Statistical meandering wake model
and its application to
yaw-angle optimisation of wind farms

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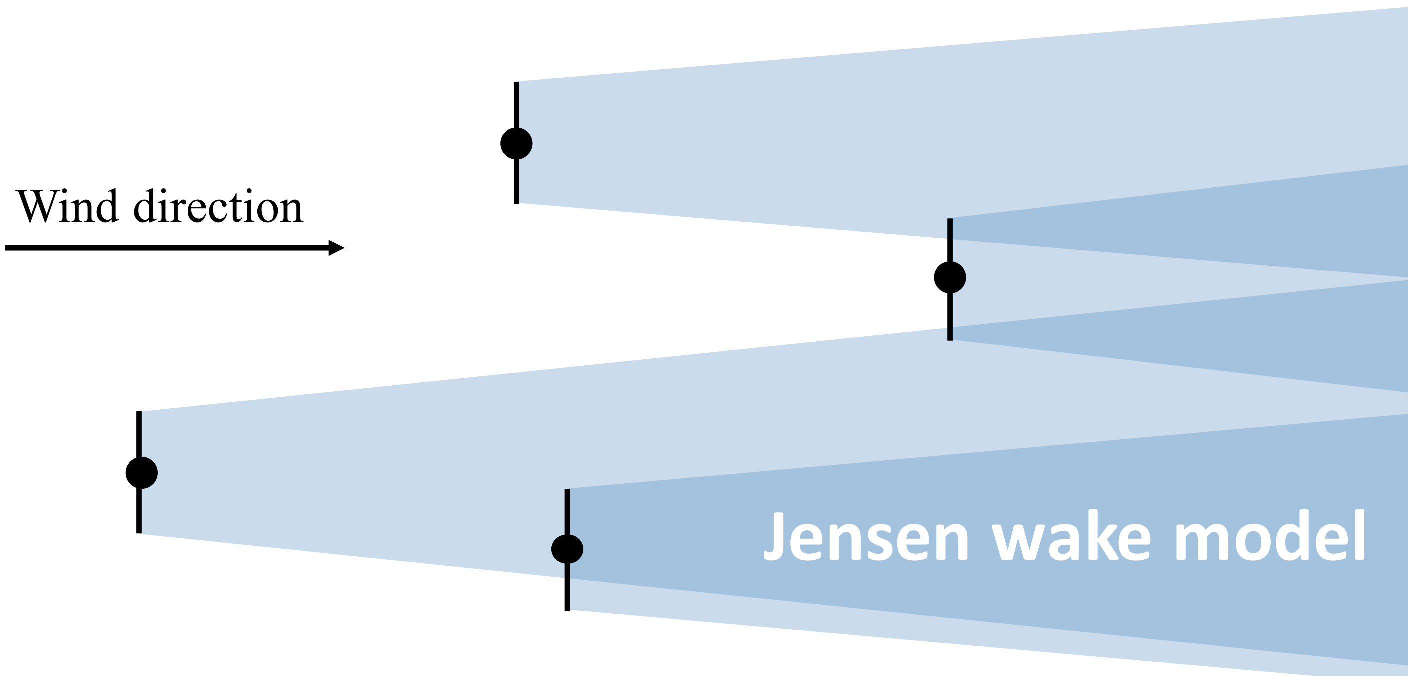

