GHG emissions and regional warming in the Baltic Sea region

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Baltic Earth Workshop
Multiple drivers for Earth system changes in the Baltic Sea region
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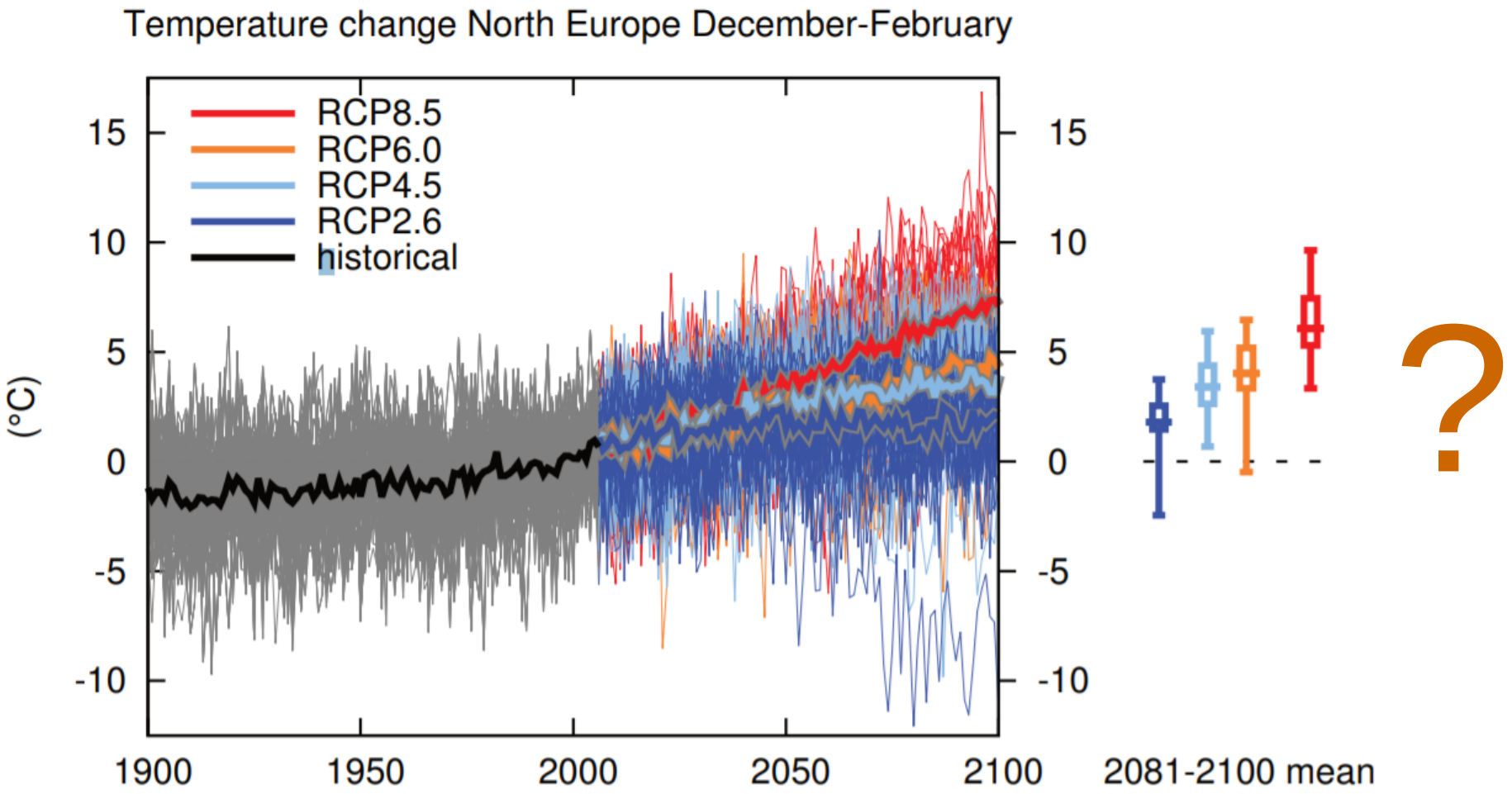
SMHI

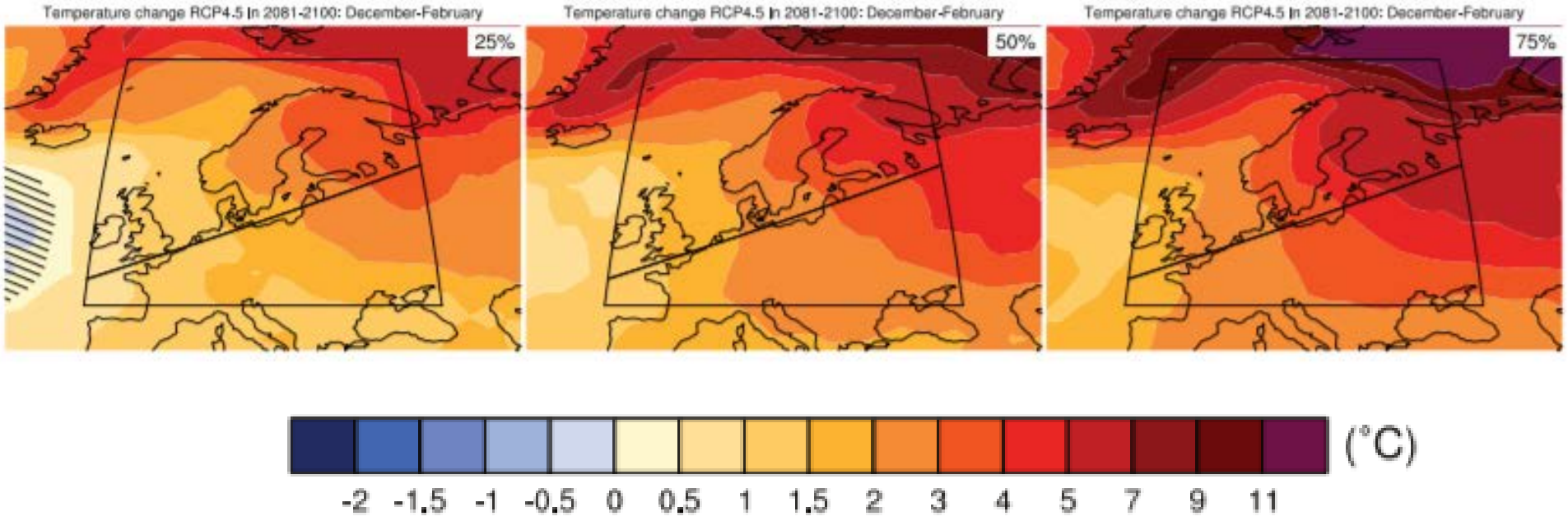
What will happen with climate in the future?



