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Interactive comment on "Application of geophysical tools for tree root studies in forest ecosystems in complex soils" *by* Ulises Rodríguez-Robles et al.

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Answers to referee #2, comments on 08 May 2017.

We have reviewed and answered all comments by referee #2. We appreciate the general comments to the manuscript by the anonymous referee #2 and responded to his/her particular annotations as follow:

Comment 1. L23 in Abstract: There is a typo in the spelling of ERT.

Authors: Revised and corrected, page 1, line 23.

Comment 2. L3, page 5: please be more precise (you mean that sensors were inserted

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at 12 cm depth only when allowed by bedrock?).

Authors: As noted, the terrain is very shallow and rocky, so we were referring that soil psychrometers were inserted between 12 to 15 cm depth, in available soil pockets close to our target plant. We inserted the following text instead, “which were inserted between 12 to 15 cm depth (page 5, lines 2-3).

Comment 3. L18, page 6 and elsewhere: Please consider the option of using the terms "bedrock" and "weathered bedrock" (instead of just "rock") whenever appropriate, and please replace throughout the text.

Authors: We thank the reviewer for this observation, we have considered the option of using the terms of "bedrock" and "weathered bedrock" and inserted whenever was needed in the text.

Comment 4. Line 10, page 9: leaf litter accumulates under exfoliated rocks, or on exfoliated rocks (L26, Page 10), or both?

Authors: corrected with the following text, “leaf litter accumulation under and on top of exfoliated rocks” (page 9, line 10).

Comment 5. Lines 14-17 in page 8 and again in Lines 16-18 in page 11: this appears like an unusual rooting pattern, did you find any other published papers reporting similar rooting patterns in oaks or in other tree species? Can you provide any references of similar findings?

Authors: Using stable isotope analysis of xylem water (δ18O y δ2H), we identified that oak trees are able to remain active during drought using alternative water sources in the substrate. Thus, oak locates their finest roots into the fractured rock, which is revealed by its particular isotopic signature (Rodriguez-Robles et al., in preparation). Also, our results suggest that use of water from the top soil by oak is limited by the presence of pine roots, likely imposing competition conditions for water (Rodriguez-Robles et al., in preparation). In another study, del Castillo et al. (2016) reported similar patterns of

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root distribution for Quercus ilex and Pinus halepensis, two typical Mediterranean tree species coexisting in a mixed forest.

Comment 6. Line 27-28 in page 8: Why is this finding so surprising, am I missing something here...?

Authors: Regarding this question, our surprise arose from the fact that we did not expect that the GPR method could allow us to distinguish diameter changes along a single root. We are moderating our statement by deleting the surprising term.

Comment 7. Line 10, page 9: only leaf litter accumulated under rocks? what about root litter, was it also present under rocks? Were you able to distinguish between living and dead roots?

Authors: Using either the 500 or the 800 MHz antennas, we have not been able to identify dead roots in these types of shallow rocky soils. On the other hand, to be able to identify active roots in these shallow and rocky soils, we had to carry out GPR profiles during dry periods, when the soil is less conductive and signals from humid active roots have the highest contrast in the radargrams. In the dry periods, alive roots have a very well defined reflected hyperbolic signal, due to its water content and ions concentration. On the other hand, accumulated leaf litter under and on top of exfoliated rocks produced noisy signals in radargram traces, particularly when using the 800 MHz antenna as shown in Figure 4. We have been able to improve signal responses and interpretation using processing routines.

Comment 8. Line 7, page 12: Please clarify what exactly is meant by regolith here (weathered bedrock only? all types of bedrock?).

Authors: We refer to fragmented material of weathered bedrock observed between exfoliated rock layers and the forest floor surface. We added the following text to clarify this point “we want to highlight the major limitations encountered in this study; certain field conditions (e.g., leaf litter, weathered bedrock regolith)” page 12, lines 7-9.

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Comment 9. For the sake of clarity, please rephrase item IV in lines 11-12 of page 12, this sentence is a bit confusing.

Authors: We change the text of point IV to improve clarity: “given the contact resistance problem for electrodes in the ERT survey that result especially during dry periods, from moisture content in the soil-bedrock and soil temperature.” page 12, lines 12-14.

Comment 10. The quality of the figures is rather good, although I have some suggestions for improving Fig 5 (whose size in the final version should be at least twice as big as that in the PDF version that I have reviewed). I was a little confused by the legend of Fig 5, as it is not clear to me whether the three layers mentioned in the legend (soil, intermediate, bottom) are depicted or delineated in any way in the figure or not...It appears that only the water potential categories are represented by different colors.

Authors: We thank observations regarding this figure. Figure 5 has currently dimension of 1588 x 1658 pixels (300 dpi), however we have no problems to increase the size in the final version. Regarding the three substrate layers mentioned in the legend, only two; the intermediate and bottom layers represented by soil pockets-rock fractures the first and the fresh bedrock the second, are depicted in the figures. Thus, the intermediate layer is depicted with a dotted band following the GPR profile whereas the fresh rock is delimited by a solid line. The top soil corresponds to the first20-25 cm in the tomograms. Based on this comment, we have included the following text in the legend of Figure 5 “The top soil corresponds to the first 20-25 cm layer, the intermediate layer include soil pockets and rock fractures and is depicted by the dotted strip along the radargram and the fresh bedrock begins underneath the solid line” page 22, lines 4-5.

Comment 11. Please note that some of the "soil" water potential values shown in this figure (-24 MPa) are extremely and unusually low for soil and require further clarification.

Authors: The reviewer is correct, there are some fairly low soil water potentials, how-

ever these represent resistivity values for the fresh bedrock extrapolated to water potential units.

Comment 12. Applying the terms "Increasing rock moisture content" and "soil water potential" to the same moisture potential data appears rather contradictory. For the sake of clarity, I recommend to change to "Soil/bedrock water potential" and "Increasing soil/bedrock moisture content".

Authors: We adopted the suggestion by the reviewer and modified the terms in figure 5 as recommended.

Comment 13. Figure 3 should also be enlarged in the final version of the published paper. With the current size, it is very difficult to spot the B (in A) mentioned in the legend...

Authors: We thank the observations for this figure. Accordingly, we have increased the size of letters along the different radargrams (in A), for better sighting. We also followed the suggestion to increase the size of figure 3, in the final version.

Comment 14. Table 5: four soil DEPTHS....comparing forest STANDS...

Authors: Revised and corrected with the following text, “Nested two-way analysis of variance to examine root diameter differences observed among the combination of four soil depths (10, 20, 30 and >30 cm) and three forest stands (Pinus cembroides, Quercus potosina and mixed forest) in a semiarid forest ecosystem in Central-North México” (page 19, table 5).

Comment 15. The correct reference for Querejeta et al (2007) is: Querejeta JI, Estrada Medina H, Allen MF, Jimenez-Osornio JJ (2007) Water source partitioning among trees growing on shallow karst soils in a seasonally dry tropical climate. Oecologia 152:26–36.

Authors: Reference corrected.

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Reference

del Castillo J, Comas C, Voltas J, Ferrio JP (2016). Dynamics of competition over water in a mixed oak-pine Mediterranean forest: spatio-temporal and physiological components. Forest Ecology and Management 382, 214-224. doi:10.1016/j.foreco.2016.10.025.

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