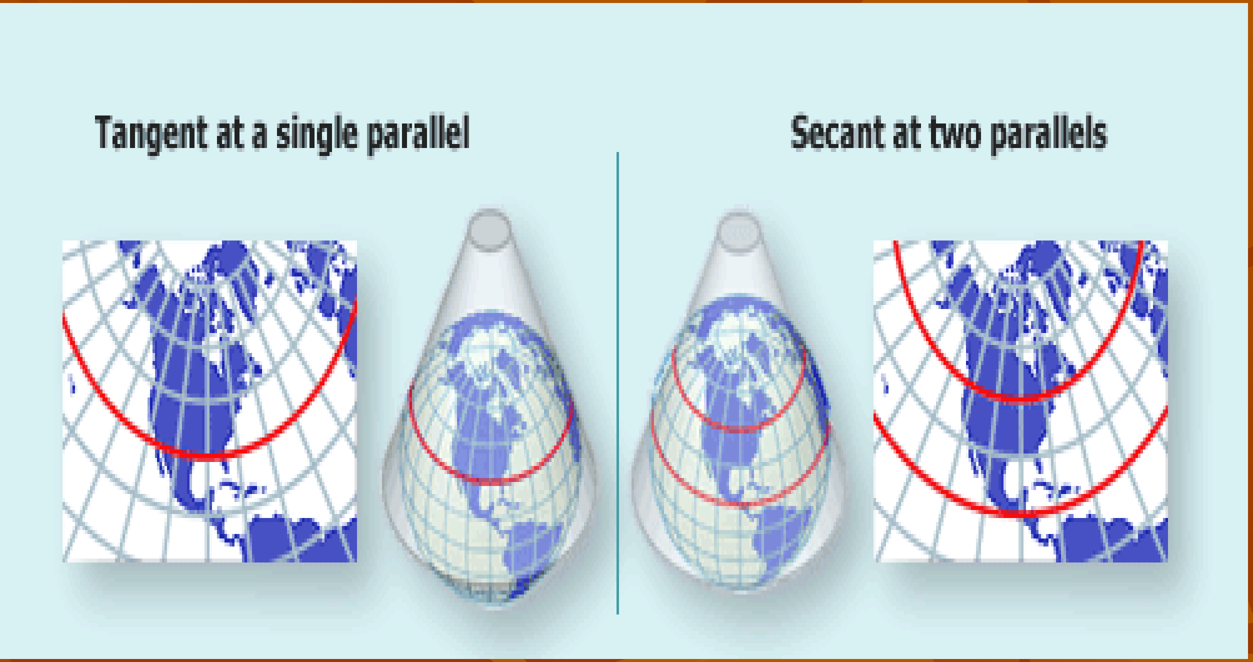
This projections represent the *central* meridian and each parallel as a straight line segment, but not the other meridians.



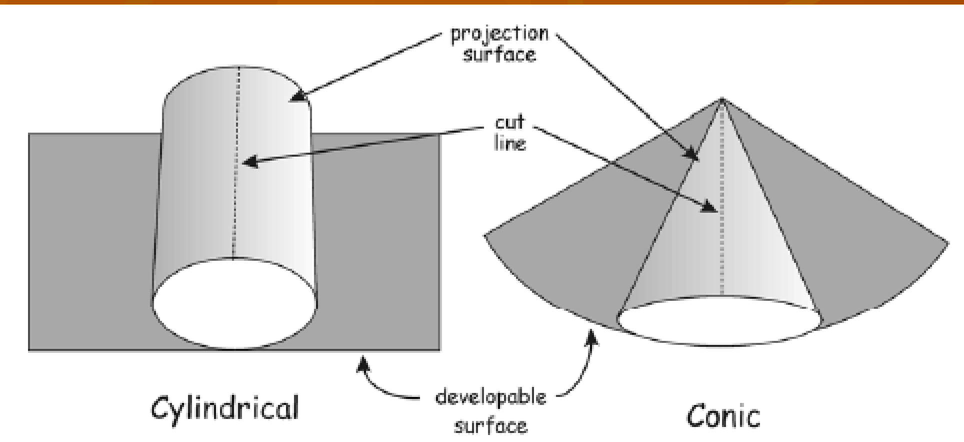
- A point on the Earth along the straight line representing its parallel, at a distance which is a function of its difference in longitude from the central meridian.

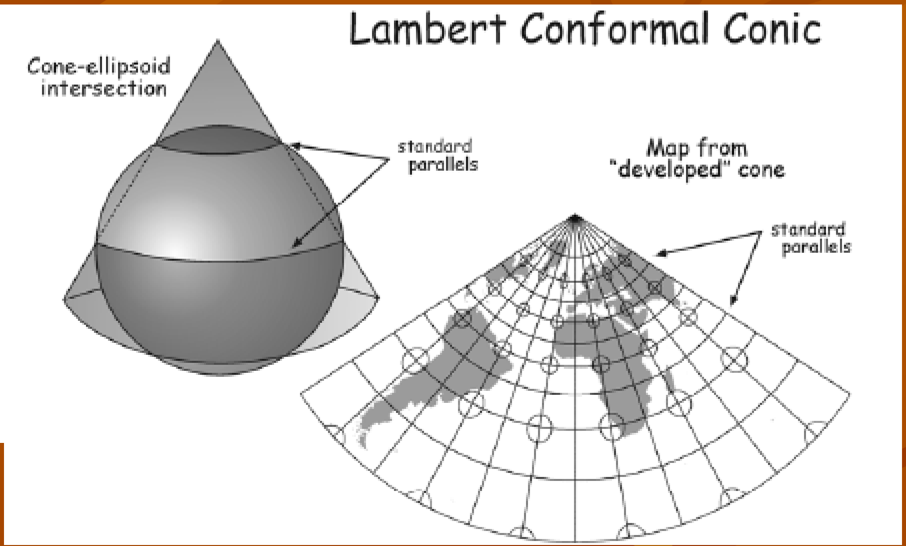
Conical map projection

A map projection where the Earth's surface is projected onto a tangent or secant cone, which is then cut from apex to base and laid flat.



CONICAL PROJECTION





A map is relatively free of distortion in the middle latitude region.

- ❖ It is useful for viewing countries that fall in the middle latitude region.

Perspective Projection

Perspective projections are classified based on the projection center or viewpoint .

