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The effect of slip heterogeneity and non-instantaneous rupture in numerical modelling of an Iberian seismogenic tsunami

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In many studies of historical seismogenic tsunamis, such as the Lisbon 1755 event, rupture is modelled as being homogeneous and instantaneous. Here a method is proposed to estimate slip as an asymmetric sinusoid, rather than as an average slip, using empirical scaling laws, observations of slip on faults, and by conserving seismic moment. Rupture propagation is modelled using simple physical assumptions of rupture velocity, slip velocity and hypocentre location. Tsunami simulations are then conducted using the open source finite element Fluidity software, with an unstructured and multiscale computational mesh. For non-instantaneous rupture, a time-dependent normal flow velocity boundary condition is imposed within the tsunamigenic region, and for instantaneous rupture vertical sea floor deformation is translated to the sea surface. This study shows that the range of maximum wave heights for different heterogeneous slips is strongly negatively correlated to distance from coastline to earthquake epicentre according to a power law. It is difficult to predict the maximum wave height at local coastlines when slip heterogeneity is taken into account, and therefore a wide range of slip distributions when modelling is recommended. However, modelling rupture non-instantaneously suggests that maximum wave heights at local coastlines may be consistently under-estimated by 5-10% compared to when modelled instantaneously. The UK coastline is shown to be protected from an Iberian tsunami for all models used in this study.