Supplementary Materials: Evaluating GRACE Mass Change Time Series for the Antarctic and Greenland Ice Sheet—Methods and Results

Andreas Groh [1,*], Martin Horwath [1], Alexander Horvath [2], Rakia Meister [3], Louise Sandberg Sørensen [3], Valentina R. Barletta [3], René Forsberg [3], Bert Wouters [4,†], Pavel Ditmar [5], Jiangjun Ran [5,‡], Roland Klees [5], Xiaoli Su [6,§], Kun Shang [6], Junyi Guo [6], C.K. Shum [6,7], Ernst Schrama [8] and Andrew Shepherd [9]

1. Antarctic Ice Sheet

1.1. GRACE-derived mass change time series

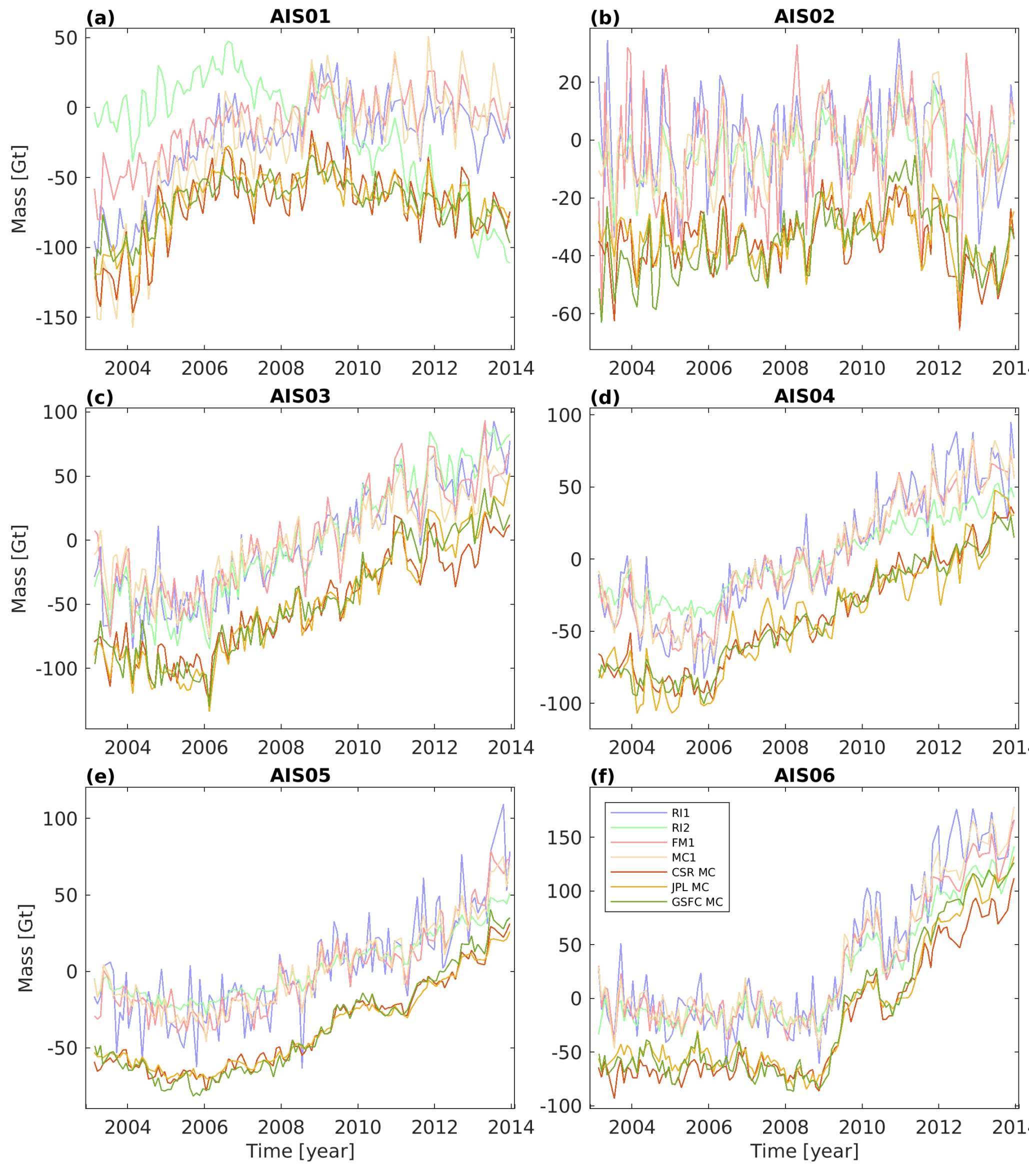

Figure S1. Comparison of GRACE-derived mass change time series for different drainage basins of the Antarctic Ice Sheet from the participants (faint colours) with alternative time series extracted from the mascon products provided by CSR, JPL and GSFC (bold colours). The alternative results are shifted along the y-axis to increase readability.

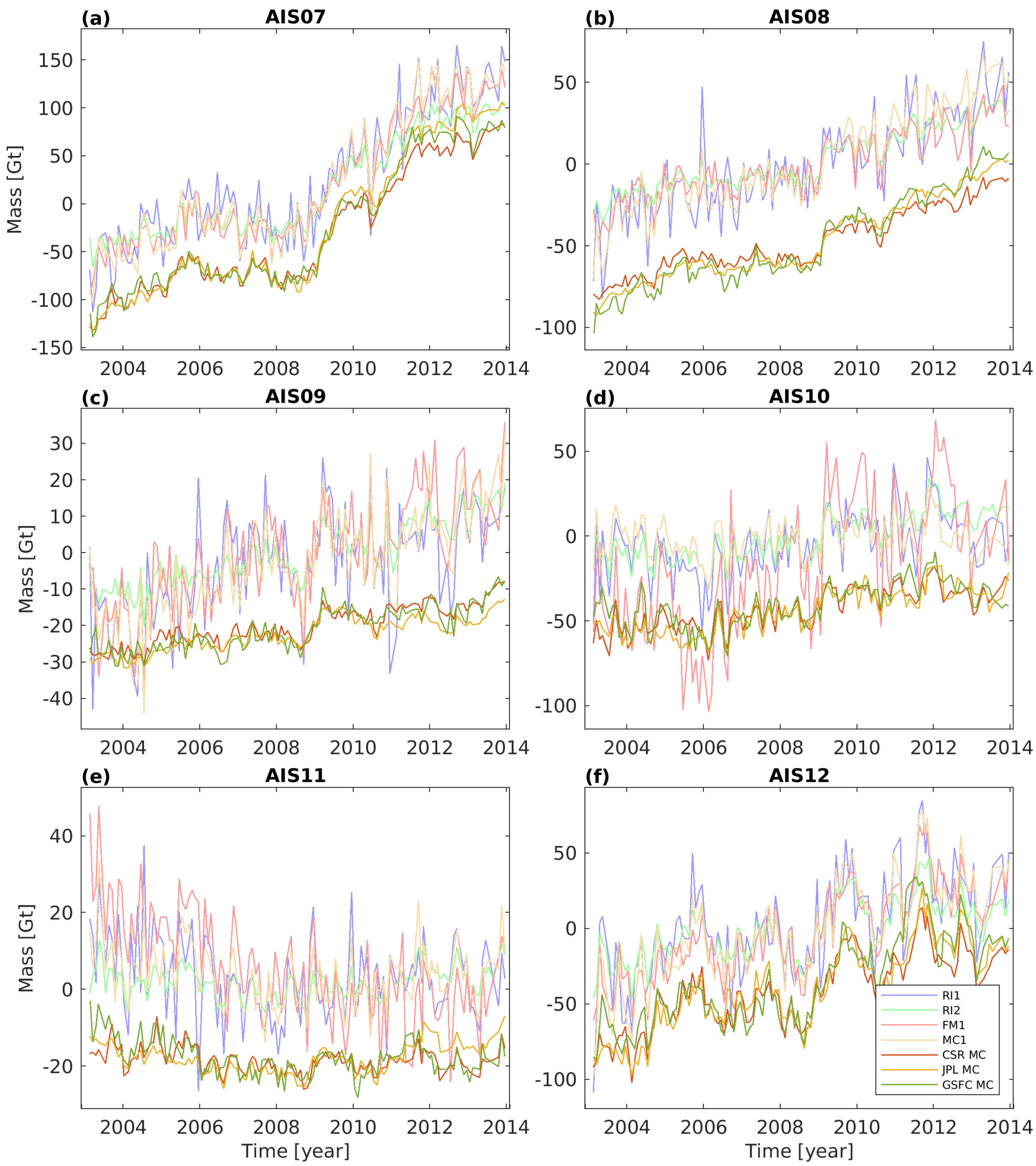

Figure S2. Comparison of GRACE-derived mass change time series for different drainage basins of the Antarctic Ice Sheet from the participants (faint colours) with alternative time series extracted from the mascon products provided by CSR, JPL and GSFC (bold colours). The alternative results are shifted along the y-axis to increase readability.

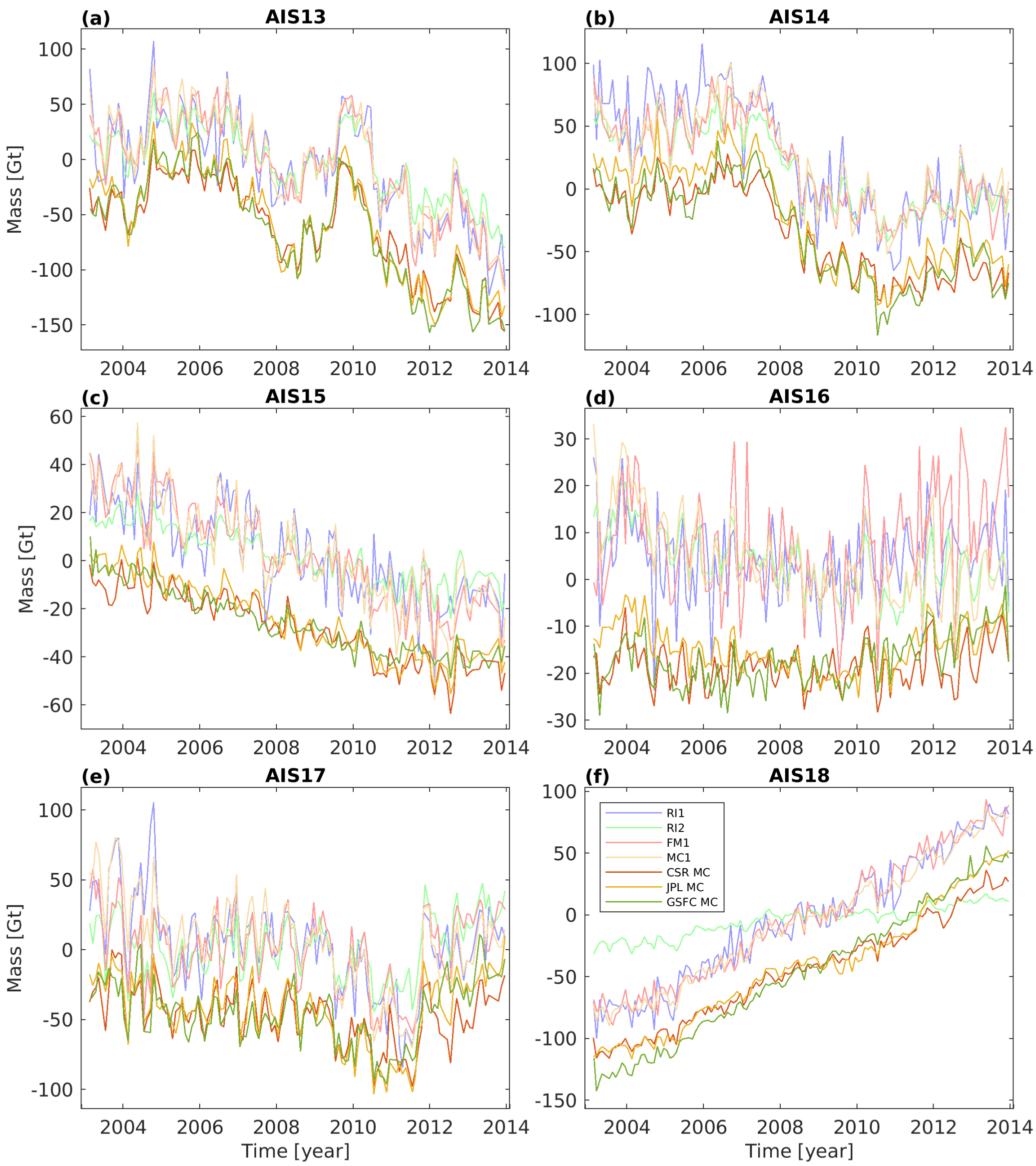

Figure S3. Comparison of GRACE-derived mass change time series for different drainage basins of the Antarctic Ice Sheet from the participants (faint colours) with alternative time series extracted from the mascon products provided by CSR, JPL and GSFC (bold colours). The alternative results are shifted along the y-axis to increase readability.

