Red Symbols = Angles

Great Circle Equation:

https://en.m.wikipedia.org/wiki/Great-circle_distance

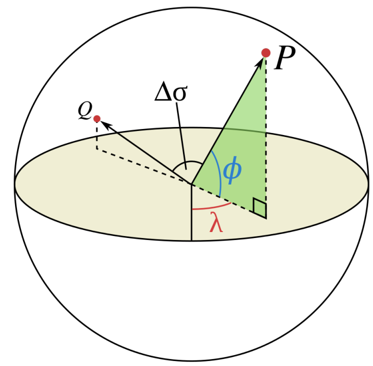
Central Angle Equation between two pair of coordinates:

ϕ = latitude

λ = longitude

$\Delta\sigma$ = central angle between them

$\Delta\sigma = \cos^{-1}((\sin\phi_1 \sin\phi_2) + (\cos\phi_1 \cos\phi_2 \cos\Delta\lambda))$



Distance between the pair of coordinates:

d = distance

r = radius (earths radius)

$\Delta\sigma$ = central angle between them

$\mathrm{d} = r * \Delta\sigma$

Law of sines:

Used to assist in the solution of calculating coordinates from altitude looking down through the camera as a sight:

https://en.m.wikipedia.org/wiki/Law_of_cosines

$$\frac{\mathrm{a}}{\sin\alpha} = \frac{\mathrm{b}}{\sin\beta} = \frac{\mathrm{c}}{\sin\gamma}$$

Particular use (calculating the coordinates of a point perpendicular to the iPad):

Knowns:

ϕ_1 = latitude, iPad GPS

b = earths radius

maj = Earth's radius at the equator, represented as *a* (adjusted WGS84) (major axis)

$\min$ = Earth's radius at the pole, represented as *b* (adjusted WGS84) (minor axis)

$x = \frac{1}{\sqrt{\frac{1}{maj^2} + \frac{\tan^2(\phi_1)}{min^2}}}$ (adjusted for WGS84)

$b = \frac{x}{\cos(\phi_1)}$

ζ = aircraft altitude

$c = b + \zeta$

β = provided by iPad (pitch of the iPad)

θ = Angle of orientation (true north heading of the iPad)

To Be Solved:

α = central angle between them

Getting the central angle between aircraft and desired coordinates:

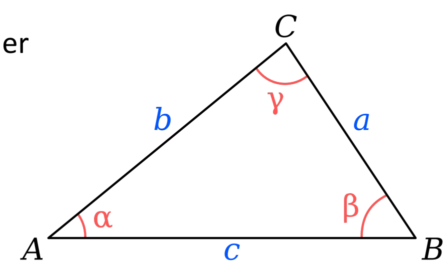
solving for $\propto$ using dissectible pieces:

κ = constant to make breaking up the equation easier

$\kappa = \frac{\sin\beta}{b}$

$\gamma = \sin^{-1}(c * K)$

$\alpha = 180 - (\beta + \gamma)$



Finding the distance over the ground from directly below the aircraft to point of interest:

solving for d:

$\mathrm{d} = r\Delta\sigma$

$\mathrm{d} = r \propto$

This solution on a sphere projects a circle onto the sphere. To calculate where on the circle the coordinates are, another angle is needed. The angle of orientation from North:

Known:

θ = Angle of orientation (true north heading of the iPad)

d = distance from aircraft coordinates to coordinates of point of interest

$\mathrm{d}_r = \frac{\mathrm{d}}{60}$ (distance converted into miles from cords)

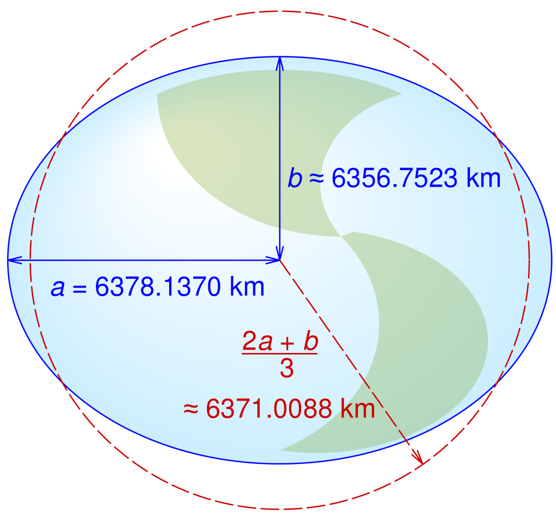
ϕ_1 = latitude, iPad GPS

λ_1 = longitude, iPad GPS

To Be Solved:

ϕ_2 = latitude of point of interest

λ_2 = longitude of point of interest



Solving:

$$\phi_2 = \mathrm{d}_r \sin\varphi + \phi_1$$

$$\lambda_2 = \frac{\mathrm{d}_r \cos\varphi}{\cos\phi_1} + \lambda_1$$