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Simulating the European carbon balance with JULES

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The present day European carbon balance is presented as simulated by JULES following the CarboEurope-IP Continental Integration modelling protocol. JULES is the Joint UK Land Environment Simulator. It is a UK community land surface model based on the land surface components of the Hadley Centre GCM, MOSES (land surface and hydrology) and TRIFFID (dynamic global vegetation model, and carbon cycle). JULES simulates soil temperature and moisture on 4 soil layers and includes representation of snow accumulation and melt and soil moisture freezing and thawing, and simulates carbon fluxes due to photosynthesis and respiration. 9 surface types can be present in each gridbox including 5 plant functional types (broadleaf tree, needleleaf tree, C3 grass, C4 grass and shrub) which can vary dynamically with competition between types determined by their respective net carbon fluxes.

When coupled to the Hadley Centre GCM, HadCM3LC, large positive climate-carbon cycle feedbacks significantly accelerate 21st century climate change and CO2 rise. Such positive feedbacks are common to all 11 C4MIP models but the magnitude of the feedback is uncertain, with terrestrial carbon cycle response to climate constituting the greatest uncertainty. Here we present results from high-resolution simulations of the European continental carbon balance using JULES driven by 20th century climate data at daily timescales. Following the CarboEurope-IP bottom-up modelling protocol we use climate data from the regional climate model, REMO, forced by reanalysis boundary conditions. In these simulations, fractions of PFTs are prescribed and invariant in time and JULES simulates the carbon and water fluxes and stores of the European land surface. We present comparison of JULES results with both observations and other models to investigate climate impacts on terrestrial carbon balance. We also explore the importance of representing diurnal cycles of temperature and radiation, and sub-daily variability of precipitation.