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Spatially aggregated probabilistic wind power forecasts using weather forecasting ensembles

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How to create aggregated probabilistic forecasts?

Ensemble weather forecasts better than deterministic?

Data

Data (1 year)

- Synthetic power production data
  - Wind speed measurements 10m
  - Logarithmic wind profile
  - Power curve
- Wind speed forecasts
  - ECMWF EPS
  - ECMWF EPS control member (as deterministic forecast)

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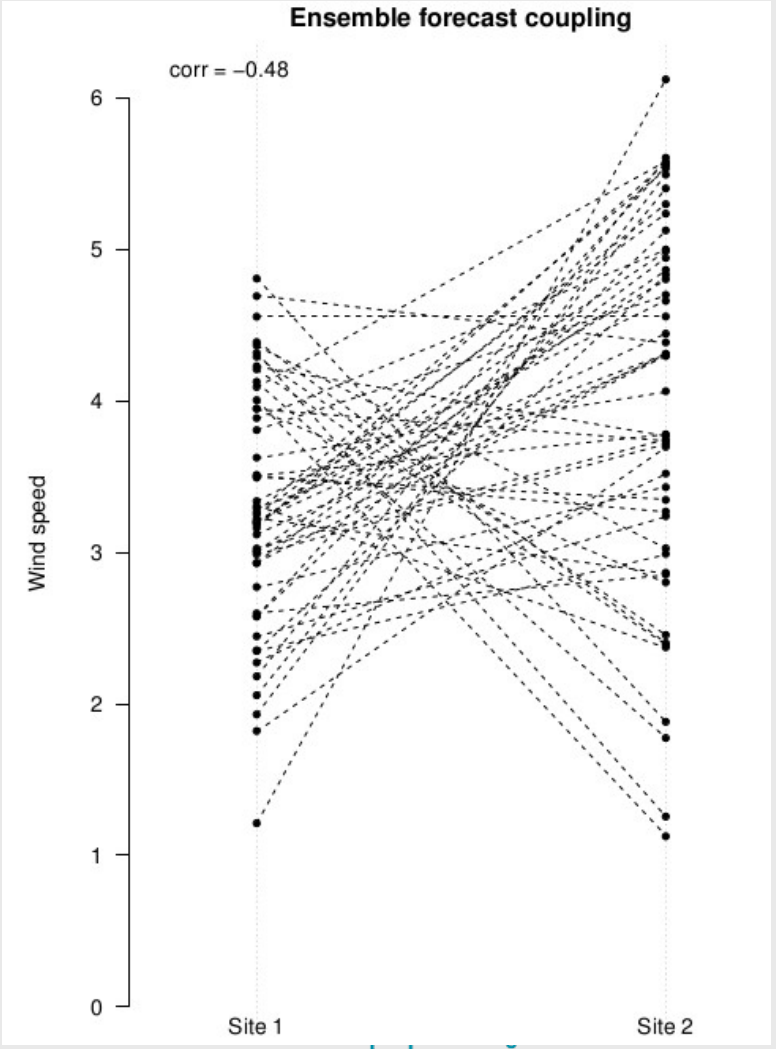
Motivation

Ensembles provide information on

- uncertainty
- stochastic dependencies in space, time and across variables
  - Time-varying spatial dependencies

Aggregated uncertainty

- Total variance = sum of site variances + covariances
- Negative covariances reduces uncertainty!