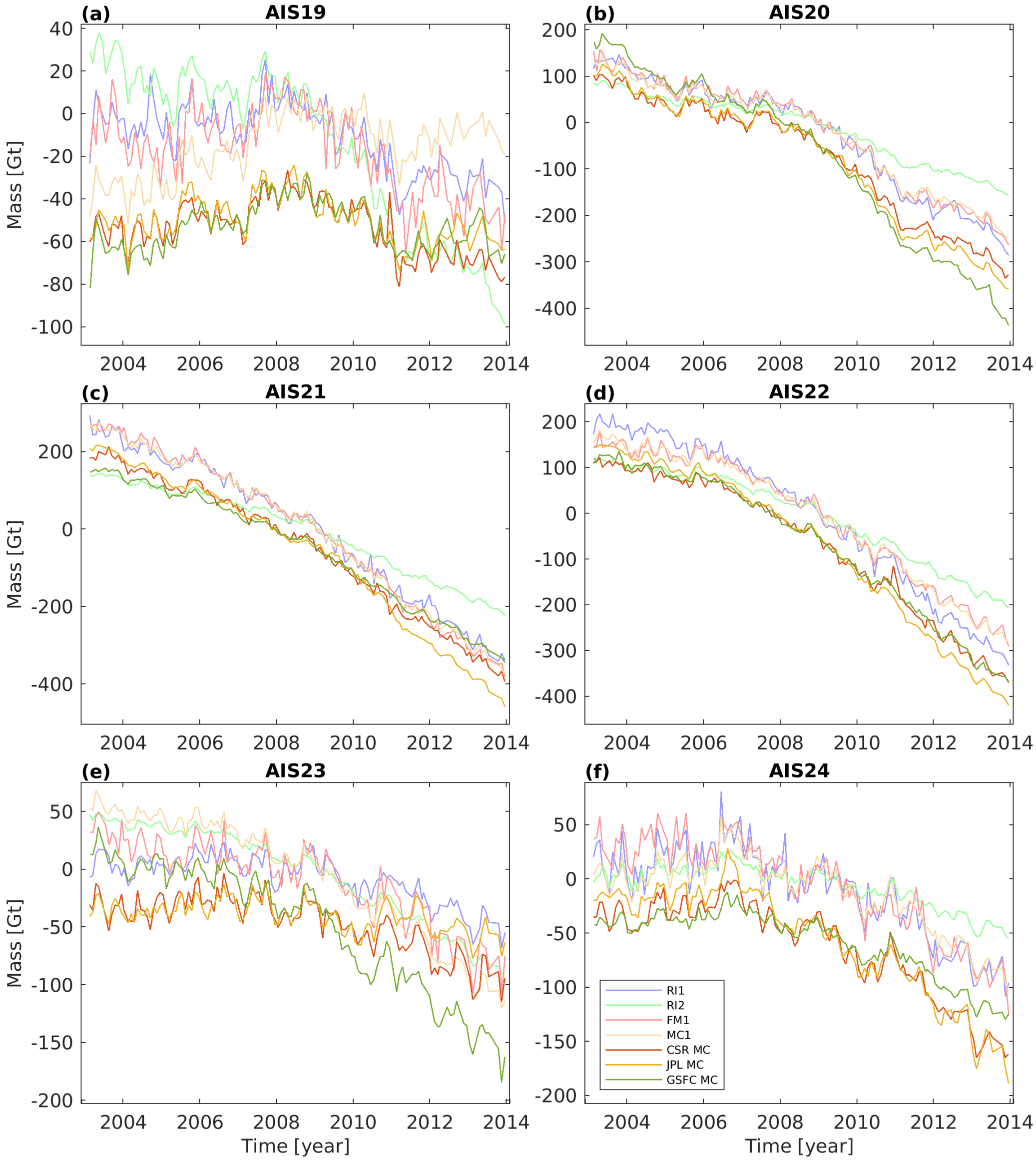

Figure S4. Comparison of GRACE-derived mass change time series for different drainage basins of the Antarctic Ice Sheet from the participants (faint colours) with alternative time series extracted from the mascon products provided by CSR, JPL and GSFC (bold colours). The alternative results are shifted along the y-axis to increase readability.

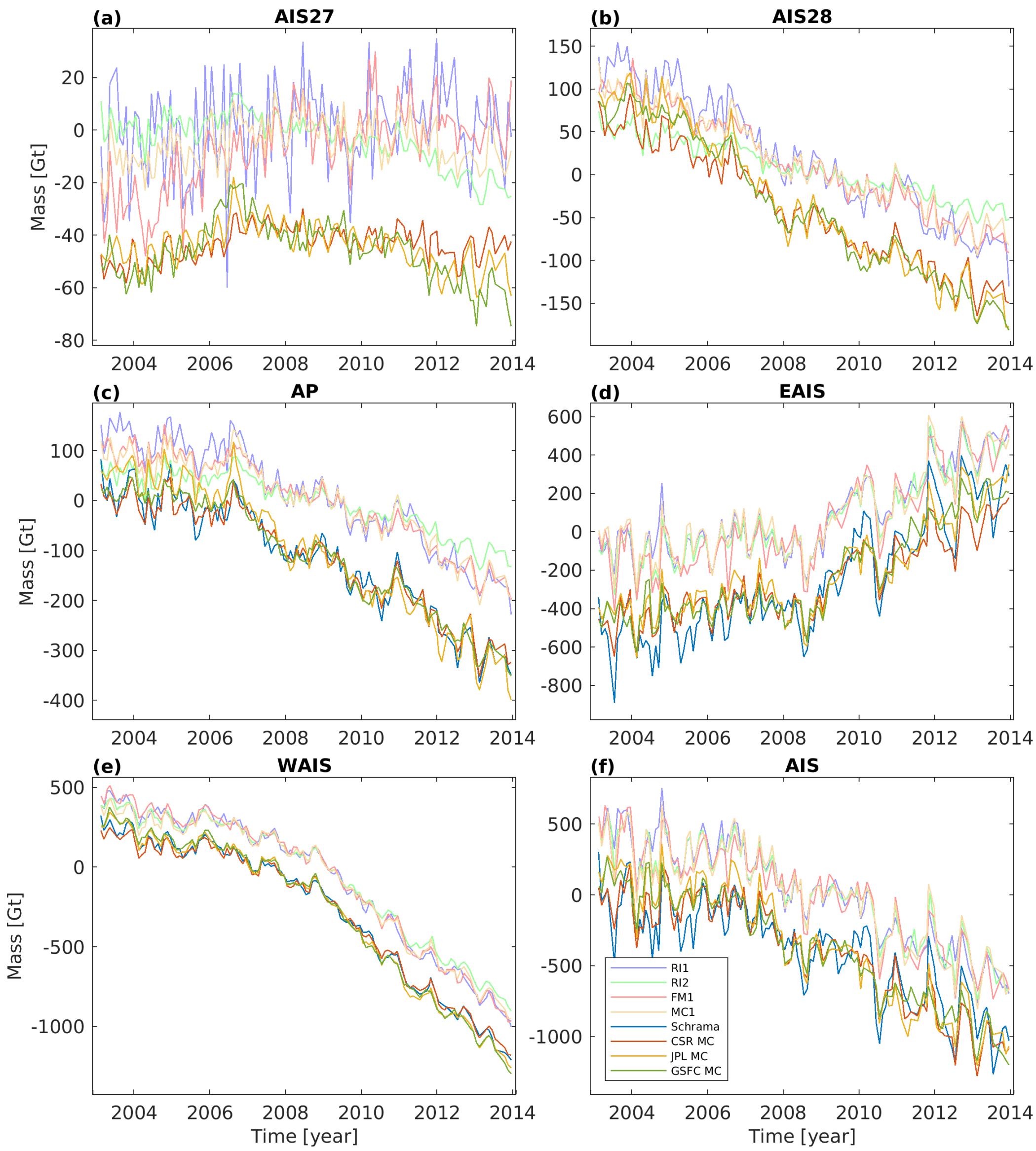

Figure S5. Comparison of GRACE-derived mass change time series for different drainage basins of the Antarctic Ice Sheet from the participants (faint colours) with alternative results (bold colours), namely the updated time series from Schrama *et al.* [1] and time series extracted from the mascon products provided by CSR, JPL and GSFC. The alternative results are shifted along the y-axis to increase readability.

1.2. Temporal variations

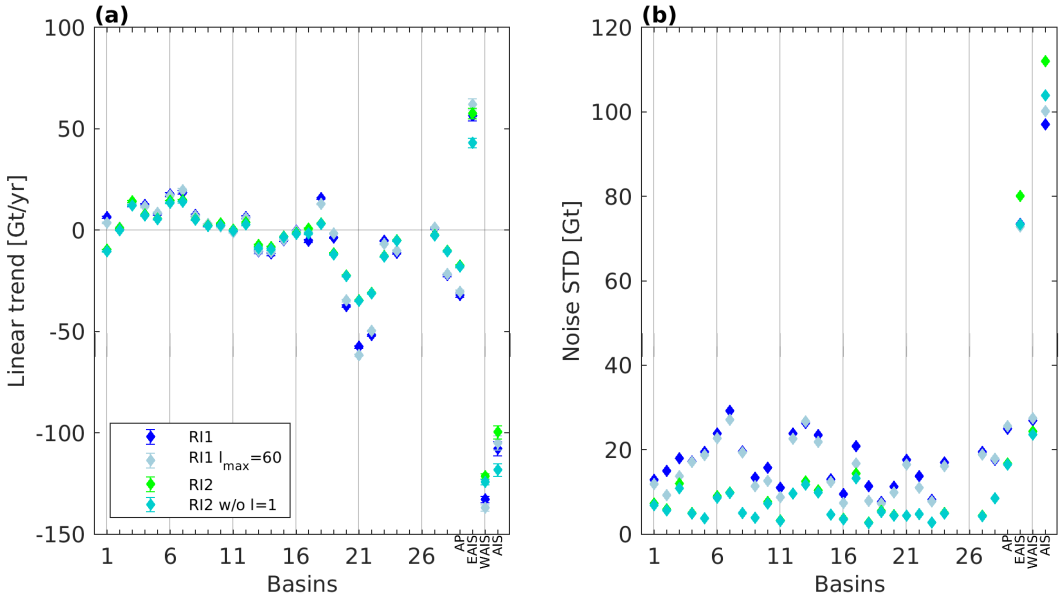

Figure S6. (a) Linear trends in ice mass change derived using a consistent linear, periodic (1 yr, 1/2 yr, 161/365.25 yr) and quadratic model. **(b)** Noise level, given in terms of the scaled standard deviation of the noise time series, derived from the mass change time series. Both panels compare results for all AIS basins and aggregations from different variants of methods RI1 ($l_{\max} = 90$: dark blue; $l_{\max} = 60$: light blue) and RI2 (incl. degree one: light green; excl. degree one: cyan).

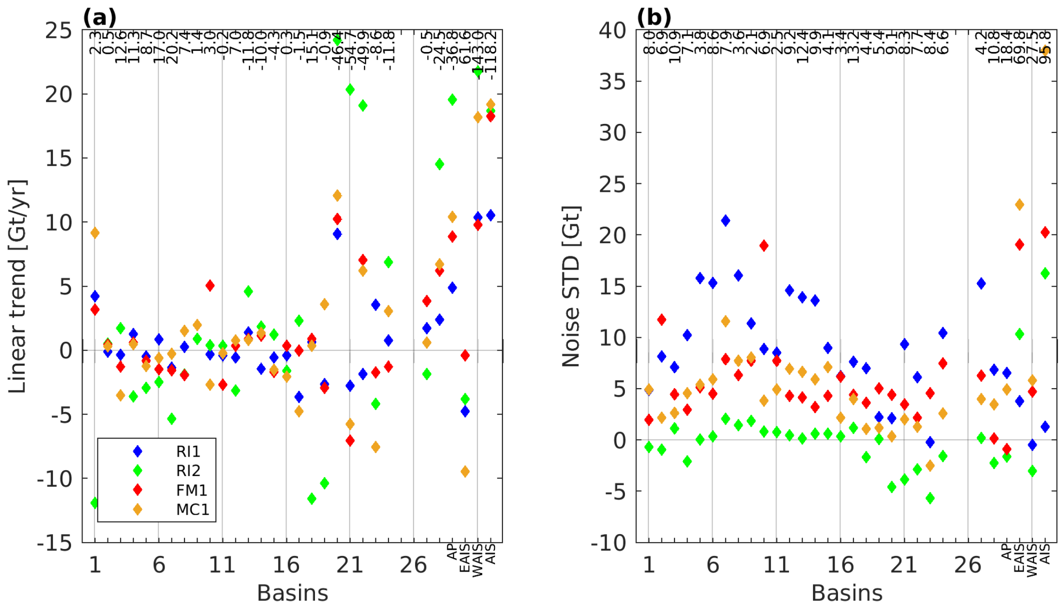

Figure S7. **(a)** Differences between linear trends in ice mass change derived from the products by the participants and the mean of the estimates derived from the mascon products by CSR, JPL and GSFC. Mean values from the mascon products are indicated by numbers at the top margin (units: gigatons per year). Linear trends are calculated using a consistent linear, periodic (1 yr, 1/2 yr, 161/365.25 yr) and quadratic model. **(b)** Differences between the noise level, given in terms of the scaled standard deviation of the noise time series, derived from the products of the participants and the RMS of the corresponding estimates from the mascon products by CSR, JPL and GSFC. RMS values from the mascon products are indicated by numbers at the top margin (units: gigatons). Both panels compare results for all AIS basins and aggregations.

Table S1. Temporal changes and noise level of mass change time series for the AIS drainage basins AIS01–AIS12 generated by the participants, by Schrama *et al.* [1] and extracted from the mascon products provided by CSR, JPL and GSFC. Temporal changes are derived from the following model: $y(t) = a + bt + \sum_{i=1}^{3} (c_i \sin(2\pi t/T_i) + d_i \cos(2\pi t T_i)) + et^2/2$, $T_i = 1\,yr, 1/2\,yr, 161/365.25\,yr$, with t: linear trend, e: acceleration, A_1: annual amplitude ($A_1 = \sqrt{c_1^2 + d_1^2}$), A_2: semi-annual amplitude ($A_2 = \sqrt{c_2^2 + d_2^2}$), A_3: 161-day amplitude ($A_3 = \sqrt{c_3^2 + d_3^2}$). Uncertainties are formal errors from the least squares adjustment. Scaled standard deviations of the noise time series (NSTD) are used a measure of the noise level as described in Section 2.4 (main document).

