USE OF RAREPS IN SHORT PERIOD PRECIPITATION FORECASTS

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Abstract: Using the bearing, distance and nature of precipitation observed on the radar at Townsville for the four months January - April, 1956, at the hours of 0430 and 0700 GMT, the known direction of the upper winds as obtained from the 0400 GMT rawin flight and the type of clouds observed at 0400 and 0700 GMT a precipitation forecast was made for the periods 0500 - 1100 GMT and 0800 - 1400 GMT respectively and these forecasts were compared with the actual ensuing weather.

1. INTRODUCTION

By far the most common cause of serious aerodrome weather deterioration especially in the tropics is that caused by precipitation and for this reason accuracy in the forecasting of precipitation is of prime importance to aerodrome terminal forecasts. With the installation of radar at selected places in Australia a method of using the rareps from these stations to obtain the maximum possible improvements to the terminal forecasts particularly from an aviation point of view was needed. With this in mind the following parameters were considered:

(a) Bearing from the station, distance from the station and nature of the precipitation observed by the radar.

(b) Direction and speed of movement of the precipitation as observed by the radar.

(c) Upper wind velocities as obtained from the rawin flight.

(d) Type of cloud visually observed at the time of the rarep.

No other factors such as synoptic charts were considered in making the precipitation forecasts which were based solely on the above parameters.

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2. DISCUSSION OF DATA

Reference parameter (b), it was not possible to obtain very satisfactory results from the radar. The movement of the precipitation on the radar screen was usually so slow that it was not possible to give an accurate estimation of the movement. Better results were obtained by plotting the precipitation areas at three hourly intervals and obtaining the velocity of movement from the displacement over the interval. While some reasonable results were obtained from this method, especially if there were only a few widely scattered precipitation areas, it was not in general satisfactory due to difficulty in identifying individual precipitation areas and was not used as a parameter.

If no upper winds were available, it would be of some assistance for forecast purposes.

The methods used to make the forecasts were as follows:

(1) If it was actually raining at the station at the time of the rarep, the precipitation being either of the rain, shower or thunderstorm type, the forecast would be for a continuance, at least for some time, of the precipitation.

(2) The rarep was then utilised in the broad sense of one of two alternatives : either there was precipitation shown or there was not. If no precipitation was shown on the rarep the forecast was automatically for fine and no further parameters could be employed.

(3) If precipitation was shown on the rarep, the predominant cloud at the station at the time of the rarep was noted. The clouds were classified by type into the following categories: cumulus, large cumulus, cumulonimbus, altocumulus and altostratus, which were treated together and called for convenience altostratus, stratocumulus and stratus. The following heights were then used as being average mid-heights for the clouds concerned.

Cumulus 10,000 ft. This may seem high but most cumulus clouds which produce precipitation have tops of 15,000 ft especially in the tropics, with a base of 3-4,000 ft giving an approximate mid-height of 10,000 ft.

Large cumulus 12,000 ft. This height was chosen to be slightly higher than that for cumulus clouds and to preserve the observed difference in build.

Cumulonimbus, 12,000 ft, 15,000 ft, 20,000 ft. Clouds of this type have a considerable variation in thickness and for this reason the three heights were used. Recent literature concerning the flights of jet aircraft in the tropics gives Cb tops to well over 30,000 ft as a common occurrence and so a mid-height of 20,000 ft would be possible.

Altostratus. If the height of the base of this type of cloud was known a variable mid-height of about 2,000 ft above the base was used. If no height was given a height of 10,000 ft was used, this being regarded as a reasonable height for Ac As which is producing precipitation. This height is probably a little low but 12,000 ft is probably a bit high.

Stratocumulus and stratus. A height of 2,000 ft above the known base was used.

If a combination of more than one type of cloud was present an effort was made to determine the predominant cloud type. To assist in this, the local weather and type of precipitation in the rarep was used, e.g., shower type precipitation usually denotes cumulus type clouds, heavy showers large Cu or Cb, thunderstorms Cb. Steady rain over a fair area usually denotes St or As type cloud, etc.

(4) Having determined the predominant cloud type the wind at the mid-height was obtained from the 0400 GMT rawin. Using this wind and the bearing and distance of the precipitation from the station, a decision was made as to whether the precipitation would reach the station in the forecast period, e.g., say the cloud was Cu, the 10,000 ft wind was 290/15 and the rarep was "Brkn Mod 270 40-60 to 310 50-60", the forecast would be for showers. If the 10,000 ft wind was 240/15, the forecast would be fine. If the wind at 10,000 ft was 290/5 the forecast would also be fine as the precipitation would not reach the station in the forecast period. If the wind direction did not fall within the rarep bearings but was within a few degrees, the forecast would be for precipitation in the area. If the rarep was scattered, the forecast would be for precipitation in the area. A rarep for isolated strong precipitation was

regarded as a thunderstorm and if it were forecast to pass over the station a thunderstorm would be forecast. Solid precipitation on the radar was regarded as rain.

