Data Base creation, Frequency-time analysis & Moment Tensor Inversion programs

(tutorial)

Computer exercises 3.

Your first actions after 1-st login:

Enter $HOME directory and execute script /**opt/fmt/structdir**.

A structure of directories will be created in your $HOME. Directories Taiwan2007, Chile2007, Indones2008, Chile2010, ashock_04_03, and ashock_05_03 with needed subdirectories and files correspond to the earthquakes which will be studied during the exercises.

I. Taiwan 2007 earthquake, M_w = 6.2

1. Creating data base

Enter directory $HOME/Taiwan2007
1.1 Execute command: **dbcreator**

Click button *New* 

1.2 *Data Page Info* will appear.
Select the type of data in *Input type of data* frame as *seed volumes.* Click *Browse* button to browse the directory Taiwan2007/DATA/SEED.
Select in *Output dbase dt* ***origin dt.***
Click *Next* > button for next page.
1.3 *Directories Page Info* will appear.
Type 'Taiwan2007' in *Data base name* box. Click *Browse* button to browse the directory Taiwan2007/Db
Click *Next* > button for next page.
1.4 *Origin Page Info* will appear.
Fill the empty boxes for event date and time information in *Date* and *Time* frames.
Year: 2007 Month: 9 Day 6 Hour: 17 Minute: 51 Second: 26.19
Click *Next* > button for next page.
1.5 *HypoPage Info* will appear.
Fill the empty boxes for hypocenter coordinates and magnitudes in *Hypocenter* and *Magnitudes* frames.
Latitude: 24.340 Longitude: 122.21 Depth: 61.0
Mb: Ms: 6.1 Mw:6.2
Click *Finish* button to finish the preparation of input data.
1.6 Main window with the list of station information will appear (see 'Data Base Frequency-time analysis program Reference Manual').
Click button  to create data base.

1.7 To save the project-file click button  , browse directory $HOME/Taiwan2007 and type name of project-file 'Taiwan2007'.

2. Floating filtering of records

1.1. Enter directory $HOME/Taiwan2007/Ftan
1.2. Execute command:
ftan
1.3. *New/Open* start.
Click on *New* tab window will appear
Brows:
$HOME/Taiwan2007/Db/Taiwan2007.wfdisc
$HOME/Taiwan2007/Db/Taiwan2007.instrument
$HOME/Taiwan2007/Db/Taiwan2007.origin
Click on OK. Start window will disappear.

1.4. Click button  and assign following bandpass filtering parameters:
short period zero = 45, short period corner = 50, long period corner = 140, long period zero = 150.

1.5.Click button and assign following bounds for FTAN diagram:
group velocity from 2 to 6, periods from 45 to 150.

1.6. Until you didn't select a station and a channel to be processed the light of semaphore button is red **.** Click on '+' near selected station, available channels will appear. Click on one of them. The semaphore light will change to yellow . The program is ready for processing of selected seismograms. Click on semaphore button. The semaphore light will change to green , and selected waveforms will be plotted.

1.7. To apply bandpass filtering click on the button .

1.8. Click on the button to view FTAN maps for selected components and to make floating filtering (see an example of processing on p.p. 27-33 and reference dispersion curves shown on the last page of this tutorial).

1.9. Clicking correspondent button view the results of processing:

- View calculated group velocity curves.
- View cleaned and raw amplitude spectra.
- View estimated polarization anomalies.
- View cleaned and raw seismograms.
- View a FTAN diagrams for cleaned and raw records.

1.10. To save results click the button . The **Save Records Dialog** will appear.
Click component toggle buttons required to be saved. Click OK button to save records.

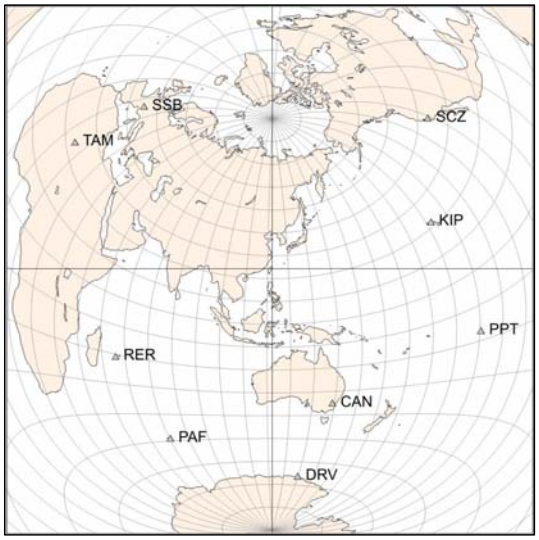
1.11. Select next station-channel. Button changes green color to yellow and you can work with new selection.

1.12. After you finished the processing of all records push the button to save results.
The **Save Location As Dialog** will be invoked for selection of directory name. Click the 'Create New Folder' toolbar button to create a new directory (mentioned further as **FLT**).

Note: The results can be saved by pushing the button after any seismogram's processing is finished. It is recommended to save the results few times during the session.

Recommended components to be saved and correspondent period ranges for floating filtering:

Record	Tmin	Tmax
CAN:1:LHT	70.00	120.00
CAN:1:LHZ	70.00	120.00
DRV:1:LHZ	60.00	120.00
KIP:1:LHT	60.00	120.00
KIP:1:LHZ	60.00	120.00
PAF:1:LHT	60.00	120.00
PAF:1:LHZ	60.00	120.00
PPT:1:LHZ	60.00	120.00
RER:1:LHT	60.00	120.00
RER:1:LHZ	60.00	120.00
SCZ:1:LHT	60.00	120.00
SSB:1:LHT	70.00	120.00



TAM:1:LHT 70.00 120.00
TAM:1:LHZ 80.00 120.00

3. Moment Tensor & Source Depth Inversion.

2.1. Enter directory $HOME/Taiwan2007/MomTens.

2.2. Execute command **MomTens**. The main window of the program will appear.

2.3. Push button  to start a New Project.

Define Project Directory - type Project Name (**Inversion** for example);

Filtered Wave Form Disc DB Name - browse directory $HOME/Taiwan2007/Ftan/FLT (if you saved the directory with results of floating filtering under name **FLT**), and click **table.wfdisc**.

Instrument, Site, Sensor DB Root Names - browse directory HOME/Taiwan2007/Db and click on 'Taiwan2007.site' for example

Origin Info Event Db Name - browse directory HOME/Taiwan2007/Db and click on 'Taiwan2007.origin'

Note: Next time you can just use  to open Project Name **Inversion**, if you have saved it.

2.4. To select records to be used for the inversion push button  . In this example all the records are recommended to be used, so push button 'OK'.

2.5. Push button 
Click on the button '3SMAC MODEL' – the structure models for all stations will be calculated. Click on the button 'Get Source Model from' and on radio button '3SMAC' at the bottom . Click 'OK'.

2.6. Push button  .

During filtering by FTAN program you determined for every wave the spectral domain where the signal is of a good quality. It is given by maximum and minimum periods on the pages 4-5. Type these period values in the text boxes "T min" and "T max" in the uppermost left part of the window. During typing the cursor must be situated in the text box. To associate this pair of values to any record click on the correspondent record name.

Parameters to be given in the right frame (Spectral rage):

Tmin=60, Tmax=120, Nw=12, N points FFT = 32768

Type in the text box "T min" at the bottom 100.

Push 'Get' button. Click 'OK'.

2.7. Push button  .
Recommended grid characteristics:

0.0	-	Initial Depth
5.0	-	Depth Step
21	-	Number of Depth Values
15.0	-	Initial Dip
15.0	-	Dip Step
6	-	Number of Dip Values
0.0	-	Initial Strike
15.0	-	Strike Step
12	-	Number of Strike Values
0.0	-	Initial Slip
15.0	-	Slip Step
12	-	Number of Slip Values

2.8. Push the button  to perform the selection and rarefication of polarity data.
Push the arrow in the combo box, choose the angle of polarity data smoothing (10 degrees), Push radio button ‘bulletin plus supplementary’. Push radio button ‘ak135 model’, and confirm by pushing OK.

2.9. Push the button  to start the inversion.

2.10.View of results:

Viewing the results.

II. Indonesia 2008 earthquake, M_w = 7.4

1. Creating data base

Enter directory $HOME/Indones2008
1.1 Execute command: **dbcreator**

Click button *New* 

1.2 *Data Page Info* will appear.
Select the type of data in *Input type of data* frame as *seed volumes.* Click *Browse* button to browse the directory Indones2008/DATA/SEED.
Select in *Output dbase dt* ***origin dt***.
Click *Next* > button for next page.
1.3 *Directories Page Info* will appear.
Type 'Indones2008' in *Data base name* box. Click *Browse* button to browse the directory Indones2008/Db
Click *Next* > button for next page.
1.4 *Origin Page Info* will appear.
Fill the empty boxes for event date and time information in *Date* and *Time* frames.
Year: 2008 Month: 2 Day 20 Hour: 8 Minute: 8 Second: 30.52
Click *Next* > button for next page.
1.5 *HypoPage Info* will appear.
Fill the empty boxes for hypocenter coordinates and magnitudes in *Hypocenter* and *Magnitudes* frames.
Latitude: 2.768 Longitude: 95.964 Depth: 26.0
Mb: 6.5 Ms: 7.5 Mw:7.4
Click *Finish* button to finish the preparation of input data.
1.6 Main window with the list of station information will appear (see 'Data Base Frequency-time analysis program Reference Manual').
Click button  to create data base.

