Impacts of extreme events in grassland models

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PaSim (Pasture Simulation model) is a plot-scale, process-based, biogeochemical model simulating fluxes of carbon, nitrogen, water and energy at the soil-plant-animal-atmosphere interface for managed grasslands. The pros and cons of the model were evaluated in the frame of several European and international projects. Some of the limitations include: soil C pools averaged over the whole soil profile, homogeneous herds (type, age) of grazing animals, no explicit representation of plant communities and limited sensitivity of vegetation to extreme events (e.g. regrowth after heat and water stress). With respect to the latter, the Farquhar-based photosynthesis is calculated from an optimum temperature, which remains constant during the whole simulation. This equation does not account for plant acclimation to growth temperature. However, evidence exists of a shift in the optimum temperature for the photosynthesis as growth temperature changes. At the same time, the maximum photosynthetic rate also changes, remaining stable only in a limited range of temperature. The range of optimum temperatures can be quite wide (especially for C3 plant species) and, as a general rule, the optimum temperature increases with increasing growth temperature, and this also determines a modification of the response curve of carbon assimilation. Thus, the response to temperature is an important area for model improvement. The photosynthesis process can be improved by expressing the optimum temperature as a function of the growth temperature while also modulating the maximum photosynthetic rate. An elaboration has been suggested in which the optimum temperature can be estimated at any day via a linear regression on the average growth temperature over the previous ~20 days. Modulation of the maximum photosynthetic rate is also under development, together with the development of a similar approach to adapt the respiration process. These improvements are being developed in a series of modules that are parts of a C++ library. The latter consist of externalizing the core of the model that could be invoked within the BioMA platform via a dedicated wrapper. This solution, which is under development, may also be used with the RECORD platform in the same way but without a dedicated wrapper. An assessment of the improved modelling solution will be performed with datasets from experimental and long-term observational grassland sites in the Massif Central of France.