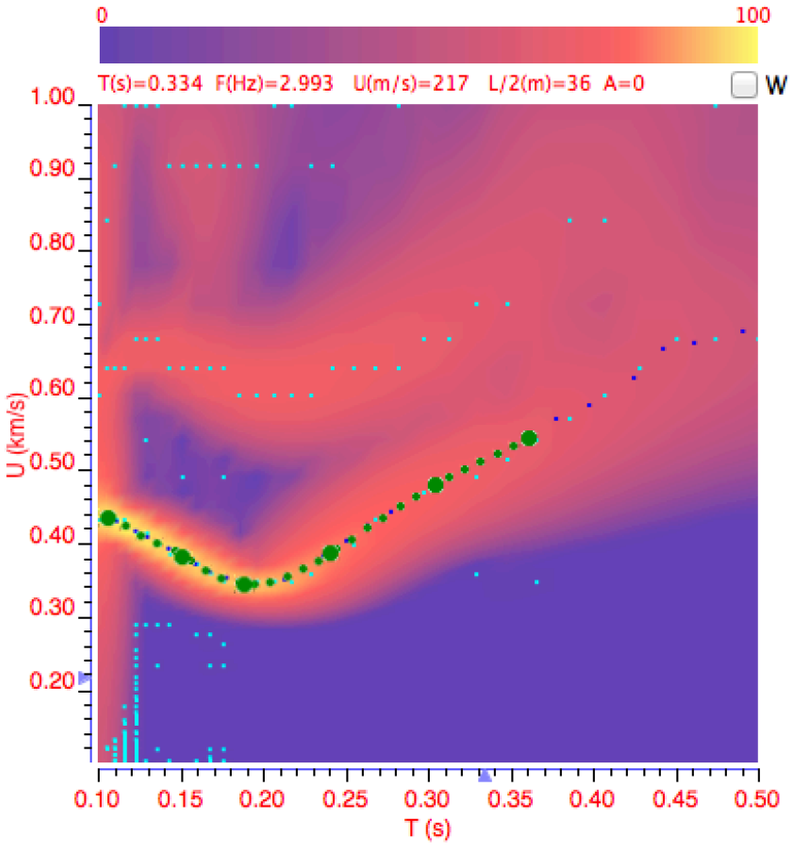
UNIVERSITÀ
DEGLI STUDI DI TRIESTE

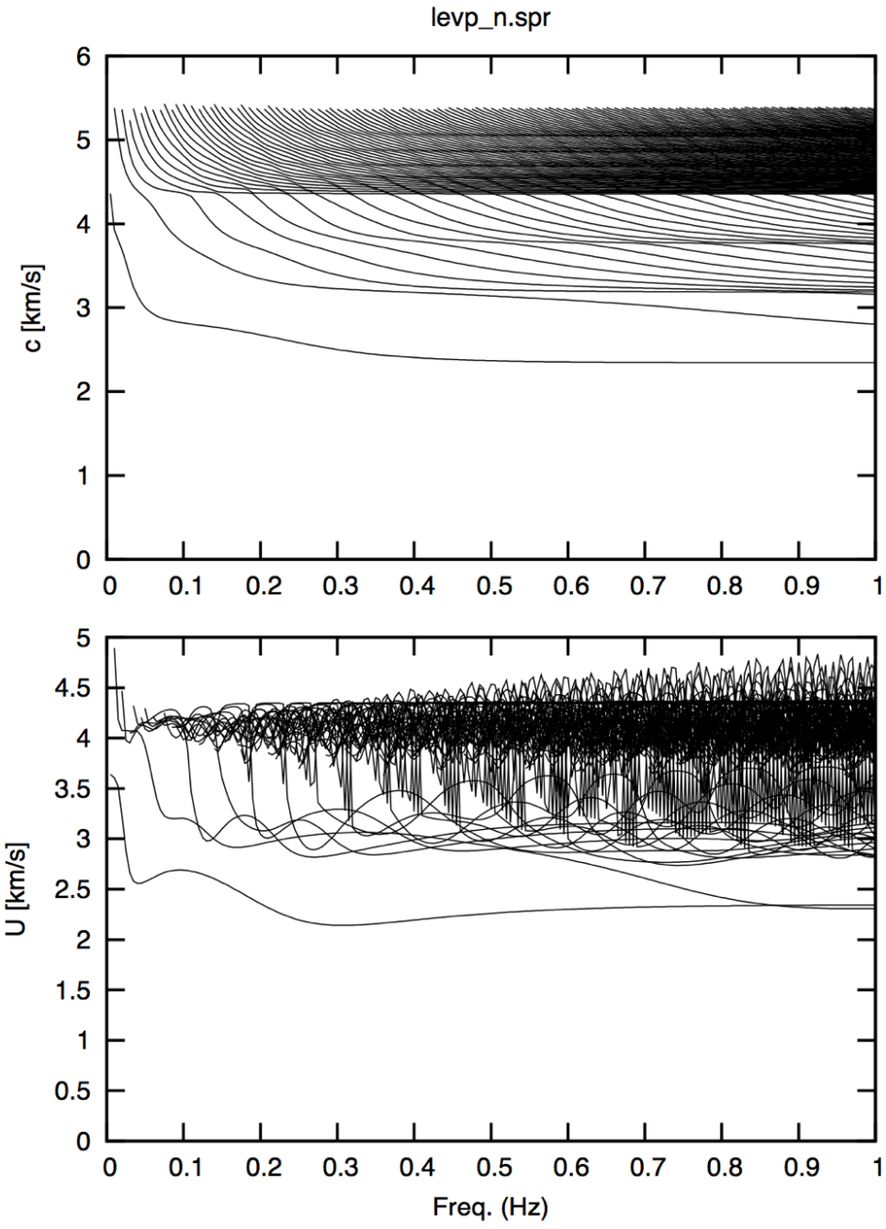
FTAN: Frequency Time ANalysis

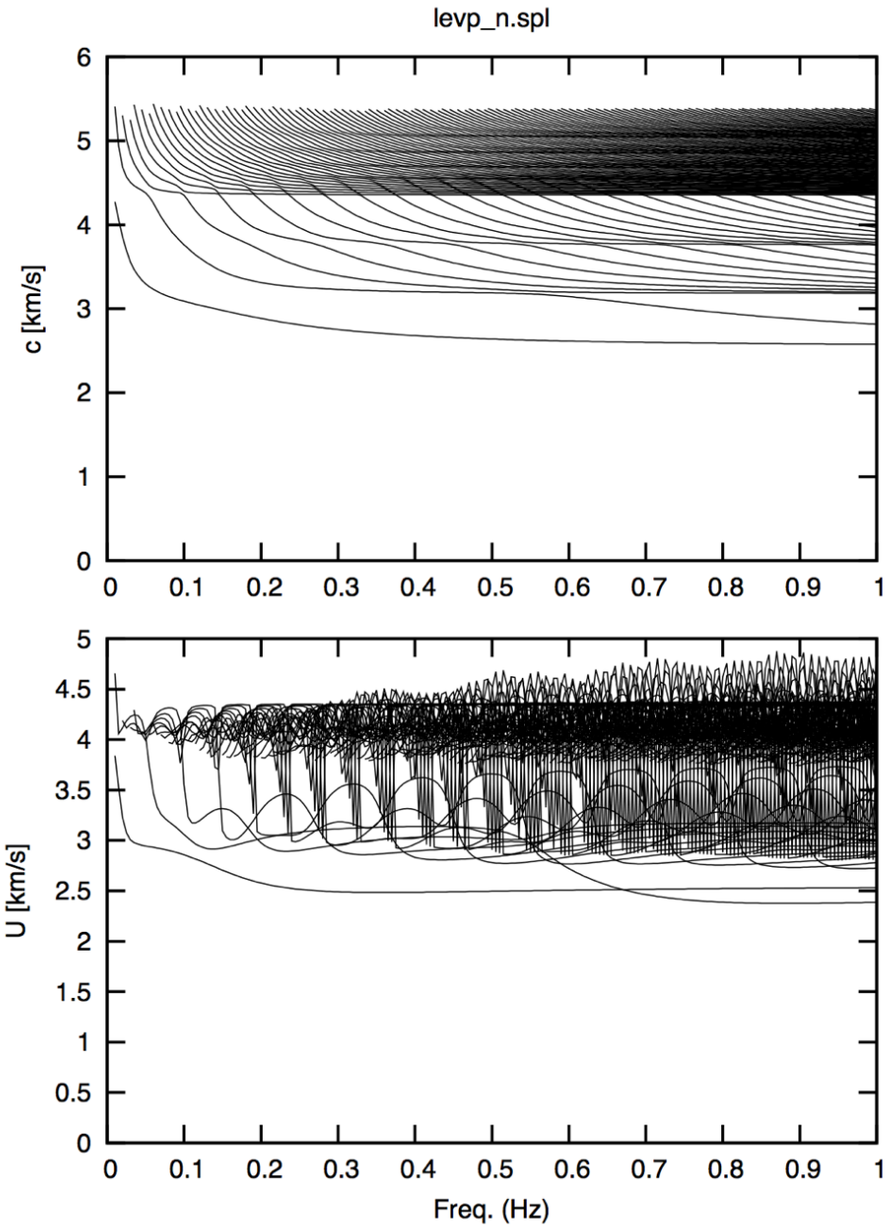


Franco Vaccari
vaccari@units.it

Surface wave dispersion

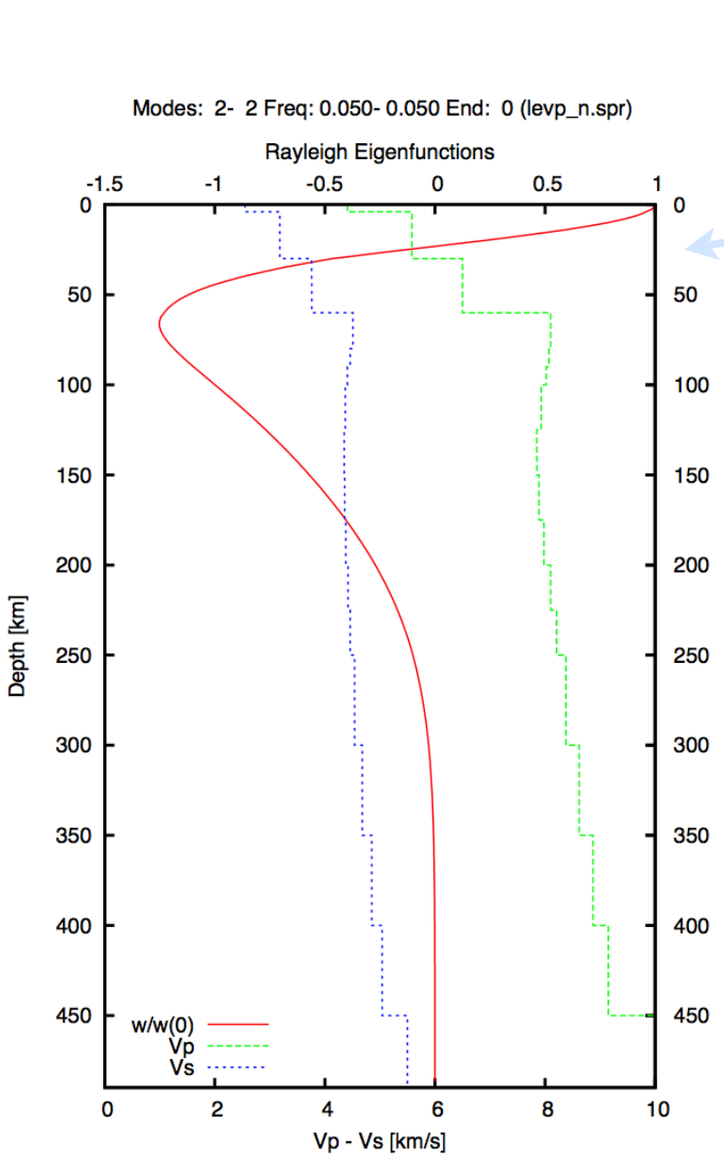
- Surface waves, showing not impulse nor quasi-harmonic behavior, are difficult to be studied in time or spectral domain, since their principal feature, dispersion, is described by a function rather than a single parameter.

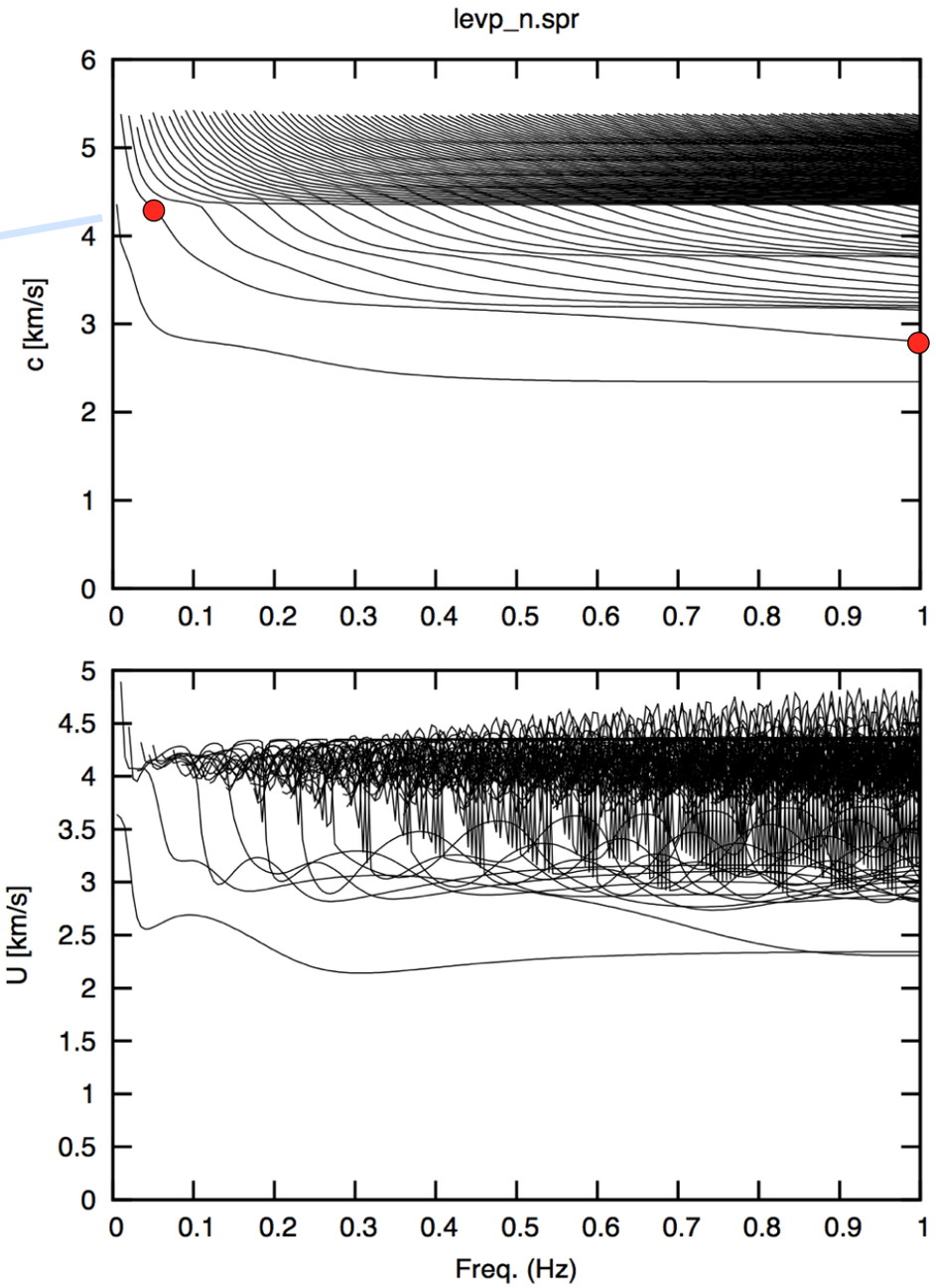


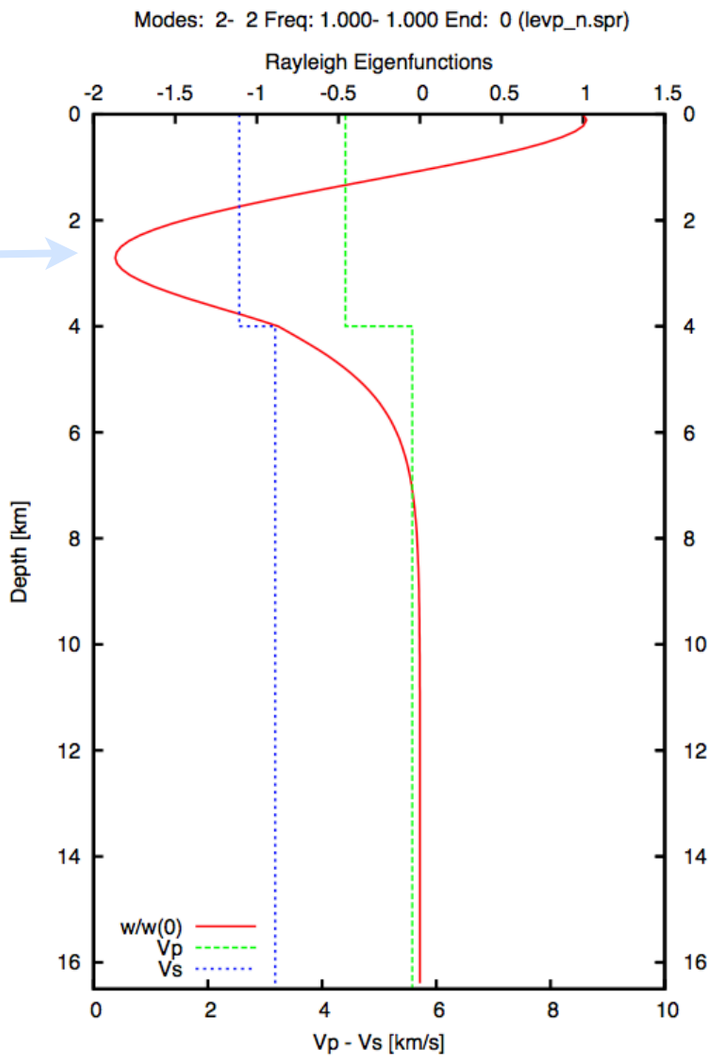


Surface wave dispersion

- For a given mode, shorter frequencies (longer periods) sample a larger portion of the structure, where faster layers are present: phase velocity c is therefore faster







