The impact of temporal aggregation of solid precipitation measurements on the correction for wind-induced undercatch.

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Introduction:

Solid precipitation measurements are affected by systematic wind-induced errors, due to the aerodynamic response of catching type gauges. The snowflakes deviate from their undisturbed trajectories due to the alteration of the airflow field around the body of the gauge and the corresponding developed turbulence. The resulting effect consists in a certain degree of undercatch, which is a function of the undisturbed wind velocity.

The correction of wind-induced errors has been addressed in the literature from the conceptual, numerical and experimental point of view. The Collection Efficiency (CE) curve of a single gauge, i.e. the relationship between the expected undercatch and the undisturbed wind speed, is derived from CFD simulations or field test studies (Colli et al., 2015; Wolff et al., 2015). This is used to apply a suitable transfer function (TF) to correct the wind-induced errors in real world measurements.

Snowfall depth and wind speed measurements are commonly recorded at a temporal resolution in the order of 30-60 minutes, although the effect of wind bursts can affect the measurements at a much higher resolution. In this work, we investigate the impact of the aggregation scale on the accuracy of snowfall data when corrected by using the transfer function.

Methodology

1. Wind and Snowfall Intensity. One-minute time series

From existing Collection Efficiency (CE) curves:
1. *Haukeliseter (Wolff et al. 2015)*
2. *Marshall (Colli et al. 2015)*

2. 3 synthetic Wind-affected time series.

3 Sampling intervals (5, 15 and 30 min.).
+
Tranfer Function applied at different aggregation time

3. Corrected Time Series at different time resolution

References:

Colli, M., Rasmussen, R., Thériault, J. M., Lanza, L. G., Baker, C. B., & Kochendorfer, J. (2015). An improved trajectory model to evaluate the collection performance of snow gauges. Journal of Applied Meteorology and Climatology, 54(8), 1826-1836.

Wolff, M. A., Isaksen, K., Petersen-Øverleir, A., Ødemark, K., Reitan, T., & Brækkan, R. (2015). Derivation of a new continuous adjustment function for correcting wind-induced loss of solid precipitation: results of a Norwegian field study. Hydrology and Earth System Sciences, 19(2), 951-967.

