A Rain Gauge in Wind: the Significance of Mounting Height and Gauge Shape

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1. Introduction

- Accurate rainfall measurement is extremely important.
- Rain gauges underestimate due to 'the wind effect'.
- Wind accelerates over the rain gauge orifice, which distorts the rainfall droplets and causes the 'wind-induced undercatch'.

Figure 1. Talla Water research station, Scottish Borders. Elevation: 430m. Identical aerodynamic rain gauges (ARG100s) are mounted at different heights: reference pit gauge (1), ground-mounted gauge (2), 1-metre mounted gauge (3). There is also a ground mounted straight-sided gauge (4) and wind speed measurement at two metres (5) This upland site is situated at the top of a valley running east-west, with strong winds observed. (Picture by M.Pollock, April 2015. With thanks to University of Dundee/British Geological Survey/Borders Forest Trust for site provision).

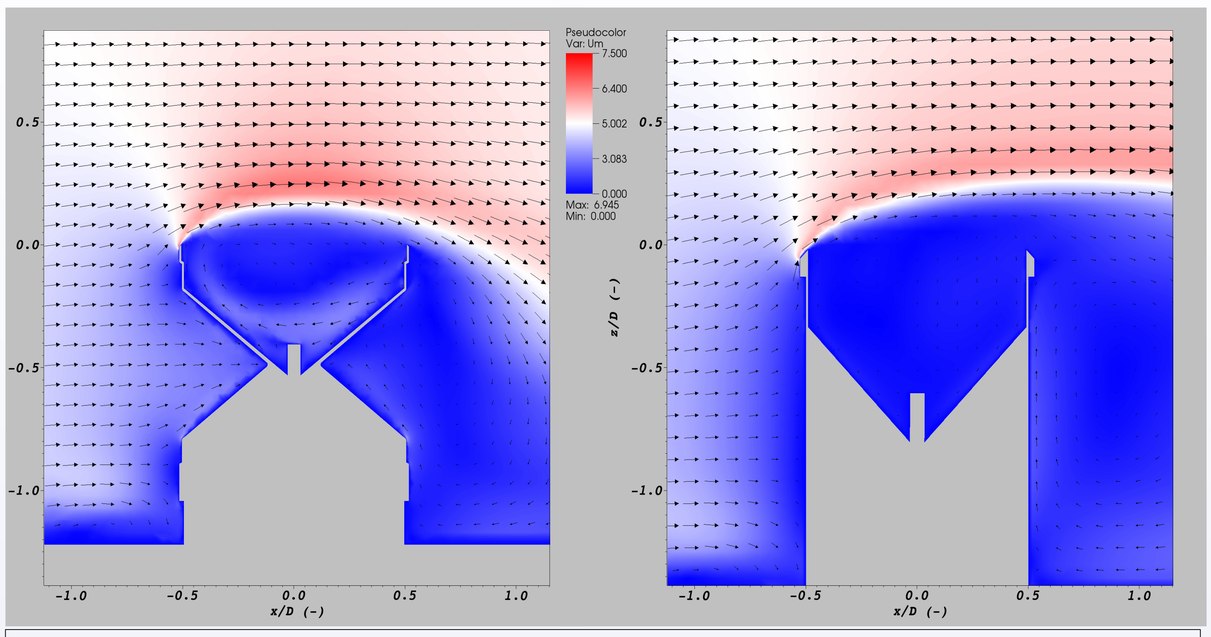

Figure 2. A time-averaged Computational Fluid Dynamics (CFD) visualisation of the EML ARG100 aerodynamic rain gauge (left) and the Casella rain gauge (right). The graphic shows the stream-wise vertical view of the air velocity magnitude (U_m in m/s). The uniform inflow velocity from the left of the picture is 5 m/s. Red indicates acceleration of the wind, whereas the blue colour shows areas where there is a deceleration. The white colour is the shear layer, where wind speed is the same as at the inlet (5 m/s). (Image provided by M. Colli, University of Genoa).[b]

2. Methodology

- An exposed research site in the UK is selected and equipped with five rain gauges and a wind sensor (Fig.1)
- Rain gauges are mounted at different heights to investigate the wind effect.
- 'Aerodynamic' and conventional cylindrical gauge profiles are selected to study the effects of the gauge shape (Fig. 2).
- High resolution (1 minute) data are recorded at the site to capture the evolution of rain events.

3. Results and discussion

Table 1: Comparison of catch ratios for two events, A and B, for gauges mounted at different heights.

