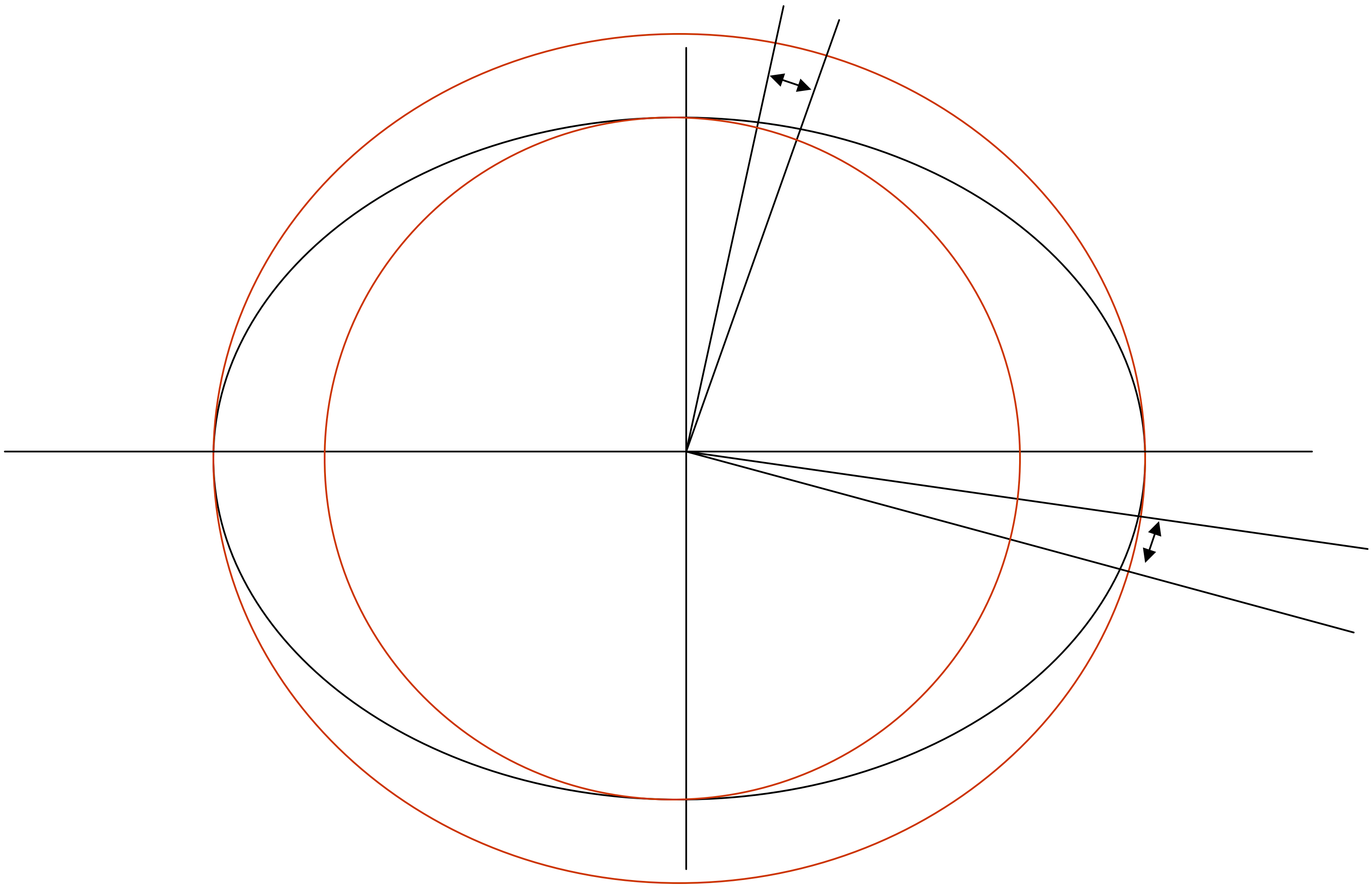
Is a degree of latitude, measured along a meridian, longer at the pole than the equator?

