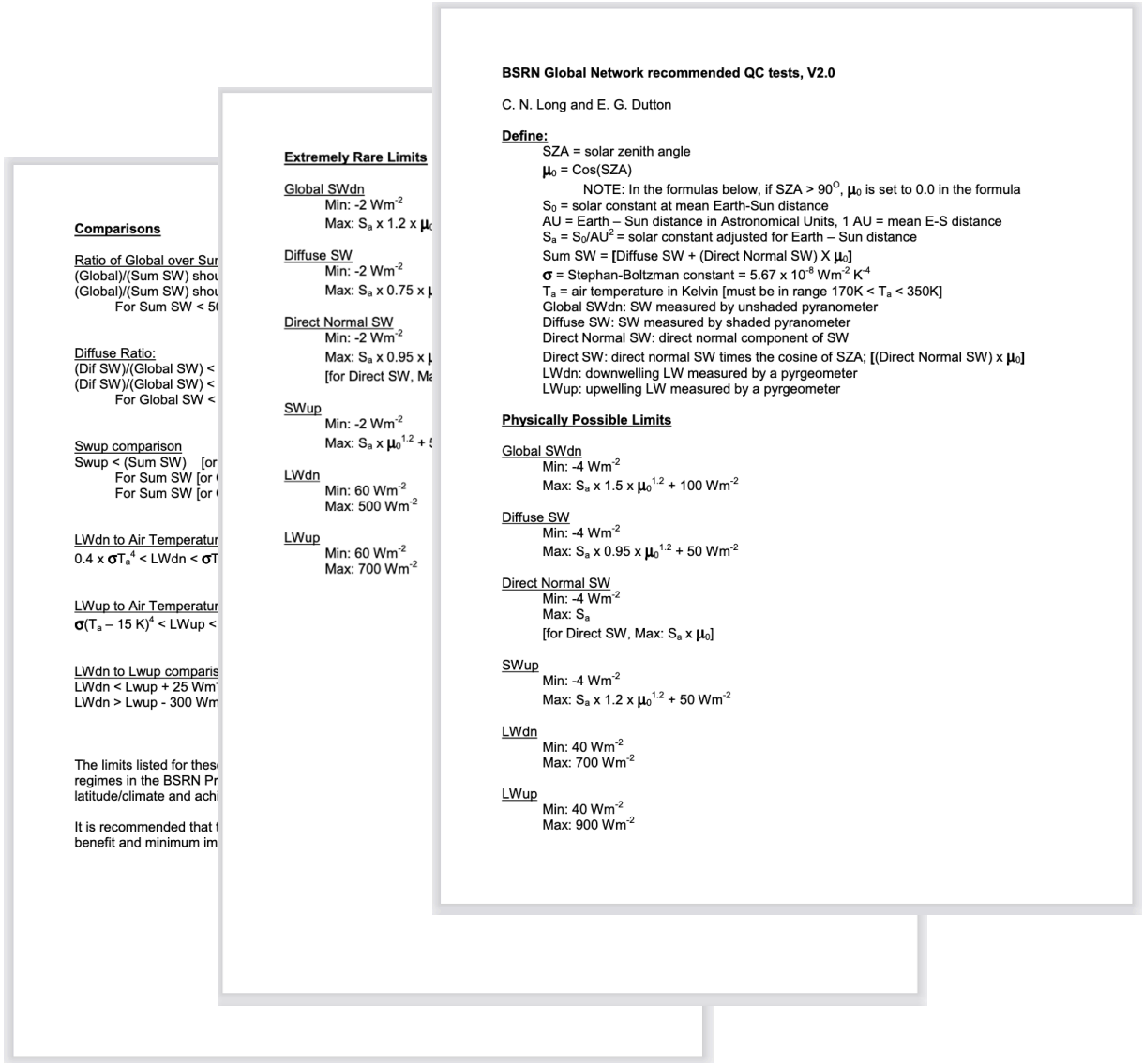
BSRN Recommended Quality control tests

BSRN Global Network recommended QC tests, V2.0

- https://bsrn.awi.de/data/quality-checks/

Two types of tests:

- **Single variable** value limits (Extremely rare and physically possible limits)
- Consistency limits from **multi-variable** comparison



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C. N. Long and E. G. Dutton

Define:

