Map projections

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Outline

- Relevant terms
- Why map projections?
- Map projection categories
  - Projection surfaces
  - Features preserved from distortions
- Map projection examples
- Right choice

Relevant terms

- parallels of latitude
  - lines of equal latitude on the surface of a sphere
- meridian
  - lines of equal longitude
- grid
  - rectangular coordinate system superimposed on a map
- graticule
  - set of parallels and meridians seen on a map

Relevant terms

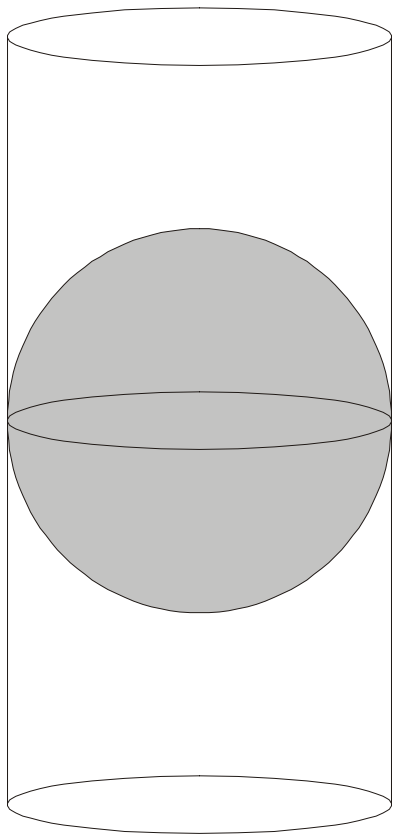
- scale factor
  - $k = \frac{\text{distance on the projection}}{\text{distance on the sphere}}$
  - describes the distortions as a result of projection
  - unrelated to map scale

Why map projections?

- problem of mapping *three-dimensional* coordinates related to a particular datum on a flat surface
  - maps are *two-dimensional*
  - impossible to convert spheroid into flat plane without distortions

