Karlsruhe Institute of Technology

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Verbesserungen von Windfeldmodellen (z.B. WRF)

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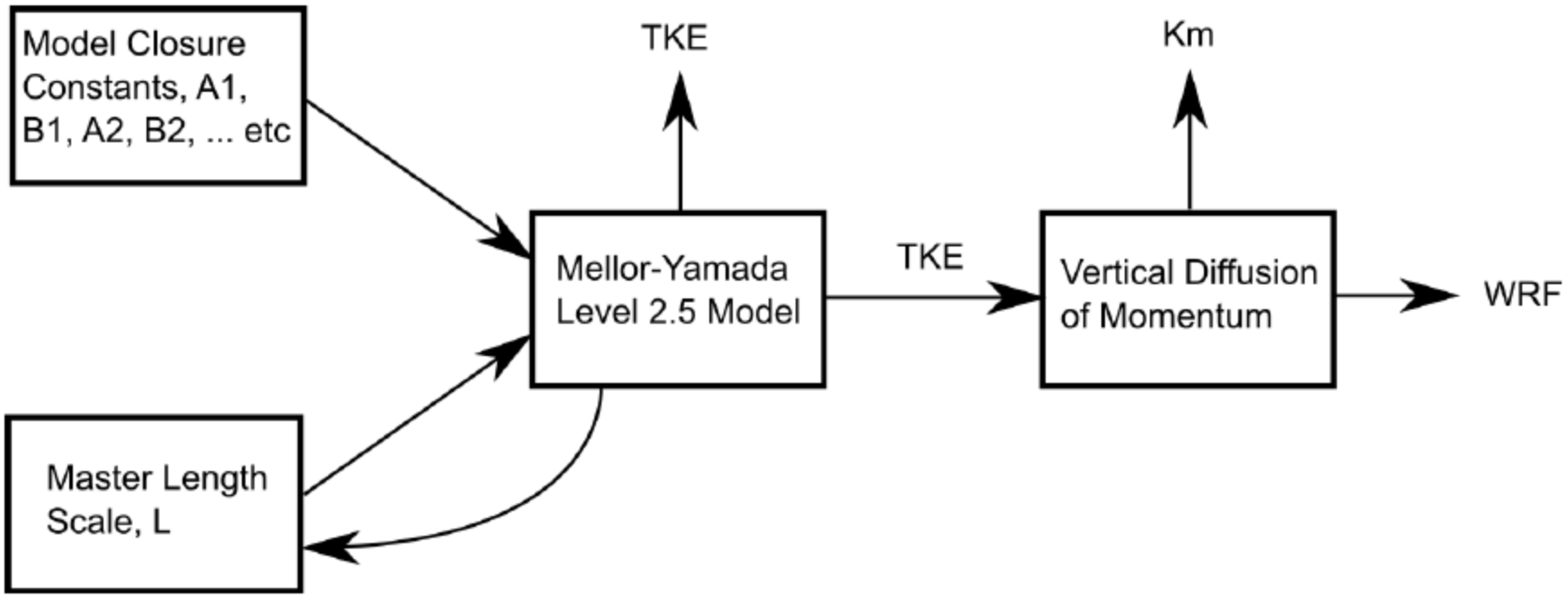
Weather Research and Forecast (WRF) model (http://www.mmm.ucar.edu/wrf/users/)

- **Mellor-Yamada-Janjic (MYJ) planetary boundary layer scheme:**
- **Turbulence closure of the atmospheric boundary layer equations (one equation model)**
- **Specification of the length scale, l**
- **Differential equation for TKE:**

