ATMOSFERA ZIEMSKA

Skład chemiczny

GAZ	MASA MOL.	% OBJĘT.
N_2	28.01	78.110
O_2	31.999	20.953
A_r	39.942	0.943
H_2O	18.005	0 - 7
CO_2	44.009	0.01 - 0.1
O_3	47.998	0 - 0.01

$d_p = -\rho \cdot g \cdot dh$ $\qquad p = n \cdot k \cdot T$ $\qquad \rho = n \cdot m$

$\frac{dp}{p} = -\frac{mg}{kT} \cdot dh$ $\qquad p = p_0 \cdot e^{-h/[kT/mg]}$

$H = kT/mg$ -----skala wysokości

$p = p_0 \cdot e^{-h/[H}$

$H \approx 7 + 1$ km jeśli $h<120$ km

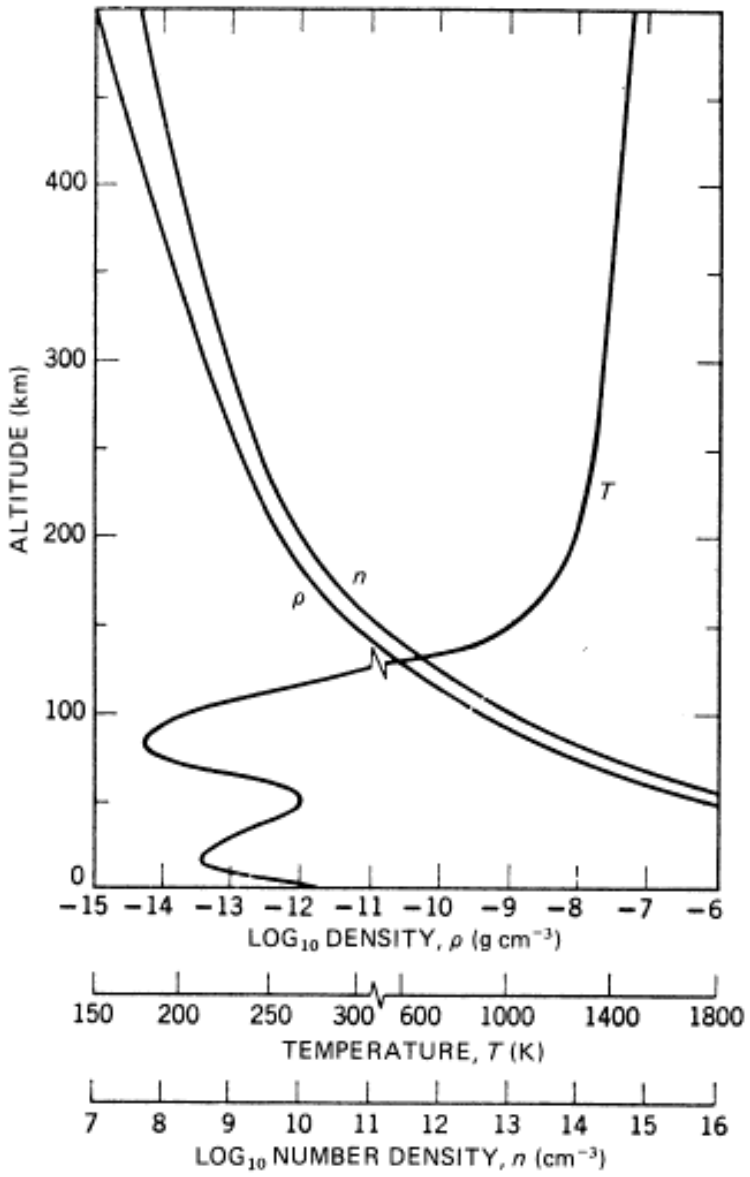
Grubość atmosfery

$n_T = \int_0^{n\infty} n_0 e^{-h/H} dn$ $\qquad p = n \cdot k \cdot T$

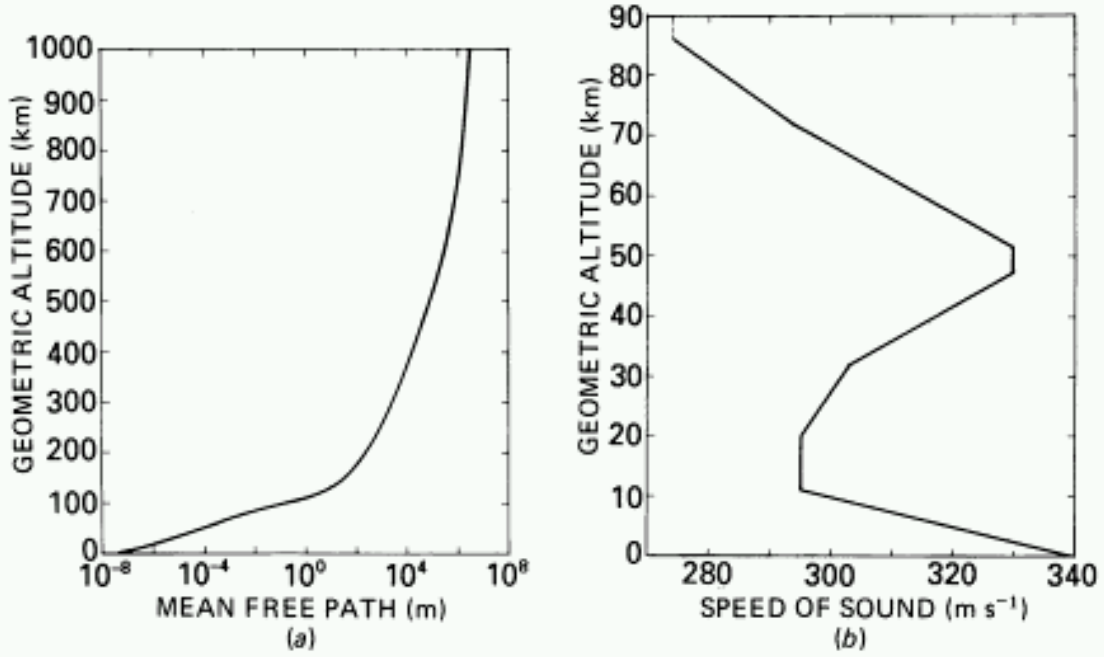
$n_0 = \frac{p_0}{kT}$

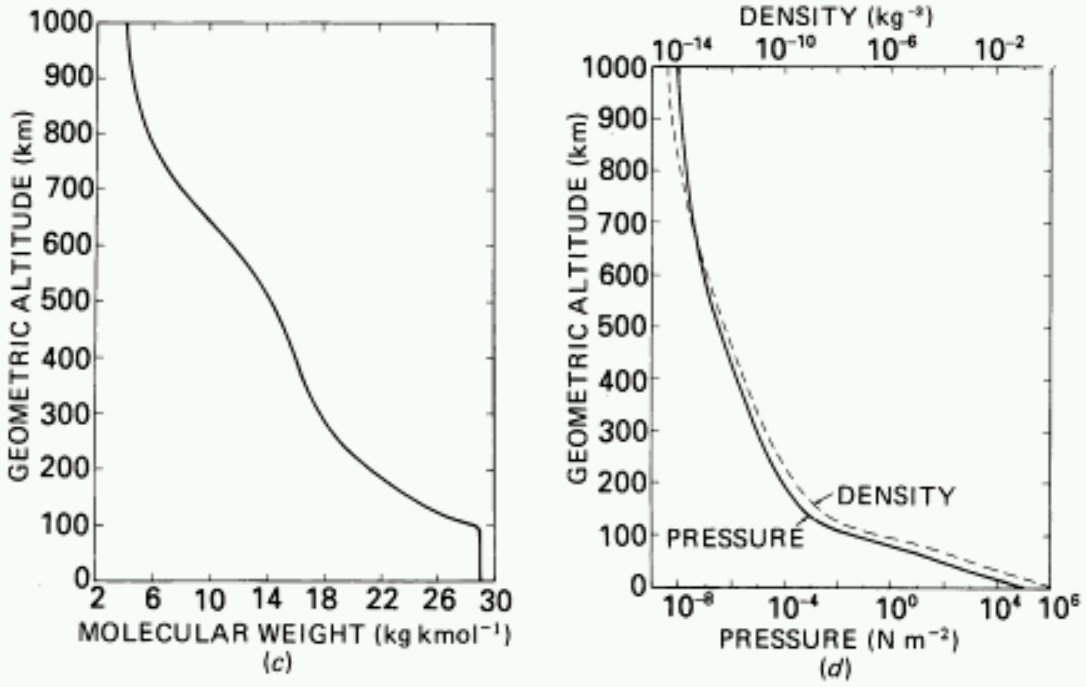
$n \cdot T = n_0 \cdot H = \frac{p_0}{kT} \cdot H$