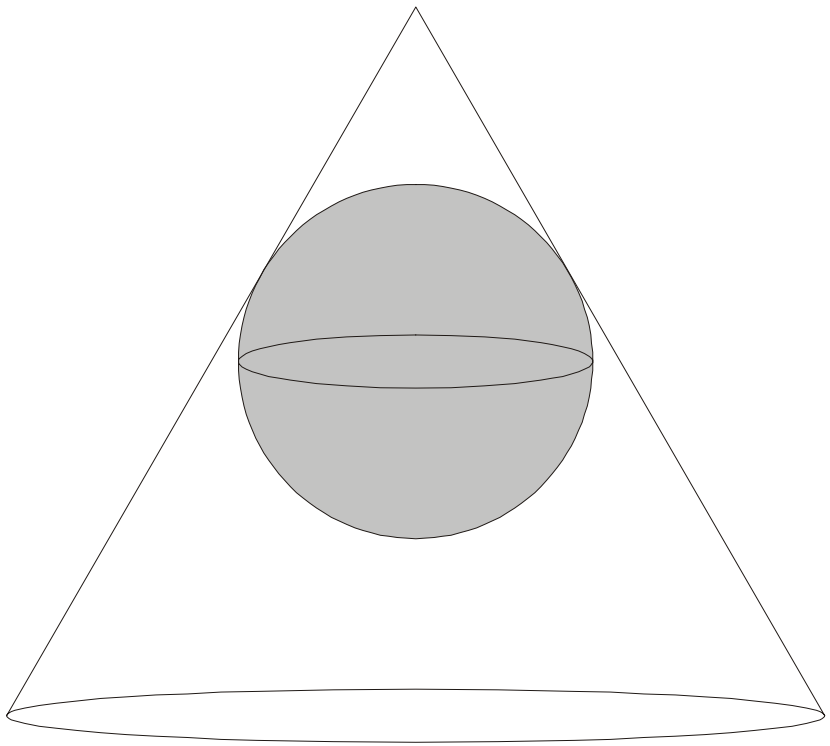
→ map projections

Cylindrical projections



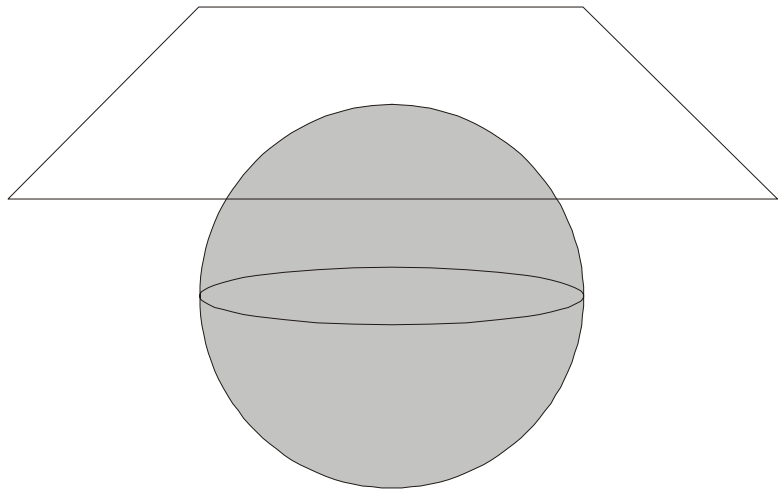
- cylinder that has its entire circumference tangent to the Earth's surface along a great circle (e.g. equator)

Conic projections



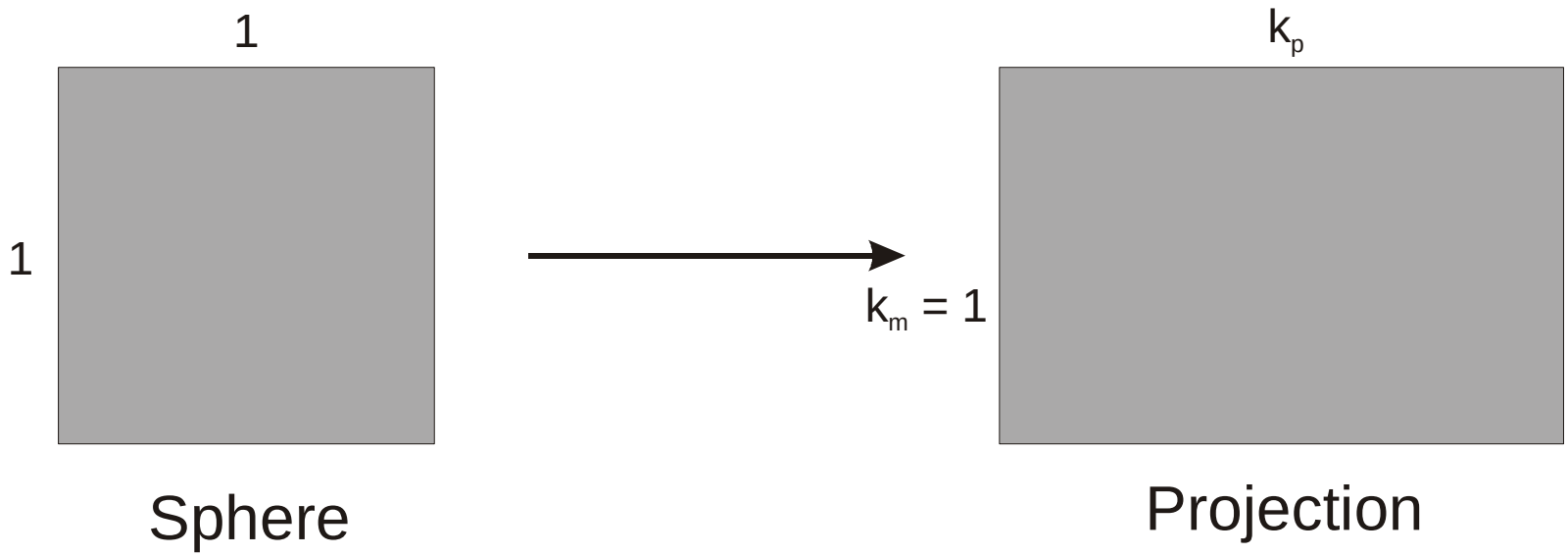
- cone that is tangent to the surface along small circle (e.g. parallel of latitude)

