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LATVIJAS UNIVERSITATE
ANNO 1919

Assessment of wind parameters from results of regional climate models

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Projektu finansē Eiropas Savienības Igaunijas – Latvijas programma. Igaunijas – Latvijas programma tiek īstenota atbilstoši Eiropas teritoriālās sadarbības principiem, tā atbalsta Igaunijas un Latvijas pārrobežu sadarbību. Programmu finansē Eiropas Reģionālās attīstības fonds, Igaunijas Republika un Latvijas Republika.

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Introduction

1. Workflow
2. Regional climate model (RCM) data used in the analysis
3. Concept of inter-model statistics
4. Monthly average wind speed and gust and their change in the near future as calculated by ensemble of RCMs
5. Wind speed from DMI HIRLAM

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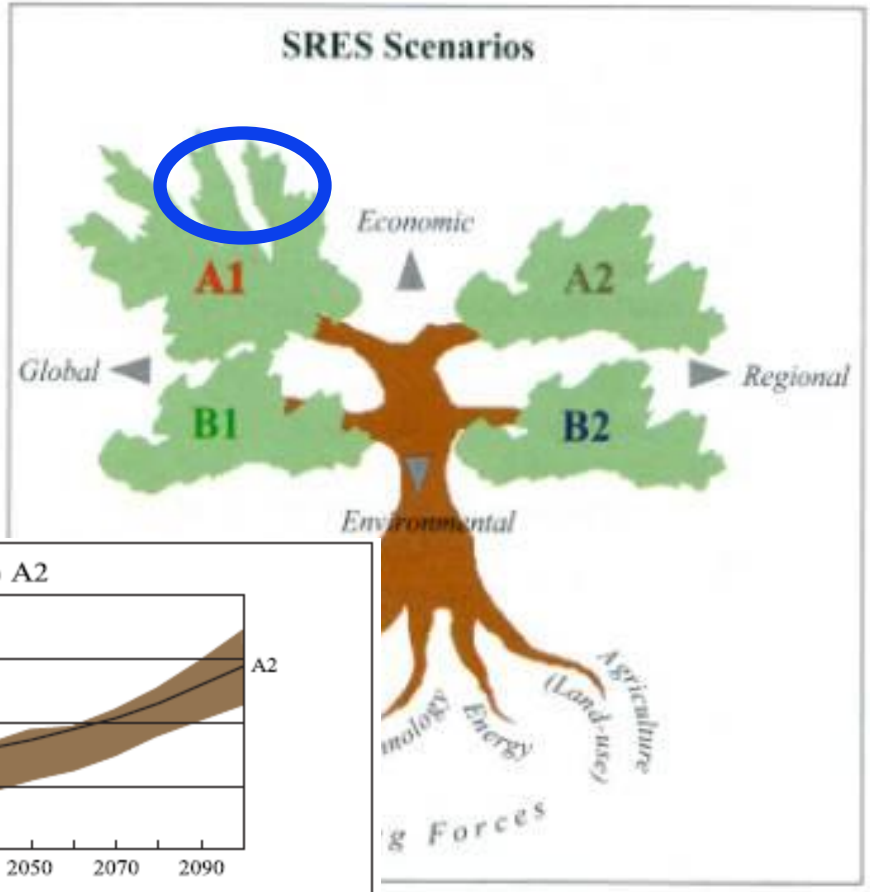
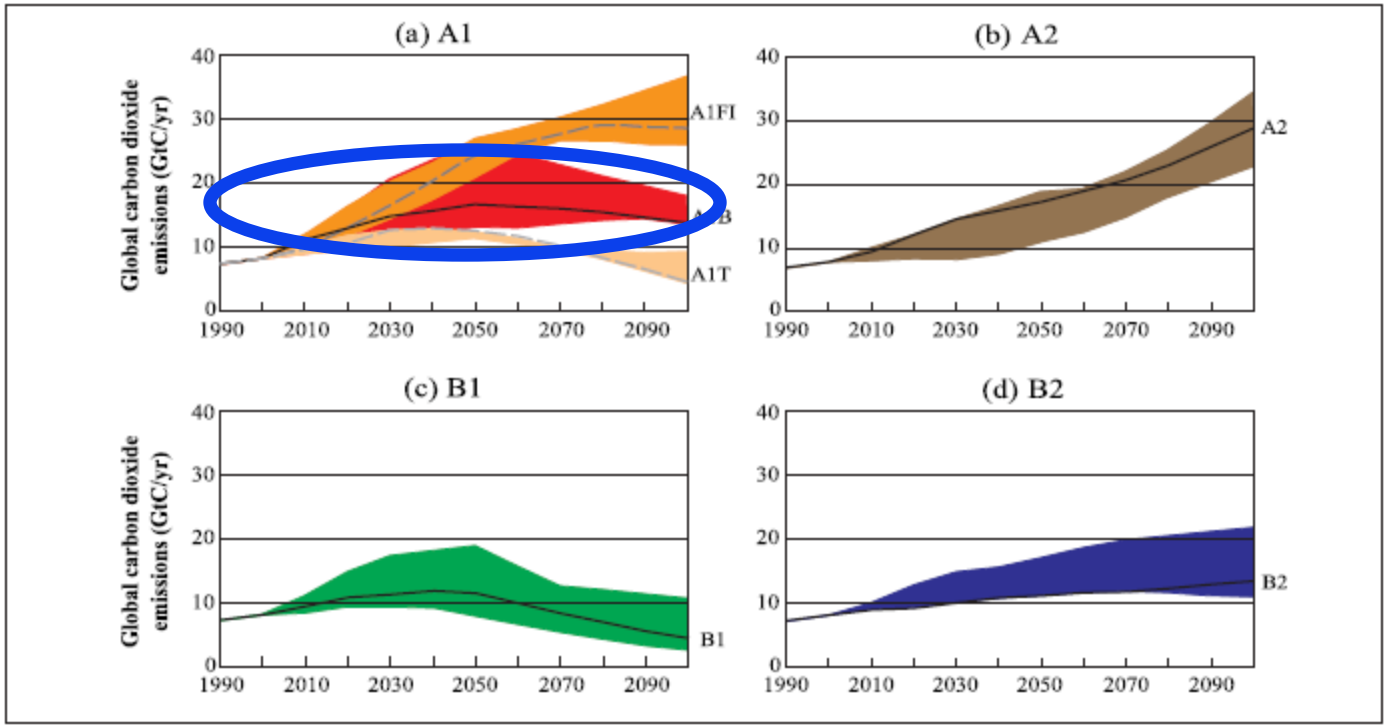
IPCC (2007) – storylines and scenario families

PRUDENCE (2006) – A2, B2, time slices (1961-90, 2071-2100)

ENSEMBLES (2009) – A1B, continuous time (1951-2100)





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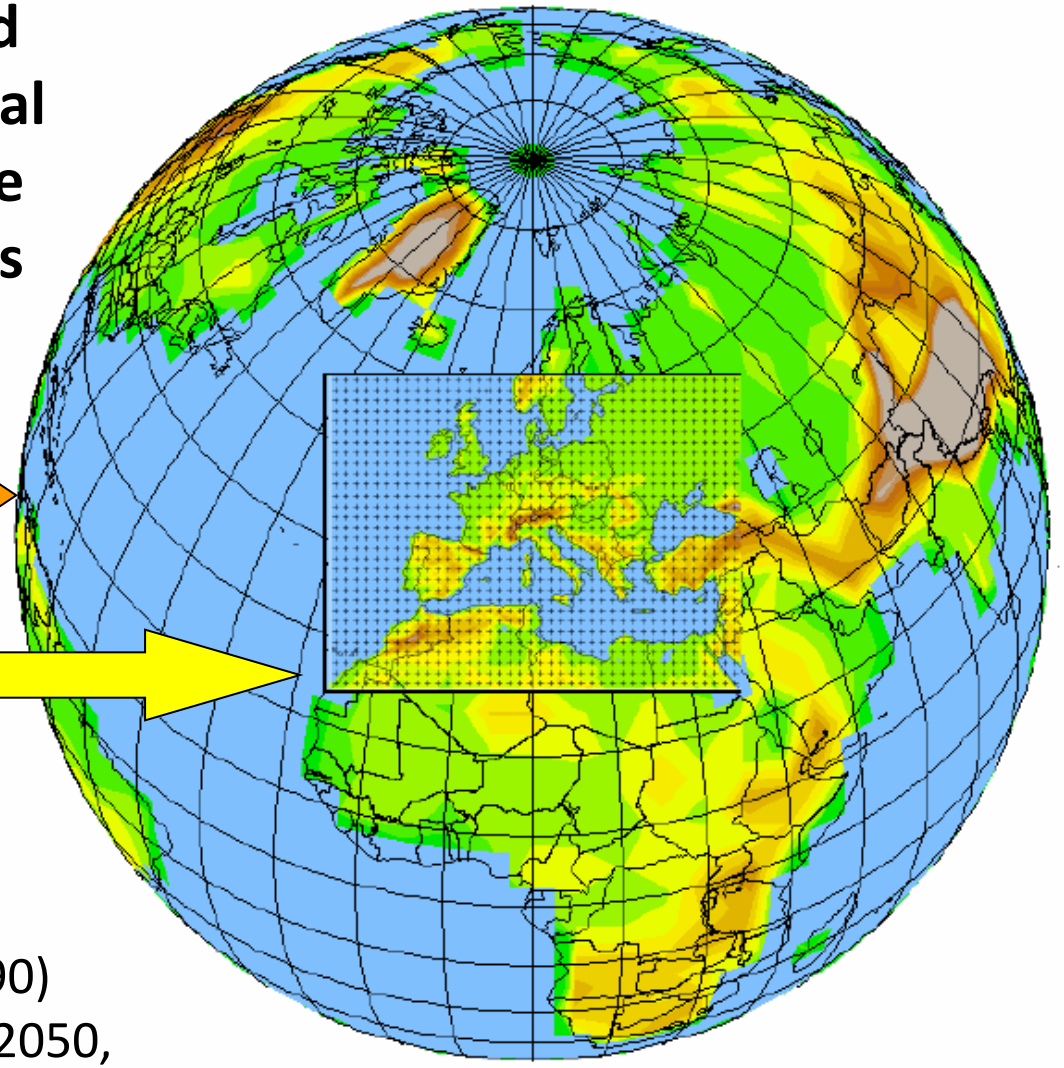
Global and regional climate models