1.7 To save the project-file click button  , browse directory $HOME/Indones2008 and type name of project-file 'Indones2008'.

2. Floating filtering of records

1.3. Enter directory $HOME/Indones2008/Ftan

1.4. Execute command:
ftan
1.3. *New/Open* start.
Click on *New* tab window will appear
Brows:
$HOME/Indones2008/Db/Indones2008.wfdisc
$HOME/Indones2008/Db/Indones2008.instrument
$HOME/Indones2008/Db/Indones2008.origin
Click on OK. Start window will disappear.

1.6. Click button  and assign following bandpass filtering parameters:
short period zero = 100, short period corner = 120, long period corner = 270, long period zero = 280.

1.7. Click button and assign following bounds for FTAN diagram:
group velocity from 2 to 6, periods from 100 to 280.

1.6. Until you didn't select a station and a channel to be processed the light of semaphore button is red. Click on '+' near selected station, available channels will appear. Click on one of them. The semaphore light will change to yellow. The program is ready for processing of selected seismograms. Click on semaphore button. The semaphore light will change to green, and selected waveforms will be plotted.

1.7. To apply bandpass filtering click on the button.

1.8. Click on the button to view FTAN maps for selected components and to make floating filtering (see an example of processing on p.p. 27-33 and reference dispersion curves shown on the last page of this tutorial).

1.9. Clicking correspondent button view the results of processing:

- View calculated group velocity curves.
- View cleaned and raw amplitude spectra.
- View estimated polarization anomalies.
- View cleaned and raw seismograms.
- View a FTAN diagrams for cleaned and raw records.

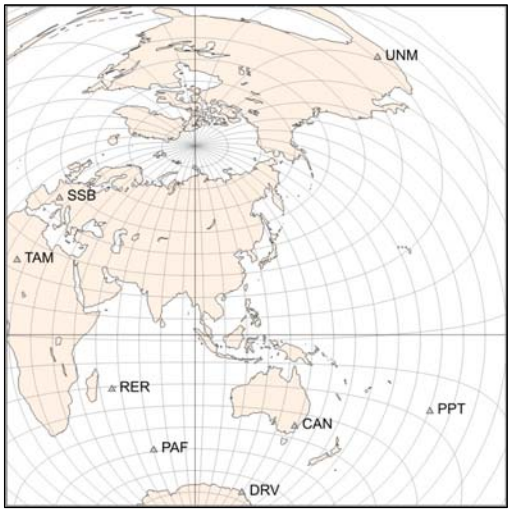
1.10. To save results click the button. The **Save Records Dialog** will appear.
Click component toggle buttons required to be saved. Click OK button to save records.

1.11. Select next station-channel. Button changes green color to yellow and you can work with new selection.

1.12. After you finished the processing of all records push the button to save results.
The **Save Location As Dialog** will be invoked for selection of directory name. Click the 'Create New Folder' toolbar button to create a new directory (mentioned further as **FLT**).

Recommended components to be saved and correspondent period ranges for floating filtering:

Record	Tmin	Tmax
CAN:1:LHT	150.00	250.00
CAN:1:LHZ	150.00	250.00
DRV:1:LHT	150.00	250.00
DRV:1:LHZ	150.00	250.00
PAF:1:LHZ	150.00	250.00
PPT:1:LHZ	150.00	250.00
RER:1:LHT	150.00	250.00
RER:1:LHZ	150.00	250.00
SSB:1:LHT	150.00	250.00
SSB:1:LHZ	150.00	250.00
TAM:1:LHT	150.00	250.00
TAM:1:LHZ	150.00	250.00



UNM:1:LHT 150.00 250.00
UNM:1:LHZ 150.00 250.00

3. Moment Tensor & Source Depth Inversion.

2.1. Enter directory $HOME/Indones2008/MomTens.

2.2. Execute command **MomTens**. The main window of the program will appear.

2.3. Push button  to start a New Project.

Define Project Directory - type Project Name (**Inversion** for example);

Filtered Wave Form Disc DB Name - browse directory $HOME/Indones2008/Ftan/FLT (if you saved the directory with results of floating filtering under name **FLT**), and click **table.wfdisc**.

Instrument, Site, Sensor DB Root Names - browse directory HOME/Indones2008/Db and click on 'Indones2008.site'

Origin Info Event Db Name - browse directory HOME/Indones2008/Db and click on 'Indones2008.origin'

Note: Next time you can just use  to open Project Name **Inversion**, if you saved it.

2.4. To select records to be used for the inversion push button  . In this example all the records are recommended to be used, so push button 'OK'.

2.5. Push button 
Click on the button '3SMAC MODEL' – the structure models for all stations will be calculated. Click on the button 'Get Source Model from' and on radio button '3SMAC' at the bottom . Click 'OK'.

2.6. Push button  .

During filtering by FTAN program you determined for every wave the spectral domain where the signal is of a good quality. It is given by maximum and minimum periods on the pages 8-9. Type these period values in the text boxes "T min" and "T max" in the uppermost left part of the window. During typing the cursor must be situated in the text box. To associate this pair of values to any record click on the correspondent record name.

Parameters to be given in the right frame (Spectral rage):

Tmin=150, Tmax=250, Nw=12, N points FFT = 32768

Type in the text box "T min" at the bottom 150.

Push 'Get' button. Click 'OK'.

2.7. Push button  .
Recommended grid characteristics:

0.0	-	Initial Depth
2.0	-	Depth Step
21	-	Number of Depth Values
5.0	-	Initial Dip
15.0	-	Dip Step
6	-	Number of Dip Values
0.0	-	Initial Strike
15.0	-	Strike Step
12	-	Number of Strike Values
0.0	-	Initial Slip
15.0	-	Slip Step
12	-	Number of Slip Values

2.8. Push the button  to perform the selection and rarefication of polarity data.
Push the arrow in the combo box, choose the angle of polarity data smoothing (5 degrees), Push radio button ‘bulletin plus supplementary’. Push radio button ‘manually’, type P-wave velocity value 8.1, and confirm by pushing OK

2.9. Push the button  to start the inversion.

2.10. View of results:

Viewing the results.

III. Chile 2007 earthquake, M_w = 7.7

1. Creating data base

Enter directory $HOME/Chile2007
1.1 Execute command: **dbcreator**

Click button *New* 

1.2 *Data Page Info* will appear.
Select the type of data in *Input type of data* frame as ***ah binaries files***. Click *Browse* button to browse the directory Chile2007/DATA/AH.
Select in *Output dbase dt* ***origin dt***.
Click *Next* > button for next page.
1.3 *Directories Page Info* will appear.
Type 'Chile2007' in *Data base name* box. Click *Browse* button to browse the directory Chile2007/Db
Click *Next* > button for next page.
1.4 *Origin Page Info* will appear.
Fill the empty boxes for event date and time information in *Date* and *Time* frames.
Year: 2007 Month: 11 Day 14 Hour: 15 Minute: 40 Second: 50.53
Click *Next* > button for next page.
1.5 *HypoPage Info* will appear.
Fill the empty boxes for hypocenter coordinates and magnitudes in *Hypocenter* and *Magnitudes* frames.
Latitude: -22.247 Longitude: -69.890 Depth: 40.0
Mb: 6.7 Ms: 7.4 Mw:7.7
Click *Finish* button to finish the preparation of input data.
1.6 Main window with the list of station information will appear (see 'Data Base Frequency-time analysis program Reference Manual').
Click button  to create data base.

1.7 To save the project-file click button  , browse directory $HOME/Chile2007 and type name of project-file 'Chile2007'.

2. Floating filtering of records

1.5. Enter directory $HOME/Chile2007/Ftan

1.6. Execute command:
ftan
1.3. *New/Open* start.
Click on *New* tab window will appear
Brows:
$HOME/Chile2007/Db/Chile2007.wfdisc
$HOME/Chile2007/Db/Chile2007.instrument
$HOME/Chile2007/Db/Chile2007.origin
Click on OK. Start window will disappear.

1.8. Click button  and assign following bandpass filtering parameters:
short period zero = 110, short period corner = 115, long period corner = 270, long period zero = 280.

1.9. Click button and assign following bounds for FTAN diagram:
group velocity from 2 to 6, periods from 110 to 280.

1.6. Until you didn't select a station and a channel to be processed the light of semaphore button is red **.** Click on '+' near selected station, available channels will appear. Click on one of them. The semaphore light will change to yellow . The program is ready for processing of selected seismograms. Click on semaphore button. The semaphore light will change to green , and selected waveforms will be plotted.

1.7. To apply bandpass filtering click on the button .

1.8. Click on the button to view FTAN maps for selected components and to make floating filtering (see an example of processing on p.p. 27-33 and reference dispersion curves shown on the last page of this tutorial).

1.9. Clicking correspondent button view the results of processing:

- View calculated group velocity curves.
- View cleaned and raw amplitude spectra.
- View estimated polarization anomalies.
- View cleaned and raw seismograms.
- View a FTAN diagrams for cleaned and raw records.

