Calculation of high of clouds observed 19/2-2013 from Copenhagen. by Tom Axelsen

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What is known!

Sunset Copenhagen (CPH) : 17:24 CET

Sunset at Clouds as seen from CPH : 18:20 CET

Direction to sun as seen from CPH at 18:20 CET

Altitude : $-8°$

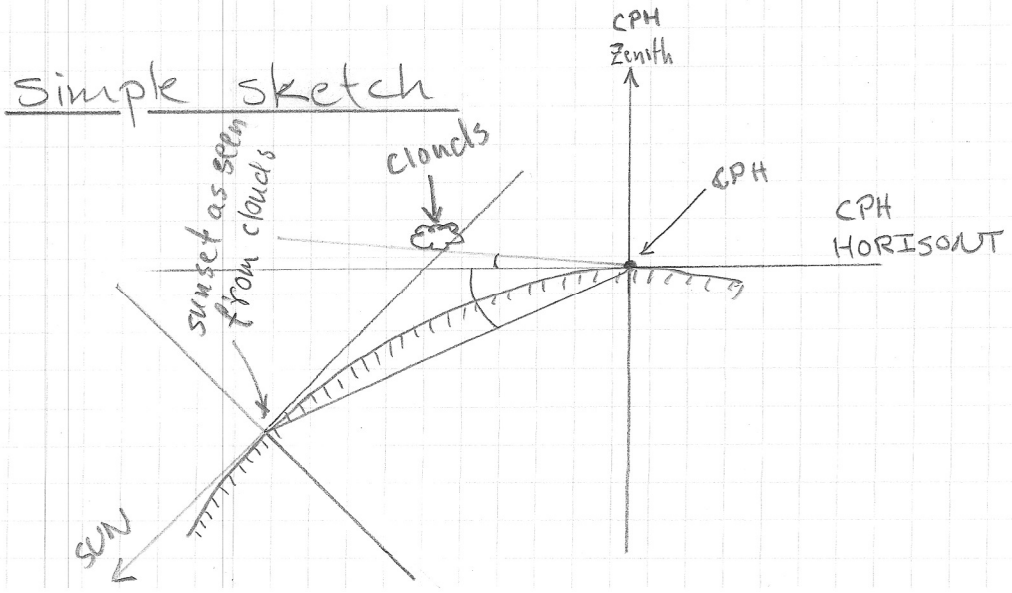
Azimuth : $262°$

Direction to clouds from CPH at 18:20 CET

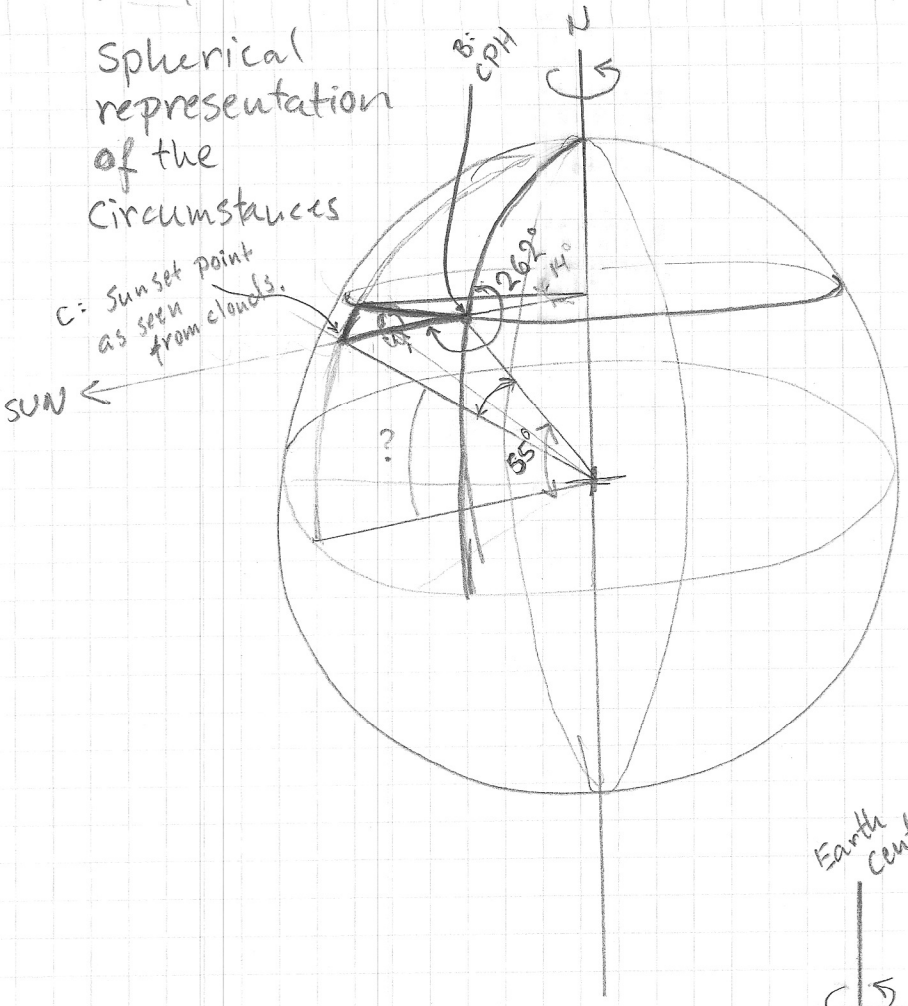
Altitude : app. $8°$ (center of clouds)

