Uncertainty assessment of satellite-based solar radiation data in the southeastern Sonoran Desert

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***Abstract*—The development of solar energy projects requires accurate estimates of solar irradiance. These data are typically obtained over arbitrary locations using geo-stationary satellite imagery, satellite-to-irradiance models, and other input sources of modeled atmospheric data. This article presents the first uncertainty assessment of this type of modeled solar radiation data for the southeastern Sonoran Desert. The assessment is performed for the hourly time scale at a single site of high quality ground measurements over the period 2019-2022 (4 years of data). Model-typical uncertainties are obtained, providing information for solar industry practitioners and research-oriented applications.**

***Index Terms*—GHI, DNI, satellite-based estimates, uncertainty, Sonoran Desert.**

I. Introduction

Solar radiation modeled data sets are a critical asset in the development of solar energy projects. Even if solar radiation measurements are available in the vicinity of the project site or in the climatically affine area of the project, there is always a need for site-specific data sets. This means that modeled data is essential, as it is almost impossible that high quality long term measured data sets will be available for the exact location of the project. However, modeled data need to be validated before they can be used [1], [2], which is usually done with at least one year of on-site measurements or with another measured data set in the affine area of the project. A second step is the site-adaptation of these modeled datasets based on ground measurements [3], which is also usually done, but not addressed in this work.

The Sonoran Desert in the state of Sonora is one of the best places in Mexico for solar energy. At its south-eastern location, the focus of this work, the annual average of daily Global Horizontal Irradiation (GHI) and Direct Normal Irradiation (DNI) are about 5.8 kWh/m^2 and 7.0 kWh/m^2 [4], respectively. Despite the region's rich solar resources, a detailed solar assessment using high quality ground measurements as a reference has not yet been carried out. In particular, the available satellite-derived solar radiation data have not yet been evaluated locally, so solar industry practitioners rely on these modeled datasets without really knowing their uncertainty. The objective of this work is then to assess the uncertainty of the solar radiation data set for this region as provided by the suppliers, without any post-processing technique. This provide valuable information for solar developers in this region. The considered site is the measuring station of "Plataforma Solar de Hermosillo (PSH)", University of Sonora, Mexico.

There are many works on the evaluation of solar satellite data, but not many of them include several models. In fact, there are only a few works worldwide that aim to benchmark such models [5]–[8], i.e. to give recommendations on which models to use and their typical uncertainty for different regions or climates. Among these works, the only one that includes a site in the Sonoran Desert is Ref. [7]. The site considered is located at the University of Arizona (ARI, [9]), Tucson, Arizona, 350 km north of the PSH site in an urban area. The other nearby arid and semi-arid sites considered in previous benchmarking work [6], [7] are the Desert Rock (DRA, SURFRAD network) and Las Vegas (LAS, University of Nevada [10]) sites in the Mohave Desert, and the Albuquerque (ALB, SOLRAD network) site on the southeastern edge of the Arizona/New Mexico Plateau. All these other stations are more than 800 km from PSH. Although they do not have exactly the same climate as PSH, the previous assessments at these sites (DRA, LAS, and ALB) provide a reasonable context for comparison with this work, in addition to the ARI site. The work in Ref. [7] covers both the GHI and DNI, while the work in Ref. [6] covers only the GHI.

In this article, three satellite GHI estimation models in the southeastern Sonoran Desert are evaluated on an hourly time basis using 4 years of data (2019-2022) from a high quality measuring station (PSH). The models considered are: (a) the National Solar Radiation Data Base (NSRDB) Physical Solar Model (PSM, version 3.2.2), (b) the Solcast commercial model, and (c) the CERES SYN1deg product of the

NASA/Power platform. For the DNI only the NSRDB/PSM product is evaluated. Quality control procedures are carefully applied to ensure a representative evaluation of the models. This is the first benchmarking initiative of solar satellite models for this specific site and the southeastern Sonoran Desert. The time base (hourly) is the same as in Refs. [6], [7], so direct comparisons can be attempted. The variability of the results is tested against different decisions in the quality criteria, leading to no significant impact in the assessment.

