

# Probabilistic forecast information optimised to end-users' applications: three diverse examples

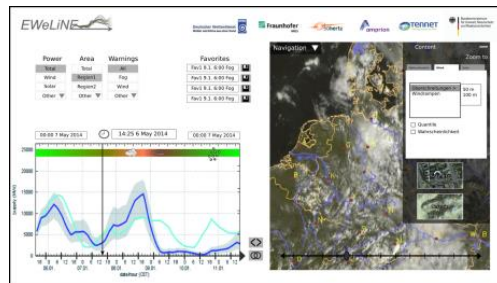
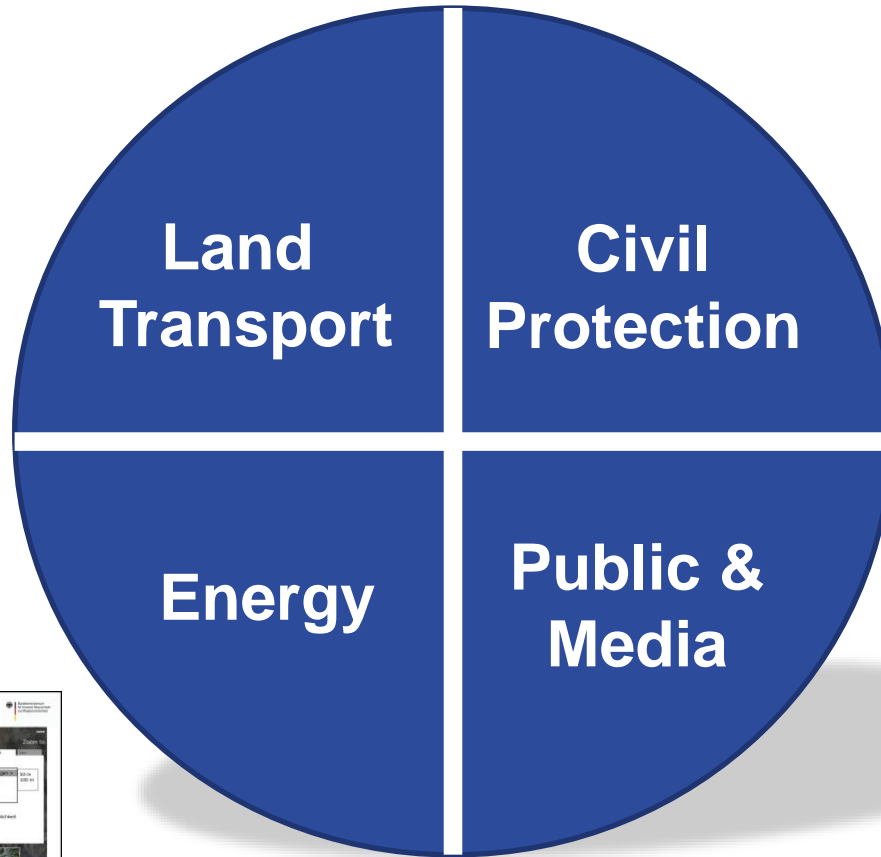
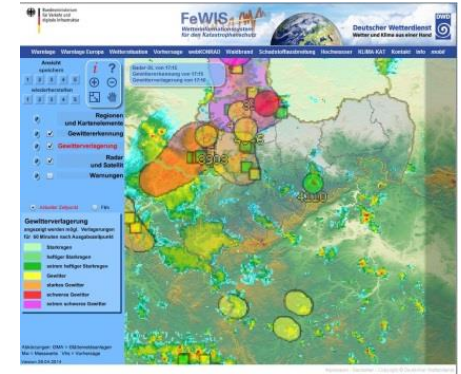
ECMWF User Seminar 2015

Vanessa Stauch, Renate Hagedorn, Isabel Alberts, Reik Schaab

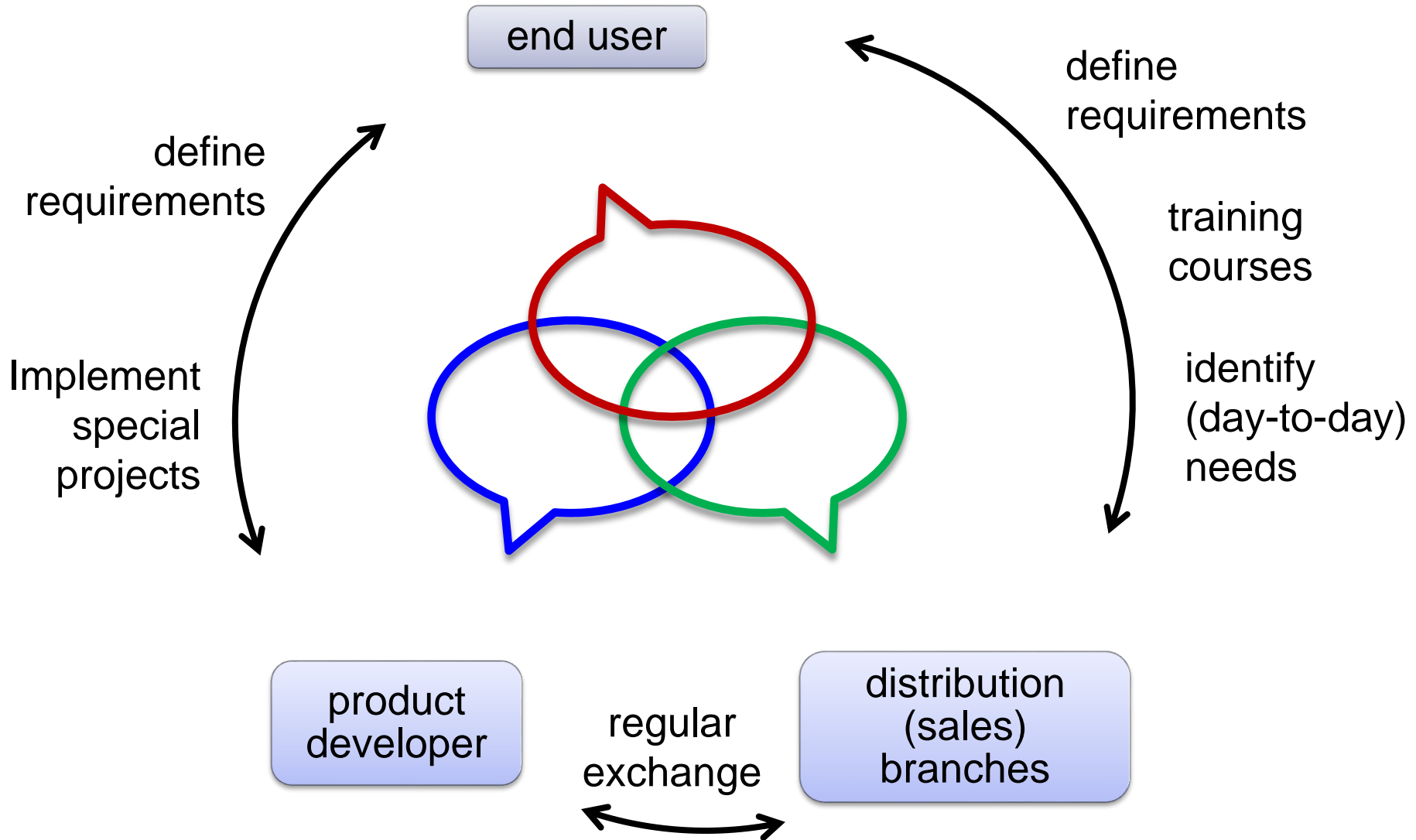


# Our group

Deutscher Wetterdienst  
Wetter und Klima aus einer Hand



# Our objectives





- ✓ Get to know the users' world and understand (weather-dependent) decision making processes
- ✓ Identify gaps for additional weather information
- ✓ Start iterative process of product development
- ✓ Elaborate an accepted visualisation
- ✓ Organise training courses
- ✓ Accompany test phases



