juliaMT3DAni File Format Instruction

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1 Input File Formats

There are two files required to run juliaMT3DAni, the model file and the data file. A right handed Cartesian coordinate system with with the z axis pointing down is used in all the input/output files.

1.1 Model file format

The model file describes the mesh geometry and model conductivity. Here is an example model file:

```
# Format:         Model3DAni
# Description:    The 1D anisotropic model used by Josef Pek (2002)
# ...
NX:     22
40000 ... 40000
NY:     40
40000 ... 40000
NAIR:    7
100 ... 100000
NZ:     95
500 ... 60000
Resistivity Type:  Conductivity
Model Type:        Linear
Sigma_X:
1.00000e-04 ... 1.00000e-02
Sigma_Y:
1.00000e-04 ... 1.00000e-02
Sigma_Z:
```

```
1.00000e-04 ... 1.00000e-02
Sigma_Strike:
0.00 ... 0.00
Sigma_Dip:
0.00 ... 0.00
Sigma_Slant:
0.00 ... 0.00
Origin (m):    120000.00    120000.00         0.00
```

At the beginning of file, the lines preceded with '#' and empty lines will be ignored by the code, so that one can put any comment about this file at the beginning. The remainder of the model file will be read in by the code, following is a brief description.

- **NX**, **NY**: number of cells in x- (North-South) and y- (East-West) directions, respectively, followed by the cell sizes (in meters) in corresponding directions. the order of the cell sizes is from south to north for x-direction and from west to east for y-direction.
- **NZ**: number of earth cells in z- (Bottom-Top) direction (not including the air cells), followed by the cell sizes (from top to bottom) in z-direction.
- **NAIR**: number of air cells in z-direction, followed by the cell sizes (from bottom to top) in z-direction. Note the order of the air cell sizes is different from that of the earth cell sizes.
- **Resistivity Type**: indicates the model parameters given in this file is '`Conductivity`' or '`Resistivity`'.
- **Model Type**: indicates the form of the parameters is '`Linear`' or '`Log`' (natural log).
- **Sigma_X**, **Sigma_Y**, **Sigma_Z**: principal conductivities $\sigma_{x'}$, $\sigma_{y'}$, and $\sigma_{z'}$ (or resistivities) of cells, respectively, not including the air cells.
- **Sigma_Strike**, **Sigma_Dip**, **Sigma_Slant**: three Euler angles (in degrees) α_s (strike), α_d (dip), and α_l (slant) of cells, respectively, not including the air cells.
- **Origin**: the offsets of the global origin from southern, western, and upper boundaries of the model (not including air), respectively. The global origin means it is also the origin in the data file.

Note that 1) no blank lines are allowed among **Model Type**, **Sigma_X**, ... and **Sigma_Slant**; 2) air conductivity is assumed to be constant, and is assigned in the source file `readModel3DAni.jl` to be $10^{-8} S/m$; 3) the order of the cell conductivities and Euler angles is that they vary fastest in x-direction and slowest in z-direction.

1.2 Date file format

The data file contains information about site locations, frequencies/periods and data types, which is required by forward modeling. Besides, since the data file was formatted to be compatible with a future inversion code, it contains data values and data errors. Data values and errors won't be used by forward modeling, so their values can be set arbitrarily. Here is an example data file:

```
# Format:          MT3DData_1.0
# Description:     Data file generated at 2016/10/11 21:00:32
Receiver Location (m):      55
#          X            Y            Z
    -8000.00    -10000.00         0.00
    ...
     8000.00     10000.00         0.00
Frequencies (Hz):      31
    1.00000e+02
    ...
    1.00000e-04
DataType:  Rho_Phs
DataComp:     4
RhoXY
PhsXY
RhoYX
PhsYX
Data Block:    6820
# FreqNo.  RxNo.   DCompNo.    Value          Error
     1        1       1    1.000000e+00    2.000000e-02
     1        1       2    1.000000e+00    2.000000e-02
     1        1       3    1.000000e+00    2.000000e-02
     1        1       4    1.000000e+00    2.000000e-02
     1        2       1    1.000000e+00    2.000000e-02
     1        2       2    1.000000e+00    2.000000e-02
     1        2       3    1.000000e+00    2.000000e-02
     1        2       4    1.000000e+00    2.000000e-02
     ...
    31       55       4    1.000000e+00    2.000000e-02
```

The following is an brief explanation of the keywords of the data file.

