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Development of solar radiation database and its integration into solar process applications in Lesotho

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Declaration

I **Lebohang Bulane,** do hereby declare that this dissertation – ***Development of solar radiation database and its integration into solar process applications in Lesotho,*** is a pure result of my own research work except where cited in the references chapter.

I also declare, that this dissertation has never been submitted for an acceptance for any degree.

I further declare, that it is not being submitted in candidature of any other degree other than Master of Science in Sustainable Energy, offered by the Energy Research Centre of the Faculty of Science & Technology at the National University of Lesotho.

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Date : May 2020

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I thank you for handholding me, through this journey which is my greatest learning experience.

Abstract

Solar energy is a viable alternative source of energy for socio-development of a developing country like Lesotho. Investment in solar process applications, requires a accurate solar radiation data for the successful implementation of solar process projects. However, in Lesotho measured solar radiation datasets are not sufficient both temporally and spatially as there are only seven solar radiation measuring sites, two of which are not reliably operational.

This study solves the problem of the scarcity of solar radiation data in Lesotho, by developing a solar radiation database for the country. It has a primary objective of developing an accurate solar radiation database for Lesotho. This is achieved by merging ground measured solar radiation data with satellite – derived solar radiation data. The merged data is complimented by solar radiation data derived from sunshine duration data. Merging solar radiation datasets is important because ground measured data are sparsely distributed and cannot be interpolated accurately to represent solar radiation at any location. Although satellite – derived datasets are spatially continuous, they are not accurate as they are inferred from extra- terrestrial solar radiation modified with atmospheric models. As a result, each of the databases cannot be relied up unilaterally. Measured ground data is from five stations and sunshine duration derived solar radiation is form twelve stations.

The improved database is validated using a leave one out cross validation technique. Its reliability in estimating ground solar radiation is tested by relative bias error (rBE), relative mean bias error (rMBE) and normalized root mean square error (NRMSE). Results show that the database is credible as it has a maximum error of 2.7 % which is comparable to other studies of similar nature in Africa.

An interpolation tool, increases the accuracy and reliability of interpolated solar radiation as compared to manual reading of data from solar radiation maps. It has an accuracy of 99.54%.

The improved database and interpolation tool can confidently be used in any solar application process design and sizing in the country.

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Chapter One: Introduction

Solar radiation plays an important role for the existence and maintenance of social well-being of all forms of life. It is important that this natural resource, which is in abundance in Lesotho [1]–[3] and environmentally friendly, is utilized for the uplifting of socio-economic situation of Basotho. Daily solar radiation in Lesotho is between 5 kWh/m^2 and 7 kWh/m^2 with daily sunshine hours ranging between 10.2 and 13.8 hours [3]. Its intensity on the ground is variable in space and time, as the time of the day influences it, day of the year including the surrounding geo-physical environment including the orientation of the surface on which it is falling on.

Harnessing of solar power for social development has a myriad of advantages over other renewable sources of energy [3]. Solar power can be harvested almost anywhere whereas harnessing of wind power, and hydropower including geothermal power is limited only to specific geographic locations where these resources are economically viable. However the amount of solar energy reaching the surface of the earth is not the same on yearly basis [4] due to the varying weather patterns. As a result , for a successful design of a solar process application, a good knowledge of solar energy patterns at a location of interest is of paramount importance [5]. Investors need solar radiation information for the design of solar application project. This information is also important for the banks so that they can endorse the loan.

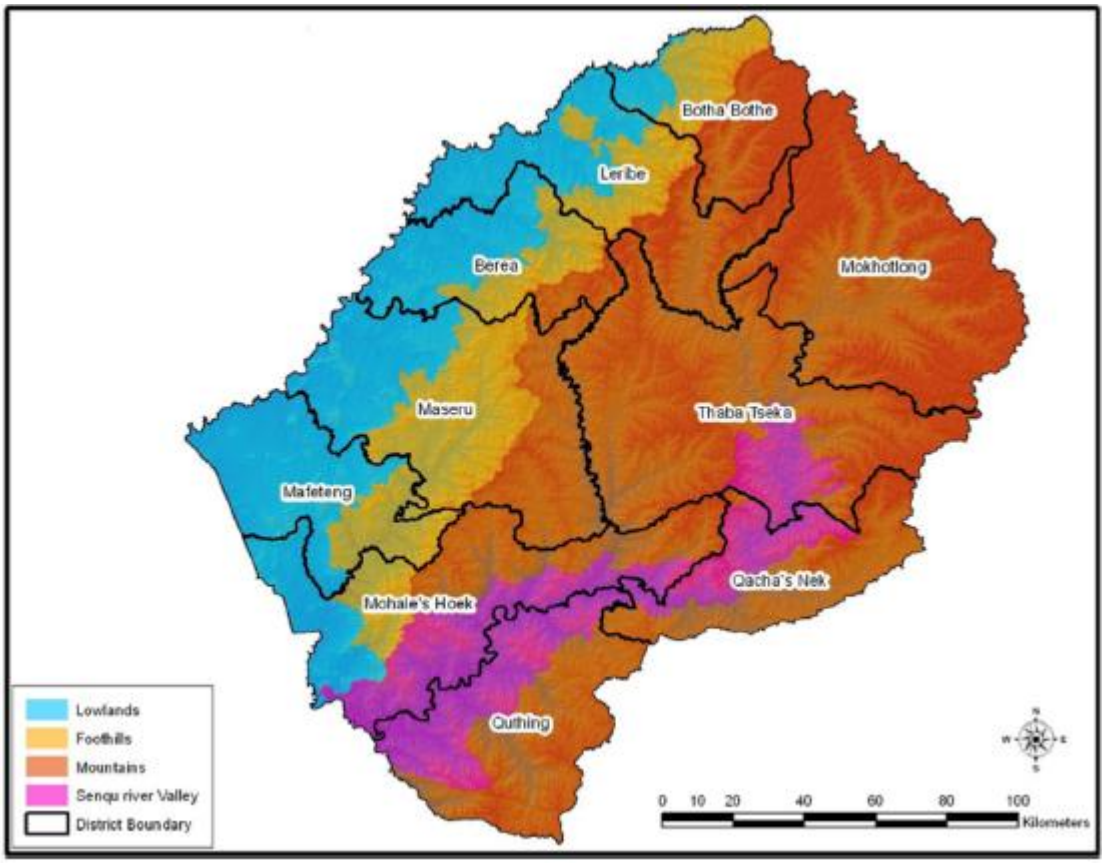


Fig 1.1. 1 A map of a study area showing administrative districts and ecological areas

Source : P. P. Zhou and T. Simbini, [6]

The research study covers the entire country of Lesotho that lies between longitude 27° east to 29.5° east and latitude 28.5° south to 30.75° south. This area is mountainous characterized by valleys with deep slopes and gorges, making it largely inaccessible using modern transport like cars and buses. It is the area with altitude ranging between 1300 m and 3482 m above sea level comprising of four ecological regions; lowlands, foothills, mountains and the Senqu valley [2]. This terrain hinders the speedy socio-economic development of the communities such as development of modern power supplies like electricity, running water supply and road infrastructure.

The study area has only seven solar radiation measuring stations, due to the high cost of acquiring and maintaining these stations. The Lesotho Meteorological Services (LMS) operates and maintains four stations and the Lesotho Highlands Development Authority (LHDA) operates and maintains the other three solar radiation stations.

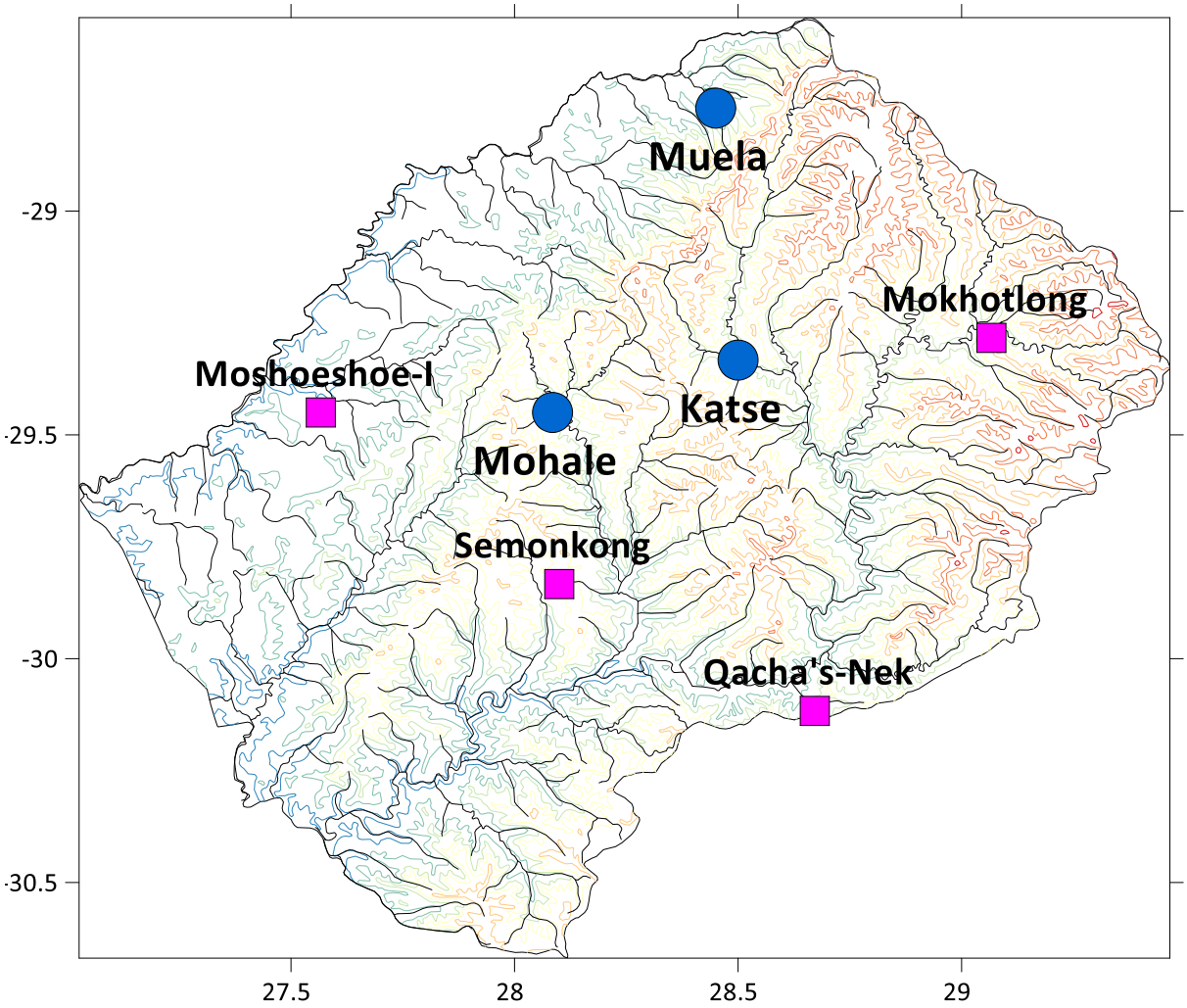


Fig 1.1. 2 Station network distribution of ground solar radiation in Lesotho.

Fig 1.1.2 shows distribution of solar radiation measuring sites in Lesotho. LMS manages magenta coloured ground solar radiation stations and LHDA manages blue coloured ground solar radiation stations.

As the basis for ground – measured solar radiation, database developed by Gopinathan [7] is used. Since it does not cover the entire study area interpolation using Surfer software [8], [9] is used, since it is a common practice to estimate solar radiation [10] by fill data gaps, where there is no ground-measured solar radiation data [11]–[15]. In order to establish a reliable and robust solar radiation database [15], [16] in the study area, a combination of satellite – derived database and Gopinathan [7] modelled solar radiation database are used.

Harnessing of solar energy has a potential of changing the general socio-economic status quo of Basotho nation [17]. It is therefore important to have a robust and reliable

solar radiation database for Lesotho. Solar radiation database is important for an effective and optimal design of a solar process application and for a proper choice of appropriate materials.

There are several solar application processes, which have significant potential in the development of socio-economic activities of Basotho nation [2], [3], [18]–[20]. Electricity power generation for different applications, solar water heating and different solar drying applications are amongst the distinct solar application processes in Lesotho. These solar process applications are at different infant stages [21]. As a result, this research study addresses the problem of lack of reliable solar radiation data in Lesotho to increase investor confidence to fund them since only 23 % of Basotho have access to clean energy [22].

1.1 Objectives of the study

This research study has the following objectives

- Development of solar radiation database for Lesotho
- Development of an interpolation tool that estimates solar radiation at any location in Lesotho.

The research study has the following specific outcomes:

- The improved solar radiation database of Lesotho.
- The improved solar radiation map of Lesotho.
- An interpolation application tool, which estimates solar radiation at any location.
- The integration of solar radiation database into one of the solar process application.

In Lesotho, due to the absence of reliable solar radiation ground – measured data, design and development of solar process applications is based on satellite – derived data and non-standardized interpolation techniques. As a result, similar solar projects implemented by different sources, have different project designs. It is therefore important that this research study establishes one source of solar radiation data and an interpolation tool so that results from similar projects have similar outcome. With

good solar radiation database, the design of any solar process application is optimally sized hence ensures the project's economic viability.

Major contribution of this research study is the building of a robust solar radiation database constructed from both ground – derived solar radiation data and satellite – derived solar radiation data. Another contribution of this study is the development of an interpolation application tool, which eases the processes of estimating solar radiation and its integration into solar process application anywhere in Lesotho.

Using the combination of the already developed ground solar radiation database by Gopinathan [7] and the satellite-derived ground solar radiation, the empirical model which best simulates ground solar radiation anywhere in Lesotho will be developed to build an improved solar radiation database for Lesotho.

1.2 Importance of this study

Direct measurements of solar radiation are not available for long periods in Lesotho, especially in the remote villages where solar process applications such as implementation of socio-economic uplifting projects, like solar harvesting for power generation are vital. The design and techno-economic implementation of such projects depend on the amount and quality of the available solar resources for the sound resource harvesting projections and materials to be used. There are readily available solar radiation databases such as NSRDB, NASA – SSE and PVGIS [23], [24]–[26] but these databases do not take full cognisance of local climate variability in space due to the existing mountains and valleys [27] . Taking cognisance of local climate is important for the techno-economic design of such applications as a proper storage size and estimation and frequency of the occurrence of extreme weather phenomenon are taken into account. The basis of this research is to provide solar radiation information for determining areas with highest solar harvesting potential.

1.3 Scope and structure of the dissertation

The research study covers the entire country of Lesotho, from latitude 28.5° south to 30.75° south, and between longitudes 27.0° east and 29.5° east. The study is based on the assumption that there is strong correlation between ground clearness index and satellite clearness index as published by Hove et al [15] in 2014. This study employs 5355 grid-points at 0.05° x 0.05° resolution. Sources of ground solar radiation data are the Lesotho Meteorological Services (LMS) and Lesotho Highland Development Authority (LHDA).

The dissertation is structured such that it has five chapters namely, introduction, literature review, methodology, results and discussions and the conclusion and recommendation.

Chapter one gives the description of the study area and the background on solar radiation database and its integration into solar application processes. It also provides the objectives and outputs of the research including the rationale behind the study and a brief contribution of the study to solar radiation database in Lesotho. It gives the motivation of the study and shows a need for an updated solar radiation database in Lesotho. It also details the scope, contents and structure of the entire dissertation.

Chapter two provides a review of the previous work done on solar radiation. It provides a theoretical background of solar radiation as an introduction to the building of solar radiation database in Lesotho. It gives details on previous solar radiation database built by Gopinathan [7] and shows the weakness of this database and proposes its improvement based on the merging of satellite – derived data and ground – derived data. It also details standard methods, which verify the reliability and confidence of solar radiation database and a background on bilinear interpolation technique. It gives a brief on the standard equipment used for measurement of solar radiation and sunshine duration. It gives a brief on measurement of solar radiation and sunshine duration in Lesotho. It also provides an inside into the application of solar radiation into solar water heating system model as an example of a solar application process.

Chapter three details the procedure and methods used in conducting this research. It first summarizes the process followed then describes the study area and the existing solar radiation climate record in Lesotho. It then details the development of solar radiation database for Lesotho based on the research – derived ground solar radiation data and satellite – derived solar radiation data. It finally describes the generic development and integration of the bilinear interpolation tool into a solar process application using Microsoft Excel software application.

Chapter four presents the discussions and results obtained after conducting the research including the integration of the developed solar radiation database into a solar process application.

Chapter five provides the conclusion and recommendations for the improvement of the developed solar radiation database.

Chapter Two: Solar radiation overview

The earth receives its energy from the sun in the form of solar radiation which is in the wavelength between 0.25 μm and 3.0 μm [28]. This is an important energy source as it has a myriad of applications, which affect humankind and the geo-physical environment. Examples of such applications are in; general science, meteorology, engineering, water resources management and other solar harnessing processes such solar hot water systems and solar water pumping systems. According to the energy policy of the Government of Lesotho [17], solar energy application is given a high priority in the design of new buildings. Amongst other targets of the policy is the replacement of energy intensive equipment like electricity geysers with solar water heating systems. The National Electrification Master Plan of the Government of Lesotho [29] seeks to increase electricity generation from solar in order to increase the percentage of Basotho with access to clean energy from 23 % [22], [30], [31]. For the successful implantation of the National Electrification Master Plan, there should be a robust and reliable solar radiation database. This research seeks to establish a solar radiation database based on the combination of satellite – derived data and ground – derived data.

2.1 Solar radiation theory

The sun is the source of all forms of life on the planet earth as it fuels it with a constant source of solar energy (G_{sc}) of about 1367 Watts per square meter (1367 W/m^2) in the wavelength ranging between 0.25 µm and 3.0 µm [28]. However not all of the energy from the sun reaches the earth's surface as part of it gets absorbed, scattered and diffused by atmospheric aerosols (Carbon dioxide, Oxygen, Water vapour, Carbon Monoxide, dust particles etc.), as shown in Fig 2.4.1.

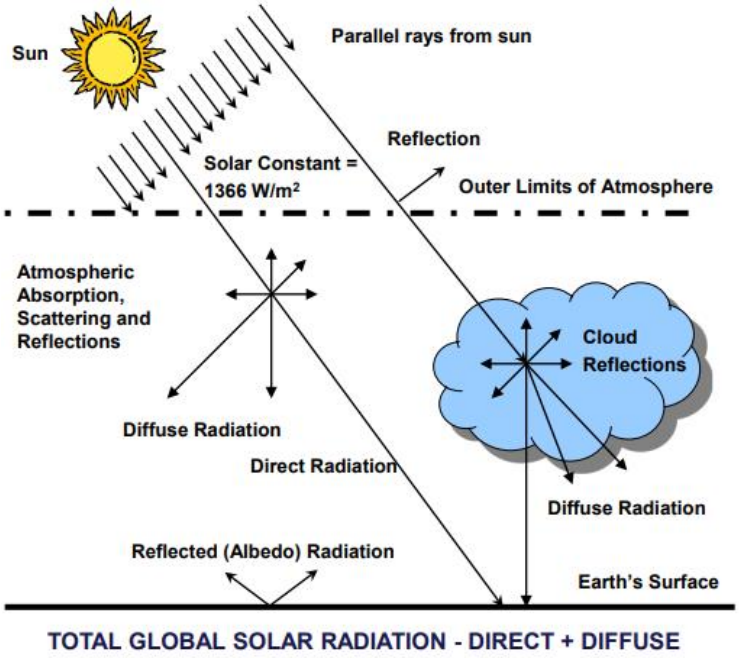


Fig 2.1. 1 Solar radiation components

Fig 2.1.1 shows solar radiation components as they travel through the atmosphere. The total solar radiation from the sun is the absorbed solar radiation component, the reflected solar radiation component, the scattered solar radiation component and the diffused solar radiation component. The diffused solar radiation component and the scattered solar radiation component are due to the presence of aerosols and other atmospheric gases as shown in Fig 2.1.1. The total solar radiation reaching the ground is determined by several environment factors such as the prevailing weather conditions, atmospheric aerosols and the geophysical location including the climatological conditions.

The solar radiation at the top of the atmosphere referred to as the normal extra-terrestrial solar radiation ($\boldsymbol{G_{on}}$), is the product of a solar constant ($\boldsymbol{G_{SC}}$) and a correction factor ($\boldsymbol{\varepsilon}$) due to the earth's orbit [32], as shown in equation (1).

$$\boldsymbol{G_{0n} = G_{SC}\varepsilon} \quad \text{---------- (1)}$$

According to Spencer [33] the correction factor is the eccentricity of the earth (ε) is given by

$$\varepsilon = (\mathbf{1.00011} + \mathbf{0.034221}\cos \boldsymbol{B} + \mathbf{0.001280}\sin \boldsymbol{B}) + \mathbf{0.000719}cos\mathbf{2}\boldsymbol{B} + \mathbf{0.000077}sin\mathbf{2}\boldsymbol{B} \quad (2)$$

Where ***B*** is in radians given by

$$\boldsymbol{B} = \frac{\mathbf{360}}{\mathbf{365}}(\boldsymbol{n} - \mathbf{1}) \quad (3)$$

According to Duffie [28], the correction factor ($\boldsymbol{\varepsilon}$) can be estimated as

$$\varepsilon = \mathbf{1} + \mathbf{0.033}\cos\left(\frac{\mathbf{360}\boldsymbol{n}}{\mathbf{365}}\right) \quad (4)$$

Thus equation (1) can be written as

$$\boldsymbol{G_{0n}} = \boldsymbol{G_{SC}}\left(\mathbf{1} + \mathbf{0.033}\cos\frac{\mathbf{360}\boldsymbol{n}}{\mathbf{365}}\right)\cos\boldsymbol{\theta_z} \quad (5)$$

Throughout this research equation (5) is referred to as

$$\boldsymbol{G_0} = \boldsymbol{G_{SC}}\left(\mathbf{1} + \mathbf{0.033}\cos\frac{\mathbf{360}\boldsymbol{n}}{\mathbf{365}}\right)\cos\boldsymbol{\theta_z} \quad (6)$$

Where

$\boldsymbol{G_{SC}}$ = 1367 W/m^2

$\boldsymbol{n}$ - is the day number in the year

$\boldsymbol{\theta_z}$ - is the Zenith angle of the sun, given by

$$\cos\theta_z = \cos\emptyset cos\delta cos\omega + \sin\emptyset\sin\delta \quad (7)$$

Where

$\emptyset$ - is the latitude defined as the angular location south or north of the equator, such that$-90^{\circ} \leq \emptyset \leq 90^{\circ}$. South is (-) negative and north is (+) positive.

$\boldsymbol{\omega}$ **-** is the angular hour angle, defined as the angular position of the sun, due east or due west of the local meridian. It is negative before noon and positive in the afternoon. It increases by 15° every hour and is calculated by:

$$\boldsymbol{\omega} = \mathbf{15}^{\circ}\,\Delta\boldsymbol{t} \quad (8)$$

Where

Δt - is the time interval

Since sunset and sunrise occur when the zenith angle is 90°, [34] then equation (1) can be written as

$$\omega_s = cos^{-1}(-\tan\delta\, tan\emptyset) \quad \text{---------- (9)}$$

Where

δ - is the angular declination of the sun [18], given by

$$\delta = 23.45 \sin\left(360\frac{284+n}{365}\right) \quad \text{---------- (10)}$$

Where n is the day number of the year with n = 1 on the 1st January.

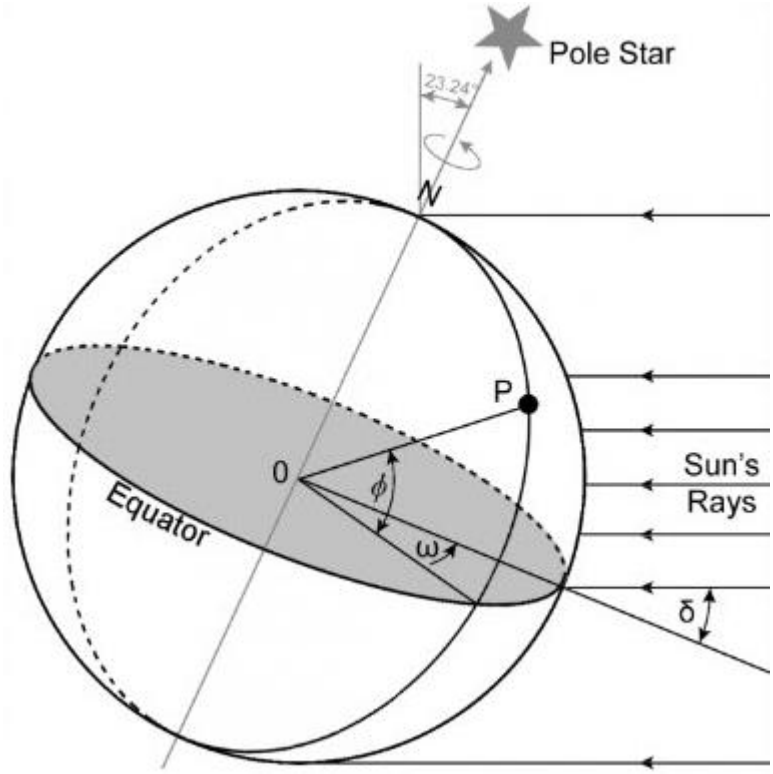


Fig 2.1. 2 Angles defining the position of the sun

Fig 2.1.2 shows angles defining the position of the sun. The location of the observer at point P with respect to the sun's rays can be found if the latitude (Ø) and the hour angle at that point (P) and the sun's declination angle are known. The angular distance of point P measured from the center of the earth, south or north of the equator is the latitude (Ø) of point P. The angle, which the earth turns such that the meridian of point P is perpendicular to the sun's rays, is the hour angle given by equation (8). The

angular distance of the sun's rays relative to the equator south (or north) gives the sun's declination angle (δ) given by equation (10).

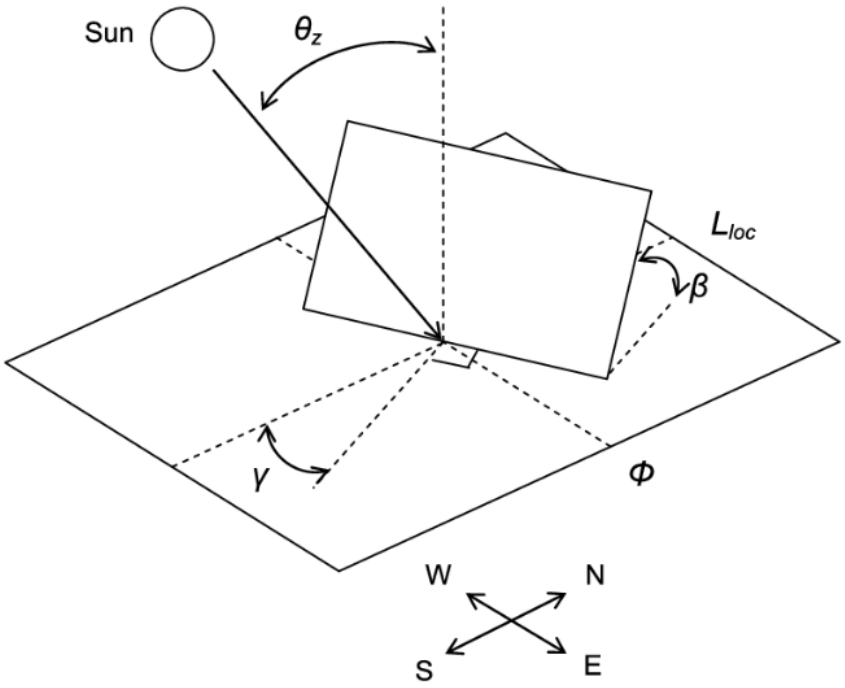


Fig 2.1. 3 Angels defining position of the sun relative to cardinal points

Fig 2.1.3 shows angles defining the position of the sun relative to the cardinal points.

From Fig 2.1.3 the Zenith angle (θ_z), is the angle of incidence of beam radiation on a horizontal surface. It varies according to the location of point P on the earth's surface relative to the position of the sun. As a result, it can be deduced from equation (7). At solar noon, the zenith angle is equal to the difference between the latitude angle and the solar declination angle. When the sun is directly overhead it said to be at the Zenith.

The slope (β), is the angle of interest between the plane of the surface and the horizontal plane such that $0 \leq \beta \leq 180°$.

The surface azimuth angle(γ), is the deviation of the projection on a horizontal plane of the normal to the surface from the local meridian, with zero due south, east negative and west positive such that $-180° \leq \gamma \leq 180°$.

2.1.1 Equation of time and apparent solar time

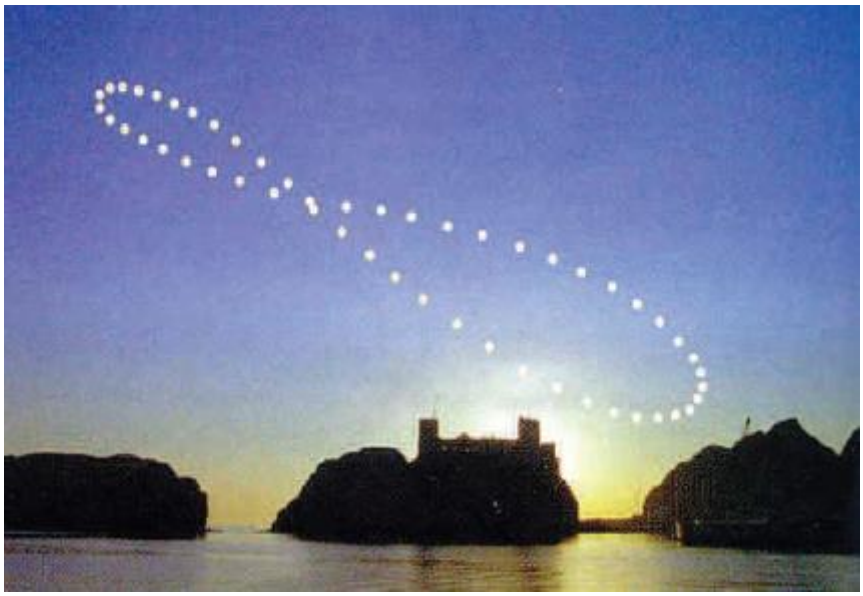


Fig 2.1. 4 The annual positions of the Sun relative to the fixed ground observer.

Source: Tingilinde [35].

Fig 2.1.4 shows the annual positions of the sun relative to the fixed observer on the ground. It illustrates how the sun's position changes across the sky. This is due to the elliptical orbit of the earth around the Sun and the tilting of the Earth on the fixed axis. As a result, on different days, the sun does not have the same position relative to the observer on the ground at 12 noon. This picture was constructed by taking a picture of the sun using a fixed camera on the same time throughout the year; then 365 pictures, are superimposed to make a single picture.

From equations (8) – (10), the hour angle is not the same throughout the year because the Earth rotates around the sun around the fixed axis. As a result, a solar day is the total time taken by the earth to rotate itself around the fixed axis around the sun. This total time does not always equal to 24 hours as it changes every year.

The graph shown Fig 2.4.4 is defined by the equation of time (E_t). According to Igbal [36], the equation of time is given by

$$E_t = 229.2(0.000075 + 0.001868\cos B - 0.032077\sin B - 0.014615\cos 2B - 0.04089\sin 2B) - - (11)$$

Where B is given by equation (3).

Observation of solar radiation measurements is at local standard times. As a result, it is important to establish a local apparent time (also called the true solar time) in terms of the equation of time. The correction is needed because there is a difference between the local longitude, (L_{loc}) and the standard time meridian's longitude (L_{stm}). The local apparent time (L_{at}) is calculated by taking cognisance of the standard time's longitude (L_{st}).

According to Igbal [36], the local apparent time (L_{at}) is given by

$$L_{at} = L_{st} \pm (L_{stm} - L_{loc}) + E_t \quad ----------(12)$$

Such that the equation of time (E_t) is given by equation (10).

In equation (11), "+" applies if the required apparent time is at the location west of the standard time meridian (Lstm). The "−" applies if the required apparent time is at the location east of the standard time meridian (Lstm). All the variables in equation (11) are expressed in hours.

