Accuracy of near real time updates in wind power forecasting with regard to different weather regimes

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Outline

- Study site
- Wind power forecasting - method
- Cluster analysis – method and results
- Observed power by clusters
- Forecast errors by clusters
- Conclusions
Study site

North-West-Germany single wind farms
Wind power forecast

→ data ←
observed wind power input (2004 – 2006)

→ objective ←
forecast wind power of the next 4 hours
without wind speed information from weather forecasts (Numerical Weather Prediction)

→ method ←
Neural Networks
Clustering

**data:** 500 hPa heights from ECMWF analysis data (6-hourly), Jan. 2005 – April 2007

**Principal Component Analysis (PCA)**
- reduction of data
- take as much components to have 99 % of explained variance

→ relate single clusters to points in time

**Cluster analysis**
- k-mean clustering
- separately for: 
  - *summer* (April - Sept) and
  - *winter* (Oct. - March)

### Time and Cluster Assignment

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<th>Cluster</th>
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</table>
Summer - Cluster

500 hPa level January 2005 - April 2007

Cluster No. 1  Cluster No. 2  Cluster No. 3  Cluster No. 4

Cluster No. 5  Cluster No. 6  Cluster No. 7

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Summer - Cluster

sea level January 2005 - April 2007

Cluster No. 1 Cluster No. 2 Cluster No. 3

Cluster No. 4

Cluster No. 5 Cluster No. 6 Cluster No. 7

hPa

-20 0 20 40 60

40

-20 0 20 40 60

40

-20 0 20 40 60

40

-20 0 20 40 60

40

1000 1005 1010 1015 1020 1025

hPa
Winter - Cluster

500 hPa level January 2005 - April 2007

Cluster No. 1  Cluster No. 2  Cluster No. 3  Cluster No. 4
Cluster No. 5  Cluster No. 6  Cluster No. 7

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Winter - Cluster

Sea level January 2005 - April 2007

Cluster No. 1
Cluster No. 2
Cluster No. 3
Cluster No. 4
Cluster No. 5
Cluster No. 6
Cluster No. 7

Latitude
Longitude

hPa

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Observed wind power input for different clusters

Summer

Winter

Number of cluster

Observed wind power (% inst. power)
Forecast errors (RMSE) of wind power forecasts depending on clusters - winter

- Winter cluster sea level pressure
- NN (training with three wind farms)
- NN (training with one wind farm)
- persistence

Forecast:
- one wind farm (●), 2005
- training with data of 2004

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Training within clusters
Forecast errors (RMSE) - winter

RMSE (% inst. power)

look ahead time (h)

forecast:
one wind farm (.), 2006
training with data of 2005,
separately for each cluster

persistence
NN (training with complete data)
NN (training within the single clusters)
Conclusions

• near real time updates, require: near real time wind power data
• advantage: no NWP data necessary – very actual shortest term forecasts possible
• wind power input and forecast errors depend on weather situation (clusters)
• for some clusters improvements are possible (as shown):
  • consideration of geographical distribution of the wind farms
  • training differentiation by clusters

Perspectives

• larger data set including more wind farms
• more sophisticated methods to capture spatial patterns
• apply different methods: Neural Networks, autoregressive models
• combine with model using NWP
Thank you for your attention.

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Forecast errors (RMSE) of wind power forecasts depending on clusters - summer

Forecast:
one wind farm (.), 2005
training with data of 2004

Summer cluster sea level pressure

NN (training with three wind farms)

RMSE (% inst. power)
look ahead time (h)
**Summer – Cluster**

**temporal distribution**

**occurence of each cluster (%)**

**number of cluster**

Cluster No. 1          Cluster No. 2           Cluster No. 3    Cluster No.4
Cluster No. 5         Cluster No. 6           Cluster No. 7
Winter – Cluster

Temporal distribution

Occurrence of each cluster (%)