Project EWeLiNE

Scenario Forecasts for Operational Planning

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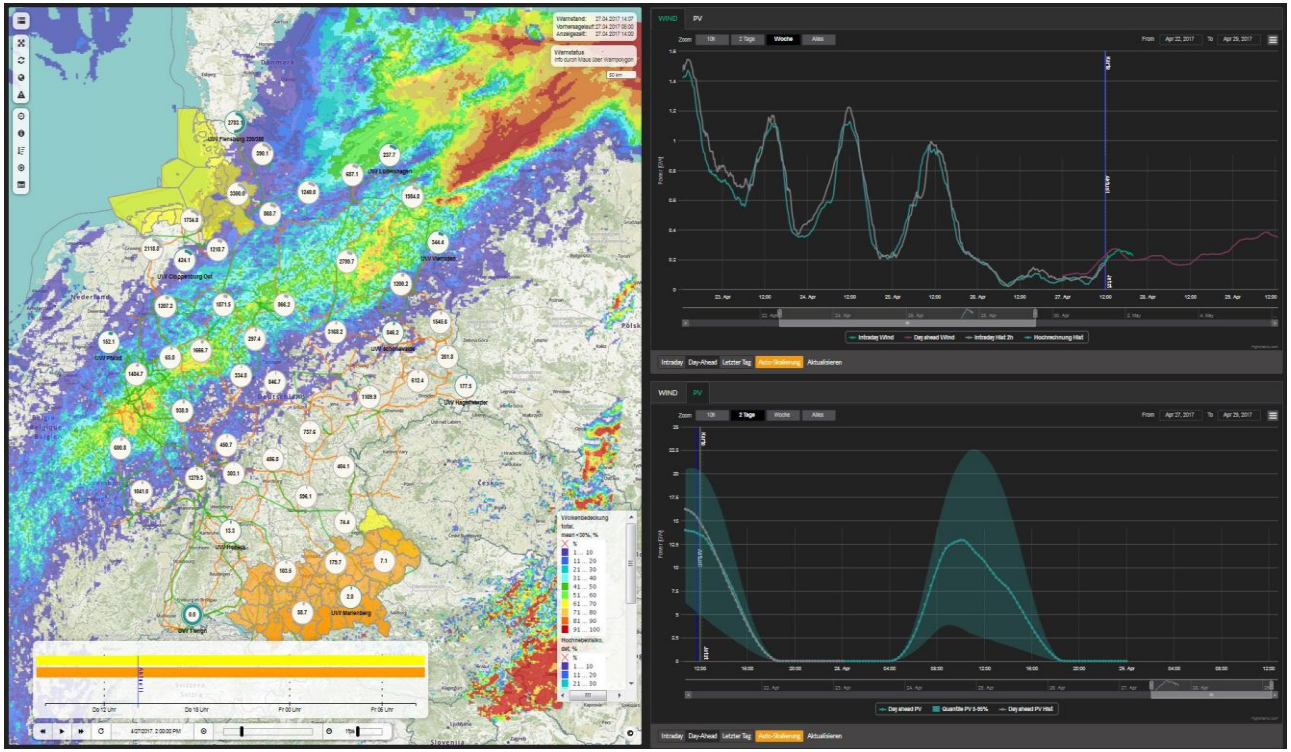
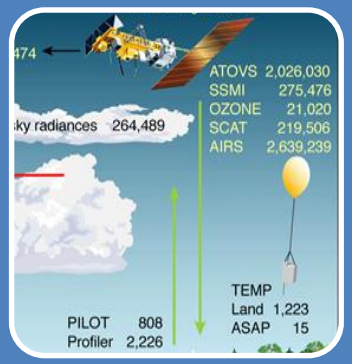


Project EWeLiNE

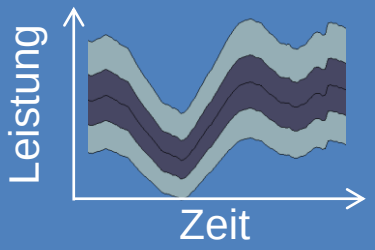
- Project Partners: Fraunhofer IWES, German Weather Service, 50Hertz (TSO), Amprion (TSO), Tennet (TSO)
- Dec 2012 to Feb 2017 (4 ¼ years)
- 20 Researcher
- Scope
  - Improvement of wind power- and PV forecasts for grid integration
  - Dealing with critical weather situations
- Hypothesis
  - coordinated progress in power and weather forecast necessary
  - close cooperation between meteorology and energy industry necessary
- Successor: Project Gridcast

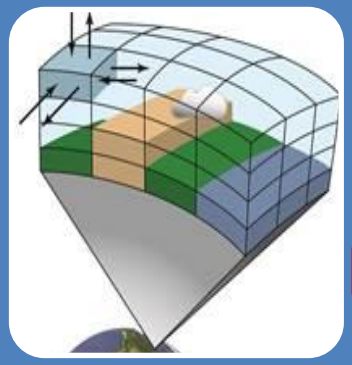
Probabilistic forecast



Assimilation

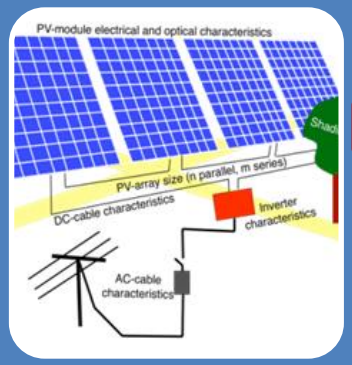
- Ensemble Assimilation
  Kenda (LETKF)





Weather model

- Physical perturbation of the model physics
- Stochastic perturbation of the model physics
- Dual calibration

