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TRMM PR/TMI 6-yr rainfall difference over land in 3G68 dataset

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1. INTRODUCTION

One of the main objectives of the Tropical Rainfall Measuring Mission (TRMM) is to estimate the tropical/subtropical precipitation rate as accurate as possible. By several updates of the algorithms for sensors onboard the TRMM satellite, there is a drastic convergence among the products. However, there is a still negligible difference between the Precipitation Radar(PR) and the TRMM Microwave radiometer, TMI.

This study is to try to document the difference of the precipitation estimates over land by both algorithms, 2A25 from PR and 2A12 from TMI and to understand the characteristics of the difference for future algorithm improvements.

2. DATA

The data we used in this study is the TRMM 3G68 Version 5 data, which consist of unconditional rain rate, total pixel number, rain pixel number and percentage of convective rain for PR 2A25 and TMI 2A12 with horizontal resolution of 0.5 deg x 0.5 deg.

To compare these 2 products in fair, we masked the TMI data with the same swath of PR. So we have two datasets of TMI, one is masked data and another is unmasked data. In this study we mainly use "Masked" data. But this is not completely correct, because of the horizontal resolution of 3G68. If we have TMI data and we do not have PR data in a box of 0.5 deg x 0.5 deg, then the data are discarded from the "Masked" data. If we have both TMI and PR data, we classified as "Masked" data. Using these variables in 3G68, we can obtain conditional rain rate, too.

3. RESULTS

3.1 *DIFFERENCE BETWEEN 2A25 AND 2A12*

Fig. 1 is the annual (top) and summer (bottom) rainfall difference over land between Masked TMI 2A12 and PR 2A25, averaged during 1998 to 2002. The unit is mm/day. The figure shows that for annual rainfall, there are large (greater than 3 mm/day) positive biases (that is, TMI is larger than PR) over equatorial Africa, the maritime continents and South America. On contrary, there are small biases over arid regions, such as Sahara, Saudi Arabia, Australia, etc. For summer, the tendency is the same as that in annual one, except for China.

We would like to see not only unconditional rain rate, as shown in Fig. 1, but also conditional rain rate in both products. Fig. 2 shows the conditional rain rate for TMI 2A12 (middle) and PR 2A25 (bottom) with 3B43 unconditional rain rate, averaged annually between 1998 and 2003. Note that the coast lines are not shown in TMI 2A12 figure, because there is a large amount of conditional rain (more than 6 mm/hr) along the coast.

From this figure, we notice that except for the coast, we still see the large difference between TMI conditional rain rate (middle) and PR conditional rain rate (bottom) over Sahara, Saudi Arabia and Australia.

3.2 *EQUATORIAL AFRICA*

As is shown in Fig. 1, over the equatorial Africa the TMI unconditional rain rate is larger than the PR unconditional rain rate. Fig. 3 is the differences of conditional/unconditional rain rates, TMI-PR, every day in 6 years (1998-2003) over the central Africa (5N-5S, 15-30E). The abscissa is the PR convective percentage (%). The top is for conditional and the bottom is for unconditional.

This figure shows that for conditional rain rate (top figure) we have a large variance of the difference in conditional rain rate and it is not evident there is a bias when the PR convective percentage is lower (less than 10 %), however, when the PR convective percentage is higher (greater than 80 %) then there is a positive bias (TMI is larger than PR). For unconditional rain rate, it is evident that the TMI unconditional rain rate is larger than the PR one both in the lower (less than 10 %) and higher (greater than 90 %) convective percentage. In the middle range of the convective percentage, there seems no bias.

3.3 *SAHARA DESERT*

Fig. 4 is the same as Fig. 3, but for over Sahara Desert. It is clearly shown that the TMI conditional rain rate is far larger than the PR one. But the TMI unconditional rain rate is below the PR one. It is interesting to note that there is no dependency of the convective percentage with both conditional and unconditional rain rate differences over the region.

Fig. 5 is the temporal change of TMI and PR conditional rain rate (top) and unconditional one (bottom) over the region in 1998.

