AN ENSEMBLE OF REGIONAL CLIMATE CHANGE SCENARIOS FOR THE NORDIC COUNTRIES

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A changing wind climate in the Nordic region?

Change in wind over the Baltic Sea in 70 years time at the time of CO₂-doubling



A need for regional ensemble simulations

- Changes are uncertain
- Size and sometimes even sign of changes differs!
- \succ Uncertainties depend on forcing, response and natural variability
- Detailed regional climate information is needed for impact models and adaptation studies
- > An ensemble can illustrate uncertainties
- > Ensembles can be used to construct probabilistic scenarios



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CES	& ENS	SEME	BLES	GCM	-RCM	l Ma	trix	22/	2/2	010	, + *Ê	**** * * NSEMBLES*
Giobai model Regional inst.	METO-HC Standard	METO-HC Low sens.	METO-HC Hi sens.	MPIMET Standard	MPIMET Ens.m. 1	MPIMET Ens.m. 2	IPSL	CNRM	NERSC	MIROC	СССМЗ	i otal number
МЕТО-НС	2100	2100*	2100*	2100 (late 2010)								4
MPIMET				2100			2050*					2
CNRM								2100				1
DMI				2100*				2100	2100* (04/2010)			3
ETH	2100											1
KNMI				2100* 2100	2100*	<u>2100</u> *				<u>2100</u> *		1+4
ІСТР				2100								1
SMHI		2100*		2100* 2100*					2100			3+1
UCLM	2050											1
C4I			2100*		2050 (A2)*							2
GKSS							2050*					1
METNO	2050*								2050*			1
СНМІ								2050* (12/2009)				1
OURANOS**											2050*	1
VMGO**	2050*											1
Total (1951- 2050)	5	2	2	7+2	0+1	0+1	2	3	3	0+1	1	25+5

Red: Online now; *: non-contractual runs; **:affiliated partners without obligations; <u>underscore</u>: 50km resolution; (in parantheses): Expected date. For partner acronym explanations, see the participant list. **NOTE** that all partners also did an ERA-40 driven analysis 1951(1961)-2000



Which RCM scenarios to use?

Recommendation to the CES project:

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- 1) All available at the ENSEMBLES data base !
- 2) A subset sampling as large uncertainty as possible
- 3) A smaller subset consisting of:

i) DMI - HIRHAM forced with ECHAM5

ii) Met.No – HIRHAM forced with HadCM3ref (Delivery in summer)

iii) SMHI – RCA3 forced with BCM

(rationale: as many forcing AOGCMs as possible)



HIRHAM in ECHAM5: 50-year RP wind speed (m s⁻¹): 2021-2050



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Selection of simulations

No.	Institute	RCM	GCM
1	DMI	HIRHAM5	Arpège
2	DMI	HIRHAM5	ECHAM5
3	Met.No	HIRHAM	HadCM3Q0 (ref)
4	SMHI	RCA3	BCM
5	SMHI	RCA3	ECHAM5
6	SMHI	RCA3	HadCM3Q3 (low)
7	VMGO	RRCM	HadCM3Q0 (ref)
8	C4I	RCA3	HadCM3Q16 (high)
9	CNRM	RM4.5	Arpège
10	ETH	CLM	HadCM3Q0 (ref)
11	KNMI	RACMO2	ECHAM5
12	Hadley Centre	HadRM3Q0	HadCM3Q0 (ref)
13	Hadley Centre	HadRM3Q3	HadCM3Q3 (low)
14	Hadley Centre	HadRM3Q16	HadCM3Q16 (high)
15	MPI-M	REMO	ECHAM5



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Ensemble mean change (2021-2050 vs 1961-1990) in T2m



An example of spread between individual simulations

Winter (DJF) changes in T2m in the three recommended CES simulations



Ensemble mean change (2021-2050 vs 1961-1990) in precipitation



An example of spread between individual simulations

 Summer (JJA) changes in precipitaiton in four simulations with the same GCM



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Change in annual mean wind speed (2021-2050 vs 1961-1990)

• Change in 3 RCM-simulations forced by 3 GCMs



Summary of results for the Nordic countries

- Largest temperature increase in the northeast in winter. All changes are large compared to the spread between the scenarios
- Strongest summertime increases in temperatures over oceans were sea-ice is reduced
- Increasing precipitation in winter and summer
- Larger spread in precipitation than in temperature indicating larger uncertainty
- Small changes in wind speed, large spread
- Locally, over ocean, up to c. 10% increase



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Colored lines represent averages over RCMs forced by the same GCM Gray field is max/min of all RCM simulations



Why are differences between ensemble members so large?



Concluding remarks

- The 3 recommended RCM scenarios fit well in the wider range of CES/ENSEMBLES RCM-GCM matrix
- Uncertainties in climate change can to some degree be illustrated by the spread between the simulations
- Choice of GCM is important, but also choice of RCM plays a role as source of uncertainty
- Role of natural variability as a source of uncertainty is not addressed in the **CES/ENSEMBLES RCM-GCM matrix**



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Problems with global climate models

Details in precipitation are not captured: example winter (DJF)

Observations



mm/month



