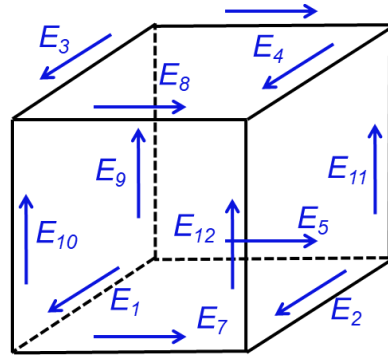


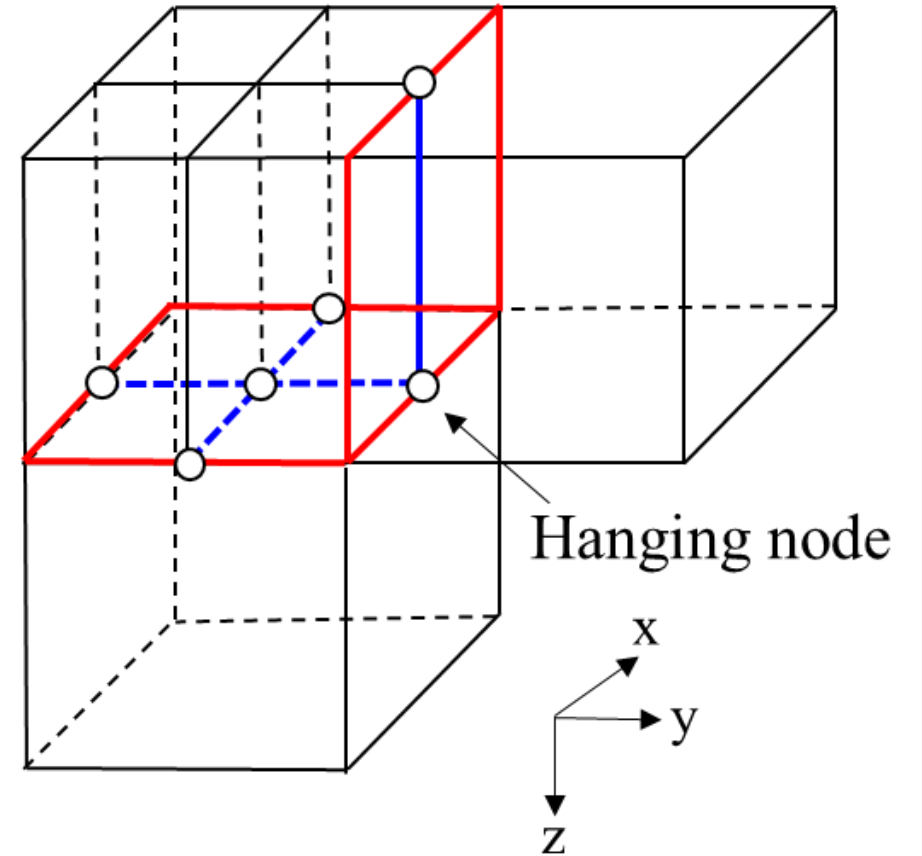
Forward algorithm

- The edge-based hexahedral element is used.

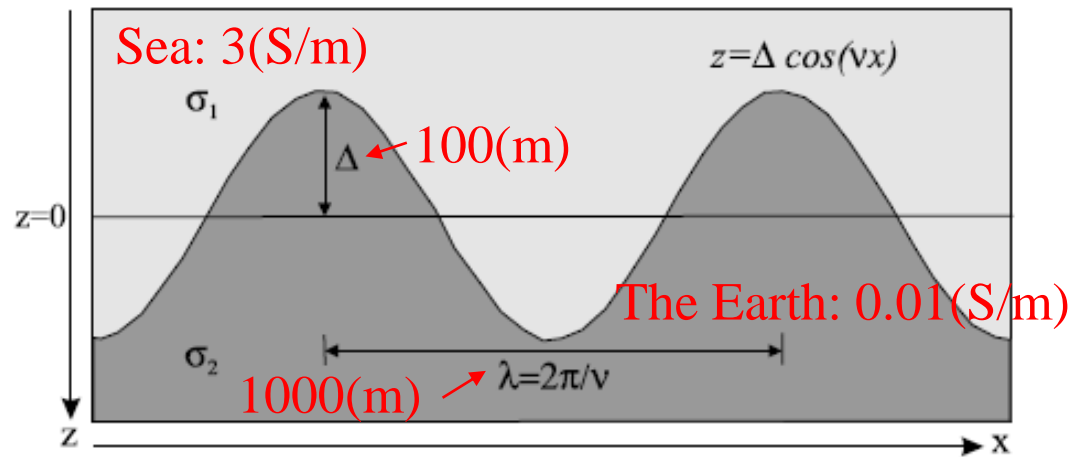
$$\mathbf{E}(\mathbf{r}) = \sum_{i=1}^{12} \mathbf{N}_i(\mathbf{r}) \mathbf{E}_i$$



- As in Grayver & Burg (2014, GJI), non-conforming meshes with 1-irregular hanging nodes is used.
- In FEMTIC, division numbers of only the horizontal edges can be doubled.
- Except for the treatment of adjacent elements with different division numbers, the forward calculation algorithm follows the methods of Usui (2015) and Usui et al. (2017).



