Evaluation of TMPA 3B42 Daily Precipitation Estimates of Tropical Cyclone Rainfall over the Pacific and Australia region

Yingjun Chen [α], Elizabeth Ebert [β], Kevin Walsh [γ] and Noel Davidson [δ]

[α] School of Earth Sciences, University of Melbourne, Australia, email: yingjc@student.unimelb.edu.au
[β,δ] The Centre for Australian Weather and Climate Research (CAWCR), Bureau of Meteorology, Australia
[γ] School of Earth Sciences, University of Melbourne, Australia

CAWCR www.cawcr.gov.au

THE UNIVERSITY OF MELBOURNE

Introduction

This study evaluates the Tropical Rainfall Measuring Mission (TRMM) Multi-satellite Precipitation Analysis (TMPA) 3B42 version 7 (V7) estimates of daily rainfall in tropical cyclones (TCs) over the Pacific and Australia region.

Over the Pacific, the Comprehensive Pacific Rainfall Database (PACRAIN) of 24h rain gauge observations is utilized as reference data. The evaluation is performed on two different terrain types: low-lying atoll sites (assumed to represent open-ocean conditions) and coastal and island sites (over land).

The evaluation is also performed over Australia region using a high quality gauge-based gridded rainfall product from the Australian Water Availability Project (AWAP).

TMPA 3B42

The TMPA 3B42 (V7) 3-hourly, 0.25° × 0.25° product is evaluated in this study. The 3-hourly estimates are produced in three stages: 1) the microwave rainfall estimates are combined, 2) infrared (IR) rainfall estimates are created with microwave calibration, and 3) the microwave and IR estimates are then combined [1]. In this study 3-hourly data will be converted into 24 hour rain rate to correspond to the PACRAIN/AWAP daily accumulation period.

PACRAIN

The Comprehensive Pacific Rainfall Database (PACRAIN) contains daily and monthly precipitation records from the tropical Pacific basin. Data have been collected from hundreds of Pacific island stations, with some monthly records going back as far as the 1800s, and daily records beginning in 1942. The PACRAIN data contains almost 2 million daily observations from 710 sites, which include 151 atolls and 492 non-atoll (coastal and island) sites (Figure 2). More information about the PACRAIN database is given by Greene et al. (2008) [2] and PACRAIN website `http://pacrain.evac.ou.edu/`.

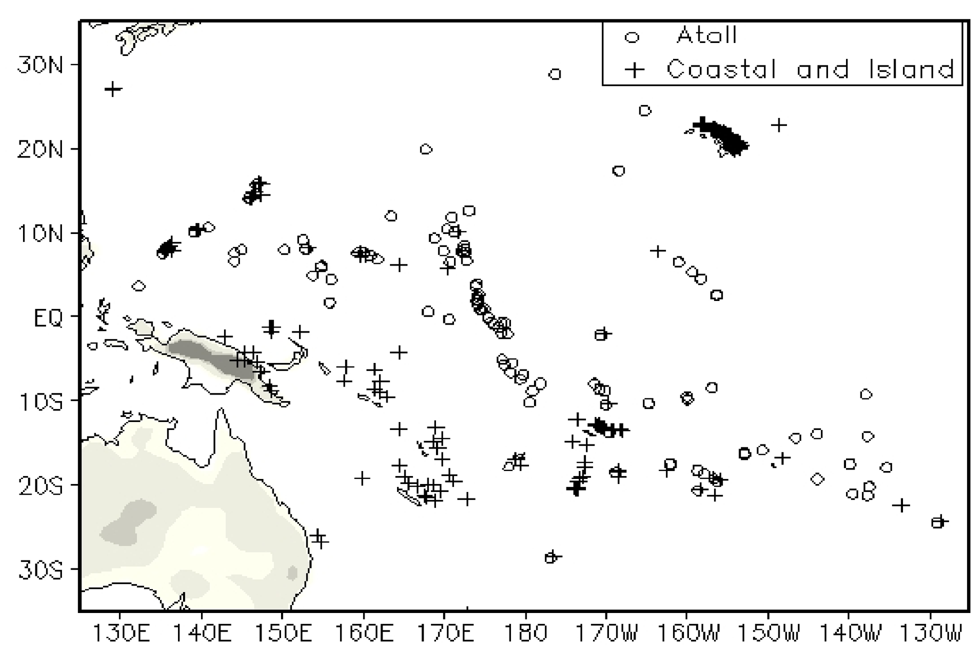

Figure 1 : Locations of PACRAIN atoll sites (circles) and coastal and island sites (crosses).

