Automatic slow slip event detections with the geodetic matched filter on InSAR time series: application to the North Anatolian Fault

Estelle Neyrinck[*†1], Baptiste Rousset[‡1], Cécile Doubre[1], Luis Rivera[1], Cécile Lasserre[2], Marie-Pierre Doin[3], Philippe Durand[4], and Flatsim Working Group

[1]Institut Terre Environnement Strasbourg – Ecole Nationale du Génie de l'Eau et de l'Environnement de Strasbourg, université de Strasbourg, Institut National des Sciences de l'Univers, Centre National de la Recherche Scientifique – France

[2]Université Lyon 1 – Univ Lyon, Univ Lyon 1, ENSL, CNRS, LGL-TPE, F-69622, Villeurbanne, France – France

[3]Université Grenoble Alpes – Université Grenoble Alpes, Université Savoie Mont Blanc, CNRS, IRD, IFSTTAR, ISTerre, 38000 Grenoble, France – France

[4]Centre National d´tudes Spatiales [Toulouse] – Centre National d'Etudes Spatiales - CNES (Toulouse, France) – France

Résumé

Analysis of the Interferometry Synthetic Aperture Radar (InSAR) time series enabled the detection and characterization of slow slip events (SSE) on several strike-slip fault segments worldwide. With the increase of InSAR acquisitions and the development of automatic processing methods, the implementation of automatic SSE detection methods is much needed to overcome the large incoming flow of data. Here, we adapted the original geodetic matched filter approach developed for GNSS time series by Rousset et al. (2017) to InSAR time series. The method is computing physics-based templates that are correlated with InSAR time series, taking advantage of the high spatial resolution of the InSAR observations. By comparing true and false detections in synthetic tests including realistic noise, we derive a probabilistic estimation of the true detections as a function of magnitudes. For example, we show that this method enables the detection with 98 % confidence of shallow SSEs with magnitudes larger than 4.75. And it can detect events with magnitudes larger than 4.55 with 83 % confidence. The amplitude of events we can detect increases rapidly with depth. We applied this method along the Izmit segment of the North Anatolian Fault by using the InSAR time series from 2016 to 2021 automatically processed in the framework of the FLATSIM project between CNES and Form@Ter by using Sentinel-1 SAR images and based on the NSBAS processing chain (Thollard et al., 2021; Doin et al., 2011). It detected without any prior knowledge three transient events already reported by previous studies (Aslan et al., 2019; Neyrinck et al., 2024). Based on a weighted stacked time series associated with the detections, we characterize magnitudes for these three events ranging from 4.2 to 4.4, also compatible with previous estimates. Applying this method on worldwide strike-slip fault segments may allow us rapid detection and first order characterization of transient slip events, to enhance our understanding of aseismic slip dynamics throughout the seismic cycle.

[*]Intervenant

[†]Auteur correspondant: estelle.neyrinck@etu.unistra.fr

[‡]Auteur correspondant: baptiste.rousset@unistra.fr

Mots-Clés: Slow slip events, Strike Slip fault, SAR interferometry, North Anatolian Fault