Global IPCC storyline

Global circulation model

Regional climate model



"RUN" = Storyline+GCM+RCM

Time slices:

"Contemporary climate" (1961-1990)

"Climate change scenarios" (2021-2050, 2071-2100 – near and far future)

OR

"Continuous climate"

PRUDENCE, ENSEMBLES (~40 "runs" for A1B)

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RCM data

ENSEMBLES

"The ENSEMBLES project (contract number GOCE-CT-2003-505539) is supported by the European Commission's 6th Framework Programme as a 5 year Integrated Project from 2004-2009 under the Thematic Sub-Priority "Global Change and Ecosystems". "...develop an ensemble prediction system for climate change based on the principal state-of-the-art, high resolution, global and regional Earth System models developed in Europe, validated against quality controlled, high resolution gridded datasets for Europe, to ***produce for the first time, an objective probabilistic estimate of uncertainty in future climate*** *at the seasonal to decadal and longer timescales". http://ensembles-eu.metoffice.com/index.html*

Model data sets for the A1B scenario are given for the time period 1961 – 2100.

23 model runs were considered.

Institution	GCM	RCM
C4I	HadCM3Q16	RCA3
CNRM	ARPEGE	Aladin
CNRM	ARPEGE_RM 5.1	Aladin
DMI	ARPEGE	HIRHAM
DMI	ECHAM5-r3	DMI-HIRHAM5
ETHZ	HadCM3Q0	CLM
GKSS	IPSL	CLM
HC	HadCM3Q0	HadRM3Q0
HC	HadCM3Q16	HadRM3Q16 (high sensitivity)
HC	HadCM3Q3	HadRM3Q3 (low sens.)
ICTP	ECHAM5-r3	RegCM
KNMI	ECHAM5-r3	RACMO
KNMI	ECHAM5-r3	RACMO
KNMI	MIROC	RACMO
METNO	BCM	HIRHAM
METNO	HadCM3Q0	HIRHAM
MPI	ECHAM5-r3	REMO
SMHI	BCM	RCA
SMHI	ECHAM5-r3	RCA
SMHI	HadCM3Q3	RCA
UCLM	HadCM3Q0	PROMES
VMGO	HadCM3Q0	RRCM

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RCM data – wind related output data

Field name	short name	MKS Units CF Standard	Cell_ methods	CF standard_ name
10-meter U wind	uas	m s-1	time: mean	eastward_wind
10-meter V wind	vas	m s-1	time: mean	northward_wind
10-meter wind speed	wss	m s-1	time: mean	wind_speed
10-meter daily max. wind speed, without gust	wssmax	m s-1	time: maximum	wind_speed
10-meter daily max. wind speed incl. gust	wsgsmax	m s-1	time: maximum	wind_speed_of_gust

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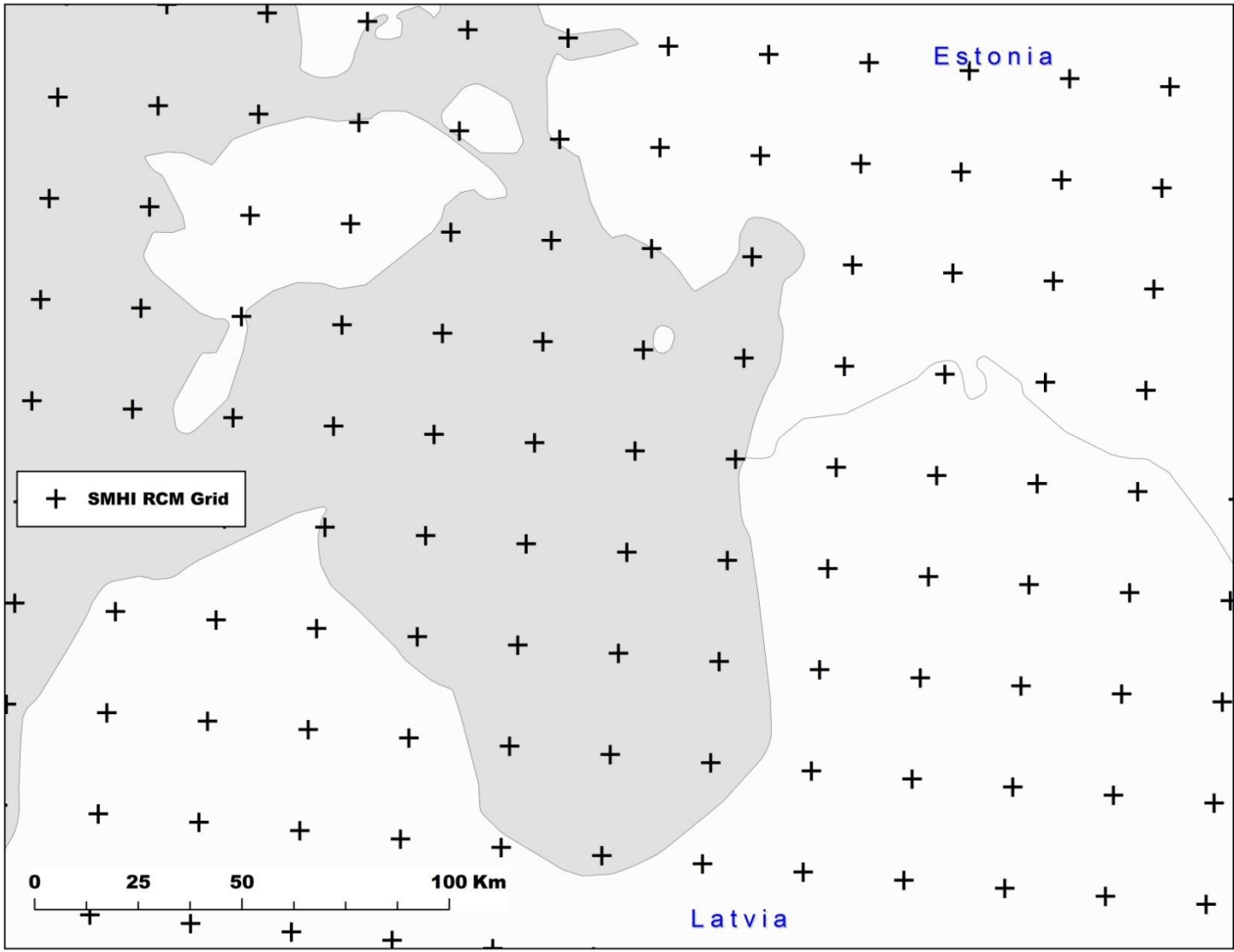
DECISIONS / RESULTS SO FAR

RCMs: ENSEMBLES, A1B storyline, list of parameters
– W10m (u, v, W), maxW, maxGust, T2m, p0m. &
"3d fields = u,v @ different p", land/sea fraction

Time periods: 1981-2010 (con-temporary) 2021-2050 (near future)



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RCM calculations scattered, and do not match observations

... Bias correction via statistical downscaling – uncertainty eliminated, procedure for wind related parameters to be developed

... Removal of biases for future climate projections – uncertainty remains

ENSEMBLE OF FUTURE CLIMATE PROJECTIONS

Quantifying uncertainty e.g. Moderate, Average or Significant climate change

Annual average wind speed at Ruhnu (1961-1990) as calculated by transient RCM runs.