Region		AIS01	AIS02	AIS03	AIS04	AIS05	AIS06	AIS07	AIS08	AIS09	AIS10	AIS11	AIS12
t [Gt/yr]	RI1	6.5±0.5	0.4±0.4	12.3±0.5	12.6±0.6	8.2±0.5	17.9±0.8	18.9±0.9	7.6±0.5	2.3±0.4	2.7±0.5	-0.6±0.3	6.5±0.8
	RI2	-9.6±0.3	1.0±0.2	14.3±0.4	7.8±0.2	5.8±0.1	14.5±0.4	14.9±0.5	5.5±0.2	2.3±0.1	3.4±0.2	0.2±0.1	3.9±0.4
	FM1	5.5±0.3	0.9±0.5	11.4±0.5	12.0±0.4	7.9±0.3	15.6±0.6	18.7±0.7	5.4±0.3	3.4±0.3	8.0±0.9	-2.8±0.3	7.4±0.5
	MC1	11.5±0.5	0.8±0.3	9.1±0.5	11.8±0.5	7.5±0.3	16.4±0.6	20.0±0.8	8.9±0.4	3.4±0.3	0.3±0.3	-0.4±0.2	7.8±0.6
	CSR MC	3.3±0.4	-0.2±0.2	11.2±0.4	11.3±0.3	8.6±0.2	16.3±0.5	18.9±0.5	5.9±0.2	1.5±0.1	2.9±0.2	-0.3±0.1	6.0±0.4
	JPL MC	2.3±0.3	0.1±0.2	13.5±0.4	11.5±0.4	8.0±0.2	16.5±0.5	22.0±0.6	7.7±0.2	1.2±0.1	3.3±0.2	0.4±0.1	7.5±0.4
	GSFC MC	1.3±0.3	1.5±0.3	13.2±0.4	11.2±0.2	9.5±0.2	18.3±0.6	19.8±0.6	8.5±0.2	1.6±0.1	2.7±0.3	-0.5±0.1	7.6±0.5
e [Gt/yr^2]	RI1	-4.2±0.3	-0.3±0.3	1.5±0.4	2.0±0.4	2.4±0.4	6.9±0.6	3.4±0.6	0.6±0.4	-0.6±0.3	0.0±0.3	0.8±0.2	-0.3±0.5
	RI2	-4.8±0.2	-0.4±0.1	1.9±0.3	1.1±0.1	1.6±0.1	4.6±0.3	2.8±0.3	0.6±0.1	0.2±0.1	0.5±0.2	0.4±0.1	-0.4±0.3
	FM1	-2.2±0.2	-0.2±0.4	1.4±0.4	1.6±0.3	2.4±0.2	6.0±0.4	3.4±0.5	0.2±0.2	0.0±0.2	-0.2±0.6	1.0±0.2	-0.2±0.4
	MC1	-4.5±0.3	-0.7±0.2	1.3±0.4	1.8±0.3	2.3±0.2	6.6±0.4	3.4±0.5	0.8±0.3	-0.1±0.2	-0.2±0.2	0.8±0.1	-0.6±0.4
	CSR MC	-4.0±0.3	-0.9±0.2	1.0±0.3	1.5±0.2	2.2±0.1	5.2±0.3	3.0±0.4	0.6±0.1	0.1±0.0	-0.2±0.2	0.2±0.1	-0.5±0.3
	JPL MC	-3.7±0.2	-0.3±0.2	1.9±0.3	1.4±0.3	2.3±0.1	6.8±0.4	4.0±0.4	0.9±0.1	-0.2±0.1	0.0±0.2	0.6±0.1	-0.6±0.3
	GSFC MC	-3.4±0.2	-1.0±0.2	1.9±0.3	1.2±0.2	2.8±0.2	7.1±0.4	3.8±0.4	1.0±0.2	0.1±0.1	0.2±0.2	0.5±0.1	0.5±0.4
A_1 [Gt]	RI1	2.2±2.0	3.7±1.8	4.7±2.3	7.0±2.5	3.0±2.3	3.0±3.4	9.6±4.0	2.6±2.2	2.0±1.6	0.8±2.1	2.1±1.3	9.0±3.3
	RI2	6.0±1.4	3.5±0.8	3.0±1.9	1.6±0.9	0.7±0.6	0.7±1.8	1.5±2.0	1.0±0.7	0.3±0.5	2.2±1.1	0.4±0.4	4.9±1.7
	FM1	3.5±1.3	11.5±2.2	10.0±2.2	0.8±1.8	1.5±1.3	2.4±2.4	2.8±2.8	4.7±1.2	5.1±1.2	12.7±3.8	2.3±1.2	8.2±2.2
	MC1	3.6±2.0	4.7±1.3	3.6±2.2	3.2±2.0	0.7±1.3	2.6±2.6	6.1±3.2	1.5±1.5	1.4±1.3	1.1±1.4	1.2±0.9	10.3±2.5
	CSR MC	4.2±1.5	3.9±1.0	3.9±1.8	1.3±1.3	2.0±0.8	1.8±2.0	4.7±2.3	2.1±0.7	1.2±0.3	1.1±0.9	1.1±0.4	6.6±1.8
	JPL MC	4.5±1.5	4.9±1.0	5.0±1.8	10.2±1.7	1.0±0.7	5.2±2.2	2.3±2.6	0.8±0.7	0.4±0.3	2.7±1.0	0.6±0.3	6.1±1.9
	GSFC MC	2.7±1.2	1.7±1.2	5.5±1.8	6.1±1.0	2.4±1.0	4.2±2.4	3.9±2.6	3.9±0.9	1.1±0.4	3.5±1.2	1.4±0.4	4.6±2.2

continued on next page

Table S1. – continued from previous page

Region		AIS01	AIS02	AIS03	AIS04	AIS05	AIS06	AIS07	AIS08	AIS09	AIS10	AIS11	AIS12
A_2 [Gt]	RI1	5.7±2.0	5.8±1.8	5.1±2.3	4.7±2.5	3.2±2.3	2.5±3.4	1.7±4.0	1.8±2.2	1.6±1.6	4.6±2.0	1.5±1.3	5.6±3.3
	RI2	5.3±1.4	3.7±0.8	5.9±1.9	2.7±0.9	1.2±0.6	2.8±1.8	1.5±2.0	1.4±0.7	0.9±0.5	2.7±1.1	1.4±0.4	4.1±1.7
	FM1	3.1±1.3	8.6±2.2	5.6±2.2	4.0±1.8	3.4±1.3	3.9±2.3	0.8±2.8	2.6±1.2	0.6±1.2	5.6±3.8	2.3±1.2	6.1±2.2
	MC1	6.7±2.0	5.2±1.3	5.8±2.1	5.0±2.0	1.3±1.3	1.7±2.6	2.5±3.2	3.0±1.5	0.9±1.3	3.5±1.4	0.7±0.9	5.5±2.6
	CSR MC	4.8±1.6	4.8±1.0	6.3±1.8	3.8±1.3	2.0±0.8	0.9±2.0	1.4±2.3	1.2±0.7	0.6±0.3	2.7±0.9	1.0±0.4	3.2±1.9
	JPL MC	5.7±1.5	3.6±1.0	5.2±1.8	5.4±1.7	0.7±0.7	1.3±2.2	1.2±2.6	0.8±0.7	0.6±0.3	2.1±1.0	0.7±0.3	2.3±1.9
	GSFC MC	4.0±1.2	5.5±1.2	3.1±1.8	1.4±1.0	1.4±1.0	0.5±2.5	2.2±2.6	1.0±0.9	0.5±0.4	3.2±1.2	1.3±0.4	4.9±2.2
A_3 [Gt]	RI1	3.4±2.0	0.2±1.9	1.3±2.4	1.6±2.6	2.0±2.3	5.6±3.5	2.8±4.0	0.5±2.2	0.5±1.6	0.0±2.1	0.7±1.3	0.2±3.3
	RI2	9.2±1.4	0.8±0.8	6.5±1.9	1.6±0.9	0.9±0.6	4.0±1.8	3.4±2.0	1.7±0.7	0.9±0.5	2.0±1.1	0.9±0.4	3.4±1.7
	FM1	10.2±1.3	1.7±2.2	8.9±2.2	4.2±1.8	3.4±1.4	5.1±2.4	8.9±2.9	2.7±1.3	0.9±1.2	2.7±3.9	1.3±1.2	3.2±2.2
	MC1	19.9±2.1	5.6±1.3	6.3±2.2	2.8±2.1	0.6±1.3	4.5±2.6	8.0±3.2	2.7±1.5	1.9±1.3	2.6±1.5	1.6±0.9	6.1±2.6
	CSR MC	17.4±1.6	2.6±1.1	6.8±1.8	3.0±1.3	1.7±0.8	3.9±2.0	1.7±2.3	0.9±0.7	0.4±0.3	2.9±0.9	0.7±0.4	2.9±1.9
	JPL MC	7.9±1.5	1.2±1.0	2.0±1.8	5.9±1.7	1.4±0.7	1.8±2.2	1.6±2.7	0.6±0.7	0.1±0.3	2.3±1.0	0.4±0.3	0.9±1.9
	GSFC MC	0.2±1.2	0.6±1.2	2.0±1.8	0.6±1.0	0.3±1.0	2.4±2.5	2.5±2.6	0.6±0.9	0.2±0.4	0.7±1.2	0.1±0.4	1.5±2.3
NSTD [Gt]	RI1	12.9	15.1	18.0	17.3	19.6	24.0	29.3	19.7	13.5	15.7	11.0	23.8
	RI2	7.3	6.0	12.0	5.0	3.8	9.0	10.0	5.1	4.0	7.7	3.3	9.7
	FM1	9.9	18.6	15.4	10.1	8.9	13.1	15.8	10.0	9.9	25.9	10.3	13.6
	MC1	12.9	9.1	13.5	11.7	9.2	14.6	19.5	11.4	10.2	10.7	7.5	16.2
	CSR MC	8.7	7.1	10.8	6.5	4.2	9.0	8.0	3.5	1.8	6.5	2.4	8.7
	JPL MC	7.2	6.1	11.0	9.1	2.3	7.5	6.8	2.4	1.4	6.7	1.9	8.7
	GSFC MC	7.9	7.5	10.7	5.2	4.5	9.2	8.7	4.6	2.8	7.3	3.1	10.3

Table S2. Like Table S1 but for drainage basins AIS13–AIS24.

