NOTES ON THE REDUCTION OF BAROMETER READINGS

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A considerable amount of thought has been given by meteorologists of many countries to the problems associated with the reduction of barometer readings to a common level. If such readings are reduced to a level below that of the terrain the values obtained are ficticious because a hypothetical column of air is assumed to replace that portion of the earth between the level of the terrain and that to which readings are reduced. It is this ficticious nature of the reduced values which is the root of the problems of reduction and which makes a clear statement of the purposes of reduction essential.

The purpose of the reduction of barometer readings is therefore stated to be (in the opinion of this writer) as follows.

Barometer readings are reduced to a common level in order to map the horizontal pressure gradients existing at the general level of the terrain.

The present method of reduction employed in Australia assumes a ficticious column of air below the station with a temperature the same as the screen temperature at the station, pressures being reduced to mean sea level. It is evident that this method of reduction does not support the statement above for if elevated, level terrain has zero horizontal pressure gradient but finite horizontal temperature gradient, the reduced mean sea level pressures will exhibit a finite horizontal gradient. Another obvious defect of the present Australian method is the false diurnal variation induced in the reduced value of mean sea level pressure by the diurnal variation of screen temperature, for consider the case of a station level pressure constant with time but having a screen temperature showing considerable time variation. The mean sea level pressure in this case will exhibit a false variation, and the amount of this variation in Australia, where the diurnal range of temperature is considerable for many stations, may be three or four mb for a station with an elevation of 1000 feet.

In the case of steeply sloping or irregular terrain the difficulty of height differences between neighbouring stations is evident and in this case it seems reasonable to reduce the pressure at the higher station to the level of the lower by using the pressure increment between the two levels for the real air column above the lower station. Two difficulties are immediately apparent however. Firstly it is difficult to assess this real pressure increment from surface station data and secondly the higher station may be situated on top of a mountain range dividing air of markedly different properties on either side (as frequently occurs in summer in the vicinity of coastal ranges in Australia).

It has been suggested that a solution to the problems of reduction is the use of a method in which barometer readings are reduced to a level in the free air, the argument for this method being that the reduced values so obtained would not be ficticious. While this is a reasonable assumption it seems likely that false values would still result if screen temperatures were used, especially where strong radiation inversions occur as in inland Australia. Also, in Australia the relatively large number of stations at low elevations makes the suggestion of upward reduction of little benefit in this country.

From the foregoing brief discussion a number of rules may be stated for guidance in the derivation of a method of reduction of barometer readings in Australia.

RULE ONE — Barometer readings should be reduced to mean sea level for synoptic purposes.

RULE TWO — Screen temperature should not be used in the reduction of formula.

RULE THREE — No strong horizontal density gradients should be apparent in the ficticious atmosphere between terrain and mean sea level.

RULE FOUR — The reduction increment should not have a diurnal variation.

The attached charts (figs. 1-4) give mean 900 mb isotherms over Australia for four months, January, April, July and October, and should be regarded as approximate only, as they are based on a preliminary analysis of Australian radiosonde data. A more complete analysis should be avialable in the near future.

A possible reduction method based on those charts consists of the assumption of a ficticious atmosphere with the indicated 900 mb temperatures and a fixed lapse rate (possibly 5°C/100mb). Given the mean station level pressure and elevation of a station it would be possible to calculate a reduction increment which would be constant for a given station for a given month. Such a method would satisfy rules one, two and four above while the present method satisfies only rule one. Rule three would not be satisfied by the method, for horizontal temperature gradients of 1°C in 30 miles are present, which in the case of level terrain at 1000 feet would introduce a false pressure gradient in the reduced values of about one mb in 200 miles.

Referring now to figure 5 it will be seen that the plateau area of Western Australia is that in which this effect is likely to be most pronounced, but it is difficult to see how it could be overcome. Over the remainder of the continent the lack of agreement with rule three should not produce large errors.

A further source of error from this suggested method could result from the deviation of actual conditions from the mean atmosphere. In such a case the reduced values for the area of high ground in the south-east of the continent could be consistently higher or lower than the values for neighbouring low level stations. An idea of the magnitude of these errors may be gained from the table of approximate values of standard deviation of 900 mb temperatures below.

Standard deviation °C

	January	April	July	October
Laverton	5	5	3	3
Rathmines	4	5	3	4
Charleville	2	3	3	4

From this table it is apparent that on 85% of occasions the reduction error for a station within this area at an elevation of 1000 feet would not exceed 0.5 mb. Such errors would be much smaller than those occasioned by the present method.

These notes should be regarded as preliminary in nature and as a basis for further consideration of the problem in Australia. However it is pointed out that the adoption of a revised method such as that suggested would result in reduced values more useful to the synoptic meteorologist and would permit direct evaluation of pressure changes.