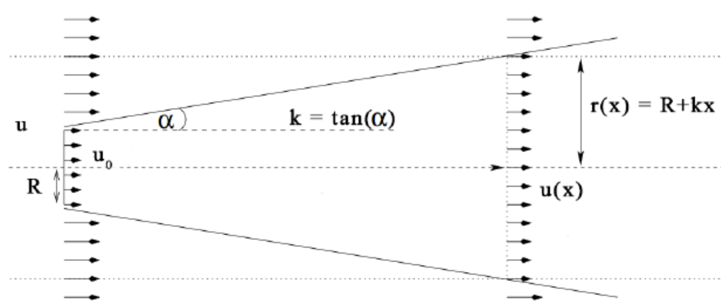

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Statistical meandering wake model
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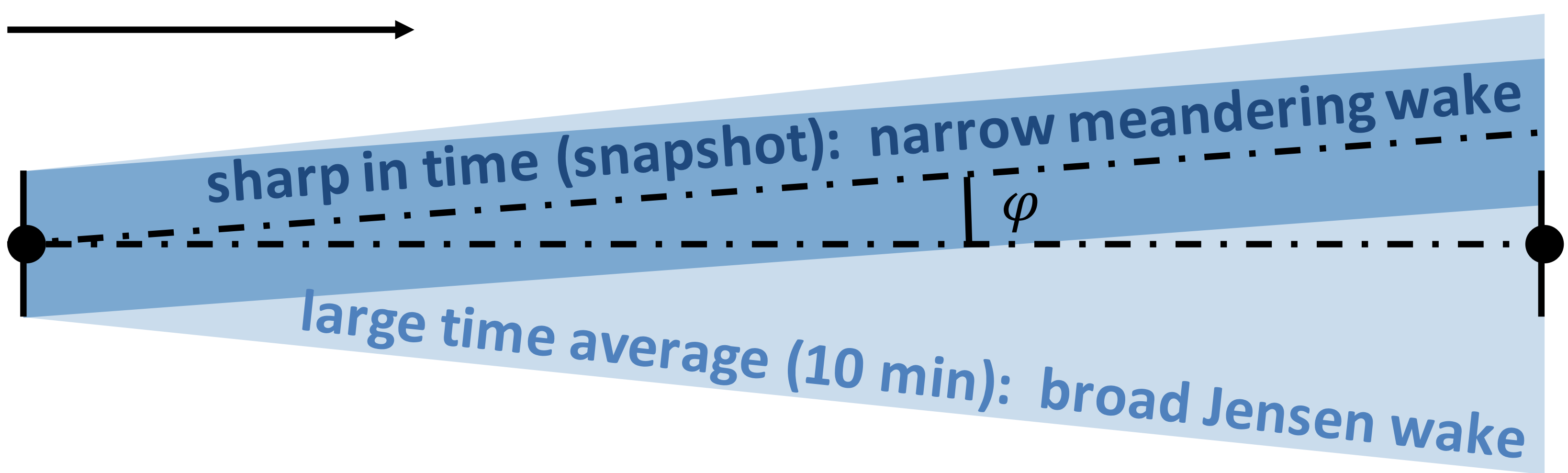
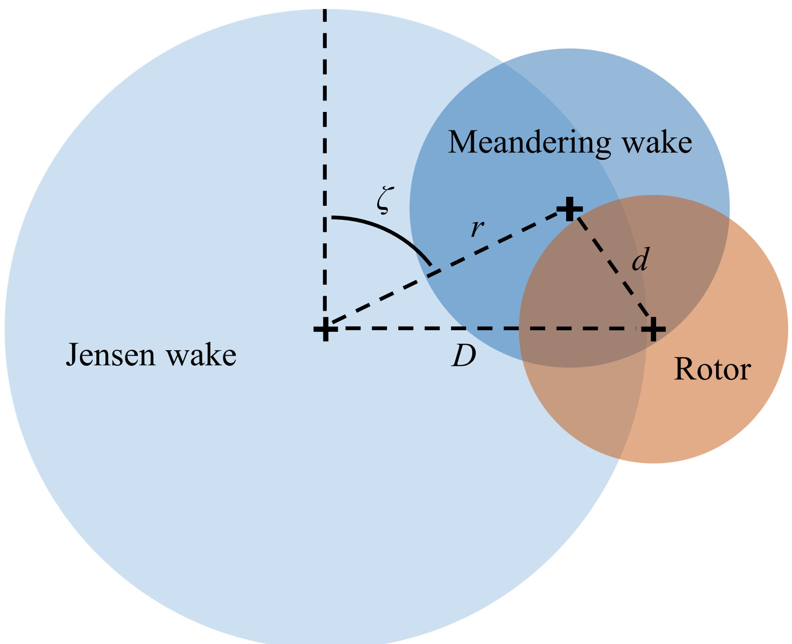
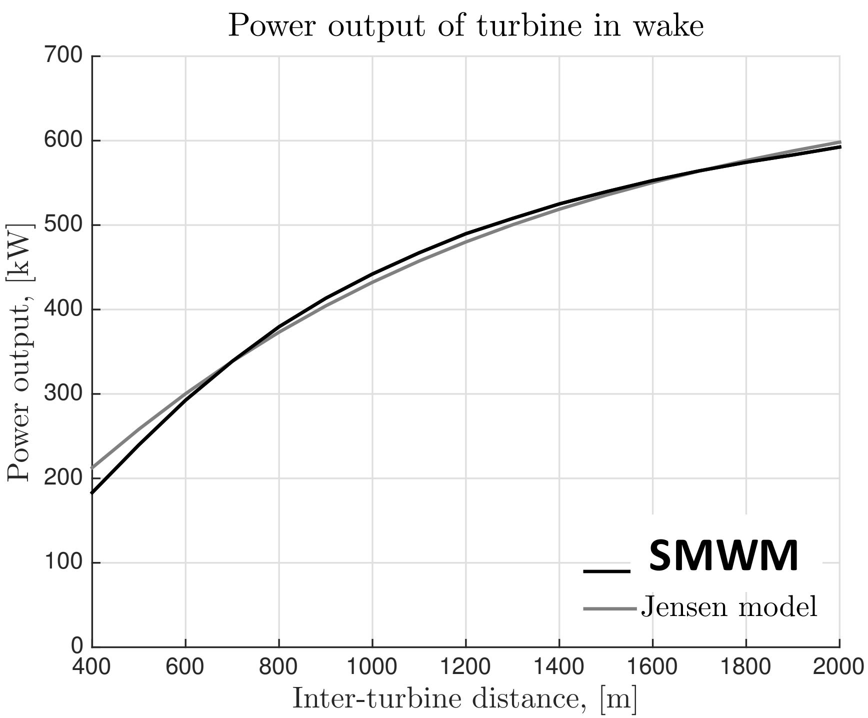