According to Duffie [28], the difference in minutes in equation (11) is given by

$$Solar\ Time = 4(L_{st} - L_{loc}) + E_t + \ Standard\ Time = ------(13)$$

2.1.1.1 The hour angle

According to Igbal [36], the hour angle in equation (8) can be written as

$$\omega = 15(12 - L_{at}) \quad ----------(14)$$

Where

L_{at} – is the apparent local time calculated by equation (12).

Equation (14) gives the angular distance of the sun due to the earth's rotation on its axis at 15° per hour east or west of the local meridian. Before noon, it is negative and positive in the afternoon.

2.1.1.2 The declination angle

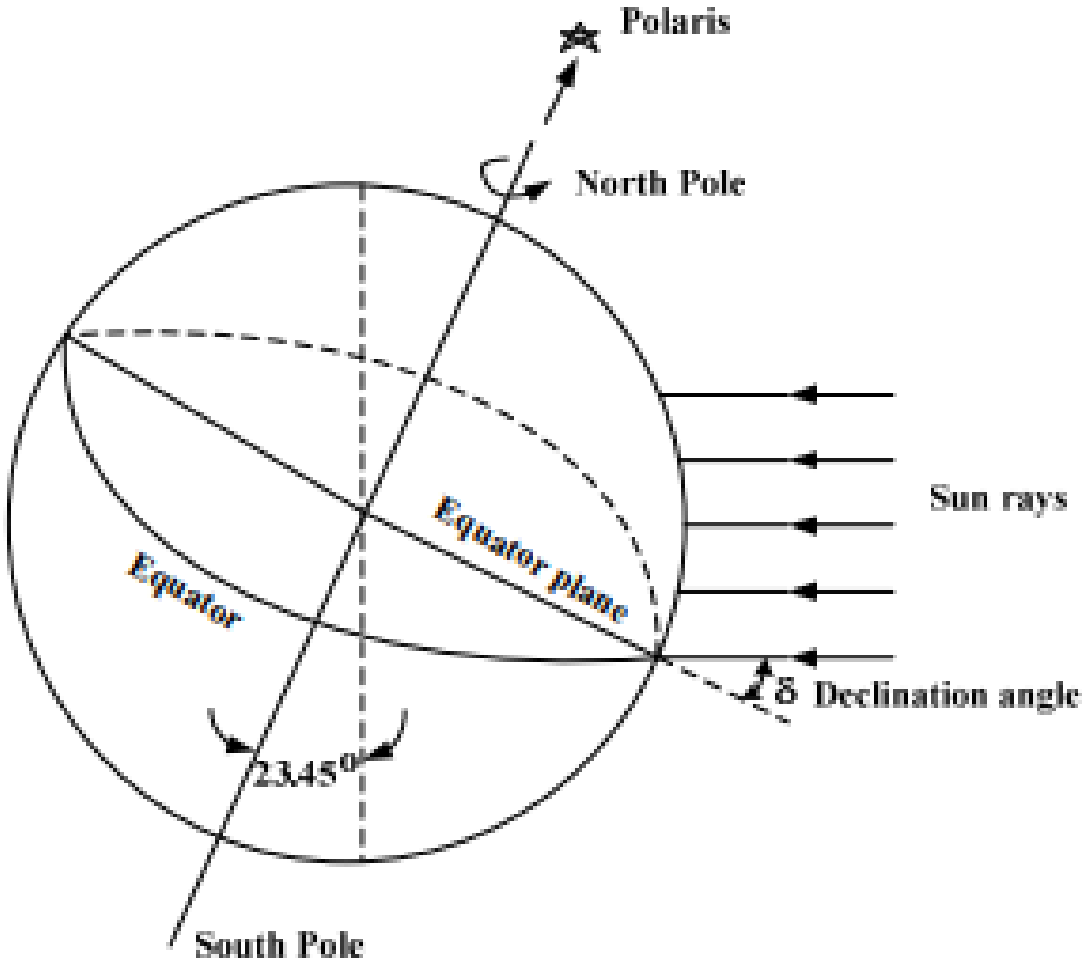


Fig 2.1. 5 The solar declination angle

Source: Karafil et al [37].

Fig 2.1.5 shows the solar declination angle (δ). It is the angle between the path of sunrays and the equatorial plane. It is varies due to the earth's rotation angle on a fixed orbital axis. The southerly direction has a negative value, with a minimum of − 23.45° during the winter solstice approximately on the 21st June and a maximum of +23.45° during summer solstice approximately on the 21st December.

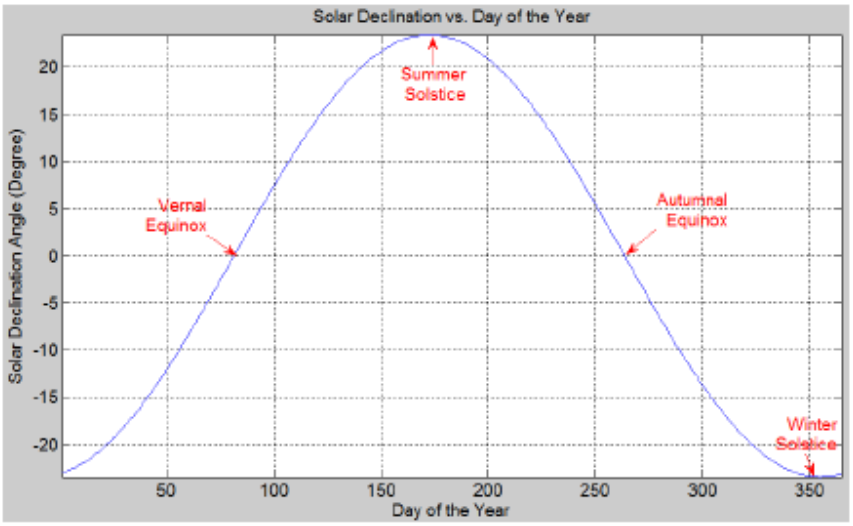


Fig 2.1. 6 Annual variation of declination angle in the northern hermisphere

Source: Karafil et al [37].

Fig 2.1.6 shows an annual variation of the declination in the northern hermisphere. Twice every year the declination angle is zero at the equator during the equinox. This condition occurs on the 20th March (autumn equinox) and on the 23rd September (vernal equinox) [37].

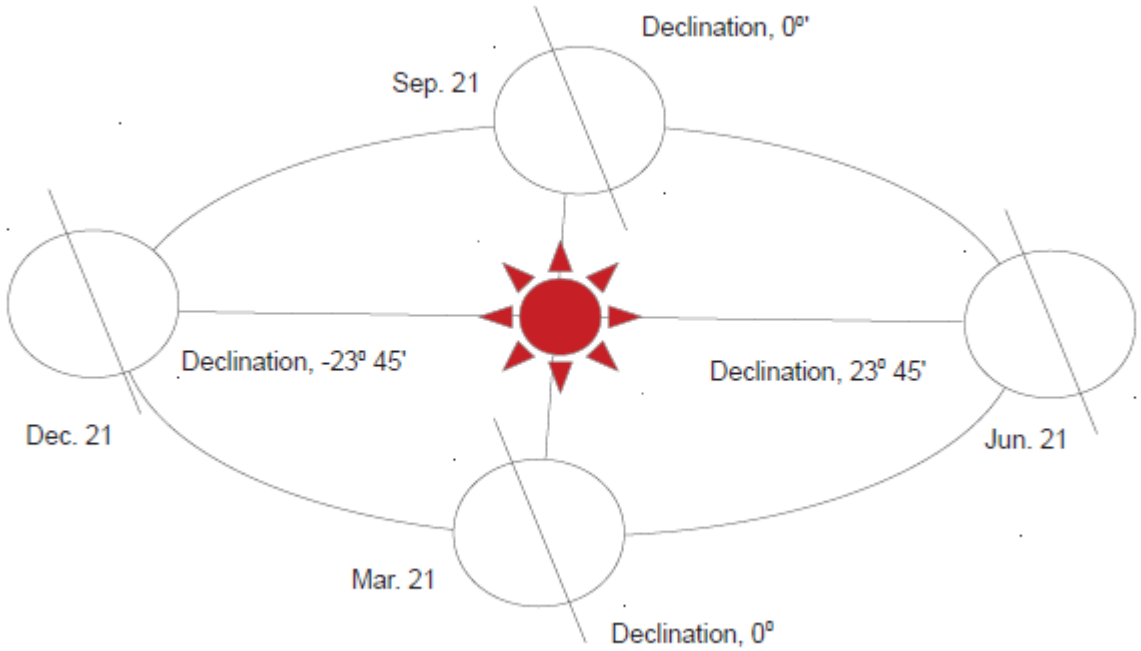


Fig 2.1. 7 Declination angles (δ) at different times of the year

Source : Seyed et al. [38]

Fig 2.1.7 shows declination angles ($\boldsymbol{\delta}$) at different times of the year. During each equinox, at the equator, day-length and night-length are equal, as the declination angle equals zero (0) and the latitude is zero (0). The hour angle ($\boldsymbol{\omega_s}$) is 90^o at 12 noon during the equinox.

Throughout the year, the declination angle is given by equation (10) such that$-23.45° \leq \delta \leq 23.45°$.

2.1.2 Total (global) solar radiation

From Fig 2.1.1, when solar radiation from the sun enters the earth's atmosphere, part of it either gets absorbed, reflected or diffused by the atmospheric constituents and the rest reaches the earth's surface. As a result the total solar radiation emitted by the sun ($\boldsymbol{G_t}$) is the sum of all solar radiation which reach the surface (beam solar radiation) of the earth and that which gets diffused. The total solar radiation that reach the earth is schematically shown in Fig 2.4.8.

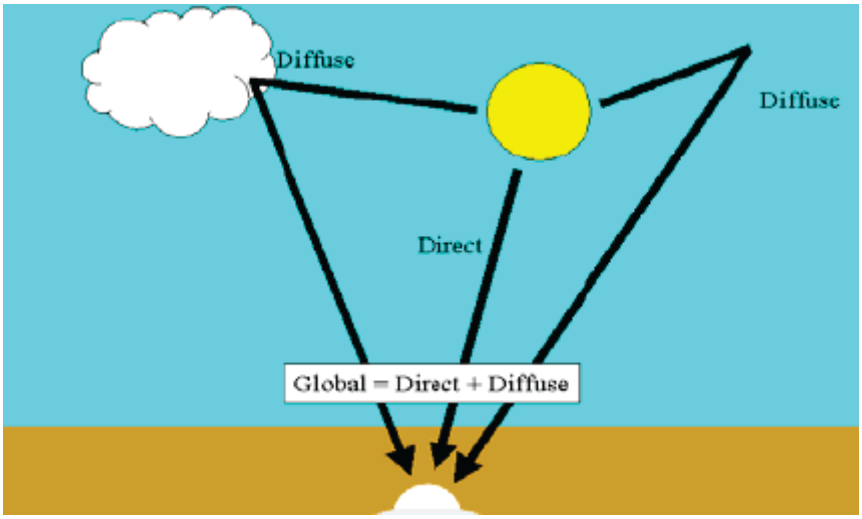


Fig 2.1. 8 Total solar radiation reaching the surface of the earth.

Fig 2.1.8 shows a total solar radiation reaching the surface of the earth. From Fig 2.1.8, the total (global) solar radiation ($\boldsymbol{G_t}$), is the sum of the direct beam ($\boldsymbol{I_b}$), and the diffuse solar radiation ($\boldsymbol{I_d}$).

$$G_t = I_b + I_d \quad (15)$$

Where

G_t – is the total (global) solar radiation emitted by the sun.

I_b – is the beam radiation absorbed by surface of the earth.

I_d – is the diffused radiation by atmospheric constituents.

2.1.2.1 Direct (beam) solar radiation

A direct (beam) solar radiation (I_b) is part of the solar radiation that passes straight through the atmosphere and eventually reaches surface of the earth. It reaches the surface of the earth without any atmospheric attenuation or any disturbance. The amount of direct solar radiation reaching the surface of the earth is the function of the point's latitude (∅), the sun's declination angle (δ) and the surface's characteristics. In order to estimate its amount, the knowledge of its intensity and direction at different times of the day is required [39].

2.1.2.2 Diffuse solar radiation

When solar radiation enters the earth's atmosphere, part of it is scattered or absorbed by the atmospheric constituents. The diffuse solar radiation (I_d) is the scattered component of the solar radiation. Part of the diffuse solar radiation is randomly reflected into different directions back into space and another part of it reaches the earth's surface. Near the surface of the earth in the absence of beam solar radiation objects do not have sharp shadows due to the presence of the scattered solar radiation.

2.1.2.3 Clearness index

The clearness index ***(K)*** determines how transparent the prevailing atmospheric conditions are. It is a dimensionless number which is gives a fraction of solar radiation which goes through and reaches the surface of the earth. It is defined as the ratio of the surface radiation on a horizontal surface to corresponding the horizontal extra-terrestrial radiation [40],[36]. This ratio of the incoming solar radiation at the top of the atmosphere (G_t) to the ratio of solar radiation reaching the ground (I_t) determines the

amount of solar radiation reaching the ground (**K**). This ratio is the atmospheric clearness index [15], [40], [41]. Thus

$$Clearness\ Index = \frac{Solar\ radiation\ reaching\ the\ ground}{Solar\ radiation\ at\ top\ of\ the\ atmosphere}$$

$$K = \frac{G_t}{I_t} ------------------------ \quad (16)$$

The clearness index determines fluctuations in solar radiance due to the presence of impurities in the atmosphere. It indicates the ratio of the actual solar radiation on the earth's surface to the originally emitted solar radiation. It determines the transparency of the prevailing atmospheric conditions to the solar radiation. It provides the relationship between the actual solar radiation on the ground and the solar radiation originally available at the top of the atmosphere [40].

In 2008, Ianetz and Kudish [42] showed that clearness index is a function of the prevailing weather conditions, which in turn depends on the solar and site altitude, the ground albedo, cloudiness and the atmospheric transparency [43]. The atmospheric transparency depends on the amount of water vapour and the amount of aerosol in the atmosphere excluding the amount of clouds. They further established that the relative magnitudes of the measured global solar irradiation and the extra-terrestrial solar irradiation on a clear day, provides a platform for studying the influence of cloudiness on global solar irradiation. As a result, they concluded that the magnitude of the global solar irradiation on clear day gives a good estimation of maximum available solar energy on a particular day as shown in table 2.5.2.

Table 2.1. 1 Classification of sky condition according to clearness index

Source: A. Ianetz and A. Kudish [42]

Sky condition	**Clearness Index(K)**
Clear sky	0.7 ≤ K < 0.9
Partly cloudy sky	0.3 ≤ K < 0.7
Cloudy sky	0.0 ≤ K < 0.3

Table 2.1.1 shows classification of sky condition as defined by the clearness index.

From table 2.1.1, the clearness index can be used to complement human-observed sky condition [41], [44], [45] as in most countries sky condition is measured by human using World Meteorological Organization (WMO) guidelines only three times a day [46], [47].

Table 2.1. 2 WMO classification of cloud cover in terms of oktas and tenths

Source: WMO [46]

Code	Oktas	Amount of sky covered (tenths)
0	0	0
1	1	1/10 or less but not zero
2	2	2/10 – 3/10
3	3	4/10
4	4	5/10
5	5	6/10
6	6	7/10 – 8/10
7	7	9/10 or more but not 10/10
8	8	10/10
9	Sky obscured by weather elements such as fog. In this case cloud cover is indiscernible for reasons other than fog or other meteorological phenomena, or observation is not made	

From table 2.1.2, it can be inferred that for an ideal weather condition where the atmosphere is considered to be perfectly clear, that is, the cloud code is zero and there are no aerosols or water vapour in the atmosphere, the clearness index is one. This means, the clearer the sky, the higher is the clearness index. As a result, the clearness index is an important factor in the analysis of solar radiance.

The clearness index from equation (16) can be expressed on hourly basis [32], daily basis or monthly basis such that

The hourly clearness index (K_h) is given by

$$K_h = \frac{G_h}{G_{oh}} \quad (17)$$

The daily clearness index (K_d) is given by

$$K_d = \frac{G_d}{G_{od}} \quad \text{---------- (18)}$$

The monthly clearness index (K_m) is given by

$$K_m = \frac{(G_d)_m}{(G_{0d})_m} \quad \text{---------- (19)}$$

Where

G_h, is the global hourly ground irradiation

G_d, is the total daily ground irradiation

$(G_d)_m$ is the total monthly ground irradiation

G_{oh}, is the global hourly extraterrestrial irradiation

G_{od}, is the total daily extraterrestrial irradiation

$(G_{od})_m$ is the total monthly extraterrestrial irradiation

From equation (18) – (20) we can write monthly clearness index as

$$K_m = \frac{\bar{H}}{\bar{H_0}} = \frac{(G_d)_m}{(G_{0d})_m} \quad \text{---------- (20)}$$

2.1.3 Solar radiation on a horizontal surface

From equations (6) and (7), on any given day and time, between sunrise and sunset, G_0 is given by

$$G_0 = G_{SC}\left(1 + 0.033\cos\frac{360n}{365}\right)(\cos\emptyset\cos\delta\cos\omega + \sin\emptyset\sin\delta) \quad \text{----- (21)}$$

From equation (21), the total daily solar radiation (H_0) on a horizontal plane from sunrise until sunset is given by

$$H_0 = \frac{24\,x3600G_{sc}}{\pi}\left(1 + 0.033\cos\frac{360n}{365}\right)\left(\cos\emptyset\cos\delta\sin\omega_s + \frac{\pi\omega_s}{180}\sin\emptyset\sin\delta\right) \quad \text{---(22)}$$

The total daily extraterrestrial radiation on a horizontal plane is thus, written as

$$\boldsymbol{H_0 = \frac{24}{\pi} G_0 \left(cos\emptyset\ cos\ \delta\ sin\ \omega_s + \frac{\pi\omega_s}{180} \sin\emptyset \sin\delta \right)} - - - - - - - - - - - - - (23)$$

The monthly mean daily extraterrestrial solar radiation ($\overline{H_0}$) on a horizontal plane [48] is thus given as

$$\boldsymbol{\bar{H}_0 = \frac{24\ x3600 G_{sc}}{\pi} \left(1 + 0.033\ cos\frac{360n}{365}\right) \left(cos\emptyset\ cos\delta \sin\omega_s + \frac{\pi\omega_s}{180} \sin\emptyset \sin\delta \right)} - - (24)$$

Where

$\boldsymbol{G_{sc}}$ – Is the solar constant = 1.367 kW/m^2

$\boldsymbol{n}$ – Is the day of the year which varies between 1 and 365.

$\emptyset$ – Is the latitude defined as the angular location south or north of the equator, such that $-90^\circ \leq \emptyset \leq 90^\circ$. South is (**-**) negative and north is (**+**) positive.

$\boldsymbol{\omega}$ – Is the angular hour angle, defined as the angular position of the sun, due east or due west of the local meridian. It is negative before

$\boldsymbol{\delta}$ – Is the angular declination of the sun [18], given by equation (10)

Such that the mean value of the ***n***th day of the year, given in table 2.4.1.

Table 2.4. 1 Table of monthly average day (*n*)

Source: Klein [19]

Month	***n* for *i*th day of the month**	**Monthly mean day**		
		Date	***n***	$\boldsymbol{\delta}$
January	*'i*	17	17	-20.9
February	*31 + i*	16	47	-13.0
March	*59 + i*	16	75	-2.0
April	*90 + i*	15	105	9.4
May	*120 + i*	15	135	18.8
June	*151 + i*	11	162	23.1
July	*181 + i*	17	198	21.2
August	*212 + i*	16	228	13.5
September	*243 + i*	15	258	2.2
October	*273 + i*	15	288	-9.6
November	*304 + i*	14	318	-18.9
December	*334 + i*	10	344	-23.0

Table 2.4.1 shows monthly mean day of each month as explained in Klein [19]. The monthly mean day is the day which has a daily extra-terrestrial horizontal radiation nearly equal to the mean daily extra-terrestrial horizontal radiation for that particular month.

2.1.4 Solar radiation on a tilted surface

The total incident solar radiation ($\boldsymbol{H_T}$) on a tilted plane is the sum of all solar radiation which includes, the diffuse solar radiation from the sky, all the solar radiation which is being reflected from other objects in the direction of the tilted plane and the beam solar radiation commonly known as the direct normal solar radiation [28].

Thus

$$\bar{\boldsymbol{H}}_{\boldsymbol{T}} = \bar{\boldsymbol{H}}_{\boldsymbol{T,b}} + \bar{\boldsymbol{H}}_{\boldsymbol{T,r}} + \bar{\boldsymbol{H}}_{\boldsymbol{T,d}} \quad (25)$$

Where

$\bar{\boldsymbol{H}}_{\boldsymbol{T}}$ - is the monthly mean solar radiation incident on a surface.

$\bar{\boldsymbol{H}}_{\boldsymbol{T,b}}$ - is the beam radiation on the tilted surface.

$\bar{\boldsymbol{H}}_{\boldsymbol{T,r}}$ - is the reflected ground solar radiation on the tilted surface.

$\bar{\boldsymbol{H}}_{\boldsymbol{T,d}}$ - is the diffused solar radiation on the tilted surface.

The beam solar radiation ($\bar{H}_{T,b}$) on the titled surface is given by

$$\bar{\boldsymbol{H}}_{\boldsymbol{T,b}} = \bar{\boldsymbol{R}}_{\boldsymbol{b}}\, \bar{\boldsymbol{H}}_{\boldsymbol{b}} \quad (26)$$

Where

$\bar{\boldsymbol{R}}_{\boldsymbol{b}}$- is the ratio of monthly mean beam radiation on the tilted surface to that on the horizontal surface.

$\bar{\boldsymbol{H}}_{\boldsymbol{b}}$ - is the monthly mean beam solar radiation on a horizontal surface given by

$$\bar{\boldsymbol{H}}_{\boldsymbol{b}} = (\bar{\boldsymbol{H}}_{\boldsymbol{g}} - \bar{\boldsymbol{H}}_{\boldsymbol{d}}) \quad (27)$$

Where

$\bar{H}_g$ - is the monthly mean global solar radiation on the ground.

$\bar{H}_d$ - is the monthly mean diffuse solar radiation.

The ratio of the monthly mean beam solar radiation on a horizontal surface to that on the horizontal surface ($\bar{R}_b$), is proportional to the atmospheric transmittance [49] given by

$$\bar{R}_b = \frac{\bar{H}_{T,b}}{H_b} \quad (28)$$

Which can be calculated for surfaces facing towards the equator at the angle of 180° (azimuth angle $\gamma = 0$) [50], such that equation (16) becomes

$$\bar{R}_b = \frac{cos\theta}{cos\theta_z} = \frac{sin\,\delta \sin(\emptyset - \beta) + cos\,\delta cos(\emptyset - \beta)}{sin\delta sin\emptyset + cos\delta cos\emptyset cos\omega} \quad (29)$$

Where

δ – is the declination angle given by equation (7).

$\emptyset$ – is the latitude angle

β – is slope angle of the tilted surface

ω – is the hour angle given by equation (5)

Assuming that the intensity of solar radiation is the same in all directions, then in equation (15), the reflected solar radiation ($\bar{H}_{T,r}$) is the portion of solar radiation that is not absorbed by the surface of the earth and its objects such as mountains, buildings and vegetation. This portion of radiation is given by

$$\bar{H}_{T,r} = {}^{1}/_{2}\,\bar{H}_g \rho (1 - cos\beta) \quad (30)$$

Where

ρ – is the reflectance of the ground

$\bar{H}_g$ - is the monthly mean global solar radiation on the ground.

The reflectance of the ground (ρ) is 0.2 in hot and humid regions. It is 0.5 in dry regions and 0.9 in cold regions covered with snow [51].

The diffused solar radiation ($\bar{H}_{T,d}$) in equation (15) is the portion of solar radiation whose original direction from the sun has been changed by the atmosphere [28]. The amount of this solar radiation is not easy to determine, as it depends on the prevailing atmospheric weather conditions. Its overall amount depends on three components: the amount of isotropic diffuse radiation, the amount of circumsolar diffuse solar radiation and the horizon brightening. The isotropic diffuse solar radiation is assumed to be received equally in all directions around the atmosphere. The circumsolar diffuse radiation is received from the solar radiation directed towards the earth and is concentrated in the portion of the sky around the sun [28].

2.2 Solar radiation measurement

Solar radiation on the ground is measured using instruments called solar radiometers. The commonly used radiometers are pyrheliometers, pyranometers, pyrgeometers, albedometers, and radiometers [52], .

Fig 2.2. 1 A pyrheliometer instrument for measuring beam solar radiation.

Source : The Australian Government, Bureau of Meteorology [53]

Fig 2.2.1 shows a pyrheliometer for measuring beam solar radiation which is sometimes referred to as the direct solar radiation.

Pyrheliometers are solar radiation measuring equipment, which measure a beam solar radiation (I_b) refered to in equation (15). The Pyrheliometer measure solar radiation when

$$I_b = I_{bn} cos\theta_z \quad (31)$$

Where

I_b – is the total beam solar radiation

I_{bn} – is the direct normal radiation from the sun

θ_z – is the Zenith angle

They have a small aperture through which only the beam radiation can go through it. For it to measure the beam solar radiation, it always faces the sun. It has sensors, which tracks the position sun throughout the day.

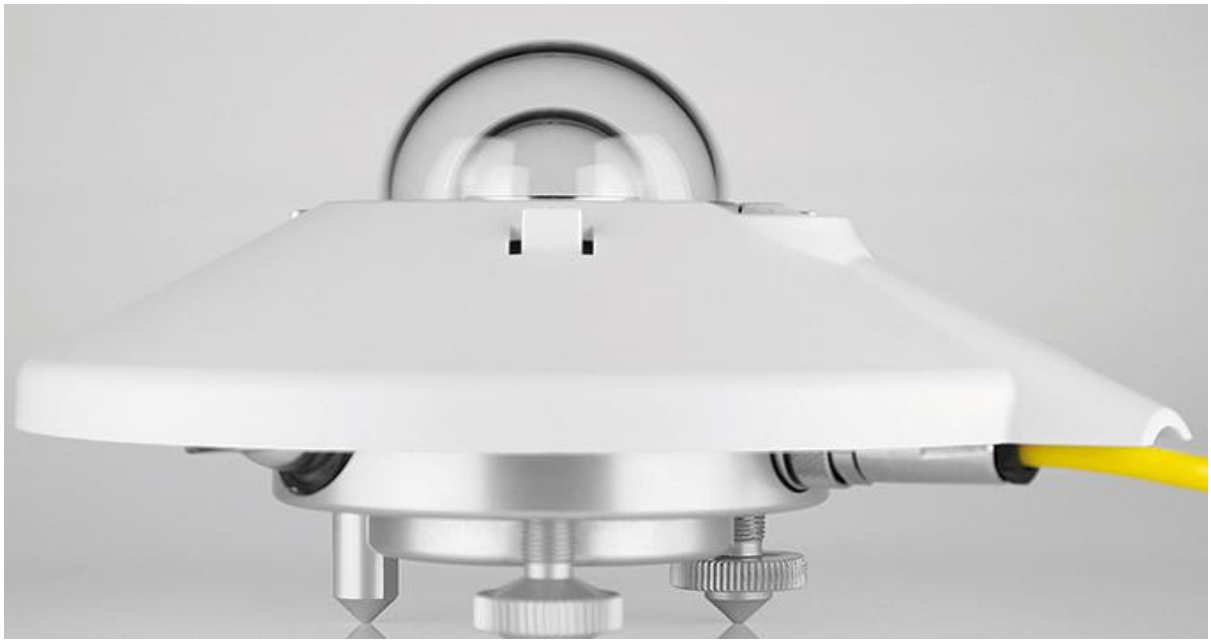


Fig 2.2. 2 A pyranometer instrument for measuring global (sky) solar radiation

Source: Kipp & Zonene [54]

Fig 2.2.2 shows a pyranometer instrument is used to measure global (sky) solar radiation (G_t) and diffuse solar radiation (I_d) described in equation (15). It measures solar radiation in the wavelength between 0.285 μm and 2.8 μm. It has a protective glass cover on the top so that solar radiation at sunrise and sunset is eliminated [55]. It measures solar radiation over the entire solar energy spectrum independent of the solar radiation's angle of incidence. They are covered with a uniform hemispherical cover, to carter for adverse weather elements [28]. On the top it has a transparent glass which gives a 180° horizontal field view for the measurement of the global solar radiation. Sensors under a shade of the pyranometer measure the diffuse radiation.

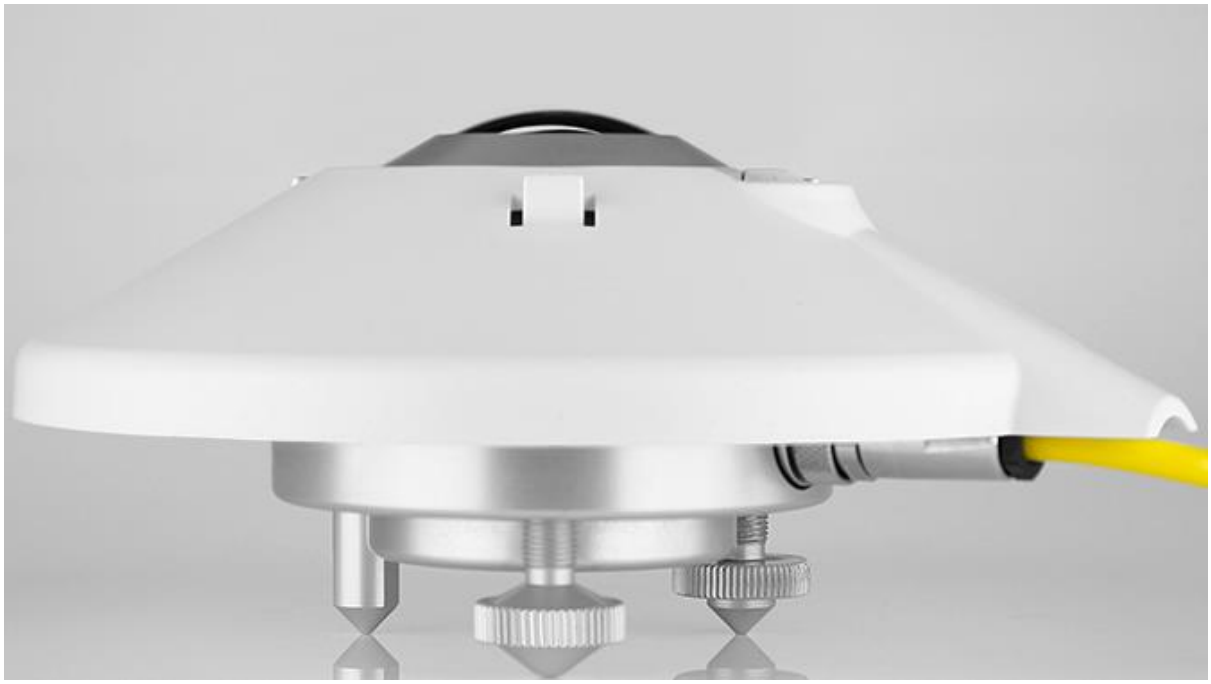


Fig 2.2. 3 A pyrgeometer for measuring terrestrial solar radiation.

Source : Kipp & Zonene [56]

Fig 2.2.3 shows a pyrgeometer for measuring terrestrial solar radiation in the wavelength between 4.5 μm and 100 μm (infra-red-spectrum). This is the radiation emitted from the earth's surface to the surrounding atmosphere.

Fig 2.2. 4 An albedometer for measuring reflected solar radiation

Source: Kipp & Zonene [57]

Fig 2.24 shows an albedometer used for measuring the reflected ground solar radiation in the wave length between 0.3 μm and 2.8 μm. It consists of two pyranometers placed back –to- back as shown in Fig 2.2.4. The bottom pyranometer measures the reflected solar radiation from the ground. It is positioned such that it does not have contact with the ground so that effects of ground temperature are eliminated.

Fig 2.2. 5 A radiometer for measuring the solar radiation balance.

Source: Kipp & Zonen [58]

Fig 2.2.5 shows a radiometer for measuring the difference between incoming solar radiation and the outgoing solar radiation. The upper part measures the incoming solar radiation and the bottom part measures the outgoing solar radiation.

Fig 2.2. 6 A sunshine recorder for measuring sunshine duration.

Source: The Australian Government Bureau of Meteorology [53]

Fig 2.2.6 shows a sunshine recorder used for the measurement of the time when sunrays are visible to the observer on the ground.

