An attempt to quantify transient fluid flow during slow slip event using GNSS and gravity data-1st report

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Slow slip events (SSEs) cause crustal deformation. The observed deformations are usually explained with a fault model based on elasticity dislocation theory and fault slip distributions on plate interfaces have been inferred. On the other hand, a recent study analyzing the temporal gravity change which was obtained in the Tokai area indicates that long-term SSEs could cause transient fluid flow within the fault fracture zone. According to their study, fault slip cannot explain the observed negative gravity anomalies because the density redistribution which is expected from a dislocation theory is too small. However, their fluid-flow model neglects the deformation outside the fault fracture zone for simplicity. Therefore, how large surface deformation occurs due to such fluid flow (if it exists) has not yet been estimated. In this study, we propose a model which can consider the crustal deformation outside the fault fracture zone, which is induced by fluid flow. Instead of poroelasticity theories, we combine Mogi model with an ordinary dislocation model. Our model does not include a physical mechanism to drive the fluid flow itself. However, the kinematic approach allows us to quantify the fluid volume which is injected within the fault fracture zone during the SSEs in a very simple manner, using crustal deformation and gravity anomaly data. A preliminary result indicates that the injected fluid volume is approximately 0.01% if assuming that the thickness of the fault fracture zone is 200 m and the length and the width of the area where the fluid flow occurs are of the fault model of the SSE. For this volume change, our model can explain the crustal deformation and the gravity anomaly simultaneously.

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