Supplementary Information for

High resolution mapping of ice mass loss in the Gulf of Alaska from constrained forward modelling of GRACE data

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Table S1: Synthetic mass allocated and recovered by the inversion for each mascon. Three mascon delineations are tested (Fig. 2) to account for the spatial heterogeneity of glacial mass loss. The use of a supplementary diffuse mass to discriminate soil moisture and other low frequency signals from glacial mass change signals is also tested.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
5 Mascons – 55,000 km^2-scale														
Mass allocated (Gt/yr)	-7.58	-6.27	-9.77	-7.86	-11.48									
Recovery without diffused mass (Gt/yr)	-7.61	-6.43	-10.59	-7.91	-11.50									
Recovery with diffused mass (Gt/yr)	-8.12	-6.52	-10.74	-8.10	-11.65									
9 Mascons – 30,000 km^2-scale														
Mass allocated (Gt/yr)	-3.30	-5.09	-4.88	-3.78	-3.09	-6.96	-11.11	-1.57	-3.18					
Recovery without diffused mass (Gt/yr)	-3.50	-4.92	-4.56	-3.68	-3.25	-8.04	-10.71	-2.22	-3.23					
Recovery with diffused mass (Gt/yr)	-3.72	-5.18	-4.77	-3.73	-3.34	-8.17	-10.77	-2.27	-3.23					
14 Mascons – 20,000 km^2-scale														
Mass allocated (Gt/yr)	-2.15	-3.16	-3.07	-2.20	-4.76	-7.61	-4.19	-4.05	-2.71	-1.11	-2.00	-1.18	-3.09	-1.68
Recovery without diffused mass (Gt/yr)	-2.15	-3.05	-3.18	-3.43	-4.29	-7.86	-4.10	-3.75	-2.48	-2.06	-2.05	-1.13	-3.10	-1.71
Recovery with diffused mass (Gt/yr)	-2.54	-2.81	-3.80	-2.73	-5.02	-7.44	-4.60	-3.49	-2.75	-1.86	-1.90	-1.32	-3.16	-1.56

Table S2: Mass losses (mean of the three solutions ±stdev) from this study after selecting a spatial subset corresponding to the delineation used by Arendt et al. (2013). Ice mass loss maps from this study were overlaid over the 6 mascons delineated by Arendt et al. (2013; see Fig. 7A) and corresponding mass losses were isolated.

Mascon number from Arendt et al. (2013; see Fig. 7B)	Name of glacier area	Mass loss (Gt/yr) form our study		
		55,000-km-scale	30,000-km-scale	20,000-km-scale
1	Southwestern Alaska Range	2.6 ± 0.3	3.0 ± 0.2	2.8 ± 0.4
2	Central Alaska Range	1.4 ± 0.2	1.1 ± 0.3	1.5 ± 0.2
3	Eastern Alaska Range	1.0 ± 0.1	1.1 ± 0.09	1.5 ± 0.2
4	Chugach Mountains	8.9 ± 0.07	7.9 ± 0.3	7.7 ± 0.3
5	Wrangell Mountains	1.8 ± 0.2	2.0 ± 0.2	1.7 ± 0.06
6	Saint Elias Mountains	17.8 ± 0.7	16.7 ± 0.9	17.4 ± 1.4
7	Juneau Icefield	1.9 ± 0.1	2.1 ± 0.3	2.6 ± 0.6
8	Stikine Icefield	3.4 ± 0.4	3.5 ± 0.4	2.9 ± 0.5

Table S3: Comparison of mass losses obtained by Luthcke et al. (2008) with results from this study. Ice mass loss maps from this study were overlaid over mascons 6, 7, and 10 delineated by Luthcke et al. (2008; see Fig. 7A) and corresponding mass losses were isolated.

