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Climate variations in lake ice phenology and their implications to lake ecology

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Lake ice phenology consists of the dates of freezing and ice breakup. Long time-series exist of these dates in a number of lakes, and most of them show trends toward milder winters during the last 100 years. This work analyses the statistics of the time series for their physical interpretation. The results provide tools to understand variations in the past lake seasons and to make projections into the future. The freezing date is related to fall air temperature with correlation time scale depending on the lake depth. Ice growth depends primarily on air temperature and snow accumulation. Ice breakup depends on the maximum ice and snow thicknesses, solar radiation and air temperature; the onset of melting is the primary question. Warmer climate brings also qualitative changes to lake ice seasons by moving boundaries of ice climate zones. Then implications of the changing physical conditions to lake ecosystems are discussed. Future projections of lake ice phenology will also influence the ecology of lakes. Shorter ice seasons have less oxygen problems, and thinner snow and ice cover strengthen the light level in the water body in winter. Thinner ice is also more breakable and open water spots could come more frequent in future. Both qualitative and quantitative changes are anticipated.