Applications of the WMO Solid Precipitation Intercomparison Experiment (WMO-SPICE) results for nowcasting activities

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(Based on a true story) - Mosqueruela (Spain)

Observation
Gauge: 16 mm
Snow depth: 60 cm

Something is wrong !

Reference: Buisán, S. T., Earle, M. E., Collado, J. L., Kochendorfer, J., Alastrué, J., Wolff, M., Smith, C. D., and López-Moreno, J. I.: Assessment of snowfall accumulation underestimation by tipping bucket gauges in the Spanish operational network, Atmos. Meas. Tech., 10, 1079-1091, https://doi.org/10.5194/amt-10-1079-2017, 2017.

	Precip (mm)	Temp (°C)	Wind (km/h)	Catch	Adjusted (mm)
19/01/2017 15:00	0.0	-4.08	28.32	0.17	0.00
19/01/2017 16:00	0.4	-4.22	28.56	0.18	2.27
19/01/2017 17:00	0.4	-4.40	27.18	0.19	2.15
19/01/2017 18:00	0.4	-4.60	23.82	0.22	1.85
19/01/2017 19:00	0.4	-4.18	24.24	0.22	1.83
19/01/2017 20:00	0.4	-3.87	26.10	0.20	1.97
19/01/2017 21:00	0.6	-3.63	26.28	0.21	2.88
19/01/2017 22:00	1.0	-3.62	20.34	0.29	3.48
19/01/2017 23:00	1.4	-3.53	16.50	0.36	3.89
20/01/2017 0:00	0.6	-3.45	14.76	0.37	1.62
20/01/2017 1:00	0.4	-3.37	19.68	0.29	1.39
20/01/2017 2:00	0.2	-3.15	20.34	0.28	0.72
20/01/2017 3:00	0.2	-3.08	18.84	0.30	0.66
20/01/2017 4:00	0.2	-2.97	18.30	0.31	0.64
20/01/2017 5:00	0.2	-2.85	13.08	0.41	0.49
20/01/2017 6:00	0.2	-2.67	14.22	0.39	0.51
20/01/2017 7:00	0.2	-2.63	15.78	0.36	0.55
20/01/2017 8:00	0.2	-2.40	15.48	0.37	0.54
20/01/2017 9:00	0.2	-2.07	18.93	0.32	0.62
20/01/2017 10:00	1.4	-1.33	14.04	0.47	2.96
20/01/2017 11:00	0.4	-1.10	19.74	0.34	1.19
20/01/2017 12:00	1.6	-0.97	17.64	0.41	3.87
20/01/2017 13:00	1.4	-0.90	16.50	0.43	3.24
20/01/2017 14:00	1.2	-1.08	17.82	0.39	3.05
20/01/2017 15:00	0.6	-1.60	17.28	0.37	1.61
20/01/2017 16:00	0.4	-2.02	20.28	0.31	1.30
20/01/2017 17:00	0.4	-2.20	21.48	0.29	1.40
20/01/2017 18:00	0.2	-2.02	26.46	0.22	0.89
20/01/2017 19:00	0.2	-2.00	24.00	0.25	0.79
20/01/2017 20:00	0.0	-1.88	21.24	0.29	0.00
20/01/2017 21:00	0.4	-1.70	22.26	0.29	1.40
20/01/2017 22:00	0.2	-1.80	19.38	0.32	0.62
20/01/2017 23:00	0.0	-1.65	23.67	0.26	0.00

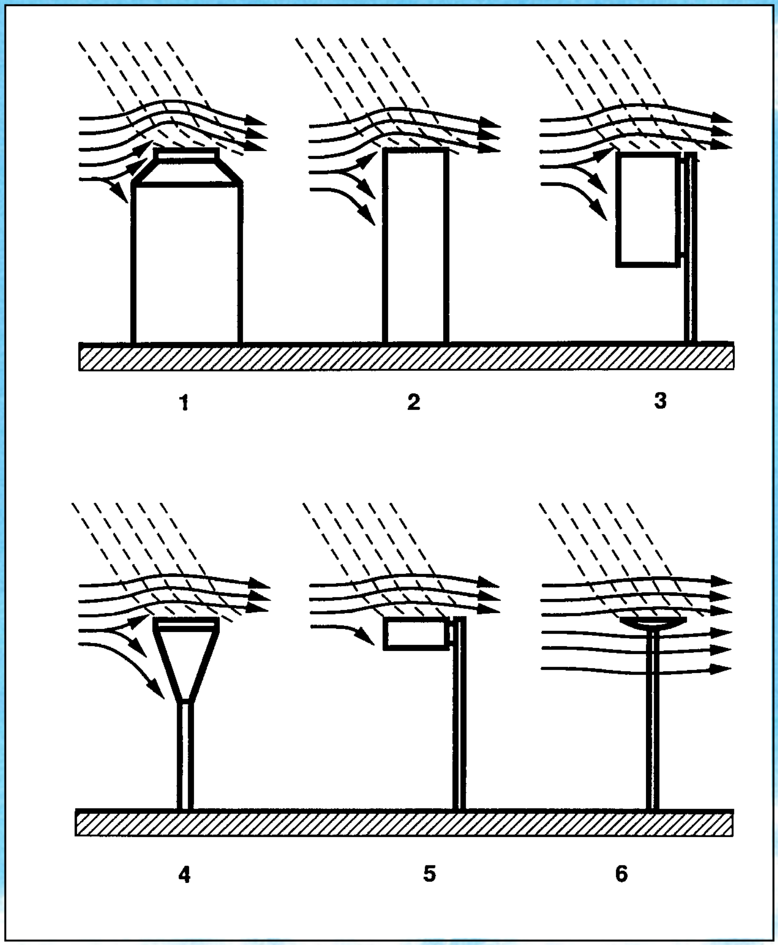
(yellow warning)

Measured
16 mm

Transfer function (adjustment of precipitation in real-time) using wind and temperatura

Adjusted
50.4 mm
(red warning)

