Deformation analysis of the Snow MicroPen using Particle Image Velocimetry.

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Particle image velocimetry was used to determine the deformation beneath and adjacent to the tip and the cylinder of the Snow MicroPenetrometer (SMP) as it moved through a layered snowpack. The Snow MicroPen was inserted into a snowpack contained in a 0.156 m^3 sample of snow in an aluminum cube with a clear lexan side. The SMP consists of 12 mm diameter cylinder with a tapered cone attached to a tip with a base diameter of 5 mm. 250 penetration force measurements per millimeter were measured at the cone tip, with an accuracy of 0.01 N. The displacement of the surrounding snow caused by the Snow MicroPen was calculated using particle image velocimetry (PIV) in which particle paths are traced with a rapid sequence of digital photographs. The Snow MicroPen was inserted into the snow at varying distances from the visible edge of the snow to investigate the size of the zone of influence of the SMP. Horizontal influence of the SMP cylinder ranged from 1 mm to 10 mm beyond the edge of the cylinder. Deformation by the tip of the Snow MicroPen appears to affect the snowpack in both the horizontal and vertical directions from the tip surface by approximately the same order of magnitude as the size of the tip (~5mm). A separate PIV experiment was performed using an indenter similar to a ski, on sample of the same snow. Mechanical properties are estimated from both indentation experiments, which occur at very different length scales, and are compared.