Understanding extreme merging bushfires through physics - Junction fire behaviour and dynamics at various scales

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Understand junction fire dynamics: physics of propagation, fire regimes, and the development of scaling laws across different scales.

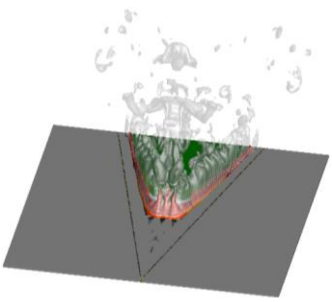
Extreme bushfires pose risks worldwide, with merging fires being particularly intense and difficult to predict. This research explores the physical mechanisms behind junction fires to improve our understanding of their complex behaviour and to develop scaling laws describing how they evolve across various scales.

Objectives

- Develop a thorough understanding of the complex dynamics of junction fires.
- Investigate the effects of slope angle, intersection angle, and wind speed on fire behaviour.
- Conduct a dimensional analysis of the problem based on Byram's Convective Number.
- Develop a robust modelling tool to simulate junction fires in detail and parametrise the problem to be incorporated in an operational models.

Methodology and Numerical Modelling

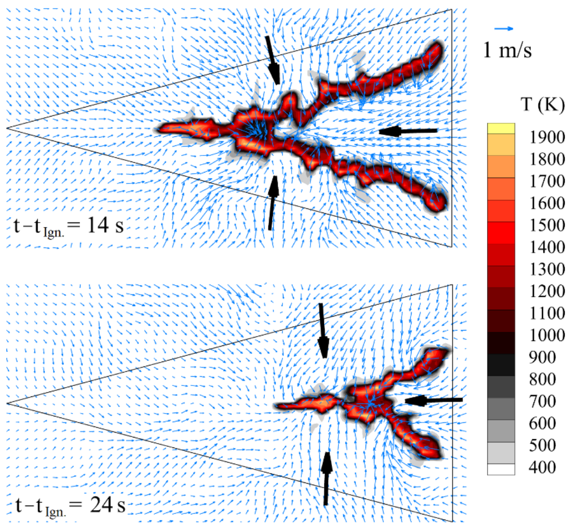
- Use FIRESTAR3D, a physics-based bushfire model that simulates various fire phenomena.
- Conduct numerical simulations replicating laboratory and field-scale experiments.
- Explore the effects of parameters such as slope angles, junction angles, wind speed, fuel moisture content, etc.
- Merge the results into a unifying scaling law.



Preliminary Results and Discussion

- FIRESTAR3D effectively reproduced experimental results, demonstrating its capability to simulate junction fires.
- The dynamics of junction fires were found to be strongly influenced by the properties of flow around the flames.
- On flat terrain with no wind, the deceleration in fire spread is caused by changes in flame inclination and trailing flame separation, which widens the angle between the junction-fire arms and results in a lower ROS.

We now aim to conduct a dimensional analysis to establish similarities between real-world wildfire scenarios and scaled-down experimental or numerical models. This would help develop effective wildfire management strategies, ultimately contributing to the protection of lives, property, and ecosystems from wildfires.



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