Flood generating Circulation Patterns (CPs)

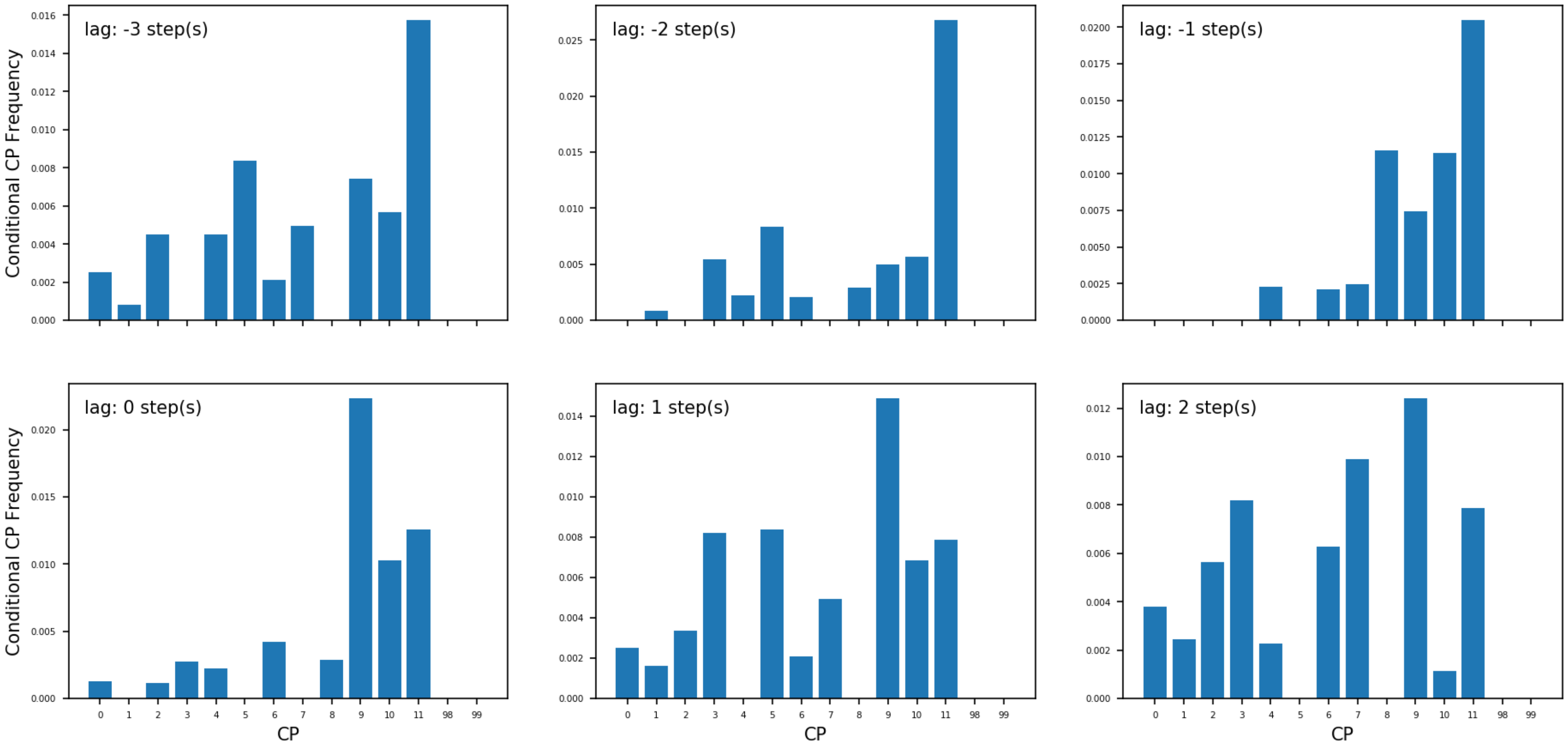

Figure 1: Conditional occurrence of CPs before and after a flood event. A higher incidence of wet CPs (CPs with a higher value) before a flood is more often than for the other CPs.

CPs were calibrated using objective functions from past research with recent data.

Results show that floods with probabilities greater than 0.99 occur when wet CPs happen in close succession.

Here CP 0 refers to the driest and CP 13 to the wettest.

Conditional CP frequencies are shown at steps before and after an extreme event.