% of Pit Catch	Ground (2)	Pedestal (3)	Ground (4)
Event A	91%	84%	82%
Event B	93%	83%	78%

- Table 1 shows (a) that the ground level aerodynamic gauge catch is greater than the corresponding pedestal catch for both rainfall events and (b) that aerodynamic gauge catch is greater than cylindrical gauge catch.
- More CFD modelling and field studies needed to explore these effects.

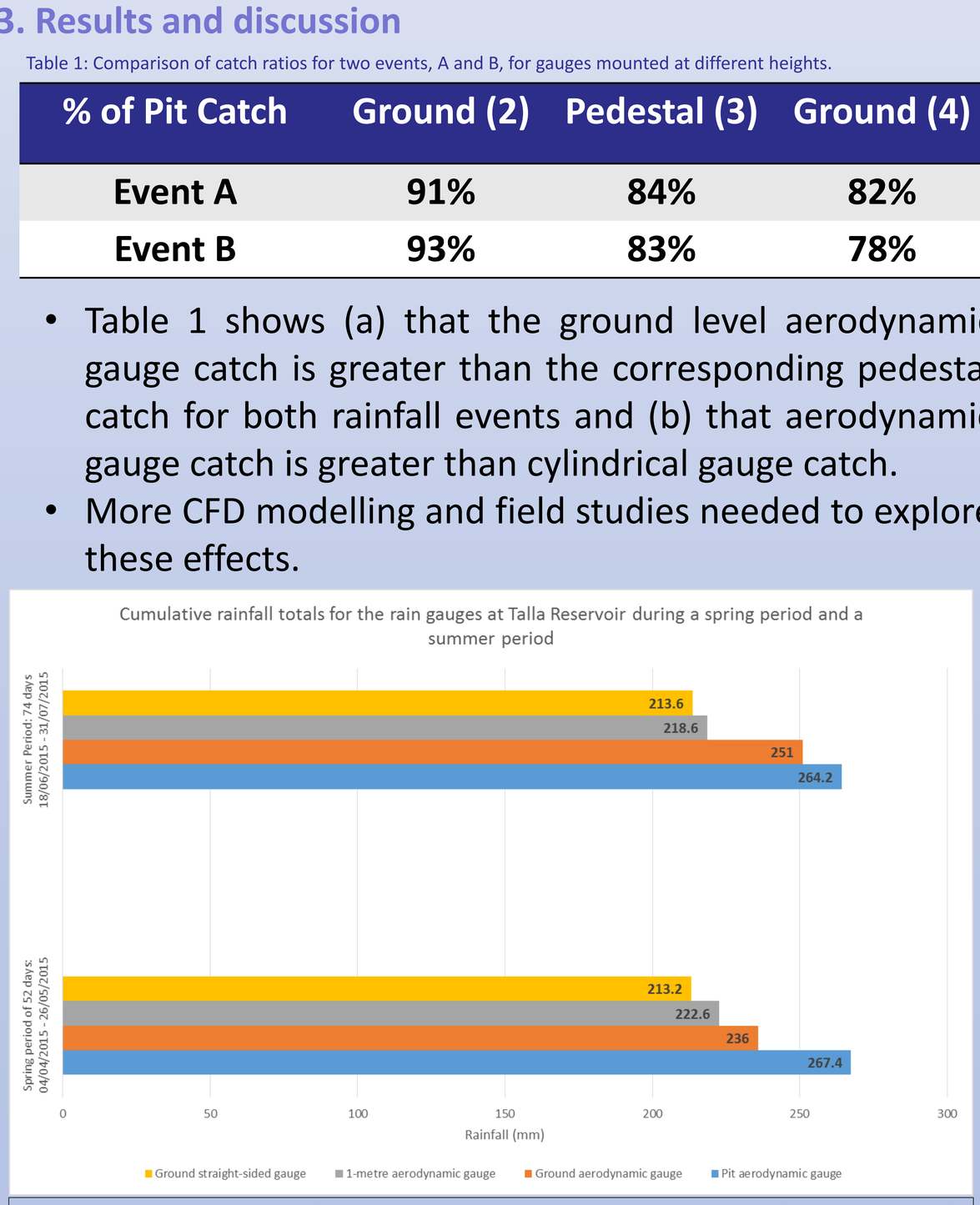

Figure 3. Cumulative rainfall totals for the four chosen rain gauges, covering a spring period lasting 52 days and a summer period lasting 74 days, at Talla Water.

