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Impacts of different hydrodynamic regimes on flocculation

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A number of activities carried out in coastal zones and estuaries are affected by sediment transport. Therefore, good knowledge of the processes involved is necessary to adequately manage these areas. Flocculation is a key process on fine sediment dynamics, which affects the effective particle size and settling velocity. The process is further complicated under the combined effect of currents and waves. This research seeks to improve our understanding of the flocculation process under the combined effect of currents and waves.
The study site is the Dee Estuary located in Liverpool Bay, United Kingdom. Measurements of volume concentration, grain size and current velocities near the sea bed were obtained from a mooring deployed between 12 February 2008 and 9 March 2008. Turbulent properties could also be calculated because of the fast sampling rate used for current velocities. Water samples were taken from a research vessel during the first two days of the study in order to calibrate moored instruments and convert volume to mass concentration. The observations almost covered two fortnightly periods and three different dynamic regimes can be distinguished: currents-only, combined waves and currents, and wave dominated.
During the currents-only regime, floc aggregation and breakup coincide with periods of low and high turbulent stress respectively. The combination of waves and spring tide currents makes the second regime and the floc breakup is most dominant when waves are higher than one meter and small flocs are found even with low turbulent stress from both waves and currents. The third regime is identified as wave-dominant during neap tides with current speed less than 0.25 m/s and waves of 1-2 meters height. In this regime the wave effect takes large sediment into suspension at the same time as small particle sizes from floc breakup. In this case the median particle size is strongly related to the wave height which means that a slight particle aggregation is still present.
The relationships between turbulent properties and median grain size appeared to have no difference between the three regimes until data separation in flood and ebb cycles was performed. Differences in behaviour and magnitude are clearly visible depending on the regime and flood and ebb cycles. Specifically, turbulent kinetic energy seems to be a better predictor for floc size than the widely used turbulent stress.
According to observations, the combination of currents, waves and tidal cycle has an important effect on the flocculation process and need to be taken into account in sediment transport modelling studies.