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Fine-scale wavelike structures in the surface-based turbulent layer at Dome C, Antarctica

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A long-term experiment to study the spatial and temporal structure of thermal turbulence in the extremely stable boundary layer was carried out at the Concordia station, Dome C in Antarctica during 2012. The atmospheric boundary layer at this site during the winter is strongly stably stratified with temperature inversions reaching a strength 35°C in 100-200 m. Despite high static stability, intense thermal turbulence occurs sometimes in the surface layer extending from the surface to heights of a few – a few tens of metres. The spatial and temporal structure of the turbulence was observed by an advanced high-resolution sodar in the height range from 2 m to 150 m with vertical resolution $\approx$ 2 m and time resolution of 2 s. The variation and statistics of the depth of the surface-based turbulent layer (STL) is determined for the entire winter period. The median value of the STL depth is found to be l6 m, while the depth of the inversion layer is of 125 m. The wind speed is a parameter that affects the formation and development of the STL. Typical patterns of turbulence structure as shown by the sodar echograms are analysed and classified. Wave activity within the STL is observed for a significant part of the time; the time scales that characterize these undulation processes are determined. Often regular trains of waves with periods of 30-60 s and a periodicity of 5-10 minutes are observed. Some characteristics of the wavelike structures (form, spatial and temporal scales) are determined and the correlation with meteorological parameters is analysed. The Richardson number estimated using the vertical profiles of temperature and wind velocity from the 45-m meteorological tower, indicates that in some cases significant turbulence may occurr even when Ri is larger than the critical value equal to 0.25.