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Large-Scale Particle Image Velocimetry (LSPIV) of aeolian sand transport patterns

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This paper presents results of laboratory testing and proof-of-concept field deployment of large-scale particle image velocimetry (LSPIV) using a consumer-level digital video camera to measure advection velocities of streamers and sand transport patterns over a beach surface. The LSPIV algorithm developed in this study employs interrogation windows of ten different sizes to resolve the displacement vector field at a range of scales. Laboratory testing shows that the vertical downward velocities and accelerations of falling batches of sand measured with the LSPIV method agree very closely with the theoretically predicted fall velocities and accelerations. The field experiment was successful in recording the advection of streamers at a frequency of 25 Hz over a field of view of 1.3×1.6 m2 and over a period of 144 seconds. The vector field of streamer propagation could be resolved to a scale of 108 mm, exhibiting a mean advection speed of 4.01 m/s. Individual time-series segments however reveal that speeds fluctuate continuously between 3 and 7 m/s and with directional variability of 15-20°. Because of the experimental design these advection results may be representative of horizontal flight velocities of the saltating grains. 2D variograms and a time-space collage indicate length and time scale characteristics of streamers that are largely in line with previous studies. The high spatio-temporal variability of the measured advection and the lack of any link between local propagation speeds and grain cloud densities inside streamers confirm the importance of measuring boundary layer turbulence concurrently with the small-scale sand transport dynamics.