Supplement to: Sub-kilometre scale distribution of snow depth on Arctic sea ice from Soviet drifting stations

Robbie D.C. MALLETT,[1] Julienne C. STROEVE,[1,2,3] Michel TSAMADOS,[1] Rosemary WILLATT,[1] Thomas NEWMAN,[1] Vishnu NANDAN, [3] Jack C. LANDY, [4] Polona ITKIN, [4,5] Marc OGGIER, [6] Matthias JAGGI [7] and Don PEROVICH [8]

[1] *Centre for Polar Observation and Modelling, UCL, London, UK*

[2] *National Snow and Ice Data Center, University of Colorado, Boulder, CO, USA*

[3] *Centre for Earth Observation Science, University of Manitoba, Winnipeg, Canada*

[4] *Department of Physics and Technology, UiT The Arctic University of Norway, Tromsø, Norway*

[5] *Cooperative Institute for Research in the Atmosphere,*
Colorado State University, Fort Collins, CO, USA

[6] *Geophysical Institute, University of Alaska Fairbanks, Fairbanks, AK, USA*

[7] *WSL Institute for Snow and Avalanche Research SLF, Davos Dorf, Switzerland*

[8] *Thayer School of Engineering, Dartmouth College, Hanover, NH, USA*

Correspondence: Robbie Mallett <robbie.mallett.17@ucl.ac.uk>

BEST-FIT STATISTICS FOR LOG-NORMAL AND GAMMA DISTRIBUTIONS

Figure 3 of the main paper shows that the skew normal distribution has a superior fit to the observed data than the log-normal or gamma distributions. Here we provide the parameters of best fit for all three distributions for comparative purposes. For completeness, we restate that for the skew normal curve described in Eq. 2 of the main paper, the parameters of best-fit were $a = 2.54$, $\xi =$ -1.11 & $\omega = 1.50$.

The log-normal distribution is described as follows:

$$f(x,s) = \frac{1}{sx\sqrt{2\pi}}\exp\left(-\frac{\log^2(x)}{2s^2}\right) \tag{S1}$$

For $x > 0$ & $s > 0$. Analogous to the skew normal distribution described in the main manuscript, two more locating and scaling parameters (ξ & ω) are applied during the fit, such that x in the above equation can be represented by $(\sigma_D - \xi)/\omega$. The corresponding best-fit parameters for the log-normal distribution are $s = 0.17$, $\xi =$ -5.82, $\omega = 5.73$.

The gamma distribution is described as follows:

$$f(x,a) = \frac{x^{a-1}e^{-x}}{\Gamma(a)} \tag{S2}$$

for $x \geqslant 0$, $a > 0$, and $\Gamma(a)$ being the gamma function. As with the skew normal and log-normal distributions, locating and scaling parameters are applied such that $x = (\sigma_D - \xi)/\omega$. The parameters of best-fit for the Gamma distribution are $a = 26.15$, $\xi =$ -5.06 & $\omega = 0.19$.