SZA = solar zenith angle
μ_0 = Cos(SZA)
NOTE: In the formulas below, if SZA > 90°, 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
$S_a = S_0/AU^2$ = solar constant adjusted for Earth – Sun distance
Sum SW = [Diffuse SW + (Direct Normal SW) X μ_0]
σ = Stephan-Boltzman constant = 5.67×10^{-8} Wm^{-2} K^{-4}
T_a = air temperature in Kelvin [must be in range 170K < T_a < 350K]
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: $S_a \times 1.5 \times \mu_0^{1.2} + 100$ Wm^{-2}

Diffuse SW
Min: -4 Wm^{-2}
Max: $S_a \times 0.95 \times \mu_0^{1.2} + 50$ 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: $S_a \times 1.2 \times \mu_0^{1.2} + 50$ 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
Min: -2 Wm^{-2}
Max: $S_a \times 1.2 \times \mu$

Diffuse SW
Min: -2 Wm^{-2}
Max: $S_a \times 0.75 \times$

Direct Normal SW
Min: -2 Wm^{-2}
Max: $S_a \times 0.95 \times$
[for Direct SW, Ma

SWup
Min: -2 Wm^{-2}
Max: $S_a \times \mu_0^{1.2} +$

LWdn
Min: 60 Wm^{-2}
Max: 500 Wm^{-2}

LWup
Min: 60 Wm^{-2}
Max: 700 Wm^{-2}

Comparisons

Ratio of Global over Sur
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(Global)/(Sum SW) shou
For Sum SW < 5(

Diffuse Ratio:
(Dif SW)/(Global SW) <
(Dif SW)/(Global SW) <
For Global SW <

Swup comparison
Swup < (Sum SW) [or
For Sum SW [or (
For Sum SW [or (

LWdn to Air Temperatur
0.4 x σT_a^4 < LWdn < σT

LWup to Air Temperatur
$\sigma(T_a - 15\ K)^4$ < LWup <

LWdn to Lwup comparis
LWdn < Lwup + 25 Wm
LWdn > Lwup - 300 Wm

The limits listed for thes
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It is recommended that t
benefit and minimum im

BSRN Recommended Quality control tests

The main tests

Extremely rare limits (QFERL)

Quantity	Variable	Min (W/m2)	Max (W/m2)
Global	SWD	–2	$S_a \times 1.2 \times \mu_0^{1.2} + 50$
Diffuse	DIF	–2	$S_a \times 0.95 \times \mu_0^{1.2} + 10$
Direct normal	DIR	–2	$S_a \times 0.95 \times \mu_0^{0.2} + 10$
Longwave downward	LWD	60	500

Physically possible limits (QFPPL)

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Direct normal	DIR	–4	S_a
Longwave downward	LWD	40	700

Parameters

SZA	=	solar zenith angle
μ_0	=	cos(SZA)
S_a	=	S_0/AU^2 with S_0 = 1366 W/m^2 and AU = actual normalized sun-earth distance
SUM	=	μ_0 DIR + DIF
T_a	=	Air temperature (K)
σ	=	Stefan–Boltzmann constant

Comparisons (BSRN-QFCMP)

Parameter	Min	Max	Restriction to data
SWD/SUM	0.92	1.08	SZA < 75° and SUM > 50 W m^{-2}
SWD/SUM	0.85	1.15	75° < SZA < 93° and SUM > 50 W m^{-2}
DIF/SWD	–	1.05	SZA < 75° and SWD > 50 W m^{-2}
DIF/SWD	–	1.10	75° < SZA < 93° and SWD > 50 W m^{-2}
LWD	$0.4 \times \sigma T_a^4$	$\sigma T_a^4 + 25$ Wm^{-2}	–

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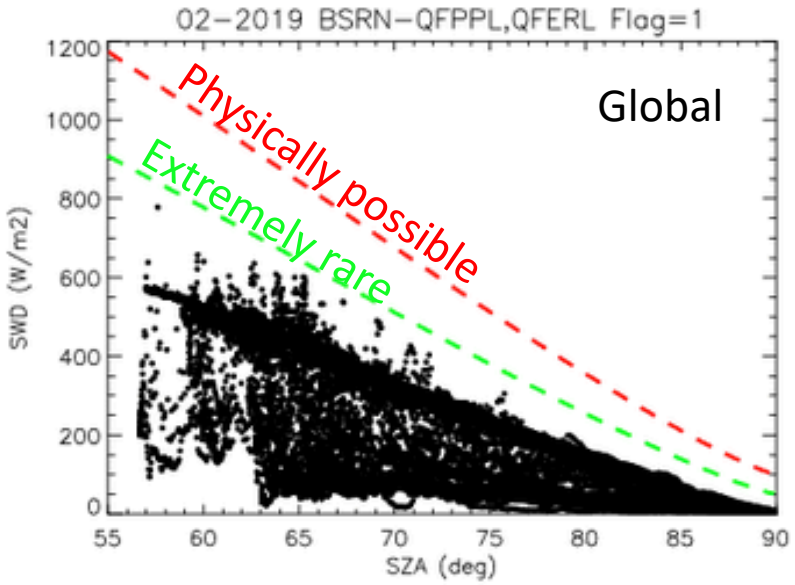

