

# Use Cases of Weather and Climate Services to Support the German Energy Transition

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The energy sector has a wide range of requirements for weather and climate data and services. As in many other countries, the share of renewable energies has increased in Germany during the last years and the German government aims at a further expansion within the next decades. As a consequence, there is a growing need for high quality meteorological information on several time scales. In this presentation, we will discuss the experience of Germany's national meteorological service (Deutscher Wetterdienst, DWD) with the provision of user-oriented services for various stakeholders in the energy sector.

## Satellite-based surface radiation data for Europe and Africa

A frequently used product from the data centers is the surface radiation dataset SARAH ("Surface Solar Radiation Data Set - Heliosat"). It is based on METEOSAT data and produced by the Satellite Application Facility on Climate Monitoring (CM SAF, <https://www.cmsaf.eu>), a EUMETSAT activity organized as a network with contributions from several national meteorological services in Europe and led by DWD.

## Regional reanalysis (COSMO-REA6)

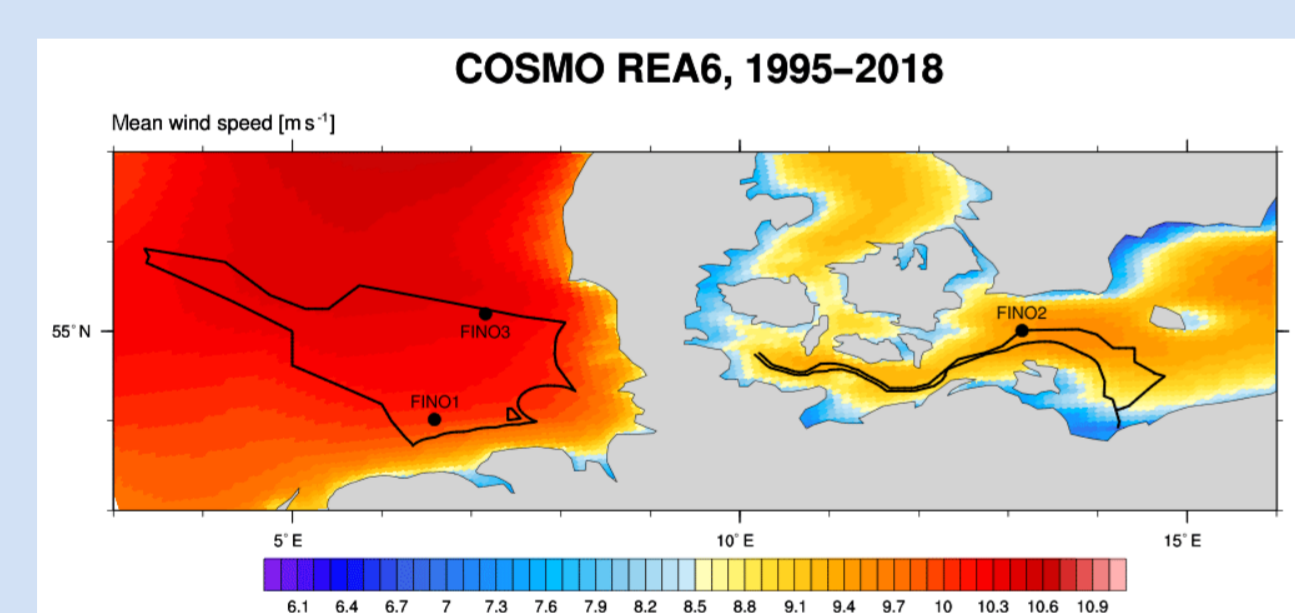
Based on the numerical weather prediction model COSMO, regional reanalysis datasets have been developed with grid spacing of 6 km (COSMO-REA6) and 2 km (COSMO-REA2). Applications of COSMO reanalyses include renewable energy assessments as well as meteorological risk estimates. The COSMO reanalysis datasets provide spatio-temporal consistent data of atmospheric parameters covering both near-surface conditions and vertical profiles. In many studies, evaluation of the COSMO reanalyses point to an overall good quality.

