RAINFALL VARIATIONS IN THE ARID AND SEMI-ARID REGION BASED ON TRMM PR DATA

Chikako Harada* and Akimasa Sumi
Center for Climate System Research, The University of Tokyo, Tokyo, Japan

1. INTRODUCTION

In arid and semi-arid regions, seasonal and yearly rainfall variations have an enormous impact on not only the natural environment but human society. Therefore, it is important to clarify accurate rainfall characteristics and make reliable predictions. In most arid and semi-arid regions, however, distribution of gauges is so scarce that it is difficult to understand rainfall characteristics in these areas. Satellite remote sensing data seems to overcome this hurdle. Using TRMM (Tropical Rainfall Measuring Mission) precipitation radar data, we investigated seasonal and year-to-year variations of rainfall in the arid and semi-arid region qualitatively. Harada et al. (2003) shows relationship between seasonal and year-to-year variations of rainfall and zonal wind changes in the Sahara desert region based on TRMM PR data and reanalysis data. However, we found that quantitative validation of TRMM PR in semi-arid region is needed since TRMM PR rain estimation has been validated by comparison with short-term data (Nicholson et al. (2003)) or limited ground observation (Adeyewa and Nakamura (2003)). In this study, we compare long-term TRMM PR data with rain gauge observation in inland semi-arid region of Australia where gauge number is enough for validation.

2. DATA AND METHODS

Monthly rainfall amount is estimated based on TRMM PR rain rate data (2A25, Ver.5) from 1998 to 2000. To calculate monthly averaged rainfall amount, monthly averaged rain rate of each 2.5º x 2.5º latitude-longitude grid box is divided by total pixel number and multiplied by 24 hours. Daily rain gauge observation data maintained by Australian Bureau of Meteorology are compared with TRMM PR observation. All quality controlled station data are averaged in each grid box.

To choose grid box for validation, we set three criteria as follows. First, we choose grid box in arid and semi-arid land area based on climatological rainfall amount (New et al. (2000)). We only use grid box in which daily rain amount is less than 1 mm. Second, we take gauge number into consideration because of inequitable gauge distribution. We only use grid box with five or more gauges. Finally, we have to take TRMM pixel number into account to choose grid box since we can use small number of data in northwestern part of Australia. To eliminate this region, we only use grid in which TRMM PR total pixel number is more than 30,000. Applying these criteria, about 27 grid boxes are selected for each month.

3. RESULTS AND DISCUSSIONS

TRMM PR has a net tendency to overestimate gauge observation and annual mean bias is about 16%. Monthly bias of TRMM PR varies seasonally; 17% underestimation in February while 78% overestimation in October. It is well known that both frontal system rainfall and wave-like disturbances are observed in inland Australia. Therefore, rainfall intensity varies largely according to seasonality of rainfall systems. In this study, to estimate rainfall amount based on TRMM PR rain rate data, we simply multiply 24 hours. Consequently, when TRMM PR observed convective rainfall system which sometimes contain large rain rate pixels, estimated rain amount shows very large value. So, we consider relationship between monthly variation of TRMM bias and variation of convective rainfall ratio. We divide

* *Corresponding author address*: Center for Climate System Research, The University of Tokyo, 4-6-1 Komaba, Meguro-ku, Tokyo, Japan 153-8904; e-mail: harada@ccsr.u-tokyo.ac.jp

validation grid boxes into two groups according as whether convective rainfall ratio is more than 50% or not. As a result, annual mean bias is larger in “more convective” group. Especially, monthly bias is small from July to August. In these months, convective rainfall ratio is less than 50% in all grid boxes. These results suggest that convective rainfall ratio seems to relate TRMM PR bias. However, further investigation is needed since other factors may contribute to bias.

4. CONCLUSIONS

We compare TRMM PR rainfall estimation with gauge observation in inland semi-arid region of Australia for qualitative validation. According to this validation, TRMM PR data shows some bias of monthly rain amount in semi-arid region. However, seasonal variations and year-to-year variations of TRMM PR rain estimation show good agreement with gauge observation. So, TRMM PR data is still valued for qualitative approach in semi-arid regions where distribution of gauges is so scarce. Moreover, improving the way of converting hourly rain rate into daily rain amount will contribute to more accurate daily or monthly rain estimation.

ACKNOWLEDGMENTS.

The authors are grateful to Prof. Y. N. Takayabu of CCSR, University of Tokyo for her valuable comments. We also thank to Australian Bureau of Meteorology for data arrangement.

REFERENCES

Adeyewa, Z. D., K. Nakamura, 2003: Validation of TRMM Radar Rainfall Data over Major Climatic Regions in Africa. *J. Appl. Meteor*., 42, 331-347.

Harada, C., A. Sumi and H. Ohmori, 2003: Seasonal and year-to-year variations of rainfall in the Sahara desert region based on TRMM PR data. *Geophys. Res. Lett.*, 30 (6), 1288, doi:10.1029/2002GL016695.

New, M., M. Hulme, and P. Jones 2000: Representing twentieth-century space-time climate variability. Part II: Development of a 1961-90 mean monthly terrestrial climatology. *Journal of Climate*, **12**, 829-856.

Nicholson, S. E., et al., 2003: Validation of TRMM and Other Rainfall Estimates with a High-Density Gauge Dataset for West Africa. Part II: Validation of TRMM Rainfall Products. *J. Appl. Meteor.*, 42 (10), 1355-1368.