Source mechanism solution

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1. A general introduction

The generalize cut and paste method (gCAP) (Zhu and Ben-Zion, 2013) for the full moment tensor inversion has been integrated in GeoTaos and GeoTaos_map. This manual provides a step-by-step guide for estimating moment tensor and source mechanism solutions using the gCAP method.

The gCAP method gives reasonable result for earthquakes of medium size with a magnitude from ~3 to ~6.

2. A step-by-step guide

Step-1: Prepare data files

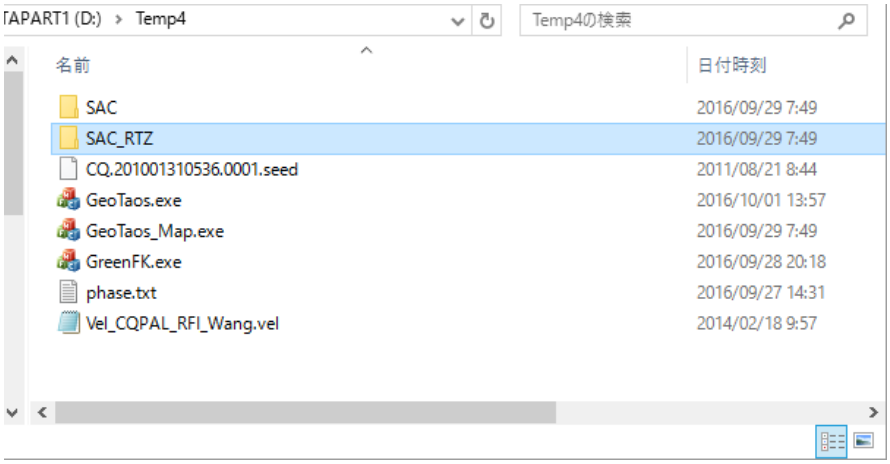
Data file required for CAP are:

1) A seed file of all available wide band seismograms
2) An ASCII text file containing basic information of the target earthquake and P and S arrive times (if they are available).
3) A ASCII text file of 1D velocity model.

The seed file (???.seed) and the phase data file (for example, phase.txt) should be placed in a working folder such as "CAP_Sample".

It is better to put the velocity model file in separated fold such as "Vel_Models". It is convenient to name your velocity file with local or regional place name such as "Vel_Sichuan.vel". The title of the file would be used for sub folders for saving Green function of the model.

It is better to create two empty sub folders "SAC" and "SAC_RZT" under the working folder for later use. In the following example, the 1D velocity model is placed in the same working folder for demo convennice.



File: Phase.txt

```
time_zone=8.0
2010 01 31 05 36 57.40 30.28  105.71  5  4.8
```

File: Vel_CQPAL_RFI_Wang.vel

```
! 1D model of PAL from RFI by Wang et al., 2102
! H      Vp       Vs       Density  Qp       Qs
layers=21, format=2 (thickness of each layer is given)
 1.0000    3.9800    2.3000    2.4300  847  600  0.00      0.00      1.00      1.00
 1.0000    5.2000    3.0000    2.5000  847  600  0.00      0.00      1.00      1.00
 1.0000    5.4000    3.1200    2.6000  847  600  0.00      0.00      1.00      1.00
 1.0000    5.7445    3.2039    2.6489  847  600  0.00      0.00      1.00      1.00
 2.0000    5.9370    3.3116    2.6864  847  600  0.00      0.00      1.00      1.00
 2.0000    6.7431    3.7611    2.9132  847  600  0.00      0.00      1.00      1.00
.....
 5.0000    7.8836    4.4050    3.2750  847  600  0.00      0.00      1.00      1.00
10.0000    7.8227    4.3688    3.2549  847  600  0.00      0.00      1.00      1.00
10.0000    7.8672    4.3978    3.2681  847  600  0.00      0.00      1.00      1.00
 0.0000    7.4391    4.1524    3.1263  116   76  0.00      0.00      1.00      1.00
```

Step-2: Start GeoTaos or GeoTaos_Map

Start GeoTaos or GeoTaos_Map.