## Climate simulations and seasonal forecasts

DWD also runs climate models to produce climate projections and seasonal forecasts. The debates in the recent winter about the risks of a shortage in gas availability have led to an increased interest in seasonal forecasts.

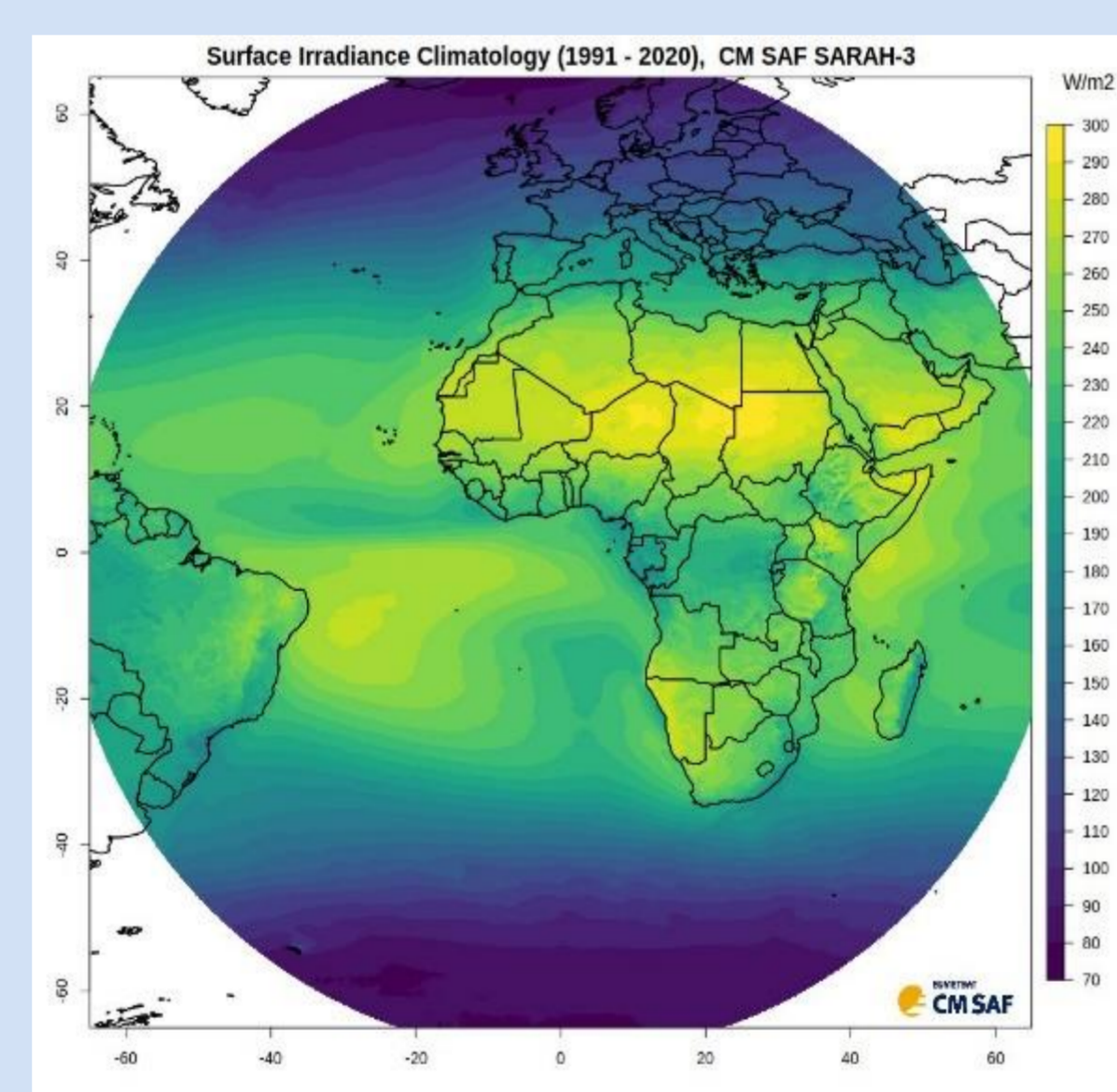
## Example: Offshore wind park planning based on reanalysis data

Climatological information on the wind conditions in the German offshore regions was derived on the basis of DWD's regional reanalysis.



