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EXTRAORDINARY SNOWSTORM OF 5 JULY 1900

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ABSTRACT

Exceptional snowfalls were reported over the Central Districts of New South Wales on 5 July 1900. Record falls on the Central Tablelands resulted in extensive damage to buildings and blocked railways. Snow even fell on parts of the Central Western Plains giving the only snowfalls on record for some locations. Data from that time are sparse but an attempt is made to describe the synoptic situation which caused such a unique event. One of the main contributing factors was a deepening low which moved across the State and gave a mechanism for heavy precipitation. This was enhanced over the Central Districts by the orographic lifting generated by upslope winds. It is thought that an extreme 'cold pool' was advected into the circulation around the low, providing the means for the precipitation to fall as snow.

INTRODUCTION

The snowstorm of 5 July 1900 was described by Russell (1903) as: 'a phenomenal snowstorm, in some instances the experience unprecedented, in which all the higher parts from the northern to the southern boundary of the State participated'. Record snowfalls were reported at several places on the Central Tablelands, resulting in widespread damage to buildings and halting railway traffic. Snow fell over most of the Central Western Slopes, and parts of the Plains, with reports from several towns where snow had previously been unknown. The snowstorm took place while flood rains were falling on the southern half of the New South Wales coast and the nearby ranges. Figure 1 shows certain locations which are referred to in this paper and the topography of the surrounding area.

This paper describes an attempt to reconstruct the synoptic situation which produced the unique snowstorm. A shortage of data from the period in question makes reconstruction difficult. Today's meteorologist tends to take for granted the present upper air network and the ready supply of satellite pictures. These were not available in 1900, when only a poor surface network supplied all observations. To help understanding of this event a comparison was made with a more recent heavy snowfall for which there was a similar surface analysis to that of July 1900, but for which upper level analyses are available. Such a comparison might suggest a possible upper air configuration for the snowstorm in 1900 and thus shed further light on the meteorological ingredients which generated the storm.

DESCRIPTION OF THE SNOWSTORM

Russell (1903) vividly describes the chaos resulting from the heavy snow: 'Railway traffic became paralysed, passengers being shut up in their carriages, unable to reach hotels; in places snow 8 feet deep on rails. Telegraph wires down everywhere.... Bathurst had a unique experience, all

