Source parameters determination for
Vrancea (1990), Turkey (1999), Colima (2003) and Sumatra (2004) earthquakes

Tutorial

Computer exercises 3

Your first actions after 1-st login:

Enter $HOME directory and execute script /**opt/fmt/bin/structdir**.
A structure of directories will be created in your $HOME.
Directories VRANCEA, TURKEY, COLIMA, and SUMATRA corresponds to the
earthquakes which will be studied during the exercises.

I. Floating filtering of Vrancea, 1990 earthquake records

1.1. Enter directory $HOME/VRANCEA/FTAN

1.2. Execute command:

> **ftan**

1.3. *New/Open* start window will appear.
Click on *New* tab
Brows:

> /opt/VRANCEA/DB/90150_VRANCEA_1040_l.wfdisc
> /opt/VRANCEA/DB/90150_VRANCEA_1040.instrument
> /opt/VRANCEA/DB/90150_VRANCEA_1040.origin

Click on OK. Start window will disappear.

1.4. Click button and assign following bandpass filtering parameters:
short period zero = 80, short period corner = 90, long period corner = 220, long period zero = 200.

1.5. Click button and assign following bounds for FTAN diagram:
group velocity from 2 to 6, periods from 80 to 220.

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 p.p.35-43 of manual).

1.9. 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.

1.10. 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.

1.11. 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 Vrancea 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:

```
ANMO.LHT      100     190
ANMO.LHZ      100     190
CHTO.LHT      100     190
ERM.LHZ       100     190
HRV.LHZ       100     190
KIP.LHT       110     170
KIP.LHZ       100     170
```

II. Moment Tensor & Source Depth Inversion for Vrancea, 1990 earthquake.

2.1. Enter directory $HOME/VRANCEA/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/VRANCEA/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 /opt/VRANCEA/DB and click '90150_VRANCEA_1040.site'

Origin Info Event Db Name - browse directory /opt/VRANCEA/DB and click '90150_VRANCEA_1040.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
Structural models and related stations table:

```
Model     Station
CONT      CHTO
```

```
CONT    ERM
CONT    HRV
CONT    TOL
OCEAN   KIP
T_CON   ANMO
```

Click on the model 000, and after on the radio button 'Get Source Model from Model List'.
Click 'OK'.

2.6. Push button .
We recommend following spectral bands to be used in the inversion
(Spectral Range for every wave):

Record	Tmin	Tmax
ANMO.LHT	100	190
ANMO.LHZ	100	190
CHTO.LHT	100	190
ERM.LHZ	100	190
HRV.LHZ	100	190
KIP.LHT	110	170
KIP.LHZ	100	170

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

Tmin=100, Tmax=190, Nw=12, N points FFT = 32768

Type in the text box at the bottom 120.

Push 'Get' button.

2.7. Push button .
Recomended grid characteristics:

0.0	-	Initial Depth
5.0	-	Depth Step
41	-	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 all project lists and parameters.

 Viewing the results.

 View of the map of stations for selected records.

III. Floating filtering of Turkey, 1999 earthquake records

3.1. Enter directory $HOME/TURKEY/FTAN

3.2. Execute command:
ftan

3.3. *New/Open* start window will appear.
Click on *New* tab
Brows:
    /opt/TURKEY/DB/1999229_TURKEY_0001_l.wfdisc
    /opt/TURKEY/DB/1999229_TURKEY_0001.instrument
    /opt/TURKEY/DB/1999229_TURKEY_0001.origin
Click on OK. Start window will disappear.

3.4. Click button and assign following bandpass filtering parameters:
short period zero = 80, short period corner = 90, long period corner = 260, long period zero = 280.

3.5. Click button and assign following bounds for FTAN diagram:
group velocity from 2 to 6, periods from 80 to 280.

Follow instructions 1.6 – 1.12.