COSMO-REA6 average wind speed 1995-2018 in the German Exclusive Economic Zone (EEZ) in the North Sea and Baltic Sea at 116 m height. The boundaries of the EEZ and the locations of the FINO measurement sites. (<https://doi.org/10.5194/asr-17-115-2020>)

## Product example: Surface radiation



Spatial distribution of mean surface solar radiation (global radiation) in the period 1991-2020 based on the CM SAF SARAH-3 data set (derived from METEOSAT observations)

## Numerical weather predictions of the ICON model suite

Weather forecasts are of particular interest for the daily operation of the energy system, the predictive balancing of production and consumption, the management of congestion and the weather dependent thermal rating of the overhead lines in the electrical grid. In close contact with our key user groups, DWD optimizes and co-designs forecast products and services tailored to the user needs. One special focus lies on the co-development of products that make use of ensemble forecast information and to foster its integration in the user's decision processes. For the product development, we use our global to regional ICON model suite that provides deterministic and ensemble forecasts with different horizontal resolutions and forecast horizons and the new model ICON-ART (see example below).

## Realtime observations from radar, satellites and various point observations

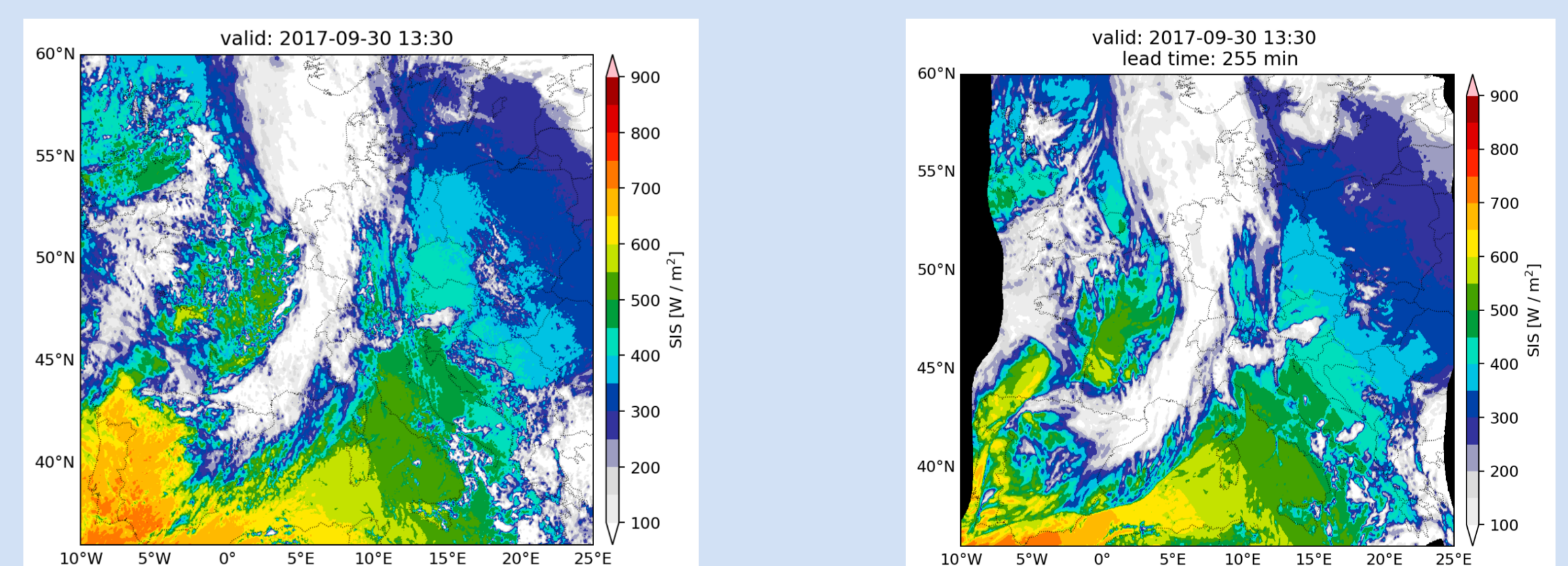
The actual measurements for a range of meteorological parameters as well as data products derived from radar or satellite images support the monitoring activities of the energy sector and provide a reference for the model forecasts.

