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Physical interpretation of river memory and application to seasonal flood forecasting

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The various geophysical and hydrological processes involved in the river flow generating process exhibit persistence at several distinct timescales which propagates into the river flow behavior and manifests itself as river memory. We investigate the latter at two seasonal periods of interest, i.e. 3-month High Flow Seasons (HFS) and 1-month Dry Months (DM), by exploiting a dataset of 224 European rivers spanning more than 50 years of daily flow data. We compute the lagged seasonal correlation for the peak flows in the HFS and the average flows in the DM both against the average flows in the antecedent months. We link correlation magnitude to various geophysical catchment characteristics e.g. basin size, presence of lakes, glaciers etc., as well as rainfall-related properties such as seasonality. To exploit the river memory in flood forecasting, we fit a bivariate Meta-Gaussian probability distribution model between peak HFS flow and average pre-HFS flow in order to condition the peak flow distribution in the HFS upon observance of a higher-than-usual (e.g. 95th quantile) flow in the pre-HFS month. The benefit of the suggested methodology is demonstrated by updating a season in advance the flood frequency distribution in real-world applications. Our findings suggest that there is a traceable physical basis for river memory which in turn can be statistically assimilated into flood frequency estimation to improve predictions for technical purposes.