# RELATIONSHIP BETWEEN PRECIPITATION AND BARRIER LAYER IN THE TROPICAL REGIONS

Yo. Yasuda and Masahisa. Kubota*
Tokai University, JAPAN

## 1. Introduction

A tropical region where the precipitation occupies about 70 percent of the global precipitation is an important area when considering global distribution of water and heat. Moreover, it is considered that the precipitation strongly contributes to formation of a barrier layer in the tropical region since precipitation affects on the vertical profile for water temperature, salt and density of a surface layer. Therefore, it is important for us to investigate the relation between precipitation and the vertical structure of such parameters in order to understand the formation process of a mixed layer or a barrier layer. In the present study, we investigate the effects of precipitation on sea surface parameters and a mixed layer thickness (MLT) or a barrier layer thickness (BLT) by using TRMM/TMI rain rate data, Argo observation data and WOA98 data.

## 2. Data

The TRMM/TMI 3G68 product is used in this study. The precipitation data are converted from 1-hour average precipitation data of 0.5-degree grid to 1-day accumulated precipitation data of 1-degree grid. Our analysis period is from January 1, 2002 to December 31, 2003.

In order to investigate the effect of precipitation on vertical ocean structure, the pressure, temperature, and salinity data observed by Argo float also used here. The density was estimated by using the Argo data. For the mixed layer depth it is the depth at which the calculated in situ density has increased by 0.125 sigmatheta from the sea surface value. Similarly, the depth of which 0.8°C change was done from the sea surface was defined as an isothermal layer. The barrier layer was defined as the difference between the thickness of isothermal layer and the mixed layer depth. Moreover, in order to investigate how much sea surface temperature (SST) and sea surface salinity (SSS) are changed by the effect of the precipitation, the climatological monthly mean (CMM) SST and SSS data which are adopted from the WOA 1998 data.

*Corresponding author address: Masahisa Kubota, School of Mar. Sci. and Tech., Tokai University Shimizu-Orido, Shizuoka, JAPAN
424-8610;
e-mail: kubota@mercury.oi.u-tokai.ac.jp

## 3. Method

The anomaly from CMM data is estimated for the grid of which precipitation is more than 15 mm/day. Also, the difference between the previous and next observation SST and SSS data is estimated. Then, we investigated how SST and SSS would be changed by precipitation.

Next, we investigated the relation between a barrier layer thickness estimated from Argo data and precipitation by examining the variation of BLT.

## 4. Results

First, we compared the observation value with CMM for SST and SSS in the grid of which precipitation is more than 15 mm/day. (Figs. 1 and 2). From Fig.1 in most cases the observation value of SSS is less than the CMM value. This means precipitation makes SSS decrease. On the other hand, from Fig.2 shows that the observation value of SST is higher than CMM in many cases. Considering that the temperature of rain is generally lower than SST, this result is interesting. Since it was difficult to explain the relation of precipitation, SST, and SSS only from these results.

Then, the observation value of SST and SSS for the same grid was compared with the previous and next observation values (Figs. 3 and 4). It is difficult for us to find a clear relation between precipitation and variation of SSS and SSS. In order to understand the reason, we need exact observation time for precipitation. This is a future issue.

Next, the relation between precipitation and MLT or BLT was investigated. Lukas and Lindstrom (1991) showed that the thickness of a mixed layer in the western equatorial Pacific generally is thick and that thickness of an isothermal layer is thicker than that of isohaline layer there. Moreover, it is shown that strong rain determines the feature of the water mass in the western equatorial Pacific. Moreover, according to Spintall and Tomczak (1992), strong local rain influences the formation of a barrier layer. Also, they reported that the barrier layer of the thickness of 25-m always exists in the region of 10°S-10°N and 150°E-170°E.

The mixed layer depth, isothermal layer depth and BLT observed at 5°N, 144°E are given in Table.1. Also the profiles are shown in Fig. 5a), b) and c). We can find heavy rain on March 21. SSS becomes considerably low compared with previous and next profiles observed on March 11 and 31, respectively. However, we cannot find decrease of SST and ILD. This difference between SST and SSS is consistent with results shown in Figs. 3 and 4. Moreover, it is considered that the change of SSS influences the formation of a barrier layer in the western equatorial Pacific.

