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Website- www.aarf.asia, **Email** : editor@aarf.asia , editoraarf@gmail.com

A MATHEMATICAL MODELING OF SOLAR ENERGY POTENTIAL AND SOLAR RADIATION MAPPING STUDY

Nomula Venkatesham, Research Scholar, Dept of Physics, Vinayaka Missions Sikkim University, Gangtok,

Dr Vipin Kumar, Professor, Dept of Physics, Vinayaka Missions Sikkim University, Gangtok,

Abstract: *The utilization of solar energy has gained significant attention as a sustainable and abundant renewable resource. To harness this potential effectively, accurate assessment and mapping of solar radiation are paramount. This abstract presents a mathematical modeling approach for evaluating solar energy potential and conducting solar radiation mapping studies.The proposed model integrates geographical and meteorological data to predict solar radiation levels at specific locations over time. The Earth's curvature, topography, and atmospheric conditions are considered to determine the amount of solar energy reaching the Earth's surface. Various parameters, including latitude, longitude, altitude, and local climatic factors, are integrated into the model to enhance accuracy.*

Through the implementation of advanced computational techniques, the model facilitates the simulation of solar radiation patterns across different time scales, accounting for seasonal variations and daily fluctuations. Additionally, factors such as cloud cover, atmospheric attenuation, and shading effects are integrated to provide a comprehensive representation of real-world conditions. The model's validation is achieved through comparisons with ground-based measurements and existing solar radiation databases, demonstrating its reliability and precision.The solar radiation mapping study conducted using this model yields valuable insights for solar energy applications. By visualizing the spatial distribution of solar radiation, regions with optimal solar energy potential can be identified. This information is indispensable for strategic placement of solar power infrastructure, such as photovoltaic panels and solar thermal systems. Moreover, the model aids in the assessment of economic feasibility, energy generation forecasts, and policy formulation related to solar energy integration.

In conclusion, the mathematical modeling approach presented in this abstract offers a robust framework for evaluating solar energy potential and generating solar radiation maps. The model's comprehensive consideration of geographic, meteorological, and atmospheric parameters contributes to its accuracy in predicting solar radiation levels. The resulting insights empower decision-makers, urban planners, and energy professionals to effectively harness solar energy, accelerating the transition toward sustainable and renewable energy sources.

Keywords: olar energy, mathematical modeling, solar radiation, potential assessment, mapping study

1. Introduction

The majority of India has 300 to 330 sunny days per year, which is sufficient to generate over 5,000 quadrillion kilowatt-hours per year more than India's total annual energy consumption. The average solar irradiance ranges between 4 and 7 kWh m-2day-1 (Laskar, 2016). Solar Thermal Energy (STE) and Solar Photovoltaic (SPV) technology can be implemented in India due to the country's abundant solar resources and vast wastelands. (Rao et al., 2018) The India energy portal estimates that if 10% of the waste land were used to harness solar energy, the installed solar capacity would reach 8,000 GW, which is approximately fifty times the current total installed power capacity of the country. As of October 2018, the country has the fifth-highest solar installed capacity in the globe, with a total installed capacity of 21,73 GW, compared to a goal of 100 GW by 2022 (Kabir, 2018). Despite the fact that thermal energy supplies 63.84 percent of the world's energy needs, it is a cause for concern that thermal power plants emit a significant quantity of harmful gases such as COx, SOx, and NOx, which are detrimental to human health and the environment. The installed solar power grid in India attained 3,743 MW in March 2015, 6,762 MW in March 2016, and 8,062 MW in July 2016 (Kabir, 2018). The cumulative installed capacity of renewable energy has increased from 35.51 GW on 31.03.2014 to 73.35 GW on 31.10.2018 (an increase of approximately 106% over the past four and a half years). During the last four and a half years (2014-15 to 2018-19), more than 37.84 GW of grid-connected renewable power capacity has been added, including 21.7 GW of solar power, 13.98 GW of wind power, 0.7 GW of small hydro power, and 1.5 GW of bio-power (MNRE, 2018).

The world's territory surface, oceans, which make up around 71% of the planet's surface, and air all assimilate sun based energy. Convection, or air dissemination, is welcomed on by warm air ascending from the seas that has lost water to dissipation. Water fume consolidates into mists at high elevations where it is colder, finishing the water cycle by making precipitation fall on the world's surface. Convection is advanced rapidly by the idle intensity of water buildup, which brings about air peculiarities including wind, typhoons, and enemies of twisters. The seas and bodies of land shut out the sun's beams, keeping the surface at a typical temperature of 14 °C. Green plants use photosynthesis to change sun based energy into artificially put away energy that is utilized to make food, wood, and biomass, which is utilized to make petroleum products. Around 3,850,000 exajoules (EJ) of sun based energy are ingested every year by the world's climate, seas, and bodies of land consolidated. As far as biomass, photosynthesis catches around 3,000 EJ every year. How much sun powered energy that arrives at Earth's surface is colossal to such an extent that it will ultimately be gotten from the planet's all's non-sustainable assets — coal, oil, gaseous petrol, and mined uranium — in about two years. Topographical area, irregularity, and overcast cover all influence how much sun oriented energy people might actually utilize. The amount of sun based energy we can tackle is likewise obliged by the land that is open to people .

SOLAR IRRADIATION BASICS

As per Munawwar (2006), the sun is a 1.4 million km in breadth circle of very blistering vaporous stuff with an inward temperature of 15 million degrees Kelvin and a strain that is 70 billion times more noteworthy than that of the environment on The planet. The sun has been producing energy at a pace of 3.9 x 1026 W for very nearly five billion years and will do as such for some more. Given the 150 million kilometer distance between the earth and the sun, it requires 8 minutes for sun based radiation to arrive at the world's surface.

Irradiance is the proportion of how much sun based radiation falls on a given surface region in a given measure of time. Light is the term used to depict the vital of irradiance over any reasonably determined time span. As per Bhattacharya et al. (1996), the typical extraterrestrial irradiance or motion thickness at a mean earth-sun distance is right now perceived to be 1367 Wm-2 with a vulnerability of the request for 1%. The math of the Earth and Sun is especially critical on the grounds that it impacts the development of nearby planet groups and structures by aiding the assurance of occasional light. Immediate and diffuse (dissipated and reflected) short-frequency and long-frequency radiation from the sky and mists, starting as warm emanation or by impression of warm radiation starting from the earliest stage, up the radiation that arrives at the world's surface.

