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Numerical simulation of the climate effect of high-altitude lakes in the Tibetan Plateau

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Studies of the lake effect in the high-altitude Tibetan Plateau (TP) are rarely performed until recently and little attention was paid to modelling of frozen lakes. In this study, the Weather and Forecasting model (WRF v3.6.1) is employed to conduct three numerical experiments in the Ngoring Lake basin (original experiment, experiment with a tuned model, and no-lake experiment), in order to investigate the influences of parameter optimization on the lake simulation and the high-altitude lake on the regional climate. After the lake depth, the roughness lengths and initial surface temperature are corrected in the model, the simulation of the air temperature is distinctly improved. In the experiment with a tuned model, the simulated sensible heat flux (H) is clearly improved, especially during the periods of ice melting (from late spring to early summer) and freezing (late fall). The improvement of latent heat flux (LE) is mainly manifested by the sharp increase in the correlation coefficient between the simulation and observation, whereas the improvement in the average value is small. The optimization of initial surface temperature shows most prominent effect in the first year, and which distinctly weakens after a freezing period. After the lakes become grassland in the model, the daytime temperature clearly increases during the freezing and melting periods, the nocturnal cooling appears in other stages, especially from September to October. The annual mean H increases by 6.4 times in the regions of Ngoring Lake and Gyaring Lake, and the LE declines by 56.2%. The sum of H and LE increases from 71.2 W m-2 (with lake) to 84.6 W m-2 (no lake). For the entire simulation region, the sum of H and LE also increases slightly. After the lakes are removed, the air temperature increases significantly over the two lakes from June to September, and a typical abnormal convergence field forms. At the same time, the precipitation clearly increases in the two lakes and surrounding areas.