NOTES AND CORRESPONDENCE

Analysis of Cloud Amount over the China Continent and the East China Sea*

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1. Introduction

It has been well known that many disturbances appear over the East China Sea especially during the season from February to April and sometimes a depression which is originated over this area develops into a very strong cyclone. Ninomiya (1972) examined the heat and moisture budgets in February 1968 and estimated the amount of sensible heat supply and the evaporation from the sea surface as about 300 ly/day and 10 mm/day, respectively. Nitta et al. (1973) studied the wave disturbances during the same period and found the two types of disturbances, i.e., one is a long wave with 4,000~5,000 km wavelength and the other is a medium-scale disturbance with 2,000 km wavelength.

The cloud photographs taken from the satellite have been utilized for analysis of atmospheric disturbances over the area where networks of upper air observations are sparse such as the Pacific and the Atlantic Oceans. Ninomiya and Akiyama (1973) have made analyses of cloud and radar echo associated with wave disturbances over the east coast of the Asian Continent during February 1968. In this paper, we examine the variations of cloud amount over the region from 20°N to 36°N, 100°E to 140°E for the period January–March, 1968. The cloud amount in each 1 deg² square is taken to be as 1 (or 0) if the cloud coverage is larger (or smaller) than the half". In this estimation the very grey cloud is omitted. This omission corresponds to the neglect of clouds such as cirrus and scattered clouds.

In order to examine the wave disturbances, the spectral analyses are applied to the time series data of areal mean cloud amount for 5°×5° blocks of latitude and longitude. A maximum lag of 20 days is used for the spectral analysis.

2. Data and method of analysis

The ESSA 3 digitized cloud pictures are used in this study. We measure the cloud amount by the eyes in 1° latitude and 1° longitude squares over the region from 20°N to 36°N, 100°E to 140°E for the period January–March, 1968. The cloud amount in each 1 deg² square is taken to be as 1 (or 0) if the cloud coverage is larger (or smaller) than the half. In this estimation the very grey cloud is omitted. This omission corresponds to the neglect of clouds such as cirrus and scattered clouds.

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![Fig. 1. Mean cloud amount for January, February and March in 1968. The unit of isopleths is percent.](image)
3. Mean cloud amount

Fig. 1 shows the horizontal distributions of the monthly-mean cloud amount in January, February and March of 1968. The general features of the monthly-mean cloud amount patterns for three months are similar to each other. The region of large cloud amount is found over the China Continent and the Southwest Islands of Japan. The region of small cloud amount lies over the south-western part of the Pacific Ocean and the eastern part of the Himalayas. In February, the cloud amount is generally larger than that in January and March especially over the Southwest Islands.

Through the whole period, the persistent cloudy region lies over the China Continent and the East China Sea. Surface weather observations show that stratus type clouds are dominant over the former region but cumulus clouds exist over the latter region. The former cloudy region may be caused by the topographic effect of the Tibet plateau. On the other hand, the latter cloudy region may be caused by a large amount of heat and moisture supplies from the sea surface and the large-scale upward motions which will be discussed in the next section.

4. Mean vertical motion

Fig. 2 shows the horizontal distributions of monthly-mean vertical velocity at 600 mb in January, February and March. We used the daily values of the vertical $\omega$-velocity which were computed on the routine basis using the quasi-geostrophic $\omega$-equation at the Electronic Computation Center of Japan Meteorological Agency.

The monthly-mean distributions of the vertical velocity for three months are similar to each other in general. The large upward motion is found over the southern part of China and the East China Sea. The downward motion is found over the northern area centered around 125°E and 35°N. In comparison between the distributions of mean cloud amount and those of mean vertical velocity, it may be mentioned that the area of large cloud amount corresponds generally to that of large upward motion, especially agreement is good over the China and the East China Sea. The area of small cloud amount near 125°E and 35°N corresponds to that of downward motion. However the area of large cloud amount lies far from the area of large upward motion in some regions, for example, near Taiwan Island in February. These discrepancies may be due to the fact that the clouds respond not only to the large-scale vertical motion but also to the other effects such as heat and moisture supplies from the surface and the topographic effect.

