

Development and applications of regional reanalyses for Europe and Germany based on DWD's NWP models: Status and outlook

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Jan Keller^{1,2,3}, Maarit Lockhoff³, Deborah Niermann¹,
Roland Potthast¹, Thomas Rösch¹, Sabrina Wahl^{2,3}

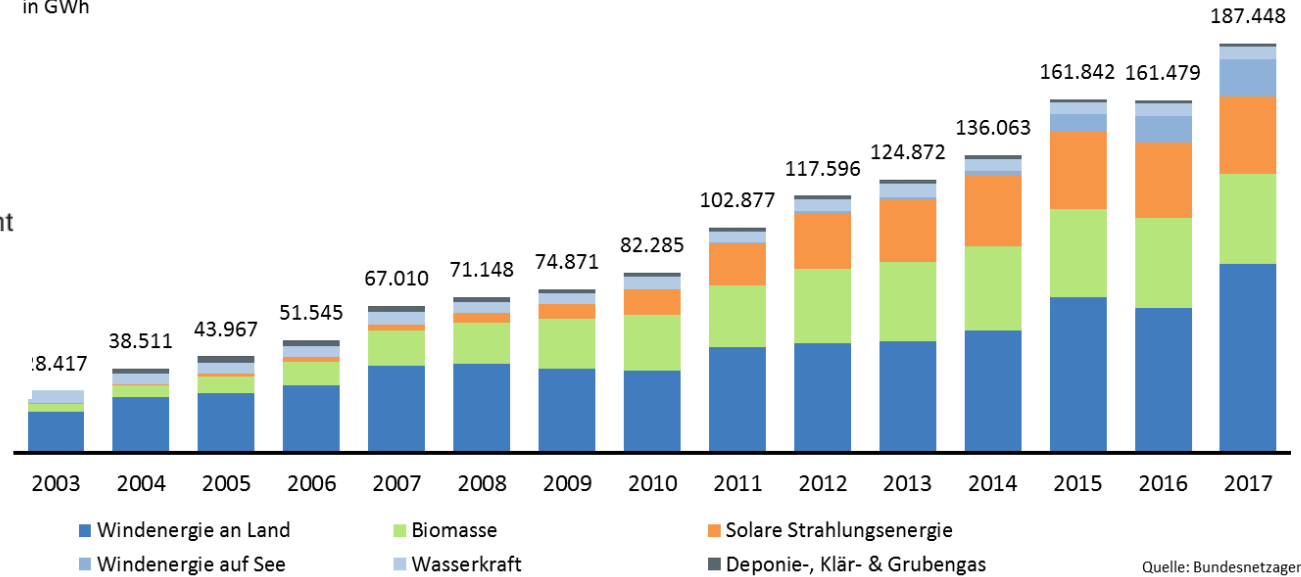
- 1) Deutscher Wetterdienst, Offenbach, Germany
- 2) Hans Ertel-Centre for Weather Research, Bonn, Germany
- 3) University of Bonn, Bonn, Germany



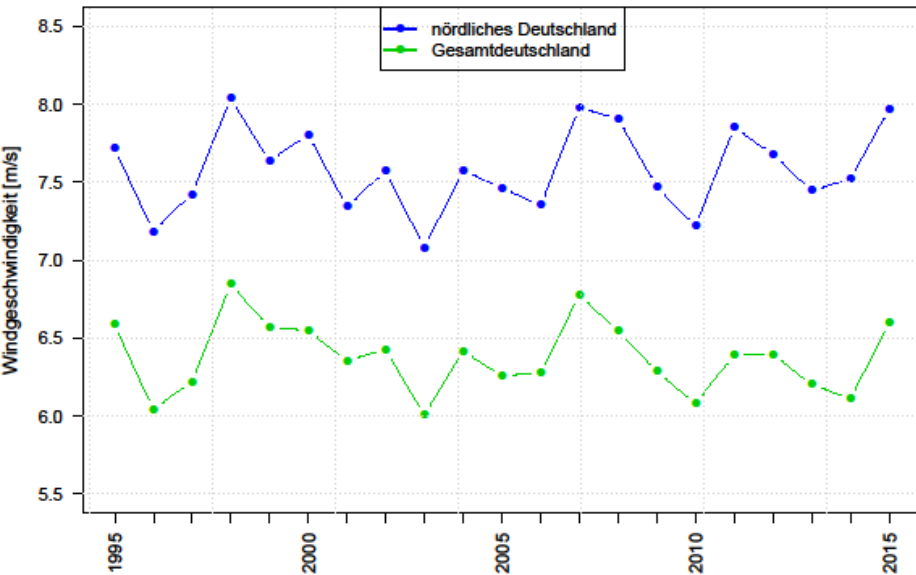
Entwicklung der eingespeisten Jahresarbeit aus Anlagen mit einem Zahlungsanspruch nach dem EEG in GWh



Bundesnetzagentur Bundeskartellamt

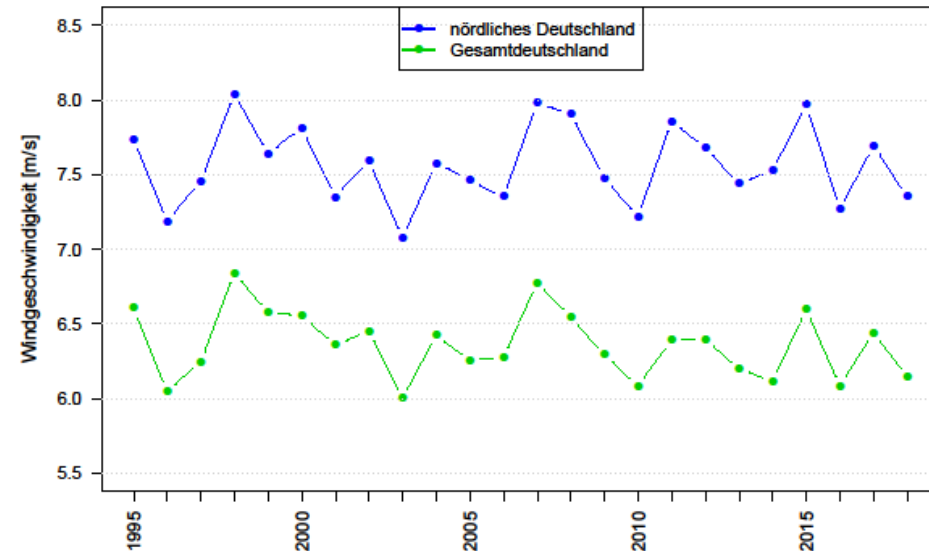


Jahresmittel der Windgeschwindigkeit über Deutschland in 100m Höhe (ERA-Interim)



Jahresmittel der Windgeschwindigkeit in 100m Höhe über Deutschland, sowie dem nördlichen Bereich Deutschlands. Die Daten basieren auf der globalen atmosphärischen Reanalyse "ERA-Interim" und stellen den Mittelwert über folgende Bereiche dar:
 Deutschland: ca. 6°O – 15°O, ca. 48°N – 55°N; nördliches Deutschland: ca. 6°O – 15°O, ca. 52°N – 55°N
 (Quelle: Deutscher Wetterdienst, Nationale Klimaüberwachung, basierend auf ERA-Interim: Dee et al. (2011)).