(COSPAR International Reference Atmosphere, 1961.)



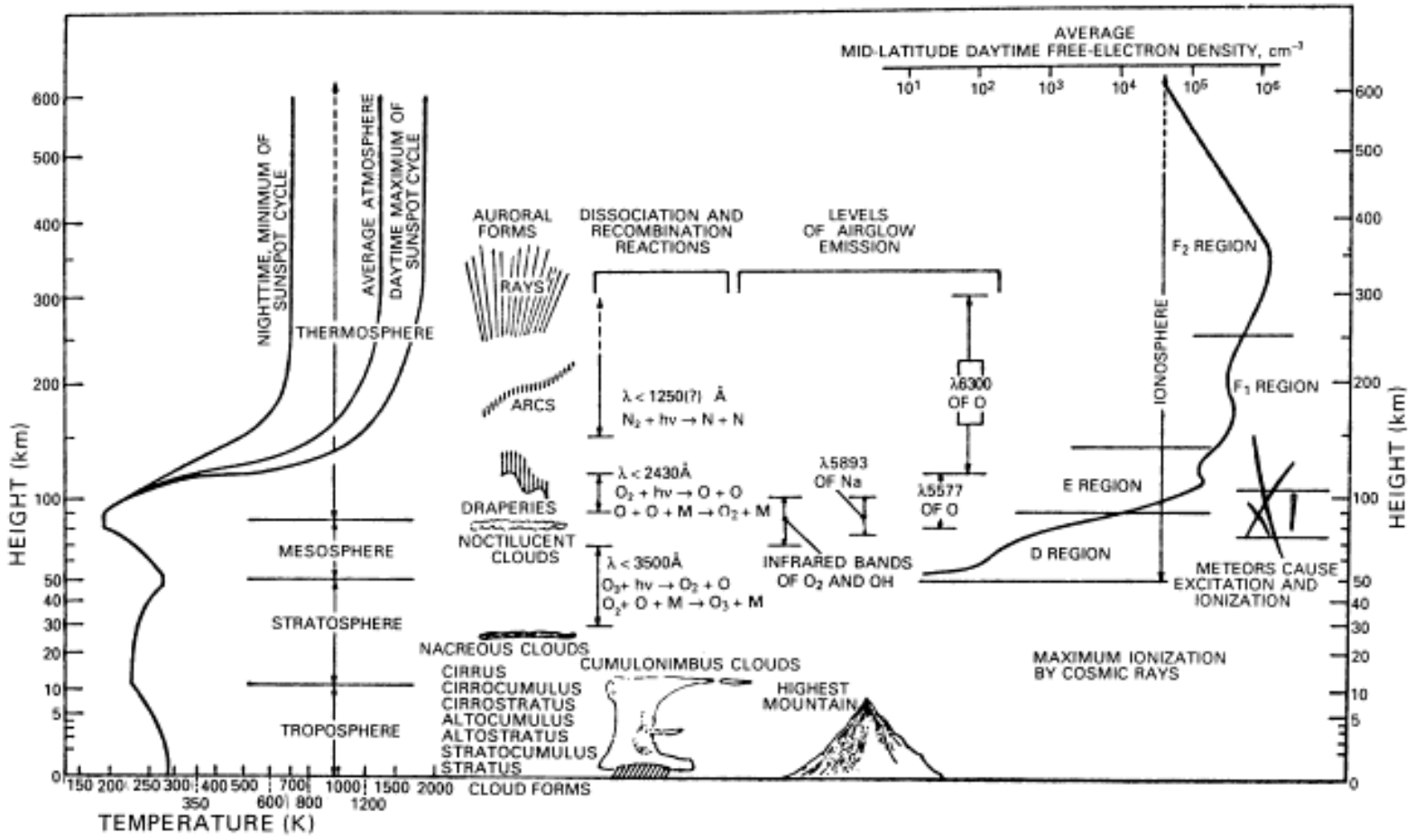
(*a*) Mean free path as a function of geometric altitude. (*b*) Speed of sound as a function of geometric altitude. (*c*) Mean molecular weight as a function of geometric altitude. (*d*) Total pressure and mass density as a function of geometric altitude.





