

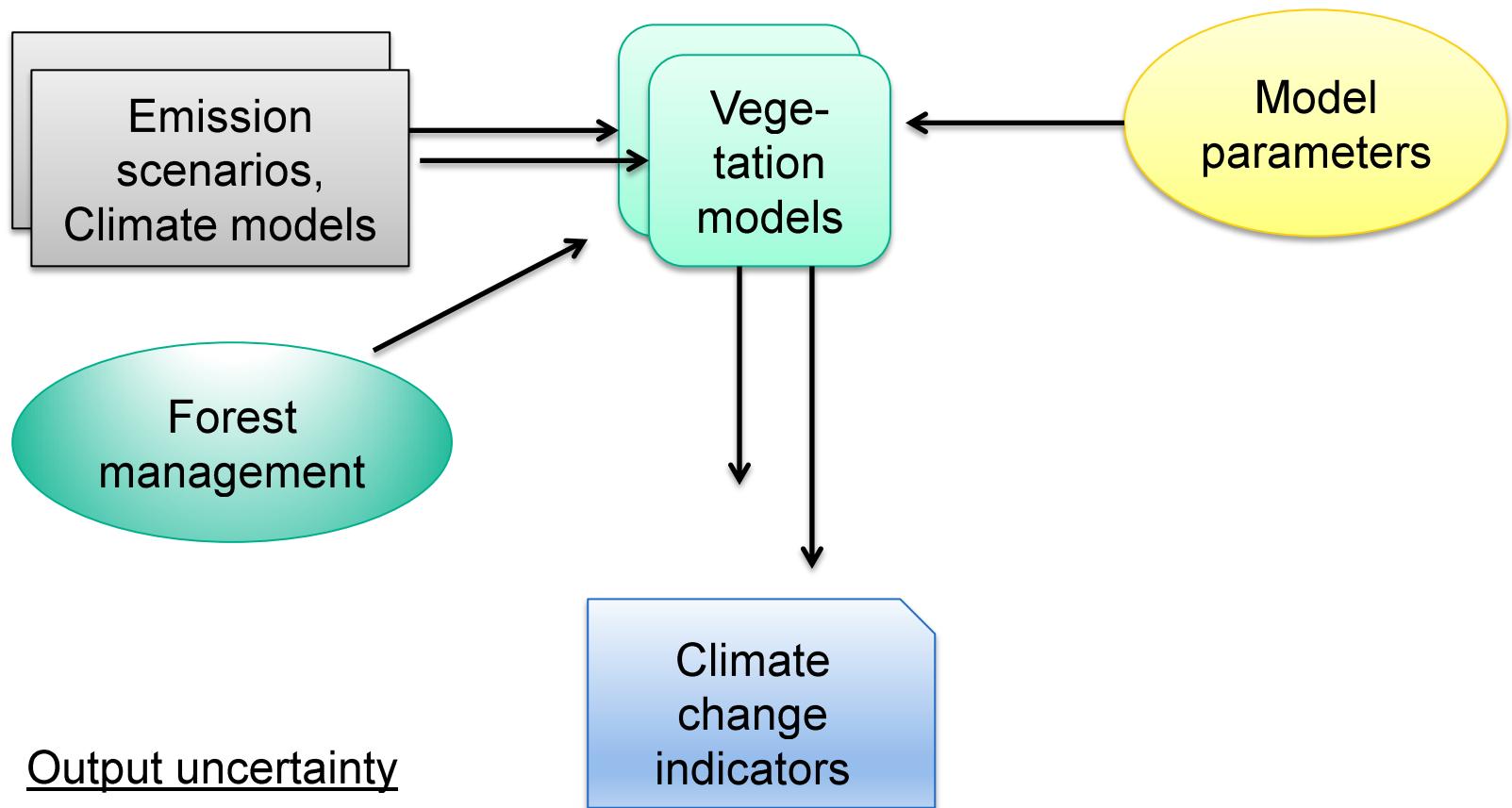
Assessment of uncertainty of climate change indicators

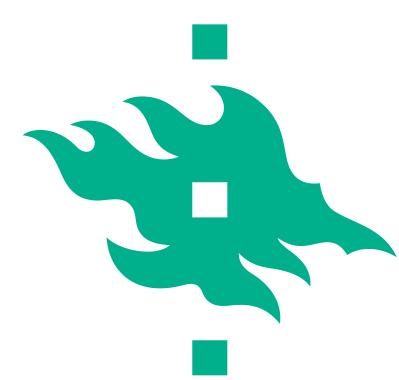
Annikki Mäkelä (Uhel), Francesco Minunno (Uhel), Mikko Peltoniemi (Luke), Tuula Aalto (FMI), Tiina Markkanen (FMI), Jarmo Mäkelä (FMI), Jouni Susiluoto (FMI)

Driver uncertainty

Structural uncertainty

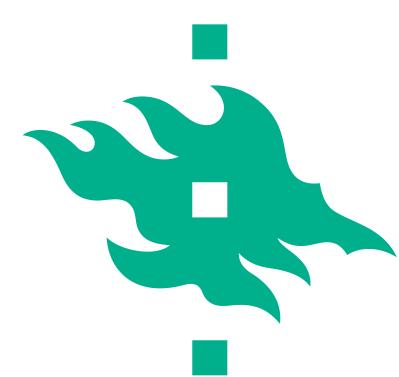
Parameter uncertainty





Simulation setup: General

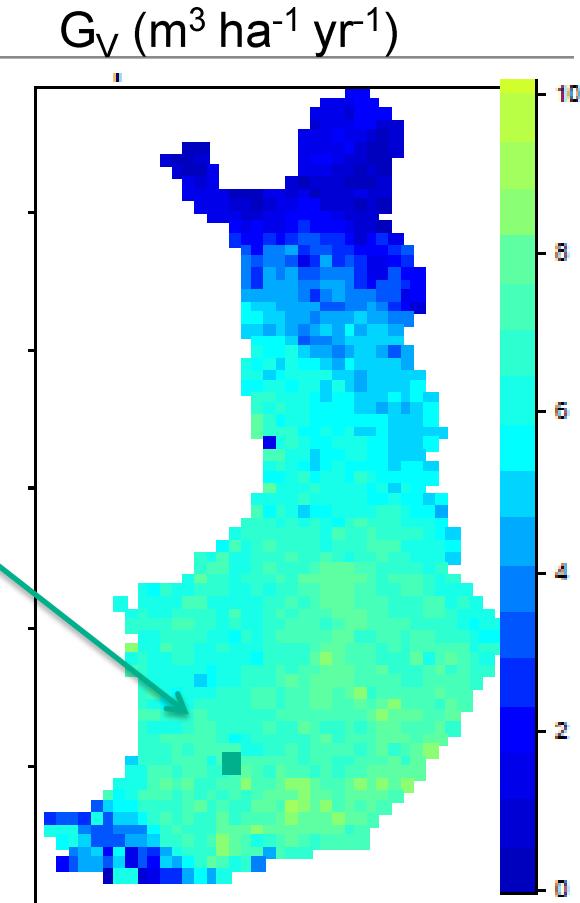
- Two locations: Hyytiälä and Sodankylä
- Driver uncertainty
 - 5 Climate Models
 - 2 Climate Scenarios
 - 3 management scenarios (PREBAS)
- Parameter uncertainty
 - Bayesian calibration of each model
 - Choose 100 parameter vectors from posterior distribution
- Structural uncertainty
 - 2 vegetation models
- Time span: 1980-2010 reference period, 2010 – 2100 transient
- Spatial resolution
 - climate models 0.1×0.2 degrees
 - forest data 16×16 m => $8 \text{ km} \times 8 \text{ km}$ grid