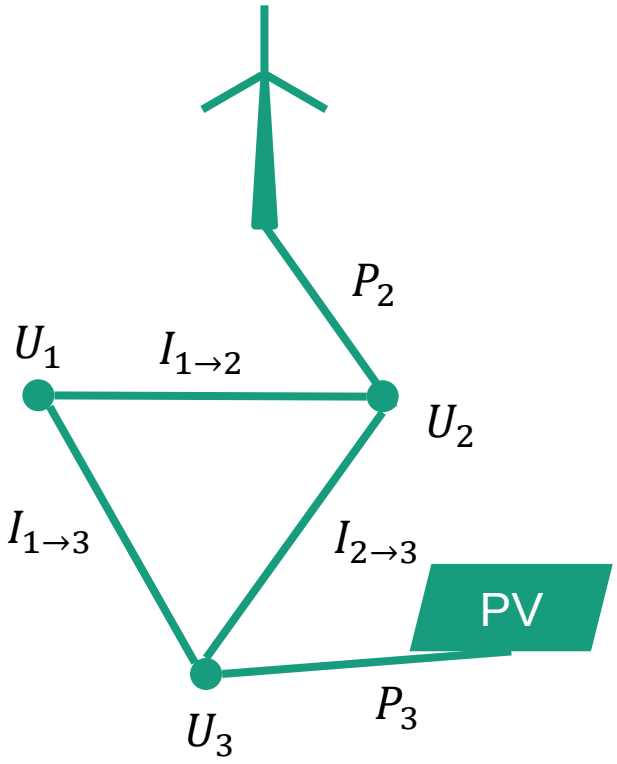


Power forecast

- Scenario forecast for operation planning
- Quantile forecast for trading
- Calibration

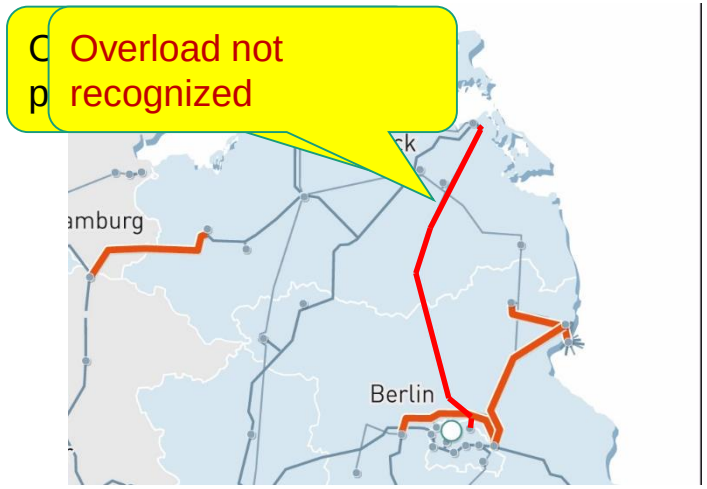
Problem description

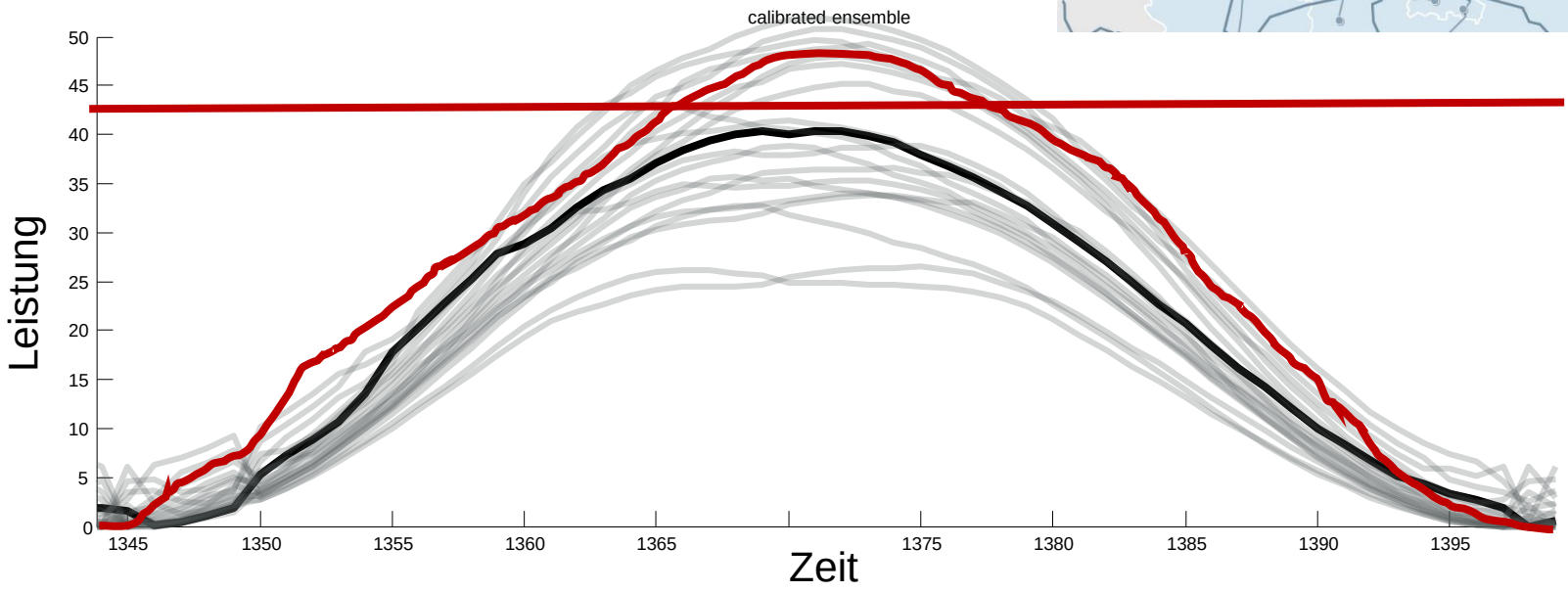
- RES forecast for congestion forecast becomes one of the most important forecast for TSO in Germany
  - Operational planning: forecasting the future system state + actions
  - System state parameters: node voltage and branch current
- Risks can be captured with uncertainty information (risk for (n-1)-violation)
- Further Need: operational planning process which is capable of integrating uncertainties (e.g. UMBRELLA project)
- Here: focus on probabilistic forecast



Motivation: congestion forecast

- Thermal overload?
- Deterministic forecast: „No“.
- Reality: „Yes“.
- Ensemble recognize possible overload.