AWAP

The Australian Water Availability Project (hereafter AWAP) provides a daily high quality 0.05° × 0.05° gridded rainfall product, dating back to 1900, based on an extensive network of rain gauges, as described by Jones et al. (2009) [3]. These grids are derived from rain-gauge data only, recorded at 9am Australian Eastern Standard Time (AEST) for 24hr accumulated rainfall. They are then updated at later dates when more data arrives, since many observation records are still provided in the form of paper-based documentation. It is also during this process that suspect values are confirmed and removed if found to be erroneous. For direct comparison, AWAP grids are here averaged to the same 0.25° × 0.25° resolution as the 3B42.

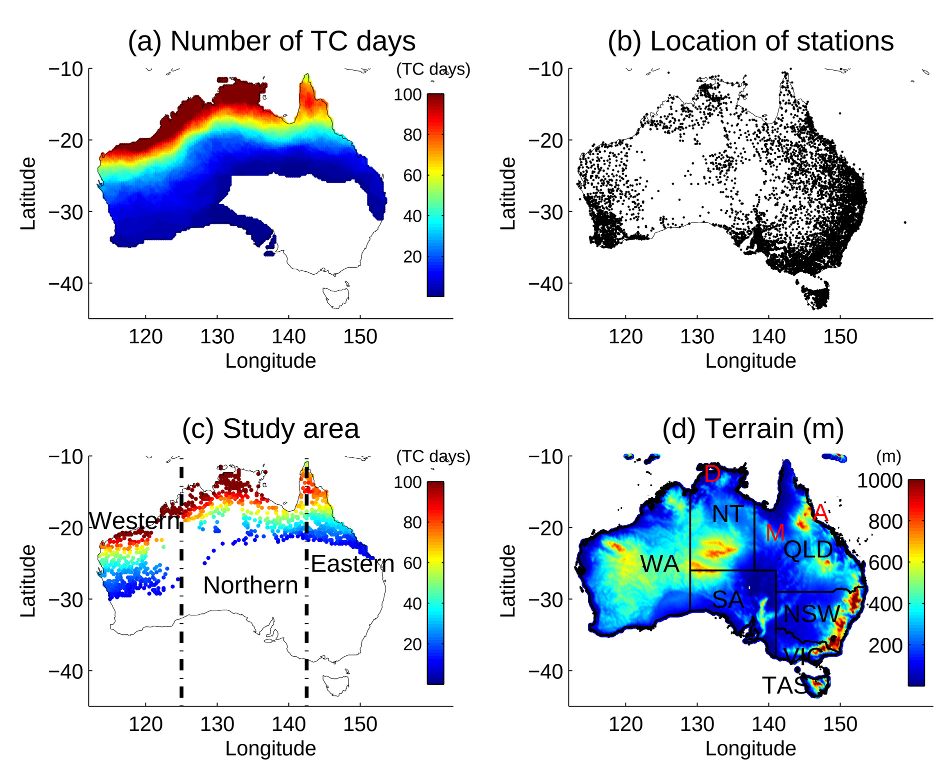

Figure 2 : (a) Number of TC days during period from Jan. 1998 to Dec.2011; (b) location of rain gauge stations; (c) study areas with at least ten TC days and at least one rain gauge station in an AWAP 0.25° box; the color scale indicates number of TC days; (d) Australian terrain, with topographic height indicated in meters.