Region		AIS13	AIS14	AIS15	AIS16	AIS17	AIS18	AIS19	AIS20	AIS21	AIS22	AIS23	AIS24
t [Gt/yr]	RI1	-10.4±0.9	-11.4±0.9	-4.9±0.4	-0.1±0.2	-5.1±0.8	15.8±0.3	-3.5±0.3	-37.3±0.6	-57.5±0.6	-51.7±0.4	-5.1±0.3	-11.0±0.5
	RI2	-7.2±0.6	-8.1±0.5	-3.1±0.1	-1.3±0.1	0.8±0.5	3.6±0.1	-11.2±0.3	-22.2±0.3	-34.4±0.2	-30.7±0.2	-12.8±0.1	-4.9±0.2
	FM1	-10.9±0.8	-8.9±0.7	-6.0±0.3	0.6±0.3	-1.5±0.7	16.1±0.3	-3.8±0.4	-36.1±0.6	-61.7±0.4	-42.8±0.4	-10.3±0.4	-13.0±0.4
	MC1	-11.0±0.9	-8.7±0.8	-5.9±0.3	-1.8±0.2	-6.3±0.7	15.5±0.2	2.7±0.3	-34.3±0.6	-60.5±0.4	-43.6±0.4	-16.1±0.2	-8.7±0.4
	CSR MC	-10.6±0.7	-9.5±0.6	-4.2±0.1	0.2±0.1	-2.5±0.5	13.3±0.2	-1.8±0.2	-39.8±0.6	-55.0±0.4	-46.9±0.4	-6.4±0.3	-12.3±0.3
	JPL MC	-12.3±0.9	-10.7±0.8	-4.8±0.2	-0.2±0.1	-1.7±0.6	14.7±0.2	-1.0±0.2	-43.7±0.7	-61.6±0.4	-54.7±0.3	-2.6±0.3	-14.7±0.3
	GSFC MC	-12.6±0.8	-9.9±0.7	-4.0±0.1	0.8±0.1	-0.3±0.5	17.4±0.2	0.1±0.2	-55.7±0.7	-47.6±0.3	-48.0±0.3	-16.8±0.3	-8.3±0.2
e [Gt/yr^2]	RI1	-2.9±0.7	0.3±0.6	0.2±0.3	0.6±0.2	2.4±0.5	0.3±0.2	-1.6±0.2	-5.7±0.4	-4.9±0.4	-6.5±0.3	-2.1±0.2	-3.9±0.4
	RI2	-2.4±0.4	0.2±0.4	0.2±0.1	0.5±0.1	1.9±0.4	-0.4±0.1	-2.5±0.2	-3.0±0.2	-3.8±0.2	-4.5±0.2	-2.1±0.1	-2.2±0.1
	FM1	-3.3±0.6	0.2±0.5	0.3±0.2	0.9±0.2	2.0±0.5	0.7±0.2	-2.2±0.3	-5.3±0.4	-5.5±0.3	-6.3±0.3	-2.3±0.3	-3.1±0.3
	MC1	-2.7±0.6	0.3±0.6	0.3±0.2	0.7±0.1	2.3±0.5	0.3±0.1	-1.7±0.2	-4.9±0.4	-5.6±0.3	-6.0±0.2	-2.8±0.1	-4.0±0.3
	CSR MC	-3.2±0.5	-0.2±0.4	0.0±0.1	0.3±0.1	1.5±0.3	0.3±0.1	-1.9±0.2	-5.8±0.4	-4.9±0.3	-6.9±0.3	-2.4±0.2	-4.4±0.2
	JPL MC	-2.7±0.6	0.8±0.6	0.6±0.1	0.8±0.1	2.6±0.4	0.9±0.2	-1.3±0.2	-6.4±0.5	-6.7±0.3	-7.5±0.2	-1.0±0.2	-4.3±0.2
	GSFC MC	-3.3±0.6	-0.1±0.5	0.6±0.1	0.6±0.1	2.8±0.4	0.4±0.1	-1.8±0.2	-6.8±0.5	-4.4±0.2	-6.5±0.2	-3.0±0.2	-3.1±0.2
A_1 [Gt]	RI1	5.7±4.0	7.2±3.9	1.9±1.6	0.9±1.1	4.6±3.3	3.0±1.4	3.1±1.2	6.4±2.7	7.7±2.4	5.0±1.8	5.3±1.1	3.6±2.2
	RI2	3.3±2.5	2.8±2.4	0.7±0.6	0.1±0.5	3.7±2.2	1.6±0.5	3.3±1.3	3.3±1.3	5.0±1.0	5.2±0.9	2.9±0.5	1.8±0.8
	FM1	8.4±3.5	2.4±3.0	2.2±1.1	3.0±1.2	14.2±2.8	2.7±1.1	2.4±1.7	1.5±2.6	9.4±1.6	7.6±1.8	3.9±1.8	5.0±1.9
	MC1	5.8±3.6	3.2±3.5	0.8±1.4	0.7±0.7	4.6±2.9	1.2±0.9	2.3±1.2	4.2±2.4	7.3±1.8	5.7±1.5	4.1±0.9	2.9±1.6
	CSR MC	6.3±3.1	2.7±2.4	1.3±0.6	1.1±0.4	4.1±2.1	0.9±0.7	1.3±1.0	5.0±2.6	8.2±1.7	2.9±1.6	5.0±1.4	5.2±1.4
	JPL MC	12.5±3.7	3.6±3.4	1.3±0.6	0.3±0.4	2.6±2.6	1.1±1.0	3.9±1.0	7.8±3.0	4.9±1.7	5.7±1.3	6.1±1.1	6.8±1.5
	GSFC MC	9.3±3.6	2.7±3.1	0.8±0.5	1.2±0.5	5.1±2.1	1.0±0.7	1.4±1.1	5.1±2.8	5.7±1.2	6.4±1.2	5.9±1.4	3.1±0.9
A_2 [Gt]	RI1	7.0±4.0	1.3±3.9	3.6±1.6	2.2±1.1	9.2±3.3	2.4±1.4	2.8±1.2	3.9±2.7	2.0±2.4	6.1±1.8	3.4±1.1	5.3±2.2
	RI2	5.1±2.5	5.5±2.4	2.0±0.6	2.5±0.5	8.6±2.2	1.6±0.5	2.6±1.3	2.0±1.3	2.1±1.0	3.2±0.9	1.7±0.5	2.9±0.8
	FM1	5.1±3.5	4.3±3.0	4.1±1.1	4.6±1.2	10.3±2.8	2.2±1.1	2.7±1.7	4.7±2.6	3.7±1.7	6.3±1.8	3.6±1.8	3.1±1.9
	MC1	3.9±3.7	5.0±3.5	4.9±1.4	2.4±0.7	9.6±2.9	2.1±0.9	2.7±1.2	4.1±2.4	3.3±1.8	4.7±1.5	3.2±0.9	4.9±1.6
	CSR MC	6.7±3.1	4.9±2.4	2.4±0.6	2.1±0.4	9.9±2.1	1.4±0.7	2.9±1.0	6.1±2.7	1.3±1.7	5.2±1.7	4.6±1.4	4.4±1.4
	JPL MC	6.3±3.7	4.9±3.4	1.7±0.6	1.3±0.4	6.8±2.6	1.7±1.0	3.1±1.0	4.3±3.0	2.9±1.8	4.1±1.3	3.2±1.1	4.4±1.5
	GSFC MC	7.3±3.6	5.3±3.2	1.7±0.5	1.4±0.5	9.4±2.2	2.1±0.7	2.2±1.1	4.4±2.8	2.9±1.2	4.4±1.2	4.6±1.4	2.7±0.9

continued on next page

Table S2. – continued from previous page

	Region	AIS13	AIS14	AIS15	AIS16	AIS17	AIS18	AIS19	AIS20	AIS21	AIS22	AIS23	AIS24
A_3 [Gt]	RI1	2.4±4.0	0.3±4.0	0.1±1.6	0.5±1.1	1.9±3.4	0.3±1.4	1.3±1.3	4.7±2.7	4.0±2.5	5.3±1.9	1.7±1.2	3.2±2.3
	RI2	2.2±2.5	4.9±2.4	3.1±0.6	2.4±0.5	4.5±2.2	0.2±0.5	1.7±1.3	1.0±1.3	1.5±1.0	3.2±0.9	0.7±0.5	0.8±0.8
	FM1	3.4±3.6	5.4±3.1	3.3±1.1	3.9±1.2	4.1±2.9	3.0±1.1	1.7±1.7	1.6±2.6	4.1±1.7	7.8±1.8	4.9±1.8	3.0±1.9
	MC1	3.8±3.7	7.7±3.5	6.4±1.4	4.8±0.7	3.7±3.0	1.9±0.9	1.5±1.2	2.1±2.5	2.5±1.8	6.3±1.5	2.8±0.9	2.5±1.6
	CSR MC	3.3±3.1	6.3±2.5	4.4±0.6	2.8±0.5	3.9±2.1	1.7±0.7	3.1±1.0	0.8±2.7	3.4±1.7	5.2±1.7	2.1±1.4	6.6±1.4
	JPL MC	4.2±3.7	4.4±3.4	3.5±0.7	1.6±0.4	4.6±2.6	0.4±1.1	2.3±1.1	4.6±3.0	2.7±1.8	4.6±1.3	5.7±1.1	4.4±1.5
	GSFC MC	0.5±3.6	0.5±3.2	0.3±0.5	0.8±0.5	1.8±2.2	0.4±0.7	0.2±1.1	0.7±2.9	1.3±1.2	0.3±1.3	0.4±1.4	0.9±0.9
NSTD [Gt]	RI1	26.4	23.5	13.1	9.6	20.8	11.5	7.7	11.3	17.6	13.8	8.2	17.0
	RI2	12.6	10.5	4.7	3.7	14.4	2.8	5.6	4.5	4.4	4.8	2.8	5.0
	FM1	16.6	13.1	8.4	9.6	17.7	8.1	10.5	13.5	11.8	9.9	13.0	14.1
	MC1	19.1	15.8	11.2	5.6	17.3	5.5	6.6	9.4	10.3	9.0	5.9	9.2
	CSR MC	11.9	9.4	4.2	3.3	13.6	4.6	5.7	10.2	11.0	10.0	10.2	7.2
	JPL MC	12.5	10.0	4.2	2.8	13.7	3.8	5.1	8.4	6.9	5.5	6.7	7.1
	GSFC MC	12.8	10.2	3.8	4.0	12.3	4.8	5.5	8.6	6.0	6.7	8.0	5.2

Table S3. Like Table S1 but for drainage basins AIS27 and AIS28 as well as for the aggregations AP, EAIS, WAIS and the entire AIS.

	Region	AIS27	AIS28	AP	EAIS	WAIS	AIS
t [Gt/yr]	RI1	1.2±0.5	-22.1±0.6	-31.9±0.9	56.8±2.8	-132.6±1.5	-107.7±3.5
	RI2	-2.3±0.1	-10.0±0.3	-17.2±0.5	57.8±2.6	-121.3±1.2	-99.6±3.3
	FM1	3.4±0.3	-18.3±0.4	-27.9±0.6	61.2±3.0	-133.2±1.5	-100.0±3.6
	MC1	0.1±0.2	-17.8±0.5	-26.4±0.8	52.1±3.3	-124.8±1.7	-99.1±4.4
	Schrama	NaN±NaN	NaN±NaN	-35.0±0.9	81.6±3.3	-138.7±1.5	-92.2±4.3
	CSR MC	0.6±0.1	-21.1±0.4	-32.9±0.7	55.3±2.7	-133.2±1.5	-110.8±3.5
	JPL MC	-0.8±0.1	-26.5±0.5	-42.0±0.8	62.1±2.9	-146.6±1.7	-126.5±3.8
	GSFC MC	-1.2±0.2	-26.0±0.5	-35.5±0.7	67.3±2.4	-149.2±1.5	-117.4±2.8

continued on next page

Table S3. – continued from previous page

Region		AIS27	AIS28	AP	EAIS	WAIS	AIS
e [Gt/yr^2]	RI1	-0.3±0.4	0.5±0.4	-3.6±0.7	17.1±2.0	-24.6±1.1	-11.2±2.4
	RI2	-1.1±0.1	-0.1±0.2	-3.3±0.4	14.1±1.9	-21.6±0.9	-11.8±2.4
	FM1	-1.2±0.2	0.3±0.2	-4.0±0.4	15.4±2.1	-23.1±1.0	-11.7±2.5
	MC1	-1.1±0.2	0.6±0.3	-4.6±0.6	16.3±2.3	-25.2±1.2	-13.5±3.0
	Schrama	NaN±NaN	NaN±NaN	-4.2±0.6	14.9±2.3	-24.4±1.1	-13.7±3.0
	CSR MC	-0.8±0.1	0.8±0.3	-4.4±0.5	10.5±1.9	-25.5±1.1	-19.4±2.4
	JPL MC	-1.2±0.1	1.5±0.3	-4.0±0.6	19.0±2.0	-25.6±1.2	-10.6±2.7
	GSFC MC	-1.9±0.1	0.9±0.3	-4.1±0.5	18.5±1.7	-25.4±1.1	-11.0±1.9
A_1 [Gt]	RI1	1.3±2.2	1.4±2.6	2.1±3.9	26.9±12.0	27.7±6.4	56.7±14.7
	RI2	0.9±0.6	2.0±1.1	4.3±2.3	11.7±11.5	27.6±5.4	46.6±14.8
	FM1	2.5±1.3	4.0±1.5	3.0±2.6	69.7±12.9	20.8±6.4	79.3±15.5
	MC1	0.7±1.0	2.3±1.9	5.2±3.5	24.1±13.7	27.3±7.0	54.8±18.3
	Schrama	NaN±NaN	NaN±NaN	15.1±3.8	100.9±14.1	26.1±6.5	136.9±18.4
	CSR MC	0.7±0.5	3.7±1.7	8.5±3.1	16.0±11.4	25.8±6.5	46.8±14.7
	JPL MC	2.3±0.5	8.1±2.0	17.2±3.5	31.7±12.3	32.5±7.3	80.1±16.3
	GSFC MC	1.1±0.9	3.5±2.1	5.7±3.1	23.8±10.4	25.5±6.6	43.0±11.7
A_2 [Gt]	RI1	3.0±2.2	5.2±2.6	7.9±4.0	43.5±12.0	21.7±6.5	70.9±14.7
	RI2	1.5±0.6	1.9±1.1	6.2±2.3	51.1±11.5	18.7±5.4	79.1±14.8
	FM1	1.7±1.3	3.9±1.5	8.4±2.6	60.5±12.8	23.8±6.4	89.7±15.4
	MC1	2.0±1.0	5.2±2.0	11.5±3.5	52.2±13.9	26.1±7.1	88.7±18.5
	Schrama	NaN±NaN	NaN±NaN	11.0±3.8	46.9±13.9	20.4±6.6	72.0±18.2
	CSR MC	1.7±0.5	5.8±1.7	11.4±3.1	49.9±11.4	25.9±6.5	86.3±14.8
	JPL MC	2.1±0.5	6.5±2.1	12.8±3.5	40.2±12.3	23.5±7.3	74.4±16.4
	GSFC MC	0.9±0.9	3.1±2.1	5.9±3.1	42.7±10.3	23.2±6.6	70.1±11.7

continued on next page

Table S3. – continued from previous page

Region		AIS27	AIS28	AP	EAIS	WAIS	AIS
A_3 [Gt]	RI1	0.2±2.2	0.4±2.6	3.0±4.0	14.1±12.2	20.2±6.5	9.1±14.9
	RI2	0.4±0.6	3.1±1.1	2.3±2.3	10.5±11.5	9.5±5.4	24.7±14.8
	FM1	2.7±1.3	4.0±1.5	4.7±2.6	7.7±13.0	13.0±6.5	20.0±15.7
	MC1	2.6±1.0	5.0±2.0	3.6±3.6	6.9±14.0	12.5±7.2	16.8±18.7
	Schrama	NaN±NaN	NaN±NaN	4.7±3.9	12.3±14.2	12.7±6.6	21.9±18.5
	CSR MC	3.0±0.6	9.9±1.8	7.1±3.2	13.7±11.6	17.9±6.6	36.6±15.0
	JPL MC	5.4±0.5	11.7±2.1	16.3±3.6	17.6±12.5	2.6±7.4	34.6±16.6
	GSFC MC	0.7±0.9	0.9±2.2	1.5±3.1	14.7±10.5	2.0±6.7	12.1±11.9
NSTD [Gt]	RI1	19.5	17.7	25.0	73.6	27.0	97.1
	RI2	4.4	8.6	16.8	80.1	24.4	112.1
	FM1	10.4	11.0	17.5	88.9	32.2	116.1
	MC1	8.2	14.3	23.3	92.8	33.3	133.8
	Schrama	NaN	NaN	25.9	93.8	30.9	134.6
	CSR MC	3.8	11.5	19.8	72.8	28.6	105.4
	JPL MC	3.0	11.8	20.3	74.1	27.6	102.0
	GSFC MC	5.3	8.9	14.5	61.8	26.2	77.7