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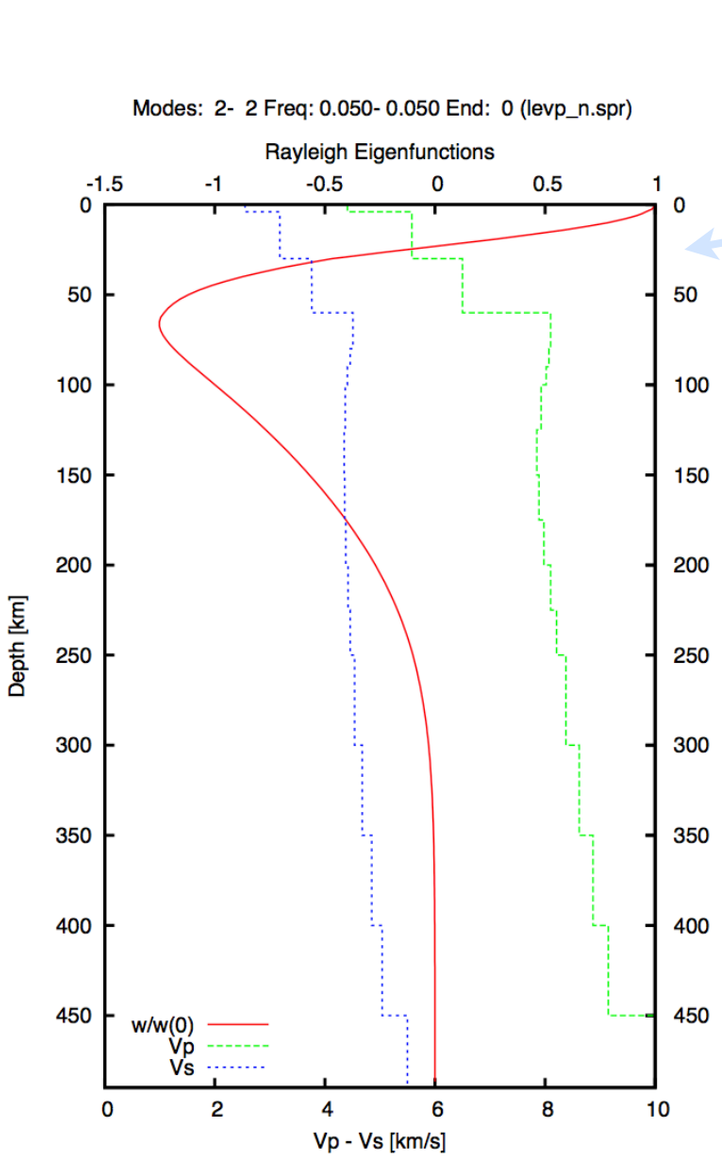
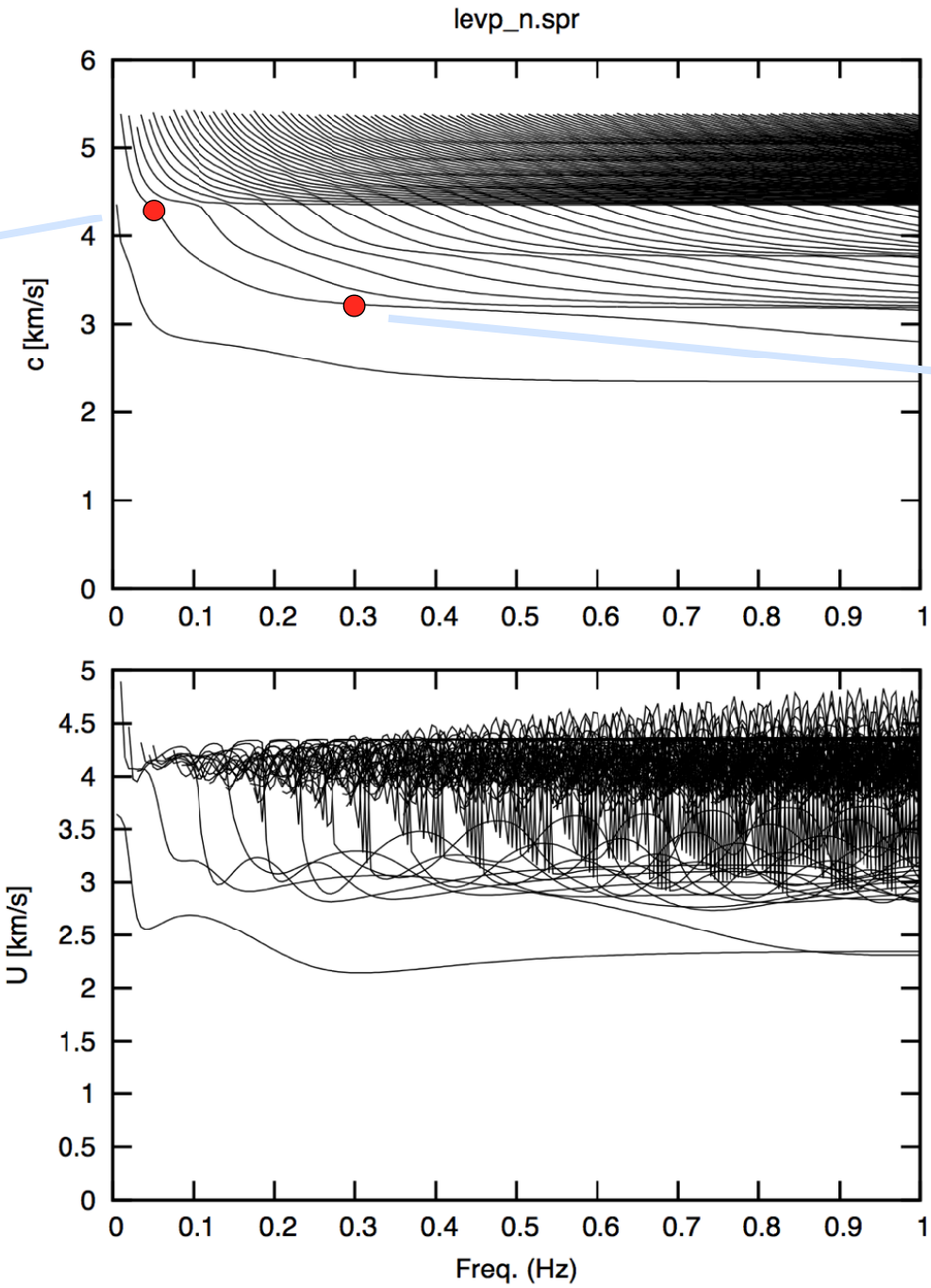
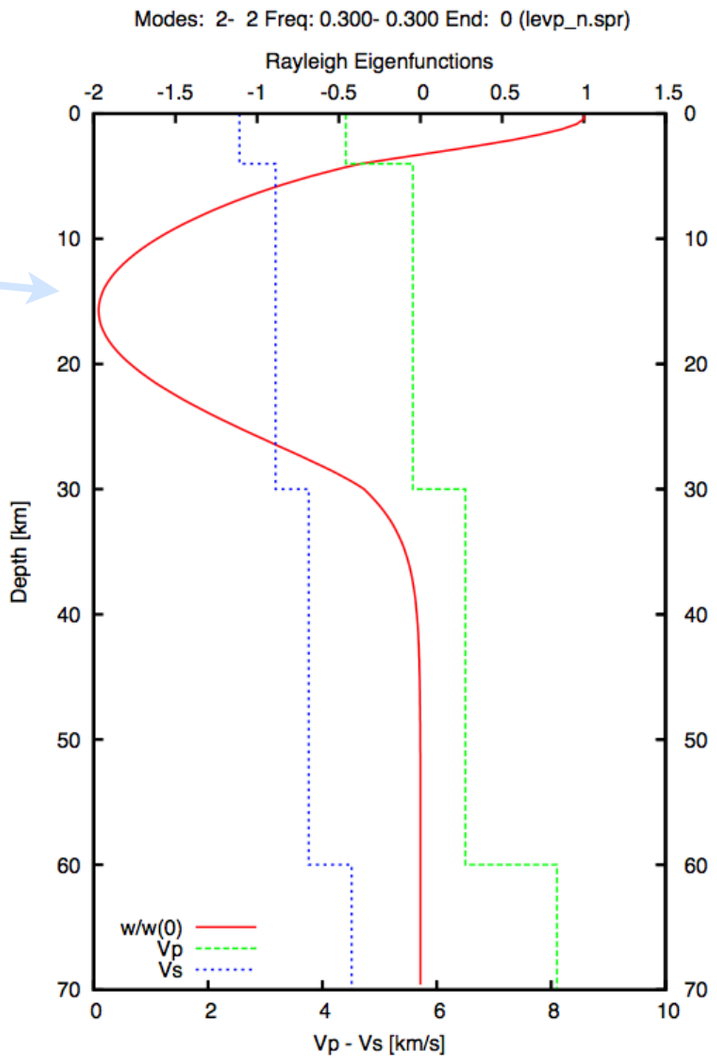
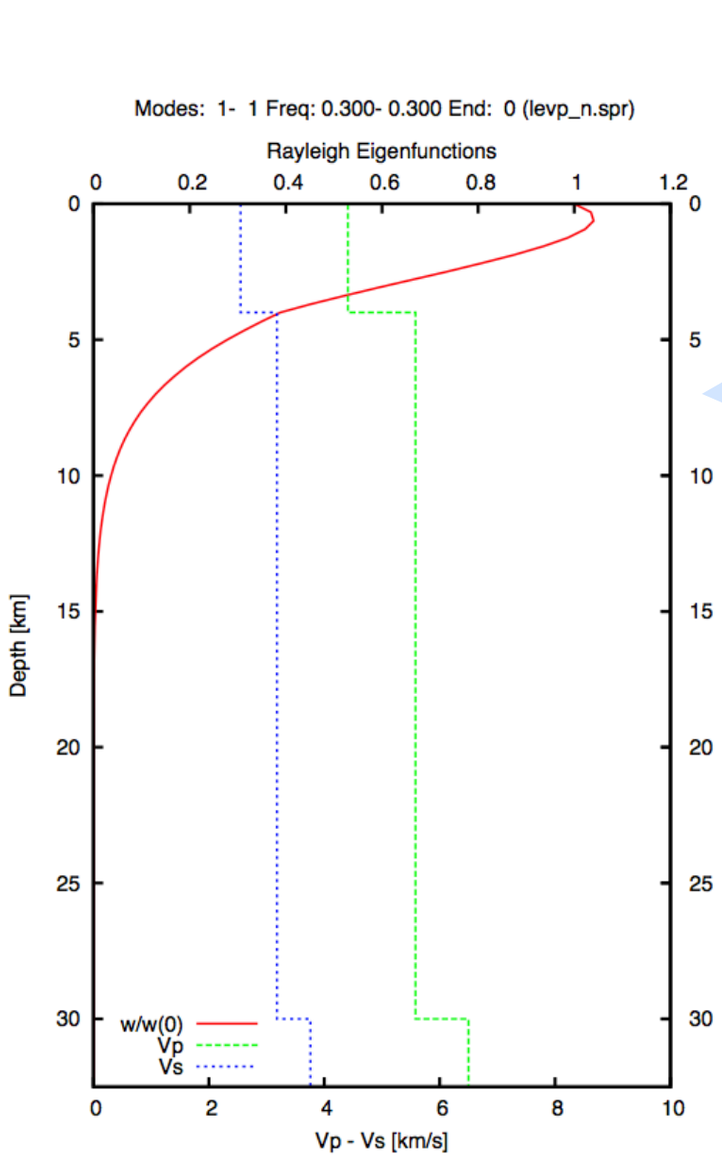


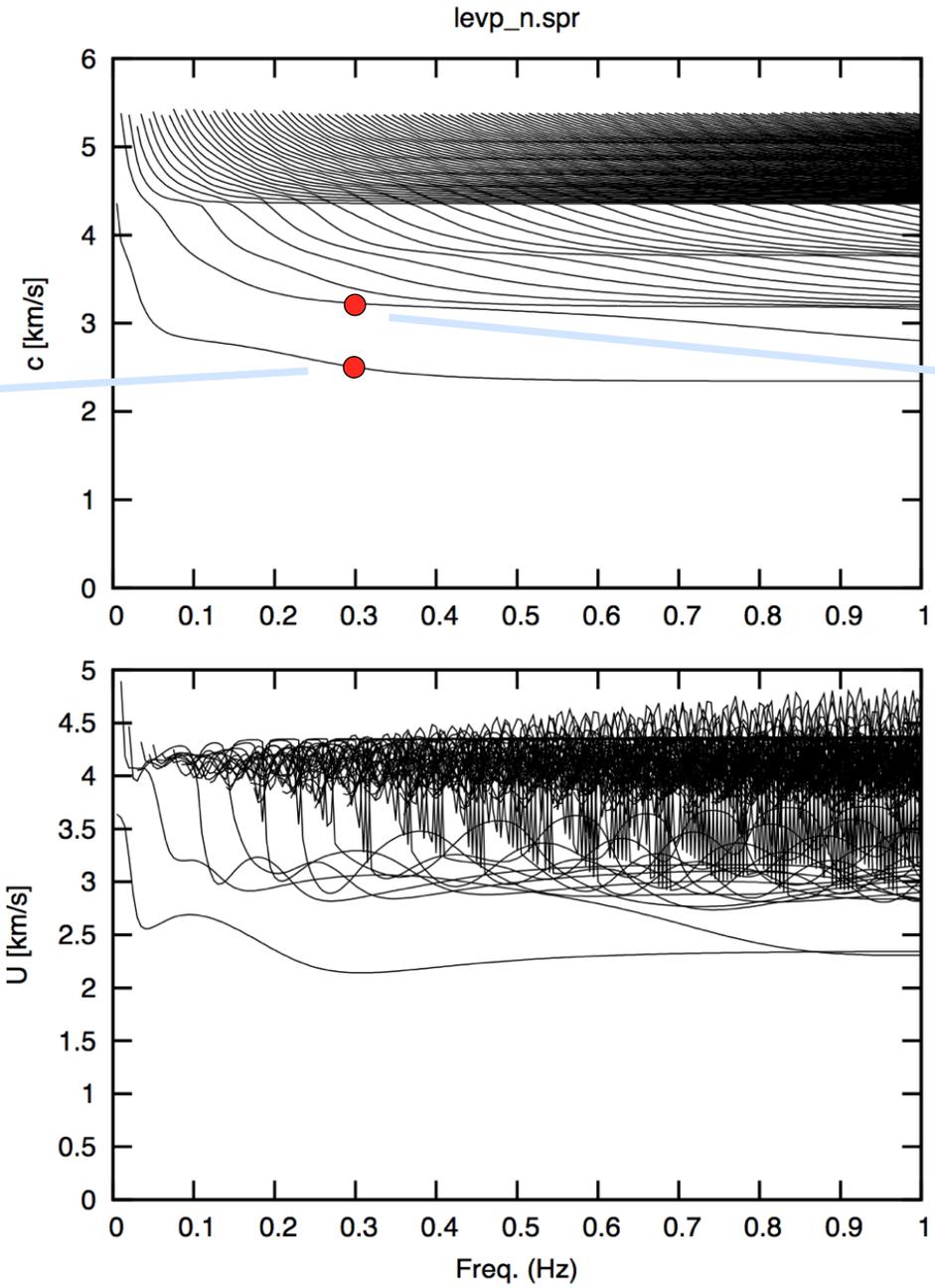


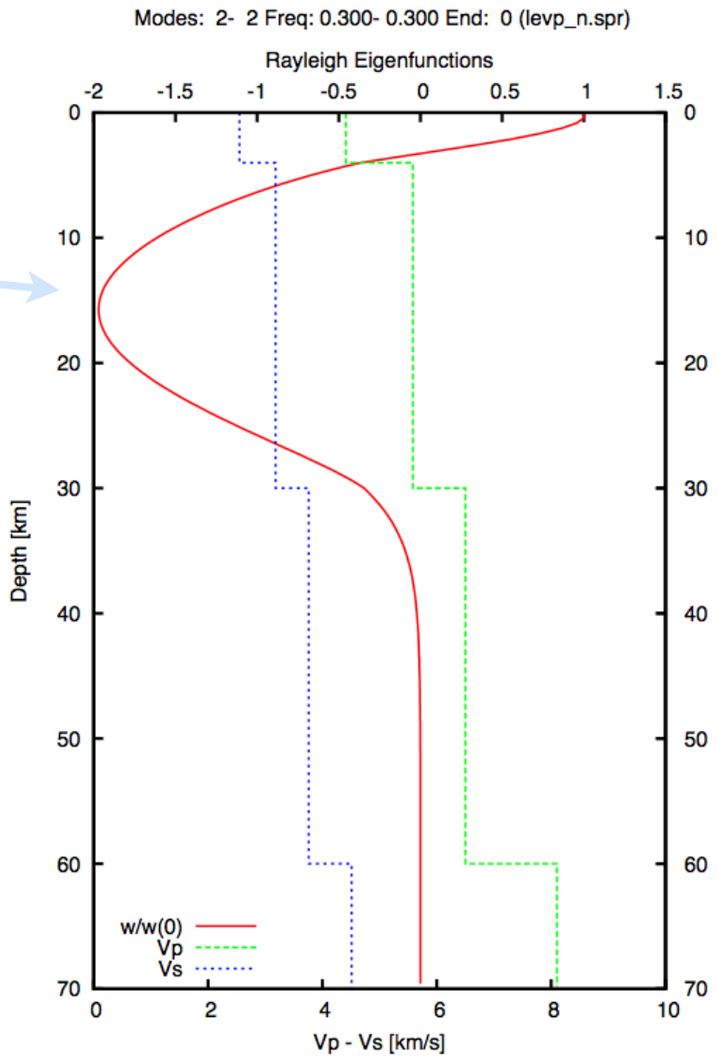


Surface wave dispersion

- For a given frequency, higher modes sample a larger portion of the structure, where faster layers are present: phase velocity c is therefore faster







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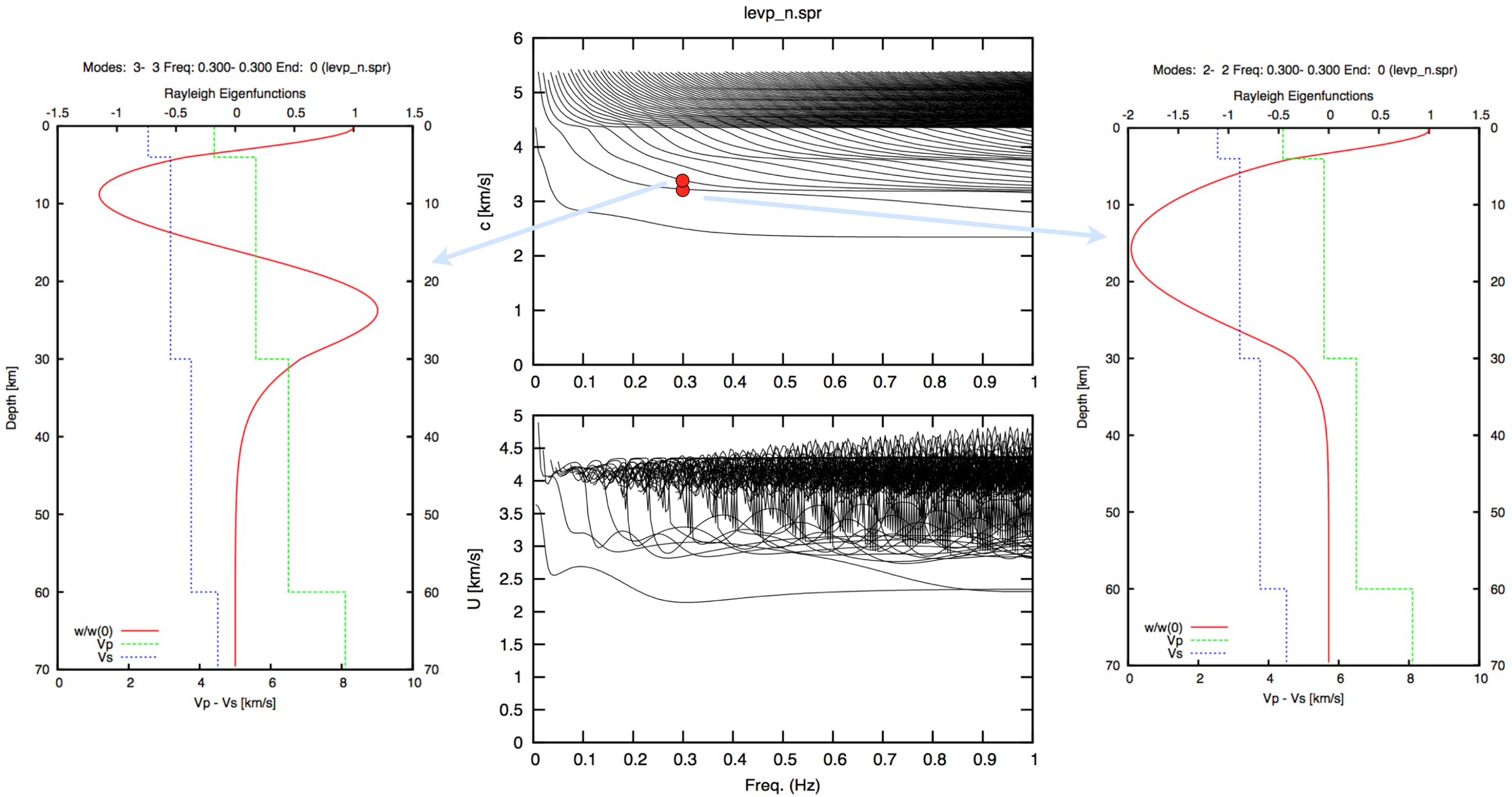

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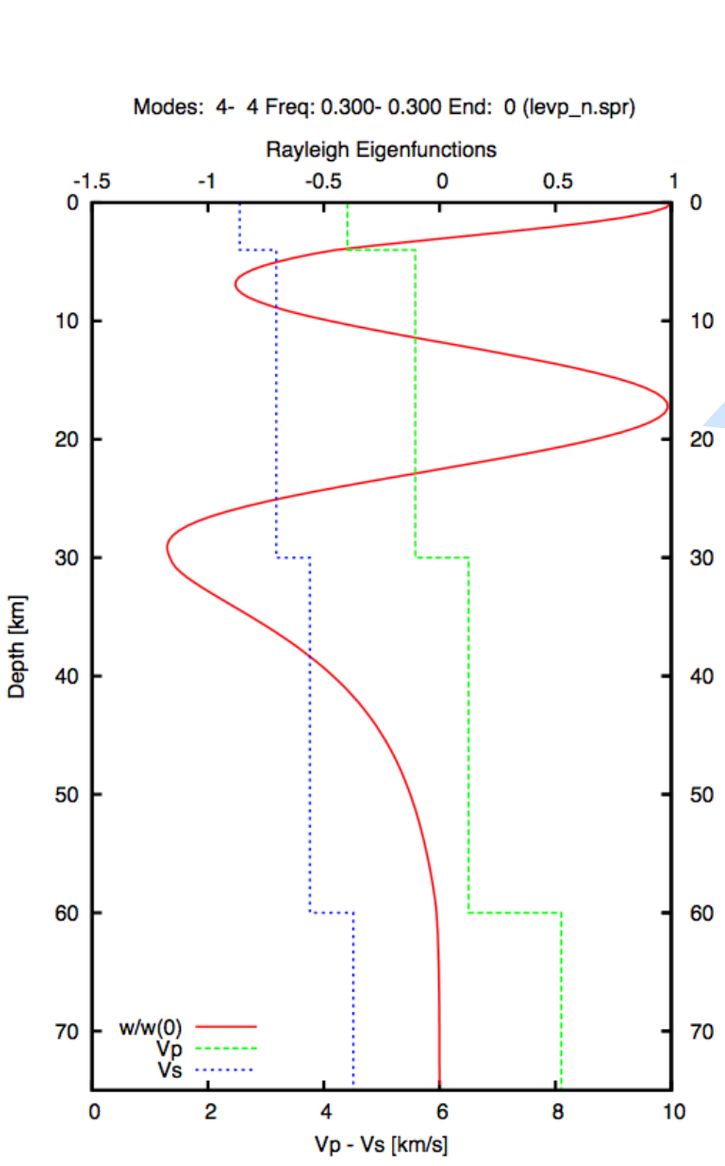