In the evaluation of the forecasts, a forecast of showers when only showers in the area were received or vice versa was not regarded as serious. Similarly a forecast of fine when there were showers in the area or vice versa was not regarded as serious. A serious forecast error was one in which precipitation was forecast and did not occur in the immediate vicinity of the station or no precipitation was forecast and some was actually received at the station.

A total of 237 forecasts were made and there were 22 errors fulfilling the conditions previously laid down.

There was no appreciable difference between the 0430 GMT and 0700 GMT forecasts, there being 12 errors at 0430 GMT and 10 at 0700 GMT.

No precipitation was reported on the rarep on a total of 54 occasions and on only two of these occasions did precipitation occur.

On two occasions only, precipitation which was forecast did not occur, while the remaining 20 forecast errors occurred when precipitation was not forecast and some did occur.

Subdividing these errors into cloud types the errors with predominating cloud type were as follows:

Cumulus	-	6
Large cumulus	-	4
Cumulonimbus	-	2
Altostratus	-	10

The number of occasions of each predominating clouds was as follows:

Cumulus	-	60
Large cumulus	-	24
Cumulonimbus	-	44
Altostratus	-	39

Stratocumulus - 11
Stratus - 5
Total - 183

The number of occasions when errors occurred expressed as a percentage of the number of occasions when this particular cloud type was used for forecasting were as follows:

Cumulus 6/60 or 10%
Large cumulus 4/24 or 16%
Cumulonimbus 2/44 or 5%
Altostratus 10/39 or 26%.

Combining the cumulus type clouds together the percentage was 12/128 or 9%.

It can be seen from this that the results obtained with cumulus type clouds were much better - approximately 3 times - than that obtained from As type cloud.

The use of radar for precipitation forecasting assumes that the precipitation forms some distance away from the station, is detected by radar and its movement is then forecast from known upper wind conditions. No assistance can be given by radar in forecasting the formation of cloud and subsequent precipitation. If cloud and precipitation forms after the rarep is taken and moves towards the station, or forms over the station radar is no help, and it is considered that a large percentage of the forecast errors which occurred were due to these reasons. The better figures obtained for cumulus type cloud than for altostratus support this view.

At Townsville and Darwin cumulus type clouds of sufficient build to produce precipitation do not form in the vicinity of the station, usually not within 30 miles of the station. At night cumulus forms over the sea, and during the day about 30 miles inland at a sufficient distance from the coast to overcome the coastal cooling in the lower layers. Similar conditions probably exist at Brisbane. The precipitation from these clouds can then be detected at some distance from the station and the radar used for forecasting.

Altostratus and stratus type cloud, however, have no favoured areas of formation, can form, intensify or decrease in any area and may do so in the immediate vicinity of the station. This formation, intensification or decrease in intensity close to the station can cause errors before the precipitation is detected by radar.

Regarding the three mid-heights used for cumulonimbus type clouds, no appreciable difference in the forecasts were noted, although on some occasions slightly greater accuracy was obtained by the use of the 15,000 ft wind and it would seem that except on unusual occasions this could be used as a general mid-height for cumulonimbus type clouds.

3. CONCLUSIONS

(1) Using rareps and rawins only, good results can be obtained in short term forecasts of precipitation from cumulus type clouds.

(2) The results are not as good with altostratus type cloud but they are still a valuable adjunct to other forecasting aids.

(3) Some of the forecasting errors may have been caused by failure to pick up precipitation due to the relatively poor siting of the Townsville radar.

(4) The success of this method of forecasting depends to a great extent upon the skill and experience of the radar operators. With more experience better results should be obtained. This is illustrated by half the errors occurring in the first month. The ideal would be for a screen in the meteorological office to be viewed by the forecaster and used in conjunction with his other forecasting aids.

4. REMARKS

The investigation was hampered by insufficient data especially about cloud types and bases. The radar records give cloud types but rarely bases, while the summary of Aerodrome Weather Reports gives bases but not types. Valuable information is being lost and it would seem advisable that both these records should contain both

cloud types and bases. The Aerodrome Weather Report form does not contain low cloud types restricting its use in an investigation of this nature.

Some standard and easily accessible method of recording the rareps should be introduced and these records should be retained for some period for research purposes.

The time of "Rareps" or "Tafors" should be altered so that "Rareps" are done immediately prior to the issue of "Tafors".