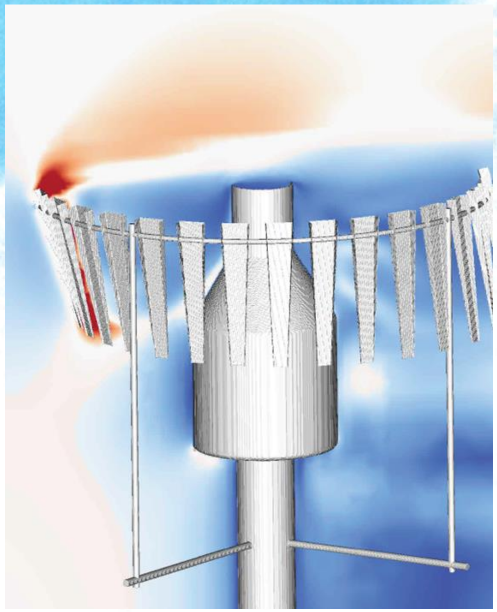
Undercatch > 50%
High wind snowfall episode



The accurate prediction and verification of snowfall is encumbered by the large potential undercatch of solid precipitation

Combined effect of gauge and wind perturb air flow around the gauge. Particles are deviated from their original trajectories

A wind shield can be used to reduce the perturbation above the gauge orifice.



WIND SPEED

UNDERCATCH OF SOLID PRECIPITATION (SNOW)

World Meteorological Organization(WMO)
SPICE (Solid Precipitation Intercomparison Experiment)

SPICE Sites

List of SPICE Sites contact persons

Commissioning protocols of the SPICE Sites
(Some protocols are still in finalization and will be made available below when completed)

- Australia - Guthega Dam
- Canada - Bratt's Lake
- Canada - CARE (Annexe)
- Canada - Caribou Creek
- Chile - Tapado
- Finland - Sodankyla
- France - Col de Porte
- Italy - Forni Glacier
- Japan - Joetsu
- Japan - Rikubetu
- Rep. of Korea - Gochang Observatory
- Nepal (operated by Italy) - Pyramid International Laboratory Observatory
- New Zealand - Mueller Hut
- Norway - Haukeliseter
- Poland - Hala Gasienicowa
- Russian Fed. - Valdai (Manual observation part only)
- Russian Fed. - Voljskaya
- Spain - Aramon-Formigal
- Switzerland - Weissfluhjoch
- USA - Marshall

Legend

1.	Caribou Creek, Saskatchewan, Canada	11.	Haukeliseter, Norway
2.	Bratt's Lake, Saskatchewan, Canada	12.	FMI/Sodankylä Arctic Research Centre, Finland
3.	Marshall Site, Colorado, USA	13.	Valdai, State Hydrological Institute, Russia
4.	CARE, Ontario, Canada	14.	Voljskaya Observatory, Gorodec, Russia
5.	Tapado AWS, Región de Coquimbo, Chile	15.	Pyramid Observatory, Nepal
6.	Formigal, Spain	16.	Gochang, Korea
7.	Col de Porte, France	17.	Joetsu, Japan
8.	Weissfluhjoch, Davos, Switzerland	18.	Rikubetu, Hokkaido, Japan
9.	Forni Glacier, Italy	19.	Guthega Dam, New South Wales, Australia
10.	Hala Gasienicowa Station, Poland	20.	Mueller Hut Weather Station, New Zealand

ONE OF THE MAIN OBJECTIVES OF THIS PROJECT → ANALYZE PERFOMANCE OF AUTOMATIC INSTRUMENTS FOR MEASURING SOLID PRECIPITATION (snowfall)

WORLD METEOROLOGICAL ORGANIZATION

WEATHER CLIMATE WATER

user name | Password | OK

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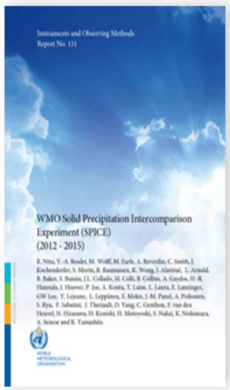
"ONLY **1000** pages"

WMO Solid Precipitation Intercomparison Experiment (SPICE) (2012 - 2015)

IOM_131_en.pdf (104Mb)



World Meteorological Organization (WMO)

Published by: WMO ; 2018

The Solid Precipitation Intercomparison Experiment (SPICE) was conducted as an internationally coordinated project, initiated and guided by the Commission for Instruments and Methods of Observation (CIMO) of the World Meteorological Organization (WMO). The SPICE field experiments took place between 2013 and 2015, with a preparatory stage during the winter of 2012/13.

SPICE was carried out as a major international effort, and has been remarkable for the diversity of organizations which hosted SPICE tests, contributed with instruments, and were engaged in the data analysis and the derivation of results. In addition to National Meteorological and Hydrological Services, research organizations, academia, and the private sector played active roles and made unique contributions. Field experiments were conducted at twenty sites located in fifteen countries, on all continents except Africa and Antarctica, as outlined in Section 2 of this report. The instrument manufacturing community made a significant contribution to SPICE, as more than twenty instrument manufacturers provided instruments measuring precipitation amount, snow depth, and snow water equivalent. Each instrument model was tested on one or more sites in different climate regimes and over a large range of environmental conditions, providing a solid foundation for the results presented in this report.

