Reply to the Interactive comment on "Multi-century cool and warm season rainfall reconstructions for Australia's major climatic regions" by Mandy Freund et al., by Anonymous Referee #1,

This paper is generally good and well written. I have a few comments, most of which are relatively minor.

Reply: We want to thank Anonymous Referee #1 for his/her careful and constructive review of our paper. We will take into account all his/her valuable advice for the revision of the manuscript. The reviewer's comments are in black. Below are our replies to his/her comments in blue. Comments in italic are suggested changes to the manuscript.

Major Comments

1. The abstract refers to cool and warm season rainfall reconstructions as being sub- annual. Elsewhere in the abstract they are referred to as seasonal and on p11 as bi- seasonal. Sub-annual is confusing. What they really are is half-year reconstructions, with the two parts of the year based on the cold and warm part of the year. Stick with one definition for them. Bi-seasonal seems best, sub-annual doesn't mean anything.

We agree with the reviewer and see that multiple definition could lead to confusion. We will change all references to: bi-seasonal.

2. When using CPS and rescaling using the mean and SD from the calibration period, you are assuming a normal distribution. How good is this for some of the smaller NRM regions? Particularly for the warm season, some regions show large positive spikes indicating that the distributions for some regions will be positively skewed. This makes using CPS more difficult, and it might be that proxies are less good at differentiating wet seasons from one another, but it could be worth a comment.

We agree with the reviewer and add a plot to the supplement showing the individual distributions. Most of the seasonal and regional rainfall distributions tend to follow a normal distribution. All instrumental cool season time series are approximate normally distributed (Chi-square test, 5% significance level). The distribution of instrumental rainfall during the warm season in the Central Slopes, Rangelands and Southern Slopes doesn't follow a normal distribution (Chi-square test, 5% significance level) and shows positive skewness (see Supporting Figure 1 for details).

We add a statement as followed p.5 l.24:

*"It should be noted that not all of the records strictly follow a normal distribution."*

3. You've used deciles based on the period 1900-2014, so for the proxy series the last 30 years up to 2014 is based on instrumental data. Do your results get altered by basing both on the period from 1900-1984 and not padding with instrumental data? Also you do pad with 30 years, not the 20 you say, as 2014 is 30 years after 1984.

We agree with the reviewer. Deciles strongly depend on the baseline. We added a plot to the supplement showing different baselines (S.Figure 2) and refer to it on page 6 line 22:

*"It is important to note that deciles deliver quantitative statements only in conjunction with a baseline period and duration (see details in supplementary figure 2)."*

4. What would be useful in Table 1, when text on p9 discusses the cool and warm season rainfall series, is to add a % value for how much the cool or the wet season contributes to the overall 'annual' total. You could base this on a April to March year. This could help in the importance of some of the rainfall declines. Some regions get much more rain in one season compared to the other.

We agree with the reviewer and add the contribution of seasonal rainfall in percentages to the annual average in table 1.

5. Is it worth also concluding that the 400-year reconstruction didn't produce a drought as extreme as the 3 in the instrumental period? As these are different lengths, did you go back and look at droughts of different lengths of numbers of years. The Millennium drought was 13, the WW2 drought 11 and the Federation drought 9.

Yes, this comment is true based on the 3 instrumental droughts we have been looked at. This is again true only in conjunction with a baseline period and duration of these droughts. Looking at other past drought events of different duration and intensity hasn't been done in this study and remains for future work.

Minor Comments

1. In the abstract or in the Introduction you mention the high-variability of Australian rainfall. This could be emphasized a bit more, as Australian averages (when expressed in percentage terms) are highly variable compared to other parts of the world. I recall seeing a plot of N and separately S Australian averages (Giorgi regions) compared to other similar sized regions of the world and Australia needed a different scale from all other regions.

Good point, we added the citation: {Nicholls:1997gh} to p.2 line 2.

2. On p2 lines 19-26 you talk about decrease in rainfall. Might be worth mentioning in impact terms that the costs of droughts are much more than the costs of floods. I'm assuming this is the case?

Not necessarily and depends on multiple factors. It is hard to quantify the costs of natural disasters. For example, the total economic cost of Queensland floods is estimated as $14bn (http://australianbusinessroundtable.com.au/our-papers/social-costs-report) compared to $7bn caused by Black Saturday bushfires. A report by the WMO estimated the cost of the 1981 drought with US$15.15bn (http://www.wmo.int/pages/prog/drr/ transfer/2014.06.12-WMO1123_Atlas_120614.pdf). It is hard to integrate and compare those costs and beyond the scope of this study, we therefore back away from any statement.

3. Add in on p3 that Cook has also produced the OWDA (Old World Drought Atlas) with a paper in 2016 in Science Advances.

Yes, we will add this reference!

4. Line 12, change Europe to Eurasia as there are lots of proxies across the whole boreal forest zone and from eastern Asia.

Yes, we have changed that.

5. Useful if Figure 1 and Table 1 could be linked and the map named the 8 regions. It took me a while to realize that the big bit in the middle was called 'Rangelands'. I t also seems as though this region is just what's left from naming the other regions.

Yes, we add this into the Figure caption 1:

*"Full names of the Natural Resource Management (NRM) clusters shown on Australian continent as abbreviations are given in table 1."*

6. P4, line 16, these two references are missing (BJ93 and T et al.2015).

We will add those.

7. Another ref missing on p6 line 4. A better ref here would be Cook et al (1994, IJC, 14, 379-402).

We will add this missing reference.

8. On p6, the dates of the various droughts do overlap – maybe they are close regions and overall only affect part of Australia? Worth mentioning this though.