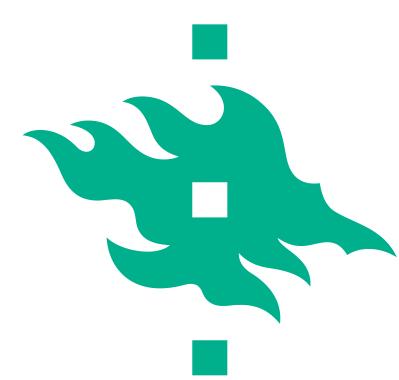
Simulation setup: Forest data - PREBAS

Focus area:

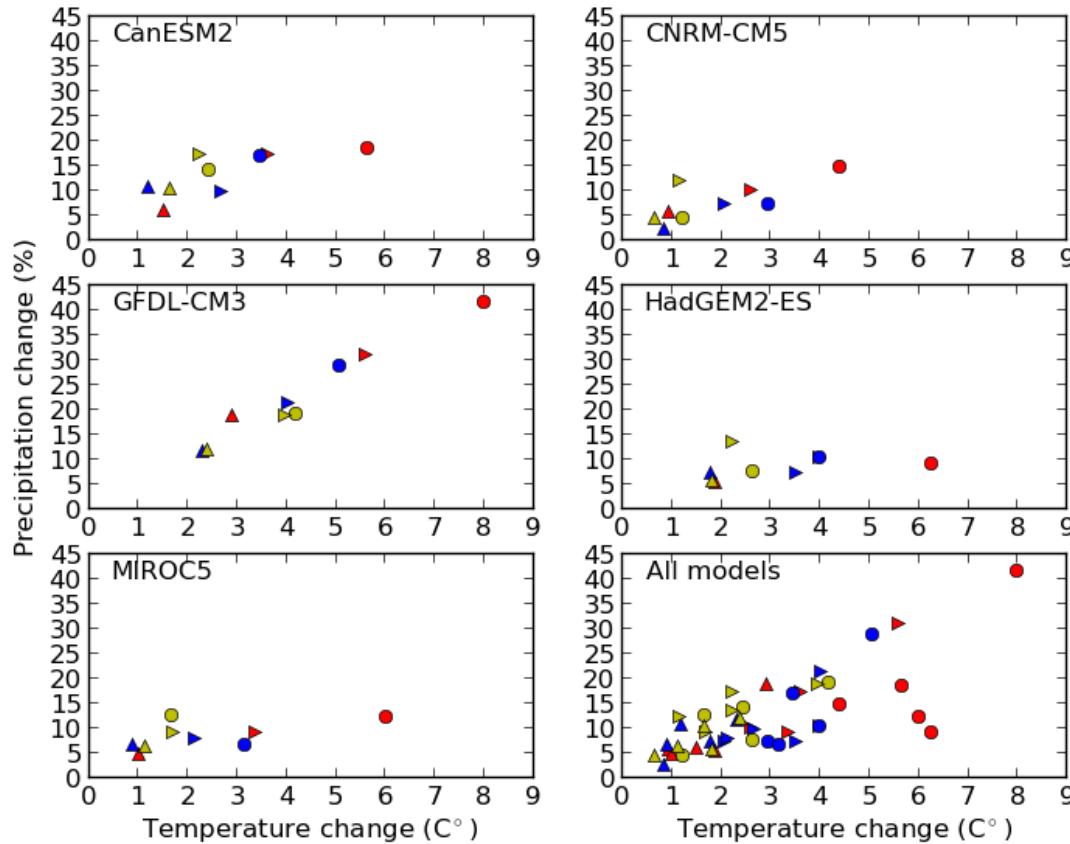
- Typical intensively managed forest area in Finland
 - 8 km x 8 km
 - Initialised with forest data (2013) from 16 meter resolution forest inventory maps
 - Re-initialized forests every 30 year.
- 200 dominant forest categories simulated.



