Fault-model of the 2017 Kos-Bodrum (east Aegean Sea) M_w 6.6 earthquake from inversion of seismological and GPS data – *Preliminary Report*

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Overview

The 20 July 2017 Kos-Bodrum M_w 6.6 normal fault earthquake (AFAD, 2017) at the NW edge of the Quaternary Gökova Bay graben, was a destructive earthquake associated with a small tsunami (Yalciner et al., 2017). In addition, it is the first normal faulting earthquake in the Aegean covered by a dense array of continuous GPS stations which permit a detailed finite fault modeling (FFM). The preliminary seismological evidence (epicenters, hypocenters of the main shock and of the main aftershocks, and focal mechanism of the main shock) deriving from various agencies, data and techniques, indicate a shallow, nearly E-W striking normal faulting, but its details, including its dip (northerly or southerly) are not resolved. On the basis of independent analysis of seismological and geodetic data we obtained Finite Fault Models (FFM), which are very similar and hence describe the "true" fault.

Seismological modeling

From the inversion of teleseismic long-period *P*- and *SH*- and broad-band *P*- waveforms retrieved from the Federation of Digital Seismograph Networks (FDSN) and from the Global Digital Seismograph Network (GDSN), the epicenter determined by the National Observatory of Athens (NOA) (www. gein.noa.gr), we computed a teleseismic *P*- and *SH*- body waveform inversion for double-couple (BWIDC) point source with the minimum misfit between observed and synthetic waveforms, and is summarized in Fig. 1. Using this solution, and testing various possible fault patterns, we computed the variable slip model utilizing broad-band *P*- waveforms shown in map view in Fig. 2. (see Yolsal-Çevikbilen et al., 2014, and references therein).

Geodetic Data and Inversion

Among the available 30sec GPS records, we selected those of 15 stations, from which co-seismic (static) slip vectors were computed. These displacements were computed from the mean values of three daily static solutions before and after the earthquake, using the CSRS-PPP platform. Slip vectors were derived first from preliminary and then from final satellite orbits.

We assumed all 9 fault parameters defining an *Okada-type* fault as free variables and adopted a search space defined by the spread of all available seismological solutions, practically discarding only non-reasonable solutions. A redundant system of 45 stochastic observations (from 15 GPS stations) and of 9 unknowns was formed and was solved using the TOPological INVersion (TOPINV) algorithm (see Saltogianni et al., 2017, and references therein). This algorithm does not select an isolated solution through sampling of the search space based on the minimum misfit principle, because such a solution may represent one of the numerous local extrema of the highly non-linear Okada-type equations. Through exhaustive searches of the gridded search space, the algorithm identified a cluster of 9-dimensional grid points, which satisfy the confidence intervals to which each of the observation equations was transformed.

From the population of this cluster of grid-points the mean value and the uncertainty of each of the 9 variables were then computed and represent the final product of the inversion. The uniform slip model is summarized in Fig. 3.

Discussion and Summary

The seismological and geodetic model (Fig. 2 and Fig. 3), based on independent data and methods, are very similar, and their differences are within the uncertainty limits, mainly because seismological estimates depend on adopted epicenter after NOA. Both models indicate that the fault responsible for the Kos-Bodrum earthquake was associated with a 25km long normal fault, offshore the Kara Islet. This fault has a nearly E-ESE strike and a southerly dip and ruptured the upper crust from the surface (sea bed) to the depth of 12km.