5. Power spectra of cloud amount and 4~5 day period disturbances

Fig. 3 shows the time series of cloud amount averaged over 5° x 5° blocks along the longitudinal belts between 25°N and 30°N for three months. Over the ocean area, the short period variations of cloud amount are dominant but over the continent such variations are not clear because the cloud amount is almost 100%.

Then we apply the spectral analysis to the time series of cloud amount averaged over 5° x 5° blocks during the period from 1 January to 30 March 1968, to examine the periodicity of the cloud amount variations. Fig. 4 shows the power spectra of cloud amount. A large amount of power density is found in the period range more than 5 days over the China, while the short period
Fig. 3. Time series of cloud amount in 5° × 5° blocks along the longitudinal belt of 25°–30°N.

Variations less than 5 days predominate over the East China Sea. The former large power density may be caused by the long period trend of the cloud variations as indicated in Fig. 3 and the latter large power density may result from the variations associated with the wave disturbances found by Nitta et al. (1973). The small power density of cloud amount in the short period range over the China may be due to the existence of the stationary large cloud amount and the small amplitude of the wave disturbances over this region.

The power spectral analysis of cloud amount shows a predominant period of about 4 to 5 days over the ocean area. The same band-pass filter as used in Nitta et al. (1973) is applied to pick up the wave disturbances of 4 to 5-day period. Fig. 5 shows the time series of the filtered cloud amount for 5° × 5° blocks along the longitudinal

Fig. 4. Power spectra of cloud amount in 5° × 5° blocks.

Fig. 5. Time series of the filtered cloud amount in 5° × 5° blocks along the longitudinal belt of 25°–30°N.
belts between 25°N and 30°N. We can detect the wave disturbances with 4 to 5-day period propagating eastward during the whole period except from mid-January to mid-February. From the phase speed of these disturbances, the mean wavelength is estimated to be about 4,000−5000 km. This value is almost identical with that obtained from the analysis of upper wind data by Nitta et al. (1973). The eastward propagating disturbances are found also along the belt 30°N−35°N (not shown) but are not found clearly along the belt 20°N−25°N (not shown).

6. Cloud types and large-scale vertical velocity

Next we examine the relation between the cloud types and the vertical velocity over the triangular region enclosed by Naze (28°N, 130°E), Kadena (26°N, 128°E) and Minamidaitojima (26°N, 131°E). The vertical velocity averaged over this region is computed using the kinematic method. We classify the cloud types over this region into five categories (A, B, C, D and E). In category A, thick clouds cover almost the whole area, in B thick clouds cover less than half of the area and thin clouds or clear area coexist, in C thin clouds cover almost the whole area, in D thin clouds cover less than half of the area and in E there are no clouds. Fig. 6 shows the vertical distributions of the vertical velocity for five categories. The vertical profiles of $\omega$ for A and E are quite different from each other. In the case A when the area is covered by thick clouds, strong upward motion takes place through the troposphere. On the other hand, in the clear sky case, downward motion prevails. The similar conclusions were obtained by Ninomiya (1974) using the radar observations.

7. Conclusions

The cloud amount over the China and the East China Sea taken from the satellite is analysed. The horizontal distributions of the mean cloud amount well correspond to those of the mean vertical motion in a sense of large scale motion. There exist the variations of cloud amount with 4 to 5-day period especially over the East China Sea. These variations propagate eastward and correspond to the wave disturbances with the wavelength of 4,000−5,000 km. The general results of cloud amount variations during February 1968 in this study agree with those by Ninomiya and Akiyama (1973).

The relation between the cloud types and the large-scale vertical velocity are examined. In cases that the area is covered by thick clouds, upward motion predominated through the whole troposphere. On the other hand, in cases of thin clouds or no clouds, downward motion prevails.

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References


気象衛星による中国大陸・東シナ海における雲の解析

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