P3.52 LIFE CYCLE OF CONVECTIVE ACTIVITY IN TERMS OF CLOUD TYPE OBSERVED BY SPLIT WINDOW

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1. Introduction

Mesoscale deep convective system (hereafter called DC) is a significant meteorological phenomenon. The structure and evolution of DC have been studied by many authors using rain radar, wind profilers and satellite observations. These studies have revealed the substantial variety and complexity of convective processes and structures in DC.

Satellite observations from geostationary orbit are effective in studying the evolution of DC in terms of cloud, considering high temporal observations and wide range of coverage. A large number of studies have been conducted using the infrared and/or visible radiance images from geostationary weather satellites (eg. Machado et. al.). The previous study mostly used single infrared data to delineate DC using the threshold of brightness temperature of the infrared channel (TBB). Depending on the value of the TBB threshold, we might discard both the beginning and ending stages of the DC life cycle.

In this study, we aim to see how effectively we can delineate the life cycle of DC over the eastern tropical Pacific by using split window cloud type information, and some preliminary results for case studies are reported.

2. Data

The split window (11 and 12 μm) data of GOES-West/East data over the area of180-60W and 30S-30N are used to study the life cycle of deep convective activity. The three infrared data of 6.7, 11 and 12 μm are gridded on 0.1 latitude/longitude within the area. We are collecting hourly data, but so far we have used only three hourly data as a preliminary survey.

3. Cloud Type Classification by Split Window

Inoue (1985) showed the feasibility of cirrus cloud detection using the split window data. Furthermore, he developed a method to classify several cloud types based on a threshold technique in the two-dimensional diagrams of brightness temperature of 11 μm (TBB) and brightness temperature difference between the split window (BTD) (Inoue,1987). The BTD is used to classify optically thin cloud and the TBB is used to classify the level of cloud.

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Optically thin cirrus cloud shows the larger BTD due to the differential absorption characteristics between the split window, while optically thick cumulus type cloud shows the smaller BTD due to the black-body characteristics. In this study, we use the TBB threshold of 210K, 253K and 288K to classify very cold cloud, high-level cloud and cloud free. As the BTD threshold, we used 1K and 2.5K to classify optically thick cloud and optically thin cloud. Seven cloud types of very cold cloud colder than 210K, cumulonimbus-type (CB), dense cirrus-type, cirrus-type, thin cirrus-type (CI), low-level cumulus/stratocumulus-type (CU) and non-classified cloud are classified in this study. Hereafter we combine dense cirrus-type cloud and cirrus-type cloud, and call it as DCI.

4. Identification of DC

Inoue and Aonashi (2000) studied the relationship between cloud information from VIRS (Visible Infrared Scanner) and precipitation information from PR (Precipitation Radar) on board TRMM. They found that the clouds colder than 260K in TBB with smaller BTD correspond well to the rain observed by PR from the dataset for rain events during June, 1998 over the frontal zone in east Asia. The clouds colder than 210K in TBB indicate a higher possibility of convective rainfall by PR. Therefore, CB classified by the split window is considered as a good indicator of DC in this study. Further, the anvil cloud associated with the DC is considered to correspond to cirrus-type cloud.

5. Case Study 1

Fig.1. shows the 6 hourly temporal variation of cloud type distribution over the area of EQ-5N and 170W-160W during May 14 06Z – May 15 00Z, 2001. The darker area corresponds to CB and the brighter area corresponds to CI. We can see the evolution of the DC in the Figure. At the developing stage CU and CB cloud are dominant then DCI increases. Then the cloud amount of CI becomes very large at the decaying stage.

Fig.2. shows the temporal variation of cloud amount for each cloud type in the area. The CB first shows a peak, then DCI shows a peak and finally CI shows a peak. This delineates the characteristics of the DC life cycle. From the temporal change of CB cloud amount we can classify the DC stages as developing, mature and decaying.

Here, we introduce the cloud amount ratio of DCI/CB and CI/CB. Figure 3. shows the temporal variation of CB cloud amount and the ratio for the above case. The value of DCI/CB ratio is small at the developing/mature stage, while the value of

CI/CB becomes very large at the decaying stage.

