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Comparing the version 7 TRMM 3B43 monthly precipitation product with the TRMM 3B43 version 6/6A and Bureau of Meteorology datasets for Australia

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Recently, Fleming et al. (2011) compared the Tropical Rainfall Measuring Mission (TRMM) 3B43 (version 6/6A) monthly product with the Australian Bureau of Meteorology (the Bureau) monthly gridded dataset for the period 1998 to 2010. They found that the two datasets generally show a strong spatial and temporal agreement with each other. Since then, a new release (version 7) of the TRMM 3B43 product has been made available. This note briefly compares the 3B43 versions 6/6A and 7 (3B43 v6/6A and v7, respectively) products to that provided by the Bureau within the context of the previous work of Fleming et al. (2011). It is found that 3B43 v7 displays an improved correlation with the Bureau dataset compared to 3B43 v6/6A, with a cross correlation for the entire time series of 0.970 for 3B43 v7 versus the Bureau, compared to 0.932 for 3B43 v6/6A versus the Bureau. This improvement is especially noticeable for several months (October 2006, January 2007, and October 2008) where 3B43 v6/6A showed a relatively poor correlation with the Bureau dataset. However, the generally decreased correlation and increased scatter between 3B43 v6/6A and the Bureau after 2004 was also noted with 3B43 v7, although not as strongly, with a cross correlation for the period 1998 to 2003 of 0.947 and 0.976 for 3B43 v6/6A and v7 versus the Bureau, respectively, while 0.919 and 0.965 are the corresponding values for the period between 2004 and 2010. The reason for the improvement in the results is beyond the scope of this work, but there were several modifications to the 3B43 processing, including the improved treatment of the rain gauge input. We therefore recommend that workers employing this TRMM product change to the latest version for their studies.

Introduction

In a recent study, Fleming et al. (2011) (henceforth F2011) analysed how the Tropical Rainfall Measuring Mission (TRMM) and *TRMM Other Data Precipitation Data Set*[1], version 6/6A 3B43 (e.g. Kummerow 2000, Huffman et al. 2007) monthly precipitation dataset compared with the monthly gridded rainfall provided by the Australian Bureau of Meteorology (the Bureau) for Australia (Jones et al. 2009). They found that when examined over the whole continent, for areas with ground-based observations (i.e. rain gauges), the correlation between the Bureau and 3B43 was generally very good, although poorer for those areas without rain gauges, generally corresponding to dryer regions. A high level of correlation was also discerned when the time series of the correlations between the datasets for each month was examined, although the scatter in the correlation values increased from around 2004 onwards, with several specific months (October 2006, January 2007 and October 2008) showing much poorer results (see Figs. 4 and 11, F2011).

[1]When examining the websites providing these data, several variations on this name are given. The one used in this work is stated as being the official one by Huffman and Bolvin (2012).

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Since then, a new release (version 7) of the 3B43 dataset has been made available. It is therefore the purpose of this work to examine briefly how the correlation between the 3B43 and Bureau datasets changed between releases. In the next section, a brief introduction to the 3B43 and Bureau datasets is given, although the reader is referred to F2011 and the cited web sites for more information. The methodology followed here is a simplified version of that used in F2011, with only the cross correlation between the full continental datasets being assessed, without considering only those areas with adequate rain gauge coverage, nor the differences that arise when considering possible seasonal, or climate-zone dependencies, as was done in F2011.

Comparison between datasets

The TRMM and Other Data Precipitation Data Set 3B43 product provides monthly rainfall (average hourly rate) between latitudes 50ºN/50ºS over a 0.25º × 0.25º grid. Some details about how versions 6/6A and 7 (henceforth referred to as 3B43 v6/6A and 3B43 v7) differ are outlined in Huffman and Bolvin (2012). The changes in processing include the use of additional satellites and a superior means of incorporating rain gauge information from the Global Precipitation Climatology Centre[2]. The Bureau dataset is a sequence of total monthly rainfall grids derived from rain gauge observations, originally provided with a 0.05º × 0.05º resolution[3]. As in F2011, these data are converted to the same 0.25º × 0.25º grid as the TRMM 3B43 time series.

