Restart of the long-term slow slip events along the Nankai trough after the 2016 Kumamoto earthquake, Japan

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Abstract

Transitional crustal deformation along the Nankai Trough has been observed by GEONET around June 2018. Analysis by time-dependent inversion shows that the long-term SSE occurred in the northern part of Hyuga-Nada Sea from around June 2018 to September and then the slip region moved to the Bungo Channel northeast of 50 km. The sliding area of SSE in 2018 corresponds to the non-slip area of the Hyuga-nada SSE and Bungo channel SSE which were occurring just before the 2016 Kumamoto earthquake. The case of 2018 is a typical example in which long-term SSE was affected by stress perturbation due to a large earthquake, and it gives information on the physical mechanism of SSE. In addition, it has been about 20 years since the last occurrence of the Hyuga-nada earthquake and the probability of the occurrence of the earthquake is 70 to 80% within the next 30 years off the coast of Shikoku. Thus, there is concern about the influence of stress change due to the 2018 SSE on the seismic gap of Hyuga-nada and off the Pacific coast of Shikoku.

Introduction

Along the Nankai Trough, the Hyuga-nada and the Bungo channel long-term SSEs have repeatedly occurred. Long-term SSEs were occurring in Hyuga-nada and Bungo Channel before the 2016 Kumamoto earthquake. Due to the occurrence of the Kumamoto earthquake, SSE in the Hyuga-nada Sea and the Bungo Channel stopped its progress. This is thought to be due to the susceptibility of long-term SSE to stress disturbance caused by a large earthquake. It has been of interest to know when the remaining area of the slip will resume afterwards. Under such circumstances, from around June 2018, transitional crustal deformation was detected by GEONET. The detected transient occurred in northern Kyushu and propagated northeast to the Bungo channel by about 50 km. In this study, we estimated the spatial and temporal evolution of aseismic slip on the plate interface from the observed crustal deformation data by time dependent inversion.

Analytical Method

257 GEONET stations in Shikoku and Kyushu were used in the analysis. From the position time series, the periodic component is estimated from the data of January 2013 to January 2018 and removed from the time series data, after which the linear trend component of January 2017 to January 2018 is removed. The coordinate time series data thus obtained was averaged over 3 days, sampled every 3 days, and used for the time dependent inversion. The analysis period is from January 2018 to January 2019. The weights of east-west, north-south, up-and-down components are set to 5: 5: 1. Hirose et al. (2008) is adopted as a plate boundary model, and it is modeled by a spline surface. The hyperparameters of spatial smoothing and temporal smoothing were estimated by maximum likelihood method.

Result and discussion

Aseismic slip occurred on the plate interface in the northern part of the Hyuga-nada Sea since around June 2018, subsiding in September. The amount of slippage reaches about 10 cm at the maximum. Since about September, the slip area has moved 50 km to the northeast from the north of Hyuganada to the Bungo Channel. The maximum slippage of the Bungo channel SSE from September 2018 until January 2019 reaches 7 cm. The area slipped at SSE in 2018 corresponds to the area where slip began or did not start in the long-term SSE that occurred until just before the 2016 Kumamoto earthquake. It is thought that reactivation occurred in 2018 two years after the long-term SSE, which stopped due to the stress disturbance accompanying the Kumamoto earthquake in 2016, from the balance between the plate loading and stress relaxation due to viscoelastic deformation. This case is a typical example of stress disturbance to long-term SSE by a large earthquake and very important in understanding the physical process of long-term SSE.

Keywords: slow slip event, Hyuga-nada seas, Bungo channel