Geophysical Research Abstracts
Vol. 20, EGU2018-4489, 2018
EGU General Assembly 2018


# Monte Carlo approach to assess the uncertainty of wide-angle layered models: Application to the Santos Basin, Brazil

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In the Santos Basin (Brazil), two parallel wide-angle refraction profiles show different crustal structures. One shows moderate crustal velocity gradient, and a clear Moho with topography. The other has an anomalous velocity zone, and no clear Moho reflections. This has large implications on the geological and geodynamical interpretation of the basin. Model uncertainties must be excluded as a source of these differences.

We developed VMONTECARLO, a tool to assess model uncertainty of layered velocity models using a Monte Carlo approach and simultaneous parameter perturbation using all picked refracted and reflected arrivals. It gives insights into the acceptable geological interpretations allowed by data and model uncertainty through velocity-depth plots that provide: a) the velocity-depth profile range that is consistent with the travel times; b) the random model that provides the best fit, keeping most of the observations covered by ray-tracing; c) insight into valid models dispersion; d) main model features unequivocally required by the travel times, e.g., first-order versus second-order discontinuities, and velocity gradient magnitudes; e) parameter value probability distribution histograms.

VMONTECARLO is seamlessly integrated into a RAYINVR-based modelling work-flow, and can be used to assess final models or sound the solution space for alternate models, and is also capable of evaluating forward models without the need for inversion, thus avoiding local minima that may trap the inversion algorithms and providing information for models still not well-parametrised.

Results for the Brazilian models show that the imaged structures are indeed geologically different and are not due to different interpretations of the same features within the model uncertainty bounds. These differences highlight the strong heterogeneity of the crust in the middle of the Santos Basin, where the rift is supposed to have failed.

The authors acknowledge TIDES COST Action ES1401 for the support to attend this conference.