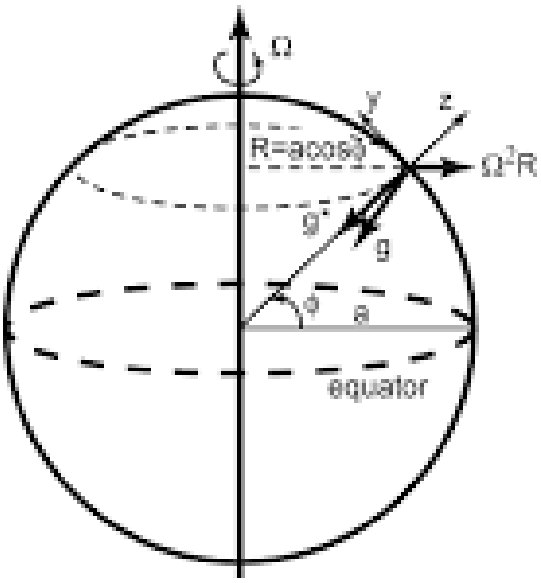
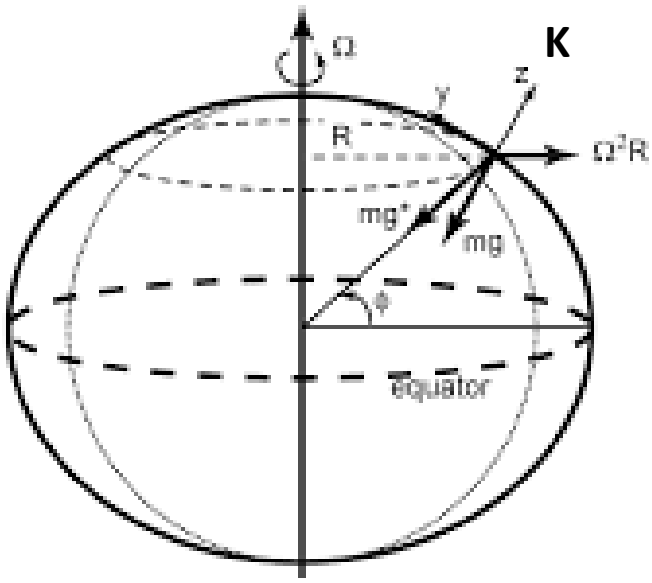
Normal (or called Effective) Gravity

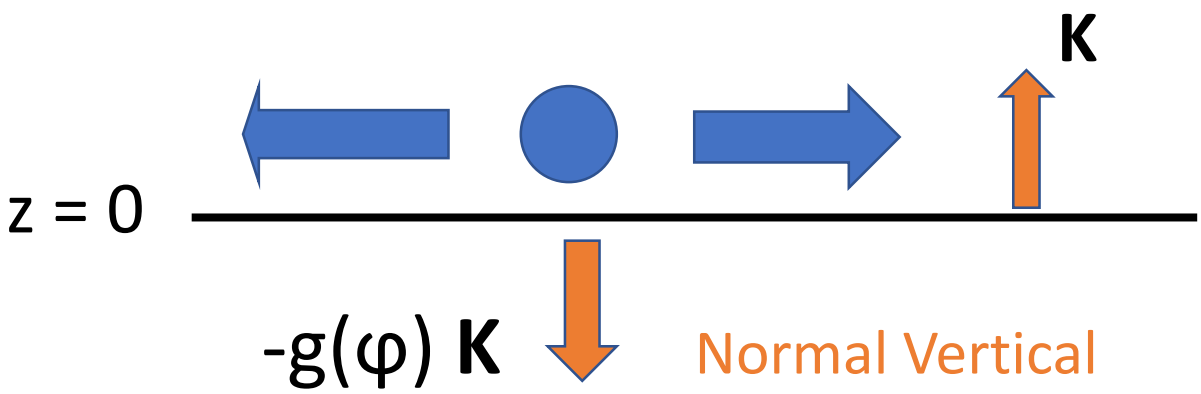
(Uniform Mass Density inside the Solid Earth)