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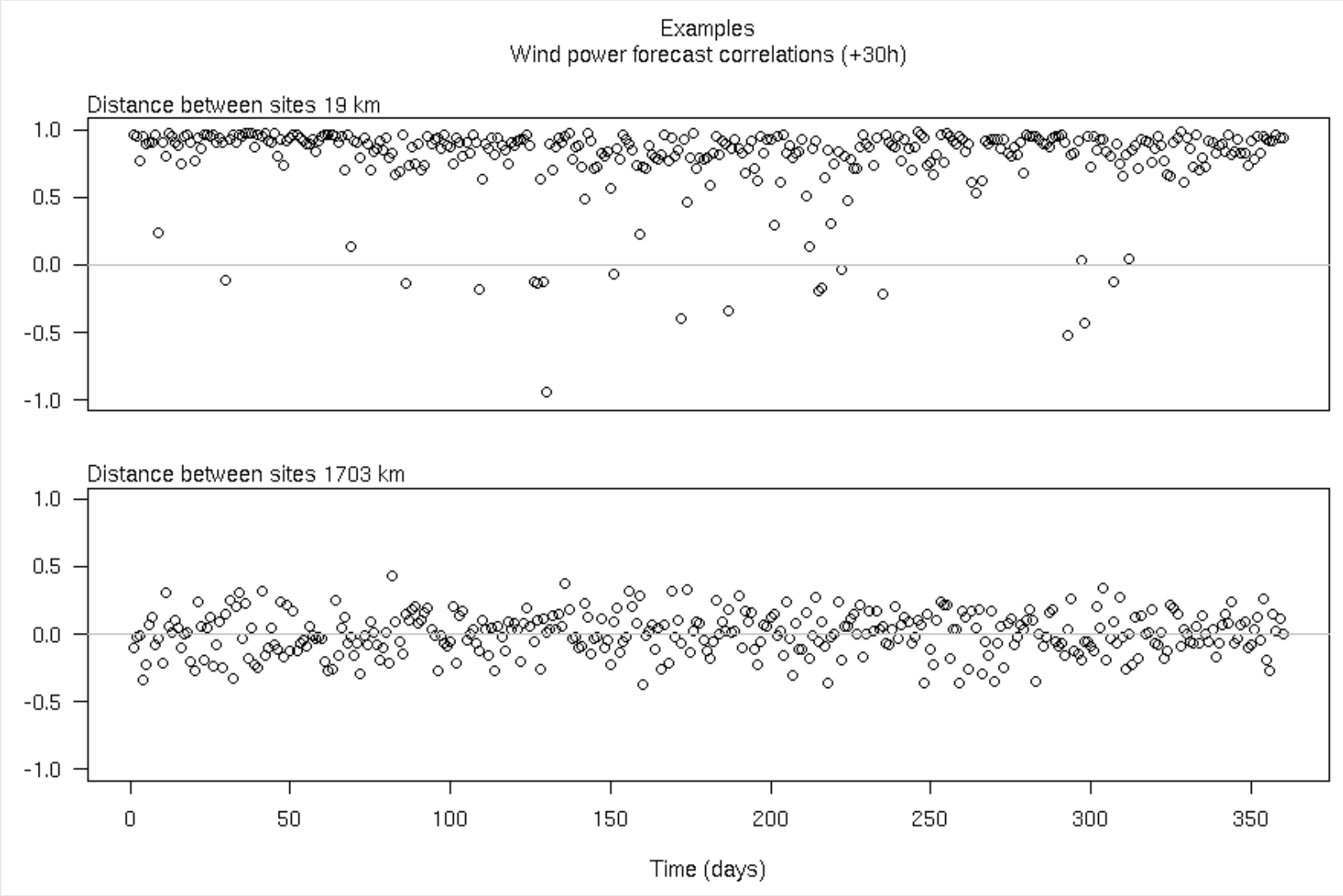