A sunshine recorder is another equipment which measures solar radiation indirectly as it measures the duration and period at which sunrays are visible to the observer on the ground [28] as depicted in equation (31). The duration of sunshine is the total time in which the sunrays are visible to the observer on the ground at any location.

Sunshine recorders are instruments made up of a solid spherical transparent glass with a 10 cm diameter as shown in Fig 2.2.3.It has three curved grooves which are used to hold the inserted special paper for reading the sunshine duration. The long curved grooves take the summer calibrated papers. The short curved grooves take the winter calibrated papers and the straight curved grooves take papers calibrated for sunshine duration the equinox months (March and September) This spherical glass act as a convex lens, which concentrates sunrays on a strip of treated paper, mounted on the opposite surface of the sphere. The sphere concentrates sunrays to burn a

trace on the paper which has hours and minutes marked on it. This paper is mounted into a slot such that the concentrated sunrays make a burnt on it on the appropriate hour and minute mark whenever the sunrays are incident on it. The summation of the burnt marks on the paper indicate the duration of the bright sunshine at the location of observation. That is the duration of clear sky in a day.

However, sunshine duration measurements are not accurate, as the sunshine recorder does not make any mark on the paper when there is not enough solar radiation especially early in the morning and late in the afternoon.

2.2.1 Measurement of solar radiation in Lesotho

Two institutions, the Lesotho Meteorological Services (LMS) and the Lesotho Highlands Development Authority (LHDA), take solar radiation measurements in the country. These institutions have just recently started collecting solar radiation. LHDA started measuring solar radiation in 2011 and LMS started in 2012. However, solar radiation measurements from these institutions are not continuous ever since the period of their existence after commissioning.

LHDA has installed solar radiation equipment at the following locations; Katse, Muela and Mohale. These stations measure only global solar radiation. Though not continuous, available solar radiation at Katse weather station's starts from 20th October 2005 to September 2017. Muela weather station's solar radiation data starts from the 21st December 2005 to September 2015, with periods of missing data. Available solar radiation data at Mohale weather station's starts from 1st October 2007 to 31st August 2017. Solar radiation at Mohale weather station also has many periods of missing data.

LMS has solar radiation measuring equipment at these locations; Moshoeshoe I, Qacha's Nek, Mokhotlong and Semonkong. LMS weather stations measure global solar radiation, beam solar radiation and diffuse solar radiation except Semonkong weather station, which measures only global radiation. Moshoeshoe I weather station measure global solar radiation, beam solar radiation and diffuse solar radiation. However, not continuous available record starts from 28th June 2012 to 31st August 2018. At Qacha's Nek weather station, LMS measures global solar radiation, beam

solar radiation and diffuse solar radiation. Available record starts from 30th June 2012 to 21st January 2015. Qacha's Nek solar radiation data also has many gaps of missing data. Mokhotlong weather station measure global solar radiation, beam solar radiation and diffuse solar radiation. Available record starts from 04th May 2013 to 18th May 2017. Also at Mokhotlong there are many periods with missing solar radiation data. At Semonkong weather station measurements starts from 26th March 2014 to 31st July 2017, likewise there are many periods of missing data.

Even though these solar radiation-measuring stations are not enough to measure ground solar radiation throughout the country, the research seeks to complement them with sunshine – derived solar and satellite-derived solar radiation to provide a high – level solar radiation information. It has to be noted that ground – measured solar radiation data are more accurate and reliable than satellite – derived solar radiation data.

2.2.2 Measurement of sunshine duration in Lesotho

LMS has about fourteen weather stations in the country, which for at least some time did record sunshine duration. Out of these, eight of these stations have sunshine duration record of more than ten years. These are Mokhotlong, Sehlabathebe, Semonkong, Oxbow, Quthing, Thaba-Tseka, Qacha's Nek and Moshoeshoe I. The sunshine recorder instruments at these weather stations is similar to the one in Fig 2.2.7.

Fig 2.2. 7 A weather station with a typical solar radiation measuring equipment.

Source: The Australian Government, Bureau of Meteorology [53]

It is important that LMS and LHDA source funds to install and train their personnel to maintain and calibrate solar radiation measuring equipment.

2.2.3 Measurement of satellite solar radiation

In addition to direct ground measurements of solar radiation by captured by pyrheliometers, pyranometers and indirect measurement of solar radiation by sunshine recorders. There is another way of measuring solar radiation. This method involves data derived from satellite which cover every place of interest on the ground [59]–[61]. However, satellite – derived solar radiation data are not as accurate and reliable as the ground measured solar radiation data, if the ground instruments are well maintained and calibrated by qualified personnel.

Solar radiation measuring equipment is costly and requires well trained personnel to operate, maintain and to calibrate it [62]. For a developing country like Lesotho, this task is near impossible. So there is a need for development of reliable methodologies of converting satellite – derived solar radiation to ground solar radiation.

2.3 Development of solar radiation database

For the development of any solar process application, a feasibility study must first consider the availability of temporal and spatial solar radiation distribution at the site of interest. However in most cases, due to the absence of actual ground measured solar radiation data, interpolation techniques, empirical models and satellite – derived data are normally used to fill missing data gaps in the ground solar radiation database [63]. Ground – measured solar radiation data or solar radiation models normally develop solar radiation database.

Solar radiation models are developed using the geophysical processes and statistical based methods [39]. The geophysical processes based models take cognisance of atmospheric physical processes, which have effect on solar radiation by absorbing, reflecting or diffusing it. Such physical processes include prevailing weather conditions, climatic conditions, aerosols, albedo and the ground physical environment. They also take cognisance of the earth's geometry, its position relative to the sun, including the physical location of the point of interest based on its latitude and longitude as depicted in equation (1).

The measured historical meteorological data such as cloudiness, day length (S_0) and sunshine duration (S) develop statistical based solar radiation models. The statistical modelling of solar radiation forms the basis of this research.

The day length can also be defined as maximum possible daily sunshine duration (S_0) in hours on a horizontal plane [28]. The difference between ω_s in the morning and ω_s in the afternoon as defined in equation (9) gives day length (S_0). For any location, it depends on the location's latitude ($\emptyset$) and its angular declination (δ) such that

$$S_0 = \frac{2}{15} cos^{-1}(-\tan\delta \, tan\emptyset) \quad \text{---------- (32)}$$

In addition, equation (10) gives the angular declination.

Equation (26) translates into

$$S_0 = \frac{2}{15}\omega_s \quad \text{---------- (33)}$$

Since

$$\omega_s = cos^{-1}(-\tan\delta \, tan\emptyset)$$

Then monthly mean day length ($\overline{S_0}$) is given as

$$\overline{S_0} = \frac{2}{15}\omega_s \quad \text{---------- (34)}$$

Where n in equation (10) is the average day of the month, given in table 2.4.1.

In 1924, Angstrőm realised that there is a linear relationship between the monthly mean daily clearness index and the monthly mean relative sunshine [64]. As a result, in 1940, Prescott improved the linear relation developed by Angstrőm such that it is now known as Angstrőm – Prescott model [65]–[68] which is given as

$$\frac{H}{H_0} = a + b\left(\frac{S}{S_0}\right) \quad \text{---------- (35)}$$

where

S - Sunshine duration in hours (hours with bright sunlight)

S_0 - Day length (maximum possible daily sunshine duration), given by equation (28) and equation (29) such that the regression coefficients ***a*** and ***b*** are site dependent [7].

H - is the measured daily global solar radiation on a horizontal ground surface.

H_0 - is daily extraterrestrial solar radiation on a horizontal surface given by equation (13).

a and ***b*** are regression coefficients specific for each site.

Equation (16) defines the ratio $\frac{H}{H_0}$.

The coefficients ***a*** and ***b*** are determined by plotting $\left(\frac{H}{H_0}\right)$ against $\left(\frac{S}{S_0}\right)$ in equation (31).

The ratio $\left(\frac{H}{H_0}\right)$ is the clearness index at the site of interest. It determines the transparency of the atmosphere to the solar radiation as explained in section 2.1.2.3.

The ratio $\left(\frac{S}{S_0}\right)$ is the cloudless index, which determines the prevailing local atmospheric characteristics and conditions [69], [70] or the percentage of possible sunshine [71].

When considering monthly figures, it can be inferred [72] that

$$\frac{\bar{H}}{\bar{H_0}} = a + b\left(\frac{\bar{S}}{\bar{S_0}}\right) \quad (36)$$

and

$$\bar{H} = \overline{H_0}\left(a + b\left(\frac{\bar{S}}{\bar{S}_0}\right)\right) - - - - - - - - - - - - - (37)$$

Where

$\bar{H}$ – It is monthly mean global solar radiation on a horizontal surface.

$\bar{H}_0$ – It is monthly mean extra-terrestrial solar radiation on a horizontal surface calculated by equation (22) and equation (23).

$\bar{S}$ – It is monthly mean number of hours of sunshine duration (bright sunshine).

$\bar{S}_0$ – It is monthly mean maximum number of possible sunshine hours (day length), which is also referred to as as monthly mean length of the day in hours, given by equation (8) and equation (9).

In 1988, Gopinathan [7] established the first basis for solar radiation database in Lesotho, as he worked out the values of the constants coefficient ***a*** and ***b*** in equations (31) – (33) for different places in Lesotho as depicted in table 2.5.1.

Table 2.3. 1 Angstrőm coefficients for different places in Lesotho.

Source: Gopinathan solar radiation database

Location	**Latitude ∅ (°)**	**Elevation**	***a***	***b***
Leribe	-28.53	1670	0.274	0.501
Letśeng-la-Terae	-29.00	3085	-0.160	1.057
Maputsoe	-28.89	1670	0.274	0.501
Maseru	-29.32	1571	0.277	0.495
Mokhotlong	-29.17	2230	0.191	0.617
Oxbow	-28.72	2650	0.052	0.794
Qacha's Nek	-30.07	1970	0.244	0.546
Quthing	-30.41	1650	0.275	0.499
Sehlaba-Thebe	-29.88	2320	0.166	0.649
Semonkong	-29.73	2160	0.207	0.595
Thaba-tseka	-29.58	2160	0.207	0.595
Tśakholo	-29.70	1565	0.277	0.494

The coefficients ***a*** and ***b*** are site dependent as they depend on the altitude of the site of interest. In Lesotho [2], they are given by .

$$a = 0.265 + 0.70h - 0.135\left(\frac{S}{S_0}\right) - - - - - - - - - (38)$$

And

$$b = 0.401 + 0.108h - 0.325\left(\frac{S}{S_0}\right) - - - - - - - - - \text{(39)}$$

Where

h – is the elevation of the site location.

and the correlation of the monthly mean daily diffuse radiation in Lesotho is given by

$$\frac{H}{H_d} = 1.017 - 1.159K_T - - - - - - - - - - - \text{(40)}$$

where

K_T – is the clearness index.

However the established solar radiation database by Gopinathan [7] is not good enough as it is based on equation (35). Equation (35) is based on the sunshine duration. It does not take cognisance of the actual observed solar radiation data nor does it take cognisance of satellite measured solar radiation. As a result there is a need for a more reliable solar radiation database which takes cognisance of the observed ground solar radiation and the satellite - derived solar radiation.

In 2010, Journée et al [16] showed that a much more reliable solar radiation database can be established by merging ground – measured solar radiation with satellite – derived solar radiation. In 2014, Hove et al [15], developed a solar radiation database for Zimbabwe by merging ground - measured solar radiation and satellite-derived solar radiation. From this study he concluded that there is a strong correlation between the ground-measured solar radiation and satellite-derived solar radiation.

Table 2.3. 2 Correlation between different solar radiation parameters

Source : Hove et al [15]

Narration	Correlation (R^2)
Relationship between ground and satellite – measured radiation data	0.705
Relationship between ground clear-sky index and satellite – clear sky index	0.898
Relationship between ground clearness index and satellite – clearness index	0.963

Table 2.3.3 shows a correlation between different solar radiation parameters. From table 2.3.3, Hove et al [15] concluded that

$$\bar{K}_{ground} = D\bar{K}_{satellite} + E \quad (41)$$

Where

$\bar{K}_{ground}$ – is the monthly mean ground clearness index

$\bar{K}_{satellite}$is –the monthly mean satellite-derived clearness index

D and E –are site specific coefficient constants

And

$$\bar{K}_{ground} = \frac{\bar{H}_{ground}}{\bar{H}_0} \quad (42)$$

$$\bar{K}_{satellite} = \frac{\bar{H}_{satellite}}{\bar{H}_0} \quad (43)$$

Where

$\bar{H}_{satellite}$ –is the monthly mean satellite – derived solar radiation

$\bar{H}_{ground}$ – is the monthly mean ground – measured radiation

$\bar{H}_0$ – is monthly mean extra-terrestrial solar radiation on a horizontal surface calculated by equation (24).

$\bar{H}_{Satellite}$ is monthly mean satellite – derived solar radiation because it is not calculated from actual ground measured solar radiation but from derived satellite solar radiation. The derived satellite solar radiation datasets are calculated from the difference between the incoming and outgoing sensed solar radiation and a combination of global circulation models (GCM) and other complex models [73]–[75].

$\bar{H}_{Ground}$ is monthly mean ground – measured solar radiation because it is not calculated from actual ground observations but from the derived solar radiation. The derived solar radiation datasets are calculated from sunshine duration datasets Gopinathan [7].

Substituting equation (42) and equation (43) into equation (41) yields the improved Gopinathan [7] solar radiation database as

$$\bar{H} = \bar{H}_0(D\bar{K}_{satellite} + E) \quad (44)$$

Where

$\overline{H}$ – is the estimated monthly mean ground solar radiation

$\overline{H}_0$ – is the monthly mean extra-terrestrial solar radiation given by equation (24)

$\overline{K}_{satellite}$ – is the monthly mean satellite-derived clearness index

D and E – are site specific coefficient constants

$\overline{K}_{Satellite}$ is monthly mean satellite – derived clearness indices because it is not calculated from actual satellite solar radiation measurements but from the derived satellite solar radiation. The derived satellite solar radiation datasets are calculated from the difference between the incoming and outgoing sensed solar radiation and a combination of global circulation models (GCM) and other complex models [73]–[75].

Since monthly mean satellite – derived solar radiation datasets are available for every place on the surface of the earth, monthly mean satellite – derived clearness index is easily calculated for every place on the surface of the earth. As a result, equation (44) develops a solar radiation database for Lesotho since it takes cognisance of both ground – derived solar radiation and satellite – derived solar radiation as described in the methodology chapter.

2.4 Cross validation and reliability

There are several methods and types of validating solar radiation depending on the type of input and output data, spatial and temporal resolution of data, type of methodology and type of algorithm applied, surface geometry and type of sky including the spectral resolution [76]–[78]. The validation method is either deterministic or statistical (often referred to as “stochastic”). With the deterministic method, the past measurements, the present measurements or the future measurements are determined using the available data. The results are fully dependent on initial conditions and the input parameters. On the other hand, a stochastic method predicts the expected data virtually, whilst keeping some original statistical properties of the data, such as cumulative data frequency and variance [79]. With the stochastic

method, there is an element of uncertainty and randomness, because with the same set of parameters and initial set conditions, the results may exhibit a totally new ensemble of data consisting of different data output [80]–[82]**.** As a result, due to the uncertainties, it is important to take cognisance of reliable validation method for the optimal design of solar process application is very important. As a result it imperative that solar radiation databases provide accurate data (*with known degree of uncertainty)* for the techno-economic improvement and understanding of various solar process applications [83], [24].

Solar process application sizing and optimization without the knowledge of solar radiation data uncertainty is impossible for engineers. They have to ensure that selected equipment and material operate as per the specified manufacturer's conditions within a certain degree of accuracy.

2.4.1 Leave – one – out cross validation

The leave – one out – cross validation (***LOOCV)*** technique is a form of a deterministic method of predicting the data output as it involves all data sample in the determination of how the expected results behave when subjected to an independent data set [15], [84]–[87].

With this method, data samples are grouped together independent of each other one by one. Each data sample is singled out of the data sample and omitted from the grouped data sample and its value is predicted using the other group members. This is to check how the other group members influence the omitted data set. The predicted value is noted. If the difference between the real data and the predicted value is small then the prediction is taken to be reliable.

Then the data sample that was omitted in the group is returned into the group and another element in the sample is removed. The process is repeated on all data samples until they are all tested.

LOOCV has five distinct steps [88]

i) Removal of data point with known data value from the entire dataset
ii) Use remaining data points with known data values for the estimation of the data value at the point where there is a removed known data value

iii) Compare difference between the estimated data value and the original known data value

iv) Repetition of the previous steps on all known data values

v) Calculation of the root mean squares of the differences between known data values and estimated data values.

2.4.2 Reliability

It is important to have an indicative measure of confidence on solar radiation data during the development or implementation of solar process applications. Solar radiation statistical properties determine this level of confidence.

The common statistical properties are; the relative bias error (rBE) , relative mean bias error (rMBE), root mean square error (RMSE) and the normalised root mean square error (NRMSE) [15], [39], [62], [89]–[91].

Relative bias error (rBE) determines how data samples are close to each other or far apart from each other, with respect to the known data sample.

It is given by

$$\boldsymbol{rBE} = \frac{(\boldsymbol{DATA_{Known} - DATA_{Estimate}})}{\boldsymbol{DATA_{Known}}} \quad (45)$$

Where

$DATA_{Known}$ – is the value of the known data sample

$DATA_{Estimate}$ – is the value of data sample being investigated

Relative mean bias error (rMBE) is given by

$$\boldsymbol{rMBE} = \frac{\boldsymbol{1}}{\boldsymbol{N}} \sum_{\boldsymbol{i=1}}^{\boldsymbol{i=N}} \left(\frac{(\boldsymbol{DATA_{Known,i} - DATA_{Estimate,i}})}{\boldsymbol{DATA_{Known,i}}} \right) \quad (46)$$

Where

$DATA_{Known,i}$ – is the *i*th measured (known) data set

$DATA_{Estimate,i}$ –is the *i*th estimated (unknown) data set

Relative mean square error (RMSE) is given by

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{i=N}\left(DATA_{Known,i} - DATA_{Estimate,i}\right)^2} - - - - - (47)$$

Normalised root mean square error (NRMSE) is given by

$$NRMSE = \frac{1}{N}\left(\sqrt{\frac{1}{N}\sum_{i=1}^{i=N}\left(DATA_{Known,i} - DATA_{Estimate,i}\right)^2}\right) - - - - (48)$$

The normalised root mean square error gives the level of confidence of the value of the estimated data value. It is given in percentages. The lower the NRMSE the closer the estimated data value to the known data value.

2.5 Solar radiation interpolation

For the optimal design and application of solar process application, there has to be a strong and reliable solar radiation database. A quality controlled ground solar radiation data obtained from ground weather stations, or from satellite – derived data builds a reliable solar radiation database. Ground sourced data are more acceptable due to their accuracy as compared to satellite-derived data at short distances [92]. At distances more than 34 km away from weather stations satellite-derived data are better substitute and are more acceptable [93], as it is the case in Lesotho where weather stations with solar radiation equipment are far from each other; more than 50 km apart. As an example the radial distance between Moshoeshoe I weather station and the closest weather station is over 100 km – Mohale weather station is the closest weather station to Moshoeshoe I weather station.

Since there are only 12 sites with published solar radiation measurements in Lesotho [7], [94], solar radiation availability in others areas is achieved by means of interpolating the published solar radiation data. However these published solar radiation results are not good enough as they are derived from equation (35). Equation (35) is based on measured sunshine duration data and calculated day length data as defined by equation (34).

An interpolation process involves filling data gaps in between available solar radiation data to produce a set of new solar radiation values [95]. There are several methods

proven applicable for interpolation of missing data values. Common interpolation techniques include linear regression interpolation technique, bilinear interpolation technique, nearest neighbour interpolation technique, spline interpolation technique, inverse distance weighting interpolation technique and kriging interpolation technique.

A linear regression interpolation technique finds a best straight line, which fits through the sample data points. This assumes an ideal world by ignoring real world processes, which interact in a complex way in real world.

Bilinear interpolation technique [96] functions in the similar fashion as the linear interpolation technique except that the interpolation is in two directions. For solar radiation interpolation, the interpolation is done in both the north – south direction and the East – West direction.

A nearest neighbour interpolation technique finds the value of an unknown data value from the three nearest known data values. As results in order to get the best estimate of an unknown data value, there should be many known data values. This situation is not feasible in real world as there are few solar radiation sites in the world.

A spline interpolation technique assumes a surface cover (rubber – sheeting) that goes through some known data points whilst minimising the actual physical characteristics of the covered surface. This technique is not appropriate where sample data points are close to each other and have high variance. It requires data samples, which do not vary too much and are not close to each other. However, solar radiation variability has high variation in space and time.

The inverse distance weighting (IDW) interpolation technique estimates data values by computing weighted averages then allocates the greatest weights to data points nearest to produce a smooth distance. However, in real world solar radiation is not continuous in space and time. It varies depending on the geographical location and the prevailing weather patterns.

Kriging interpolation technique functions more or less the same as the IDW interpolation technique as it uses weights based on the nearest known data points. However unlike the IDW's interpolation technique which relies only on the algorithm based on a simple distance between data points, kriging interpolation technique employs semi – variogram weights. A semi-variogram is a graph that estimates a difference between a known data value at one location and a known data value at another location based on the distance in between them and the direction [97] . This technique has the advantage that it takes cognizance of data angular distance weighting (directional bias). It also has the advantage that it takes all data points as being related to one another, but nearest data points are more related to one another than furthest data points. This relationship between data points reduces estimation errors (kriging variance) between estimated data points and known data points. As a result, these properties proofs kriging interpolation technique as the best interpolating technique in solar radiation databases with poorly distributed known solar radiation data points [98], [99], .

A critical choice of these interpolation technique is needed as for the same situation they produce different results [100], as a result a chosen interpolation technique should be able to handle various computational errors and fairly easy to use. This research is based on bilinear interpolation technique and kriging interpolation technique.

2.5.1 Bilinear Interpolation

Interpolation technique is the way of estimating unknown solar radiation data using known solar radiation data values at specific locations. In this research, areas with known solar radiation data are taken to be equidistant. There are several methods of interpolation [101]–[104], but throughout this research a bilinear interpolation [105] method is used. This method uses a ratio to find an unknown value between four known values.

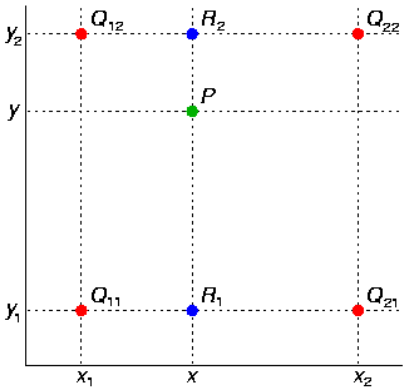


Fig 2.5. 1 Bilinear interpolation

In fig 2.5.1, to find the amount of solar radiation at point ***P***, solar radiation values at red points (***Q_{11}, Q_{12}, Q_{21}***, and ***Q_{22}***) are used by linearly interpolating along both axes to find the solar radiation values at the two blue points ***R_1*** and ***R_2***. Then linearly interpolate solar radiation values of ***R_1*** and ***R_2*** at point **P**.

From fig 2.5.1, ***R_1*** is the weighted average solar radiation of ***Q_{11}*** and ***Q_{21}*** and ***R_2*** is the weighted average of solar radiation of ***Q_{12}*** and ***Q_{22}***.

$$\boldsymbol{R_1} = \frac{(x_2 - x)}{(x_2 - x_1)}\boldsymbol{Q_{11}} + \frac{(x - x_1)}{(x_2 - x_1}\boldsymbol{Q_{21}} \quad \text{---------- (49)}$$

$$\boldsymbol{R_2} = \frac{(x_2 - x)}{(x_2 - x_1)}\boldsymbol{Q_{12}} + \frac{(x - x_1)}{(x_2 - x_1}\boldsymbol{Q_{22}} \quad \text{---------- (50)}$$

$$\boldsymbol{P} = \frac{(y_2 - y)}{(y_2 - y_1)}\boldsymbol{R_1} + \frac{(y - y_1)}{(y_2 - y_1)}\boldsymbol{R_2} \quad \text{---------- (51)}$$

After substituting ***R_1*** and ***R_2***, equation (51) becomes

$$\boldsymbol{f(P) = (x_2 - x)(y_2 - y)f(Q_{11}) + (x - x_1)(y_2 - y)f(Q_{12}) + (x_2 - x)(y - y_1)f(Q_{21}) + (x - x_1)(y - y_1)f(Q_{22})} \quad \text{---------- (52)}$$

Any function can be estimated by a linear function [103], [106], [107] of the form

$$\boldsymbol{f(x_i, y_i) \approx a_0 + a_1 x_i + a_2 y + a_3 x_i y_i} \quad \text{------ (53)}$$

The bilinear interpolation starts at a nearby point $f(x_i)$, then add a nearby value so as to decrease any corrections, when other values from $f(x_i)$'s are incorporated [105].

So for any function $\boldsymbol{f}$, the unknown value at any point $(\boldsymbol{x}, \boldsymbol{y})$, can be found if the value of the function *f* is known at four equidistant points.

Then equation (53) can be written as

$$\boldsymbol{f(x,y) \approx a_0 + a_1 x + a_2 y + a_3 xy} \quad (54)$$

Where the coefficients $\boldsymbol{a_0, a_1, a_2, a_3}$ are found by solving the matrix

$$\begin{pmatrix} \mathbf{1} & \boldsymbol{x_1} & \boldsymbol{y_1} & \boldsymbol{x_1 y_1} \\ \mathbf{1} & \boldsymbol{x_1} & \boldsymbol{y_2} & \boldsymbol{x_1 y_1} \\ \mathbf{1} & \boldsymbol{x_2} & \boldsymbol{y_1} & \boldsymbol{x_2 y_1} \\ \mathbf{1} & \boldsymbol{x_2} & \boldsymbol{y_2} & \boldsymbol{x_2 y_2} \end{pmatrix} \begin{pmatrix} \boldsymbol{a_0} \\ \boldsymbol{a_1} \\ \boldsymbol{a_2} \\ \boldsymbol{a_3} \end{pmatrix} = \begin{pmatrix} \boldsymbol{f(Q_{11})} \\ \boldsymbol{f(Q_{12})} \\ \boldsymbol{f(Q_{21})} \\ \boldsymbol{f(Q_{22})} \end{pmatrix} \quad (55)$$

Such that

$$\boldsymbol{a_0} = \frac{\boldsymbol{f(Q_{11})x_2y_2}}{\boldsymbol{(x_1 - x_2)(y_1 - y_2)}} + \frac{\boldsymbol{f(Q_{12})x_2y_1}}{\boldsymbol{(x_1 - x_2)(y_2 - y_1)}} + \frac{\boldsymbol{f(Q_{21})x_1y_2}}{\boldsymbol{(x_1 - x_2)(y_2 - y_1)}} + \frac{\boldsymbol{f(Q_{22})x_1y_1}}{\boldsymbol{(x_1 - x_2)(y_1 - y_2)}}$$

$$\boldsymbol{a_1} = \frac{\boldsymbol{f(Q_{11})y_2}}{\boldsymbol{(x_1 - x_2)(y_2 - y_1)}} + \frac{\boldsymbol{f(Q_{12})y_1}}{\boldsymbol{(x_1 - x_2)(y_1 - y_2)}} + \frac{\boldsymbol{f(Q_{21})y_2}}{\boldsymbol{(x_1 - x_2)(y_1 - y_2)}} + \frac{\boldsymbol{f(Q_{22})y_1}}{\boldsymbol{(x_1 - x_2)(y_2 - y_1)}}$$

$$\boldsymbol{a_2} = \frac{\boldsymbol{f(Q_{11})x_2}}{\boldsymbol{(x_1 - x_2)(y_2 - y_1)}} + \frac{\boldsymbol{f(Q_{12})x_2}}{\boldsymbol{(x_1 - x_2)(y_1 - y_2)}} + \frac{\boldsymbol{f(Q_{21})x_1}}{\boldsymbol{(x_1 - x_2)(y_1 - y_2)}} + \frac{\boldsymbol{f(Q_{22})x_1}}{\boldsymbol{(x_1 - x_2)(y_2 - y_1)}}$$

$$a_3 = \frac{f(Q_{11})}{(x_1 - x_2)(y_1 - y_2)} + \frac{f(Q_{12})}{(x_1 - x_2)(y_2 - y_1)} + \frac{f(Q_{21})}{(x_1 - x_2)(y_2 - y_1)} + \frac{f(Q_{22})}{(x_1 - x_2)(y_1 - y_2)}$$

Equation (54) can also be written as

$$f(x, y) \approx b_{11} f(Q_{11}) + b_{12} f(Q_{12}) + b_{21} f(Q_{21}) + b_{22} f(Q_{22}) - - - \quad (56)$$

Such that

$$\begin{pmatrix} b_{11} \\ b_{12} \\ b_{21} \\ b_{22} \end{pmatrix} = \left[\begin{pmatrix} 1 & x_1 & y_1 & x_1 y_1 \\ 1 & x_1 & y_2 & x_1 y_1 \\ 1 & x_2 & y_1 & x_2 y_1 \\ 1 & x_2 & y_2 & x_2 y_2 \end{pmatrix}^{-1} \right]^T \begin{bmatrix} 1 \\ x \\ y \\ xy \end{bmatrix} - - - - - - - - - - - - - - - \quad (57)$$

So the final interpolated value is given by equation (56).

2.5.2 Kriging Interpolation

As described, the kriging interpolation technique applies the weighted sum of distances [108] as shown in equation (58).

$$\check{z}(x_0) = \sum_{i=1}^{N} \lambda_i z(x_i) - - - - - - - - - - - - - - - - - - \quad (58)$$

Where

x_0 – Estimated data point

x_i – Data points surrounding x_0

λ_i – Weights assigned to data points

N – Total number of data points

Krigging applies Equation (58) for the estimation of a value at a given point with respect to the nearby data points. In addition to the calculation of weights based on geometrical distances, it takes cognisance of the spatial correlation within the sample data [108].

Chapter Three: Methodology

3.1 Background

The research has two parts: the first part is the development of solar radiation database in Lesotho. The second part is the development of an interpolation tool.

The methodology for the first part is based on Hove et al [15] who realised that there is a strong correlation between ground clearness index and satellite – derived clearness index. With this relationship a solar radiation database for Lesotho is developed by merging ground solar radiation database with satellite – derived solar radiation database. The ground solar radiation from five stations is complemented with sunshine duration derived solar radiation from twelve stations.

The methodology for the second part is based on a bilinear interpolation technique, implemented with Visual Basic for Application (VBA) on a Microsoft Excel application software.

3.1.1 Developing solar radiation database

The Hove et al [15] database development technique is based on the correlation between ground clearness index and satellite clearness index as defined in section 2.1.2.3.

Ground solar radiation is derived from database developed by Gopinathan [7], [94] and ground measured data from LHDA and LMS. Satellite – derived solar radiation is downloaded from Photovoltaic Geographical Information System [23].

The methodology has four distinct steps outlined as follows:

i) Obtaining data

a) Download 11 years (2005 – 2016) monthly satellite – derived solar radiation data from the Photovoltaic Geographical Information System [23] for 17 identified locations.

b) Calculate monthly mean satellite – derived ground solar radiation for 17 identified locations as depicted in table 4.1.3.

ii) Calculation of clearness indices for 17 locations

a) Calculation of monthly mean derived extra – terrestrial solar radiation using equation (24).
b) Calculation of monthly mean ground – derived clearness indices using equation (20).
c) Calculation of monthly mean satellite – derived clearness indices using equation (60).

iii) Determination of regression coefficients (***D*** and ***E***) in equation (41) for each of the 17 locations in table 4.1.3.

a) Plot a graph of monthly mean ground – derived clearness index against monthly mean satellite – derived clearness index for all 17 locations.
b) Read and record regression coefficients from the plotted graphs.
   - The slope of the graph is the ***D*** coefficient.
   - The intercept of the graph is the ***E*** coefficient.
c) Individually map the regression coefficients (***D*** and ***E***) using Surfer geo-spatial application software.
d) Find the correction factor (***CF***).
   - Find the difference between actual coefficients and the graph
   - Apply equation (61)

iv) Determine reliability between new database and ground derived databases by statistical methods.

a) Find relative bias error using equation (rBE) using equation (64)
b) Find relative mean bias error (rMBE) using equation (65).

c) Find root mean square error (RMSE) using equation (66).

d) Find normalised root mean square error (NRMSE) using equation (67).