**how good is
an engineering-model-based wind-farm optimisation
facing multiple meandering dynamics ???**

Statistical meandering wake model

(two-turbine calibration)





0.04 0.0001

$k_{Jensen} \gg k_{meander}$

$0 \leq \zeta \leq 2\pi$

$r = x \tan\varphi$

$p(\varphi \geq 0) = N(\mu,\sigma) + N(-\mu,\sigma)$

$\mu = \arctan k_{Jensen}$

$\sigma = 1.65\,\mu$

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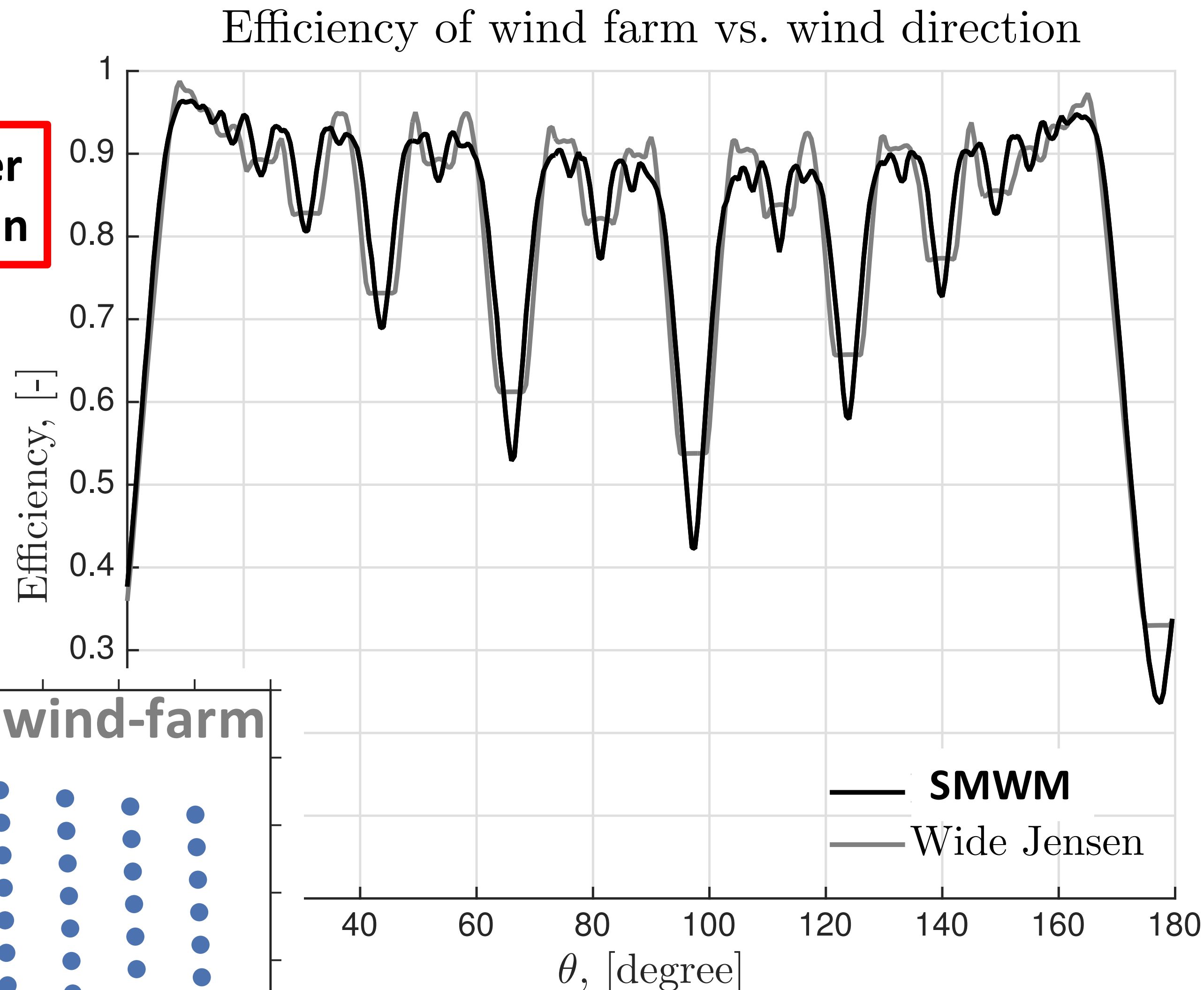
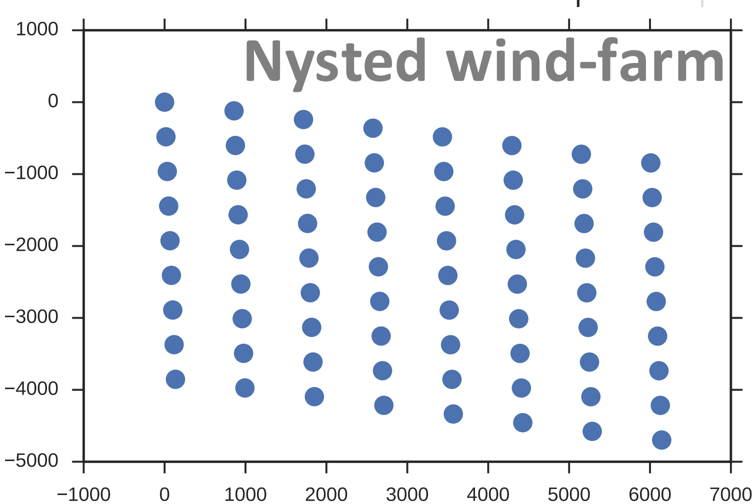
Statistical meandering wake model