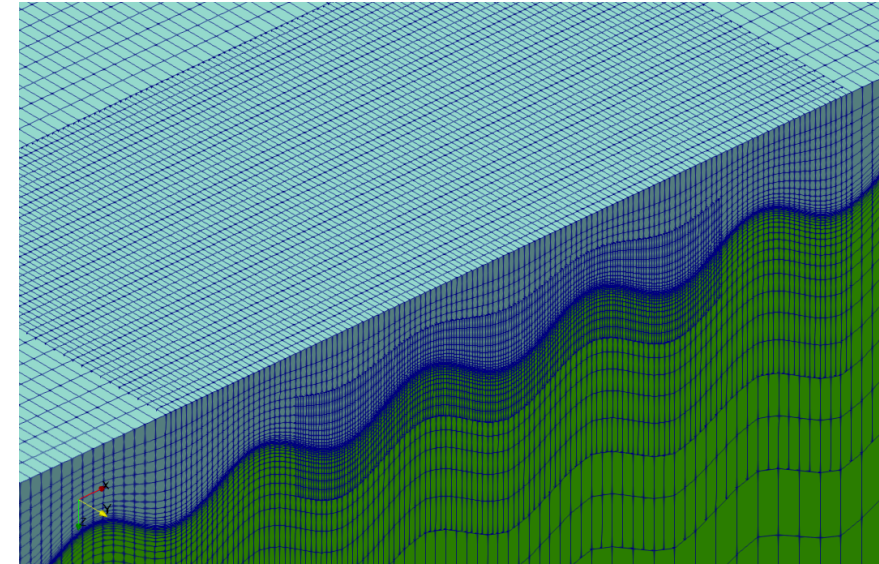
Test of forward calculation (1) - Seafloor with 2-D sinusoidal undulation -



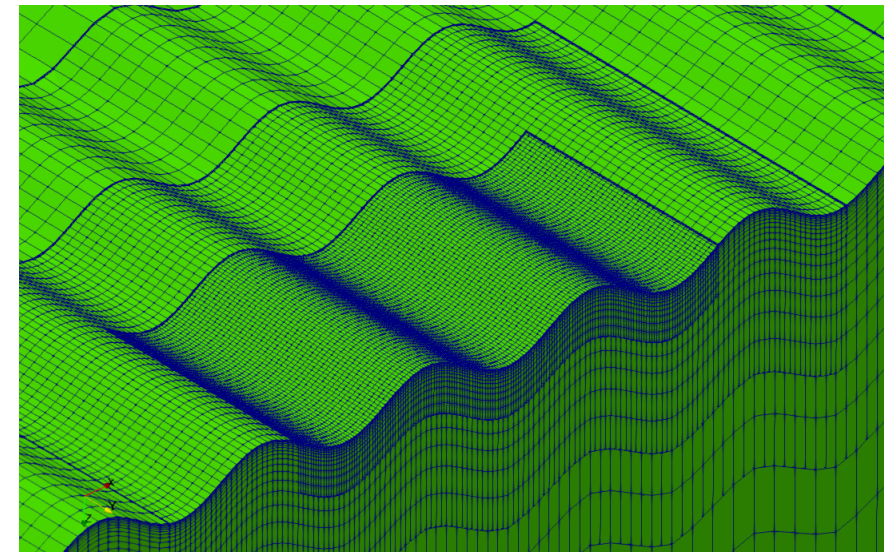
Schwalenberg & Edwards (2004, GJI)

- Schwalenberg & Edwards (2004) and Usui et al. (2018) showed semi-analytical formulation for the seafloor with 2-D sinusoidal undulation.
- I calculated the apparent resistivity, the phase, and the vertical magnetic transfer functions (tipper) by using developed inversion code.
- I compared the calculated response functions with the analytical solutions.

