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Results of Simulations of Atmosphere-lake Interactions Using Numerical Model

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***Abstract*—Lakes influence the regional atmosphere through modifying thermodynamic characteristics. This study examines the effects of the Baikal lake on meteorological parameters in summertime using the numerical model. Diurnal variations in the lakes' impact on the atmosphere are found through changing the surface energy budget, which includes changes in sensible and latent heat fluxes. The changes in heat fluxes cause relatively lower surface temperature which leads to a shallow boundary layer over the lake surfaces. Greater heat capacity in water bodies compared to grasslands causes slower heating and cooling rates in the lakes. The amplitude of air temperature over the lake surfaces is smaller than that over the grasslands. Lakes promote diverging winds near the ground, furthermore, tend to stabilize the overlying atmosphere in the summertime.**

Keywords—numerical simulation; lake-atmosphere; interaction;

I. INTRODUCTION

Numerical modeling approach is widely used to design and simulate in various fields including atmorsphere and its underlying surface [1]. In some regions, the presence of lakes play important role in determining the regional climate. Interactions between the lake and atmosphere through exchanging heat, water vapor, and momentum fluxes [2] define the regional climate and weather. Atmospheric circulations in the surrounding region are affected by lakes through differences in thermal and frictional properties between lake and land surfaces [3].

Numerical studies examined lake-atmosphere interactions. the impacts of the Laurentian Great Lakes on regional climate studied by Notaro et al. [4] conducting numerical simulations with and without lakes. The results presented the decreased (increased) sea-level pressure in autumn-winter (summer), weakened cold-season cyclones and increased (decreased) turbulent fluxes during the cold (warm) season due to the presence of the lakes. the Weather Research and Forecasting (WRF) model used to investigate the effects of African Great Lakes on regional climate and revealed that the daytime cooling by lakes modifies the dynamics and stability of the regional atmospheric condition [4].

Satellite data shows the reduced precipitation on and surrounding lakes (e.g., Baikal lake) in the summertime. Dynamic interactions between lakes and atmosphere should be conducted in order to explain the importance of the lakes in atmospheric circulations through assessing the changes in meteorological parameters. This study investigates the impacts of lakes in the summertime in the Baikal Lake region on some meteorological parameters.

II. METHODOLOGY

Simulations are conducted using the WRF model [5]. It is an open-source, atmospheric dynamical modeling system designed for both research and numerical prediction. Interactions of lake-atmosphere over the Baikal Lake region (Fig. 1) are investigated. The numerical simulations are set up with three domains. The initial and boundary conditions are taken from National Center for Environmental Prediction (NCEP) reanalysis data. The lake-atmosphere interactions and impacts of the lake on regional weather are tested comparing two simulations – the original case ("LAKE" experiment) and the case without lakes in the Baikal Lake region ("NOLAKE" experiment).

Spatial and temporal variations of various parameters are examined. Figure 2 shows the difference between the two simulations. This explores the horizontal impacts of lakes on some parameters.

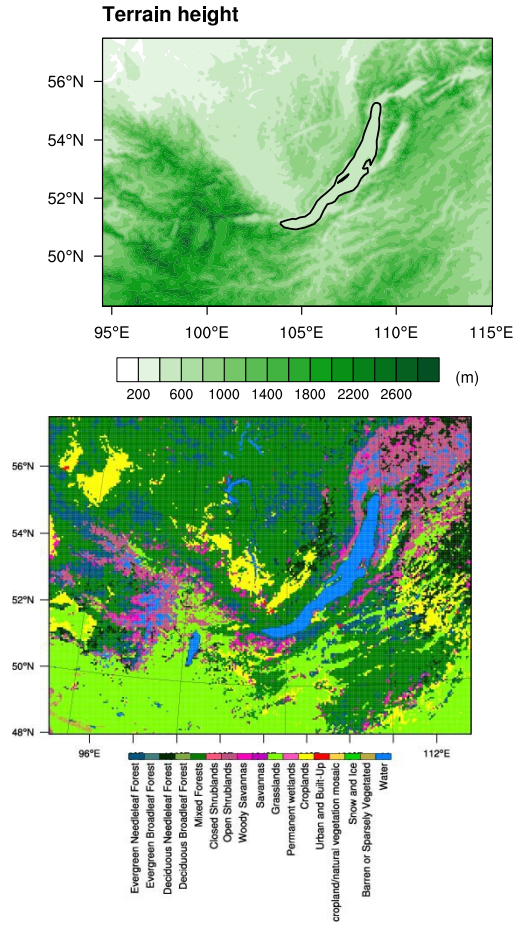

Figure 1. Terrain and land-use categories in the domain.

III. RESULTS

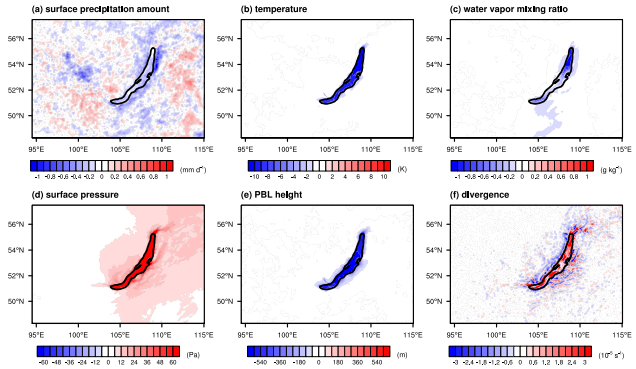

Figure 2. Difference between LAKE and NOLAKE simulations.

The lakes are significantly cooler and reduced water vapor mixing ratio over the lakes in the LAKE simulation is accompanied by suppressed evaporation from the cool water surfaces which is partly in agreement with the results by Notaro et al. [3]. The reduced precipitation and evaporation are caused by the Baikal Lakes in the summertime. Thinned boundary layer height over the lake is associated with reduced sensible heat flux, cooler air over the lakes. Temporal variations of impacts of lakes on some near-surface parameters are explored and will be presented in the presentation.

IV. CONCLUSIONS

Numerical simulations are conducted to examine the lake-atmosphere interactions. The domain area surrounding the Baikal lake was chosen and summertime case is examined. Two distinct cases with and without the lake were run to illustrate the impacts of lake on surrounding region.

ACKNOWLEDGMENT

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