Jahresmittel der Windgeschwindigkeit über Deutschland in 100m Höhe



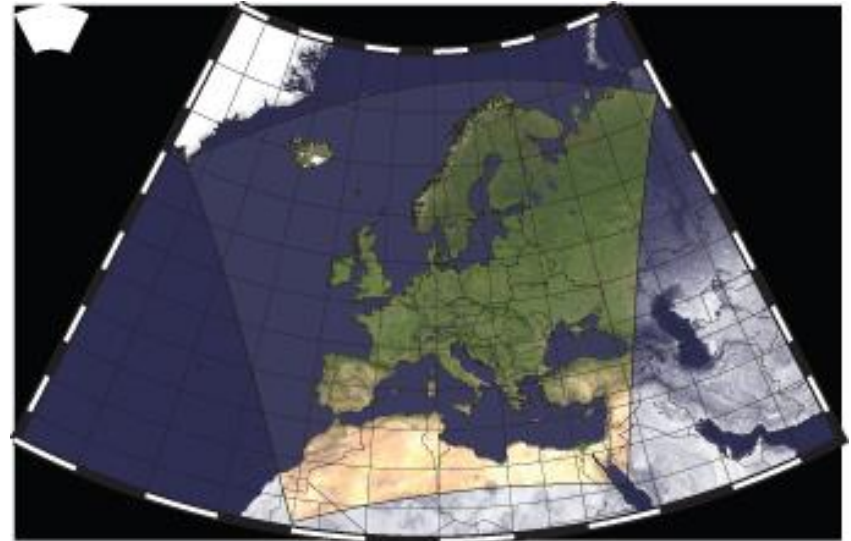
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 (Quelle: Deutscher Wetterdienst, Nationale Klimaüberwachung, basierend auf C3S/ERA-Interim: Dee et al. (2011)).

Outline

1. Introduction to COSMO-REA6
2. Evaluation examples
3. Selected applications
4. Outlook
5. Summary



The regional reanalysis system based on the COSMO-NWP-model of the German Meteorological Service (DWD) (developed at the Hans-Ertel-Center for Weather Research (HERZ) at University of Bonn)



ERA-Interim Reanalysis (T255)

COSMO-REA6 (6.2 km)

- COSMO-EU v4.25
- CORDEX EUR-11 Domain
- Period 1995-2017(2018)

Soil moisture analysis (SMA)

Continuous nudging

SYNOP, SHIP, PILOT, TEMP,
AIREP, AMDAR, ACARS,...

SST analysis (daily)

Snow analysis (6-hourly)

Data available at:

https://opendata.dwd.de/climate_environment/REA/

More details:

























<http://reanalysis.meteo.uni-bonn.de/>



Open data access to selected parameters

Index von ftp://opendata.dwd.de/climate_environment/REA/COSMO_REA6/hourly/2D/

 In den übergeordneten Ordner wechseln

Name	Größe	Zuletzt verändert
 ALWU_S		24.01.2019 14:35:00
 ASOB_S		24.01.2019 14:01:00
 ASWDIFD_S		31.01.2019 12:59:00
 ASWDIR_S		31.01.2019 12:58:00
 ATHB_S		31.01.2019 13:11:00
 ATHD_S		24.01.2019 14:58:00
 CLCT		24.01.2019 14:38:00
 DURSUN		24.01.2019 13:58:00
 H_PBL		24.01.2019 14:52:00
 LWU_S		24.01.2019 15:51:00
 PMSL		18.01.2019 11:59:00
 PS		31.01.2019 13:04:00
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 QV_S		24.01.2019 16:41:00
 RAIN_CON		24.01.2019 15:05:00
 RAIN_GSP		24.01.2019 15:15:00
 RELHUM_2M		24.01.2019 16:58:00
 RUNOFF_G		24.01.2019 15:44:00
 RUNOFF_S		24.01.2019 15:49:00
 SNOW_CON		24.01.2019 15:50:00
 SNOW_GSP		24.01.2019 15:57:00
 SOBS_RAD		24.01.2019 16:51:00
 SWDIFDS_RAD		31.01.2019 13:10:00
 SWDIRS_RAD		24.01.2019 16:49:00
TURS_RAD		28.01.2019 00:54:00

Evaluation of global horizontal irradiance estimates from ERA5 and COSMO-REA6 reanalyses using ground and satellite-based data



dienst



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Sources of uncertainty in annual global horizontal irradiance data



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^b European Commission, Joint Research Centre, Via Fermi 2749, I-21027 Ispra, Italy

^c University of Helsinki, Viikinkaari, 5 E, P.O. Box 56, 00014 Helsinki, Finland



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Bias correction of a novel European reanalysis data set for solar energy applications



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^d Deutscher Wetterdienst, Offenbach, Germany



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Contents lists available at ScienceDirect

Applied Energy

journal homepage: www.elsevier.com/locate/apenergy



Energy/ radiation



Electricity self-sufficiency of single-family houses in Germany and the Czech Republic

Luis Ramirez Camargo^{a,b,*}, Felix Nitsch^{a,c}, Katharina Gruber^{a,c}, Wolfgang Dörner^a

^a Institute for Applied Informatics, Technologie Campus Freyung, Technische Hochschule Deggendorf, Freyung, Germany



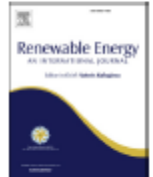
Energy/wind



Contents lists available at ScienceDirect

Renewable Energy

journal homepage: www.elsevier.com/locate/renene



Assessing variables of regional reanalysis data sets relevant for modelling small-scale renewable energy systems

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Contents

Energy

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The benefit of long-term high resolution wind data for electricity system analysis

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^c Hans-Ertel-Centre for Weather Research, Climate Monitoring and Diagnostics, Germany



Article

Optimal Siting of Wind Farms in Wind Energy Dominated Power Systems

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Examples from hydrology

Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2018-24>

Manuscript under review for journal Hydrol. Earth Syst. Sci.

