EMS Annual Meeting Abstracts
Vol. 11, EMS2014-257, 2014
14th EMS / 10th ECAC

Validation of offshore boundary layer wind shear profiles for wind energy research

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With the on-going trend to scale up offshore wind turbines, it becomes crucial to accurately consider wind shear within the entire boundary layer. In this study the shear profile of Gryning is validated for an observation site 85km offshore based on lidar observation data up to 315m height. Since there are no boundary layer depth observations, the shear profile is fitted to the data with a least square fit, where the boundary layer depth is approximated with the Rossby-Montgommery relation. For optimal fits (r^2 > 0.9, residual sum of squares < 1 m/s), the constant c of the Rossby-Montgommery equation is typically found to be highest for unstable conditions (approximately 0.14), with decreasing values for neutral (approximately 0.09) and stable (approximately 0.06) conditions. These values are significantly smaller than found for similar onshore studies, which indicates that the boundary layer offshore is typically shallow compared to onshore sites. A second group of fitted profiles is found where c is nearly twice as large for the same stability compared to the previously mentioned values. For this second group the mean wind profile above 100m is nearly constant with strong shear close to the surface. This might be caused by wind-wave misalignment and/or swell, but this is matter of current research. In coming months the impact of considering boundary layer shear profiles for wind energy purposes is studied by performing fatigue load assessment and by assessing the potential power production. This is done for a state of the art wind turbine (hub height 90m, rotor radius of 126m) and a scaled version representing future wind turbines (hub height 150m, rotor radius of 250m). Preliminary results show that wind shear has minor influence on the power production of unstable and neutral conditions (< 1% difference), but uncertainty increases significantly for stable conditions.