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Evaluating the performance of different regionalization methods for a wide range of hydrological models in different climate regions

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Hydrological models have been widely used to predict runoff in regions with observed discharge data, and regionalization methods have been extensively discussed for providing runoff predictions in ungauged basins (PUB), especially during the PUB decade (2003-2012). Great progress has been achieved in the field of regionalization in a large number of studies, in which different hydrological models have been coupled with various regionalization methods. However, most of these studies have concentrated their evaluations on either one hydrological model or one regionalization method. In our study, we assess the performance of three regionalization methods (spatial proximity, physical similarity and regression methods) and four daily lumped rainfall-runoff models (GR4J, WASMOD, HBV and XAJ) at the same time. Our aim is to evaluate how the performance depends on the interrelationship between the hydrological model and regionalization method. This investigation uses data from 86 evenly distributed catchments in Norway, covering three different climate zones (oceanic, continental and polar tundra) according to the Köppen-Geiger classification. The results show that (a) the output averaging option for distance-based methods performs better for all hydrological models and the regression method performs worst in most cases; (b) the difference between the parameter averaging option and output averaging option is positively related to the number of hydrological model parameters, i.e. the more the number of parameters, the larger the difference between the two options; (c) models with fewer parameters tend to produce similar performance for the different regionalization methods; and (d) clear differences in the performance of regionalization methods exist between the three climate classes. This study provides insight to the influence from hydrological models on the performance of regionalization methods in various climate regions.