

BSRN Global Network recommended QC tests, V2.0

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Define:

SZA = solar zenith angle

$\mu_0 = \text{Cos}(\text{SZA})$

NOTE: In the formulas below, if $\text{SZA} > 90^\circ$, μ_0 is set to 0.0 in the formula

S_0 = solar constant at mean Earth-Sun distance

AU = Earth – Sun distance in Astronomical Units, 1 AU = mean E-S distance

$S_a = S_0/\text{AU}^2$ = solar constant adjusted for Earth – Sun distance

Sum SW = [Diffuse SW + (Direct Normal SW) X μ_0]

σ = Stephan-Boltzman constant = $5.67 \times 10^{-8} \text{ Wm}^{-2} \text{ K}^{-4}$

T_a = air temperature in Kelvin [must be in range $170\text{K} < T_a < 350\text{K}$]

Global SWdn: SW measured by unshaded pyranometer

Diffuse SW: SW measured by shaded pyranometer

Direct Normal SW: direct normal component of SW

Direct SW: direct normal SW times the cosine of SZA; [(Direct Normal SW) x μ_0]

LWdn: downwelling LW measured by a pyrgeometer

LWup: upwelling LW measured by a pyrgeometer

Physically Possible Limits

Global SWdn

Min: -4 Wm^{-2}

Max: $S_a \times 1.5 \times \mu_0^{1.2} + 100 \text{ Wm}^{-2}$

Diffuse SW

Min: -4 Wm^{-2}

Max: $S_a \times 0.95 \times \mu_0^{1.2} + 50 \text{ Wm}^{-2}$

Direct Normal SW

Min: -4 Wm^{-2}

Max: S_a

[for Direct SW, Max: $S_a \times \mu_0$]

SWup

Min: -4 Wm^{-2}

Max: $S_a \times 1.2 \times \mu_0^{1.2} + 50 \text{ Wm}^{-2}$

LWdn

Min: 40 Wm^{-2}

Max: 700 Wm^{-2}

LWup

Min: 40 Wm^{-2}

Max: 900 Wm^{-2}

Extremely Rare Limits

Global SWdn

$$\text{Min: } -2 \text{ Wm}^{-2}$$

$$\text{Max: } S_a \times 1.2 \times \mu_0^{1.2} + 50 \text{ Wm}^{-2}$$

Diffuse SW

$$\text{Min: } -2 \text{ Wm}^{-2}$$

$$\text{Max: } S_a \times 0.75 \times \mu_0^{1.2} + 30 \text{ Wm}^{-2}$$

Direct Normal SW

$$\text{Min: } -2 \text{ Wm}^{-2}$$

$$\text{Max: } S_a \times 0.95 \times \mu_0^{0.2} + 10 \text{ Wm}^{-2}$$

$$[\text{for Direct SW, Max: } S_a \times 0.95 \times \mu_0^{1.2} + 10 \text{ Wm}^{-2}]$$

SWup

$$\text{Min: } -2 \text{ Wm}^{-2}$$

$$\text{Max: } S_a \times \mu_0^{1.2} + 50 \text{ Wm}^{-2}$$

LWdn

$$\text{Min: } 60 \text{ Wm}^{-2}$$

$$\text{Max: } 500 \text{ Wm}^{-2}$$

LWup

$$\text{Min: } 60 \text{ Wm}^{-2}$$

$$\text{Max: } 700 \text{ Wm}^{-2}$$

Comparisons

Ratio of Global over Sum SW:

(Global)/(Sum SW) should be within +/- 8% of 1.0 for SZA < 75°, Sum > 50 Wm⁻²

(Global)/(Sum SW) should be within +/- 15% of 1.0 for 93° > SZA > 75°, Sum > 50 Wm⁻²

For Sum SW < 50 Wm⁻², test not possible

Diffuse Ratio:

(Dif SW)/(Global SW) < 1.05 for SZA < 75°, GSW > 50 Wm⁻²

(Dif SW)/(Global SW) < 1.10 for 93° > SZA > 75°, GSW > 50 Wm⁻²

For Global SW < 50 Wm⁻², test not possible

Swup comparison

Swup < (Sum SW) [or Global SW if Sum SW missing or “bad”]

For Sum SW [or Global SW] > 50 Wm⁻²

For Sum SW [or Global SW] < 50 Wm⁻², test not possible

LWdn to Air Temperature comparison

$$0.4 \times \sigma T_a^4 < \text{LWdn} < \sigma T_a^4 + 25$$

LWup to Air Temperature comparison

$$\sigma(T_a - 15 \text{ K})^4 < \text{LWup} < \sigma(T_a + 25 \text{ K})^4$$

LWdn to Lwup comparison

$$\text{LWdn} < \text{Lwup} + 25 \text{ Wm}^{-2}$$

$$\text{LWdn} > \text{Lwup} - 300 \text{ Wm}^{-2}$$

The limits listed for these tests are set in order to accommodate all latitudes and climate regimes in the BSRN Program. Naturally, these limits could be further refined for specific latitude/climate and achieve better results.

It is recommended that these tests be performed in the order listed above to achieve maximum benefit and minimum impact for “missing” or “bad” cases of some values.