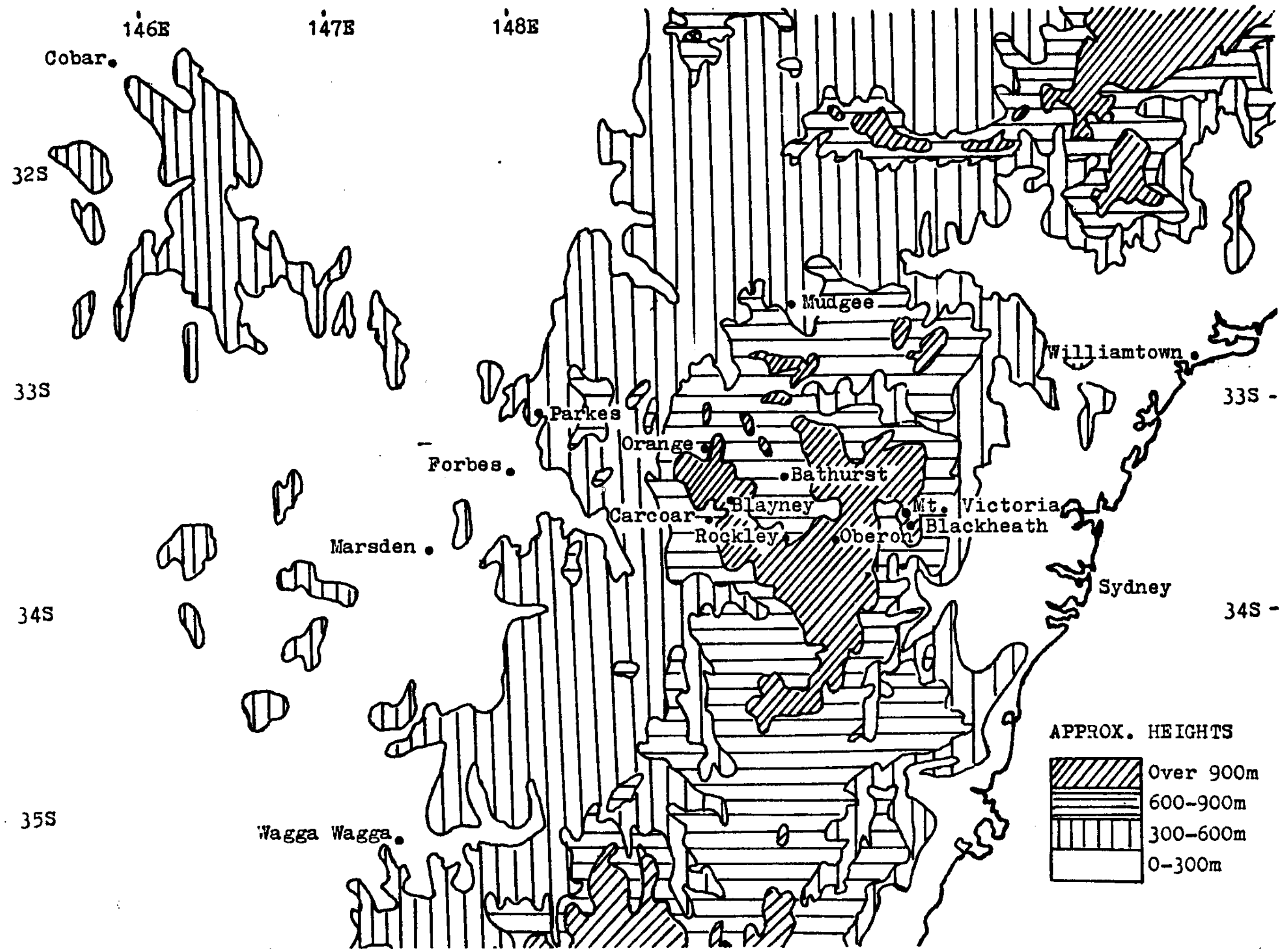

Fig. 1 Topographical and location map

business being suspended; roofs, verandahs and lightly constructed buildings collapsed under the weight of the snow. The phenomenal fall of snow at Bathurst was surpassed on the mountains, and at places between Locksley and Rydal, it fell to a depth of 4 feet. The passenger train which left Bathurst was unable to proceed beyond Locksley'.

Similar havoc was reported at Blayney where many buildings were damaged and railway traffic was also blocked. Snow commenced in Blayney at 0500 EST on 5 July, increasing in intensity during the day. By 1200 EST, 40 cm of snow lay in the main street and by 1700 EST, 'the standard measurement was 27 inches' (68 cm).

Further details are available in Russell (1903) but snow depths are given for selected locations in Table 1, together with their approximate elevation. It is interesting to note that 23 cm fell at Forbes, which is only about 240 m above sea level. The fall was described in the local Forbes Gazette: 'For the first time in its history Forbes has had a fair and square snowstorm'.

Table 1 - Snow depths resulting from storm on 5 July 1900 for selected locations, at given elevations.

Location	Elevation (m) (to nearest 10 m)	Depth of Snow (cm) (to nearest 5 cm)
Marsden	210	5
Forbes	240	25
Parkes	340	10
Mudgee	450	55
Bathurst	700	70
Carcoar	720	90
Orange	860	45
Rockley	880	80

SURFACE CHARTS, JULY 1900

The Sydney weather charts for July 1900 were obtained from archives for examination. At that time the charts were analysed only once daily, and were based on very limited data. Indeed on 5 July 1900 no observations were received from western New South Wales, no doubt as a result of the adverse weather, and the analysis for that day appears rather inaccurate. A re-analysis was undertaken using the available charts and supplementing the data with individual station records from several places in the Central Districts.

Figure 2 depicts the movement of surface systems from 3 to 6 July 1900. It seems that a low formed on a cold front over the Great Australian Bight and moved to the southern inland of New South Wales, where it became 'cut off'. The low then slowed down and intensified while continuing to move east eventually crossing the central New South Wales coast. Widespread rain fell as the low passed over the State, with heavy rain in the east, south from the centre of the low. Rapid ridging from the high

