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DIURNAL VARIATION OF THE CLOUD COVERAGE PHOTOGRAPHED BY THE SATELLITES OVER INDIAN OCEAN AND PENINSULAR INDIA*

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ABSTRACT

Since March 1970 a new satellite ITOS-1 came into operation and has been providing daily pictures of the cloud coverage during afternoon hours. These pictures have given us an opportunity to study the diurnal variations in the cloud coverage by comparing them with those of ESSA-8 taken during the forenoon. Some features of these variations are discussed in this paper.

INTRODUCTION

DIURNAL variation of clouding over land areas is well known; and conventional data have revealed many interesting aspects of it. On the other hand, some aspects of the diurnal variations even on land areas could be detected with greater clarity with the help of satellite pictures which started providing us with overall cloud coverage both in the morning and in the evening, since March this year (1970). Very little was known about the diurnal variations over the sea areas. But availability of data during afternoon hours since the launching of ITOS-1 have revealed a few aspects of the diurnal variation in cloud configuration and coverage over sea areas also.

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DATA UTILISED

The data utilised in this study are the cloud pictures which are taken by ESSA-8 and ITOS-1 and received by Automatic Picture Transmission (APT) unit at Bombay. The time of the passage of ESSA-8 over the Indian region is between 0800 to 1100 hrs. I. S. T. and that of ITOS-1 between 1400 and 1700 hrs. The ITOS-1 pictures with latitude and longitude grids became available from March 1970 and hence necessarily the period of study is confined to the months of March to November 1970. The satellite pictures cover the area of the South Asia and Indian Ocean north of 20°S. Working charts of the Indian Ocean and the Southern Hemisphere Analysis Centre (INOSHAC) and Weather Central, Poona were used.

STUDY AND RESULTS

As was expected from our knowledge of conventional data marked diurnal variations of clouding over land areas were noticed by comparing ESSA-8 and ITOS-1 pictures. The evolution of clouds during the day and the final structure they attain by late afternoon hours could be studied under a variety of synoptic conditions. Even though marked variations in the clouding could be observed only over the land areas, it is noticed that the effect of air sea inter-action in either supplying the moisture or in the form of developing local circulations like the sea breeze, plays an equally important role in the evolution of clouds. Some select cases over sea and land are discussed below.

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CASE A: Organisation of cloud chains during afternoon near Equator

During the Northern summer season Southeasterly trades prevail over South Indian Ocean between Lat. 20-15°S at the surface and the lower levels of the atmosphere. These winds veer gradually and become Westerly/Southwesterly by the time they reach Equator or 5°N. Small cumulus clouds of various sizes develop in this area. One of the marked diurnal variation noticed in the developments of these clouds is that the chain of clouds organise themselves along the stream flow markedly well in the afternoons and in general there is an enhancement of clouding during the day. The correlation between direction of orientation of these chains of clouds and the wind flow as could be observed in the afternoon charts from the available ships data is so good that one can take the orientation of the clouds as representative of the surface air flow where ships data are not available. Plate I and II depict two instances of the feature discussed above. Pictures taken by ESSA-8 and by ITOS-1, with surface charts corresponding to 1200 hrs. of the respective days are also seen in figures. Surface chart shows stream line analysis 15°N and 15°S and isobars over the remaining area.

CASE B: Diurnal variation of cloud along the west coast

Plate III A and B show the APT mosaics of forenoon and afternoon pictures of 29th Sept. 1970.

The bright cloud patches over coastal Andhra Pradesh, Orissa and Gangetic West Bengal are associated with a cyclonic system. These patches are seen both in the morning and evening. Over rest of the Peninsular India, a remarkable increase in cellular convective activity can be noticed inthe afternoon picture. Most interesting is the almost continuous line of convective clouds along the entire west coast in the afternoon picture and the absence of it in the morning picture; even though the winds were onshore both in evening and morning. That these developments occur only in the afternoon shows that the convergence at the coast due to the change in the frictional effects is not sufficient to produce clouds, and it requires the additional help of the diurnal heating for their production.

