CLOUD STUDY

A Pictorial Guide

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R.S.S.

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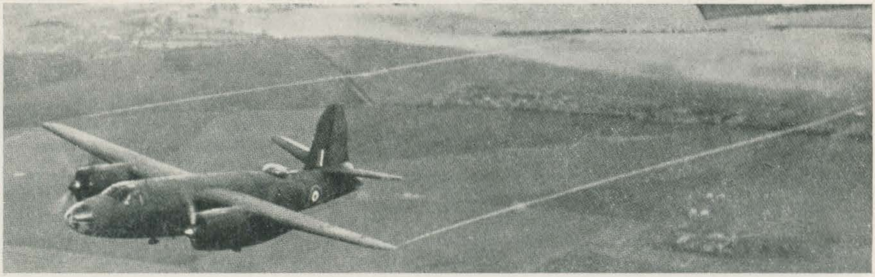
The funnel clouds of *tornadoes* and *waterspouts* grow downwards from the cloud, sometimes reaching the ground (or sea) for a few minutes. They occur under newly formed parts of vigorous cumulonimbus clouds, not where rain is falling but where the vertical growth is most rapid. The violence of the rotation is most probably due to vertical stretching of a part of the cloud originally rotating slowly.

The direction of rotation of tornadoes is predominantly cyclonic, particularly in the larger ones. Waterspouts, similar phenomena occurring over the sea, are more common than tornadoes, and generally less violent; their direction of rotation may be cyclonic or anticyclonic. Where a waterspout [no. **66**] impinges on the sea spray is thrown up by the violent wind.

The centrifugal force in the rotating column causes a reduction of pressure in the centre, and the outline of a tornado funnel cloud [nos. **64**, **65**] is where the reduction of pressure is just sufficient to produce condensation. If the funnel reaches the ground the pressure inside is about the same as at the main cloud base, perhaps 70 mb lower than at the ground nearby.

Tornadoes and waterspouts move with their parent clouds, usually receding into them after a few minutes. *Dust devils*, on the other hand, are produced in extremely unstable layers of dry air over very hot ground and drift initially with the surface wind. Their direction of rotation may be either way, and their path curves towards the side that is moving forwards. They are visible because of the dust blown up; if they extend up to the condensation level there is not normally any rotation to be seen in the cumulus cloud formed at their top. They may have inflow at the top and a flow of cool air down the centre which is often free of dust. The hollow centre sometimes seen in funnel clouds both of tornadoes and waterspouts may be due to centrifuging outwards of the cloud droplets. The tornado illustrated in no. **65** is blowing up dust which is being thrown out from the centre. It is a 'dust-spout'.



67 R.A.F.

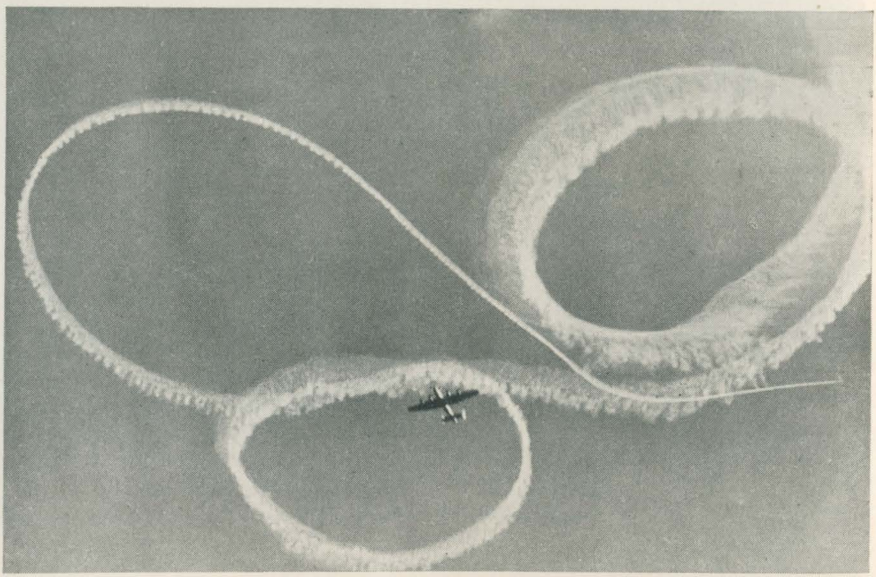
An aircraft wing lifts the aircraft by producing a 'downwash' of air in its wake. At the outer edges of this downwash there are vortices trailing backwards from the wingtips, and on account of the rapid rotation the pressure in the centre of these vortices may be low enough to cause condensation. *Wing tip condensation trails* [no. **67**] are then formed. Such trails may also be formed at the tips of the propeller blades, particularly when the aircraft is climbing or taking off under full power. They are then spiral, indicating roughly the tracks of the propeller tips.