		Annual average wind
ENS_SMHI_RCA_BCM	SMHIRCA	4.25
ENS_SMHI_RCA_ECHAM5-r3	SMHIRCA	5.09
ENS_SMHI_RCA_HadCM3Q3	SMHIRCA	5.24
ENS_C4I_RCA3_HadCM3Q16	C4IRCA3	5.50
ENS_KNMI_RACMO_MIROC	KNMI-RACMO2	5.95
ENS_VMGO_RRCM_HadCM3Q0	VMGO-RRCM	6.01
ENS_HC_HadRM3Q16 (high sensitivity)_HadCM3Q16	METO-HC HadRM3Q16	6.09
ENS_KNMI_RACMO_ECHAM5-r3	KNMI-RACMO2	6.15
ENS_METNO_HIRHAM_BCM	METNOHIRHAM	6.40
ENS_ICTP_RegCM_ECHAM5-r3	ICTP-REGCM3	6.76
ENS_MPI_REMO_ECHAM5-r3	MPI-M-REMO	6.84
ENS_KNMI_RACMO_ECHAM5-r3	KNMI-RACMO2	6.93
ENS_ETHZ_CLM_HadCM3Q0	ETHZ-CLM	6.95
ENS_CNRM_Aladin_ARPEGE_RM 5.1 ens.mb to 2100	CNRM-RM5.1	6.97
ENS_METNO_HIRHAM_HadCM3Q0	METNOHIRHAM	7.01
ENS_HC_HadRM3Q3 (low sens.)_HadCM3Q3	METO-HC_HadRM3Q3	7.03
ENS_HC_HadRM3Q0_HadCM3Q0	METO-HC_HadRM3Q0	7.05
ENS_CNRM_Aladin_ARPEGE	CNRM-RM4.5	7.22
ENS_DMI_HIRHAM_ARPEGE	DMI-HIRHAM5	7.53
ENS_DMI_DMI-HIRHAM5_ECHAM5-r3	DMI-HIRHAM5	7.59
ENS_UCLM_PROMES_HadCM3Q0	UCLM-PROMES	7.65
Median	**50%**	**6.84**
Low	**17%**	**5.41**
High	**83%**	**7.32**

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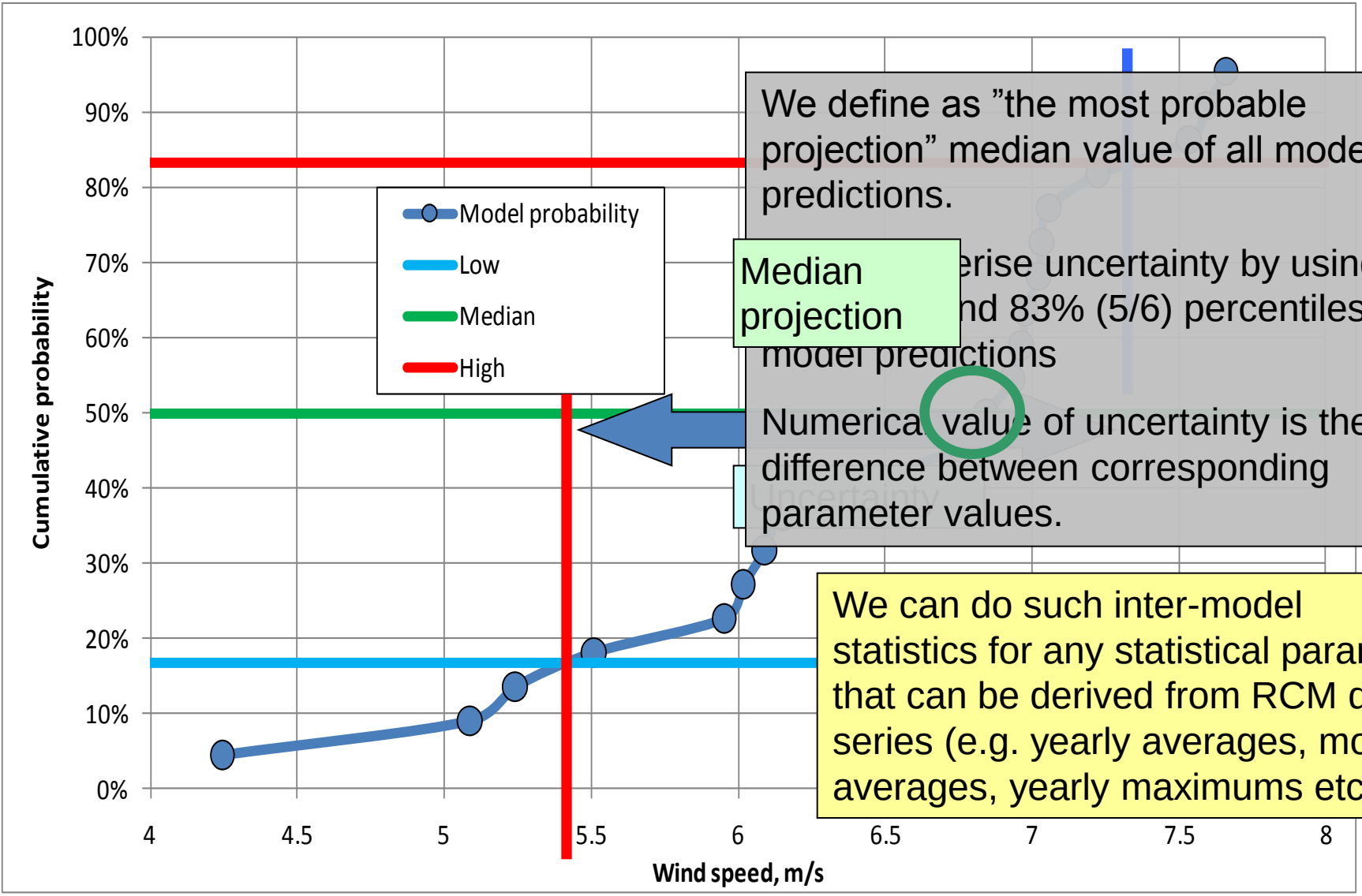
Inter-model statistics



We define as ”the most probable projection” median value of all model predictions.

Median projection

erise uncertainty by using nd 83% (5/6) percentiles of model predictions

Numerical value of uncertainty is the difference between corresponding parameter values.

We can do such inter-model statistics for any statistical parameter that can be derived from RCM data series (e.g. yearly averages, monthly averages, yearly maximums etc.)

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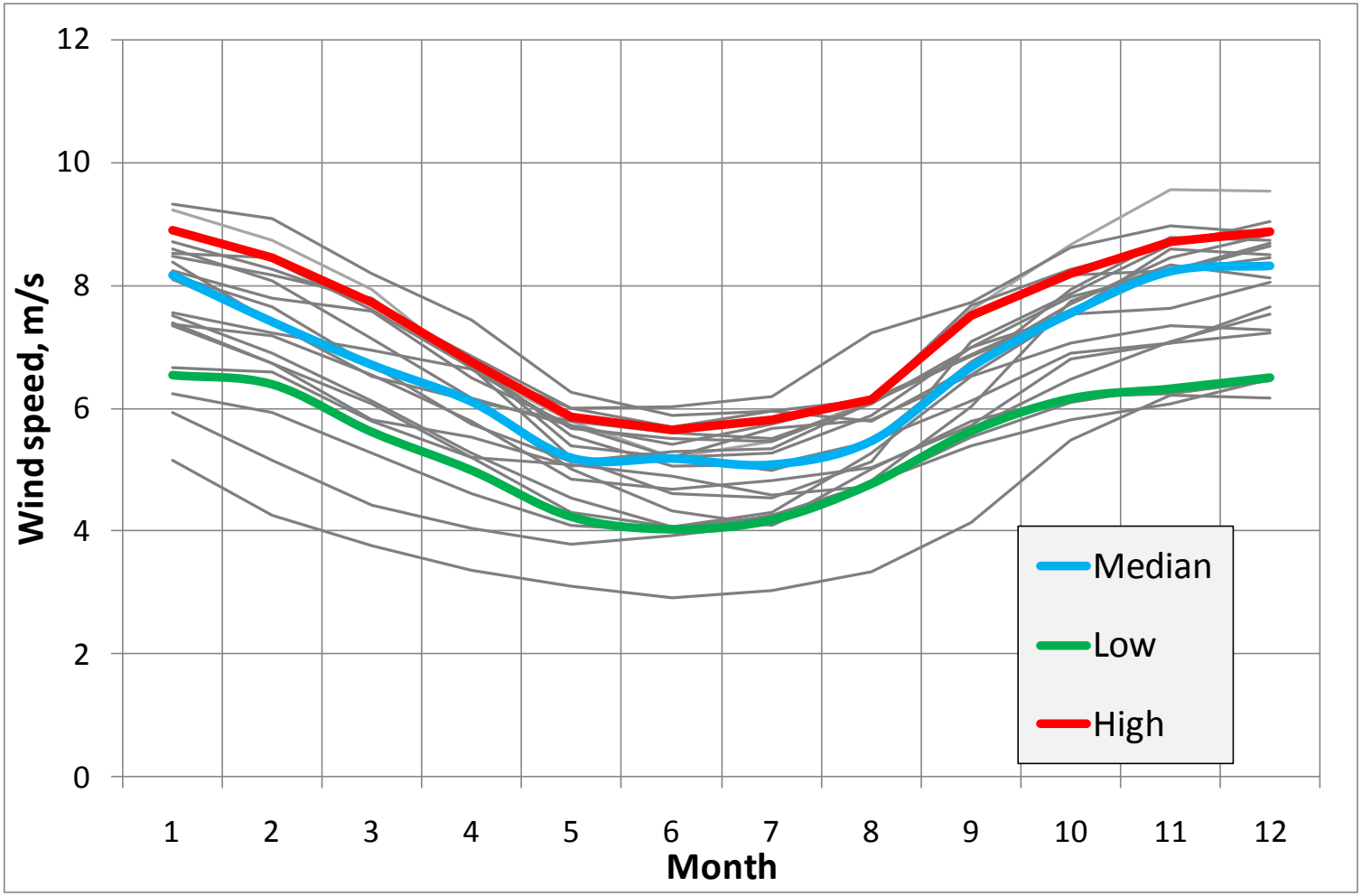
Average wind data from ENSEMBLES



Monthly average wind speed (Ruhnu), data from ENSEMBLES transient runs for the period 1961-1990. Gray lines – model data (23 models), colored lines – median, 17% and 83% percentiles.