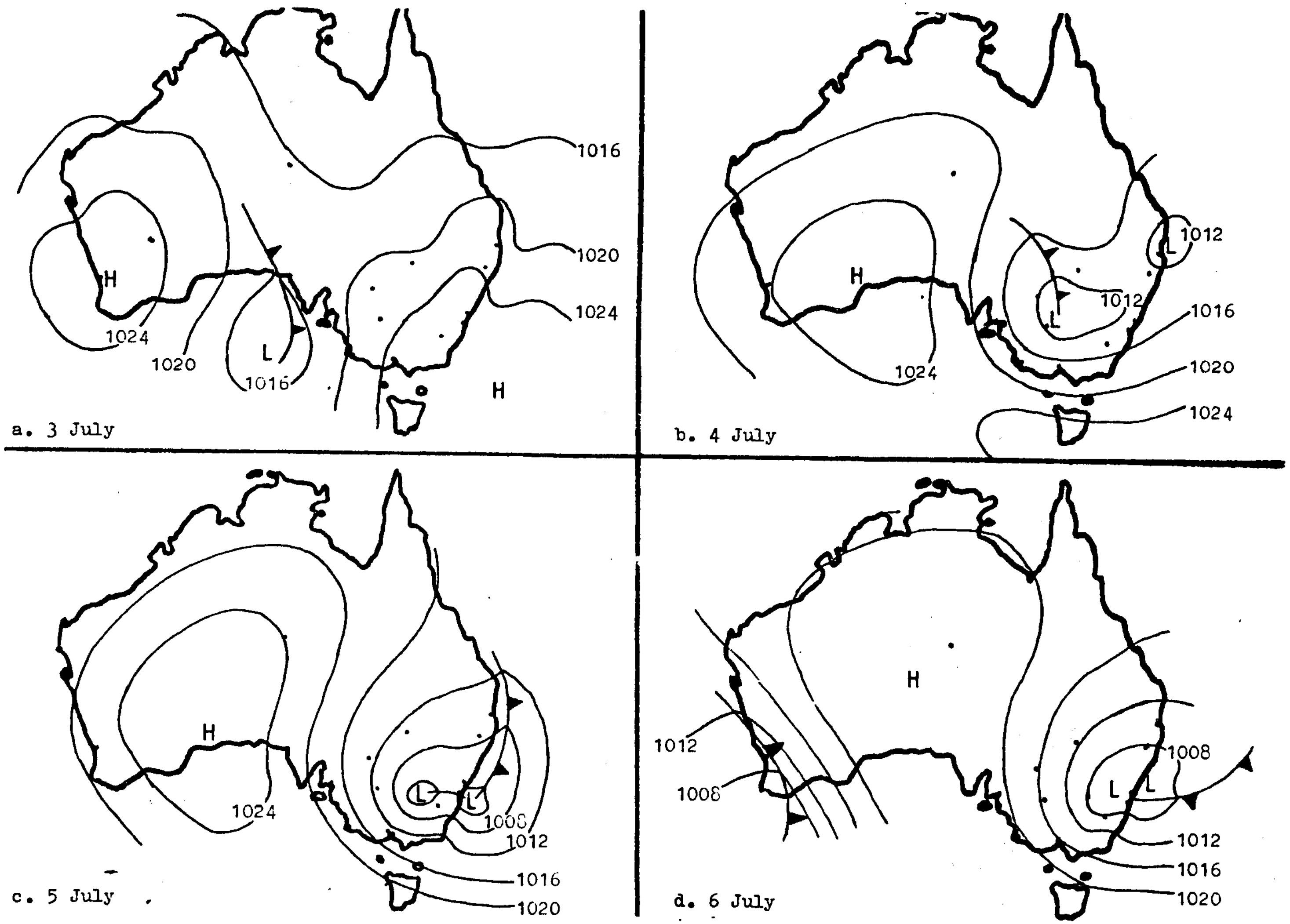

Fig. 2 0900 EST mean sea level pressure charts, 3-6 July 1900 near Western Australia, over the Great Australian Bight and towards the south of Tasmania gives the appearance that any deep southerly flow was short-lived. Nevertheless, as will be seen later, a mass of very cold air must have followed the cold front into New South Wales.

A more detailed analysis over central New South Wales is given in Fig. 3 for 0900 EST on 5 July 1900.

SNOW PRODUCING SYNOPTIC SITUATIONS

Snow is not uncommon over the Central Tablelands with usually several occurrences each year. These generally result from a deep southwest to southerly airstream being directed from the Southern Ocean towards southeast Australia. Shanahan (1967) examined three severe cold outbreaks during 1966 which produced snow over the Tablelands. In those outbreaks there was strong flow from the Southern Ocean, extending to at least 300 mb (about 9000 m). This type of flow can produce heavy snowfalls over the Central Tablelands but the surface analyses in Fig. 2 do not support the existence of such flow on 5 July 1900.

Colquhoun (1978) describes three synoptic situations which can produce heavy snow over the Snowy Mountains of New South Wales. They require the presence of cold pre-frontal northwesterlies, strong westerlies or a 'cold pool'. A check was made to see if such situations might have applied to the Central Tablelands in July 1900. The first two situations mentioned do not fully explain the events of 5 July. Firstly, the heavy snowfalls took place behind the front and not in the pre-frontal airstream. Secondly, there is no evidence of a strong and persistent westerly wind regime. (Both Orange and Mount Victoria, which are elevated stations, reported only a light westerly component.) However, the west-southwesterly flow over the area at the time would have generated orographic lifting, but considering the wind strengths involved it would not provide sufficient lift by itself to account for the reported snowfalls.

The third possibility that a 'cold pool' was advected over the area was not obvious from the surface charts, but neither was it precluded by them. This type of situation has been described by Bahr and Armstrong (1971). They have included a reference to a snowstorm on 1 September 1970 that provides a situation which has some surface features similar to those of 5 July 1900 and for which upper level analyses are available.

SNOWSTORM, 1 SEPTEMBER 1970

Heavy snow covered parts of the Central Tablelands on the first day of Spring in 1970 with reports of 15 cm at Oberon, 23 cm at Blackheath and 25 cm at Mount Victoria, to name a few. The synoptic situations for that time are shown in Fig. 4. Cold southwest to southerly airflow extended over the eastern section of the Great Australian Bight during 30 August, entering southwestern New South Wales. During 31 August and 1 September, a low moved from central Bass Strait over the southeast of New South Wales to finish off the central coast. Rapid ridging took place over the Bass Strait area as the low moved away. Had only surface charts been considered one could be forgiven for assuming that since heavy snow did fall on 30 or 31 August it would be unlikely to affect the Central Tablelands on 1 September.

