Geodesy Equations

The reference ellipsoid is defined with two parameters:

- **a = semi-major axis & b = semi-minor axis**
- **a = semi-major axis & f = flattening**
- **a = semi-major axis & e^2 = eccentricity squared**

Given one combination of the ellipsoid parameters, other elements are computed as (e'^2 is second eccentricity squared):

$$f = \frac{a-b}{a}, \qquad e^2 = \frac{a^2-b^2}{a^2}, \qquad e^2 = 2f - f^2$$

$$b^2 = a^2(1-e^2), \qquad e'^2 = \frac{a^2-b^2}{b^2} = \frac{e^2}{1-e^2}$$

Given one also knows the geodetic latitude, ϕ, the following quantities are also computed as:

N = Ellipsoid normal (radius of curvature perpendicular to meridian).
M = Radius of curvature in the meridian plane.
R_m = Geometrical mean radius of curvature at given latitude.

$$N = \frac{a}{\sqrt{1-e^2\sin^2\phi}}, \quad M = \frac{a(1-e^2)}{(1-e^2\sin^2\phi)^{3/2}}, \quad R_m = \sqrt{M\,N}$$

If longitude (east), λ, and ellipsoid height, h, are also known (watch units), the geocentric X, Y, Z coordinates of a point are computed as:

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

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

$$Z = (N(1-e^2)+h)\sin\phi$$

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