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Modelling irrigated maize yield response to climate change scenarios in Portugal

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Irrigated maize production has a significant economic value in Portugal. However, high yield production is primarily supported by irrigation, being water resources already under pressure. Furthermore, future climate change projections, with prolonged drought periods, are very likely to worsen the current status and subject maize production to risk and uncertainty. The present study aims to assess climate change impacts on several aspects of irrigated maize production, i.e. grain yield, growth cycle length, seasonal water input and crop water productivity. A key maize growing area of Portugal is used for this purpose (Ribatejo). Further, two independent process-based crop models are used (STICS and AquaCrop) and are run for three study sites. These simulations incorporate a typical maize cultivar, prevailing cultural practices, soil characteristics and historic meteorological and regional production data over the period of 1986–2005. Future climate change projections are obtained under two emission scenarios, RCP4.5 and RCP8.5, using outputs from a Global Climate Model / Regional Climate Model chain, namely MPI-M / SMHI-RCA4, covering the future period of 2021–2080. The two crop models show clear agreement in the selected parameters over the historic period, where the grain yield is satisfactorily tested against statistical data (r=0.69). Therefore, the averaged outputs of the two crop models are used henceforth. Regarding future climate change scenarios, the mean growing seasonal temperature is projected to increase by 1.5 and 3.1ºC for RCP4.5 and RCP8.5, respectively, with important precipitation reductions in both scenarios. As a result, grain yield is decreased by –3% to –17%, with associated reductions in the growing cycle length (–4% to –12%), depending on the period and scenario. The decrease of seasonal water input varies from –3% to –9%, with decreased crop water productivity. The highest reduction generally occurs in 2061–2080 under RCP8.5, when atmospheric CO_2 forcing is stronger, also demonstrating that the carbon fertilization effect is not sufficient to mitigate other adverse impacts. Our findings illustrate the potential risks of climate change on irrigated maize production in Portugal, covering aspects relevant to both agronomic traits (yield, growing duration) and proper use of resources (irrigation and crop water productivity). The obtained results may thereby support decision-making processes in medium-to-long term agricultural planning in Portugal.