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A NOTE ON AN INTERESTING CASE OF CONVECTION

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INTRODUCTION

The purpose of this note is to briefly discuss two separate and individually interesting phenomena that occurred in Victoria on 28 August 1976. The first phenomenon (subsequently referred to as 'cumulus simplex'[1]) involves lenticular shaped clouds (Fig 1) in a region far removed from undulating terrain. The second is the confined occurrence of hail-bearing thunderstorms south of the Great Dividing Range under generally anticyclonic conditions (Fig 2(b)).

'CUMULUS SIMPLEX'

The clouds shown in Fig 1 were observed around 0230 GMT 28 August at Echuca. They were orientated east-west, at the time of observation confined to the immediate area, and lasted for only 30 minutes or so. The selection of genera, species, and variety classification for these clouds is not a straightforward exercise. Their height of approximately 1800 m places them in the low cloud group; their isolation suggests a genus of cumulus rather than stratocumulus; there is no cumulus lenticularis species; the pileus classification requires a parent cloud and infers saturation in a moist stable layer rather than in the thermal plume itself; and so on. Rather than get involved in a semantic argument, let us call them 'cumulus simplex' and look for the mechanism of formation.

We can exclude lee waves as a mechanism since the orientation of the clouds is east-west, the mountains are well to the south, and the phenomenon is isolated in space and time. The only feasible mechanism is buoyant plumes capped by an inversion. Such plumes may penetrate into the inversion or induce gravity waves without penetration. In the latter case there would have to be sufficient ambient moisture at the inversion level for saturation to be achieved by a local expansion there. The data in this case suggest penetrative convection.

The nearest representative[2] radiosounding on this occasion is Wagga, 0000 GMT 28 August (Fig 3). While there is a series of lapse rate discontinuities in the sounding, the main feature to note is the subsidence inversion at 850 mb, so characterised by the large discontinuity in the dew point trace. On the assumption that the Wagga sounding is representative of the conditions at Echuca, the constructions in Fig 3 show the effect of the observed diurnal variation of the dry bulb and dew point temperatures at Echuca on the Convective Condensation Level (CCL) and subsequent buoyancy of a cumulus plume. It is clear that around noon, convective plumes would be saturating right at the base of the inversion. As noted earlier there is insufficient ambient moisture in the 750-850 mb layer for the clouds to

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[1] Plate XXI of McAide (*Clouds*, circa 1930) shows a cloud similar to that reported here. He quotes Taffara (*Le Nubi*) as the original source of the photograph and the classification.

[2] Established from spatial and temporal continuity checks of the limited data base.

be produced by local expansion. The east-west alignment of the clouds and their apparent isolation would appear to be related to the east-west orientation of the river valley and adjacent irrigation areas around Echuca. It is along the river valley that evapotranspiration would be most enhanced and the effect of an increase in the surface dew point on the CCL first realised. One would then expect that similar clouds might form at other locales at a later time and indeed such a formation was observed (independently) some 25 miles south of Echuca around 1 pm. By mid-afternoon fair weather cumulus prevailed north of the Dividing Range with cumulonimbus to the south.

THE THUNDERSTORMS

The general requirements for deep convection leading to thunderstorms are well known: low-level moisture, weak static stability, and a trigger mechanism such as ascent over mountainous terrain, insolation, or low-level convergence. Thunderstorms are uncommon in the vicinity of surface anticyclones since the latter are generally attended by suitably suppressive subsidence inversions in the lower troposphere (as noted in the Wagga sounding). While the occurrence of thunderstorms on the 28th in southern Victoria is therefore unusual, the two most interesting aspects are:

(i) their confinement to the southern region

(ii) their absence the previous afternoon when the broadscale mass distribution appeared to be very similar.

At first one might think that cold advection aloft in association with the passage of the upper level trough over Tasmania (Fig 2(c),(d)) gave rise to the increased instability on the 28th. However, it is clear from the Laverton soundings (Fig 4) that the upper troposphere there is characterised by substantial warming. This was indeed the typical behaviour over most of the southeastern mainland and application of simple geostrophic theory showed that the warming could for the most part be explained by horizontal advection. It is evident from the cross-sections shown in Fig 5 that the passage of the trough over Tasmania was nevertheless important is displacing the subsidence inversion that had existed on the cyclonic side of the jet stream shown over Mount Gambier. It is suggested that the orientation of this jet stream along the Dividing Range and its attendant thermally indirect circulation plays a part in contrasting the static stability across the Divide. The other major positive contribution to the instability on the cyclonic side is (from Fig 4) the warmer, but more particularly moisture enhanced, boundary layer. This is the result of weak but persistent overland advection of maritime air from west of Mount Gambier.

