

How to use Fite2dmt.jl

by Dieno Diba

How to import Fite2dmt.jl package

In the Julia REPL, run the following commands:

```
using Pkg
```

```
Pkg.add(url="https://github.com/dienodiba/Fite2dmt.jl")
```

How to run Fite2dmt.jl (1/2)

- For inversion of apparent resistivity and phase, run the following commands in the Julia REPL:

```
using Fite2dmt
```

```
InversionRhoaPhase("[FILE01]", "[FILE02]", "[FILE03]", "[FILE04]")
```

- For inversion of tipper, run the following commands in the Julia REPL:

```
using Fite2dmt
```

```
InversionTipper("[FILE01]", "[FILE02]", "[FILE03]", "[FILE04]")
```

- For joint inversion of apparent resistivity, phase, and tipper, run the following commands in the Julia REPL:

```
using Fite2dmt
```

```
InversionRhoaPhaseTipper("[FILE01]", "[FILE02]", "[FILE03]", "[FILE04]")
```

How to run Fite2dmt.jl (2/2)

- FILE01 is the name of the file containing the observation data
- FILE02 is the name of the file containing the initial model
- FILE03 is the name of the file containing the topography information
- FILE04 is the name of the file containing the setting parameters

Input files of inversion

You need to have four input files:

1. Observation data
2. Initial model
3. Topography
4. Setting parameters of the inversion

The name and extension of the input files can be chosen freely

Format of the observation data file (1/4)

Inversion of apparent resistivity and phase

Number of stations

Number of periods

repeat from the first station to the last

Y coordinate value of the station (km)

Z coordinate value of the station (km)

repeat from the first period to the last

period (s)

ρ_a -TE (Ωm)

$\delta\rho_a$ -TE (Ωm)

ϕ -TE (degree)

$\delta\phi$ -TE (degree)

ρ_a -TM (Ωm)

$\delta\rho_a$ -TM (Ωm)

ϕ -TM (degree)

$\delta\phi$ -TM (degree)

Format of the observation data file (2/4)

Inversion of tipper

Number of stations

Number of periods

repeat from the first station to the last

Y coordinate value of the station (km)

Z coordinate value of the station (km)

repeat from the first period to the last

period (s)

Re(Tzy)

δ Re(Tzy)

Im(Tzy)

δ Im(Tzy)

Format of the observation data file (3/4)

Inversion of apparent resistivity, phase, and tipper

Number of stations

Number of periods

repeat from the first station to the last

Y coordinate value of the station (km)

Z coordinate value of the station (km)

repeat from the first period to the last

period (s)

$\rho_a\text{-TE } (\Omega m)$

$\delta\rho_a\text{-TE } (\Omega m)$

$\phi\text{-TE } (degree)$

$\delta\phi\text{-TE } (degree)$

$\rho_a\text{-TM } (\Omega m)$

$\delta\rho_a\text{-TM } (\Omega m)$

$\phi\text{-TM } (degree)$

$\delta\phi\text{-TM } (degree)$

$Re(Tzy)$

$\delta Re(Tzy)$

$Im(Tzy)$

$\delta Im(Tzy)$

Format of the observation data file (4/4)

Precautions:

- All the stations must have same periods dan data components. Having different periods or data components for different stations is not allowed.
- Z coordinate is positive downward. Station located at a negative Z coordinate means that it is above sea level (e.g., on a hill).
- The flag for missing data is 99999 by default.