IPCC (AR5, WGI, 2013)

CMIP5 RCP4.5 scenarios at the end of the century: Change in DJF temperature

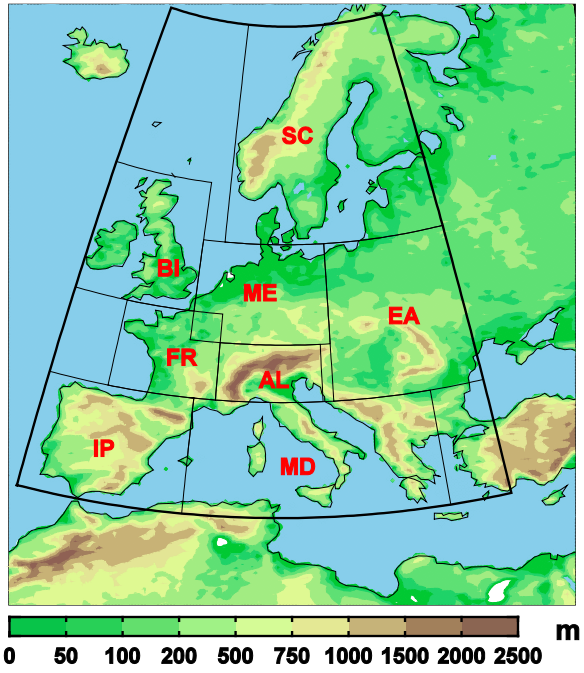
25% 50% 75%



IPCC (AR5, WGI, 2013)

RCM simulations

24 EURO-CORDEX simulations with 7 RCMs under RCP8.5 (available at ESGF in October 2018) at 12.5 km grid spacing (GCMs from CMIP5)

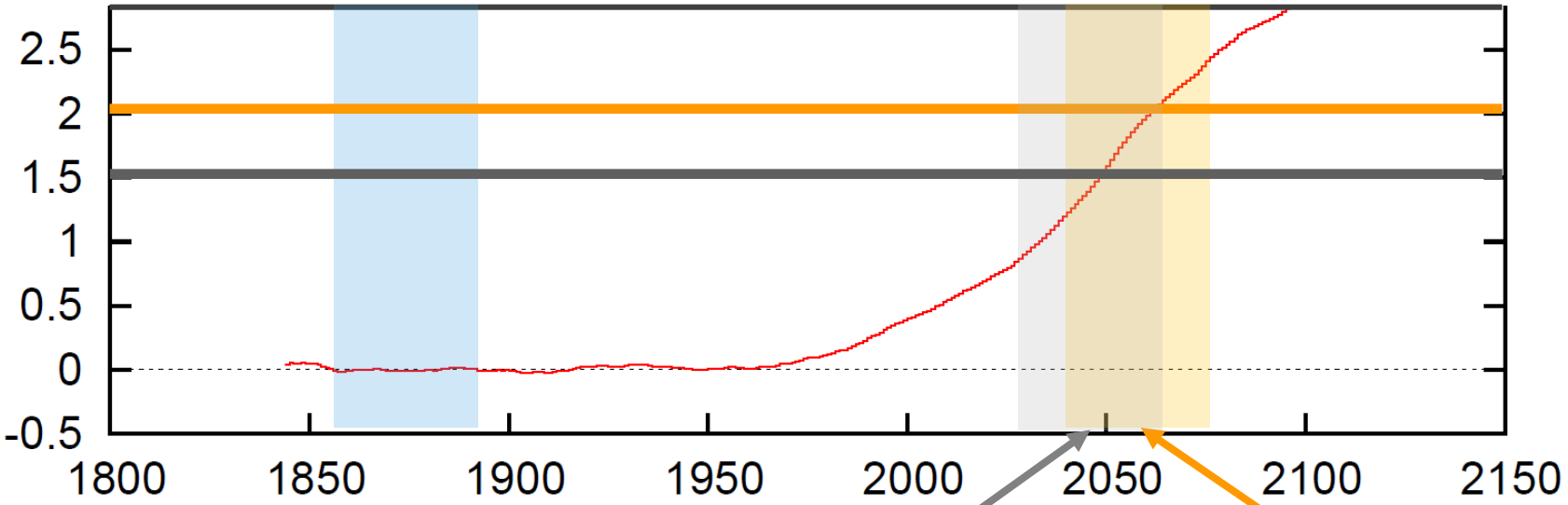


No	Institute	RCM	GCM
1	SMHI	RCA4	EC-EARTH-r12
2			HadGEM2-ES
3			MPI-ESM-LR-r1
4			NorESM1-M
5			IPSL-CM5A-MR
6	BTU Cottbus	CCLM4-8-17	EC-EARTH_r12
7			MPI-ESM-LR-r1
8	DWD	CCLM4-8-17	CanESM2
9			MIROC5
10	ETH	CCLM4-8-17	HadGEM2-ES
11	HZG-GERICS	REMO2009	MPI-ESM-LR-r1
12			MPI-ESM-LR-r2
13		REMO2015	EC-EARTH_r12
14			HadGEM2-ES
15			CanESM2
16			MIROC5
17	KNMI	RACMO2.2	EC-EARTH-r1
18			EC-EARTH-r12
19			HadGEM2-ES
20	DMI	HIRHAM5	EC-EARTH-r3
21			HadGEM2-ES
22			NORESM1-M
23	IPSL	WRF3.3.1	IPSL-CM5A-MR
24		WRF3.6.1	HadGEM2-ES

Changes at different warming levels

Global annual mean 2m-temperature

30-year running mean anomaly w.r.t. 1861-1890
in one simulation by one global climate model

