2-D MAGNETOTELLURIC INVERSION OF THE CENTRAL PART OF PARANÁ BASIN

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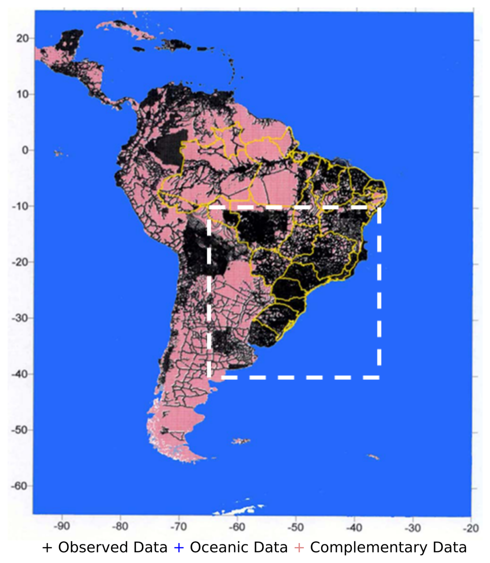
SUMMARY

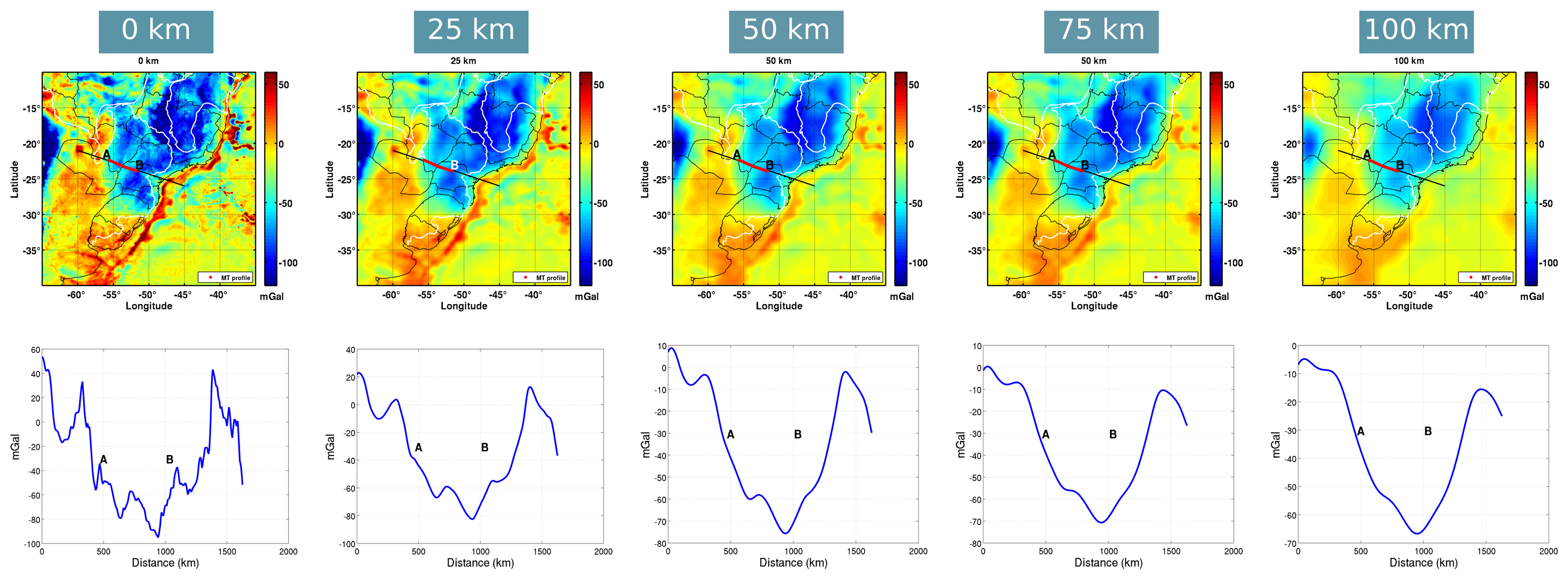
In the past years, substantial effort has been directed to improve the magnetotelluric (MT) inversion algorithms. Many different techniques were developed to estimate 2-D/3-D geoelectric models of the Earth. However, to evaluate the deep structural architecture of the lithosphere under a sedimentary basin is a great challenge, requiring the integration of different geophysical and geological studies. In this work, we present the resulting Paraná Basin lithospheric model, obtained from processing and inversion of broadband and long-period magnetotelluric soundings along an E-W profile across the central part of the basin. Our results are complemented by a qualitative joint interpretation of gravimetric data, in order to obtain a more precise geoelectric model of the deep structure of the region.

