The Micro-structure of Cumuli in Maritime and Continental Air

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Since 1950 a number of measurements have been made of the droplet spectra in clouds, chiefly cumuli, using the sampler described by SQUIRES and GILLESPIE (1952). This device takes ten sampling rods at each loading, and these can be exposed at intervals of about three seconds, taking some thirty seconds in all. In sampling cumuli, the general practice has been to make horizontal runs at various levels, to obtain representative data for the whole cloud.

It has been found that the characteristics of the droplet spectrum change rather erratically from one sample to the next. It is evident that the "grain" of a cumulus is smaller than the distance flown in three seconds, that is, about 200 m. Nevertheless, certain types of clouds have distinctive characteristics, and the erratic variation within the one cloud is not so great as to mask these characteristic differences.

One of the most striking differences is that between cumuli in maritime and in continental air masses. In maritime cumuli the droplets are bigger, and the droplet concentrations smaller, than in continental cumuli. At corresponding levels, there seems to be no notable difference in liquid water content between the two types of cloud. The difference in micro-structure is most simply discussed in terms of droplet concentrations.

Only those cumuli which were forming in an unmodified maritime air mass and which were sampled over the sea have been included in the class of "maritime cumuli". These have been measured off the eastern and southern coasts of Australia at various seasons of the year, and off the island of Hawaii during Project Shower, October to December 1954. The class of "continental cumuli" includes only cumuli observed over the land in an air mass which was estimated to have spent at least two days over the land. These have been sampled in south-eastern Australia only. There is some evidence of a seasonal variation in the micro-structure of continental cumuli in this region, the lower concentrations occurring during the rainier autumn months. This variation is not however so great as to confuse the rather marked contrast between maritime and continental cumuli, and it will not be discussed here.

This contrast is illustrated in Fig. 1, which gives histograms of the percentages of all samples, irrespective of position in the cloud, for which the droplet concentration fell in the specified ranges. Table 1 shows for each air mass type the median, first and third quartile and maximum droplet concentration.

Table 1

Air mass type	Maritime	Continental
1st quartile droplet concentration	19	150
Median droplet concentration	42	290
3rd quartile droplet concentration	66	470
Maximum droplet concentration observed	400	2 810

It will be noted that the continental values entered in this table are all about seven times the maritime values. This implies that, if the droplet concentrations found in the continental clouds were divided by seven, the resulting

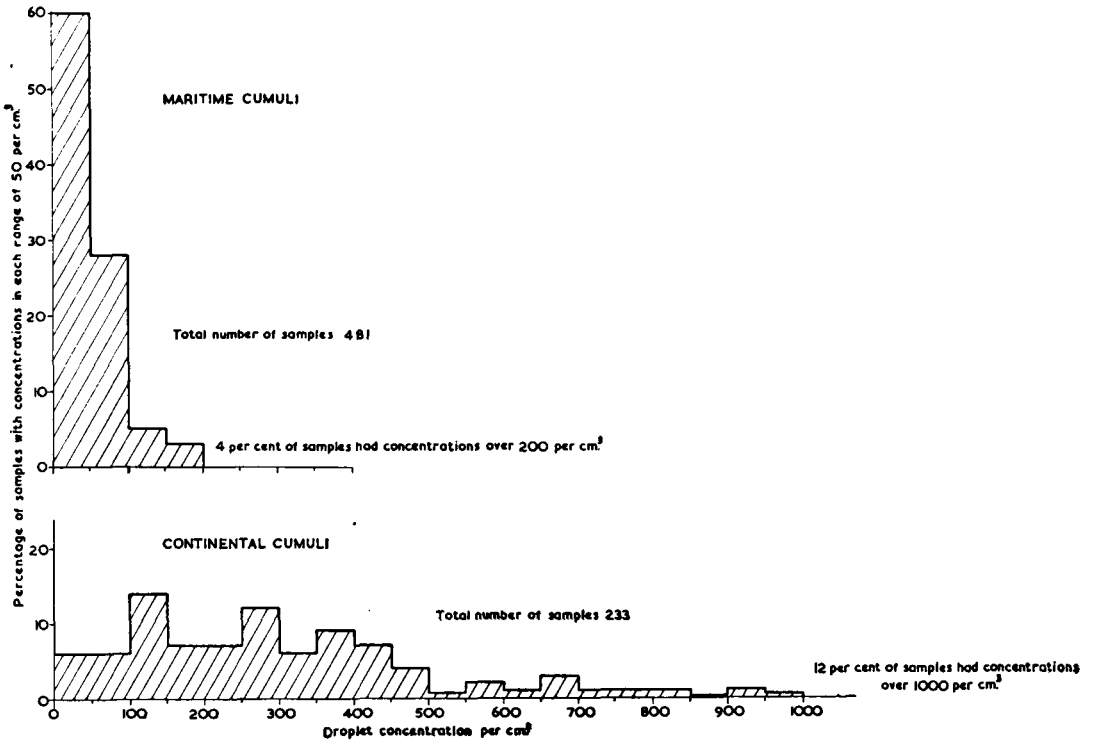

Fig. 1. Histograms of the percentages of all samples taken in maritime and continental cumuli in which the droplet concentration fell in the specified ranges.

histogram would resemble that shown for the maritime cumuli in Fig. 1. Thus, if the continental values are grouped in ranges of 350, instead of 50 as in Fig. 1, the first three ranges contain respectively 58, 26, and 5 per cent of all continental samples. The first three ranges of the maritime droplet concentration shown in Fig. 1 contain respectively 60, 28 and 5 per cent of all maritime samples. As regards this series of observations, one may conclude that the continental cumuli had, in general, droplet concentrations about seven times those found in maritime cumuli. It may be remarked that minimum values of the concentration have no significance, since samples taken at the edge of a cloud will sometimes show very low values. quite unrepresentative of the cloud as a whole,

It is well known that maritime cumuli are more liable to yield rain without the presence of ice than continental cumuli. It seems possible that the difference in microstructure described is partly responsible for this, and it is hoped to enlarge on this and other aspects of the microstructure of clouds in a later paper.

REFERENCES

SQUIRES, P., and GILLESPIE, C. A., 1952: A cloud droplet sampler for use on aircraft. *Quart. J. R. Met. Soc.*, **78**, pp. 387—393.