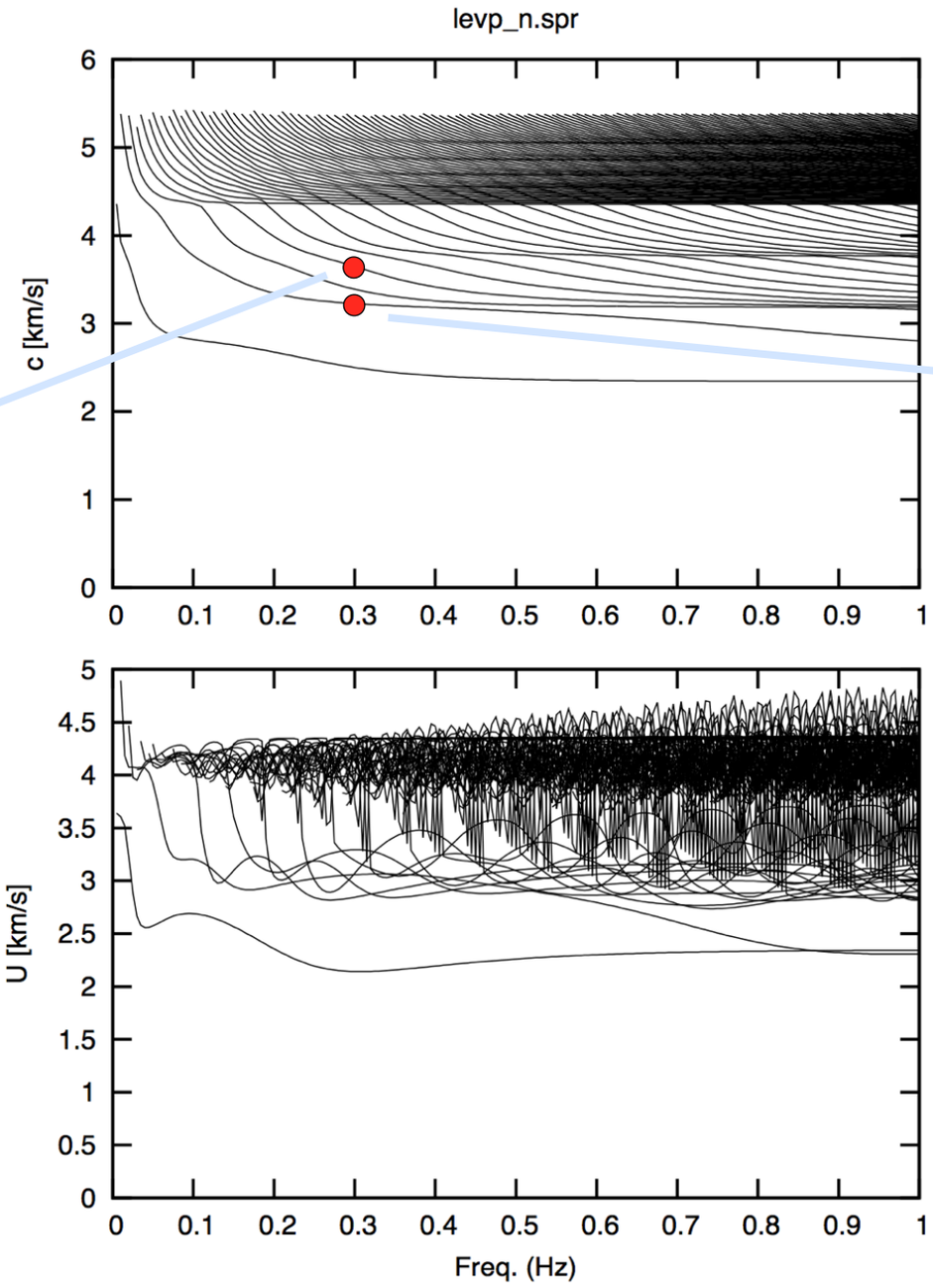

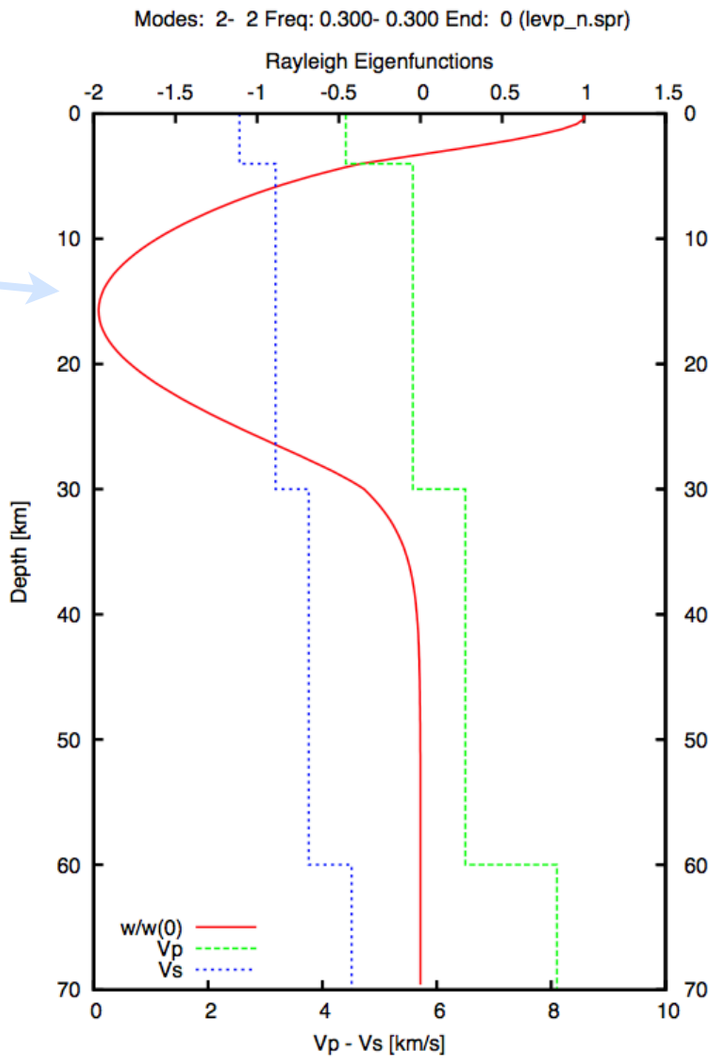

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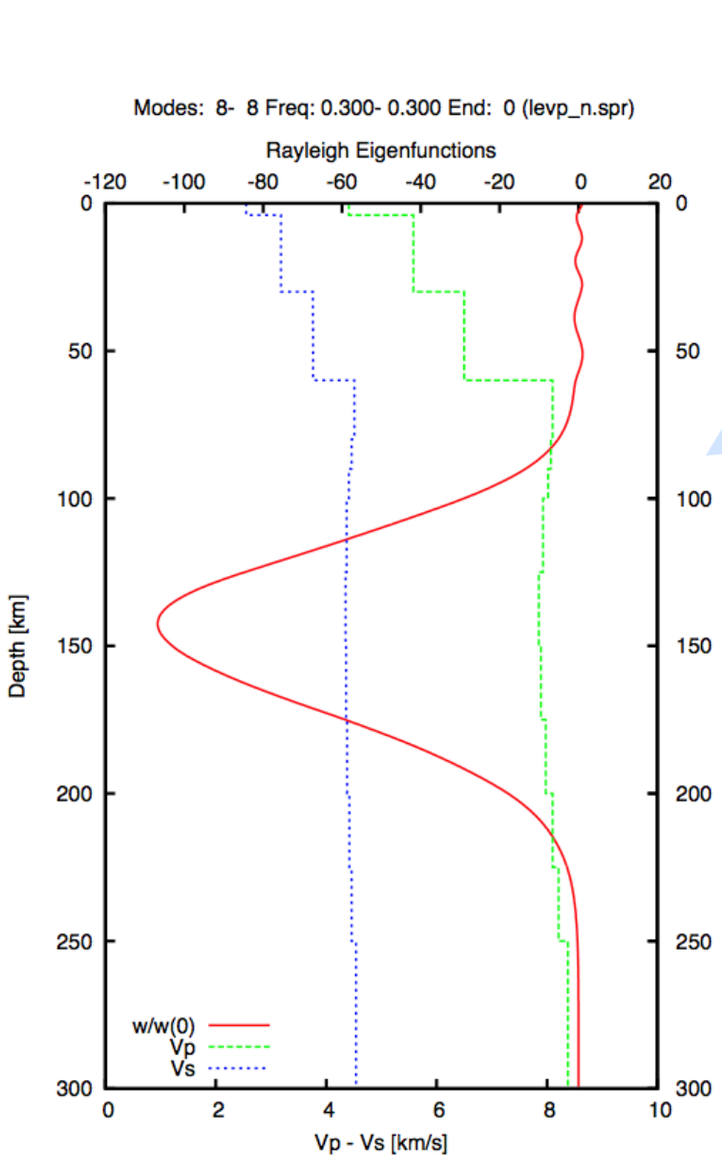

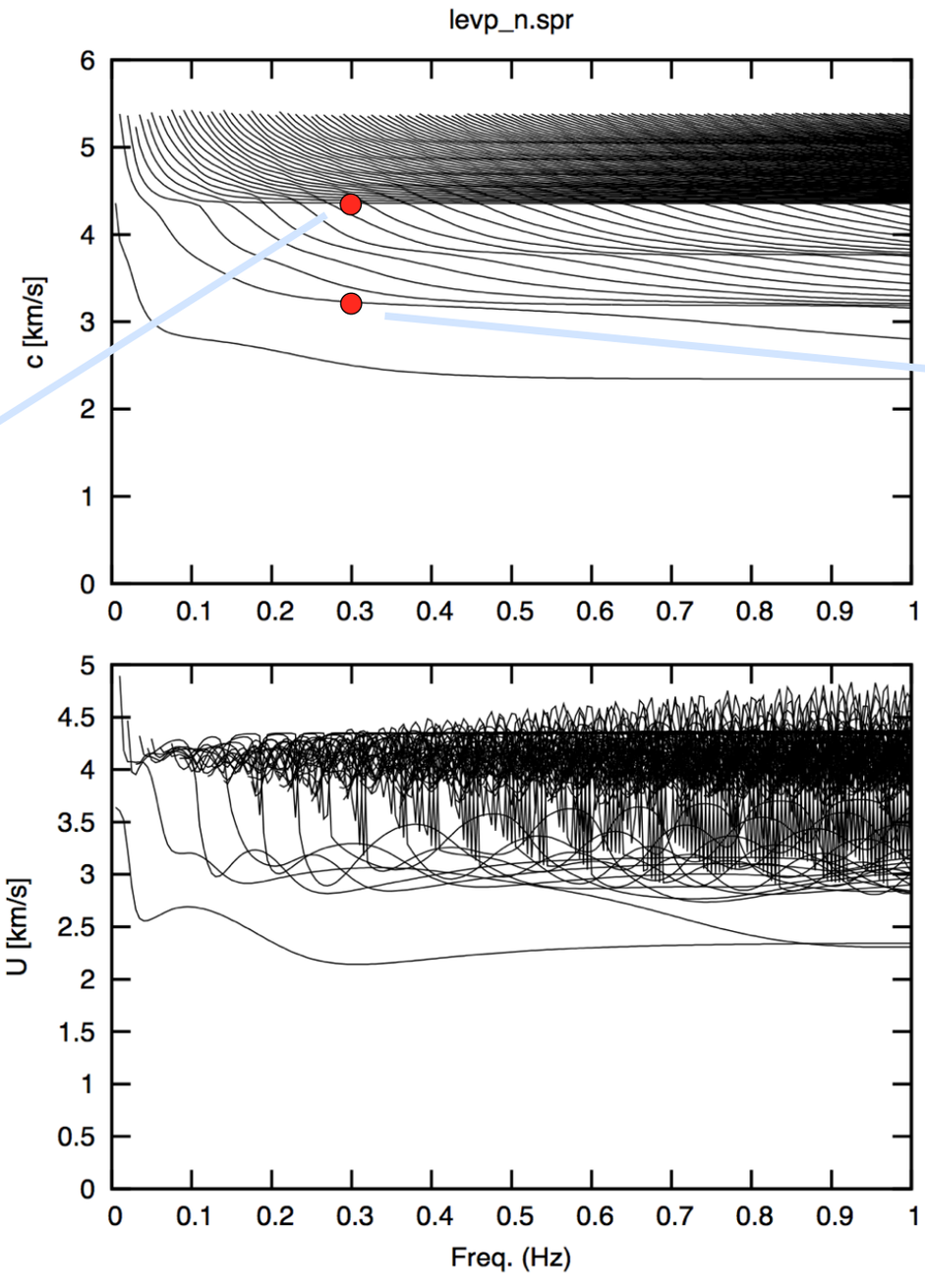

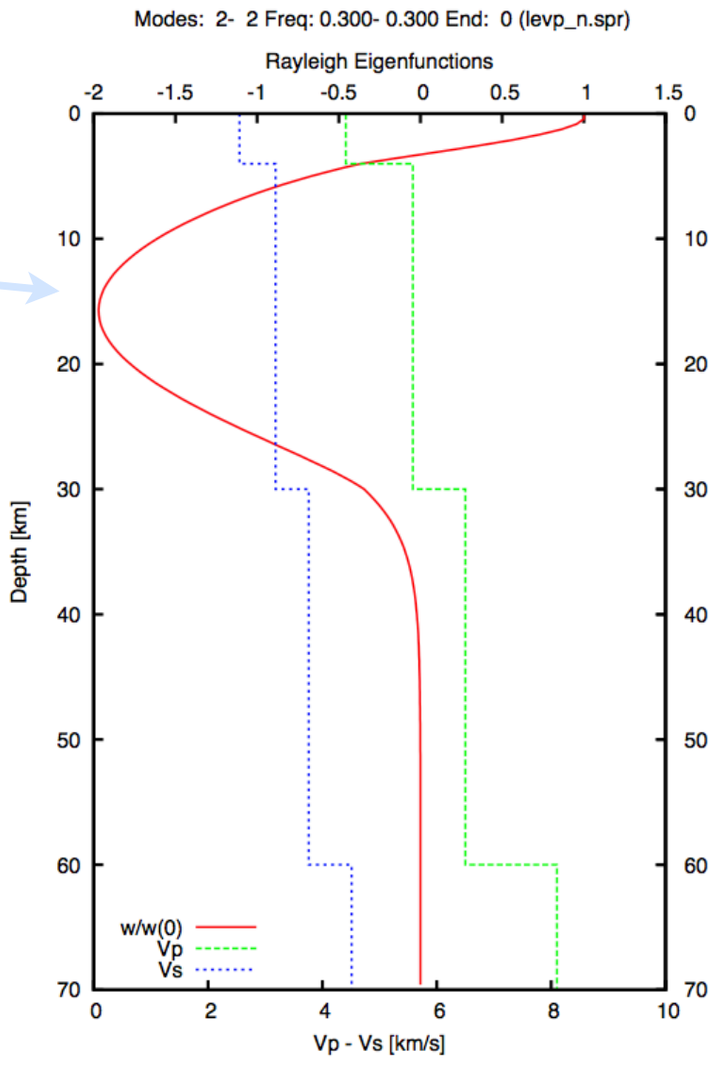

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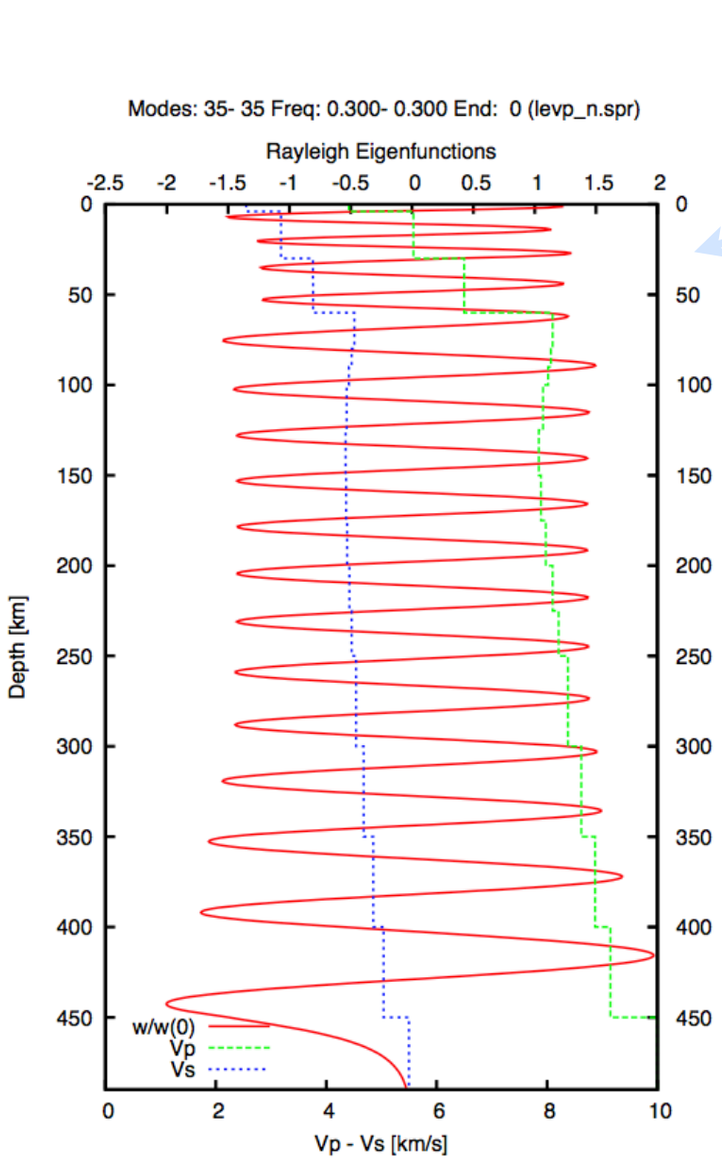
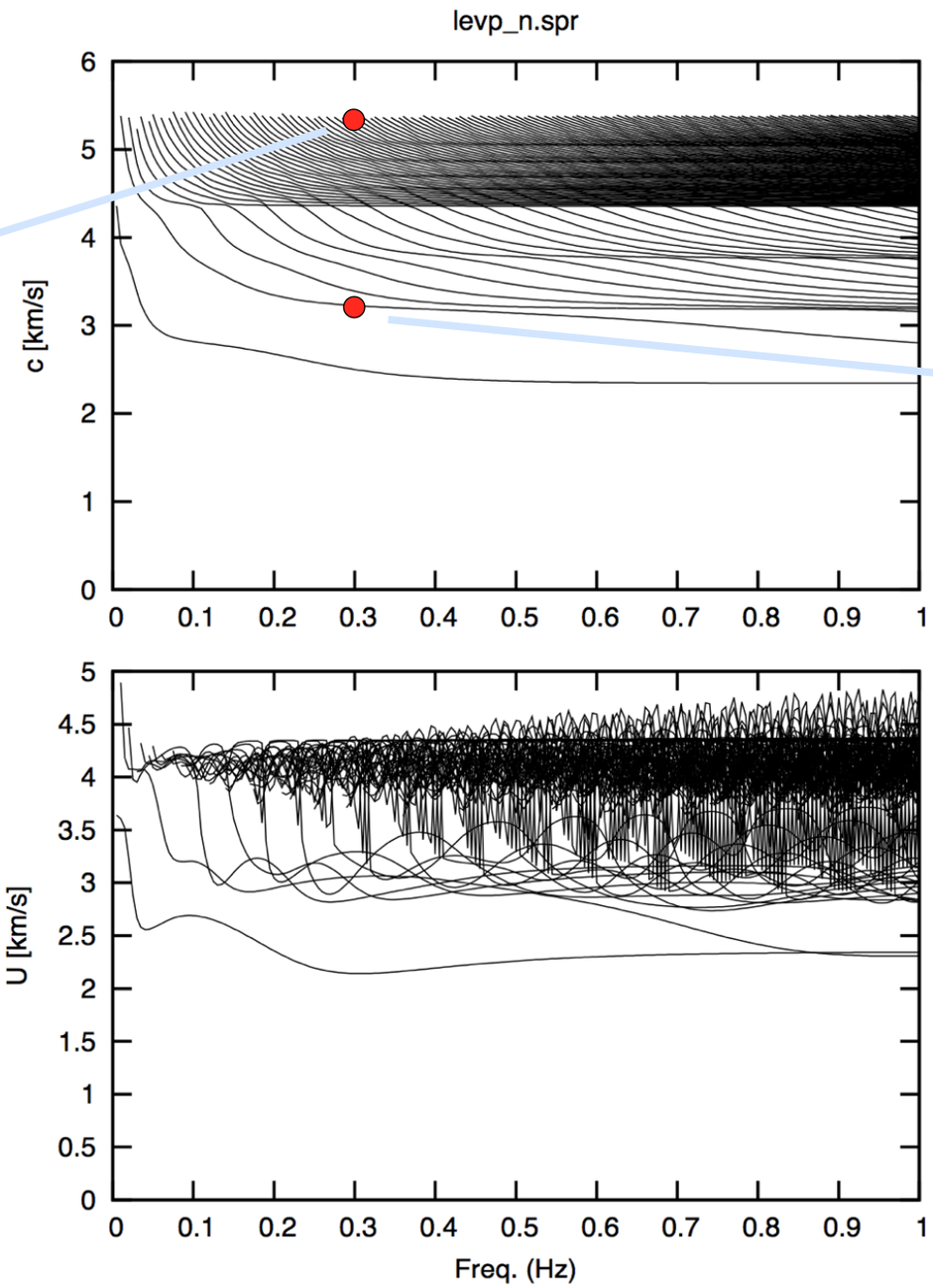
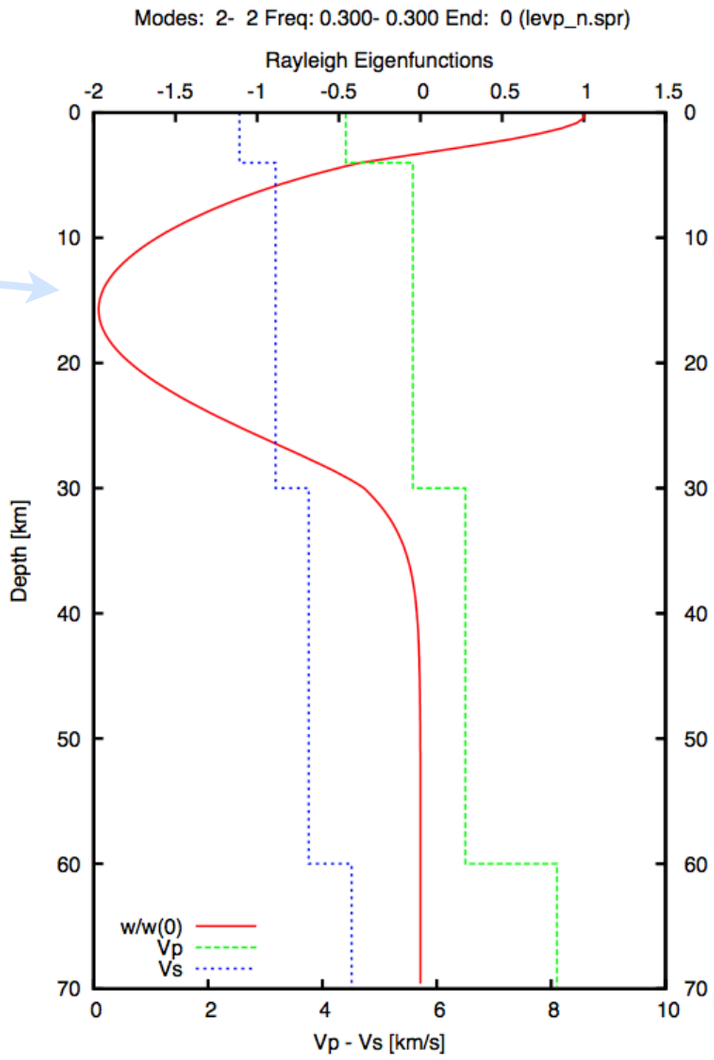


