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Extracting ecosystem climate change indicators from century long simulations

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Contents

Estimating climate change indicators

Future climatic drivers propagated through impact models
Our impact models: JSBACH and PREBAS
Our drivers: Selection of CMIP5 models

- In CMIP5 the GHGs concentrations and LUCC were implemented as optional representative concentration pathways (RCPs)
- There were altogether four RCPs, RCP2.6, RCP4.5, RCP6.0 and RCP8.5, ordered by increasing severity of the climate impact
- Altogether 28 models participated CMIP5

CMIP5 Model	Institute(s), Countr(y)ies	Scenarios	Time-span
CanES M2	Canadian Centre for Climate Modelling and Analysis, Canada	RCP 4.5 r1 RCP 8.5 r1	1980-2099
CNRM-CM5	National Centre for Meteorological Research, Météo France and CERFACS, FRANCE	RCP 4.5 r1 RCP 8.5 r1	1980-2099
GFDL-CM3	Geophysical Fluid Dynamics Laboratory, NOAA, USA	RCP 4.5 r3 RCP 8.5 r1	1980-2099
HadGE M2-ES	Met Office, UK	RCP 4.5 r1 RCP 8.5 r1	1980-2099
MIROC5	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology, Japan	RCP 4.5 r2 RCP 8.5 r2	1980-2099

Climate drivers

The models are

- downscaled (0.1°x0.2°) to lat-lon grid covering Finland and further to the impact model resolution
- bias-corrected to daily time-resolution with the FMI gridded harmonized climate data (Aalto et. al., 2012).
  - a quantile-quantile type bias correction for daily mean temperature (Räisänen et. al. 2013)
  - parametric quantile mapping for daily precipitation (Räty et. al. 2014)
- The models reproduce the current climate well (Ruosteenoja et al. 2016, Geophysica)
  - T changes biased slightly towards higher end of CMIP5

Climate drivers

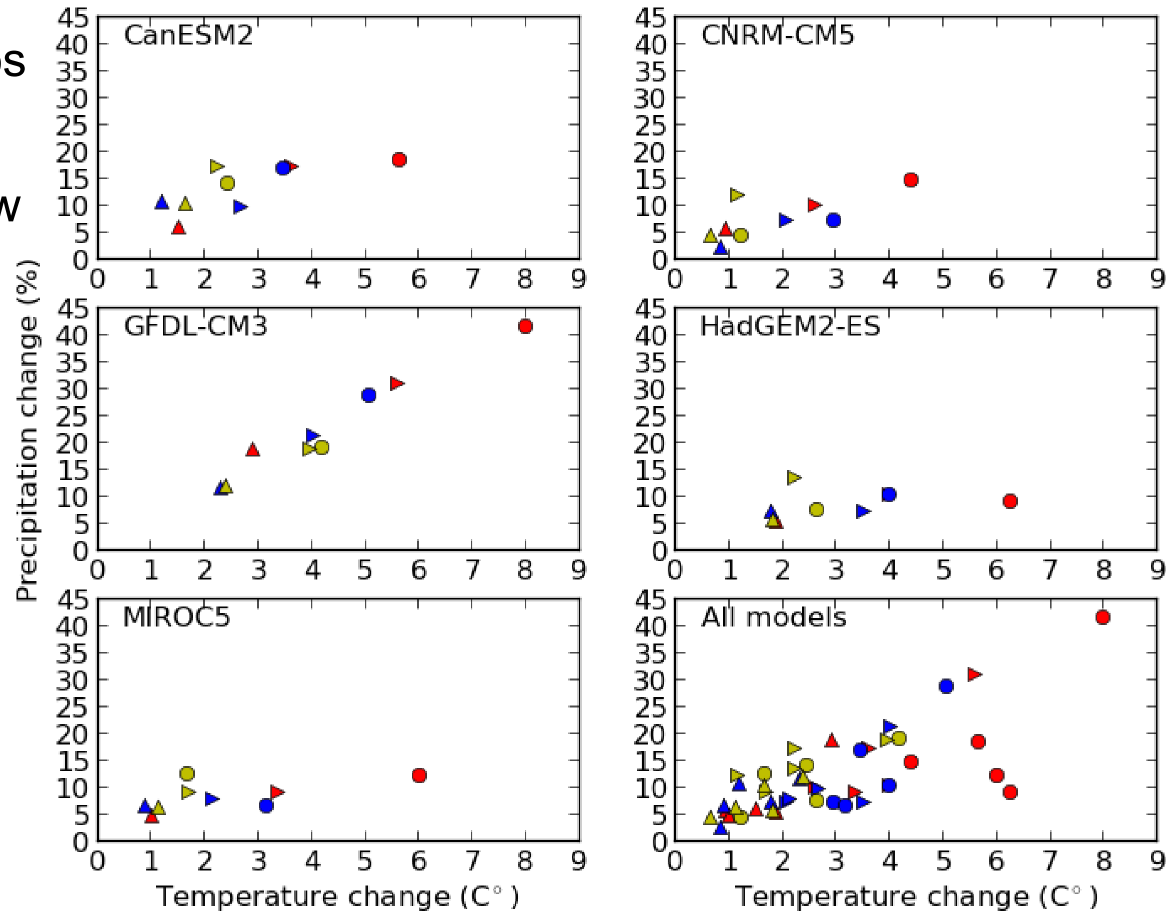
5 donwscaled CMIP5 RCP2.6, RCP4.5 and RCP8.5 scenarios provided

-Tmin, Tmax, Pr, Rs, Rh, and w

Further needed

-Yearly mean [CO2] concentration

-Downwelling longwave radiation Rl



● 2071-2100

▶ 2041-2070 - 1981-2010

▲ 2011-2040

Scenario simulations

Transient run with **[CO2] and climate of 1980-2100** – both models

- 1981-2010 as reference
- 2011-2040, 2041-2070, 2071-2100 as scenario periods
- Trends through all 120 years

Ecosystem models have varying starting points

- JSBACH does not account harvesting
- JSBACH land cover from National CORINE 2012
- JSBACH initial state soil carbon in equilibrium with pre-industrial [CO2]
- PREBAS manages forests according to the ’management assumption’. Real forest initial state, periodic initialisation for 30 yrs.

