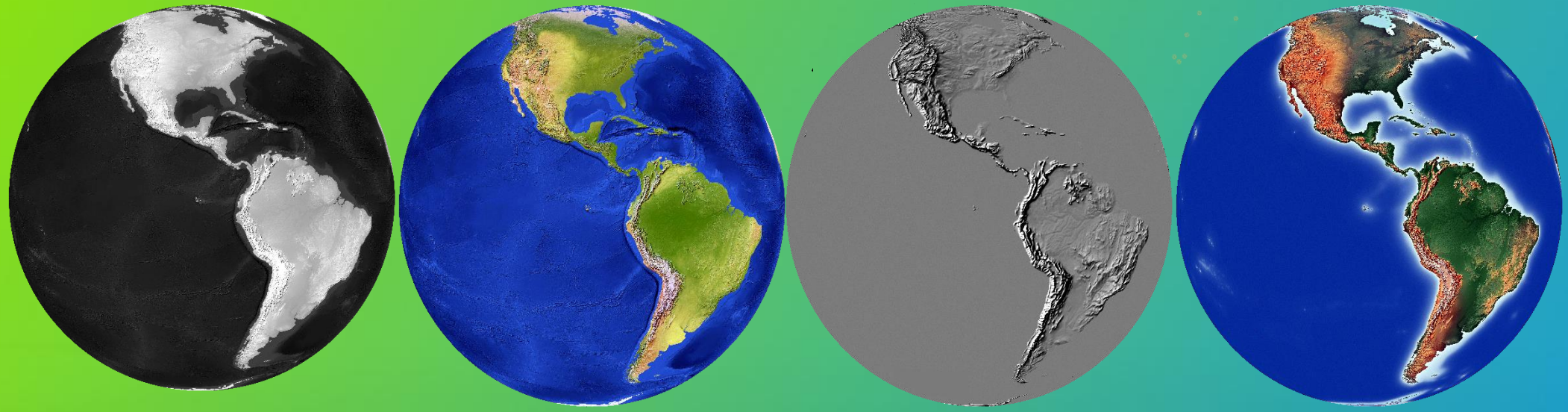


Coordinate Systems and Map Projections

Mehran Ghandehari

Medici Land Governance

MEDICI LAND GOVERNANCE

MEDICI LAND
GOVERNANCE

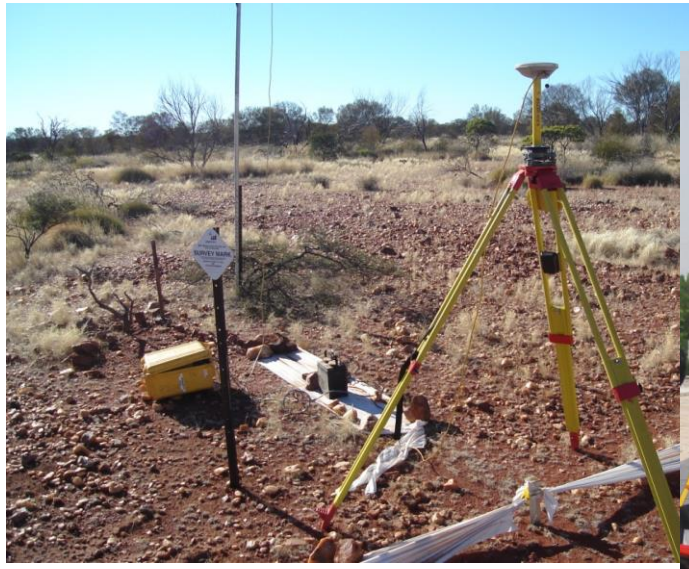
GeoInformation

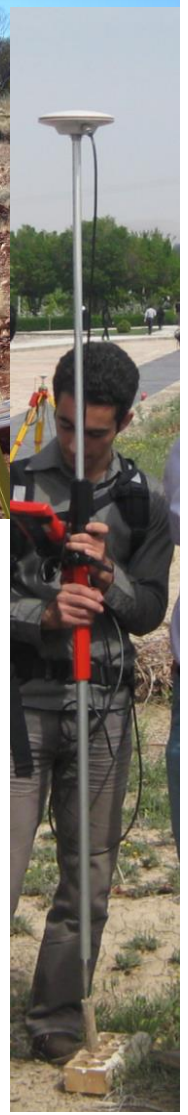
- Surveying
- Photogrammetry and Remote Sensing
- Geodesy
- GIS

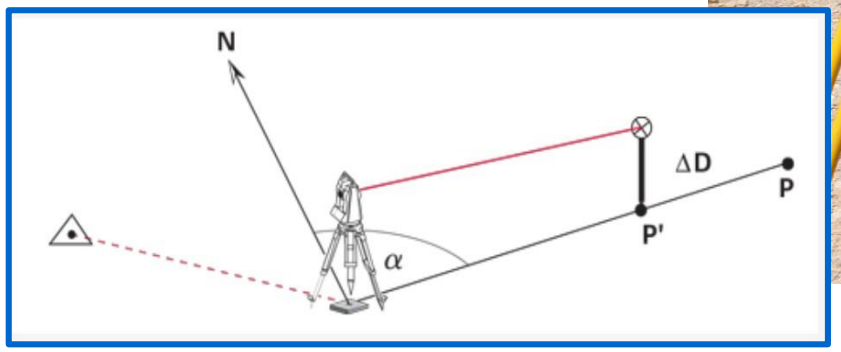
MEDICI LAND GOVERNANCE

GeoInformation

- Surveying
  - Precise Positioning







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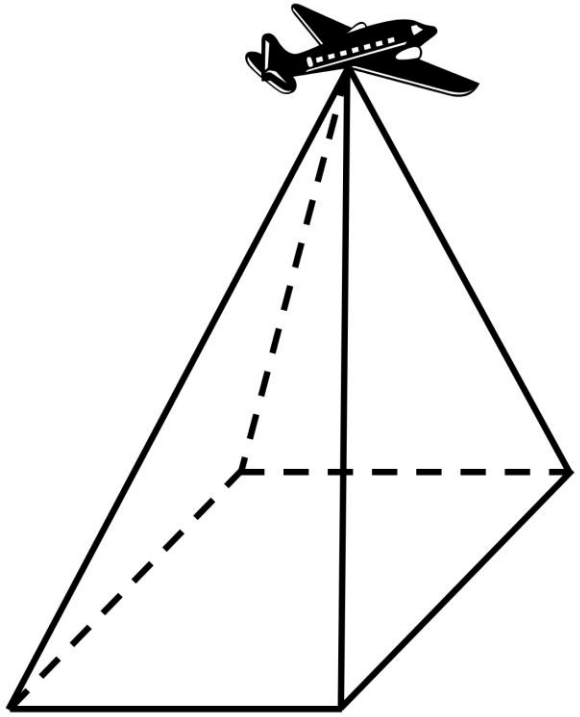
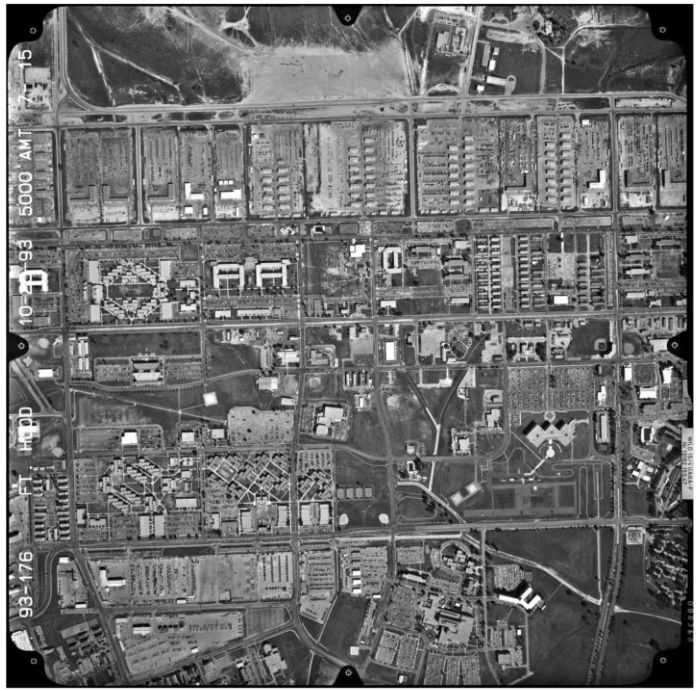
GeoInformation

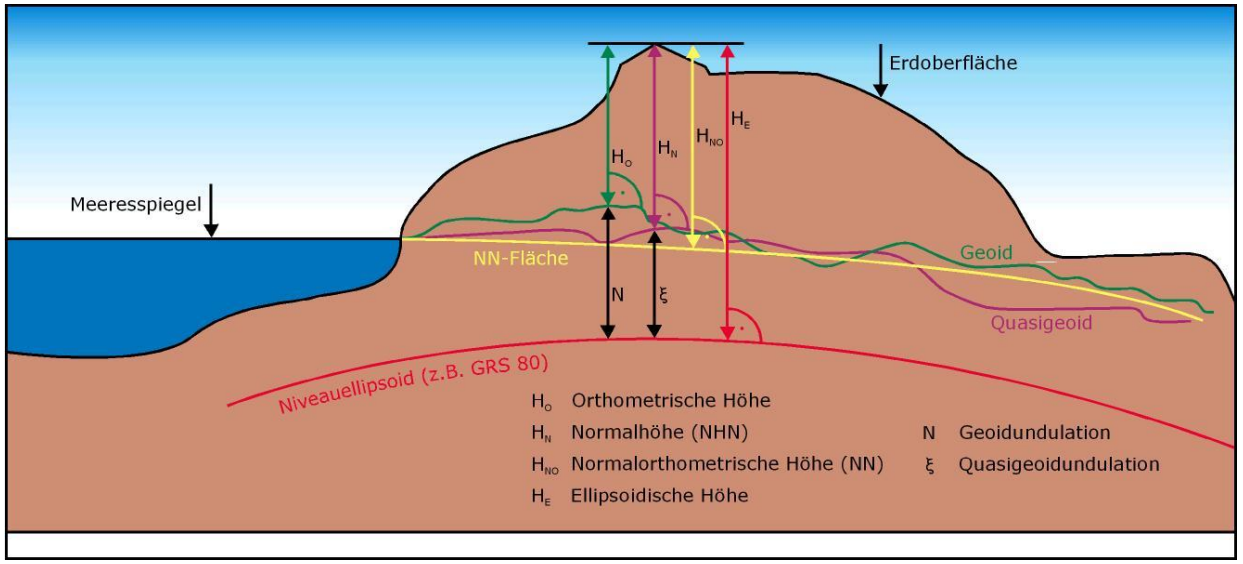
- Photogrammetry and Remote Sensing

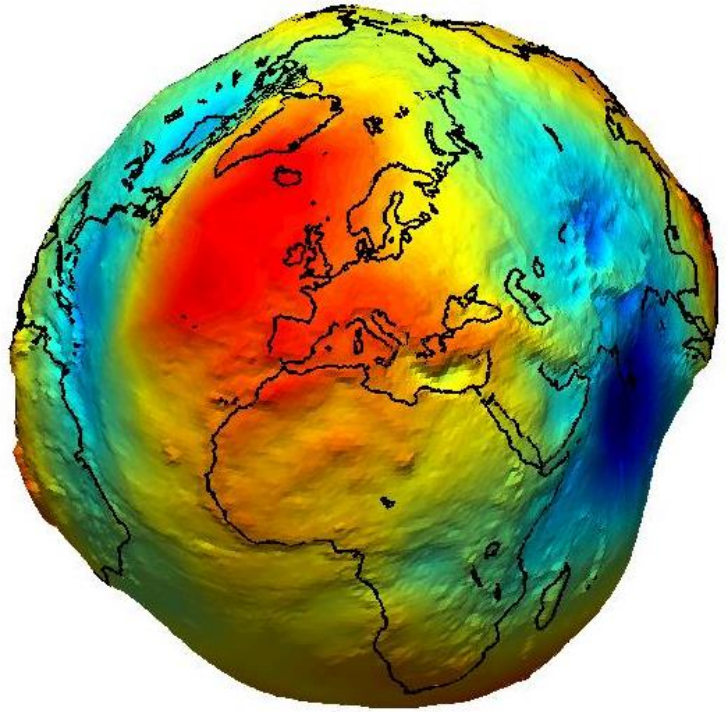




GeoInformation

- Geodesy: Geodesy is concerned with measuring the size and shape of the Earth.





