South Eastern Australian
Climate initiative

Final report for Project 1.4.2

Reanalysis Archive Intercomparison

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Abstract
Reanalysis datasets are global atmospheric datasets created by assimilating observed weather data using state-of-the-art coupled GCMs. There are two datasets commonly used, one created by the National Centers of Environmental Prediction (NCEP) and the National Center for Atmospheric Research (NCAR) in the USA termed 'NCEP/NCAR Reanalysis' (Kalnay *et al.* 1996) and one created by the European Centre for Medium Range Weather Forecasting in Europe termed 'ERA40' (Uppala *et al.* 2005). There has been significant international research effort in quality controlling, assessing and comparing these datasets. The NCEP/NCAR Reanalysis dataset is used for statistical downscaling model calibration in SEACI Project 1.3.4. Here, the ERA40 fields over the SEACI region are extracted for the variables required to produce the predictor series used in the statistical downscaling models. Comparison of the spatial and temporal properties of the NCEP/NCAR and ERA40 predictor series shows a high degree of agreement. Reanalyses predictors thus provide a baseline for atmospheric conditions over the SEACI region that will be compared to predictors from CSIRO climate model historical runs in subsequent SEACI Projects.

Significant research highlights, breakthroughs and snapshots
Overall, it is evident that the two Reanalyses produce predictor series with a high degree of similarity. As well as giving confidence in the use of both these datasets to understand historical SEACI region atmospheric-rainfall linkages, this also provides a baseline to which historically forced climate model predictor series will be evaluated against.

The extracted ERA40 fields have been used to produce NHMM input predictor sets for the calibrated NHMMs selected in Project 1.3.4. Project 1.4.3 '*Comparison of Observed and Reanalyses Downscaled Synoptics and Precipitation*' will statistically downscale these ERA40 predictor series and compare downscaled weather state and rainfall to those obtained by downscaling the NCEP/NCAR reanalysis predictor series previously extracted.

Statement of results, their interpretation, and practical significance against each objective

Objective 1: Extract atmospheric predictors required by statistical downscaling models from available Reanalyses archives (e.g., ERA40).

ERA40 fields for the 6 by 5 grid over the SEACI region (see Project 1.3.4 Report Figure 2) were extracted for 1958 to 2001 (44 years). The fields investigated where selected based on their use in statistical downscaling model calibration in Project 1.3.4.

Objective 2: Compare NCEP/NCAR and ERA40 predictors used by statistical downscaling models.

The distributions and monthly anomalies of the daily NCEP/NCAR and ERA40 Reanalyses fields were compared. Odd numbered Figures 1 to 11 show the monthly ERA40 anomalies (relative to NCEP/NCAR) of the daily atmospheric predictors used. These show monthly differences between the ERA40 and NCEP/NCAR Reanalyses across the region. They are used here for qualitative comparison, to see where the two reanalyses products deviate. Correspondingly, the quantile-quantile plots comparing the distributions of the daily predictor series are shown in even numbered Figures 2 to 12. These plot the percentiles of the cumulative distributions of the two series against each other. A plot with all points on the one-

to-one line indicates that the two datasets have the same distribution. A 'U' shaped plot means that one dataset's distribution is skewed relative to the other, whereas a 'S' shape means that one dataset's distribution has longer tails than the other. The sea level pressure (SLP) and geopotential height (GPH) fields are very similar between the two reanalysis datasets. The moisture related variables, dew-point temperature depression (DT_d) at the 700 and 850 hPa levels, are also similar with the exception that higher values (indicating drier air) are not as frequent in the ERA40 dataset. It is not possible to say which reanalysis dataset, NCEP/NCAR or ERA40, is the more realistic. It is more a case of assessing the effect of these deviations on statistically downscaled rainfall series, which will be undertaken in Project 1.4.3.

Summary of methods and modifications (with reasons)

- Codes for extracting ERA40 atmospheric fields for the variables (predictors) required for statistical downscaling over south-eastern Australia been be developed and tested.
- The extracted ERA40 fields have been compared to the NCEP/NCAR fields. A spatial and temporal multi-variate intercomparison has been undertaken for the predictors over south-eastern Australia that shows good agreement between NCEP/NCAR and ERA40.

Summary of links to other projects

The extraction and assessment of ERA40 statistical downscaling predictors undertaken in this project is a precursor to Project 1.4.3 *Comparison of Observed and Reanalyses Downscaled Synoptics and Precipitation* where the NCEP/NCAR and ERA40 downscaled weather state series will be assessed and compared to observed rainfall trends. Also, the results of this Project will be used in assessing GCM performance in the subsequent Project 1.5.2 '*Extraction of Predictors from Coupled Climate Model Historical Runs*'.

Publications arising from this project

None to date.

Acknowledgement

The archives of both the NCEP/NCAR and ERA40 Reanalysis data are maintained on CSIRO servers by Mark Collier, CMAR. His assistance is gratefully acknowledged.

Recommendations for changes to work plan from your original table

None

References

Kalnay, E., M. Kanamitsu, R. Kistler, W. Collins, D. Deaven, L. Gandin, M. Iredell, S. Saha, G. White, J. Woollen, Y. Zhu, A. Leetmaa, R. Reynolds, M. Chelliah, W. Ebisuzaki, W. Higgins, J. Janowiak, K. C. Mo, C. Ropelewski, J. Wang, R. Jenn, and D. Joseph, 1996: The NCEP/NCAR 40-year reanalysis project, *Bulletin of the American Meteorological Society*, **77**, 437-471.

