Imaging Global Fault System Activity

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November 16, 2022

Abstract

Earthquake moment release is localized along a global fault system. This network of branching and anastomosing fractures defines the geometrically complex boundaries of tectonic plates and serves as the locus of contemporary elastic strain energy storage between earthquakes. The slow deformation of the earth's crust in between earthquakes has been observed geodetically for decades and provides a filtered representation of the underlying earthquake behaviors. Here we describe efforts to model fault system activity at a global scale incorporating both tectonic plate motions and earthquake cycle effects. Interseismic earthquake cycle effects are represented using a first-order quasi-static elastic approximation, and these models yield a unified estimate of slip deficit rates and subduction zone coupling constrained by nominally interseismic geodetic surface velocity estimates. We present key findings from a kinematic global fault system model with 1.6×107 km2 of fault system area including 16 subduction zones and constrained by observations 22,500+ GPS velocities. Further, we describe new approaches to the efficient representation of viscoelastic deformation in large-scale block models and the prospects for high-resolution block scale models that directly image partial fault coupling across the entire global fault system. Because global geodetic observations capture faults behaviors at varying stages throughout the earthquake cycle, consideration of time-dependent deformation including viscous dissipation of coseismically induced stresses is important for accurate imaging of fault coupling. And, because concentrations of fault coupling have been shown to spatially correlate with recent significant earthquakes, being able to estimate partial coupling patterns on a global scale may highlight pending seismicity.

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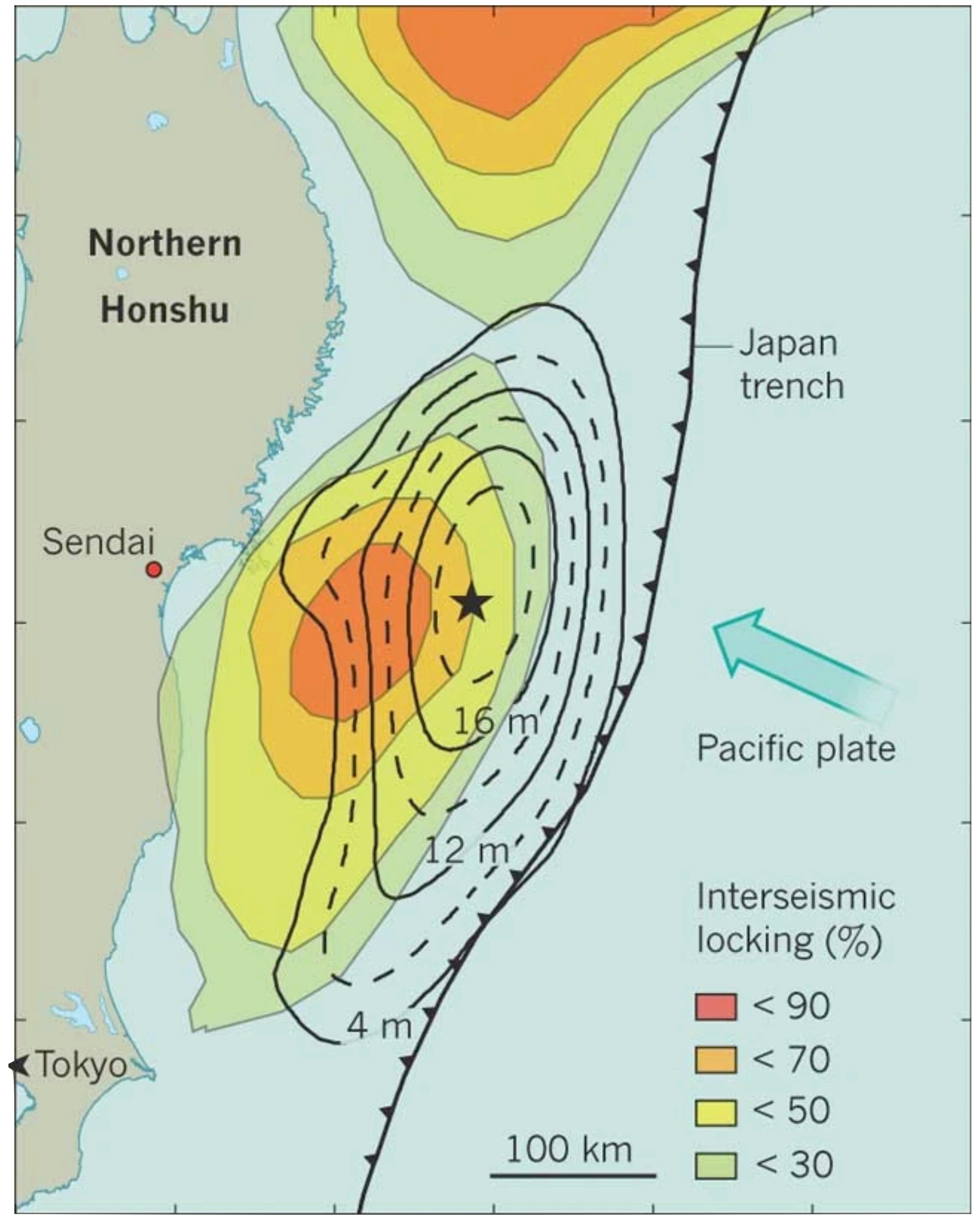

