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Prospects for improving the representation of coastal and shelf seas in global ocean models

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The ability to accurately represent coastal and shelf seas in global scale ocean models represents one of the on-going challenges of ocean modelling, particularly when the global model is to be used in biogeochemical, climate and Earth System simulations. The motivation for this is, however, wide ranging and includes both upscaling and downscaling issues. The dynamic motivation includes dense water formation on high latitude shelves and cascading into the deeper ocean, lateral frictional/mixing effects, pinch points and exchange regions, whereas the biogeochemical motivation include carbon and nutrient cycling, shelf-ocean exchanges and land-sea coupling. Moreover, society interacts with the ocean at a local/regional scale for example through the exploitation of Living Marine Resources and the drive to achieve and maintain Good Environmental Status. Hence, global assessments of vulnerability to climate change and other large scale drivers require information at the scale of this interaction. Here, we review the physical processes prevalent in shelf seas globally and their scales, and provide a baseline assessment of three global model configurations (NEMO at resolutions of 1, 1/4 and 1/12 deg.) and a regional model (NEMO AMM7;~7km resolution) focusing on the NW European continental shelf. Then we discuss the options for improving on this position based on current and prospective modelling approaches. We contrast structured and unstructured (finite element and finite volume) approaches, highlighting some novel ways forward for both, including generalised grid methods and global nesting approaches. We conclude that a single solution is not available currently or on intermediate timescales that can accommodate both upscaling and downscaling for both the dynamics and biogeochemistry, particularly in an Earth Systems context; as is often the case the choice of approach remains context dependent. Instead, we match the various options with the original motivations and propose a suite of approaches.