3.1.2 Developing interpolation tool

The improved solar radiation database in placed in an Excel spreadsheet and a VBA code is used to implement a bilinear interpolation technique on the database. The code is implemented using a VBA code and inbuilt functions of Microsoft Excel application software.

3.1.3 Integrating database into solar application process

Using spreadsheets in Microsoft Excel application software, the developed solar radiation database is integrated into the thermo-economic model developed by Tawanda Hove [109]. This model runs on a Microsoft Excel application platform.

3.2 Developing solar radiation database

3.2.1 Data acquisition

The study area is between longitude 27° east to 29.5° east and latitude 28.5° south to 30.75° south as shown in fig 3.1.1. The study area is assumed to be a flat surface. In order that data points are established, the study area is divided into 5355 distinct grid-points at which solar radiation data is studied. These grid-points are each three minutes (0.05° x 0.05°) apart from each other – about 5 km x 5.5 km [110].

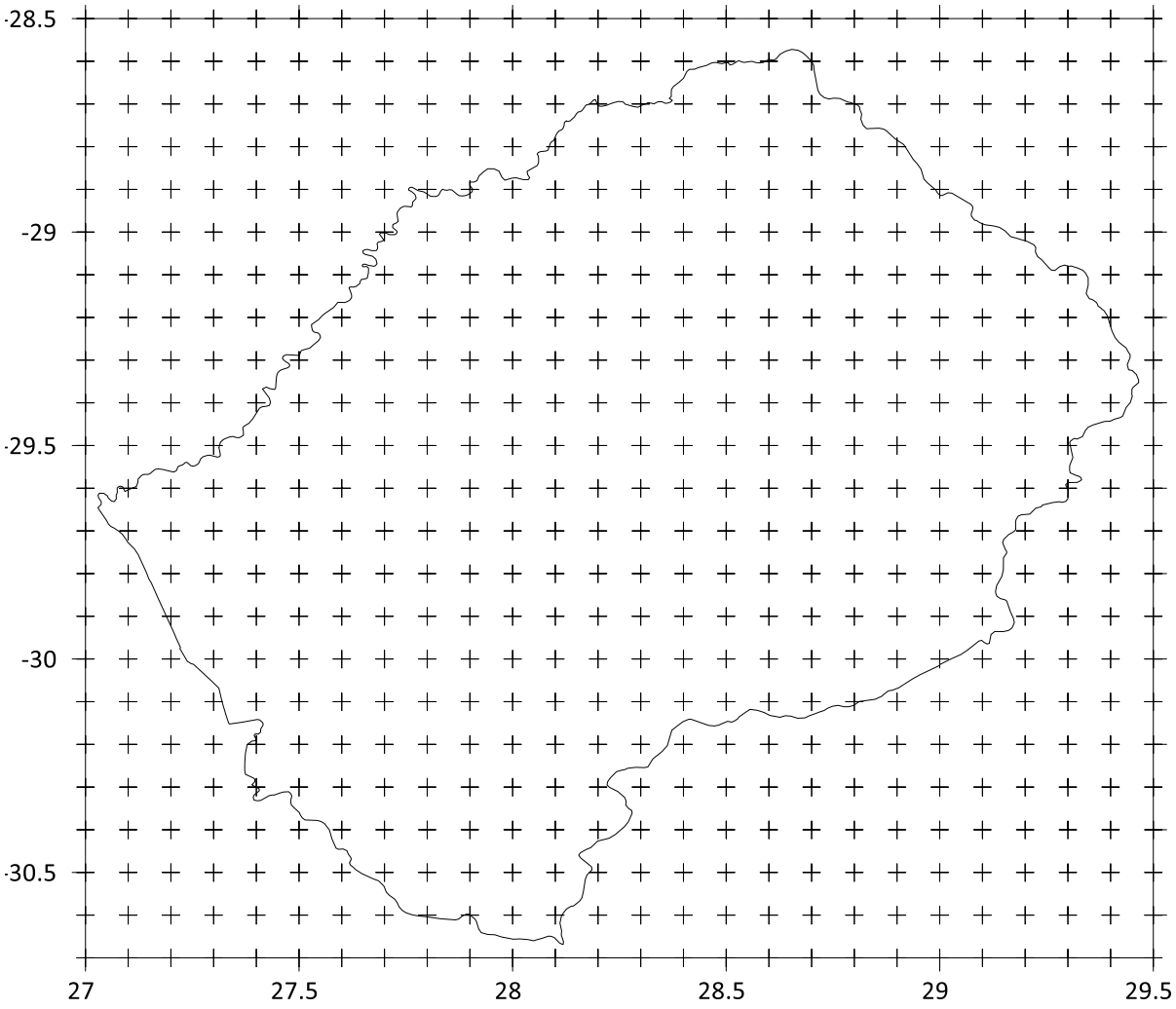


Fig 3.2. 1 Grid point map of the study area span by a 0.05° x 0.05° grid points.

Fig 3.2.1 shows a study area with 5355 grid points which are about – about 5 km x 5.5 km [110] apart. It is assumed that the study area is perfectly flat even though, in reality, it is rugged with mountains and steep valleys.

Ground solar radiation measured data supplied by both LMS and LHDA complemented by data derived from sunshine duration published by Gopinathan [7], [94]. These data are shown in tables 4.1.4 and 4.1.5

Monthly mean satellite – derived solar radiation is calculated from downloaded satellite – derived solar radiation data that spans a period of 11 years from 2005 to 2016. This data is freely downloaded from Photovoltaic Geographical Information System [23].

Clearness indices

The clearness index determines how transparent the prevailing atmospheric conditions are. It is a dimensionless number, which gives a fraction of solar radiation, which goes through and reaches the surface of the earth. It is defined as the ratio of the surface radiation and the extra-terrestrial radiation [40],[64].

a) Monthly mean ground – derived clearness index

Monthly mean ground – derived clearness index ($\bar{K}_{Ground}$) is the ratio between monthly mean ground – derived solar radiation and the monthly mean extra-terrestrial solar radiation defined in equation (20) which is written as

$$\bar{K}_{Ground} = \frac{\bar{H}_{Ground}}{\bar{H}_0} \quad (59)$$

Where

$\bar{K}_{Ground}$ – Monthly mean ground - derived clearness index

$\bar{H}_{ground}$ – Monthly mean horizontal solar radiation

$\bar{H}_0$ – Monthly mean extra-terrestrial solar radiation on a horizontal surface calculated by equation (24).

Equation (59) calculates the monthly mean ground - derived clearness indices ($\bar{K}_{Ground}$). The monthly mean extra-terrestrial solar radiation for the seventeen locations is shown in table 4.2.1. Datasets in tables 4.1.4, 4.1.5 and 4.2.1 are input into equation (59) to yield the monthly mean ground - derived clearness indices outlined in table 4.2.2.

b) Monthly mean satellite – derived clearness index

Monthly mean satellite clearness index ($\bar{K}_{Satellite}$) is the relationship between monthly mean satellite-derived solar radiation and the monthly mean extra - terrestrial solar radiation defined in equation (20) which is written as

$$\bar{K}_{Satellite} = \frac{\bar{H}_{Sattellite}}{\bar{H}_0} \quad (60)$$

Where

$\bar{K}_{Satellite}$ – is the monthly mean satellite –derived clearness index

$\bar{H}_{Satellite}$ – is the monthly mean satellite – derived horizontal solar radiation

$\bar{H}_0$ – is monthly mean extra-terrestrial solar radiation on a horizontal surface calculated by equation (24).

The monthly mean satellite – derived clearness indices ($\bar{K}_{Satellite}$) for seventeen stations are determined using equation (57). Monthly mean satellite – derived solar radiation data in table 4.2.3 and monthly mean extra-terrestrial solar radiation in table 4.2.1 are input into equation (60) to yield the monthly mean satellite – derived clearness indices outlined in table 4.2.3

3.2.2 Data conversion

The regression coefficients ***D*** and ***E*** defined by equation (44) as shown in Table 4.2.4, are found by plotting the monthly mean ground - derived clearness index ($\bar{K}_{Ground}$) against the monthly mean satellite – derived clearness index ($\bar{K}_{Satellite}$) for all seventeen ground stations.. A sample plot of $\bar{K}_{Ground}$ against $\bar{K}_{Satellite}$ for four solar radiation sites is shown in Fig 4.2.1 – Fig 4.2.4.

3.2.3 Cross validation

Using equation (41) a ground solar radiation is produced. But there has to be a way of ensuring that the equation is accurate for every location in the country. As a result a geo-spatial application software – Surfer is introduced to produce a map spanning both coefficients ***D*** and ***E*** as shown in fig 4.2.5 and fig 4.2.6. Then an ***LOOCV*** technique is applied as explained in section 2.4.1. An example of the results at Mokhotlong^{Gop} after application of ***LOOCV*** are shown in fig 4.2.7 and fig 4.2.8.

3.2.4 Correction factor

Since $D \neq D_{LOOCV}$ and $E \neq E_{LOOCV}$, a correction factor is introduced as described in Hove et al [15].

The correction factor (***CF***) is defined as

$$CF = \frac{1}{1+\overline{\Delta X}} \quad (61)$$

Where

$$\overline{\Delta X} = \frac{\sum_{i=1}^{N}((\bar{X}-X_i)/X_i)}{N} \quad (62)$$

Such that ***X*** takes the values of any of the original regression coefficient ***D*** and ***E*** and X_i takes the values of regression coefficients from the line graph D_{LOOCV} and E_{LOOCV} as shown in table 4.2.5. The original regression coefficients ***D*** and ***E*** for each station are multiplied by the correction factor (**CF**) to yield the final regression coefficients D_{CF} and E_{CF} shown in table 4.2.5.

3.2.5 Final solar radiation database

A Kriging interpolation inbuilt into Surfer application software is applied to map the final coefficients D_{CF} and E_{CF} in table 4.2.5. Fig 4.2.7 and fig 4.2.8 show contour plots of final regression coefficients (D_{CF} and E_{CF}) for the seventeen locations. From the contour maps, regression coefficients D_{CF} and E_{CF} at all other 5355 grid-points are read and tabled. Then for each grid point, a set of coefficients D_{CF} and E_{CF} is used in equation (44) to produce equation

$$\bar{H}_{Calculated} = \bar{H}_0(D_{CF}\bar{K}_{Satellite} + E_{CF}) \quad (63)$$

Where

$\bar{H}_{Calculated}$ – Solar radiation at any location

D_{CF} *and* E_{CF} – Regression constants for that location

Equation (63) forms the basis of the newly improved solar radiation database for each 0.05° X 0.05° grid point in Lesotho.

Tables 4.2.7 and 4.2.8 shows deviations between calculated solar radiation by equation (63) and the original ground data.

3.2.6 Database reliability

In order that the accuracy and the confidence level on the established solar radiation database for Lesotho from section 3.6 is determined, ***LOOCV*** method and statistical methods are applied to the final solar radiation database.

Measuring the reliability of the newly improved solar radiation database, statistical tests are applied [15], [62], [111], [112]; the relative bias error (rBE), relative mean bias error (rMBE), root mean square error (RMSE) and the normalised root mean square error (NRMSE) are applied.

The relative bias error (rBE) in equation (45) becomes

$$\boldsymbol{rBE} = \frac{(\boldsymbol{H_{Ground}} - \boldsymbol{H_{Calculated}})}{\boldsymbol{H_{Ground}}} \quad ----------(64)$$

Relative mean bias error (rMBE) in equation (46) becomes

$$\boldsymbol{rMBE} = \frac{\mathbf{1}}{\boldsymbol{N}}\sum_{\mathbf{1}}^{\boldsymbol{N}}\left(\frac{(\boldsymbol{H_{Ground}} - \boldsymbol{H_{Calculated}})}{\boldsymbol{H_{Ground}}}\right) \quad ---------(65)$$

Relative mean square error (RMSE) in equation (47) becomes

$$\boldsymbol{RMSE} = \sqrt{\frac{\mathbf{1}}{\boldsymbol{N}}\sum_{\boldsymbol{i}=\mathbf{1}}^{\boldsymbol{i}=\boldsymbol{N}}(\boldsymbol{H_{Ground}} - \boldsymbol{H_{Calculated}})^{\mathbf{2}}} \quad ----(66)$$

Normalised root mean square error in equation (48) becomes

$$\boldsymbol{NRMSE} = \frac{\mathbf{1}}{\boldsymbol{N}}\left(\sqrt{\frac{\mathbf{1}}{\boldsymbol{N}}\sum_{\boldsymbol{i}=\mathbf{1}}^{\boldsymbol{i}=\boldsymbol{N}}\left(\boldsymbol{H_{Ground,i}} - \boldsymbol{H_{Calculated,i}}\right)^{\mathbf{2}}}\right) \quad -----(67)$$

For all months, the calculated horizontal solar radiation ($\bar{\boldsymbol{H}}_{\boldsymbol{Calculated}}$) is not exactly the same as the ground solar radiation as shown in tables 4.2.7 and 4.2.8.

The monthly mean deviation for all the stations is determined using the equation

$$\overline{\Delta H}_{month} = \frac{1}{N}\left(\sum_{i=1}^{N}\left(\frac{\bar{H}_{Ground}-\bar{H}_{calculated}}{\bar{H}_{Ground}}\right)\right) - - - - -(68)$$

Where

$\overline{\Delta H}_{month}$ – Monthly mean deviation for the month.

$\bar{H}_{Ground}$ – ground measured solar radiation.

$\bar{H}_{calculated}$ – Solar radiation calculated using equation (31).

N – Total number of solar radiation locations.

The correction factor (***CF$_m$***) from section 3.4.3 for each month is thus given as

$$CF_{month} = \frac{1}{(1+\overline{\Delta H}_{month})} - - - - - - - - - - - - - - - - (69)$$

Then the mean horizontal solar radiation database for each month at each weather station is produced by multiplying equation (47) by the appropriate monthly correction factor to yield the results shown in table 4.3.2 such that

$$\bar{H}_{Calculated,month} = \bar{H}_0 CF_{month}(D\bar{K}_{satellite} + E) - - - - - - - -(70)$$

Then a country – wide correction factor ($\overline{CF}_{month}$) in table 4.3.2 is introduced to produce the final horizontal solar radiation database ($\bar{H}_{Database}$) given by

$$\bar{H}_{Databse} = \bar{H}_0 \overline{CF}_{month}(D\bar{K}_{satellite} + E) - - - - -(71)$$

Where

$\overline{CF}_{month}$ – is the monthly mean correction factor for the country.

$\bar{K}_{Satellite}$ – is the satellite – derived clearness index.

$\bar{H}_{Database}$ – is the final solar radiation database.

The extract of final horizontal solar database for Lesotho is shown in table 4.2.6. The entire solar radiation distribution as calculated in equation (68) is shown in the maps in Fig 4.3.1 – Fig 4.3.5.

3.3 Development of interpolating tool

In this research, an interpolation technique employed is the bilinear interpolation. It is implemented on a Microsoft Excel software using a Visual Basic for Applications (VBA) code as depicted in section 4.3. Its implementation is on the Microsoft Excel application. This tool is an easy to adapt and to use. The VBA code as shown in section 4.3, makes use of the already inbuilt functions of Microsoft Excel application software; ROUNDDOWN (), INDEX (), MATCH (), MMULT (), MINVERSE ().

The MMULT () function manipulate product of the matrix in equation (55). The function MINVERSE () manipulates the inverse matrix of the matrix in equation (57). The final interpolation solar radiation is given by equation (55), where the quotients are solved by the matrix in equation (56).

3.4 Integration into solar process application

The developed solar radiation database with the interpolation too are integrated into thermo-economic model for aiding solar collector choice and optimal sizing for a solar water heating system as described by Tawanda Hove [109]. This model is based on the Microsoft Excel based model. The interpolation tool together with the developed solar radiation database are placed in one of the worksheets within the model and linked to the model.

Chapter Four: Results and Discussions

The knowledge of the amount of available solar radiation at any location, for the development and design of solar process applications is of paramount importance. With the results of this study, at any location in the country, with only the geographic coordinates, the amount of horizontal solar radiation can be found with a better precision as the established horizontal database is based on both ground derived data and satellite – derived data. So the design and sizing of any solar process system can be economically optimised.

4.1 Data acquisition

4.1.1 Observed sunshine duration

Table 4.1. 1 LMS – measured sunshine duration

Source: Lesotho Meteorological Services (LMS)

Weather Station	Latitude	Longitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mokhotlong	**-29.283**	**29.067**	13.75	13.03	12.23	11.34	10.60	10.23	10.36	10.33	11.46	12.35	13.22	13.33
Sehlabathebe	**-29.881**	**29.062**	13.77	13.11	12.23	11.33	10.38	10.20	10.34	10.31	11.45	12.35	13.23	13.85
Semonkong	**-29.833**	**28.100**	13.77	13.11	12.23	11.33	10.38	10.20	10.34	10.31	11.43	12.33	13.23	13.35
Oxbow	**-28.717**	**28.617**	13.70	13.06	12.22	11.36	10.64	10.23	10.41	10.36	11.47	12.34	13.13	13.76
Quthing	**-30.417**	**27.717**	13.83	13.14	12.33	11.31	10.34	10.18	10.29	10.88	11.43	12.33	13.44	13.91
Thaba-Tseka	**-29.550**	**28.583**	13.76	13.10	12.23	11.33	10.33	10.22	10.35	10.32	11.45	12.35	13.22	13.84
Qacha's-Nek	**-30.117**	**28.672**	13.32	13.00	12.00	11.00	10.34	10.00	10.20	10.39	11.43	12.36	13.26	13.30

Table 4.1.1 shows original calculated long – term monthly mean sunshine duration supplied by LMS as derived from original manuscripts depicted in the appendixes. The algorithm used by LMS to calculate the long – term mean sunshine duration is such that each length of the burnt tick on the sunshine chart is estimated and converted into fractions of hours. Then the sum of the hourly fractions is taken as the duration of bright sunshine (in hours) on that particular day. The monthly sunshine duration mean is taken as the average of sunshine duration for that particular month. The long – term monthly mean sunshine duration for a place on a particular month is taken as the 30 – year mean. However comparing figures in table 4.1.1 and figures in table 4.1.2 one concludes that long – term monthly mean sunshine duration from LMS are dubious as for some months, long – term monthly mean values are more than calculated day lengths.

4.1.2 Calculated sunshine duration

Table 4.1. 2 Calculated monthly mean day lengths in Lesotho

Weather Station	Latitude	Longitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mokhotlong	-29.283	29.067	13.648	12.987	12.149	11.259	10.513	10.150	10.344	11.001	11.866	12.756	13.436	13.847
Sehlabathebe	-29.881	29.062	13.690	13.011	12.153	11.241	10.475	10.104	10.302	10.976	11.863	12.774	13.472	13.893
Semonkong	-29.833	28.100	13.687	13.009	12.153	11.242	10.478	10.108	10.306	10.978	11.863	12.773	13.469	13.889
Oxbow	-28.717	28.617	13.679	13.004	12.152	11.246	10.486	10.117	10.314	10.983	11.864	12.769	13.462	13.880
Moshoeshoe-I	-29.450	27.567	13.660	12.993	12.150	11.254	10.502	10.138	10.332	10.994	11.866	12.761	13.446	13.860
Quthing	-30.417	27.717	13.727	13.033	12.156	11.224	10.442	10.062	10.265	10.954	11.860	12.791	13.505	13.935
Thaba-Tseka	-29.550	28.583	13.667	12.997	12.151	11.251	10.496	10.130	10.325	10.990	11.865	12.764	13.452	13.867
Qacha's-Nek	-30.117	28.672	13.706	13.021	12.154	11.233	10.461	10.086	10.286	10.966	11.862	12.782	13.486	13.912

Table 4.1.1 shows calculated monthly mean day lengths using equation (32) and equation (10). It shows that Lesotho has lowest monthly mean day lengths in June and highest monthly mean day lengths in December. Both the highest monthly mean day length and the lowest monthly mean day length are at Quthing.

4.1.3 Monthly mean satellite solar radiation

Table 4.1. 3 Monthly mean satellite – derived horizontal solar radiation [kWh/m^2]

Source: European Commission [23]

Weather Station	Longitude	Latitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Leribe	28.050	-28.883	6.896	6.624	5.706	4.794	4.073	3.624	3.989	4.722	5.879	6.274	6.966	7.171
Letseng-la-Terae	28.817	-28.917	6.132	5.832	5.172	4.523	3.924	3.377	3.868	4.366	5.739	6.121	6.844	6.752
Maputsoe	28.890	-27.907	7.116	6.626	5.816	4.791	4.122	3.632	4.013	4.756	5.938	6.512	7.207	7.418
Mokhotlong^{Gop}	29.067	-29.283	6.632	6.427	5.609	4.805	4.068	3.631	3.998	4.617	5.739	6.172	6.807	6.982
Maseru	27.567	-29.450	7.060	6.511	5.691	4.725	3.970	3.483	3.871	4.599	5.784	6.263	6.984	7.266
Oxbow	28.617	-28.717	6.195	6.007	5.142	4.329	3.727	3.163	3.684	4.305	5.574	5.737	6.469	6.530
Qacha's-Nek^{Gop}	28.672	-30.117	6.534	6.256	5.473	4.629	3.902	3.393	3.716	4.456	5.600	5.828	6.593	6.708
Quthing	27.717	-30.417	6.972	6.414	5.595	4.490	3.702	3.209	3.580	4.325	5.603	6.099	6.949	7.330
sehlabathebe	29.062	-29.881	6.105	5.804	5.175	4.439	3.868	3.415	3.717	4.361	5.437	5.661	6.139	6.302
Semonkong	28.100	-29.833	6.625	6.150	5.452	4.632	3.916	3.491	3.831	4.614	5.847	6.221	6.977	7.122
Thaba-Tseka	28.583	-29.550	6.551	6.093	5.306	4.497	3.691	3.213	3.560	4.446	5.739	6.196	6.836	6.985
Tsa'kholo	27.159	-29.648	7.139	6.540	5.751	4.726	3.972	3.485	3.862	4.607	5.854	6.433	7.263	7.521
Mohale	-28.480	28.060	6.720	6.360	5.514	4.725	4.111	3.699	4.130	4.807	6.002	6.096	6.802	6.997
Katse	-29.490	28.480	6.317	5.896	5.232	4.539	3.841	3.469	3.931	4.403	5.857	6.005	6.721	6.786
Qacha's-Nek^{Obs}	-30.117	28.467	6.130	5.690	5.060	4.242	3.613	3.147	3.492	4.181	5.430	5.462	6.241	6.448
Mokhotlong^{Obs}	-29.280	29.067	6.599	6.329	5.600	4.796	4.059	3.635	4.059	4.561	5.811	6.082	6.769	6.946
Moshoeshoe-I	-29.450	27.561	6.317	5.896	5.232	4.539	3.841	3.469	3.931	4.403	5.857	6.005	6.721	6.786

Table 4.1.3 shows an eleven years long-term monthly mean satellite-derived horizontal solar radiation dataset at selected location for the period (2005 – 2016). It shows that highest monthly mean solar radiation in Lesotho is in December and lowest monthly mean solar radiation is in June. Tśakholo has the highest monthly mean solar radiation whereas Oxbow and Quthing have lowest monthly mean solar radiation.

4.1.4 Monthly mean horizontal ground – derived solar radiation

Table 4.1. 4 Gopinathan solar radiation database [kWh/m^2]

Source: Gopinathan [7]

Weather Station	Latitude	Longitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Leribe	-28.883	28.050	7.136	6.639	5.769	5.297	4.025	3.744	4.042	4.442	5.761	6.467	7.158	7.300
Letseng-la-Terae	-28.917	28.817	5.847	5.394	4.983	3.528	2.417	2.511	4.075	3.336	4.836	6.108	5.825	5.433
Maputsoe	-28.896	27.102	7.136	6.422	5.958	4.953	3.933	3.583	3.450	4.544	5.717	6.311	7.019	7.189
Mokhotlong[Gop]	-29.283	29.067	6.992	6.508	5.817	5.186	3.919	3.692	4.211	4.511	5.853	6.119	6.889	6.733
Maseru	-29.450	27.567	7.247	6.883	5.822	4.708	3.911	3.422	3.725	4.681	5.897	6.367	7.086	7.622
Oxbow	-28.717	28.617	5.206	4.633	4.253	3.917	2.969	2.861	3.315	4.144	5.139	5.883	4.711	5.286
Qacha's-Nek[Gop]	-30.117	28.672	6.631	5.911	5.608	4.922	3.611	3.486	3.872	4.356	5.631	5.772	6.586	7.336
Quthing	-30.417	27.717	7.092	6.178	5.969	4.825	3.608	3.369	3.575	3.839	5.614	6.061	5.411	7.217
Sehlabathebe	-29.881	29.062	6.567	5.753	5.150	4.700	3.203	3.031	3.458	4.322	5.317	5.992	6.250	6.756
Semonkong	-29.833	28.100	7.161	6.067	5.733	5.047	3.519	3.075	3.486	4.547	6.067	6.433	7.183	6.133
Thaba-Tseka	-29.550	28.583	7.300	6.392	5.808	4.922	3.711	3.614	4.122	4.478	6.078	6.619	6.978	7.203
Tsa'kholo	-29.648	27.159	7.303	6.661	5.944	4.908	3.872	3.586	3.825	4.392	5.558	6.222	7.231	7.900

Table 4.1.4 shows monthly mean horizontal ground – derived solar radiation database. They are derived from the Angstrőm – Prescott model as described in equation (37) with regression coefficients given by equation (38) and equation (39). This database is developed using Gopinathan [7] empirical model. It has the following weaknesses:

It is based on sunshine duration, which indirectly measures ground solar radiation.

It does not show the time span of the original data used to construct it (the length of the record is not known)

It does not indicate the source of original data used to construct it (if original data is from LMS or any other source, it should be stated).

It does not have an interpolation tool. If this database is applied anywhere in Lesotho, one has to arbitrarily choose amongst many interpolation techniques [102]. Since each interpolation technique has its own interpolation algorithm, it has its unique result. As a result, there has to be a standardised interpolation technique to get similar results for a proper design and implementation of a solar process application.

This research improves this existing database by incorporating satellite – derived solar radiation into it and develops an interpolation tool, which standardizes estimation of data between grid points. The incorporation of satellite – derived solar radiation is through equation (41) as described in Hove et al [15], who recognised that there is a stronger correlation between clearness index computed from satellite – derived data and that computed from ground – measured data as shown in table 2.3.3

4.1.5 Monthly mean measured horizontal ground solar radiation

Table 4.1. 5 Ground measured solar radiation database [kWh/m^2]

Source: LMS and LHDA

Weather Station	Latitude	Longitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mohale	-28.480	28.060	7.195	5.931	5.494	4.774	4.149	3.627	3.860	6.377	5.667	7.267	5.394	7.377
Katse	-29.490	28.480	6.305	6.857	5.763	5.368	4.703	4.349	4.383	5.071	5.896	6.592	6.924	6.802
Qacha's-Nek[Obs]	-30.117	28.467	6.072	6.113	5.461	4.855	3.918	3.781	3.895	4.456	5.001	6.171	5.702	6.776
Mokhotlong[Obs]	-29.280	29.067	6.473	5.283	6.302	4.836	2.056	3.942	4.045	4.206	5.839	7.010	4.811	6.276
Moshoeshoe-I	-29.450	27.561	6.032	6.688	6.244	5.803	5.426	4.383	4.429	5.610	6.143	6.148	6.662	6.008

Table 4.1.5 shows monthly mean measured horizontal ground solar radiation database as supplied by both Lesotho Meteorological Services (LMS) and Lesotho Highland Development Authority (LHDA).

4.2 Development of solar radiation database

4.2.1 Calculating monthly mean extra – terrestrial solar radiation ($\bar{H}_0$)

Table 4.2. 1 Monthly mean extra-terrestrial horizontal solar radiation [kWh/m^2]

Weather Station	Latitude	Longitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Leribe	28.050	-28.883	11.926	11.004	9.557	7.696	6.076	5.366	5.669	6.968	8.817	10.463	11.632	12.110
Letseng-la-Terae	28.817	-28.917	11.926	11.003	9.555	7.692	6.071	5.361	5.664	6.963	8.814	10.461	11.632	12.112
Maputsoe	27.91	-28.89	11.903	11.027	9.632	7.817	6.222	5.519	5.819	7.099	8.908	10.503	11.621	12.075
Mokhotlong^{Gop}	29.067	-29.283	11.934	10.994	9.526	7.647	6.016	5.303	5.608	6.914	8.779	10.446	11.636	12.124
Maseru	27.567	-29.450	11.938	10.989	9.513	7.626	5.991	5.277	5.582	6.891	8.763	10.438	11.637	12.130
Oxbow	28.617	-28.717	11.922	11.008	9.570	7.717	6.101	5.392	5.695	6.990	8.833	10.470	11.631	12.105
Qacha's-Nek^{Gop}	28.672	-30.117	11.950	10.971	9.459	7.541	5.890	5.172	5.480	6.800	8.698	10.408	11.642	12.152
Quthing	27.717	-30.417	11.956	10.962	9.434	7.503	5.845	5.124	5.433	6.759	8.668	10.394	11.643	12.161
sehlabathebe	29.062	-29.881	11.946	10.977	9.478	7.571	5.926	5.209	5.516	6.832	8.721	10.419	11.640	12.144
Semonkong	28.100	-29.833	11.945	10.979	9.482	7.577	5.933	5.217	5.523	6.839	8.725	10.421	11.640	12.143
Thaba-Tseka	28.583	-29.550	11.940	10.987	9.505	7.613	5.976	5.261	5.567	6.877	8.753	10.434	11.638	12.133
Tsa'kholo	27.159	-29.648	11.942	10.984	9.497	7.601	5.961	5.246	5.552	6.864	8.743	10.430	11.639	12.136
Mohale	28.060	-28.480	11.917	11.014	9.589	7.746	6.136	5.430	5.731	7.022	8.855	10.480	11.628	12.096
Katse	28.480	-29.490	11.938	10.988	9.510	7.621	5.985	5.271	5.576	6.886	8.759	10.437	11.637	12.131
Qacha's-Nek^{Obs}	28.467	-30.117	11.950	10.971	9.459	7.541	5.890	5.172	5.480	6.800	8.698	10.408	11.642	12.152
Mokhotlong^{Obs}	29.067	-29.280	11.934	10.994	9.526	7.647	6.016	5.304	5.609	6.914	8.779	10.446	11.636	12.124
Moshoeshoe-I	27.561	-29.450	11.938	10.989	9.513	7.626	5.991	5.277	5.582	6.891	8.763	10.438	11.637	12.130

Table 4.2.1 shows calculated monthly mean extra-terrestrial horizontal solar radiation ($\bar{H}_0$) datasets which are calculated using equation (24) which states that

$$\bar{H}_0 = \frac{24\,x3600G_{sc}}{\pi}\left(1 + 0.033\,cos\frac{360n}{365}\right)\left(cos\emptyset\,cos\delta\sin\omega_s + \frac{\pi\omega_s}{180}\sin\emptyset\sin\delta\right)$$

With the variables as explained in section 2.1.3.

