



**HAL**  
open science

## On quality control procedures for solar radiation and meteorological measures, from subhourly to montly average time periods

Bella Espinar, Philippe Blanc, Lucien Wald, Carsten Hoyer-Klick, Marion Schroedter Homscheidt, Thomas Wanderer

### ► To cite this version:

Bella Espinar, Philippe Blanc, Lucien Wald, Carsten Hoyer-Klick, Marion Schroedter Homscheidt, et al.. On quality control procedures for solar radiation and meteorological measures, from subhourly to montly average time periods. EGU General Assembly 2012, Apr 2012, Vienne, Austria. hal-00691350

**HAL Id: hal-00691350**

**<https://minesparis-psl.hal.science/hal-00691350>**

Submitted on 29 Nov 2014

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

# Controlling the quality of measurements of meteorological variables and solar radiation. From sub-hourly to monthly average time periods

Authors: Espinar, B.<sup>(1)</sup>, Blanc, P.<sup>(1)</sup>, Wald, L.<sup>(1)</sup>, Hoyer-Klick, C.<sup>(2)</sup>, Schroedter-Homscheidt, M.<sup>(2)</sup>, Wanderer, T.<sup>(2)</sup>  
 (1) MINES ParisTech, CEP – Centre énergétique et procédés, BP 207, 1 rue Claude Daunesse, 06904 Sophia Antipolis Cedex France  
 (2) DLR, German Aerospace Center DLR, Wessling, Germany

European Geosciences Union 2012, Vienna (Austria) 22 – 27 April 2012

Long-term radiation and meteorological measurements are available from a large number of ground measuring stations. However, close examination of the data often reveals a lack of quality, often for extended periods of time. Quality Control Procedures (QCPs) are a measure of how well data serve the purpose for which they were produced. We have searched in the bibliographic references the QCPs that are available for the solar radiation and meteorological data series which are of interest in the field of renewable energies, grouping them together by average time periods, checking them and modifying them if necessary. All of the QCPs that are presented in this document are applicable for all latitudes; they are not optimized regionally nor seasonally with the aim of being generic. The research leading to those results has partly received funding from the European Union's Seventh Framework Programme (FP7/2007-2013).

## TYPES OF QUALITY CONTROL PROCEDURES (QCPs)

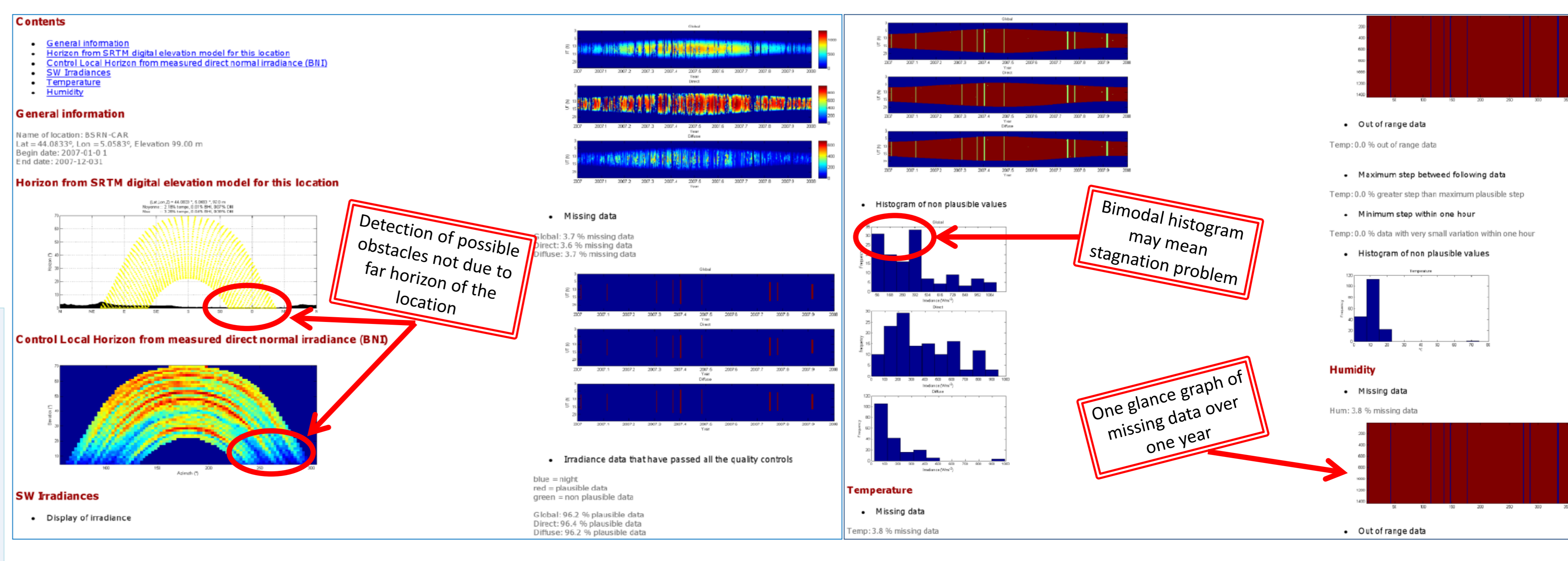
- **Range QCPs:** verify that values are within a specific range (*based on extrema* for physically possible values and *based on rare observations* for possible but extremely rare values).
- **Step QCPs:** aimed at detecting unrealistic increments or stagnations in the time series, with respect to their sampling and integration period.
- **Consistency QCPs:** verify the consistencies between two or more independent time series.