1.3. Results from synthetic data sets

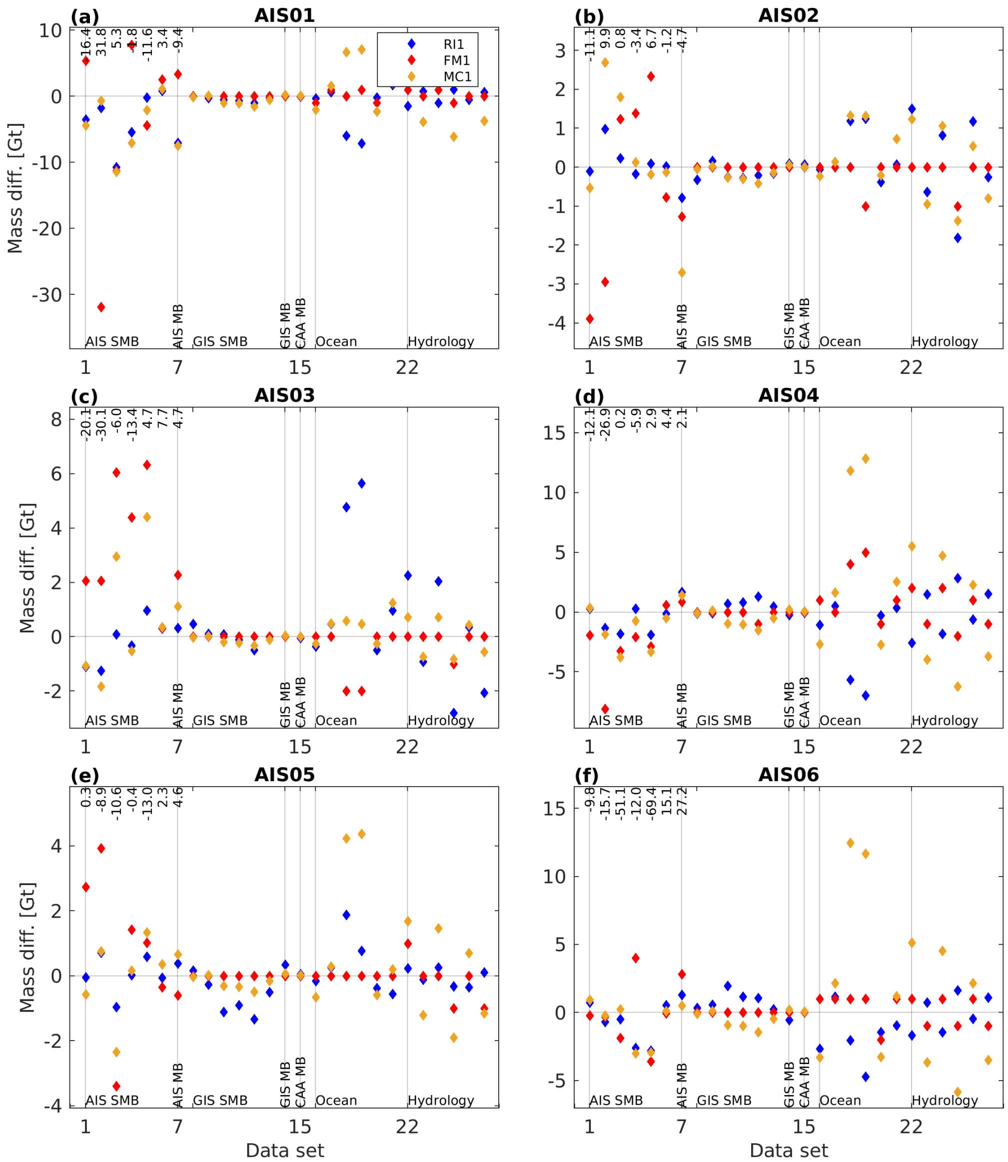

Figure S8. Differences between mass change estimates derived from different synthetic data sets and the corresponding true mass change for different drainage basins of the Antarctic Ice Sheet. True (non-zero) mass changes are indicated by numbers at the top margin (units: gigatons).

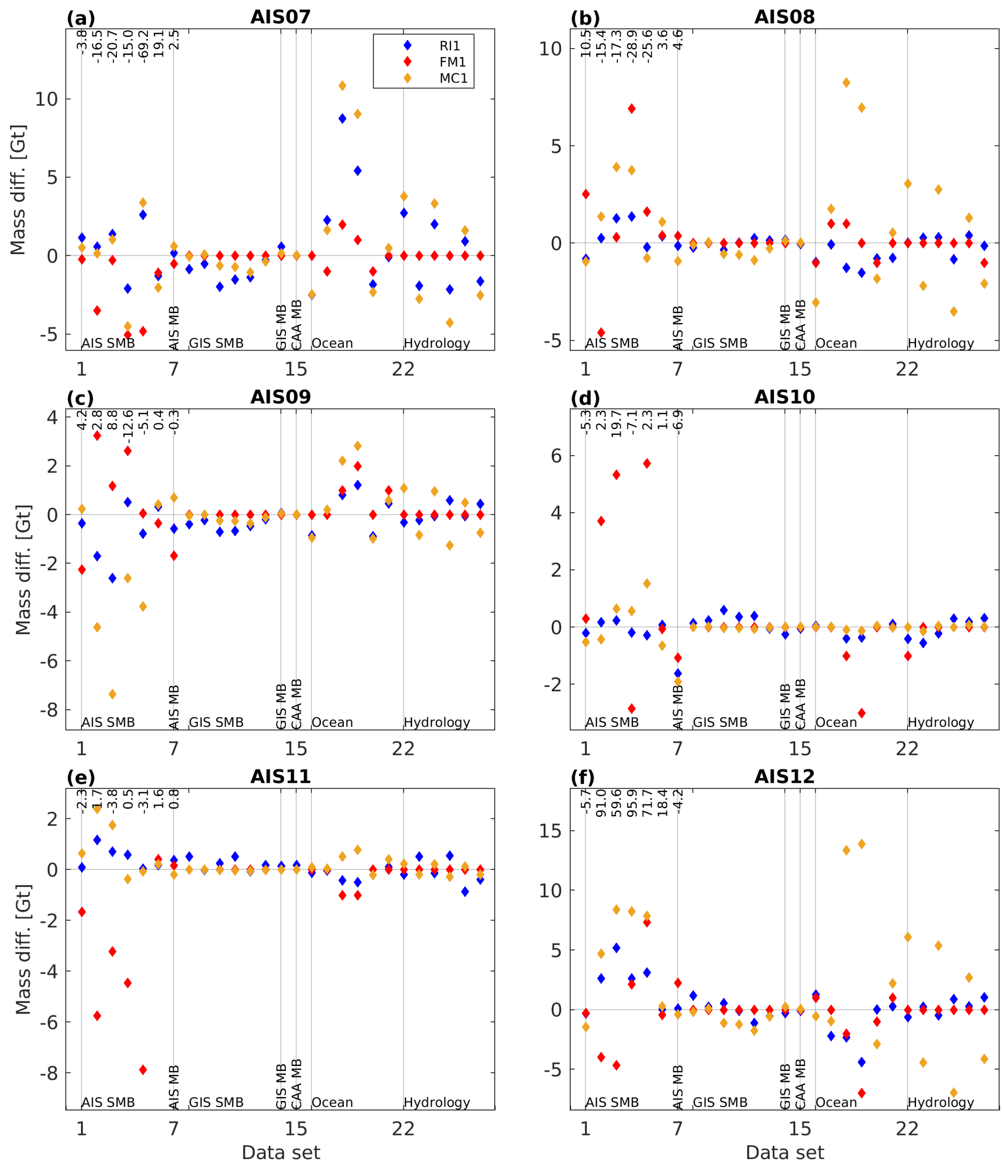

Figure S9. Differences between mass change estimates derived from different synthetic data sets and the corresponding true mass change for different drainage basins of the Antarctic Ice Sheet. True (non-zero) mass changes are indicated by numbers at the top margin (units: gigatons).

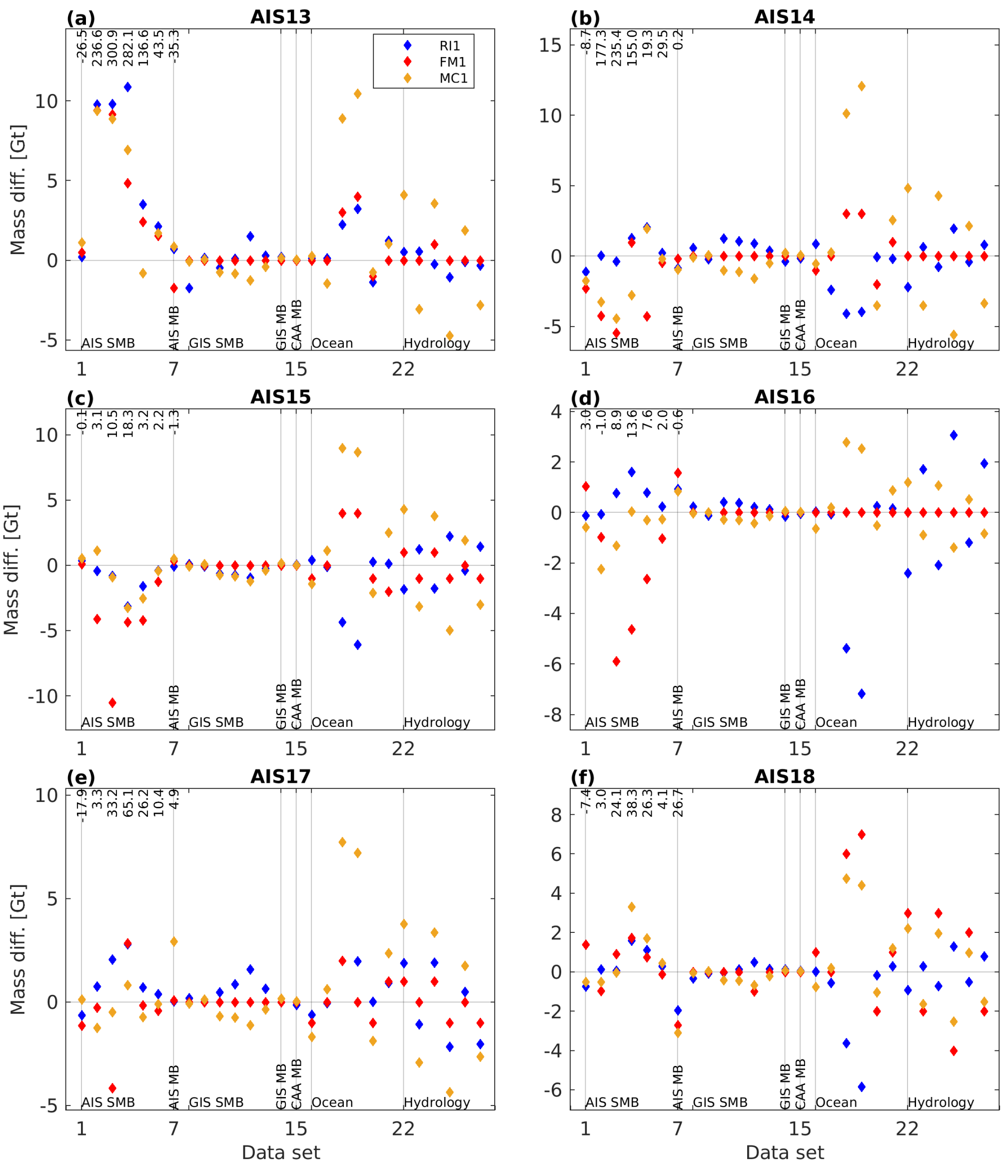

Figure S10. Differences between mass change estimates derived from different synthetic data sets and the corresponding true mass change for different drainage basins of the Antarctic Ice Sheet. True (non-zero) mass changes are indicated by numbers at the top margin (units: gigatons).

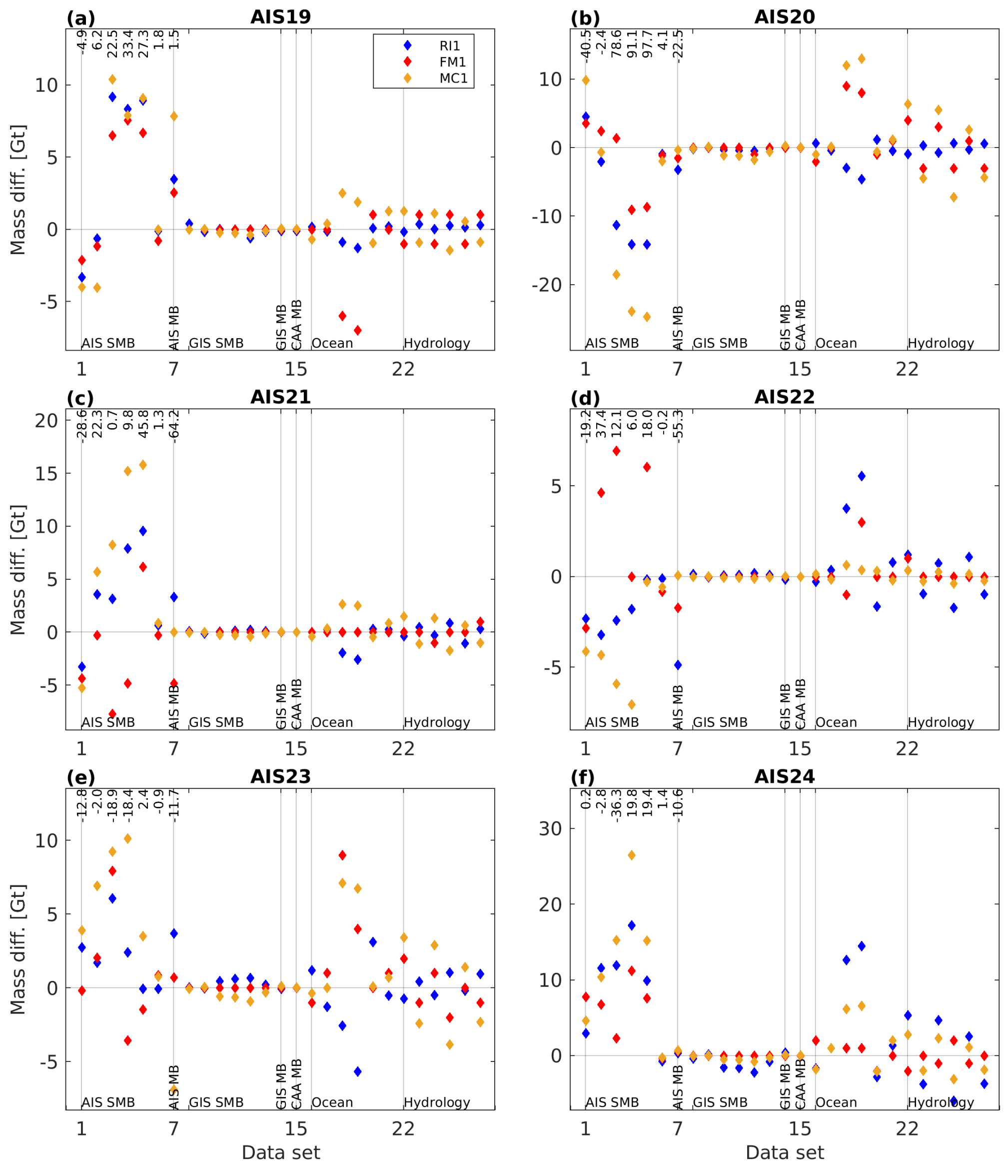

Figure S11. Differences between mass change estimates derived from different synthetic data sets and the corresponding true mass change for different drainage basins of the Antarctic Ice Sheet. True (non-zero) mass changes are indicated by numbers at the top margin (units: gigatons).

