

**Title:** Projections of climate change impacts on flowering-veraison water deficits for Riesling and Müller-Thurgau in Germany

**Journal Name:** remote sensing

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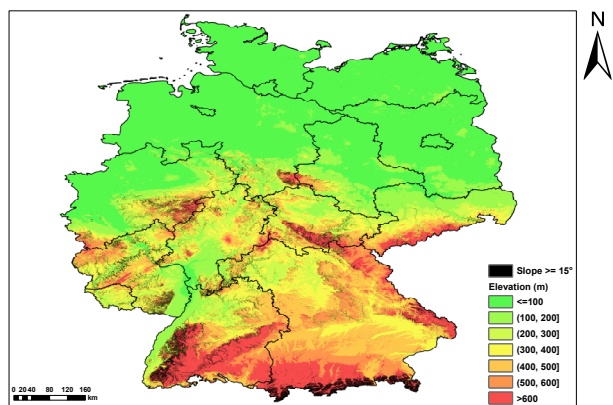
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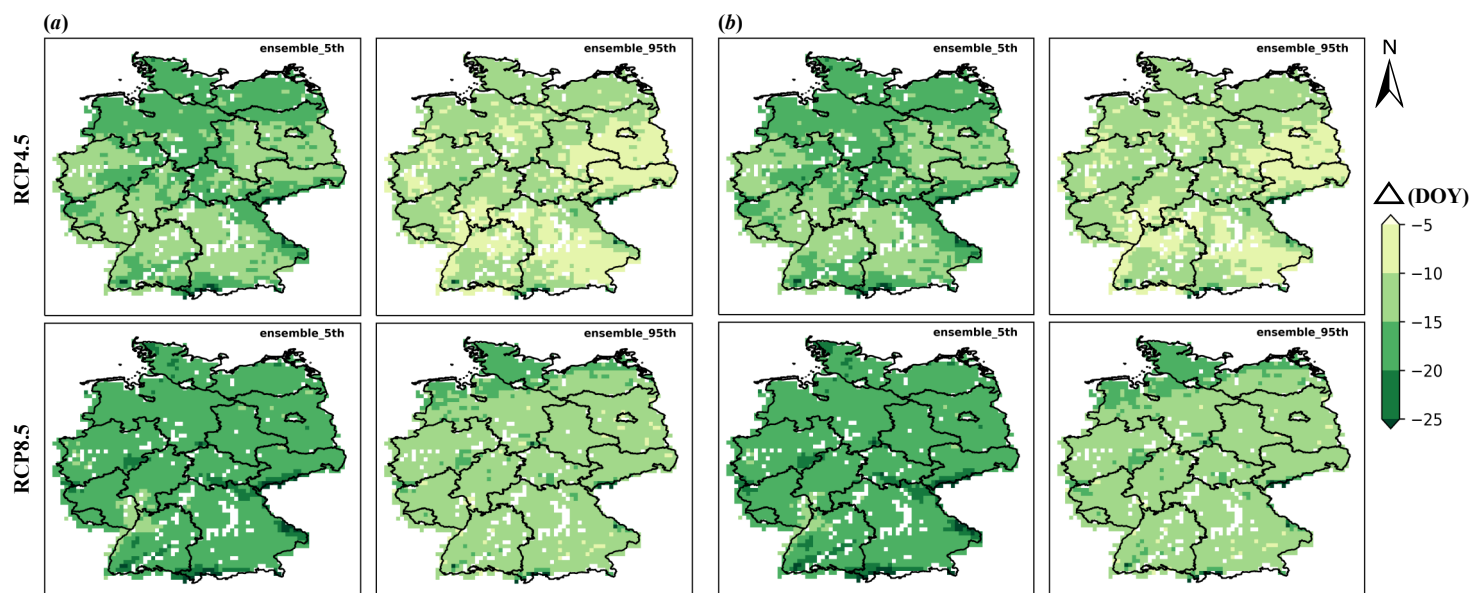
## Supplementary Material

**Table S1.** Calibrated STICS model parameter values for simulating BBCH09, BBCH65 and BBCH81 over 1956—2019 at Eltviller Sonnenberg for grape varieties of Müller-Thurgau and Riesling. The differences (Riesling minus Müller-Thurgau) in calibrated values between the two varieties are also shown. The respective Growing Degree Days (GDD) difference for varieties during the budburst—ripening phase is 150 degree.day<sup>-1</sup>.

