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Supplement of

A modelling system for identification of maize ideotypes, optimal sowing dates and nitrogen fertilization under climate change – PREPCLIM-v1

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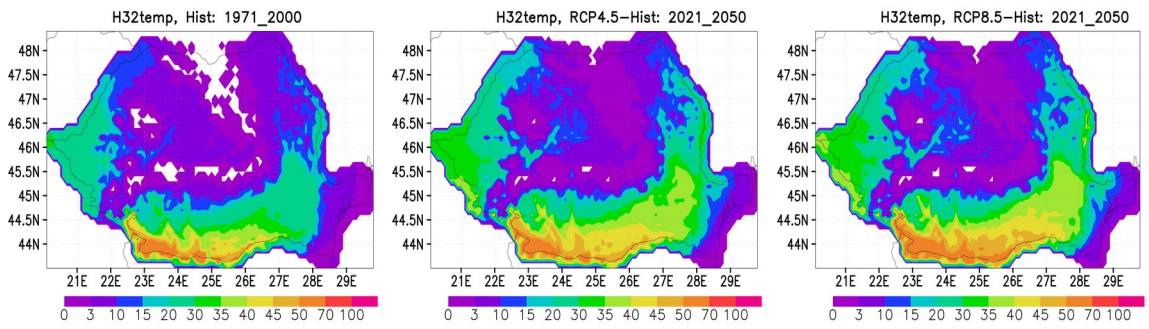
Section S1: Projected changes in agro-climate indicators over the SE Romania

a)



b)

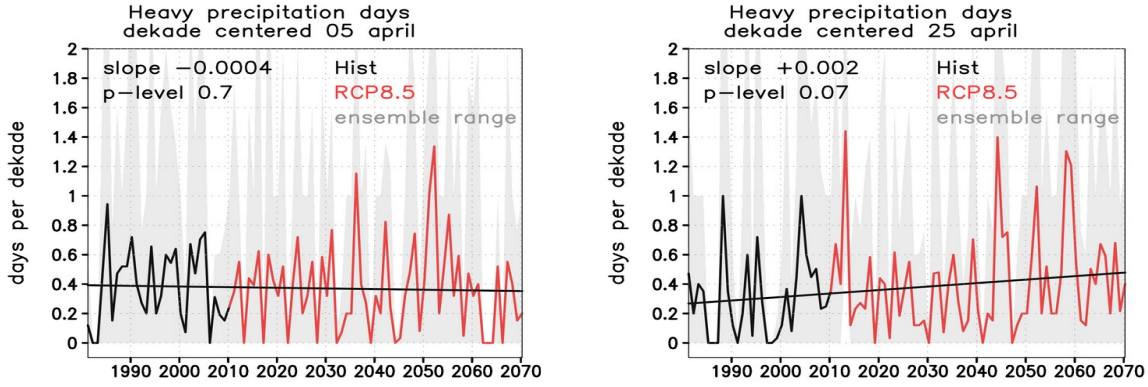


Fig. S1 a) The scorching index H32temp (degrees above 32°C sum in summer JJA) for: Hist (1971-2000, left) and changes (2021-2050) relative to it, under RCP4.5 (middle) and RCP8.5 (right). The scorching index classes are: reduced intensity drought for H32temp ϵ[0,10], moderate intensity drought for H32tempϵ(10,30], high intensity for H32tempϵ(30,50] and severe drought conditions for H32temp > 50. Note the difference RCP4.5-Hist is already comparable to the index in Hist in Southern regions.

b) Heavy precipitation days (R10mm indicator, the number of days with heavy precipitation (>10 mm per day) in a 10-day period), for the Southern Romania target area along historical simulations and RCP8.5 scenarios; the 10-day periods shown are centred on April 5$^{th;}$ (right) and on April 25th (left). Note the time shift of extreme precipitation towards late April-May (the trend switches from negative to positive statistically significant at p=0.07 Pearson level). Black line is for the Hist run, red line for the RCP8.5 scenario; grey shading shows the range between the minimum and maximum of the ensemble members.

Section S2: Fertilization: levels of N fertilization in Romania.

