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Hydrology and Earth System Sciences
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Interactive comment on "Resolution-dependence of future European soil moisture droughts" *by* Eveline C. van der Linden et al.

Anonymous Referee #1

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The manuscript entitled "Resolution-dependence of future European soil moisture droughts" by Eveline C. van der Linden presents differences between low (standard) resolution and high-resolution runs of EC-Earth with respect to drought conditions over central Europe. They find that droughts happen to be more severe and durable in the high-resolution experiments and explore potential causes leading to the differences between the model runs.

The manuscript is generally in a good shape, mostly well structured and well written. The overall presentation of the results is good with mostly concise and high quality figures. The methodological approach is well explained and technically sound, but some clarifications are needed in this context. However, the considered ensemble is relatively small and some of the conclusions might not be robust. The authors thus

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need to discuss some limitations of their approach before final publication.

Major comment:

The ensemble used in this study consists of 6 ensemble members, each containing 5 years of simulation, resulting in a sample size of 30 years. This is mostly fine for assessing the averaging land surface water and energy balance components. However, I doubt the sample size is large enough for assessing droughts. Droughts are extreme events. An extreme drought event is thus defined as a 1/30 year event, which does not correspond to the 1st quantile, simply because the sample size is too small. It would be good if the authors could discuss the robustness of their results and provide a concise reasoning why the ensemble is not larger. Please also provide some insights into why you choose the years 2002-2006 for present day climate conditions. Maybe because these are the last yers of the CMIP5 historical runs? I was just wondering because in 2003 central Europe experienced a major drought and heatwave.

More comments:

Introduction: It might be good to add a few more references in the first part of the introduction. Especially regarding the uncertainty in European drought trends, such as e.g. Samaniego et al., 2018 (DOI: 10.1038/s41558-018-0138-5)

p. 1, l. 22-25: You write that potential evaporation is enhanced through larger atmospheric moisture demand due to the increasing temperatures. You also write that humidity and wind speed might affect evapotranspiration. This is all a bit confusing, since the atmospheric moisture demand is also defined through humidity and wind speed. Maybe consider to rephrase this part.

p. 2, l. 3: What do you mean by hydroclimatic components?

P. 2, l. 12-14: This is also a bit confusing. You write about quantifying drought severity, and later drought characteristics (such as e.g., severity). Seems redundant.

p. 2, l. 18: Please outline what variables are needed to compute PDSI.

p. 2, l. 26-27: The north-south wetting vs. drying pattern in Europe is actually a well-known feature which was assessed in many studies.

Sec. 2.1 and 2.2: Why do you choose the years 2002-2006? How do the model runs differ? Why don't you use more recent SST data? What version of HTESSEL do you use? Does HTESSEL include river routing or where does the runoff go? Are there open water bodies in HTESSEL?

p. 5, eq. 1: Do you really mean dθ within the integral? Shouldn't it just be θ?

p. 8, l. 15: The validation period is 1982-2011, right? Might be worth to mention this here as well. What happens if you choose just 2002-2006 as validation period? How is an event like 2003 represented in the model?

p. 9, eq. 4: Well, dS/dt is not necessarily just soil moisture. This might include also snow/ice water storage and water in open water bodies. How is this represented in HTESSEL?

p. 9, l.10-11: Does the soil water content determines runoff?

p. 9, l. 23-27: Here it would help if you could provide more information on how runoff is treated in HTESSEL.

p. 12, l. 19: remove "is"

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