Deutscher Wetterdienst
Wetter und Klima aus einer Hand

Slowly but surely…

Observing and supporting the growing use of ensemble products

Renate Hagedorn

Deutscher Wetterdienst

Product Development and Customer Relations

1995: early days…

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BOTTGER, H.: THE MEMBER STATES EXPERIENCES WITH THE ECMWF EPS

3. Use of medium-range forecast guidance

All ECMWF Member States have developed their own procedures and concepts for the use of medium-range forecast products. The primary forecast guidance is the output from the deterministic T213L31 high resolution model. To an increasing extent forecasters are beginning to combine the results from the deterministic model and the EPS in an appropriate way. Sm… signal of the support for the solution offer by the T213 model and it wi… dence in the overall pe…m. Forecasters h… ls the use of guidance f… y tend to rely on … l EPS mean) rather than … eme solutions off… he ensemble. After all, t… sts have a low pro… e used by the forecaster… s that a well balan… l detect at an early stage… ios late in the fore… th increasing probabiliti…

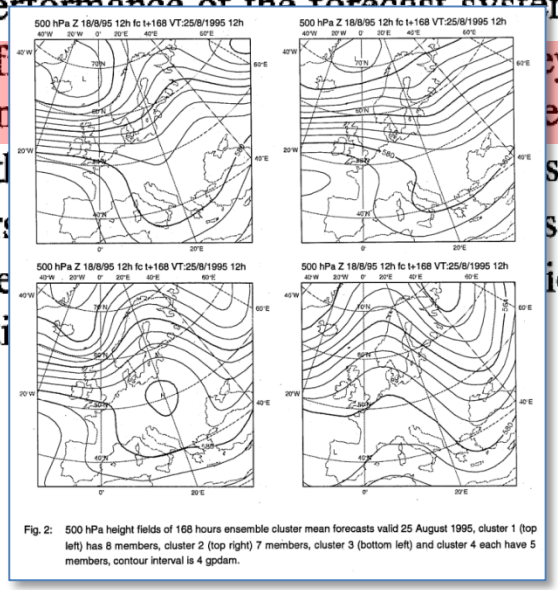

Fig. 2: 500 hPa height fields of 168 hours ensemble cluster mean forecasts valid 25 August 1995, cluster 1 (top left) has 8 members, cluster 2 (top right) 7 members, cluster 3 (bottom left) and cluster 4 each have 5 members, contour interval is 4 gpdam.

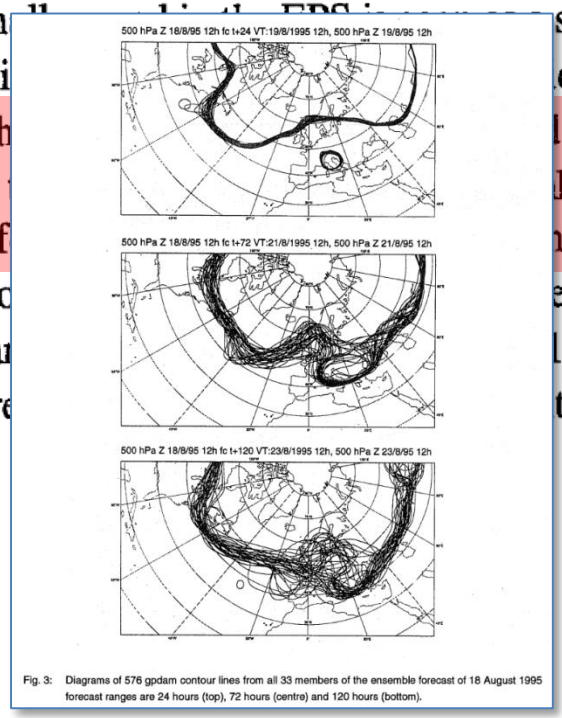

Fig. 3: Diagrams of 576 gpdam contour lines from all 33 members of the ensemble forecast of 18 August 1995 forecast ranges are 24 hours (top), 72 hours (centre) and 120 hours (bottom).

2002: some progress…

SMITH, L.A.: PREDICTABILITY PAST PREDICTABILITY PRESENT

2. Contrasting 1995 and 2002 Perspectives on Predictability

What has changed in the short time since the 1995 ECMWF Seminar on Predictability? Since I cannot avoid indirectly criticising what was happening in 1995, we will focus mostly on my contribution to the seminar.

A major focus of my 1995 paper was on ensemble formation for systems of chaotic differential equations, in contrast this talk does not contain a single differential equation. In fact, it contains only one equation and, as it turns out, that equation is ill-posed. The 1995 paper focuses on constructing perfect ensembles, while below we will be more concerned with interpreting operational ensembles. The 1995 paper quantifies the difference between some forecast probability density function (PDF) and a perfect PDF obtained by propagating current uncertainty forward in time under a perfect model, while below I am content to discuss how to change an ensemble of simulations into a PDF forecast in the first place. There is also a question as to how one should evaluate any forecast PDF, given that we never have access to the "perfect PDF", if such a thing exists, but only observations of a single realization of weather. That is, we have only measurements of the one thing that happened, a target often called the *verification*. In general, it seems to me that the 1995 paper focuses on doing maths within the perfect model scenario (PMS), whereas the current paper is more interested in quantifying information content and debating resource allocation.

2002: some progress…

SMITH, L.A.: PREDICTABILITY PAST PREDICTABILITY PRESENT

2. Contrasting 1995 and 2002 Perspectives on Predictability

What has changed in the short time since the 1995
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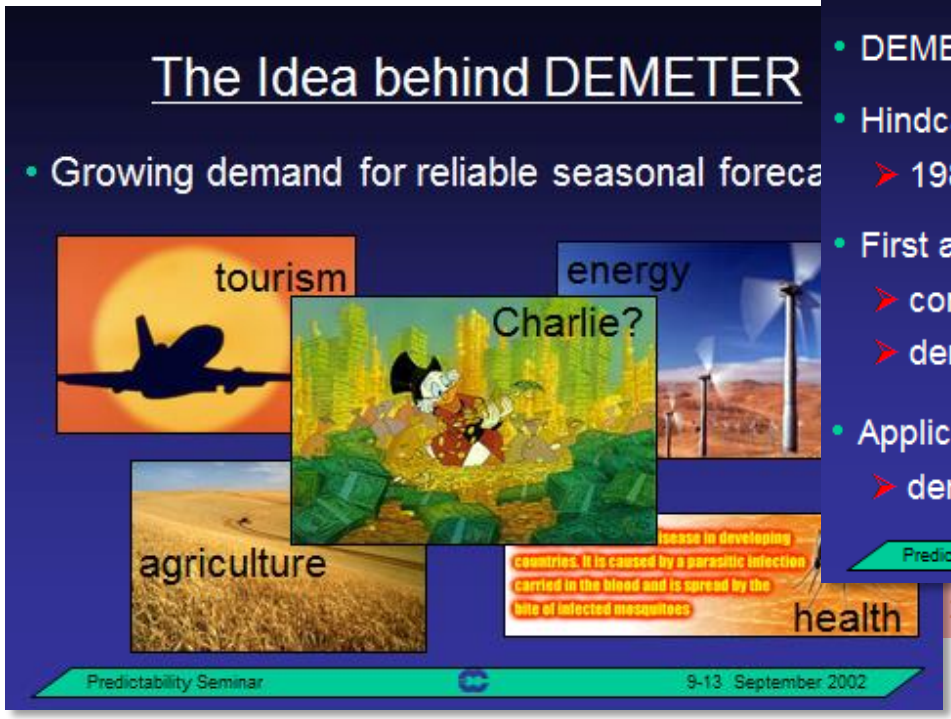

Summary

- DEMETER multi-model ensemble system fully installed
- Hindcast production follows closely ERA-40 production
  - 1987 – 1997 available, 1958 onwards started
- First assessment of skill
  - confirms potential of seasonal forecasting
  - demonstrates multi-model advantages
- Application of DEMETER data in end user models
  - demonstrates need for downscaling

Predictability Seminar 9-13 September 2002

resource allocation.

2010: moving towards users…

Conclusions

- MM-concept does work for medium-range weather forecasting
  - it improves on (o
  - it is of comparabl
    drawback of nece
- Improvements thr
  - Improved spread
  - Reducing ensemb
- Weighting MM's ir
  improvements (se
  - No stable error ch
  - Effort of calculatir
    synthetic ensemb
  - This might chang

ECMWF Seminar,

The future…

- Monitor performance of different models to detect if skill of individual models change
- For applications needing local information, add value to forecasts by
  - Applying a suite of post-processing methods to the DMO
  - Working with users, i.e. move on from simple examples and ideal scenarios to "real life" applications and face the reality of forecasters and users
- Where should this work be done? Who should do this work?
  - Directly at the source of the forecasts or individually for/by users?

ECMWF Seminar, 7 September 2010: *The TIGGE experience* 48

2017: where do we stand today?

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✓

?

Potential vs. actual value

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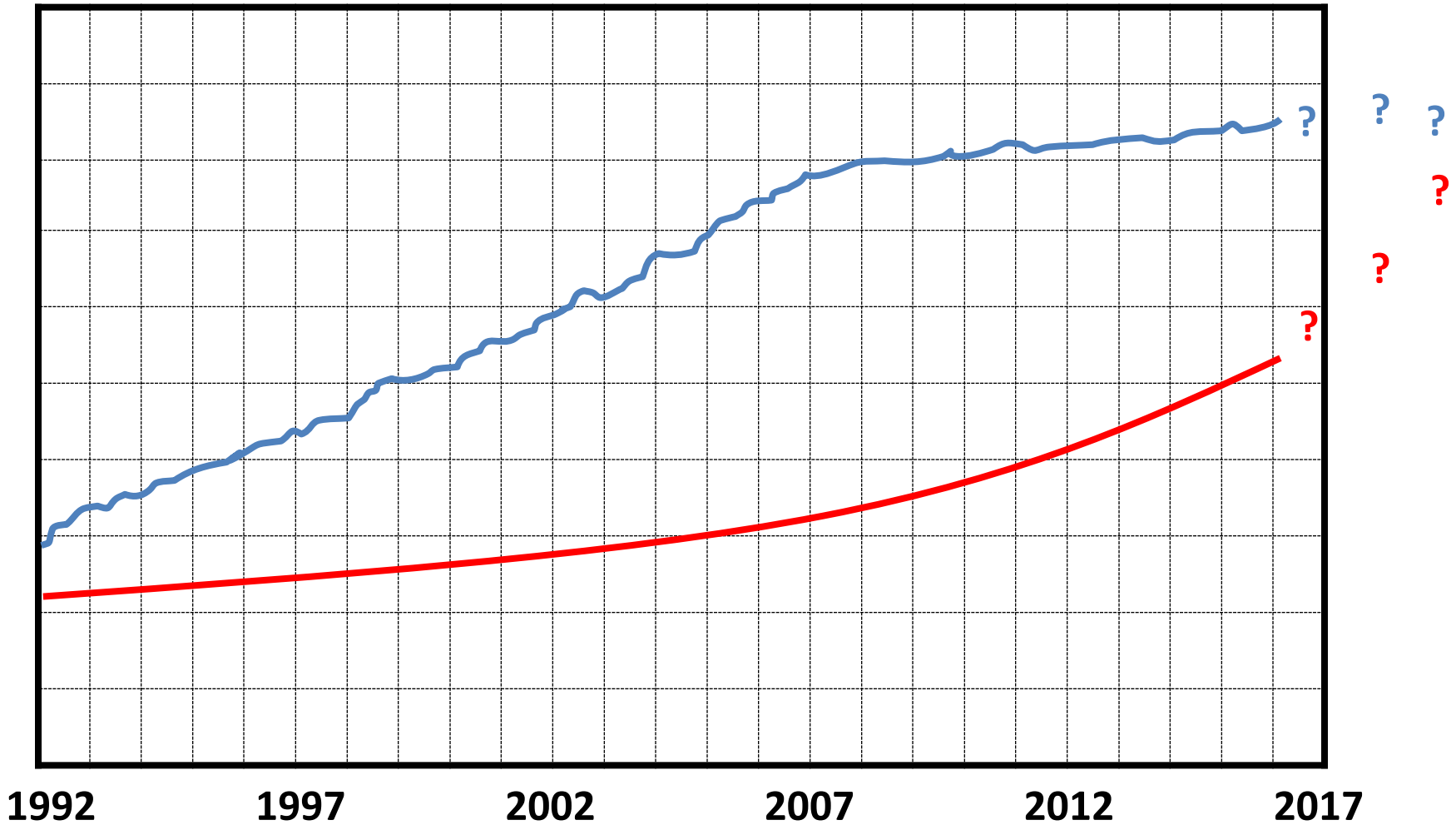

Closing the gap

➔ Main goal of Division on Product Development and Customer Relations at DWD

➢ **Enhancing the importance and utility of weather information and (probabilistic) forecast products for the user by…**

- Collecting user requirements
- Consolidating requirements and possibilities
- Planning, coordinating and conducting new developments
- Supporting users to integrate weather information into their own decision support systems

➢ **Fostering the dialogue between users and developers in particular on integrating probabilistic information**

Focus groups

Ensemble of user requirements

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How to design forecast products,
which fulfill all those requirements?