Collection(s) and Series: IOM Report- No. 131

Language(s): English

Format: Digital (Free)

Tags: Instruments and Methods of Observation Programme (IMOP) ; Precipitation   Add tag

IT IS ALSO A REPOSITORY OF HIGH QUALITY DATA FOR VALIDATION AND TESTING OF SATELLITE AND RADAR PRODUCTS

R2

A field reference configuration for the SPICE project

DFAR

(Double Fence Automatic Reference)

Octogonal double fence (DFIR fence)

+

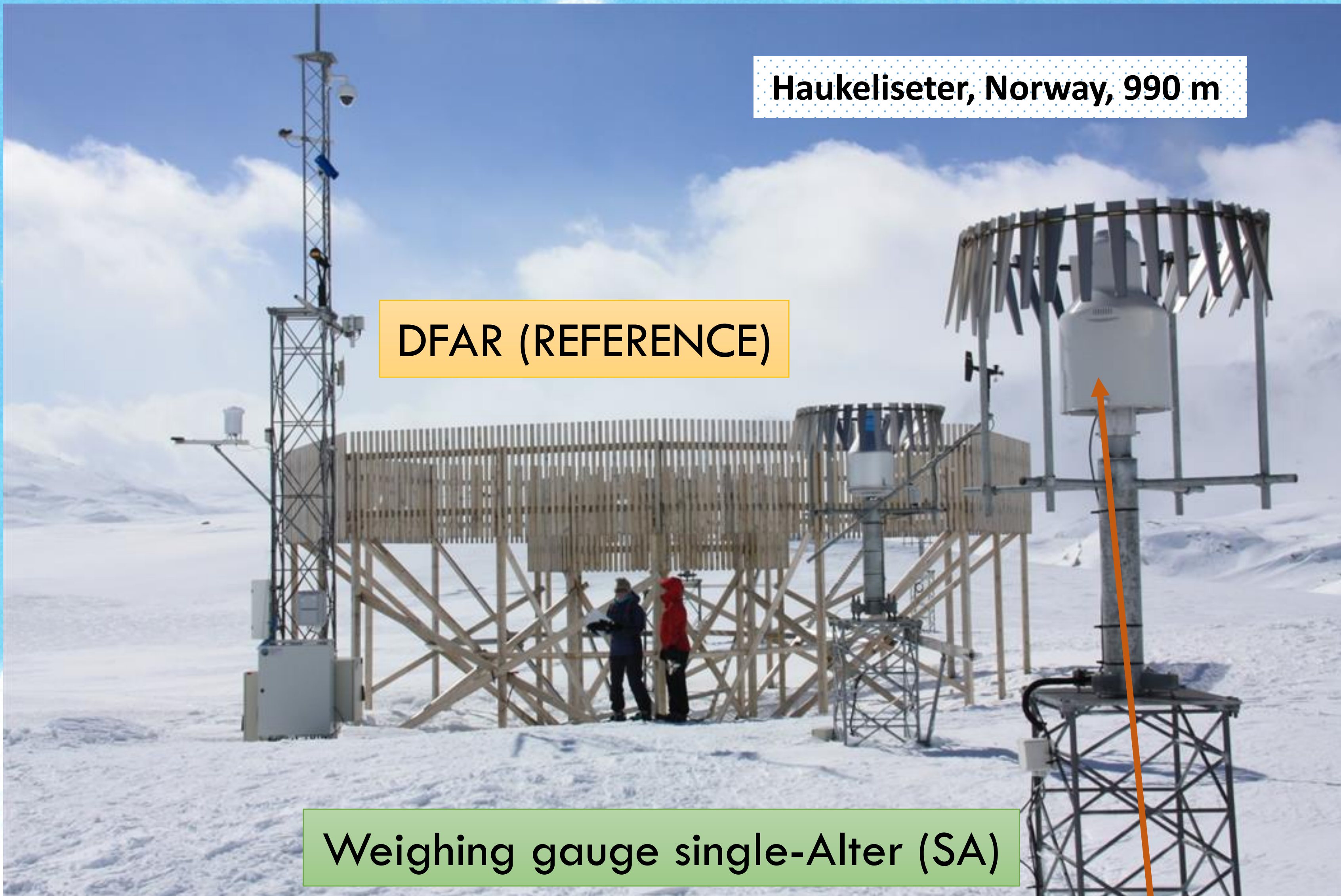
Automatic gauge (model not prescribed) with Alter shield

