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Drifting-snow statistics from multiple-year autonomous measurements in Adélie Land, East Antarctica

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Table S1. Meteorological instruments installed at D47 and D17 along the respective observation periods (sensors marked with * are manufactured by Campbell Scientific, Inc.). Instrument types and specificities are given for the sensors nearest to 2 m as recovered by the ultrasonic depth gauge (2013-2018) or for the nearest original height when information on surface height is not available (2010-2012).

	D47			D17		
	Period	Sensor	Accuracy	Period	Sensor	Accuracy
Wind speed	01/10 - 12/12	Young 05103	$\pm$0.3 m s^{-1}	02/12 - 12/10	RNRG 40C	$\pm$ 0.14 m s^{-1}
				01/11 - 12/18	A100LK*	$\pm$ 0.1 m s^{-1}
Wind direction	01/10 - 12/12	Young 05103	$\pm$ 3 °	02/12 - 12/10	RNRG 200P	$\pm$ 4 °
				12/12 - 12/18	W200P*	$\pm$ 2°
Air temperature	01/10 - 12/12	Vaisala HMP155	$\pm$0.3 °C	02/10 - 12/18	Vaisala HMP45	$\pm$0.4 °C
Relative humidity	01/10 - 12/12	Vaisala HMP155	$\pm$1 %	02/10 - 12/18	Vaisala HMP45	$\pm$2%
Snow height	01/10 - 12/12	SR50A*	$\pm$0.01 m	12/12 - 12/18	SR50A*	$\pm$0.01 m
Snow mass flux	01/10 - 12/12	2G-FlowCapt™	-	12/12 - 12/18	2G-FlowCapt™	-

Table S2. Comparison of drifting snow occurrences at D17 and D47 over the period 2010-2012.

D47 \ D17	DR	nDR
DR	53.7%	28.3%
nDR	3.4%	14.6%

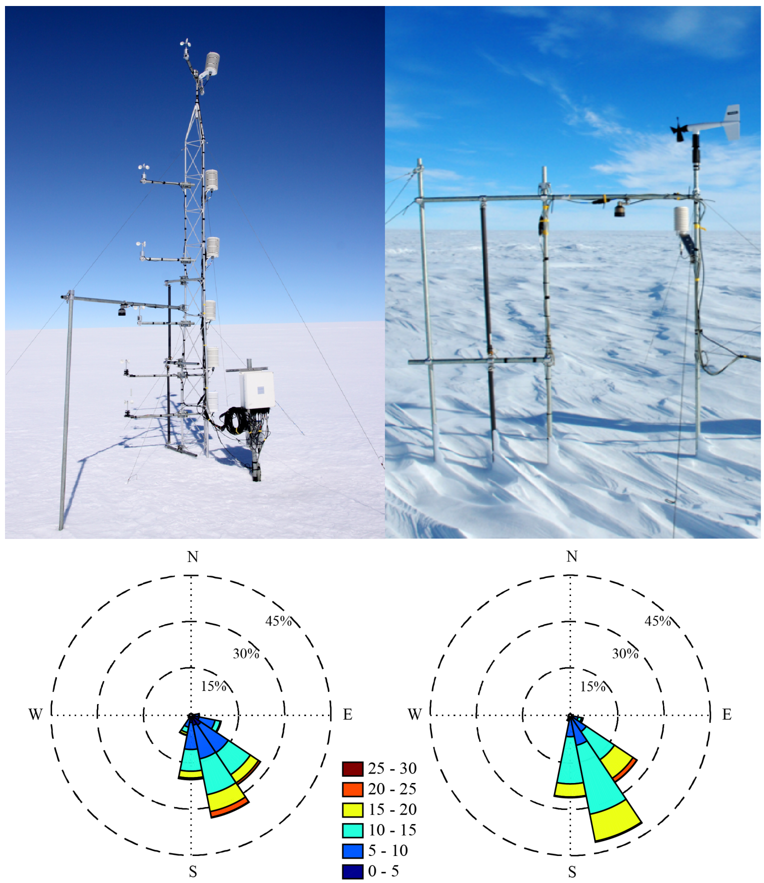

Figure S1. Pictures of the meteorological equipment and wind roses at D17 (left panel) and D47 (right panel) for the respective observation periods. At D17 the wind speed from the measurement closest to 2 m is used while wind direction is taken at the upper level of the meteorological mast. The colours indicate the wind speed ranges in m s-1. The pictures were taken in late January 2014 at D17 and in early January 2011 at D47.

