Possible Course Projects/Reviews

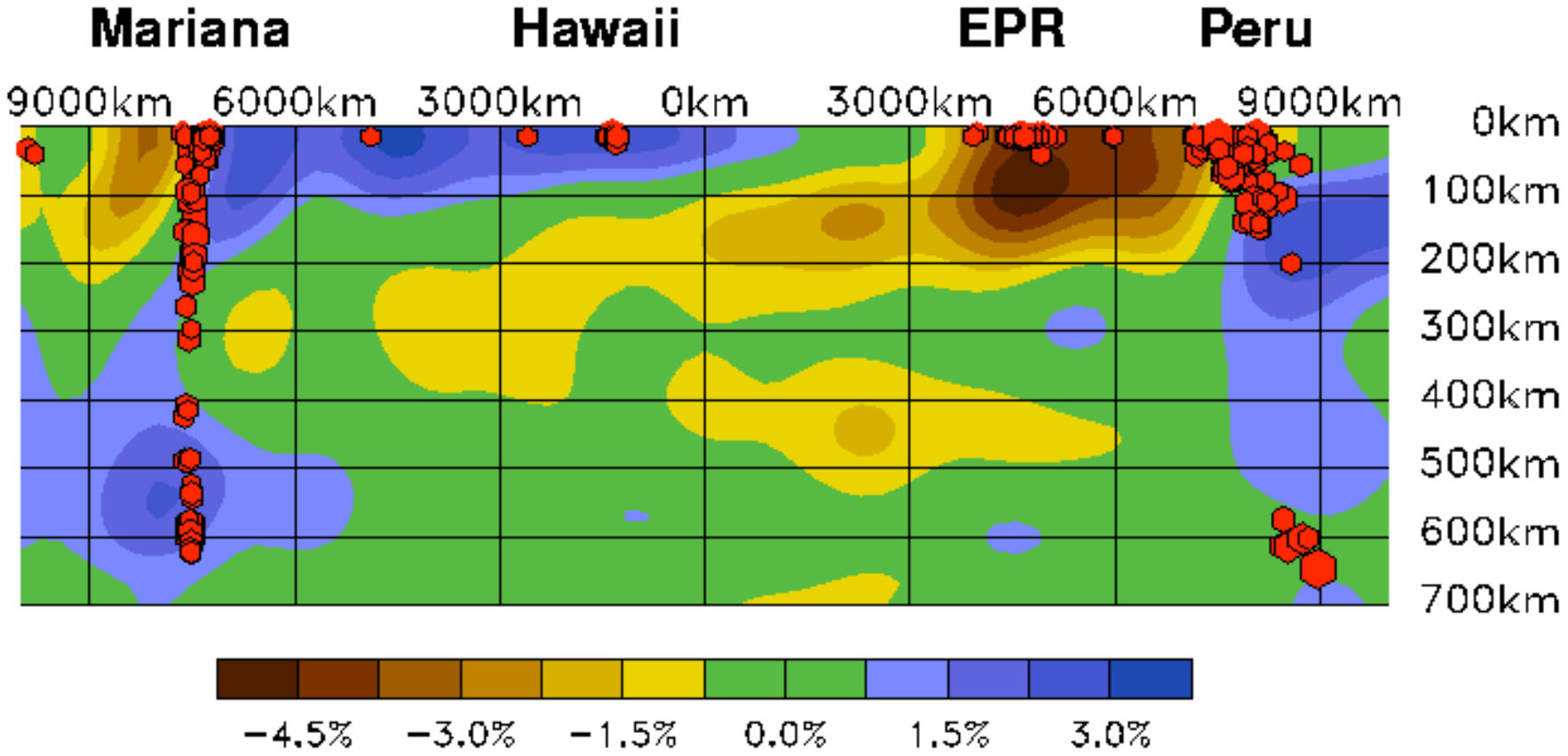
(1) Surface wave group velocity inversion
(2) Seismic source mechanism inversion
(3) Seismic source-time (moment rate) inversion
(4) Attenuation modeling (e.g., SS, S, SdS, PdP, PP)
(5) Receiver function analysis
(6) Coherence measures of body waves
(7) Surface wave waveform modeling
(8) Lithosphere asthenosphere boundary
(9) Subduction zone sensitive small seismic phases
(10) Seismic anisotropy (shear splitting)
(11) Seismic anisotropy (inversions)
(12) Seismic slip inversions
(13) Double difference analysis of epicenter locations
(14) Noise correlation

The above could be review or programming projects. Some data and program help may be available, but vary broadly. Your other suggestion? Speak to me.

