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.

キーワード：TRMM、降雨レーダー、過小評価、インド亜大陸北東部
Keywords: TRMM, PR, underestimation, northeastern Indian subcontinent

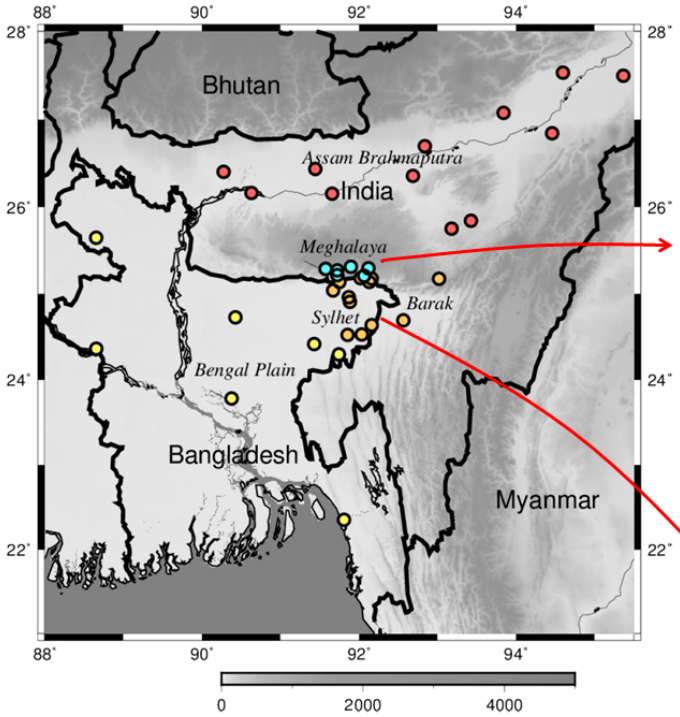

Fig. 1: Raingauge network

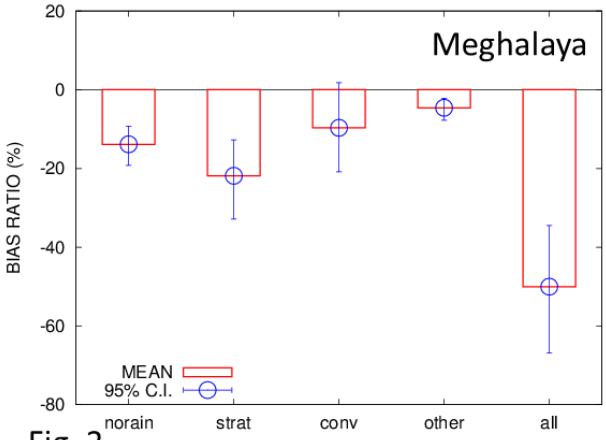

Fig. 2

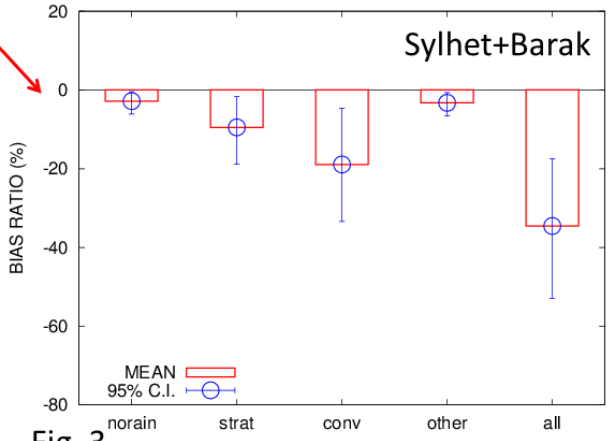

Fig. 3

チャオプラヤ流域の土地利用変化が陸域水収支に及ぼす影響
Impact of land-use change on terrestrial water balance in the Chao Phraya River Basin