Azimuthal projections



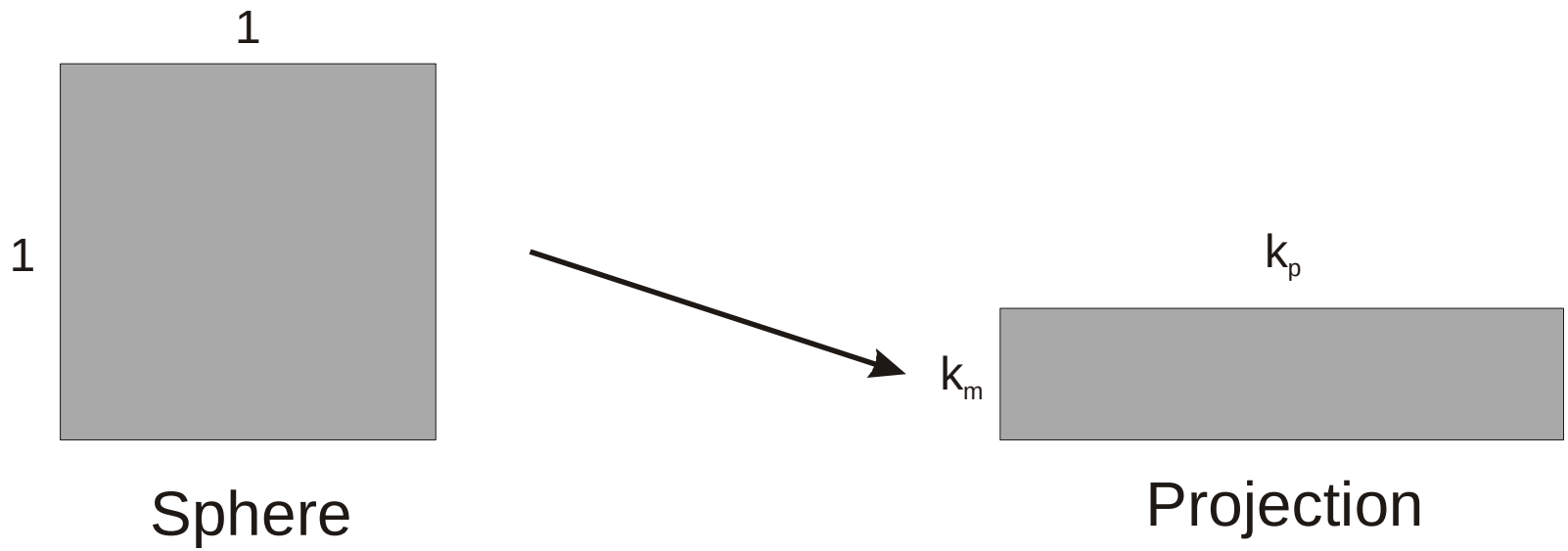
- projecting positions directly to a plane tangent to the Earth's surface