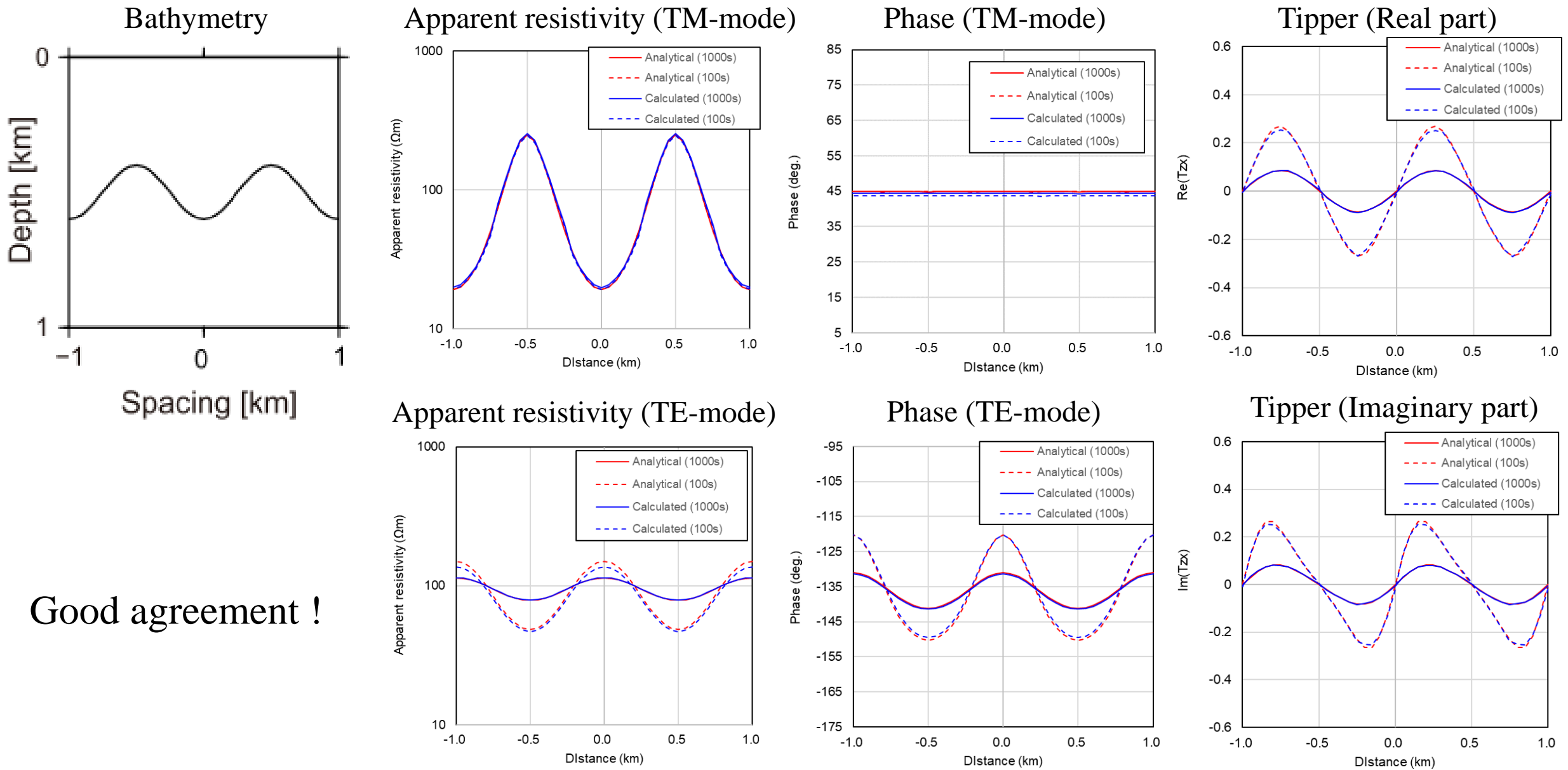
Mesh of the sea and the subsurface



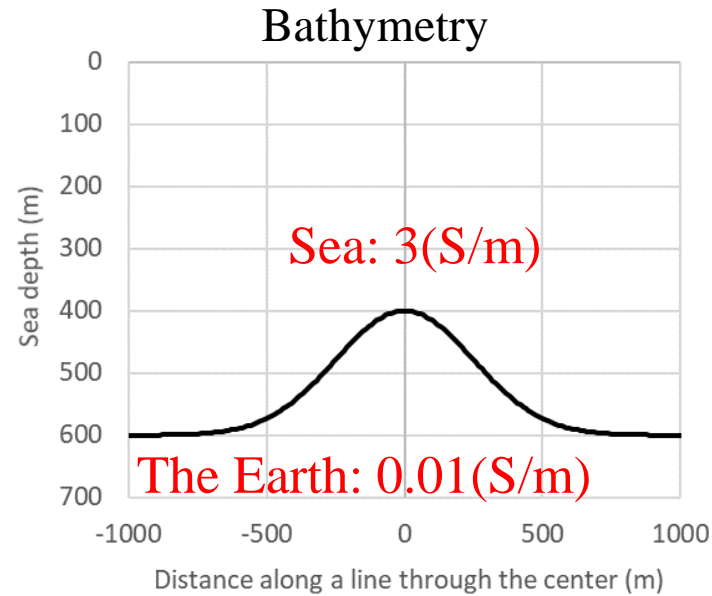
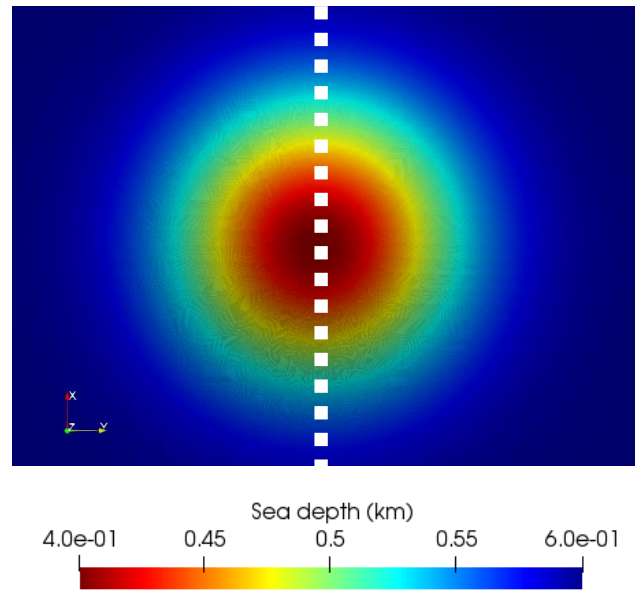
Mesh of the subsurface



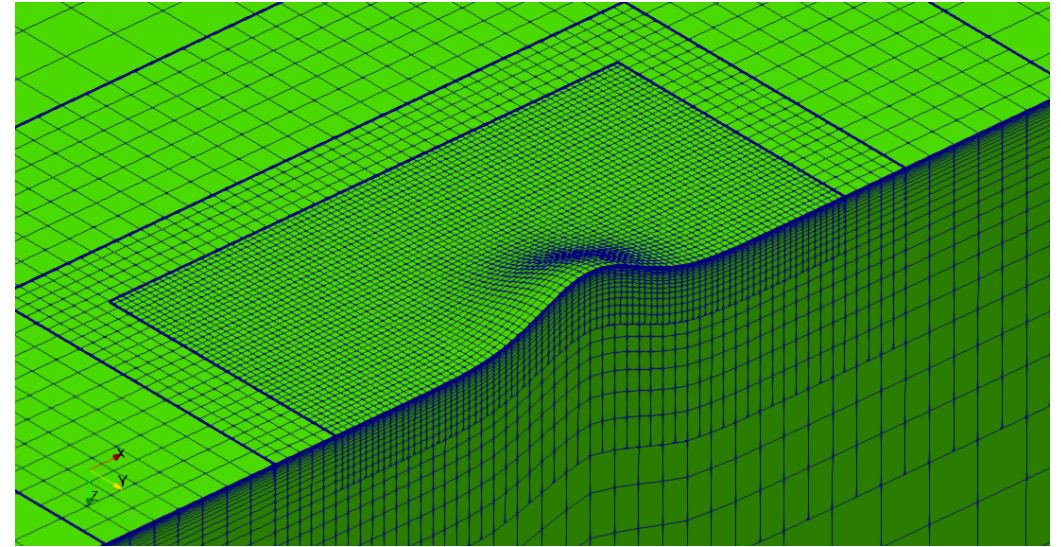
