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# LIDAR application to volcanic areas: Mt.Etna and Stomboli volcanoes (Italy)

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DEMs derived from LIDAR data are nowadays largely used for quantitative analyses and modelling in geology and geomorphology. In recent years, LIDAR technology has also been extensively applied in volcanology, where accurate DEMs are required for precise morphometric and volumetric measurements of volcanic features. We have performed several airborne LIDAR surveys at Mt. Etna volcano (2004, 2005, 2006 and 2007) and a survey at Stromboli volcano (2005). In general, LIDAR data are largely affected by systematic errors. The removal of these errors usually produces a great improvement in the DEM quality. In our case, LIDAR data have been corrected using a procedure that does not require a priori knowledge of the surface, such as the presence of known ground control points. Systematic errors are detected on the basis of distortions in the areas of overlap among different strips. Discrepancies between overlapping strips are assessed at a number of chosen computational tie points. At each tie point a local surface is constructed for each strip containing the point. Displacements between different strips are then calculated at each tie point, and minimization of these discrepancies allows the identification of major systematic errors. These corrections are particularly important for certain studies at Mt. Etna, in which it is essential to detect submetric vertical variations in time. We show some examples in which the corrections applied proved to be crucial, such as the calculation of volumes emplaced by recent lava flows; the calculation of the volumes of erosion and deposition of recently formed pyroclastic cones; and the mapping of the areas newly covered by ash by either detecting changes in volume, changes in surface roughness or changes in the LIDAR intensity return signal.
During the 2004 Mt. Etna survey an effusive eruption was ongoing and it was thus possible to describe in detail the mophological features of an active lava channel. The 2006 Mt. Etna LIDAR survey was planned during another effusive eruption: a very complex active lava field has been quantitatively investigated using a time sequence of airborne LIDAR data. In particular on the morning of the 18th November 2006, ten overlapping strips, about every ten minutes, map two hours of evolution of the lava fields. These data show how multitemporal LIDAR data on active lava flows acquired over short intervals are ideal for the study and detailed quantification of all morphological changes: overflows, the advance of flow fronts, volume flow pulses along channels, etc.
In order to improve the capabilities of LIDAR in terms of surface mapping, the information derived from the back scattered laser energy (intensity) have been investigated. LIDAR intensity maps were used for the identification and mapping of different lava flows: the intensity information was used to compare the lava flows with respect to their age of emplacement; analyzed lava flows vary in age between those dating prior to A.D. 1610 and those active during the survey (2004–2005 eruptions).