In conclusion it cannot be emphasised too strongly that, in reducing downwards, it is not the temperature of the air above the station that is important, rather it is the temperature of the air above neighbouring stations at a lower elevation.

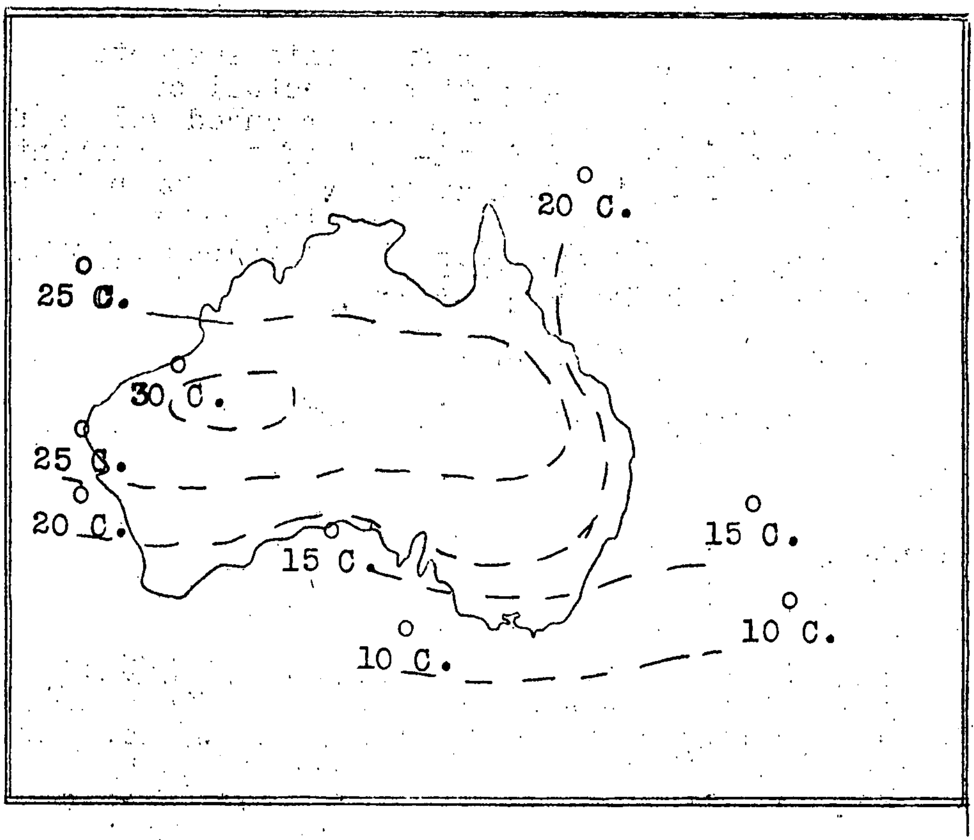

Fig.1.-900 mb. Temperature--January.