-20.872560												
-1.158140												
0.0152	1425.8510	142.5851	54.6254	2.8660	1373.1430	137.3143	-146.6127	2.8660	0.0816	0.0500	0.1396	0.0500
0.0250	1181.0870	118.1087	60.3410	2.8660	1481.5800	148.1580	-145.7744	2.8660	0.0061	0.0500	0.1728	0.0500
0.0444	887.7673	88.7767	63.7729	2.8660	1674.4860	167.4486	-146.4617	2.8660	-0.0904	0.0500	0.1688	0.0500
0.0730	714.3665	71.4367	64.6526	2.8660	2033.7290	203.3729	-147.1520	2.8660	-0.1527	0.0500	0.1479	0.0500
0.1235	528.1189	52.8119	63.2765	2.8660	2251.1400	225.1140	-148.1308	2.8660	-0.2068	0.0500	0.1180	0.0500
0.2128	370.2458	37.0246	59.5153	2.8660	2561.2130	256.1213	-151.2938	2.8660	-0.2131	0.0500	0.0884	0.0500
0.3559	259.4693	25.9469	54.7791	2.8660	3191.1750	319.1175	-153.5832	2.8660	-0.1910	0.0500	0.0424	0.0500
0.5814	268.4538	26.8454	50.9491	2.8660	4292.6180	429.2618	-154.7642	2.8660	-0.2447	0.0500	0.0242	0.0500
0.9804	251.5856	25.1586	50.0634	2.8660	5869.0760	586.9076	-152.5316	2.8660	-0.2103	0.0500	-0.0210	0.0500
1.6949	139.8016	13.9802	53.8208	2.8660	6838.5460	683.8546	-149.5833	2.8660	-0.1824	0.0500	0.0210	0.0500
2.8571	65.8733	6.5873	60.6989	2.8660	7196.4700	719.6470	-145.7360	2.8660	-0.0342	0.0500	-0.0814	0.0500
4.6512	32.7247	3.2725	62.2160	2.8660	7252.7450	725.2745	-143.0754	2.8660	0.0135	0.0500	-0.0422	0.0500
7.8740	8.8926	0.8893	62.1123	2.8660	7317.1790	731.7179	-142.0588	2.8660	0.0071	0.0544	-0.0253	0.0544
13.6986	18.0493	1.8049	56.0425	2.8660	6341.5100	634.1510	-144.8337	2.8660	1.1035	1.8549	-0.9194	1.8549
22.7273	0.0056	5.4726	80.3523	361.0127	99999.0000	99999.0000	99999.0000	99999.0000	0.1014	0.2440	-0.0902	0.2440
37.1747	99999.0000	99999.0000	99999.0000	99999.0000	10587.7300	1058.7730	-141.2596	2.8660	0.1746	0.0500	-0.1134	0.0500
62.8931	99999.0000	99999.0000	99999.0000	99999.0000	8620.6390	862.0639	-136.3408	2.8660	0.1443	0.9282	0.0080	0.9282
108.6957	99999.0000	99999.0000	99999.0000	99999.0000	13853.4700	1385.3470	-136.4102	2.8660	0.1460	0.6373	-0.1943	0.6373
-8.549770												

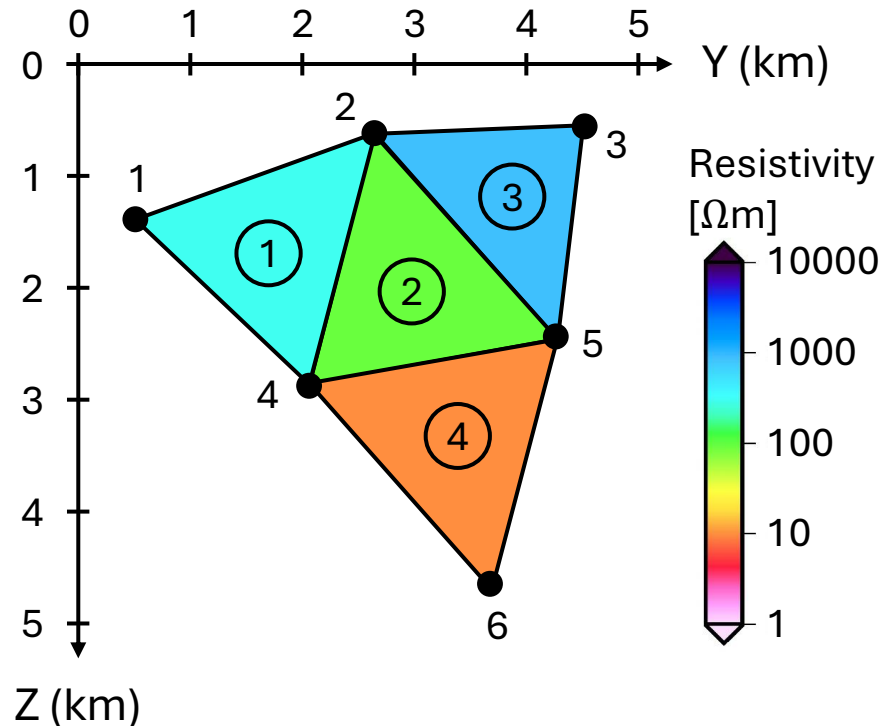
example of missing data

Format of the initial model file (1/2)

- A triangular element is built up of three nodes
- Construct the triangles by listing the nodes that are the vertices as EL2NO
- Store the coordinates of the nodes as NO2YZ

EXAMPLE OF A MESH

The node numbers are shown next to the corresponding nodes and the element numbers in the center of the corresponding triangles.