4. DISCUSSION

We showed two characteristic regions to understand the differences between the TMI and PR rain estimates. Over the central Africa, the TMI estimate is mainly determined the 85 GHz signal. If a box with 0.5 deg x 0.5 deg is covered by almost convective rain, then the TMI 2A12 algorithm tends to overestimate the rain rate. It is understandable that the variance is getting larger and with no bias when the PR convective percentage becomes smaller. There is a positive bias in the small convective percentage in unconditional rain rate. If this is due to the rain with low storm height (less than 1.5 km or so), then there is a chance for the PR 2A25 to miss the rain.

In this study it is recognized that over the arid regions, the conditional rain rate by the TMI 2A12 is much larger than that by PR 2A25 and the unconditional rain rate is opposite. The speculation to explain the results over the arid regions is as follows. Over a box we have one rain pixel with 5 units of rain in TMI, and four rain pixels with 3, 1, 1, 1 units of rain in PR. Thus we get that the TMI conditional rain is larger than PR one, but the TMI unconditional rain is lower than PR one.

We do not know the reason why the TMI conditional rain is so high at this moment.

5. SUMMARY

TRMM PR/TMI 6-year rainfall difference over land are examined by using 3G68 version 5 data set.

The results are as follows.

1) For conditional rain rate, TMI estimate is larger over the coast all over the world and over the arid regions, such as Sahara Desert, Saudi Arabia, and Australia. However, the unconditional rain rate by TMI estimate over the arid region is smaller than PR estimate.

2) For unconditional rain rate, TMI estimate is larger over the equatorial Africa, the maritime continent and South America. The difference may be related with the convective rain rate. If the convective rain is dominant, then the TMI estimate is apt to overestimate. When the convective rain is very small (less than 10%) then the TMI estimate is larger. This may be due to the PR rain observation near the surface.

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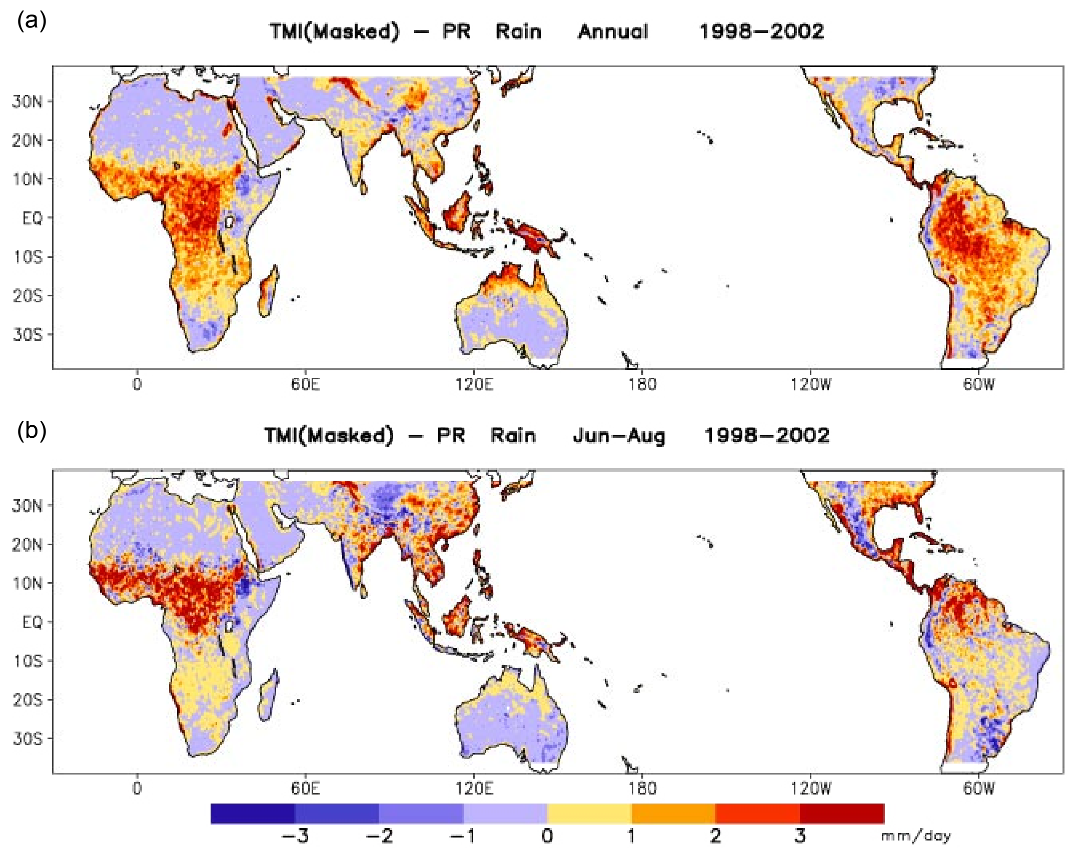

