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Flow Duration Curve and Hydrologic Similarity: Exploration of Climate and Landscape Controls across Continental United States

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The Flow Duration Curve (FDC) is an important signature of a catchment's functioning. Therefore it serves an important role in characterizing hydrologic similarity and differences at the catchment scale. In this paper we analyze regional variations of the FDC across the continental United States and interpret these through the use of simple models to understand the climatic and landscape controls on the FDCs and their roles in governing hydrologic similarity. The functional model we use, following L'vovich (1979), treats a catchment as a nonlinear, two-stage filter. At the first stage, precipitation events are filtered nonlinearly into fast runoff and wetting (infiltration). In the second stage, the infiltrated water is again filtered, in a somewhat more linear fashion, governed by a competition between subsurface drainage and evaporation and transpiration. This allows the FDC to be separated into the FDC of fast runoff, and the FDC of slow subsurface runoff. This enables us to determine how the FDC associated with the precipitation itself cascades through the catchment system and gets modified, transforming into the FDC of fast runoff, and in turn into the FDC of slow runoff, and the relative roles of climatic and landscape controls. The FDC of total runoff is then a convolution of the two components. This analysis is repeated for about 200 catchments across the continental United States. The spatial variations in the FDCs and their components are then evaluated on the basis of the parameters of the two filters (models), and in this way we are able to assess the relative contributions of climate (as manifested in the FDCs of precipitation and relative seasonality of precipitation and potential evaporation) and landscape factors (soil depth, residence time) in these transformations. As part of the investigation we were also able to assess effects of land use and land cover changes, such as urbanization and irrigation activity. We will present the results of these multi-facted analyses, highlighting the regional patterns in the variations of the FDCs and the two components, drawing connections to regional variations of climate and landscape features, including land use and land cover changes.