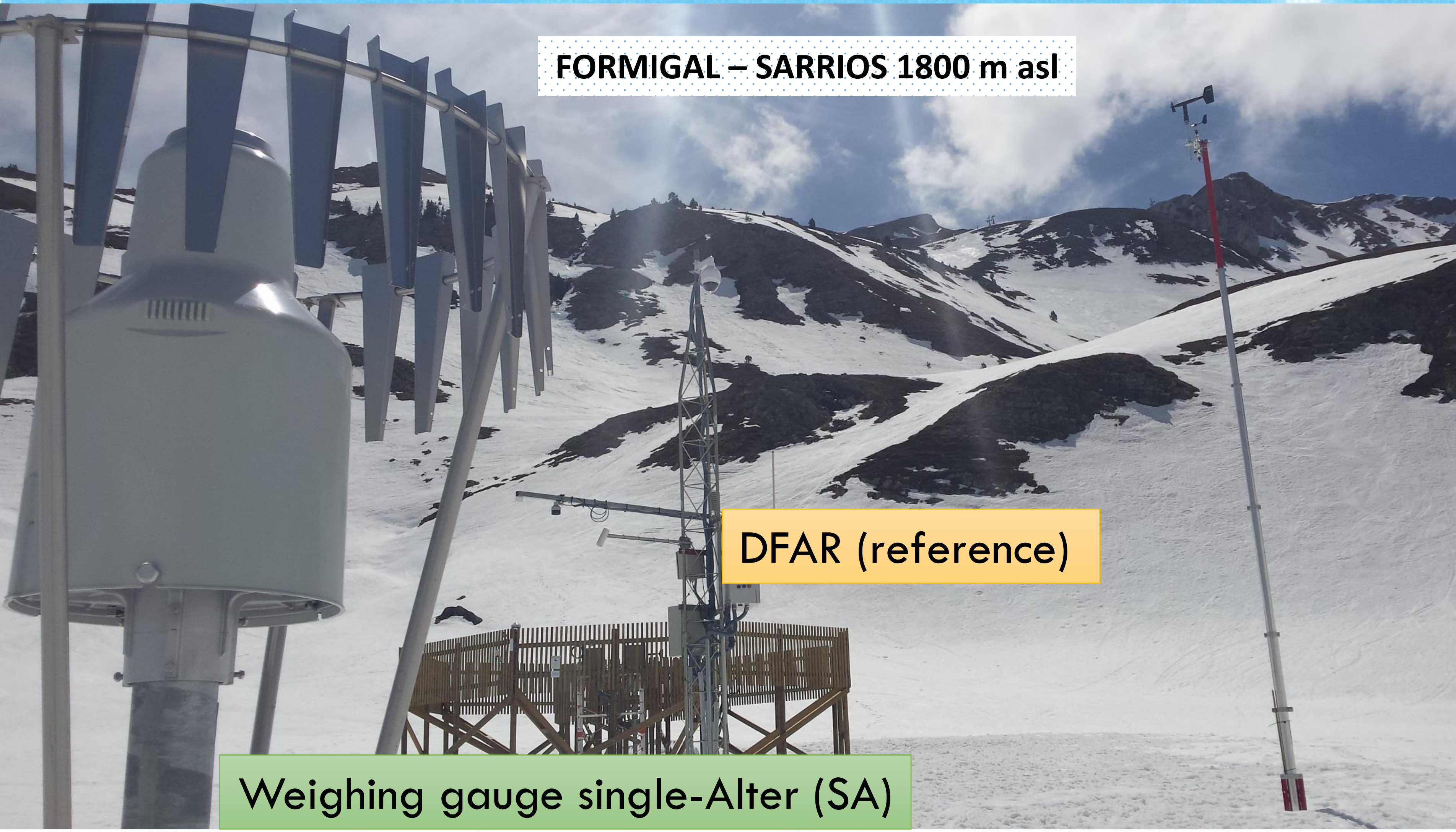
+

Precipitation Detector or Precipitation Type Sensor

TRUE PRECIPITATION (REFERENCE)

DFAR (FORMIGAL-SPAIN)


Haukeliseter, Norway, 990 m
DFAR (REFERENCE)
Weighing gauge single-Alter (SA)
OPERATIONAL

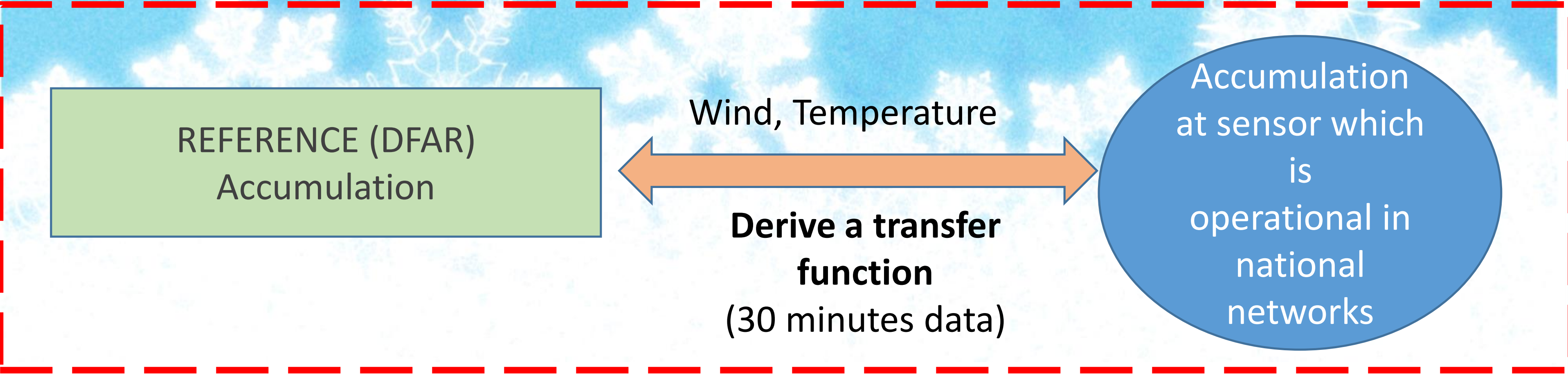

FORMIGAL – SARRIOS 1800 m asl
DFAR (reference)
Weighing gauge single-Alter (SA)

Universal transfer functions (and determining how universal they are)

$$CE = e^{-a(U)(1 - [\tan^{-1}(b(T_{air}))+c])} \qquad (3)$$

$$CE = (a)e^{-b(U)} + c \qquad (4)$$

- *CE is catch efficiency, U* is wind speed, T_{air} is air temperature, and *a*, *b*, and *c* are coefficients
- Eq. 4 is defined separately for liquid, mixed, and solid precipitation



Reference:

Kochendorfer and other SPICE authors.: **Analysis of single-Alter-shielded and unshielded measurements of mixed and solid precipitation from WMO-SPICE,** Hydrol. Earth Syst. Sci., 21, 3525-3542, https://doi.org/10.5194/hess-21-3525-2017, 2017.

OBJECTIVES OF THIS PRESENTATION

1) To demonstrate the utility of transfer functions for the adjustment of precipitation measurements for nowcasting activities in operational networks.

2) Highlight a number of challenges for solid precipitation measurements that were identified and/or characterized in WMO-SPICE and must be considered for nowcasting activities