# Three divers applications

Mid- to longterm probabilistic (road) weather forecasts for manpower planning



Probabilistic weather forecasts to support the German „Energiewende“



Probabilistic mid- to longterm weather forecasts and warnings for the new „warn-weather“ app

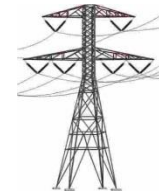


# Three divers user groups

„hands on“ practitioners with very detailed local knowledge and only a few different decisions to take



TSO staff with regional to nationwide responsibility. High education in data analysis and interpretation



The public...  
Mostly very local interest area, very varying meteorological background

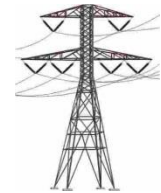


# Developer-User-Dialogue

Visits at the road maintenance authorities  
Biennial user workshops  
Regular (annual) training courses



Regular project meetings  
Visits at the control rooms  
Biannual user events with industry  
and research community



Via digital media platforms in hindsight  
(ratings and reviews, posts on twitter  
and facebook...)





- ✓ NWP model fields: ICON, (ICON-Nest), COSMO-EU, COSMO-DE(-EPS), IFS
- ✓ Statistical postprocessing products
  - ✓ Optimised point forecasts
    - ✓ with MOS-MIX system, derived from deterministic IFS, GME, ICON
    - ✓ new: with Ensemble-MOS, derived from ensemble IFS
  - ✓ Optimised gridded warning products (with WarnMOS system)





Application 1

# PROBABILISTIC FORECASTS FOR ROAD MAINTENANCE

# Our product developm. approach

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Wetter und Klima aus einer Hand



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# Which decisions do they make?

## Summer

### **thunderstorms:**

Clearance of road works necessary?

### **heat:**

Which alert level is necessary?

More frequent control tours (level 1),  
speed limits (level 2)

closure of road sections (level3)



<http://www.spiegel.de>

## Winter

### **snowfall:**

Do I need to clear the road? How  
many snowplougher do I need?

Which route do I take first? How  
many tours do I have to plan for?

### **clear ice:**

Do I need to grit the road? How  
long does it need protection? Do I  
need several rounds? How much  
anti-icing do I need?



<http://www.abendblatt.de/hamburg/>

# Based on what weather forecast?

## Winter

When and where is the **snowfall**, how much will fall and within what time?

>> rather deterministic mindset

Are there (any) indications for the formation of **ice**?

>> “risk-avers” mindset

### **snowfall:**

Do I need to clear the road? How many snowplougher do I need? Which route do I take first? How many tours do I have to plan for?

### **clear ice:**

Do I need to grit the road? How long does it need protection? Do I need several rounds? How much anti-icing do I need?

# Our product developm. approach



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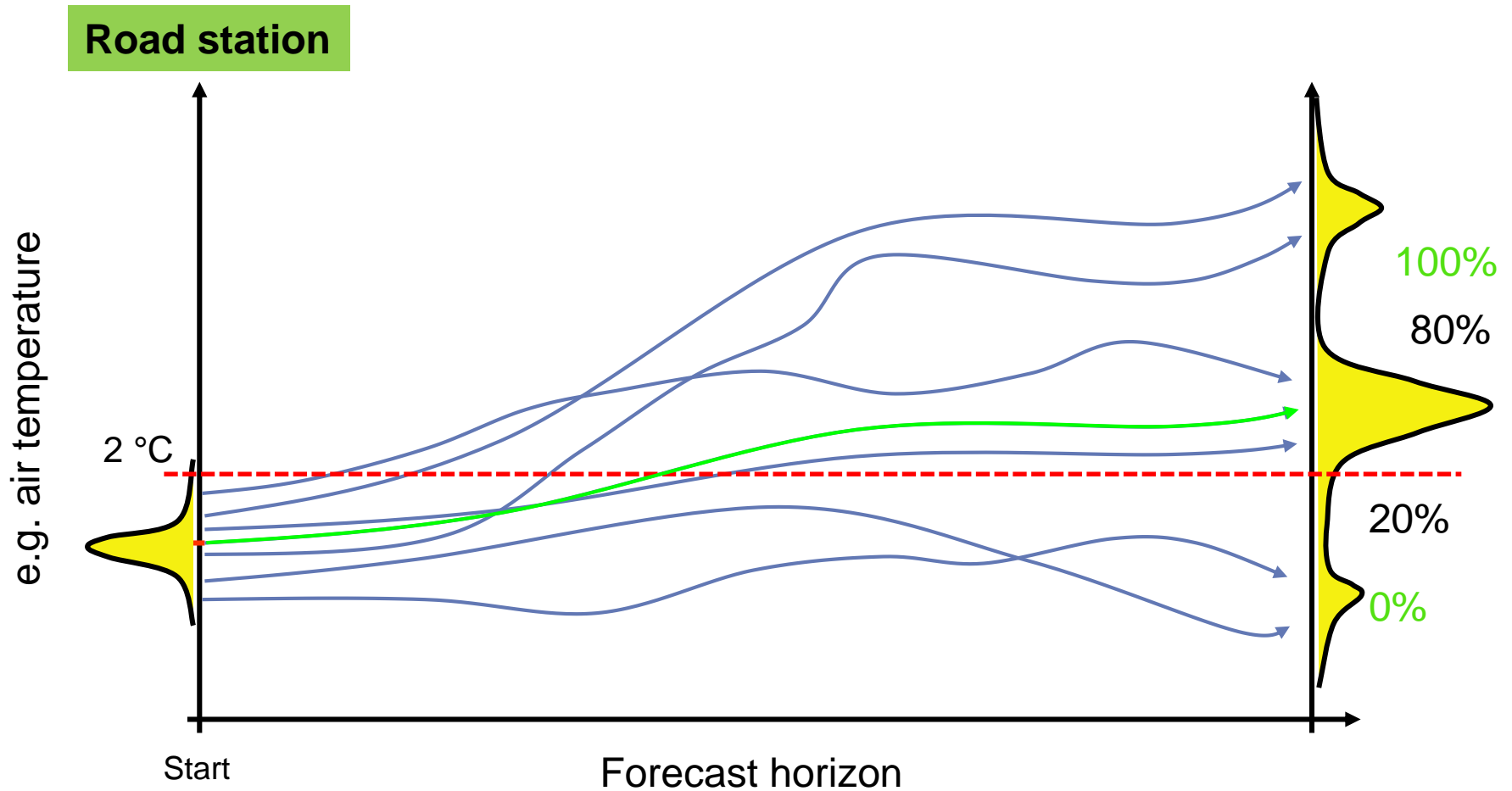




