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# Winter Monthly Precipitation Downscaling from the North Atlantic Oscillation: An Information Theoretical approach

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The present work assesses Non-Gaussianity and asymmetry within the statistical response of the monthly winter (December to February) precipitation to the North-Atlantic Oscillation (NAO) over the North Atlantic European Region (NAE). In order to evaluate asymmetry, data is split through the median of the NAO index and side correlations are computed for each regime (NAO- and NAO+). Statistically significant differences between these correlations are found: a) near Central North-Atlantic, around 45N and Southeast of Iceland, with much stronger correlations in the wet-favorable regime, respectively NAO- and NAO+; b) South of Greenland and West Mediterranean near 36N, where, in both cases, the correlation is only relevant for the dry-favorable NAO+ regime. Based on the above decomposition, a map of a statistical test of asymmetry, applicable for every bivariate distribution, is shown. In order to evaluate redundancy and Non-Gaussianity, the Mutual Information (MI) is computed from Information Theory, and its positive contributions due to the linear correlation, a purely Gaussian term, and due to Non-Gaussianity, which vanishes in pure Gaussian cases, are studied. MI is estimated through the truncated Edgeworth expansion of the bivariate probability density function (PDF) in terms of Hermite polynomials and cumulants, which are based on single and cross statistical moments, up to fourth order for each variable. The map of Non-Gaussian MI over the NAE domain reveals some coherent regions, consistent with the spatial distribution of asymmetry, where the nonlinear component of the response of monthly winter precipitation to NAO is more important. In both approaches, Gaussian Anamorphosis is applied to each variable in order to prevent the influence of outliers and to obtain Non-Gaussianity and asymmetry measures not influenced by marginal PDFs.