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Use of productivity-defined indicators to assess exposure of grassland-based livestock systems to climate change and variability

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Abstract

Climate change research that aims to accelerate the adaptation process of agricultural production systems first requires understanding their climatic vulnerability, which is in part characterised by their exposure. This paper moves beyond traditional metrics of climate variables and proposes specific indicators that focus on the variation in seasonal boundaries and seasonal and yearly herbage productivity in response to weather conditions. In addition to identifying variability and trends, the paper shows for a grassland-based livestock system how statistical interpretations of these indicators over several sites and climatic years (past and future) enable the characterisation of classes of climatic years and seasons, their frequencies of occurrence and their variation from the past to the expected future. The frequency of occurrence and succession of seasonal extremes is also examined by analysing the difference between observed or predicted seasonal productivity and past mean productivity. The data analysis and corresponding statistical graphics used in our approach can help farmers, advisers and scientists envision site-specific impacts of climate change on herbage production patterns. An illustrative analysis is performed on three sites in south-western France using a series of climatic years covering two 30-year periods in the past and the future. We found that the herbage production of several clusters of climatic years can be identified as "normal" (i.e. frequent) and that the most frequent clusters in the past become less common in the future, though some clusters remain common. In addition, the year-to-year variability and the contrast between spring and summer-fall herbage production are expected to increase.