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Model-based decomposition of climate time series

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Climate time series exhibit variability at a wide range of temporal scales. Most climate time series exhibit long-term variability in the form of slow changes in the mean and periodic variability in the form of annual, semi-annual or daily cycles. In the analysis and interpretation of climate records, a key aspect and challenging task is how to extract physically relevant components, specifically periodic and long-term components, in a framework as flexible as possible, for example in which the amplitude and phase of the periodic components are not assumed to be constant. In this work, this issue is addressed by considering autoregressive decomposition, a model-based approach for decomposing an observed time series into latent constituent sub-series. The method, based on the DLM (dynamic linear model) representation for an autoregressive process, is particularly useful for isolating time-varying cycles in climate time series, allowing to retrieve fluctuations in the amplitude and phase of the periodic components and to assess their statistical significance. Furthermore, the approach is easily implemented in a Bayesian framework for further statistical inference on the derived components. The autoregressive decomposition method is illustrated for sea-level and temperature time series for the North Atlantic.