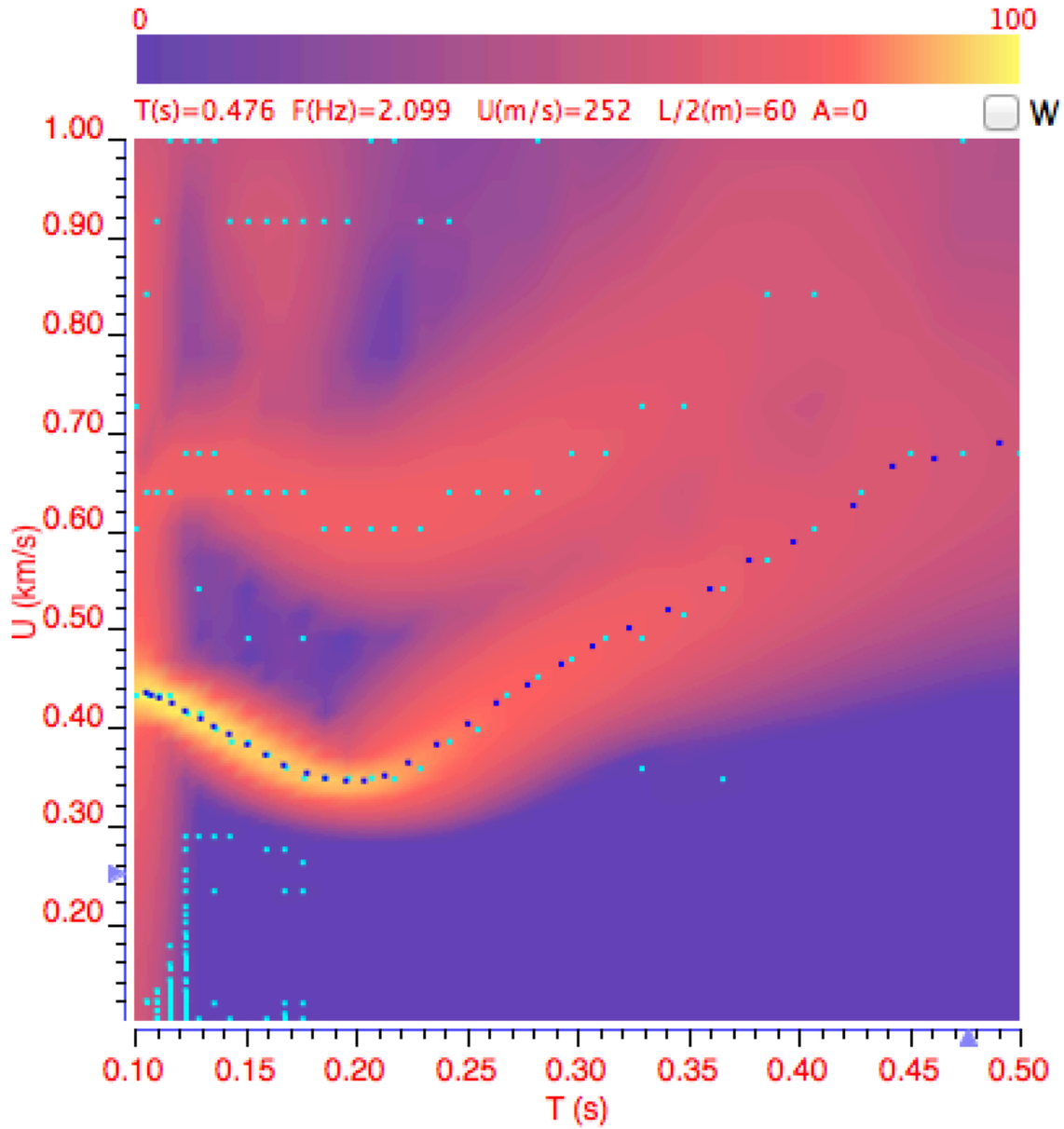




FTAN - Graphical representation

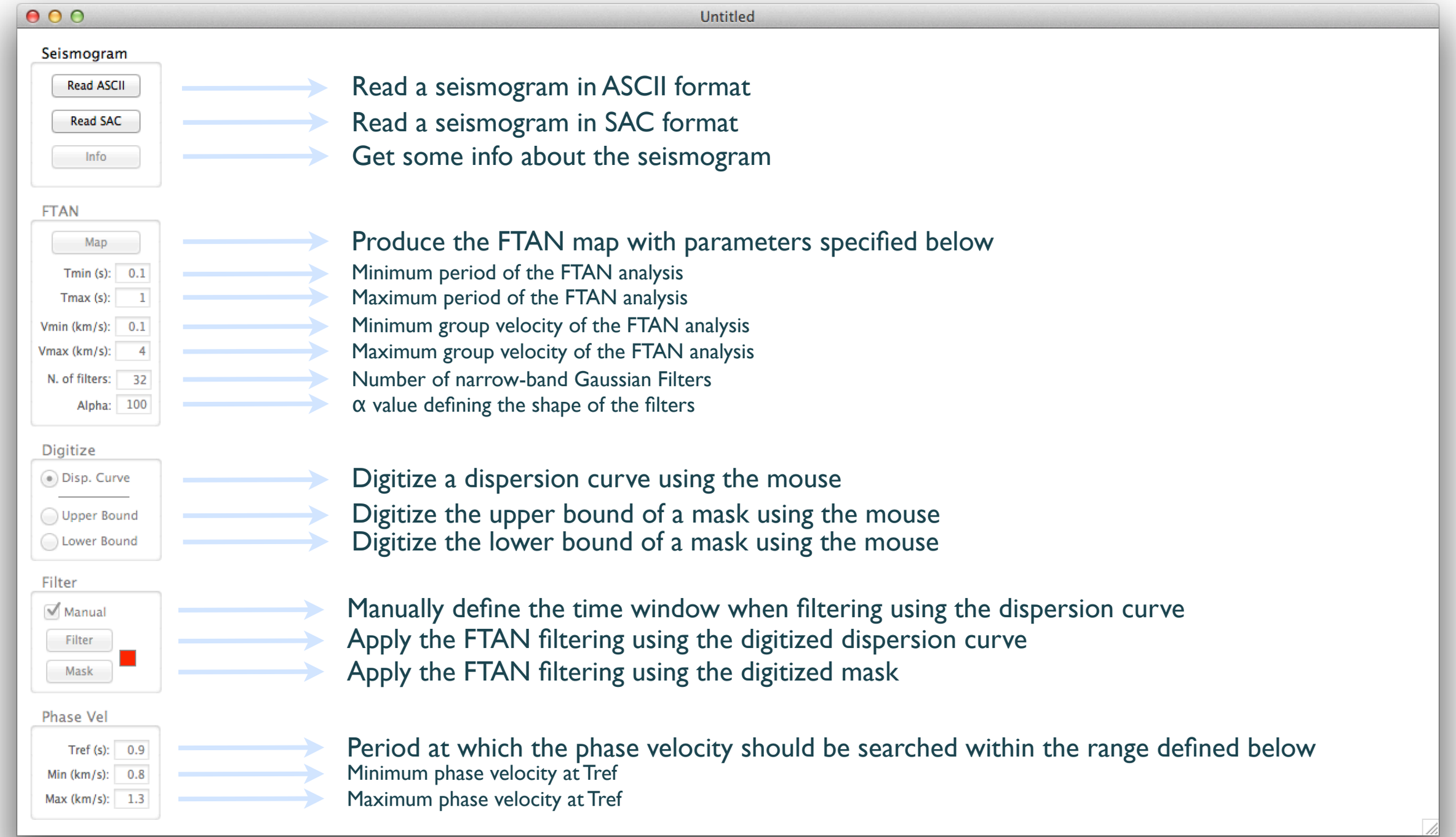
- Converting:
  - the frequency to period T
  - arrival times t of energy packets to group velocity U

  one has the typical FTAN map of a signal:



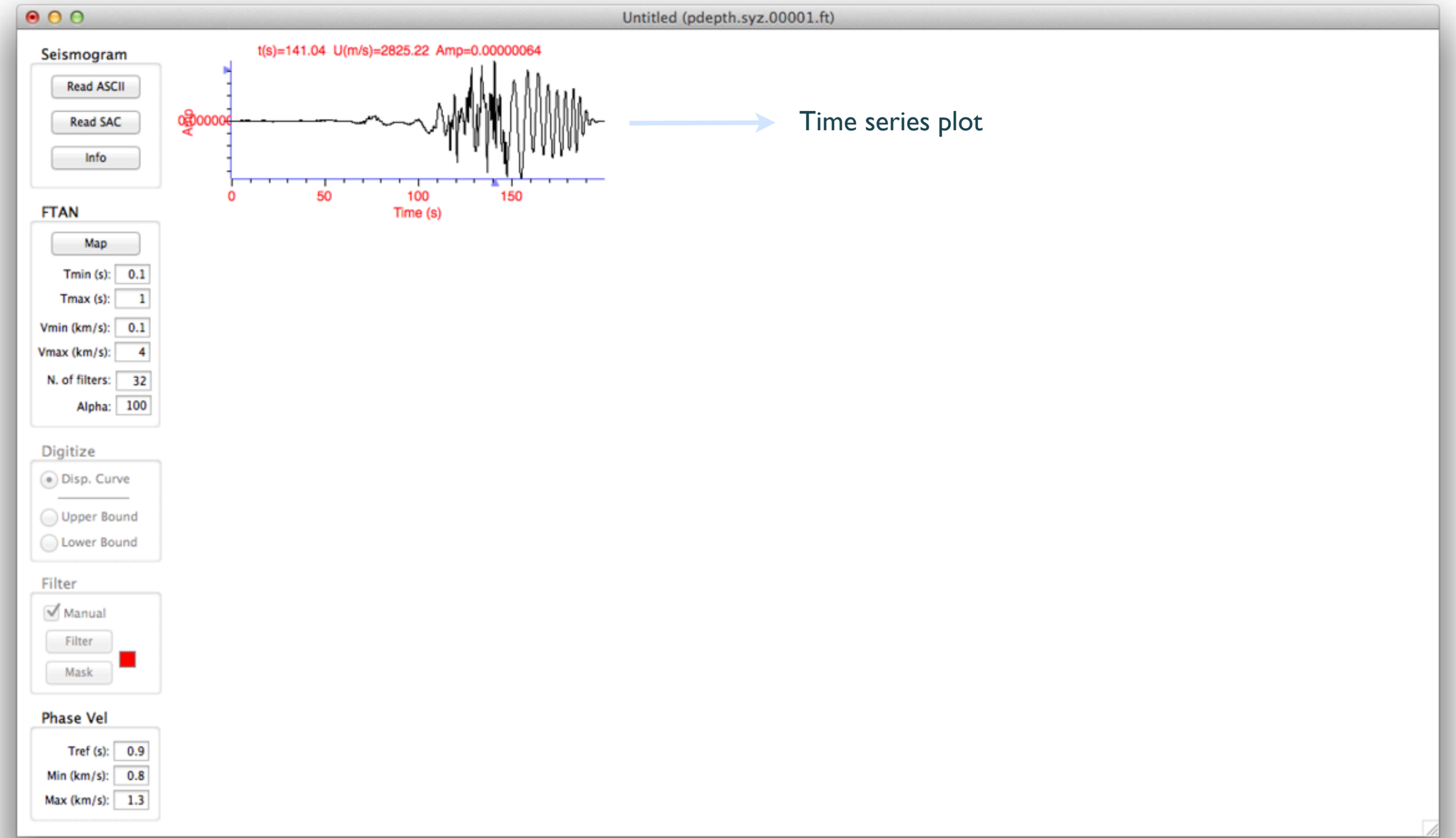
FTAN - XFTAN20123 graphic user interface

New empty window



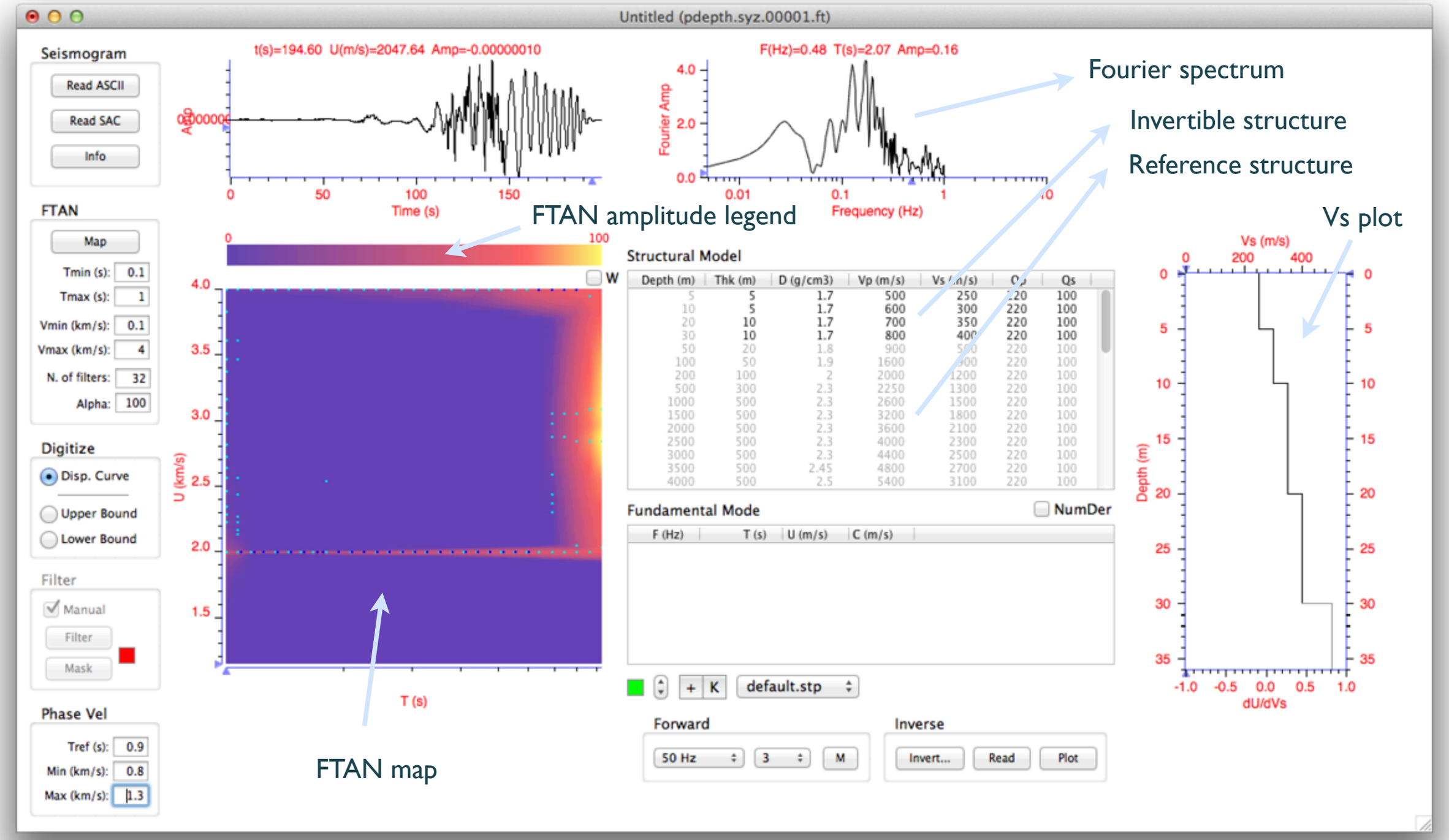
FTAN - XFTAN20123 graphic user interface

- After reading a seismogram



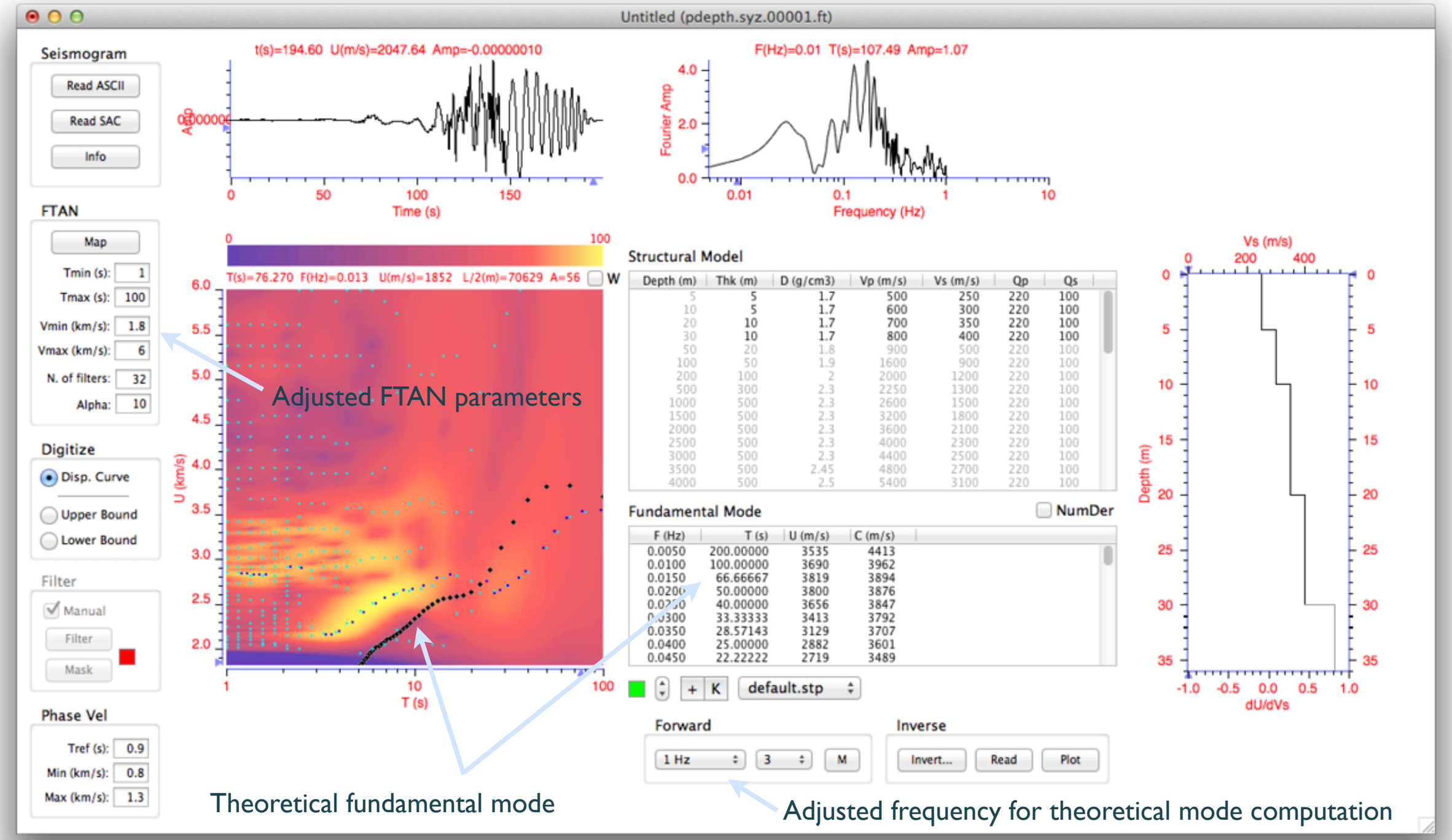
FTAN - XFTAN20123 graphic user interface