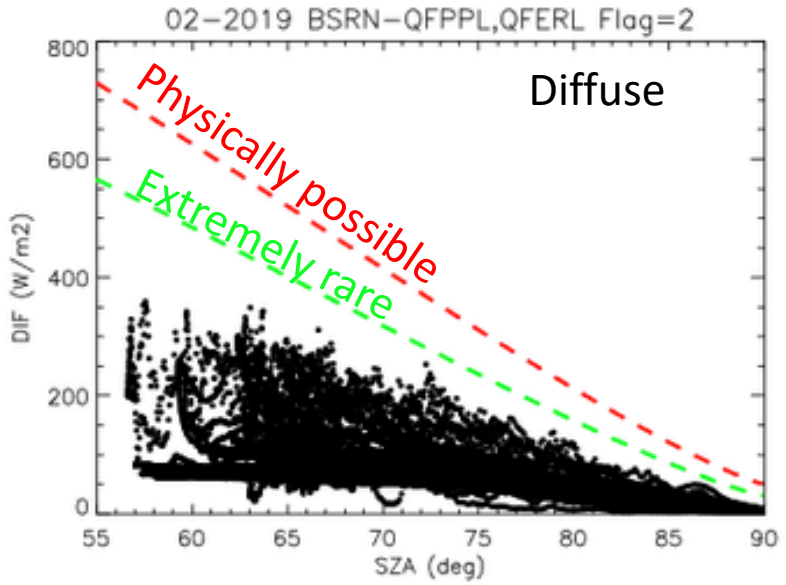

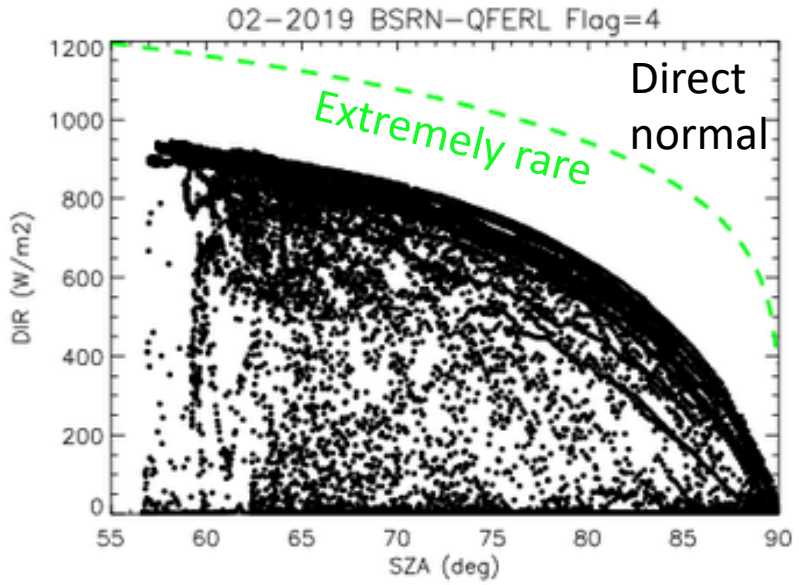

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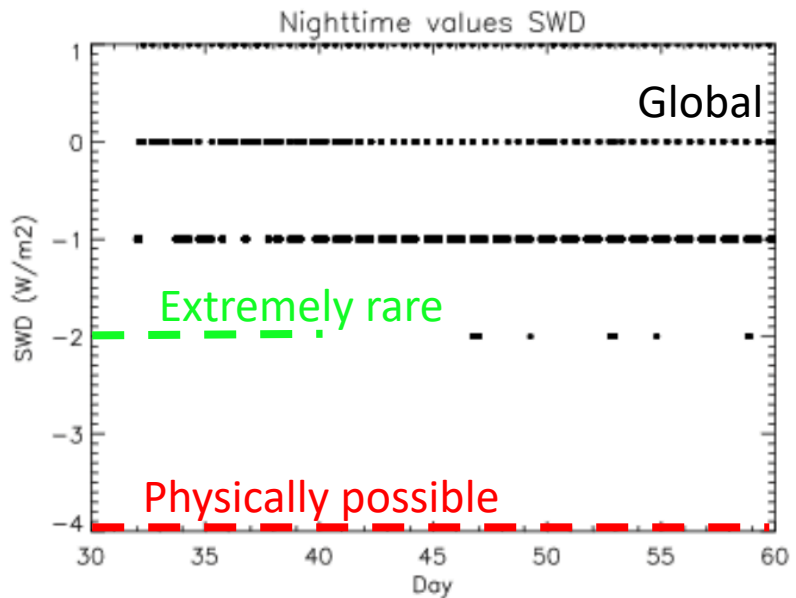