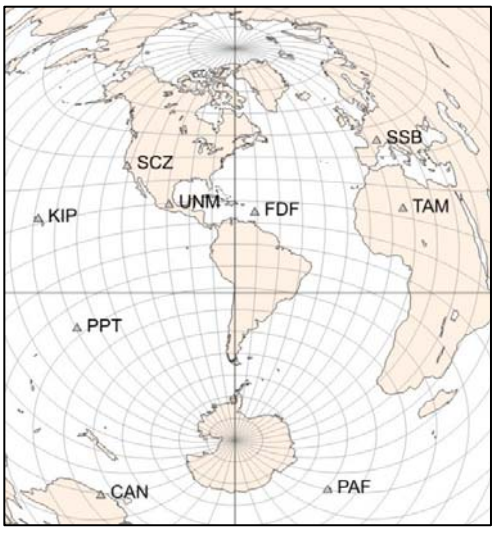
1.10. To save results click the button . The **Save Records Dialog** will appear.
Click component toggle buttons required to be saved. Click OK button to save records.

1.11. Select next station-channel. Button changes green color to yellow and you can work with new selection.

1.12. After you finished the processing of all records push the button to save results.
The **Save Location As Dialog** will be invoked for selection of directory name. Click the 'Create New Folder' toolbar button to create a new directory (mentioned further as **FLT**).

Recommended components to be saved and correspondent period ranges for floating filtering:

Record	Tmin	Tmax
CAN:1:LHT	140.00	250.00
CAN:1:LHZ	140.00	250.00
FDF:1:LHT	140.00	250.00
KIP:1:LHT	140.00	250.00
KIP:1:LHZ	140.00	250.00
PAF:1:LHT	140.00	250.00
PAF:1:LHZ	140.00	250.00
PPT:1:LHZ	140.00	250.00
SCZ:1:LHT	140.00	250.00
SCZ:1:LHZ	140.00	250.00
SSB:1:LHT	150.00	250.00
SSB:1:LHZ	150.00	250.00
TAM:1:LHT	140.00	250.00
TAM:1:LHZ	140.00	250.00



UNM:1:LHT 150.00 250.00
UNM:1:LHZ 150.00 250.00

3. Moment Tensor & Source Depth Inversion.

2.1. Enter directory $HOME/Chile2007/MomTens.

2.2. Execute command **MomTens**. The main window of the program will appear.

2.3. Push button  to start a New Project.

Define Project Directory - type Project Name (**Inversion** for example);

Filtered Wave Form Disc DB Name - browse directory $HOME/Chile2007/Ftan/FLT (if you saved the directory with results of floating filtering under name **FLT**), and click **table.wfdisc**.

Instrument, Site, Sensor DB Root Names - browse directory HOME/Chile2007/Db and click on 'Chile2007.site'

Origin Info Event Db Name - browse directory HOME/Chile2007/Db and click on 'Chile2007.origin'

Note: Next time you can just use  to open Project Name **Inversion**, if you saved it.

2.4. To select records to be used for the inversion push button  . In this example all the records are recommended to be used, so push button 'OK'.

2.5. Push button 
Click on the button '3SMAC MODEL' – the structure models for all stations will be calculated. Click on the button 'Get Source Model from' and on radio button '3SMAC' at the bottom . Click 'OK'.

2.6. Push button  .

During filtering by FTAN program you determined for every wave the spectral domain where the signal is of a good quality. It is given by maximum and minimum periods on the pages 12-13. Type these period values in the text boxes "T min" and "T max" in the uppermost left part of the window. During typing the cursor must be situated in the text box. To associate this pair of values to any record click on the correspondent record name.

Parameters to be given in the right frame (Spectral rage):

Tmin=140, Tmax=250, Nw=12, N points FFT = 32768

Type in the text box "T min" at the bottom 200.

Push 'Get' button. Click 'OK'.

2.7. Push button  .
Recommended grid characteristics:

0.0	-	Initial Depth
5.0	-	Depth Step
21	-	Number of Depth Values
15.0	-	Initial Dip
15.0	-	Dip Step
6	-	Number of Dip Values
5.0	-	Initial Strike
15.0	-	Strike Step
12	-	Number of Strike Values
0.0	-	Initial Slip
15.0	-	Slip Step
12	-	Number of Slip Values

2.8. Push the button  to perform the selection and rarefication of polarity data.
Push the arrow in the combo box, choose the angle of polarity data smoothing (10 degrees), Push radio button ‘bulletin plus supplementary’. Push radio button ‘ak135 model’, and confirm by pushing OK .

2.9. Push the button  to start the inversion.

2.10.View of results:

Viewing the results.

IV. Chile 2010 earthquake, M_w = 8.8

1. Creating data base

Enter directory $HOME/Chile2010
1.1 Execute command: **dbcreator**

Click button *New* 

1.2 *Data Page Info* will appear.
Select the type of data in *Input type of data* frame as *seed volumes.* Click *Browse* button to browse the directory Chile2010/DATA/SEED.
Select in *Output dbase dt* ***origin dt***.
Click *Next* > button for next page.
1.3 *Directories Page Info* will appear.
Type 'Chile2010' in *Data base name* box. Click *Browse* button to browse the directory Chile2010/Db
Click *Next* > button for next page.
1.4 *Origin Page Info* will appear.
Fill the empty boxes for event date and time information in *Date* and *Time* frames.
Year: 2010 Month: 2 Day 27 Hour: 6 Minute: 34 Second: 14.25
Click *Next* > button for next page.
1.5 *HypoPage Info* will appear.
Fill the empty boxes for hypocenter coordinates and magnitudes in *Hypocenter* and *Magnitudes* frames.
Latitude: -35.909 Longitude: -72.732 Depth: 35.0
Mb: Mw:8.8
Click *Finish* button to finish the preparation of input data.
1.6 Main window with the list of station information will appear (see 'Data Base Frequency-time analysis program Reference Manual').
Check off the check box of station KIP (NET: IU).
Click on + near station name WAKE to open this record. Check on the location 10 instead of selected by default location 00.
Click button  to create data base.

1.7 To save the project-file click button  , browse directory $HOME/Chile2010 and type name of project-file 'Chile2010'.

2. Floating filtering of records

1.7. Enter directory $HOME/Chile2010/Ftan
1.8. Execute command:
ftan
1.3. *New/Open* start.
Click on *New* tab window will appear
Brows:
$HOME/Chile2010/Db/Chile2010.wfdisc
$HOME/Chile2010/Db/ Chile2010.instrument
$HOME/Chile2010/Db/ Chile2010.origin
Click on OK. Start window will disappear.

1.10. Click button  and assign following bandpass filtering parameters:

short period zero = 170, short period corner = 200, long period corner = 550, long period zero = 580.

1.11. Click button and assign following bounds for FTAN diagram:
group velocity from 2 to 8, periods from 170 to 580.

1.6. Until you didn't select a station and a channel to be processed the light of semaphore button is red. Click on '+' near selected station, available channels will appear. Click on one of them. The semaphore light will change to yellow. The program is ready for processing of selected seismograms. Click on semaphore button. The semaphore light will change to green, and selected waveforms will be plotted.

1.7. To apply bandpass filtering click on the button.

1.8. Click on the button to view FTAN maps for selected components and to make floating filtering (see an example of processing on p.p. 27-33 and reference dispersion curves shown on the last page of this tutorial).

1.9. Clicking correspondent button view the results of processing:

- View calculated group velocity curves.
- View cleaned and raw amplitude spectra.
- View estimated polarization anomalies.
- View cleaned and raw seismograms.
- View a FTAN diagrams for cleaned and raw records.

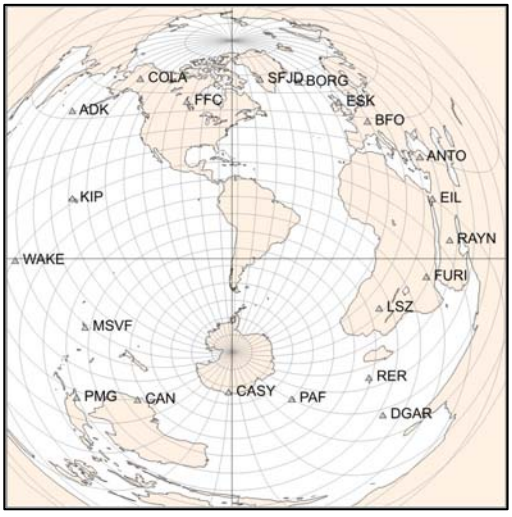
1.10. To save results click the button. The **Save Records Dialog** will appear.
Click component toggle buttons required to be saved. Click OK button to save records.

1.11. Select next station-channel. Button changes green color to yellow and you can work with new selection.

1.12. After you finished the processing of all records push the button to save results.
The **Save Location As Dialog** will be invoked for selection of directory name. Click the 'Create New Folder' toolbar button to create a new directory (mentioned further as **FLT**).

