Validation of GSMaP toward practical hydrological use over Vietnam: basin-scale validation and estimation of accuracy with time lapse from microwave observation

*Masato I. Nodzu[1], Jun Matsumoto[1,2], Thanh Ngo-Duc[3], Long Trinh-Tuan[3], Tri Truong-Duc[4]

1. Tokyo Metropolitan University, 2. Japan Agency for Marine-Earth Science and Technology, 3. University of Science and Technology of Hanoi, Vietnam Academy of Science and Technology, 4. Ministry of Natural Resources and Environment, Vietnam

1. Introduction

Satellite observation is a promising tool to grasp the horizontal distribution of precipitation intensity over mountainous regions where it is difficult to put gauge stations and surface weather radars are obstructed by orographic clutters. GSMaP has been developed based on passive microwave observation from the TRMM and GPM satellites with the aid of infrared observation and improved with some modification methods. However, the performance of GSMaP is still poor in one-to-one comparison in the scales of 0.1-degree-grid and one hour, i.e. at its highest resolution. Generally such precipitation data has tendency to perform better in lower resolution. It is useful to show a higher limit of resolution and expectant accuracy in a precipitation dataset. For example, in the use for flood warning, the highest resolution is not necessarily needed depending on features of a river basin like topography and expansion of the upstream region. In this study, we investigate the dependence of the GSMaP performance on scale of regional mean. We also examine the relationship between the performance of hourly precipitation and time lag from the microwave radiometer (MWR) observation.

2. Data and methods

The GSMaP version used in this analysis is the semi-standard product, RNL version 6 from 2006 to 2010.

The horizontal resolution dependency is assessed by daily regional mean precipitation in different regions within the Thu Bon River basin, compared with the VnGP data. The regions are A, B, C and D in order of areas. The parameters used for assessment are biases, root mean square difference (RMSD), probability of detection (POD) and false alarm ratio (FAR). The POD and FAR are determined for heavy precipitation over the 95th percentile of hourly precipitation in the VnGP. The analysis period is months from April to October in 5 years from 2006 to 2010.

We examine the relationship between the GSMaP performance and time lag from the MWR observation for hours with precipitation exceeding 1 mm/hour in gauge observation from April to September in 2010. The GSMaP data are compared with gauge precipitation data observed at 6 stations within northern Vietnam. Besides biases and RMSD, we also define GGR as the ratio of GSMaP precipitation to gauge observation. The GGR in the best skill is 1.0. The closer to 1.0 the GGR value is, the better performance we obtain. The performance is measured with the ratio of cases with GGR from 0.5 to 2.0 to all the cases.

3. Results and discussions

The daily regional mean of the GSMaP precipitation is compared with that of the VnGP over the upstream basin of the Thu Bon River in central Vietnam, over four different regions. Against our expectation, the GSMaP performance shows a small dependence on the difference of regions (Fig. 1). The RMSD normalized by the total precipitation shows smaller values for the regional mean over the larger areas, except the region A. The smallest bias is seen in the largest region D. However, it is difficult to be

convinced that GSMaP could reproduce the closer values to the VnGP in the larger-area region, because the biases are scattered in the positive and negative values over the smaller region. The POD and FAR show worse values in regional mean over the larger-area regions. In this analysis, only the larger-area regions (C, D) include highlands over 800 m above sea level. This variety of orographic features in the regions may affect impartiality in the comparison analysis.

The ratio of cases with GGR from 0.5 to 2.0 to all the cases is correlated with the time lag from the MWR observation (Fig. 2). At almost all the grids with gauge stations, the higher this ratio, the smaller time lag. A smaller RMSD between GSMaP and the gauge precipitation is roughly related with a smaller time lag from the MWR observation. However, exceptions to this tendency are not negligible. It is difficult to find correlation between the bias normalized by the total precipitation and the lag time. In the present study, we limited the analysis to time with precipitation exceeding 1 mm/hour. On the other hand, GSMaP sometimes shows zero precipitation under this limitation. Therefore, it is challenging for using a simple RMSD to sufficiently estimate the difference of the both data. This problem also applies to the bias analysis.