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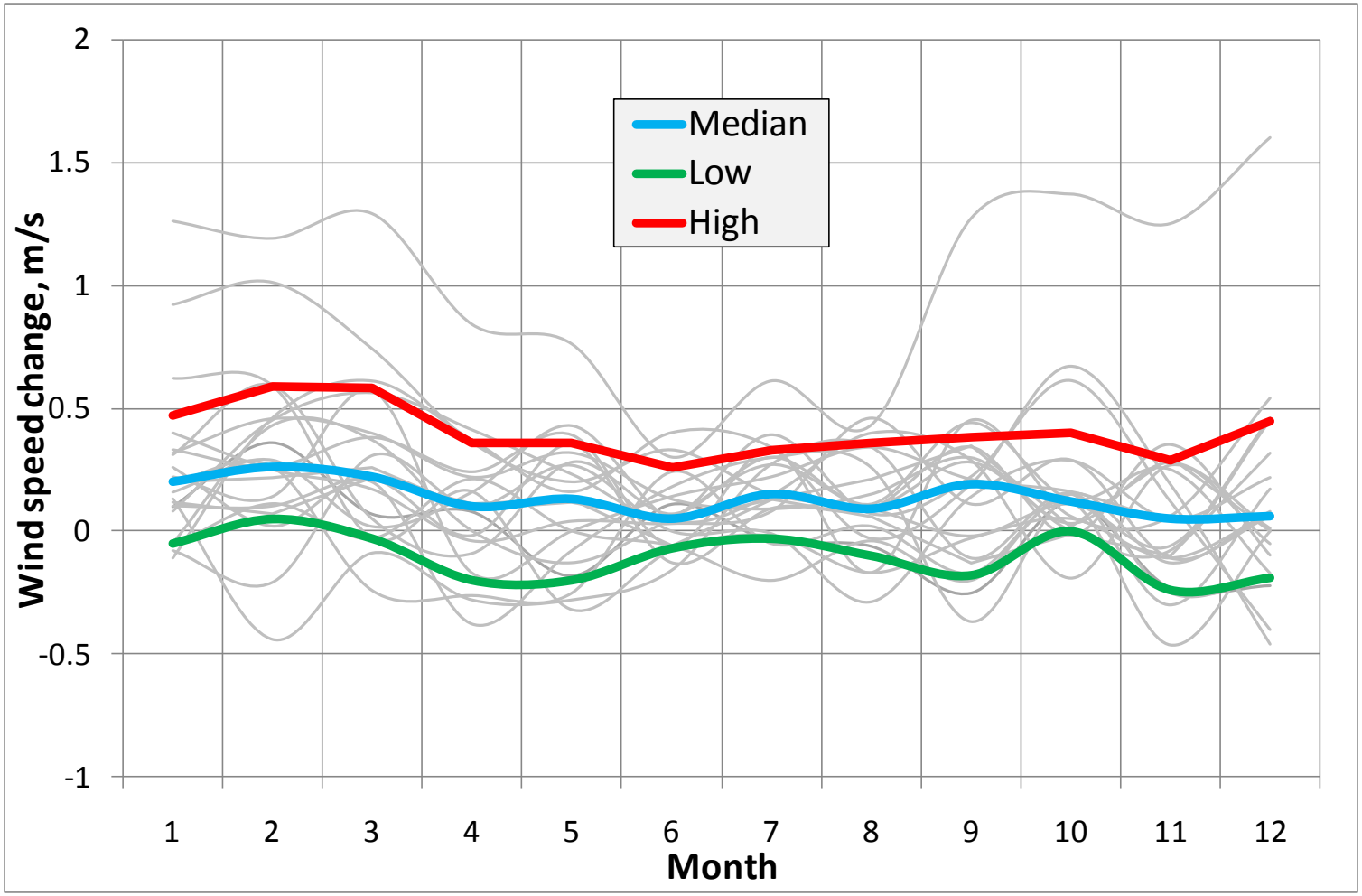
Average wind data from ENSEMBLES



Change of monthly average wind speed (Ruhnu) between time periods 2021-2050 and 1961-1990, data from ENSEMBLES transient runs. Gray lines – model data (23 models), colored lines – median, 17% and 83% percentiles.

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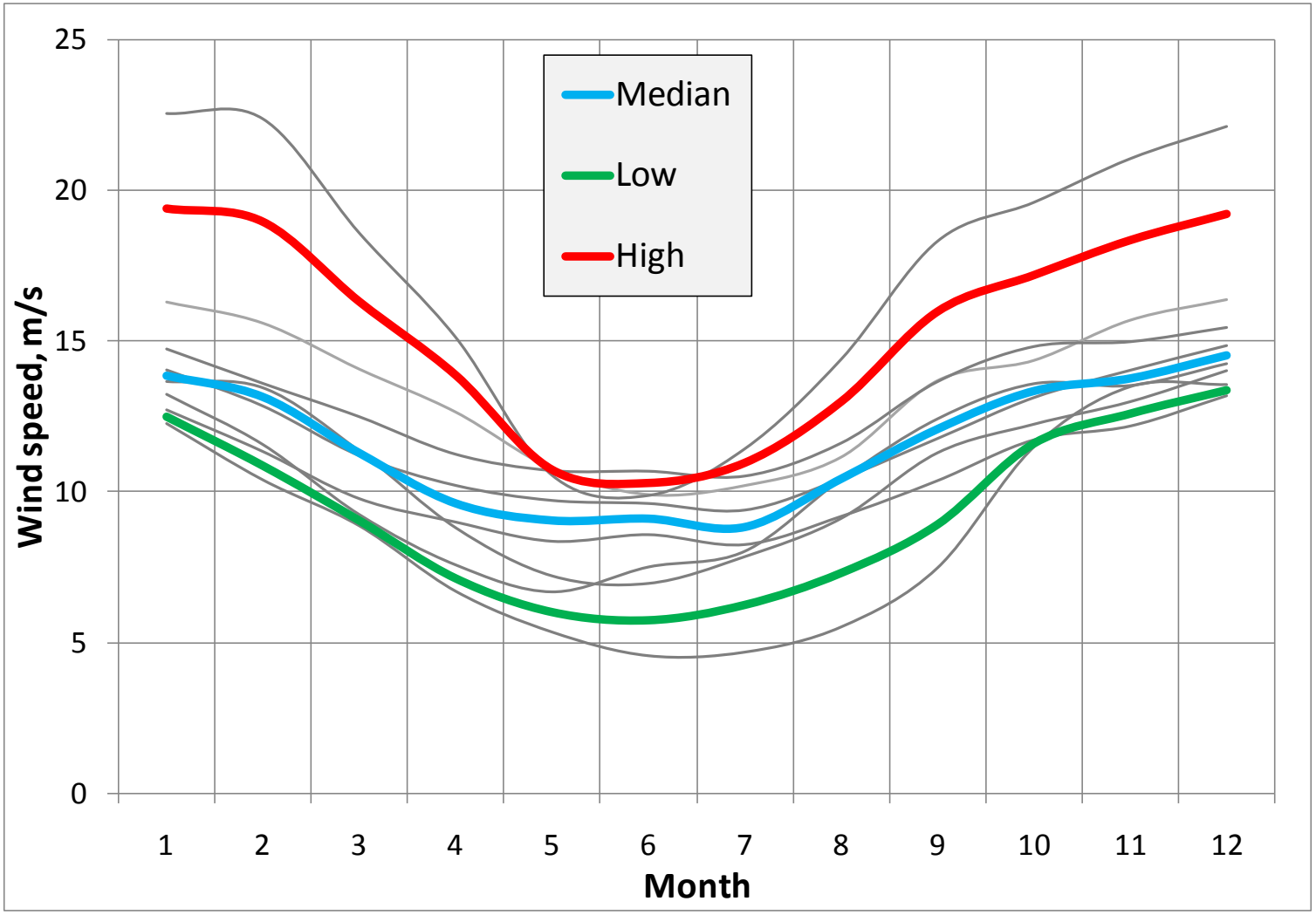
Wind gust data from ENSEMBLES



Monthly average wind gust (Ruhnu), data from ENSEMBLES transient runs for the period 1961-1990. Gray lines – model data (8 models), colored lines – median, 17% and 83% percentiles.