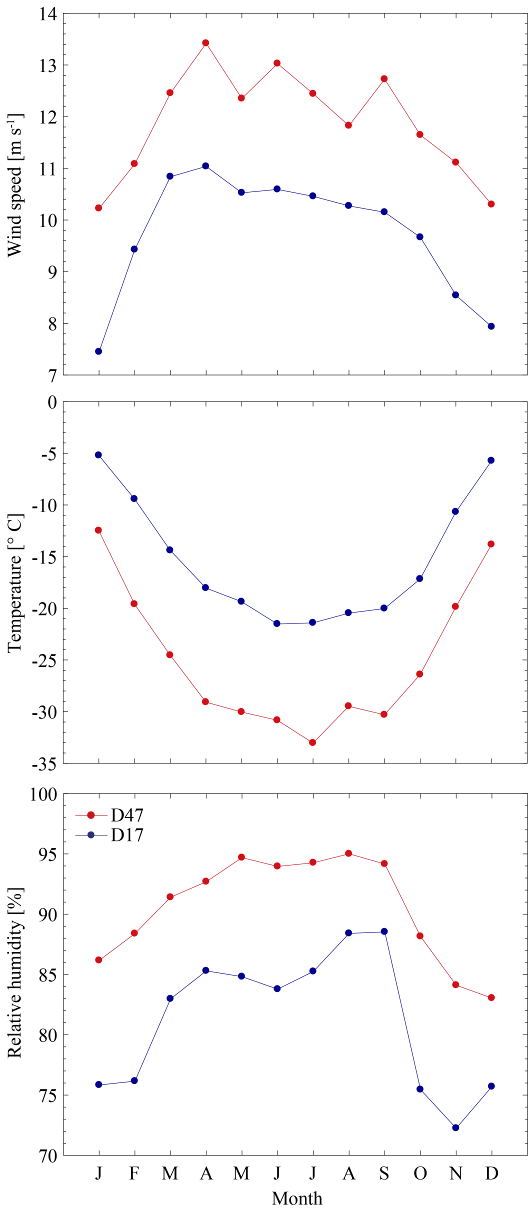

Figure S2. Monthly timeseries of wind speed (upper panel), temperature (middle panel) and relative humidity (lower panel) at 2-m height for D47 (red circles) and D17 (blue squares) for the respective observation periods 2010-2012 and 2010-2018. Mean values for each variable have been first determined from the measurement level closest to 2 m for each month of the observation period, and averaged within each monthly bin to produce monthly average values.

S1 Intercomparison between snow particle counters S7 and second-generation FlowCapt™ sensors during a drifting snow event in Adelie Land

S1.1 Snow particle counters

The measurement principle of the snow particle counter S7 (SPC-S7) follows an optical method based on the strong absorption of the infrared light by the snow. The diameter and number flux of snow particles are detected by their shadows on a super-luminescent diode sensor. Electric pulse signals corresponding to a snow particle passing through a sampling area of 50 mm^2 (2 mm in height and 25 mm in width) and whose voltage is directly proportional to the size of the particle are classified into 32 size bins from ~40 to 500 μm (Sato et al., 1993). This means that snow particles smaller than 40 μm remain undetected and snow particles larger than 500 μm are assigned to the maximum diameter class. Thanks to a self-steering vane the SPC-S7 measures perpendicularly to the horizontal wind vector the distribution size spectrum of snow particles every 1 s, from which the horizontal snow mass flux, η, can be computed assuming fully spherical snow particles with a density equal to that of ice as follows

$$\eta = \sum_{id=1}^{32} \eta_d = \sum_{id=1}^{32} n_d \frac{4}{3}\pi(\frac{d}{2})^3 \rho_i \qquad \text{(S1)}$$

with η_d (kg m^{-2} s^{-1}) the horizontal snow mass flux for the class of diameter d (m), id the index and n_d the measured number flux of snow particles (part. m^{-2} s^{-1}) for each of the 32 diameter classes, and ρ_i the particle density (917 kg m^{-3}).

S1.2 Experimental set-up

Two SPCs were installed on 28 January 2014 (Fig. S3) a few hours before strong drifting snow occurred in conjunction with strong katabatic winds reinforced by the passage of a low-pressure system off the Adelie Coast. The equipment was removed on 29 January once drifting snow ceased. One SPC was installed at a fixed position 1 m above the ground, while the position of the other was alternatively switched manually between 0.5 and 2 m above the ground every 1-2 hours. This was done in order to study the vertical gradient of the mass flux for two ranges of height (0.1-1.1 m and 1.2-2.2 m) above the snow surface for which 2G-FlowCapt™ measurements are also available for comparison. The high energy requirements of the SPCs (~15 W) were fulfilled by an electric generator that was housed together with the acquisition system in a mobile shelter downwind of the measurement structure. Only a few data are missing due to problem with the acquisition system of the SPC at the beginning of the experiment, resulting in an timeseries almost continuous along the event.

