

## Comment on hess-2022-106

Anonymous Referee #2

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Referee comment on "Snow persistence is associated with stream high-flow and low-flow signatures with differing relationships by aridity and climatic seasonality" by Edward Le et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2022-106-RC2>, 2022

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### 1 General comments

Le et al. analysed how well snow persistence (along with aridity and precipitation seasonality) can explain a range of flow signatures in over 1000 catchments in North America, using a 19-year data set. They applied a linear model with interaction term (multilinear regression) and visually analysed the influence of snow persistence on each response variable. With a very short results section and basically only one figure (Figure 3), they come to significant results, such as that snow persistence influences low flow characteristics, and in some climate regions also high flow characteristics. Furthermore, the authors established a link between the spatial changes observed and future climatic changes, such as how a reduction in snow persistence could change flow characteristics.

In my opinion, the fitted linear models are not able to capture the variance sufficiently to draw these essential conclusions. The authors report values for  $R^2$  ranging from 0.11 to 0.25 (Table 1). Similarly (or as a consequence), the explained effect of snow persistence on the response variables is small: the largest values on the y-axes in Fig. 3 cover only 0.1% (for  $Q_{95}$ ) to 4% (for  $Q_5$ ) of the indicated interquartile range in Table 1. The effect is statistically significant, as mentioned by the authors, but in my view too small to be relevant. This is a common problem: as sample size increases, decreasing effects become statistically significant. The authors need to find ways to create models with greater predictive value that are able to produce effects of relevant size. In my opinion, the small effect size of the linear models makes this manuscript too weak to be considered for publication in HESS. I will explain this in more detail in the next section.

### 2 Specific comments on the small effect size

The authors discuss these low  $R^2$  values in their "Limitations" section and mention that this is to be expected as geological and topographical factors were not included. They cite

Addor et al. (2018), for example, who considered these factors important. I disagree with this expectation of low  $R^2$  values and also with the explanation: Addor et al. (2018), a very similar but much more comprehensive study (barely cited by Le et al.), concluded "... that climatic attributes are by far the most influential predictors for signatures that can be well predicted based on catchment attributes". Instead of simple linear models, they trained Random Forests and found that they could explain large parts of the variances of signatures such as  $Q_{95}$  ( $R^2 > 0.8$ ),  $Q_5$  ( $R^2 \sim 0.6$ ) and BFI ( $R^2 \sim 0.5$ ) with climatic attributes alone (read from their Figure 5). These values are much larger compared to those reported here. Only for the slope of the flow duration curve was a similarly small  $R^2$  value reported.

The reasons for the larger  $R^2$  values reported by Addor et al. (2018) could be that they used

- more and other climatic variables
- more complex models
- a longer dataset, limited to the US.

The first item is important for the aim of the Le et al. manuscript, namely to show the predictive value of snowpack persistence (SP). As the authors indicate, snowpack persistence is easier to determine compared to snowfall fraction (which was used by Addor et al., 2008) and is therefore a very interesting and globally available predictor variable. To show the predictive value of SP, I would suggest repeating the Addor et al. (2018) study for the US and Canadian datasets and only use their climatic variables, then replace the snowfall fraction with SP and then remove step-wise all other climatic variables until the three used here remain (i.e. SP, seasonality of precipitation and aridity). With this setup, one can find out what the authors were aiming for, namely (line 418ff): "how far we can go in explaining detailed streamflow characteristics with a simple, widely available and accurate satellite-based snow-related metric" (along with seasonality and aridity).