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

Record	Tmin	Tmax
ALE.LHT	100.00	250.00
ATD.LHT	100.00	250.00
ATD.LHZ	120.00	160.00
BDFB.LHT	100.00	250.00
BDFB.LHZ	100.00	250.00
BGCA.LHT	100.00	220.00
BGCA.LHZ	100.00	220.00
COCO.LHT	110.00	170.00
COCO.LHZ	100.00	180.00
FFC.LHT	100.00	250.00

```
FFC.LHZ        100.00   250.00
HDC.LHT        100.00   140.00
HDC.LHZ        100.00   250.00
HYB.LHT        100.00   250.00
HYB.LHZ        100.00   250.00
KDAK.LHT       100.00   250.00
KDAK.LHZ       120.00   200.00
KIP.LHT        100.00   250.00
KIP.LHZ        100.00   250.00
KMI.LHT        100.00   250.00
KMI.LHZ        100.00   210.00
KOG.LHT        100.00   250.00
KOG.LHZ        120.00   160.00
NRIL.LHT       100.00   170.00
NRIL.LHZ       110.00   200.00
RPN.LHT        110.00   250.00
SHEL.LHT       110.00   200.00
SHEL.LHZ       100.00   250.00
TLY.LHZ        100.00   200.00
UNM.LHT        100.00   200.00
UNM.LHZ        100.00   250.00
```

IV. Moment Tensor & Source Depth Inversion for Turkey, 1999 earthquake.

4.1. Enter directory @HOME/TURKEY/MomTens.

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

4.3. 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/TURKEY/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 /opt/TURKEY/DB
                                          and click '1999229_TURKEY_0001.site'

Origin Info Event Db Name   - browse directory /opt/TURKEY/DB
                                          and click '1999229_TURKEY_0001.origin'

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

4.4. 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'.

4.5. Push button ▤
Click on the button '3SMAC MODEL' – the structure models for all stations will be calculated. Click on the model 000, and after on the radio button 'Get Source Model from Model List'. Click 'OK'.

4.6. Push button ![omega button] .

We recommend following spectral bands to be used in the inversion
(Spectral Range for every wave):

Record	Tmin	Tmax
ALE.LHT	100.00	250.00
ATD.LHT	100.00	250.00
ATD.LHZ	120.00	160.00
BDFB.LHT	100.00	250.00
BDFB.LHZ	100.00	250.00
BGCA.LHT	100.00	220.00
BGCA.LHZ	100.00	220.00
COCO.LHT	110.00	170.00
COCO.LHZ	100.00	180.00
FFC.LHT	100.00	250.00
FFC.LHZ	100.00	250.00
HDC.LHT	100.00	140.00
HDC.LHZ	100.00	250.00
HYB.LHT	100.00	250.00
HYB.LHZ	100.00	250.00
KDAK.LHT	100.00	250.00
KDAK.LHZ	120.00	200.00
KIP.LHT	100.00	250.00
KIP.LHZ	100.00	250.00
KMI.LHT	100.00	250.00
KMI.LHZ	100.00	210.00
KOG.LHT	100.00	250.00
KOG.LHZ	120.00	160.00
NRIL.LHT	100.00	170.00
NRIL.LHZ	110.00	200.00
RPN.LHT	110.00	250.00
SHEL.LHT	110.00	200.00
SHEL.LHZ	100.00	250.00
TLY.LHZ	100.00	200.00
UNM.LHT	100.00	200.00
UNM.LHZ	100.00	250.00

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

Tmin=100, Tmax=250, Nw=12, N points FFT = 32768

Type in the text box at the bottom 150.

Push 'Get' button.

4.7. Push button ![grid button].

Recomended grid characteristics:
0.0   -   Initial Depth

```
 5.0   -        Depth Step
 11    -        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
```

4.8. Push the button [icon] 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

4.9. Push the button [icon] to start the inversion.

4.10. View of results:

[icon] Viewing all project lists and parameters.

[icon] Viewing the results.

[icon] View of the map of stations for selected records.

V. Floating filtering of Colima, 2003 earthquake records

5.1. Enter directory $HOME/COLIMA/FTAN

5.2. Execute command:
                ftan

 5.3. *New/Open* start window will appear.
Click on *New* tab
Brows:
        /opt/COLIMA/DB/COLIMA_l.wfdisc
        /opt/COLIMA/DB/COLIMA.instrument
        /opt/COLIMA/DB/COLIMA.origin
Click on OK. Start window will disappear.

5.4. Click button [icon] and assign following bandpass filtering parameters:
short period zero = 80, short period corner = 90, long period corner = 260, long period zero = 280.

5.5. Click button [icon] and assign following bounds for FTAN diagram:

group velocity from 2 to 6, periods from 80 to 280.

Follow instructions 1.6 – 1.12.