Uppala, S.M., Kållberg, P.W., Simmons, A.J., Andrae, U., da Costa Bechtold, V., Fiorino, M., Gibson, J.K., Haseler, J., Hernandez, A., Kelly, G.A., Li, X., Onogi, K., Saarinen, S., Sokka, N., Allan, R.P., Andersson, E., Arpe, K., Balmaseda, M.A., Beljaars, A.C.M., van de Berg, L., Bidlot, J., Bormann, N., Caires, S., Chevallier, F., Dethof, A., Dragosavac, M., Fisher, M., Fuentes, M., Hagemann, S., Hólm, E., Hoskins, B.J., Isaksen, L., Janssen, P.A.E.M., Jenne, R., McNally, A.P., Mahfouf, J.-F., Morcrette, J.-J., Rayner, N.A., Saunders, R.W., Simon, P., Sterl, A., Trenberth, K.E., Untch, A., Vasiljevic, D., Viterbo,

P., and Woollen, J. 2005: The ERA-40 re-analysis. *Quart. J. R. Meteorol. Soc.*, 131, 2961-3012.doi:10.1256/qj.04.176

Project Milestone Reporting Table

To be completed prior to commencing the project				Completed at each Milestone date	
Milestone description[1] (brief) (up to 33% of project activity)	Performance indicators[2] (1- 3 dot points)	Completion date[3] xx/xx/xxxx	Budget[4] for Milestone ($) (SEACI contribution)	Progress[5] (1- 3 dot points)	Recommended changes to workplan[6] (1- 3 dot points)
1. Develop and test codes to extract required predictors from ERA40	Codes working. Fields extracted over south-east Australian region.	1/5/2007	10K	Completed.	None.
2. Compare ERA40 extracted fields to previously extracted NCEP/NCAR fields	Fields compared. Report on comparison (3-5 pages).	30/6/2007	5	Completed. This report is the report on comparison of NNR and ERA40 predictor fields.	None.
3. Extract ERA40 fields for south-east Australian region in format required for NHMM	NHMM input files created.	30/6/2007	5	Completed.	None.

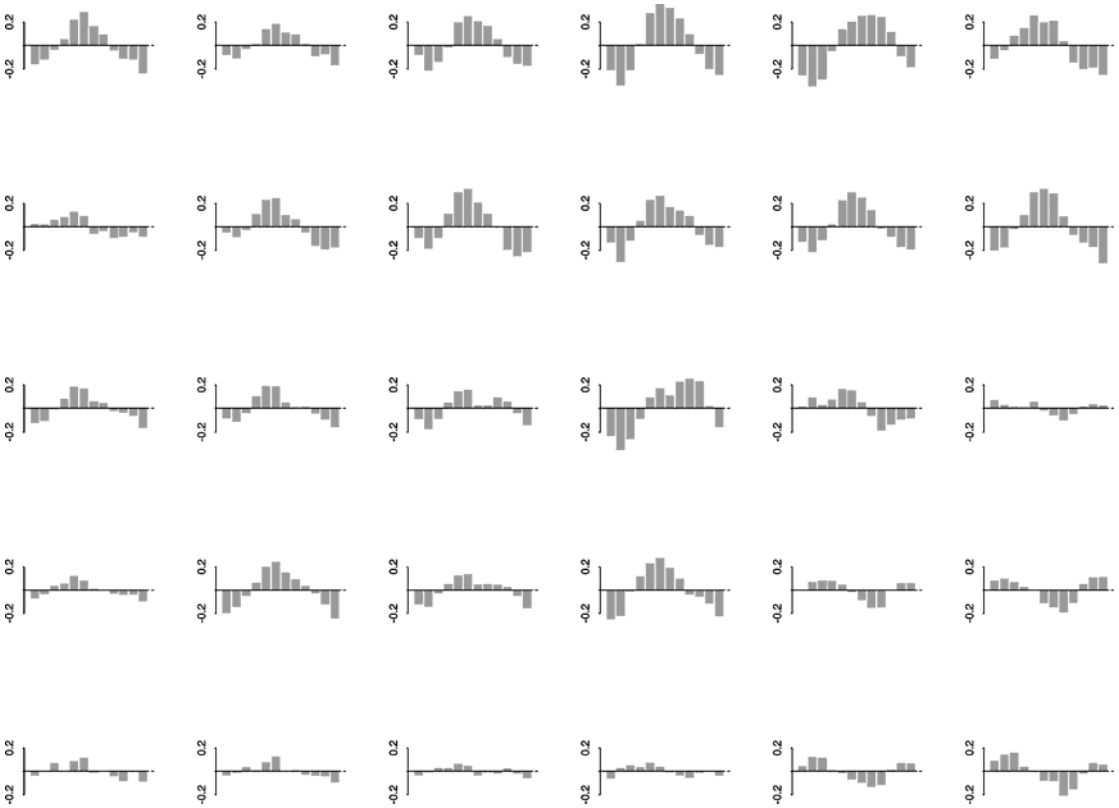

Figure 1. Monthly anomalies of ERA40 SLP (hPa), relative to NCEP/NCAR, for the 6 by 5 grid over south east Australia.

