Lab2: Moment tensor inversion

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Prepare a working directory

```
cd ~   #### cd to your home directory
cp /home/aki2/student16/.cshrc . ## copy .cshrc file into your home directory
cp -r /home/aki2/student16/Lab2 /home/aki2/student16/Lab2.tgz . ## copy Lab2
```

Run these command only once to create your working directory

Login to the server earth

```
ssh -XY student16@earth # replace student16 with your account name

# then, type your password.

# if you successfully login to that server, you will see something like:
`student??@earth%`


cd Lab2/TDMT/ #

gedit tdmt.config &  #Set MTPACKAGE by the path to your current directory (pwd)


source tdmt.config  #Please remember to run this command every time you login!!!
```

Basic Methodology

Synthetic seismogram

$$U_n(x,t) = \sum_{i,j} M_{ij} \cdot G_{ni,j}(x,z,t)$$

Observed n^{th} component of displacement/velocity (KNOWN)

n^{th} component Green's function COMPUTABLE given velocity structure

M_{ij} is the scalar seismic moment tensor (UNKNOWN)

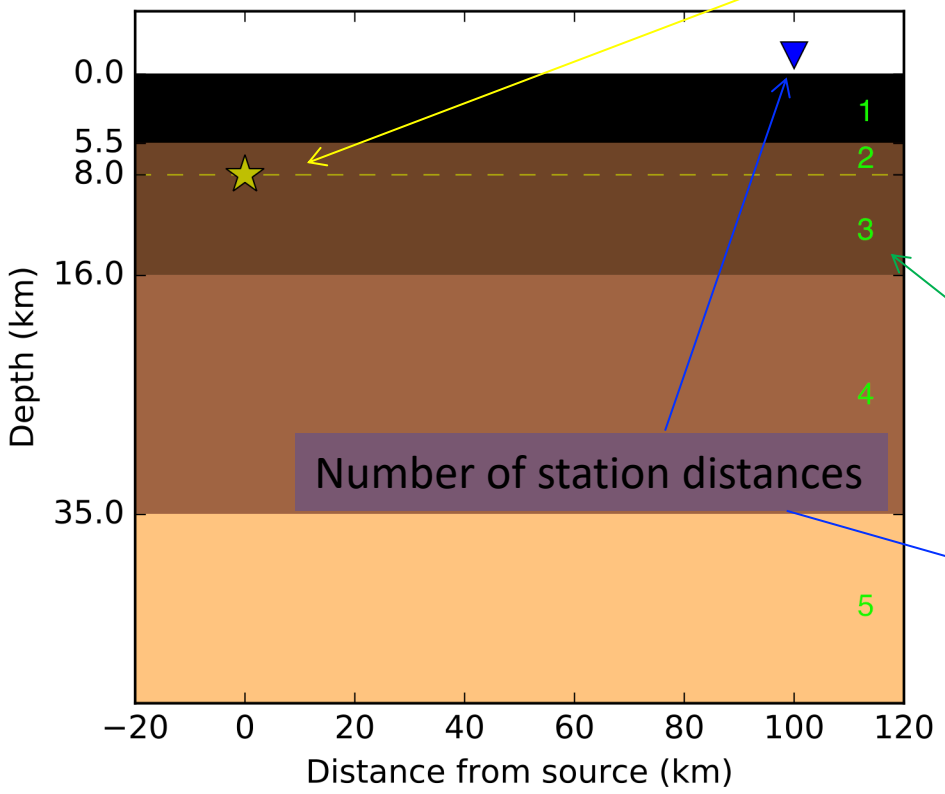
Find (M_{ij}) that maximize

$$VarRed = \left(1 - \sum_n \frac{\sqrt{(data_n - synth_n)^2}}{\sqrt{data_n^2}}\right) * 100$$

EXAMPLE – Earth model (MODEL.socal)

Earthquake depth

Layer number beneath the source



/home/seis/thanhson/Workspaces/PHYS3070/TDMT_release/EXAMPLE/MODEL.socal (mo...

