

The impact of a windshield in a tipping bucket rain gauge on the reduction of losses in precipitation measurements during snowfall events

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1. EXPERIMENTAL SITE

- At Formigal-Sarriós in the Pyrenees range, a WMO-SPICE (Solid Precipitation Intercomparison Experiment) site has been set up by AEMET (Spanish State Meteorological Agency) in 2013. (Figure 1)
- The test field site is located at 1800 m asl in a flat area in a subalpine environment with no vegetation, except small amount of grass.
- The site is equipped with 18 automatic devices measuring snow on the ground, precipitation, air temperature, wind, air pressure, visibility, type of precipitation and radiation. (Figure 2)
- A DFIR (Double Fence International Reference) has also been built, according to WMO-SPICE requirements. (Figure 3)
- The test site will be used as a long-term reference to monitor the changes in precipitation and to test new instruments.

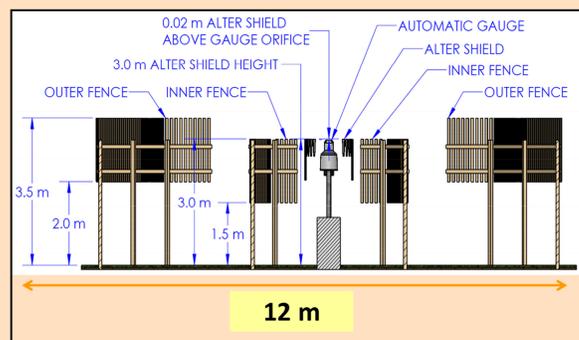


Figure 3. DFAR
WMO-SPICE has defined a reference configuration with a DFIR shield and automatic gauge in the center; this is referred to as the Double-Fence Automatic Reference (DFAR)

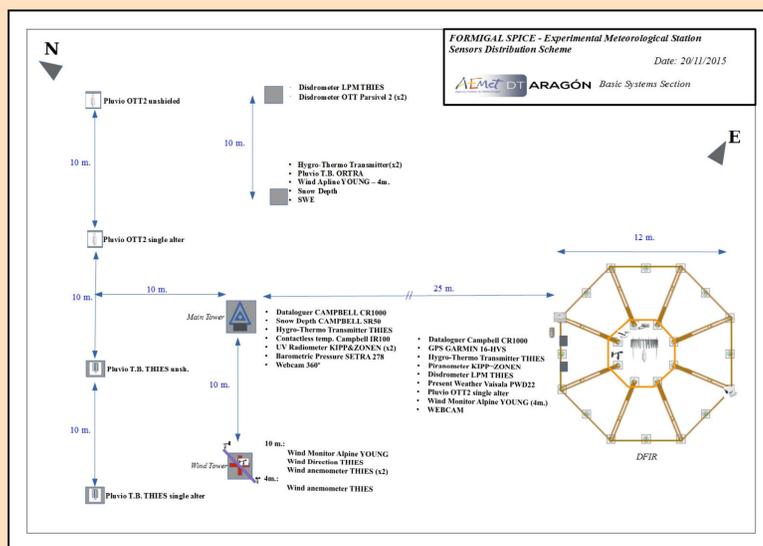


Figure 2. Site layout



Figure 1. Formigal test site

2. INSTRUMENTS INTERCOMPARISON

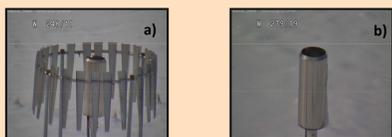


Figure 4. Webcam images of the two heated Thies Tipping Bucket Rain Gauges :

- a) TPB1- Protected with a single alter windshield
- b) TPB2 -Without protection in operational configuration



Figure 5. As the snow depth can reach 3m the height of the DFIR has been adjusted (outer fence at 4m and inner fence at 3.5m). The reference gauge is a heated OTT Pluvio² with a single alter windshield (DFAR).

Methodology

- 2015-2016 Winter Season (November 20 — March 20).
- 1 minute data temporal resolution.
- Discrimination threshold of tipping bucket of 0.2mm.
- Air temperature was measured with a PT100 from Thies and protected by a standard radiation screen at a height of 4.5 m.
- Wind was measured at a standard height of 10 m with a heated Thies anemometer.
- Gauges orifice at a height of 3.5m.
- Data quality controlled.
- Two webcams provide high resolution images to detect problems on the instruments.

