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MCP and long term wind speed predictions

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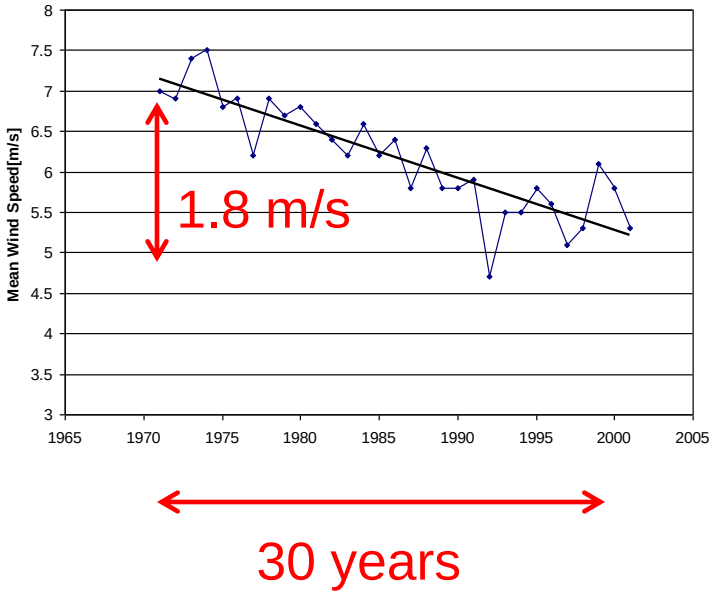
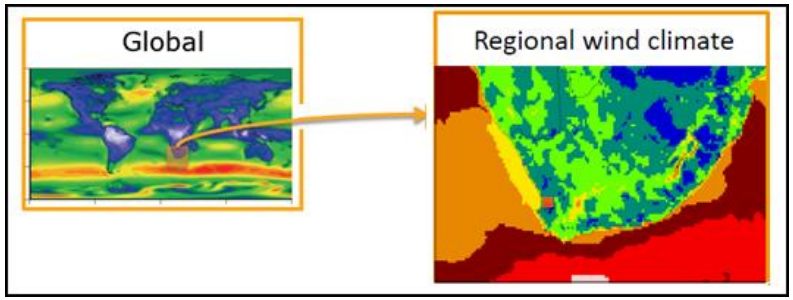
Agenda

- Long term data sources
- MCP methods (Measure- Correlate-Predict)
- Uncertainty discussion
- Conclusion

Long term data sources

1. Meteorological station
   - Change in vegetation
   - Building activity
   - Degrading instrumentation
2. Synthetic data – an alternative?
   - Reanalysis/Mesoscale
   - Spatial resolution
   - Temporal resolution
   - Mast height and wind speed





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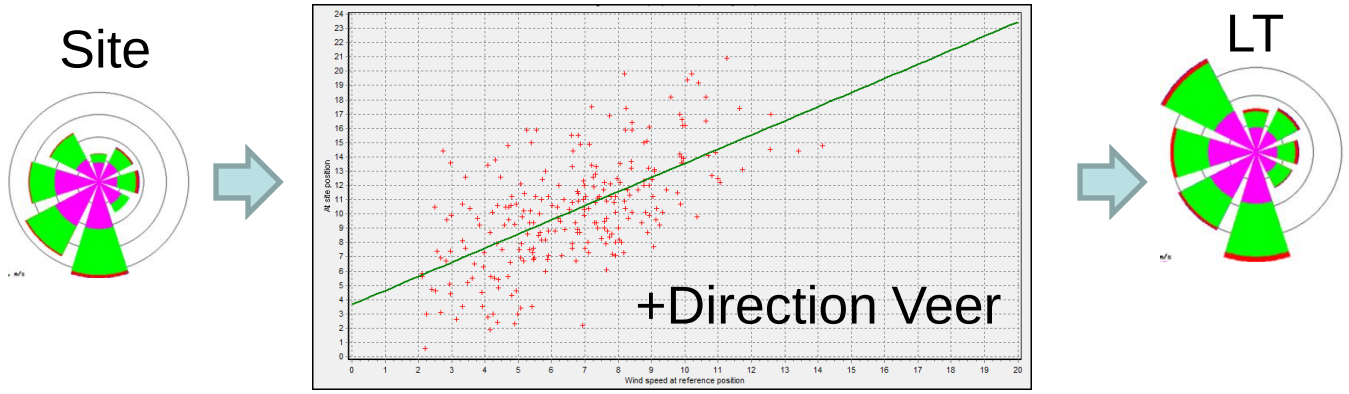
MCP, Linear Regression Family

