ASSESSMENT OF WIND SPEED PROJECTIONS CONSIDERING WIND POWER DEVELOPMENT IN RUSSIA

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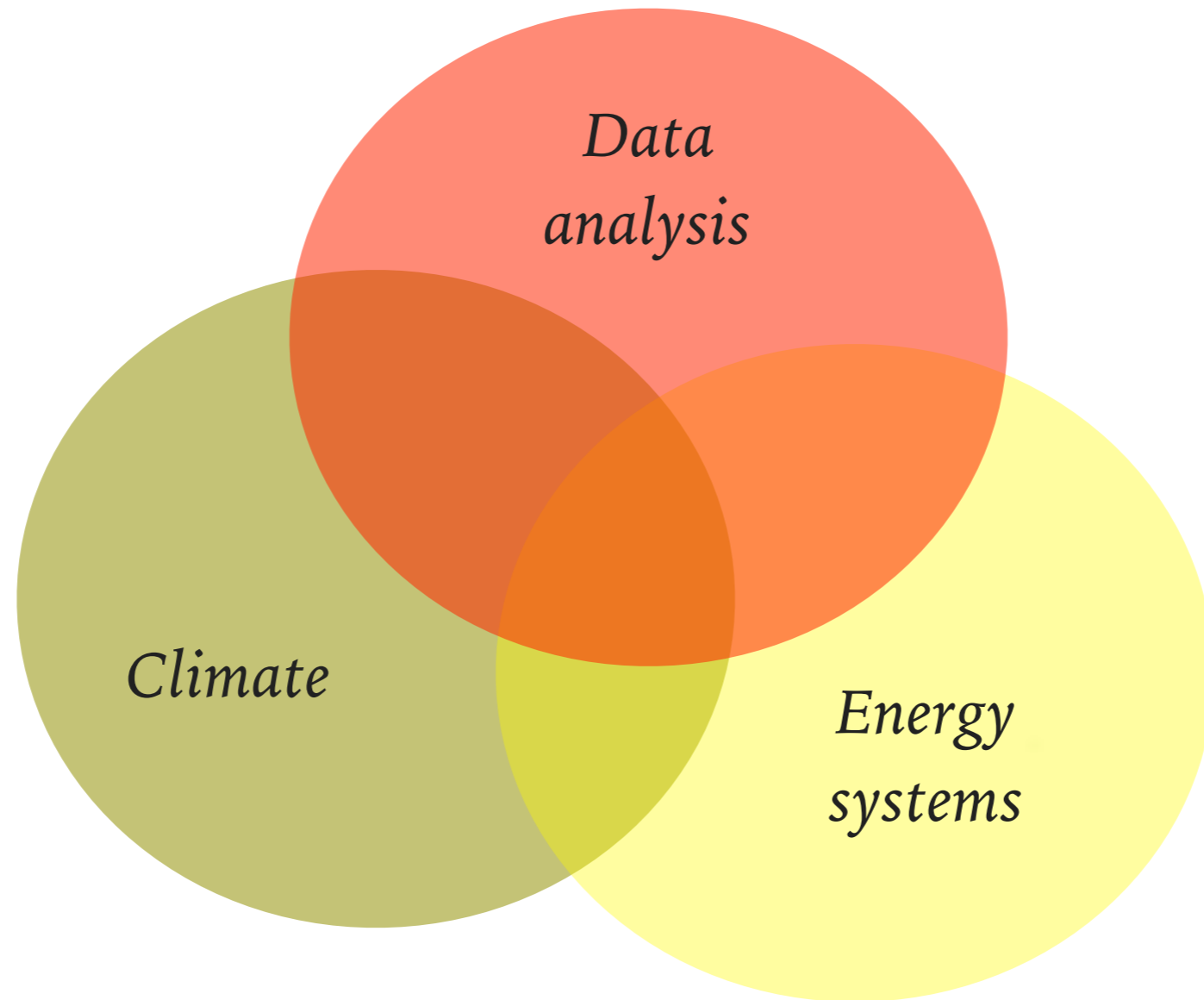
CITES 2019

MPEI
GEPLab

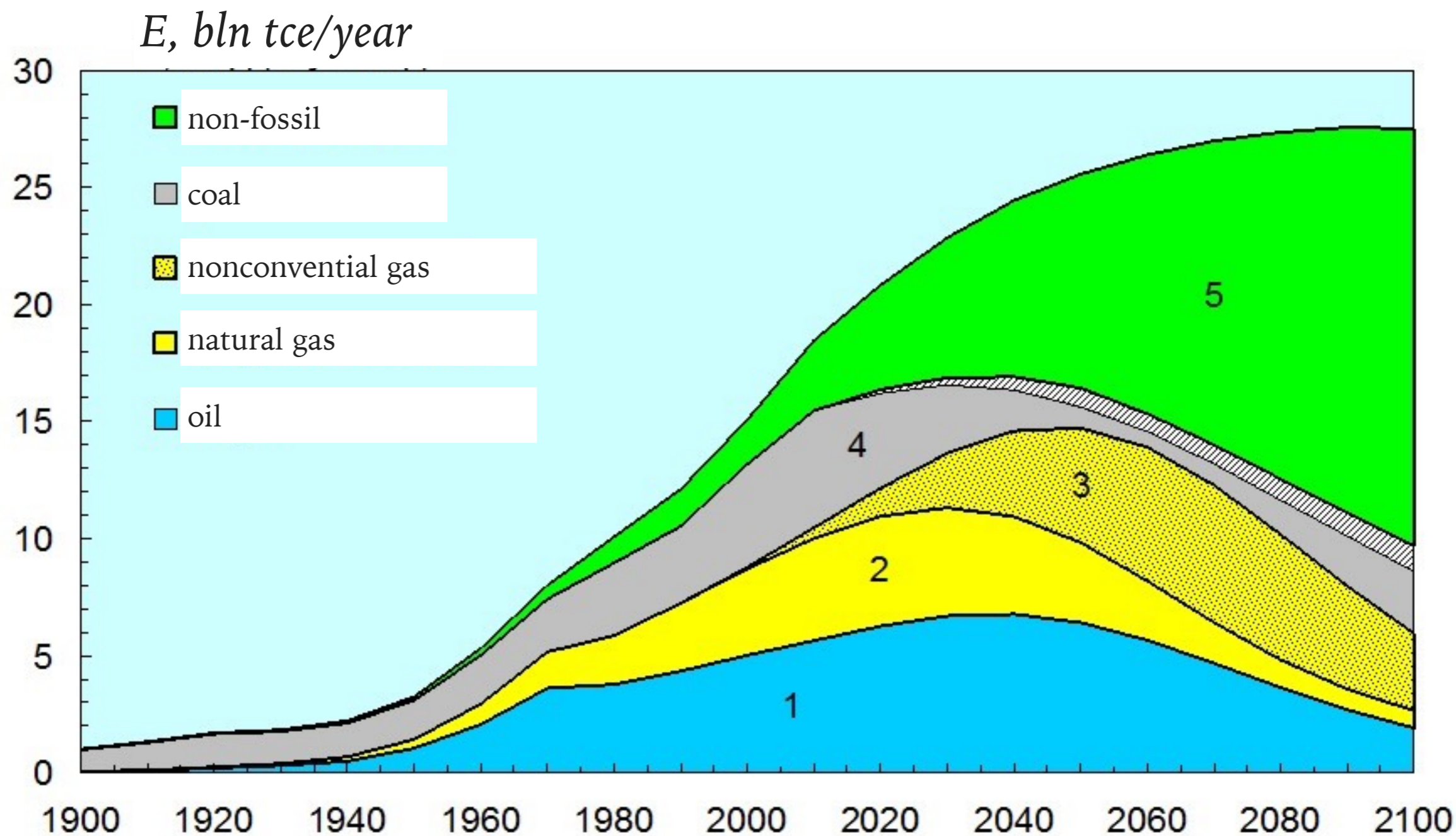# BACKGROUND

How does the climate change impact the power systems?

