Leibniz-Zentrum für Agrarlandschaftsforschung (ZALF) e.V.

Mitglied der Leibniz-Gemeinschaft

Leibniz Centre for Agricultural Landscape Research

Conversion of single-species pine forest stands to species-rich mixed decidous forests in north-eastern German lowlands – simulation of effects on carbon budget

Michael Janott, Hubert Jochheim, Uwe Heinrich

Potsdam, 10th September 2013

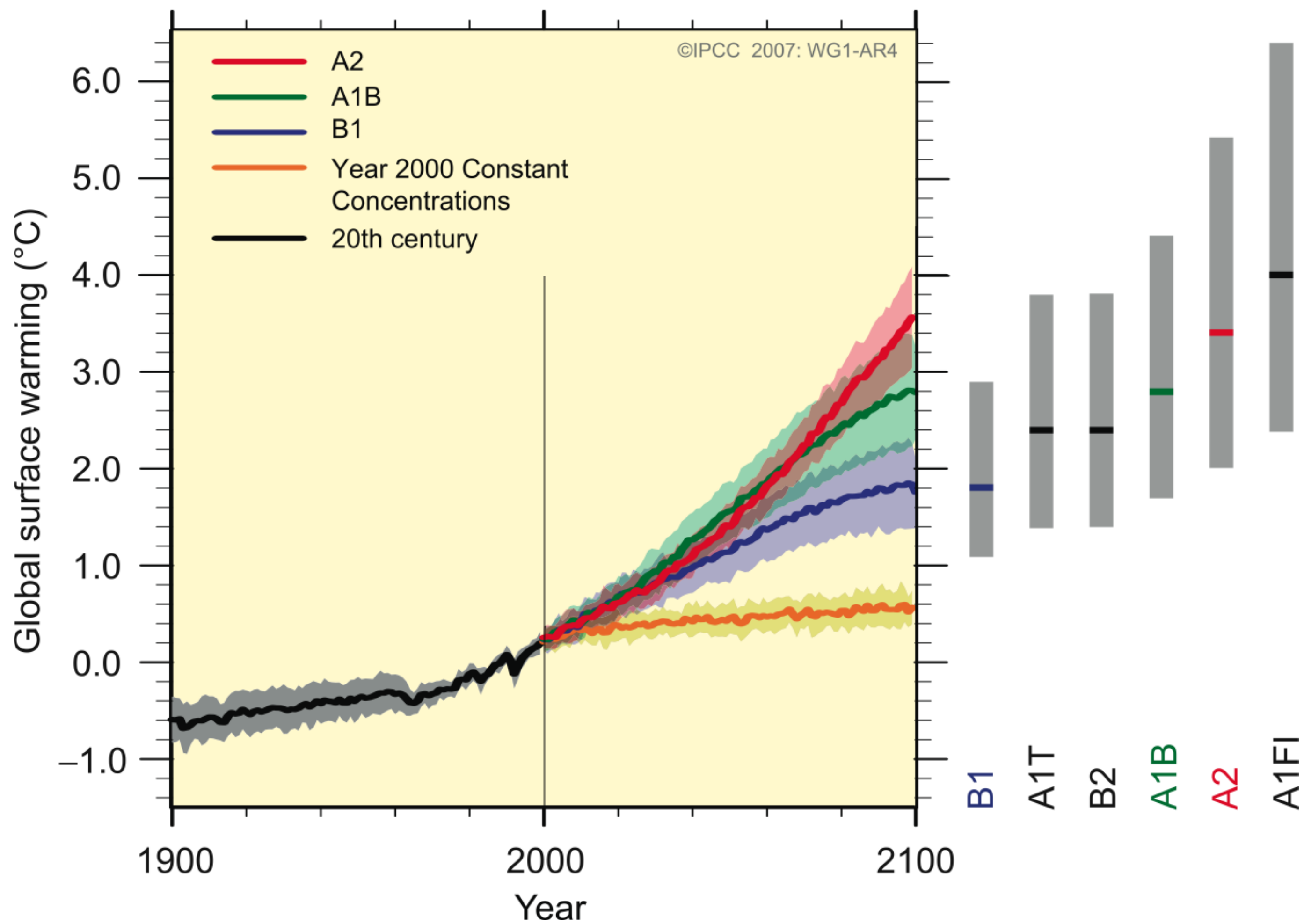
INKA BB KLIMAWANDEL UND INNOVATION

Context and motivation

- Project INKA BB (Innovation Network of Climate Change Adaptation Brandenburg Berlin)

- Climatic conditions affect stability of forest structures via
  - promoting pathogen development
  - extreme weather events like storm and drought

Uncertainties about future climate



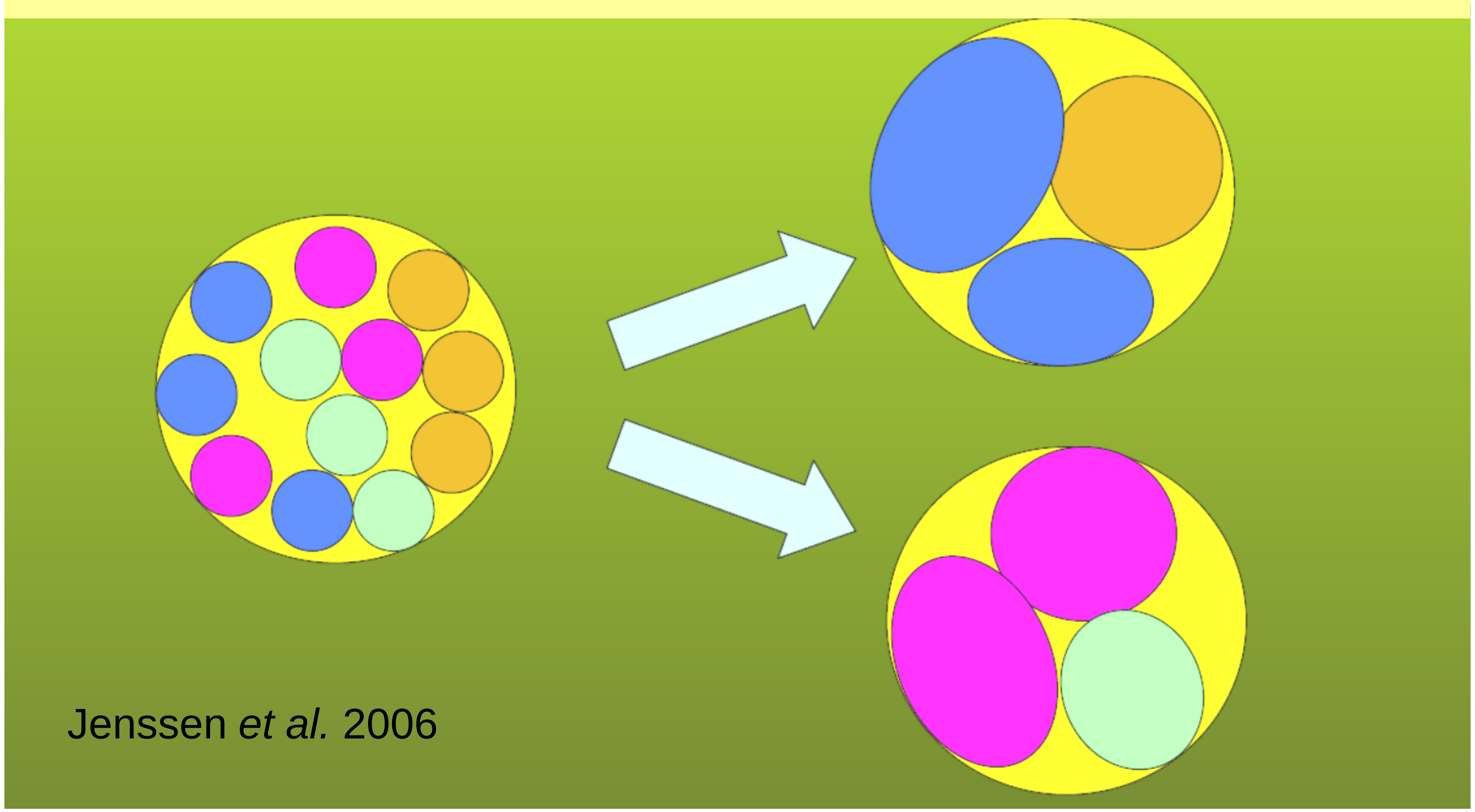
- Future development of climate is uncertain, hence, unfavourable climatic condition can lead to decline of individual tree species
- Large areas of North-Eastern German lowlands are covered by single-layered pine forests

