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Application of terrestrial scanning LIDAR to study the evolution of ice-contact Miage Lake and Miage Glacier ice cliff (Mont Blanc massif, Italy)

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Several alpine glaciers have recently been affected by unusual hydrological phenomena, in particular the formation of lakes which may attain large volumes (e.g. the supraglacial Effimero Lake developed on the Belvedere Glacier, Monte Rosa massif, Italy, or the ice-contact lake which has developed on the Rochemelon Glacier, Vanoise massif, France). In contrast to these recently-formed lakes, ice-contact Miage Lake (Mont Blanc massif, Italy) has existed since at least the 18th Century). It is located at 2020 m asl on the southern margin of the Miage Glacier, which is the third largest Italian glacier (11 km2) and one of the main debris-covered glaciers of the Alps.

Recently, interest in the lake (36,000 m2; maximal depth: c. 30 m) has been renewed especially in the context of natural hazards associated with the dynamics of Miage Glacier. Terrestrial scanning LIDAR (LIght Detection And Ranging) surveys represent nowadays the most powerful tool to accurately map its inaccessible surfaces. A laser scanner enables researchers to capture laser range data at a rate of thousands of x, y, z and laser-intensity points per second; such data can be used to construct a very accurate 3D model of the surveyed surface. In July 2003, June and September 2004, June and September 2005, and June and October 2006, seven terrestrial scanning LIDAR surveys have been carried out in order to monitor the evolution of the subaerial ice cliff bounding to the north the lake.

The comparison between repeated surveys showed significant retreats of the ice cliff during summer under normal conditions (e.g. 45 m between the end of July 2003 and the beginning of September 2004), while advances of the ice cliff occurred during

winter. A drainage of the lake took place in early September 2004. A laser scanner survey provided data for constructing a DEM of the exposed lake bed, which is ice-floored in the ice cliff area. By subtracting this DEM from a flat surface representing the pre-drainage lake level, the overall drained volume of the lake (323 000 m3) was obtained. The lake has refilled during summer 2005, but not completely: the 2004 drainage modified the dynamics of the ice cliff in 2005 and 2006, with a major uplift of the ice-foot and a very reduced calving.