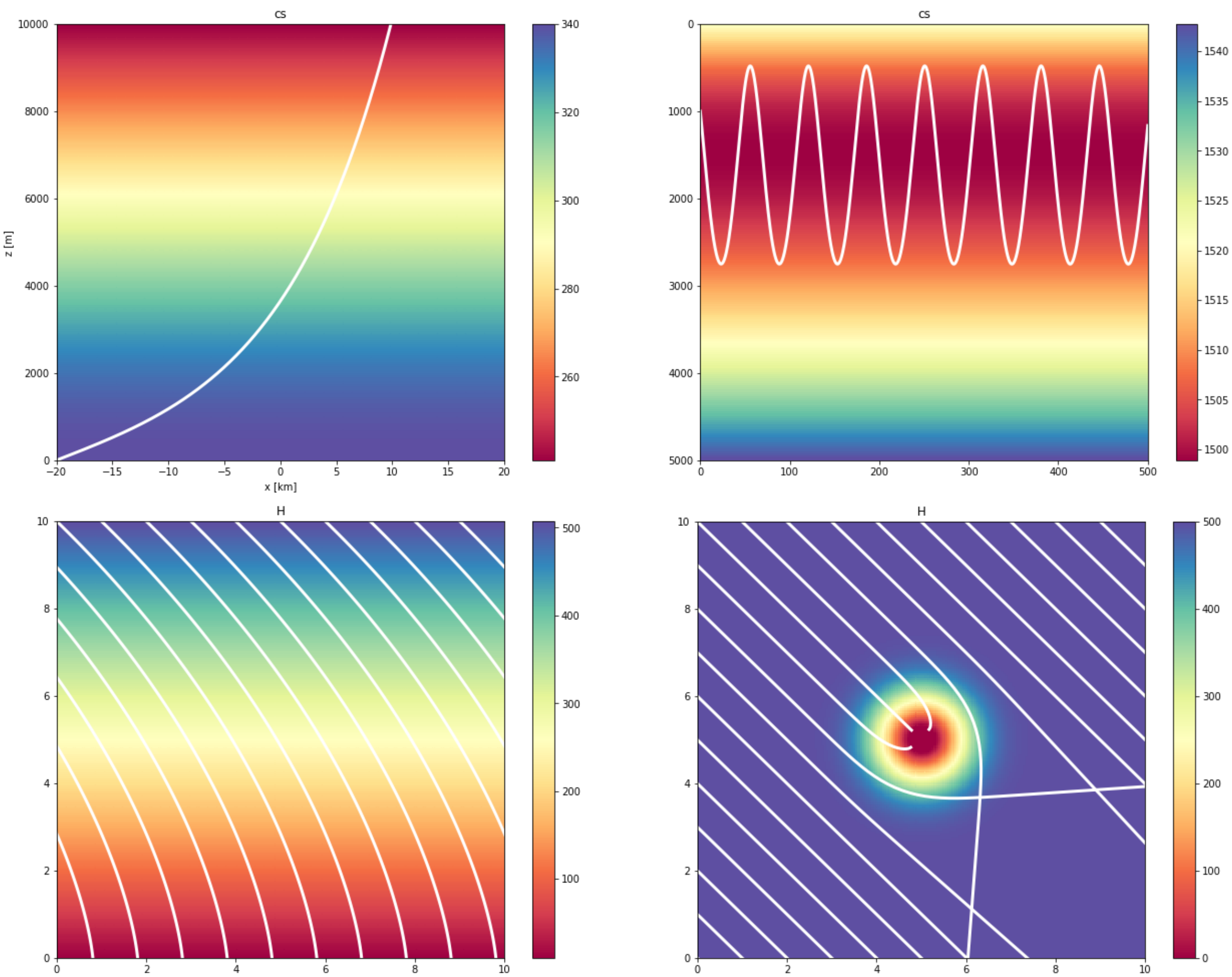
Activity 2 – Ray Tracing

Introduction

During this activity, we will use a basic python code to perform some ray-tracing in various cases: surface gravity waves, acoustic waves, and internal waves.



Get and run the script

The script is available as a jupyter notebook here:

wget http://stockage.univ-brest.fr/~gula/Fluid/ray_tracing.ipynb

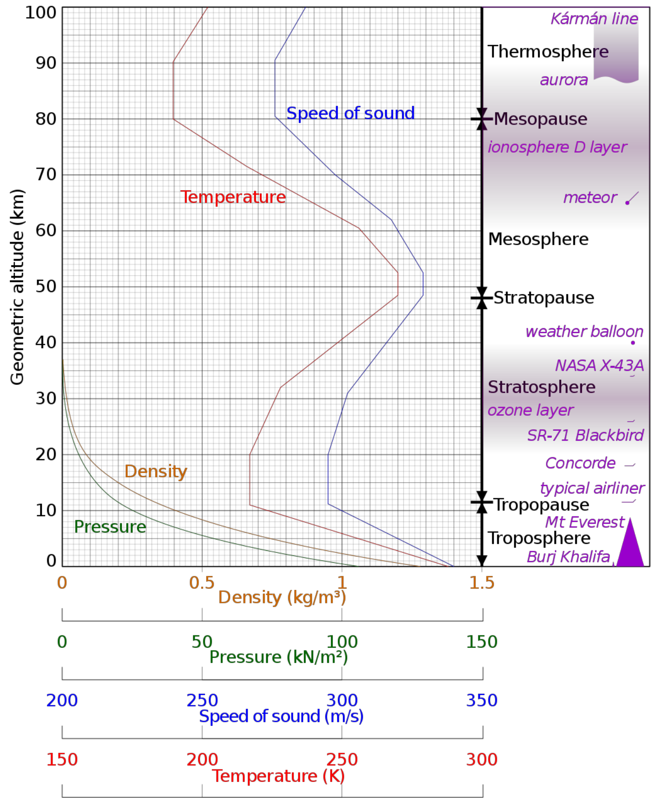
Or as a python script here:

wget http://stockage.univ-brest.fr/~gula/Fluid/ray_tracing.py

It requires numpy, matplotlib and scipy.

Acoustic waves

1. Atmosphere



a) The speed of sound in the atmosphere is not constant. In particular the speed of sound decreases (following temperature) with increasing altitude up to about 10 km. You can check what happens for an acoustic wave emitted from the ground using the atmospheric profile already implemented in the code.

b) Extend this vertical profile to add the speed of sound increase visible in the stratosphere (between 20 and 50 km). What happens to an acoustic wave emitted from the ground?

2. Ocean

a) The speed of sound is also variable in seawater. You can find more details in http://stockage.univ-brest.fr/~gula/Fluid/Mackenzie81.pdf. Check what happens for acoustic waves.

Long surface gravity waves

a) Try the different available topographies. Check what happens depending on the topographic slope. Note in particular what happens in the 'island' case, which corresponds to the formation of caustics (https://en.wikipedia.org/wiki/Caustic_(optics)).
b) Create your own topography to illustrate the different propagation properties of the waves depending on the depth of the flow.

The code could also be modified to add a background velocity shear (e.g. U(z) = U0 z/Lz) for acoustic waves, or to model short surface gravity waves in a sheared environment or to model internal waves in a variable stratification N(z).