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A database of multi-year (2004–2010) quality-assured surface solar hourly irradiation measurements for the Egyptian territory

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Abstract

A database containing the global and diffuse components of the surface solar hourly irradiation measured from 1 January 2004 to 31 December 2010 at eight stations of the Egyptian Meteorological Authority is presented. For three of these sites (Cairo, Aswan, and El-Farafra), the direct component is also available. In addition, a series of meteorological variables including surface pressure, relative humidity, temperature, wind speed and direction... is provided at the same hourly resolution at all stations. The details of the experimental sites and instruments used for the acquisition are given. Special attention is paid to the quality of the data and the procedure applied to flag suspicious or erroneous measurements is described in details. Between 88 and 99 % of the daytime measurements are validated by this quality control. Except at Barrani where the number is lower (13 500), between 20 000 and 29 000 measurements of global and diffuse hourly irradiation are available at all sites for the 7-year period. Similarly, from 9000 to 13 000 measurements of direct hourly irradiation values are provided for the three sites where this component is measured. With its high temporal resolution this consistent irradiation and meteorological database constitutes a reliable source to estimate the potential of solar energy in Egypt. It is also adapted to the study of high-frequency atmospheric processes such as the impact of aerosols on atmospheric radiative transfer. In the next future, it is planned to complete regularly the present 2004–2010 database, which has been placed on the PANGAEA repository (doi:10.1594/PANGAEA.848804) and contains the individual meteorological and irradiation data files of the 8 stations.

1 Introduction

With the development of solar-based renewable energy technologies, national meteorological services must face increasing demands for reliable data on solar resource. Complete and accurate solar radiation data for specific regions are also indispensable for a large variety of solar energy related researches. The surface solar irradiation (SSI), i.e. the downwelling broadband solar irradiation received at ground level on a horizontal plane, and its diffuse and direct components are measured by means of pyranometers and pyrheliometers (WMO, 2008). Pyranometers are hemispherical sensors measuring the global irradiation on a horizontal plane, abbreviated in GHI. Shaded pyranometers measure the diffuse irradiation on a horizontal plane, abbreviated in DHI. Pyrheliometers, comprised of thermopile sensors and a Sun tracking mechanism, measure the direct (or beam) irradiation (DNI) incident from the Sun on a normal plane. The varying aperture (or opening) half-angles of the different pyrheliometeric systems, normally between 2.5 and 5°, means they are also measuring the radiation surrounding the solar disc, i.e. the circumsolar radiation (Blanc et al., 2014).

Measuring the SSI and its components is more difficult than other meteorological variables. Systematic errors due to the instruments themselves exist (e.g., Muneer and Fairooz, 2002; Younes et al., 2005), but the most important ones are usually random and due to operational causes such as maintenance and instrument reading. Therefore, one of the major concerns of operational radiometric networks is to perform a rigorous quality control (QC) on the measurements (e.g. Journée and Bertrand, 2011; Moradi, 2009; Roesch et al., 2011). This is an indispensable step before further processing of the data

In order to provide the large community of potential users with high quality SSI data, the Egyptian Meteorological Authority (EMA) started establishing in the 1960s a network of stations measuring the GHI, DHI and DNI, as well as more common surface meteorological variables. Currently, this network includes more than 10 sites.

The aim of this paper is to describe the SUSIE (SUrface Solar Irradiance in Egypt for energy production) database elaborated in the framework of the eponymous Egyptian/French project. The database covers the period 2004–2010 and includes the quality-checked hourly measurements of the SSI components performed at eight EMA stations. These stations were selected for being representative of the different types of Egyptian climates (Diabaté et al., 2004), namely "coastal" (Matruh, Barrani), arid Sinai Peninsula (El-Arish), "urban" (Cairo), "Nile valley and upper Egypt" (Asyut and Aswan), and "desert" (El-Kharga and El-Farafra). For all sites, meteorological variables such as air temperature, pressure, wind direction/speed, and humidity are also included in the database.

Measurements are currently going on at the EMA stations and SUSIE was an opportunity to make measurements available to a wide audience. Note that for the moment no SSI data is proposed after 2010 because EMA was unable to attend the World Meteorological Organization (WMO) International Pyrheliometer Comparison (IPC-XI) held at the World Radiation Center (WRC) in Davos in September-October 2010 and calibrate its absolute reference pyrheliometer, namely the self-calibrating Absolute Cavity Pyrheliometer Model HF No.31103. Therefore, the EMA cannot consider its post-2010 measurements reliable before this reference instrument is calibrated again in the frame of the 12th International Pyrheliometer Comparison (IPC-XII) to be organized in September-October 2015 at the WRC and a correction is designed for the data from 2011 to 2015.