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

Record	Tmin	Tmax
AAK.LHT	100.00	200.00
AAK.LHZ	100.00	250.00
CTAO.LHT	150.00	250.00
CTAO.LHZ	140.00	250.00
KONO.LHZ	110.00	250.00
LVC.LHZ	120.00	200.00
MTE.LHT	105.00	160.00
MTE.LHZ	105.00	250.00
NNA.LHT	100.00	200.00
PTCN.LHZ	100.00	200.00
RCBR.LHT	115.00	200.00
RCBR.LHZ	130.00	220.00
RPN.LHT	130.00	200.00
RPN.LHZ	110.00	200.00
SNAA.LHT	100.00	200.00
SNAA.LHZ	100.00	250.00
TAU.LHT	130.00	250.00
TAU.LHZ	130.00	250.00
WAKE.LHT	110.00	200.00
WAKE.LHZ	110.00	250.00
YAK.LHT	110.00	250.00
YAK.LHZ	115.00	250.00
YSS.LHT	110.00	200.00
YSS.LHZ	130.00	250.00

VI. Moment Tensor & Source Depth Inversion for Colima, 2003 earthquake.

6.1. Enter directory @HOME/COLIMA/MomTens.

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

6.3. 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/COLIMA/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 /opt/COLIMA/DB
                                                          and click 'COLIMA.site'

Origin Info Event Db Name   - browse directory /opt/COLIMA/DB
                     and click 'COLIMA.origin'

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

6.4. To select records to be used for the inversion push button [waveform icon] . In this example all the records are recommended to be used, so push button 'OK'.

6.5. Push button [α β ρ icon]
Click on the button '3SMAC MODEL' – the structure models for all stations will be calculated. Click on the model 000, and after on the radio button 'Get Source Model from Model List'. Click 'OK'.

6.6. Push button [ω icon] .
We recommend following spectral bands to be used in the inversion
(Spectral Range for every wave):

Record	Tmin	Tmax
AAK.LHT	100.00	200.00
AAK.LHZ	100.00	250.00
CTAO.LHT	150.00	250.00
CTAO.LHZ	140.00	250.00
KONO.LHZ	110.00	250.00
LVC.LHZ	120.00	200.00
MTE.LHT	105.00	160.00
MTE.LHZ	105.00	250.00
NNA.LHT	100.00	200.00
PTCN.LHZ	100.00	200.00
RCBR.LHT	115.00	200.00
RCBR.LHZ	130.00	220.00
RPN.LHT	130.00	200.00
RPN.LHZ	110.00	200.00
SNAA.LHT	100.00	200.00
SNAA.LHZ	100.00	250.00
TAU.LHT	130.00	250.00
TAU.LHZ	130.00	250.00
WAKE.LHT	110.00	200.00
WAKE.LHZ	110.00	250.00
YAK.LHT	110.00	250.00
YAK.LHZ	115.00	250.00
YSS.LHT	110.00	200.00
YSS.LHZ	130.00	250.00

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

Tmin=100, Tmax=250, Nw=18, N points FFT = 32768

Type in the text box at the bottom 150.

Push 'Get' button.

6.7. Push button ![rubik's cube icon].

Recomended grid characteristics:

0.0	-	Initial Depth
5.0	-	Depth Step
11	-	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

6.8. Push the button ![icon] 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'. Push radio button 'manually', and print in edit box at the bottom
'7.2'- the value of P-wave velocity in the source location. Confirm by pushing OK.

6.9. Push the button ![icon] to start the inversion.

6.10. View of results:

![INFO icon]   Viewing all project lists and parameters.

![RESULTS icon]   Viewing the results.

![DB MAP icon]   View of the map of stations for selected records.

VII. Floating filtering of Sumatra, 2004 megaearthquake records.

7.1. Enter directory $HOME/SUMATRA/FTAN

7.2. Execute command:

ftan

7.3. *New/Open* start window will appear.
Click on *New* tab

Brows:
  /opt/SUMATRA/DB/IRIS_GEOSCOPE_23h_20_h_v.wfdisc
  /opt/SUMATRA/DB/IRIS_GEOSCOPE_23h_20_h.instrument
  /opt/SUMATRA/DB/IRIS_GEOSCOPE_23h_20_h.origin

Click on OK. Start window will disappear.

7.4. Open item menu Settings->Total Settings.
Change 'Raw spectrum: group velocity and width' values from 3.6 and 1800 to 4 and 4000.

7.5. Push button ⊕ to disable the polarization measurements.

7.6. Click button and assign following bandpass filtering parameters:
short period zero = 80, short period corner = 90, long period corner = 260, long period zero = 280.