Samples: Surface wave group velocity inversion

Likely data set: Alberta Seismic Array Time picks

Papers to read: Ekstrom, Tromp and Larson, 1997;
Laske and Masters papers, more

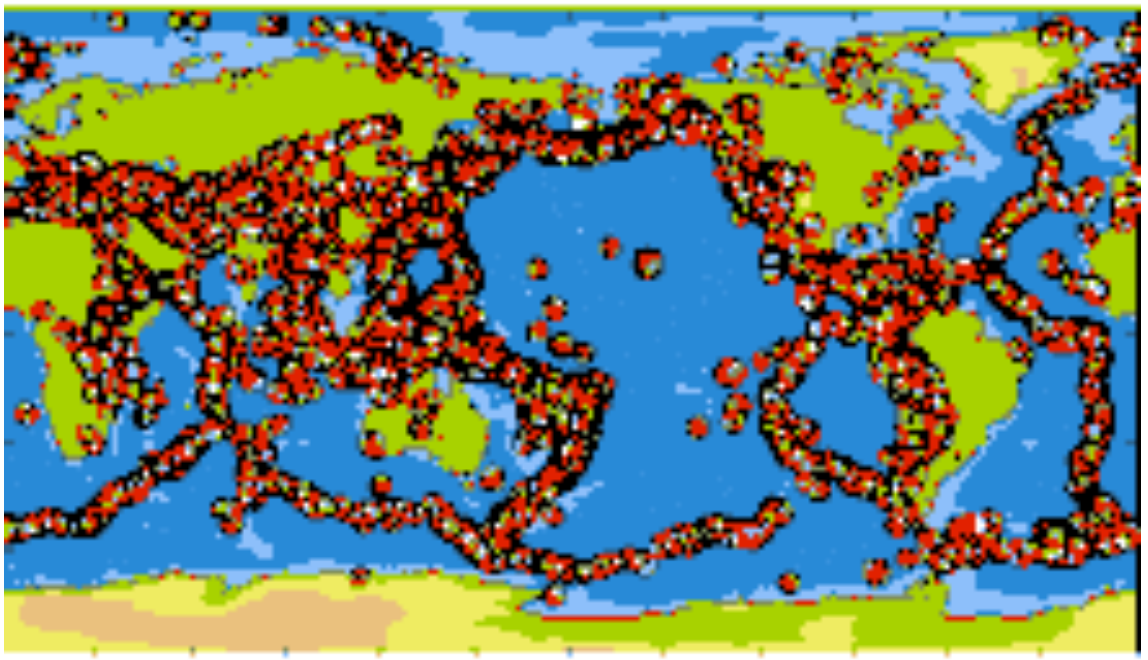


Shear velocity tomography of the earth: velocities (dv/v) are plotted in percent. Red means slower than reference speed, blue means faster.

(2) Seismic source mechanism inversion

What's available:

1. Programs to run a synthetic computation for earth's response at a station
2. Scripts to plot an earthquake mechanism like these "beachballs"



Papers listed at
http://www.seismology.harvard.edu/projects/CMT/cmt_pubs.html#method

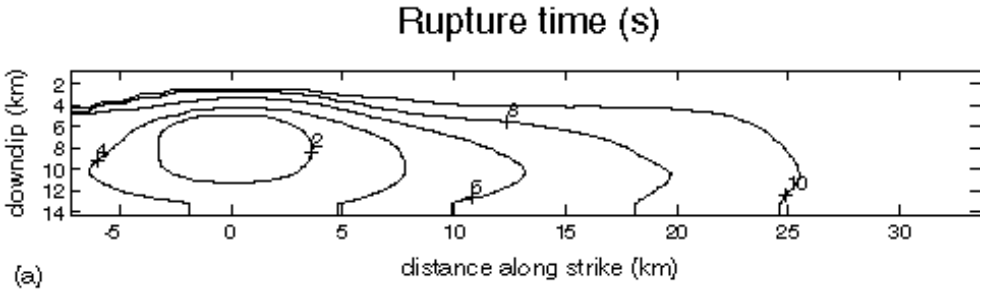
What needs to be done:

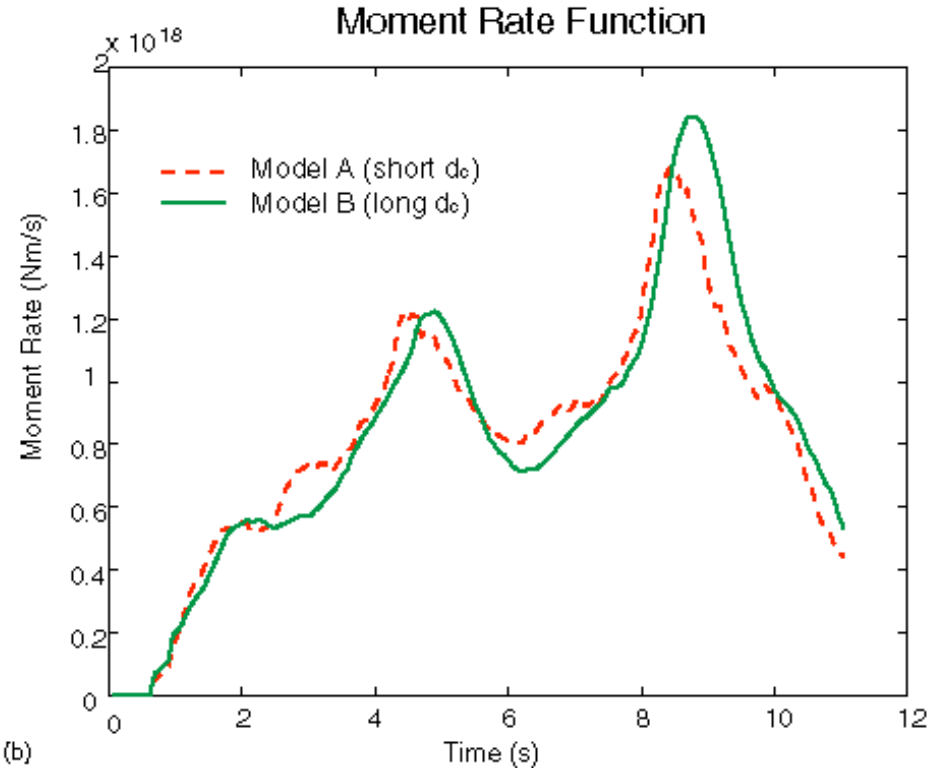
1. Choose a good earthquake, get data
2. Do these computations for your specific case
3. Data set from Alberta, but some require data from IRIS
4. Write an inversion code to do the analysis, plot the beachballs.

(3) Seismic source-time (moment rate) inversion

Seismic sources are not delta functions, I.e., it has a finite duration. How do we extract the rate of moment release from an event if we know the waveforms at the station?

Solution: Deconvolve a delta function (assume the correct moment tensors) from the final waveforms of P (or S).





What's available:

Programs to compute the full response at a station, assume the Earth structure is known, source moment tensor is know, and assume 1 sec duration.

What needs to be done:

(1) Choose a good earthquake (large earthquake so that the source time function could be more interesting)