From theory to practice

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Civil Protection

Open-Data

(Renewable) Energy Systems

Road & Rail Services

➔ Weather warnings: from EXtreme event Information to COMunication and action

- Research project of the **Hans-Ertel-Zentrum** (funded by DWD)
- Inter- and **transdisciplinary approach** involving meteorology, social sciences, and psychology
- **Ultimate goal is to facilitate transparent and effective communication of risk and uncertainties to specific user groups**
- Using the DWD's fire brigade information system (FeWIS) as a testbed, the project will implement **different ways of communicating probabilistic weather information**
- Use of this **information will be analyzed in terms of usage and preferences** to determine whether and how risk-based warnings can help emergency managers to reduce the risk of loss and damage

Understanding the understanding

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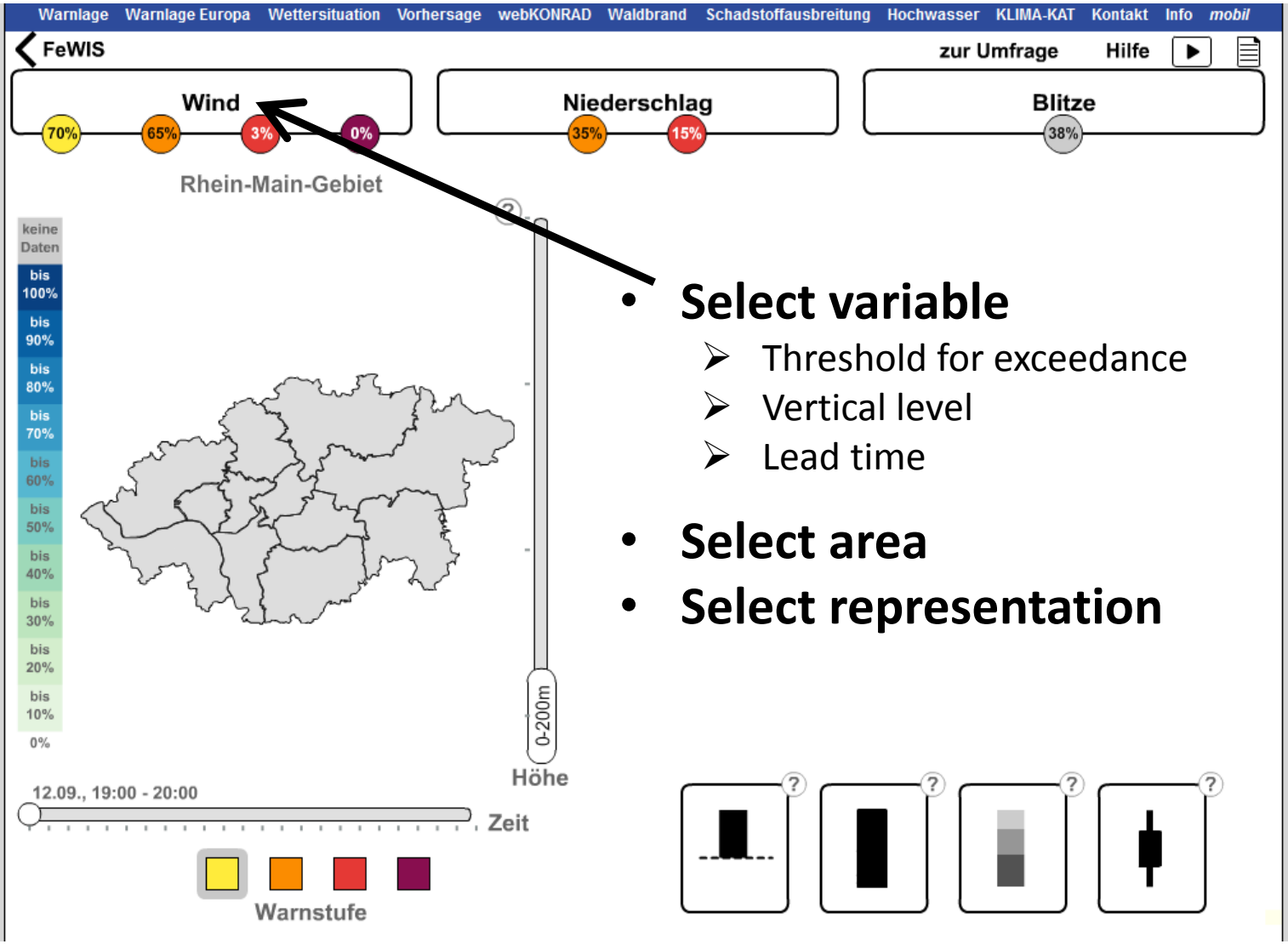
- Quantify user preferences by analyzing web usage behavior
  - Which representations do users select?
  - How do users search? Where do they start? Where do they stop?
  - Do search patterns differ by user types or weather conditions?

- Repeated surveys after gaining experience with representations
  - How well do users understand the different probabilistic formats?
  - Include items on numeracy, graph literacy, trust
  - Questions about usability, usefulness, user preferences, likelihood of future use, suggestions and complaints

Courtesy: Nadine Fleischhut

Max-Planck-Institut für Bildungsforschung
Max Planck Institute for Human Development

FeWIS_pro



- **Select variable**
  - Threshold for exceedance
  - Vertical level
  - Lead time
- **Select area**
- **Select representation**

FeWIS_pro

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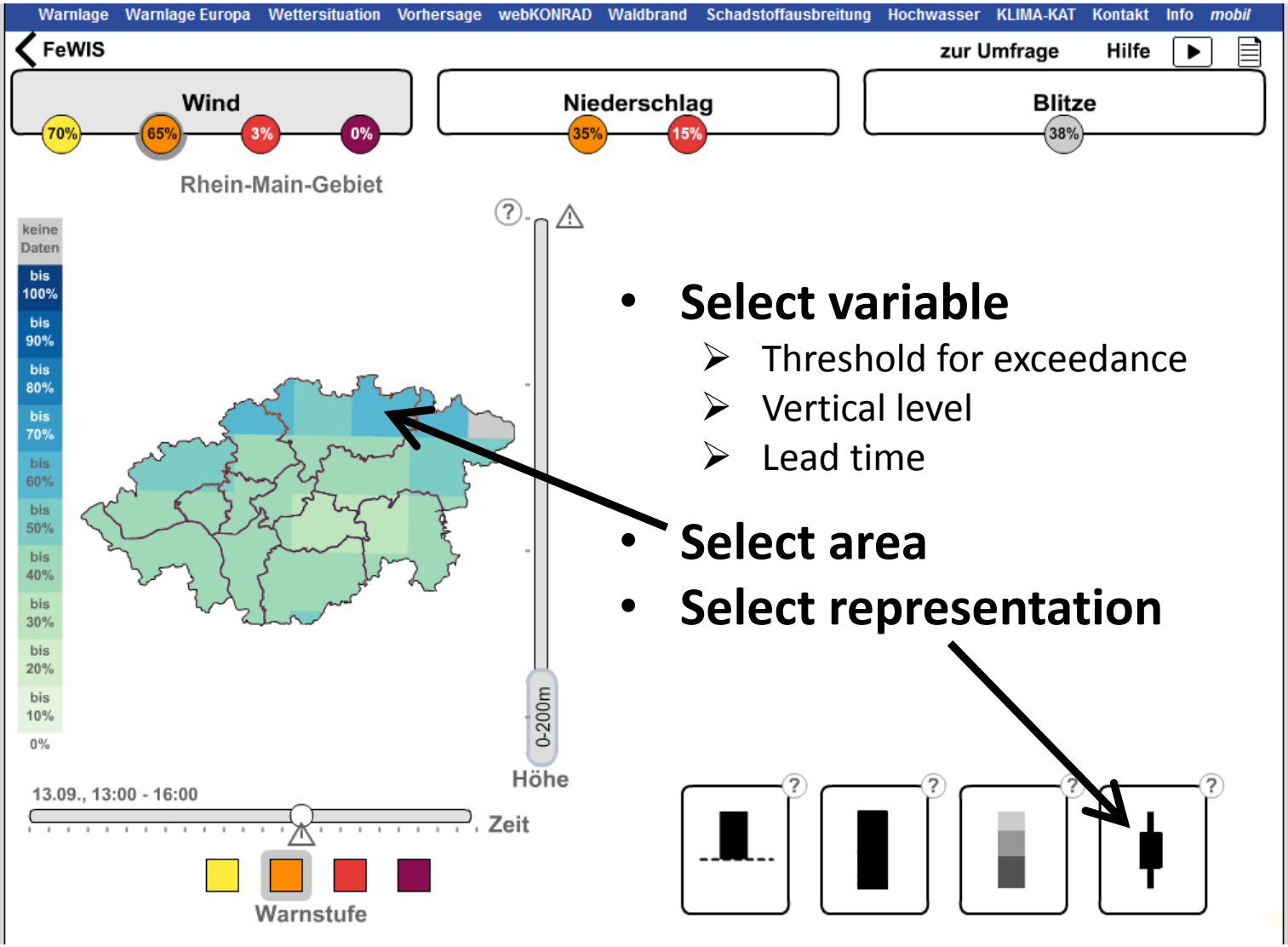
Wetter und Klima aus einer Hand