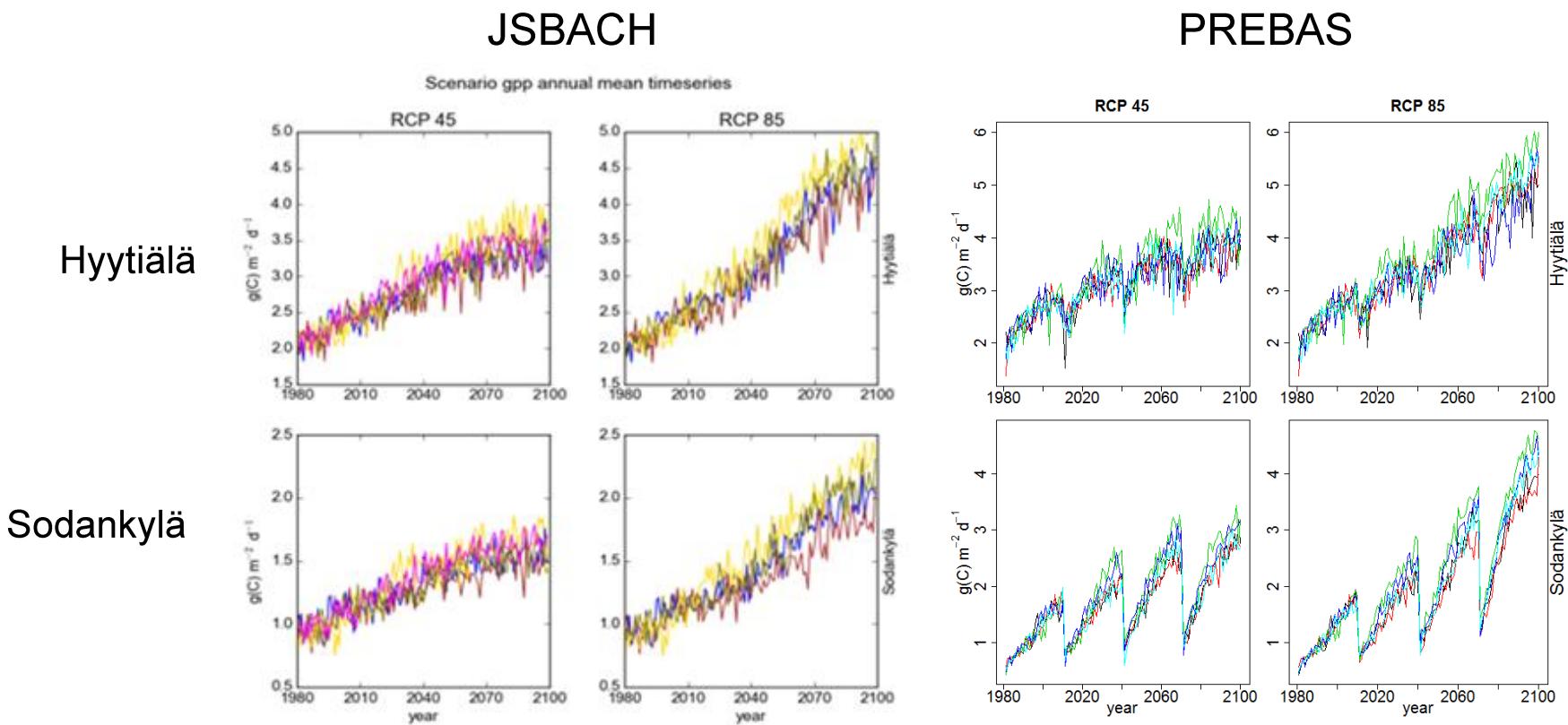
Test period: results of stem growth and harvests correspond to statistics
www