Over the Pacific : TMPA 3B42 vs. PACRAIN

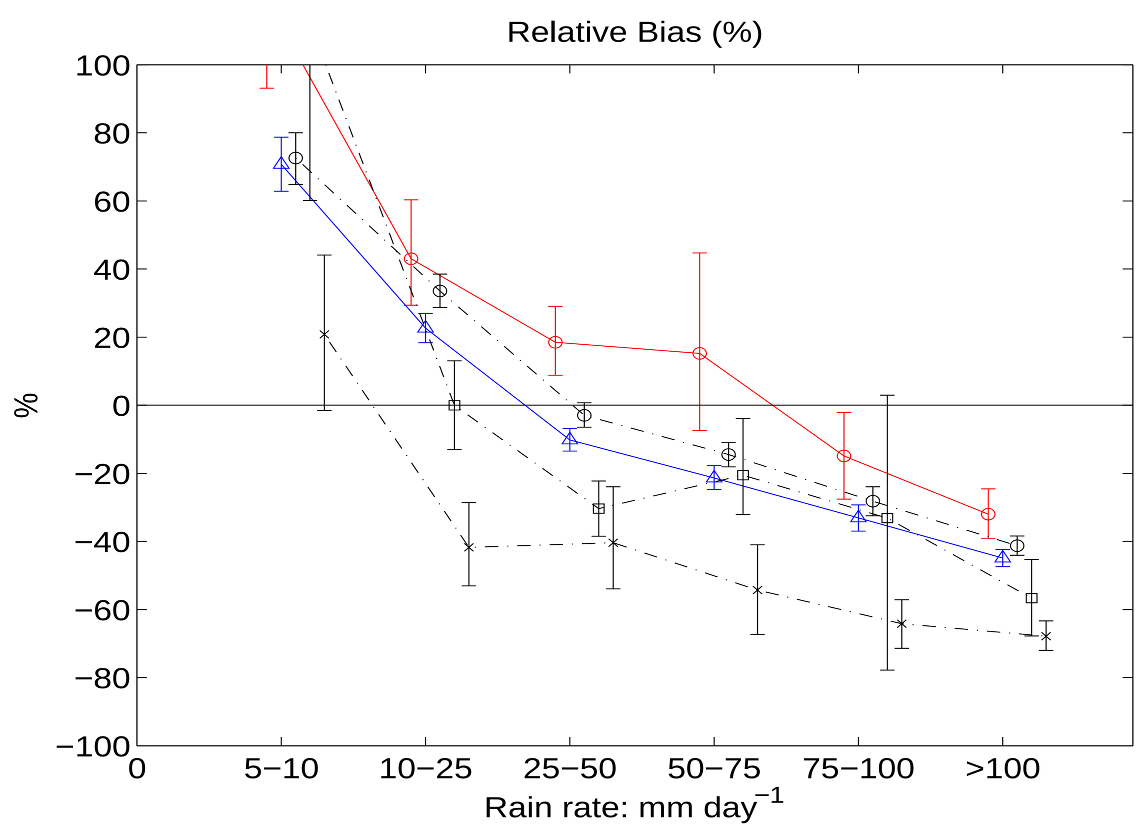

Figure 3 : Relative bias (as percentage of PACRAIN gauge rainfall) as a function of PACRAIN gauge rain on atoll sites (red solid line with open circles), and coastal and island sites (blue solid line with triangles). Coastal and island sites were separated further into three subgroups according to their elevation: elevation <100m (black broken line with open circles), elevation 100-200m (black broken line with open squares), and elevation >200m (black broken line with crosses). The error bars indicate 95% confidence intervals.