LINKE TURBIDITY FACTOR

At the point when there are no mists overhead, the linke turbidity factor (LTF) is a genuinely reasonable estimation to reenact the climatic retention and dissipating of sun oriented radiation. In contrast with a dry, clear environment, it depicts the optical thickness of the air because of both water fume retention and spray molecule ingestion and dispersing. The wide band annihilation coefficient at unit air mass () and Rayleigh's optical thickness (R) can be utilized to ascertain LTF. The optical thickness of an unadulterated Rayleigh dissipating climate per unit region mass along a specific way length is known as the Rayleigh's optical thickness. LTF should be visible as the amount of perfect, dry airs expected to produce a similar measure of outsider radiation constriction as the genuine environment. This idea expects that LTF be greater than 1. Subsequently, it sums up the turbidity of the environment and, thusly, the constriction of sun based energy in the immediate bar. The constriction of the radiation by the unmistakable sky environment increments with expanding LTF.

THE SOLAR SPECTRUM

Daylight is a sort of electromagnetic (EM) radiation, explicitly infrared, noticeable, and bright light, that the sun discharges. At the point when the sun is over the skyline, daylight is viewed as light since it has been separated by the world's air. Daylight, a mix of splendid light and brilliant intensity, is what we experience when the direct sun oriented radiation isn't discourage by mists. It is seen as diffused light when it is hindered by mists or bounces off of different articles .

The sun's radiation has a range that is like a dark body with a temperature of around 5,800 K . Most of the electromagnetic range is covered by the sun's EM radiation. While the atomic combination process in the sun brings about the development of gamma beams, interior retention and thermalization change these very high-energy photons into lower-energy photons before they arrive at the surface and are delivered into space. Subsequently, this interaction doesn't make the sun discharge gamma beams, while sun based flares do . The sun additionally creates radio waves, noticeable light, infrared light, X-beams, bright light, and different frequencies; the main direct sign of the atomic response is the outflow of neutrinos.

SPECTRAL COMPOSITION OF SUNLIGHT AT EARTH'S SURFACE

Most of the electromagnetic energy from the sun that arrives at the planet's surface is light that falls inside the scope of frequencies that the visual frameworks of the living things that possess the outer layer of the earth are delicate to. It follows that the sun enlightens, which is an estimation of light inside a specific responsiveness range. The awareness scope of people and creatures is around 400-700 nm , and under ideal conditions, the world's air's retention and that's what dissipating produce light, for most of this reach, is practically identical to an equivalent energy illuminant . In people, the helpful frequency range for variety vision is about 450-650 nm. The otherworldly organization changes generally comparable to how straightforwardly daylight can enlighten, except for impacts that happen at dusk and dawn. In the upper climate, Rayleigh dispersing makes blue frequencies prevail when brightening is roundabout. Ozone, residue, and water particles will all assimilate explicit frequencies, while water fume in the lower environment causes extra dissipating.

VARIATIONS IN SOLAR IRRADIANCE

On The planet, the sun powered radiation changes with the place of the sun over the skyline. In the mid year, longer times of daylight are competent at higher scopes, though wintertime close to the applicable shaft encounters practically no daylight. At the point when mists are absent to darken the immediate radiation, it is seen as daylight. The retention of electromagnetic radiation as intensity brings about the warming of the ground (and different things).

TYPES OF SOLAR RADIATION

The sum of direct, diffuse, and reflected solar radiation is what is commonly referred to as global radiation. The three elements stated above combine to form the solar radiation that is present on the surface of the earth. As the various elements, such as weather, location, etc., change, so does the actual percentage of each of these componentsDIRECT RADIATION

The earth gets immediate radiation from sun powered beams that are coordinated in an orderly fashion from the sun to it. Bar radiation or direct shaft radiation are different names for direct radiation. As immediate radiation comprises of sun radiates moving in an orderly fashion, things that block the way of the sun beams cast shadows on them. Direct radiation is available when there are shadows.

DIFFUSE RADIATION

The course of direct radiation is fixed. There is no clear course for diffuse radiation. The diffuse radiation is brought about by sun beams that have been dissipated by climatic particles. Assuming there is just diffuse radiation present and no immediate radiation, no shadows of the items will create.

REFLECTED RADIATION

The piece of radiation that is reflected from surfaces other than air particles is known as reflected radiation. Reflected radiation comes from surfaces like slopes, trees, structures, and water. Reflected radiation normally makes up a minor piece of the complete radiation, yet in regions with snow, it can reach 15%.

DATA ABOUT SOLAR RADIATION

For sun powered energy applications including photovoltaic innovation, sun oriented warm frameworks, and uninvolved sun based plans, sunlight based radiation information is an indispensable information. For the plan, improvement, and execution appraisal of sun powered advances for a particular geographic region, sun oriented radiation information ought to be current, reliable, and effectively open. Applications for sun based energy request exhaustive comprehension and a careful evaluation of the conceivable outcomes of the site. Thus, a vital part of sunlight based energy transformation frameworks is the recognition of sun powered radiation at ground level

SWPP

A requirement for an eco-accommodating environmentally friendly power source is developing as petroleum derivative assets are exhausting and worldwide contamination issues are deteriorating. It is critical that the use of this energy source be monetarily suitable, particularly taking into account that it very well might be utilized in non-industrial countries. Researchers and specialists are progressively thinking about sun based energy as a reasonable answer for this issue.

THE SOLAR CHIMNEY

The stack is a warm motor, truth be told. Because of its ideal surface-to-volume proportion, it acts like a strain tube with little misfortune and erosion, similar as a hydroelectric cylinder. The air temperature increment (T) in the authority and volume are practically relative to the vertical push of the air warmed there. The gatherer brings the air temperature up in a huge sun powered chimney stack by 350C. This makes the chimney stack's updraught speed be generally V=15 m/s. The capacity of the stack to move heat into motor energy is generally free of the authority's temperature (T) and is affected by the surrounding temperature (To) and chimney stack level.