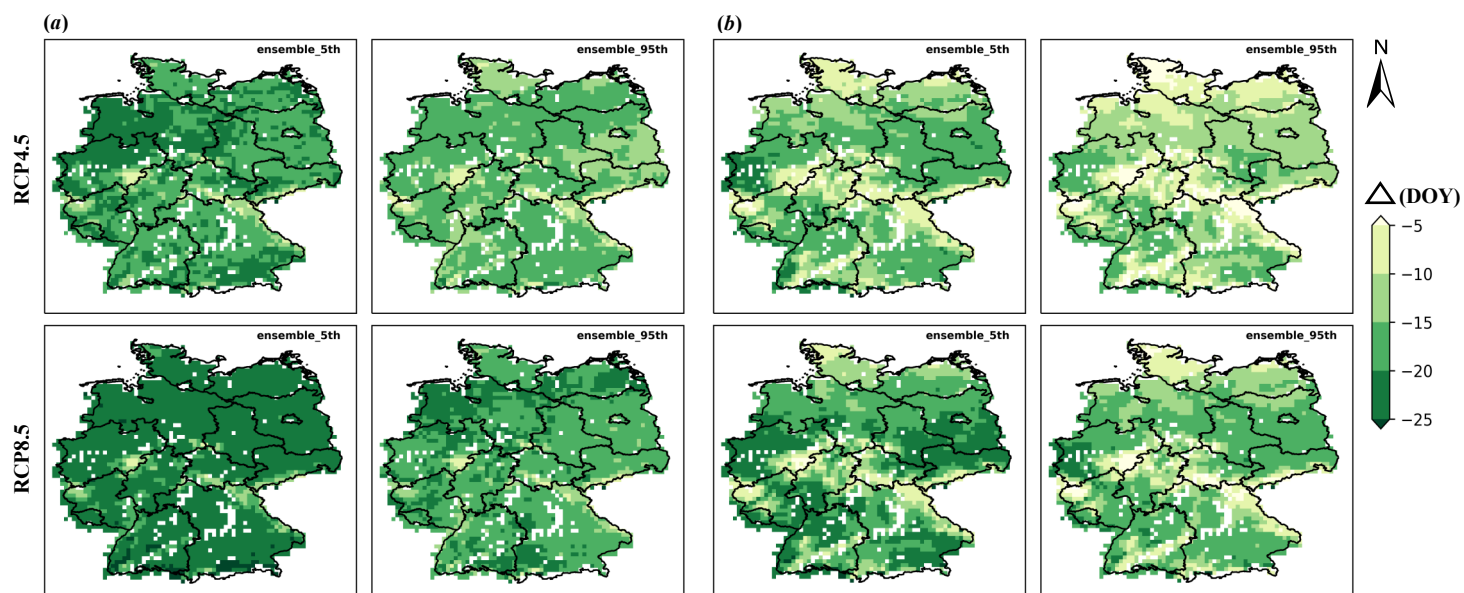
| STICS Code         | Parameter Description  | Units                       | Calibrated values between grapevine varieties |          |            |
|--------------------|--|-----------------------------|---|----------|------------|
|                    |  |                             | Müller-Thurgau                                | Riesling | Difference |
| <i>jvc</i>         | Required minimum dormancy days (until dormancy break)                                      | days                        | 70  | 70       | 0          |
| <i>stdordebour</i> | Chilling requirement between dormancy break and budburst (define the post-dormancy period) | °C degree.day <sup>-1</sup> | 5800  | 6250     | 450        |
| <i>stlevdrp</i>    | Thermal requirement between budburst and fruit setting onset                               | °C degree.day <sup>-1</sup> | 320   | 350      | 30         |
| <i>stflodrp</i>    | Thermal requirement between flowering and fruit setting onset                              | °C degree.day <sup>-1</sup> | 60  | 80       | 20         |
| <i>stdrpdes</i>    | Thermal requirement between fruit setting onset and fruit water dynamic onset (BBCH85)     | °C degree.day <sup>-1</sup> | 585   | 705      | 120        |



