

# An assessment of the impact of a single-Alter windshield on snowfall accumulation reported by a heated tipping bucket gauge

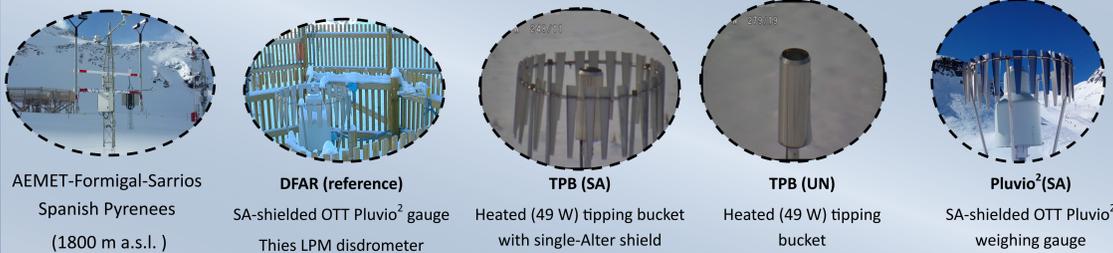
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## INTRODUCTION

- Undercatch of solid precipitation can result from wind-induced updrafts at the orifice of a precipitation gauge → This effect can be reduced by the use of wind shields
- Tipping bucket (TPB) precipitation gauges are widely used in operational networks and are available with heating for all-season operation and generally are not equipped with wind shields

**Objective:** To assess the undercatch of precipitation and overall performance of the single-Alter shielded TPB gauge relative to the other gauges, taking into account factors such as accuracy, measurement resolution, response delays and heating.

## SITE CONFIGURATION

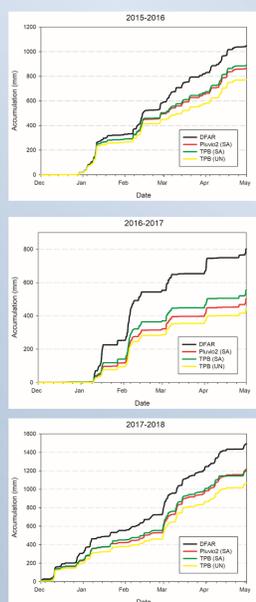


## METHODOLOGY

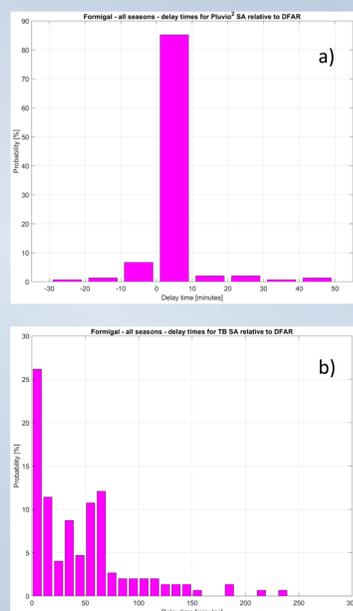
- Data from 2015-2016, 2016-2017, and 2017-2018 winter seasons
- Minutely data were recorded and quality controlled to identify and/or remove doubtful or erroneous values
- Catch ratios were computed over 1 hour assessment intervals for using the accumulation from each test instrument relative to the DFAR
- Precipitating periods were identified by finding individual or consecutive hourly periods meeting the following criteria:
  - Weighing gauge in DFAR reports  $\geq 0.25$  mm accumulated precipitation;
  - Precipitation detector in DFAR reports 60 minutes of precipitation occurrence (continuous precipitation);
  - Maximum temperature does not exceed 0 °C (focus on periods with solid precipitation).
- Response delay:** the time elapsed from the start of the period as indicated by the DFAR to the first response by each test gauge

