Spatial Verification

for Ensemble

at DWD

Susanne Theis

Deutscher Wetterdienst (DWD)

Introduction

**Spatial Verification
of Single Simulations**

Box Statistics (e.g. averaging)
Fraction Skill Score
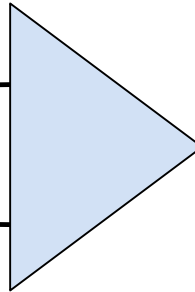Wavelets (Base Transformation)
MODE, CRA, SAL, DAS
…

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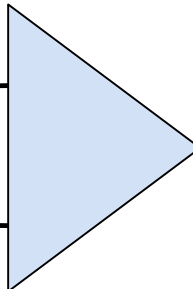of Ensemble Simulations**

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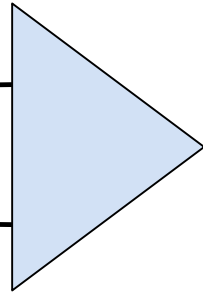Wavelets (Base Transformation)
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**Verification
of Spatial Ensemble Products**

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Box Statistics (e.g. averaging)
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…

„multivariate",
i.e. several locations

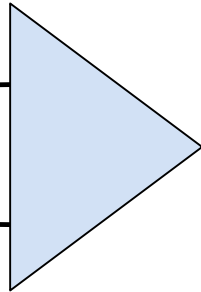**Verification
of Spatial Ensemble Products**

object-oriented

scale-related

base transformation

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Box Statistics (e.g. averaging)
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**Verification
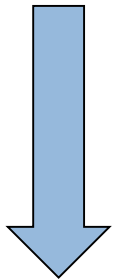of Spatial Ensemble Products**

Box Statistics

History: Spatial Ensemble Products at DWD

2009: Awareness, Implementation

2011: Forecaster's Feedback and Verification Results

since 2012: Operational

2015: Evaluation in European Severe Storms Laboratory

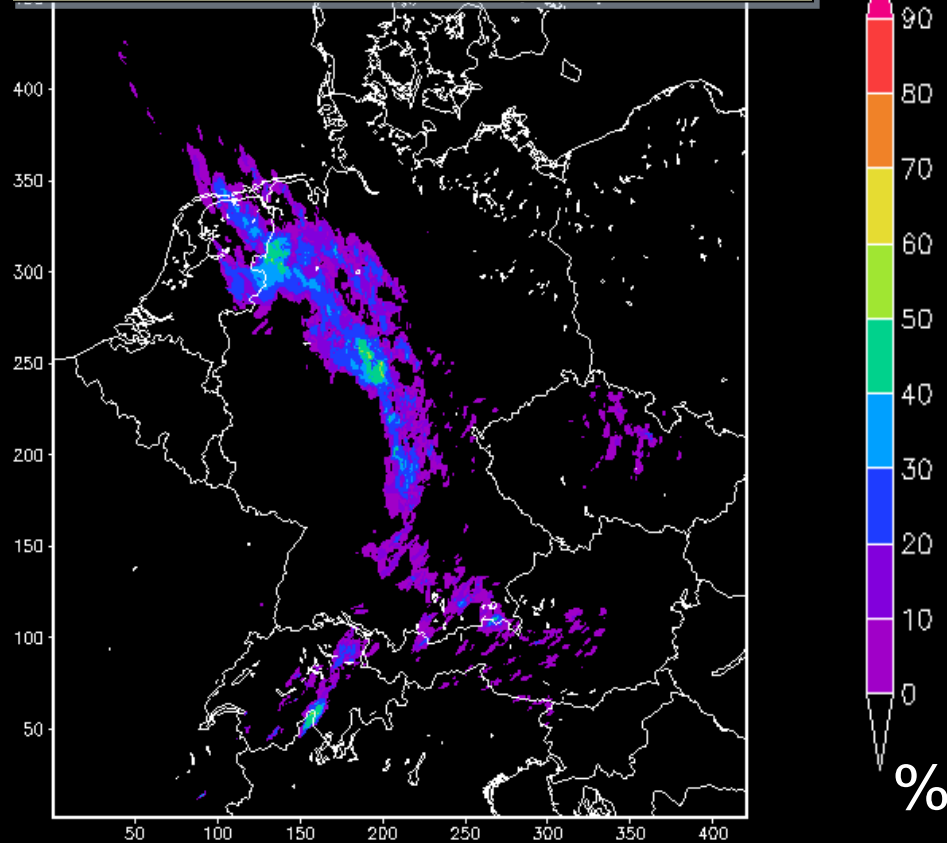**2015:** Information on DWD Web Site

2015: Discovering Similar Issues in Renewable Energies

2016: Discussion at WWRP Working Group on Predictability
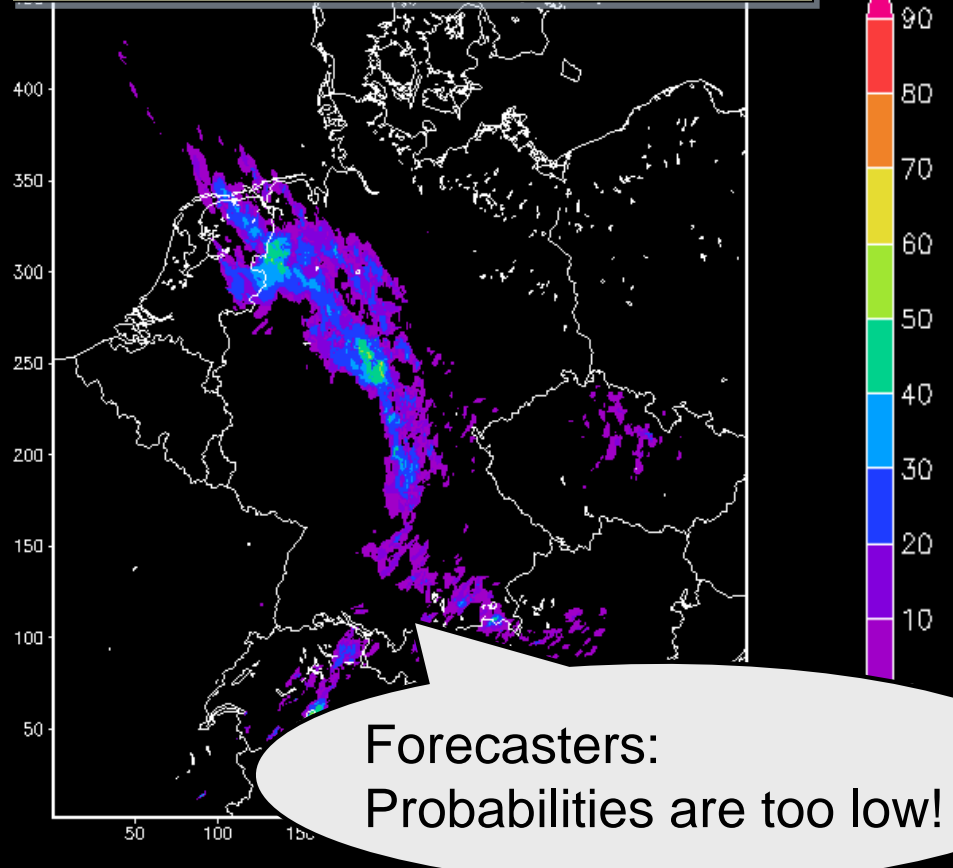
Awareness
(2009)

