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Interseismic coupling on the Main Himalayan Thrust: Bayesian modelling accounting for prediction uncertainties

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Most of the convergence rate across the Himalaya of central Nepal has been shown to be absorbed by slip along a major basal thrust fault: the Main Himalayan Thrust fault (MHT). In this context, the geodetic strain measured across the Nepal Himalaya can be used to determine the pattern of locking of the fault in the interseismic period and estimate the return period of large earthquakes required to release the elastic strain which builds up in the interseismic period. A coupling map already exists (*Ader et al.*, 2012), which indicates that the MHT is locked from the surface to a distance of approximately 100 km down dip. However, these results are obtained assuming a planar fault in a purely elastic and infinitely long half-space. These assumptions can thus strongly impact inferences of seismogenic coupling. For instance, the 2015 Mw 7.8 Gorkha–Nepal earthquake revealed a potential key role of fault geometry in controlling damaging ruptures along MHT. However, what controls the arrest of the rupture is not yet clear since this portion of the fault appears locked during the pre-seismic period. Going forward, we need a robust coupling model to understand its spatial relationship to interseismic, preseismic, and postseismic slip, which will provide better insights into the mechanical behaviour of the MHT. In this study, we propose a new coupling model obtained from the joint inversion of multiple observations (GPS and levelling data) in a fully Bayesian framework. This approach allows to evaluate the population of plausible coupling models given geodetic data and forward problem uncertainties. We first explore a few simple forward models to derive first order conclusions on the extent of interseismic plate coupling. We then use a fully Bayesian approach to explore in greater detail the range of possible models of plate coupling and assess the variability allowed by the interseismic velocity. In addition, we account for uncertainty in the assumed elastic structure used to compute the Greens functions. Thus, our solution includes the ensemble of all plausible models that are consistent with our prior information and fit the available observations within data and prediction uncertainties. Our goal is not only to obtain a trustworthy coupling distribution but also to produce realistic estimates of uncertainty, which can impact our interpretation and assessment of future rupture processes.