MONIMET climate change indicators

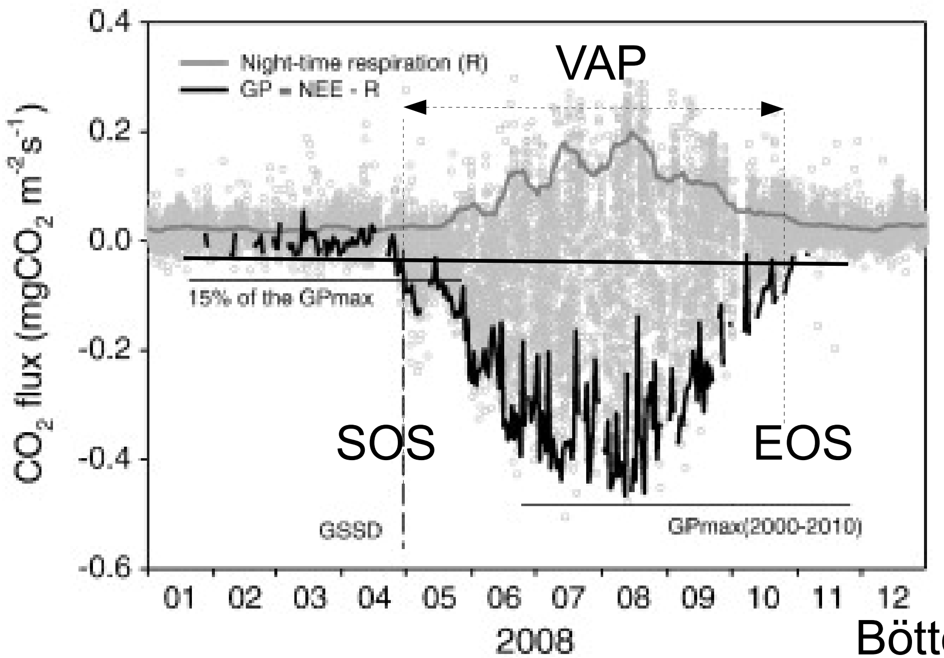
vegetation active season (VAP, days)
carbon uptake rate (gross primary production, GPP, gC/m2/a)
forest and soil respiration rates (g/m2/a)
wetland methane emission rates (molCH4/m2/a)
vegetation and soil evaporation rates (ET, mol/m2/a)
soil moisture (soil moisture index, SMI, %)
soil frost period (days)
snow cover (depth, m, extent, %, duration)
surface albedo (%)

MONIMET climate change indicators

vegetation active season (VAP, days)

Sodankylä, EC measurements

NEE=TER-GPP



Böttcher et al. 2014, RSE

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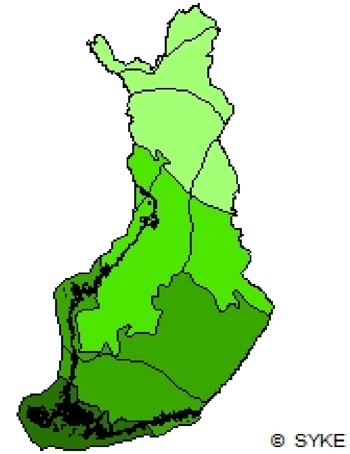
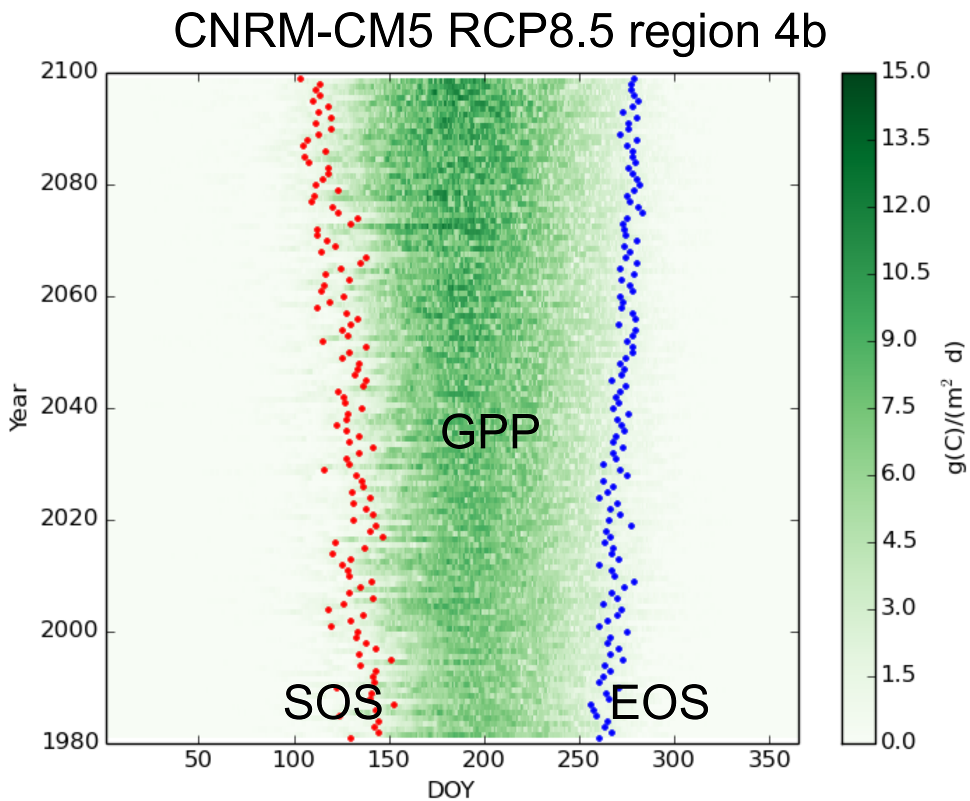
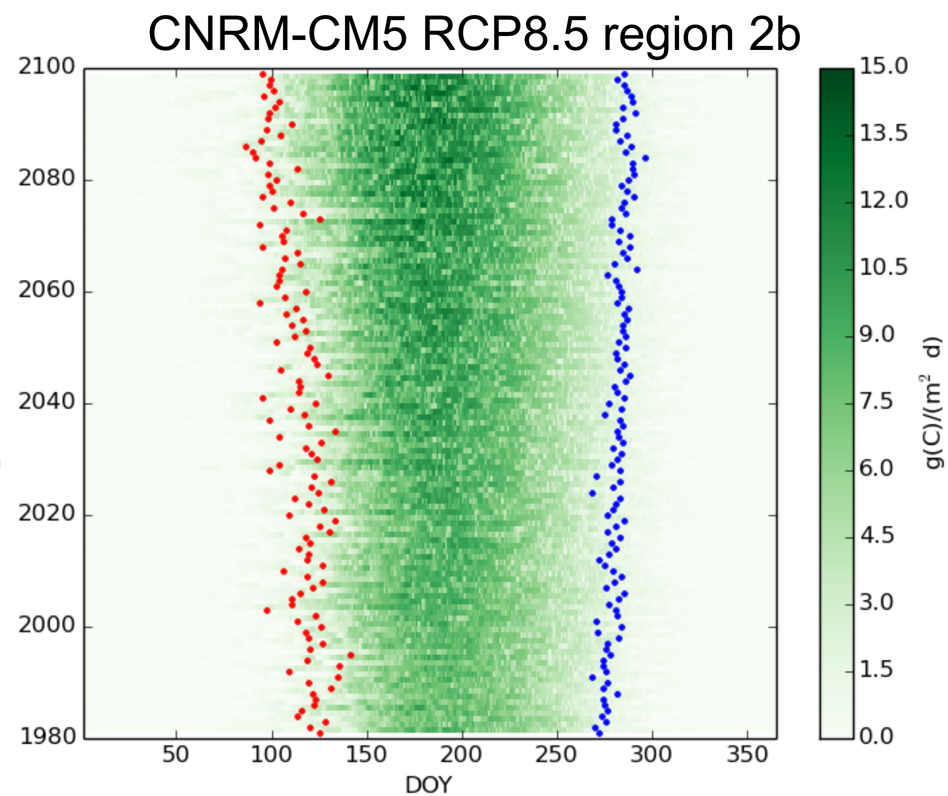
MONIMET climate change indicators