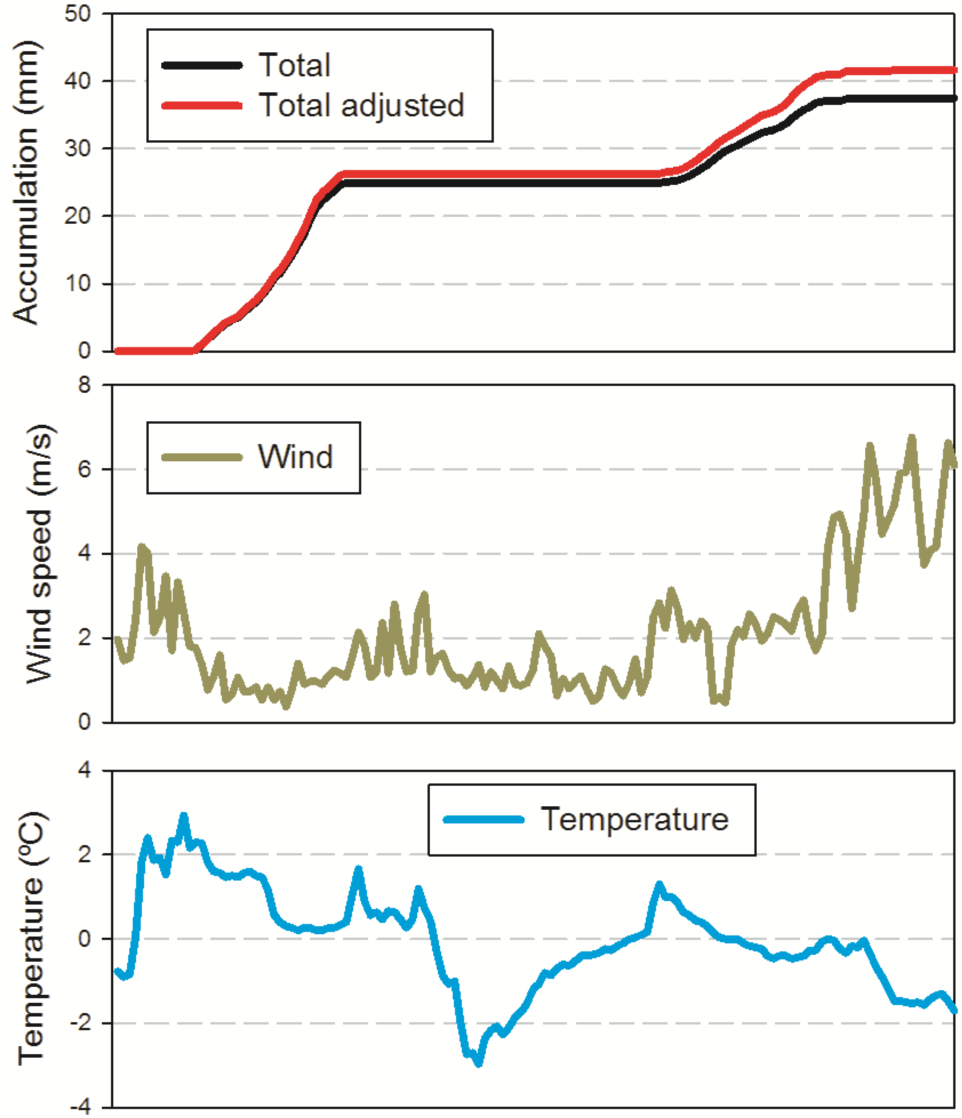
IMPACTS

- **Radar precipitation validation products**
- **Issue suitable warnings of snowfall**
- **Assimilation of precipitation**
- **Verification of near-real time products**
- **Aviation**
- **Mountain environments (security)**
- **…**

Examples of aplication of transfer functions

Switzerland
Station: Marsens, 714 m a.s.l.

Switzerland
Station:Marsens, 714 m a.s.l.



