Dependence of in-situ snow sampling accuracy on sampler cross-section

Marko Kaasik (marko.kaasik@ut.ee)
Kati Anttila (kati.anttila@syke.fi)
Pavla Dagsson Waldhauserova (pavla@lbhi.is)
Anders Ginnerup (ang@asiaq.gl)
Timo Hampinen (timo.hampinen@ely-keskus.fi)
Leena Leppänen (leena.leppanen@ulapland.fi)
Yijing Liu (yili@ign.ku.dk)
Andri Gunnarsson (andri.gunnarsson@landsvirkjun.is)
Kirsty Langley (kal@asiaq.gl)
Outi Meinander (outi.meinander@fmi.fi)
Ali Nadir Arslan (ali.nadir.arslan@fmi.fi)

Nordic Snow Network

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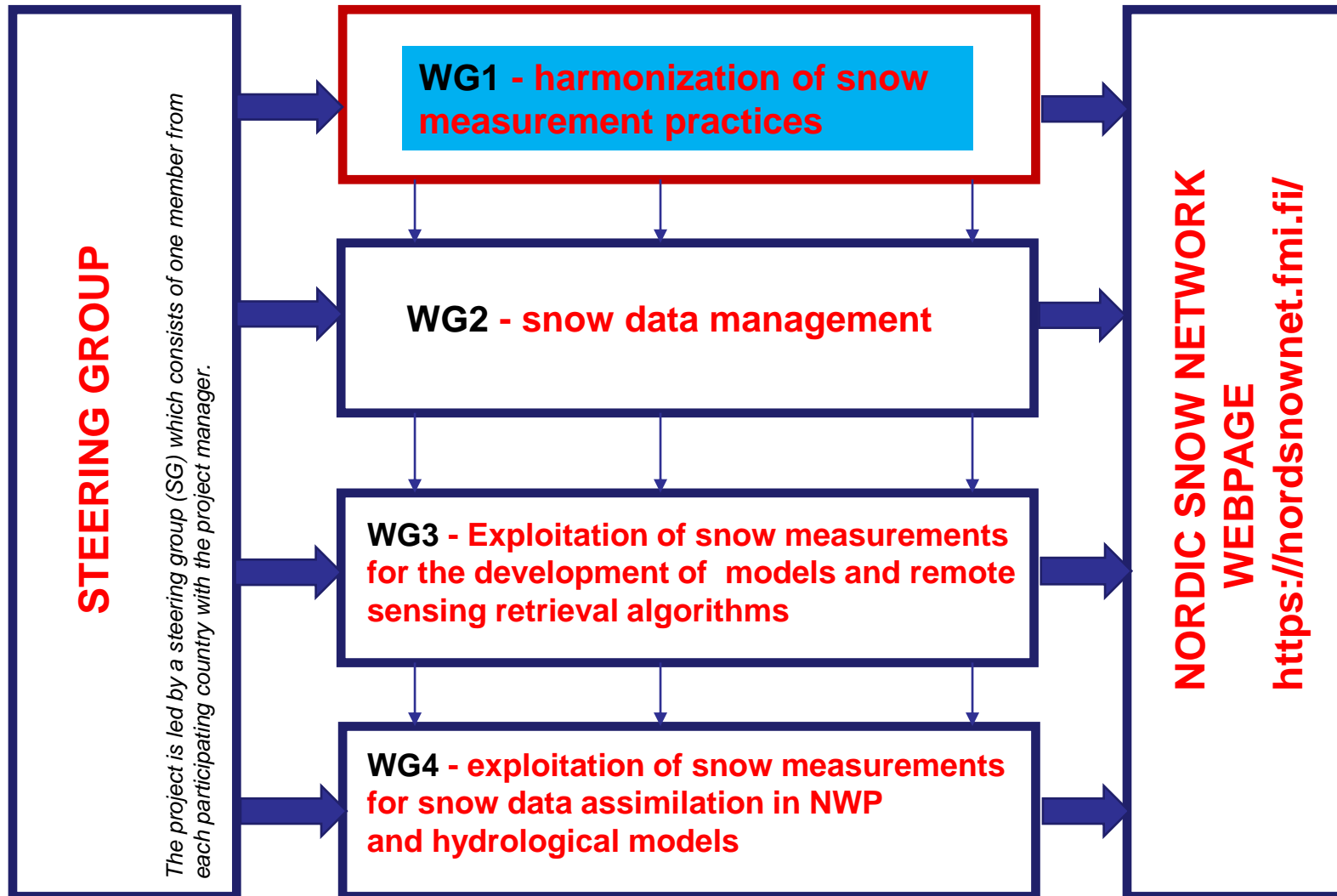

NORDIC SNOW NETWORK

https://nordsnownet.fmi.fi/

ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

PROJECT ORGANIZATION

Snow water equivalent (SWE)

SWE $[kg/m^2]$ = mass of snow $[kg]$ / area $[m^2]$

- Basically same, as precipitation amount [mm]

- Can be measured once in the end of winter in case of stable snow cover.

Purposes:

- Hydrology

- Hydroenergetics

- Deposition fluxes of pollutants measured in snow water

Why snow samplers´ performance intercomparison?

- Measured snow water equivalent: SWE = sample weight/cross-section area

- Samplers of different area and sampling techniques (tube bulk sampler, layer-wise)

- How the results from different samplers compare to each other, in terms of SWE (entire snow package)?

Field campaign

- Sodankylä (67.3620°N, 26.6338°E), site of Finnish Meteorological Institute.

- March 24, 2022.

- Snow cover nearly 60 cm deep.

