Simulation of the 2004 tsunami of Les Saintes in Guadeloupe (Lesser Antilles)

Authors :
Louise Cordrie - CEA, DAM, DIF, F-91297 Arpajon, France.
Javier Escartin - Institut de Physique du Globe de Paris, 75238 Paris, France and Laboratoire de Géologie, UMR 8538, Ecole Normale Supérieure, PSL Research University, CNRS, Paris, France
Nathalie Feuillet - Institut de Physique du Globe de Paris, 75238 Paris, France
Audrey Gailler - CEA, DAM, DIF, F-91297 Arpajon, France.
Philippe Heinrich - CEA, DAM, DIF, F-91297 Arpajon, France.

Abstract :
The arc of the Lesser Antilles which formed due to the plunge of the Atlantic oceanic plate under the Caribbean plate, is a subduction zone with significant tectonic activity. Earthquakes in this context are known to be associated with sudden subsidence or uplift of the sea floor and to have the potential to trigger landslides and tsunamis. The historical tsunamigenic earthquakes in this region are rare, but traces of the important damages they generated along the coasts show that they pose a considerable threat to the closest inhabited islands. The most recent tsunamigenic earthquake occurred in 2004 in the area of Les Saintes normal fault system located in the back arc of the subduction. This Mw6.3 earthquake generated small waves with 2m of run-up in several bays of Les Saintes, a group of islands in the South of Guadeloupe. A recent survey done in the source area using deep-sea vehicles, revealed for the first time an important co-seismic slip on the Roseau fault plane, attributed to the 2004 event, which had not been predicted in the seismic inversion models. This event and the data-set on the Roseau fault gives the opportunity to model precisely the earthquake, to compare the simulation results with the observations and to evaluate the impact of the rupture heterogeneity and rupture shallowness on the height of the tsunami waves. In order to avoid a loss of quality from the data-set in the modeling of the initial sea-surface deformation especially in shallow depth and near field context, a transfer function of the deformation from the sea-floor to the sea-surface and different numerical schemes were used. Results on the tsunami height distribution indicate some local tsunami amplification phenomena linked to the bathymetry or the coast-line geometry and highlight the most endangered areas of the islands. The simulations give additional constrains on the source, show the impact of the slip heterogeneities on the tsunami and finally provide a complementary estimation of the intensity the 2004 co-seismic slip and the possible contribution of displacements linked to strong aftershocks that followed the Mw6.3 earthquake over several months.

Keywords:
Seismology, tectonic, numerical modeling, tsunami