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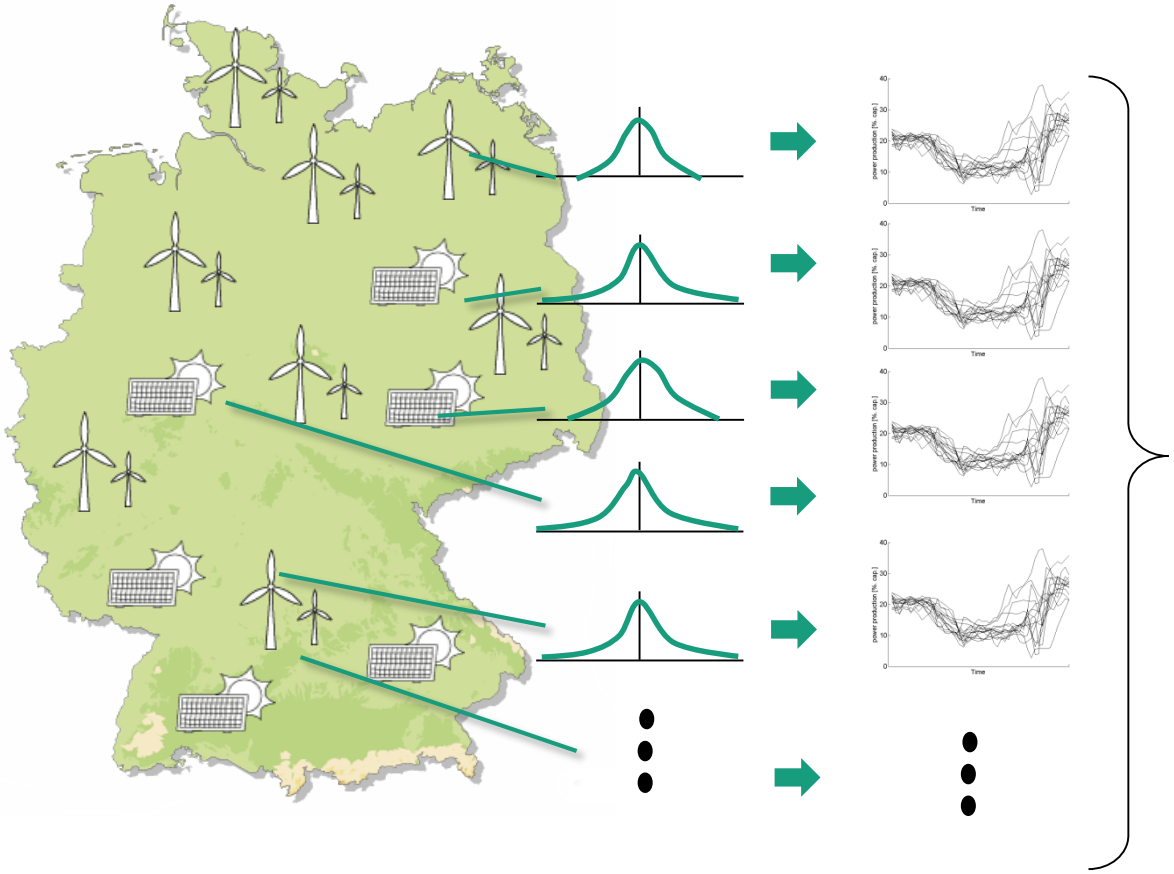
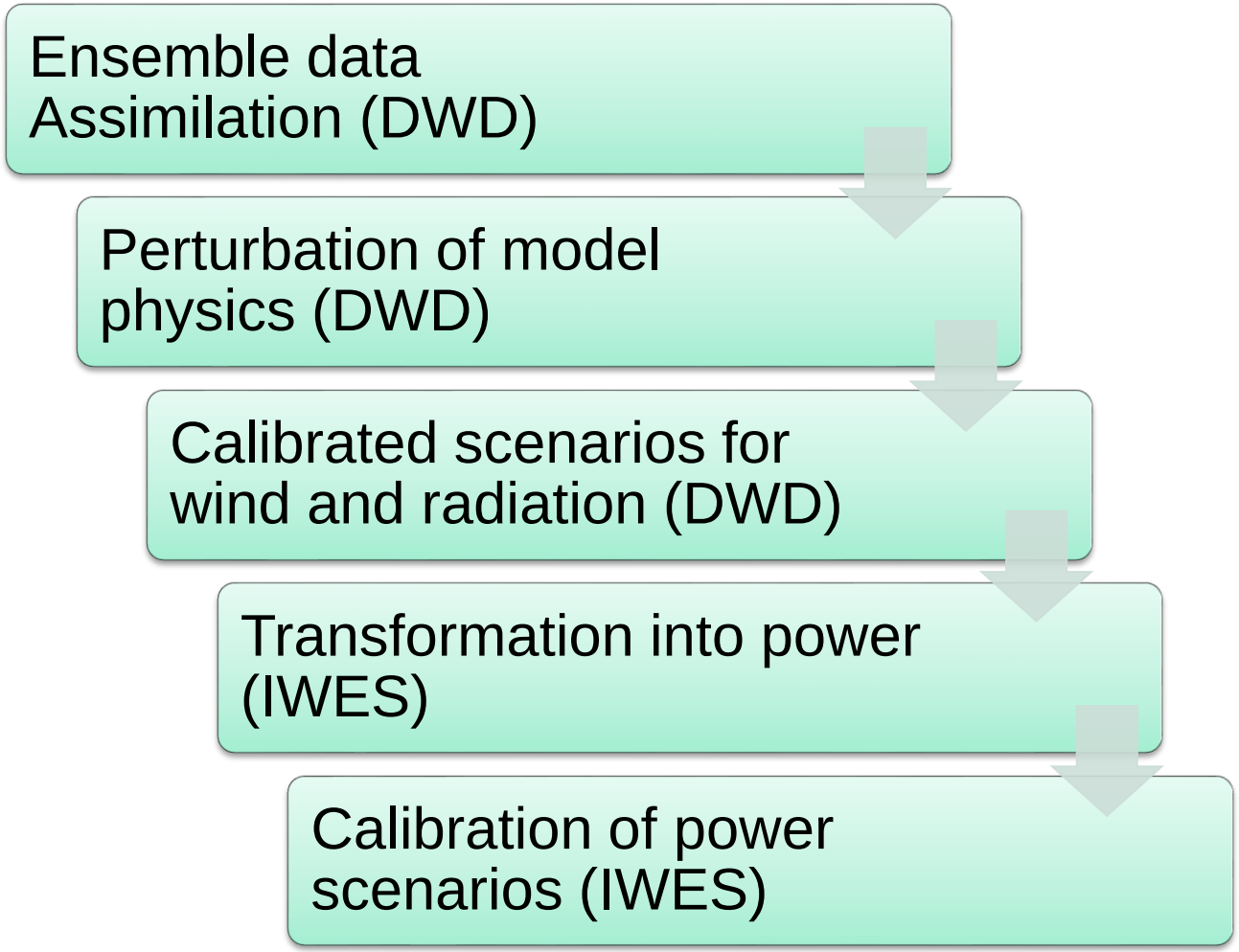
Motivation: Scenario forecast



