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Numerical investigation of mid-latitude subgrid-lake effects using a coupled single-column model with an application to Lake Geneva, Switzerland

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This paper investigates further the potential of an atmospheric single-column model (SCM) in order to explore the nonlinear effects of a subgrid-scale mid-latitude open freshwater body. This SCM has been implemented in the computational grid of the Canadian Regional Climate Model (C-RCM) driven by NCEP-NCAR reanalyses.
The objectives of this paper is threefold: 1) to propose a novel coupling technique between a combined land-open water surface and the atmosphere; 2) to evaluate the nonlinear effects as the fractional areas of both surfaces increases incrementally from land to open water; 3) to evaluate the predictability of the atmosphere-surface system as the open-water surface fractional area increases, in terms of the sample entropy method. The coupling methodology produced realistic results as regard to the atmospheric flow field profiles and well as to other variables such as surface fluxes, which behaved differently overland and the open waters. Results showed that the mean surface fluxes and other relevant quantities may not be arithmetically averaged on the basis of the fractional area of the land and that of the open water surfaces, as simulated quantities evolve in a highly nonlinear manner as a function of the respective land and open water areal fraction. The sample entropy method also showed that the predictability of the atmosphere-surface system varies when the lake surface area increases. Finally, if the land and Lake Geneva surface areas are prescribed to the observed values with respect to the grid mesh size, resolving both simultaneously with this SCM have non negligible impacts on the lower atmospheric variables, surface variables and fluxes. The coupling technique used in this SCM may also be implemented in RCMs.