Another interesting feature noticed in these two pictures is a cloud free zone of about 200 kms in width running off the entire West Coast of India. This kind of cloud free zone is often observed around the south peninsular India during premonsoon season and weak monsoon conditions. Raghavan (1969) speculates that this might be due to upwelling of cold waters.

CASE C: Development of clouding over the eastern slope of the Western Ghats

The previous case was one in which the effect of topography combined with the diurnal heating in the development of a line of clouds to the western side of the Western Ghats. In such cases prevailing winds were westerlies. Similar developments are observed along the eastern slope of the Western Ghats, when moist easterlies from Bay of Bengal prevailed over Peninsular India. As in the case B; the cloud developments are noticed only in the afternoon picture.

Plate III C and D Show APT mosaics of forenoon and afternoon statellite picture of 25th March 1970. The clouds are found, where the moist current in the lower troposphere is normal to the mountain range. It is found that the extent of such cloud developments are determined by the general synoptic conditions.

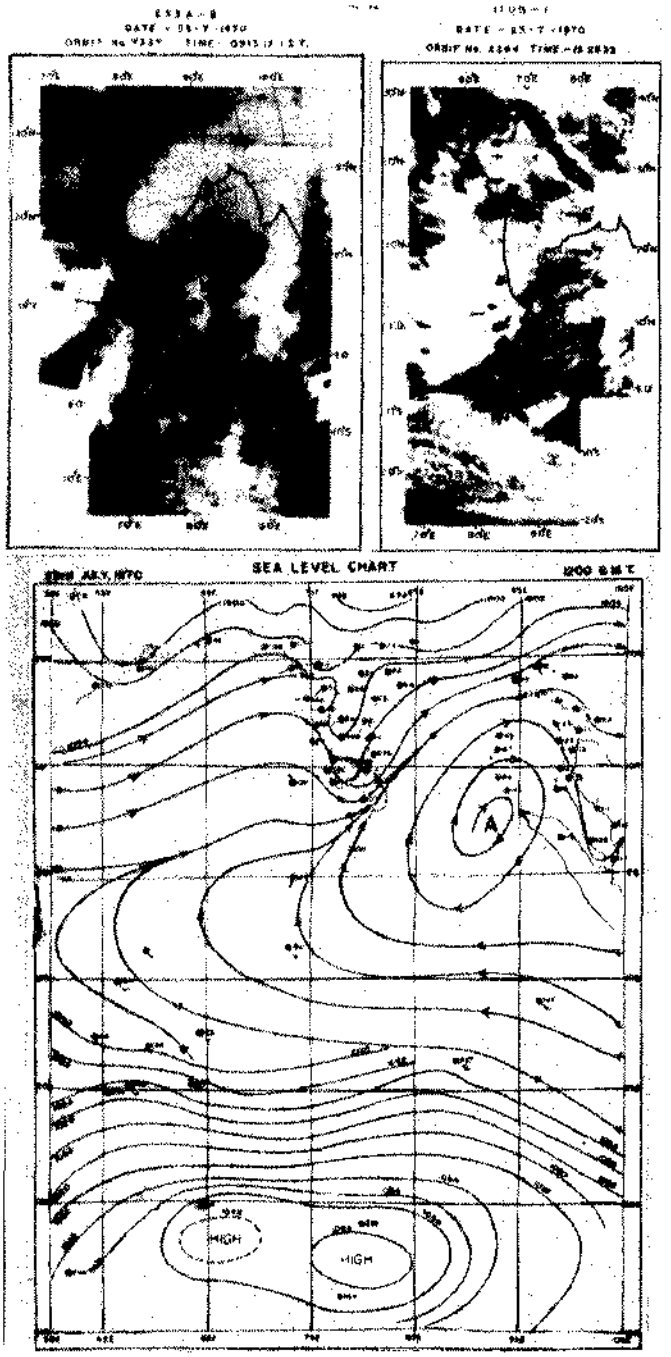

Plate 1. Organisation of cloud chains during afternoon near Equator.