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FeWIS_pro

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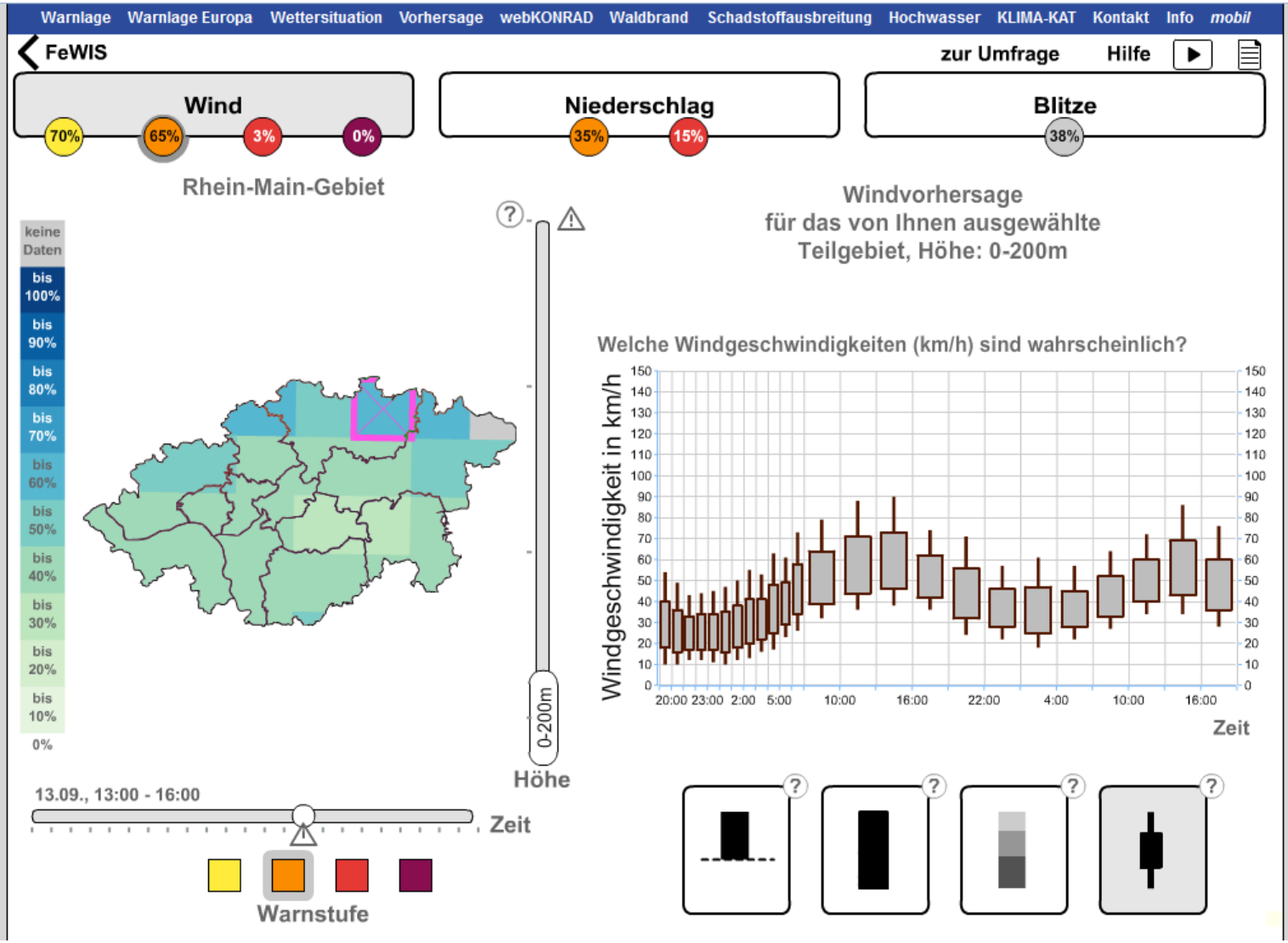
Wetter und Klima aus einer Hand



FeWIS_pro

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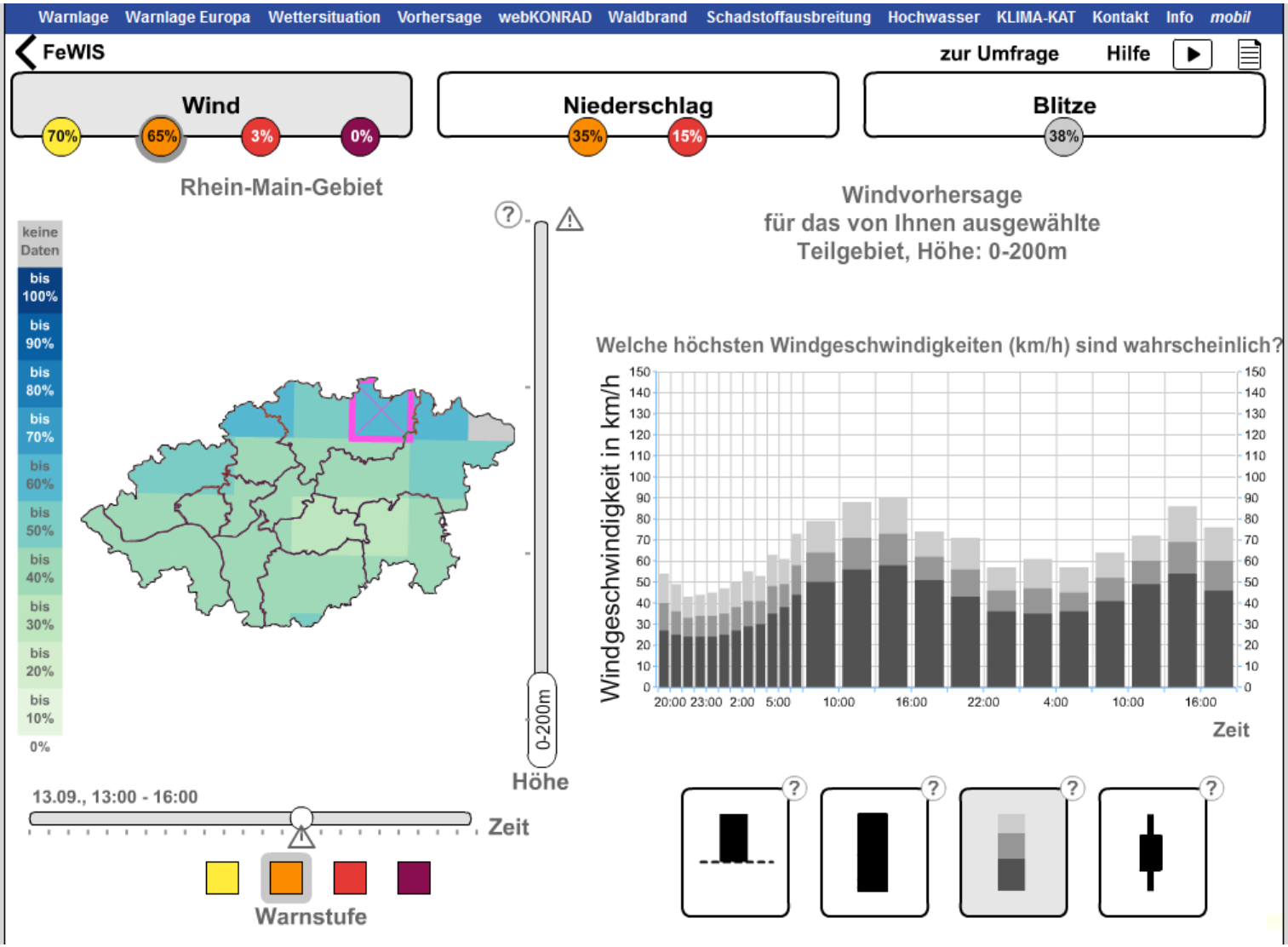
Wetter und Klima aus einer Hand



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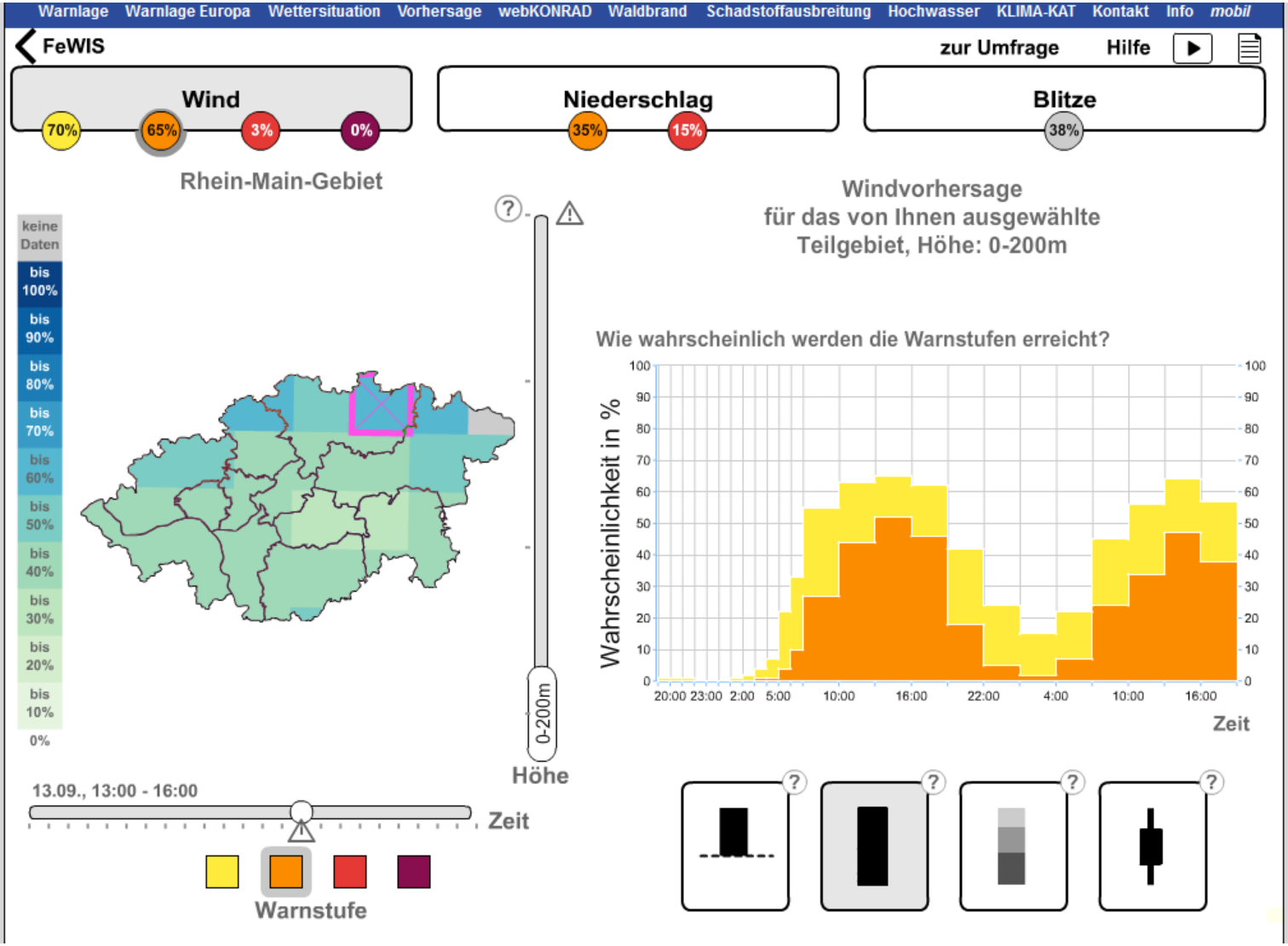