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MODEL_d17.socal | MODEL_d20.socal | plot_VR_by_depth | MODEL.socal*

A "fake" layer at the source depth

```
.F.
    0   64
GREEN.X
    6.0       8.00          X  512 1024     0.500      5    Y
    1    1    1    1    1    1    1    1    1    1    0
 0.5500E+01 0.5500E+01 0.3180E+01 0.2400E+01    600.00     300.00
 0.2500E+01 0.6300E+01 0.3640E+01 0.2670E+01    600.00     300.00
 0.8000E+01 0.6300E+01 0.3640E+01 0.2670E+01    600.00     300.00
 0.1900E+02 0.6700E+01 0.3870E+01 0.2800E+01    600.00     300.00
 0.4000E+03 0.7800E+01 0.4500E+01 0.3300E+01    600.00     300.00
   3
  0.4000000E+03  1.500000E+00          0
    1  10000.0      30.0       2.9        2.5
  100.00       0.0       10.0
```

Ln 15, Col 1 INS

```
# edit model file
cd EXAMPLE/
gedit MODEL.socal & # then you can edit the model
```

EXAMPLE:
commands to generate Green's function

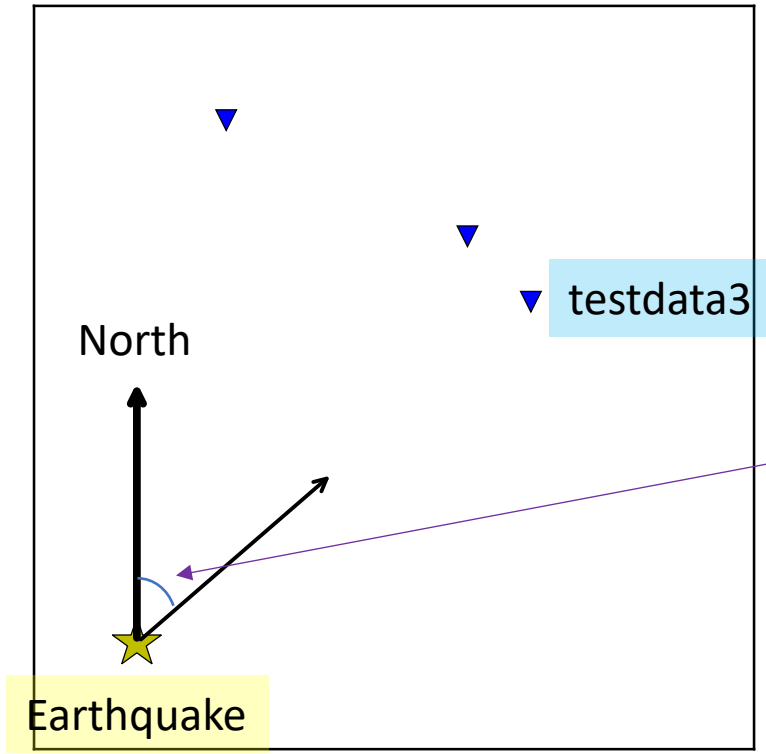
```
# generate Green's functions
cp MODEL.socal MODEL_d8.socal
gedit MODEL_d8.socal &
./run_parallel 1 MODEL_d8.socal

# convert Green's functions to usable ASCII
format
./run_fkrsort socal 100 8 1

# filter Green's functions
./run_filter socal100d8.disp socal100d8 0.02
0.10
# or
./run_filter_for_many_files socal 8 0.02 0.10
```

Preparing Green's functions

EXAMPLE – station configuration (mt_inv.in)



Number of stations

Data

/home/seis/thanhson/Workspaces/PHYS3070/TDMT_release/EXAMPLE/mt_inv.in

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MODEL_d20.socal | plot_VR_by_depth | MODEL.socal* | mt

```
3  8 1 1
testdata1 100.  10.  0 120
testdata2 100.  40.  0 120
testdata3 100.  50.  0 120
socal100d8 0 120
socal100d8 0 120
socal100d8 0 120
```

Azimuth (deg)

Distance (km)

Source depth (km)

Ln 7, Col 11

```
# the same, you can edit the station file
gedit mt_inv.in & # then you can edit the model
```