S1.3 Computation of integrated snow mass fluxes from SPC data

According to the diffusion theory of drifting snow (Radok, 1977), the averaged drifting snow particle density (kg m^{-3}) in the diffusion layer can be approximated by a function of height. When the wind profile follows a power law, an expression for the vertical distribution of the snow mass flux η(z) (kg m^{-2} s^{-1}) writes

$$\eta(z) = az^{-b} \qquad \text{(S2)}$$

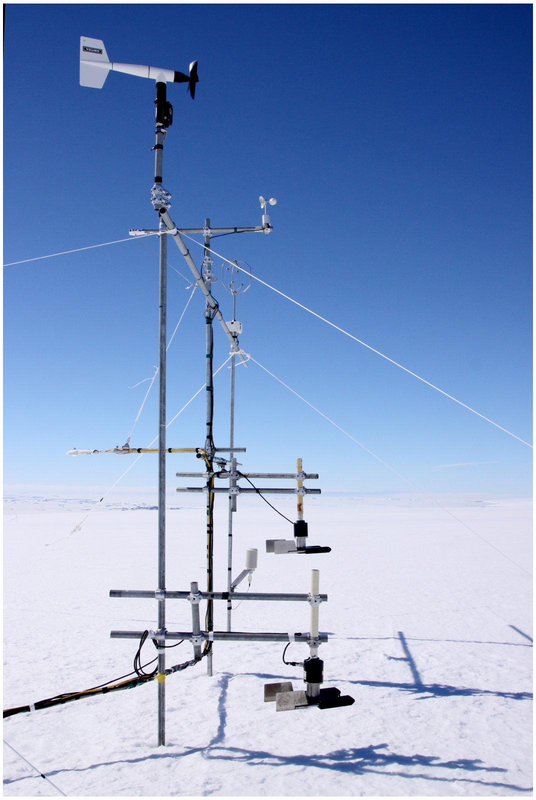

Figure S3. Picture of the snow particle counters installed at D17 during the intercomparison experiment in late January 2014.

where a is the calibration parameter and b the exponent independent of height. These parameters were derived by regression from the data measured by the two SPCs (Trouvilliez et al., 2015), alternatively available for the two height ranges. Then, the half-hourly average of the horizontal snow mass flux vertically integrated over the corresponding height covered by the 2G-FlowCapt™ can be estimated. Because (i) snow depth measurements revealed insignificant height change after the event and were affected by the presence of drifting snow particles perturbing the travel of ultrasound pulses along the measuring path during the event, (ii) the two 2G-Flowcapts were respectively installed at 0.1 and 1.2 m above the snow surface at the beginning of the event, and (iii) the heights of the SPCs were regularly checked and manually adjusted along the experiment, constant heights are used in the integration. Finally, data were processed following the procedure described in Guyomarc'h et al. (2019). Resulting integrated snow mass fluxes are compared in Fig. S4. Although more data are necessary to better assess the performance of the 2G-FlowCaptTM in Antarctic conditions, a high degree of agreement between the two types of sensor is depicted with a correlation coefficient of 0.82 and 0.93 and a rmse of 70 10^{-3} and 13 10^{-3} kg m^{-2} s^{-1} (by taking the SPC-S7 as a reference) for the lower and upper height range, respectively.

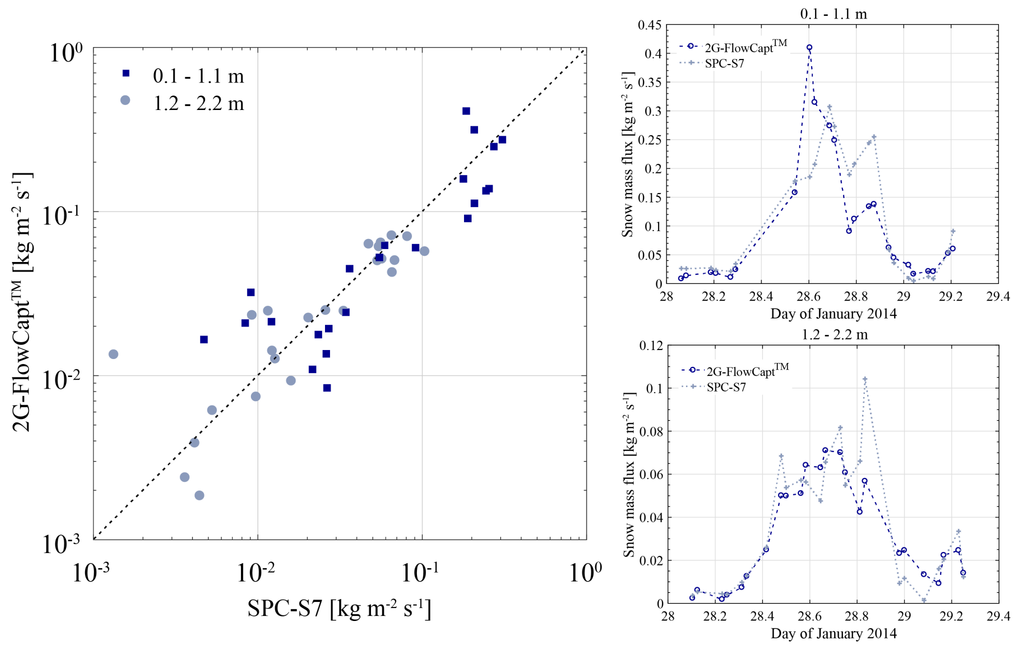

Figure S4. Comparison between snow mass fluxes provided by 2G-Flowcapt™ sensors and computed from measurements made with snow particle counters (SPC-S7) during a snow transport event at site D17 in late January 2014. A distinction is made between snow mass fluxes integrated over 0.1 to 1.1 m and 1.2 to 2.2 m above ground.

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