- FTAN map has been produced with default parameters



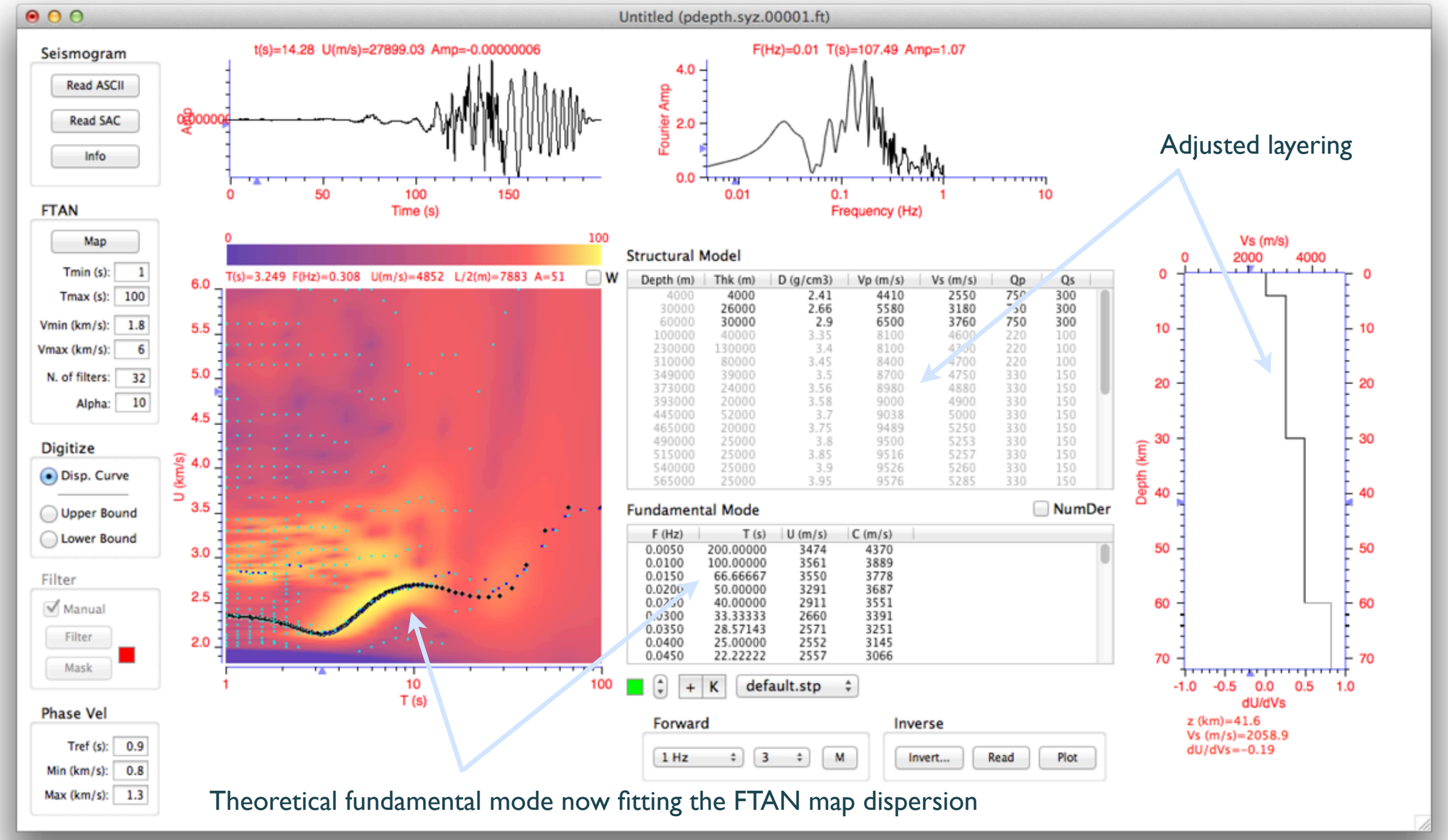
FTAN - XFTAN20123 graphic user interface

- FTAN map after adjusting parameters



FTAN - XFTAN20123 graphic user interface

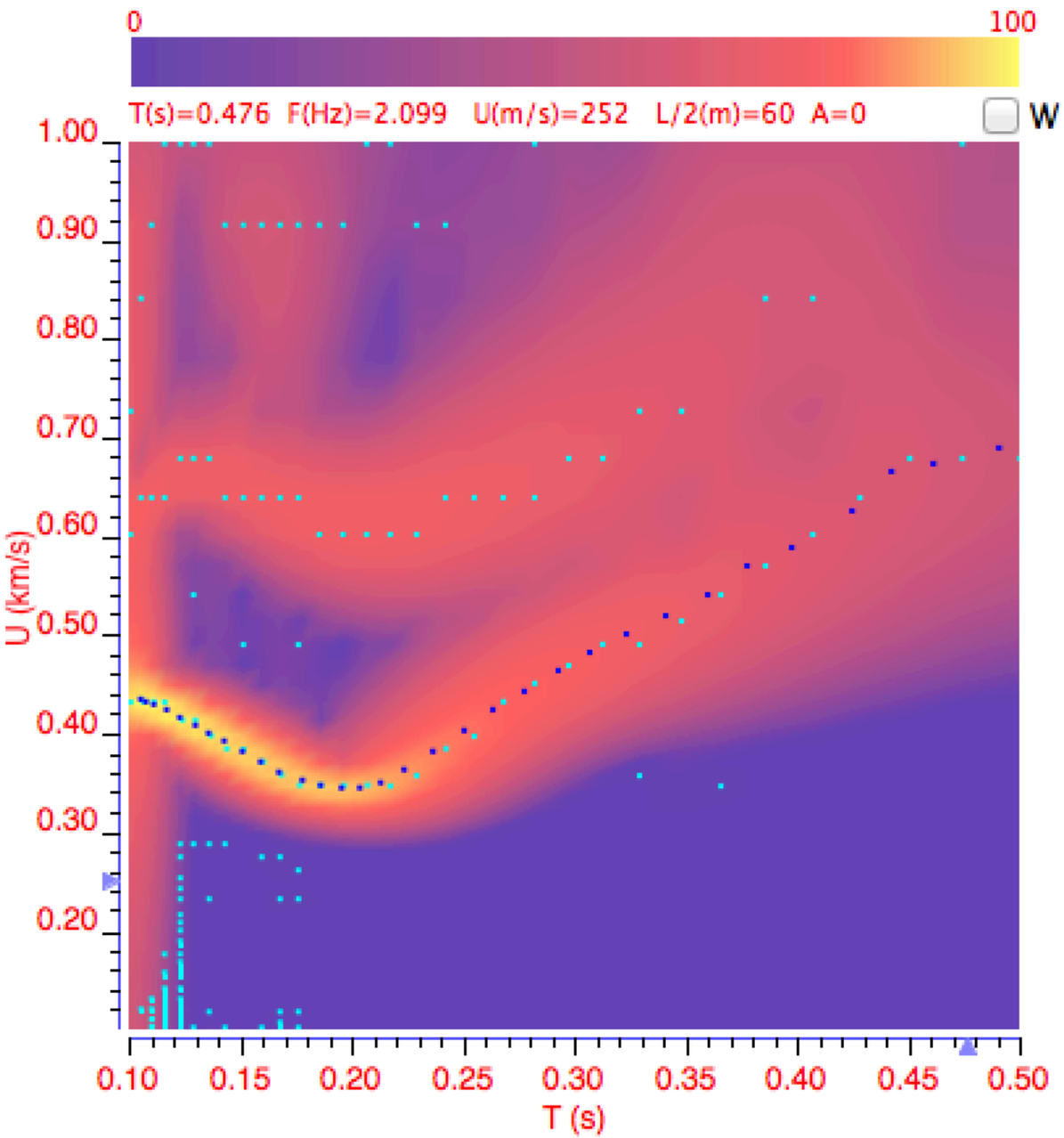
- FTAN map after adjusting structure layering

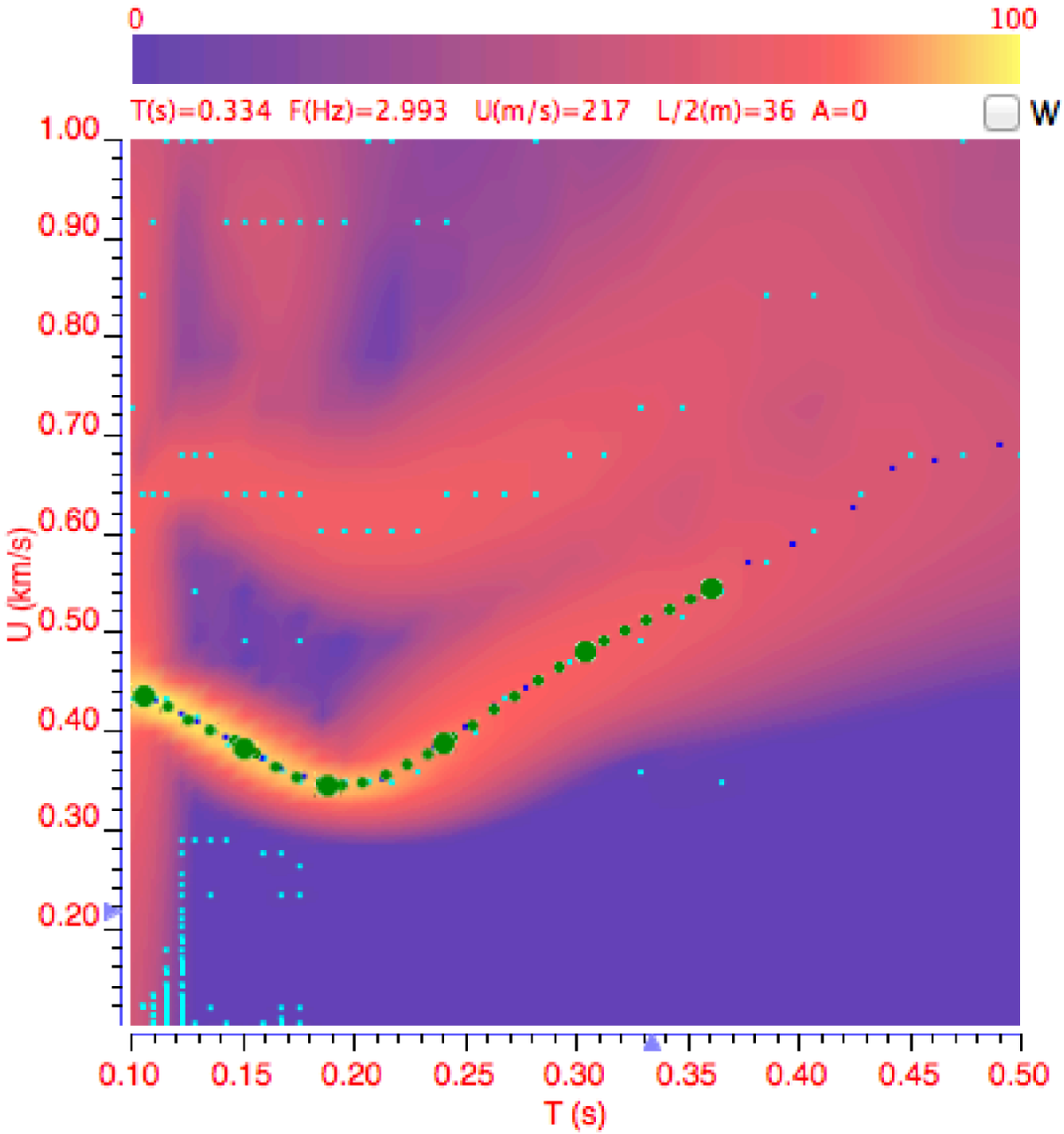


Theoretical fundamental mode now fitting the FTAN map dispersion

FTAN - Dispersion

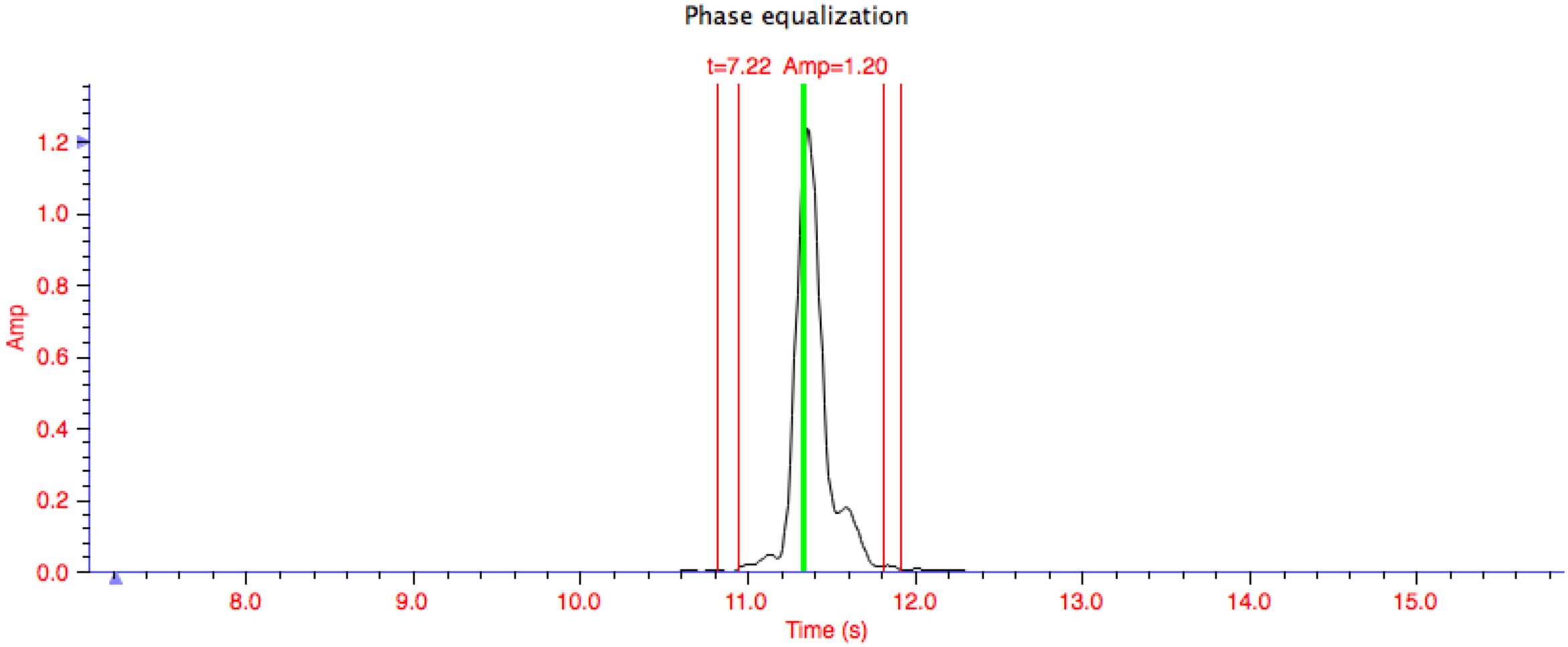
- Dispersion curve of Rayleigh fundamental mode digitized manually by the user on the FTAN map (from synthetic seismogram)





FTAN - Phase equalization

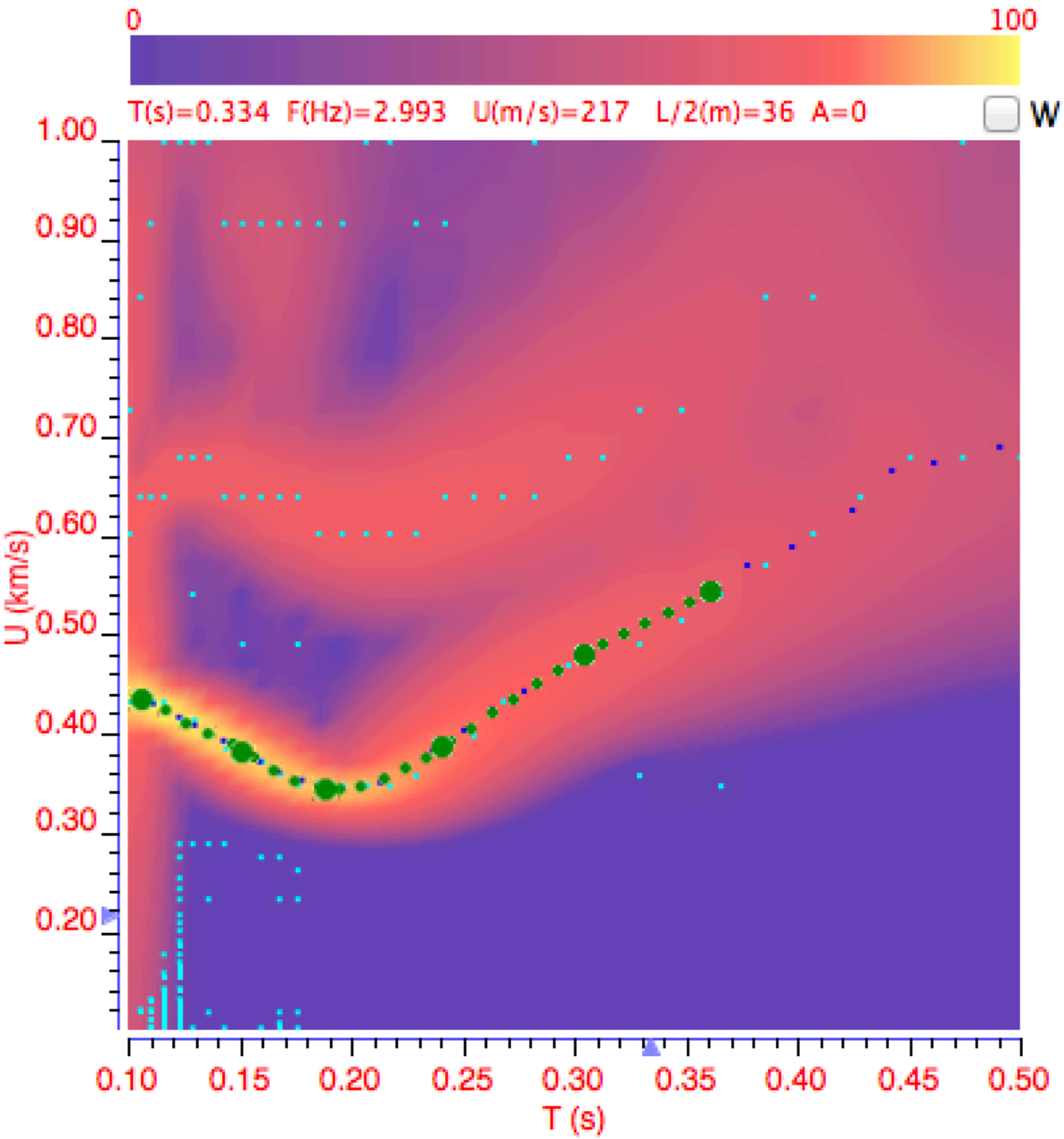
- Performed according to the user-identified dispersion relation for Rayleigh fundamental mode



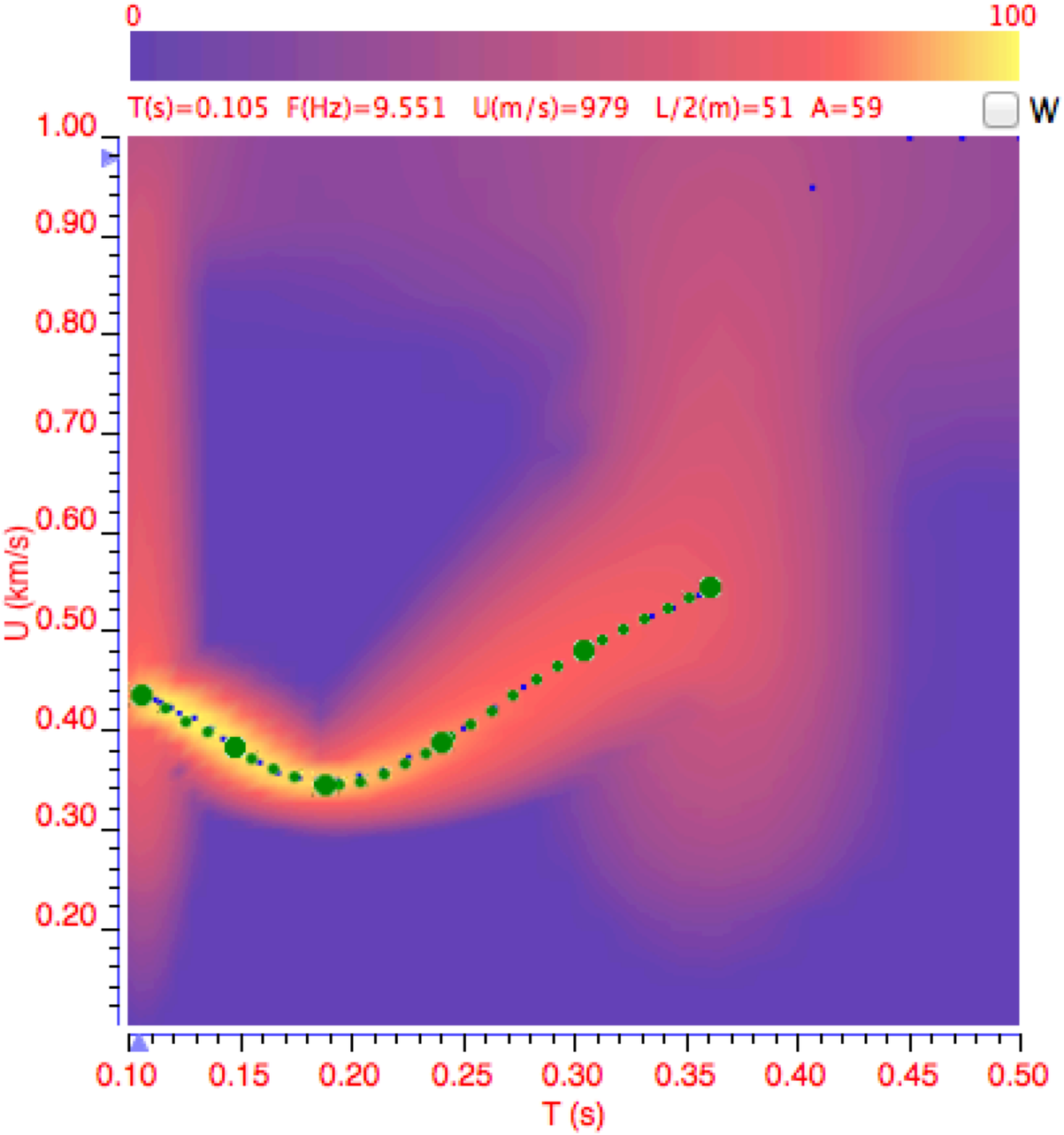
FTAN - Filtered map

- Filtered according to the user-identified dispersion relation for Rayleigh fundamental mode