Acknowledgements

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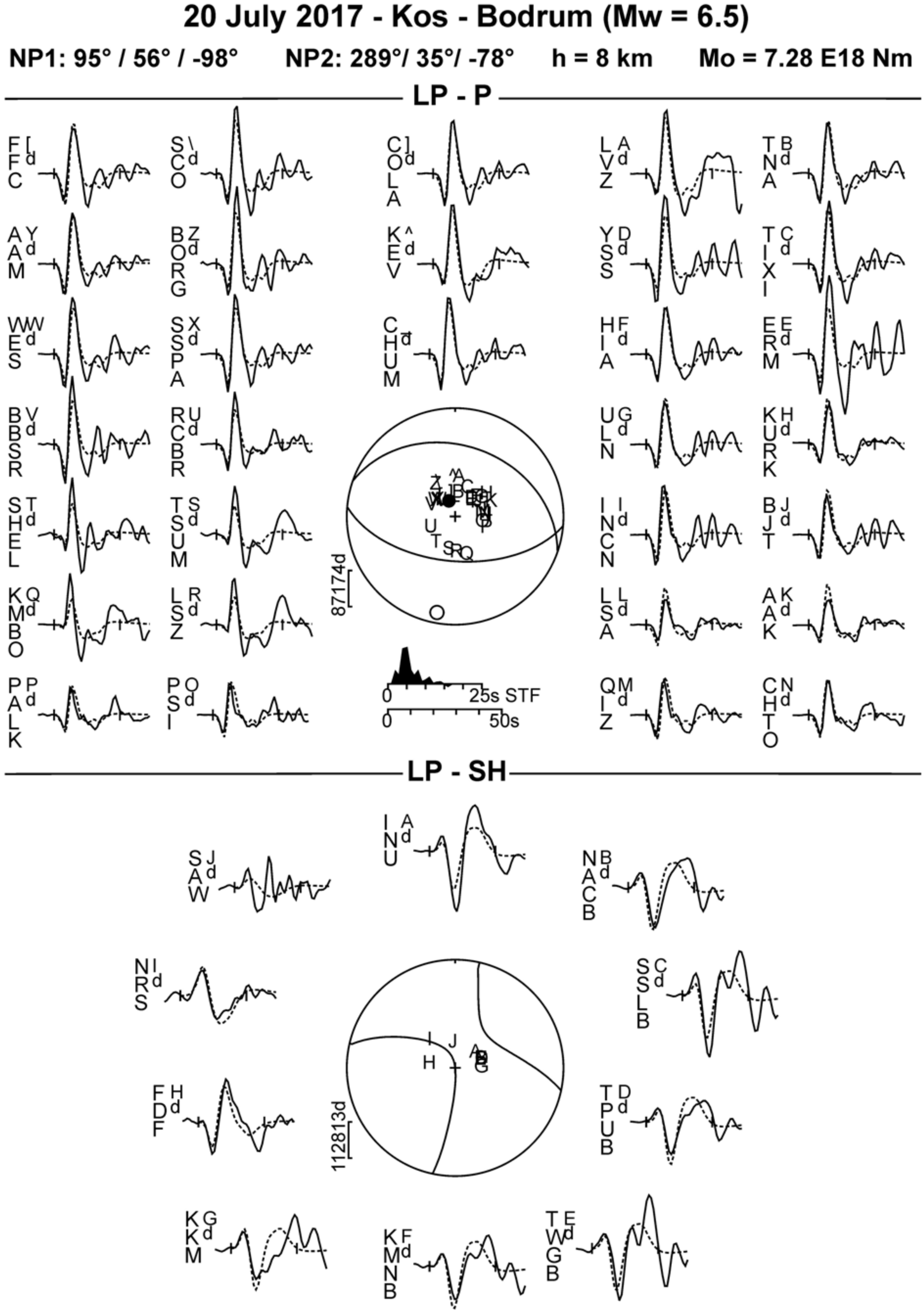

Figure 1: The radiation patterns and synthetic waveform fits for the minimum misfit solution obtained from the point-source inversion. Focal spheres are shown with *P*- (top) *and SH*- (bottom) nodal planes in lower hemisphere projections. Solid and open circles mark *P*- and *T*-axes, respectively. Synthetic waveforms (dashed lines) fit to observed long-period 31 *P*- and 10 *SH*- waveforms (solid lines) used in the inversion. The header shows the fault parameters.