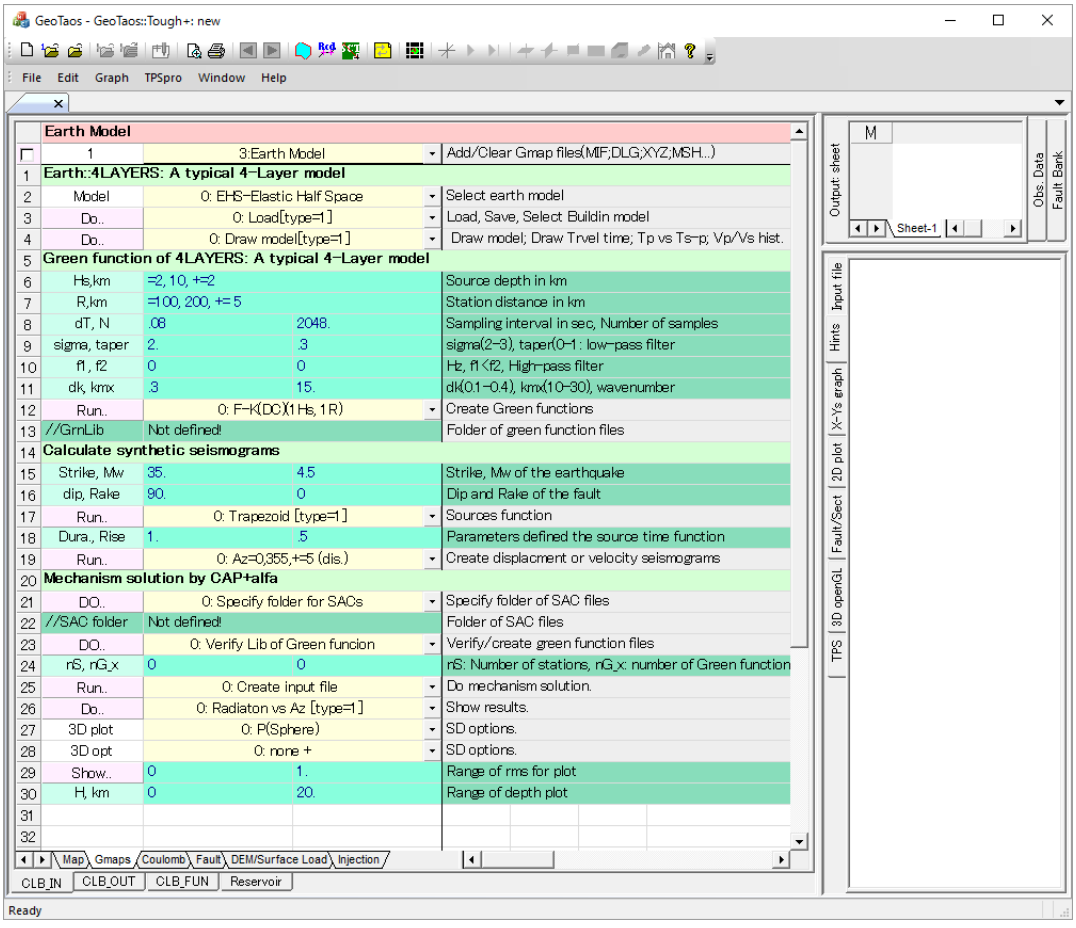
In the case of GeoTaos

Click [File]->[New]

Highlight "Coulomb stress"

Click <OK>

Tag to "Gmaps" working sheets, sellect "3: Earth Model" in row-0. All works could be carried out in following work sheet.