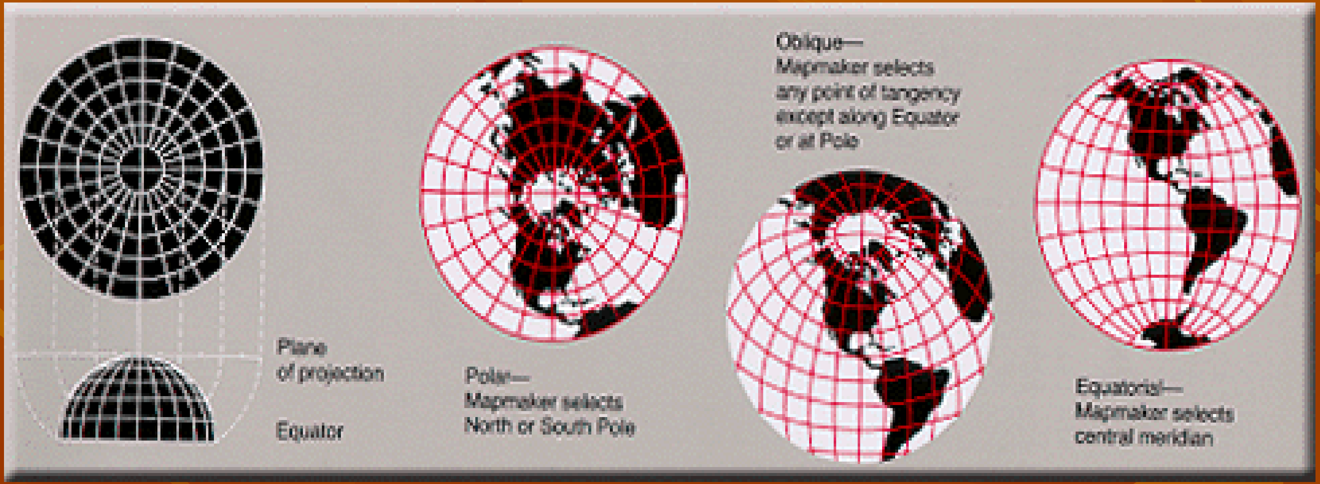
One of the most popular perspective projections is polar stereo projection with the projection plane tangent to the north or South Pole and the viewpoint at the opposite pole.

This polar stereo projection is used in NOAA GVI (Global Vegetation Index) data for global study.

It is not suitable for representing small areas.

AZIMUTHAL PROJECTION

In this projection distances and directions accurate from the center point, but distorts shapes and sizes elsewhere.



❖ Useful for the polar region of the world because the poles usually appears near the center of the map.

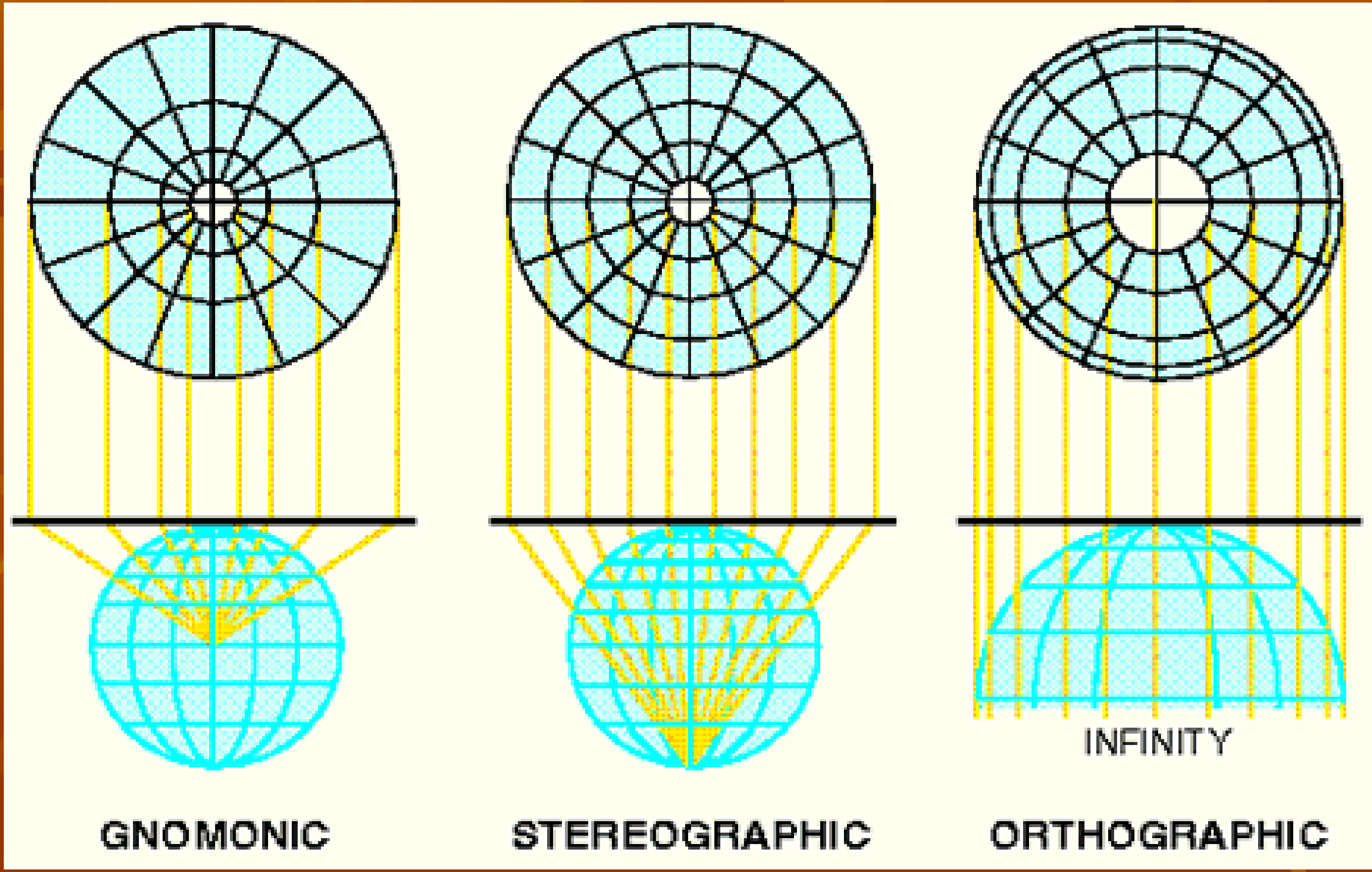
Azimuthal projections

- The five common azimuthal (also known as Zenithal) projections are the -
- *Stereographic* projection, the *Orthographic* projection,
- the *Lambert azimuthal equal-area* projection,
- the *Gnomonic* projection and
- the *azimuthal equidistant* projection.

