EGU21-10937
https://doi.org/10.5194/egusphere-egu21-10937
EGU General Assembly 2021

High-resolution regional projections of sea level changes along Western European coasts during the 21st century

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Coastal regions are subject to an increasing anthropogenic pressure. Projections of coastal sea level changes are of great interest for coastal risk assessment and decision-making processes. Sea level projections are typically produced using global climate models. However, their coarse resolution limits the realism of the representation of coastal dynamical processes influencing sea level changes at the coast, potentially leading to substantial biases. Dynamical downscaling methods can be used to refine projections at regional scales by increasing the model spatial resolution and by explicitly including more processes. Such methods rely on the implementation of a high-resolution regional climate model (RCM).

In this work, we developed the IBI-CCS regional ocean model based on a 1/12° North Eastern Atlantic NEMO ocean model configuration. IBI-CCS includes coastal processes such as tides and atmospheric pressure forcing in addition to the ocean general circulation (dynamic sea level). This RCM is used to perform a dynamical downscaling of CNRM-CM6-1-HR, a global climate model (GCM) developed by the Centre National de Recherches Météorologiques (CNRM) with a 1/4° resolution over the ocean. CNRM-CM6-1-HR contributes to the Coupled Model Intercomparison Project 6th Phase (CMIP6). IBI-CCS is thus forced by the GCM ocean and atmospheric outputs at the lateral and air-sea boundaries. Several corrections were applied to the GCM forcings to avoid the propagation of climate drifts and biases into the regional simulations. The computations are performed over the 1950 to 2100 period for several CMIP6 climate change scenarios.

In order to validate the dynamical downscaling method, the regionally downscaled (IBI-CCS) and GCM (CNRM-CM6-1-HR) simulations are compared to reanalyses and observational datasets over the 1993-2014 period. These comparisons are performed at different time scales for a selection of ocean variables including sea level. The results show that large scale performances of IBI-CCS are better than those of the GCM thanks to the corrections applied. In addition, high frequency diagnostics are carried out and highlight for example that IBI-CCS sea level extreme events are similar to those of a reference regional ocean reanalysis. In a second phase, the RCM and GCM sea level rise projections are compared over the 21st century. These comparisons allow to investigate the impact of the model resolution and of a more complete representation of coastal processes for the simulation of projected sea level changes.