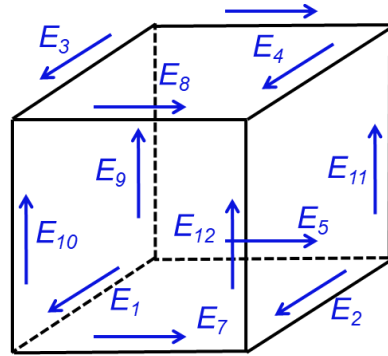


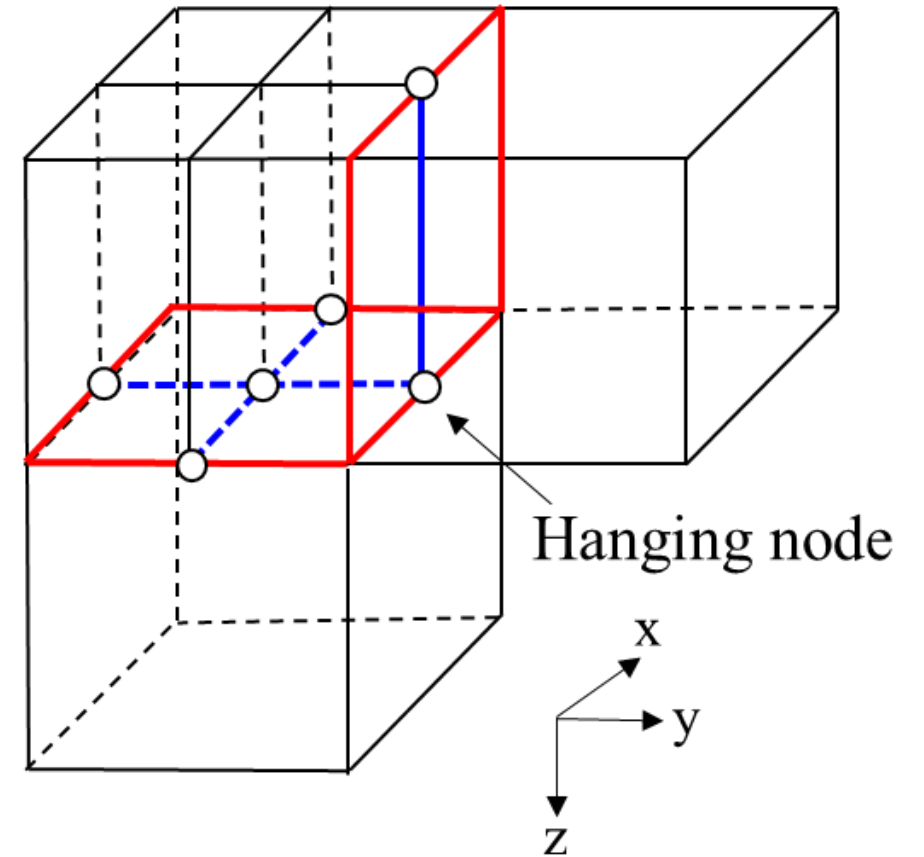
# Forward algorithm

- The edge-based hexahedral element is used.

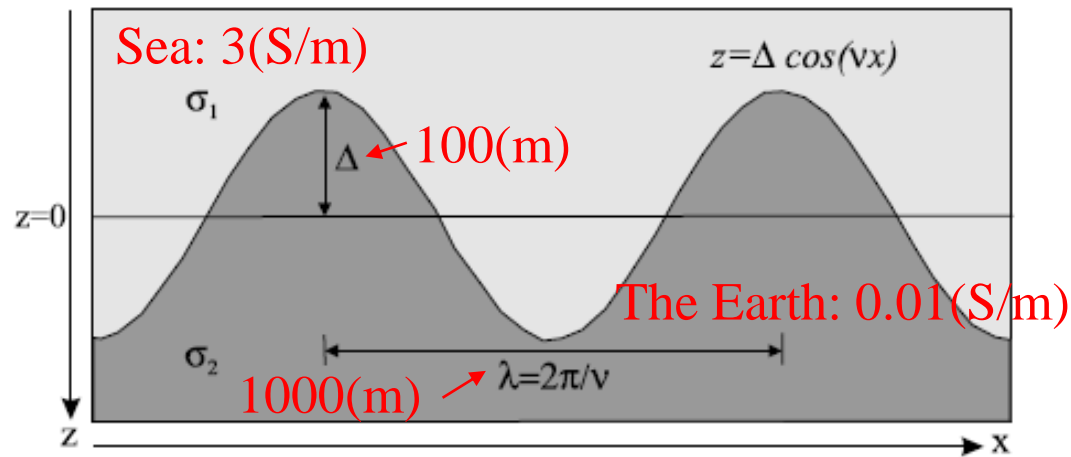
$$\mathbf{E}(\mathbf{r}) = \sum_{i=1}^8 \mathbf{N}_i(\mathbf{r}) \mathbf{E}_i$$



- 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).