GRAVITY FIELD

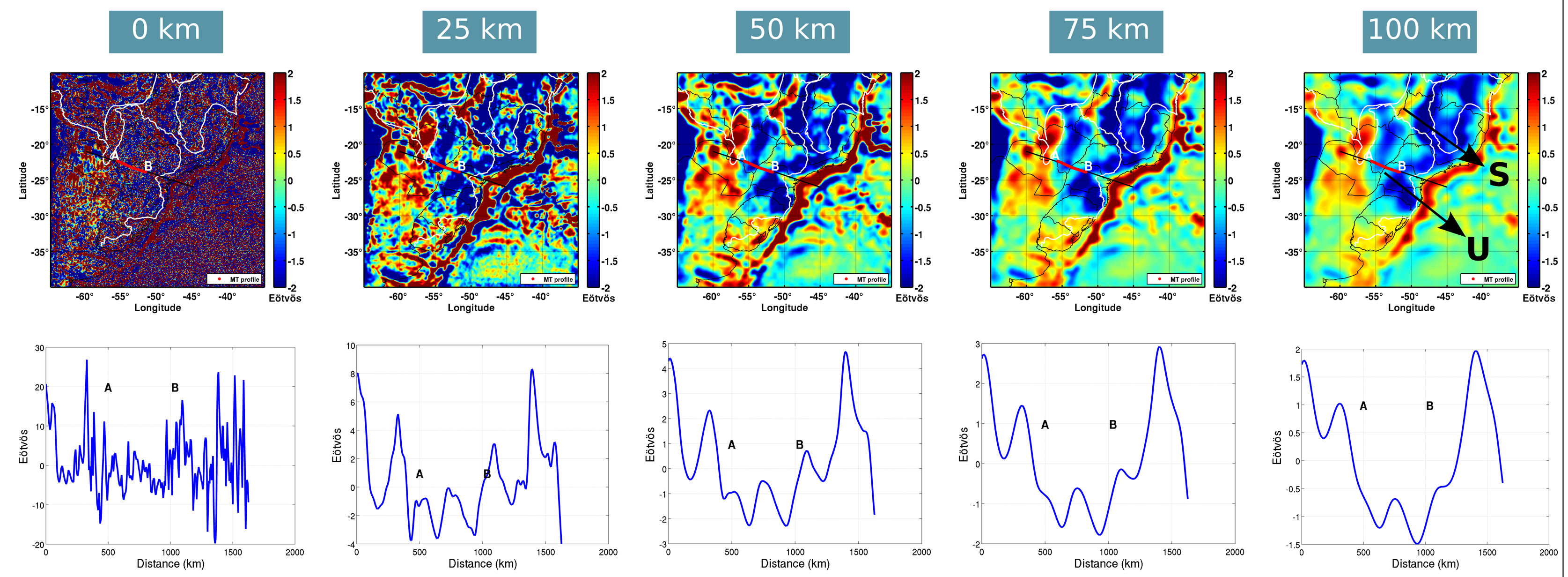


The great development in collecting gravity and topographic data in the last three decades enabled the representation of the gravity field of a large segment of the South American (SAM) plate. High resolution (5' x 5') digital gravity models in the region defined by 25N – 65S and 95W – 20W integrating conventional land surveys and satellite missions derived gravity were computed. The used methodology consists in combining global geopotential models with gravity and topographic data for the representation of the gravity field. For each set of data, the processing was carried out in three steps: 1) standardization, evaluation and ressampling of the basic data; 2) data gathering by merging different files; and 3) computation of digital models (Sá, 2004).