Test of forward calculation (1) - Seafloor with 2-D sinusoidal undulation -



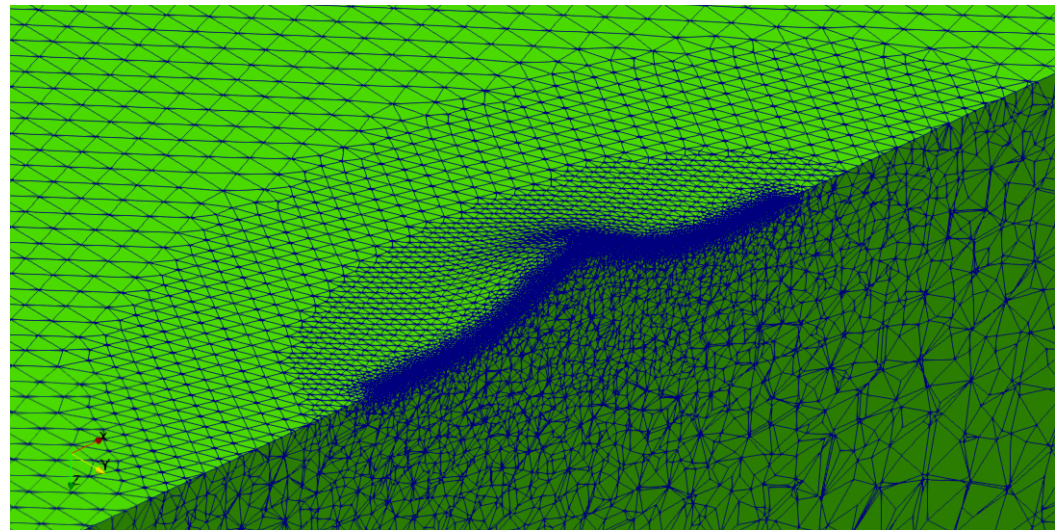
Test of forward calculation (2) - Seafloor with a 3-D bell-shaped sea mountain -