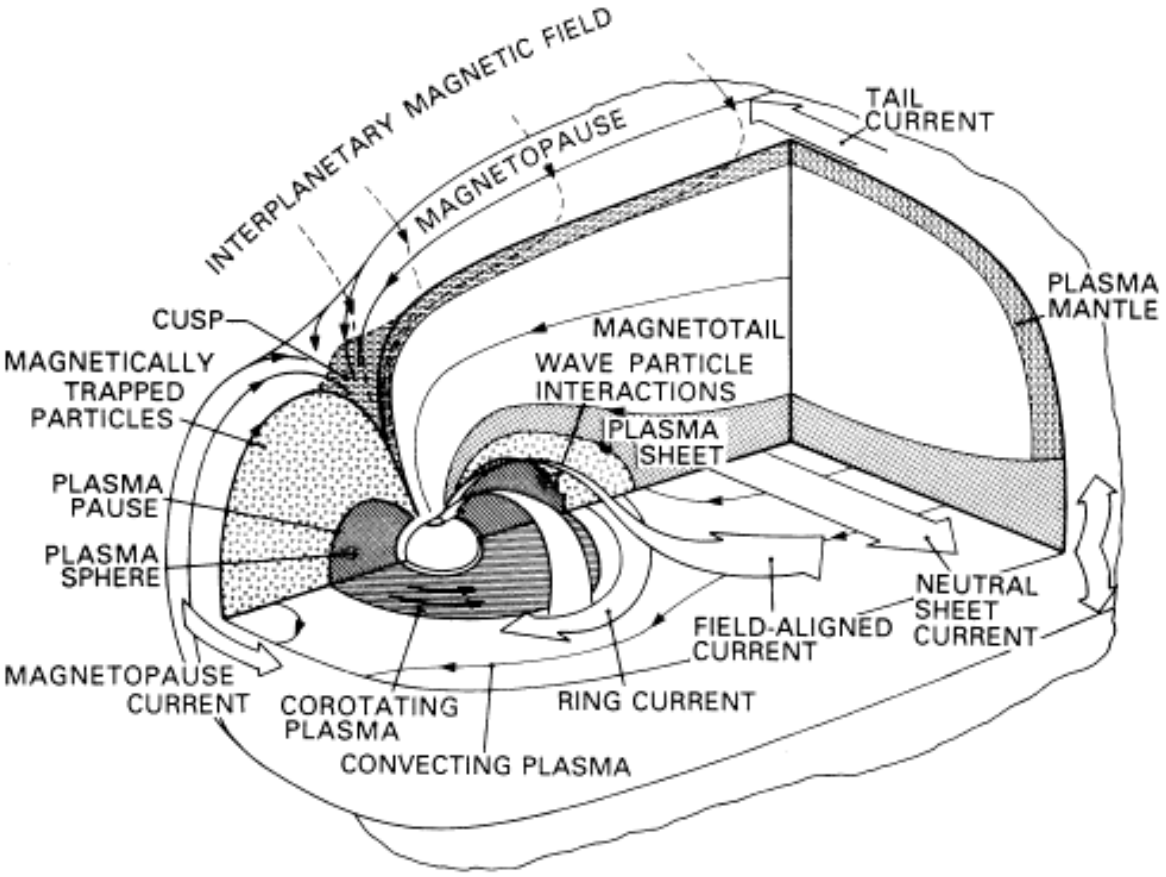
Structure of the upper atmosphere

(Adapted from Harris, M. F. in *American Institute of Physics Handbook*, D. E. Gray, ed., McGraw-Hill Book Company, 1972.)