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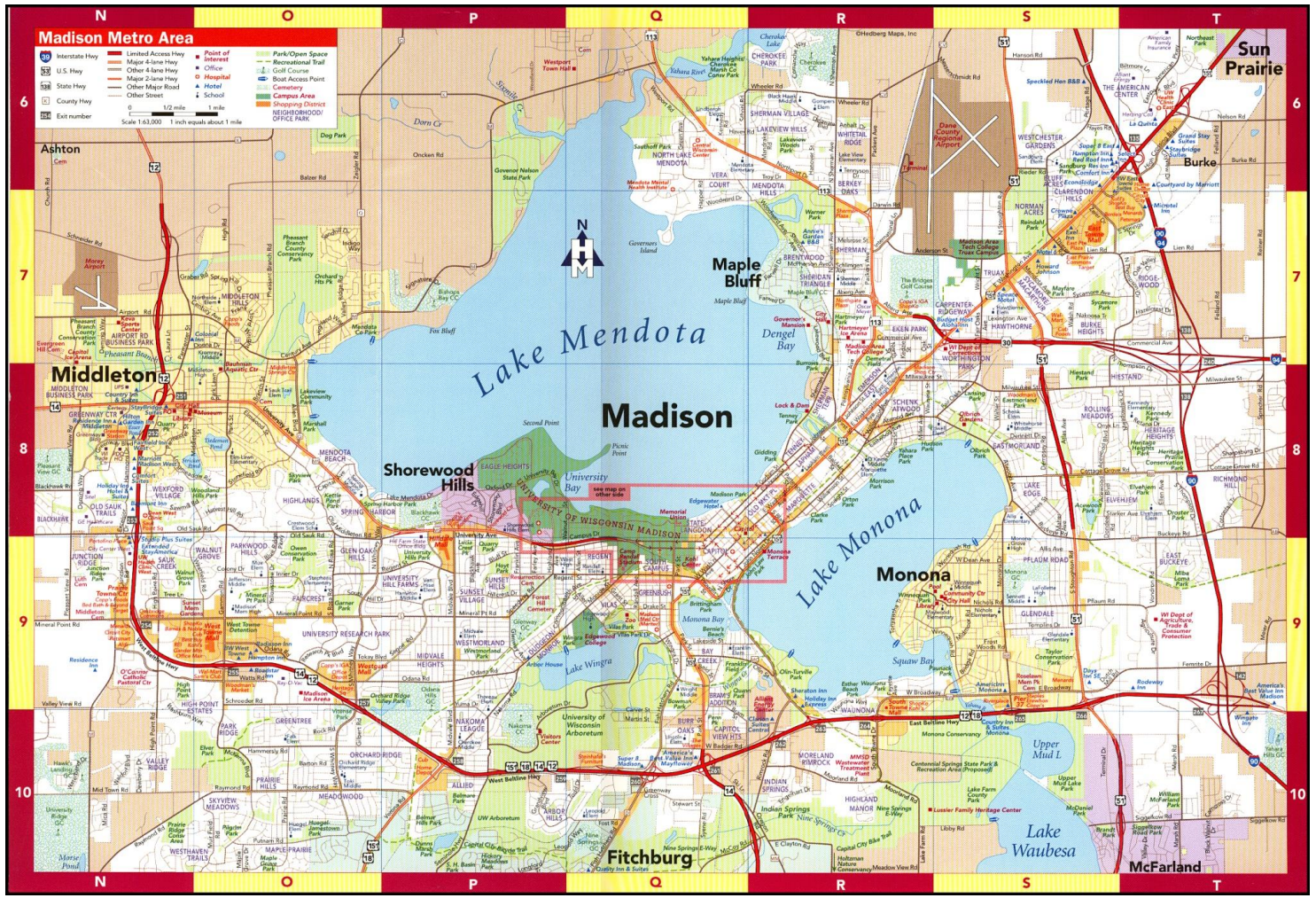
GeoInformation

- GIS

  GIS stands for Geographic Information system. GIS is used to gather, manipulate, analyze, and visualize spatial data.



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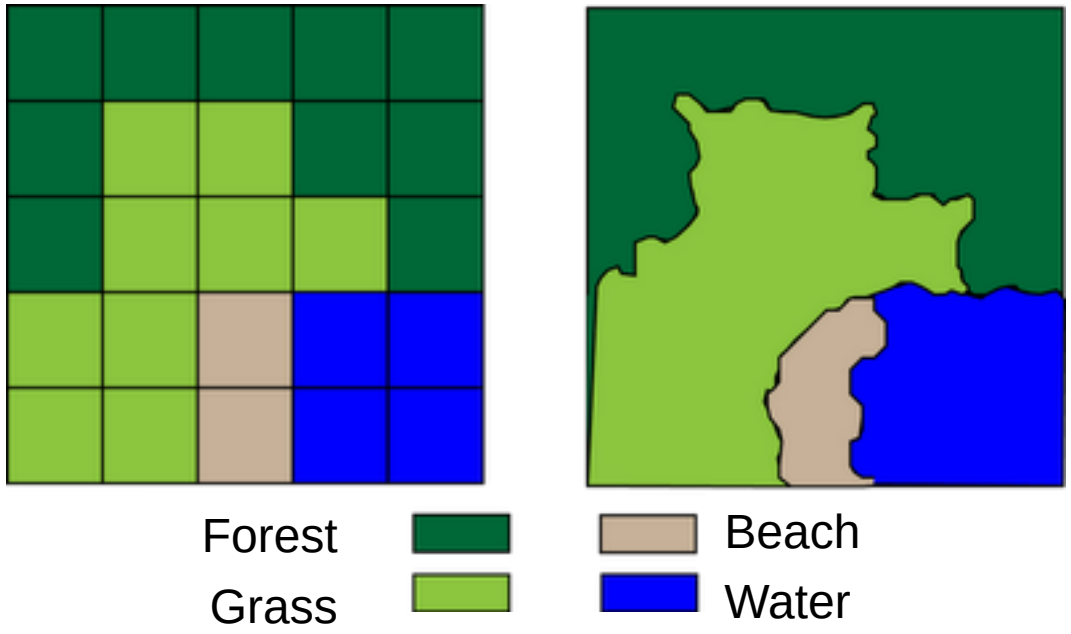
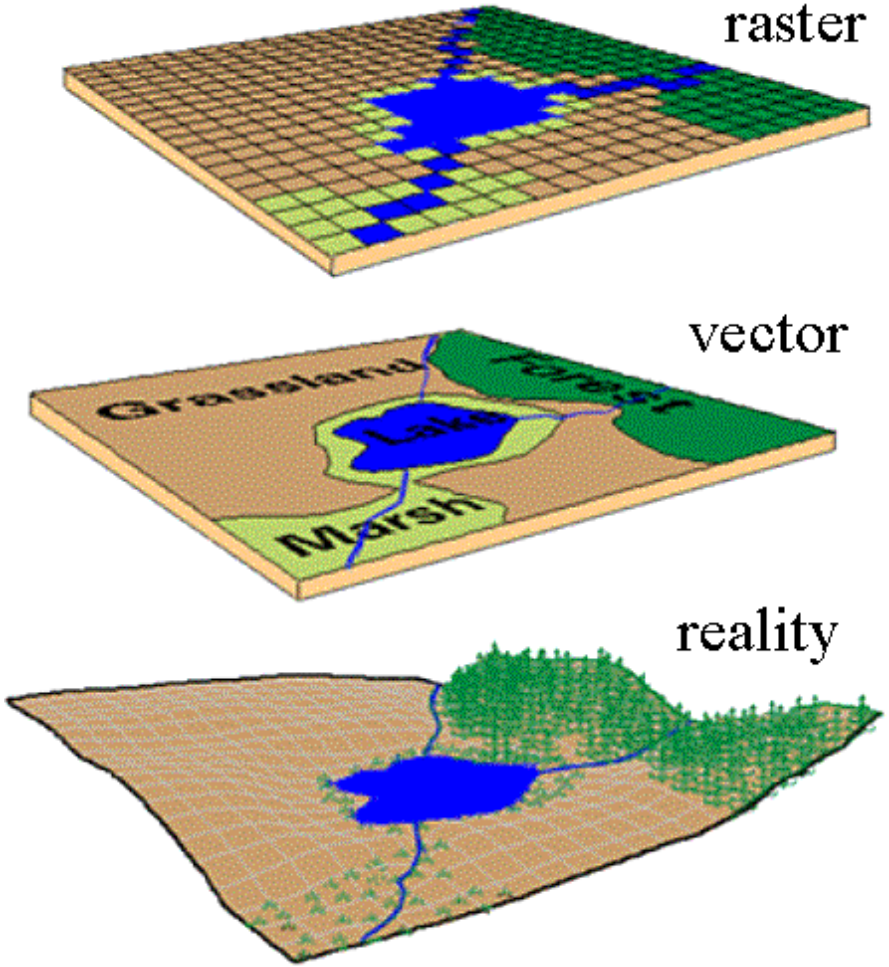
Spatial Data

- Data Type
  - Vector Data (point, polyline, polygon)
  - Raster Data



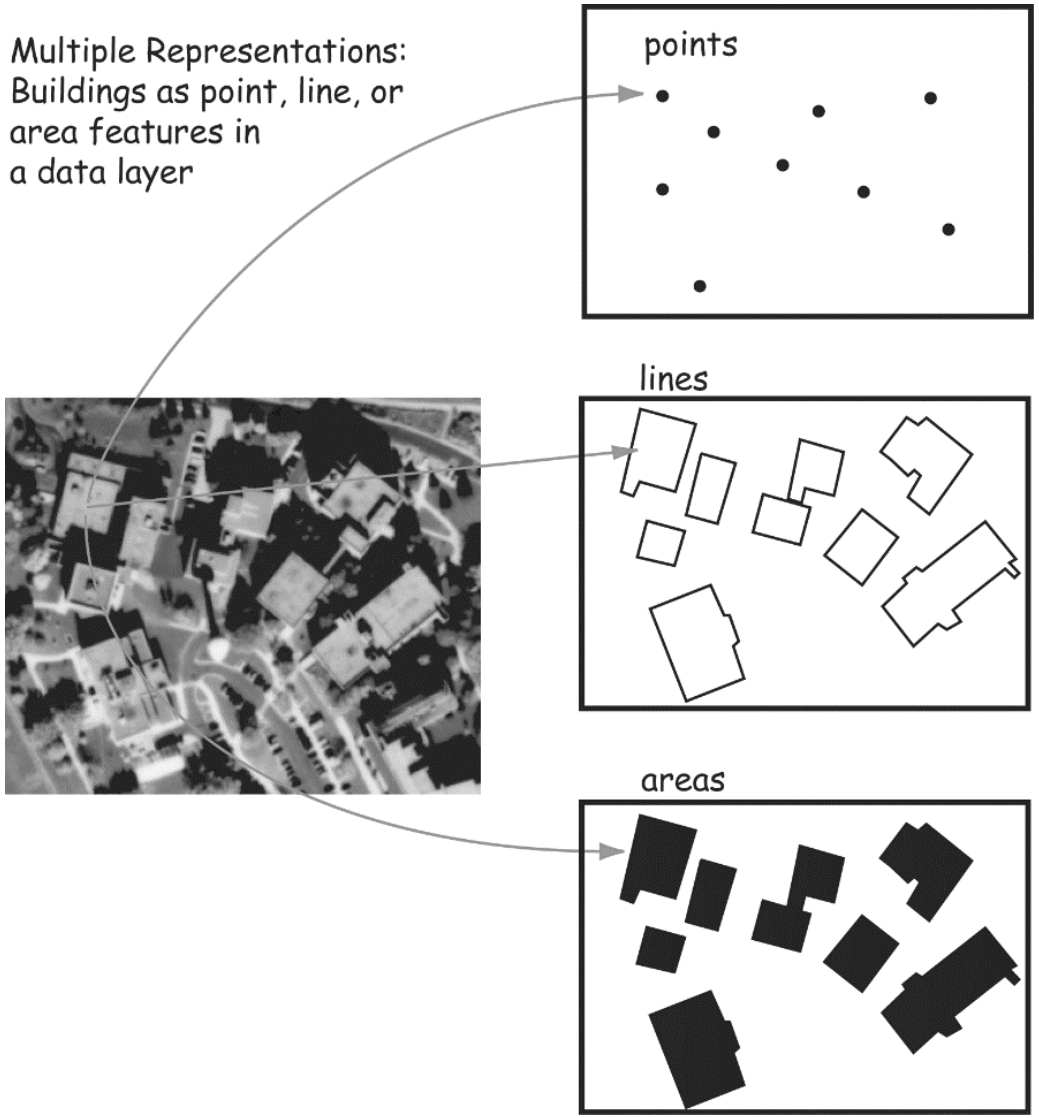


http://outsidetheneatline.blogspot.com/2009/08/did-you-know-6-raster-vs-vector.html

MEDICI LAND GOVERNANCE

Spatial Data

- Data Type
  - Vector Data (point, polyline, polygon)
  - Raster Data



Bolstad book Figs 2-14

MEDICI LAND GOVERNANCE

Spatial Data

```
INSERT INTO spatial_table VALUES
  (1, 'point', 'POINT(30 10)'),
  (2, 'line', 'LINESTRING(30 10, 10 30, 40 40)'),
  (3, 'polygon-simple',
      'POLYGON((30 10, 40 40, 20 40, 10 20, 30 10))'),
  (4, 'polygon-hole',
      'POLYGON((35 10, 45 45, 15 40, 10 20, 35 10),(20 30, 35 35, 30 20, 20 30))');
```

```
INSERT INTO spatial_table VALUES
  (5, 'multipoint', 'MULTIPOINT(10 40, 40 30, 20 20, 30 10)'),
  (6, 'multilinestring', 'MULTILINESTRING((10 10, 20 20, 10 40), (40 40, 30 30, 40 20, 30 10))'),
  (7, 'multipolygon',
      'MULTIPOLYGON(((40 40, 20 45, 45 30, 40 40)), ((20 35, 10 30, 10 10, 30 5, 45 20, 20 35), (30 20, 20 15, 20 25,
```