- ✓ Longer term planning of stand-by service and staff needs weather forecasts for the coming 5-7 days
- ✓ For a serious product, we need to introduce probabilistic forecasts
- ✓ First step:
  - Uncertainty and probabilistic forecasts of atmospheric parameters as meteograms



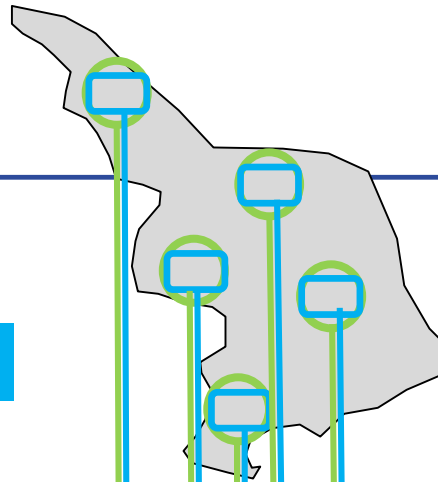
# Communication of NWP uncertainty



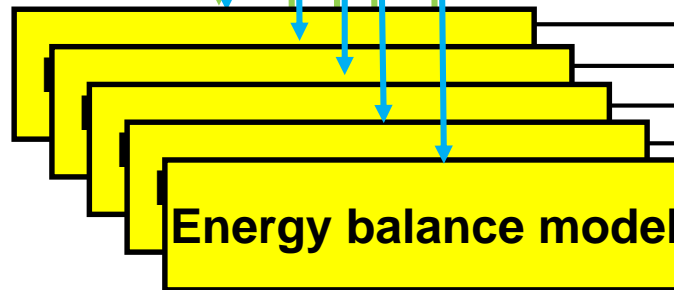
# Spatial variability



Weather forecast

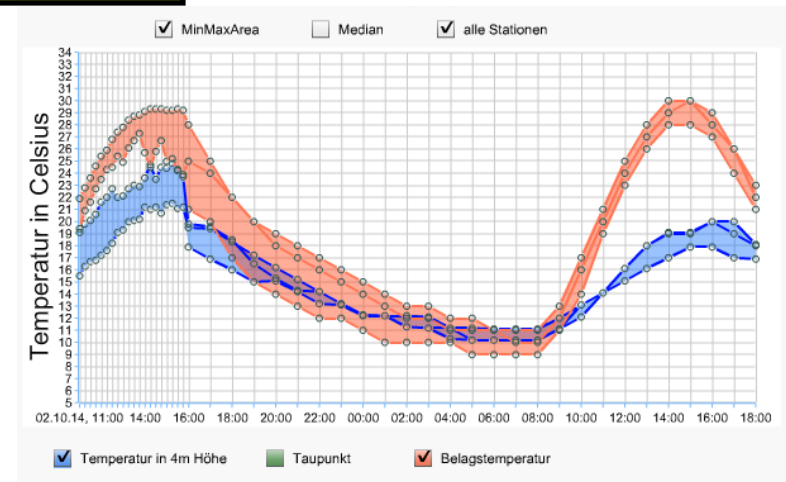


Road measurement station



Energy balance model

SWIS graphic





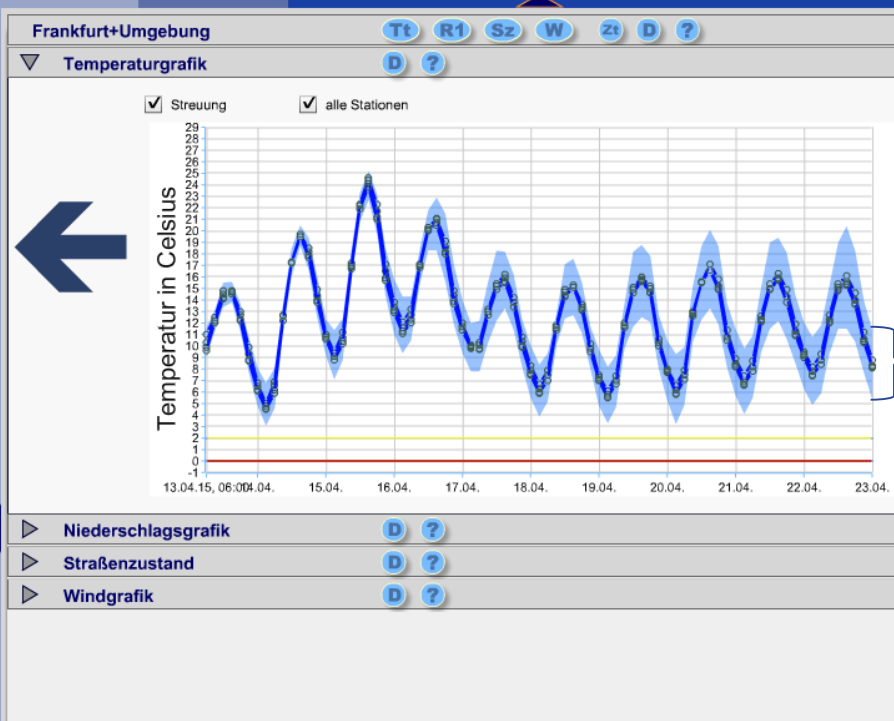
# SWIS temperature forecasts



Straßenwetter -  
Informationssystem SWIS



Frankfurter Kreuz
Gebiet xyz
⚠ A7_Scheu
A8 - Salzburg-München
WOR/STA
Pasewalk
⚠ Brandenburg
Oldenburg i H
Ruwer
Dreieck Pankow
<b>Frankfurt+Umgebung</b>
wie FDAT23 JJOF (RheinMainG. 0-400)
⚠ Strecke A66
⚠ wie FDAT35 JBOF (Vogelsb/Röhn 20
wie FDAT35 JJOF (Vogelsb/Röhn 400-6
⚠ wie FDAT35 JJOF (Vogelsb/Röhn 60
wie FDAT14 DBOF (Odenwald 200-400)
wie FDAT14 DDOF (Odenwald 400-600)
wie FDAT22 JJOF (Bergstrasse 0-200)
wie FDAT30 EBOF (südl. Taunus 200-4
wie FDAT30 EDOF (südl. Taunus 400-6
wie FDAT14 JJMS (Spessart 0-200)
wie FDAT14 JBMS (Spessart 200-400)
⚠ wie FDAT14 JDMS (Spessart 400-60



