Geophysical Research Abstracts
Vol. 16, EGU2014-6152-1, 2014
EGU General Assembly 2014

A fictitious domain method for fluid/solid coupling applied to the lithosphere/asthenosphere interaction.

Nestor Cerpa, Riad Hassani, and Muriel Gerbault

Université de Nice Sophia-Antipolis, C.N.R.S., I.R.D., Observatoire de la Côte d'Azur, Géoazur UMR 7329, Sophia Antipolis 06560 Valbonne, France.France (nestor.cerpa@geoazur.unice.fr)

A large variety of geodynamical problems can be viewed as a solid/fluid interaction problem coupling two bodies with different physics. In particular the lithosphere/asthenosphere mechanical interaction in subduction zones belongs to this kind of problem, where the solid lithosphere is embedded in the asthenospheric viscous fluid. In many fields (Industry, Civil Engineering,etc.), in which deformations of solid and fluid are "small", numerical modelers consider the exact discretization of both domains and fit as well as possible the shape of the interface between the two domains, solving the discretized physic problems by the Finite Element Method (FEM). Although, in a context of subduction, the lithosphere is submitted to large deformation, and can evolve into a complex geometry, thus leading to important deformation of the surrounding asthenosphere.

To alleviate the precise meshing of complex geometries, numerical modelers have developed non-matching interface methods called Fictitious Domain Methods (FDM). The main idea of these methods is to extend the initial problem to a bigger (and simpler) domain.

In our version of FDM, we determine the forces at the immersed solid boundary required to minimize (at the least square sense) the difference between fluid and solid velocities at this interface. This method is first-order accurate and the stability depends on the ratio between the fluid background mesh size and the interface discretization.

We present the formulation and provide benchmarks and examples showing the potential of the method : 1) A comparison with an analytical solution of a viscous flow around a rigid body. 2) An experiment of a rigid sphere sinking in a viscous fluid (in two and three dimensional cases). 3) A comparison with an analog subduction experiment.

Another presentation aims at describing the geodynamical application of this method to Andean subduction dynamics, studying cyclic slab folding on the 660 km discontinuity, and its relationship with flat subduction.