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Comparison of extreme precipitation return levels using spatial Bayesian hierarchical modeling versus regional frequency analysis

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We compare extreme precipitation return levels obtained using spatial Bayesian hierarchical modeling (BHM) with their respective counterparts from a traditional regional frequency analysis (RFA) using the same set of 24-hour annual precipitation maxima data. Our study area is the 11,478 square mile Willamette River basin (WRB) located in northwestern Oregon, a major tributary of the Columbia River whose 187 miles long mainstem, the Willamette River, flows northward between the Coastal and Cascade Ranges. The WRB encompases approximately two thirds of Oregon's population and 20 of the 25 most populous cities in the state. The U.S. Army Corps of Engineers (USACE) Portland District operates thirteen dams within the region, therefore extreme precipitation estimates are required to support risk informed hydrologic analyses as part of the USACE Dam Safety Program. Our intent is to profile for the USACE an alternate methodology to the RFA that was developed in 2008 due to the lack of an official NOAA Atlas 14 update for Oregon state. Our spatial BHM analysis involved application of leave-one-out cross validation (LOO-CV) for model selection, which also supported a comprehensive assessment of location specific model performance. We incorporated PRISM Norm81m long-term (1981-2010) mean monthly gridded data as a source of covariate information. Unlike RFA, the advantage of a spatial BHM-based analysis of hydrometeorological extremes is its ability to allow for the inclusion of geographical and climatological factors that influence regional rainfall extremes, while also providing robust estimates of uncertainty.