FeWIS_pro

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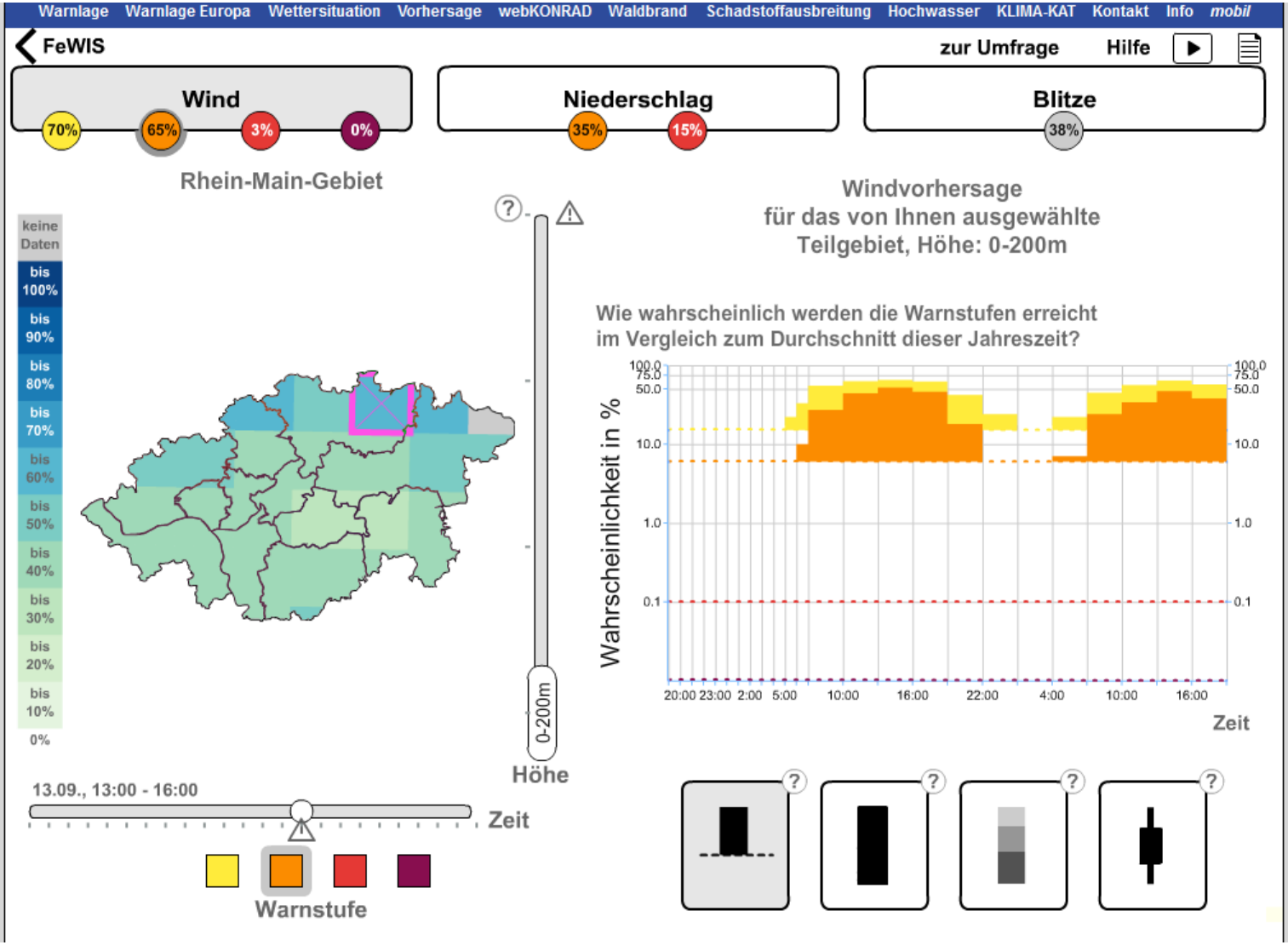
Wetter und Klima aus einer Hand



Frequency of selection

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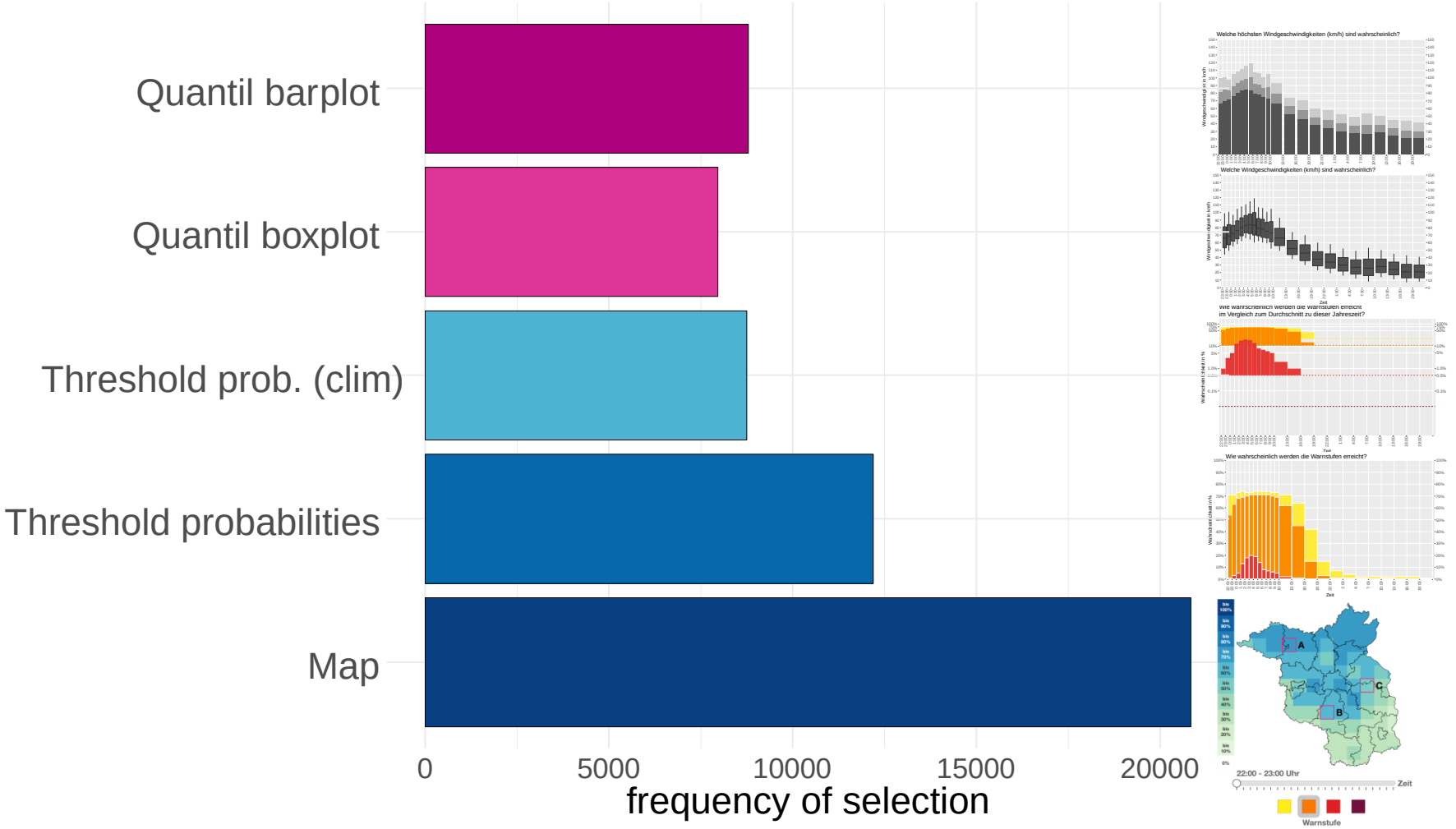

Courtesy: Nadine Fleischhut

Users guess of the median

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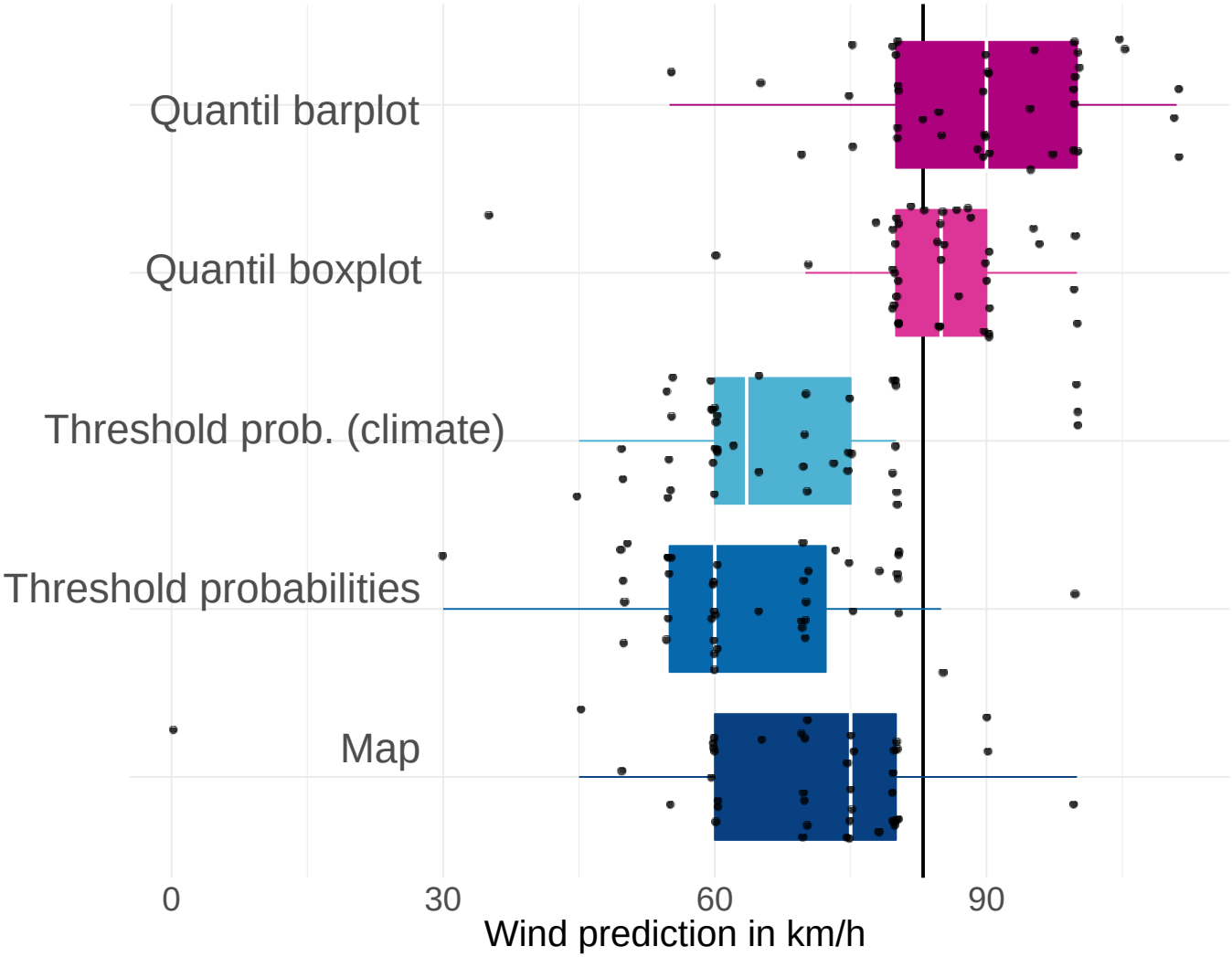