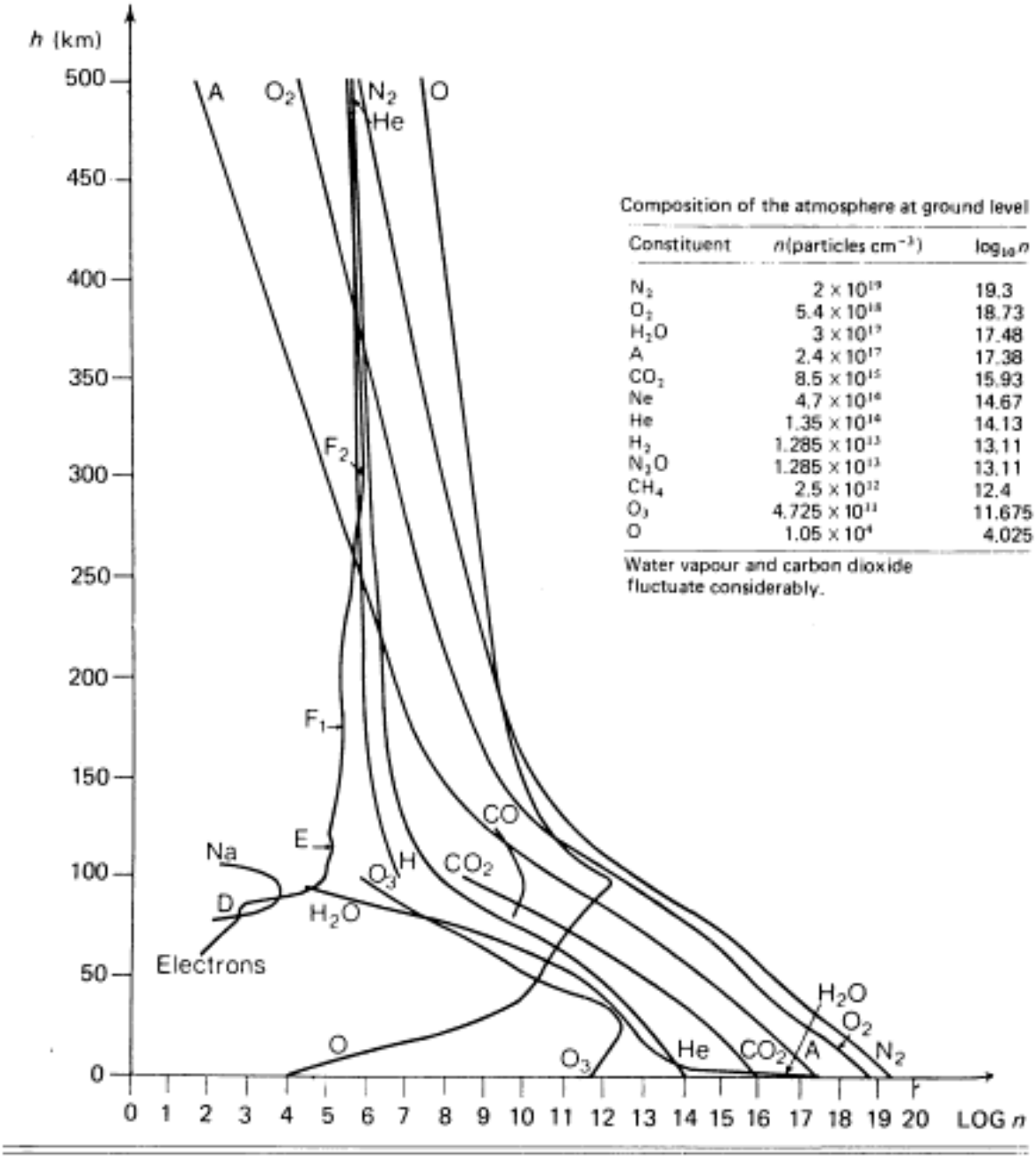


Earth's magnetosphere

Schematic view of the Earth's magnetosphere.