CONCLUSION

Given the limited temporal and spatial resolution of the conventional meteorological data network, the explanations provided here must be speculative. Despite this the author feels the phenomena are sufficiently interesting and the explanations sufficiently viable to warrant this brief note. If nothing else, Fig 1 should remind us of the danger in fitting isolated observations to preconceived models of atmospheric behaviour. Similarly, the example of the thunderstorms illustrates a problem the forecaster must continually contend with, given that his data base is further degraded from that used in establishing the hindsight explanations offered here.

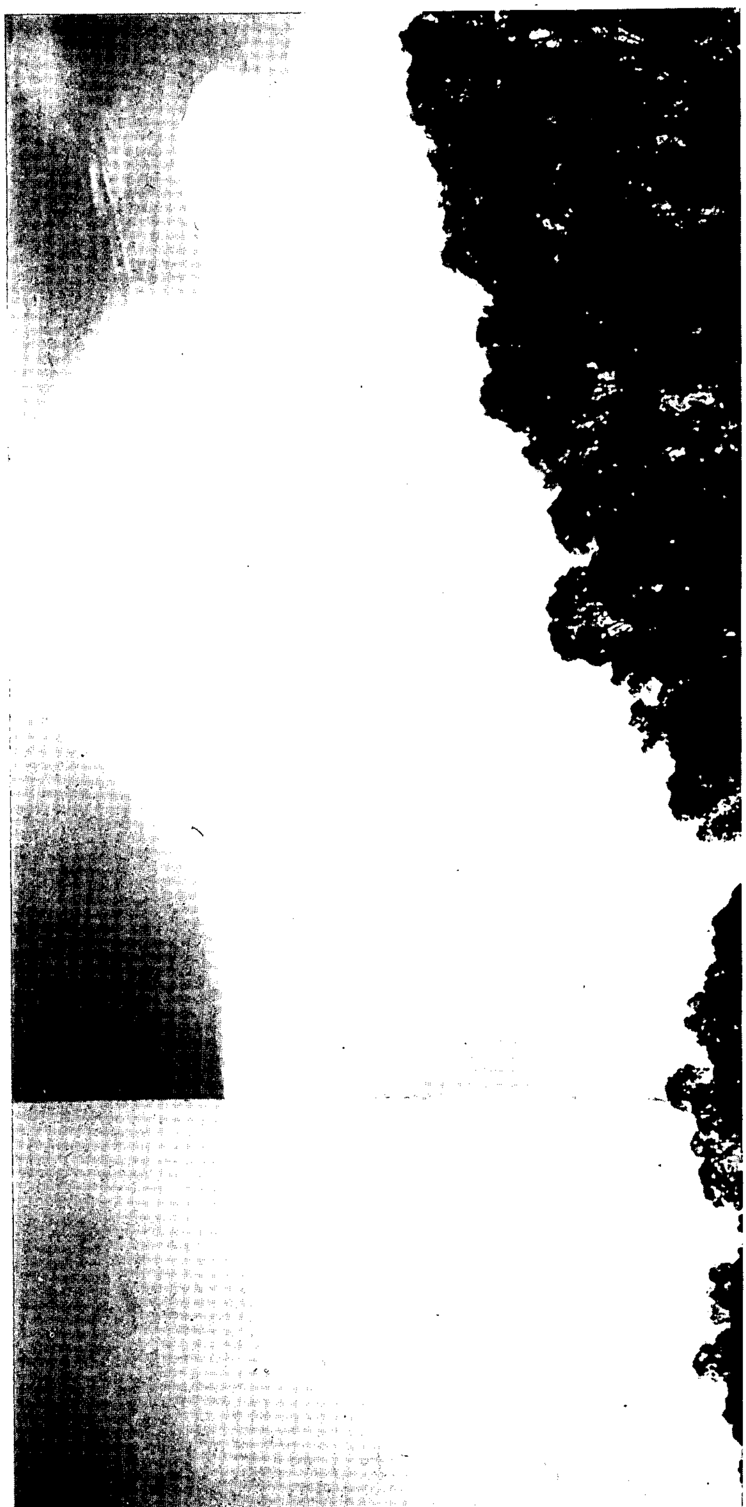

Fig 1 'Cumulus Simplex' observed at Echuca, 0230 GMT 28 August 1976.