Azimuth : $262°$ (brightest part of clouds) in sun direction

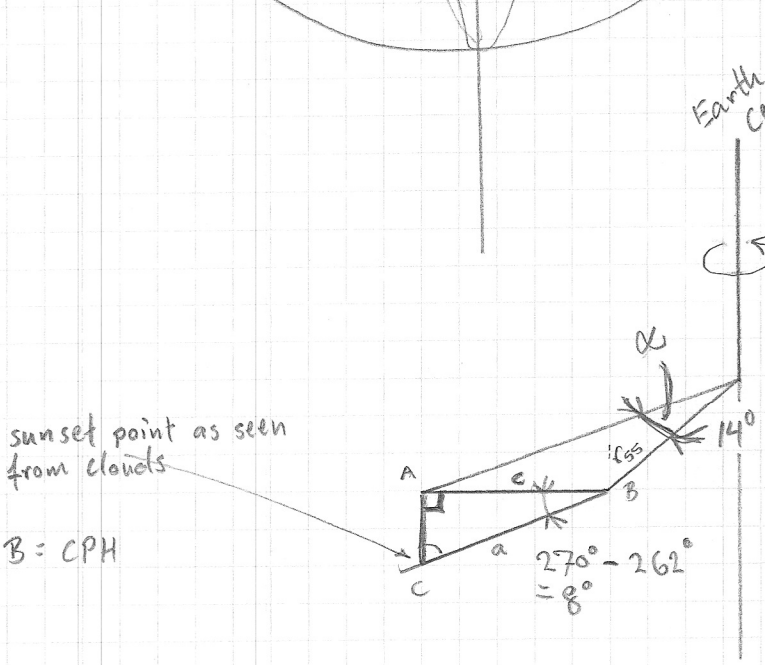
Simple sketch



Sketch with Spherical representation of the circumstances



IMPORTANT NOTE!
Non of the angles or lengths shown in the sketches are to scale!
The purpose of the sketches is to keep track of what length or angle I am calculating!