This paper is organized as follows: the study area and the available ground measuring instruments are described in Sect. 2, the QC procedures applied to the SSI measurements are detailed in Sect. 3, their results and the structure of SUSIE database are given in Sect. 4. Finally, Sect. 5 is dedicated to the summary and perspectives. The quality-checked database is available in PANGAEA under Creative Commons Attribution 3.0 Unported International Public License (CC-BY 3.0).

2 Ground stations and measurements

2.1 Location of the measurement sites

Table 1 contains the names, WMO number, and geographical characteristics (latitude, longitude, altitude, type of climate) of the eight sites whose measurements in the period 2004–2010 were considered to build the SUSIE database. The locations of these sites are reported in Fig. 1 and their surroundings briefly described below.

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Sidi Barrani (hereinafter referred to more simply as Barrani): situated in Lower Egypt along the north coast, the site is 500 m away from the Mediterranean coast. The instruments are located over a small hill outside the village of Sidi Barrani and in an open area. The soil around the measurement site is spread with numerous calcareous rocks the size of a fist.

Mersa Matruh (Matruh, hereinafter): also situated in Lower Egypt along the north coast and ~ 3000 m away from the Mediterranean coast. The instruments are located on the roof of a two-story building at the local airport. The surroundings are low residential buildings. No appreciable interception of the sky exists.

El-Arish: the station lies in the northeastern part of the arid Sinai Peninsula. The instruments are set-up on the roof of the meteorological office, away from the town center. The station is in the middle of olive farms and close to the El-Arish airport. The site has an open sky dome.

Cairo: the instruments are located on the roof of the main building of the EMA Headquarters. The site is of the urban type, surrounded by high buildings and a heavy traffic load. In addition, two large industrial areas: Shobra El-Kheima and Helwan, are located north and south, respectively, of the measurement site.

El-Kharga: the oasis is inside the Western Desert. The station itself is located at the limit of the oasis in an agricultural research center around which bare sandy surfaces with scattered shrubs can be observed. No appreciable interception of the sky exists within the field of view of the measuring instruments.

El-Farafra: this small oasis is located approximately 450 km to the southwest of Cairo and 480 km south of the Mediterranean Sea in a part of the western Egyptian desert known as the “White Desert”. The instruments are located on the roof of the two-story building of EMA station. The site is located east of the village of El-Farafra, in an extremely flat, open area deprived of any obstacles. According to the classification of Diabaté et al. (2004), the area is characterized by a dry desert climate.

Asyut is located in Upper Egypt along the Nile, and exhibits a dry desert climate. The instruments are installed over a three-story building inside the campus of Asyut

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University near cultivated fields of the Agricultural Research Centre. No appreciable interception of the sky exists.

Aswan is also situated in Upper Egypt and it exhibits a dry desert climate. The instruments are installed over a two-story building inside the premises of the Aswan military airport. The site is surrounded by sandy surfaces with sparse rocks of varying sizes.

2.2 Irradiation measurements

2.2.1 Instruments and data storage

SSI measurements are not performed with the same types of pyranometers and pyrheliometers at the eight sites. Table 2a to h contains the period of measurements – note that the measurements at Barrani and El-Farafra did not start before January and August 2005, respectively – and the details of the instruments. Data-loggers scan the signals from the radiation sensors at least every minute. However, in order to increase their storage capacity, these initial data are stored as hourly averages.

2.2.2 Instrument maintenance, calibration, and performance

Measurements of the GHI are made with pyranometers. The properties of concern when evaluating the accuracy and quality of the radiation measurements are the sensitivity, stability, response time, cosine response, azimuth response, linearity, temperature response, and spectral response (ESRA 2000; ISO-9060 1990). Deviations are caused primarily by the directional sensitivity of the individual receiver surfaces and by effects of the glass dome covering the upward-facing sensor (Geiger et al., 2002). This dome must be cleaned regularly to avoid soiling of its surface. Other errors may occur from inaccurate horizontal adjustment of the receiver surface, moisture inside the dome, etc. At the 66 % confidence level, and for hourly irradiation, achievable relative uncertainties are about 3, 8 and 20 % for operational pyranometers of high, good and

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moderate quality, respectively. In case of daily irradiation, smaller relative uncertainties of 2, 5 and 10 % can be achieved (WMO, 2008).