Power = K. (Hc/To)*(Local Sun based Radiation)*(Collector Region)

REVIEW OF LITERATURE

- Hofierka and Suri (2002) presented the r.sun solar radiation model's configuration, presentation, and capabilities. For open skies, beam, diffuse, and reflected radiation were calculated. The r.sun model estimated global radiation under clear-sky conditions by adding the beam, diffuse, and reflected components of solar radiation. For determining the interaction of solar radiation with the earth's atmosphere and surface, factors such as the earth's geometry, revolution, and rotation (declination, latitude, solar hour angle), terrain, and atmospheric attenuation (scattering, absorption) were used. The r.sun had two modes of operation. Solar incident angle (degrees) and solar irradiance values (W.m-2) for immediate time were calculated in the first mode, while the second mode predicted the daily sum of solar irradiance (Wh-2.day-1).
- Suri et al. (2005) introduced a solar radiation database for Europe based on the solar radiation model r.sun and three interactive web applications that provide access to it. The developed database included monthly and annual average values of the clear-sky global irradiation on horizontal and inclined surfaces, as well as climatic parameters required for a potential PV electricity generation assessment. It generated maps of global irradiance and additionally derived diffuse and beam components of the clear-sky. As a result of using GIS grid maps for all input parameters, it was determined that the solar radiation model r.sun is highly effective for rapidly estimating vast areas with complex terrain.
- Calculating total solar radiation, Kryza et al. (2010) assessed the r.sun model. Linke Turbidity Factor (LTF) was derived using an empirical formula and meteorological measurements as the primary parameter. The r.sun model required a digital elevation model and slope inclination as inputs for solar radiation modeling. The results of the r.sun model were compared to solar radiation measurements collected at the Polish Polar Station. With a variance close to 0.90, the r.sun model was found to be in reasonable agreement with measurements under clear sky conditions. It was determined that the r.sun model is a reliable and effective instrument for calculating different types of solar radiation.
- Using the r.sun model, Alvarez et al. (2011) estimated monthly solar radiation for cloudy and clear-sky conditions in south-central Chile. Clear sky map was generated after calculating three components of global solar radiation. It analyzed the efficacy of Hargreaves-Samani (HS) and Bristow-Campbell (BC) global radiation models. The model was validated using weather station observations. Compared to

models such as HS and BC for Chilean conditions, the r.sun model proved to be more accurate. The r.sun model performed well for all site conditions and can therefore be used in areas where there are no weather stations.

- Abdeladim et al. (2013) provided a contribution to solar assessment and mapping in Algeria by employing suitable models. A methodology for solar mapping was presented, leading to the creation of an Algerian solar map using the SURFER ® software and the eventual establishment of a solar atlas. In order to perform the estimation, mathematical models were used. For the validation, measured data from five (5) locations across the country were compared to those predicted by models. When measured data from five stations across the country were compared, positive outcomes were obtained.
- Joshi (2013) conducted research on developing a map of solar potential using GIS. It discussed the use of geographical information system (GIS) to create thematic maps of monthly Global Horizontal irradiance (GHI) by district in the state of Uttarakhand. Using GIS technology and SURFER software, it mapped the solar potential of every district in Uttarakhand based on satellite data. The entire state received between 3 and 6.5 kWh m-2day-1 of solar radiation.
- Using LiDAR, GIS solar radiation models, and the GRASS GIS r.sun solar model, Bode et al. (2014) predicted solar radiation across a densely vegetated landscape. On-site hemispherical photographs analyzed with a gap light analyzer were installed to validate this method's thermopile pyranometer measurements. After calibrating the r.sun model to a weather station at the study site, field measurements from a black thermopile pyranometer were compared to r.sun model predictions. The r.sun model performed better.
- Using data from ground-mounted weather stations, Gajjar et al. (2015) drew a solar map for Karnataka. One location's anticipated and actual solar power generation for the years 2012 and 2013 have been estimated and compared. Meteorological data from the ground were used to rectify the simulated results. Using Surfer 10 software, the corrected values were plotted and generation maps for all 300 locations were created. The results indicated a close match with a 5% variance.The model was then applied to every 0.25-degree station interval across the state in a grid fashion. In the first simulation using PVSyst's default settings, a 10.3% deviation was observed. Using actual data, the deviation decreased to 0.7% and 0.2% for the years 2012 and 2013, respectively. It was discovered that the central and south eastern regions of Karnataka produce substantially more solar energy than the northern and south western regions.
- Using the r.sun solar clear-sky model, Gama et al. (2016) generated solar radiation projections for various applications under clear-sky conditions in Algeria. In addition to beam and global solar radiation mapping, the district's potential for concentrating solar power designs, solar photovoltaic technologies, and solar water heaters was evaluated. Based on the r-sun model, a C-language program was created that could calculate the various components of solar irradiation. The r.sun model performed well for all site conditions and can therefore be used in areas where there are no weather stations.

RESEARCH METHODOLOGY

A portion of the sun based radiation is consumed or dissipated as it goes through the world's environment via air particles, water fume, sprayers, and mists. Direct Ordinary Radiation (DNR) is the term used to portray sun based radiation that arrives at the world's surface straightforwardly. Diffuse Radiation is the radiation that has spread past the immediate shaft. Worldwide Radiation is the amount of the immediate part of daylight and the diffuse part of bay window falling on a level surface. The connection between the three components is mathematical. A pyrheliometer, which distinguishes radiation at typical occurrence, is the best instrument for estimating direct radiation. A pyranometer can be utilized to identify diffuse radiation by safeguarding it from direct radiation with the end goal that the thermopile just gets diffuse radiation, or it tends to be utilized to work out diffuse radiation from direct radiation and worldwide radiation. A pyranometer measures worldwide radiation. This part focuses on the many instrument types and orders that are accessible for estimating different sunlight based radiation parts.

PYRANOMETERS MADE OF THERMOPILES

A sensor worked around thermopiles called a thermopile pyranometer can gauge the sun oriented radiation motion thickness across a 180° field of view. Thus, a thermopile pyranometer normally gauges frequencies somewhere in the range of 300 and 2800 nm . The dynamic part of the sensor was equitably separated into high contrast areas in the original of thermopile pyranometers. Illumination was assessed involving the distinction in temperature between the white areas — which are better depicted as being in the shade or not presented to the sun — and the dark areas, which are presented to the sun . Light is proportionate to the contrast between the temperature of the sun-uncovered region and the temperature of the shade region in all thermopile advancements.

DESIGN

A thermopile pyranometer is made of the accompanying key components to accomplish the right directional and unearthly qualities: a covered thermopile sensor in dark. It has a practically wonderful cosine reaction, a level range incorporating the scope of 300 to 50,000 nanometers, and it ingests all sun based light.

RESULTS ANALYSIS

The equations of the r.sun model were utilized to develop software for evaluating the various components of solar irradiation, including direct irradiation, diffuse irradiation, global irradiation, and direct normal irradiation. The software was developed in the C programming language and will assist in determining the solar irradiation of any location. This software will be of great assistance in determining the parameters that must be determined prior to constructing a solar plant, such as the linke turbidity factor, solar irradiation, sun shine hours, etc. India's solar atlas was created using the software that was developed. Comparing measured and calculated values for various types of irradiation from 2006 to 2013 served as an additional validation step. From 2006 to 2013, IMD values were regarded as the measured value.

