Convective water exchanges in a wind-sheltered littoral region of Eau Galle Reservoir, Wisconsin USA

William F. James and John W. Barko

With 8 figures in the text

Abstract: Rates of convective water exchange were estimated for periods of differential cooling from a heat budget model, based on detailed changes in water temperature at stations positioned along the littoral slope of the macrophyte-occupied southwest embayment in Eau Galle Reservoir, Wisconsin. Differential cooling and convective water exchanges occurred nightly over a study period of 14 days in August, 1991. Although wind speeds were negligible during most of the nights, estimated rates of convective exchange (grand mean = 0.00066 m³ m⁻¹ s⁻¹) were sufficient to result in a residence time of only ~1 day in this embayment. Rates of convective exchange calculated via a heat budget model in 1991 were very similar in magnitude to rates measured in 1989 in another embayment of Eau Galle Reservoir using dye as a tracer for water movement. Our results suggest that substantial horizontal water movements and solute transport can occur in the absence of wind in vegetated littoral regions of lakes.

Introduction

In addition to serving as a sink for nutrients (Moeller & Wetzel 1988, Anderson 1990, James & Barko 1990), the littoral zone can also be an important source of phosphorus (P) and other nutrients to the pelagic zone of lakes and reservoirs. For instance, rooted submersed macrophytes in the littoral zone can mobilize sediment P directly by root uptake and senescence (Barko & Smart 1980, Carpenter 1980) and indirectly by increasing the pH in the water column during photosynthesis, thereby stimulating P release from sediments through enhanced ligand exchange with iron hydroxide particles (Boström et al. 1982, Drake & Heaney 1987, James & Barko 1991, James et al. 1996). Mobilized P can be transported horizontally from the littoral to the pelagic zone via wind-driven and convective circulation (Weiler 1978,