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Spatial Data

- Spatial Reference System

```
INSERT INTO spatial_table VALUES
  (9, 'point', ST_GeomFromText('POINT(-123.12 49.28)', 4326)),
  (10, 'point', ST_GeomFromText('POINT(491272.2 5458589.7)', 26910));
```

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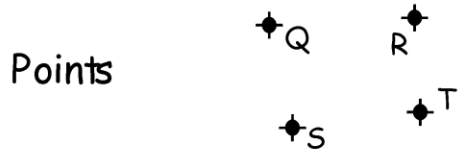
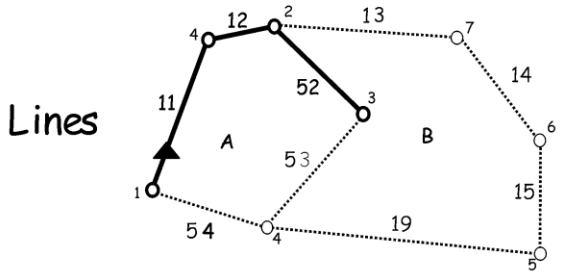
Spatial Data

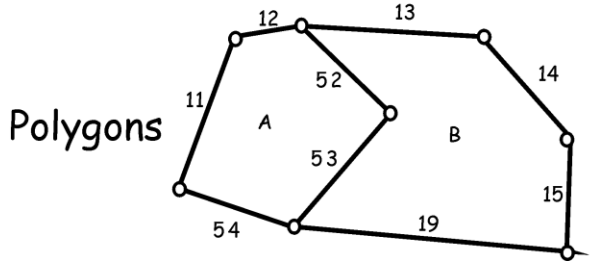
- Topology
  - Adjacency – which vector features are next to each other?
  - Connectivity – which arcs connect to each other?
  - Containment – which vector features are within other polygons?
  - Coincidence – which vector features occupy the same space?



Point ID	X	Y
Q	32.7	45.6
R	76.3	19.5
S	22.7	15.8
etc...		



Line ID	Begin node	End node	Left poly	Right poly
11	1	4	...	A
12	4	2	...	A
52	2	3	B	A
etc ..				



Polygon ID	Lines
A	11,12,52,53,54
B	52,53,19, 15,14,13

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Coordinate Systems

- -111.9173784, 40.6181582 (WGS84)
- 422403.025719, 4496774.8452 (WGS84 – UTM 12N)
- 1000,1000 (local)

- 799 W. Coliseum Way Midvale, UT 84047
- J39M+7W Midvale, Utah

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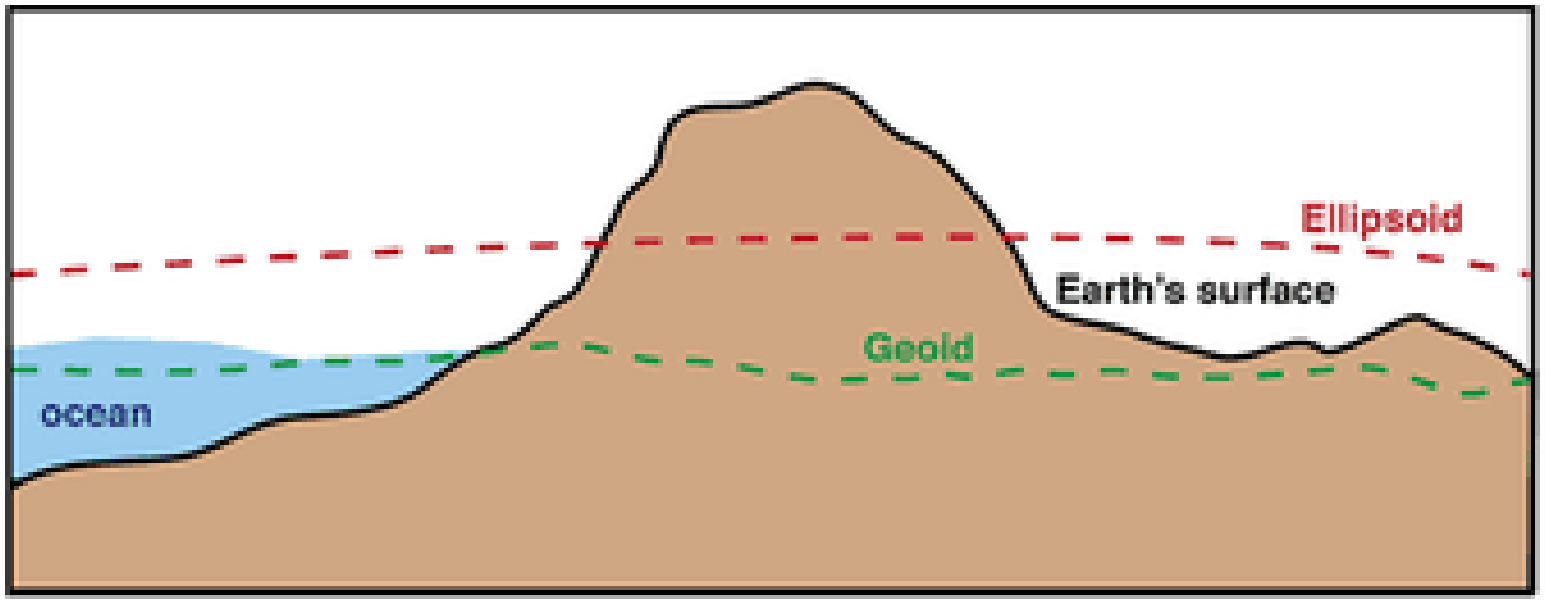
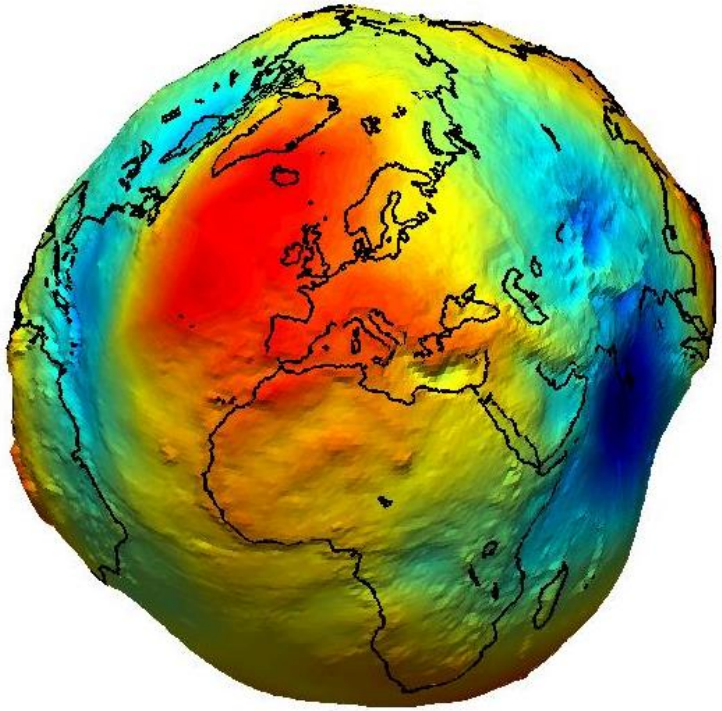
Datums





http://michaelminn.net/tutorials/gis-projections/index.html

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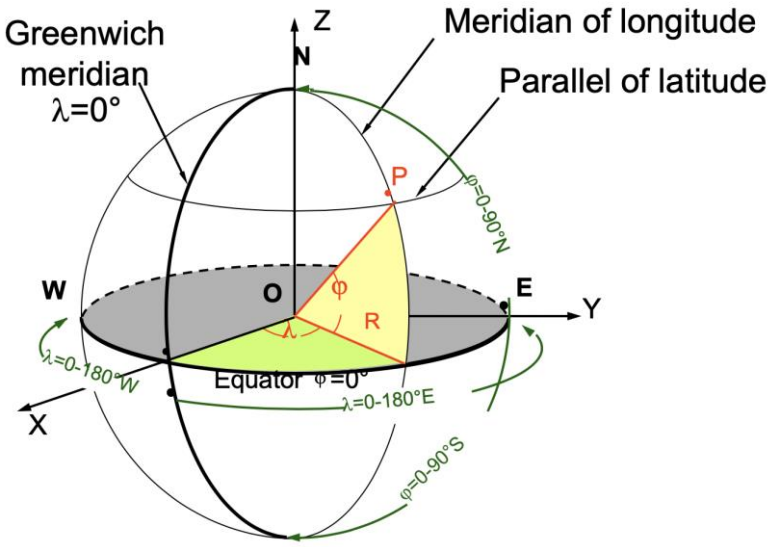
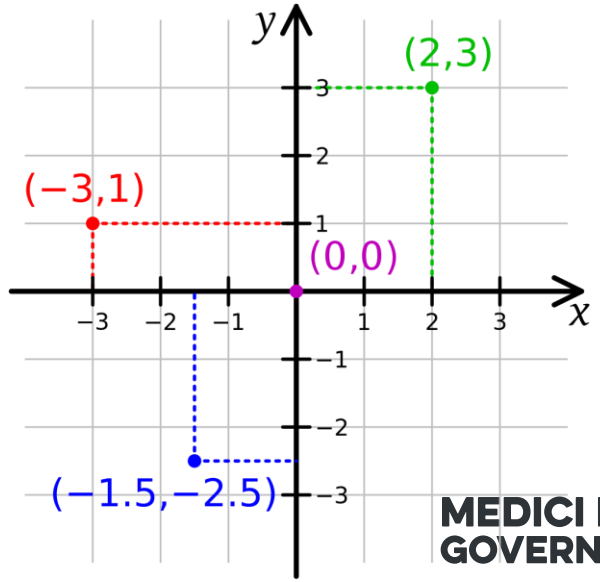
Types of Coordinate Systems

- **Geographic Coordinate Systems (GCS)** = A reference system (based on a sphere or spheroid) using latitude and longitude to define the location of points on the surface of spheroid

  e.g., WGS84 (EPSG:4326)
- **Projected Coordinate Systems** = A systematic mathematical transformation of locations on the earth (latitude and longitude) to planar coordinates (a flat, two-dimensional surface)
- e.g., WGS84, UTM Zone 35S (EPSG:32735)





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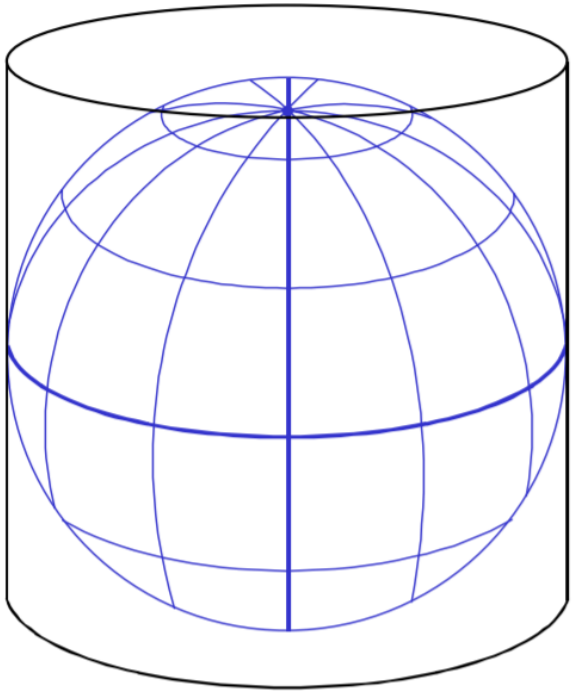
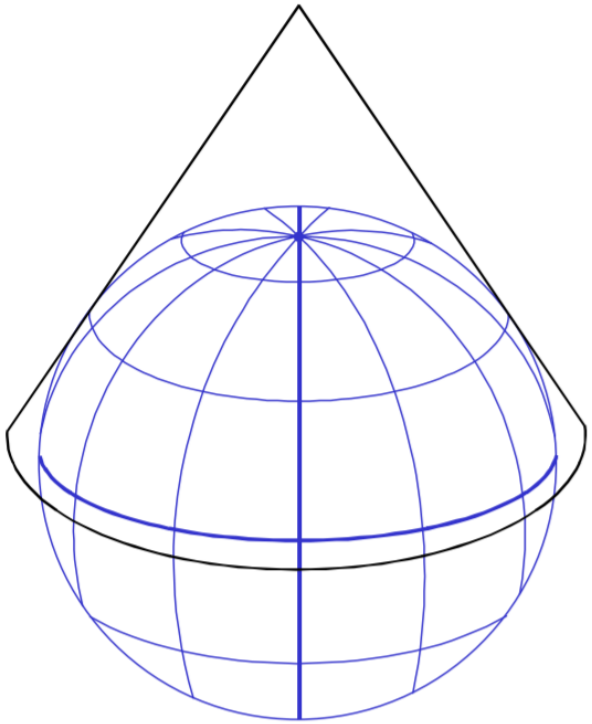
Map Projection (Developable Surface)

