The role of blocking in extreme weather in Australia

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Slow-moving transient anticyclones are associated with high-impact weather in Australia, such as heat waves, fire weather, drought, and heavy rainfall. Rossby wave breaking and tropical-extratropical interactions frequently play a role in the development of these events, which may also combine spatially and/or temporally to form compound hazards.

Heat waves in southeastern Australia

Extreme temperatures in this region are commonly associated with overturning Rossby waves, leading to the formation of an upper-level anticyclone flanked by an upper-level trough (Fig. 1). The slow-moving surface high-pressure system causes surface heating due to adiabatic warming by descent, as well as advection of warm continental air from the interior. This pattern is also evident on days of high fire danger.

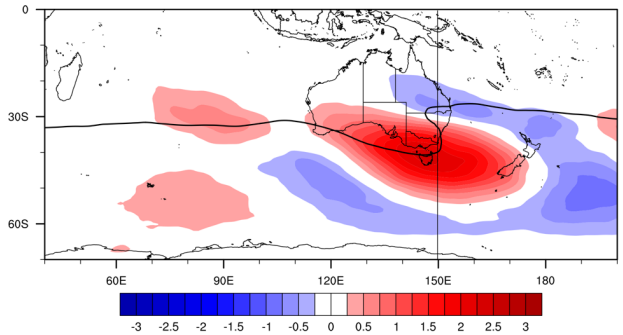

Figure 1: Composite 350-K PV anomaly for all heat wave days [PVU]. Thick black line shows −2 PVU contour.

Tropical cyclones, or strong convection, may affect heat wave development directly through the advection of anomalously anticyclonic PV into the anticyclone, or indirectly as the divergent outflow at upper levels perturbs the wave guide. Fig. 2 shows air parcel back trajectories from the upper-level anticyclone on 28 January 2009, at the start of the prolonged heat wave prior to the Black Saturday bushfires.

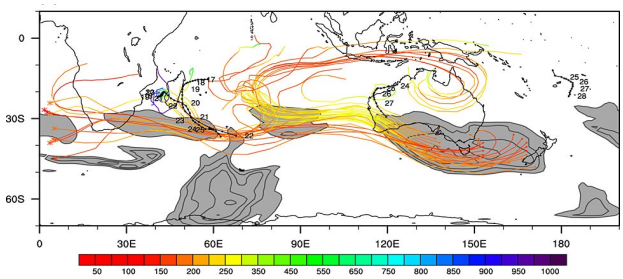

Figure 2: Air parcel back trajectories from the 350-K PV anomaly on 28 Jan 2009. Colours show trajectory height [hPa]. Tracks of named tropical cyclones are shown in black with dates indicated by the numbers.

Heavy rainfall over eastern Australia

The mean upper-level trough seen over northeastern Australia during heat waves in the southeast is also associated with enhanced rainfall, potentially compounding the hazards from extreme temperatures, fire weather, and heavy rainfall.

Heavy rainfall over the eastern seaboard is also associated with slow-moving coherent cyclonic PV anomalies. In contrast to fast-moving systems, these anomalies are detached from the stratospheric high-PV reservoir to the south, and the PV contours show well-defined overturning and anticyclonic wave breaking. A high amplitude trough at 500 hPa and cyclonic PV anomaly persist for several days, and there is a strong anticyclonic anomaly and associated upper-level ridge to the south of the continent, which are largely absent in the slow-moving cases. These PV dipoles are often the result of anticyclonic wave breaking and are associated with atmospheric blocking.

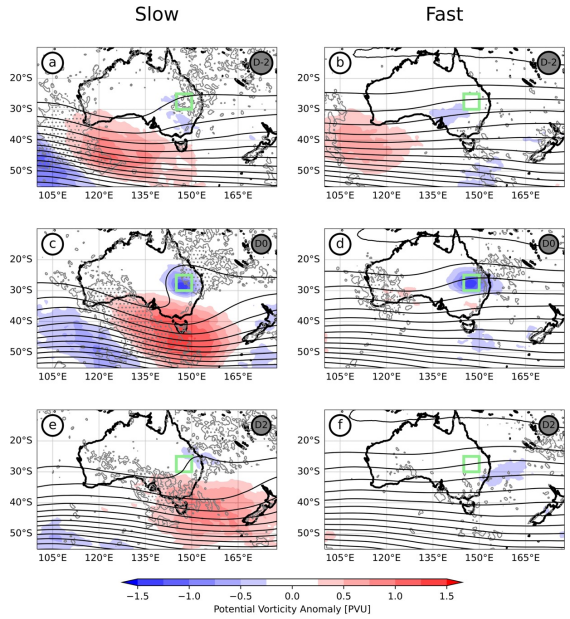

Figure 3: Composites for slow and fast coherent cyclonic PV anomalies. 500 hPa geopotential height (contours), 330 K PV anomalies (shaded), mean vertical motion anomalies 400-700 hPa (stippled).

Courtesy of Dr Michael Barnes, ARC CLEX, Monash University

FOR FURTHER INFORMATION

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