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Postseismic deformation following the 2015 Mw 7.8 Gorkha earthquake and the distribution of brittle and ductile crustal processes beneath Nepal

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Studies of geodetic data across the earthquake cycle indicate a wide range of mechanisms contribute to cycles of stress buildup and relaxation. Both on-fault rate and state friction and off-fault rheologies can contribute to the observed deformation; in particular, the postseismic transient phase of the earthquake cycle. One problem with many of these models is that there is a wide range of parameter space to be investigated, with each parameter pair possessing their own tradeoffs. This becomes especially problematic when trying to model both on-fault and off-fault deformation simultaneously. The computational time to simulate these processes simultaneously using finite element and spectral methods can restrict parametric investigations.

We present a novel approach to simulate on-fault and off-fault deformation simultaneously using analytical Green's functions for distributed deformation at depth [Barbot, Moore and Lambert., 2016]. This allows us to jointly explore dynamic frictional properties on the fault, and the plastic properties of the bulk rocks (including grain size and water distribution) in the lower crust with low computational cost. These new displacement and stress Green's functions can be used for both forward and inverse modelling of distributed shear, where the calculated strain-rates can be converted to effective viscosities.

Here, we draw insight from the postseismic geodetic observations following the 2015 Mw 7.8 Gorkha earthquake. We forward model afterslip using rate and state friction on the megathrust geometry with the two ramp-décollement system presented by Hubbard et al., (pers. comm., 2015) and viscoelastic relaxation using recent experimentally derived flow laws with transient rheology and the thermal structure from [Cattin et al., 2001]. The calculated strain-rates can be converted to effective viscosities. The postseismic deformation brings new insights into the distribution of brittle and ductile crustal processes beneath Nepal.

References

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