# Factors Causing Differences Between Satellite and Ground-Based Observations of Typhoon Precipitation: A Case Study of Typhoon Faxai (2019

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## 1. Background and Objective

In 2019, Typhoon No. 15 (Faxai) caused significant damage in the Kanto region, and my grandmother was also affected. This experience sparked my interest in meteorological observation and forecasting. In particular, I focused on meteorological satellites, which enable wide-area observations even in regions without ground-based stations, and became especially interested in their accuracy in observing typhoons. However, it has been pointed out that satellite data may lose accuracy when capturing phenomena such as typhoons and linear precipitation systems, where intense rainfall occurs over short periods. Therefore, this study aims to clarify how accurately satellite data can capture precipitation under such conditions and to explore methods for improving its accuracy.

## 2. Data and Methodology

In this study, AMeDAS was used as ground-based data, and GSMaP was used as satellite-based data to compare precipitation amounts. Specifically, comparisons were made for hourly precipitation and total precipitation during the typhoon passage period.

## 3. Results

The spatial distributions of total precipitation from GSMaP and AMeDAS during the typhoon passage period (from 10:00 on September 8 to 24:00 on September 9) were compared. The results showed a significant difference in total precipitation between the two datasets in regions approximately 30 km away from the typhoon track, particularly on the right side of the typhoon (the eyewall passage region).
To investigate this further, time series of hourly precipitation were analyzed at three locations—Tateyama, Ushiku, and Tonosho—where the differences were especially large. The results indicated that the discrepancy between the two datasets tended to increase during the period when the eyewall was likely passing over these right-side regions.

## 4. Discussion

One possible factor causing the discrepancy between GSMaP and ground observations is the difference in spatial resolution. GSMaP calculates average precipitation over grid cells of approximately 11 km ×11 km. As a result, when intense rainfall occurs locally within a small area, the values are averaged with surrounding areas and appear “smoothed.” Consequently, in phenomena such as the typhoon eye and eyewall, where precipitation changes drastically over short distances, large differences can arise between point observations and area-averaged data.

Additionally, two other factors may explain the overall discrepancies. The first is misestimation due to sensor characteristics. GSMaP estimates precipitation using microwave radiometers that detect cloud water and ice particles. Therefore, in regions with high water vapor content or due to radiative properties, precipitation may be overestimated. A comparison between the distribution of integrated water vapor during the typhoon (Figure 3) and the GSMaP precipitation distribution (Figure 1, right) shows some

 

degree of correspondence, although not perfect.

The second factor is the insufficient representation of topographic effects. AMeDAS, being a ground-based observation system, can directly capture precipitation variations influenced by terrain such as mountains and coastlines. In contrast, GSMaP, based on satellite observations from above, has difficulty representing such localized variations in detail. Although Chiba Prefecture has relatively flat terrain, a comparison between the topographic map (Figure 4) and the AMeDAS precipitation distribution (Figure 1, left) shows a certain level of correspondence.

## 5. Future Work

As a future direction, composite radar data from the GPV radar provided by the Research Institute for Sustainable Humanosphere, Kyoto University, are being used to generate precipitation distribution maps in order to verify the validity of GSMaP precipitation data over the ocean. This will enable comparisons with GSMaP even in offshore areas where AMeDAS observations are unavailable.

Furthermore, although GSMaP includes corrections for cloud motion (drift effects), it does not sufficiently account for the advection of raindrops caused by wind during their fall. While this effect is generally small under normal conditions, it may not be negligible during strong winds such as those in typhoons. Therefore, a program is currently being developed to apply corrections that take into account the advection of precipitation particles by wind.

Keywords: meteorology, satellite

 

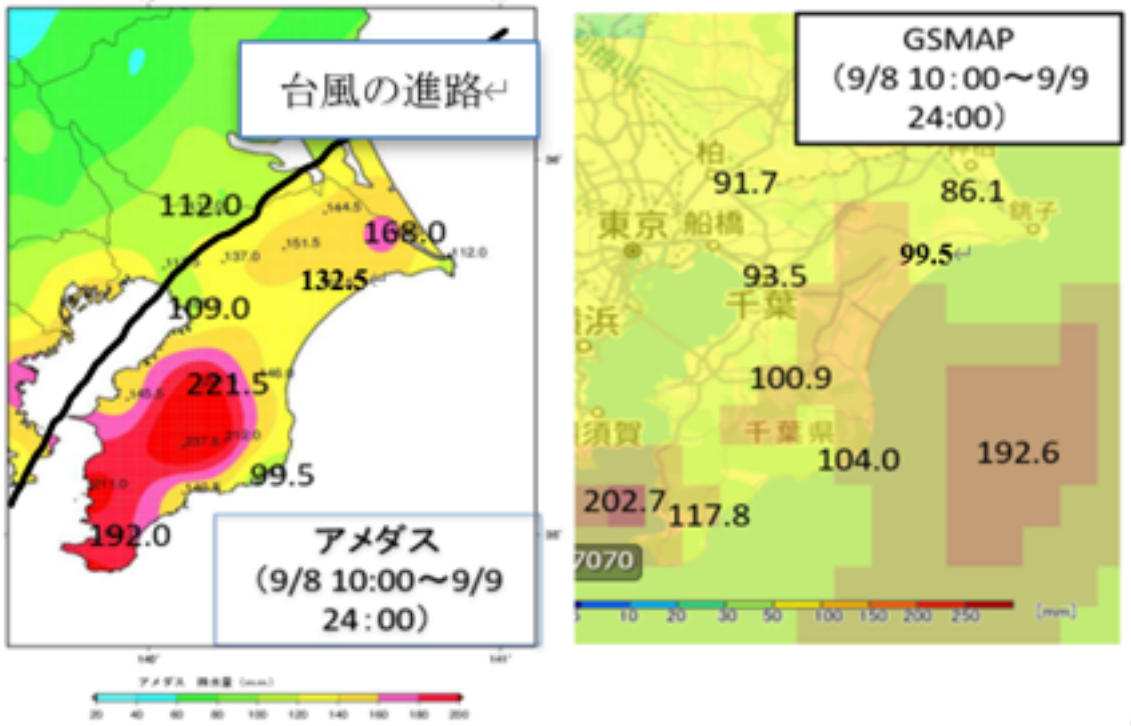


図１　合計降水量分布図（左：アメダス　右：GSMaP）