Atmospheric stability using Doppler Wind Lidar profiler: A Case Study in Florianópolis Island

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The effects of atmospheric stability can be important for many wind energy applications. This work aims to investigate the atmospheric stability using two Doppler wind lidar profilers based on a simple method that analyses how the wind shear variates with height. The experiment was carried on Florianopolis Island, located in the south coast of Brazil. The dataset covered a period from December 2014 to February 2015. The Windcube08 lidar has a range from 40m to 500m and the Windcube70 lidar was setup to range from 100m to 1000m. Both lidars recorded a 10min average wind speed with a vertical resolution of 20m. In addition, a 3D sonic anemometer measured turbulent fluxes at 20Hz. The method evaluated the variation of wind shear with height and was associated with the stability classes based on Obukhov Length. The wind speed of the two lidars was compared at 100m, 200m, 300m, 400m and 500m. This comparison showed an excellent agreement, with values better than R2=0.996 and RMSE=0.15 m/s. The results of wind profile indicated an unique condition at night, where were consistently observed convective wind profiles from 40m to 120m and stratified flow above 120m. Then, the presented method was adjusted to consider wind profile heights from 120m to 300m. The analysis of the atmospheric stability also presented a good agreement when comparing both lidars. The Very stable, stable and near stable conditions represented 41,2% (Windcube08) and 27,6% (Windcube70). On the other hand, the unstable condition was dominated by a very unstable condition with 21% and 38,7%, respectively. The neutral condition was the most frequent with 36,8% and 32,2%, respectively. The results of atmospheric stability classes diverged between the two lidars from 5h to 10h UTC, because of differences on wind speed average of around -0.8 m/s from 100m to 200m. In conclusion, the site presented specific conditions, which showed the challenges to propose an universal method to estimate the atmospheric stability using only doppler wind lidar data. However, the method achieved good agreement when comparing the wind profile with the atmospheric stability classes.

Key-words: Atmospheric stability, wind shear, wind profile, doppler lidar, wind energy.