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Interactive comment on "High-precision relocation of seismic sequences above a dipping Moho: the case of the January–February 2014 seismic sequence in Cephalonia Isl. (Greece)" *by* V. K. Karastathis et al.

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We would like to thank the anonymous reviewer for his/her constructive comments that were taken almost all into account.

Reviewer: 1. p.2701, l.14-24: The dominating process is certainly the ongoing subduction while e.g. the Cephalonia Transform Fault Zone (currently described as the 'major seismo-tectonic structure' controlling the regional seismicity) is a secondary effect (structure) as a result of the subduction. The subduction is the driving force.

Author: We are in favour of a slightly different interpretation because of kinematic evidence. In our study area (Cephalonia and western Greece) active tectonics is controlled by a combination of processes. First, the Hellenic subduction is separated by the CTF in a dextral offset of between 80-100 km, into the northern and southern segments, which are characterized by different convergence rates and slab composition [Royden and Papanikolaou, 2011; Pearce et al., 2012]. Secondly, the oceanic part of the African lithosphere subducts beneath Peloponnese and central Greece causing domino-style tectonics [Westaway, 1991; Ganas et al., 2014], while the continental part of the lithosphere west & northwest of the CTF collides and subducts beneath NW Greece. In this study we want to emphasize the importance of CTF. We don't want to enter into the discussion on the dynamics (i.e. forces) of the subduction etc.

References:

Royden, L. H., and D. J. Papanikolaou (2011), Slab segmentation and late Cenozoic disruption of the Hellenic arc, Geochem. Geophys. Geosyst., 12, Q03010, doi:10.1029/2010GC003280

Ganas, A., V. Karastathis, A. Moshou, S. Valkaniotis, E. Mouzakiotis, and G. Papathanassiou (2014), Aftershock relocation and frequency–size distribution, stress inversion and seismotectonic setting of the 7 August 2013 M=5.4 earthquake in Kallidromon Mountain, central Greece, Tectonophysics, 617, 101-113, doi:10.1016/j.tecto.2014.01.022.

Pearce, F. D., S. Rondenay, M. Sachpazi, M. Charalampakis, and L. H. Royden (2012), Seismic investigation of the transition from continental to oceanic subduction along the western Hellenic Subduction Zone, J. Geophys. Res., 117, B07306, doi:10.1029/2011JB009023

Westaway, R. (1991), Continental extension on sets of parallel faults: observational evidence and theoretical models, in The Geometry of Normal Faults, edited by. A. M. Roberts, G. Yielding and B. Freeman, Spec. Publ. Geol. Soc. London, 56, 143-169

Reviewer: 2. p.2703, l. 5-10: There is relevant additional study (Sodoudi et al., JGR, 2006) not referred to in the text, proposing a crustal thickness of ∼20 km around the plate boundary. It is worth to mention he non-uniqueness of the proposed crustal thickness in this region.

Author: We added a relative comment and the reference.

Reviewer: 3. p.2704, l.3-6: While the region of interest is certainly at the western border of the Greek seismic network leaving a large azimuthal gap it might be useful to include stations from Italy further to the Northwest to reduce the azimuthal gap.

Author: The Italian stations that would improve the azimuthal coverage were at distances greater than 340 km. The errors that may be introduced by such distant phases are considerable due to inaccurate modeling of the velocity structure of the region crossed by the ray-path.

Reviewer: 4. p. 2704, l. 24-26: The comparison between the 'roughly estimated magnitude of Md=5.0' and 'reports from local people' is not reliable enough to be mentioned as scientific rationale in a peer reviewed seismological paper. This part should be skipped.

Author: We rephrased this particular part of the text in order to avoid the misunderstanding that the local accounts are related with the magnitude estimation.

Reviewer: 5. p.2705, l.4 (and several times later in the text and also in the title): The term 'relocate' is widely used to describe the process of relative relocation of hypocenters involving waveform cross-correlation (e.g. hypoDD) while in this context it is mis-

leading since here actually absolute hypocenter determination is meant.

Author: We agree that the term relocate is frequently related to the hypocentral location procedure involving HypoDD. In our study we use it to describe our improved calculated locations relative to the original locations calculated by NOA, provided to the public and still exist in the earthquake catalogs. However, the term "relocation" has been also used in this context in various papers in the past (e.g. Husen & Smith, 2004; Lomax 2005)

References:

Husen, S., Smith, R. B. (2004), Probabilistic Earthquake Relocation in Three-Dimensional Velocity Models for the Yellowstone National Park Region, Wyoming, Bull. Seism. Soc. Am. 94(3), 880-896.

