Ecosystem modeling of vegetation growth and risk of damage – linking user needs to model development

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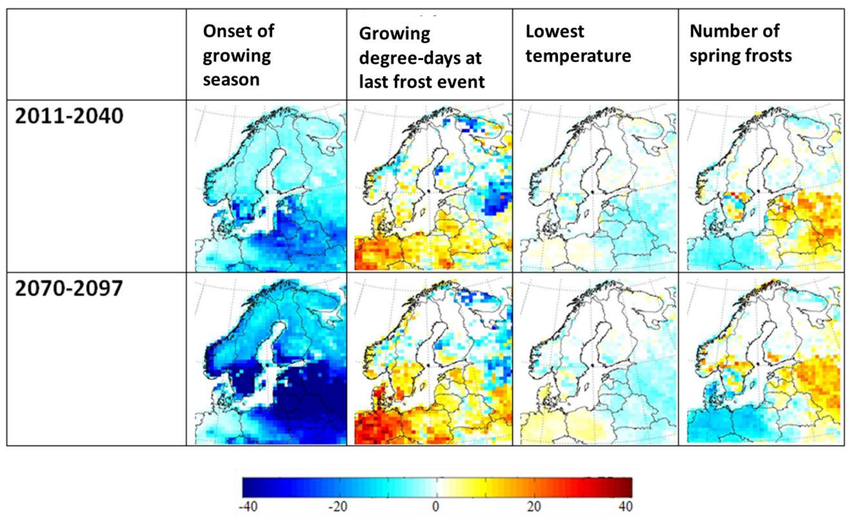
- A warmer climate will extend the growing season in the Nordic countries, and influence the risk for damage caused by extreme weather events and insect pests. Climate- and ecosystem modeling can help to explore the potential outcome.
- Stakeholder communication is essential for getting a picture of the adaptation options: - Which management alternatives are available and feasible? - How can information from impact model runs driven by data from an ensemble of climate model runs be used? - Which spatial and temporal resolution would be needed?
- Transformed into the world of modeling, these questions are closely related to which ecosystem processes and interactions should be included for the model to provide useful and relevant results. Below are five examples of ongoing work:

1) Spring Frost Damage

The risk of spring frost damage commonly influences the selection of plant species and varieties, both within agriculture and forestry. The climate change signal can be assessed by a spring backlash index. The index indicated that the general future trend is of a reduced frost risk, although frost events can become more harmful in the future by occurring at a later phenological stage.

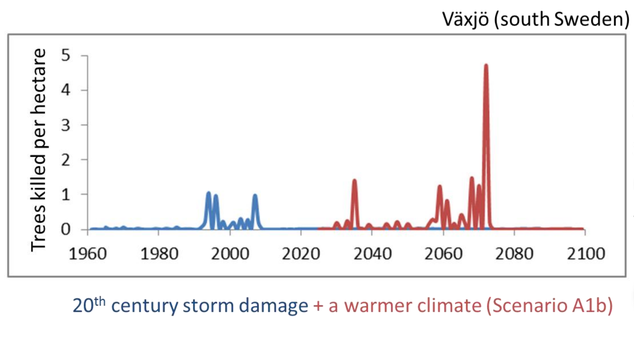


Climate change signal – scenario A1B compared with 1961-1990

Four aspects of spring backlash severity, showing the change in the 10% most harmful events. The climate change signal was calculated for two time periods, based on an RCA3 x 7 GCM ensemble of temperature data.

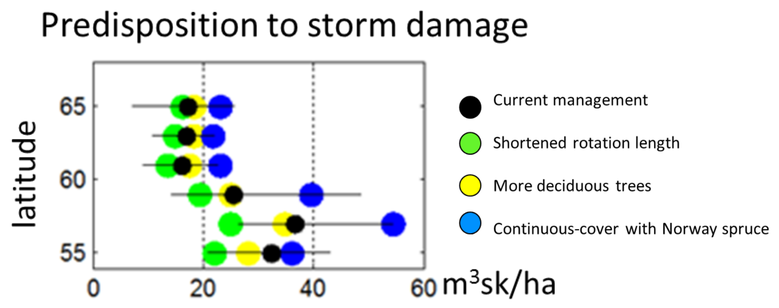
2,3) Bark Beetles attacks after wind-felling of Norway spruce

A warmer climate allowing for two generations of spruce bark beetles per year may increase the risk of outbreaks leading to tree killing in Sweden. The risk is tightly coupled to the population size, generally increasing after wind-felling of Norway spruce. Different forest management options, influencing the predisposition to storm and insect damage, can be explored by ecosystem modeling.



Simulation of spruce bark beetle attacks on standing trees for the period 1961–2010 (blue line) and 2025–2075 (red line), given the same amount of storm damage.

