Great Lakes' regional climate regimes

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We simulate the seasonal cycle of the Great Lakes' water temperature and lake ice using an idealized coupled lake–atmosphere–ice model. Under identical seasonally varying boundary conditions, this model exhibits more than one seasonally varying equilibrium solutions, which we associate with distinct regional climate regimes. Colder/warmer regimes are characterized by abundant/scarce amounts of wintertime ice and cooler/warmer summer temperatures, respectively. These regimes are also evident in the observations of the Great Lakes' climate variability over recent few decades, and are found to be most pronounced for Lake Superior, the deepest of the Great Lakes, consistent with model predictions. Multiple climate regimes of the Great Lakes also play a crucial role in the accelerated warming of the lakes relative to the surrounding land regions in response to larger-scale global warming. We discuss the physical origin and characteristics of multiple climate regimes over the lakes, as well as their implications for a longer-term regional climate variability.