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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Regional GRACE-based estimates of water mass variations over Australia: validation and interpretation" *by* L. Seoane et al.

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Review of "Regional GRACE-based estimates of water mass variations over Australia: validation and interpretation" by Seoane and coworkers.

The article deals with the validation of a regional GRACE solution, derived from the Energy Integral method. This method is elegant mathematically speaking, and drives to very interesting results. Readers should note – this is not well explained in the main text, that regional TWS is "true" mass storage variations, while ICA and GRGS provide TWS spatially filtered at GRACE resolution. As for the mascon method, no further interpretation is required.

Evaluation is based on the comparison with classical global solutions and performed on

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a specific area, Australia. This region is interesting as the various climatic settings allow focusing on both interannual and month to month terrestrial water storage changes for GRACE data evaluation. The article is very interesting and deserves publication in HESS. I would ask the authors to consider comments and suggestions below for the benefit of the reader.

Several points are important to me: Authors are comparing GRACE TWS with rainfall or discharge data. Well, these fluxes are only one part of the mass balance equation (d TWS)/dt=P-ET-R, and not directly comparable with TWS. Soil moisture (SM) from AWRA model is presented and would be more adequate in this duty. Surface water and groundwater data would deserve more space in the article, as it provides a direct comparison with GRACE TWS. Fig 15 is somehow lost at the end of the article and not really interpreted. The comparison of GRACE solutions is not fully fair. On one side, regional solutions provide "true" inverted mass variations, while the 2 other products (GRGS and ICA) are spatially filtered with leakage remaining and potentially problematic. Also comparison is mainly based on PCA, i.e. looking at correlation among solutions; this point should be discussed in the paper. In general, the article would benefit from being more focused on the interpretation of the GRACE solutions. Some figures and parts of the article could be sent to supplementary material.

Page 5356 Line 25 : Authors may also cite the recent article below to support the use of GRACE for groundwater studies. Taylor, R.G., Scanlon, B.R., Döll, P., Rodell, M., van Beek, R., Wada, Y., Longuevergne, L., Leblanc, M., Famiglietti, J.S., Edmunds, M., Konikow, L., Green, T.R., Chen, J., Taniguchi, M., Bierkens, M.F.P., Macdonald, A., Fan, Y., Maxwell, R.M., Yechieli, Y., Gurdak, J.J., Allen, D., Shamsudduha, M., Hiscock, K., Yeh, P.J.F., Holman, I., Treidel, H. (2013) :Groundwater and climate change, Nature Climate Change, doi : doi:10.1038/nclimate1744

Page 5357 Line 7 : Aliasing is not the only reason for stripes. They also appear during the the fitting of Stokes coefficients (underdetermined system). Save, Himanshu; Bettadpur, Srinivas; Tapley, Byron D. (2012). Reducing errors in the GRACE gravity

HESSD
10, C2796–C2800, 2013

solutions using regularization JOURNAL OF GEODESY Volume: 86 Issue: 9 Pages: 695-711 DOI: 10.1007/s00190-012-0548-5

Page 5359 Line 8 : don't you take into account the static field to correct range rate data? line 25: the long-wavelength information from global solutions. This is of major interest when discussing regional solutions. What is exactly done over Australia and how do you come up with degree 6? Figure 2 is very difficult to read, but of major interest

Page 5360 Line 28 and around. Figure 3 is very difficult to read. Showing maps of trends and amplitude of seasonal cycle would support the interpretation made in this section. Similarly, Figure 4 would deserve some improvement. Could you show the "central desert" region on Figure 1. The way Figure 4 is plotted may look suspicious. Why don't you show the whole time period? From the rainfall data, 2006.5 to 2006.9 is even dryer than the selected period, and there might be dryer periods throughout the period of interest (2003- 2011). This whole discussion on the Australian climatic settings and how they are captured by GRACE solutions could also be sent to the results and discussion part. Line 28: "we remember", please update

Page 5361 ICA solution. Why using a 400-km Gaussian smoother, while lighter filters have been shown to be sufficient? Please explain.

Page 5363-5364 I don't understand how the groundwater data is computed: Why do you need connection between unconfined aquifers to compute distributed GW storage ? I don't understand why you are not using borehole with a thick saturated zone? These are as important to determine storage variations (as wells might not penetrate the whole saturated thickness anyway). They may be even more important as connected to large-scale permeable structure. The fact that they contain long-term variations is surely realistic and should be included for a full investigation of GWS. Why not using PCA-derived method (Longuevergne et al., 2007) to extract main regional information content from well data and compare to GRACE? This method is powerful and

HESSD

10, C2796–C2800, 2013

has been applied successfully in Longuevergne et al., 2010, and Scanlon et al., 2012 Beware of modes with similar explained variance. They are not well resolved, and any linear combination of modes would fit into the PCA determination process (see e.g. Longuevergne et al., 2007). This is why 2 are switched . . . but more could happen.

Longuevergne, L., N. Florsch, and P. Elsass (2007), Extracting coherent regional information from local measurements with Karhunen-Loève transform: Case study of an alluvial aquifer (Rhine valley, France and Germany), Water Resour. Res., 43, W04430, doi:10.1029/2006WR005000.

Longuevergne, L., Scanlon, B., Wilson, C.R. (2010): GRACE hydrological estimates for small basins : evaluating processing approaches on the High Plains Aquifer, USA., Water Res. Res., 46, W11517, doi: 10.1029/2009WR008564

Scanlon, B.R., Longuevergne, L., Long, D. (2012) : Ground Referencing GRACE Satellite Estimates of Groundwater Storage Changes in the California Central Valley, US, Water Res. Res. 48, W04520, doi:10.1029/2011WR011312 Line 1, Sy has no unit

Page 5364 Comparison of GRACE with streamflow data is not really meaningful and may be removed. It is only one flux in the mass balance equation The region of interest is far smaller than the resolution of GRACE Figure 10 does not bring much explanation on processes

Page 5365 It would be best to focus this part on the comparison among GRACE solutions. Considering the high correlation between PDO and SOI, the significance of climatic index within GRACE data cannot be interpreted that straightforward. I would suggest to remove this part as it is anyway out of topic Do you detrend data prior to correlation computation? Line 12 : SOI : same 13 month averaging as ??? rainfall? Page 5367 Line 20 : Could you compute correlation between the mode and GW? I have difficulties to see the groundwater contribution in the second mode. Is it here really the point of the article?

HESSD

10, C2796–C2800, 2013

Page 5380 and followings This part is much more meaningful for the evaluation of regional GRACE solutions and would deserve to be expanded.

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