4.1 CREATE A MATHEMATICAL MODEL TO EVALUATE SOLAR RADIATION ON HORIZONTAL SURFACES.

This section contains the equations of the r.sun model that were used to develop software in the C programming language in order to evaluate the various components of solar irradiation, including direct irradiation, diffuse irradiation, global irradiation, and direct normal irradiation. As inputs, the program required digital elevation and linke turbidity.

4.2 DEVELOP A SOLAR ATLAS FOR THE INDIAN CLIMATE.

After successfully completing the developed program, a large matrix of solar irradiation values was generated and depicted in the form of a solar map for clear skies using version 13.0.383 of the Surfer golden software.

TABLE3.13RESULTSOFCORRELATION – WINTERSEASON(LOCATION 2)

Variables	GlobalSolarRadiation	Ambienttemperature	Relativehumidity	mosphericpressure	Windspeed	Precipitation
Global SolarRadiation	1					
Ambienttemperature	0.917	1				
Relativehumidity	-0.958	-0.993	1			
mosphericpressure	-0.564	-0.846	0.778	1		
Windspeed	-0.907	0.663	-0.746	-0.162	1	
Precipitation	-0.270	-0.136	0.018	0.643	0.652	1

TABLE3.14RESULTS OFCORRELATION–PREMONSOONSEASON (LOCATION2)

Variables	Global SolarRadiation	Ambienttemperature	Relativehumidity	mosphericpressure	Windspeed	Precipitation
lobal SolarRadiation	1					
Ambienttemperature	0.870	1				
Relativehumidity	-0.397	0.798	1			
mosphericpressure	0.500	-0.862	-0.993	1		
Windspeed	-0.119	0.593	0.959	-0.919	1	
Precipitation	0.124	-0.597	-0.960	0.921	-1.000	1

TABLE3.15RESULTS OFCORRELATION–SOUTHWESTMONSOON SEASON(LOCATION2)

Variables	Global SolarRadiation	Ambienttemperature	Relativehumidity	mosphericpressure	Windspeed	Precipitation
lobal SolarRadiation	1					
Ambienttemperature	-0.756	1				
Relativehumidity	0.821	-0.987	1			
mosphericpressure	0.848	-0.479	0.506	1		
Windspeed	-0.776	0.337	-0.368	0.988	1	
Precipitation	0.775	-0.571	0.554	0.959	-0.928	1

TABLE3.16RESULTS OFCORRELATION –POSTMONSOON SEASON(LOCATION2)

Variables	Global SolarRadiation	Ambienttemperature	Relativehumidity	Atmosphericpressure	Windspeed	Precipitation
Global SolarRadiation	1					
Ambienttemperature	0.698	1				
Relativehumidity	-0.926	-0.916	1			
Atmosphericpressure	0.240	-0.527	0.143	1		
Windspeed	-0.454	-0.955	0.756	0.756	1	
Precipitation	-0.971	-0.505	0.808	-0.467	0.226	1

The discoveries of the relationship examination led between the factors for the four seasons at Area 2 are displayed as a connection grid in Tables 3.13 to 3.16. While different measurements have a negative relationship with worldwide sun powered radiation throughout the colder time of year, it tends to be shown that encompassing temperature has a positive connection with it. Worldwide sun radiation associates emphatically with encompassing temperature and gaseous tension during the pre-rainstorm season.

TABLE3.17RESULTSOFCORRELATION – WINTERSEASON(LOCATION 3)

Variables	lobal SolarRadiation	Ambienttemperature	Relativehumidity	mosphericpressure	Windspeed	Precipitation
lobal SolarRadiation	1					
Ambienttemperature	0.919	1				

Relativehumidity	-0.999	-0.905	1			
mosphericpressure	-0.982	-0.828	0.988	1		
Windspeed	-0.039	-0.430	0.005	-0.151	1	
Precipitation	0.091	-0.309	-0.125	-0.277	0.992	1

TABLE3.18RESULTS OFCORRELATION–PREMONSOONSEASON (LOCATION3)

Variables	Global SolarRadiation	Ambienttemperature	Relativehumidity	mosphericpressure	Windspeed	Precipitation
lobal SolarRadiation	1					
Ambienttemperature	0.975	1				
Relativehumidity	0.195	-0.409	1			
mosphericpressure	-0.165	0.381	-1.000	1		
Windspeed	-0.717	0.543	0.544	-0.569	1	
Precipitation	-0.002	-0.221	0.980	-0.986	0.699	1

TABLE3.19RESULTSOFCORRELATION –SOUTHWESTMONSOON SEASON(LOCATION3)

Variables	Global SolarRadiation	Ambienttemperature	Relativehumidity	mosphericpressure	Windspeed	Precipitation

lobal SolarRadiation	1					
Ambienttemp erature	0.222	1				
Relativehumi dity	-0.878	0.598	1			
mosphericpress ure	0.030	-0.135	-0.322	1		
Windspeed	-0.732	0.714	0.968	-0.474	1	
Precipitation	0.473	-0.351	-0.725	0.884	-0.810	1

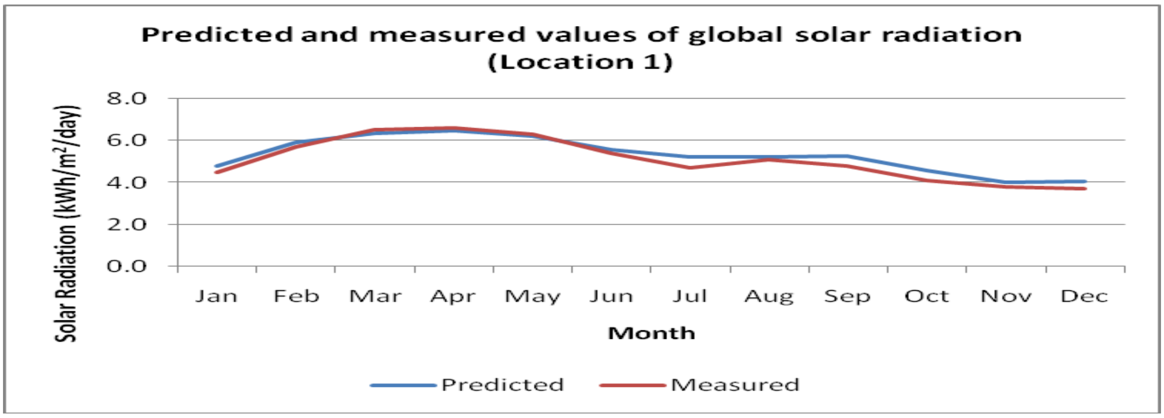

Figure4.1predicted and measured values of global solar radiation using meteonorm forlocation 1