Flood associations using distance-based methods

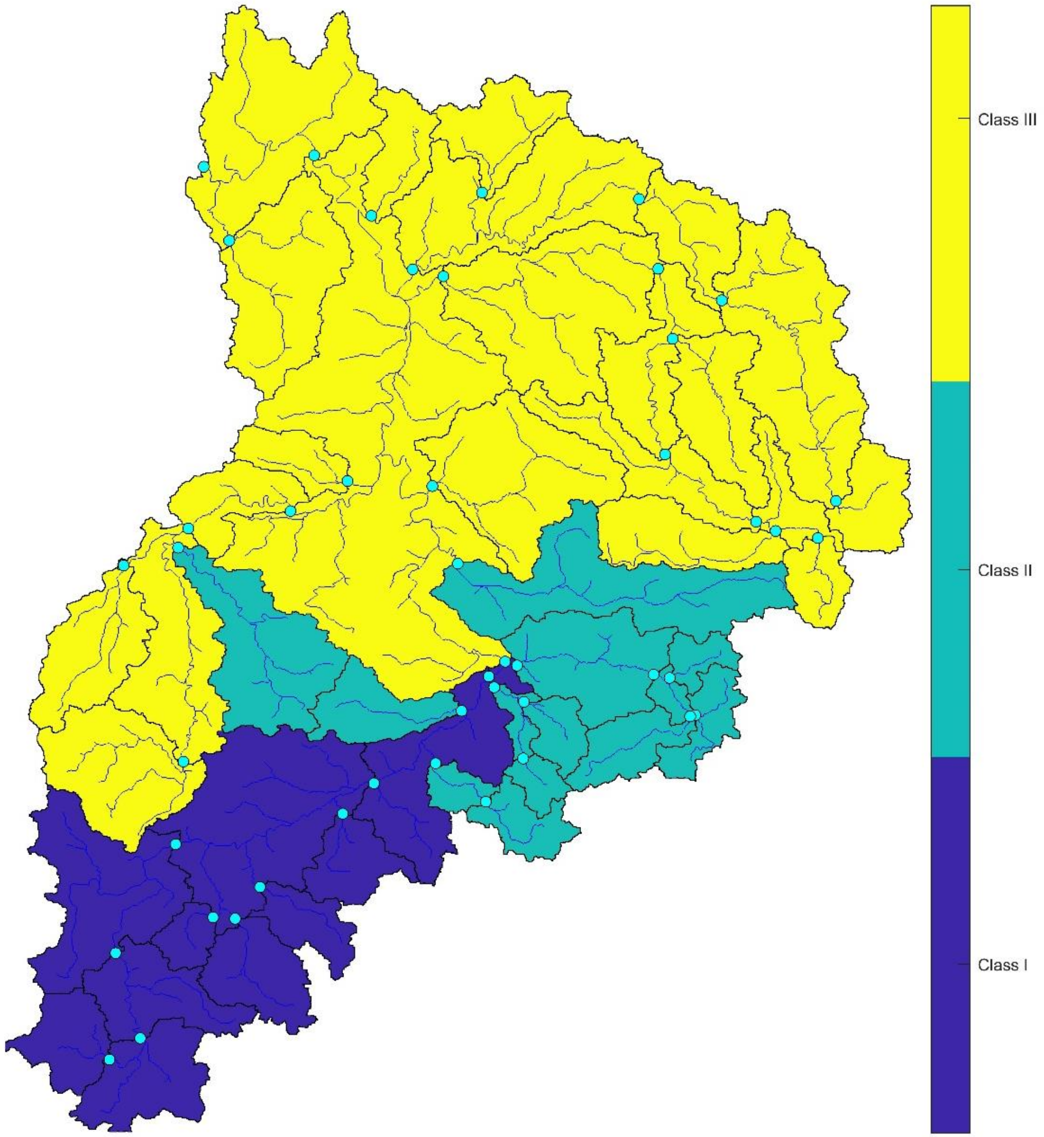

Figure 2: Clusters of sub-catchments that bring floods together in the Neckar catchment.

Using the discharge time series of two gauges and reducing the length of the combined time series, at which at least one of them had a flood peak with a return period more than a given threshold, pair-wise associations were investigated.

Using correlation of these time series as a distance, clusters of catchment that bring floods together were calculated using the Ward clustering method.