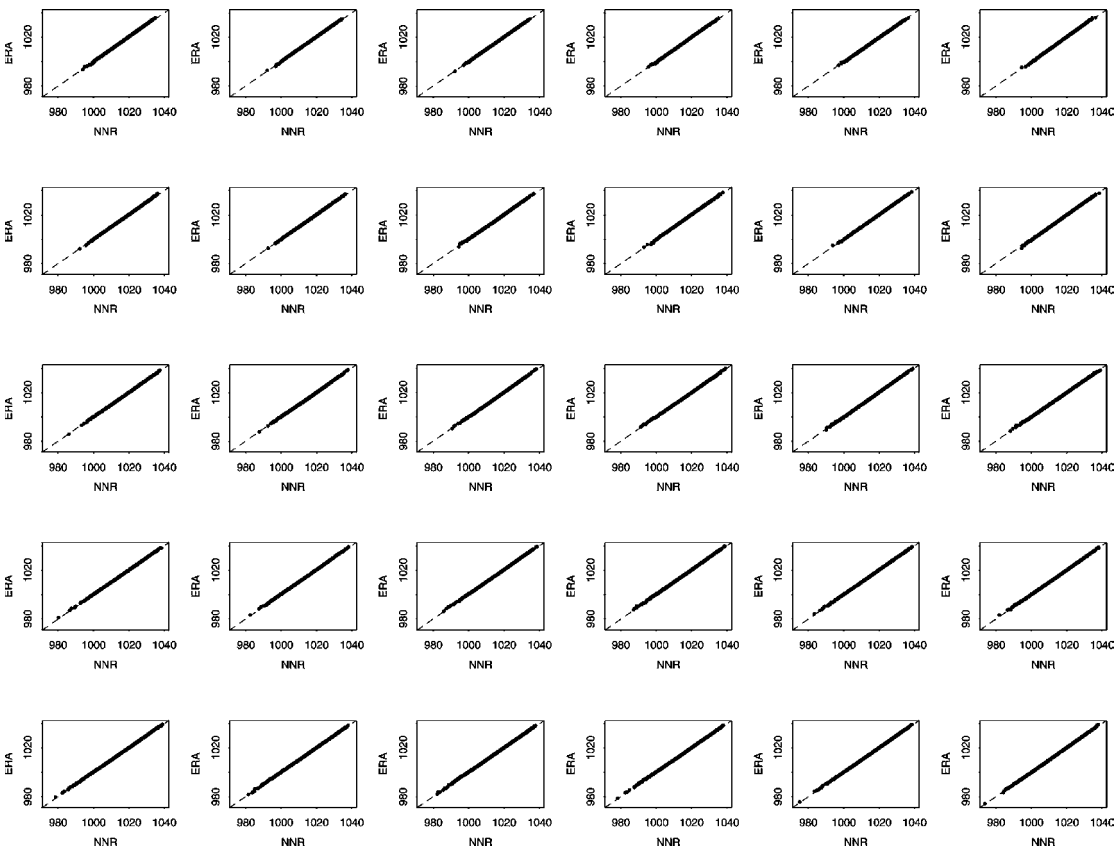

Figure 2. Distribution of daily NCEP/NCAR versus ERA40 SLP (hPa) for the 6 by 5 grid over south east Australia.

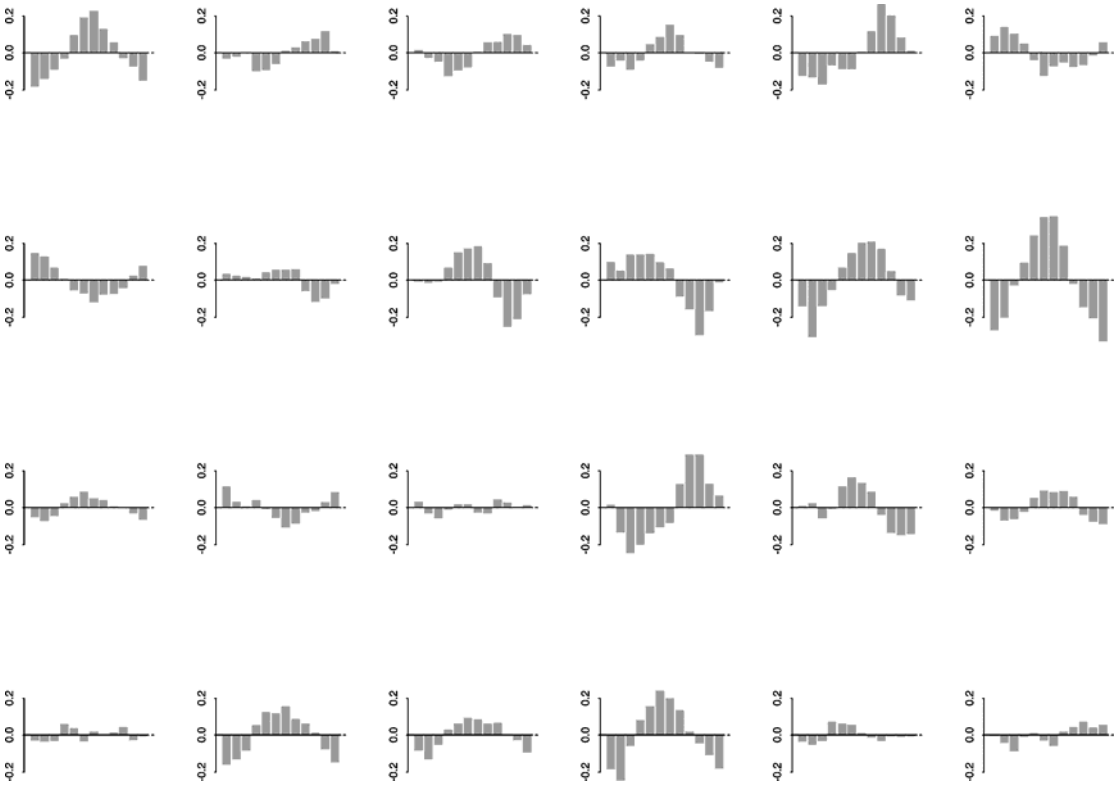

Figure 3. Monthly anomalies of ERA40 North-South SLP gradient (hPa), relative to NCEP/NCAR, for the 6 by 5 grid over south east Australia.

