A Network Inversion Filter combining GNSS and InSAR for tectonic slip modeling

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Time dependent slip modeling can be a powerful tool to improve our understanding on the interaction of earthquake cycle processes such as interseismic, coseismic, postseismic, and aseismic slip. Interferometric Synthetic Aperture Radar (InSAR) observations allow us to model slip at depth with a higher spatial resolution than when using GNSS alone. Typically, the temporal resolution of InSAR has been limited. However, the recent generation of SAR satellites including Sentinel-1, COSMO-SkyMED, and RADARSAT-2 permits the use of InSAR for time-dependent slip modeling, at intervals of a few days when combined. The increasing amount of SAR data makes a simultaneous data inversion of all epochs challenging. Here, we expanded the original Network Inversion Filter (Segall and Matthews, 1997) to include InSAR observations of surface displacements in addition to GNSS. In the NIF framework, geodetic observations are limited to those of a given epoch, where a physical model describes the slip evolution over time. The combination of the Kalman forward filtering and backward smoothing allows all geodetic observations to constrain the complete observation period. Combining GNSS and InSAR allows us to model time-dependent slip at an unprecedented spatial resolution. We validate the approach with a simulation of the 2006 Guerrero slow slip event. In our study, we emphasize the importance of including the InSAR covariance information, and demonstrate that InSAR provides an additional constraint on the spatial extent of the slow slip.