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Some remarks on using circulation classifications to evaluate circulation model and atmospheric reanalysis data

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Automated classifications of atmospheric circulation patterns represent a tool widely used for studying the circulation in both the real atmosphere, represented by atmospheric reanalyses, and in circulation model outputs. It is well known that the results of studies utilizing one of these methods are influenced by several subjective choices, of which one of the most crucial is the selection of the method itself. Authors of the present study used eight methods from the COST733 classification software (Grosswettertypes, two variants of Jenkinson-Collison, Lund, T-mode PCA with oblique rotation of principal components, k-medoids, k-means with differing starting partitions, and SANDRA) to assess the winter 1961–2000 daily sea level pressure patterns in five reanalysis datasets (ERA-40, NCEP-1, JRA-55, 20CRv2, and ERA-20C), as well as in the historical runs and 21st century projections of an ensemble of CMIP5 GCMs. The classification methods were quite consistent in displaying the strongest biases in GCM simulations. However, the results also showed that multiple classifications are required to quantify the biases in certain types of circulation (e.g., zonal circulation or blocking-like patterns). There was no sign that any method should have a tendency to over- or underestimate the biases in circulation type frequency. The bias found by a particular method for a particular domain clearly reflects the ability of the algorithm to detect groups of similar patterns within the data space, and whether these groups do or do not differ one dataset to another is to a large extend coincidental. There were, nevertheless, systematic differences between groups of methods that use some form of correlation to classify the patterns to circulation types (CTs) and those which use the Euclidean distance. The comparison of reanalyses, which was conducted over eight European domains, showed that there is even a weak negative correlation between the average differences of CT frequency found by cluster analysis methods on one hand, and the remaining methods on the other. This suggests that groups of different methods capture different kinds of errors and that averaging the results obtained by an ensemble of methods very likely leads to an underestimation of the errors actually present in the data.