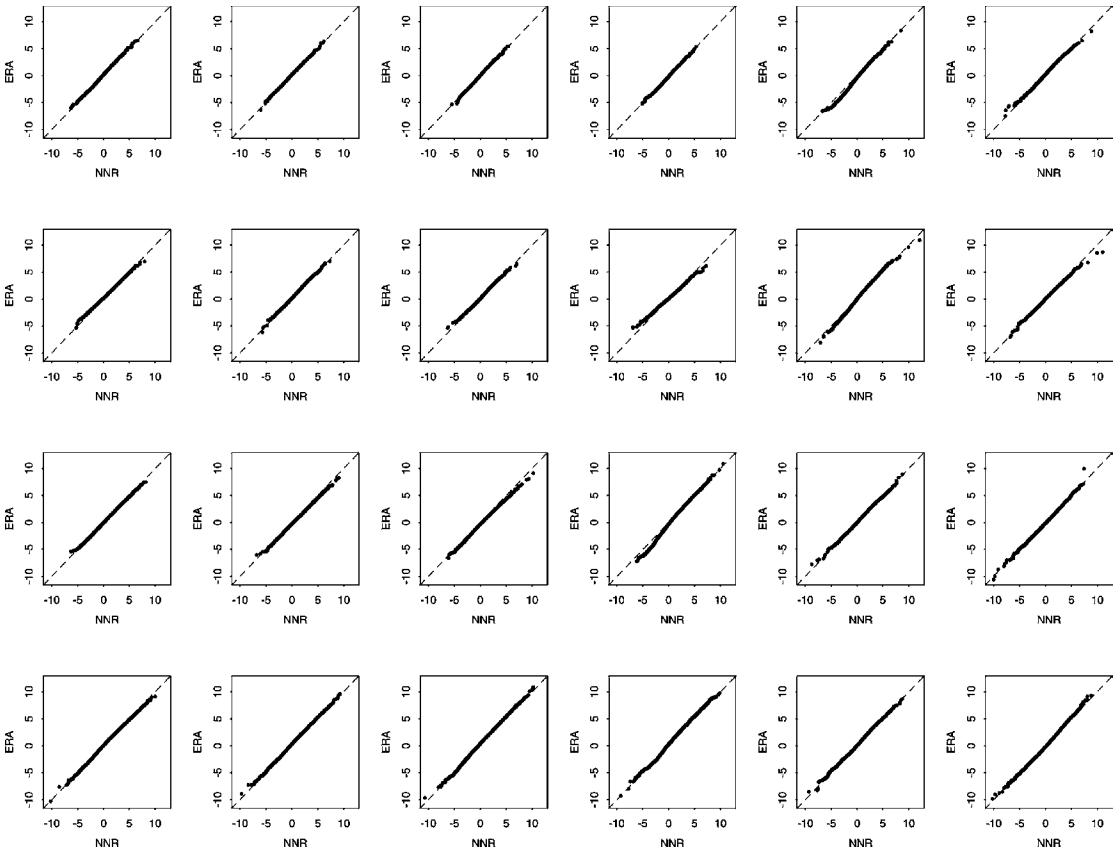

Figure 4. Distribution of daily NCEP/NCAR versus ERA40 North-South SLP gradient (hPa) for the 6 by 5 grid over south east Australia.

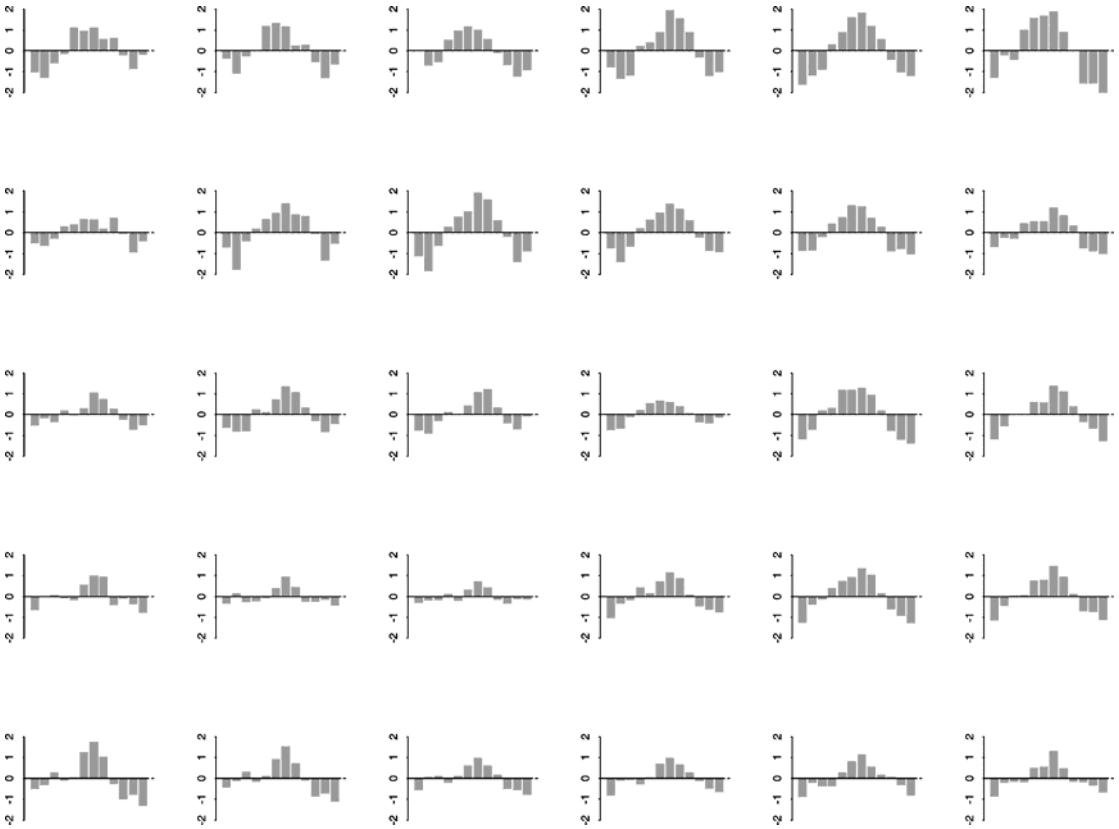

Figure 5. Monthly anomalies of ERA40 DT_d700 (^oC), relative to NCEP/NCAR, for the 6 by 5 grid over south east Australia.