Those droughts are historical reported droughts from different regions. Back in those days, they might have affected the entire continent, but were only reported in the settlement areas along the coast but those historical droughts seem to be have been indeed quite regionally constrained to a certain area. Overlapping periods will be definitely be future work but we will show individual years in an animation/video.

9. P7 introduces STRP and STRI, but Table 1 just refers to STRI and STRL. How do these two relate to STRP?

We will correct that in table 1.

10. On p8 the cool season paragraph refers to 3 regions which extend back to 1200, 1260 and 1366. This is OK, but in the next paragraph the wet season 3 regions extend back to just 2 years?

Good point, we changed in to p.8, line 15-16:

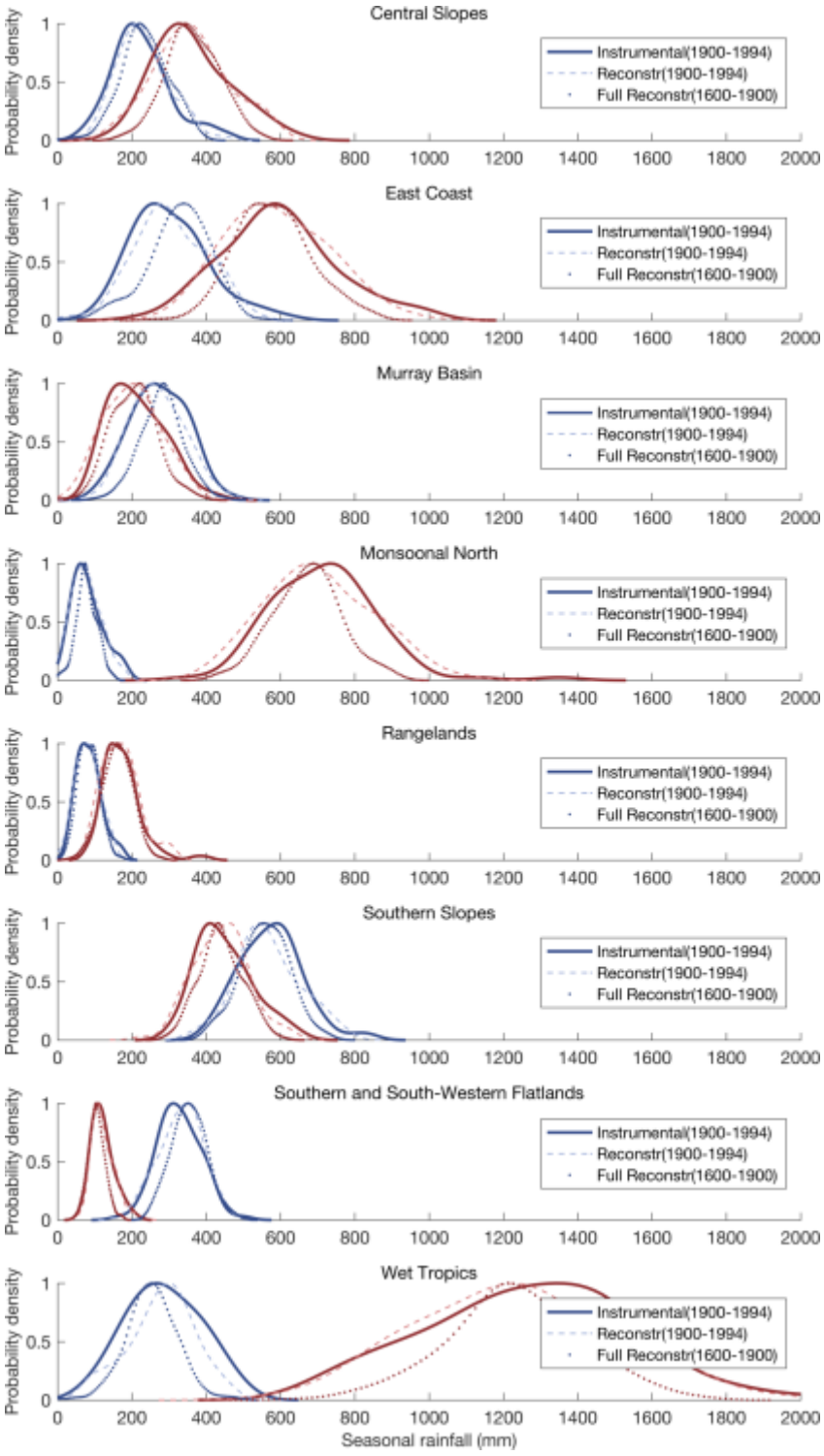
*"In the warm season, the Southern and Southwestern Flatlands, Wet Tropics, and Murray Basin warm season reconstructions are skillful (CE > 0) for the longest period, extending back to 1200,1200 and 1234, respectively "*

11. Remove the 'as' before ENSO's on line 14 of p12. 12. Move the left bracket on line 7 of p13, so begin with Cook et al. (2016) found. . ..

Will be changed.

13. In Table 1, SE Drought is in twice in the third column. This is why it doesn't get a date the first time? I presume all these dates are the accepted dates?

We will correct that in table 1.




*Supporting Figure 2: Normalised probability density distribution of the instrumental records (1900-1994), the reconstructed records during the instrumental period (1900-1994) and through the entire reconstructed period (1600-1900). Cool season records are shown in blue, warm season records are shown in red. Note all cool season records follow approximate a normal distribution according to a Chi-square test (5% significance level) while warm season records of Central Slopes, Rangelands and Southern Slopes are not normally distributed.*