VAP and GPP in forest vegetation zones







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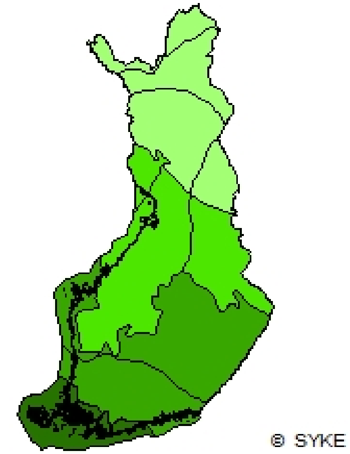
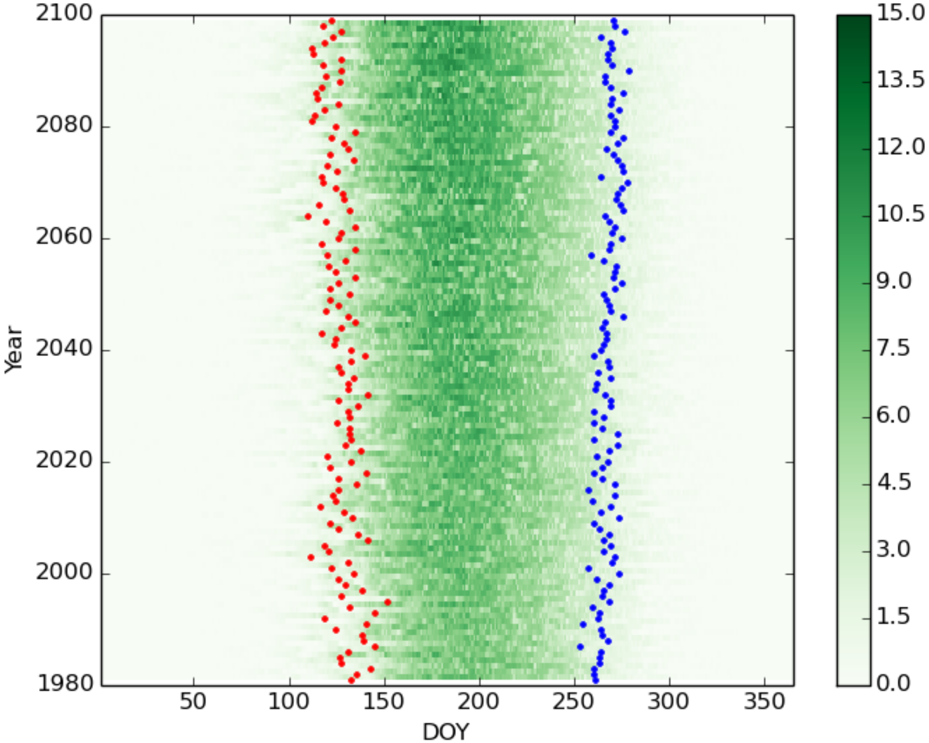
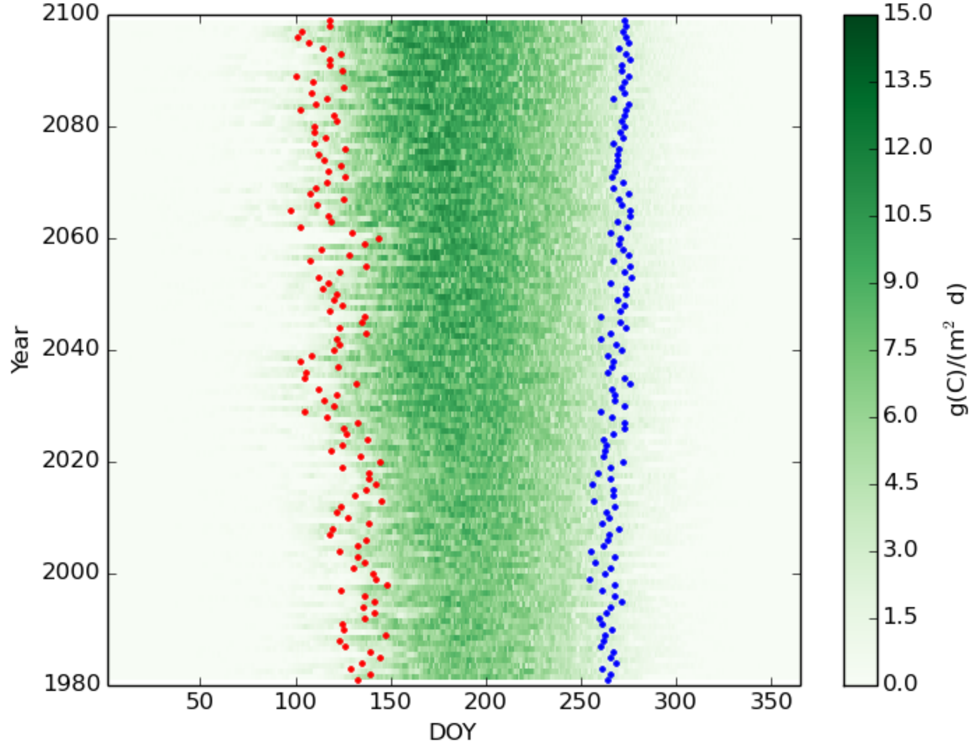
VAP and GPP in forest vegetation zones