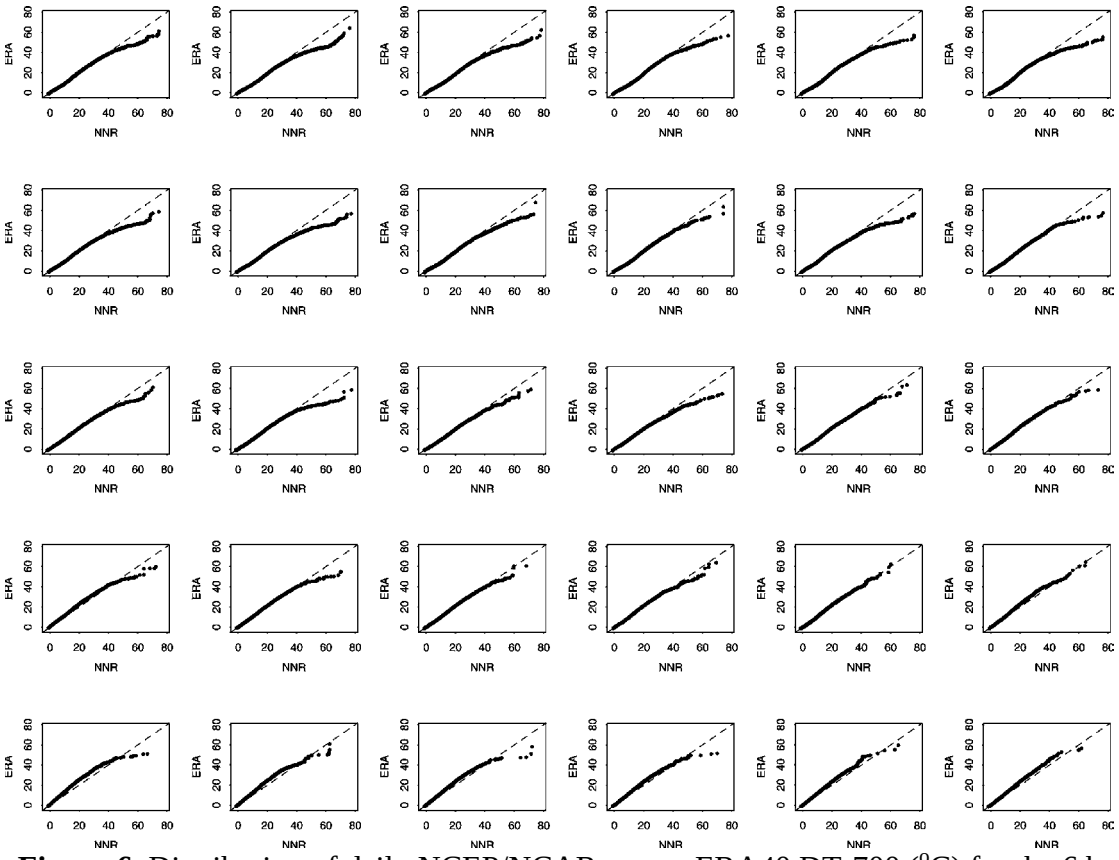

Figure 6. Distribution of daily NCEP/NCAR versus ERA40 DT_d700 (^oC) for the 6 by 5 grid over south east Australia.

