



Coseismic slip distribution of the 2011 Mw 9.0 Tohoku (Japan) earthquake from a joint inversion with GRACE Gravity changes and inland GPS measurements

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The well-observed 2011 MW 9.0 Tohoku, Japan earthquake gained global interest because of its magnitude and the size and impact of the consequent tsunami. Several slip distribution models derived from onshore GPS and/or radar interferometry displacements have been published as well as others derived from teleseismic waveforms and strong motions. These models rely on terrestrial data from Japan and hence are poorly constrained due to the lack of observations in the ocean. In this study, we combine onshore GPS data with gravity changes derived from the Gravity Recovery and Climate Experiments (GRACE) satellites to determine the slip distribution of the main event. Our joint inversion model suggests that the maximum slip of ~ 44 metres ruptured to the boundary of the Japan trench, near to a bend in this trench located ~ 120 km south-east of the earthquake epicentre. The joint inversion model shows some distinct shallow-slip patches, which are confirmed by offshore GPS observations; however, those shallow-slip patches were not included in previously published models. Our data suggest that gravitational changes detected by GRACE can make a unique contribution to determining the slip distribution in large events, in particular for oceanic megathrust events with sparse offshore observations. In this paper, the joint inversion strategy is also demonstrated together with an efficient weighting method for different datasets.