DEVELOPMENT OF A TECHNIQUE TO DEFINE THE LIFE STAGE OF DEEP CONVECTION USING THE SPLIT WINDOW DATA OF GOES

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1. INTRODUCTION

In a simple deep convection, we understand that cumulus type cloud developed into cumulonimbus type clouds and decay with dominant anvil clouds. We also know that convective-type rain is dominant at developing and mature stage, and stratiform-type rain is dominant at decaying stage (e.g. Byers and Braham, 1949). Therefore, if we could know the stage of deep convection, the rainfall rate estimation algorithm might be improved. This is the motivation of this work.

The split window (11 and 12 μm) is effective in identifying the cirrus cloud that consists of ice crystals. Inoue (1987) developed the cloud type classification technique. We also developed the simple method to track the deep convection defined by the infrared brightness temperature (TBB) of 253K using the high temporal observations from geostationary satellite. Therefore we can track the deep convection with cloud type classification using the high temporal resolution images. Here we aim to develop the technique to define the life stage of deep convection using the split window data of GOES (Geostationary Operational Environmental Satellite).

2. DATA AND METHOD

We use the GOES-W hourly data for May and July 2001. The 8km resolution data are mapped onto 0.1 latitude/longitude grid over the area of 180-60W, 30N-30S.

Cloud type classification is based on the split window method (Inoue, 1987). Here, we use the TBB of 253K for the cloud threshold of deep convection, and brightness temperature difference between the split window (BTD) of 1K for the cirrus/cumulonimbus type cloud classification. A deep convection is defined as the cloud area that is colder than 253K TBB. Cumulonimbus type cloud area is defined as the BTD smaller than 1K within the deep convection. Anvil cloud (cirrus type cloud) area is defined as the BTD larger than 1K, in this study as seen in Figure. 1.

We track the deep convection by labeling the cloud area that is colder than 253K. We simply identify the cloud area as the same system when the cloud area is overlapped with the two consecutive images taken by hourly.

3. EVOLUTION OF DEEP CONVECTION

Figure 2 shows an example of the evolution of deep convection in terms of cloud type classified by the split window. The maps show 2 hourly cloud type distribution over the area of 4N-12N and 157W-145W with 0.2 latitude/longitude grid during 09 May 12UTC-10 May, 04UTC, 2001.

The labels A1-A6 in the figure correspond to the time sequence of the deep convection. The clouds shown in the figure are colder than 253K. The darker area corresponds to the cumulonimbus type cloud and brighter area corresponds to the cirrus type cloud.

The deep convection mostly consists of cumulonimbus type cloud from A1 to A2. Cirrus type cloud begins to extend from the time shown in A3. The deep convection mostly consists of cirrus type cloud at the time shown in A6. The deep convections over this area are not simple. Some are merge and some are split. However, we can see the typical evolution of deep convection in terms of cloud type distribution in the Figure 2. At the beginning the deep convection is covered by cumulonimbus type cloud, then cirrus type cloud increases with the decrease of cumulonimbus-type cloud.

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4. IDENTIFICATION OF LIFE STAGE

Here, we note the ratio of cirrus cloud coverage defined by the split window within the deep convection. The objective tracking was performed using the hourly images of July 2001. We sort the deep convection depending on the duration time. We select only simple deep convection (no merge, no split). Figure 3 shows the percentage of cirrus type cloud coverage within the cloud colder than 253K. The curves represent the different duration of the deep convection.

Generally, we can see the similar tendency of the cirrus type cloud amount increase toward the decaying stage. This preliminary results show that the 20% or less of cirrus cloud amount is a good indicator to identify the earlier stage of deep convection.

Comparing the PR rainfall type observation and coincide IR image, we find that convective-type rain observed by the PR/TRMM is dominant at the developing stage defined by the split window technique and the stratiform-type rain is dominant at the decaying stage defined by the split window.

Concluding Remarks

The percentage of cirrus type cloud within the cloud area colder than 253K increase toward the decaying stage. We may conclude the percentage of cirrus cloud amount is a good indicator to identify the life stage of deep convection. Further cases are required to establish the statistically solid meaning.

The higher temporal and spatial resolutions are preferable to identify each convective cell.

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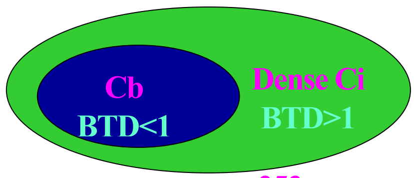

Figure 1. Schematic diagram of deep convection used in this study. Deep convection is defined by the TBB of 253K

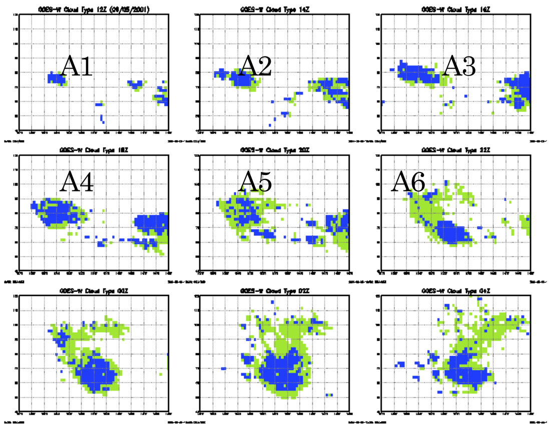

Figure 2. Cloud type map over the area of 4N-12N and 157W- 145W with 0.2 latitude/longitude grid during 09 May 12UTC-10 May, 04UTC, 2001.

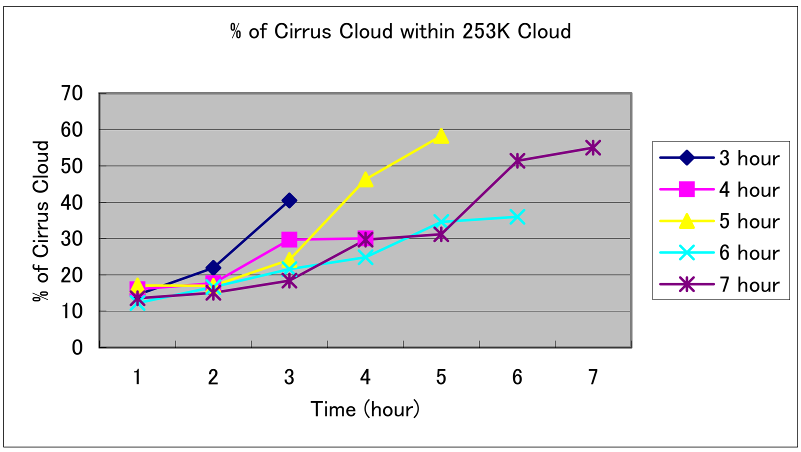

Figure 3. Percentage of cirrus type cloud within the deep convection in terms of life time.