PROBLEM: Decline of pine can lead to forest decline on large areas

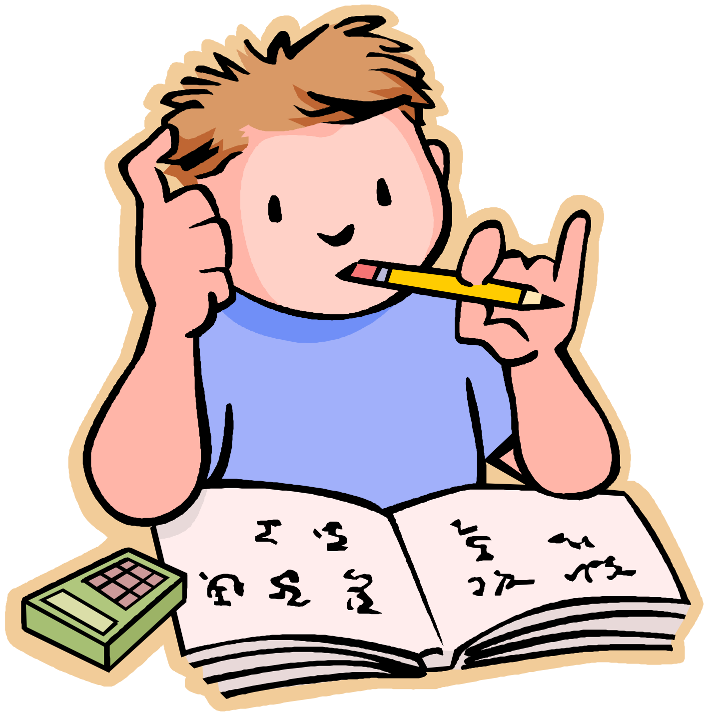
SOLUTION: Conversion of dominating pine forests into climate adaptive species-rich mixed deciduous forests

Adaptivity

Ability of ecosystems to organise themselves at varying environmental conditions without long-lasting successions, maintaining their system determining life functions



Crowe & Parker 2008: Using **portfolio** theory to guide reforestation and restoration under climate change scenarios." Climatic Change 89(3-4): 355-370

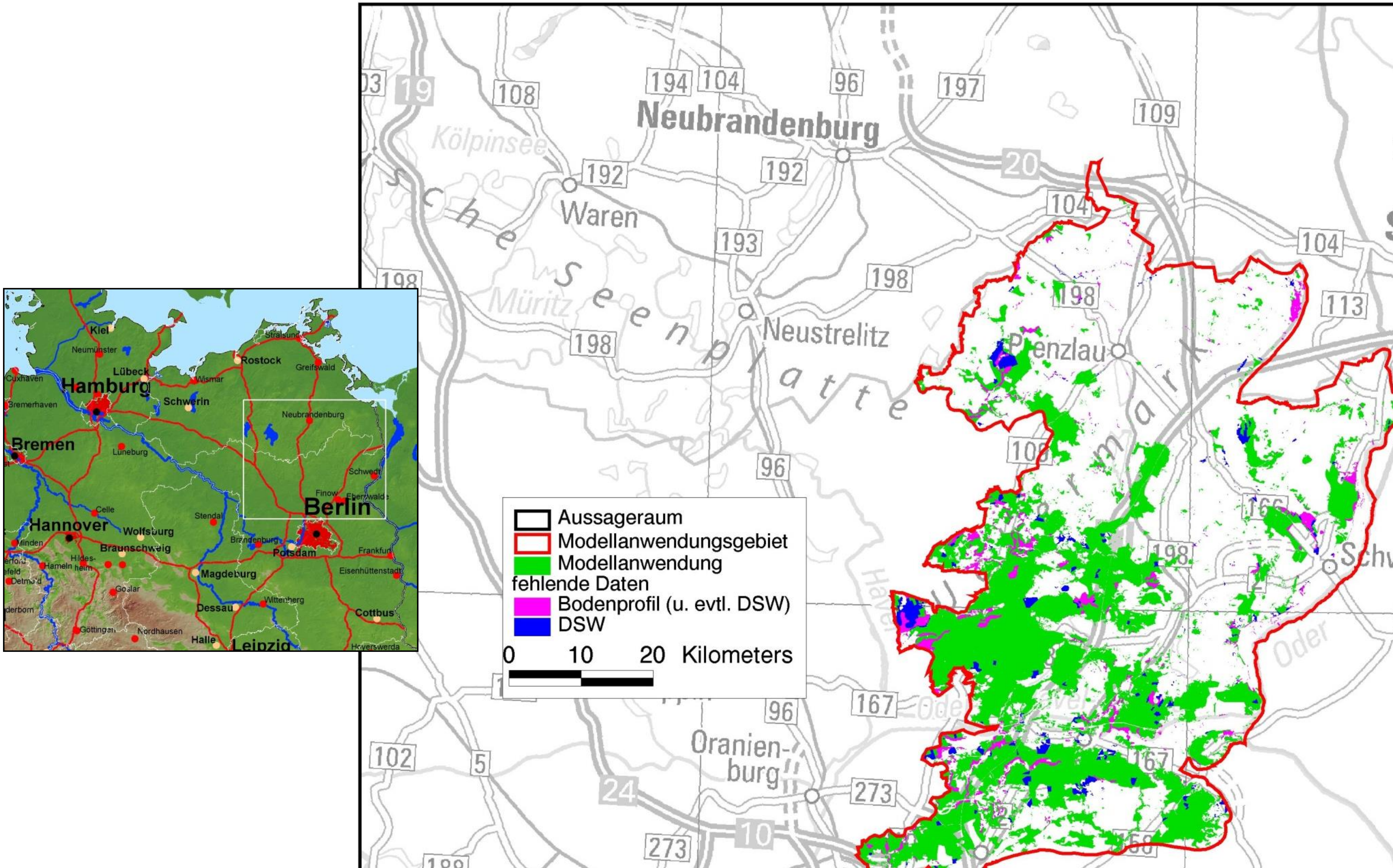


- TASK:

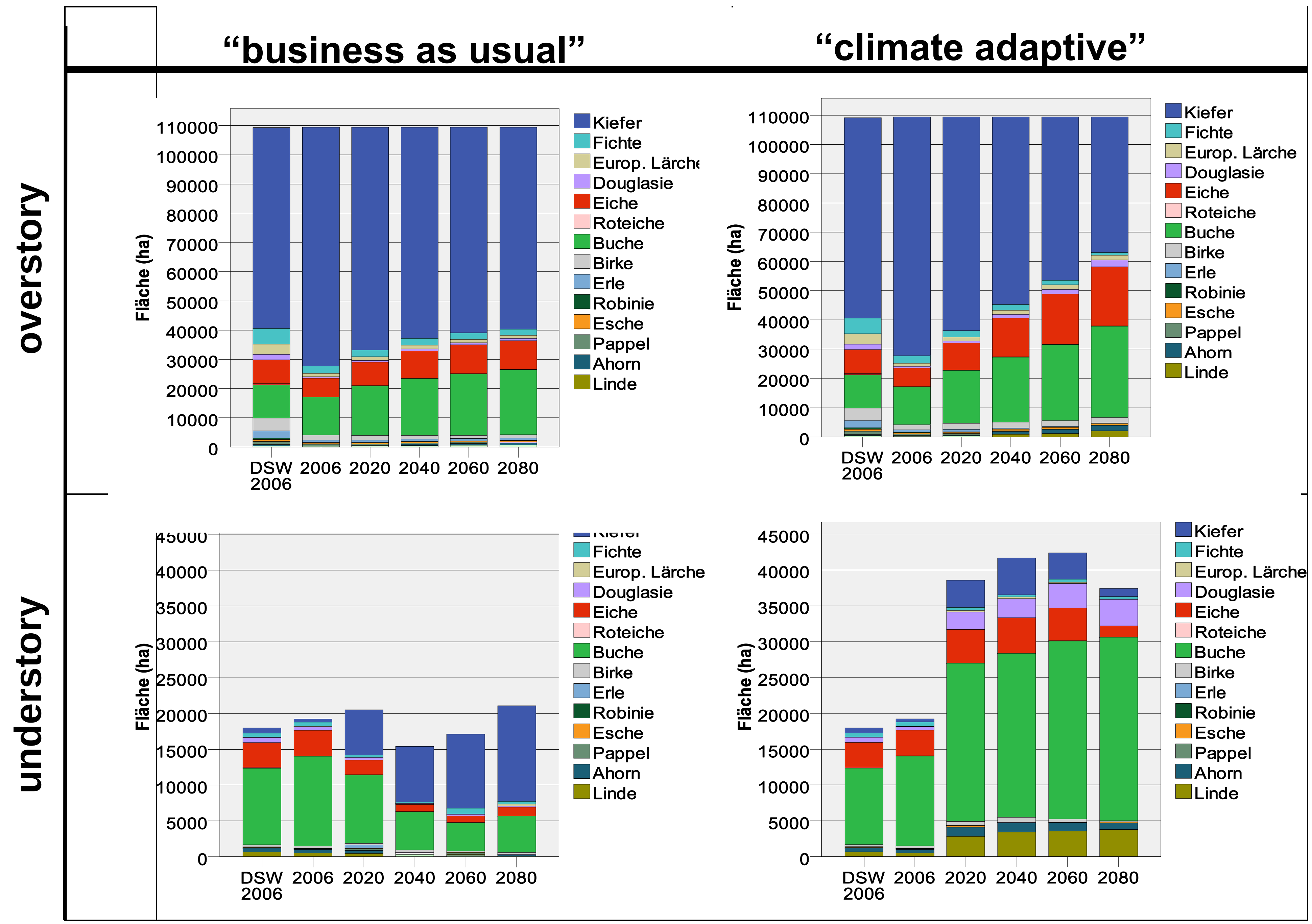
Quantification of effects of forest conversion on carbon and water balance in model region

Simulation period 2006 - 2100

Model region



Management scenarios



Pine

Oak

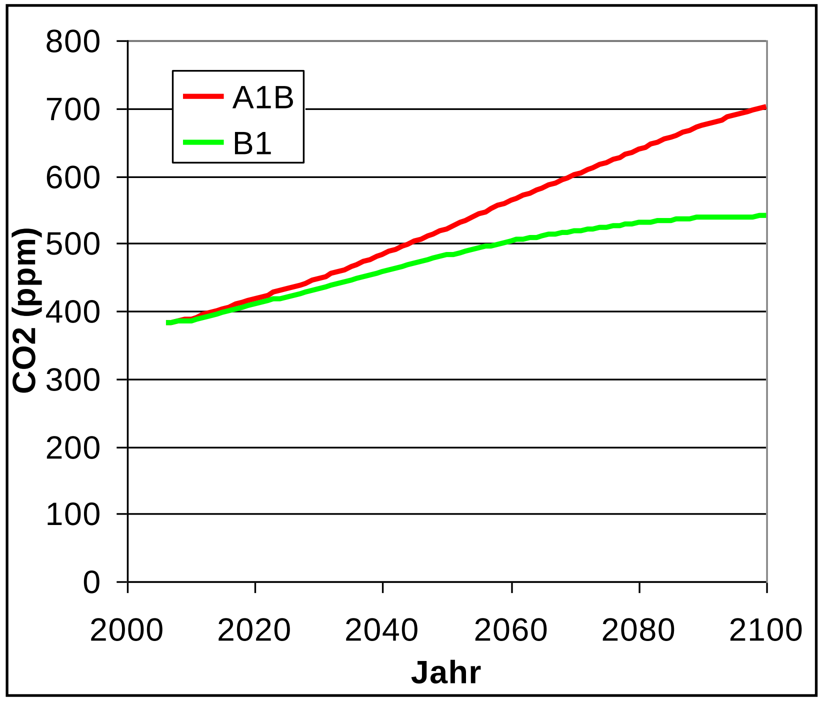
Beech

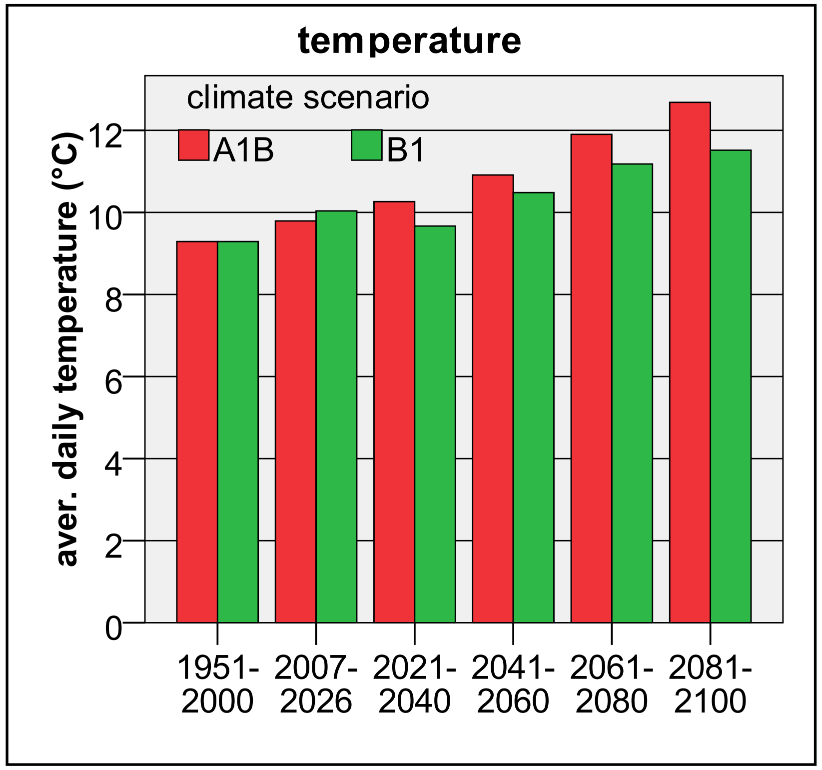
Generation of scenarios: NEWAL-NET TP-B: Martin Jenssen

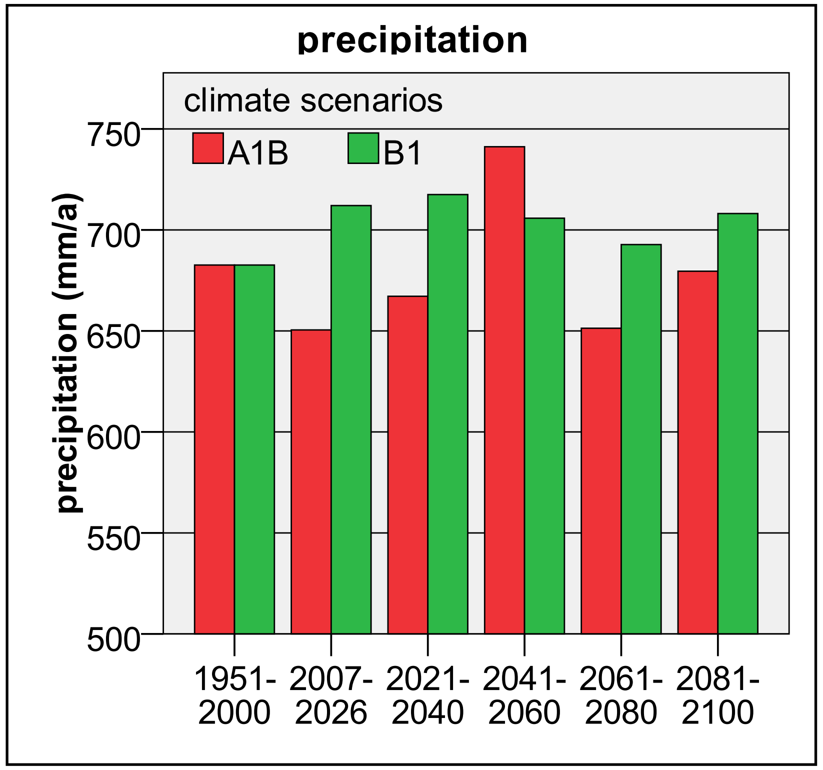
- Maintainance of current tree species distribution under consideration of rotation period
- Conversion to climate adaptive mixed deciduous forests under consideration of rotation period