Lomax, A., (2005), A Reanalysis of the Hypocentral Location and Related Observations for the Great 1906 California Earthquake, Bull. Seism. Soc. Am., 95, 861-877.

Reviewer: 6. p. 2710, l. 20-25: The space-time evolution shows that there is no space-time evolution. It is not adequate to describe the hypocenter catalogue as 'high-precision relocated' for many reasons. Is the width (NW-SE) of the seismic cloud an artefact of the hypocenter precision or is it real? If it is real how can it be explained tectonically since these are aftershocks of a larger earthquake that activated a planar fault plane? Technical corrections:

Author: Based on our relocated data we believe that the aftershock cloud includes both on-fault and off-fault aftershocks. This synchronous occurrence of events explains the "cloudy" appearance, although preserving "linear' features that we discuss in the paper. We also demonstrate that the two, largest mainshocks (Jan. 26 and Feb. 3) occurred on two, different fault planes.

Reviewer: 7. p. 2700, l.8: Replace ‘locations were’ by ‘the hypocentral location precision was’.

Author: We replaced the term ’locations were’ with the term ’the hypocentral precision was’ as suggested.

Reviewer: 8. p.2701, l.15-16: The Cephalonia Transform Fault Zone is not indicated (labelled) in Figure 1.

Author: The Cephalonia Transform Fault Zone is abbreviated as ’CTFZ’ in the bottom left in figure one.

Reviewer: 9. p. 2702, l. 5: Replace ‘suffer’ by ‘suffers’.

Author: Corrected ’suffer’ to ’suffers’ in the text.

Reviewer: 10. p. 2702, l.15: Replace ‘at the geometrical edge of’ by ‘outside’.

Author: Replaced the term ’at the geometrical edge of’ with the term ‘outside’ in the text

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Reviewer: 11. p.2702, l. 19: Skip ‘microseismicity’.

Author: Removed ’microseismicity’ in the text.

Reviewer: 12. Figure 4: There is not much information in this figure. No details are provided on what the relation between Vp and Vs is- (e.g. is there a constant Vp/Vs, does it vary laterally or with depth)?

Author: Haslinger et al., 1999 give a separate velocity model for the S-waves. The model proposed by Hirn et al., (1996) was derived by P-wave active seismic survey therefore there wasn’t any S-wave velocity information. For this model we used the Vp/Vs value proposed for the area 1.80 (This value is compatible with the Wadati diagrams of Haslinger et al., 1999 and the results of prior studies (Hatzfeld et al., 1995; Le Meur et al., 1997). Sachpazi, et al. do not provide an S-wave velocity model. We used the constant value of Vp/Vs=1.80 (suggested by the corresponding author by personal communication). NOA’s model includes a constant Vp/Vs=1.73 as used by daily analysis.

Reviewer: 13. Figure 6: This figure is way too trivial to be considered as a stand-alone figure. Its content can be described in one sentence in the text.

Author: The reason we used this figure is to emphasize how strongly the Moho structure and the use of distant phases can influence the final hypocentral determination. Epicentral miscalculations in the range of 5-6 km are important in case of strong earthquakes near the urban environment with severe damage. In this particular case of Cephalonia earthquake the epicentral location provided to public was far from the microseismic epicenter, at a place with no significant damage and without aftershock activity. In general these mislocations could be problematic in the first hours of the event when the emergency plans are laid out.

Reviewer: 14. Figure 7: What should the reader conclude from looking at the different epicentral distributions that look (almost) fully equal in first-order approximation and with the resolution provided. More or less the same is the case for Figures 8 and 9.

Author: The only case where the location differences in the maps are small is this between the 1D and 2D version of Haslinger model as was actually expected. However, even in this case the differences in the three major events are noticeable. The figure also points out the effect of the velocity model on the final location. In Figures 8 and 9 it is clearly pointed out that for the 2D and 1 D models of Haslinger et al. the number of events with low ERH and ERZ values are a lot higher in comparison with the other models (the total number of events is the same for all models). However, we removed them and added the more quantitative measure of the standard deviation of the residuals.

Interactive comment on Solid Earth Discuss., 6, 2699, 2014.