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Interactive comment on "Evaluating uncertainty in estimates of soil moisture memory with a reverse ensemble approach" *by* D. MacLeod et al.

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We thank the reviewer for the useful comments. The reviewer makes three main points which we will discuss in turn.

The first point suggests we make more discussion of the explanation of why we chose certain gridpoints, and suggested giving more information about general orography and vegetation.

We chose the grid points indiscriminately, in that we took every 10th point from the underlying data without considering a priori the local characteristics. To use low resolution data is suboptimal, since regions of high spatial heterogeneity or complex topography may show memory characteristics which are somewhat dependent on choice of point. However the expense of rerunning the experiment at higher resolution puts this option

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outside the scope of this study.

Though our results are unable to capture finer scale variations in moisture memory and its uncertainty, they do give a broad picture of the global pattern. Futhermore, where there is spatial coherence across several gridpoints this gives confidence that the results do not arise from choosing a certain point, but are indicative of a larger patterns across a region (e.g. in figure 4 Southern Africa and Northeast Asia for the May start date and East North America, North South America, Europe and Equatorial Africa for the November start date).

In terms of giving more information about orography and vegetation type, this is a good idea, and in a future version of the manuscript we will provide this as supplementary information.

The second point raises the issue of sensitivity to start dates (whilst acknowledging the computational expense) and suggests more discussion.

We agree, and ideally we would look at multiple start dates. However as the reviewer points out, repeating for extra extra start dates is computationally prohibitive. We plan to add some discussion on this point on the manuscript, namely that whilst boreal winter is impacted by snow in the Northern Hemisphere, results for the Southern Hemisphere in the same season are unaffected. Furthermore the November start date result in Northeast Asia does give some indication of what results look like where snow is present.

The final point asks to try to more explicitly discriminate implications of findings from the perspective of atmosphere-land coupled model on the one hand and from the perspective of seasonal flow forecasting applications on the other.

This is a good comment and important to make this distinction. We would suggest that variations in memory and its uncertainty are important from the perspective of atmosphere-land coupled modelling since the feedback between the land and the at-

mosphere mean that anomalies in soil moisture which persist over a long time can influence atmospheric conditions over an extended period into the future.

For example, a persistent dry soil may exacerbate heating anomalies such as in the case of the 2003 European heatwave. A long memory means that the land surface becomes one of several sources of predictability for the atmosphere. This is only true for situations where there is strong soil moisture-atmosphere coupling, where variations in soil moisture strongly influence the atmosphere via latent and sensible heat fluxes. In regions where coupling is absent, soil moisture memory is less important.

In contrast soil moisture memory is important for hydrological applications independently of the strength of land-atmosphere coupling. Soil moisture is one of the main controls on both rainfall runoff generation and evaporation. Uncertainty and variability in the persistence in soil moisture can then directly influence the predictability of streamflow, with implications for effective flood forecasting and water resource management.

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