Simulation setup: climate uncertainty



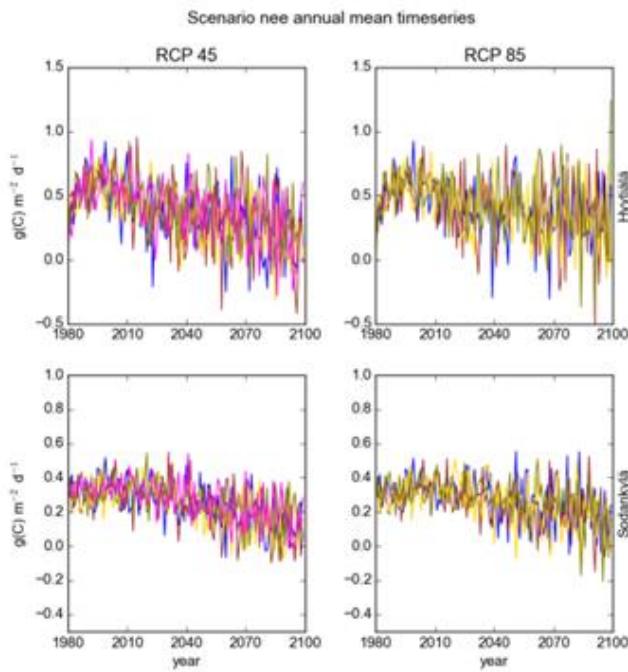
Results: Climate uncertainty: GPP



Results: Climate uncertainty: NEE

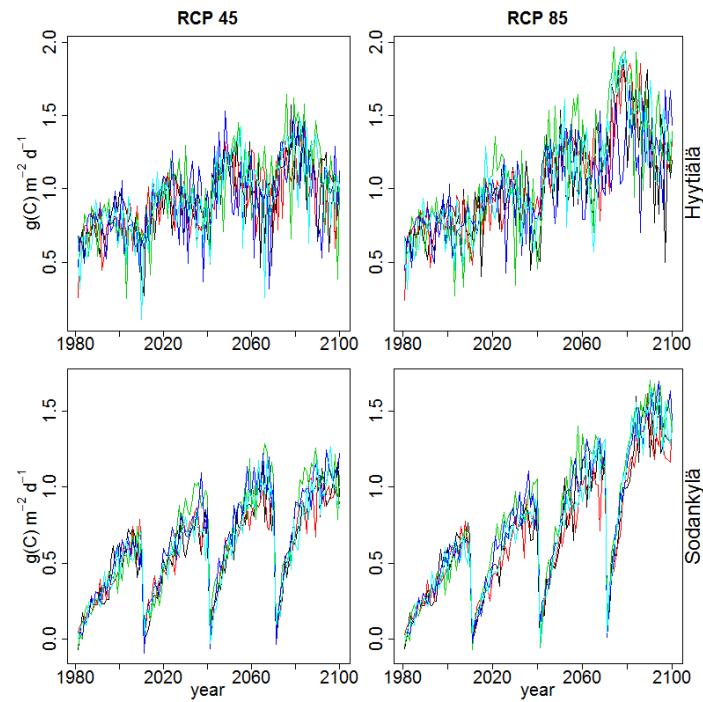
Hyytiälä

JSBACH



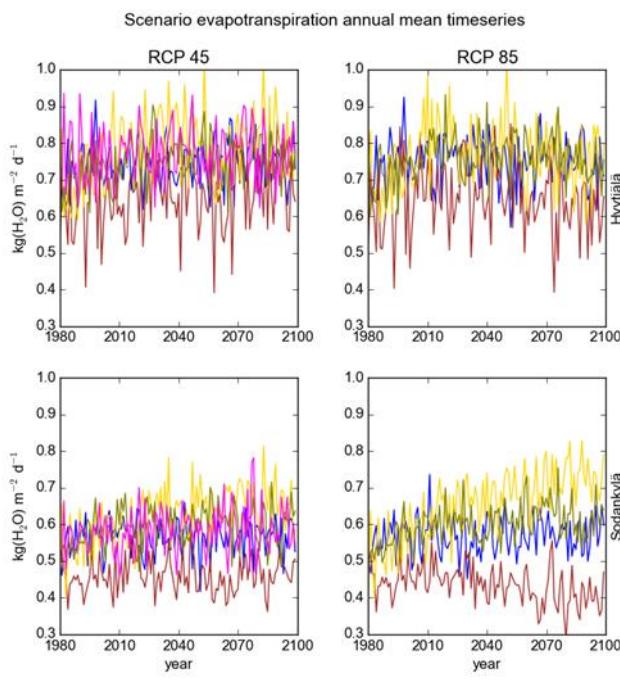
Sodankylä

PREBAS



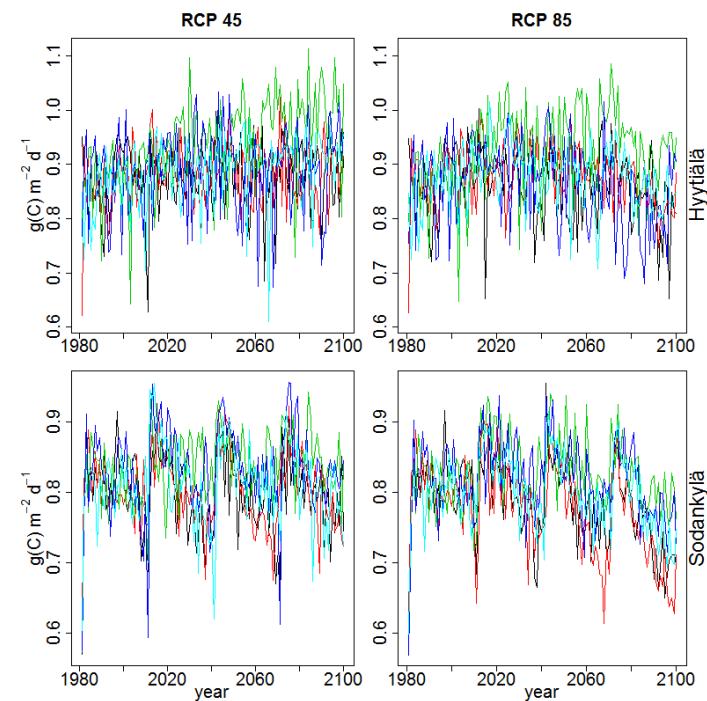
Results: Climate uncertainty: Evapotranspiration