- For the *Gnomonic* projection, the perspective point (like a source of light rays), is the centre of the Earth.

- For the Stereographic this point is the opposite pole to the point of tangency, and

- for the Orthographic the perspective point is an infinite point in space on the opposite side of the Earth.


INFINITY
GNOMONIC
STEREOGRAPHIC
ORTHOGRAPHIC

Stereographic projection

- The Stereographic projection is a conformal azimuthal projection. All meridians and parallels are shown as circular arcs or straight lines. Since the projection is conformal, parallels and meridians intersect at right angles.
- In the polar aspect the meridians are equally spaced straight lines, the parallels are unequally spaced circles centered at the pole. Spacing gradually increases away from the pole.

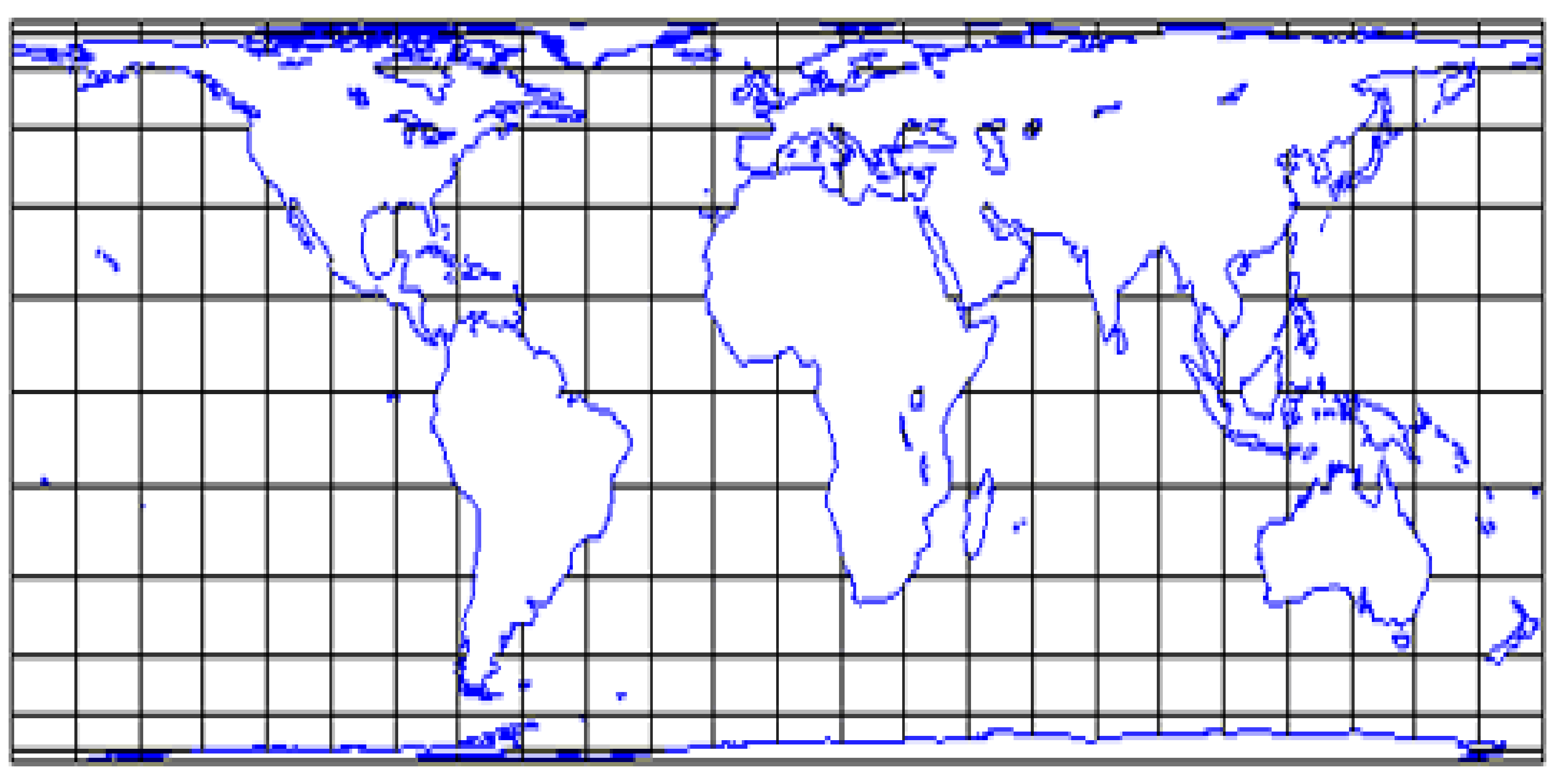
- The scale is constant along any circle having its centre at the projection centre, but scale increases moderately with distance from the centre.
- The areas increase with distance from the projection center. The ellipses of distortion remain circles (indicating conformality).
- The Stereographic projection is commonly used in the polar aspect for topographic maps of polar regions. Recommended for conformal mapping of regions approximately circular in shape (e.g. The Netherlands)

EQUAL AREA PROJECTION

An **equivalent** map projection, also known as an **equal-area** map projection, correctly represents areas sizes of the sphere on the map. When this type of projection is used for small-scale maps showing large regions, the distortion of angles and shapes is considerable.

The Lambert cylindrical equal-area projection is an example of an equivalent map projection.

