Wed. Apr. 04, 2018

- Linear (Spectral) Mixing
  - Review Theory
  - Show Io Example (posted in Monday slides)
- Map Projections

- Reading: Chapter 9 ("Environmental" Remote Sensing")
  - Once again -- Satellites old but principles still apply

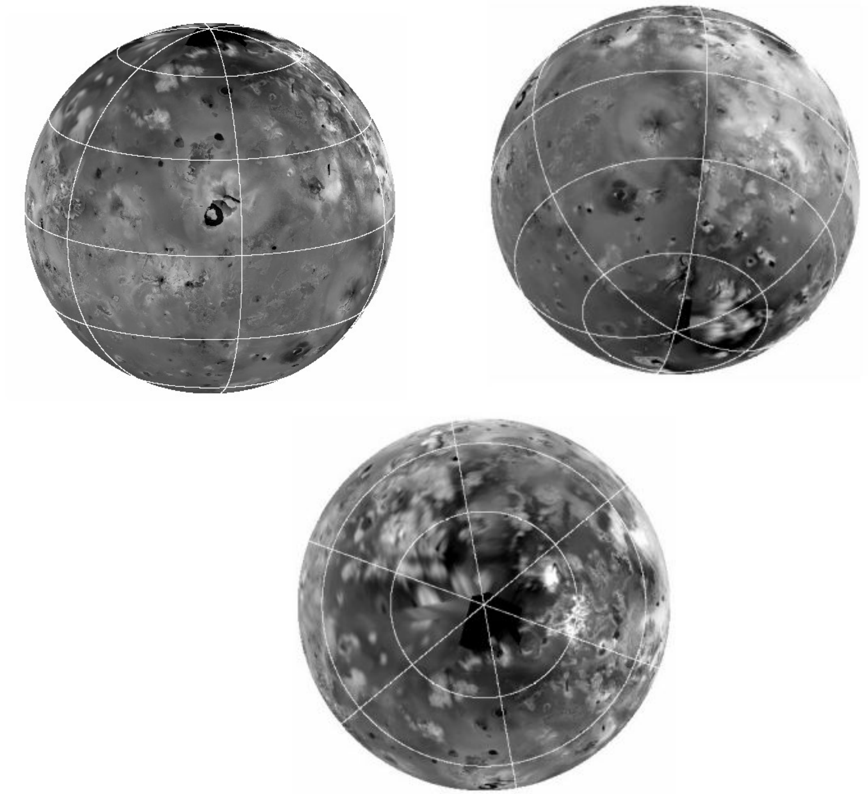
Map Projections

- If region covered is large enough, you must consider the curvature of the Earth
- Impossible to display curved surface on flat paper (or computer screen) without some distortion.
- Standard map "projections" define the distortion
  - Can be geometric "projection" or more complicated math formulae
    - "Project" sphere (or ellipsoid) onto a (rolled up) plane (then if necessary unroll plane)
  - Different projections have different advantages/disadvantages
    - Mercator good for navigation because azimuth (compass) directions correct
    - Mercator bad for estimating size of regions – exaggerates high latitudes
  - All can be reduced to a pair of formula for converting (latitude, longitude,) = (λ,ϕ) into (x, y)
  - Notation: Lines of latitude = "parallels", Lines of longitude = "meridians"
- John P. Snyder, 1987 "Map Projections – A Working Manual"
  - USGS Professional Paper 1395, available on USGS web site

Orthographic Projection

- "True perspective" image – as if taken from a very large distance
- "Sub-satellite" location is presented "without distortion"
- Locations towards the "limb" are badly foreshortened

Orthographic projection of earth – from location over equator. From Wikipedia



Orthographic projections of Io from different locations

Distortion: “Tissot's Indicatrix”