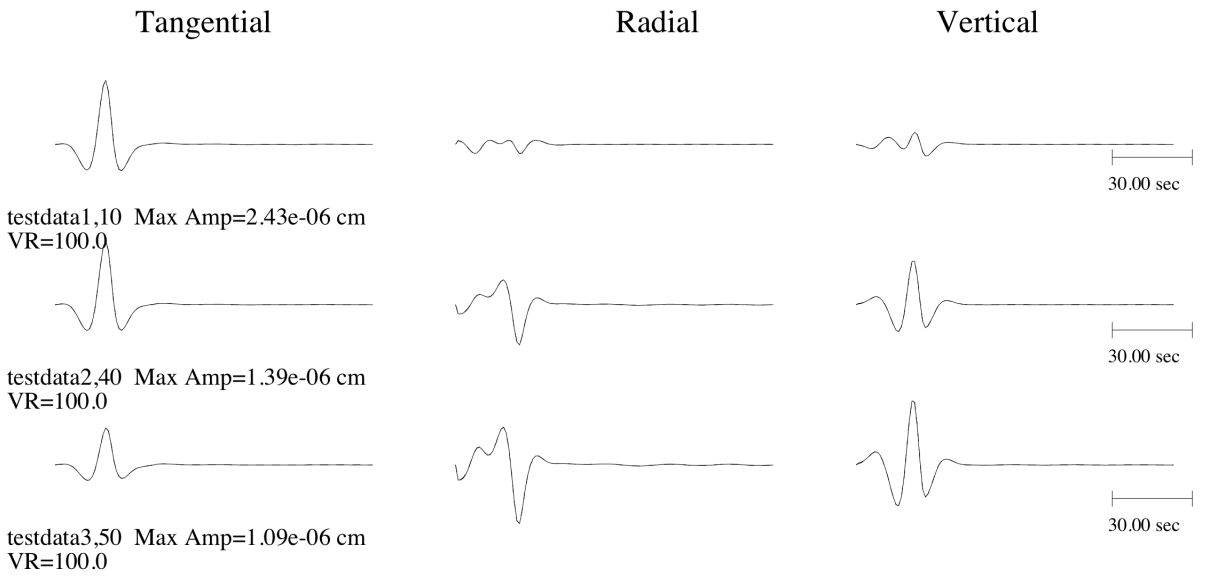
EXAMPLE:
commands to do inversions

```
# run MT inversion
gedit mt_inv.in &
./run_inversion

# view MT solution
gv mt_plot_d8.ps
# or
gs mt_plot_d8.ps
```