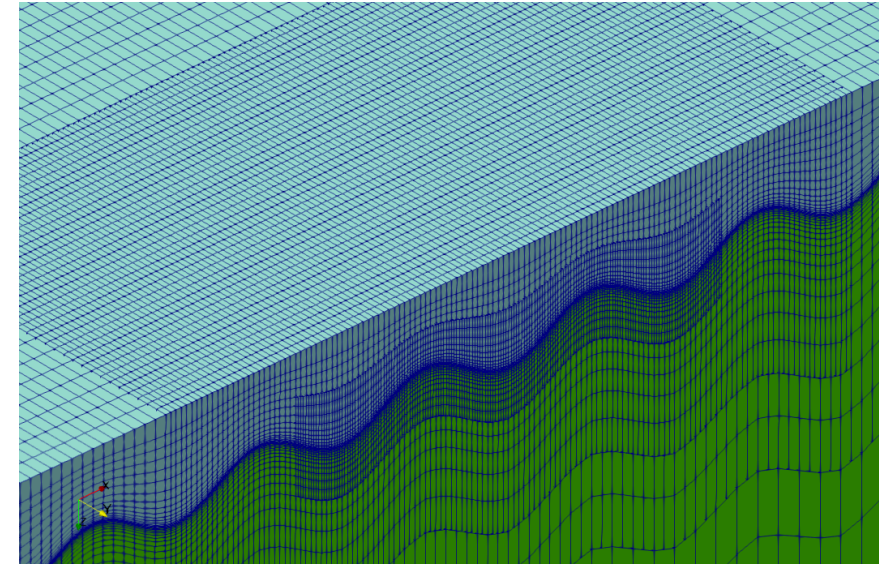
## Test of forward calculation (1) - Seafloor with 2-D sinusoidal undulation -



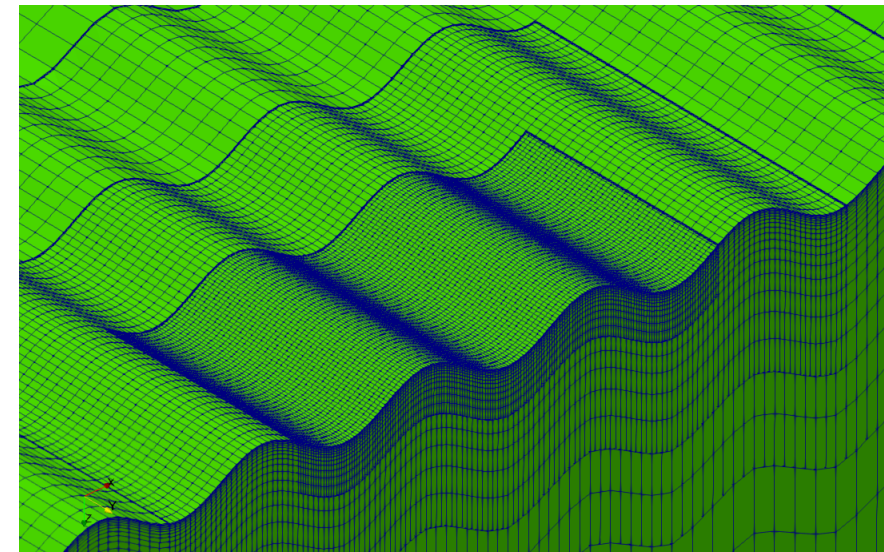
Schwalenberg & Edwards (2004, GJI)

- 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.

