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A step further from model-fitting for the assessment of the predictability of monthly temperature and precipitation

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"With four parameters I can fit an elephant, and with five I can make him wiggle his trunk", ∼ John von Neumann. This famous quote, literally possible as proved by Mayer et al. (2010), has been widely used to question the parsimony of a model providing a good description of the available data. Still, a significant part of the hydrological literature insists in adding parameters, trend or of other type, to models to increase their descriptive power within the concept of geophysical time series analysis and without testing their predictive ability. Herein, we move a step further from model-fitting and actually run in forecast mode several automatic univariate time series models with the aim to assess the predictability of monthly temperature and precipitation. We examine a sample of 985 monthly temperature and 1552 monthly precipitation time series, observed at stations covering a significant part of the Earth's surface and, therefore, including various real-world process behaviours. All the time series are 40-years long with no missing values. We compare the naïve based on the monthly values of the last year, ARFIMA, exponential smoothing state space model with Box-Cox transformation, ARMA errors, Trend and Seasonal components (BATS), simple exponential smoothing (SES), Theta and Prophet forecasting methods. Prophet is a recently introduced model inspired by the nature of time series forecasted at Facebook and has not been applied to hydrometeorological time series in the past, while the use of BATS, SES and Theta is rare in hydrology. The methods are tested in performing multi-step ahead forecasts for the last 48 months of the data. The results are summarized in global scores, while their examination by group of stations leads to 5 individual scores for temperature and 6 for precipitation. The groups are formed according to the geographical vicinity of the stations.

The findings suggest that all the examined models are accurate enough to be used in long-term forecasting applications. For the total of the temperature time series the use of an ARFIMA, BATS, SES, Theta or Prophet model, instead of the naïve method, leads in about 19-29% more accurate forecasts in terms of root mean square error, or even in about 30-32% more accurate forecasts specifically for the temperature time series observed in North Europe. For the total of the precipitation time series the use of all these automatic methods leads in about 21-22% better forecasts than the use of the naïve method, while for the geographical regions of North America, North Europe and East Asia these percentages are 26-29%, 22-24% and 32-38% respectively. We think that the level of the forecasting accuracy can barely be improved using other methods, as indicated by the experiments of Papacharalampous et al. (2017).

References

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