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CAPTURING SUBGRID TEMPERATURE AND MOISTURE VARIATIONS FOR WILDLAND FIRE MODELING

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ABSTRACT

Coupled atmosphere-wildfire behaviour models, such as FIRETEC, leverage computational fluid dynamics to capture complex non-linear fire-atmosphere interactions. Processes ranging in scale from regional weather patterns to the combustion of fine-scale fuels strongly influence these fire-atmosphere interactions, driving wildfire behaviour. Many wildfire behaviour studies have focused on fires during extreme conditions (i.e., hot, dry, and windy), where dominant processes are resolved, and smaller-scale variations have less influence on fire behaviour. This has resulted in wildfire behaviour models primarily performing well for these cases. However, wildfire behaviour models can struggle in marginal conditions (e.g. prescribed burns and low-intensity fire), as the small-scale variations significantly influence fire physics while simultaneously operating at scales below grid resolution. Since wildfires occur on the scale of hundreds of meters, we must develop sub-grid parameterizations to capture the overall effects of these small-scale processes while maintaining computational efficiency. In an effort to generalize wildfire behaviour models and improve their overall performance, especially during marginal conditions, we have developed a new set of equations capturing the finer-scale subgrid variations in temperature and moisture. This is completed by leveraging approaches traditionally utilized in turbulence modeling, i.e., closure. The work presented here is the first phase of our research initiative that describes new methods and the initial results of simulations ranging from idealized wildfire scenarios to comparisons with simple experimental burns. Furthermore, we will describe the ongoing work which will expand these equations to a coupled solid-gas phase system that will ultimately be integrated into FIRETEC.

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