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GO_3D_OBServer - Offshore Benchmark of Subduction Environment in Realistic Visco-Elastic Representation

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In order to improve our understanding of the geodynamical processes that shape the deep crust in the various on-shore environments, there is an need of improving our ability to build the regional 3D high-resolution seismic models via full-waveform inversion (FWI). One can start addressing this topic through answering questions which are related both to the acquisition design but also to the optimal processing schemes. The acquisition-related issues focus mainly on the shooting strategy and the optimal OBS spacing which can be acceptable to perform reliable FWI. While the number of available instruments is typically limited, the spacing between OBS shall not be chosen at the expense of the maximum offset necessary to sample the deepest structures. The processing-related questions refer to the computational cost of the FWI when performed at the regional scale. We need to assess the feasibility of 3D FWI using the crustal models with a depth of the order of 30 km and which cover a surface of the order of 5000 km2 for a maximum frequency of 8 to 15 Hz. The underlying questions behind tackle the problem of computational resources, efficient numerical strategies, IO and data management, robust regularization and optimization approaches etc.

To start answering these questions, we believe the first step is to build a realistic 3D marine model, amenable to benchmark different acquisition geometries and imaging techniques suitable for crustal imaging. While the most of the models in the imaging community have been designed to fit the requirements of exploration scale, the available crustal-scale models are rather smooth or lack well defined structures. By realistic we mean that the proposed model shall incorporate possibly wide range of complex three-dimensional lithospheric features. A good examples of the natural settings fulfilling this assumption are subduction zones. Indeed, the nature of these margins warrants the variety of structures characterized by distinct physical parameters.

The aim of the model we present here is to benchmark various imaging approaches with the special emphasis of multi-parameter waveform inversion techniques. Therefore, the size of introduced geological features spans from tens of kilometers to tens of meters - namely to the order of seismic wavelengths or smaller. The model contains deterministic, stochastic and empirical components. The deterministic part covers the shape of the main geological units, as well as its projection into 3D. The stochastic components include small scale perturbations and random warping of the 3D cube - introducing further spatial variation of the structure. The empirical components impose the physical parametrisation - Vp ,Vs, Rho, Qp, Qs - in terms of the parameters magnitude and relations between them. Such variability in terms of structure and parameters is reflected by the anatomy of the seismic wavefield.

The size final model is 30 km x 175 km x 100 km leading to ca. 33.6*10^9 DOF - taking into account 25 m grid size. Therefore apart from the challenges related to the seismic imaging of the geologically complex setting, the model imposes significant computational burden in terms of seismic wavefield modelling. The large size of the computing domain can further contribute to the development of the efficient forward/inverse problem solvers. We believe that the development of such benchmark tests is important for the future geological discoveries.