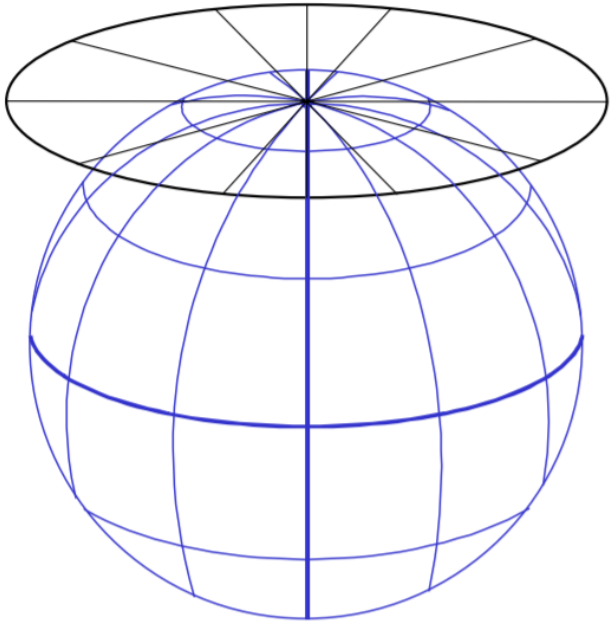
A surface that can be unfolded into a plane without stretching, tearing or shrinking



Cylindrical Projection

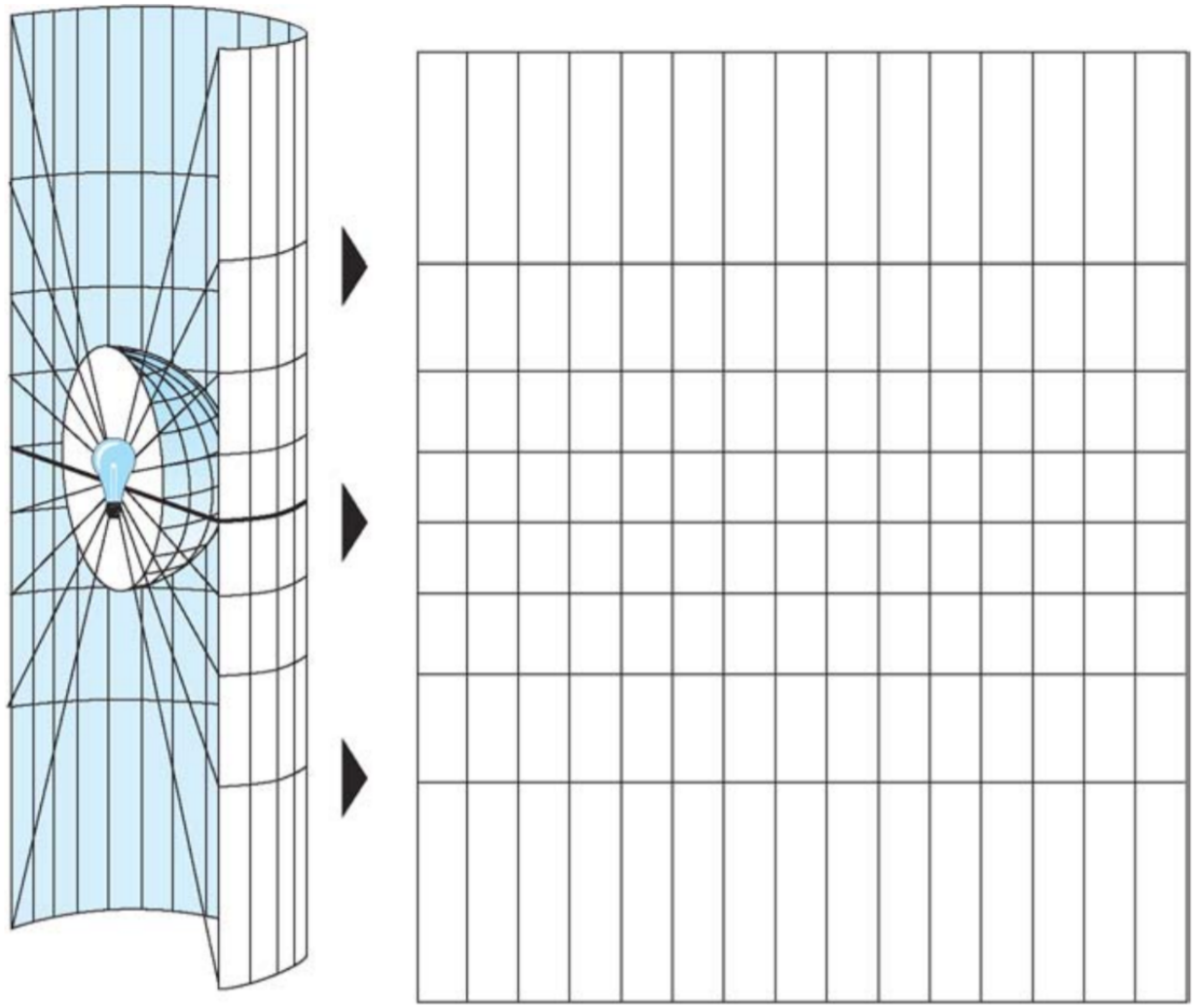


Conic Projection



Azimuthal Projection

Map Projection



The graticule of a geographic coordinate system is projected onto a cylindrical projection surface.

http://downloads2.esri.com/support/documentation/ao_/710Understanding_Map_Projections.pdf

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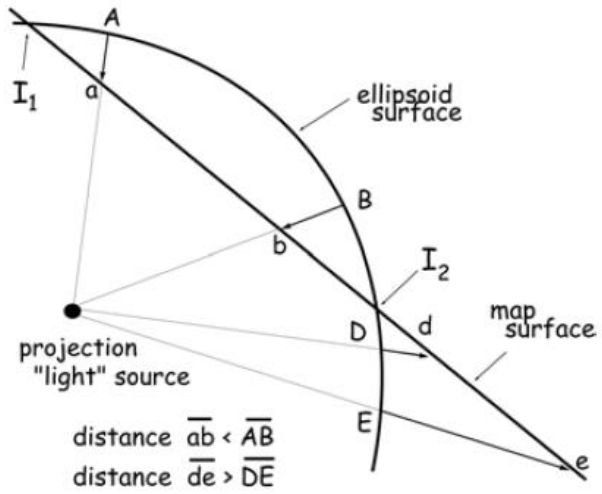
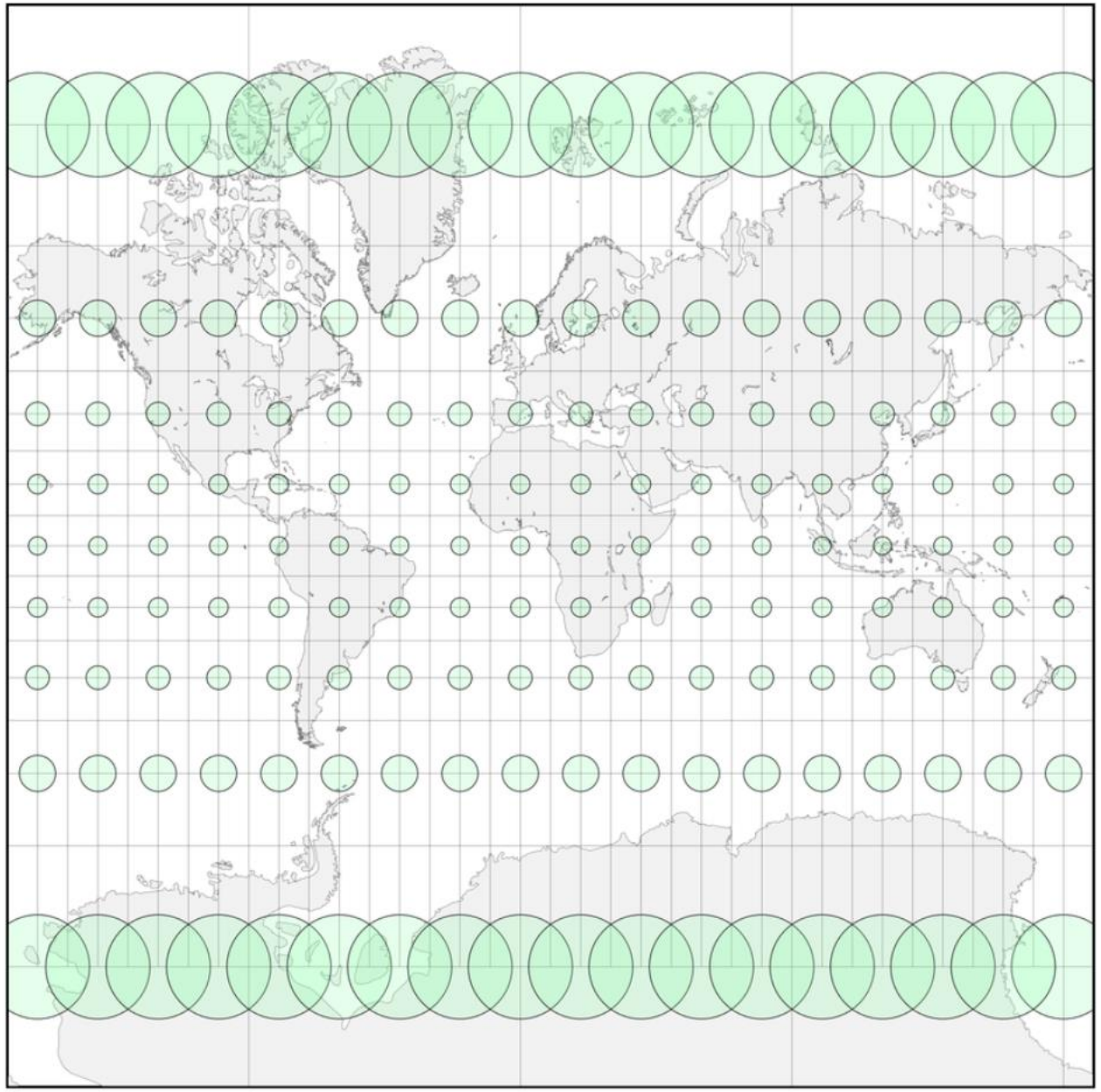
Map Distortion

- Tissot's Indicatrix

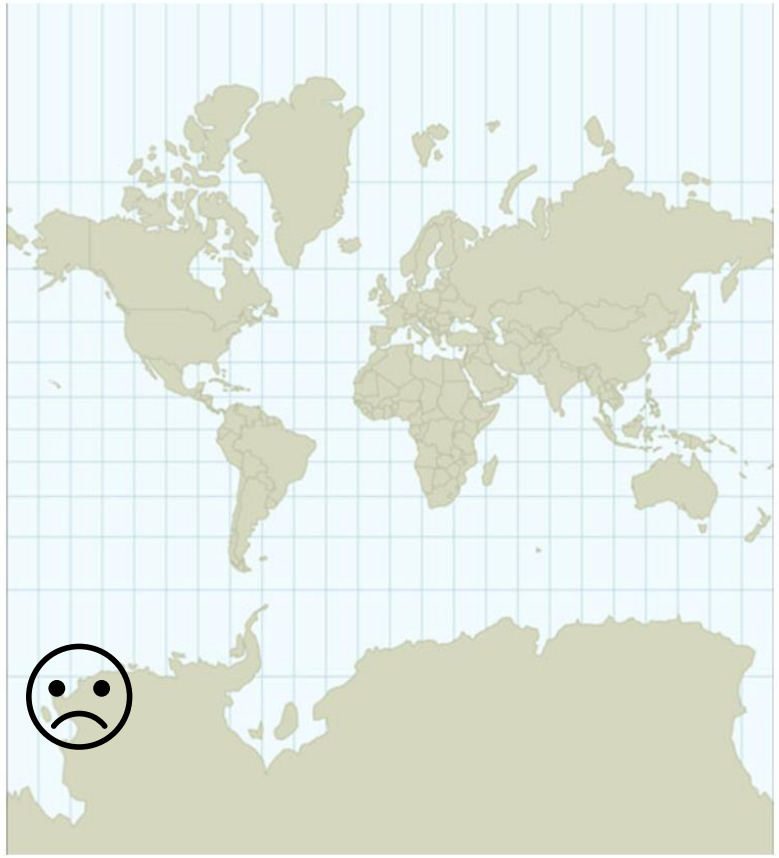


- Projected coordinate systems designed for specific purposes (preserve shape, area, distance, Angle.)