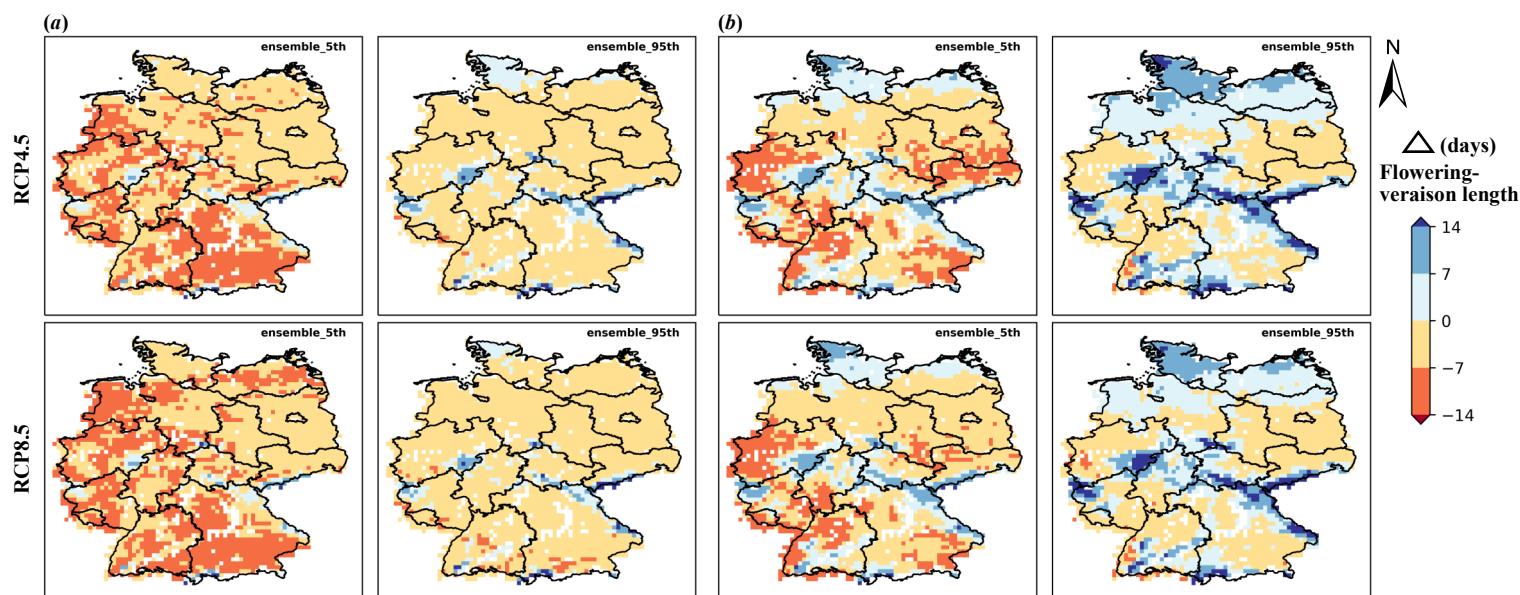
**Figure S1.** Elevation and slope ( $>15^\circ$ ) map in Germany based on the European Digital Elevation Model (EU-DEM, v.1.1)