The article is structured as follows. Section II introduces the PSH measuring station and the solar data set. Section III describes the quality procedure applied to the measured data. Section IV gives a brief description of the models considered. Section V presents the results of the models evaluation, the comparison with previous benchmarking works in the region, and the variability of the performance metrics with different quality criteria choices. Finally, section V summarizes the main conclusions.

II. Location and Ground Data

The state of Sonora is situated in the northwest of Mexico and shares a border with the US state of Arizona. Almost half of its land is covered by the Sonoran Desert. According to the updated Köppen-Geiger climate classification [11], most of this desert is classified as BWh (hot and arid desert), except for some adjacent highlands classified as BSh (hot and arid steppe). The PSH site is situated on the southeastern border of the Sonoran Desert, at a latitude of +29.0253º and a longitude of -111.1434º, with an altitude of 165.48 m above sea level. Figure 1 displays the location of the PSH site and nearby affine stations that were previously mentioned.

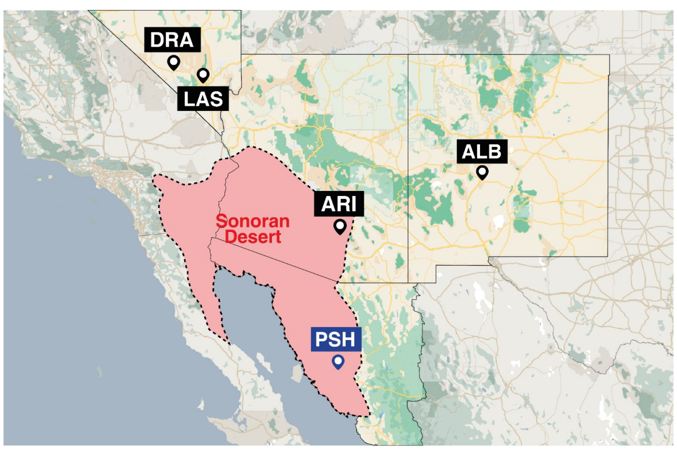

Fig. 1. Location of the PSH and other arid/semi-arid measuring stations in the affine area. The Sonoran Desert area is included as reference.

The PSH solar station is a dedicated measurement facility located on a 32 m high platform in a rural area 21 km southwest of the city of Hermosillo, Mexico. This station is part of the Mexican Solarimetric Network[1], also referred as HMO13 or HER. Solar measurements are obtained using a Kipp & Zonen Solys2 station equipped with a precision sun-tracking sensor and spectrally flat Class A radiometers according to the ISO 9060:2018 standard. Measurements of GHI and its components, DNI and DHI (Diffuse Horizontal Irradiance), are recorded at 1-minute intervals. The station is maintained daily by specialized technical staff who monitor the cleaning of the pyranometer domes and the alignment of the sun tracker.

III. Data Quality Procedure

Ensuring the quality of the measured data used for comparison is essential for any performance evaluation. A very careful quality procedure was then applied, consisting of five quality levels (A to E), which were applied sequentially to the 1-min data according to the list below.

A. Retiring data indicated as invalid in the original data set.
B. Visual inspection and manual filtering to eliminate identifiable abnormal samples.
C. Individual filters: the BSRN[2] maximum filters [12] for each solar magnitude (GHI, DHI, and DNI) using local parameters and shadow detection in a solar diagram (colored measured data in an elevation vs azimuth plot). These filters only remove data from the corresponding solar magnitude separately.
D. Two magnitudes filters: the diffuse fraction BSRN filter (f_d = GHI/DHI) and the SERI-QC [13] possible boundaries in the GHI and DNI transmittance diagram (k_t and τ_b, the ratios of GHI and DNI to their respective top of the atmosphere values, respectively). Other ad-hoc filters affecting two magnitudes were introduced in the f_d vs. k_t, the f_d vs. k_p, and the k_t vs. τ_b spaces, where k_p is the modified clearness index [14].
E. Three magnitudes filter: the BSRN filter of possible values for the ratio of measured and calculated GHI. The calculated GHI is derived from the DNI and DHI measurements with their known relationship [15].

