The dynamics of heat waves and hybrid cyclones in the Australian region

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Although heat waves account for more premature deaths in the Australian region than any other natural disaster, an understanding of their dynamics is still incomplete. This talk highlights the dynamical mechanisms responsible for heat waves in southeastern Australia using 10-day backward trajectories computed from the ERA-Interim reanalyses. Prior to the heat wave, trajectories located over the south Indian Ocean descend and aggregate over the Tasman Sea. This descent is accompanied by a strong adiabatic warming. A key finding is that the temperatures are raised further through diabatic heating in the boundary layer over eastern Australia but not over the inner Australian continent.

In the second part of the talk, I will shed light on the dynamics of hybrid cyclones (HCs) in a composite potential vorticity framework. A clustering of their upper-tropospheric structure reveals that HCs can be associated with a north–south elongated trough, a cut-off, and cyclonically breaking troughs. The effect of these features on the intensity is quantified using piecewise potential vorticity (PV) inversion. The maximum intensity of cyclones associated with an elongated trough is largely determined by their upper-tropospheric cyclonic PV anomaly. Conversely, the intensity of cyclones associated with cyclonic wave breaking is dominated by diabatically generated lower-tropospheric PV anomalies. Given the fact that numerical weather prediction models struggle to adequately represent these diabatic processes, the results raise interesting questions concerning the predictability of the systems.