



REPLY TO XI ET AL.:

Water table fluctuation is well recognized and discussed in our study

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We appreciate the comments by Xi et al. (1) and agree that a fluctuating groundwater table is one of the reasons that roots are observed below the water table. We discuss this issue in Fan et al. (2), with roots found below the water table for reasons that include groundwater rise/fall that outpace root response, temporary perched water tables, and wetland plants that are insensitive to water-logging. Furthermore, we made our rooting depth data available (2) as an appendix in the Supplementary Information where, under “Drainage,” there is a column titled “Water Table Range (m).” There, we recorded any water table fluctuations reported in each study.

Water table fluctuations are fully represented in our inverse model of root–groundwater interactions. Examples of seasonal water table and root uptake depths are given in figure 7 of our paper (2) for several

cases. In case-4 of the eastern Amazon, where the water table is deep, it rises and falls 10 m or more across the seasonal cycle but remains below the root-uptake depth. In case-9 of the western Amazon, however, where the water table is shallower, it rises from 3- to 4-m deep in the dry season to the surface in the wet season and submerges roots. Here is an example of where we find roots below the water table, temporarily, and often within a meter or so of the surface.

In conclusion, we discuss the importance of water table fluctuations in our paper (2) and in previous work (3) and agree with Xi et al. (1) and other researchers (4, 5) that groundwater fluctuations can stimulate deep root growth. For example, roots have been observed to follow a declining water table in the dry season, as articulated by Naumburg et al. (4) many years ago.

- 1 Xi B, Di N, Liu J, Zhang R, Cao Z (2018) Hydrologic regulation of plant rooting depth: Pay attention to the scenario with intense seasonal groundwater table fluctuation. *Proc Natl Acad Sci USA* 115:E3863–E3864.
- 2 Fan Y, Miguez-Macho G, Jobbágy EG, Jackson RB, Otero-Casal C (2017) Hydrologic regulation of plant rooting depth. *Proc Natl Acad Sci USA* 114:10572–10577.
- 3 Engel V, Jobbágy EG, Stieglitz M, Williams M, Jackson RB (2005) The hydrological consequences of Eucalyptus afforestation in the Argentine Pampas. *Water Resour Res* 41:W10409.
- 4 Naumburg E, Mata-Gonzalez R, Hunter RG, McLendon T, Martin DW (2005) Phreatophytic vegetation and groundwater fluctuations: A review of current research and application of ecosystem response modeling with an emphasis on great basin vegetation. *Environ Manage* 35:726–740.
- 5 Loheide SP, II, Butler JJ, Jr, Gorelick SM (2005) Estimation of groundwater consumption by phreatophytes using diurnal water table fluctuations: A saturate-unsaturated flow assessment. *Water Resour Res* 41:W07030.

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