Recommended components to be saved and correspondent period ranges for floating filtering:

Record	Tmin	Tmax
SFJD:1:LHZ	250	420
BORG:1:LHT	250	500
BORG:1:LHZ	250	500
ESK:1:LHZ	250	500
BFO:1:LHT	250	500
BFO:1:LHZ	250	500
ANTO:1:LHT	250	500
ANTO:1:LHZ	250	500
EIL:1:LHT	250	400
EIL:1:LHZ	250	450
RAYN:1:LHZ	250	500
FURI:1:LH Z	250	500
LSZ:1:LHT	250	500



LSZ:1:LHZ	250	500
RER:1:LHT	250	500
RER:1:LHZ	250	500
DGAR:1:LHT	250	500
DGAR:1:LHZ	250	500
PAF:1:LHT	250	500
PAF:1:LHZ	250	350
CASY:1:LHZ	250	350
CAN:1:LHT	250	500
CAN:1:LHZ	250	500
PMG:1:LHT	250	500
PMG:1:LHZ	250	500
MSVF:1:LHT	250	500
MSVF:1:LHZ	250	500
WAKE:1:LHT	250	350
WAKE:1:LHZ	250	450
KIP:1:LHT	250	500
KIP:1:LHZ	250	500
ADK:1:LHT	250	500
ADK:1:LHZ	250	500
COLA:1:LHT	250	500
COLA:1:LHZ	250	500
FFC:1:LHT	250	500
FFC:1:LHZ	250	350

3. Moment Tensor & Source Depth Inversion.

2.1. Enter directory $HOME/ Chile2010/MomTens.

2.2. Execute command **MomTens**. The main window of the program will appear.

2.3. Push button  to start a New Project.

Define Project Directory - type Project Name (**Inversion** for example);

Filtered Wave Form Disc DB Name - browse directory $HOME/Chile2010/Ftan/FLT (if you saved the directory with results of floating filtering under name **FLT**), and click **table.wfdisc**.

Instrument, Site, Sensor DB Root Names - browse directory HOME/Chile2010/Db and click on 'Chile2010.site' for example

Origin Info Event Db Name - browse directory HOME/Chile2010/Db and click on 'Chile2010.origin'

Note: Next time you can just use  to open Project Name **Inversion**, if you have saved it.

2.4. To select records to be used for the inversion push button  . In this example all the records are recommended to be used, so push button 'OK'.

2.5. Push button 
Click on the button '3SMAC MODEL' – the structure models for all stations will be

calculated. Click on the model ‘crust2_0’ in the left column, click on the button ‘Get Source Model from’ and on the radio button ‘Model List’ at the bottom. Model ‘crust2_0’ will be used for the source region. Click ‘OK’.

2.6. Push button  .

During filtering by FTAN program you determined for every wave the spectral domain where the signal is of a good quality. It is given by maximum and minimum periods on the pages 16-17. Type these period values in the text boxes "T min" and "T max" in the uppermost left part of the window. During typing the cursor must be situated in the text box. To associate this pair of values to any record click on the correspondent record name.

Parameters to be given in the right frame (Spectral rage):

Tmin=250, Tmax=500, Nw=12, N points FFT = 32768

Type in the text box "T min" at the bottom 250.

Push 'Get' button. Click ‘OK’.

2.7. Push button  .
Recommended grid characteristics:

0.0	-	Initial Depth
5.0	-	Depth Step
21	-	Number of Depth Values
15.0	-	Initial Dip
15.0	-	Dip Step
6	-	Number of Dip Values
0.0	-	Initial Strike
15.0	-	Strike Step
12	-	Number of Strike Values
0.0	-	Initial Slip
15.0	-	Slip Step
12	-	Number of Slip Values

2.8. Push the button  to perform the selection and rarefication of polarity data.
Push the arrow in the combo box, choose the angle of polarity data smoothing (1 degree), Push radio button ‘bulletin plus supplementary’. Push radio button ‘ak135 model’, and confirm by pushing OK .

2.9. Push the button  to start the inversion.

2.10. View of results:

Viewing the results.

IV. Aftershock of Chilean earthquake, 04.03.2010, M_w = 6.0

1. Creating data base

Enter directory $HOME/ashock_04_03
1.1 Execute command: **dbcreator**

Click button *New* 

1.2 *Data Page Info* will appear.
Select the type of data in *Input type of data* frame as *seed volumes.* Click *Browse* button to browse the directory ashock_04_03/DATA/SEED.
Select in *Output dbase dt* ***origin dt***.
Click *Next* > button for next page.
1.3 *Directories Page Info* will appear.
Type 'ashock_04_03' in *Data base name* box. Click *Browse* button to browse the directory ashock_04_03/Db
Click *Next* > button for next page.
1.4 *Origin Page Info* will appear.
Fill the empty boxes for event date and time information in *Date* and *Time* frames.
Year: 2010 Month: 3 Day 4 Hour: 1 Minute: 59 Second: 50.4
Click *Next* > button for next page.
1.5 *HypoPage Info* will appear.
Fill the empty boxes for hypocenter coordinates and magnitudes in *Hypocenter* and *Magnitudes* frames.
Latitude: -33.238 Longitude: -72.22 Depth: 35.0
Mb: Mw:6.0
Click *Finish* button to finish the preparation of input data.
1.6 Main window with the list of station information will appear (see 'Data Base Frequency-time analysis program Reference Manual').
Check off the check box of station KIP (NET: IU).
Click button  to create data base.

1.7 To save the project-file click button  , browse directory $HOME/ashock_04_03 and type name of project-file 'ashock_04_03'.

2. Floating filtering of records

1.9. Enter directory $HOME/ashock_04_03/Ftan
1.10. Execute command:
ftan
1.3. *New/Open* start.
Click on *New* tab window will appear
Brows:
$HOME/ashock_04_03/Db/ashock_04_03.wfdisc
$HOME/ashock_04_03/Db/ashock_04_03.instrument
$HOME/ashock_04_03/Db/ashock_04_03.origin
Click on OK. Start window will disappear.

1.12. Click button  and assign following bandpass filtering parameters:
short period zero = 35, short period corner = 40, long period corner = 80, long period zero = 85.
1.13. Click button  and assign following bounds for FTAN diagram:

group velocity from 2 to 6, periods from 35 to 85.

1.6. Until you didn't select a station and a channel to be processed the light of semaphore button is red . Click on '+' near selected station, available channels will appear. Click on one of them. The semaphore light will change to yellow . The program is ready for processing of selected seismograms. Click on semaphore button. The semaphore light will change to green , and selected waveforms will be plotted.

1.7. To apply bandpass filtering click on the button .

1.8. Click on the button to view FTAN maps for selected components and to make floating filtering (see an example of processing on p.p. 27-33 and reference dispersion curves shown on the last page of this tutorial).

1.9. Clicking correspondent button view the results of processing:

- View calculated group velocity curves.
- View cleaned and raw amplitude spectra.
- View estimated polarization anomalies.
- View cleaned and raw seismograms.
- View a FTAN diagrams for cleaned and raw records.

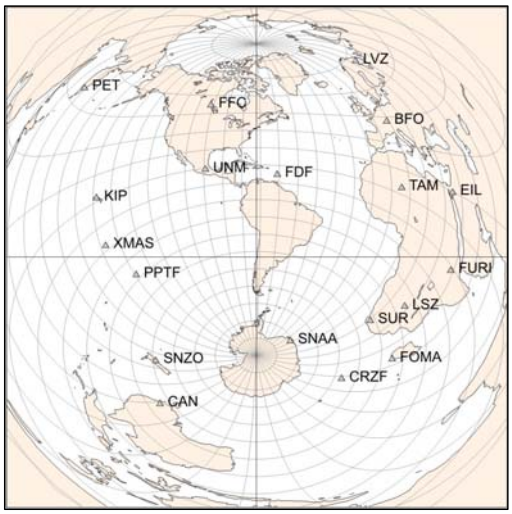
1.10. To save results click the button . The **Save Records Dialog** will appear.
Click component toggle buttons required to be saved. Click OK button to save records.

1.11. Select next station-channel. Button changes green color to yellow and you can work with new selection.

1.12. After you finished the processing of all records push the button to save results.
The **Save Location As Dialog** will be invoked for selection of directory name. Click the 'Create New Folder' toolbar button to create a new directory (mentioned further as **FLT**).

Recommended components to be saved and correspondent period ranges for floating filtering:

Record	Tmin	Tmax
FDF:1:LHZ	50	70
LVZ:1:LHZ	50	70
BFO:1:LHT	50	70
BFO:1:LHZ	50	70
TAM:1:LHT	50	70
TAM:1:LHZ	60	70
EIL:1:LHT	50	70
EIL:1:LHZ	50	70
FURI:1:LHZ	50	70
LSZ:1:LHZ	50	70
SUR:1:LHT	50	70
SUR:1:LHZ	50	70
FOMA:1:LHT	50	70
FOMA:1:LHZ	50	70
CRZF:1:LHT	60	70
CRZF:1:LHZ	50	70



SNAA:1:LHT	50	70
SNAA:1:LHZ	50	70
CAN:1:LHT	50	70
CAN:1:LHZ	50	70
SNZO:1:LHZ	50	70
PPTF:1:LHZ	50	70
XMAS:1:LHZ	50	70
KIP:1:LHT	50	70
KIP:1:LHZ	50	70
PET:1:LHZ	60	70
UNM:1:LHT	50	70
UNM:1:LHZ	50	70
FFC:1:LHZ	50	70

3. Moment Tensor & Source Depth Inversion.

2.1. Enter directory $HOME/ashock_04_03/MomTens.

2.2. Execute command **MomTens**. The main window of the program will appear.

2.3. Push button  to start a New Project.

Define Project Directory - type Project Name (**Inversion** for example);

Filtered Wave Form Disc DB Name - browse directory $HOME/ashock_04_03/Ftan/FLT (if you saved the directory with results of floating filtering under name **FLT**), and click **table.wfdisc**.