No further calibration





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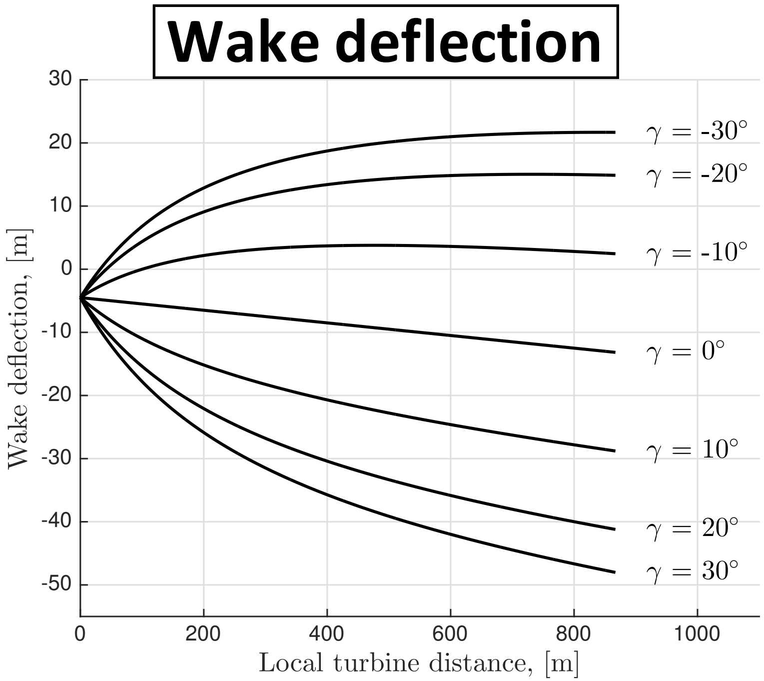
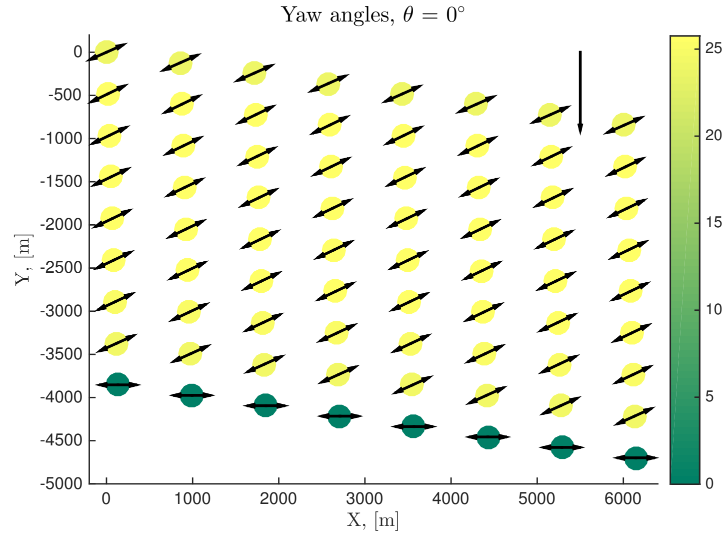
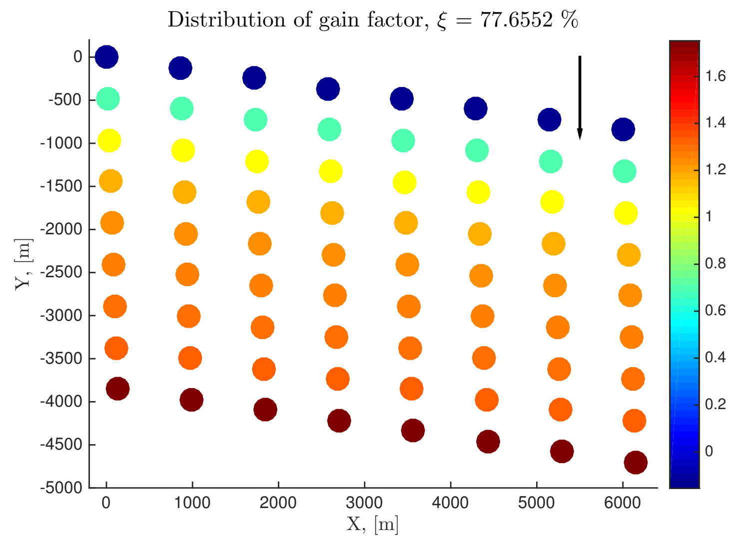
Yaw-angle optimisation of wind farms

(based on Jensen model)



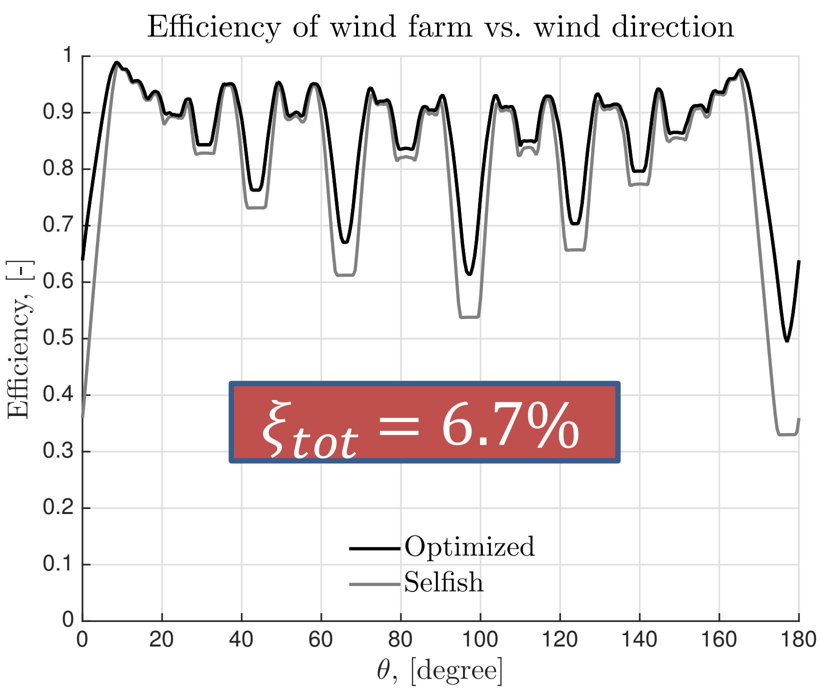
P.M.O. Gebraad et.al.,
Wind Energy 19 (2016) 95-114.



