How to use Fite2dmt.jl

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How to import Fite2dmt.jl package

In the Julia REPL, run the following commands:

```
using Pkg
Pkg.add("Fite2dmt")
```

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) | $Re(Tzy)$ | $\delta Re(Tzy)$ | $Im(Tzy)$ | $\delta Im(Tzy)$

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)	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* ($degree$)
	$Re(Tzy)$	$\delta Re(Tzy)$	$Im(Tzy)$	$\delta Im(Tzy)$

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      0.0956      5.4726     89.3523    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
```

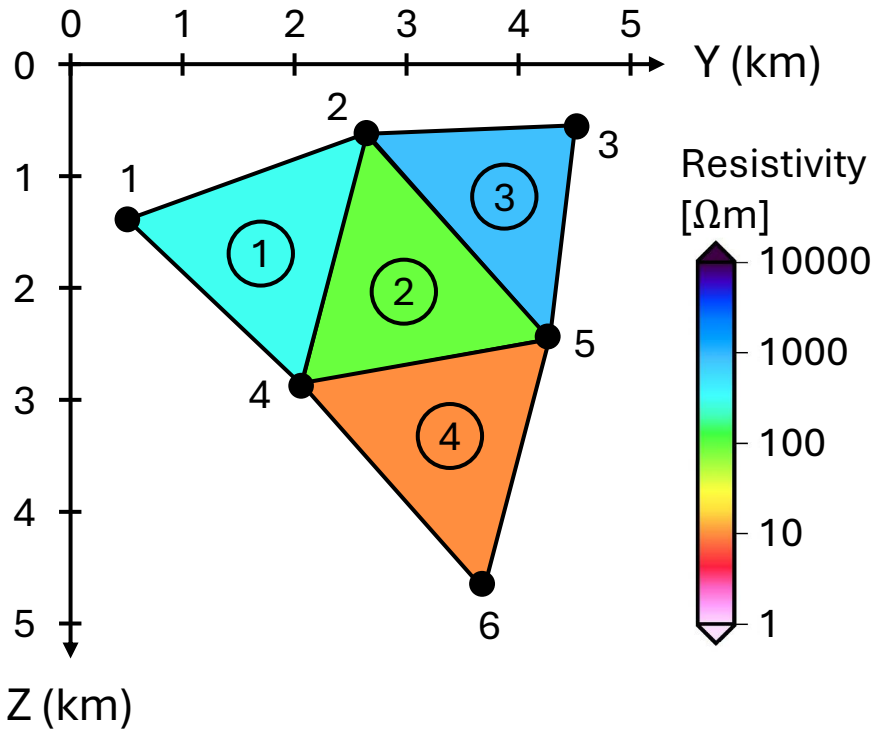
example of missing data

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.



Example of the input file for inversion

```
4
6
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)

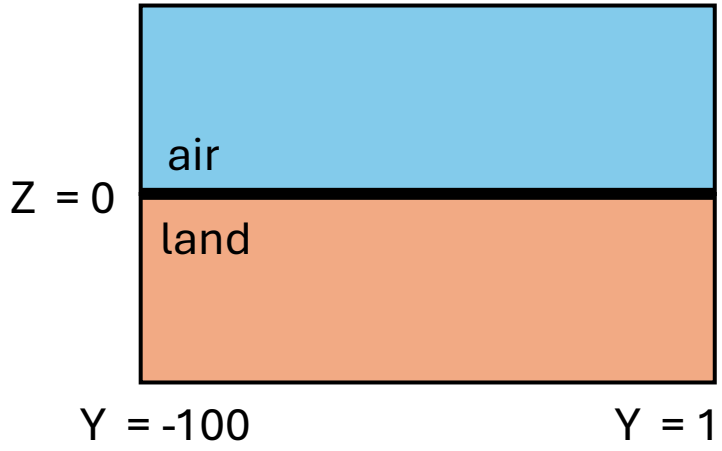
Format of the topography file

TOPO repeat from the first topography data to the last

Y coordinate value (km)	*Z coordinate value (km)*

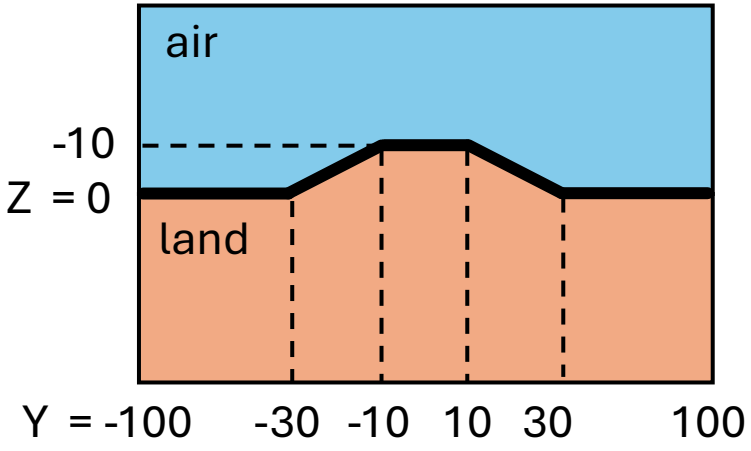
Precautions: topography file must contain (at least) the data at the side boundaries (min(Y) and max(Y))

EXAMPLE 1: Flat model




```
TOPO
-100    0
100     0
```

EXAMPLE 2: Hill model




```
TOPO
-100    0
-30     0
-10     -10
10      -10
30      0
100     0
```

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:

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

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