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An agent-based approach to modelling the effects of extreme events on global food prices

Jacob Schewe, Christian Otto, and Katja Frieler
Potsdam Institute for Climate Impact Research, Potsdam, Germany (jacob.schewe@pik-potsdam.de)

Extreme climate events such as droughts or heat waves affect agricultural production in major food producing regions and therefore can influence the price of staple foods on the world market. There is evidence that recent dramatic spikes in grain prices were at least partly triggered by actual and/or expected supply shortages. The reaction of the market to supply changes is however highly nonlinear and depends on complex and interlinked processes such as warehousing, speculation, and export restrictions.
Here we present for the first time an agent-based modelling framework that accounts, in simplified terms, for these processes and allows to estimate the reaction of world food prices to supply shocks on a short (monthly) timescale. We test the basic model using observed historical supply, demand, and price data of wheat as a major food grain. Further, we illustrate how the model can be used in conjunction with biophysical crop models to assess the effect of future changes in extreme event regimes on the volatility of food prices. In particular, the explicit representation of storage dynamics makes it possible to investigate the potentially nonlinear interaction between simultaneous extreme events in different food producing regions, or between several consecutive events in the same region, which may both occur more frequently under future global warming.