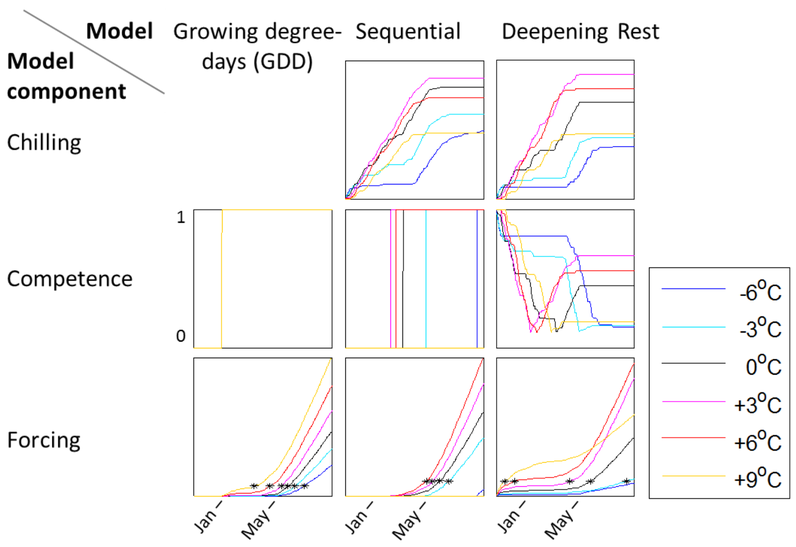
Simulated impact of forest management at landscape level, in terms of predisposition to storm damage in 2070-2100.



The latitudinal gradient in climate conditions influence tree growth and risk of storm damage.

4) Forest Tree Phenology

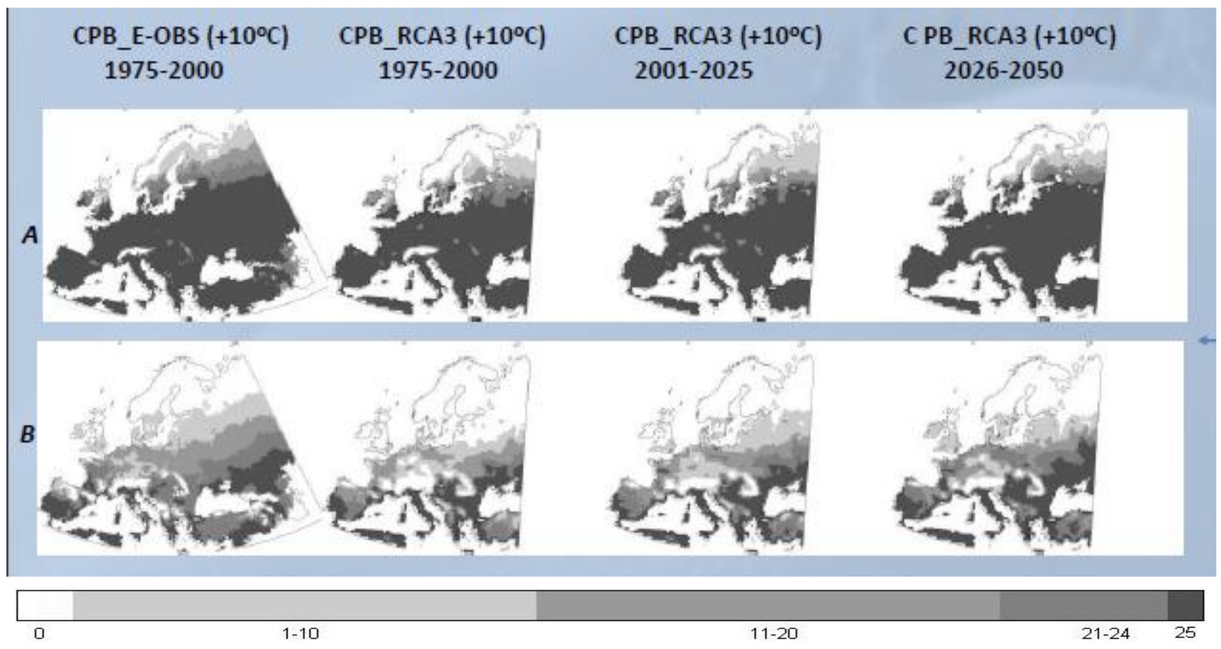
A temperature increase will influence the timing of budburst, and thereby the risk of frost damage. The estimated impact is however highly dependent on the choice of phenological model. Model uncertainties caused by knowledge gaps in the response of different tree species to cues from temperature and day length influence the reliability of climate impact assessments.



Temperature sensitivity of three phenology models, having different descriptions of temperature impact on tree physiological processes. The different temperature series were obtained by modifying one year of observed temperature data from a station in south Sweden. Asterisks indicate the predicted day of budburst for each series.

5) Colorado Potato Beetle

A temperature increase will affect the Colorado potato beetle (CPB), an invasive pest in Europe. The main concern is that the geographical area sustaining the development of at least one generation per year will expand further north. The potential distribution can be assessed by impact modeling, though sensitivity to biases in climate model data are substantial.



Number of years when the temperature requirements for completed development of A) a first and B) a second generation of the Colorado potato beetle are fulfilled according to CPB_E-OBS and CPB_RCA3 model simulations.

References

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