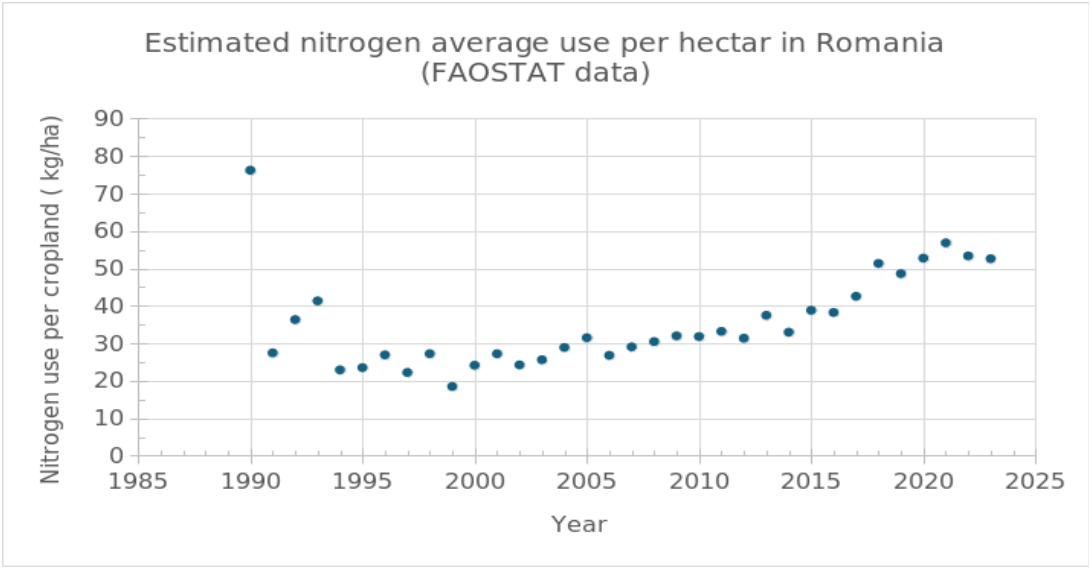


Fig. S2 Evolution of the fertilization levels in Romania (FAOSTAT register data, https://www.fao.org/faostat/) showing a strong decay after 1991, and an increase after 2003.

Section S3: The grain filling length duration: low sensitivity to fertilization-temperature

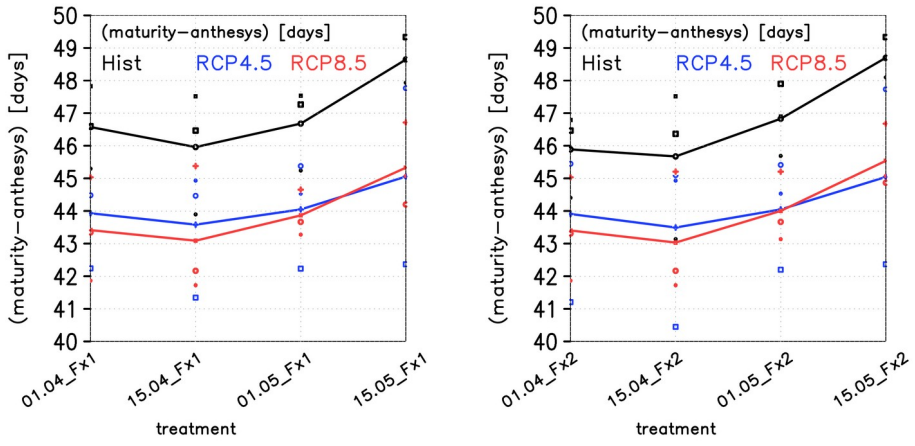


Fig. S3 Comparing difference (days) in the simulated maturity minus anthesis dates, due to climate conditions leading a too slow grain filling for some models and scenarios. These are small differences (~ 1 day, as discussed in 3.2.1) in ensemble mean time mean, for all sowing dates, shown for Hist (black), RCP4.5 (blue) and RCP8.5 (red), for Fx1 (left) versus Fx2 (right).