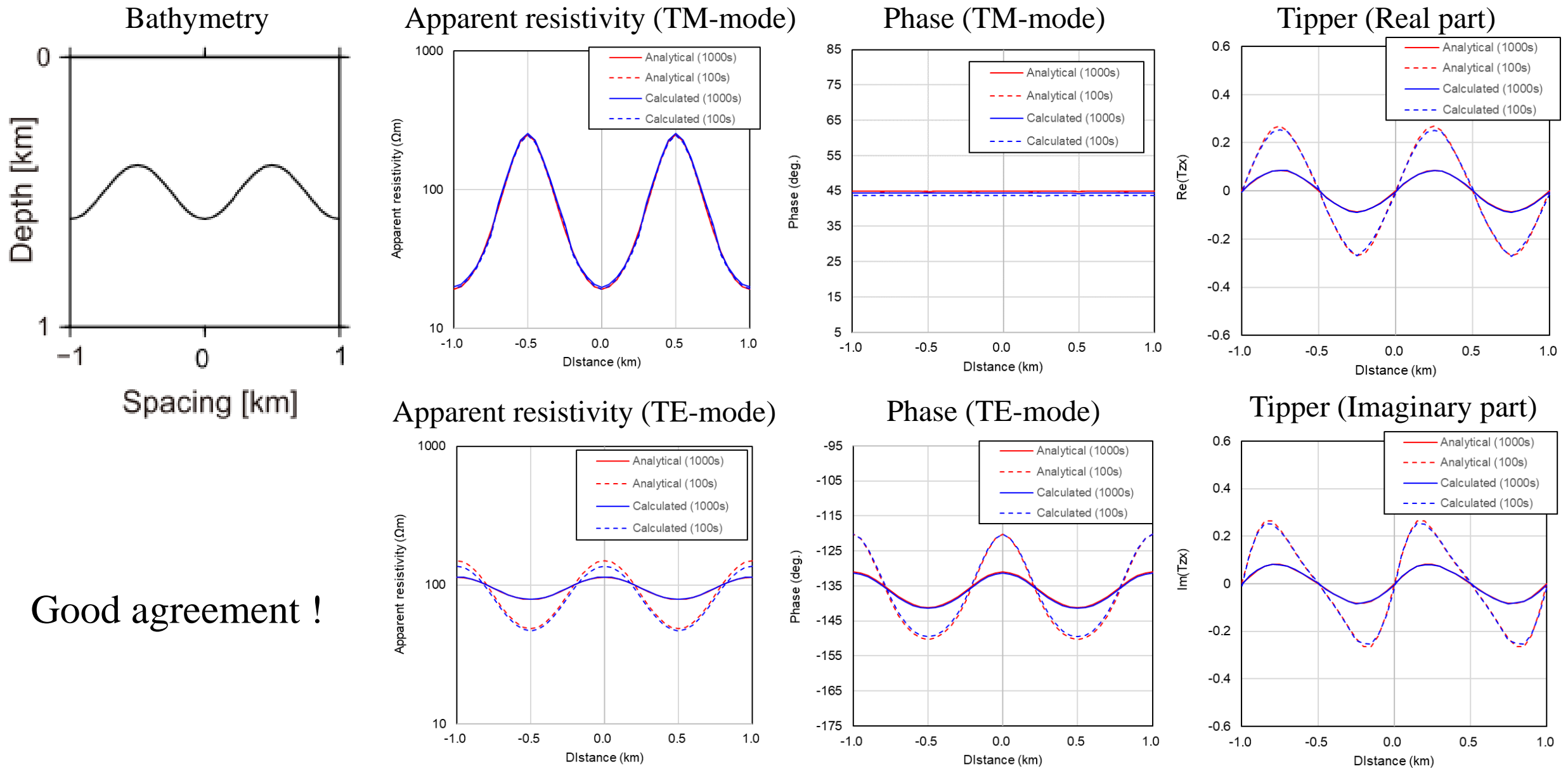
Mesh of the sea and the subsurface



Mesh of the subsurface

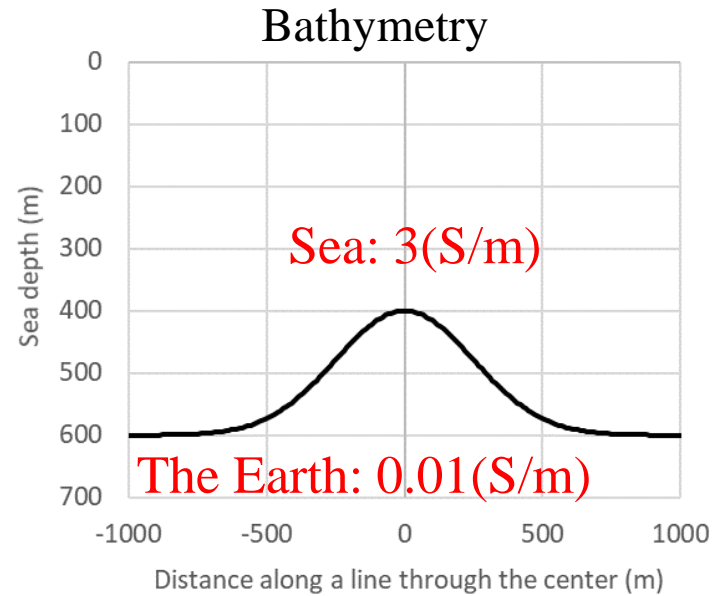
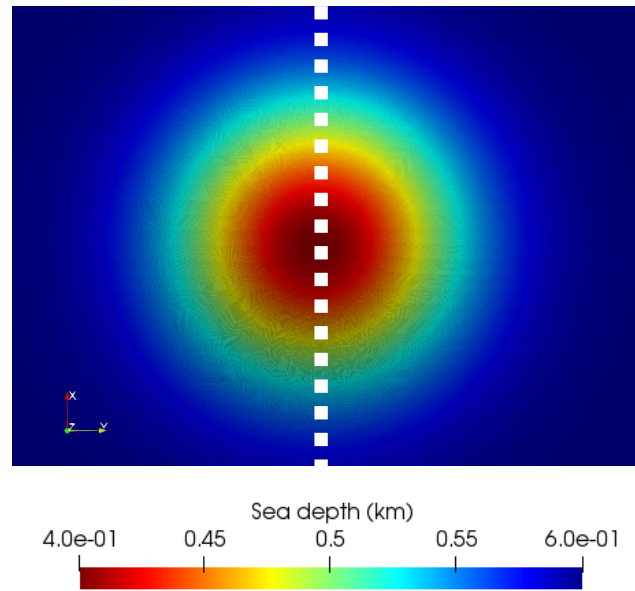