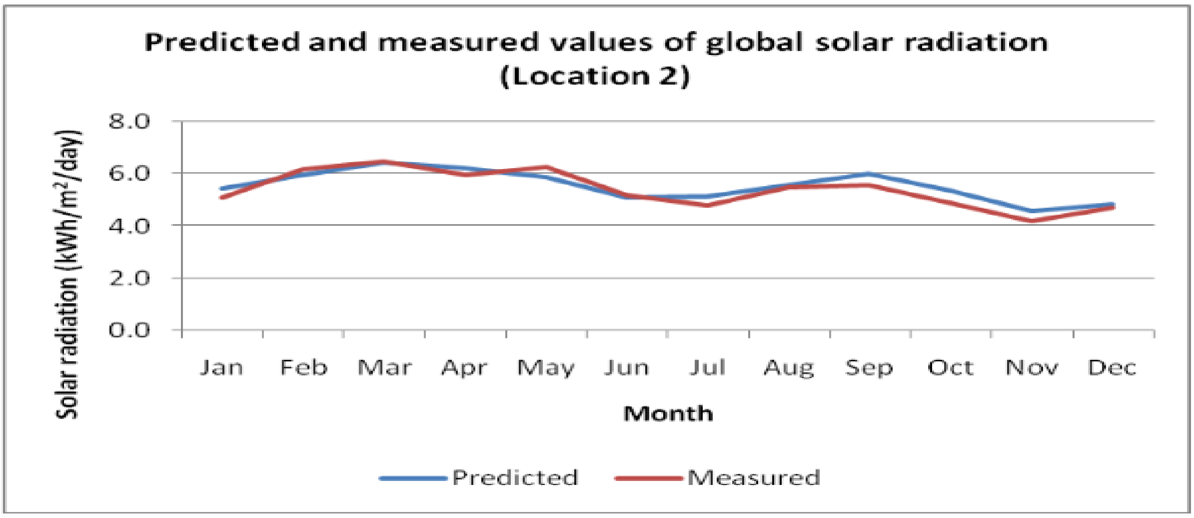

figure4.2 predicted and measured values of global solar radiation using meteonorm forlocation 2

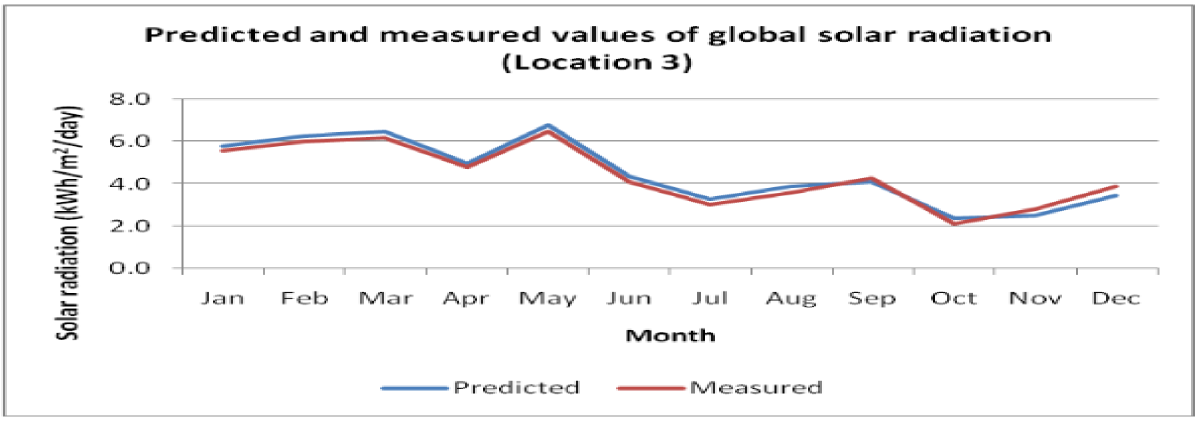

Figure4.3 predicted and measured values of global solar radiation using meteonorm forlocation 3

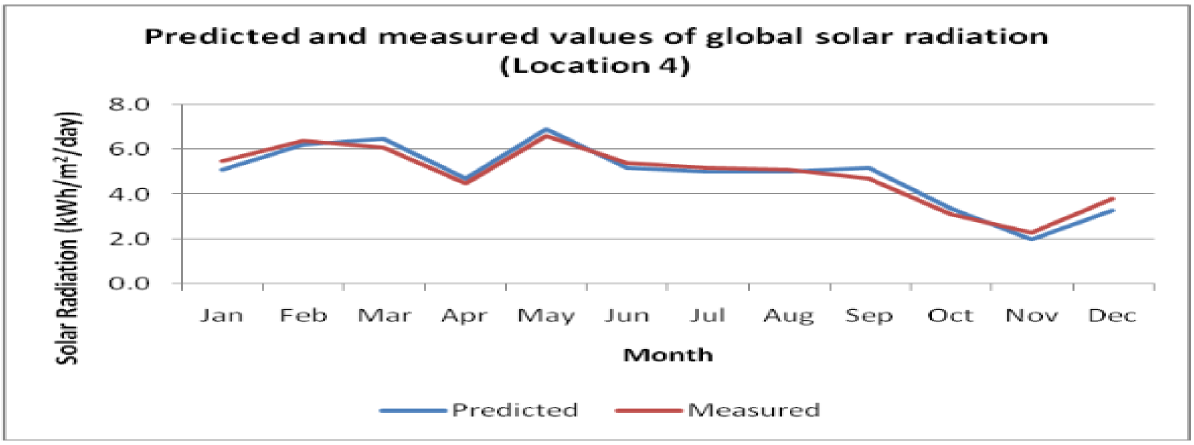

Figure4.4predicted and measured values of global solar radiation using meteonorm forlocation 4

