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# Hindcasting and forecasting macrofauna species distribution for the Jade Bay tidal basin (North Sea, Germany) in response to climatic and environmental changes

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During the last decades severe climatic and environmental changes have been monitored for the Jade Bay (German Wadden Sea), causing pronounced changes in the abundance and spatial distribution of characteristic benthic species. Due to their relatively sessile habit, benthic species are ideal organisms for small-scale species distribution modelling (SDM) and important indicators for environmental changes and disturbances. In a first step, the present distribution (representing 2009) was modelled for 10 characteristic macrofauna (> 0.5 mm) species, built on statistical relations between species presences and 11 high-resolution environmental grids. Here, five different presence-absence modelling algorithms were merged (GLM, GBM, RF, MARS, ANN) within the ensemble forecasting platform 'biomod2'. In a second step, the past distribution scenario was reconstructed for the 1970s in order to evaluate the hindcast model results with independent macrofauna data from the 1970s. In a third step, the future macrofauna distribution (representing 2050) was forecasted under potential future habitat conditions, i.e. ongoing sea-level rise and changing biogenic structures (seagrass and mussel beds). Submergence time and sediment characteristics correlated most significantly with the modelled macrofauna distribution at the study site, followed by nutrient supply and topography. The historical macrofauna data evaluated the past distribution scenario model results. Climate change induced sea-level rise and its local implications on the Jade Bay (increased sediment load, rise in the tidal height) explained the changes in the macrofauna distribution patterns since the last four decades. The forecast scenario revealed clear species distribution shifts, range size changes and niche overlap changes.