Geoscientific
Model Development
Discussions

Interactive comment on "BARRA v1.0: The Bureau of Meteorology Atmospheric high-resolution Regional Reanalysis for Australia" *by* Chun-Hsu Su et al.

Anonymous Referee #2

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GENERAL COMMENTS

The topic of the paper is very interesting with the description of the Australian regional reanalysis system BARRA. It gives a good general overview of the system and provides a snapshot of the first results. Therefore, it is a valuable contribution, though there are some shortcomings, which should be addressed in its final version. Particularly, I see as a major problem that there is a major numerical problem in the dataset, which is manifested in "grid-point storms". This should not happen, since reanalysis should be based on a robust and mature numerical weather prediction system, where such problems are already corrected. Overall I propose to accept the paper for publication

provided the comments below are properly addressed in the updated version.

SOME SPECIFIC COMMENTS

The main question for a regional reanalysis is to clearly demonstrate whether the use of such system is justified, which means that more value can be added to the global reanalysis then it would be the case with a pure dynamical downscaling. For this question one has to understand the additional information brought into the reginal system in terms of more precise dynamical and physical description of the atmosphere, but also in terms of additional and advanced use of observations. I miss a summary of this kind from the manuscript though some of these aspects are highlighted here and there in the paper.

Special attention is needed, when different types of driving datasets are used for the reanalysis during the reanalysis period since the continuity should be ensured. Otherwise, there might be some spurious climate signal which is coming from the change of the dataset and not from the climate itself. It should be assessed carefully. In the manuscript we got some examples, as the applied soil moisture fields, which are different from 2015 onwards or the SST and SIC, which is changing in 2007. Some text is needed to emphasise and discuss this aspect.

When the reanalysis is validated sometimes it is not clear enough what are the shortcomings of the datasets used for validation. In some cases it is not clear if the deficiencies identified are coming from the weaknesses of the applied observational datasets or the reanalysis itself. Therefore, at the validation part, it should be also mentioned what are the limitations, which are coming from some of the shortcomings of the validating data itself.

The existence of the "grid-point storms" is embarrassing since such numerical problems should not happen in a reanalysis, where a robust and properly (thoroughly) tested NWP system should be used. Normally, the reanalysis should not be run if such problems are not yet solved. There is a need for a thorough explanation how

this could happen and how this deficiency compromises the validity of the reanalysis results.

The figure captions should provide enough details that the figure can be read without consulting with the main text. In some figures (particularly figure 5 and 7) some information is missing in the caption.

SOME DETAILED PRACTICAL CORRECTIONS

Abstract:

"BARRA-R improves upon ERA-Interim global reanalysis in several areas at point scale to 25km resolution"; would you explain what do you exactly mean and make the sentence clearer, please? (I guess this sentence means that BARRA gives extra value to ERA-Interim until 25km resolution scale.)

Introduction:

page 2, line 6: ERA5 (no hyphen)

page 2, line: 18: please provide reference for Europe reanalysis

page 2, line 25: please give reference for the Copernicus reanalysis

page 3, line 7: "intermittency and covariability"; what do you mean exactly?

The BARRA-R reanalysis:

page 4, line 5: I think, there is a bit of confusion with reference to the UERRA (Uncertainties in Ensembles of Regional Reanalyses) system. UERRA is a system of ensemble of reanalyses, which includes several regional reanalyses. For instance, the UKMO system is one member of the UERRA system, but that is not the "UKMO's UERRA system", since UERRA is the ensemble system itself. I think, the use of UERRA in that regard is not sufficiently precise here and also other parts of the manuscript.

page 6, lines 7-14: the soil moisture treated differently before and after 2015, which

might cause a discontinuity. This should be mentioned and discussed in the text.

page 6, lines 20-30: here inhomogeneity of the SST and SIC fields are revealed and mentioned, but it is not clear how the user should interpret this inhomogeneity while using the BARRA reanalysis dataset.