Discussion started: 23 March 2018

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Improving soil moisture and runoff simulations over Europe using a high-resolution data-assimilation modeling framework

Bibi S. Naz^{1,2}, Wolfgang Kurtz^{1,2}, Carsten Montzka¹, Wendy Sharples^{2,3}, Klaus Goergen^{1,2}, Jessica Keune⁴, Huilin Gao⁵, Anne Springer⁶, Harrie-Jan Hendricks Franssen^{1,2}, Stefan Kollet^{1,2}

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10 ⁶Institute of Geodesy and Geoinformation, Bonn University, Nussal

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Article

Evaluation of the Water Cycle in the European COSMO-REA6 Reanalysis Using GRACE

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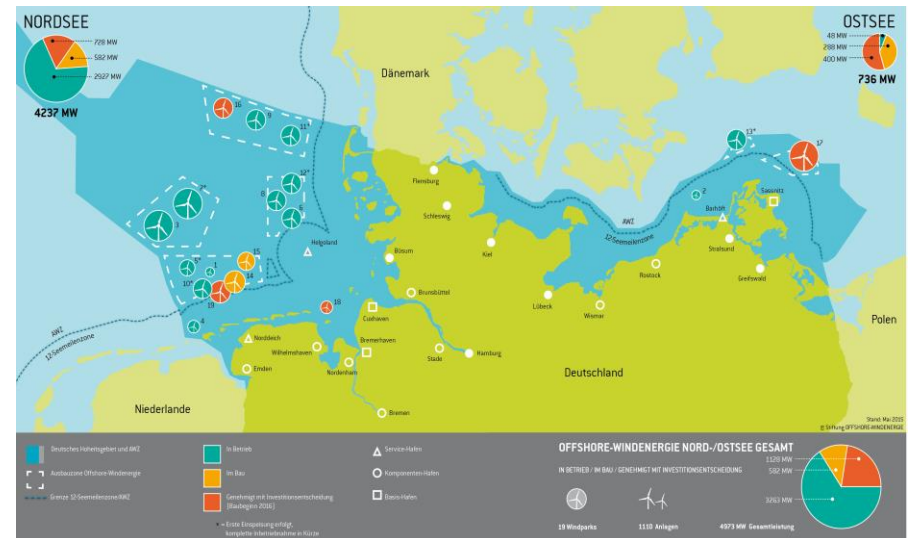
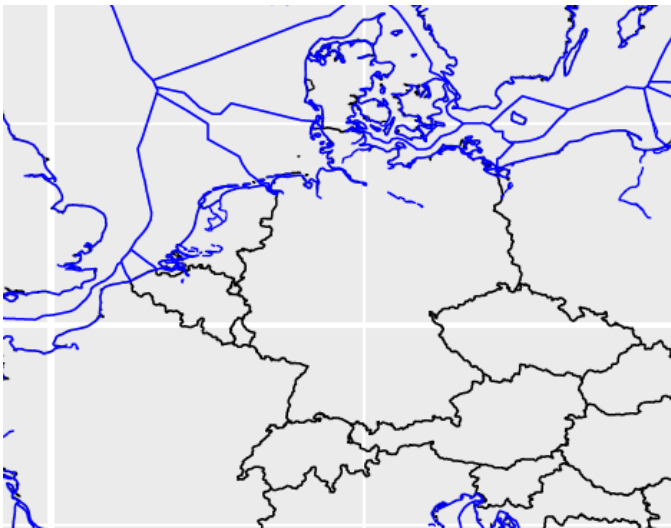
* Correspondence: springer@geod.uni-bonn.de; Tel.: +49-228-73-6149

Academic Editor: Frédéric Frappart

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Offshore wind farms in Germany's „Exclusive economic zone“



- ➔ Suggested increase in capacity to 15 GW until 2030.
- ➔ Federal agencies should provide the data needed by investors for their bids.
- ➔ Close discussion with user community (with a detailed opinion on requirements)

UERRA partners



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Meteorologisch Instituut
Ministerie van Infrastructuur en Milieu

UEA
University of East Anglia



Met Office



Deutscher Wetterdienst
Wetter und Klima aus einer Hand



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra



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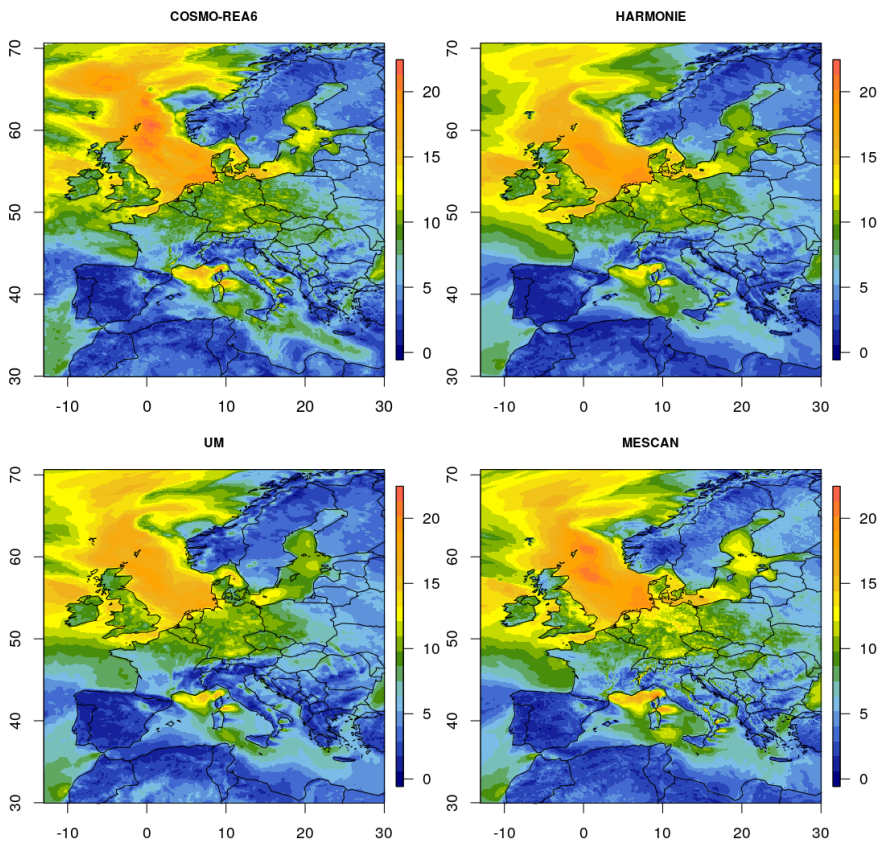
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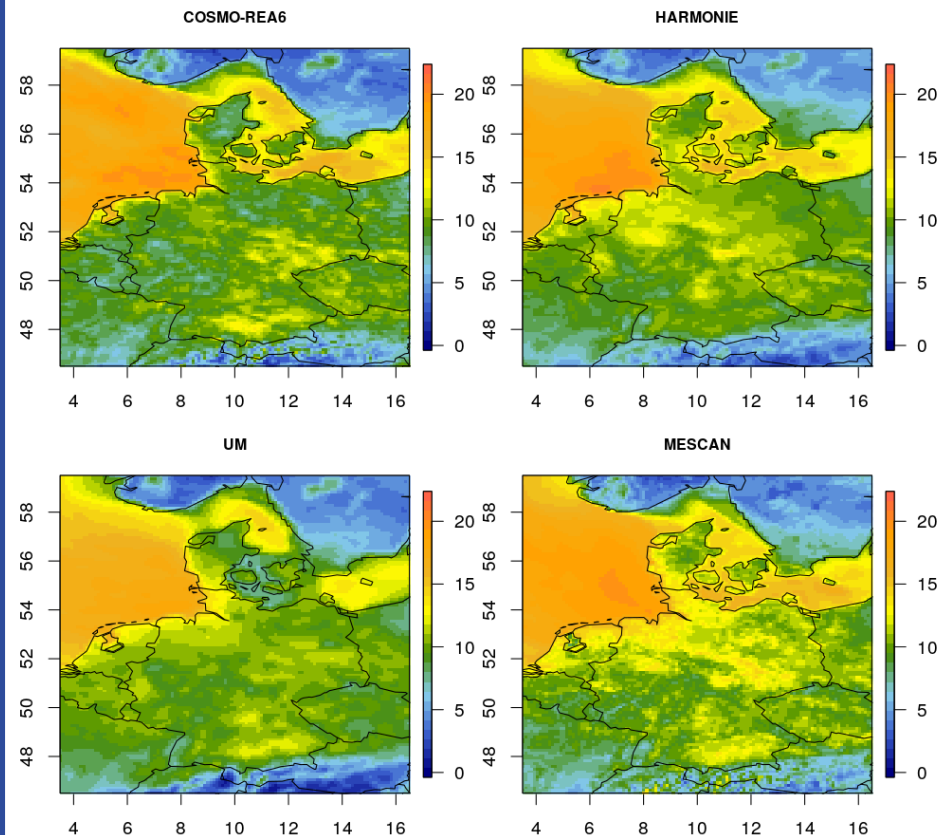


