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Article

Parametric Clear-Sky Solar Irradiance Model with Improved Diffuse Flux Estimation

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Abstract

Balancing accuracy and accessibility in solar energy flux estimation models remains a key challenge in atmospheric radiative transfer research. Since spectral models require computationally intensive spectral calculations, a widely adopted simplification strategy is to parameterize atmospheric spectral transmittances using various wavelength-averaging formulations. This work introduces a broadband parametric model derived from a spectral model that accurately estimates the three components of solar irradiance, direct normal, diffuse, and global under clear-sky conditions. The procedure used to develop the model is structured in two stages. Initially, discrete broadband transmittances are obtained by applying an independent integration scheme to the spectral transmittances provided by the source spectral model. The second stage involves fitting these results to obtain continuous broadband atmospheric transmittances, expressed as analytical functions depending solely on atmospheric state parameters and remaining independent of wavelength. The model development procedure is relatively classical; however, the calculation of the diffuse component introduces a new approach for estimating the fraction of aerosol scattering directed toward the ground. The model was tested against data collected from eight radiometric stations distributed across six continents and benchmarked against two well-established reference models. Overall, the results indicate a high level of accuracy and demonstrate the practical applicability of the model.

Keywords: solar irradiance; parametric model; spectral model

1. Introduction

In the current energy landscape, solar energy is becoming increasingly important in the context of reducing carbon dioxide emissions associated with electricity generation from conventional sources such as coal and natural gas [1]. The generation of electricity through photovoltaic panels is subject to unpredictable fluctuations due to meteorological variability and climate change. To enhance solar energy predictability, models for solar resource estimation and forecasting play a central role in improving predictability [2]. The maximum potential of photovoltaic energy conversion is achieved under clear-sky conditions. Consequently, models designed to estimate solar energy flux on the surface under such conditions have attracted significant attention in solar engineering [3]. To date, more than one hundred clear-sky irradiance models have been proposed, ranging from simple formulations based exclusively on solar geometry [4], to highly sophisticated models comprising dozens of equations and requiring detailed atmospheric and meteorological inputs [5–7]. These approaches fall within the class of parametric models, which estimates solar irradiance based on atmospheric state variables and solar geometry, without explicit dependence on wavelength.

A physical class of models known as spectral models expresses the solar irradiance as a function of solar radiation wavelength [8,9]. Spectral models offer higher accuracy but require substantially greater computational effort.

This work presents a parametric model derived from a spectral reference, specifically the Leckner model [8]. The methodology builds on an independent integration scheme originally introduced by Molineaux and Ineichen [10]. The resulting model features a compact analytical formulation, minimal computational requirements, and an accuracy comparable to that of other widely used models in the field. Its key distinguishing feature is a novel approach for estimating the diffuse component of irradiance resulting from aerosol scattering.

This paper is organized as follows. In the second section, the steps undertaken in developing the model and the defining equations of the model itself are presented. In the third section its performance is evaluated through comparison with measured data and two widely accepted broadband models, namely REST2 [5] and McClear [11], across eight stations situated in distinct climatic zones. The main conclusions are presented in the final Section.

2. Proposal for a New Clear Sky Solar Irradiance Model

The source model is the Leckner spectral model [8], which estimates the three components of spectral solar irradiance at ground level under clear-sky conditions: direct, diffuse, and global. The Leckner model accounts for five attenuation factors affecting solar radiation as it passes through the Earth's atmosphere: ozone absorption, water vapor absorption, absorption by the mixed gases, Rayleigh scattering, and aerosol attenuation. Corresponding to each attenuation factor, a specific atmospheric transmittance is defined, which depends on wavelength and, where applicable, on the parameter that quantifies the respective attenuating factor.

The transmittance due to ozone absorption is defined by

$$\tau_{O_3}(\lambda) = \exp(-mlK(\lambda)) \quad (1)$$

where λ is the wavelength, $K(\lambda)$ [cm^{-1}] the ozone absorption coefficients [8], l [$cm \cdot atm$] the total column ozone content and m the optical atmospheric mass.

The transmittance associated with water vapor absorption is given by

$$\tau_w(\lambda) = \exp\left(\frac{-0.2385m_w(\lambda)}{(1+20.07mw_w(\lambda))^{0.45}}\right) \quad (2)$$

where $K_w(\lambda)$ [$cm^2 g^{-1}$] denotes the water vapor absorption coefficients [8] and w [$cm^{-2} g$] is the total column water vapor content.

The transmittance associated with mixed gases absorption is given by

$$\tau_g(\lambda) = \exp\left(\frac{-1.41mK_g(\lambda)}{(1+118.3mK_g(\lambda))^{0.45}}\right) \quad (3)$$

where $K_g(\lambda)$ km^{-1} is the absorption coefficients associated with mixed gases [8].

