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Independent Subspace Analysis of the monthly variability of the sea surface temperature field

Carlos Pires

Universidade de Lisboa-FundacaoFCUL-PT503183504, Instituto Dom Luiz (IDL) - Faculdade de Ciencias, Edifício C8, Lisboa, Portugal (capires@fc.ul.pt)

The main goal is to apply Blind Source Separation (BSS) Techniques in order to split the SST low-frequency variability into sources (scalars or subspaces of low dimension) which are the most statistically independent as possible and explaining most of the negentropy (amount of non-Gaussianity) of the multivariate SST pdf. First a number of leading PCs (over 100 years) of the SST monthly detrended anomalies around the global ocean (equatorward of 60 degrees) have been computed, standardized and collected into a state-vector Then, a new three-step BSS method has been applied. The negentropy J (invariant for linear transformations of data), is approximated as a linear combination of Frobenius norms of multivariate cumulant tensors. J may be decomposed by HOSVD (High-order SVD) into positive contributions associated to the principal axes of non-Gaussianity. The trailing null singular values (or below a threshold consistent with a null hypothesis of Gaussianity) determine the Gaussian subspace (first step). Then sources are computed on its orthogonal complement: the non-Gaussian subspace. For that a contrast function is maximized, relying on fourth-powers of cumulants, on the space of orthogonal rotations of the non-Gaussian subspace (second step). The sorting of mostly contributing squared-cumulants for the negentropy at the sought absolute maximal solution is such that it detects the scalars which merge together onto vectorial independent statistical sources (third step). A graph of the explained J and a measure of the average complexity of sources is obtained as far as decreasing sorted cumulants are collected. The application of the above method to the SST field may find non-Gaussian scalars, dyads and triads associated to nonlinear interconnections between quasi-independent scalar sources obtained by ICA (independent component analysis), does linking different oceanic basins, like the Pacific and Atlantic ones. The method provides more efficient and more optimal sources than ICA.
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