

Interactive comment on “Past terrestrial water storage (1980–2008) in the Amazon Basin reconstructed from GRACE and in situ river gauging data” by M. Becker et al.

Anonymous Referee #2

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This paper makes use of time-variable gravity data of the GRACE satellite mission and in-situ river water level data to reconstruct long-term inter-annual variations in total continental water storage (TWS). For this purpose, the paper presents a combination technique by scaling water level time series to TWS and by integrating them with GRACE data to derive past spatio-temporal TWS variations in an EOF decomposition framework. The approach is applied for a period of three decades to the Amazon basin, revealing storage dynamics in space and time, and their relation to general oscillation patterns, e.g., ENSO. The approach has high potential and relevance to unravel climate variability and its impact on terrestrial water storage also for other regions.

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In most parts, the paper is clearly and concisely written. I recommend publication in HESS with some minor modifications that may help to improve the clarity and support the validity of the methods and results:

- 1) To allow for reconstructing past water storage variations from recent GRACE observations, one main assumption of the approach used here is the stationarity of the spatial patterns. In Chapter 5, the authors test this stationarity based on the gauge data for different time periods. However, the time periods they chose are overlapping. It should be more convincing to prove the stationarity for independent time periods, e.g., 1980-2002 and 2003-2008, or for two separate periods of 14 years each.
- 2) The authors use in-situ water level time series as a proxy for total water storage comparable to GRACE data. At the beginning of Chapter 2.1., they argue for using water level instead of discharge by saying that water level represents one of the TWS components, presumably surface water storage. However, neither variable represents surface water volumes directly. Even water level may relate in a nonlinear way to inundation extent and thus surface water volumes.
- 3) ‘Scaling factors’ between GRACE time series and water level (Table 1): Is there some physical reason or regular pattern that may explain the variation of scaling factors found among the different stations?
- 4) page 8131, lines 1 and 2, Figure 2: Mode 1 of the EOF results rather suggests a North-South pattern than a West-East pattern as claimed by the authors in the text.
- 5) page 8131, line 15: for computation of the regression between GRACE and water level time series, have water level data also been averaged for the same 10-day periods as GRACE?
- 6) page 8132, lines 8-10. Another reason for a poor correlation between water level and TWS may be the significant contribution of other than surface water components to TWS. Do the authors have an explanation why the correlations tend to be higher for

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the northern Amazon basin, in particular the Rio Negro, and less for the south(-east)?

7) page 8132, line 18: refer to Chapter 4 instead of Chapter 3.

8) page 8137, line 26: comparison of reconstructed TWS to model output: Has the ISBA model output been filtered in the same way as GRACE data? Filtering of GRACE data to reduce error-prone signal components and to subset for a particular area usually results in signal amplitude damping. The comparison to an unfiltered model output may not be consistent in terms of e.g. amplitudes in this case.

9) page 8138, line 21-23: 'In effect, river levels in downstream flows . . .' This sentence is not clear to me neither from the point of view of its English expression nor from its argument in relation to the 'directional correlation' mentioned before. This part should be re-formulated. The authors may also consider that precipitation events in upstream areas may affect downstream water levels with some time delay only due to water transport and not 'directly' as written in the text.

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