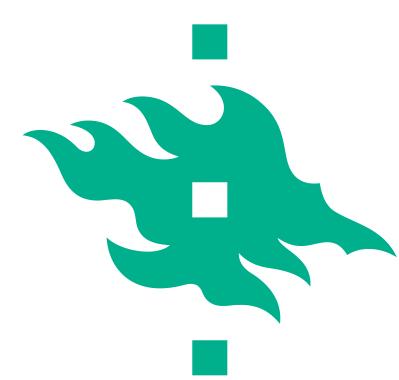
Hyytiälä



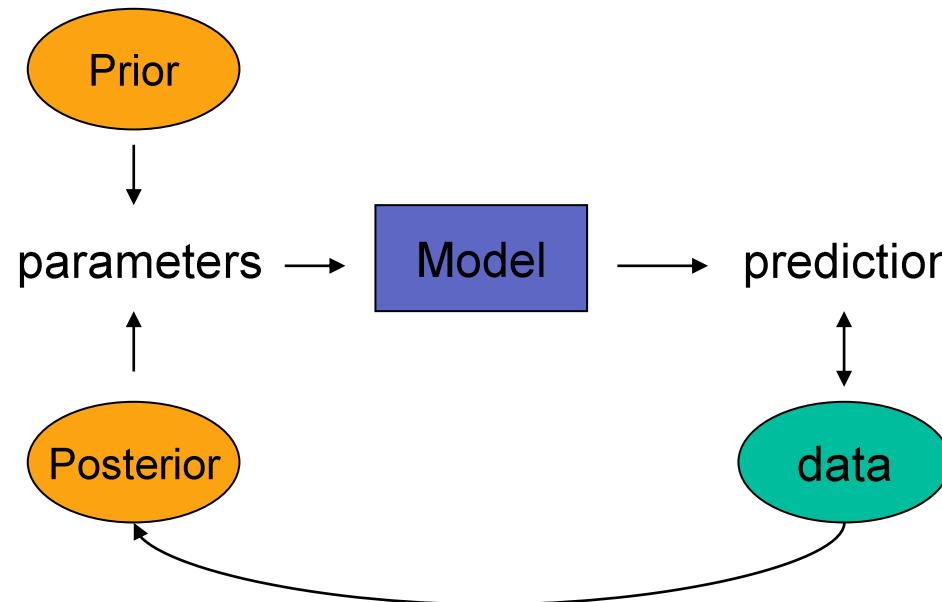
Sodankylä

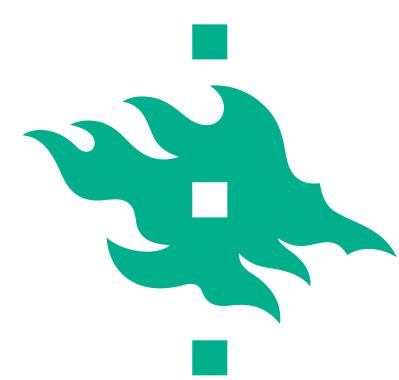
PREBAS



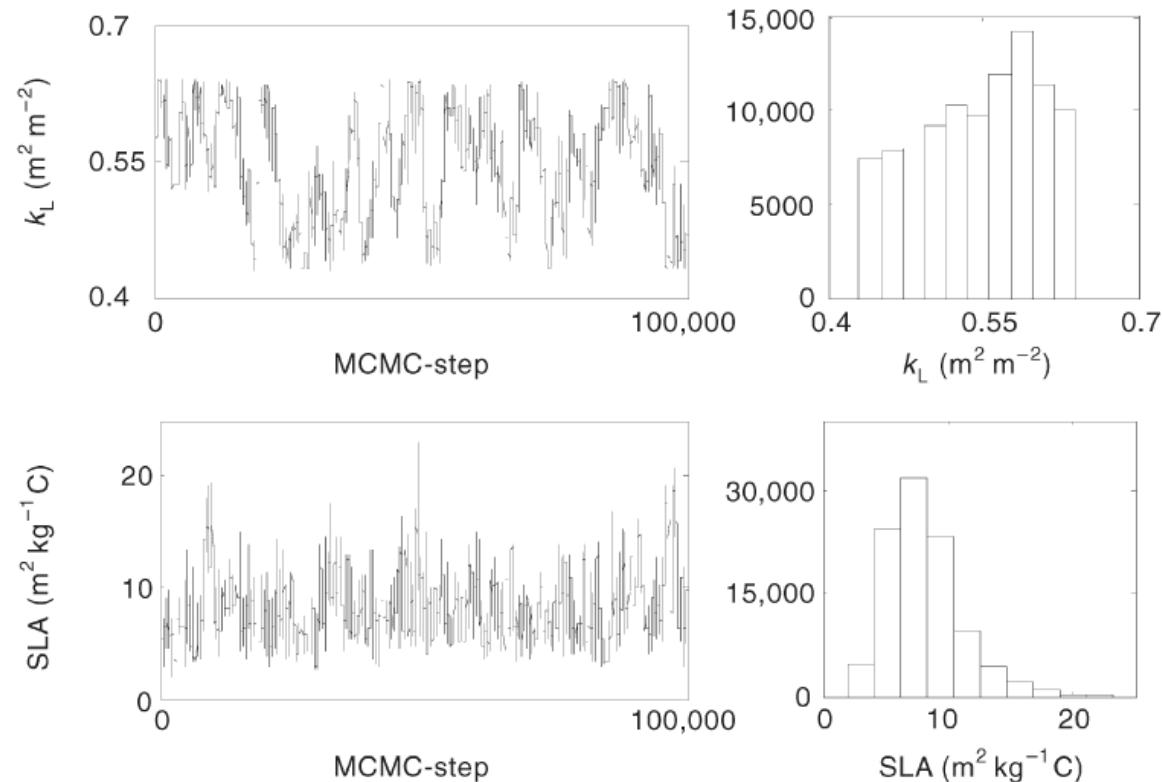


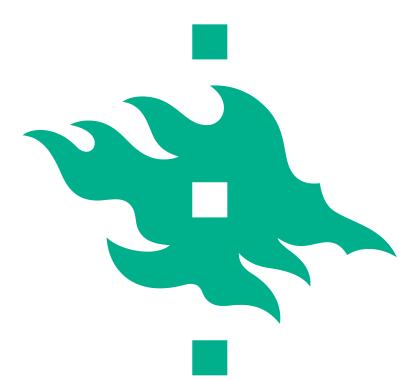
Parameter uncertainty – Bayesian calibration





Parameter uncertainty – Bayesian calibration





Parameter uncertainty – Bayesian calibration

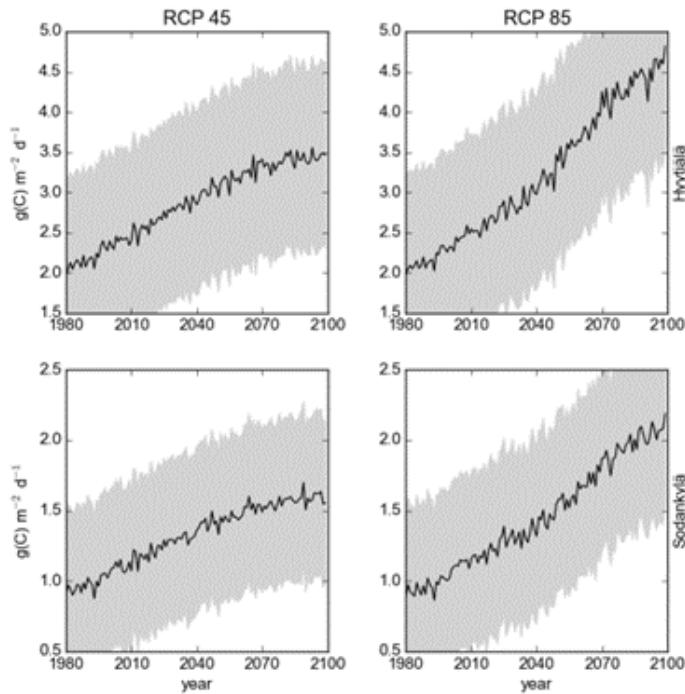
- JSBACH
 - 15 parameters
 - Photosynthesis and hydrology
 - 6 boreal flux sites
- PREBAS
 - All parameters calibrated
 - One module at a time
 - PRELES: 10 boreal flux sites
 - CROBAS: long-term growth experiments
 - YASSO: Tuomi et al. 2011