Section S4: Relation between models' precipitation and Harvest

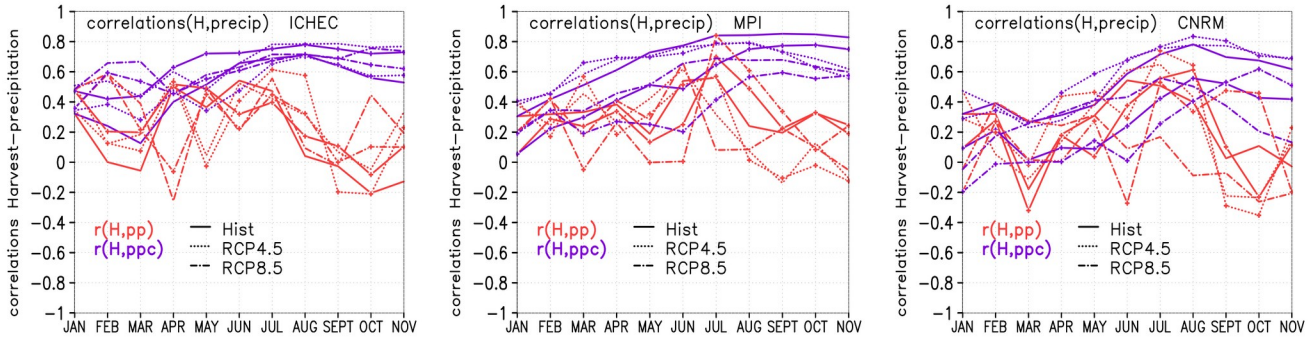
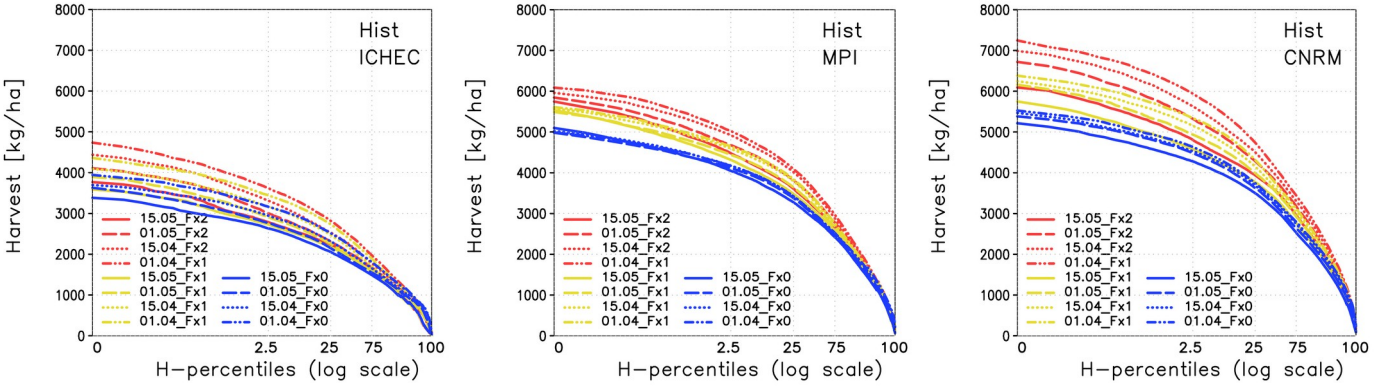


Fig. S4 Correlations between model precipitation (accumulated since January- plum and monthly- pink) and Harvest for the models: ECEARTH-ICHEC (left); MPI (middle) and CNRM (right); full line is for Hist, dot-dot is for RCP4.5 and dot-line is for RCP8.5; shown are two treatments: 01.04_Fx0 (no mark) and 15.05_Fx2 (marked lines) corresponding to description in Table 1a. Note all models showing high correlation with accumulated precipitation (to a max ~ 0.8 to 0.9 by spring-summer, discussed in 3.2.2).

