PSyclone: a code generation and optimisation system for finite element and finite difference codes

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The GungHo project, a collaboration between the Met Office, NERC and STFC was initiated to deliver a scalable, numerically accurate dynamical core. A novel separation of concerns for the software implementation of the dynamical core, written using finite elements, is being implemented. This approach distinguishes between three layers: the Algorithm layer, the Kernel layer and the Parallelisation System (PSy) layer. Together this separation is termed PSyKAl.

The Algorithm layer specifies the algorithm that the scientist would like to run (in terms of calls to kernel and infrastructure routines) and logically operates on full fields. The Kernel layer provides the implementation of the code kernels as subroutines. These subroutines operate on local fields (a set of elements, a vertical column, or a set of vertical columns, depending on the kernel). The PSy layer sits in-between the algorithm and kernel layers and its primary role is to provide node-based parallel performance for the target architecture. The PSy layer can be optimised for a particular hardware architecture, such as multi-core, many-core, GPGPUs, or some combination thereof with no change to the algorithm or kernel layer code. This approach therefore offers the potential for portable performance.

Rather than writing the PSy layer manually, STFC are developing a code generation system called PSyclone which can help a user to optimise the code for a particular architecture (by providing optimisations such as blocking, loop merging, inlining etc). PSyclone has recently been adopted by the GungHo project as part of their build system. PSyclone has been written in such a way that it can be modified for use with different API's and this approach has allowed it to be extended to finite difference Ocean models within the GOcean project.

In this talk the key features of the PSyclone system will be introduced and some initial performance results for two ocean benchmarks will be presented which illustrate the benefit of its use.