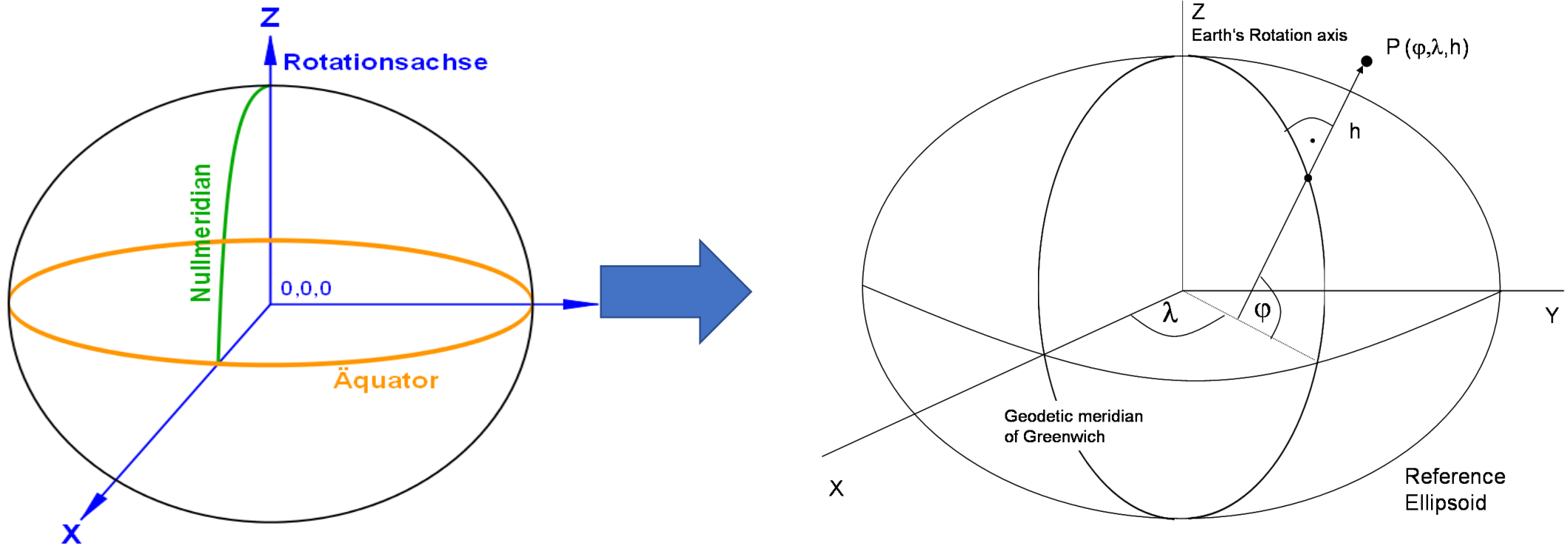


Conversion of ECEF – coordinates (X,Y,Z) to geodetic coordinates Latitude φ , Longitude λ and ellipsoidal height h



Constants of reference ellipsoid

Reference ellipsoid - WGS84

Semi major axis	$a = 6378\,137,000\text{m}$
First eccentricity	$e^2 = 0.00669437999013$
Semi minor axis	$b = a \cdot \sqrt{1 - e^2}$ $= 6356\,752.3142\text{m}$
Second eccentricity	$e'^2 = \frac{e^2}{1 - e^2}$ $= 0.00673949674226$

Conversion of ECEF – coordinates (X,Y,Z) to geodetic coordinates Latitude φ , Longitude λ and ellipsoidal height h

Starting with Earth Centred Earth Fixed (ECEF) coordinates X,Y,Z:

$$X = 4146524.660 \text{ m}$$

$$Y = 613137.825 \text{ m}$$

$$Z = 4791516.962 \text{ m}$$

The latitude φ , longitude λ and the ellipsoidal height h are calculated

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The longitude λ is calculated directly as

$$\lambda = \tan^{-1} \left(\frac{Y}{X} \right) = \tan^{-1} \left(\frac{613\,137.825\text{m}}{4\,146\,524.660\text{m}} \right) = 8,411255267^\circ$$

Calculation of auxiliary values

$$p = \sqrt{(X^2 + Y^2)} = \sqrt{(4\,146\,524.660^2 + 613\,137.825^2)} = 4191611,23536 \text{ m}$$

$$\theta = \tan^{-1} \left(\frac{Z \cdot a}{p \cdot b} \right) = \tan^{-1} \left(\frac{4791516.962 \text{ m} \cdot 6378\,137,000\text{m}}{4\,191\,611.23536\text{m} \cdot 6\,356\,752.3142\text{m}} \right) = 48,91595499^\circ$$

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The latitude φ is now calculated as

$$\varphi = \tan^{-1} \left(\frac{Z + e'^2 \cdot b \cdot \sin^3 \theta}{p - e^2 \cdot a \cdot \cos^3 \theta} \right) = 49,01124240^\circ$$

Radius of curvature in prime vertical

$$N = \left(\frac{a}{\sqrt{1 - e^2 \cdot \sin^2 \varphi}} \right) = 6\,390\,336,0677 \text{ m}$$

Ellipsoidal height h

$$h = \frac{p}{\cos \varphi} - N = 182,8984 \text{ m}$$

Conversion of ECEF – coordinates (X,Y,Z) to geodetic coordinates Latitude φ , Longitude λ and ellipsoidal height h

Geodetic coordinates calculated

Latitude $\varphi = 49,01124240^\circ$

Longitude $\lambda = 8,411255267^\circ$

Ellipsoidal height h = 182,8984 m

Conversion of Latitude φ , Longitude λ and ellipsoidal height h to ECEF – coordinates (X,Y,Z)

Geodetic coordinates

Latitude $\varphi = 49,01124240^\circ$

Longitude $\lambda = 8,411255267^\circ$

ellipsoidal height $h = 182,8984 \text{ m}$

Calculation of X,Y,Z

$$X = (N + h) \cdot \cos \varphi \cdot \cos \lambda = 4\,146\,524.660 \text{ m}$$

$$Y = (N + h) \cdot \cos \varphi \cdot \sin \lambda = 613\,137.825 \text{ m}$$

$$Z = (N \cdot (1 - e^2) + h) \cdot \sin \varphi = 4\,791\,516.962 \text{ m}$$

$$\text{With } N = \left(\frac{a}{\sqrt{1 - e^2 \cdot \sin^2 \varphi}} \right) = 6\,390\,336,0677 \text{ m}$$