Climate projections

- IPCC-SRES (emissions scenarios) **A1B**, **B1**
- Global climate model ECHAM5-MPI-OM
- Regionalization with REMO (Jacob 2005, 2006)







Geo data

Climate projections
REMO (Jacob et al. 2005, 2006)

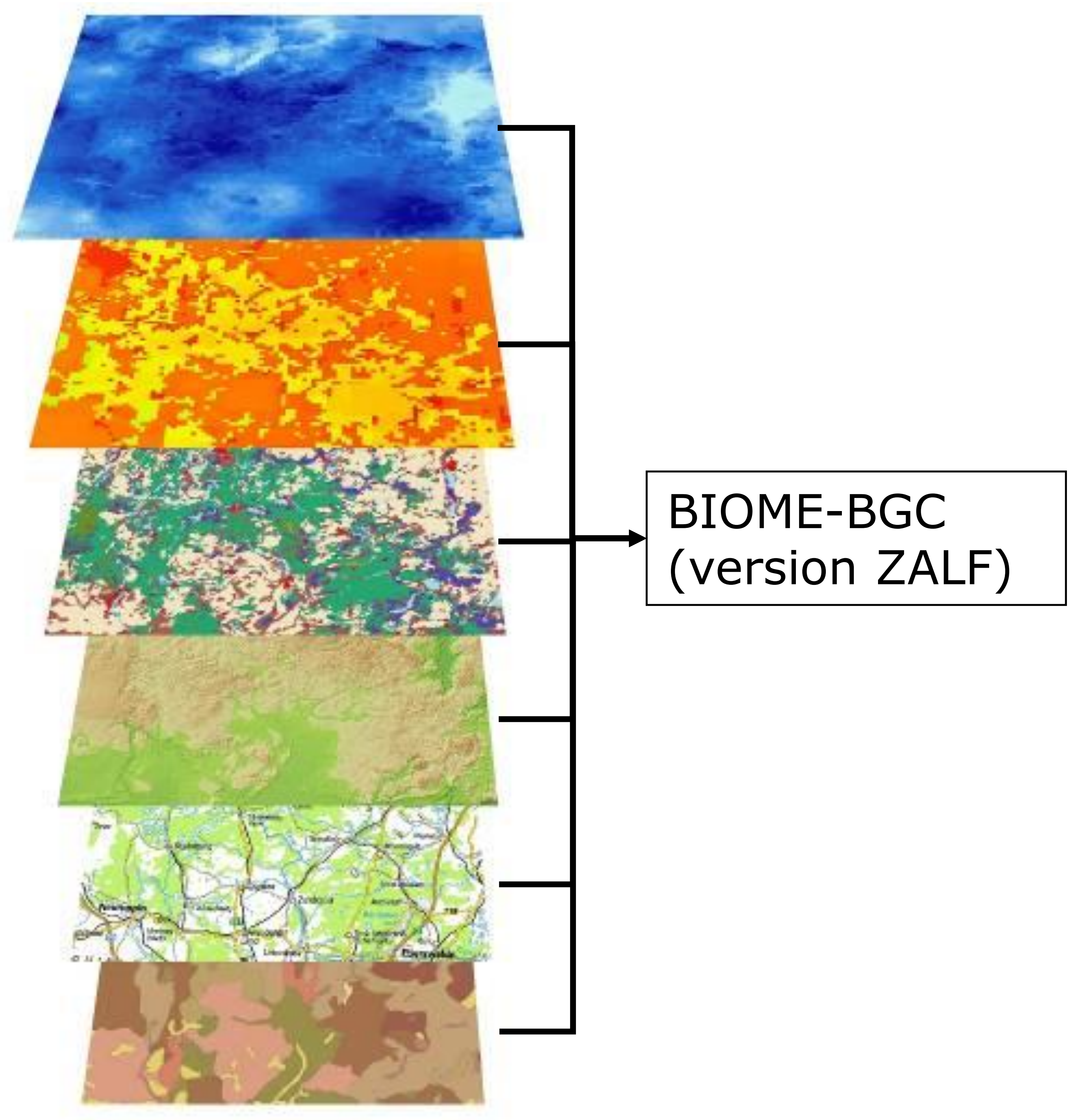
N deposition
(Gauger et al. 2008)

Forest stands
Forest survey map
Forest inventory data base (LFE 2006)
Management scenarios (Jenssen)

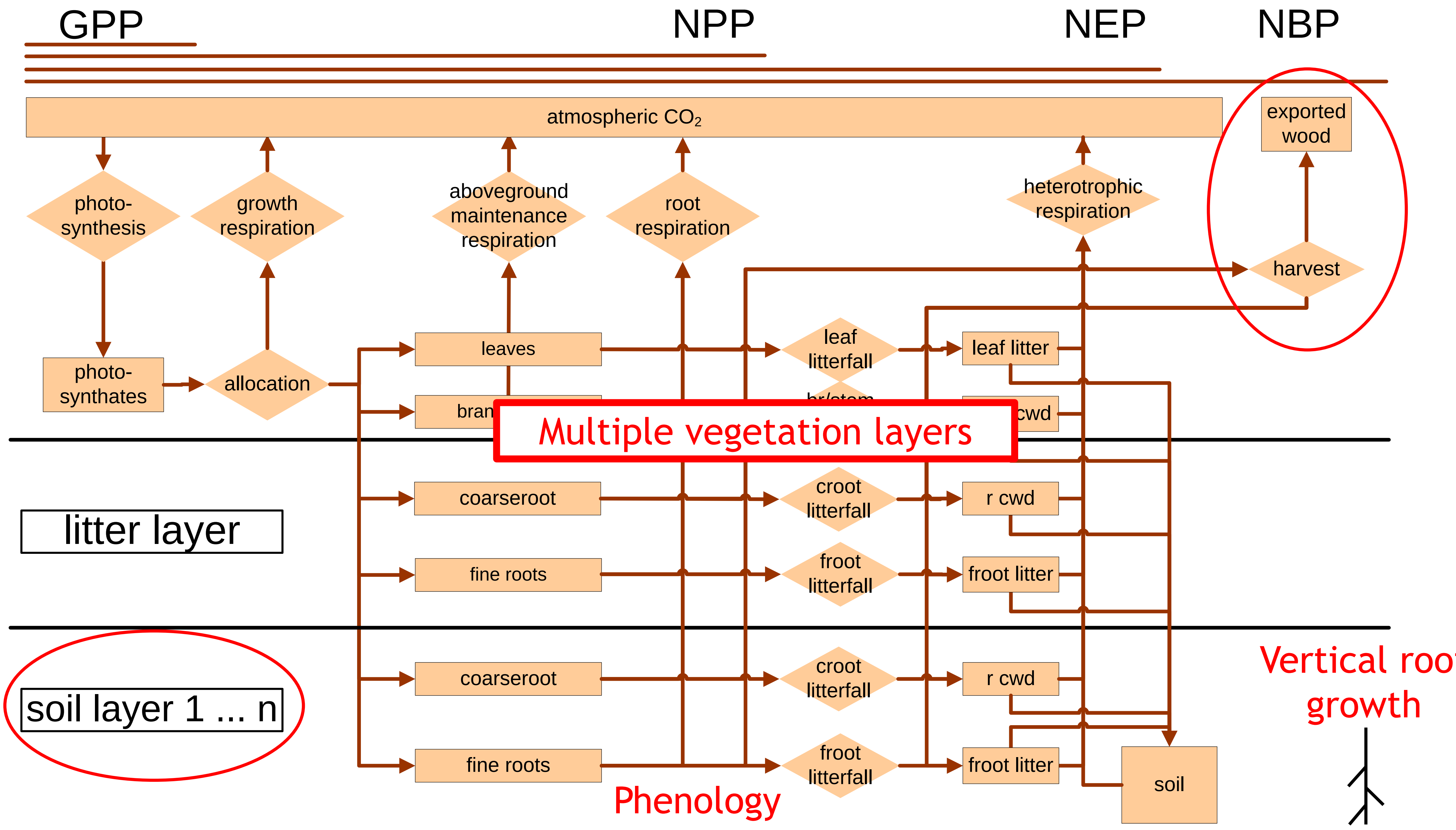
Relief
DEM25 (LUA)

