Intercomparison between TRMM3B42, GPCP-1DD and Radar-AMeDAS

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1. INTRODUCTION

Precipitation data derived from satellite-based observation is very useful, because it covers wide domain even in mountainous and oceanic region, where surface observation is very sparse or nonexistent.

TRMM3B42 and GPCP-1DD (Global Precipitation Climatology Project One-Degree Daily Precipitation Data Sets) provide gridded daily precipitation data over broad area with comparatively high-resolution as we couldn't get previously. They enabled us to investigate rainfall events whose timescale is within a few days, or to analyse phenomena whose transition occurs abruptly like Asian monsoon onset, or to validate output data from model simulation.

But including some kinds of error is inevitable for any observation data, so intercomparison is required.

In this study, we compared TRMM3B42 and GPCP1-DD. In addition, they were evaluated on Japan domain by Radar-AMeDAS, which is very high-quality gridded precipitation data.

2. DATA AND METHOD

- TRMM3B42 (data period 1998-2002)
- GPCP-1DD (data period 1998-2002)
- Radar-AMeDAS (data period 1998-2000)

We used three kinds of daily precipitation datasets TRMM3B42, GPCP-1DD and Radar-AMeDAS for making intercomparison (hereinafter referred to as 3B42, GPCP, RA respectively).

3B42 is one of the level three product of TRMM combined by multi-satellite global estimates, TMI, PR, VIRS, GPI (GOES Precipitation Index) and IR (InfraRed) of geostationary satellite. But it is not used surface observation data differently from 3B43 (3B43 is adjusted by GPCC (Global Precipitation Climatology Centre) which is estimated in situ component gauge).

Meanwhile GPCP is also produced by multi-satellite combined data such as SSM/I, GPI, TOVS (TIROS Operational Vertical Sounder), geosynchronous orbit IR Tb histograms and so on, but accumulated monthly precipitation amount is scaled by Satellite-Gauge (SG) combination data.

RA is gridded hourly precipitation data made by Japan Meteorological Agency, as a product for aiding short-range weather forecast whose horizontal resolution is 5km (currently operated at 2.5km). This radar-based estimation is adjusted by high-density gauge network called AMeDAS (Automated Meteorological Data Acquisition System), which placed on every 17km distance in average over the land of Japan. Accordingly, RA is very accurate. To make comparison, each grid value was simply averaged in the GPCP grid, then 1x1 degree grid data was made. RA available area (refer to as Japan domain hereafter) extends 128E-142E in longitude and 30N-39N in latitude. However, poor quality grids due to far from radar-site were eliminated.

We compared daily precipitation amount, wet-day frequency (over 0.1 mm per day). And, in order to check similarity of the frequency distribution of daily precipitation, we used gamma distribution and also compared the parameters of it.

Gamma distribution is widely known which fits well to frequency distribution of precipitation amount. There are two parameters that referred to as scale parameter and shape parameter. The former relates frequency of heavy precipitation, and the latter relates shape of distribution. The shape of distribution changes considerably season to season in certain place. Therefore fitting to gamma distribution was carried out on each season (DJF, MAM, JJA, SON).

3.RESULTS

Figure 1 shows correlation coefficient of daily precipitation amount between 3B42 and GPCP from 1998 to 2002. Both data are highly correlated except light rain area. And correlation is higher over ocean than land. There are distinct land-sea contrast around maritime continent, India peninsula, and so on.

Figure 2 shows difference of 3B42 from GPCP. As for daily precipitation and wet-day frequency, 3B42 is larger almost all over continents in all season, but the result is contrary over oceans. The pattern of seasonal change is not outstanding except east Pacific Ocean (3B42 is larger on JJA, smaller on DJF). It is very interesting that large negative area extends just south of Japan in wet-day frequency in DJF. We don't know the reason why such large discrepancy appears there.

In scale parameter, 3B42 is smaller over continents, and summer-hemisphere ocean. Figure 4 is scattering

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diagram of scale parameter. The value of northern hemisphere (39.0N-EQ) is indicated by red point and that of southern hemisphere (EQ-39.0S) is indicated by blue one. As is shown, both are good correlated but magnitude relation is reversed between JJA and DJF.