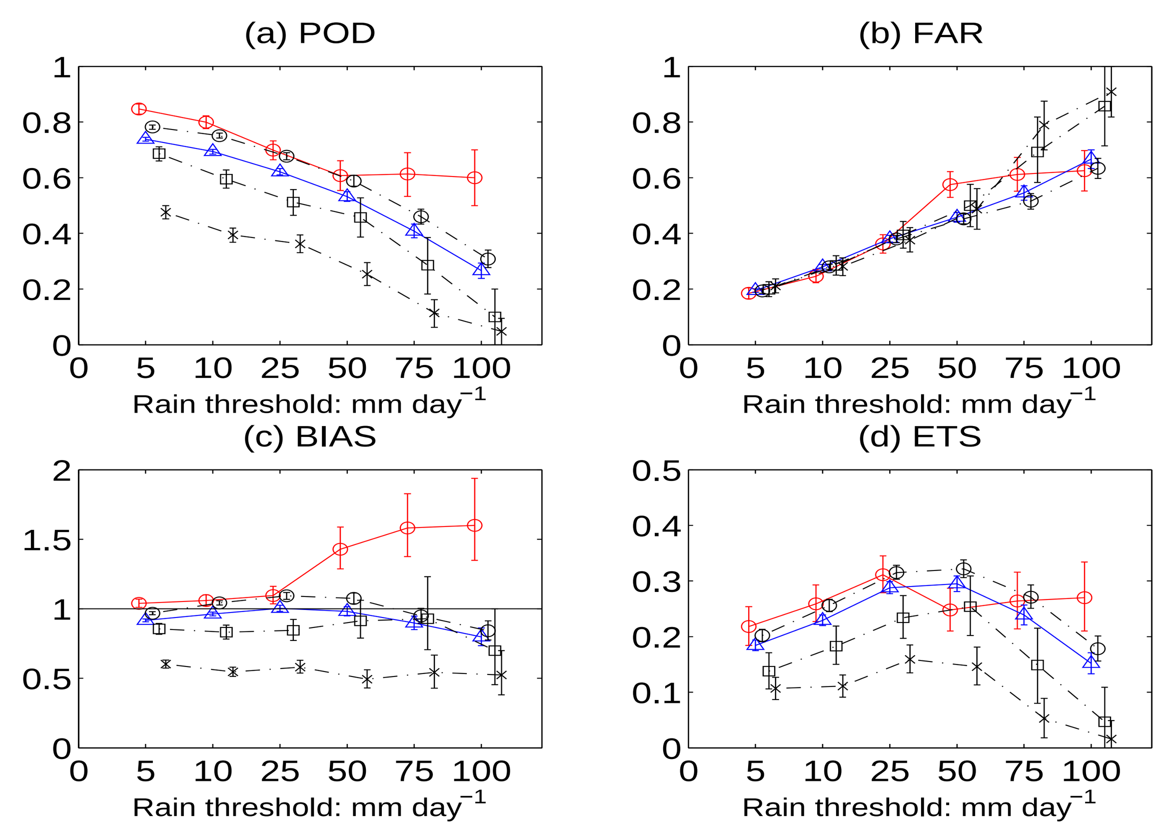

Figure 4 : a) POD, b) FAR, c) FBI, and d) ETS on atoll (red solid line with open circles), and coastal and island sites (blue solid line with triangle), at different rain thresholds. Coastal and island sites were further separated into three subgroups according to their elevation: elevation <100m (black broken line with open circles), elevation 100-200m (black broken line with open squares), and elevation >200m (black broken line with crosses). The error bars indicate 95% confidence intervals.