7.7. Click button and assign following bounds for FTAN diagram:
 group velocity from 2 to 9, periods from 300 to 800.

7.8. Assign for every record the orbit number (2 or 3) pushing button . Click required orbit number in pop up menu.

Follow instructions 1.6 – 1.12.

Viewing results of processing remember that polarization measurements were not performed (see item 7.5).

Recommended components to be saved and correspondent period ranges for floating filtering (the number in component name indicates the orbit number):

Record	Tmin	Tmax
AFI:2:VlHZ	400.00	620.00
APE:2:VlHT	400.00	620.00
APE:2:VlHZ	400.00	560.00
APE:3:VlHT	400.00	650.00
ASCN:2:VlHT	450.00	650.00
ATD:2:VHT	400.00	600.00
ATD:3:VHT	400.00	650.00
CAN:2:VHZ	400.00	650.00
CRZF:2:VHT	400.00	650.00
CRZF:2:VHZ	400.00	600.00
DRV:2:VHT	400.00	650.00
DRV:2:VHZ	400.00	650.00
DRV:3:VHT	400.00	650.00
ECH:2:VHZ	400.00	540.00
KIP:2:VHT	400.00	650.00
KIP:3:VHT	400.00	560.00
KONO:2:VlHT	400.00	560.00
KWAJ:2:VlHT	400.00	650.00
LSZ:2:VlHT	400.00	560.00
LSZ:3:VlHZ	400.00	600.00
NWAO:2:VlHZ	400.00	600.00
PET:2:VlHZ	400.00	600.00
PMSA:2:VlHT	400.00	600.00
RAYN:3:VlHT	400.00	650.00
RAYN:3:VlHZ	400.00	620.00

TRIS:2:VlHZ   400.00   600.00

VIII. Moment Tensor & Source Depth Inversion

for Sumatra, 2004 megaearthquake.

8.1. Enter directory @HOME/SUMATRA/MomTens.

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

6.3. 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/SUMATRA/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 /opt/SUMATRA/DB
                                          and click 'IRIS_GEOSCOPE_23h_20_h.site'

Origin Info Event Db Name   - browse directory /opt/SUMATRA/DB
                                          and click 'IRIS_GEOSCOPE_23h_20_h.origin'

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

8.4. 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'.

8.5. Push button ▤
Click on the button '3SMAC MODEL' – the structure models for all stations will be
calculated. Click on the model 'centroid', and after on the radio button 'Get Source Model
from Model List'. Click 'OK'.

8.6. Push button ▤ .
We recommend following spectral bands to be used in the inversion
(Spectral Range for every wave):

Record	Tmin	Tmax
AFI:2:VlHZ	400.00	620.00
APE:2:VlHT	400.00	620.00
APE:2:VlHZ	400.00	560.00
APE:3:VlHT	400.00	650.00
ASCN:2:VlHT	450.00	650.00
ATD:2:VHT	400.00	600.00
ATD:3:VHT	400.00	650.00
CAN:2:VHZ	400.00	650.00
CRZF:2:VHT	400.00	650.00
CRZF:2:VHZ	400.00	600.00

```
DRV:2:VHT      400.00   650.00
DRV:2:VHZ      400.00   650.00
DRV:3:VHT      400.00   650.00
ECH:2:VHZ      400.00   540.00
KIP:2:VHT      400.00   650.00
KIP:3:VHT      400.00   560.00
KONO:2:VlHT    400.00   560.00
KWAJ:2:VlHT    400.00   650.00
LSZ:2:VlHT     400.00   560.00
LSZ:3:VlHZ     400.00   600.00
NWAO:2:VlHZ    400.00   600.00
PET:2:VlHZ     400.00   600.00
PMSA:2:VlHT    400.00   600.00
RAYN:3:VlHT    400.00   650.00
RAYN:3:VlHZ    400.00   620.00
TRIS:2:VlHZ    400.00   600.00
```

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

Tmin=500, Tmax=650, Nw=12, N points FFT = 32768

Type in the text box at the bottom 500.

Push 'Get' button.

8.7. Push button .
Recomended grid characteristics:

3.0	-	Initial Depth
10.0	-	Depth Step
11	-	Number of Depth Values
10.0	-	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

8.8. 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'. Push radio button 'ak135 model', and confirm by pushing OK

8.9. Push the button to start the inversion.

8.10. View of results:

 Viewing all project lists and parameters.

 Viewing the results.

 View of the map of stations for selected records.