Scenarios describe the correct temporal and spatial correlations between grid nodes.

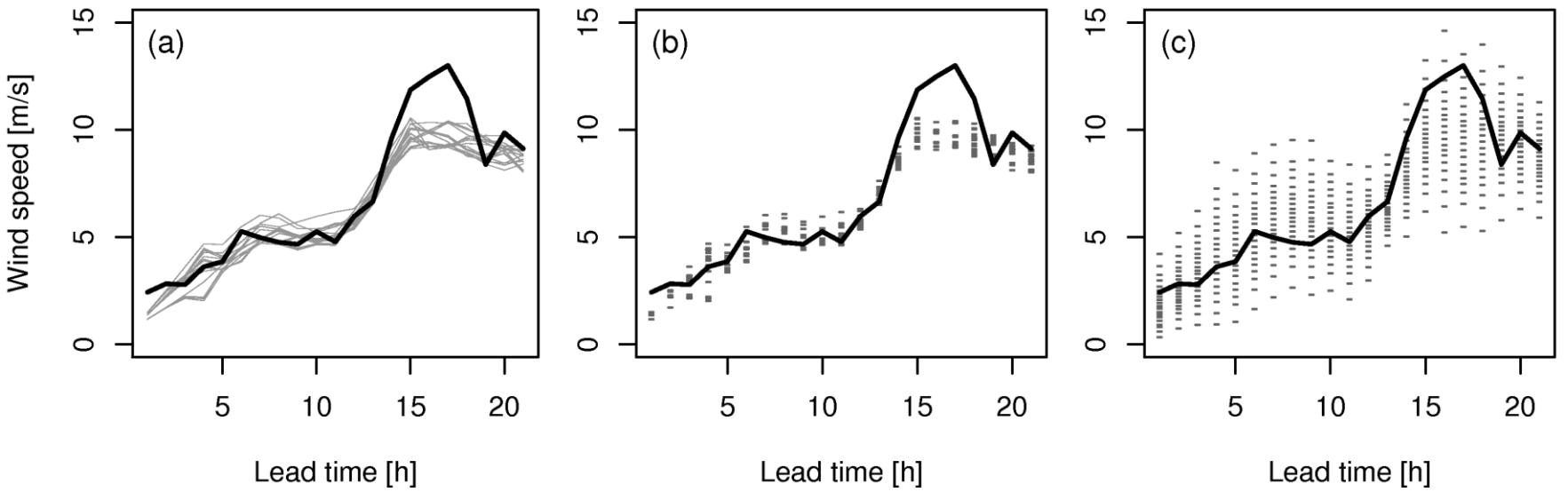
Process to generate reliable scenario forecasts