Original

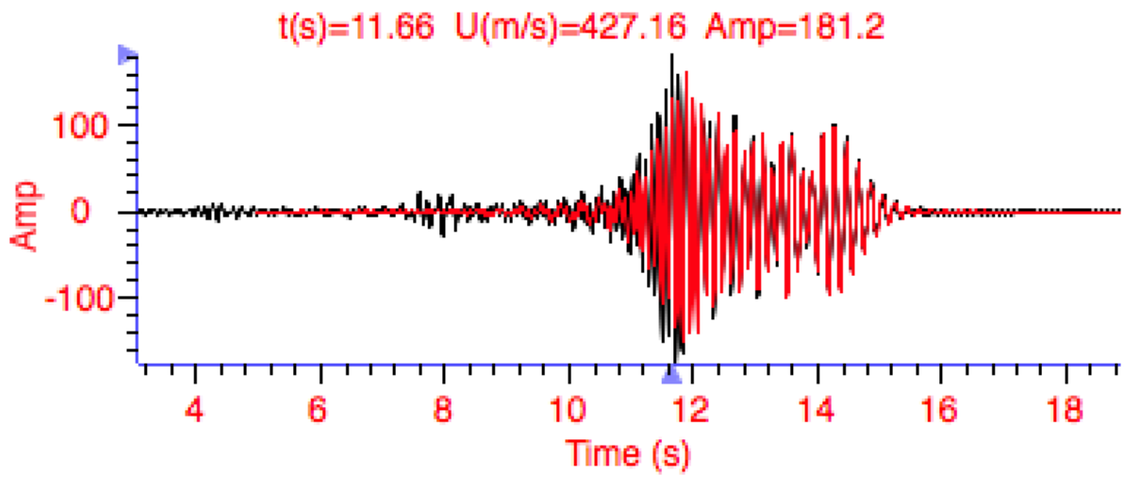


Filtered



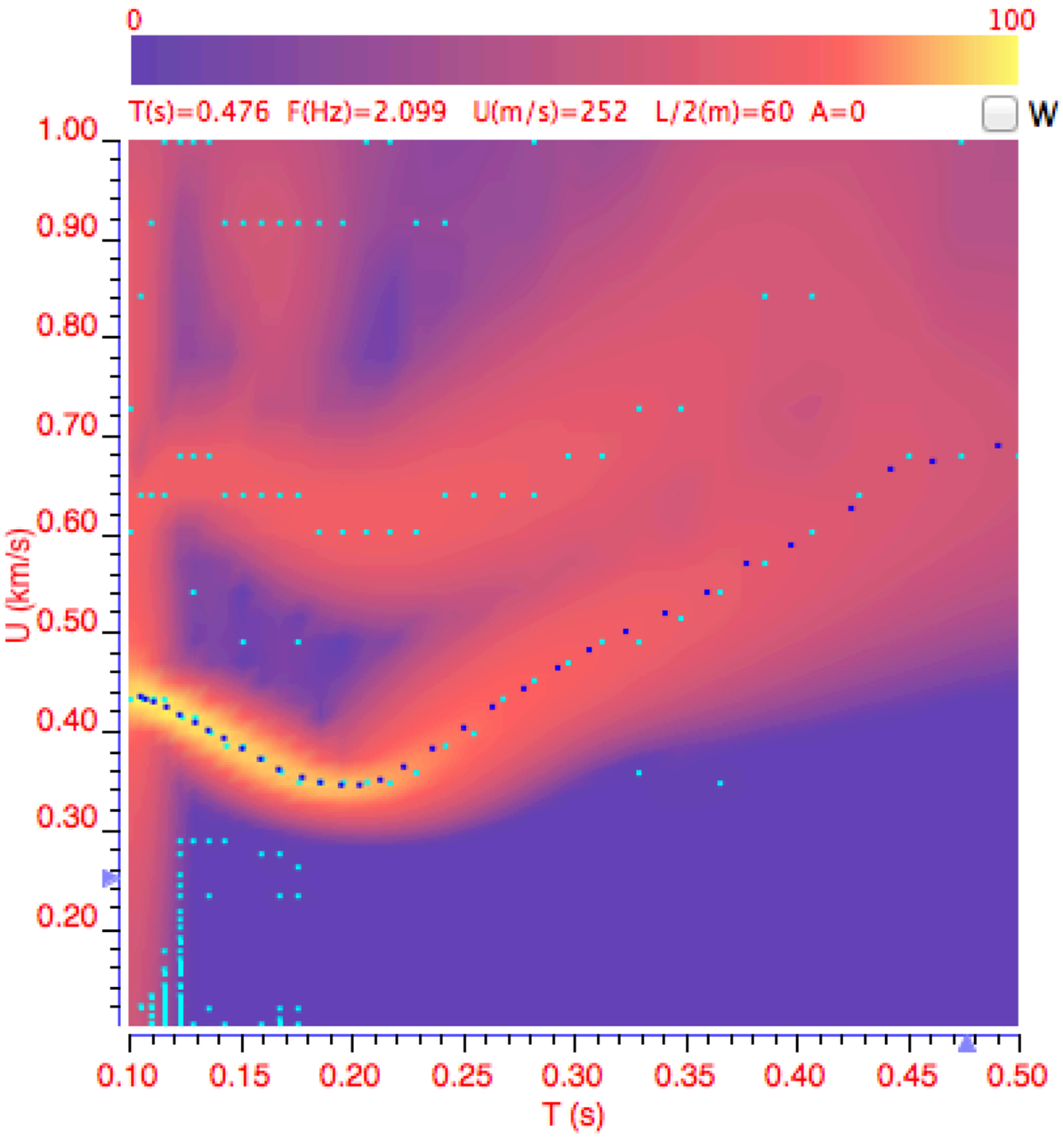
FTAN - Filtered seismogram

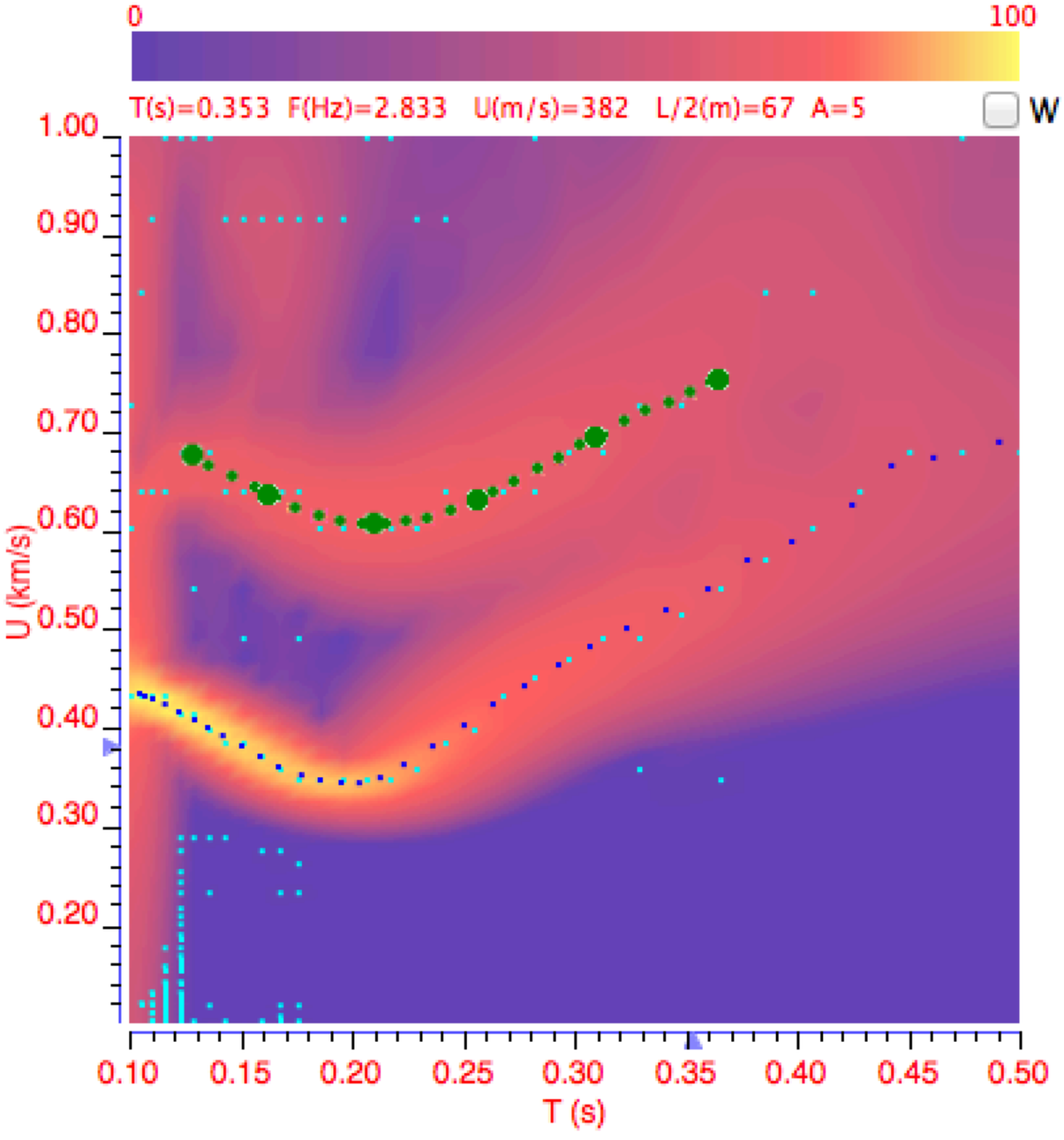
- Performed according to the user-identified dispersion relation for Rayleigh fundamental mode



FTAN - Filtered map, higher mode

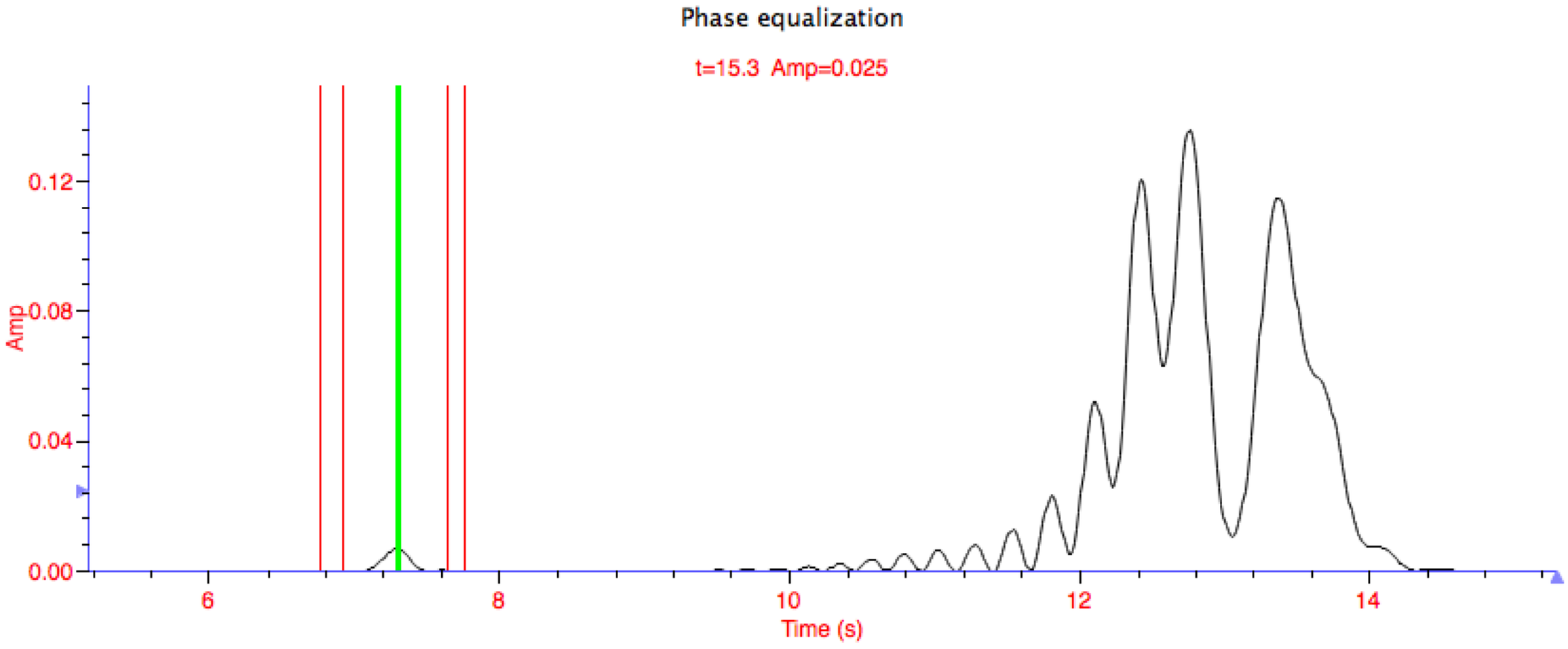
- Dispersion curve of Rayleigh higher mode(s) digitized manually by the user on the FTAN map





FTAN - Phase equalization

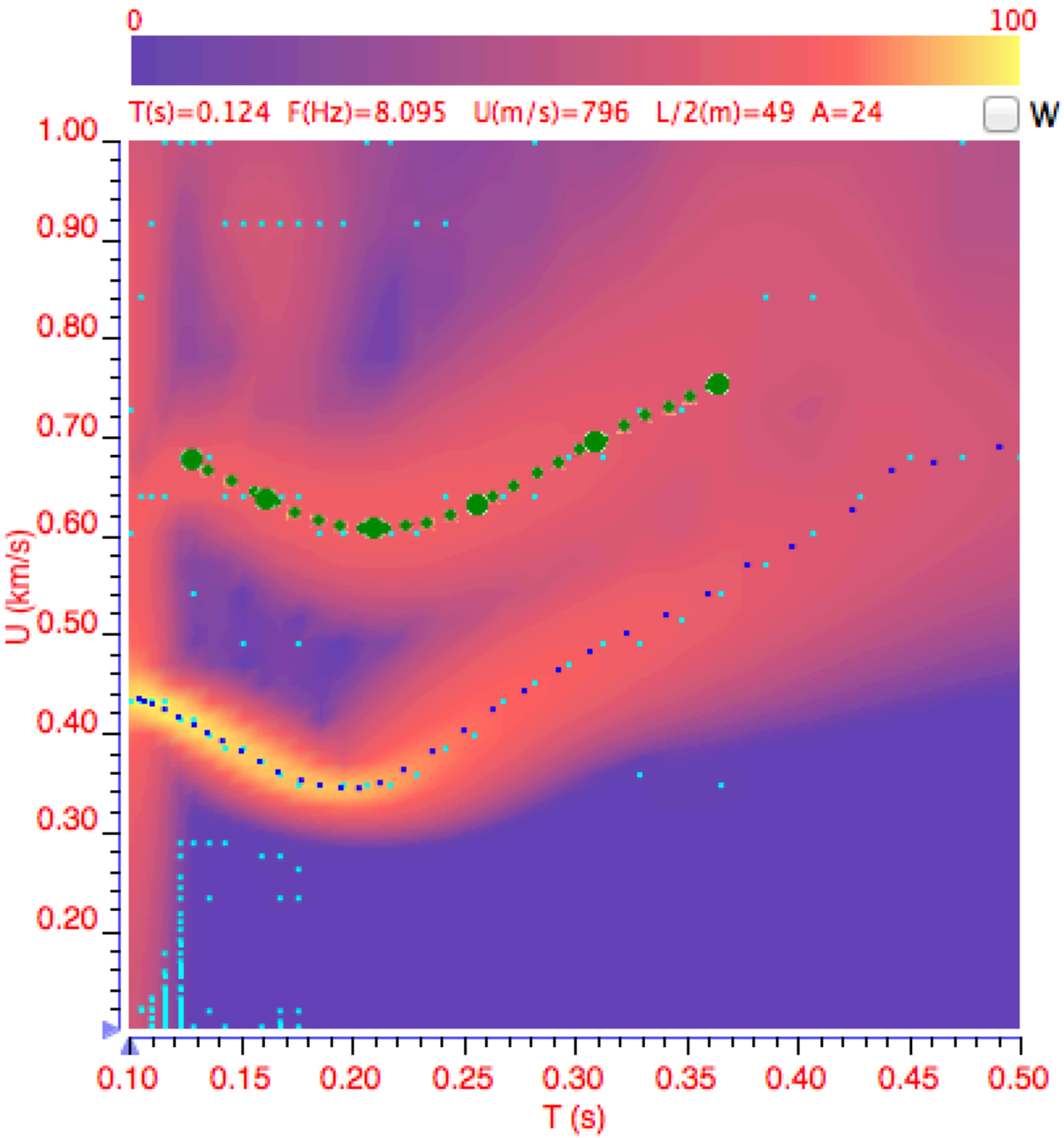
- Performed according to the user-identified dispersion relation for Rayleigh higher mode(s)



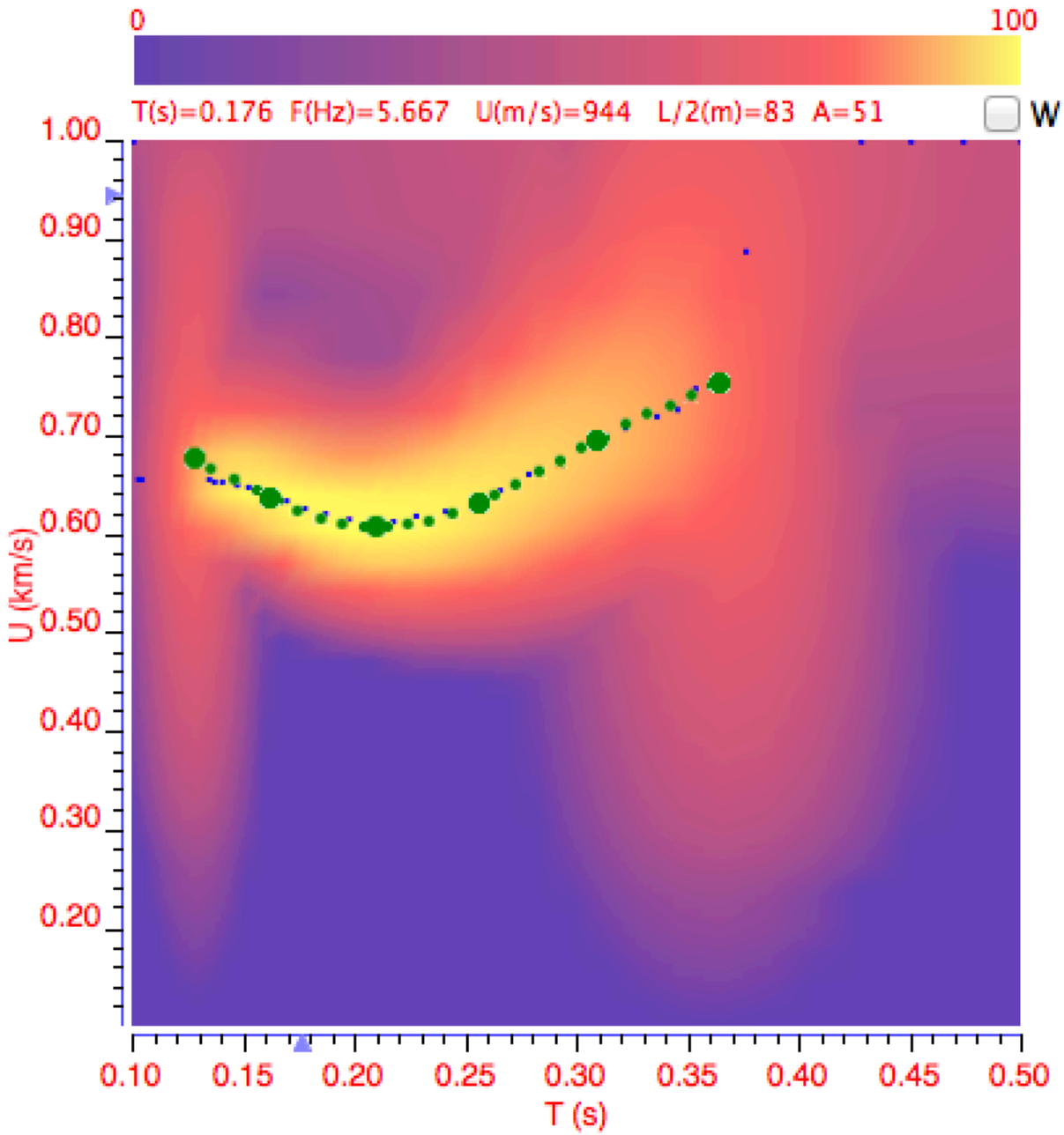
FTAN - Filtered map, higher mode

- Performed according to the user-identified dispersion relation for Rayleigh higher mode(s)

