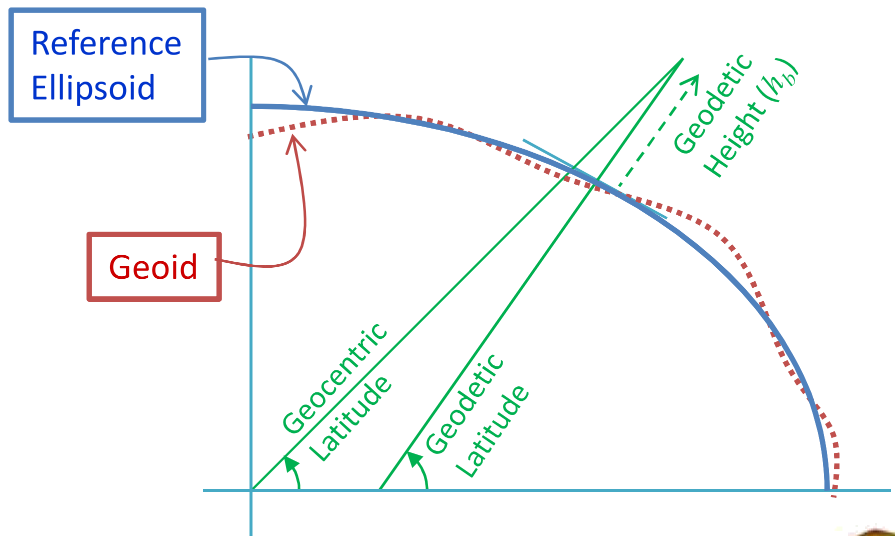
Earth Shape

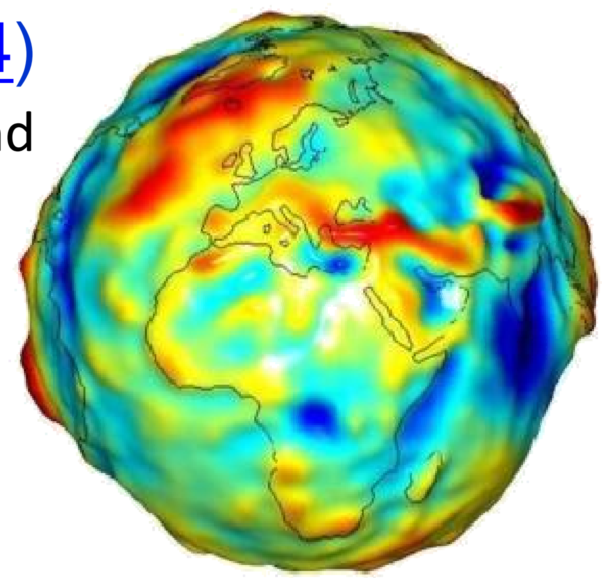
Geoid and Reference Ellipsoid

Geoid: Gravitational equipotential surface which “best” fits (in a least square sense) the mean sea level

Reference Ellipsoid: A mathematical approximation to the geoid



- The World Geodetic System (WGS 84)
  - Provides a model for the geoid, earth rate, and gravity
    - This model is used by the Global Positioning System (GPS)
    - The max. difference between the ref. ellipsoid and the geoid is +3 meters to -51 meters (approx).



NASA's Grace Gravity Model

Specific Force, Gravitation, and Gravity

- Specific force is the non-gravitational force per unit-mass
  - Gravitational force is mass attraction $\vec{\gamma}_{ib}^{?}$
  - Specific force sensed when stationary is referred to as the acceleration due to gravity g_b
- The centrifugal term is $\omega_e^2 r_e \simeq \left(73\times10^{-6}\right)^2 6.4\times10^6 = 0.034\, m/s^2$
  - This is at the equator
- The gravitational force is ~9.8m/s^2 on the surface of the ellipsoid

$$\vec{g}_b^{?} = \vec{\gamma}_{ib}^{?} - \Omega_{ie}^{?}\Omega_{ie}^{?}\vec{r}_{ib}^{?} \qquad \vec{f}_{ib}^{b} = \vec{a}_{ib}^{b} - \vec{g}_b^{b}$$

Gravitational force ≠ acceleration due to gravity

Geodetic to ECEF Position

$$\vec{r}_{eb}^{\,e} = \begin{bmatrix} x_{eb}^e \\ y_{eb}^e \\ z_{eb}^e \end{bmatrix} = \begin{bmatrix} (R_E + h) Cos(L_S) Cos(\lambda_b) \\ (R_E + h) Cos(L_S) Sin(\lambda_b) \\ \left(R_E(1-e^2) + h\right) Sin(L_S) \end{bmatrix}$$