Generation of Scenarios
→ Calibration

Quantile = threshold [%] of an statistical distribution

COSMO-DE-EPS **Quantiles** **calibrated**



— Beobachtung

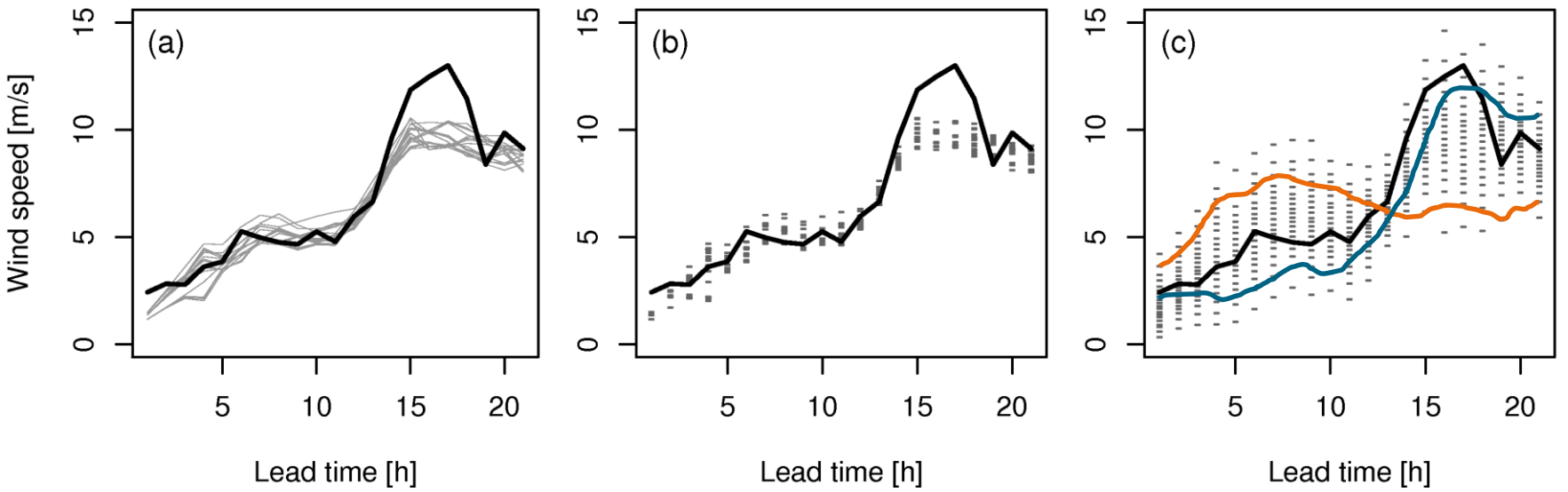
FINO 1, 02.03.2013, 03 UTC

Calibration **here:** Non-homogeneous Gaussian Regression (Schuhen et al. 2012)

Generation of Scenarios
→ Ensemble Copular Coupling

Scenario = **one** realization of the calibrated ensemble based on calibrated quantiles

COSMO-DE-EPS **Quantiles** **calibrated**



— Beobachtung

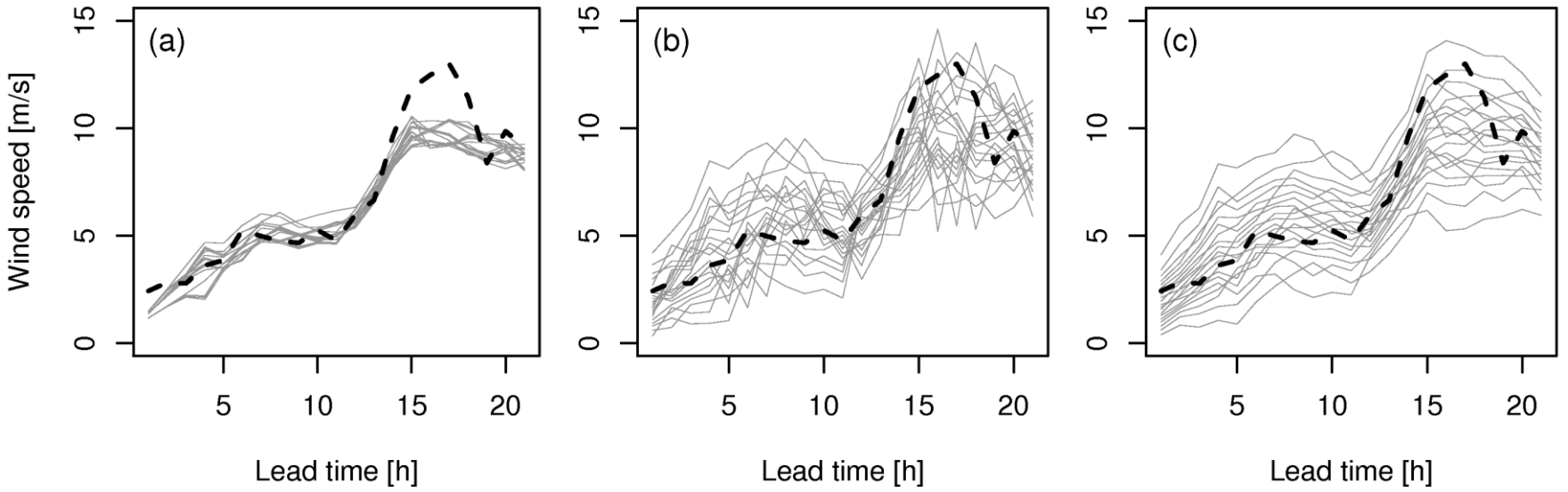
FINO 1, 02.03.2013, 03 UTC

Ensemble Copula Coupling (Schefzik R., Thorarinsdottir T., and T. Gneiting, 2013)

Generation of Scenarios
→ dual Ensemble Copular Coupling

Scenarios = member of the calibrated ensemble

COSMO-DE-EPS **ECC** **dual-ECC**



— Beobachtung

FINO 1, 02.03.2013, 03 UTC

Neu: d-ECC (Ben Bouallègue Z., Heppelmann T., Theis S. and P. Pinson, 2016)

