Long-distance spot-fires: An empirical analysis

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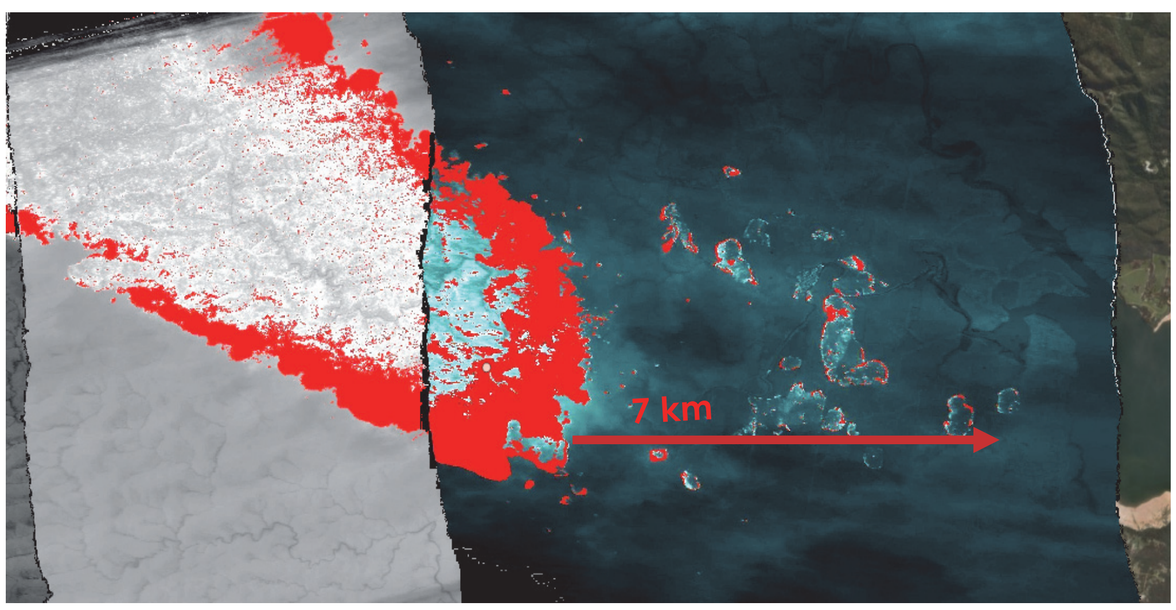
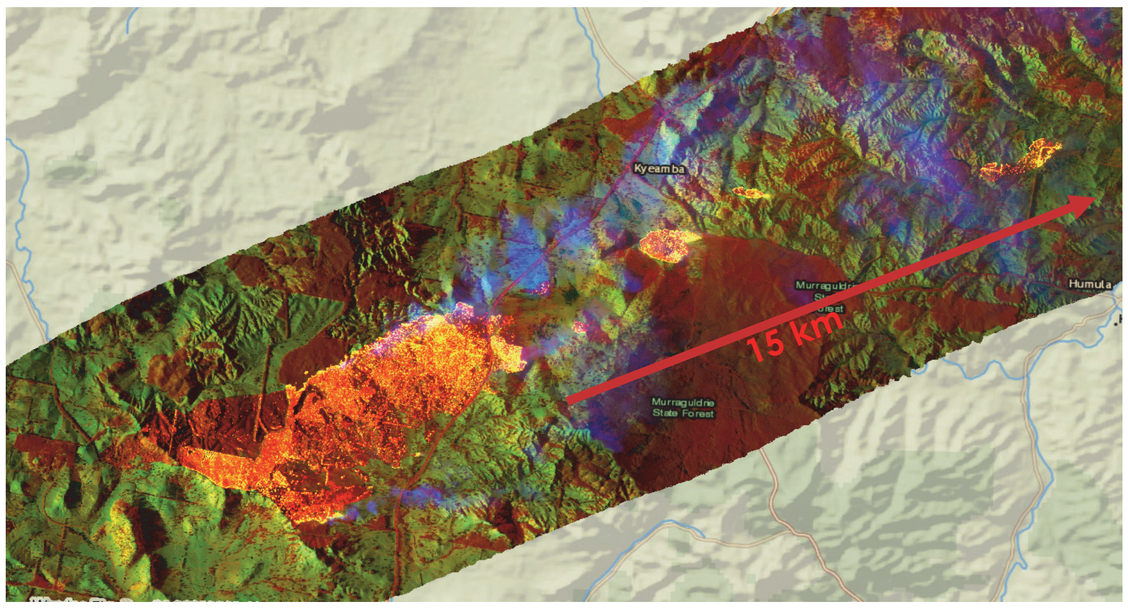
Bushfires can ignite spot-fires at very long distances downwind. The number and maximum distance of spot-fires are not necessarily correlated, and can vary widely between bushfires. Bushfire observations from infrared aerial mapping collected by fire agencies helps to understand the processes and quantify the risk factors.