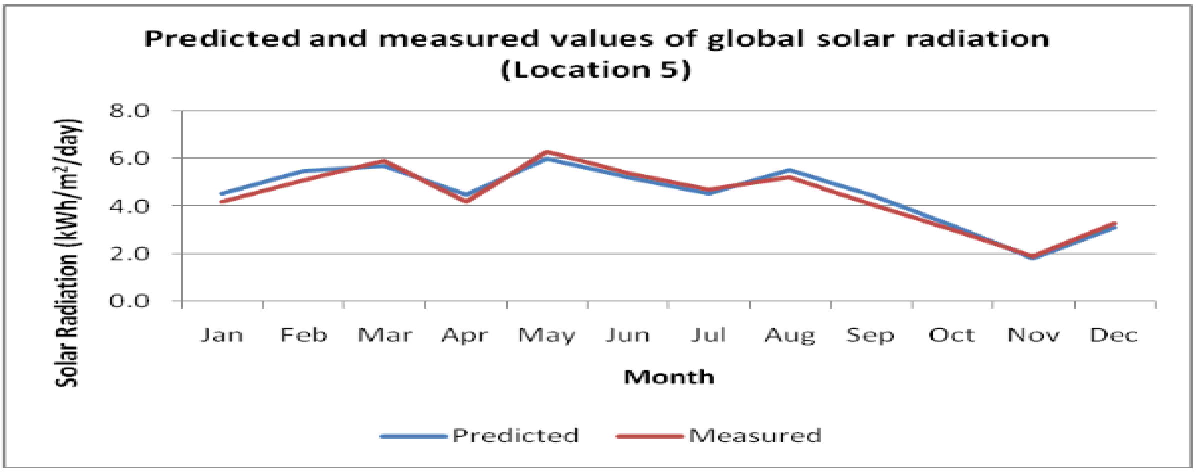

Figure4.5predicted and measured values of global solar radiation using meteonorm forlocation 5

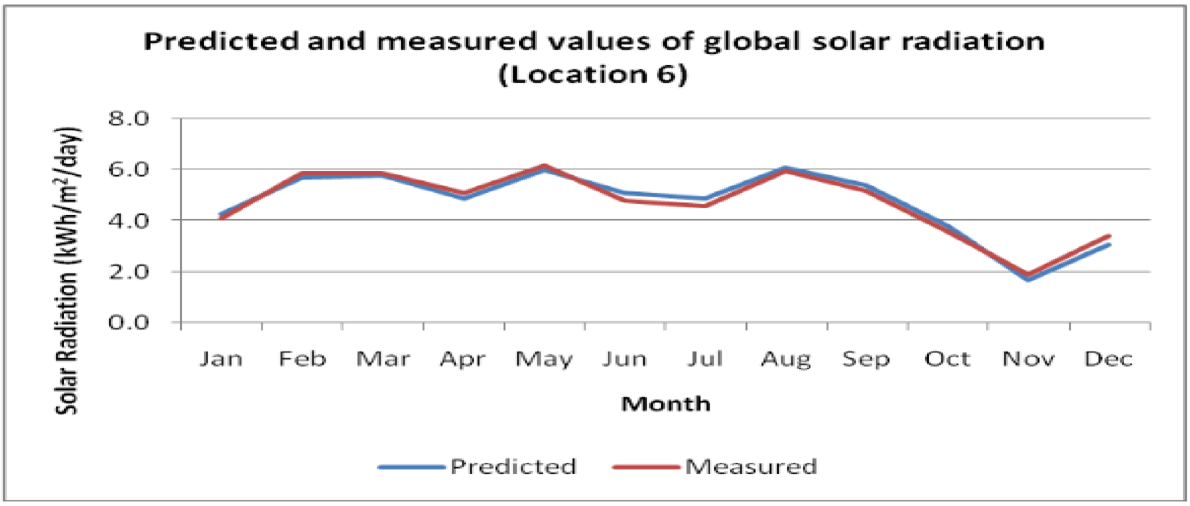

Figure4.6predicted and measured values of global solar radiation using meteonorm forlocation 6

TABLE4.13PREDICTED AND MEASURED VALUES OF GLOBAL SOLAR RADIATION USING BIRD CLEAR SKYMODELFORLOCATION 5

Season	Month	Global SolarRadiation(kWh/m^2/day)		Difference	Percentagedifference (%)
		Predicted	Measured		
Winter	January	4.0	4.2	-0.2	-5.00
	February	4.8	5.1	-0.3	-6.25
Summer	March	5.5	5.9	-0.4	-7.27
	April	4.6	4.2	0.4	8.70
	May	6.5	6.3	0.2	3.08
SouthWestMonsoon	June	5.6	5.4	0.2	3.57
	July	4.8	4.7	0.1	2.08
	August	5.0	5.2	-0.2	-4.00
	September	3.8	4.1	-0.3	-7.89

NorthEastmonsoon	October	2.9	3.0	-0.1	-3.45
	November	2.2	1.9	0.3	13.64
	December	3.0	3.3	-0.3	-10.00

TABLE4.14PREDICTED AND MEASURED VALUES OF GLOBAL SOLAR RADIATION USING BIRD CLEAR SKYMODELFORLOCATION 6

Season	Month	Global SolarRadiation(kWh/m^2/day)		Difference	Percentagedifference (%)
		Predicted	Measured		
Winter	January	3.8	4.1	-0.3	-7.89
	February	5.6	5.9	-0.3	-5.36
Summer	March	6.0	5.9	0.1	1.67
	April	5.3	5.1	0.2	3.77
	May	6.6	6.2	0.4	6.06
SouthWestMonsoon	June	4.9	4.8	0.1	2.04
	July	4.5	4.6	-0.1	-2.22
	August	6.1	6.0	0.1	1.64
	September	5.0	5.2	-0.2	-4.00
NorthEastmonsoon	October	3.4	3.6	-0.2	-5.88
	November	2.1	1.9	0.2	9.52
	December	3.0	3.4	-0.4	-13.33