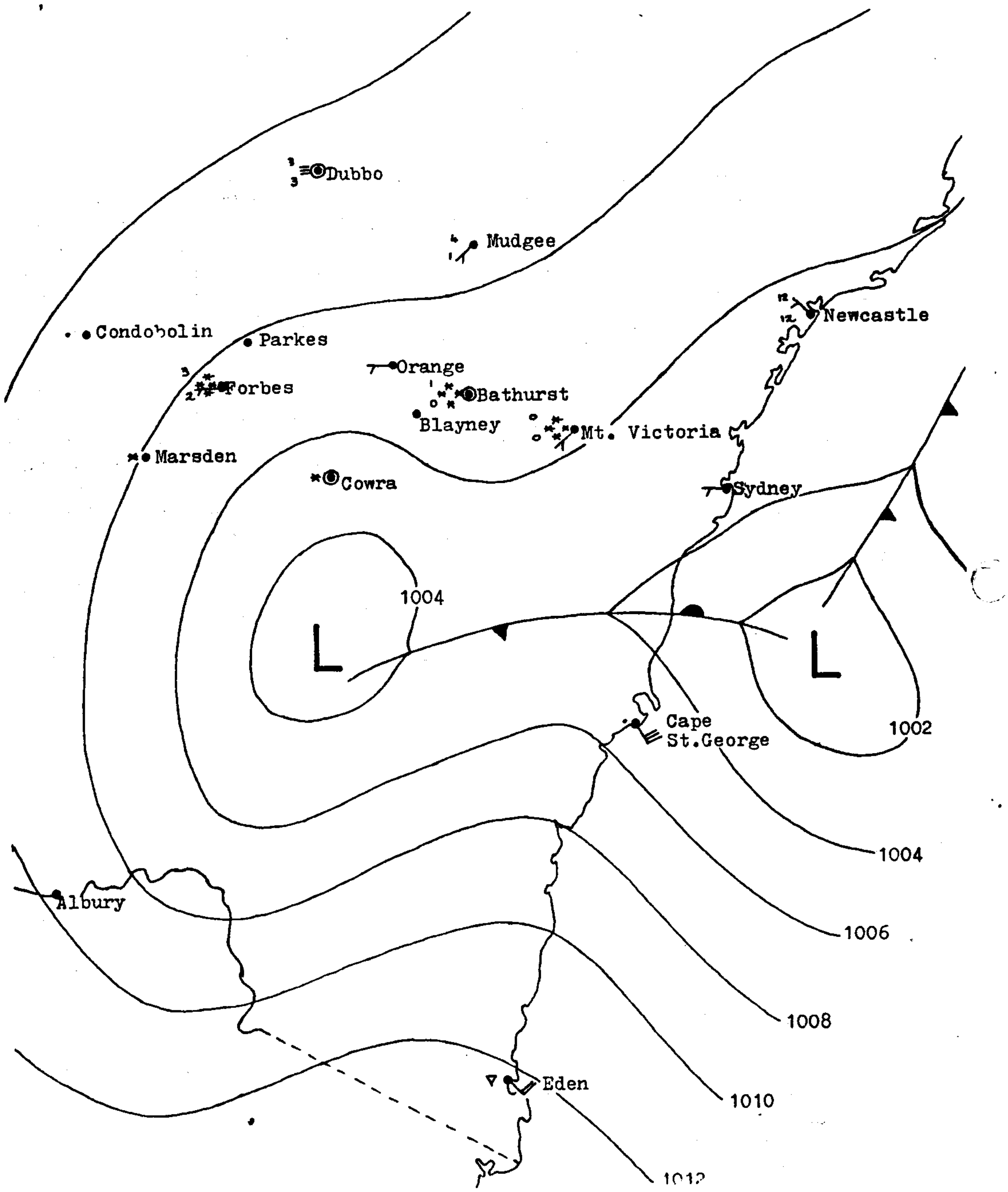

Fig. 3 0900 EST mean sea level pressure chart, 5 July 1900

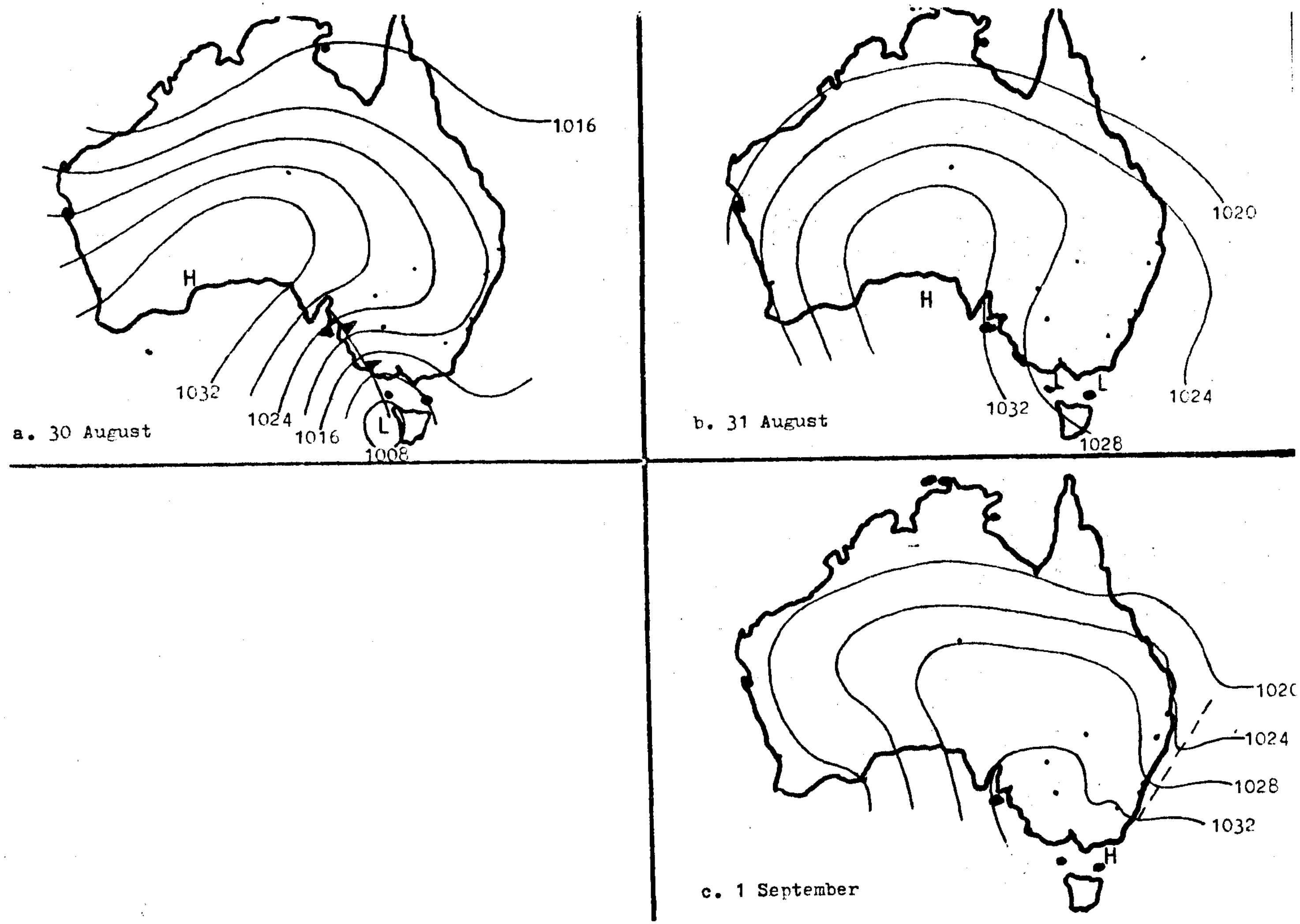

Fig. 4 0900 EST mean sea level pressure charts, 30 August - 1 September 1970

The upper level charts show that the southwest to southerly airflow which spread over the eastern section of the Great Australian Bight on 30 August was extremely deep, extending from the surface to at least the 300 mb level. Indeed a strong southerly jet stream was evident at this level over western Victoria by 2100 EST (see Fig. 5). The source of the airflow was well south of the Australian continent. As a result of this situation the air mass over the whole of southeastern Australia was cooled, but in addition, a 'cold pool' of air was advected over western Victoria. The temperature of the 'cold pool' was as low as -15°C at its centre at the 700 mb level (about 3000 m). This extremely cold air was directed to the northeast passing over the Riverina and Southwest Slopes Districts on 31 August, reaching the Central Tablelands by 1 September (see Fig. 6). At this stage the 700 mb temperature was about -12°C. The 700 mb chart for 0900 EST 1 September (Fig. 7) shows the presence of a cut-off low which was also evident at the 500 mb and 300 mb levels.

The surface charts for 1 September did not by themselves point to the snowstorm which occurred, but they would imply precipitation about the coast and ranges of New South Wales. The upper charts, however, reveal the presence of a 'cold pool' and a 'cut-off' low which together would provide a suitable mechanism for snow production. Heaviest falls occurred near Mount Victoria, probably as a result of the cold air, which had moved to the east of the mountains, being advected back over the region and being lifted in the easterly airstream.

MECHANISM FOR SNOWSTORM ON 5 JULY 1900

One of the main contributions to the precipitation on 5 July would have been synoptic scale lifting by the cut-off low. Slow movement by the low between 4 and 6 July suggests that the low had considerable vertical extent, with an upper level circulation above that on the surface. In addition, deepening of the low took place between 4 and 5 July. This intensification, coupled with the pressure of an upper circulation, would have generated strong lifting over a wide area.

