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The impacts of wave-tide interaction on the coastal morphodynamics in changing climate

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The coastal area is one of the most vulnerable areas that is connecting lands and seas under the intensive human activities subjecting to the ocean forces. Nowadays, as the climate conditions are highly concerned, coastal morphodynamics, one of the most important elements for coastal areas, would become more uncertainty under the climate changes due to its non-linear interaction to the water forces. Therefore, an investigation of tide-wave-morphodynamic interactions is required by including sea level rise in order to involve various responses of morphodynamics to changing climate. In the conference, we will present results from our process-based coupled framework of tide-wave-morphodynamics modelling to consider the climate impacts on the morphodynamic changes in application on Wadden Sea of German Bight, which is one of the most vulnerable coastal areas subjects to sea level rise. The well-evaluated third-generation phase-resolved wave model WAVEWATCH III (WW3) is set up, coupled to the well-validated General Estuary Circulation Model (GETM) including the sediment transport and morphology modules. We applied ensemble-based simulations to reduce the uncertainties of climate effects in downscaling procedure. It is proved that this process-based model is capable for application on climate scenarios in a long term aspect as long as involving specific data analysis. It is desired that the process-based numerical investigation could be one of the most promising methods for studying the coastal morphodynamic responses to climate change as the physical processes could be examined straightforward for this non-linear interactions.

Based on the preliminary results from the framework, it is indicated that the wave could propagate further more under sea level rise while the currents are observed to be increased at some locations, particularly at the region (i.e. ebb flats) of North Frisian Wadden Sea (NFW). As a result, the NFW becomes more dynamic under the sea level rise conditions especially at the intertidal areas, whereas the Elbe mouth might has less exchange of sediment far field to east and north Frisian Sea but might be highly dynamic in local, which is much similar to the pattern of observed datasets. The dam
that connecting Sylt and main land, interested by lots of previous studies, also shows impact on both hydrodynamic and morphodynamic pattern under climate conditions. Based on the sea level rise scenarios, the significance of bed level changes at most areas of German Bight would be more

serious
by keeping the identical pattern of morphological changes as that in present scenarios. However, it might also correlate to storminess, where we could looking in detail based on the process-based modelling. When considering the entire German Bight, it is found that the predominant forces from tide and wave might vary between the North Frisian Sea and East Frisian Sea due to the specific geometry. Tide-predominated and wave-dominated coastal system would be able to coexist in the German Bight. The detailed quantitative and qualitative results would be present in the conference.