Next, we shows the observation profile at 9°N, 129°W located in the eastern equatorial Pacific in Table 2 and Fig. 6a), b) and c) for comparison. We can understand from Table 2 that ILD in the eastern equatorial Pacific is relatively thin compared with the case of the western equatorial Pacific. Fig.6 shows that the change of MLD is very small, though BLT increases. This result suggests that precipitation does not directly affect BLT in this region. According to Ando and McPhaden (1997), the similarity between mixed layer salinity and freshwater flux, both having local maxima near 160°-170°E and in the far eastern Pacific is notable. On the other hand, the similarity between BLT and freshwater flux cannot be found in the eastern Pacific. Our results are consistent with their results. This suggests the formation of BLT in the eastern Pacific is a complicated function of not only freshwater flux but also location and nonlinear processes such as advection.

Acknowledgment. This study was performed under the Category 7 of MEXT RR2002 Project for Sustainable Coexistence of Human, Nature and the Earth. Also this study was supported by the Japan Aerospace Exploration Agency.

References

Ando K. and M. J. McPhaden, 1997: Variability of surface layer hydrography in the tropical Pacific Ocean, J. Geophys. Res., 23063-23078.

Lukas, R. and E. Lindstrom, 1991: The mixed layer of the western equatorial Pacific Ocean, J. Geophys. Res., 96, 3343-3357.

Spintall, J. and M. Tomczak, 1992: Evidence of the barrier layer in the surface layer of the tropics, J. Geophys. Res., 97, 7305-7316.

Table 1. Precipitation and thickness of mixed layer, isothermal layer and barrier layer at 5°N, 144°E.

| Time | Precipitation (mm/day) | MLD (m) | ILD (m) | BLT (m) |
|---|---|---|---|---|
| 2003/03/11 | 0.0 | 43 | 61 | 18 |
| 2003/03/21 | 45.9 | 17 | 53 | 36 |
| 2003/03/31 | 1.5 | 38 | 51 | 13 |

Table 2. Precipitation and thickness of mixed layer, isothermal layer and barrier layer at 9°N, 129°W.

| Time | Precipitation (mm/day) | MLD (m) | ILD (m) | BLT (m) |
|---|---|---|---|---|
| 2003/07/11 | 0.7 | 26 | 31 | 5 |
| 2003/07/20 | 48.7 | 24 | 37 | 13 |
| 2003/07/30 | 0.4 | 24 | 28 | 4 |

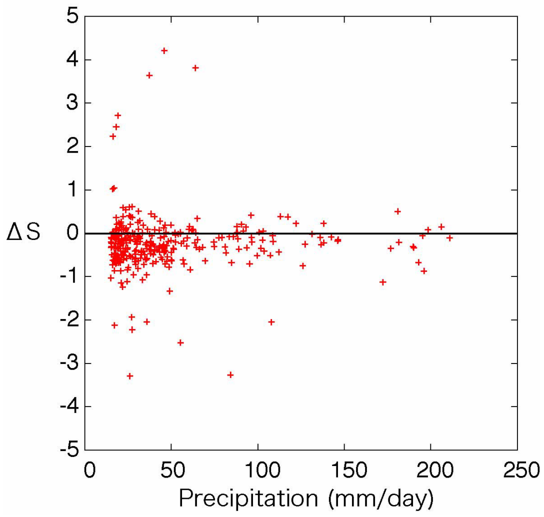


Figure 1. Scatter diagram between precipitation and anomaly from CMM SSS values.
ΔS = observation - CMM

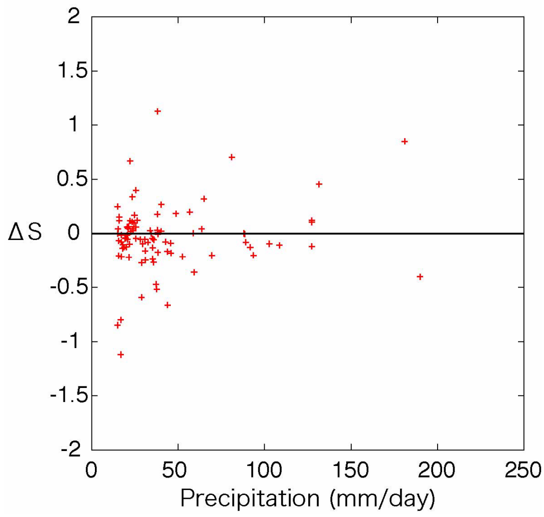


Figure 3. Scatter diagram of between precipitation and a difference with the previous and the next observation SSS values.

