



## **A Combined Kohonen Networks and Complex Networks approach for the analysis of Large Scale Atmospheric Features and River Floods in England and Germany**

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Floods and other hydroclimatic extremes may represent specific states of organization of the atmospheric circulation. Given this hypothesis an open question is how best to identify such states, and their space-time persistence. Such a mapping would facilitate a physically meaningful identification of the potential severity, frequency and duration of such events in future climates. With this in view, the link between large scale atmospheric circulation and the extreme floods in Germany and England is investigated by a combined Kohonen Networks and Complex Networks approach. Historical data from 57 streamflow gages in England and 68 in Germany and the Reanalysis Historical Data of the Atmospheric Circulation Fields, bounded from 90W to 70E and from 20N to 80N, are used for the purpose. The common period of record is from 1960 to 2012.

A finite number of typical atmospheric configurations of the considered region are identified by using the Kohonen Networks approach. This approach is preceded by the application of the Principal Component Analysis of the selected atmospheric variable; a number of PCs is retained to explain more than the 99% of the variance. Then the historical sequence of the atmospheric fields, by using k-nearest neighbor methods, is transformed into a binary matrix which identifies, at each time step, the atmospheric configuration most similar to one of the typical ones identified by the Kohonen Network. A further binary matrix is constructed by using as a threshold the 99th percentile of the discharge rates. Finally the Event Synchronization method is applied determining synchronization, causality and delay between the extreme floods in each streamflow gage and the associated atmospheric circulation feature. We find that the proposed approach can be useful and effective to identify the most critical atmospheric circulation patterns responsible of the extreme floods and thus to be used as part of a prediction strategy.