	Monthly	Daily	Hourly	Sub-hourly (1-minute average except for WS which is 2-minute)
<b>Global Horizontal Irradiance GHI (Wm<sup>-2</sup>)</b>	<p><u>QCP based on extrema</u> [3,7] 0.03 GHI<sub>toa</sub> &lt; GHI &lt; 1.2 I<sub>0</sub></p> <p><u>QCP based on rare observations</u> [2,3,13] 0.03 GHI<sub>toa</sub> &lt; GHI &lt; GHI<sub>toa</sub></p>	<p><u>QCP based on extrema</u> [3,7] 0.03 GHI<sub>toa</sub> &lt; GHI &lt; 1.2 I<sub>0</sub></p> <p><u>QCP based on rare observations</u> [2,3,13] 0.03 GHI<sub>toa</sub> &lt; GHI &lt; GHI<sub>toa</sub></p>	<p><u>QCP based on extrema</u> [3,4,7] <b>0.03 GHI<sub>toa</sub> &lt; GHI &lt; min (1.2 I<sub>0</sub>, 1.5 I<sub>0</sub> cos(SZA))<sup>1.2</sup> + 100</b></p> <p><u>QCP based on rare observations</u> [4,5,7] 0.03 GHI<sub>toa</sub> &lt; GHI &lt; 1.2 I<sub>0</sub> cos(SZA)<sup>1.2</sup> + 50</p>	<p><u>QCP based on extrema</u> [3,4,7] <b>0.03 GHI<sub>toa</sub> &lt; GHI &lt; min (1.2 I<sub>0</sub>, 1.5 I<sub>0</sub> cos(SZA))<sup>1.2</sup> + 100</b></p> <p><u>QCP based on rare observations</u> [3,4] 0.03 GHI<sub>toa</sub> &lt; GHI &lt; 1.2 I<sub>0</sub> cos(SZA)<sup>1.2</sup> + 50</p> <p><u>Step QCP</u> [14] Maximum step for two following measures: 1000 W m<sup>-2</sup></p>
<b>Beam Normal Irradiance BNI (Wm<sup>-2</sup>)</b>	<p><u>QCP based on extrema</u> [4] 0 &lt; BNI &lt; I<sub>0</sub></p>	<p><u>QCP based on extrema</u> [4] 0 &lt; BNI &lt; I<sub>0</sub></p>	<p><u>QCP based on extrema</u> [4] 0 &lt; BNI &lt; I<sub>0</sub></p> <p><u>QCP based on rare observations</u> [4] 0 &lt; BNI &lt; 0.95 I<sub>0</sub> cos(SZA)<sup>0.2</sup> + 10</p>	<p><u>QCP based on extrema</u> [4] 0 &lt; BNI &lt; I<sub>0</sub></p> <p><u>QCP based on rare observations</u> [4] 0 &lt; BNI &lt; 0.95 I<sub>0</sub> cos(SZA)<sup>0.2</sup> + 10</p>
<b>Diffuse Horizontal Irradiance DHI (Wm<sup>-2</sup>)</b>	<p><u>QCP based on extrema</u> [3,7] 0.03 GHI<sub>toa</sub> &lt; DHI &lt; 0.8 I<sub>0</sub></p>	<p><u>QCP based on extrema</u> [3,7] 0.03 GHI<sub>toa</sub> &lt; DHI &lt; 0.8 I<sub>0</sub></p>	<p><u>QCP based on extrema</u> [3,4,5,7] <b>0.03 GHI<sub>toa</sub> &lt; DHI &lt; min (0.8 I<sub>0</sub>, 0.95 I<sub>0</sub> cos(SZA))<sup>1.2</sup> + 50</b></p> <p><u>QCP based on rare observations</u> [3,4] 0.03 GHI<sub>toa</sub> &lt; DHI &lt; 0.75 I<sub>0</sub> cos(SZA)<sup>1.2</sup> + 30</p>	<p><u>QCP based on extrema</u> [3,4,7] <b>0.03 GHI<sub>toa</sub> &lt; DHI &lt; min (0.8 I<sub>0</sub>, 0.95 I<sub>0</sub> cos(SZA))<sup>1.2</sup> + 50</b></p> <p><u>QCP based on rare observations</u> [3,4] 0.03 GHI<sub>toa</sub> &lt; DHI &lt; 0.75 I<sub>0</sub> cos(SZA)<sup>1.2</sup> + 30</p>
<b>Temperature Temp (°C)</b>	<p><u>QCP based on extrema</u> [10,14] -90 &lt; Temp &lt; + 60</p> <p><u>QCP based on rare observations</u> [10,14] -80 &lt; Temp &lt; + 50</p>	<p><u>QCP based on extrema</u> [10,14] -90 &lt; Temp &lt; + 60</p> <p><u>QCP based on rare observations</u> [10,14] -80 &lt; Temp &lt; + 50</p>	<p><u>QCP based on extrema</u> [10,14] -90 &lt; Temp &lt; + 60</p> <p><u>QCP based on rare observations</u> [10,14] -80 &lt; Temp &lt; + 50</p> <p><u>Step QCP</u> [8,9] Maximum step for two following measures: 8 °C</p>	<p><u>QCP based on extrema</u> [10,14] -90 &lt; Temp &lt; + 60</p> <p><u>QCP based on rare observations</u> [10,14] -80 &lt; Temp &lt; + 50</p> <p><u>Step QCP</u> [11,14] Maximum step for two following measures: 3 °C Minimum step over the past 60 minutes: 0.1 °C</p>
<b>Relative Humidity Hum (%)</b>	<p><u>QCP based on extrema</u> [14] 0 &lt; Hum &lt; 100</p>	<p><u>QCP based on extrema</u> [14] 0 &lt; Hum &lt; 100</p>	<p><u>QCP based on extrema</u> [14] 0 &lt; Hum &lt; 100</p> <p><u>Step QCP</u> [9] Maximum step for two following values: 30 %</p>	<p><u>QCP based on extrema</u> [14] 0 &lt; Hum &lt; 100</p> <p><u>Step QCP</u> [14] Maximum step for two following values: 10 % <b>Minimum step over the past 120 minutes: 0.1 %</b></p>
<b>Wind Speed WS (m s<sup>-1</sup>)</b>			<p><u>Step QCP</u> [8,9] maximum step for two following values: 15 m s<sup>-1</sup></p>	<p><u>QCP based on extrema</u> (2-min average) [10] 0 &lt; WS &lt; 150</p> <p><u>QCP based on rare observations</u> (2-min average) [10] 0 &lt; WS &lt; 80</p> <p><u>Step QCP</u> [11,14] maximum step for two following values (2-min average): 20 m s<sup>-1</sup> Minimum step over the past 60 minutes except for no wind periods (2-minute average): 0.5 m s<sup>-1</sup> [4,7,12] For GHI &gt; 50 W m<sup>-2</sup> (if not, test not possible): DHI/GHI &lt; 1.05, for SZA &lt; 75° DHI/GHI &lt; 1.10, for 93° &gt; SZA &gt; 75° For DHI+BHI &gt; 50 W m<sup>-2</sup> (if not, test not possible)  1 - GHI / (BHI+DHI)  ≤ 0.08, for SZA &lt; 75°  1 - GHI / (BHI+DHI)  ≤ 0.15, for 75° &lt; SZA &lt; 93°</p>
<b>Consistency checks</b>	<p>[7] DHI ≤ 1.1 GHI</p>	<p>[7] DHI ≤ 1.1 GHI</p>	<p>[1,5,6,13] For GHI &gt; 20 W m<sup>-2</sup> (if not, test not possible)  1 - GHI / (BHI + DHI)  = 0.15 DHI ≤ 1.1 GHI</p>	