Comparison of European regional reanalyses on continental / national scale

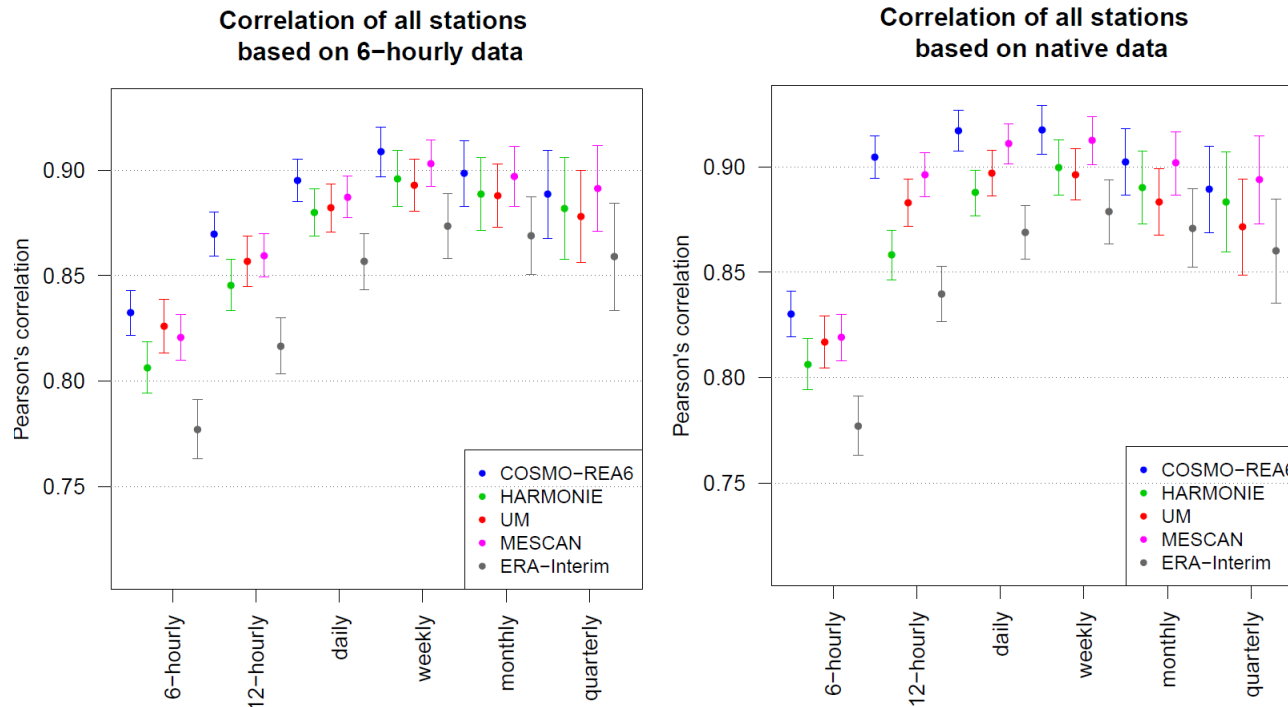
daily mean of 10m-Windspeed for 2008-03-1



daily mean of 10m-Windspeed for 2008-03-01

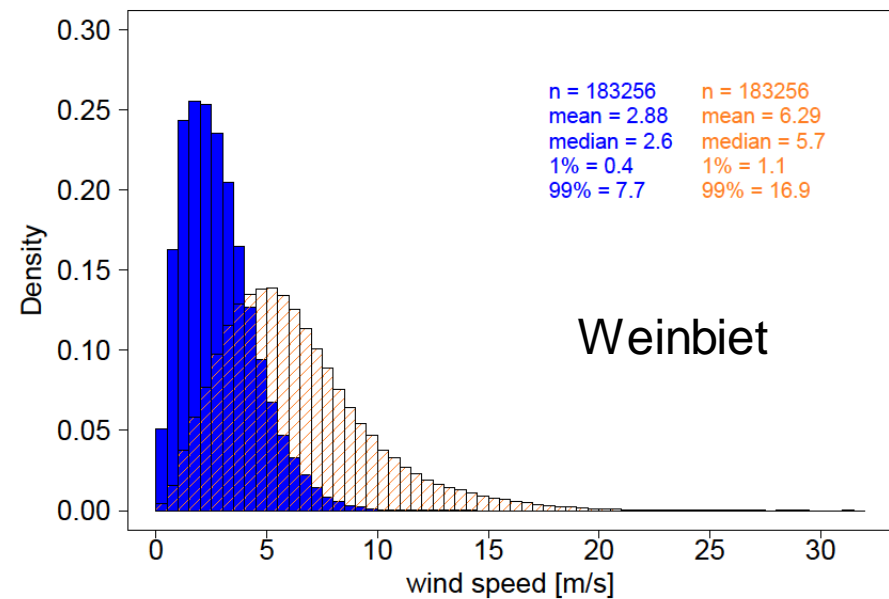
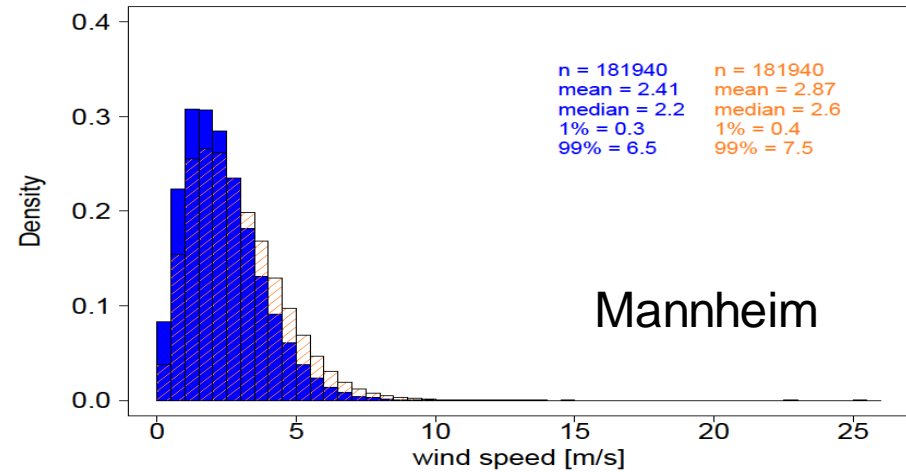
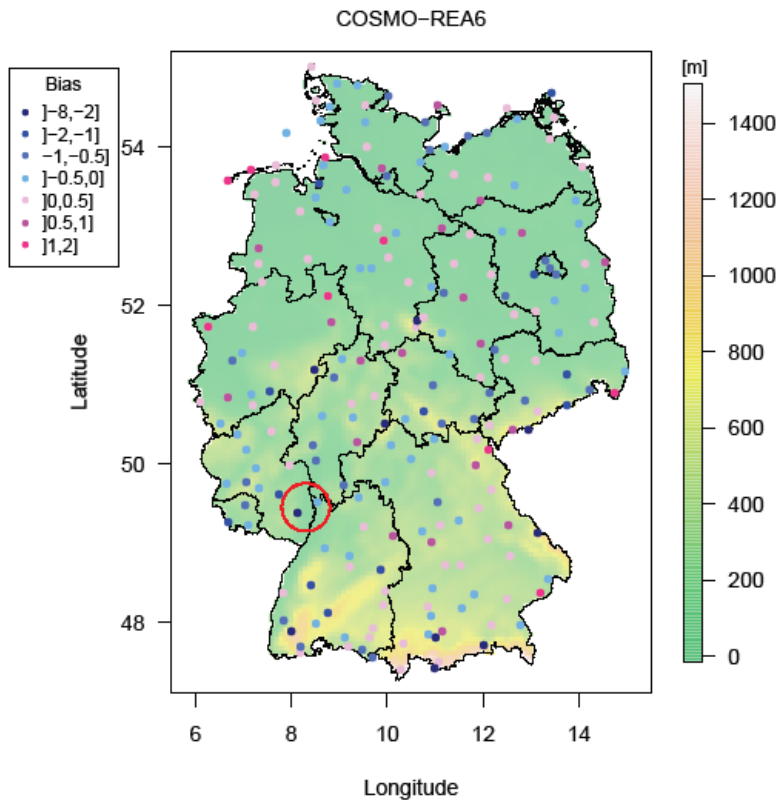