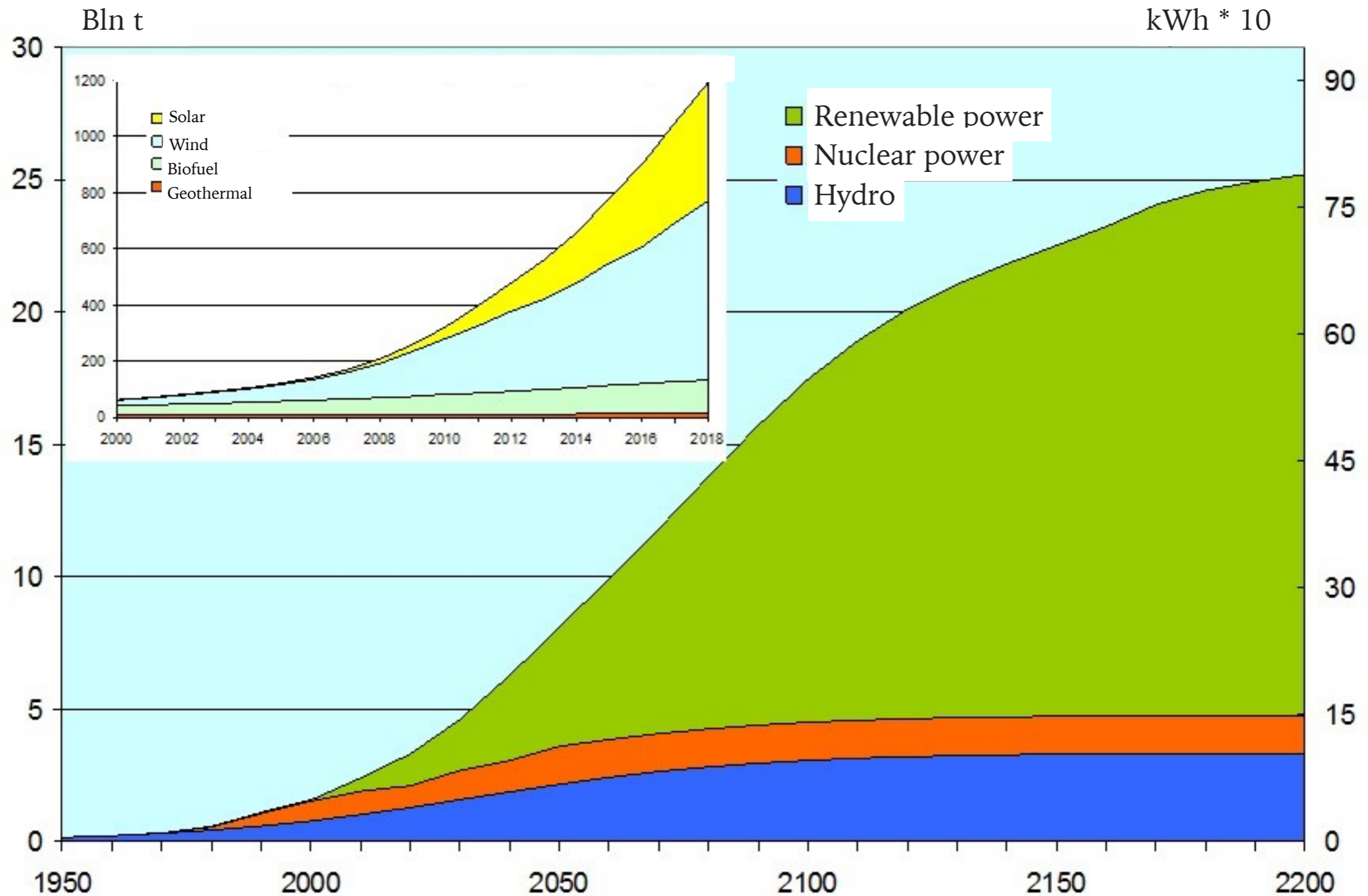What should be like an efficient energy system to meet the challenges of the future?

BACKGROUND

MOTIVATION: GLOBAL PICTURE

E, bln tce/year

[Klimenko et al 2019]

MOTIVATION: GLOBAL PICTURE

[Klimenko et al 2019]

MOTIVATION

Hannover Messe 2017

WIND POWER IN RUSSIA: GOOD NEWS

Russian wind resources are quite satisfactory
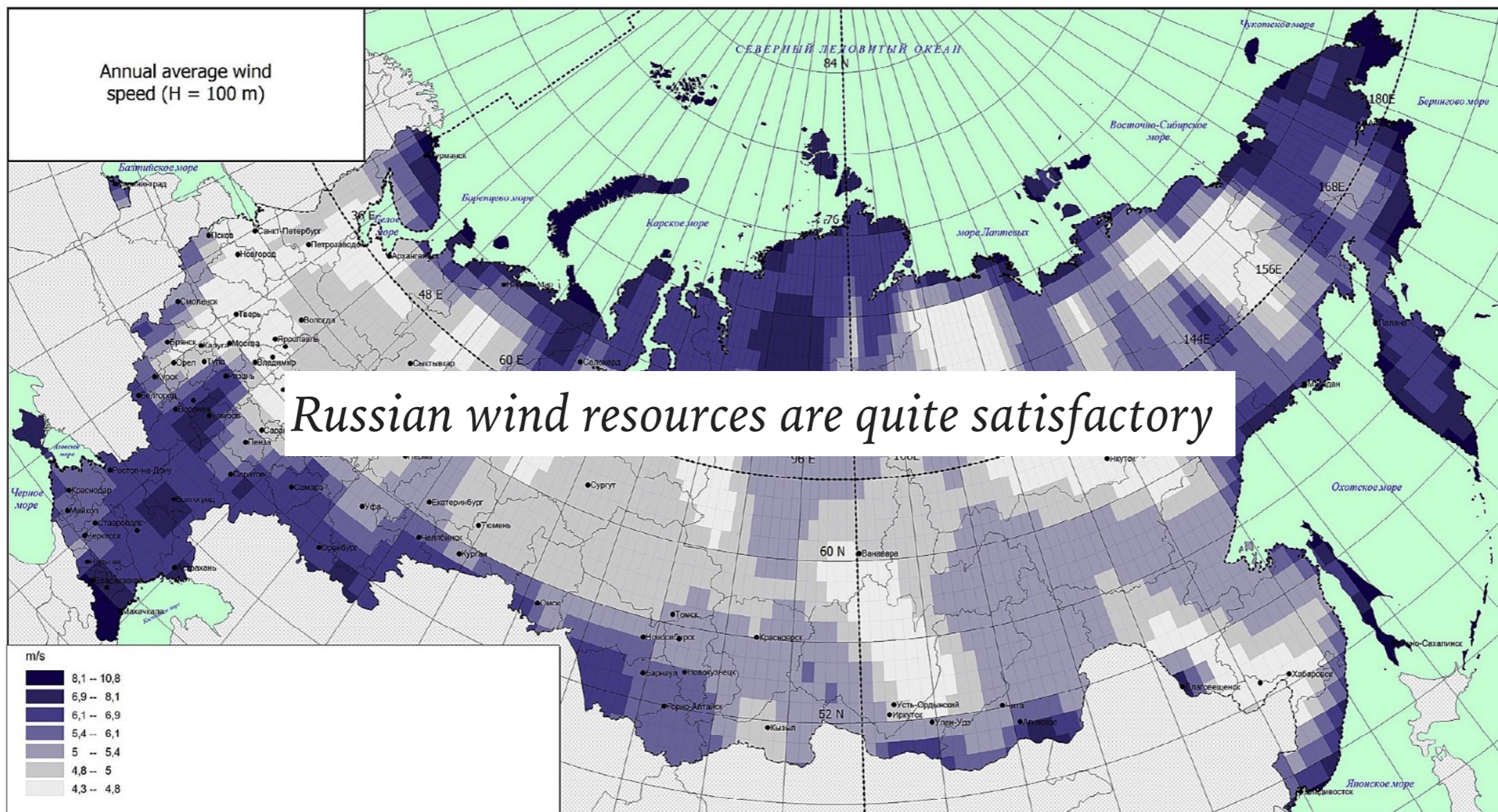
[Ermolenko et al 2017]

WIND POWER IN RUSSIA: BAD NEWS (1/2)