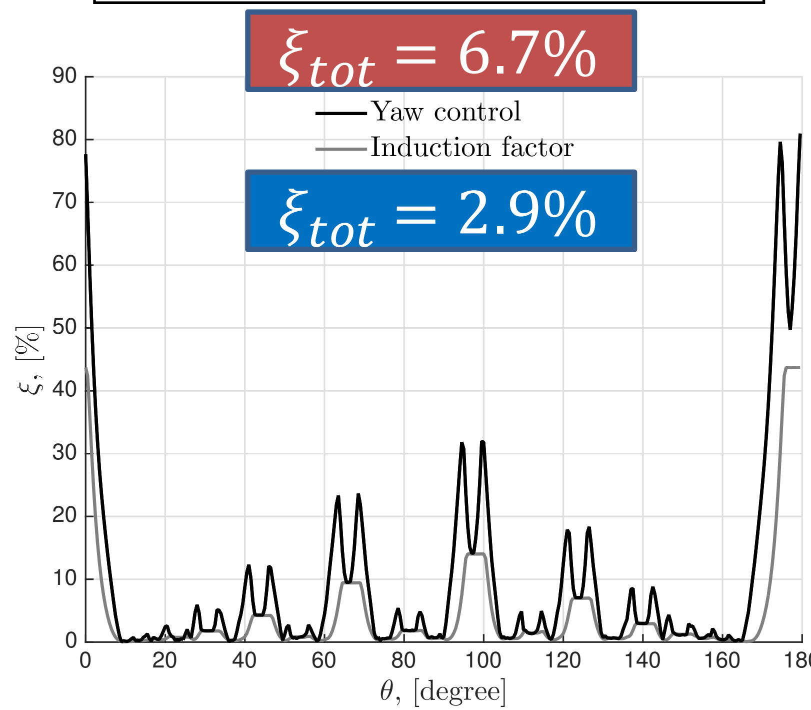


Yaw-angle optimisation of wind farms
(based on Jensen model)