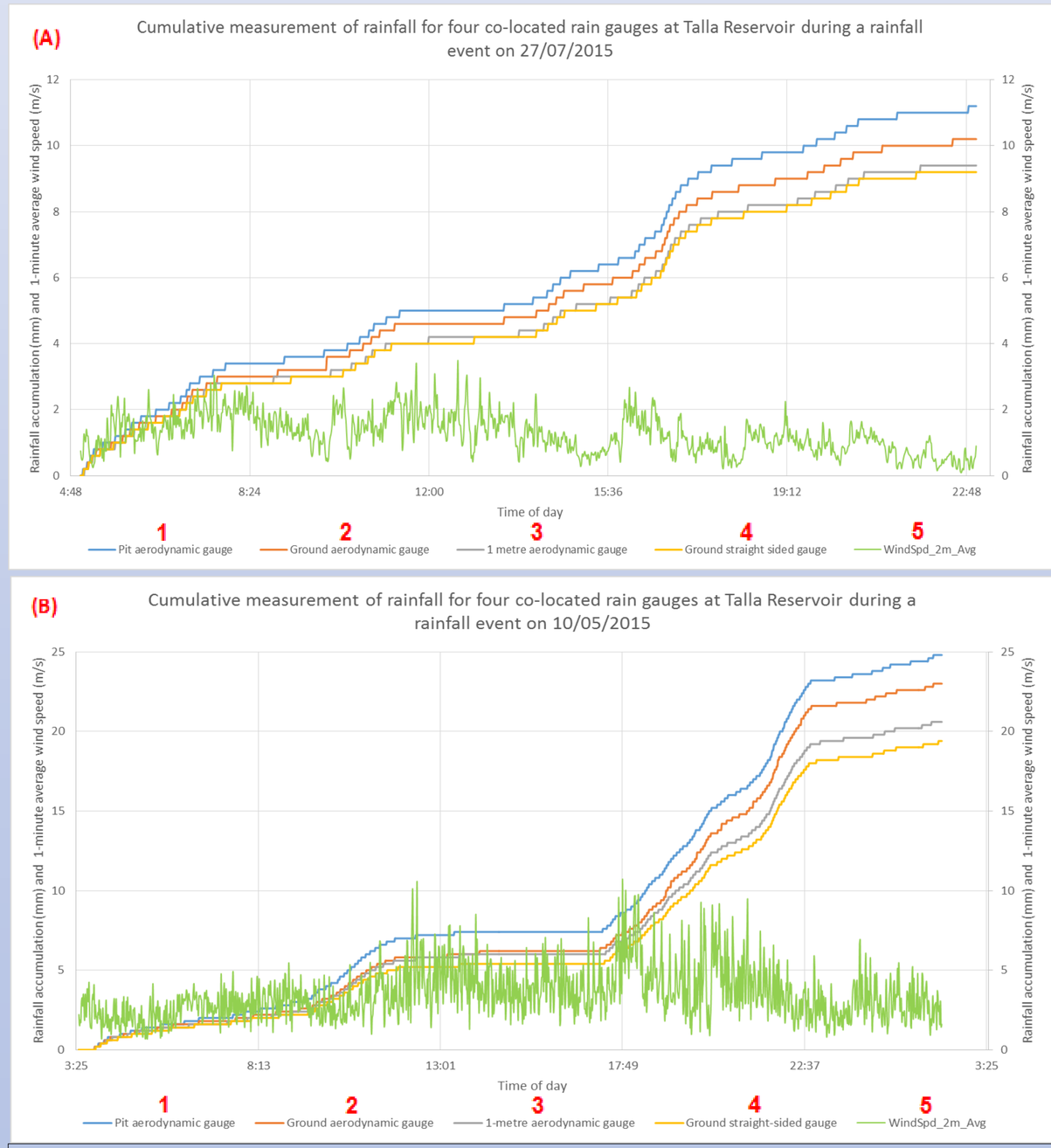

Figure 4. Two events from Talla Water research station. (A) is a rainfall event where wind speeds ranging from 0-3 m/s. (B) is a rainfall events where wind speeds range from 1-11 m/s. The cumulative totals (mm) of rain gauges mounted at different heights are plotted.

References

a. Goodison, B. E., Louie, P. Y. T. and Yang, D. (1998) WMO Solid Precipitation Measurement Intercomparison: Final Report. World Meteorological Organisation
b. Colli, M., R. Rasmussen, J. M. Theriault, L. G. Lanza, C. B. Baker & J. Kochendorfer (2015) An Improved Trajectory Model to Evaluate the Collection Performance of Snow Gauges. Journal of Applied Meteorology and Climatology, 54, 1826-1836.

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