A hybrid-domain approach to modelling climate data time series

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In order to model climate data time series that often contain periodic variations, trends, and sudden changes in mean (mean shifts, mostly artificial), this study proposes a hybrid-domain (HD) algorithm, which incorporates a time domain approach and a newly developed frequency domain approach through an iterative procedure that is analogue to the well known backfitting algorithm. A two-phase competition procedure is developed to address the confounding issue between modelling periodic variations and mean shifts. A variety of distinctive features of climate data time series, including trends, periodic variations, mean shifts, and a dependent noise structure, can be modeled in tandem using the HD algorithm. This is particularly important for homogenization of climate data from a low density observing network in which reference series are not available to help preserve climatic trends and long-term periodic variations, preventing them from being mistaken as artificial shifts. The HD algorithm is also powerful in estimating trends and periodicities in a homogeneous data time series (i.e. in the absence of any mean shift). The performance of the HD algorithm (in terms of false alarm rate, detecting power, hit rate, and estimation accuracy) is assessed via Monte Carlo simulations. Its power is further illustrated through its application to a few climate data time series.