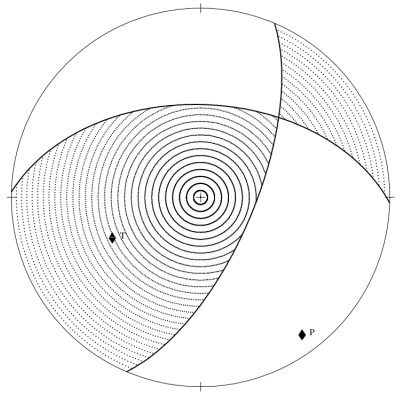
MT Inversion

View results

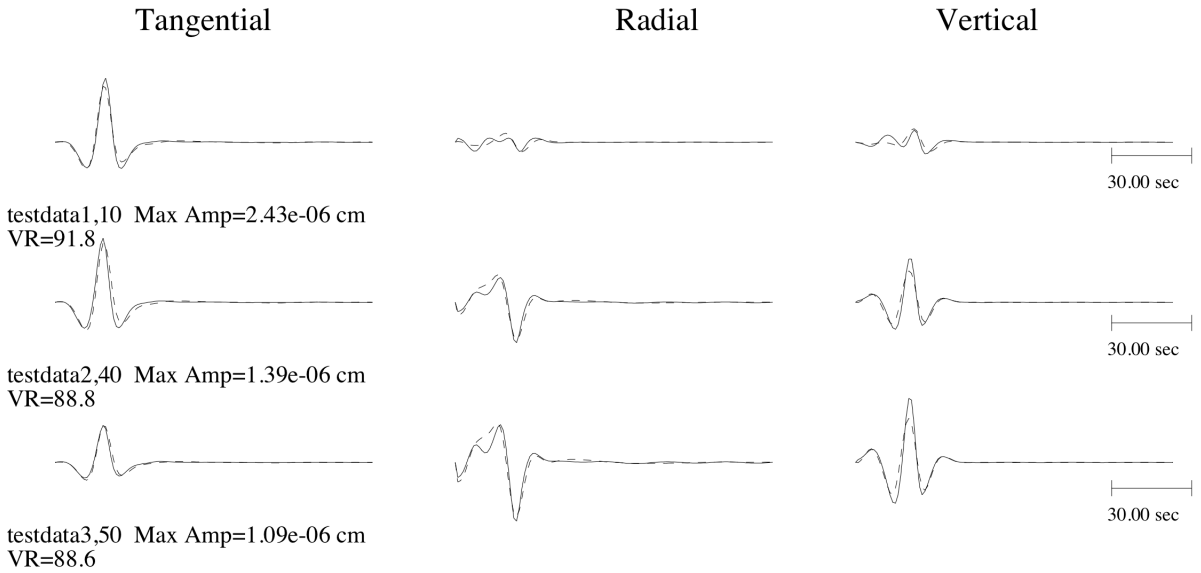
EXAMPLE - solution for depth = 8 km



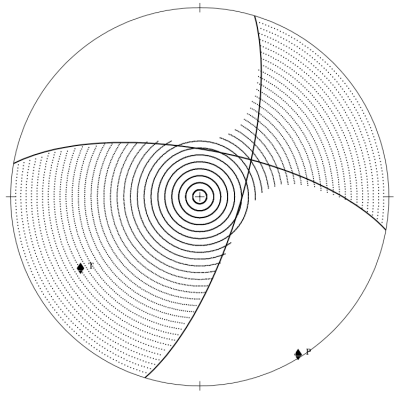
Strike=23 ; 272
Rake =45 ; 149
Dip =67 ; 49
Mo =1.00e+20
Mw =2.6
Percent DC=100
Percent CLVD=0
Percent ISO=0
Variance=2.90e-18
Var. Red=1.00e+02
RES/Pdc.=2.90e-20



EXAMPLE - solution for depth = 20 km



Strike=17 ; 280
Rake =21 ; 161
Dip =72 ; 70
Mo =1.01e+20
Mw =2.6
Percent DC=87
Percent CLVD=13
Percent ISO=0
Variance=5.47e-15
Var. Red=9.02e+01
RES/Pdc.=6.27e-17



PROBLEM – prepare data

```
cd PROBLEM/DATA_SUN
$REDI_MT_BINDIR/tdmt_redi_prepdata 19980812141000 BKS 1998
224 36.755 -121.464 0.02 0.05
# Repeat the command for other stations, e.g., PKD, KCC, CMB
# Please record the azimuths and distances of the stations
cp *.data ../
cd ../
```

