Ray tracing toy models

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1 Toy model 1

We consider an isotropic environment whose density is defined by :

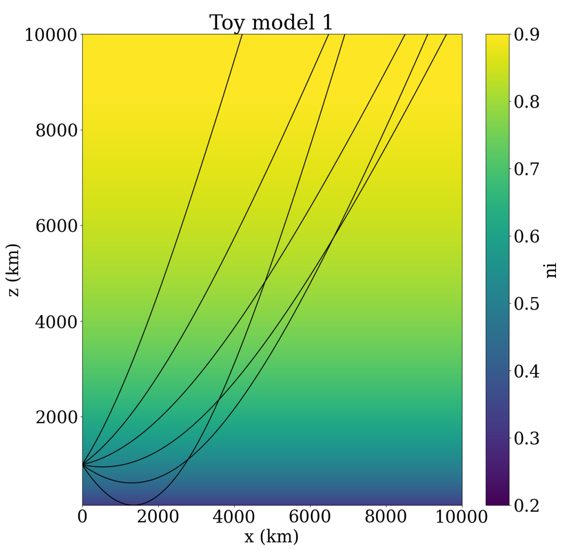
$$n_e(z) = n_0(\frac{z}{z_0})^{-3}$$

The ordinary propagation mode of the Appleton-Hartree equation is used.

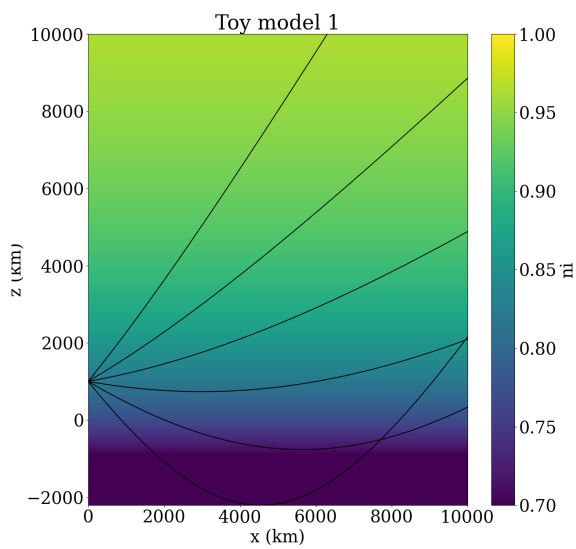
Six rays are traced with the following initial angles (x,k) : $-50°, -30°, -10°, 10°, 30°, 50°$

n_0 (cm^{-3})	z_0 (km)	R_E (km)	z (km)	B (T)
115	$2R_E$	6400	$1000 + z_0$	0

Table 1: Global parameters



(a) Ray tracing with $f_0 = 100kH_z$.
z is the altitude above z_0.



(b) Ray tracing with $f_0 = 150kH_z$.
z is the altitude above z_0.

2 Toy model 2

We consider an anisotropic environment whose density and magnetic field along z are defined by :

$$n_e(z) = n_0(\frac{z}{z_0})^{-2}$$

$$B(z) = B_0(\frac{z}{z_{B0}})^{-3}$$

The extraordinary propagation mode of the Appleton-Hartree equation is used.

Three rays are traced with the following initial angles (k,B) : $10°, 20°, 30°$

n_0 (cm^{-3})	z_0 (km)	R_E (km)	z (km)	B_0 (T)	z_{B0}
100	$2R_E$	6400	$1000 + z_0$	6.10^{-5}	R_E

Table 2: Global parameters

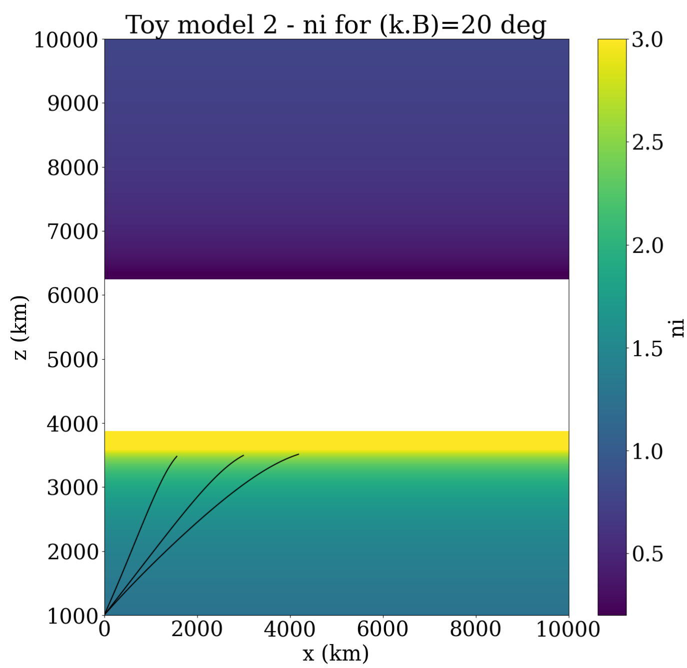


Figure 2: Ray tracing with a $f_0 = 100kH_z$. z is the altitude above z_0.

The refractive index n_i shown in figure 2 is computed with the Appleton-Hartree equation :

$$n_i^2 = 1 - \frac{2X(1-X)}{2(1-X) - Y^2 sin^2(\theta) \pm \sqrt{Y^4 sin^4(\theta) + 4(1-X)^2 Y^2 cos^2(\theta)}}$$

with $X = (\frac{\omega_p}{\omega})^2$, $Y = \frac{\omega_c}{\omega}$ and $\theta = 20°$ is the propagation angle (between the wave vector and the local magnetic field vector).