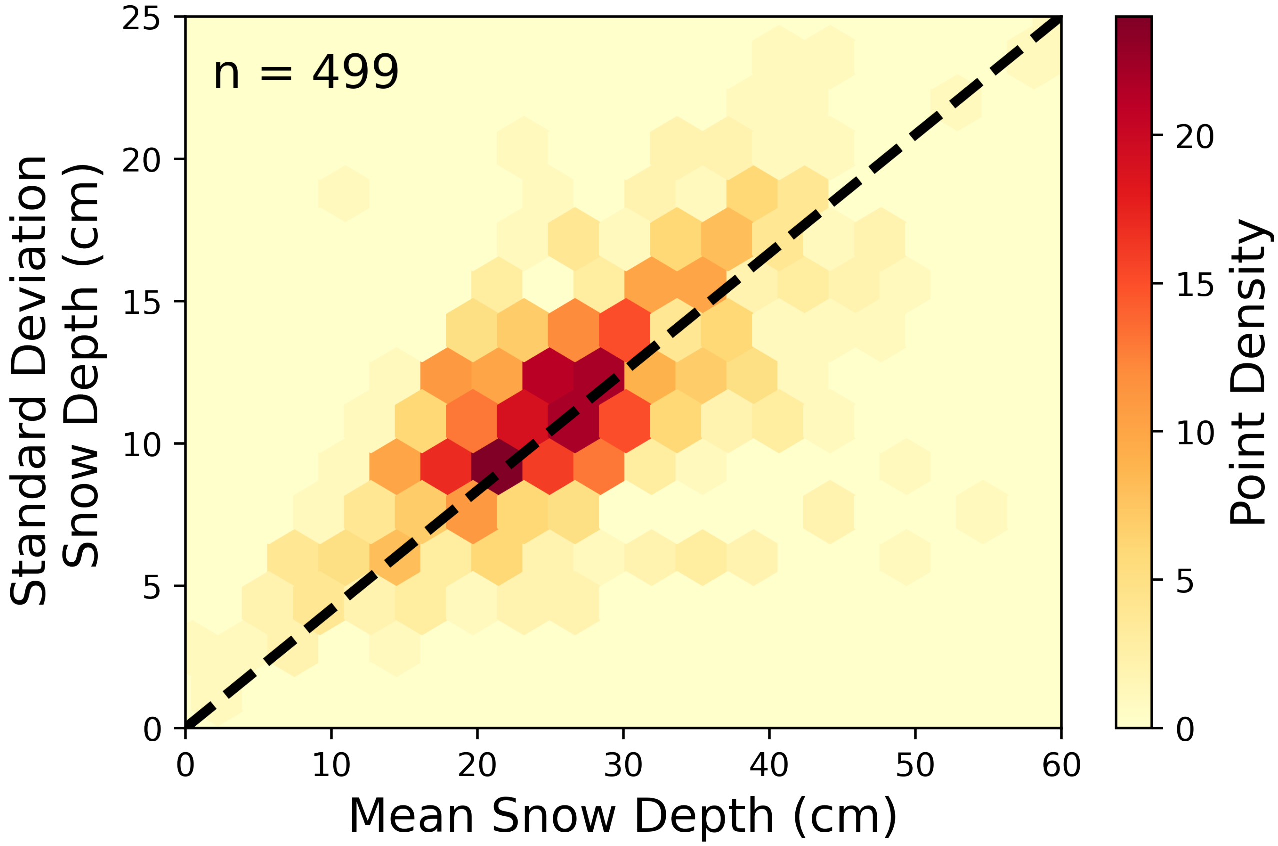

Fig. S1. Point density plot corresponding to Fig. 2a of the main paper, and the regression (black dash line) between mean and standard deviation of the snow depth. The Pearson r value of the correlation is 0.66.