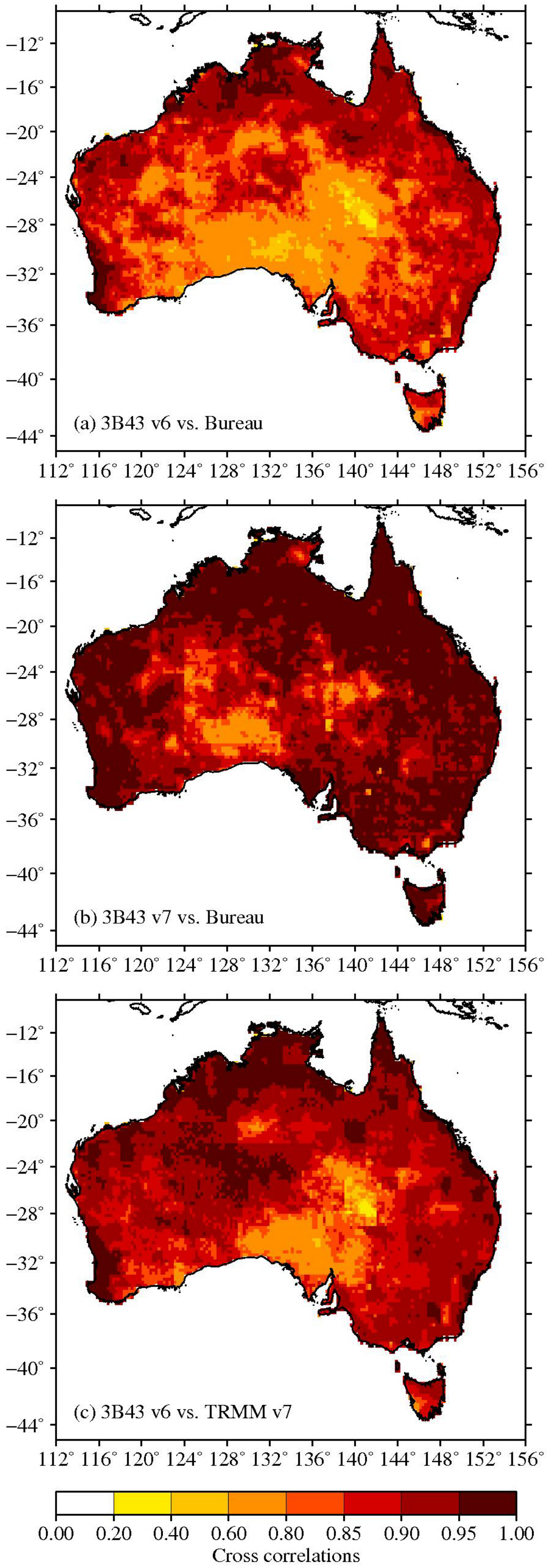
The primary means of analysis is to determine the cross correlation between the datasets, given by

$$R = \frac{\sum_{t=1}^{n}\left[\left(x(t)-\bar{x}\right)\left(y(t)-\bar{y}\right)\right]}{\sqrt{\sum_{t=1}^{n}\left(x(t)-\bar{x}\right)^2}\sqrt{\sum_{t=1}^{n}\left(y(t)-\bar{y}\right)^2}}$$

where x and y are the datasets being compared, with averages of $\bar{x}$ and $\bar{y}$, respectively, and n is the number of data points. The correlations are found for three situations; (i) spatially, where the cross correlation is found between the time series for each grid point, (ii) temporally, where the cross correlations is found for the entire continent for each month, and (iii) considering all data together (to give a single value). We present three series of comparisons: (i) 3B43 v6/6A versus the Bureau, (ii) 3B43 v7 versus the Bureau, and (iii) 3B43 v6/6A versus v7, over the same time period (January 1998 to December 2010) as in F2011. Since the v6/6A processing ceased in June 2011 (Huffman and Bolvin 2012), we excluded 2011 from our analyses.

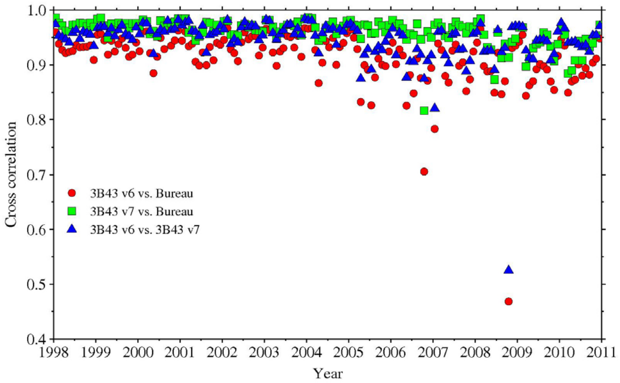
The first series of comparisons are shown in Fig. 1, where we present (a) the cross correlation over the Australian continent for the full time series between 3B43 v6/6A and the Bureau dataset (as done in F2011), (b) the same, but for 3B43 v7 and the Bureau, and (c) between 3B43 v6/6A

Fig. 1. The cross correlation over the Australian continent for the full time series (1998 to 2010) between (a) 3B43 v6 and the Bureau (as done in Fleming et al. 2011), (b) 3B43 v7 and the Bureau, and (c) between 3B43 v6/6A and v7.