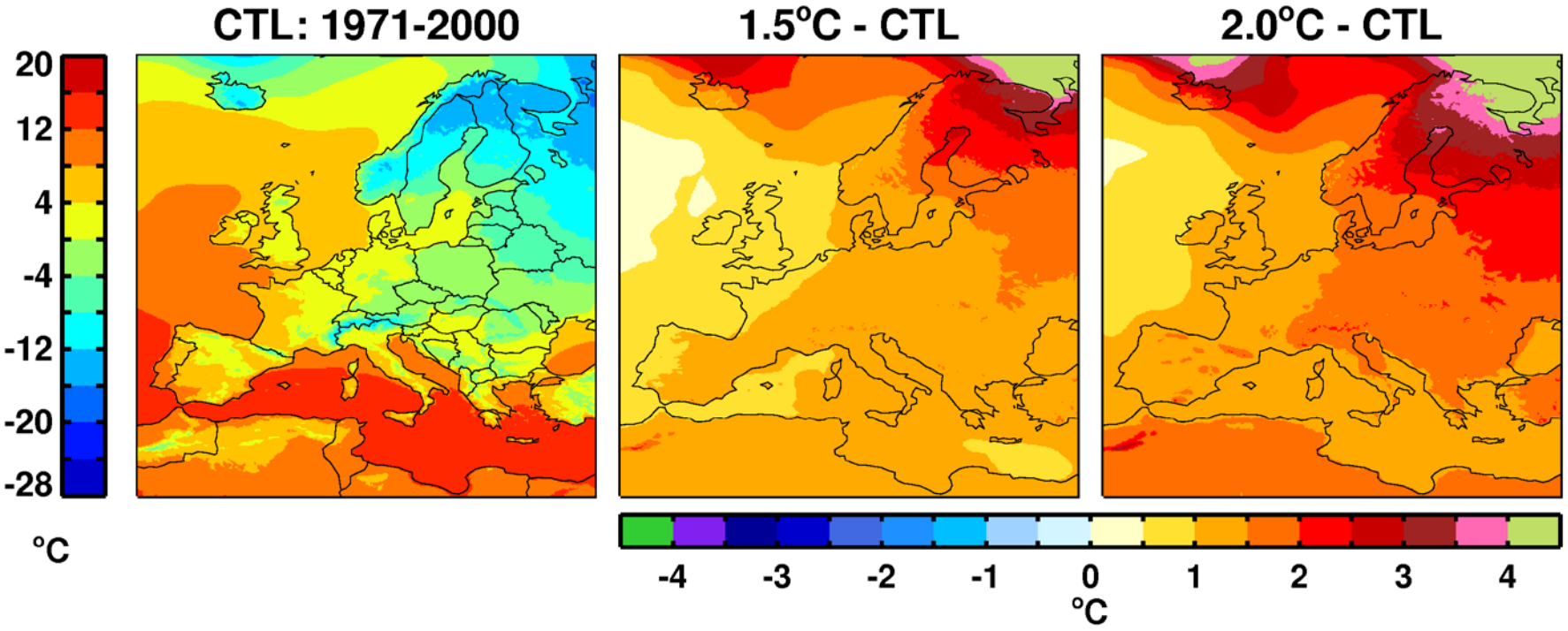


”Preindustrial” conditions
(1861-1890)

1.5°C warming
(2033-2062)

2°C warming
(2046-2075)

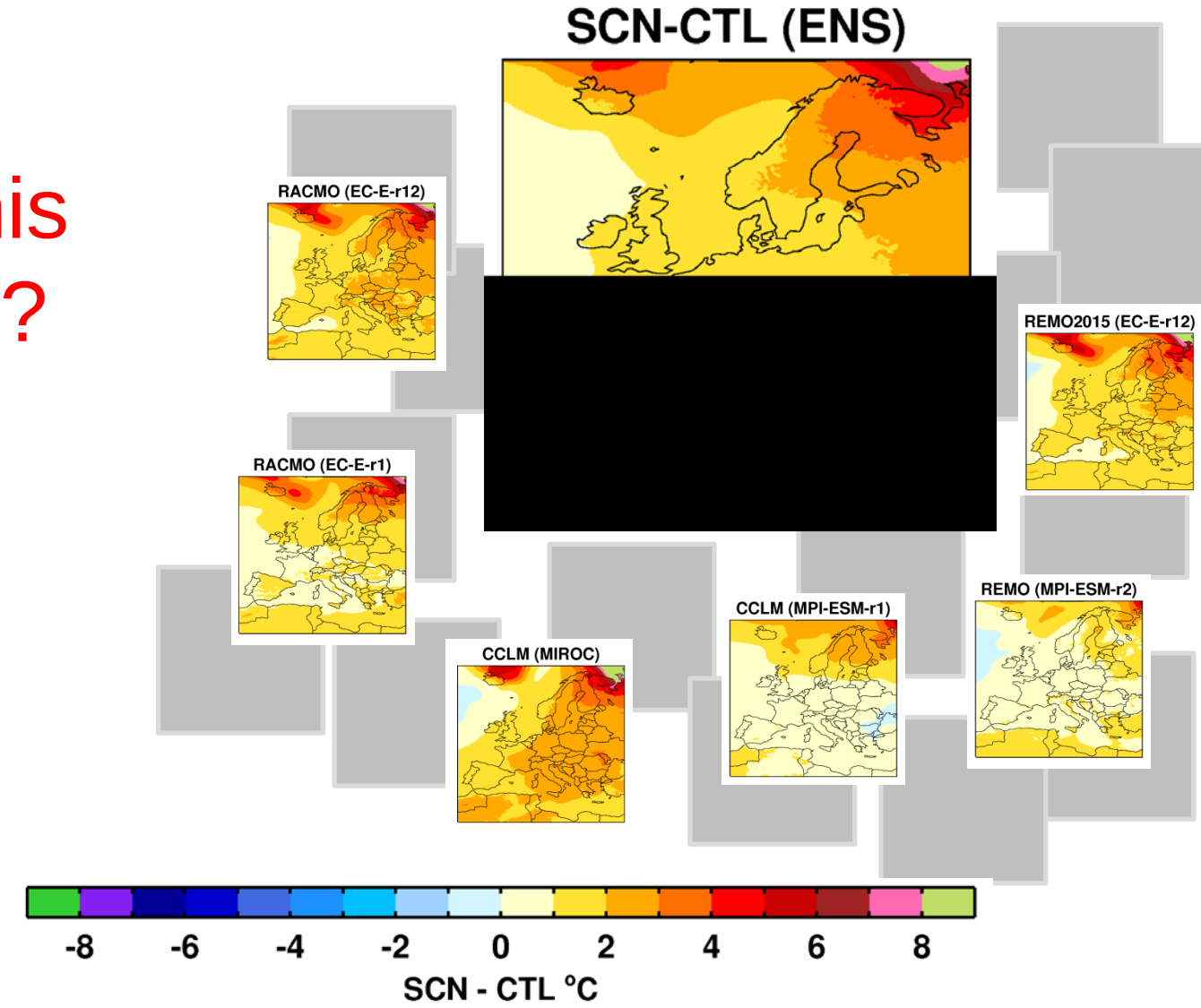
Ensemble mean temperature change (DJF)



