Data Quality Assessment Using SERI-QC

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Abstract

- High-quality solar resource data requires stringent calibration, operation and maintenance, and data quality assessment and control procedures.
- Strict protocols for calibration, measurement, modeling, operation and maintenance, and data quality assessment and control are used at NREL.
- NREL's SERI-QC software package is used to assess measurement data quality.
- SERI-QC uses three component data analyses in the K-space, as shown in Figure 1.

Variable	Definition
K_t	Global (GHI) / (ETRN * cos (Z))
K_n	Direct (DNI) / ETRN
K_d	Diffuse (DHI)/ (ETRN * cos(Z))

Fig. 1: Definition of the K-space used in SERI-QC. ETRN represents extraterrestrial radiation, and Z is the solar zenith angle.

Method

SERI-QC: an empirical approach
Operates in K-space: fraction of possible irradiance

Perform one-element, two-element, or three-element tests based on available measurements.

1. One-element test by defining a range of acceptable values between minimum and maximum values of K_t, K_d, or K_n, based on three air mass regimes and the month of the year
2. Zenith angle (at the middle of the hour) < 80° and all three of the elements are present: three-element test performed using a range of acceptable values fulfilling $K_t = K_d + K_n$ within arbitrary error limit of ± 0.03, which accounts for measurement uncertainties
3. Data passes the three-element test (or at least two elements pass the one-element test): two-element test performed by defining a range of acceptable values within boundaries.

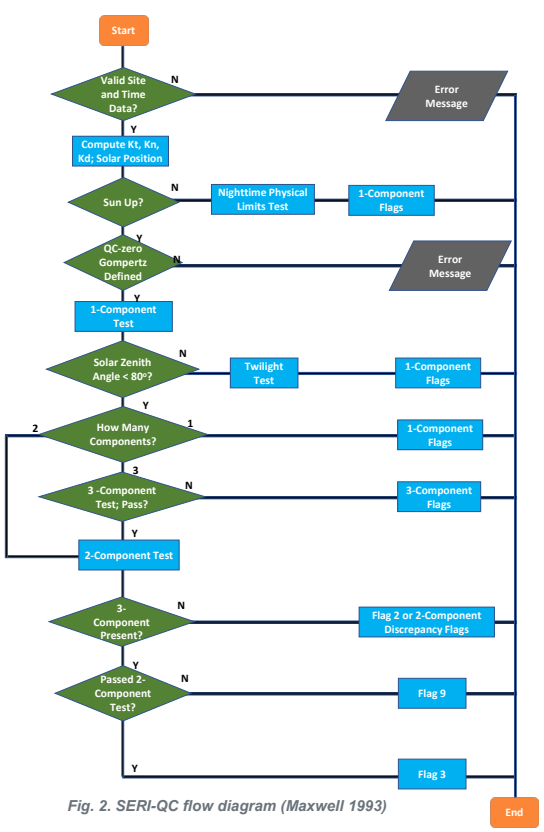

Fig. 2. SERI-QC flow diagram (Maxwell 1993)

QCFIT: Provides an Envelope of Expected Values

Air Mass/Zenith Angle Ranges

Range	Air Mass	Zenith Angle
Low	1.00–1.25	0.00–36.96
Medium	1.25–2.50	36.96–66.57
High	2.50–5.76	66.57–80.00

Maximum K_t and K_n

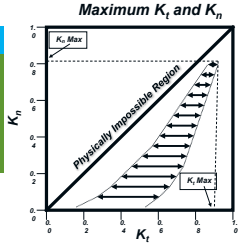

Fig. 3. Relationship between Kt and Kn and their expected area

Output

Flag	Description
00	Untested (raw data)
01	Passed one-component test; data fall within min-max limits of K_t, K_n, or K_d
02	Passed two-component test; data fall within 0.03 of the Gompertz boundaries
03	Passed three-component test; data came within 0.03 of satisfying $K_t = K_n + K_d$
04	Passed visual inspection; not used by SERI-QC
05	Failed visual inspection; not used by SERI-QC
06	Value estimated; passes all pertinent SERI-QC tests
07	Failed one-component test; lower than allowed minimum
08	Failed one-component test; higher than allowed maximum
09	Passed three-component test but failed two-component test by >0.05
10-93	Failed two- or three-component tests in one of four ways. To determine the test failed and the manner of failure (high or low), examine the remainder of the calculation (flag + 2)/4.
	REM: 0 — Parameter too low by three-component test ($K_t = K_n + K_d$)
	REM: 1 — Parameter too high by three-component test ($K_t = K_n + K_d$)
	REM: 2 — Parameter too low by two-component test (Gompertz boundaries)
	REM: 3 — Parameter too high by two-component test (Gompertz boundaries)
	The magnitude of the test failure (distance in K-units) is determined from: d = (INT (flag +2)/4)/100.
94-97	Data fall into a physically impossible region where $K_n > K_t$ by K-space distances of 0.05–0.10 (94), 0.10–0.15 (95), 0.15–0.20 (96), or ±0.20 (97).
98	Not used
99	Missing data (associated data field is filled with -9900)

Fig. 4. SERI-QC returns a two-digit quality flag (Maxwell 1993)

- *Magnitude of the error*
- *Direction of the error (high, low)*
- *Test that reported the error.*

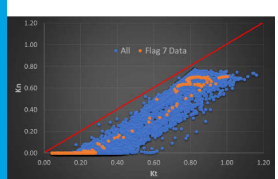

Fig. 5. Example SERI-QC output with Flag 7 for GHI data

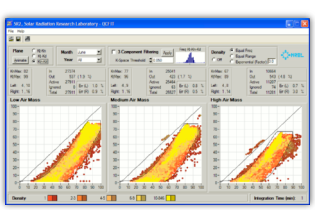

Fig. 6. QCFIT example using multiyear data to create the three air mass regimes

Tracker failure June 6 and 7

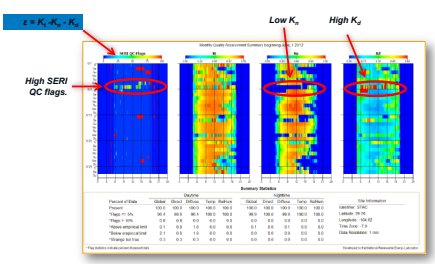

Fig. 7. SERI-QC cylinder plots showing a month of data with associated quality flags

Conclusions and Future Work

- *SERI-QC depends on redundancy of the three-component solar irradiance measurements and their expected coupling.*
- *SERI-QC outputs color-coded images for ease of visualization and understanding in addition to comma-separated value (csv) files with flags.*

Future work:

- *Make SERI-QC available in other programming languages, such as Python, as a package.*
- *Update QCFIT software from being semiautomated to a more autonomous program by selecting optimum envelopes for the two-element data.*
- *Refine the current partitioning of atmospheric combinations to improve quality assessment.*

References

Maxwell, E., S. Wilcox, and M. Rymes. 1993. *Users Manual for SERI_QC Software: Assessing the Quality of Solar Radiation Data* (NREL/TP-463-5608). Golden, CO: National Renewable Energy Laboratory. https://www.nrel.gov/docs/legosti/old/5608.pdf.

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