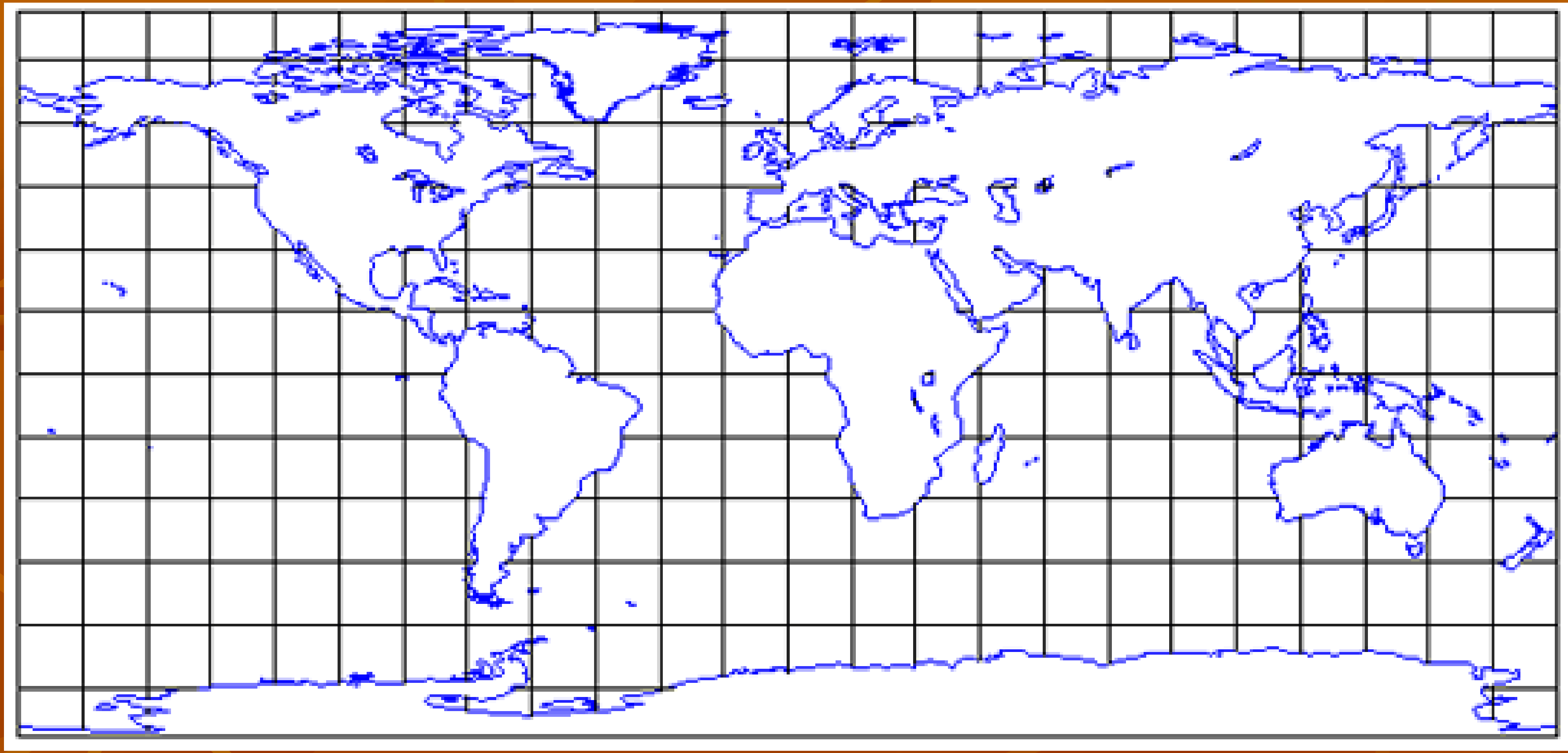
It preserves area.



Equal-area map projection

Equidistant map projection

- An **equidistant** map projection correctly represents distances.
- If the scale on a map is correct along all meridians, the map is *equidistant along the meridians*
- If the scale on a map is correct along all parallels, the map is *equidistant along the parallels.*



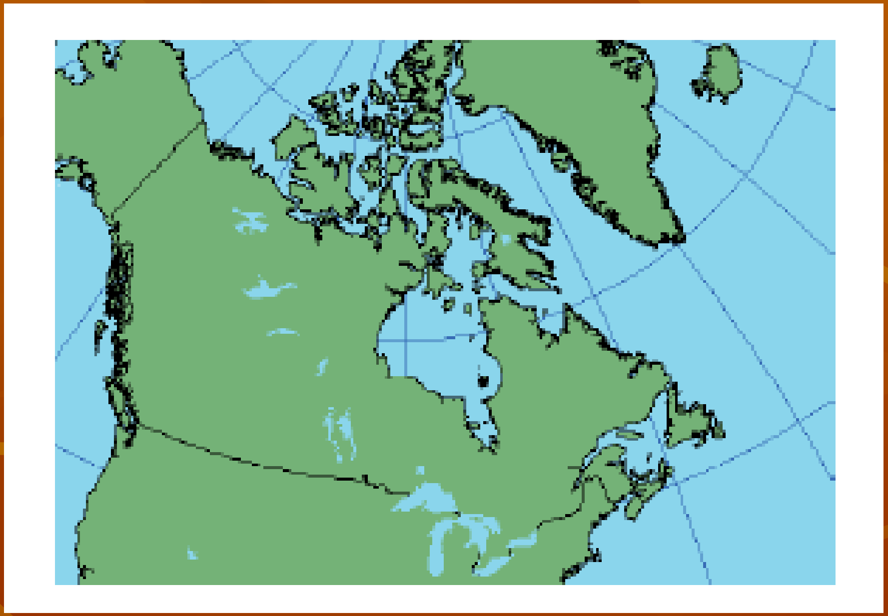
Equidistant **map projection**

A conformal **map projection**

- A **conformal** map projection represents angles and shapes correctly at infinitely small locations.
- Shapes and angles are only slightly distorted, as the region becomes larger. At any point the scale is the same in every direction.
- On a conformal map projection meridians and parallels intersect at right angles (e.g. Mercator projection).