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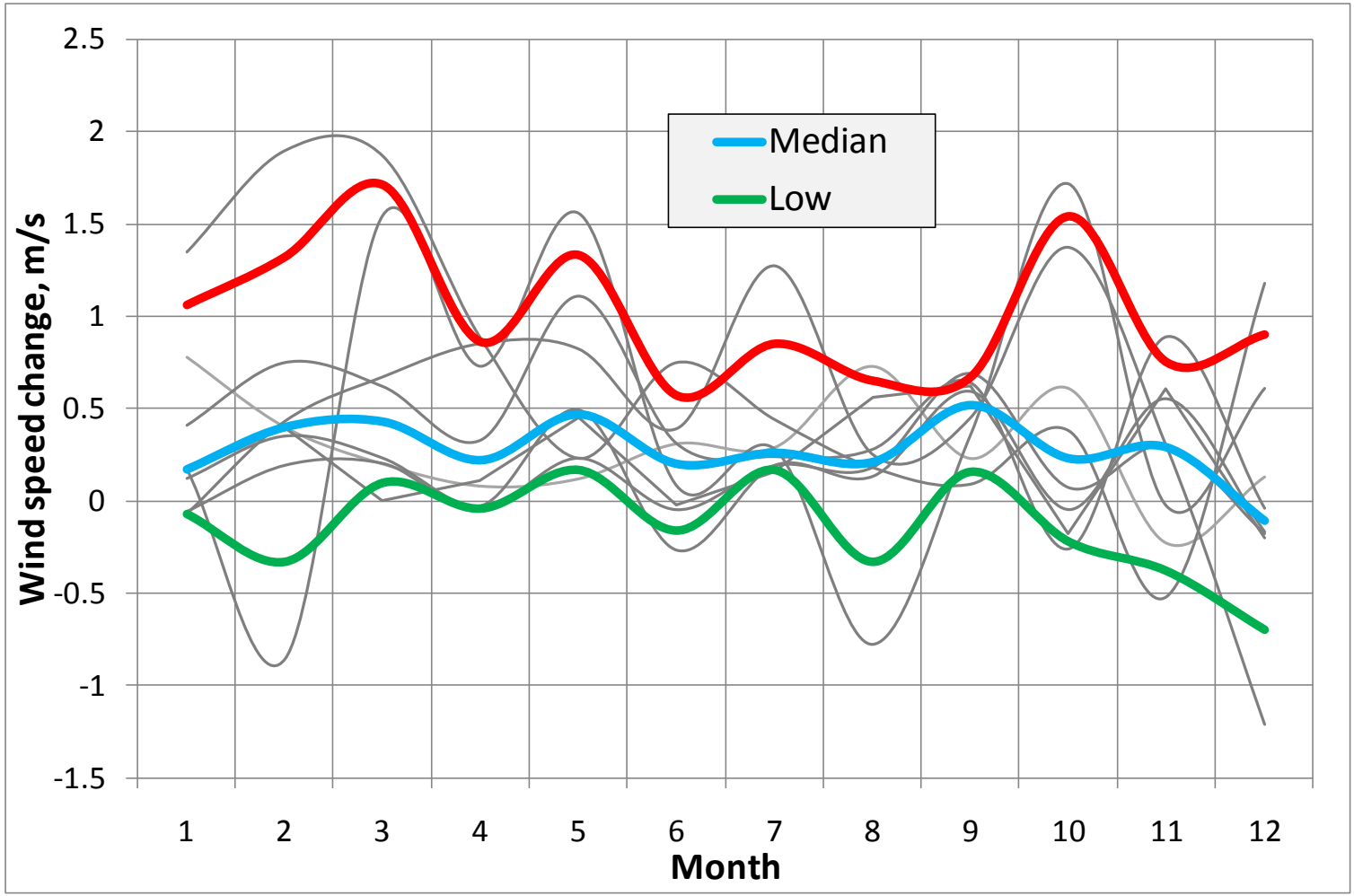
Wind gust data from ENSEMBLES



Change of monthly average wind gust (Ruhnu) between time periods 2021-2050 and 1961-1990, data from ENSEMBLES transient runs. Gray lines – model data (8 models), colored lines – median, 17% and 83% percentiles.

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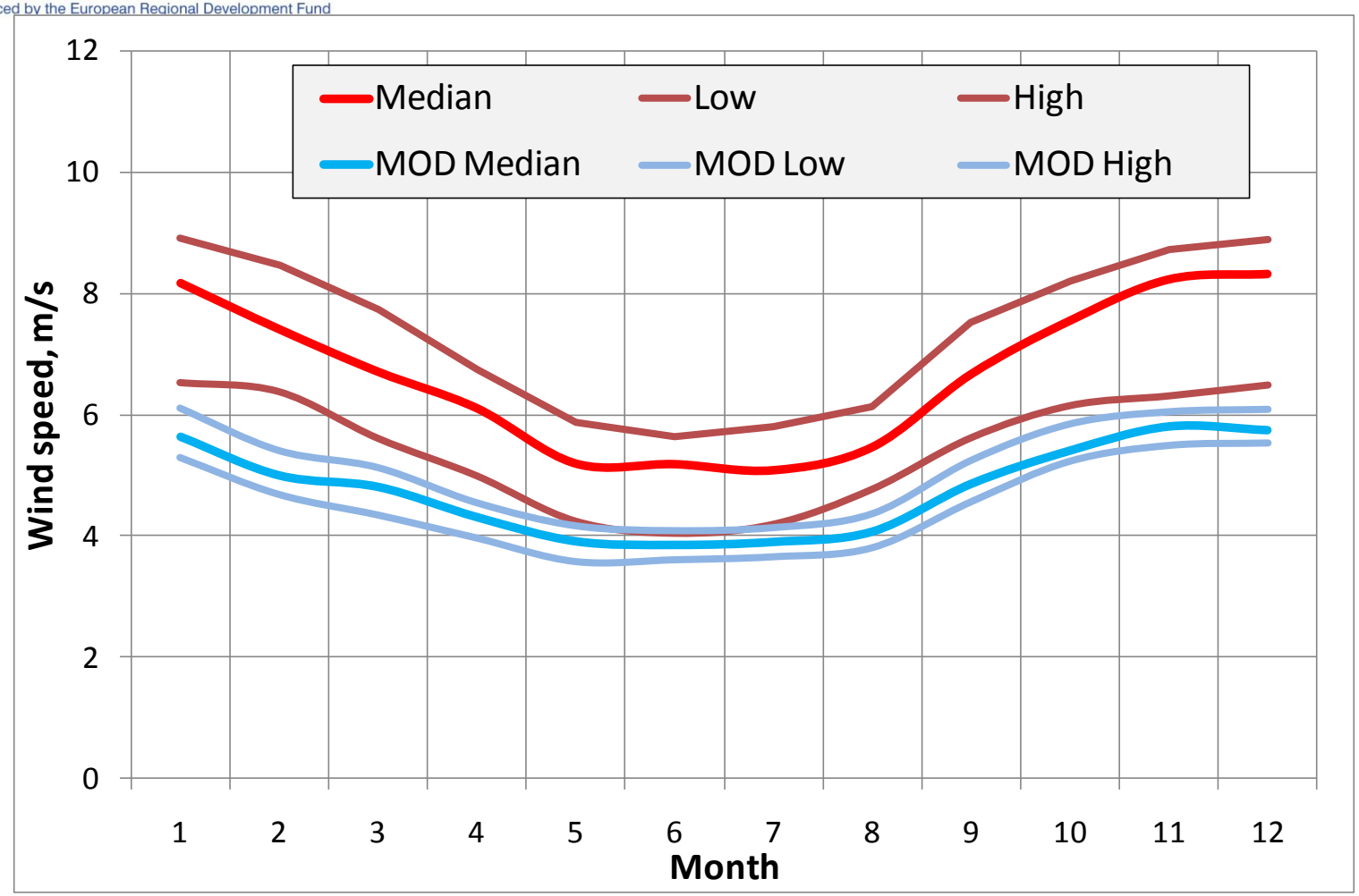
Need for bias correction ?



Statistical bias correction significantly reduces uncertainty of model results for the control time period 1961-1990.

JUST EXAMPLE GIVEN !!!

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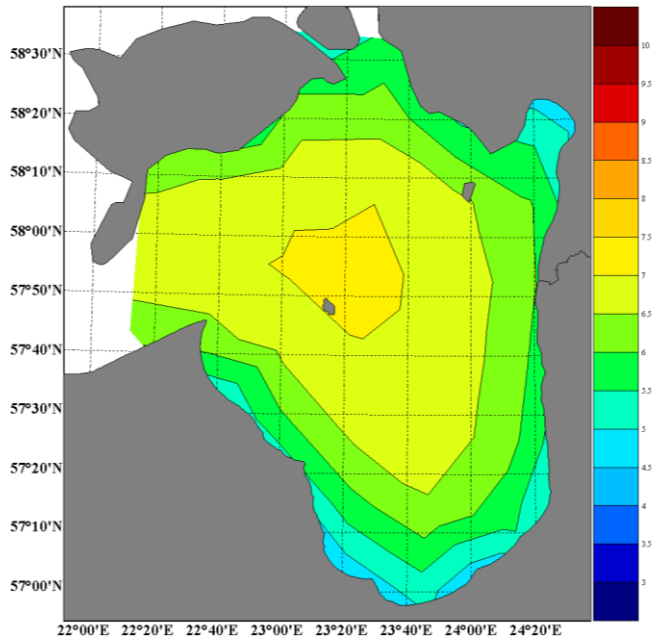
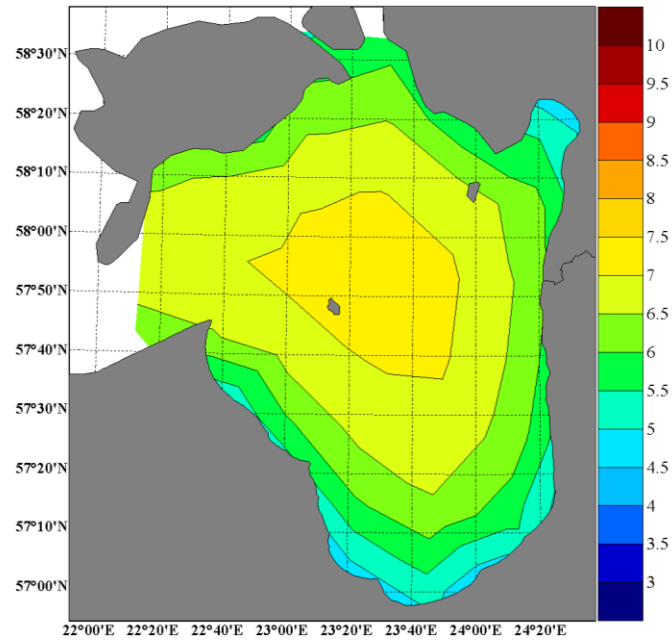
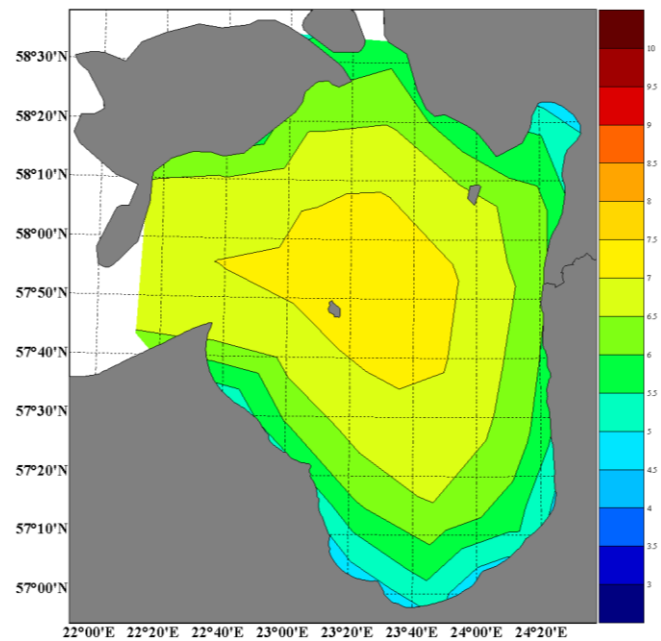