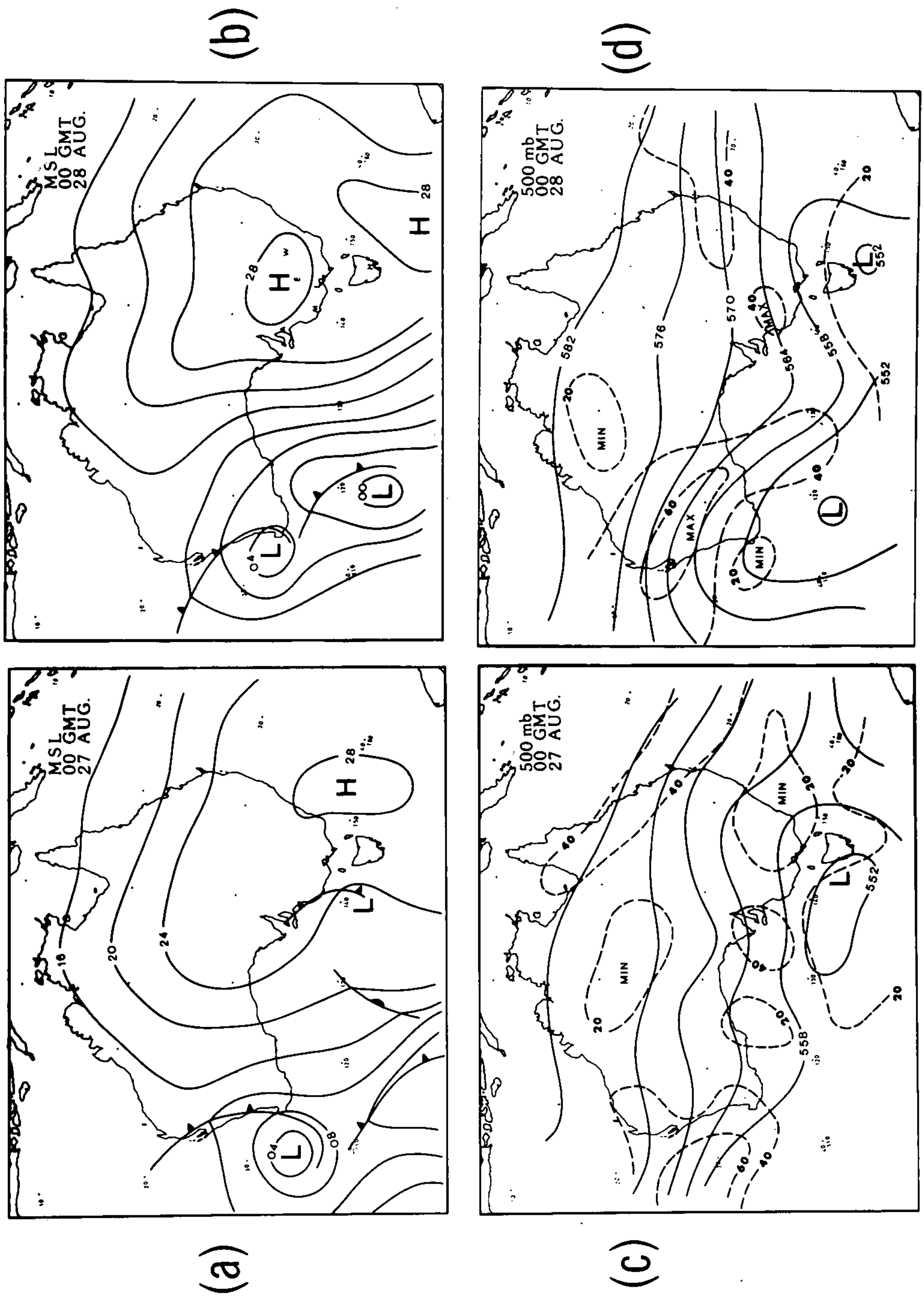

Fig 2 Mean sea level (MSL) and 500 mb analyses for 27 and 28 August 1976. The locations of Echuca (E) and Wagga (W) are shown in panel (b) along with other stations used in constructing the cross-sections shown in Fig 5.