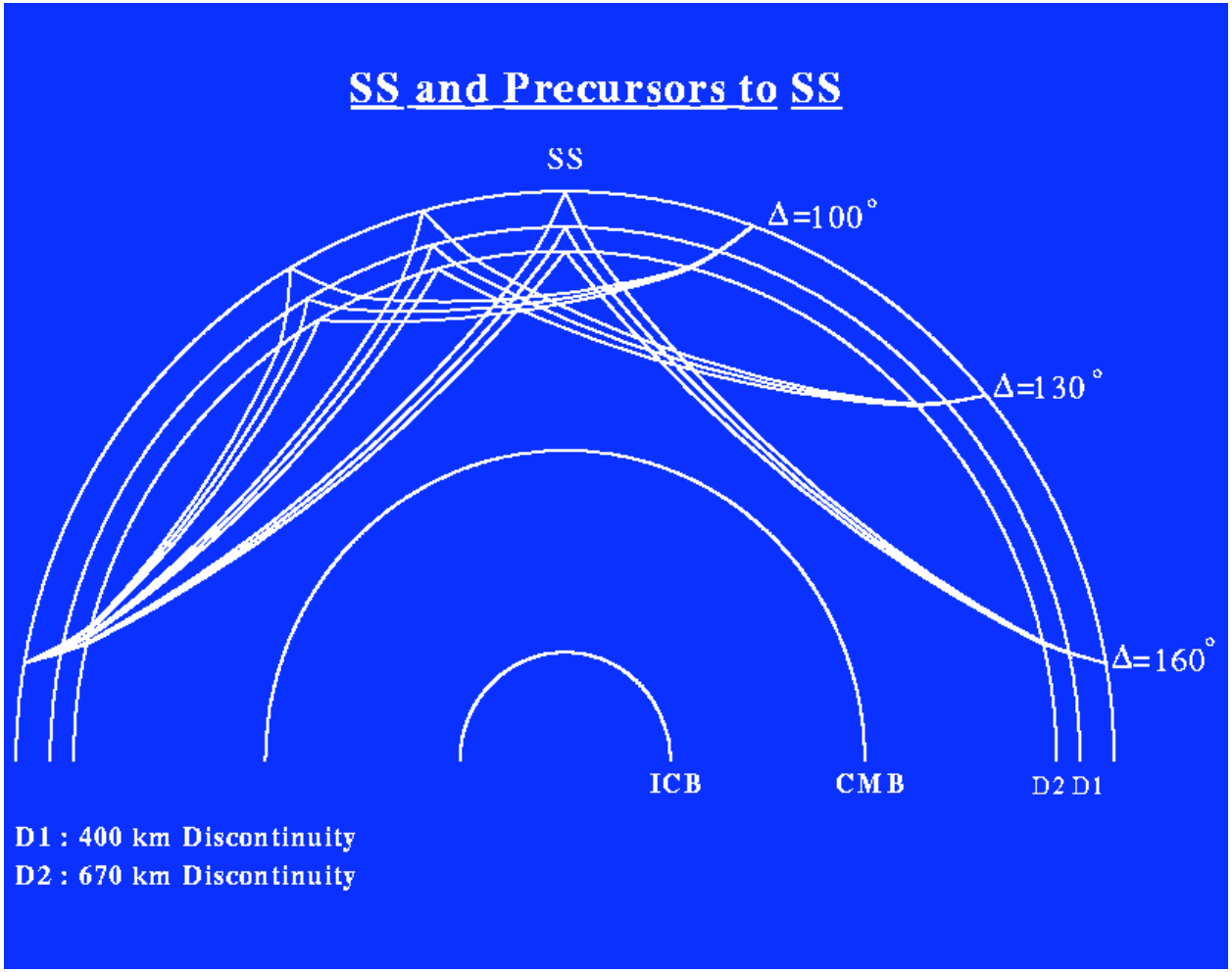
(2) compute the full response (synthetic seismogram) at a station (or better yet), at multiple stations

(3) Invert for the P wave waveform by effectively deconvolving the impulse response (synthetic) from the observation

