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Comparing the spatial structure of variability in two datasets against each other on the basis of EOF-modes

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In analysis of climate variability or change it is often of interest how the spatial structure in modes of variability in two datasets differ from each other, e.g. between past and future climate or between models and observations. Often such analysis is based on Empirical Orthogonal Function (EOF) analysis or other simple indices of large-scale spatial structures. The present analysis lays out a concept on how two datasets of multi-variate climate variability can be compared against each other on basis of EOF analysis and how the differences in the multi-variate spatial structure between the two datasets can be quantified in terms of explained variance in the leading spatial patterns. It is also illustrated how the patterns of largest differences between the two datasets can be defined and interpreted.
We illustrate this method on the basis of several well-defined artificial examples and by comparing our approach with examples of climate change studies from the literature. These literature examples include analysis of changes in the modes of variability under climate change for the Sea Level Pressure (SLP) of the North Atlantic and Europe, the SLP of the Southern Hemisphere, the Surface Temperature of the Northern Hemisphere, the Sea Surface Temperature of the North Pacific and for Precipitation in the tropical Indo-Pacific. The discussion of the literature examples illustrates that the method introduced here is at least partly more sensitive than the approaches used in the literature and it allows a better quantification of the changes in the modes of variability.