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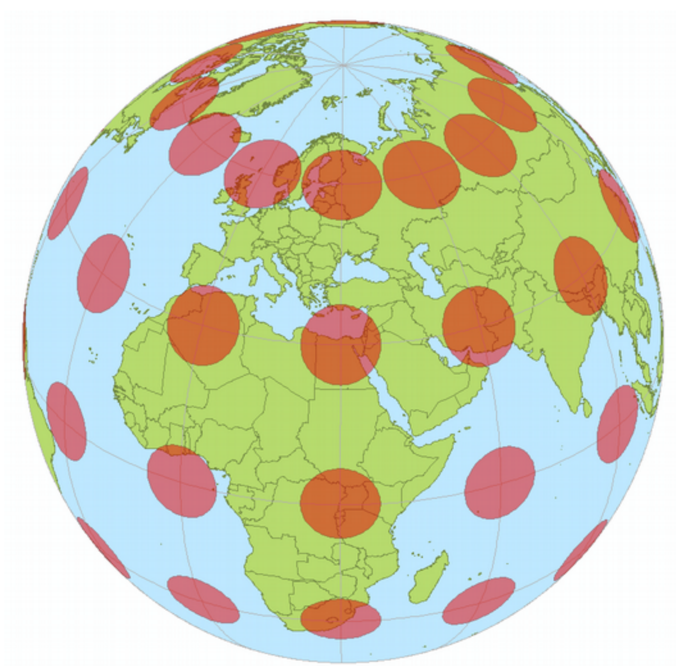
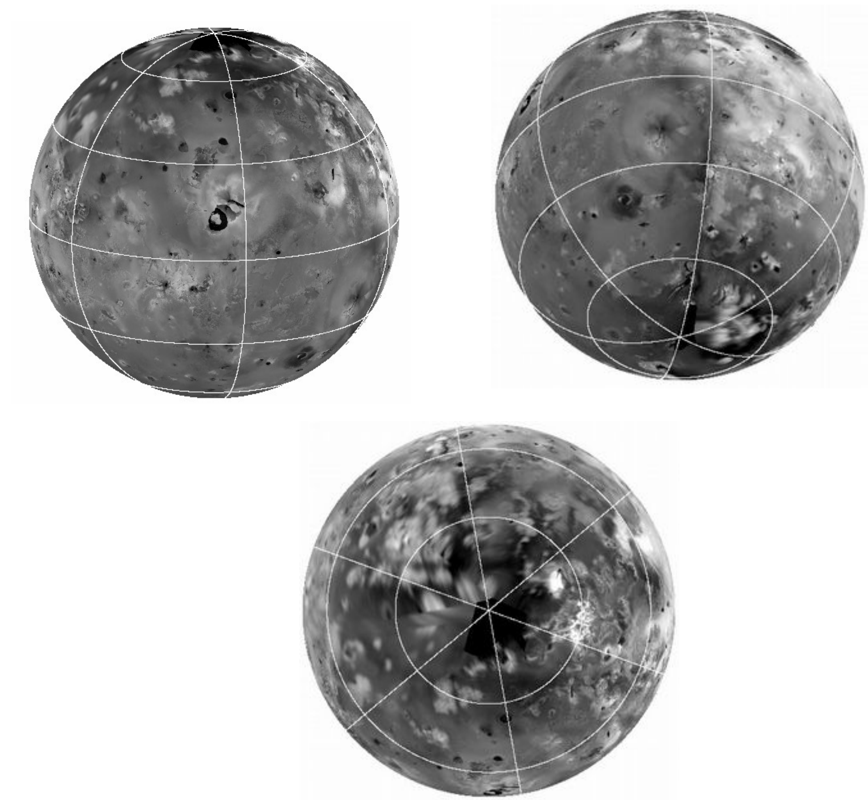
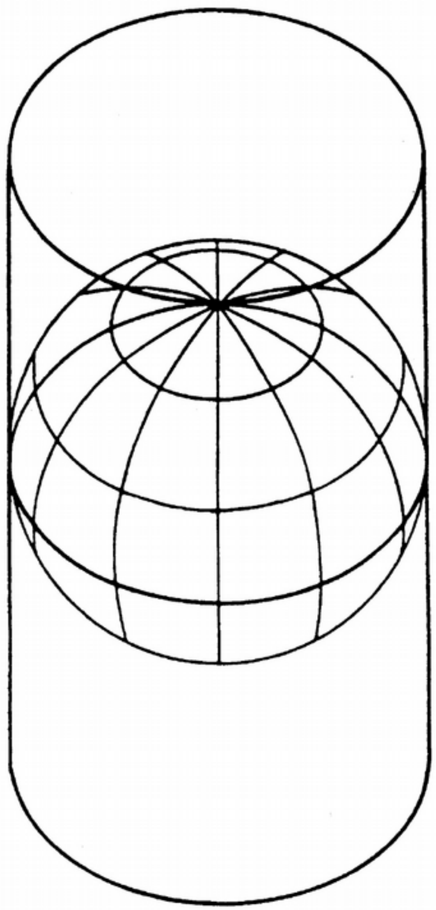


