Modelling managed forest ecosystems in Sweden

Poster presentation:

Bergkvist, John; Lagergren, Fredrik; Finnander Linderson, Maj-Lena; Miller, Paul; Jönsson, Anna Maria

2022

Document Version:
Publisher's PDF, also known as Version of record

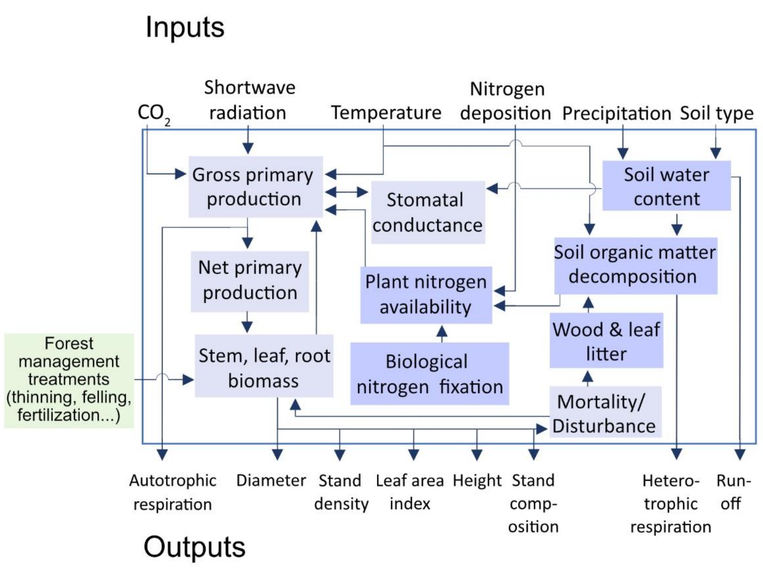
Modelling managed forest ecosystems in Sweden: An evaluation from the stand to the regional scale

John Bergkvist[a], Fredrik Lagergren[a], Maj-Lena Linderson[a], Paul Miller[a] & Anna Maria Jönsson[a]

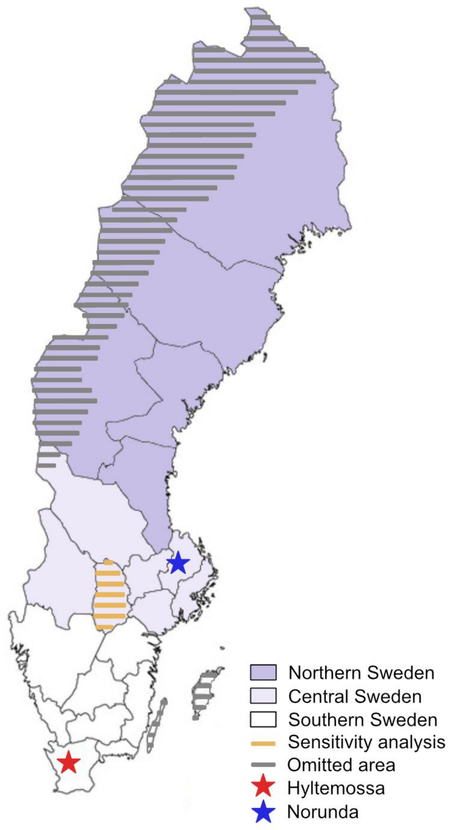
[a]Department of Physical Geography and Ecosystem Science, Lund University

Corresponding author
John Bergkvist
john.bergkvist@nateko.lu.se

Conceptual model diagram



Study area



SUMMARY

- The dynamic vegetation model LPJ-GUESS was used to simulate forest standing volume for the three main regions of Sweden. The model results were evaluated against observational data from the Swedish National Forest Inventory.
- We also simulated carbon fluxes of net ecosystem exchange (NEE), gross primary productivity (GPP), and ecosystem respiration (Reco) at the local scale on a daily time step for two sites in Sweden and evaluated the results against data from the Integrated Carbon Observation System (ICOS).
- The model was updated with new parameters (**Opt**) for the two dominating coniferous species Norway spruce (*Picea abies L. Karst*) and Scots pine (*Pinus sylvestris L.*) and the new parameters were compared against the original (**Orig**).
- For **Opt** and **Orig**, simulations were run with one dominating soil type representing the most frequently occurring soil on forested land: sandy silty till. Additional simulations based on several soil types were run in the scenario **Optw**.