## Nowcasting derived from satellite images and radar data

Nowcasting products are important to derive an estimate of the radiation for the next few hours or to assess the very short term thunderstorm development.

## Example: Radiation nowcasting for the estimation of the expected in-feed

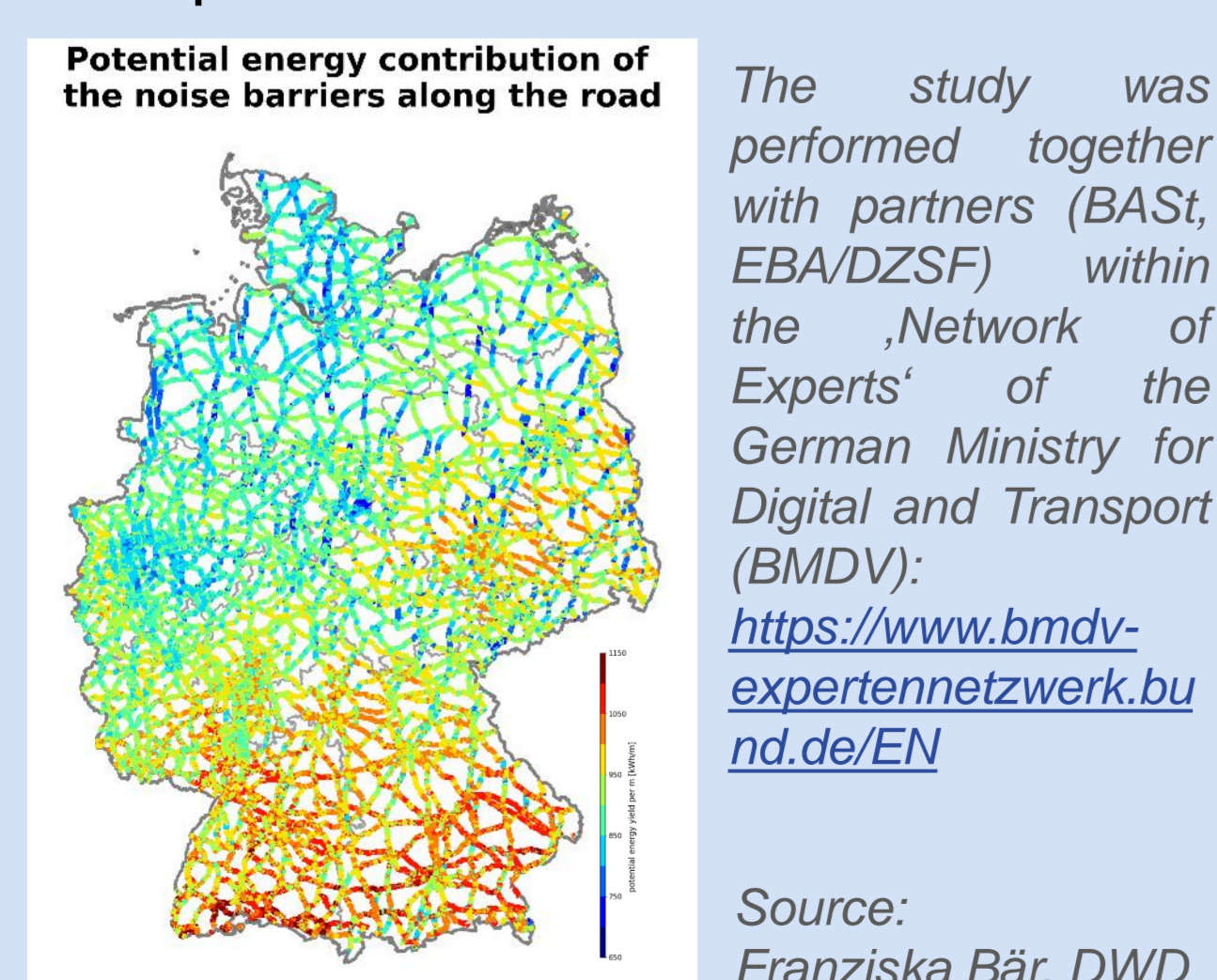
Grid operators permanently calculate the actual in-feed of renewable power in their control area in order to balance out production and consumption. The radiation nowcasting provides the necessary gridded information for the applied power models.