— Expectation value at RWS

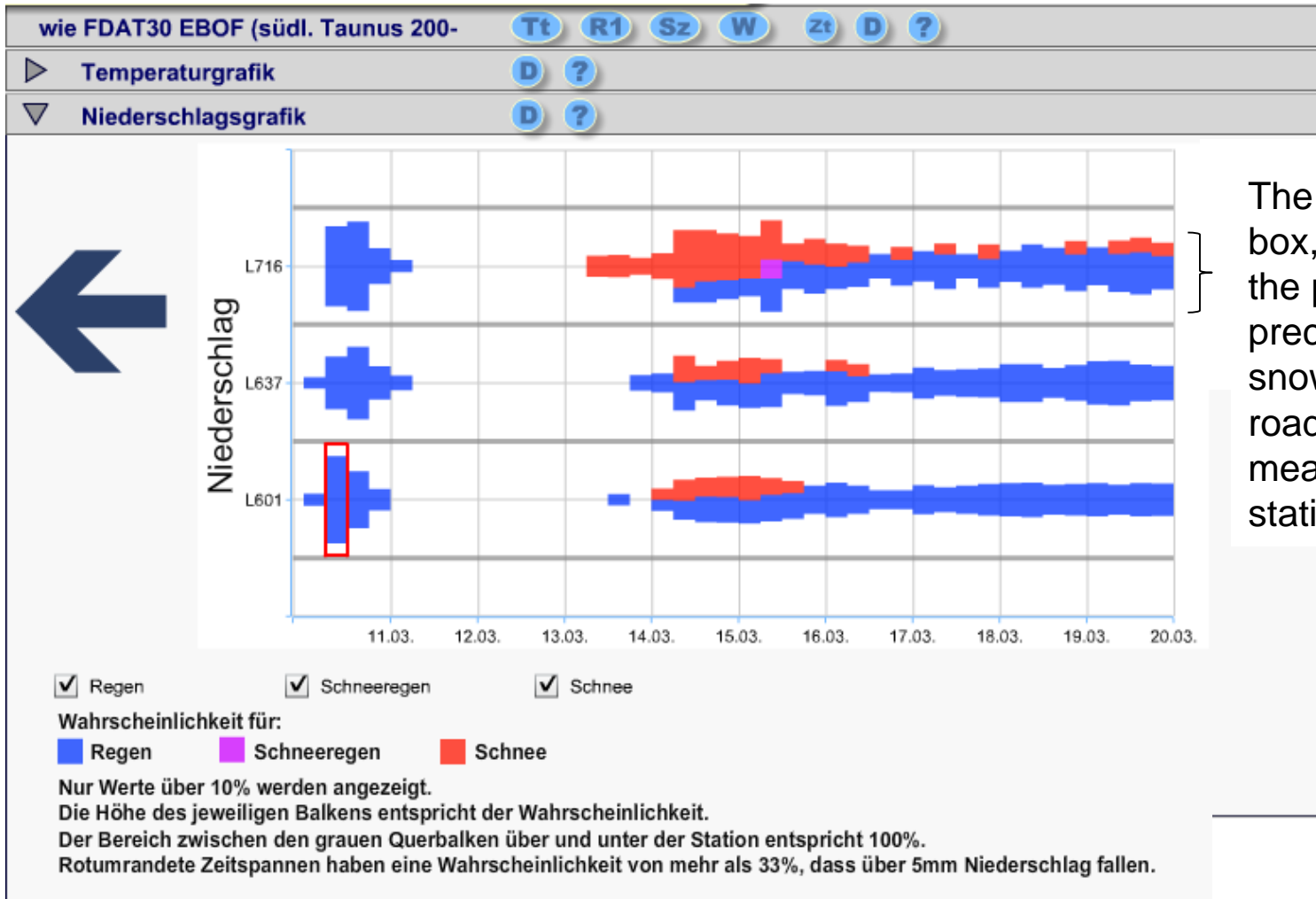
— „overall picture“ of the uncertainty area, built from the standard deviation (or any reasonable quantile) at the road measurement stations

Tabelle Synop  
Tabelle GMA  
Allgemeine Berichte

Impressum Disclaimer Kontakt © DWD



# SWIS precipitation forecasts



The higher the box, the higher the probability for precipitation (rain, snow, sleet) at the road measurement station

# Our product developm. approach

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Wetter und Klima aus einer Hand



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- ✓ Identify gaps for additional weather information
- ✓ Start iterative process of product development
- ✓ Elaborate an accepted visualisation
- ✓ Organise training courses: this autumn
- ✓ Accompany test phases: upcoming winter season



# Plans for test user workshop



- ✓ (re-) Introduction to the reasons and the implications of probabilistic and uncertainty forecasts (e.g. with games, discussions, definition of terms)
- ✓ Presentation of developed products and collection of user feedback
- ✓ Role plays and use cases: which decision do I come to in different example situations? And with different kinds of forecast products?
- ✓ Lots of time for discussions, concerns and individual decision making processes



Application 2

# PROBABILISTIC FORECASTS FOR THE ENERGY SECTOR

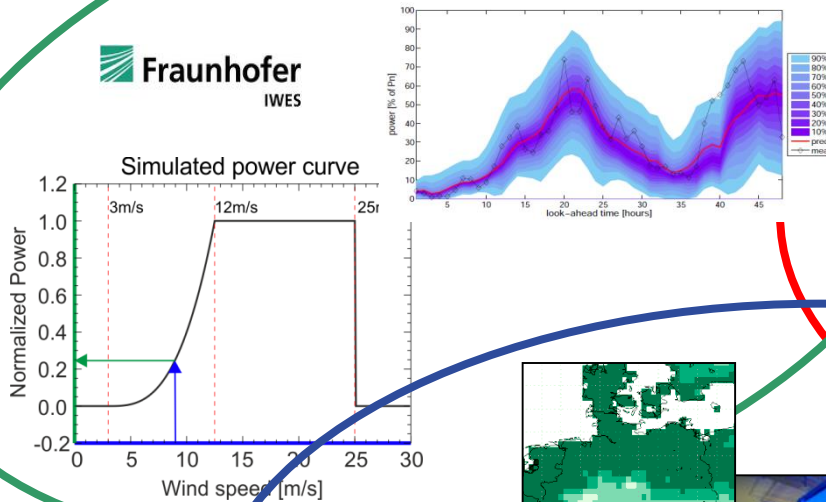
# EWeLiNE & ORKA research projects

Deutscher Wetterdienst  
Wetter und Klima aus einer Hand



energy&meteo systems

Fraunhofer  
IWES



50hertz

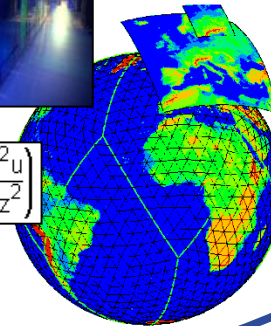
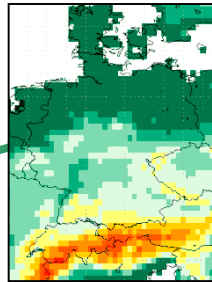


Tennet  
Taking power further

amprion

Thüringer  
Energienetze  
Ein Unternehmen der Thüringer Energie

avacon



$$\rho \left( \frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} + w \frac{\partial u}{\partial z} \right) = \rho g_x - \frac{\partial p}{\partial x} + \mu \left( \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} \right)$$

ORKA:  
2012 – 2015  
EWeLiNE:  
2012 – 2016  
[www.projekt-eweline.de](http://www.projekt-eweline.de)