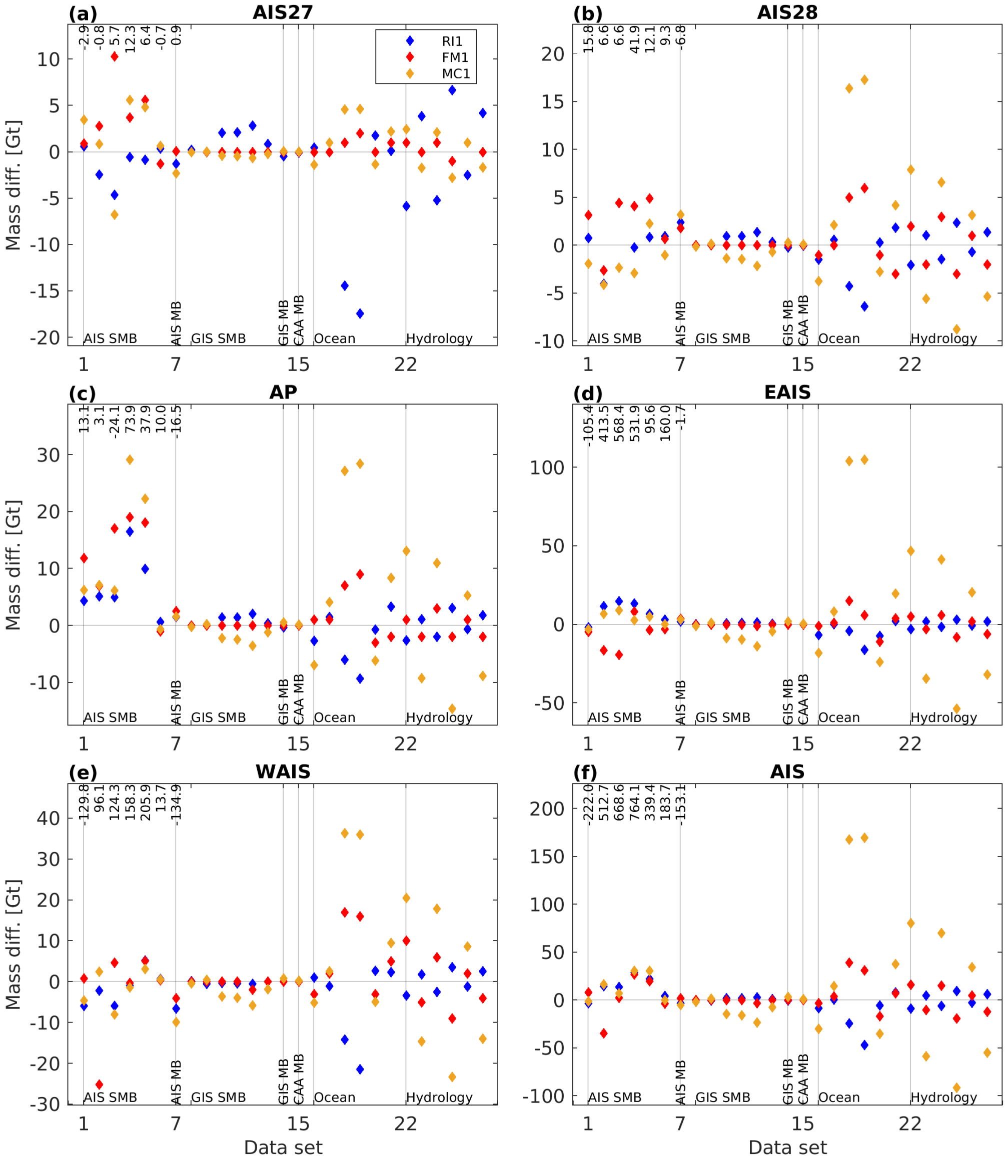

Figure S12. Differences between mass change estimates derived from different synthetic data sets and the corresponding true mass change for different drainage basins of the Antarctic Ice Sheet and selected aggregations. True (non-zero) mass changes are indicated by numbers at the top margin (units: gigatons).

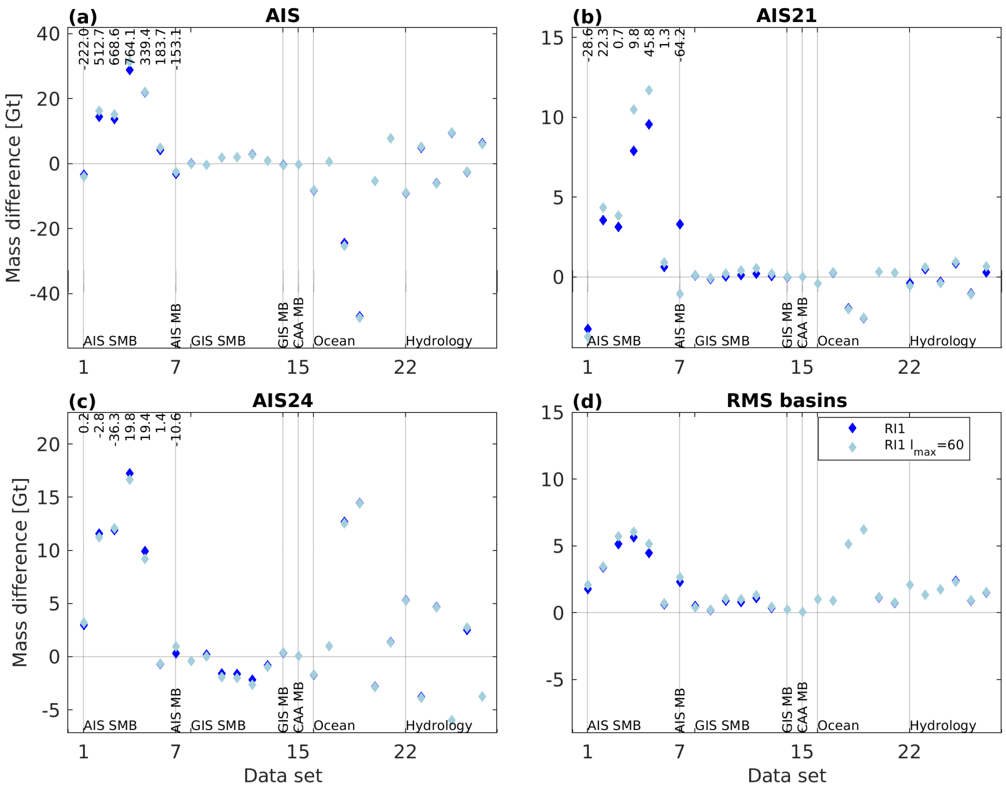

Figure S13. Differences between mass change estimates derived from different synthetic data sets and the corresponding true mass change for the AIS as well as drainage basins AIS21 and AIS24. Results for method RI1 using a maximum SH-degree $l_{\max} = 90$ (dark blue) and $l_{\max} = 60$ (light blue). True (non-zero) mass changes are indicated by numbers at the top margin (unit: gigatons). **(d)** RMS of the differences for all drainage basins (AIS01–AIS24, AIS27, AIS28).

2. Greenland Ice Sheet

2.1. GRACE-derived mass change time series

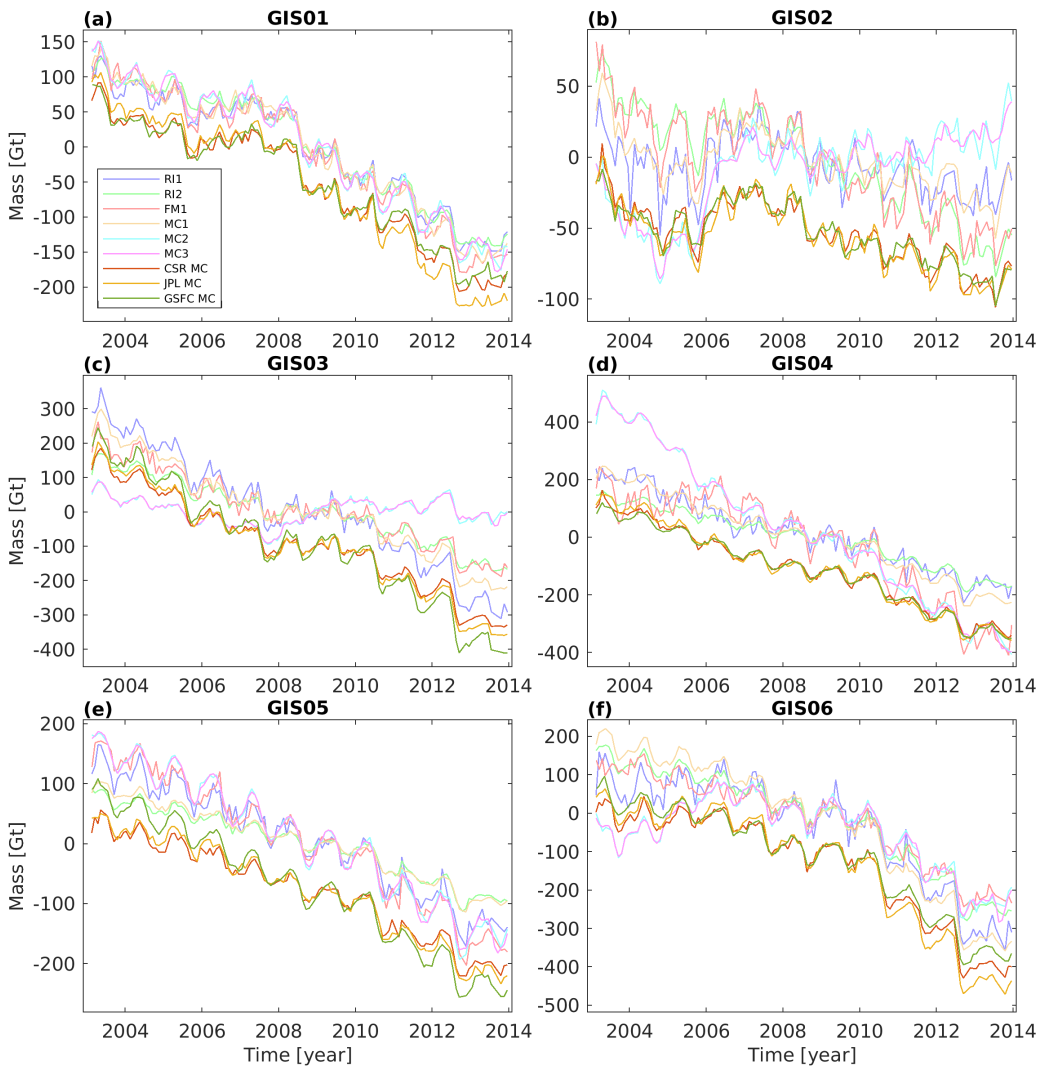

Figure S14. Comparison of GRACE-derived mass change time series for different drainage basins of the Greenland Ice Sheet from the participants (faint colours) with alternative time series extracted from the mascon products provided by CSR, JPL and GSFC (bold colours). The alternative results are shifted along the y-axis to increase readability.

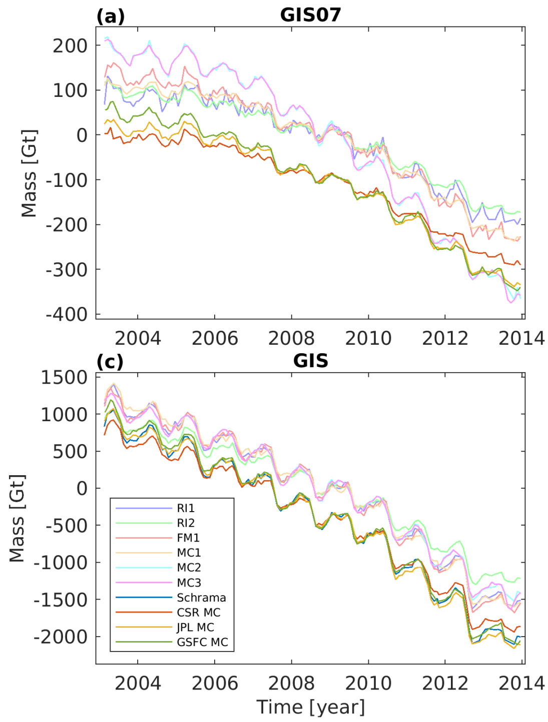

Figure S15. Comparison of GRACE-derived mass change time series for different drainage basins of the Greenland Ice Sheet from the participants (faint colours) with alternative results (bold colours), namely the updated time series from Schrama *et al.* [1] and time series extracted from the mascon products provided by CSR, JPL and GSFC. The alternative results are shifted along the y-axis to increase readability.

