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Simulation systems for tsunami wave propagation forecasting within the French tsunami warning center

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Improvements in the availability of sea-level observations and advances in numerical modeling techniques are increasing the potential for tsunami warnings to be based on numerical model forecasts. Numerical tsunami propagation and inundation models are well developed, but they present a challenge to run in real-time, partly due to computational limitations and also to a lack of detailed knowledge on the earthquake rupture parameters.
A first generation model-based tsunami prediction system is being developed as part of the French Tsunami Warning Center that will be operational by mid 2012. It involves a pre-computed unit source functions database (i.e. a number of tsunami model runs that are calculated ahead of time and stored) corresponding to tsunami scenarios generated by a source of seismic moment 1.75E+19 N.m with a rectangular fault 25 km by 20 km in size and 1 m in slip. The faults of the unit functions are placed adjacent to each other, following the discretization of the main seismogenic faults bounding the western Mediterranean and North-East Atlantic basins. An authomatized composite scenarios calculation tool is implemented to allow the simulation of any tsunami propagation scenario (i.e. of any seismic moment). The strategy is based on linear combinations and scaling of a finite number of pre-computed unit source functions. The number of unit functions involved varies with the magnitude of the wanted composite solution and the combined wave heights are multiplied by a given scaling factor to produce the new arbitrary scenario. Uncertainty on the magnitude of the detected event and inaccuracy on the epicenter location are taken into account in the composite scenarios calculation. For one tsunamigenic event, the tool produces finally 3 warning maps (i.e. most likely, minimum and maximum scenarios) together with the rough decision matrix representation. A no-dimension code representation is chosen to show zones in the main axis of energy at the basin scale. This forecast system provides warning refinement compared to the rough tsunami risk map given by the decision matrix.
Together with this forecasting system, another operational tool based on real time computing is implemented as part of the French Tsunami Warning Center. This second tsunami wave propagation simulation tool takes advantage of multi processor approaches and more realistic seismological parameters, once the focal mechanism is established.
Example on 3 historical tsunamigenic earthquakes with comparison of the results obtained with the two tools are shown: (1) the 2003 Boumerdès earthquake (Mw=6.9, northeastern Algerian margin), (2) the 1887 Imperia earthquake (Mw=6.5, Ligurian margin), and (3) the 1969 Gorringe Bank earthquake (Mw=7.8, Azores-Gibraltar fracture zone). Calculations based on the real time computing are done using fault parameters derived from seismological studies on these events.