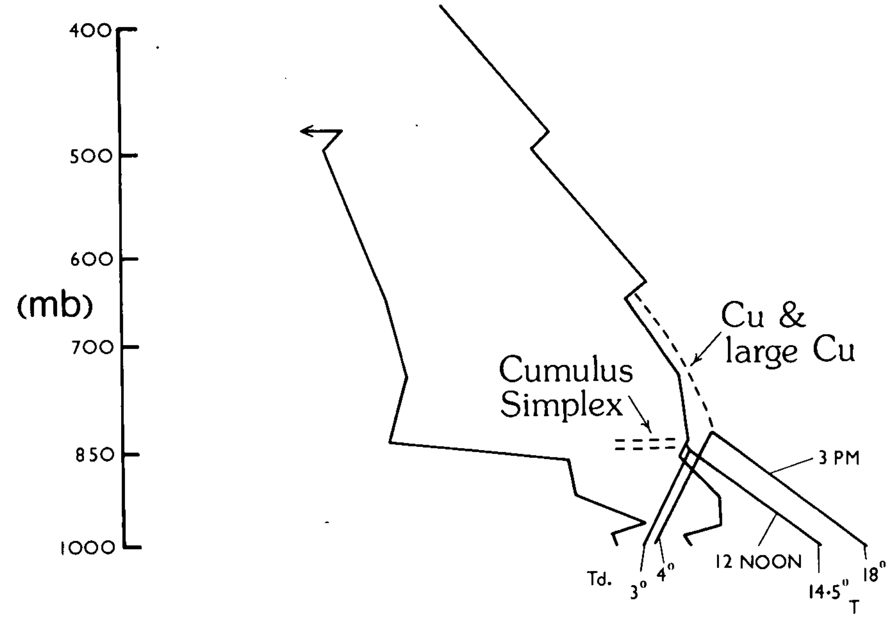

Fig 3 Radiosounding at Wagga 0000 GMT 28 August 1976 with constructions of convective condensation levels (CCL) based on the diurnal variation of dry bulb and dew point temperatures observed at Echuca. Note the CCL around noon (0200 GMT) occurred just below the subsidence inversion. (To avoid complexity only the adiabats and mixing ratio isopleths necessary to indicate the CCL constructions on the skew T–log p plane are retained.)

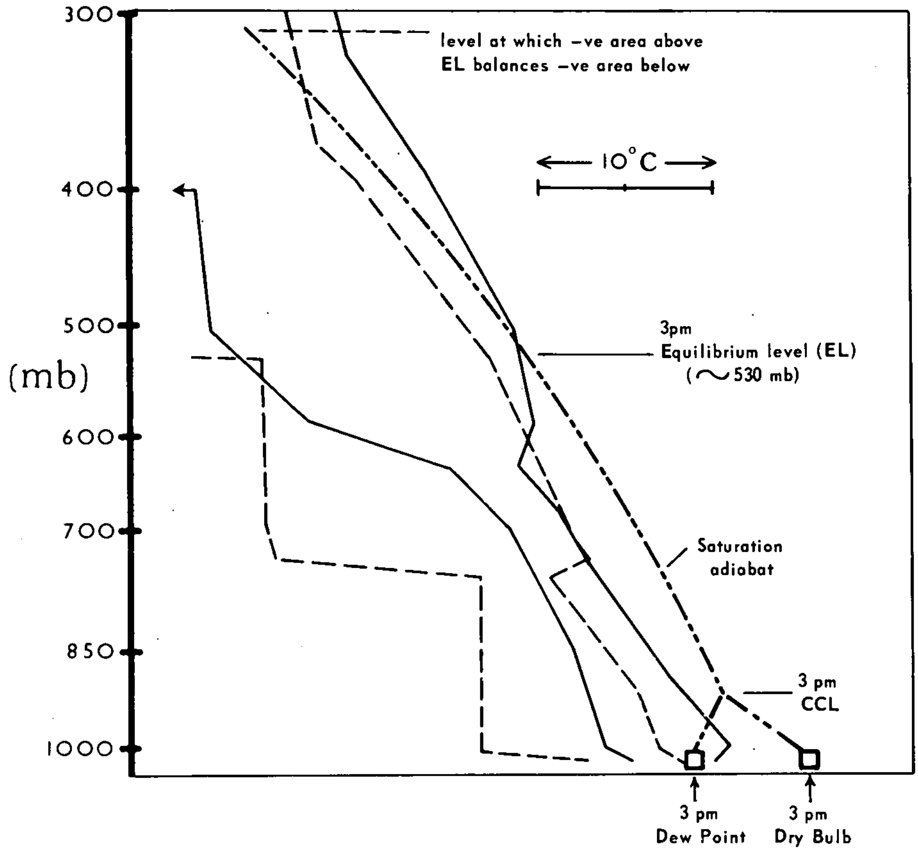

Fig 4 Radiosoundings for Laverton (dashed 0000 GMT 27 August; solid 0000 GMT 28 August). The CCL and related constructions are based on representative 3 pm dry bulb and dew point values south of the Divide on 28 August.

