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

*Yinhuan Ao[1], Zhaoguo Li[1]

1. Key Laboratory of Land Surface Process and Climate Change in Cold and Arid Regions, Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences

Lakes regulate the water and heat exchange between the ground and the atmosphere on different temporal and spatial scales. However, studies of the lake effect in the high-altitude Tibetan Plateau (TP) are gradually performed until recently and little attention was paid to modelling of frozen lakes. In this study, we employ the WRF v3.6.1 model to conduct the three groups of long-term simulation experiments of Ngoring Lake basin in the TP (original experiment, experiment with a tuned model, and no-lake experiment). Based on these experiments, we evaluate the effect of model improvement on the simulation in the high-altitude lake basin, and investigate the influence of 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 H on the lake surface is also clearly improved, especially during the periods of ice melting (from late spring to early summer) and freezing (late fall). However, the H on the lake ice is predominantly negative, which exhibits a relatively large difference from the observation. The improvement of LE is primarily manifested by the rapid increase in the correlation coefficient between the simulations and observations, whereas the improvement in the averaged LE is relatively small. The initial surface temperature improvement shows most prominent effect in the first year, and which distinctly weakens after a freezing period. After the lake becomes the grassland in the model, the daytime temperature clearly increases during the freezing and melting periods, the nocturnal cooling appears in other time, especially from September to October. The annual mean H increases by 6.37 times in the regions of original Ngoring Lake and Gyaring Lake areas, and the LE declines by 56.17%. The sum of H and LE increases from 71.23 W m-2 (with lake) to 84.58 W m-2 (without lake). For the entire simulation region, the sum of H and LE also increases slightly. After the lakes disappear, 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 original two lakes and surrounding areas, whereas the precipitation generally decreases in other regions. The pattern of the precipitation increase region is consistent with the inter-annual variation of the convergence field.

Keywords: lake effect, Tibetan Plateau, frozen lake, latent heat flux, precipitation

