Cloud statistics over eastern China during GAME-IOP as seen from TRMM TMI

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Abstract

We compare spatial and vertical distribution of clouds observed from TRMM TMI, ISCCP, surface and upper-air soundings over eastern China during GAME-IOP. Spatial distribution of clouds from TRMM TMI and that from ISCCP were well corresponded with each other, while amount of cloud water and ice water was quit different. Cloud vertical structure estimated from RAOB often exhibited multilayer structure, while TRMM TMI showed unimodal vertical structure.

Keyword: Cloud distribution, TRMM TMI, ISCCP.

1. Introduction

Cloud plays key roles in climate system. Climatology of spatial distribution of clouds was compiled from surface visual cloud observation (Warren et al., 1986; 1988) and from the International Satellite Cloud Climatology Project (ISCCP)(Rossow and Schiffer, 1991; 1999). However, surface observer often missed high clouds because lower clouds spread over the sky. Further ISCCP cannot observe lower clouds when high- and/or mid-level clouds are covered broad area. TRMM TMI provides not only rainfall rate, but also vertical distribution of cloud water and cloud ice. TRMM TMI gives opportunity to make inter-comparison between cloud statistics from TRMM TMI, ISCCP, and conventional observation.

2. Data

An integrated data set with simultaneous observations at the surface, from radiosonde and from satellites, were collected over eastern China during the GAME-IOP. We used the TRMM TMI standard product 2A12 from May to July 1998. TRMM 2A12 includes rainfall rates and the vertical structure of hydrometeors based upon the nine channels of the TRMM TMI (Kummerow, et al, 1998). ISCCP DX product (Rossow and Schiffer, 1999) from GMS-5 was also employed. ISCCP DX products provide cloud top pressure, cloud top temperature, and cloud optical thickness during daytime. Four times per daily radiosonde observation data at 27 stations in eastern China were provided by TIPEX, HUBEX, JEXAM and SCSMEX. Routine visual cloud observation data from surface were provided by TIPEX and obtained from SCSMEX data archive.

We selected TRMM orbits passed over eastern China near 00 and 06 UTC. Then TRMM 2A12 and ISCCP DX data were regrided on 0.5 degree boxes. ISCCP cloud optical depth was converted into cloud water path. Cloud vertical structure was evaluated from radiosonde data at daylight hours with the algorithm of Wang and Rossow (1995). We compiled collocated dataset from two satellite products, surface weather observations and cloud vertical structure evaluated from radiosonde observations at 27 stations in eastern China except near the coast.

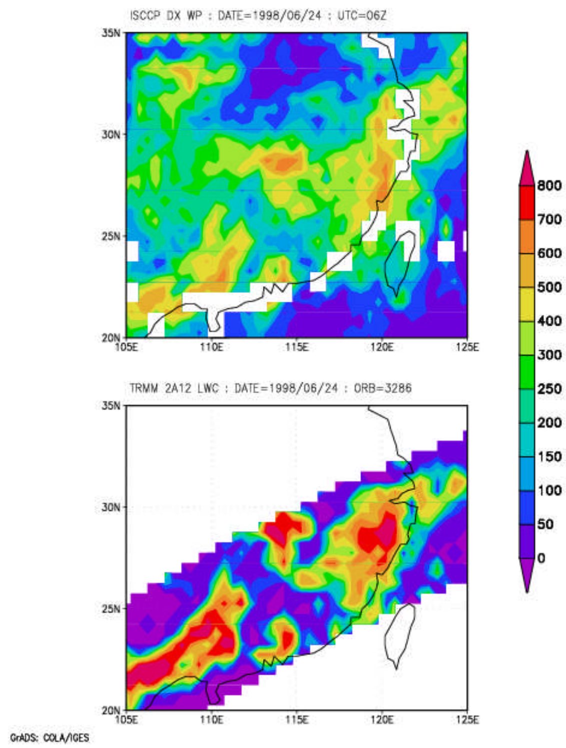

Fig. 1: Spatial distribution of cloud water path of ISCCP DX (upper panel) and vertical integrated liquid water content of TRMM TMI at 06UTC, June 24, 1998.

3. Results

3.1. Spatial variation of clouds

Figure 1 shows spatial distribution of cloud water path of ISCCP DX (upper panel) and vertical integrated liquid water content of TRMM TMI at 06UTC, June 24, 1998. According to ISCCP cloud classification table, larger cloud water areas are corresponded with vigorous deep convective clouds. Spatial distribution of cloudy pixels are well corresponded with TMI and ISCCP DX during daytime.