EPS Product Example: Probability Maps

„Event somewhere in 2,8km-Box"

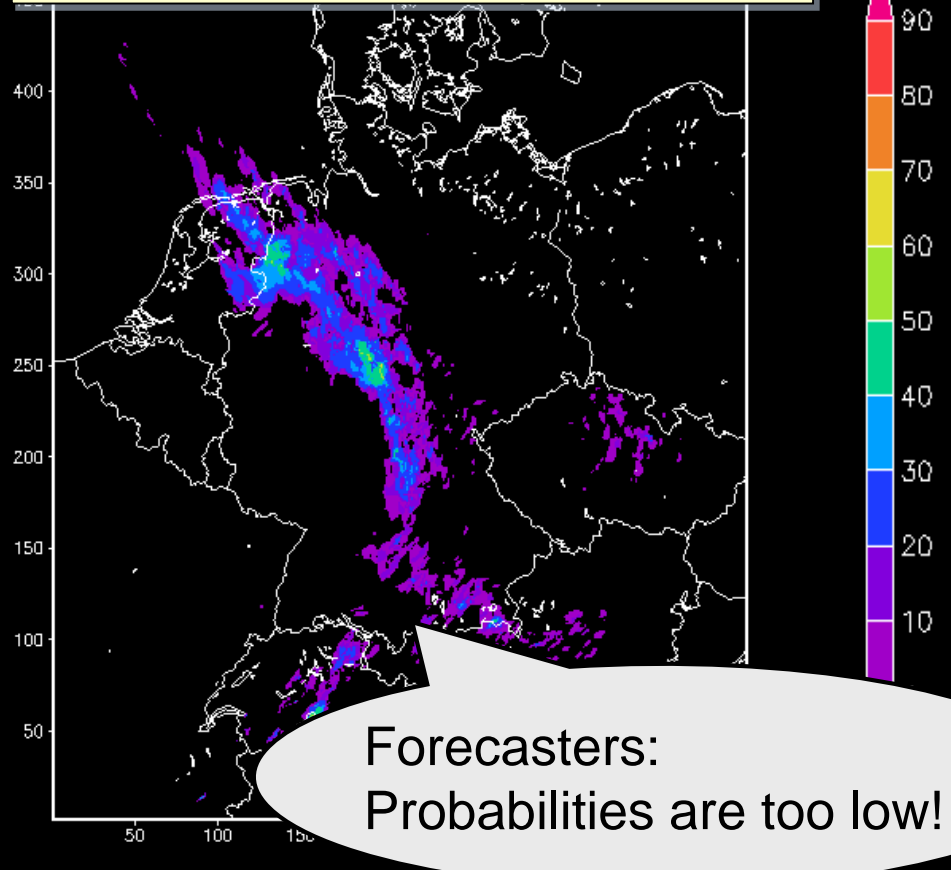# EPS Product Example: Probability Maps

„Event somewhere in 2,8km-Box"

Forecasters:
Probabilities are too low!

Source: EWGLAM / SRNWP meeting, Athens, 2009

EPS Product Example: Probability Maps

EPS Product Example: Probability Maps

„Event somewhere in 2,8km-Box"

„Event somewhere in 28km-Box"

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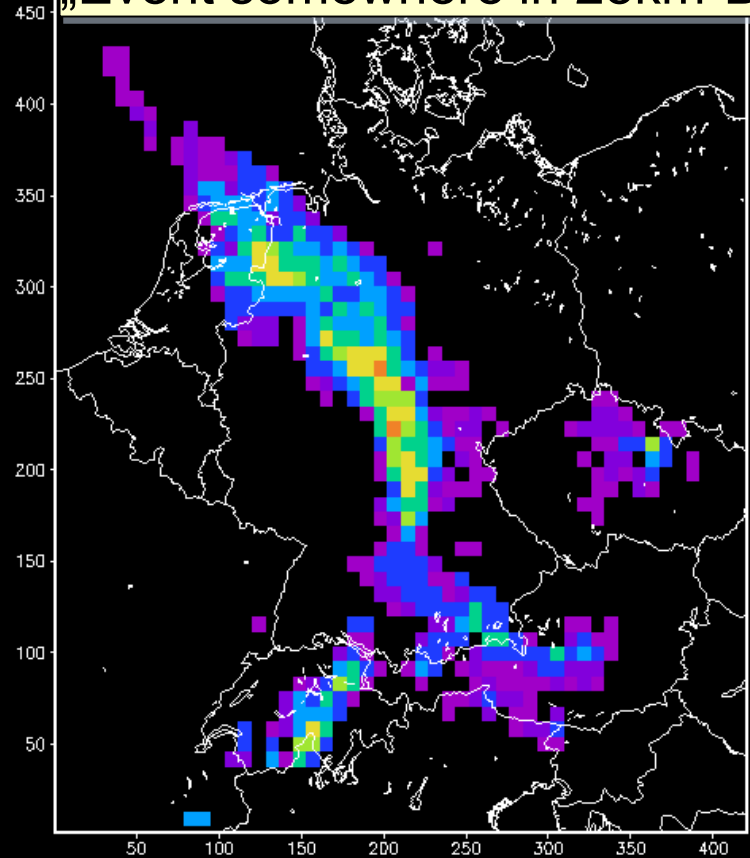
EPS Product Example: Probability Maps

„Event somewhere in 2,8km-Box"

