Atmospheric stability and turbulence fluxes at Horns Rev—an intercomparison of sonic, bulk and WRF model data

Direct estimations of turbulent fluxes and atmospheric stability were performed from a sonic anemometer at 50 m height on a meteorological mast at the Horns Rev wind farm in the North Sea. The stability and flux estimations from the sonic measurements are compared with bulk results from a cup anemometer at 15 m height and potential temperature differences between the water and the air above. Surface flux estimations from the advanced weather research and forecast (WRF) model are also validated against the sonic and bulk data. The correlation between the sonic and bulk estimates of friction velocity is high and the highest among all velocity comparisons. From the sonic–bulk–WRF intercomparison, it is found that the atmospheric stability measures at the sonic height tend to be closer to the neutral value than the WRF and bulk estimates, which are performed within an air layer closer to the surface, not only from a systematic bulk and WRF under-prediction of the friction velocity when compared with the sonic value but also because of the lower magnitude of the sonic heat flux compared with that from the WRF simulations. Although they are not measured but parameterized or estimated, the bulk–WRF comparisons of friction velocity and 10 m wind speed show good agreement. It is also shown that on a long-term basis, the WRF and bulk estimates of stability are nearly equal and that a correction towards a slightly stable atmospheric condition has to be applied to the long-term wind profile at Horns Rev and at other locations over the North Sea, the correction being larger for points close to the coast. Copyright © 2011 John Wiley & Sons, Ltd.