BOUGUER ANOMALY

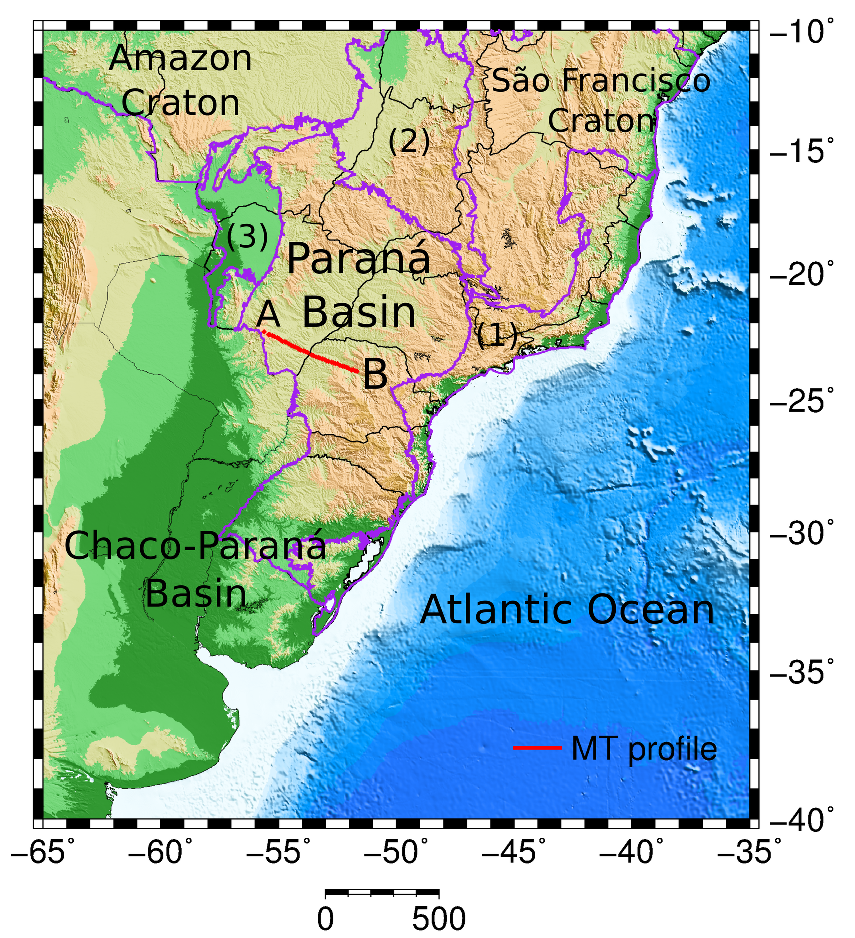


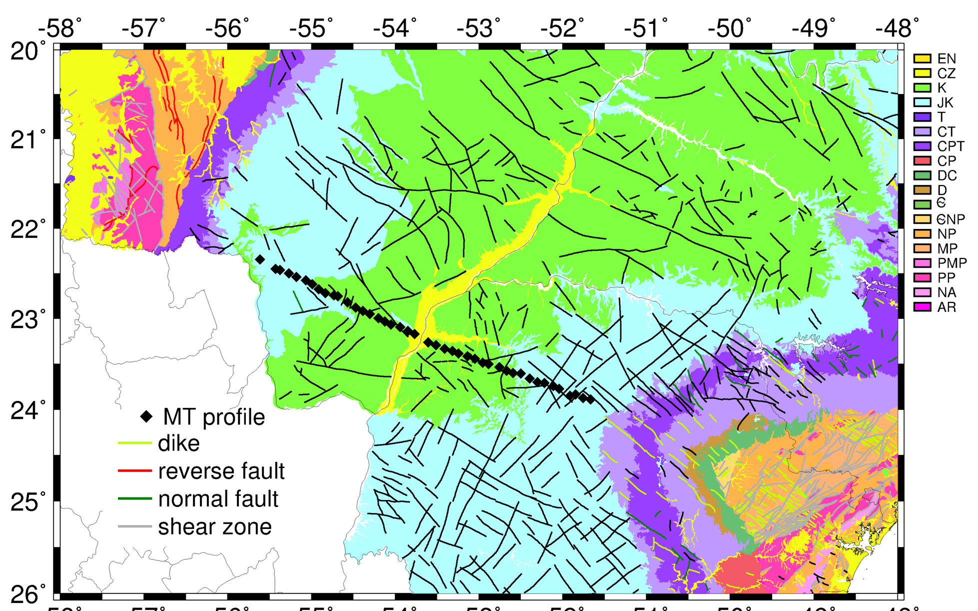
VERTICAL DERIVATIVE (g_{zz})