Some jet aircraft have engines near enough to the wingtips for exhaust, which contains a high proportion of water vapour, to be drawn into the wingtip vortices. A dense wingtip trail is then formed and the cloud-filled vortices can be seen for a mile or two behind the aircraft. The vortex motion delays the mixing of the air in the vortex with the surrounding air, so that trails of this kind are abnormally slow to spread and evaporate.

68 *J. L. Monteith*

If an aircraft flies in relatively dry air just above a thin layer of cloud the downwash may penetrate into the cloud forming a *dissipation trail* [no. **68**], or *distrail*, which sometimes consists of a row of clear holes. Under suitable conditions a long strip of cloud along the track of the aircraft may be cleared [no. **71**].

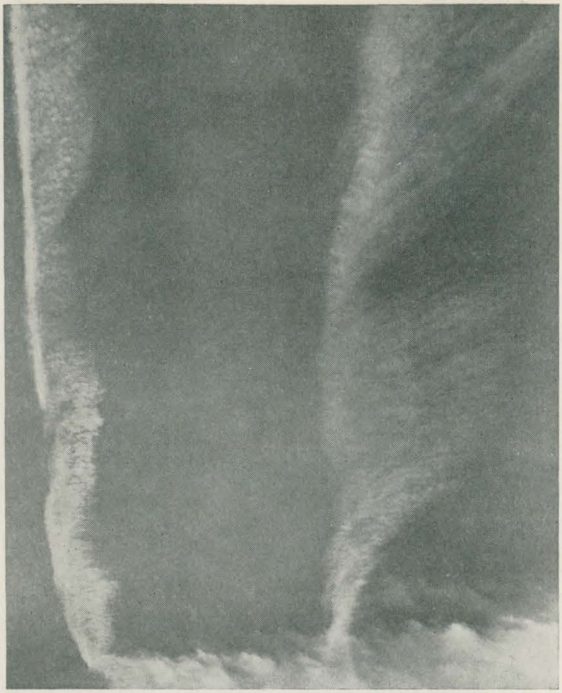
If the surrounding air is cold enough engine exhaust forms a cloud when mixed with it in proportions between certain limits. The cloud so formed, known as an *exhaust condensation trail* [no. **69**] or *contrail* is in the region of downwash so that it is extended in a vertical curtain whose lower edge assumes the form of pendulous blobs, which correspond with the holes of a distrail [no. **68**]. Contrails are usually at two or three times the height of this type of distrail; and normally form only when the temperature is low enough (less than about −38° C) for the droplets to freeze in a few seconds.



69 *M. Hubbard*

A small wind shear can draw out a contrail into an almost horizontal sheet of cloud [no. **70**]. In this picture, the right hand trail is a few minutes older than the other and has been extended more. Sometimes several trails drawn out in this way cover most of the sky with cirrus. If the trails are very persistent the clear air must be saturated for ice.

Brightly coloured parts of complex haloes are occasionally seen in persistent contrails. Parts of coronae have been seen from accompanying aircraft in the first few metres of the trails, but they disappear as the droplets freeze and grow into crystals.



70 *R. S. Scorer*

71 *W. Tribble*

Sometimes ice crystals appear along the path of an aircraft which flies through a cloud of supercooled droplets. If the crystals grow and eventually fall out of the cloud layer, they may leave a fall-streak hole [see no. **28** and p. 45] in the form of a long clear lane. In the present example [no. **71**], however, the crystal trail lies below a clear lane which is probably an ordinary distrail; it was produced in a very thin wave cloud.

72 R. S. Scorer

A contrail in clear air may become cirriform [no. **72**] if only a few of the cloud particles originally formed in it turn into ice. These few can grow larger than if there were many, and then they have appreciable fall speeds, and give the cloud a fibrous appearance.

73 E. A. Phoenix

A halo is usually seen round the sun when it is looked at through *cirrostratus* [no. **73**]. This cloud is probably several thousand feet deep and is composed of sparsely distributed ice crystals. Persistent condensation trails readily form in such cloud, as seen in this picture.

This halo has an angular radius of 22°. It is very faintly coloured and the cloud is brighter outside it than inside. Often there is a more brightly coloured tangent arc at the top of the 22° halo, and occasionally other rings and arcs appear (*complex haloes*, described, for example, in the 'Observer's Handbook', published by H.M. Stationery Office).