page 7, line 14: "linearised about a guess", not "linearised around a guess"?

page 8, line 13-15: the one-month spin-up period seems quite short for me particularly for the surface processes.

page 8, lines 22-24: "Most of the observations prior to 2003 are supplied by ECMWF and those between 2003 and 2009 and conventional data from 2003 are extracted from the UKMO operational archives" Does this choice causes any discontinuity? (Though changes in the observing system are usual and the data assimilation system should be able to handle to minimise such discontinuities.)

page 9, line 4: "UKMO's OPS system", what is that? Please have a reference there.

page 9, lines 15-19: changes in observation quantities and screening (thinning) are mentioned here, which might cause discontinuities. It should be explained how this problem can be alleviated.

Preliminary evaluation of ten-year regional reanalysis:

page 9, lines 26-28: it is a basic characteristic of the data assimilation system that the analysis draws nearer to the observations than the guess (RMSE and biases are smaller). This is more a basic sanity check than a real evaluation. On top of that it does not ensure that there are no spurious jumps in standard deviations and biases in the timeseries.

page 10, pages 3-5: this kind of information, what needs to be consolidated and presented altogether in the overview part of the document in order to get an impression what additional information is provided from the regional reanalysis (see also at specific

comments)

page 10, lines 8-9: what observations do you mean, which are not used in the analysis? Or do you mean that since it is a forecast it is an indirect relation, only?

page 11, lines 11-14: please mention "figure not shown" when you discuss a particular aspect, which is not supported by any presented figures.

page 11, lines 16-19: it would be good to include some information about the strengths and weaknesses of the AWAP dataset, which is used for validation since it influences the interpretation of the results.

page 11, lines 24-26, Figure 5: ". . .. BARRA-R shows cold and warm biases around 1K in daily maximum and minimum temperature, respectively. . ." It is quite confusing since the order of the figures is the opposite than in the text (top: minimum, bottom: maximum temperature) and the colour code in the inset is counter-intuitive (red: cold bias, blue: warm bias). I think, that the text states just the opposite than what is seen in the figure: in the minimum temperature there is a cold bias (the reanalysis is colder than the AWAP dataset) and a warm bias (the reanalysis is warmer than the AWAP dataset) in the maximum temperature. Please, clarify this confusion and improve the colour scale of the Figure.

page 12, lines 14-19: one would expect that at least at lower levels some improvements can be detected. Maybe some discussion about this can be put here.

page 13, line 2: ". . . to adjust to remove the excess", is that correct English-wise? Please check.

page 13, line 11: I think, there is a typo there, since it should read as "The first row. . .." and not the "first column".

Figure 7: it is difficult to read these figures, maybe figures only for Australia (as in the supplementary material) would be sufficient.

page 13, line 25: it is very difficult to see the details in Tasmania, I am not sure if such details should be discussed here.

page 14, line 17: what do you mean "temperate region", please? How the latitude bands were selected (for instance 39.2 looks a bit strange choice)?

page 14, lines 18-24: "grid-point storms"; as I mentioned above, I see this numerical issue as a major problem and the reanalysis should not have such numerical instability (and this should have been corrected prior to production).

Summary and outlook:

page 15, line 2: what do you mean on "global effort"?

page 15, line 18: I think the wind bias should be improved with model development efforts and not via post-processing. It is true that some specific users might use post-processing, but I think the modelling community should aim to improve the reanalysis with the improvements of the NWP methodology.

page 15, line 22: what is "GA6 configuration"?

page 16, line 3: I disagree that the grid-point storms should be screened out via post-processing. This is a major numerical problem, which has to be solved before producing a reanalysis.

page 16, line13-14: it is important to get an overview in this paper about the relative merits between reanalysis and downscaling, since this gives justification for having reanalysis instead of simple downscaling. Therefore, some information about this issue should be provided at an early part of this paper.

page 16: lines 18-22: this part of the text is mostly repetition (see page 15, lines 3-7), which should be avoided.