Introduction to Global Navigation Satellite System (GNSS) Coordinate Systems, Datum, Geiod

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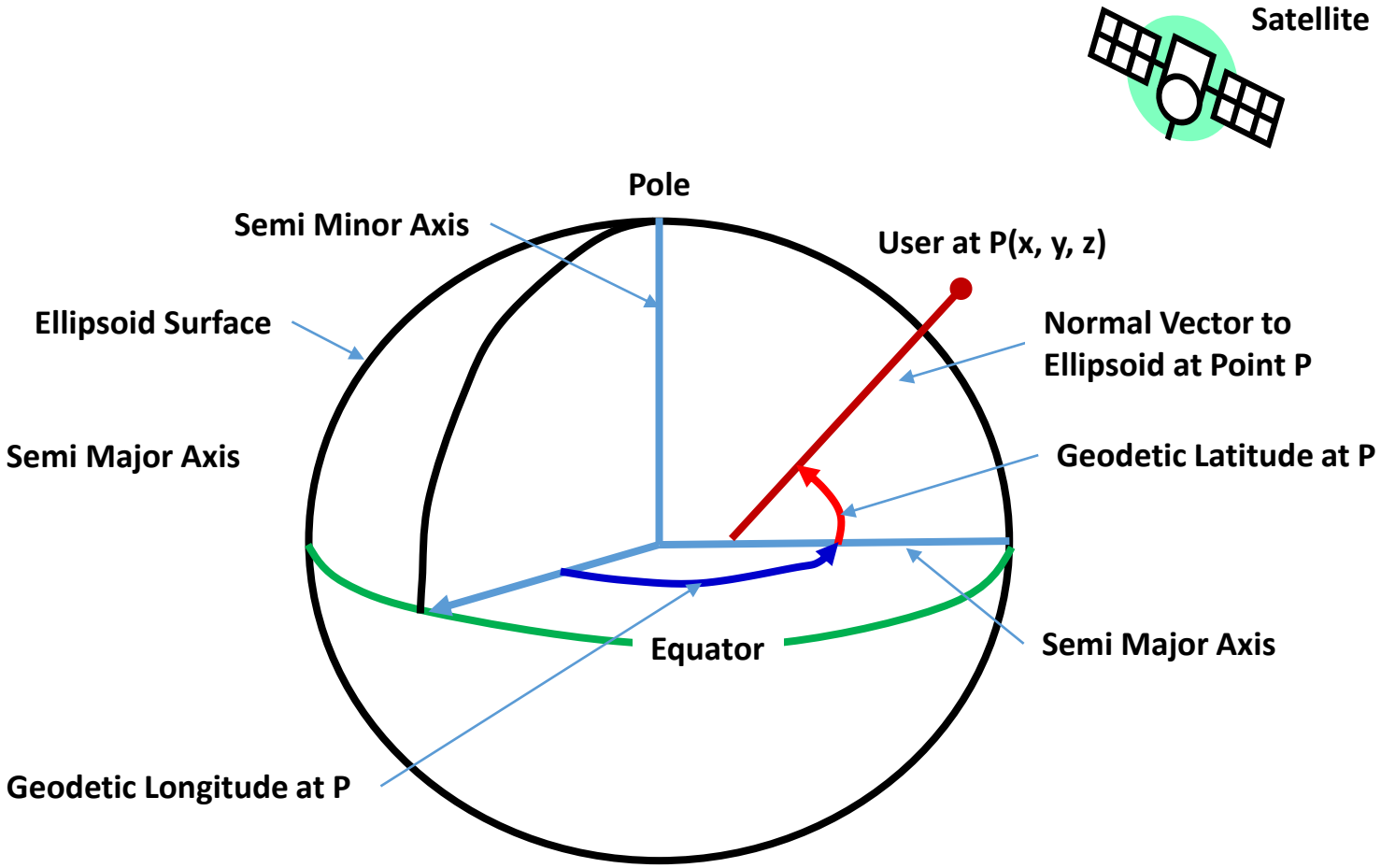
Geodetic Coordinate System



