
125 years of Large Subduction Earthquakes Revisited: Insights from the SubQuake 2.0 Catalog (1900–2024)

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Résumé

Earthquakes occurring along subduction interfaces account for most of the seismic energy released at the Earth's surface. To better understand the underlying mechanisms, we compiled an exhaustive catalog consisting of 202 Mw7.5+ subduction interface events between 1901 and 2023. This updated database Subquake 2.0 (SQ2), represents a significant revision of the 2018 release by van Rijsingen and colleagues (SQ1).

We developed an automatic procedure to identify events that are strong candidates for earthquakes nucleated along the subduction interface. This procedure exploits both the ISC-GEM catalog and the Slab2.0 model, accounting for uncertainties associated with slab and event positions to calculate the probability that the event occurred within a specific distance to the slab. A thorough and detailed bibliographic review of each automatically detected event allowed us to remove 30 events from SQ1 and add 50 new ones.

The frequency of Mw7.5+ subduction earthquake varies little between 1901 and 2023 (one event every 211 days in average), although some slight variations are observed. Consistent with previous studies, we identify two bursts of Mw8.5+ events during the periods 1946-1965 and 2004-2011. Furthermore, we confirm that certain subduction zones hosted more Mw7.5+ earthquakes than others. For example, regions such as West Sunda, Japan-Kuril-Kamchatka, Aleutian-Alaska, Central and South America or Melanesia exhibit higher M7.5+ seismic activity, whereas zones like the Mediterranean, Ryukyus, SE Asia, Tonga-Kermadec, Cascades, Lesser Antilles and South Sandwich show relatively lower activity.

We assembled the rupture envelopes for 77% of SQ2 events, with more than half involving asperities. This new database allows for providing well-constrained scaling laws relating Mw to rupture geometry (length, along-dip width and area), which we use to estimate first order rupture dimensions for events for which only the hypocenter is known. Finally, we estimate the seismic energy radiated by the M7.5+ events over the last 125 years and compare it to the one expected from kinematic and seismogenic parameters of each trench segment (as defined by Heuret et al., 2011).

The Subquake2 database is available on the web-tool submap.fr.

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Mots-Clés: Subduction, interface, mega, earthquakes, database, submap