(From NASA)

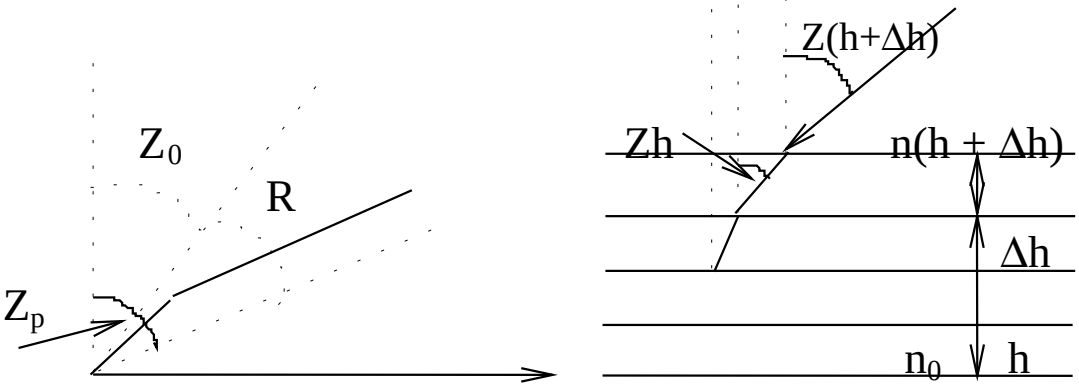


Composition of the atmosphere at ground level

Constituent	n(particles cm^{-3})	$\log_{10} n$
N_2	2×10^{19}	19.3
O_2	5.4×10^{18}	18.73
H_2O	3×10^{17}	17.48
A	2.4×10^{17}	17.38
CO_2	8.5×10^{15}	15.93
Ne	4.7×10^{14}	14.67
He	1.35×10^{14}	14.13
H_2	1.285×10^{13}	13.11
N_2O	1.285×10^{13}	13.11
CH_4	2.5×10^{12}	12.4
O_3	4.725×10^{11}	11.675
O	1.05×10^{4}	4.025

Water vapour and carbon dioxide fluctuate considerably.

REFRAKCJ A ASTRONOMICZNA



$$\frac{\sin Z(h+\Delta h)}{\sin Z(h)} = \frac{n(h)}{h(h+\Delta h)}$$ dla h

$$\frac{\sin Z(h)}{\sin Z(h-\Delta h)} = \frac{n(h-\Delta h)}{n(h)}$$ dla h - Δh

$$\frac{\sin Z(h+\Delta h)}{\sin Z(h-\Delta h)\dfrac{n(n-\Delta h)}{n(h)}} = \frac{n(h)}{n(h+\Delta h)}$$

$$\frac{\sin Z(h+\Delta h)}{\sin Z(h-\Delta h)} = \frac{n\left(h-\Delta h\right)}{n(h+\Delta h)}$$

