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Uncertainties in transient projections of maximum and minimum flows over the United States

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Global multi-model ensemble experiments provide a valuable basis for the examination of potential future changes in runoff. However, these projections suffer from uncertainties that originate from different sources at different levels in the modelling chain. We present the partitioning of uncertainty into four distinct sources of projections of decadally-averaged annual maximum (AMax) and minimum (AMin) flows over the USA. More specifically, we quantify the relative contribution of the uncertainties arising from internal variability, global impact models (GIMs), global climate models (GCMs), and representative concentration pathways (RCPs). We use a set of nine state-of-the-art GIMs driven by five CMIP5 GCMs under four RCPs from the ISI-MIP multi-model ensemble. We examine the temporal changes in the relative contribution of each source of uncertainty over the course of the 21st century. Results show that GCMs and GIMs are responsible for the majority of uncertainty over most of the study area, followed by internal variability and RCPs. Proportions vary regionally and depend on the end of the runoff spectrum (AMax, AMin) considered. In particular, for AMax, large fractions of uncertainty are attributable to GCMs throughout the century with the GIMs increasing their share especially in mountainous and cold areas. For Amin, the contribution of GIMs to uncertainty increases with time, becoming the dominant source over most of the country by the end of the 21st century. Importantly, compared to the other sources, the RCPs contribution to uncertainty is negligible generally (for AMin especially). This finding indicates that the effects of different emission scenarios are barely noticeable in hydrological impact studies, while GIMs and GCMs make up most of the amplitude of the ensemble spread (uncertainty).