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Ocean-biogeochemical model sensitivity in the Southern Ocean towards the development of the earth system model, CSIR-VR-ESM

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Modelling the earth system is a balance between available computing power and model complexity, particularly as an earth system model comprises of multiple individual, interacting numerical models each representing different system components such as the atmosphere, land and ocean. In addition, these models are run for very long periods to simulate hundreds of years of earth/climate evolution. For the development of the CSIR Variable Resolution Earth System Model (VR-ESM), we discuss the compromises of computation versus complexity made in configuring the ocean-biogeochemistry component.

The Southern Ocean is a key region for global carbon exchange: both physical and biological mechanisms drive carbon from the atmosphere to the surface ocean and then to the deep ocean and conversely. Our research shows that the spatial scales of the surface ocean dynamics are important in driving these exchanges, these range from the mesoscale O(10-100km) to the submesoscale O(1km). However, the ocean components of earth system models (and thus the associated biogeochemical model) were generally run at coarse resolutions of 100km or more, and have recently incorporated the mesoscale through model resolution. Submesoscale-resolving tends to be reserved for the local to regional ocean domain. Leveraging the representation of the necessary mesoscale and submesoscale ocean features over a global ocean with the computational power of the CHPC is a key decision in the configuring of VR-ESM. For the ocean model, this can be done by the choice of model resolution and/or the use of subgrid-scale parameterizations.

We have used the ocean-ice-biogeochemistry modeling platform NEMO to perform sensitivity tests using varying model resolution and subgrid-scale parameterizations in order to best represent the necessary ocean-biogeochemical dynamics in the Southern Ocean. This leads to optimizing the ocean model configuration in VR-ESM with consideration to cpus and wall time.

HPC content

The NEMO ocean-ice-biogeochemistry model compiles with the intel parallel studio. Output is stored in netcdf format. Model configurations range in size with vertical resolution and domain, for the most commonly used configurations: 2 million gridpoints on 6 nodes (144 cpus), 78 million gridpoints using 50 nodes (1200 cpus).

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