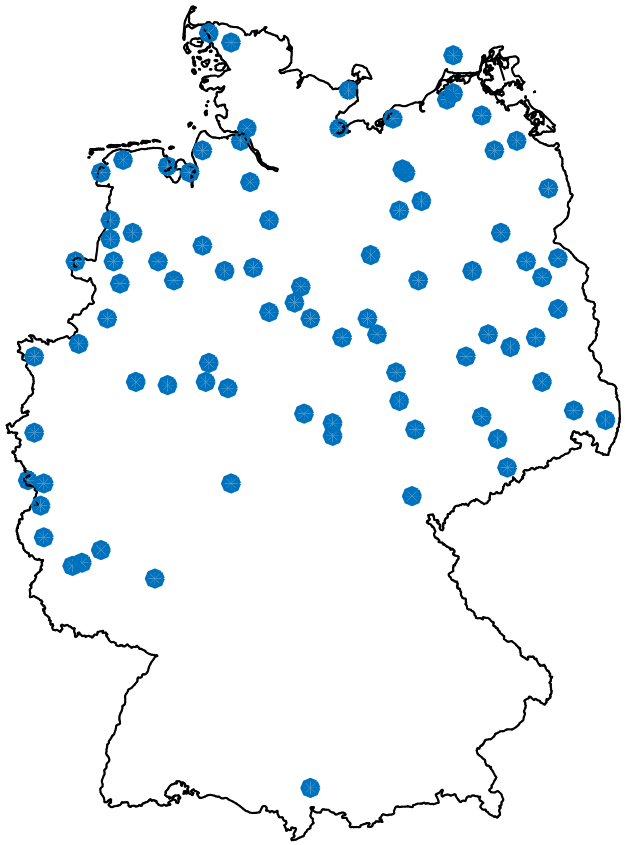
Data base

Power data

- 87 wind farms
- February 2015

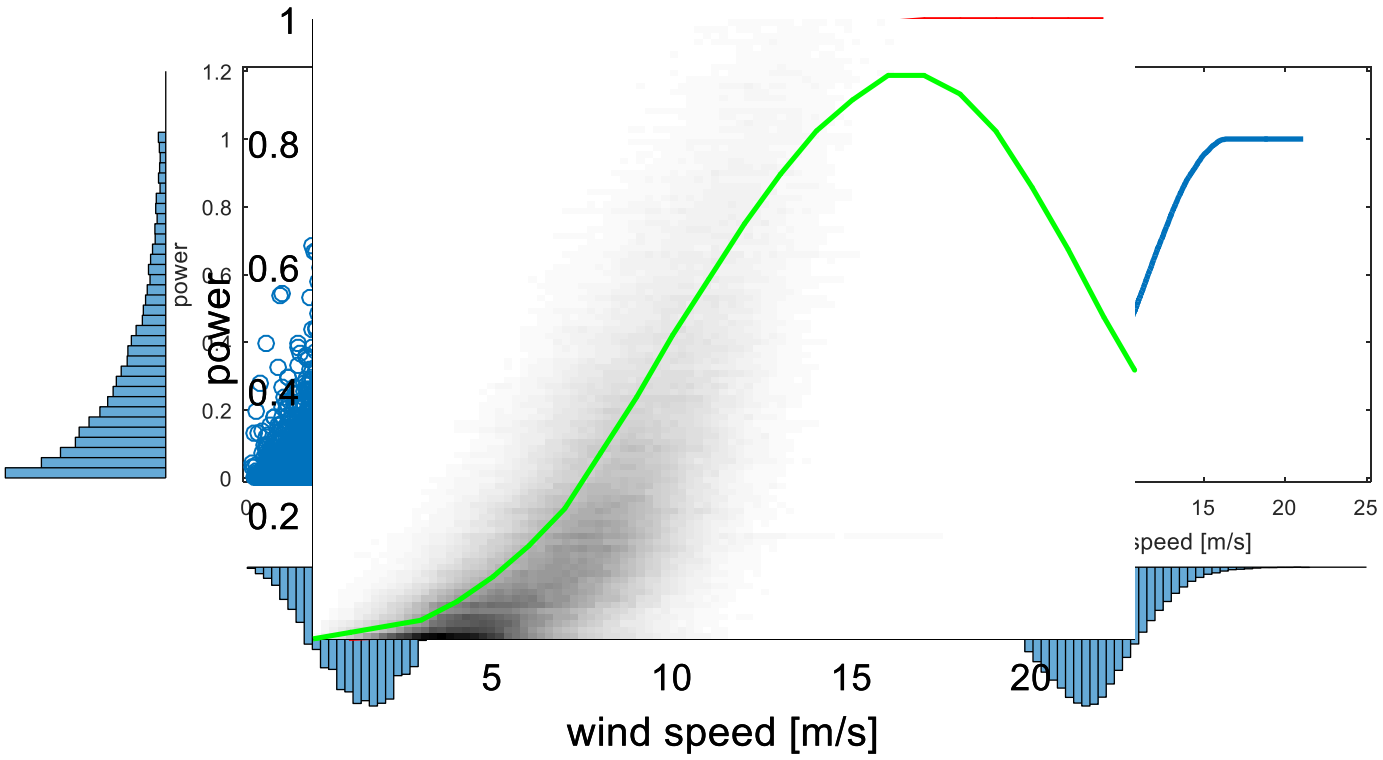
Weather data

- Day-Ahead forecast
- Model run 3 am UTC
- Wind speed at 100 m
- Data sets
  1. Uncalibrated scenarios (original)
  2. Calibrated scenarios (ECC)
  3. Dual calibrated scenarios (d-ECC)