Non-conforming deformed hexahedral mesh

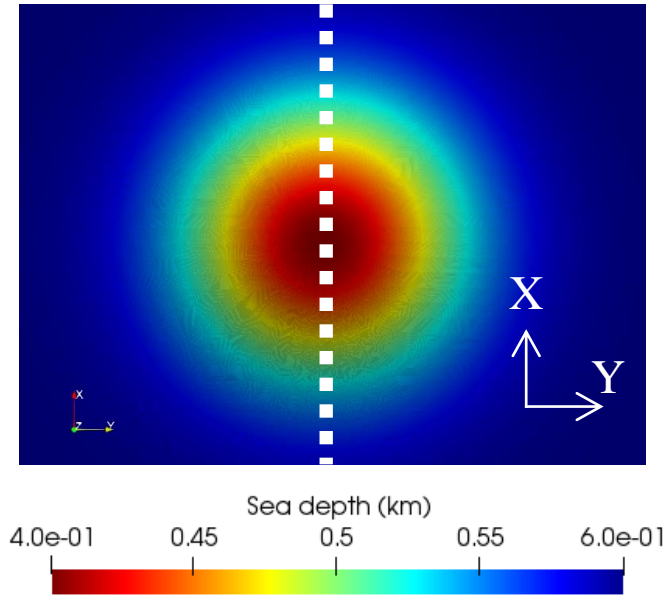


Tetrahedral mesh

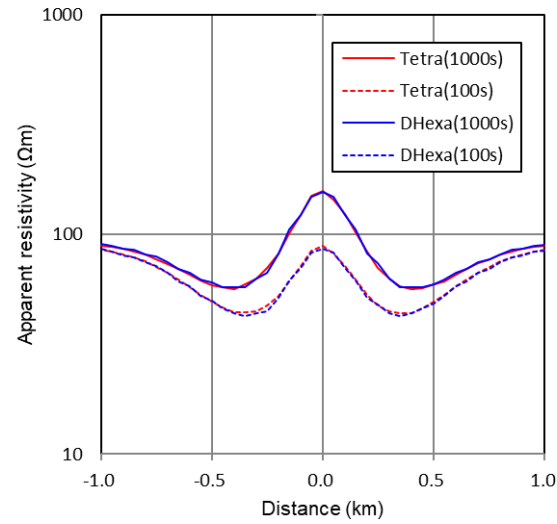


- Analytical solutions of the 3-D bathymetry is not available.
- I compared the calculated response function by a non-conforming deformed hexahedral mesh with those obtained by a tetrahedral mesh.

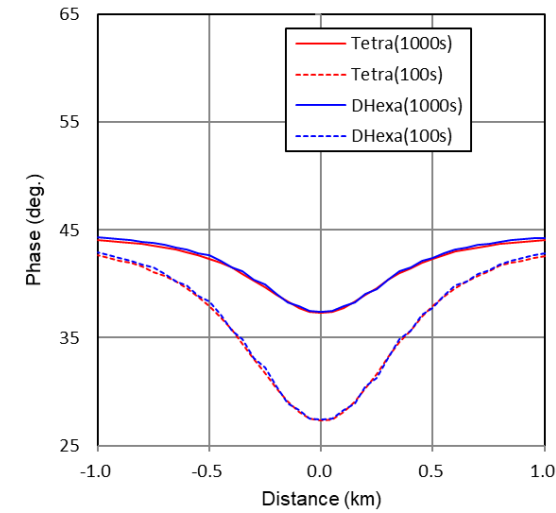
Test of forward calculation (2) - Seafloor with a 3-D bell-shaped sea mountain -



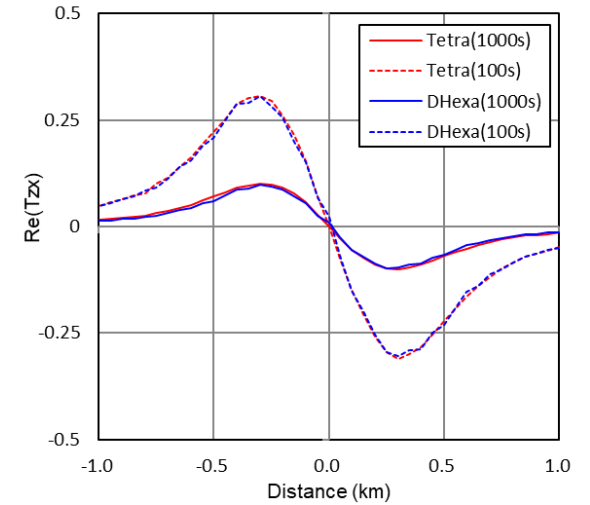
Apparent resistivity (XY)