4.2.2 Calculating monthly mean clearness indices

Table 4.2. 2 Monthly mean ground – derived clearness indices

Weather Station	Latitude	Longitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Leribe	28.050	-28.883	0.598	0.603	0.604	0.688	0.662	0.698	0.713	0.637	0.653	0.618	0.615	0.603
Letseng-la-Terae	28.817	-28.917	0.490	0.490	0.522	0.459	0.398	0.468	0.719	0.479	0.549	0.584	0.501	0.449
Maputsoe	27.91	-28.89	0.600	0.582	0.619	0.634	0.632	0.649	0.593	0.640	0.642	0.601	0.604	0.595
Mokhotlong^{Gop}	29.067	-29.283	0.586	0.592	0.611	0.678	0.652	0.696	0.751	0.652	0.667	0.586	0.592	0.555
Maseru	27.567	-29.450	0.607	0.626	0.612	0.617	0.653	0.649	0.667	0.679	0.673	0.610	0.609	0.628
Oxbow	28.617	-28.717	0.437	0.421	0.444	0.508	0.487	0.531	0.582	0.593	0.582	0.562	0.405	0.437
Qacha's-Nek^{Gop}	28.672	-30.117	0.555	0.539	0.593	0.653	0.613	0.674	0.707	0.641	0.647	0.555	0.566	0.604
Quthing	27.717	-30.417	0.593	0.564	0.633	0.643	0.617	0.658	0.658	0.568	0.648	0.583	0.465	0.593
sehlabathebe	29.062	-29.881	0.550	0.524	0.543	0.621	0.540	0.582	0.627	0.633	0.610	0.575	0.537	0.556
Semonkong	28.100	-29.833	0.599	0.553	0.605	0.666	0.593	0.589	0.631	0.665	0.695	0.617	0.617	0.505
Thaba-Tseka	28.583	-29.550	0.611	0.582	0.611	0.647	0.621	0.687	0.740	0.651	0.694	0.634	0.600	0.594
Tsa'kholo	27.159	-29.648	0.612	0.606	0.626	0.646	0.650	0.684	0.689	0.640	0.636	0.597	0.621	0.651
Mohale	28.060	-28.480	0.604	0.539	0.573	0.616	0.676	0.668	0.673	0.908	0.640	0.693	0.464	0.610
Katse	28.480	-29.490	0.528	0.624	0.606	0.704	0.786	0.825	0.786	0.737	0.673	0.632	0.595	0.561
Qacha's-Nek^{Obs}	28.467	-30.117	0.508	0.557	0.577	0.644	0.665	0.731	0.711	0.655	0.575	0.593	0.490	0.558
Mokhotlong^{Obs}	29.067	-29.280	0.542	0.481	0.662	0.632	0.342	0.743	0.721	0.608	0.665	0.671	0.413	0.518
Moshoeshoe-I	27.561	-29.450	0.505	0.609	0.656	0.761	0.906	0.831	0.793	0.814	0.701	0.589	0.572	0.495

Table 4.2.2 shows monthly mean ground – derived clearness indices ($\overline{K}_{Ground}$) calculated using equation (20) and data in tables 4.1.4, 4.1.5 and 4.2.1. The monthly mean ground – derived clearness index is the ratio of the surface radiation on a horizontal surface to the corresponding horizontal extra-terrestrial radiation [40],[36]. It determines the amount of solar radiation reaching the ground. [15], [40], [41].

Table 4.2. 3 Monthly mean satellite – derived clearness index

Weather Station	Latitude	Longitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Leribe	28.050	-28.883	0.578	0.602	0.597	0.623	0.670	0.675	0.704	0.678	0.667	0.600	0.599	0.592
Letseng-la-Terae	28.817	-28.917	0.514	0.530	0.541	0.588	0.646	0.630	0.683	0.627	0.651	0.585	0.588	0.557
Maputsoe	27.907	-28.890	0.598	0.601	0.604	0.613	0.663	0.658	0.690	0.670	0.667	0.620	0.620	0.614
Mokhotlong^{Gop}	29.067	-29.283	0.556	0.585	0.589	0.628	0.676	0.685	0.713	0.668	0.654	0.591	0.585	0.576
Maseru	27.567	-29.450	0.591	0.592	0.598	0.620	0.663	0.660	0.693	0.667	0.660	0.600	0.600	0.599
Oxbow	28.617	-28.717	0.520	0.546	0.537	0.561	0.611	0.587	0.647	0.616	0.631	0.548	0.556	0.539
Qacha's-Nek^{Gop}	28.672	-30.117	0.547	0.570	0.579	0.614	0.662	0.656	0.678	0.655	0.644	0.560	0.566	0.552
Quthing	27.717	-30.417	0.583	0.585	0.593	0.598	0.633	0.626	0.659	0.640	0.646	0.587	0.597	0.603
sehlabathebe	29.062	-29.881	0.511	0.529	0.546	0.586	0.653	0.656	0.674	0.638	0.623	0.543	0.527	0.519
Semonkong	28.100	-29.833	0.555	0.560	0.575	0.611	0.660	0.669	0.694	0.675	0.670	0.597	0.599	0.587
Thaba-Tseka	28.583	-29.550	0.549	0.555	0.558	0.591	0.618	0.611	0.640	0.646	0.656	0.594	0.587	0.576
Tsa'kholo	27.159	-29.648	0.598	0.595	0.606	0.622	0.666	0.664	0.696	0.671	0.670	0.617	0.624	0.620
Mohale	28.060	-28.480	0.564	0.577	0.575	0.610	0.670	0.681	0.721	0.685	0.678	0.582	0.585	0.578
Katse	28.480	-29.490	0.529	0.537	0.550	0.596	0.642	0.658	0.705	0.640	0.669	0.575	0.577	0.559
Qacha's-Nek^{Obs}	28.467	-30.117	0.513	0.519	0.535	0.562	0.613	0.609	0.637	0.615	0.624	0.525	0.536	0.531
Mokhotlong^{Obs}	29.067	-29.280	0.553	0.576	0.588	0.627	0.675	0.685	0.724	0.660	0.662	0.582	0.582	0.573
Moshoeshoe-I	27.561	-29.450	0.529	0.537	0.550	0.595	0.641	0.657	0.704	0.639	0.668	0.575	0.578	0.559

Table 4.2.3 shows monthly mean satellite – derived clearness indices ($\overline{K}_{Satellite}$) calculated using equation (20) and data in tables 4.1.3 and 4.2.1. The monthly mean satellite – derived clearness index is the ratio of the satellite measured radiation on a horizontal ground surface to the corresponding horizontal extra-terrestrial radiation [40],[36]. It determines the amount of satellite measured solar radiation reaching the ground. [15], [40], [41].

$\overline{K}_{Satellite}$ is monthly mean satellite – '***derived'*** clearness index because it is not calculated from actual ground solar radiation measurements but from the derived satellite solar radiation. The satellite solar radiation datasets are calculated from the difference between the incoming and outgoing sensed solar radiation and a combination of global circulation models (GCM) and other complex models [73]–[75], [113].

4.2.3 Finding regression coefficients

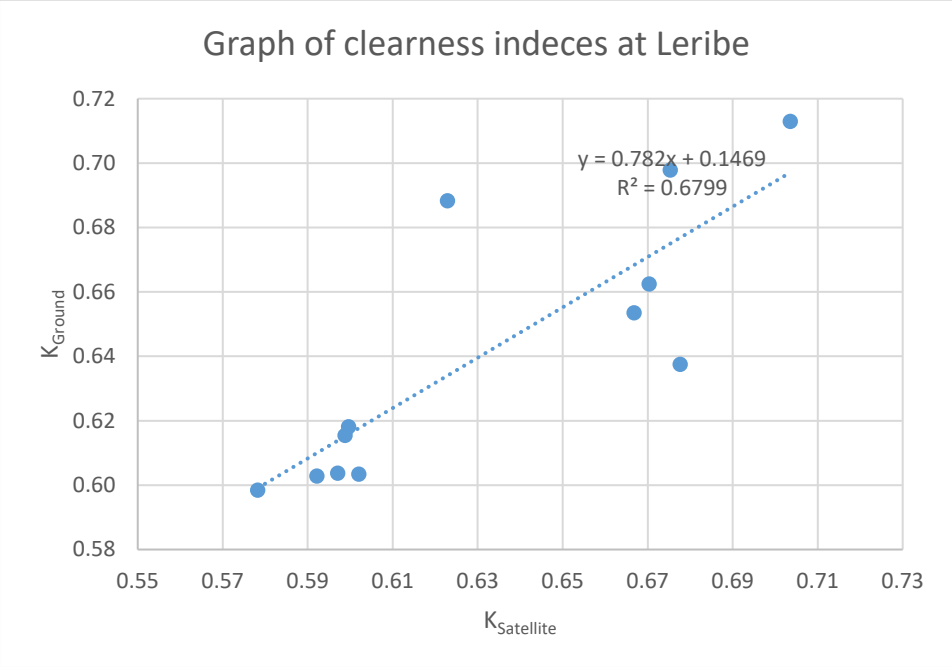


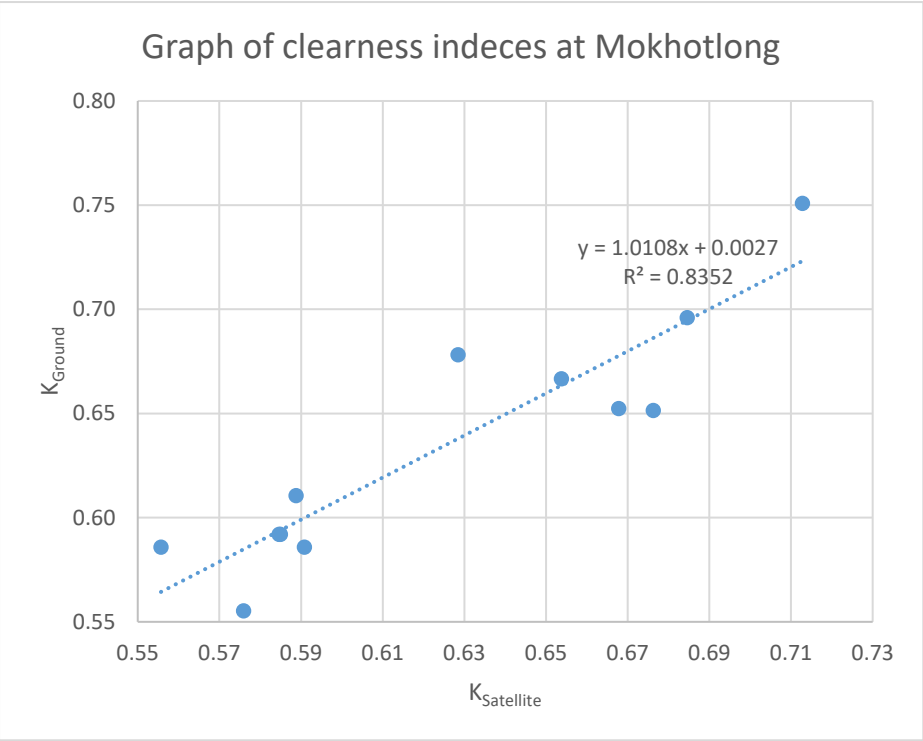
Fig 4.2. 1 Regression coefficients D and E at Leribe

Regression Statistics	
Multiple R	0.824576658
(R^2)	0.679926666
Adjusted R^2	0.647919332
Standard Error	0.024349684
Observations	12

Coefficients		*Standard Error*	*t Stat*
E	0.146884423	0.107470404	1.366743004
D	0.782029035	0.169674504	4.60899556

Month	*Predicted K_{Ground}*	*Residuals*
Jan	0.5981037	-0.000702662
Feb	0.617669538	-0.014345906
Mar	0.613793226	-0.010131823
Apr	0.633979028	0.054289989
May	0.671112662	-0.00867503
Jun	0.674979522	0.022794977
Jul	0.69710302	0.015782782
Aug	0.676813193	-0.039353576
Sep	0.668363664	-0.014937653
Oct	0.61579941	0.00225848
Nov	0.615176293	0.000215401
Dec	0.609982471	-0.007194978

Fig 4.1.1 shows regression coefficients at Leribe with R^2 =0.6799 and a standard error of 0.0243. The regression coefficient ***D*** = 0.782 with a standard error of 0.1074 and a statistical test of 1.3667. The regression coefficient ***E*** = 0.1469, with the standard error of 0.16967 and a statistical test of 4.6090.



Regression Statistics	
Multiple R	0.913893
(R^2)	0.835201
Adjusted R^2	0.818721
Standard Error	0.024386
Observations	12

Coefficients		*Standard Error*	*t Stat*
E	0.002652	0.089077	0.029768
D	1.010833	0.141991	7.118995

Month	*Predicted K_{Ground}*	*Residuals*
Jan	0.56435	0.02150
Feb	0.59363	-0.00162
Mar	0.59779	0.01282
Apr	0.63789	0.04034
May	0.68624	-0.03473
Jun	0.69467	0.00143
Jul	0.72320	0.02771
Aug	0.67772	-0.02523
Sep	0.66352	0.00319
Oct	0.59989	-0.01405
Nov	0.59396	-0.00191
Dec	0.58480	-0.02944

Fig 4.2. 2 Regression coefficients *D* and *E* at Mokhotlong[Gop]

Fig 4.1.2 shows regression coefficients at Mokhotlong with R^2 =0.8352 and a standard error of 0.0243. The regression coefficient ***D*** = 1.0108 with a standard error of 0.14200 and a statistical test of 7.1190. The regression coefficient ***E*** = 0.0027, with the standard error of 0.0891 and a statistical test of 0.0298.

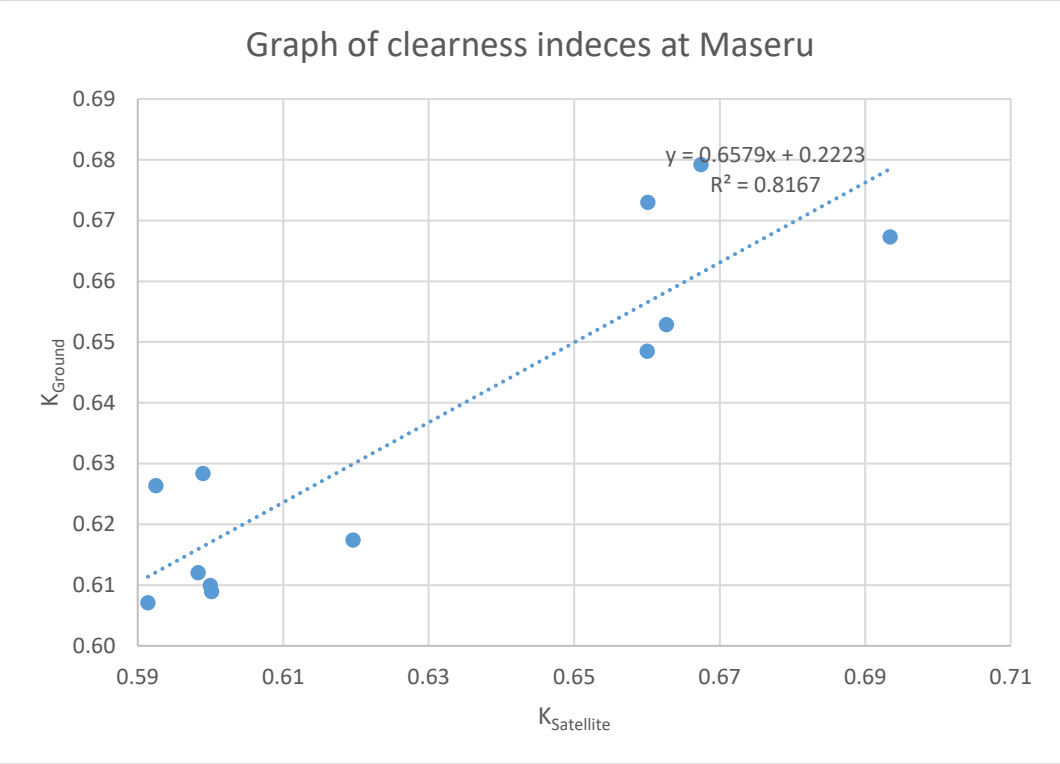


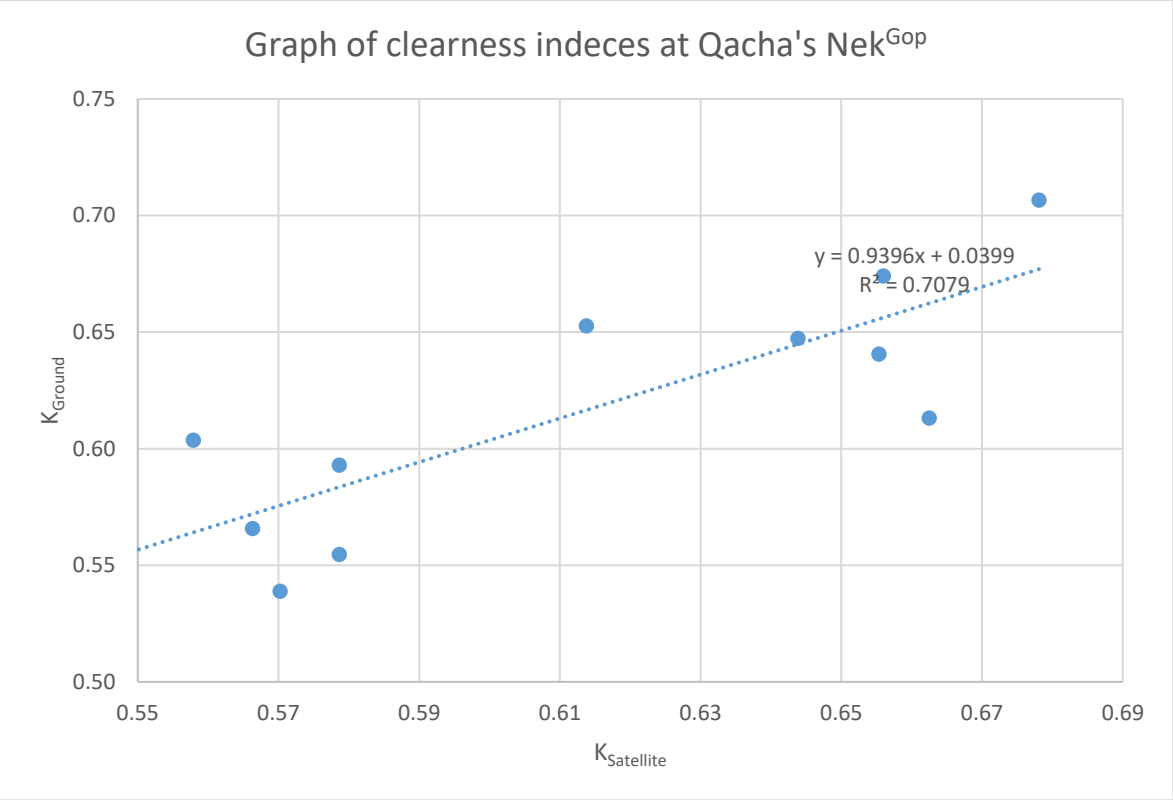
Fig 4.2. 3 Regression coefficients *D* and *E* at Maseru

Regression Statistics	
Multiple R	0.903716
(R^2)	0.816703
Adjusted R^2	0.798373
Standard Error	0.01209
Observations	12

Coefficients		*Standard Error*	*t Stat*
E	0.222311	0.062062	3.582094
D	0.65787	0.098557	6.675042

Month	*Predicted K_{Ground}*	*Residuals*
Jan	0.611370	-0.00428
Feb	0.612092	0.014279
Mar	0.615906	-0.00386
Apr	0.629915	-0.01248
May	0.658277	-0.00543
Jun	0.656517	-0.00801
Jul	0.678485	-0.01121
Aug	0.661393	0.017833
Sep	0.656581	0.016418
Oct	0.617009	-0.00708
Nov	0.617122	-0.00819
Dec	0.616362	0.012022

Fig 4.1.3 shows regression coefficients at Maseru with R^2 = 0.8167 and a standard error of 0.0121. The regression coefficient ***D*** = 0.6579 with a standard error of 0.0986 and a statistical test of 6.6750. The regression coefficient ***E*** = 0.2223, with the standard error of 0.0621 and a statistical test of 3.5821.



Regression Statistics	
Multiple R	0.841362
(R^2)	0.70789
Adjusted R^2	0.678679
Standard Error	0.030106
Observations	12

Coefficients		*Standard Error*	*t Stat*
E	0.039852	0.116565	0.341887
D	0.93963	0.190874	4.922776

Month	*Predicted K_{Ground}*	*Residuals*
Jan	0.553623	0.001214
Feb	0.575643	-0.036836
Mar	0.583546	0.009360
Apr	0.616555	0.036130
May	0.662349	-0.049271
Jun	0.656227	0.017830
Jul	0.677000	0.029671
Aug	0.655620	-0.015094
Sep	0.644807	0.002548
Oct	0.583564	-0.028987
Nov	0.571970	-0.006230
Dec	0.564050	0.039666

Fig 4.2. 4 Regression coefficients *D* and *E* at Qacha's Nek^Gop

Fig 4.1.4 shows regression coefficients at Qacha's Nek^Gop with R^2 = 0.7079 and a standard error of 0.0301. The regression coefficient ***D*** = 0.9396 with a standard error of 0.1909 and a statistical test of 4.9228. The regression coefficient ***E*** = 0.0399, with the standard error of 0.1166 and a statistical test of 0.3419.

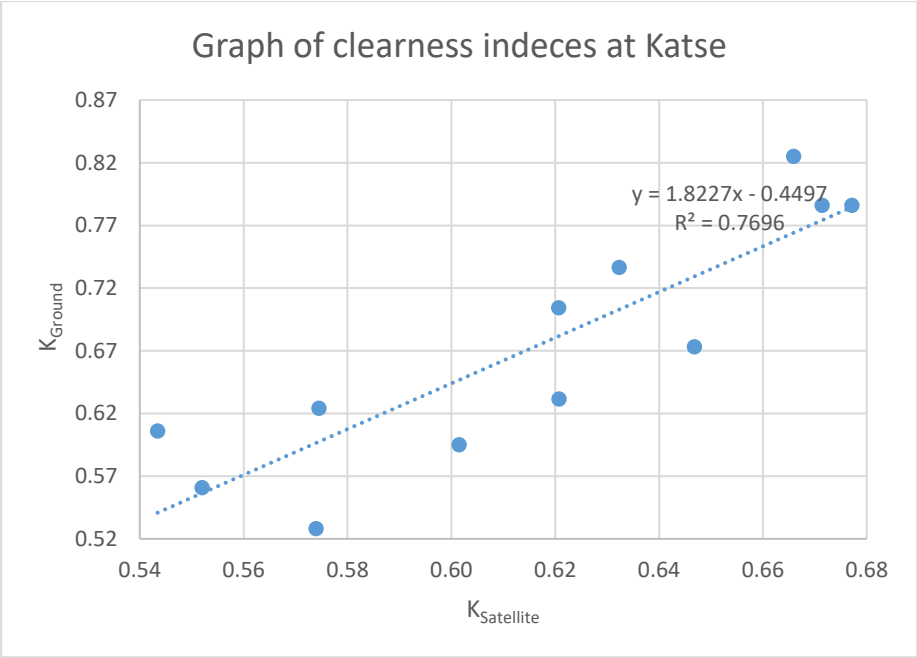


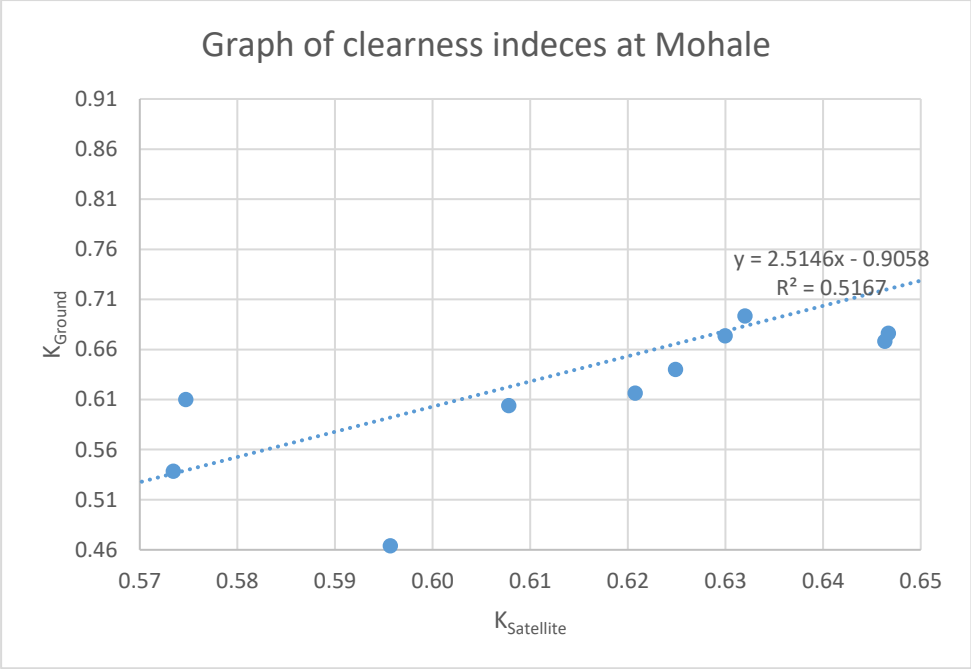
Fig 4.2. 5 Regression coefficients *D* and *E* at Katse

Regression Statistics	
Multiple R	0.877253925
(R^2)	0.769574449
Adjusted R^2	0.746531894
Standard Error	0.048469343
Observations	12

Coefficients		*Standard Error*	*t Stat*
E	-0.44966	0.19449	-2.312042009
D	1.82273	0.31540	5.779097246

Month	*Predicted KGround*	*Residuals*
Jan	0.59649	-0.06840
Feb	0.59747	0.02654
Mar	0.54081	0.06520
Apr	0.68168	0.02271
May	0.78456	0.00130
Jun	0.76416	0.06097
Jul	0.77417	0.01191
Aug	0.70292	0.03358
Sep	0.72925	-0.05611
Oct	0.68177	-0.05015
Nov	0.64674	-0.05171
Dec	0.55653	0.00415

Fig 4.1.5 shows regression coefficients at Katse with R^2 = 0.7696 and a standard error of 0.04847. The regression coefficient ***D*** = 1.8227 with a standard error of 0.3154 and a statistical test of 5.7791. The regression coefficient ***E*** = -0.4497, with the standard error of 0.1945 and a statistical test of -2.3120.



Regression Statistics	
Multiple R	0.718809116
R Square	0.516686545
Adjusted R Square	0.468355199
Standard Error	0.078205501
Observations	12

Coefficients		*Standard Error*	*t Stat*
E	-0.9058	0.472924274	-1.9153
D	2.5146	0.769064802	3.2696

Month	*Predicted K_{Ground}*	*Residuals*
Jan	0.622551	-0.018768
Feb	0.536120	0.002398
Mar	0.515611	0.057379
Apr	0.655065	-0.038768
May	0.720301	-0.044200
Jun	0.719391	-0.051344
Jul	0.678264	-0.004796
Aug	0.737083	0.171083
Sep	0.665507	-0.025475
Oct	0.683386	0.010083
Nov	0.591985	-0.128085
Dec	0.539353	0.070492

Fig 4.2. 6 Regression coefficients *D* and *E* at Mohale

Fig 4.1.6 shows regression coefficients at Katse with R^2 = 0.5167 and a standard error of 0.0782. The regression coefficient ***D*** = 2.5146 with a standard error of 0.4729 and a statistical test of -1.9153. The regression coefficient ***E*** = -0.9058, with the standard error of 0.4729 and a statistical test of -1.9153.

The plot of the clearness indices gives the regression coefficients which are described as the regression constants ***D*** and ***E*** in equation (41). They are obtained using Microsoft Excel 2016 application software by plotting the ground – derived clearness indices against the satellite – derived clearness indices in tables 4.2.2 and 4.2.3.

Table 4.2. 4 Regression coefficients *D* and *E*

Weather Station	Longitude	Latitude	***D***	***E***
Leribe	28.050	-28.883	0.782	0.147
Letseng-la-Terae	28.817	-28.917	0.537	0.189
Maputsoe	27.907	-28.890	0.455	0.331
Mokhotlong^{Gop}	29.067	-29.283	1.011	0.003
Maseru	27.567	-29.450	0.658	0.222
Oxbow	28.617	-28.717	1.262	-0.226
Qacha's-Nek^{Gop}	28.672	-30.117	0.940	0.040
Quthing	27.717	-30.417	0.909	0.045
sehlabathebe	29.062	-29.881	0.402	0.340
Semonkong	28.100	-29.833	0.527	0.284
Thaba-Tseka	28.583	-29.550	1.005	0.038
Tsa'kholo	27.159	-29.648	0.634	0.234
Mohale	28.060	-28.480	2.515	-0.906
Katse	28.480	-29.490	1.823	-0.450
Qacha's-Nek^{Obs}	28.467	-30.117	1.059	0.007
Mokhotlong^{Obs}	29.067	-29.280	1.103	-0.109
Moshoeshoe-I	27.561	-29.450	2.338	-0.799

Table 4.2.4 shows regression coefficients ***D*** and ***E*** from the regression plots of ground – derived clearness indices and satellite – derived clearness indices as defined in equation (44). Samples of regression coefficients ***D*** and ***E*** are shown from fig 4.2.1 to fig 4.2.4.

4.2.4 Mapping regression coefficients

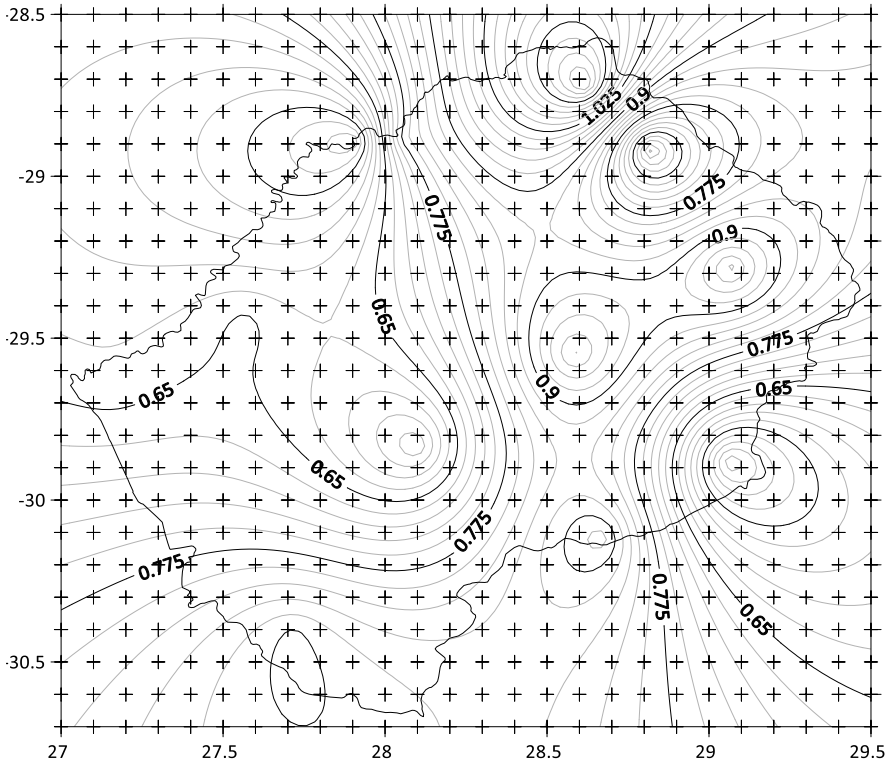


Fig 4.2. 7 Contour map of all *D* coefficients

Fig 4.2.5 shows contour map of all ***D*** coefficients as derived from table 4.2.4. Coefficients of ***D*** range between 0.4191 and 1.2415.