Length of a degree

http://www.csgnetwork.com/degreelenllavcalc.html

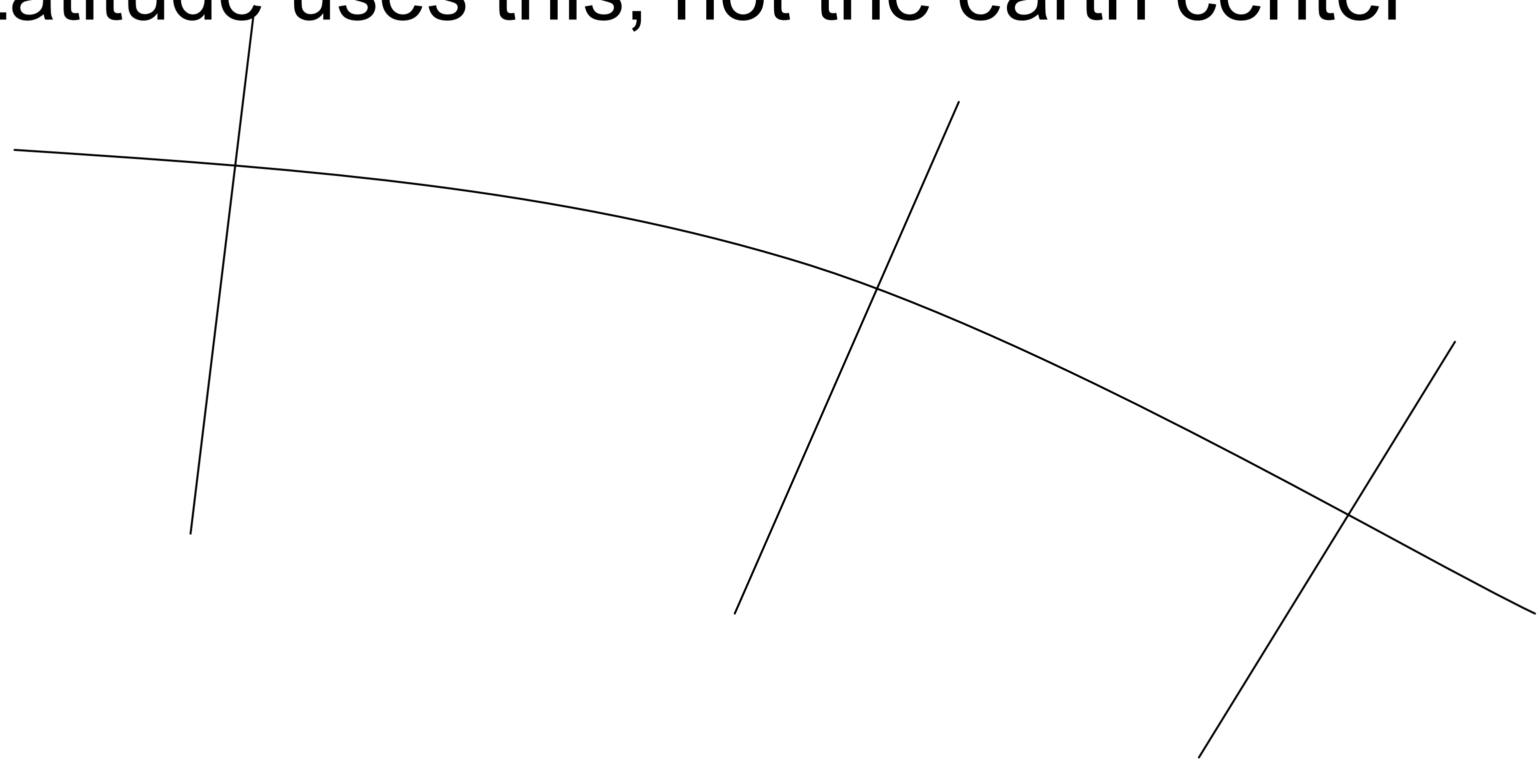
Latitude	**Length of 1 Degree of Latitude**
0	110574.27m
45	111131.75m
90	111693.92m

Counterintuitive?

