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Assessing crop-specific impacts of extremely wet (2007) and dry (2003) conditions in France on regional maize and wheat yields

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Extreme weather conditions can strongly affect agricultural production. In France, crop yields were greatly influenced by drought and heat stress in 2003 and by extremely wet conditions in 2007. Both maize and wheat yield where historically low in 2003, in contrast to 2007 when wheat yields were lower and maize yields were higher than long-term averages. Even though maize yield loss was lower in regions with higher maize irrigation percentages; yield loss was still very considerable. Remotely sensed (AMSR-E) JJA soil moisture related significantly to reported regional crop yield for 2002-2007. The spatial correlation between JJA soil moisture and wheat yield anomalies was positive in dry 2003 and negative in wet 2007. Biweekly soil moisture correlated positively from the first half of June until the second half of July in 2003. In 2007, the relation was negative the first half of June until the second half of August. An analysis with a spatial version (10 by 10 km) of the EPIC crop growth model was used to infer causal relations between rainfall, soil moisture and rainfed wheat and rainfed and irrigated maize yield. The negative impacts of the 2003 heat wave and drought on wheat yield were captured by the model, while negative damages to yield due to excessive wetness in 2007 were not. Modelling suggests that regional drought mitigation increased with increasing maize irrigation percentages from 0 to 40%. At higher irrigation percentages the compensating effect of irrigation was small. The above average maize yields in 2007 were reproduced by the model, but the below average wheat yields were not. The model overestimation of wheat yield in 2007 may be due to a misrepresentation of the impact of wet conditions on plant physiological processes, or due to the incapacity of the model to represent determining factors such as lodging and unfavourable harvesting conditions. Strenghts and limitations of this regional assessment will be discussed. Extreme events affect different parts of the agricultural production system and understanding which part of the climate risk can be attributed with crop growth models is essential to inform adaptation responses.