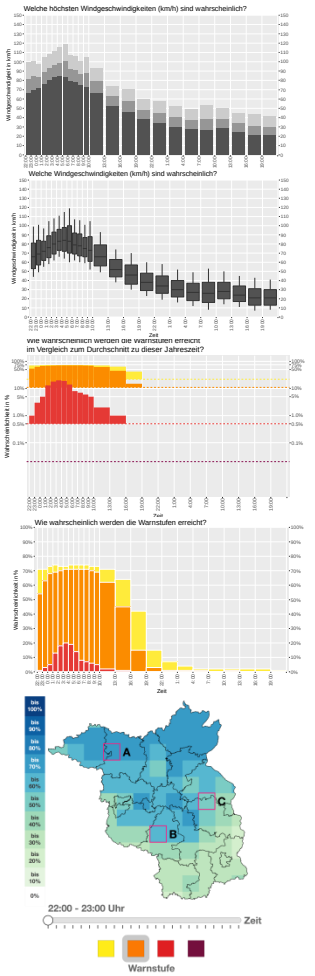

Courtesy: Nadine Fleischhut

Result from a survey

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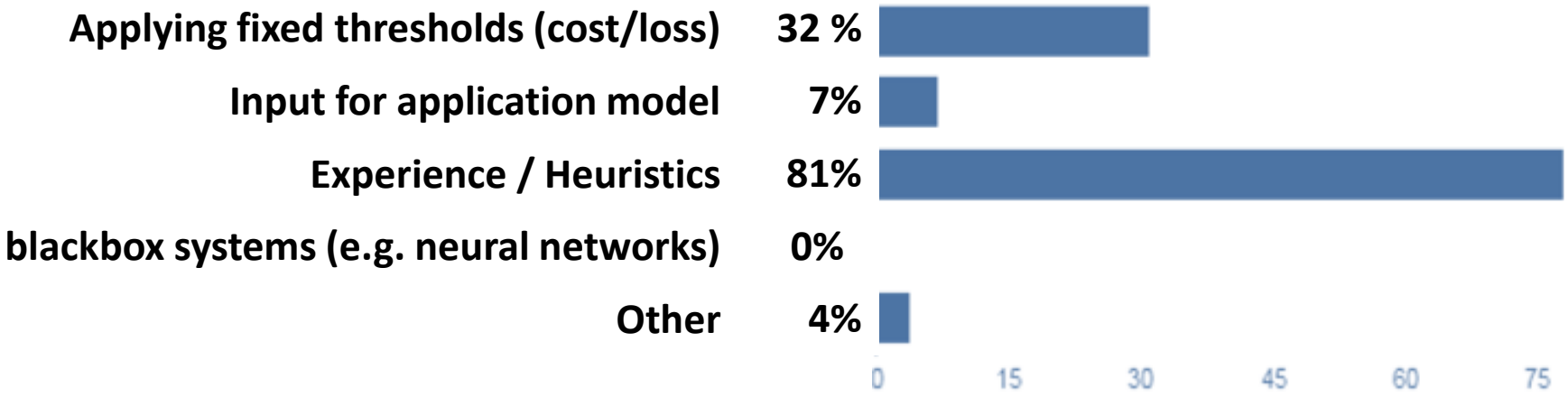
How do you transform probabilistic information on weather and warnings into actual decisions?



Use of probabilistic information not necessarily systematic but rather heuristic

German Energiewende

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German Energiewende

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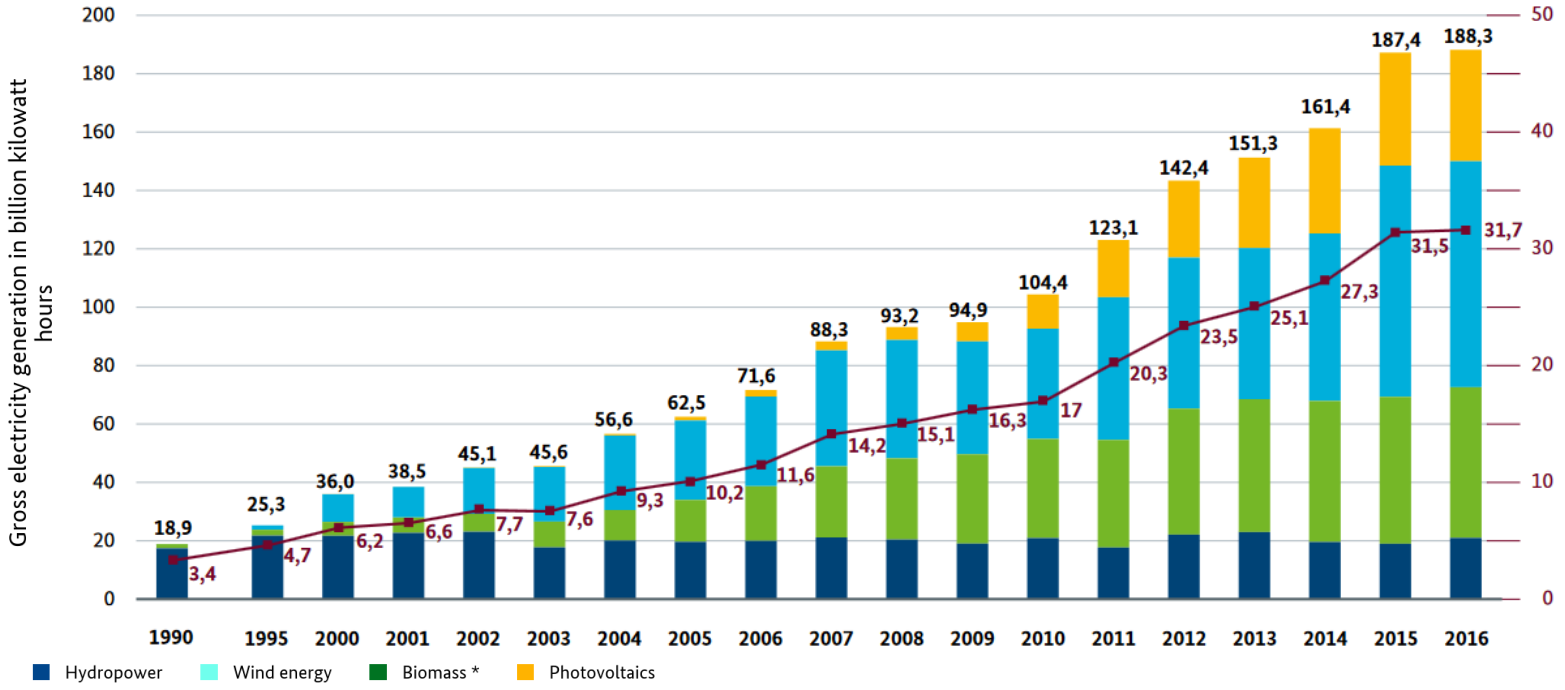
Growing proportion of weather-dependent power production requires new strategies for managing the power grid

Development of renewables-based electricity generation in Germany



* incl. solid and liquid biomass, biogas incl. biomethane, sewage gas and landfill gas as well as the biogenic fraction of waste, from 2010 incl. sewage sludge; BMWi based on Working Group on Renewable Energy-Statistics (AGEE-Stat); as at February 2017; all figures provisional

The scale cascade…

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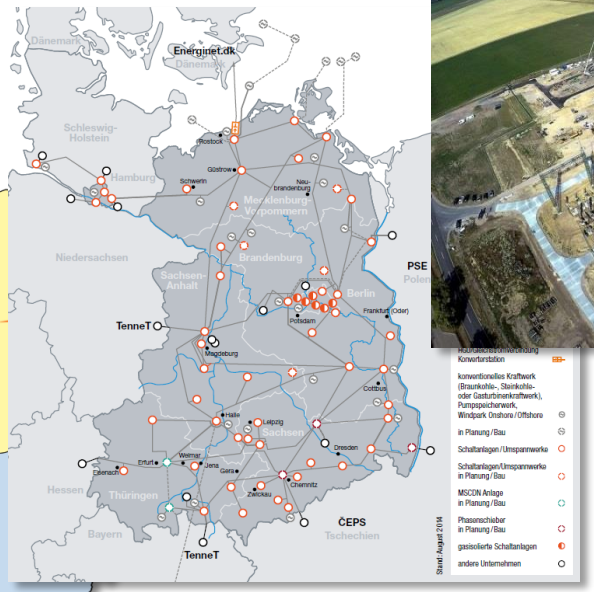
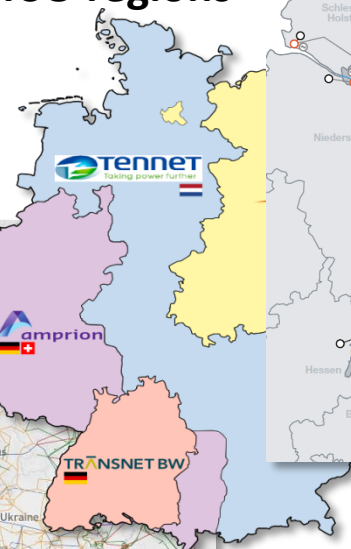
Substation Jessen/Nord

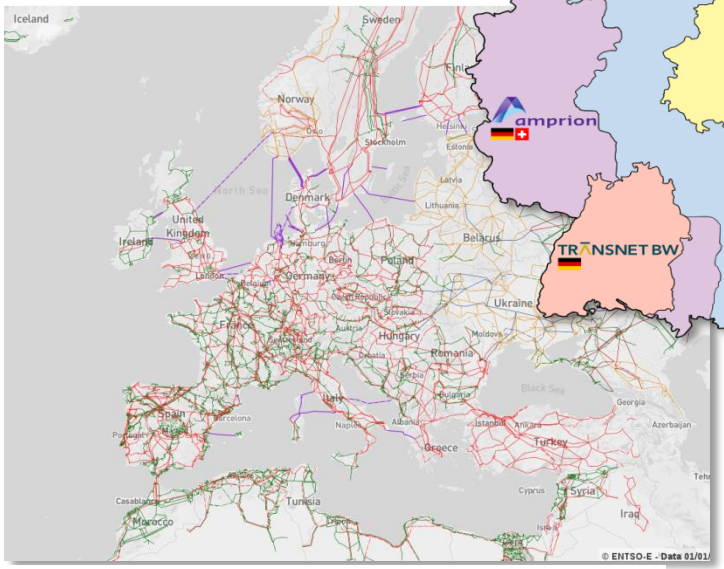
The 50Hertz zone



The German TSO regions



The European Grid



https://www.entsoe.eu/map/Pages/default.aspx

Facing reality at the local scale

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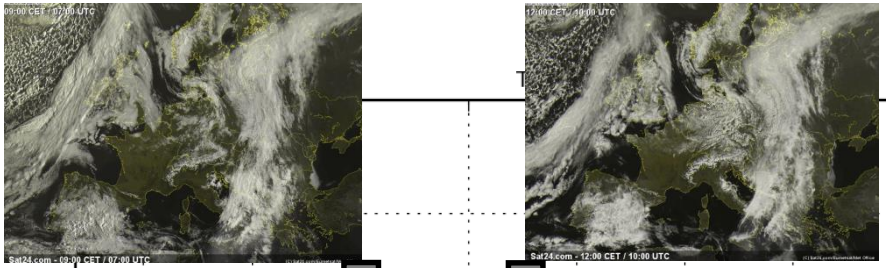