Correlation depending on temporal resolution for 10m wind German stations



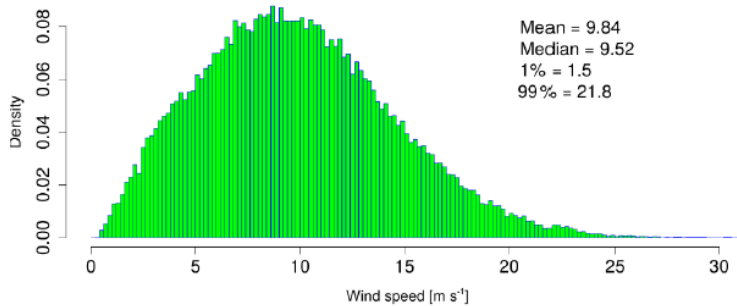
- ➔ Clear added value of regional reanalyses on hourly and daily scale
- ➔ Maximum peak at weekly timescale
- ➔ The use of hourly instead of six hourly reanalysis and observation data can improve the results significantly

Bias of 10m wind speed depends on orographic representation

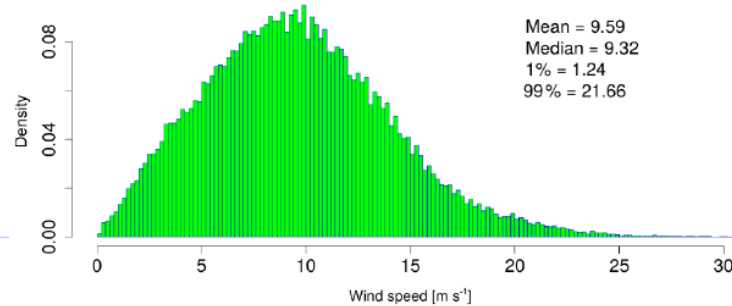


Comparison against mast measurements over the ocean

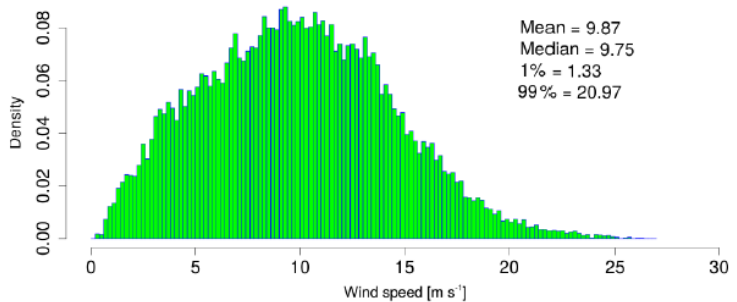
(e) Hourly wind speed at FINO1 in 100 m



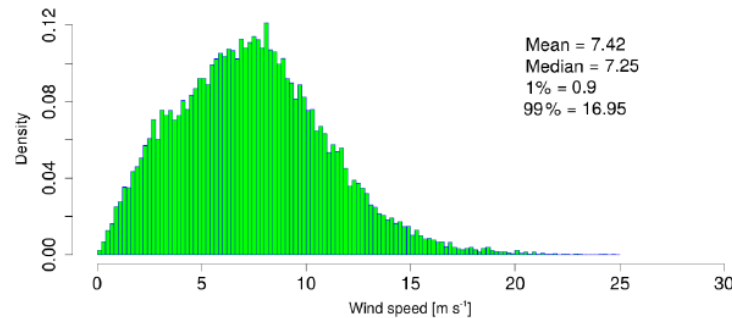
(f) Hourly wind speed of COSMO-REA6 at FINO1 in 116 m



(g) Hourly wind speed at FINO2 in 102 m



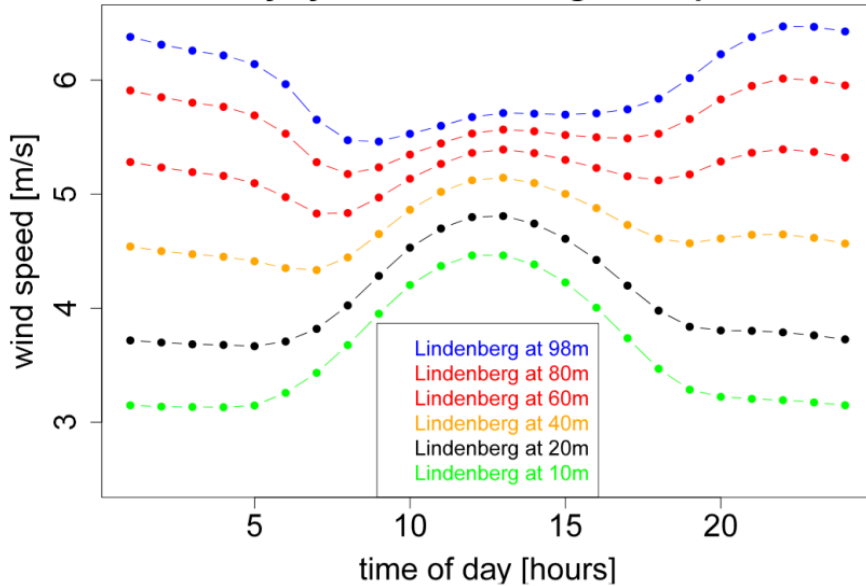
(h) Hourly wind speed of COSMO-REA6 at FINO2 in 116 m



