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Modeled vs observed ground deformation caused by the 2014 Cephalonia and 2015 Lefkada earthquake sequences, Ionian Islands, Greece

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Two strong earthquakes were recorded in the recent seismic activity of Ionian Sea, Greece. On January 26, 2014, a Mw 6.1 event occurred in Cephalonia Island, followed by a Mw 5.3. A second strong event of magnitude Mw 6.0 on February 3, 2014, in the same area was associated to a different fault. On November 17, 2015, a Mw 6.4 event occurred in Lefkada Island, followed by a regular aftershock sequence with no exceptional events. Both seismic sequences caused extensive damages. The ground deformation caused by those events has been examined by modeling the seismogenic faults and analyzing the available GPS time series.

The Cephalonia seismogenic fault, associated with the Mw6.1 event, is a dextral strike slip fault, while it dips with a high angle towards the ESE. The fault strike is 23°, its dip angle is 68° and the estimated rake plunge is 175°. Based on the aftershock distribution, the fault width is 10.0 km, while the top of the fault is located at 7.0 km depth and the bottom of the fault at 16.28 km. The Lefkada seismogenic fault, associated with the Mw6.4 event is also dextral and is the extension of the Cephalonia transfer fault towards the NNE. The estimated strike, dip and rake values are 203°, 88° and 159° respectively. The aftershock distribution defines a fault width of 9.0 km, while the top of the fault has been determined at 3.0 km depth and the bottom at 13.0 km depth.

The horizontal and vertical ground deformation in several levels was modeled. The Cephalonia seismogenic fault shows low values of horizontal displacement (1.5 cm) at the surface, while the values increase gradually (4.7 cm) at the top of the fault, receiving the greatest values (8.2 cm) in the middle of the fault (11.64 km depth) and finally decrease (5.2 cm) up to fault bottom. The maximum modeled value difference of the vertical displacement of the four aforementioned depths is minimal (5.6 mm). The Lefkada fault shows large values (maximum 8.7 cm) of horizontal displacement at the surface, increasing gradually (maximum 11.1 cm) at the top of the fault. In the middle part the horizontal displacement values is the maximum (12.6 cm) and at the fault bottom a value decrease is recorded (9.3 cm). The maximum modeled vertical displacement is again very low (18 mm).

According to the comparison between the modeled and observed ground displacements for Cephalonia earthquake the two approaches are compatible, with differences: 2.5 cm and 0.2 cm for the horizontal and vertical component, as detected on the GPS station (VLSM). Finally, we found that the differences between the modeled and the observed displacements for Lefkadas earthquake are 40.8 cm and 7.9 cm for the two nearest GPS sites (PONT, SPAN) at horizontal plane respectively. At the vertical component, the differences are quite smaller 2.5 cm and 0.4 cm for PONT and SPAN. The large differences for PONT station caused by very local displacements, thus were not confirmed by theoretical approach as expected.