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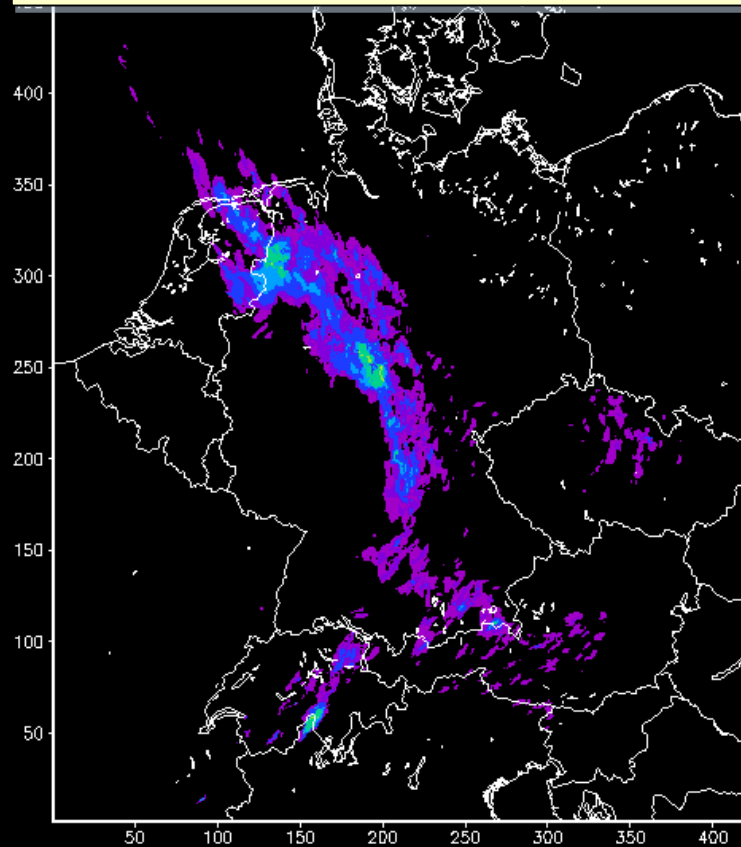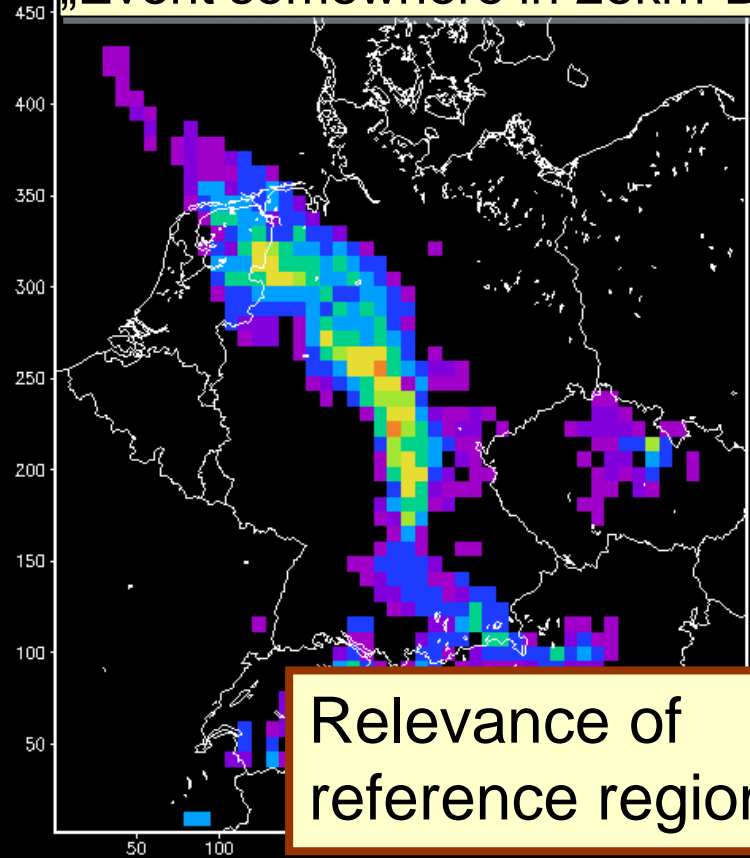
Relevance of reference region!

Source: EWGLAM / SRNWP meeting, Athens, 2009
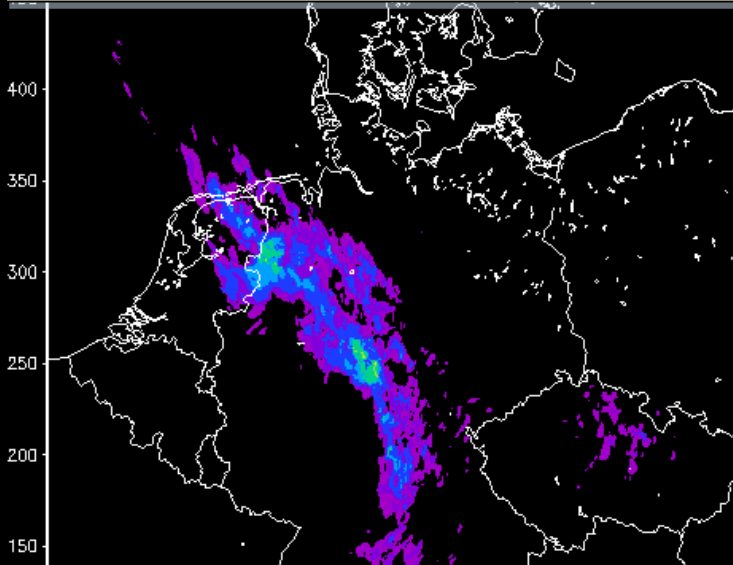
EPS Product Example: Probability Maps

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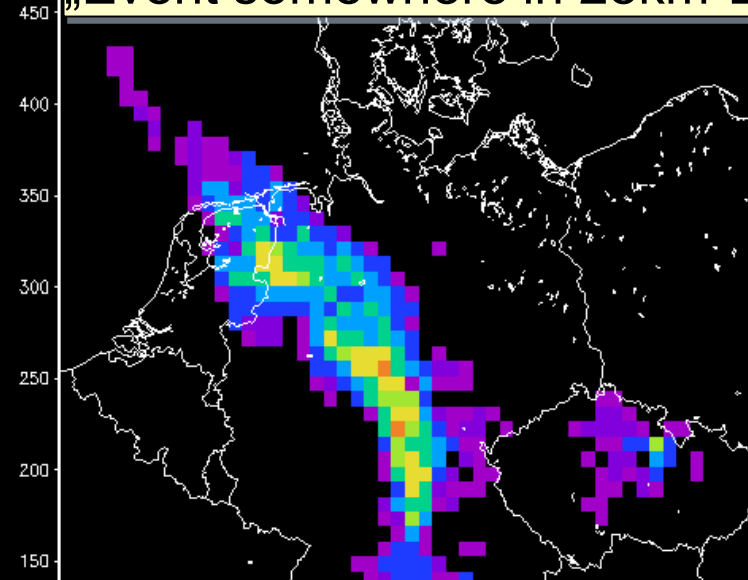
Implementation of a Spatial Ensemble Product

Forecaster's Feedback at DWD (2011)

Forecasters' Feedback

➔ what they **prefer to use**:

    ➔ 90%-quantile of precipitation

    ➔ precipitation probabilities for an <u>area</u> (10x10 grid points)

Forecasters' Feedback

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Key Product of COSMO-DE-EPS

Verification Results (2011)

Ben Bouallègue, Z. (2011):
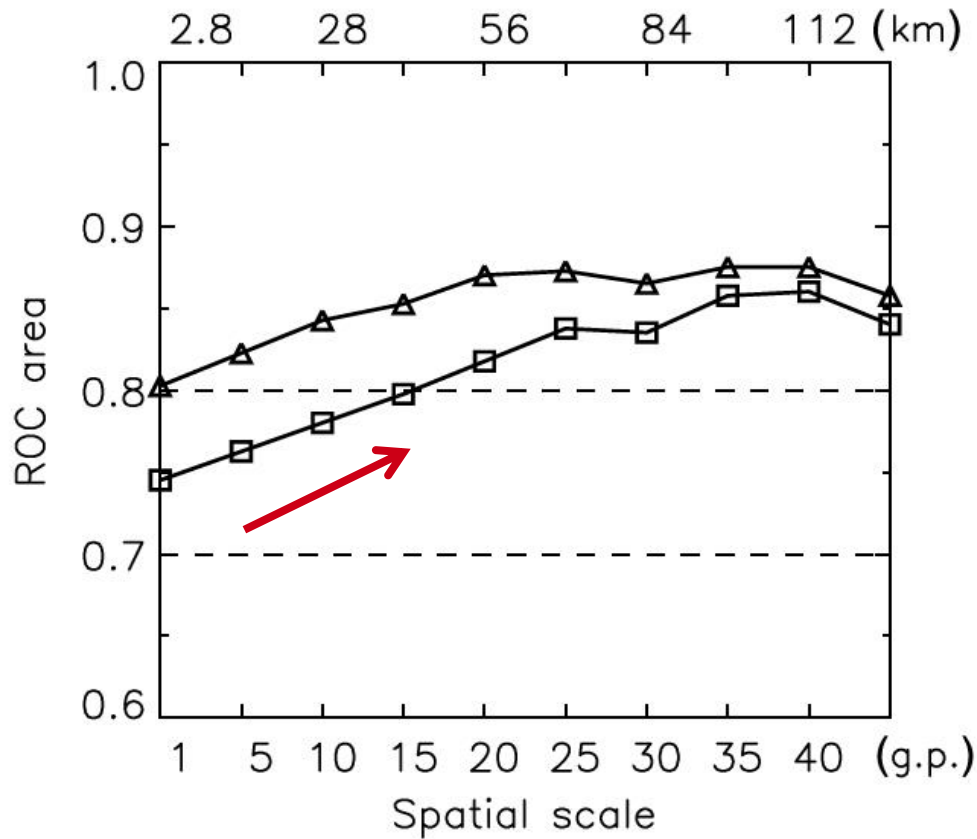
***Upscaled** and fuzzy **probabilistic forecasts**: verification results. COSMO Newsletter 11, 124-132.*

Ben Bouallègue, Z. and S.E. Theis (2014):

Spatial Techniques Applied to Precipitation Ensemble Forecasts: From Verification Results to Probabilistic Products. Meteorological Applications, 21, 922-929.

Figure 6. ROC area as a function of the window size used for the uspcaling process. The triangles refer to a threshold of 10 mm $(6\,h)^{-1}$ and the squares to a threshold of 20 mm $(6\,h)^{-1}$.

Observations:

Radar data,
upscaled in the same way

Ben Bouallègue and Theis (2014)

- **„upscaling"** → substantial quality gain

  (looking at ROC area, „high" precipitation thresholds)

- **optimal window size:**

  balance between

  good verification results

  and access to fine-grid information

Verification Results

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  (looking at ROC area, „high" precipitation thresholds)

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Looked at Quality of Spatial Ensemble Product

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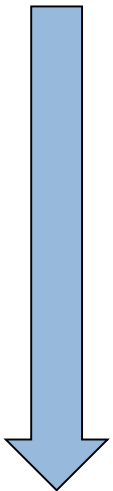
since 2012: Operational

2015: Evaluation in European Severe Storms Laboratory
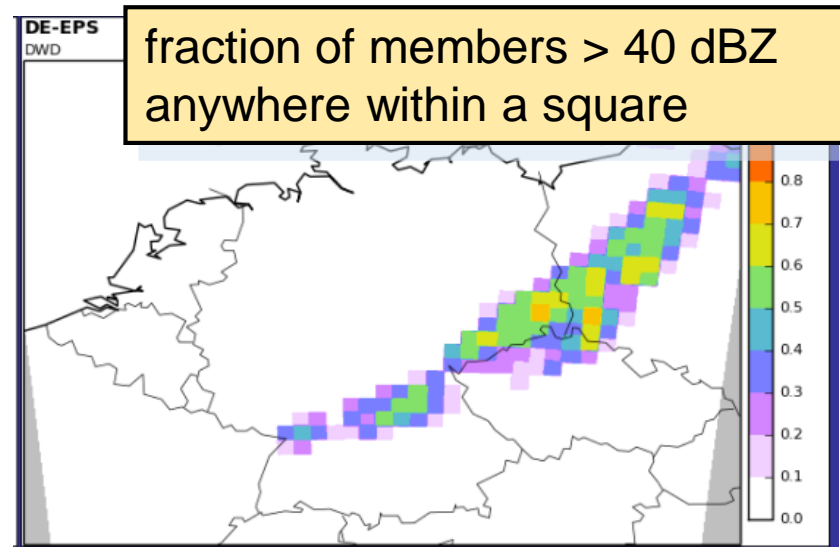
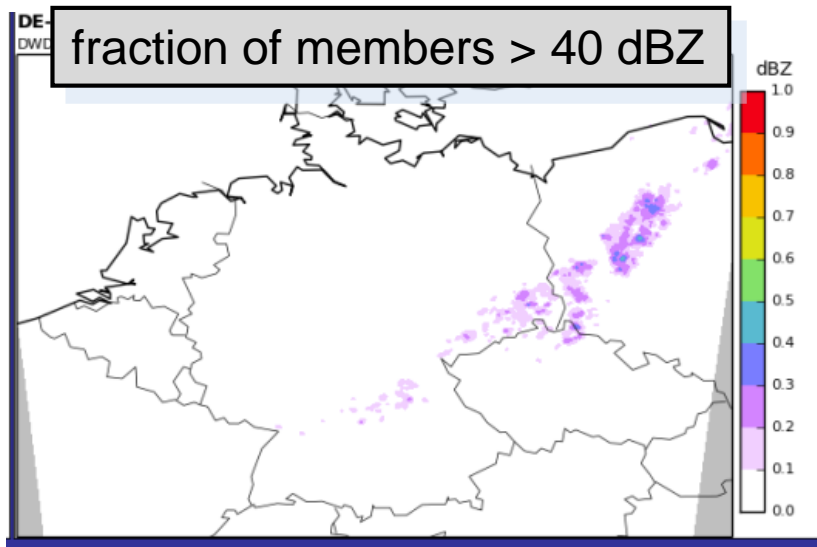**2015:** Information on DWD Web Site

