Geodetic Azimuths from the GSDM

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As shown in a video link, a rotation matrix is used to compute local coordinate differences from ECEF coordinate differences. Local Δe and Δn values are used in many applications.

- http://www.globalcogo.com/XYZ-to-enu.mp4

In addition to computing local undistorted distances, Δe and Δn values can also facilitate computation of azimuths from Earth-centered Earth-fixed (ECEF) geocentric coordinates. While a Mercator map enables one to sail a straight line bearing point-to-point, a geodetic line is the shortest distance between two points as shown in Figure No. 1. With due regard to quadrants, the geodetic line azimuth is computed as $\alpha = \text{atan}(\Delta e/\Delta n)$.

- http://www.globalcogo.com/3DGPSAZ.pdf

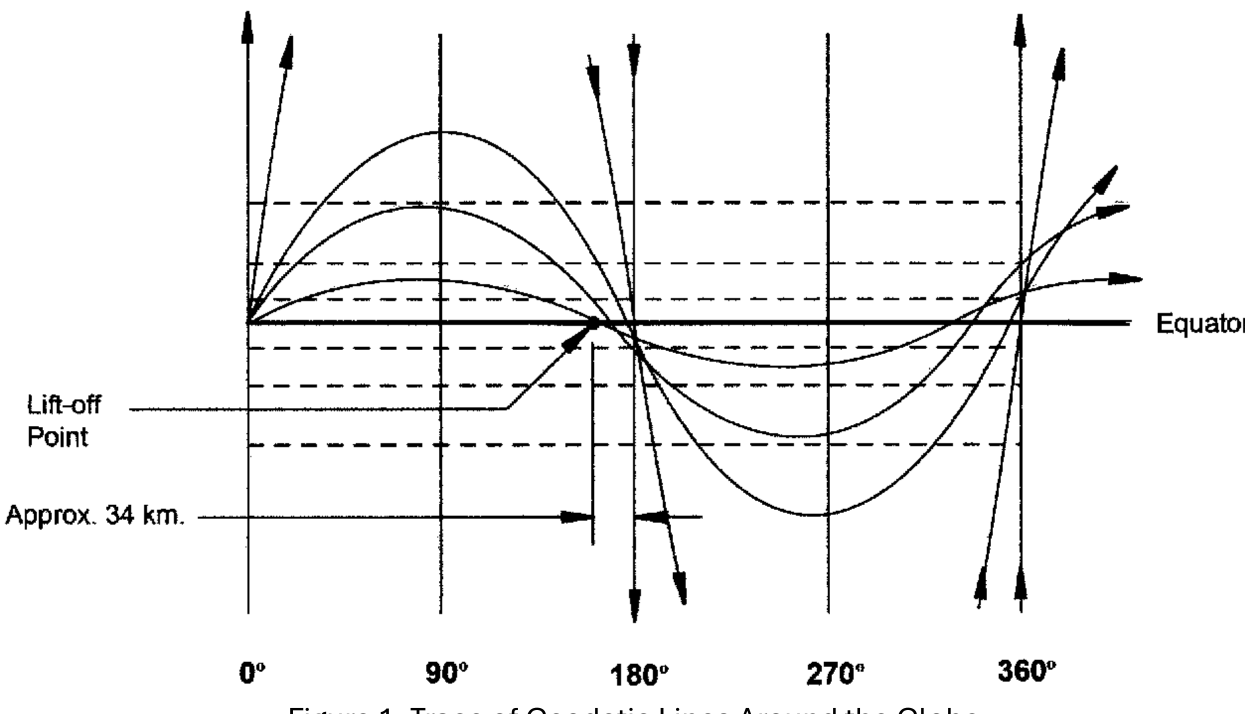

Figure 1. Trace of Geodetic Lines Around the Globe

In general, the GSDM facilitates computing the azimuth from any point to any other point given the ECEF coordinates of the end points. A particular example is computing the direction from anywhere on Earth to Mecca. The geodetic line azimuth to Mecca can be readily obtained by using local ECEF coordinates and the following coordinates of Mecca.

X =	4,562,180.521 m
Y =	3,804,593.694 m
Z =	2,315,118.448 m

If needed, the "local" ECEF coordinates to use in the rotation algorithm can be computed using the well-known geodetic equations:

$X = \langle N + h \rangle \cos\phi \cos\lambda$ ϕ = north latitude

$Y = \langle N + h \rangle \cos\phi \sin\lambda$ λ = east longitude

$Z = (N\,[1 - e^2] + h) \sin\phi$ h = ellipsoid height

Where: $N = \frac{a}{\sqrt{1 - e^2 \sin\phi^2}}$

GRS 80 parameters a = semimajor axis of ellipsoid = 6,378,137 m
e^2 = eccentricity squared = 0.006694380023