GHI<sub>toa</sub> = Horizontal Irradiance at top of atmosphere; I<sub>0</sub> = normal irradiance at the top of the atmosphere corrected from Sun-Earth distance; SZA = Solar Zenithal Angle (rad); BHI = Beam Horizontal Irradiance. QCPs in bold have been modified compared to their corresponding bibliographic references.

### Quality Control (QC) Output Report:

After checking the plausibility of the data, some graphs, histograms and figures of flagged values may help in the interpretation of the result of QC and also to detect some other features of data.



References

- [1] CIE 1994, report no. CIE-108, International Commission on Illumination.
- [2] ESA 2000, European Solar Radiation Atlas, Les Presses de l'Ecole des Mines de Paris (FRA).
- [3] Geiger et al. 2002, Sol. Energy, 73, 475-480.
- [4] Long and Dutton 2002, BSRN Global Network recommended QC tests, V2.0.
- [5] De Miguel et al. 2001, Sol. Energy, 70, 143-153.
- [6] Molleaux and Irnich 2003, International Daylight Measurement Programme, available at: <http://dimp.entpe.fr/library/software/qcqc.pdf>.
- [7] Muneer and Fairouz 2002, Build. Serv. Eng. Res. T., 23, 151-166.
- [8] NDBC 2009, Handbook of Automated Data Quality Control Checks and Procedures, NOAA.
- [9] Vejen et al. 2002, Quality control of meteorological observations. Automatic methods used in the Nordic countries, Norwegian Meteorological Institute.
- [10] WMO No. 305
- [11] WMO No. 488
- [12] WMO No. 557
- [13] Younes et al. 2005, Energy, 30, 1533-1549.
- [14] Zahumenský 2004, Guidelines on Quality Control Procedures for Data from Automatic Weather Stations, World Meteorological Organization.