2D finite-difference modelling in Matlab, version 1

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ABSTRACT

An updated CREWES 2D elastic finite-difference modeling program is offered for general use. It has many of the features of the original workbench version, but it may be set up so that very little Matlab coding is required. The program runs from two ascii files which must be named and stored in the working directory. The first file describes the geology, and is easiest to use for layer cake cases. The second file specifies how the finite-difference gridded data is obtained from the geology file, and gives the parameters of the finite-difference operations. The main controls of the program are by menu, and besides the main command to start the computations, there are commands to save or continue computations, and to output in various ways. An essential feature of this version is the capacity to apply a wavenumber correction filter.

```
%  Vp,   Vs,  rho,   X1,  Z1,  X2,  Z2,  X3,  Z3,  X4,  Z4,  X5,  Z5,
 4000  2500  2.70     0    0
 3000  1875  2.50     0  240
 4000  2500  2.70     0  260
 4500  2600  2.75     0  500
 -20  1210     % Left and right X limits to which the model will be extended
Microseismic model % The plot title
```

FIG. 1. The starting point for a model is the geological cross section, in the .geo file, in this case named 'spSimp.geo'. The cross section may have flat layers like this, or may define each horizon with many X/Z pairs

```
%Parameter file for 2D finite-difference program
gfdFile =   'spSimp.geo'    %Geological definition file
xMin        0       %Starting X point within geological model
lengthX     400     %X metres for the calculated model
lengthZ     500     %Z metres
%
shotDepth   250     %Depth of the energy source
shotX       0       %200        %X position of the energy source
centreFreq  200     %Frequency in Herz at centre of Ricker wavelet
energySrc   31      %Code number of the energy source (10,11,12,13,21,22,23,31)
%                       10-explosion, 11-Z_rupture, 12-double couple, 13-squeese bulge
%                       21-Z_monopole, 22-X_monopole, 23-external XZ twist
%                       31 - vertExpl
%
Dt          .0001   %Sample rate in seconds
Dxz         0.75        %Sample rate in metres
nstep       900     %2000     %101      %Number of time steps
iLbnd       7       %Boundary code left     <= 0 for rigid, =7 mirror
iRbnd       0       %Boundary code right    <= 0 for rigid, =8 free
iTbnd       0       %Boundary code top      <= 0 for rigid, =8 free
iBbnd       0       %Boundary code bottom   <= 0 for rigid, =8 free
wncvar   =  'c75p40s24min'      %Wave number correction file ('' indicates no corrections)
%wncvar   =   ''      %Wave number correction file ('' indicates no corrections)
%
trX         100     %250        %X position of the well in the case of 'Z' acquisition
trZ         200     %Z level of flat 'X' acquisition
nframes     50      %Number of movie frames (< nstep)
mvXmax      1000        %X length of the displayed model
mvZmax      1000        %Z
mvPlot      2       %Code number of the movie plot (2,3,4,5)
%                       2-displacemnt, 3-pressure/twist, 4-abs amp displacement, 5-arrows
mvAmp       300     %Amplitude for movie code 4 (larger is higher amplitude)
mvClip      .5      %Amplitude clip level - fraction of 1 (1 is unclipped)
mvTif    =  ''      %Character string included in the movie tiff files ('' indicates no tiff file)
```

FIG. 2. The next step specifies the portion of the .geo file to use, and also the mechanics of the finite-difference calculations. Finally the ongoing extractions must be specified: the seismic data collected over time, and the periodic snapshots for quality control and for movies.

The parameter names on the left must be used, followed by the parameter values.

FINITE-DIFFERENCE CODE

The code is available through the CREWES website.

