

Annular cloud formations over the Indian land area

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ABSTRACT. From films of daily digital cloud cover mosaics from ESSA satellites obtained from the US Weather Bureau, enlarged photographic prints were made for a study of cloud systems and their structure over the Indian Ocean and adjoining areas.

1. Introduction

The existence of annular cloud formations over ocean areas is mentioned in literature on satellite meteorology. An examination of the ESSA photographs over the area 40° E—160° E and 30° N—30° S for 1967-1969, however, revealed the existence of such cloud formations over the Indian land area as well*. These have been noticed mostly in the SW monsoon months June to August and occasionally in the months of May and September. A few cases have also come to notice in the winter months of November and January. In some cases during the monsoon, the meso-scale annular cloud formations have been observed to cover the entire Peninsula and the central parts of the country; in some other cases, the area covered is relatively small, the favourable region being from southeast Madhya Pradesh to Orissa and Andhra Pradesh coasts. A corridor from the Punjab to Assam along and to the south of the foot Himalayas seems to be comparatively unfavourable. Tibet and other Himalayan high lands have often shown open cellular patterns in large numbers; but owing to the peculiar terrain and existence of marked ascending and descending currents and the complication arising from snow cover, it is not safe, without intensive studies, to come to any conclusions about the annular formations in this area. These formations are not always annular; their shapes are : circular or elliptic rings, U or horse-shoe and irregular.

The rings are generally found in groups of more than 3 or 4 but may occasionally be isolated. Each ring, when examined under a microscope, reveals further infra or 'fine' structure, made up of several discrete cloud elements. There

are instances when the small circular ring pattern cells are found arranged in a circle or ellipse.

These circular formations do not seem to be associated with any particular synoptic situation. They have been found in disturbed weather as well as in near fair weather situations. It is proposed to take up a study of the association of the cellular patterns with rainfall patterns over the areas concerned.

2. Discussion

Measurements were made in a few cases of the area of the cloud free space and the width of the cloud matter forming the ring (or limps around). In the 40 odd instances examined, the width of the cloud area forming the ring or limps was found to vary from 10 km to 50 km but frequently of the order of 20 km. The central open space in the ring has diameters or width ranging from 10 km to 80 km and occasionally even over 100 km. The total dimension of the ring is of the order 50 to 120 km.

The ratio of the open or inner cloud free area to the total area of the rings was found to vary from as low as 5 per cent (one case only) to as much as 55 per cent. Percentages in the case of the patterns measured are given below, along with the dates on which these occurred.

13 Jun 1967 55 per cent (≈100 km)

23 Jun 1967 7 per cent (120 km)

25 Jun 1967 (5 specimens) 12 per cent (80 km), 5 per cent (80 km), 20 per cent (80 km), 13 per cent (70 km), 11 per cent (120 km)

1 Jul 1967 (5 specimens) 30 per cent (110 km), 18 per cent (100 km), 32 per cent (130 km), 24 per cent (85 km), 41 per cent (90 km)

*The existence of 'cellular convection' type of clouds over India was pointed out by Koteswaram (1961). *Sci. Rep.*, 2 November 1961, p. 31, Met. Div., Hawaii Institute. Geophys., Univ. Hawaii.

