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Spatio-temporal Pattern of the Surface-based Turbulent Layer during Polar Winter at Dome C, Antarctica as observed by Sodar

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The characteristics of the atmospheric turbulence in the extremely stable boundary layer are not well understandable till now. During the winter 2012, a long-term experiment was carried out at the Concordia station, Dome C, Antarctica to study the spatio-temporal structure of turbulence. In spite of the lower atmospheric layer in the interior of Antarctica during winter is strongly stably stratified with a temperature inversion strength reaching 35°C, the intense thermal turbulence occurs sometimes in the near-surface layer extending from the surface to heights of a few – a few tens of metres. The turbulence pattern was observed by a specially developed high-resolution sodar beginning from the lowest height of ≈2 m and with vertical resolution <2 m. Statistics of the depth of the surface-based turbulent layer (STL) was determined for the entire winter period. The median value of the STL depth was found to be l6 m, meanwhile the depth of the inversion layer was of 125 m. Wind speed was found to be a relevant meteorological variable influencing the formation and development of the STL. Wave activity within the STL was observed during the significant part of the time. Statistics of the occurrence of undulation events and of the characteristics of temperature inversions are presented. Typical patterns of spatio-temporal distribution of turbulence as shown by the sodar are analysed and classified. The oscillations of wave-like fine-scale turbulent layers showing a braid pattern were attributed to the Kelvin-Helmholtz instability. Some specific frequency domains which characterize undulation processes were determined. Regular trains of waves at periods of 30-60 s often appeared in the internal structure of the STL with a periodicity of 5-10 min. The main characteristics of the wavelike structures (form, spatial and temporal scales) were determined. Their correlation with meteorological conditions is analysed.