2015: Discovering Similar Issues in Renewable Energies

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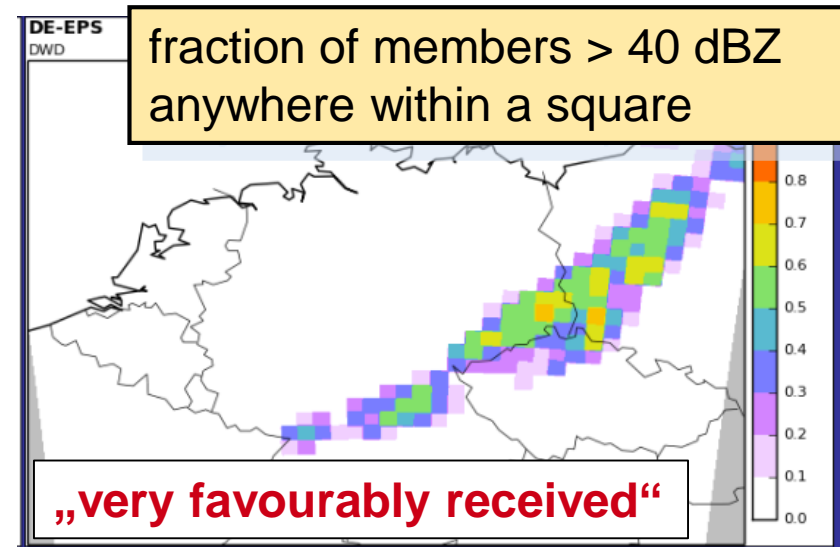# Evaluation at ESSL
(2015)

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

simulated reflectivity, 06 UTC Run on May 12th, + *15 hours forecast*

fraction of members > 40 dBZ

fraction of members > 40 dBZ anywhere within a square

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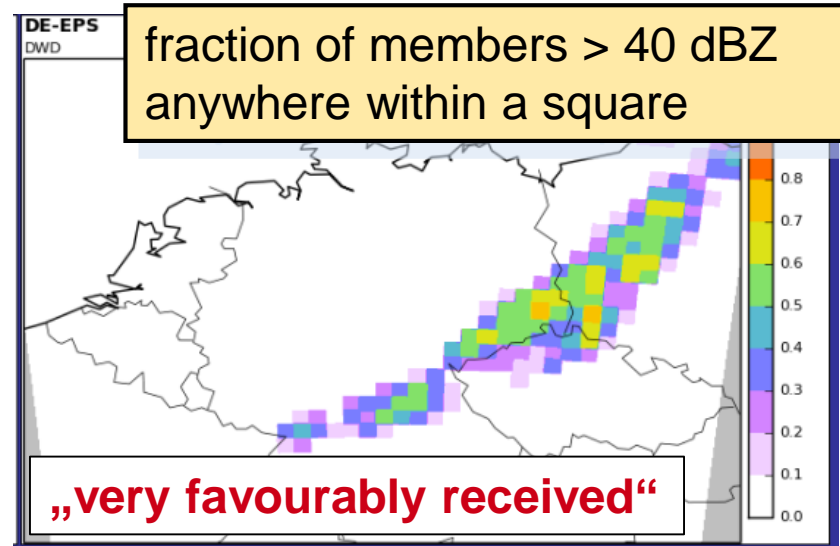
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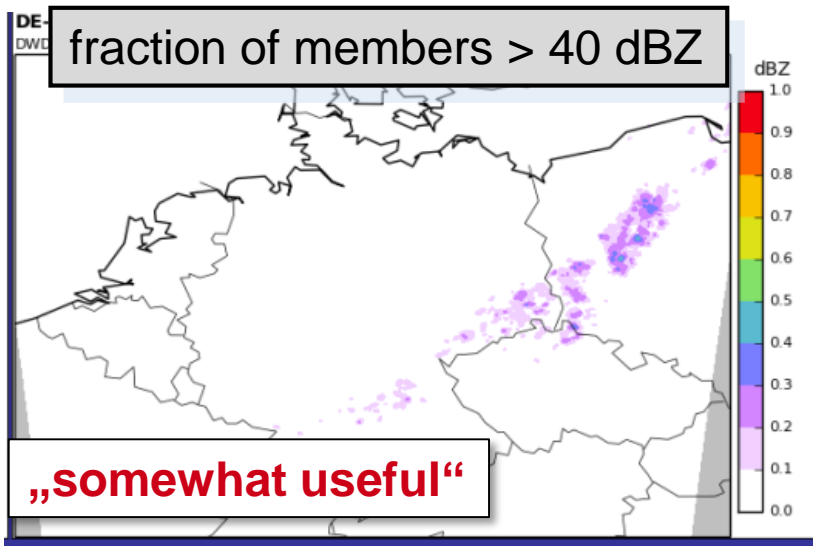
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smoothed version
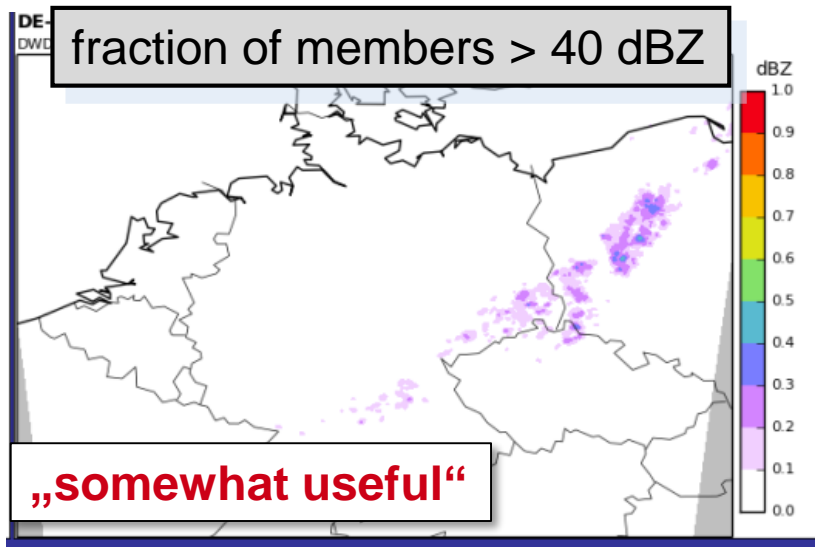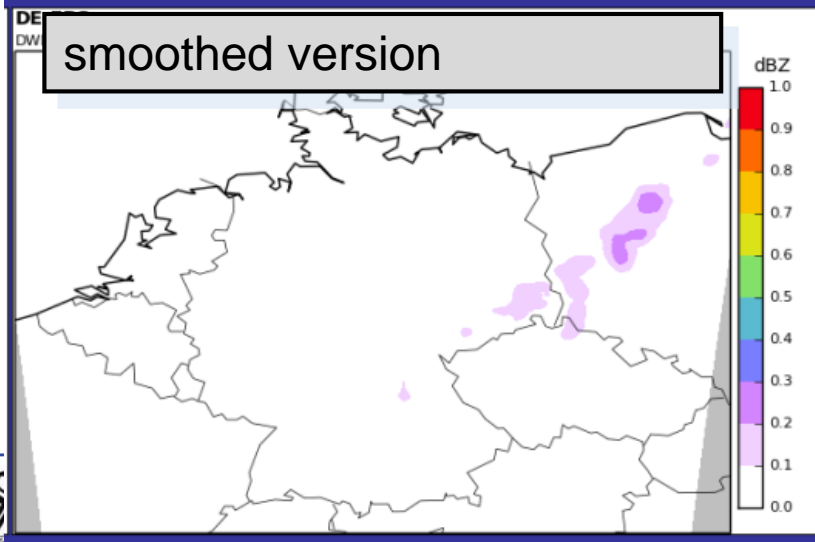
somewhat related to