Topography
TK25 (BKG)

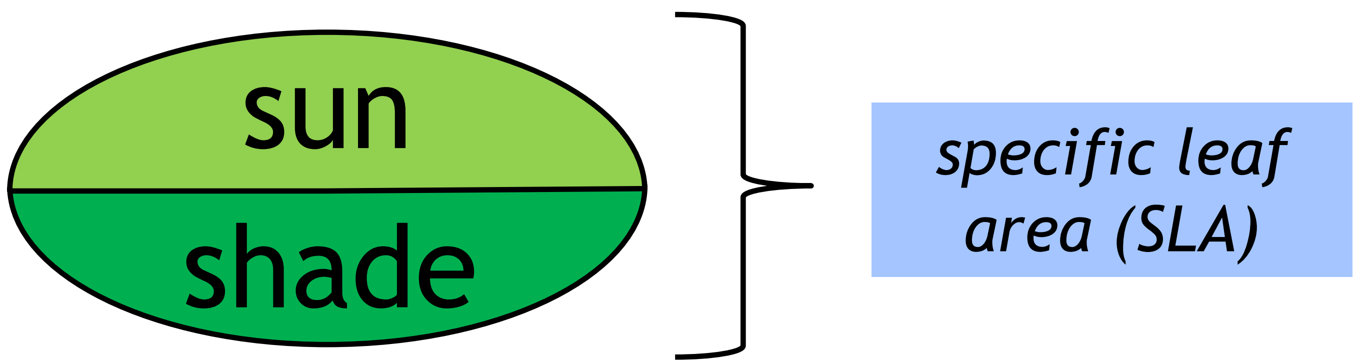
Soil map
BÜK300 (Bauriegel et al. 2001)



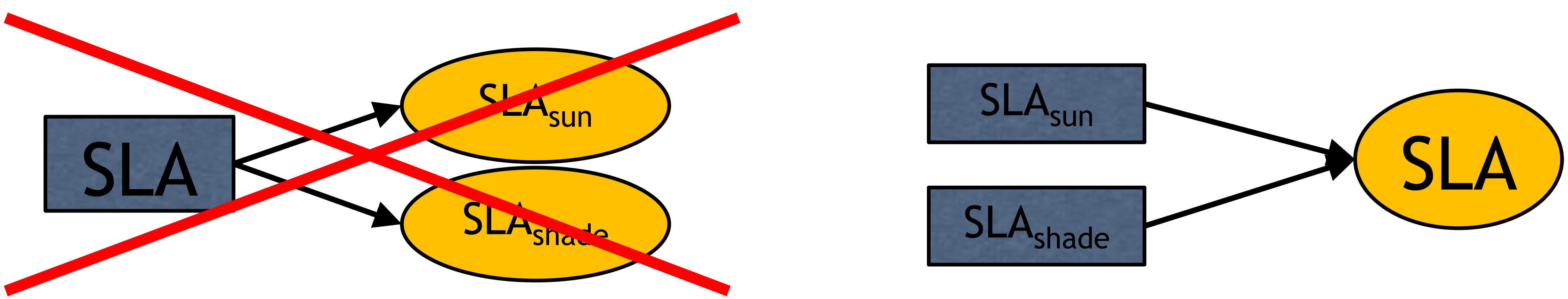
Carbon pools and fluxes of BIOME-BGC (vers. ZALF)



Leaf-shade model



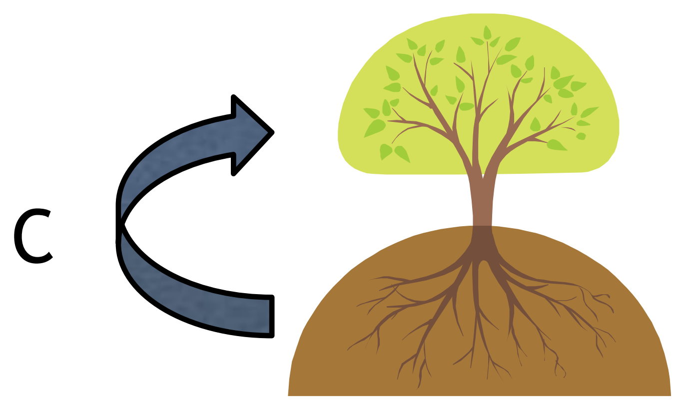
- Photosynthesis is computed for sunlit and shaded leaf area seperately
- SLA is parameter for total canopy of vegetation layer in Biome-BGC



- In shaded canopies the fraction of shaded leaf area is higher
- Compute SLA of canopy from constant SLA_{shade} and SLA_{sun} instead of compute SLA_{shade} and SLA_{sun} from constant SLA

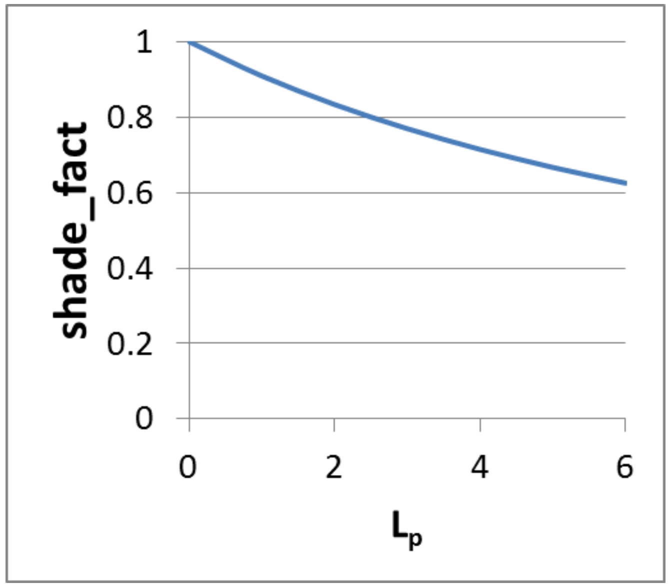
Allocation

- Ecophysiological parameters of vegetation might change under shading conditions
  - Allocation of carbon shifted to leaf and stem