The transmittance associated with Rayleigh scattering is given by

$$\tau_R(\lambda) = \exp(-0.008735 \cdot \lambda^{-4.08} mp/p_0) \quad (4)$$

where p is the atmospheric pressure and p_0 the normal atmospheric pressure. $\tau_R(\lambda)$ is a continuous function of wavelength.

The transmittance associated with aerosols attenuation is given by

$$\tau_a(\lambda) = \exp(-m\beta\lambda^{-\alpha}) \quad (5)$$

Here, α is the Ångström exponent, and β is the turbidity coefficient; together, they define the optical properties of aerosols content in the atmosphere. The function $\tau_a(\lambda)$ is also continuous function of wavelength.

The Leckner model calculates the direct normal solar irradiance at ground level by applying the product of the transmittances to the spectral solar irradiance at the top of the atmosphere $G_{ext}(\lambda)$:

$$DNI(\lambda) = G_{ext}(\lambda) \cdot \tau_R(\lambda) \cdot \tau_{O_3}(\lambda) \cdot \tau_g(\lambda) \cdot \tau_w(\lambda) \cdot \tau_a(\lambda) \quad (6)$$

The diffuse irradiance is evaluated as:

$$G_d(\lambda) = \gamma \cdot G_{ext}(\lambda) \cdot \tau_w(\lambda) \cdot \tau_g(\lambda) \cdot \tau_{O_3}(\lambda) \cdot (1 - \tau_R(\lambda) \cdot \tau_a(\lambda)) \cdot \cos(\theta_z) \quad (7)$$

In this equation $\gamma = 1/2$ is the downward fraction of the scattered radiation and θ_z is the zenithal angle.

Finally, the global spectral irradiance on a horizontal surface is obtained by summing the horizontal projection of the direct normal component and the diffuse component:

$$G(\lambda) = DNI(\lambda) \cdot \cos(\theta_z) + G_d(\lambda) \quad (8)$$

The development of our parametric model for estimating solar energy flux under clear-sky conditions follows a two-stage procedure.

In the first stage, discrete broadband transmittances are derived by independently integrating scheme applied to the spectral transmittances from the source spectral model.

$$\bar{\tau}_k = \frac{\int_0^\infty G_{ext}(\lambda) \tau_k(\lambda) d\lambda}{\int_0^\infty G_{ext}(\lambda) d\lambda} \quad (9)$$

In this integral [10], which represents a weighted average of the spectral transmittance by the extraterrestrial spectral irradiance, the index k denotes the five attenuation processes included in the source spectral model.

In the second stage, the discrete broadband transmittances obtained by integrating over wavelength were fitted with continuous functions, whose independent variables are the optical atmospheric mass and parameters characterizing the atmospheric attenuation factors. The resulting functions that define the broadband transmittances in the proposed model are:

$$\bar{\tau}_{O_3}(m, l) = \frac{1 - 0.01543 \cdot l^{0.25} - 0.0001372 \cdot m^{0.75} - 0.03896 \cdot (ml)^{0.68}}{1 - 0.01446 \cdot l^{0.1} + 0.001042 \cdot m^{0.15} - 0.01346 \cdot (ml)^{0.28}} \quad (10)$$

$$\bar{\tau}_w(m, w) = \frac{1 + 0.1221107 \cdot w^{0.36} + 0.0097977 \cdot m + 0.524285 \cdot (mw)^{0.26}}{1 + 0.1287524 \cdot w^{0.37} + 0.0098063 \cdot m + 0.6960652 \cdot (mw)^{0.3}} \quad (11)$$

$$\bar{\tau}_g(m) = \exp(-0.01328 \cdot m^{0.35} + 0.00001137 \cdot m^{2.1}) \quad (12)$$

$$\bar{\tau}_R(m) = \exp(0.0033062 \cdot m^{1.9} - 0.10135 \cdot m^{0.85}) \quad (13)$$

$$\bar{\tau}_a(m, \alpha, \beta) = 0.3571e^{-m\beta^{0.45-\alpha}} + 0.4276e^{-m\beta^{0.82-\alpha}} + 0.2135e^{-m\beta^{1.78-\alpha}} \quad (14)$$

Here, as in Leckner's work, the extraterrestrial spectral irradiance at the mean Sun-Earth distance, along with the corresponding spectral intervals published by Thekaekara [12], are used.

The calculation of the direct normal broadband irradiance remains consistent with the methodology established by the source spectral model:

$$DNI = G_{CS} \cdot \varepsilon(J) \cdot \bar{\tau}_{O_3}(m, l) \cdot \bar{\tau}_R(m) \cdot \bar{\tau}_g(m) \cdot \bar{\tau}_w(m, w) \cdot \bar{\tau}_a(m, \alpha, \beta) \quad (15)$$

In this equation $G_{SC} = 1361.1 \text{ W/m}^2$ is the solar constant and $\varepsilon(J)$ the Spencer correction for Earth's orbital eccentricity [13] with J being the Julian day.

