



## **Dominant circulation patterns for the Rhine basin determined by a high-resolution precipitation data set.**

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In this study, we present the dominant circulation patterns for the Rhine basin, as they are determined by a high-resolution precipitation data set, CHR08. These patterns are constructed with the singular value decomposition (SVD) and explained through the maximum covariance analysis. This linear method, objectively, isolates coupled modes of variability between mean sea level pressure and precipitation fields on daily data for the period of 1979 until 2008. Hence, the SVD method identifies pairs of coupled spatial patterns, with each pattern explaining a fraction of the covariance between these two fields and the variations of the regional atmospheric circulation. The two fields are first normalized for all the grid points, by subtracting the mean and dividing by the standard deviation of each time series. The SVD method was preferred due to the orthogonality of the patterns, and the fewer subjective decisions that are required.

The mean sea level pressure covering Europe, is taken from ERA-Interim reanalysis data on a  $1.5^\circ \times 1.5^\circ$  grid resolution, while the recently published high-resolution precipitation data set CHR08 (covering the 134 sub-basins of the Rhine), is up-scaled to the same grid resolution. The two fields under examination can be defined on a different number of grid points. However, the two variables are required to span over the same period of time.

The SVD is performed on the cross-covariance matrix, which is constructed by the two normalized fields of mean sea level pressure and precipitation. This yields two spatially orthogonal sets of singular vectors and a set of the total variance between each pair of the vectors. Each pair of spatial pattern describes a fraction of the square covariance between the two variables. This study attempts a dynamical interpretation of the results, establishing a relationship between the modes through the squared covariance factor, their frequency distributions and matched patterns from studies that used different methods.