# Test of forward calculation (1) - Seafloor with 2-D sinusoidal undulation -

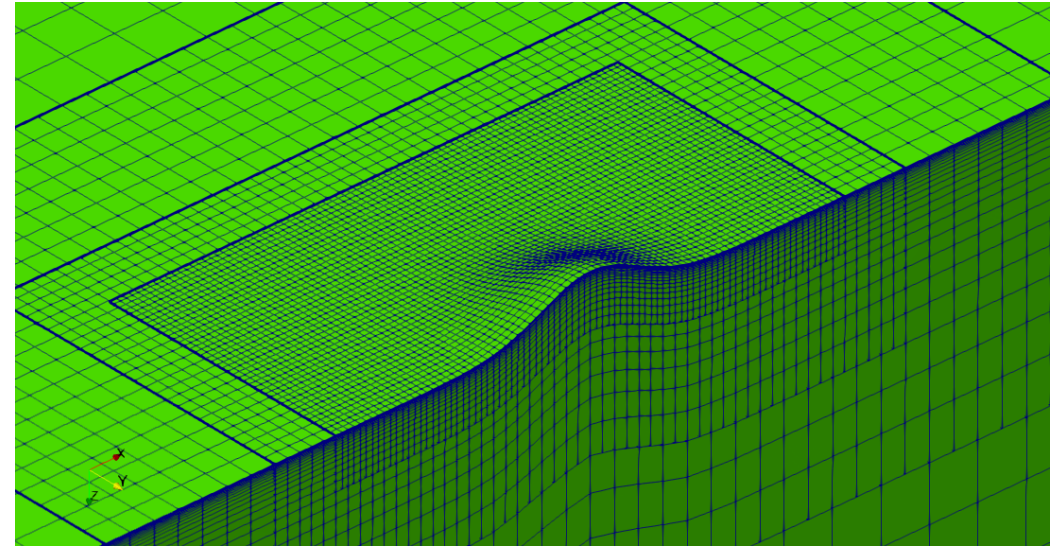




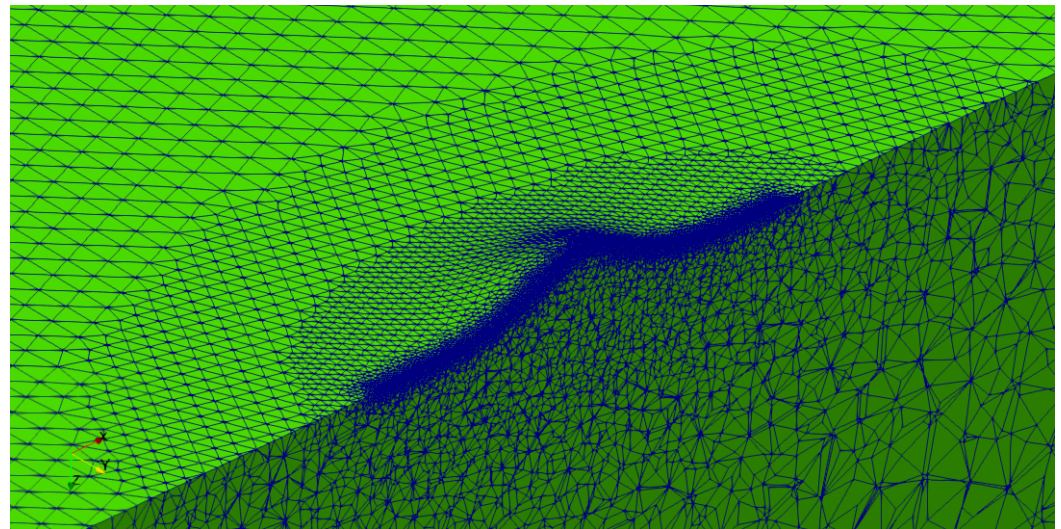
## Test of forward calculation (2) - Seafloor with a 3-D bell-shaped sea mountain -