The calculation of the diffuse irradiance component in the proposed model no longer follows the formulation given in Equation (7) of the source Leckner model. Instead, the diffuse irradiance is constructed as the sum of two distinct contributions: one associated with Rayleigh scattering by air molecules and the other corresponding to aerosol scattering [14]. The multiply reflected radiation between the ground and the atmosphere was neglected.

$$G_d = \gamma \cdot G_{CS} \cdot \varepsilon(J) \bar{\tau}_{O_3}(m, l) \bar{\tau}_g(m) \bar{\tau}_w(m, w) (1 - \bar{\tau}_R(m)) \bar{\tau}_a(m, \alpha, \beta) \cos(\theta_z) + F_c \omega_0 G_{CS} \cdot \varepsilon(J) \bar{\tau}_{O_3}(m, l) \bar{\tau}_g(m) \bar{\tau}_w(m, w) (1 - \bar{\tau}_a(m, \alpha, \beta)) \bar{\tau}_R(m) \cos(\theta_z) \quad (16)$$

In the first term of Equation (16), corresponding to Rayleigh scattering, the fraction of scattering directed toward the ground is taken as $\gamma = 1/2$, as in the Leckner model. In the second term, associated with aerosol scattering, ω_0 represents the single-scattering albedo, while F_c denotes the fraction of aerosol scattering directed toward the ground.

The aerosol scattering downward fraction is modeled using two components: one that depends on the air mass through the sine of the Sun's elevation angle h , and another obtained by integrating the Henyey-Greenstein phase function [15] up to the Sun's elevation angle. The resulting analytical expression is given by

$$F_c = \left(\frac{1}{\sin h} \right)^{0.5} \frac{1-g^2}{2g} \left(\frac{1}{1-g} - \frac{1}{\sqrt{1+g^2-2g \cos h}} \right) \quad (17)$$

Here, g is the asymmetry factor.

To the best of our knowledge, this formulation provides a novel analytical expression for the downward aerosol scattering fraction, as it consistently incorporates both the optical atmospheric mass dependence and the solid angle restriction of the scattered radiation reaching ground level.

The broadband global horizontal is the sum of direct and global components:
$$G = DNI \cdot \cos(\theta_z) + G_d \quad (18)$$

We will refer to the proposed model, defined by equations (10–18), as the Clear-Sky Multivariable Model, hereafter abbreviated as CSMV.

3. Model Accuracy

In this section, the proposed model (CSMV) is validated by applying it to measured data and by comparing its performance with that of two reference models: REST2 [5] and McClear [11].

3.1. Dataset

The performance of all three models was evaluated against measurements from eight stations across various climate zones. Each selected location hosts both a radiometric Baseline Surface Radiation Network (BSRN) station [16] and an Aerosol Robotic Network (AERONET) station [17]. Radiometric data were obtained from BSRN, while atmospheric parameters such as the Ångström turbidity coefficient (β), Ångström exponent (α), and water vapor column content (w) were retrieved from AERONET. The geographical coordinates of the stations, the Köppen-Geiger climate zone [18], and the number of records available at each station are provided in Table 1.

Table 1. Summary of stations from which data were collected. N denotes the number of records available from each station. The climate zone is indicated according to the Köppen-Geiger classification.

Station	Climate	BSRN index	BSRN station			AERONET station			N
			Lat. [deg]	Long. [deg]	Alt. [m]	Lat. [deg]	Long. [deg]	Alt. [m]	
Bondville (USA)	Dfa	BON	40.06	-88.36	213	40.06	-88.36	213	275
Boulder (USA)	Dfb	BOU	40.05	-105.0	1577	40.05	-105.0	1577	279
Carpentras (France)	Csa	CAR	44.08	5.05	100	44.08	5.05	100	315
Darwin (Australia)	Aw	DAR	-12.42	130.89	30	-12.42	130.89	30	216
Fukuoka (Japan)	Cfa	FUA	33.58	130.37	3	33.58	130.37	3	122
Gobabeb (Namibia)	Bsh	GOB	-23.56	15.04	407	-23.56	15.04	407	453
Palaiseau (France)	Cfb	PAL	48.71	2.20	156	48.70	2.20	156	281
Petrolina (Brazil)	Bsh	PTR	-9.07	-40.32	387	-9.07	-40.32	387	65

The spatial distribution of the eight selected stations is depicted in Figure 1.

