Geophysical Research Abstracts
Vol. 21, EGU2019-5900, 2019
EGU General Assembly 2019

Projection of leading modes of circulation variability on self-organizing maps

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Self-organizing maps (SOMs) have recently become one of the most popular methods in synoptic climatology. Owing to its ability to organize circulation types (CTs) into an array in which similar CTs tend to lie close to each other, it was suggested that the leading two modes of circulation variability should project on main diagonals of the array with opposite phases in opposite corners. Based on this concept—never properly tested—, researchers have attempted to directly explain SOM CTs as modes and changes in the CTs as a result of changes in these modes. Our work is based on artificial datasets generated with three predefined modes with predefined ratios of explained variance, which are used to generate SOMs of various settings (including the selection of seed points and array size). The results show that each phase of the leading mode tends to project "well" (that is, with correlation of 0.95 or more) on at least one CT regardless the SOM size, except for cases in which all three modes explain similar portion of the total variability (which, however, resembles real circulation). The projection of the remaining two modes on the CTs is very sensitive to parameters such as size and shape of SOM array, SOM initialization, the exact ratio of modes' explained variances and even to minor changes in the generation of data. Moreover, only the first mode tends to project on a diagonal, although reliably only if it explains at least half of the total variability and for larger SOMs. In other cases, linear combinations of two modes often project on diagonals instead of one mode, or modes project on SOM lines/columns. Additionally, there does not seem to be a link between the quality of classification (in terms of, e.g., explained variance and pattern correlation ratio) and how modes project onto it, although some solutions with similar CTs in opposite corners are clearly inferior in terms of the topographic error. A similar study is planned that will be based on a real circulation dataset and modes identified by PCA, results of which will also be presented.