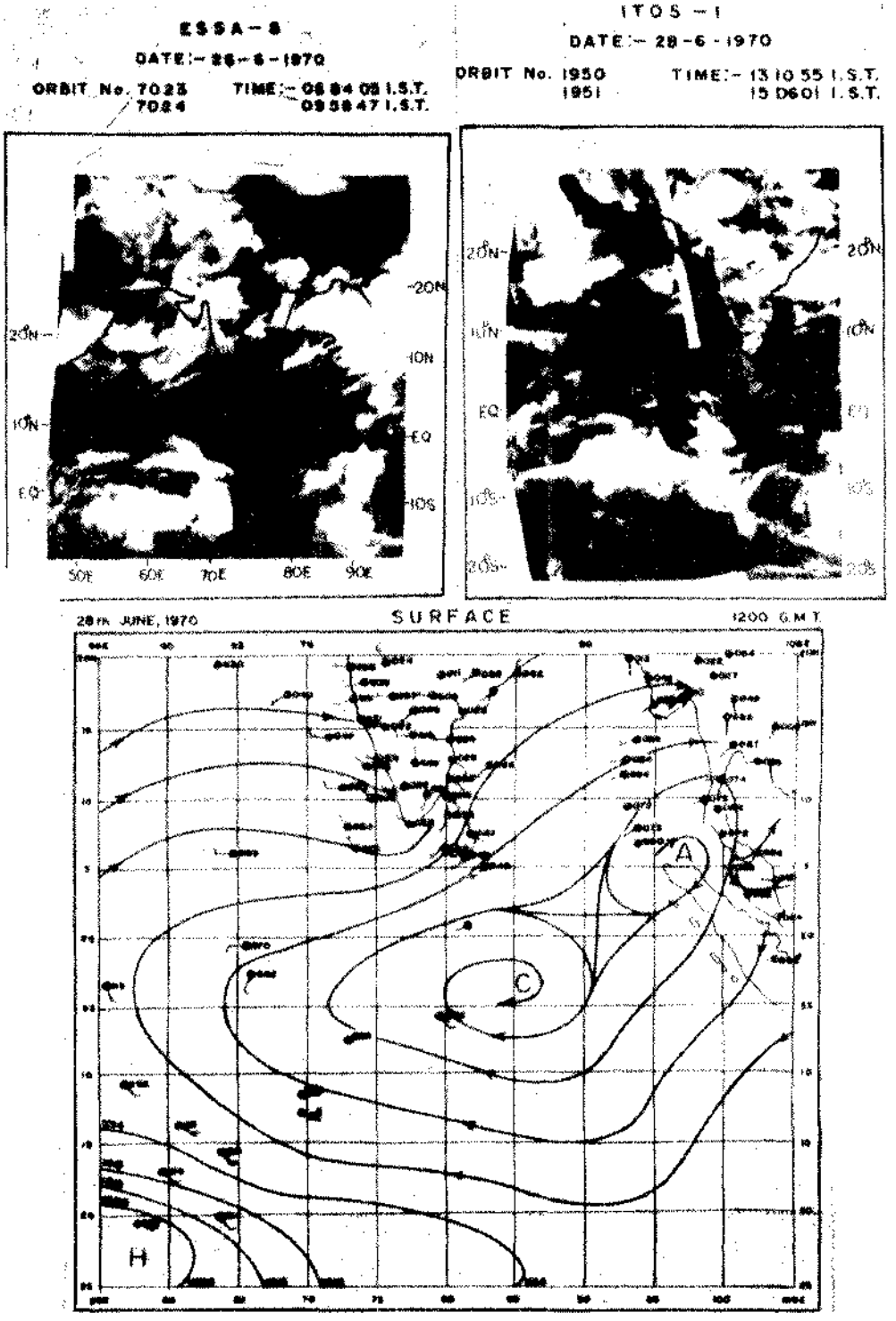

Plate II. Organisation of cloud chains during afternoon near Equator.

