Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Characterization of turbulent flow structures in the atmospheric boundary layer through super-large-scale particle image velocimetry

MICHAEL HEISEL, YUN LIU, TEJA DASARI, ALEC PETERSEN, JIARONG HONG, FILIPPO COLETTI, MICHELE GUALA, Saint Anthony Falls Laboratory, University of Minnesota — Super-large-scale particle image velocimetry (SPIV) using natural snowfall has previously been shown to be a reliable field measurement technique for near-surface atmospheric flows (Toloui et al. *Exp. Fluids*, 55:1737, 2014; Hong et al. *Nature Comm.* 5:4216, 2014). Here we present results from SPIV measurements in the thermally neutral atmospheric surface layer. The data were collected at the EOLOS field station over relatively flat, snow-covered farmland, allowing the development of a fully rough wall boundary layer with a Reynolds number $Re_\tau \sim \mathcal{O}(\infty\prime)$. The data include three time-resolved 15-minute acquisition periods with a field of view extending from 3 m to 19 m above the ground and up to 14 m wide. The flow statistics are validated and supplemented by sonic anemometry from a meteorological tower immediately downstream of the SPIV field of view. The time-resolved planar measurements provide temporal and spatial characterization of key wall turbulence features at high Reynolds number, including ramp-like structures, spanwise vortices, and uniform momentum zones. In comparing the findings to laboratory studies, Reynolds number similarity and the scaling behavior of characteristic properties are discussed.

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Date submitted: 28 Jul 2017 Electronic form version 1.4