The Global Satellite Mapping of Precipitation (GSMaP) project Part III
- Overview of the satellite mapping group -

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Introduction

Precipitation is a key meteorological parameter in the global water and energy cycle. The need for the accurate estimation of the global precipitation distribution and its variation has been increasing. Space borne microwave radiometry has been proved to be the best sensor to estimate precipitation with the necessary accuracy and detail from low earth orbit. In order to draw the world wide precipitation map, we need to develop an algorithm to combine all the data from currently available each space-borne microwave radiometry, that are SSM/I, TRMM / TMI, AMSR-E. In this report, we are going to deal with an evaluation of the global precipitation map using the Aonashi's algorithm and an integration method for combining the data from some microwave and infrared radiometers. This presentation is a part of The Global Satellite Mapping of Precipitation (GSMaP) Project in Japan.

Comparison between the 2A21 and Aonashi's algorithm

One of the objectives in the satellite mapping group is to evaluate our product developed in the Algorithm group. In order to do so, we compare with GPROF and PR data in not only level 2 but also level 3. In figure 1, initial results are shown. This figure shows one month precipitation distribution on July, 1998 obtained by using Aonashi's algorithm for TMI 1B11 data sets. In order to compare the result, precipitation distribution of 2A21 for the same period is shown on side by side. Overall trend is quite similar in these two panels, but in some regions such Andes and Himalayan Mountains, some unrealistically high rain rate are shown. These biased high rain rates would be due to the scattering effect of snow, and these effects are now being removed by taking use of 85 GHz scattering data base (First results will appear at the conference.).

Although we still have this problem on land area, the rainfall estimation over the ocean is quite good. In figure 2, scattering plots of PR vs Aonashi's algorithm and PR vs 2A21 are shown. Note that the initial comparison between Aonashi's algorithm and 2A25 in 0.25 grid reveals that the cross correlations efficient is about 0.8 over ocean. In table 1, cross correlation coefficients in some seasons for land and ocean cases are shown. Note that the coefficients over ocean in Aonashi vs PR show better value than 2A21 vs PR in any season.

Sampling Error Analysis

If we use presently available all microwave radiometer data on LEO satellites and the rainfall retrieval is 100% correct, how much accurate is the mean rainfall estimation in a certain location and time period? In order to estimate the error due to the non uniform temporal sampling of precipitation, we are doing the sampling error analysis using radar-rain gauge network in Japan. In figure 3, one of the results is shown. If you have 1 degree×1 degree grid and one month mean precipitation data from 6 currently available microwave radiometers (TMI, AMSR-E, AMSR, SSMI-F13, F14 and F15), the error due to the non uniform sampling is about 20 % in rms. However, if you take the 0.1 degree and 1 day resolution or more, the error would be more than 150%, suggesting that the combination of infrared radiometers would be required to compensate for the error.

Integration of infrared and microwave radiometers

Although microwave radiometers can provide fairly accurate rainfall estimation, these

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sensors are on LEO satellites and do not provide the temporal sampling, spatial resolution and coverage needed to understand the different regimes over the globe. On the other hand, geostationary visible-infrared sensors are always watching the upwelling radiation which depends on cloud top reflectance and emission, but the IR radiation is not directly coupled with precipitation. Thus, several calibration technique to match the IR brightness temperature with MW rainfall have been developed and tested (eg. Huffman et al. 2001, Marzano et al.2004).

In this project, we are exploring multi spectral and moving vector approach. Brightness temperature difference between 10.8 μ and 11.9 μ is proved to be a good indicator of optically thick cumuliform clouds and optically thin cirrus clouds (Inoue 1985), and this split window method is found to be effective delineating rain area (Inoue 2000). In figure 4, one example of precipitating clouds observed by the GOES-W and the TRMM/PR is shown. Note that the rain area can be delineated by using the split window values. In some cases, however, the split window tends to miss the rain area. Statistical examination reveals that the averaged POD is about 70 %, while the FAR is about 60% for one month data sets detected by the GOES-W and TRMM/PR.