Original

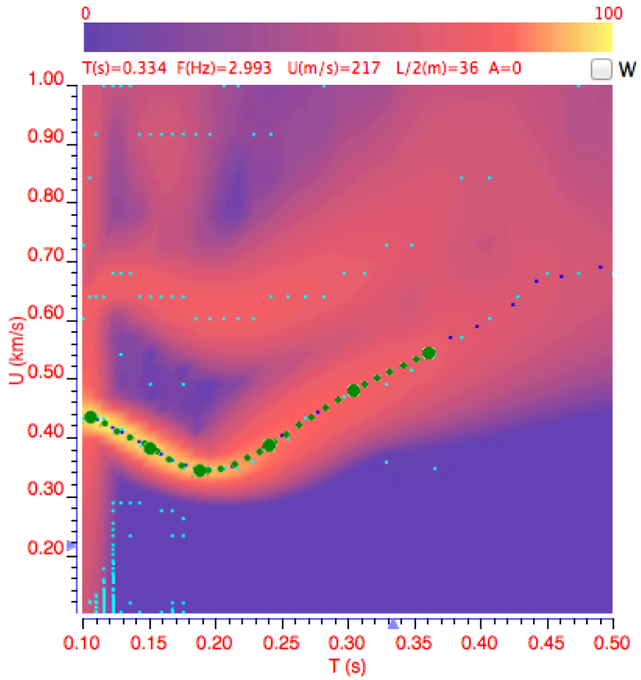


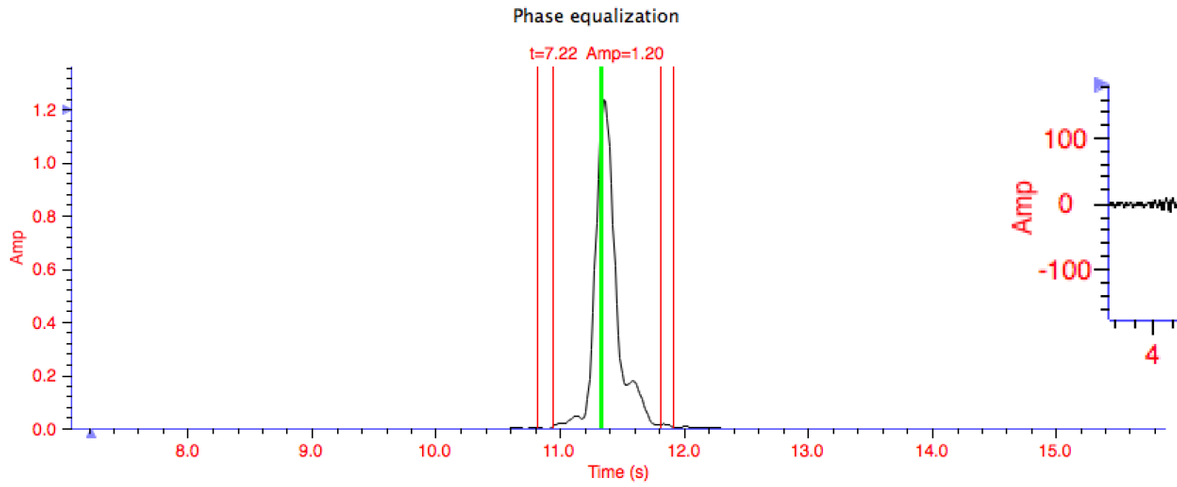
Filtered

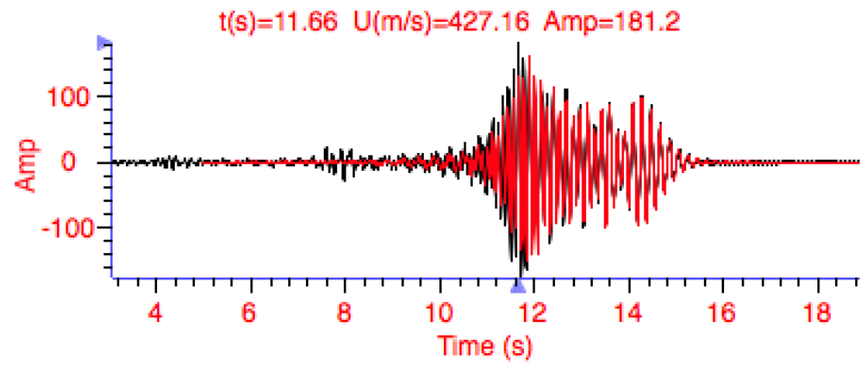


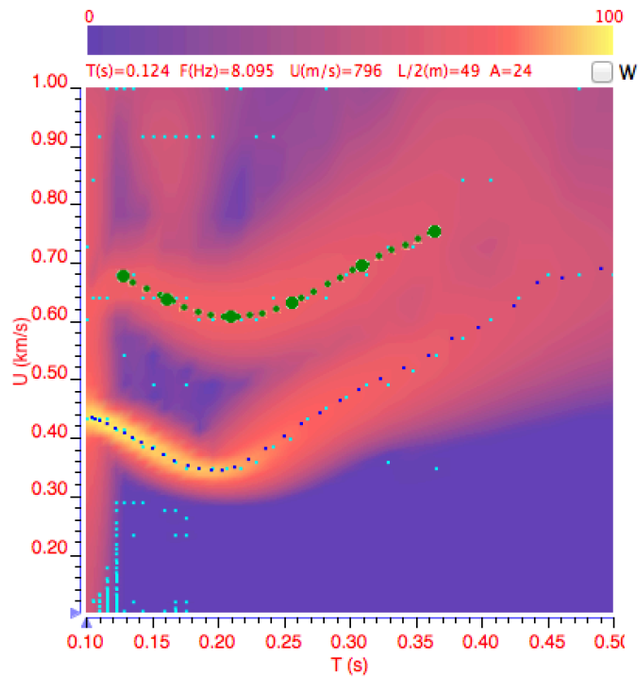
FTAN - Filtered seismograms

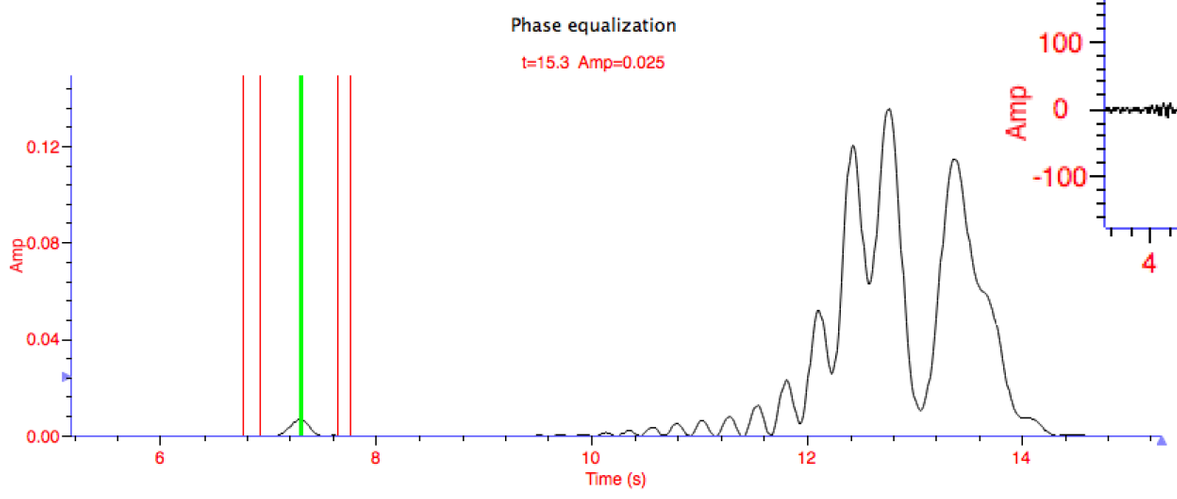
- Performed according to the user-identified dispersion relation

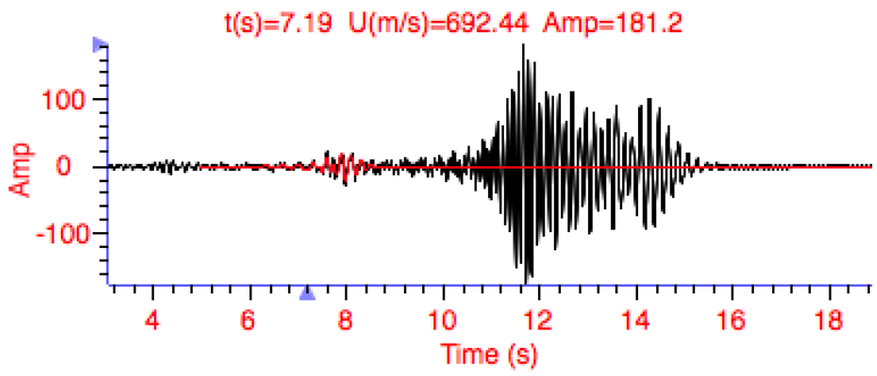










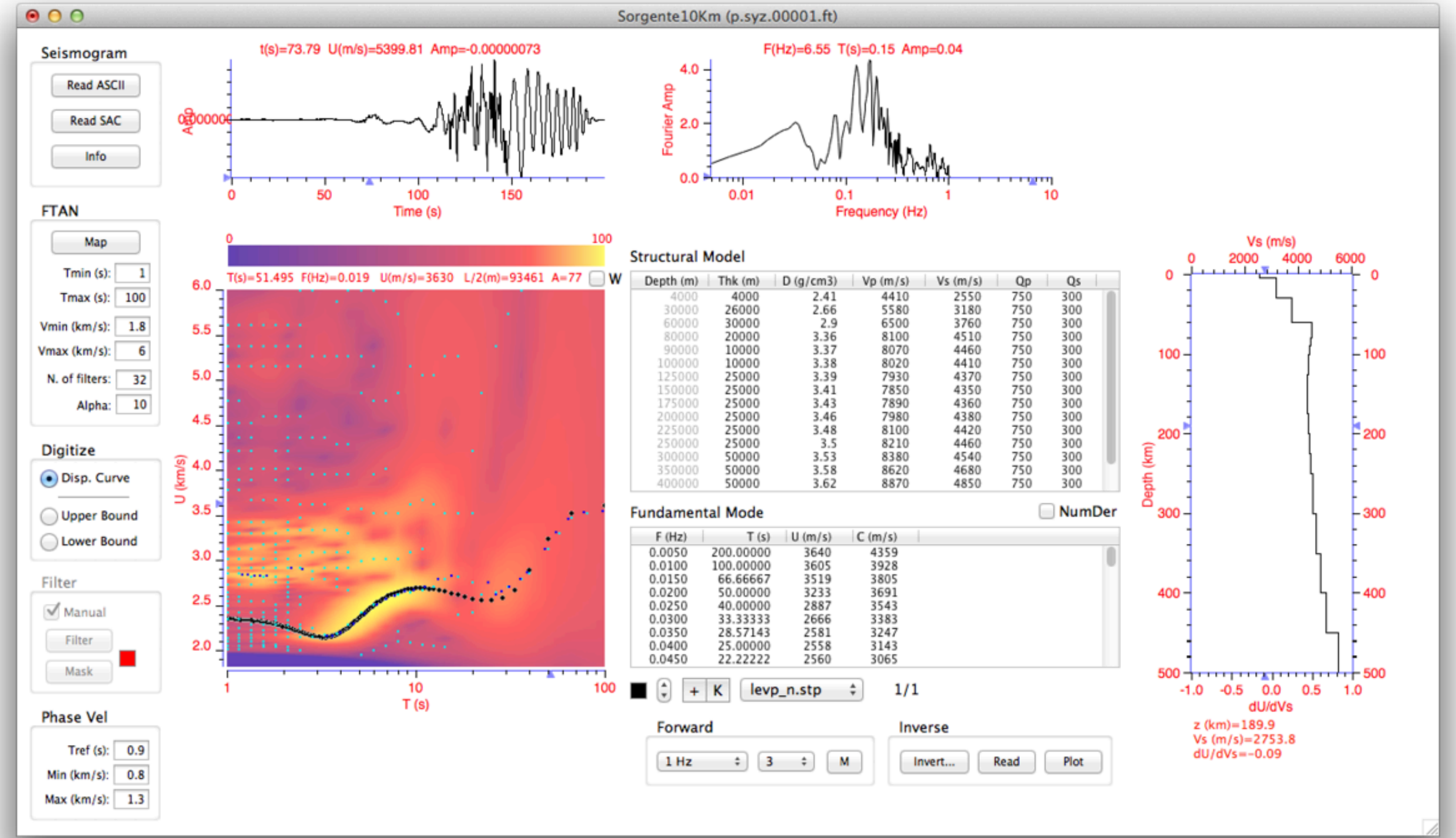


FTAN - Parametric tests from synthetics

- Effect of motion type:
  - Same distribution of ridges in the FTAN map
  - Change in the period range more evident in the FTAN map
- Effect of epicentral distance
  - Stable fundamental mode dispersion identification
  - Better signal/noise ratio with increasing distance
- Effect of source depth
  - Longer periods better excited by deeper sources for the same mode
  - Different excitation of modes: higher modes better excited by deep sources

