



## Supplement of

## Greenland Ice Sheet seasonal and spatial mass variability from model simulations and GRACE (2003–2012)

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Table S1. Timing of the seasonal cycle maximum and minimum for cumulative mass change 

- (2003-2012) for GRACE, MAR v3.5.2, ISSM forced by MAR v3.5.2, and MAR v3.5.2 +
- ISSM, within the different regions of the ice sheet defined in Figure 12a, as well as the high
- (above 2000 m) and low (below 2000 m) elevation regions defined in Figure 1a. The 2.5 %
- and 97.5% bounds and median value for GRACE are provided.

	< 2000 m	>2000 m	Reg 1	Reg 2	Reg 3	Reg 4	Reg 5	Reg 6	Reg 7	Reg 8
Maximum:										
GRACE (2.5 %)	10 Apr	3 Mar	20 Dec	28 Feb	26 Jun	21 Apr	10 Mar	28 Sep	25 Feb	28 Feb
GRACE median	26 Apr	17 Mar	30 Jan	3 Apr	30 Jun	6 May	27 Mar	3 Nov	11 Mar	11 Mar
GRACE (97.5%)	24 Mar	3 Apr	15 Feb	21 Apr	2 Jul	21 May	3 May	17 Jul	24 Mar	24 Mar
MAR v3.5.2	30 Apr	11 May	30 Apr	30 Apr	10 May	21 Apr	30 Apr	21 May	21 May	11 May
MAR v3.5.2 + ISSM	21 Apr	10 May	30 Apr	30 Apr	10 May	21 Apr	30 Apr	21 May	11 May	10 May
ISSM	21 Oct	1 Oct	10 Oct	1 Oct	1 Oct	21 Oct	10 Oct	1 Oct	1 Oct	21 Apr
Minimum:										
GRACE (2.5 %)	10 Sep	6 Sep	31 Jul	15 Aug	16 Sep	10 Sep	8 Sep	9 May	19 May	26 May
GRACE median	22 Sep	21 Sep	13 Aug	5 Sep	23 Sep	8 Oct	22 Sep	22 May	7 Jun	18 Sep
GRACE (97.5%)	9 Oct	10 Oct	27 Aug	15 Sep	9 Oct	9 Oct	7 Oct	17 Jul	23 Jul	25 Dec
MAR v3.5.2	30 Sep	31 Aug	20 Sep	20 Sep	20 Sep	1 Oct	20 Sep	21 Aug	21 Aug	22 Aug
MAR v3.5.2 + ISSM	30 Sep	31 Aug	20 Sep	20 Sep	20 Sep	1 Oct	20 Sep	21 Aug	21 Aug	22 Aug
ISSM	1 Jun	20 Jun	22 May	10 Jun	22 May	1 Jun	10 Jun	1 Jun	1 Jun	20 Jun



Figure S1. MAR v3.5.2 – MAR v2.0 average SMB, aggregated to the GRACE-LM grid, with
no filtering applied, for the period 2003-2010.



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Figure S2: Same as Figure 4, but for MAR v3.5.2. Dashed lines show the MAR v2.0

2 3 4 detrended unfiltered and Gaussian-filtered timeseries for comparison with MAR v3.5.2.



Figure S3: Detrended cumulative timeseries of Greenland mass change for MAR v3.5.2,

ISSM, and MAR v3.5.2 + ISSM. Spatial and temporal Gaussian filtering has been applied to
 the model outputs.



2 3 4

Figure S4: Difference between ISSM and observations for (a) Greenland Ice Sheet thickness (m), and (b) Annual ice velocities, for the year 2003. Thicknesses are obtained from Morlighem et al. (2015), and velocities are those of Rignot et al. (2012).





Figure S5: Same as Fig. 8b for MARv 3.5.2 + ISSM, MAR v3.5.2 and ISSM. Note a different axis is used for ISSM data.



Figure S6: Same as Fig. 11b-e, but for additional regions shown in Fig. 11a: (a) Region 2, (b)
Region 3, (c) Region 7, (d) Region 8.



Figure S7: Same as Fig. 11b-e, but showing seasonal cycles for MAR v3.5.2, ISSM and
MAR v3.5.2 + ISSM. Note the different axis for ISSM.



Figure S8: Same as Fig. S6, but showing seasonal cycles for MAR v3.5.2, ISSM and MAR
v3.5.2 + ISSM. Note the different axis for ISSM.



Figure S9: Same as Fig. 12, but showing seasonal cycles for MAR v3.5.2, ISSM and MAR
v3.5.2 + ISSM. Note the different axis for ISSM.