Annual mean temperatures 1971-2000 in the Nordic and Baltic countries are about 0.7-0.9°C above those in the second half of the 19th century

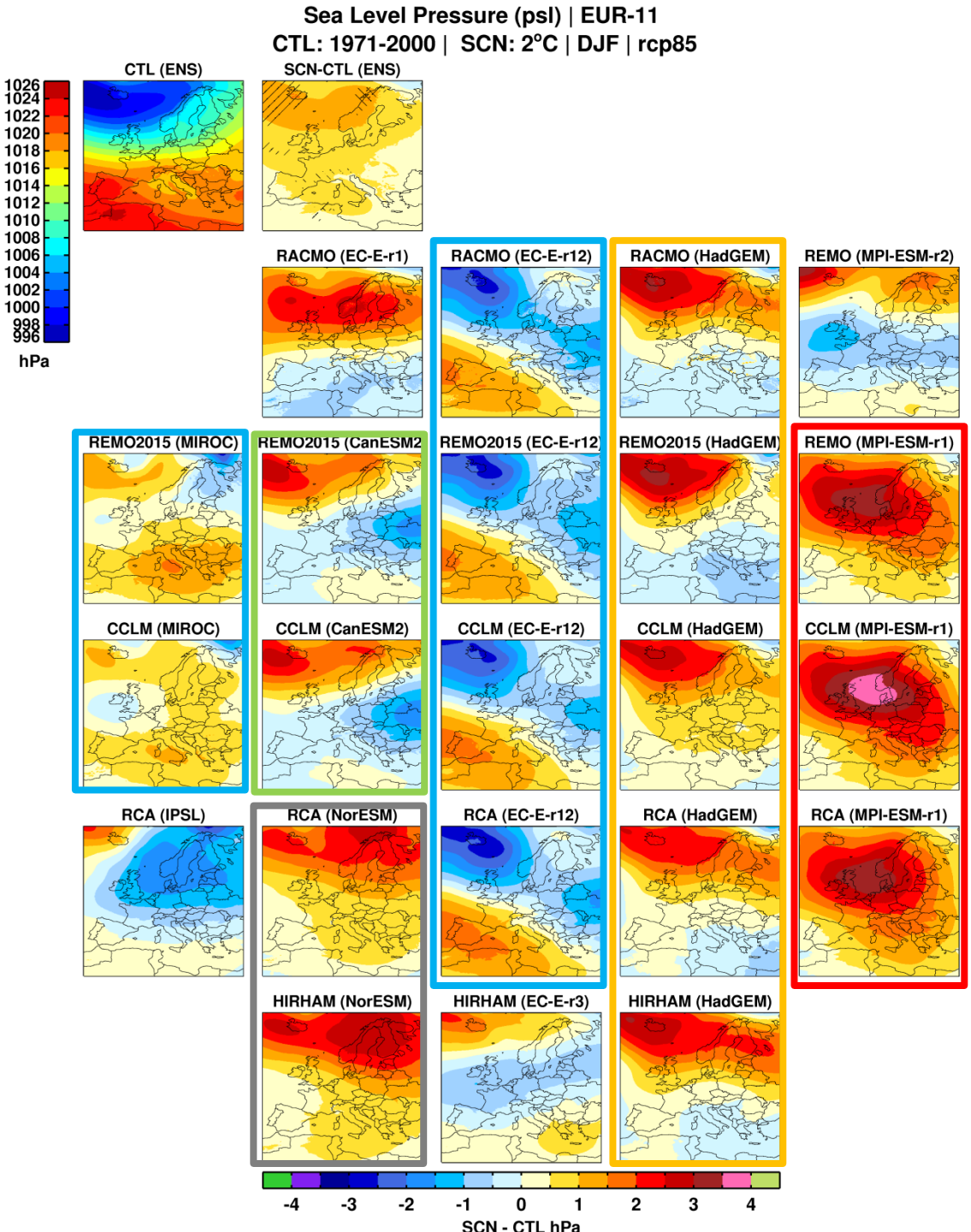
Responses differ between simulations

Why is this the case?



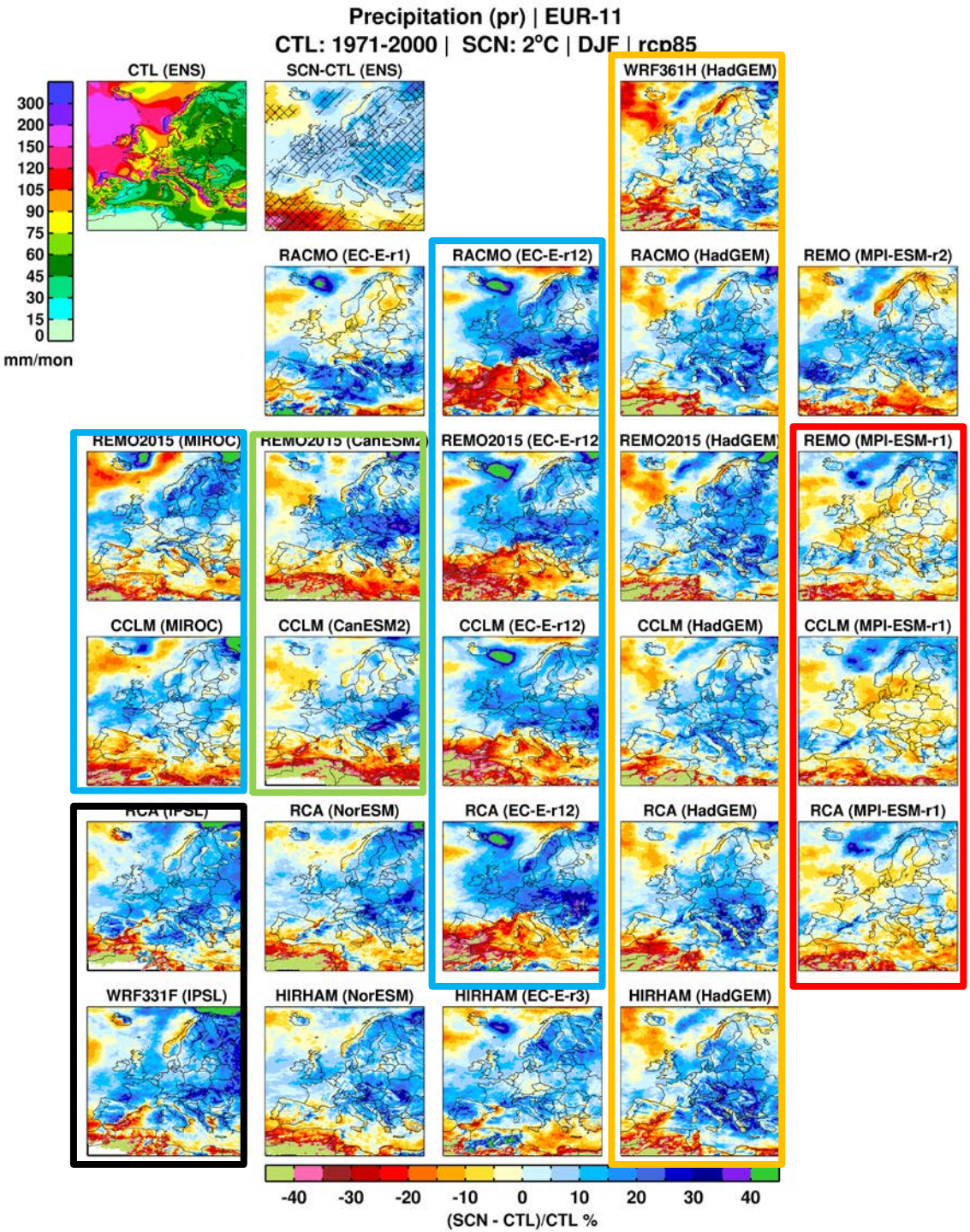
MSLP (DJF)