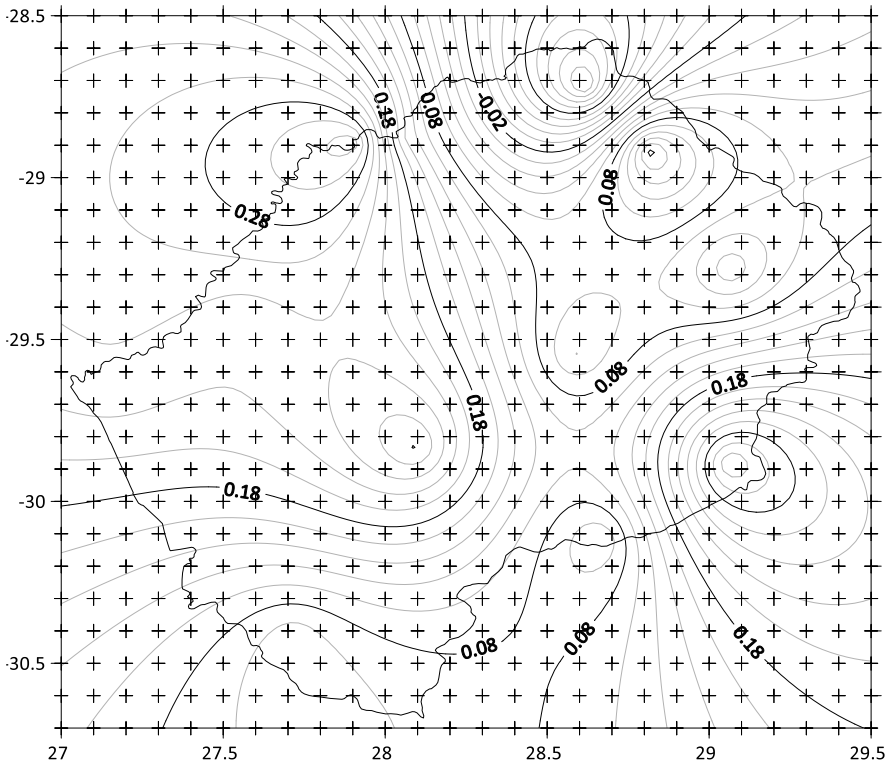


Fig 4.2. 8 Contour map of all *E* coefficients

Fig 4.2.6 shows contour map of all ***E*** coefficients as derived from table 4.2.4. Coefficients of ***E*** range between -0.2264 and 0.3401

Table 4.2. 5 Regression coefficients and correction factor

Weather Station	Longitude	Latitude	D	E	D_{LOOCV}	E_{LOOCV}	D_{CF}	E_{CF}	$\overline{\Delta D}$	$\overline{\Delta E}$
Leribe	28.050	-28.883	0.782	0.147	0.771	0.146	0.7996	0.1555	0.0141	0.0074
Letseng-la-Terae	28.817	-28.917	0.537	0.189	0.538	0.219	0.5495	0.2002	-0.0010	-0.1581
Maputsoe	27.907	-28.890	0.455	0.331	0.376	0.315	0.4648	0.3505	0.1735	0.0496
Mokhotlong^{Gop}	29.067	-29.283	1.011	0.003	1.010	0.002	1.0335	0.0028	0.0008	0.2457
Maseru	27.567	-29.450	0.658	0.222	0.649	0.225	0.6726	0.2354	0.0136	-0.0121
Oxbow	28.617	-28.717	1.262	-0.226	1.343	-0.229	1.2900	-0.2397	-0.0647	-0.0100
Qacha's-Nek^{Gop}	28.672	-30.117	0.940	0.040	0.927	0.049	0.9607	0.0422	0.0138	-0.2295
Quthing	27.717	-30.417	0.909	0.045	0.935	0.045	0.9293	0.0477	-0.0287	-0.0050
sehlabathebe	29.062	-29.881	0.402	0.340	0.438	0.301	0.4110	0.3602	-0.0904	0.1156
Semonkong	28.100	-29.833	0.527	0.284	0.548	0.279	0.5388	0.3009	-0.0399	0.0181
Thaba-Tseka	28.583	-29.550	1.005	0.038	1.016	0.045	1.0277	0.0403	-0.0110	-0.1784
Tsa'kholo	27.159	-29.648	0.634	0.234	0.687	0.253	0.6482	0.2477	-0.0836	-0.0797
Mohale	28.060	-28.480	2.515	-0.906	2.593	-0.934	2.5710	-0.9591	-0.0312	-0.0312
Katse	28.480	-29.490	1.823	-0.450	1.880	-0.464	1.8636	-0.4761	-0.0312	-0.0312
Qacha's-Nek^{Obs}	28.467	-30.117	1.059	0.007	1.092	0.007	1.0824	0.0072	-0.0312	-0.0794
Mokhotlong^{Obs}	29.067	-29.280	1.103	-0.109	1.137	-0.170	1.1273	-0.1154	-0.0312	-0.5571
Moshoeshoe-I	27.561	-29.450	2.338	-0.799	2.676	-0.807	2.3903	-0.8457	-0.1446	-0.0100
Average									**-0.0219**	**-0.0556**
Correction Factor							**1.0224**	**1.0589**		

Table 4.2.5 shows a summary of regression coefficients and associated correction factors as described in section 3.2.3 such that

$$\overline{\Delta D} = \sum_{i=1}^{N} ((\overline{D} - D_i)/D_i) \; and \quad \overline{\Delta E} = \sum_{i=1}^{N} ((\overline{E} - E_i)/E_i)$$

The corrected coefficients D_{CF} and E_{CF} in table 4.2.5 are obtained after the application of the correction factor in equation (58).

4.2.5 Regression coefficients

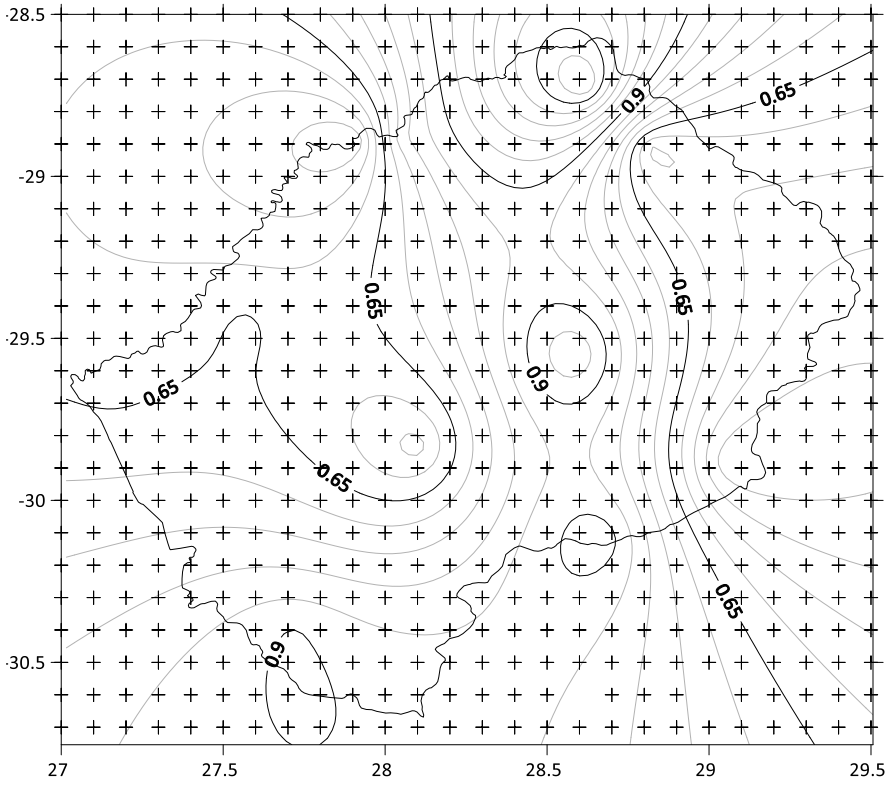


Fig 4.2. 9 Contour map D_{LOOCV} coefficients at Mokhotlong

Fig 4.2.7 shows a contour map of D_{LOOCV} coefficients at Mokhotlong. The D_{LOOCV} coefficient estimated by Surfer application software is 1.010

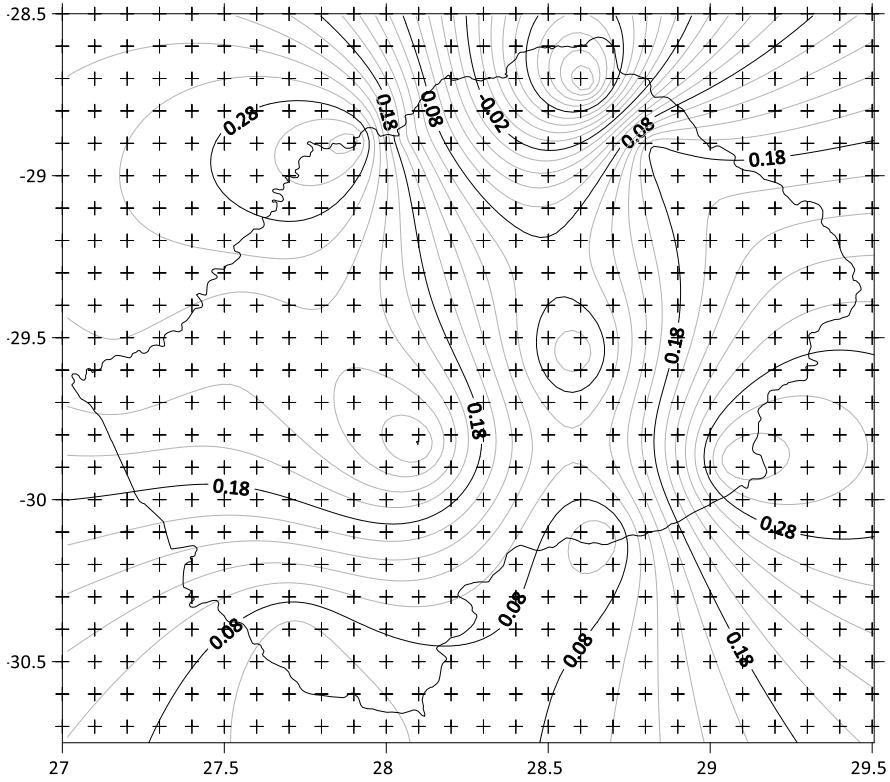


Fig 4.2. 10 Contour map of E_{LOOCV} coefficients at Mokhotlong.

Fig 4.2.8 shows a contour map of E_{LOOCV} coefficients at Mokhotlong. The E_{LOOCV} coefficient estimated by Surfer application software is 0.002.

4.2.6 Correction factor mapping

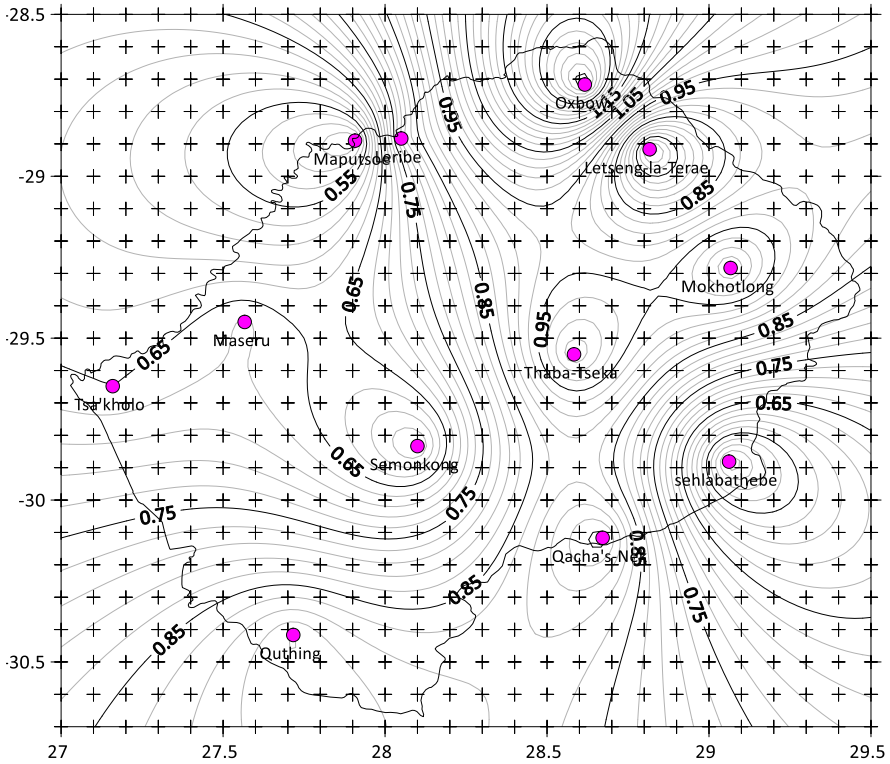


Fig 4.2. 11 Contour map of adjusted coefficient D_{CF}

Fig 4.2.9 shows a map of final regression coefficients (D_{CF}). Final regression coefficient is a product of original regression coefficient (***D***) and the correction factor (***CF***) where ***CF*** is given by equation (61).

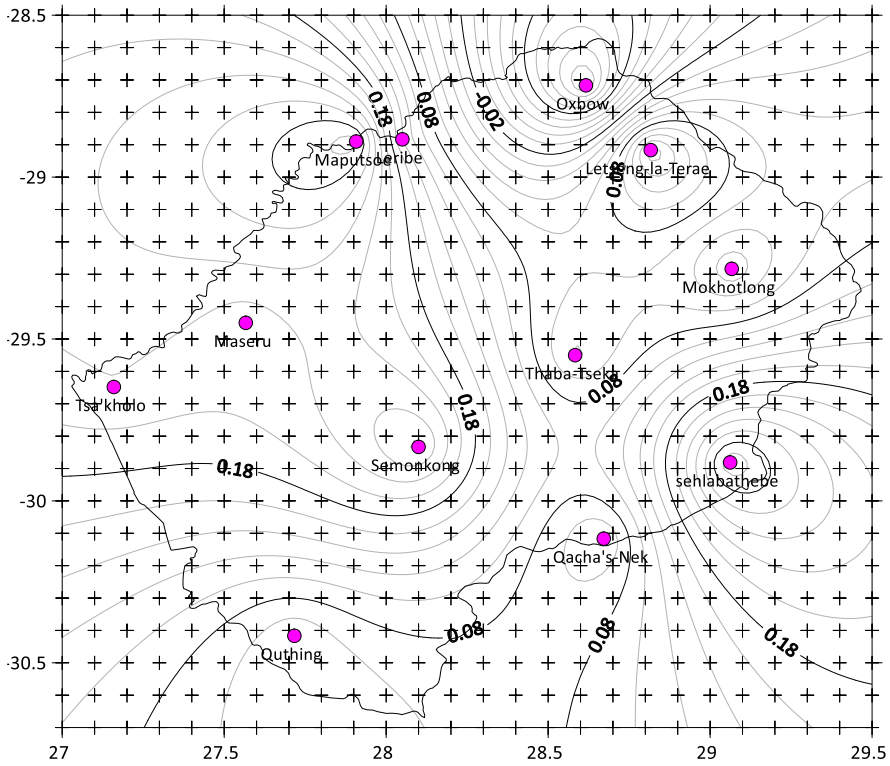


Fig 4.2. 12 Contour map of adjusted coefficient E_{CF}

Fig 4.2.10 shows a map of final regression coefficients (E_{CF}). Final regression coefficient is a product of original regression coefficient (***E***) and the correction factor (***CF***) where ***CF*** is given by equation (61).

4.2.7 Extract of developed solar radiation database in Lesotho

Table 4.2. 6 Extract of developed solar radiation database (kWh/m^2)

Weather Station	Latitude	Longitude	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Leribe	28.05	-28.88	7.125	6.775	5.821	4.854	4.039	3.609	3.767	4.642	5.858	6.350	7.121	7.303
Letseng-la-Terae	28.82	-28.92	5.568	5.228	4.577	3.885	3.241	2.833	3.016	3.624	4.745	5.217	5.878	5.882
Maputsoe	27.91	-28.89	7.232	6.714	5.850	4.792	3.938	3.503	3.613	4.489	5.675	6.411	7.164	7.363
Mokhotlong^{Gop}	29.07	-29.28	6.660	6.452	5.604	4.813	4.058	3.643	3.838	4.577	5.746	6.125	6.821	6.951
Maseru	27.57	-29.45	7.309	6.735	5.839	4.799	3.922	3.467	3.625	4.505	5.743	6.375	7.178	7.423
Oxbow	28.62	-28.72	4.964	4.940	4.176	3.604	3.216	2.696	3.134	3.704	4.894	4.675	5.363	5.294
Qacha's-Nek^{Gop}	28.67	-30.12	6.558	6.258	5.445	4.598	3.842	3.363	3.517	4.364	5.544	5.772	6.587	6.670
Quthing	27.72	-30.42	6.817	6.268	5.438	4.372	3.575	3.121	3.319	4.148	5.422	5.891	6.769	7.087
sehlabathebe	29.06	-29.88	6.587	6.128	5.332	4.392	3.579	3.172	3.252	4.063	5.186	5.810	6.481	6.677
Semonkong	28.10	-29.83	6.926	6.397	5.573	4.608	3.744	3.337	3.448	4.341	5.572	6.200	7.008	7.181
Thaba-Tseka	28.58	-29.55	6.975	6.481	5.617	4.755	3.877	3.398	3.593	4.630	6.030	6.487	7.232	7.351
Tsa'kholo	27.16	-29.65	7.335	6.729	5.852	4.773	3.894	3.441	3.589	4.477	5.750	6.455	7.326	7.556
Mohale	28.06	-28.48	5.653	5.596	4.793	4.552	4.501	4.159	4.739	5.372	6.693	5.372	6.114	6.122
Katse	28.48	-29.49	5.887	5.564	5.026	4.662	4.141	3.826	4.322	4.708	6.506	5.947	6.740	6.587
Qacha's-NekObs	28.47	-30.12	6.499	6.030	5.336	4.483	3.800	3.330	3.534	4.370	5.730	5.723	6.600	6.775
MokhotlongObs	29.07	-29.28	5.862	5.671	5.017	4.366	3.731	3.371	3.635	4.150	5.343	5.402	6.069	6.165
Moshoeshoe-I	27.56	-29.45	4.838	4.639	4.293	4.247	3.955	3.704	4.325	4.488	6.356	5.282	6.005	5.717

Table 4.2.6 shows an extract of the final solar radiation database for Lesotho produced by equation (48).

4.2.8 Solar radiation database reliability

Table 4.2. 7 January to June reliability of solar radiation database

Weather Station	Jan			Feb			Mar			Apr			May			Jun		
	H_{Ground}	$H_{Database}$	rBE	H_{Ground}	$H_{Database}$	rBE	H_{Ground}	$H_{Database}$	rBE	H_{Ground}	$H_{Database}$	rBE	H_{Ground}	$H_{Database}$	rBE	H_{Ground}	$H_{Database}$	rBE
Leribe	7.136	7.125	-0.002	6.639	6.775	0.021	5.769	5.821	0.009	5.297	4.854	-0.084	4.025	4.039	0.003	3.744	3.609	-0.036
Letseng-la-Terae	5.847	5.568	-0.048	5.394	5.228	-0.031	4.983	4.577	-0.082	3.528	3.885	0.101	2.417	3.241	0.341	2.511	2.833	0.128
Maputsoe	7.136	7.232	0.013	6.422	6.714	0.045	5.958	5.850	-0.018	4.953	4.792	-0.032	3.933	3.938	0.001	3.583	3.503	-0.022
Mokhotlong^{Gop}	6.992	6.660	-0.047	6.508	6.452	-0.009	5.817	5.604	-0.037	5.186	4.813	-0.072	3.919	4.058	0.035	3.692	3.643	-0.013
Maseru	7.247	7.309	0.009	6.883	6.735	-0.022	5.822	5.839	0.003	4.708	4.799	0.019	3.911	3.922	0.003	3.422	3.467	0.013
Oxbow	5.206	4.964	-0.046	4.633	4.940	0.066	4.253	4.176	-0.018	3.917	3.604	-0.080	2.969	3.216	0.083	2.861	2.696	-0.058
Qacha's-Nek^{Gop}	6.631	6.558	-0.011	5.911	6.258	0.059	5.608	5.445	-0.029	4.922	4.598	-0.066	3.611	3.842	0.064	3.486	3.363	-0.035
Quthing	7.092	6.817	-0.039	6.178	6.268	0.015	5.969	5.438	-0.089	4.825	4.372	-0.094	3.608	3.575	-0.009	3.369	3.121	-0.074
sehlabathebe	6.567	6.587	0.003	5.753	6.128	0.065	5.150	5.332	0.035	4.700	4.392	-0.066	3.203	3.579	0.118	3.031	3.172	0.047
Semonkong	7.161	6.926	-0.033	6.067	6.397	0.054	5.733	5.573	-0.028	5.047	4.608	-0.087	3.519	3.744	0.064	3.075	3.337	0.085
Thaba-Tseka	7.300	6.975	-0.045	6.392	6.481	0.014	5.808	5.617	-0.033	4.922	4.755	-0.034	3.711	3.877	0.045	3.614	3.398	-0.060
Tsa'kholo	7.303	7.335	0.004	6.661	6.729	0.010	5.944	5.852	-0.016	4.908	4.773	-0.028	3.872	3.894	0.006	3.586	3.441	-0.040
Mohale	7.195	5.653	-0.214	5.931	5.596	-0.056	5.494	4.793	-0.128	4.774	4.552	-0.046	4.149	4.501	0.085	3.627	4.159	0.147
Katse	6.305	5.887	-0.066	6.857	5.564	-0.188	5.763	5.026	-0.128	5.368	4.662	-0.132	4.703	4.141	-0.119	4.349	3.826	-0.120
Qacha's-Nek^{Obs}	6.072	6.499	0.070	6.113	6.030	-0.014	5.461	5.336	-0.023	4.855	4.483	-0.077	3.918	3.800	-0.030	3.781	3.330	-0.119
Mokhotlong^{Obs}	6.473	5.862	-0.094	5.283	5.671	0.073	48.000	5.017	-0.895	4.836	4.366	-0.097	2.056	3.731	0.815	3.942	3.371	-0.145
Moshoeshoe-I	6.032	6.032	0.000	6.688	6.688	0.000	6.244	6.244	0.000	5.803	5.803	0.000	5.426	3.955	-0.271	4.383	4.383	0.000
rMBE			**-0.020**			**0.024**			**-0.025**			**-0.043**			**0.063**			**-0.006**
RMSE			**0.205**			**0.231**			**0.232**			**0.321**			**0.294**			**0.181**
NRMSE			**0.012**			**0.014**			**0.014**			**0.019**			**0.017**			**0.011**

Table 4.2.7 shows reliability of solar radiation database for H_{Ground} and $H_{Database}$ units are in kWh/m^2.

H_{Ground} - is the monthly mean horizontal solar radiation from ground solar radiation database .

$H_{Database}$ – is the calculated monthly mean horizontal solar radiation

From table 4.2.7 the lowest normalised root mean square error (NRMSE) between January and June is 1.1 % and the highest is 1.9 %. This shows that for the period between January and June, the newly developed database has a reliability, which ranges between 98.1% and 98.9 %. This is comparable to other studies of similar nature [15], [62], [89], [114].

Table 4.2. 8 July to December reliability of solar radiation database

Weather Station	Jul			Aug			Sep			Oct			Nov			Dec		
	H_{Ground}	$H_{Database}$	rBE	H_{Ground}	$H_{Database}$	rBE	H_{Ground}	$H_{Database}$	rBE	H_{Ground}	$H_{Database}$	rBE	H_{Ground}	$H_{Database}$	rBE	H_{Ground}	$H_{Database}$	rBE
Leribe	4.042	3.767	-0.068	4.442	4.642	0.045	5.761	5.858	0.017	6.467	6.350	-0.018	7.158	7.121	-0.005	7.300	7.303	0.000
Letseng-la-Terae	4.075	3.016	-0.260	3.336	3.624	0.086	4.836	4.745	-0.019	6.108	5.217	-0.146	5.825	5.878	0.009	5.433	5.882	0.083
Maputsoe	3.450	3.613	0.047	4.544	4.489	-0.012	5.717	5.675	-0.007	6.311	6.411	0.016	7.019	7.164	0.021	7.189	7.363	0.024
Mokhotlong^{Gop}	4.211	3.838	-0.089	4.511	4.577	0.015	5.853	5.746	-0.018	6.119	6.125	0.001	6.889	6.821	-0.010	6.733	6.951	0.032
Maseru	3.725	3.625	-0.027	4.681	4.505	-0.037	5.897	5.743	-0.026	6.367	6.375	0.001	7.086	7.178	0.013	7.622	7.423	-0.026
Oxbow	3.315	3.134	-0.055	4.144	3.704	-0.106	5.139	4.894	-0.048	5.883	4.675	-0.205	4.711	5.363	0.138	5.286	5.294	0.002
Qacha's-Nek^{Gop}	3.872	3.517	-0.092	4.356	4.364	0.002	5.631	5.544	-0.015	5.772	5.772	0.000	6.586	6.587	0.000	7.336	6.670	-0.091
Quthing	3.575	3.319	-0.072	3.839	4.148	0.080	5.614	5.422	-0.034	6.061	5.891	-0.028	5.411	6.769	0.251	7.217	7.087	-0.018
sehlabathebe	3.458	3.252	-0.060	4.322	4.063	-0.060	5.317	5.186	-0.025	5.992	5.810	-0.030	6.250	6.481	0.037	6.756	6.677	-0.012
Semonkong	3.486	3.448	-0.011	4.547	4.341	-0.045	6.067	5.572	-0.082	6.433	6.200	-0.036	7.183	7.008	-0.024	6.133	7.181	0.171
Thaba-Tseka	4.122	3.593	-0.128	4.478	4.630	0.034	6.078	6.030	-0.008	6.619	6.487	-0.020	6.978	7.232	0.037	7.203	7.351	0.021
Tsa'kholo	3.825	3.589	-0.062	4.392	4.477	0.019	5.558	5.750	0.035	6.222	6.455	0.037	7.231	7.326	0.013	7.900	7.556	-0.044
Mohale	3.860	4.739	0.228	6.377	5.372	-0.158	5.667	6.693	0.181	7.267	5.372	-0.261	5.394	6.114	0.133	7.377	6.122	-0.170
Katse	4.383	4.322	-0.014	5.071	4.708	-0.072	5.896	6.506	0.103	6.592	5.947	-0.098	6.924	6.740	-0.027	6.802	6.587	-0.032
Qacha's-NekObs	3.895	3.534	-0.093	4.456	4.370	-0.019	5.001	5.730	0.146	6.171	5.723	-0.073	5.702	6.600	0.158	6.776	6.775	0.000
MokhotlongObs	4.045	3.635	-0.101	4.206	4.150	-0.013	5.839	5.343	-0.085	7.010	5.402	-0.229	4.811	6.069	0.262	6.276	6.165	-0.018
Moshoeshoe-I	4.429	4.429	0.000	5.610	5.610	0.000	6.143	6.143	0.000	6.148	6.148	0.000	6.662	6.662	0.000	6.008	6.008	0.000
rMBE			**-0.073**			**0.002**			**-0.019**			**-0.036**			**0.040**			**0.012**
RMSE			**0.406**			**0.222**			**0.196**			**0.453**			**0.453**			**0.411**
NRMSE			**0.024**			**0.013**			**0.012**			**0.027**			**0.027**			**0.024**

Table 4.2.8 shows reliability of solar radiation database for H_{Ground} and $H_{Database}$ units are in kWh/m^2.

H_{Ground} - is the monthly mean horizontal solar radiation from ground solar radiation database

$H_{Database}$ – is the calculated monthly mean horizontal solar radiation

From table 4.2.8 the lowest normalised root mean square error (NRMSE) between January and June is 1.2 % and the highest is 2.7 %. This shows that for the period between July and December, the newly developed database has a reliability, which ranges between 97.3% and 98.8 %. This is comparable to other studies of similar nature [15], [62], [89], [114].

4.2.9 Comparison of improved database

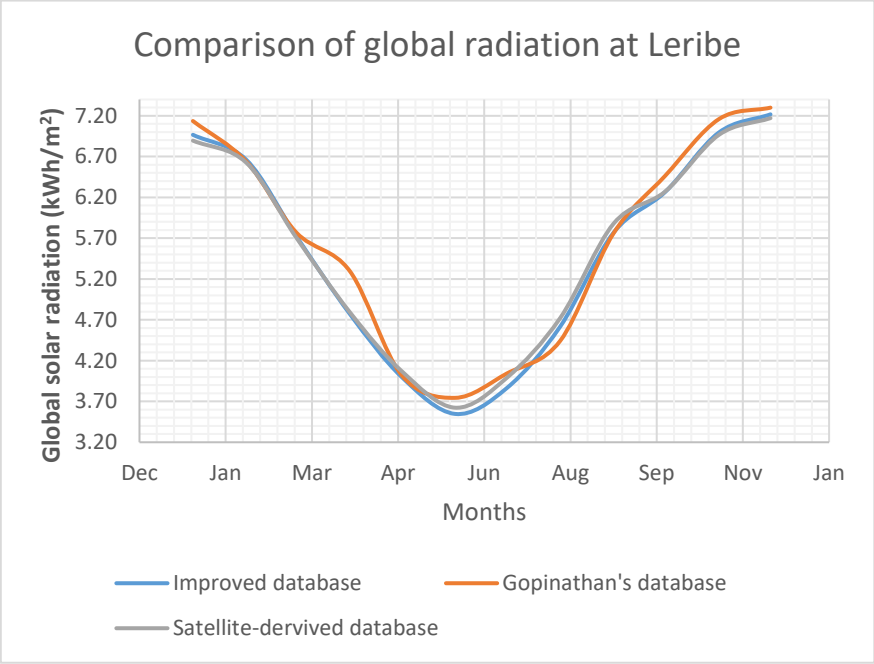


Fig 4.2. 13 Performance of improved database at Leribe

Fig 4.2.13 shows the comparison of the improved database at Leribe and other databases (Ground measured database, Satellite – derived database and Gopinathan developed database). The variation between Gopinathan developed database and improved database is between 1.1 % and 2.7 %, which gives a confidence level between 97.3 % and 99.9%.

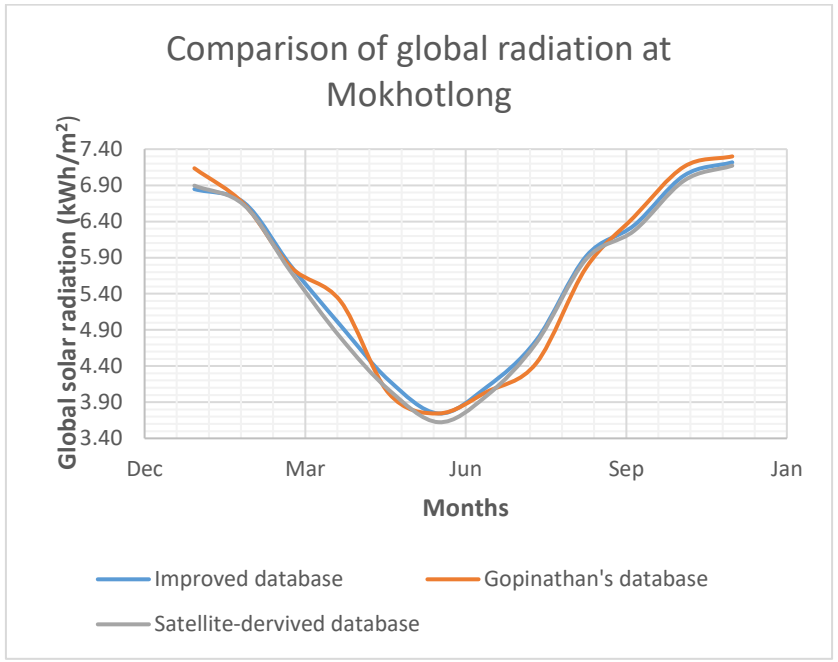


Fig 4.2. 14 Performance of improved database at Mokhotlong

Fig 4.2.14 shows the comparison of the improved database at Mokhotlong and other databases (Ground measured database, Satellite – derived database and Gopinathan developed database). The variation between Gopinathan developed database and improved database is between 1.1 % and 2.7 %, which gives a confidence level between 97.3 % and 99.9%.

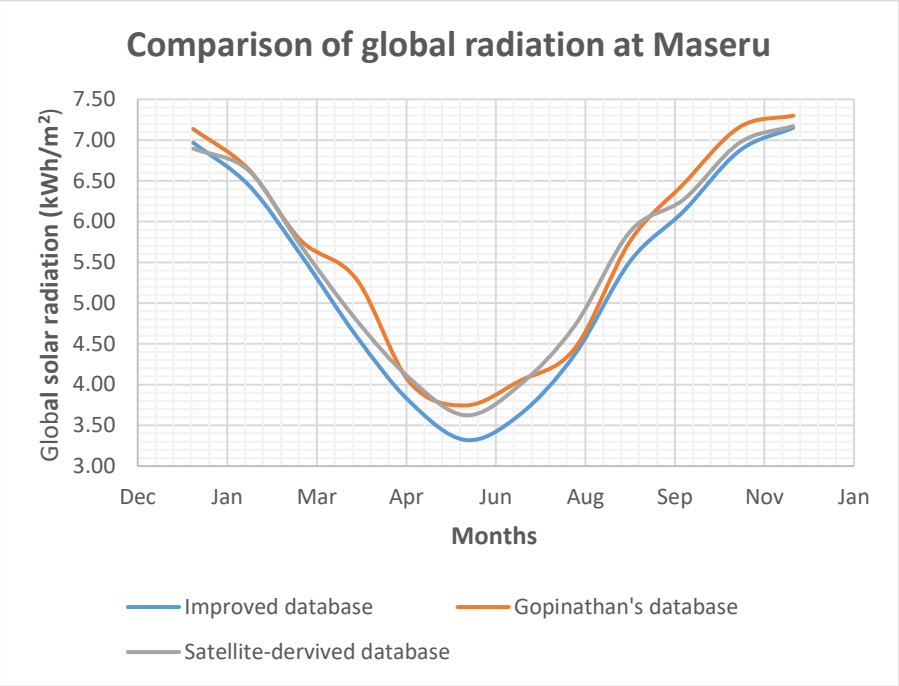


Fig 4.2. 15 Performance of improved database at Maseru

Fig.4.2.15 Shows the comparison of the improved database at Maseru and other databases (Ground measured database, Satellite – derived database and Gopinathan developed database). The variation between Gopinathan developed database and improved database is between 1.1 % and 2.7 %, which gives a confidence level between 97.3 % and 99.9%.