v: vegetation layer

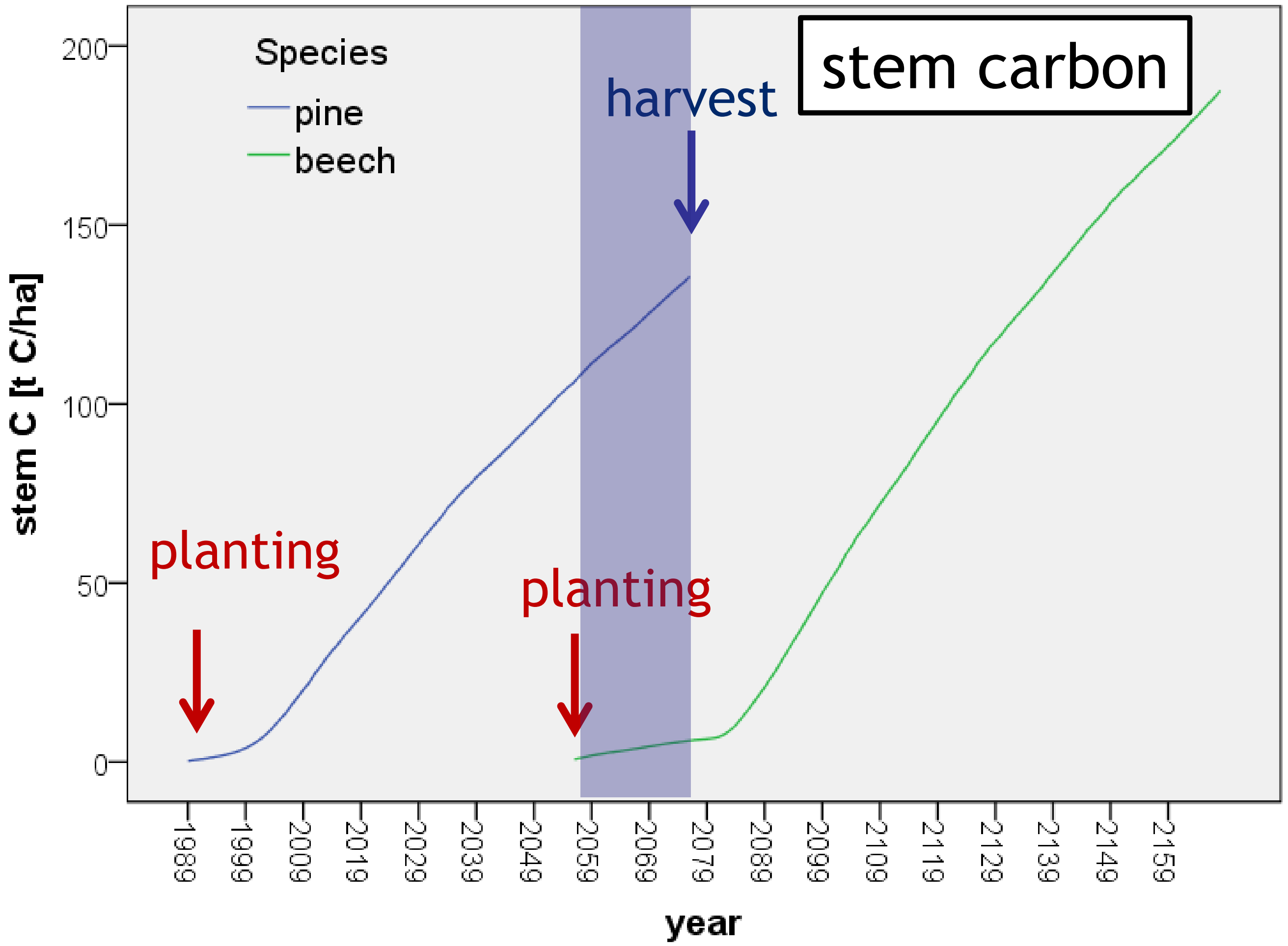
L_p: leaf area index

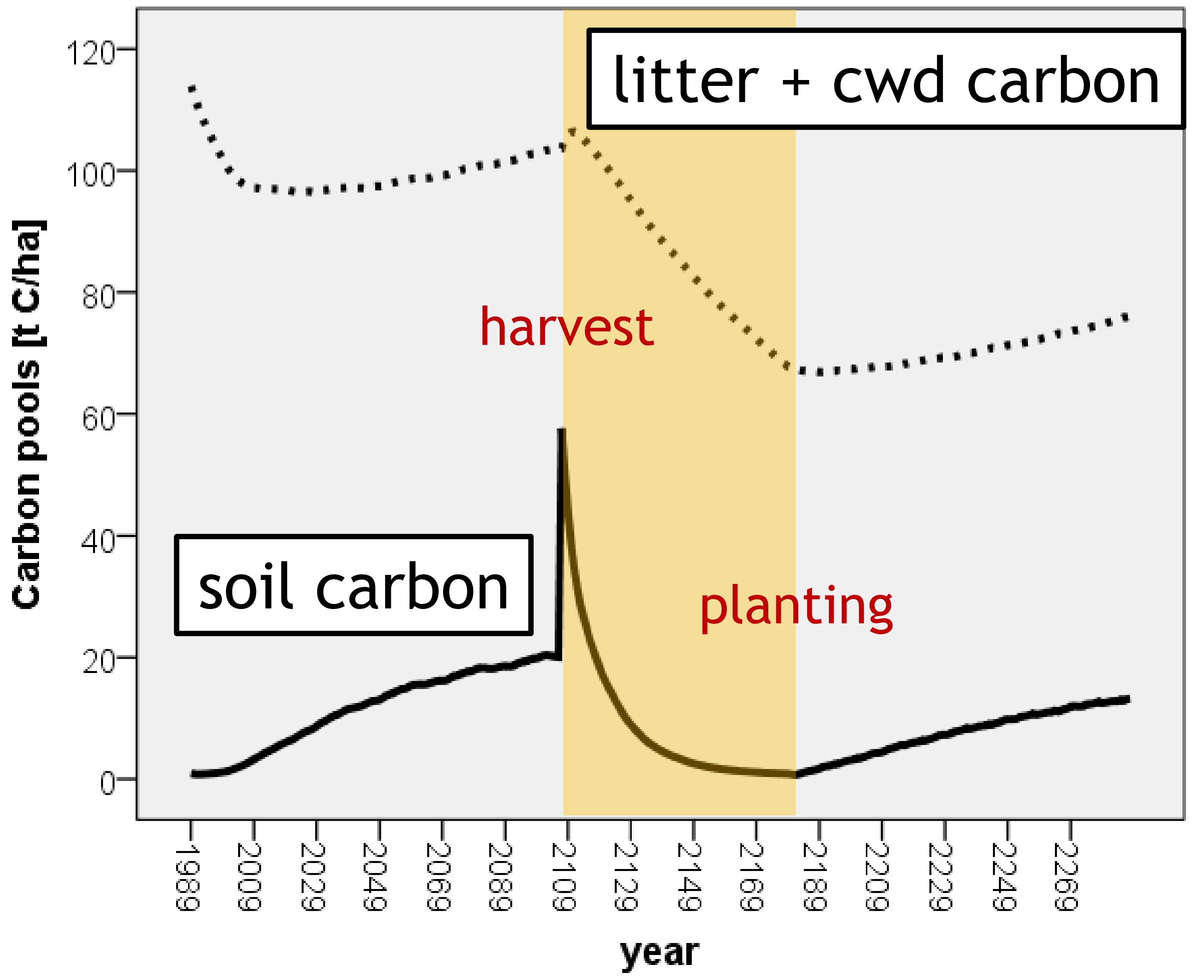


- (fine root : leaf carbon) * shade_fact
- (coarse root : stem carbon) * shade_fact