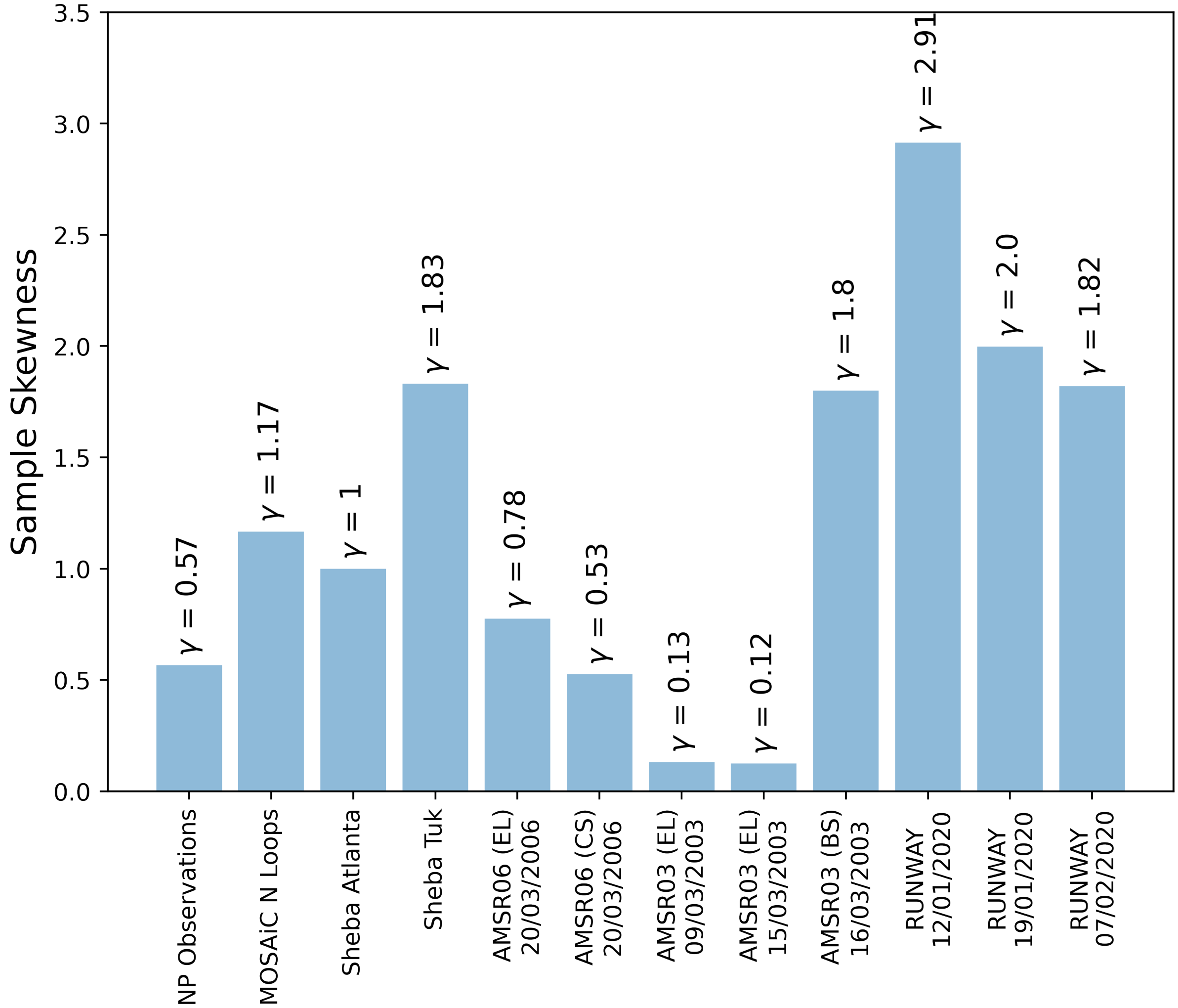

Fig. S2. Sample skewness (γ) for all observational data considered in this study. Note that sample skewness is different to the skewness parameter of the skew normal distribution (a), although the two variables have the same sign.

