

WIND DATA SUITE Presentations

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Multiple Synoptic Scale Correlate Predict MSSCP.

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<https://www.WindDataSuite.de/wds/publics/WDS-Present20171017-DrHF-MSSCP.pdf>

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*Multiple Synoptic Scale
Correlate Predict
MSSCP*

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2.1 The frequency domain of time series

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1. Introduction

Several MCP (**M**easure **C**orrelate **P**redict) methods exist already.

Every MCP method is more or less erroneous.

No evidence for any principles of using different algorithms situational.

Solution: Capturing the physical processes which are essential for the MCP.

Focus in the following: MCP methods based on the linear regression model with vertical distances.

2. Theoretical background of MSSCP

2.1 The frequency domain of time series

Resolving those physical processes, whose variances contribute to a great extent to the total variance of the time series.

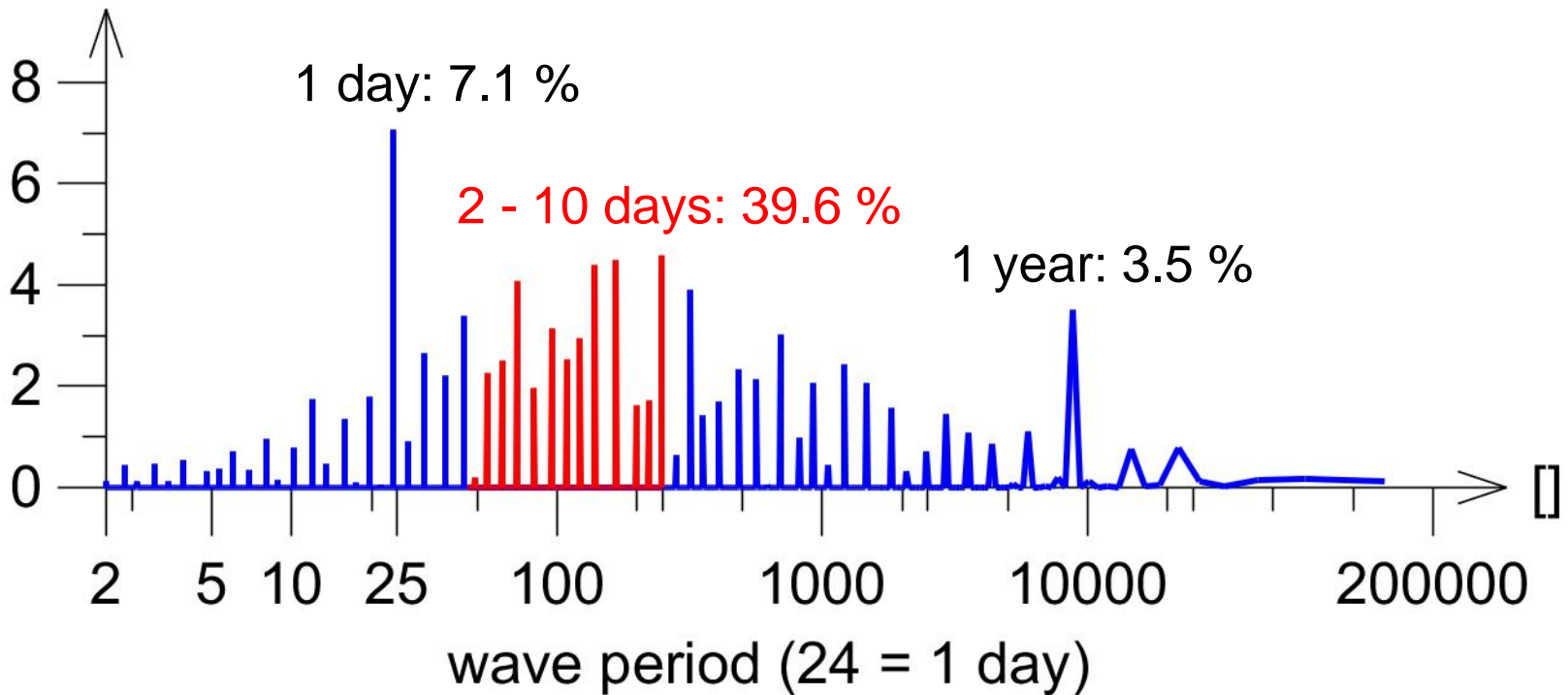
Detection of those processes by converting the time series into the frequency domain of its Fourier Transform.

2.1 continued

Fig.1

Schwerin - declaring variances of wind speed frequencies

Decl.Variance-v [%]



2.2 Resolving the synoptic scale processes

The u- and v-components of the horizontal wind velocity will be calculated directly from the wind speeds and wind directions of the wind measurement.