Details of the quality procedure are given in Table I. This table shows the number of filtered samples at each level and the percentage relative to the number of original samples. This corresponds to the original 1 minute uncorrupted daylight samples (level A) with an added solar altitude filter of $\alpha_s > 7°$. As can be seen, the overall data rejection of the quality procedure is low. In total, only 2.29% (GHI), 1.47% (DHI) and 0.44% (DNI) of the data are discarded, reflecting the high quality of the data set. Fig. 2 shows two different data quality plots illustrating the samples before (level A) and after (level E) the quality procedure. The data distribution of the remaining samples (in blue) in these two spaces have a healthy shape after filtering.

IV. Models

This section presents the models that will be evaluated. The cloud information for all models is derived from GOES-East satellite imagery. This means that the main input information

[1]https://solarimetrico.geofisica.unam.mx/red/

[2]BSRN - Baseline Surface Radiation Network.

TABLE I
QUALITY PROCEDURE SUMMARY: DISCARDED SAMPLES AND PERCENTAGES AT EACH LEVEL.

	GHI		DHI		DNI	
original samples (level A)	954840		954840		954840	
filtering level	**samples**	**percentage**	**samples**	**percentage**	**samples**	**percentage**
manual filtering (level B)	17375	1.82 %	9134	0.96 %	2003	0.21 %
individual filters (level C)	908	0.10 %	2113	0.22 %	0	0 %
two magnitude filters (level D)	2241	0.23 %	1478	0.15 %	813	0.09 %
three magnitude filters (level E)	1353	0.14 %	1353	0.14 %	1353	0.14 %
complete filtering (level B to E)	21877	2.29 %	14078	1.47 %	4169	0.44 %
final number of samples	932963		940762		950671	

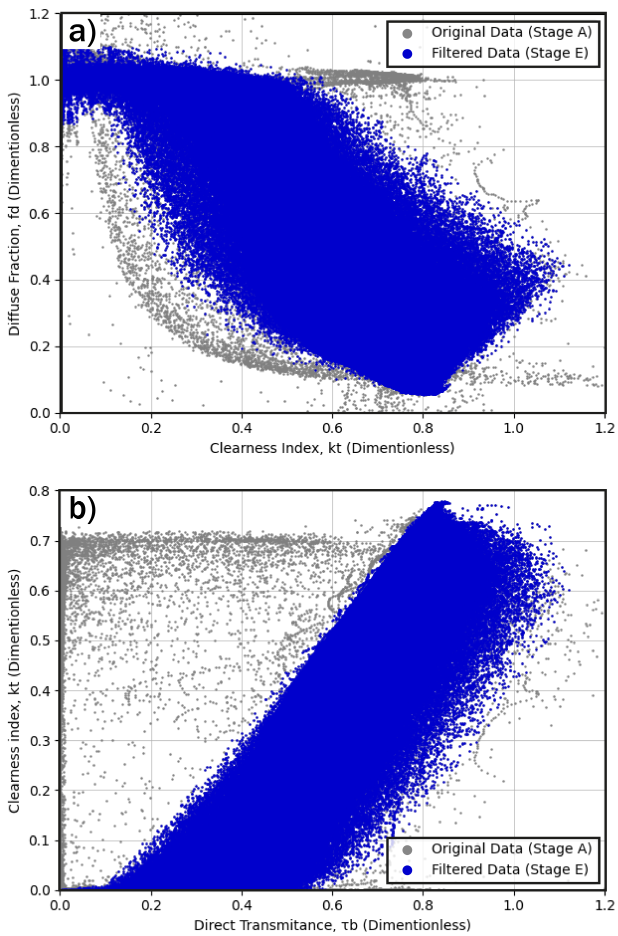

Fig. 2. Quality control diagrams. (a) f_d vs. k_t plot. (b) k_t vs. τ_b plot.

experience the same parallax effects due to the satellite viewing angle, which is known to be a significant factor affecting the performance of satellite-based solar irradiance estimation [16], [17]. Depending on the model, additional atmospheric input information from various sources is also used. Most of the estimates are available for free on their respective web portals, except for Solcast, whose data is commercial but freely available for non-commercial research use. The models are briefly introduced below.