CNRM-CM5 RCP4.5 region 3b



GFDL-CM3 RCP4.5 region 3b



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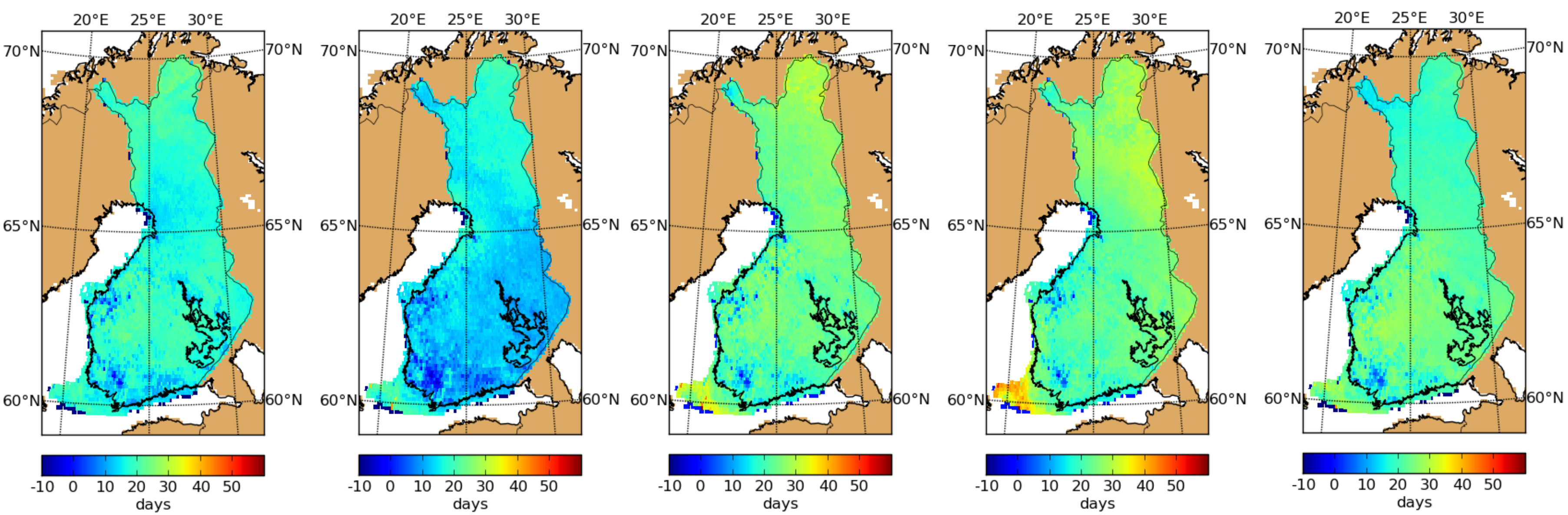
VAP change by the end of century



