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Testing and development of transfer functions for weighing precipitation gauges in WMO-SPICE

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Transfer functions

Transfer function coefficients for the transfer functions that were developed, tested, and recommended are listed in Tables 1 – 4. The equations used in the tables are included here for ease of reference:

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

where *CE* is the catch efficiency, *U* is the mean wind speed, T_{air} is the mean air temperature, and *a*, *b*, and *c* are coefficients fit to the data. Equation 2 was also fit to the precipitation measurements:

$$CE = (a)e^{-b(U)} + c \quad (2)$$

where *a*, *b*, and *c* are coefficients fit to the data. Equation 1 was fit as a function of wind speed and air temperature, while Equation 2 was fit separately to solid and mixed precipitation measurements as a function of wind speed only. In the latter case, precipitation type was determined using air temperature, with solid precipitation defined as T_{air} < -2 °C, and mixed defined as 2 °C ≥ T_{air} ≥ -2 °C. For some of the gauges examined here, Eq. 2 unrealistically over-predicted catch efficiency at low wind speeds when insufficiently constrained by the available measurements, and in these cases a more constrained function was used to describe realistic corrections:

$$CE = (a)e^{-b(U)} + (1-a), \quad (3)$$

Tables

Wind Speed	Eq. 3, *f(U, mixd)*		Eq. 3, *f(U, solid)*		Eq. 1 *f(U, T_{air})*			U_{thresh}
	a	***b***	***a***	***b***	***a***	***b***	***c***	**(m s^{-1})**
f(U_{GH})	23.3	0.00227	4.00	0.0334	0.0633	0.67	0.26	6.1
f(U_{10m})	19.7	0.00196	4.53	0.0215	0.0465	0.66	0.25	8

Table S1. Shielded MRW500 transfer function coefficients for gauge-height (GH) and 10 m wind speeds. Coefficients for Eq. 3 and Eq. 1 are provided, along with the maximum wind speed threshold (U_{thresh}), above which the transfer function should be applied by forcing the wind speed down to U_{thresh}.

Wind Speed	Eq. 2, *f(U, mixd)*			Eq. 2, *f(U, solid)*			Eq. 1 *f(U, T_{air})*			U_{thresh}
	a	***b***	***c***	***a***	***b***	***c***	***a***	***b***	***c***	**(m s^{-1})**
f(U_{GH})	0.982	0.0201	0.00	0.829	0.213	0.32	0.0404	0.4247	0.00	6.1
f(U_{10m})	0.98	0.0137	0.00	0.886	0.143	0.25	0.0312	0.427	0.00	8

Table S2. Double-Alter transfer function coefficients for gauge-height (GH) and 10 m wind speeds. Coefficients for Eq. 2 and Eq. 1 are provided, along with the maximum wind speed threshold (U_{thresh}), above which the transfer function should be applied by forcing the wind speed down to U_{thresh}. Also note that the Eq. 1 form of this function should only be used for T_{air} is ≤ 5 °C. For T_{air} is > 5 °C, use the Eq. 1 type coefficients from K2017b.

Wind Speed	Eq. 2, *f(U, mixd)*			Eq. 2, *f(U, solid)*			Eq. 1 *f(U, T_{air})*			U_{thresh}
	a	***b***	***c***	***a***	***b***	***c***	***a***	***b***	***c***	**(m s^{-1})**
$f(U_{GH})$	0.260	1.512	0.95	1.068	0.049	0.00	0.0146	0.27	0.05	6.1
$f(U_{10m})$	0.254	1.052	0.95	1.075	0.039	0.00	0.0110	0.29	0.08	8

Table S3. Belfort double-Alter transfer function coefficients for gauge-height (GH) and 10 m wind speeds. Coefficients for Eq. 2 and Eq. 1 are provided, along with the maximum wind speed threshold (U_{thresh}), above which the transfer function should be applied by forcing the wind speed down to U_{thresh}.

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Wind Speed	Eq. 2, *f(U, mixd)*			Eq. 2, *f(U, solid)*			U_{thresh}
	a	***b***	***c***	***a***	***b***	***c***	**(m s^{-1})**
$f(U_{GH})$	0.492	0.00	0.492	0.187	0.410	0.875	6.1
$f(U_{10m})$	0.492	0.00	0.492	0.186	0.230	0.875	8

Table S4. Small DFIR (SDFIR) transfer function coefficients for gauge-height (GH) and 10 m wind speeds. Coefficients for Eq. 2 are provided, along with the maximum wind speed threshold (U_{thresh}), above which the transfer function should be applied by forcing the wind speed down to U_{thresh}. The recommended Eq. 1 type SDFIR transfer function is available in K2017b.