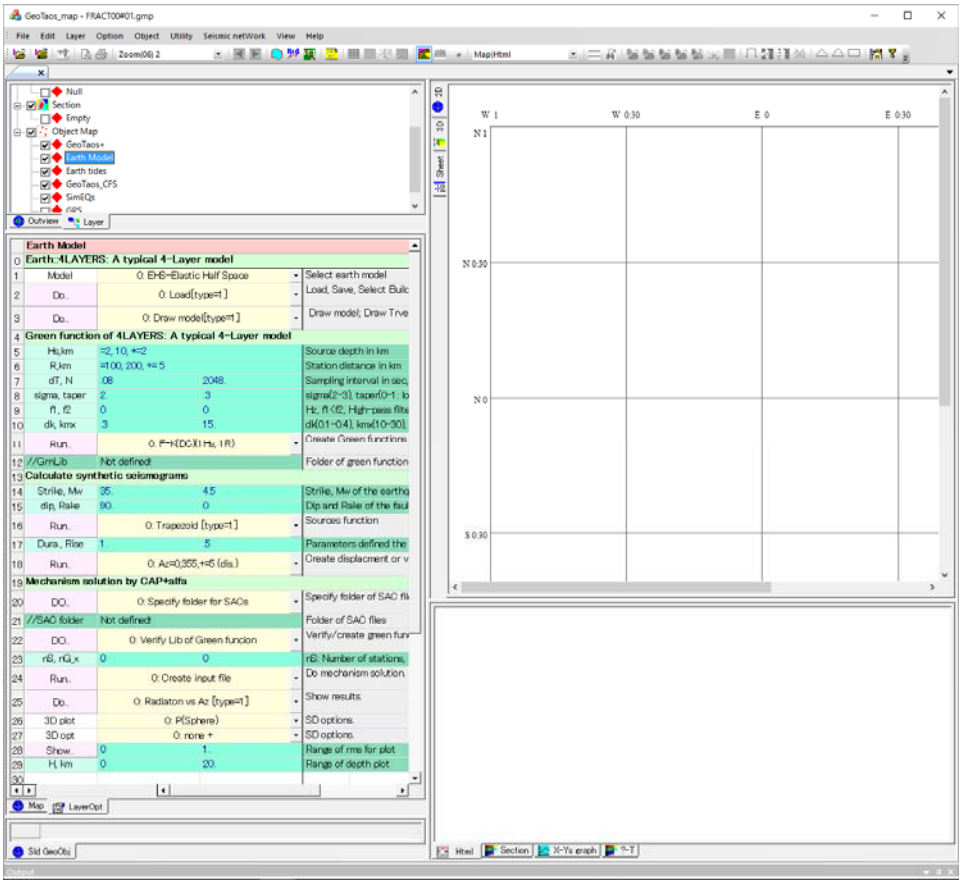
"Earth model" working sheet in GeoTaos.

You can also use GeoTaos_map

In the case of GeoTaos_Map

Click [File]->[Empty World]

Tag to "Layer", Highlight "Earth Model"

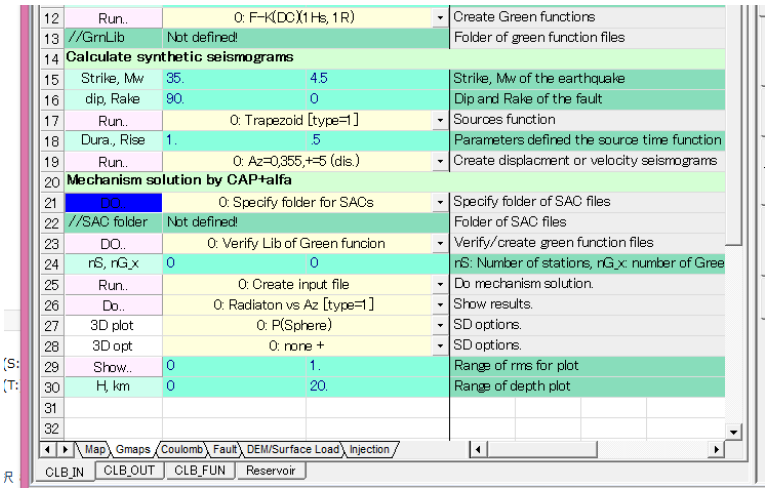


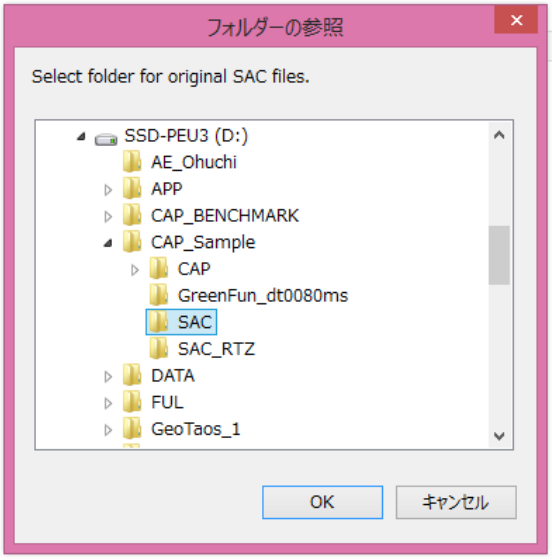
"Earth model" layer in GeoTaos_Map.

You will find the working sheet in GeoTaos and GeoTaos_Map are uniform.