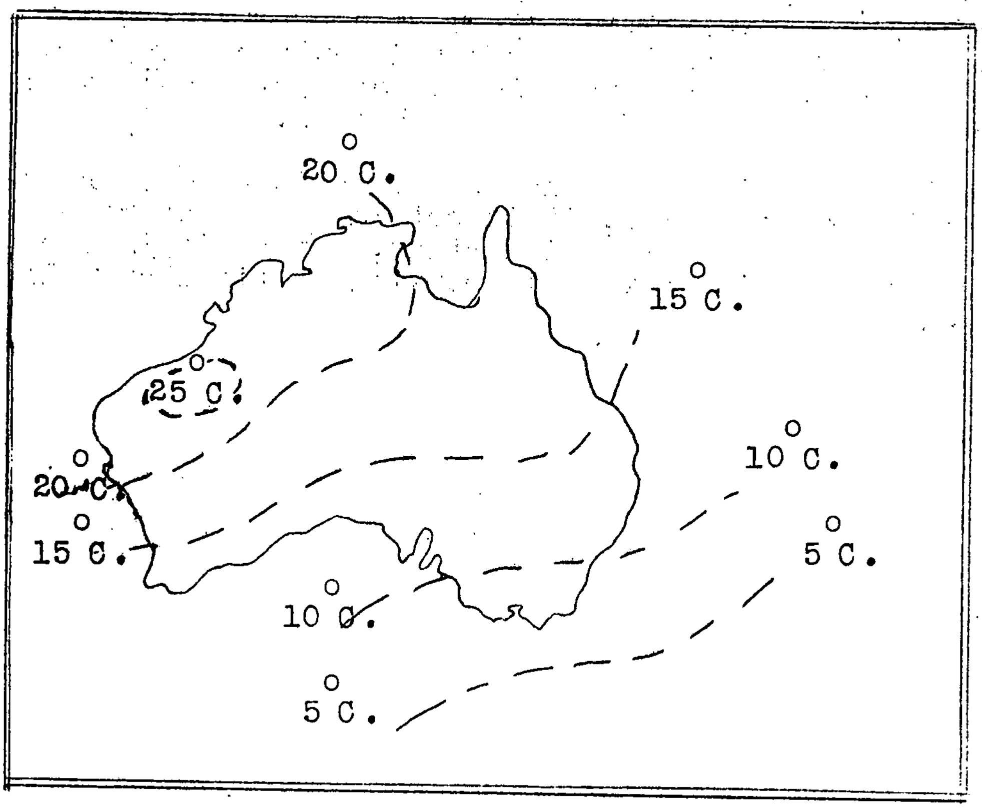

Fig.2.-900 mb.Temperature--April.

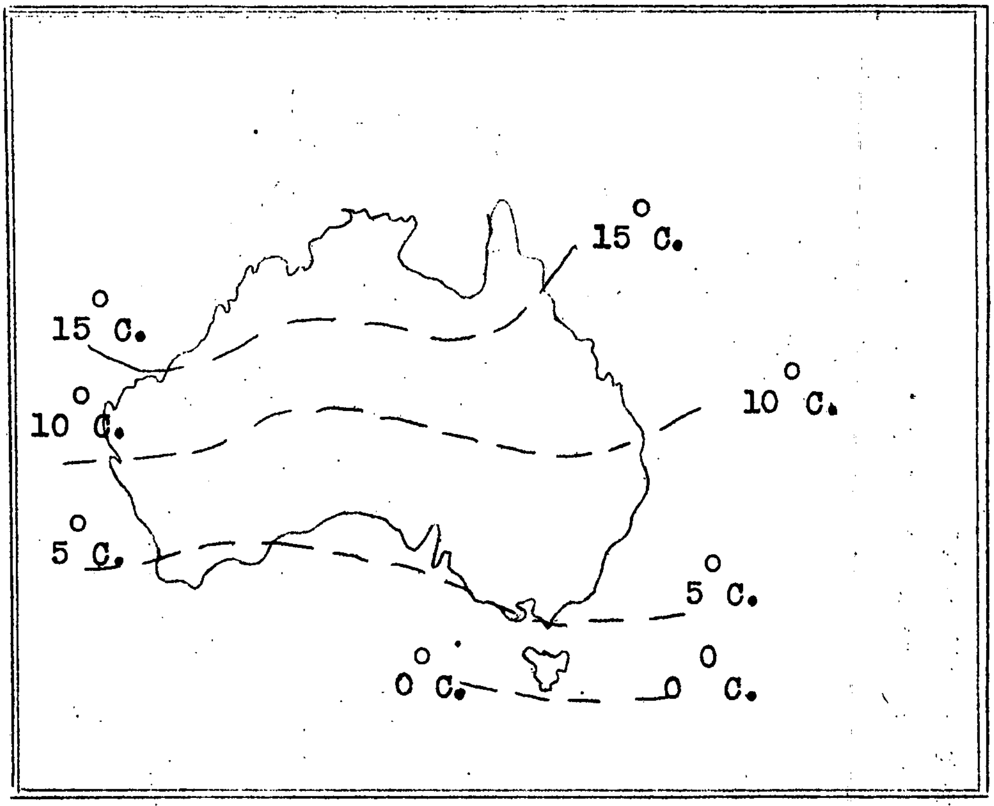

Fig.3.--900 mb. Temperature--July.