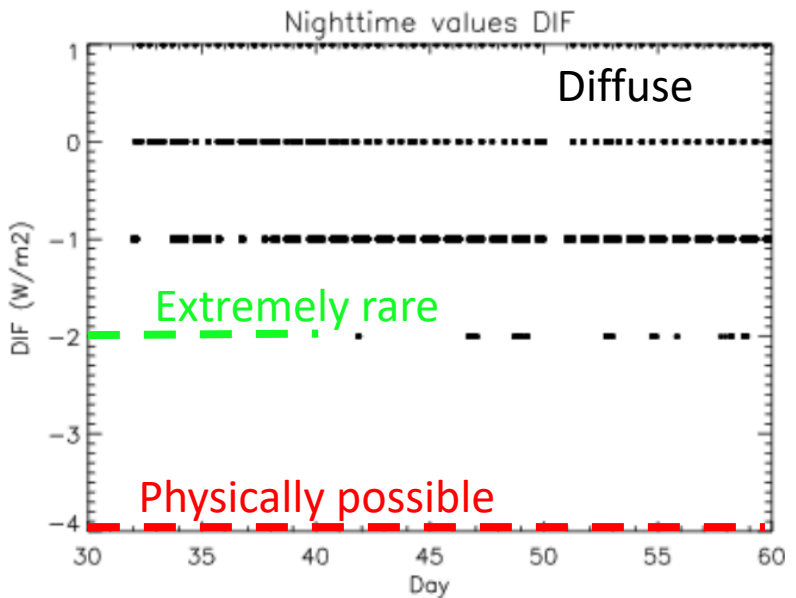

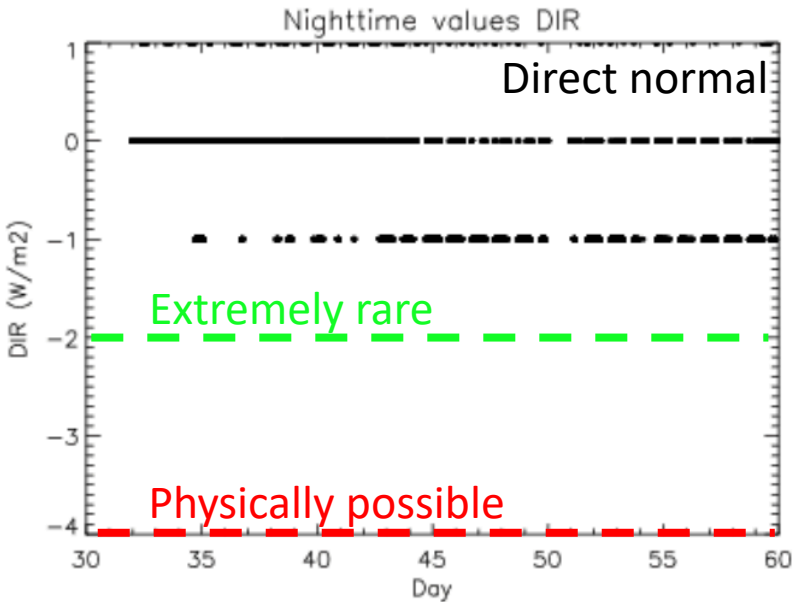

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Comparisons (BSRN-QFCMP)