I. *PSM v3.2.2 (NSRDB)*. The NSRDB is a two-step physical model to calculate solar radiation from cloud and aerosol properties, which are fed into a radiative transfer model (RTM). The Fast All-Sky Radiation Model (FARMS) is used to compute the GHI [18]. Estimates are available at a spatial resolution of 4 km^2 and a time rate of 5 minutes (for the PSH site). The data are publicly available at https://nsrdb.nrel.gov/.
II. *Solcast*. This is a semi-empirical model that estimates the GHI from a satellite estimation of the clear-sky index [19] (k_c, the ratio of the GHI to the corresponding clear-sky solar irradiance). The conversion is done using the REST2 clear-sky model version 5 [20] run with MERRA-2[3] atmospheric inputs. The k_c index is estimated from visible and infrared satellite imagery. The relationship between this information is proprietary. Estimates are available at 2 km^2 space resolution and 5-minute time rate.
III. *NASA-CERES*. A 1° spatial resolution RTM with hourly time steps is used to compute solar estimates [21]. Clear sky irradiance estimates are obtained by retrieving the necessary aerosol data from the Terra and Aqua Moderate Resolution Imaging Spectroradiometer (MODIS). Cloud properties for all-sky solar estimates are obtained from 3-hourly GOES satellite imagery and MODIS information (twice during the daylight period). Estimates are available at 1 degree spatial resolution and 1 hour time rate. The data are publicly available at https://power.larc.nasa.gov/.

V. RESULTS

The evaluation employs common metrics such as Mean Bias Deviation (MBD), Mean Absolute Deviation (MAD), Root Mean Squared Deviation (RMSD), and Standard Deviation (SD). Their corresponding relative values (indicated by an added "r") are calculated as a percentage of the mean measurement value, which are 544 W/m^2 for GHI and 657 W/m^2 for DNI. The relative Kolmogorov-Smirnov integral (rKSI) and rOVER metrics, as defined in Refs. [22], [23],

[3]MERRA-2 - Modern-Era Retrospective Analysis for Research and Applications version 2.

TABLE II
PERFORMANCE INDICATORS FOR EACH MODEL IN THE PSH SITE (HOURLY EVALUATION).

magnitude and models	**MBD** (W/m^2)	**MAD** (W/m^2)	**RMSD** (W/m^2)	**SD** (W/m^2)	**rMBD** (%)	**rMAD** (%)	**rRMSD** (%)	**rSD** (%)	**rKSI** (%)	**rOVER** (%)
GHI – PSM/NSRDB	+7.2	25.5	48.3	47.8	+1.3	4.7	8.9	8.8	49.1	0.0
GHI – Solcast Product	−3.4	32.3	51.0	50.9	−0.6	5.9	9.4	9.4	37.2	0.0
GHI – CERES SYN1deg	+10.7	39.0	70.8	70.0	+2.0	7.2	13.0	12.9	89.7	18.0
DNI – PSM/NSRDB	+6.7	65.6	105.1	104.8	+1.0	10.0	16.0	16.0	169.6	85.3