Instrument, Site, Sensor DB Root Names - browse directory HOME/ashock_04_03/Db and click on ‘ashock_04_03’ for example

Origin Info Event Db Name - browse directory HOME/ashock_04_03/Db and click on ‘ashock_04_03.origin’

Note: Next time you can just use  to open Project Name **Inversion**, if you have saved it.

2.4. To select records to be used for the inversion push button  . In this example all the records are recommended to be used, so push button 'OK'.

2.5. Push button 
Click on the button ‘3SMAC MODEL’ – the structure models for all stations will be calculated. Click on the button ‘Get Source Model from’ and on the radio button ‘3SMAC’ at the bottom. Model ‘3SMAC’ will be used for the source region. Click ‘OK’.

2.6. Push button  .

During filtering by FTAN program you determined for every wave the spectral domain where the signal is of a good quality. It is given by maximum and minimum periods on the pages 20-21. Type these period values in the text boxes "T min" and "T max" in the uppermost left part of the window. During typing the cursor must be situated in the text box. To associate this pair of values to any record click on the correspondent record name.

Parameters to be given in the right frame (Spectral rage):

Tmin=50, Tmax=70, Nw=12, N points FFT = 32768

Type in the text box "T min" at the bottom 100.

Push 'Get' button. Click ‘OK’.

2.7. Push button  .
Recommended grid characteristics:

0.0	-	Initial Depth
5.0	-	Depth Step
21	-	Number of Depth Values
15.0	-	Initial Dip
15.0	-	Dip Step
6	-	Number of Dip Values
5.0	-	Initial Strike
15.0	-	Strike Step
12	-	Number of Strike Values
10.0	-	Initial Slip
15.0	-	Slip Step
12	-	Number of Slip Values

2.8. Push the button  to perform the selection and rarefication of polarity data. For this event we use supplementary polarities only. USGS bulletin doesn’t contain any polarities.
Push the arrow in the combo box, choose the angle of polarity data smoothing (1 degree). Push OK .

2.9. Push the button  to start the inversion.

2.10.View of results:

Viewing the results.

IV. Aftershock of Chilean earthquake, 05.03.2010, M_w = 6.7

1. Creating data base

Enter directory $HOME/ashock_05_03
1.1 Execute command: **dbcreator**

Click button *New* 

1.2 *Data Page Info* will appear.
Select the type of data in *Input type of data* frame as *seed volumes.* Click *Browse* button to browse the directory ashock_05_03/DATA/SEED.
Select in *Output dbase dt* ***origin dt***.
Click *Next* > button for next page.
1.3 *Directories Page Info* will appear.
Type 'ashock_05_03' in *Data base name* box. Click *Browse* button to browse the directory ashock_05_03/Db
Click *Next* > button for next page.
1.4 *Origin Page Info* will appear.
Fill the empty boxes for event date and time information in *Date* and *Time* frames.
Year: 2010 Month: 3 Day 5 Hour: 11 Minute: 47 Second: 14.9
Click *Next* > button for next page.
1.5 *HypoPage Info* will appear.
Fill the empty boxes for hypocenter coordinates and magnitudes in *Hypocenter* and *Magnitudes* frames.
Latitude: -36.85 Longitude: -73.70 Depth: 15.0
Mb: Mw:6.7
Click *Finish* button to finish the preparation of input data.
1.6 Main window with the list of station information will appear (see 'Data Base Frequency-time analysis program Reference Manual').
Click on + near station name HNR to open this record. Check on the location 10 instead of selected by default location 00.
Check off the check box of station KIP (NET: IU).
Check off the check box of station TRIS (NET: IU).
Click button  to create data base.

1.7 To save the project-file click button  , browse directory $HOME/ashock_05_03 and type name of project-file 'ashock_05_03'.

2. Floating filtering of records

1.11. Enter directory $HOME/ashock_05_03/Ftan
1.12. Execute command:
ftan
1.3. *New/Open* start.
Click on *New* tab window will appear
Brows:
$HOME/ashock_05_03/Db/ashock_05_03.wfdisc
$HOME/ashock_05_03/Db/ashock_05_03.instrument
$HOME/ashock_05_03/Db/ashock_05_03.origin
Click on OK. Start window will disappear.

1.14. Click button and assign following bandpass filtering parameters:
short period zero = 50, short period corner = 60, long period corner = 220, long period zero = 250.

1.15. Click button and assign following bounds for FTAN diagram:
group velocity from 2 to 6, periods from 50 to 250.

1.6. Until you didn't select a station and a channel to be processed the light of semaphore button is red. Click on '+' near selected station, available channels will appear. Click on one of them. The semaphore light will change to yellow. The program is ready for processing of selected seismograms. Click on semaphore button. The semaphore light will change to green, and selected waveforms will be plotted.

1.7. To apply bandpass filtering click on the button .

1.8. Click on the button to view FTAN maps for selected components and to make floating filtering (see an example of processing on p.p. 27-33 and reference dispersion curves shown on the last page of this tutorial).

1.9. Clicking correspondent button view the results of processing:

- View calculated group velocity curves.
- View cleaned and raw amplitude spectra.
- View estimated polarization anomalies.
- View cleaned and raw seismograms.
- View a FTAN diagrams for cleaned and raw records.

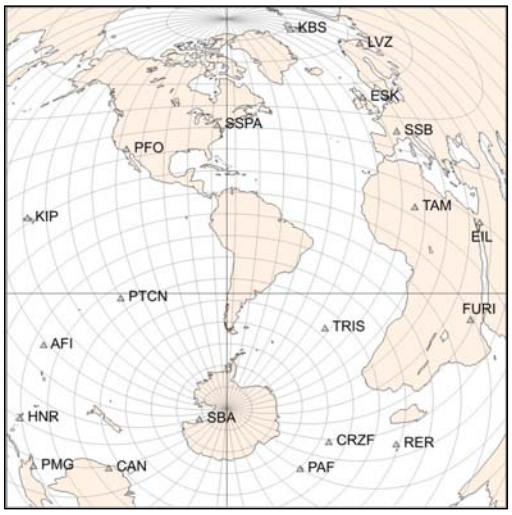
1.10. To save results click the button. The **Save Records Dialog** will appear.
Click component toggle buttons required to be saved. Click OK button to save records.

1.11. Select next station-channel. Button changes green color to yellow and you can work with new selection.

1.12. After you finished the processing of all records push the button to save results.
The **Save Location As Dialog** will be invoked for selection of directory name. Click the 'Create New Folder' toolbar button to create a new directory (mentioned further as **FLT**).

Recommended components to be saved and correspondent period ranges for floating filtering:

Record	Tmin	Tmax
KBS:1:LHT	80	200
KBS:1:LHZ	90	200
LVZ:1:LHT	80	200
LVZ:1:LHZ	80	200
ESK:1:LHZ	90	200
SSB:1:LHT	80	200
SSB:1:LHZ	90	200
TAM:1:LHT	100	200
TAM:1:LHZ	80	200
EIL:1:LHT	80	200
EIL:1:LHZ	110	200
FURI:1:LHZ	80	200



TRIS:1:LHZ	80	200
RER:1:LHT	80	200
RER:1:LHZ	80	200
CRZF:1:LHZ	80	200
PAF:1:LHT	80	200
PAF:1:LHZ	80	200
SBA:1:LHT	80	140
SBA:1:LHZ	80	200
CAN:1:LHT	80	200
CAN:1:LHZ	80	200
PMG:1:LHT	80	200
PMG:1:LHZ	80	200
HNR:1:LHT	130	200
HNR:1:LHZ	80	200
AFI:1:LHZ	80	200
PTCN:1:LHZ	80	200
KIP:1:LHT	80	200
KIP:1:LHZ	80	200
PFO:1:LHT	80	200
PFO:1:LHZ	80	200
SSPA:1:LHT	90	200
SSPA:1:LHZ	90	200

3. Moment Tensor & Source Depth Inversion.

2.1. Enter directory $HOME/ashock_05_03/MomTens.

2.2. Execute command **MomTens**. The main window of the program will appear.

2.3. Push button  to start a New Project.

Define Project Directory - type Project Name (**Inversion** for example);

Filtered Wave Form Disc DB Name - browse directory $HOME/ashock_05_03/Ftan/FLT (if you saved the directory with results of floating filtering under name **FLT**), and click **table.wfdisc**.

Instrument, Site, Sensor DB Root Names - browse directory HOME/ashock_05_03/Db and click on ‘ashock_05_03’ for example

Origin Info Event Db Name - browse directory HOME/ashock_05_03/Db and click on ‘ashock_05_03.origin’

Note: Next time you can just use  to open Project Name **Inversion**, if you have saved it.

2.4. To select records to be used for the inversion push button  . In this example all the records are recommended to be used, so push button 'OK'.

2.5. Push button 
Click on the button ‘3SMAC MODEL’ – the structure models for all stations will be calculated. Click on the button ‘Get Source Model from’ and on the radio button ‘3SMAC’ at the bottom. Model ‘3SMAC’ will be used for the source region. Click ‘OK’.

