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## The effect of multiple splay fault rupture on tsunamis

**Iris van Zelst**<sup>1,2</sup>, Leonhard Rannabauer<sup>3</sup>, Alice-Agnes Gabriel<sup>4</sup>, and Ylona van Dinther<sup>5</sup>

<sup>1</sup>School of Earth and Environment, University of Leeds, Leeds, United Kingdom of Great Britain and Northern Ireland (iris.vanzelst@erdw.ethz.ch)

<sup>2</sup>Seismology and Wave Physics, Institute of Geophysics, ETH Zürich, Zürich, Switzerland

<sup>3</sup>Department of Informatics, Technical University of Munich, Garching, Germany

<sup>4</sup>Department of Earth and Environmental Sciences, Geophysics, LMU Munich, Munich, Germany

<sup>5</sup>Department of Earth Sciences, Utrecht University, Utrecht, The Netherlands

Earthquake rupture on splay faults in subduction zones could pose a significant tsunami hazard, as they could accommodate more vertical displacement and are situated closer to the coast. To better understand this tsunami hazard, we model splay fault rupture dynamics and tsunami propagation and inundation constrained by a geodynamic seismic cycle (SC) model; building on work presented in Van Zelst et al. (2019). This two-dimensional modelling framework considers geodynamics, seismic cycles, dynamic ruptures, and tsunamis together for the first time. The SC model provides six blind splay fault geometries, self-consistent stress and strength conditions, and heterogeneous material properties in the domain. We find that all six splay faults are activated when the megathrust ruptures. The largest splay fault closest to the nucleation region ruptures immediately when the main rupture front passes the branching point. The other splay faults are activated through dynamic stress transfer from the main megathrust rupture or reflected waves from the surface. Splay fault rupture results in distinct peaks in the vertical surface displacements with a smaller wavelength and larger amplitudes. The effect of the vertical surface displacements also translates into the resulting tsunami, which consists of one large wave for the megathrust-only model and seven waves for the model including splay faults. Here, six of the waves can be attributed to the splay faults and the seventh wave results from the shallow tip of the megathrust. The waves from the rupture including splay faults have larger amplitudes and result in two episodes of coastal flooding. The first episode is due to the large wave caused by rupture on the largest splay fault nearest to the coast. The second flooding episode results from the combination and interference of the waves caused by the rest of the splay faults and the shallow megathrust tip. In contrast, the tsunami caused by rupture on only the megathrust has only one episode of flooding. Our results suggest that larger-than-expected tsunamis could be attributed to rupture on large splay faults. When multiple smaller splay faults rupture their effect on the tsunami might be hard to distinguish from a pure megathrust rupture. Considering the significant effects splay fault rupture can have on a tsunami, it is important to understand splay fault activation and to consider them in hazard assessment.

References:

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