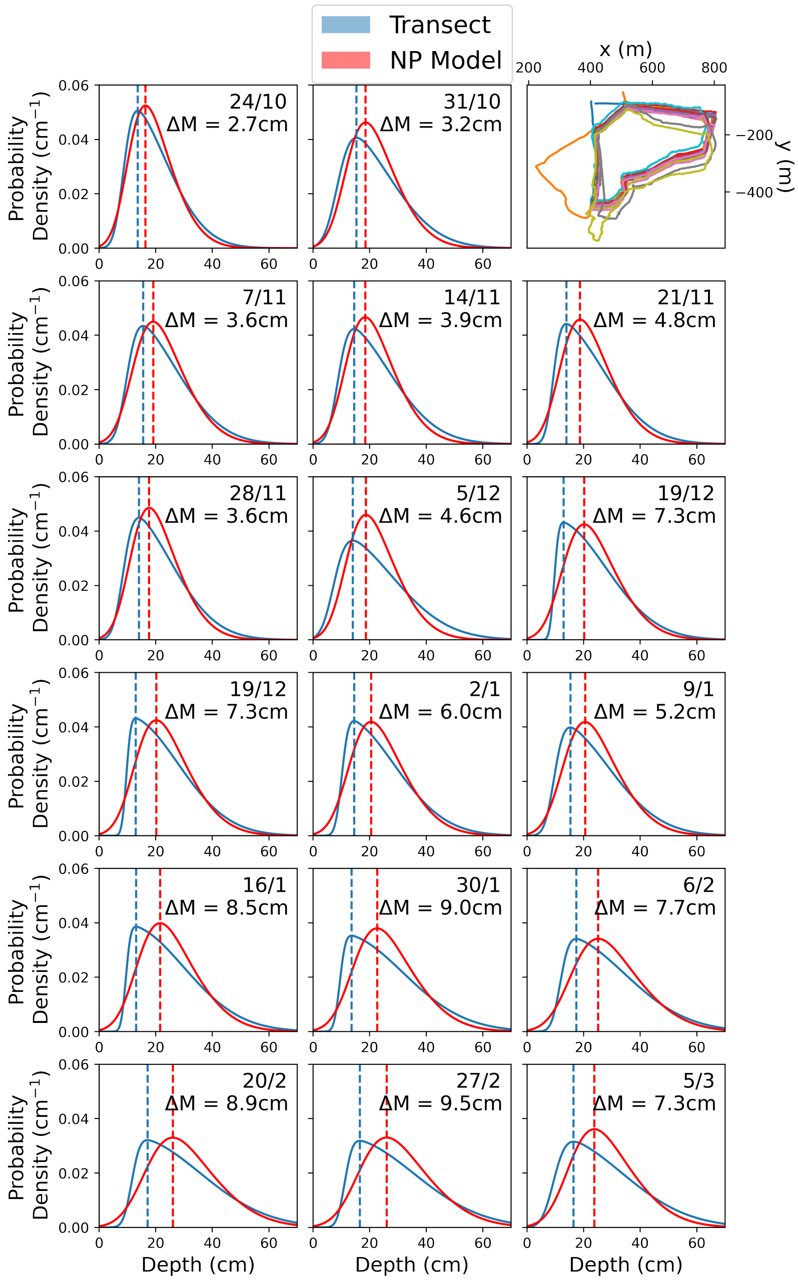

Fig. S3. Comparison of the NP model when initialised by the mean snow depth of each transect (red curves), with a skew normal curve fitted to the observed data. The NP model consistently overestimates the modal value of the snow depth by comparison to the skew normal curve of best fit. This discrepancy grows over the course of the measurements, from 2.7 centimetres at the end of October to 9.5 centimetres at the end of February. ΔM indicates the mismatch in the mode of the two distributions to the nearest centimetre.

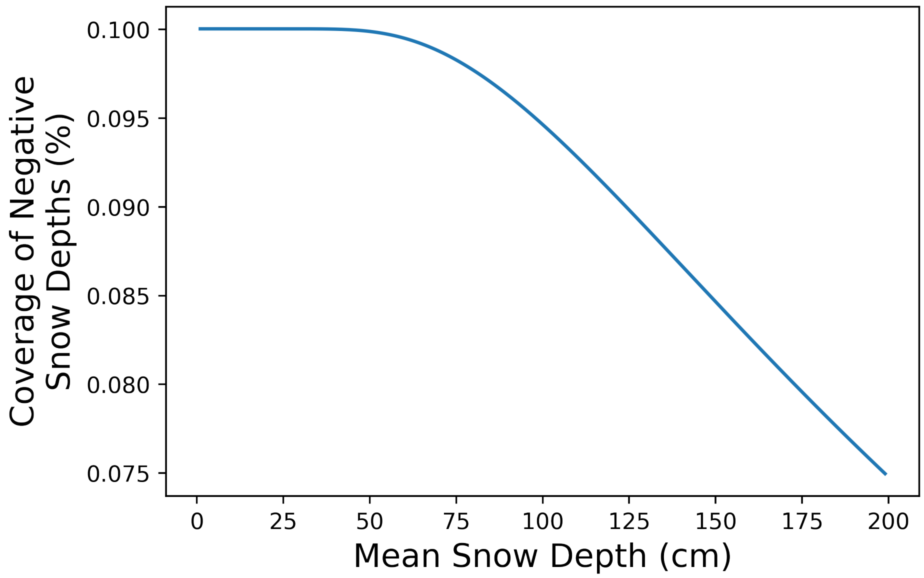

Fig. S4. Areal coverage of negative snow depths in the NP model as a function of mean snow depth.