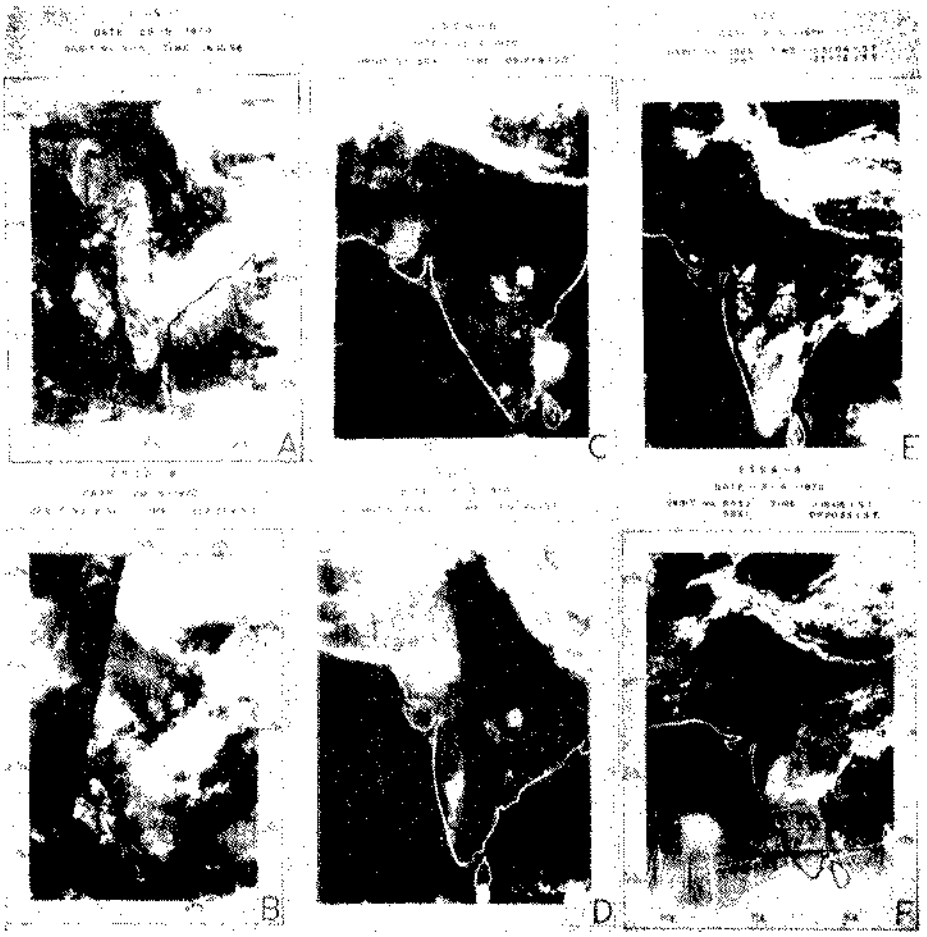

Plate III. A and B. Diurnal variation of cloud along the west coast;
C and D. Development of clouding over the eastern slope of the western ghats; and
E and F. Clouds associated with wind discontinuities.

