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Comparison of daily atmospheric circulation indices and patterns from three datasets in European regions, 1957–2002

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The aim of this study is to compare daily indices of atmospheric circulation (flow strength and direction, relative vorticity) calculated using three datasets of sea-level pressure over Europe in the period 9/1957–8/2002: ECMWF ERA-40 and NCEP/NCAR reanalyses, and a gridded reconstruction of ground-based data that was produced within the European project EMULATE (EMSLP dataset). We used the same spatial resolution of 5x5 degrees latitude/longitude for all three datasets, even though the reanalyses are available for finer grids. We have performed the analysis in six European regions that correspond to the following spatial domains defined within the COST733 project: the British Isles (D04), the Baltic region (D05), Central Europe (D07), Eastern Europe (D08), Western Mediterranean (D09), and Central Mediterranean (D10). The indices were used to classify daily circulation into pre-defined circulation patterns. We studied differences in the overall variability and time evolution of the circulation indices, as well as their distributions under the specific circulation types. The analysis was performed separately for the pre-satellite (until 1978) and satellite era (from 1979).
Flow strength and vorticity from the EMSLP dataset generally have lower values and lower overall variability, resulting in more days with hybrid (unclassified) circulation, namely in the Mediterranean. Also the time persistence of the circulation indices (expressed as lag autocorrelation with lags from 1 to 5 days) is mostly greater in EMSLP compared to the two reanalyses. Pearson correlations of daily flow strength and vorticity between the three datasets are relatively high; not surprisingly, the two reanalyses correspond to each other very well. The correlations of reanalyses and EMSLP range from around 0.65 in the Baltics and Central Mediterranean in summer to around 0.95 over the British Isles. Sligthly better accord is usually found for EMSLP x ERA-40 than for EMSLP x NCEP/NCAR. Circulation indices from reanalyses correspond better with those from EMSLP in the satellite era than in the pre-1979 period (with a few exceptions in the Mediterranean). Flow direction is sometimes distorted in EMSLP in various regions and seasons, mostly in the Mediterranean. The EMSLP thus seems to be a valid representation of atmospheric circulation in Western and Central Europe.