1961-1990



1981-2010

2021-2050



Annual average wind speed (RCM ensemble median) for different time periods

Slight increase of wind speed in the near future

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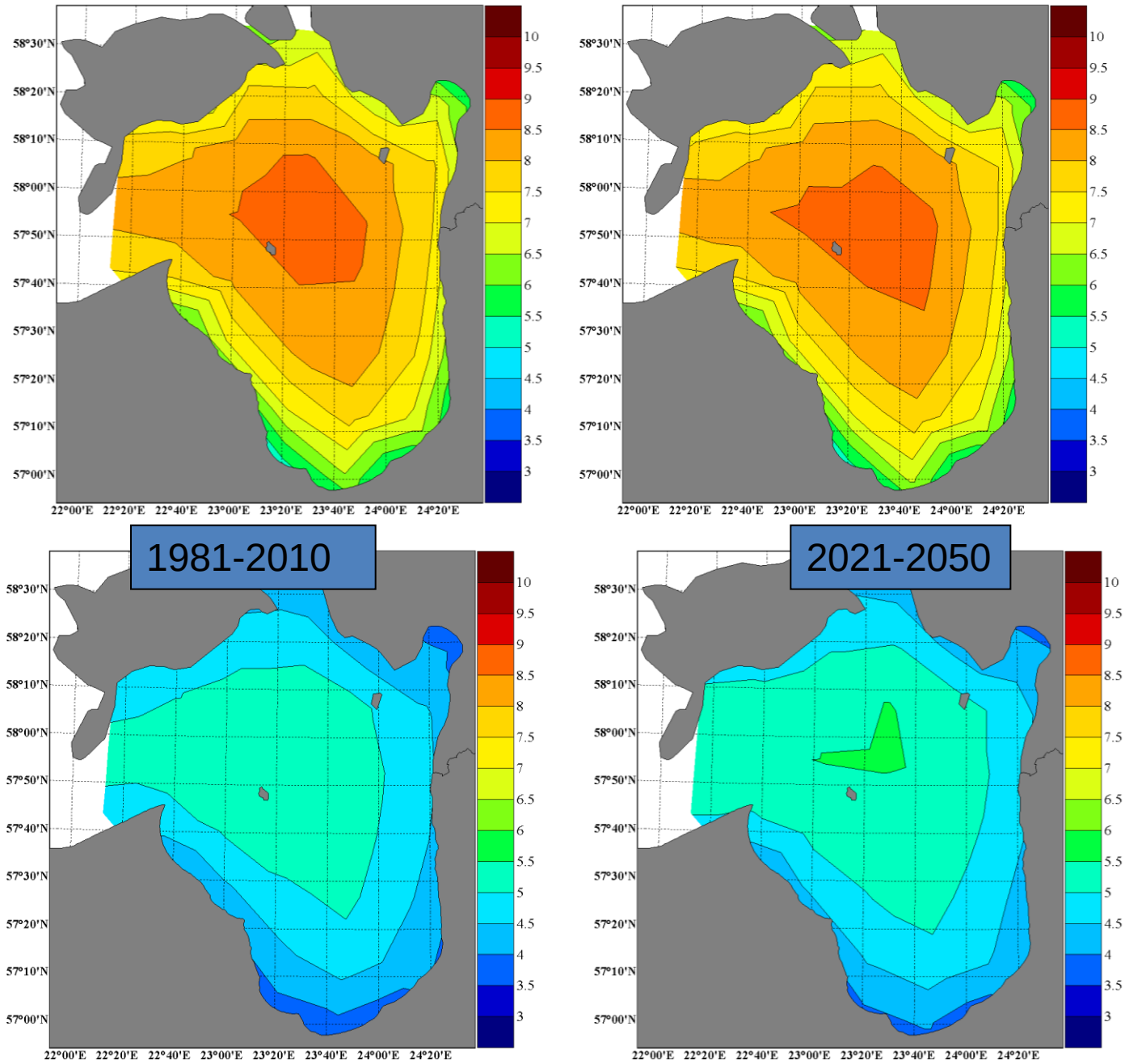
January

Average wind speed (RCM ensemble median) for different time periods

Slight increase of wind speed in the near future



July

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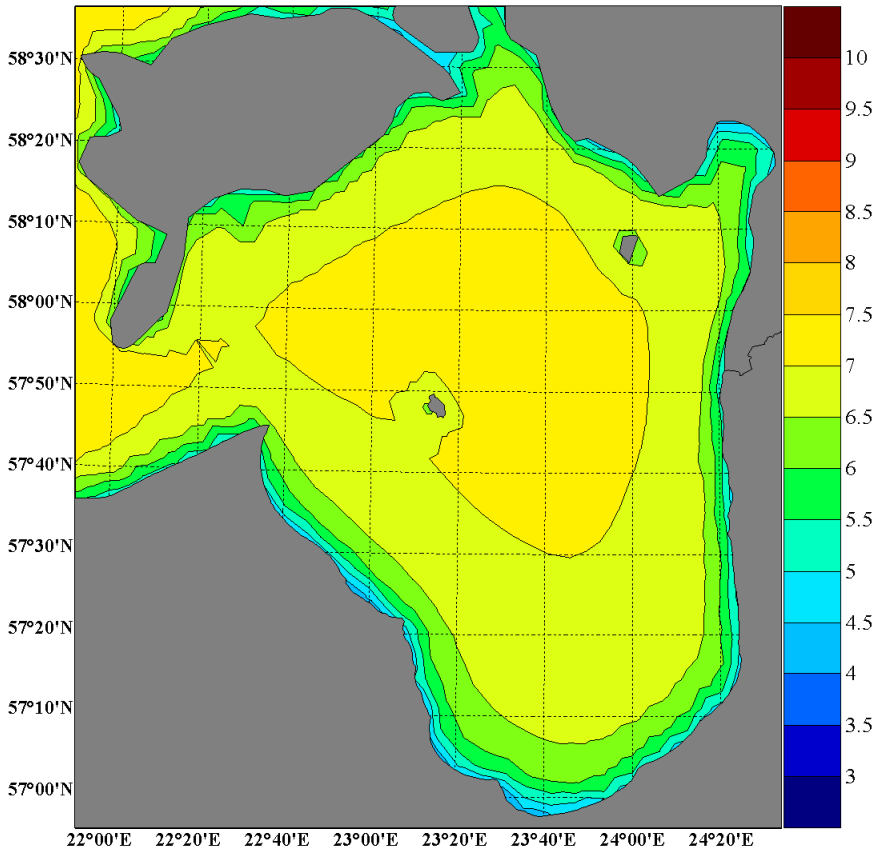
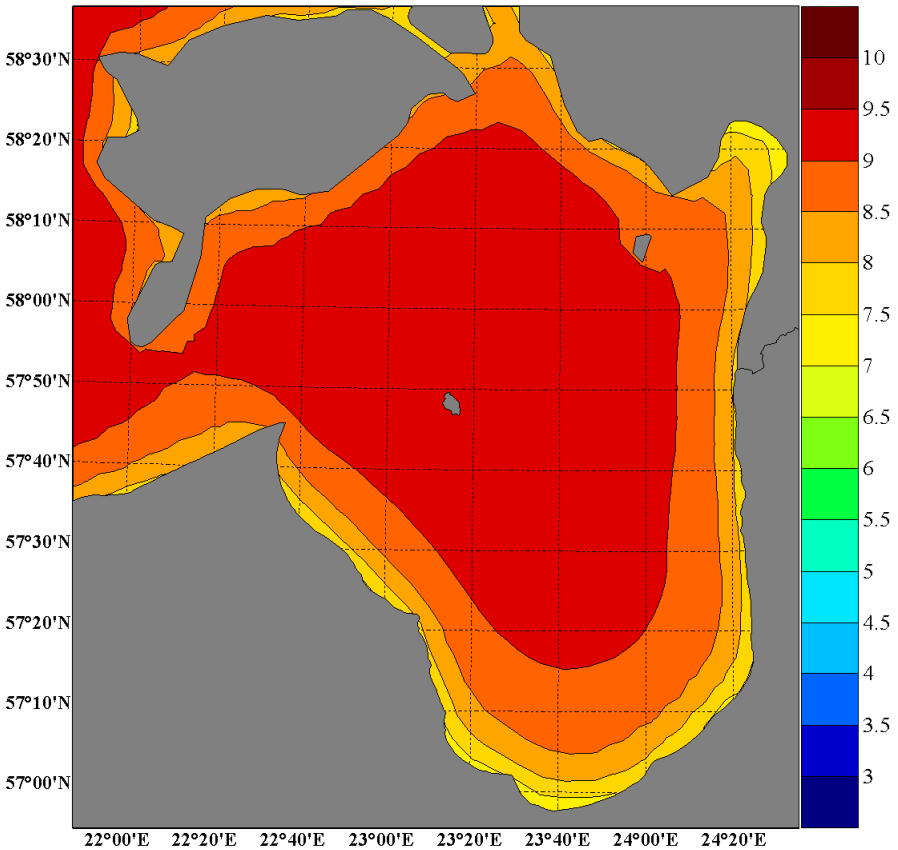
Annual average wind speed from DMI HIRLAM 2008-2010 at 10m and 100m