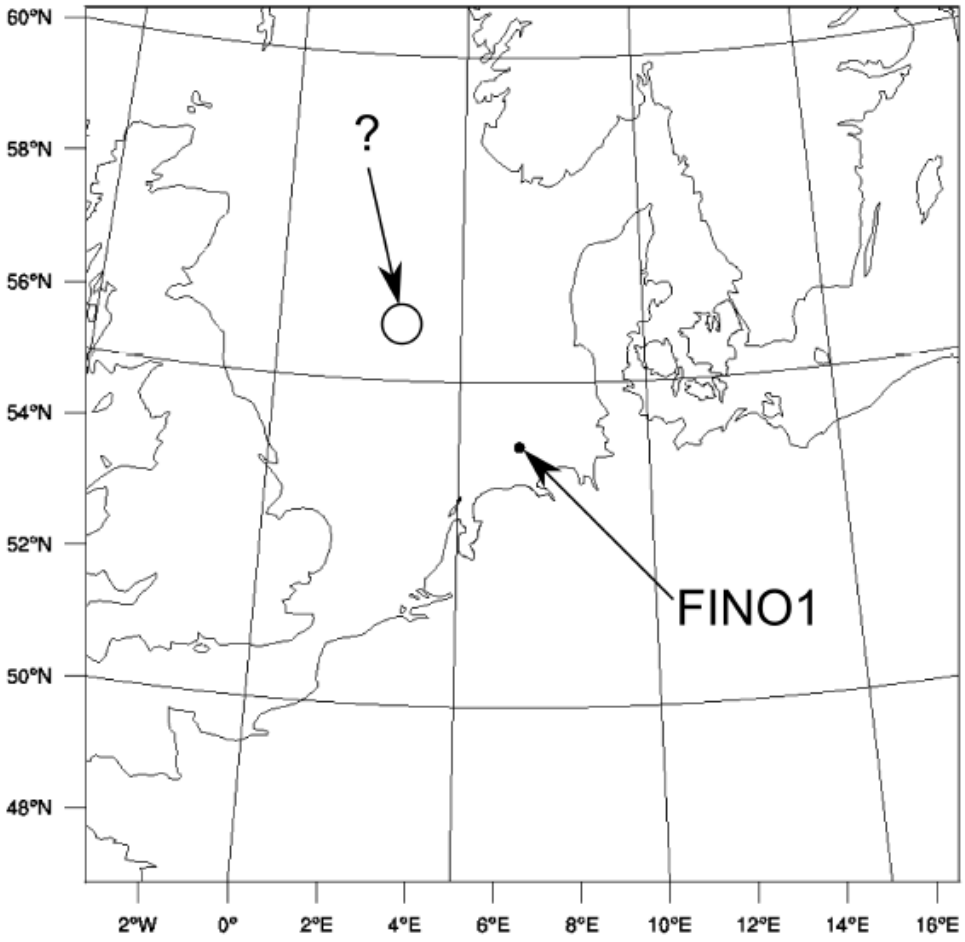
$$\tfrac{1}{2} q^2 = \tfrac{1}{2} (u'^2 + v'^2 + w'^2)$$

- **Exchange coefficients solved algebraically**
- **Typical example for TKE and eddy viscosity (K_m) will be shown below**

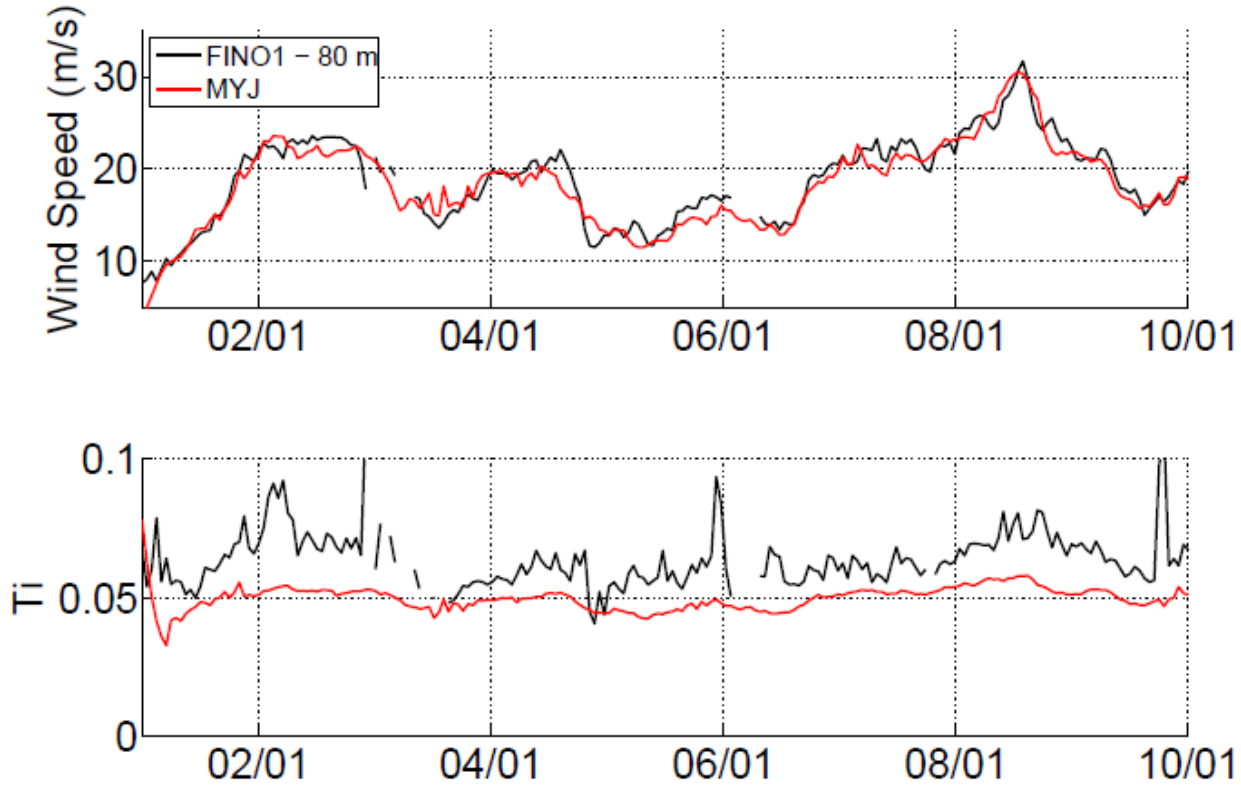
Weather Research and Forecast (WRF) model (http://www.mmm.ucar.edu/wrf/users/)