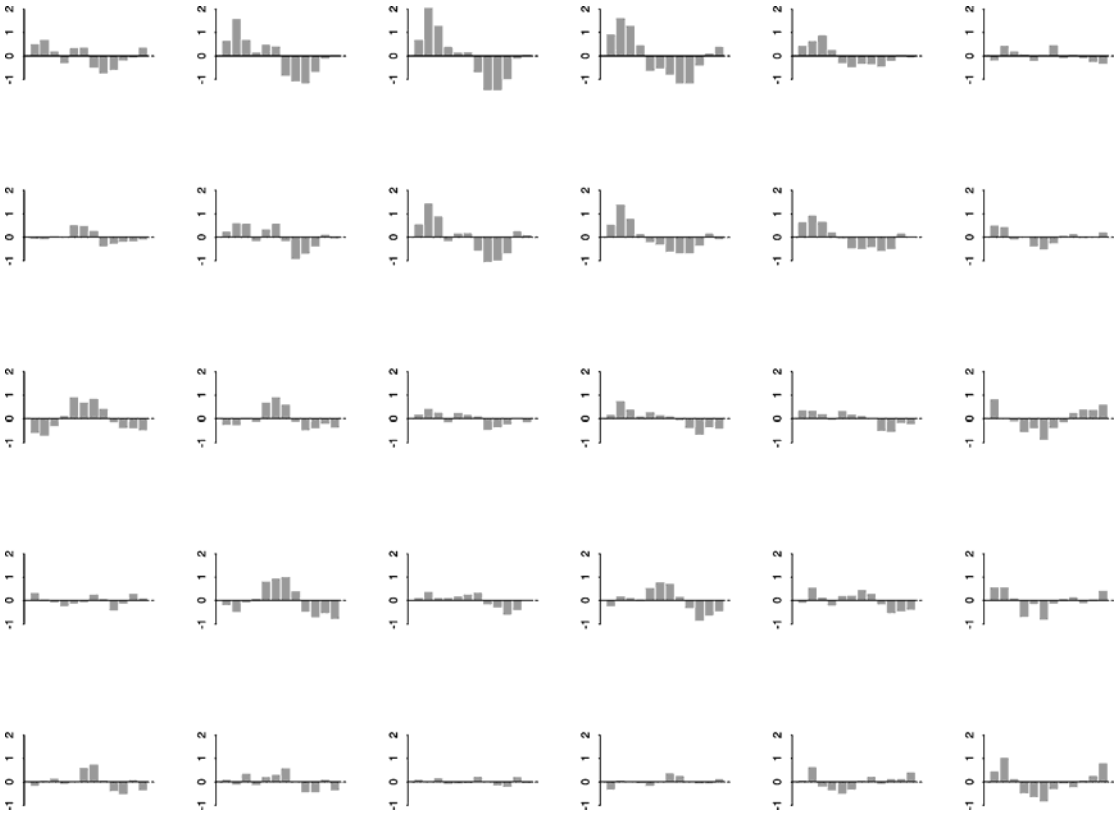

Figure 7. Monthly anomalies of ERA40 DT_d850 (^oC), relative to NCEP/NCAR, for the 6 by 5 grid over south east Australia.

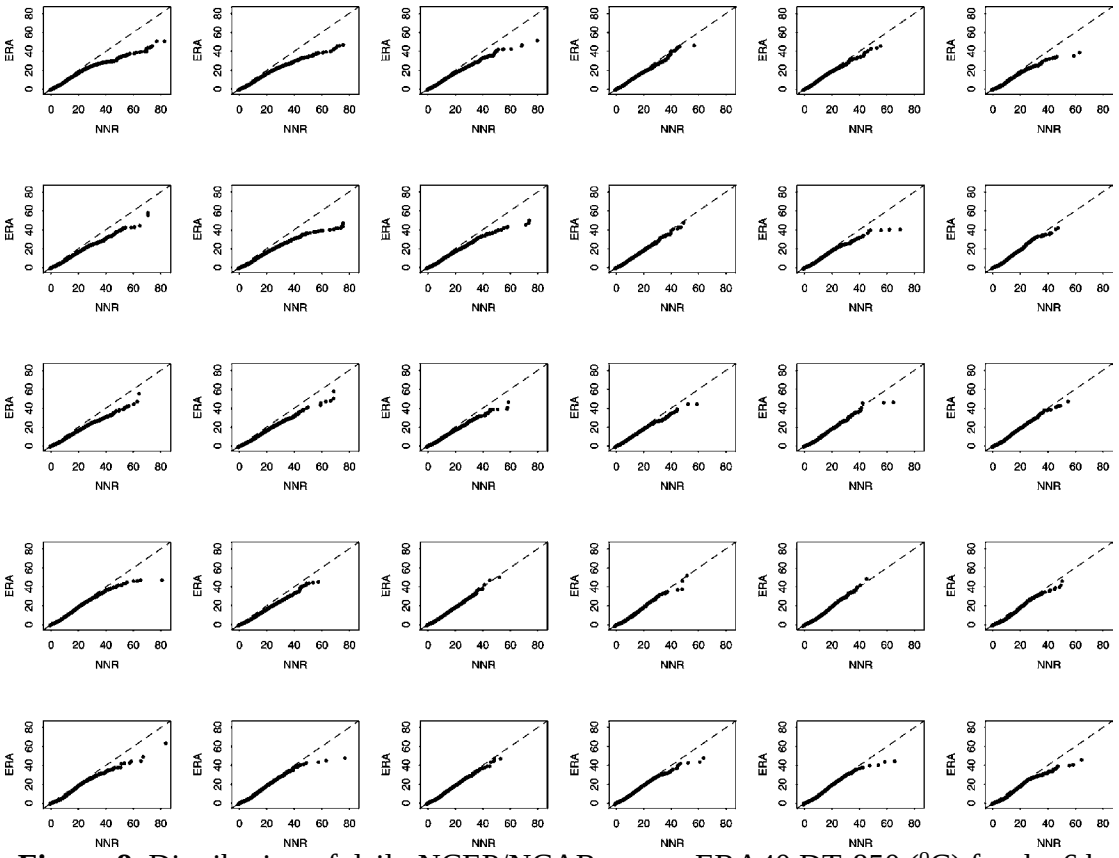

Figure 8. Distribution of daily NCEP/NCAR versus ERA40 DT_d850 (^oC) for the 6 by 5 grid over south east Australia.