Deutscher Wetterdienst  
Wetter und Klima aus einer Hand



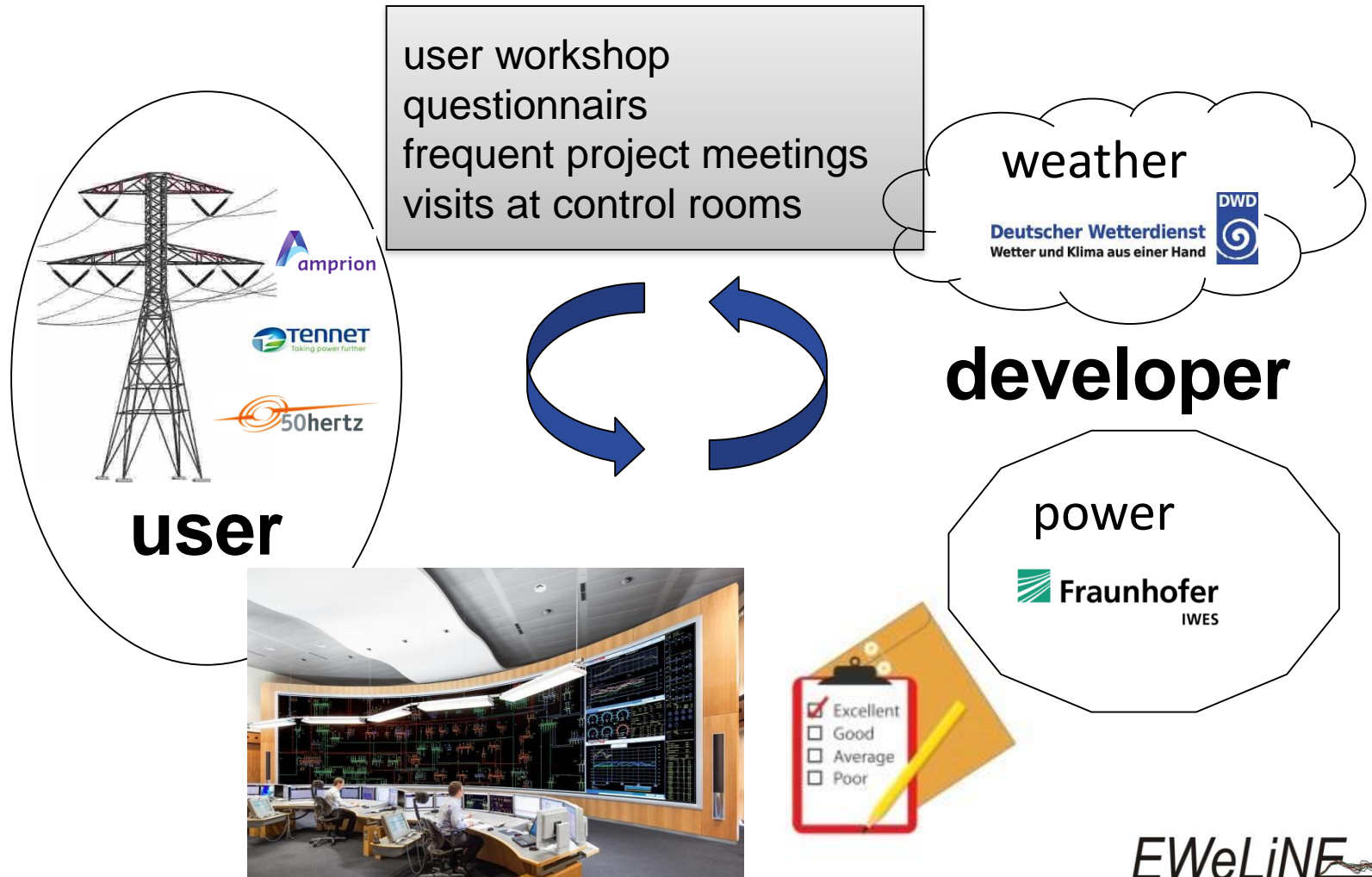
# Our product developm. approach



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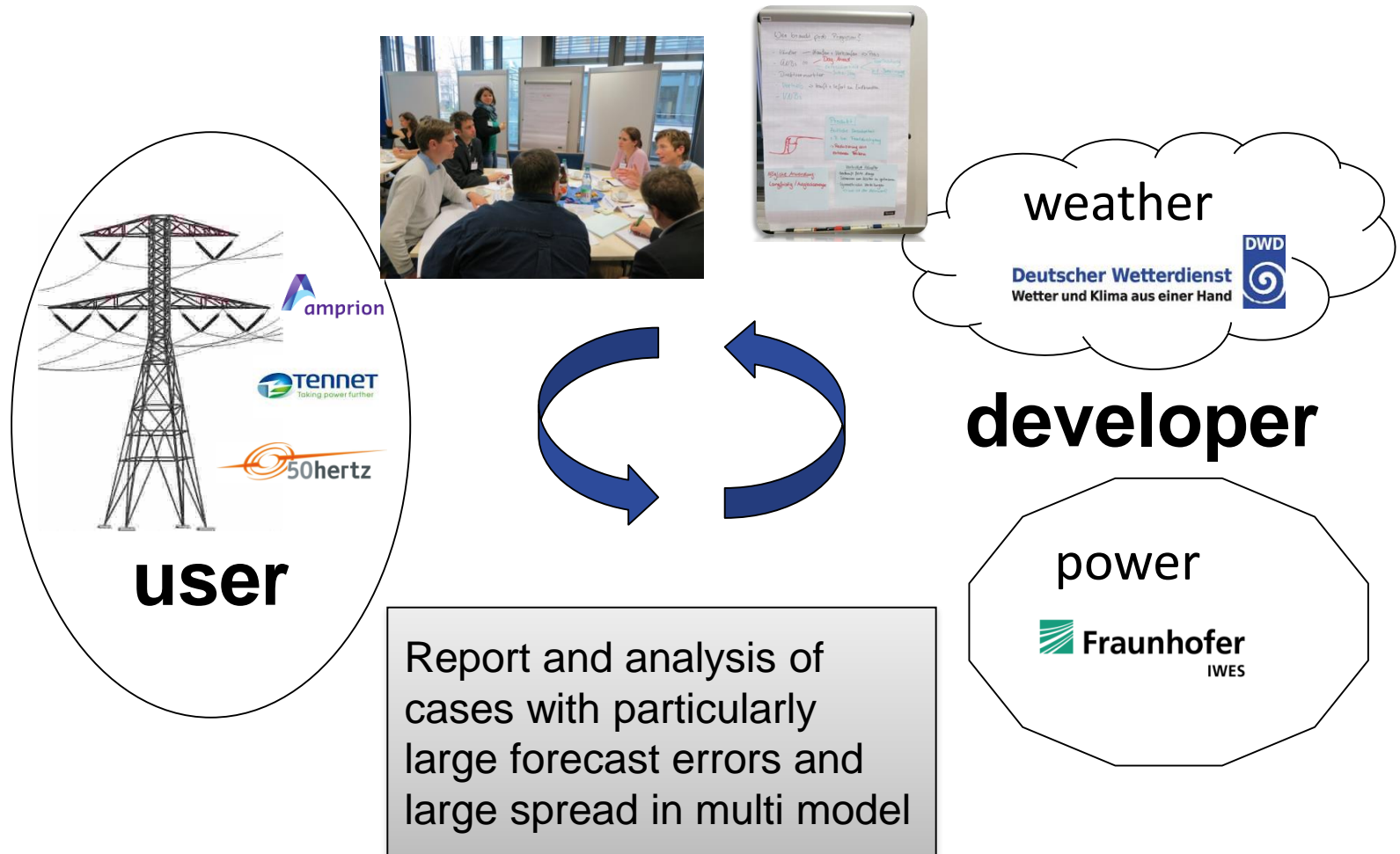