Fig. 1 (a) Annual rainfall difference between Masked TMI 2A12 and PR 2A25 (mm/day), averaged from 1998 to 2002. (b) the same as (a), but for the difference in Jun-Aug.

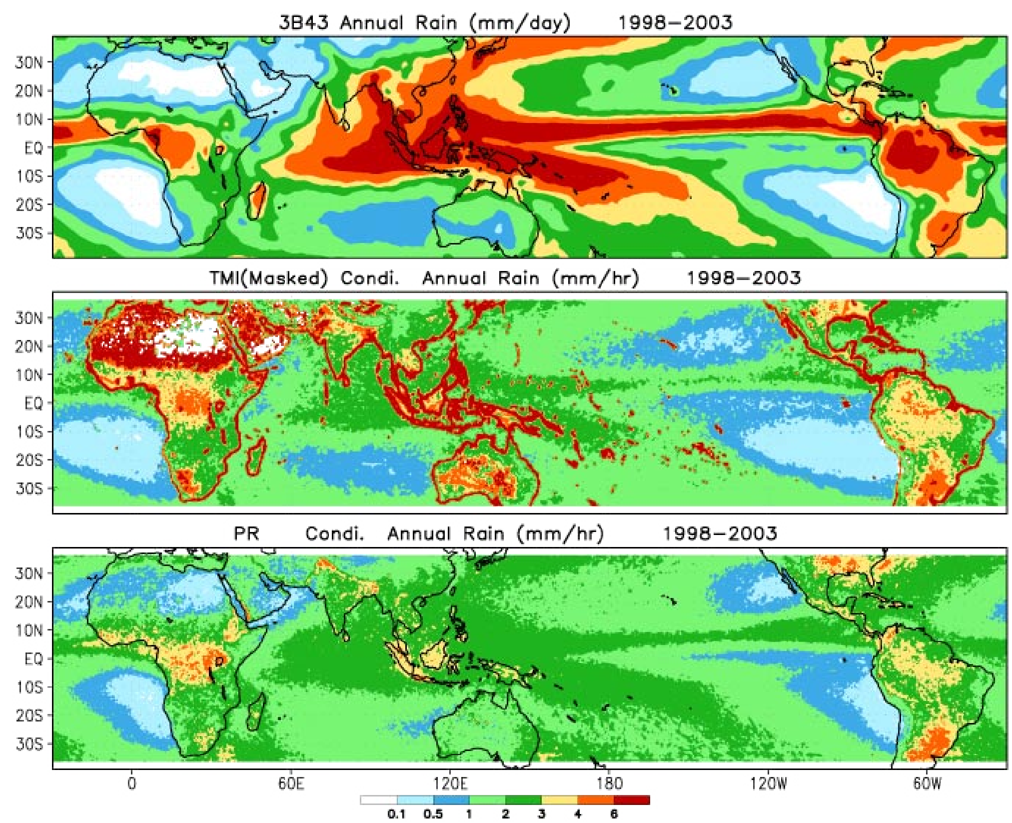

Fig. 2 (a) Annual rainfall by 3B43 (mm/day), averaged from 1998 to 2003. (b) the same as (a), but for Masked TMI 2A12 conditonal annual rain rate (mm/hr). (c) the same as (b) but for PR 2A25.

