Comments on "Variability in Estimating Total Cloud Cover from Satellite Pictures"

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The study of Young (1967) illustrates a desirable trend towards objectivizing the processing of meteorological satellite cloud picture data. It represents work of a type that is vital if the satellite data are to be significantly used in climatology. Nevertheless, while Young's general conclusions are very likely correct, we do have reservations concerning some of his specific procedures. These reservations are principally related to matters of scale, which must be a fundamental consideration when dealing with data providing both coverage of the order of 10^6 km^2 and resolution of the order of 1 km.

We would first question whether the torn paper test, as used in Young's study, was homogeneous to the cloud estimates as made from the Nimbus pictures. Four of the torn paper samples (B2, C2, E1 and F) obviously represent features (cloud vortices) whose scale is at least that of an entire Nimbus frame, and the other samples could well be considered representative of cloud patterns covering areas of similar scale. Yet, in the torn paper test, the observer was asked to make a single estimate for a total area which, in the Nimbus pictures, was subdivided into 100 squares for which the cloud cover was estimated individually. To provide a valid comparison, it would seem that either:

1) The torn paper cover estimate should have been determined from the mean of estimates of 100 subdivided squares (although, as Young points out, it would not be easily feasible to obtain an objective cover value for each subdividing square individually), or

2) The torn paper samples should each have simulated cloud patterns typical of those within the individual small grid squares used with the Nimbus pictures. They should then have been photographically reduced to the scale of these grid squares, and surrounded by a larger torn paper pattern to maximize the experimental situation analogy.

With regard to the results from Young's torn paper tests, somewhat analogous tests, conducted by Donald W. Beran and one of us (Barnes), have not shown a tendency to overestimate cloud amounts. A slight tendency toward overestimation would, however, partially compensate for the inability of existing satellite TV cameras (at Nimbus and especially TIROS, ESSA and ATS resolutions) to detect very small or thin clouds. Such a tendency would also make satellite and ground cloud cover observations more homogeneous, since Barnes (1966) has shown that cloud cover as estimated from satellite pictures averages some 14% less than concurrent ground observed cloud cover.

A second major reservation concerns the procedure Young used for consolidating the individual estimates for subsequent analyses of their significant sources of variability. As stated in his Section 3, "Each element (the area under one square of the grid overlay)—was treated as an individual picture." The sample, therefore, really consisted of 1000 "mini-pictures," not 10 pictures; the 1000 "mini-pictures" could then have been divided as appropriate for subsequent analyses.

Young used, instead, the procedure of combining the separate grid square estimates in terms of the individual Nimbus picture from which they were taken. We feel this approach has no real meaning, due to the following factors:

1) Several of the Nimbus pictures used (Fig. 1 of Young's paper) vary more from part to part (for example, from the lower left to the upper right of Picture No. 1) than others do from one to another (for example, 6 and 8 would appear to have much the same character).

2) The grid squares used were of such scale that many of the cloud amount estimates for the individual "mini-pictures" would be either 0/8 or 8/8 (or, at least, close to these values), regardless of what the mean cloud amount for the total picture was. Thus, the variability in both the estimates and the mean amounts would very likely depend on grid size. Further experiments using different grid sizes should perhaps have been considered.

A better procedure might have been to consider the grid primarily as an aid to objective estimates, and to take each observer's so-derived total cloud cover estimate for each picture before proceeding to the statistical analyses. The other alternative would have been to consider each set of estimates for a given grid square and picture as a separate set of 10 samples, and not to subsequently combine them in terms of the picture they came from, but rather to consider them as 1000 individual "mini-pictures." (The choice between these alternatives would seem to be determined by whether the real interest was in mesoscale cloud cover estimates for areas of the order of 10^4 km^2, or total picture cloud cover estimates for areas of the order of 10^6 km^2. This decision was evaded by the author, although in Section 2 of the paper, he implies that the mesoscale is of primary interest.)

Accordingly, the meaning of the estimated cloud cover amounts for each entire picture is questionable, because the 100 estimates making up each mean ranged all the way from 0/8 to 8/8. Furthermore, in Young's Fig. 5, Nimbus Pictures 1, 2, 6, 8 and 9 all have mean estimated cloud amounts of 5/8, but the range of their standard deviations is from 1.3 to 2.0, or about one-half of the total range of standard deviations. This suggests that something more than just the mean cloud cover of the picture as a whole is operating. It may be, at least in part, the differences in the way this mean cloud cover was organized at the scale of the grid squares.

REFERENCES

Barnes, J. C., 1966: Note on the use of satellite observations to determine average cloudiness over a region. *J. Geophys. Res.*, **71**, 6137–6140.

Young, M. J., 1967: Variability in estimating total cloud cover from satellite pictures. *J. Appl. Meteor.*, **6**, 573–579.