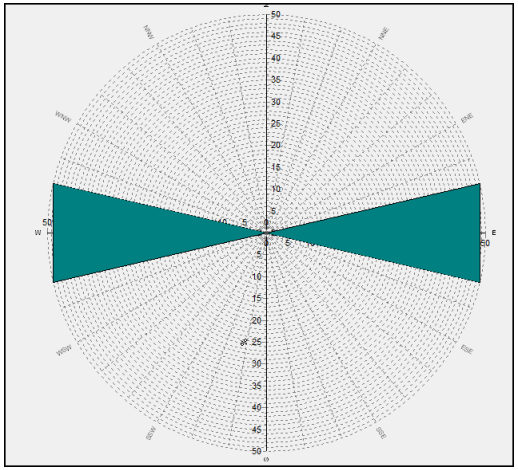


- Create artificial time series based on sectorwise linear link between V_{ST} and V_{LT}
- On-site wind direction distribution modified (Veer)
- Method in different variants using, orthogonal regression, residual models, wind speed filtering
- Not suitable for time averaging, requires a good correlation on a high frequent time scale ($\leq$hourly)

More details: http://www.res-group.com/resources/download-area.aspx

Time averaging, illustration

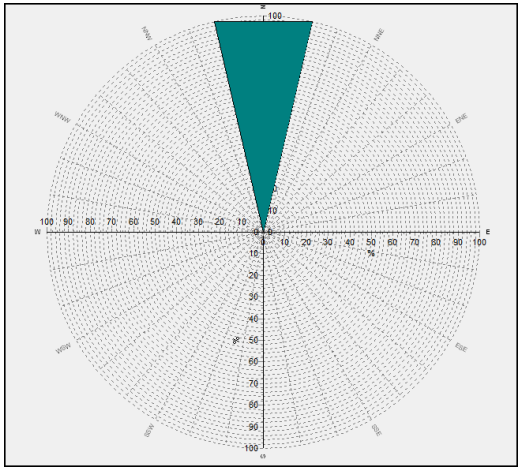
Diurnal variation



2 m/s 50%

6 m/s 50%

Average value



4 m/s 100 %

- Average wind speed is by defalt OK, Layout orientation wrong
- Energy density more sensitive to direction distribution lowered 60 %

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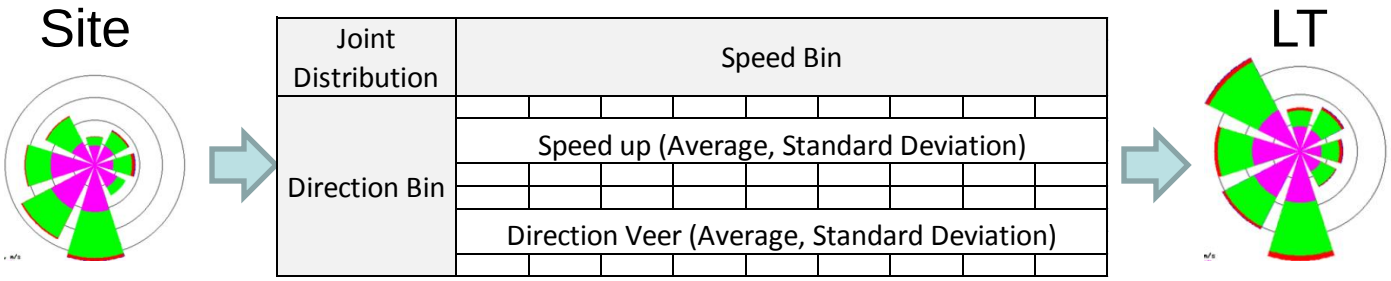
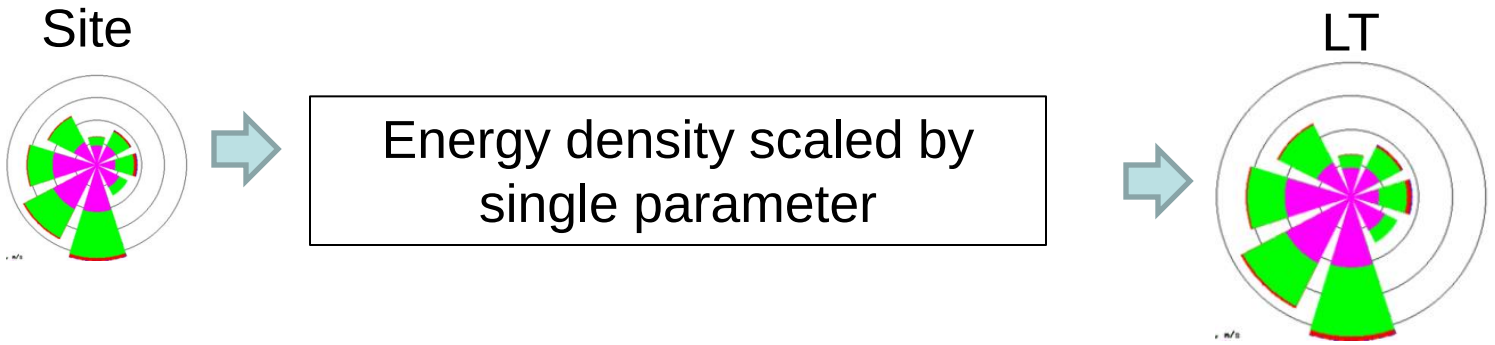
MCP, Matrix Method



