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Comment on hess-2021-550

Anonymous Referee #1

Referee comment on "Revisiting parameter sensitivities in the variable infiltration capacity model across a hydroclimatic gradient" by Ulises Sepúlveda et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-550-RC1>, 2021

This paper studies the sensitivity of the VIC model to 43 soil, vegetation, and snow parameters using the DELSA sensitivity analysis method in about 5500, 0.05 degree grid cells in Chile. The authors find that different goodness-of-fit metrics (the authors try eight of these) have more or less sensitivity to different parameters. Precipitation and aridity are also found to control parameter sensitivity. Recommendations are provided for how to select calibration parameters based on climatology and which variable is of interest.

Summary of findings:

- VIC is overparameterized - only 12 of the 43 parameters are sensitive – 7 soil parameters, 2 vegetation parameters, and 3 snow parameters.
- Mean annual precipitation and aridity control which parameters are sensitive.
- Leaf area index and hard-coded snow parameters are sensitive.
- Provides guidance on the most relevant parameters for model calibration depending on the target process (runoff, snow, or ET) and climate type (humid/arid).

This paper is well-written, and I think it will be a useful resource for VIC modelers, as it describes the VIC parameters in depth, where they came from, and what good min/max values are for calibration. Its point that some of the hard-coded snow model parameters are sensitive and perhaps should be exposed to users is well-taken.

My main criticism of this paper is that some of the findings, e.g. that VIC is overparameterized and certain parameters are more sensitive under certain conditions – are well-known from other studies (such as Demaria et al., 2007 and Gou et al., 2020).

On the other hand, examining parameter interactions, which the authors say is possible using the DELSA method, might be more interesting.

Some other critiques:

- I wonder whether the amount of peak SWE is a useful goodness-of-fit parameter. I imagine that many combinations of parameters could give the same peak SWE, since it is an integrated measure of the entire season's snowfall. This would be worth mentioning in Section 3.4 performance metrics.
- You study 101 catchments throughout Chile, but only a few catchments are highlighted in the figures. Is there any justification for why these catchments are spotlighted?
- In Figure 3, indicate whether the rows are organized by latitude (they appear to be, but it would help readers interpret the figure if this were more clear).
- L315: SnowLegth typo
- In Section 4.3.1, it is claimed that humid environments enable recharge of the lower soil layers and thus cause increased sensitivity of baseflow parameters. Is this true for all wet catchments, or does it depend whether precipitation occurs as rainfall or snowfall? I imagine that snowy catchments will have more sensitivity to baseflow parameters, as water will have more time to infiltrate into the soils. (I'm assuming here that snowmelt runoff is generated more gradually than rainfall runoff.)
- L380: syntax should be "LAI, Rmin, etc. being the most important parameters."