$$shade\_fact^{v} = \frac{1}{\left(1 + \sum_{i=1}^{v-1} L_p^i / 10\right)}$$

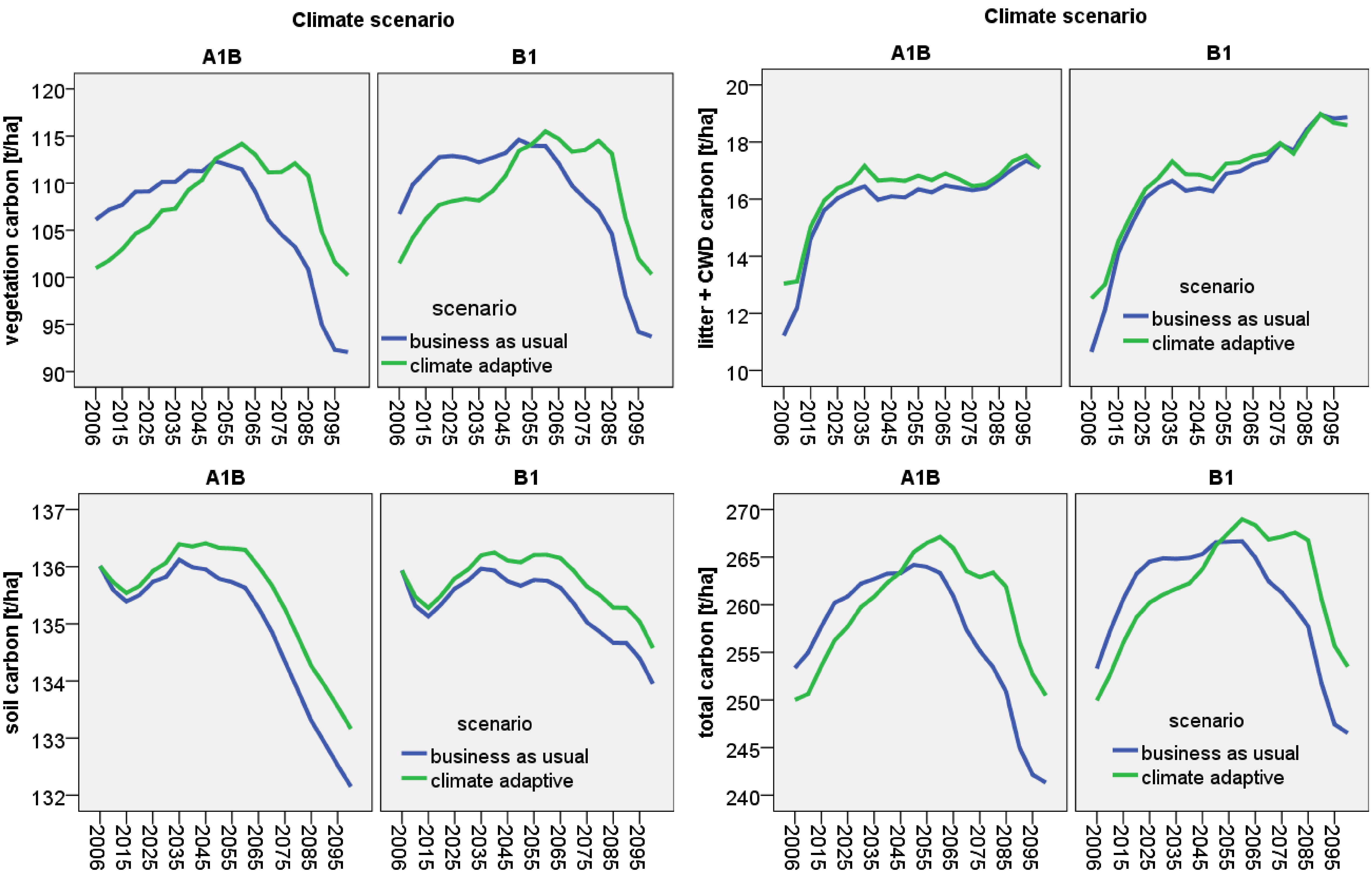
Simulation of shading and clearing



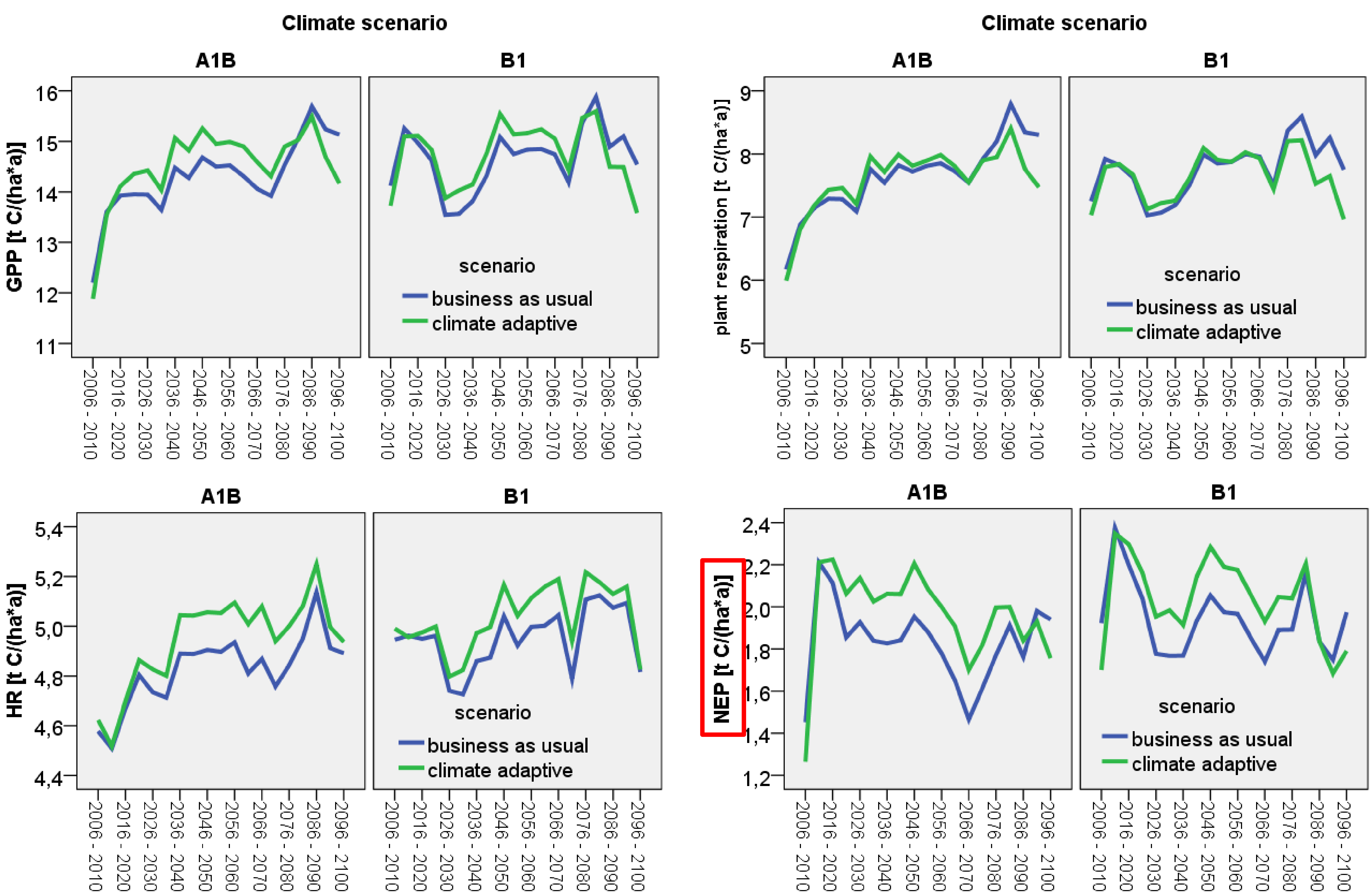


1 vegetation layer → 2 layers → 1 layer Understory layer benefits from removal of overstory layer	1 vegetation layer → 0 layer → 1 layer Litter and soil C become decomposted during deforested period and rise again after planting

