Underestimation characteristics of TRMM 2A25 V7 near surface rain over and around the Meghalaya Plateau

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Utilizing our original tipping bucket raingauge network over Bangladesh and northeast India (Fig. 1), we have detected underestimation of the near surface rain in TRMM 2A25 V7 dataset over and around the Meghalaya Plateau. This underestimation was prominent especially in the monsoon season. Such underestimation of TRMM PR sensor was detected in other mountaneous areas also (Prat and Barros 2010; Wilson and Barros 2014; Terao et al. 2017).
In the present study, we further analyzed the characteristics of underestimation utilizing TRMM 2A25 V7 and raingauge dataset. In TRMM 2A25 dataset, rain type is defined for each ray to distinguish stratiform and convective rainfalls. We evaluated the contribution to the underestimation from different types of rainfall (Figs. 2 and 3) for two regions, Meghalaya and Sylhet-Barak areas, with different orographic situation. In these figures, we evaluated the averaged contribution ratio and their 95 % confidence intervals for each rain type. These confidence intervals were evaluated by the boot-strap method. The Meghalaya area is the hill area in India, and Sylhet-Barak area is the northeastern part of the Bengal Plain, which consists of both Sylhet Division in Bangladesh and Barak Basin in Assam, India.
Figure 2 shows that the underestimation has been highly contributed by stratiform rain over the Meghalaya Plateau. Averaged for the stratiform rain cases, rainfall intensity detected by raingauges was greater than 6 mm h^{-1}, with more than 50 % negative bias ratio. Most notable result was the high contribution of the no-rain detected cases. We detected tipping of raingauge more than 5 % out of TRMM 2A25 no-rain detected cases. For other areas, this ratio was much less than 0.5 %. Over the Sylhet-Barak area, underestimation was explained mainly only by the convective rain (Fig. 3). Thus, although the areas of underestimation in TRMM PR sensor were geographically adjacent to each other, the cause of the underestimation was largely different.
For near nadir cases, the clutter free bottom height (CFB height) of the ray tends to be lower. Therefore, we checked the impact of the angle of ray to check its impact on the underestimation (not shown), but we found no clear tendency.