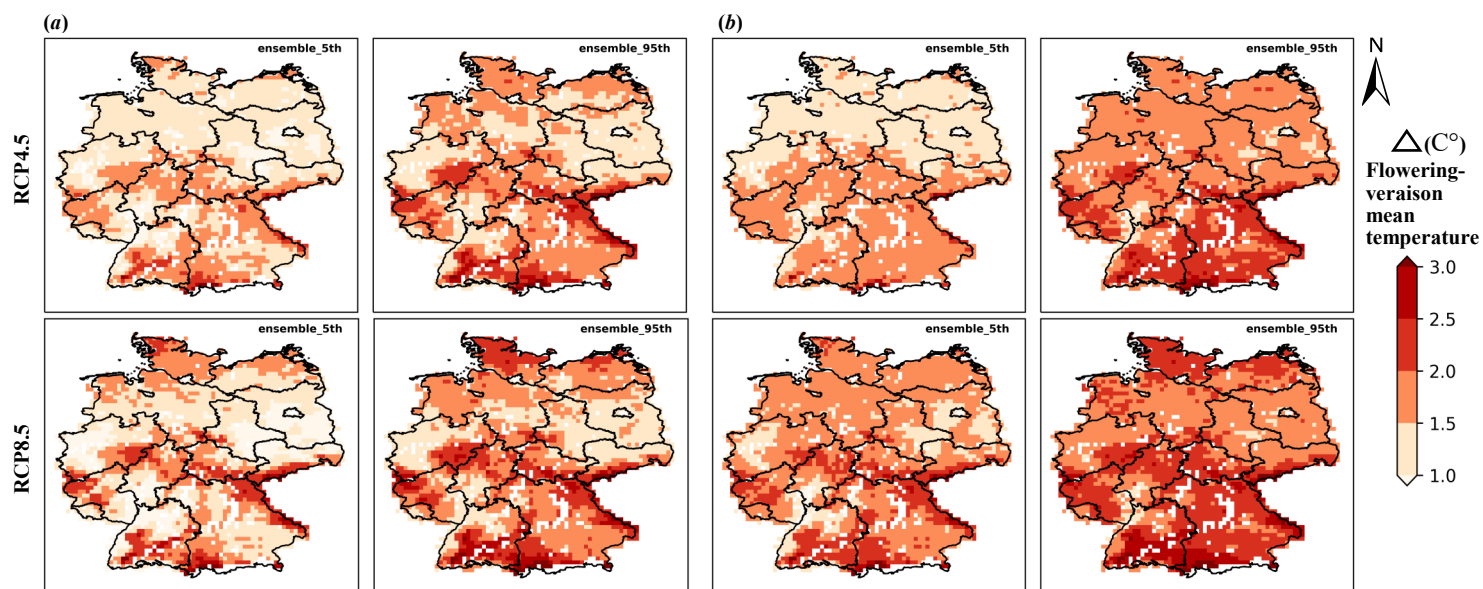
**Figure S2.** Mean changes (DOY) of the flowering stage (BBCH65) between the future period (2041—2070) with two climate change scenarios (RCP4.5 and RCP8.5) and the baseline period (1976—2005), as projected by the 5<sup>th</sup> and 95<sup>th</sup> percentile of ensemble simulations under different climate models for **(a)** Müller-Thurgau and **(b)** Riesling. DOY: day of year, where the negative values indicate the advanced days for the phenology stage.