Sunset CPH 17:24
Observed sunset clouds 18:20
(18:20 - 17:24)

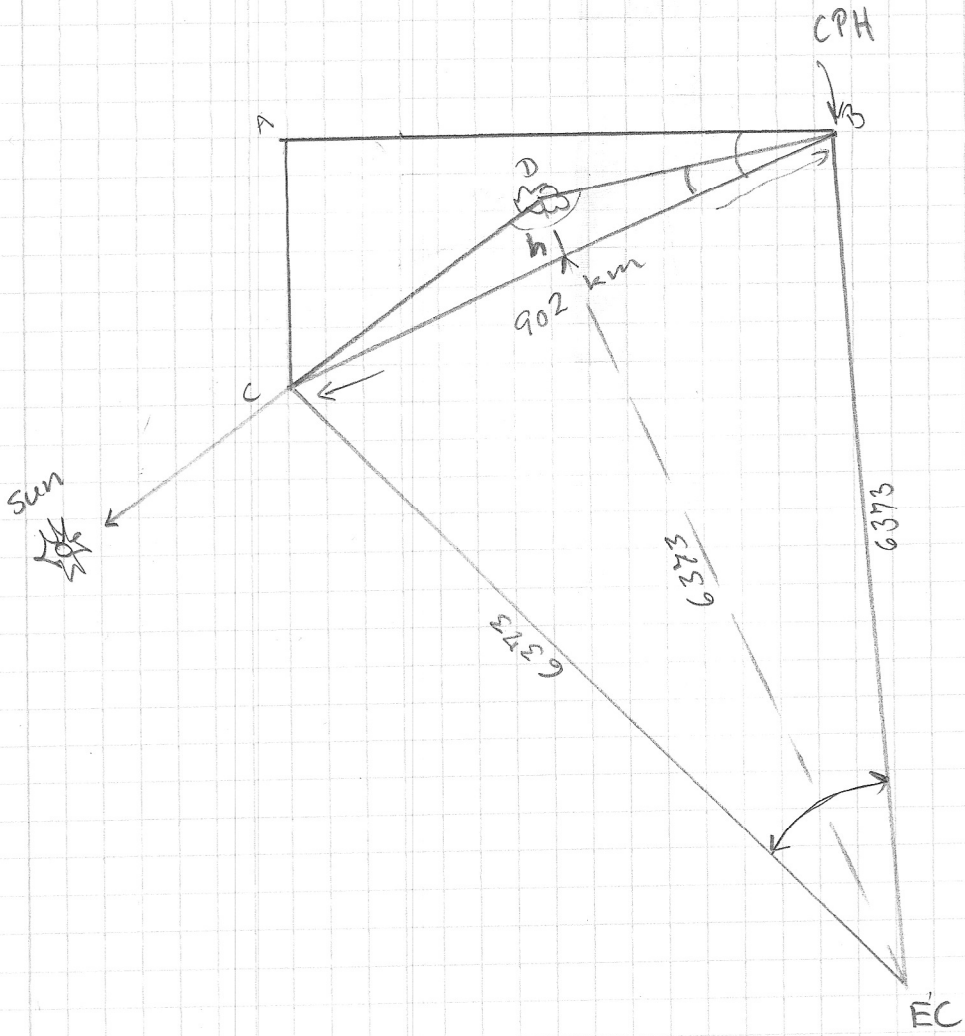
$$\alpha = \frac{56^m}{60^m/h} \times 15°/h$$