4 Example of the input
6 file for inversion
EL2NO
1 2 4
2 5 4
2 3 5
4 5 6
NO2YZ
0.5 1.4
2.7 0.7
4.5 0.6
2.1 2.9
4.3 2.4
3.7 4.7
RESISTIVITY
300
100
1000
10

Format of the initial model file (2/2)

Number of elements

Number of nodes

EL2NO

repeat from the first element to the last

*Index of the first node of
the element*

*Index of the second node
of the element*

*Index of the third node of
the element*

NO2YZ

repeat from the first node to the last

Y coordinate value of the node (km)

Z coordinate value of the node (km)

RESISTIVITY

repeat from the first element to the last

Resistivity value of the element (Ωm)

Format of the topography file

TOPO

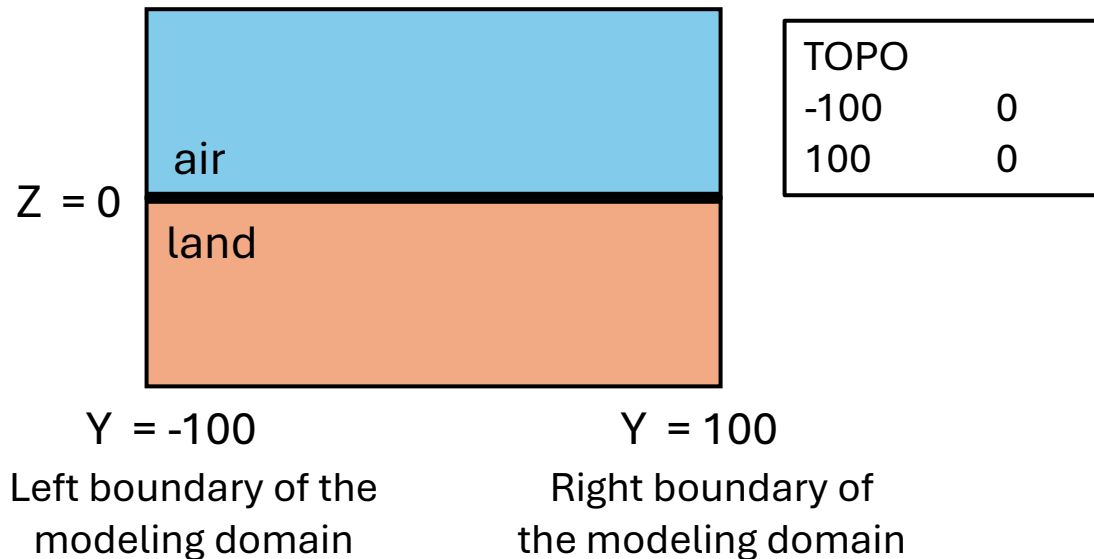
repeat from the first topography data to the last

Y coordinate value (km)

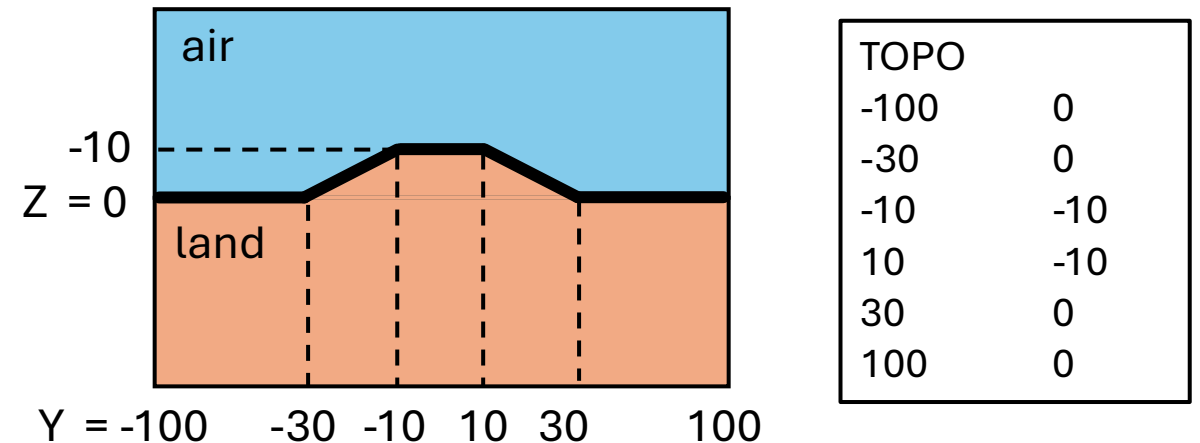
Z coordinate value (km)

