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Scalability of the Finite-volumE Sea ice-Ocean Model, Version 2.0 (FESOM2)

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A study of the scalability of the Finite-volumE Sea ice-Ocean circulation Model, Version 2.0 (FESOM2), the first mature global model of its kind formulated on unstructured meshes, is presented. This study includes an analysis of main computational kernels with a special focus on bottlenecks in parallel scalability. Several model enhancements, improving this scalability for large numbers of processes, are described and tested. Three model grids at different resolutions are used on four HPC systems with differing computation and communication hardware to demonstrate the model's scalability and throughput. Furthermore, strategies for improvements in parallel performance are presented and assessed. We show that in terms of throughput, FESOM2.0 is on par with the state-of-the-art structured ocean models and in realistic eddy resolving configuration (1/10 degree resolution), it can produce about 16 years per day on 14,000 cores. This suggests that unstructured-mesh models are becoming extremely competitive tools in high-resolution climate modelling. It is shown that the main bottlenecks of FESOM2 parallel scalability are the two-dimensional components of the model, namely the computations of external (barotropic) mode and the sea-ice model.