Quantification of the relation between dynamical properties of meteorological variables and their predictability

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Local properties of chaotic systems can be summarized by dynamical indicators, that describe the recurrences of all states in phase space. Faranda et al. (2017) defined such indicators with the local dimension (d, approximating the local number of degrees of freedom of the system) and the inverse of persistence (θ, approximating the time it takes to leave a local state). It has been conjectured that such indicators give access to the local predictability of systems. The aim of this study is to evaluate how the predictability of climate variables such as temperature and precipitation is related to dynamical properties of the atmospheric flow.

The predictability of a chaotic system can be evaluated through ensembles of simulations, with probability scores (e.g. Continuous Rank Probability Score, CRPS). In this work, we consider ensembles of climate forecasts with a stochastic weather generator (SWG) based on analogs of atmospheric circulation (Yiou and Déandréis, 2019). We are interested in relating predictability scores of European temperatures and precipitation, obtained with this SWG, and the local dynamical properties of the synoptic atmospheric circulation, obtained from the NCEP reanalysis. We show experimentally that the CRPS of local climate variables can be predicted from large-scale (d, θ) values of geopotential height fields, for time leads of 5 to 10 days. A practical application is that the predictability of local variables (in Europe) can be anticipated from large-scale dynamical quantities, which can help to dimension the size of ensemble forecasts.

References


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