Accelerating high-fidelity wild-fire simulations on Tensor Processing Units

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Wildfires pose serious threats to society, environment, and ecosystems. To examine the complex interaction of wildfires, arising from strong coupling precession between combustion, atmospheric flow, heat-transfer, topography, and fuel properties, we present a high-fidelity open-source simulation framework that uses the graph-based TensorFlow as programming paradigm for simulations on Tensor Processing Unit (TPU) compute architectures. The TPU architecture employs accelerated dense matrix multiplication, large high bandwidth memory, and a fast inter-chip interconnect, making it attractive for high-performance scientific computing. The simulation framework is integrated into an ensemble-simulation platform to support large-scale batch processing for parametric analysis. All simulations are executed on TPUs to enhance computational efficiency. The solver is demonstrated in simulations of various wildfire scenarios of increasing complexity, including prescribed fires, rotating fireline scenarios in canyon fires, and extreme fires with strong fire/atmospheric coupling.