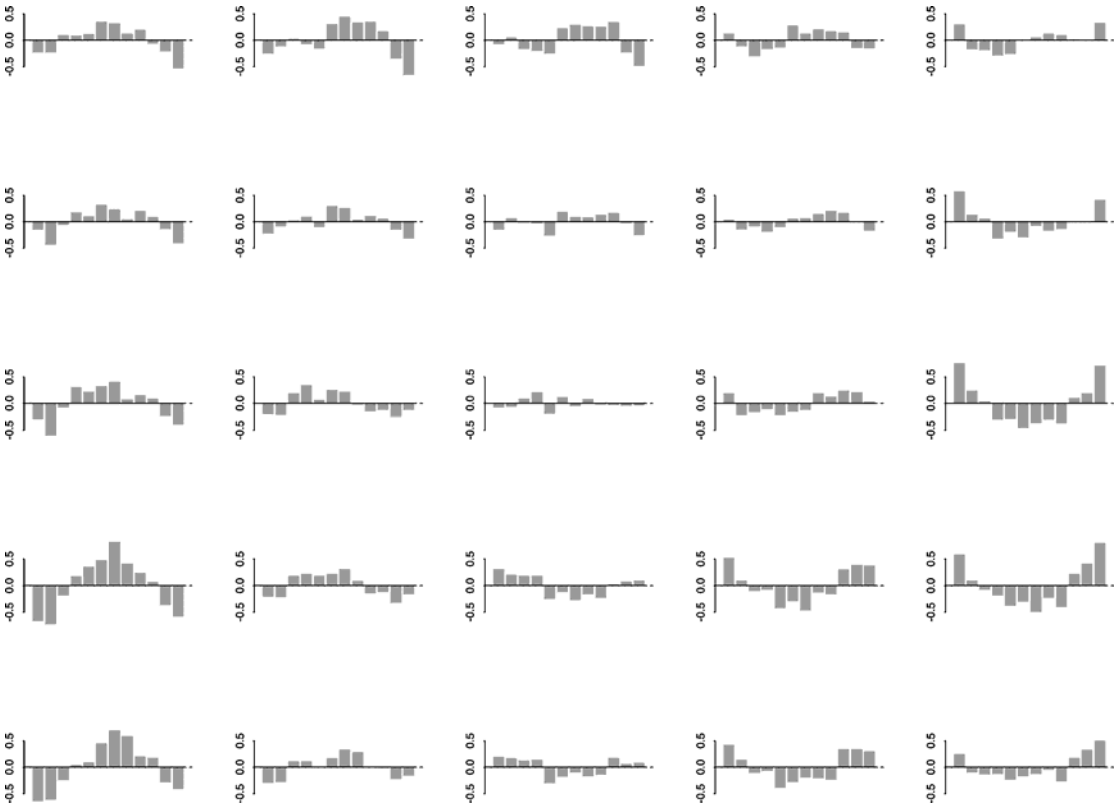

Figure 9. Monthly anomalies of ERA40 East-West GPH500 gradient (m), relative to NCEP/NCAR, for the 6 by 5 grid over south east Australia.

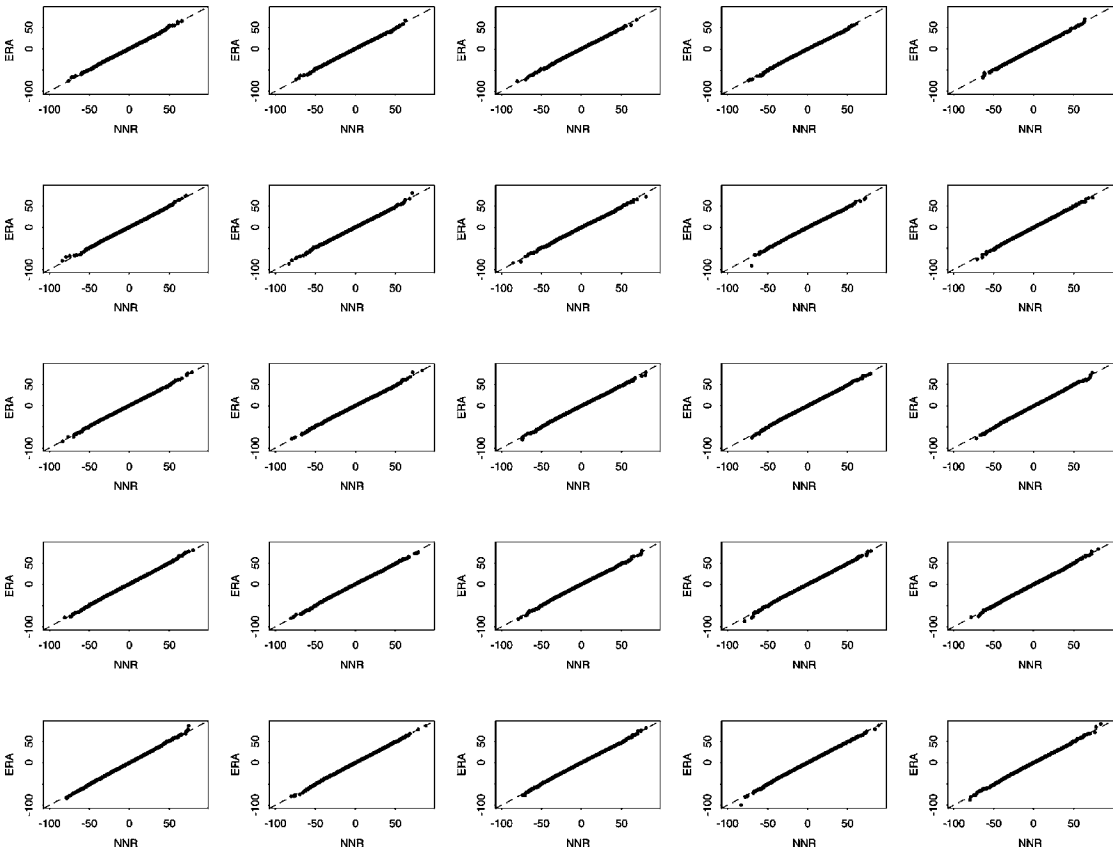

Figure 10. Distribution of daily NCEP/NCAR versus ERA40 East-West GPH500 gradient (m) for the 6 by 5 grid over south east Australia.