Next, we show the results, which derived from comparison between RA for three years from 1998 to 2000. Table 1 shows the average value of daily precipitation, wet-day frequency and scale parameter over Japan domain in each season. In daily precipitation, 3B42 is smaller in all season. It underestimates 14% for the year around. Wet-day frequency is fairly good on JJA for both 3B42 and GPCP, but very bad on DJF especially 3B42 (underestimated by up to 61%). GPCP and 3B42 are insufficient in both daily precipitation and wet-day frequency in all season. Scale and shape parameter are also good in JJA, but disastrous consequences are found in DJF.

Correlation of daily precipitation amount between 3B42, GPCP and RA is not so good. Correlation coefficient of each grid (the figure is omitted) is around 0.3 to 0.6 in yearly average, which is nearly same result as Rubel (2002) made comparison between GPCP and gauge over Alps.

Figure 4 compares 3B42, GPCP and RA in map. As is shown here, in JJA, daily precipitation is very good around Kyushu region where has much rainfall in summer. In DJF, precipitation around Hokuriku (northern coast line facing Japan sea), which is typically seasonal snowfall, can't be captured well. As for wet-day frequency, each estimation is too small in all area in both seasons, but distribution of a position in DJF is very good for GPCP, although its quantity is entirely wrong. Reflected in these results, scale parameter is good in JJA in its position and value.

4.CONCLUSION

3B42 and GPCP are both satellite combined precipitation data, but there are some following differences between them.

・Correlation is higher over ocean than land.
・3B42 has more rainfall and wet-day frequency almost all land area.
・Magnitude relation of scale parameter changes between JJA and DJF. 3B42 is larger in winter hemisphere.

We are using 3B42 and GPCP to evaluate our climate model. But these results suggest that we should take into account of uncertainty or difference of observation data.

In recently, some people tried to evaluate sub-monthly satellite-based precipitation by using gauge or radar data for certain area. For example, Rubel (2002) evaluated GPCP over European Alps and reported that GPCP does not have systematic error for monthly but it is not good for daily, GPCP estimates precipitation amount short. And Ramage (2001) got the result that 3B42 and GPCP overestimate by respectively 11% and 6%, compared with gauge over Niger and West Africa. Meanwhile, over Japan domain, daily precipitation amount is somewhat short in all season (3B42 underestimates by 14% yearly).

With comparison between RA, we found that 3B42 and GPCP succeed reasonable estimation in summer (JJA) in the place where has much rainfall, but fail in winter (DJF). This is as same consequence as E. Ebert has got, by which she validated GPCP-1DD with 6000-gauge dataset over Australia (Huffman et al 2001). It seems that satellite-based observation is not good at capturing light rain. And, as far as over Japan domain, GPCP has somewhat better in accuracy than 3B42.

Although GPCP and 3B42 have much room for improvement, they are considered to be high accurate and very useful data over tropical and subtropical region, when and where large amount of rain falls.

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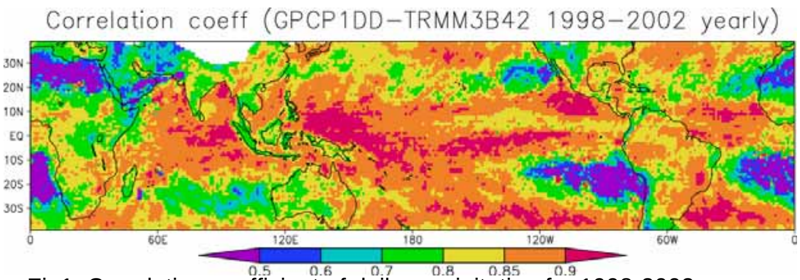

