

AIRCRAFT AND CLOUD FORMATION

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IN this note I wish to call attention to the increasing role played by aircraft in cloud formation. Most frequently the contrails caused by high-flying jets appear to seed the sky, or serve as a catalyst, leading to significant cloudiness if not a complete overcast. On rare instances, the reverse can happen and the passage of a plane through a cloud layer causes at least a local disappearance of the cloud. The interesting question arises as to the overall and perhaps long-term effect these aircraft disturbances might have on our weather.

One's awareness of contrails undoubtedly depends on geographic location with respect to the airways, the local climate, and, of course, whether one looks up at the sky. The writer's circumstances favour all these conditions. Arizona is bridged by cross-country airways. The dry air of the surrounding Sonoran desert produces transparent skies particularly during the winter months. Often clear from horizon to horizon, the onset of any cloudiness is noticeable. Finally, I am an observational astronomer whose livelihood in a real sense depends on these clear skies. Thus my colleagues and I have become keen scanners of the heavens, worrying constantly about the clouds and whether they will interfere with our work.

A rather typical contrail sequence is here chronicled for a January day. The sky was crystal clear early and at the solar telescope, photometric observations were under way. Suddenly the image dimmed, and the photometry was ruined, by the passage of a newly formed contrail. Most commonly such a contrail is an isolated event. But this was not to be the case on this day. Going outside about 0815 (local Standard time), we found two jets cavorting and apparently enjoying their art work. These contrails spread until the sky was quite overcast from the resulting cirrus (Fig. 1). That these clouds consisted of ice crystals is proved by the brilliant section of a 46° halo seen at about 0930 (Fig. 2, p. 59).

In the spring of 1965 astronomers the world over travelled thousands of miles to study a total eclipse of the sun from the South Pacific islands of French Polynesia (Bateson 1964). After a month's preparation at the site on Bellingshausen (during which time there was much cloudiness), eclipse day fortunately dawned clear. About ten minutes before totality a high-flying jet with its trailing contrail was seen to cross the northern sky moving east to west. This jet contained American airborne eclipse experiments sponsored by the Sandia Corporation (Cox, *et al.* 1965). The contrail from this plane persisted until after totality. Fortunately, this contrail just missed interfering with the ground-based party. But what if it had? (Already there existed a sense of competition



Fig. 1. Expanding contrails at 0900 LST

between the aeroplane and ground-based groups !) The possibility of contrail interference is now seriously considered in expedition planning.

But all may not tally on the deficit side against aircraft. On 13 March 1968 a striking example of aircraft-induced cloud clearance was witnessed over Tucson. The first indication that the prevailing conditions were peculiar occurred about 1000 LST when an aircraft passed through a rather uniform layer of altocumulus that covered the sky. The result of this passage was the appearance of a distinct cleft in the cloud layer. Shortly afterward another plane apparently made a spiral descent through the layer. Almost immediately the cloud disappeared inwards to the locus of this spiral and the circumference of the clearing began to enlarge (Fig. 3). While blown out of sight within 40 minutes, we had the impression that the growth of the clearing persisted.

These somewhat qualitative descriptions could be continued almost without end. Reinking (1968) recently suggested that contrails do affect significantly the "radiation budget." Certainly the day is rare when some evidence of them is not visible. It would seem to us that a quantitative study of their influence is in order.

REFERENCES

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| COX, A. M.,
LIEBENBERG, D. H.
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| REINKING, R. F. | 1968 | Insolation reduction by contrails. <i>Weather</i> , 23 , pp. 171-173 |



Fig. 2. Final cloudy sky at 0930 LST (*See article on page 56*)