- 10 different samplers from 7 work groups, 4 countries (Greenland, Estonia, Finland, Iceland).

Samplers and samples

Institution	Samlpling equipment	Area, cm²	Number of cores
Uni. Tartu	Deposition sampler	44	3
FMI	KM	100	8
Arctic Centre	AC white	79	8
Arctic Centre	AC transparent	69	8
FMI	FMI layer-wise (5 cm)	100	1
Uni. Oulu	TH tube	100	10
FMI	Tube	100	8
Greenland Survey	1m federal sampler	11	10
Greenland Survey	Rip cutter	100	1
Uni. Iceland	Federal	11	8
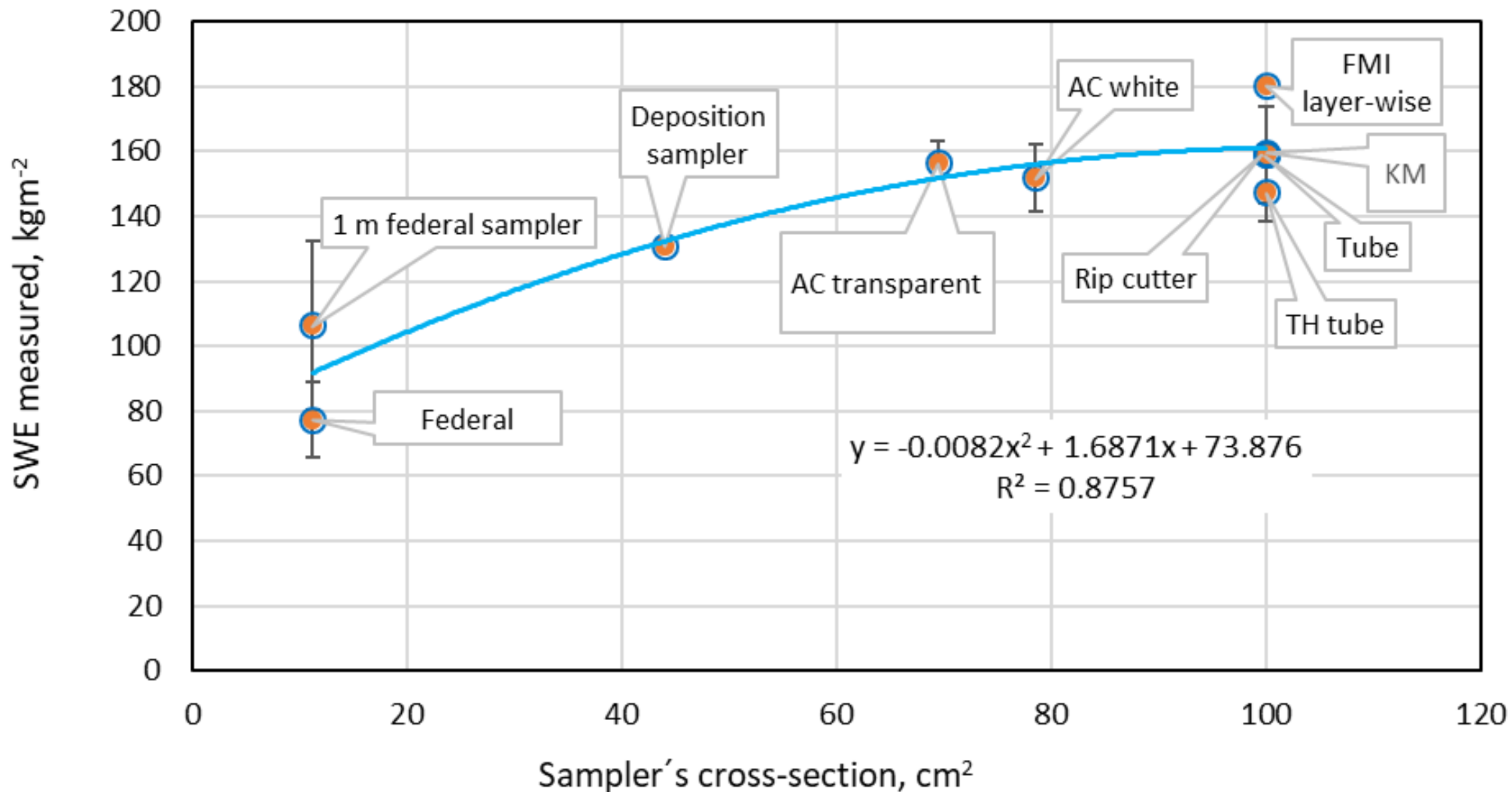
Qualitative physical interpretation

- Sampler´s walls have finite thickness.

- In general, the walls of tube sampler, relative to its diameter are thicker for thinner tubes.

- Thus, the snow inside is slightly compressed, creating more friction force to the walls.

- Consequently, snow inside gets partially clogged - a part of snow swept aside from direct path, when pushing the sampler down through snow.

- As a result, less snow gets in.

- I seems that the systematic underestimating is negligible for samplers $S \geq 80$ cm^2, according to shape of regression curve.

What then?

- A correction function to SWE can be derived.

- Fist guess:

$$SWE_{correct} = (-5.1 \cdot 10^{-5} \, S^2 + 0.0105 \, S + 0.46) \, SWE_{measured}$$

for $100 \text{ cm}^2 > S > 10 \text{ cm}^2$

- More comparison experiments needed with different sampling principles (bulk, layer-wise etc.), sampler shapes and sizes, snow type (high and low density, hard and soft).

Many thanks to Nordic Snow Network for enabling the intercomparison exercise!

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Thank you!