Studying firebrands using a vertical wind tunnel
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Where does this component of research fit?
One component of 'Fire behaviour under extreme fire weather conditions' is an investigation of *firebrand potential and spotfire initiation*, which is the likelihood of firebrand generation, spotfire ignition, and spotfire development into new bushfires.

This component is the study of firebrand aerodynamic and combustion characteristics in order to better understand their likely transport distances, and, for a given distance, what mass they will be and whether they will be flaming or glowing.

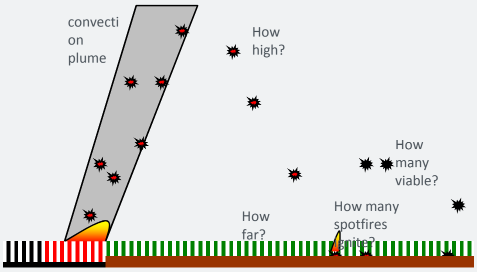
What are firebrands?

Flaming or glowing vegetative material, sometimes termed 'embers' carried ahead of a bushfire by its convection plume, and wind. Some firebrands ignite spotfires or structures.

Why is spotting a problem?
Spotting can make a bushfire uncontrollable, hazardous, expensive and deadly by;
•increasing its rate of spread
•'jumping' breaks in fuel
•multiplying the number of fires
•stretching firefighting resources
•making a fireground confusing
•igniting residences and infrastructure
•trapping firefighters and residents

What determines the size and nature of the problem?
•the number of firebrands
•the height to which they get lofted in the convection plume, and hence
•the distance to which they will travel
•the probability that they will ignite spotfires
•the speed at which the spotfires will develop

What characteristics should be measured in order to understand spotting potential of a particular firebrand type?



The above questions can be estimated using measurements and models of;
•the terminal velocity (falling speed), as the firebrand is burning
•its flameout time (flaming firebrands, versus glowing ones, have a very high probability of igniting a fuelbed)
•its burnout time
•how quickly its terminal velocity and mass are reduced as it burns (firebrands with low terminal velocities and which burn slowly can be transported long distances and still be alight on landing)

What is firebrand terminal velocity?
It's the speed at which a firebrand will fall in still air. Many firebrands have terminal velocities between 8 and 2 m s^{-1}.

Why is terminal velocity of a firebrand important?
Firebrands being lofted in the convection plume, or travelling with the wind, always have a relative airflow of velocity equal to the velocity they would have if falling in still air: their **terminal velocity**. A firebrand with a terminal velocity of 6 m s^{-1} has a relative air velocity of 6 m s^{-1}, if it is being lofted or if it is falling. This means two things:

1. Firebrand behaviour of a burning sample must be measured at its terminal velocity.
2. Knowing sample terminal velocity, and wind velocity, allows calculation of lofting height in a convection plume, and its travel distance when falling to the ground.

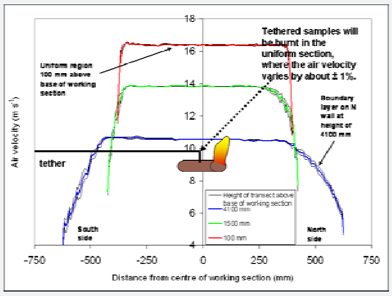
Which firebrand types will be selected for investigation?

Selection will be based on the notoriety of particular species, based on field observations, a study of spotting behaviour deduced from a CRC report of the Kilmore-East fire (Cruz *et al*. 2010), and consultation with our End Users.

Possibilities include flakes of stringybark and peppermint bark, long cylinders of bark from 'gum bark' types, twigs, leaves, fruit, charcoal and animal scat.

How will firebrand samples be investigated?
Firebrand samples will be burnt, untethered or tethered or, in the CSIRO vertical wind tunnel, for which the velocity of the airflow is accurately measured.

Tethered samples. Profiles of air velocity for airflow which has not been modified, and the position of a tethered firebrand sample for study.



Non-tethered samples. Profiles of air velocity for airflow which has been modified to allow the study of samples which are free to move.