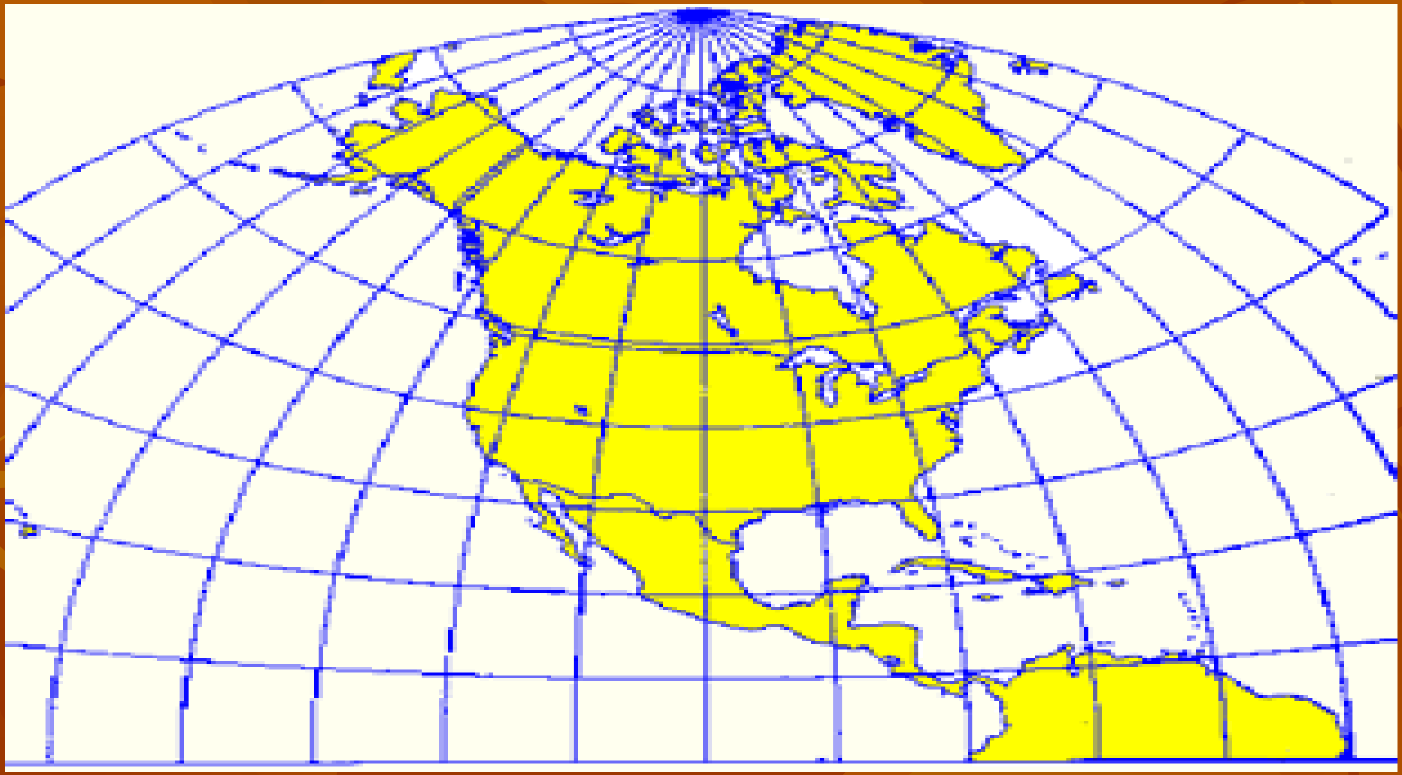
POLYCONIC PROJECTION

A series of successive cones produce a polyconic projection.



- ❖It is conical projection.
- ❖The cones are assumed to in normal position.
- ❖In terms of intrinsic properties of a polyconic projection is equivalent and is geometric in nature for a given parallel.
- ❖It is used for large and medium scale mapping.

The Polyconic projection is neither conformal nor equal-area. The polyconic projection is projected onto cones tangent to each parallel, so the meridians are curved, not straight



The polyconic projection is an example of a conic projection, equidistant along the parallels

Contd…………..

- The scale is true along the central meridian and along each parallel. The distortion increases away from the central meridian in East or West direction.
- The polyconic projection is used for early large-scale mapping of the United States until the 1950's, early coastal charts by the U.S. Coast and Geodetic Survey, early maps in the International Map of the World (1:1,000,000 scale) series and for topographic mapping in some countries (ie.India).

Mercator Map Projection

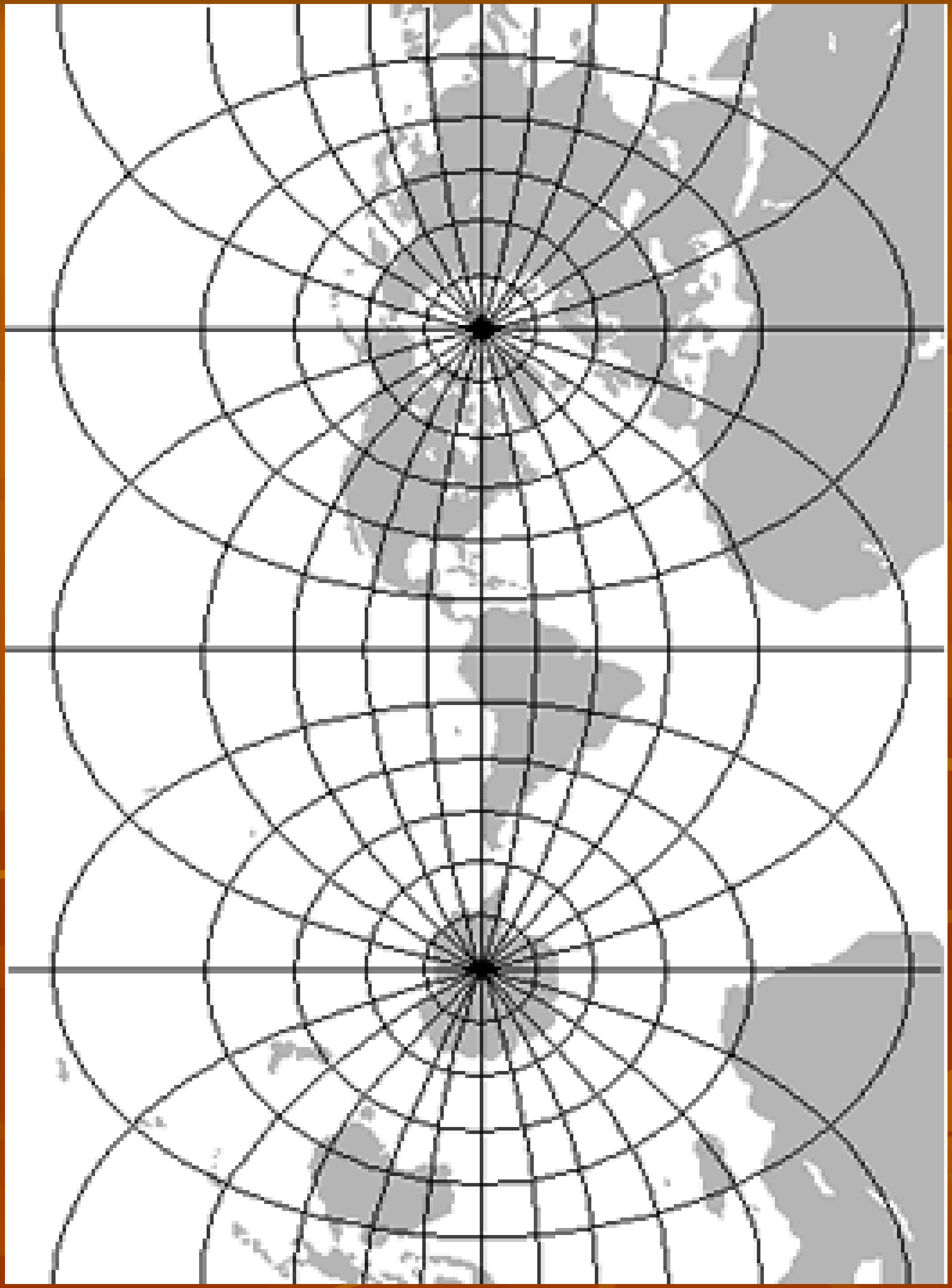
The Mercator projection has straight meridians and parallels that intersect at right angles.

