Evaluation of RL05 GRACE Based Global Geopotential Models on a Regional Scale: A case study of Turkey

Emel Zeray Öztürk[1] (emelzeray@selcuk.edu.tr), Walyeldeen Godah[2] (walyeldeen.godah@igik.edu.pl), Ramazan Alpay Abbak[1] (aabbak@selcuk.edu.tr)

[1] Selçuk University, Geomatics Eng. Dept., Konya Turkey, [2] Institute of Geodesy and Cartography, Warsaw, Poland

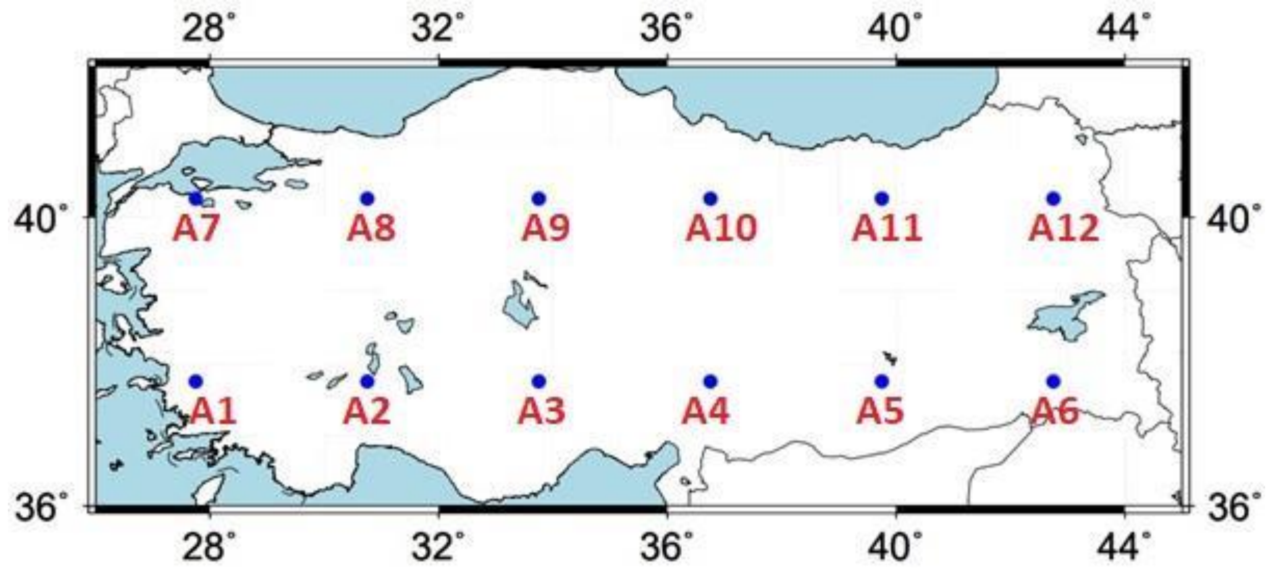
Introduction

Since the launch the Gravity Recovery and Climate Experiment (GRACE) satellite mission in March 2002, several releases (RL), i.e. RL01, RL02, RL03, RL04, and RL05, of GRACE-based GGMs have been developed. These releases generated by from the official GRACE Science Data System, i.e. CSR, GFZ and JPL, centres are gradually getting better results. GRACE-based GGMs are highly affected by the noise caused by various reasons during the acquisition of data. Especially, the orbital plane followed by GRACE satellites is one of the most common causes of the noise. An appropriate filtering method is essentially needed to minimize these noise. It should be noted that, applying such filter, may led to the loss of some of the mass variations signal, and decrease of the spatial resolution. Thus, the aforementioned appropriate filter should be chosen as a compromise between reducing noise, keeping signal and the spatial resolution. Recent studies revealed the suitability of de-correlation filters to reduce the noise included in GRACE solutions.