# Identification of user needs





# Identification of user needs



See also poster by  
Thomas Schumann about solar eclipse

# Our product developm. approach



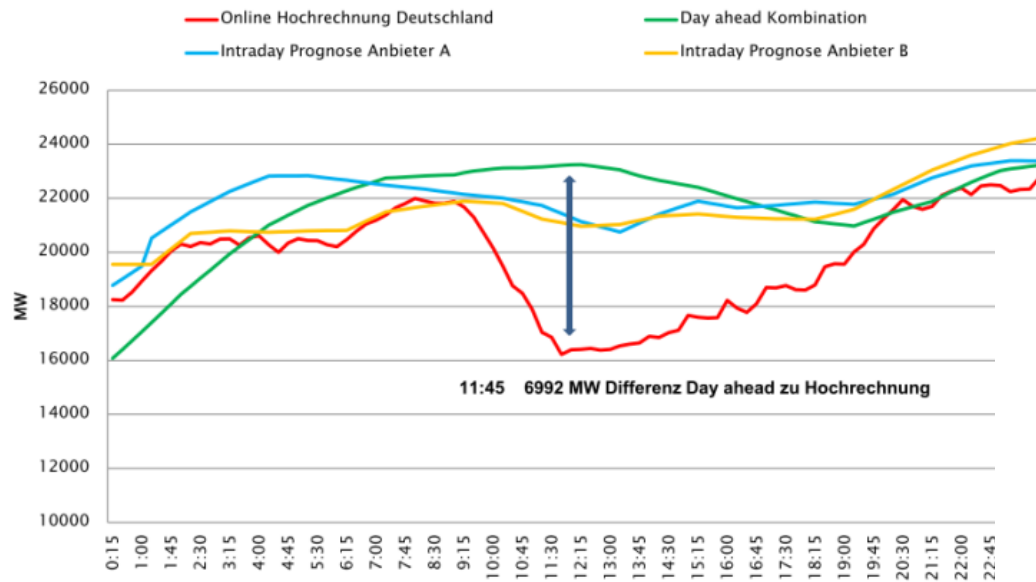
- ✓ Get to know the users' world and understand (weather-dependent) decision making processes
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# Critical event: steep gradients

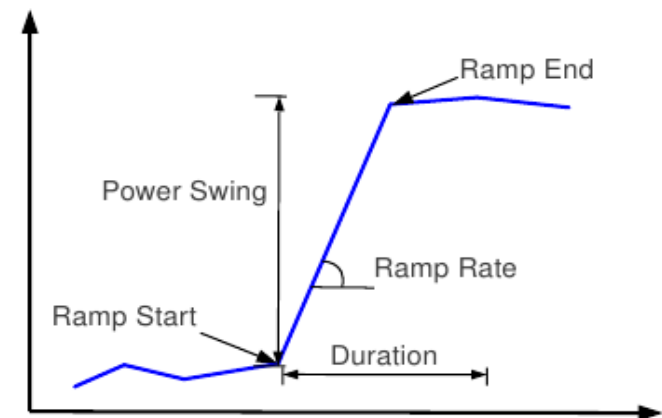
30.01.2013: quick drop-off of wind power feed-in

30.01.2013: Einbruch der Windeinspeisung



Parameters: amplitude and duration

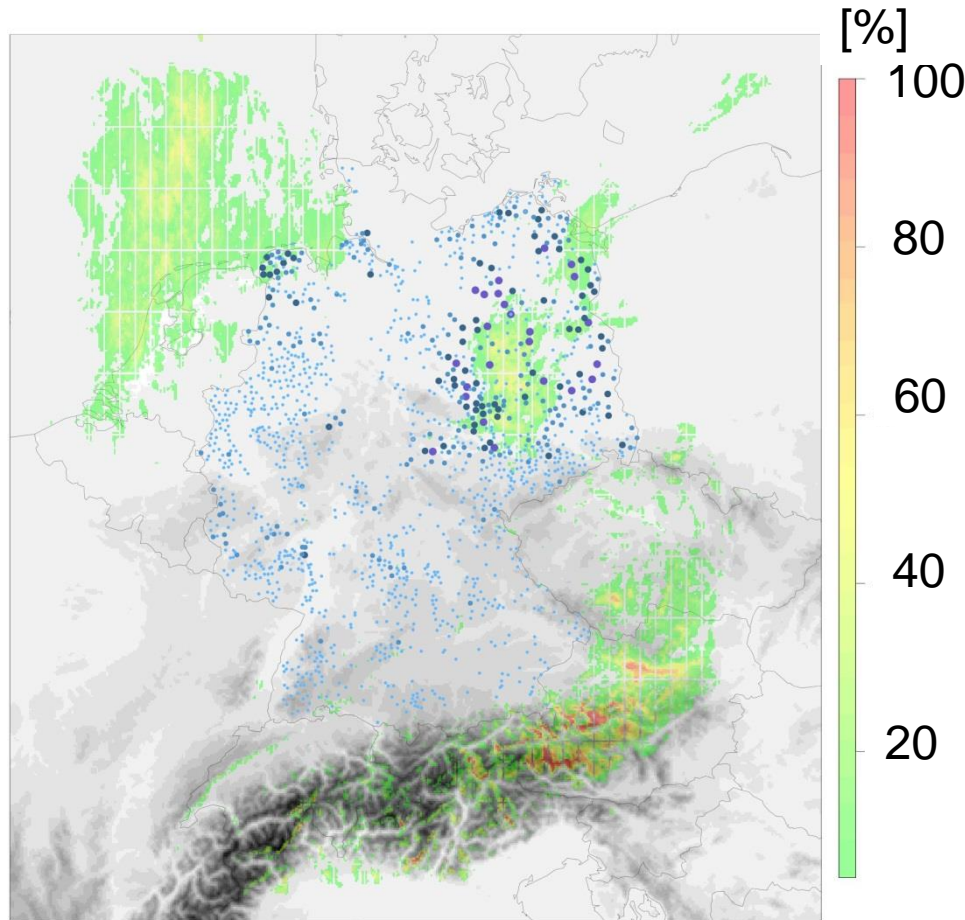
Optimised to users sensitivities



Sevlian et al. (2012)

# Probabilistic wind ramp forecasts

COSMO-DE-EPS 15UTC run, 05.12.2012



Probability for the occurrence of an increase in wind speed of **7 m/s** within the next **3 hours**.

