

Supplement to Sudden Frequency Deviations [SFD]

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A. Great circle distance:

The total great circle arc angle Φ and distance d are found from the station coordinates (latitude and longitude).

$$\cos(\Phi) = \sin A \cdot \sin C + \cos A \cdot \cos C \cdot \cos \Delta L$$

where (all angles are in common units)

Φ = Angle of the great circle arc from transmitter a and receiver c

A = latitude of station a (+ for northern hemisphere)

C = latitude of station c (+ for northern hemisphere)

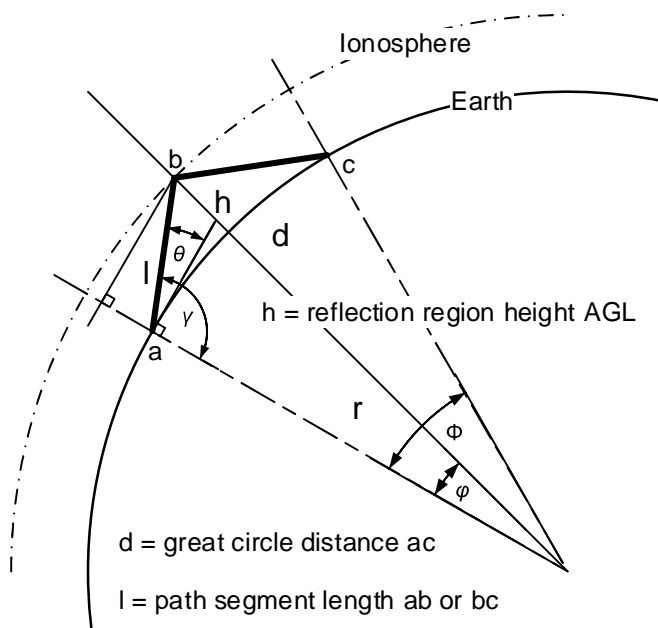
ΔL = angular difference in longitude between stations a and c (magnitude > 0)

$$\Phi = \arccos(\cos(\Phi))$$

$$d = r \cdot \Phi = 222 \cdot \Phi^\circ \text{ km}$$

For additional details on position, distance and bearing calculations, see [PDBC].

B. Radio path length:



A hop is defined as the radio path from the ground up to the reflection region and back down to the ground. For a 1-hop circuit a-b-c, the total radio path length is $2 \cdot l$ and for an m-hop circuit the total path length is $2 \cdot m \cdot l$.

$$\varphi = \frac{\Phi}{2 \cdot m}$$

From Law of Cosines, the radio path segment length l is given by

$$l^2 = 2 \cdot r \cdot (r+h) \cdot (1 - \cos \varphi) + h^2$$

$$l = \sqrt{2 \cdot r \cdot (r+h) \cdot (1 - \cos \varphi) + h^2}$$

where

φ = Angle of the great circle arc from transmitter a (or receiver c) and point on Earth below reflection region b

l = path segment length from transmitter a (or receiver c) to reflection region b (km)

r = Earth radius (6370 km)

h = height of reflection region above ground level (km)

C. Elevation angle:

By inspection

$$l \cdot \sin \gamma = (r+h) \cdot \sin \varphi \text{ or } \sin \gamma = \frac{(r+h) \cdot \sin \varphi}{l}$$

where

γ = angle between Earth radial to transmitter a (or receiver c) and radio path l . Note: $\gamma > \frac{\pi}{2}$ rad.

Therefore,

$$\sin \gamma = \frac{(r+h) \cdot \sin \varphi}{\sqrt{2 \cdot r \cdot (r+h) \cdot (1 - \cos \varphi) + h^2}}$$

and

$$\theta = \arcsin \gamma - \frac{\pi}{2}$$

θ = elevation angle (Note: θ must be > 0)

References:

- [PDBC] Reeve, W., Position, Distance and Bearing Calculations, 2014,
http://www.reeve.com/Documents/Articles%20Papers/Reeve_PosDistBrngCalcs.pdf
- [SFD] Reeve, W., Sudden Frequency Deviations Due to Solar Flares, 2014,
http://www.reeve.com/Documents/Articles%20Papers/Reeve_SudFreqDev.pdf

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