Uncertainty analysis of flow velocity measurements using LDA and ADV in laboratory experiments

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Abstract. Velocity profiles for open channel flow are measured in a smooth laboratory flume using a Laser Doppler Anemometer (LDA) and an Acoustic Doppler Velocimeter (ADV). The LDA used in this experiment measures two dimensional point velocities by optical techniques with lasers in a nonintrusive manner. Although the LDA is widely regarded as one of the most accurate flow measuring devices due to high temporal resolution, its complexity and sensitivity render it difficult to use in field applications. The ADV in this experiment yields a three dimensional point velocity measurement using acoustic signals. The ADV system is a more intrusive device that is known to be less accurate than the LDA and is not feasible for measurements near boundaries, however, due to its durability and user friendliness, it is widely used for flow measurements in the field. In this work, a comparative study of performance of both the LDA and ADV is presented for different flow configurations. The flow condition is varied by changing slope, discharge, or depth, and hence, different Reynolds numbers. Velocity components are measured for both the instruments at a corresponding sample volume at concurrent time along the streamline and vertical directions. An uncertainty analysis is performed to determine error bounds between the two different measurement techniques. This study aims to provide a basis for comparison between LDA and ADV measurements in turbulent flows.