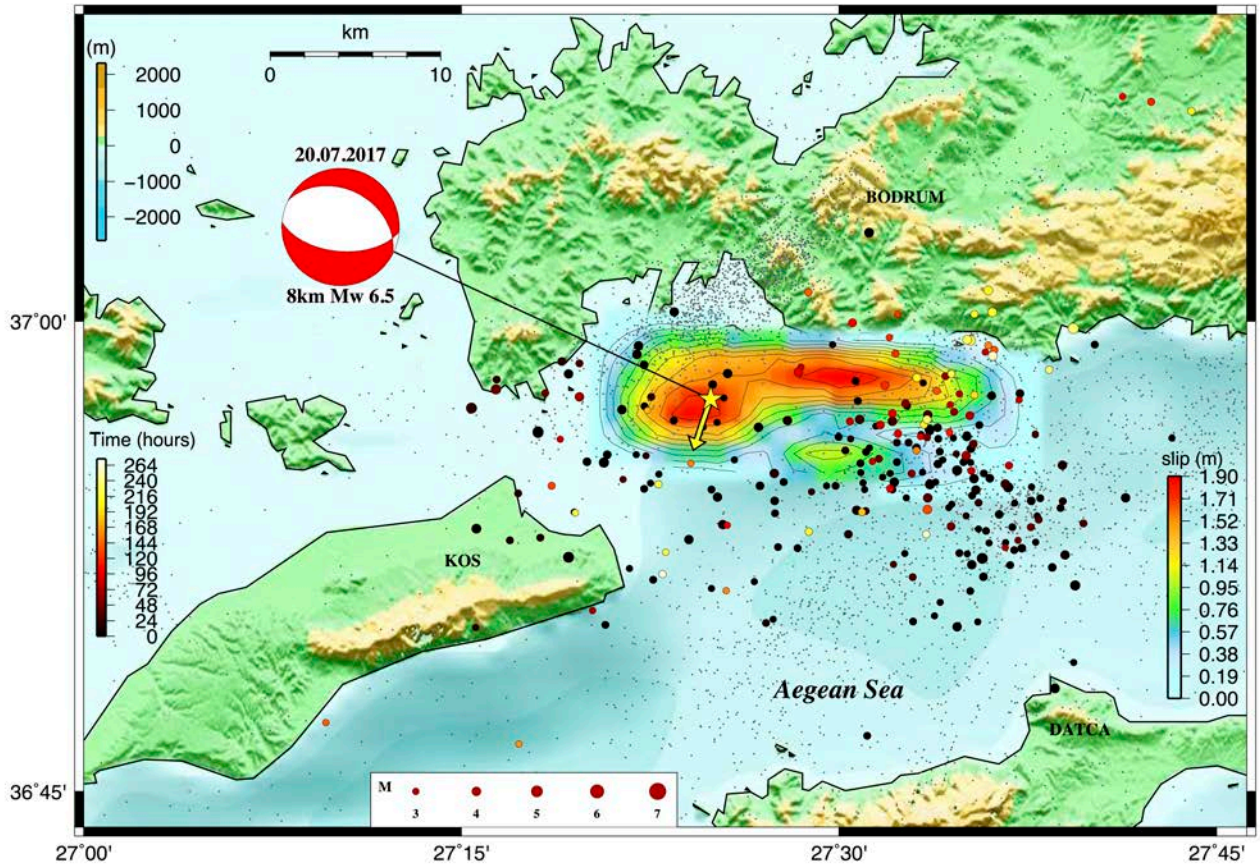

Figure 2: Map of the horizontal projection of variable slip distribution for Finite Fault Model (FFM) of the Kos-Bodrum earthquake based on slip inversion of teleseismic broad-band *P*- waveforms data. Epicenters of the background seismicity (gray dots) and of the aftershocks color-coded by elapsed time with respect to the origin time of the mainshock are after KOERI.

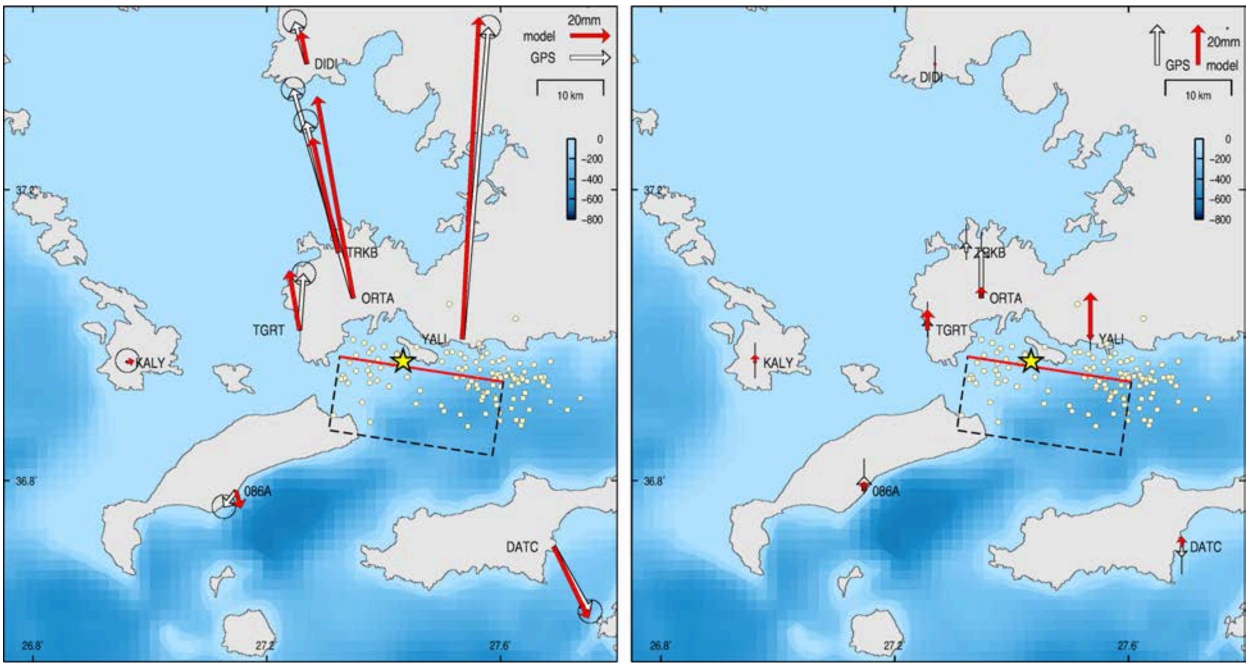

Figure 3: Fault model (rectangular, in map view, with red line indicating upper fault tip). A star marks the epicenter by NOA, at a slightly northern position than epicenters from other agencies. Selected observed and model-computed slip vectors, in map view horizontal (left) and vertical (right) are shown. Fault is well controlled by GPS stations at Bodrum, Kos and Datça.