Global radiation is derived from satellite images using the specmagic algorithm with radiation from clear sky radiation and effective cloud albedo (<https://doi.org/10.3390/rs4030622>). Left: global radiation observed for a certain time stamp, right: Nowcasting based on atmospheric motion vectors (<https://doi.org/10.3390/rs10060955>).

## Example: Photovoltaics potential

The satellite-based surface radiation data was used to estimate the potential for electricity production with photovoltaics on noise protection facilities alongside the German transport infrastructure.

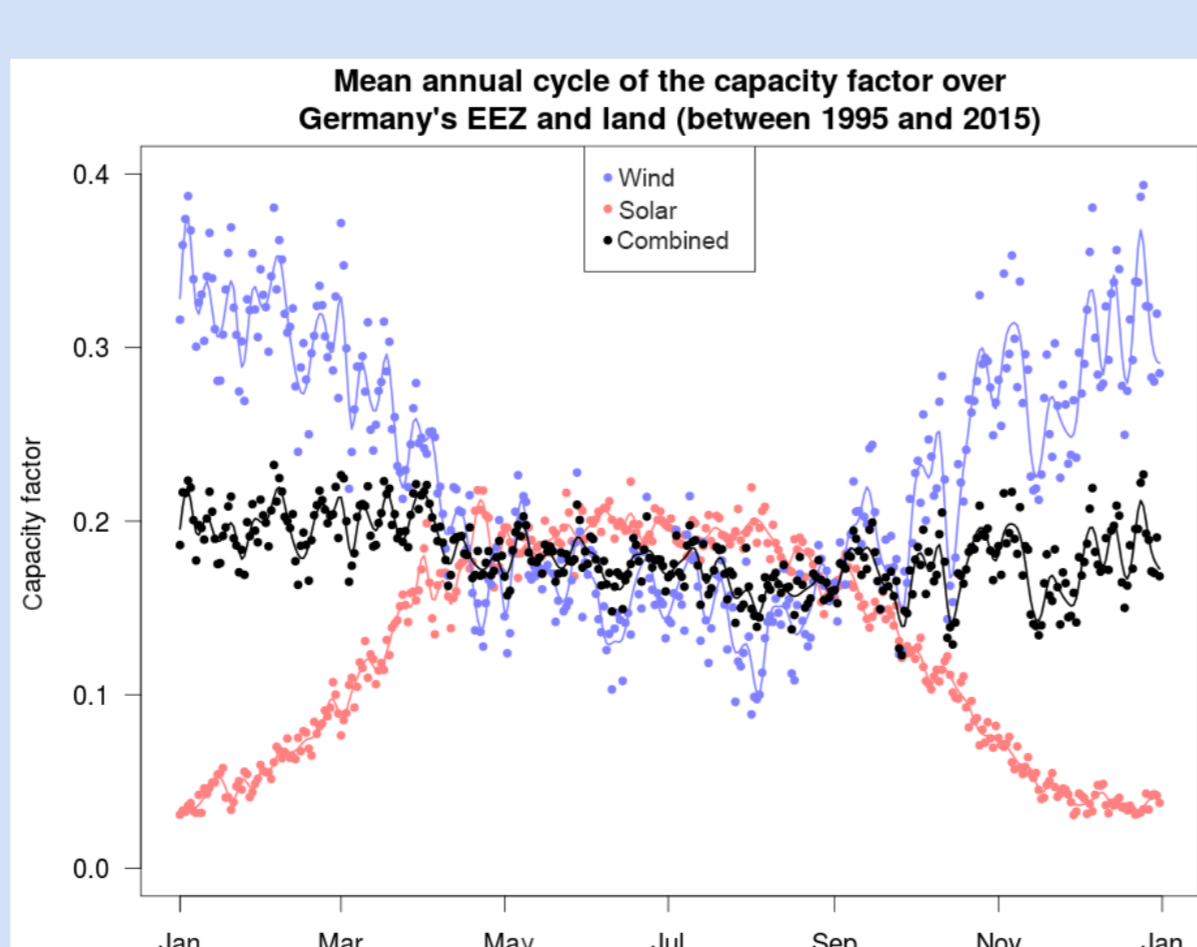


The study was performed together with partners (BAST, EBA/DZSF) within the 'Network of Experts' of the German Ministry for Digital and Transport (BMDV): <https://www.bmdv-expertennetzwerk.bund.de/EN>

Source: Franziska Bär, DWD

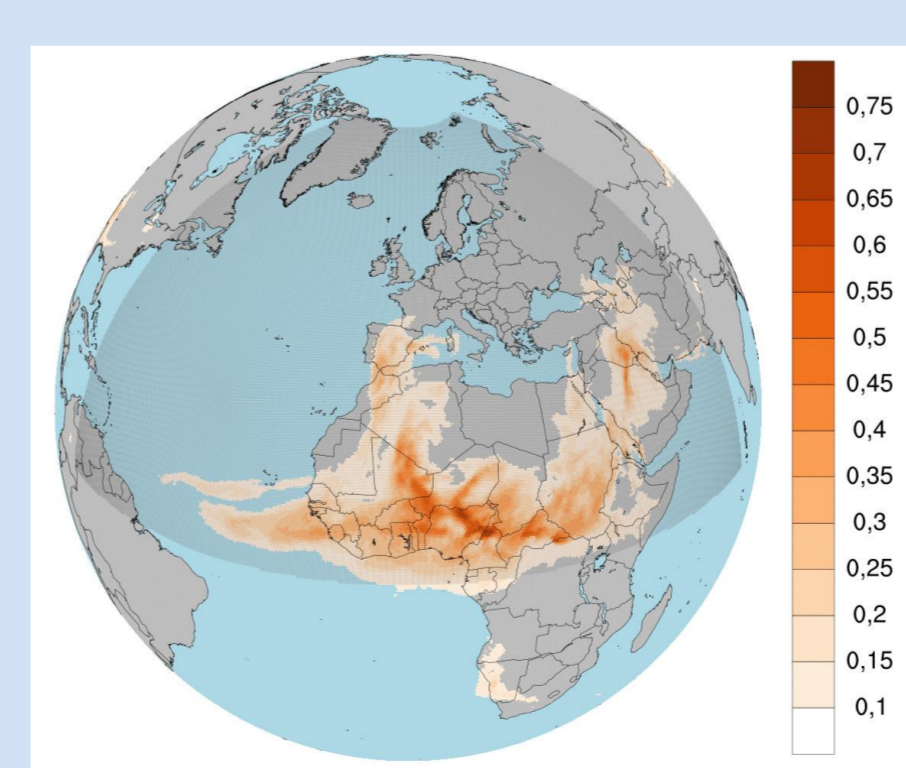
## Example: Risk analyses

The combination of high-resolution data for wind and surface radiation allows to analyze balancing effects and shortfall risks of wind energy and photovoltaics for selected regions (e.g.: <https://doi.org/10.5194/asr-16-119-2019>, <https://doi.org/10.1016/j.renene.2020.10.102>)



## Example: Mineral dust forecasts

Outbreaks of mineral dust, e.g. from deserts, can lead to significant reduction of photovoltaic yield. Together with Karlsruhe Institute of Technology, DWD develops the ICON-ART system with prognostic dust modelling. ICON-ART will become operational by the end of 2023.



ICON-ART mineral dust forecast for 05.02.2021 00 UTC. For more, see e.g. <https://doi.org/10.5194/acp-2017-441> or <https://doi.org/10.5194/acp-2022-746>

## Open Data Access

In order to fulfil its legal tasks in the provision of meteorological services, the observational data as well as the numerical weather predictions and nowcasting products are provided under an open data policy on an open data server:

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

Various other products are part of the open data portfolio, e.g. gridded datasets of various parameters for Germany or Europe, or the regional reanalysis of DWD.



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