Map Distortion

- Area



Mercator

Cylindrical Equal Area

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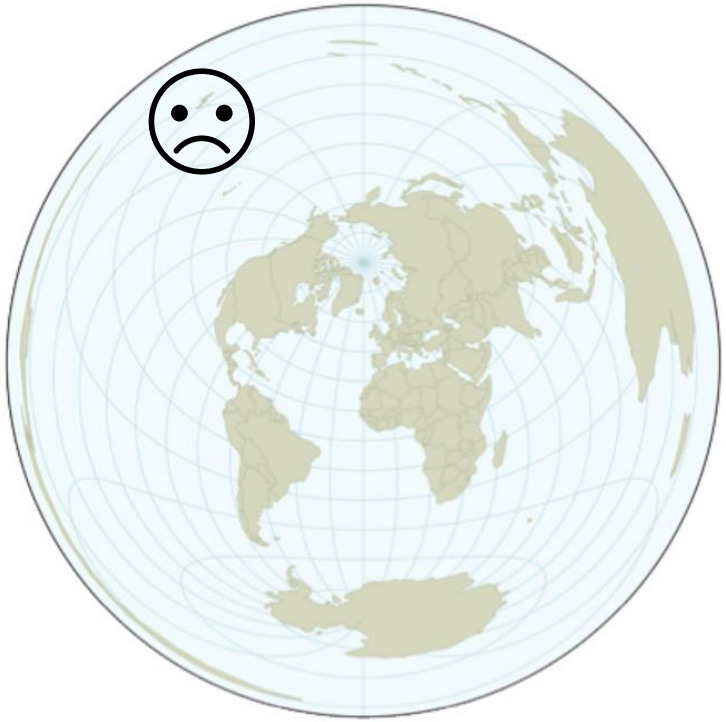
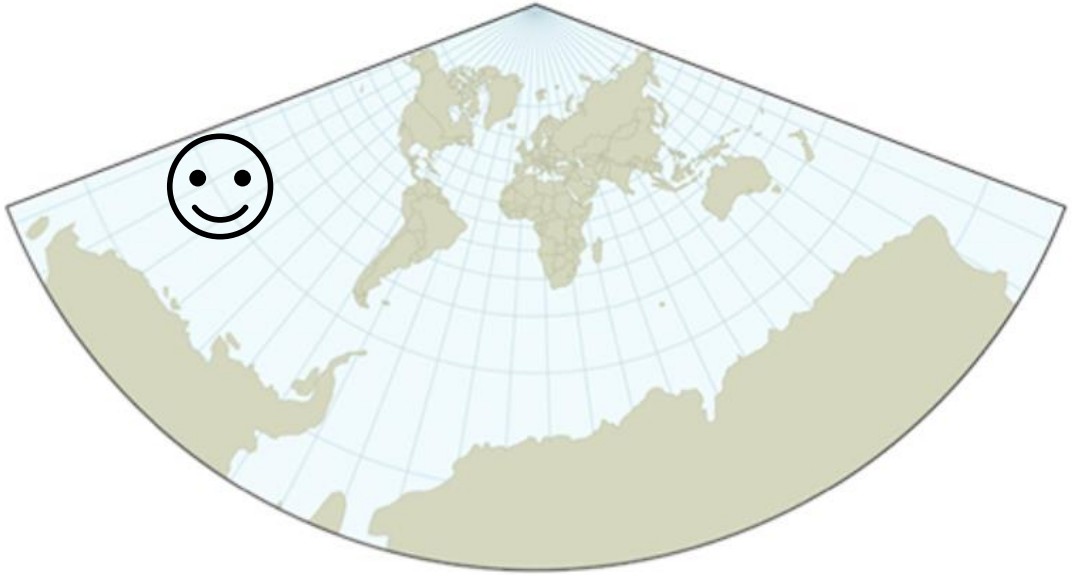
Map Distortion

- Shape



Azimuthal Equidistant



Lambert Conformal Conic

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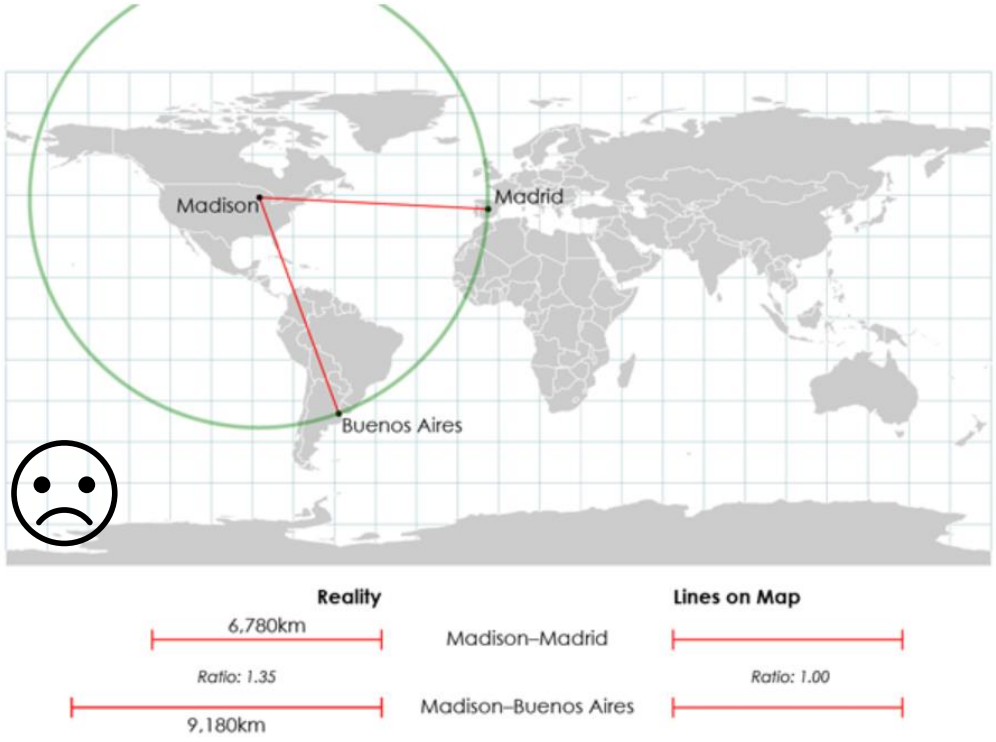
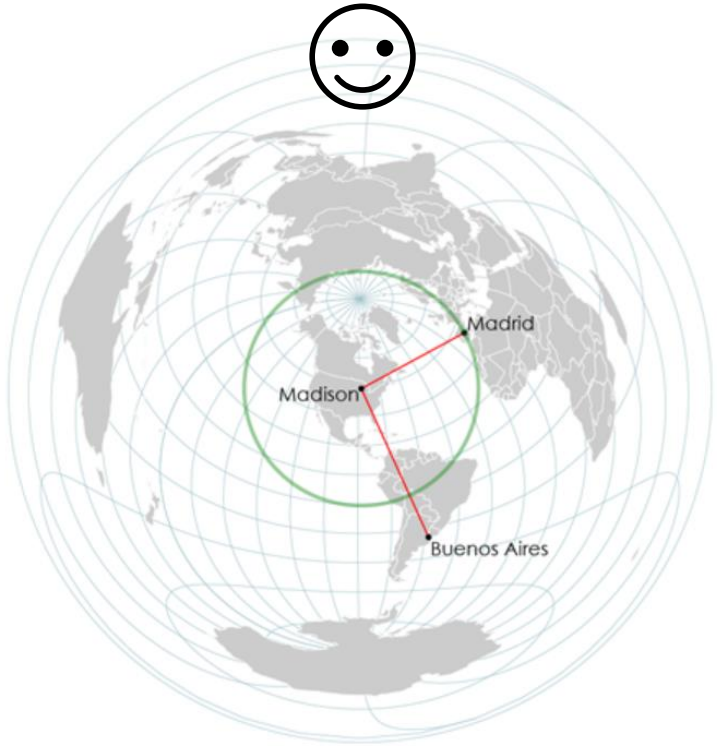
Map Distortion

- Distance



Equirectangular projection



Azimuthal Equidistant projection

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Map Distortion

- Directions

Stereographic

Mercator

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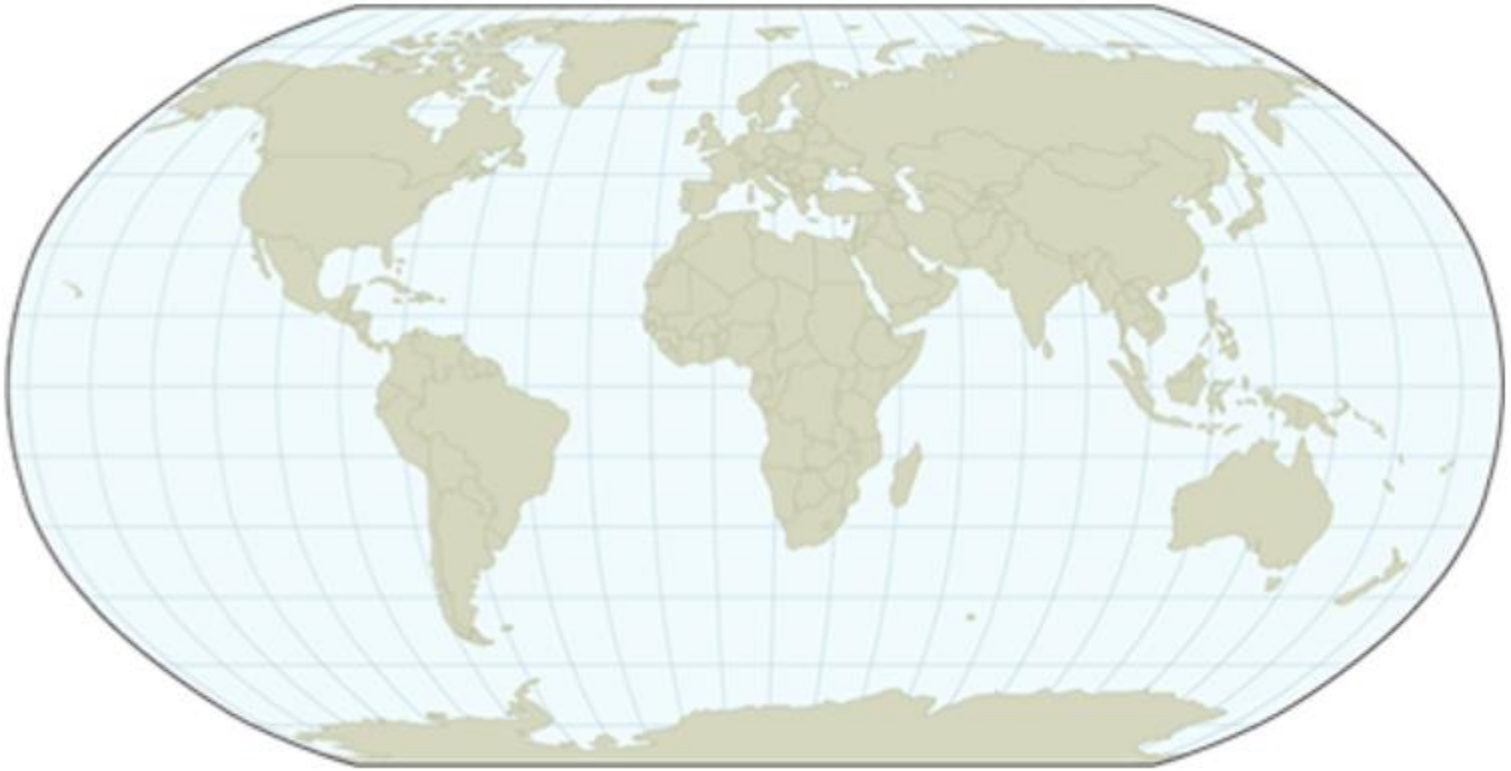
Map Distortion