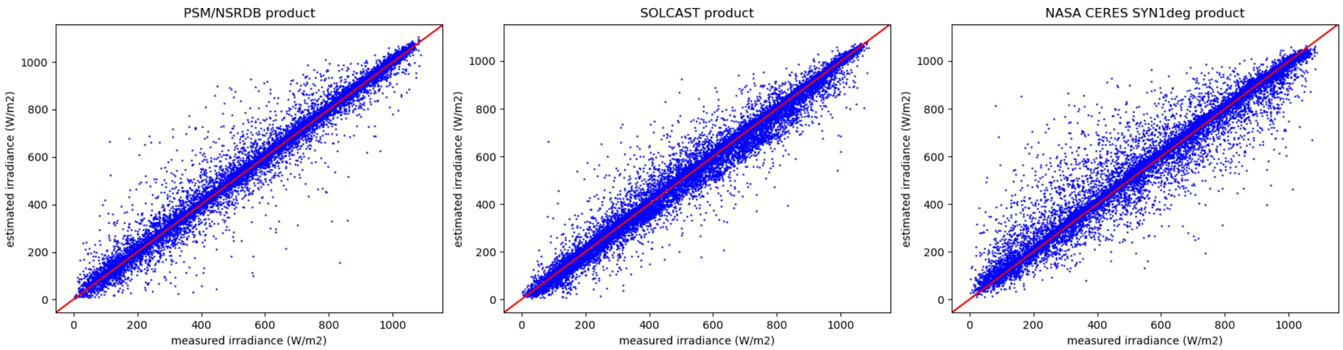

Fig. 3. Scatter plots between GHI estimates and measurements. (a) PSM/NSRDB. (b) SOLCAST. (c) CERES SYN1deg.

are also included. A broad set of metrics has been chosen to facilitate comparison with other works. Only hours with a solar elevation angle greater than 7°, evaluated at the midpoint of the hourly time interval, are considered.

A. Performance assessment

This section presents the performance assessment of the GHI and DNI satellite estimates from different data sources. The evaluation is done using the ground data that pass all filters, i.e. the last rows of Table I (level E). The quality criterion for the construction of hourly values from the 1-minute time series is to have valid data in all 60 minutes of the hour. The variability of the indicators with respect to the quality level and criteria is discussed in the Subsection V-C.

The performance metrics obtained for the GHI are presented in the first three rows of the Table II. The GHI scatter plots of the satellite estimates against the measurements are shown in Fig. 3. The Solcast and PSM models clearly outperform the CERES SYN1deg model for GHI estimation at this site, as all metrics are higher for the latter. On the other hand, PSM and Solcast have a rather similar performance and their comparison is not so straightforward, depending on the metric considered. For example, Solcast estimates have lower MBD and rKSI (bias and statistical difference), while PSM estimates have lower rMAD, rRMS and rSD (error spread). It is interesting to note that both models achieve a zero rOVER, meaning that their estimates are statistically similar to the measurements up to a 99% confidence level. The hourly indicators for the PSM and Solcast models represent a very good agreement with the quality-checked ground measurements, as the metric values are low compared to other works [5]–[7], [17], [24].

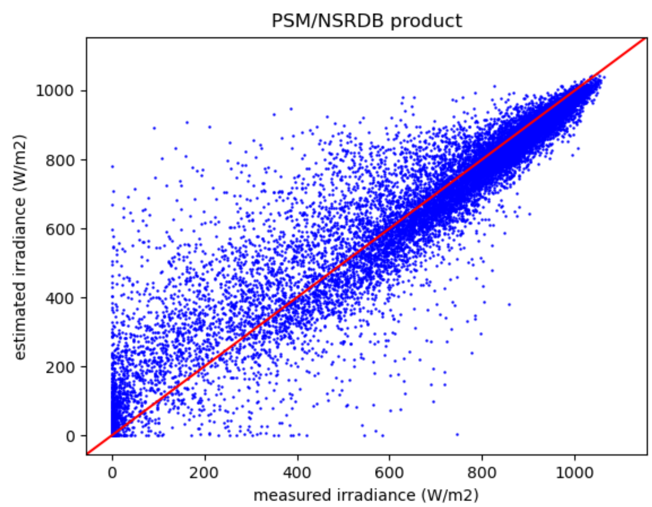

Fig. 4. Scatter plot between DNI PSM/NSRDB estimates and measurements.

