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Wind Velocity Profiles up to 100m above the North Sea - Observations compared to a Model of Wave-Coupled Ekman Layers

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For wind speed forecasts, climate models as well as wind resource assessments, the vertical wind profile above the sea has to be modelled with high accuracy. Continuing our work in [1], we analysed marine wind speed profiles that were measured at the two met masts Horns Rev (62m) and FINO1 (100m) in the North Sea. We found pronounced effects of situation dependent roughness lengths, of thermal stratification modified by the large heat capacity of the sea, and of the influence of the land-sea transition. In this work we present a detailed description of the observed wind profile characteristics at Horns Rev. One of the main results is that, in many situations, the wind shear is significantly higher than expected. Consequently the standard approaches to calculate wind speeds in higher altitudes from given lower level values lead to severe underestimations.

In order to understand the underlying effects, we developed an analytic model of the wind velocity profile in the marine atmospheric boundary layer. In particular, the flux of momentum through the Ekman layers of atmosphere and sea is described in each fluid by a common wave boundary layer specified by the inertial coupling relations [2], and two outer constant viscosity layers [3]. The three layers are coupled by matching velocity, shear stress and eddy viscosity at a specific height, which can be related to the peak wavenumber of the wave spectrum.

Here we extend the analysis given in [1] to stable and unstable thermal conditions of the marine boundary layer and present the inertially coupled wind profiles (ICWP) for this system. Remarkably, the predictions are expressible in terms of a single parameter, which is predicted for a prescribed geostrophic wind.

Finally, we compare the theoretically derived wind profiles as well as the usually applied logarithmic profiles (Monin-Obukhov corrected) with the offshore measurements from Horns Rev and FINO1. The good agreement between ICWP and observations support the basic assumption of our model that the atmospheric Ekman layer begins at 15 to 45 m height above the sea surface.

[1] J. Tambke, M. Lange, U. Focken, J.-O. Wolff, J.A.T. Bye: Forecasting Offshore Wind Speeds above the North Sea, *Wind Energy* **8** (2005) 3-16.

[2] J.A.T. Bye: Inertial coupling of fluids with large density contrast, *Phys. Lett. A* **202** (1995) 222-224.

[3] J.A.T. Bye: Inertially coupled Ekman layers, *Dyn.Atmos.Oceans*. **35** (2002) 27-39.