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Computed inundation heights of the 2011 Tohoku tsunami compared to measured run-up data: hints for tsunami source inversion

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The 11 March 2011 earthquake that took place off the Pacific coast of Tohoku, North Honshu, with Mw = 9.0, is the largest earthquake ever occurred in Japan, and generated a big tsunami that spread across the Pacific Ocean, causing devastating effects in the prefectures of Aomori, Iwate, Miyagi and Fukushima. It caused more than 15,000 casualties, swept away the low-land quarters of several villages and moreover was the primary cause of the severe nuclear accident in the Fukushima Nuclear Power Plant.

There is a very large set of observations covering both the earthquake and the tsunami, and almost certainly this is the case with the most abundant dataset of high-quality data in the history of seismology and of tsunami science. Local and global seismic networks, continuous GPS networks, coastal tide gauges in Japan ports and across the Pacific, local buoys cabled deep ocean-bottom pressure gauges (OBPG) and deep-ocean buoys (such as DART) mainly along the foot of the margins of the pacific continents, all contributed essential data to constrain the source of the earthquake and of the tsunami.

In this paper we will use also the observed run-up data to put further constraints on the source and to better determine the distribution of the slip on the offshore fault. This will be done through trial-and-error forward modeling, that is by comparing inundation data calculated by means of numerical tsunami simulations in the near field to tsunami run-up heights measured during field surveys conducted by several teams and made available on the net. Major attention will be devoted to reproduce observations in the prefectures that were more affected and where run-up heights are very large (namely Iwate and Miyagi). The simulations are performed by means of the finite-difference code UBO-TSUFD, developed and maintained by the Tsunami Research Team of the University of Bologna, Italy, that can solve both the linear and non-linear versions of the shallow-water equations on nested grids and with dynamically moving shorelines.