Mascon number (see Luthcke et al. 2008; Fig. 7A)	Mass loss (Gt/yr)				
	Luthcke et al. (2008)		Results from this study		
	April 2003 – March 2006	April 2003 – March 2007	55,000-km-scale	30,000-km-scale	20,000-km-scale
1	4.0 ± 0.5	3.6 ± 0.3	1.8 ± 0.2	1.5 ± 0.4	2.0 ± 0.3
2	4.7 ± 0.5	4.2 ± 0.3	0.3 ± 0.03	0.4 ± 0.03	0.5 ± 0.07
3	5.7 ± 0.5	5.2 ± 0.4	1.0 ± 0.1	1.1 ± 0.09	1.3 ± 0.1
4	6.0 ± 0.5	4.8 ± 0.4	1.6 ± 0.2	2.1 ± 0.08	1.9 ± 0.3
5	7.5 ± 0.5	6.4 ± 0.4	7.0 ± 0.05	6.5 ± 0.2	6.1 ± 0.3
6	9.5 ± 0.6	8.2 ± 0.5	8.1 ± 0.3	7.0 ± 0.4	9.4 ± 0.7
7	11.2 ± 0.7	9.6 ± 0.6	7.3 ± 0.4	7.6 ± 0.5	6.3 ± 0.7
8	6.5 ± 0.6	4.8 ± 0.5	0.1 ± 0.01	0.1 ± 0.0	0.2 ± 0.01
9	7.3 ± 0.6	5.6 ± 0.5	1.3 ± 0.01	0.5 ± 0.04	0.7 ± 0.07
10	15.3 ± 0.7	12.9 ± 0.8	3.8 ± 0.1	3.8 ± 0.1	3.6 ± 0.4
11	14.3 ± 0.6	11.6 ± 0.7	3.9 ± 0.3	4.1 ± 0.4	4.2 ± 1.0
12	10.2 ± 1.1	7.4 ± 0.9	3.3 ± 0.4	3.2 ± 0.4	2.6 ± 0.4

