551·524·7 : 551·501·7

A SIMPLIFIED TECHNIQUE FOR OBTAINING LAPSE RATE IN CUMULUS CELL WHEN ENVIRONMENT AIR IS ENTRAINED.

1. *General Considerations.* Austin (1948)[1] developed a graphical method of obtaining lapse rate within the Cloud Cell when air from the environment is entrained in known proportions. He used the method for determining lapse rates in updrafts only, but Byers and Braham[2] utilised his technique for obtaining the lapse rates of downdrafts also. As the technique is the same whether we consider an updraft or a downdraft, we will consider only the updraft. In the method developed by Austin, a known proportion of environment air is allowed to mix with the cloud air at a certain stage of its ascent, usually 50 mb. above condensation level, and the mixture, now unsaturated, is allowed to be saturated at constant pressure by evaporation of rain water from the cloud. The process is repeated at every 50 mb. step. The method, although simple, requires some calculation, for, the temperature and mixing ratio of the mixture have to be determined at every stage from the temperatures and mixing ratios of the two air masses. The basis of the simplified technique described here is that the entrained air is first allowed to be saturated by water in the cloud and so to attain its wet-bulb temperature and then allowed to mix with the saturated air of the cloud. If we ignore the latent heat of evaporation liberated due to the small amount of condensation that will take place as a result of mixing the two saturated air-masses, the resulting temperature will be the proportionate mean of the temperatures

of the quantities of the two air masses. The proportionate mean can be marked off directly on the tephigram by dividing by eye estimation the isobaric distance between the two temperature lines.

2. *The Technique.* The technique is best illustrated with reference to the figure, in which ABCD is the sounding, PRST the wet-bulb curve and B (850 mb. level) is the condensation level.

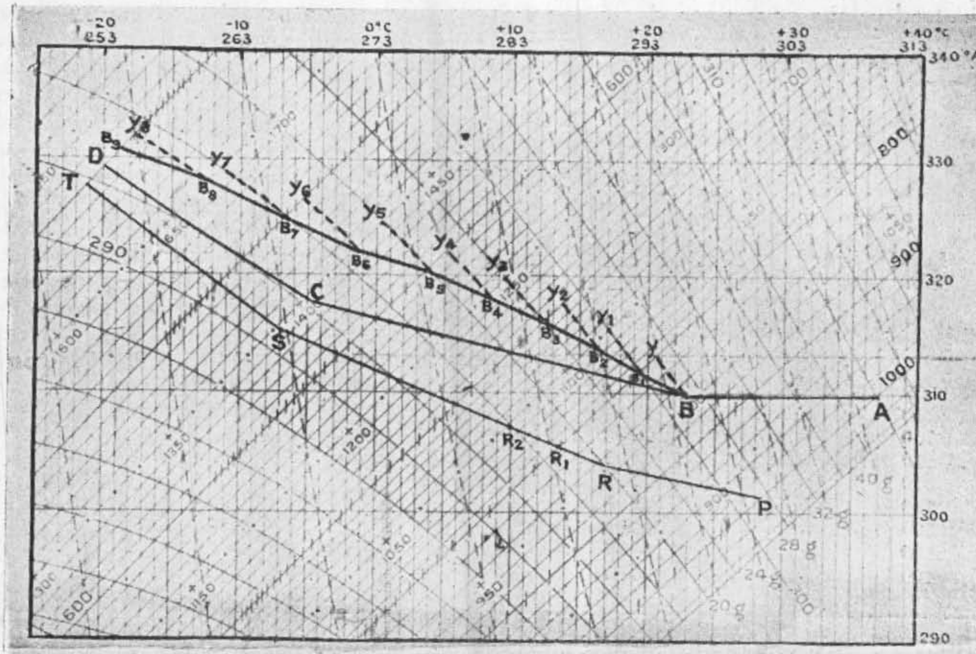

FIG.

Entrainment is taken to be at the rate of 25 per cent., *i.e.*, 1 part of environment air in 4 parts of cloud, at each 50 mb. step. From B draw BY meeting the 800 mb. isobar at Y. Let R_1 be the wet-bulb temperature of the environment air at 800 mb. level. Divide R_1Y into two parts such that $R_1B_1=4B_1Y$. BB_1 then represents the lapse rate between 850 and 800 mb. level. From B_1 draw the saturated adiabat B_1Y_1 to meet the 750 mb. isobar at Y_1. Let R_2 be the wet-bulb temperature of the environment air at 750 mb. level. Divide R_2Y_1 into two parts such that $R_2B_2=4B_2Y_1$; B_1B_2 then represents the lapse rate between 800 and 750 mb. Repeat the process at at every 50 mb. step and the lapse rate will be given by the curve B_1B_2..............B_9. With a little practice, the drawing of the saturated adiabats BY, B_1Y_1 etc., can be dispensed with and the points B_1, B_2, etc. obtained simply by inspection.

3. *The error involved.* As will be seen in section 1, the new method has been developed by ignoring the latent heat of evaporation liberated due to the small amount of condensation that takes place as a result of mixing the two saturated air masses. Humphreys[3] has calculated the error involved in ignoring condensation in such mixing in the case of equal quantities of two air masses, one at a temperature of 0°C and the other at 20°C, at normal pressure. He found the error involved in this

particular case to be 1·6°C. As will be seen from the figure, we are concerned with temperature difference of less than half that order. The proportion in which the two air masses is mixed in our case is 4 : 1 and this also reduces the error, as the maximum error involved is when the two air masses are taken in equal proportions. Again, we are working at pressures much lower than the normal pressure and this will have the effect of reducing the error still further. The error is, therefore, not likely to exceed 0·5°C, an amount which can be ignored for all practical purposes. As a further confirmation of the magnitude of error involved, the resulting temperatures calculated by the accurate method of Austin were compared with the temperature values obtained by the new method. The result of comparison is tabulated below and shows that the difference between the values obtained by the two methods is negligible.

TABLE.

Level (mb.)	Resultant temperature by accurate method of Austin. °A	Resultant temperature by the approximate method described here. °A
800	292·3	292·3
750	289·1	288·8
700	285·3	285·2
650	281·2	281·0
600	276·6	276·6
550	271·8	271·8
500	266·3	266·3
450	260·6	260·6
400	254·7	254·6

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2. Byers, H. R., and Braham, R. R., Thunderstorm Structure and Circulation, *Jour. of Met.* (*American Met. Society*), 5, 3, 71—86, (1948).
3. Humphreys, W. J., Physics of the Air, 261—262, (1940).

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