Fig1: Correlation coefficient of daily precipitation for 1998-2002

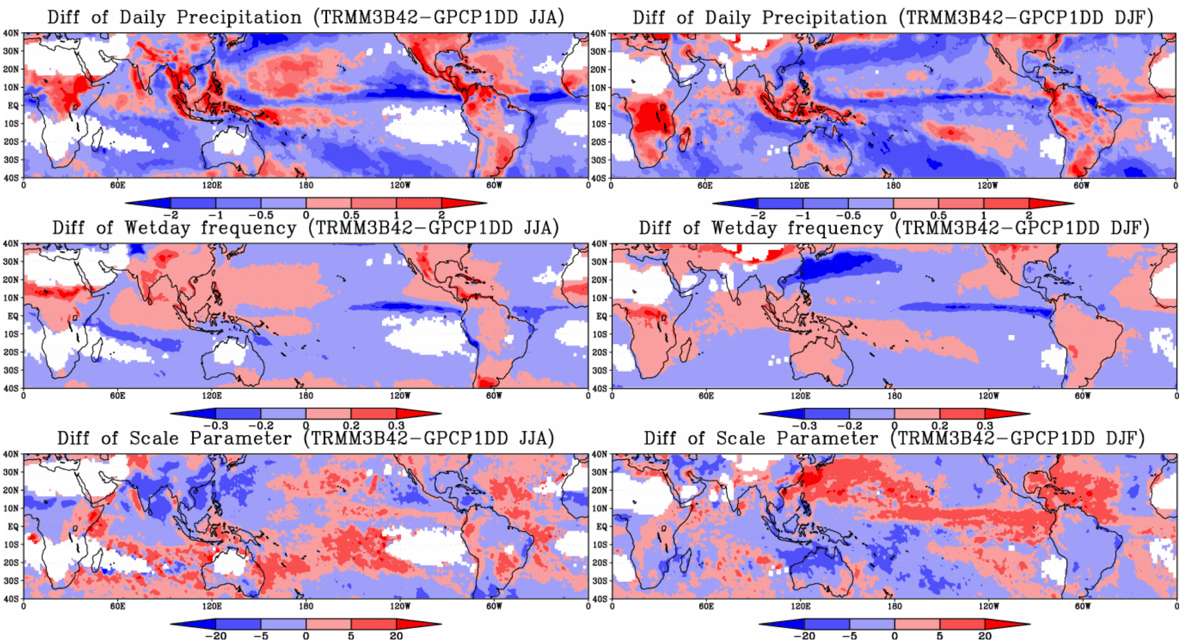

Fig2: Difference TRMM3B42 from GPCP1DD (1998-2002)
Left: JJA, Right: DJF, Blue: N-hemisphere
Upper: Daily precipitation, Middle: Wet-day frequency, Lower: Scale parameter

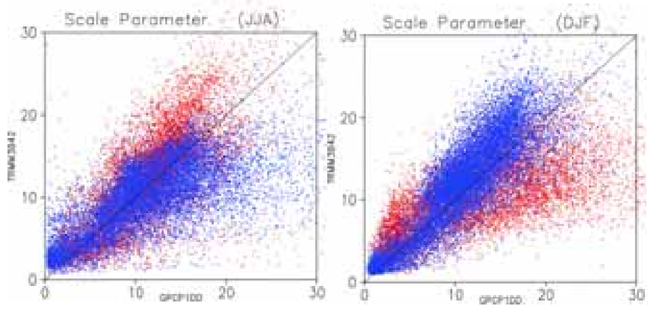

Fig3: Scattering diagram of scale parameter. GPCP1DD vs. TRMM3B42 for (1998-2002)
Left: JJA, Right: DJF
Blue: N-Hemisphere (39N-EQ), Red: S-Hemisphere (EQ-39S)

	Daily Precipitation (mm/day)			Wet-day Frequency			Scale Parameter			Shape Parameter		
	TRMM	GPCP	RA	TRMM	GPCP	RA	TRMM	GPCP	RA	TRMM	GPCP	RA
DJF	2.9	3.0	3.4	0.25	0.34	0.64	20.5	15.1	5.2	0.63	0.64	1.19
MAM	5.0	5.0	5.0	0.51	0.50	0.61	13.9	14.5	10.5	0.71	0.69	0.87
JJA	6.6	7.0	8.0	0.60	0.59	0.72	17.4	19.1	16.3	0.64	0.63	0.72
SON	5.3	5.8	6.7	0.45	0.53	0.68	20.5	17.6	13.7	0.57	0.63	0.81
Yearly	4.9	5.2	5.7	0.45	0.49	0.66						