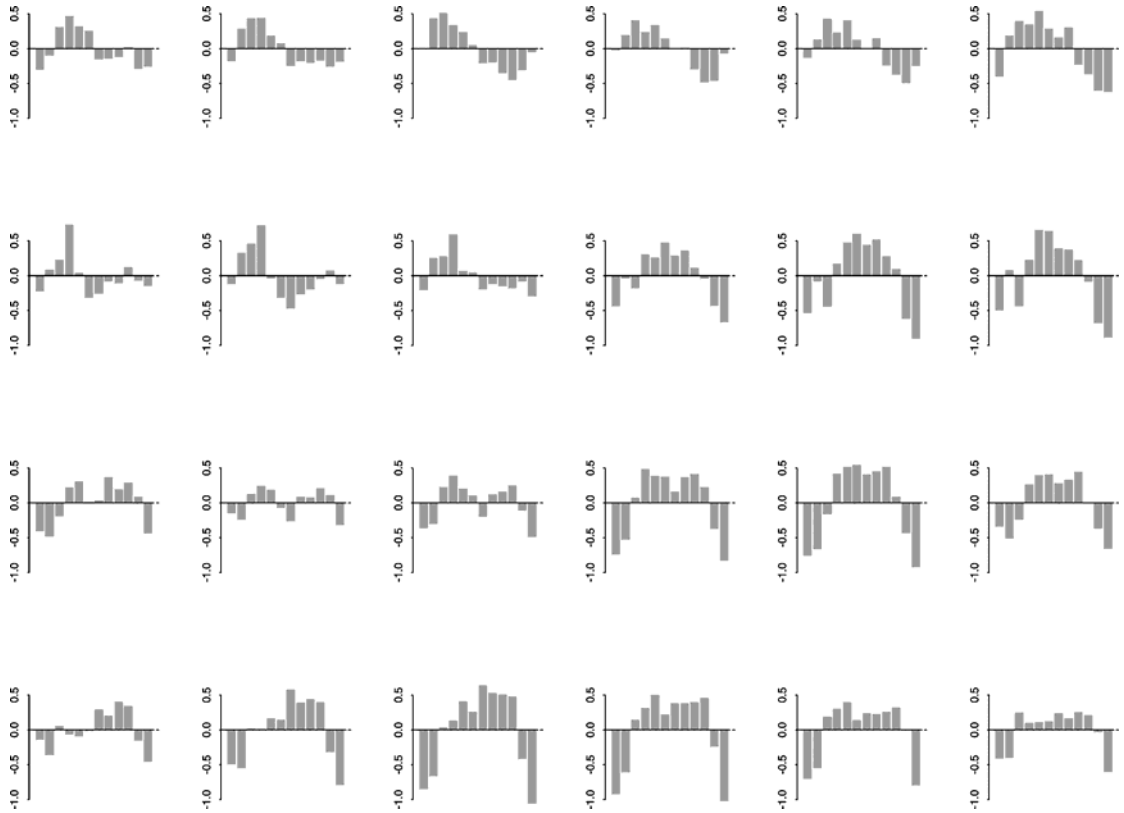

Figure 11. Monthly anomalies of ERA40 North-South GPH700 gradient (m), relative to NCEP/NCAR, for the 6 by 5 grid over south east Australia.

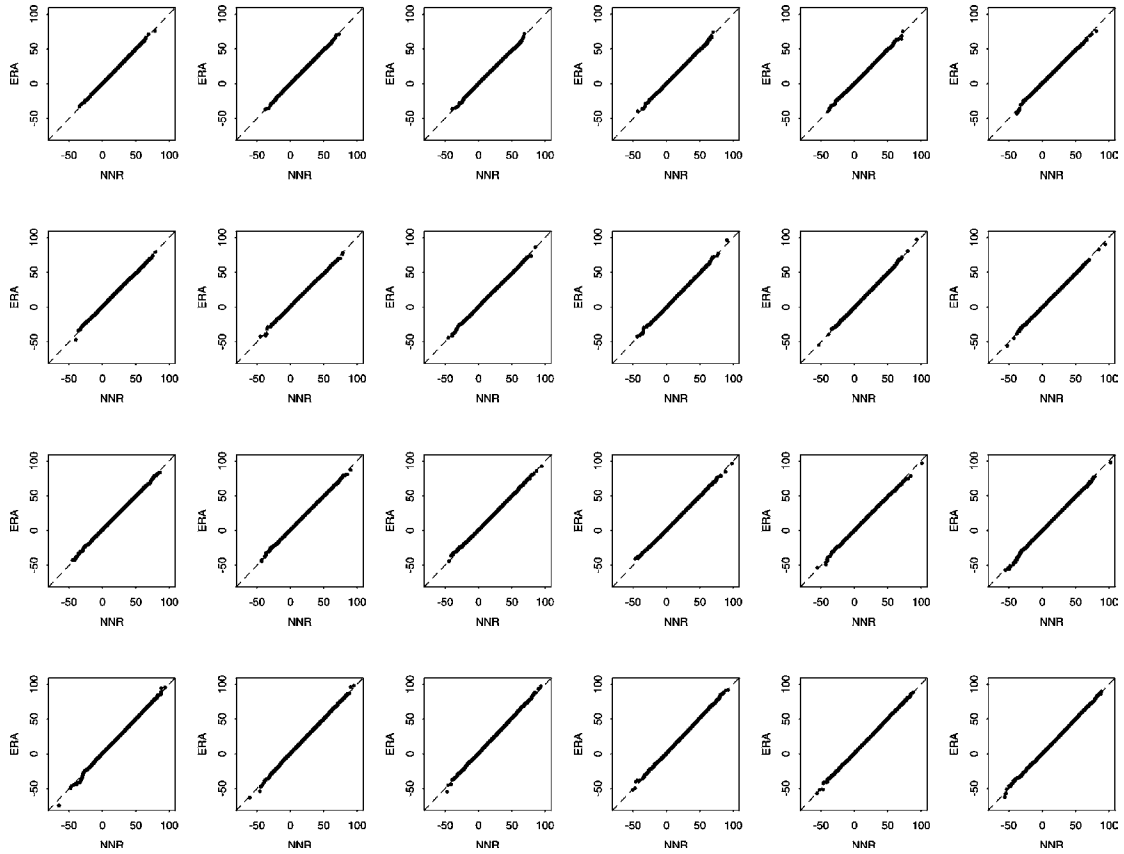

Figure 12. Distribution of daily NCEP/NCAR versus ERA40 North-South GPH700 gradient (m) for the 6 by 5 grid over south east Australia.