We thank the reviewers for their valuable and useful comments on this manuscript. We believe that their suggestions will further improve our manuscript and we can address these comments in the revised manuscript. These comments are in line with the complexity of the problem this paper seeks to discuss, and we feel highlights the importance of the paper as a means of adding clarity on how hydrologic models change in the changing world we live in. Please see below our response to each of the reviewers' comment.

**Anonymous Referee #1**

This is an interesting study on the ongoing problem of understanding hydrological nonstationarity. I like the work, but I am unclear regarding the robustness of the results as discussed below.

1. The introduction is well written. I wonder whether there are two other relevant links to be made here. (a) To work on streamflow elasticity (e.g. http://engineering.tufts.edu/cee/people/vogel/documents/climate-elasticty.pdf), and (b) on classification approaches trying to assess nonstationarity (e.g. http://www.hydrolearth-syst-sci.net/18/273/2014/). I think these two previous approaches might be interesting to connect with here since they both found that a lot of the variability in runoff ratio was difficult to explain and predict.

We agree with the reviewer comment to provide a link between the streamflow elasticity approach and the methodology presented here in the revised manuscript. Indeed, normalized sensitivities of runoff ratio to precipitation and fractional vegetation cover in Figure 3a is indicative of elasticity of runoff ratio to changes in precipitation and fractional cover respectively, and this approach is similar to Zheng et al. (2009) for computing climate elasticity of streamflow.

The methodology of Sawicz et al. (2014) to characterize changes in streamflow through catchment classification is interesting. However, the approach requires long term streamflow and climate data records to characterize hydrologic change. While these datasets are available for the Hydrologic Reference Stations in Australia, our methodology is limited by the availability of remotely sensed vegetation products. In the revised Introduction, we will incorporate Sawicz at al. (2014) approach to detect hydrologic change.

2. Similarly, there has been a lot of work on trying to disaggregate the roles of vegetation, storage, energy and moisture on predicting runoff ratio using Budyko type frameworks, which I think also show that it is difficult to come up with simple explanations for reasons for nonstationarity - which I think is line with the results shown here.

We agree with the reviewer comment that it is difficult to disaggregate the role of vegetation, climate and soil moisture on streamflow using the empirical methods such as the Budyko framework or the streamflow elasticity approach. Due to the two-way interactions between catchment water balance and vegetation dynamics, implementation of catchment scale ecohydrologic models is the next logical step to disaggregate the roles of various factors. Nevertheless, previous investigations on assessing climate elasticity of streamflow have shown that the degree of sensitivity of streamflow to various factors depends on the model structure and calibration approach (Sankarasubramanian et al., 2001). Therefore, further research on both data-based and modeling approaches are required.

3. In the results section (3.1) the authors state that variables increase, or decrease, or show trends. It would be good if they could quantify these a bit more, rather than just stating that the trends are statistically significant. Especially since the value of such significance tests is regularly questioned (e.g. http://onlinelibrary.wiley.com/doi/10.1002/esp.3618/abstract).

We will provide additional information about changes in water balance variables and the rate of trends in the revised manuscript. We agree with the reviewer that the results of the trend analysis are impacted by defining the significance level. While we removed the impact of the start and end year on trend analysis and reduced the impact of autocorrelation on trend analysis, we will present the results of a bootstrap procedure introduced by Douglas et al. (2000) to compute the field significance of regional trend tests in the revised manuscript. In this approach, time series of runoff ratio for every catchment will be resampled 10,000 times using the bootstrap approach. In the next step, the Kendall's S is calculated for each bootstrap sample and regional test statistics is calculated for each iteration. Finally, the CDF of regional test statistics is compared with the historical mean. Our preliminary analysis using the bootstrap approach provided similar results to that presented in the manuscript.

4. The main question I have relates to the fact that the authors largely focus on analysing the 20 out of 166 catchments for which they saw nonstationarity in the response. While the subsequent analysis of those 20 is fine, I wonder what can be said about the 146 catchment where runoff ratio is not changing? For example, how many of the stationary catchments have experienced precipitation or vegetation or ET changes similar to the ones where runoff ratio changed? That would be a baseline analysis to see whether an interpretation of the causes of runoff ratio nonstationarity are robust. So my main question to the authors is whether they can demonstrate that the catchments not showing runoff ratio change have experienced changes that are smaller regarding the potential driving variables?

We agree with the reviewer comment to provide a baseline analysis to show whether stationary catchments experienced similar changes in precipitation, runoff and vegetation compared to the catchments with non-stationary hydrologic response. To show these differences, we will implement the approach of Coopersmith et al. (2014) by developing regime curves based on daily runoff, precipitation and monthly fractional vegetation cover for each catchment using pre-drought and drought period data. Our preliminary analysis shows that in some cases, large changes in the regime curves have been observed particularly in catchments with non-stationary response.

**References:**

Coopersmith, E. J., B. S. Minsker, and M. Sivapalan (2014), Patterns of regional hydroclimatic shifts: An analysis of changing hydrologic regimes, *Water Resour. Res.*, *50*(3), 1960–1983, doi:10.1002/2012WR013320.

Douglas, E. M., R. M. Vogel, and C. N. Kroll (2000), Trends in floods and low flows in the United States: impact of spatial correlation, *J. Hydrol.*, *240*(1–2), 90–105, doi:http://dx.doi.org/10.1016/S0022-1694(00)00336-X.

Sankarasubramanian, A., R. M. Vogel, and J. F. Limbrunner (2001), Climate elasticity of streamflow in the United States, *Water Resour. Res.*, *37*(6), 1771–1781, doi:10.1029/2000WR900330.

Sawicz, K. A., C. Kelleher, T. Wagener, P. Troch, M. Sivapalan, and G. Carrillo (2014), Characterizing hydrologic change through catchment classification, *Hydrol. Earth Syst. Sci.*, *18*(1), 273–285, doi:10.5194/hess-18-273-2014.

Zheng, H., L. Zhang, R. Zhu, C. Liu, Y. Sato, and Y. Fukushima (2009), Responses of streamflow to climate and land surface change in the headwaters of the Yellow River Basin, *Water Resour. Res.*, *45*(7), doi:10.1029/2007WR006665.