2.6. Push button  .

During filtering by FTAN program you determined for every wave the spectral domain where the signal is of a good quality. It is given by maximum and minimum periods on the pages 24-25. Type these period values in the text boxes "T min" and "T max" in the uppermost left part of the window. During typing the cursor must be situated in the text box. To associate this pair of values to any record click on the correspondent record name.

Parameters to be given in the right frame (Spectral rage):

Tmin=80, Tmax=200, Nw=12, N points FFT = 32768

Type in the text box "T min" at the bottom 150.

Push 'Get' button. Click ‘OK’.

2.7. Push button  .
Recommended grid characteristics:

0.0	-	Initial Depth
5.0	-	Depth Step
21	-	Number of Depth Values
15.0	-	Initial Dip
15.0	-	Dip Step
6	-	Number of Dip Values
0.0	-	Initial Strike
15.0	-	Strike Step
12	-	Number of Strike Values
0.0	-	Initial Slip
15.0	-	Slip Step
12	-	Number of Slip Values

2.8. Push the button  to perform the selection and rarefication of polarity data. For this event we use supplementary polarities only. USGS bulletin doesn’t contain any polarities.
Push the arrow in the combo box, choose the angle of polarity data smoothing (1 degree). Push OK .

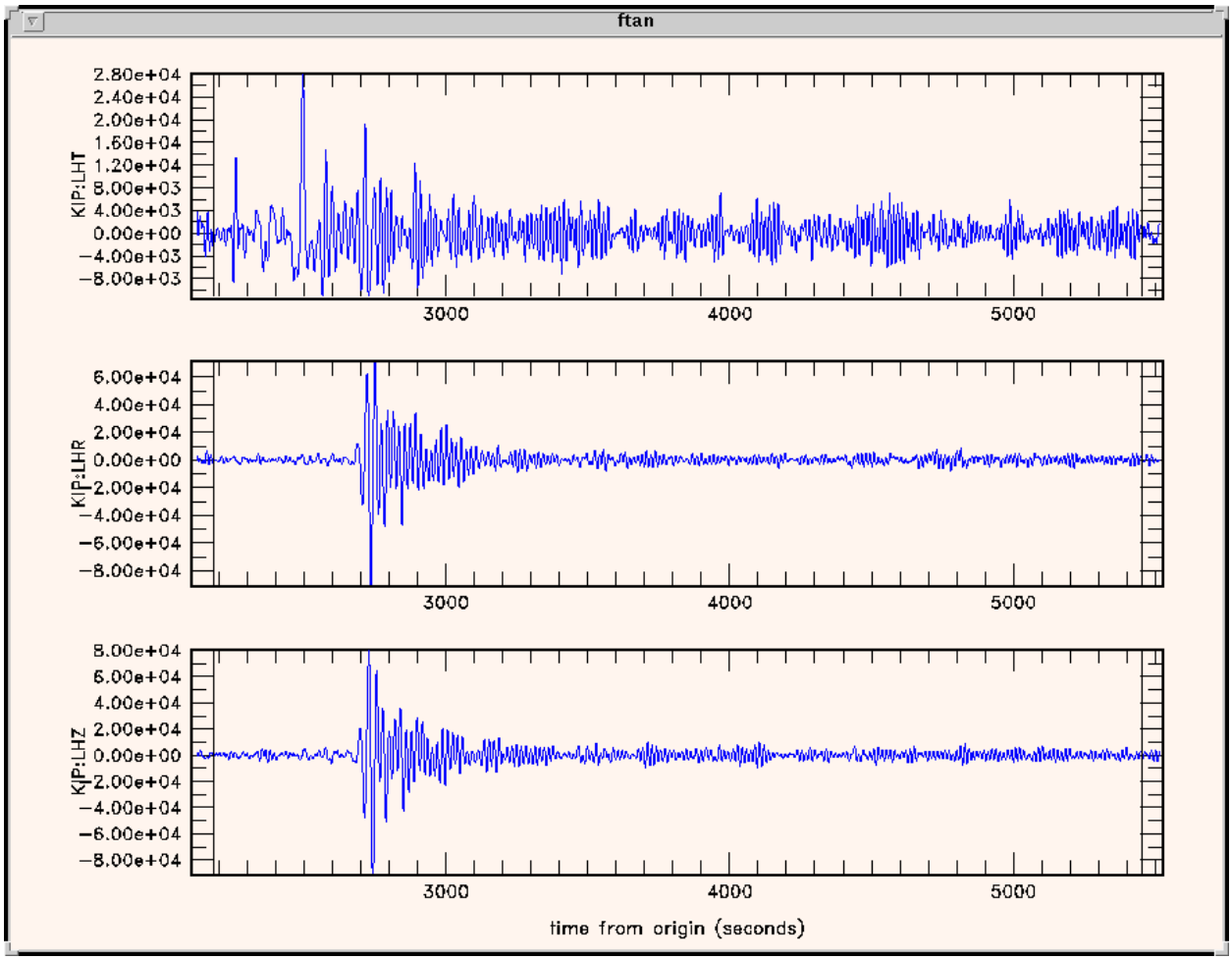
2.9. Push the button  to start the inversion.

2.10.View of results:

Viewing the results.

Example of processing performance

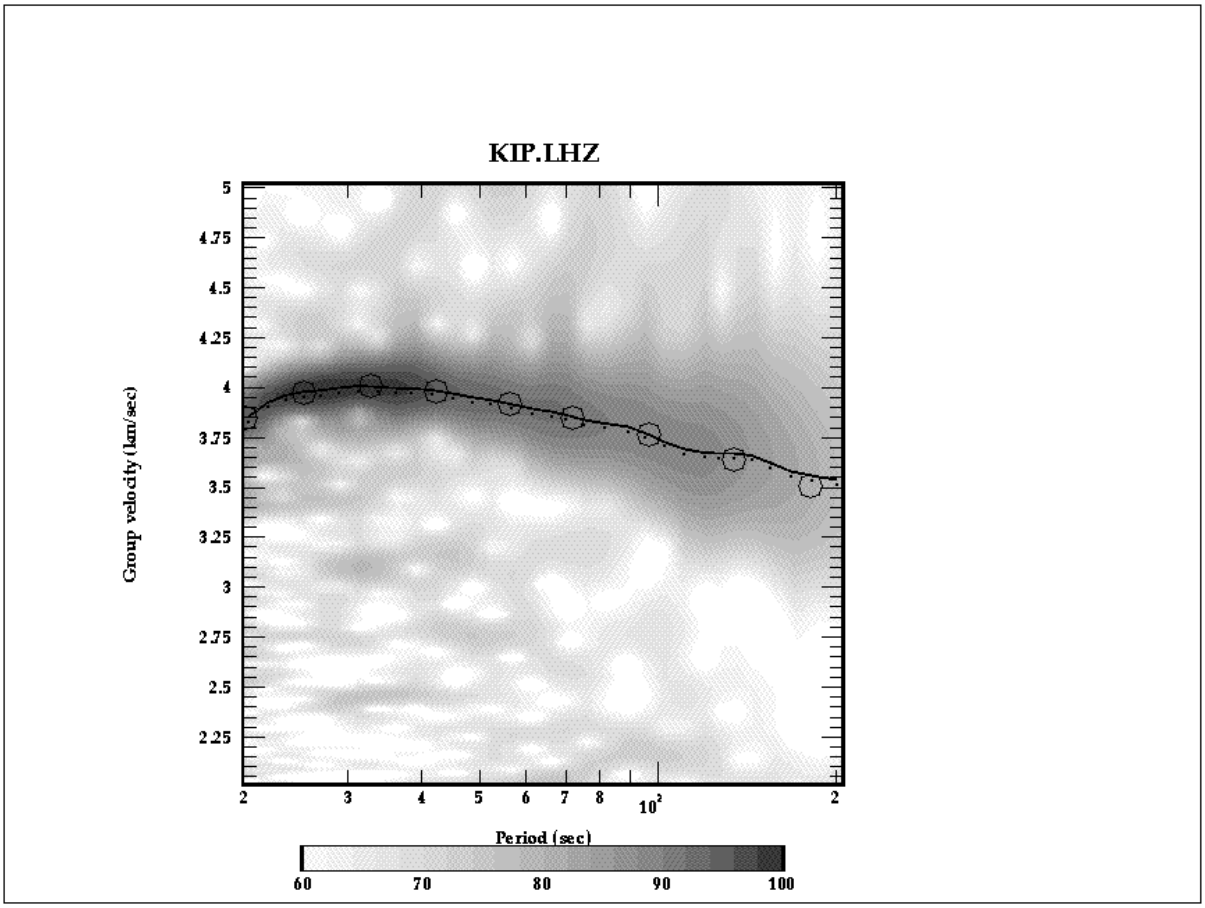
Until you didn't select a station and a channel to be processed the light of semaphore button is red . Click on '+' near selected station, available channels will appear. Click on one of them. The semaphore light will change to yellow . The program is ready for processing of selected seismograms. Click on semaphore button. The semaphore light will change to green , and selected waveforms will be plotted



Note, that the raw waveforms can be plotted at any moment by clicking on the button .

