Supplementary

dH values at crossover locations before and after data culling

The data culling procedure has the purpose of removing obvious outliers before further data processing. The elevation differences at crossovers, based on data from the same ICESat campaign, can before and after data culling be used to check the culling procedure. As an example, the crossover elevation differences based on laser campaign L2B (17 February 2004 to 20 March 2004) are presented here. The statistics of the crossover elevation differences are summarised in table 1.

	μ_{dh}	σ_{dh}	No. Points: $\|dh\| > 0.5$m	max $\|dh\|$
Before	0.056 m	1.54 m	253	54.3 m
After	0.027 m	0.54 m	100	10.8 m

Table 1: *Statistics of elevation differences at crossovers before and after data culling. Here μ_{dh} is the mean value of the elevation difference at the crossovers and σ_{dh} is the standard deviation of the elevation difference at the crossovers.*

Seasonal signal

In all three methods for deriving elevation changes presented in this paper, a seasonal signal in the elevations is assumed:

$$s(t) = D\cos\left(\frac{2\pi}{T}t + \phi\right) = \alpha\cos(\omega t) + \beta\sin(\omega t)\,, \tag{1}$$

with amplitude $D = \sqrt{\alpha^2 + \beta^2}$, period T (365 days), and a phase ϕ.

As an example, the amplitude, D, of the seasonal signal estimated using method M3 is shown in Fig. 1. It is seen that a pattern is found, which shows large seasonal amplitude in the coastal regions and little in the interior part of the ice sheet, as expected. It is also seen that overall, larger amplitudes are found in the southern part of Greenland than in the northern part. A similar pattern is found by M1 and M2.

The empirical variogram and variogram model

The empirical variogram (seen in Fig. 2) is based on all data. Furthermore it is assumed, for simplicity, that the variogram is isotropic. Figure 2 shows the empirical variogram and two exponential variogram models with ranges of 50 km and 150 km, respectively. In this study, the exponential variogram model with a range of 50 km is used.

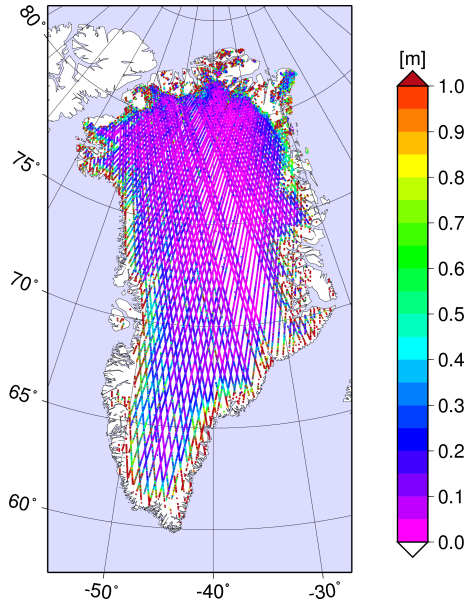

Figure 1: *The amplitude of the seasonal signal found with M3.*

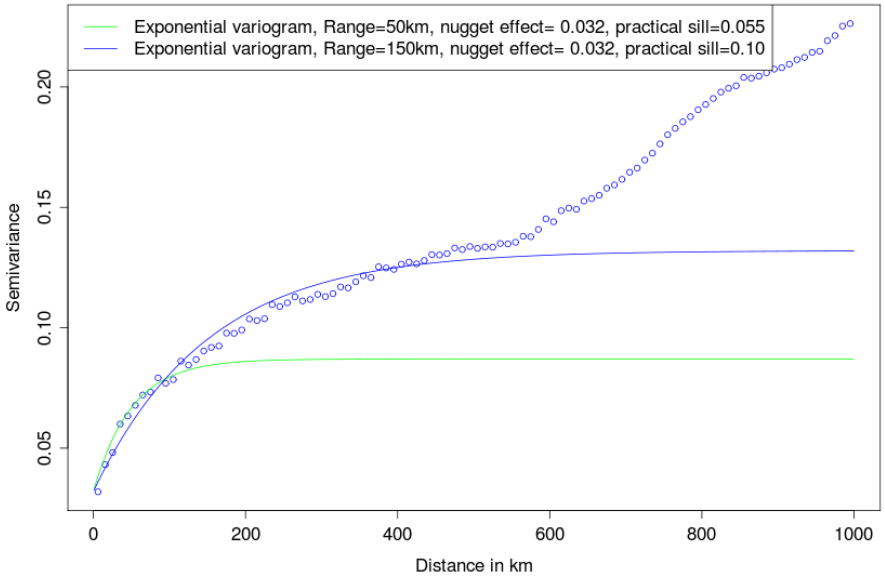

Figure 2: *The blue points represents the empirical variogram, and the blue and green lines represents an exponential variogram model with a range of 150 km and 50 km respectively.*

The variance of dH/dt

The variance of the dH/dt values are estimated in the regression procedure in all three methods. We show here, as an example, the variances obtained from method M2 (see Fig. 3). The largest variances are found in the coastal areas, associated with varying topography and with the largest elevation changes. The variances are used as weights in the interpolation.

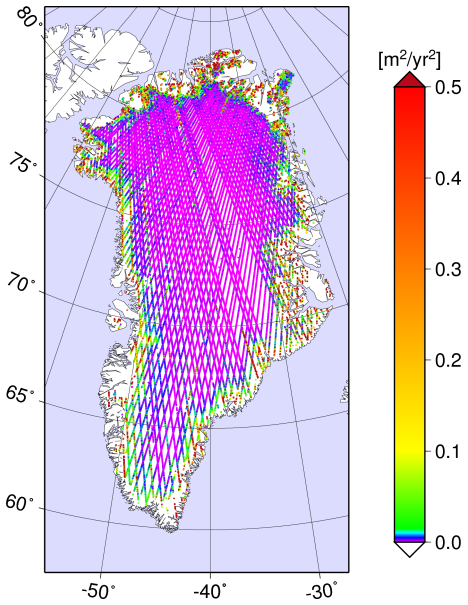

Figure 3: *The variance of dH/dt estimated from the regression procedure in M2.*