Normal Geopotential Surface = z Surface

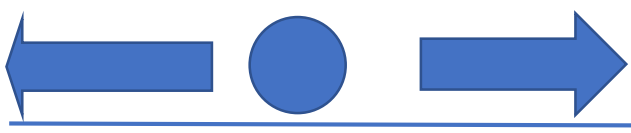




The two figures are from the website:
https://atoc.colorado.edu/~cassano/atoc5050/Lecture_Notes/hh_ch1.pdf



z = constant
Normal Horizontal



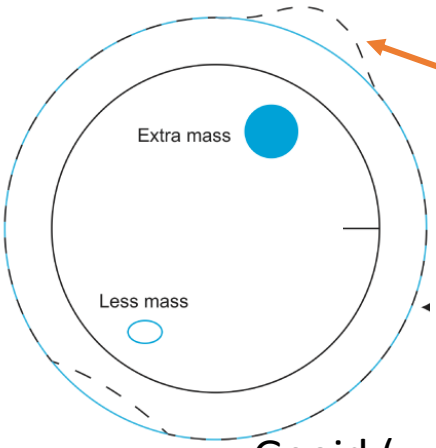
Normal Geopotential Surface

Any movement on z = constant (i.e., z surfaces) is not against the effective gravity.
The normal geopotential surface coincides with the z-surface.

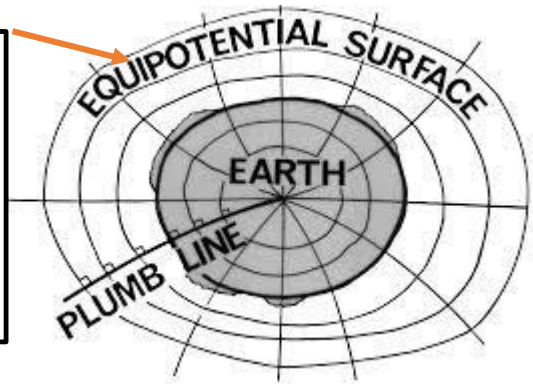
True Gravity

(Non-uniform Mass Density inside the Solid Earth): $g(\lambda, \varphi, z) = -g(\varphi)\,\mathbf{K} + \delta\mathbf{g}$

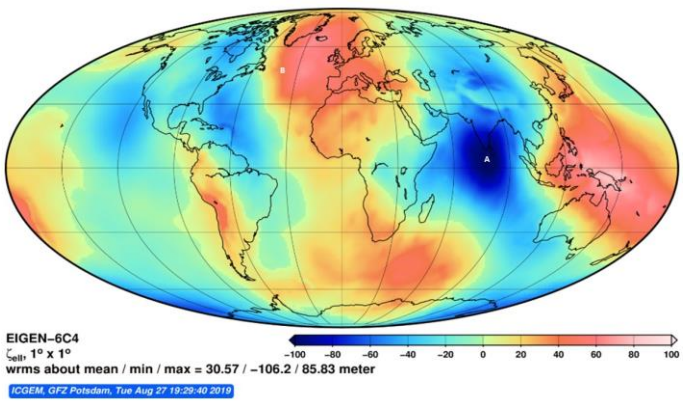
$\delta\mathbf{g}$ = Gravity Disturbance