Linear trend %/10 years for the seasonal wind speed for 1977-2011

[Second Assessment Report... 2014]
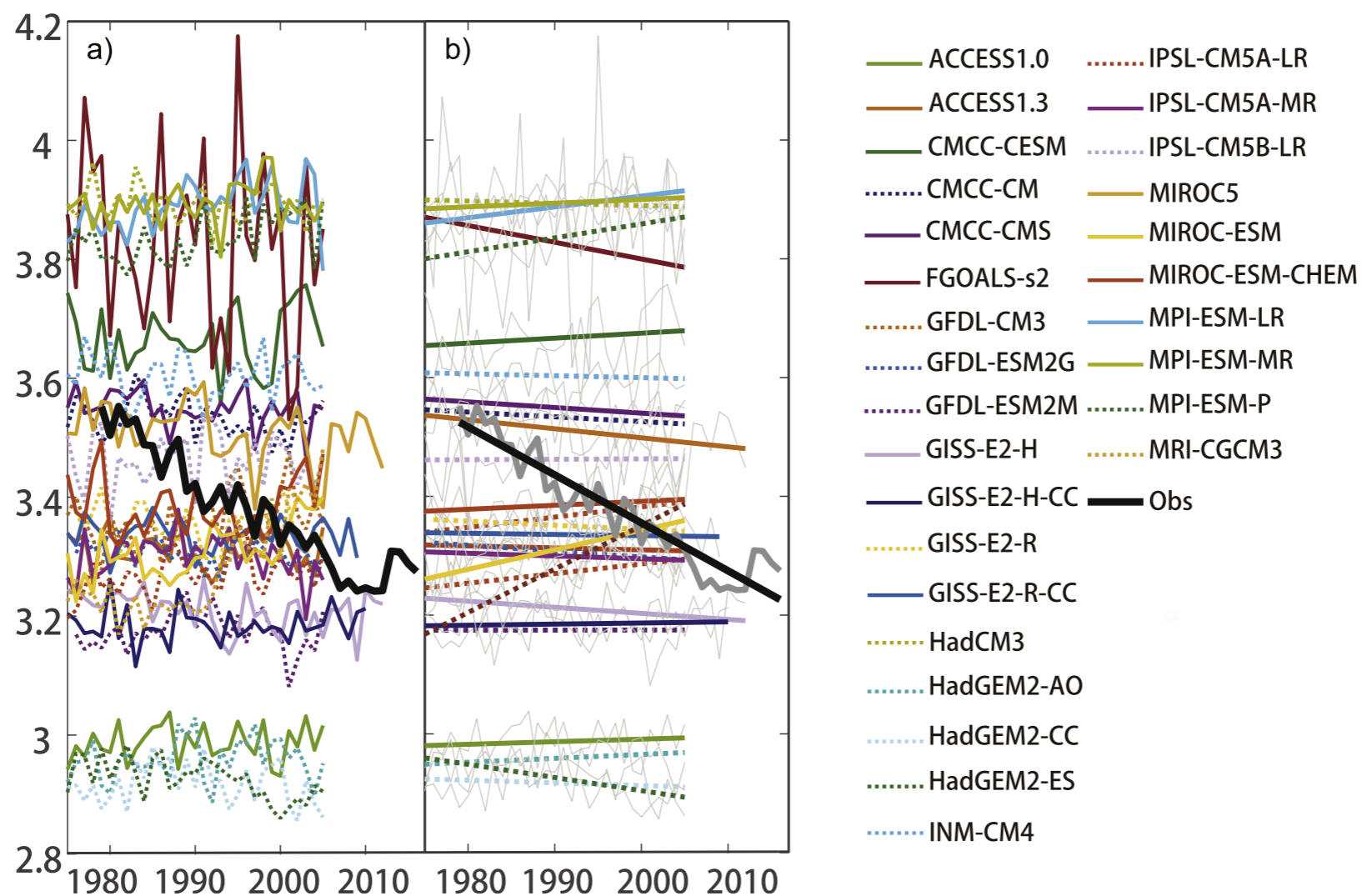
WIND POWER IN RUSSIA: BAD NEWS (1/2)

The wind power per unit area

$$E = \frac{1}{2}\rho U^3$$

ρ is air density, U is air velocity

Which means that 5% change of the wind speed may still be a lot

WIND POWER IN RUSSIA: BAD NEWS (2/2)

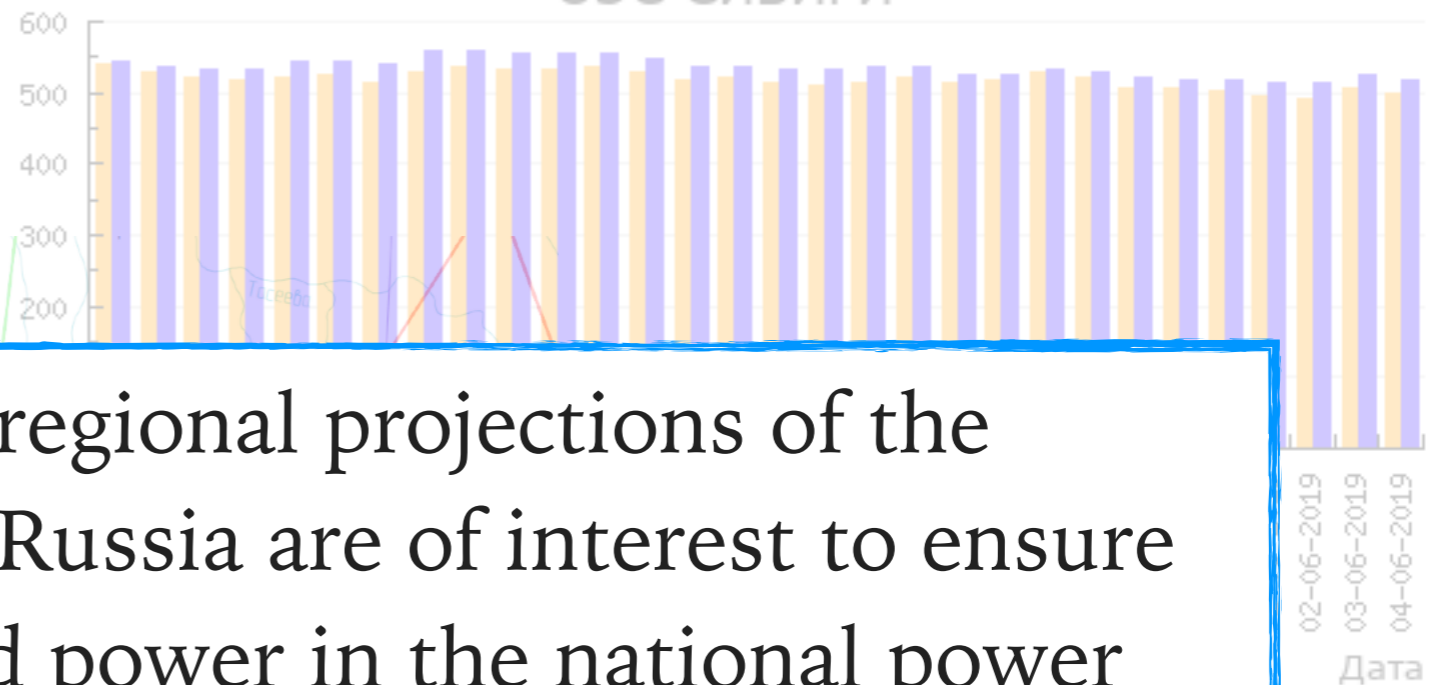*The global climate models seem to heavily underestimate the decreasing tend of the wind speed*

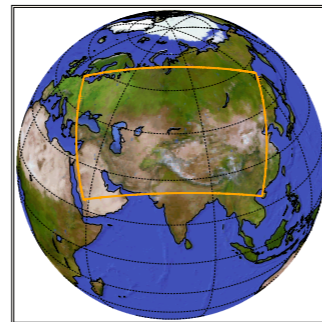[Tian et al. 2019]

AIM OF THE WORK

Robust **multidecadal** regional projections of the surface wind speed in Russia are of interest to ensure integration of the wind power in the national power systems

WORKFLOW (1/2)

Global climate modelling

Ensemble approach should be used

Regional downscaling

Calibration for the certain operation site

Roshydromet observations+ remote sensing data
+ monitoring

WORKFLOW (2/2)

CMIP5 simulation results were used to construct an ensemble estimation

Ensemble optimisation was one of the main points of the work. The CMIP5 quality ranking was used. The ranking considers reproducibility of the daily wind speed distributions in European CORDEX domain [Carvalho et al. 2017]