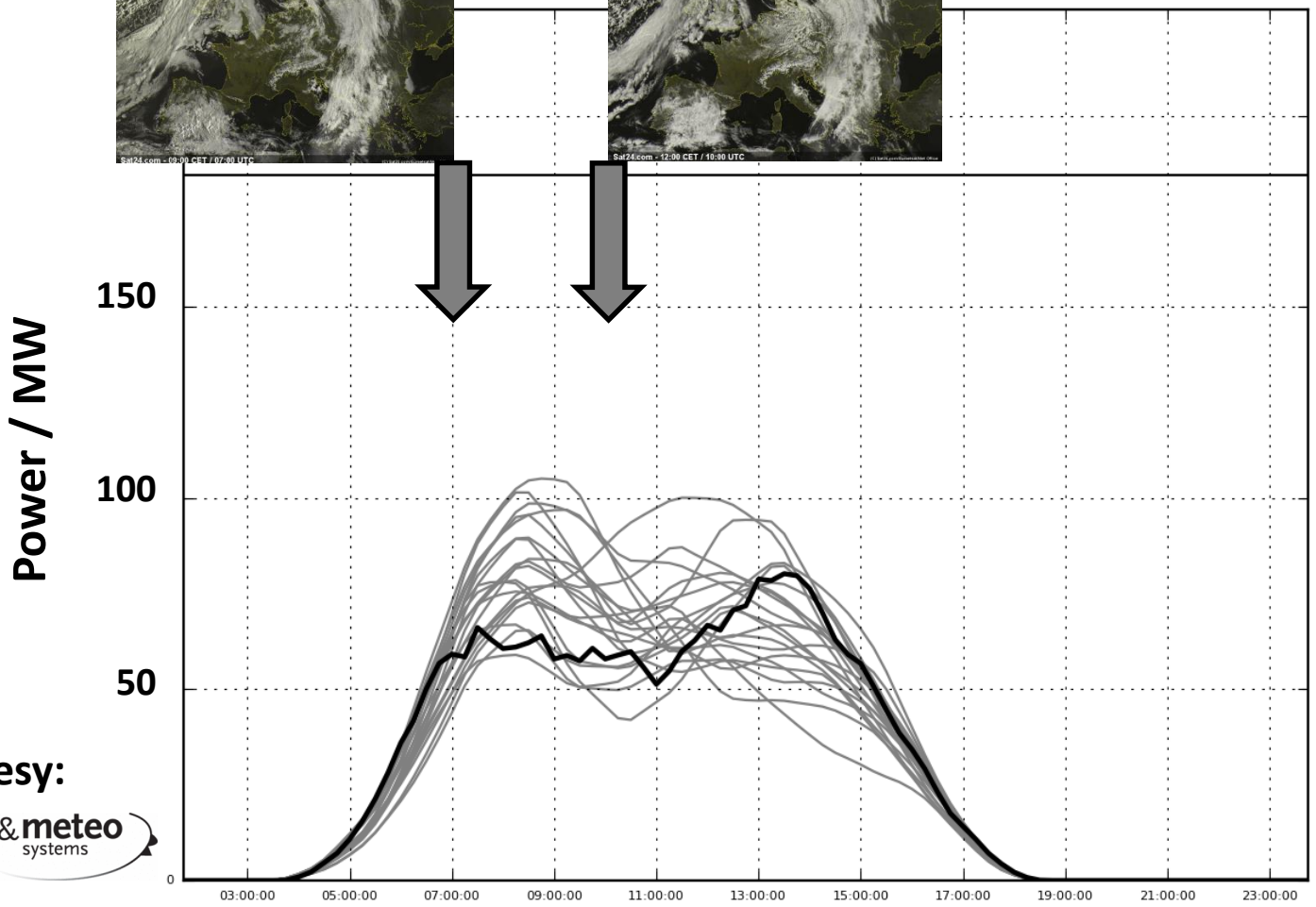

Courtesy:

energy & meteo systems

Facing reality at the local scale

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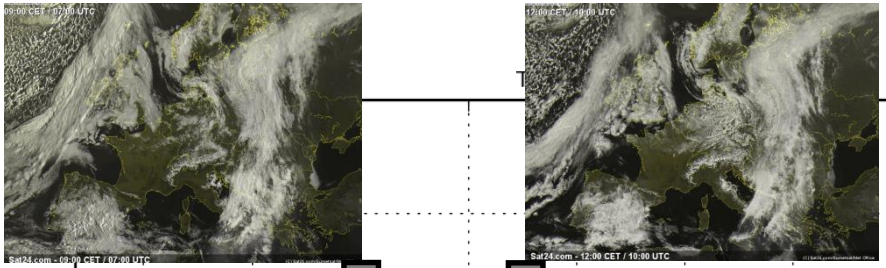

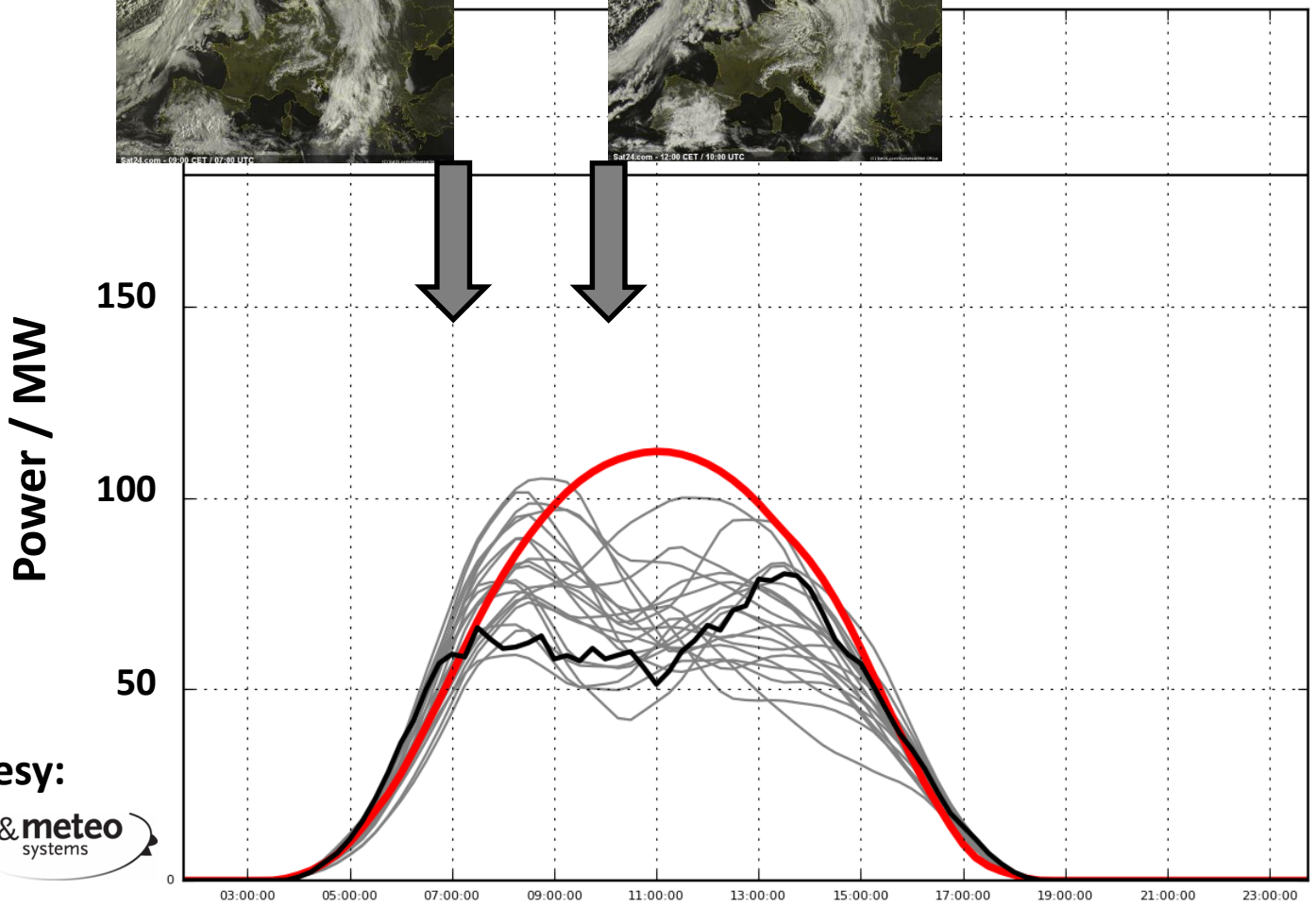

Courtesy:
energy & meteo systems

FINO 3: 2014-07-08, 03 UTC

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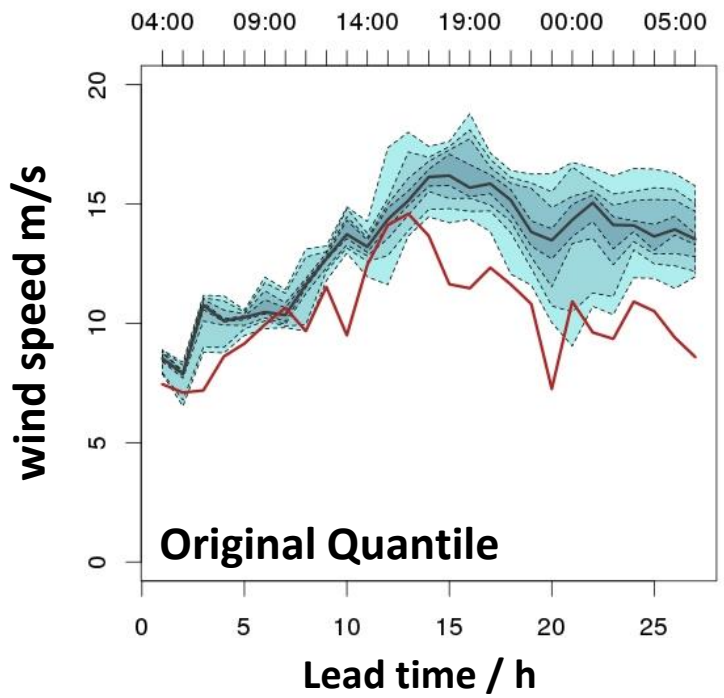
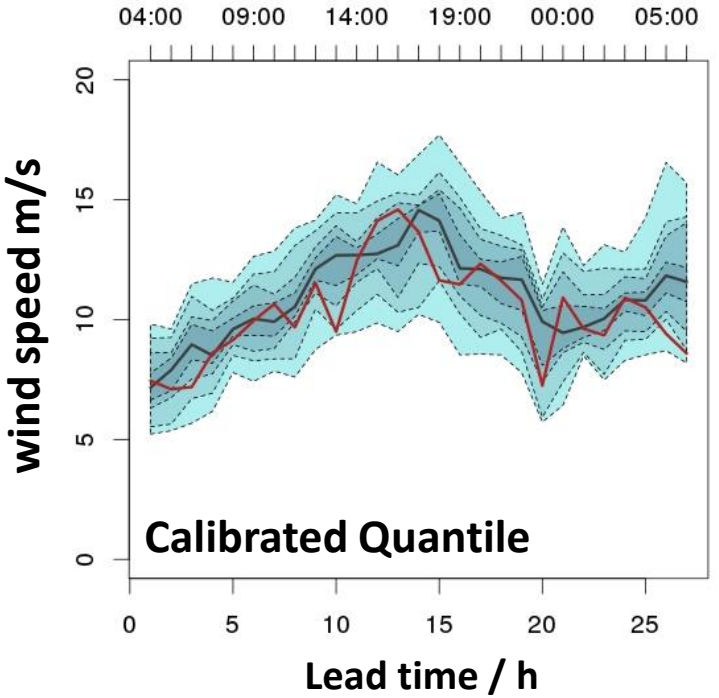
Results from the RE-project *EWeLiNE*