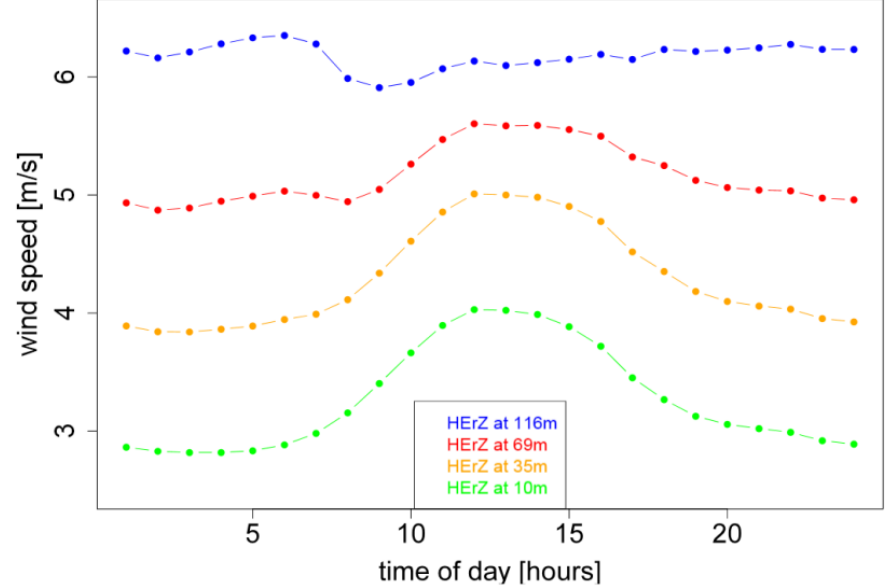
Borsche et al., 2016

Daily cycle of wind speed

Daily cycle of Lindenberg wind speed

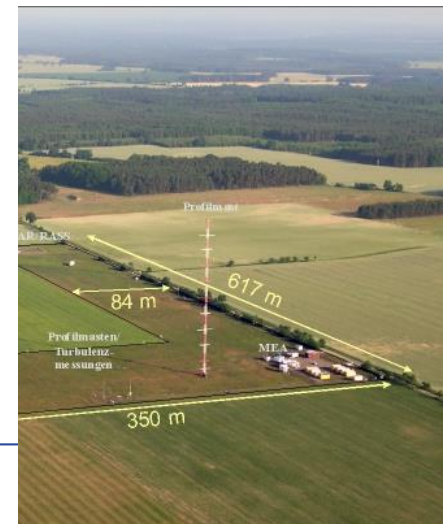


Daily cycle of HErZ wind speed at tower location Lindenberg



- ➔ Good agreement at 10m height
- ➔ Problems above 50m

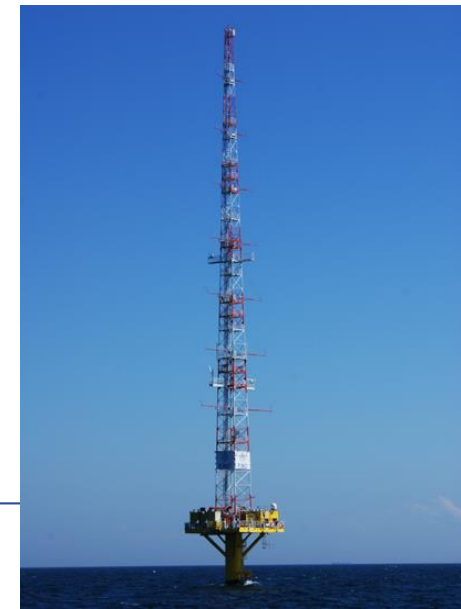
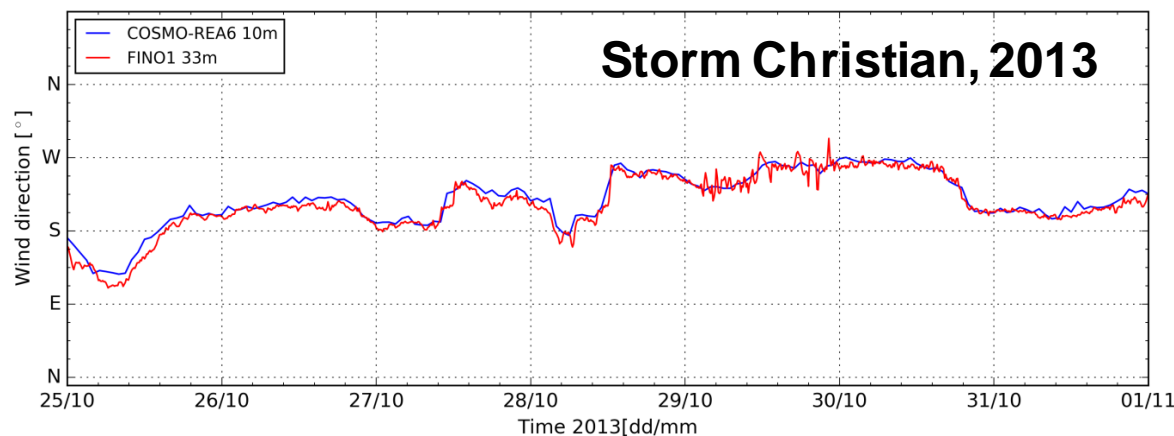
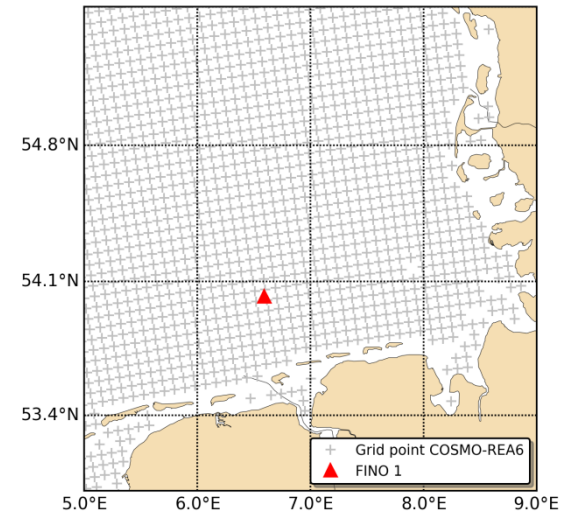
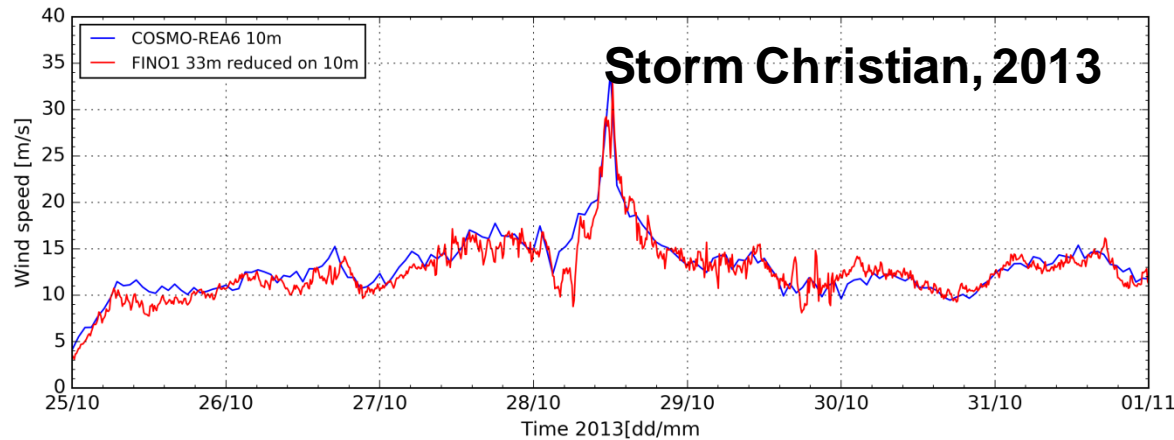
Borsche et al., 2016