Scale is true at the equator or at two standard parallels equidistant from the equator.

The projection is often used for marine navigation because all straight lines on the map are lines of constant azimuth.

Transverse Mercator Projection

- Transverse Mercator projections result from projecting the sphere onto a cylinder tangent to a central meridian. Transverse Mercator maps are often used for areas with larger north-south than east-west extent. Distortion of scale, distance, direction and area increase away from the central meridian.
- . The Transverse Mercator projection is also known as the Gauss-Kruger or Gauss Conformal projection.



World map in Transverse Mercator projection.

Oblique Mercator

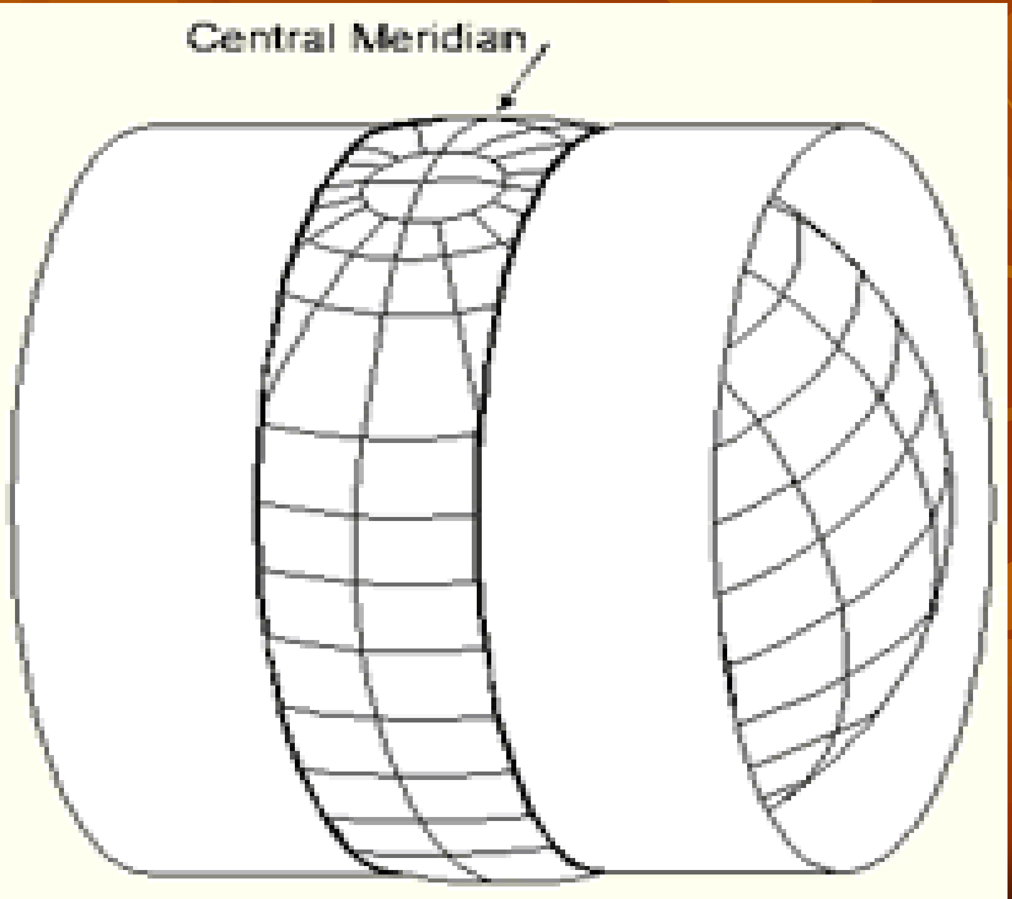
- Oblique Mercator projections are used to portray regions along great circles.
- Distances are true along a great circle defined by the tangent line formed by the sphere and the oblique cylinder, in another place distance, shape, and areas are distorted.
- Once used to map Landsat images (now replaced by the Space Oblique Mercator), this projection is used for areas that are long, thin zones at a diagonal with respect to north, such as Alaska State Plane Zone 5001.

Space Oblique Mercator

- The Space Oblique Mercator is a projection designed to show the curved ground-track of Landsat images.
- There is little distortion along the ground-track but only within the narrow band (about 15 degrees) of the Landsat image.