Model: COSMO-DE-EPS

Courtesy: T. Heppelmann



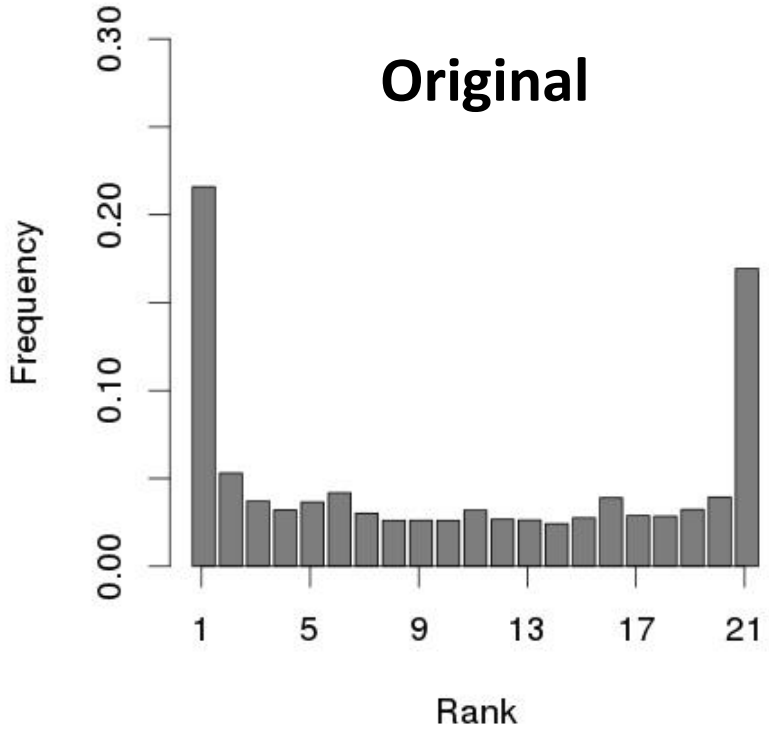


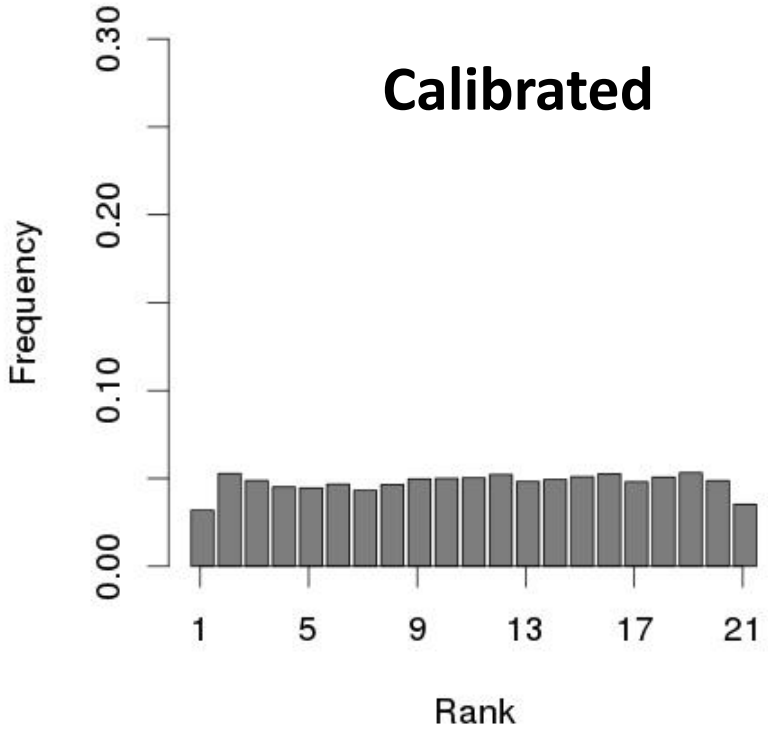
FINO 3: JJA-2014, 03 UTC

Results from the RE-project *EWeLiNE*

Model: COSMO-DE-EPS

Courtesy: T. Heppelmann





Dedicated visualization system

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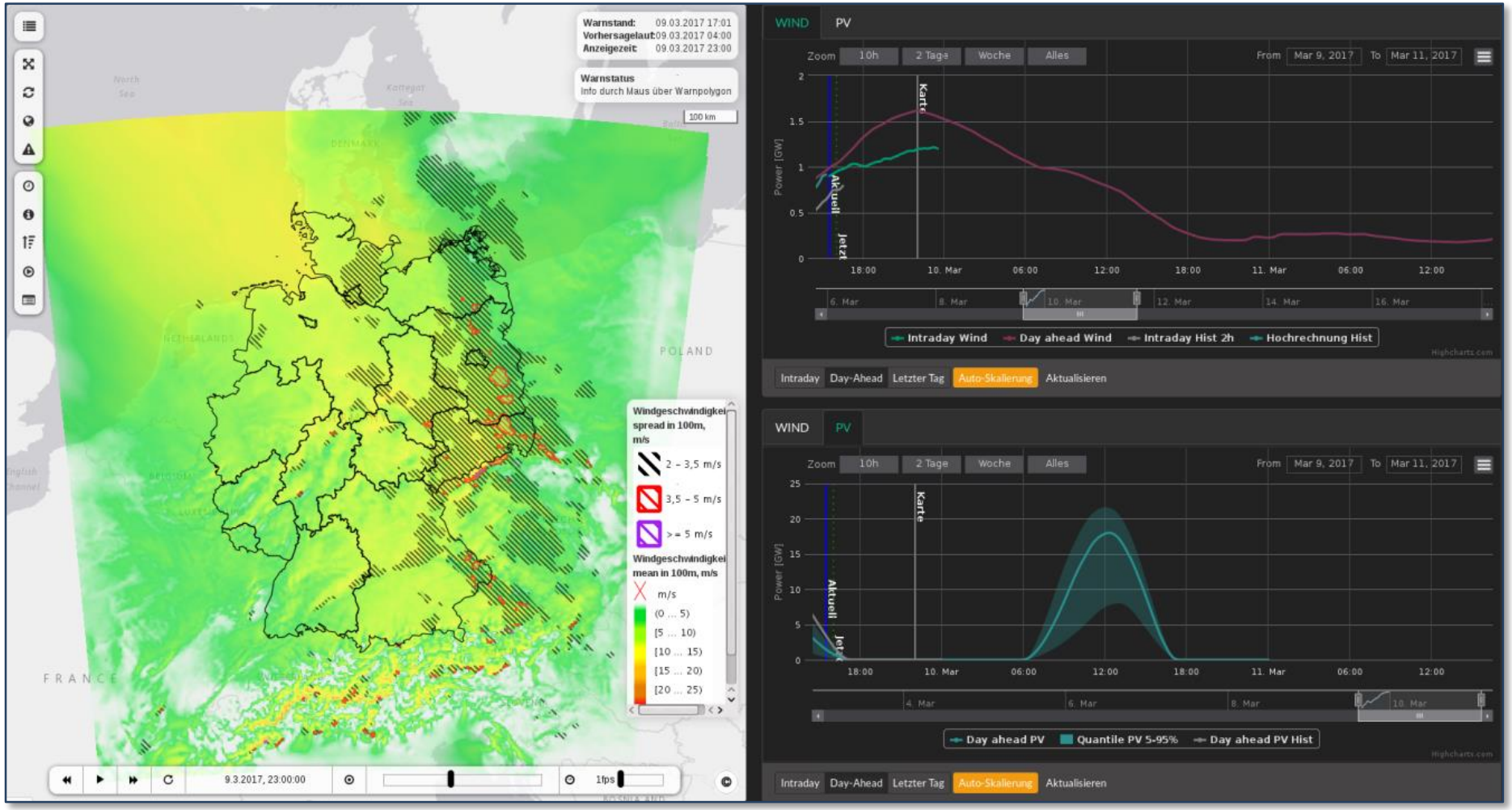
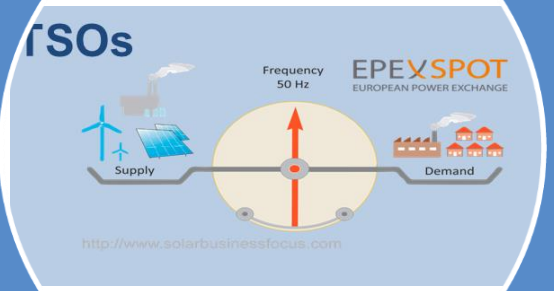
http://energyforecaster.de/



A close dialogue circle

weather forecasts

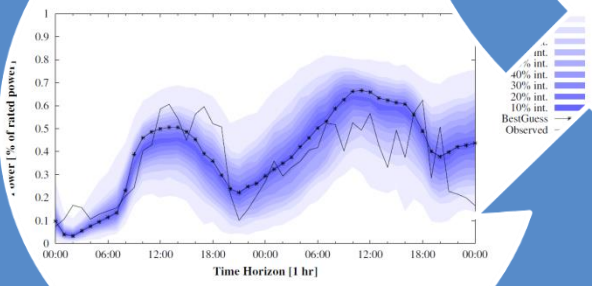
grid operation



50hertz

amprion

TenneT
Taking power further



power forecasts

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energy & meteo systems

Fraunhofer IWES

meteo control
Energy & Weather Services

Road & Rail Services

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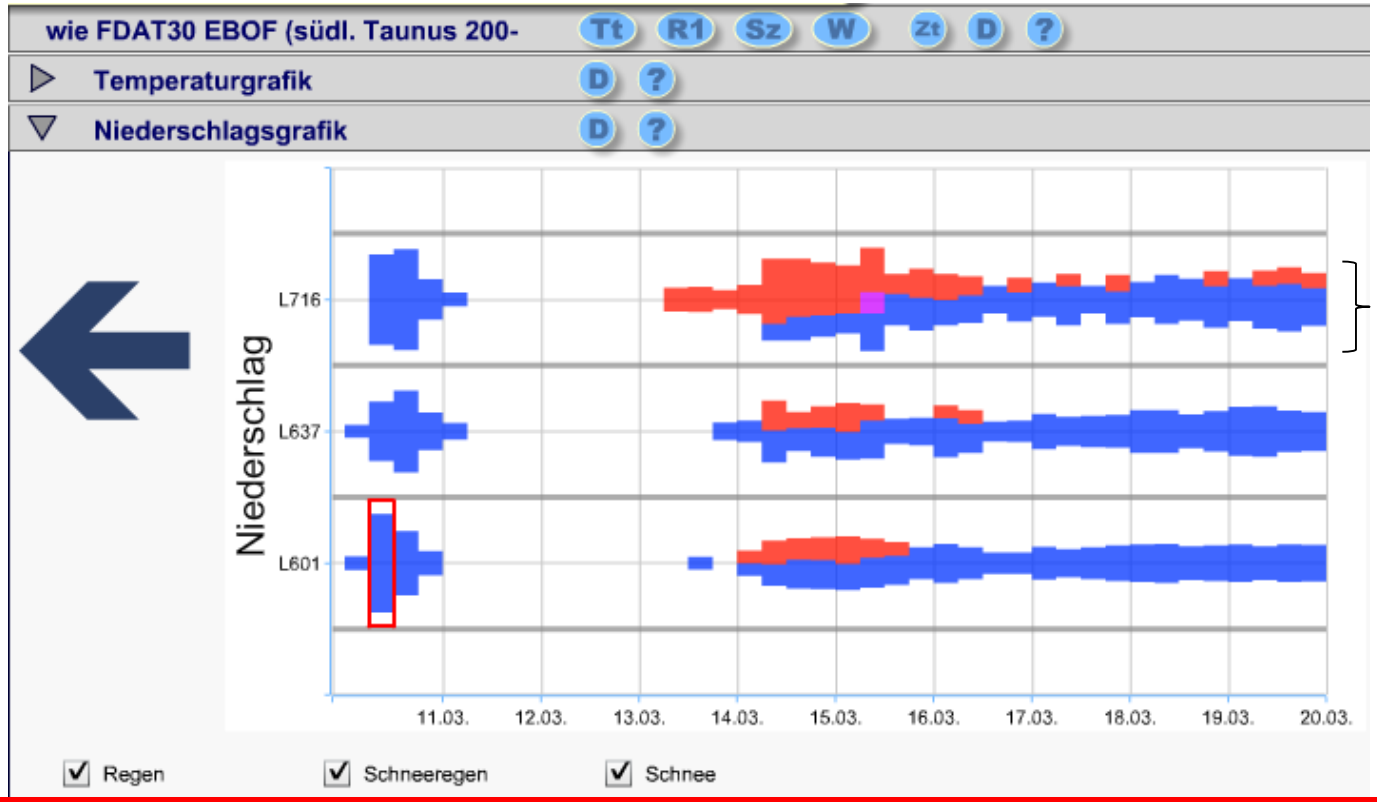
▲ AUTOBAHNDIREKTION NORDBAYERN: OPERATOR BEI DER ARBEIT AN EINER MULTIFUNKTIONSWAND

Trend forecasts



The higher the bars, the higher the probability for
Rain
Sleet
Snow

A users statement:
Without the new probabilistic trend forecasts,
I wouldn't be able to organize the schedule for "on call duty" anymore!