CanESM2 | CNRM-CM5 | GFDL-CM3 | HadGEM2-ES | MIROC5

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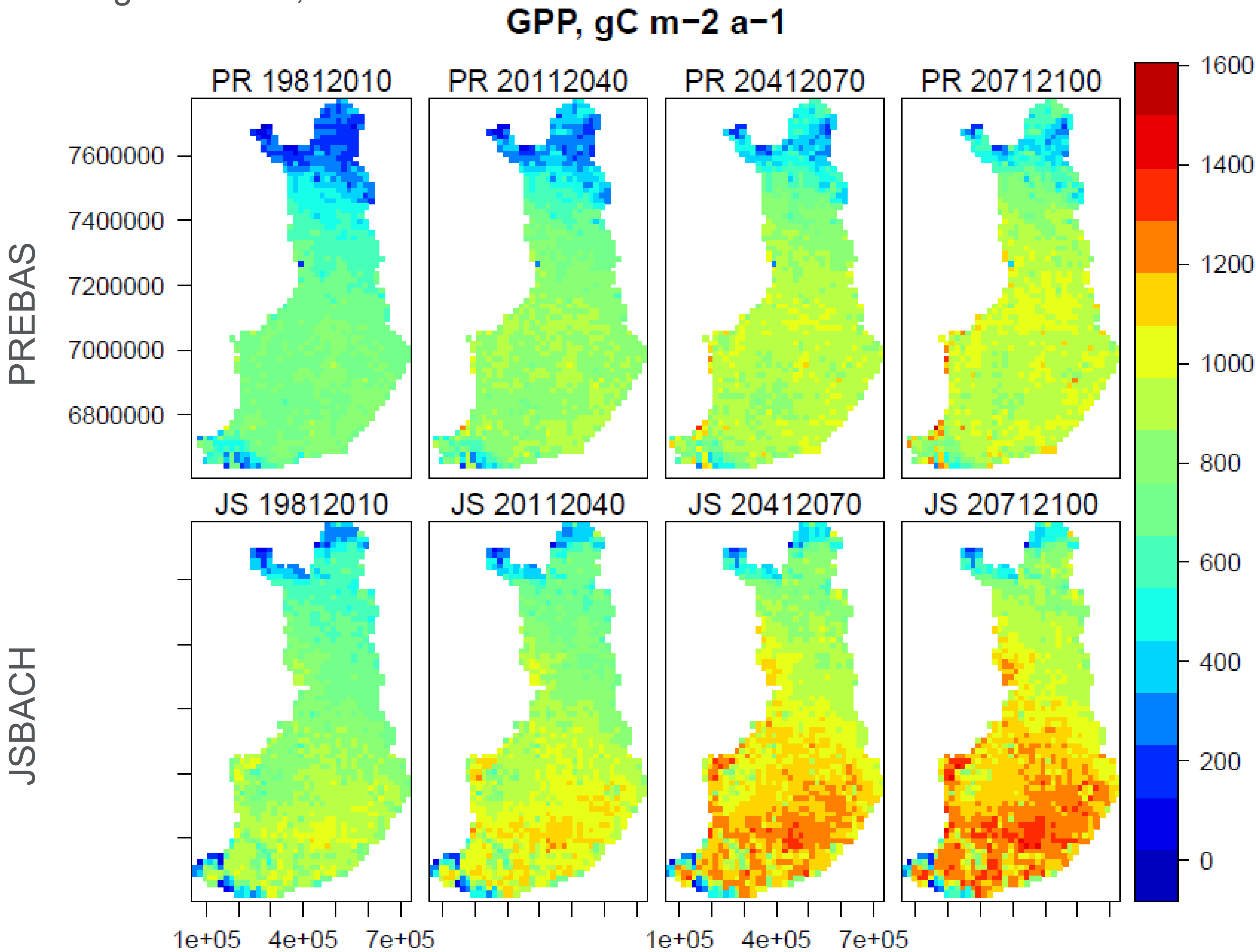
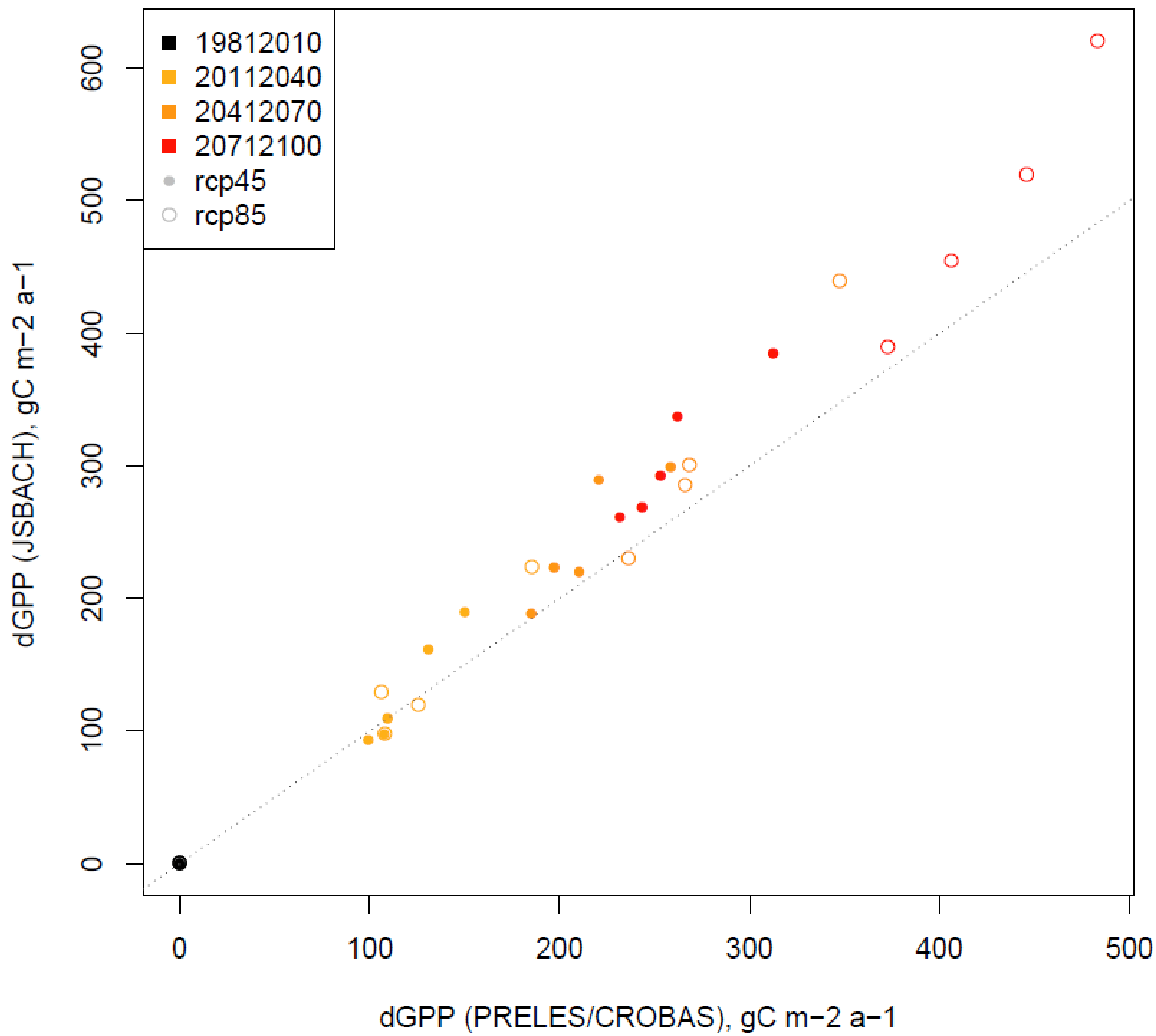
Forcing: CanESM, RCP4.5



