Clim. Past Discuss.,
doi:10.5194/cp-2016-68-AC1, 2016

Climate of the Past Discussions
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EGU

Interactive comment on "Deforestation decreases resistance of simulated Easter Island climate to drought" *by* Alexander Lemburg et al.

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Received and published: 17 October 2016

Response to Reviewers and Editor:

We thank the three reviewers for their constructive comments on our manuscript. The comments mainly concern i) our assumption of extreme changes in Easter Island land surface, ii) the use of present-day large-scale climate as atmospheric boundary conditions for our meso-scale simulations, iii) the use of simulations of typical weather situations instead of climate simulations, iv) limited novel information regarding the effect of deforestation on precipitation in heterogeneous terrain.

i) Regarding the first comment, we agree that our study is a theoretical one. In contrast to reviewer 1, we think that the COSMO model, a non-hydrostatic model widely tested in many meso-scale simulations, is perfectly suited for simulating the airflow over the

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complex terrain of Easter Island as well as the details of land-surface – atmosphere interaction. Admittedly, the assumption regarding the land surface conditions are simplified – for good reasons though. We do not aim at simulating the impact of best reconstructions of past land surface conditions on Easter Island near-surface climate. Instead, we want to explore the effect of deforestation on Easter Island climate in principle. Therefore we have chosen extreme differences in surface conditions to isolate the main processes at work. We agree that we should more strongly emphasize the exploratory character of our study.

ii) The reviewers question the use of present-day large-scale atmospheric boundary conditions for driving our Easter Island weather simulations. Mann et al. (Quaternary Res. 2008) discussed possible large-scale climatological trigger for radical changes in moisture balance on Easter Island. They qualify their hypothesis as "untested". Hence the hypothesis of unchanged large-scale climate is still a valid working assumption. The assumption is corroborated by palaeo climate simulations. These simulations differ with respect to many details of past climate change, but they agree that the climate conditions in a large region around the Easter Island did not changed significantly (see Junk and Claussen, cited in our paper). Because Easter Island is a small spot in the Southern Pacific Ocean, it is safe to assume that any local climate change on Easter Island did not affect the large-scale subtropical climate. Hence we still think it is reasonable and consistent within our climate model world to assume that past typical large-scale weather situations – calm periods with sunny weather and periods with convective rain or large-scale rainfall – were not radically different from today's meteorological conditions.

iii) The reviewers criticize that with simulations of a number of distinct weather situations, i.e. simulations over a few days, one cannot quantify any change of Easter Island climate arising from changes in land-surface conditions. That is correct, and we should address the limitation of our study more clearly. Climate simulations, i.e. simulations over several decades to achieve a statistically robust signal in changes of the

length of dry season, for example, are not feasible for small regions such as Easter Island. To represent the small-scale complex orography of Easter Island in atmospheric simulations, a two-step downscaling is necessary: from either global palaeo-climatic simulations or global present-day climate simulations at coarse-scale to a limited-area simulation of intermediate resolution as first step, and then to a local, high-resolution simulation. For a statistically meaningful analysis of the Easter Island local climate, we would need to simulate at least 30 years for each land surface. With our approach, all synoptic case studies for each land surface, initial soil moisture and ensemble member added up to a total of approximately 5 simulated years in high resolution. This took us some 2 months with our granted share of the DKRZ super computer. So 90 years of high-resolution simulation would have demanded about 3 years of time or a much higher share of the DKRZ computer which would had been beyond the resources of our project. Therefore, we can only qualitatively explore the direction which the local Easter Island climate might take given a drastically altered land surface, but unchanged large-scale climate conditions in this region of the subtropical Southern Pacific.

iv) We agree with the reviewers that it is well known that deforestation affects the near-surface atmosphere mainly via changes in roughness length and heat fluxes. “Clouds prefer native vegetation” (Lyons, Meteorol. Atmos. Phys. 2002), for example, and many other papers demonstrate the link between clouds, precipitation and change in land-surface conditions. New papers still appear. Hence our statement that the climate of a deforested Easter Island appears to be significantly less resistant to drought than a forested island seems to be a trivial hypothesis. But this does not necessarily hold, at least if the processes involved are concerned. For example, van der Molen et al. (in: Tropical Montane Cloud Forests: . . . , 2010) show that in contrast to the Easter Island case, deforestation on Puerto Rico leads to a decrease in precipitation despite an increase in evapotranspiration. Moreover, in the discussion on Easter Island ecosystem change, local climate processes rarely enter. For example, Mann et al. (2008) conclude that the rapid deforestation . . . “was probably exacerbated by the island’s small size, its droughty climate, and the rarity of primeval fires.” They do not mention the possibility

that deforestation could have affected the local climate.

In summary, we cannot do new climate simulations with new boundary conditions as suggested by the reviewers. We can, however, revise our manuscript by including a discussion of previous work on the effect of deforestation on precipitation, by better explaining the set-up and outline of our numerical experiment, and by more strongly highlighting the limitations of our study.

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