Tisso't Indicatrix for orthographic projection
From Wikipedia



Orthographic projections of Io from different locations

“Regular” Cylindrical Projections

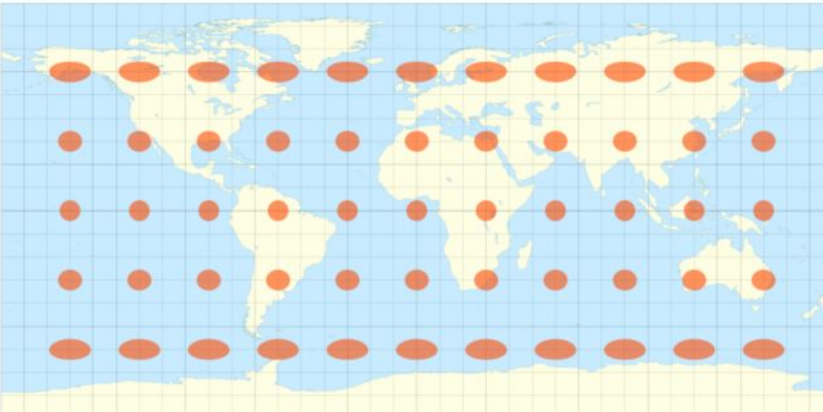


C. Regular cylindrical (Mercator).

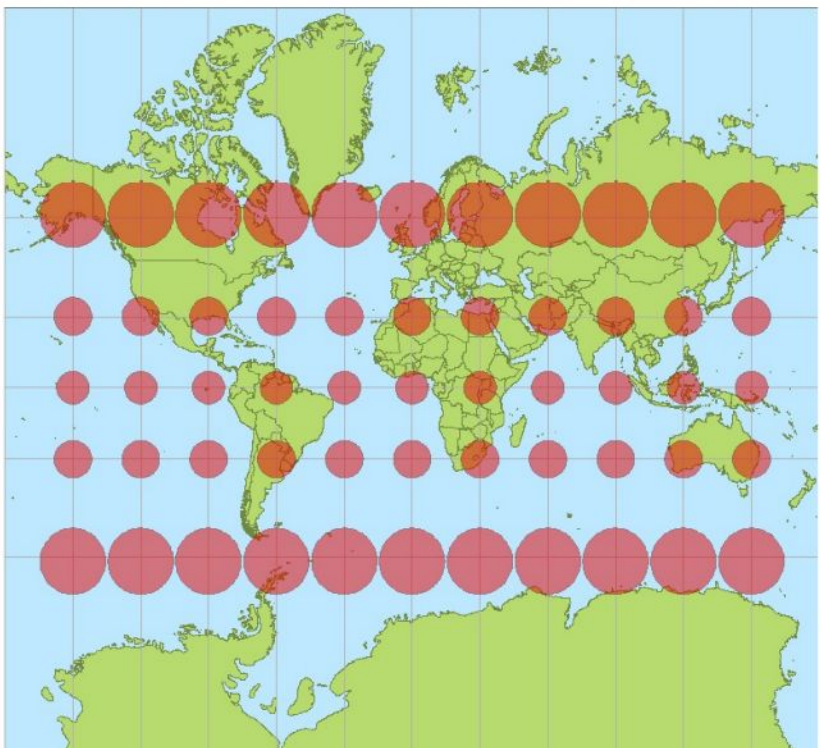
From our text by Sabins

- “Regular” cylindrical projections align cylinder with rotation axis
- Different versions plot latitudes differently
- Only one or two latitudes (usually equator) can be plotted without distortion
  - Equirectangular Plate Carrée (flat square)
    - $x = \phi$, $y = \lambda$ produces 2 x 1 rectangle
    - Simple conversion (useful for computer storage)
  - Mercator
    - Preserves azimuth (compass) directions
    - Can’t extent to poles (y would be infinite)
  - Miller
    - Compromise between above two

Distortion in Cylindrical Projections



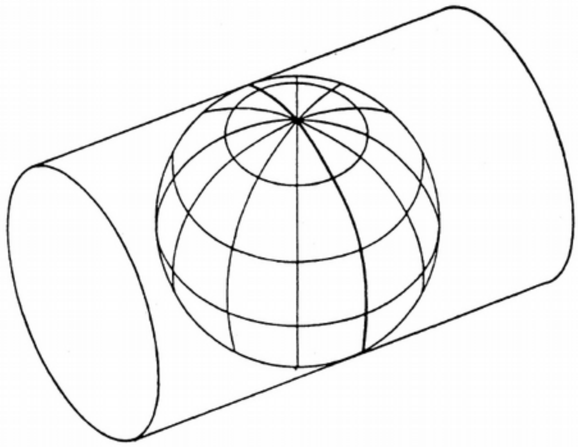
- In all regular cylindrical projections the horizontal scale becomes “infinitely large” as you approach latitudes $\pm 90^{\circ}$
- Plate Carrée keeps the vertical scale constant for all latitudes
  - Different horizontal and vertical scales means shapes and directions are distorted



- Mercator stretches the vertical scale just as much as the horizontal scale as you increase latitude
  - Shapes and directions remain correct (i.e. they are “conformal”) but sizes grow infinitely large at high latitudes
- True circles of constant size are “Tissot's Indicatrix”, used to indicate amount of distortion

Images from Wikipedia

Transverse Cylindrical Projections



D. Transverse cylindrical (Transverse Mercator).

From our text by Sabins

- Regular cylindrical has distortion at arbitrary latitude.
- Transverse cylindrical projections use a sideways cylinder
  - Line of contact between sphere and cylinder is some (arbitrary) meridian (line of longitude) instead of the equator
- Instead of being distortion free along the equator, it is distortion free along that line of longitude
- Transverse Mercator" maps are transverse cylindrical, with "Mercator-like" projections in the opposite direction
- Universal Transverse Mercator maps are Transverse Mercator, with a set of standard choices for different lines of longitude (zones) and other constants
  - Used for USGS 7.5 minute quad series
  - Basis for UTM coordinate systems

