Climate control of the spring clear-water phase through the transfer of energy and mass to lakes

Dröscher, Iris, Alain Patoine, Kerri Finlay, Peter R. Leavitt

Limnol. Oceanogr., 54(6_part_2), 2009, 2469-2480 | DOI: 10.4319/lo.2009.54.6_part_2.2469

ABSTRACT: We analyzed decade-long time series of water transparency, algal abundance, zooplankton density, heat income, hydrology, and climate from six polymictic lakes of the northern Great Plains to determine how energy and mass transfers interact to regulate lake structure during the spring clear-water phase (CWP). Timing (date of occurrence) and intensity (Secchi transparency) of CWP were highly variable among lakes (mean lake-pair synchrony, S = 0.072, p = 0.53); however, CWP occurred in all lakes when water overlying the sediments reached 16.1° C ± 3.7° C and *Daphnia* cleared the water column of diatoms. At a decadal resolution, timing and intensity of CWP were correlated strongly and positively ($r2 > 0.90$, $p < 0.05$) with the net heat income (θ) and lake volume, but not with other independent lake, catchment, or climate features. Instead, at an annual resolution, the strength of correlations between CWP characteristics and heat income ($r_{CWP-\theta}$) was itself correlated inversely with the winter index of the North Atlantic Oscillation ($r < -0.55$, $p < 0.05$) and with precipitation during February-April ($r < -0.675$, $p < 0.05$). We conclude that the transfer of energy interacts with lake volume to regulate differences in timing and intensity of CWP among lakes, whereas the transfer of mass overrides energetic regulation to introduce temporal variation in CWP characteristics among years.