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Classification of reconstructed daily pressure patterns for the period 1850 to 2003 in the North-Atlantic - European Region

A. Philipp (1), J. Jacobeit (1), P. Della-Marta (2) and D. Fereday (3)
(1) University of Augsburg, (2) University of Bern, (3) Met Office

Within the EU funded project EMULATE (European and North Atlantic daily to MULTidecadal climATE variability), mean sea level pressure (MSLP) fields have been reconstructed back to the year 1850 on the daily scale in order to assess changes in coupling between the atmospheric circulation in the North-Atlantic-European region on the one hand and temperature and precipitation including their extremes in Europe on the other hand. A necessary part within these investigations is the examination of characteristic atmospheric circulation patterns. After testing various possible methods for pattern classification, two of them have finally been used: i) t-mode Principal Component Analysis (PCA) and ii) non-hierarchical clustering by an advanced modification of the simulated annealing approach.

T-mode PCA of the MSLP dataset results in score patterns describing typical dominant pressure configurations, and in loading time series describing the degree of realisation of each PC-pattern at each day of the analysed period. Using the PCA approach based on the correlation matrix and a VARIMAX orthogonal rotation, detailed examination of the loadings may indicate the appropriate number of PCs to be extracted. The so-called "dominance criteria" ensures that each extracted PC-pattern is actually represented at least one time in the original dataset, i.e. it prevents the extraction of purely artificial components. This method works fine even if standard approaches like the commonly used scree test fails to suggest a preferred number of PCs. However, high-number PCs are realised only a few times in the original dataset imposing unfavourable constraints for subsequent analyses of frequency changes in pattern occurrence. Therefore particular clustering techniques without the constraint of orthogonality have further been used.

With respect to non-hierarchical Cluster Analysis it has been found that the results of all commonly used algorithms searching for an optimal classification are more or less depending on randomness without any systematic strategy to account for this problem. In contrast to that, the simulated annealing technique tries to approximate a global optimum of the classification function being able to leave worse local optima once they have been reached. Modifications of the standard simulated annealing algorithm lead to a technique called SANDRA (Simulated ANnealing in Diversified RAndomised runs) which ensures to get classification results very near to the global optimum, especially for voluminous datasets with daily resolution which do not show any clear natural separation into clusters.

Details and comparisons of these methods as well as some first results of analysing frequency changes within the resulting pattern classifications will be presented for different 2-month and 3-month seasons of the year.