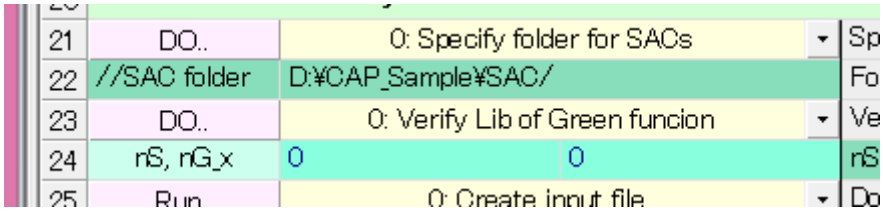
Step-3: Convert seed file to SAC files

3-1 Specify SAC folder

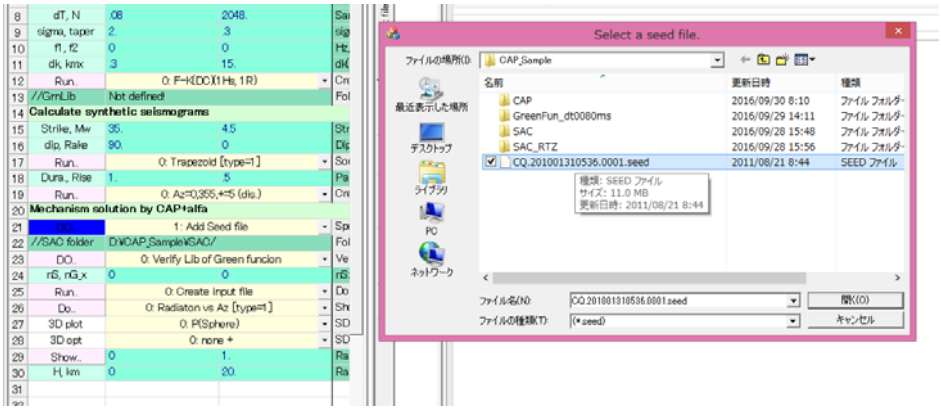




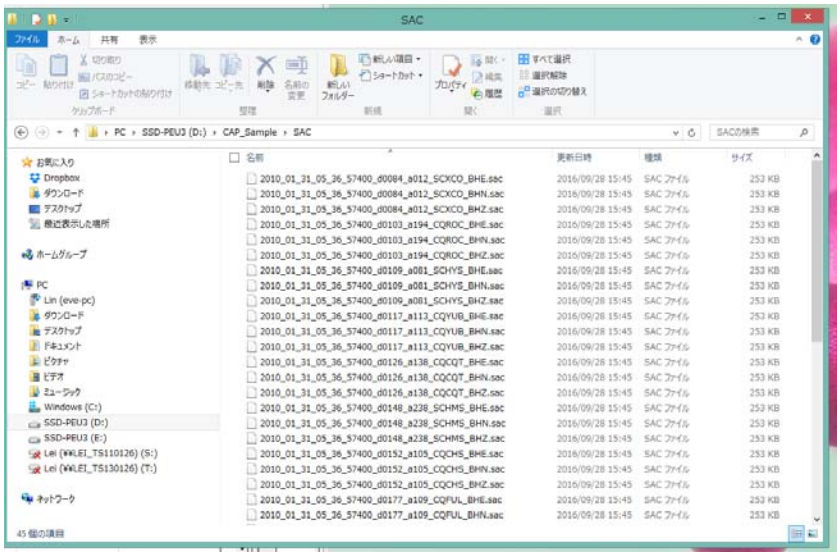
Be sure row-22 shows the full path name of the folder you specified.



Add the seed file

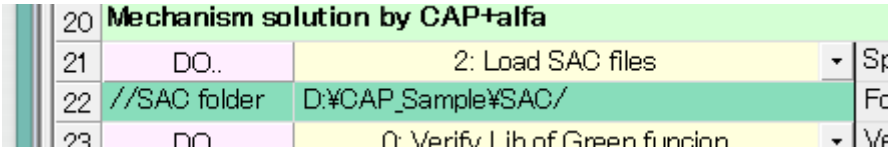


You can explore the SAC folder to check the SAC files created.



Step-4: Rotate, resample, and save the rescaled seismograms to a new folder

4-1 Load SAC files. Select 2: Load SAC files and click <DO..> in row-21.

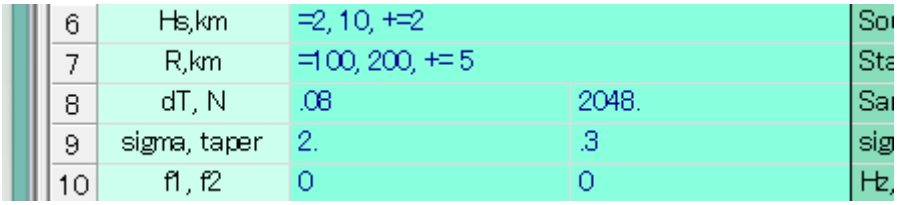


4-2 Rote NEZ record to RTZ record.