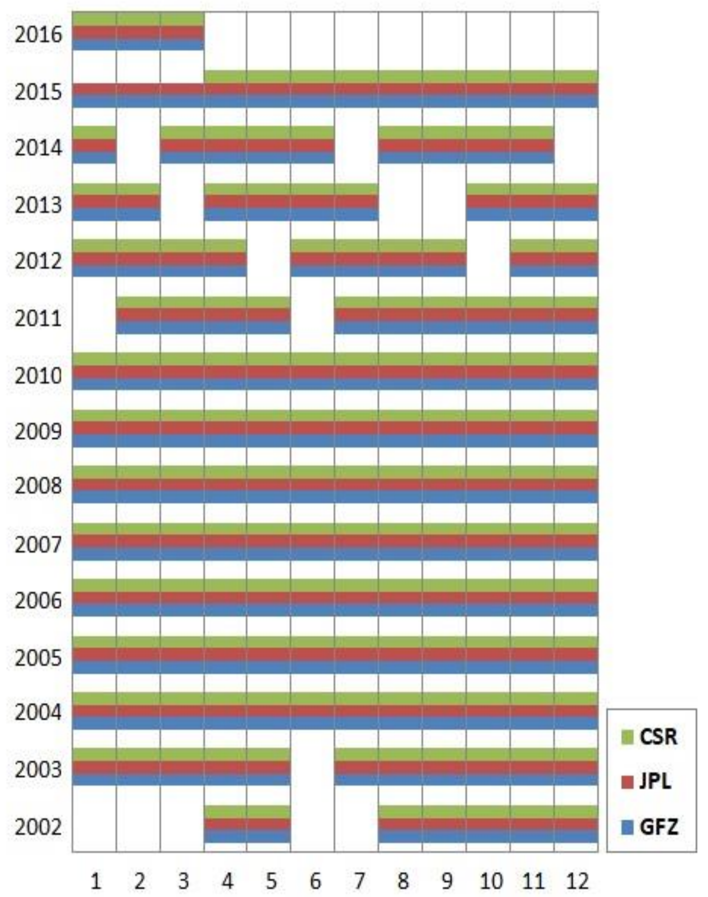
The main aim of this contribution is to study the performance of de-correlation filters (DDK1—DDK8) applied to reduce the noise in RL05 GRACE-based GGMs as well as to select the most suitable GRACE-based GGM time series to estimate mass variations within the Earth system in Turkey.

Materials & Methods

12 points represent different climate features and regions were selected.



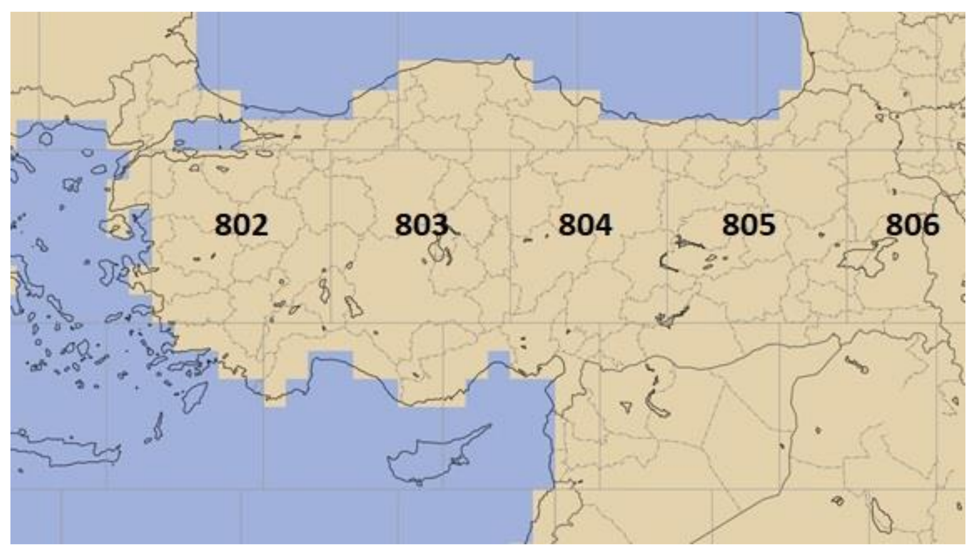
Attainability of RL05 GRACE-based GGMs from the CSR, GFZ, and JPL centers



Why CSR, JPL, GFZ Data

- They are the official GRACE Science Data System continuously releases monthly GRACE-based GGMs.
- CSR, GFZ and JPL monthly GRACE-based GGMs cover a longer period compared to other scientific teams.

- WaterGAP (Water Global Assesment and Prognosis) Global Hydrological Model (WGHM) and mascon solutions produced by Jet Propulsion Laboratory were used as control data.
- *dΔEWT* values obtained by formulae were tested in the study area by means of the control data.