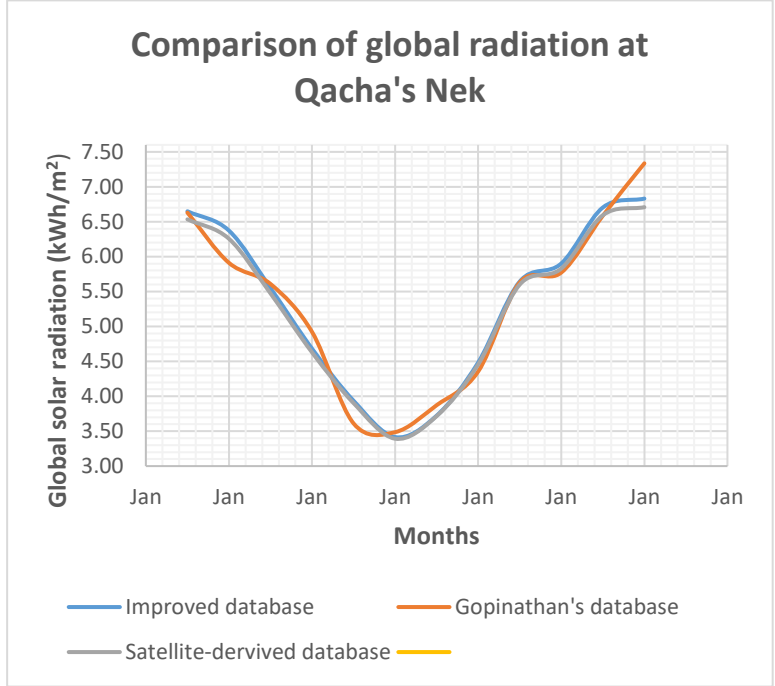


Fig 4.2. 16 Performance of improved database at Qacha's Nek

Fig 4.2.16 shows the comparison of the improved database at Qacha's Nek and other databases (Ground measured database, Satellite – derived database and Gopinathan developed database). The variation between Gopinathan developed database and improved database is between 1.1 % and 2.7 %, which gives a confidence level between 97.3 % and 99.9%.

4.2.10 Improved Lesotho solar radiation atlas

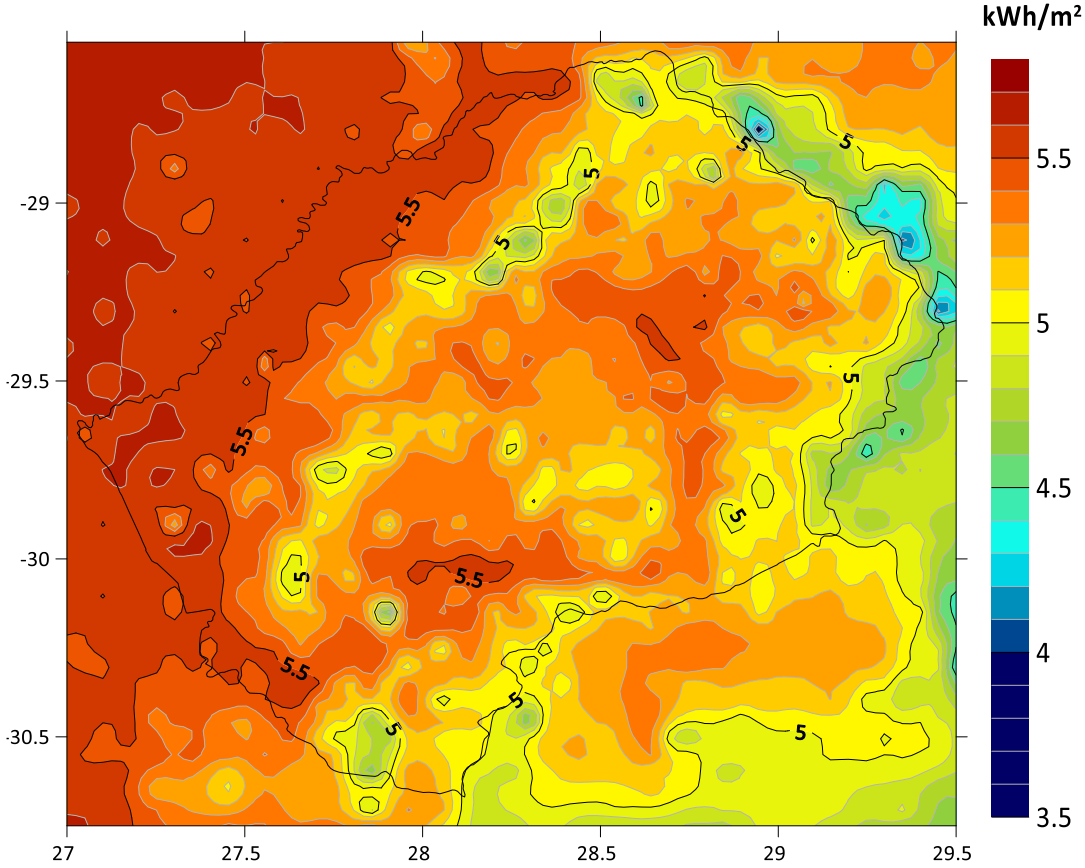


Fig 4.2. 17 Annual mean solar radiation distribution in Lesotho

Fig 4.2.17 shows a map of mean annual horizontal solar radiation distribution as reveal by the improved solar radiation database. It shows that monthly mean solar radiation ranges between 3.7 kWh/m^2 and 5.8 kWh/m^2 with a minimum confidence level of 97.3 %. It shows that the lowlands and other low lying grounds like the Senqu valley have higher solar radiation as compared to the highlands. The south-western part of the country has highest solar radiation as compared to the north-eastern parts of the country which have low solar radiation

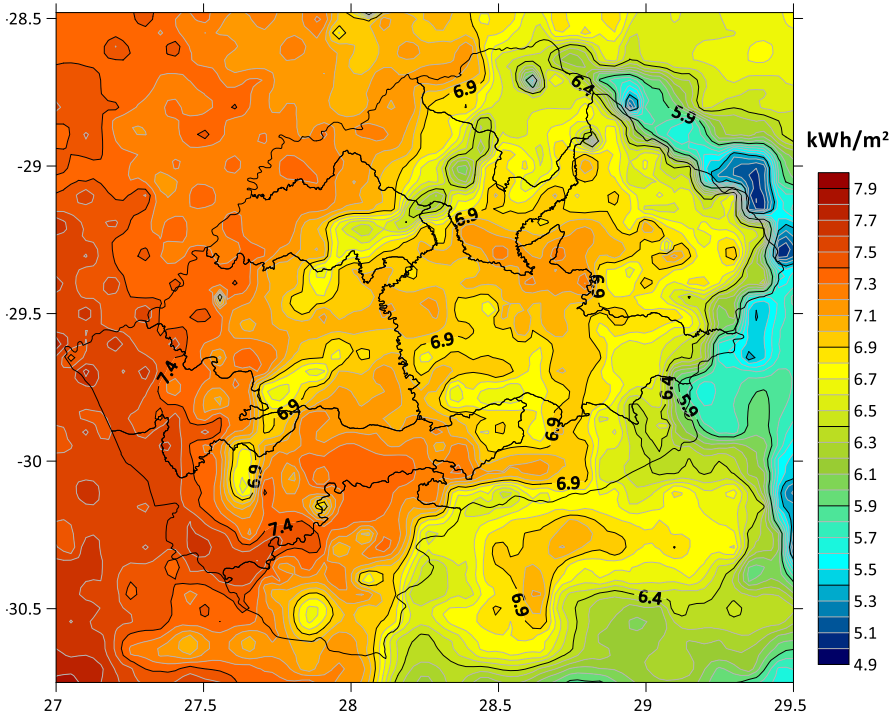


Fig 4.2. 18 December monthly mean solar radiation distribution

Fig 4.2.18 shows monthly mean solar radiation distribution in summer December as reveal by the improved solar radiation database. It shows that monthly mean solar radiation ranges between 4.9 kWh/m^2 and 7.9 kWh/m^2 with a minimum confidence level of 97.3 %. It shows that in December the south- western parts of the country have higher solar radiation due to the fact that this region receives least rainfall in summer as compared to northern regions.

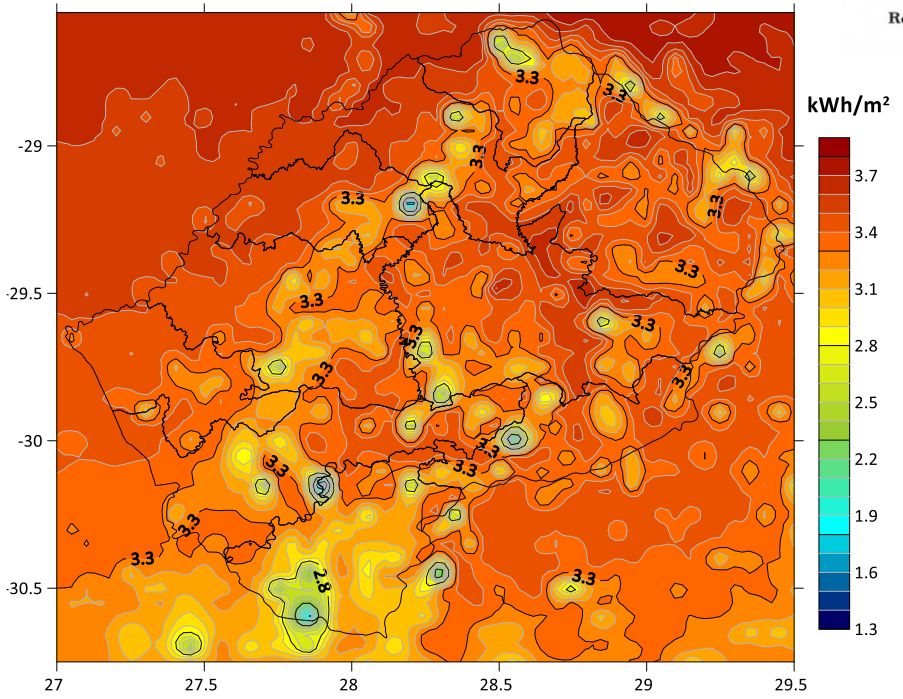


Fig 4.2. 19 June monthly mean solar radiation distribution

Fig 4.2.17 shows monthly mean solar radiation distribution in autumn June as reveal by the improved solar radiation database. It shows that monthly mean solar radiation ranges between 1.3 kWh/m^2 and 3.8 kWh/m^2 with a minimum confidence level of 97.3 %. %. It shows that in July the southern regions of the country receive least solar radiation as number of bright sunshine hours are fewer due to the cloud cover as a result of frontal system often traversing the country in winter season.

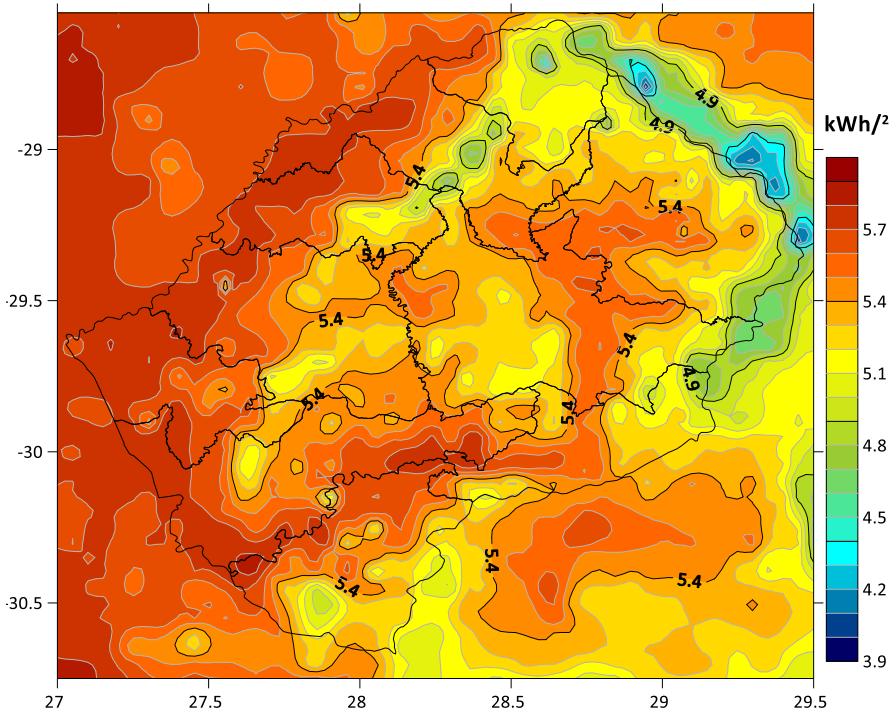


Fig 4.2. 20 March monthly mean solar radiation distribution

Fig 4.2.18 shows monthly mean solar radiation distribution in winter March as reveal by the improved solar radiation database. It shows that monthly mean solar radiation ranges between 3.9 kWh/m^2 and 5.9.0 kWh/m^2 with a minimum confidence level of 97.3 %.

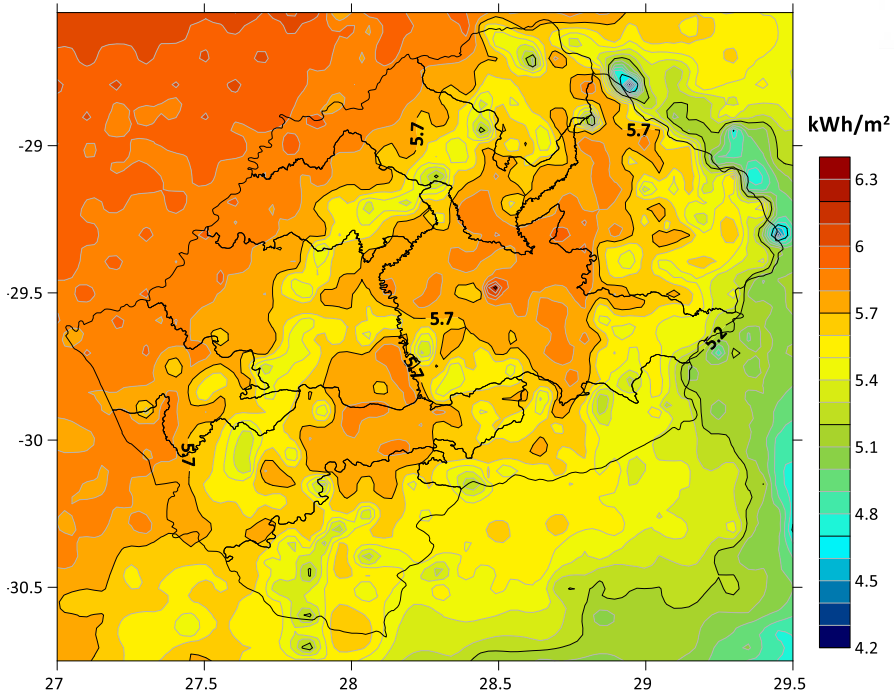


Fig 4.2. 21 September monthly mean solar radiation distribution

Fig 4.2.19 shows monthly mean solar radiation distribution in September as reveal by the improved solar radiation database. It shows that monthly mean solar radiation ranges between 4.2 kWh/m^2 and 6.3 kWh/m^2 with a minimum confidence level of 97.3 %.

4.3 Interpolation code in Visual Basic

```
Sub Macro1()
'
' An interpolating VBA Ccode
' It is run within a worksheet containg Solar Radiation Database

'Build a Matrix

   Range("R2").FormulaR1C1 = "Interpolation Matrix"
   Range("R3").FormulaR1C1 = "1"
   Range("R4").FormulaR1C1 = "1"
   Range("R5").FormulaR1C1 = "1"
   Range("R6").FormulaR1C1 = "1"
```

‘A ROUNDDOWN () for addition of 0.0.05 to make 0.05◦ x 0.05◦ grid point around that location given by the latitude and longitude.

```
   Range("S3").FormulaR1C1 = _

"=IF(R[7]C[10]>=(ROUNDDOWN(R[7]C[10],0)+0.05),(ROUNDDOWN(R[7]C[10],0)+0.05),ROUNDDOWN(
R[7]C[10],0))"
   Range("S4").FormulaR1C1 = "=R[-1]C"
   Range("S5").FormulaR1C1 = "=R[-1]C+0.05"
   Range("S6").FormulaR1C1 = "=R[-1]C"
```

‘A ROUNDDOWN () for subtraction of 0.0.05 to make 0.05◦ x 0.05◦ grid point around that location given by the latitude and longitude

```
 Range("T3").FormulaR1C1 = _
     "=IF(R[8]C[9]<=(ROUNDDOWN(R[8]C[9],0)-0.05),(ROUNDDOWN(R[8]C[9],0)-
0.05),ROUNDDOWN(R[8]C[9],0))"
   Range("T4").FormulaR1C1 = "=R[-1]C-0.05"
   Range("T5").FormulaR1C1 = "=R[-2]C"
   Range("T6").FormulaR1C1 = "=R[-2]C"
   Range("U3").FormulaR1C1 = "=RC[-2]*RC[-1]"
   Range("U4").FormulaR1C1 = "=RC[-2]*RC[-1]"
   Range("U5").FormulaR1C1 = "=RC[-2]*RC[-1]"
   Range("U6").FormulaR1C1 = "=RC[-2]*RC[-1]"
```

‘INDEX() and MATCH() functions to pair of longitude, latitude and corresponding row of solar radiation data

‘ depending on the input latitude, longitude and the month.

```
 Range("X3").FormulaArray = _

"=(INDEX(R1C3:R1951C14,MATCH(R3C19&R3C20,R1C1:R1951C1&R1C2:R1951C2,0),MATCH(Inputs!R6
C2,R1C3:R1C14,0)))"
Range("X4").FormulaArray = _

"=(INDEX(R1C3:R1951C14,MATCH(R3C19&R4C20,R1C1:R1951C1&R1C2:R1951C2,0),MATCH(Inputs!R6
C2,R1C3:R1C14,0)))"
Range("X5").FormulaArray = _
```

"=(INDEX(R1C3:R1951C14,MATCH(R5C19&R5C20,R1C1:R1951C1&R1C2:R1951C2,0),MATCH(Inputs!R6C2,R1C3:R1C14,0)))"

Range("X6").FormulaArray = _

"=(INDEX(R1C3:R1951C14,MATCH(R6C19&R6C20,R1C1:R1951C1&R1C2:R1951C2,0),MATCH(Inputs!R6C2,R1C3:R1C14,0)))"

'Build Inverse Matrix

Range("R9").FormulaR1C1 = "Inverse Matrix"

Range("S10:V13").FormulaR1C1 = "=MINVERSE(R[-7]C[-1]:R[-4]C[2])"

Range("S10:V13").FormulaArray = "=MINVERSE(R[-7]C[-1]:R[-4]C[2])"

Range("Y9").FormulaR1C1 = "Coefficient Matrix"

Range("Y10").FormulaArray = "=MMULT(RC[-6]:RC[-3],R[-7]C[-1]:R[-4]C[-1])"

Range("Y10").FormulaArray = "=MMULT(RC[-6]:R[3]C[-3],R[-7]C[-1]:R[-4]C[-1])"

Range("Y11").FormulaArray = "=MMULT(R[-1]C[-6]:R[2]C[-3],R[-8]C[-1]:R[-5]C[-1])"

Range("Y12").FormulaArray = "=MMULT(R[-2]C[-6]:R[1]C[-3],R[-9]C[-1]:R[-6]C[-1])"

Range("Y13").FormulaArray = "=MMULT(R[-3]C[-6]:RC[-3],R[-10]C[-1]:R[-7]C[-1])"

'Input location of Coordinates of interest

Range("R15").FormulaR1C1 = "Location of Interest (Lat/Lon)"

Range("S16").FormulaR1C1 = "=Inputs!R[-6]C[-17]"

Range("AB9").FormulaR1C1 = "Location of Interest (Lon/Lat)"

Range("AB10").FormulaR1C1 = "x"

Range("AB11").FormulaR1C1 = "y"

Range("AC10").FormulaR1C1 = "=Inputs!RC[-27]"

Range("AC11").FormulaR1C1 = "=Inputs!R[-2]C[-27]"

'Interpolated solar radiation results

Range("Q15").FormulaR1C1 = "f(x,y) = "

Range("R15").FormulaR1C1 = Y10 + Y11 * AC10 + Y12 * AC11 + Y13 * AC10 * AC11

End Sub

4.4 Validation of interpolating tool

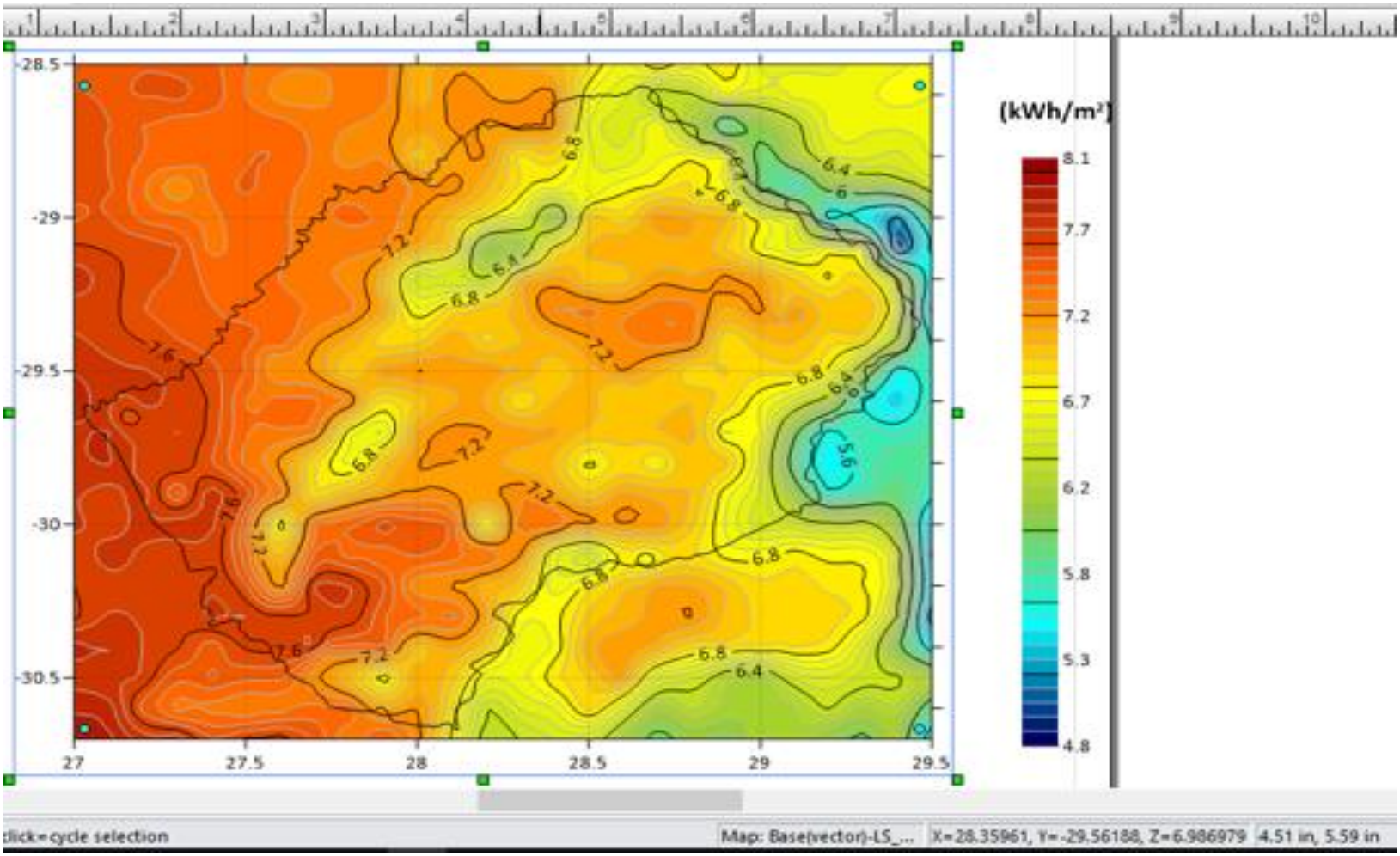


Fig 4.4. 1 Solar radiation distribution in November.

Fig 4.4.1 shows solar radiation distribution in November as revealed by the newly improved solar radiation database for Lesotho. Surfer application software shows that at longitude 28.35961° and latitude – 29.56188° horizontal solar radiation is 6.986979 kWh/m^2.

From fig 4.3.1 using Surfer application software at longitude (X) 28.35961° and latitude(Y) – 29.56188°, solar horizontal radiation (Z) is 6.986979 kWh/m^2.

Table 4.3. 1 Verifying the interpolation tool

Solar Geometry data	
MONTH	1/Dec/20
Average Day	10 December 2020
Day Num	344
Latitude (Degrees)	-29.56188
Longitude (Degrees)	28.35961
Horizontal Radiation (kWh/m^2)	7.019

Table 4.3.1 shows the results of integrating the interpolation tool into the newly developed solar radiation database.

From the table 4.3.1 at longitude 28.35961° and latitude – 29.56188°, the interpolation tool estimates solar radiation as 7.019 kWh/m^2.

Form fig 4.3.1 Surfer application software at longitude 28.35961° and latitude – 29.56188°, estimates solar radiation as 6.986979 kWh/m^2.

Since Surfer application software is a tested geo-spatial interpolating software [9], the developed interpolation tool is tested against it to check how the tool is reliable. Then the confidence level is given as

$$\boldsymbol{Confidendece\ Level} = \frac{(\mathbf{7}.019 - \ 6.986979)}{\mathbf{7}.019}\ \mathbf{x\ 100}\%$$

Which is just 0.46 % more than what Surfer application reads.

4.5 Database integration into solar process application

Table 4.5 1 Database integration into solar process application

Solar Geometry data		
MONTH	1-Jun-20	
Average Day	10-Jun-2020	
Day Num	162	
Latitude	-29.56188	°
Longitude	28.35961	°
Azimuth	180.00	°
Tilt	33.88	°
Interpolated Solar Radiation data		
Horizontal Rad	3.201	kW/m^2
H_o	5.366	kW/m^2
Diffuse(Scattered) Radiation	3.058	kW/m^2

Table 4.5.1 shows the results of the newly developed database and the integrating the interpolation tool into the thermo-economic model for aiding solar collector choice and optimal sizing for a solar water heating system as described by Tawanda Hove [109].

This integration of the newly developed database and the interpolation tool into the model enhances the functionality of the model as one no longer needs to capture solar radiation from another source and input it into the model.

Chapter Five: Conclusions and Recommendations

5.1 Conclusions

This study has established a reliable method for estimating ground solar radiation at any location in the country, thereby building a more accurate solar radiation database of Lesotho. The improved database is validated using a leave one out cross validation technique. Its reliability in estimating ground solar radiation is tested by relative bias error (rBE), relative mean bias error (rMBE) and normalized root mean square error (NRMSE). Minimum NRMSE is found be 1.1% with 2.7% as the maximum. This shows that the database has a minimum reliability factor of 97.3 % as it has a maximum error of 2.7 %.

The database is credible as it has a maximum error comparable to other published databases. It is therefore a good tool for energy policy makers and the public, investors or government departments that are adopting solar technology as the sustainable source of energy.

These results build on the knowledge of spatial and temporal and spatial distribution of solar radiation in Lesotho. This has been achieved by merging ground solar radiation data with the satellite – derived solar radiation. The merged data has been complimented with the published sunshine duration derived solar radiation data.

The newly established database coupled with interpolation tool ease access to accurate solar radiation data in Lesotho. The interpolation tool when applied to solar radiation database stored in Microsoft Excel, reads and interpolates solar radiation at any location, in the country with the accuracy of 99.54% and outputs it for any solar application analysis. This eliminates the need for manual capturing of data from solar radiation map or manual estimation of solar radiation data in between datasets in the database. It also eliminates the need of expensive geo-spatial software such as Surfer software, since an ordinary computer with Microsoft Excel is good enough to read and manipulate solar radiation data.

5.2 Recommendations

This study can be improved by eliminating the following limitations

The study does not take cognizance of shading due to mountains and valleys: It assumes flat ground surface, without taking cognizance of geo-physical features. The direct solar radiation component from satellite derived data has to be removed when the sun is shadowed by mountains or other features.

Datasets are not of the same temporal span: Ground solar radiation is influenced by the surrounding environment. The temporal span of the sunshine duration derived data is not known, so comparison with other datasets is not accurate.

Few datasets used in the study: Only fifteen stations used in the study. The number of observed and derived solar radiation datasets have to be increased. This can be achieved by increasing the number of installed solar radiation measuring stations and sunshine duration observing stations. Reduction of the grid-points distance, can increase the number of grid-points with satellite – derived data.

