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Bayesian gravimetric inversion for local crustal model refinement in the Guangdong province, South China

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The knowledge of the Earth crustal structure is a fundamental subject for many geophysical applications. As a first approximation, the crust composition can be subdivided into sediments and crystalline crust; the latter, in the case of the continental crust, can be further subdivided into upper, middle and lower crust, as it is done for example in the CRUST1.0 global model.

Gravimetric inversion methods, in order to guarantee the uniqueness of the solution of the inverse problem, are generally used to infer only one boundary between two layers, e.g. the crustal thickness (i.e. the Moho depth). Here a method based on a Bayesian approach is proposed to refine an already existing crustal model by combining gravimetric observations and some a priori conditions on the crustal structure. Basically the method consists in subdividing the crustal volume under investigation into voxels and in estimating a label and a mass density for each voxel in such a way that the resulting gravimetric signal is consistent with the observed one and the a priori conditions are satisfied. The label characterizes the material type of each voxel, e.g. sediments, oceanic crust, upper crust, etc. The estimation procedure is based on a simulated annealing driven by a Gibbs sampler at each iterative step. Moreover, the proposed solution allows to easily integrate seismic profiles available in the study area to further constrain the result of the gravimetric inversion.

In this work the method is applied to refine the crustal model beneath the Guangdong province in the Southern China. This region has been selected for its complex geological structure (e.g. both continental and oceanic crust are present) and for the plan of building here a massive detector of neutrino and geo-neutrino flux. For the latter experiment, an accurate knowledge of the underlying crustal structure is required. The gravity signal to be inverted, at a ground level and at a medium-high spatial resolution, comes from a recent global model including data from the GOCE satellite mission. The prior crustal model is a combination of the already existing CRUST 2.0, CUB 2.0 and GEMMA global crustal models. The result shows that this prior crustal model is improved in terms of both resolution and gravity signal consistency.