FORMULAE

$$EWT^{(GRACE)} = \frac{R \cdot \rho_{av}}{3} \sum_{n=0}^{N_{max}} \left(\frac{2n+1}{1+k_n}\right) \sum_{m=0}^{n} \overline{Y}_{nm}(\varphi,\lambda)$$

$$\Delta EWT_i^{(GRACE)} = EWT_i^{(GRACE)} - EWT^{(GRACE)}_{mean}$$

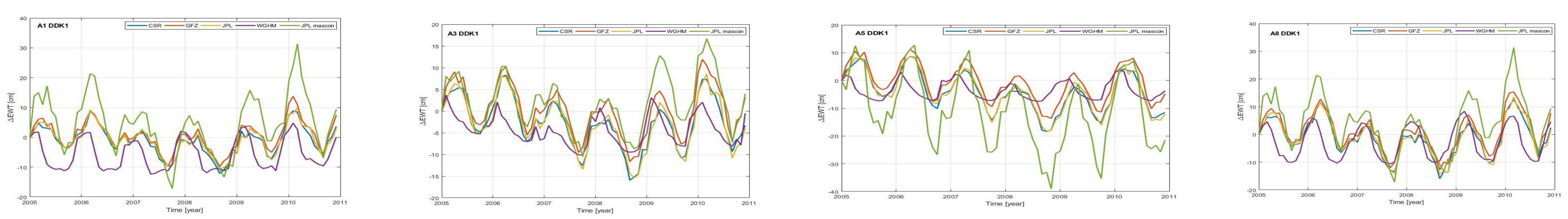
$$\Delta EWT_i^{(WGHM)} = EWT_i^{(WGHM)} - EWT^{(WGHM)}_{mean}$$

$$d\Delta EWT_i = \Delta EWT_i^{(WGHM)} - \Delta EWT_i^{(GRACE)}$$

- Mascons number #:802, #:803, #:804, #:805 and #:806 were used in the investigation.

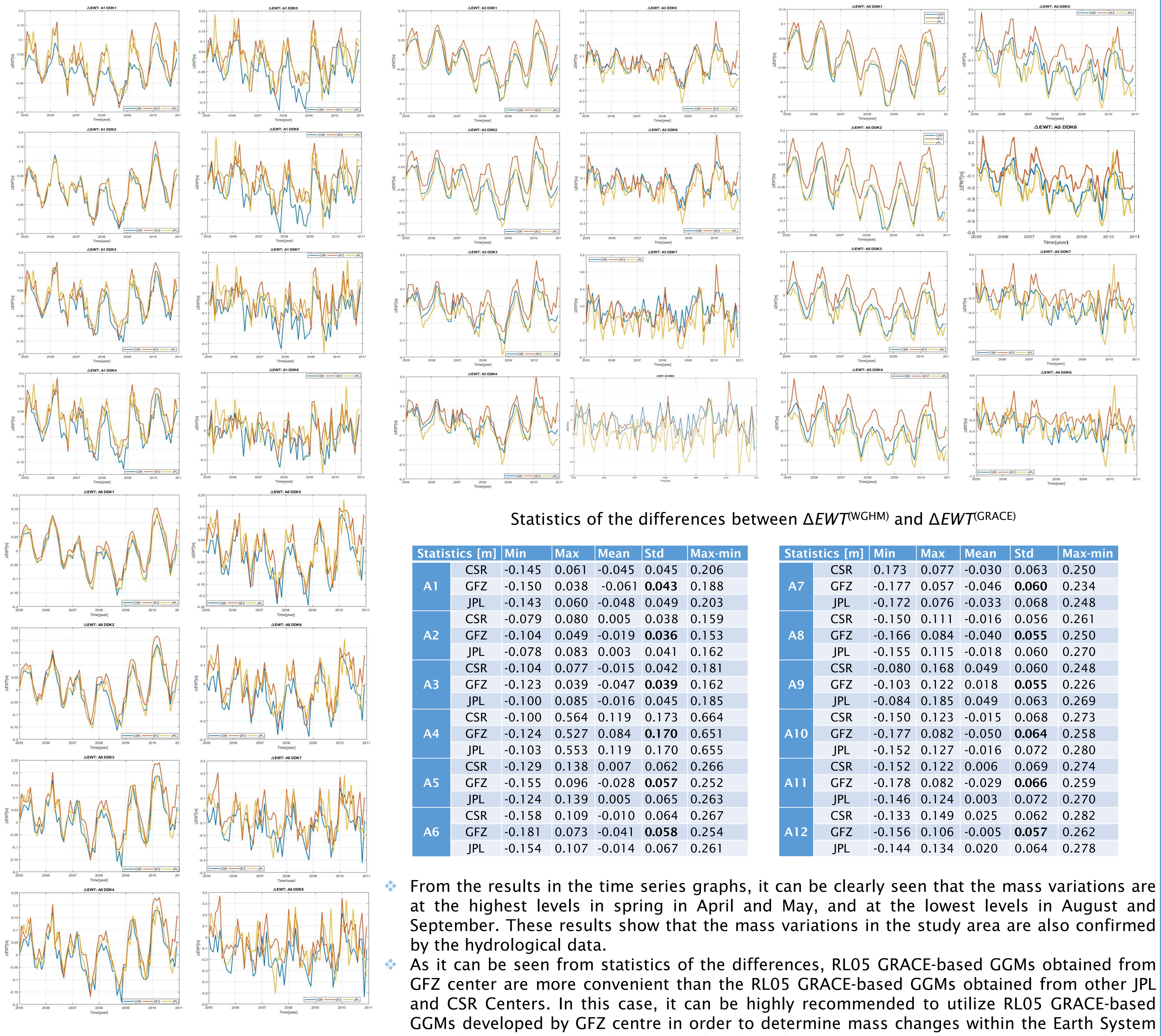
Results

Time series of ΔEWT obtained at points 1,3,5,8 using CSR, GFZ, JPL GRACE-based GGMs, WGHM and JPL mascons.