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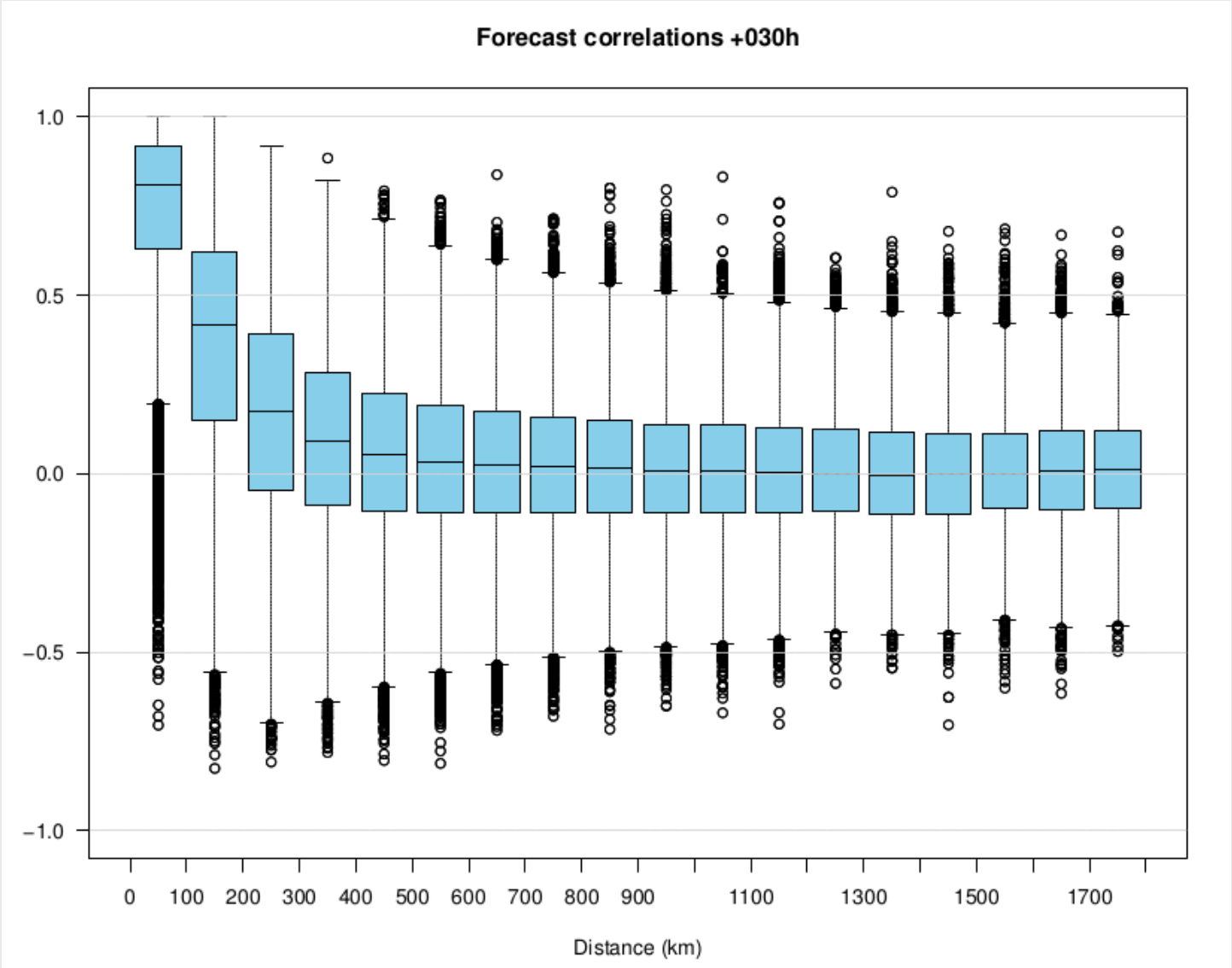

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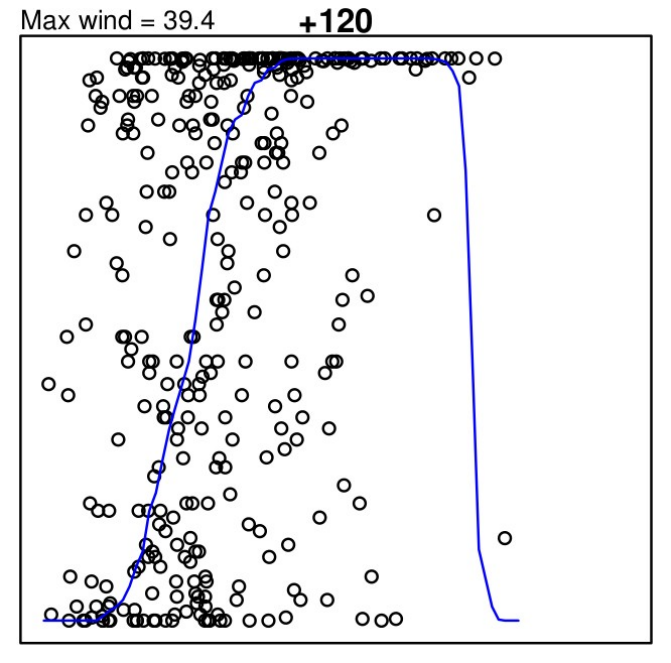
Statistical methods

Quantile mapping (QM)

- wind speed → wind power
- preserves variation
  - Regression methods don't!