Results: Parametric uncertainty: GPP

Hyytiälä

JSBACH

Scenario gpp annual mean timeseries

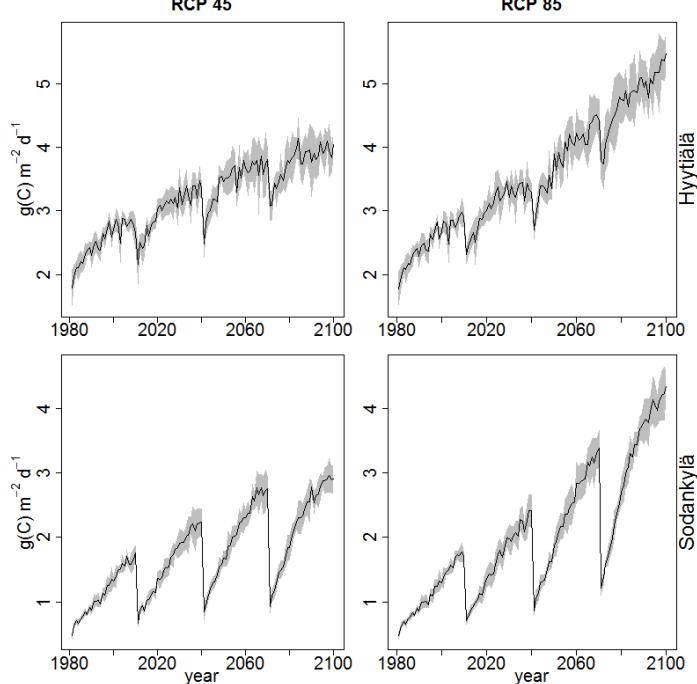


Sodankylä

PREBAS

RCP 45

RCP 85

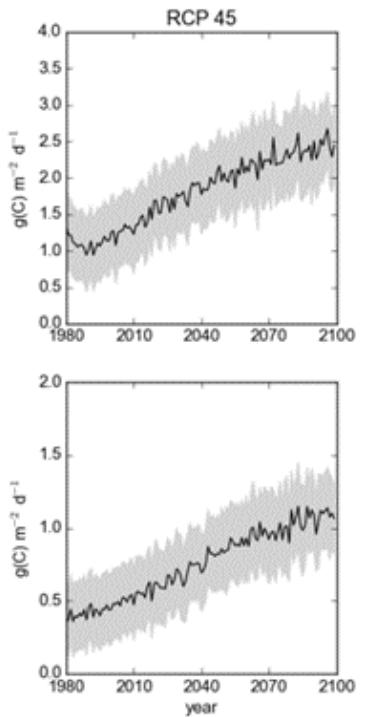


Results: Parametric uncertainty: Soil respiration

Hyytiälä

JSBACH

Scenario soil respiration annual mean timeseries

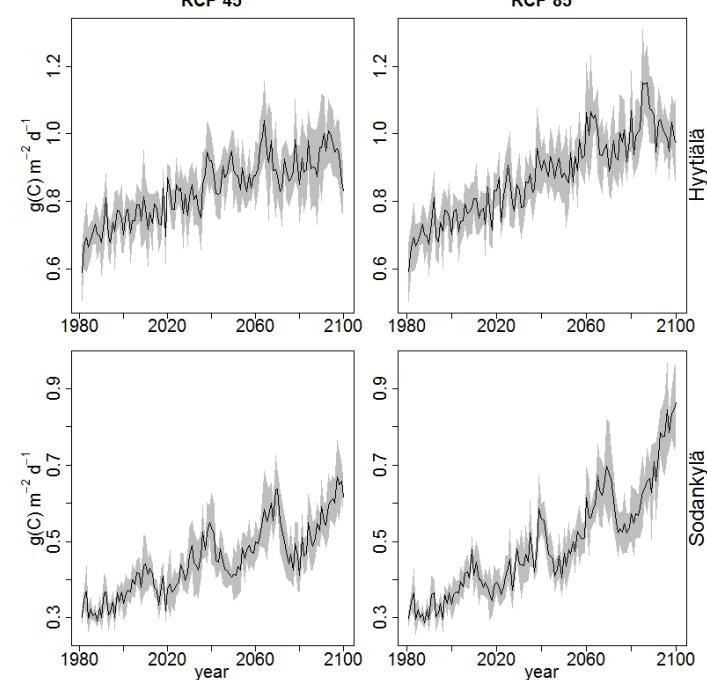


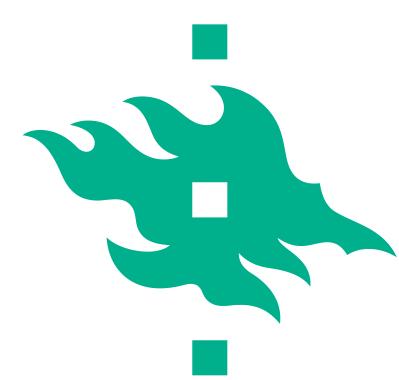
Sodankylä

PREBAS

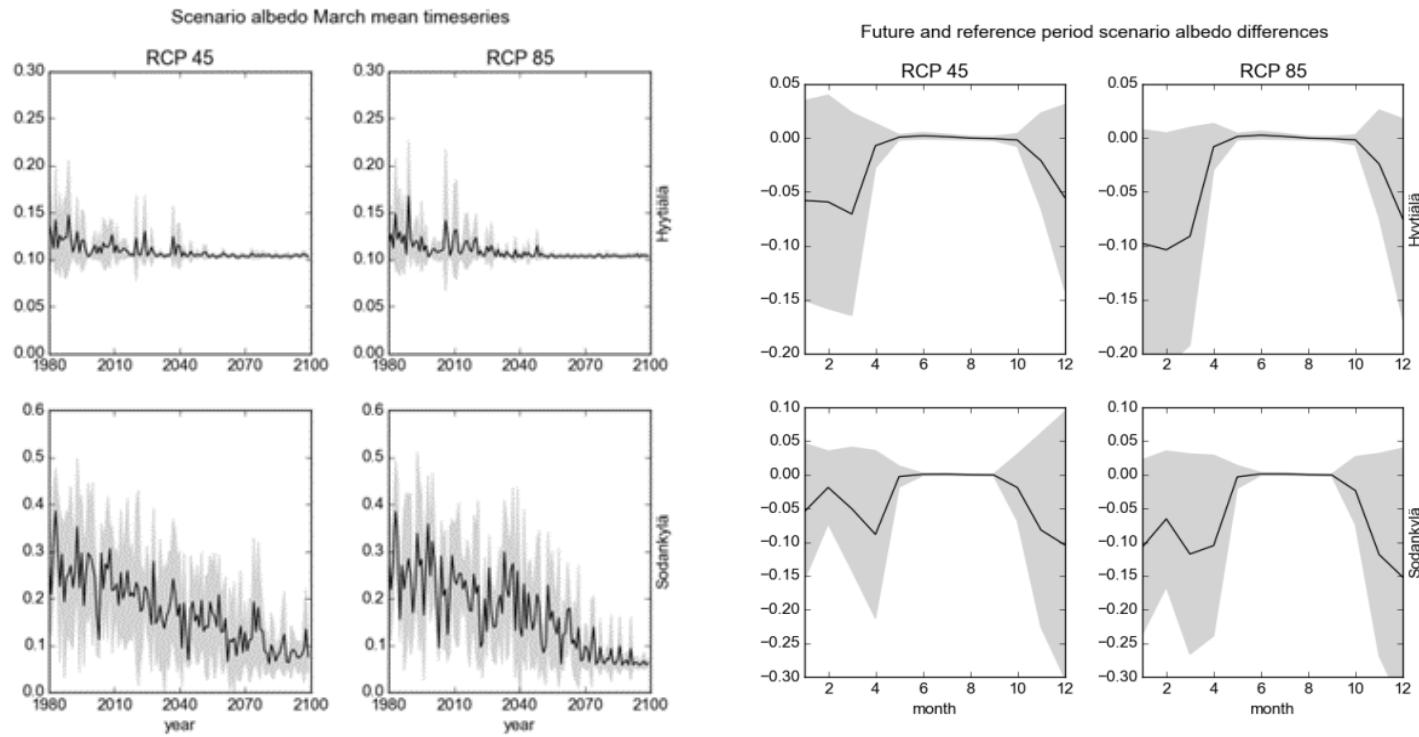
RCP 45

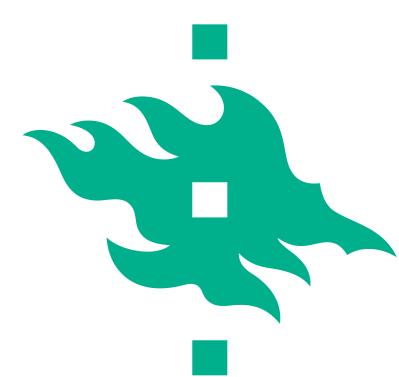
RCP 85





