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Interactive comment on "Can river temperature models be transferred between catchments?" *by* Faye L. Jackson et al.

Anonymous Referee #4

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The paper by Jackson and colleagues assesses the performance of statistical temperature models fit to data from one basin when applied to another basin. Successfully doing so should ultimately depend on the degree of similarity between two basins and the adequacy of the temperature sample and model calibration within the first basin. In basins where the covariance structure among predictor variables used in the model is similar, one would expect a high degree of transferability because temperature measurements are being taken and applied along similar predictor variable ranges and combinations of ranges. In basins where the covariance structure is appreciably dif-

ferent, one would expect low transferability. It would be interesting, therefore, for the authors to provide tables for the four catchments summarizing the pairwise correlation coefficients among all the predictor variables at the observation sites (below the diagonal) and those same variables representing reaches in the full network (above the diagonal). The authors could compare those correlation matrices among the four basins to determine which were most (dis)similar and the representativeness of their temperature samples, which could provide insights to their results in Table 3. Bladnoch, for example, is the main outlier and one might expect its covariance structure to differ most from the other three basins. Also useful would be tables that summarized descriptive statistics for the temperature observations and network reach characteristics in the four basins. Oftentimes, simply knowing the mean, median, standard deviations, minima, and maxima is very informative for understanding datasets and the performance of statistical models.

Thinking about this question more broadly, one might also ask whether there's ever utility in transferring a model developed and calibrated for one area to another area? The author's models developed using data pooled across basins and fit with a RNS seem to provide the best of most worlds – the largest sample size to provide robust parameter estimates, highest predictive performance, ability to account for local variation with the RNS, and ability to incorporate (or test for) basin level effects. Where those effects aren't significant the data can be pooled and separate categories retained in the model structure only for those basins that are appreciably different. That said, the transferability question presents a challenge if the issue involves application to a basin that is entirely lacking in temperature data. For that topic, the authors cite work by Millar as an example of providing informed priors that would be worth developing and exploring in more detail. There's also a large literature on the ungauged basin topic that could be drawn on here (for a recent review, see Hrachowitz et al. 2013. Hydrological Sciences Journal 58:1198-1255).

However, it's also the case that reliable miniature temperature sensors are inexpen-

sive and easily deployed, thereby making new monitoring efforts straightforward and decreasing the probability that ungauged basins will remain so indefinitely. Remote sensing imagery from the MODIS satellite has also been used recently to accurately predict stream temperatures (McNyset et al. 2015. Water 7:6827–6846), which in some regards renders the ungauged basin topic moot given the global availability of this imagery source. And as the authors demonstrate here and in their previous work (Jackson et al. 2016), it's possible to derive many useful model predictors from geospatial datasets that are available for most basins. So I wonder if a more useful tact for thinking about 'transferability' wouldn't be attempting to establish a scalable modeling framework that can be consistently applied (i.e., transferred) to other basins as new data become available? The focus then largely becomes one of efficient sampling design, which the authors have experience with (Jackson et al. 2015) and that others have developed network design theory for (Som et al. 2014. Environmetrics 25:306-323). In this context, the RNS models, like the similar SSN models (Ver Hoef et al. 2006), provide another advantage in their ability to borrow strength from other areas when fit to across-basin datasets, thereby minimizing the number of new temperature samples required in previously ungauged basins.

Incorporating a temporal dimension to the purely spatial models considered here by the authors would also be a way to reduce costs associated with new temperature monitoring in a scalable framework. Rotating panel designs could be used wherein most sites are monitored for short periods (e.g., 1-2 years) to capture spatial variation in a dataset while a small number of sites are monitored indefinitely to capture temporal variation. The sites representing spatial variation would not all have to be monitored in the same years because the temporal sites could be used for standardization. Isaak et al. (2010) provide an example of models fit to similar space-time temperature datasets that were gradually accumulated over the span of fourteen years.

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