Generating pair-wise discharge simulations with a custom dependence structure

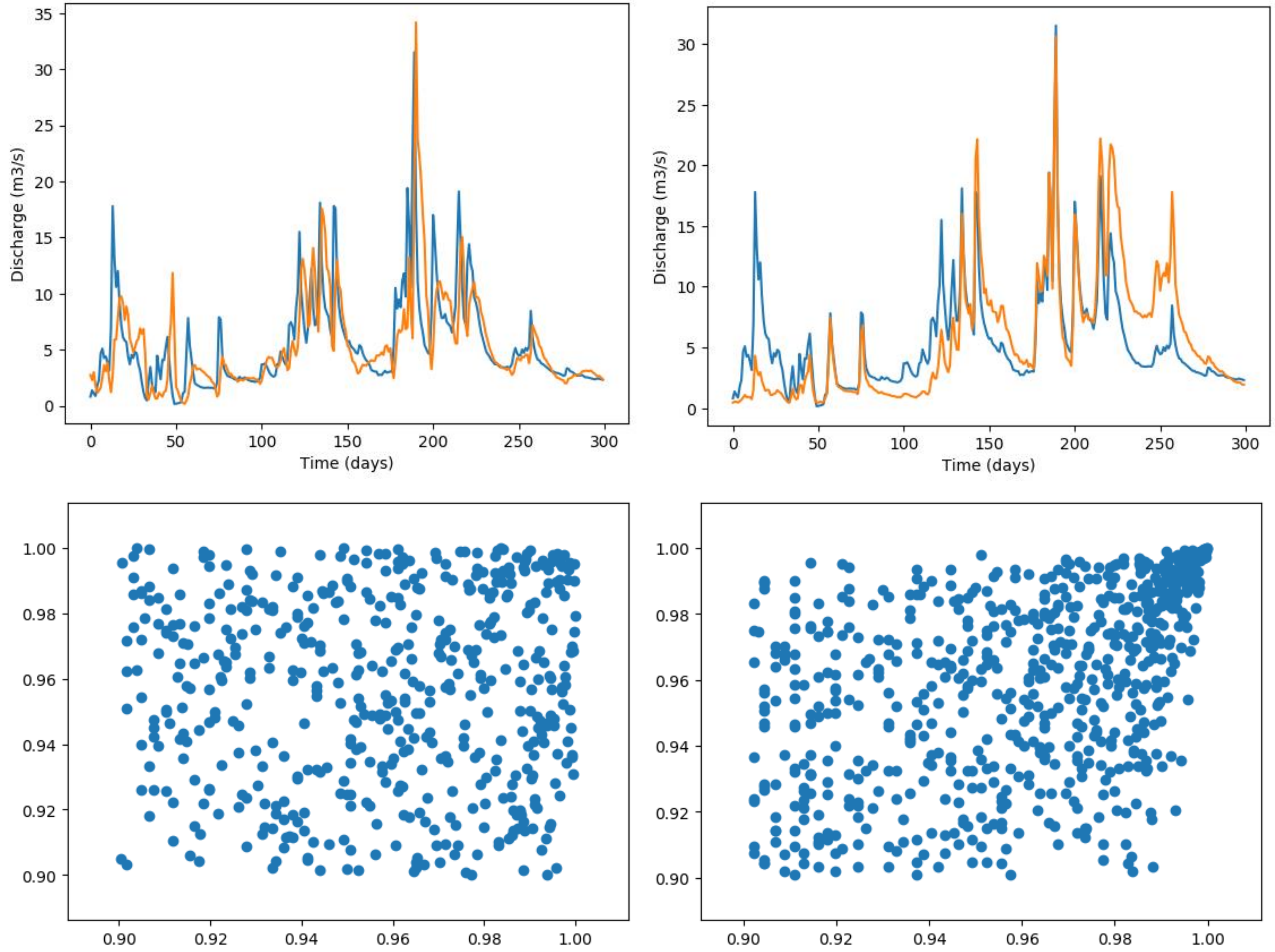

Figure 3: Simulated time series with equal correlation but contrasting behaviors on short and long time scales

Two time series that have equal correlation but relate to each other on a different scale can be generated by manipulating the Fourier Phase ($\Psi_{A,k}$ and $\Psi_{B,k}$) and Power ($c_{A,k}$ and $c_{B,k}$) spectrums using Eq. 1.

$$\rho(n) = \frac{\sum_{k=1}^{n} c_{A,k}\, c_{B,k} \cos\left(\psi_{A,k} - \psi_{B,k}\right)}{\sum_{k=1}^{T/2} c_{A,k}\, c_{B,k} \cos\left(\psi_{A,k} - \psi_{B,k}\right)} \ldots (1)$$

The series on the left have correlation mainly in the long waves while on the right have mainly from the short waves.

Further inspection of the upper right corner of the empirical copula of the two series validates the different dependence structure.