Finally, we are developing a method to combine the data from geostationary infrared radiometers and LEO microwave radiometers using moving vector and the Kalman filtering technique. Figure 5 shows one example of rainfall distribution near Japan with 0.1 degree and one day resolution that is made by combining infrared GMS images every hour and radar-rain gauge data in 4 every hour using moving vector technique. The true distribution observed by the radar-rain gauge network is also shown in the same figure for comparison. The cross correlation coefficient of this distribution to the true data is about 0.92 and the rms error is about 120%. This rms error is 20% better than that without moving vector technique, showing the effectiveness of this technique. In the future we are going to apply Kalman filtering to this method.

Acknowledgements

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Table 1. Cross correlation coefficients of our product vs 2A21, our product vs 2A25, and 2A25 vs 2A21

	Date	Aonashi vs GPROF	Aonashi vs PR	PR vs GPROF
Ocean	**January 1**	**0.79**	**0.77**	**0.82**
	April 1	**0.92**	**0.83**	**0.82**
	July 1	**0.88**	**0.83**	**0.72**
Land	**January 1**	**0.72**	**0.65**	**0.71**
	April 1	**0.73**	**0.58**	**0.74**
	July 1	**0.74**	**0.57**	**0.70**

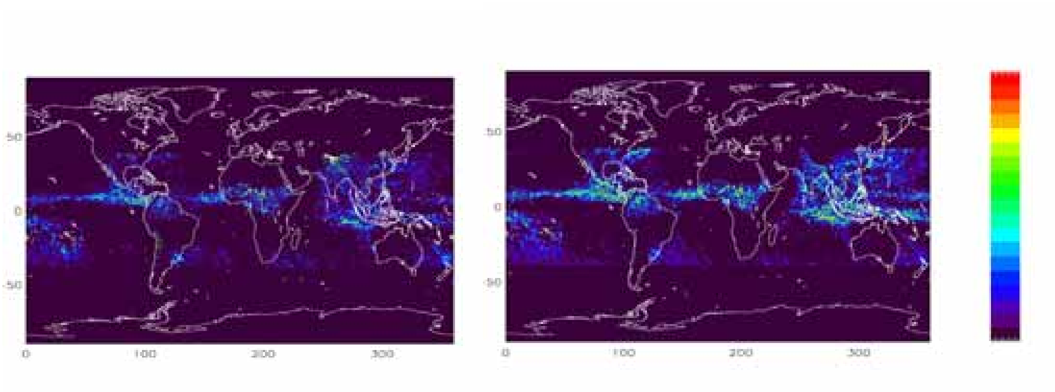

Figure 1. Upper panel shows 2A12(GPROF) rainfall distribution on July 1998. Lower panel shows rainfall distribution retrieved by the Aonashi's algorithm on the same period.

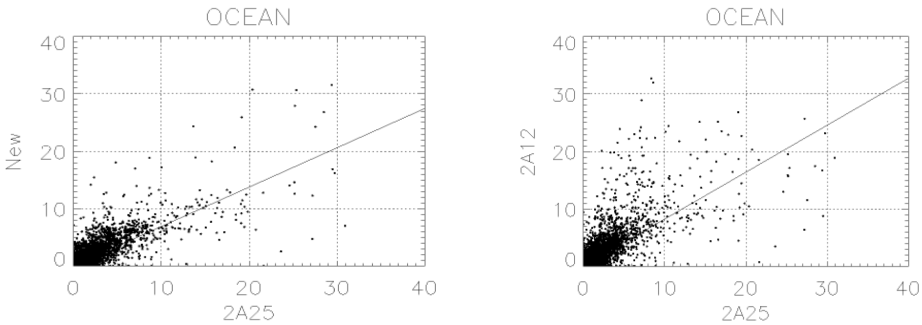

Figure 2. Scattergram of Aonashi's rainfall retrieval vs 2A25 (left panel) and GPROF vs 2A25 (right panel) for July 1 in 1998. The cross correlation coefficients are 0.83 and 0.72, respectively.

