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Modelling the long-term morphological evolution of a coupled open coast, inlet and estuary system to explore climate change impacts

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Coastal and shoreline management increasingly needs to account for morphological change occurring at decadal to centennial timescales. Critical aspects of geomorphic behaviour at these temporal scales emerge at a system level, such that accounting for the feedbacks between different landform components is of key importance. In this study we develop new methods to simulate the large-scale evolution of a coupled open coast – inlet – estuary system, allowing us to explore the system's response to climate change impacts and management interventions.
The system explored here encompasses the Deben estuary (eastern England) and its adjacent shorelines. The estuary itself mainly consists of finer sediments. Sediments throughout the inlet, on the other hand, including the ebb-tidal delta itself, comprise a mixture of gravel and sand. The ebb-tidal shoals and sediment bypassing show broadly cyclic behaviour on a 10 to 30 year timescale. Neighbouring beaches consist of mixed sediment and are partially backed up by sedimentary cliffs, the behaviour of which is potentially influenced by the sediment bypassing at the inlet. In addition, the open coast has undergone major transformations as a result of numerous sea defences which have altered sediment availability and supply.
The interlinked behaviour of this system is approached by coupling a new inlet model (MESO_i) with an existing, and recently extended, model for the open coast (SCAPE+). MESO_i simulates the evolution at the mouth of the Deben at an aggregated scale, conceptualizing the inlet by different geomorphic features that are characterized mainly by their volume. The behaviour of the inlet shoals is influenced by the estuarine tidal prism, linking estuarine processes with inlet dynamics. SCAPE+ computes the shaping of the shore profile and has proven capable of providing valuable information in terms of decadal evolution and related cliff recession rates. Simulations conducted with this composition of models highlight the coastal system's sensitivity to different scenarios of sea level rise, changing wave climate, and different management strategies.