

Prediction of extreme rainfall in the tropical Southwest Pacific using a poor man's ensemble

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1: Introduction

Extreme rainfall is a significant weather hazard for the Southwest Pacific Islands, and is a major focus of the WMO Severe Weather Forecasting and Disaster Risk Reduction Demonstration Project (SWFDDP).

The Bureau of Meteorology uses a Poor Man's Ensemble (PME) to generate operational rainfall forecast guidance for Australia. This project trials the PME over the SWFDDP domain (see Figure 1), and compares the PME forecast guidance to guidance from the Bureau of Meteorology's ACCESS-R regional NWP model.

3: Case Study: Tropical Cyclone Vania

Tropical Cyclone Vania formed on January 5 2011, and subsequently passed over Fiji, Vanuatu and New Caledonia before being downgraded to a tropical depression on January 15. Extreme rainfall associated with the cyclone caused flooding in some islands.

The figures show TRMM rainfall observations (Fig. 2), PME forecasts of daily rain (Fig. 3) and probability of rainfall exceeding 100 mm (Fig. 4) for January 12 when the cyclone was near Vanuatu.

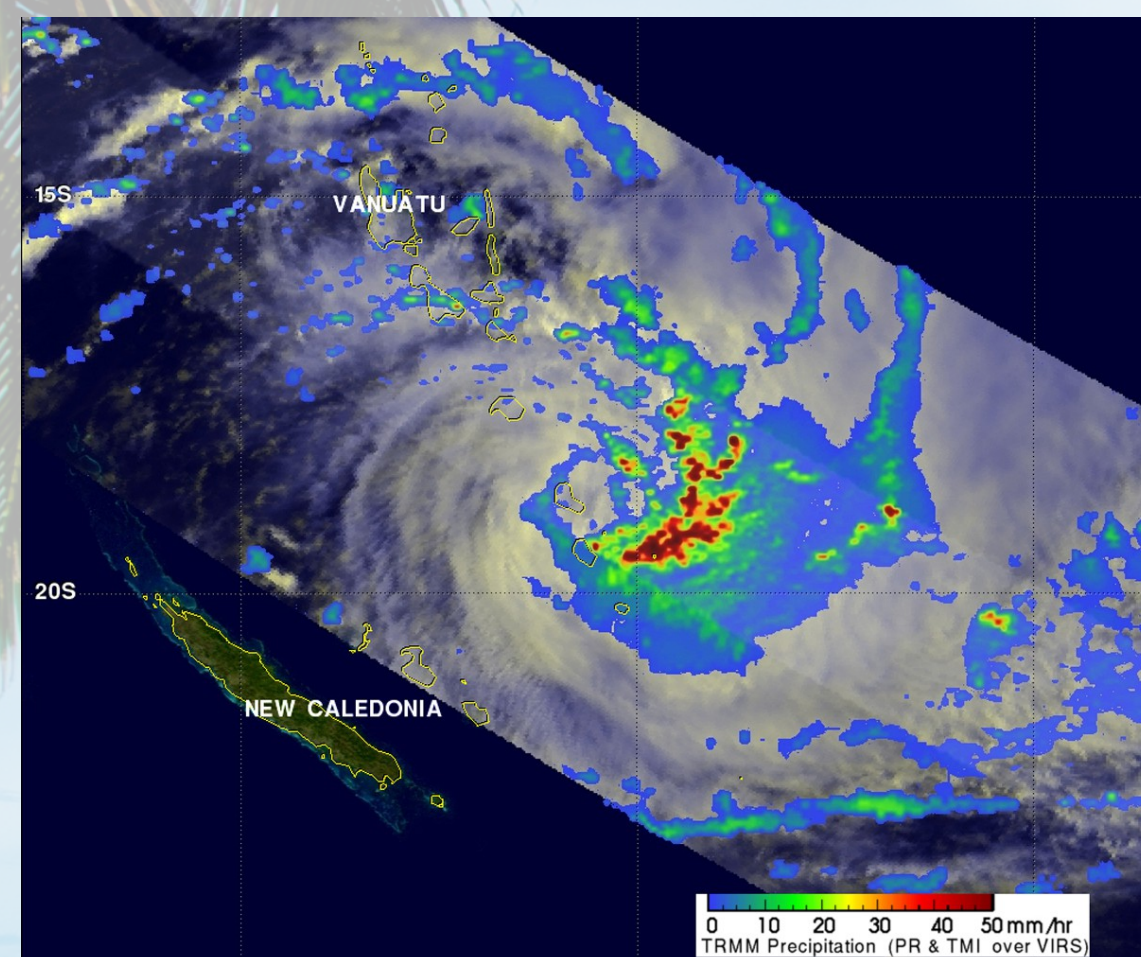


Figure 2: TRMM image of TC Vania: 2011-01-12T04:35Z

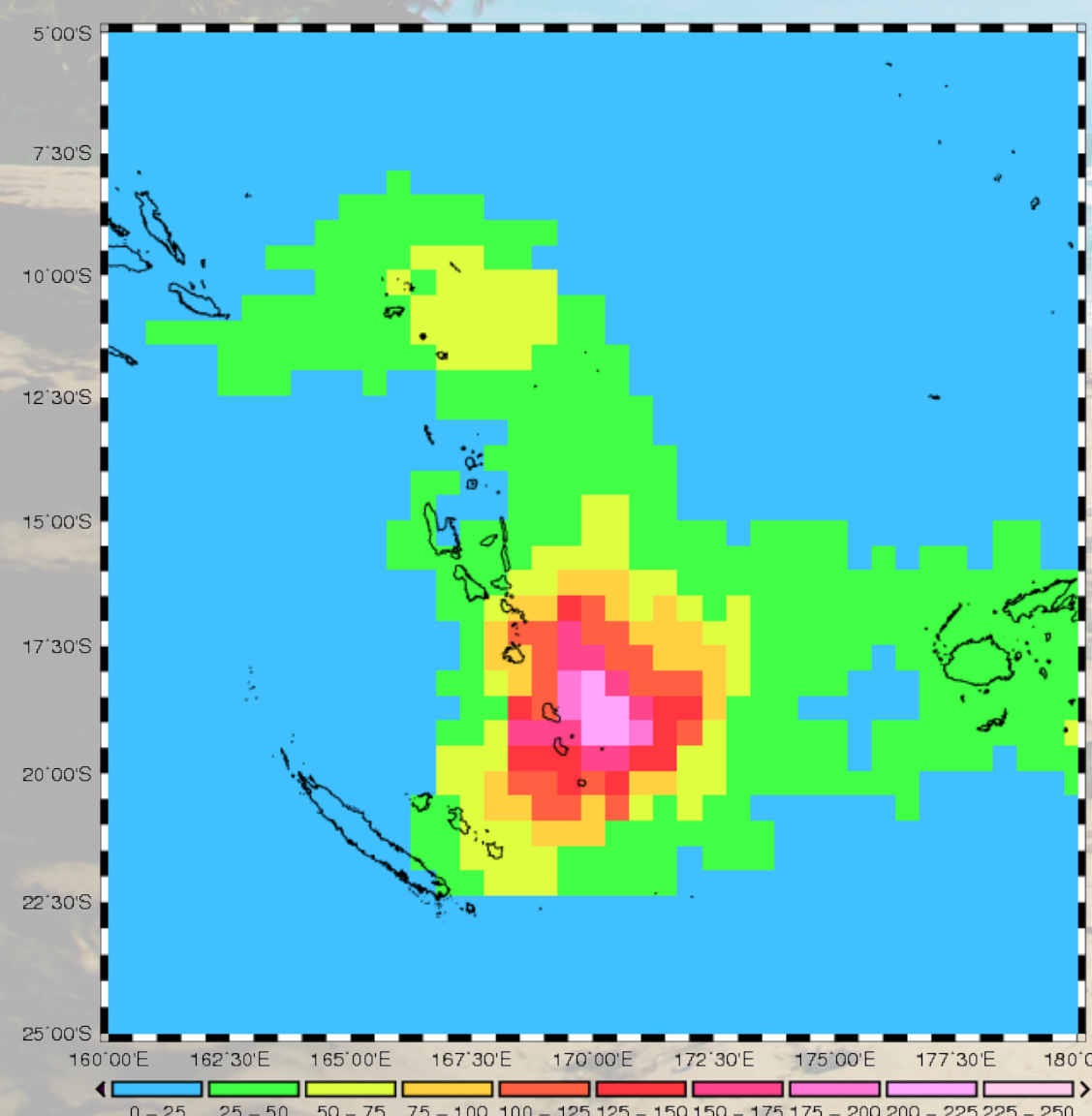


Figure 3: PME 24 h lead time forecast of daily accumulated precipitation over Vanuatu. Valid: 12 January 2011 (units: mm).

