

## A new approach to time dependent inversion of geodetic data using Monte Carlo mixture Kalman filter

# Jun'ichi Fukuda[1], Tomoyuki Higuchi[2], Shin'ichi Miyazaki[3], Teruyuki Kato[4]

[1] Earthquake Research Institute, Univ. of Tokyo, [2] Inst. Stat. Math., [3] ERI, [4] Earthq. Res. Inst., Univ. Tokyo

In the last decade, the continuous GPS networks have observed transient crustal deformation associated with various types of aseismic fault slip events in many subduction zones. It is important to precisely clarify the whole time history of these events to understand the physical process of earthquake generation. For this purpose, we develop a new time dependent inversion method for imaging transient fault slips from geodetic data. Segall and Matthews (1997) presented a time dependent inversion method to infer spatio-temporal distribution of fault slip from geodetic data. They modeled a transient crustal deformation associated with fault slip events using a linear Gaussian state space model and employed Kalman filter. They introduced a scaling parameter that represents temporal smoothness of the fault slip and assumed that the scaling parameter is constant over observation period. Under this assumption, abrupt changes of slip have been overly smoothed whereas estimated slips in 'quiet' steady state period have been oscillatory. In order to improve the method, we develop a new filtering technique, Monte Carlo mixture Kalman filter (MCMKF), and apply it to the time dependent inversion. The MCMKF allows variations of the temporal smoothness of slips in the following steps: (1) we prepare a limited number of competing state space models, each of which is characterized by different temporal smoothnesses, (2) we introduce a switching structure among these competing models. We examine the validity of thus introduced MCMKF based inversion scheme through numerical experiments using simulated displacement time series. Then the results are compared with those obtained by conventional Kalman filter based scheme. In all cases, MCMKF gives significantly smaller AIC (Akaike information criterion) values than Kalman filter. This indicates that MCMKF yields better state estimates than Kalman filter. We also find that MCMKF is capable of imaging initiation process of transient slip events in cases of high signal-to-noise ratio, while Kalman filter is not. Furthermore, MCMKF is superior to Kalman filter in detecting small signals from noisy datasets. From all results above, we conclude that the new filtering approach introduced here may provide a powerful tool for imaging the time history of fault slips.