The DNI performance evaluation is only done for the PSM/NSRDB satellite estimates in this work. The performance metrics for this comparison are presented in the last row of Table II and the scatter plot is shown in Fig. 4. As expected, the metrics are higher than for the GHI case because the DNI is more difficult to estimate from satellite imagery. The metrics for mean bias and error spread are relatively good, as the values are lower than typical values in other works [5], [7], [24], [25]. The statistical metrics (rKSI and rOVER) are relatively high, showing that there is still important room for improvement in DNI satellite estimation, even for a favourable site such as the PSH.

B. Comparison with previous benchmark works

Tables III and IV show the comparison with previous benchmark works in the affine domain (see stations in Fig. 1) for the GHI and DNI respectively. For the GHI, the error distributions obtained in this work are more similar to those of Ref. [6] than those of Ref. [7], but there are differences. In addition, the bias has a different sign than in most of the other cases (sites and models). For DNI, there is only one previous benchmark work to compare with [7]. The DNI bias is between the ranges of the previous work (where there are positive and negative biases), with this work being one of the lowest. The DNI error spread found in this work is lower than in the other benchmark works.

TABLE III
GHI PERFORMANCE COMPARED TO PREVIOUS BENCHMARKS AT STATIONS IN THE AREA (NSRDB GHI ESTIMATES).

		MBD (W/m^2)	**RMSD** (W/m^2)	**rMBD** (%)	**rRMSD** (%)	
DRA	NSRDB	−8.9	64.9	−1.5	10.8	Ref. [6]
DRA	CERES	−20.7	73.9	−3.4	12.3	Ref. [6]
ALB	NSRDB	+3.3	76.7	+0.6	13.6	Ref. [7]
ARI	NSRDB	−7.6	71.7	−1.1	12.7	Ref. [7]
DRA	NSRDB	−12.6	69.2	−2.2	12.2	Ref. [7]
LAS	NSRDB	−9.2	63.4	−1.6	11.1	Ref. [7]
PSH	NSRDB	+7.2	48.3	+1.3	8.9	this work
PSH	CERES	+10.7	70.8	+2.0	13.0	this work

TABLE IV
DNI PERFORMANCE COMPARED TO PREVIOUS BENCHMARKS AT STATIONS IN THE AREA (NSRDB DNI ESTIMATES).

		MBD (W/m^2)	**RMSD** (W/m^2)	**rMBD** (%)	**rRMSD** (%)	
ALB	NSRDB	+41.8	145.9	+6.2	21.6	Ref. [7]
ARI	NSRDB	+12.1	129.7	+1.8	19.0	Ref. [7]
DRA	NSRDB	−18.6	133.8	−2.5	17.8	Ref. [7]
LAS	NSRDB	+1.0	127.5	+0.1	17.6	Ref. [7]
PSH	NSRDB	+6.7	105.1	+1.0	16.0	this work

These differences are not large, but they are noticeable. They can be explained by the different location of the sites (in particular differences in cloud regime, frequency and intermittency), the time period of the comparisons and/or the quality procedures applied in the different works. A difference in performance due to location is valid and understandable. On the other hand, the field of solar resource assessment needs to further investigate performance differences due to time periods or quality procedures in order to have more robust evaluations of satellite estimates. As a first step, the next subsection examines the extent to which the quality procedure used in this work affects the metrics.

C. Variability with quality criteria

For simplicity, the analyses presented in this subsection are carried out for the GHI and DNI satellite estimates of the NSRDB data provider.

The first analysis deals with the different filtering criteria, i.e. at what point the applied incremental filters affect the performance metrics. In this work, we choose incremental filters as shown in Table I, conceptually ordered as: originally annotated invalid data, manual filtering by detailed visual inspection, univariate independent filters for each quantity (GHI, DHI, DNI), bivariate filters involving two quantities as a pair, and tri-variate filters involving the three quantities. Each of these is called a "level". The automatic filters (levels C to E) are versions of the well-known BSRN and SERI-QC filters, locally adapted to the data. The hourly values for this test are only generated from the 1 minute time series if all 60 minutes are available.