The shading-unshading method (WMO, 1981; McArthur, 2004) is used to calibrate the pyranometers every year by comparison against the EMA reference Pyrheliometer HF 31103, itself being calibrated every 5 years at the World Radiometric Reference (WRR), at Davos in Switzerland (WMO/TD No. 1320). In order to minimize the uncertainties further, the measurements performed by the pyranometers are corrected to account for: (1) thermal offsets, (2) cosine response, and (3) temperature sensitivity of the calibration constant. These corrections follow the WRC (1985 and 1995) guidelines. The pyrheliometers and pyranometers used at the EMA stations are traceable to the World Radiometric Reference (WRR) standards.

2.3 Meteorological variables

Basic meteorological variables, namely the relative humidity, mean see level pressure, dry-bulb temperature, wet-bulb temperature, wind direction, wind speed, and cloud amount are also measured at the EMA sites. Except for cloud amount, measurements are performed at the frequency of 1 Hz for the 10 min preceding each hour and their averages are stored by the data-loggers.

All measurements are performed in agreement with the WMO requirements. Mercury thermometers manufactured by R. Fuess and Theodor Friedrichs, which count among the most accurate meteorological thermometers (WMO, 2008), are used for routine observations of the air, wet-bulb, and dry-bulb temperatures. Based on the recommendation of the Commission for Instruments and Methods of Observation, several regional associations of WMO have set up Regional Instrument Centers (RICs) to maintain standards and provide advice (WMO/CIMO, 1985). Cairo (Egypt) is one of those RICs for RA I (Africa). Their terms of reference and locations are given in WMO (2008, Annex 1.A).

The operational instruments for measuring atmospheric pressure are mercury (R. Fuess, type 11a-9) barometers, and Short and Mason barographs are used for

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continuous pressure recording. Surface wind characteristics (speed and direction) are monitored with Munro cup or propeller anemometers. Finally, the measurements of the cloud amount are made by visual observation according to the Code table 2700 in WMO (2010).

3 Details of the quality control applied to the data

The EMA is particularly aware of the importance of the quality assurance and management of its observing systems. In spite of the quality of the instruments used and of the dedication of the personal who calibrate, maintain and operate them, measurement errors are still possible. Therefore, quality control (QC) procedures aiming at flagging suspicious values are applied to the measurements of solar radiation and other meteorological variables.

3.1 Meteorological variables

Beside the care brought onsite to the maintenance of the instruments by qualified personnel, the surface meteorological hourly data must pass a classical quality check (validation and reviewing) before being accepted into the database and archived. This quality check comprises the four following steps:

- Highly experienced observers screen the records of hourly data. If they detect any logical error, they correct them.
- The reviewed records are sent to the central mainframe for the data entry.
- Computer programs test the internal self-consistency of the datasets and print a list of the suspicious data.
- The data entry errors detected in the previous phase of the checking procedure are corrected.

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3.2 SSI components

After a visual observation of the datasets of the SSI components to detect and remove periods of obviously erroneous measurements, the datasets are submitted to the QC. This QC is a succession of tests which result in flagging data as "successfully passed" (flag = 0) or "failed" (flag = 1) depending on the result of the test. In essence, the QC of the radiometric observations includes limits within which data are expected to lie for being acceptable. These tests are guided either by physical reasoning – detecting physically impossible events – or by criteria based on the expected statistical variability of the data – detecting very rare and thus questionable events. Furthermore, they either treat the various solar radiation parameters separately or compare them to each other. De Miguel et al. (2001), Geiger et al. (2002), Long and Dutton (2002), Muneer and Fairooz (2002), and Younes et al. (2005) have proposed such tests, which have been adopted here for hourly irradiation. The measurements have units of $\mathrm{MJ\,m^{-2}}$, noted G for the GHI, D for DHI and B_n for the DNI. Denoting θ_S the solar zenith angle, E_0 and $E_{0,n}$ the hourly irradiation at top of atmosphere received on a horizontal surface, respectively at normal incidence, the conditions to pass are:

$$G > \max(0.03E_0, 0.0036\,\mathrm{MJ\,m^{-2}}) \tag{1}$$

$$G < E_0, \tag{2}$$

$$D > \max(0.03E_0, 0.0036\,\mathrm{MJ\,m^{-2}}) \tag{3}$$

$$D < \min(0.8E_{0,n}, 0.95E_0\cos(\theta_S)^{0.2} + 0.18\,\mathrm{MJ\,m^{-2}}, 0.75E_0\cos(\theta_S)^{0.2} + 0.108\,\mathrm{MJ\,m^{-2}}) \tag{4}$$

$$B_n > 0.0036\,\mathrm{MJ\,m^{-2}} \tag{5}$$

$$B_n < \min(E_{0,n}, 0.95E_{0,n}\cos(\theta_S)^{0.2} + 0.036\,\mathrm{MJ\,m^{-2}}) \tag{6}$$