Nadaraya-Watson (NW) method

- wind speed → wind power CDF
- steps
  - Assign weights to each training case
  - Compute weighted fractions of cases below threshold → CDF

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Forecasting approaches

Wind power ensemble for each site

Deterministic wind speed
- NW
- QM → NW

Ensemble wind speed
- power curve
- QM
- NW
- QM → NW

Spatial aggregation

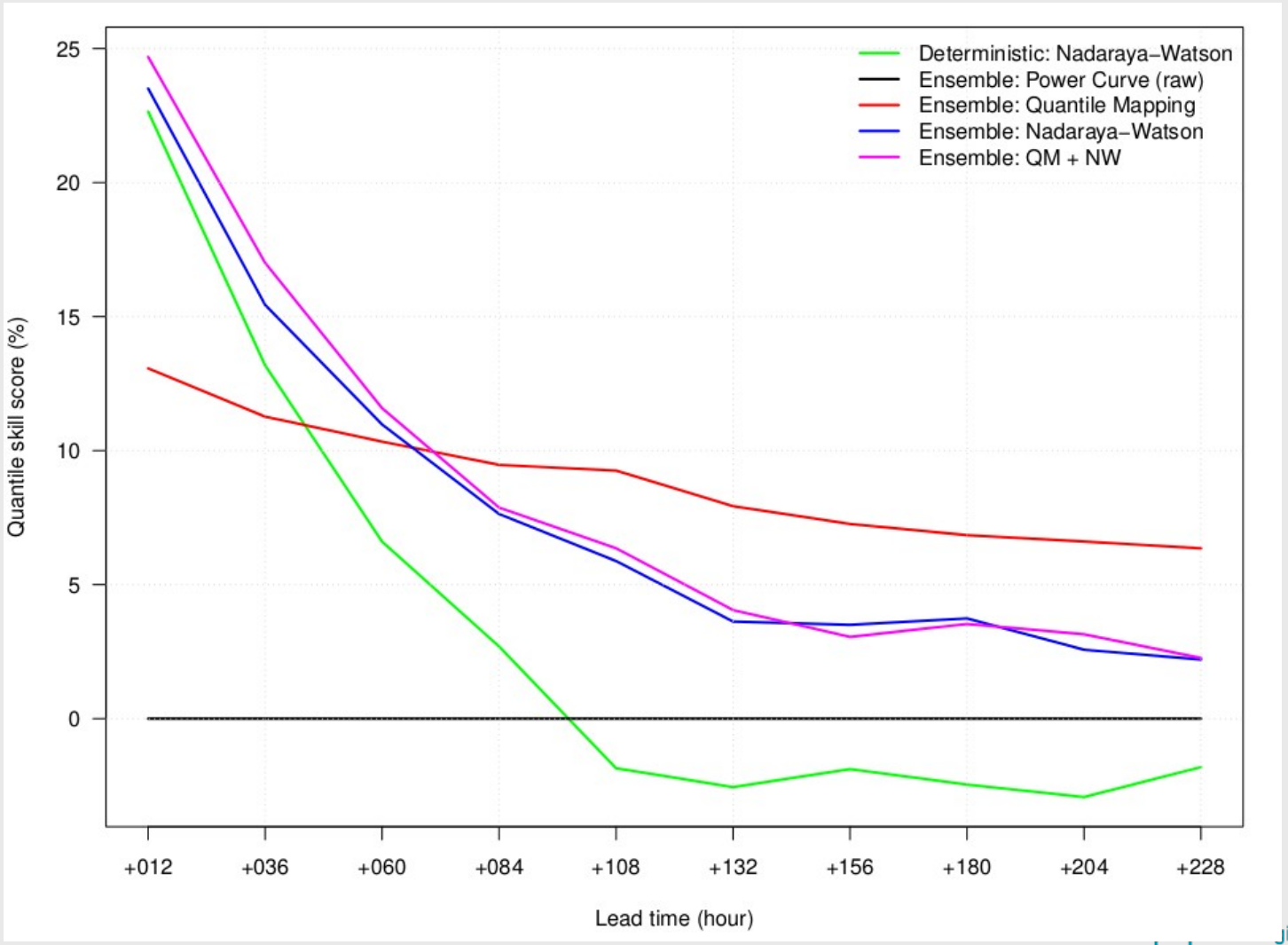
- random coupling
- historical measurement coupling
- ensemble coupling

Recalibration of aggregated forecast?