Another contribution to the lifting process could be attributed to the upslope winds over the Central Districts, which were north of the surface low. The resulting orographic lifting would have enhanced that already generated by the low itself. The combined effect was to produce heavy precipitation over the area being considered.

One factor, which was necessary for production of snow, was the input of cold air into the precipitation process. This probably commenced during 3 to 4 July while the low was moving from the Great Australian Bight to southern New South Wales and while the ridge was pushing towards the south of Tasmania. The surface analyses from the time were 'sketchy' over the Great Australian Bight and Southern Ocean and may not indicate the full extent of southerly flow. However it would seem that a significant 'pool' of cold air was advected towards New South Wales in the flow above the surface, in a manner not unlike the situation described for 1970. The cold pool probably passed over the southwest of the State during 4 July and reached the Central Districts on 5 July.

Just how cold the air mass involved actually was is impossible to say, but an estimate can be made from surface observations. Snow commenced at Forbes at 0930 EST and at 0900 EST the dry-bulb temperature was 38°F

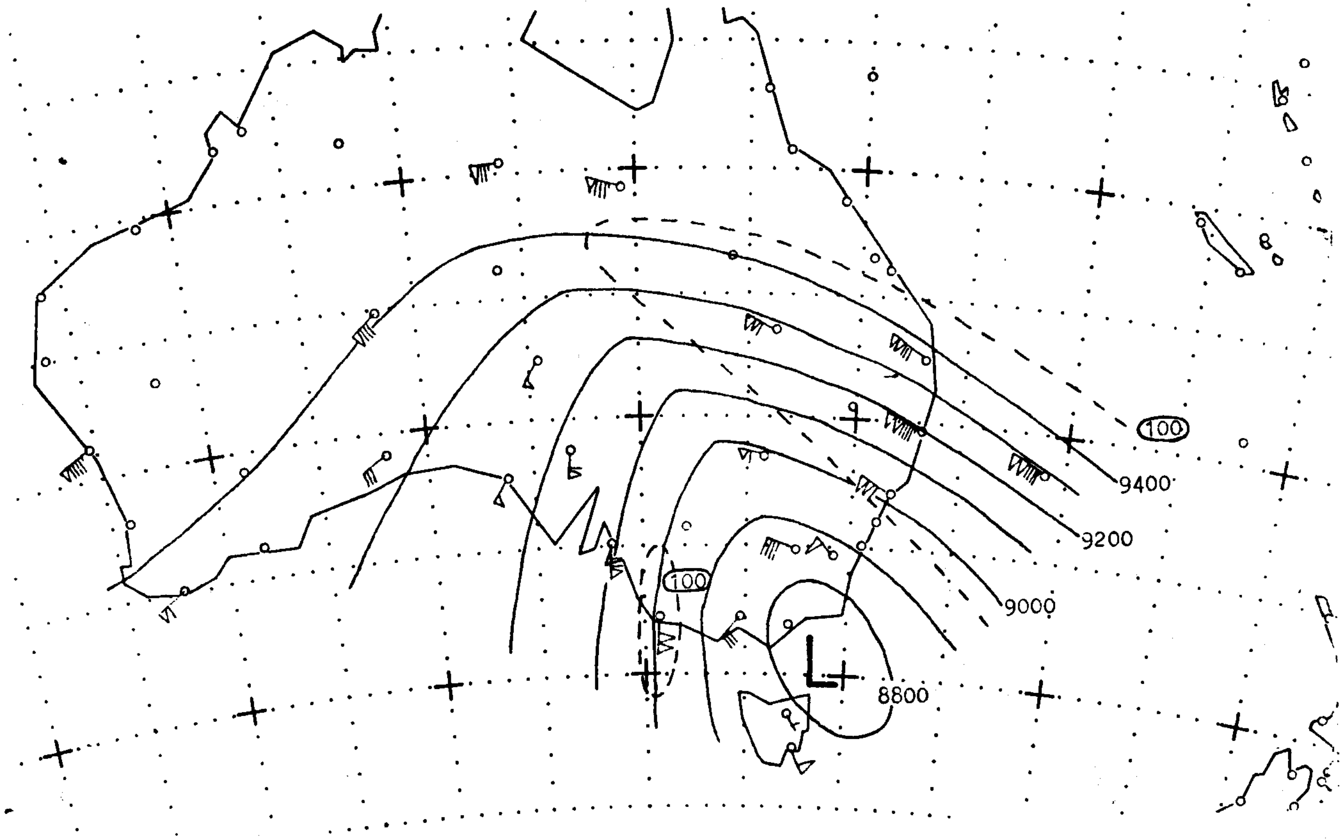

Fig. 5   300 mb analysis, 2100 EST 30 August 1970

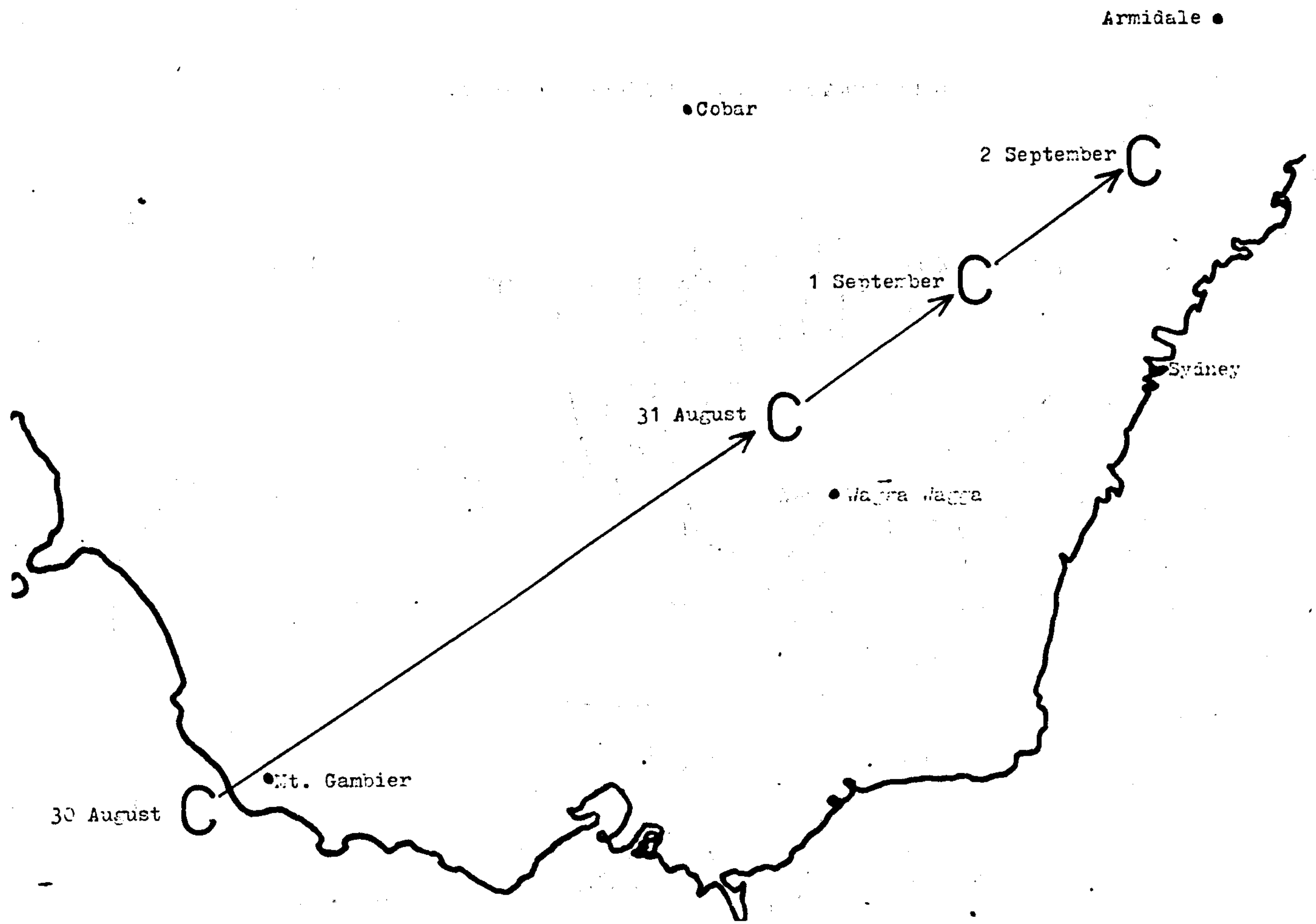

Fig. 6   Path of 'cold pool' at 700 mb level, 30 August - 2 September 1970

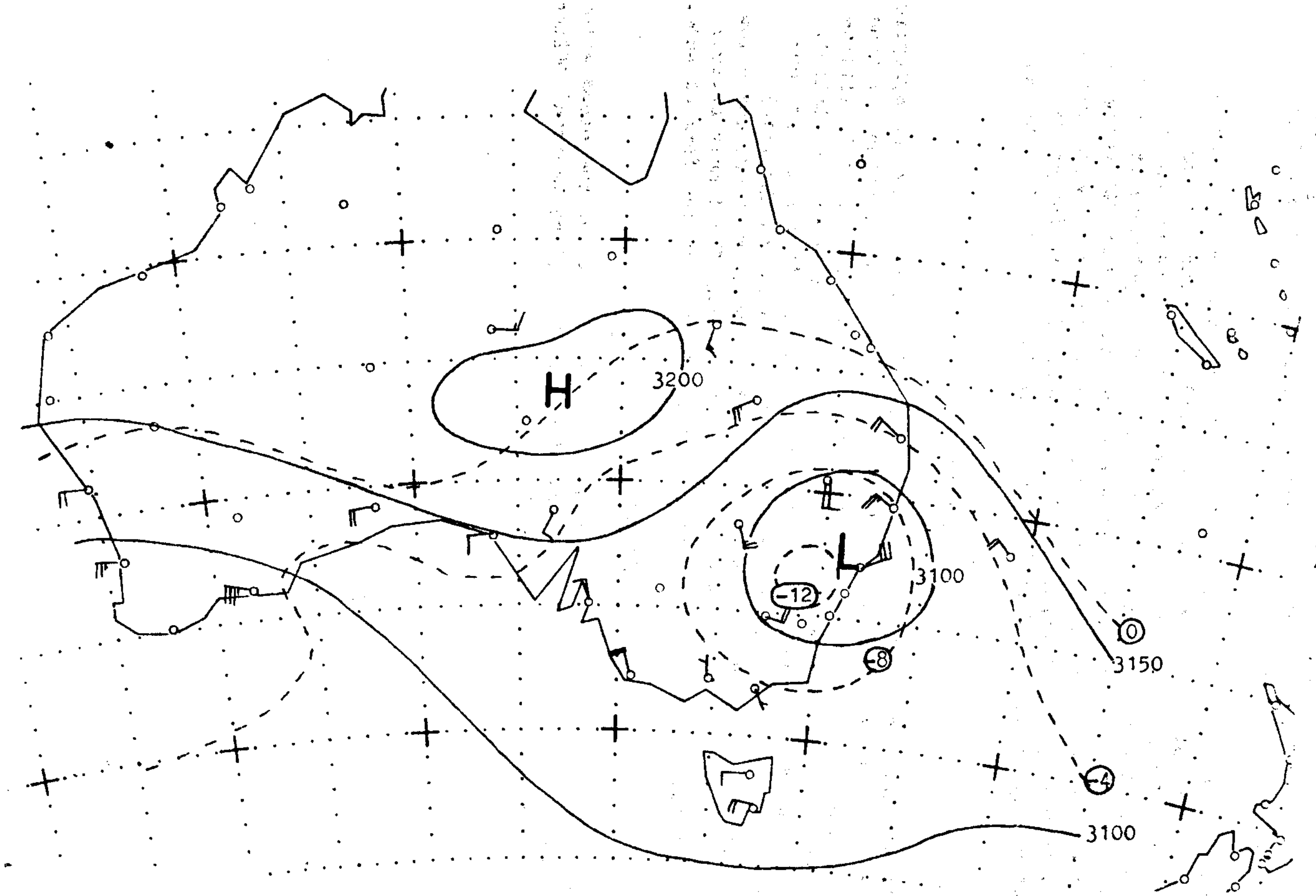

Fig. 7 700 mb analysis, 0900 EST 1 September 1970

(3.3°C) and the wet-bulb temperature was 37°F (2.8°C). If a saturated adiabatic lapse rate is assumed and the elevation of Forbes is taken as 240 m, a freezing level of about 700 m (above sea level) is obtained and a 700 mb temperature of about -16°C. Further extrapolation gives a 500 mb temperature of about -37°C.

Upper air statistical data for Cobar, Wagga Wagga and Williamtown are considered in an attempt to estimate the likely frequency of such cold air over Forbes. The mean 700 mb temperature for July is -4.6°C and the corresponding standard deviation 3.1°C. A 700 mb temperature of -16°C implies a frequency of occurrence of about one July day in 300 years, if a normal distribution is assumed. A similar consideration of September data yields a frequency of one September day in about 10 years for which the temperature will reach -12°C at 700 mb (as was the case for 1 September 1970).

CONCLUSION

The extraordinary snowstorm on 5 July 1900 resulted from a complex synoptic situation, but two factors stand out. Firstly, there was a strong lifting mechanism that produced heavy precipitation. A large part of this lifting was generated by the developing low and its associated upper circulation. Since the low was located to the south of the Central Districts, upslope winds would have produced a topographic lifting, enhancing the total lifting process. Secondly, it seems that a 'cold pool' with extremely low temperatures must have been advected over the region. The timely arrival of the cold air caused the heavy precipitation to fall in the form of snow.

ACKNOWLEDGMENTS

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REFERENCES

Bahr, V.J. and Armstrong, J.G. 1971. Snow; how, where and why. **Aust. Ski. Year Book.**

Colquhoun, J.R. 1978. Snowfall on the New South Wales Snowy Mountains. **Tech. Report 25.** Bur. Met., Australia.

Russell, H.C. 1903. **Results of Rain, River and Evaporation Observations made in New South Wales during 1900.** **Met. of N.S.W.** Dept of Instruction

Shanahan, B.W. 1967. **Three cold snaps on the Northern and Central Tablelands of N.S.W. during 1966.** **Met. Note 10.** Bur. Met., Australia.