POTSDAM INSTITUTE FOR CLIMATE IMPACT RESEARCH

P I K

Locally adapted stand-scale forest management alternatives for the 21st century

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Managing forests in the 21st century - 03.03.2020, Potsdam

Leibniz Association

objectives

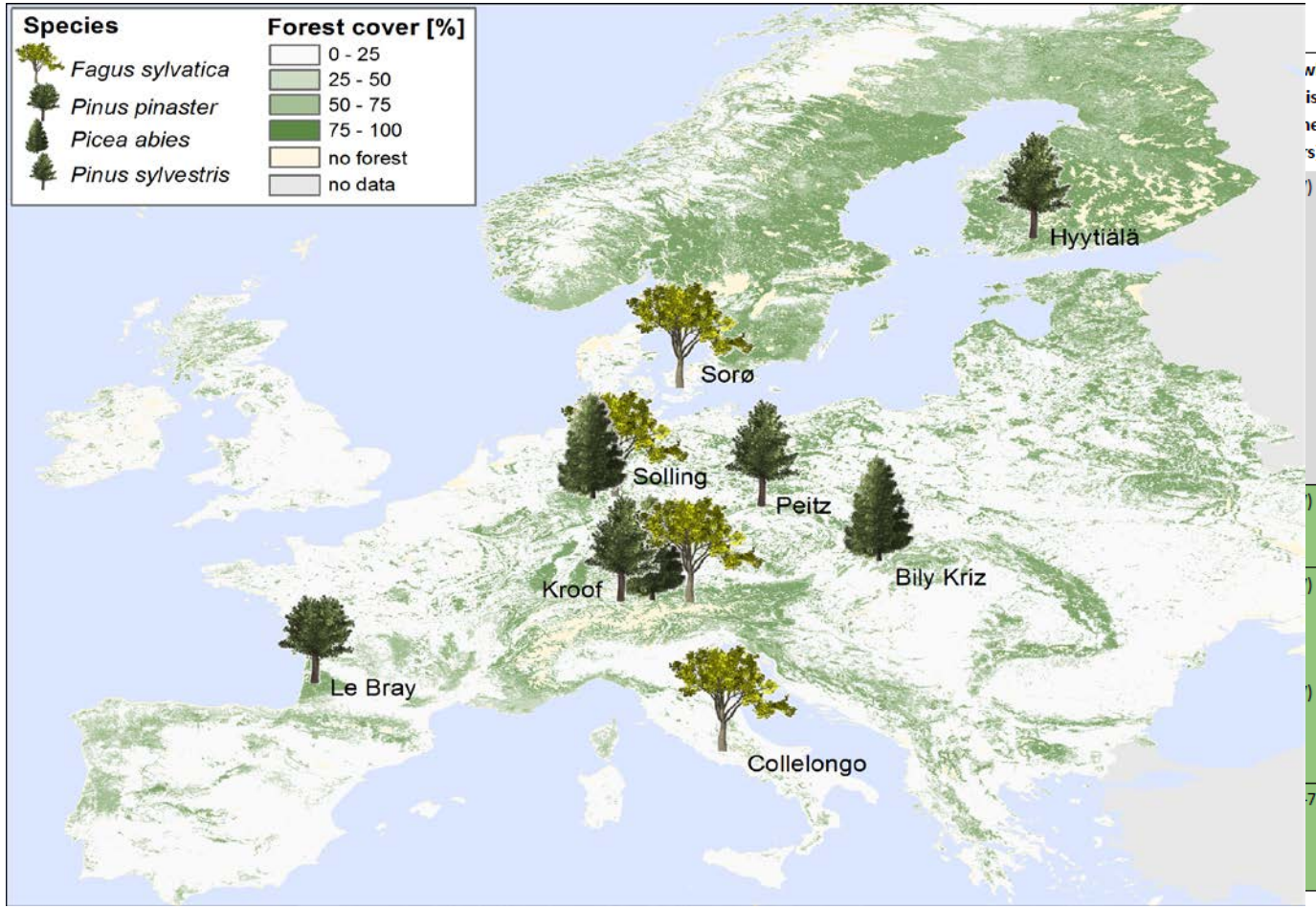
- **FORMASAM: development** of locally adapted stand scale **alternative forest management systems**