However, spatial distribution of cloud water and cloud ice are very different between two satellites products. Figure 2 indicates difference of vertical integrated cloud water and vertical integrated cloud ice at 06UTC, June 24, 1998. Vertical integrated cloud water of TMI are larger than that of ISCCP around and in deep convective clouds. On the other hand, vertical integrated cloud water of TMI is smaller in other area. Vertical integrated cloud ice is generally smaller in TRMM TMI in and around convective cloud area. One cause of these cloud water/ice differences between two satellite products may due to the use of different frequency of sensors. ISCCP (GMS-5) received infra-red and visible bands, while TRMM TMI uses nine microwave bands. Further ISCCP

3.2. Cloud vertical structure

Clouds are often formed in different levels. Cloud vertical structure estimated from radiosonde clearly indicate that there are single-layer and multi-layered cloud distribution. We first compare cloud vertical structure between surface visual observation and radiosonde observation, and cloud vertical structures are quit similar.

Cloud vertical structure from radiosonde was compared with cloud vertical structure from 9 grids around the upper-air station in TRMM TMI and ISCCP DX data. TRMM TMI frequently missed lower shallow clouds observed by surface observer and estimated CVS from radiosonde. ISCCP DX also does not captured in lower clouds in Meiyu frontal zone because deep convective cloud covers broad region. Furthermore, multilayered clouds are often captured in radiosonde, while TRMM TMI indicates unimodal cloud vertical structure. ISCCP DX also frequently missed multilayered structure in and around active convective cloud systems.

4. Summary

An integrated data set with simultaneous observations at the surface, from radiosonde and from satellites, was collected over eastern China during the GAME-IOP. We analyze the cloud type, cloud amount, cloud vertical structure (CVS), and so on. We select orbits which TRMM pass over eastern China near 00/06 UTC. Spatial distribution of cloudy pixels are well corresponded with TMI and ISCCP DX during daytime. However, cloud water path (column total cloud water) is very different between two satellites products. Cloud water path of TMI are larger than that of ISCCP around and in deep convective clouds.

Cloud vertical structure estimated from radiosonde clearly indicate that there are single-layer and multi-layered cloud distribution. TMI frequently missed lower shallow clouds observed by surface observer and estimated CVS from radiosonde. ISCCP DX also does not captured in lower clouds. Further TRMM TMI shows unimodal structure of vertical distribution of cloud water.

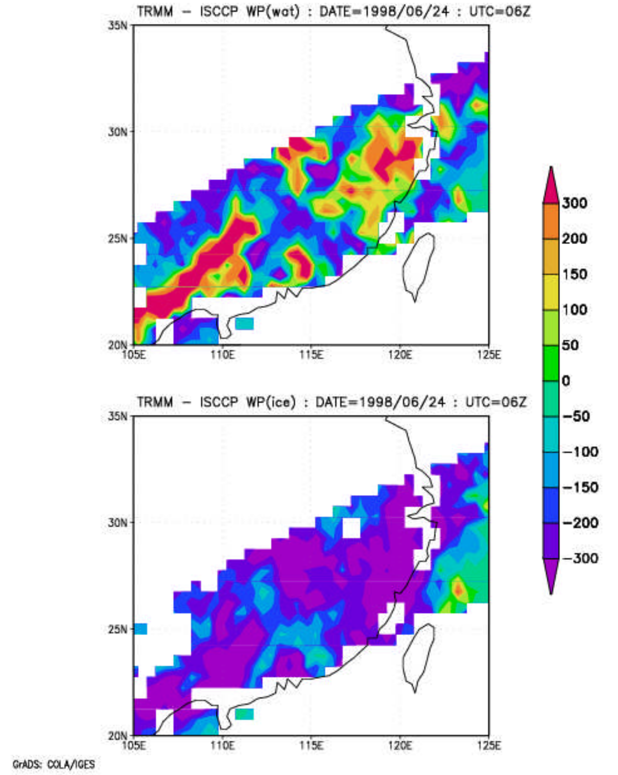

Fig. 2: Difference of vertical integrated cloud water (upper panel) and vertical integrated cloud ice (lower panel) between TRMM TMI and ISCCP DX at 06UTC, June 24, 1998.

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