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The influence of subduction zone tectonics on earthquake-generated tsunamis

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It has been observed that some subduction zones produce many tsunamis, while there are no observations of tsunamis at others. This could hint at a structural or tectonic influence on tsunamigenesis. To investigate a possible link between subduction zone tectonics and tsunamis, we use a global tsunami database and a global earthquake-tectonic database that includes geometrical, mechanical and seismicity parameters of all subduction zones for interplate, intraslab, and overriding plate earthquakes. We statistically correlate the tsunami database with the earthquake database to identify tectonic parameters that influence tsunamigenesis.

First, we confine ourselves to studying the relation between interplate (or megathrust) earthquakes and tsunamis. We find that the Pearson's product-moment correlation coefficients reveal high positive correlations of $\sim$0.65 between the maximum water height of tsunamis and the seismic coupling in a subduction zone. The Spearman's rank correlation coefficient results in correlations of $\sim$0.60 between the number of tsunamis in a subduction zone and subduction velocity (positive correlation) and the sediment thickness at the trench (negative correlation). Moreover, there is a positive correlation between the latter and tsunami magnitude. In an effort towards multivariate statistics, we perform a binary decision tree analysis, but the data is proven to be too scarce. The validity of all correlations are checked extensively using the p-value of the correlations.

To study the relationship between outer rise (or bending plate related) earthquakes and tsunamis, we perform the same set of tests with the outer rise subduction zone earthquake dataset. As outer rise faults are usually much steeper than the megathrust, we expect that the size of the tsunamis could be significantly higher than tsunamis that are caused by a rupture of the same size on the megathrust.