yaw optimisation



yaw vs. induction factor optimisation



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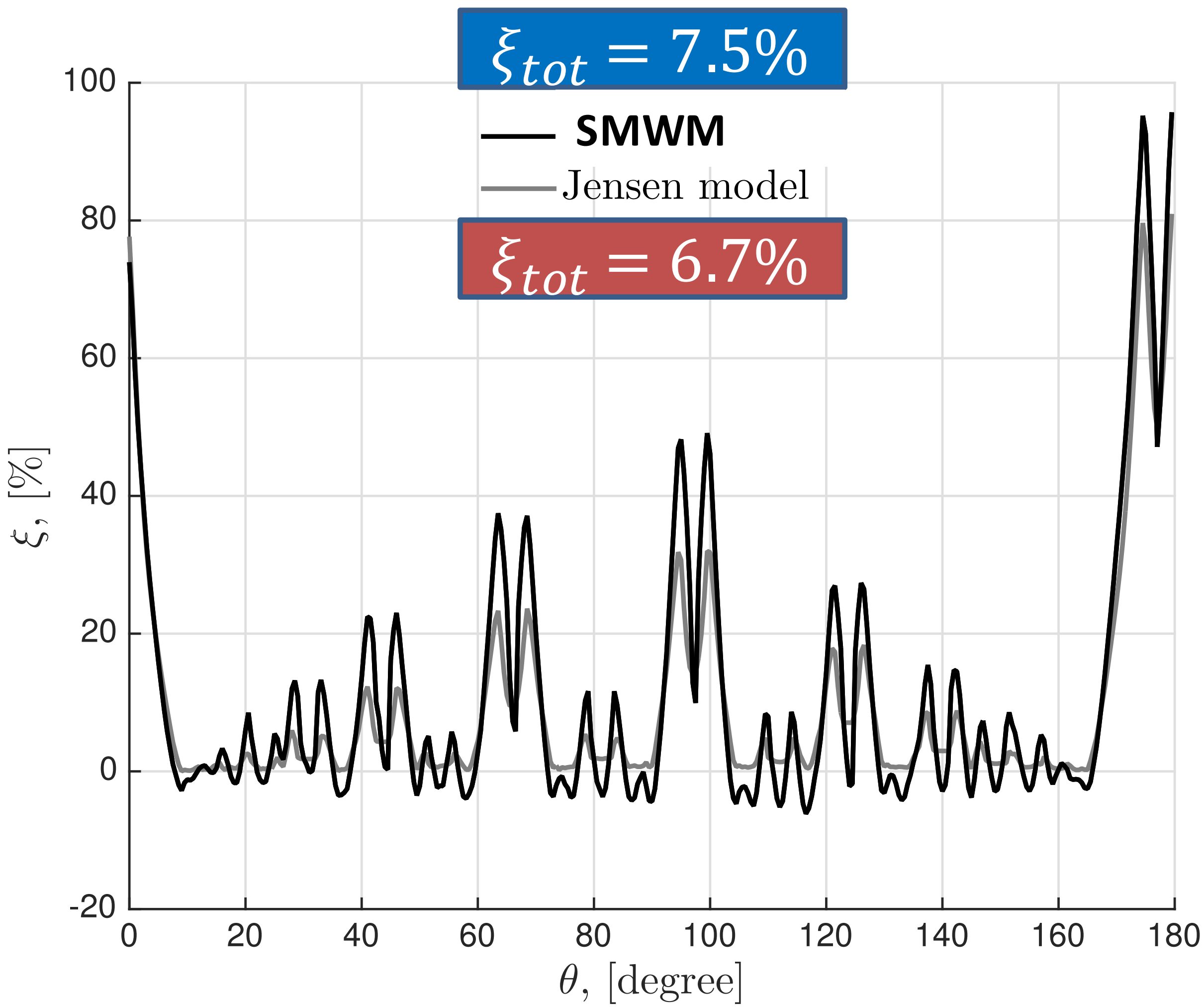
Statistical Meandering Model with table-based optimal yaw-control from Jensen model



INDICATION:
Operational robustness of table-based yaw control for real-life wind farms

Induction factor optimisation:
$\xi_{tot} = 2.9\%$ → 0.7%

OUTLOOK:
- Extensions of Statistical Meandering model.
- Multi-objective optimisation power + load.
- Combined yaw + pitch control.
- Smart (big data) wind-famm control

FunRes — Fundamental Research on Renewable Energy Systems

at the interface between engineering + physics + mathematics + economics

Gorm Andresen + Mahdi Abkar + Martin Greiner (greiner@eng.au.dk)

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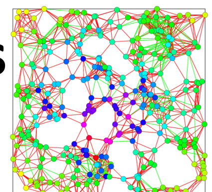
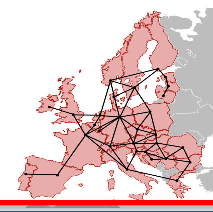
M Victoria (PostDoc)
M Dahl (Master15 + PhD18)
B Tranberg (Master15 + PhD19)
H Liu (Master16 + PhD19)
S Kozarcanin (Master15 + PhD19)
K Zhu (PhD20)
J Kruse (Master18)
S Siggaard (Master17)
M Kofoed (Master16)
L Schwenk_Nebbe (Master16)
M Janum (Master16)
M Raunbak (Master16)
C Poulsen (Master16)
N Skou-Nielsen (Master15)
M Hansen (Master15)
K Holm (Master15)
E Eriksen (Master15)
A Thomsen (Master14)
B Sairanen (Master14)
T Jensen (Master13)
T Zeyer (Master13)
A Søndergaard (Master13)
R Rodriguez (PhD14)
M Rasmussen (PostDoc11)