Non-conforming deformed hexahedral mesh

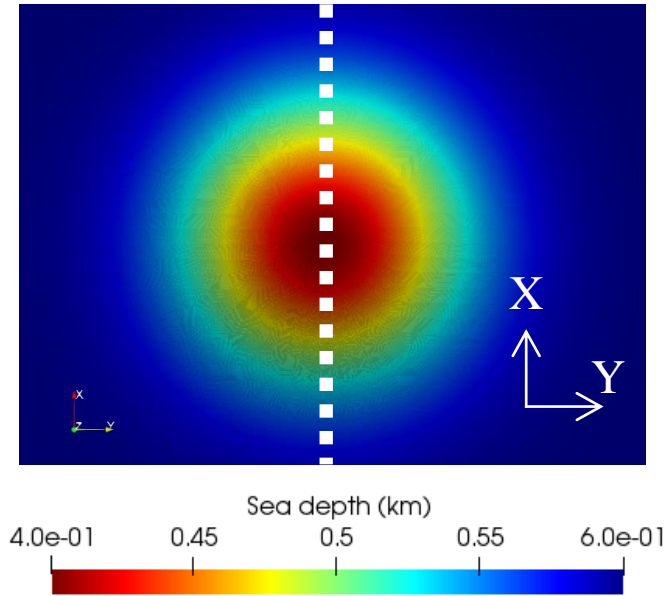


Tetrahedral mesh

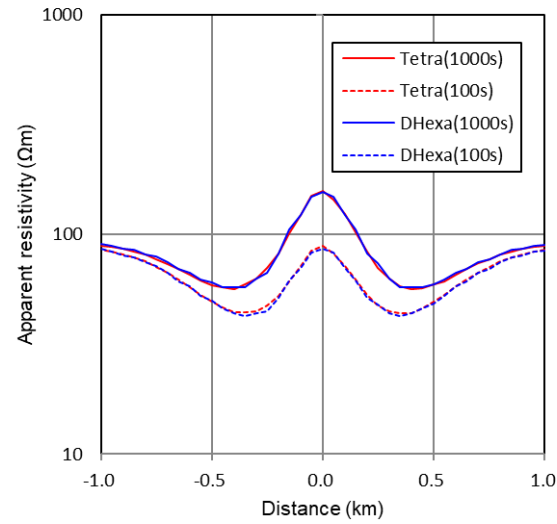


- Analytical solutions of the 3-D bathymetry is not available.
- I compared the calculated response function by a non-conforming deformed hexahedral mesh with those obtained by a tetrahedral mesh.

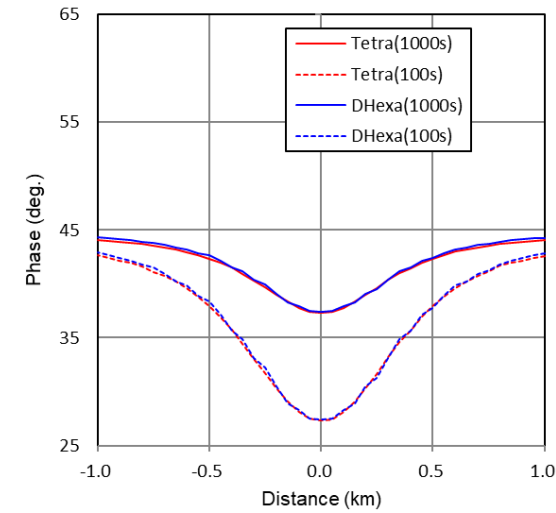
# Test of forward calculation (2) - Seafloor with a 3-D bell-shaped sea mountain -



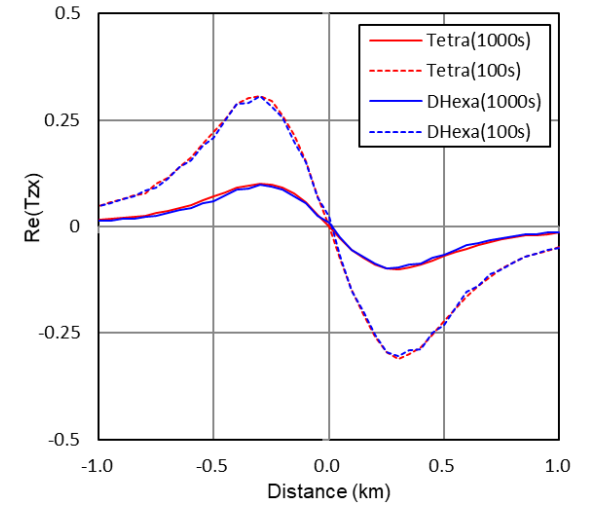
Apparent resistivity (XY)