Equidistant projections



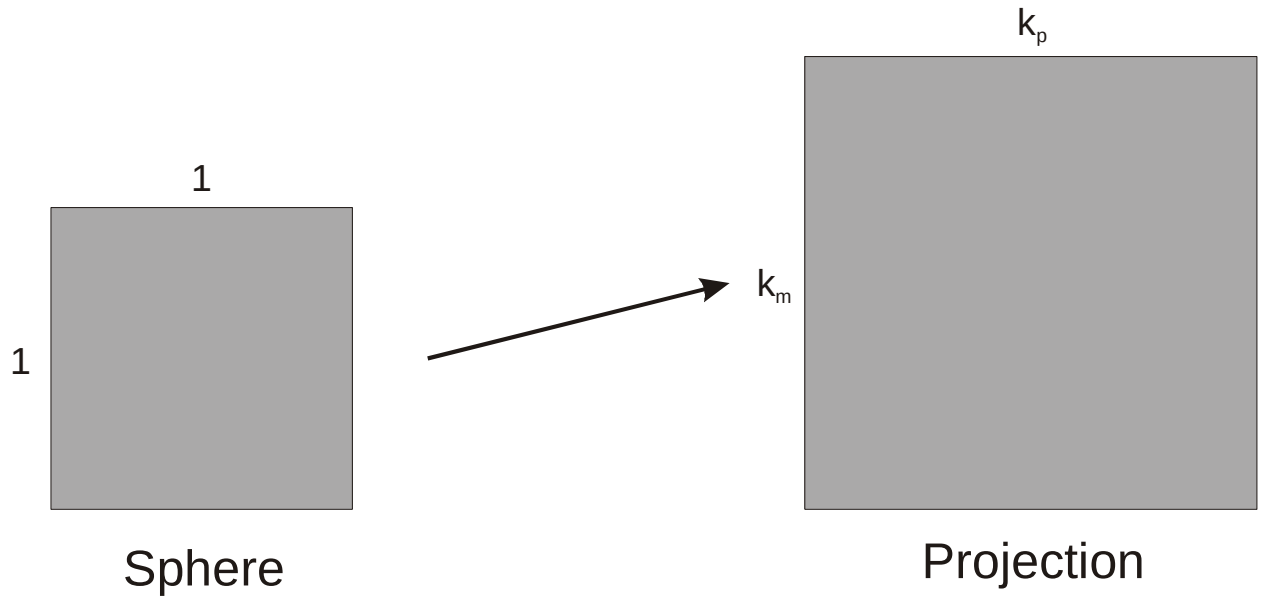
- scale factor along a meridian is equal to 1
- shape and area of square are distorted

Equal-area projections



- equal areas are represented by the same map area regardless of where they occur

Conformal projections



- angles on a conformal map are the same as measured on the Earth's surface
- meridians intersect parallels at right angles

Map projections examples

- Cylindrical projections
  - Mercator projection
  - Transverse Mercator projection
  - Oblique Mercator projection
- Azimuthal projections
  - Lambert Azimuthal Equal-Area projection
  - Stereographic (conformal) projection

Map projections examples

- Conic projections
  - Conic projection with two standard parallels
  - Lambert Conformal Conic projection
  - Albers Conic Equal-Area projection