Section S5: Model-spread for optimal genotype



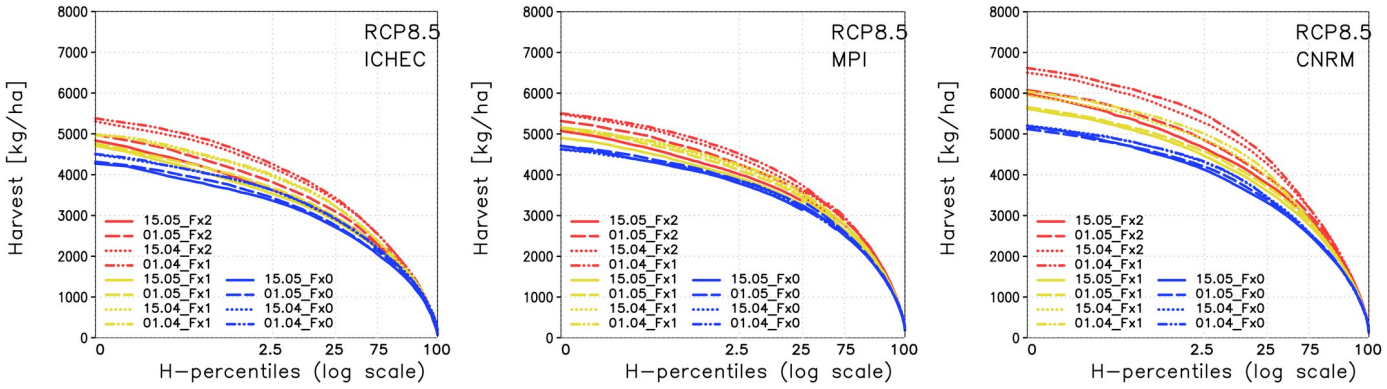


Fig. S5: Harvest time mean simulated by models: ECEARTH-ICHEC (left), MPI (Middle) and CNRM (right). As in Fig.7a, (that shows the same but for the ensemble mean) are shown percentiles of the H distribution ordered from maximum H values (left) to minimum H (right), logarithmic scale. Simulations are for Hist (top) and RCP8.5 (bottom). Note: there is a significant inter-model spread, in some models genotypes being found that lead superior highest Harvest in scenarios compared to Hist. This spread is linked (Fig. S4) to projected precipitation for the region.

Section S6: Changes in genotype parameters: percents of change in scenarios relative to Hist for a same H-percentile

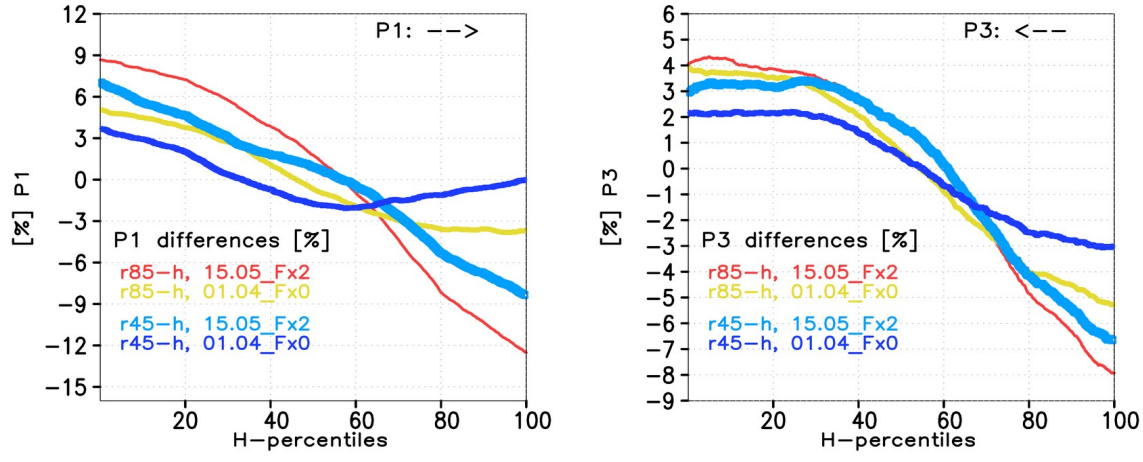


Fig. S6: Percent changes of P1 (left) and P3 (right) genotype parameters (y-axis) as a function of the Harvest percentile (ordered from highest H, left, to the lowest H right, x-axis). Differences (running means over 378=P2xP3xP4xP5 intervals simulated) are shown for treatment 01.04_Fx0 (GTR1 in Table 1b) (yellow for RCP8.5 minus Hist and dark blue for RCP4.5 minus Hist) and for treatment 15.05_Fx2 (GTR12 in Table1b) (red for RCP8.5 minus Hist and light blue for RCP4.5 minus Hist). Percent changes are expressed as differences relative to Hist. Arrows indicate the Harvest monotony as a function of the genotype parameter (lower H for higher P1 and higher H for higher P3, as seen in Fig. 8). Computation was done for all parameters, and P1 and P3 show the highest percentage of change in scenarios compared to Hist (discussed in 3.3.2 ii).