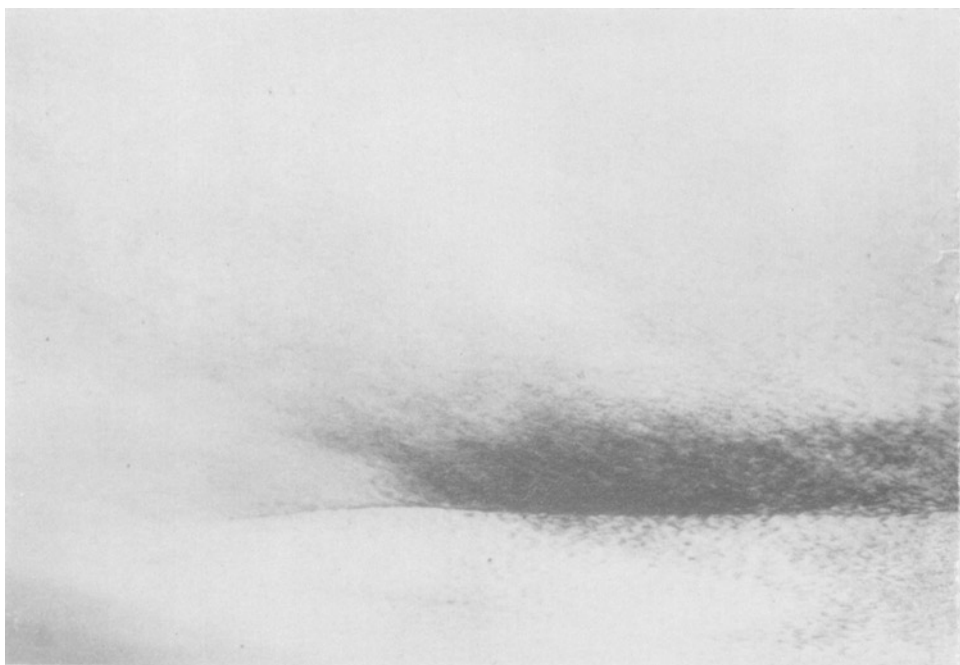
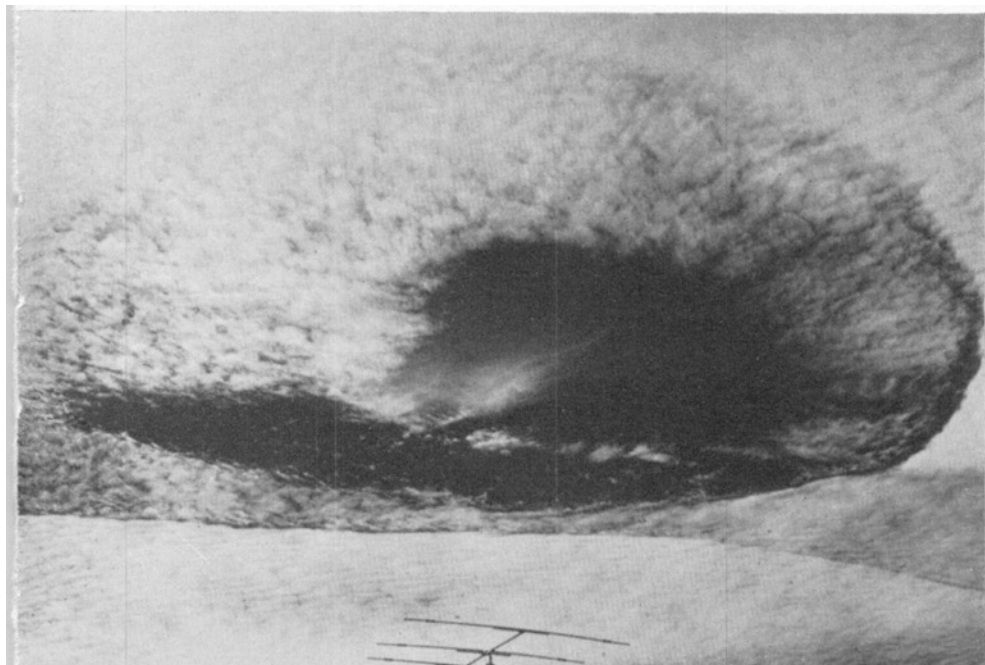


Fig. 3. Aircraft induced cloud clearing over Tucson, Arizona, 13 March 1968 (*See article on page 5*)



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CLOUDS (See notes on page 65)

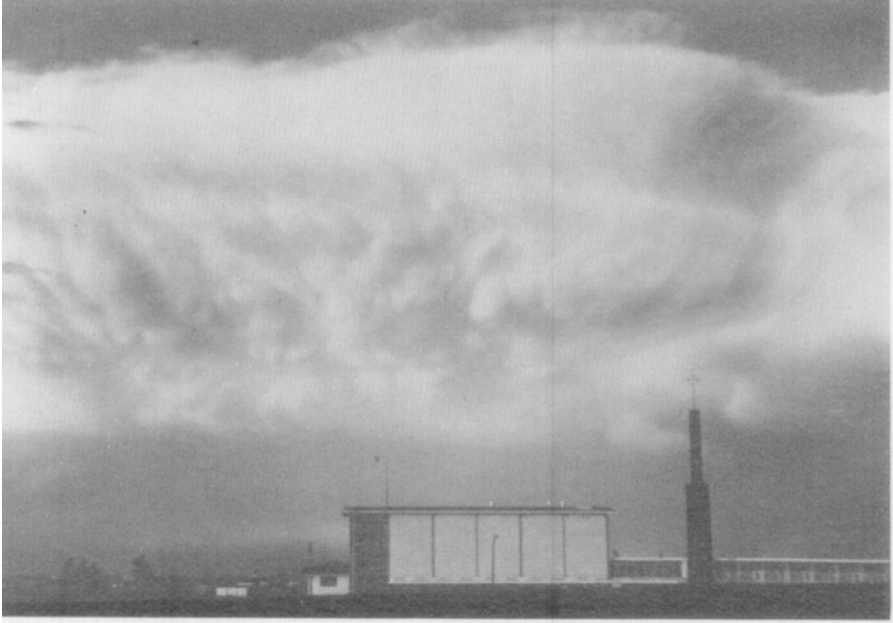


Fig. 12.