Parameter	Min	Max	Restriction to data
SWD/SUM	0.92	1.08	SZA < 75° and SUM > 50 W m^{-2}
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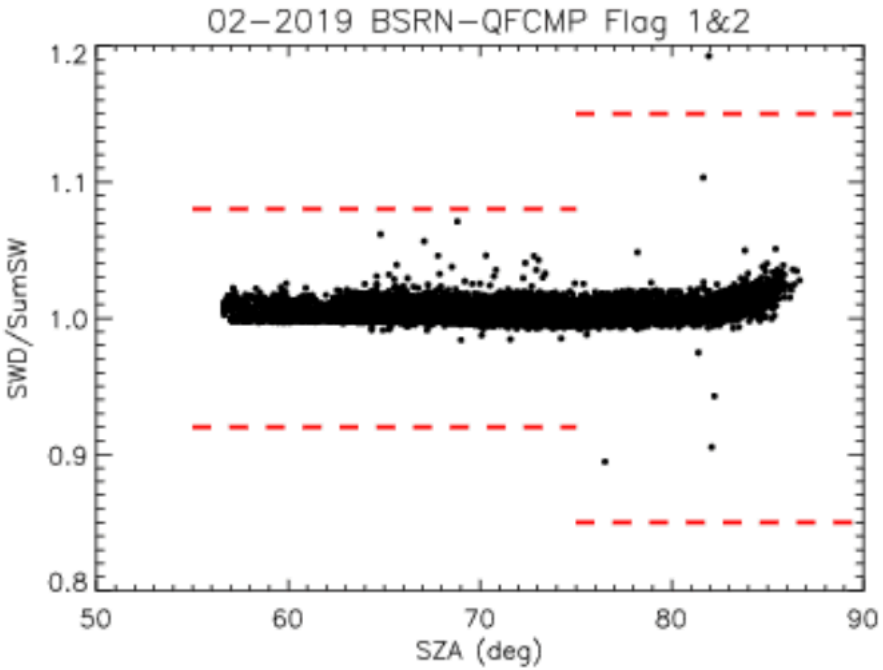

Test meaning:
- Consistency between the three SW downwelling irradiance measurements (**global = direct*cos(SZA) + diffuse**)
- The thresholds are for guidance they do not represent a physical reason
- Inspect in detail the data points that fall out of the limits
- But DO NOT use the thresholds as a blind test to clean data

Some limitations:
- The test is usually unable to detect “tracker-off” problems.

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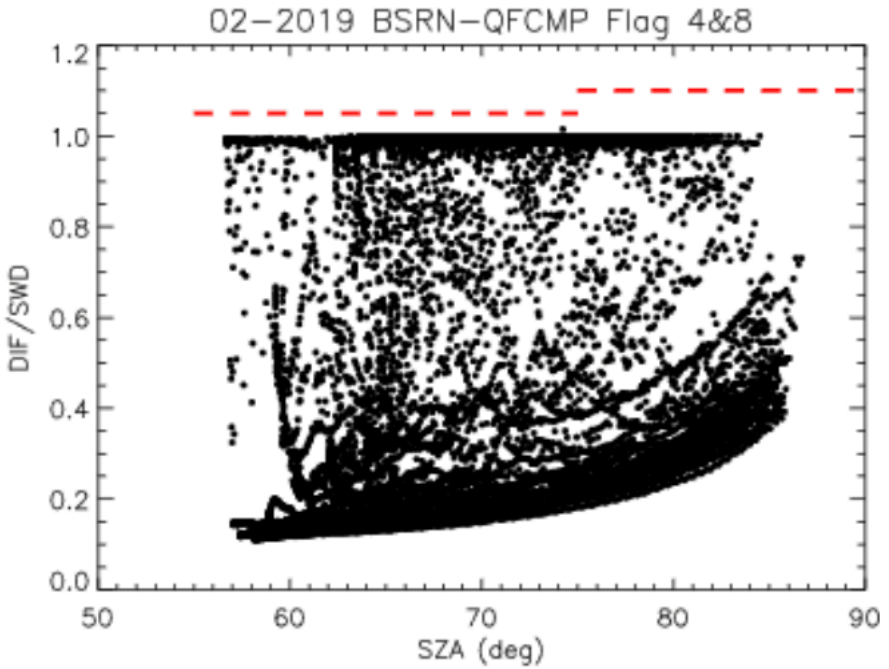

Test meaning:

- Diffuse irradiance should be always be smaller or equal to Global (**global = direct*cos(SZA) + diffuse**)