- Compromises



Robinson

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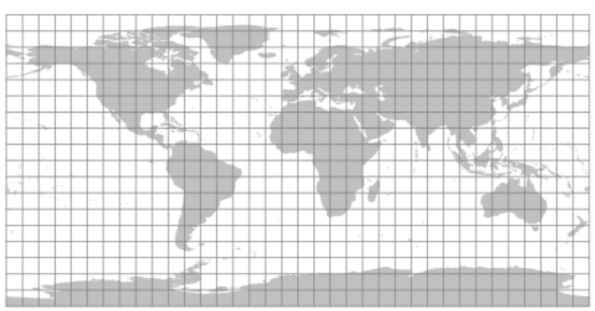
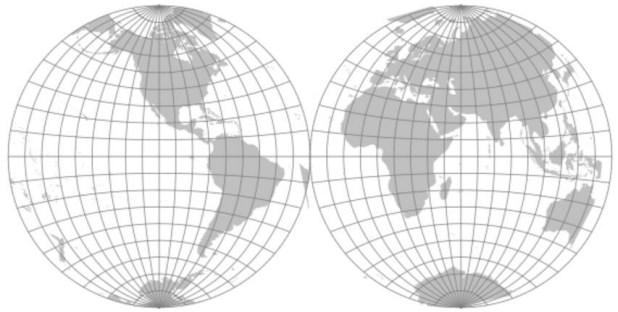
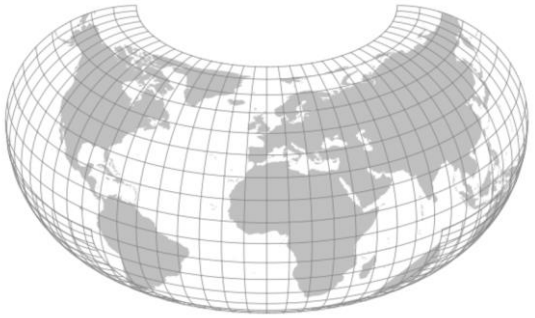
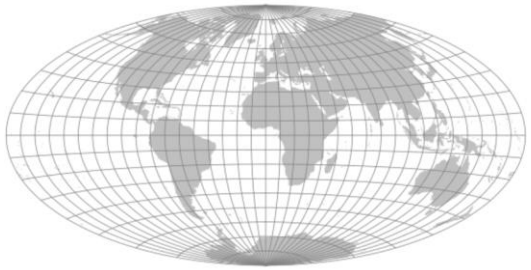
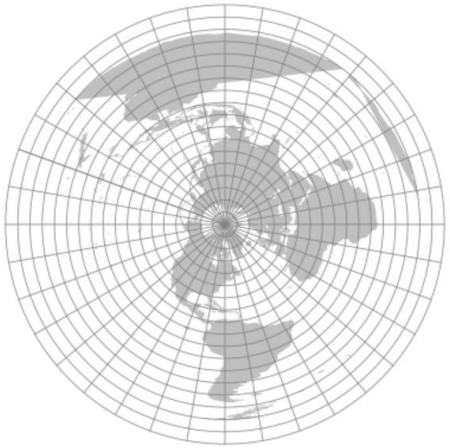
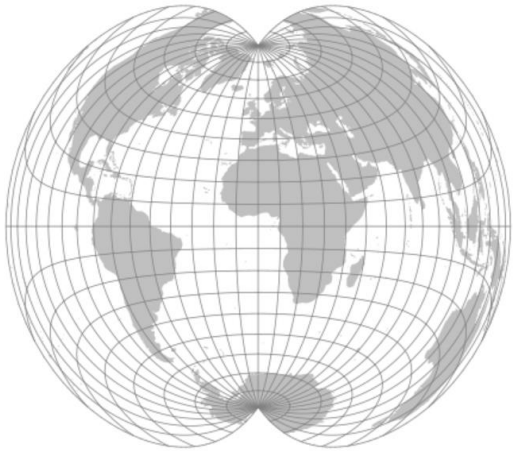
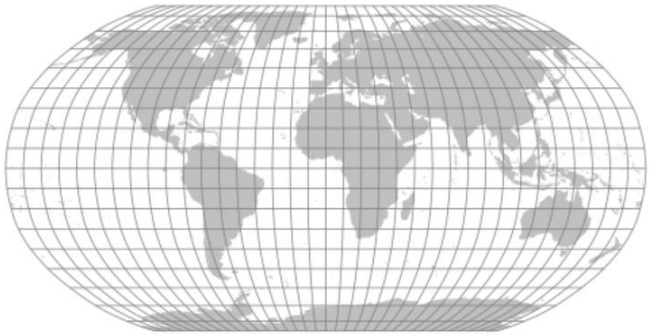
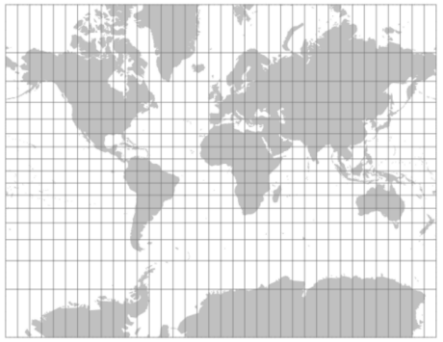
Map Projections

https://www.jasondavies.com/maps/transition/

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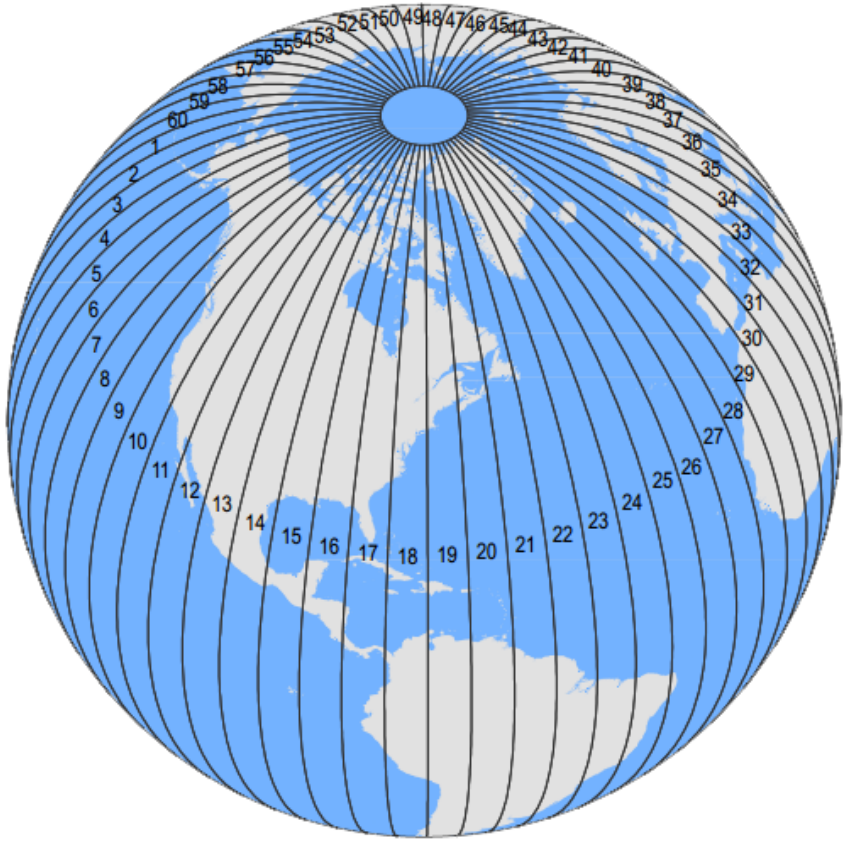
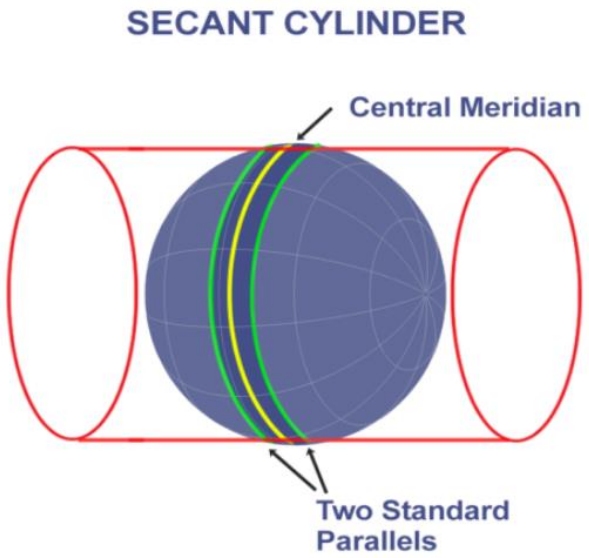
Universal Transverse Mercator

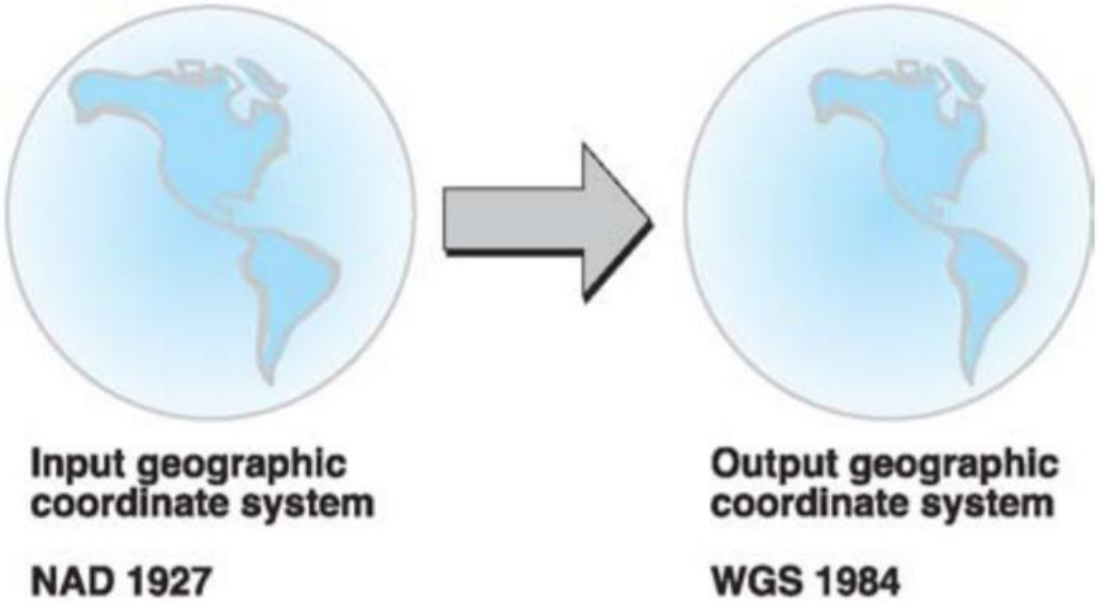




MEDICI LAND
GOVERNANCE

Geographic Transformation

- The accuracy of a particular transformation can range from centimeters to meters



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Python

```
import pyproj


inProj = pyproj.Proj(init='epsg:4326’)


# https://spatialreference.org/ref/epsg/wgs-84-utm-zone-12n/
outProj = pyproj.Proj(init='epsg:32612’)
outProj = pyproj.Proj("+proj=utm +zone=12 +ellps=WGS84 +datum=WGS84 +units=m +no_defs"’)


x1,y1 = -111.9173784, 40.6181582
x2,y2 = pyproj.transform(inProj,outProj,x1,y1)
```