Original R-code was developed to facilitate ensemble calculations

VALIDATION DATASET

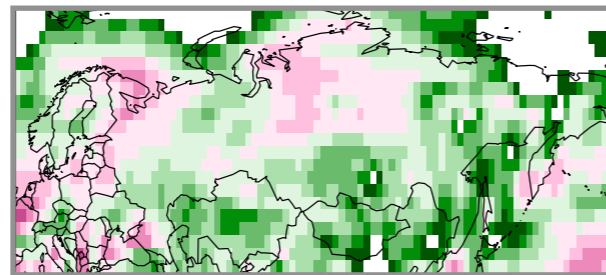**Reanalysis 20Vc**

The long-term variability is of high interest for the considered problem

Relative change of the surface wind speed
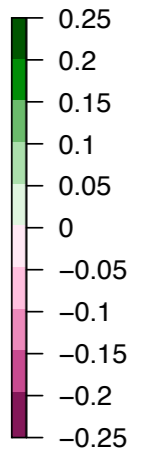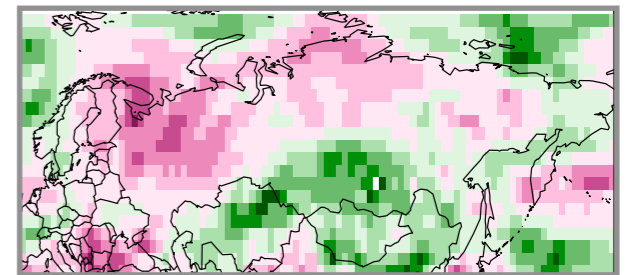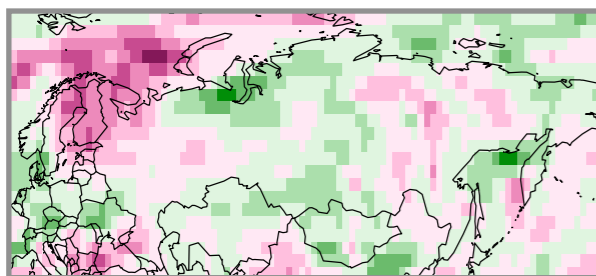

1995-2004 vs 1911-1920
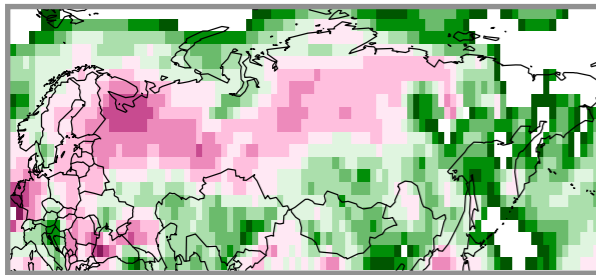
1995-2004 vs 1921-1930
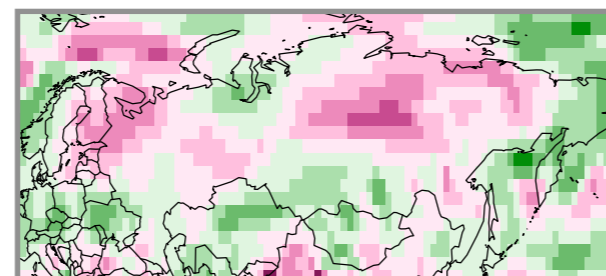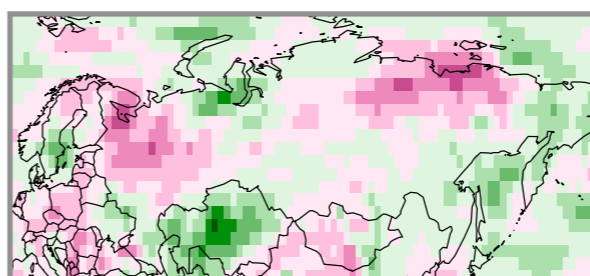
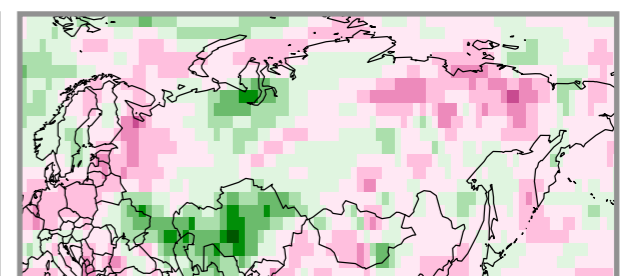1995-2004 vs 1931-1940
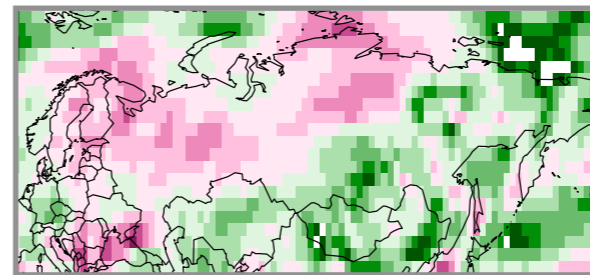
1995-2004 vs 1941-1950

1995-2004 vs 1951-1960

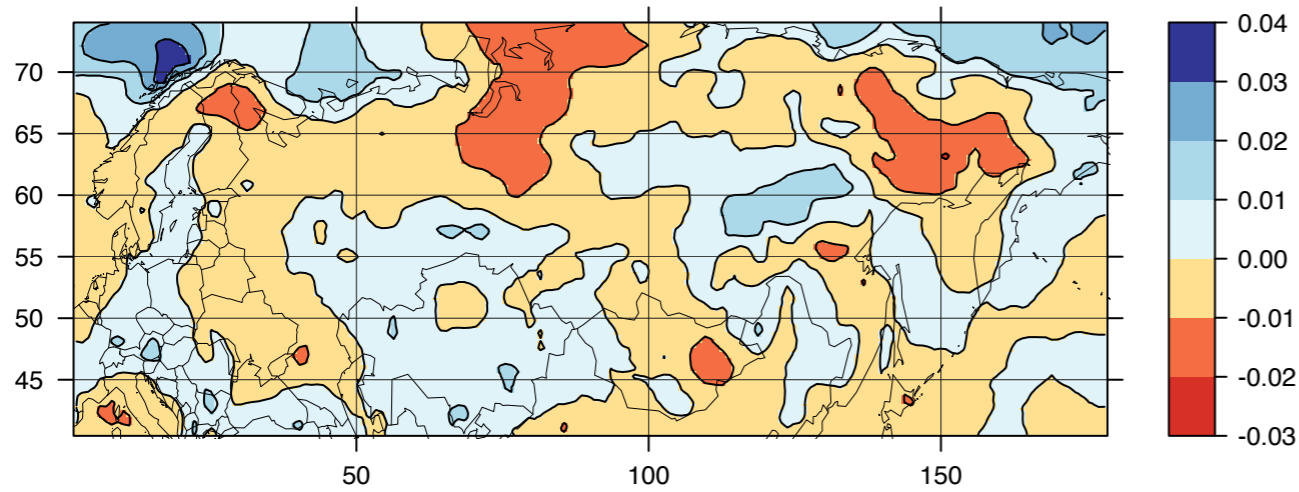1995-2004 vs 1961-1970
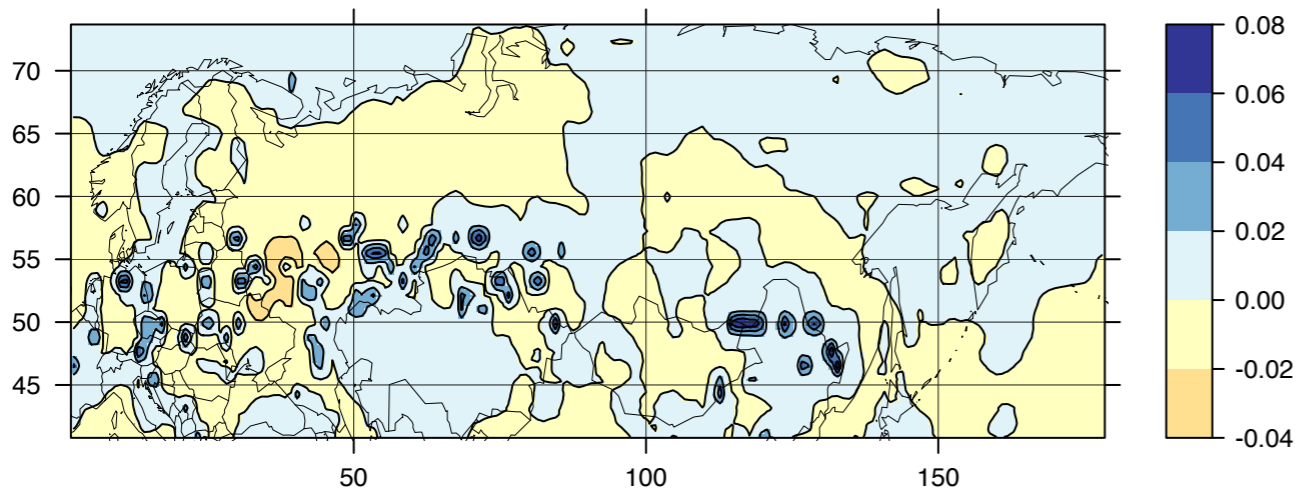
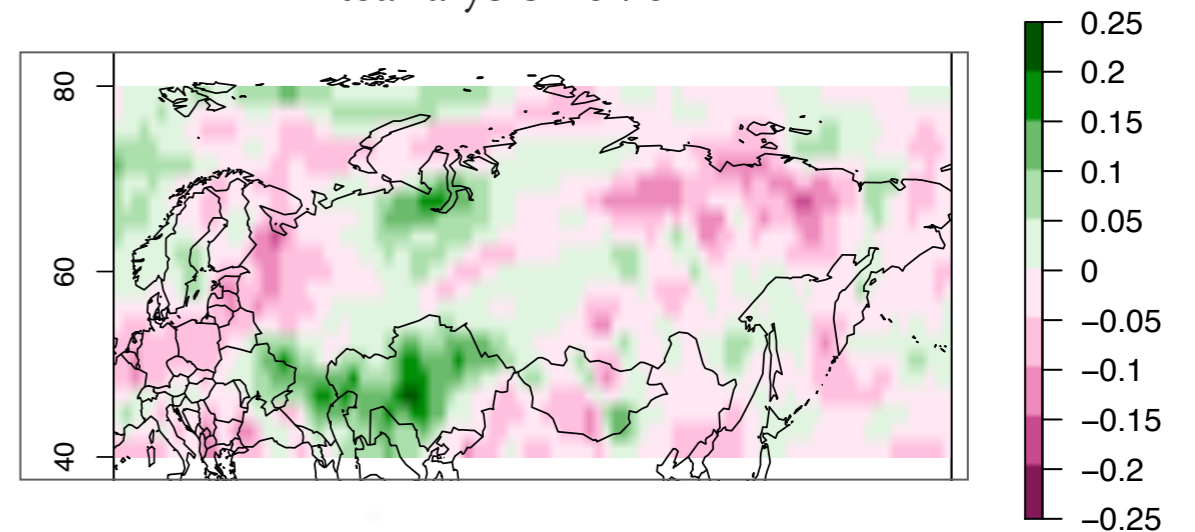1995-2004 vs 1971-1980