- investigate distinct **alternative management scenarios** for their climate change **mitigation potential**
- analyse the **interacting effects of climate change and forest management on** forest dynamics

FORMASAM management scenarios

- **9 typical European forest stands across** (PROFOUND DB, Reyer et al. 2019)

- **local expertise** for the contruction of realistic alternative management systems
- management definition by **rotation period**, **thinning regime**, **harvest type**, **planting**



when is ned s]	Remarks
)	regenerate as pure pisy stand
	allow any NR of species formerly present on plot
)	regenerate as pure pisy stand
)	regenerate as pure pisy stand
)	regenerate as pure pisy stand
7)	regenerate as pure pisy stand

FORMASAM management scenarios

Table 23: Detailed FORMASAM management schedule for Hyytiälä. Ini = Initialization data, HM = Historic Management, FM = Future Management, TB=Thinning from below, TA = Thinning from above, H= Harvest, P=Planting

Name	Ini	HM	FM1	FM2	FM3	FM4	FM5	FM6	FM7	FM8	FM9	FM10	FM11	FM12	FM13	FM14	FM15	FM16	FM17	FM18	FM19	Remarks
Current generic	1995	1996-2011	2026	2041	2056	2071	2086	2101	2102	2117	...	2242	2243	2258	...							Only simulate pine and spruce (no hard-woods) and regenerate as pure pine stand.
		TB	TB20	TB20	TB20	TB20	TB20	H	P	TB20	TB20	H	P	TB20	TB20							
Current Site-specific	1995	1996-2011	2031	2051	2052	2072	2102	2122	2142	2143	2163	2193	2213	2233	2234	2254	2284	2304				
		TB	TA20	H	P	TB20	TB20	TA20	H	P	TB20	TB20	TA20	H	P	TB20	TB20	TA20				
Bioenergy	1995	1996-2011	2021	2022	2042	2082	2083	2103	2143	2144	2164	2204	2205	2225	2265	2266	2286	2326				
		TB	H	P	TB25	H	P	TB25	H	P	TB25	H	P	TB25	H	P	TB25	H				
HWP	1995	1996-2011	2031	2071	2081	2082	2102	2132	2152	2192	2202	2203	2223	2253	2273	2313						
		TB	TA10	TA10	H	P	TB10	TB10	TA10	TA10	H	P	TB10	TB10	TA10	TA10						
Multifunctional-Adapted	1995	1996-2011	2021	2041	2042	2062	2082	2102	2122	2123	2143	2163	2183	2203	2204	2224	2244	2264	2284	2285	2305	
		TB	TA20	H	P	TB20	TB20	TA20	H	P	TB20	TB20	TA20	H	P	TB20	TB20	TA20	H	P	TB20	