Keywords: TRMM, PR, underestimation, northeastern Indian subcontinent

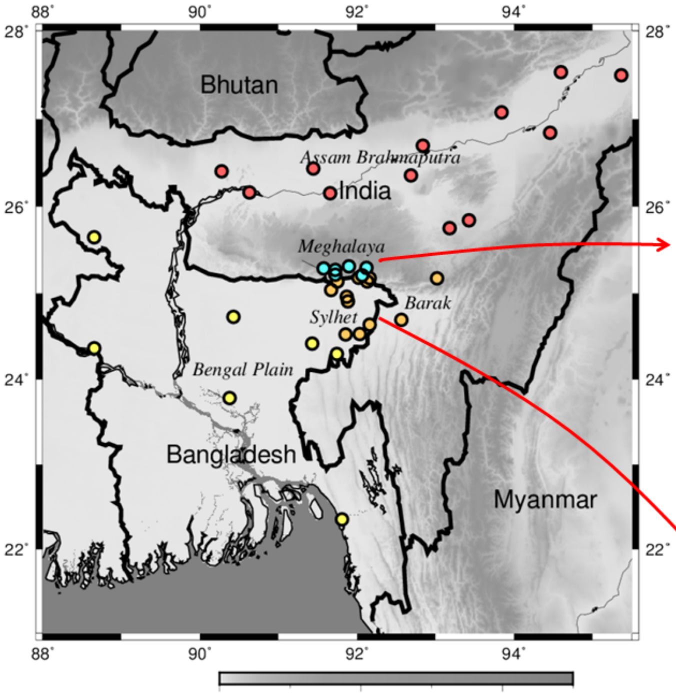

Fig. 1: Raingauge network

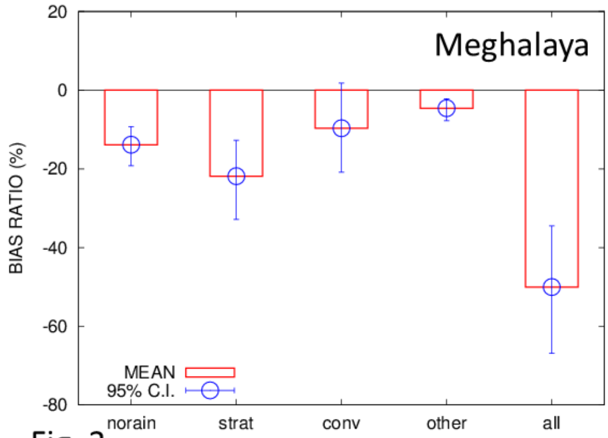

Fig. 2

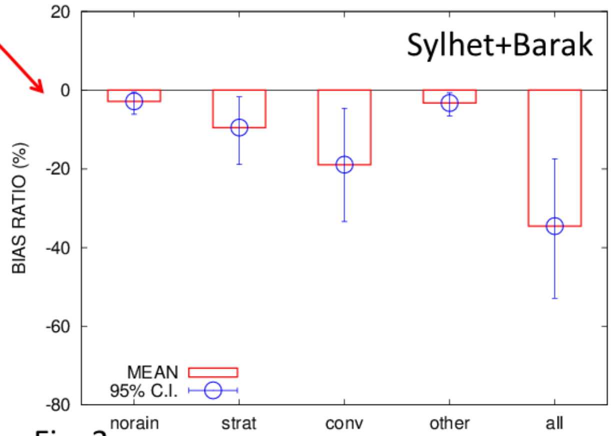

Fig. 3

Impact of land-use change on terrestrial water balance in the Chao Phraya River Basin

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Deforestation in the mountainous upper-reaches of the Chao Phraya river has been worried to enhance floods in the lower reaches. To cope with this issue, afforestation is expected to reduce the risks of floods by increasing water holding capacity and slowing the response of discharge. On the other hand, afforestation has impacts not only on the terrestrial water balance and the water resources/uses, but also on the social and economical issues, e.g., reduction in income due to decreases in croplands. Thus, the impacts of deforestation/afforestation should be carefully assessed. The water resource assessment has been conducted by a global hydrological model (H08; Hanasaki et al., 2008ab) in this region, but effects of land-use change have not explicitly examined since a bucket-type model without an explicit consideration for vegetation type is used for the land surface scheme of H08. Then, another land surface model, MATSIRO (Takata et al, 2003; Nitta et al., 2014) that includes processes of vegetation canopy is used to examine the impacts of vegetation change on the terrestrial water balance in the Chao Phraya river basin. In the numerical experiments, near surface meteorological conditions were given, and the results with the present and cultivated vegetation distributions were compared. The preliminary experiments were conducted at a horizontal resolution at 1°×1° from 1 January, 1979 to 31 December, 2007 with the meteorological data by Kim et al., (2009).
The calculated river discharge in the northwestern upper-reaches of the basin, where natural vegetation is broad-leaf evergreen forest, has been compared with the observed inflow of the Bhumipol dam, and that in the northeastern upper-reaches where natural vegetation is mixed forest has been compared with the observed inflow of the Sirikit dam. The observed seasonal change of river discharge, that shows an increase from July to September and a decrease in October, has been roughly presented by the calculation on the northwestern point, but the observed small peaks in May and June has not appeared. Besides, the calculated discharge was concentrated in August on the northeastern point where observed one showed a gradual increase in July and a decrease in September. Moreover, the calculated annual discharges were smaller by a few factors than observed ones. As for the calculated differences due to the land-use change, the beginning time of river discharge was later and the annual discharge was smaller for broad-leaf evergreen forest than cropland, implying the mitigation effect for floods by forest. In contrast, the beginning time of discharge did not show a significant difference and the annual discharge was larger for mixed forest than cropland.
A high-resolution experiment will be conducted using a 5'×5' meteorological data in the Chao Phraya river basin (Kotsuki et sl., 2013). The model and its settings will be improved for better representation of the observed river discharge. The reason for different response to land-use change for different types of forest will be examined, to understand and quantify the impacts of land-use change on the terrestrial water balance and the water resources.