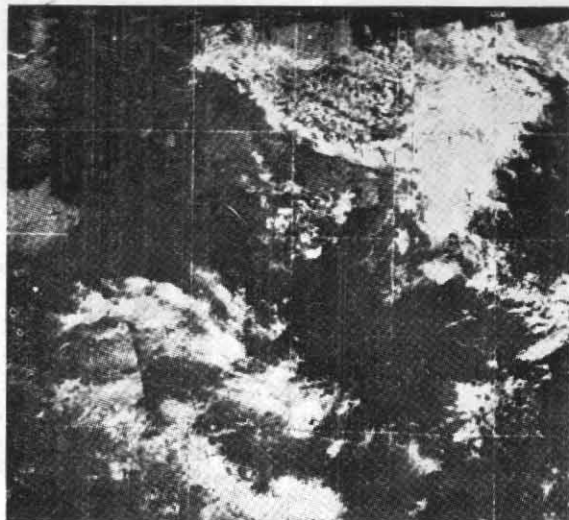


Fig. 1
Example of annular cloud formations on 9 June 1967

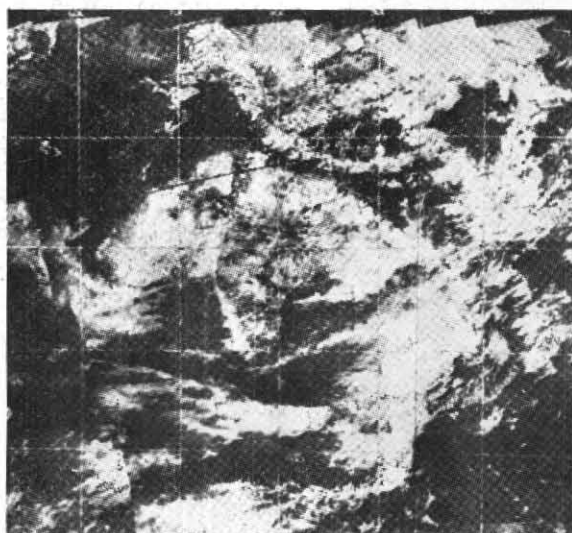


Fig. 2
Example of annular cloud formations on 1 July 1967

18 Jul 1967	(4 specimens) 34 per cent (130 km), 26 per cent (100 km), 38 per cent (94 km), 48 per cent (75 km)
19 Jul 1967	(8 specimens) 21 per cent (85 km), 19 per cent (170 km), 24 per cent (50 km), 20 per cent (60 km), 15 per cent (40 km), 25 per cent (60 km), 30 per cent, 15 per cent (45 km)
20 Jul 1967	(5 specimens) 28 per cent (75 km), 26 per cent (80 km), 30 per cent (90 km), 29 per cent (85 km), 45 per cent (120 km)
20 Aug 1967	(7 specimens) 18 per cent (65 km), 11 per cent (50 km), 40 per cent (85 km), 12 per cent (60 km) 32 per cent (75 km) 35 per cent (90 km), 36 per cent (90 km)
8 Sep 1967	(2 specimens) 13 per cent (65 km), 19 per cent (65 km)
15 Jun 1969	(2 specimens) 40 per cent (120 km), 41 per cent (110 km)
17 Jun 1969	(4 specimens) 37 per cent (50 km), 36 per cent (80 km), 23 per cent (62 km), 36 per cent (50 km).

The cloud area is likely to be slightly more than the area of ascent, due to the spread of the clouds into areas of gentle descending motion also. Hence one would expect the clear area to be somewhat smaller than the cloud area. However, when the inner area is much smaller than the cloud area, one has to infer one or the other of two alternatives, *viz.*,—

1. The descending current in the cloud free space has a significantly larger velocity. This appears to be improbable.
2. The compensating descending currents occur in the clear areas outside the ring, in addition to the central cloud free space.

A few typical cases of the annular formations observed by the satellite over India are shown in the four figures.

The experience described by some aviators during the IInd World War may be mentioned in passing, as it may be relevant and of some interest. They occasionally reported that they met a number of cyclones when flying, say, from Calcutta to Allahabad in the monsoon season. In those non-satellite days, the weathermen hearing this story were somewhat baffled as they did not see a cyclonic storm, as generally understood, on their charts of the time. They thought that the fliers may have encountered some monsoon squalls and wrongly described them as cyclones. From the cloud pictures now furnished by the satellites, it seems that these aviators must have crossed some of these annular cell formations with a ring of cloud elements, and a central cloud free area. The satellites have now been able to see them and only they can recognise them, since neither an observer on ground nor one in an aircraft can see these mesoscale formations.

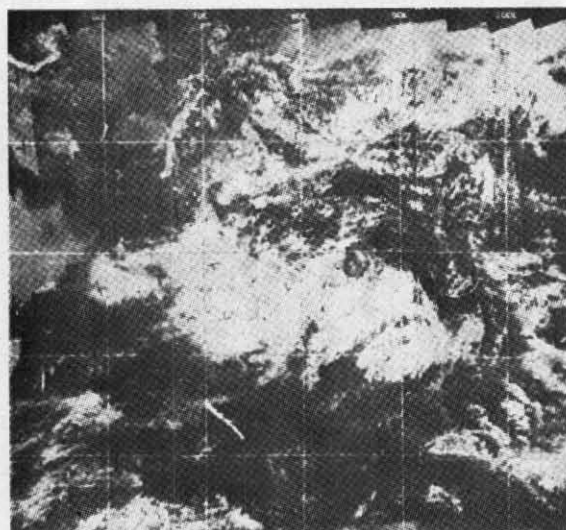


Fig. 3
Example of annular cloud formations
on 18 July 1967

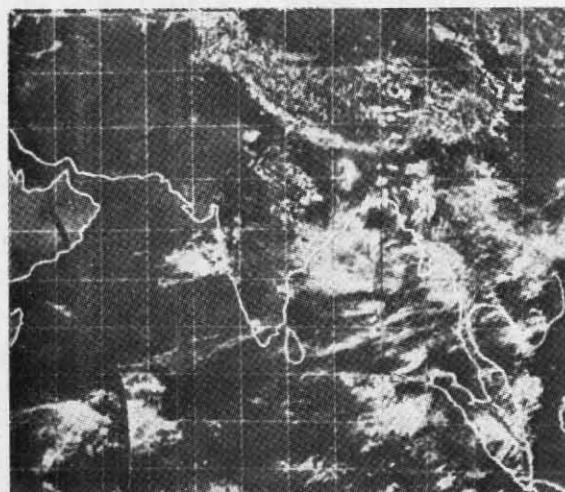


Fig. 4
Example of annular cloud formations
on 17 June 1969

Each of the 'cells' was probably accompanied by horizontal winds at the ends of a diameter blowing in opposite directions. It is possible to envisage such a cloud ring, if the cloud area is

predominantly the ascending area, the descending area being predominantly outside the ring. Ascending warm air and descending cool air outside the ring, will form solenoids, which generate horizontal motion, which will be anticlockwise and therefore cyclonic. At this stage I am entering into too much of speculation, though in the right sense.

Acknowledgements

The measurements of the cloud sizes on the photographs were carried out by Messers H. S. S. Sinha and D. C. Sah to whom my thanks are due. Thanks are also due to Mr. B. N. Sreenivasiah for valuable discussions about these cloud pictures.

DISCUSSION

DR. P. KOTESWARAM remarked that similar cellular structure was observed by him over the Peninsula in May 1960 when there was a cyclonic storm in the Arabian Sea. The picture was taken with a narrow angle camera. The rings were more than 100 km in diameter with holes in the centre.

DR. D. M. PATEL : Do you regard the rings as vortex motions ?

DR. P. R. PISHAROTY : I believe that the rings contain horizontal winds along their lengths and circular motion along the peripheries of the rings as in a toroid.

SHRI J. SHUKLA : How can such organisation of clouds be explained without reference to any synoptic feature ?

DR. PISHAROTY : There was no synoptic situation. The cell system can be considered as a meso-scale phenomenon.

SHRI SHUKLA wondered about the hydrodynamic and thermodynamic factors which may give rise to such a type of convection.