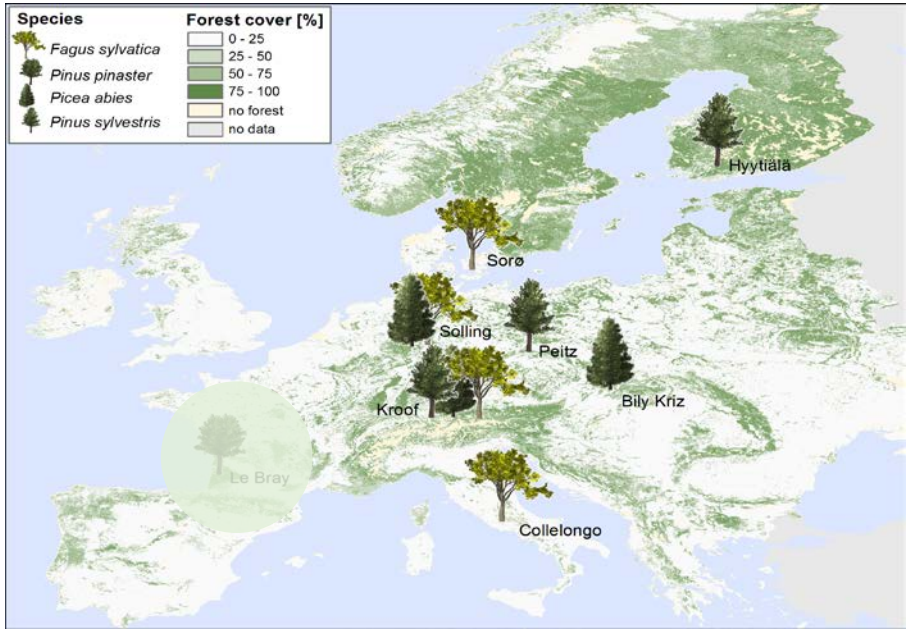
FORMASAM management scenarios

	current site specific (CSS)		**bioenergy focussed (BE)**		**harvested wood products (HWP)**		**multifunctionally adapted (MFA)**		**no management (noMan)**	
	deciduous	coniferous	deciduous	coniferous	deciduous	coniferous	deciduous	coniferous	deciduous	coniferous
silvicultural system	shelterwood / even-aged clearcut	even-aged clearcut	even-aged clearcut / shelterwood	even-aged clearcut	even-aged clearcut / shelterwood	even-aged clearcut	even-aged clearcut	even-aged clearcut / shelterwood	-	-
rotation length	97.5 years	107 years	**70 (-27.5) years**	**62 (-45) years**	**105 (+7.5) years**	**118 (+11) years**	90 (-7.5) years	110 (+3) years	-	-
mean thinning return period	12 years	17 years	**21 (+9) years**	**27 (+10) years**	**14 (+2) years**	**20 (+3) years**	11 (-1) years	17 (+-0) years	-	-
mean thinning intensity	19 % BA	19 % BA	**21 (+2) % BA**	**25 (+6) % BA**	**18 (-1) % BA**	**13 (-6) % BA**	19 (+-0) % BA	15 (-4) % BA	-	-
thinning regime	above-below / below-above	below / above-below / below-above	below / above	below	below-above / above	above / below-above	below-above / above-below	above / below-above / above-below	-	-
harvest type	stem only	stem only	**stem + branches (+ stumps)**	**stem + branches (+ stumps)**	stem only	stem only	stem only	stem only	-	-
species	*Fagus sylvatica*	*Pinus sylvestris, Picea abies*	*Fagus sylvatica*	*Pinus sylvestris, Picea abies*	*Fagus sylvatica*	*Pinus sylvestris, Picea abies*	***Fagus sylvatica, Pseudotsuga meziesii, Betula pendula, Picea abies, Sorbus aucparia, Quercus pubescens***	***Picea abies, Pinus sylvestris, Fagus sylvatica, Abies alba, Quercus robur, Betula pendula, Sorbus aucuparia***	*Fagus sylvatica*	*Pinus sylvestris Picea abies*