WRF Model Domain



WRF with original MYJ scheme (simulation for January 2005 compared to FINO1 data)

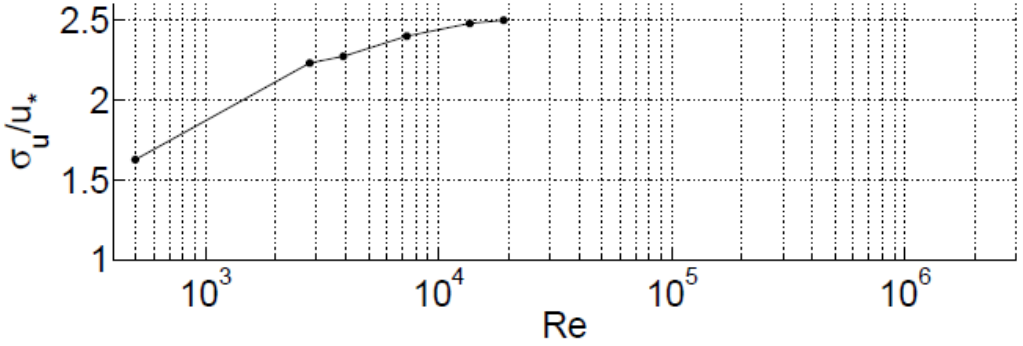


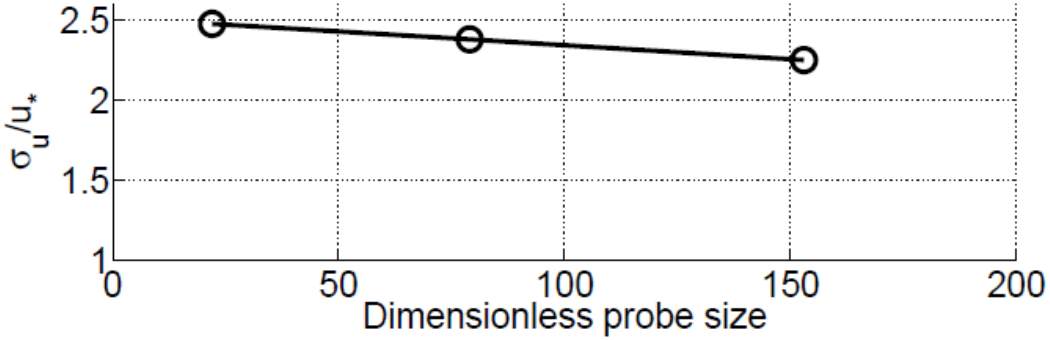
- Turbulence Intensity: $\mathrm{Ti} = \frac{\sqrt{\frac{1}{2}(\sigma_u^2+\sigma_v^2+\sigma_w^2)}}{U}$.

Mellor-Yamada (1982) closure constants determined from laboratory data between 1950-1975

Have these data been obtained for sufficiently high Reynolds numbers?