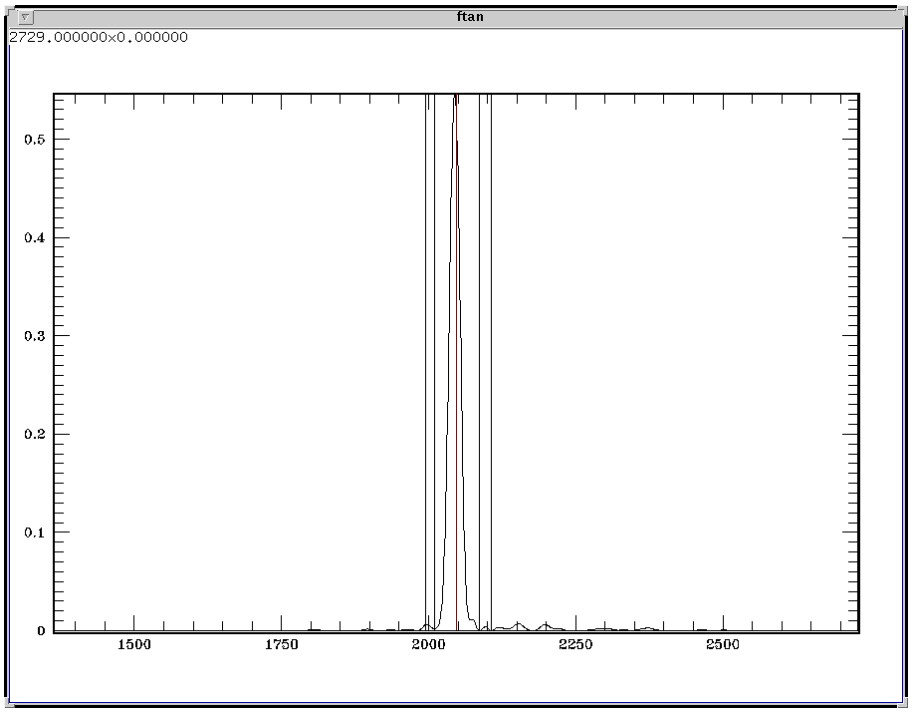
To apply bandpass filtering click the button . Filtered records will be plotted

To view FTAN maps for selected components and to make floating filtering push the button .



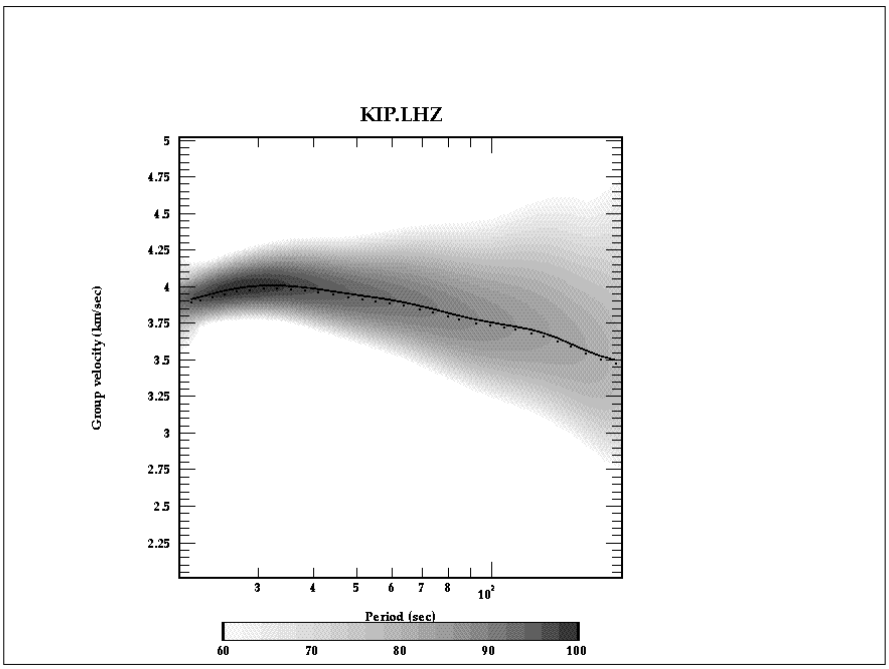
To make a floating filtering it is necessary to plot dispersion curve to make phase equalization (black circles). Use mouse to do this. Click left mouse button to put a point and the right one to delete the point nearest to cursor location. Type "e" to finish the plotting.

The picture of envelope of signal will appear:



It is necessary to cut a signal which you've selected. This signal is concentrated near the center of picture (red vertical line). To do this you must set four points to define the filtering window with cosine edges. Use the same commands as above.

The picture of FTAN map for a cleaned signal will appear:



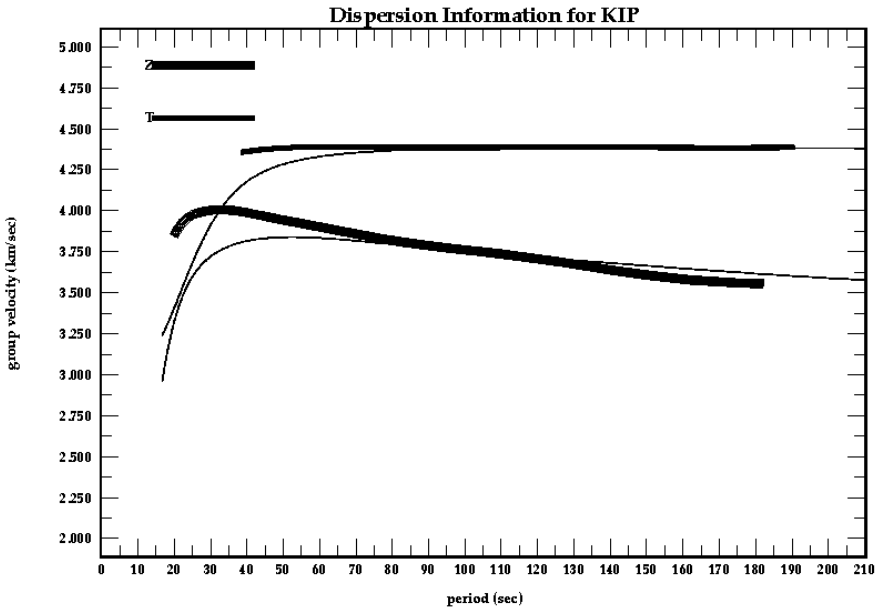
You can continue with filtering of this component. If you're satisfied with the result of filtering type "y". FTAN diagram of next component will appear.

Note: to interrupt the floating filtering process type “q” .

View of results

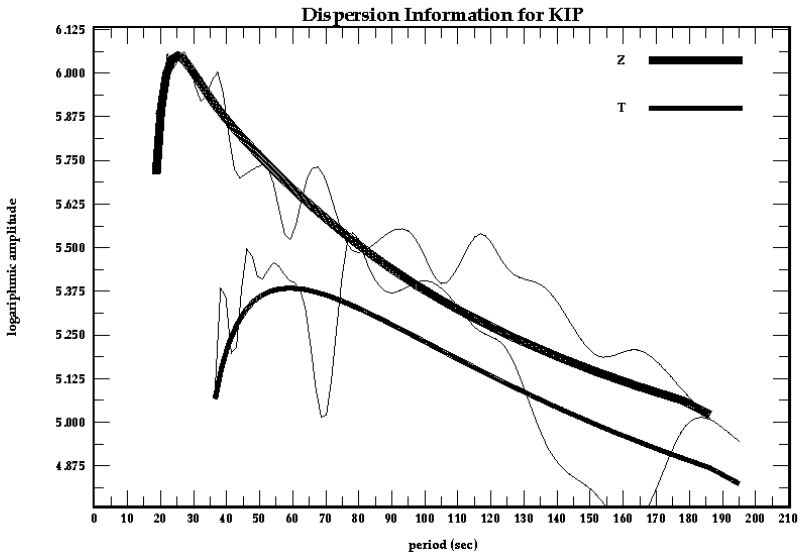
To view results of FTAN calculation of group velocities click button 

. Here is an example of group velocities plotting. The thin lines are theoretical curves.



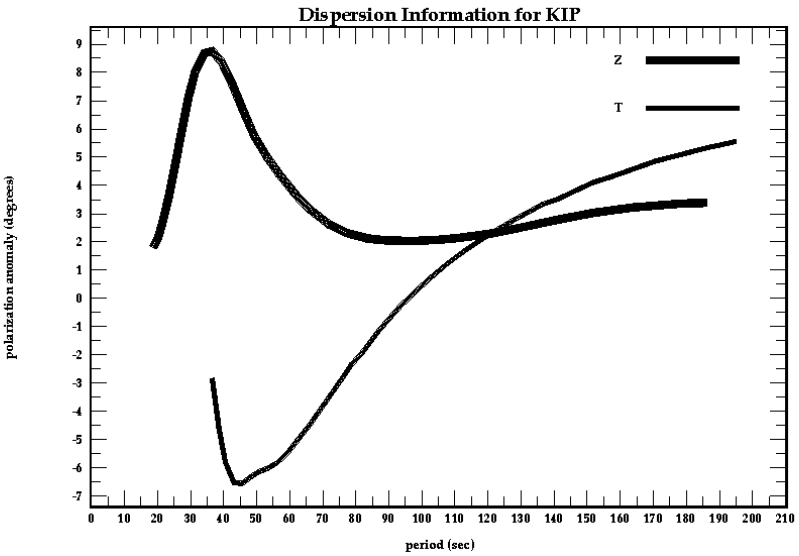
To view amplitude spectra push the button 

.
Here is an example of picture of amplitude spectra.
Thin lines present the amplitude spectra of raw signals; thick lines present the amplitude spectra of cleaned signals.