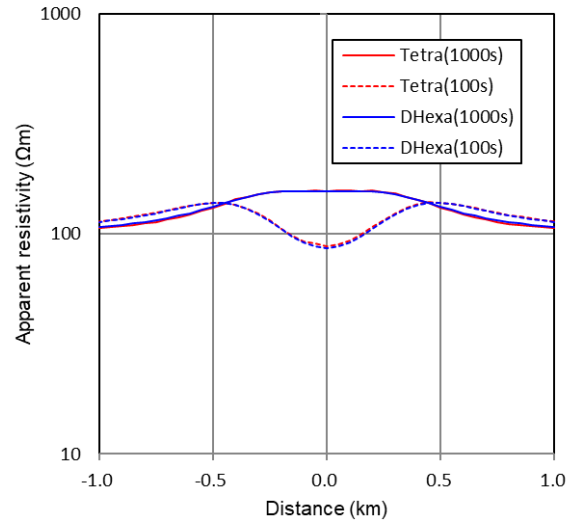
Phase (XY)



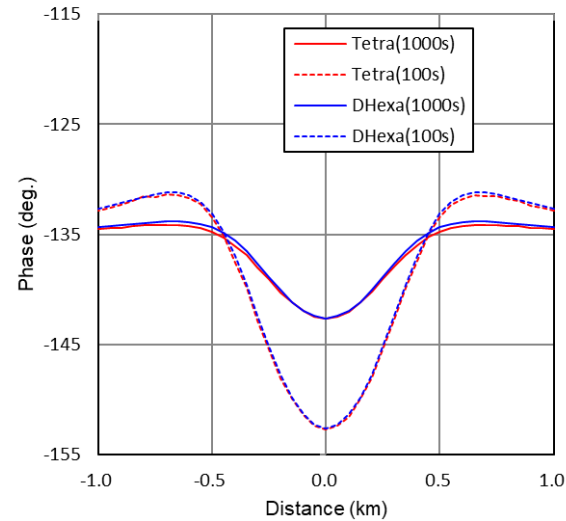
Tipper (Real ZX)



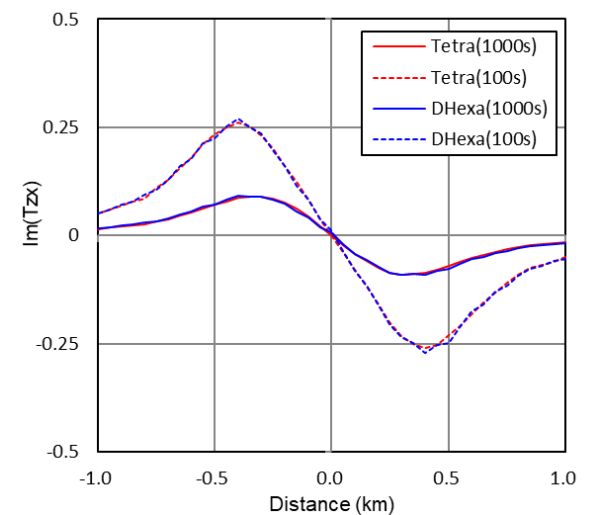
Apparent resistivity (YX)



Phase (YX)

