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Impact of climate change on wheat yields and irrigation water supply in the South Mediterranean: Case study in the Tensift region (Morocco)

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This work aims to quantify the impact of climate change on cereal grain yields and water needs in the Tensift Haouz region of Morocco, this region extends on about 20000 km^2. It is characterized by a semi-arid Mediterranean climate. The Med-CORDEX ensemble runs under scenarios RCP4.5 and RCP8.5 have first been evaluated and bias-corrected using the quantile-quantile approach. The impact of climate change on the duration of the main wheat phenological stages based on the degree day approach is then analyzed considering three typical sowing dates (early around November, 15th; intermediate around December 15th and late around January, 15th). The results showed that the rise in air temperature causes a shortening of the development cycle up to 50 days (around 30%) and that this decrease is stronger when wheat is sown early. Finally, the impact of the rise in temperature and the decrease of precipitation amount on wheat yields is evaluated based on the Aquacrop model calibrated by Toumi et al. (2016) on several plots of winter wheat in the region of study. As expected, optimal wheat yields for all climate scenarios and time horizons will decrease on the order of 10 to 30% depending on the sowing date. The results also show that the fertilizing effect of CO_2 significantly slows down the negative impact of temperature rise and can even counterbalance it as higher optimal yields of 9 and 8% at mid-century for RCP 4.5 and RCP 8.5 scenarios, respectively. Finally, irrigation water needs do not differ significantly between the historical periods and future scenarios as the effect of the increase in temperature is almost perfectly mitigated by the shortening of the development cycle. This study provides some details on the impact of climate change on agricultural production in the southern Mediterranean area that not very positive considering the food security of the countries in this region. It leaves also some open issues that will be discussed among which: (1) the ability of a simple model such as Aquacrop to accurately simulate the fertilizing effect of CO_2 on the plant physiological processes; (2) the potential effects of nutrients that could become a limiting factor for wheat growth and production.