Tables V and VI show the metrics found at each level for GHI and DNI respectively. The metric values are shown in the upper part of the tables, while the performance degradations with respect to level E are shown in the lower part. As expected, all performance degradations are positive when the quality procedure is relaxed. Using data with almost no quality procedure (level A) produces much larger performance metrics for GHI than the other levels, and larger for DNI, which in this work required less filtering (see Table I), especially manual filtering, as the station tracking alignment is well maintained. In any case, it is clear that almost no quality control leads to increased unrepresentative metrics. It is interesting to note that this unrecommended practice leads to a large range for the GHI metrics, which includes with a large margin all the variability of Table V. However, this is not the case for DNI (well maintained at this station, so little quality filtering required), reinforcing the idea that an important part of the performance differences with other benchmarking works can be explained by the location of the site, the time period chosen, or the quality procedures used in other works, rather than the quality procedure used in this work.

Looking at the levels from B to E, the rMBD is slightly affected, varying by a maximum of $+0.1\%$ for GHI and $+0.2\%$ for DNI. The rRMSD varies more, but only differences of $+0.6\%$ for GHI and of $+0.4\%$ for DNI can be explained by the different quality levels. The differences in rKSI are also small, with a maximum of $+3.5\%$ and $+4.2\%$ for GHI and DNI respectively. This analysis shows that it is possible to refine the performance metrics in this work with the automatic filters applied, but cannot explain the differences with other benchmarking works. Please note that this is true for this work, as the manual filtering has been done thoroughly and with great attention to detail, and may not be the case when only automatic filters are used for the quality procedure. The general conclusion is that the performance metrics in this work are robust to the choice of quality filters, especially the automatic ones.

Another analysis concerns the number of valid 1 minute data within the hour that must be available to generate the hourly value. This choice can vary from requiring all the 60 minutes in the hour (very strict approach) to not including any criteria in this sense (very relaxed approach). Tables VII and VIII show the analysis varying the minimum percentage of 1 minute

TABLE V
VARIATION IN PERFORMANCE INDICATORS ACROSS THE QUALITY PROCEDURE (NSRDB GHI ESTIMATES).

different quality criteria	**MBD** (W/m^2)	**MAD** (W/m^2)	**RMSD** (W/m^2)	**SD** (W/m^2)	**rMBD** (%)	**rMAD** (%)	**rRMSD** (%)	**rSD** (%)	**rKSI** (%)	**rOVER** (%)
level A (with original samples)	+15.0	33.7	81.3	79.9	+2.8	6.3	15.3	15.0	105.3	22.3
level B (with manual filtering)	+7.6	26.5	51.2	50.6	+1.4	4.9	9.5	9.4	52.6	0.0
level C (with GHI univariate filter)	+7.6	26.3	50.5	49.9	+1.4	4.9	9.3	9.2	52.6	0.0
level D (with bivariate filters)	+7.3	25.7	48.8	48.3	+1.3	4.7	9.0	8.9	49.8	0.0
level E (with all filters)	+7.2	25.5	48.3	47.8	+1.3	4.7	8.9	8.8	49.1	0.0
performance degradation (A to E)	+7.8	+8.2	+33.0	+32.1	+1.5	+1.6	+6.4	+6.2	+56.2	+22.3
performance degradation (B to E)	+0.4	+1.0	+2.9	+2.8	+0.1	+0.2	+0.6	+0.6	+3.5	0
performance degradation (C to E)	+0.4	+0.8	+2.2	+2.1	+0.1	+0.2	+0.4	+0.4	+3.5	0
performance degradation (D to E)	+0.1	+0.2	+0.5	+0.5	0	0	+0.1	+0.1	+0.7	0

TABLE VI
VARIATION IN PERFORMANCE INDICATORS ACROSS THE QUALITY PROCEDURE (NSRDB DNI ESTIMATES).