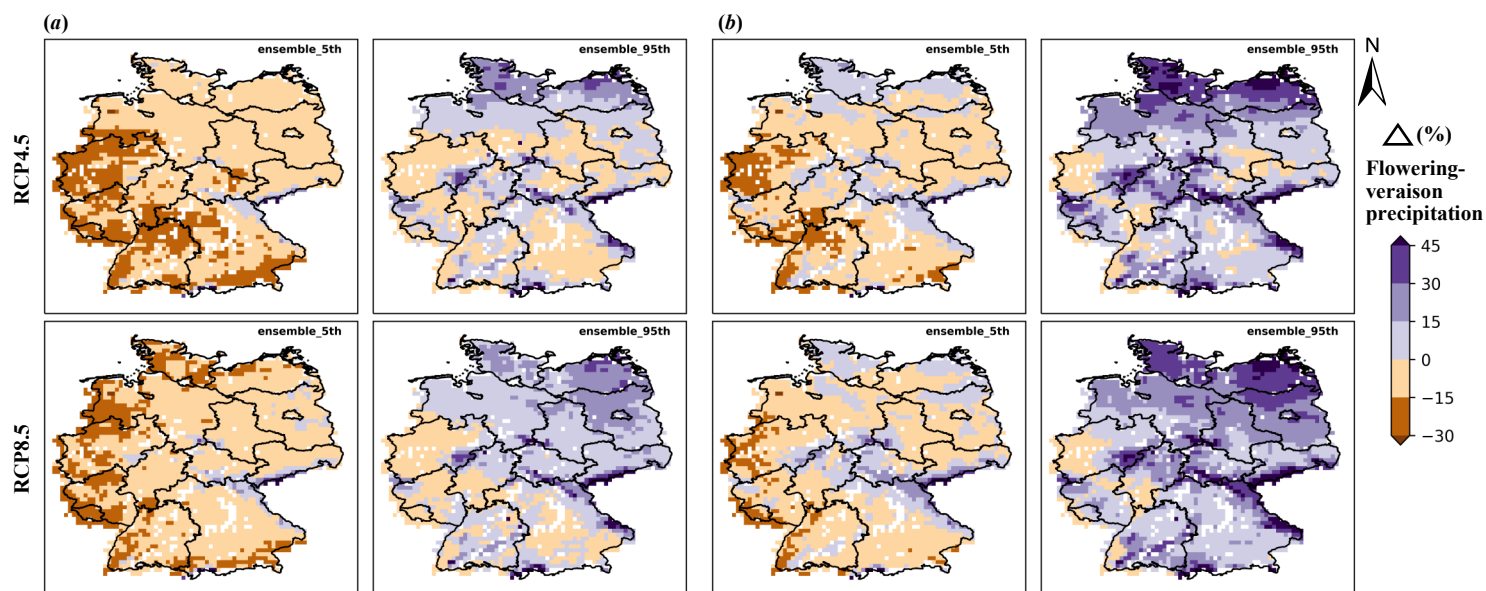
**Figure S3.** Mean changes (DOY) of the veraison stage (BBCH81) between the future period (2041—2070) with two climate change scenarios (RCP4.5 and RCP8.5) and the baseline period (1976—2005), as projected by the 5<sup>th</sup> and 95<sup>th</sup> percentile of ensemble simulations under different climate models for *(a)* Müller-Thurgau and *(b)* Riesling. DOY: day of year, where the negative values indicate the advanced days for the phenology stage.



**Figure S4.** Mean changes (days) of the phenophase (BBCH65—BBCH81) between the future period (2041—2070) with two climate change scenarios (RCP4.5 and RCP8.5) and the baseline period (1976—2005), as projected by the 5<sup>th</sup> and 95<sup>th</sup> percentile of ensemble simulations under different climate models for *(a)* Müller-Thurgau and *(b)* Riesling. Positive values indicate the extended period while negative values denote the shortened period.