2.2. Temporal variations

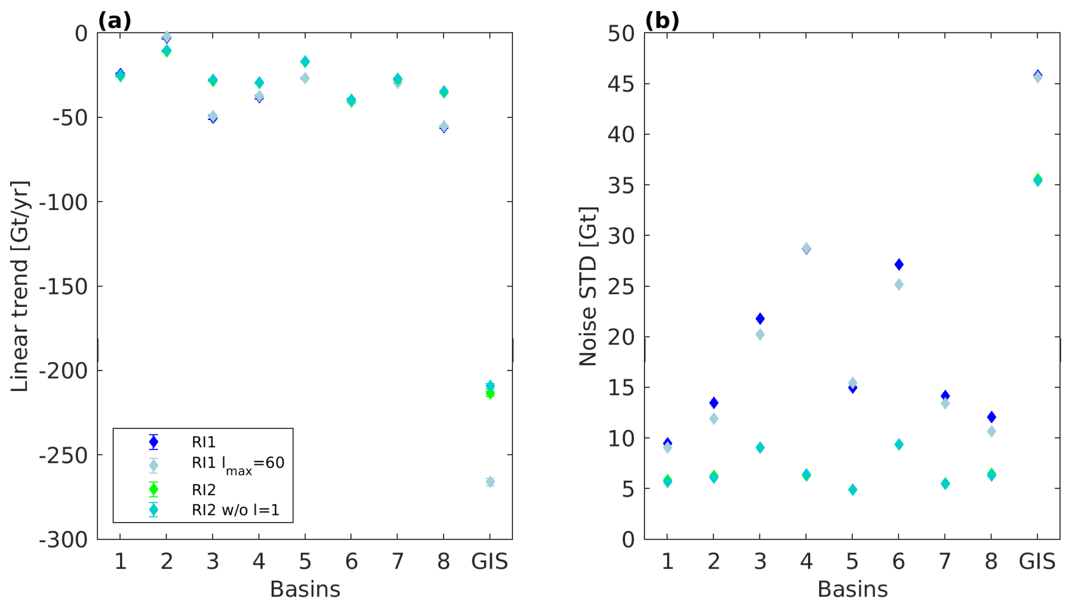

Figure S16. **(a)** Linear trends in ice mass change derived using a consistent linear, periodic (1 yr, 1/2 yr, 161/365.25 yr) and quadratic model. **(b)** Noise level, given in terms of the scaled standard deviation of the noise time series, derived from the mass change time series. Both panels compare results for all GIS basins and aggregations from different variants of methods RI1 ($l_{\max} = 90$: dark blue; $l_{\max} = 60$: light blue) and RI2 (incl. degree one: light green; excl. degree one: cyan).

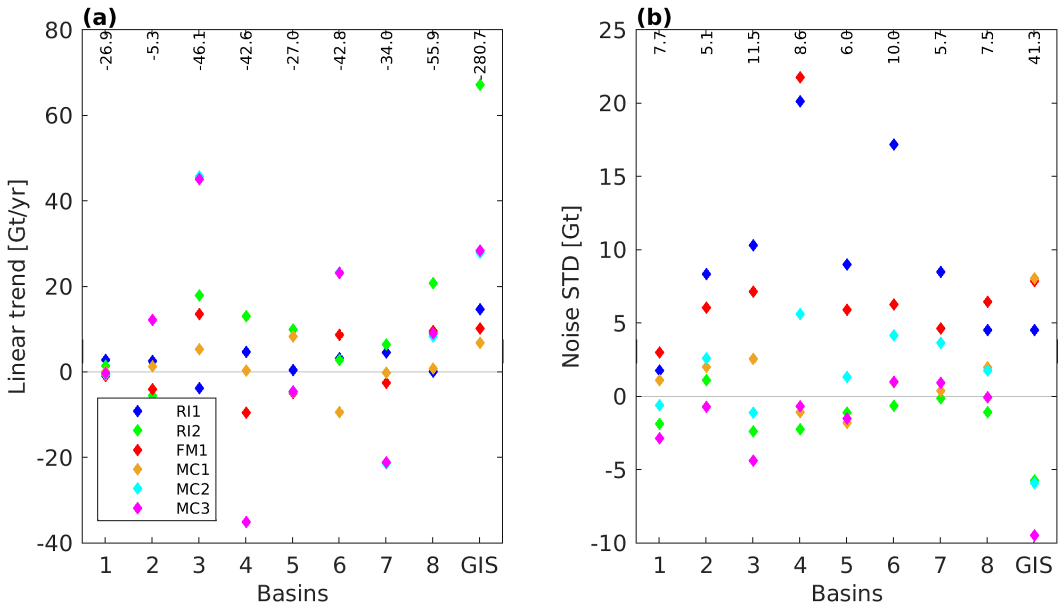

Figure S17. **(a)** Differences between linear trends in ice mass change derived from the products by the participants and the mean of the estimates derived from the mascon products by CSR, JPL and GSFC. Mean values from the mascon products are indicated by numbers at the top margin (units: gigatons per year). Linear trends are calculated using a consistent linear, periodic (1 yr, 1/2 yr, 161/365.25 yr) and quadratic model. **(b)** Differences between the noise level, given in terms of the scaled standard deviation of the noise time series, derived from the products of the participants and the RMS of the corresponding estimates from the mascon products by CSR, JPL and GSFC. RMS values from the mascon products are indicated by numbers at the top margin (units: gigatons). Both panels compare results for all GIS basins and aggregations.

Table S4. Temporal changes and noise level of mass change time series for the GIS and its drainage basins generated by the participants, by Schrama *et al.* [1] and extracted from the mascon products provided by CSR, JPL and GSFC. Temporal changes are derived from the following model: $y(t) = a + bt + \sum_{i=1}^{3} (c_i \sin(2\pi t/T_i) + d_i \cos(2\pi t T_i)) + et^2/2$, $T_i = 1\,yr, 1/2\,yr, 161/365.25\,yr$, with t: linear trend, e: acceleration, A_1: annual amplitude ($A_1 = \sqrt{c_1^2 + d_1^2}$), A_2: semi-annual amplitude ($A_2 = \sqrt{c_2^2 + d_2^2}$), A_3: 161-day amplitude ($A_3 = \sqrt{c_3^2 + d_3^2}$). Uncertainties are formal errors from the least squares adjustment. Scaled standard deviations of the noise time series (NSTD) are used a measure of the noise level as described in Section 2.4 (main document).

Region		GIS01	GIS02	GIS03	GIS04	GIS05	GIS06	GIS07	GIS08	GIS
t [Gt/yr]	RI1	-24.1±0.5	-2.7±0.5	-50.0±1.1	-37.9±0.9	-26.5±0.4	-39.5±0.9	-29.4±0.5	-55.7±0.6	-265.9±2.2
	RI2	-25.4±0.3	-10.8±0.3	-28.2±0.5	-29.6±0.3	-17.0±0.2	-39.9±0.5	-27.5±0.2	-35.0±0.3	-213.5±1.6
	FM1	-27.8±0.5	-9.4±0.4	-32.5±0.8	-52.2±1.1	-31.8±0.4	-34.0±0.6	-36.5±0.4	-46.3±0.6	-270.5±2.2
	MC1	-26.8±0.5	-4.0±0.5	-40.7±0.9	-42.3±0.5	-18.6±0.2	-52.2±0.6	-34.1±0.3	-55.0±0.5	-273.8±2.2
	MC2	-27.5±0.4	6.9±0.6	-0.4±1.0	-77.7±0.9	-31.6±0.4	-19.4±0.9	-55.3±0.5	-47.6±0.9	-252.7±2.1
	MC3	-27.2±0.3	6.8±0.5	-1.1±0.9	-77.8±0.7	-31.5±0.3	-19.6±0.7	-55.0±0.4	-46.8±0.8	-252.2±1.7
	Schrama	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	-283.3±2.3
	CSR MC	-25.9±0.5	-5.5±0.4	-41.4±0.8	-42.2±0.5	-23.4±0.3	-40.6±0.7	-28.6±0.3	-50.0±0.5	-257.7±2.0
	JPL MC	-30.4±0.5	-5.4±0.4	-44.8±0.9	-44.3±0.6	-25.7±0.3	-46.8±0.7	-34.9±0.3	-60.5±0.6	-292.9±2.3
	GSFC MC	-24.5±0.5	-5.1±0.3	-52.3±0.9	-41.4±0.4	-31.8±0.3	-40.8±0.6	-38.3±0.3	-57.1±0.5	-291.3±2.0
e [Gt/yr^2]	RI1	-3.2±0.3	-1.2±0.4	-0.0±0.7	1.2±0.6	-1.6±0.3	-11.7±0.7	-5.2±0.3	-4.3±0.4	-26.1±1.6
	RI2	-2.8±0.2	-1.3±0.2	-0.9±0.3	-2.0±0.2	-1.3±0.1	-5.9±0.3	-3.8±0.2	-3.2±0.2	-21.3±1.2
	FM1	-3.4±0.4	-1.0±0.3	1.1±0.6	-11.2±0.8	-1.6±0.3	-5.1±0.4	-5.1±0.3	-3.2±0.4	-29.5±1.6
	MC1	-3.2±0.4	-0.6±0.3	1.0±0.6	-1.0±0.3	-1.0±0.2	-8.7±0.4	-6.1±0.2	-4.9±0.4	-24.7±1.6
	MC2	-2.9±0.3	-1.0±0.4	3.7±0.7	2.5±0.6	-1.1±0.3	-13.8±0.6	-8.9±0.3	-2.2±0.6	-23.8±1.4
	MC3	-2.8±0.2	-0.8±0.3	3.3±0.6	2.6±0.5	-1.1±0.2	-13.9±0.5	-8.9±0.3	-2.2±0.6	-23.8±1.2
	Schrama	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	-26.8±1.6
	CSR MC	-3.2±0.3	-1.1±0.2	0.2±0.5	-0.2±0.4	-1.7±0.2	-10.3±0.5	-4.5±0.2	-3.5±0.4	-24.3±1.4
	JPL MC	-3.9±0.4	-1.3±0.3	0.0±0.6	0.3±0.4	-2.0±0.2	-11.5±0.5	-5.7±0.2	-4.9±0.4	-28.8±1.6
	GSFC MC	-2.8±0.3	-1.4±0.2	-0.7±0.7	-1.6±0.3	-1.3±0.2	-6.9±0.4	-4.6±0.2	-2.9±0.4	-22.3±1.4

continued on next page

Table S4. – continued from previous page

Region		GIS01	GIS02	GIS03	GIS04	GIS05	GIS06	GIS07	GIS08	GIS
A_1 [Gt]	RI1	14.3±2.1	7.7±2.2	32.0±4.5	18.5±3.7	21.5±1.9	36.7±4.0	15.0±2.0	8.3±2.5	152.4±9.4
	RI2	9.4±1.4	10.7±1.3	19.9±2.1	18.3±1.5	11.9±0.9	26.1±2.2	13.1±1.1	6.9±1.5	116.0±7.2
	FM1	13.7±2.2	15.3±1.8	24.7±3.3	50.6±4.6	22.1±1.8	22.2±2.7	15.6±1.6	6.0±2.7	162.9±9.5
	MC1	6.3±2.1	5.2±2.0	20.2±3.6	20.6±2.1	10.4±0.9	27.6±2.6	11.2±1.2	3.6±2.3	102.6±9.5
	MC2	23.5±1.8	9.1±2.5	16.7±4.0	28.7±3.8	30.8±1.6	32.0±3.6	24.3±1.9	10.3±3.7	167.3±8.7
	MC3	23.1±1.5	8.6±2.1	18.1±3.8	28.8±3.2	30.7±1.2	30.9±3.2	23.5±1.7	9.9±3.5	166.0±7.7
	Schrama	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	164.3±9.6
	CSR MC	11.8±2.0	7.6±1.5	24.8±3.3	22.7±2.1	15.4±1.2	27.6±2.8	9.3±1.1	4.9±2.2	123.5±8.5
	JPL MC	12.8±2.1	8.5±1.7	24.9±3.9	24.8±2.6	16.5±1.1	36.0±3.0	15.6±1.2	9.5±2.4	147.4±9.9
	GSFC MC	15.6±2.1	8.1±1.4	41.2±4.0	23.5±1.8	23.3±1.3	31.4±2.4	16.7±1.1	8.4±2.2	167.5±8.6
A_2 [Gt]	RI1	7.1±2.1	3.2±2.2	9.1±4.5	8.5±3.7	6.7±1.9	12.2±4.0	5.3±2.0	8.6±2.6	55.2±9.5
	RI2	6.0±1.4	4.1±1.3	6.3±2.1	4.6±1.5	3.2±0.9	8.3±2.2	4.0±1.1	4.8±1.5	40.9±7.2
	FM1	8.2±2.3	2.8±1.9	4.6±3.4	21.9±4.6	5.8±1.8	2.3±2.7	6.4±1.6	6.6±2.7	55.8±9.6
	MC1	6.7±2.1	2.7±2.0	7.0±3.7	5.0±2.1	3.1±0.9	12.7±2.6	6.0±1.2	8.6±2.3	50.6±9.5
	MC2	5.0±1.8	0.7±2.5	3.1±4.1	5.3±3.8	5.3±1.6	13.4±3.6	7.5±1.9	4.6±3.7	39.4±8.7
	MC3	4.4±1.5	0.2±2.2	4.6±3.8	5.4±3.2	4.6±1.2	12.8±3.2	5.9±1.7	2.3±3.5	37.7±7.6
	Schrama	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	46.2±9.7
	CSR MC	6.7±2.0	3.0±1.5	6.2±3.3	3.7±2.2	5.4±1.2	12.9±2.8	4.5±1.1	5.8±2.2	47.0±8.6
	JPL MC	8.4±2.2	3.5±1.7	7.0±3.9	6.4±2.6	3.6±1.1	12.6±3.0	6.0±1.2	6.9±2.4	52.3±10.0
	GSFC MC	6.5±2.1	2.5±1.4	9.5±4.0	4.8±1.8	4.1±1.3	8.9±2.4	6.1±1.1	6.1±2.2	47.4±8.7
A_3 [Gt]	RI1	2.7±2.1	1.0±2.3	0.0±4.6	1.0±3.8	1.4±1.9	9.6±4.1	4.3±2.0	3.5±2.6	21.5±9.6
	RI2	5.0±1.4	4.2±1.3	3.5±2.1	2.0±1.5	1.0±0.9	0.3±2.2	0.2±1.1	3.1±1.5	17.6±7.2
	FM1	6.0±2.3	2.3±1.9	7.1±3.4	7.1±4.7	3.5±1.8	5.0±2.8	1.3±1.6	5.2±2.7	13.5±9.7
	MC1	5.7±2.2	4.8±2.0	5.8±3.7	4.0±2.1	1.9±0.9	2.9±2.7	2.6±1.2	3.1±2.3	16.4±9.7
	MC2	6.8±1.8	8.8±2.5	3.3±4.1	8.9±3.8	3.4±1.6	9.6±3.7	2.4±2.0	7.9±3.7	15.4±8.8
	MC3	2.2±1.5	2.5±2.2	1.6±3.8	2.9±3.2	1.4±1.2	3.7±3.2	1.3±1.7	4.6±3.5	11.2±7.7
	Schrama	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	NaN±NaN	20.6±9.7
	CSR MC	6.4±2.1	4.0±1.5	2.5±3.4	4.0±2.2	3.4±1.3	5.2±2.9	1.9±1.1	4.5±2.2	14.9±8.7
	JPL MC	4.7±2.2	6.3±1.7	3.5±3.9	5.1±2.7	4.8±1.1	3.1±3.1	1.9±1.2	6.6±2.5	19.3±10.1
	GSFC MC	1.3±2.1	1.0±1.4	1.4±4.0	1.1±1.8	1.1±1.3	2.4±2.4	1.0±1.2	2.1±2.2	10.8±8.7

