SUPPLEMENTARY INFORMATION

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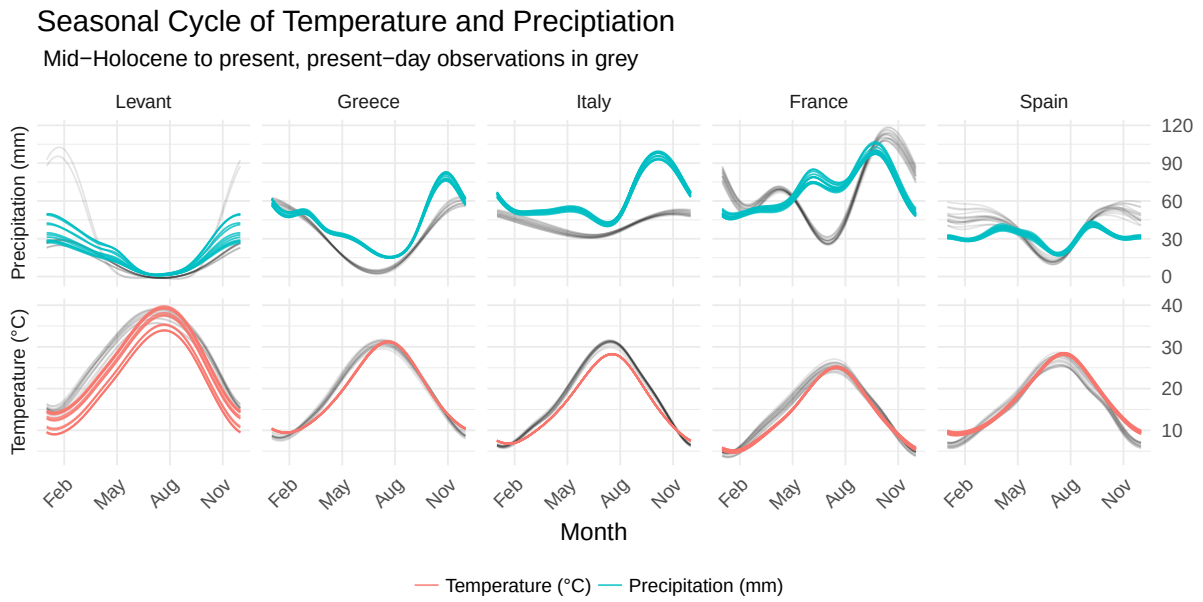
Long-term monthly climate means for the mid-Holocene were estimated by downscaling an ensemble of PMIP3 simulations (Braconnot et al. 2012). A perfect prognosis approach was employed, in which regression-based transfer functions were first used to predict small-scale temperature and precipitation climatologies (Deblauwe et al. 2016) from large-scale atmospheric reanalysis variables from present-day observations (Dee et al. 2011), and then applied to simulated large-scale atmospheric variables from the mid-Holocene. Topographic predictors derived from a digital elevation model (Jarvis et al. 2008) were also included to capture additional small-scale spatial heterogeneity. These transfer functions were estimated using a generalized additive model (GAM) in order to account for non-normal data distributions and nonlinear predictor-predictand relationships (Vrac et al. 2007; Barton et al. 2017). Model selection was carried out using a combination of restricted maximum likelihood for smoothness selection and AIC (Wood 2006). Temperature was modeled as Gaussian with an identity link function, with 2-meter air temperature, mean sea level pressure, and elevation selected as predictors. Precipitation was downscaled with a two-step hurdle process, with precipitation occurrence modeled as binomial with a logit link with 2-meter air temperature and convective precipitation rate as predictors and precipitation accumulation as Gamma distributed with a log link and mean sea level pressure, total column water, large scale precipitation rate, convective precipitation rate, elevation, and distance from the coast as predictors. After fitting to the present-day reanalysis data, the GAMs were used to downscale the PMIP3 simulation outputs. Both the ensemble mean atmospheric fields and the outputs from each individual model were downscaled separately, to assess the sensitivity of the downscaled fields to climate-model biases. The resulting high-resolution monthly climatologies were then temporally downscaled to daily resolution using the MarkSim weather generator. In all cases, additional data on the number of rainy days per month from the CCSM4 model were also used to parameterize the weather generator, as that was the only model for which daily data for the mid-Holocene were readily available.



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