GPP change estimates, using forcings of 5 climate models



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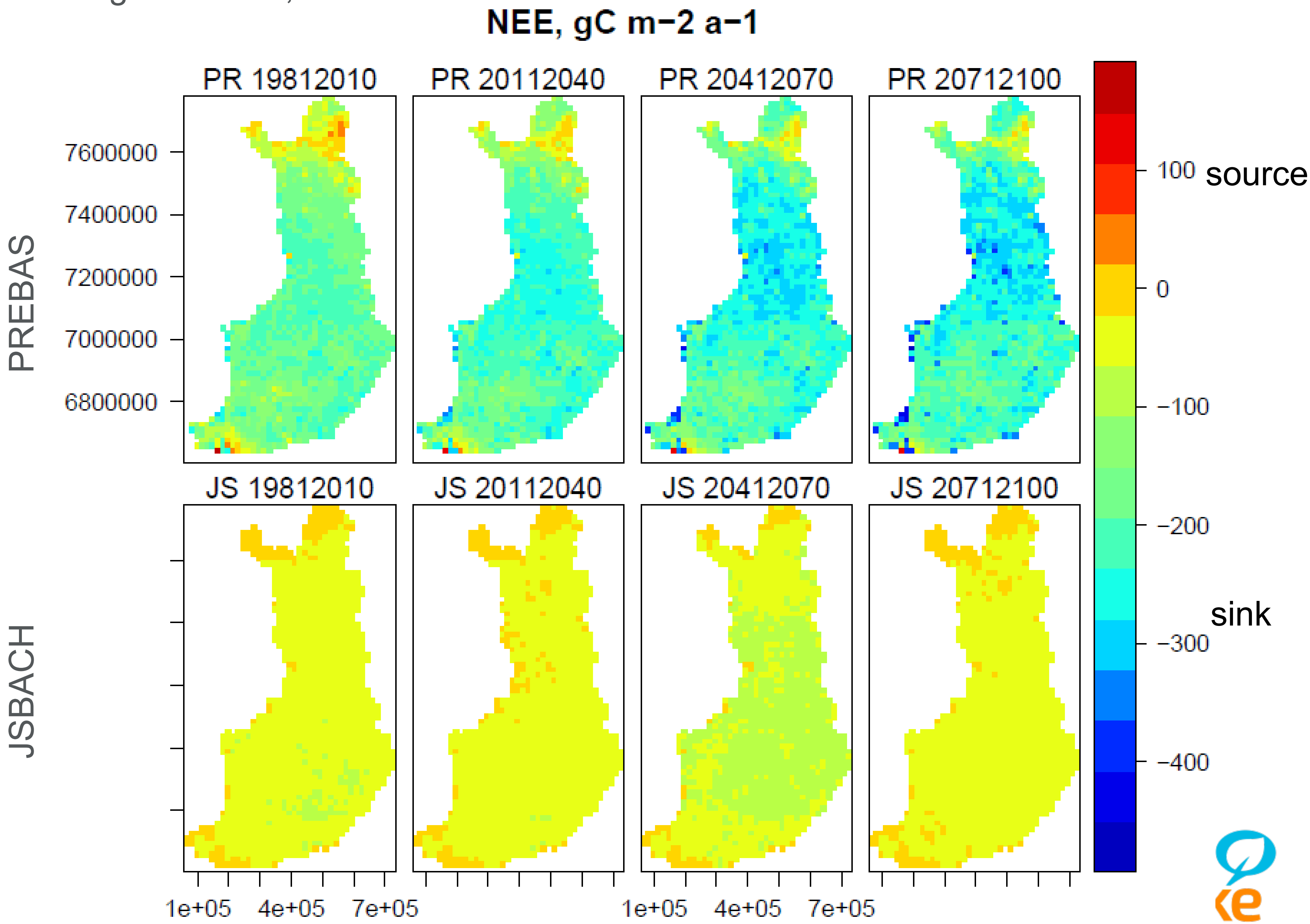
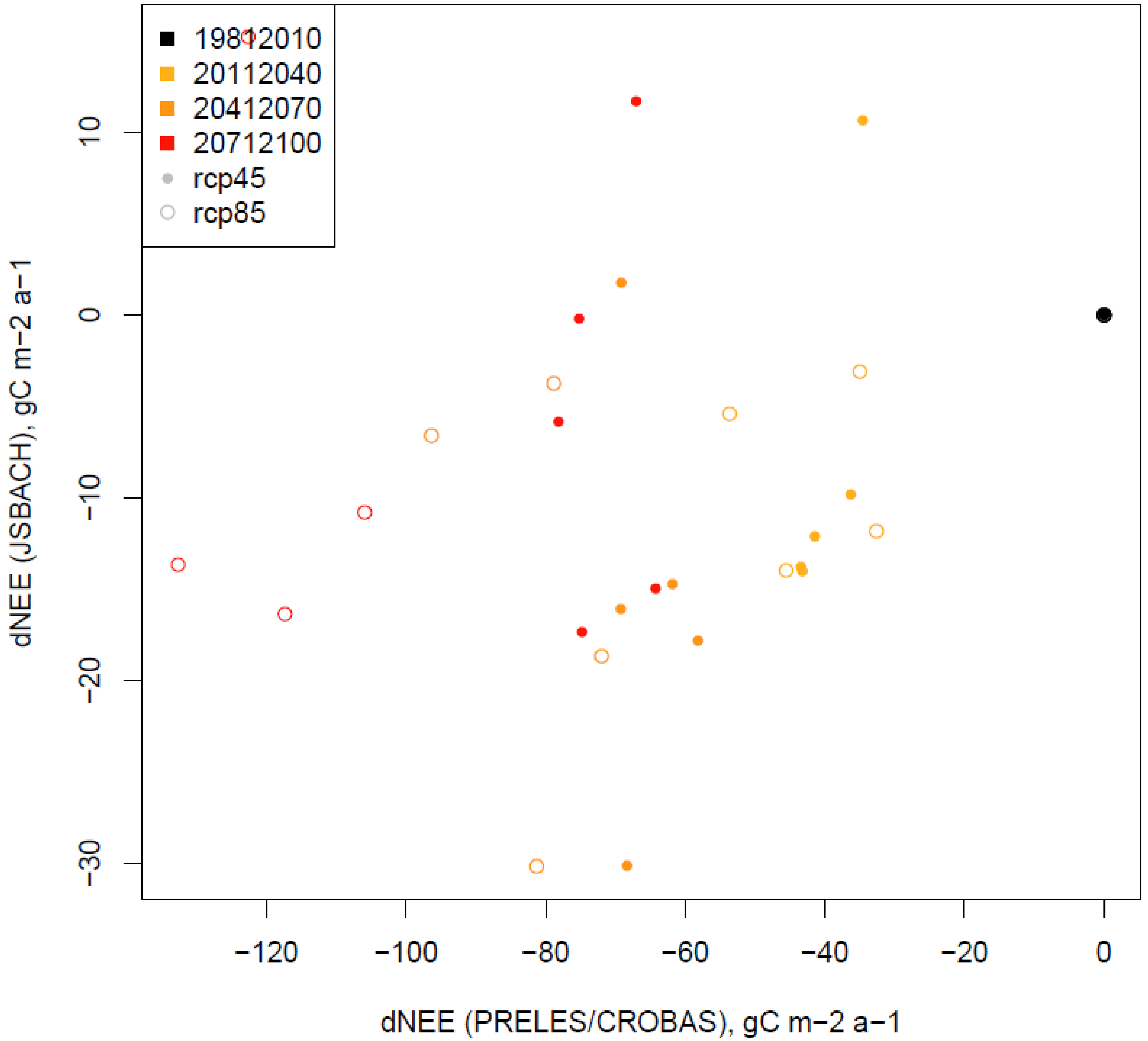
Forcing: CanESM, RCP4.5



