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Published in:
EMS Annual Meeting Abstracts

Publication date:
2013

Document Version
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

Citation (APA):
Floors, R., Peña, A., & Gryning, S-E. (2013). The effect of baroclinicity on the wind profile in the planetary boundary layer. In *EMS Annual Meeting Abstracts* European Meteorological Society. EMS Annual Meeting Abstracts, Vol.. 10 <http://www.ems2013.net/>

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The effect of baroclinicity on the wind profile in the planetary boundary layer

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The wind in the free atmosphere is an important parameter for the estimation of wind resources at typical heights of wind turbines. Mesoscale models, such as the weather research and forecasting (WRF) model, are often used to perform downscaling from the large-scale model data to the wind speed near the surface at a certain site. In this study, the wind in the free atmosphere is estimated by using the gradients of the pressure and temperature fields from WRF in an area surrounding the site of interest and therefore we can estimate the effect of geostrophic wind shear (baroclinity) on the wind profile in the planetary boundary layer (PBL).

The effect of geostrophic shear is studied with a wind lidar that measures the wind profile up to a 1000 metres. Two years of wind speed observations are available from sites in Denmark and Germany. In addition, radio soundings from a two-week intensive campaign and measurements from tall meteorological masts are used. It is found that the flow is often baroclinic and that the effect on both wind speed and turbulent structure of the PBL is profound. We discuss the effect of baroclinicity on the empirical constants in the geostrophic drag law and how this study can be used to improve the assessment of wind energy resources.