

We thank the reviewer for the many useful comments. We have addressed the reviewer's comments below. We show how the text in the manuscript has changed, by indicating new text in boldface.

Comment: 1) In various figures (2,4,8,10,11,12), concise panel labels would be very helpful to allow the reader to immediately see what each panel shows, without having to read the caption.

Reply: We agree that this will help readability and have now added concise labels to all these figures, either in the figure or in the colour bar description.

Comment: 2) Similarly, in Figs. 6 and 7, a legend would be very helpful so the reader can immediately see what each line represents.

Reply: We agree that this will help readability and have now added legends to these figures.

Comment: 3) L54-55: By “the amount of irrigation needed to compensate evapotranspiration”, do you mean, after subtracting actual precipitation?

Reply: This is indeed the case, and we now indicate this as follows: "... compensate evapotranspiration, **after subtraction of the precipitation**, that..."

Comment: 4) L55: PCR-GLOBWB should be defined/spelled out.

Reply: We now add: "... that was calculated by the **PCRaster Global Water Balance model** (PCR-GLOBWB; ..."

Comment: 5) L71-73: How are these concentrations of the various greenhouse gases fed into the model? Is it through the radiation scheme?

Reply: This is indeed hard-coded in the radiation scheme, which we change for every year. We now state: " Annual concentrations of CO₂, CH₄, and N₂O, **which are manually set in the RRTMG radiation module**, ... "

Comment: 6) L76: What is meant by “convergence between months”?

Reply: This was to check whether the monthly spin-up caused discontinuities in the time series. We rephrase the sentence as follows: " We checked **whether temperatures and precipitation at the end of a month agreed with those at the end of the spin-up period for the subsequent month** and they agreed within a few percent for all selected points."

Comment: 7) L92: What is meant by “both deltas”?

Reply: We now rephrase the sentence as follows: "... the reference for **the changes in temperature and precipitation** was taken ..."

Comment: 8) L152-154: In this sentence, it sounds like the implicit assumption is that the measurements are biased, but assuming these biases are constant in time, then we can use them to evaluate WRF's interannual variability. This should be made explicit.

Reply: It is not so much the problem that we assume a constant bias. Rather, it is the complete lack of data in the places where we are most interested in, meaning we can only compare it to measurements that are relatively far away. We try to make this clearer by stating: "**Although not covering the glacierised areas of interest, we compared our WRF output with data of the region surrounding WKSK, to ensure that the WRF output is a reasonable representation of the regional climate between 1980-2010.**"

Comment: 9) L156: GHCN has not been defined.

Reply: We now state: "... from **the Global Historical Climatology Network (GHCN)** ..."

Comment: 10) L159-160: Please explain the relevance of many of these stations being situated in urban environments.

Reply: We now state: " This implies that the interannual variability is very well reproduced in WRF. **This is despite the fact that many of these stations are situated in urban environments, with a potential heat island effect, a lack of evaporative cooling that is seen for irrigated agriculture, and a very difference surface energy balance than snow-covered areas. Hence, their locations might not be representative of the wider area, which might give rise to biases and trend differences when comparing the stations to the model outcome.**"

Comment: 11) L166-167: Implicit in this sentence is that the stations measure snow less reliably than rain. Please make this explicit and provide a reference.

Reply: This is indeed the case. We now state: "... with a significant fraction of snowfall, **which is more difficult to reliably measure than rain (Archer, 1998),** making comparisons of precipitation very uncertain."

Comment: 12) L185: How do you know that the discrepancy is only in part due to the different spatial resolution? Have you quantified the effect of the spatial resolution?

Reply: We averaged over identical large areas to come to this conclusion. We now state this more explicitly: "... **as is evident from e.g. averaging over 1x1° areas.**"

Comment: 13) Figure 6 is never referenced in a meaningful way. This figure shows nicely that there is no clear distinction between growing and shrinking glaciers in terms of temperature trends, but that there is a clear distinction in terms of snowfall trends. It would be nice to have some words to this effect in the text.

Reply: We agree and add: "**Fig. 6 shows that the trend and the interannual variability of temperature are very similar for nearby regions of both growing and shrinking glaciers.** The snowfall trends in **Fig. 5** have a very different pattern, with most of the Tibetan Plateau showing an increase and the western and southern mountain ranges, such as the Himalaya and the Hindu-Kush, showing a decrease in snowfall. **Furthermore, the mean level, the**

trend, and the interannual variability of snowfall is quite distinct for the two nearby regions of contrasting glacier mass balance trends. "

Comment: 14) Figure 6 caption: how is representativeness of the bins determined?

Reply: The representativeness was not checked, but we simply picked two nearby points with contrasting mass balances. We increased the representativeness by averaging over larger areas, and modify the caption as follows:

"...for two nearby 2x3° bins that have, on average, growing glaciers (38-40° N, 73-76° E, blue lines) and shrinking glaciers (35-37° N, 72-75° E, orange, dashed lines)."