- Fraction Skill Score
- Neighbourhood Method

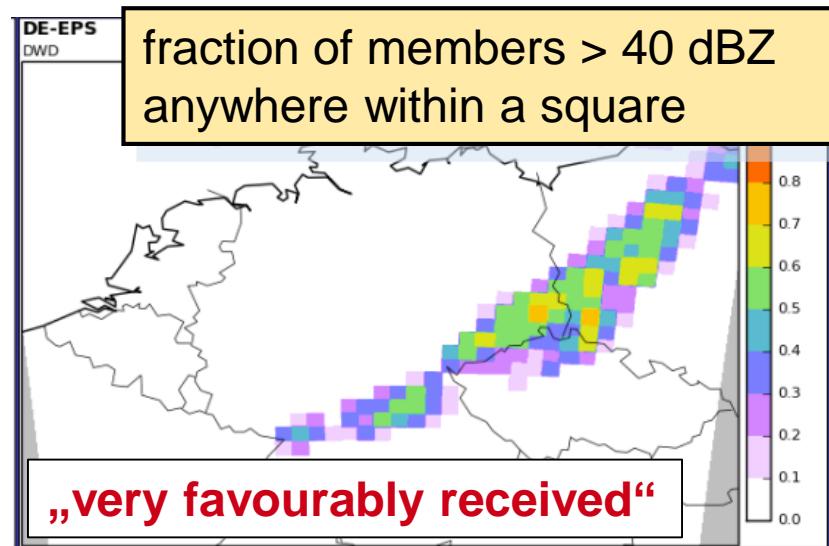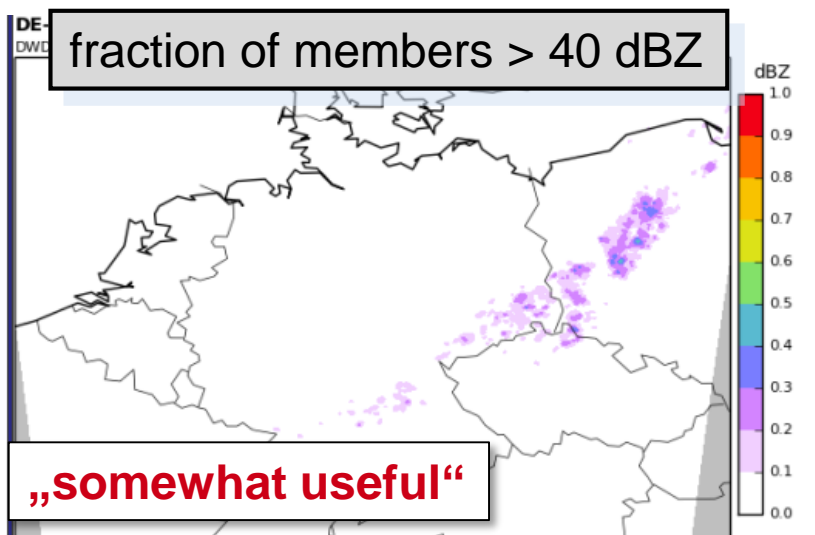## simulated reflectivity, 06 UTC Run on May 12th, + *15 hours forecast*

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„**smoothing out the signal to below the lowest threshold**"

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smoothed version

**despite critical evaluation,
verification result still favourable**

Precip thres: 10mm/6h, Reference: COSMO-DE-EPS

(Ben Bouallègue and Theis, 2014)

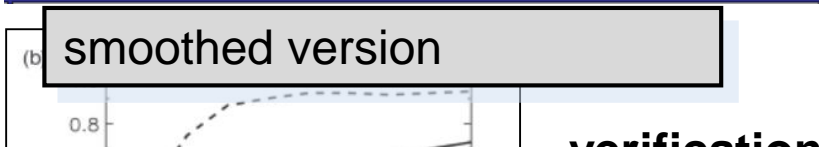**simulated reflectivity, 06 UTC Run on May 12th, +** *15 hours forecast*

