

Insights from ACCESS-fire simulations of a destructive fire-generated tornadic vortex at Green Valley, NSW on 30 December 2019

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The dynamic interaction between intense fires, topography and favourable atmospheric conditions during the extraordinary 2019/20 Australian bushfire season led to dangerous pyro-convective hazards, including fire-generated tornadic vortices (FGTV). One of these occurred in the late afternoon of 30 December 2019 at the Green Valley/Talmalmo fire in southern NSW. Tragically, it overturned a 12-tonne fire truck resulting in the death of a firefighter. Based on the damage to the truck, it is estimated that extraordinary wind speeds in the range 250-350 km/h occurred. The FGTV occurred within a deep, dry, well mixed boundary layer. Himawari-8 IR satellite images around the time of the FGTV, showed that the area of 'hot' fire grew significantly and that the pyro-convection deepened and bifurcated into separated convective towers. Simulations using the coupled fire-atmosphere model ACCESS-Fire showed deep vertical motion in the fire plume consistent with the satellite observations, and captured the transient, split convective towers near the head fire. A vertical cross-section through the north-eastern tower (along the direction of the ambient wind), shows a strong updraft above the leading edge of the fire front, light winds near the valley floor in the lowest few hundred metres, and a fire-front jet of ~20m/s attached to the nearby ridgeline. Simulated fields of the lowest kilometre vertical wind shear showed that the FGTV formed close to the axis of maximum shear, at around the time when the maximum shear value was reached. Along this axis, the background vertical wind shear in the valley was enhanced by shear due to the tilted fire updraft, providing a rich source of horizontal vorticity to be tilted and stretched vertically. Drawing from the observations, and insights from ACCESS-Fire, a conceptual model for the Green Valley FGTV is proposed, that may be applied to similar environments.