$$= 14°$$

$r_{55} = 3655$ km

$$c = 3655 \cdot 2\pi \cdot \frac{14}{360} = 893 \text{ km}$$

$$a \sim \frac{893}{\cos(B)} = 902 \text{ km}$$

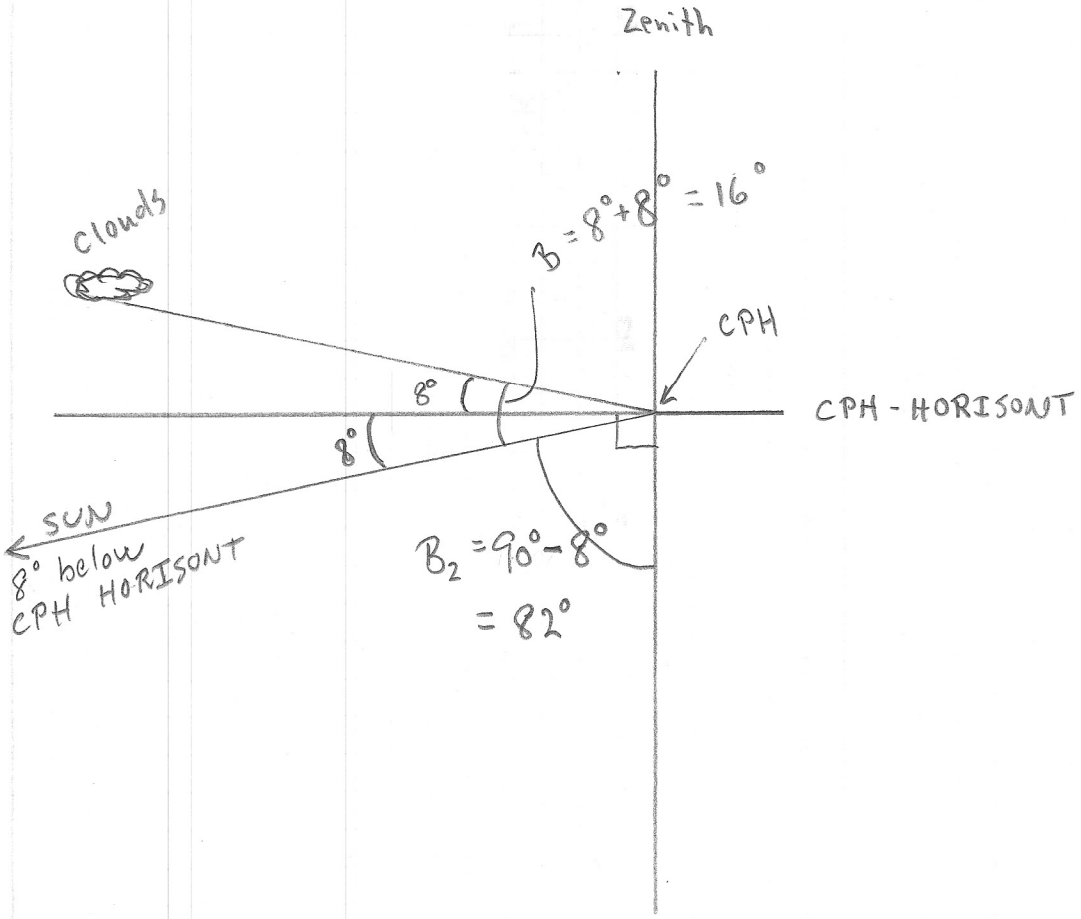


$$EC = \frac{902\ km}{6373 \times 2\pi} \times 360^\circ = 8{,}1^\circ$$

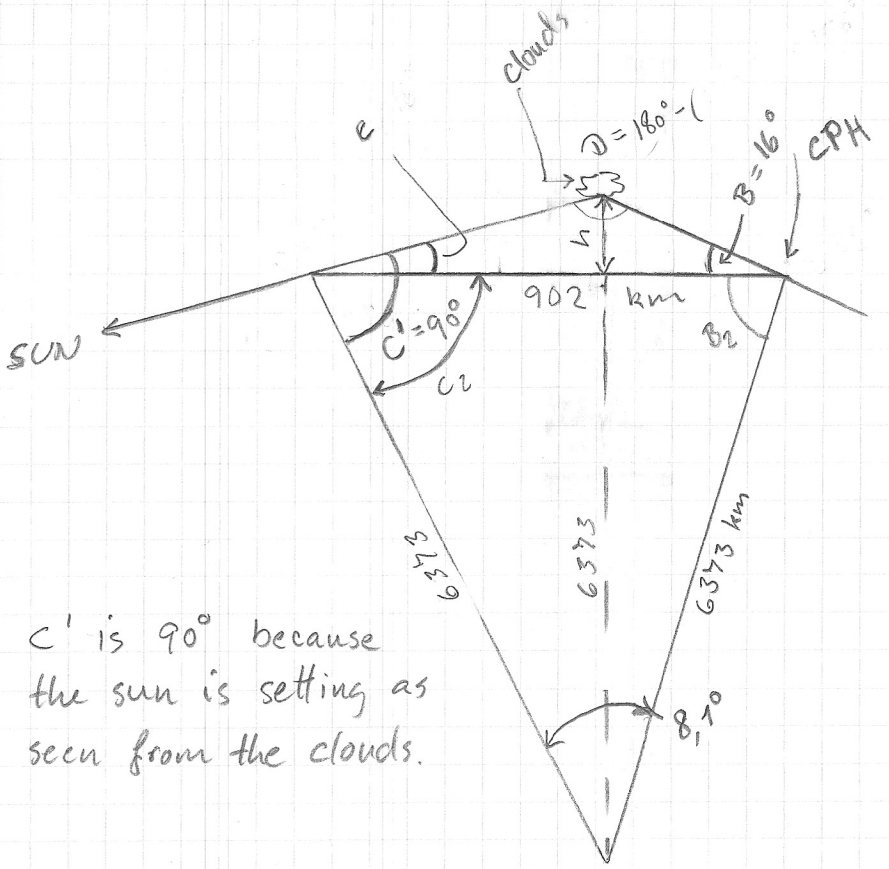
EC is the angle as seen from Earth Center between the two points on Earths surface.

