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On the representation of heavy lake-effect snow events for the Laurentian Great Lakes region in a Regional Climate Model

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Lakes are important components of the climate system and can affect regional climate by modulating surface albedo, surface energy and moisture budgets. Therefore, they should be realistically represented in climate models. Many climate models are currently representing lakes interactively using 1D models. However, for large lakes such as the Laurentian Great Lakes, 3D models are required, as it is important to simulate the circulation patterns which can impact lake temperature as well as ice freeze/melt onset dates and fractional coverage, and by extent lake-effect snow as suggested by recent studies. The aim of this study is to compare lake-effect snow simulated by a regional climate model (CRCM5: Canadian Regional Climate Model, Version 5) with 1D and 3D models for the Great Lakes.

In this investigation, two CRCM5 simulations at 10 km horizontal resolution are performed and analysed over the Great Lakes region for the 1979-2012 period. The first simulation (CRCM5_HL), where the Great Lakes are handled by a 1D lake model (Hostetler), is used as a base to represent the configuration of recent regional climate modelling studies. The second simulation (CRCM5_NEMO), where the Great Lakes are simulated by a 3D ocean model (NEMO), is used to assess the impact of representing circulation in large lakes. Preliminary results indicate improved 2-m air temperature directly over the Great Lakes in summer and lower ice cover for CRCM5_NEMO. Both the summer 2-m air temperature and lake ice cover are overestimated in CRCM5_HL. The lower ice cover in turn leads to greater snowfall generated during heavy lake-effect snow events in the case of CRCM5_NEMO.

The impacts on lake-atmosphere interactions in the Laurentian Great Lakes region will be discussed by comparing turbulent heat and moisture fluxes as well as lake ice cover. Finally, some results and challenges on diagnosing heavy lake-effect snowfall from regional climate model simulations and observational datasets will be discussed.