Equipotential Corresponding to true gravity Is the True Geopotential

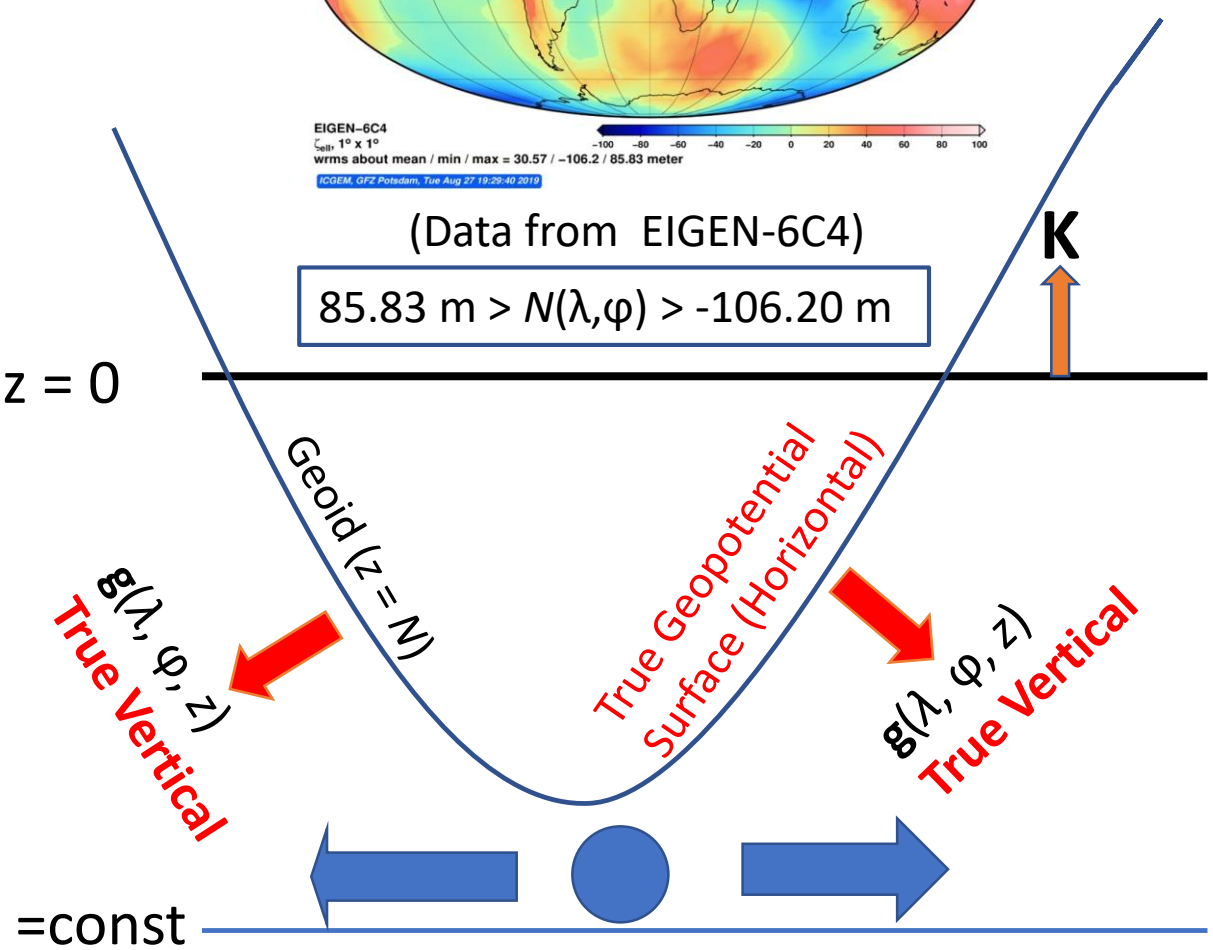


Geoid ($z = N$) is an equipotential surface at top ocean



(Data from EIGEN-6C4)

85.83 m > $N(\lambda,\varphi)$ > -106.20 m



(1) Any movement along the geoid surface (true horizontal surface) , z= N(λ,φ), (-106.20 m to 85.83 m, from EIGEN-6C4) is not against the true gravity.

(2) Any movement on the z-surface is against the true gravity. An additional force, Gravity Disturbance, shows up in the z-surface momentum equations.