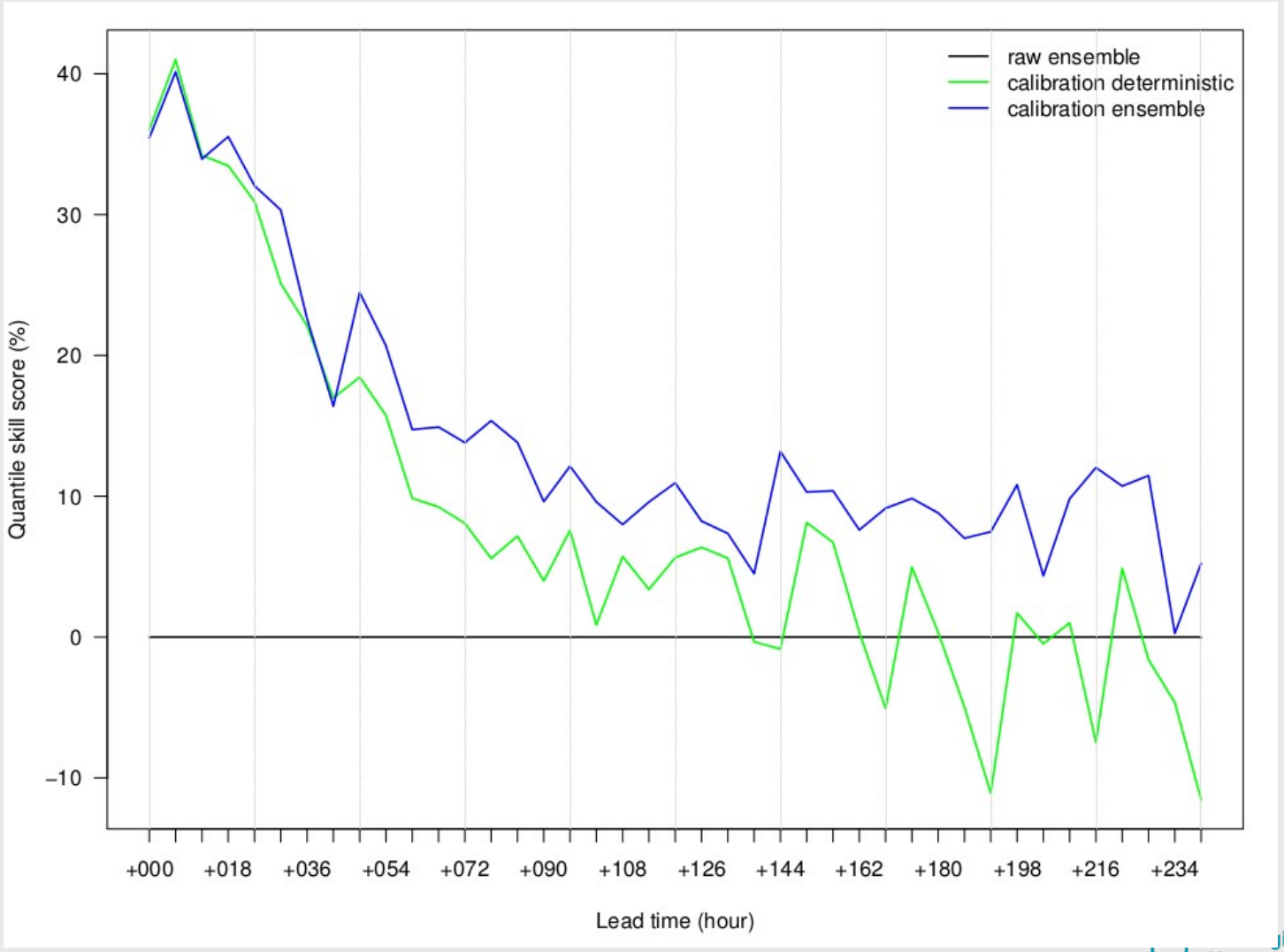
- no
- yes, NW.

Many possible combinations!