simulation setup

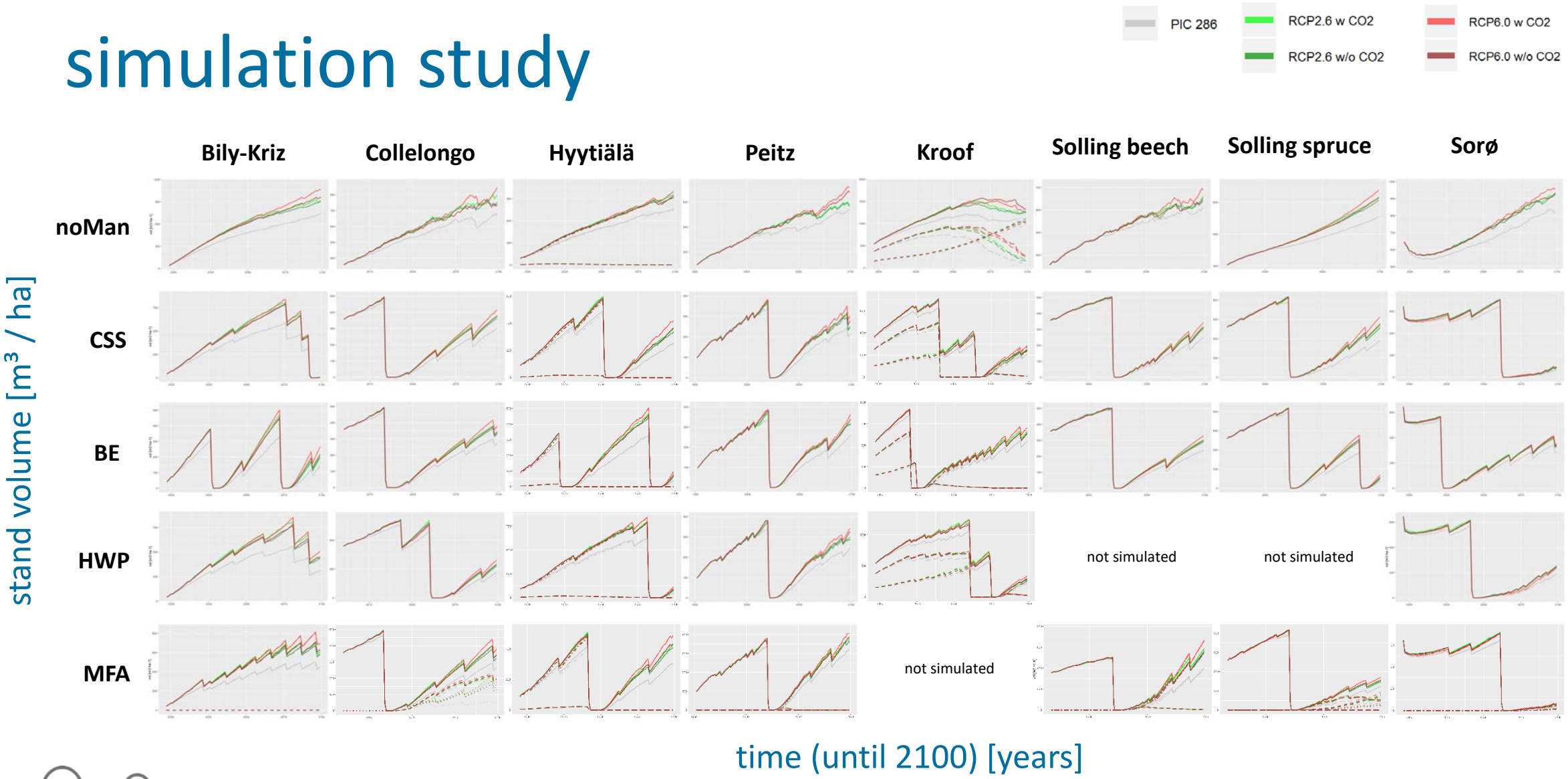
ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

- 8 sites simulated across Europe with alternative management scenarios
- 4-5 locally-adapted management scenarios
- simulation period: 1944-1997 to 2100



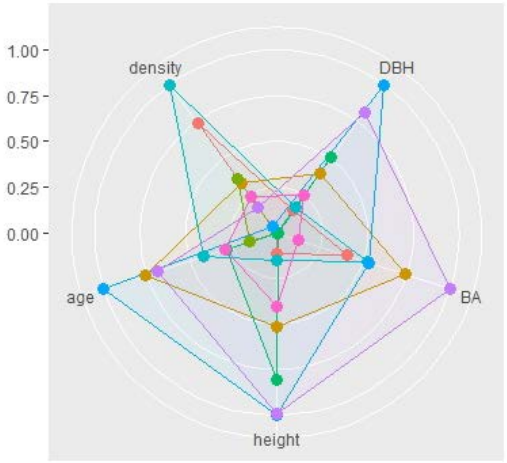
GCMs		climate scenarios		FORMASAM management scenarios
IPSL		**RCP 2.6** with CO2 fertilization (**w CO2**)		**noMan**: no management (control)
GFDL	X	**RCP 2.6** without CO2 fertilization (**w/o CO2**)	X	**CSS**: current site-specific (BAU)
MIROC5		**RCP 6.0** with CO2 fertilization (**w CO2**)		**BE**: bioenergy (mitigation)
		RCP 6.0 without CO2 fertilization (**w/o CO2**)		**HWP**: harvested wood products (mitigation)
		pre-industrial control with CO2 fixed at 286 ppm		**MFA**: multifunctionally adapted (adaptation)