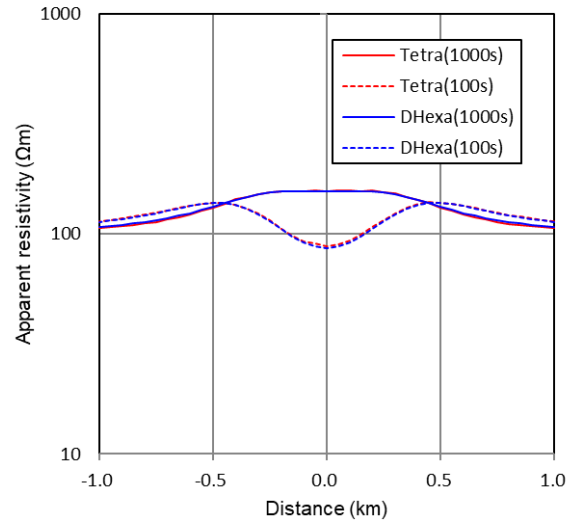
Phase (XY)



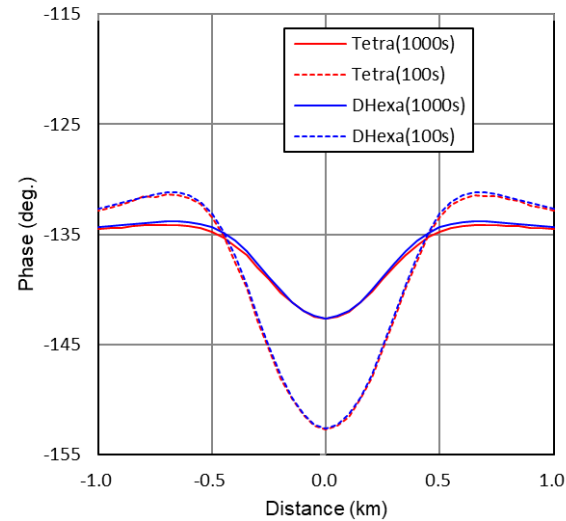
Tipper (Real ZX)



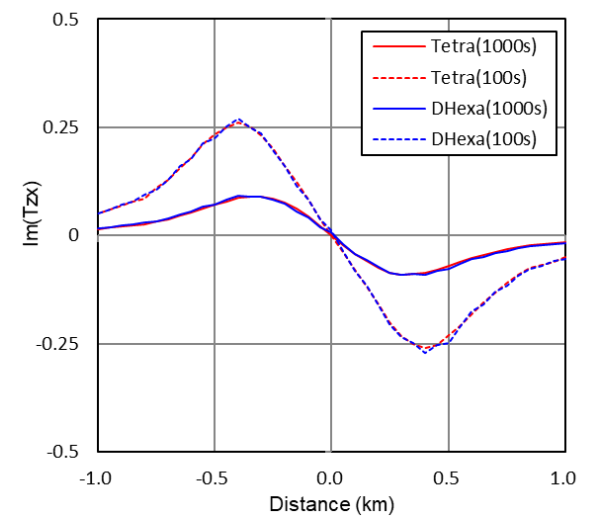
Apparent resistivity (YX)



Phase (YX)



