Towards better seismic hazard assessments with InSAR

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The recent earthquake in Chengdu, China, reminds us that seismic hazard is still a major threat. The last decades research efforts have turned to quantifying this threat, rather than predicting the event. For this a detailed description of past earthquake mechanisms and accurate analysis of uncertainties is vital. Our research in this field involves the following computational setup.

INSAR
Co-seismic deformation is an important observable that can be related to subsurface change. Space borne SAR provides dense spatial coverage and has well understood accuracy.

TOPOGRAPHY
With FEM modeling it is not required to assume flat earth. The same height map that is used in SAR processing defines the upper boundary of the computational domain.

FEM FORWARD MODEL
Physics connect subsurface processes to deformation at the surface. Elastic behavior is assumed and modeled by Finite Element Methods. These are more flexible than the more commonly used analytical or boundary element methods.

LAYERING
Earth's elastic properties vary with depth. Commonly used models assume homogeneity, which has been reported to affect inversion results significantly. Our FEM based model does not have this limitation.

HETEROGENITY
Elasticity parameters are known up to certain accuracy. To account for this they are modeled as random fields, and stochastic finite elements (SFEM) are employed to track how uncertainty propagates to observable quantities.

NON-CONFORMING FAULT
The earthquake mechanism is a combination of fault geometry and distributed slip. The slip gives rise to discontinuities, which in conventional FEM models can only occur at element boundaries. Our method employs the Partition of Unity Method (PUM, also known as XFEM) to achieve mesh-independence.

INVERSION
The forward model links earthquake mechanisms to surface displacements. The probability distribution for which propagated uncertainty matches that of the InSAR acquisition represents our knowledge of the system.

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