"Select 4: Rotate NE to RT" and click <DO..> in row-21.

4-3 Resampling

Check the sampling interval is that you want in row-8. The default is 0.08 second.

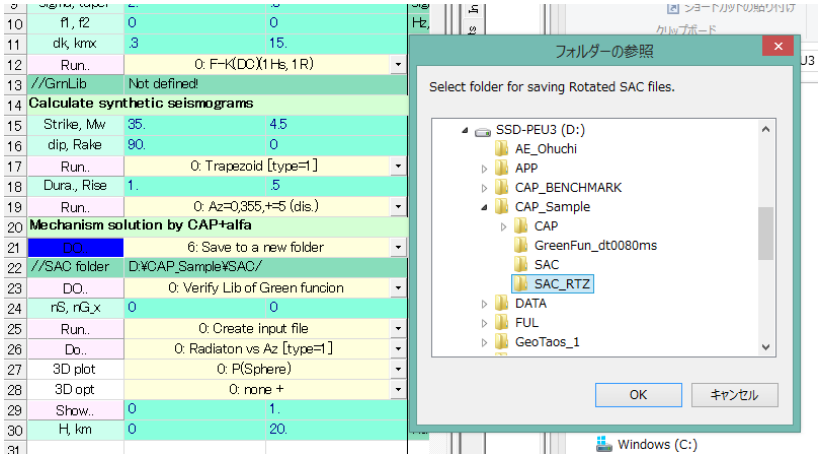


6	Hs,km	=2, 10, +=2		So
7	R,km	=100, 200, += 5		Sta
8	dT, N	.08	2048.	Sa
9	sigma, taper	2.	.3	sig
10	f1, f2	0	0	Hz,

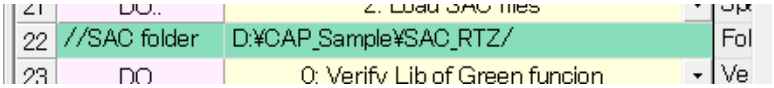
Select “5: Resampling” and click <DO..> in row-21

4-4 Save SAC files, which are ready for CAP inversion, to a new folder.

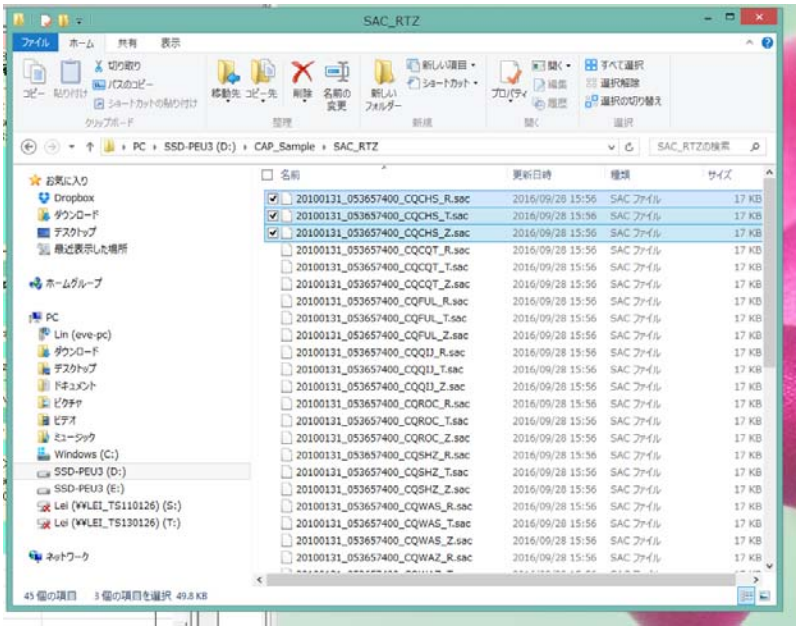
Select “6: Save to a new folder”, and then click <DO..> in row-21.



Be sure the SAC folder in row-22 has changed to the new one.



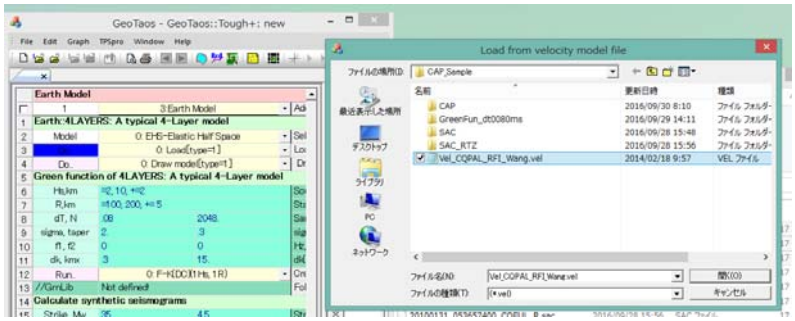
You can explore the SAC_RTZ folder to check the rotated and rescaled SAC files.



