

Introduction to acoustical oceanography- Lab 1: Ray tracing lab using the software package RAY.

In this lab we will skim the possibilities of the ray-tracing software package RAY which was developed at WHOI in the early 90s and provide the ray paths on a spherical Earth.

The documentation and software may be found at the ONR acoustics library:
<http://www.hlsresearch.com/oalib/>

Basic instructions:

The program is run through a DOS window.

Open one (Start→All Programs→accessories→command prompt).

Change directory to RAY (type: cd desktop\RAY)

Open the directory RAY on your desktop

Open the file which includes the sound speed profile 'test.ssp'.

Open the application Matlab.

Change directory to the desktop\RAY directory

Exercise 1: Sound Rays in an ocean of constant sound speed.

Change the sound speed in 'test.ssp' such that it will have a constant sound speed at 0 and 5000m, e.g. 1500.

The file should read:

```
-1 0
0 1.500e+03
5000 1.500e+03
```

Open the driver file 'test.RAY'

In that file specify the following:

1. the range (horizontal distance) and depth of the source:

```
source {
    range          =          0 (km);
    depth          =          500 (m);
};
```

2. the range and depths of the receivers

```
receiver {
    range          =          100 (km);
    depths         = {500, 2000} (m);
};
```

3. The initial angles (relative to the horizontal) of the rays leaving the source:

```
angles {
    first          =          -15 (degrees);
    last           =          15 (degrees);
    number         =          16
};
```

4. The type of model you want to use

```
model {  
    bath_smoothing = 10 (km);  
    bottom_depth = 5000 (m);  
    max_bounces = 20;  
    bottom_type = reflecting; // absorbing  
};
```

Save 'test.RAY'

Execute the program by typing at the command line:

```
'RAY test.RAY'
```

Analyze the data Matlab. At the command prompt type:

```
'load test.mat'
```

Plot the sound speed by typing:

```
figure;  
plot(ctab(:,2),-ctab(:,1))  
xlabel('sound speed [m]')  
ylabel('depth [m]')
```

plot all the rays by typing:

```
figure;  
plot(fan(:,1)/1000,-fan(:,2),'-')  
xlabel('distance [km]')  
ylabel('depth [m]')
```

Plot on top the rays that connect source and receiver within the angles chosen by typing:

```
plotpath(eigenrays); (you can execute all these commands at once by typing plot_rays)
```

After each exercise type:

```
close('all')
```

```
clear all
```

to delete all that Matlab has loaded.

Exercise 2: Sound Rays in an ocean of linearly varying sound speed.

Change the sound speed in 'test.ssp' such that it will have a linearly variable sound speed, as would be expected in an isothermal ocean (why?).

The file should read:

```
-1 0  
0 1.500e+03  
5000 1.550e+03
```

2.1 As above plot the sound speed and rays.

Exercise 3: Sound Rays in the SOFAR channel.

Change the sound speed in 'test.ssp' such that it will have a linearly variable sound speed, as would be expected in an isothermal ocean (why?).

The file should read:

```
-1 0
0 1.530e+03
1500 1.48e+03
5000 1.550e+03
```

3.1 As above plot the sound speed and rays.

3.2 Change the position of the source to near the surface (e.g. 50m) and near the bottom (e.g. 4900m) and see how it affects the rays.

Exercise 4: Sound Rays in the ocean where sound speed varies both horizontally as well as vertically (see: <http://staff.washington.edu/dushaw/WOA/> for details).

Choose a latitude and a longitude near of your source and receiver. For example in the North Atlantic:

```
lat=[22 23];
lon=[-70 -71]
```

[These are two positions in the North Atlantic. The programs will convert the negative longitudes to positive longitudes by adding 360; this is something to be a little careful about. The negative values will be returned.]

Compute the distance between them and convert the lat and lon appropriately:

```
[r, glat, glon]=dist(lat,lon,10);
```

[Get 10 soundspeed profiles on a path between the two positions.]

```
[P1,z]=getlev(glat,glon,'c');
```

[Gets the World Ocean Atlas sound speed (P1) (at the 33 standard depths) at those 10 points and writes them to a file "templev.ssp".

Plot those sound speeds:

```
figure(1);
plot(P1,-z);
xlabel('Sound Speed (m/s)');
ylabel('Depth (m)')
```

Modify 'test.RAY' by:

1. replacing the sound speed file to 'templev.ssp'.
2. put the appropriate range between source and receiver (range= max(r)-min(r), r was calculated by the function dist.m above).

Run the program and observe how the rays change depending on the vertical position of the source.