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Complex networks for climate model evaluation with application to statistical vs. dynamical modeling of South American climate

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We introduce difference measures on complex networks as a tool for climate model evaluation. The approach facilitates the quantification of a model's ability to reproduce the spatial covariability structure of climatological time series.
We apply our methodology to compare the performance of a statistical and a dynamical regional climate model (RCM) simulating the South American climate, as represented by the variables 2m temperature, precipitation, sea level pressure, and geopotential height field at 500hPa. For each variable, networks are constructed from the RCM outputs and evaluated against a reference network, derived from the ERA-Interim reanalysis, which also drives the models. We compare two network characteristics, the (linear) adjacency structure and the (nonlinear) clustering structure, and relate our findings to conventional methods of model evaluation. To set a benchmark, we construct different types of random networks and compare them alongside the RCM networks.
Our main findings are: i) The linear network structure is better reproduced by the statistical model STARS in summer and winter for all variables except geopotential height field, where the dynamical model CCLM prevails. ii) For the nonlinear comparison, the seasonal differences are more pronounced and CCLM performs almost as good as STARS in summer (except for sea level pressure), while STARS performs better in winter for all variables.