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Erratum

Wang, R., 2005. The dislocation theory: a consistent way for including the gravity effect in (visco)elastic plane-earth models (*Geophys. J. Int.,* **161,** 191–196)

In Wang (2005), I showed that the (visco)elastic-gravitational dislocation theory may not be able to resolve the deformation field of wavenumbers smaller than a certain critical value due to the destabilizing effect of gravity. I also proposed an approach to solve the problem. The first equation of motion, based on which I started my analysis, was given in the form,

$$\nabla \cdot \boldsymbol{\Gamma} + \rho \nabla(\psi + \mathbf{u} \cdot \mathbf{g}) - \mathbf{g} \nabla \cdot (\rho \mathbf{u}) = \mathbf{0}, \tag{1}$$

where $\mathbf{u}$ is the displacement vector, ψ is the Eulerian incremental potential, $\mathbf{g}$ is the earth's gravity, ρ is the density, and $\boldsymbol{\Gamma}$ is the Lagrangian incremental stress tensor. Unfortunately, this equation was derived incorrectly. Its correct form should be

$$\nabla \cdot \boldsymbol{\Gamma} + \rho \nabla(\psi + \mathbf{u} \cdot \mathbf{g}) - \rho \mathbf{g} \nabla \cdot \mathbf{u} = \mathbf{0} \tag{2}$$

(see e.g. Backus 1967), i.e. the last term $-\mathbf{g}\nabla \cdot (\rho \mathbf{u})$ should be corrected to $-\rho \mathbf{g} \nabla \cdot \mathbf{u}$. The same mistake was made in a following paper by Wang *et al.* (2006), in which the related software for modelling co- and post-seismic deformation was presented.

The plane-earth model used consists of a stack of homogeneous layers overlaying a homogeneous halfspace. It has been known that the critical wavenumber exists only when the gravity effect in the homogeneous halfspace, usually used for simulating the medium below the crust or upper mantle, is taken into account. The problem can be avoided by using the Adams–Williamson condition that requires a density gradient as a result of the initial hydrostatic equilibration,

$$\frac{d\rho}{dz} = \frac{\rho^2 g}{\kappa}, \tag{3}$$

where κ is the bulk modulus. By assuming a constant gravity value, but a depth-dependent density according to the Adams–Williamson condition, I then derived from eq. (1) the modified equation of motion for the homogeneous halfspace, that is, eq. (12) in Wang (2005) and eq. (10) in Wang *et al.* (2006),

$$\nabla \cdot \boldsymbol{\Gamma} + \rho g \left[\nabla u_z - \left(\nabla \cdot \mathbf{u} + \frac{\rho g}{\kappa} u_z \right) \mathbf{e}_z \right] = \mathbf{0}, \tag{4}$$

where the self-gravitating term $\rho \nabla \psi$ has been neglected and $\mathbf{g} = g\mathbf{e}_z$ has been used. In the following, the correct derivation of the equation is presented.

The correction is made by assuming a decreasing gravity field in addition to the increasing density. This treatment gives a more consistent and closer plane-earth approximation to a self-gravitating elastic earth with spherical geometry especially for the deep structure, than using the constant gravity. For simplicity, a fully compensated variation between the density and gravity is used by assuming the product ρg to be constant,

$$\frac{d(\rho g)}{dz} = \frac{d\rho}{dz} g + \rho \frac{dg}{dz} = 0. \tag{5}$$

By this assumption, one can relate the gravity gradient included in the corrected equation of motion, eq. (2), with the Adams–Williamson gradient of density,

$$\frac{dg}{dz} = -\frac{\rho g^2}{\kappa}, \tag{6}$$

and arrive at the same result as eq. (4).

For values of the seismic parameter $\frac{\kappa}{\rho}$ taken from a seismic reference model, the assumed vertical gravity gradient in the whole mantle is smaller than 3 per cent per 100 km. Keeping in mind that the static deformation due to earthquakes is in general limited to the crust and the upper mantle, this can be seen to be a tolerable modification on the constant gravity which has usually been assumed for the plane-earth model. Therefore, it should be noted that all numerical results and conclusions presented in the mentioned two papers are consistent with the modified approximation by eq. (6) and can be regarded as still valid despite the mistake made there.

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