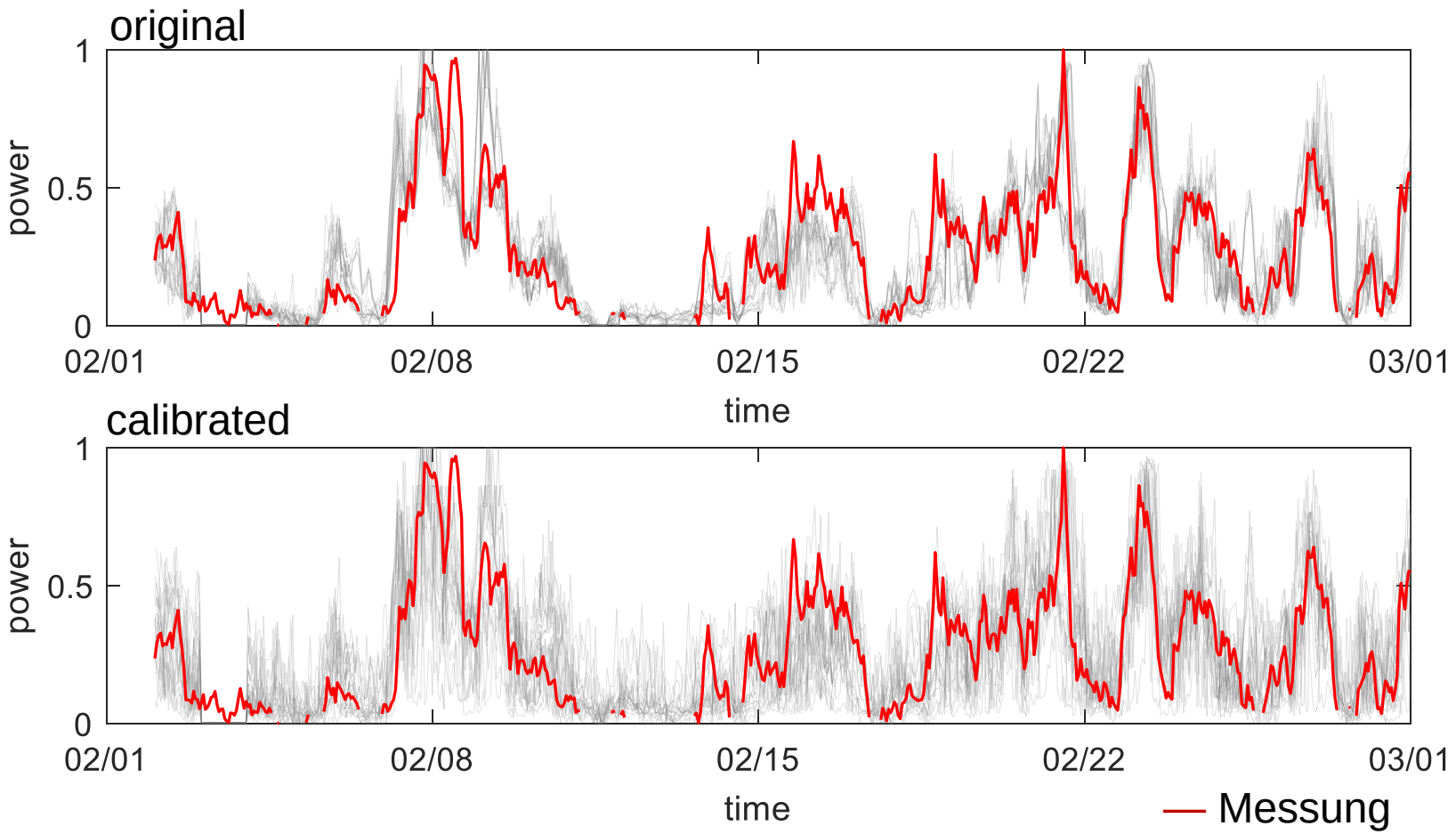


Transformation into power

- Option 1: Transformation for minimal forecast error (RMSE)
- Option 2: statistics preserving power curve
  → comonotonic copular power curve