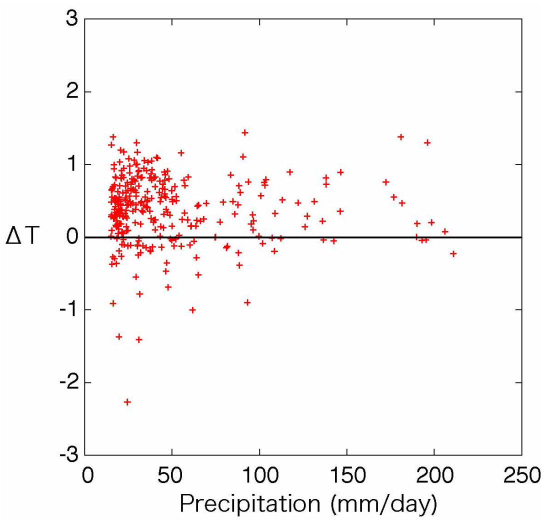


Figure 2. Same as Figure 1, except for CMM SST values.

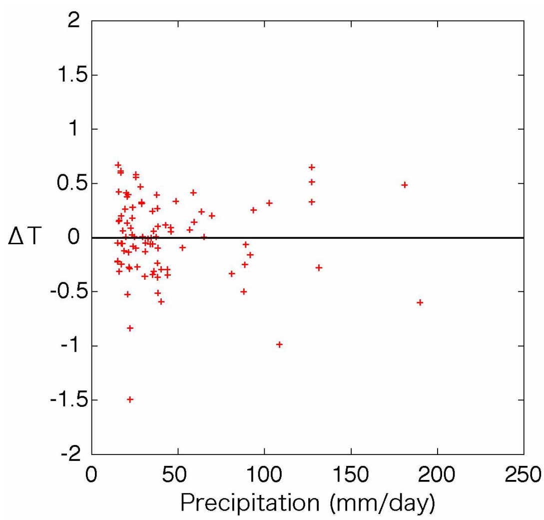


Figure 4. Same as Fig. 3, except for SST.