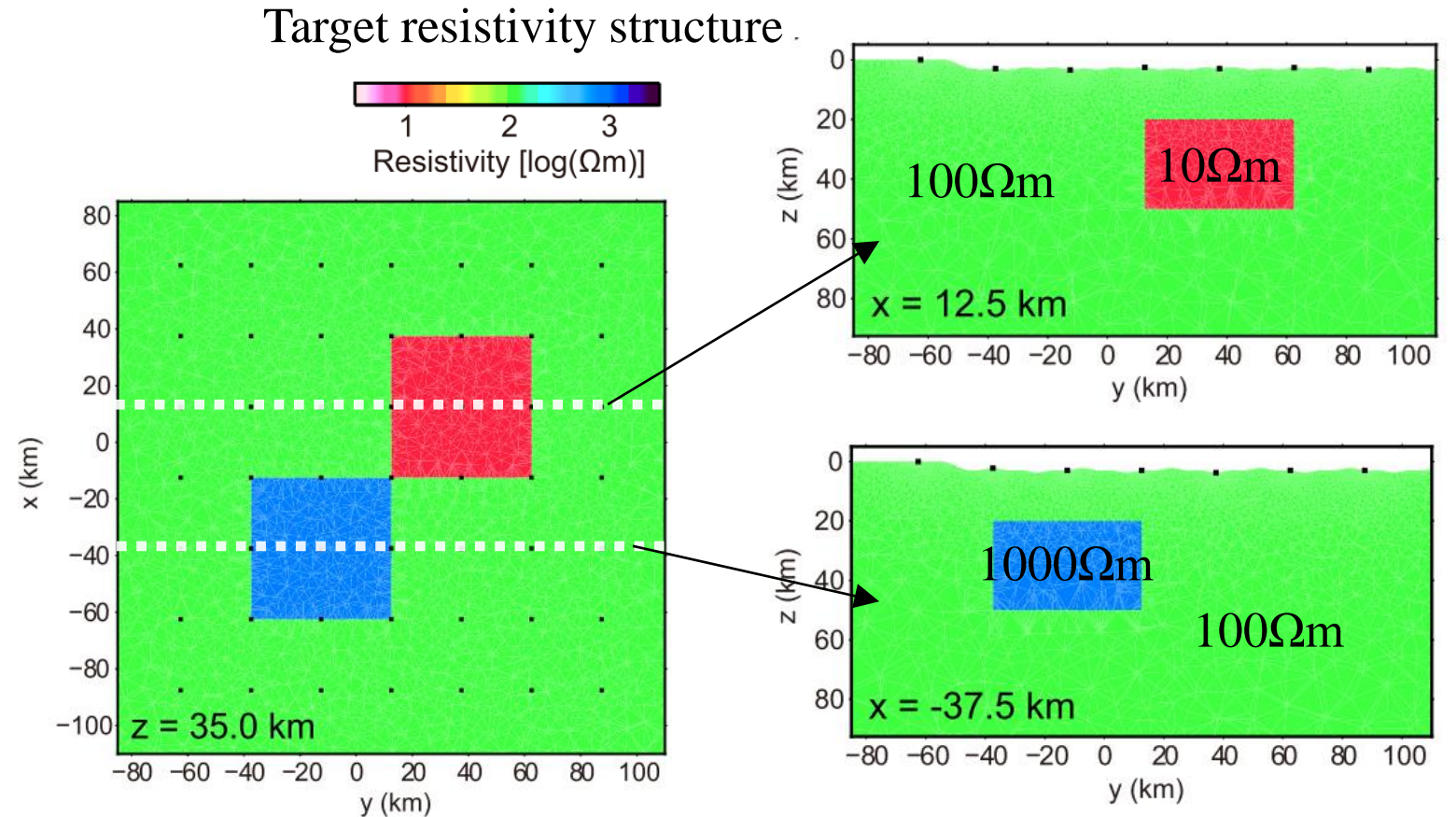
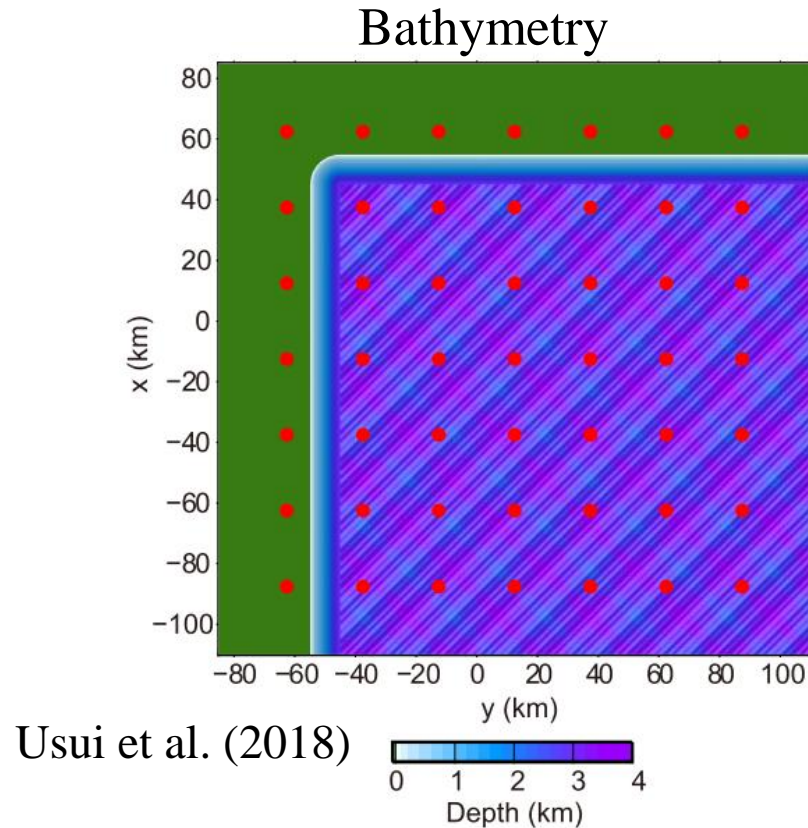


Tipper (Imaginary ZX)



Good agreement !