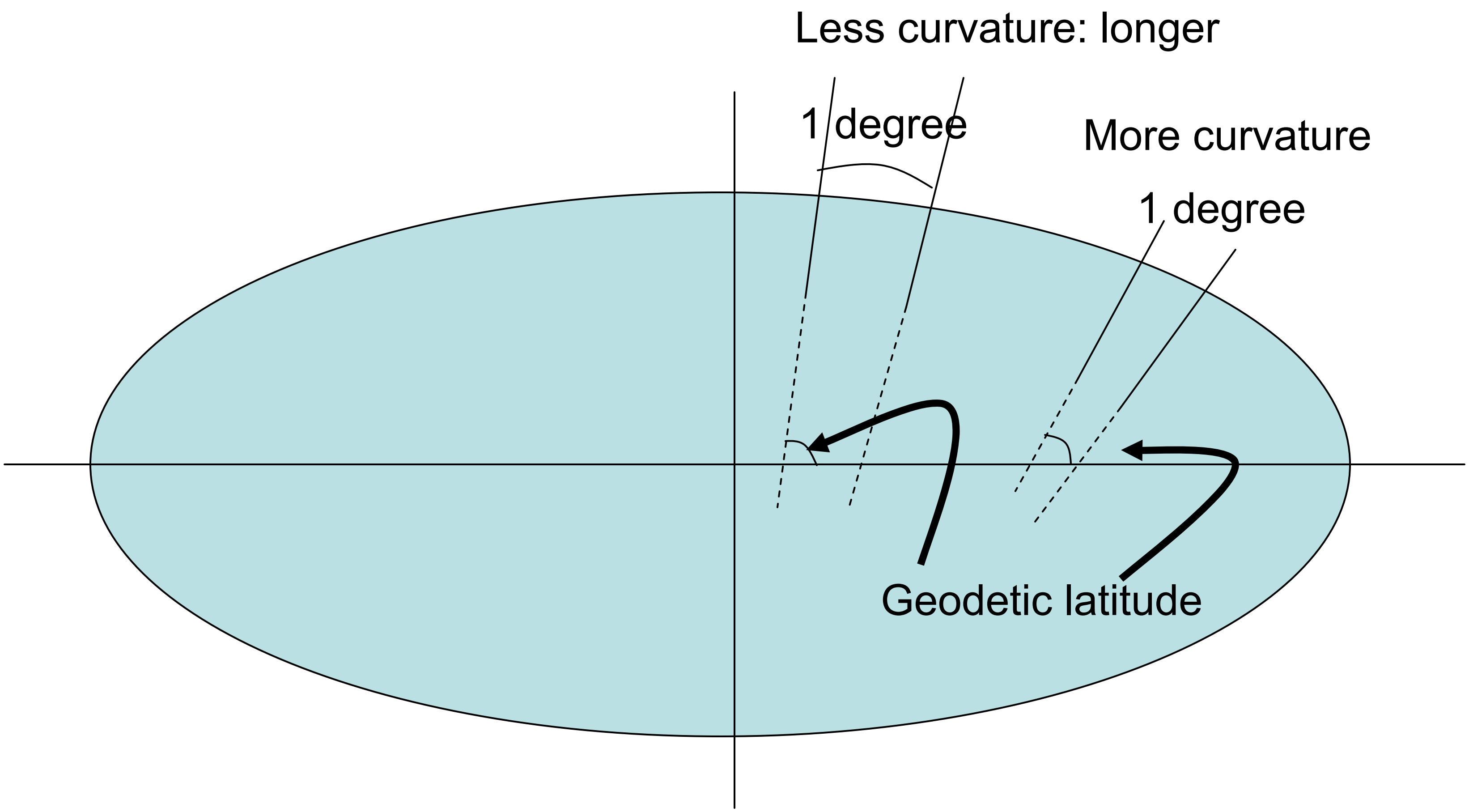


But…ellipsoidal “geodetic” latitude is not geocentric!