Strong dependency on forcing GCM and ensemble members



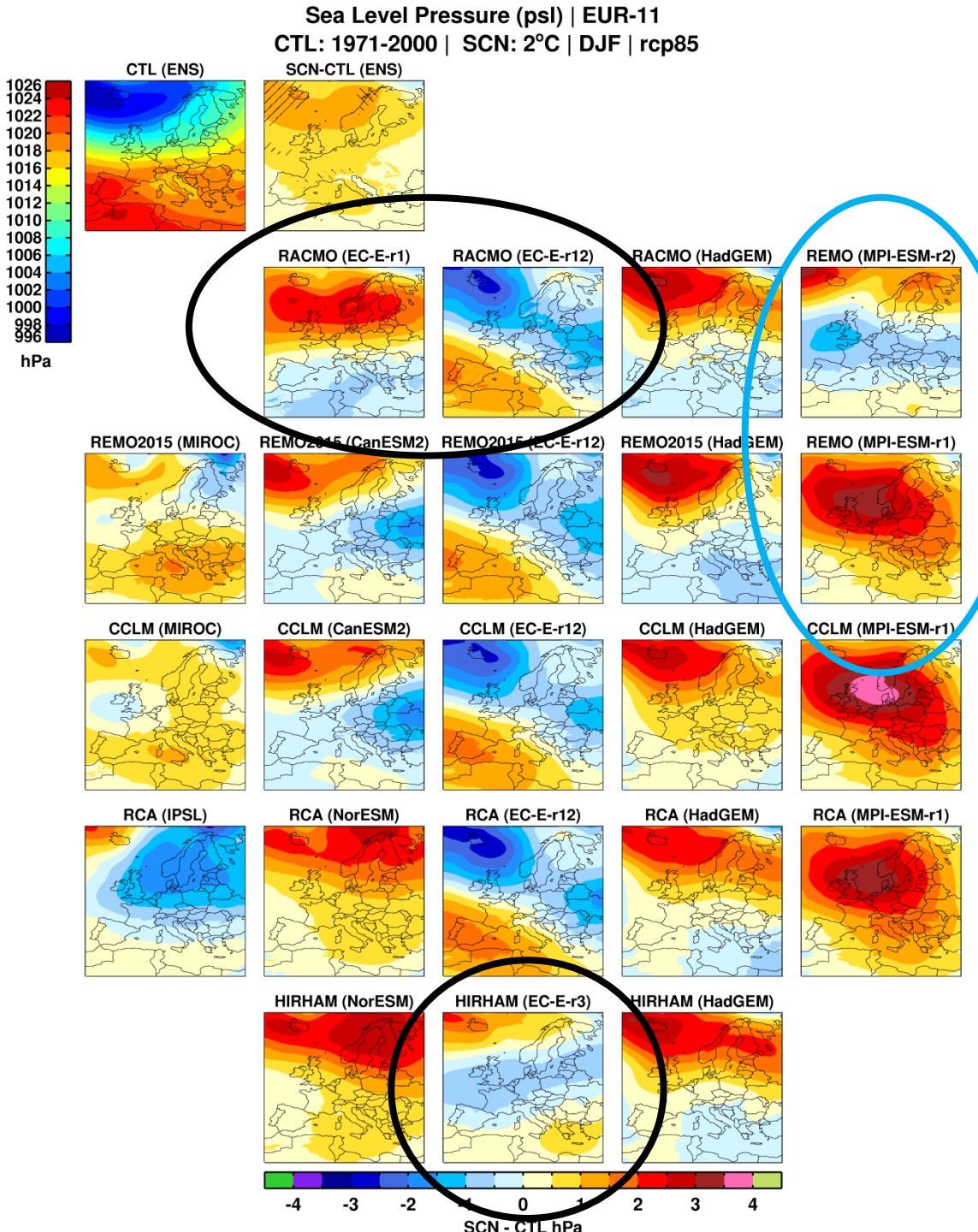
Precipitation (DJF)

Strong dependency on forcing GCM and ensemble members



MSLP (DJF)

Large differences between members of the same GCM – indicative of large influence of natural internal variability