6. Case Study 2

Figure 4. shows another example of the evolution of DC over the area of 5N-15N and 180-170W. The figure shows rather from mature stage to decaying stage. We can clearly see that CI is dominant at the decaying stage. A similar characteristics of temporal variation of each cloud type can be seen. First, CB peak appears and followed by a peak of DCI and CI.

7. Summary

With the use of cloud type information classified by the split window, we can delineate the life cycle of deep convection. Contrary to the previous studies which use the TBB threshold to identify DC, we may track from the beginning to the end of the DC since the split window can classify cumulus-type (mostly appears at developing stage), cumulonimbus-type (mature stage) and cirrus-type cloud (decaying stage). In the developing stage the DCI/CB ratio is smaller, and in the decaying stage the CI/CB ratio becomes larger. These ratios could be used to identify the stage of DC from a single snap shot by satellite.

Acknowledgment

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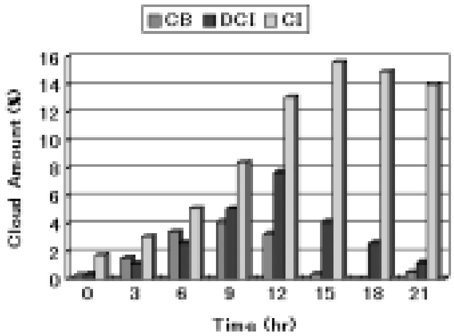

Fig. 2. Temporal variation of cloud amount within the area for Cumulonimbus-type cloud (CB), dense cirrus-type cloud (DCI) and thin cirrus-type cloud (CI).

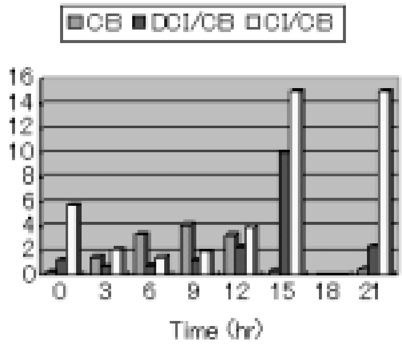

Fig.3. Temporal variation of CB cloud amount and the cloud amount ratio of DCI/CB and CI/CB. In the figure, ratio has ceiling at value of 15.

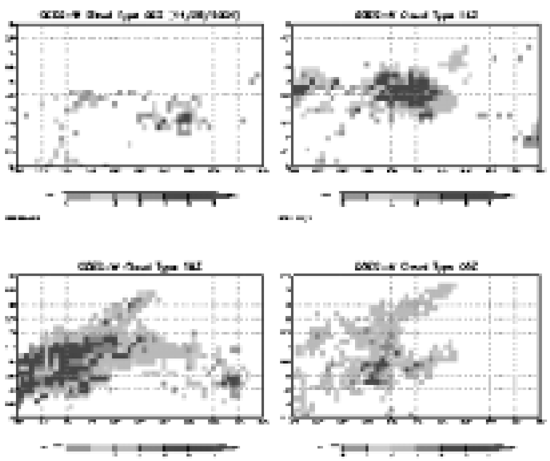

Fig. 1. Six hourly cloud type map for the deep convective activity. The darker area corresponds to cumulonimbus-type cloud, while the brighter area corresponds to cirrus-type cloud.

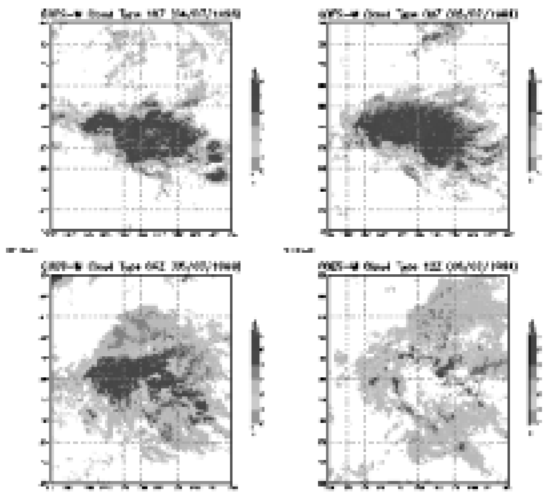

Fig. 4. Six hourly cloud type map for another case of deep convective activity.