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Implications of inter-annual variation in bimodal wave climate on sediment fluxes on a gravel-dominated coast

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The Suffolk coast of eastern England has several morphological features that are consistent with a north to south littoral transport of gravel and sand. Orford Spit, which extends 10 km south from the Orford Ness foreland is a prime example of this. Additional evidence comes from the various estuarine inlets, which are all offset to south. Many of the shoreline management issues are the consequence of diminishing foreshore sediment volumes arising from unimpeded alongshore redistribution of material along much of the coast. Offshore, a series of ridges and banks have formed through the large-scale organisation of sand waves produced by the opposing shelf tidal currents that interact with waves propagating inshore. The offshore wave climate is strongly bimodal and variation between northeasterly and southerly wave directions drives significant, but often quite localised, day to day reversals in alongshore sediment transport. The net-effect over an annual timescale appears to favour a southward transport in most (though not all) locations. It is clear, however, that inter-annual variability in offshore bimodality is also significant and has the potential to force transitions from southward to northward alongshore sediment flux. To investigate this, we implement a regional SWAN wave model to explore the consequences of inter-annual wave climate variability for alongshore sediment flux. Modelling is accomplished using a 50 m grid for the entire 70 km long Suffolk shoreface and shoreline. Specific northeasterly and southerly conditions are evaluated in the context of offshore and inshore wave observations, which provides confidence in the modelling approach and some quantification of the main uncertainties. Net annual fluxes are computed using a multi-simulation approach, drawing from a frequency distribution of the offshore wave climate across 10º direction sectors. Contrasting years are then investigated to demonstrate the significance of inter-annual changes in wave direction frequency on the spatial variability in alongshore transport direction. We also consider some of the implications for shoreline morphodynamics and management of the evolving shoreline planform configuration.