SPICE
Solid Precipitation Intercomparison Experiment

QC Snowfall and Wind data at 1 min Time-Resolution

Reconstruction of synthetic Wind-affected Time Series

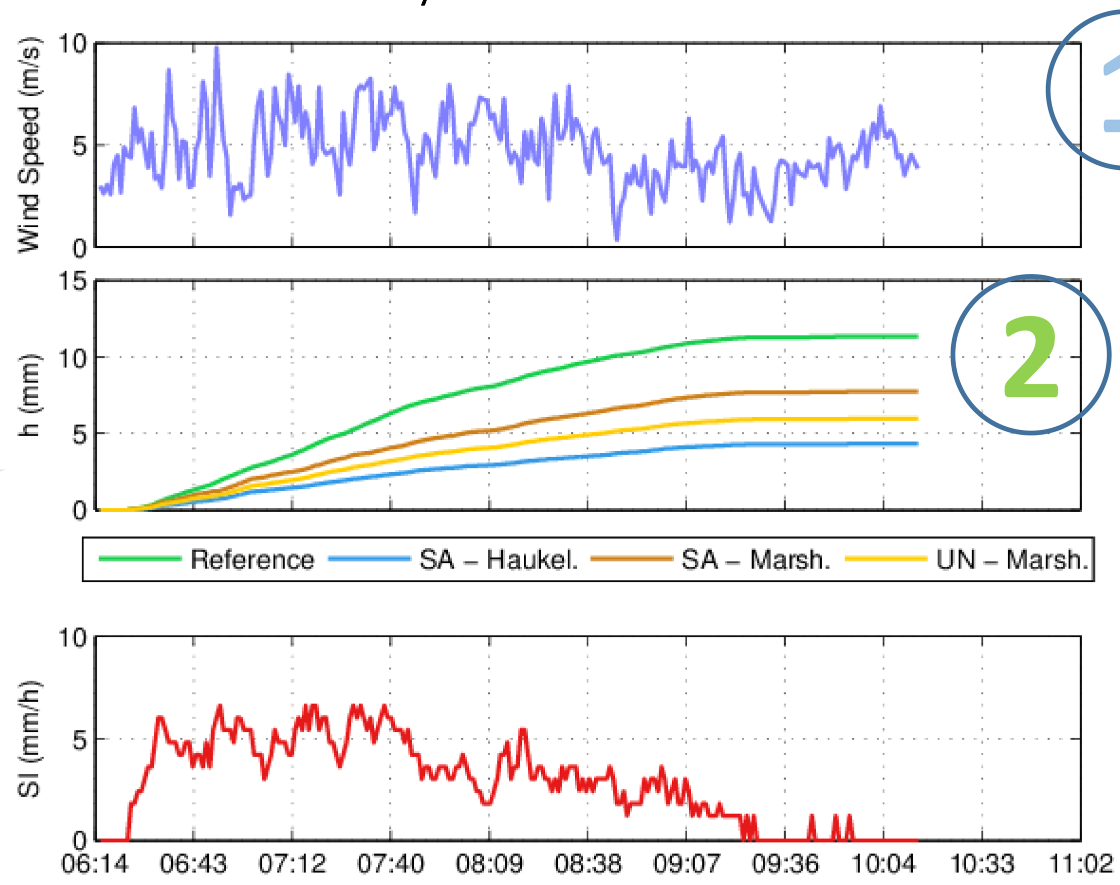

Figure 2 – Measured and synthetic data from a sample snowfall event. The one minute wind speed (upper panel), the one minute snowfall intensity (lower panel) measured form the DFIR and the snow accumulation (central panel) measured from the reference (DFIR) and the synthetic series obtained from the TF of Heukeliseter (SA) and Marshall (SA and UN).

Use the *Transfer Functions* to correct the wind-affected time series at different sampling times (5, 15 and 30 minutes)