Undercatch of 10%

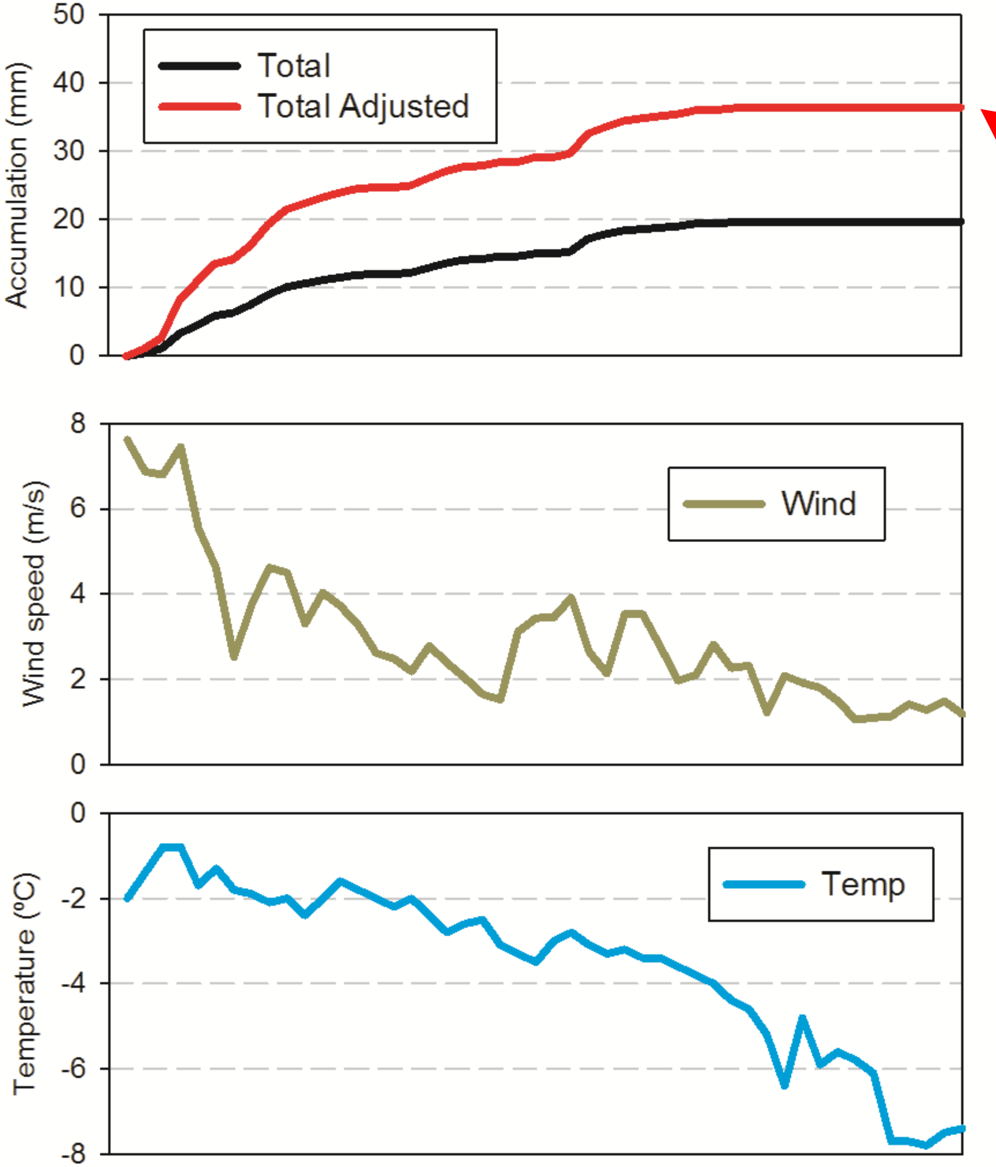
Adjustment

Low wind snowfall episode < 2m/s

Temperature near 0°C

Norway
Station:TromsØ, 100 m a.s.l.

Norway
Station:TromsØ, 100 m a.s.l.



