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Interactive comment on "Variations of global and continental water balance components as impacted by climate forcing uncertainty and human water use" *by* H. Müller Schmied et al.

Anonymous Referee #3

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This manuscript presents a quantitatively useful update on our ability to marry terrestrial models of water and energy balanceâĂŤtheir uncertain physical processes and tuning parameters, with records of hydrometeorological forcing that are fragmentary and have significant time-dependent biases. These forcing biases result from an amalgam of diverse satellite and in situ data as well as inputs from atmospheric reanalyses. The analysis presented here covers time scales from annual to century and spatial scales from 0.50 degree lat/lon grids to global land means. While the formalism here is a largely a standard approach there are two specific aspects I feel are noteworthy:

1) The first is the identification of how specific differences in forcing data propagate through the water balance and, by virtue of tuning / calibration on observed discharge,

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affect gauged and ungauged contributions differently. Both the low precipitation in the PGFv2 data (as a result primarily of no snowfall undercatch correction) and the low values of downward SW radiation in the WATCH forcing (resulting from the older NCEP reanalysis values) are cases in point. In gauged regions, discharge (Q) is controlled by calibration and so AET responds to the differences in precipitation and radiative forcing. (Note the large spread in global AET in Table 3, focused in Europe and N. America where snowfall is significant.) Conversely, in ungauged regions the resulting uncertainty from forcing data sets in discharge is over 18% (Table 2). These results quantify the effects of forcing data quality and (un)availability on regional and global results.

2) The other noteworthy aspect of this paper is the attempt to identify the relative roles of climate forcing versus anthropogenic effects on changing water balance. Diagnostic indicators involving the relative changes in P versus Q and changes in the actual versus "naturalized" P and Q changes are considered. The resulting maps (Figs 3,4) are valuable, I think, not only for their consistency but also their differences between forcing data sets. One is not surprised to see the western US and Europe exhibit significant increases in diversions /extractions through the middle of the 20th Century. The growth of these impacts throughout southern Asia in the second half of the 20th Century is reasonably consistent across the four homogeneous data sets. Nevertheless there are significant regional differences in the estimated growth of anthropogenic effectsâĂŤAustralia, China and Mexico are discussed as examples where the forcing data set differences have significant interpretive consequences.

So, basically, my sense is that this paper is a valuable assessment of where our diagnostic modeling capabilities for water balance stand. That said, there are some aspects of the presentation that need improvement:

i. The discussion in section 2.4.2 on the construction of the indicators for anthropogenic effects was difficult to follow. The reasoning behind An and Bn seems clear enough, but I had a difficult time trying to understand how An and Bn were incorporated in Figs

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3 and 4. What combinations of An >0, Bn<0 and Ivarpredoc,n >0 make up red or blue areas in those Figs? Presumably An and Bn are of opposite sign in both blue and read areas? Perhaps some schematic picture would be useful.

ii. There were numerous places in the manuscript where I was unsure as to what Figures or Tables the discussion related to. Does sevtion4.2 refer to the information in Fig 2? Does the discussion in section 4.3 relate to Table 2 and 3? Does section 4.4 refer to Figures 3 and 4? Alluding to the appropriate graphic needs to be added.

iii. I don't really see a lot of value of section 4.1. It largely discusses differences with the standard version WaterGAP 2.2. Perhaps mentioning earlier estimates from papers such as Oki and Kanae (2006), Haddeland et al, (2011) and Rodell et al, (2015) would give some context outside the WaterGAP model.

I recommend accpetance after attention to these these three areas of concern.

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