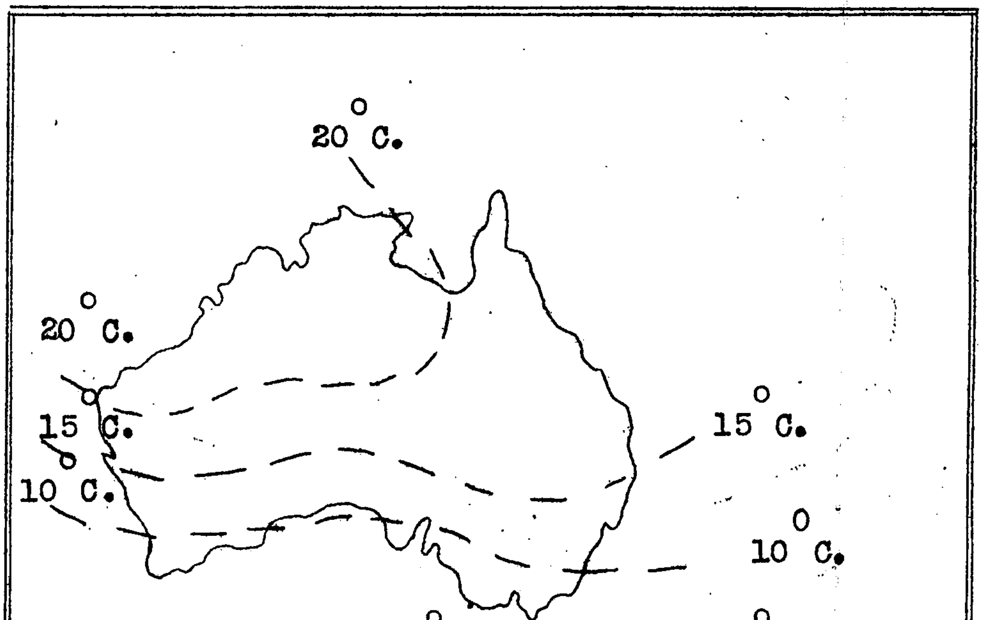

Fig.4.-900 mb. Temperature--October.

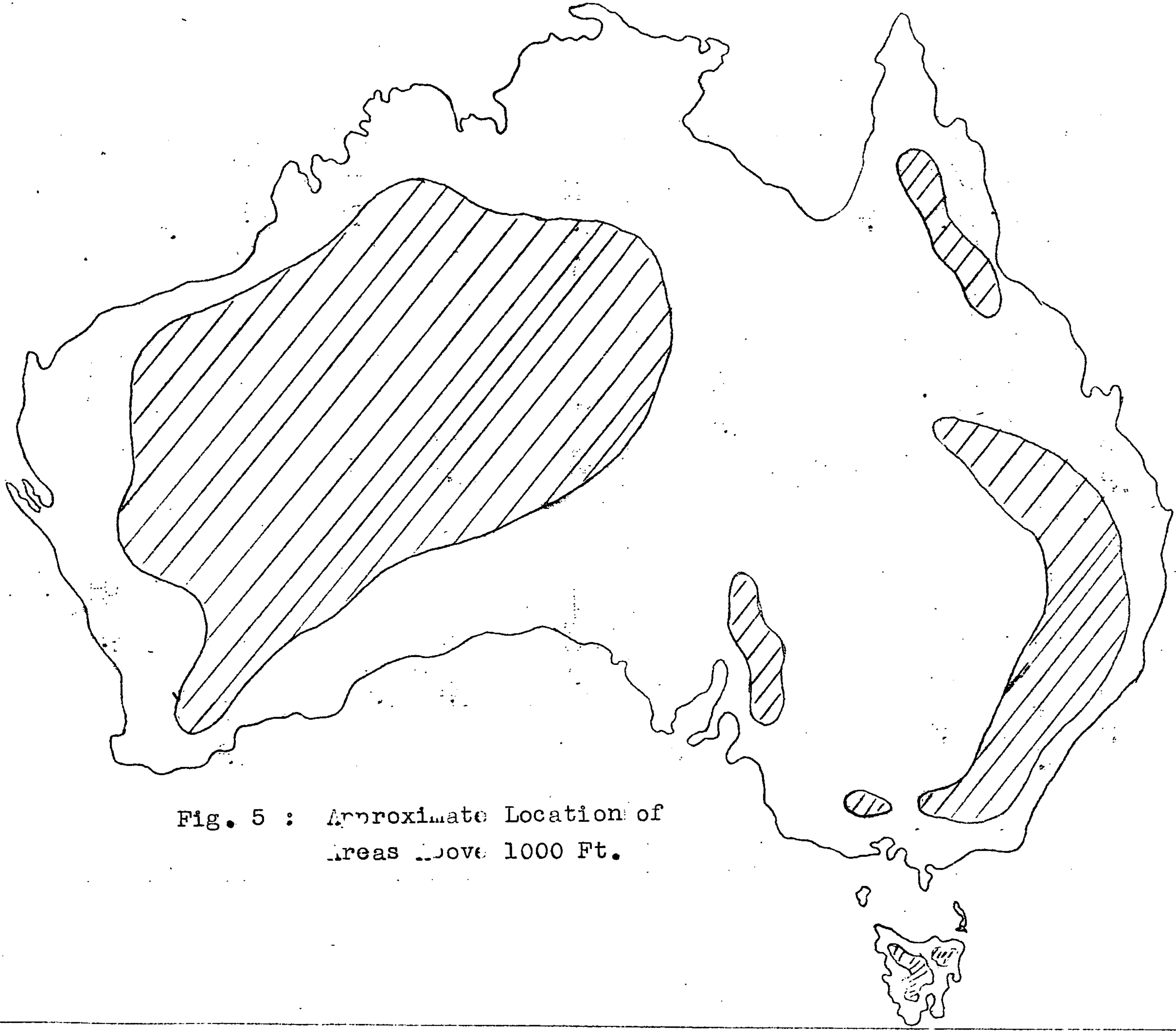

Fig. 5 : Approximate Location of Areas Above 1000 Ft.