- Creation of joint probability distribution between LT- data and Site-data (Speed up, Veer)
- On-site wind direction distribution modified
- Not suitable for time averaging, requires a good correlation on a high frequent time scale (≤hourly)

More details: http://www.res-group.com/resources/download-area.aspx

MCP, Wind Index (Energy Index)



- Converting wind speed into energy through application of a simplified power curve and comparing E_{LT} with E_{ST}
- On-site wind rose scaled by single parameter
- On-site wind direction distribution not modified
- Suitable for time averaging, typically on a monthly scale

More details: see WindPRO handbook

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Uncertainty, RES

- Uncertainty Wind Speed ⇨ Production Uncertainty
- Bootstrap on 106 mast data with varying measurement periods, typically 1Year of data
- Matrix method recommended and used for calculations
- Number of concurrent hours (years) used as uncertainty driver
- Wind Speed Prediction Uncertainty(%)
  375 /sqrt(# concurrent hours) = 4/sqrt(# concurrent years)
- Prod. Uncertainty(%), extracted by Suzlon
  1.96*Wind Speed Prediction Uncertainty (%) = 7.8/sqrt(concurrent Years)

Source:RES MCP Errors, 28 January 2005

Uncertainty Suzlon

- Uncertainty Energy Density ⇨ Production Uncertainty
- Modelled and measured uncertainties correlated, R>0.8
  - 6 globally spread quality masts with 7-19 years of data
  - Re-analysis data and Mesoscale used as LT-data
  - MCP using linear correlation, Wind Index and Site data
- Four drivers influence the Wind Energy Density Uncertainty
  - Hourly Pearson (the strongest driver)
  - Wind Speed Index
  - Number of concurrent years
  - Variability (the weakest one)

Uncertainty, Suzlon, Example

Suzlon Energy Ltd.

- Production uncertainty varying Pearson and wind speed index
- Recommended MCP method driver dependend (colour scale)

Production Uncertainty	Pearson-Hourly					
Wind Speed Index	0.4	0.5	0.6	0.7	0.8	0.9
90%	11.5%	10.3%	9.5%	9.0%	8.5%	8.1%
92%	10.7%	9.4%	8.5%	7.9%	7.3%	6.9%
94%	9.5%	8.6%	7.6%	6.9%	6.3%	5.8%
96%	8.1%	8.0%	7.0%	6.2%	5.4%	4.9%
98%	7.2%	7.2%	6.5%	5.7%	4.8%	4.2%
100%	6.8%	6.8%	6.3%	5.5%	4.6%	4.0%
102%	7.2%	7.2%	6.5%	5.7%	4.8%	4.2%
104%	8.1%	8.0%	7.0%	6.2%	5.4%	4.9%
106%	9.5%	8.6%	7.6%	6.9%	6.3%	5.8%
108%	10.7%	9.4%	8.5%	7.9%	7.3%	6.9%
110%	11.5%	10.3%	9.5%	9.0%	8.5%	8.1%
Best MCP method						
Site data	Wind Index	Wind Index/Linear Correlation		Linear Correlation		

1 concurrent year, Pearson -Monthly >0.8,Variability =6%, Mast Weibull V=7.1m/s, Weibull k=2

Suzlon model presented at Vindkraftnet meeting Fredericia 31/5 2013

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Conclusion

- Energy Density seems to be a better uncertainty indicator than wind speed.
- Four main drivers identified for uncertainty estimates
- Recommended MCP method depends on drivers
- Uncertainties above 10% on Production Estimates possible ☹
- Linear correlation method is often biased at low Pearson values
- Update with more masts, including Matrix method next time
- Is the all sector wind speed sensitive enough for LT quality evaluations?

Thank You


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