Have these data been obtained by sufficiently small sensors close to the wall?





Hutchins et al., 2009.
J Fluid Mech 635, 103-136.

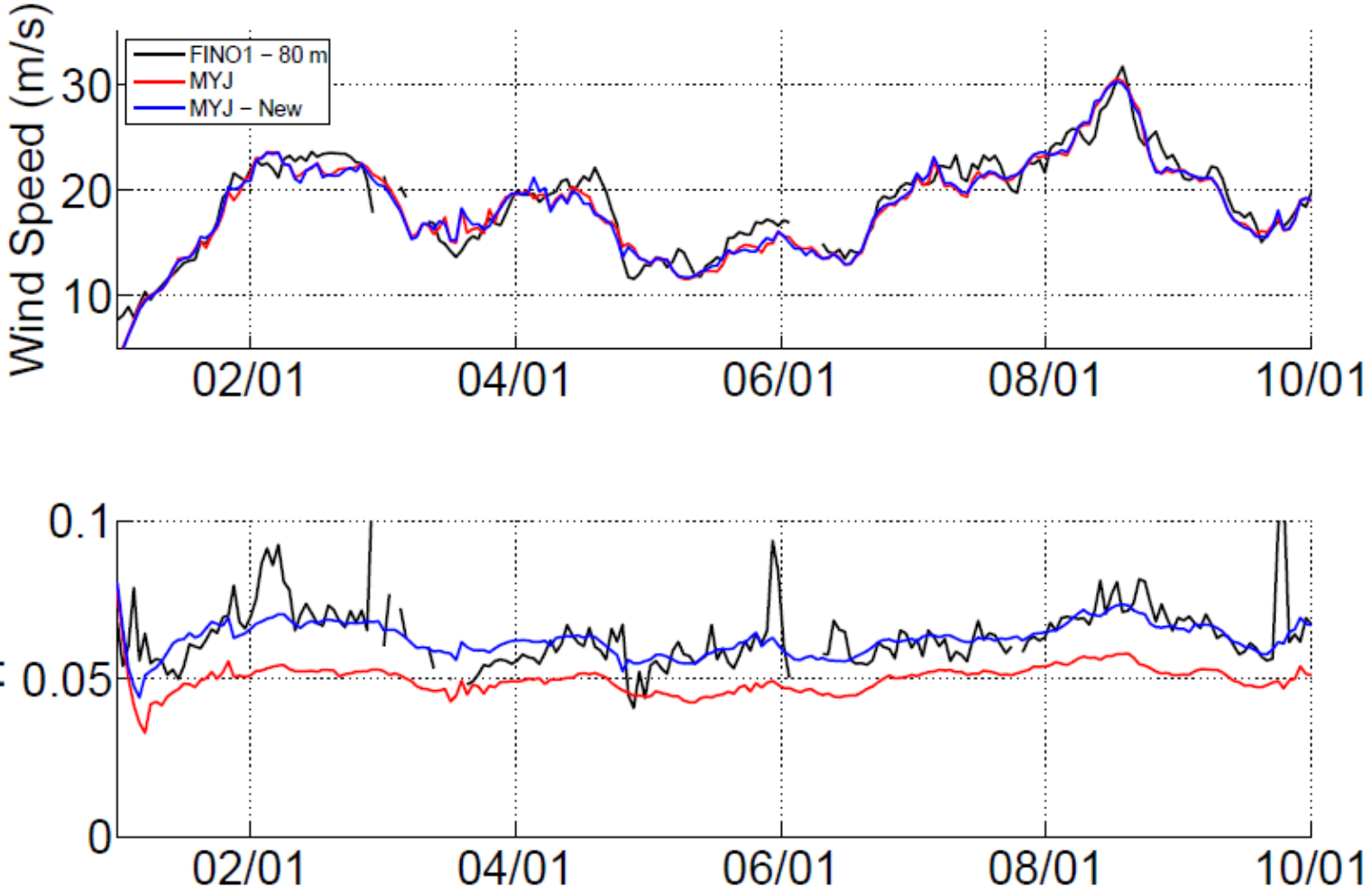
Marusic et al., 2010.
Int J Heat & Fluid Flow 31, 418-428.

- B_1 = MY closure constant.
- $q = \sqrt{\sigma_u^2 + \sigma_v^2 + \sigma_w^2}$
- u_* = friction velocity.