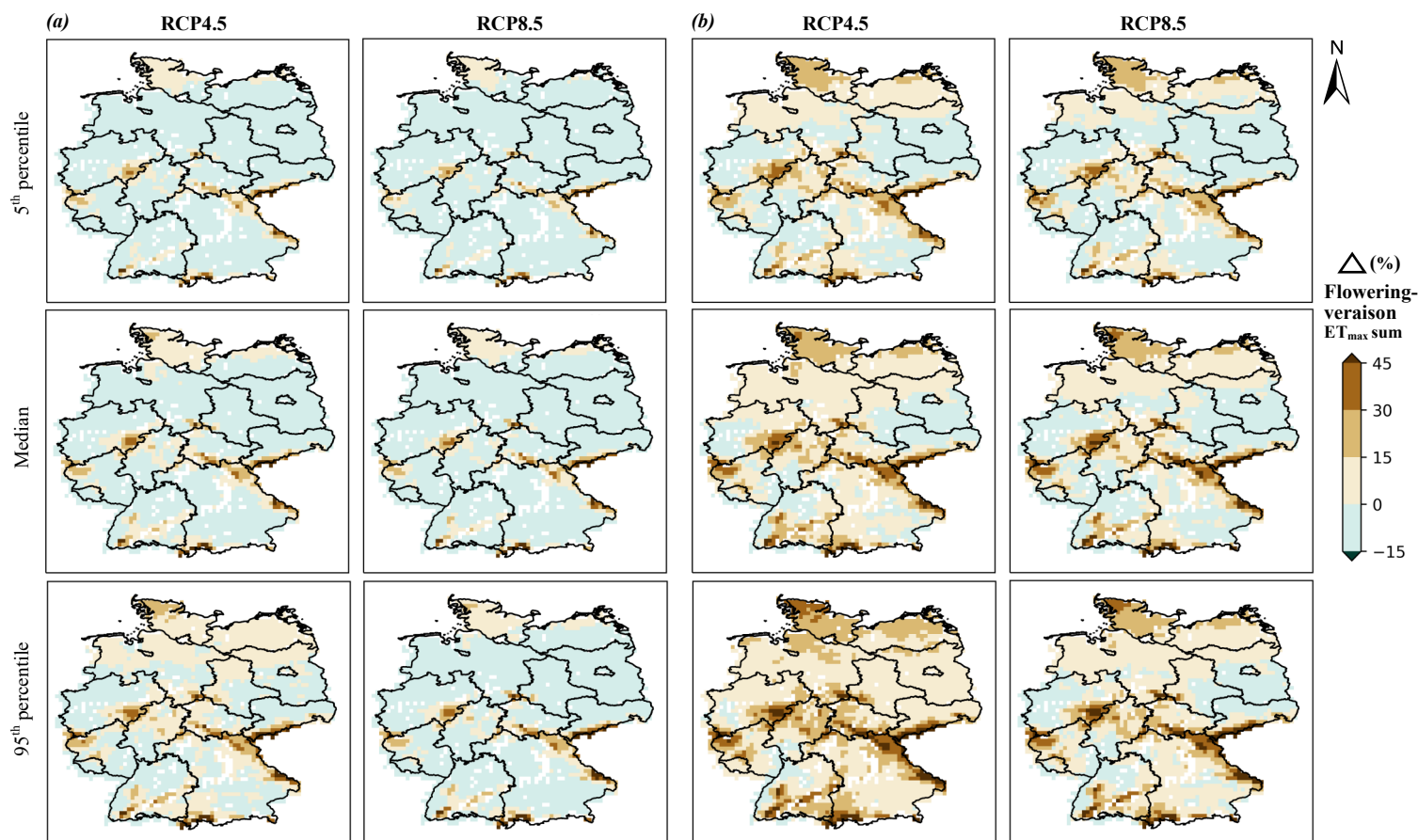


**Figure S5.** Mean changes (C°) of the average phenophase (BBCH65—BBCH81) temperature between the future period (2041—2070) with two climate change scenarios (RCP4.5 and RCP8.5) and the baseline period (1976—2005), as projected by the 5<sup>th</sup> and 95<sup>th</sup> percentile of ensemble simulations under different climate models for (a) Müller-Thurgau and (b) Riesling. Positive values indicate increased temperatures.