UTM Zone System

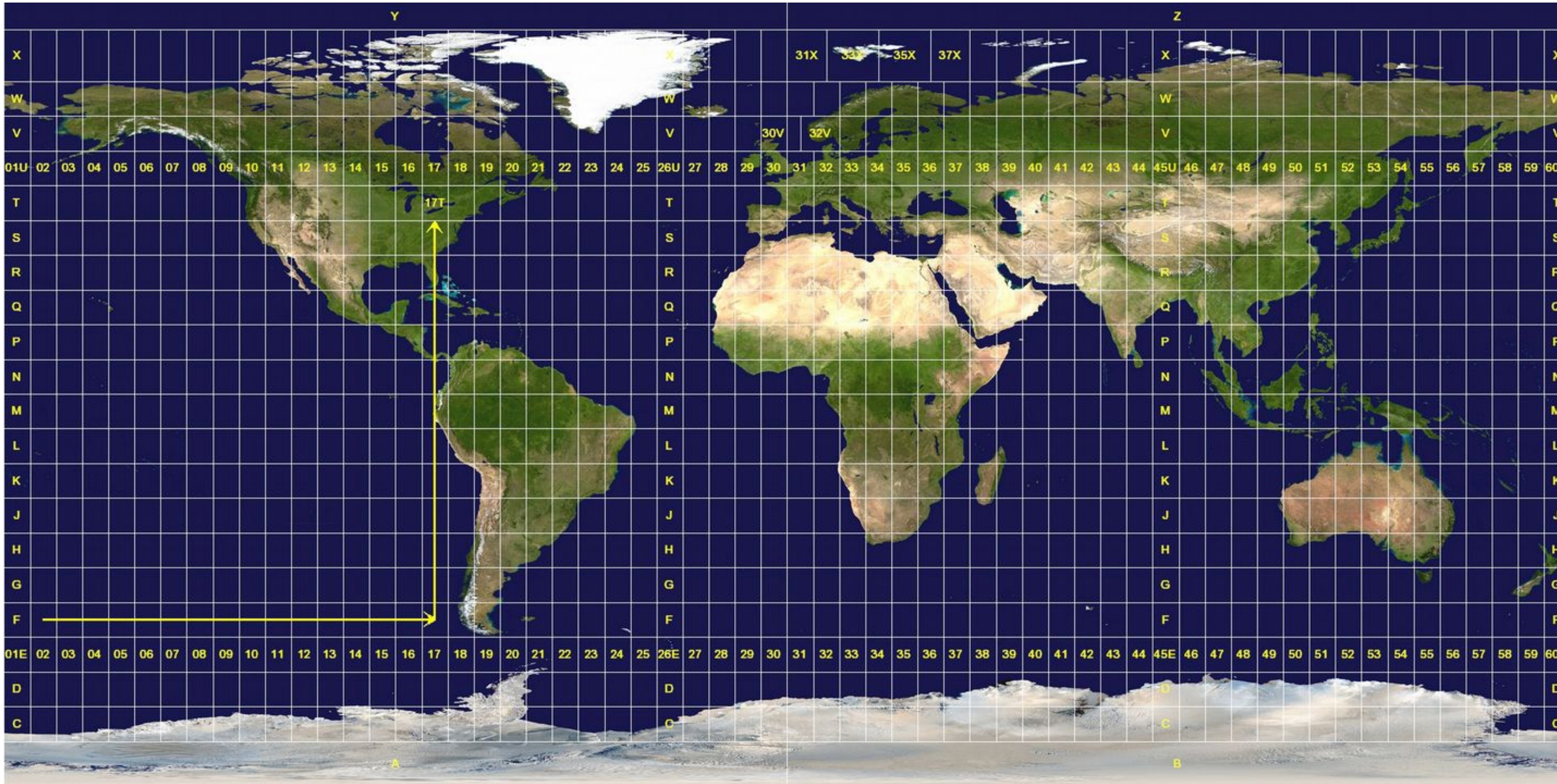


Image from Wikipedia

- UTM System has
  - 60 standard longitudes zones 1 – 60
  - 20 standard latitude zones denotes by letters
- UTM coordinates measure “projected” distance N from equator, and E within that zone relative to the zone’s standard meridian