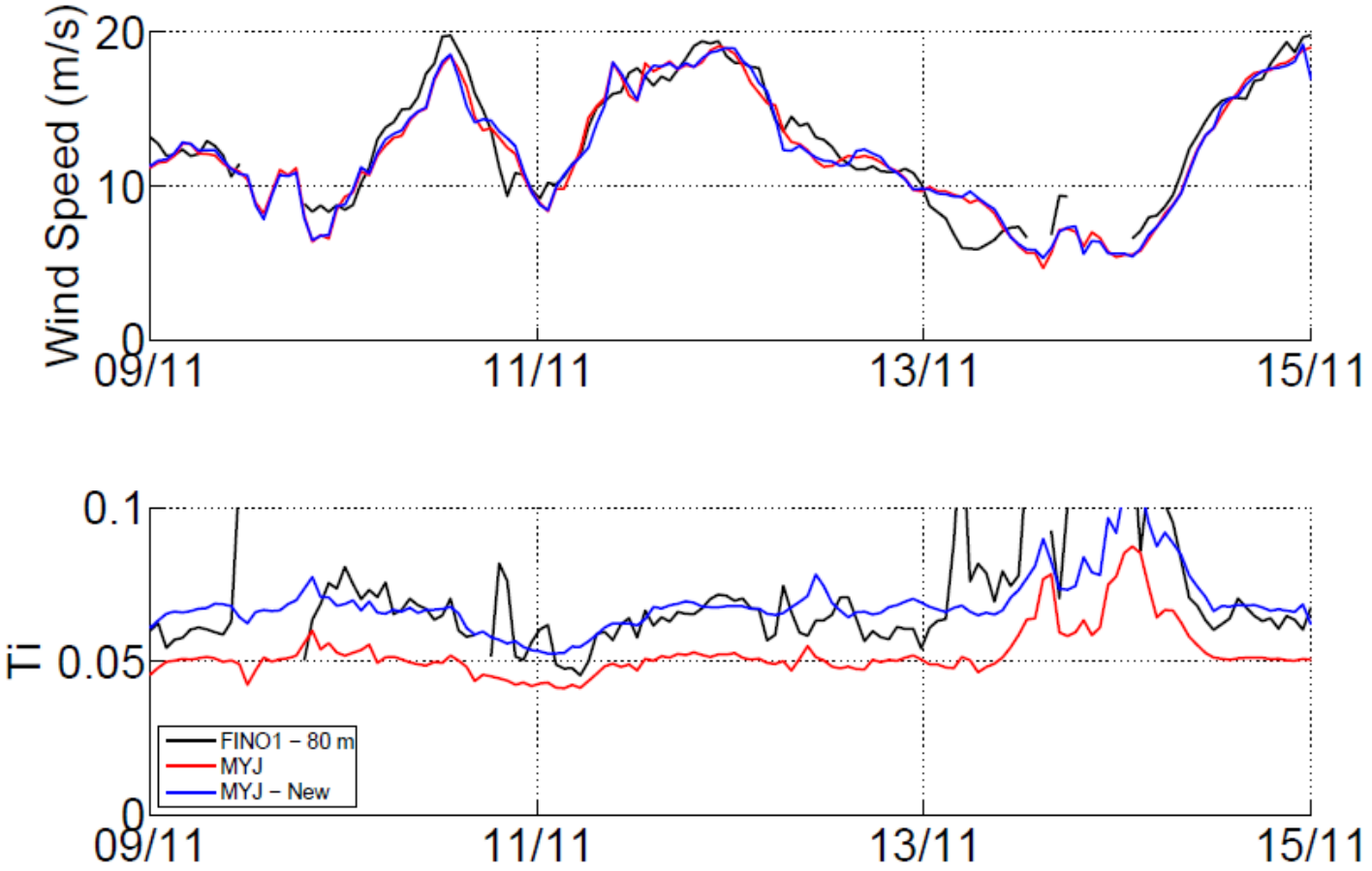
Length scale l dependent on stability according to Nakanishi (2001)

Author	Re (x 10^4)	$\frac{q}{u_*}$	$B_1 = \left(\frac{q}{u_*}\right)^3$
Laboratory Data:			
Österlund (1999)	2.25	2.97	26.2
Carlier & Stanislas (2005)	2.06	2.96	25.9
Mellor-Yamada Models:			
Mellor & Yamada (1982)	-	2.55	16.6
Current WRF	-	2.28	11.9
Updated here	-	2.96	26.0