- At 100 km altitude the vertical derivative of Bouguer gravity indicate a strong correlation between positive gradient and suture zone (**S**) or lower crust basalt underplating (**U**) such as in the Paraná basin (Santos and Ussami, 2011; Mariani et al., 2013).
- Cratonic lithosphere is characterized by negative vertical gradient.

STUDY REGION





In the left, the purple contours and numbers indicate some of the main tectonic provinces within South American lithospheric plate, being (1) Mantiqueira Province; (2) Tocantins Province; and (3) Pantanal Basin. The red line represents the MT profile. The figure above represents the geological map of the central region of the study area.

The Paraná Basin is a large sedimentary basin in central-eastern South America that extends through Brazil, Paraguay, Uruguay and Argentina. Evolved completely over the South American continental crust, this Paleozoic basin is filled with sedimentary and volcanic rocks deposited from the Silurian to the Cretaceous, when a significant basaltic effusion covered almost the entire area of the basin. A series of superposed sedimentary and volcanic rock layers were laid down under the influence of different tectonic settings, probably originated from distant collisional dynamics of continental boards that led to the amalgamation of Gondwanaland (Zalán et. al., 1990). In this work we used MT profiles previously collected in the states of Paraná and Mato Grosso do Sul. The MT data were collected in according to an east-west profile (E - W), in the central region of the Paraná Basin.

IMPEDANCE TENSOR

For an anisotropic or a laterally inhomogeneous earth model, the relation between the electric and magnetic fields is given by the impedance tensor:

$$\begin{bmatrix} E_x \\ E_y \end{bmatrix} = \begin{bmatrix} Z_{xx} & Z_{xy} \\ Z_{yx} & Z_{yy} \end{bmatrix} \begin{bmatrix} H_x \\ H_y \end{bmatrix}$$

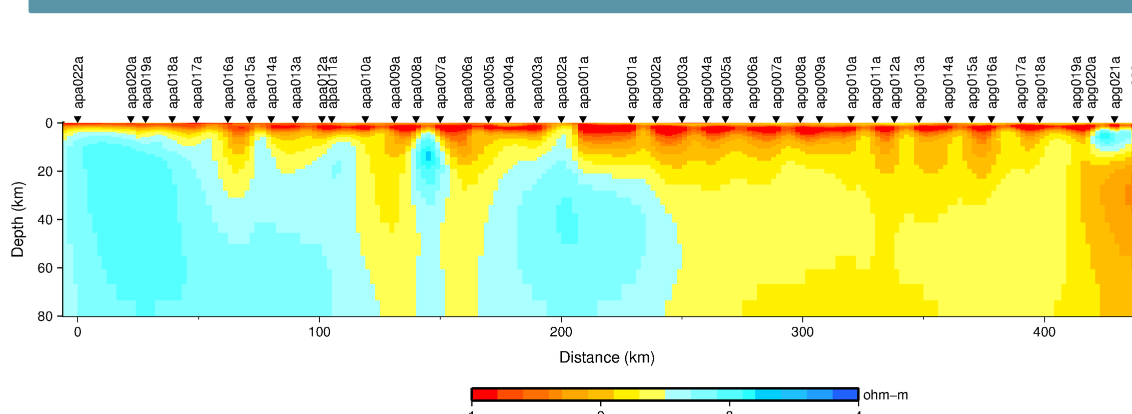
Thus it is possible to calculate the apparent resistivity (ρ_a) and phase (ϕ) as

