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Influence of climate variability on the forage production of a permanent grassland in the French Massif Central

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Climate Services (CS) provide support to decision makers across socio-economic sectors. In the agricultural sector, one of the most important CS applications is to provide timely and accurate yield forecasts based on climate prediction.
In this study, the Pasture Simulation model (PaSim) is used to simulate, for the period 1959-2015, the forage production of a mown grassland system (Laqueuille, Massif Central of France) under different management conditions, with meteorological inputs extracted from the SAFRAN atmospheric database. The aim is to generate purely climate-dependent time series of optimal forage production, a variable that is found to maximize the years of brighter and warmer weather conditions at the grassland.
In the long term, a remarkable increase in simulated forage yield (>29%) is obtained in all simulations between 1959-1979 and 1995-2015. Such increase seems consistent with observed rising trends in temperature and CO_2 and multi-decadal changes in incident solar radiation. At interannual timescales, Sea Surface Temperature anomalies of the Mediterranean (MED), Tropical North Atlantic (TNA), equatorial Pacific (El Niño Southern Oscillation), and the North Atlantic Oscillation (NAO) index, appear robustly correlated with annual forage yield values. Relying on climatic predictors uniquely, a stepwise statistical multi-regression model with leave-one-out cross-validation is developed in this work. Under specific management conditions (e.g., 3 annual cuts) and from 1 to 5 months in advance, the generated model successfully provides a p-value<0.01 in correlation (t test), a root mean square error (RMSE) percentage of 14.6% (1.24 t DM ha-1) and a 71.43% hit rate predicting above/below average years in terms of forage yield collection.
These results may help in stimulating the debate about understanding the climate mechanisms at play in European grasslands and provide a useful springboard to implement a grassland seasonal forecasting system in France.