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Agriculture in Southern Mediterranean areas under climate change: Impacts on irrigated wheat grain yield and irrigation requirements

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The southern Mediterranean regions are likely to face drastic climate changes (CC). Agricultural yields, particularly of cereals, could be severely affected, especially if significant changes occur at the key phenological stages. In addition, while agriculture is expected to meet around 83% of North African food demand by 2050, the increase in agricultural water requirements due to the intensification of practices, the extension of arable land and the expected warming could jeopardize the water supply of other key economic sectors. In this context, the present work aims to quantify the impact of CC on the grain yields of irrigated cereals and their water requirements in the Tensift-Haouz region of Morocco. The Med-CORDEX ensemble runs under scenarios RCP4.5 and RCP8.5 are first evaluated and disaggregated using the quantile-quantile approach. The impact of CC on the duration of the main wheat phenological stages based on the degree-day approach is then analysed by considering three typical sowing dates (early, around November 15th; intermediate, around December 15th; and late, around January, 15th). The results show that the rise in air temperature causes a shortening of the development cycle of up to 50 days (around 30%). The impacts of rising temperature, increasing atmospheric CO2 concentration and changes in precipitation on wheat yields are next evaluated, based on the AquaCrop model (previously calibrated on several plots of winter wheat in the region of study), both with and without taking into account the fertilizing effect of CO2. As expected, optimal wheat yields for all climate scenarios and time horizons will decrease on the order of 7 to 30% depending on the sowing date, if CO2 concentration rise is not considered. The results also show that the fertilizing effect of CO2 can counterbalance yield losses, since optimal yields could increase by 7% and 13% respectively at mid-century for the RCP4.5 and RCP8.5 scenarios. Finally, water requirements are expected to decrease by 13 to 42% depending on sowing date, scenario and horizon, mainly in response to the shortening of the cycle. This decrease is associated with a change in temporal patterns, with the requirement peak coming two months earlier than under current conditions. This study provides

some quantitative elements for agricultural practices adaptation, in particular concerning the sowing date and also for water management in the south mediterranean region related to the temporal patterns of the crop water needs