EARTHQUAKE MAGNITUDE DEPENDENCE ON HYPOCENTRAL LOCATION ALONG THE SUBDUCTION MEGATHRUST AND ITS IMPLICATIONS

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Different scales of heterogeneities exist on seismogenic faults, including stress distribution and frictional properties. Here, we investigate rupture scenarios considering a variety of heterogeneities along the megathrust interface using spontaneous rupture simulations. We first estimate heterogeneous initial stress distribution from interseismic locking models below Nicoya peninsula, Costa Rica, then initiate spontaneous ruptures at different nucleation points and observe the eventual earthquake magnitudes and slip distribution. We find that $\sim 40\%$ of nucleations tested develop into large earthquakes of $M_w > 7.2$ based on present interseismic locking models. Of these events, those nucleated from deeper depths have a tendency for larger-amplitude shallow slip, suggesting increased tsunami potential. Furthermore, irrespective of the input locking models we do not observe scenario earthquakes with intermediate magnitudes between 6 and 7, a result consistent with observations in Nicoya. Such hypocentre-dependent rupture extents are not only observed in Nicoya, but also in the Cascadia subduction zone, posing challenges in estimating rupture extents from locking models. In addition, when we consider heterogeneous frictional properties on the megathrust, we also find the hypocentre-dependent rupture scenarios. Considering pervasive heterogeneities in nature, the hypocentre-dependent earthquake magnitudes shed lights on understanding foreshock/mainshock observations in certain subduction zones, such as in Tohoku, northeast Japan and Iquique, northern Chile where large foreshocks occurred in a few days before the mainshocks. We interpret why the foreshocks did not rupture larger areas and then could have become the mainshocks is due to their hypocentral locations.