Authors: Hebert[1], H., F.Boudin[2], F., P. Bernard[3], S. Peyrat[3], M. Béjar-Pizzaro[3]

Affiliations:
1. CEA/DASE / LDG, centra DAM Ile de France, Arpajon, France
2. Geosciences Montpellier, Montpellier, France
3. Institut de Physique du Globe de Paris, UMR7154 CNRS, Paris, France

Title: Tsunami modelling and source constraints from regional tide-gages and tilt measurements for the 2008 M=7.5 Tocopilla subduction earthquake

Abstract

We focus on the small tsunami (a few tens of cm) generated by the November 2007, M=7.5 Tocopilla earthquake, which ruptured about 140 km of the southernmost part of the major, 1000 km long seismic gap of the northern Chile subduction. We first use the available regional tide-gage records, within 1000 km, at coastal stations and on nearby DART buoys (source of data: SHOA, Chile; University of Hawai; NOAA/NBDC) , to constrain the offshore, up-dip extension of the rupture, poorly constrained by the on-land records (GPS, InSAR, accelerograms). For this purpose, various source models, compatible with the geodetic/seismological data, are used as input for numerical calculations, including the best-fit, minimal seismological and geodetic inverted models. The vertical static displacement of the ocean floor is calculated using uniform, instantaneous dislocations in an elastic half-space. The tsunami wave is calculated using a finite-difference scheme solving the hydrodynamic equations, under the non linear shallow water assumption. Bathymetric data derived from the 1' GEBCO dataset are used. The time and amplitude of the first oscillations at the closest tide-gages constrain the offshore part of the source. The later part of the signal is persistent during more than one day, with dominant period of 40 to 45 minutes. Numerical simulation correctly reproduces these spectral characteristic as well as the persistence of the waves, which appear to be trapped within a narrow band (50 to 70 km wide) along at least the 800 km long coastline of the model, suggesting a very efficient trapping by the shallow area between the trench and the coast. This characteristic period was already present for previous tsunamis in this area (2001,1995,1877 major earthquakes) . At 200 to 300 km north to the epicentral area, tilt records from a long base tiltmeter and from broad-band seismometers (STS2) of the IPOC array, installed at short distances from the coast (3 to 25 km), show a clear signal very similar to the tsunami records, which proves to be mostly due to changes in the crustal loading due to the fluctuation in sea level, and can be modelled with a simple Boussinesq model. In conclusion, our study shows the ability of weak tsunami recordings to constrain seismic sources, and the ability of tiltmeters and very broad band seismometers to act like remote, on-land tide-gages.