Test of inversion

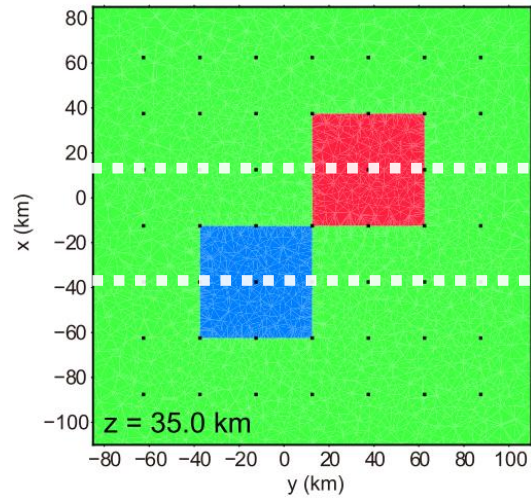


- I used the impedance tensor and the tipper calculated by a tetrahedral mesh as input data.
- Periods: 16 periods from 31.6 to 10,000 s
- Gaussian noise was added to the synthetic data.

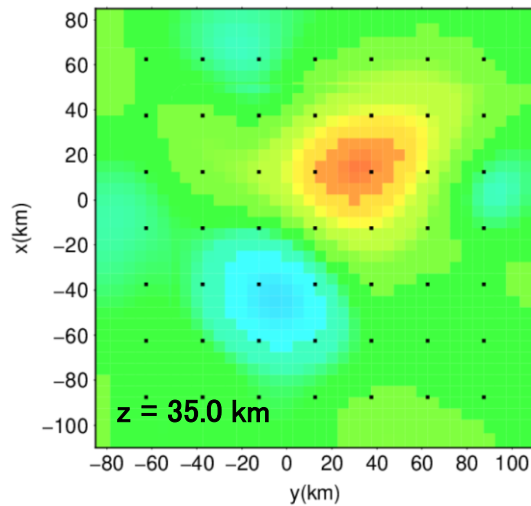
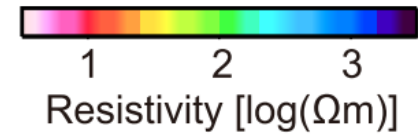
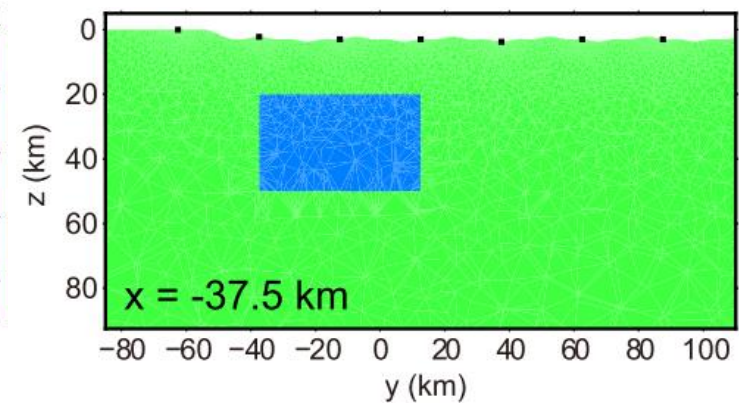
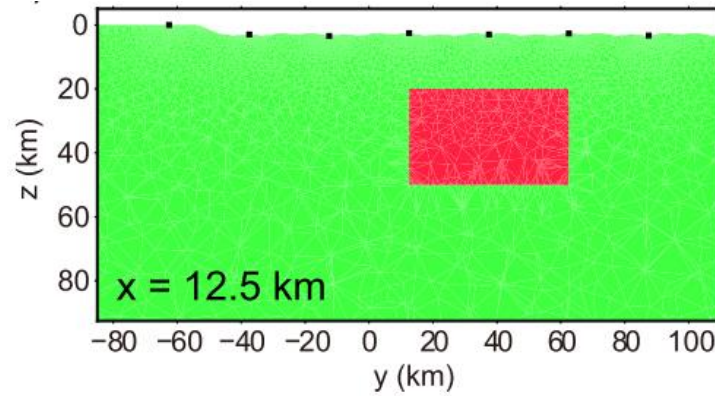
Standard deviation for the impedance tensor components: $0.05 \times \max(|Z_{xy}|, |Z_{yx}|)$

Standard deviation for the tipper components: $0.05 \times \max(|T_{zx}|, |T_{zy}|, 1.0)$

Test of inversion



True structure



Inversion result (RMS = 1.03)

