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Hybrid Gyrofluid/Gyrokinetic Modeling of Tokamak Turbulence with GryfX NOAH MANDELL, Princeton University, BILL DORLAND, University of Maryland - College Park, EDMUND HIGHCOCK[1], University of Oxford, GREG HAMMETT, Princeton University — Gyrofluid models are more efficient than gyrokinetic models, but have a disadvantage in their potential lack of physics fidelity. Here we present three major improvements to the physics fidelity and speed of gyrofluid models, which we encapsulate in the GryfX gyrofluid turbulence code. First, we implement a new nonlinear closure to model the cascade of free energy simultaneously in $k_\perp$ and $v_\perp$ via nonlinear phase-mixing (NLPM). Second, we use a hybrid algorithm that improves zonal flow physics by simulating zonal flow modes with a fully gyrokinetic model. These two improvements bring heat flux predictions from nonlinear GryfX simulations into agreement with the gyrokinetic code GS2. Third, we implement the equations on modern heterogeneous computing platforms, both as a standalone simulation tool that exploits the power of GPUs and as a component of TRINITY (a transport modeling code for tokamaks). GryfX has a roughly 1,200 times performance advantage over GS2 due to the combination of GPU acceleration and the reduction of hundreds of velocity space grid points to six gyrofluid moments. This makes GryfX ideal for large parameter scans, and enables the use of the TRINITY-GryfX system for efficient multi-scale analysis of tokamak turbulence on transport time scales.

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