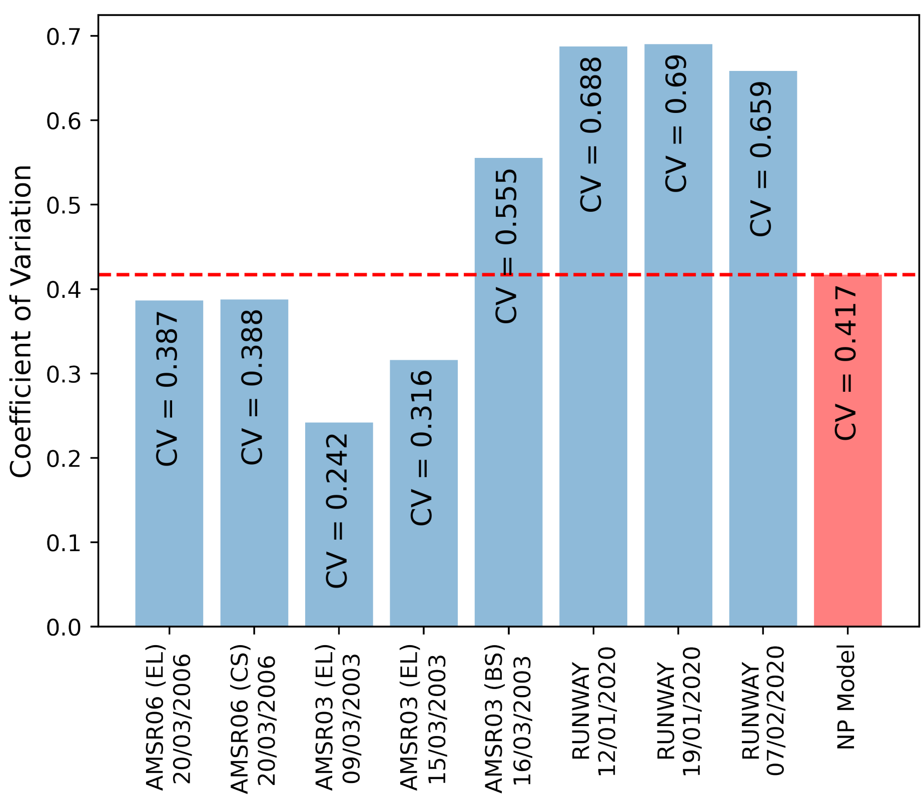

Fig. S5. Coefficient of variation for the six FYI data sets considered in this paper, compared to that generated from the NP data.