The UTM projection

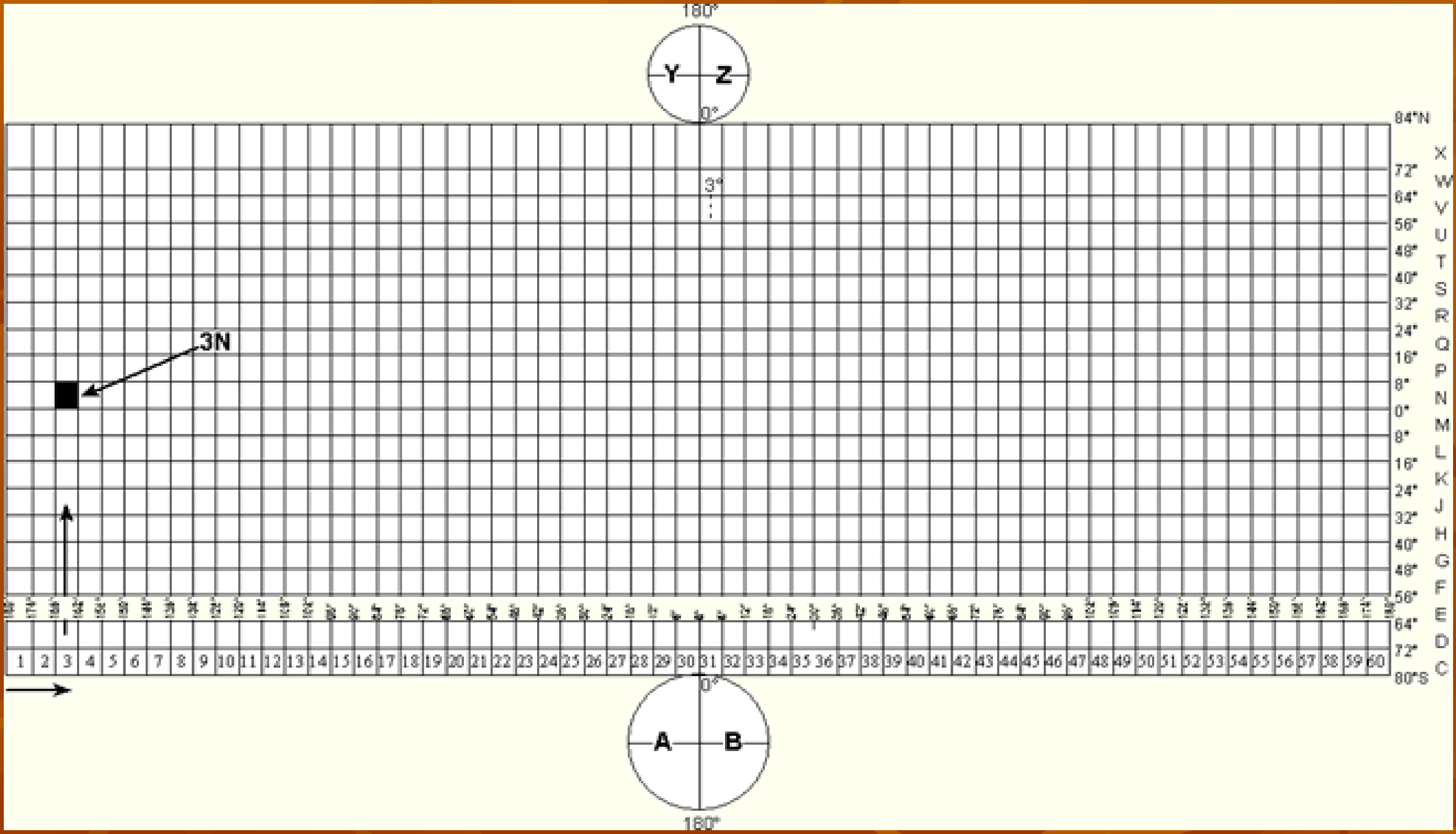
is a projection accepted worldwide for topographic mapping purposes. It is a version of the Transverse Mercator projection, but one with a transverse secant cylinder.



The UTM projection is designed to cover the world, excluding the Arctic and Antarctic regions.

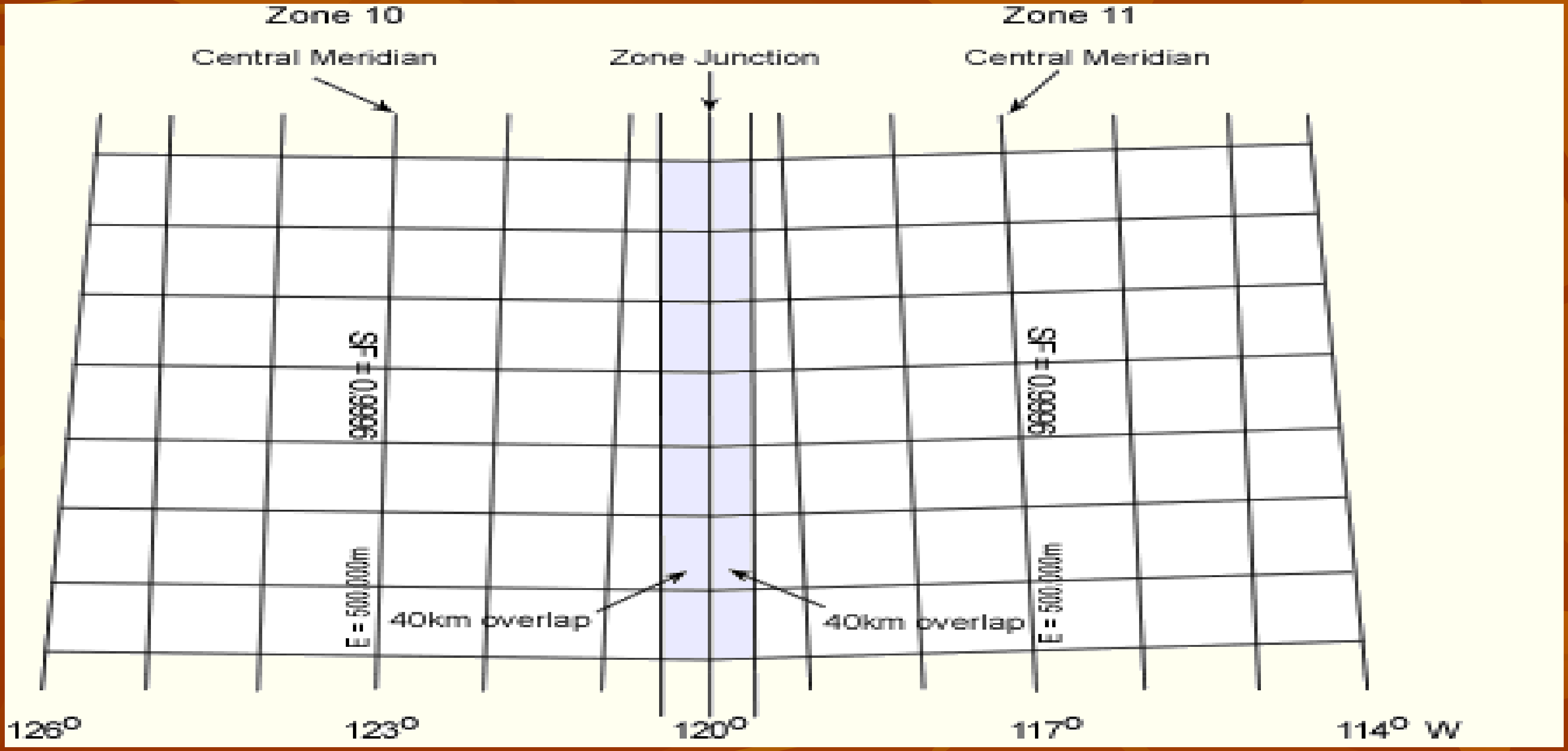
To keep scale distortions within acceptable limits, 60 narrow, longitudinal zones of six degrees longitude in width are defined and numbered from 1 to 60. The figure below shows the UTM zone numbering system.