Wind at 10m



Wind at 100m

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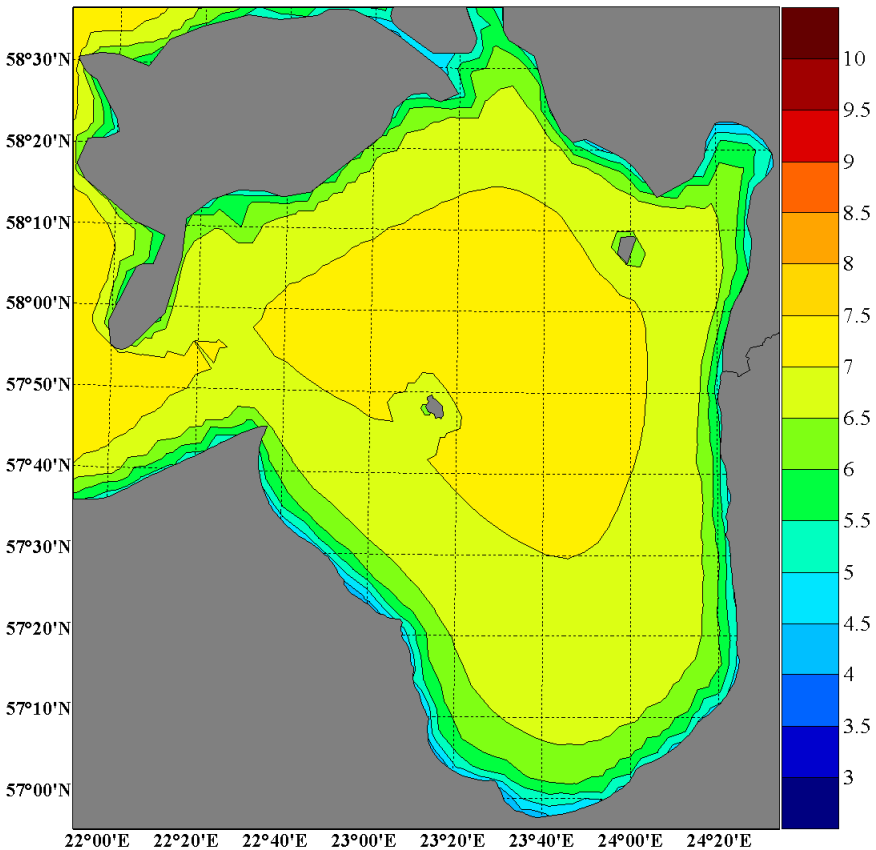
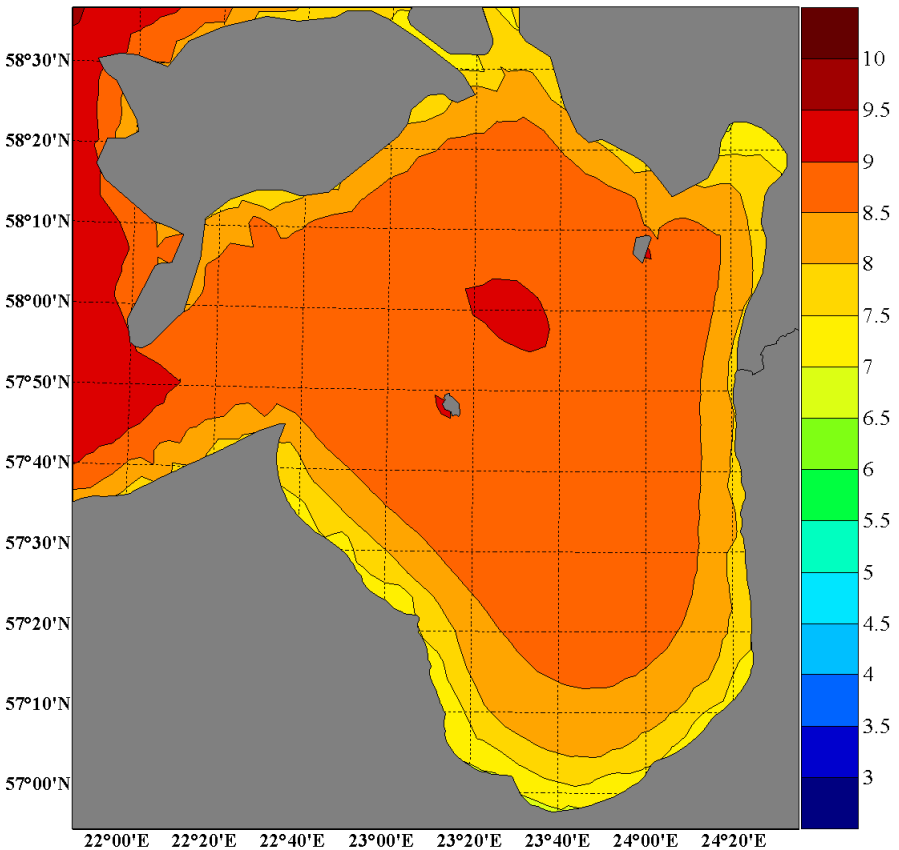
Annual average wind speed and wind gust from DMI HIRLAM 2008-2010



Wind at 10m



Wind gust at 10m

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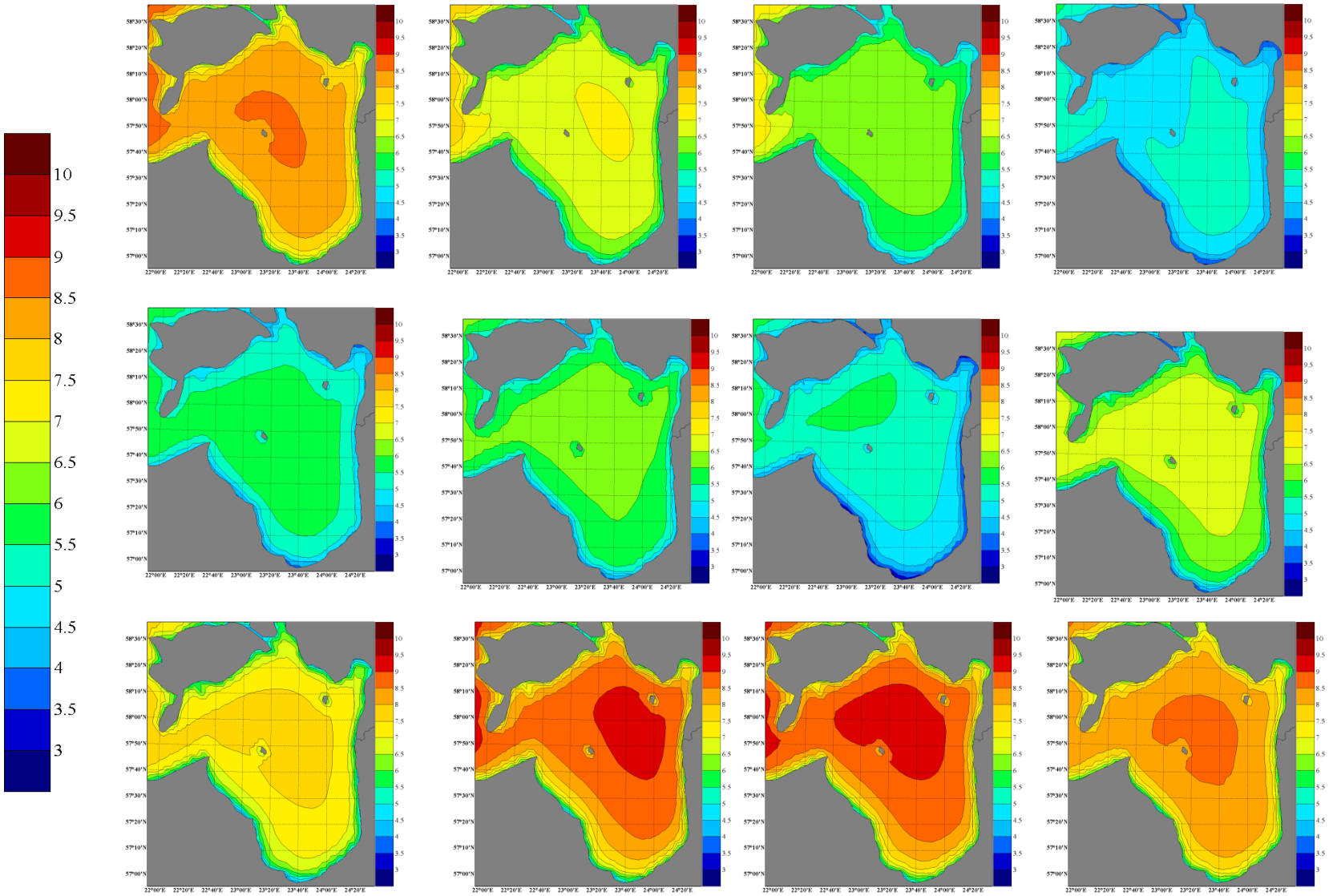
Monthly average wind speed from DMI HIRLAM 2008-2010



