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Interactive comment on "Future projections of High Atlas snowpack and runoff under climate change" *by* Alexandre Tuel et al.

Anonymous Referee #1

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The manuscript of Tuel et al is well written and pleasant to read, it deals with the impacts of climate change on the snow cover in Morocco which is very important for surface water resources. I think this is an interesting contribution for HESS. The main problem with this manuscript is a partial description of the methods used, so it is difficult to say whether certain assumptions, for example on bias-correction, may have a large impact on the results. See my specific comments below.

One element that needs to be discussed in the manuscript is that the runoff coefficients are not only impacted by climatic parameters but also by surface conditions. Significant changes in vegetation cover, land use or agricultural practices often have a greater impact, and this aspect is absent from the manuscript.

Page 1, line 30 : no reference to the litterature except to the previous

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Discussion paper

publication of the authors, while an important body of work exist for the Mediterranean and Morocco : Driouech et al https://doi.org/10.1007/s41748-020-00169-3, Drobinski et al https://doi.org/10.1007/s10113-020-01659-w, Cramer et al https://doi.org/10.1038/s41558-018-0299-2, Lionello et al https://doi.org/10.1007/s10113-018-1290-1

In particular, climate projections on runoff already exist for the basin of interest, see Jaw et al https://doi.org/10.1016/j.ejrh.2015.02.008 Tramblay et al http://doi.org/10.1007/s11269-017-1870-8

Page 2, line 38 : what is a "parametric snow module" ?

Section 2.2: it is not clear why the authors consider TRMM rainfall, while daily precipitation data is available at 7 locations (line 75). Why also mention CHIRPS rainfall if it is not used in the study, as the author state

Section 2.3: The authors should justify why they rely on only one RCM, when nowadays large ensemble of climate model experiments are available, such as the Euro-CORDEX (Jacob et al https://doi.org/10.1007/s10113-020-01606-9) or Med-CORDEX (Ruti et al https://doi.org/10.1175/BAMS-D-14-00176.1) initiatives.

It is well established that to obtain robust projections it is necessary to consider several combinations of GCM/RCM, and the use of only one RCM strongly reduce the relevance of the work (see Frernandez et al https://doi.org/10.1007/s00382-018-4181-8).

In addition, the RegCM version 3 is rather outdated (2006) since the current version is RegCM-4 (https://www.ictp.it/research/esp/models/regcm4.aspx).

Page 5, line 142: the bias correction method is not detailed. what kind of approach is used beside the use of CDFt? In such a mountainous area, and since this study consider several variables in RCM simulations (temperature, precipitation, humidity...) a pixel-by-pixel and variable-by-variable bias correction with CDFt without considering the spatial correlation and inter-variable dependencies can lead to strong uncertainties.

See Vrac et al https://hess.copernicus.org/articles/22/3175/2018/

It is quite surprising that the authors seems to apply a simplistic method for bias correction of RCM outputs while they develop a high-resolution physically based framework for snow simulations.

Page 6, line 178: similar to my comment above, how do you compute catchment-averaged October-May precipitation ? with observed rainfall or TRMM ?

Page 6, line 177: watershed-specific fixed effects, are the parameters fixed according to size, land use etc. ?

Page 6, line 180: It is not clear if these sentences are results of sensitivity analysis or results of previous works

Page 6, line 185: Only precipitation and temperature are bias-corrected ? Line 125 the author state they use 6-hourly wind speed, specific humidity, air temperature, precipitation, and downward longwave and shortwave from the RCM simulations. Later on in the text, relative humidity seems to be an important driver of change, therefore better explanations on the method used to bias correct this parameter (and others) are required

Page 7, line 188, I don't understand this sentence "Therefore, we use the ERA/MRCM precipitation data, bias-corrected with TRMM,"

Page 8, line 213: the author mention a "statistical downscaling of the MRCM output to 1km,", but nothing in the method section about this. How is it possible to downscale 12km RCM simulations to 1km, with "reference" precipitation being TRMM data at 25km spatial resolution ? there is a confusion here between "downscaling" and "bias correction".

Section 4, results I see no validation of the methods applied, prior to produce future scenarios. What about the efficiency of bias-correction ? What about the efficiency of panel regression to reproduce the inter-annual variability of runoff coefficients ? since

the authors rely on TRMM rainfall, it would be interesting to see a comparison of the model driven by either observed rainfall or TRMM to reproduce discharge dynamics

Page 10, line 280: it should be noted that the Oum Rbia basins has several areas with karstic functioning

Page 10, line 294-297: this is not a result and should be in the introduction. The "Source: Direction de la Recherche et de la Planification de l'Eau, Rabat" is not in the reference list. This is not a result of the present study since the data and method used to obtain this result are not presented

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