Subject offered for a contract starting October 2018

SUBJECT TITLE: Systematic detection of transient events on continental faults and their role in the seismic cycle.

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Context:

With the recent spatial and temporal densification of geodetic measurements, new fault behaviours have been detected. Among them, aseismic transient events such as slow slip have been identified along the North Anatolian and the San Andreas faults. They have been shown to accommodate up to several centimetres of slip and thus would significantly contribute to strain release along plate boundaries. In this way, transient events challenge the idea and nature of the seismic cycle, raising fundamental questions on the influence of rheology and stress on the slip behaviour of faults.

Assessing their spatial and temporal distribution is of central importance in moving closer towards redefining the seismic cycle (if there is one), mapping the strain distribution along fault zones, and understanding crustal deformation along plate boundaries in general. Newly available SAR measurements from the European Space Agency Sentinel 1 mission, combined with ground GPS stations provide an unequalled opportunity to detect and quantify these events. However, such opportunity comes with a challenge: we need to develop tools to absorb, process and mine this now continuous flow of data.

Project:

This project will consist in:

(1) Developing a new method of assimilation of InSAR data. This will include the implementation of an Ensemble Kalman filter, which will reconstruct the evolution of ground displacements from InSAR data as well as solve for the PDF of the parameters of a best-fitting deformation model (Fig. 1). This model will first be an *ad hoc* parameterised function of time before being physically based (see (4)).

(2) Identifying transient events on selected fault zones including the Chaman Fault (Pakistan), the Longitudinal Valley Fault (Taiwan) and the San Andreas Fault System (California).

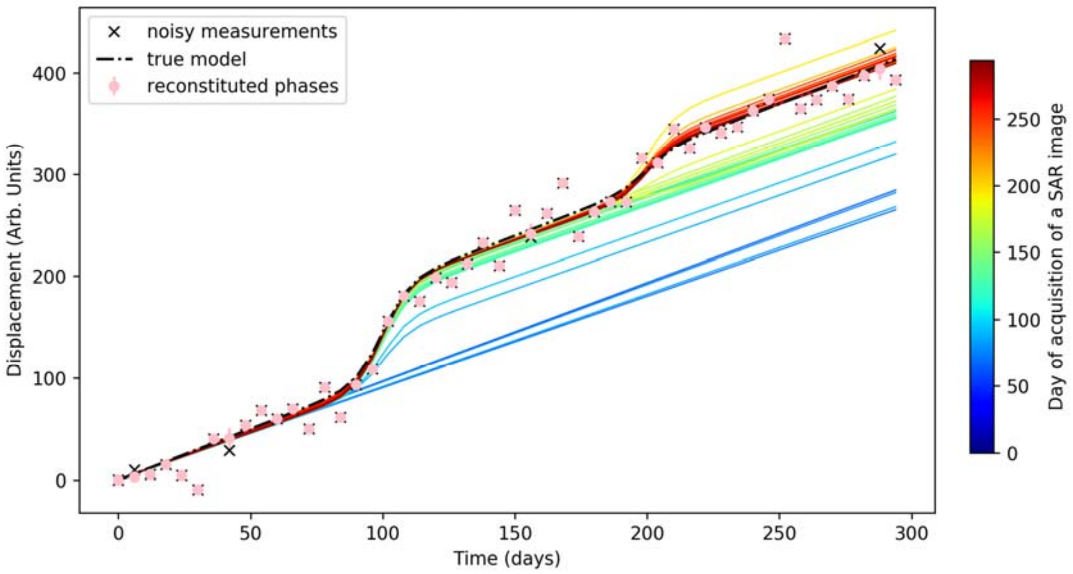

Fig 1 –Results of the first setup of Kalman filter assimilation on a synthetic set of InSAR data on one pixel. Colored lines are models derived at each assimilation of a new acquisition. Models accurately predict the velocity as well as the amplitude of the two slow slip events (at 100 and 200 days) at the time they happened.

(3) Investigating the dynamics of slow slip events, by looking at the range of behaviours produced by simple dynamic models of faults, such as the well-known spring-slider system, including different friction laws. Various mechanisms, that could explain slow slips, will be investigated.

(4) Building a physical model that will be updated iteratively and instantaneously as more InSAR data are collected. We aim at reconstructing strain along the fault to identify whether slip behaviour can be understood from what the model has learnt from the past (see (1)) and from the physical understanding of the phenomenon (see (3)).

These results will be considered in the general scope of the seismic cycle and crustal deformations.