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Coupling Thermo-Mechanical Geodynamic Models with Synthetic Seismic Surveys

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Over the past 5 years, the open-source software movement has facilitated the development of advanced, collaborative, low-cost computational tools over a wide range of applications including computational tectonics and computational seismology. Codes such as Underworld (www.underworldproject.org) and Gale (www.geodynamics.org) allow simulating the evolution of rheologically realistic 3D models of the Earth's lithosphere and underlying mantle submitted to time-dependent kinematic or dynamic conditions. On the other hand, codes such as Madagascar RSF (www.reproducibility.org) can simulate the propagation of elastic waves through complex 3D models, which offer the opportunity to explore them via synthetic seismic reflection and refraction techniques.

We have developed a workflow to transform 2D and 3D Underworld/Gale output models into a format suitable to run Madagascar RSF scripts. This is done by selecting the key elements of the particle and mesh data generated from Underworld/Gale models, and non-destructively interpolating them into Madagascar's RSF file format. With this new workflow one can image Underworld/Gale computational tectonic models using synthetic seismic techniques.

This workflow allows us to directly compare synthetic seismic sections with real seismic data, thereby facilitating the iterative refinement of the crustal deformation models. This inversion procedure provides a new way to further constrain subsurface geology, particularly in regions of poor data, in a manner that is geometrically, thermally and mechanically self-consistent.