(4) Interpret how earthquake moments are released

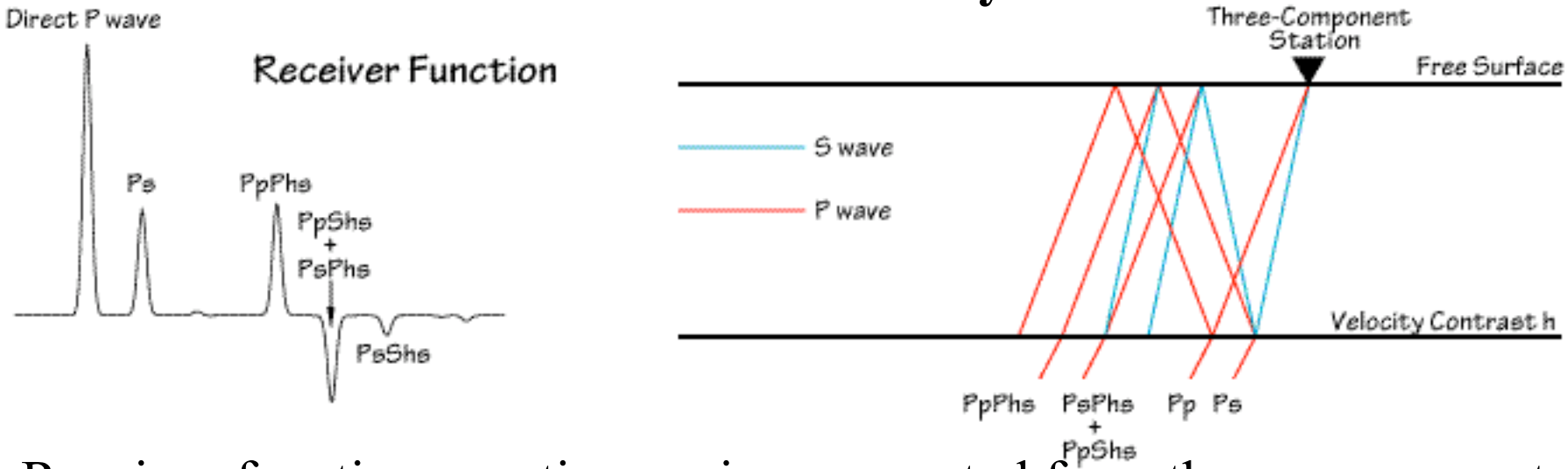
Lots of references.

Attenuation modeling using PP, SS type of waves



Study energy/amplitude decay of waves. The data set is readily available. You need to apply the ideas similar to a paper by Flanagan and Wiens (1998), Roth and Wiens (1998) to analyze the attenuation of the upper mantle through spectral modeling of SS and SS precursors (or PP and PP precursors).

Receiver function analysis



Receiver functions are time series, computed from three-component seismograms, which show the relative response of Earth structure near the receiver. The waveform is a composite of P-to-S converted waves that reverberate in the structure beneath the seismometer.

Modeling the amplitude and timing of those reverberating waves can supply valuable constraints on the underlying geology. Often, the main features of the structure can be approximated by a sequence of nearly-horizontal layers.

Tons of references

What's Available:

(1) Seismic Data from Alberta

(2) Examples that comes with it

What needs to be done:

(1) Understand receiver functions

(2) Develop codes for water-level deconvolution method

(3) Perform receiver function analysis on Alberta data

Great number of papers. See me.

(6) PP or SS Precursor Analysis Using Coherence Measures

What's available:

(1) Data sets I have

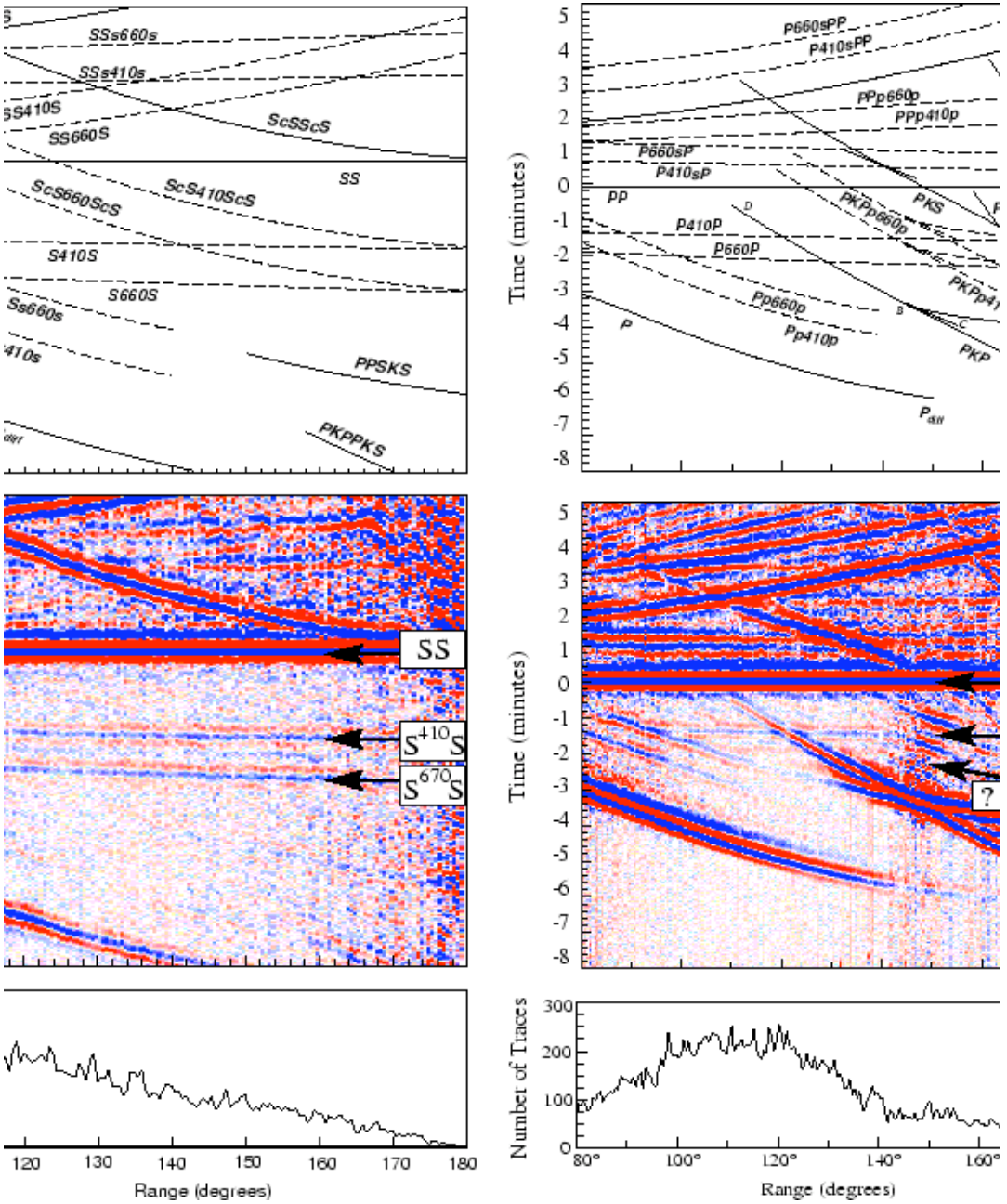
(2) Some tools available

What needs to be done:

(1) Understand theory, especially on the Coherence Measures

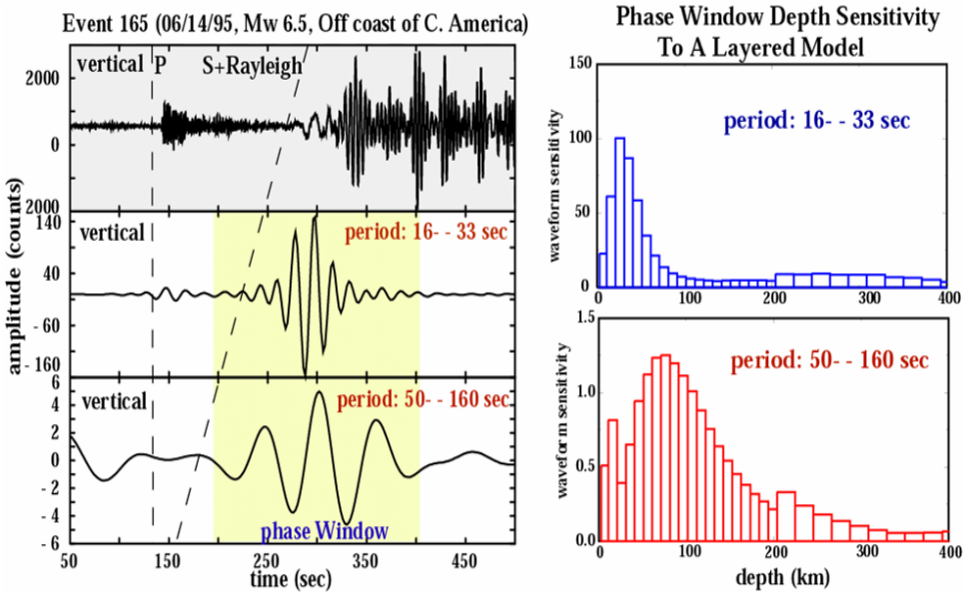
(2) Develop and apply the algorithm to the precursor data.

Suggested reading : Key, S. C. and Smithson, S. B., 1990, Geophysics, Soc. Of Expl. Geophys, 55, 1057-1069), more



(7) Surface Wave Waveform Modeling

This project utilizes the reflectivity method to generate synthetic seismograms for regional distance surface waves. Below shows an earlier effort by Gu et al. 2005 to model the ridge structure.