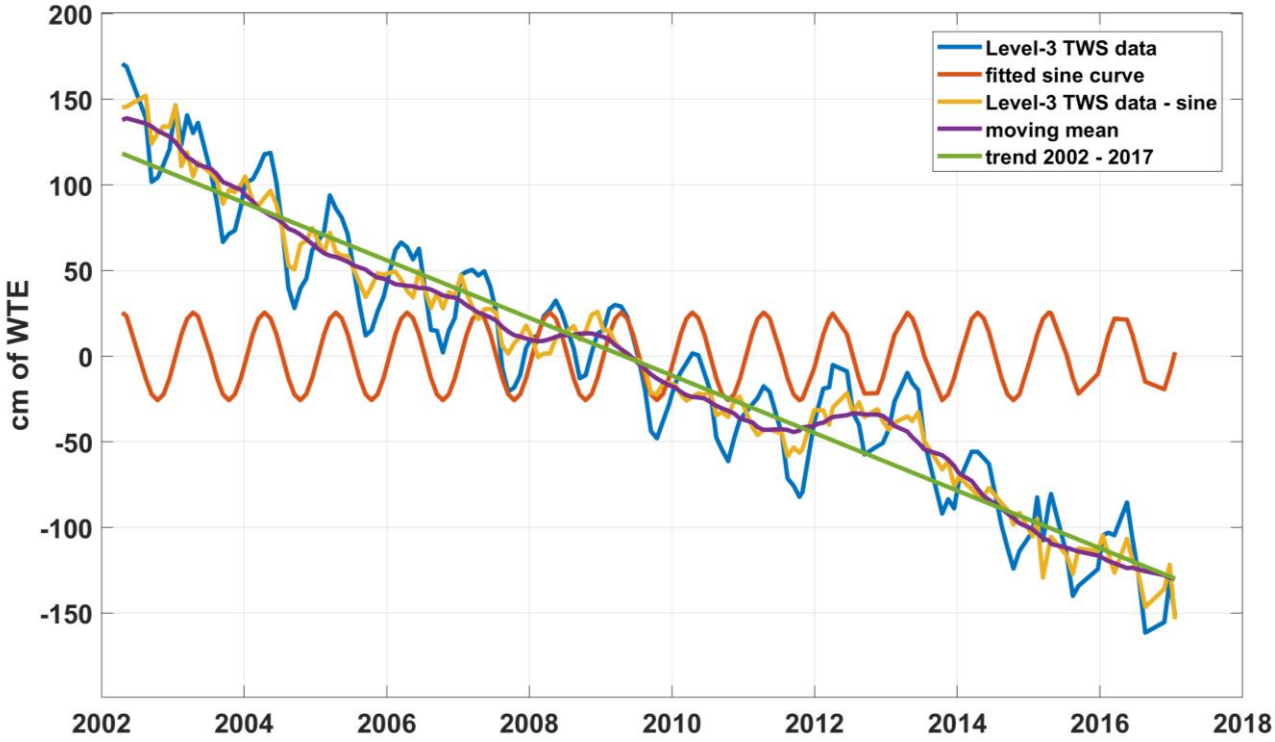

Figure S1: Trend computation performed over all TWS data time-series (blue line). First, seasonal variations are removed by fitting a sine curve with a 1-year period (orange line). It is subtracted from the original data (purple line). Then, a 13-month moving average filter is applied (green line). Finally, a line ax + b is fitted, where (a) represents the trend.