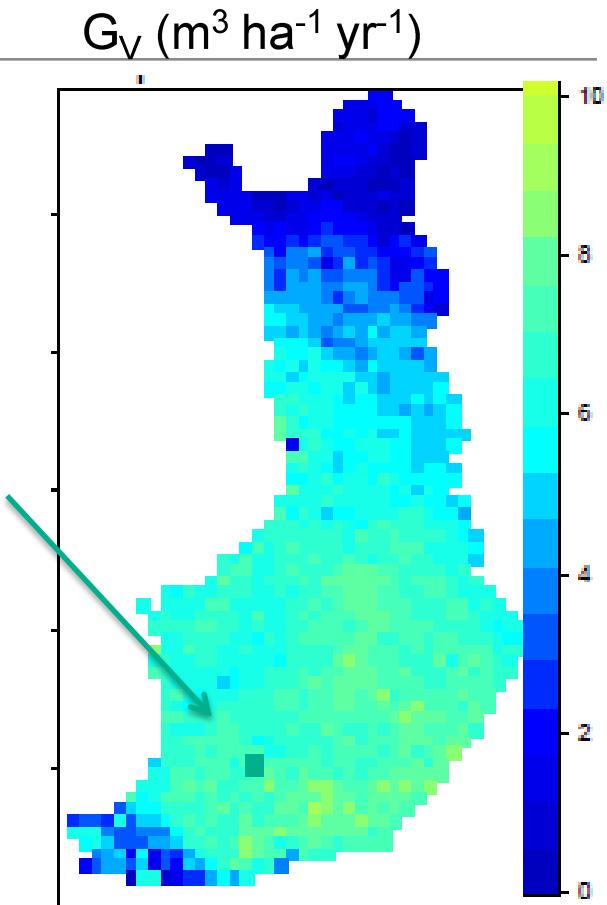
Results: Parametric uncertainty albedo - JSBACH





Simulation setup: Forest data - PREBAS

- Harvest scenarios
 - BAU, harvest @ dbh 24-30 & Age 60-100
 - DEL: Aims at near term C sink increase: Increased harvest dbh (@36cm @30% prob)
 - NAT: Reference, no harvests

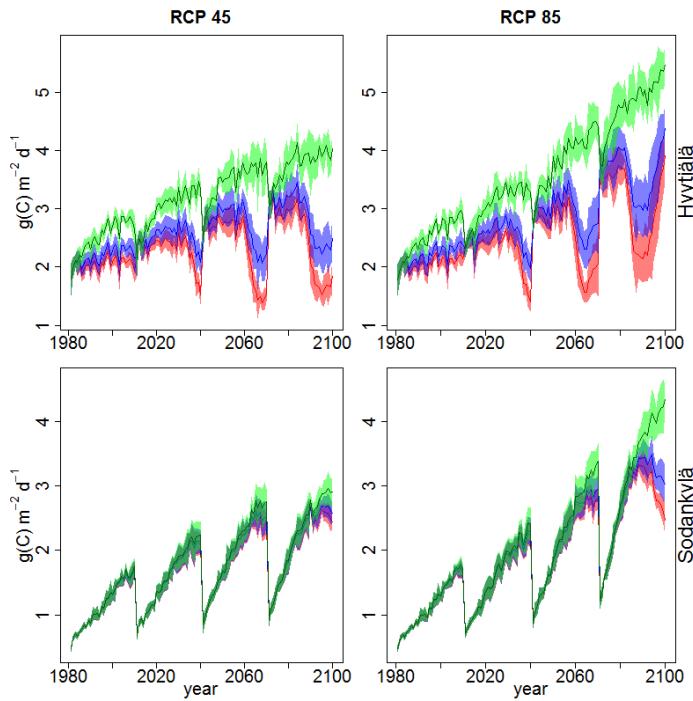


Test period: results of stem growth and harvests correspond to statistics
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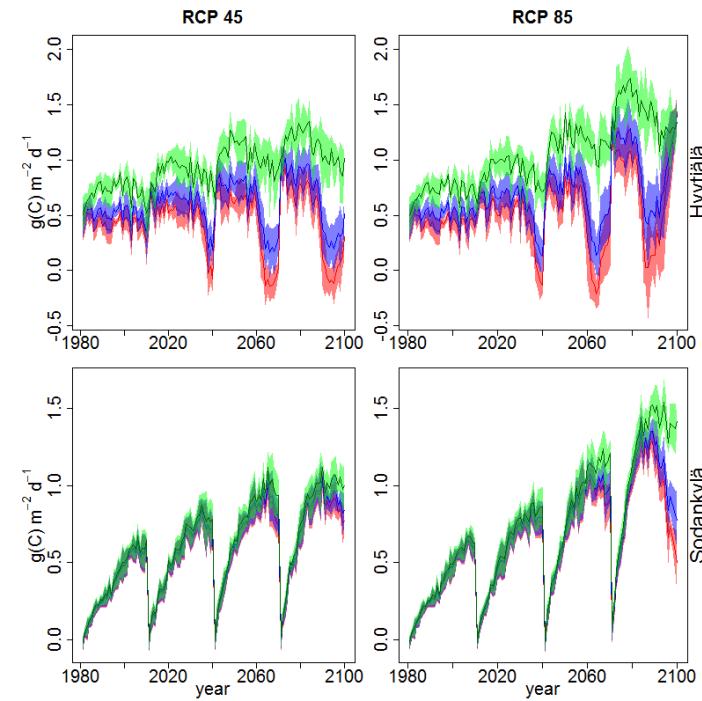
Results: Management - PREBAS

