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Averaging interval selection for the calculation of Reynolds shear stress for studies of boundary layer turbulence.

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It is widely recognised that boundary layer turbulence plays an important role in sediment transport dynamics in aeolian environments. Improvements in the design and affordability of ultrasonic anemometers have provided significant contributions to studies of aeolian turbulence, by facilitating high frequency monitoring of three dimensional wind velocities. Consequently, research has moved beyond studies of mean airflow properties, to investigations into quasi-instantaneous turbulent fluctuations at high spatio-temporal scales. To fully understand, how temporal fluctuations in shear stress drive wind erosivity and sediment transport, research into the best practice for calculating shear stress is necessary.

This paper builds upon work published by Lee and Baas (2012) on the influence of streamline correction techniques on Reynolds shear stress, by investigating the time-averaging interval used in the calculation. Concerns relating to the selection of appropriate averaging intervals for turbulence research, where the data are typically non-stationary at all timescales, are well documented in the literature (e.g. Treviño and Andreas, 2000). For example, Finnigan et al. (2003) found that underestimating the required averaging interval can lead to a reduction in the calculated momentum flux, as contributions from turbulent eddies longer than the averaging interval are lost. To avoid the risk of underestimating fluxes, researchers have typically used the total measurement duration as a single averaging period. For non-stationary data, however, using the whole measurement run as a single block average is inadequate for defining turbulent fluctuations.

The data presented in this paper were collected in a field study of boundary layer turbulence conducted at Tramore beach near Rosapenna, County Donegal, Ireland. High-frequency (50 Hz) 3D wind velocity measurements were collected using ultrasonic anemometry at thirteen different heights between 0.11 and 1.62 metres above the bed.

A technique for determining time-averaging intervals for a series of anemometers stacked in a close vertical array is presented. A minimum timescale is identified using spectral analysis to determine the inertial sub-range, where energy is neither produced nor dissipated but passed down to increasingly smaller scales. An autocorrelation function is then used to derive a scaling pattern between anemometer heights, which defines a series of averaging intervals of increasing length with height above the surface. Results demonstrate the effect of different averaging intervals on the calculation of Reynolds shear stress and highlight the inadequacy of using the total measurement duration as a single block average.

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