Available:

1. Code to compute synthetics
2. Data from Alberta

Need:

1. Be very patient with effect of model changes relative to waveforms
2. Need to find proper events for our field data

Many references: Check web

My own: **Gu et al., 2005, JGR; Gu, Pure and Applied Geophysics, 2006**

Investigation of Unstacked SS precursors.

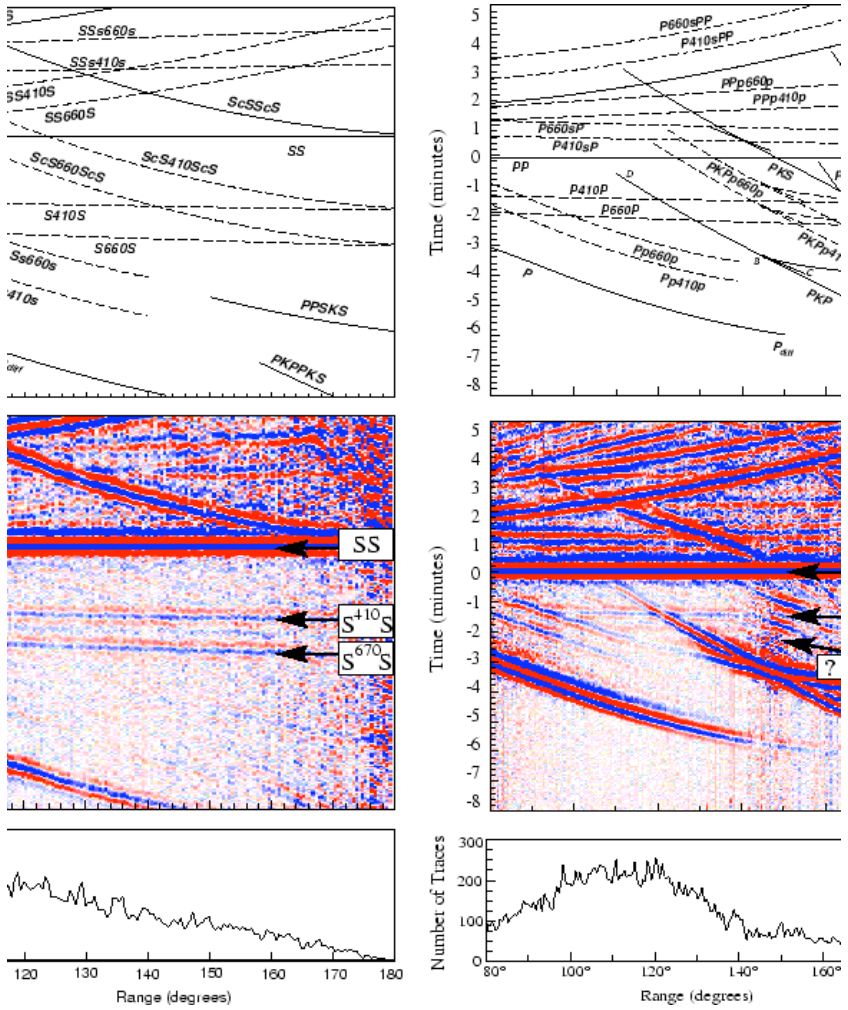
In this project, you will be given data of SS or PP precursors (individual traces), and you will try to investigate the feasibility of unstacked modeling of discontinuity depth, discontinuity thickness and compare with those of stacked results.

Available:

1. Data set
2. Modeling software for SS

Need:

1. Refine data set to eliminate noisy ones
2. Examine the individual seismograms and compare with stacks of different widths.



General guidelines

(1) \A difficult project can be very rewarding, learning and grade wise, if you can pull it off or make significant progress! An easier project can turn into a major project and be very rewarding and challenging at the same time. It all depends on what you do and how much effort you put into it.

(2) I am available to help. That said, there are innovations involved in each of the aforementioned project. I do get pretty cranky at the end of terms when things pile up, so take action early.

(3) Multiple groups could present on the same project. I need a firm answer by early October.

(4) Reviews must be done with care, no copying, thoroughness and your own assessment of the subject matter a big plus.