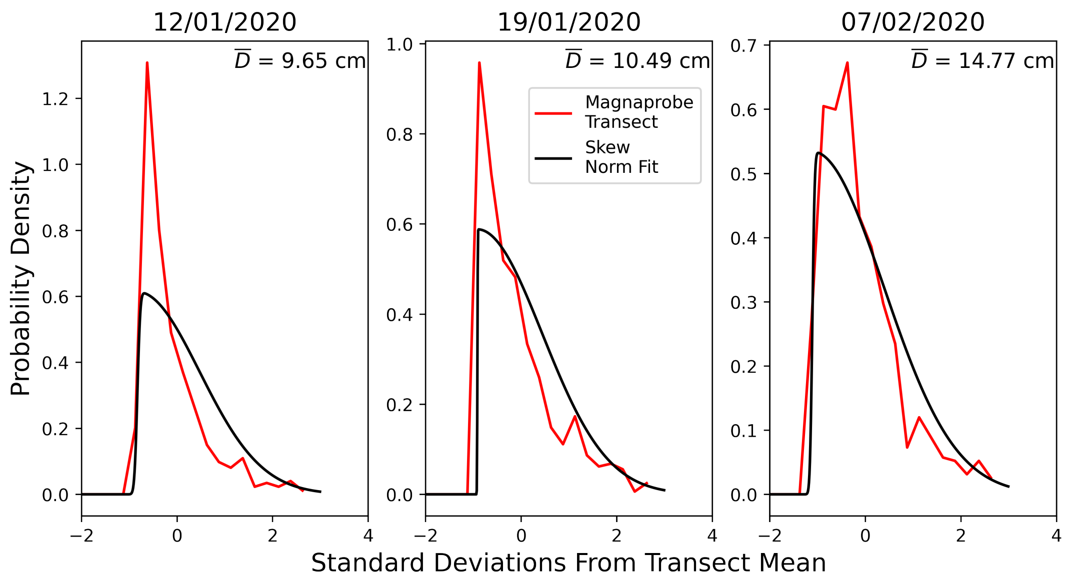

Fig. S6. Distribution of snow depths measured on the "Runway" transect of the MOSAiC expedition (red). Black lines indicate the best-fit skew-normal curves, which have a poor quality of fit. $\overline{D}$ indicates the mean depth of the transect.

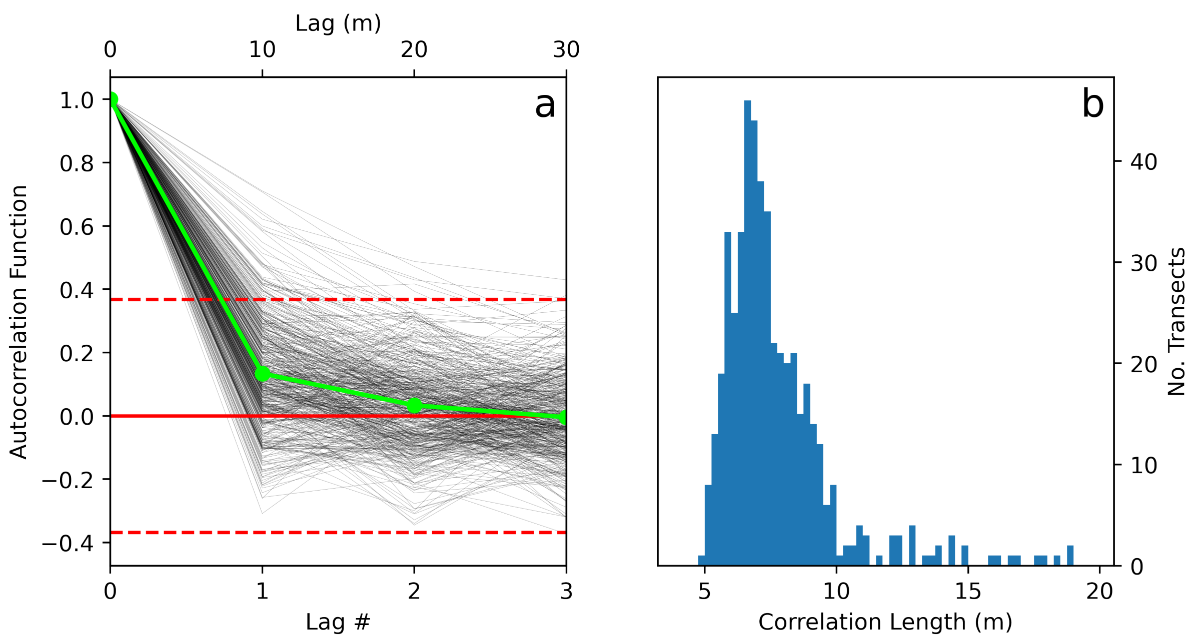

Fig. S7. (a) Autocorrelation functions of 499 transects (black lines). The mean of these autocorrelation functions is shown in green. Red dashed lines indicate a value of $\pm 1/e$, the positive value of which corresponds to the threshold for the 'autocorrelation length'. (b) Distribution of transect correlation lengths with a bin size of 25 cm.