simulation study

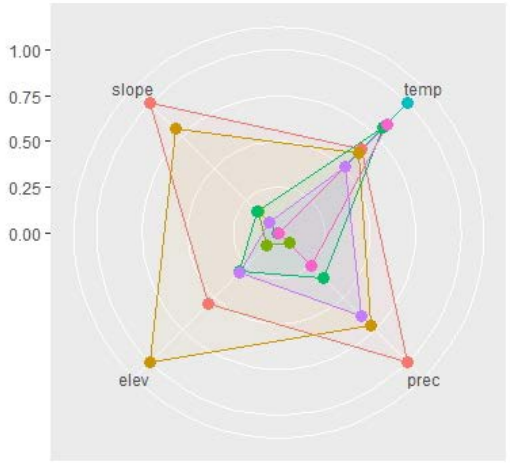


climate change effects on productivity

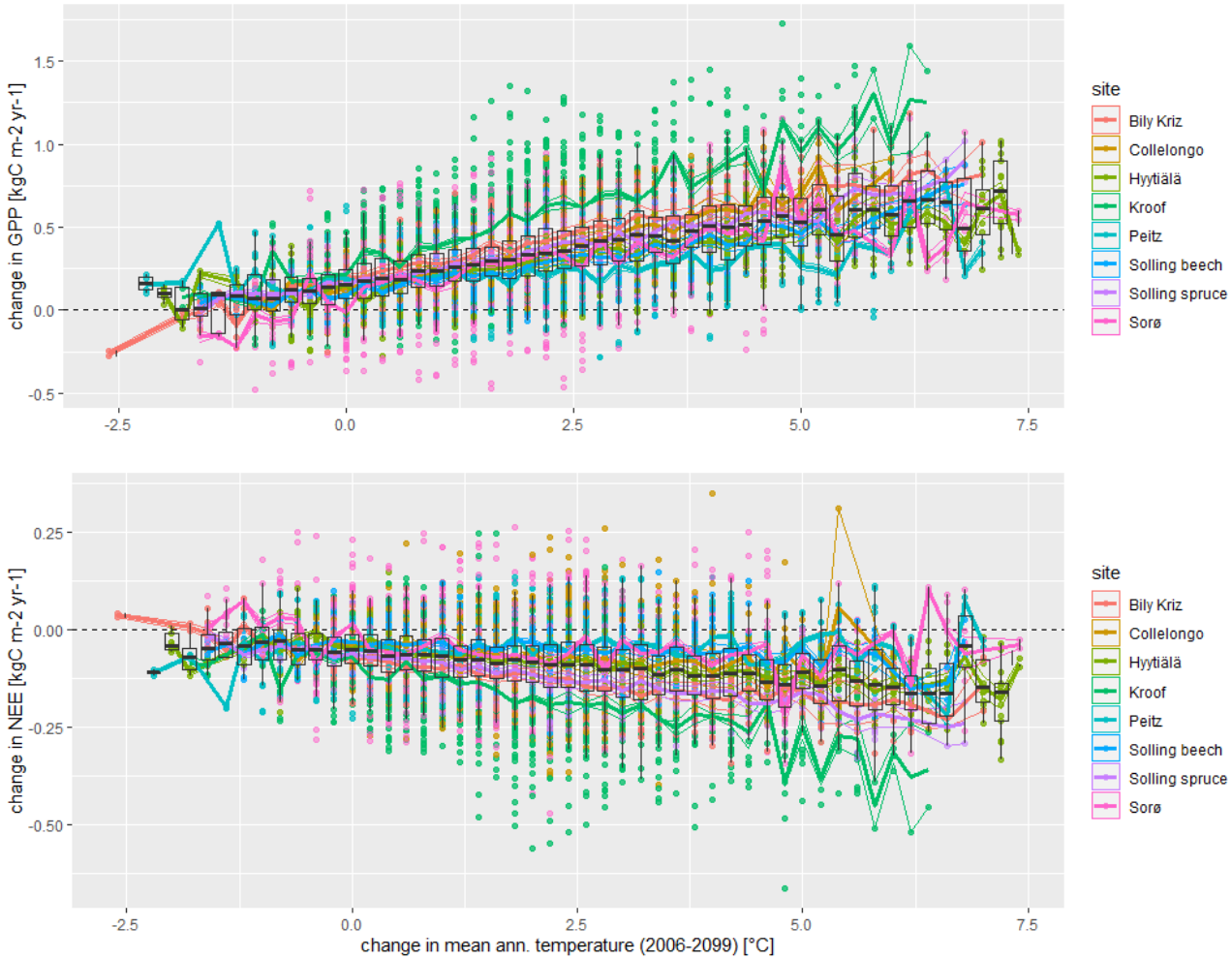
- increase in **gross productivity** with temperature increase
- small **ecosystem productivity** increase despite increased **respiration**