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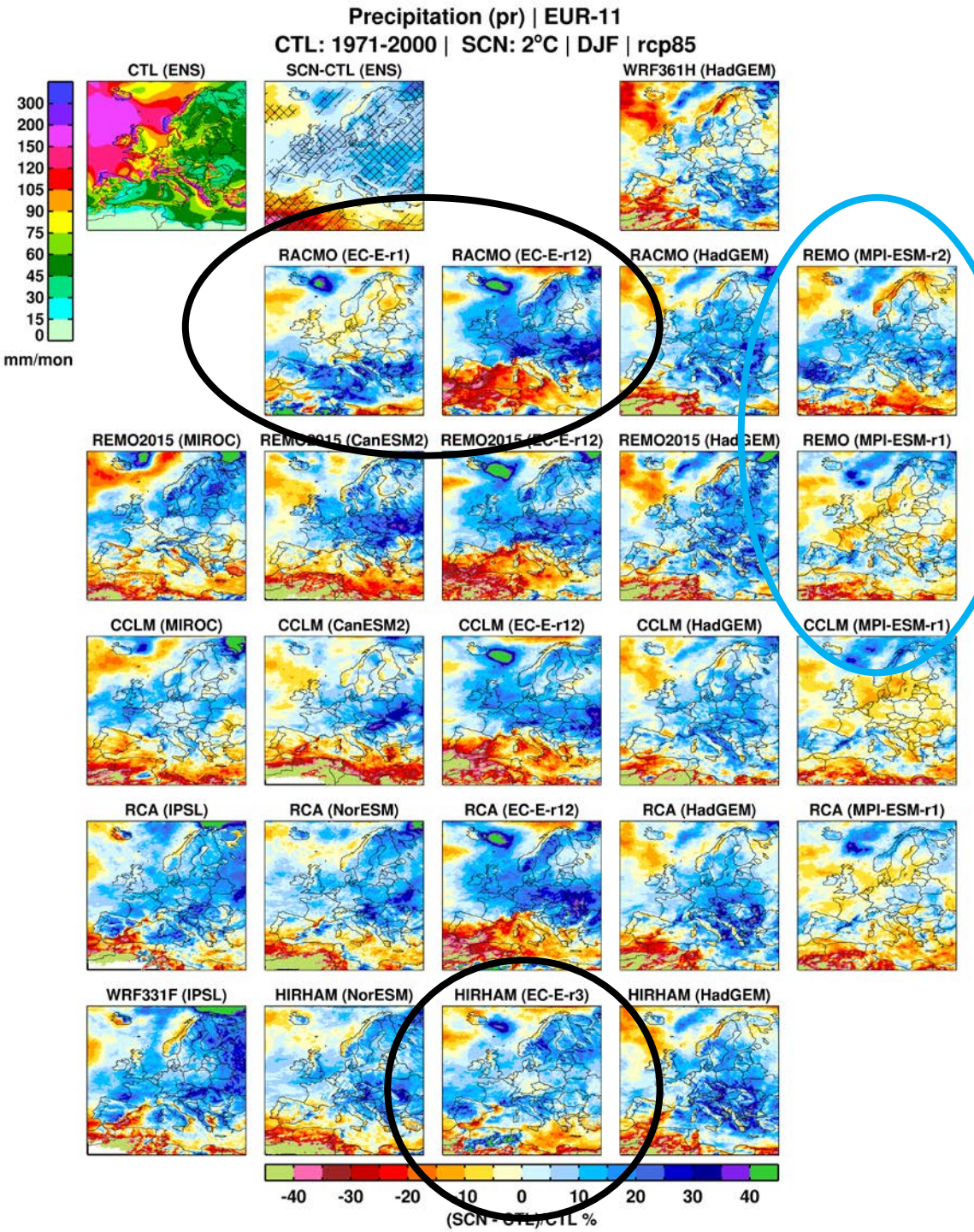
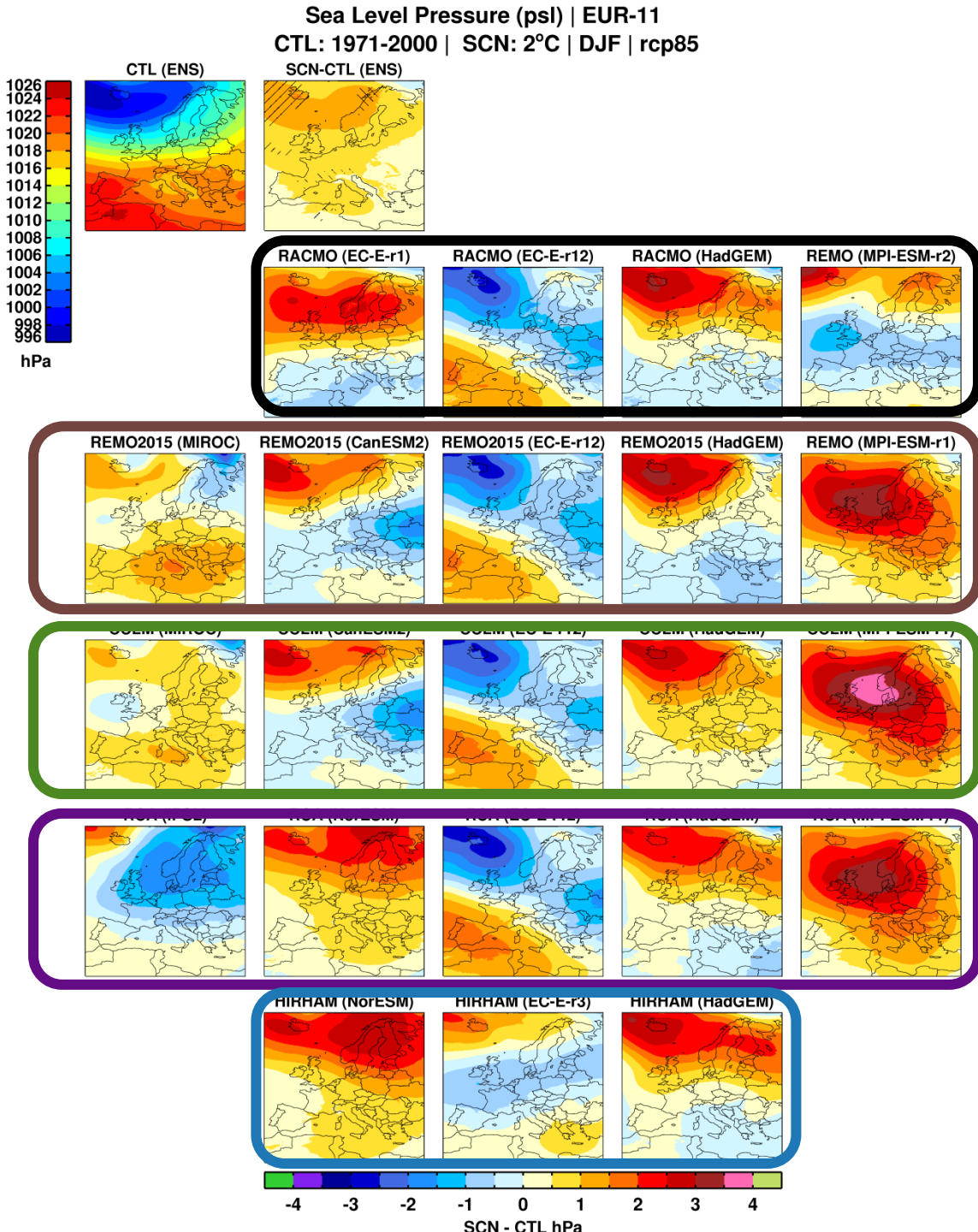