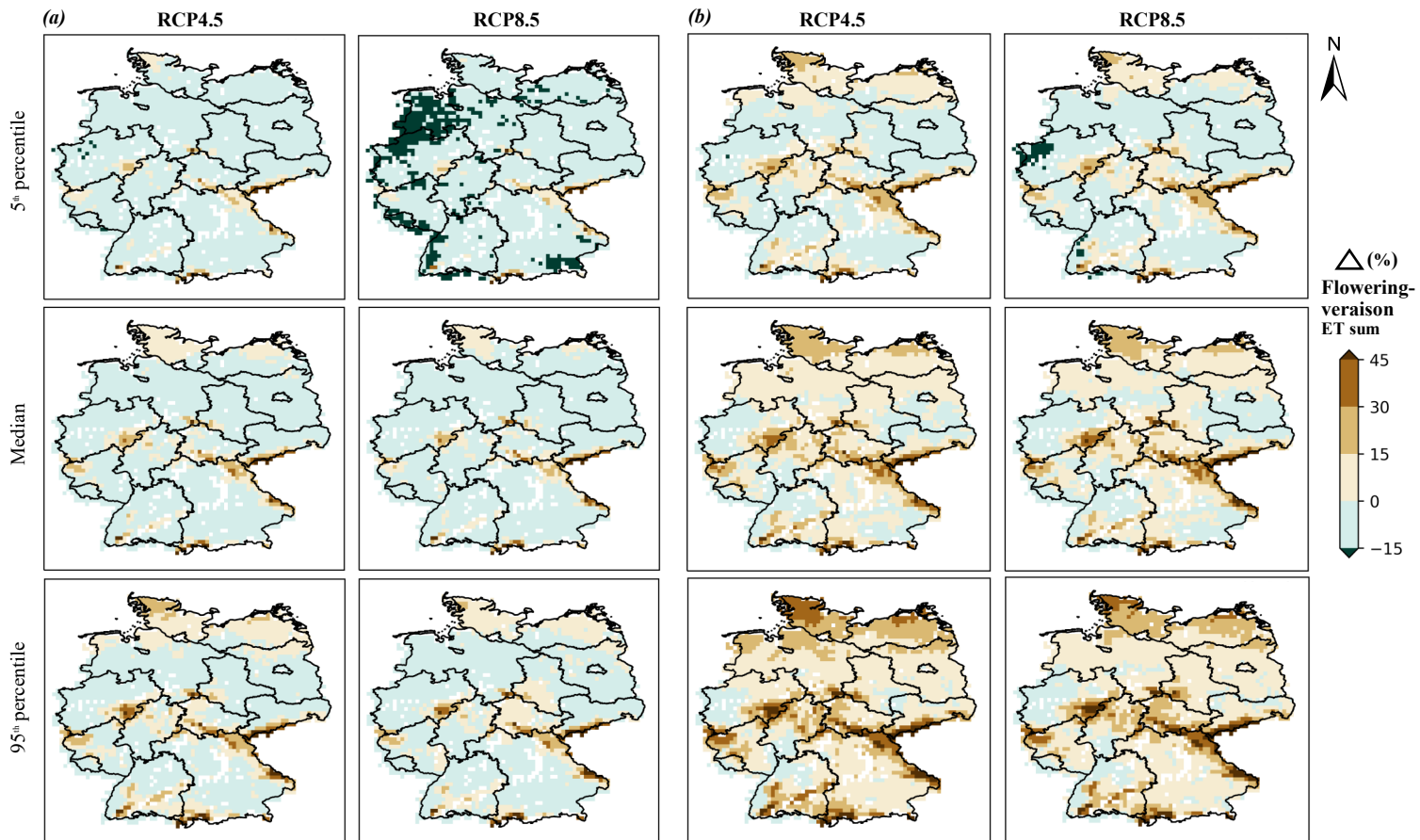


**Figure S6.** Mean changes (%) of precipitation sum (mm) in the phenophase (BBCH65—BBCH81) between the future period (2041—2070) with two climate change scenarios (RCP4.5 and RCP8.5) and the baseline period (1976—2005), as projected by the 5<sup>th</sup> and 95<sup>th</sup> percentile of ensemble simulations under different climate models for (a) Müller-Thurgau and (b) Riesling. Positive values indicate increased precipitation while negative values denote reduced precipitation.





**Figure S7.** Projected (temporal) mean changes (%) of maximum evapotranspiration ( $ET_{max}$ ) sum (mm) during the flowering (BBCH65)—veraison (BBCH81) phenophase for (a) Müller-Thurgau and (b) Riesling between the future period (2041—2070) with two climate change scenarios (RCP4.5 and RCP8.5) and the baseline period (1976—2005). The 5<sup>th</sup> percentile, median and 95<sup>th</sup> percentile of simulations under different climate models are shown. Positive values indicate increased  $ET_{max}$  (increased crop water demand) while negative values denote respective reductions (decreased crop water demand).



**Figure S8.** Projected (temporal) mean changes (%) of actual evapotranspiration (ET) sum (mm) during the flowering (BBCH65)—veraison (BBCH81) phenophase for (a) Müller-Thurgau and (b) Riesling between the future period (2041—2070) with two climate change scenarios (RCP4.5 and RCP8.5) and the baseline period (1976—2005). The 5<sup>th</sup> percentile, median and 95<sup>th</sup> percentile of simulations under different climate models are shown. Positive values indicate increased ET (increased evapotranspiration) while negative values denote respective reductions (decreased evapotranspiration).