For G, D and B_n measured at Aswan, Cairo and El-Farafra, and satisfying the aforementioned QC procedures, an additional "consistency check" is performed. This test

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flags out any measurement for which the measured and computed G do not agree with each other within specified limits (Roesch et al., 2011):

$$0.92 \le (B_n \cos(\theta_S) + D)/G \le 1.08 \quad \text{if } \theta_S > 75° \tag{7}$$

$$0.85 \le (B_n \cos(\theta_S) + D)/G \le 1.15 \quad \text{otherwise} \tag{8}$$

Practically, E_0, $E_{0,n}$ and θ_S were obtained from the McClear service available at the SoDa service (www.soda-pro.com; Gschwind et al., 2006). Within a few clicks, the McClear service delivers time-series of the SSI components that should be observed if the sky were clear for the site of interest (Lefevre et al., 2013). It also provides precise values of E_0 using an accurate algorithm for computing θ_S (Blanc and Wald, 2012). Estimates of SSI in McClear are performed with a 1 min step; estimates may be then aggregated for various durations. Here, hourly values for E_0 and the SSI components for clear-sky G_{clear}, D_{clear}, B_{clear} and $B_{clear,\,n}$ were requested for, where B_{clear} denotes the direct SSI on an horizontal surface. Unfortunately, the McClear service does not provide estimates of θ_S. As θ_S varies greatly within an hour, an effective θ_S was computed for each hour:

$$\cos(\theta_S) = B_{clear}/B_{clear,n} \tag{9}$$

$$E_{0,n} = E_0/\cos(\theta_S) \tag{10}$$

4 Results

4.1 Results of the quality check

Theoretically, the maximal number of data that can be acquired between 1 January 2004 and 31 December 2010 is equal to the number of hours (61 368) in this period. Among these, approximately half are nighttime hours during which measurements are performed but give a null result that do not meet the minimum value requirement (see

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Eqs. 1, 3 and 5 above) of the QC. They are flagged accordingly. In addition, several daytime values are missing in the sets of original data because of instrumental problems or maintenance operations. In the case of El-Farafra and Barrani, the measurement period did not start in 2004 but in 2005, which contributes to increase significantly the number of missing data. In El-Arish, the data of 2010 were also discarded from the start after a visual screening because there was obviously a problem with them. Table 3 reports for each station and for each irradiation component (G, D, and B_n) the total duration (in hours) of the measurement period, the number of available (non-night and non-missing) data before QC, and the proportion of this available data that passed the QC.

Even though the number of missing data is significantly larger at Barrani than elsewhere, the proportion of existing data validated by the QC (between 88.7 and 98.8 %) is remarkably large at all sites, which emphasizes the excellent quality of the measurements performed at the EMA stations. Therefore, at seven of the eight stations, from about 18 000 to 28 000 G and D hourly values passed the QC successfully and are included in the final SUSIE database. Note that these figures correspond approximately to between 60 and 93 % of the total number of daytime hours and therefore to the theoretical maximum of possible data in this 7-year period. In the case of B_n, the number of valid data is smaller but still > 10 000 at Aswan and Cairo, and a little less (8360) at El-Farafra because the measurement period is shorter.

4.2 The SUSIE database: description and where to access it

For each of the eight surface stations, one file containing the hourly meteorological observations and another containing the hourly components of the surface irradiation performed in parallel between 2004 and 2010 can be downloaded from the Pangaea website (http://www.pangaea.de/) using a unique identifier (doi:10.1594/PANGAEA.848804). Note that to avoid any risk of confusion, two time stamps are given in UT: one at the beginning, and the other at the end, of the measuring hour. The meteorological files are self-explanatory and contain 11 columns in

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which one can find the average, start and end times of the measurements, the relative humidity (in %), the surface pressure (in hPa), the dry- and wet-bulb temperatures (in °C), the wind direction (in °, and increasing clockwise with 0° denoting the wind blowing from the north), the wind speed (in $\mathrm{m\,s^{-1}}$), and the cloud fraction (in okta).