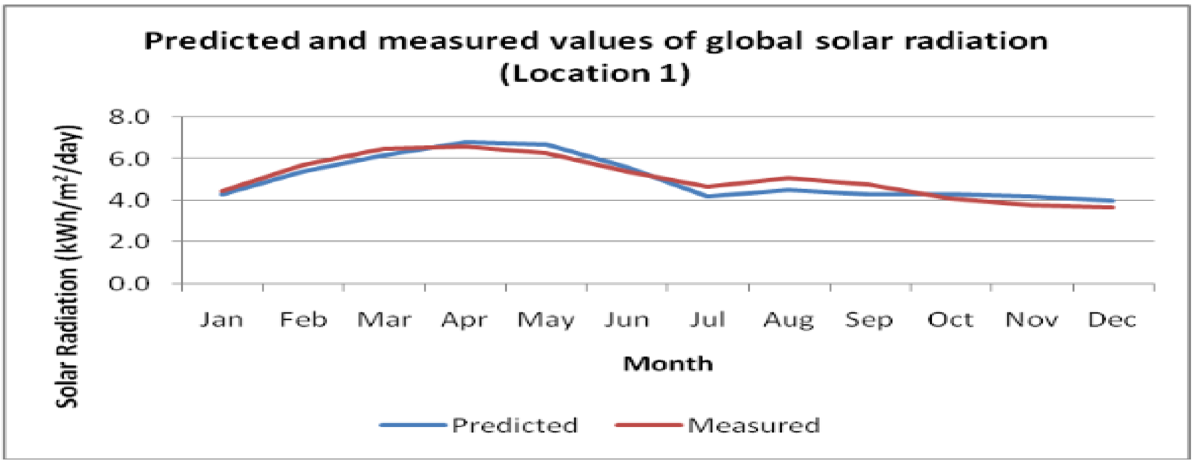

Figure4.7predicted and measured values of global solar radiation using bird clear sky modelforlocation1

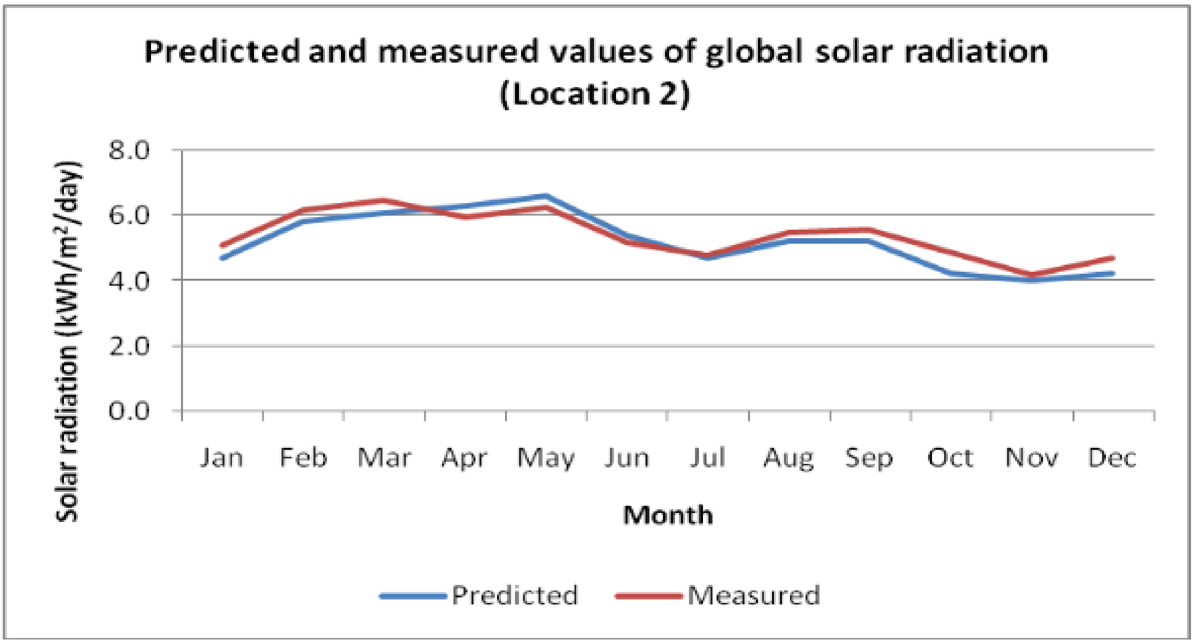

Figure4.8predicted and measured values of global solar radiation using bird clear sky modelforlocation2

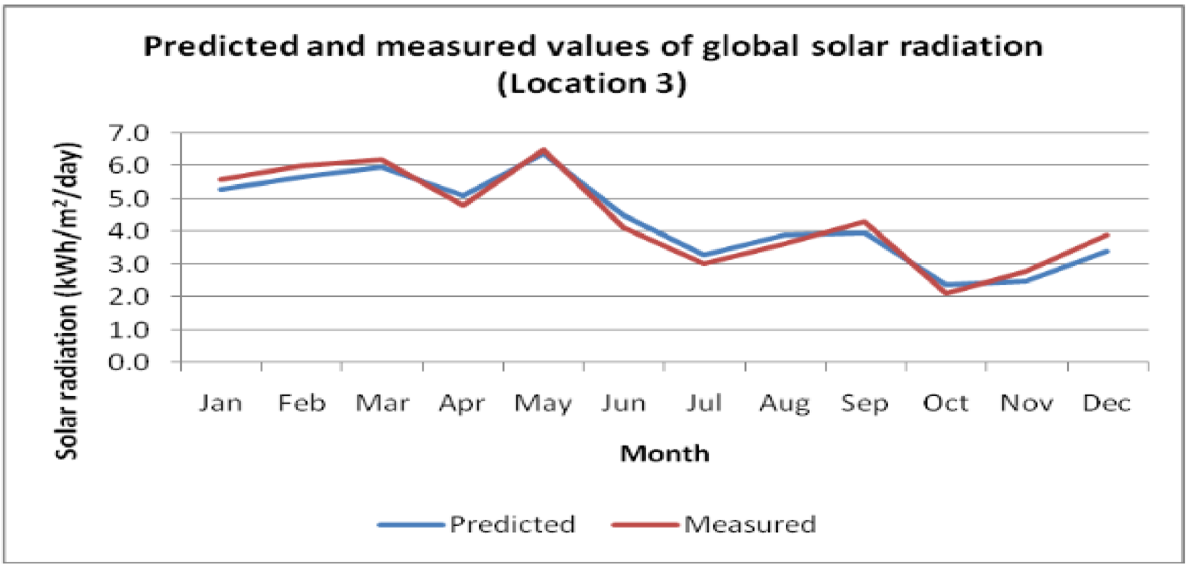

Figure4.9predicted and measured values of global solar radiation using bird clear sky modelforlocation3