$Z_0 = Z_p - R$

$Z_p = R + Z_0$

$$\boxed{\frac{\sin Z_p}{\sin Z_0} = n_0}$$

$R = Z_p - Z_0$

$$\frac{\cos R \sin Z_0 + \sin R \cos Z_0}{\sin Z_0} = n_0$$

$1+R\ ctgZ_0 = n_0$; $\boxed{R\ ctgZ_0 = n_0 - 1}$

$$R = (n_0 - 1)\ tgZ_0$$

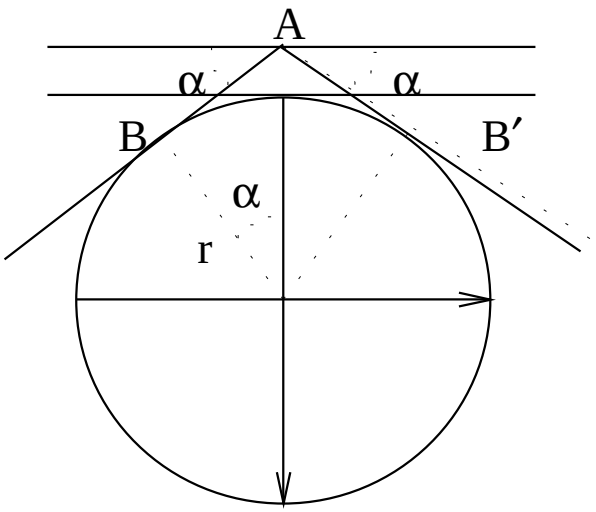
$R = 206266'' (n_0 - 1)\ tgZ_0$

$$R = 60.25'' \frac{b}{760}\left(\frac{273}{273+t}\right) tgZ_0$$

$n = 1 + 2876 \cdot 10^{-4} + 1.624 \cdot 10^{-6}/\lambda^2 + 1.36 \cdot 10^{-8}/\lambda^4$ [λmkm]

ZASIĘG WIDOCZNOŚCI

bez refrakcji



$a^2 = (r + h)^2 - r^2 =$
$r^2 + 2rh + h^2 - r^2$
$a^2 = 2rh + h^2 \approx 2rh$

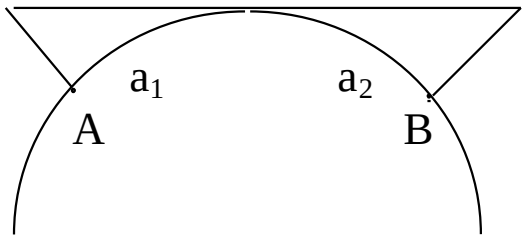
$$a = \sqrt{2r} \cdot \sqrt{h}$$

$$a = 3.6\sqrt{h[m]}\ [km]$$

$\alpha = \gamma$

Z UWZGLĘDNIENIEM REFRAKCJI

$$a = 3.9\sqrt{h[m]}\ [km]$$



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$$AB = 3.9(\sqrt{h_2[m]} + \sqrt{h_1[m]})\ [km]$$

WSCHODY ZACHODY GWIAZD

$\cos z = \sin\varphi \cdot \sin\delta + \cos\varphi \cdot \cos\delta \cdot \cos t$

dla $z = 90°$ $\cos z = 0$

$$\cos t = -\frac{\sin j \ \sin d}{\cos j \ \cos d} = -\mathrm{tg}\delta \cdot \mathrm{tg}\varphi$$

$\sin\delta = \sin\varphi \cdot \cos z - \cos\varphi \cdot \sin z \cdot \cos A$

dla $z = 90°$ $\cos z = 0$ $\sin z = 1$

$$\cos A = -\frac{\sin d}{\cos j}$$

$\delta_{¤} = -23°27'8''$ $\approx$ 23 XII

$\delta_{¤} = +23°27'8''$ $\approx$23 VI

$\delta_{¤} = 0$ 21 III, 22 IX

ŚWITY I ZMIERZCHY

$h_¤ = -18°$ -świt astronomiczny

$h_¤ = -12°$ -świt żeglarski

$h_¤ = -6°$ -świt cywilny

$$\cos t = \frac{\sin h - \sin d \cdot \sin j}{\cos d \cdot \cos j}$$

$$h = h_¤ - R$$

$$\cos a = \frac{\sin h \cdot \sin j - \sin d}{\cos h \cdot \cos j}$$

KOŁO PODBIEGUNOWE

BIAŁE NOCE

DNIE I NOCE POLARNE

$\varphi - 90° + \delta_¤ > - 0°51'$ $90° - \varphi + \delta_¤ < 0°51'$