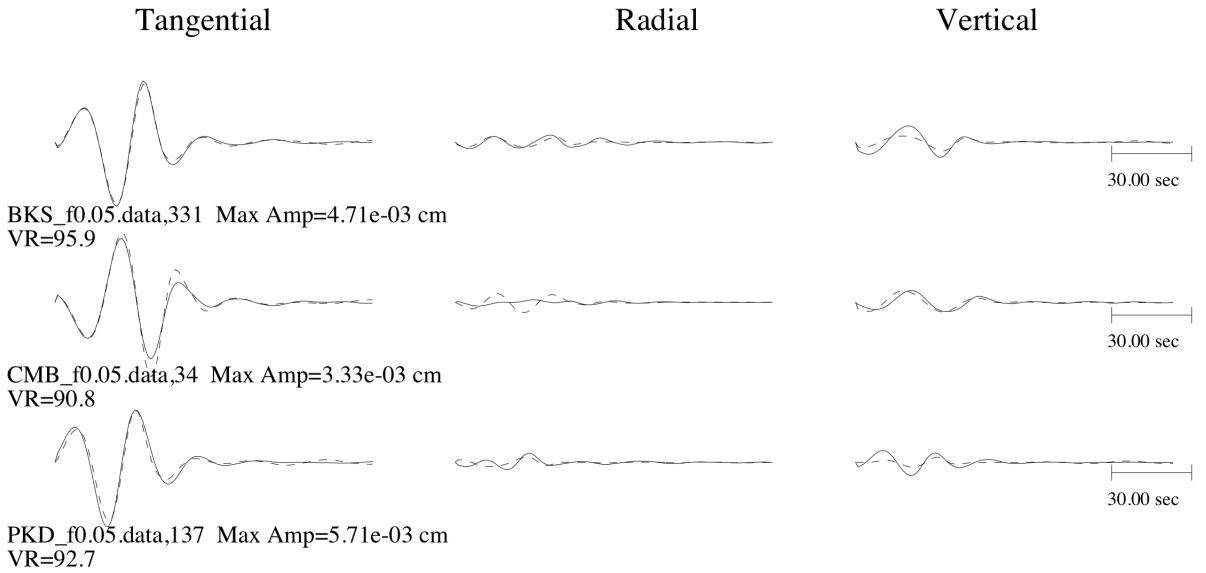
PROBLEM commands

```
# generate Green's functions
cp MODEL.gil7 MODEL_d8.gil7
gedit MODEL_d8.gil7 &
./run_parallel 1 MODEL_d8.gil7

# convert Green's functions to usable ASCII
format
./run_fkrsort gil7_ 125 8 16

# filter Green's functions
./run_filter gil7_125d8.disp gil7_125d8 0.02
0.05
or
./run_filter_for_many_files gil7_ 8 0.02
0.05

# run MT inversion
gedit mt_inv.in &
./run_inversion

# view MT solution
gv mt_plot_d8.ps
# or
gs mt_plot_d8.ps
```

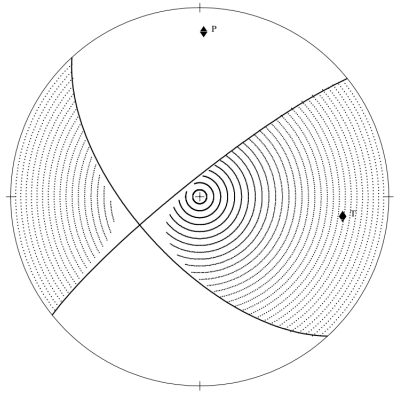
Preparing Green's functions

MT Inversion

PROBLEM - solution for depth = 8 km



Strike=231 ; 137
Rake =28 ; 172
Dip =83 ; 62
Mo =5.38e+23
Mw =5.1
Percent DC=92
Percent CLVD=8
Percent ISO=0
Variance=5.54e-08
Var. Red=9.34e+01
RES/Pdc.=6.03e-10



Hints to organize files - AFTER TASK 1

Modify the file VR_by_depth.dat and run the script plot_VR_by_depth to generate the figure as required to submit.

Create a directory for TASK 1

mkdir TASK1

#Move all files recently created for this task to the directory, e.g. *d8*, and repeat for other depths

