EMS Annual Meeting Abstracts,
Vol. 6, EMS2009-573, 2009
9th EMS / 9th ECAM

9th EMS Annual Meeting
9th European Conference on Applications of Meteorology
High resolution meteorology
- applications and services

Turbulence structure of the marine boundary layer during mixed sea and growing sea conditions

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Data have been analyzed from the joint Swedish-US-Finnish field experiment BASE, which was performed during the autumn 2003 in the Baltic Sea. Turbulence data were obtained with sonic anemometers at 2.5 and 5 m above the water surface from an anchored ASIS buoy and simultaneously at 10, 18 and 26 m on the Östergarnsholm tower. Additional slow-response, 'profile data' were obtained from three levels on the buoy and five levels on the tower. In a previous study (Högström et al, 2008, Boreal Env. Res.) it was demonstrated that the buoy and the tower instrumentation 'see' virtually the same undisturbed marine conditions for wind from a wide sector. Surface wave characteristics were obtained from the ASIS and from two additional Waverider buoys in the area. In a recent study (Smedman et al, 2009 and Högström et al.,2009, J. Atm. Sci.) the BASE data set was used to study the turbulence structure of the marine surface layer during swell conditions. It was demonstrated that the turbulence data could be used for a reasonably accurate turbulence kinetic energy (TKE) budget analysis. The present study attempts a formally similar analysis of conditions with growing sea and with mixed sea conditions, both for unstable conditions. All cases represent relatively low heat flux and high wind. During these conditions, the turbulence structure is of the UVCN type (Unstable Very Close to Neutral conditions, see Smedman et al., 2007a,b, Q. J. Roy. Met. Soc.). It is demonstrated how the turbulent flux of momentum and of sensible and latent heat is strongly affected and how this is linked to the turbulence structure, which differs from that during 'ordinary' conditions by strong influence of surface-layer-scale detached eddies, which bring down dry and cold air to the surface, thus enhancing the net upward flux of sensible heat and moisture.