EGU22-9982
https://doi.org/10.5194/egusphere-egu22-9982
EGU General Assembly 2022

Measuring turbulence in a natural boundary layer using a field-based particle tracking velocimetry system

Christy Swann[1], Callum Gray[2], Edward Braithwaite[1], Charles Key[1], Sarah Trimble[1], and Madeline Kelley[1,2]

[1]Naval Research Laboratory, Sediment Dynamics Section, Stennis Space Center, United States of America (christy.swann@nrlssc.navy.mil)

[2]La Vision, Inc., Ypsilanti, MI

Existing aeolian transport models often fail in field environments. The discrepancy between models and prediction has been attributed to inadequate field measurements and uncertainty in the general knowledge of the fundamental physical processes (turbulence) driving sand transport. The main challenges of measured and modeled aeolian transport include (1) coarse resolution measurements (relative to fluid-grain scale physics) made with obtrusive instrumentation that disrupt natural fluid and sediment flow, (2) an inadequate understanding of the fundamental physical relationships between turbulence and sediment transport, and (3) the inability of aeolian transport models, derived from wind-tunnel observations, to simulate natural boundary layer processes at the appropriate field scales (mm - cm).

Here, we introduce F-PTV, a Field-based Particle Tracking Velocimetry system. The field-based system is capable of providing the first unobtrusive measurements of turbulence and the resulting sand transport by wind in a field environment and consists of 3 integral components: (1) an illuminated volume, (2) neutrally-buoyant seeding material in the form of helium bubbles, and (3) 4 high speed cameras. The 527 nm laser and 4, high-resolution, high-frame rate cameras are mounted on rigid frames to be deployed on the subaerial beach. The laser beam is directed to the surface through a fiber-to-volume optics collimator at a height of 2.23 m and directs a defocused beam vertically down to create an ellipsoidal cone of light over the sampling area. At 1200 frames per second, the cameras capture the scattered light from helium bubbles and sand particles passing through the illuminated volume, enabling us to track individual helium bubbles and sand grains. The F-PTV system has the capability to provide the first unobtrusive observations of turbulence and transport in a field environment.