NEE change estimates, using forcings of 5 climate models



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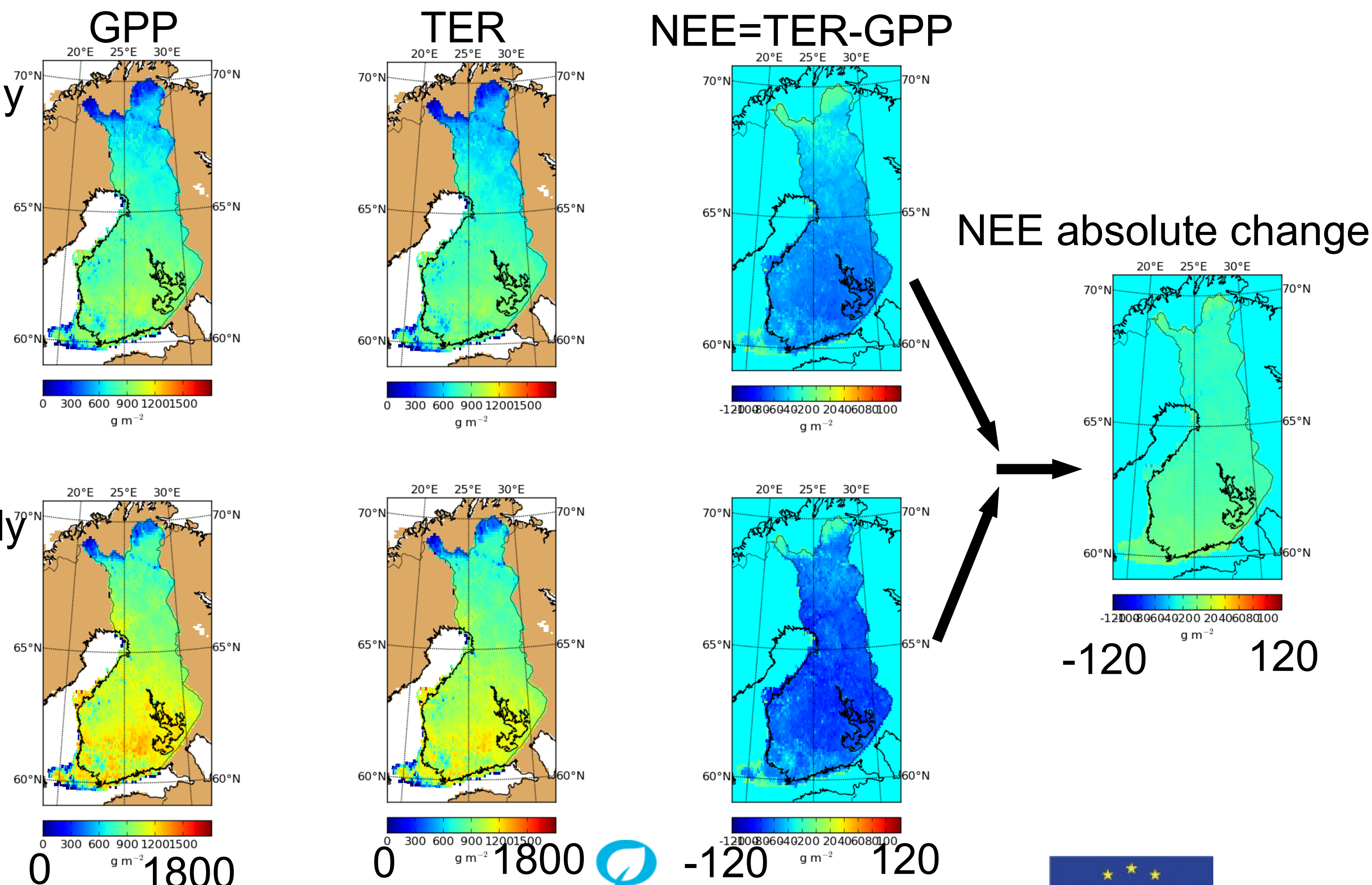
MONIMET climate change indicators

Forcing: CanESM, RCP4.5

Average of yearly sums through 1981-2010 in g/m2/a

Average of yearly sums through 2041-2070 in g/m2/a



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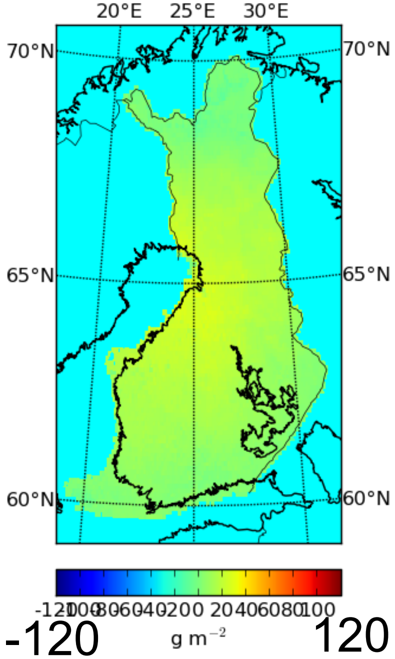
MONIMET climate change indicators

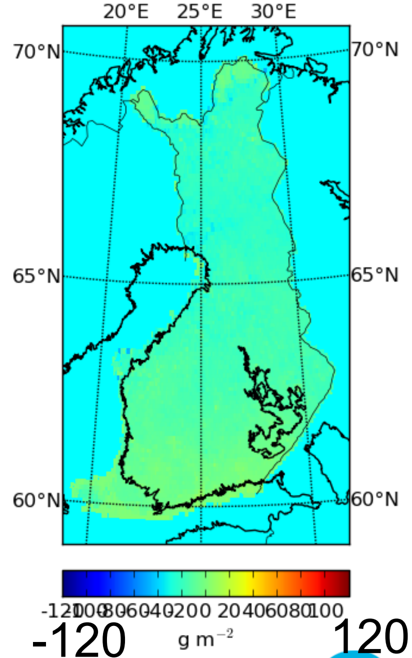
Forcing: CanESM, RCP4.5

Change of average yearly NEE from

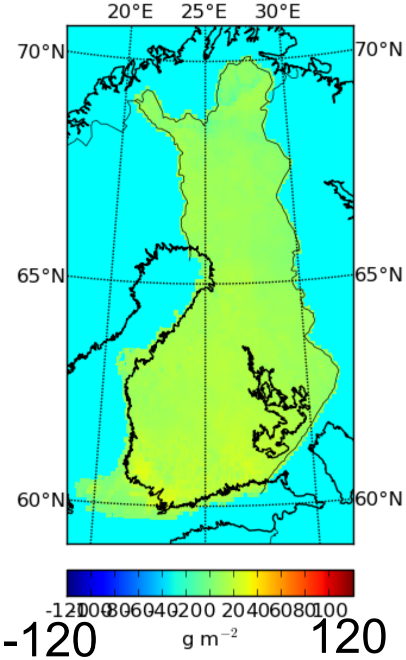
1981-2010 to
2011-2040 (g/m2/a)