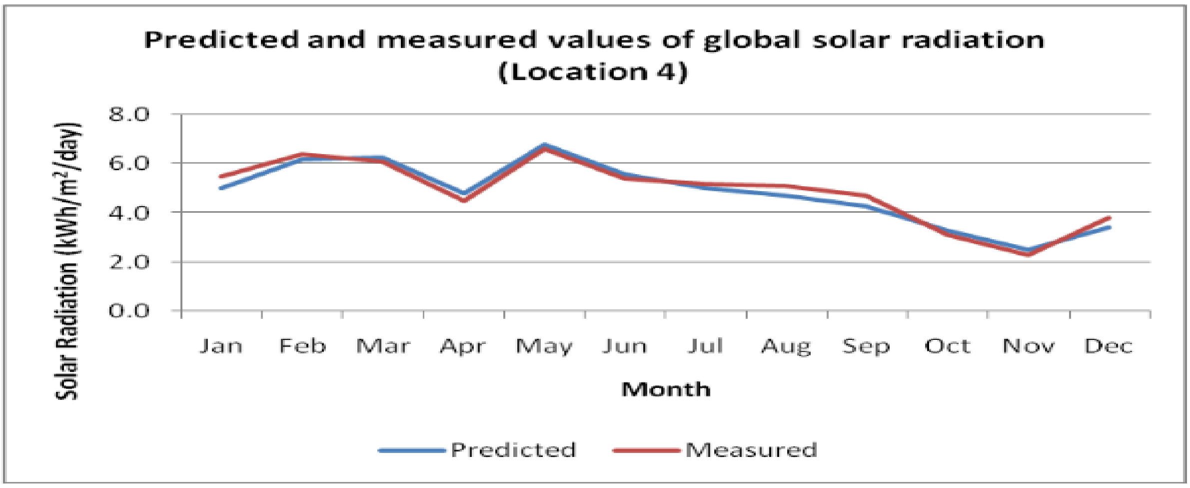

Figure4.10predicted and measured values of global solar radiation using bird clear sky modelforlocation4

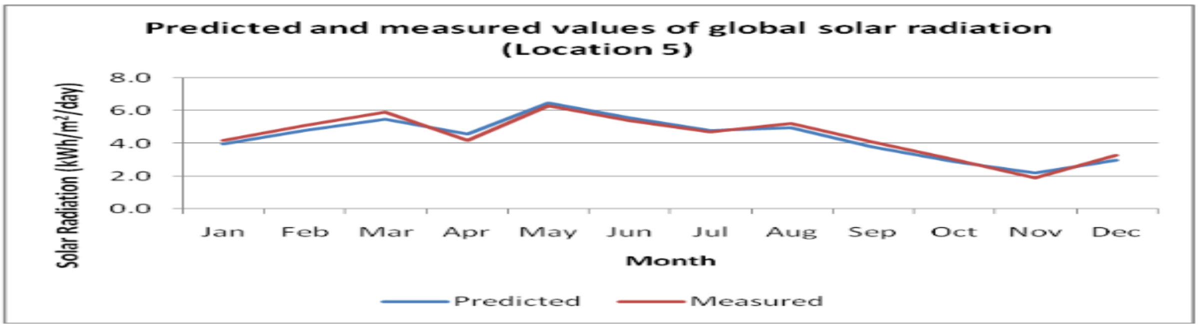

Figure4.11predicted and measured values of global solar radiation using bird clear sky modelforlocation5

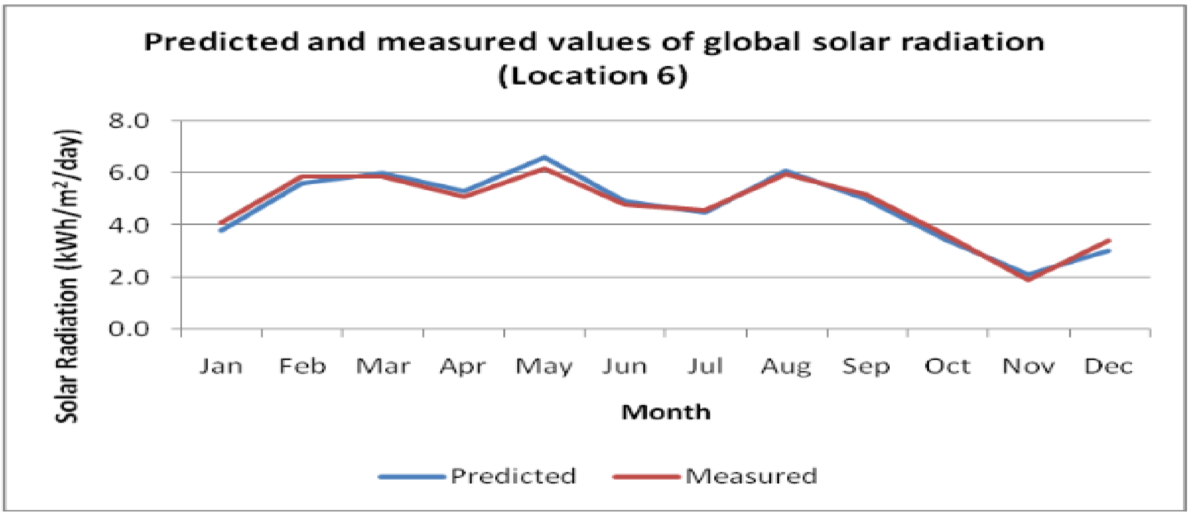

Figure4.12predicted and measured values of global solar radiation using bird clear sky modelforlocation6

STATISTICAL INVESTIGATION

The exhibition of the models viable can be assessed exhaustively utilizing measurable examination. A model should be checked for legitimate understanding since assessment of a model's exhibition frequently depends on assessing the exactness of gauge values comparative with noticed values. Measurable procedures that rate the model's exactness can be utilized to concentrate on the exhibition of the model. Any model's exhibition can be surveyed utilizing one of four classes of factual measurements: normal estimations, connection measures, contrast measures, and degree measures.

Conclusion

Solar being a pure and green energy source, the proposed system reduces carbon emissions. Carbon is emitted in all existing systems through electricity generation and steam generation (diesel). The total quantity of carbon emissions produced by the proposed system design is 277,16 TCO2 per year. Since the devised system is an entirely green and carbon-free source of energy, its carbon emissions are negligible.Thus, the use of solar energy to generate electricity will eliminate or significantly reduce the use of fossil fuels and lead to a reduction in CO2 emissions.Nations are urged to lessen their energy utilization and exploit environmentally friendly power sources by the rising worldwide energy requests and rising estimating for petroleum derivatives. Worries about ecological issues are additionally raised by the inescapable utilization of petroleum products. Because of its security and great effect on the condition of the climate because of its shortfall of emanations while in activity, sun oriented energy is for the most part a decent elective energy hotspot for settling these issues. Because of difficulties emerging from oil emergencies and other ecological issues, concentrates on sun powered radiation have acquired significance, which has expanded the interest for exact estimations of surface sun based radiation.

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