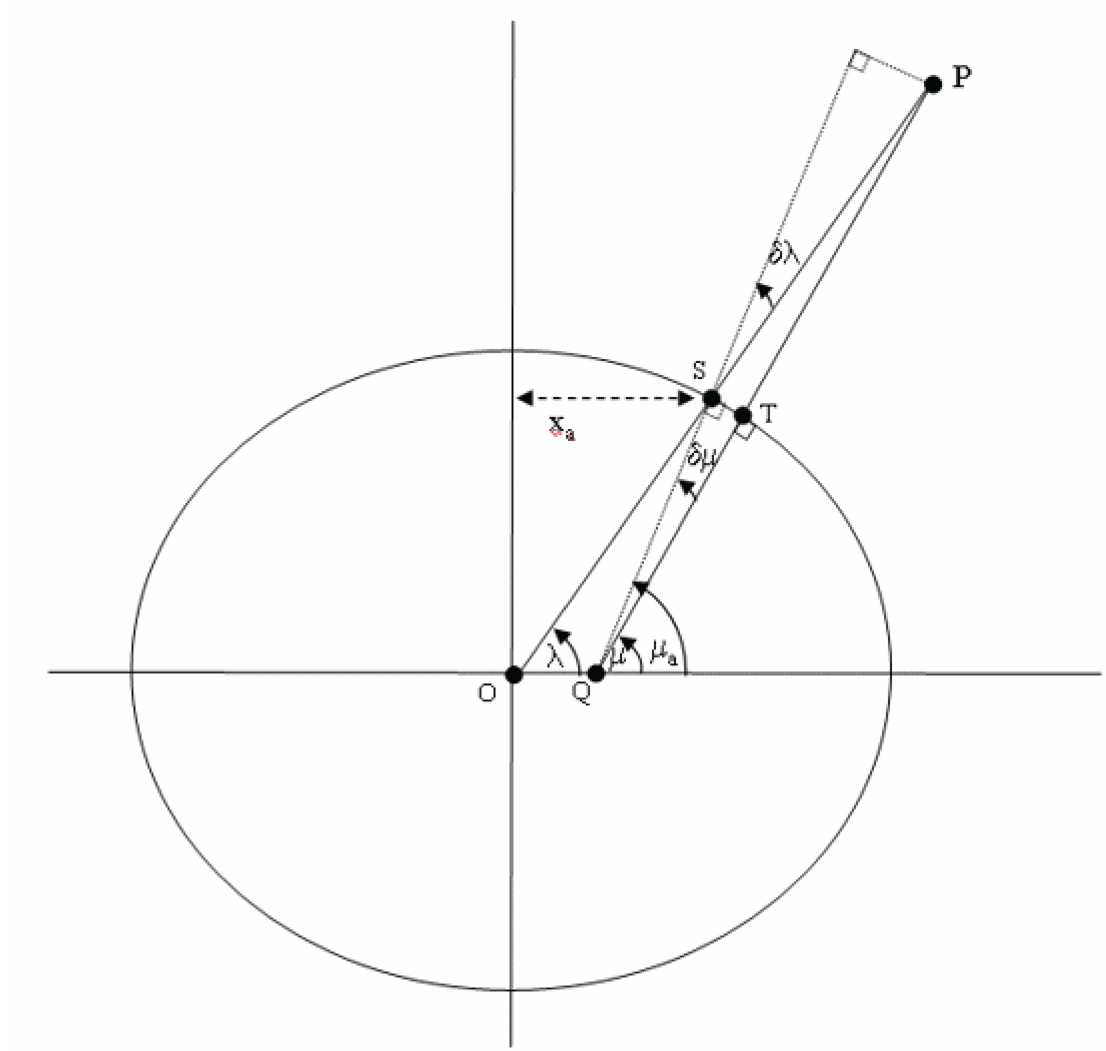
- Surface normal and the deflection of the vertical
- Latitude uses this, not the earth center