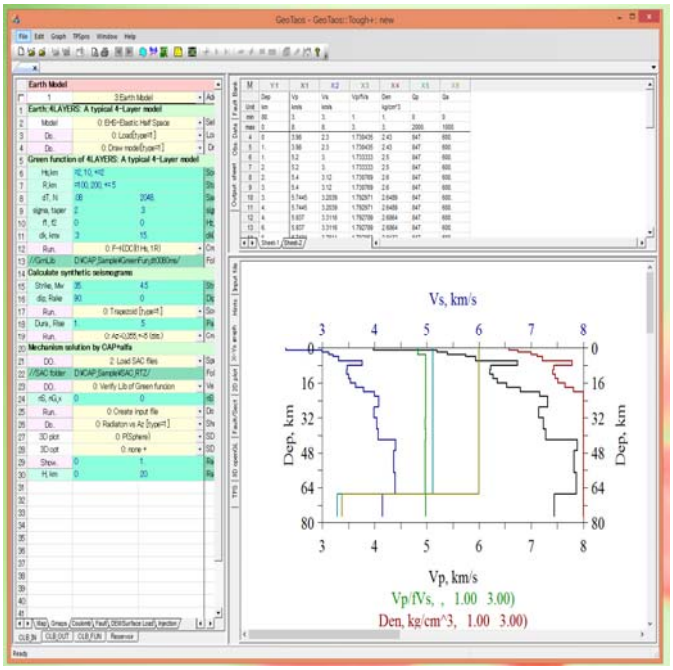
Update: 10/2/2016

Step-4: Specify the 1D velocity model, determine depth range and other parameters

Select “0: Load” and then click <Do..> in row-3. Specify the velocity file in the file dialogue box appeared.



You will see a profile plot showing Vs, Vp, and other data against depth.



Step-5: Load and show the rescaled seismograms

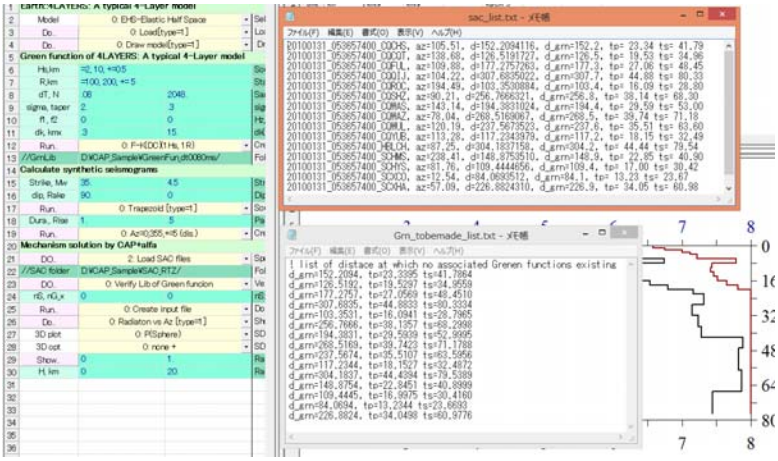
If you use GeoTaos_Map, you can load the new rotated and resampled SAC files and show waveforms.

Step-6: Verify green functions

In row-6, type a range of focal depth. Say, “=2, 10, +=0.5”, means 2, 2.5, 3.5,..10 km.

Select “0: Verify Lib of Green function” and click <DO..> in row-23.

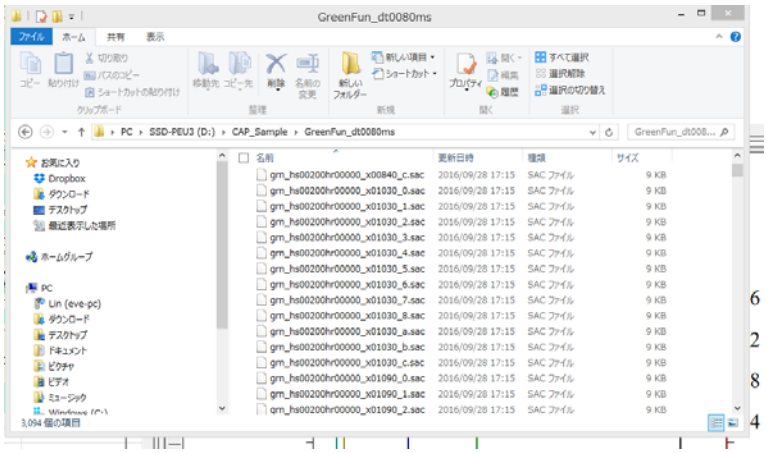
Two text files will be created. One is “sac_list.txt” containing a list of stations with some information. Another is “Grn_tobemade_list.txt” containing a list of distance for which new Green function should be made.