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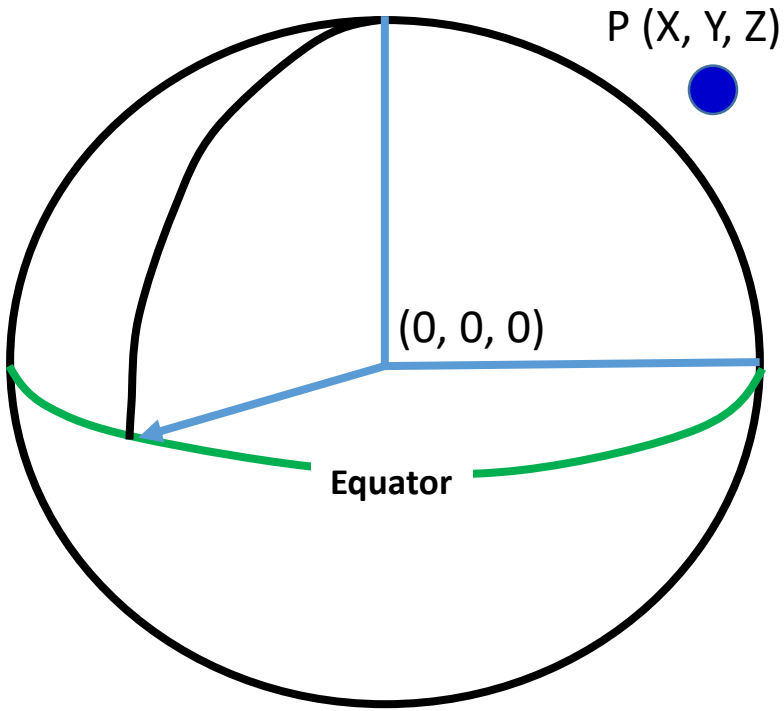
ECEF (Earth Centered, Earth Fixed)

ECEF Coordinate System is expressed by assuming the center of the earth coordinate as (0, 0, 0)



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Coordinate Conversion from ECEF to Geodetic and vice versa

Geodetic Latitude, Longitude & Height to ECEF (X, Y, Z)

$$X = (N + h)\cos\varphi\cos\lambda$$

$$Y = (N + h)\cos\varphi\sin\lambda$$

$$Z = [N(1 - e^2) + h]\sin\varphi$$

$\varphi = Latitude$
$\lambda = Longitude$
H = Height above Ellipsoid

ECEF (X, Y, Z) to Geodetic Latitude, Longitude & Height

$$\varphi = \text{atan}\left(\frac{Z + e^2 b\sin^3\theta}{p - e^2 a\cos^3\theta}\right)$$

