A prototype reversibly-staggered atmosphere-ocean coupled model for regional climate simulations

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This talk describes a prototype atmosphere-ocean coupled model based on a reversibly-staggered grid that is appropriate for global and regional climate simulations. Specifically, we modify the Conformal Cubic Atmospheric Model (CCAM) to include an in-line ocean model and evaluate its performance. CCAM is a semi-implicit, semi-Lagrangian atmospheric model based on the Conformal Cubic grid and can be stretched to have a regional focus by using the Schmidt transformation. CCAM employs a reversibly-staggered grid that pivots between Arakawa A and C grids, and was originally intended to improve the treatment of the Coriolis terms. However, it has been shown by McGregor (2005) that the staggered grid can also produce very good dispersion characteristics for both the atmosphere and ocean. Consequently we can use a common grid for both the atmosphere and ocean models, thereby eliminating message passing between the atmosphere and ocean components. Load balance issues are not noticeably exacerbated by the coupling strategy and the prototype model has produced 2 simulation years per day on 13,824 cores at 13 km resolution with coupling every 3 minutes in a single precision configuration, using a geometric multi-grid implicit solver for the atmosphere, ocean and sea-ice components. Furthermore, the coupled regional model can assimilate large-scale atmosphere and ocean circulation data from a host model using a convolution-based scale-selective filter. This filter can accommodate irregular coastlines and costs only 5% of the runtime in the 13 km resolution experiment by using a 1D approximation to the 2D filter. Some preliminary results are presented to demonstrate the potential capabilities of the prototype coupled climate model.