[2]gpcc.dwd.de
[3]www.bom.gov.au/jsp/awap/rain/index.jsp

Fig. 2. The cross correlation over the whole Australian continent for each month when comparing 3B43 v6/6A and the Bureau, 3B43 v7 and the Bureau, and 3B43 v6/6A and v7 (see also Table 1).



and v7. As can be see, higher correlation values arise when considering 3B43 v7, although there is still a lower correlation when examining those drier areas with few or no rain gauges (c.f. Fig. 1, F2011). The overall cross correlation, when considering the complete dataset, is 0.970 for 3B43 v7 verses the Bureau, compared to 0.932 for 3B43 v6/6A. When comparing 3B43 v6/6A with v7, we obtain an overall cross correlation of 0.958.

How the cross correlation varies over time is presented in Fig. 2. The better correlation between 3B43 v7 and the Bureau compared to that for 3B43 v6/6A and the Bureau is again immediately apparent. However, as in F2011, there does seem to be an increase in the scatter of the R values starting from 2004, although it is much less pronounced when considering 3B43 v7 that v6/6A. This is illustrated further in Table 1, which shows the correlation for the three series of

Fig. 3. Examples of how the 3B43 v7 product is improved relative to 3B43 v6/6A, using examples that displayed poorer cross correlations with the Bureau dataset in Fleming et al. (2011). (a–c) October 2006, (d–f) January 2007, (g–i) October 2008, (a,d,g) 3B43 v6/6A, (b,e,h) 3B43 v7. (c,f,i) the Bureau.

