Effect of Roughness Lengths on Surface Energy and the Planetary Boundary Layer Height over High-altitude Ngoring Lake

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The high-altitude lakes in the Tibetan Plateau (TP) have a unique roughness length distributions and atmospheric boundary layer variation characteristics. However, how different types of roughness lengths affect the lake surface energy exchange and the planetary boundary layer height (PBLH) remains unclear in the TP lakes. In this study, a tuned Weather Research and Forecasting (WRF) model version 3.6.1 was used to investigate the responses of the freeze-up date, turbulent flux, meteorological variables, and PBLH to surface roughness variations in the Ngoring Lake. Of all meteorological variables, the lake surface temperature responded to roughness length variations most sensitively, increasing roughness lengths can put the lake freeze-up date forward. The effect of momentum roughness length on wind speed was significantly affected by the fetch length. An increase in the roughness length for heat can increase the nightly PBLH during most months, especially in the central lake area in autumn. The primary factors that contribute to sensible heat flux (H) and latent heat flux (LE) were the roughness lengths for heat and momentum, respectively. Although the momentum roughness length also had an important effect on the sensible heat flux, there was no obvious correlation between H and the PBLH.

Keywords: Lake ice , Lake temperature, Roughness length, Turbulent flux , Tibetan Plateau