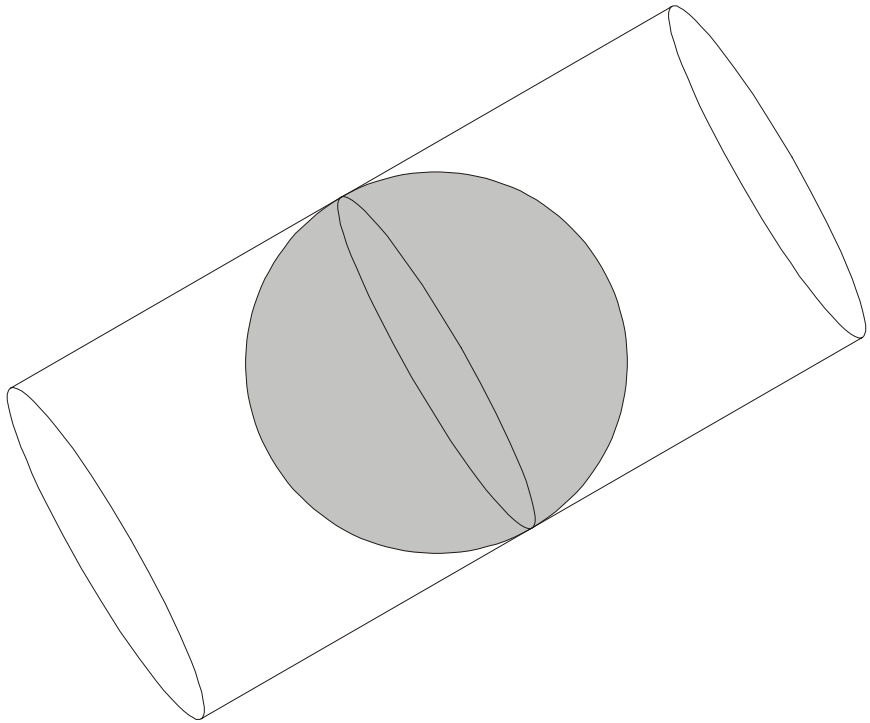
Mercator projection

- regular cylindrical projection
- particularly useful for navigation
  - course with constant azimuth (compass direction) is straight line
- meridians of longitude
  - equally spaced vertical lines
  - intersected at right angles by straight horizontal parallels
- projection parameters
  - true scale latitude
  - central meridian

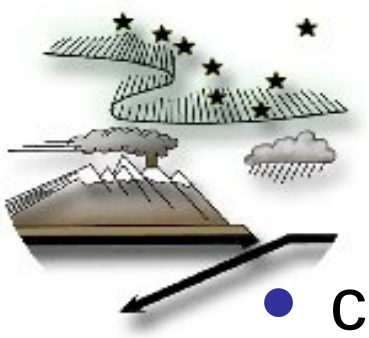
Transverse Mercator projection

- conformal cylindrical projection
- central meridian and equator are straight lines
- scale is constant along any meridian
- central meridian mapped at true scale
  - slightly reduced scale (0.9996) in UTM system
- projection parameters
  - central scale
  - central meridian
  - origin latitude

Oblique Mercator projection



- azimuth of central line needs to be specified
- example for this projection: peninsular Malaysia



