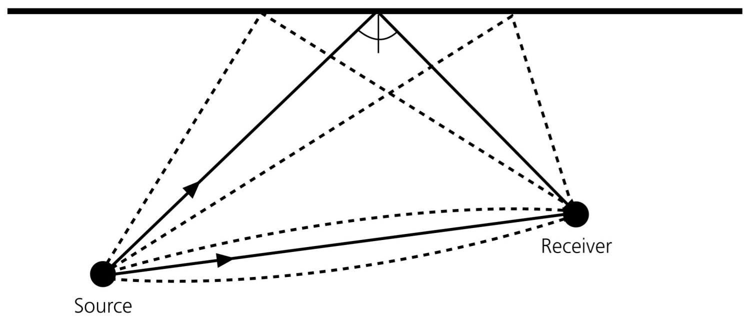
GEOPH624

Homework 2

Due Thursday, Oct 10, 2013

Problem 1 (35 points). Fermat's Principle problem:

Figure 2.5-13: Fermat's principle for direct and reflected waves.



(1) Use the Fermat's principle to show (by pen) that the angles of incidence for the incident and reflected waves at the surface of a homogeneous halfspace (think of earth's surface) are equal.

(2) <u>1D Migration and Scattering</u>: Assume a constant half-space velocity of 5 km/s, assume source location is (0 km, 4 km) in horizontal and depth dimensions, and assume station location is (8 km, 3 km). Assume the period of the wave is 0.1 sec. Write a program (whichever language) to compute the Fresnel zone by considering a dense grid of point scatterers at the surface between source and receiver. First, find the position of minimum time (the Fermat path) through ray tracing. Provide me with the ray angle(s) at the surface. Then draw the two end-geometries (similar to above).

If you get this, you are the master of scattering and migration.

Problem 2 (35 pt) Copy the content of ~jgu/seismolab/lab_assign2/ to your working directory. You are going to focus on the records that start with "unknown" to address the following questions (in the same directory as the previous problem),

a. What is the event latitude and longitude (note: you should have all the info you need to find out)? Report here and tell me how you did that:

b. Explain how you identify Love and Rayleigh in this case. You must present details (e.g., component) rationale to get full credit.

c. Enter the dominant frequencies of Rayleigh waves and Love waves with strong sensitivities to relatively large depths. Explain in detail how you get your answer.

d. Make a plot (hopefully not hand-drawn) of the Rayleigh wave phase velocity dispersion curve with sampling periods (assuming relatively narrow passband, 5 sec on each side around the center period, need to work with frequencies, not period when using SAC) at 5 sec, 15 sec, 30 sec and 60 sec. Briefly explain whether your result looks reasonable or not.

Problem 3 (30 pt). Attached is a table of seismic wave speeds, density and quality factor (published on page 308 of the Nobel-winning paper, Preliminary Reference Earth Model by Dziewonski and Anderson, 1981). This is one of the most cited models in geophysical community since 1981. The Earth is basically chopped into several key regimes, between them are sharp jumps in elastic properties. For each depth regime (e.g., LVZ), the structure and density are assumed to vary according to a cubic/quadratic polynomial (see tables). Hence, knowing the coefficients and the formulae you can compute these quantities at a given depth. For this problem, perform the following tasks (use of computer is *optional*):
(1) Report the shear and compressional velocities at 399 and 401 km. Report the percentages of the velocity jumps. Do the same problem for 669 and 671 km.
(2) Is the transition zone an ideal Poisson solid? What about innercore? Need to use numbers to back your claims (hint: to obtain rough average properties of each region, average the top and bottom velocities of it).
(3) VSH and VSV are horizontally and vertically propagating shear wave speeds. Report values at 90 km, 150, 210 km and 230 km depths for both velocities. 3.1 If you compare the ratio of VSV/VSH, plot the ratio with depth and what trend do you see, what does the trend imply? 3.2 Are Rayleigh waves only sensitive to VSV?