Topographic effects on thermal circulation in Himalayan glacial lakes

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The thermal structure of two Himalayan glacial lakes, Tsho Rolpa and Imja in Nepal, was examined by observations in the pre-monsoon seasons of 1996 and 1997. Tsho Rolpa had an isothermal surface layer 15 to 20 m thick, whereas Imja possesses no isothermal layer. This difference in thermal structure is explained by condition that diurnal valley winds, producing wind-driven currents, blow strongly near the water surface of Tsho Rolpa, but very weakly near that of Imja. The wind observations at ca. 2 m above the top of the end moraine indicated that strong, diurnal valley winds and weak, nocturnal mountain winds are common to the lakes. It was suggested that the weak wind near the surface of Imja results from topographic screening effects of the upwind dead-ice zone and end moraine 20 to 25 m higher than the water surface. In order to ascertain the topographic effects, three-dimensional numerical simulation of airflow was carried out by making topographic models of actual size in the calculation domain, corresponding to Tsho Rolpa and Imja and their surrounding topography. The simulation revealed that, when winds blow with constant velocities of 1 to 5 m s-1 at 2 m above the points corresponding to the weather stations, the wind velocity at 2 m above the surface for Imja is 33 to 42 % smaller than for Tsho Rolpa. The consistently small wind velocity in Imja, resulting from the screening effect, may cause the isothermal surface layer or wind-driven thermal circulation to undevelop. It is concluded that not only the height of end moraine but its three dimensional shape, including the dead-ice zone, can affect the wind velocity near the lake surface.