Climate-related variations in mixing dynamics in an Alaskan arctic lake

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ABSTRACT: Mean epilimnetic temperatures from mid-June through mid-August in a small, arctic kettle lake had no trend from 1975 to 2008 and varied annually up to ±3° C relative to the mean Analysis of data from temperature arrays deployed on the lake from 1998 to 2007 showed that as mean summer temperatures shifted from 2.5° C below the mean, to the mean, and to 3° C abov the mean, deepening of the mixed layer during cold fronts decreased, average metalimnetic thickness increased from 2 to 5 m, maximum values of water-column stability increased fourfold, minimum values of Lake numbers (L_N) increased from ≤1 to 10, the metalimnetic coefficient of ed diffusivity (K_z) decreased from 10^{-5} m2 s^{-1} to 10^{-7} m2 s^{-1}, and time scales for mixing across the metalimnion increased from days to months. Mean surface temperatures and mixing regimes wer significantly correlated with mean air temperatures, but not with mean insolation, or mean wind speeds during summer. They also depended upon the frequency and persistence of events with higher winds, heating, or cooling. In summers with cold surface temperatures, the surface ener fluxes that induce mixing by heat loss were low but with frequent wind events heat was mixed downwards, leading to lower stability. The warmest surface temperatures resulted when atmospheric conditions led to persistent positive buoyancy flux in early summer and winds were elevated primarily on diel cycles as opposed to longer ones. Summers with cooler water temperatures and enhanced vertical mixing are linked to frontal activity and low atmospheric pressure near the northern Alaskan coast.