Precautions: topography file must contain (at least) the data at the side boundaries (min(Y) and max(Y))

EXAMPLE 1: Flat model



EXAMPLE 2: Hill model



Format of the setting parameters file (1/3)

The file contains keywords along with their associated values

Keyword	Description	Condition and datatype	Default	Example
TRADEOFF	Trade-off parameter for balancing the data misfit and model roughness	Required Positive real value	None	TRADEOFF 10
MAXITER	Maximum iteration number	Required Positive integer	None	MAXITER 30
OUTFILE	Filename of output files	Required Any	None	OUTFILE Model01_out
FIXBLOCK	Elements with fixed resistivity value during the inversion. Resistivity of the air layer must be specified here.	Required First entry is the number of fixed resistivity values (integer) Second entry is the resistivity (positive real values, separated by space or tab)	None	FIXBLOCK 2 1E+10 500

Format of the setting parameters file (2/3)

Keyword	Description	Condition and datatype	Default	Example
DAMPING	Damping factor to control step size of Gauss-Newton model update	Optional Positive real value	0.05	DAMPING 0.1
STATIC	Cut the roughness penalty of elements just beneath the observation stations to accommodate static shift	Optional Yes 1 or No 0	0	STATIC 1
HOR2VER	Relative strength of roughness penalty between the horizontal and vertical directions. Setting it smaller (greater) than one implies higher (lower) penalty in the horizontal than the vertical direction	Optional Positive real value	1	HOR2VER 0.1

HOR2VER is η in the calculation of model roughness as follow:

$$\|R\mathbf{m}\|^2 = \sum_{i=1}^{N_m} \sum_{j=1}^{N_{nb}} \left(\frac{m_i - m_j}{\sqrt{\eta(y_i - y_j)^2 + (z_i - z_j)^2}} \right)^2$$

Format of the setting parameters file (3/3)

	Keyword	Description	Condition and datatype	Default	Example
Group 1	USE_RTE	Use TE mode apparent resistivity in the inversion	Optional Yes 1 or No 0	1	USE_RTE 0
	USE_PTE	Use TE mode phase in the inversion	Optional Yes 1 or No 0	1	USE_PTE 0
	USE_RTM	Use TM mode apparent resistivity in the inversion	Optional Yes 1 or No 0	1	USE_RTM 0
	USE_PTM	Use TM mode phase in the inversion	Optional Yes 1 or No 0	1	USE_PTM 0
Group 2	USE_TYR	Use real part of Tipper in the inversion	Optional Yes 1 or No 0	1	USE_TYR 0
	USE_TYI	Use imaginary part of Tipper in the inversion	Optional Yes 1 or No 0	1	USE_TYI 0

- These keywords allow you to mute one or more data components in the inversion
- Group 1 is applicable in apparent resistivity and phase inversion
- Group 2 is applicable in tipper inversion
- Both group 1 and 2 are applicable in apparent resistivity, phase, and tipper joint inversion

Output files

There are three output files from the inversion:

1. Logfile
2. Resistivity model
3. Data

Output file 1: logfile

- Filename: [*OUTFILE*].log.txt
- This file contains a detailed report of the inversion
- It includes the evolution of the objective function, data misfit, and model roughness
- It also includes the total runtime and the runtime per iteration

Output file 2: resistivity structure

- Filename: [*OUTFILE*].res.txt
- This file contains the final resistivity structure
- Its format is the same as that of the initial model input file

Output file 3: data

- Filename: [*OUTFILE*].cal.txt
- This file contains a side-by-side comparison between the input data and the model response calculated from the final resistivity structure