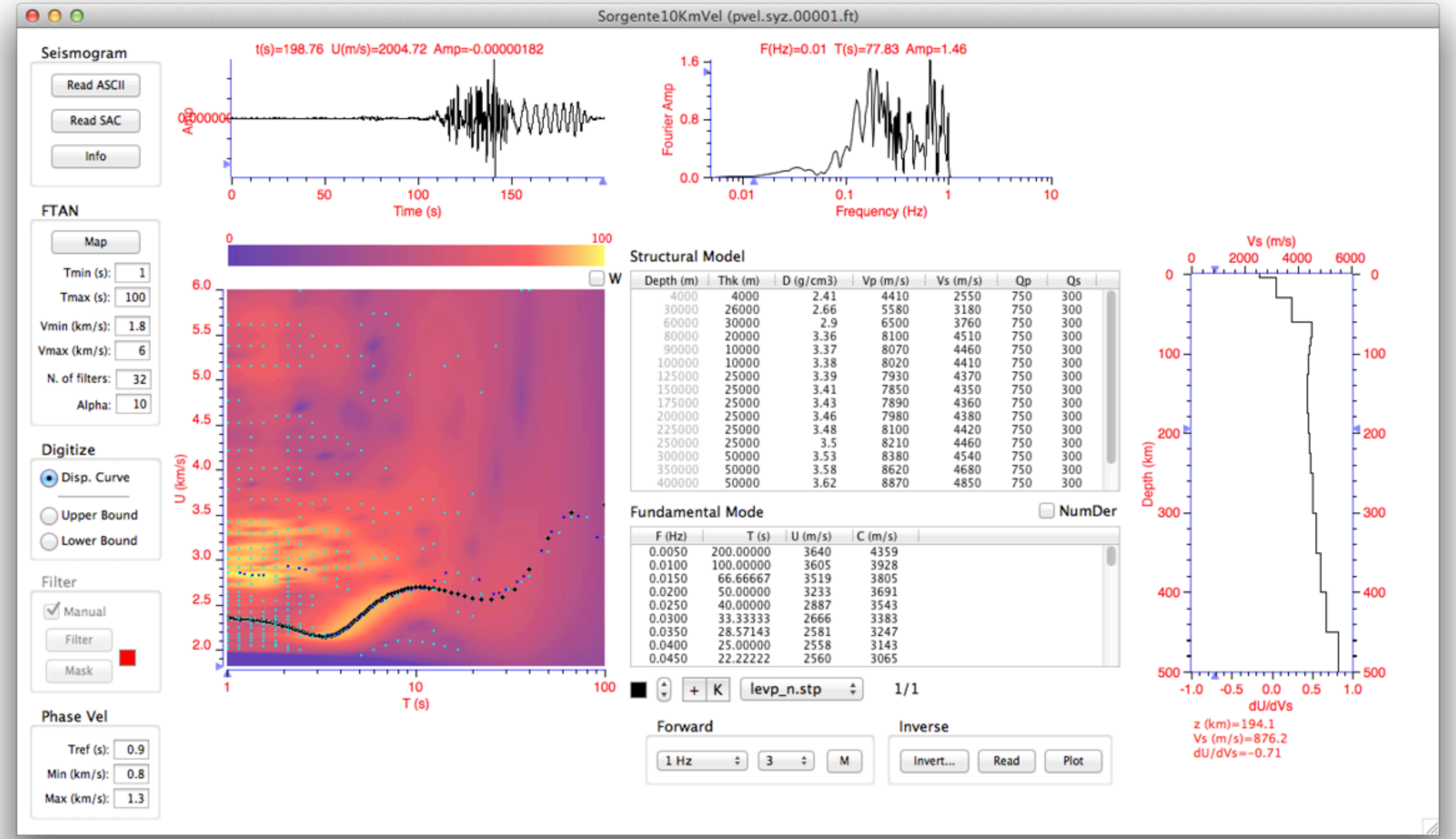
FTAN - Effect of motion type

- Displacement time series



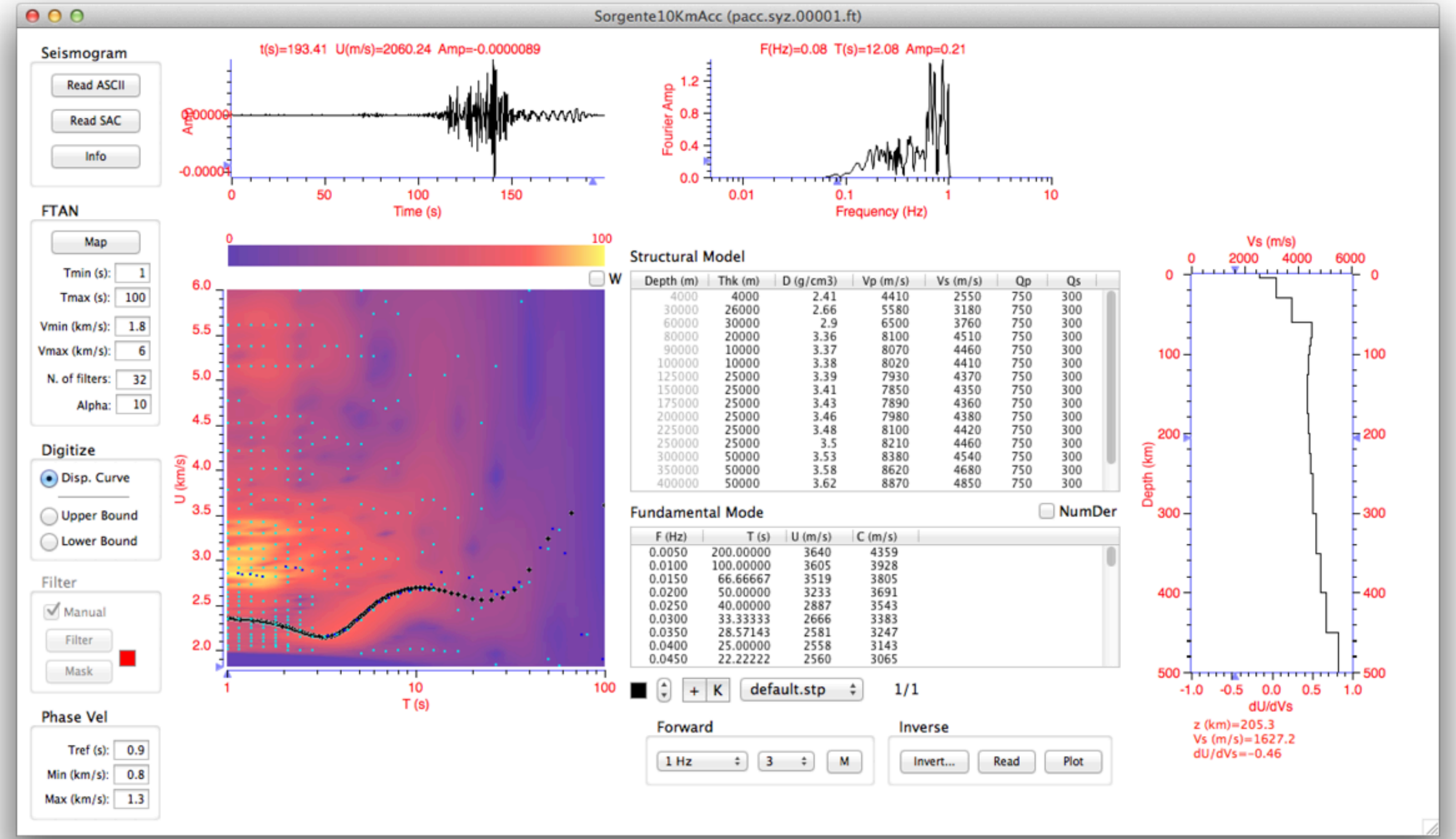
FTAN - Effect of motion type

- Velocity time series



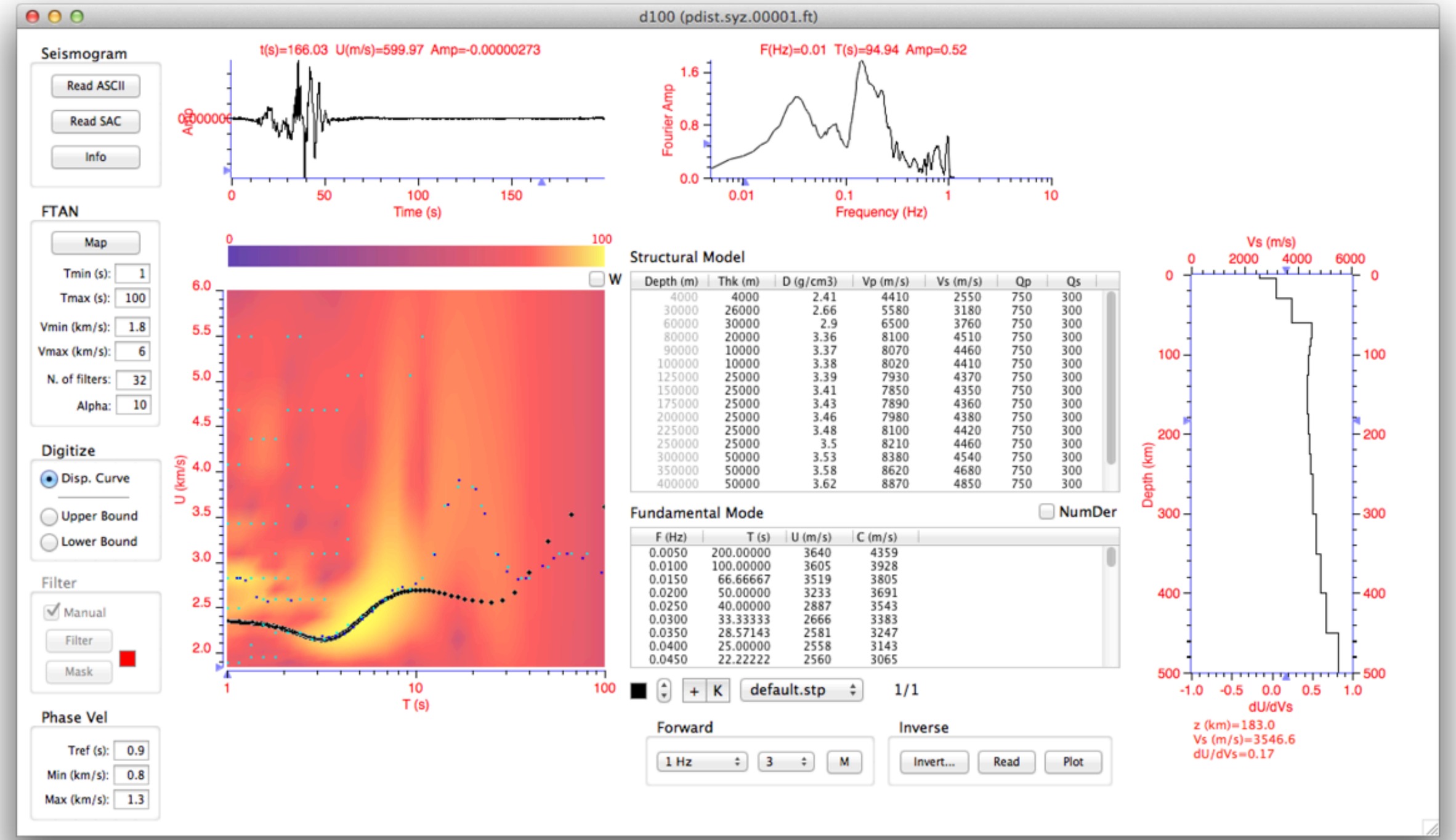
FTAN - Effect of motion type

- Acceleration time series



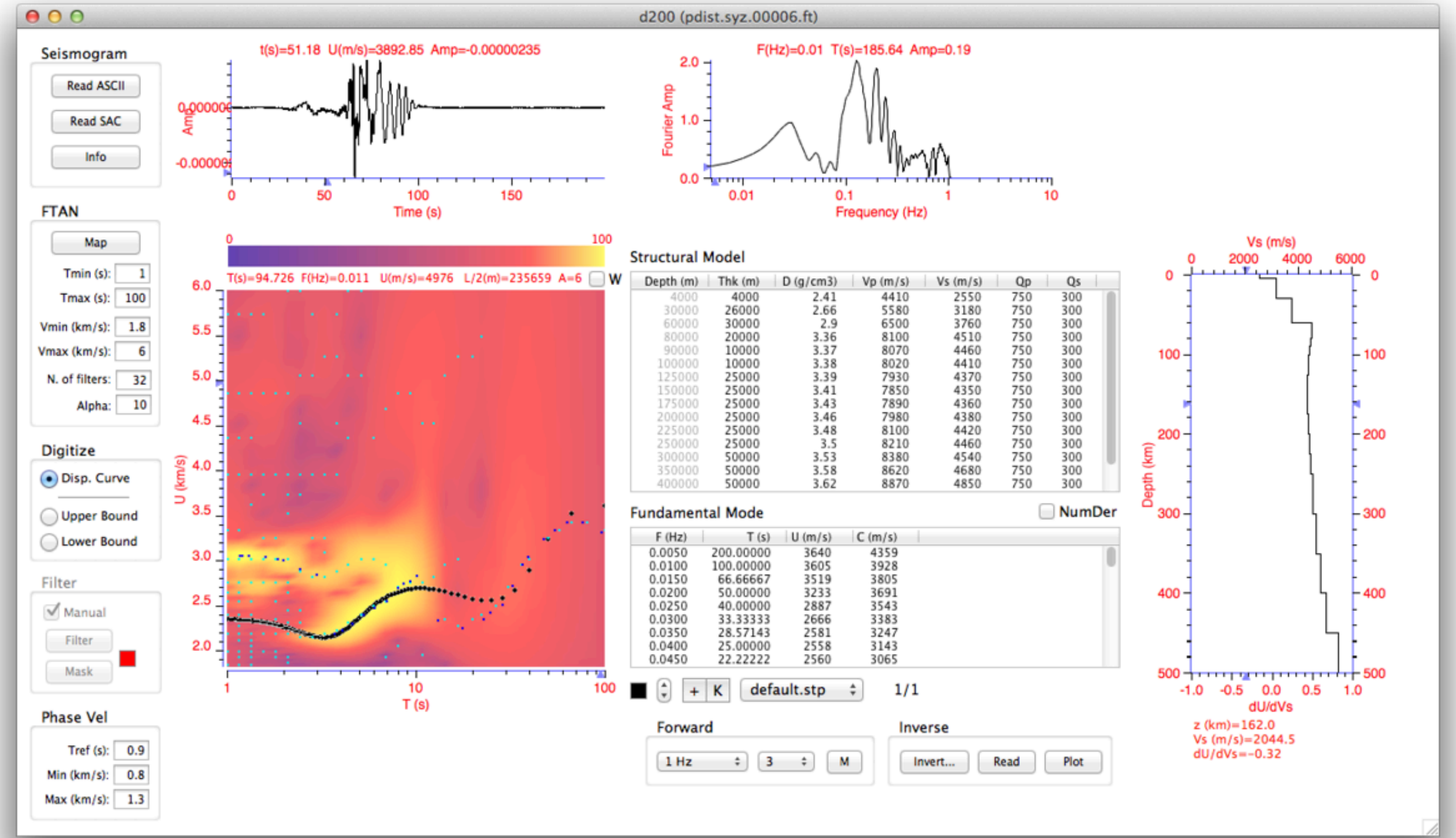
FTAN - Effect of epicentral distance

- 100 km



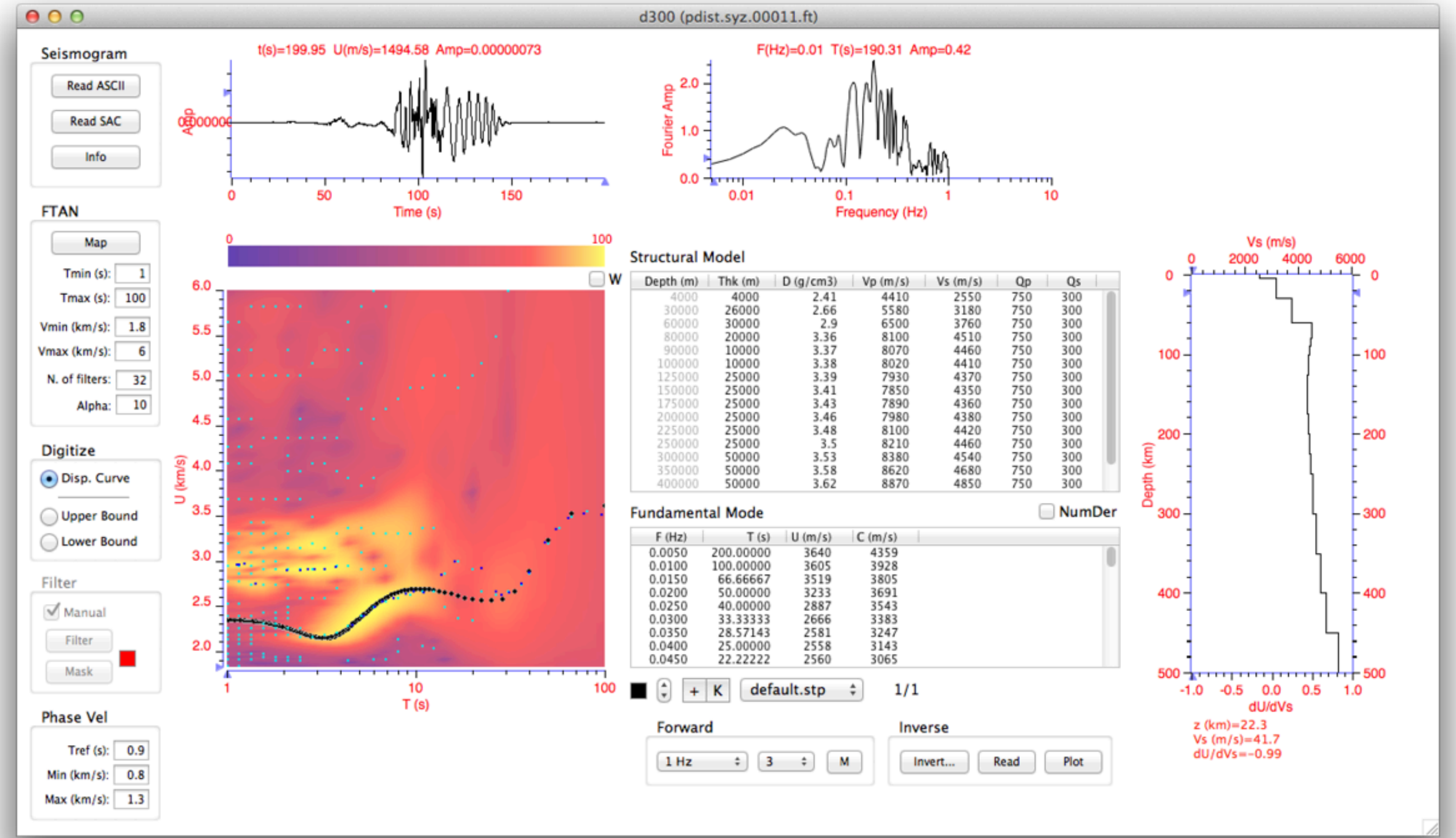
FTAN - Effect of epicentral distance

- 200 km



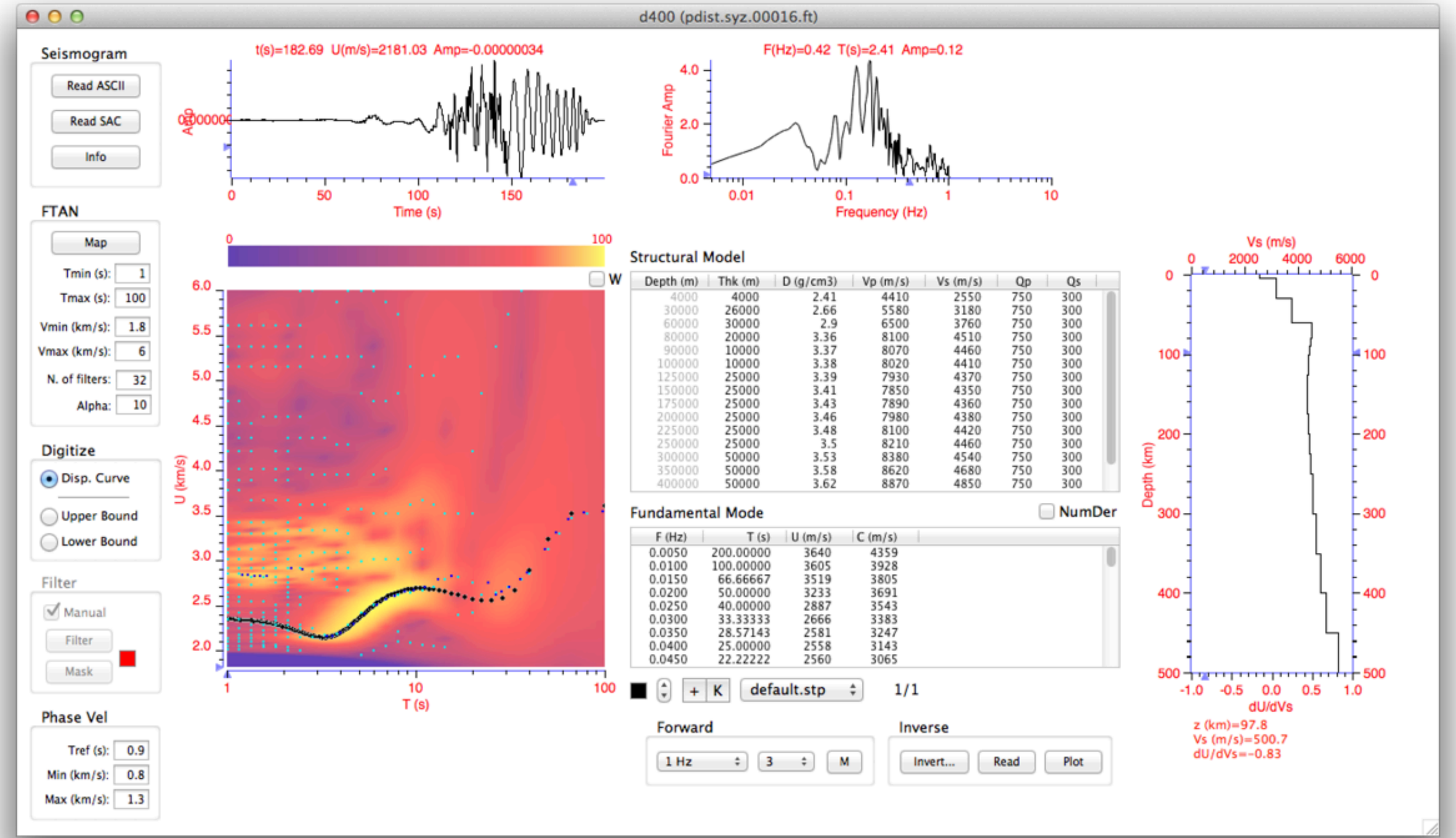
FTAN - Effect of epicentral distance

- 300 km



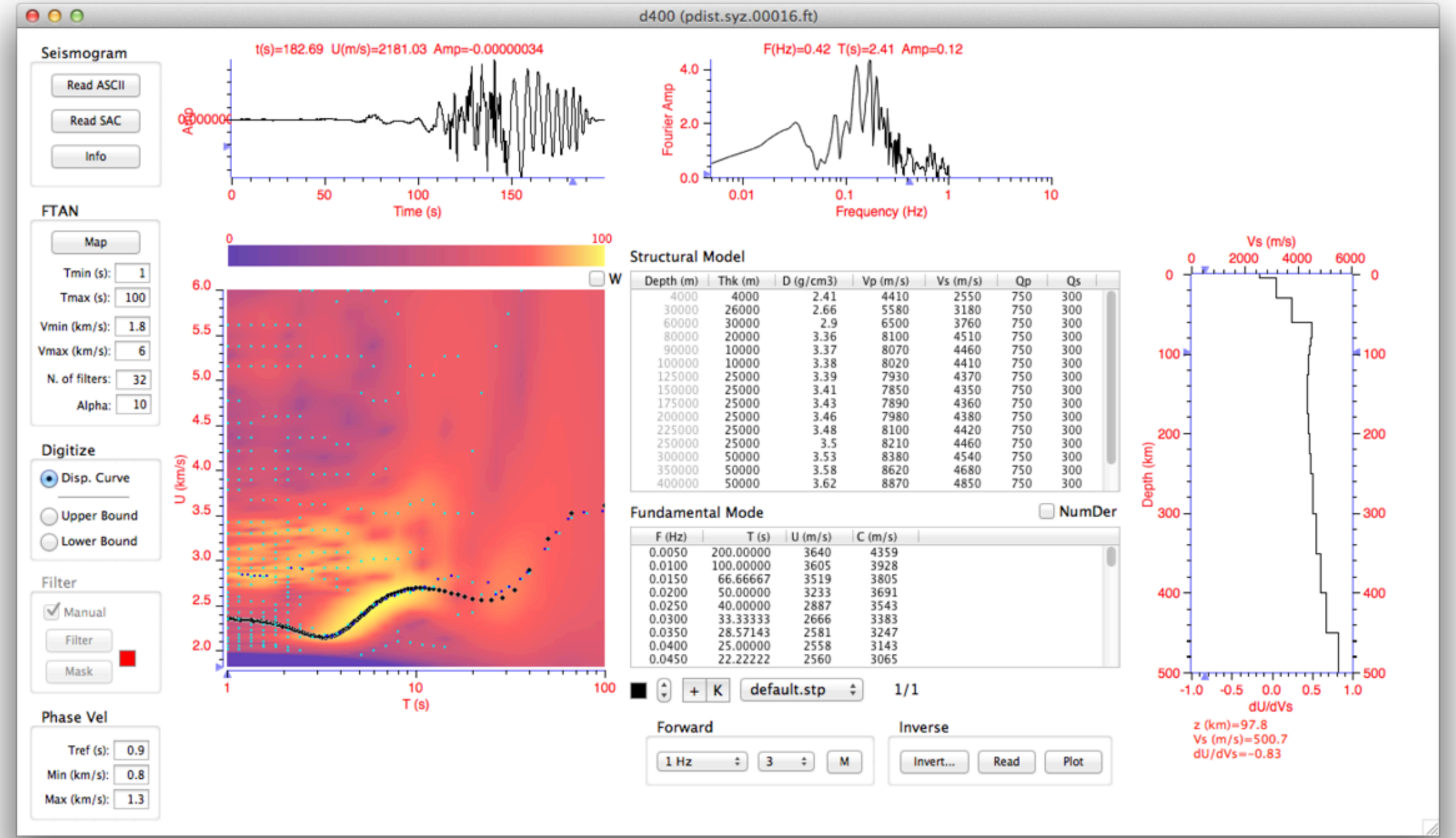
FTAN - Effect of epicentral distance

- 400 km



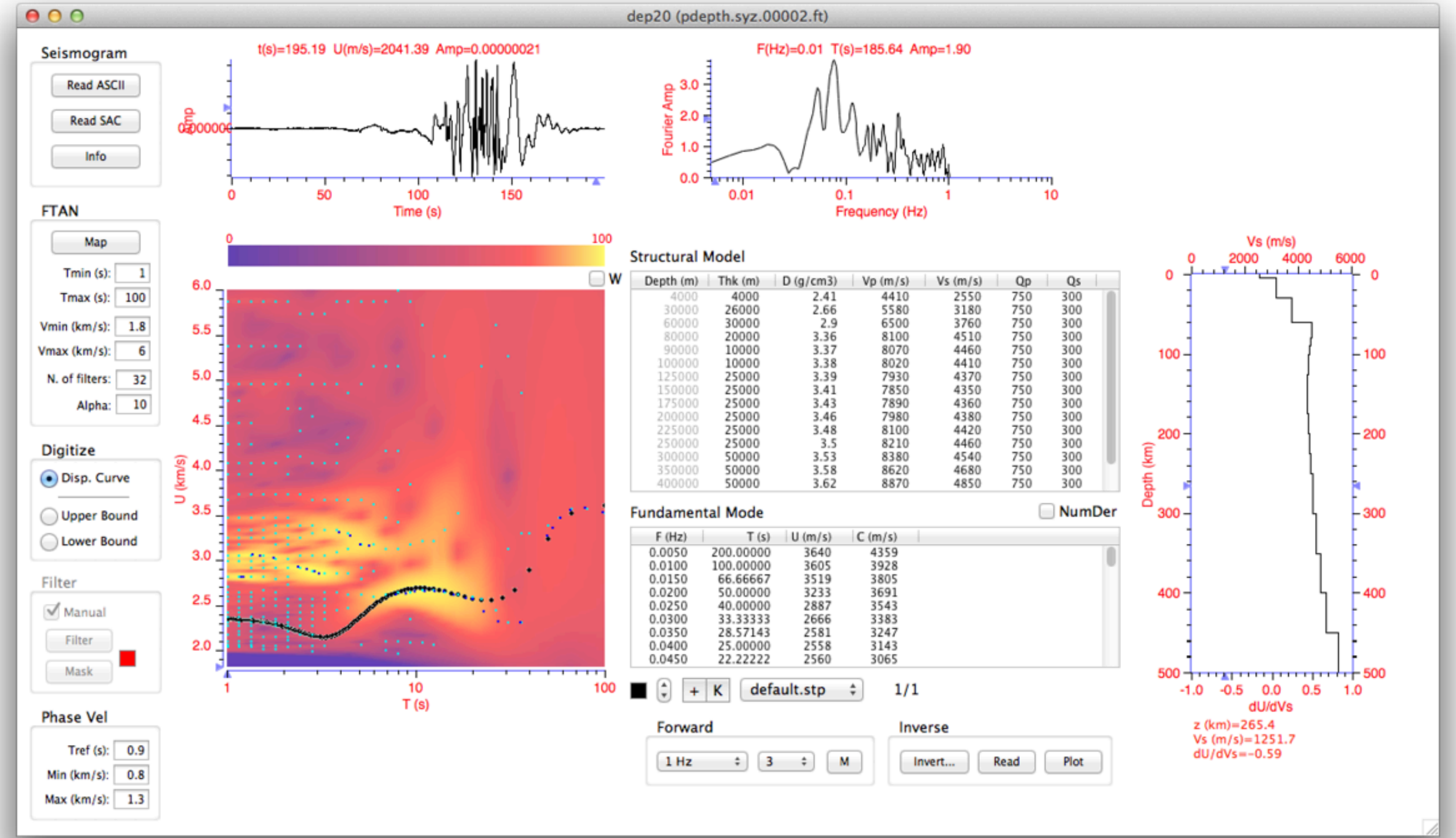
FTAN - Effect of source depth

- 10 km



FTAN - Effect of source depth

- 20 km



FTAN - Effect of source depth

- 30 km