# THE EFFECTS OF FIRE-PLUME DYNAMICS ON THE LATERAL AND LONGITUDINAL SPREAD OF LONG-RANGE SPOTTING

bushfire&natural HAZARDSCRC

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**HIGH-RESOLUTION NUMERICAL MODELLING IS USED TO EXPLORE HOW THE DYNAMICS OF BUSHFIRE PLUMES UNDER DIFFERENT WIND CONDITIONS CAN MODIFY: (I) THE DISTANCE TRAVELLED BY FIREBRANDS, AND (II) THE SPREAD IN LANDING POSITIONS OF FIREBRANDS. THIS RESEARCH WILL EVENTUALLY HELP US TO PREDICT MORE ACCURATELY WHERE FIREBRANDS MAY LAND, GIVEN THE PLUME STRENGTH AND WIND CONDITIONS.**

## MODELLING METHODOLOGY

We use a two-stage modelling process to estimate firebrand transport: **Firstly** we use the UK Met Office Large-Eddy Model (LEM) to perform high-resolution, time-varying, three-dimensional simulations of bushfire plumes, represented by a surface heat source, under weak (5 m $s^{-1}$) and strong (15 m $s^{-1}$) background winds. **Secondly** we use the velocity fields produced in the LEM plume simulations to perform Lagrangian particle transport calculations. Approximately 0.5 million particles with a fall speed of 6 m $s^{-1}$, representative of potential firebrands, were lofted from near the base of each plume and their positions tracked until they landed.

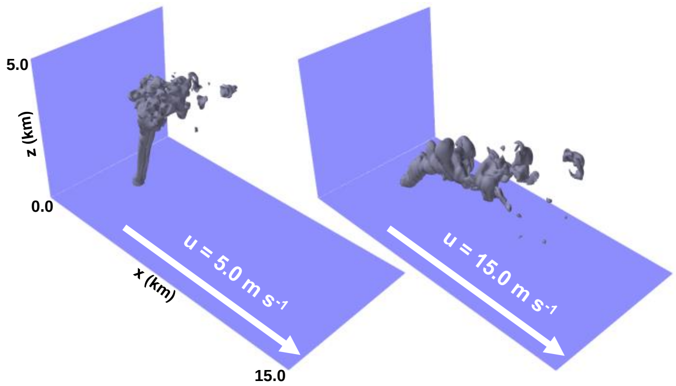


**Figure 1** Visualisation of the instantaneous passive-tracer field in bushfire plumes simulated with the LEM under (left) 5 and (right) 15 m $s^{-1}$ background wind speeds.

## PLUME DYNAMICS

Figure 1 shows the different structure of the two simulated plumes. Under weak winds the lower section of the plume is smooth and almost upright. Under stronger winds the plume is bent over and turbulent throughout, with a number of individual puffs visible. The smoother region of the weak-wind plume consists of a counter-rotating vortex pair, indicated by the bifurcation along the plume centreline.

## FIREBRAND TRAJECTORY CALCULATIONS

Figure 2 shows the trajectories of 100 individual firebrands, calculated for both of the simulated plumes. Trajectories in the 5 m $s^{-1}$ background wind plume fall into two distinct paths, due to the counter-rotating vortex pair. Trajectories in the 15 m $s^{-1}$ background wind plume have large longitudinal spread, falling in clumps due to the puffy nature of the plume.

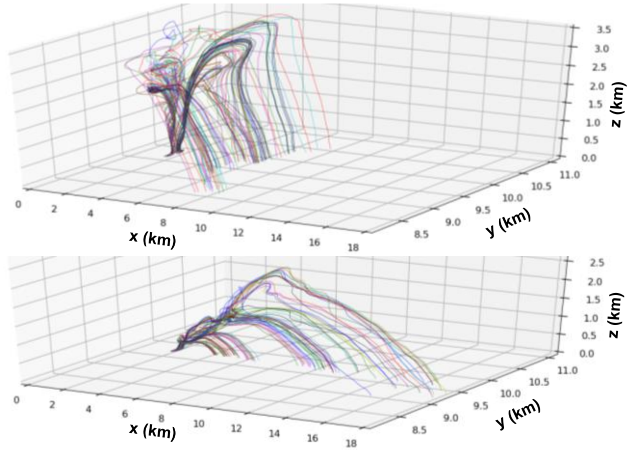


**Figure 2** Trajectories of firebrands lofted by plumes under (top) 5 and (bottom) 15 m $s^{-1}$ background wind speeds.

## FIREBRAND LANDING POSITION SPREAD

There are striking differences in the spatial distribution of firebrand landing positions for the two different plumes (Figure 3). Firebrands are carried much further and have much more **longitudinal spread** when lofted by the plume under 15 m $s^{-1}$ background winds. Firebrands lofted by the plume under 5 m $s^{-1}$ background winds have much larger **lateral spread**, landing within a v-shaped area, due to the counter-rotating vortex pair structure of the plume.

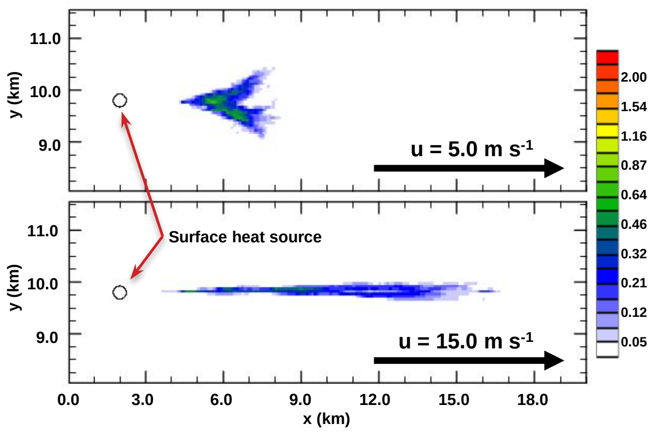


**Figure 3** Spatial distributions potential-firebrand landing position under (top) 5 and (bottom) 15 m $s^{-1}$ background wind speeds. Units: percent of particles launched per $km^2$.

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