Progress towards a new CRM for E3SM-MMF

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The representation of clouds and other small scale processes in climate models is a major source of uncertainty that limits our ability to make accurate predictions of local and regional climate change. The multiscale modelling framework (MMF) approach seeks to improve this representation by embedding a cloud-resolving model (CRM) inside of each coarse global climate model (GCM) grid cell. This has the possibility of allowing a representation of small scales processes with high computational performance on modern supercomputing architectures, since the majority of the work is in the CRMs. Each CRM is independent and does not require parallel communication, so they can be run for example on the accelerators (GPUs and similar architectures) that dominate the processing power of modern supercomputers. In this talk, I will present recent progress towards the development of a new CRM model for use within the E3SM-MMF configuration. The main design goals of the new CRM are improved numerics and computational performance, with an emphasis on accelerators. The focus here will be on some novel numerical schemes, in particular the combination of weighted essentially non-oscillatory (WENO) approaches with a Hamiltonian formulation. This allows, for the first time, transport operators that are simultaneously high-performance, energy-conserving, high-order and oscillation-limited (and optionally positive-definite). This new scheme will be demonstrated in the context of the thermal shallow water equations in doubly periodic domains. If time permits, the extension of this approach to domains with boundaries and 3D equations (such as the anelastic equations) will be discussed.