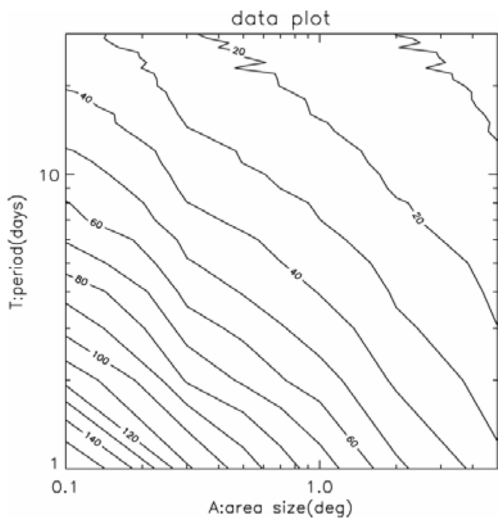

Figure 3. Sampling error as a function of area size and integration period.

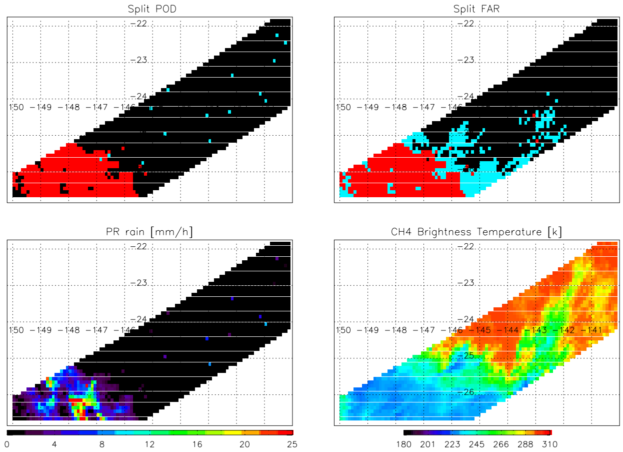

Figure 4 One example of precipitating clouds observed by TRMM/PR and GOES-W. Lower left panel shows the precipitation observed by PR. Lower right panels shows the brightness temperature observed by the GOES-W. Upper left panes shows the rain area detected by the TRMM/PR. Upper right panels shows the rain area by split window. In this case, FAR is estimated 38%, and POD is 95%.

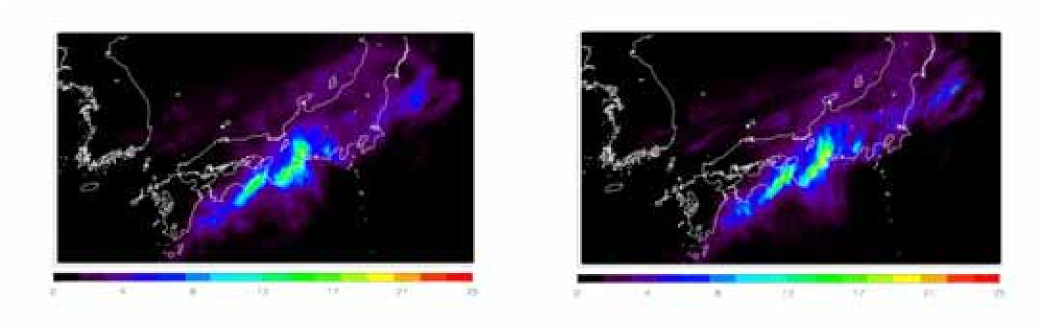

Figure 5 One example of rainfall distribution near Japan with 0.1 degree and one day resolution that is made by combining infrared GMS images every hour and radar-rain gauge data in 4 every hour using moving vector technique (Left panel). Right panel shows the true distribution observed by the radar-rain gauge network in Japan.

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