Results

Time series of ΔEWT obtained at points 1,3,5,8 using CSR, GFZ and JPL GRACE-based GGMs and DDK1-DDK8 filters



Statistics of the differences between $\Delta EWT^{(WGHM)}$ and $\Delta EWT^{(GRACE)}$

Statistics [m]		Min	Max	Mean	Std	Max-min
A1	CSR	-0.145	0.061	-0.045	0.045	0.206
	GFZ	-0.150	0.038	-0.061	**0.043**	0.188
	JPL	-0.143	0.060	-0.048	0.049	0.203
A2	CSR	-0.079	0.080	0.005	0.038	0.159
	GFZ	-0.104	0.049	-0.019	**0.036**	0.153
	JPL	-0.078	0.083	0.003	0.041	0.162
A3	CSR	-0.104	0.077	-0.015	0.042	0.181
	GFZ	-0.123	0.039	-0.047	**0.039**	0.162
	JPL	-0.100	0.085	-0.016	0.045	0.185
A4	CSR	-0.100	0.564	0.119	0.173	0.664
	GFZ	-0.124	0.527	0.084	**0.170**	0.651
	JPL	-0.103	0.553	0.119	0.170	0.655
A5	CSR	-0.129	0.138	0.007	0.062	0.266
	GFZ	-0.155	0.096	-0.028	**0.057**	0.252
	JPL	-0.124	0.139	0.005	0.065	0.263
A6	CSR	-0.158	0.109	-0.010	0.064	0.267
	GFZ	-0.181	0.073	-0.041	**0.058**	0.254
	JPL	-0.154	0.107	-0.014	0.067	0.261

Statistics [m]		Min	Max	Mean	Std	Max-min
A7	CSR	0.173	0.077	-0.030	0.063	0.250
	GFZ	-0.177	0.057	-0.046	**0.060**	0.234
	JPL	-0.172	0.076	-0.033	0.068	0.248
A8	CSR	-0.150	0.111	-0.016	0.056	0.261
	GFZ	-0.166	0.084	-0.040	**0.055**	0.250
	JPL	-0.155	0.115	-0.018	0.060	0.270
A9	CSR	-0.080	0.168	0.049	0.060	0.248
	GFZ	-0.103	0.122	0.018	**0.055**	0.226
	JPL	-0.084	0.185	0.049	0.063	0.269
A10	CSR	-0.150	0.123	-0.015	0.068	0.273
	GFZ	-0.177	0.082	-0.050	**0.064**	0.258
	JPL	-0.152	0.127	-0.016	0.072	0.280
A11	CSR	-0.152	0.122	0.006	0.069	0.274
	GFZ	-0.178	0.082	-0.029	**0.066**	0.259
	JPL	-0.146	0.124	0.003	0.072	0.270
A12	CSR	-0.133	0.149	0.025	0.062	0.282
	GFZ	-0.156	0.106	-0.005	**0.057**	0.262
	JPL	-0.144	0.134	0.020	0.064	0.278

- From the results in the time series graphs, it can be clearly seen that the mass variations are at the highest levels in spring in April and May, and at the lowest levels in August and September. These results show that the mass variations in the study area are also confirmed by the hydrological data.
- As it can be seen from statistics of the differences, RL05 GRACE-based GGMs obtained from GFZ center are more convenient than the RL05 GRACE-based GGMs obtained from other JPL and CSR Centers. In this case, it can be highly recommended to utilize RL05 GRACE-based GGMs developed by GFZ centre in order to determine mass changes within the Earth System in Turkey compared to other CSR and JPL-based GGMs.

Conclusion

- The results obtained indicate that DDK1 and DDK2 filters are more suitable to reduce the noise contained in RL05 GRACE-based GGMs than DDK3-DDK8 filters as well as more effective to retrieve mass variations with the Earth system in the study area.
- The results of the comparison between equivalent water thickness variations also demonstrate the superiority of RL05 GRACE-based GGMs developed by GFZ centre to estimate temporal mass variations, over other GGM time series analyzed.

Acknowledgement

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