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Learning recurrent transfer functions from data: From climate variability to high river discharge

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Interpretation of flood hazard and its variability remains a major challenge for climatologists, hydrologists and water management experts. This study investigates the existence of links between variability in high river discharge, worldwide, and inter-annual and inter-decadal climate oscillation indices: El Niño-Southern Oscillation, North Atlantic Oscillation, Pacific Interdecadal Oscillation, and Atlantic Multidecadal Oscillation. Global river discharge data used here stem from the ERA-20CM-R reconstruction at 0.5 degrees resolution and form a multidimensional time series, with each observation being a spatial matrix of estimated discharge volume. Elements of matrices aligned spatially form time series which were used to induce dedicated predictive models using machine learning tools, including multivariate regression (e.g. ARMA) and recurrent neural networks (RNNs), in particular the Long Short Term Memory model (LSTM) that proved to be effective in many other application areas. The models are thoroughly tested and juxtaposed in hindcasting mode on a separate test set and scrutinized with respect to their statistical characteristics. We hope to be able to contribute to improvement of interpretation of variability of flood hazard and reduction of uncertainty.