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Assessing the value of post-processed state-of-the-art long-term weather forecast ensembles for agricultural water management mediated by farmers' behaviours

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Recent advances in modelling of coupled ocean-atmosphere dynamics significantly improved skills of long-term climate forecast from global circulation models (GCMs). These more accurate weather predictions are supposed to be a valuable support to farmers in optimizing farming operations (e.g. crop choice, cropping and watering time) and for more effectively coping with the adverse impacts of climate variability. Yet, assessing how actually valuable this information can be to a farmer is not straightforward and farmers' response must be taken into consideration. Indeed, in the context of agricultural systems potentially useful forecast information should alter stakeholders' expectation, modify their decisions, and ultimately produce an impact on their performance. Nevertheless, long-term forecast are mostly evaluated in terms of accuracy (i.e. forecast quality) by comparing hindcast and observed values and only few studies investigated the operational value of forecast looking at the gain of utility within the decision-making context, e.g. by considering the derivative of forecast information, such as simulated crop yields or simulated soil moisture, which are essential to farmers' decision-making process. In this study, we contribute a step further in the assessment of the operational value of long-term weather forecasts products by embedding these latter into farmers' behavioral models. This allows a more critical assessment of the forecast value mediated by the end-users' perspective, including farmers' risk attitudes and behavioral patterns.

Specifically, we evaluate the operational value of thirteen state-of-the-art long-range forecast products against climatology forecast and empirical prediction (i.e. past year climate and historical average) within an integrated agronomic modeling framework embedding an implicit model of the farmers' decision-making process. Raw ensemble datasets are bias-corrected and downscaled using a stochastic weather generator, in order to address the mismatch of the spatio-temporal scale between forecast data from GCMs and our model. For each product, the experiment is composed by two cascade simulations: 1) an ex-ante simulation using forecast data, and 2) an ex-post simulation with observations. Multi-year simulations are performed to account for climate variability, and the operational value of the different forecast products is evaluated against the perfect foresight on the basis of expected crop productivity as well as the final decisions under different decision-making criterions.

Our results show that not all products generate beneficial effects to farmers' performance, and the forecast errors might be amplified due to farmers' decision-making process and risk attitudes, yielding little or even worse performance compared with the empirical approaches.