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Numerical modeling on intersesimic and post-seismic vertical deformation of NE Japan: Role of rheological heterogeneity

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Nation wide deployment of dense geodetic network has clarified the strain accumulation and release processes through the megathrust earthquake cycle for the NE Japan subduction zone system. Prior to the 2011 Tohoku Oki earthquake, vertical deformation was characterized by rapid subsidence in the forearc and gentle uplift in the backarc. The large subsidence is only observed in a latitude range between N37 and N40 degrees. At the Tohoku Oki earthquake, coseismic vertical deformation shows a subsidence simply increasing eastward reaching a 1.2 m on the Oshika Peninsula. Post-seismic deformation over the three years shows concentric distribution of uplift and subsidence around the epicentral area: uplift in the forearc, subsidence in the volcanic front to backarc, and uplift in further backarc to Japan Sea side. The pattern of the observed uplift and subsidence across the island arc in the middle of the NE Japan, crossing the largest slip of the Tohoku Oki earthquake, is opposite that in the interseismic period (Nishimura, 2014). Here, we developed two dimensional and three dimensional finite element models of the NE Japan subduction zone to simulate the vertical crustal deformation during the megathrust earthquake cycle. Two dimensional model transects and three dimensional model includes an area of large coseismic slip of the Tohoku Oki earthquake. Temperature dependent heterogeneous viscosity structures were utilized to investigate the role of rheological heterogeneity (Muto et al., 2013). Deformation along plate boundary is the kinematically assigned using the split node method. During interseismic period, backslip is given to a locked portion at a plate convergence rate of 80 mm/year. At the coseismic step, the amount of slip corresponding to slip deficit accumulated during the interseismic period for 500 years is given along the locked portion. Our preliminary models indicate that the pattern of vertical deformation implies the rheological heterogeneity normal to the NE Japan island arc. Especially the model with presence of rheological contrast between thick, cold forearc and weak volcanic front reproduce similar pattern of vertical deformation observed in the interseismic period. Those results strongly suggest that the incorporation of rheological heterogeneity is required to explain the strain accumulation process in three-dimensional subduction zone systems from the geodetic observation.

References:
Muto, J., B. Shibazaki, Y. Ito, T. Iinuma, M. Ohzono, T. Matsumoto, and T. Okada (2013), Geophys. Res. Lett., 40, doi:10.1002/grl.50906.
Nishimura, T. (2014), J. Disaster Res., 3, 294-302.

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