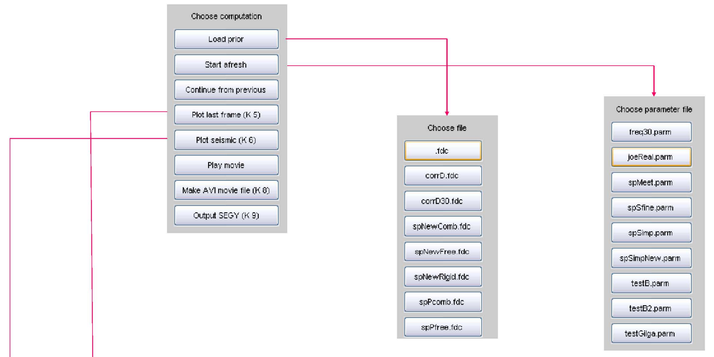

FIG. 3. The main menu, and the two sub menus that are usually used to initiate a project. Load prior leads to a menu listing previously calculated models. Start afresh presents a list of parameter files.

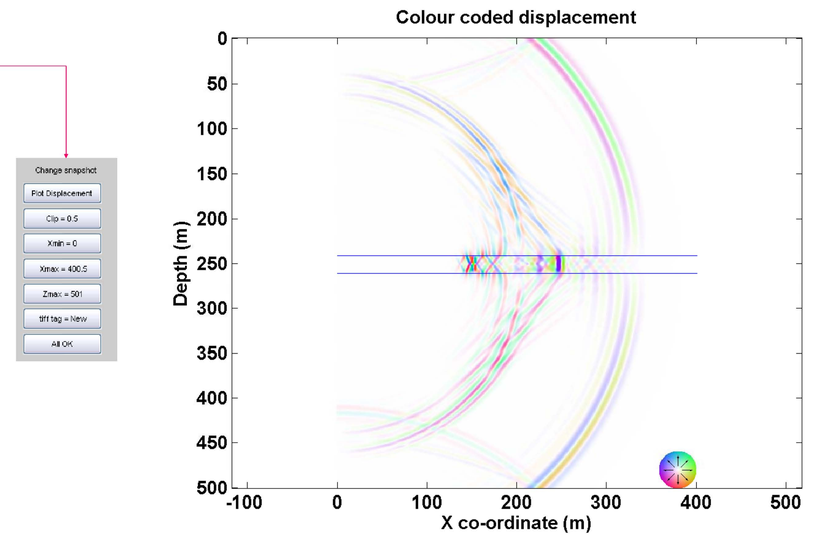

FIG. 4. The final frame parameter menu and the resulting snapshot. These data were computed with the parameters given in Figure 2.

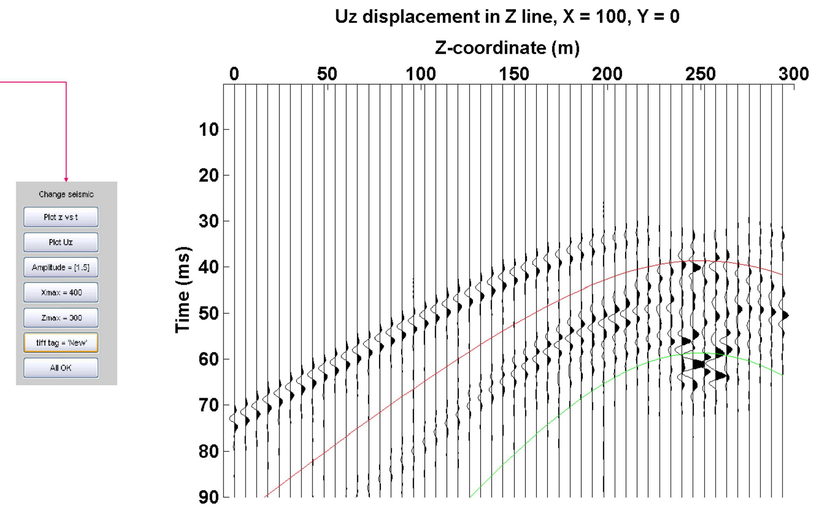

FIG. 5. The seismic parameter menu and the resulting seismic plot. These data were also computed with the parameters given in Figure 2, down a line at X = 100. Only 3 traces are near the narrow low velocity zone (20 metres thick, centered at 250 metres). The rest are from the adjacent high velocity area.