3. RESULTS

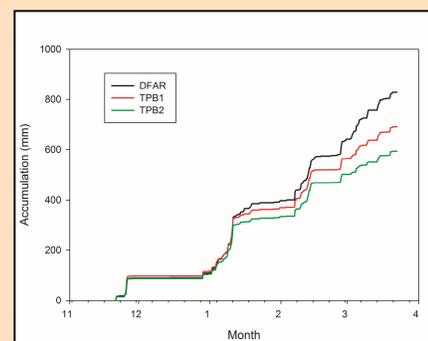


Figure 6. Accumulated precipitation during the study period

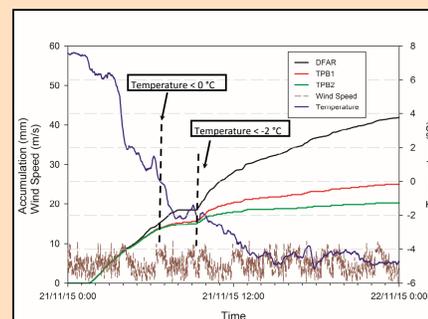


Figure 7. Differences in accumulated precipitation under snow regime during snowfall episode.

- DFAR:** Double-Fence Automatic Reference
- TPB1:** Tipping Bucket Rain Gauge protected with a single alter windshield
- TPB2:** Tipping Bucket Rain Gauge without protection in operational configuration

Temperature between 0 °C and -2 °C

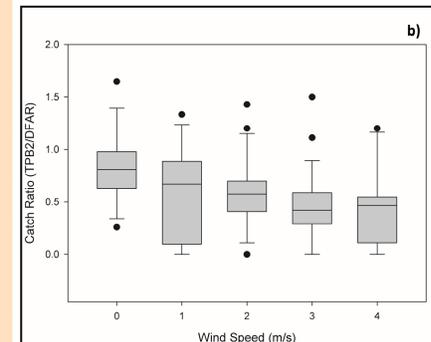
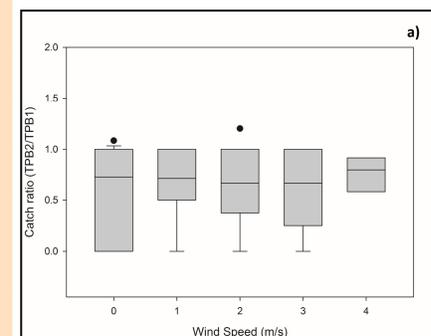


Figure 8. **Mixed precipitation** (Number of events =106)
Ratios between snow precipitation measurements made by a) TPB1 and TPB2 b) DFAR and TPB2.
The data are sampled with 1h-period and averaged over 0.5 m/s wind speed bins.

Temperature below -2 °C

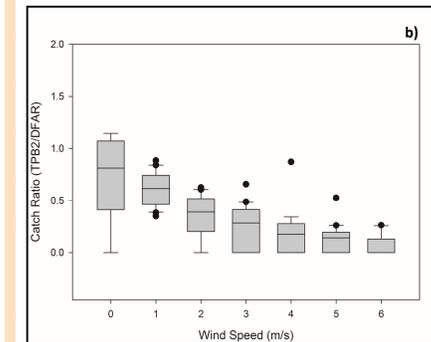
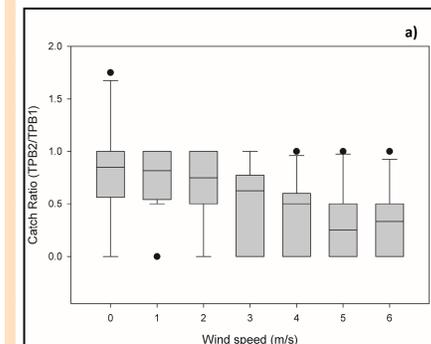


Figure 9. **Snow regime** (Number of events =182)
Ratios between snow precipitation measurements made by a) TPB1 and TPB2 b) DFAR and TPB2.
The data are sampled with 1h-period and averaged over 0.5 m/s wind speed bins.

4. CONCLUSIONS

- Strong dependence of the undercatch to wind speed and high sensitivity to snow regime.
- Most countries use tipping bucket rain gauges and no shields. At large scale, this is a problem.
- The use of single alter shield in a tipping bucket rain gauge can reduce the undercatch up to 40% when wind speed exceeds 6 m/s. The differences when compared with DFAR can reach values higher than 70%.
- Significant impact in nowcasting operations, climatology and hidrology.
- Suitability of the installation of windshields in stations characterized by a large quantity of snowfalls during the year.

ACKNOWLEDGMENTS

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REFERENCES

- WMO-SPICE website:
<http://www.wmo.int/pages/prog/www/IMOP/intercomparisons/SPICE/SPICE.html>