## RESULTS

### Seasonal accumulation

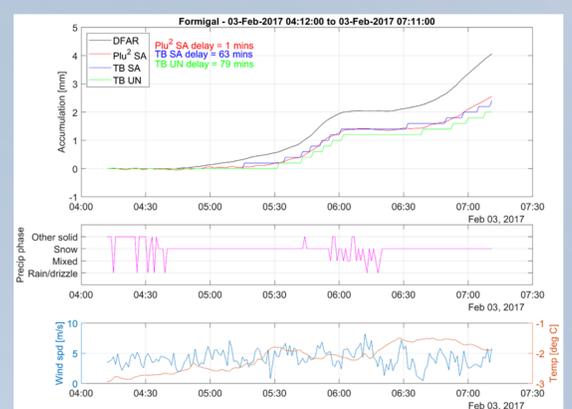


### Delays



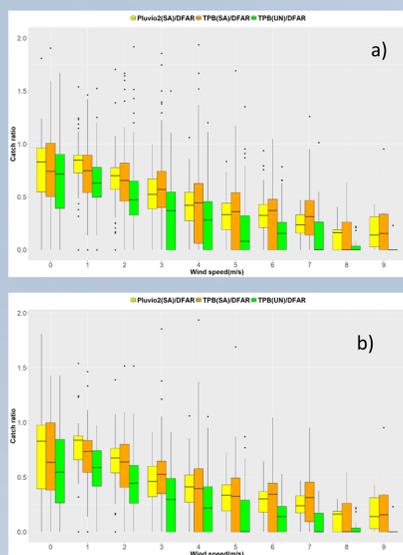
Response time histograms determined from precipitating periods over all three winter seasons for (a) the Pluvio<sup>2</sup> (SA) relative to the DFAR, (b) the TPB (SA) relative to the DFAR, and (c) the TPB (UN) relative to the TPB (SA).

\*The negative delay times in Figure 4c may result from residual precipitation in the bucket from prior precipitating periods



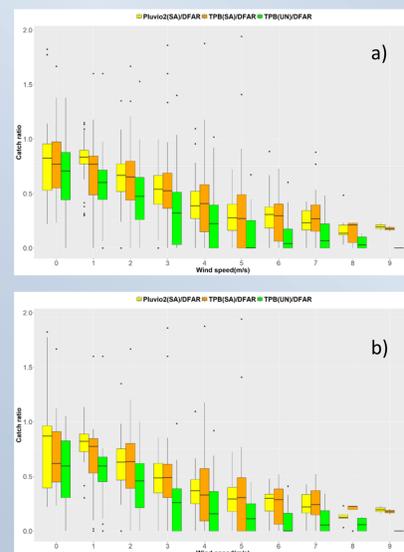
Time series of accumulation, precipitation phase, and environmental conditions (wind speed and temperature) for a precipitation event during the 2016-2017 winter season at Formigal, illustrating differences in gauge response times relative to the DFAR.

### Catch ratios



Catch ratios of Pluvio<sup>2</sup> (SA), TPB(SA) and TPB(UN), each relative to DFAR, for 1 h time periods with mean temperatures below 0°C (a), -2°C (b) and -4°C (c). The DFAR accumulation is  $\geq 0.2$  mm in all cases. The results are presented as box and whisker plots, with mean wind speed bins of 1 m/s.

1h time periods



Catch ratios of Pluvio<sup>2</sup> (SA), TPB(SA) and TPB(UN), each relative to DFAR, for 3 h time periods with mean temperatures below 0°C (a), -2°C (b) and -4°C (c). The DFAR accumulation is  $\geq 0.2$  mm in all cases. The results are presented as box and whisker plots, with mean wind speed bins of 1 m/s.

3h time periods

## CONCLUSIONS

- The total seasonal accumulation for a TPB (SA) was similar to that for a Pluvio<sup>2</sup> (SA) over the test periods at Formigal, and exceeded that for an unshielded TPB gauge.
- Response times for the Pluvio<sup>2</sup> (SA) were similar to those for the DFAR, whereas the TPB (SA) gauge was subject to response delays during snowfall events (typically within 60 to 70 minutes).
- The TPB (SA) typically responds faster than the TPB (UN), because it catches more precipitation and the possibility to trigger a tip is higher.
- The catch ratio of TPB (SA) accumulation relative to that reported by the DFAR for 1 h periods shows more spread than that for the Pluvio<sup>2</sup> (SA) relative to the DFAR, which may result from the influence of response delays (partial melting). This spread is reduced for the TPB (SA) when considering longer, 3 h periods (full melting; delay influence on accumulation reduced).

**The installation of single-Alter wind shields in networks with TPB gauges could be a good option if the time response is not critical and ancillary measurements (wind and/or temperature) are not available to adjust the measured accumulation for wind effects (i.e. hydrology and climate networks).**