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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Extreme associated functions: optimally linking local extremes to large-scale atmospheric circulation structures" *by* D. Panja and F. M. Selten

Anonymous Referee #2

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General comments

The authors of the paper describe a multivariate technique that attempts to diagnose the co-variability between warm daily temperatures at a fixed location and a set of regional circulation indicators, in this case, principal components of daily 500 hPa heights in a large sector of the Northern Hemisphere centered over Europe. Temperature observations are censored and transformed prior to the analysis: only temperatures above a fixed threshold (0°C in this case) are considered, and those observations that remain are raised to the nth power (squared in this case). This transformation ensures that extreme values in the far right hand tail of the daily temperature distribution have

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greater influence in what is essentially a multiple linear regression in which principal components serve as predictors of the transformed temperature observations. By applying the coefficients on the principal components obtained from fitting the regression to the corresponding Z500 empirical orthogonal functions, a reconstruction of a circulation pattern associated with the occurrence of warm temperatures is obtained. Iterative application of the technique results in a collection of such patterns, which the authors refer to as “Extreme associated functions” (EAFs). EAFs can be constructed to be orthogonal in space, with corresponding coefficient time series that are not orthogonal, or vice-versa. The authors demonstrate for a location in the Netherlands that the derived EAFs are relatively robust and that they are physically interpretable as circulation patterns that would be expected to be associated with warm surface conditions in the Netherlands.

While innovative, the method does have some drawbacks. These include

1. Lack of a precise definition of what is meant by an “extreme”. Familiar concepts such as recurrence frequency do not emerge simply from this technique. To refer to the functions (linear combinations of EOFs) that emerge as “Extreme Associated Functions” seems a bit of an exaggeration, since the occurrences of all temperatures above a modest threshold (0°C in this case) potentially influence the form of the function.

2. There is some apparent degeneracy as the number of principal components that are used as explanatory variables in the regression increases, perhaps suggesting over fitting of the (squared) temperature values in the right hand tail that most influence the estimated values of the regression coefficients. While not explored in the paper, one might imagine that this degeneracy problem becomes more severe when temperature exceedances are raised to higher powers.

3. Lack of a suitable inference framework in which to assess uncertainties and objectively make objective decisions concerning, for example, the EOF truncation

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point that is to be used for the analysis. The standard Gaussian framework would not be suitable in this case given the deliberate transformation of temperature into a variable with decidedly non-Gaussian characteristics.

Nevertheless, the method does provide an additional exploratory tool that may help to diagnose circulation features associated with extremes, both in the observed climate and in climate models.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 14433, 2007.