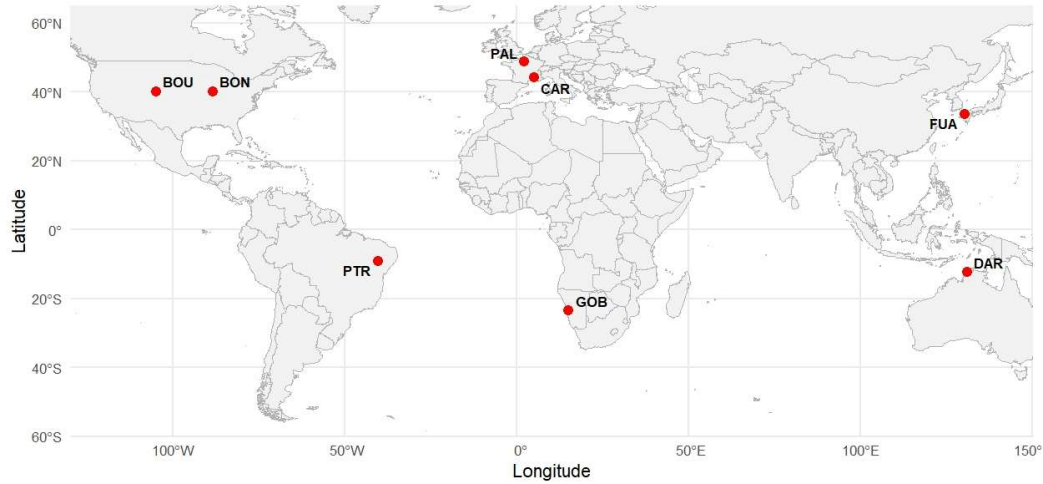


Figure 1. Location on the world map of the stations from which data were collected. Each station is indicated by the BSRN index.

3.2. Results

The accuracy of the proposed model is assessed by comparison with two existing models: REST2 [5], a complex and highly regarded model, and McClear [11], a black-box model that requires only geographic coordinates as input and provides a convenient and robust estimation framework, although its accuracy may be lower than that of more physically detailed models. The REST2 model [5] was developed using the same independent integration scheme as our model; however, its parameterization is based on the SMARTS2 spectral model [9]. This parameterization is performed over two disjoint spectral bands: the ultraviolet-visible (UV-VIS) band (0.29 – 0.70 μm) and the infrared band (IR) band (0.70 – 4.0 μm). REST2 is widely recognized as one of the most accurate and robust models for clear-sky solar irradiance estimation [3]. In contrast, the McClear model [11] is less accurate but distinguished by its operational simplicity, requiring only the user's geographic coordinates to produce estimates. It is a physical model based on look-up-tables established with the radiative transfer model libRadtran. Although McClear can operate as a standalone model, it is most commonly employed in conjunction with CAMS-derived inputs, including three-hourly aerosol properties and daily total column contents of water vapor and ozone [19].

The accuracy of CSMV, REST2, and McClear was assessed using two statistical indicators commonly employed in solar radiation modeling: the normalized root mean square error (nRMSE) and the normalized mean bias error (nMBE).

$$nRMSE = 100 \times \frac{(N \sum_{i=1}^N (c_i - m_i)^2)^{1/2}}{\sum_{i=1}^N m_i} \quad (18)$$

$$nMBE = 100 \times \frac{\sum_{i=1}^N (c_i - m_i)}{\sum_{i=1}^N m_i} \quad (19)$$

In the equations above, c and m denote the computed and measured values, respectively, while N represents the sample size.

Figure 2 presents the results of testing CSMV, REST2, and McClear models for the estimation of direct-normal irradiance (DNI) across all eight stations. Visually, it can be observed that the performance of the CSMV model closely matches that of REST2. Notably, at the Palaiseau station, CSMV demonstrates the highest accuracy among all models.

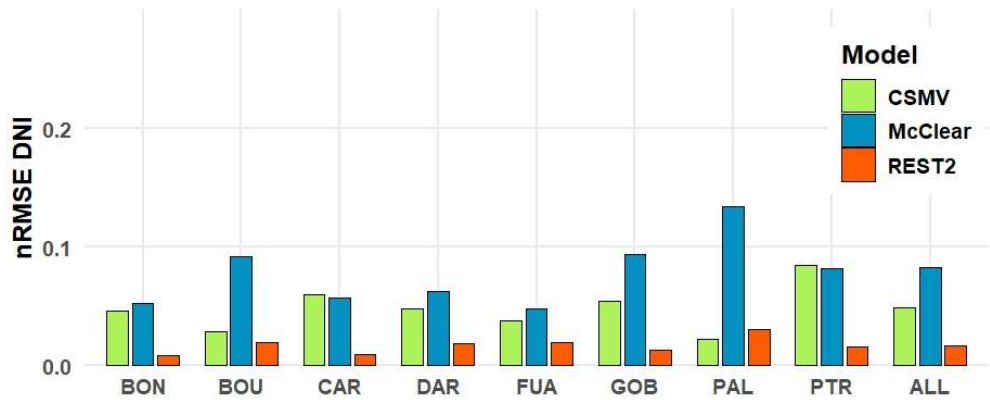


Figure 2. The statistical indicator, nRMSE, of accuracy for the estimation of direct-normal irradiance (DNI) under clear-sky conditions with the new model CSMV and the reference models REST2 and McClear.

The normalized root mean square error (nRMSE) values for the CSMV model range from 2.20% to 8.45%. In comparison, the REST2 model yields lower nRMSE values, between 0.84% and 3.00%. Conversely, the user-friendly McClear model exhibits higher nRMSE values, ranging from 4.82% to 13.37%.