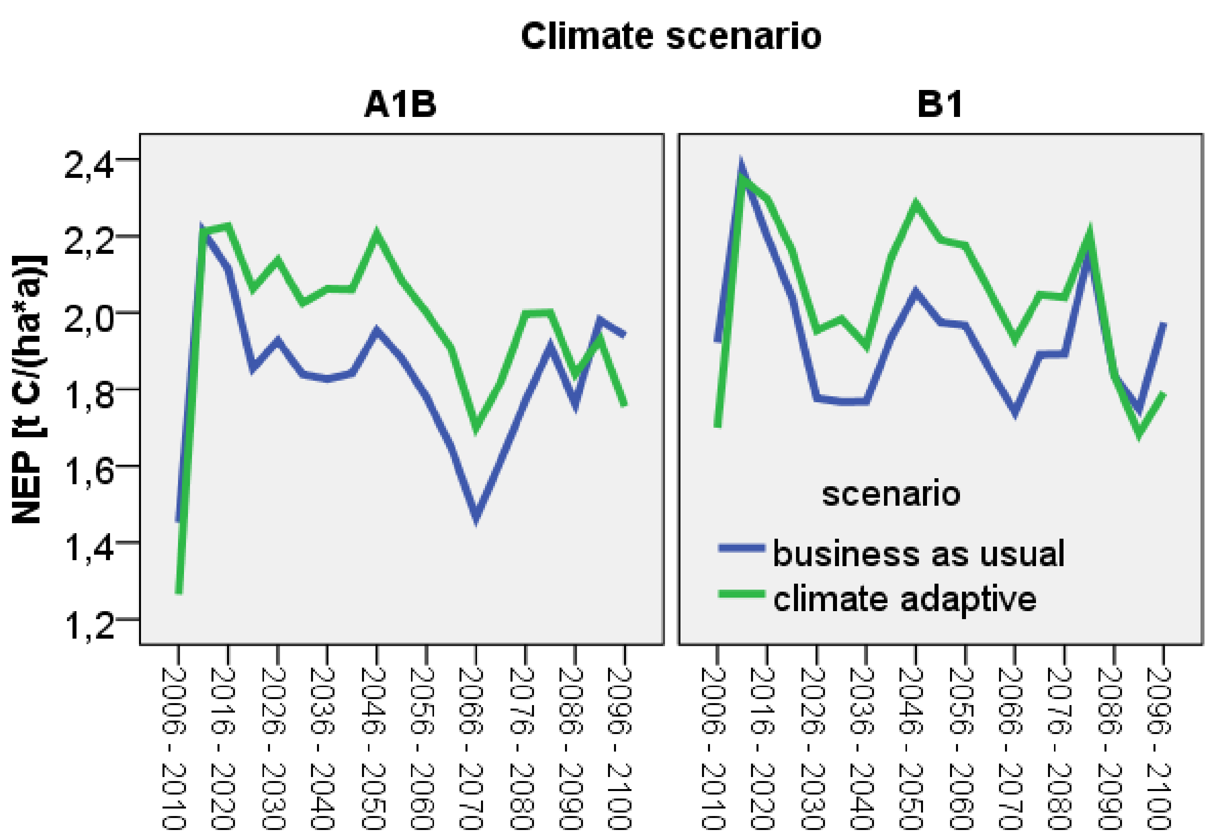
Carbon stocks

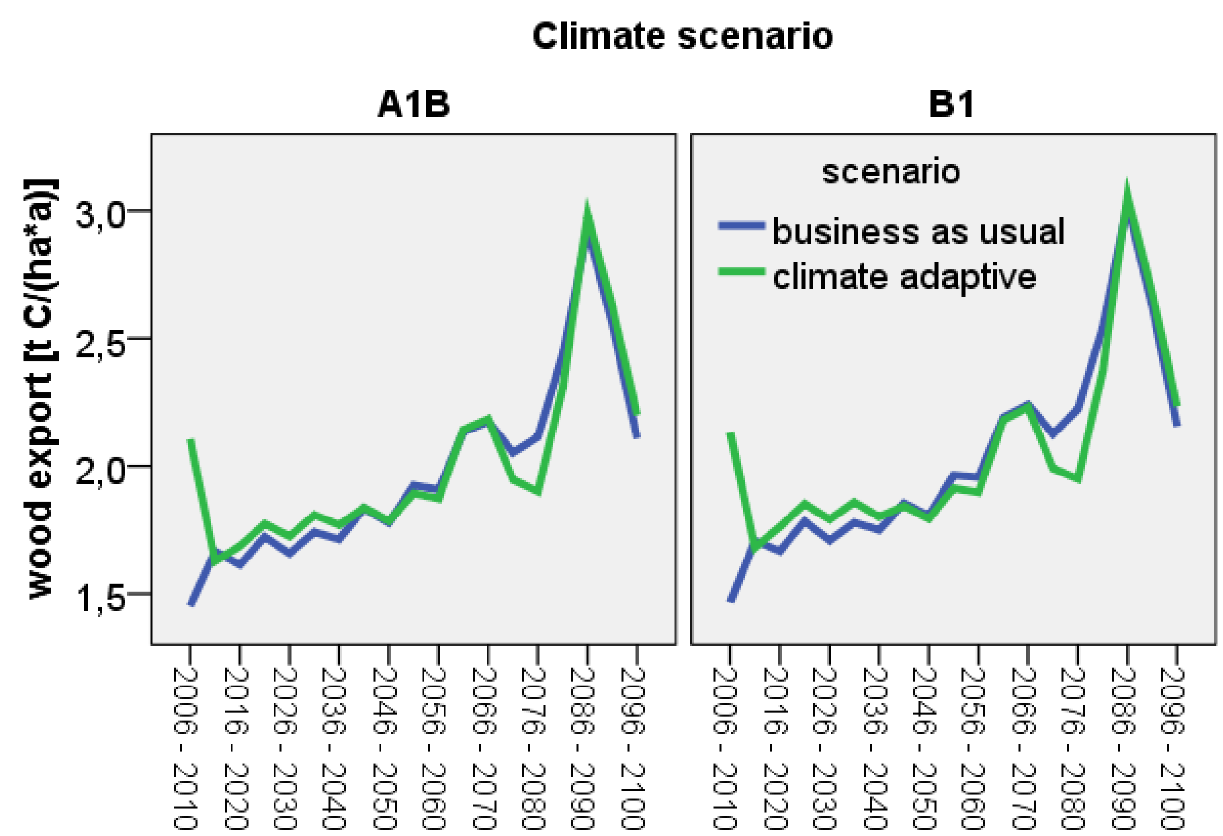


Carbon fluxes

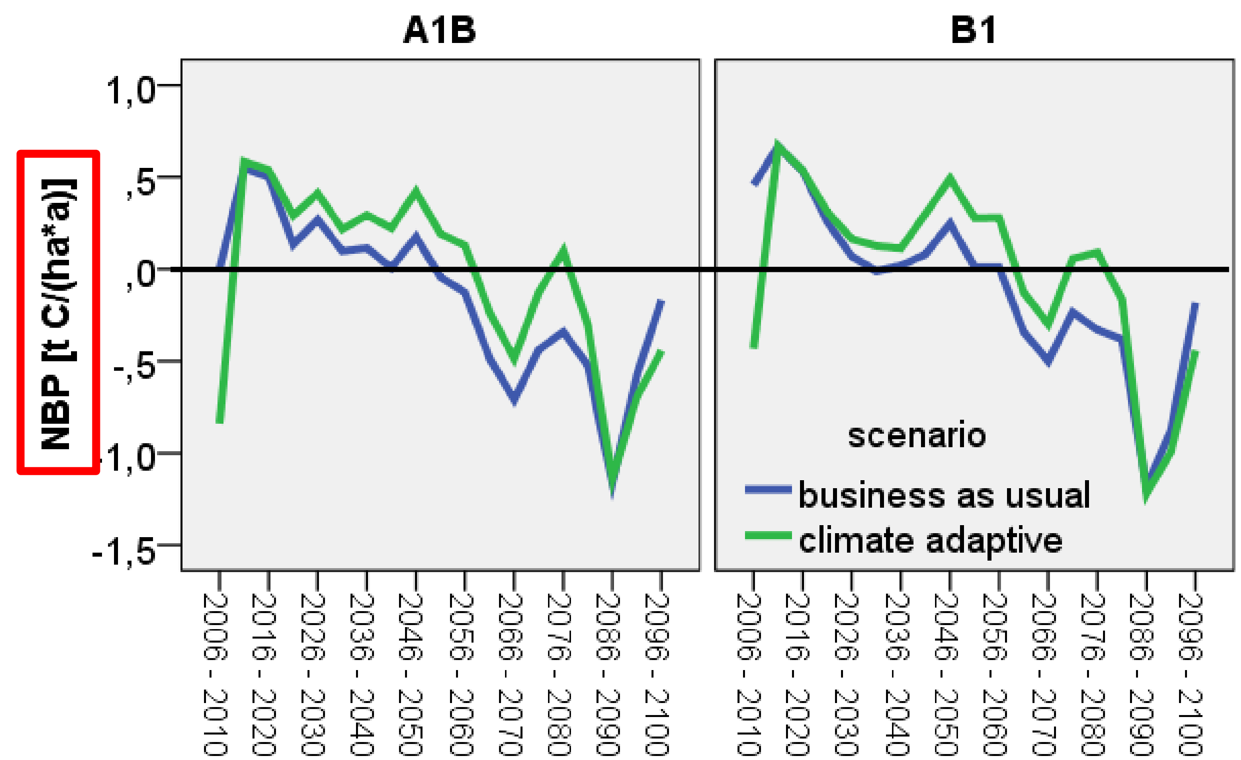


Carbon balance





- Forest conversion leads to
  - increased NEP and NBP between about 2010 and 2090
  - higher carbon stocks after 2050



Outlook

- Improve calibration
- Update regional data and use STARS climate projections

- Optional scenario: effect of a sudden pine decline in 2070
- Is climate adaptation really better than business as usual?

Thank you
for your attention.