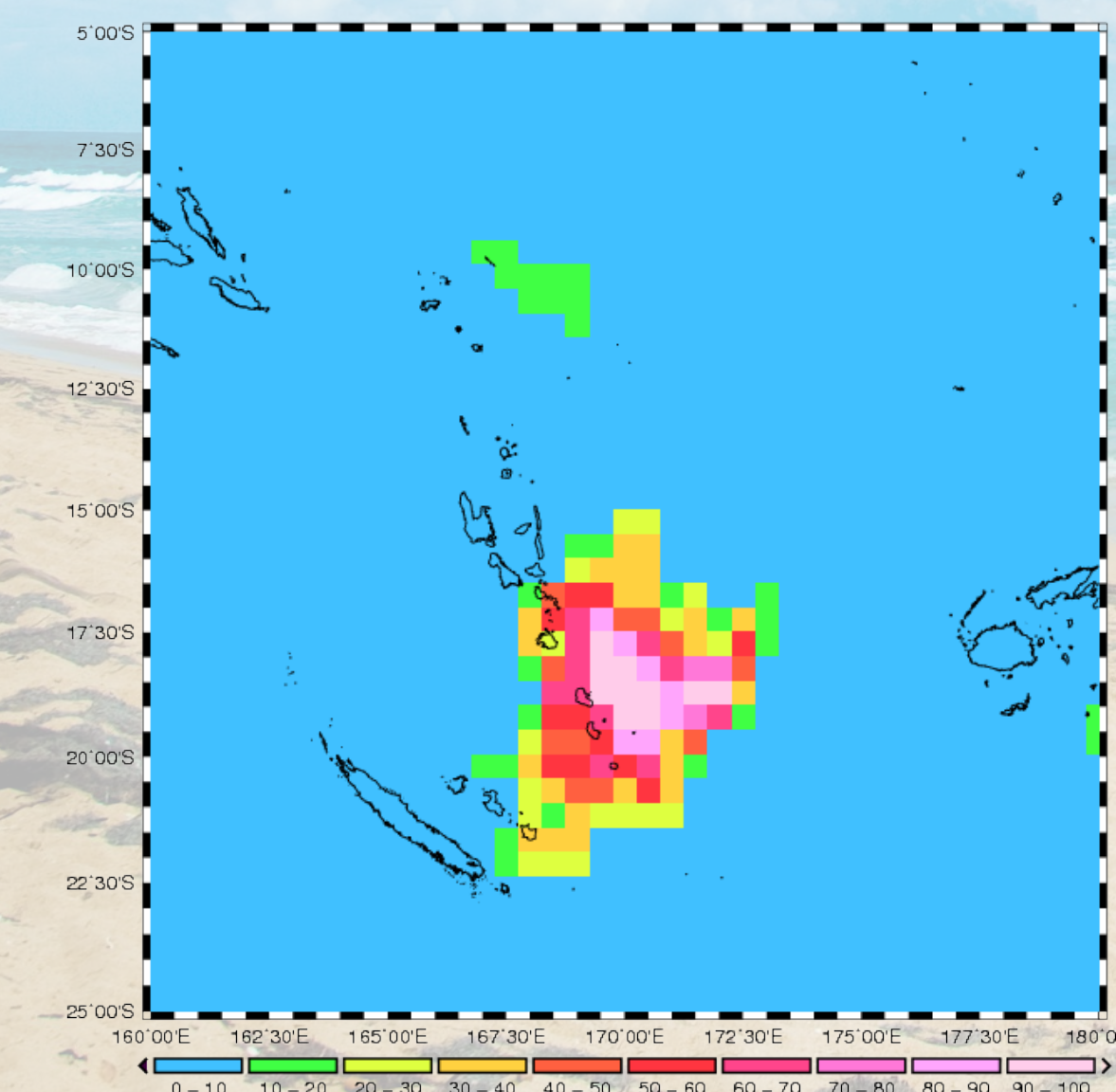


Figure 4: PME 24 h lead time forecast of the probability of precipitation exceeding 100 mm over Vanuatu. Valid: 12 January 2011 (units: %).

