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Towards Exascale Direct Numerical Simulations of Multi-Stage Ignition and Turbulent Mixing in Diesel Jets[1] JACQUELINE CHEN, MARTIN RIETH, MYOUNGKE LEE, Sandia National Laboratories, ELLIOTT SLAUGHTER, SESHU YAMAJALA, SLAC Accelerator National Laboratory, ALEX AIKEN , Stanford University — Direct numerical simulations of multi-stage ignition in low-temperature surrogate diesel jets is used to study 'turbulence-chemistry' interactions governing cool flame propagation and turbulent diffusion and their role in accelerating low- and high-temperature ignition. The effects of varying the ambient temperature and oxygen concentration on mixture formation and combustion processes is quantified. Conditional statistics are presented showing the significance of turbulent diffusion relative to laminar flame propagation. These simulations are enabled by an asynchronous task-based programming model and runtime, Legion, which is used to obtain scalable performance of the Legion-S3D DNS code on Summit at the Oakridge Leadership Computing Facility. The Legion runtime is able to hide the memory latency by overlapping communication and computation and to optimize data movement. Refactoring Legion-S3D in Regent, a companion compiled language that maps directly onto the Legion runtime, simplifies and enforces the rules of the Legion programming model enabling domain scientists to write extensible code with sequential semantics.

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