Over Australia: TMPA 3B42 vs. AWAP

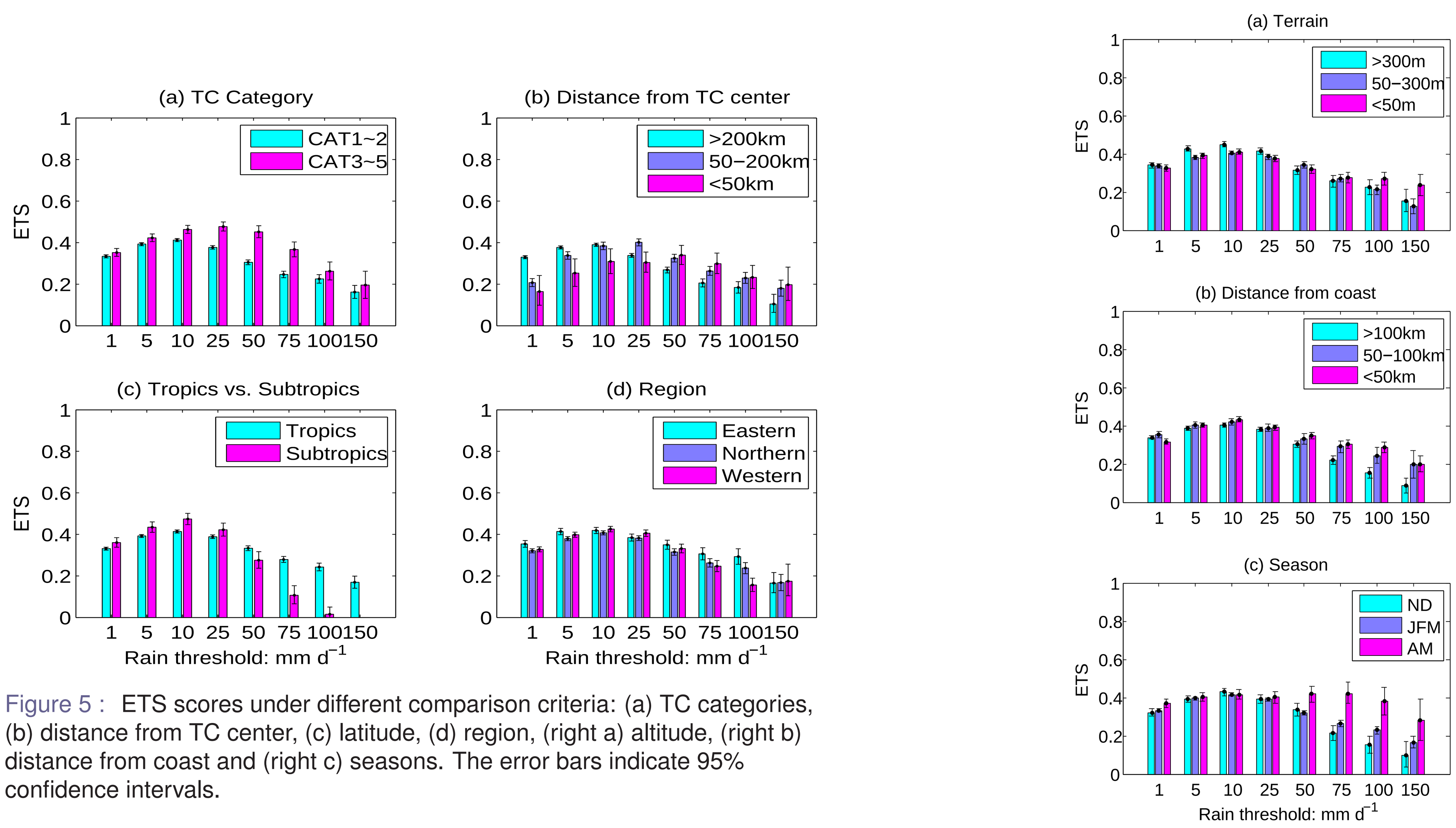

Figure 5 : ETS scores under different comparison criteria: (a) TC categories, (b) distance from TC center, (c) latitude, (d) region, (right a) altitude, (right b) distance from coast and (right c) seasons. The error bars indicate 95% confidence intervals.

Conclusions

- TMPA 3B42 has good skill at detecting intense TC rainfall;
- TMPA 3B42 performs best over the ocean, where it is better able to detect some of the heaviest TC rain events;
- TMPA 3B42 is least skillful at coastal and island sites with high elevation, where it significantly underestimates TC heavy rainfall, suggesting that TMPA 3B42 is unable to capture orographic enhancement during TC landfall.
- TC intensity, distance from TC center, latitudes (tropics vs. sub-tropics), basins, terrain, inland distance and TC seasons all have impacts on 3B42's detection skill, especially for TC heavy rain (thresholds over 50 mm).
- Among these factors, TC intensity, distance from TC center, latitude and TC seasons show the most significant influence on 3B42's heavy rain detection ability. 3B42 showed better agreement with AWAP during more intense TCs (CAT3–5), in locations closer to the TC center (eyewall), in the tropics and in the late TC seasons.

Papers

Chen, Y., E. E. Ebert, K. J. E. Walsh, and N. E. Davidson (2013), Evaluation of TRMM 3B42 precipitation estimates of tropical cyclone rainfall using PACRAIN data, J. Geophys. Res. Atmos., 118, doi:10.1002/jgrd.50250.

Chen, Y., E. E. Ebert, K. J. E. Walsh, and N. E. Davidson (2013), Evaluation of TMPA 3B42 daily precipitation estimates of tropical cyclone rainfall over Australia, J. Geophys. Res. Atmos., 118, doi:10.1002/2013JD020319.

References

[1] Huffman, G.J., R.F. Adler, D.T. Bolvin, G. Gu, E.J. Nelkin, K.P. Bowman, Y. Hong, E.F. Stocker, D.B. Wolff (2007), The TRMM multi-satellite precipitation analysis: quasi-global, multi-year, combined-sensor precipitation estimates at fine scale, *J. Hydrometeor.*, *8*, 38–55, doi: http://dx.doi.org/10.1175/JHM560.1.

[2] Greene, J. S., M. Klatt, M. Morrissey, S. Postawko (2008), The comprehensive pacific rainfall database, *J. Atmos. Oceanic Technol.*, *25*, 71â82, doi: http://dx.doi.org/10.1175/2007JTECHA904.1.

[3] Jones, D. A., W. Wang, R. Fawcett (2009), High-quality spatial climate data-sets for Australia, *Australian Meteorological and Oceanographic Journal*, *58*, 233–248.

Corresponding author: Yingjun Chen, School of Earth Sciences, University of Melbourne, Melbourne, Vic 3010, Australia. Email: yingjc@student.unimelb.edu.au or y.chen@bom.gov.au