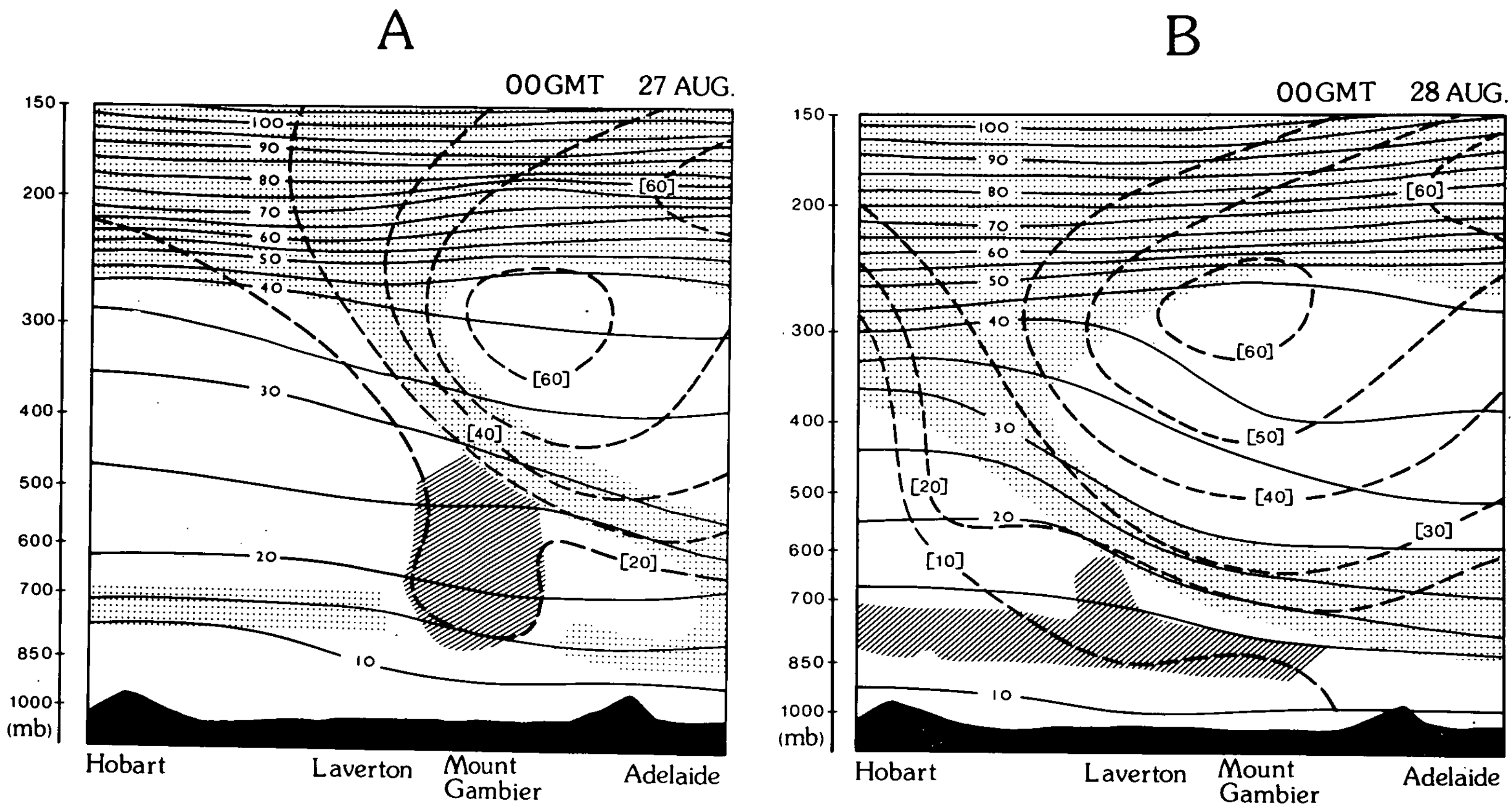

Fig 5 Cross-sections Hobart – Adelaide 0000 GMT 27 August (A) and 28 August (B). Isentropes (thin solid lines °C), isotachs (dashed lines knots), major cloud masses (hatching), major stable regions (stippling).