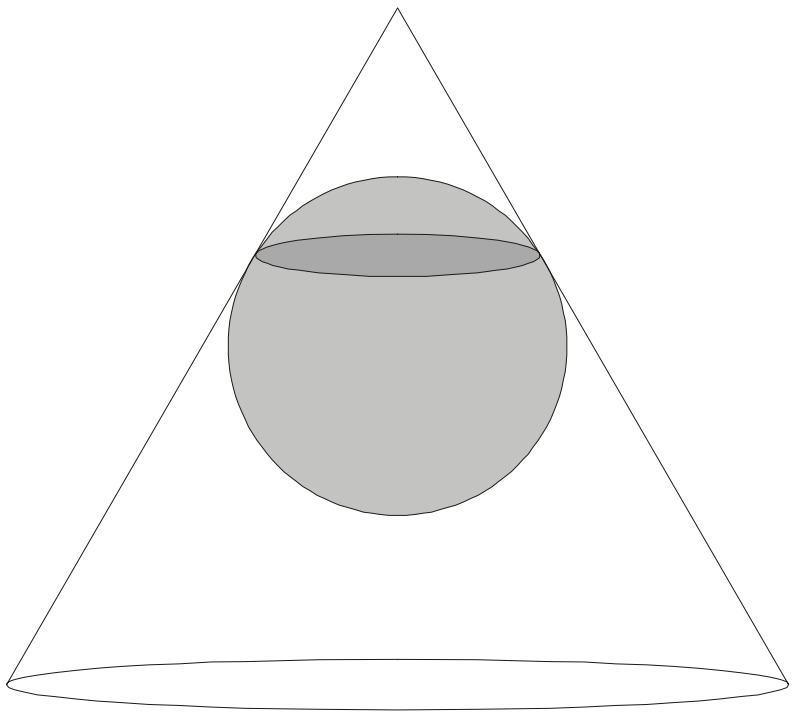
Stereographic projection

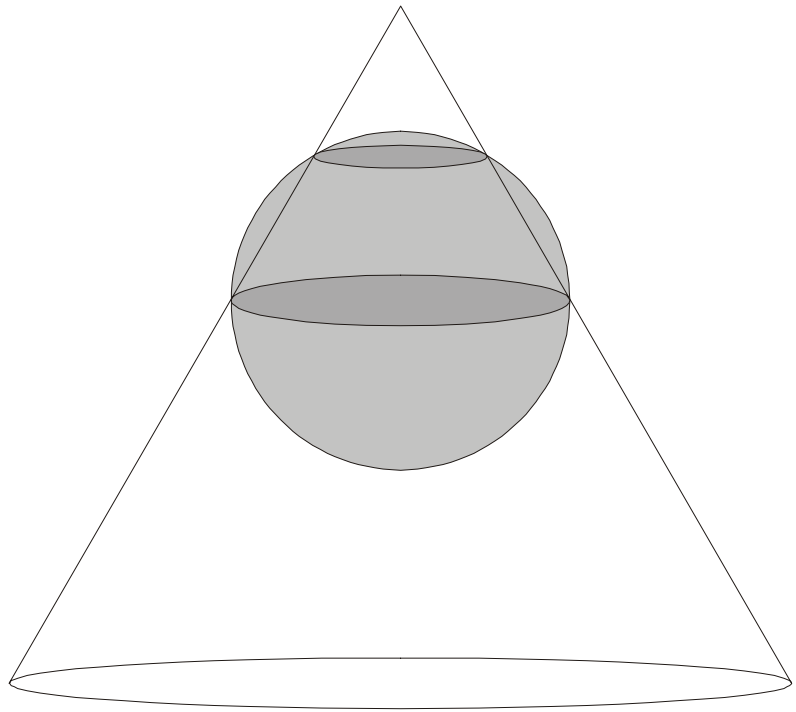
- conformal azimuthal projection
- most commonly used to map polar regions
- polar (pole is center point)
  - meridians: straight radii, parallels:concentric circles
- oblique (only central meridian straight)
  - other meridians/parallels: circular arcs
- projection parameters
  - center longitude
  - center latitude
  - center scale

Lambert Azimuthal Equal-Area projection

- scale
  - true only at center point
  - decreases in radial direction away from the center
  - perpendicular to radius increases with distance
- polar (pole is center point)
  - meridians: straight radii, parallels:concentric circles
- oblique (only central meridian straight)
  - other meridians/parallels: complex curves
- projection parameters
  - center longitude
  - center latitude

Conic projections with two standard parallels





- reduce scale factor below 1 between standard parallels
- increase it above 1 outside parallels

Albers Conic Equal-Area projection

- parallels: concentric circular arcs
- meridians: equally spaced
- scale: true along standard parallels, smaller between them, larger outside them
- scale variation along the meridians to maintain equal area
- projection parameters
  - North and South standard parallel
  - central meridian
  - origin latitude

Lambert Conformal Conic projection

- parallels: concentric circles
- meridians: equally spaced straight radii of theses circles
- scale: true along standard parallels, smaller between them, larger outside them
- projection parameters
  - North and South standard parallel
  - central meridian
  - origin latitude

Right choice

- map purpose
  - for distribution maps: equal area
  - for navigation: projections that show azimuths or angles properly
- size of area
  - some projections are better suited for East-West extent, others for North-South
  - for small areas the projection is relatively unimportant
  - for large areas the projection is very important

Right choice

- conic projections for mid-latitudes
  - true along some parallel between the poles and equator
- cylindrical for equatorial regions
  - true at the equator and distortion increases towards the poles
- azimuthal for poles
  - true only at their center point but distortion is generally worst at the edges

Questions

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