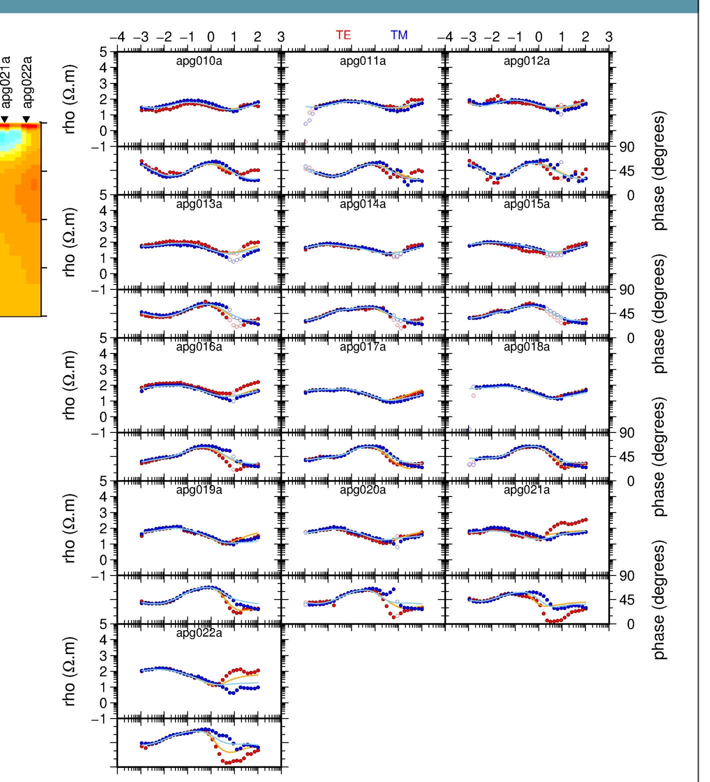
$$\rho_{a,ij}(\omega) = \frac{1}{\mu_0 \omega} |Z_{ij}(\omega)|^2$$

$$\phi_{ij} = \tan^{-1}\left(\frac{\Im(Z_{ij})}{\Re(Z_{ij})}\right)$$

where μ_0 is the magnetic permeability in the free-space and ω is the angular frequency. To calculate the impedance tensor we used a robust algorithm developed by Gary Egbert (Egbert and Booker, 1986).

