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Physical Process in Wildland Fire Spread at Fine Scales

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Many questions concerning wildland fire spread remain unanswered, hindering improvements in training and hazard mitigation as well as development of reliable physically-based predictions. To understand wildfire spread, experiments are required to understand ignition processes and burning characteristics of wildland fuels and have revealed some surprising results. For example, ignition of fine fuels depends upon intermittent flame contact driven by buoyant and inertial instabilities of the flame zone. Froude Number scaling of these processes suggests remarkable extension to large fires. With flame temperature nearly constant among free-burning hydrocarbon fires, it is expected that buoyancy-related behaviors of small and large fires will exhibit strong scaling, similar to those observed for puffing-frequencies of pool fires. Similarly, fluid behaviors of flame zones qualitatively resemble well-known meteorological phenomena related to atmospheric instabilities at large scales – Raleigh-Benard cells in clouds and longitudinal vorticity of air flows. By contrast, some characteristics of large fires seem to demonstrate behaviors distinct from small fires – especially energy release rates, because it is likely that the high velocity of air-flow induced by the pressure-field of large fires can increase fuel burning rates. Examples of changes in burning rates with ventilation can be demonstrated in the laboratory.