Photograph by I. Y. Ashwell

Underside of anvil illuminated by setting sun; looking east-south-east, Calgary, Alberta, 2040 MST 12 June 1966. Evaporation of droplets falling into clear air below the cloud causes cooling, and the resulting denser air descends, taking with it some cloud and rain which can then be seen as downward pointing cumulus-like protuberances known as mamma. This photograph shows mamma on the underside of an anvil at a stage when they are being distorted into vertical streaks by fall-out of precipitation



Fig. 13.

Photograph by D. N. Robinson

An extensive anvil developing in the presence of wind shear so that it is distorted in one direction

CLOUDS (*See notes on page 65*)

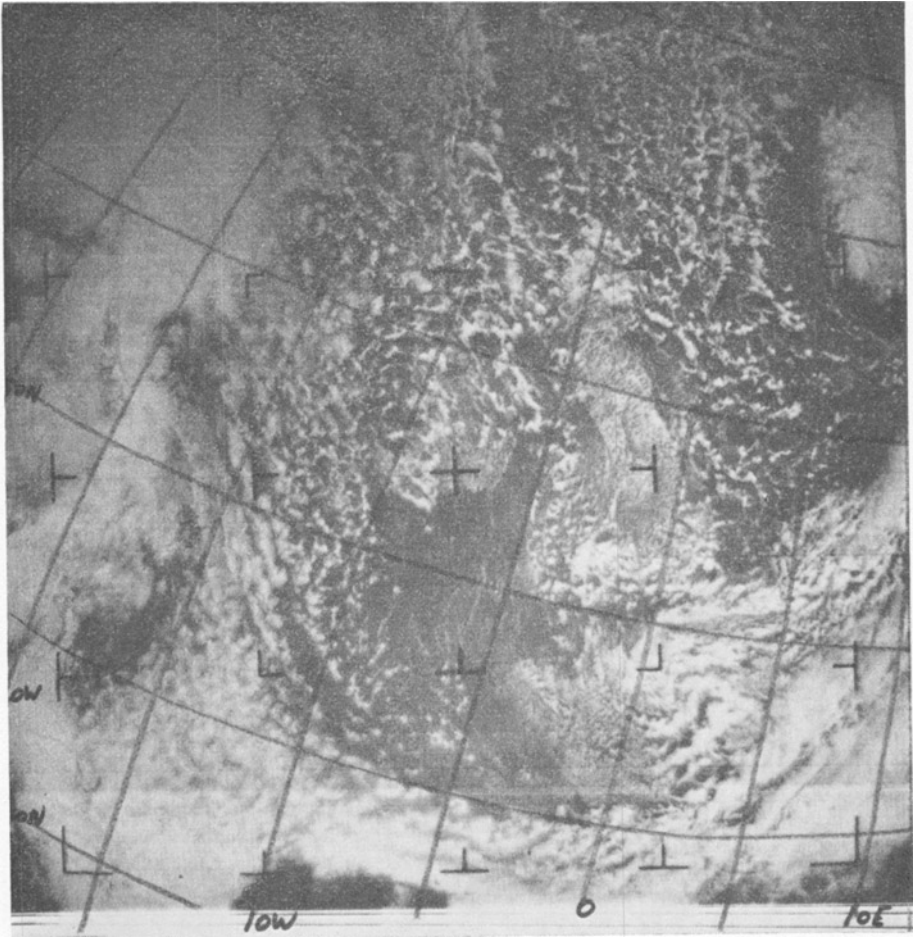


Fig. 14.

Photograph Copyright HMSO

The outline of Britain is clearly visible in this showery north-westerly airstream. Convective clouds form a coarse cellular pattern. 1127 GMT 21 April 1967

Fig. 15.
Snow falling from this
shower melts to raindrops
at a level clearly defined
by a change of visibility.
Seen near Middlemarch,
Otago, New Zealand,
1500 hr 18 September 1965



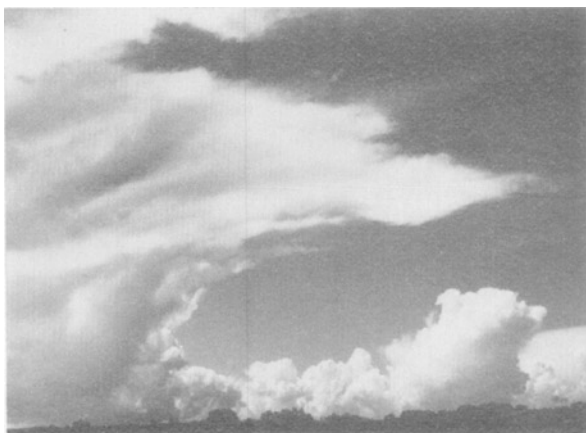
Photograph by M. J. Hammersley



Fig. 16.
Distant massive cumulus
towers capped by large
pileus clouds. Looking
north, Chislehurst, Kent,
1900 GMT 14 July 1965

Photograph by C. A. Clark

Fig. 17.
Old and decaying icy anvil
cloud. Bracknell, Berk-
shire. 1015 GMT 23 July
1965



Photograph by R. K. Pilsbury