Applications of process-based phenological models in ecology and evolution: forecasting budburst date evolution due to climate change.

Julie Gauzere*†[1], Isabelle Chuine[1], Ophelie Ronce[2], Hendrik Davi[3], Sylvie Oddou-Muratorio[3], and Sylvain Delzon[4]

[1]Centre d'Ecologie Fonctionnelle et Evolutive (CEFE) – Campus CNRS, UMR 5175 – 1919 route de Mende;34293;Montpellier Cedex 5, France

[2]Institut des Sciences de l'Evolution - Montpellier (ISEM) – CNRS : UMR5554, Institut de recherche pour le développement [IRD] : UMR226, Université Montpellier II - Sciences et techniques – Place E. Bataillon CC 064 34095 Montpellier Cedex 05, France

[3]Unité de Recherches Forestières Méditerranéennes (URFM) – Institut national de la recherche agronomique (INRA) : UR0629 – France

[4]Biodiversité, Gènes Communautés (BioGeCo) – Université de Bordeaux, Institut national de la recherche agronomique (INRA) : UMR1202 – Site de recherche Forêt - Bois de Pierroton - 69, route d'Arcachon F-33612 Cestas Cedex FRANCE, France

Abstract

Process-based phenological models simulate developmental rates and dates of occurrence of phenological stages as a function of physiological responses to climatic variables. Here, we aimed at illustrating how these models can be used to investigate diverse ecological and evolutionary issues related to the potential impact of climate change. We focused on two forest trees species (*Fagus sylvatica, Quercus petraea*), species particularly exposed to spatially and temporally variable selective pressures and for which phenotypic plasticity may thus play a key role in the adaptive response to climate change. More precisely, we studied the evolution of the date of leaf emergence (budburst), a key phenological trait determining the length of the vegetative season.

Classical phenological models describe how temperature impact bud development from dormancy initiation to budburst. However, recent experimental results suggest that some species, such as *F.sylvatica*, might also be sensitive to photoperiod. We first compared the efficiency of classical models to that of new models taking into account a photoperiod effect. As expected, these latter models provided better efficiency for *F.sylvatica*, but not for *Q.petraea.* We also found that models incorporating a photoperiod effect tend to predict increased budburst advancement with climate change.

Finally, we used the process-based species distribution model PHENOFIT, that simulates the entire phenological cycle of a tree and other processes that impact fecundity and survival, to evaluate the selective pressures on the leaf unfolding date and the level of population maladaptation (measure as the difference between plastic and optimum dates) in current and future climatic conditions.

*Speaker

†Corresponding author: julie.gauzere@cefe.cnrs.fr

Keywords: Phenological model, Tree species, Climate change, Budbust evolution, Phenotypic plasticity