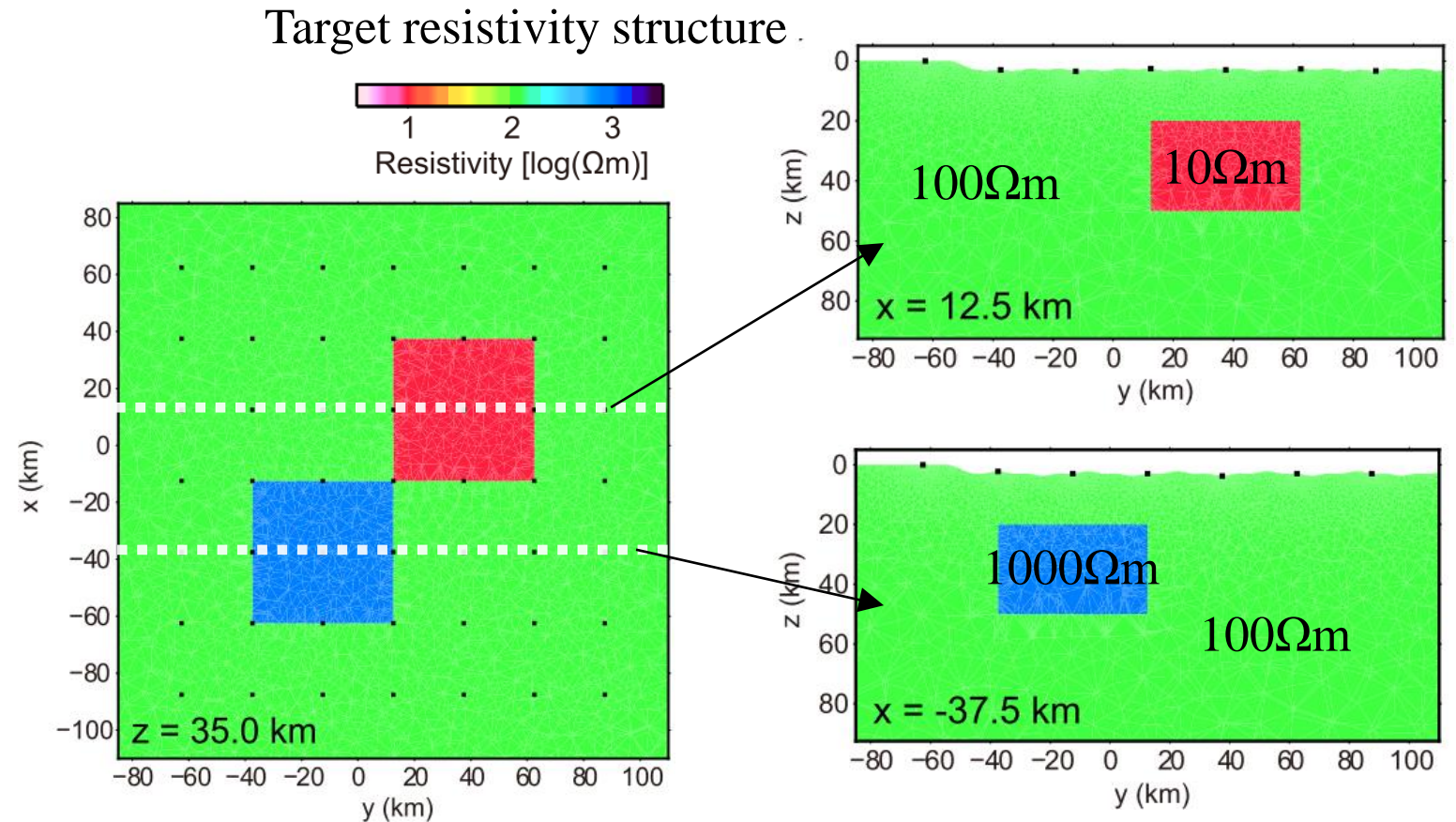
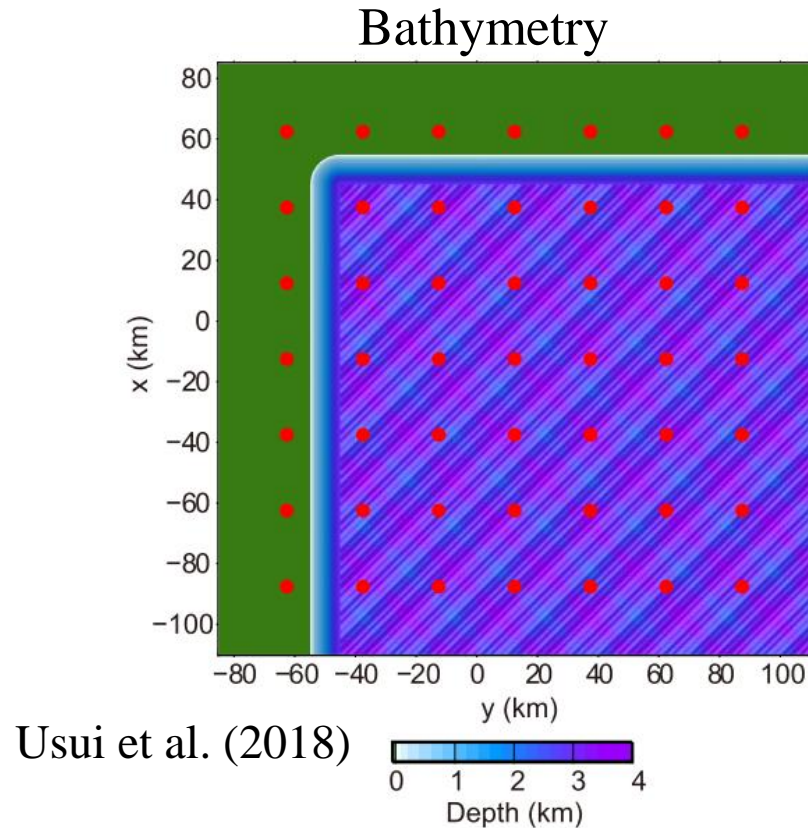
Tipper (Imaginary ZX)



Good agreement !