continued on next page

Table S4. – continued from previous page

Region		GIS01	GIS02	GIS03	GIS04	GIS05	GIS06	GIS07	GIS08	GIS
NSTD [Gt]	RI1	9.5	13.5	21.8	28.7	15.0	27.2	14.2	12.1	45.8
	RI2	5.8	6.2	9.1	6.3	4.9	9.4	5.6	6.5	35.6
	FM1	10.7	11.2	18.6	30.4	11.9	16.3	10.3	14.0	49.2
	MC1	8.8	7.2	14.1	7.5	4.2	11.0	6.1	9.5	49.3
	MC2	7.1	7.8	10.4	14.2	7.3	14.1	9.3	9.3	35.4
	MC3	4.8	4.4	7.1	7.9	4.5	11.0	6.6	7.5	31.8
	Schrama	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	46.1
	CSR MC	7.9	5.9	11.5	10.0	7.2	11.9	5.9	8.0	42.9
	JPL MC	7.9	4.6	11.0	9.1	5.4	10.0	5.5	7.3	43.4
	GSFC MC	7.2	4.9	12.0	6.1	5.2	7.7	5.6	7.3	37.2

2.3. Results from synthetic data sets

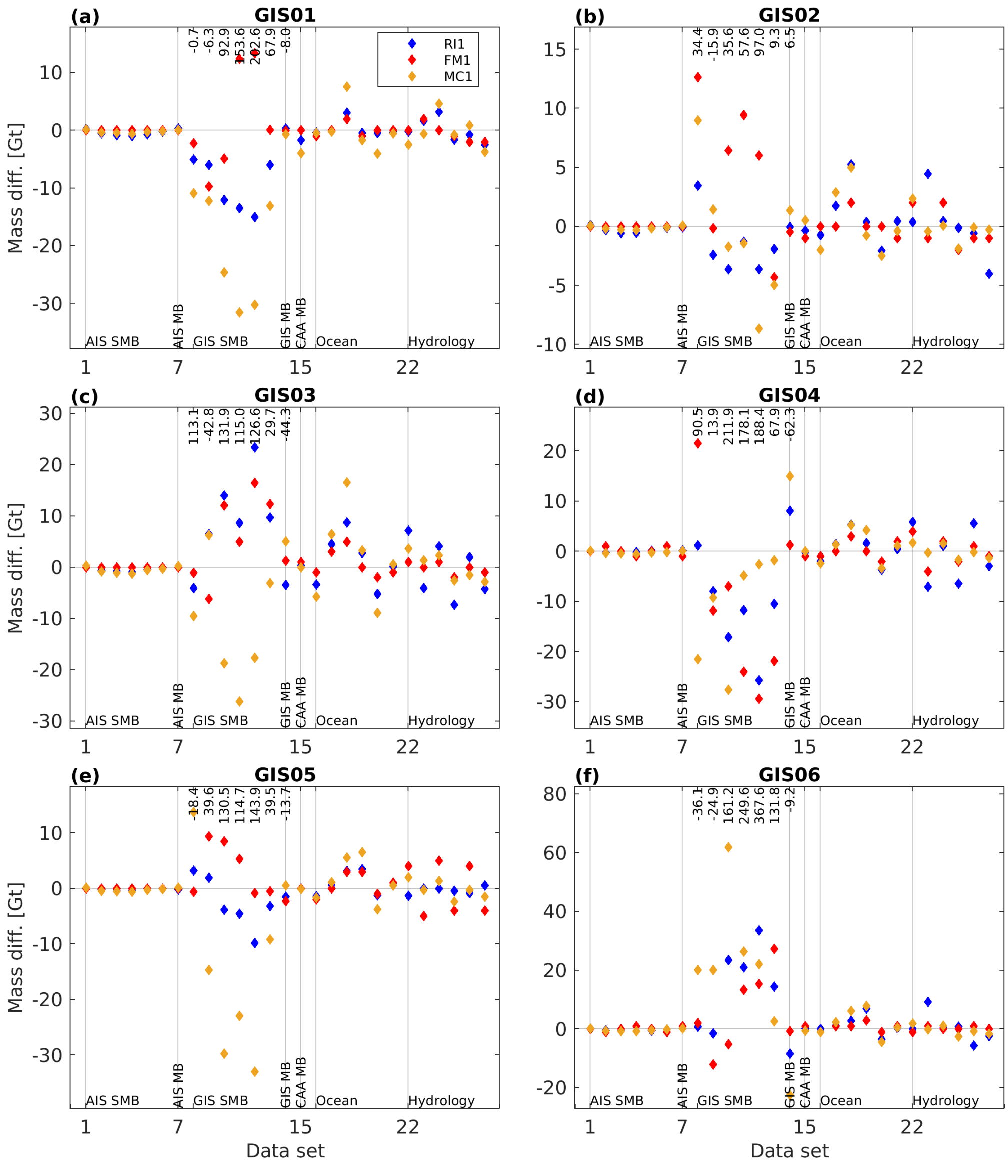

Figure S18. Differences between mass change estimates derived from different synthetic data sets and the corresponding true mass change for different drainage basins of the Greenland Ice Sheet. True (non-zero) mass changes are indicated by numbers at the top margin (units: gigatons).

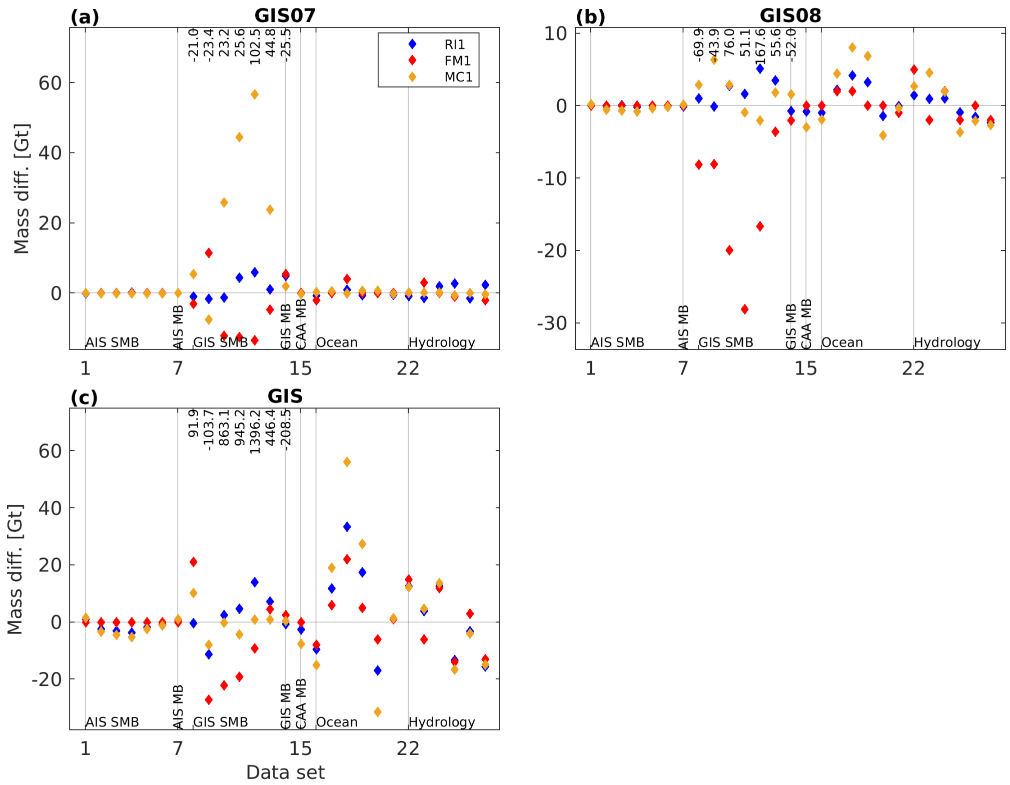

Figure S19. Differences between mass change estimates derived from different synthetic data sets and the corresponding true mass change for different drainage basins of the Greenland Ice Sheet and the entire Greenland Ice Sheet. True (non-zero) mass changes are indicated by numbers at the top margin (units: gigatons).

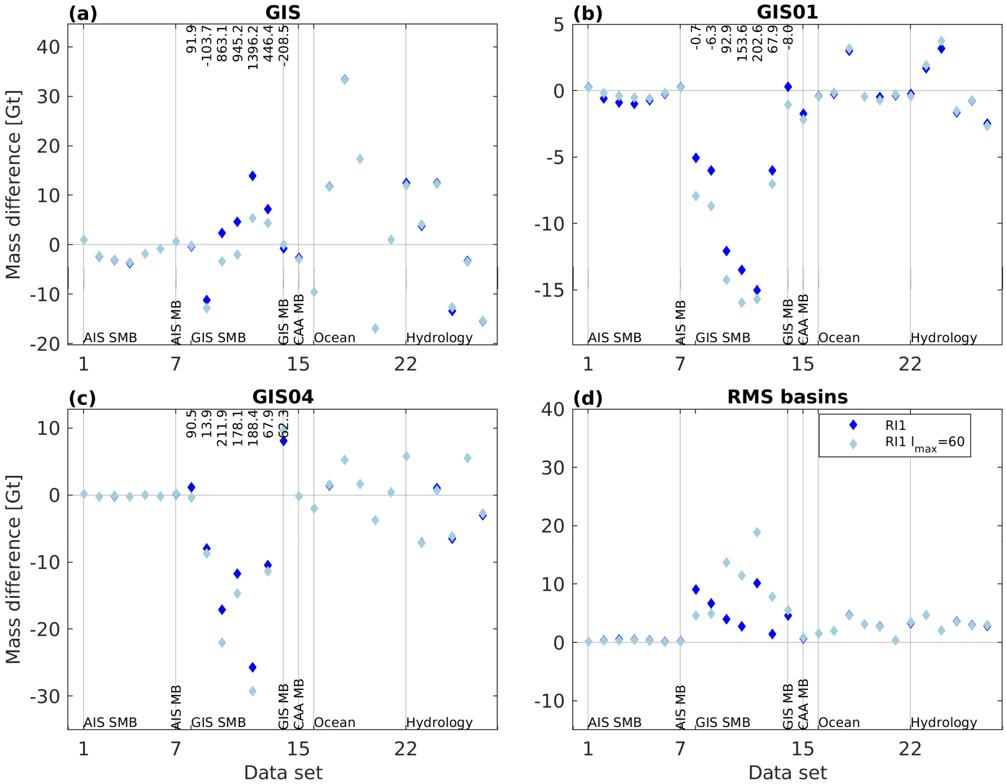

Figure S20. Differences between mass change estimates derived from different synthetic data sets and the corresponding true mass change for the GIS as well as drainage basins GIS01 and GIS04. Results for method RI1 using a maximum SH-degree $l_{\max} = 90$ (dark blue) and $l_{\max} = 60$ (light blue). True (non-zero) mass changes are indicated by numbers at the top margin (unit: gigatons). **(d)** RMS of the differences for all drainage basins (GIS01–GIS08).

1. Schrama, E.; Wouters, B.; Rietbroek, R. A mascon approach to assess ice sheet and glacier mass balances and their uncertainties from GRACE data. *J. Geophys. Res. Solid Earth* **2014**, *119*, 6048–6066. doi:10.1002/2013JB010923.