So, on the ellipsoid



Geodetic to geocentric



If geocentric: Calculate Length of an elliptical arc

- For a circle, arc length = 2 pi R A/360
- But for an ellipse, lengths are more complex
- Involves either approximation (Simpson's Rule or Prismoidal formula) or elliptic integrals
- More generic Vincenty formulation with code: (http://www.movable-type.co.uk/scripts/latlong-vincenty.html)

Distance along any geodesic line on the ellipsoid

a, b = major & minor semiaxes of the ellipsoid
f = flattening $(a-b)/a$
WGS-84 a = 6 378 137 m (±2 m) b = 6 356 752.3142 m f = 1 / 298.257223563
$\varphi 1$, $\varphi 2$ = geodetic latitude
L = difference in longitude
$U1 = \text{atan}((1-f).\tan\varphi 1)$ *(U is 'reduced latitude')*
$U2 = \text{atan}((1-f).\tan\varphi 2)$
$\lambda = L$, $\lambda' = 2\pi$ while $\text{abs}(\lambda-\lambda') > 10\text{-}12$ { *(i.e. 0.06mm)*
$\sin\sigma = \sqrt{[(\cos U2.\sin\lambda)^2 + (\cos U1.\sin U2 - \sin U1.\cos U2.\cos\lambda)^2]}$(14)
$\cos\sigma = \sin U1.\sin U2 + \cos U1.\cos U2.\cos\lambda$(15)
$\sigma = \text{atan2}(\sin\sigma, \cos\sigma)$ (16)
$\sin\alpha = \cos U1.\cos U2.\sin\lambda / \sin\sigma$(17)
$\cos^2\alpha = 1 - \sin^2\alpha$ *(trig identity; §6)*
$\cos 2\sigma m = \cos\sigma - 2.\sin U1.\sin U2/\cos^2\alpha$(18)
$C = f/16.\cos^2\alpha.[4+f.(4-3.\cos^2\alpha)]$ (10)
$\lambda' = \lambda$ $\lambda = L + (1-C).f.\sin\alpha.\{\sigma+C.\sin\sigma.[\cos 2\sigma m+C.\cos\sigma.(-1+2.\cos^2 2\sigma m)]\}$(11)}
$u^2 = \cos^2\alpha.(a^2-b^2)/b^2$
$A = 1+u^2/16384.\{4096+u^2.[-768+u^2.(320-175.u^2)]\}$ (3)
$B = u^2/1024.\{256+u^2.[-128+u^2.(74-47.u^2)]\}$ (4)
$\Delta\sigma = B.\sin\sigma.\{\cos 2\sigma m+B/4.[\cos\sigma.(-1+2.\cos^2 2\sigma m) - B/6.\cos 2\sigma m.(-3+4.\sin^2\sigma).(-3+4.\cos^2 2\sigma m)]\}$(6)
$s = b.A.(\sigma-\Delta\sigma)$(19) $\alpha 1 = \text{atan2}(\cos U2.\sin\lambda, \cos U1.\sin U2 - \sin U1.\cos U2.\cos\lambda)$(20)
$\alpha 2 = \text{atan2}(\cos U1.\sin\lambda, -\sin U1.\cos U2 + \cos U1.\sin U2.\cos\lambda)$(21)
Where:
s is the distance (in the same units as a & b) $\alpha 1$ is the initial bearing, or forward azimuth
$\alpha 2$ is the final bearing (in direction p1→p2)

Solved first by measurement!