The most recent challenge…

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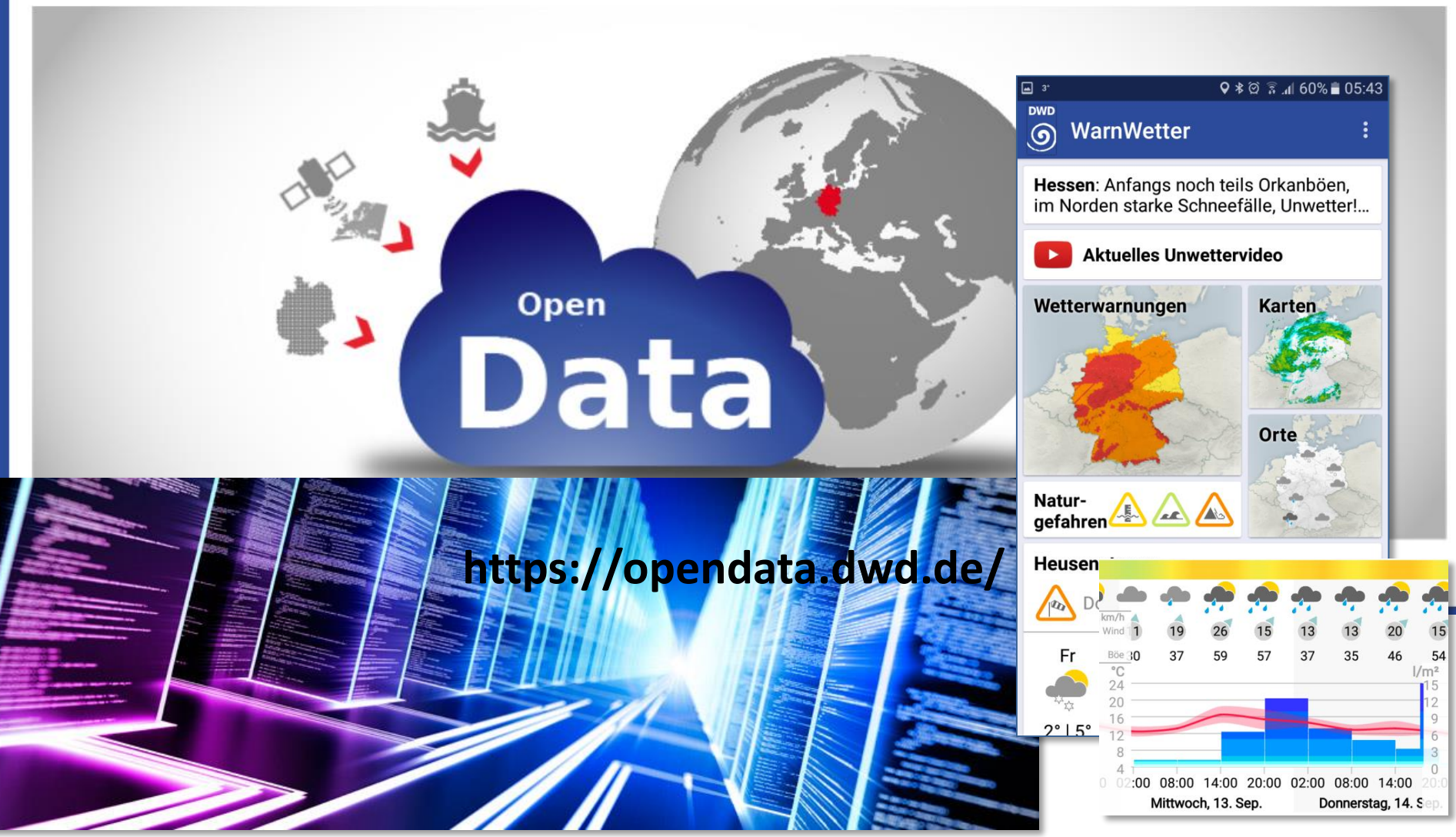
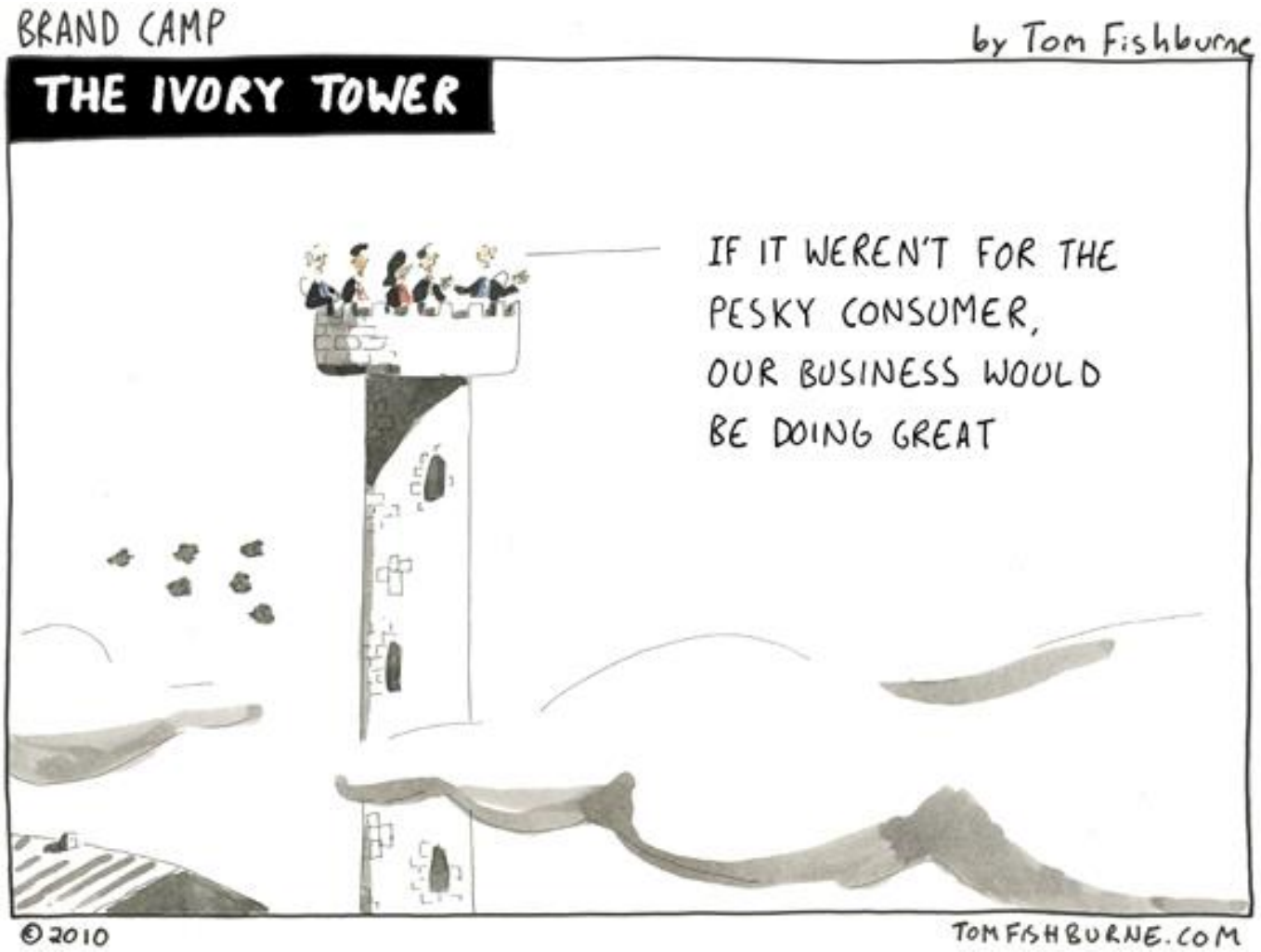


Issues to be solved

- Everyone has access to the data, but not everyone has the same background on how best to use them
  - Examples of best practice have to be provided
  - Support of individual new ideas
- Motivate and enable (new / non-expert) user to take advantage of probabilistic information
  - Provide professional expertise and technical possibilities (APIs etc.)
- Enable private sector to develop new “smart services”

Final thoughts

- Why was it so difficult to achieve this status?
  - Final decisions are always binary (or deterministic), conversion of probabilities to 0/1 was (and still is) not trivial .
- Today, ensemble products are integral part of many decision making processes. What was key to achieve this?
  - Establishing close contact and intensive dialogue between users and developers.
- My personal conclusion…
  - …do continue improving the art of ensemble forecasting, but also keep in mind to what extent your sophisticated information is used (or not) by society and how much is “lost in translation”.


BRAND CAMP
by Tom Fishburne
THE IVORY TOWER
IF IT WEREN'T FOR THE PESKY CONSUMER, OUR BUSINESS WOULD BE DOING GREAT
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TOMFISHBURNE.COM

Selected References

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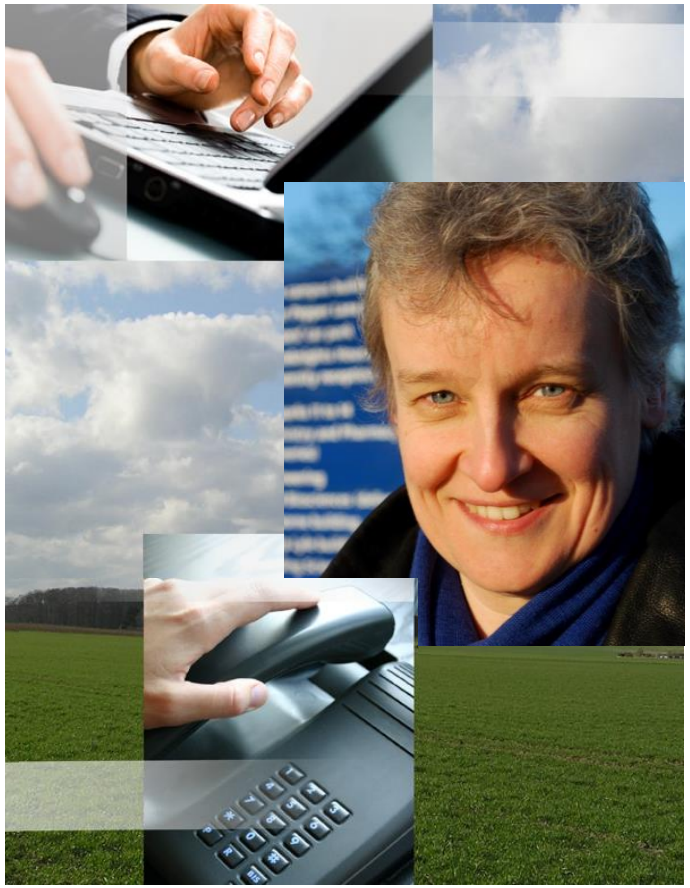
Contact:

Renate Hagedorn
Deutscher Wetterdienst
Frankfurter Straße 135
63067 Offenbach
Germany

E-Mail: renate.hagedorn@dwd.de
Tel.: +49 (0) 69 / 8062 -2701