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A diagnostic relation to estimate the mixing layer height under convective conditions

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In the framework of the "Atmospheric Boundary Layer Climate" (ABLCLIMAT) project, measurements of mixing-layer height were carried out with a high resolution surface-layer sodar at the French-Italian station of Concordia (Dome C, Antarctica). The behaviour of the mixing-layer height was monitored and estimated during several days in the austral summer 2011-2012. Despite the low temperatures, the mixing layer evolution at Dome C is similar to that observed at mid-latitudes, i.e. a nocturnal shallow stable layer followed by a typical diurnal growth. The mixing-layer heights were found to vary between 10 and 300 m. These observations were complemented by radiosounding profiles, and continuous near-surface turbulent fluxes measurements.

Focusing on convective conditions only, a new diagnostic equation is proposed and evaluated. The diagnostic equation is based on a dimensional analysis that takes into account the time-averaged integral of the near-surface turbulent heat flux, the background static stability, and the buoyancy parameter. Despite its simplicity, the proposed model is in good agreement with the observations, and it is able to reproduce the entire diurnal evolution with satisfactory accuracy. To test the diagnostic relation on a larger and completely different data set, it was also applied to measurement from the suburb of Rome (Italy).

Although diagnostic models are applicable under quasi-stationary conditions only, the obtained results support the use of a limited number of variables to characterize the general convective mixing layer behaviour. This equation can be a useful tool when direct measurements are not available, or more sophisticated model cannot be used.