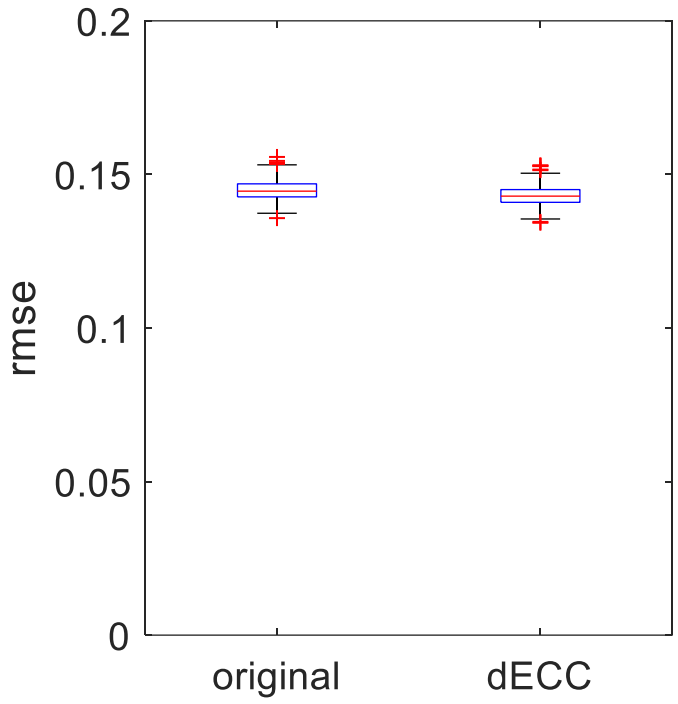


Power scenarios



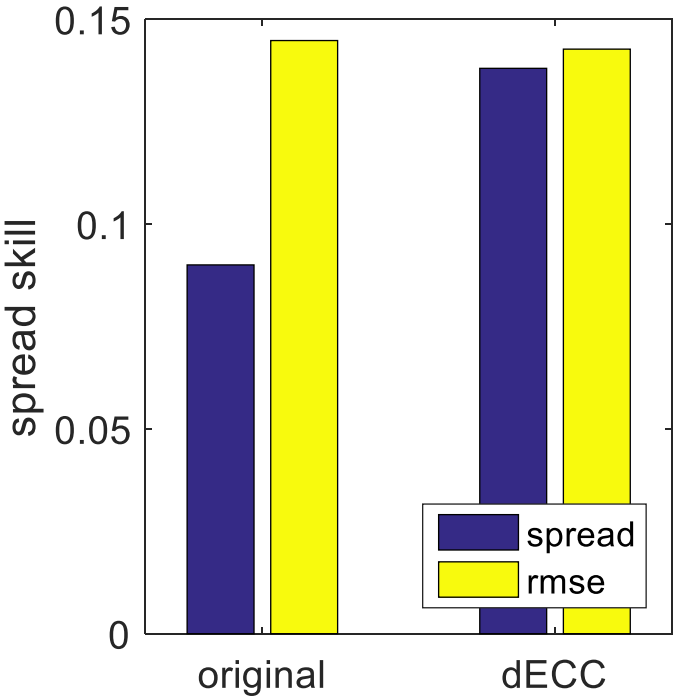
Forecast skill

- Forecast Skill does not changes



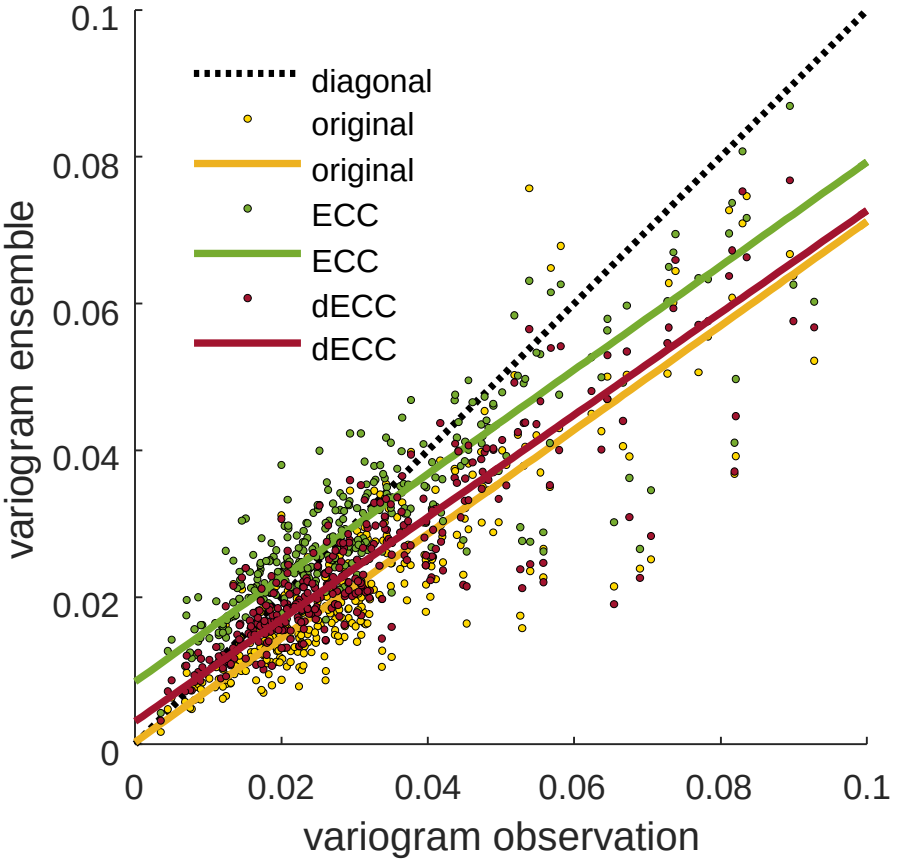
Spread Skill

- Spread and RMSE over all wind farms



Spatial relations

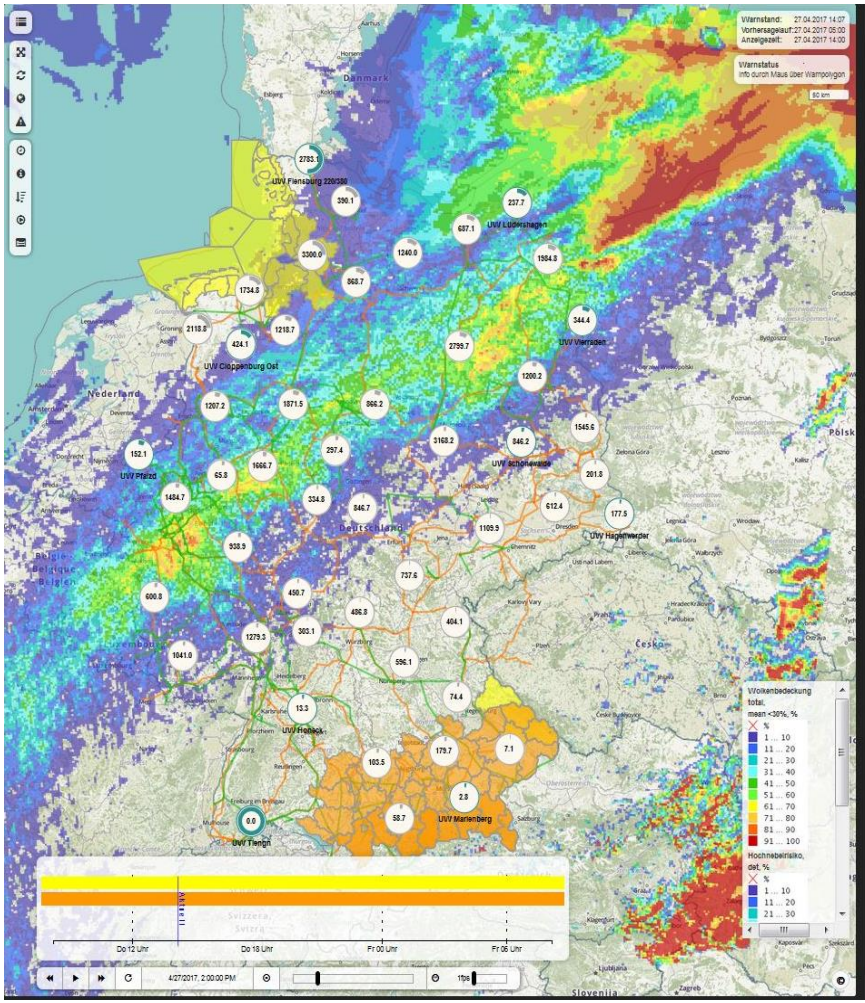
- Spatial variance between two locations
- Compare:
  variance of the ensemble wit
  variance of the observations
- Result:
  spatial relations are unchanged under dual calibration



Conclusion

- Dual calibration of the COSMO-DE-EPS
  - Spatial calibration of the NWP area
  - Calibration of the spread + preserving of the spatial correlations
- Comontonic Copular power curve
  - power curve preserves the distribution
- Results
  - The forecast quality remain the same
  - Reliable power scenarios
  - Correct spatial correlations

Thank you very much for your attention.



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