Examining flocculation processes using multi-frequency acoustics

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The modelling of sediment transport is still a developing area and this is particularly true in environments where the process of flocculation occurs. In such environments modelling is underpinned by observations and the use of acoustic profiling systems to investigate water column hydrodynamics and suspended sediments is commonly employed (Sherwood *et al.*, 2011). In general to extract the suspended sediment concentration from the acoustic measurements, physical samples of the water column are collected and used to calibrate the acoustic system. This is a regular practice when ADCP backscattered signal levels are utilised to monitor suspended load. Problems arise in the interpretation of the suspended load from the backscattered signal in fine sedimentary environments if flocculation takes place. This occurs because the interpretation of the acoustic signals backscattered from the flocculating sediments is problematic due to a lack of understanding of the interaction of sound with flocs. This deficiency has impeded sound being used to extract quantitative suspended sediment parameters in suspensions containing flocs.

Fig. 1. A view over the mixed sediment River Dee estuary, UK, at sunset.

As a step towards practically solving acoustic scattering by flocculating suspensions, a relatively simple heuristic approach has been adopted. A model is presented for the interpretation of acoustic scattering from a suspension of fine sediments as they transition from primary particles, through an intermediate regime, to the case where low density flocs dominate the acoustic scattering. The approach is based on spherical elastic solid and elastic fluid scatterers and a combination of both (Thorne *et al.*, 2014). To evaluate the model the variation of density and compressional velocity within the flocs as they form and grow in size is required. The density can be estimated from previous studies; however, the velocity is unknown and is formulated here using a fluid mixture approach.

To assess the proposed model, predictions are compared with recently published laboratory observations of acoustic scattering by flocculating cohesive suspensions (MacDonald *et al.*, 2013). The results from this study and its application to using multi-frequency acoustic systems to investigate flocculation processes in an estuarine environment will be examined. The extension of the application of acoustics measurements to suspensions of sand-mud mixtures will also be explored. These developments will improve measurement techniques in flocculating environment, which, in turn, will contribute to improving our modelling capability in mixed sediment environments (Amoudry and Souza, 2011).

References

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