Comment: 15) L230-232: It is quite confusing when you say "our simulations only go out to 2010, but we compare our results for 2000-2008". Why not compare results up to 2010? If 2008 is as far as the observations go, then the limitation is in the observations, not the simulations.

Reply: The phrasing was indeed confusing. The observations mostly go to periods later than 2010, but the 2000-2008 period was also given in Brun et al. (2017), although it is less accurate. We now rephrase as follows: " A more detailed quantitative comparison of the above results and the observed mass balances is hampered by the fact that our simulations only go out to 2010, **and hence we cannot compare with the most recent, and most accurate geodetic mass balance data. However,** we compare our results for the **intermediate** period 2000-2008, **as presented by Brun et al. (2017),** in Fig. 9."

Comment: 16) L232-233: As well as the model showing too little growth for the growing glaciers, it shows different glaciers growing to the ones in the observations (Fig. 9). Are the growing glaciers in the model and observations at least in the same areas?

Reply: They are indeed. We already mentioned: " In fact, all points where we model glacier growth in Fig. 8a also show growth or stable conditions in observations (Brun et al., 2017; Käab et al., 2015), except one point in Käab et al., (2015)." After the comparison in Fig. 9, we add: " **However, in both cases the growing glaciers are only present in the same region, mainly WKSK and the Tibetan Plateau.**"

Comment: 17) L259: Presumably the low glacier temperature sensitivity in the WKSK is because, even with warming, temperatures in the WKSK are still generally below freezing? This could be clarified. Or if there is a different reason?

Reply: Although such a narrative is sometimes employed, it is not really true that the glaciers in WKSK always experience negative temperatures. A glacier in balance loses as much mass by melt/sublimation as it has gained by snowfall, when averaged over a long period. Because the accumulation zone in WKSK is indeed very high, the glaciers need to extend down to warmer temperatures to be in balance. We now add: " The reduced temperature sensitivity is in line with previous work (Sakai & Fujita, 2017; Wang, Liu, Shangguan, Radic, & Zhang, 2019), **which argue that the generally large masses of the glaciers, and high equilibrium line altitudes, are important in explaining the lower temperature sensitivity in WKSK. "**

Comment: 18) I am slightly confused about Fig. 10b. Is temperature kept constant (similarly to snowfall being constant in Fig. 10a)? Please clarify in the caption.

Reply: This is indeed the case, and we now add, similar to 10a: "... and a spatially uniform and constant snowfall increase of $+0.5\% \text{ yr}^{-1}$ of the annual mean value, **with temperature kept constant (b).**"

Comment: 19) L279-280: The increases in the Tarim basin are just on the very edge of the basin. Can you confirm that the specific grid points that exhibit increases in moisture contributions have undergone an increase in irrigation?

Reply: These are indeed the irrigation areas. In our model, mainly the Yarkand area show largest increase in irrigation, which is very close to the edge of the basin. We now add: "The regions with the second largest increases are the areas in the Tarim basin **where irrigation has increased the most, ...**"

Comment: 20) L280: You say that the contribution is mainly in May to July, but only May is shown in Fig. 12.

Reply: We show May, because it is the month with the largest contribution to the increase in snowfall. We now clarify as follows: "... which contributes mainly in May-July, **with May showing the largest resulting increase in snowfall** (see Figs. 7 and 12)."

Comment: 21) L306-307: Do you mean the correlation is weaker because surface fluxes are lower in winter?

Reply: Mainly the snowfall is less in WKSK in winter. We now clarify as follows: "since this region contributes **relatively more** in winter (Fig. 12), **when less snowfall reaches WKSK (Fig. 7).**"

Comment: 22) L335: After "Once the groundwater is depleted, the glaciers in WKSK will also receive less snowfall from this region", you should insert, "according to our results", or something similar.

Reply: We agree, and add the following: "Once the groundwater is depleted, **our results suggest that** the glaciers in WKSK will also receive less snowfall from this region, resulting in their retreat."

Comment: Technical corrections

- 1) L122: if→of
- 2) L126: "less than 1%" should be "more than 99%", unless I misunderstand?
- 3) L147: rare→sparse
- 4) L153: of→from
- 5) L185: extremes→maxima
- 6) Figure 5 caption: insert "annual" before snowfall. Same in other figures.
- 7) L214: think→thin
- 8) L215: northwestern→southwestern. Same on L295.
- 9) L229: Fig. 3a→Fig. 8a

Reply: We corrected all these technical issues as suggested by the reviewer, except point 3), which was correct (we talk about validation of our model, not validation from our model). We thank the reviewer for the very careful reading.