The time derivatives $\frac{\partial u}{\partial t}$ and $\frac{\partial v}{\partial t}$ of the u- and v-components will be calculated with a forward-time differencing scheme.

Due to the Navier-Stokes equations, $\frac{\partial u}{\partial t}$ and $\frac{\partial v}{\partial t}$ describe the entire wind field dynamics.

2.2 continued

Digitally low-pass filtering u and v of the wind measurement.

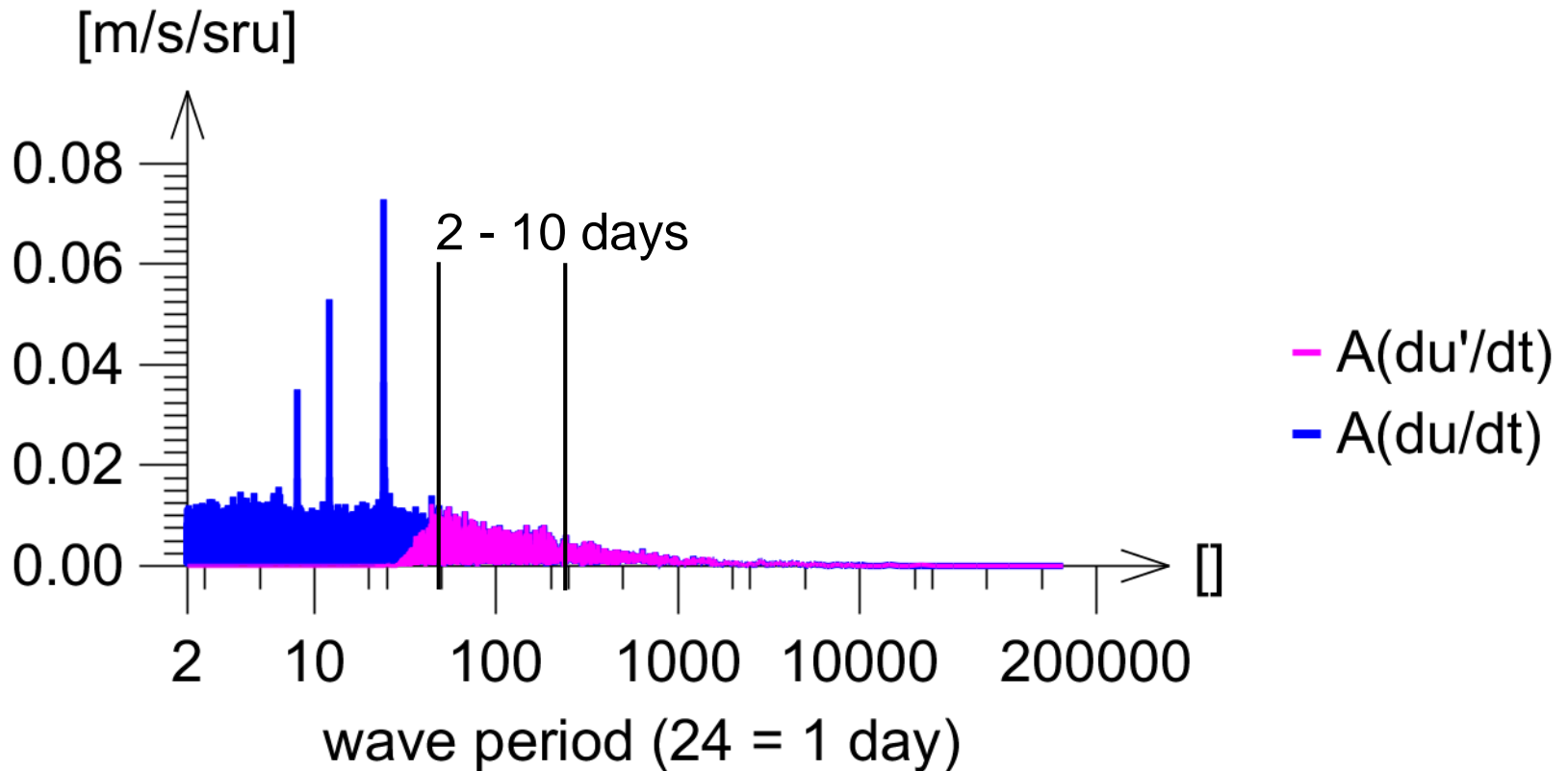
This is equivalent to neglecting all processes in the Navier-Stokes equations which yield the high frequency wave signals with periods less than the specified cut-off period of the digital low-pass filter.

The processes according to the quasi-geostrophic equations will be represented now better by far by the remaining lower frequency signals.