In terms of the normalized mean bias error (nMBE), the CSMV model produces values from 1.89% to 8.31%. Since all the values are positive, the model shows a tendency to overestimate DNI, a trend also visible in Figure 5.

Figure 3 presents the results of testing CSMV, REST2 and McClear models in estimating the diffuse solar irradiance across all eight stations. The diffuse component is widely recognized as the most challenging to estimate due to its strong dependence on atmospheric scattering. Despite this, the performance of the CSMV model remains close to that of REST2 at four out of the eight stations. Moreover, at the Bondville and Gobabeb stations, CSMV demonstrates the highest accuracy among the three models. The normalized root mean square error (nRMSE) values for CSMV range from 7.27% to 20.35%, while REST2 achieves lower nRMSE values between 4.24% and 19.90%. In contrast, the McClear model yields significantly higher nRMSE values, ranging from 7.35% and 36.72%.

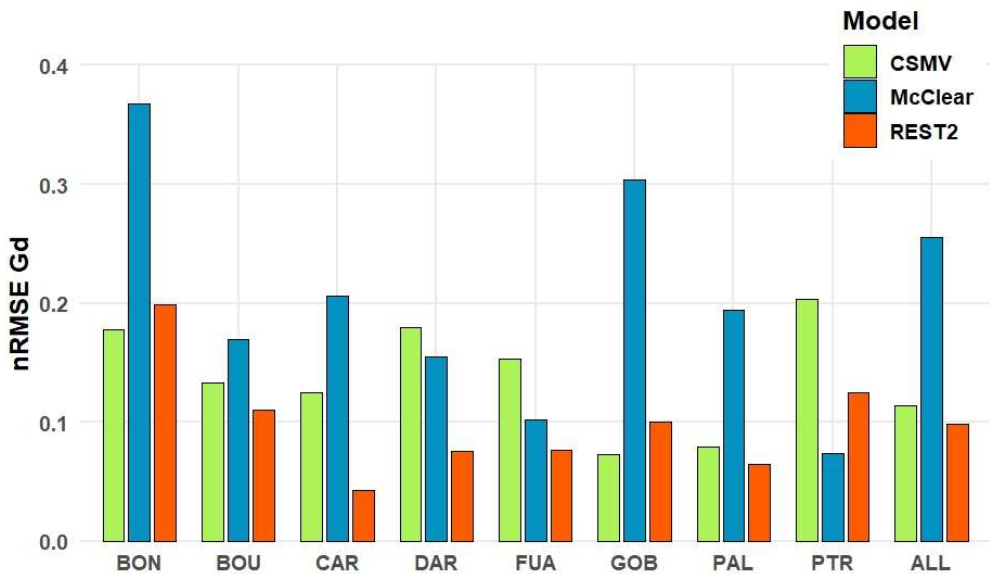


Figure 3. The statistical indicator, nRMSE, of accuracy for the estimation of diffuse irradiance (Gd) under clear-sky conditions with the new model CSMV and the reference models REST2 and McClear.

The proposed CSMV model yields good performance, with nRMSE values of approximately 7% at the Palaiseau and Gobabeb stations, which together contribute more than 700 out of the 2,000 data samples used in the evaluation. Notably, the Palaiseau station is distinguished by the highest atmospheric turbidity coefficient β , whereas the Gobabeb station is characterized by comparatively high atmospheric turbidity and Ångström exponent α values. The influence of atmospheric turbidity on collectable solar energy is substantial and cannot be neglected in solar resource assessment [20]. Also, a strong dependence of the diffuse-to-direct beam irradiance ratio on the Ångström exponent has been established in Reference [21]. The atmospheric conditions (relatively high turbidity) at these two stations indicate a higher contribution of diffuse irradiance to the global irradiance, under which the proposed CSMV model appears to estimate this component more accurately. For the ALL dataset, the resulting nRMSE is 11.4%, which is close to the value obtained with the REST2 model (9.82%). Given that the diffuse solar irradiance represents the most challenging component to estimate, this level of accuracy confirms the robustness of the proposed approach. For comparison, the parametric model SPARTA, validated using radiometric data from three locations, reports an nRMSE of 10% [7].

Figure 4 presents the results of testing CSMV, REST2 and McClear in estimating the global solar irradiance across all stations. The nRMSE values achieved by the CSMV model fall within the range of 2.88% to 5.77% demonstrating consistent and accurate performance under various conditions. In comparison, REST2 yields slightly lower nRMSE values, ranging from 0.92% to 4.49%. The McClear model shows a similar degree of accuracy for this component, with nRMSE values between 1.73% and 7.59%. Accurate estimates (nRMSE < 10%) of the global solar irradiance component obtained with the McClear model were reported in a study using measurements from 13 sites in South Africa [22]. All three models provide highly accurate estimates of the global component, with nRMSE values remaining below 8%.