WRF with modified MYJ scheme (simulation for January 2005 compared to FINO1 data)

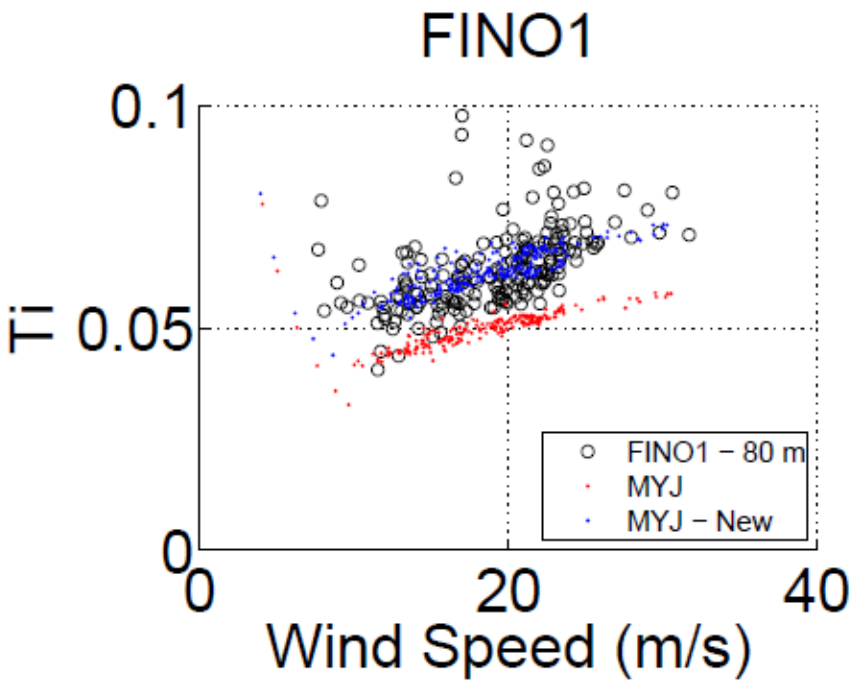


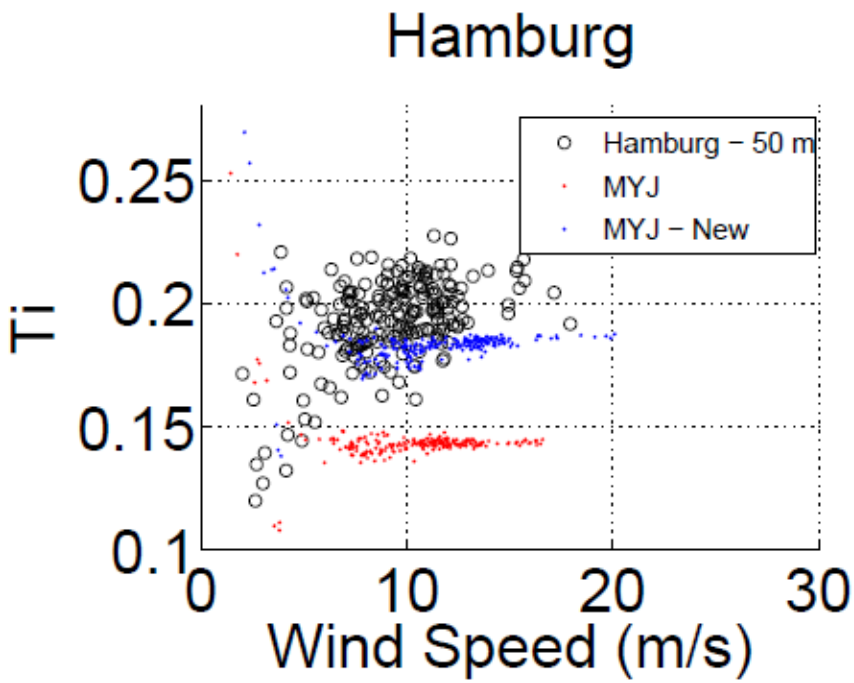
WRF with modified MYJ scheme (simulation for November 2005 compared to FINO1 data)



WRF with modified MYJ scheme (simulation for January 2005 compared to FINO1 and Hamburg data)

