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Velocity profiles, Reynolds stresses and bed roughness from an autonomous field deployed Acoustic Doppler Velocity Profiler in a mixed sediment tidal estuary

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Estuaries are among some of the most important global landscapes in terms of population density, ecology and economy. Understanding the dynamics of these natural mixed sediment environments is of particular interest amid growing concerns over sea level rise, climate variations and estuarine response to these changes. Many predictors exist for bed form formation and sand transport in sandy coastal zones; however less work has been published on mixed sediments. This paper details a field study which forms part of the COHBED project aiming to increase understanding of bed forms in a biotic mixed sediment estuarine environment. The study was carried out in the Dee Estuary, in the eastern Irish Sea between England and Wales from the 21st May to 4th June 2013. A state of the art instrumentation frame, known as SEDbed, was deployed at three sites of differing sediment properties and biological makeup within the intertidal zone of the estuary. The SEDbed deployment consisted of a suite of optical and acoustic instrumentation, including an Acoustic Doppler Velocity Profiler (ADVP), Acoustic Doppler Velocimeter (ADV) and a three dimensional acoustic ripple profiler, 3D-ARP. Supplementary field samples and measurements were recorded alongside the frame during each deployment.
This paper focuses on the use of new technological developments for the investigation of sediment dynamics. The hydrodynamics at each of the deployment sites are presented including centimetre resolution velocity profiles in the near bed region of the water column, obtained from the ADVP, which is presently the only autonomous field deployed coherent Doppler profiler . Based on these high resolution profiles variations in frictional velocity, bed shear stress and roughness length are calculated. Comparisons are made with theoretical models and with Reynolds stress values obtained from ADV data at a single point within the ADVP profile and from ADVP data itself. Predictions of bed roughness at each deployment site are compared with ripple measurements obtained on site using a three dimensional acoustic ripple profiler, 3D-ARP. These results will later be used to validate laboratory studies in mixed sediments, carried out as part of the COHBED Project, and enable development of new bed from predictors for biotic mixed sediment environments.