Step-8: Make/add green functions

Select “3: Add grnfuns (DC & ISO)” and click <DO..> in row-23.

A number of “Green_FK” will be started automatically. The number is equal to the number of focal depth been specified in row-6. For example, “2, 10, +=0.5” corresponds to 17 depths. It may take tens of minutes to tens of hours to complete all calculation. Then you can see several thousand sac files in the sub folder “GreenFun_dt0080ms”, here 80ms is the sampling interval given in row-8. Keep in mind the resampled seismograms have the same sampling interval.



If you verify green function again, you will see an empty list in “Grn_tobemade_list.txt”.

So far, it is ready to carry out CAP inversion.

Step-9: Carry out CAP inversion for a single depth or a range of depth

With following to steps, you can make CAP inversion for the first depth specified in row-6.

Select “0: Create input file” and click <OK> in row-25.

Select “1: CAP (grid search)” and click <OK> in row-25.

Step-10: Plot CAP results for a single depth or a range of depth

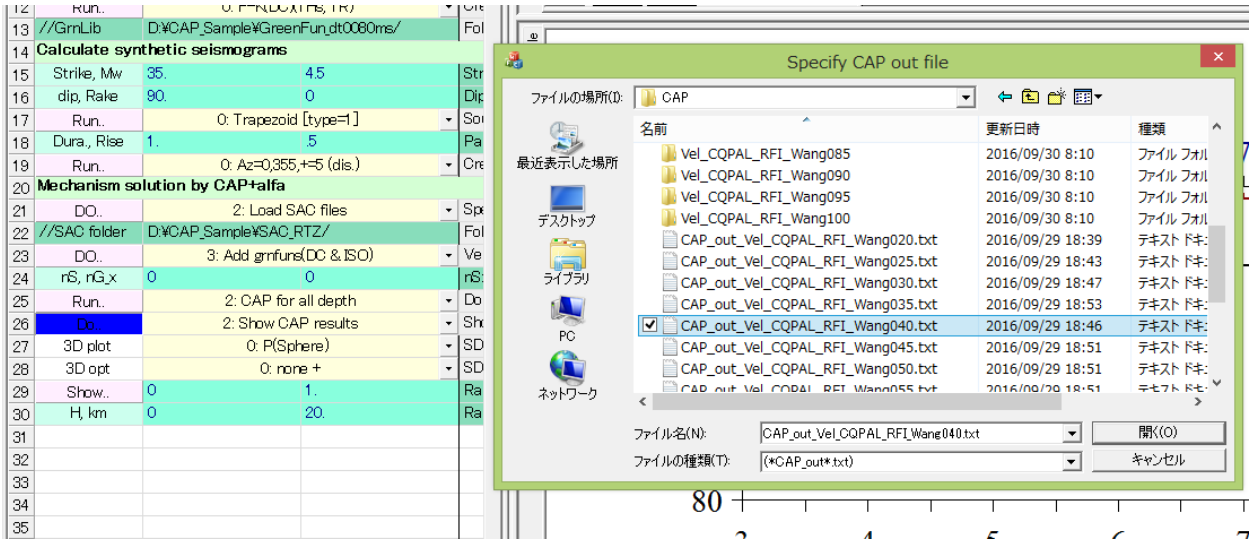
Select “2: CAP for all depth” and click <OK> in row-25.

A number of “Green_FK” will be started automatically. This time, the Green_FK will complete CAP inversion. It may take tens of minutes to a few hours.

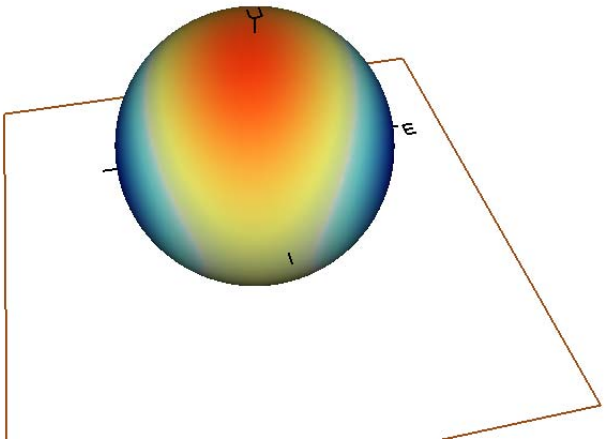
When the inversion for all depth is finished. Explore the “CAP” sub folder. You will see a lot of files and sub folders.