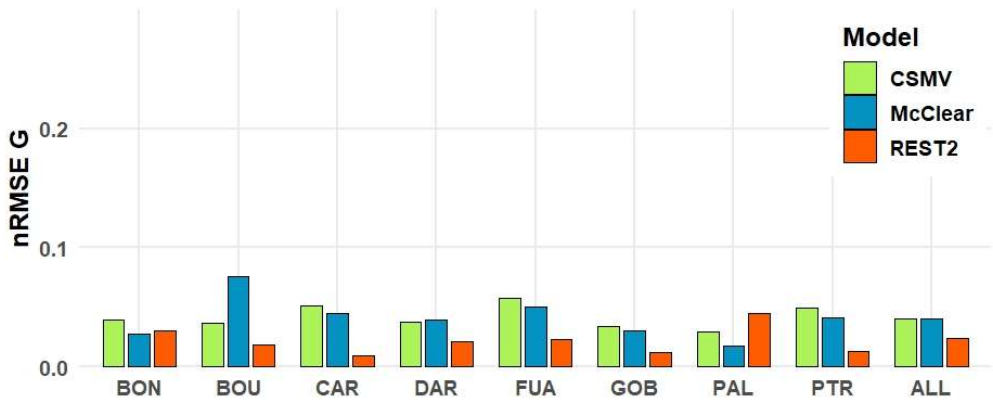


Figure 4. The statistical indicator, nRMSE, of accuracy for the estimation of global irradiance (G) under clear-sky conditions with the new model CSMV and the reference models REST2 and McClear.

The complete set of results employed for generating the graphs is provided in the table found in Appendix.

The proposed CSMV model appears to offer a balanced trade-off between performance and accessibility. In this context, accessibility refers to both the effort required to obtain the necessary input data, and the computational time needed to implement the model equations.

Following the station-by-station performance analysis, it is appropriate to provide an overall assessment of the CSMV model’s capabilities across all tested locations.

Figure 5 illustrates the average performance of the CSMV model across all stations, with estimates of direct normal irradiance plotted against the corresponding measured data. Visual inspection confirms the strong agreement between estimated and observed data.

When aggregated over all stations (labelled as “ALL” in Figure 2), the CSMV model achieves a nRMSE of 4.89% and nMBE of 4.34%, indicating consistent and moderately positive bias in the estimates.

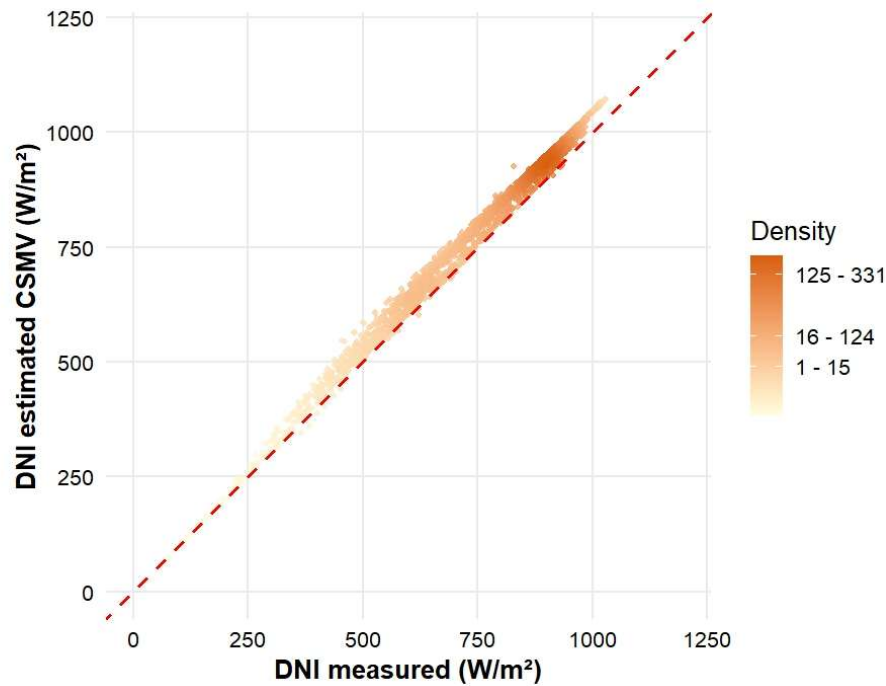


Figure 5. Comparison between modeled and measured direct normal irradiance (DNI) on ALL dataset, with the proposed CSMV.

Figure 6 focuses on the diffuse component of solar irradiance, showing CSMV estimates plotted against the corresponding measured values. Visual inspection reveals increased difficulty in accurately estimating this component.