1981-2010 to
2041-2070 (g/m2/a)



1981-2010 to
2071-2100 (g/m2/a)



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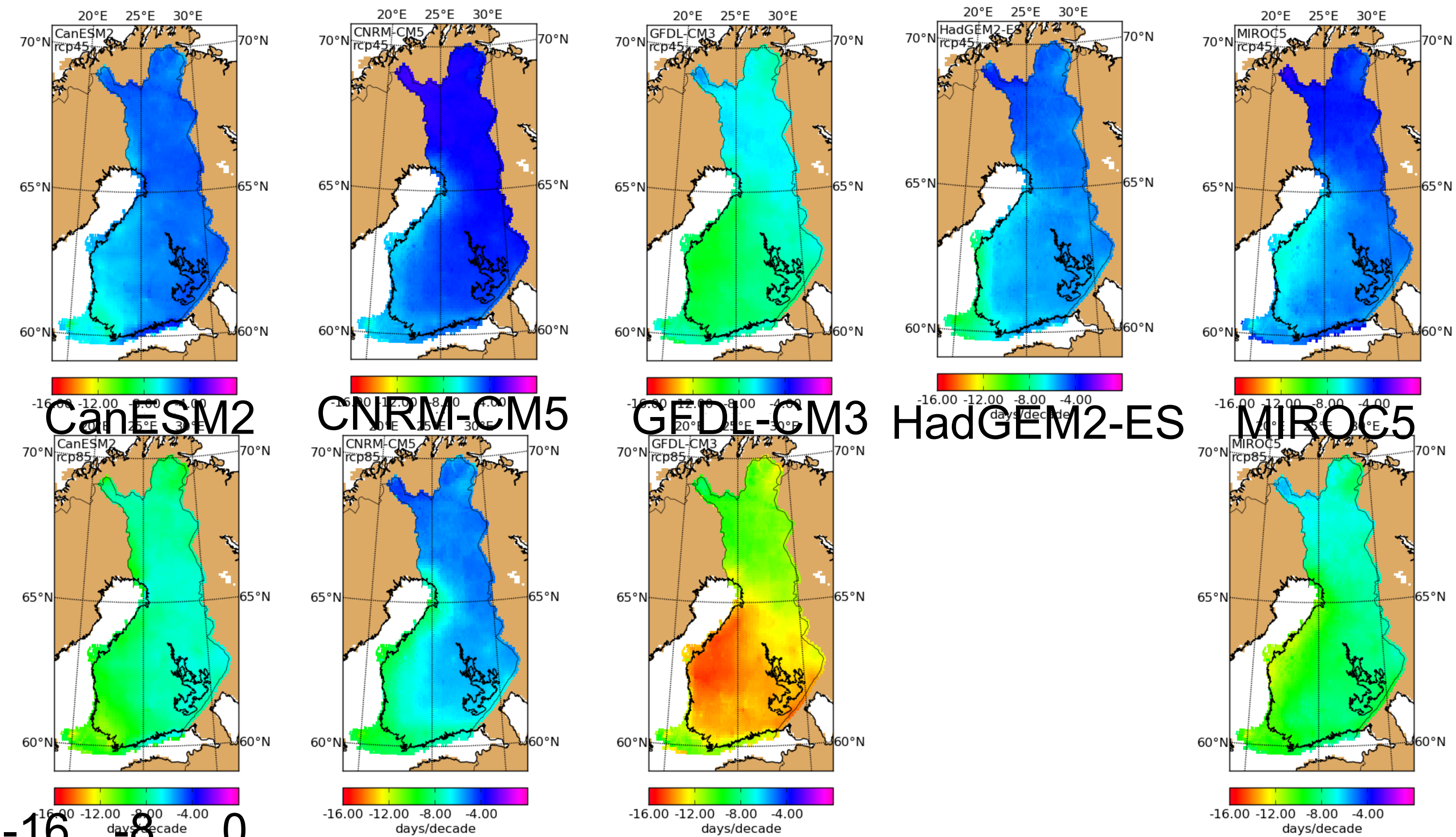
MONIMET target climate change indicators

Soil frost period – trend as days/decade

RCP4.5

RCP8.5



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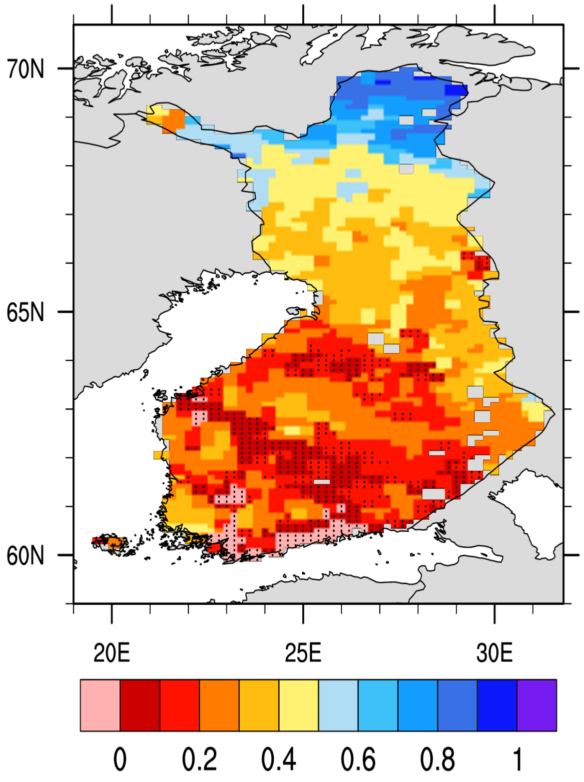
MONIMET target climate change indicators

Soil moisture index, SMI = $(\theta - \theta_{WILT}) / (\theta_{FC} - \theta_{WILT})$



No significant trends in number of days of extreme drought in July and/or in August

The driest period of 2006
(Gao et al. 2016)

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Concluding remarks

The calibrated impact models produced estimates of regional climate change indicators for Finland

Vegetation active period related indicators and their changes predicted by both models predict significant trends

Ecosystem carbon balance related indicators show clear trends in GPP and TER but the balance term NEE is sensitive to initial states and management options