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Keywords: Land-use change, Terrestrial water balance, Chao Phraya river basin

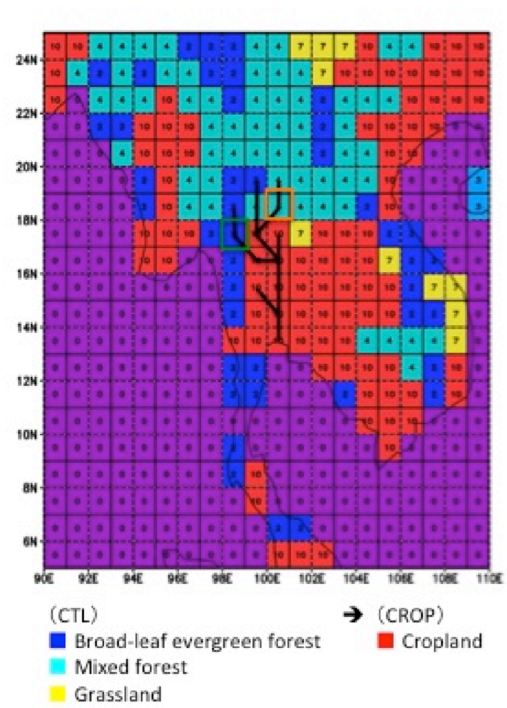

Figure Land-use distribution used in the preliminary experiment. Black lines indicate river route of the Chao Phraya river. Boxes (orange and green) are the grid points compared with observed river discharge.

An analysis of the atmospheric circulation around the Tibetan Plateau revealed by the stable isotope in precipitation—A case study of GEWEX-GAME/Tibet in 1998

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Data of stable isotopes obtained from glaciers and tree rings on the Tibetan Plateau are useful in restricting the paleoclimate. It is important to meteorologically analyze stable isotopes in precipitation over the Tibetan Plateau, which are affected by complicated atmospheric circulation processes, because the ratio of stable isotopes in precipitation based on the transport process is affected by atmospheric circulation. However, this approach has not yet been well implemented.
Data of temporally and spatially stable isotopes in precipitation were obtained over the Tibetan Plateau and Nepal during a field campaign of the Global Energy and Water Experiment Asian Monsoon Experiment/Tibet in 1998. The data reveal a relationship between stable isotopes in precipitation over the Tibetan Plateau and active/break variations of the Indian monsoon.
During a break phase, low $\delta^{18}O$ values and low d-excess values were observed at all observational sites. Transportation in this phase was an upslope process in which an air parcel gains altitude near the Himalayas. This trend can be explained by air parcels crossing over the Himalayas.
During an active phase, a characteristic trend of stable isotopes in precipitation over Tibetan Plateau was observed. Low $\delta^{18}O$ and low d-excess values were observed around the south of the Tibetan Plateau (hereinafter called region 1) while high $\delta^{18}O$ and high d-excess values were observed around the north of the Tibetan Plateau (hereinafter called region 2). The phase of region 1 coincided with the break phase, and transport might be an upslope process. However, the phase of region 2 was different because of the inland effect. To interpret the high $\delta^{18}O$ values, we used the forward trajectory from convective cloud over central India, and examined the top height of convective cloud around region 2 over the Tibetan Plateau using measurements made by the precipitation radar onboard the Tropical Rainfall Measuring Mission satellite. Results showed that air parcels at an altitude exceeding 8,000 m in convective cloud around central India were transported to the Tibetan Plateau, and high $\delta^{18}O$ values between 8,000 and 10,000 m in convective cloud around central India might be associated with precipitation around region 2 over the Tibetan Plateau.
To interpret the characteristics of stable isotopes in precipitation around the Tibetan Plateau, it is important to consider the active/break phase and trajectory of air parcels of the Indian monsoon.
Clarifying the vertical distribution of stable isotopes in precipitation in convective cloud can improve our knowledge of the paleoclimate and help determine an isotope model in future work.

