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A climatology of weather-driven mixing events in a dimictic Arctic lake

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For dimictic and polymictic Arctic lakes, mixing during the ice-free season is primarily controlled by the passage of cold fronts and their associated strong winds. At Toolik Lake, a Long Term Ecological Research site in Alaska, year-to-year variability in lake stability and mixing frequency has been considerable over the past 14 summers. Mixing is important for lake productivity, distributing dissolved gases and nutrients through the water column. Summertime Arctic warming might be expected to stabilize Arctic lakes such as Toolik, but the control of individual weather events on a season's mixing characteristics complicates the ability to predict trends in stability and mixing. With this motivation, this work aims to characterize weather systems that are conducive to mixing at Toolik. High resolution lake and meteorological data from the site were used to characterize mixing while atmospheric reanalysis data were used to describe the weather systems. Mixing events were first identified using an automated algorithm based on Lake Number and lake thermal structure. The algorithm identified mixing events that are separated by at least the timescale of weather systems, so that any given weather event should cause at most one mixing event. Because low Lake Number conditions typically highlight strong wind events, temperature profile data over time were used to identify thermocline deepening as a complementary indicator for mixing. Mixing events were found to be most often characterized by simultaneous occurrence of a low Lake Number condition and thermocline deepening. Once mixing events were identified, they were classified according to their corresponding atmospheric structures. Two primary weather system types with distinct characteristics were determined to be associated with mixing. The analysis suggests that changing the occurrence of these weather system types might change the summertime thermal structure of Toolik Lake, and by extension other lakes in the region.