(1) Highly Renewable Energy Networks

(2) Complex Networks





(3) Wind-farm Modeling + Optimization

(4) Turbulence

J Trane (Master18)
A Khamas (Master18)
B Carlsen (Master16)
A Huche (Master16)
E Thorgersen (Master16)
M Therkildsen (Master15)
P Nybroe (Master15)
J Otten (Master15)
J Bjerre (Master15)

J Herp (Master13)
U Poulsen (Assist Prof)

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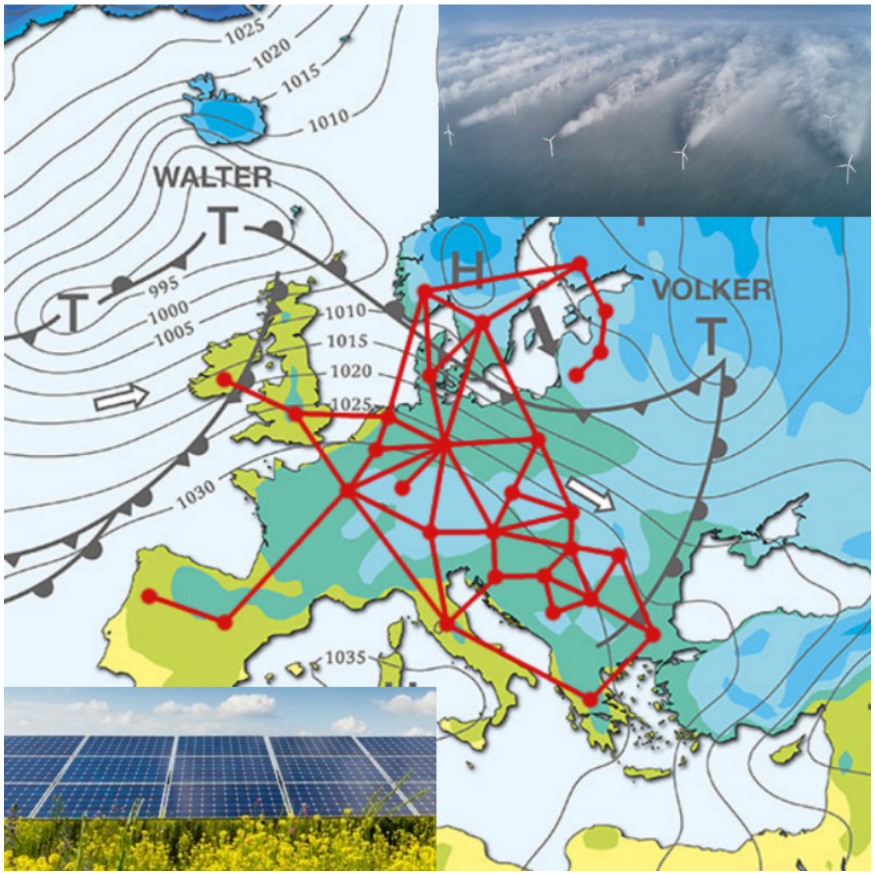
Flow-tracing and nodal cost allocation

in a heterogeneous highly renewable European electricity network



E Eriksen, L Schwenk-Nebbe, B Tranberg, T Brown, M Greiner:
Optimal heterogeneity of a simplified highly renewable pan-European electricity system,
Energy 133 (2017) 913-28.

B Tranberg, L Schwenk-Nebbe, M Schäfer, J Hörsch, M Greiner:
Flow-based nodal cost allocation in a heterogeneous highly renewable European electricity system,
Energy (2018) in press.

B Tranberg, A Thomsen, R Rodriguez, G Andresen, M Schäfer, M Greiner:
Power flow tracing in a simplified highly renewable European electricity network,
New J. Physics 17 (2015) 105002.

M Schäfer, B Tranberg, S Hempel, S Schramm, M Greiner:
Decompositions of injection patterns for nodal flow allocation in renewable electricity networks,
Eur. Phys. J. B 90 (2017) 144.

J Hörsch, M Schäfer, S Becker, S Schramm, M Greiner:
Flow tracing as a tool set for the analysis of networked large-scale renewable electricity systems,
Int. J. Electrical Power and Energy Systems 96 (2018) 390-97.

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