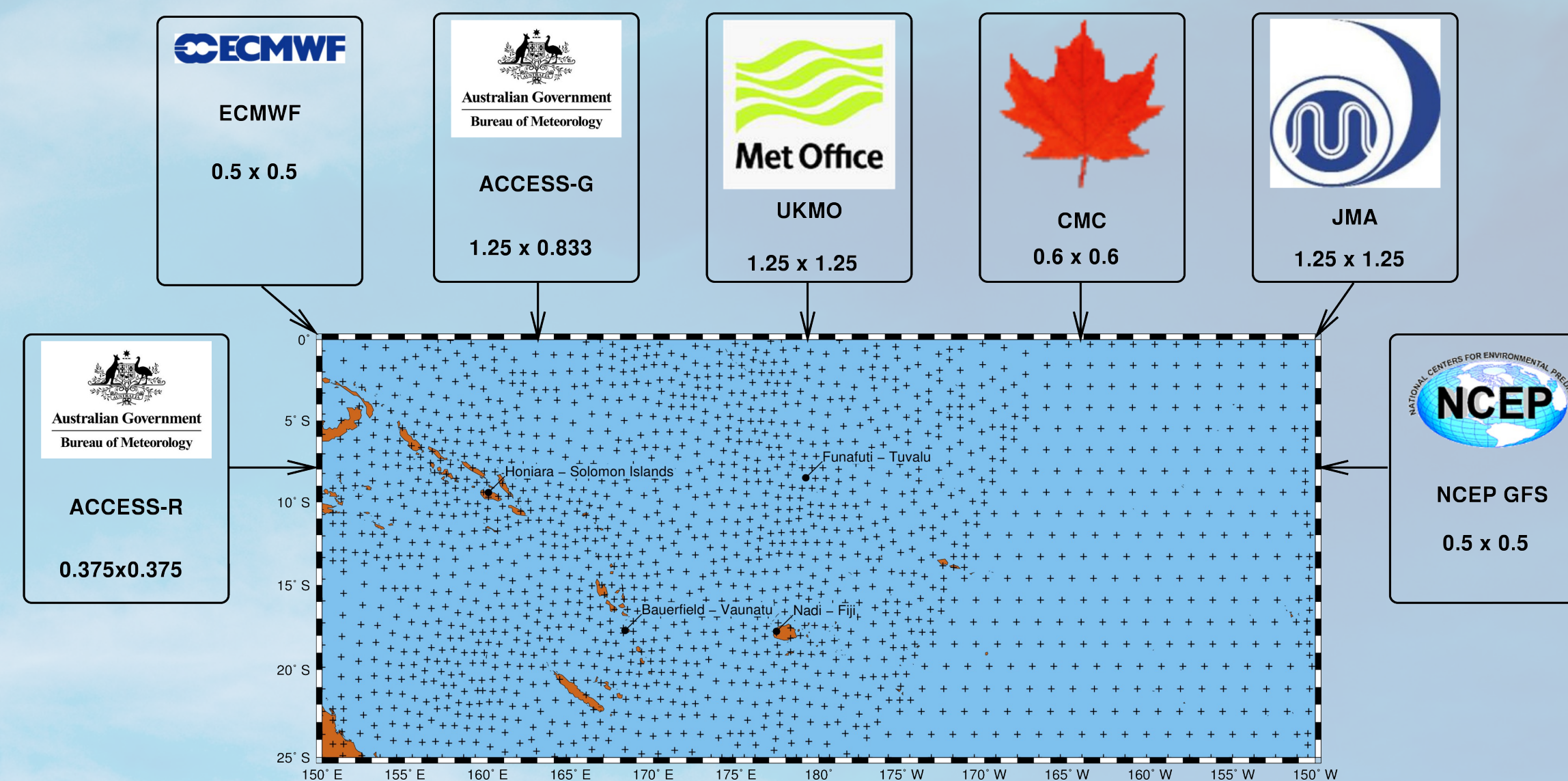


Figure 1: NWP models used in the PME, including the spatial resolution of each model. The crosses on the map show the irregular network of PME "grid points" which the NWP models are interpolated to.

4: Verification

PME daily rainfall forecasts for lead times of 1-5 days between 1 January 2011 and 31 December 2011 inclusive were verified against daily rain gauge observations from four Pacific Islands.

The probability of detection (POD), false alarm ratio (FAR) and equitable threat score (ETS) are commonly used scores for verifying rainfall forecasts. There were not enough extreme rainfall events (> 100 mm/day) during 2011 to compute reliable scores for this threshold. Therefore, the scores have been computed for the lower threshold of 10 mm/day (Figure 5). For comparison, the scores for the ACCESS-R regional NWP model run by the Bureau of Meteorology are also shown.

