

DEFLECTION OF THE VERTICAL

The direction of the vertical is defined by a local plumbline. A survey instrument is set up with horizontal carefully established perpendicular to the vertical. The ellipsoid normal through the same point is perpendicular to the local tangent to the ellipse. Due to variations of gravity, the two are not necessarily coincident. The difference is called *deflection-of-the-vertical* and is important anytime a precise astronomical observation is made and the results need to be related to geodetic quantities. An example would be an astronomical observation for azimuth from which the geodetic azimuth at a station is computed. In triangulation a station where astronomical latitude, longitude, and azimuths were compared to geodetic latitude, longitude and azimuths computed in the triangulation network were called Laplace Stations.

The deflection of the vertical is typically given as north/south and east/west components in seconds of arc, denoting the slope of the geoid with respect to the ellipsoid. The deflection-of-the-vertical components are:

$$\text{North/south: } \xi = \xi \quad \text{East/west: } \eta = \eta$$

The relationships between astronomical latitude, longitude, and azimuth and geodetic latitude, longitude, and azimuth are:

$$\begin{array}{ll} \phi = \Phi - \xi & \text{latitude} \\ \lambda = \Lambda - \eta / \cos \phi & \text{longitude} \\ \alpha = A - \eta \tan \phi & \text{azimuth} \end{array}$$

where

$$\begin{array}{ll} \phi = \text{geodetic latitude} & \Phi = \text{astronomical latitude} \\ \lambda = \text{geodetic longitude} & \Lambda = \text{astronomical longitude} \\ \alpha = \text{geodetic azimuth} & A = \text{astronomical azimuth} \end{array}$$

With publication of the North American Datum of 1983 (NAD83) and related software products from the National Geodetic Survey (NGS) the deflection-of-the-vertical components are available from an NGS program called DEFLEC96. A sister program is called GEOID96 and gives the estimates geoid height. In each case, the user inputs a latitude/longitude position and the program provides the respective components and geoid height.

Rarely is it required or feasible to compute geodetic latitude or longitude from an observed astronomical position. But, it is still quite commonplace to observe an astronomical azimuth, either solar or Polaris, and compute the corresponding geodetic azimuth.