different quality criteria	**MBD** (W/m^2)	**MAD** (W/m^2)	**RMSD** (W/m^2)	**SD** (W/m^2)	**rMBD** (%)	**rMAD** (%)	**rRMSD** (%)	**rSD** (%)	**rKSI** (%)	**rOVER** (%)
level A (with original samples)	+8.7	67.4	110.7	110.3	+1.3	10.3	17.0	16.9	176.6	92.2
level B (with manual filtering)	+7.6	66.5	107.1	106.9	+1.2	10.2	16.4	16.4	174.0	89.1
level C (with DNI univariate filter)	+7.6	66.5	107.1	106.9	+1.2	10.2	16.4	16.4	174.0	89.1
level D (with bivariate filters)	+7.5	66.3	106.3	106.0	+1.1	10.2	16.3	16.2	173.0	88.2
level E (with all filters)	+6.7	65.6	105.1	104.8	+1.0	10.0	16.0	16.0	169.6	85.3
performance degradation (A to E)	+2.0	+1.8	+5.6	+5.5	+0.3	+0.3	+1.0	+0.9	+7.0	+6.9
performance degradation (B to E)	+0.9	+0.9	+2.0	+2.1	+0.2	+0.2	+0.4	+0.4	+4.2	+3.7
performance degradation (C to E)	+0.9	+0.9	+2.0	+2.1	+0.2	+0.2	+0.4	+0.4	+4.2	+3.7
performance degradation (D to E)	+0.8	+0.7	+1.2	+1.2	+0.1	+0.2	+0.3	+0.2	+3.4	+2.9

TABLE VII
CHANGE IN GHI PERFORMANCE ASSESSMENT (NSRDB) WITH VARYING 1 MINUTE MISSING DATA THRESHOLD FOR HOURLY CALCULATION.

missing data threshold	**rMBD** (%)	**rRMSD** (%)	**rKSI** (%)
100% (complete)	+1.3	8.9	49.1
80%	+1.3	9.3	50.6
60%	+1.4	9.3	51.2
40%	+1.4	9.4	51.2
20%	+1.4	9.4	51.2
0% (no check)	+1.4	9.4	51.2

TABLE VIII
CHANGE IN DNI PERFORMANCE ASSESSMENT (NSRDB) WITH VARYING 1 MINUTE MISSING DATA THRESHOLD FOR HOURLY CALCULATION.

missing data threshold	**rMBD** (%)	**rRMSD** (%)	**rKSI** (%)
100% (complete)	+1.0	16.0	169.6
80%	+1.1	16.2	172.7
60%	+1.1	16.3	173.5
40%	+1.1	16.3	173.8
20%	+1.1	16.3	174.1
0% (no check)	+1.1	16.3	174.2

data required to generate the hourly value. It can be seen that for these datasets the impact of this decision on the metrics is small. For both quantities (GHI and DNI) the maximum variation in rMBD is 0.1%. The maximum degradation of rRMSD for different choices in this respect is 0.5% for GHI and 0.3% for DNI. Similarly, the maximum variation in rKSI is 2.1% and 4.6% for GHI and DNI respectively. This analysis shows that this choice cannot explain large differences in this work, so this issue is not behind the differences between other benchmark works.

The analysis of this subsection shows that the choices made in the quality procedures of this work do not explain the differences with the other benchmark works in the affine region. Thus, the differences can be explained by the location of the site (differences in the cloud regime with the other sites), the time span of the studies or the quality criteria in the other works. Further work is needed to better understand these differences in this arid and semi-arid area, which has a similar climate.

VI. CONCLUSIONS

This article provides a performance evaluation of satellite-based models for the hourly estimation of GHI and DNI in the southeastern Sonoran Desert. The results show that the PSM/NSRDB and Solcast estimates provide better quality modelled datasets than the CERES SYN1deg product. The results are reasonably consistent with previous assessments in the broad arid and semi-arid affine region (Sonoran Desert, Mohave Desert, and Arizona/New Mexico Plateau), with some differences. As the different studies are not easily comparable due to different locations, time periods and quality procedures between works, a benchmarking initiative for the region is still needed, and this study is a first step in that direction. This work also shows that the quality criterion of this work does not significantly affect the informed metrics, so one dimension of the problem can be discarded.

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