MPAS-seaice: A new variable resolution sea-ice model
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Introduction

• We have developed a new global resolution model that uses a variable resolution mesh.
• The model uses the Modeling for Prediction Across Scales (MPAS) framework [1].
• It is designed to reproduce the results of Los Alamos National Laboratory’s previous sea-ice model, CICE.

MPAS grids

• MPAS grids are Spherical Centroidal Voronoi Tessellations (SCVTs).
• These grids allow the regions of the domain to have increased resolution with a smooth transition region between high and low resolution regions (see figure 1).

Velocity solver

• The velocity solver of MPAS-seaice is a generalization of that used by CICE [2, 3]. The generalization allows the velocity solver to use arbitrary shaped polygonal cells instead of being restricted to quadrilaterals.
• The velocity solver solves the motion equation in an identical way to CICE except it uses more general basis functions for discretizing the internal stress.
• The internal stress tensor uses a variational principle to determine the divergence of stress operator that forms the internal stress tensor.
• The derivation of the internal stress is based on fact that over the entire domain, ignoring boundary effects, the total work done by the internal stress is equal to the dissipation of mechanical energy:

\[ \frac{\partial}{\partial t} \left( \int \sigma : \varepsilon \, dA \right) = \int \dot{W} \, dA \]

• The integral is performed by using basis functions to define velocity stresses and strain across each cell.
• Wadkmans basic functions are used for the polygonal cells (see figure 5).

Advection

• MPAS-seaice uses an Arakawa ‘B’ grid with velocity components collocated at cell vertices. A locally linear reconstruction of the previous time step tracer field is integrated over the departure region to determine the tracer value at the next time step.
• The method is second order accurate and efficient for large numbers of tracers.
• It has been extensively tested and displays low numerical diffusion (see figure 6).

Column physics

• Column physics are identical to CICE. (see figure 10).
• New grid partitions are being developed for improved performance (see figure 11).
• The model will be tested on variable resolution grids shortly.

Future work

• MPAS-seaice is being coupled into the Department of Energy’s new global climate model, the Accelerated Climate Model for Energy (ACME) [6].
• Fully coupled global climate simulations will begin next year with ACME.
• The model will be tested on variable resolution grids shortly.
• New grid partitions are being developed for improved performance (see figure 12). MPAS allows very flexible grid partitions between processes.

References