- **Extreme North Sea storm surges and their impacts:** Identification of extreme storm surge events that are extremely unlikely, but physically plausible, and might result in extreme impacts/damages.

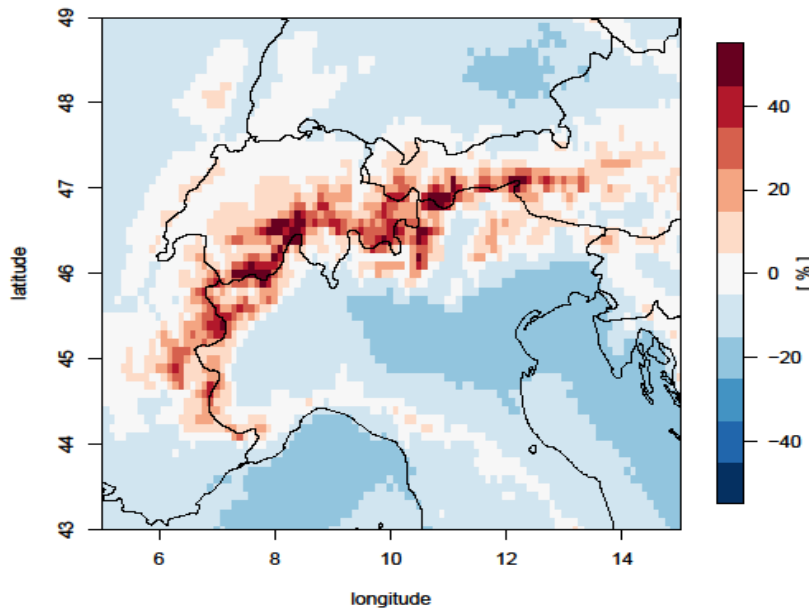


COSMO-REA6 2D – wind speed & direction at **FINO 1** during storm „Christian“ (2013)