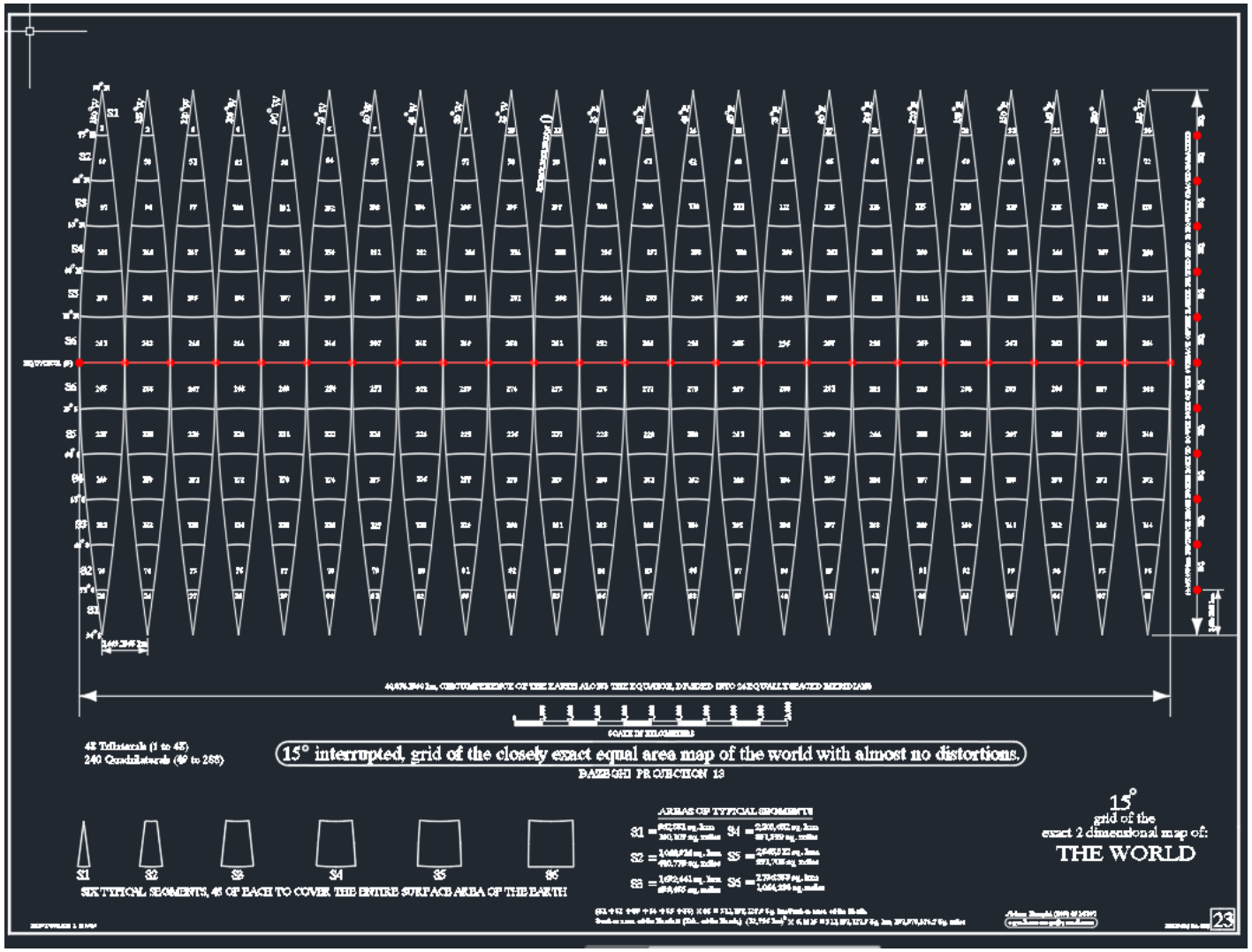
MEDICI LAND GOVERNANCE

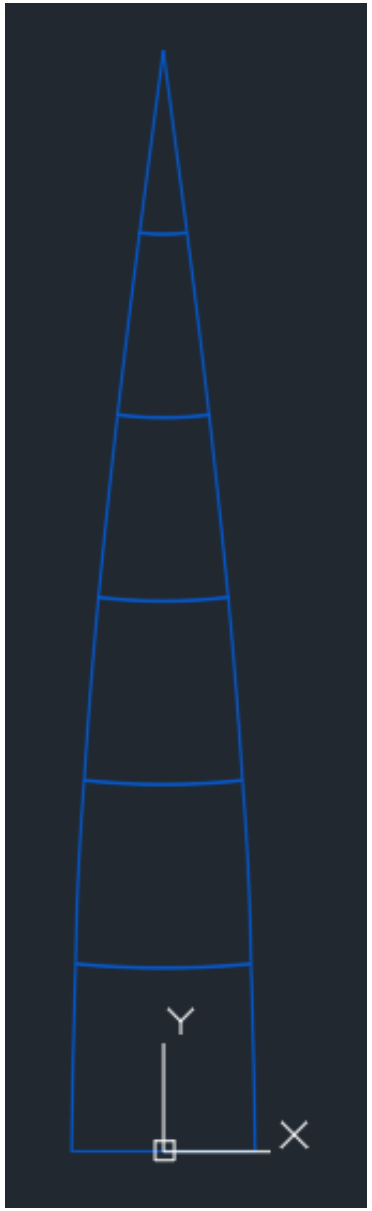
PostGIS

```
SELECT ST_SRID(the_geom) FROM your_table_name LIMIT 1;


SELECT ST_AsText(ST_Transform(ST_GeomFromText('POLYGON((743238 2967416,743238
2967450, 743265 2967450,743265.625 2967416,743238 2967416))',2249),4326)) As wgs_geom;


wgs_geom
--------------------------
 POLYGON((-71.1776848522251 42.3902896512902,-71.1776843766326 42.3903829478009,
-71.1775844305465 42.3903826677917,-71.1775825927231 42.3902893647987,-71.177684
8522251 42.3902896512902));
(1 row)
```

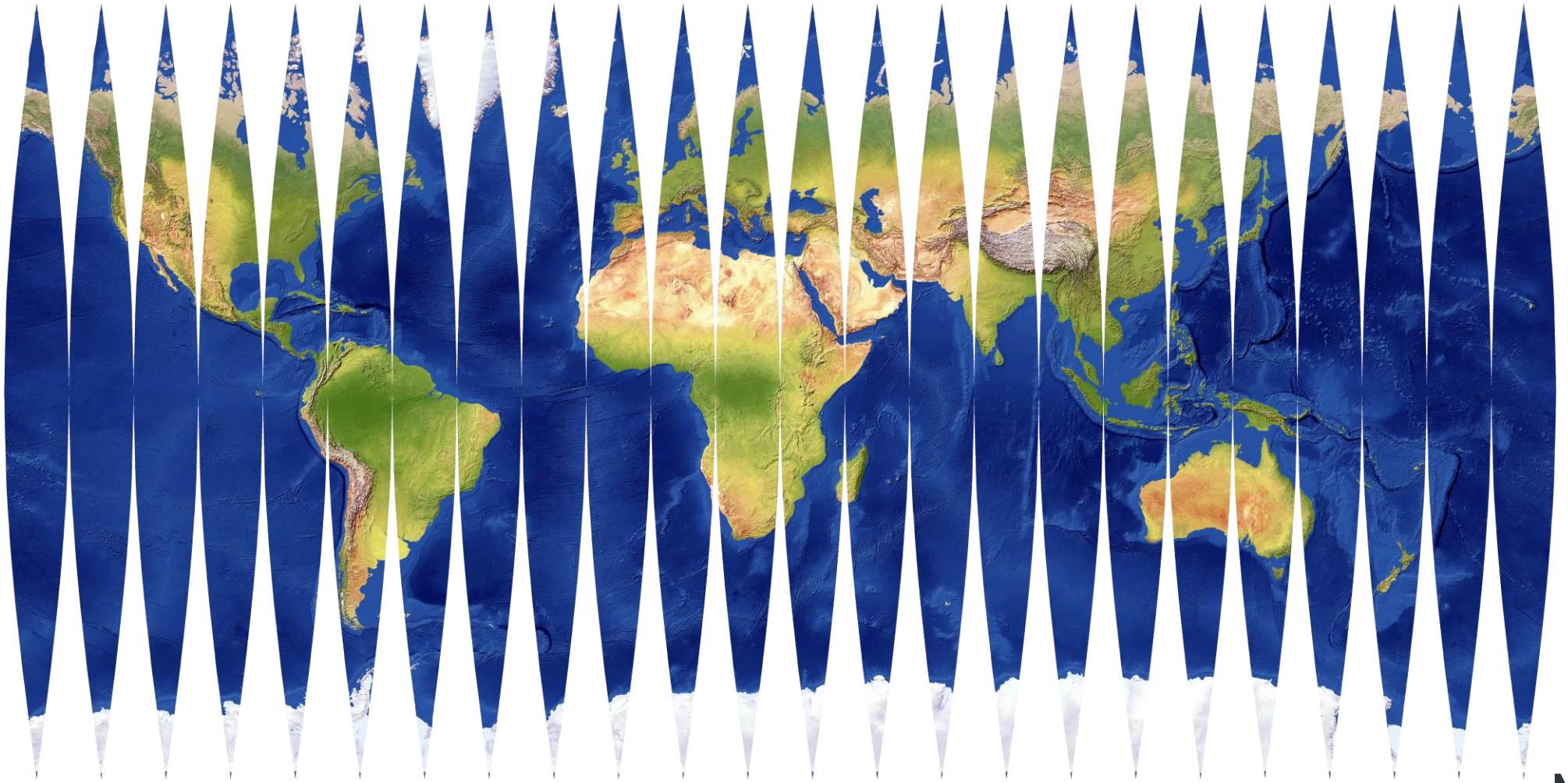
MEDICI LAND GOVERNANCE

My Project


15° interrupted, grid of the closely exact equal area map of the world with almost no distortions.
DAZEGHI PROJECTION 13
15°
grid of the
exact 2 dimensional map of:
THE WORLD
SIX TYPICAL SEGMENTS, 45 OF EACH TO COVER THE ENTIRE SURFACE AREA OF THE EARTH
23

