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ESCAPE 2: Energy-efficient SCalable Algorithms for weather and climate Prediction at Exascale

In the simulation of complex multi-scale flow problems, such as those arising in weather and climate modelling, one of the biggest challenges is to satisfy operational requirements in terms of time-to-solution and available energy without compromising the accuracy and stability of the solution. These competing factors require extreme computational capabilities in conjunction with state-of-the-art algorithms that can optimally suit the targeted underlying hardware while improving the convergence to the desired solution.

The European Centre for Medium Range Weather Forecasts (ECMWF) is leading the ESCAPE project funded by Horizon 2020 under initiative Future and Emerging Technologies in High Performance Computing. The ESCAPE projects include the development of new algorithms that are specifically designed for better energy efficiency and improved portability through domain specific languages. Both projects incorporate through ECMWF's project partners the expertise of leading European regional forecasting consortia, university research, experienced high-performance centres and hardware vendors.

This poster presents results obtained in the ESCAPE projects. The participating models IFS, ALARO, COSMO-EULAG, ICON and NEMO are broken down into smaller building blocks called dwarfs. These are then optimised for different hardware architectures and alternative algorithms are investigated. Algorithmic developments include the development of a multigrid preconditioner for the elliptic solver, semi-Lagrangian discontinuous Galerkin methods. The ESCAPE projects also investigate domain specific languages as an approach for performance portability and a new suite of weather and climate prediction benchmarks HPCW. In terms of code optimisations it was shown in ESCAPE 1 that GPU optimisation which takes full advantage of NVLink interconnect can provide a massive speedup (23x for spectral transform and 57x for MPDATA) if all computations are run on the GPU.

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