1995-2004 vs 1977-1986
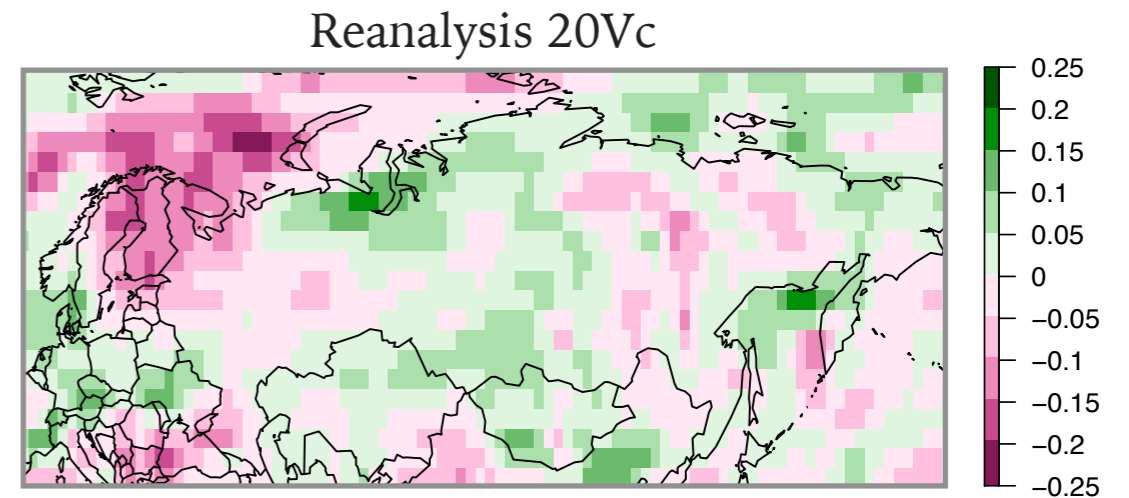
RESULTS

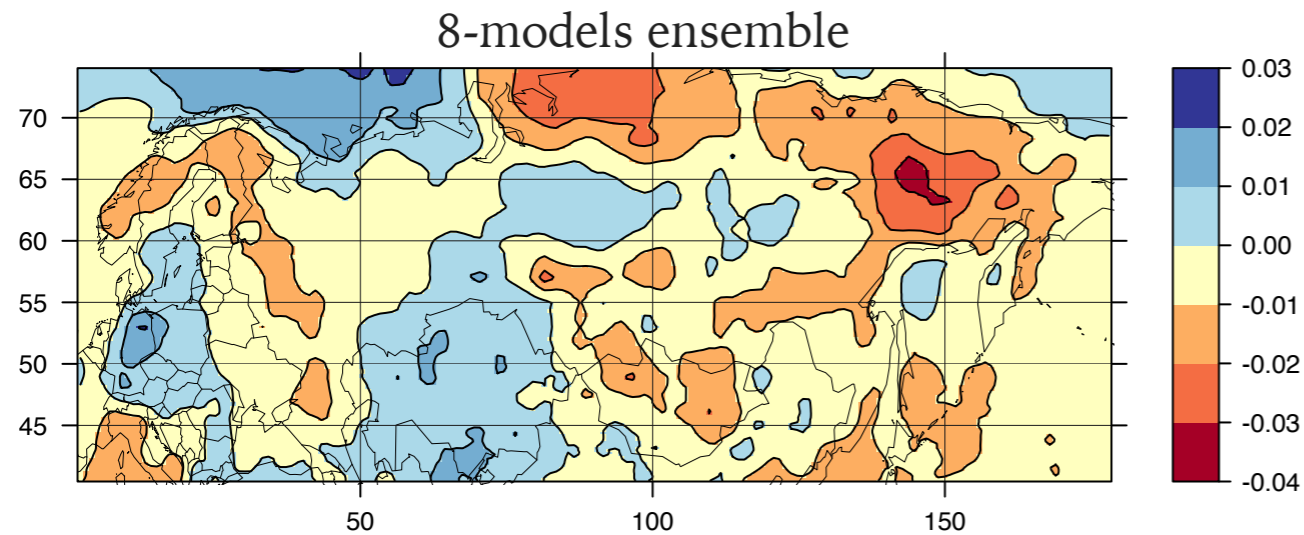## 1995-2004 vs 1977-1986
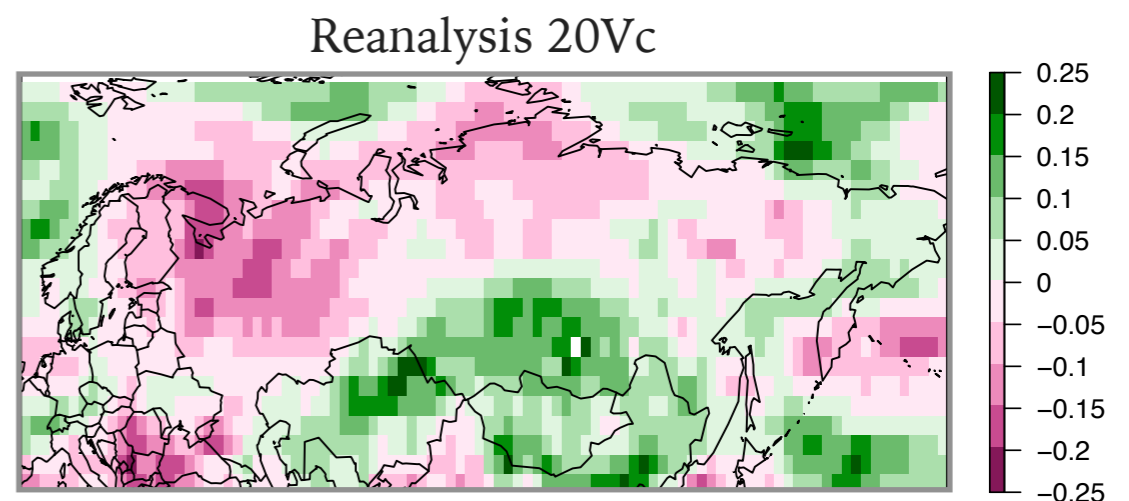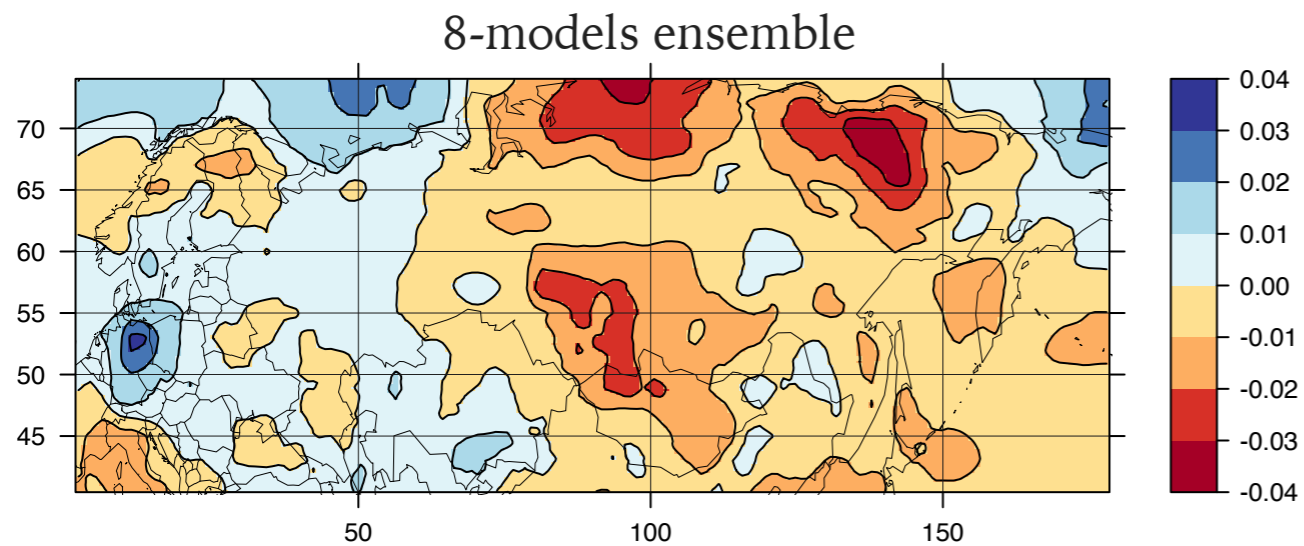
8-models ensemble