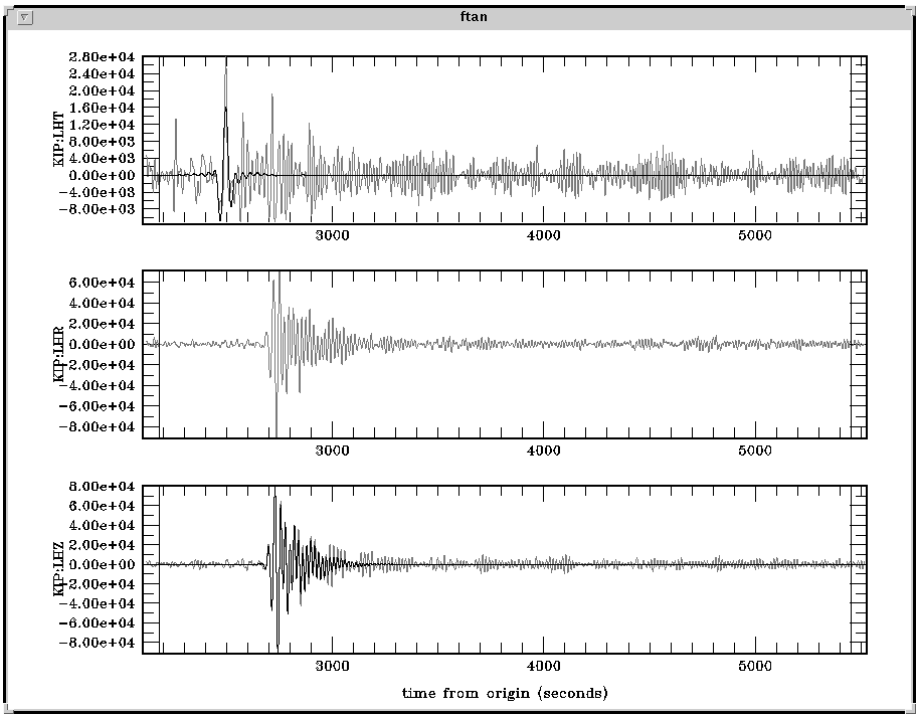
To view the FTAN estimates of polarization anomalies push the button  .

Here is an example of picture of polarization anomalies:

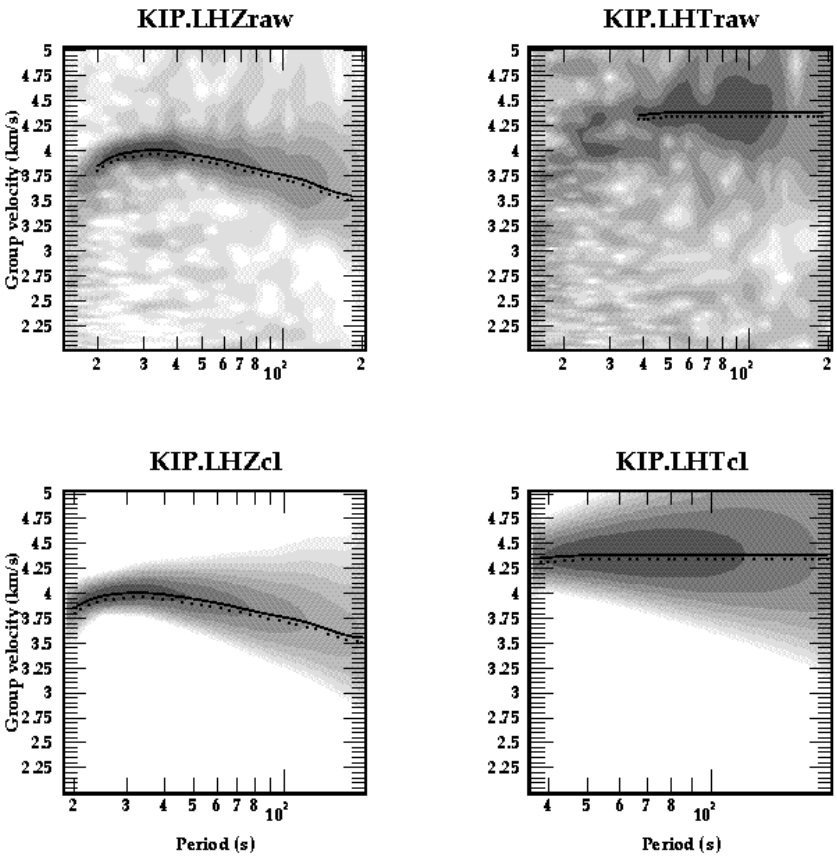


To view the picture of cleaned and raw seismograms push the button  .

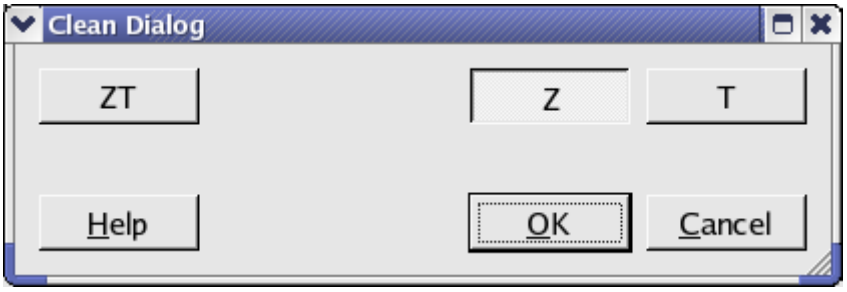
Here is an example of picture of filtered and raw signals:



To view a picture of FTAN diagrams for cleaned and raw records push the button  .
Here is an example of picture of FTAN maps for filtered and raw seismograms:

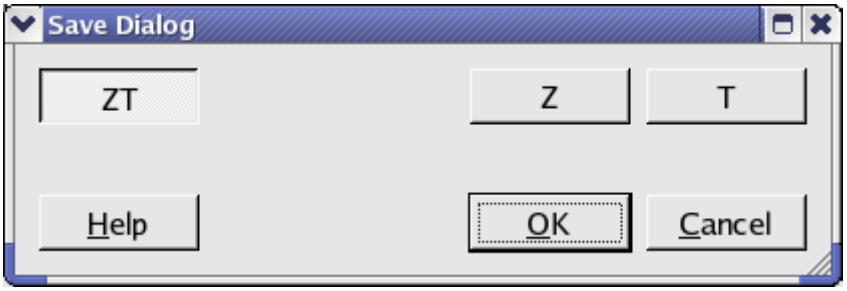


To clean any of processed components push the button  . The **Clean Records Dialog** window will appear.



Click component toggle buttons required to be cleaned. Click OK button to perform the cleaning, or Cancel - to close the window without cleaning.

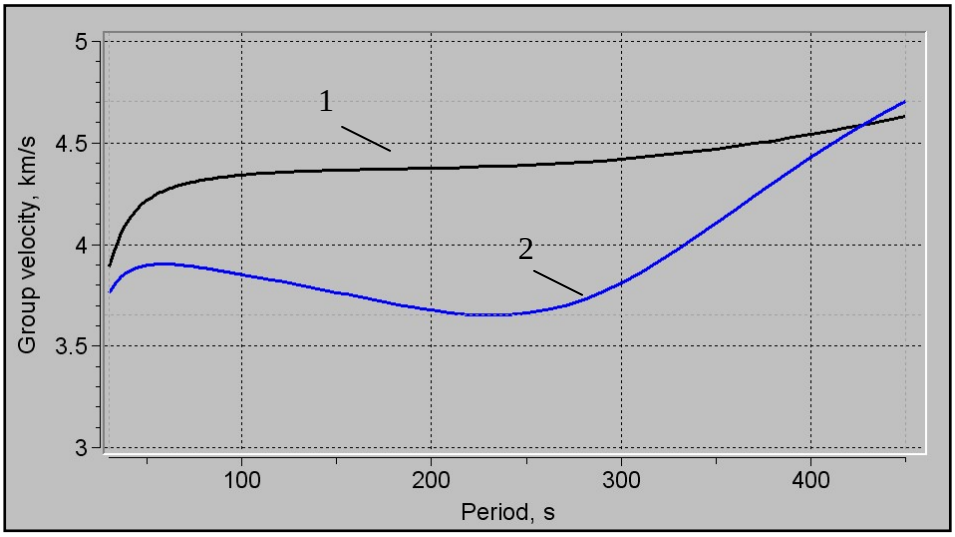
To save results click the button  . The **Save Records Dialog** will appear.



Click component toggle buttons required to be saved. Click OK button to save records, or Cancel - to close the window without saving.

Select next station-channel. Button  changes green color to yellow  and you can work with new selection.

Reference group velocity curves



Group velocity curves for fundamental Love (1) and Rayleigh (2) modes for model PREM