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verification
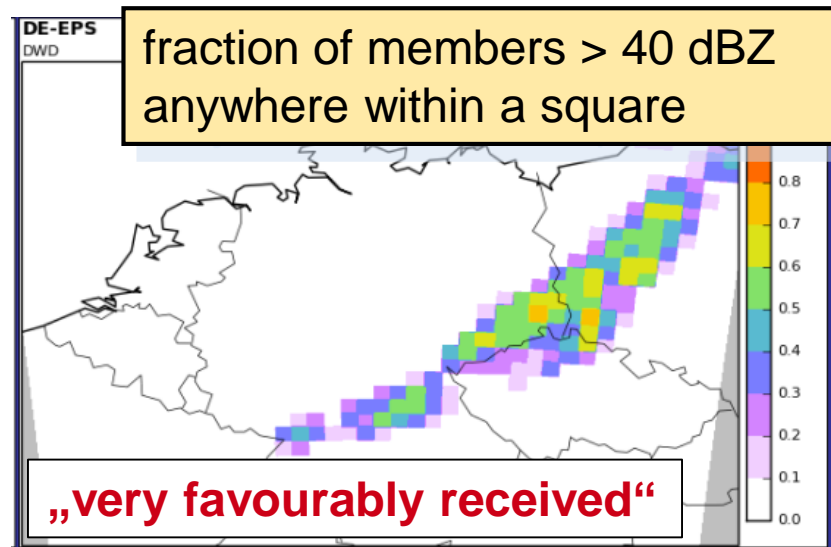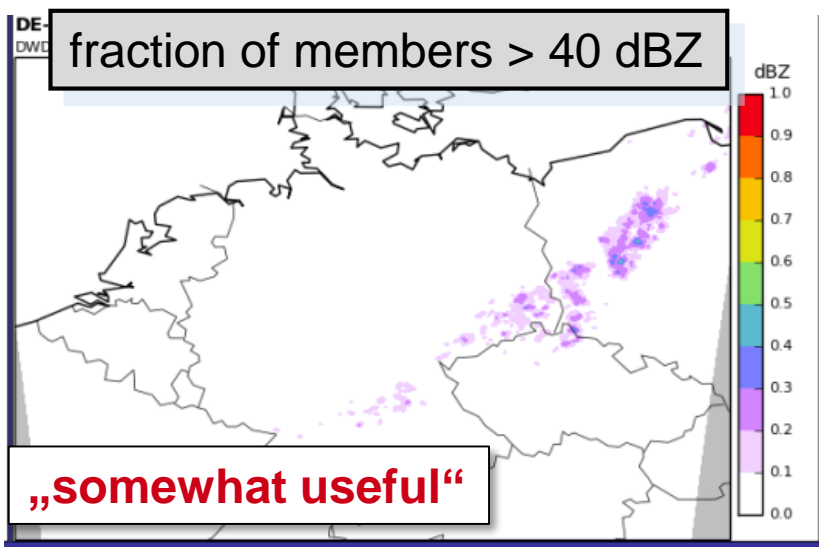
Relevance of Evaluation

Information on DWD web site (2015)

www.dwd.de → English (klick on „En" at the top)

→ RESEARCH
→ WEATHER FORECASTING
→ NUMERICAL MODELLING
→ ENSEMBLE METHODS
→ ENSEMBLE PREDICTION

(%)	
100	
90 - 99	
80 - 89	
70 - 79	
60 - 69	
50 - 59	
40 - 49	
30 - 39	
20 - 29	
10 - 19	
1 - 9	
0 - 1	

vorhergesagte
Wahrscheinlichkeit

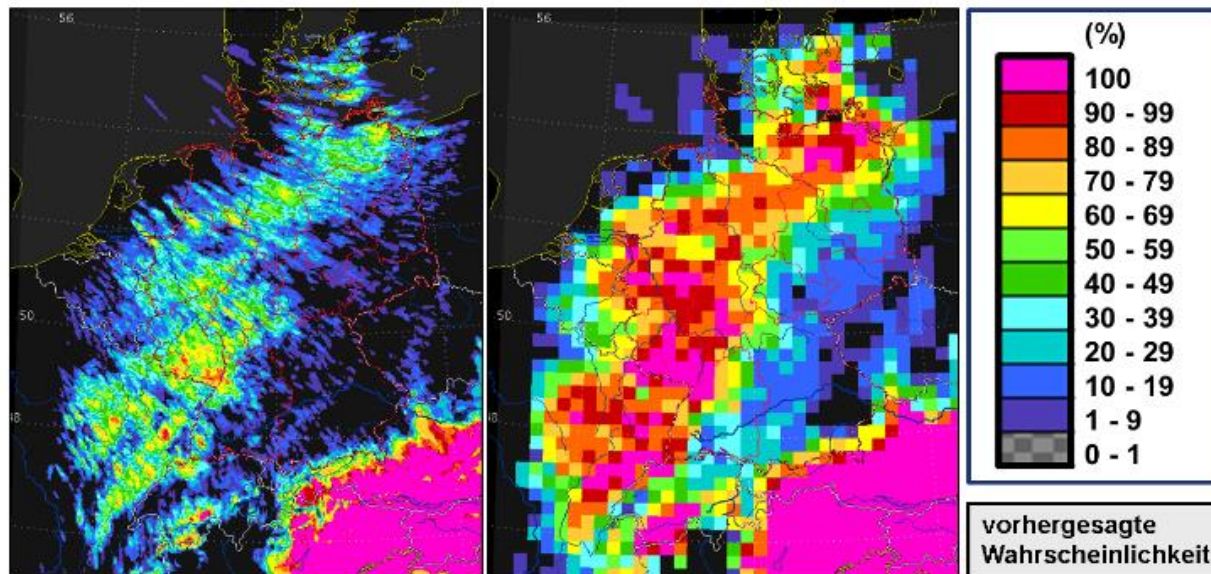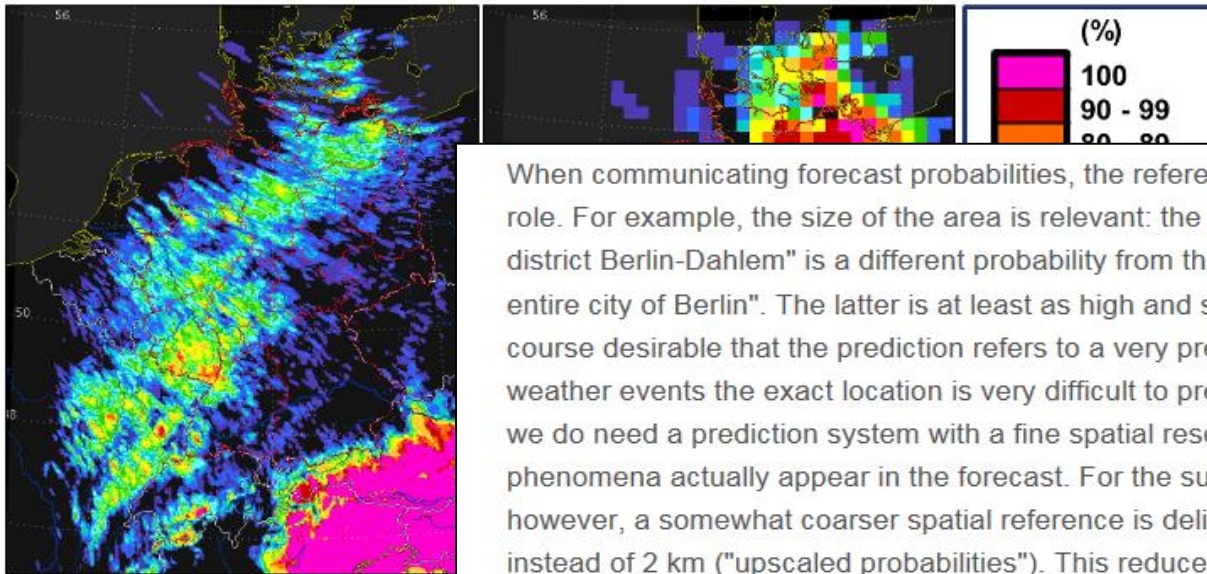*(Figure: EMS Opening Session, 2011)*