stand description



site description



mitigation potential and harvest rate

- **allocation of net ecosystem production into carbon pools / harvest is moderated by management**
- potential substitution effects from harvested products

conclusions

- the **managment system affects** the **net ecosystem productivity** as well as **allocation of assimilated carbon to carbon pools** in the forest
- net ecosystem productivity increase needs to be considered in the light of potential water or nitrogen limiting conditions

- **outlook**: analysis of harmonized simulations from FORMASAM model ensemble


Thank you and be prepared to hear more on this…
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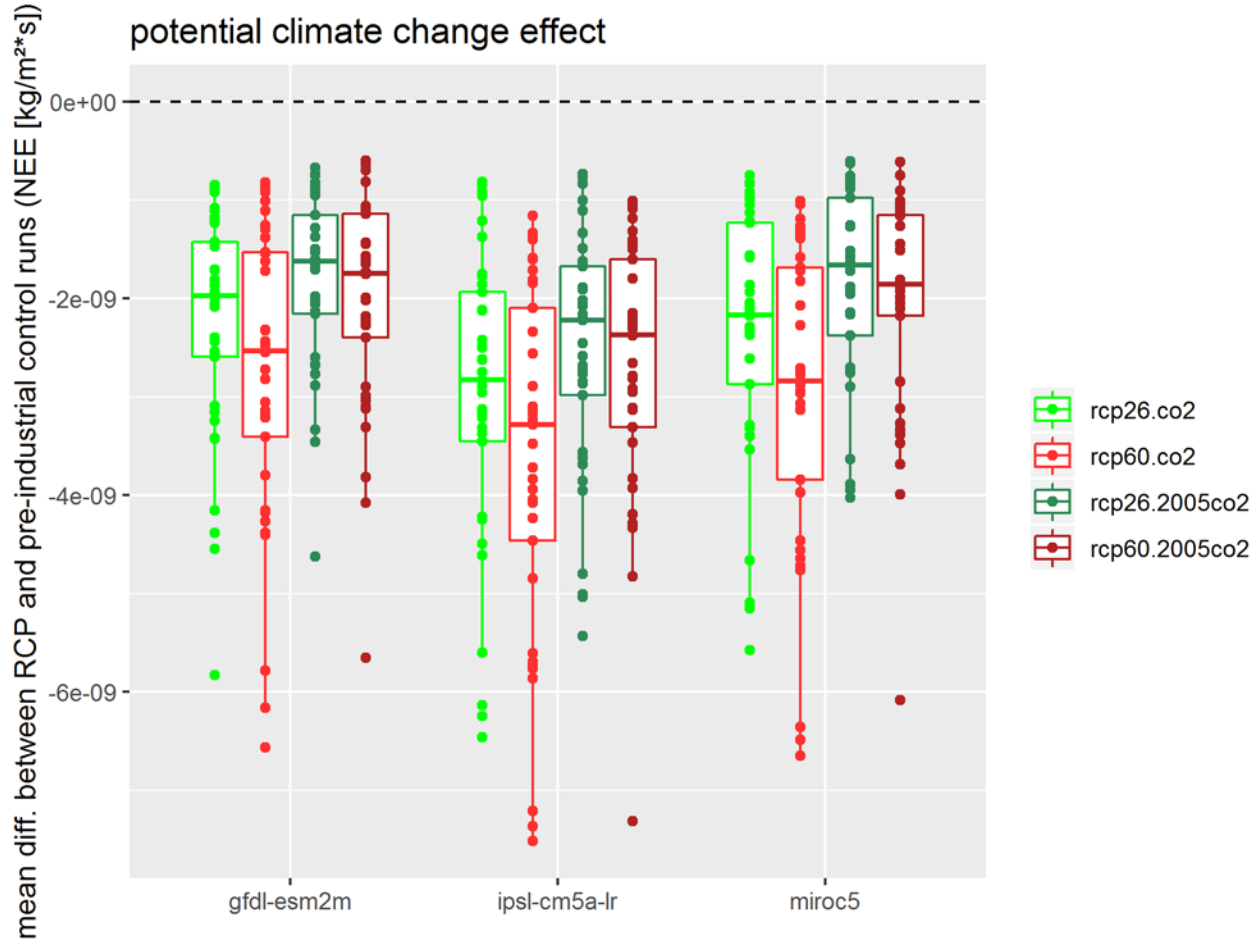
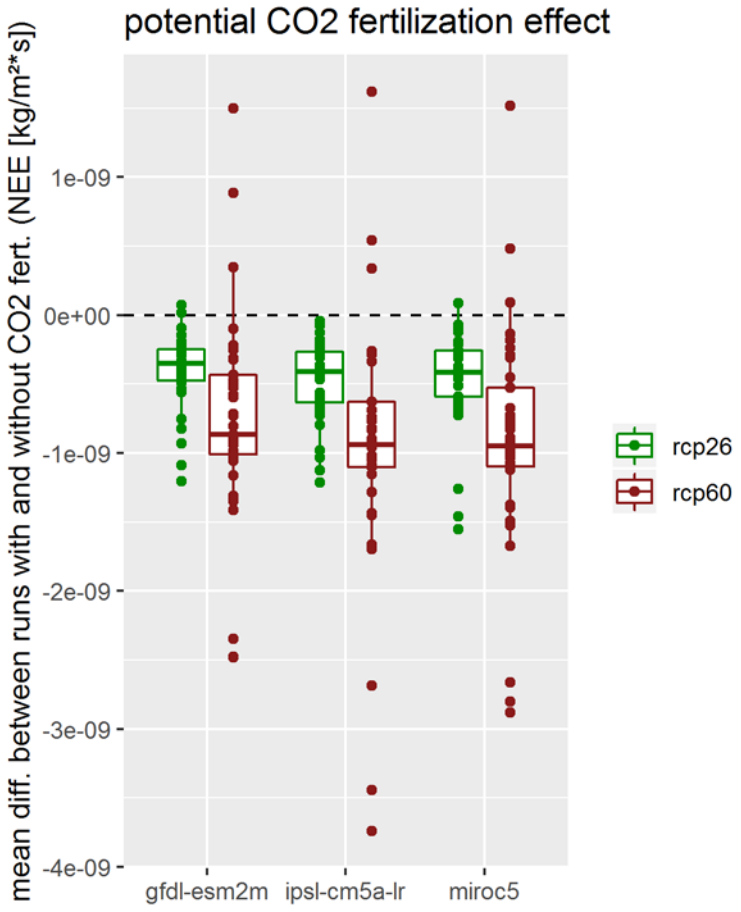
productivity response to climate change