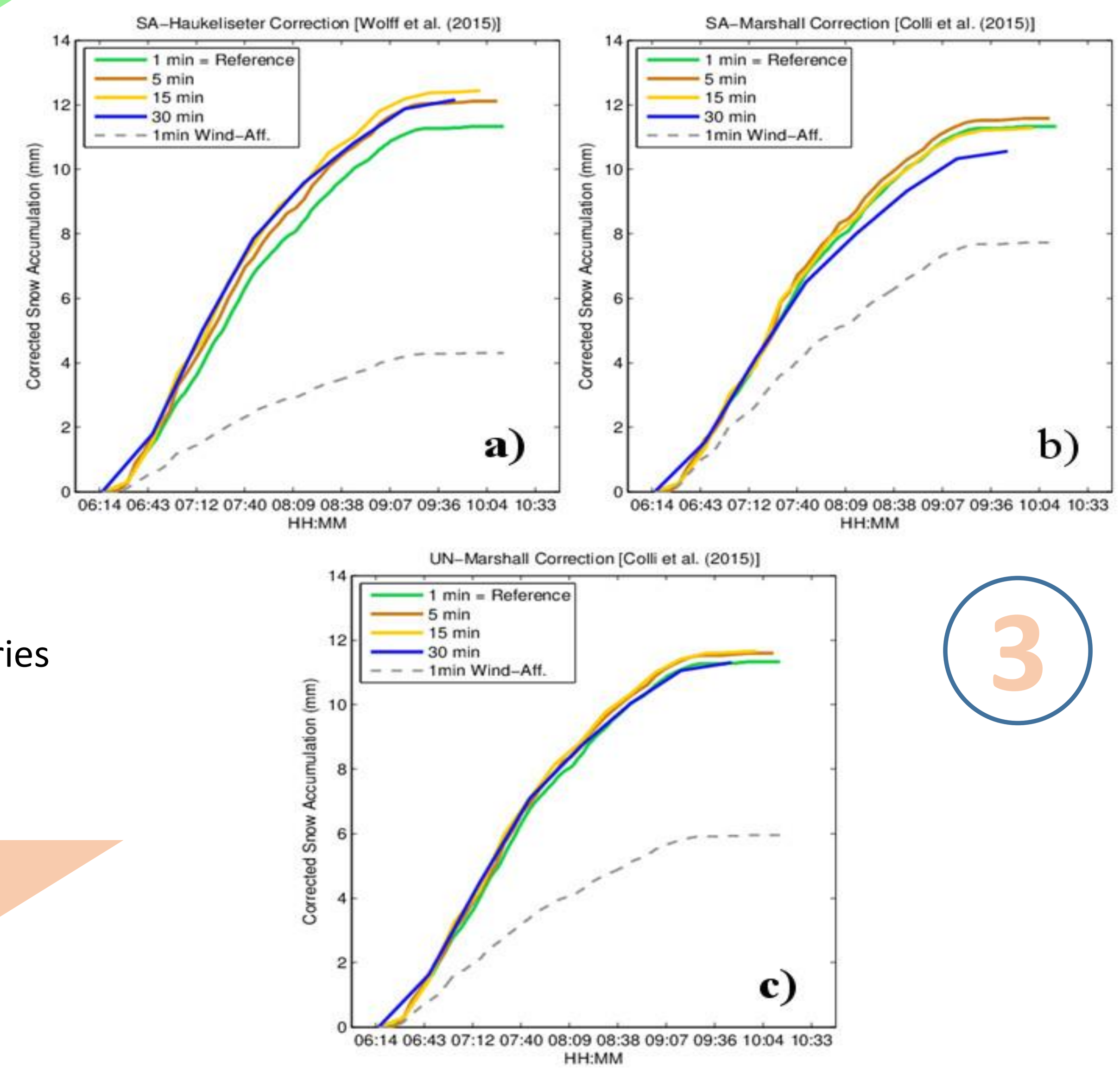

Figure 3 – Wind affected (dashed line) and reference (green line) snow accumulations, compared with the corrected values at different time resolution from the Heukeliseter (Wolff et al., 2015) transfer function for SA gauge (a), and from the Marshall (Colli et al., 2015) transfer function for SA gauge(b) and for UN gauge(c).

Evaluate the averaged error which occurs adopting different aggregation times for different transfer functions.

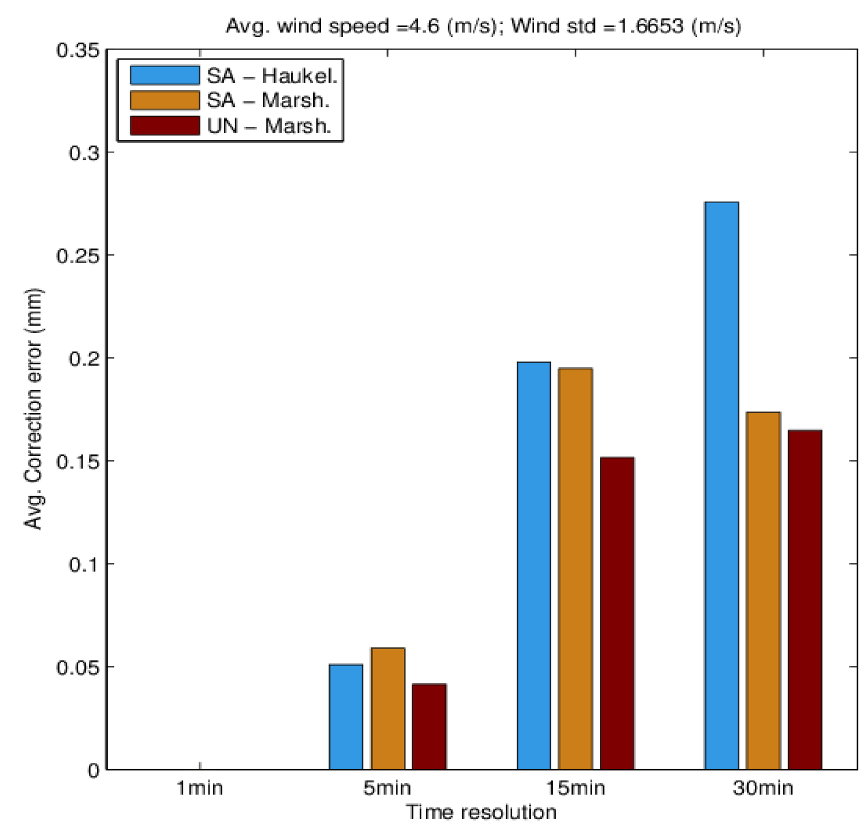

Figure 4 – Average error of the three synthetic corrected measurements from the reference, in terms of snowfall accumulation within each sampling interval for a sample event.

Conclusions

From the field measurements of snowfall and wind speed, we obtained synthetic measurements of wind-affected snowfall gauges at the time resolution of one minute. These synthetic data have been obtained by employing three different collection efficiency curves presented in the literature. From these series of snowfall measurements, we aggregated the data at different time intervals and then we corrected the snowfall data of each gauge using the associated transfer function.

It can be noted that when increasing the aggregation scale the corrected series of snowfall intensities differs from the reference from which they have been generated, and the result is strongly influenced by the shape of the transfer function used to correct the wind-affected snowfall data.

Finally, an estimation of the average value of the error by using different aggregation time has been calculated. The error increases when moving from 1 to 15 minutes for all the transfer functions here considered, while considering the 30 minutes aggregation scale it still increases for the Heukeliseter transfer function while it stabilizes for both the SA and UN transfer functions from Marshall.