all models ensemble

Reanalysis 20Vc

RESULTS

1995-2004 vs 1951-1960

8-models ensemble

Reanalysis 20Vc
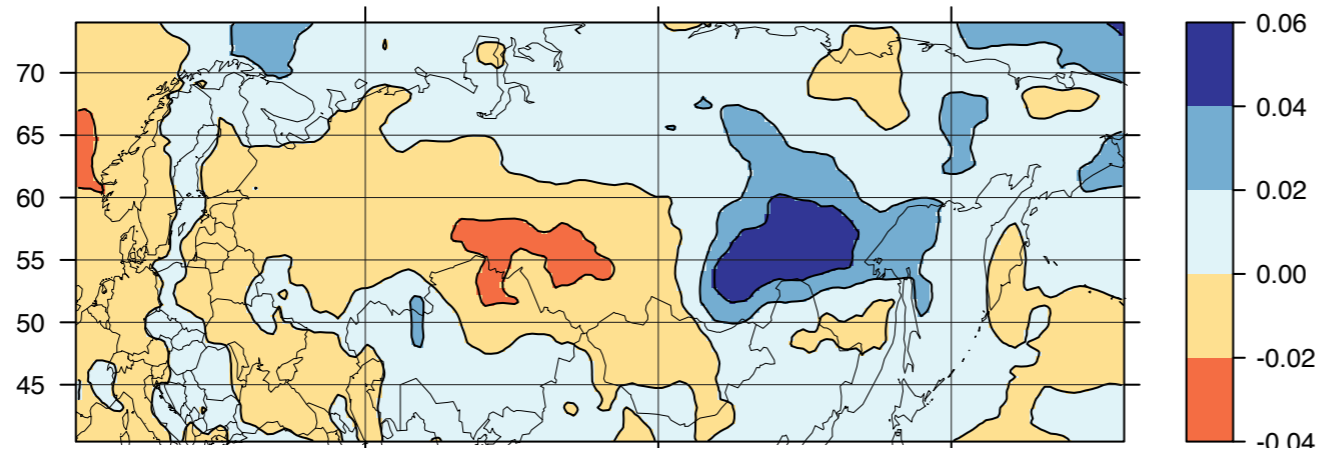
1995-2004 vs 1941-1950

8-models ensemble

Reanalysis 20Vc

RESULTS

Relative change of the annual surface wind speed 2045-2054 vs 2007-2016 (**rcp 4.5**)

8-models ensemble

9-models ensemble

all models ensemble

RESULTS

Relative change of the annual surface wind speed 2065-2074 vs 2007-2016 (**rcp 4.5**)