PREVIOUSLY MT INVERSION



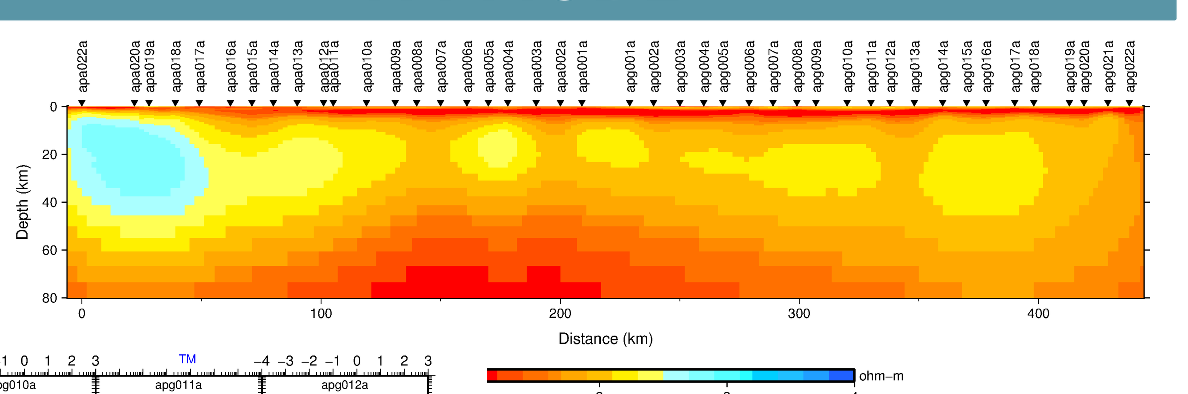


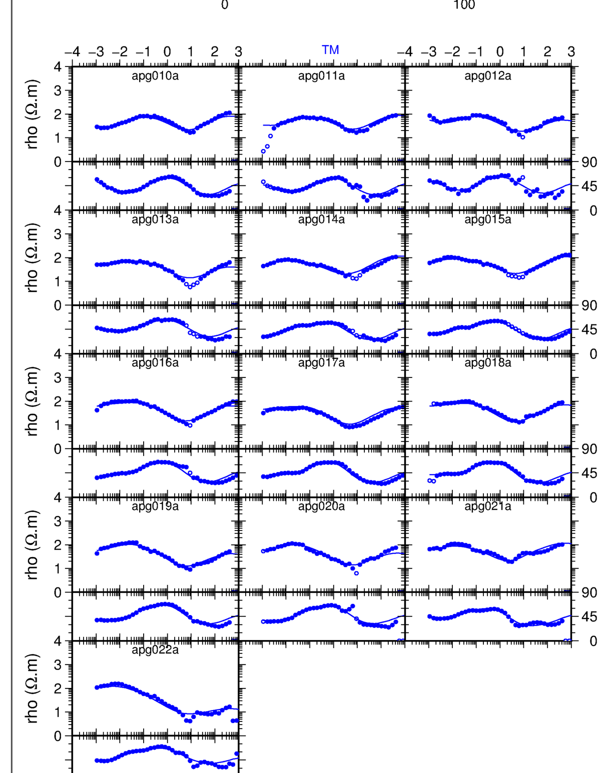
- Here we present a previously 2-D MT resistivity model using REBOCC, Reduced Basis OCCAM algorithm, proposed by Siripunvaraporn and Egbert (2000). The RMS resistivity for this model is 2.47.
- This geoelectric model was obtained through the inversion of the TM and TE mode.

CONCLUSIONS

- A gravimetric feature almost parallel and near the Paraná River indicates the presence of an anomalous deep body.
- We have presented a 2-D geoelectric model of the deep structure in the Paraná Basin.
- Presence of a high conductivity band in the upper part, that represents the sedimentary basin.
- Presence of a high conductivity body near the area of the gravimetric feature.
- Our model may help to understand the geological structure of the Paraná Basin.