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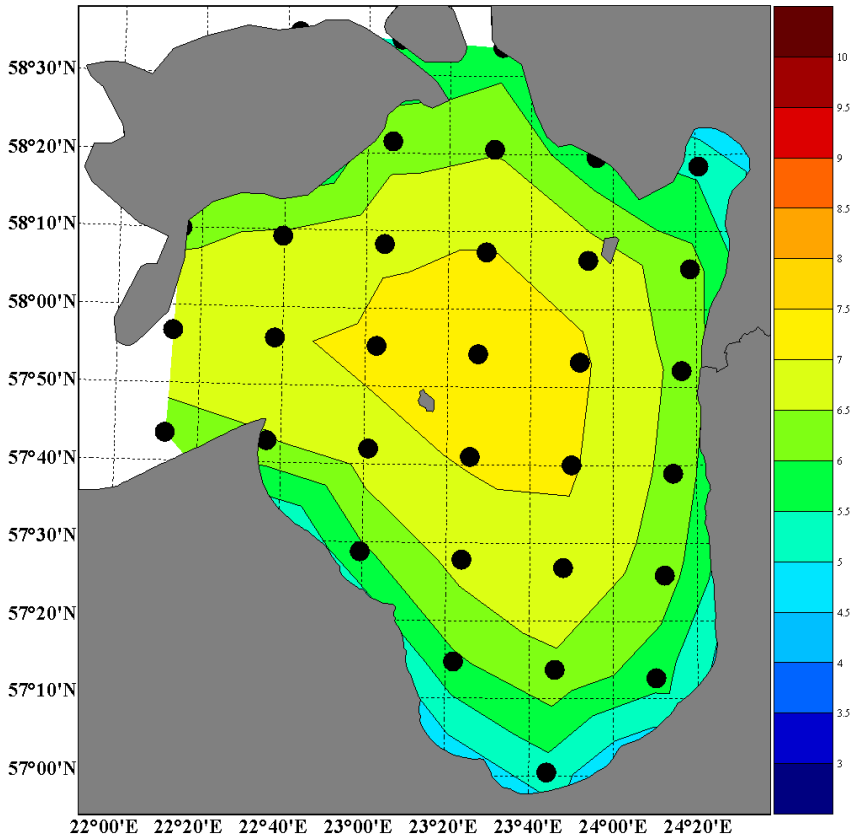
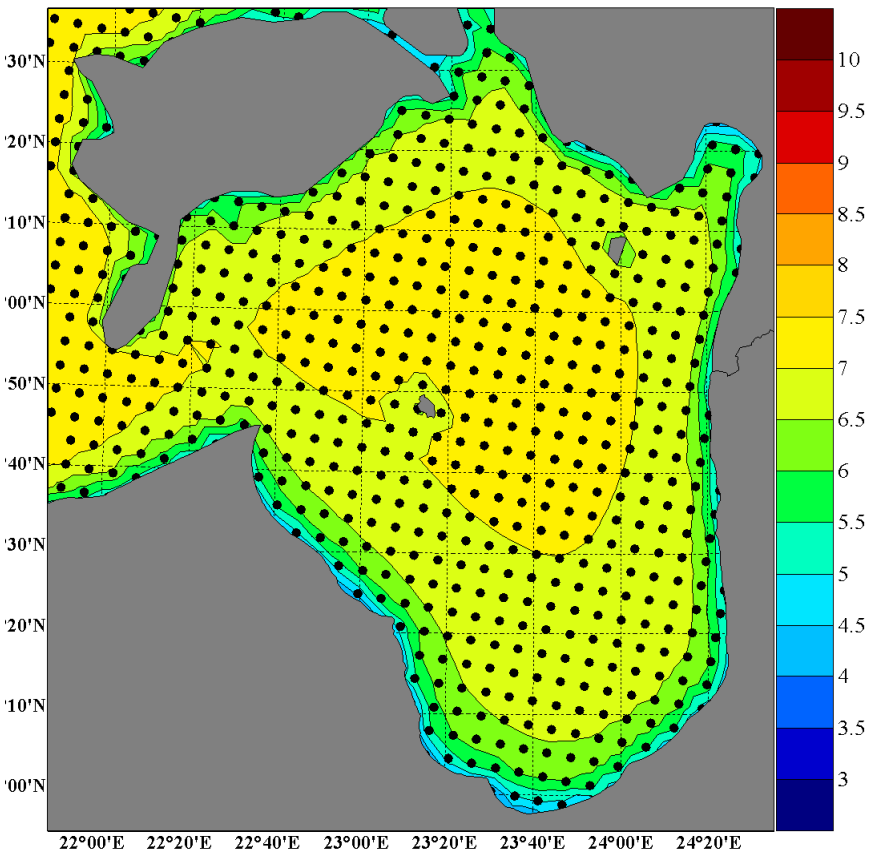
Comparison of operational model and RCM



Median of annual wind speed calculated by RCM (1961-1990)



Annual average wind from DMI HIRLAM 2008-2010 at 10m

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Summary and conclusions

RCM workflow established, data downloaded and ready for futher processing and analysis

Bias correction for the wind parameters from RCM might necessary and is under development

DMI HIRLAM output data could be used for refinement of wind analysis from RCM.

Higher wind speeds are in the Estonian part of the Gulf of Riga

Slight increase (<5%) of annual average wind speed is expected in the near future

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Thank You for attention!

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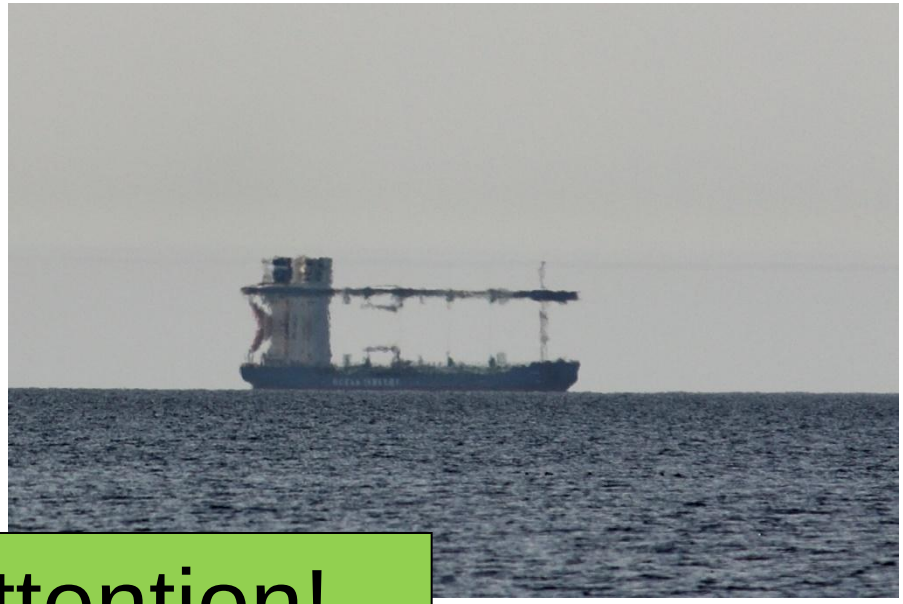
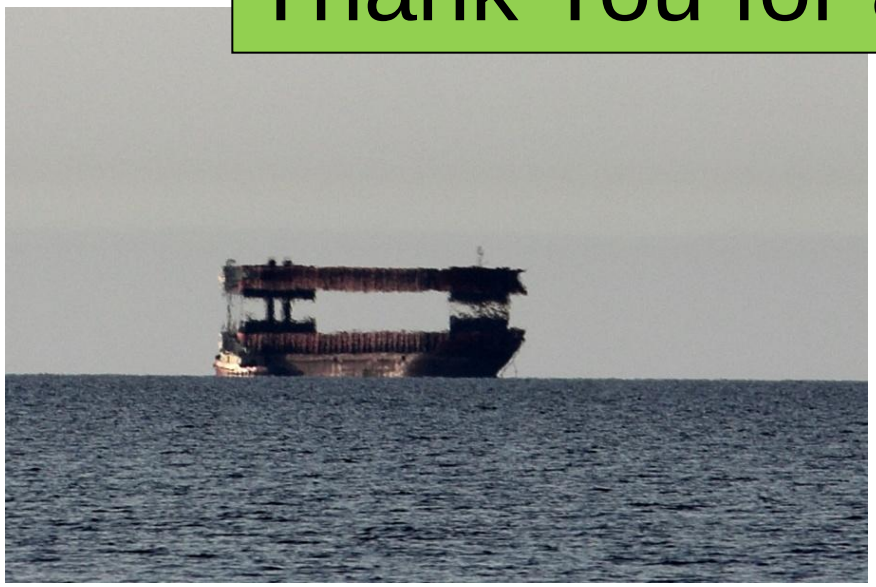
Thank You for attention!