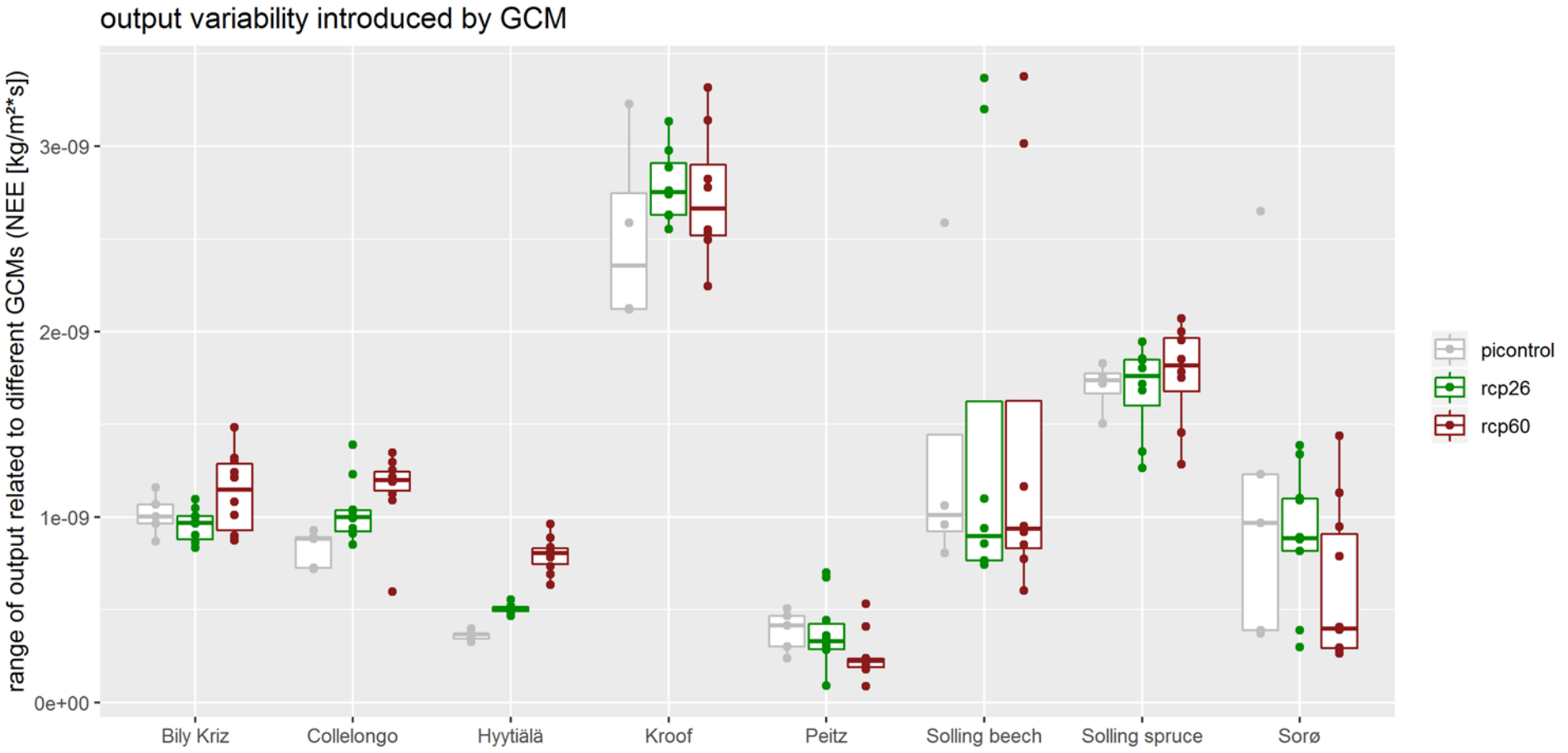
- net ecosystem productivity (NEE) is overall increasing for all sites with lower (RCP 2.6) and higher (RCP 6.0) climate change pathways
- the climate change effect is even higher if CO2 fertilization is included
- surprisingly also the water limited sites have a boost in NEE - lack of disturbances in simulation

productivity response to full CO2 fertilization



- CO2 fertilization effect on net ecosystem productivity (NEE) for the lower end climate change pathway (RCP 2.6) is always positive
- for higher end climate change pathways (RCP 6.0) CO2 fertilization has for some extreme cases negative effects on NEE

GCM effect on simulated productivity



- uncertainty introduced by simulated global climate model forcing data at the same magnitude of uncertainty of climate change effects itself and