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Interactive comment on "Climate change impacts model parameter sensitivity – What does this mean for calibration?" *by* Lieke Anna Melsen and Björn Guse

Anonymous Referee #1

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This study investigates the changes in parameter sensitivity for a hydrological model under a plausible rate of climate change. This is considered in the context of model calibration, i.e. what would happen if one were to calibrate only the most sensitive parameters. This experiment is performed using the DELSA sensitivity method across 605 catchments in the U.S. with the SAC-SMA, VIC, and HBV models in a historical and future period forced by a GCM. Results show that some parameters, especially snow, show decreasing sensitivity, while others increase in unpredictable ways.

This is an interesting and novel research question that is addressed with a well-devised and executed experiment. The large sample of catchments and comparison of Knoben

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indicators is very thorough. I fully support its publication, but I have some minor questions about the framing and interpretation of results.

1. The motivation related to calibration is somewhat unexpected. I am not sure how common is the practice of calibrating only the five most sensitive parameters. For these lumped catchment models, a calibration of 5, 15, or 30 parameters is computationally not very difficult, though there is the concern of equifinality.

It is probably not necessary because the paper would be just as interesting if framed as the change in parameter sensitivity over long timescales under climate change. The study does not perform a calibration, and does not consider how the calibrated values of the parameters would change due to climate. For example, Section 3.3 is not really considering the impact on model calibration, instead it is considering the impact of climate change on the ranking of sensitive parameters.

This is a minor clarification in a few places in the paper, but it is one possible point of improvement.

2. I imagine many readers will be interested in the diagnostic question: what can the sensitivity analysis tell us about hydrologic processes changing in the future? There are a few clear examples of this in the results, such as the decrease in snow processes, and the increase in ET processes. However, despite the very thorough experiment and comparison across climate indicators, there is not much relationship between the level of climate change and the change in parameter sensitivity across models.

The authors have a good discussion of what this could mean, that perhaps there is no consensus how the hydrological system will change in the future. My somewhat pessimistic interpretation was that the increases in parameter sensitivity do not follow any process-based reasoning, and are only the result of the simplified conceptual model structure. Additionally, it is not possible to say whether parameters are more sensitive because the processes are occurring more frequently, or with higher magnitude, or only because some other process is not occurring and the residual sensitivity had to

go somewhere.

There is nothing quantitative to do about this, but it is a very interesting issue. I would encourage the authors to consider focusing discussion more on this point, and perhaps a bit less on the calibration-related issues.

3. There is some opportunity to relate this study to previous studies of time-varying sensitivity on much shorter timescales (event or seasonal). In those cases, the temporal dynamics of sensitivity can be directly linked to flood or drought events. The change in parameter sensitivity here is expected, because of course the catchment is not stationary on a daily timestep. However in the climate change case, the driving processes are less clear, which raises more concerns about structural issues.

I am curious whether the authors view the current study as part of a continuum across timescales, or as a separate matter entirely.

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