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When communicating forecast probabilities, the reference to a space and time interval plays a role. For example, the size of the area is relevant: the probability of "rain somewhere within the district Berlin-Dahlem" is a different probability from the probability of "rain somewhere within the entire city of Berlin". The latter is at least as high and sometimes higher. Generally, it is of course desirable that the prediction refers to a very precise location. However, for some local weather events the exact location is very difficult to predict (e. g. thunderstorms). As a first step, we do need a prediction system with a fine spatial resolution, so that such important weather phenomena actually appear in the forecast. For the subsequent formulation of probabilities, however, a somewhat coarser spatial reference is deliberately chosen, e.g. a radius of 20 km instead of 2 km ("upscaled probabilities"). This reduces the pretension to high spatial accuracy, and the ensemble members are more likely to form a matching statement, and the resulting probabilities provide a more meaningful warning.

Similar Issues
in Forecasts
for Renewable Energies
(2015)
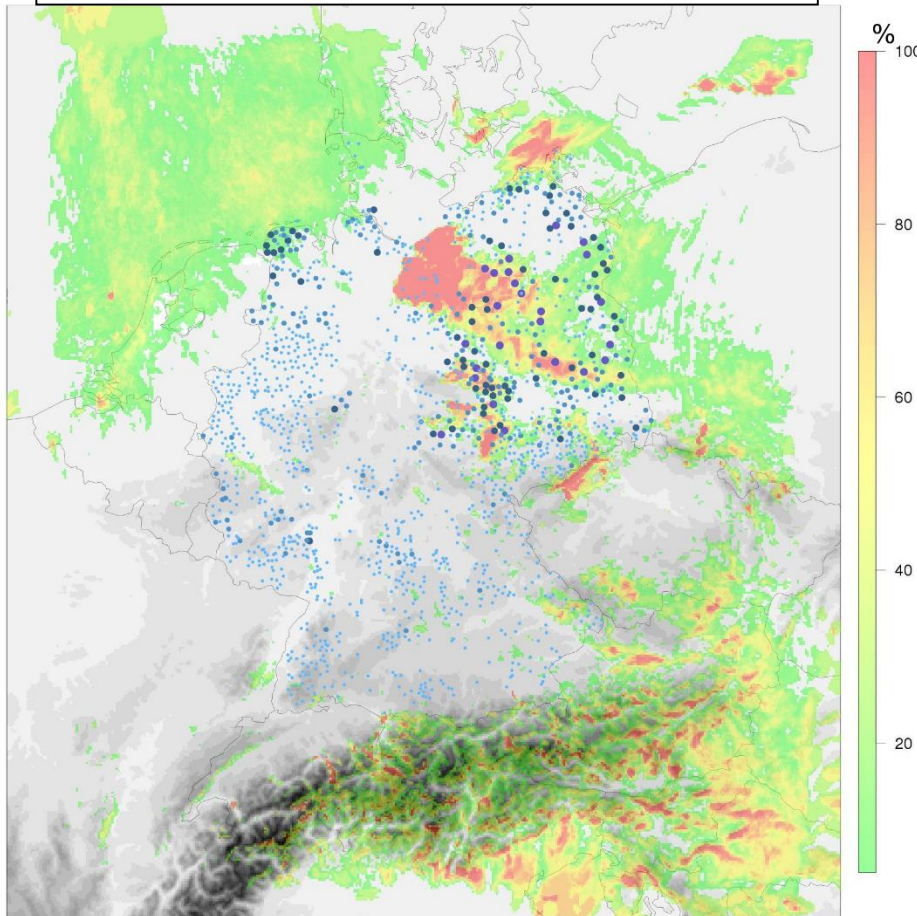
Figure: *Marcel Schäfer, Master Thesis, University of Mainz*

Verification of Wind Ramps:

- **Wind Ramps directly**

- **Spectrum of Time Series**

- **Correlation in Time**

- **Multivariate Scores:**

    p-Variogram Score,

    Multivariate Rank Histogram

    Energy Score

Discussion
at WWRP Working Group
on Predictability
(2016)

„Default" Product:

Probabilities for each grid point and time

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Probabilities for each grid point and time

Questions:

- Does „high-impact" involve any spatial or temporal „structure"?

- Are we interested in the *rough* time and location?

→ **High-impact Event not necessarily visible in „standard probabilities"**

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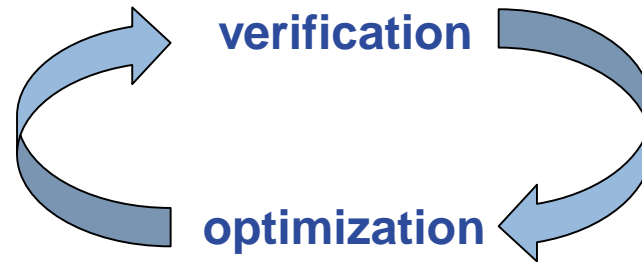
optimization

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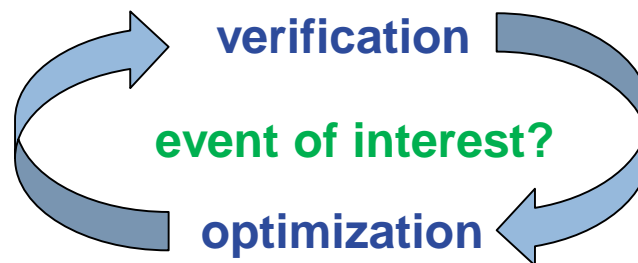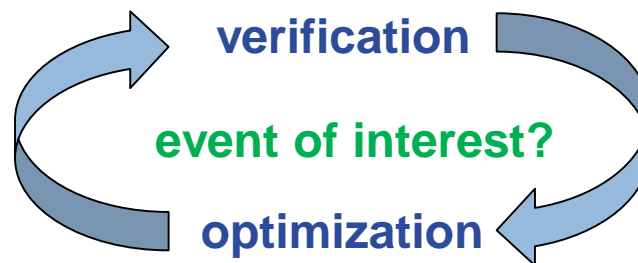
event of interest?

optimization

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Wetter und Klima aus einer Hand

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Probabilities for each grid point and time

verification

event of interest?

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Questions:

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- Are we interested in the *rough* time and location?

thoughtful definition of event   +   targeted verification