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Preparing for Exascale: Towards convection-permitting, global atmospheric simulations with the Model for Prediction Across Scales (MPAS)

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With strong financial and political support from national and international initiatives, exascale computing is projected for the end of this decade. Energy requirements and physical limitations imply the use of accelerators and the scaling out to orders of magnitudes larger numbers of cores then today to achieve this milestone. In order to fully exploit the capabilities of these Exascale computing systems, existing applications need to undergo significant development.

The Model for Prediction Across Scales (MPAS) is a novel set of Earth system simulation components and consists of an atmospheric core, an ocean core, a land-ice core and a sea-ice core. Its distinct features are the use of unstructured Voronoi meshes and C-grid discretisation to address shortcomings of global models on regular grids and the use of limited area models nested in a forcing data set, with respect to parallel scalability, numerical accuracy and physical consistency.

Here, we present work towards the application of the atmospheric core (MPAS-A) on current and future high performance computing systems for problems at extreme scale. In particular, we address the issue of massively parallel I/O by extending the model to support the highly scalable SIONlib library. Using global uniform meshes with a convection-permitting resolution of 2-3km, we demonstrate the ability of MPAS-A to scale out to half a million cores while maintaining a high parallel efficiency. We also demonstrate the potential benefit of a hybrid parallelisation of the code (MPI/OpenMP) on the latest generation of Intel's Many Integrated Core Architecture, the Intel Xeon Phi Knights Landing.