mv *d8* TASK1

mv *d11* TASK1

Hint to organize files – PREPARE FOR TASK 2

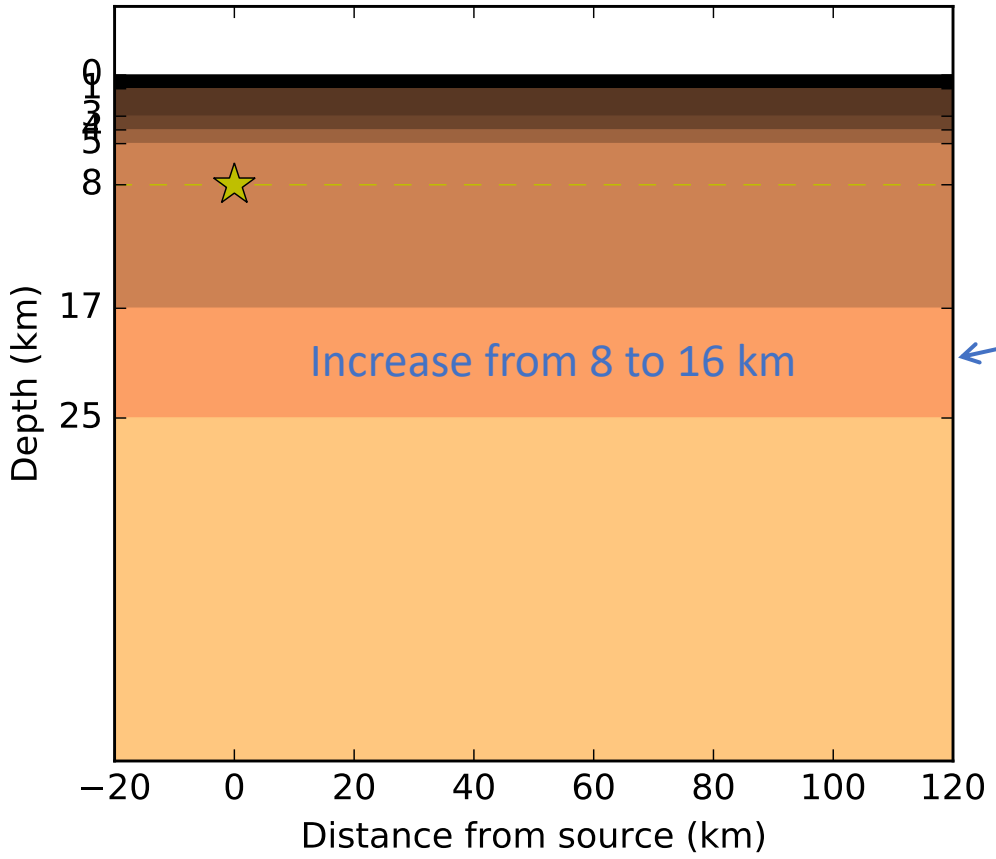
In order to prepare for TASK 2, you will need the Green's functions of the depth that gave the best VarRed from task 1. For example, if the depth you found is 14 km, copy the generated functions back to the working directory

```
cp TASK1/gil7_*d14 . #
```

#After this task, create a directory TASK2 and move all files used in this task to that directory

```
mkdir TASK2
mv *d14* TASK2
```

Hint for TASK 3



Layer 6

/home/seis/thanhson/Workspaces/PHYS3070/TDMT_release/PROBLEM/MODEL_d8.gil7 - gedit

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MODEL_d8.gil7

```
.F.
    0   64
GREEN.X
    6.0      8.00       X  512 1024    0.500     8    Y
    1    1    1    1    1    1    1    1    1    1    0
 0.1000E+01 0.3200E+01 0.1500E+01 0.2280E+01   600.00    300.00
 0.2000E+01 0.4500E+01 0.2400E+01 0.2280E+01   600.00    300.00
 0.1000E+01 0.4800E+01 0.2780E+01 0.2580E+01   600.00    300.00
 0.1000E+01 0.5510E+01 0.3180E+01 0.2580E+01   600.00    300.00
 0.0300E+02 0.6210E+01 0.3400E+01 0.2680E+01   600.00    300.00
 0.0900E+02 0.6210E+01 0.3400E+01 0.2680E+01   600.00    300.00
 0.8000E+01 0.6890E+01 0.3980E+01 0.3000E+01   600.00    300.00
 0.6000E+02 0.7830E+01 0.4520E+01 0.3260E+01   600.00    300.00
   6
  0.4000000E+03  1.500000E+00         0
   16  10000.0     30.0      1.2       1.0
  125.00      0.0       8.0
  130.00      0.0       8.0
  135.00      0.0       8.0
  140.00      0.0       8.0
  145.00      0.0       8.0
  150.00      0.0       8.0
  155.00      0.0       8.0
  160.00      0.0       8.0
  165.00      0.0       8.0
  170.00      0.0       8.0
  175.00      0.0       8.0
```

Ln 1, Col 1 INS