Geophysical Research Abstracts
Vol. 20, EGU2018-15296, 2018
EGU General Assembly 2018

Nonlinear inversion of tsunami waveforms using the Optimal Time Alignment (OTA) method: application to the 2014 M8.1 Iquique (Chile) earthquake

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The Chile subduction zone is one of the most seismically active regions in the world and it hosted a number of great tsunamigenic earthquakes in the past. Recently (1 April 2014), a M8.1 interplate thrust earthquake occurred near the city of Iquique (Chile). This event, whose epicentre was at 70.98°W 19.77°S, generated a significant tsunami recorded in the near field of the source by tide-gauges and by DART buoys in the far field.
Here, we present the coseismic slip distribution of the Iquique earthquake, obtained by joint inversion of tsunami and GPS data. We computed the Green's functions (GF) by means of a 3D fault model accounting for the variability of both strike and dip angles and solved the inverse problem using the simulated annealing technique plus the automatic Optimal Time Alignment (OTA, Romano et al. 2016) of the tsunami waveforms. Modelling of tsunami data can be affected in the near field of the tsunamigenic source by inaccurate bathymetric models, and in the far field by water density gradients, ocean floor elasticity, wave dispersion, or geopotential gravity changes, generally neglected; this could result in a mismatch between observed and predicted tsunami signals, thus affecting the retrieved tsunami source image.
In order to see if the wave dispersion can be mapped in the time mismatch of tsunami signals, we used two sets of tsunami GF, including/considering dispersive effects during the wave propagation or not; for each set of tsunami GF we compared the slip models obtained i) without taking into account the eventual mismatch of tsunami waveforms, and ii) by applying the OTA method. In addition, as an independent check, we compared the predicted deformation field with the RADARSAT-2 InSAR data.
The results of the inversion show that without using the OTA method the coseismic slip relative to the 2014 Iquique earthquake is shifted landward, illustrating the expected trade-off between the slip placement and the arrival times at the tsunami sensors