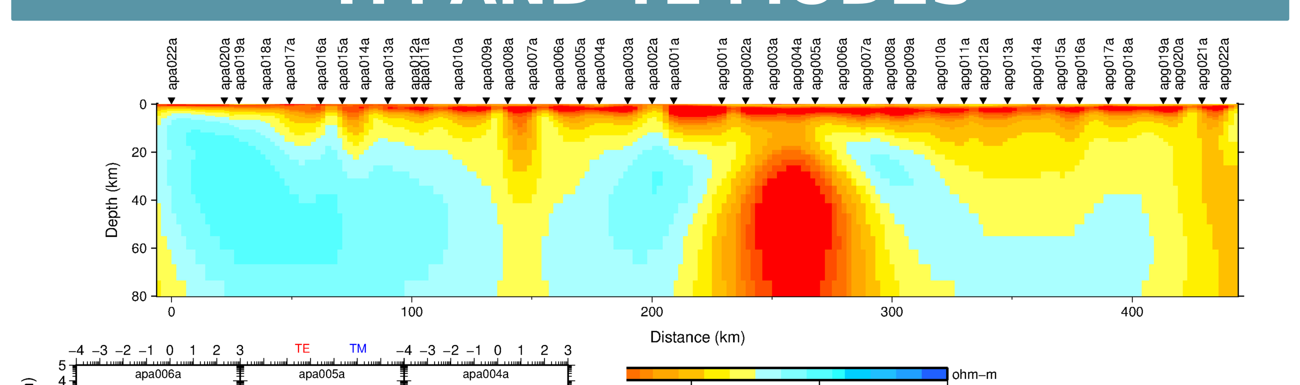
TM MODE

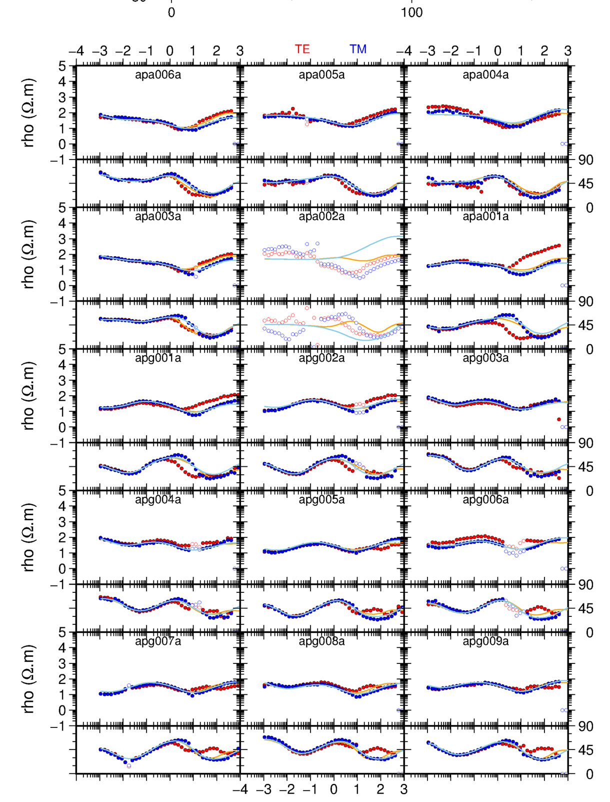




- To improve the assurance of or model, we make a new MT inversion using a different procedure.
- We initiate the inversion assuming large errors in the resistivity and phase, after we start to reduce the errors in phase then reduce the errors in the resistivity.
- The idea of this procedure is to gradually introduce the data in the inversion.
- Here we present the 2-D inversion resistivity model for the Transverse Magnetic (TM) mode using REBOCC. The RMS resistivity for this model is 2.30.

