

Centres of monsoon depressions as seen in satellite pictures

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ABSTRACT. In satellite pictures of monsoon depressions, the centre of the depression is generally inferred by the curvature of the cumuliform bands in the northern half of the depression field. The positions of the depression centres determined from satellite pictures are found in a majority of cases located southwest of the centre on the sea level isobaric chart. The shear winds between 850 and 500-mb levels do not define any closed circulation whose centre could correspond to the depression centre derived from satellite pictures. The satellite determined centre appears to be close to the centre of the depression at 700 or 500-mb level. The results are tentative as they are based on very limited observations.

1. Introduction

The satellite pictures of the monsoon depressions show heavy overcast clouding to the south of the centre of the depression, with cumuliform clouds in the north. The cumuliform clouds may be absent or in an unorganised state in the early stages of the development of the depression, but organise themselves into involuting bands as the depression becomes well-marked and deepens (Srinivasan, Raman and Ramakrishnan 1971). In the satellite pictures of monsoon depressions the centres are determined by following the cumuliform bands. The experience in using the satellite pictures during the last few years has been that the satellite determined centres of monsoon depressions sometimes differ from the centres on the surface isobaric charts. Since surface observations are plentiful over land areas, there is no uncertainty in the centres obtained from synoptic charts; the differences in the centres, therefore, require some investigation. As the satellite-determined centres depend upon the presence of cumuliform bands and these bands appear only with well-marked depressions, the cases considered in this paper will be only the well-marked system.

Studies elsewhere have shown that convective clouds that form into bands are aligned in the same direction as the wind shear through the layer of convection (Hubert 1963; and Hubert and Lehr 1967). It was felt that this may be a reason for the differences noticed in the case of the centres of monsoon depressions, as these centres depend on the orientation of the cumuliform bands. The study was therefore oriented to find out—

- (i) the vector differences between the positions of centres on surface charts and satellite pictures,

- (ii) whether a centre of circulation corresponding to the satellite picture centre exists in the shear winds in the 850-500 mb layer in which the cumuliform bands are assumed to be embedded and

- (iii) whether the satellite picture centre agrees with the centre at any lower or midtropospheric level, through which the circulation of the depression extends.

2. Data and analysis

The monsoon depressions during the months of July and August of 1966 to 1969 were considered in this study. The centres of depressions were taken from the 0300 GMT surface charts and from the APT operational bulletins as well as from APT pictures in a few cases where it was not given in the bulletins. As may be expected, the satellite-determined centres were available only on a limited number of occasions. There were in all 24 cases where the satellite picture centre could be compared with the centre on the isobaric chart. The vector differences in positions were determined in each case and are shown on a polar diagram in Fig. 1.

3. Discussion and results

Of the 24 cases studied, the vector displacement was less than or equal to one degree of latitude/longitude in 17 cases. Considering the errors involved in the operational gridding of APT pictures (Srinivasan 1970) and the time differences between the synoptic charts and satellite pictures, we may not normally consider differences upto one degree as significant. But what is noteworthy is that the satellite centres were in a majority of cases (about 60 per cent) in a southwesterly direction with respect to the isobaric centres; it was 100

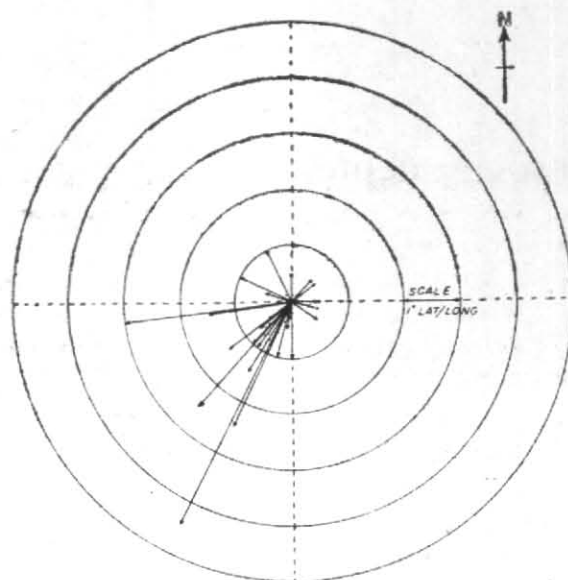


Fig. 1

per cent where the displacement was more than 1° Lat./Long. Out of the cases where the difference was more than half a degree, a few were selected where there was good wind data and the shear winds in the 850-500 mb layer were worked out. But no cyclonic circulation could be noticed in the shear wind field corresponding to the satellite picture centre, although there was certain amount of alignment of the cumuliform clouds along the shear winds.

In the cases where the difference was more than 1° Lat./Long., the upper wind charts for various levels were looked into. The satellite picture centre appeared to agree with the centre of circulation at some level between 700 and 500 mb. The magnitude of the vector differences given in Fig. 1

are also of the same order as the tilt in the centre of well-marked monsoon depressions between the surface and the lower/upper troposphere, obtained from the wind observations (Mulky and Banerji 1960). With only very few cases we have examined and with the paucity of upper winds at higher levels, the agreement between the satellite picture centre and the centre of circulation at some upper level should be taken very cautiously. If this result turns out to be correct we have in satellite pictures a method to judge the tilt of the axis of monsoon depression, to a sufficiently high degree of accuracy that is not possible with the present upper air network. However, to judge the true slope of the system, the errors due to gridding and due to the time difference between the synoptic chart and the satellite picture, should be allowed for.

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DISCUSSION

(Presented by M. C. Sharma)

SHRI D. R. SIKKA : Large differences exist even as much as 200 n. miles between the satellite determined centres and synoptically determined centres even when the depressions were over land. Could it be due to any vertical tilt of the centre of circulation ?

SHRI V. SRINIVASAN : One of the aims of the study was to verify the theory that the *CuF* bands are oriented along the direction of wind shear in the layer in which the clouds were embedded rather than the wind at any particular level. However, due to lack of P.B. data in the field of the monsoon depressions we were unable to get a satisfactory verification.

DR. R. ANANTHAKRISHNAN remarked that a large number of cases show satellite centres to the southwest of the synoptic centres. Perhaps this has a bias to the overcast area in the southwest quadrant of the depression.

DR. P. KOTESWARAM remarked that the authors could have taken the vertical shears from some Rawin stations when the depression formed close to it and related it with the tilt of the satellite centre from the conventional one.

DR. C. RAMASWAMY : Is it the conclusion that the centre of the depression cannot be determined through satellite pictures when they are over the sea ?

SHRI M. C. SHARMA : Our studies were confined to cases of depressions over land only, where the conventional centre could be accurately located and compared with satellite centres.

SHRI G. GURUNADHAM : There appears to be large variations between the conventional and satellite centres when the depressions are west of Nagpur.

SHRI SHARMA : Probably orography plays a part.

SHRI R. K. DATTA : You had about 73 per cent of the cases when the satellite centre was to the southwest of the conventional centre and in the rest of the cases the shift is to the northwest. Did you find any significant difference between the two types of situations ?

SHRI SHARMA : In the latter case no special synoptic feature has been noticed in that direction nor has there been any recurvature of the depressions in such cases.