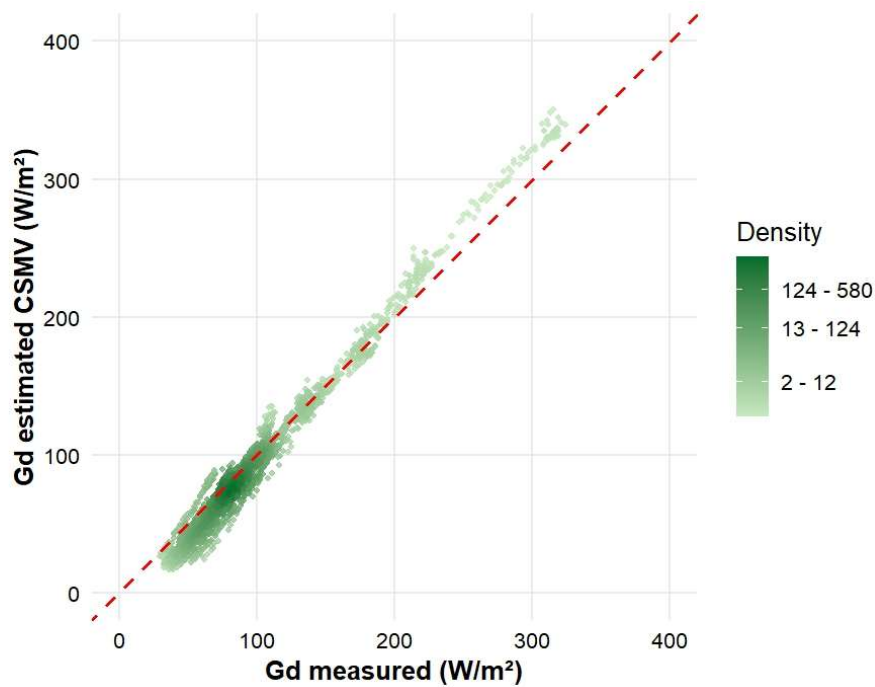


Figure 6. Comparison between modeled and measured diffuse horizontal irradiance (Gd) on ALL dataset, with the proposed CSMV.

When averaged across all stations (labelled as “ALL” in Figure 3), the model yields a nRMSE of 11.40% and a nMBE of –4.31%, indicating a moderately underestimation. This negative bias is most pronounced at low diffuse irradiance values, likely due to the complex and variable nature of atmospheric scattering.

Figure 7 presents the global irradiance values estimated by the CSMV model in comparison with measured values from the aggregated dataset (labelled “ALL” in Figure 4). For global irradiance, the model achieves a normalized root mean square error (nRMSE) of 3.99% and a normalized mean bias error (nMBE) of 2.86%, indicating strong overall agreement. Visual inspection suggests that the estimation quality is generally high, likely due to a compensatory effect: the overestimation of the direct-normal component partially offsets the underestimation of the diffuse component, resulting in improved accuracy for the global irradiance values.

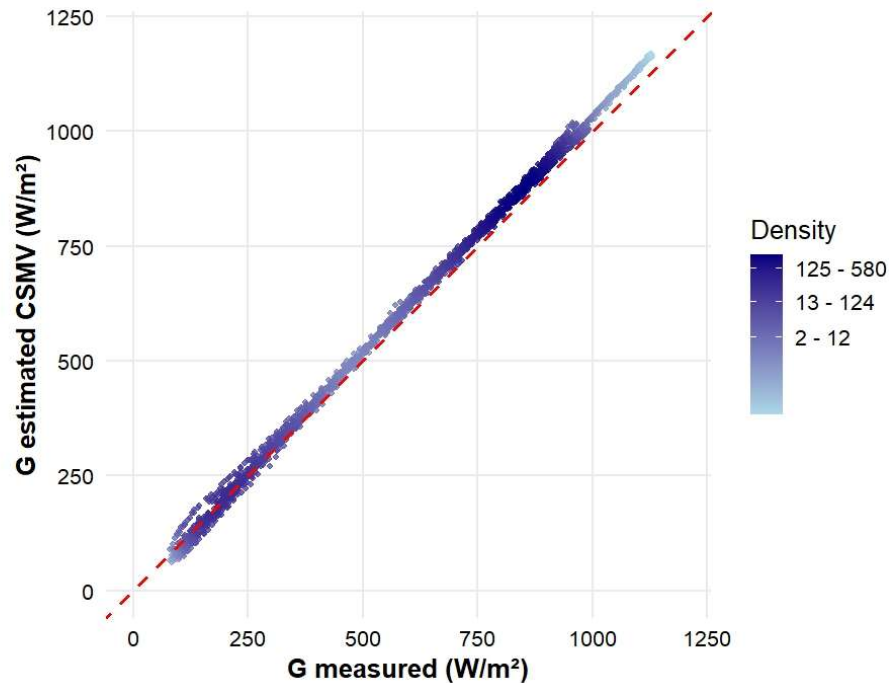


Figure 7. Comparison between modeled and measured global horizontal irradiance (G) on ALL dataset, with the proposed CSMV.

