EGU24-6248, updated on 26 Jan 2025
https://doi.org/10.5194/egusphere-egu24-6248
EGU General Assembly 2024

A new UK scale ocean-wave-river modelling system for predicting extreme sea levels at the coast

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Extreme coastal sea level events are driven by various mechanisms, spanning a wide range of time scales. The long-term decadal and seasonal variability of mean sea level is combined at the coast with the seasonal variability of freshwater discharges, the daily scale of weather-related wave and surge events, and the semidiurnal to diurnal scale of astronomical tidal oscillations. Currently, future extreme sea levels are calculated as a combination of individually modelled sea surface height associated with storm surges and waves, tide and sea level rise, with number of limitations, e.g. the interaction between sea level rise and extreme sea surface height associated with storm surges, waves and tides is not taken into account. Progress in the modelling of the coupled coastal processes is urgently needed to predict how sea level rise will influence extreme sea level change at the coast and to ensure that design criteria for coastal protection are correctly specified, and hazard warning systems picks up potential disasters.

To reproduce the non-linear interactions between mean sea level, storm surge, tides and waves, we are developing an innovative high-resolution (500m) UK scale coastal ocean model based on the NEMO and WaveWatchIII systems (NEMO-WWIII UK500). This new configuration will include intertidal areas and processes (wetting and drying scheme); tides-surge-waves and sea level rise interactions; fully vertically resolved physics to include wave-current interactions and river plume dynamics; near-shore wave processes (wave set-up and run-up); sea level rise impact on tidal range/phase. NEMO-WWIII UK500 will provide predictions of water levels and waves conditions for present (fully validated by contemporary observations) and future scenarios.

The NEMO-WWIII UK500 will also provide a downstream boundary condition to the hydrological model JULES. This will enable the quantification of the effects of ocean water levels on rivers (backwater effect), which is important to lead to correct water levels in the transitional waters (e.g. estuaries and tidal rivers) which host a large proportion of infrastructure (e.g. ports, airports, power stations) and habitats of national and international significance.