Bayesian l_1 trend filtering for slow slip detection

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This study focuses on automatic detection for slow slip events (SSEs), which are a geodetical signal of slow earthquakes. SSEs are classified into two types according to their slip durations: long-term SSEs for durations of months to years, and short-term SSEs for durations of a couple of days to weeks. Recent geodetic observations have detected many short-term SSEs in many subduction zones such as Nankai and Cascadia. SSEs are related to the other types of earthquakes including large earthquakes, and therefore refined analysis of SSEs contributes to a better understanding of earthquakes. Detecting SSEs, which is our focus here, is the first important step in the analysis. The automatic detection method based on Akaike Information Criterion (AIC) has been proposed [Nishimura, et al., 2013] and has increased a number of detectable SSEs along the Nankai Trough, southwest Japan.

In this study, we propose a new Bayesian method for detecting short-term SSEs using Global Navigation Satellite System. The proposed method models SSEs as change points of polynomial trends in observations, and employs a Bayesian version of ℓ_1 trend filtering. ℓ_1 trend filtering [Kim, et al., 2009] gives trend estimates that are piecewise polynomial, and hence it fits the analysis of time series having an underlying piecewise polynomial trend. It provides change points of a piecewise polynomial trend and so has been used to detect change points in underlying trends [Rojas and Wahlberg, 2015]. Our Bayesian version of ℓ_1 trend filtering provide not only estimates of change points but also the uncertainty of them. We report the performance comparison of our method to the AIC based detector [Nishimura, et al., 2013] through simulation studies (as well as the real data).

Keywords: Slow slip events, GNSS, Trend filtering