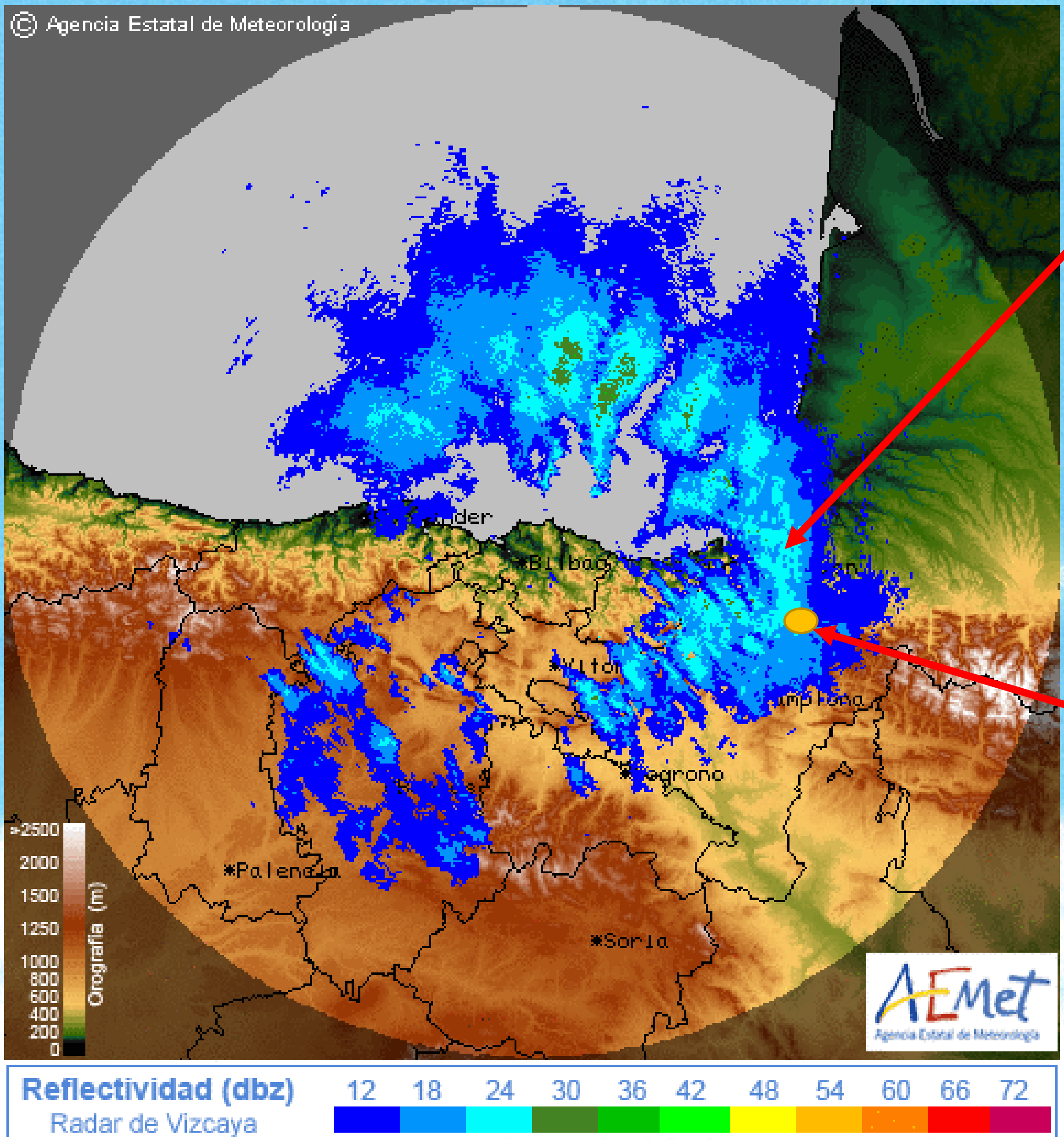
Undercatch of 50%

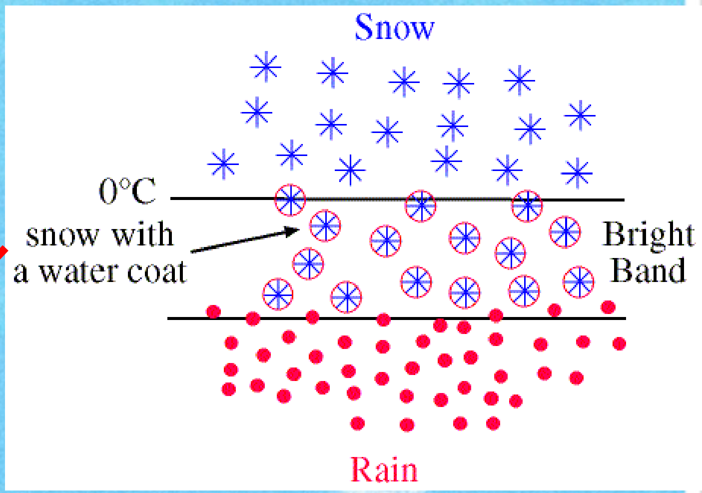
Adjustment

Moderate wind speed snowfall episode
≈ 4 m/s

Temperature < -2°C

Spain
Roncesvalles 1000 m asl

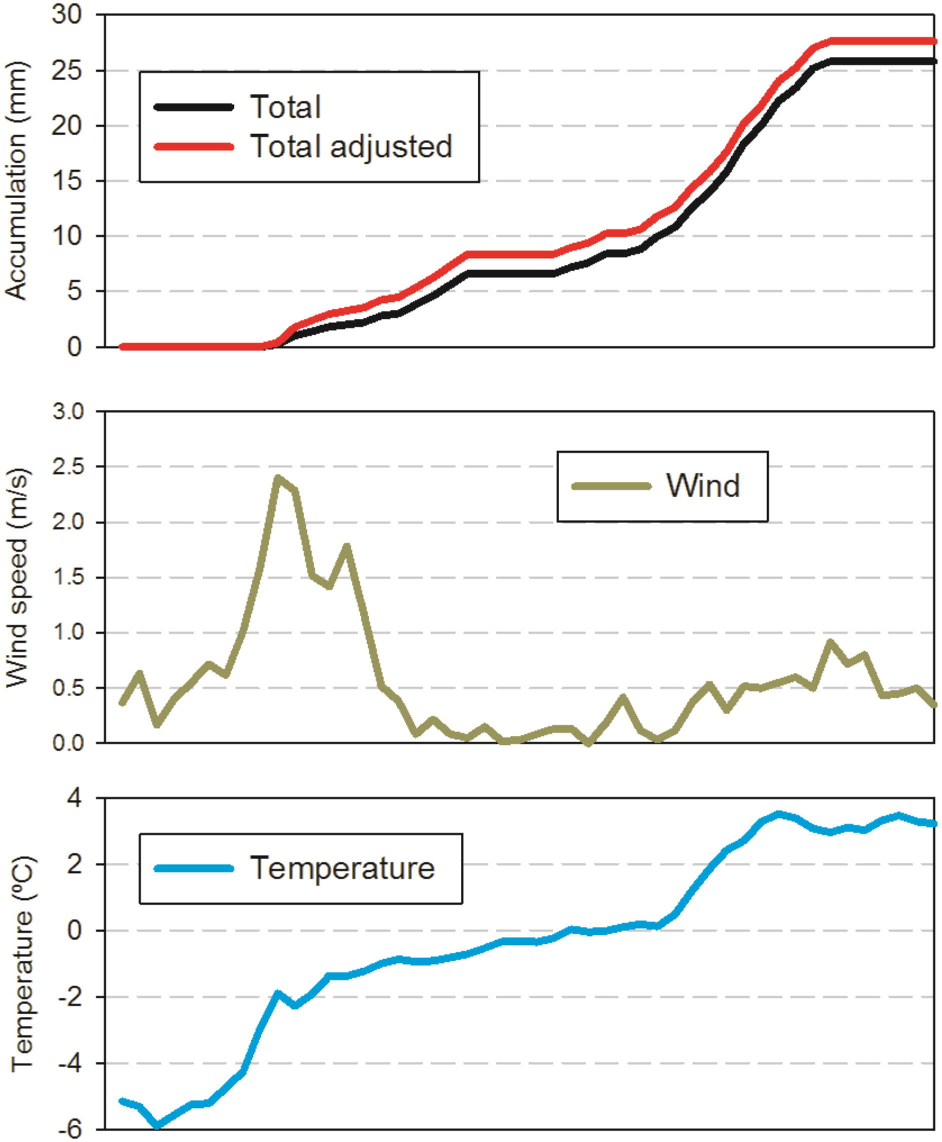




Brigth band located between 1000 – 1400 m asl

Roncesvalles station, Spain
1000 m asl

Spain
Roncesvalles 1000 m asl



Undercatch of 10%

Low wind snowfall episode < 2m/s

Temperature near 0°C

Other issues affecting nowcasting activities

Partial capping

05/12/2014
Capping started

07/12/2014
Partial capping

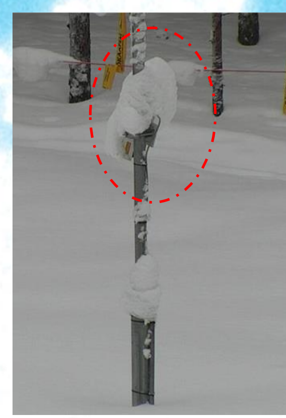
Col de Porte, France

Accretion of snow around the orifice that **reduces the opening area**, without capping it completely, thus **allowing new snow to be measured**, but **producing real time erroneous data**