Table1: Average value over Japan domain (colored area of Fig4)

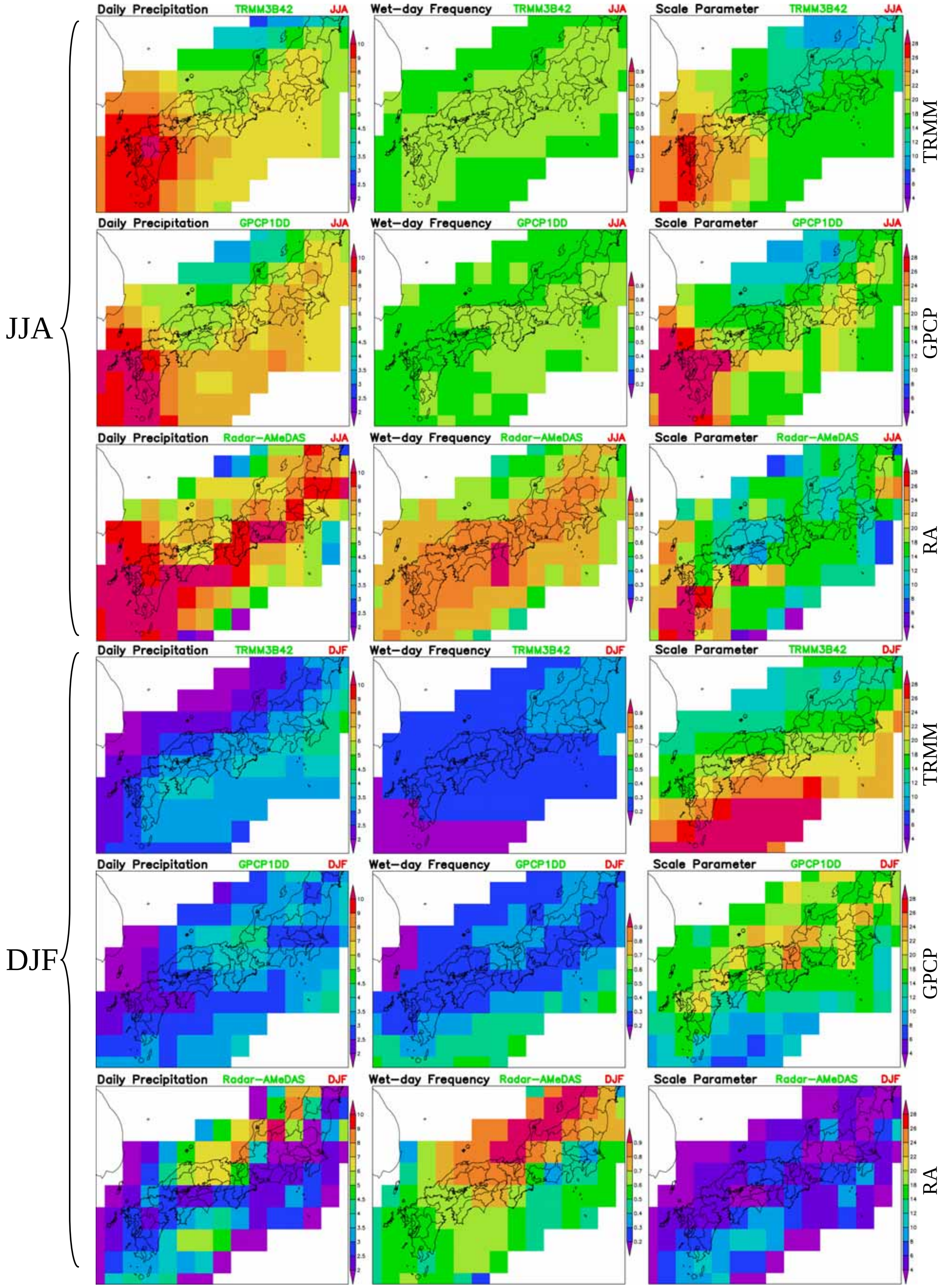

Fig4: daily precipitation (left), wet-day frequency (middle), scale parameter (right) on Japan domain