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On the statistical significance of climate trends

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One of the major problems in climate science is the prediction of future climate change due to anthropogenic green-house gas emissions. The earth's climate is not changing in a uniform way because it is a complex nonlinear system of many interacting components. The overall warming trend can be interrupted by cooling periods due to natural variability. Thus, in order to statistically distinguish between internal climate variability and genuine trends one has to assume a certain null model of the climate variability. Traditionally a short-range, and not a long-range, dependent null model is chosen. Here I show evidence for the first time that temperature data at 8 stations across Antarctica are long-range dependent and that the choice of a long-range, rather than a short-range, dependent null model negates the statistical significance of temperature trends at 2 out of 3 stations. These results show the short comings of traditional trend analysis and imply that more attention should be given to the correlation structure of climate data, in particular if they are long-range dependent.

In this study I use the Empirical Mode Decomposition (EMD) to decompose the univariate temperature time series into a finite number of Intrinsic Mode Functions (IMF) and an instantaneous mean. While there is no unambiguous definition of a trend, in this study we interpret the instantaneous mean as a trend which is possibly nonlinear. The EMD method has been shown to be a powerful method for extracting trends from noisy and nonlinear time series. I will show that this way of identifying trends is superior to the traditional linear least-square fits.