2.2 continued

Fig.2

Schwerin - amplitude spectrum du/dt and du'/dt



2.2 continued

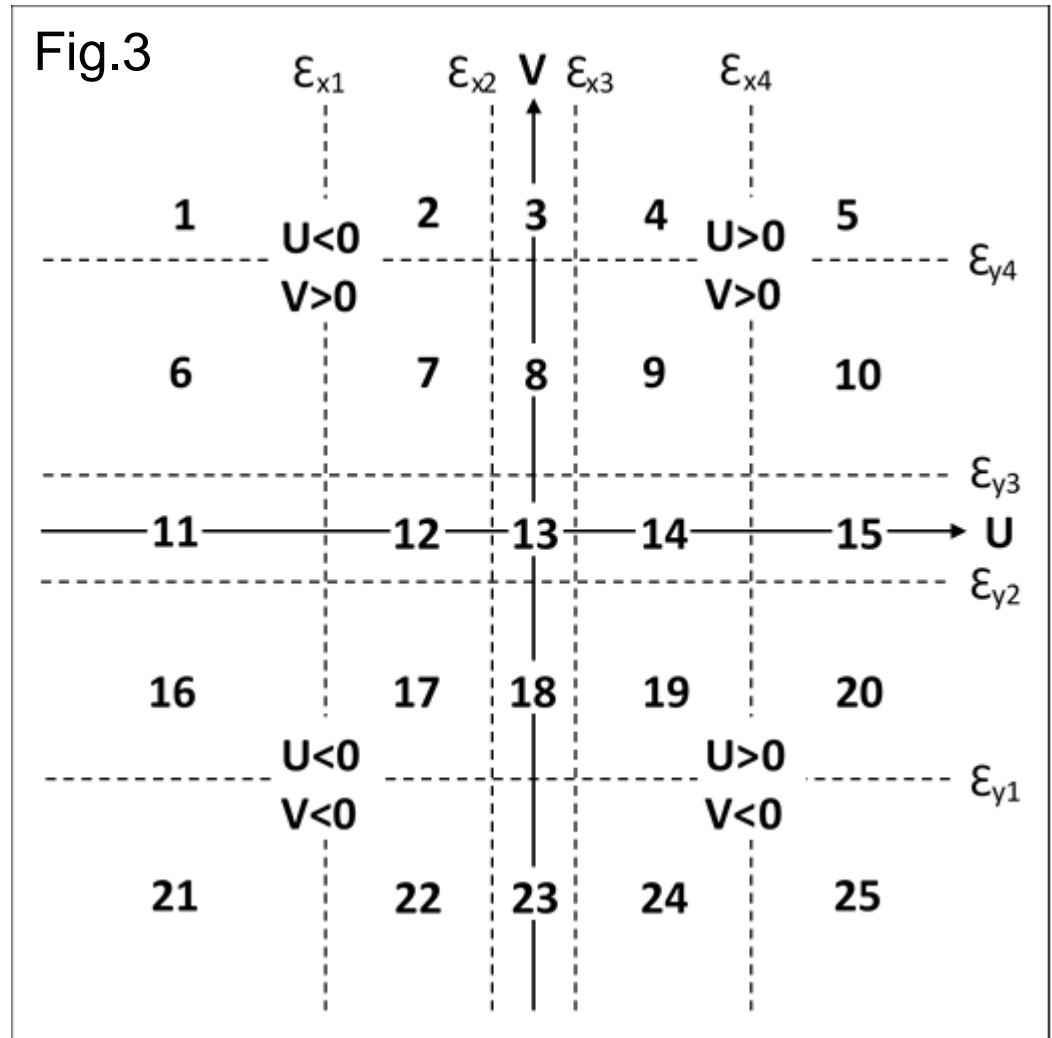
Building "synoptic scale clusters" from the low-pass filtered time derivatives

$$U = \partial u' / \partial t \text{ and}$$

$$V = \partial v' / \partial t$$

in form of a $M \times M$ matrix. Number of clusters $N_{SSC} = M^2$.

Example: $M = 5$:



3. The MSSCP method

MSSCP calculates a set of linear regressions for the wind speeds.

The extrapolations are sampled in the 6-dimensional matrix

$$A^6 = \{H \times R \times C \times SRef \times VC \times SWP\}.$$

$H(i=1, \dots, I)$: selected measurement heights

$R(j=1, \dots, J)$: reference stations to be used

$C(k=1, \dots, K)$: synoptic scale clusters

$SRef(l=1, \dots, L)$: wind direction sectors of Ref

$VC(m=1, \dots, M)$: wind speed classes

$SWP(n=1, \dots, N)$: wind direction sectors of WP

3. continued

For each element in the 4-dimensional matrix $A^4 = \{H \times R \times C \times SRef\}$, the optimal phase shift between the short-term wind speed data of the wind park and the reference station will be determined separately.