# Test of inversion

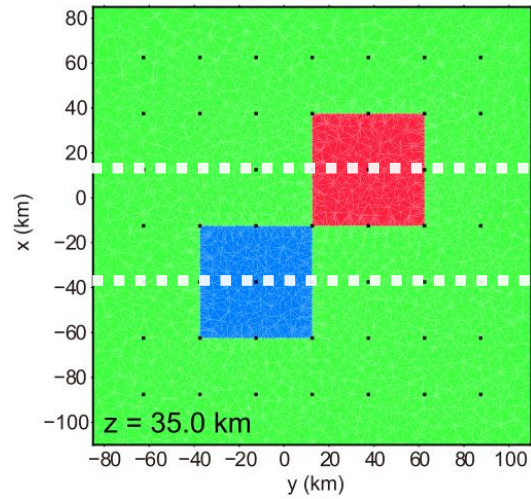


- I used the impedance tensor and the tipper calculated by a tetrahedral mesh as input data.
- Periods: 16 periods from 31.6 to 10,000 s
- Gaussian noise was added to the synthetic data.

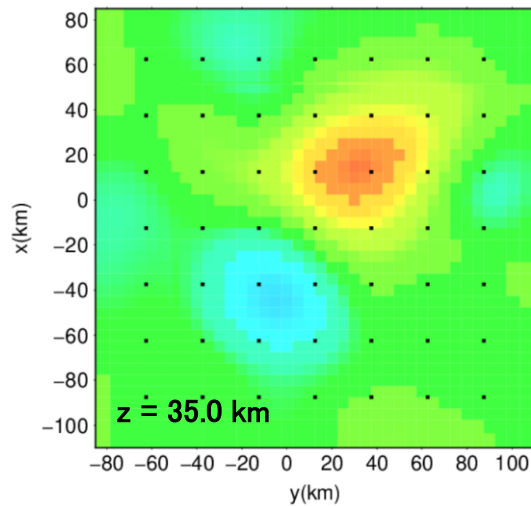
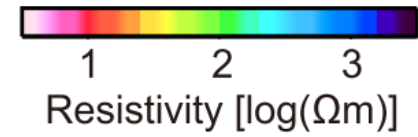
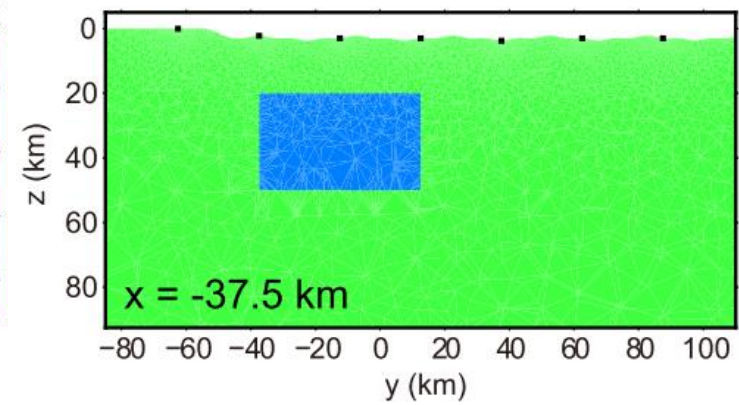
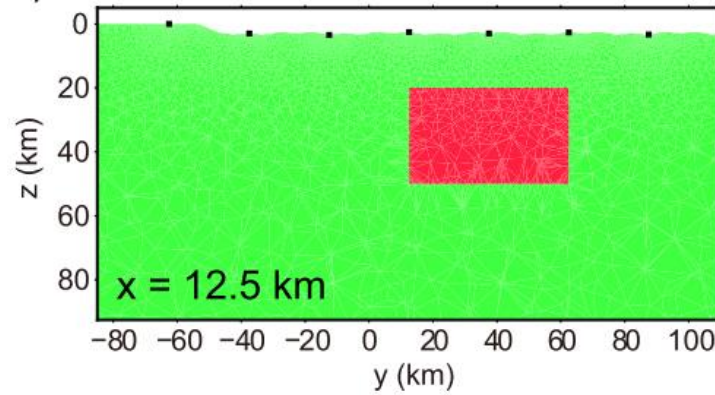
Standard deviation for the impedance tensor components:  $0.05 \times \max(|Z_{xy}|, |Z_{yx}|)$

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)