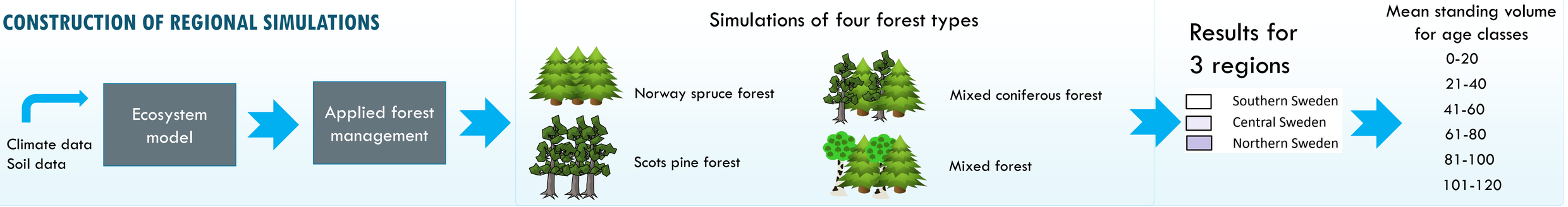
Simulations

Orig
Original parameters
One soil type

Opt
Updated parameters
One soil type

Optw
Updated parameters
Several soil types

CONSTRUCTION OF REGIONAL SIMULATIONS



CONSTRUCTION OF LOCAL SIMULATIONS

RESULTS

The model produced adequate results of standing volume in monocultures of Norway spruce and Scots pine for southern and central Sweden, after an updated parameterization of the species (**Opt** and **Optw**).

In northern Sweden, the standing volume was underestimated in Norway spruce monocultures with the original species-specific parameters (**Orig**) and overestimated with the new parameter set (**Opt**).

Stand-scale simulations of carbon fluxes produced mixed results after evaluation against EC data from ICOS. Modelled annual average GPP and interannual variation was well represented for Norunda, with a positive bias of 2%. In Hyltemossa, GPP was underestimated by 22% for the corresponding period.

Simulated NEE deviated from observed at the local scale, but the modelled interannual variation was relatively accurate for both sites.

The results highlight the potential to perform species-specific calibration to capture latitudinal gradients in key ecosystem properties, and to incorporate additional characteristics of site quality which could benefit model accuracy at the scale of individual forest stands, both regarding simulated carbon fluxes and forest stand variables.

MATERIAL & METHODS

Details of the forest management module is described in Lindeskog et al. (2021). The model is described in full in Smith et al. (2014) with appendix.

Data for input to regional scale simulations were 50 x 50 km mean monthly values for temperature, precipitation, short-wave radiation and annual values for carbon dioxide concentration and nitrogen deposition, taken from *CRUNCEP version 7* forcing dataset (Viovy, 2018). Site-specific meteorological data received from two ICOS stations enabled model simulations of ecosystem fluxes on a daily time step. Data for carbon fluxes originated from the 2020 European Warm Winter synthesis analysis (Sabbatini et al. 2018).

REFERENCES

Lindeskog, M., Smith, B., Lagergren, F., Sycheva, E., Ficko, A., Pretzsch, H., & Rammig, A. (2021). Accounting for forest management in the estimation of forest carbon balance using the dynamic vegetation model LPJ-GUESS (v4.0, r9710): implementation and evaluation of simulations for Europe. *Geoscientific Model Development, 14*(10), 6071-6112.

Sabbatini, S., Mammarella, I., Arriga, N., Fratini, G., Graf, A., Hörtnagl, L., . . . Papale, D. (2018). Eddy covariance raw data 860 processing for CO2 and energy fluxes calculation at ICOS ecosystem stations. *International Agrophysics, 32*(4), 861 495-515.

Smith, B., Wårlind, D., Arneth, A., Hickler, T., Leadley, P., Siltberg, J., & Zaehle, S. (2014). Implications of incorporating N cycling and N limitations on primary production in an individual-based dynamic vegetation model. *Biogeosciences, 11*(7), 2027-2054.

Viovy, N. (2018). CRUNCEP version 7 - atmospheric forcing data for the Community Land Model. Research data archive at the National Center for Atmospheric Research, Computational and Information Systems Laboratory.

ACKNOWLEDGEMENTS

The study contributed to the Forest Vision project, FORMAS grant number 2019-01968. We acknowledge ICOS Sweden for providing data and we would like to thank Tobias Biermann, Ulf Johansson, Mats de Val and Anders Lindroth for comments and advice.

ICOS Sweden is funded by the Swedish Research Council as a national research infrastructure (grant number 2019-00205). We would also like to thank Christofer Engberg Hydén and Johan Stendahl from the Swedish Forest Soil Inventory for providing soil data.