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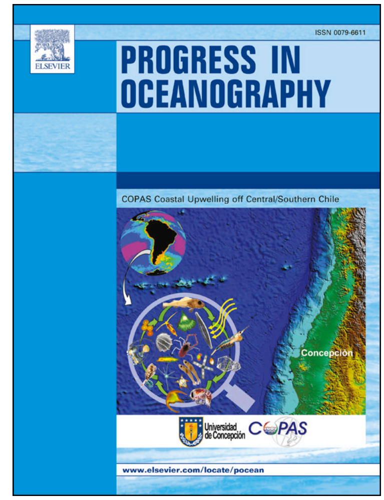

The tsunami phenomenon

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The tsunami phenomenon

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Abstract. With human activity increasingly concentrating on coasts, tsunamis (from Japanese *tsu = harbour, nami = wave*) are a major natural hazard to today's society. Stimulated by disastrous tsunami impacts in recent years, for instance in south-east Asia (2004) or in Japan (2011), tsunami science has significantly flourished, which has brought great advances in hazard assessment and mitigation plans. Based on tsunami research of the last decades, this paper provides a thorough treatise on the tsunami phenomenon from a geoscientific point of view. Starting with the wave features, tsunamis are introduced as long shallow water waves or wave trains crossing entire oceans without major energy loss. At the coast, tsunamis typically show wave shoaling, funnelling and resonance effects as well as a significant run-up and backflow. Tsunami waves are caused by a sudden displacement of the water column due to a number of various trigger mechanisms. Such are earthquakes as the main trigger, submarine and subaerial mass wastings, volcanic activity, atmospheric disturbances (meteotsunamis) and cosmic impacts, as is demonstrated by giving corresponding examples from the past.

Tsunamis are known to have a significant sedimentary and geomorphological off- and onshore response. So-called tsunamites form allochthonous high-energy deposits that are left at the coast during tsunami landfall. Tsunami deposits show typical sedimentary features, as basal erosional unconformities, fining-upward and -landward, a high content of marine fossils, rip-up clasts from underlying units and mud caps, all reflecting the hydrodynamic processes during inundation. The on- and offshore behaviour of tsunamis and related sedimentary processes can be simulated using hydro- and morphodynamic numerical models. The paper provides an overview of the basic tsunami modelling techniques, including discretisation, guidelines for appropriate temporal and spatial resolution as well as the nesting method. Furthermore, the Boussinesq approximation — a simplification of the three-dimensional Navier-Stokes equations — is presented as a basic theory behind numerical tsunami models, which adequately reflects the non-linear, dispersive wave behaviour of tsunamis. The fully non-linear Boussinesq equations allow the simulation of tsunamis e.g. in the form of N-waves.

Based on the various subtopics presented, recommendations for future multidisciplinary tsunami research are made. It is especially discussed how the combination of sedimentary and geomorphological tsunami field traces and numerical modelling techniques can contribute to derive locally relevant tsunami sources and to improve