8-models ensemble
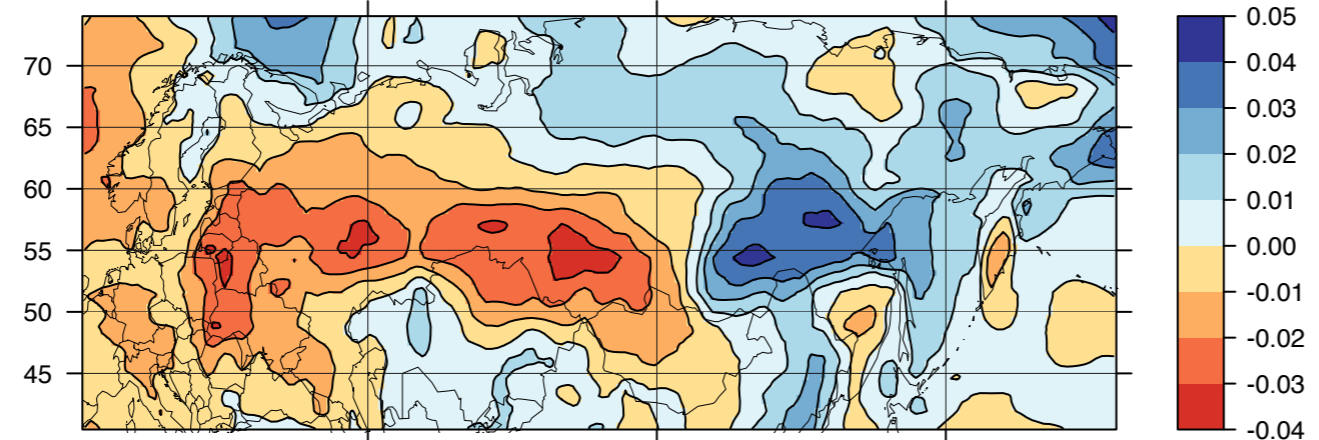
9-models ensemble

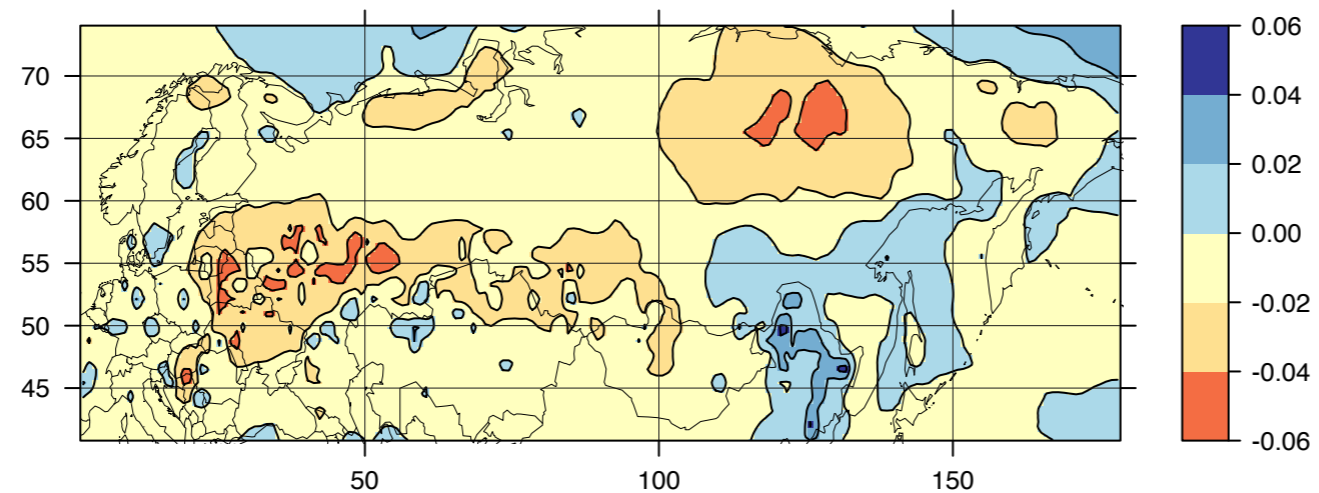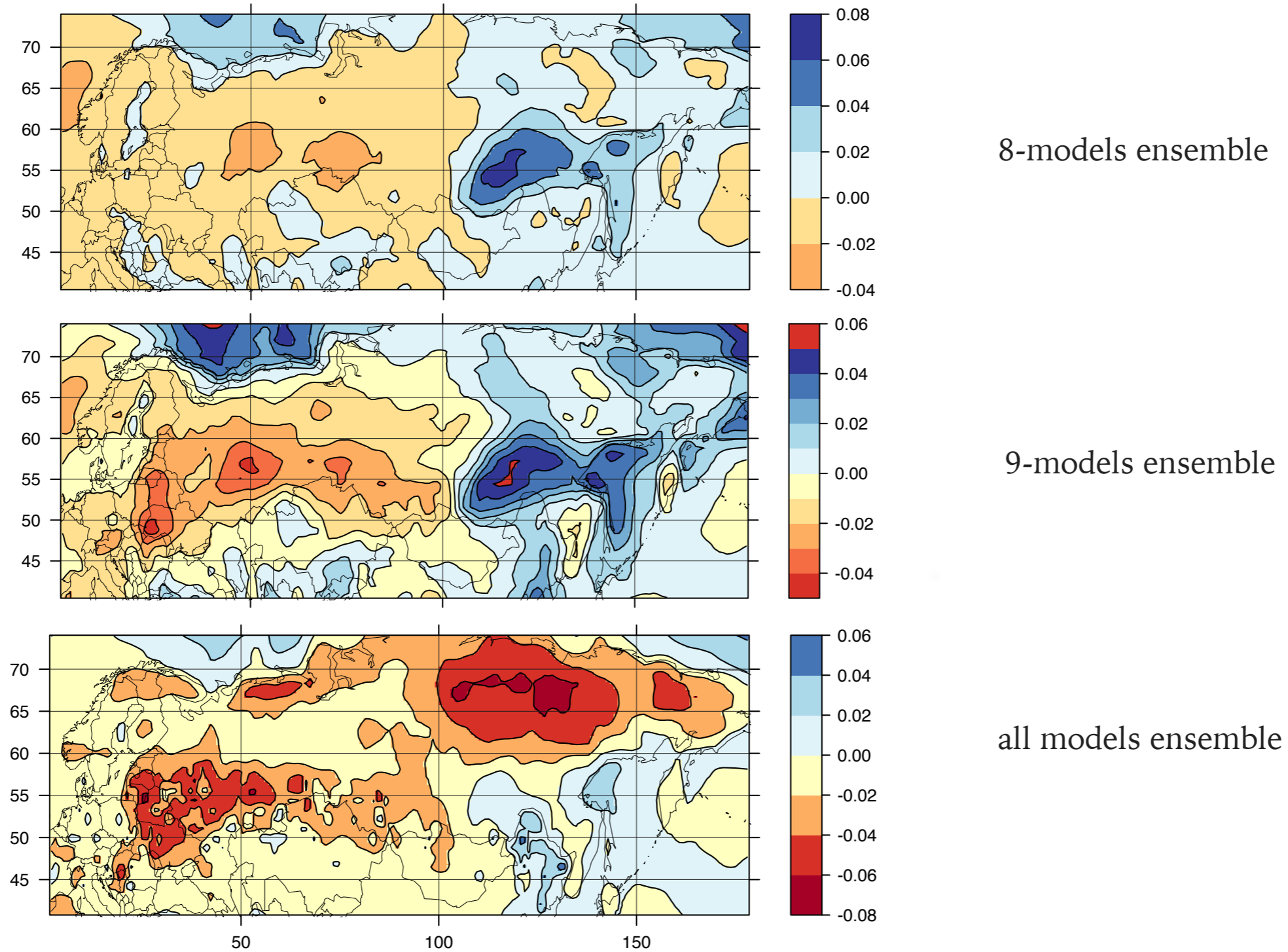all models ensemble
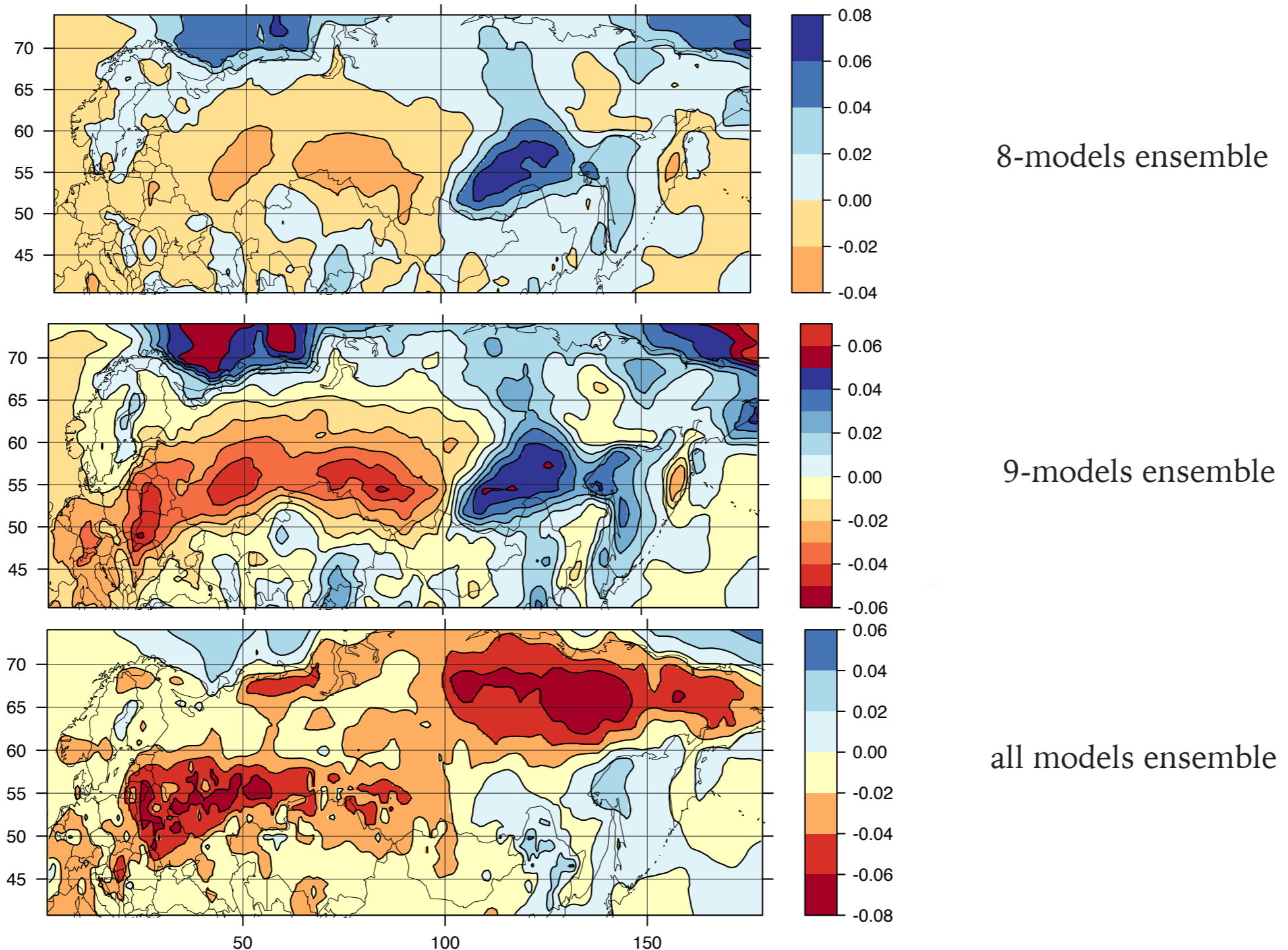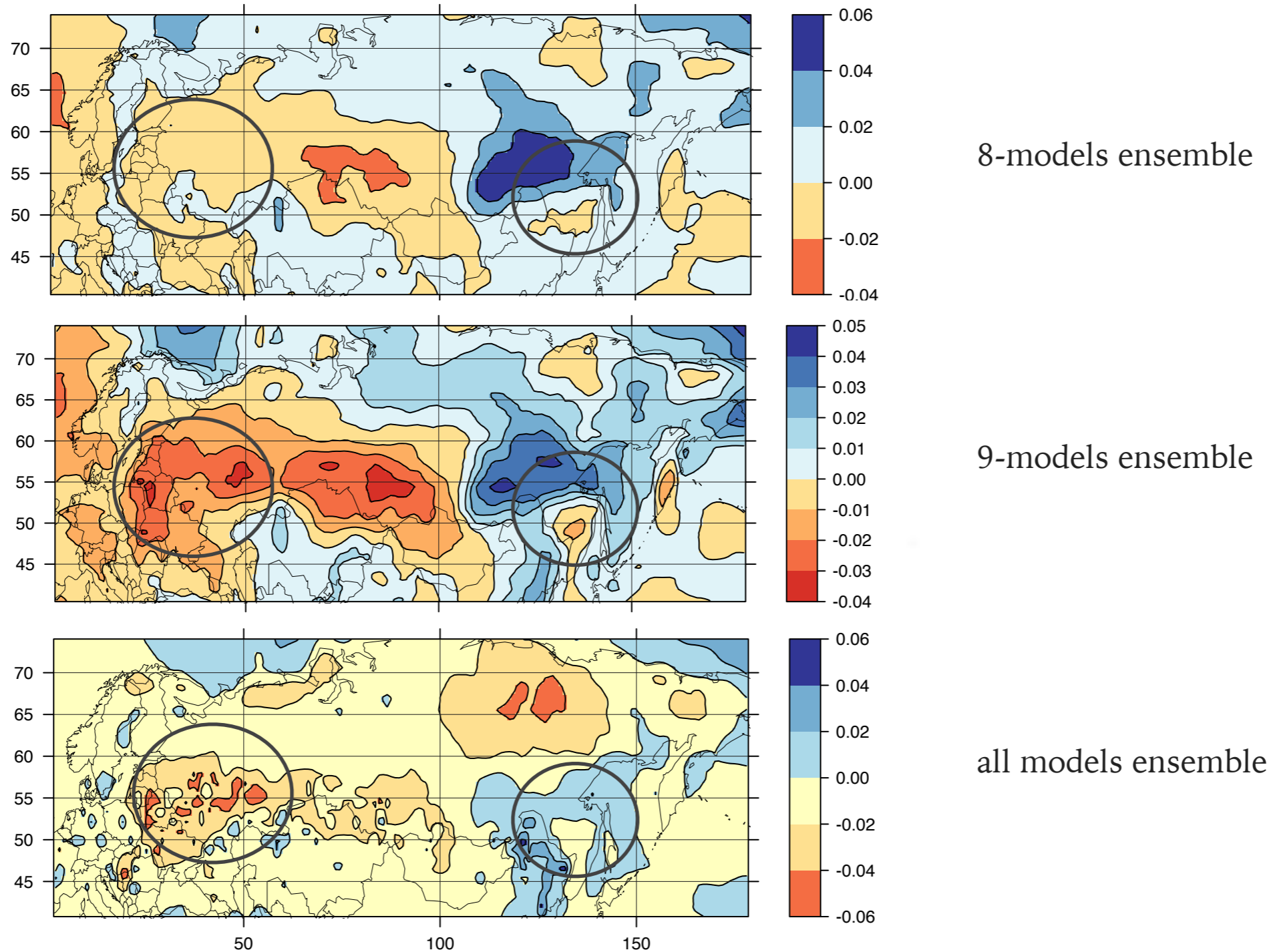
RESULTS