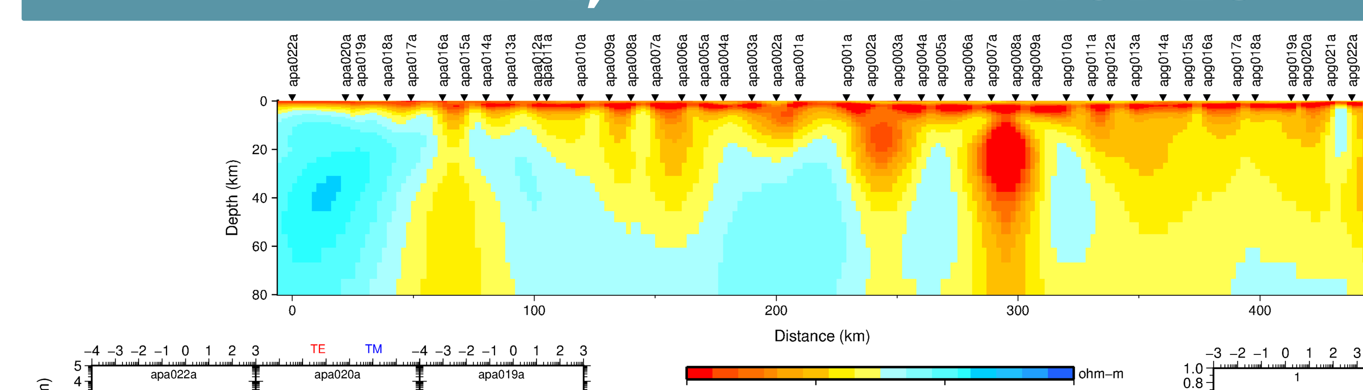
TM AND TE MODES

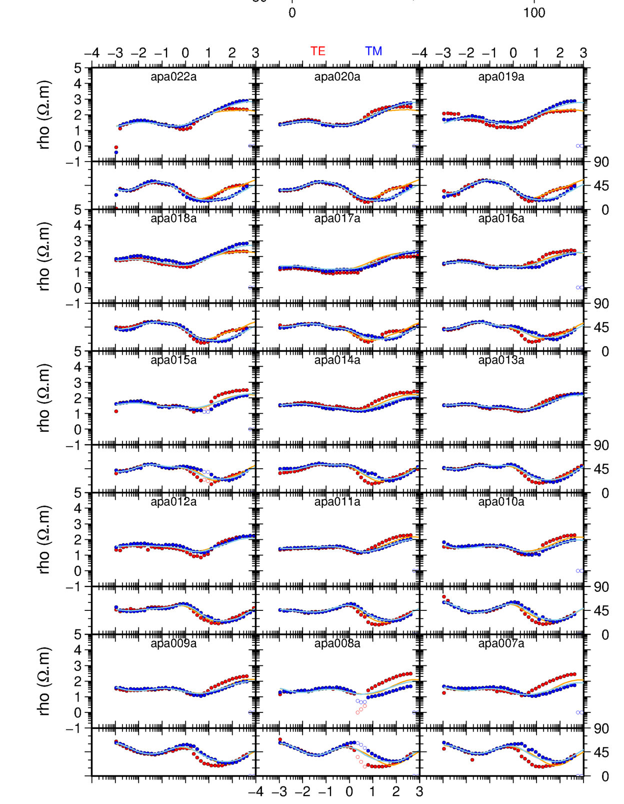




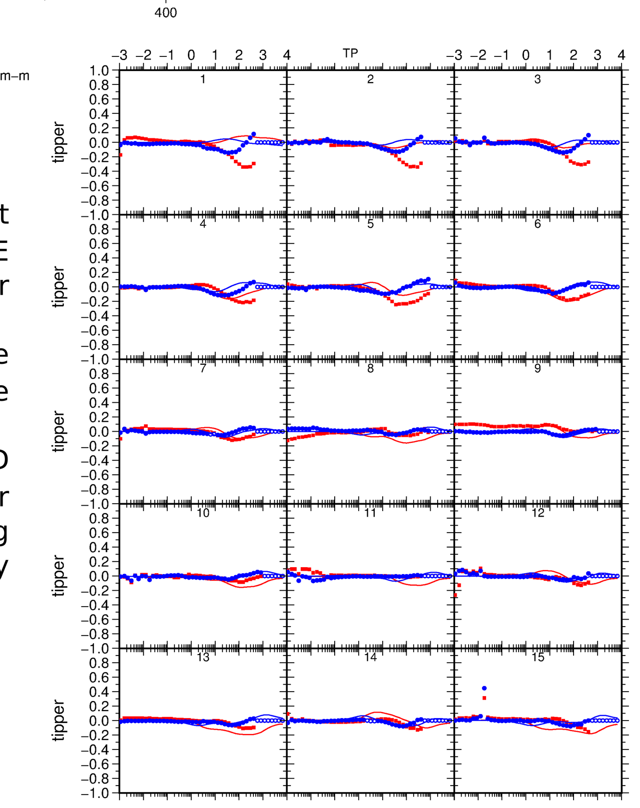
- Now, using the pre-inversion obtained for the TM mode we introduce the Transverse Electric (TE) mode.
- Again we initiate with large errors and gradually reduce them.
- Here we present the 2-D inversion resistivity model for the TM and TE mode using REBOCC. The RMS resistivity for this model is 2.48.

TM, TE AND TP MODES





- Now, using the better fit obtained for the TM and TE mode we introduce the Tipper (TP).
- Again we initiate with large errors and gradually reduce them.
- Here we present the 2-D inversion resistivity model for the TM, TE and TP mode using REBOCC. The RMS resistivity for this model is 1.91.



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