Step-11: Show CAP results

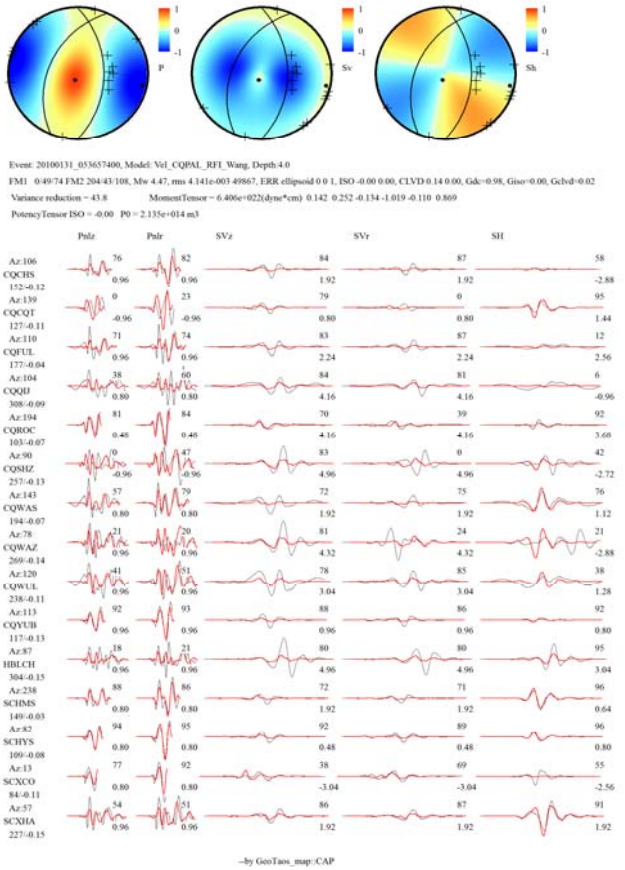
Select “2: Show CAP results” and click <OK> in row-26. Specify and “CAP_out_???.txt” of the depth you chosed.



You will see a 3D radiation ball in the 3D openGL view.

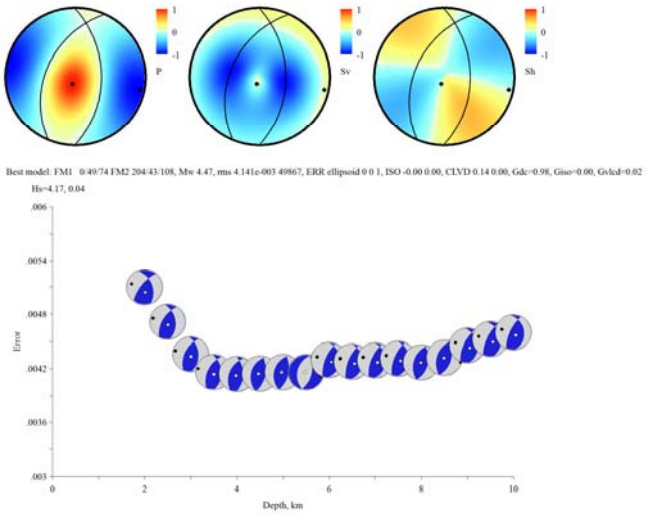


And CAP results in the “X-Ys graph” view.



Select “3: Show CAP results (Missfit vs Hs)” and click <OK> in row-26. Specify any “CAP_out_???.txt”.

You may need to change ranges for rms and depth in row-29 and row 30 to get a well arranged plot.



A. 地知道点滴

对于4级以上地震，用0.16秒的采样频率就足够了，这样连格林函数计算一起也用不了半个小时就可获得结果！

磨溪地震，发现存在两个极值中心，残差几乎一样，一为正断层，一为逆断层，这种条件下只能根据构造约束取逆断层了。

P波初动是强力约束，对明确的初动方向应该尽量利用。由于波的周期性，位错180度时仍然有较高的相关系数，但这时极性相反。当几个震相的振幅不能相互制约时，很有可能在+-Rake处出现两个极值，这时有一个P波初动方向便可约束解的不确定空间了。