Relative change of the annual surface wind speed 2065-2074 vs 2007-2016 (**rcp 4.5**)

8-models ensemble

9-models ensemble

all models ensemble

RESULTS

Wind resources in Primorye seem to have better prospects as compared with European part of Russia

8-models ensemble

9-models ensemble

all models ensemble

SUMMARY

1. The global climate models tend to **underestimate** the changes of the surface wind speed

2. The **ensemble optimisation** seems to ensure better reproducibility of the wind speed across Russia in the mid-term retrospective (up to 60 years)

3. The surface wind speed changes demonstrate **non-monotonic** features

4. The wind resources in the European part of Russia and in West Siberia are likely to have decreasing trend, in Primorye — an increasing one

OPEN QUESTIONS

Long-term variability of the surface wind speed is of highest practical interest
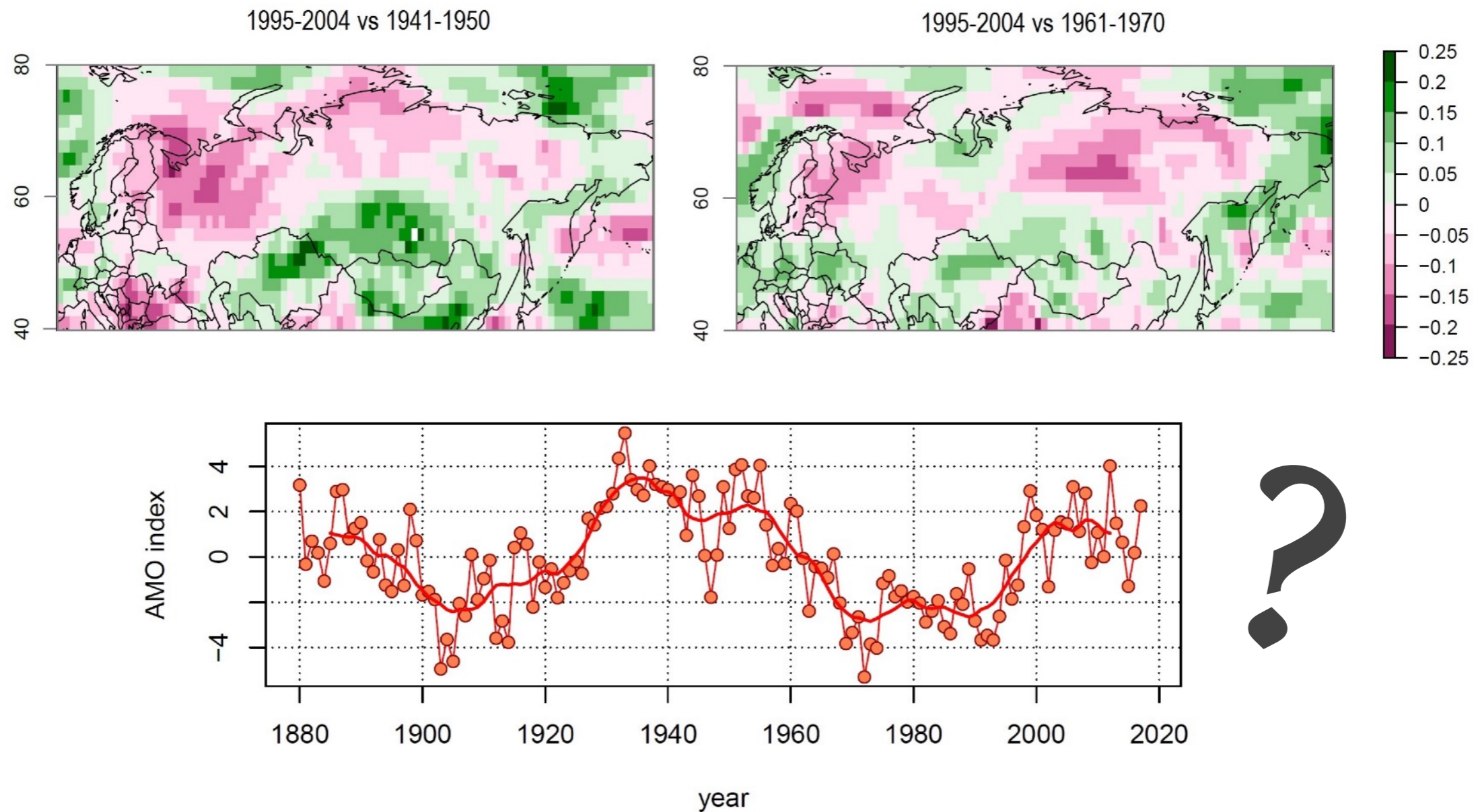
ACKNOWLEDGMENTS

Thank you for your attention!