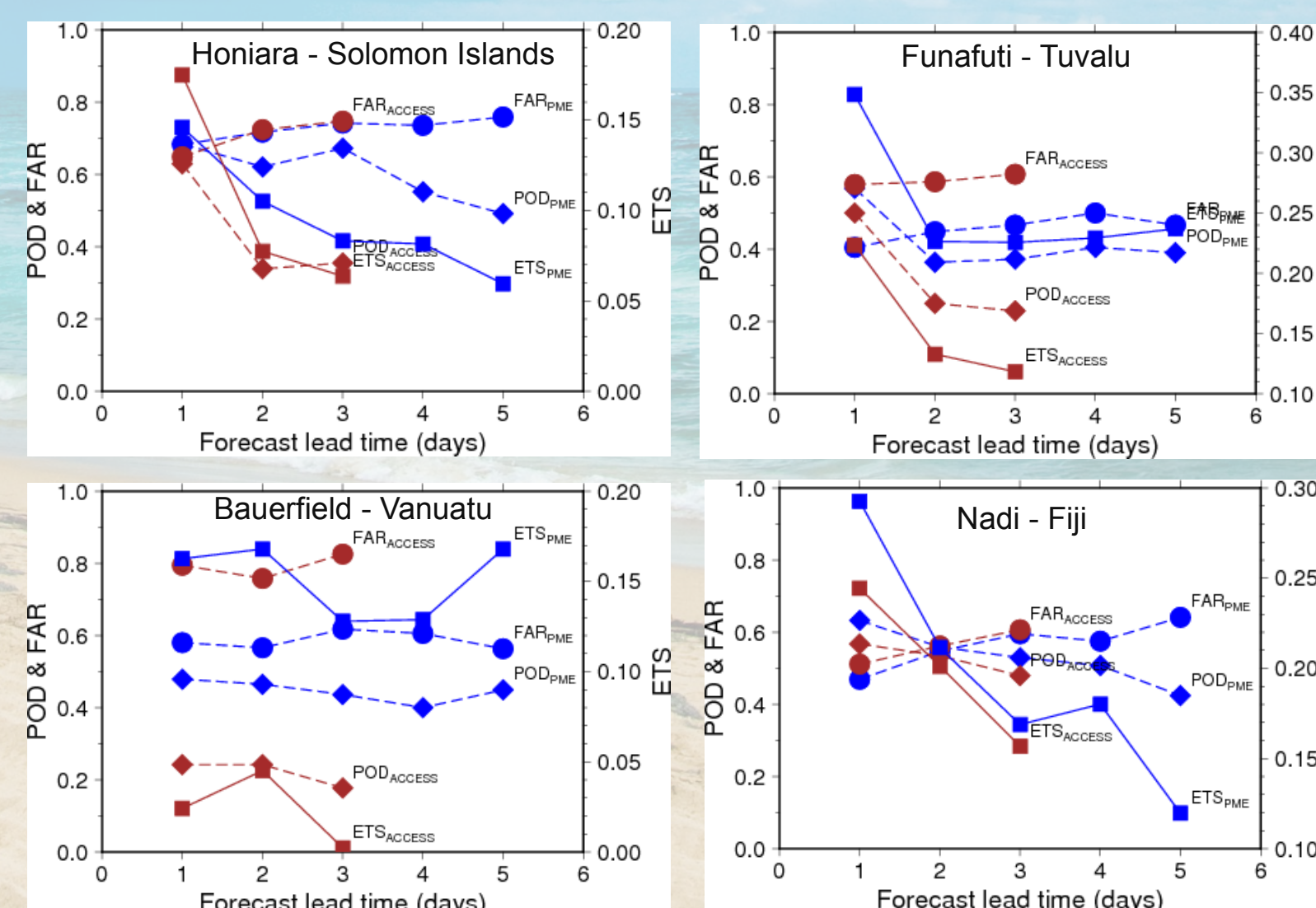


Figure 5: FAR (circles), POD (diamonds) and ETS (squares) for PME (blue) and ACCESS-R (red) 1-5 day forecasts during 2011.

2: Method

The PME produces daily rainfall accumulation forecasts at points throughout the Southwest Pacific by averaging forecasts from 7 regional and global NWP models (see Figure 1). NWP data are interpolated to an irregular network with a higher density near islands of interest, and which also ensures there are points co-located at places where rain gauge observations are available.

Additionally, the PME computes probabilities of daily rainfall exceeding predefined thresholds by counting the proportion of NWP models which forecast rainfall values exceeding the threshold. For the purposes of this project, extreme rainfall is defined as a 24 hour accumulation of 100 mm or more.

5: Summary

- The PME runs are computationally cheap, and the forecast guidance can be easily disseminated to end users as either graphical or numerical products.
- The PME's skill at the four Pacific Islands studied is better than for the ACCESS-R NWP model at all lead times (except day +1 at Honiara)
- False alarm ratios are quite high and probability of detection quite low for both the PME and NWP model, highlighting the difficulty of forecasting tropical rainfall.
- The PME appears to provide good qualitative guidance for the extreme rainfall event in the case study. The probability of detecting extreme rainfall product also shows promise.
- A longer validation period would be useful to enable the PME skill for the relatively rare extreme rainfall events to be evaluated reliably.
- The Bureau of Meteorology's operational PME for the Australian region calibrates the probabilistic rainfall forecasts. Calibration may also be feasible for the Southwest Pacific, but only at the sites where observations are available.

Acknowledgements and References

- Steven Nguyen received funding from the Monash University Talented Science Students program.
- The TRMM image (Figure 2) is courtesy of NASA: http://www.nasa.gov/mission_pages/hurricanes/archives/2011/h2011_Vania.html
- The background image is courtesy of Breezy Baldwin: <https://secure.flickr.com/photos/60202180@N00/5491495660/> and is licensed under the Creative Commons cc-by-2.0 license

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