4. Conclusions

The proposed CSMV model distinguishes itself through its practical applicability, computational efficiency, and reliable performance in estimating solar irradiance across a range of climatic conditions. Its parametric formulation enables rapid implementation while maintaining physical interpretability, making it a suitable tool for both research and operational applications in solar energy and atmospheric sciences.

The CSMV was developed based on an independent integration scheme applied to Leckner's spectral model, enabling the derivation of broadband atmospheric transmittances. It retains the physical structure of the original model, without requiring empirical calibration against specific datasets. CSMV is defined by a system of five analytical equations (for specific atmospheric transmittances), each corresponding to one of the principal atmospheric attenuation processes considered in the source spectral model.

The proposed model differs from the Leckner model in the approach used to estimate the broadband diffuse irradiance. Unlike the Leckner formulation, it accounts for the fact that aerosols not only scatter but also absorb solar radiation. An innovative aspect of the model lies in the formula (Equation 17) used to compute the fraction of aerosol scattering directed toward the ground. This formulation incorporates two factors: the first accounts for the optical atmospheric mass and allows for an intensification of the scattering process as the optical path length through the atmosphere increases; the second factor arises from the integration of the phase function with an upper limit imposed by the solar elevation angle, thereby constraining the solid angle of scattering toward the ground as the solar elevation decreases.

The model's performance was evaluated at eight stations representing diverse climate zones. Comparisons with the more complex REST2 model highlight CSMV's advantage in terms of accessibility and ease of use. Meanwhile, its comparison with the McClear model emphasizes the relatively high level of accuracy achieved by CSMV. These results demonstrate that CSMV offers a favorable balance between precision and usability.

Author Contributions: Conceptualization, E.P. and V.S.; methodology, E.P. and V.S.; software, V.S. and E.P.; data curation, V.S. and E.P.; writing-original draft preparation, E.P. and V.S.; Both authors read and approved the final manuscript.

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Data Availability Statement: The data presented in the study are openly available in Baseline Solar Radiation Network, <https://bsrn.awi.de/> and AERONET, <https://aeronet.gsfc.nasa.gov/> .

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Normalized root mean square error (nRMSE) and normalized mean bias error (nMBE), expressed as percentages, for the estimation of direct-normal (DNI), diffuse (Gd), and global (G) irradiance using the CSMV, REST2, and McClear models at each station.

Station	Model	DNI nRMSE	Gd nRMSE	G nRMSE	DNI nMBE	Gd nMBE	G nMBE
BON	CSMV	4.63%	17.77%	3.96%	4.53%	-15.78%	3.68%
	REST2	0.84%	19.90%	3.02%	-0.67%	-17.11%	-0.58%
	McClea	5.21%	36.72%	2.77%	-4.84%	33.70%	2.28%
BOU	CSMV	2.84%	13.30%	3.65%	2.32%	-11.82%	2.68%
	REST2	1.91%	11.05%	1.79%	-0.53%	-9.29%	0.89%
	McClea	9.17%	16.99%	7.59%	8.39%	-13.54%	7.06%
CAR	CSMV	5.95%	12.49%	5.09%	5.76%	-5.45%	3.52%
	REST2	0.93%	4.24%	0.92%	-0.22%	3.02%	0.53%
	McClea	5.68%	20.59%	4.51%	0.74%	15.15%	3.73%
DAR	CSMV	4.73%	17.98%	3.71%	4.46%	-10.33%	2.51%
	REST2	1.82%	7.52%	2.11%	-1.41%	4.15%	0.21%
	McClea	6.25%	15.50%	3.94%	1.29%	9.54%	3.16%
FUA	CSMV	3.81%	15.27%	5.77%	3.00%	-2.06%	3.28%
	REST2	1.89%	7.67%	2.30%	-0.48%	4.85%	1.69%
	McClea	4.82%	10.24%	5.07%	3.00%	3.15%	4.14%
GOB	CSMV	5.40%	7.27%	3.38%	5.35%	-4.98%	2.69%
	REST2	1.31%	10.01%	1.19%	1.23%	-8.97%	-1.00%
	McClea	9.37%	30.37%	3.04%	5.12%	-3.56%	2.58%
PAL	CSMV	2.20%	7.90%	2.88%	1.89%	3.52%	1.63%
	REST2	3.00%	6.45%	4.49%	-2.79%	-5.06%	-4.13%
	McClea	13.37%	19.38%	1.73%	8.09%	-12.04%	-0.02%
PTR	CSMV	8.45%	20.35%	4.894%	8.31%	15.46%	4.15%
	REST2	1.54%	12.48%	1.31%	1.51%	11.40%	-1.03%
	McClea	8.16%	7.35%	4.15%	8.05%	6.97%	3.43%
ALL	CSMV	4.89%	11.40%	3.99%	4.34%	-4.31%	2.86%
	REST2	1.54%	9.82%	1.31%	1.51%	11.40%	-1.03%

McClear	8.23%	25.52%	3.99%	3.32%	0.85%	3.01%
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