Combination of weather information with specific user data

- Installed capacity per postcode („Anlagestammdaten 2012“)
  - < 20MW
  - 20-50MW
  - 50-100MW
  - >100MW

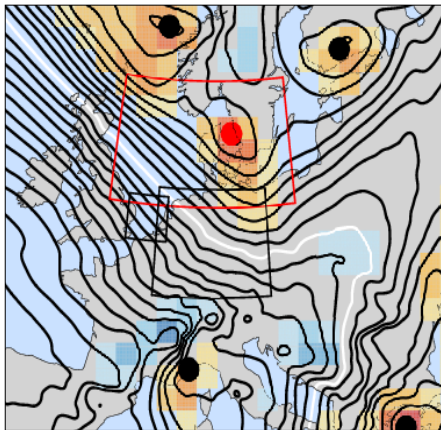
Vorhersage + 17h

Schäfer M (2014) Diploma thesis

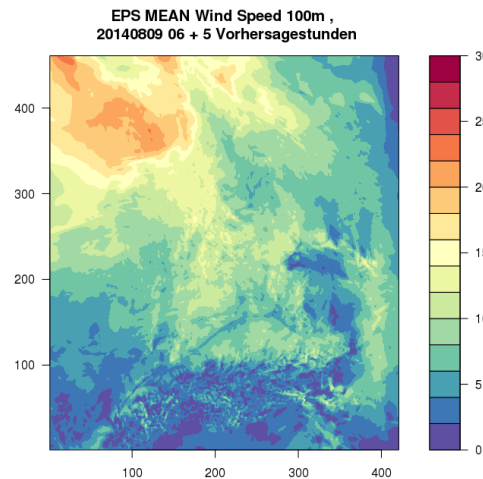
*EWeLiNE* 

# Alert product for critical situations

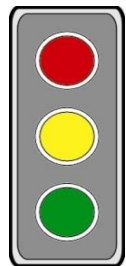
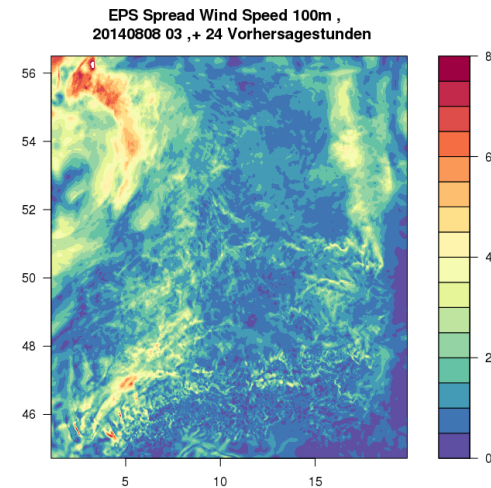
## Frontal detection algorithm



## COSMO-DE-EPS mean



## COSMO-DE-EPS spread



critical event in warning area & information from COSMO-DE-EPS  
cyclone or low stratus in warning area  
no cyclonic influence or low stratus

Steiner, Köhler, Alberts,  
submitted

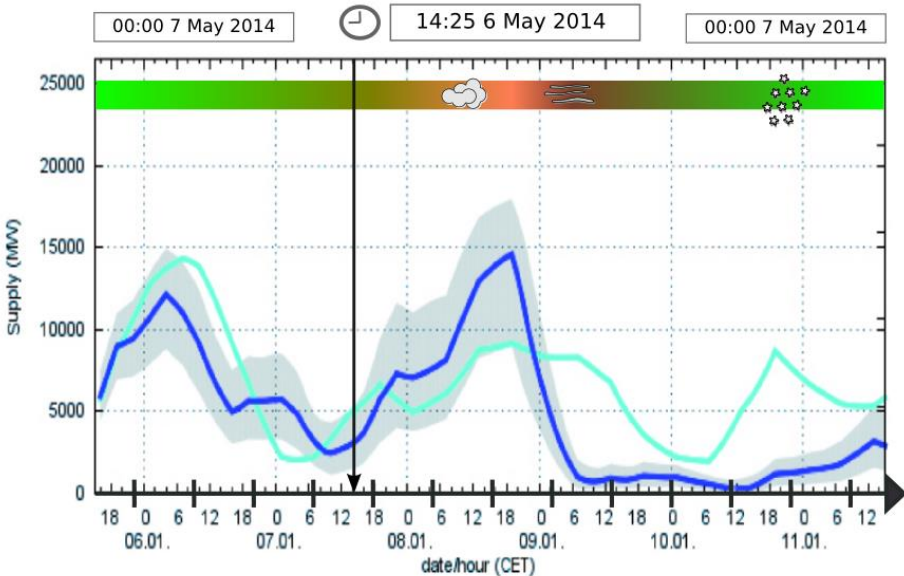
# Demonstrator



Power	Area	Warnings
Total	Total	All
Wind	Region1	Fog
Solar	Region2	Wind
Other ▼	Other ▼	Other ▼

Favorites

- Fav1 9.1. 6:00 Fog
- Fav1 9.1. 6:00 Fog
- Fav1 9.1. 6:00 Fog
- Fav1 9.1. 6:00 Fog



Navigation ▼

Content

Zoom to

Wettersituation | Wind | Solar

Überschreitungen > 50 m  
Windrampen 100 m

Quantile  
 Wahrscheinlichkeit

Satellite  
Terrain



# Our product developm. approach

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Wetter und Klima aus einer Hand



- ✓ Get to know the users' world and understand (weather-dependent) decision making processes
- ✓ Identify gaps for additional weather information
- ✓ Start iterative process of product development
- ✓ Elaborate an accepted visualisation
- ✓ Organise training courses: October – December 2015
- ✓ Accompany test phases: demonstration phase 2016



Application 3

# PROBABILISTIC FORECASTS FOR THE PUBLIC



# Our product developm. approach

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Wetter und Klima aus einer Hand



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- ✓ **Overall Objective:**  
inform all citizens and visitors in Germany about severe weather in time
- ✓ until June 2014: conceptional phase
- ✓ June 2014: publication of the tender
- ✓ September 2014 – March 2015: kick-off with ubiquitous Apps & Technology
- ✓ March - May 2015: intensive feedback phase with internal and external test users (including feedback forms)
- ✓ 03.06.2015: FIRE!