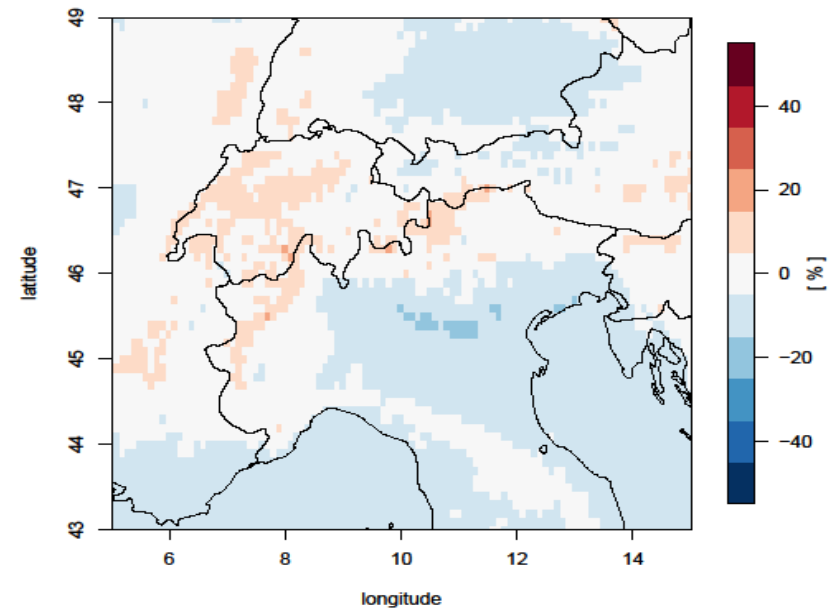


Surface radiation, REA6, comparison with satellite data

Annual bias [%] of REA6 vs SARAH-2



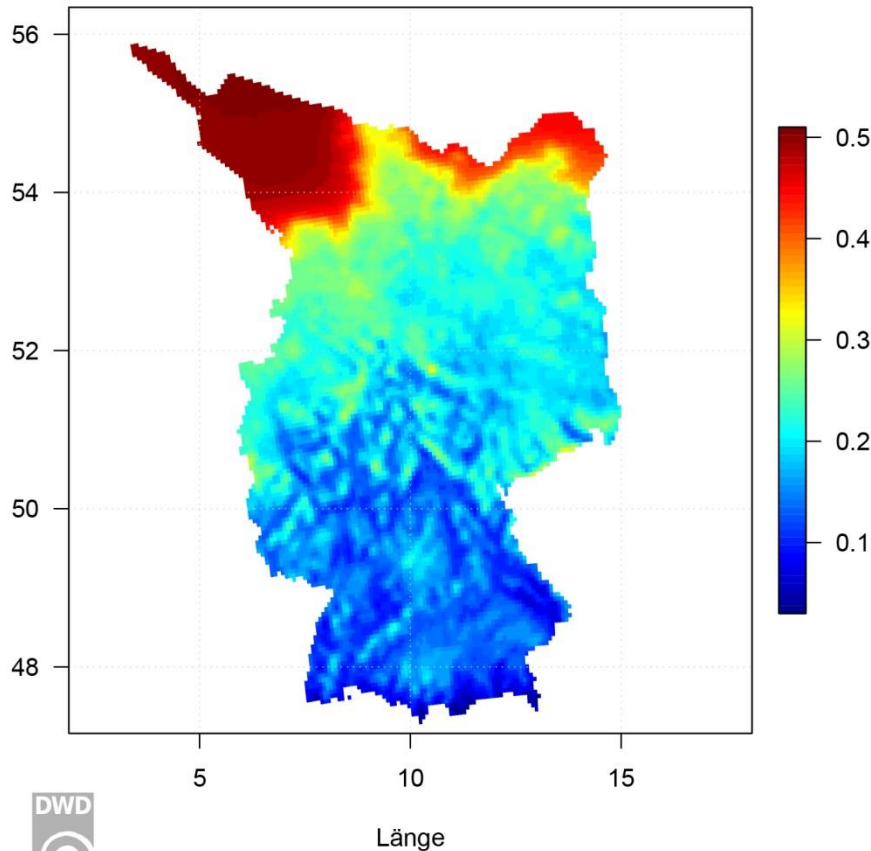
Annual bias [%] of REA6 vs HeliMont



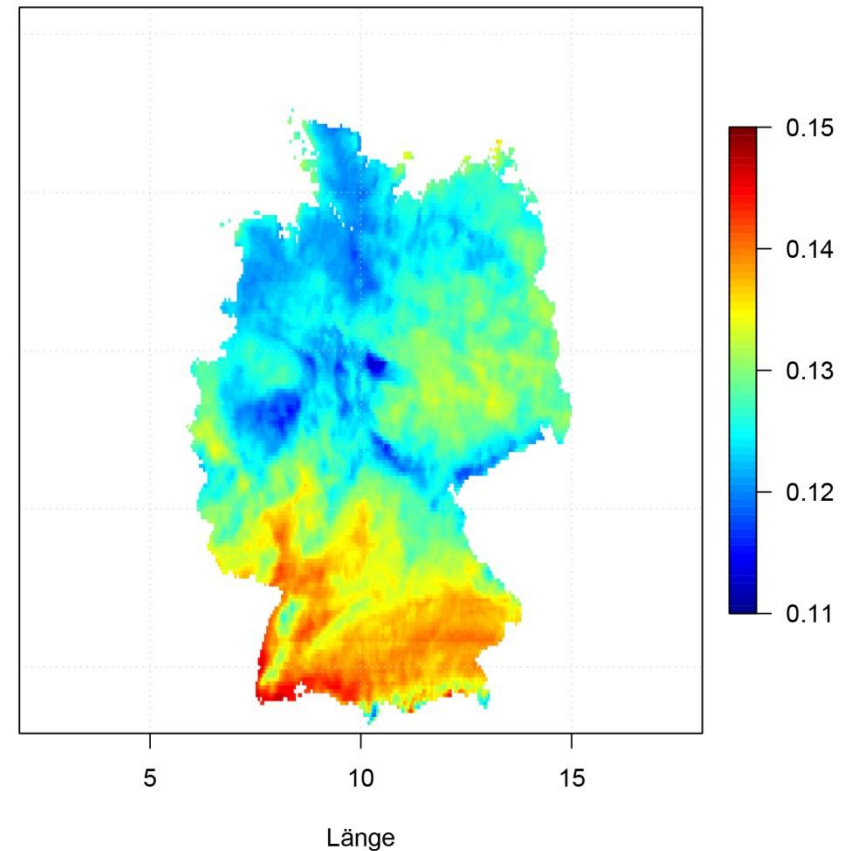
- ➔ Strong bias over the Alps in first comparison with CMSAF data
- ➔ Second reference (HeliMont) with improved algorithms for the Alpine region lead to smaller bias

Mean Capacity factor for wind energy and solar energy over Germany

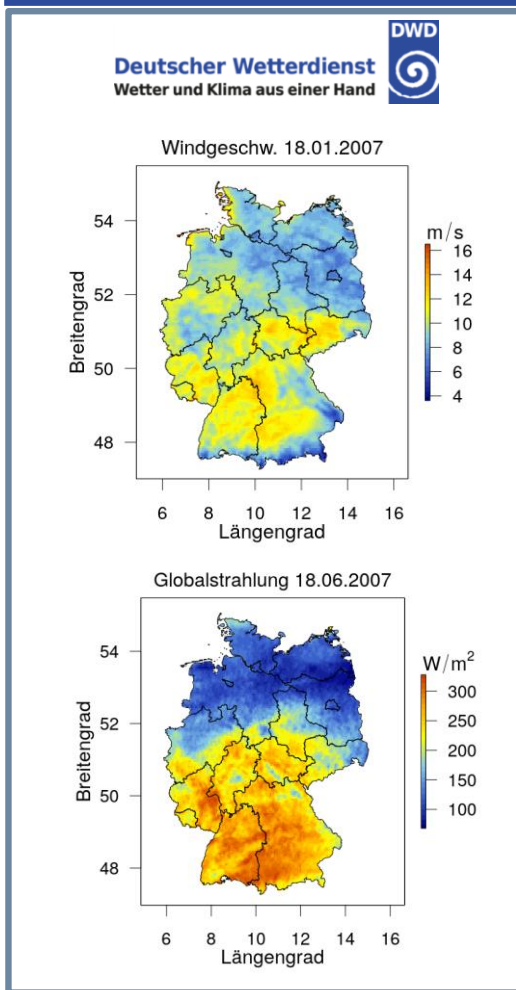
Wind



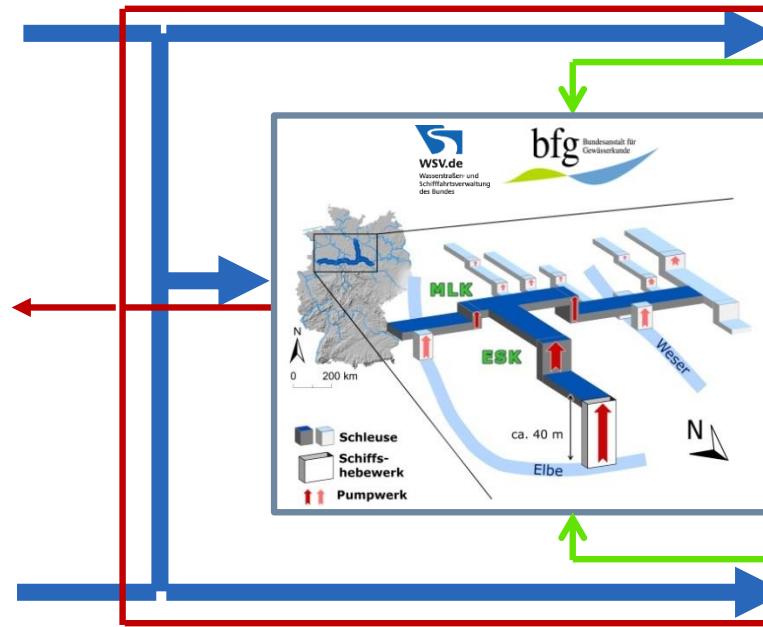
solar



Topic 5: Enhanced development of renewable energy in transport and infrastructure



→ Geography
→ Meteorology (EE- supply)
→ Energy transfer



Outlook

- COSMO-REA6 needs to be upgraded:
 - Use of latest operational COSMO model version with nudging (v5.04d4)
 - Lateral boundary conditions of ERA-5
 - Extension into the past until 1990
 - Usage of bias corrected radiosonde data
- Mid-term future is to develop an ICON-EU and/or ICON-LAM reanalysis



Conclusions

- COSMO-REA6 provides climatological data for 1995 to 2017 over Europe with an hourly temporal resolution on ~6km horizontal spacing
- COSMO-REA6 has been evaluated against independent data and other regional reanalyses
- COSMO-REA6 is freely available and successfully used in several applications

<https://www.dwd.de/reanalyse>