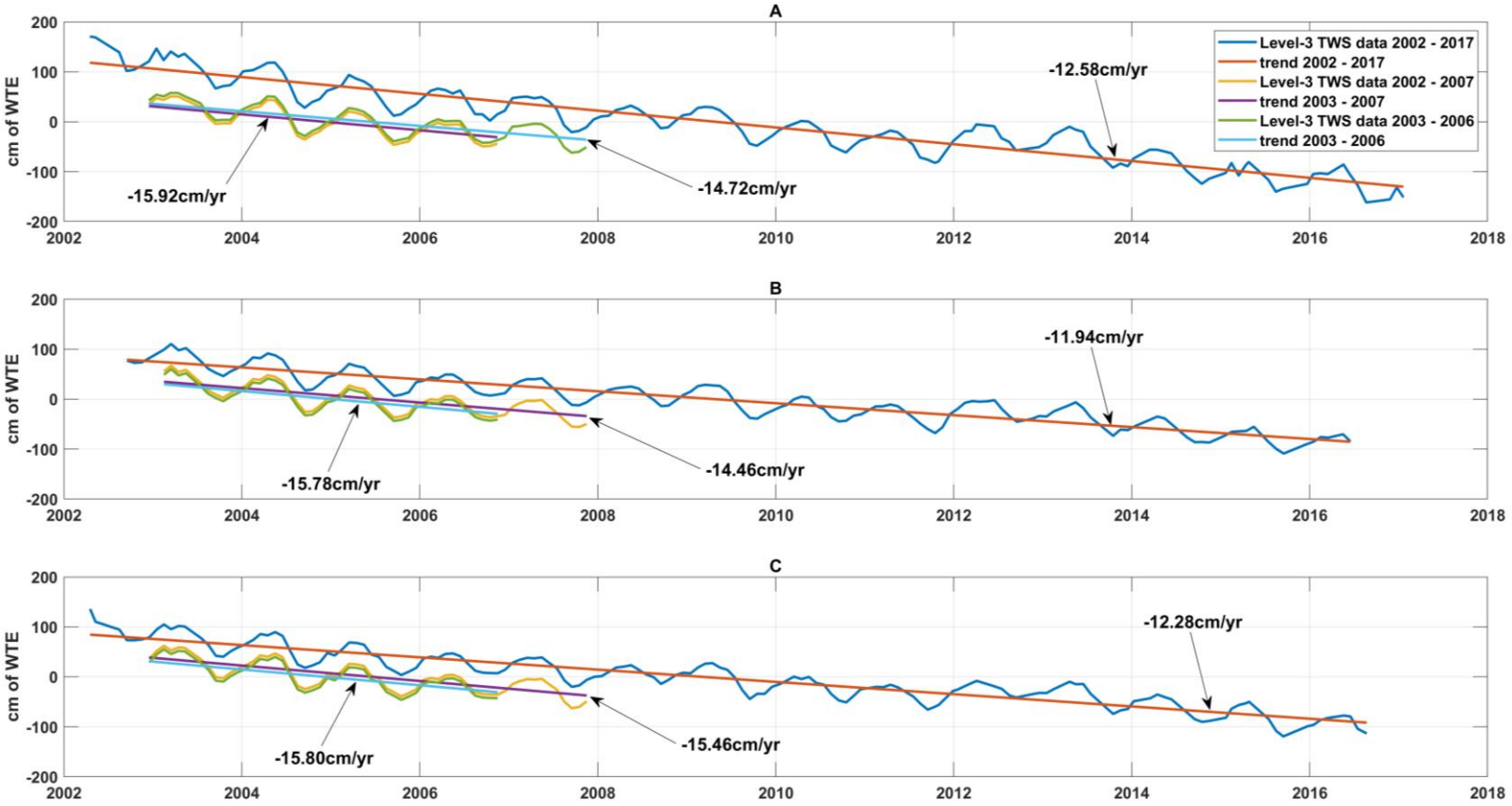

Figure S2: Time-series and trends of TWS from the three GRACE solutions used in the study: CSR-MASC (A), GRGS (B) and T96DDK8 (C). These time-series represent the signal over the Saint Elias Mountains (corresponding to the center of mascons 6, 7, and 10 in Luthcke et al. 2008) and the trends correspond to three different time-periods. The solutions are all at low spatial resolution (i.e. before inversion). The mean trends of TWS are -15.83, -14.88 and -12.26 cm/yr for 2003-2006, 2003-2007 and 2002-2017, respectively. We note that the trend decreases by 22.5 and 17.6% while considering partial time-series of 3 and 4 years vs. considering the full length of GRACE data.

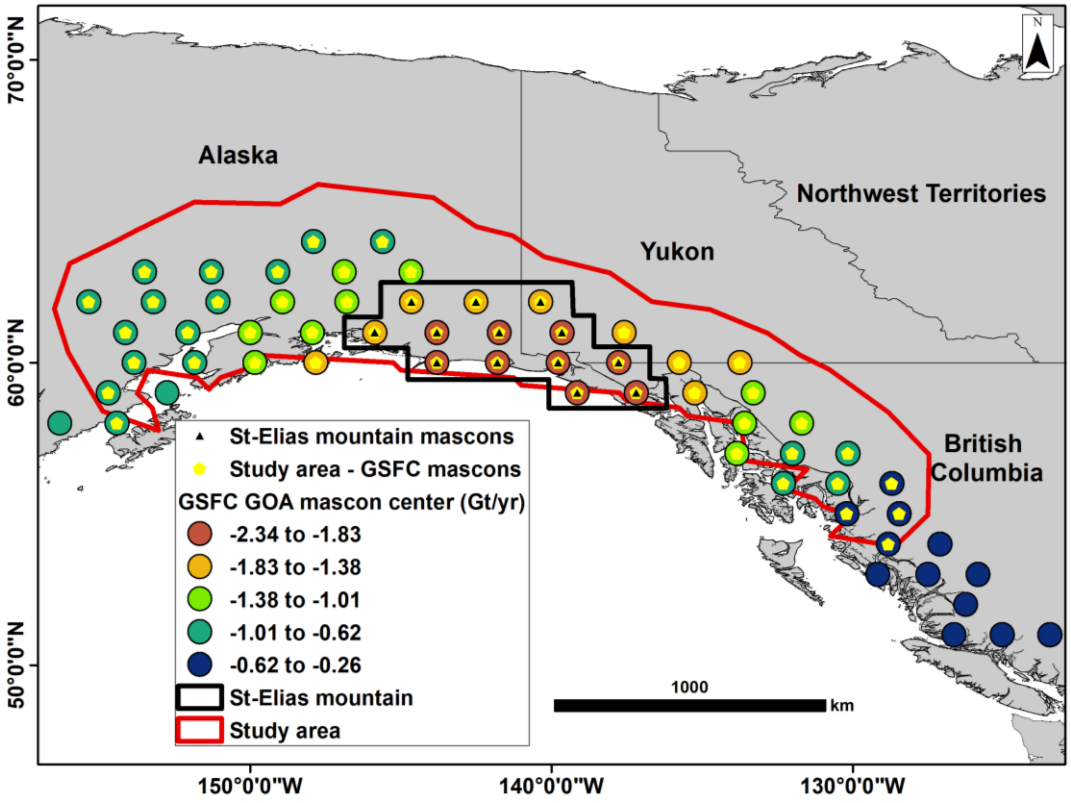

Figure S3: GRACE-derived TWS trend over the Gulf of Alaska from GSFC global mascons data (v2.4; Luthcke et al., 2013). The centers of mascons belonging to our study area (red outline) are specified by the yellow stars. We used mascons 6, 7 and 10 from Luthcke et al. (2008; Fig. 7A) to identify the centre of mascons belonging to Saint Elias Mountains (black triangles).