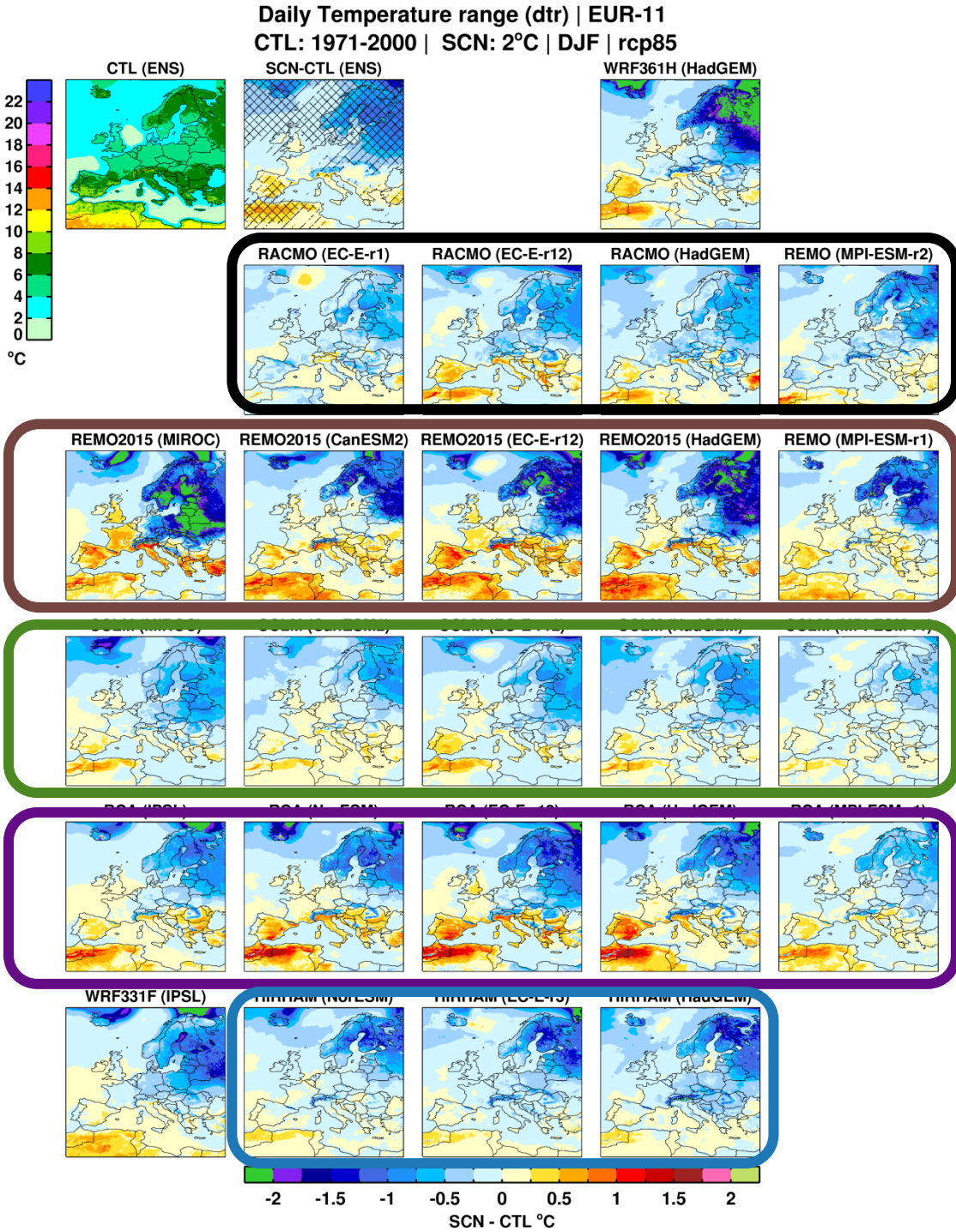
MSLP (DJF)