The irradiation files are organized chronologically as the meteorological ones. They contain the measurements (in $\mathrm{MJ\,m^{-2}}$) of the global (G), diffuse (D) and for the 3 stations where it is measured, the direct normal (B_n) irradiations. Missing values are left blank. Each available measurement is flagged "0" if it has successfully passed the QC and the visual screening. Otherwise, a flag is allotted whose value indicates the reason why the data was not considered as valid. More precisely, "1" means that the measurement is outside the range of expected extreme values, "2" that the measurement is greater than rarely observed values, "3" that the measurement is greater than rarely observed values and outside the range of expected extreme values. Flag "4" indicates that though having passed the QC successfully, the measurement is suspicious because further visual screening casts doubts on its validity. Flag "5" corresponds to night values. Finally, when G, D and B_n are available simultaneously, which is only possible at the Cairo, Aswan, and El-Farafra stations, a last consistency flag of "0" if passed, or "1" otherwise is attributed.

5 Summary and perspectives

A homogeneous database of hourly meteorological variables and surface solar irradiation components has been assembled. The data cover the period January 2004 to December 2010 and originate from eight surface stations representative of the variety of geographical (coastal, urban, and desert) conditions in the Egyptian territory. These quality-checked data are available online at http://www.pangaea.de/. The data provide an insight to the spatial and temporal variability of the global, diffuse, and direct components of the solar irradiation and thus constitute a precious tool for the estimation of the potential of solar energy in Egypt. Because of their high temporal resolution, the data

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are also adapted to atmospheric studies such as the study of the impact of aerosols on atmospheric radiative transfer. In the next future, it is planned to complete regularly the present 2004–2010 database, starting with the data of the period 2011–2015, as soon as the reference radiometer is recalibrated. Thanks to this continued acquisition, longer and more adapted to climate studies time series will eventually become available in this part of the world where they are currently very scarce.

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Table 1. Name, WMO#, Location (Lat–Long), altitude (m), SSI components measured (B_n: direct at normal incidence; D: diffuse; G: global), and type of climate for the eight sites.

Site	WMO#	Lat. (°)	Lon. (°)	Alt (m)	SSI components	Station type
Barrani	62303	31.60	26.00	23.7	G, D	Mediterranean climate
Matruh	62306	31.33	27.22	25	G, D	Mediterranean climate
El-Arish	62337	31.08	33.82	27.2	G, D	Mediterranean climate
Cairo	62371	30.08	31.28	34.4	G, D, B_n	Urban influenced climate
El-Kharga	62435	25.45	30.53	77.8	G, D	Western desert climate
El-Farafra	62423	27.06	27.99	82.2	G, D, B_n	Western desert climate
Asyut	62393	27.2	31.17	52	G, D	Desert Nile climate
Aswan	62414	23.97	32.78	192.5	G, D, B_n	Desert Nile climate

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Table 2. Details of the sets of instruments implemented at the 8 experimental sites. Their accuracy (in $\mathrm{mV\,cal^{-1}\,cm^{-2}\,min^{-1}}$) and working periods are also reported.

Station	SSI	Model	Accuracy	Working period from	Working period to
(a) for the Barrani site					
Barrani	*G*	PSP	6.324	Before	31 May 2004
	D	8-48	4.782	Before	31 May 2004
	G	PSP	6.523	31 May 2004	4 Nov 2008
	D	8-48	8.122	31 May 2004	4 Nov 2008
	G	PSP	6.803	4 Nov 2008	21 Sep 2011
	D	8-48	7.943	4 Nov 2008	21 Sep 2011
(b) for the Matruh site					
Matruh	*G*	PSP	7.894	before	1 Jun 2004
	D	8-48	6.968	before	1 Jun 2004
	G	PSP	7.150	1 Jun 2004	5 Nov 2008
	D	8-48	8.251	1 Jun 2004	5 Nov 2008
	G	PSP	7.265	5 Nov 2008	22 Sep 2011
(c) for the El-Arish site					
El-Arish	*G*	PSP	7.204	27 May 2003	17 Jul 2005
	D	8-48	8.070	27 May 2003	17 Jul 2005
	G	PSP	6.064	17 Jul 2005	28 Feb 2008
	D	8-48	8.260	17 Jul 2005	28 Feb 2008
	G	PSP	8.116	28 Feb 2008	30 Apr 2009
	D	8-48	7.469	28 Feb 2008	30 Apr 2009
	G	PSP	6.551	30 Apr 2009	6 Aug 2010
	G	PSP	6.155	6 Aug 2010	29 Nov 2010
	D	8-48	6.401	6 Aug 2010	29 Nov 2010
	G	PSP	5.692	29 Nov 2010	31 Oct 2011
	D	8-48	6.995	29 Nov 2010	31 Oct 2011

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Table 2. Continued.

