

## 4C

# FORESEE - FORESt Ecosystems in a Changing Environment



### Model Description:

The model 4C ('FORESEE' - Forest Ecosystems in a Changing Environment) has been developed to describe long-term forest behaviour under changing environmental conditions (Lasch et al., 2005). It describes processes on tree and stand level based on findings from eco-physiological experiments, long term observations and physiological modelling. The model includes descriptions of tree species composition, forest structure, total ecosystem carbon content as well as leaf area index. The model shares a number of features with gap models, which have often been used for the simulation of long-term forest development. Establishment, growth and mortality of tree cohorts are explicitly modelled on a patch on which horizontal homogeneity is assumed. Currently the model is parameterised for the five most abundant tree species of Central Europe (beech (*Fagus sylvatica* L.), Norway spruce (*Picea abies* L. Karst.), Scots pine (*Pinus sylvestris* L.), oaks (*Quercus robur* L., and *Quercus petraea* Liebl.), and birch (*Betula pendula* Roth)) as well as other tree species, namely aspen (*Populus tremula* (L.), *P. tremuloides* (Michx.)), Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), black locust (*Robinia pseudoacacia* L.), Aleppo pine (*Pinus halepensis* Mill.), Ponderosa pine (*Pinus ponderosa* Dougl.), and Lodgepole pine (*Pinus contorta* Dougl.).

### Input Data:

Daily meteorology, soil description (physical and chemical), forest stand description

### Results:

Water, carbon and nitrogen dynamics (pools and fluxes) of forest stands including soil, growth behaviour of forest stands (diameter, height, volume)

### Resolution:

- Time step: 1 day – 1 year
- Simulation period: 1 – 200 years
- Spatial: Cohorts of trees in a forest stand

### Operating system:

Linux, Unix, Windows

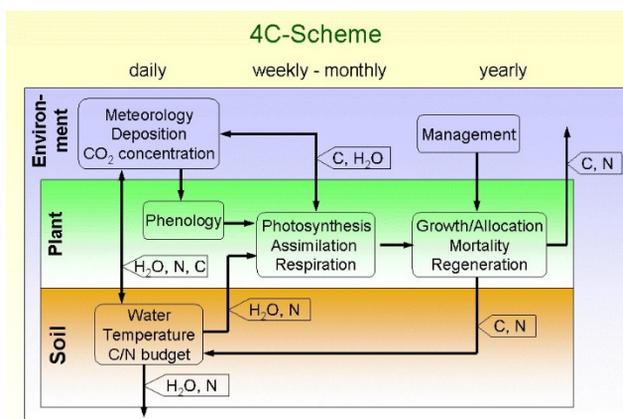
### Programming language:

Fortran90

### Model run time:

Dependent on the number of sites, scenarios and simulation time

### Model structure:



### Developer:

Potsdam Institute  
for Climate Impact  
Research  
Telegrafenberg  
D-14472 Potsdam,  
Germany

### Website:

<https://gitlab.pik-potsdam.de/foresee/4C>



### Role of the model:

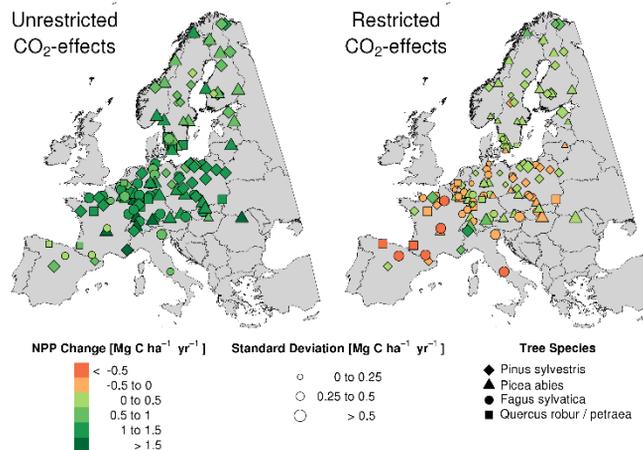
Highly-resolved temporal and spatial modelling of carbon and nitrogen in forest stands and soil pools, forest growth and yield under global change (climate, atmospheric and land-use changes).

### Model interfaces to (input data):

STARS and other climate data sources (e.g. CCLM)

**Time frames:** Validation: 1951 – 2009

Projection: 2010-2100



### EU project MOTIVE (Reyer et al 2014)

Change in net primary productivity NPP [ $\text{Mg C ha}^{-1} \text{ yr}^{-1}$ ] for 132 ICP Forests level II sites averaged over a broad set of climate scenarios compared to 1971-2000 for simulations with unrestricted  $\text{CO}_2$ - (left) and restricted  $\text{CO}_2$ -fertilization effect (right).

### Potential users and application areas:

- Researchers and universities** investigating processes and feedbacks in forest ecosystems including impacts of land use and global change.
- Consultants** supporting forest authorities in climate impact adaptation analyses (adaptation of forest management).

### Availability:

For code and documentation please see <https://gitlab.pik-potsdam.de/foresee/4C>.

### Resources needed to set up site-specific model:

High. Depending on complexity of the modelling problem and experience of user 2-3 month.

### References:

- Lasch, P., F. W. Badeck, F. Suckow, M. Lindner und P. Mohr (2005) Model-based analysis of management alternatives at stand and regional level in Brandenburg (Germany). *For. Ecol. Manage.* 207(1-2): 59-74.
- Borys, A., Lasch, P., Suckow, F., Reyer, C. (2013): Kohlenstoffspeicherung in Buchenbeständen in Abhängigkeit von Waldpflege und Klimawandel. *Allg. Forst- u. J.-Ztg.* 184(1/2), 26-35.
- Reyer C, Lasch-Born P, Suckow F, Gutsch M, Murawski A, Pilz T (2014) Projections of regional changes in forest net primary productivity for different tree species in Europe driven by climate change and carbon dioxide *Ann For Sci* 71:211-225

### Target groups:

- Research Institutes
- Universities
- Consultants