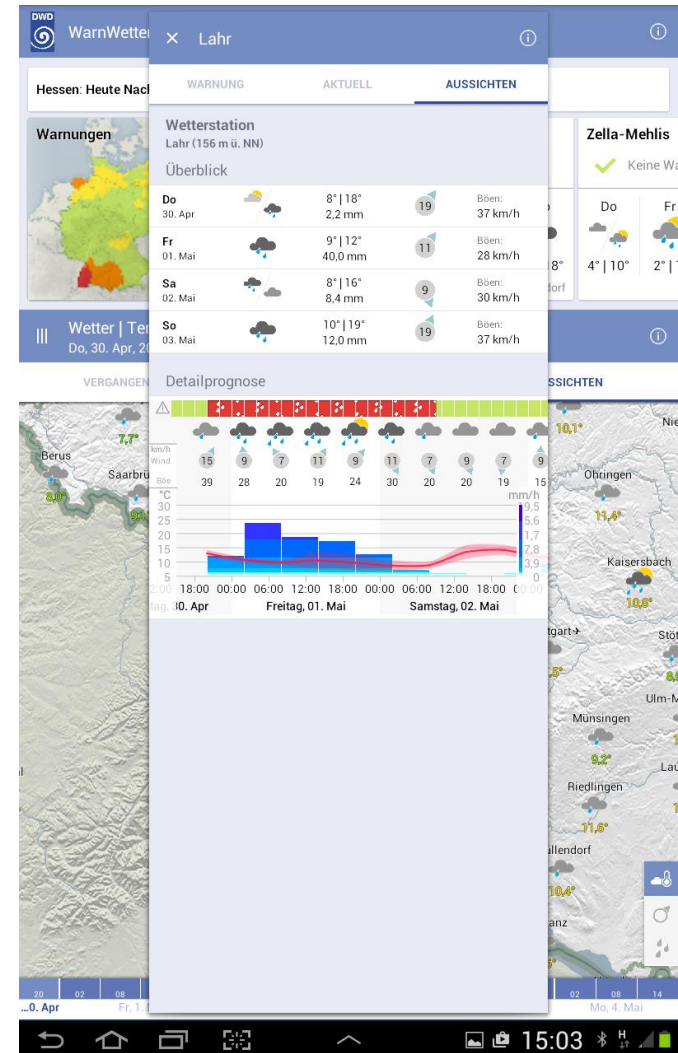
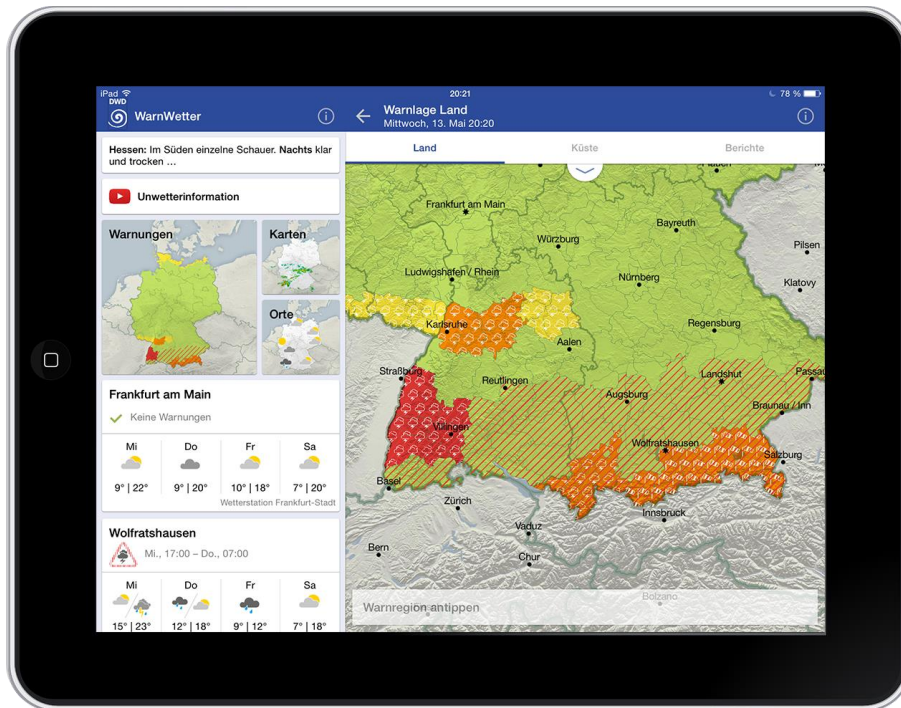
# „WarnWeather App“

Deutscher Wetterdienst  
Wetter und Klima aus einer Hand

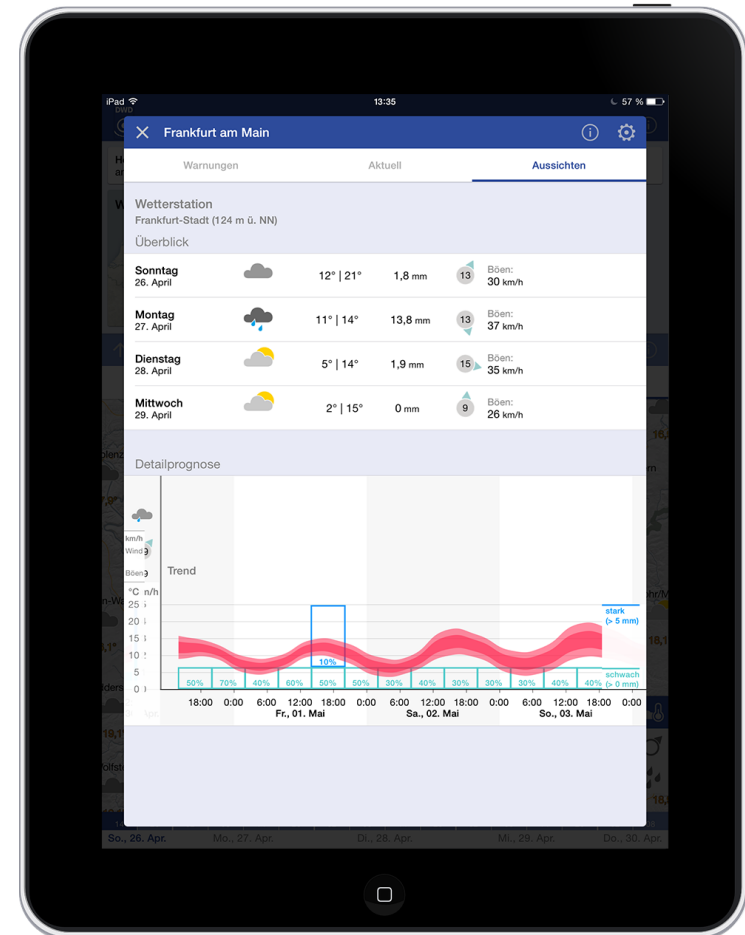


Released on June, the 3<sup>rd</sup> 2015

Until Monday > 250000 downloads



# Probabilistic forecasts

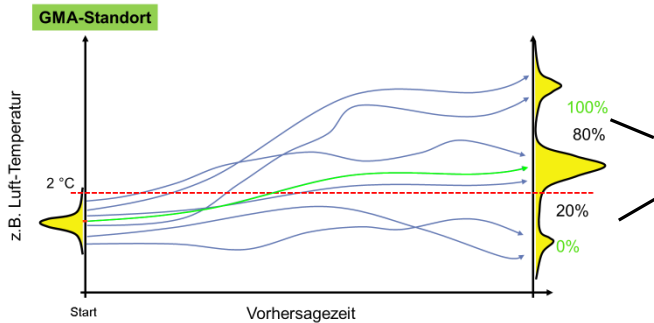


Summary

# TYPICAL USER REACTIONS TO PROBABILISTIC FORECASTS

# Probability → Decision

## Event occurred



User-optimised identification of probability thresholds

yes

no

Aufgebot



yes

cost

cost

no

loss



# Typical user concerns



- ✓ In my system, the loss cannot be quantified (value of human life?)
- ✓ Our IT systems and tools are not designed for probabilistic forecast information
- ✓ Regulations do not allow for „non-deterministic“ statements
- ✓ How do I know what 10% probability means?
- ✓ That's easy for you, you shift the responsibility towards us



# Things to discuss



- ✓ Significance and meaning of „risk“ for the user
- ✓ Context of probability and uncertainty: suitable terms needed („uncertainty“ has negative meaning) >> confidence?
- ✓ Responsibility shift towards the user >> added value of probabilistic forecast





# Thanks!

Deutscher Wetterdienst  
Wetter und Klima aus einer Hand