$$\lambda = \text{atan2}(Y, X)$$

$$h = \frac{P}{\cos\varphi} - \text{N}(\varphi)$$

$$P = \sqrt{x^2 + y^2}$$

$$\theta = atan\left(\frac{Za}{Pb}\right)$$

$$N(\varphi) = \frac{a}{\sqrt{1 - e^2\sin^2\varphi}}$$

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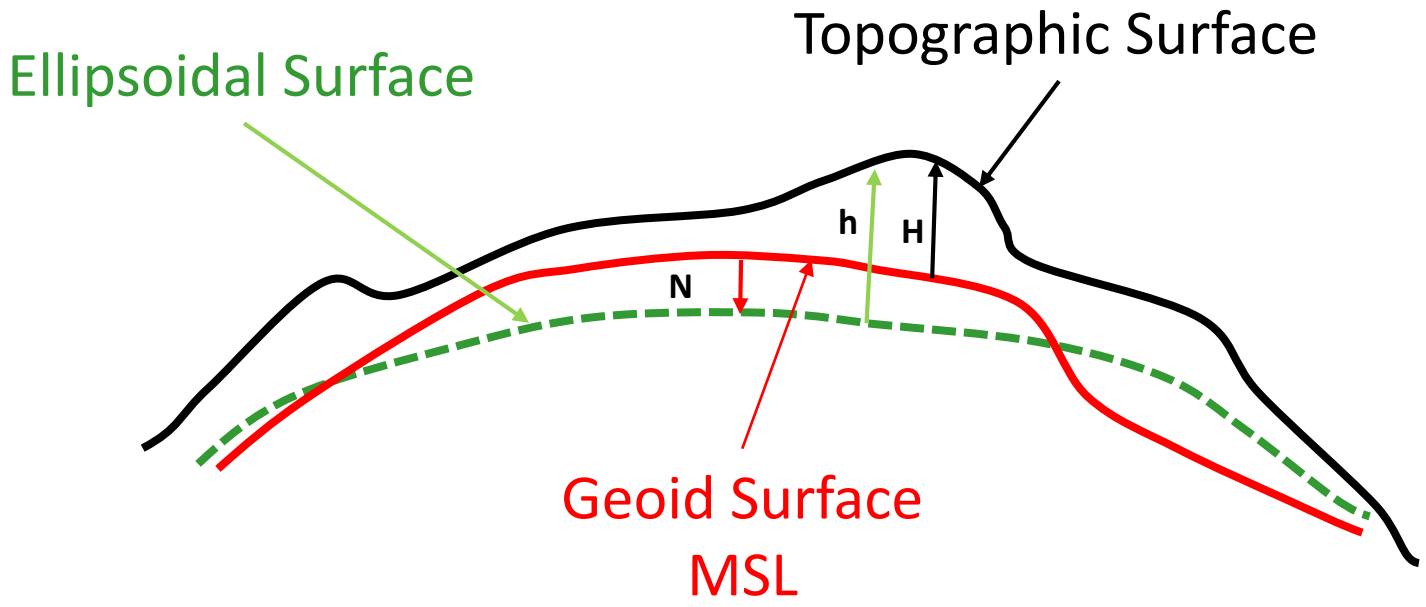
Topographic, Ellipsoidal & Geoid Height



Topographic Height (H) = Ellipsoidal Height (h) - Geoid Height (N)

- Geoid Model is based on Gravitation Measurement
- In USA, Ellipsoid is above Geoid
- Other Continents, Geoid is above Ellipsoid

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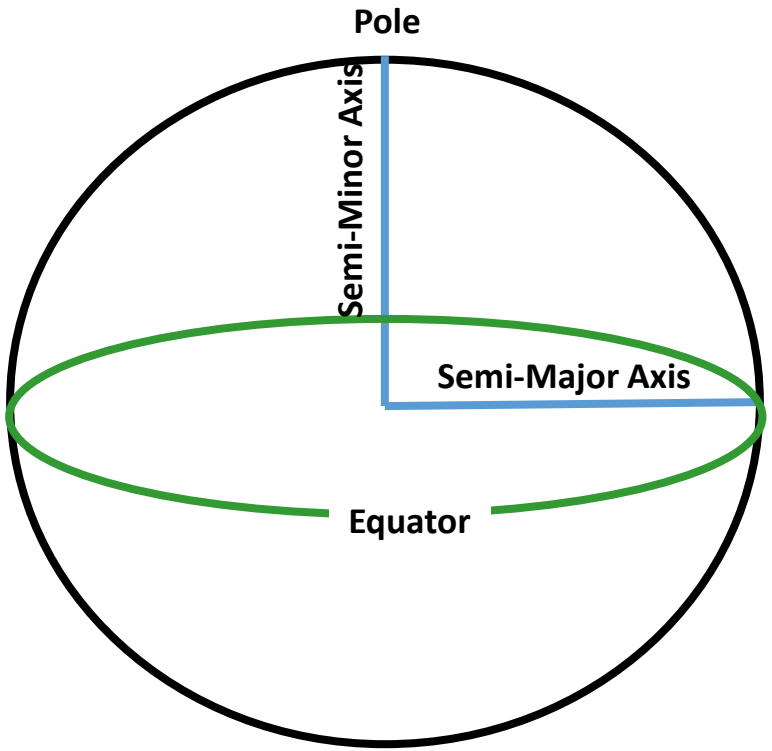
Geodetic Datum: Geometric Earth Model



WGS-84 Geodetic Datum Ellipsoidal Parameters

Semi-Minor Axis, b = 6356752.3142m

Semi-Major Axis, a = 6378137.0m

Flattening, f = (a-b)/a

= 1/298.257223563

First Eccentricity Square = e^2 = 2f-f^2

= 0.00669437999013

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