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Tsunami propagation and impact: the role of submarine canyons

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We present a multi-scenario numerical simulation in order to analyse the effects on tsunami propagation and impacts produced by the presence of a submarine canyon incised in the shelf and slope. Several synthetic scenarios have been created combining a constant, typical continental margin incised by a parameterised single canyon with diverse incident tsunami waves. Canyon parameters, slope morphology and tsunami waves are represented by mathematic functions. Canyon parameters analysed are: (i) incision in the shelf slope, i.e. distance of canyon head to the coast, (ii) canyon width and (iii) axis orientation with respect to the shoreline; canyon depth depending on these. The COMCOT tsunami model was used to propagate an ideal dipole tsunami wave across the synthetic bathymetric surfaces. In general, simulations show that the presence of a submarine canyon prevents wave set-up along the canyon axis. This produces a decrease in tsunami amplitude at the coastline located just in front of the canyon head, and consequently a zone with relatively lower run-up compared to the rest of the impacted coastline. Nevertheless, the effect is the opposite along the sides of the canyon, with an increase in wave set-up, which, when impacting the coastline, produces a greater flooding potential at both sides of the canyon axis-generated low. A detailed analysis of the different canyon configurations reveals that tsunami amplitudes and coastal impact strongly depend on the three parameters taken into account. The difference between the canyon axis-generated low and lateral maxima in wave height strengthens with increasing canyon width, incision and canyon obliquity with respect to the shoreline. Lateral maxima and the axial low always represent a wave height increase and decrease, respectively, compared to a non-canyoned margin. Moreover, the existence of a submarine canyon head near the coastline produces a variability of wave energy reaching the shore, which in turn generates trapped edge waves that spread out along the coastline. These edge waves, when coupled with tsunami secondary peaks, produce significant increases in wave height, even higher than the first arrival. Such simulations may have crucial implications in risk assessment of canyoned margins.