Review: Downscaling of climate change scenarios for a high resolution, site–specific assessment of drought stress risk for two viticultural regions with heterogeneous landscapes

This paper presents a summary of a study focused on the effects of climate change on two viticultural regions in west-central Germany. Methods used include downscaling of Coupled Model Intercomparison Project 5 (CMIP5) using a stochastic weather generator data, high resolution soil map data (soil type and water capacity), high resolution digital elevation model, scaling down to individual vineyards (accounting for slope steepness and aspect). For validation purposes, the study compared historical weather observations from nearby long-term weather stations with historical synthetic time series.

The authors thank the referee for the time and attention spent on the review and the helpful comments. Our answers to the comments are given in blue text colour.

General comments: The manuscript needs some editing for grammar and usage (e.g., abstract 2nd and 3rd sentences are unclear and confusing). There is little discussion of relative humidity, a critical component of any evapotranspiration discussion (ET ~ f(T, RH, U)), other than reference to Supplement Table S3, which shows little change in future RH—that in itself is interesting, given the sensitive of RH to changes in temperature. (How future climate change trends maintain an equilibrium in RH is an interesting find in itself.) Table S3 is rather confusing—based upon the Table caption it appears these values represent the sensitivity of ET to changes in one variable while maintaining others at baseline values. It would provide more insight if the authors explored changes in conservative variables such as specific humidity (or vapor pressure and saturation vapor pressure) and examined projected changes in the vapor pressure deficit (not mentioned at all in the manuscript). Overall, the study presents interesting and valuable results regarding the potential effects of climate change on viticulture in Germany. The study's techniques are transferable to other viticultural (agricultural) regions providing similar data are available for input.

Response: We agree that relative humidity need to be more discussed in the context of evapotranspiration and have added more details about the changes of observed and projected relative humidity in the discussion part. We added results of the vapour pressure deficit to Tables S1-S3 and a note to Table S3 to improve clarity.

Specific comments:

Page 1, line 27 (first line of Introduction): this sentence is confusing as the actual language in the WMO report cited here states that "[s]ince the 1980s, each successive decade has been warmer than any preceding one since 1850."

Response: Thank you for this advice, we have adapted the sentence to fit the statement of the WMO report.

Page 2, line 67: Need to spell out ADVICLIM.

Response: The meaning of the acronym ADVICLIM is described in the reference (Quénol et al., 2014), so for the reason of readability we propose to use only the name of the project here.

Page 4, line 159: Same for ENSEMBLES.

Response: To our knowledge, ENSEMBLES is the name of the project and cannot be spelled out in more detail. As we mentioned the reference of the project (van der Linden and Mitchell, 2009), we suggest not to change the sentence.

Page 5: Figure 1 would be helpful if you can show the wine growing regions as an inset to a larger map of Germany.

Response: We added a map of Germany with the region of Figure 1 as an inset to Figure 1.

Page 6, lines 206 - 208: "The impact of degree of slope on runoff was neglected, because several authors reported no clear findings…." Would this be the case during periods of drought (harder soil surface)?

Response: The curve number method (surface runoff model) accounts for the "antecedent moisture condition" of a soil before a precipitation event. Since the degree of slope does not necessarily reduce the infiltration capacity, we assume neglecting the impact of slope on runoff is also valid for periods of drought.

Page 13, lines 387 - 388: "In general, this indicates an increase of precipitation in winter *possibly connected* with a decrease of precipitation in a future summer." (Italics added.) Why would an increase in winter precipitation be connected with a decrease in summer precipitation?

Response: Indeed the formulation is misleading and we have revised the sentence and removed the word "connected".

Page 13, general comment: What about snowfall and runoff from snow melt? Is this an issue in this region?

Response: Snow melt is not really an issue and with global warming snowfall has decreased. In the region snowfall appears only on some days during winter and in general snow melts quickly. Snow covers with more than 10 cm are rare and do not occur every winter.

Page 17 and 18, Figures 11 and 12: difficult to see the changes for the ensemble median (b) and decrease (c) as changes are generally modest compared with the scale (a function of the larger changes exhibited in (a).

Response: Yes, the colour scale is a compromise between showing the modest changes without overemphasizing them in comparison with the results of warm simulation in (a).

Page 19, lines 498-499: "… but in general, the soil maps are still describing the current situation quite well as demonstrated in a follow–up study (Zimmer, 1999)." This study is more than 20 years old.

Response: The soil characteristics have not changed in general in the regions since the study of Zimmer from 1999, beside of some locally small-scale interventions. So we think the statement is still valid.

Page 19, lines 520 et seq.: under the more extreme scenario, is the increase in the number of predicted drought days exceed any year in the past? This would also be a good place to look at changes in vapor pressure deficit, a key control on evapotranspiration (e.g., Penman-Monteith— see Monteith and Unsworth 1990 2nd Ed.)

Response: Simulated drought stress days with observed weather data for the dry year 2018 show up to 90 days of drought stress, with many vineyards in the range of 50-90 days (see Fig. 5 on page 11). As the projections show the difference of mean annual drought stress days between 2041-2070 and 1989-2018 with many vineyards showing an increase of drought stress days in the range 33-69 days, this would mean that many years in future are in the range of the dry year 2018 and some years will likely exceed the dry year 2018.
We added the discussion about relative humidity and vapour pressure deficit at this point in the discussion part as suggested by the referee.