- **Receiver Location**: followed by an integer, which is the number of observation sites. The x, y, z locations (in meters) of sites are listed below it.

- **Frequencies**: followed by the number of frequencies, and the frequency values (in Hz) are listed below it.
- **DataType**, **DataComp**: specify the data types and components that will be computed by forward modeling (or used by inversion). The allowed values of **DataType** and **DataComp** are listed in the following table:

DataType	DataComp	Real or complex
Impedance	ZXX, ZXY, ZYX, ZYY	Complex
Impedance_Tipper	ZXX, ZXY, ZYX, ZYY, TZX, TZY	Complex
Rho_Phs	RhoXX, PhsXX, RhoXY, PhsXY, RhoYX, PhsYX, RhoYY, PhsYY	Real
Rho_Phs_Tipper	RhoXX, PhsXX, RhoXY, PhsXY, RhoYX, PhsYX, RhoYY, PhsYY, RealTZX, ImagTZX, RealTZY, ImagTZY	Real

- **Data Block**: followed by the number of data points, the maximum value of which is $N_{freq} * N_{site} * N_{type}$. A table of data parameters is given below it. The first column of the data table is the frequency index for each datum, the second column is the site index and the third column gives the data type index. For real value data (apparent resistivity and phase) the fourth column is the data, while for complex value data (impedance) the data includes two columns (the fourth and fifth columns) corresponding to the real and imaginary parts respectively. The last column is the standard error.

2 Output File Formats

Output files include forward data file, forward response file and forward field file. The format of the forward data file is exactly the same as the input data file.

2.1 Response file format

Response file is output by the code after running in the 'pure forward' mode (see README.txt). Compared with the data file, it is more straightforward to read the forward response from a response file. Here is an example response file:

```
# Format:           MT3DResp_1.0
# Description:      Data file generated at 2016/10/11 21:00:32
Receiver Location (m):      55
#          X            Y            Z
    -8000.00    -10000.00         0.00
```

```
     ...
      8000.00     10000.00         0.00
Frequencies (Hz):      31
    1.00000e+02
    ...
    1.00000e-04
DataType:  Rho_Phs
DataComp:     4
RhoXY
PhsXY
RhoYX
PhsYX
Data Block:     1705
# FreqNo.  RxNo.        RhoXX         PhsXX         RhoXY          PhsXY        ...
     1        1          0.77        178.41      10373.86          43.93        ...
     1        2          0.77        178.42      10373.86          43.93        ...
     1        3          0.77        178.42      10373.86          43.93        ...
     ...
    31       55          0.00        114.80        155.08          54.61        ...
```

In the response file, the information about site locations, frequencies/periods and data types is simply copied from the input data file. Except that, the rest content is a table of the response, which is quite easy to understand. Unlike the data table in the data file, one column of the response table corresponds to all data types of a single frequency of a single site.

2.2 Forward field file format

Forward field file contains the electric fields defined at cell edges of both modes of all frequencies, which are actually the solutions of linear systems. Here is an example field file:

```
# Frequencies:     7
# Transmitters:    2
Grid dimension:    72    54    43

Frequency #:    1
Transmitter #:  1
x-component: real
   1.000000e+00   1.000000e+00 ...
x-component: imag
   0.000000e+00   0.000000e+00 ...
y-component: real
```

```
   0.000000e+00   0.000000e+00 ...
y-component: imag
   0.000000e+00   0.000000e+00 ...
z-component: real
   0.000000e+00   0.000000e+00 ...
z-component: imag
   0.000000e+00   0.000000e+00 ...
Transmitter #:    2
...
Frequency #:    2
Transmitter #:  1
...
```

The format is very easy to understand. At the beginning the number of frequency, the number of polarization mode (transmitter), and the grid dimension are given. Next, the real and imaginary parts of E_x, E_y and E_z of each frequency and each polarization mode are listed in turn.