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The Development of Quantitative Hydrologic Storylines to Understand Uncertainty in Climate

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Future climate projections are inherently uncertain, and quantifying and managing this uncertainty is one of the key tasks in any climate application. This uncertainty stems from chaotic variability in the climate system as well as uncertainty due to the methods we use. The latter comes from both lack of understanding of the system, and from the simplifications required to model that system. In particular, uncertainty in emissions scenarios, climate models, downscaling models, and hydrology models all contribute to our uncertainty. Much work in the past has focused on the first two elements, emissions scenarios and climate models, without assessing the uncertainty due to the downscaling and hydrologic models. This larger uncertainty can be quantified using combinations of different models throughout the modeling chain; however, the combinatorial nature leads to an impossibly large number of projections. End users in particular often have limited capacity to process the enormous data volumes these combinations represent.

To make the quantification of this uncertainty accessible to end users, we aim to develop a smaller set of representative hydrologic projections or storylines. To do this, we first build the very large ensemble with multiple emissions scenarios, climate models, downscaling models, and hydrologic models, some of which include multiple internal parameter sets. This large ensemble is then used to quantify the contribution of each component to uncertainty in a variety of hydrologic metrics. Finally, subsets from this large ensemble will be selected to both span the range of uncertainty in the entire ensemble, as well as to emphasize the central tendency of that ensemble. In selecting these subsets, we attempt to both fully reveal, but also to reduce the uncertainty through careful selection based on three criteria. We select models through out the modeling chain to 1) ensure fidelity in current climate, 2) span the range of sensitivities to climate change, and 3) maximize diversity between the included models. These subsets can then be made available to end users, allowing them to assess the impact on their specific application without having to process the very large ensemble themselves.