New Zealand research burn experiments test new theory on fire spread

It's a hot, windy February day - perfect conditions for fire (in the Southern Hemisphere). Twenty-seven scientists and several million dollars of specialised equipment are gathered in a paddock of harvested wheat stubble near Darfield, New Zealand.

This is the first phase of a four-year burning programme that will test a new theory on fire spread. The new theory was developed in the US Forest Service lab in Missoula, Montana, but this is the first time it's been fully tested in the field.

The project is an international collaboration between the Scion Rural Fire Research Team and University of Canterbury from New Zealand, and the Missoula Fire Sciences Lab and San Jose State University's Fire Weather Research Laboratory in the USA. The team will use the data being collected to help unlock the mysteries of fire behaviour and produce better models for how wildfires spread.

"This science just wouldn't be possible without this collaboration," says Scion senior fire scientist Grant Pearce. "The University of Canterbury brings meteorological expertise and drone capabilities, and the Americans bring expertise and unique instrumentation that we don't have here."

A member of the Scion fire research team observes fire spread during one of the stubble experimental fires.

Researcher Mark Finney from Missoula explains, "For decades, the conventional wisdom was that fire spread by radiated heat. We've done some tests that show fire spreads by convection - hot gas and flame that moves through the wind. We're trying to understand how that works and it's a challenging problem that involves not only heat transfer but also fluid mechanics and weather - we're trying to understand how all of these factors combine to allow a fire to spread."

As the stubble fire is ignited and sweeps across the paddock, the researchers are pleased to see the flames move past their sensors as planned. Most of the equipment has been designed and built by the people looking on.

A stubble experimental fire moves past a set of “in-fire” video cameras being used to monitor flame front dynamics and fire spread rate.

The Scion team has organised the field research, and has their own sensors laid out in the paddock and weather towers reaching up to record atmospheric details. The latter includes a 10m tower located in the centre of each burn block. This has thermocouples, as well as three ATI sonic anemometers (at 1.5, 5 and 10m), to measure fire-induced turbulence and flame and air temperatures as the fire front moves by, key factors for testing the convective fire spread theory. The research team have been very impressed by the capability and reliability of the ATI sonics, especially given the high temperatures they are being exposed to.

From a cherry picker just north of the field, University of Canterbury Geography researcher Marwan Katurji is looking after three infrared cameras, which are measuring the spatial changes in surface temperatures before, during and after the flame front spreads across the field. Quadcopter drones capture images from above that measure how fast the fire is moving.

A couple of hundred meters away, researchers from San Jose State University are sitting in the shade of a van, monitoring the Doppler LIDAR machine they have brought all the way from California. The LIDAR data will show the air movement above and around the fire.

A post-burn view of one of Scion’s 10m towers equipped with ATI sonic anemometers to measure three-dimensional air movements, and thermocouples to record vertical flame and air temperatures, as the experimental

fire moves by. A range of the US Forest Service team's equipment, including a flame height reference pole, in-fire cameras, heat flux and pressure sensors, and horizontal thermocouple arrays, can also be seen.

It's been a long hot day, but as the researchers pack their equipment away, they are pleased. "Everything's gone really well," says Jason Forthofer from the Missoula lab. "Most of the burns were almost perfect. We're getting great data."

Wildfire suppression and mitigation costs are increasing globally but, more importantly, they affect people's lives. Scion Rural Fire Research team leader Tara Strand explains why this research is important. "Extreme fires are becoming more common internationally, so we need to be more prepared. The better we understand fire spread, the better we can be at preventing the leap to extreme fire behaviour."

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