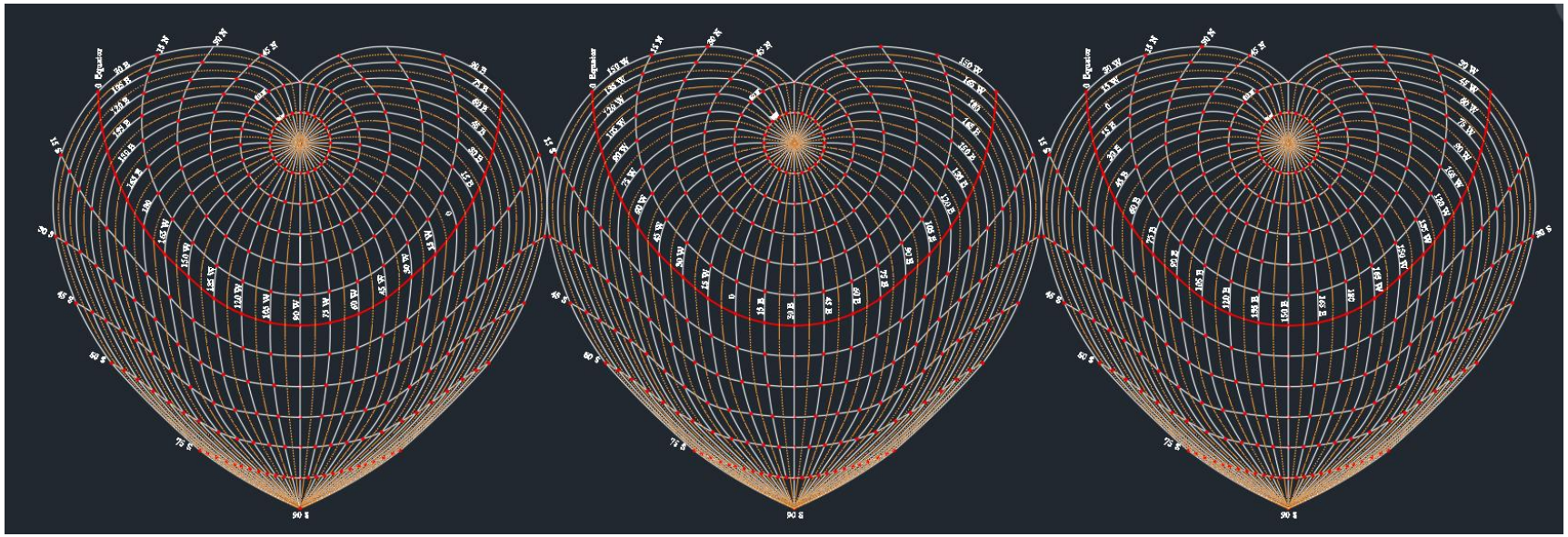

Y
X

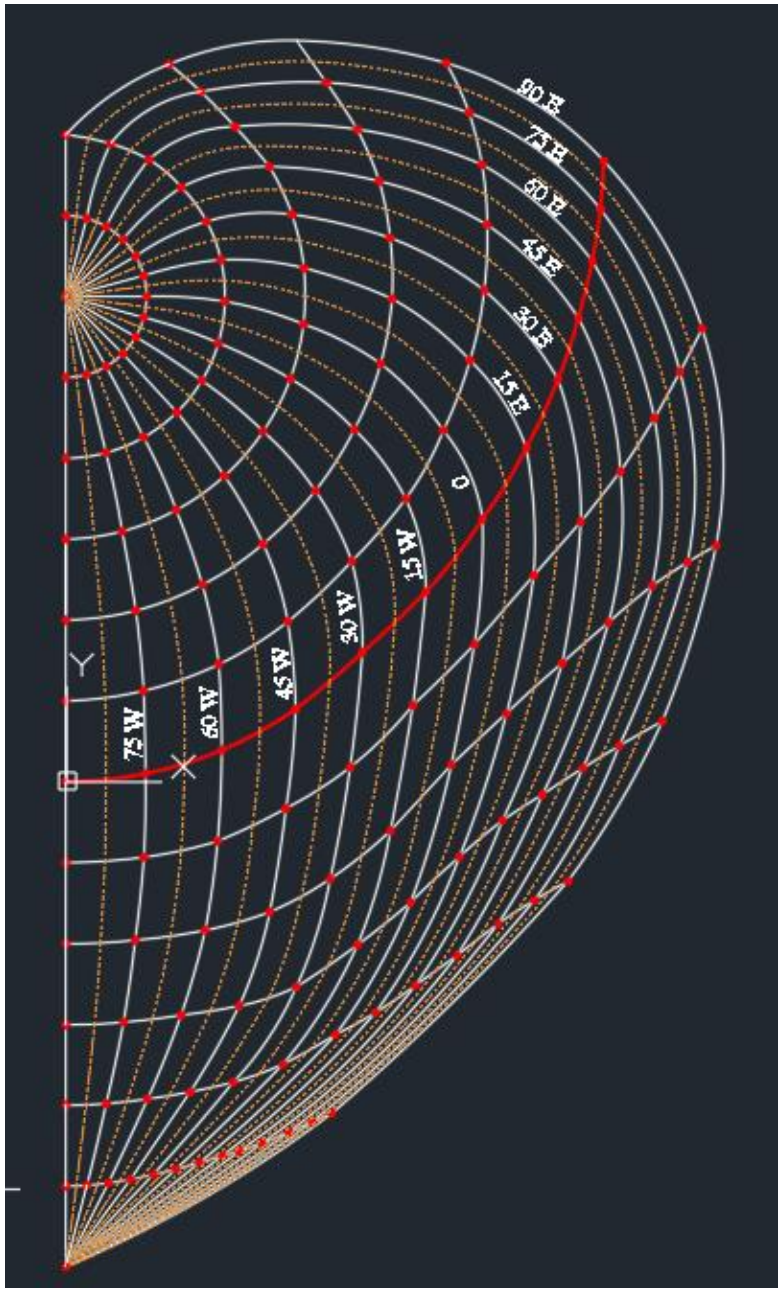
My Project



MEDICI LAND GOVERNANCE

My Project





My Project

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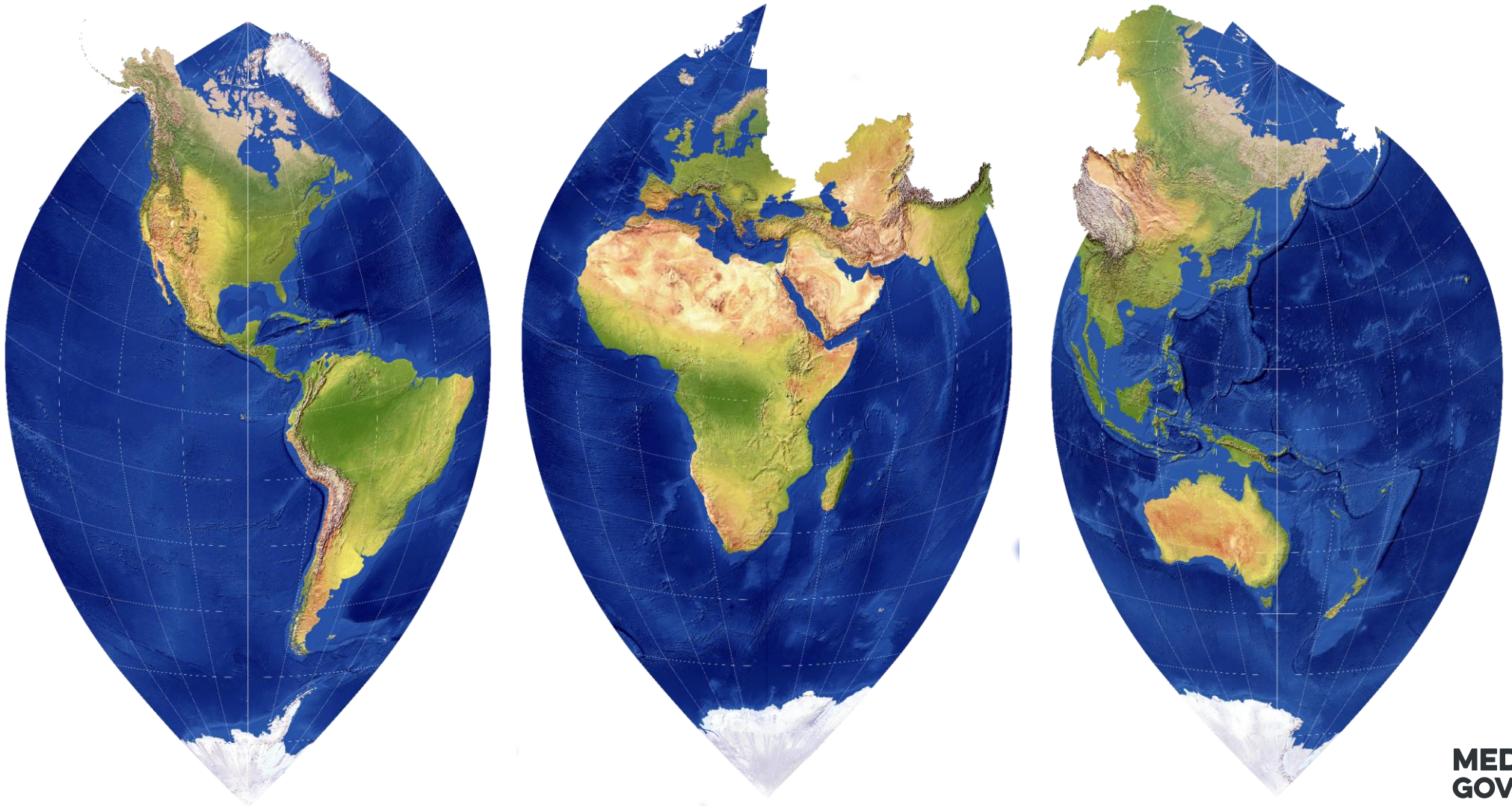

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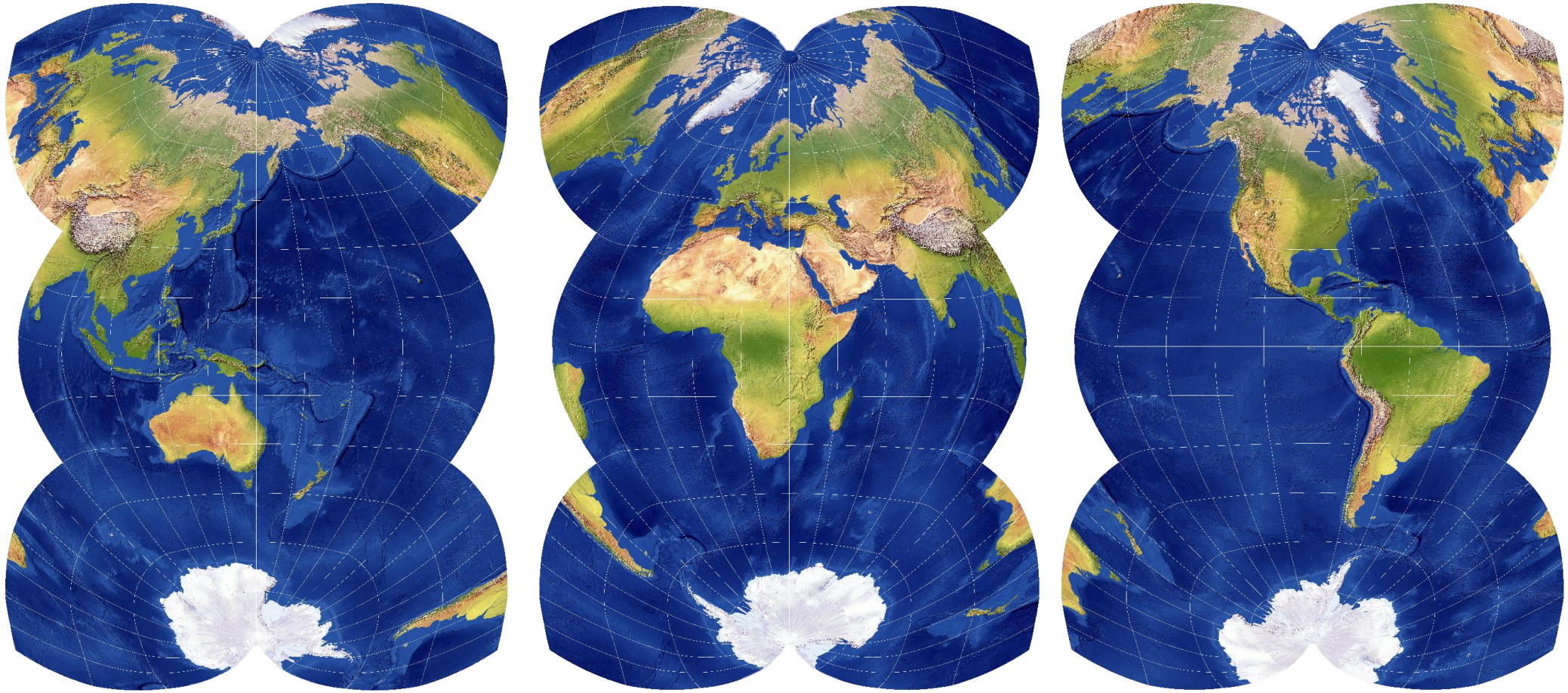

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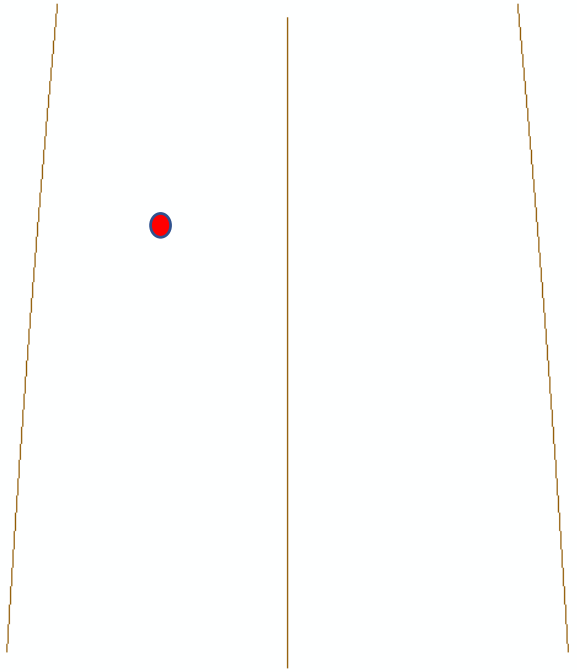

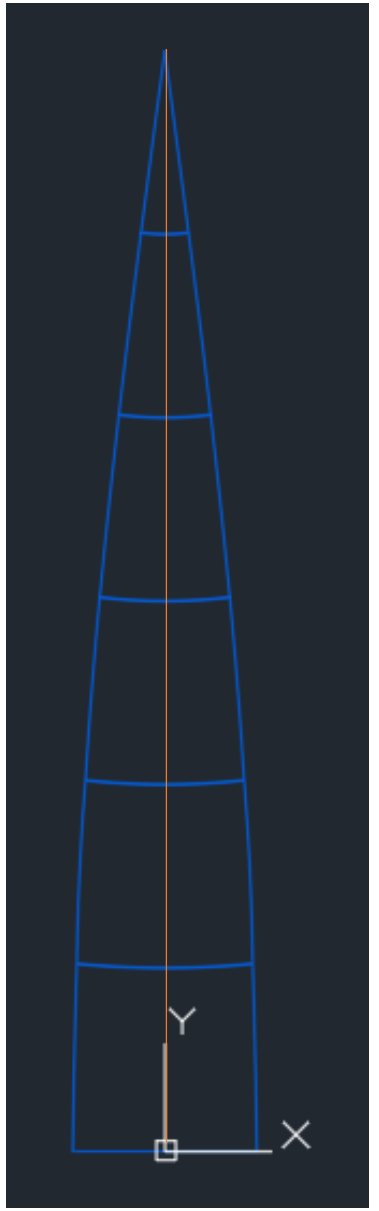

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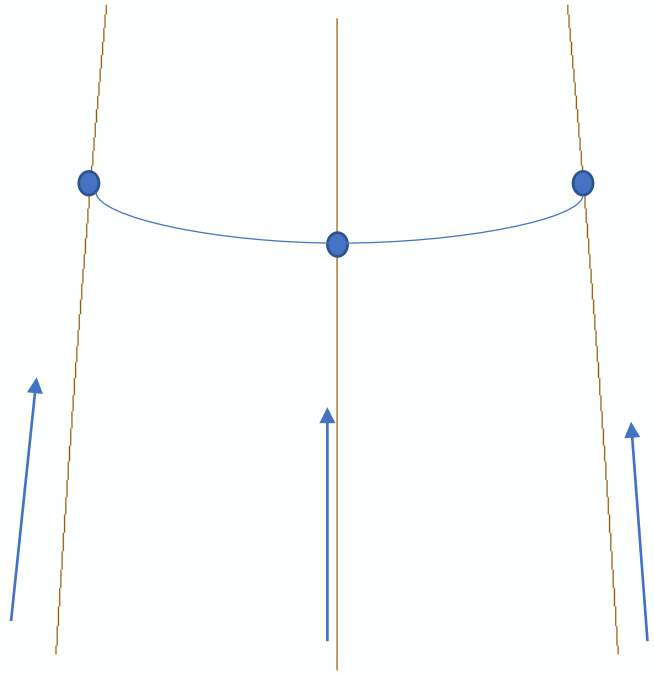
$$\frac{15\ Degrees}{Total\ length\ of\ a\ meridain} = \frac{Lattitude\ of\ the\ point\ (between\ 0\ to\ 15)}{X}$$



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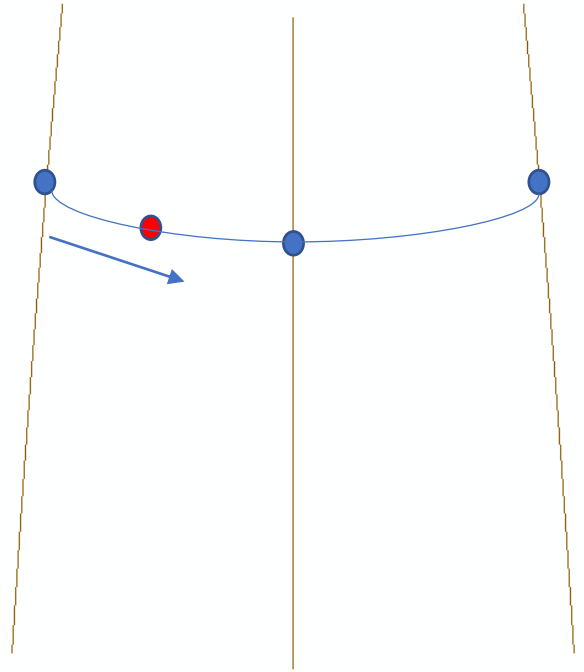
$$\frac{15\ Degrees}{Totoal\ length\ of\ a\ Parallel} = \frac{Longitude\ of\ the\ point\ (between\ 0\ to\ 15)\ starting\ from\ the\ left\ meridian}{X}$$



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Thank You!
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