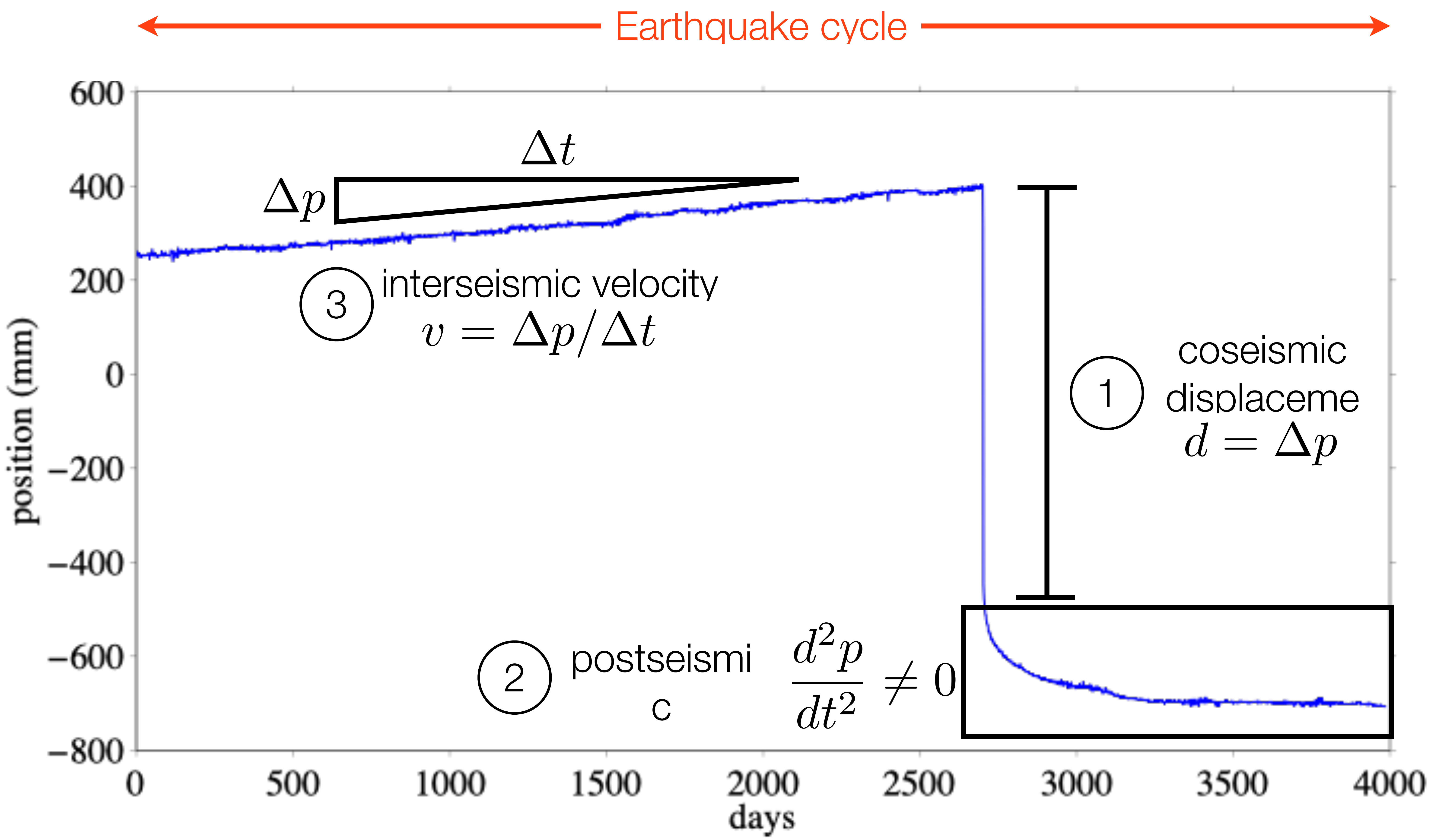

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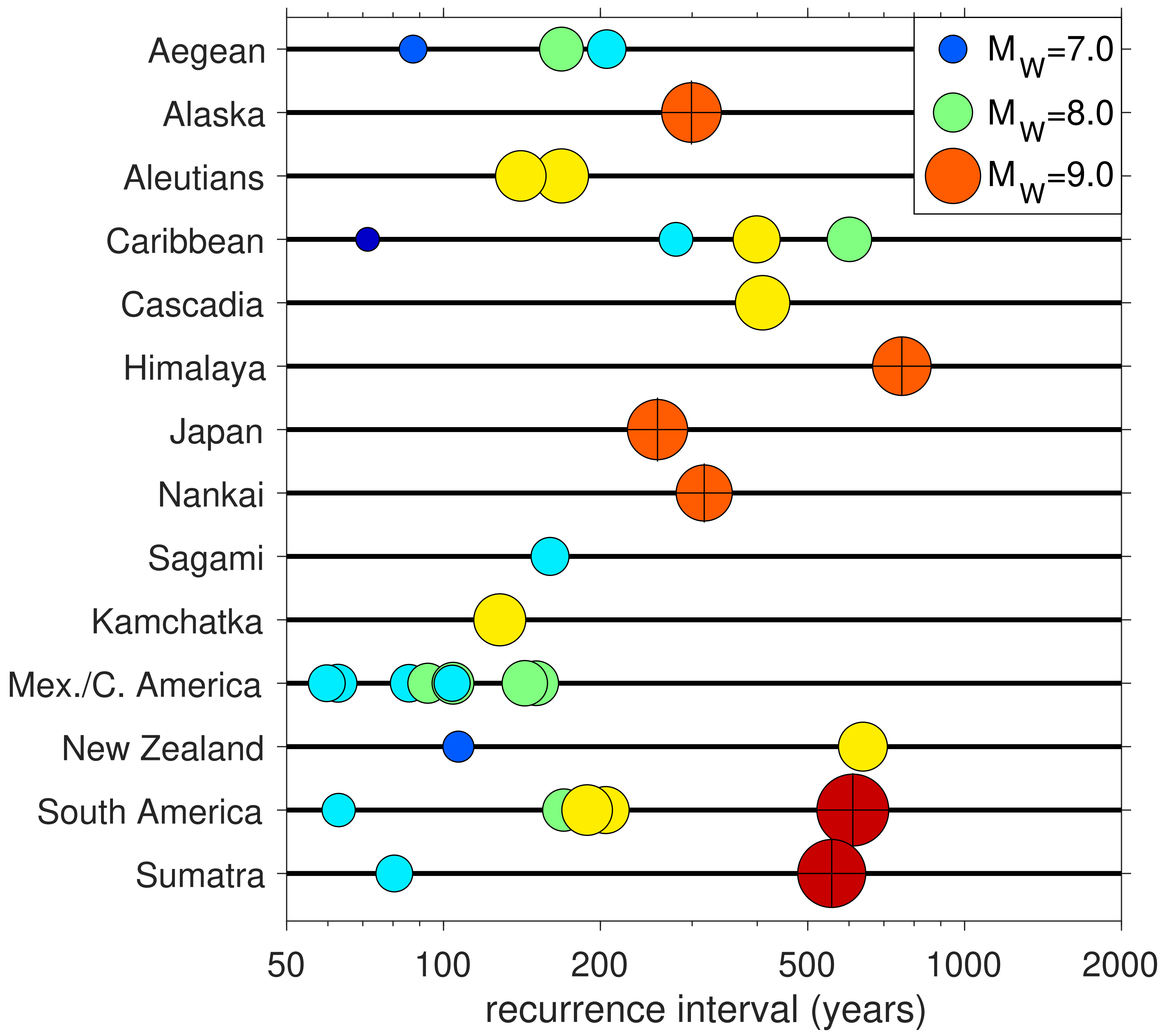
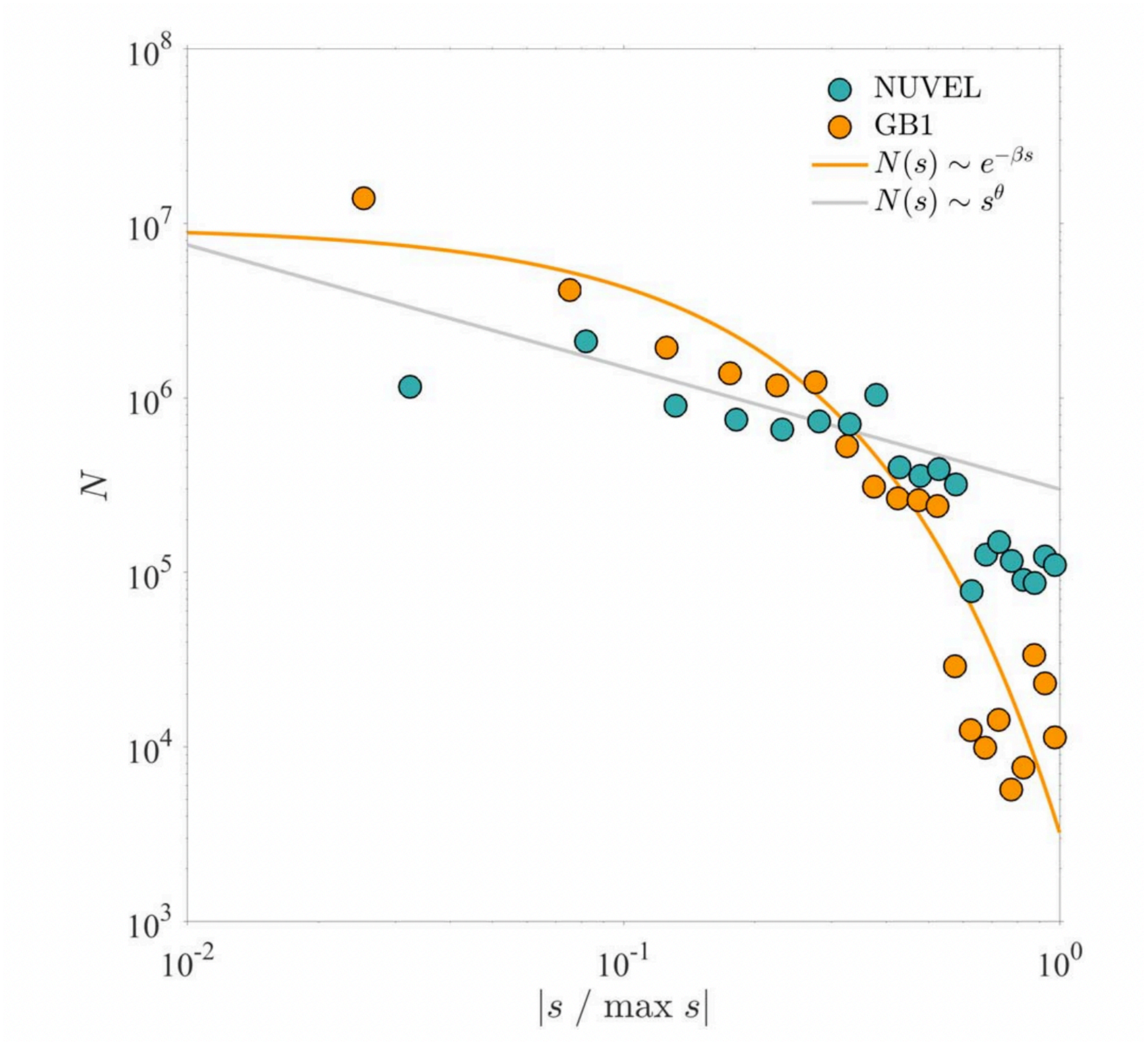
Learning from global block models

How many large earthquakes could there be?



How much active fault system matters?



Where we're headed and learning more

- Imaging global fault system kinematic activity is central to determining the current state from which earthquake cycle activity will evolve

- Goal: Image partial coupling across much more of the global fault system in space and in time

- Papers
- Results
- Code