Shaded in the figure is UTM grid zone 3 N which covers the area 168^o - 162^o W (zone number 3), and 0^o - 8^o N (letter N of the latitudinal belt).



The UTM zone numbering system

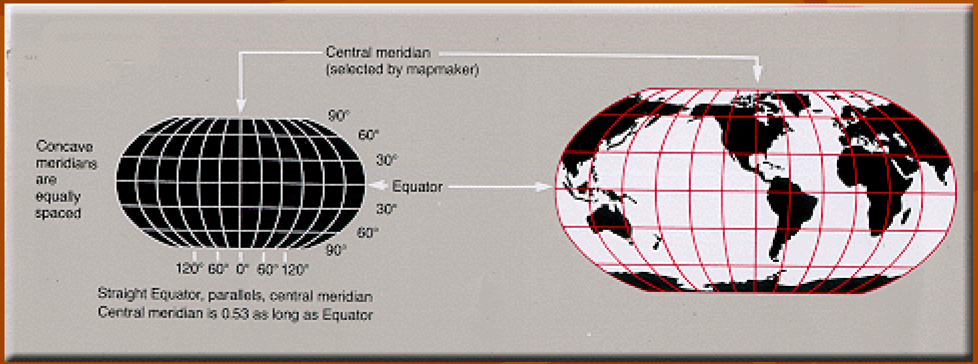
Each zone has it's own central meridian. Along each central meridian, the scale is 0.9996. The central meridian is always given an Easting value of 500,000 m; to avoid negative coordinates sometimes large values are added to the origin coordinates, called false coordinates. For positions north of the equator, the equator is given a Northing value of 0m. For positions south of the equator, the equator is given a (false) Northing value of 10,000,000 m.



2 adjacent UTM-zones of 6 degrees longitude

ROBINSON PROJECTION

The **Robinson projection** is a map projection used for geographic maps. It is an example of a pseudo cylindrical, or orthophanic projection.



- ❖The projection is neither equal-area nor conformal.
- ❖Distortion close to the poles is severe but quickly declines to moderate levels moving away from them.
- ❖It is used in many atlases and books.

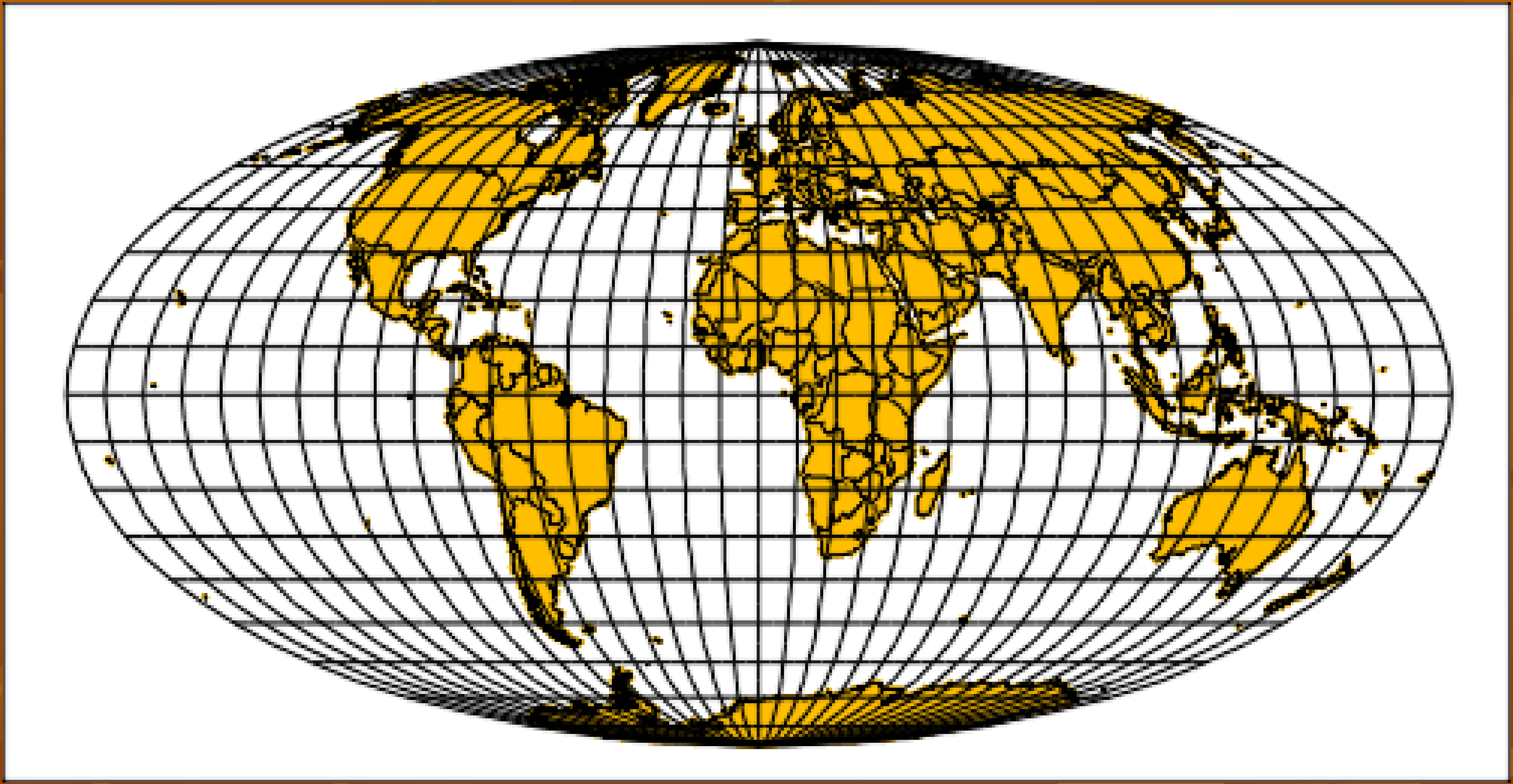
Mollweide projection

The Mollweide is another conventional equivalent projection.

On this projection, the entire Earth is represented within an ellipse. Parallels of latitude are straight lines parallel to the Equator.

The spacing of parallels along the central meridian is calculated to ensure that all areas on the map are equal to the corresponding areas on the globe.

Distortion is minimal near the intersection of the Equator and the central meridian and increases toward the edges of the map.



Mollweide projection

THANK YOU