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Dynamic Mode Decomposition to reconstruct and extrapolate hydrological time series

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Dealing with the impacts of climate change is one of the main challenges of our times. The definition of adaptation and mitigation strategies requires the research community to provide accurate analyses on several climate-related phenomena. Data with improved spatial coverage and time resolution are currently available through satellite technologies though interpretative efforts are needed to capture the hidden information embedded in the large amount of data collected. The dynamic mode decomposition (DMD) is a data-driven technique originated in the fluid dynamics community, to extract coherent structures from spatiotemporal complex fluid flow data [1]. Similarly, if we consider a time series of observed data at a grid of spatial locations, i.e. two-dimensional field data collected at different times, the DMD method provides the leading eigen-decomposition of the best-fit linear operator to approximate the relationship between time-shifted snapshots of the variable observed. The DMD method embeds automatically seasonal variations and if each location' s time series is normalized in mean and variance, the approach is equivalent to a Fourier decomposition; in addition, the real part of the DMD spectrum allows to capture exponential trends in the data [2]. A suite of DMD algorithms is available to handle different applications [2, 3]. Here, we use different DMD algorithms [2, 4] and analyze their capability to reconstruct and extrapolate time series (short-time future prediction) of soil moisture as provided by satellite technologies. Soil moisture plays a major role in the water cycle and its knowledge is relevant for a large number of applications such as climate forecasting, water resources and ecosystem management, drought and flood. The dataset analyzed in this study is produced on behalf of the Copernicus Climate Change Service (C3S); soil moisture data are provided on a global regular latitude-longitude grid at a resolution of 0.25 degress, with a temporal coverage from 1978 to present, on a daily and monthly scale [5].

Participation

In-Person

References

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