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The role of elastic compressibility in dynamic subduction models

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Recent advances in geodynamic numerical models show a trend towards more realistic rheologies. The Earth is no longer modeled as a purely viscous fluid, but the effects of, for example, elasticity and plasticity are also included. However, by making such improvements, it is essential to include these more complex rheologies in a consistent way. Specifically, compressibility needs also to be included, an effect that is commonly neglected in numerical models.

Recently, we showed that the effect of elastic compressibility is significant. This was done for a gravity driven cylinder in a homogeneous Maxwell fluid bounded by closed boundaries. For a fluid with a realistic compressibility (Poisson ratio equals 0.3), the settling velocity showed a discrepancy with the semi-analytical steady state incompressible solution of approximately 40%. The motion of the fluid was no longer restricted by a small region around the cylinder, but the motion of the cylinder compressed also the fluid near the bottom boundary. This compression decreased the resistance on the cylinder and resulted in a larger settling velocity.

Here, we examine the influence of elastic compressibility in an oceanic subduction setting. The slab is driven by slab pull and a far field prescribed plate motion. Preliminary results indicate that elastic compressibility has a significant effect on the fluid motion. Differences with respect to nearly incompressible solution are most significant near material boundaries. In line with our earlier findings, the flow is increased in regions of confined flow, such as the mantle wedge or the subduction channel. As a consequence, an increasing compressibility results in a larger slab velocity. We seek to identify surface observables, such as topography and plate motion, that allow us to distinguish the compressible and incompressible behavior.