Influence of viscoelastic relaxation on estimated interplate coupling along the Nankai Trough, southwest Japan

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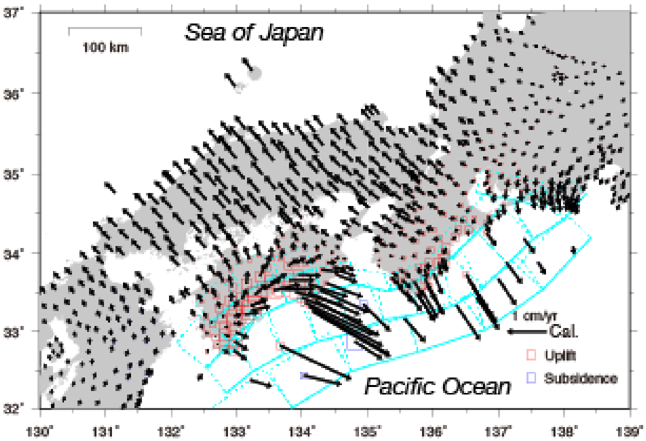
Viscoelastic relaxation in asthenosphere is an important factor for understanding crustal deformation in the subduction zone. Although interplate coupling on subduction interface has often been estimated from geodetic data using a purely elastic dislocation model, several recent studies (e.g., Li et al., 2015) pointed out that ignoring viscoelasticity in the medium made estimated coupling distribution biased. Pollitz and Evans (2017) developed viscoelastic block models introducing a viscoelastic correction term for earthquake cycles to estimate both interplate coupling and rigid rotation of microplates in western US. Once you subtracted the viscoelastic correction velocities from observed ones, the corrected velocities can be inverted by conventional elastic block models. The viscoelastic correction term consists of two components. One (hereafter, 1st component) is viscoelastic velocities due to interplate locking in the past, which is constant over the interseismic period. The other (hereafter, 2nd component) is total postseismic velocities of past earthquakes repeated with a certain recurrence interval, which is dependent on a time from the last earthquake. Here we examine these viscoelastic correction components for megathrust earthquake cycles along the Nankai trough.

We calculated viscoelastic deformation using VISCO1D (Pollitz, 1997) and assumed a 35 km thick elastic plate overriding a Maxwell viscoelastic half-space with a viscosity of 10^{19} Pa s. Coseismic fault model for the 1944 Tonankai and 1946 Nankai earthquakes estimated by Sagiya and Thatcher (1999) is used for viscoelastic calculation. A recurrence interval of megathrust earthquakes is 117 years and slip deficit accumulated for the interseismic period is completely released by the megathrust earthquakes. Figs. A-C show 1st and 2nd components as well as the sum of them as of 2007. 1st component represent a difference between elastic and viscoelastic responses of locking that has continued since the infinite past. It reaches 2 cm/yr along the Pacific coast and several mm/yr even along the coast of Sea of Japan (Fig. A). 2nd component is generally reverse to 1st component and decays with time from the last earthquake. Amplitude of 2nd component is roughly equal to that of 1st component 30 years after the last earthquake. Therefore, total viscoelastic correction is minimized 30 years after the last earthquakes during the interseismic period. Even after 61 years of the last earthquakes, velocities of 2nd component is still comparable to those of 1st component (Fig. B). Total correction velocities, therefore, exceed 2 mm/yr only near peninsulas along the Pacific Ocean (Fig. C). 2nd component reaches several mm/yr in the last years of the interseismic period for the Nankai subduction zone and cannot be ignored for better viscoelastic correction.

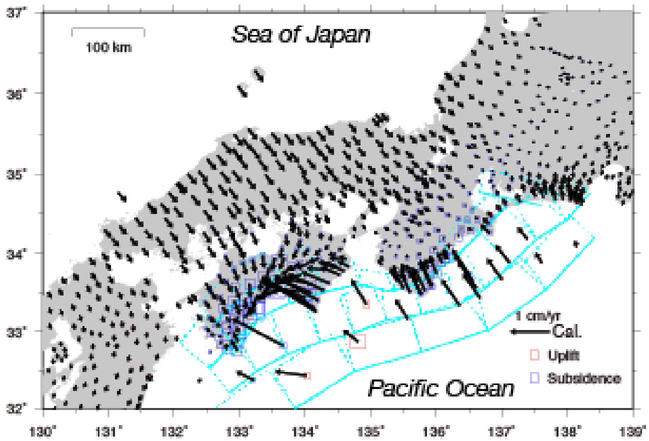
We present a result of applying viscoelastic correction to the block model of Nishimura et al.(2018) which models onshore GNSS and offshore GNSS-Acoustic velocities in southwest Japan.

Keywords: Crustal deformation, Viscoelastic relaxation, Nankai trough, Viscoelastic block model

(a)Velocity for viscoelastic correction of slip-deficit



(b) Velocity for viscoelastic correction of past earthquakes



(c) Velocity for total viscoelastic correction