Keywords: stable isotope in precipitation, the Tibetan Plateau, atomospheric circulation

Heavy rain prediction applying satellite-based cloud data assimilation over land

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For accurate flood prediction, warning systems, and optimized dam control, information of positional relationship between rain areas and river basins is crucial. This requires very fine precision in the prediction of rainfall areas. Assimilation of satellite-based microwave observation of cloud has great potential to improve precipitation areas because it can directly obtain information on rainfall locations as well as amount of cloud. However, it is difficult to observe clouds over land using satellite microwave remote sensing, because land emissivity is much stronger and more heterogeneous than that of cloud. To overcome this challenge, appropriate representation of heterogeneous land emissivity is needed. Thus, We developed a Coupled Atmosphere and Land Data Assimilation System with the Weather Research and Forecasting model (CALDAS-WRF), which can assimilate soil moisture, cloud water content over land, and heat and moisture within clouds simultaneously. Results of application of CALDAS-WRF to heavy rain events show that the system effectively assimilated cloud signals and produced very accurate cloud and precipitation distributions with appropriate intensity. Also, the local atmospheric fields are modified appropriately around the area of assimilated clouds. Furthermore, by using operationally analyzed dynamical and moisture fields as initial and boundary conditions, the system improved prediction of precipitation duration. The results demonstrate the method’s promise in dramatically improving predictions of heavy rain and consequent flooding.

Keywords: cloud assimilation, remote sensing, heavy rain prediction

Regional seasonal marches of precipitation and their long-term variations in India for 1901-2013

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Regional characteristics of climatological seasonal marches of precipitation and their long-term variations have been examined for the period 1901-2013 in India using a high resolution (0.25°×0.25°) daily gridded precipitation dataset provided by the Indian Meteorological Department.
Cluster analysis (Ward’s method) was applied for the 30-year climatological 5-day precipitation (1981-2010) at each grid box, and nine regions were divided. Then changes of seasonal precipitation characteristics, including onset, peak, and retreat of rainy season were examined for the 113-year period from 1901-2013 in a regional basis. As a result, for example, in the west coast area where typical monsoonal seasonal changes are observed, a prominent precipitation peak appeared in July prior to 1940, while precipitation in the subsequent rainy season in August has increased during the 20th century, and the degree of concentration of precipitation in July has decreased after the 1940s.

Keywords: India, precipitation, climatic variation

Predictable and unpredictable monsoons

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MAHASRI renewed GAME both in scientific and non-scientific aspects of monsoon-related issues. The infrastructures for hydro-climatological observations have been improved by economic growth and public needs. Now we can distinguish the predictable and unpredictable parts of monsoons, and must do it. The monsoonal or rainy-seasonal cycles are originated from the insolation varying astronomically with season and latitude, and are amplified geographically mainly with the solid (land) - liquid (sea) heat capacity contrast on the Earth's surface. The former astronomical process is completely predictable as described in a classical agricultural calendar which might have been changed gradually by the recent global warming. In addition, most of geographical variabilities of Asia monsoon have been revealed by GAME-MAHASRI periods. At first we must perfect to archive them, to let everybody know them, and to apply them for agricultural application, disaster prevention, and so on. Those parts might be still supported by so-called developed countries including outside of the monsoonal Asia, but are not so many in my view. At last we will recognize the truly unpredictable parts, which may be varying dynamically or even indeterministically due to nonlinear or multivariate processes. These remainder parts are so truly pioneering/challenging and/or domestic that any advanced countries can never support them. In this meaning now we are entering into indeed a qualitatively new era.

Keywords: monsoon, science and society, international collaboration