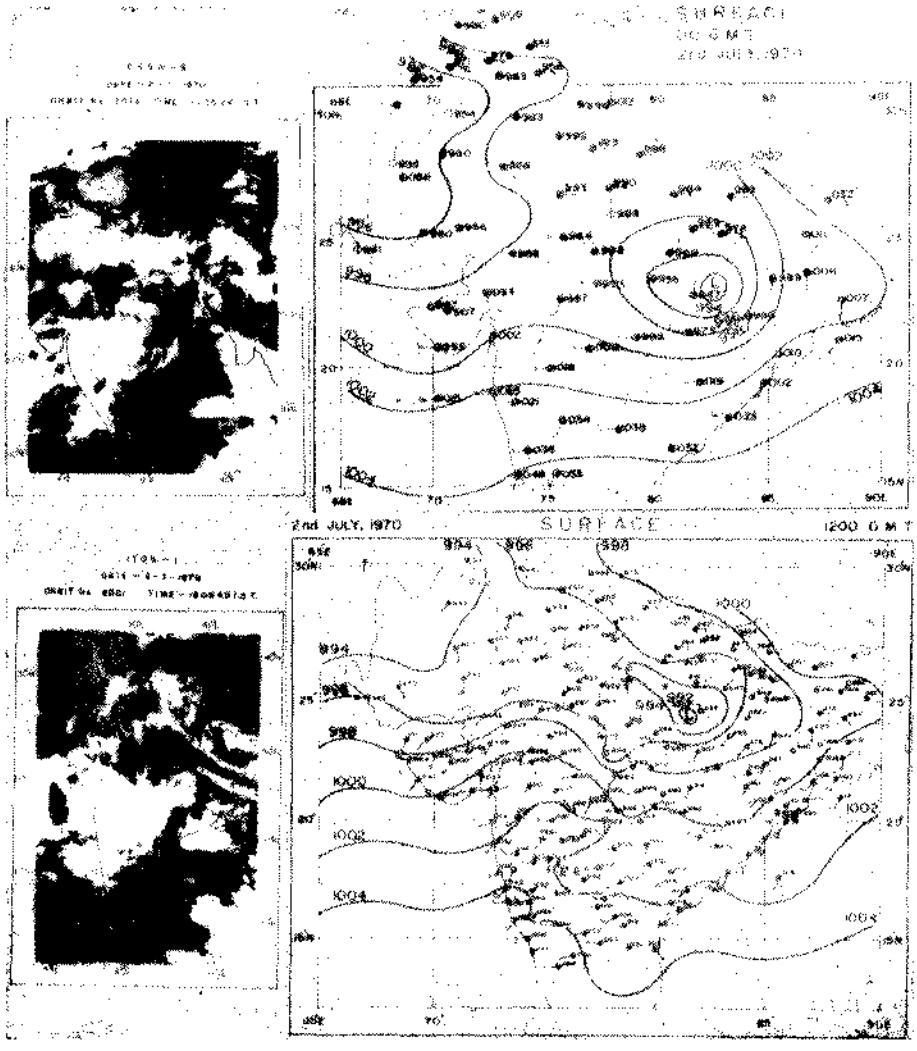

Plate IV. Diurnal changes in clouding associated with marked synoptic situation during the Southwest monsoon season.

CASE D: Clouds associated with wind discontinuities

Plate III E and F show the APT mosaics of forenoon and afternoon of 2nd April 1970. The low level winds enter the peninsular India from both the Bay of Bengal and Arabian Sea, where anticyclonic circulations exist, during this season. A well marked line of confluence forms over the central region of the Peninsular India. However, mere confluence due to the synoptic conditions is apparently not sufficient in development of significant clouding as can be seen from the morning ESSA-8 picture. Insolation received during the day combined with the convergence due to synoptic conditions, results in marked convective/activity along the zone of convergence during afternoon hours.

CASE E: Diurnal changes on clouding associated with marked synoptic situation during the Southwest Monsoon Season

Plate IV show APT mosaics of forenoon and afternoon of 2nd July 1970 and 00 and 12Z surface charts of the same day. The circular cloud banding around the well marked low pressure area is centred near latitude 23°N and longitude 81°E. Even though the banding is noticeable in both morning and evening, its structure is much more organised and clearly defined in the afternoon pictures, enabling the determination of the cloud vortex centre with greater accuracy. It is found that this feature is noticed in almost all the monsoon depressions and well marked low pressure areas, we came across during the period of our study.

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