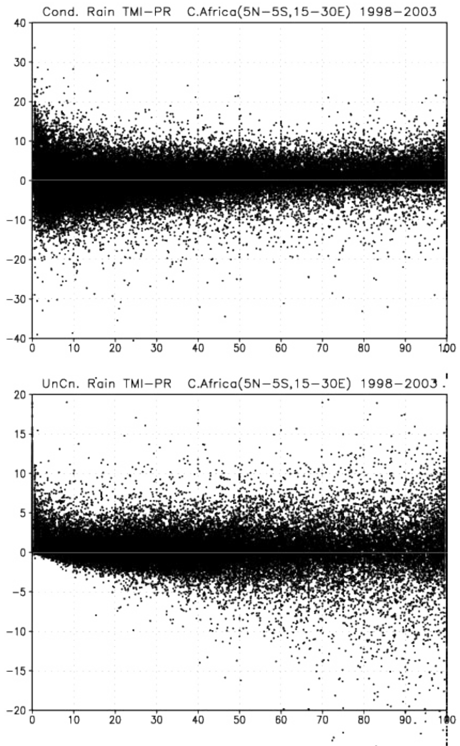

Fig. 3 The scatter plot of the dependency of PR convective rain percentage with the difference of TMI-PR conditonal rain (top) and unconditonal rain (bottom) over Central Africa (5N-5S, 15-30E).

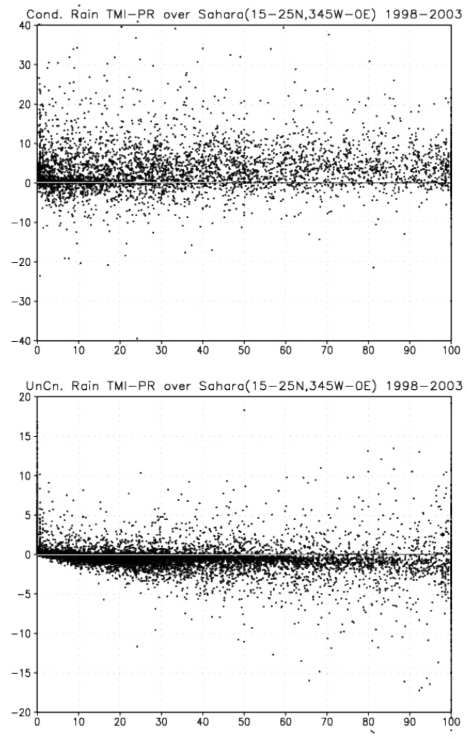

Fig. 4 Same as Fig. 3, but for over Sahara Desert (15-25N, 345W-0E).

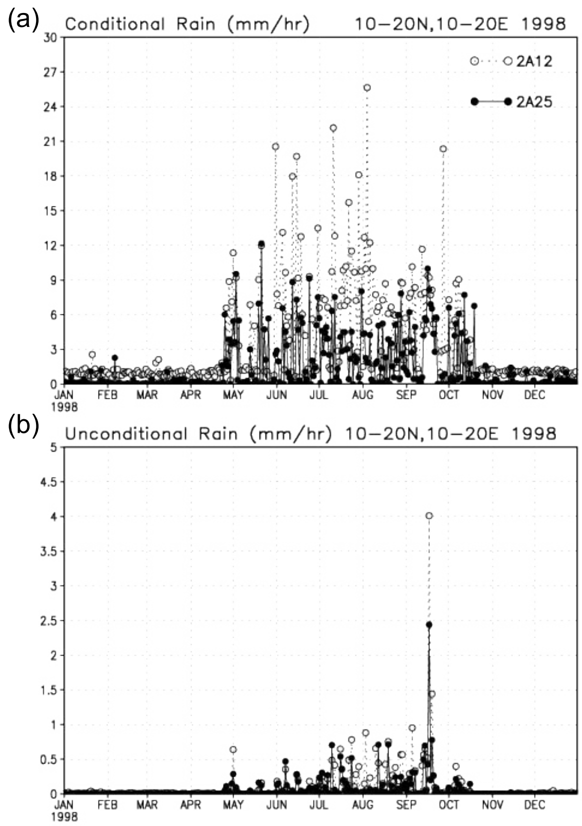

Fig. 5 Temporal change of rain over the Sahara Desert (10-20N, 10-20E) in 1998. (a) for conditonal rain rate. (b) for unconditonal rain rate.