Dear reviewer,

First of all, we would like to thank you for this clear and helpful review. We are very well aware that this review has been a significant time investment and therefore especially appreciate the reviewer's feedback and commitment. We provide our detailed answers and explanations below and hope that this address and clarify the reviewer's comments and questions.

Reviewer comments are repeated in *italic*, author replies in regular font.

Best regards,

Adrien Michel, on behalf of the authoring team.

The manuscript provides a thorough investigation of modeled future temperatures in Swiss streams. Methods are well detailed and simulated streamflow for historic and future conditions are exhaustively detailed.

My main comments involve the length of the manuscript and the primary messages. The manuscript is almost too long, with certain side analyses partially detracting from more central messages of the manuscript.

On a related note, the abstract itself predominantly focuses on the future simulations (which – as admitted in the manuscript – have some potential limitations) while neglecting what I see as the more fundamental insights into hydrological process and the sufficiency of model structure. The manuscript had more nuance and deeper investigations into process than I was led to believe by initially reading the abstract.

Thus, I have two specific thoughts:

1. *Possibly move Figure 7, 8, and 9 and some accompanying text to Supplemental section*

   We agree that the paper is rather long as it accommodates a substantial number of results. We will do our best during the revision process of the manuscript to shorten it. Figures 7, 8, and 9 could indeed be moved to the Supplementary along with part of the discussion only keeping the main message in the text. Reviewer 1 also suggested moving Section 5.3 to the Supplementary. We will consider these suggestions during the revision with the objective to shorten the paper and give the main messages better visibility.

   Rewrite abstract to better emphasize insights into appropriateness of model structure and reduce emphasis on summary of future simulations. Similarly the conclusions section could also benefit from some shifting of prioritization of messages. In particular, there should be specific mention of that model does not allow for direct input of melt water into streams and that this led to overestimate of warming under historical conditions (but is believed to be less of an issue in the future as snow diminishes).

   Thank you for this suggestion. Indeed, the paper is discussing quite extensively the models and their limitations. While the title gives some indication, this part is absent from the abstract as well as the conclusions. We definitely agree that these aspects should be included. Here is how we intend to adapt the abstract, showing additions (in green) and deletions (in red):

"Rivers are ecosystems highly sensitive to climate change and projected future increase in air temperature is expected to increase the stress for these ecosystems. Rivers are also an important socio-economical factor impacting agriculture, tourism, electricity production, and drinking water supply and quality. In addition to changes in water availability, climate change will impact the temperature of rivers. This study presents a detailed analysis of river temperature and discharge evolution over the 21st century in Switzerland, a country covering a wide range of Alpine and lowland hydrological regimes. In total, 12 catchments are studied. They are situated both in the lowland Swiss Plateau and the Alpine regions and cover overall 10% of the country's area. This represents the so far largest study of climate change impacts on river temperature in Switzerland. The impact of climate change is assessed using a chain of physics-based models forced with the most recent climate change scenarios for Switzerland including low, mid, and high emissions pathways. The ability of such models for this application is discussed in detail and recommendations for future improvements are provided. Despite the identified limitations, the used model chain is shown to provide robust results. A clear warming of river water is modelled during the 21st century, more pronounced for the high emission scenarios and toward the end of the century. ~~For the period 2030-2040, median warming in river temperature of +1.1◦C for Swiss Plateau catchments and of +0.8◦C for Alpine catchments are expected compared to the reference period 1990-2000 (similar for all emission scenarios).~~ At the end of the century (2080-2090), the median annual river temperature increase ranges between +0.9°C for low emission and +3.5°C for high emission scenarios for both Swiss Plateau and Alpine catchments. At the seasonal scale, the warming on the Swiss Plateau and in the Alpine regions exhibits different patterns. For the Swiss Plateau, the spring and fall warming is comparable to the warming in winter, while the summer warming is stronger but still moderate. In Alpine catchments, only a very limited warming is expected in winter. ~~A marked discharge increase in winter and spring is expected in these catchments due to enhanced snowmelt and a larger fraction of liquid precipitation. Accordingly,~~ The period of maximum discharge in Alpine catchments, currently occurring during mid-summer, will shift to earlier in the year by a few weeks (low emission) or almost two months (high emission) by the end of the century. ~~In summer, the marked discharge reduction in Alpine catchments for high emission scenarios leads to an increase in sensitivity of water temperature to low discharge, which is not observed in the Swiss Plateau catchments.~~ In addition, an important soil warming is expected due to glacier and snow cover decrease. These effects combined lead to a summertime river warming of +6.0◦C in Alpine catchments by the end of the century for high emission scenarios. Two metrics are used to show the adverse effects of river temperature increase both on natural and human systems. All results of this study along with the necessary source code are provided with this manuscript."

In a similar way, we propose to modify the first part of the conclusion as follows:

"This work presents the fist extensive study of climate change (CC) impact on rivers water temperature in Switzerland and, to the best of our knowledge, in Alpine areas. A chain of physics-based models has been used with 24 CC scenarios, spanning three different emissions pathways (RCP2.6, RCP4.5, and RCP8.5), and applied to two categories of catchments, namely lowland Swiss Plateau catchments and high elevation Alpine catchments. The work presented here required substantial optimization work in the source codes of the models, which underlines the importance of good documentation, maintenance, accessibility, and collaboration around model source codes, which is often undervalued.

We demonstrate the ability of the developed model chain to reliably simulate the water temperature of a variety of catchments over Switzerland despite some limitations being identified. The results obtained for water temperature and discharge for the near future with 21 CC scenarios are coherent with past and current observations in Switzerland and in central Europe (Moatar and Gailhard, 2006; Webb and Nobilis, 2007; Arora et al., 2016), and with other modelling studies using the same forcing scenarios over Switzerland.

This work shows that the computation of the temperature of water flowing into the stream network is a critical factor in Alpine catchments and that omitting the cold advection from snow and ice melt (such as in the used HSPF approach) leads to an overestimation of the summer water temperature over the historical periods. Two other approaches were tested for the inflow temperature but led to worst results. Other aspects of the physical models used such as the impact of using a lumped approach versus a discretized approach for water routing, or a simple in-stream routing computation versus a more complex one, together with the calibration period length are tested. Therefore, this work offers thus a solid basis for future work on physics-based hydrological models.

Based on our modelling results, expected CC impacts on river water temperature in Switzerland can be summarized as follows: […]”