Keywords: satellite precipitation observation, GSMaP, validation

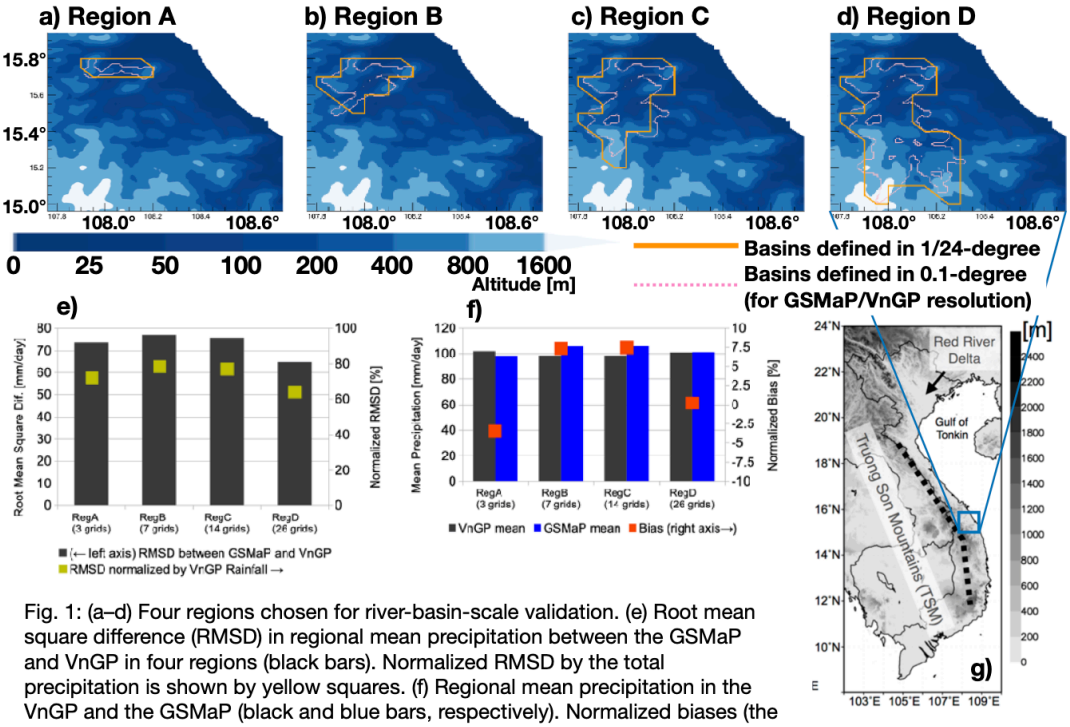

Fig. 1: (a–d) Four regions chosen for river-basin-scale validation. (e) Root mean square difference (RMSD) in regional mean precipitation between the GSMaP and VnGP in four regions (black bars). Normalized RMSD by the total precipitation is shown by yellow squares. (f) Regional mean precipitation in the VnGP and the GSMaP (black and blue bars, respectively). Normalized biases (the GSMaP minus the VnGP) are shown by red squares. (g) Countrywide map of Vietnam to show the location of the chosen area.

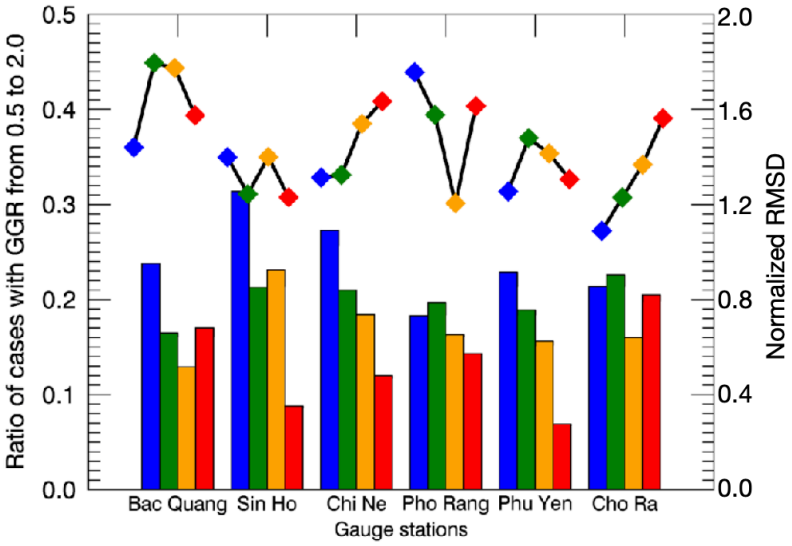

Fig. 2: Ratio of cases with GGR from 0.5 to 1.0, to all the cases (bars) and root mean square difference between the GSMaP and the VnGP normalized with the total precipitation (lines and diamonds). The green, orange and red bars and diamonds show the time lag from microwave observation with about one hour, from one to three hours and over three hours, respectively. The blue bars and diamonds show that the microwave radiometer observed almost over the gauge station.