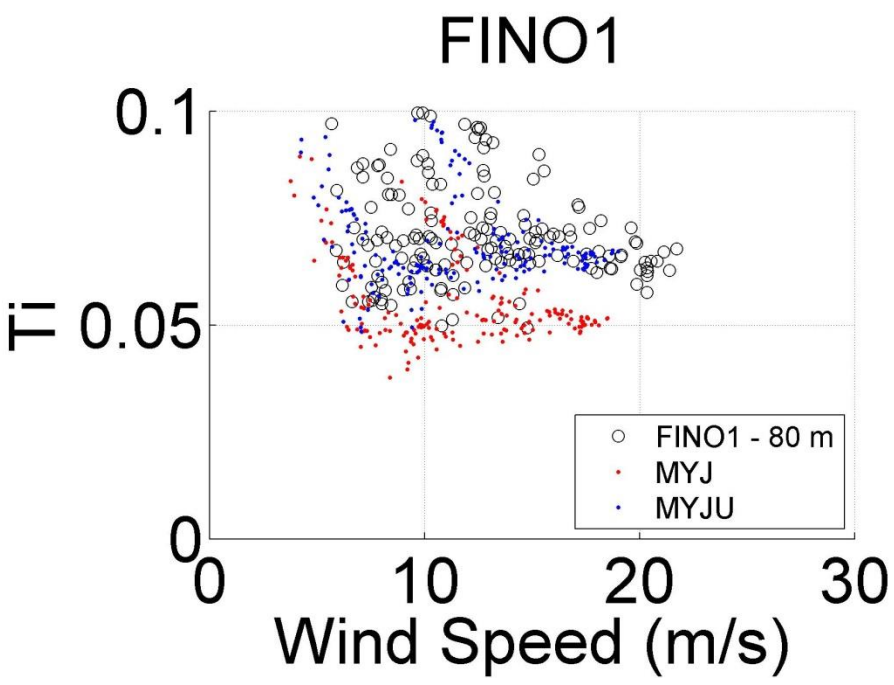
Ti as function of wind speed

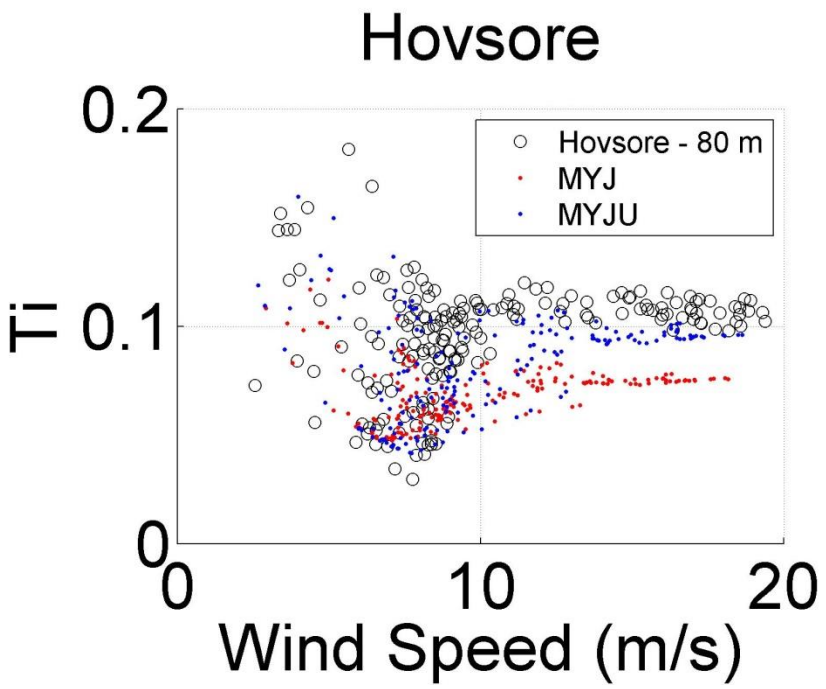




WRF with modified MYJ scheme (simulation for February 2005 compared to FINO1 and Høvsøre data)

Ti as function of wind speed





Conclusions:

Updates to MYJ scheme include:

- modified model constants
- modified specification of length scale

Better simulation of turbulence intensity (offshore and onshore)

Mean wind speed simulation nearly unchanged

Updated model is suited for the simulation of turbulence intensity

Further updates possible:

- parametrization of marine drag coefficient
- influence of moisture fluxes on stability in the MABL

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Thank you for your attention