Observing site : CPH

sunset point as seen from the clouds : C



Calculation of B and B_2



C' is 90° because the sun is setting as seen from the clouds.

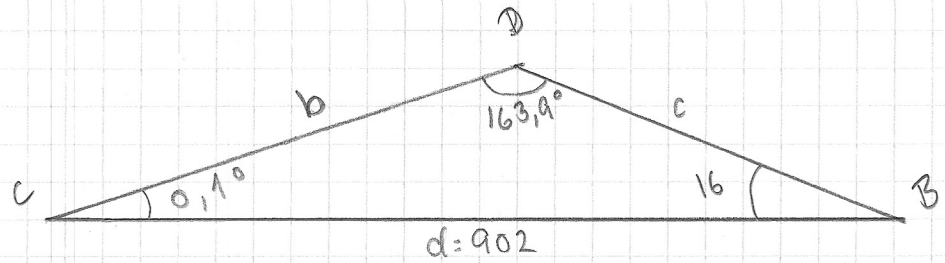
$B = 16°$

$B_2 = 82°$ see page 4.

$C_2 = 180° - (B_2 + EC) = 89,9°$

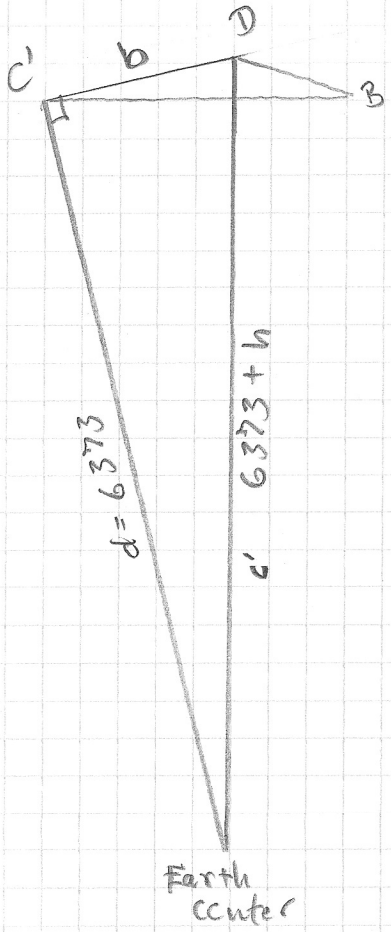
$C = 90 - 89,9° = 0,1°$

$D = 180° - (B + C) = 163,9°$



$$\frac{b}{\sin(B)} = \frac{d}{\sin(D)}$$

$$b = \frac{902 \times \sin(16°)}{\sin(163{,}9°)} = 897 \text{ km}$$



$$c'^2 = d^2 + b^2$$

$$c' = \sqrt{6373^2 + 897^2}$$

$$= 6436 \text{ km}$$

$$h = c' - 6373 = 62{,}8 \text{ km}$$

Cloud high rounded to nearest 10th. because of uncertainties

h = approximately 60 km