Hyytiälä

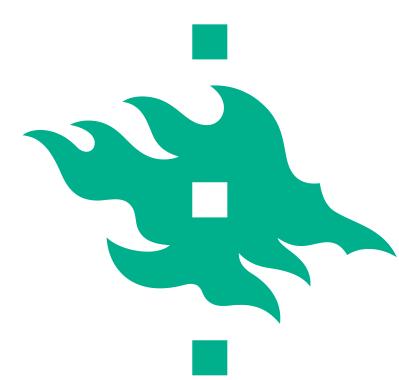
GPP



NEE



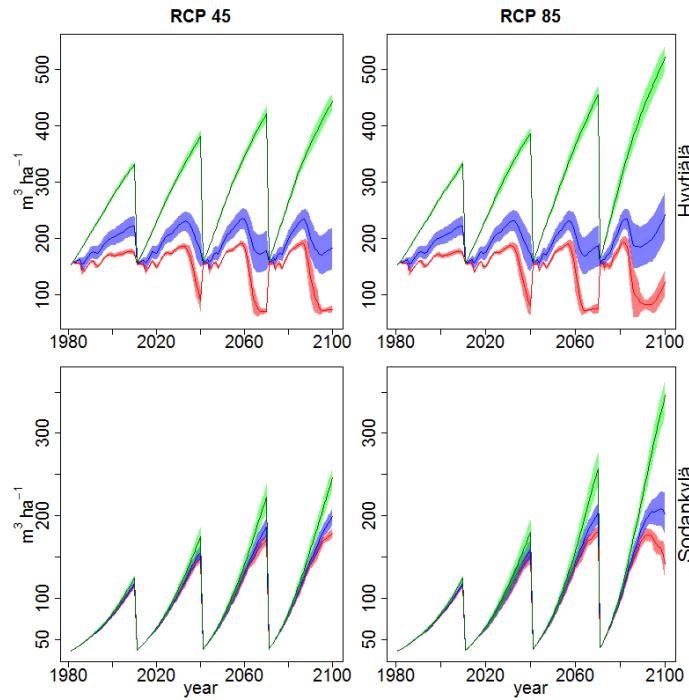
Sodankylä



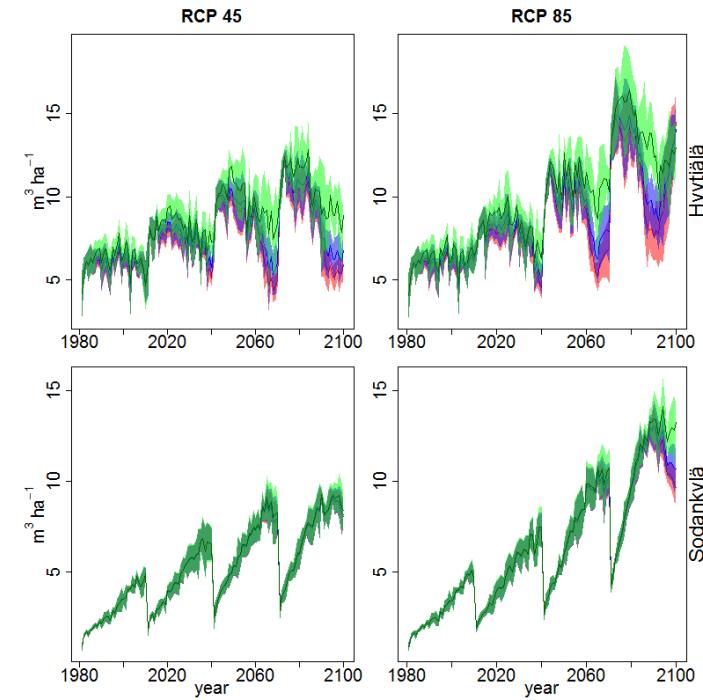
Results: Management - PREBAS

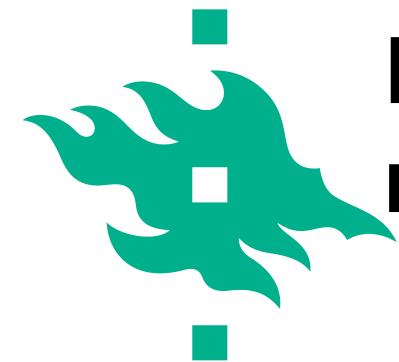
Hyytiälä

Volume

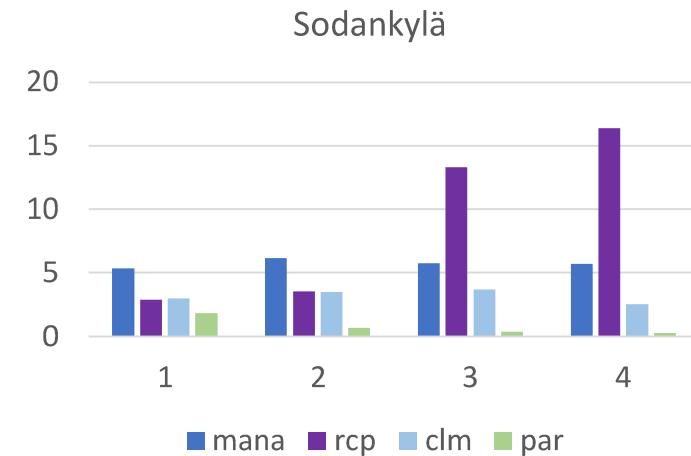
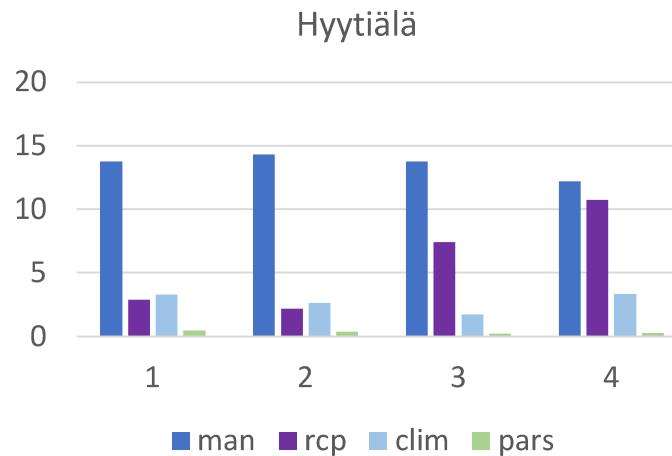


Gross growth



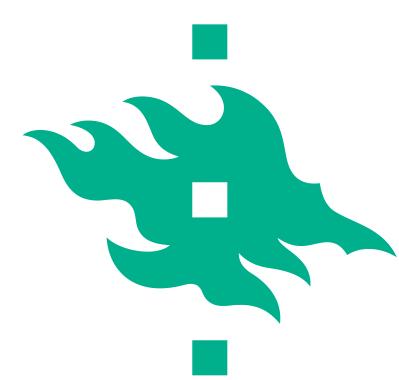


Relative significance of climate vs management? - PREBAS



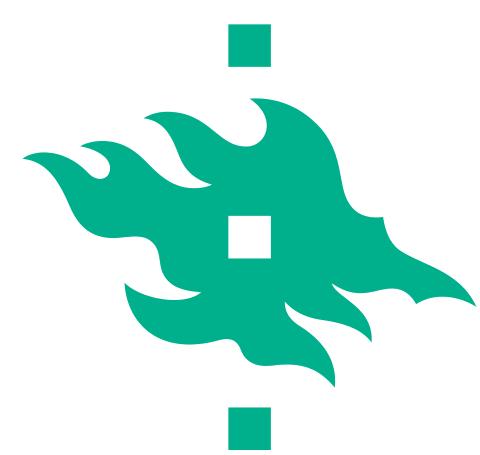
- 22 output variables were considered
- Canonical sensitivity analysis

- Climate dependent:
 - Potential photosynthesis, phenology
- Management dependent:
 - Stand characteristics



Conclusions and outlook

- Climate uncertainty
 - Similar in both models
 - Scenario more important than climate model
- Parameter uncertainty
 - Relatively small – depends on data used but assumes correct model
- Management
 - Significant especially in southern Finland
- Structural uncertainty
 - Shows in NEE
 - Related to description of vegetation dynamics
 - Needs further research



Thank you!