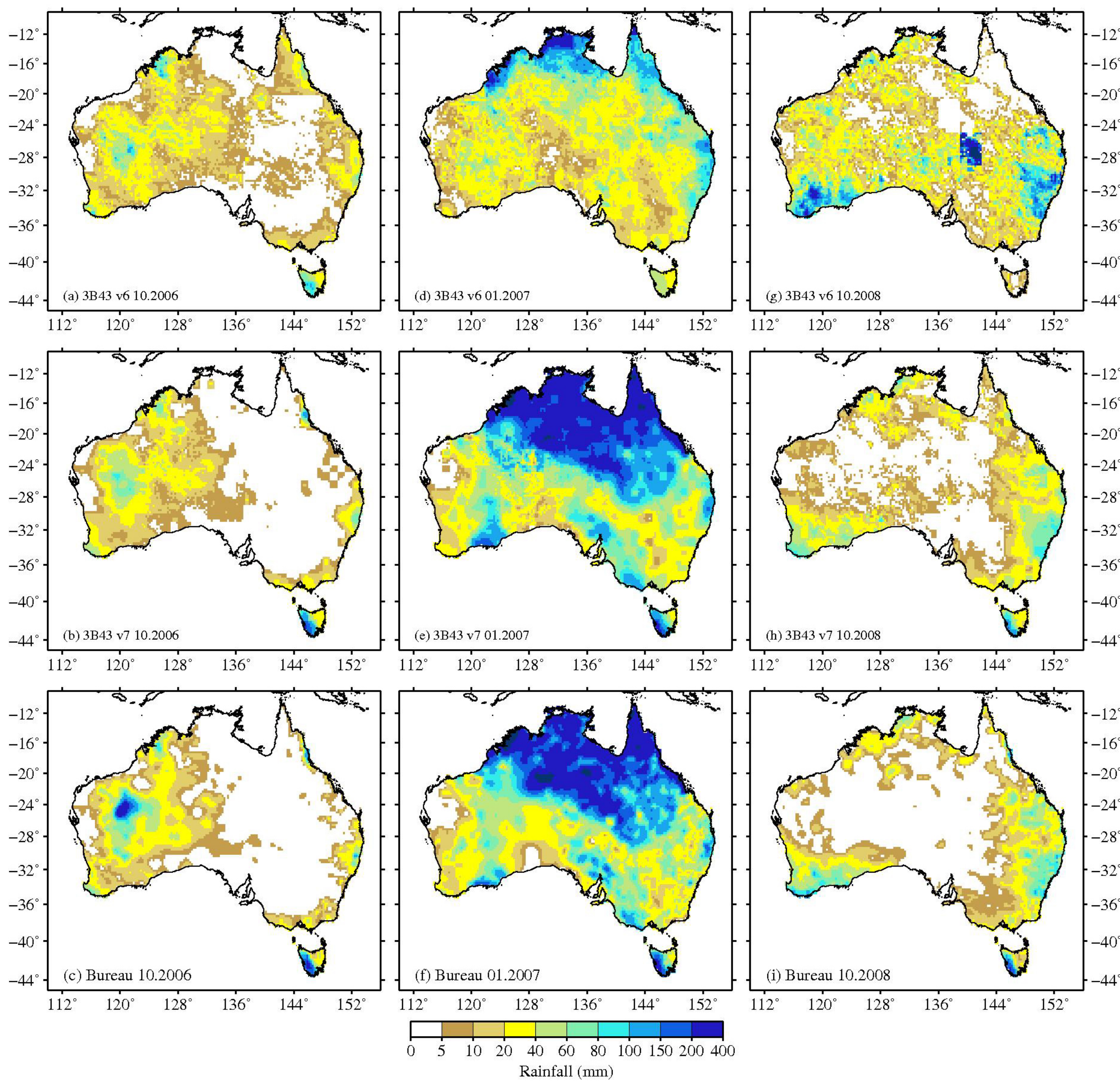


Table 1. The resulting cross correlation values when considering the full time series and the series divided into two segments representing when the correlations appeared to experience increased scatter. The values in brackets are the averages and standard deviations found from the individual months for each time series.

	January 1998–December 2010	*January 1998–December 2003*	*January 2004–December 2010*
3B43 v6/6A versus the Bureau	0.932 (0.913 ± 0.052)	0.947 (0.935 ± 0.019)	0.919 (0.894 ± 0.063)
3B43 v7 versus the Bureau	0.970 (0.960 ± 0.024)	0.976 (0.970 ± 0.010)	0.965 (0.952 ± 0.029)
3B43 v6/6A versus v7	0.958 (0.946 ±0.043)	0.969 (0.961 ± 0.013)	0.948 (0.933 ± 0.053)

comparisons for the complete time series, from January 1998 to December 2003, and January 2004 to December 2010. We also list the average values for each period found from the monthly values and their standard deviation (in brackets) to illustrate the decreased scatter when going from 3B43 v6/6A to v7, but the increased scatter between the two time periods.

Lastly, Fig. 3 presents the rainfall over Australia for three months where the cross correlations between 3B43 v6/6A and the Bureau were noticeably poorer (see also Fig. 2), namely October 2006 (a–c), January 2007 (d–f) and October 2008 (g–i). For October 2006, 3B43 v6/6A shows rainfall covering a much greater area than that indicated by the Bureau, a situation remedied by the 3B43 v7 results, leading to an improvement in the cross correlation from 0.705 to 0.816. However, neither 3B43 release shows the higher rainfall patch indicated in the west of the continent at around 25ºS/121ºE by the Bureau's data. By contrast, the Bureau's January 2007 grid shows a large expanse of rainfall not present in the 3B43 v6/6A dataset in the north of the continent which is, however, shown by 3B43 v7, with a corresponding increase in the cross correlation from 0.783 to 0.973. Finally, October 2008 shows a very great change when comparing the 3B43 v6/6A and v7 releases. What is especially obvious is the anomalous area of rainfall near the centre of the continent at around 27ºS/141ºE in the 3B43 v6/6A grid, but not in the Bureau data, and now not present in 3B43 v7, the corresponding improvement in the correlation of the rainfall pattern being from 0.468 to 0.914, incidentally also showing (not surprisingly) the poorest correlation between 3B43 v6/6A and v7 (0.525).

Conclusions

This work set out to perform some of the analysis carried out in Fleming et al. (2011), involving the correlation of the TRMM and Other Data Precipitation Data Set 3B43 product with a rain gauge-derived gridded dataset from the Bureau. The new release of 3B43, version 7, is found to better correlate with the Bureau dataset, both spatially and over time, while appearing to improve upon several months (October 2006, January 2007, and October 2008) of the 3B43 product that were less correlated with the Bureau dataset in F2011. The exact reasons for the improvement in the cross correlation is beyond the scope of this work, but there were a number of modifications to the 3B43 processing as noted above, for example, the improved treatment of the rain gauge input. Other modifications may have remedied problems associated with inland water bodies, as outlined by, for example, Tian and Peters-Lidard (2007).

We therefore reiterate the conclusion of Fleming et al. (2011) that this TRMM product is an adequate representation of monthly rainfall over Australia, especially for those areas with rain gauges, while also believed to provide accurate rainfall estimates for less densely instrumented areas. The increased scatter in the cross correlations from 2004 still exists and again, no explanation is offered, although it is much reduced relative to 3B43 v6/6A. We therefore recommend that workers employing the 3B43 product should update their studies to the latest release.

Acknowledgments

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- TRMM 3B43 product:
  Goddard Earth Sciences Data and Information Services Center (disc.sci.gsfc.nasa.gov/gesNews/trmm_v7_multisat_precip)
- Bureau monthly gridded data:
  Bureau of Meteorology, Climate data online (www.bom.gov.au/jsp/ncc/climate_averages/rainfall)

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