The 4C performance for *Pseudotsuga menziesii* (Mirb.) Franco stands in the north of Portugal

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GOAL

The main goal of this study is to parameterize the model 4C (FORESSE) and estimate net primary production (NPP) on pure stand of *Pseudotsuga menziesii,* located in Bragança, Northeast of Portugal. We also intent to evaluate the performance of the model based on observed NPP figures. This parameterization is crucial for the following steps of a wider investigation where the impact of different climate change scenarios will be tested. Further studies will then be implemented, the 4C will be tested for *Castanea sativa* and the same scenarios will be tested in pure and mixed stands.

BACKGROUND

The 4C (FORESEE - Forest Ecosystems in a Changing Environment) is a physiologically based model that can be used to evaluate a broad variety of silvicultural treatments for pure and mixed forest stands. The model has been developed to describe long-term forest behaviour under changing environmental conditions. It describes processes on tree and stand levels bases on findings from eco-physiological experiments, long term observations and physiological modelling on an intermediate level of complexity. It is used to analyse forest productivity, carbon, water and nitrogen budgets of forests including soil; to derive reduced models for application in information systems; to analyse adaption of forestry to climate change by management; and to estimate the bioenergy potential from short rotation coppice. The model includes descriptions of tree species composition, forest structure, total ecosystem carbon content as well as leaf area index (LAI) (Figure 1). The model shares a number of features with gap models, which have often been used for the simulation of long-term forest development. 4C allows simulating forests from the Mediterranean to the Boreal regions because of the large set of parameterised tree species and processes and it represent an advantage from the models only well adapted for their specific climatic region and the appropriate tree species. 4C requires climatic driving variables on a daily resolution but the outputs are given according to various time steps. The model estimates the soil carbon stock until the depth defined by the rooting depth in the soil.

METHODOLOGY

In this study, the model 4C was parameterised to estimate NPP (NPP estimated) on *Pseudotsuga menziesii* (Pm) plots. NPP is an important ecological variable due to its relevance for accurate ecosystem management and for monitoring human activity impact on ecosystems at a range of spatial scales: local, regional and global (Melillo *et al*., 1993). To estimate NPP, *Pseudotsuga menziesii* was planted in 2 permanent research plots with 512 m^2 each in the interior of Trás-os-Montes district (Bragança), Northeast of Portugal (Figure 2), in 1981 (Luís and Monteiro, 1998) with 4 subsamples each plots.

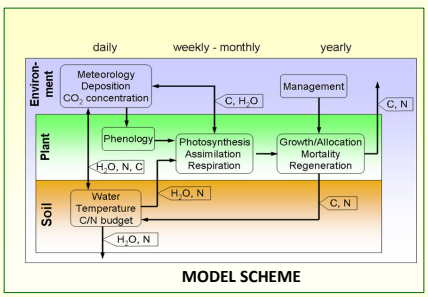

Figure 1. Model scheme of model 4C.

Each plot had 64 plants, spaced 4 x 2 m. Data presented are based on values of dendrometric variables of the plots, collected at 2 different periods (2008 and 2009). Soil samples were collected at two soil layers (horizon A: 0-20 cm; horizon B: 21-60 cm) in 2009. The model 4C was run for the period 1996-2007, based on climate data from meteorological stations of Bragança.

Figure 2. Study area localization.

RESULTS

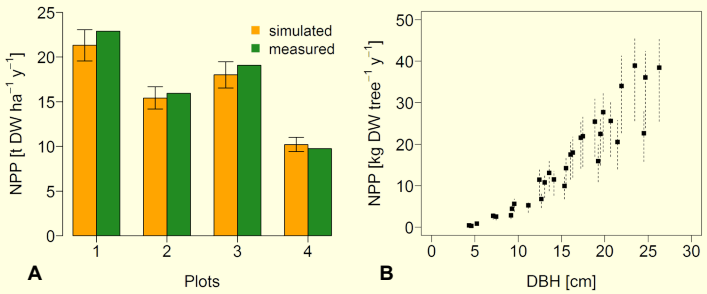

Figure 3. Simulated net primary production (NPP) with 4C. Error bars indicate standard error of the mean annual NPP. Dashed lines in Figure B indicate minimum and maximum for the period 1996-2007.

The left figure 3A shows simulated and measured annual NPP (simulated: average for 1996-2007; measured: for the year 2009) for four subsamples of one investigation plot. The NPP was separately simulated for each year in the period 1996-2007. Although the observed NPP differed between the subsamples, the simulated values were in accordance to the measured values. The simulation results encourage further investigation with 4C to analyze underlying factors which explain the differences in NPP.

The right figure 3B shows the simulated correlation between mean annual NPP per tree and the diameter. The simulated NPP is positively correlated with diameter at breast height. The reason is the higher leaf area of larger trees (Gower *et al*. 1999) which also increases the NPP.

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