Section S7: Slopes of P-genotype parameters in Hist and climate scenarios

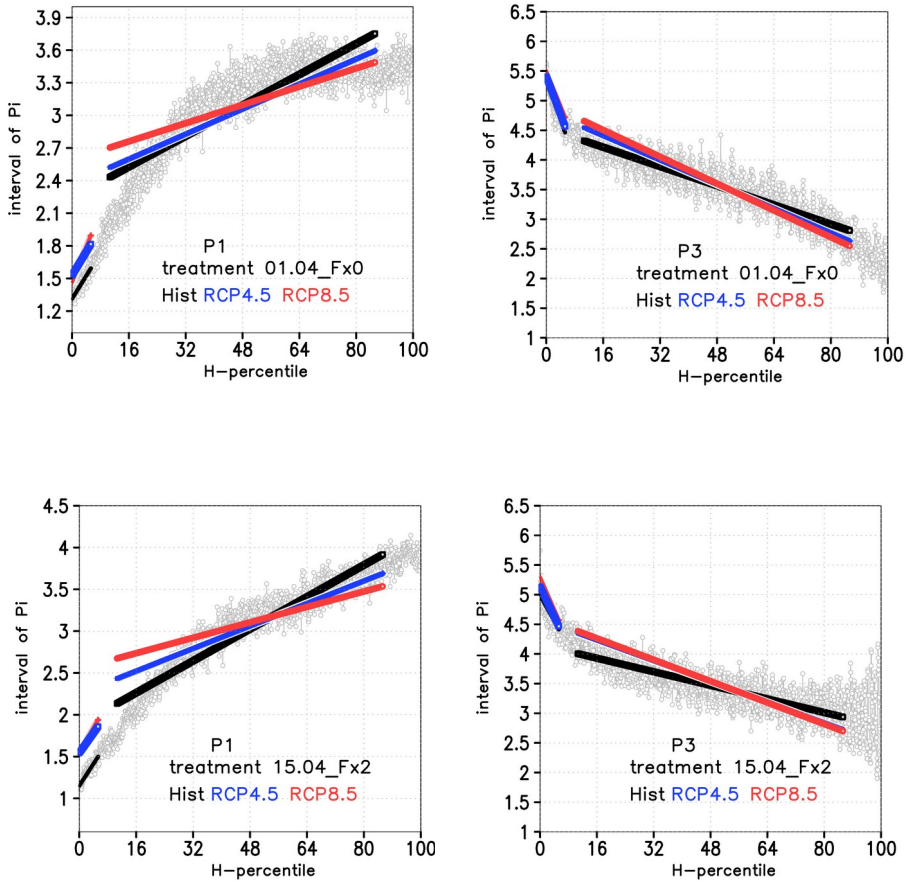


Fig. S7 The linear slopes (thick lines) of P1 and P3 parameters as a function of H percentiles (x-axis, H ordered from maximum (left) to minimum (right)) are shown for: Hist (black), RCP4.5 (blue) and RCP8.5 (red). Grey dot line shows the parameter values for Hist ensemble mean time mean. Slopes are computed over 2 sub-intervals that showed the main change in the relative difference of slopes for Hist and scenarios (where the difference changes sign), at about 200-300 H-ordered maximal values or 10^{th}-15^{th} harvest percentile. The slopes are shown for two treatments: 01.04_Fx0 (top) and 15.05_Fx2 (bottom). Note lower slope values in scenarios, allowing windows of adaptation at values comparable to Hist or higher, in scenarios, in the intermediate percentile interval (as discussed in Fig. 7c and in 3.3.2.iv). The Y-axis represents the fractional change of the parameter (the maximum being the number of equal interval changes, here this is 5 for P1 and 6 for P3, for experimental set-up with 1890 (5x7x6x3x3) parameter intervals simulated).