Construction of Frequency-Slowness and Frequency-Phase speed diagrams

ERZwp: synthesis

This program has been constructed by making use of routines originally developed for the construction of synthetic seismograms by integration over slowness and frequency written in Fortran77.
The present version allows for a surface source and calculates the seismic response of a model directly for a set of frequencies for each slowness.

The model is comprised of uniform layers (less than 500). The program will allow up to 500 frequencies and 500 slownesses.
The array of frequency-slowness terms is written out in ascii format to a specified file

Input:

The program `erzwp` is run from a control file, and makes use of a separate file containing the model. To run

```
erzwp < ewcf.in
```

The internal calculations are carried out a fixed slowness. Depending on the choice of Slowness (SL) or Phase speed (PH) a uniformly sampled array is produced in that domain.

Sample input file: `ewcf.in`

```
" Crus-ic  "                          # Title
"Crus-c1.wpz"                         # File for W-P seismogram output
"Crus.mod"                            # Velocity model file
"PH"                                  # Slowness (SL), Phase Speed (PH)
  200                                 # Number of slownesses (<500)
  3.0                                 # Minimum phasevel
  6.0                                 # Maximum phasevel
  200                                 # Number of frequencies
  0.025                               # Mininum Frequency
  1.025                               # Maximum Frequency
  1                                   #  0 = P, 1 = S
```

The final entry controls the way in which the response is projected onto the vertical and radial components.
With the P option (0) the emphasis is on P excitation and with the S option (1 – the normal case) on SV wave excitation.

When the slowness option is used, the bounds are specified in slowness
(as in file ewpf.in)

Sample model file: Crus.mod

```
Nr     Vp       Vs       Rho      Thickness. Qp-1.     Qs-1
     [km/s]   [km/s]   [Mg/m3]     km
Crus
 80      0
3     5.2117    2.9963    2.5575    0.5000    0.0010    0.0020
3     5.8000    3.4600    2.7200    0.5000    0.0010    0.0020
3     5.8311    3.4649    2.7314    0.5000    0.0010    0.0020
3     5.8453    3.4695    2.7348    0.5000    0.0010    0.0020
3     5.8717    3.4714    2.7411    0.5000    0.0010    0.0020
3     5.8869    3.4742    2.7448    0.5000    0.0010    0.0020
3     5.8895    3.4778    2.7454    0.5000    0.0010    0.0020
3     5.8936    3.4805    2.7464    0.5000    0.0010    0.0020
3     5.8950    3.4844    2.7468    0.5000    0.0010    0.0020
3     5.9007    3.4879    2.7482    0.5000    0.0010    0.0020
3     5.9112    3.4901    2.7483    0.5000    0.0010    0.0020
3     5.9216    3.4983    2.7484    0.5000    0.0010    0.0020
3     5.9367    3.5013    2.7496    0.5000    0.0010    0.0020
3     5.9471    3.5115    2.7497    0.5000    0.0010    0.0020
3     5.9575    3.5207    2.7498    0.5000    0.0010    0.0020
3     5.9624    3.5336    2.7510    0.5000    0.0010    0.0020
…….
```

The index Nr should be set at 3 as in the example, this ensures that full internal reverberations are included to give the full response.

Output:

The frequency -slowness (or frequency -phase speed) response is written out in a simple ascii format for all three components: with an outer loop over frequency and an inner over slowness

```
write(11,*) nf,nrp
do lf=1,nf
  write(11,*) FF(lf)
  write(11,*) "RU:",(PG(lp),cabs(RU(lp,lf)), lp=1,nrp)
  write(11,*) "RV:",(PG(lp),cabs(RV(lp,lf)), lp=1,nrp)
  write(11,*) "RW:",(PG(lp),cabs(RW(lp,lf)), lp=1,nrp)
enddo
```

Segment of Crus-c1.wpz:

```
         200         200
  2.50000004E-02
RU:  0.333333343     0.215410933     0.331666648     0.216053486     0.330016583     0.216732442 ……
RV:  0.333333343     0.226102114     0.331666648     0.235245228     0.330016583     0.240388960 ……
RW:  0.333333343     0.982729197     0.331666648     0.997175395     0.330016583      1.00434482 ……
  3.00251264E-02
RU:  0.333333343     0.212267652     0.331666648     0.213116676     0.330016583     0.214008242 ……
RV:  0.333333343     0.237339199     0.331666648     0.247011974     0.330016583     0.252504438 ……
RW:  0.333333343     0.981722951     0.331666648     0.997404337     0.330016583      1.00538266 ……
```

This matrix of values can then be used with any suitable display routines.

A grey tone display that is effective at isolating mode branches is specified below.

Display

Separate display programs are provided for the slowness and phase speed cases, which make use of a Fortran library of routines to produce Postscript.

A grey tone display is made with the frequency axis vertical and the phase speed (slowness) axis horizontal. The current settings for the size of matrix for display is 200x200

For Phase speed
zcf-erzwp < zcf .in

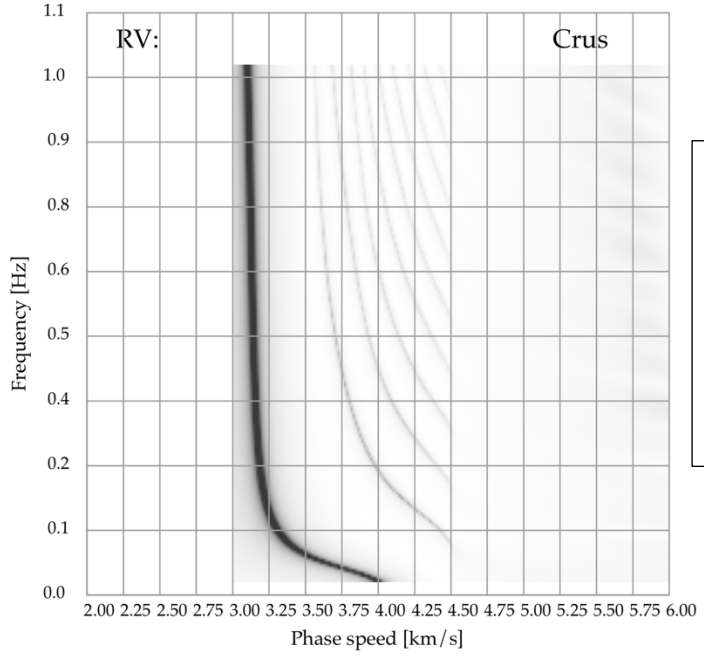
A sample input file for phase speed output (zcf.in)

```
"Crus-c1.wpz"                          # Matrix file
0.        1.125     0.125              # Fmin,Fmax, fstep
2.0       6.00      0.25               # cmin,cmax, cstep
20.0      20.0                         # Faxl,paxl
5.0                                    # max value for plot
```

The first line specifies the frequency-slowness matric file produced by erzwp,
The next three lines control the frame size and frame.
`Fmin,Fmax, fstep` – minimum and maximum frequency range and step for labelling
`cmin,cmax, cstep` - minimum and maximum phase speed range and step for labelling
`Faxl,paxl` – length of frequency and phase speed axes in mm.

The final entry is the threshold for black in display.
Where modal branches are strong a high value is needed, for the crustal case as here most modes are weakly excited by a surface source, so a low threshold is need for effective display.

The product is a Postscript file `Crus-erzwc.ps` in landscape format with three pages for the three components: the radial component is illustrated.



The fundamental mode is strong, but the higher modes are weak so a low threshold of 5.0 is used.
The width of the branch is an indication of its strength of excitation.