RCMs does not seem to influence the large-scale MSLP signal

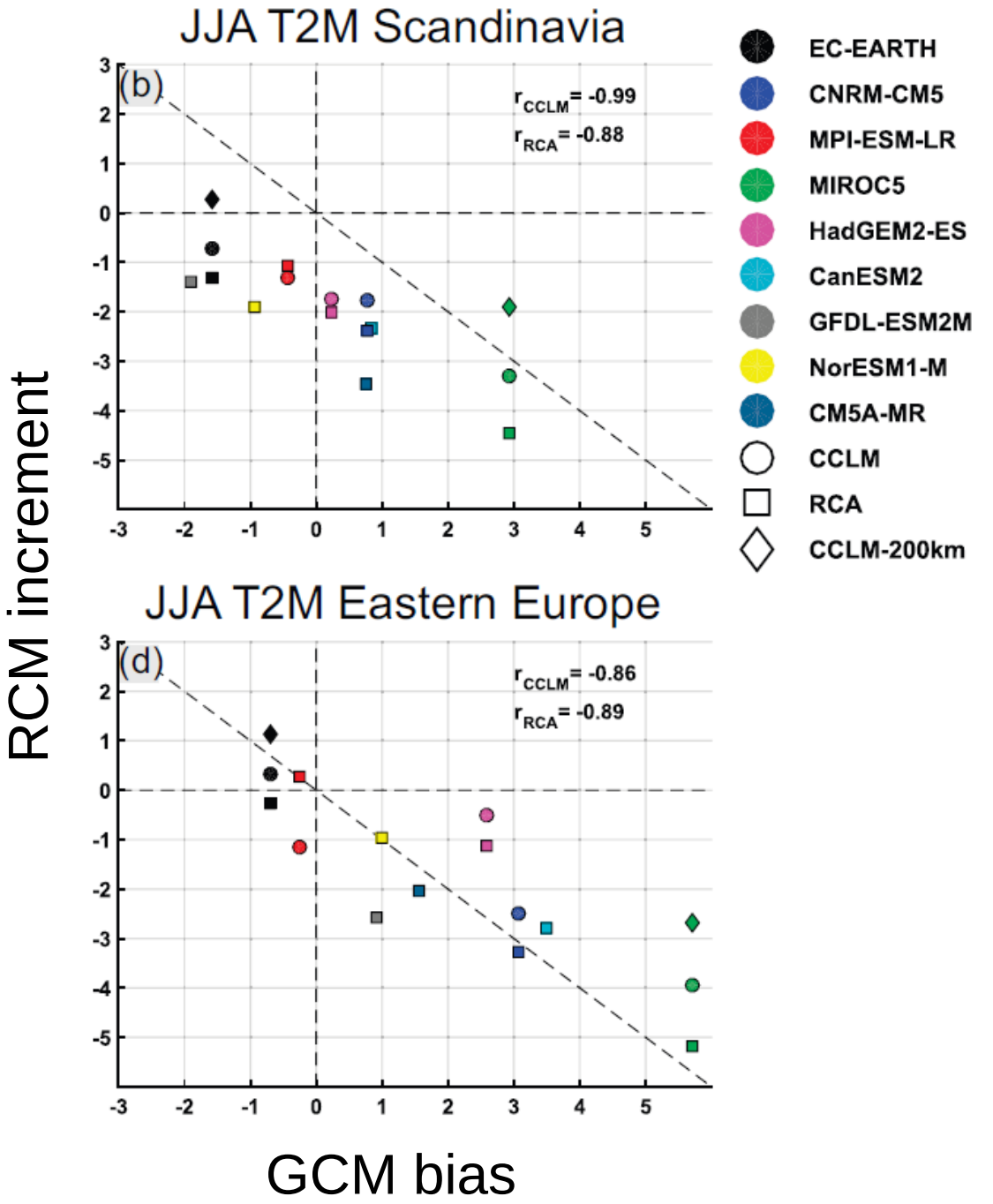


Diurnal Temperature Range (DJF)

Strong dependency on RCMs that modulate the large-scale signal

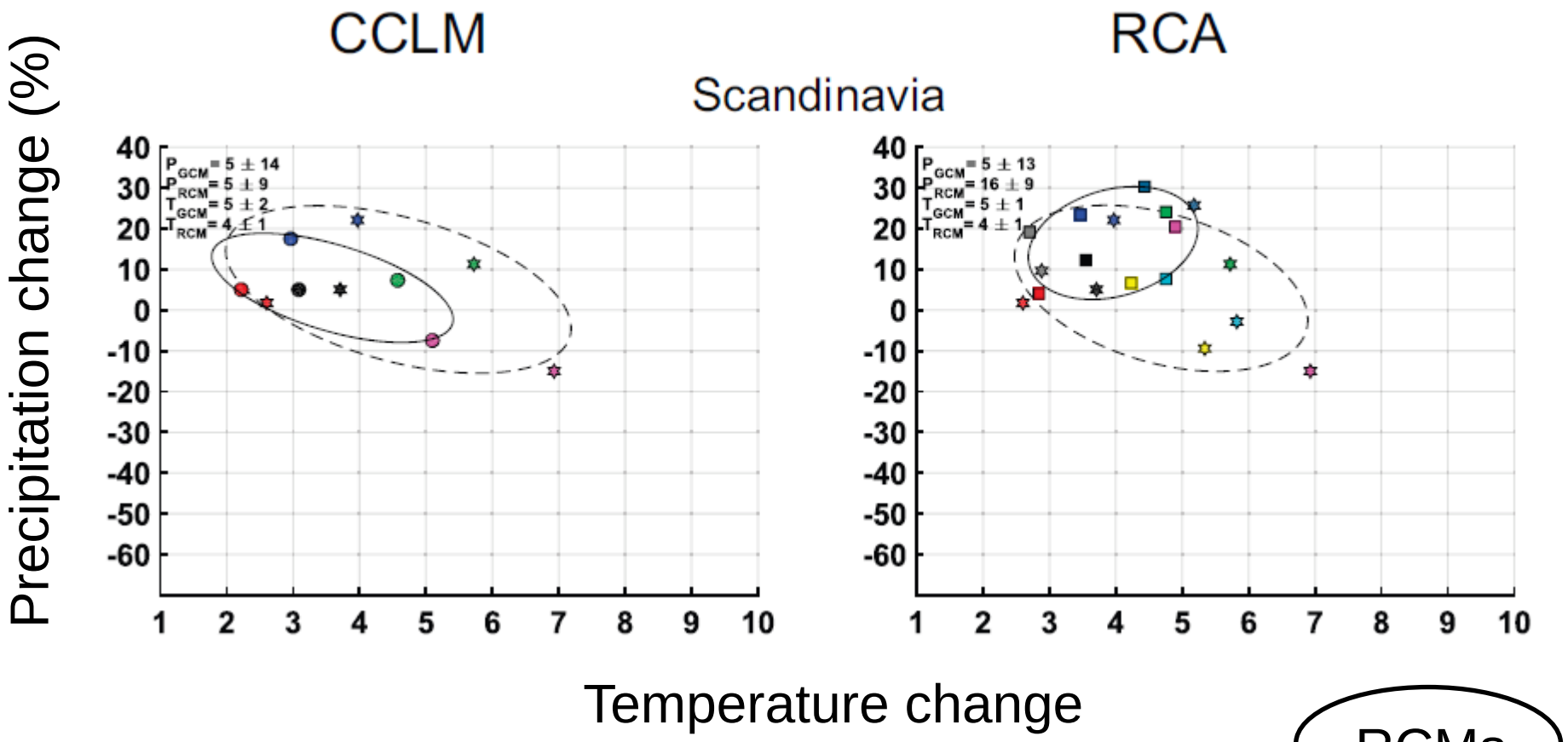


RCMs can improve the simulated climate w.r.t. the GCM also on larger scales



Sørland et al., 2018

RCMs may change the spread in results compared to the underlying GCMs



Sørland et al., 2018

Summary

- Already at SWL1.5 many changes are significant while at SWL2 stronger and more robust changes are found
- Undertainties related to choice of GCM, RCM and ensemble members varies with variable
- There is a strong impact of changes in the large-scale circulation
- Generally, there is a large impact of natural variability
- RCMs can improve also large-scale features in a GCM
- RCMs can significantly change the regional response in a GCM

Kjellström et al., 2018. European climate change at global mean temperature increases of 1.5 and 2 °C above pre-industrial conditions as simulated by the EURO-CORDEX regional climate models, *Earth Syst. Dynam*., 9, 459-478, https://doi.org/10.5194/esd-9-459-2018.

Sørland, S., Lüthi, D., Schär, C. and **Kjellström, E.**, 2018. Bias patterns and climate change signals in GCM-RCM model chains. *Environ. Res. Lett.,* 13, 074017, https://doi.org/10.1088/1748-9326/aacc77.