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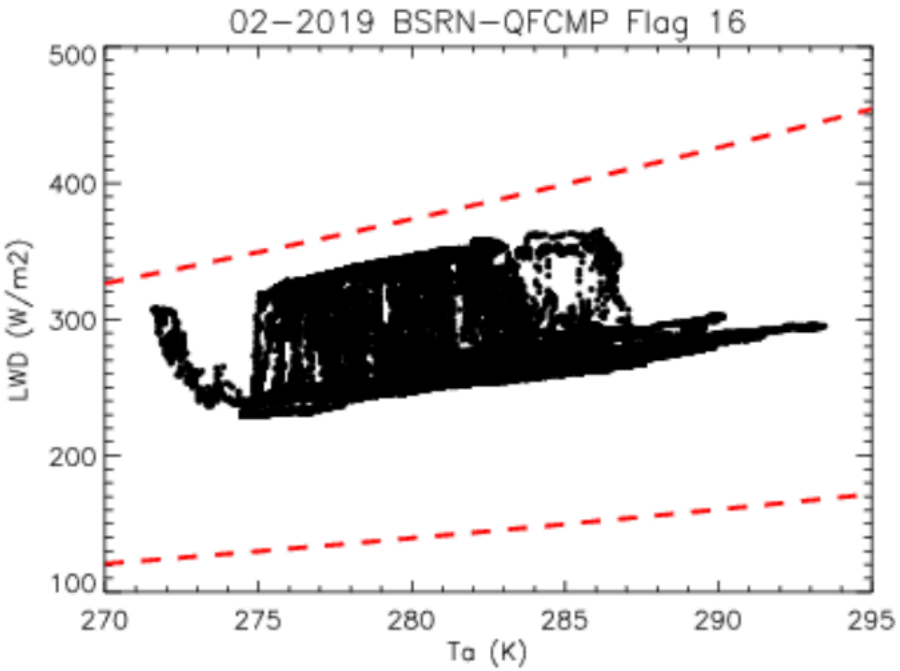

Test meaning:

- Comparison between the downwelling LW irradiance with two reference LW calculations using the air temperature and the Stefan-Boltzmann law (black body radiation $j^\star = \sigma T^4$.)

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BSRN Toolbox

- Download: https://doi.pangaea.de/10.1594/PANGAEA.774827?format=html
- Documentation: https://wiki.pangaea.de/wiki/BSRN_Toolbox

Quality codes

The quality codes that are written to the output files are unsigned integer values in decimal notation. Each *quality code* holds 6 *quality flags* (each represented by one bit of the quality code). The individual bits mean (from LSB to MSB):

Bit position	Decimal representation	Meaning
0	1	Measurement falls below the physically possible limit
1	2	Measurement exceeds the physically possible limit
2	4	Measurement falls below the extremely rare limit
3	8	Measurement exceeds the extremely rare limit
4	16	Compared with a corresponding measurement the measurement is too low
5	32	Compared with a corresponding measurement the measurement is too high

This results in quality codes between 0 and 63. A quality code of 0 means that all checks were passed successfully.

Measurements which do not fall into the physically possible limits should be taken as highly suspect. Thus, this test should be performed in any case before submitting, archiving or using these data. Measurements beyond the extremely rare cases should at least be visually inspected. If no physical reasons - such as multireflections, extreme weather conditions, etc. - can be found it is recommended to exclude these data from submitting, archiving or using. When comparing measurements with each other it is unclear which of the two (or more) values caused the inconsistency. Further investigations are recommended.

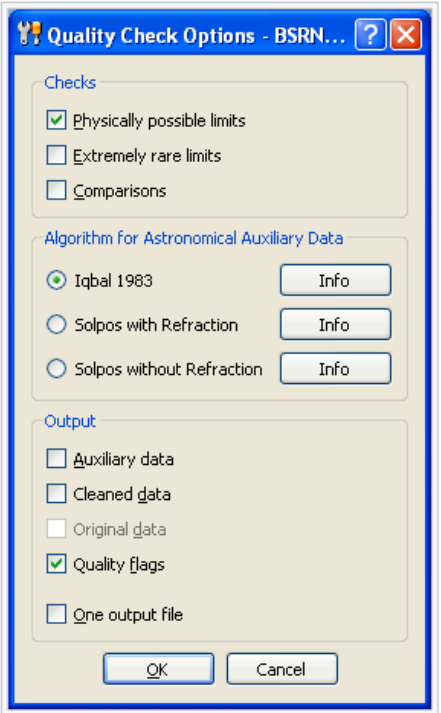

Fig. 6: Quality Check Options