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チャオプラヤ川上流域の山岳地帯では、近年、森林伐採が進んでおり、これによる洪水の増加が懸念されている。これに対し、植林を進めることによって土壌の保水能力を高め、流出応答をゆっくりにする効果で洪水を抑制できるのではないかという期待がある。一方で、実際に植林を進めようとした場合、陸域水収支や水資源・水利用の観点に加えて、収入源となる耕作地の減少によって社会経済的な影響なども与える可能性があり、慎重な影響評価が必要である。これまで当地域では、ダムなど人間活動による水利用を考慮した全球水資源モデルH08（Hanasaki et al., 2008ab）による水資源と陸域水収支の評価が行われているが、陸面水文過程にはバケツモデルが用いられており、土地利用変化（植生変化）を陽に扱うことができなかった。そこで本研究では、植生を陽に扱っている陸面水文過程モデルMATSIRO（Takata et al., 2003; Nitta et al., 2014）を用いて、チャオプラヤ川流域における植生変化が陸域水収支に及ぼす影響について調べる。具体的には、MATSIROに地上気象データ与えて、植生分布を変えた数値実験を行い、土地利用変化の影響を評価する。予備実験として、水平解像度約100kmで、1979年1月1日から2007年12月31日の全球地上気象データ（Kim et al., 2009）を与え、現在の植生分布（図）を与えた実験(CTL)と、自然植生（常緑広葉樹林、混合林、草地）を耕作地に変えた実験(CROP)を行い、チャオプラヤ流域での河川流量の変化を調べた。

流域北西部のBhumibolダムや流域北東部のSirikitダムに流入する河川流量の観測値と数値実験の河川流量を比較したところ、流域北西部（Bhumibolダム）では7月から10月に流量が増大する季節変化は定性的に再現されていたものの、5月-6月の降雨に対応した流出が表現されなかった。また、流域北東部（Sirikitダム）では流出の起こる期間が8月に集中し、7月から徐々に増加して9月に徐々に減少する様子が再現されなかった。さらに、年間の河川流量はどちらも観測の数分の1に過小評価されていた。土地利用変化に対する応答について、常緑広葉樹林から耕作地に転換したチャオプラヤ流域北西部では、森林のほうが耕地よりも河川流出の開始時期が遅く、また年間の河川流量が小さくなり、森林による洪水の緩和を示唆する結果となった。一方で、混合林から耕作地に転換したチャオプラヤ流域北東部では、森林と耕地の場合で河川流出の開始時期はほとんど変わらず、年間の河川流量は森林のほうが大きかった。

今後、チャオプラヤ流域における水平解像度約10kmの気象データ（Kotsuki et al., 2013）を用いた高解像の数値実験を行い、観測された河川流量変化や年間流量の再現性を向上するとともに、植生タイプによって耕地化した時に応答が異なる原因や、土地利用変化が陸域水収支と河川流量に及ぼす影響についてメカニズム解明と定量評価を進める。

謝辞：東京大学の新田友子博士と理化学研究所の小槻峻司博士には、MATSIROオフライン実験の実行に当たってご協力いただいた。本研究は科学技術振興機構(JST)と国際協力機構(JICA)による地球規模課題対応国際科学技術協力プログラム（SATREPS）の支援を受けて実施している。

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キーワード：土地利用変化、陸域水収支、チャオプラヤ流域
Keywords: Land-use change, Terrestrial water balance, Chao Phraya river basin

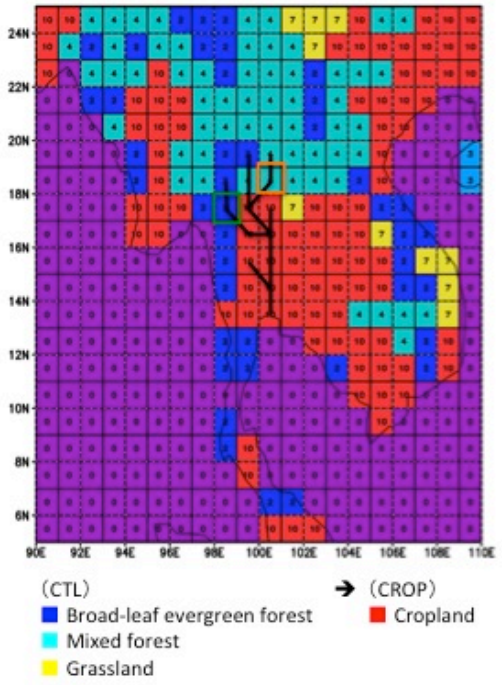

Figure Land-use distribution used in the preliminary experiment. Black lines indicate river route of the Chao Phraya river. Boxes (orange and green) are the grid points compared with observed river discharge.

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.

キーワード：降水安定同位体、チベット高原、大気循環
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.

キーワード：雲データ同化、リモートセンシング、豪雨予測
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.

キーワード：インド、降水量、気候変動
Keywords: India, precipitation, climatic variation

Predictable and unpredictable monsoons
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.

キーワード：monsoon 、science and society、international collaboration
Keywords: monsoon, science and society, international collaboration