Average skill before aggregation

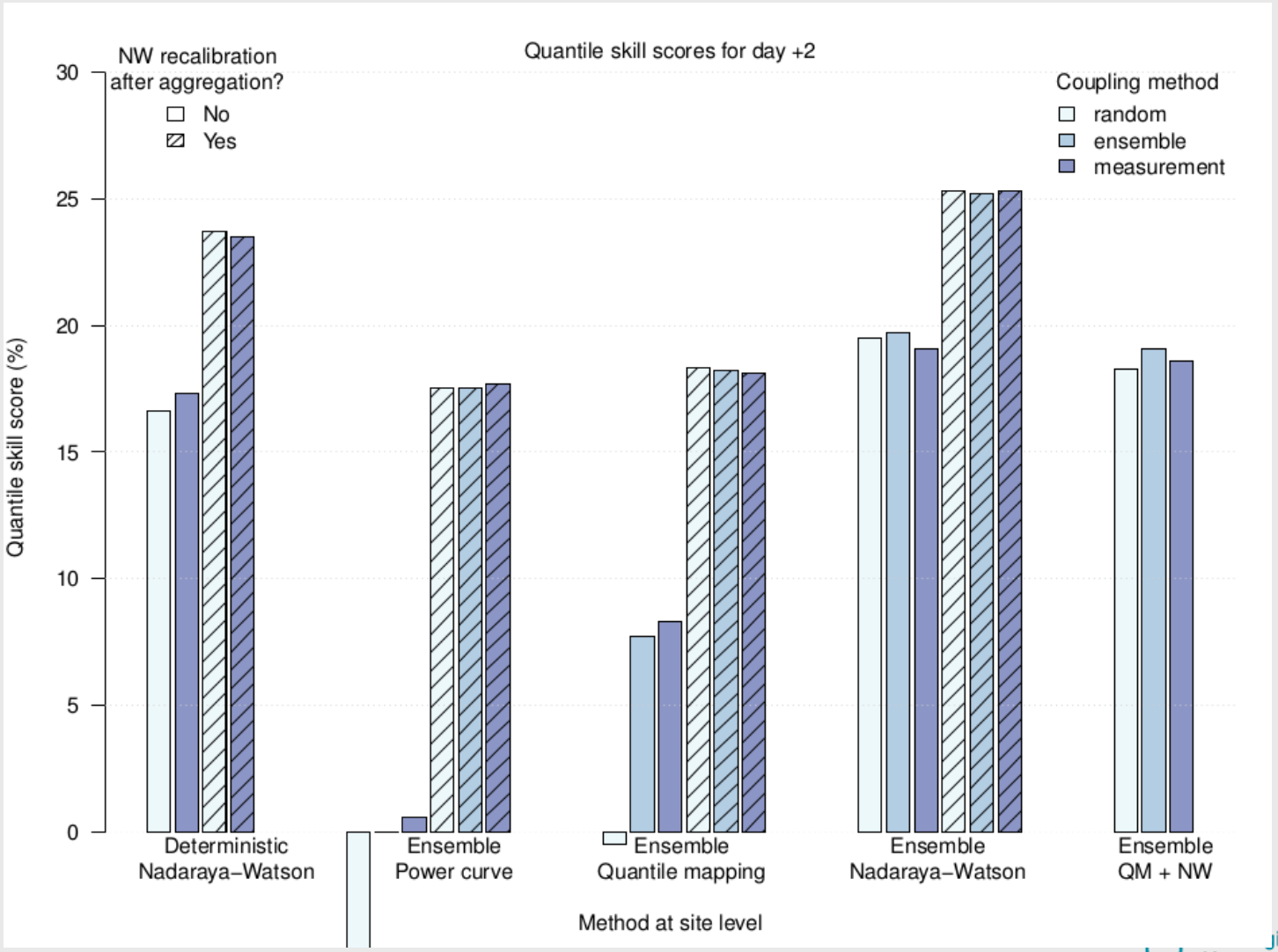


Skill after aggregation



Only the best methods are shown!

Skill after aggregation. Day +2



Concluding remarks

Ensemble weather forecasts better than deterministic

- Not so much the first days
- More due to predictive skill in ensemble mean than spatial dependencies
  - Ensemble coupling not much impact(!)

Methodology

- Statistical recalibration after aggregation important

The work is carried out under the projects

- INTREPED (Norwegian Research Council)
- ICEWIND (Nordic Top-level Research Initiative)