Abstract - 2024 WRF/MPAS Users' Workshop

Format: Poster

Title: A new software toolkit for creating and nesting variable-resolution MPAS-A meshes

To support the U.S. Environmental Protection Agency (EPA) in its development of air-quality models using the Model for Prediction Across Scales – Atmosphere (MPAS-A) model, a suite of software tools has been developed to improve and simplify the process required to create variable-resolution MPAS-A horizontal meshes and to add the ability to nest a variable-resolution regional domain inside a uniform background global mesh.

The original method for creating variable-resolution meshes requires a number of repetitive steps. In each step, a set of central generating points for a Spherical Centroidal Voronoi Tessellation (SCVT) is adjusted to fit the desired resolution pattern. Then, the Delaunay triangulation for the adjusted set is bisected with the resulting vertices serving as the set of generating points for the next step. These steps begin with a predetermined number of generating points in the initial set and are repeated until the final desired resolution is reached. Linux C-shell (csh) scripts have been developed to automate this repetitive process. In addition, the original Fortran programming used to adjust the generating points in each step has been modified to speed up the process, provide intuitive user-specified parameters to define the resolution pattern, and report additional information to assist the user in creating valid MPAS-A horizontal meshes.

EPA applications are typically focused on simulating atmospheric pollutants over the contiguous United States where proposed national pollution abatement strategies can be assessed. For various reasons involving efficiency and accountability, EPA desires to apply the MPAS-A regional modeling capability with lateral boundary values obtained directly from simulations performed on a uniform global mesh. Because the location and geometry of cells in a variable-resolution mesh do not match those of any uniform mesh, EPA has developed new software to select a set of generating points from a variable-resolution mesh to fit inside a hollowed-out set of generating points from a uniform global mesh with similar point density near the interface. A modification of Lloyd's method is then applied to the points in proximity to the interface to eliminate obtuse triangles in the dual mesh (Delaunay triangulation) and form a "nested" mesh composed of a variable-resolution inner region and a uniform global background. The resulting mesh can then be used to clip out a limited-area domain for regional simulations where a boundary zone exists with perfect geometric matching with cells in the outer uniform mesh.

Besides these tools to create and nest the SCVT generating point sets that define MPAS-A meshes, the software suite also contains structured csh scripts to create *grid.nc* mesh files, verify their quality, and identify the cells in a nested mesh that need to be included in a regional sub-domain for its boundary zone to match its parent outer mesh.

Each of these software tools and their logical relation to each other will be illustrated along with example scripts where users specify their controlling parameters.

The views expressed in this poster are those of the author and do not necessarily represent the views or the policies of the U.S. Environmental Protection Agency.