Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MTT40-P01 Room:Convention Hall Time:May 27 18:15-19:30

State and parameter estimation of numerical models of fault slip using data assimilations methods

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Numerical models of the evolution of fault slip based on rate- and state-dependent frictions laws have been widely used to simulate variety of seismic and aseismic fault slip behavior during the earthquake cycle, including earthquakes, afterslip, slow slip events, and steady aseismic creep. These numerical models consist of the equations of motion and friction law for many subdivided fault patches and include parameters that describe frictional properties of the fault. Previous numerical studies have shown that these parameters, which are often called friction parameters, as well as initial conditions of the model, are one of the governing factors in determining the evolution of fault slip. However, it has been difficult to constrain the friction parameters and initial conditions for natural faults. In this study, we develop methods to simultaneously estimate the friction parameters and initial conditions of the model based on data assimilation methods.

We focus on afterslip, which is transient, decelerating, aseismic slip triggered by stress changes due to a large earthquake. We assume cumulative slip is observable and generate simulated data using the numerical model. A nonlinear state space model is used to relate the numerical model and observations to unknown parameters and dependent variables of the model.

We first adopt the particle filter and smoother to estimate probability distributions of the parameters and dependent variables of the model. In this case, the particle filter/smoother tends to degenerate even if a simplified model and relatively a large number of particles are employed, suggesting that it is difficult to correctly estimate the probability distributions of the unknowns with the particle filter/smoother. We then adopt the ensemble Kalman filter and smoother. We find that the ensemble Kalman filter/smoother does not degenerate even if the number of particles is small, indicating that this method is useful for our problem.

Our results indicate that our methods reproduce the true parameter values reasonably well if the initial conditions are fixed to the true values. In contrast, if the initial conditions are treated as unknowns, the state variable in the rate-state friction law cannot be constrained. In addition, the estimated friction parameters exhibit large uncertainties and a systematic bias. These results suggest that there are significant trade-offs between the friction parameters and initial conditions. We will discuss the details of the results, considerations on how to overcome the trade-offs, results from other data sets, and detailed comparisons of the two methods in the presentation.

Keywords: fault slip, friction parameters, state estimation, parameter estimation, data assimilation, state space model

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A waveform display system based on SeisComP3, for efficiently browsing the seismic data of several different networks

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One of the fundamental tasks in seismological research is to systematically view and evaluate a large quantity of seismic records. Firstly the data quality must be checked and then the records can be searched for interesting phenomena, which can become targets for future scientific research.

We have developed a website, which summarizes the seismological data obtained by several different networks, including those of local sizes and a semi-global size. It allows users to efficiently browse through the entire record. The waveform archive system is based on SeisComP3 (http://www.seiscomp3.org) and the data are archived in SEED format (www.iris.edu/manuals/SEEDManual_V2.4.pdf).

Currently the website consists of three major parts; a station description page, an earthquake catalogue page, which is linked to an interactive earthquake waveform viewer, and a page to align and enlarge pre-constructed image files of waveform data, plotted in several different ways.

In this presentation we will first show how this website can be used and then we will present some applications. Finally, we will discuss how the website can develop further to reach its full potential.

Keywords: SEED, SeisComP3, Earthquake monitoring system