

Interactive comment on “Synchronicity of historical dry spells in the Southern Hemisphere” by D. C. Verdon-Kidd and A. S. Kiem

D. C. Verdon-Kidd and A. S. Kiem

Danielle.Verdon@newcastle.edu.au

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Dear Editor in Chief,

The paper “Synchronicity of historical dry spells in the Southern Hemisphere” (Manuscript number: hess-2013-521) has been revised as per the Reviewers’ comments.

We would like to thank the reviewers for their thoughtful comments. We have addressed the Reviewers’ comments and have provided refutations where necessary.

Detailed descriptions of how each Reviewer’s comments have been addressed are included below:

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Reviewer 1 (H. Bulcock)

Reviewer 1 only requested minor revisions of the paper. All corrections requested have been made. All acronyms have been spelt out and the word “continent” has been replaced by “region” in Figure 3.

Reviewer 2 (D Post)

Major comments: Reviewer 2’s main concern with the paper was that “the conclusions with regards to key indices of climate and their relationships to droughts across the entire southern Hemisphere are justified, but the authors imply that their findings are at odds with projections of increased drought as a result of anthropogenic climate change. However a closer look at the data presented in this paper indicates the exact opposite, with the periods of drier than average conditions corresponding to periods of accelerated global warming (and increased pressures in the subtropical ridge), and the periods of normal rainfall corresponding to a slowdown in global warming”.

Response: The initial reference to our findings being at odds to studies claiming an increase in droughts due to global warming was CSIRO (2007). However, as noted by the reviewer, more recent research by CSIRO in 2012 has refined this claim to the mid-latitudes only and the current theory is that droughts tend to be more frequent during periods of accelerated global warming for the regions south of 30 degrees being discussed in our study. The revised paper has been updated to reflect the more recent findings of CSIRO 2012. In particular, the reference to the 2007 report has been removed and a discussion of the link between drying trends and the rate of global warming has been included in Section 4.

General comments: 1. Reviewer 2 queried the discussion of the limitations of the reanalysis data.

Response: It was not our intention to imply that the reanalysis data was not suitable for this study. Indeed this data has been used in many similar studies (including the

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author's previous work and the studies contained with CSIRO 2012). However we feel it is important to highlight that reanalysis data is never perfect as it is essentially modelled data. As such we have used gauged data to ground truth the observations made using the reanalysis data. This has been clarified in the revised paper (see Section 2.1)

2. Reviewer 2 asked why gauged data was sources south of 30 degrees.

Response: Station data was sourced south of 30° as this is the prime region where interdecadal variability in flood and drought cycles have historically been observed, including the mid-1970s climate shift discussed in the Introduction (see Verdon-Kidd et al, 2013). The extreme drought conditions during the Big Dry in Australia (~1997-2010) were also largely confined to regions south of 30 degrees (Verdon-Kidd and Kiem, 2009a). This has been clarified in Section 2.2.

3. Reviewer 2 suggested that some discussion of how well the cumulative rainfall sums shown in Figure 3 identify well known drought periods in Australia (Federation, WW2, and Millennium droughts).

Response: As noted by the reviewer the well-known multi-year droughts in Australia (WW2 (~1937-45) and Millennium (~1997-2010)) can be identified in the 5 year rainfall sums. The Federation Drought (~1897-1902) cannot be recognized as it occurred mostly prior the analysis period used to generate the graph (1900 onwards). The authors did not include a discussion of how well the cumulative rainfall sums match these well-known droughts for a number of reasons. The cumulative sums represent dry spells (periods of low annual rainfall particular to each gauge). This is not synonymous with drought which is multifaceted (meteorological, hydrological, agricultural, economic). Thus it may not be appropriate to assess the annual cumulative rainfall sums against these well-known droughts that have very different spatial signatures in Australia and vary in their seasonality and impact (see Verdon-Kidd and Kiem 2009 for a detailed comparison of these droughts).

4. Reviewer 2 commented that "the evidence presented of drought in New Zealand,

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Africa and South America consistent with the Federation drought is hardly 'compelling'", pointing out certain stations on the west coast of South America, South Africa and NZ that do not display a dry spell during this period. The reviewer suggested that the authors tone down the language used around this point.

Response: The authors agree with the reviewer that it is primarily the eastern stations in South Africa, South America and New Zealand that also experienced a dry spell during the Federation Drought. These results actually indicate that a reduction in easterly flow south of 30° may have occurred during this time, a condition often associated with El Niño conditions (note that the Federation Drought was primarily driven by an extended El Nino phase (Verdon-Kidd and Kiem 2009)). The text has been toned down and further clarification provided as suggested.

5. The reference to Hendon et al (2007) has now been included in the reference list

6. The reviewer commented again that the timing of the dry spells across the southern Hemisphere (1910-1950, and post-1980) with a wetter period in between correlates very well with the periods of accelerated global warming as described in CSIRO (2012)

Response: This has been amended in the revised paper (see response to major comment for this reviewer).

The authors would like to thank the two reviewers for improving the content of this manuscript through their comments and suggested revisions.

Yours sincerely,

Danielle Verdon-Kidd School of Environmental and Life Sciences University of Newcastle New South Wales 2308 AUSTRALIA Tel: +61 02 4921 5749 E-mail: danielle.verdon@newcastle.edu.au

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