Oblique Cylindrical Projections

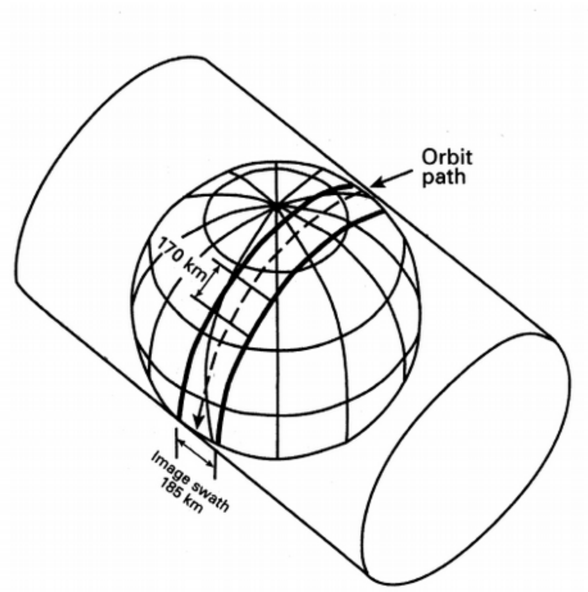
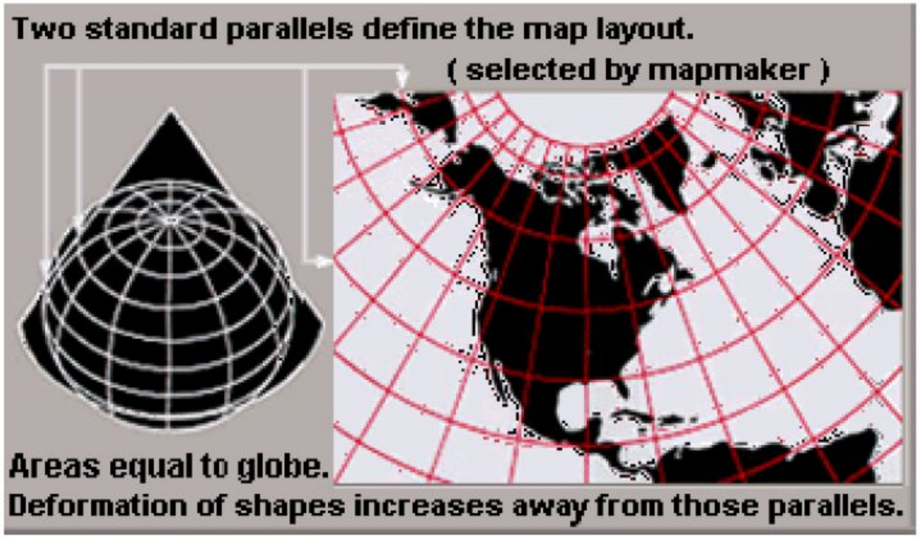


Figure 8-13 Space Oblique Mercator projection of Landsat images.

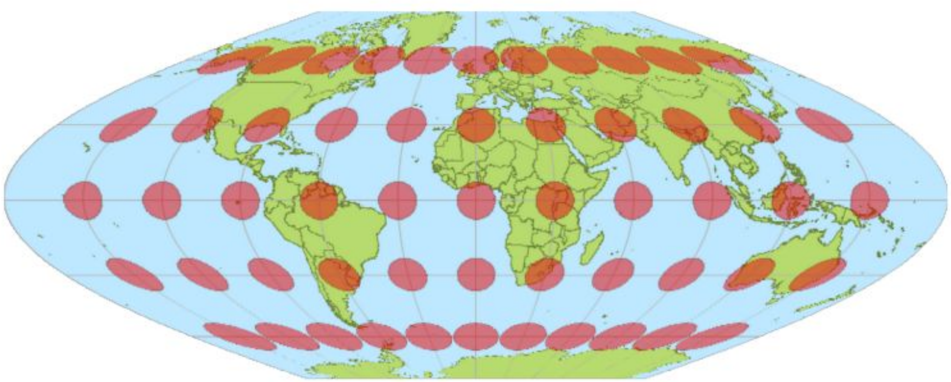
From Sabins text

- Oblique cylindrical projections use a contact circle between the sphere and the cylinder which is neither a line of latitude or a line of longitude
  - No distortion along that "great circle"
- Choosing the circle which matched a satellite's orbit plane would be ideal for satellite mapping except the Earth rotates beneath the orbit plane.
- Space Oblique Mercator projections contain additional "fudges" to compensate for the Earth's rotation.
  - Used for Landsat
  - Scale constant over 185-km swath by 170-km length to within 0.015%
- Software can convert images to different projections if needed.
- Later lab will explore "georeferencing" Landsat data

Other Projections



- Conical – project onto cone then "unroll" the cone



- Various pseudo-cylindrical projections typically limit the stretching of the horizontal scale as one approaches the poles – as a compromise between distorting shapes and stretching sizes.
- "Sinusoidal" keeps E-W scale constant, preserving area at the expense of shape and angle.

From Wikipedia