For each element in the 5-dimensional matrix $A^5 = \{H \times R \times C \times SRef \times VC\}$, the regression parameters will be calculated separately.

Multiple reference stations will be combined.

4. MSSCP validation

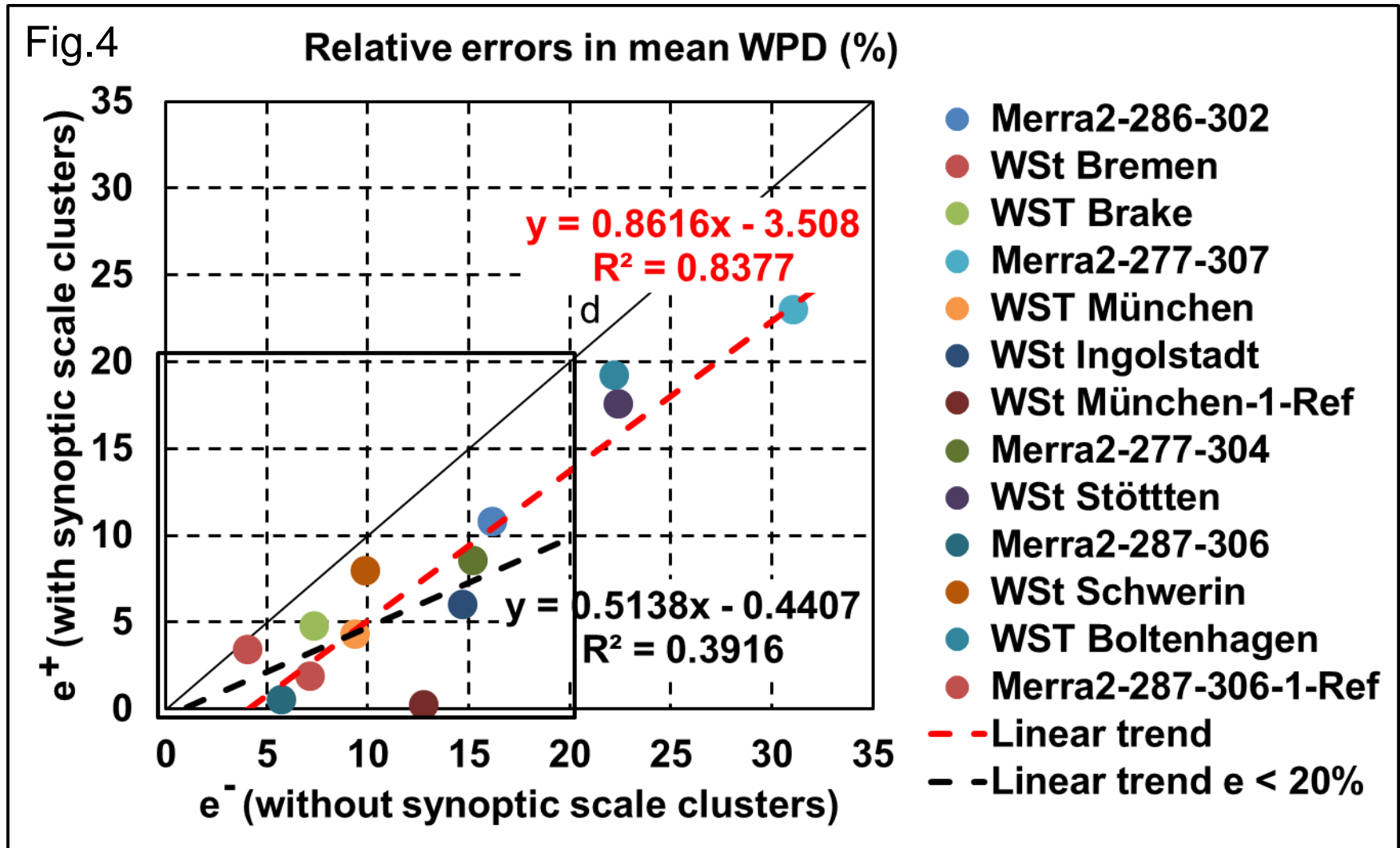
4.1 Hindcasts and used data

Long-term time series data of

- DWD (Deutscher Wetterdienst) weather stations ("WSt" in the following)
- Long-term reanalysis data of respective nearby located MERRA-2 (Modern Era Retrospective-analysis for Research and Analysis - Version 2) points.

All data have a temporal resolution of 1 hour.

4.2 Results



5. Conclusions

- By incorporating so called "synoptic scale clusters" into the regression analysis, MSSCP improves the results of long-term extrapolations to a great extent.
- Several hindcasts have been performed yielding an error reduction in the extrapolated wind power densities of approximately fifty percent on average.

Thank you for your attention!