Estimation of Rupture Zones for Large, Aleutian–Alaska Megathrust Earthquakes Using Relocated Aftershocks

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Abstract

There is increasing need to characterize historical rupture zones to better understand and estimate earthquake and tsunami hazard. We revisit analysis of large earthquake ruptures along the Aleutian–Alaska megathrust as in Sykes (1971) and Davies et al. (1981) using relocated aftershocks. We focus on the largest events – M8.2 1938, M8.6 1946, M8.6 1957, M9.2 1964, M8.7 1965 – using arrival time data from the ISC-GEM catalog. We apply a probabilistic location algorithm NonLinLoc (Lomax et al., 2000, 2014) which is robust to large error in the historical arrival data and which produces a comprehensive, location probability density function (PDF) allowing full integration of location uncertainty in the mapping of rupture zones.

The section of the Aleutian–Alaska megathrust spanning the Shumagin Gap, the 1938 rupture, and the western limit of the 1964 rupture highlights the importance of knowing the aftershock region for major earthquakes. Recent GPS studies determined sharp, lateral locking boundaries in this section of the megathrust, but with considerable uncertainty in their positions. Understanding how such a locking region relate to the rupture zones of the 1938 and 1964 events requires realistic uncertainties on the aftershock locations and rupture zones.

We show relocated hypocenters and location PDFs along the Aleutian–Alaska megathrust; we use the PDFs to estimate updated rupture boundaries for the M > 8 subduction earthquakes and to provide uncertainties for these boundaries. We discuss similarities and differences with previous results, and relate the defined rupture zones to key outstanding questions about large earthquake and tsunami occurrence and hazard along the Aleutian–Alaska megathrust.