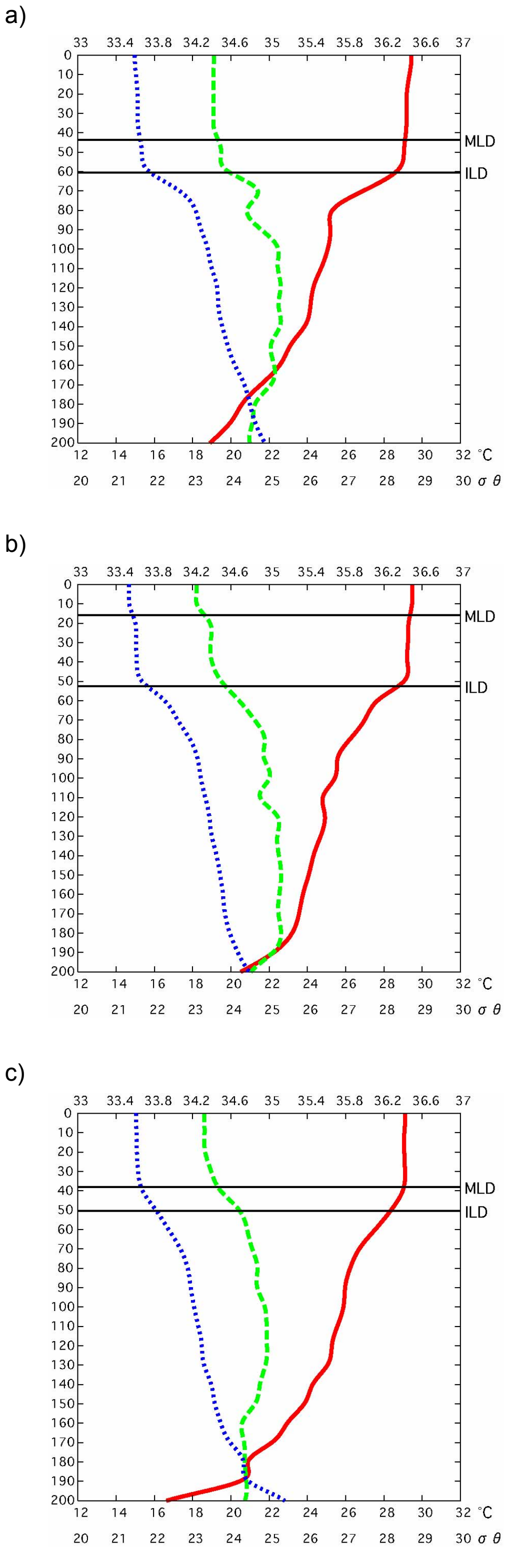


Figure 5. Vertical profile of temperature (solid line), salinity (dashed line), and sigma theta (dotted line) at 5°N, 144°E. a) 2003/3/11, b) 2003/3/21, c) 2003/3/31

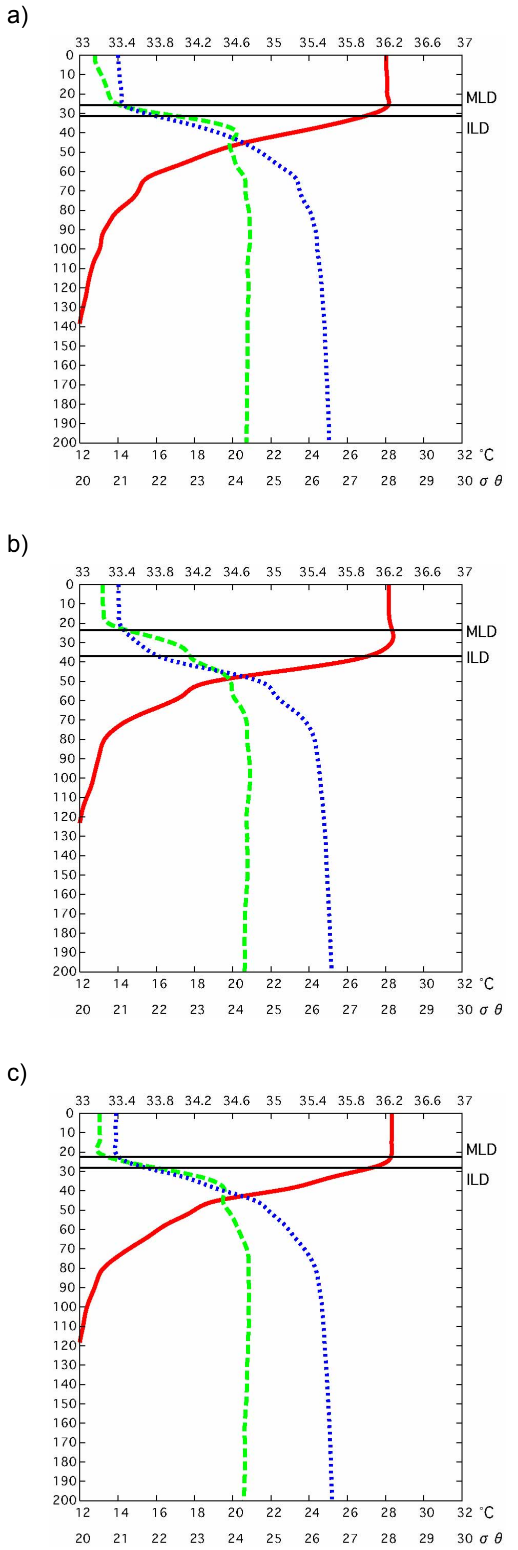


Figure 6. Same as Fig. 5, except at 9°N, 129°W. a) 2003/07/11, b) 2003/07/20, c) 2003/0730