Infrared line-scan showing a fire with numerous long-distance spot-fires. i.e. 48 spots > 500 m from source (DELWP: red = burning, white = recently burnt, grey = unburnt vegetation)



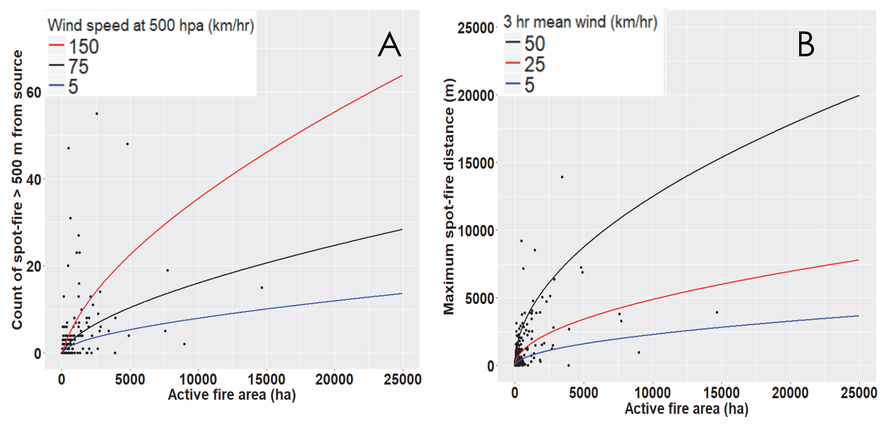
Multispectral linescan showing a fire with one very long-distance spot-fire, but few other spot-fires. Only 5 spots > 500 m from source (RFS and Air Affairs Aus.: Yellow = burning, orange = recently burnt, green = vegetation)

ANALYZING LONG-DISTANCE SPOT-FIRES

- A long-distance spot-fire ignites after pieces of burning vegetation are blown downwind of a bushfire, from 100s of metres up to many kms, to ignite new fuel.
- Infrared line-scanning equipment (RFS, DELWP, Air Affairs Australia) can "see" through smoke to create bushfire map images.
- We measured a set of 355 "source-fires" (the main fire) and their associated spot-fires using these images.
- We used spatial analysis techniques to match spot-fire measurements to data describing fuels, surface and upper level weather, topography and source-fire burning area.
- We have calculated statistical models (GLM) to help identify and understand the main drivers of a) the amount of long-distance spotting (no. spot-fires > 500 m from source), b) maximum spot-fire distance, c) any differences between models a and b.
- The data collected also allows us to describe spot-fire spatial distributions.

WHAT IS DRIVING LONG-DISTANCE SPOT-FIRE IGNITIONS?

- Spot-fire distance and number are generally exponentially distributed; spot-fires mostly ignite close to the source and become less common with increasing distance.
- The active (burning) area of the source-fire (log transformed) was by far the strongest predictor of both maximum distance and number of long-distance spot-fires, from the variables tested in statistical modelling.
- Fuel, weather and topography played secondary roles (although these influence burning area).
- Surface weather (wind, temperature) was important for maximum spot-fire distance, and upper level weather conditions (upper wind, temperature lapse) were important for long-distance spot-fire number.
- Some variables did not perform as well as expected: e.g. Bark Hazard Level and Forest Fire Danger Index. Vegetation height maps and individual weather variables (wind speed, temp) performed better in the models.
- The maximum distance model fit the data better than the spot-fire number model.



GLM modelling results showed that log transformed active source-fire area had the strongest influence on number of long-distance spot-fires (plot A) and maximum spot-fire distance (plot B). Different lines show how different levels of selected variables (plot A: upper level wind, plot B) surface wind) alter the relationship.

STILL TO DO

- Insights have been gained into long-distance spotting, but there remain gaps and significant outliers that require further investigation.
- Statistics will be finalized and a paper will be submitted for publication.
- Other projects will look at using line-scan data to investigate fire spread rates, and the influence of spot-fires on fire spread rates.

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