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Changes in regional and simultaneous soybean losses in the Americas due to projected global warming

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Soybeans are globally used as the main source of protein for livestock. However, most soybean production is concentrated in regions in The United States of America, Brazil and Argentina, rendering the supply chain vulnerable to regional disruptions. In 2012, simultaneous soybean losses in these three countries led to shortages in global supplies and to record prices. The losses were linked to anomalous weather conditions in all three countries. In this experiment, we investigate how climate change may affect future events with similar or larger impacts than the one from 2012 for each country individually and simultaneously. For that, we develop a hybrid model, coupling a process-based crop model with a machine learning model, to improve the simulation of soybean production. We assess the frequency and magnitude of events with similar or larger impacts than 2012 under different future climatic forcing conditions. We also evaluate the events with respect to present day and future conditions to disentangle the impacts of (changing) climate variability from the long-term mean trends. Results indicate that long-term trends of mean climate increase the occurrence and magnitude of 2012 analogue crop yield losses. Conversely, 2012 analogue crop yield losses that are caused by changes in climate variability show an increase in frequency in each country individually, but not simultaneously across the Americas.