(d) for Cairo					
Cairo	G	PSP	7.108	before	9 Feb 2002
	D	8-48	8.513	before	7 Feb 2002
	B_n	NIP	7.608	before	9 Feb 2002
	G	PSP	7.108	9 Feb 2002	21 Apr 2005
	D	8-48	8.513	7 Feb 2002	21 Apr 2005
	B_n	NIP	7.720	9 Feb 2002	25 Apr 2005
	G	PSP	7.108	21 Apr 2005	13 Jul 2008
	D	8-48	8.513	21 Apr 2005	13 Jul 2008
	B_n	NIP	6.082	25 Apr 2005	13 Jul 2008
	G	K&Z	8.115	13 Jul 2008	10 May 2012
	D	K&Z	8.038	13 Jul 2008	8 Feb 2012
	B_n	K&Z	7.264	13 Jul 2008	8 Feb 2012
(e) for El-Kharga					
El-Kharga	G	PSP	6.707	22 Sep 2003	5 Nov 2005
	D	8-48	8.144	22 Sep 2003	5 Nov 2005
	G	PSP	6.307	5 Nov 2005	28 Dec 2008
	D	8-48	8.730	5 Nov 2005	28 Dec 2008
	G	PSP	7.168	28 Dec 2008	20 Apr 2011
	D	8-48	8.122	28 Dec 2008	20 Apr 2011
(f) for El-Farafra					
El-Farafra	G	PSP	6.410	20 Aug 2005	19 Apr 2007
	D	8-48	7.330	20 Aug 2005	19 Apr 2007
	B_n	NIP	7.608	20 Aug 2005	20 Apr 2007
	G	PSP	6.080	19 Apr 2007	23 Feb 2009
	D	8-48	8.201	19 Apr 2007	23 Feb 2009
	B_n	NIP	7.230	20 Apr 2007	22 Feb 2009
	G	Eko802	7.030	23 Feb 2009	16 May 2011
	D	8-48	8.901	23 Feb 2009	16 May 2011
	B_n	NIP	7.068	22 Feb 2009	15 May 2011

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Table 2. Continued.

(g) for Asyut					
Asyut	G	PSP	6.269	21 Sep 2003	4 Nov 2005
	D	8-48	7.779	21 Sep 2003	4 Nov 2005
	G	PSP	6.043	4 Nov 2005	27 Dec 2008
	D	8-48	7.747	4 Nov 2005	27 Dec 2008
	G	PSP	6.521	27 Dec 2008	29 Jan 2011
	D	8-48	6.972	27 Dec 2008	29 Jan 2011
(h) for Aswan					
Aswan	G	PSP	5.572	12 Oct 2003	7 Nov 2006
	D	8-48	7.073	12 Oct 2003	7 Nov 2006
	B_n	NIP	5.072	12 Oct 2003	7 Nov 2006
	G	PSP	6.375	7 Nov 2006	25 Jul 2008
	D	8-48	8.261	7 Nov 2006	25 Jul 2008
	B_n	NIP	5.603	7 Nov 2006	20 Oct 2011
	G	PSP	5.678	25 Jul 2008	20 Oct 2011
	D	8-48	7.356	25 Jul 2008	20 Oct 2011
	B_n	NIP	5.890	25 Jul 2008	20 Oct 2011

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Table 3. Duration of the period 2004–2010 (in hours), numbers of available (non-missing, non-night, non-suspicious) data for the G, D, and B_n components of the SSI. The proportion of available measurements having passed the quality check is also reported.

Site	Hours	G Data	%Pass	D Data	%Pass	B_n Data	%Pass
Barrani	61 368	13 543	89.7	13 427	91.8		–
Matruh	61 368	24 177	91.9	23 685	92.4	–	–
El-Arish	61 368	20 998	95.5	20 344	95.8	–	–
Cairo	61 368	23 481	98.5	22 284	97.4	12 939	88.7
El-Kharga	61 368	27 128	96.1	27 439	97.5	–	–
El-Farafra	61 368	19 853	97.2	18 738	91.8	8986	93.1
Asyut	61 368	28 542	98.4	28 473	98.9		–
Aswan	61 368	21 342	96.4	21 343	94.8	10 827	96.7

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Figure 1. Location of the 8 surface stations of the Egyptian Meteorological Authority (EMA) whose data are included in the SUSIE database.

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