Complete capping

Switzerland

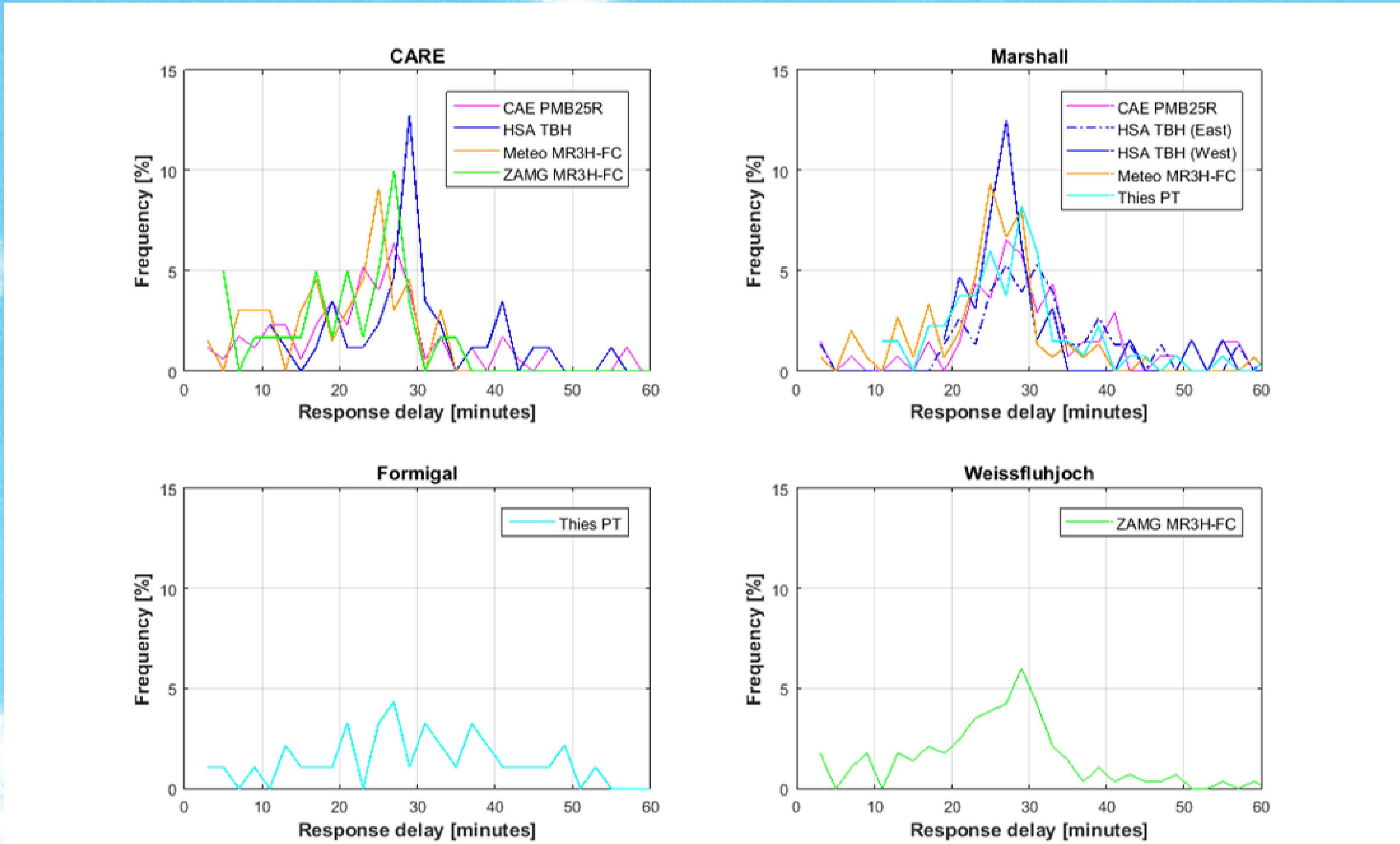
British Columbia, Canada



Snow depth sensor, Sodankylä, Finland

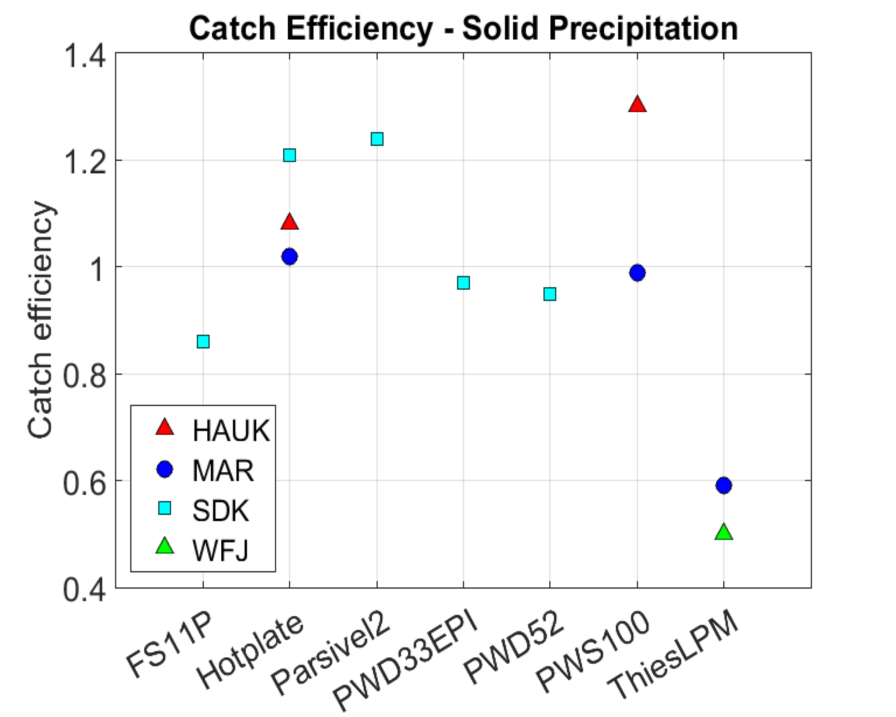
Factors favoring capping: absence of heating, wet snow, calm conditions (no wind)

Delays in melting snow for tipping buckets rain gauges



Time required for melting can result in delays in the reporting of precipitation relative to the reference configurations. **These delays increase the potential for missed and false reports over operational time scales**. Heating can also cause evaporative and wetting losses, which reduce reported precipitation totals.

Non-catchment technologies (more often used in nowcasting)



Present Weather Detectors, Disdrometers, etc

1) Complex technologies
2) A lot of data in short periods of time
3) In windy conditions, errors such as:

   i) **WRONG METAR AUTO CODE**
   Reference: SN
   Sensor under test : +SN

   ii) Wrong accumulation intensities

NEXT WMO-CIMO Intercomparison

Discussions (and conclusions)

- Snowfall measurements remain a great challenge, especially under windy environments → Impact in nowcasting activities:

  Some other examples:

  - ❑ Verification of short range NWP models integrating in-situ observations (blending techniques)
  - ❑ Another source of error for validation of radar precipitation products
  - ❑ … (all that you can imagine)

Thank you for your attention