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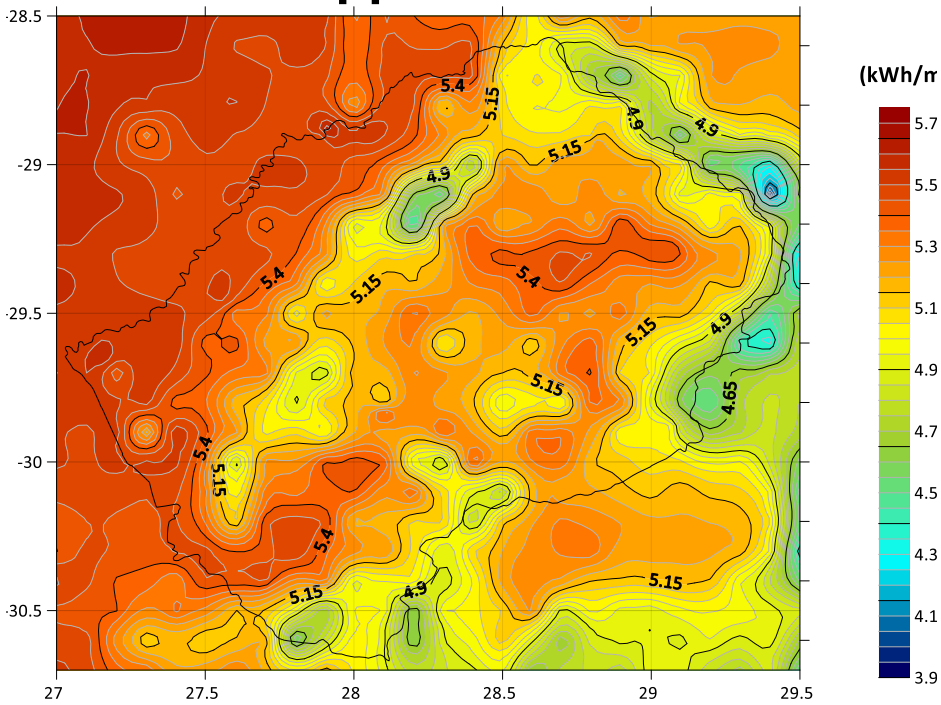
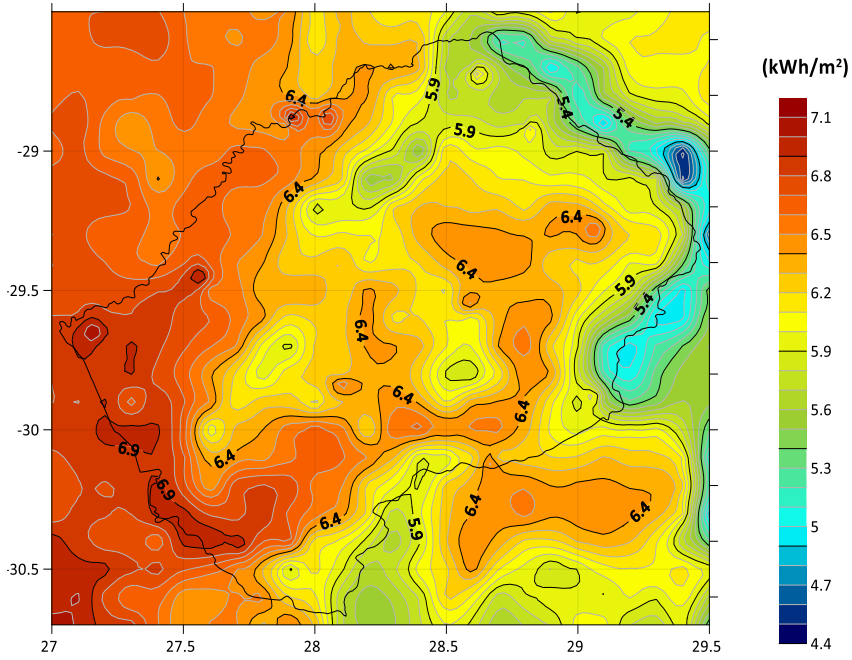
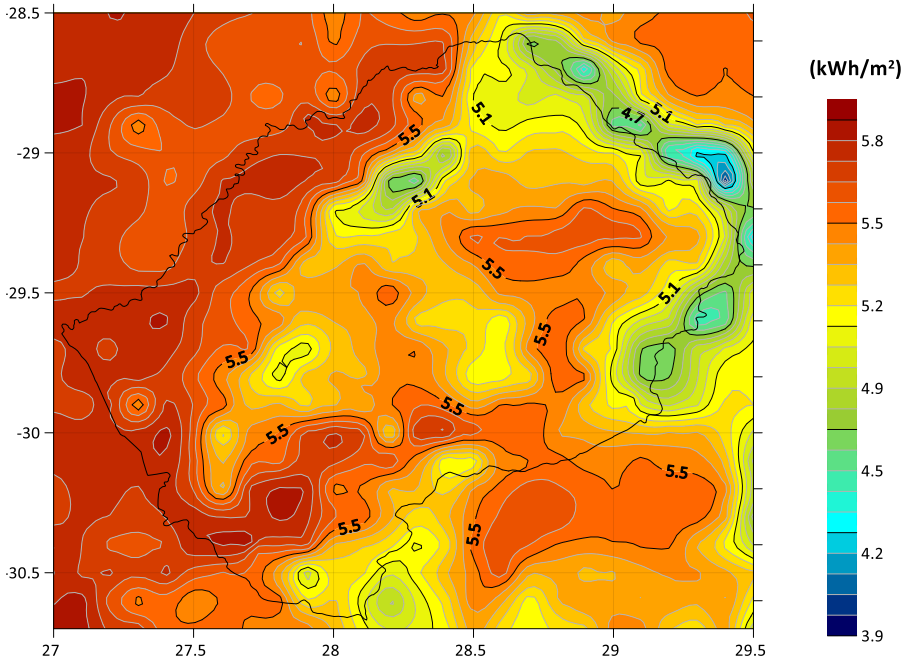
Appendices



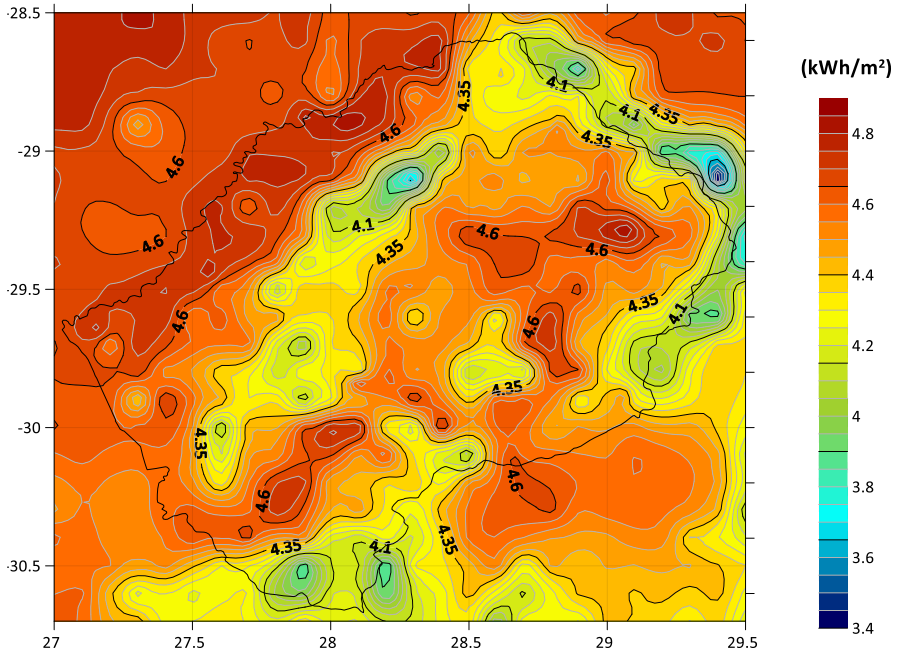
Appendix 1 – Modelled January monthly mean solar radiation in Lesotho



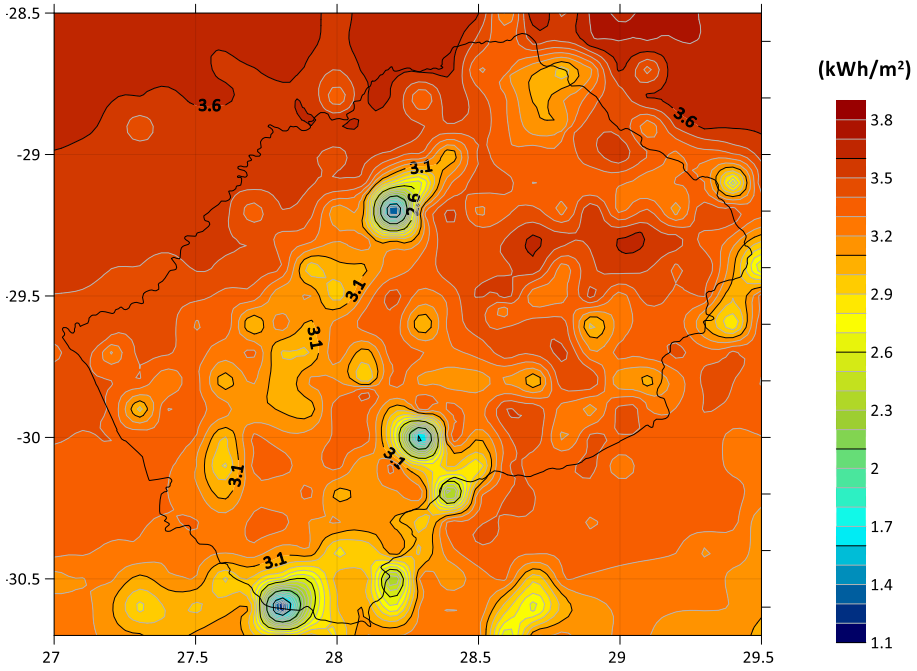
Appendix 2 – Modelled February monthly mean solar radiation in Lesotho



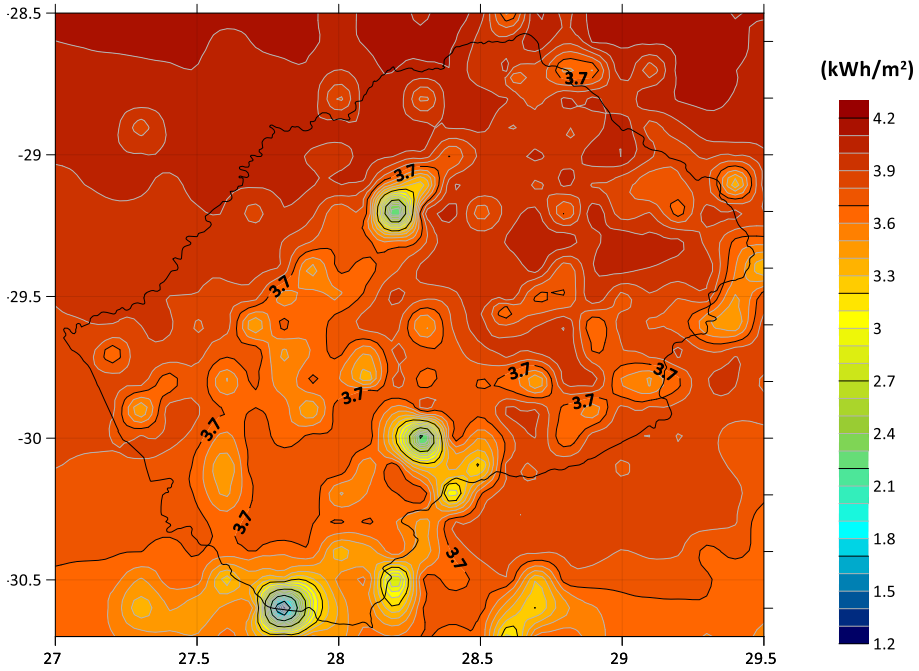
Appendix 3 – Modelled April monthly mean solar radiation in Lesotho



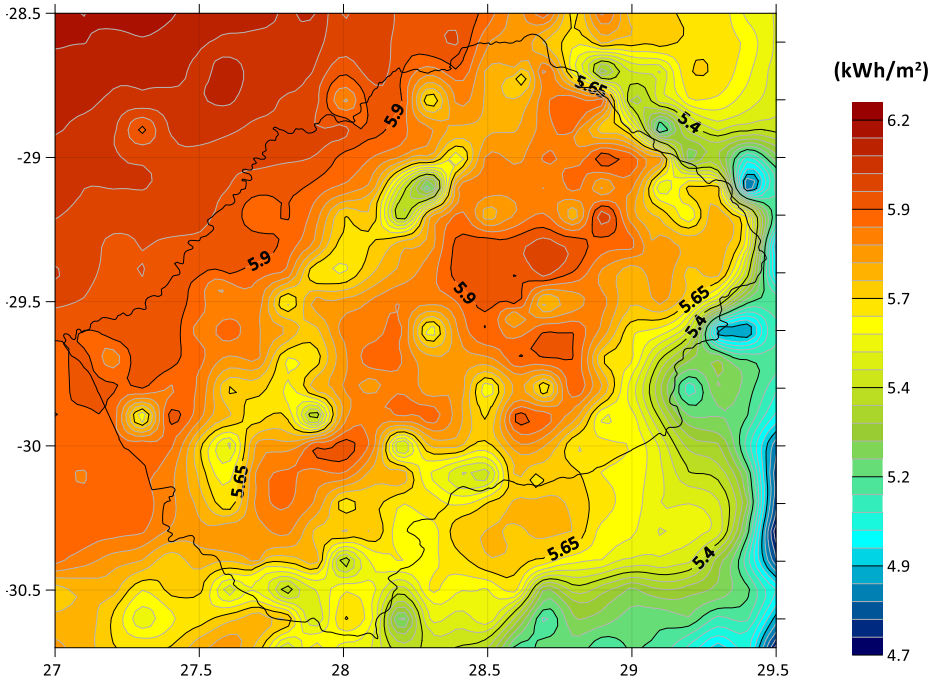
Appendix 4 – Modelled May monthly mean solar radiation in Lesotho



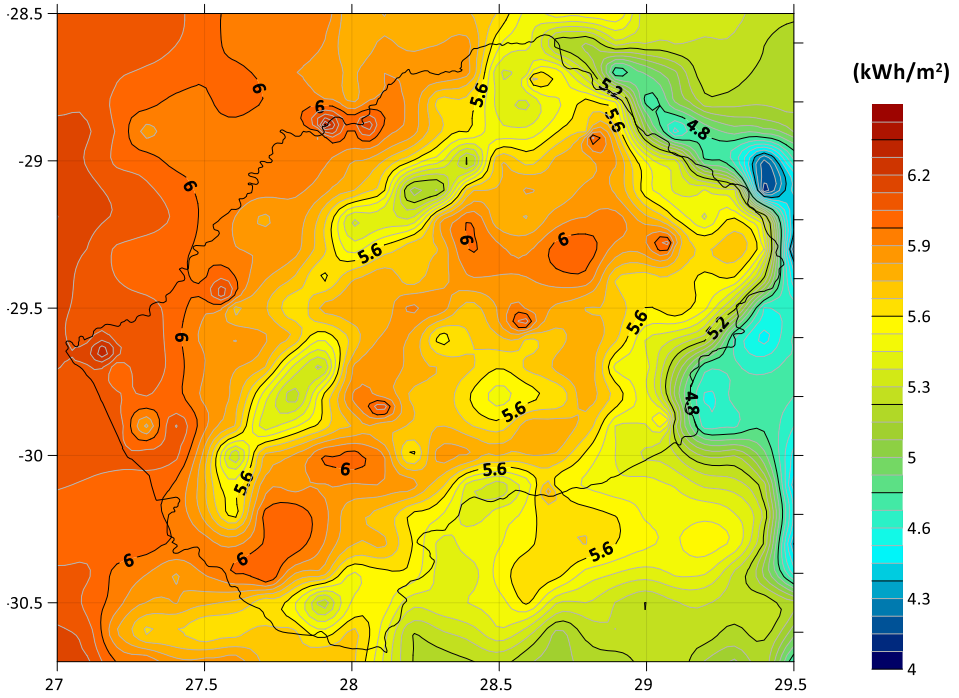
Appendix 5 – Modelled July monthly mean solar radiation in Lesotho



Appendix 6 – Modelled August monthly mean solar radiation in Lesotho



Appendix 7 – Modelled October monthly mean solar radiation in Lesotho



Appendix 8 – Modelled November monthly mean solar radiation in Lesotho

Appendix 9 – Improved solar radiation for Lesotho

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.25	-28.50	7.238	6.856	5.937	4.967	4.269	3.745	4.221	4.974	6.158	6.723	7.479	7.612
27.30	-28.50	6.868	6.768	5.954	4.900	4.230	3.723	4.267	4.965	6.249	6.364	7.353	7.750
27.30	-28.50	7.239	6.856	5.937	4.967	4.269	3.745	4.221	4.974	6.158	6.723	7.479	7.612
27.35	-28.50	7.236	6.885	5.938	4.963	4.285	3.747	4.231	4.972	6.157	6.697	7.454	7.592
27.45	-28.50	7.156	6.873	5.870	4.925	4.260	3.730	4.206	4.949	6.130	6.639	7.386	7.523
27.50	-28.50	6.747	6.780	5.878	4.816	4.198	3.692	4.267	4.928	6.208	6.263	7.255	7.618
27.55	-28.50	7.063	6.830	5.803	4.900	4.247	3.714	4.203	4.911	6.136	6.542	7.372	7.470
27.60	-28.50	7.071	6.773	5.796	4.909	4.246	3.745	4.209	4.959	6.123	6.586	7.323	7.428
27.65	-28.50	7.071	6.773	5.796	4.909	4.245	3.745	4.209	4.959	6.123	6.586	7.323	7.428
27.70	-28.50	6.668	6.680	5.802	4.821	4.180	3.718	4.257	4.948	6.200	6.206	7.225	7.547
27.75	-28.50	7.048	6.705	5.730	4.907	4.222	3.738	4.196	4.952	6.108	6.571	7.310	7.430
27.80	-28.50	7.031	6.704	5.730	4.879	4.215	3.738	4.196	4.940	6.106	6.557	7.263	7.389
27.85	-28.50	7.045	6.751	5.739	4.908	4.208	3.744	4.184	4.948	6.124	6.588	7.271	7.480
27.90	-28.50	6.646	6.658	5.752	4.819	4.187	3.730	4.267	4.949	6.190	6.224	7.175	7.614
27.95	-28.50	6.804	6.511	5.581	4.796	4.174	3.693	4.179	4.903	6.025	6.396	7.069	7.258
28.00	-28.50	6.763	6.479	5.536	4.788	4.106	3.629	4.090	4.873	5.978	6.363	6.994	7.206
28.05	-28.50	6.763	6.522	5.529	4.775	4.180	3.629	4.091	4.893	6.007	6.363	6.974	7.206
28.10	-28.50	6.488	6.553	5.727	4.756	4.186	3.734	4.287	4.939	6.137	6.065	7.031	7.442
28.15	-28.50	6.937	6.661	5.686	4.863	4.228	3.755	4.226	4.946	6.060	6.459	7.147	7.321
28.20	-28.50	6.809	6.596	5.642	4.864	4.208	3.727	4.192	4.913	5.999	6.389	7.019	7.260
28.25	-28.50	6.738	6.576	5.616	4.821	4.192	3.645	4.143	4.905	5.994	6.383	7.022	7.244
28.30	-28.50	6.249	6.371	5.564	4.718	4.137	3.674	4.226	4.892	6.031	5.983	6.878	7.349
28.35	-28.50	6.736	6.548	5.634	4.844	4.233	3.760	4.211	4.891	6.022	6.346	6.983	7.213
28.40	-28.50	6.736	6.500	5.587	4.844	4.233	3.760	4.211	4.891	5.990	6.344	6.938	7.174
28.45	-28.50	6.514	6.390	5.352	4.648	3.992	3.407	3.823	4.717	5.766	6.133	6.693	6.958
28.50	-28.50	6.134	6.251	5.578	4.700	4.102	3.707	4.212	4.798	6.005	5.880	6.795	7.144
28.55	-28.50	6.561	6.397	5.563	4.797	4.170	3.735	4.155	4.830	5.920	6.217	6.883	7.072
28.60	-28.50	6.301	6.224	5.322	4.576	3.745	3.249	3.590	4.576	5.782	6.006	6.663	6.843
28.65	-28.50	6.327	6.259	5.357	4.690	4.186	3.750	4.164	4.750	5.846	6.077	6.703	6.864
28.70	-28.50	6.166	6.128	5.543	4.713	4.259	3.806	4.280	4.885	6.029	5.798	6.821	7.161
28.75	-28.50	6.522	6.343	5.394	4.708	3.979	3.482	3.836	4.678	5.754	6.092	6.758	6.942
28.80	-28.50	6.455	6.255	5.504	4.658	3.996	3.542	4.028	4.662	5.652	6.129	6.794	6.925
28.85	-28.50	6.623	6.450	5.558	4.880	4.276	3.757	4.172	4.882	5.893	6.151	6.832	7.035
28.90	-28.50	6.261	6.251	5.592	4.726	4.275	3.799	4.291	4.876	6.003	5.808	6.816	7.120
28.95	-28.50	6.374	6.299	5.478	4.843	4.286	3.815	4.193	4.824	5.736	5.917	6.661	6.834
29.00	-28.50	6.350	6.276	5.472	4.798	4.278	3.789	4.176	4.851	5.723	5.840	6.577	6.747
29.05	-28.50	6.361	6.276	5.518	4.833	4.290	3.822	4.206	4.864	5.751	5.851	6.611	6.775
29.10	-28.50	6.062	6.132	5.593	4.719	4.319	3.786	4.300	4.857	5.779	5.507	6.511	6.850
29.15	-28.50	6.372	6.304	5.578	4.832	4.297	3.825	4.188	4.825	5.701	5.860	6.582	6.776
29.25	-28.50	6.497	6.420	5.625	4.877	4.296	3.825	4.170	4.859	5.716	5.833	6.548	6.818
29.30	-28.50	6.191	6.249	5.663	4.791	4.339	3.775	4.246	4.837	5.759	5.503	6.438	6.892
29.35	-28.50	6.554	6.537	5.665	4.880	4.290	3.812	4.155	4.853	5.661	5.773	6.496	6.879
29.40	-28.50	6.554	6.525	5.646	4.810	4.276	3.812	4.152	4.799	5.623	5.769	6.486	6.879
29.45	-28.50	6.556	6.568	5.687	4.870	4.292	3.810	4.143	4.812	5.607	5.761	6.483	6.903
29.50	-28.50	6.289	6.420	5.726	4.731	4.322	3.770	4.244	4.813	5.614	5.407	6.348	6.981
27.00	-28.55	7.215	6.653	5.851	4.957	4.254	3.753	4.242	4.932	6.208	6.638	7.352	7.590
27.05	-28.55	7.251	6.763	5.896	4.968	4.274	3.745	4.212	4.964	6.153	6.725	7.463	7.625

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.10	-28.55	7.244	6.774	5.906	4.940	4.281	3.747	4.221	4.972	6.149	6.730	7.439	7.608
27.15	-28.55	7.237	6.657	5.862	4.929	4.257	3.745	4.250	4.939	6.201	6.625	7.339	7.562
27.20	-28.55	7.226	6.846	5.940	4.951	4.272	3.743	4.220	4.977	6.153	6.718	7.457	7.626
27.25	-28.55	7.206	6.760	5.910	4.962	4.247	3.746	4.256	4.936	6.214	6.624	7.386	7.561
27.30	-28.55	7.239	6.856	5.937	4.967	4.269	3.745	4.221	4.974	6.158	6.723	7.479	7.612
27.35	-28.55	7.205	6.806	5.912	4.948	4.265	3.749	4.266	4.932	6.206	6.602	7.359	7.532
27.40	-28.55	7.236	6.885	5.938	4.963	4.284	3.747	4.231	4.972	6.157	6.697	7.454	7.592
27.45	-28.55	7.117	6.797	5.832	4.914	4.236	3.727	4.240	4.912	6.189	6.545	7.296	7.455
27.50	-28.55	7.094	6.818	5.795	4.893	4.220	3.720	4.170	4.920	6.130	6.617	7.330	7.440
27.55	-28.55	7.102	6.775	5.815	4.891	4.222	3.724	4.244	4.907	6.181	6.521	7.290	7.438
27.60	-28.55	7.071	6.773	5.796	4.909	4.245	3.740	4.209	4.959	6.123	6.586	7.323	7.428
27.65	-28.55	7.031	6.719	5.789	4.894	4.224	3.743	4.257	4.923	6.184	6.481	7.255	7.344
27.70	-28.55	7.076	6.771	5.794	4.917	4.230	3.743	4.198	4.946	6.116	6.580	7.323	7.433
27.75	-28.55	7.012	6.650	5.707	4.885	4.201	3.738	4.251	4.909	6.163	6.455	7.242	7.354
27.80	-28.55	7.048	6.705	5.730	4.907	4.221	3.738	4.195	4.951	6.108	6.571	7.310	7.430
27.85	-28.55	7.004	6.693	5.727	4.898	4.207	3.750	4.261	4.920	6.188	6.483	7.229	7.407
27.90	-28.55	7.045	6.751	5.750	4.916	4.225	3.748	4.209	4.961	6.124	6.591	7.283	7.480
27.95	-28.55	6.627	6.231	5.316	4.582	3.957	3.368	3.889	4.708	5.803	6.146	6.777	6.960
28.00	-28.55	6.731	6.449	5.536	4.558	3.702	3.115	3.729	4.583	5.921	6.292	6.994	7.206
28.05	-28.55	6.745	6.425	5.562	4.813	4.171	3.722	4.242	4.880	6.087	6.241	6.924	7.132
28.10	-28.55	6.937	6.661	5.685	4.863	4.227	3.753	4.224	4.947	6.060	6.459	7.147	7.321
28.15	-28.55	6.904	6.582	5.684	4.852	4.205	3.765	4.277	4.899	6.114	6.322	7.053	7.235
28.20	-28.55	6.809	6.596	5.640	4.864	4.202	3.725	4.186	4.913	5.999	6.387	7.019	7.260
28.25	-28.55	6.639	6.407	5.524	4.750	4.033	3.653	4.121	4.738	5.987	6.189	6.872	7.109
28.30	-28.55	6.738	6.576	5.597	4.816	4.068	3.644	4.079	4.856	5.976	6.380	7.018	7.244
28.35	-28.55	6.725	6.440	5.621	4.820	4.206	3.771	4.244	4.793	6.085	6.214	6.890	7.132
28.40	-28.55	6.743	6.548	5.611	4.844	4.219	3.713	4.129	4.891	6.009	6.347	6.978	7.217
28.45	-28.55	6.603	6.371	5.590	4.830	4.189	3.760	4.233	4.812	5.997	6.126	6.824	7.066
28.50	-28.55	6.551	6.352	5.556	4.760	4.174	3.735	4.155	4.797	5.859	6.216	6.860	7.056
28.55	-28.55	6.479	6.256	5.529	4.738	4.149	3.743	4.209	4.736	5.959	6.051	6.745	6.911
28.60	-28.55	6.342	6.263	5.398	4.756	4.209	3.750	4.183	4.813	5.872	6.087	6.738	6.890
28.65	-28.55	6.240	6.118	5.349	4.732	4.186	3.762	4.237	4.754	5.939	5.934	6.615	6.738
28.70	-28.55	6.552	6.363	5.545	4.855	4.269	3.827	4.201	4.885	5.921	6.147	6.876	7.067
28.75	-28.55	6.568	6.297	5.582	4.859	4.305	3.855	4.265	4.856	6.005	6.053	6.847	7.011
28.80	-28.55	6.627	6.420	5.594	4.879	4.291	3.839	4.206	4.875	5.939	6.204	6.930	7.117
28.85	-28.55	6.558	6.334	5.538	4.850	4.284	3.843	4.267	4.838	5.957	6.003	6.726	6.915
28.90	-28.55	6.624	6.450	5.557	4.883	4.270	3.829	4.207	4.884	5.893	6.151	6.832	7.035
28.95	-28.55	6.317	6.168	5.447	4.805	4.297	3.828	4.240	4.762	5.786	5.734	6.547	6.712
29.00	-28.55	6.362	6.278	5.519	4.833	4.292	3.822	4.206	4.865	5.751	5.852	6.612	6.775
29.05	-28.55	6.359	6.276	5.517	4.821	4.275	3.822	4.198	4.855	5.751	5.849	6.604	6.775
29.10	-28.55	6.372	6.329	5.583	4.868	4.296	3.825	4.188	4.859	5.742	5.860	6.596	6.792
29.15	-28.55	6.372	6.329	5.583	4.874	4.298	3.825	4.192	4.869	5.743	5.860	6.596	6.792
29.20	-28.55	6.411	6.332	5.596	4.879	4.255	3.694	4.116	4.845	5.707	5.840	6.527	6.752
29.25	-28.55	6.499	6.421	5.620	4.905	4.307	3.825	4.170	4.874	5.720	5.835	6.541	6.818
29.30	-28.55	6.499	6.422	5.626	4.911	4.304	3.825	4.176	4.885	5.720	5.835	6.548	6.818
29.35	-28.55	6.554	6.536	5.666	4.880	4.294	3.812	4.162	4.853	5.661	5.773	6.496	6.879
29.40	-28.55	6.554	6.514	5.661	4.842	4.289	3.812	4.152	4.813	5.602	5.771	6.481	6.871
29.45	-28.55	6.556	6.572	5.692	4.883	4.299	3.810	4.155	4.836	5.607	5.761	6.495	6.903
29.50	-28.55	6.598	6.555	5.685	4.863	4.269	3.798	4.147	4.836	5.584	5.746	6.455	6.910

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.05	-28.60	7.228	6.781	5.956	4.927	4.273	3.741	4.205	4.933	6.143	6.757	7.458	7.652
27.15	-28.60	7.200	6.755	5.924	4.955	4.272	3.730	4.204	4.934	6.139	6.722	7.473	7.619
27.20	-28.60	6.877	6.721	5.943	4.886	4.216	3.718	4.250	4.948	6.214	6.364	7.337	7.785
27.25	-28.60	7.217	6.824	5.913	4.952	4.261	3.732	4.209	4.941	6.138	6.725	7.484	7.644
27.35	-28.60	7.265	6.851	5.913	4.965	4.254	3.727	4.208	4.940	6.132	6.680	7.469	7.598
27.40	-28.60	6.926	6.760	5.929	4.886	4.216	3.697	4.257	4.942	6.215	6.309	7.320	7.748
27.45	-28.60	7.190	6.849	5.859	4.914	4.257	3.719	4.207	4.946	6.118	6.661	7.416	7.559
27.55	-28.60	7.114	6.756	5.782	4.897	4.238	3.719	4.188	4.934	6.108	6.631	7.356	7.511
27.60	-28.60	6.655	6.636	5.758	4.760	4.170	3.679	4.208	4.921	6.170	6.185	7.142	7.489
27.65	-28.60	7.057	6.709	5.737	4.862	4.233	3.722	4.178	4.924	6.104	6.563	7.320	7.399
27.75	-28.60	7.062	6.715	5.770	4.862	4.229	3.729	4.191	4.934	6.098	6.548	7.295	7.427
27.80	-28.60	6.681	6.668	5.772	4.763	4.205	3.703	4.251	4.927	6.173	6.170	7.187	7.570
27.85	-28.60	7.015	6.729	5.792	4.891	4.221	3.724	4.185	4.928	6.084	6.529	7.303	7.433
27.95	-28.60	6.864	6.575	5.684	4.832	4.178	3.710	4.171	4.905	6.017	6.438	7.177	7.345
28.00	-28.60	6.240	6.382	5.597	4.662	4.102	3.647	4.233	4.884	6.086	5.973	6.879	7.291
28.05	-28.60	6.687	6.439	5.563	4.574	3.799	3.287	3.726	4.628	5.870	6.322	7.031	7.154
28.15	-28.60	6.944	6.681	5.717	4.873	4.201	3.753	4.190	4.918	6.065	6.471	7.143	7.331
28.20	-28.60	6.407	6.563	5.781	4.805	4.189	3.711	4.255	4.907	6.041	6.013	7.036	7.450
28.25	-28.60	6.838	6.643	5.736	4.892	4.083	3.608	4.013	4.800	6.012	6.419	7.098	7.311
28.35	-28.60	6.832	6.649	5.699	4.906	4.222	3.641	4.098	4.869	5.969	6.375	7.056	7.307
28.40	-28.60	6.429	6.552	5.794	4.857	4.183	3.734	4.255	4.884	6.087	6.081	7.032	7.482
28.45	-28.60	6.483	6.337	5.561	4.720	4.030	3.584	3.980	4.585	5.640	6.190	6.880	6.990
28.55	-28.60	6.273	6.204	5.359	4.594	3.939	3.440	3.857	4.659	5.753	5.972	6.722	6.873
28.60	-28.60	5.713	5.792	5.220	4.399	3.895	3.410	4.085	4.599	5.914	5.672	6.646	6.816
28.65	-28.60	6.174	6.063	5.247	4.550	4.040	3.614	4.110	4.644	5.765	5.921	6.648	6.750
28.75	-28.60	5.755	5.654	4.931	4.503	4.149	3.750	4.185	4.770	5.724	5.782	6.423	6.468
28.80	-28.60	5.275	5.366	4.861	4.185	4.004	3.601	4.057	4.603	5.730	5.275	6.306	6.587
28.85	-28.60	6.280	6.183	5.390	4.797	4.263	3.797	4.185	4.847	5.764	5.925	6.737	6.855
28.95	-28.60	6.049	6.027	5.339	4.753	4.262	3.795	4.192	4.844	5.662	5.708	6.531	6.587
29.00	-28.60	6.037	6.093	5.595	4.742	4.313	3.781	4.273	4.833	5.809	5.501	6.546	6.838
29.05	-28.60	6.323	6.285	5.556	4.831	4.260	3.711	4.126	4.848	5.739	5.855	6.656	6.746
29.15	-28.60	6.414	6.367	5.595	4.778	4.147	3.689	4.018	4.710	5.669	5.813	6.639	6.784
29.20	-28.60	6.245	6.297	5.660	4.771	4.342	3.777	4.275	4.884	5.764	5.460	6.496	6.914
29.25	-28.60	6.523	6.500	5.622	4.894	4.281	3.809	4.183	4.875	5.703	5.839	6.594	6.844
29.35	-28.60	6.563	6.587	5.664	4.906	4.270	3.794	4.148	4.848	5.660	5.761	6.555	6.933
29.40	-28.60	6.293	6.428	5.701	4.808	4.329	3.758	4.251	4.850	5.712	5.392	6.499	6.997
29.45	-28.60	6.531	6.571	5.693	4.896	4.257	3.794	4.143	4.847	5.614	5.748	6.516	6.891
27.00	-28.65	7.228	6.782	5.956	4.927	4.273	3.741	4.205	4.933	6.143	6.757	7.458	7.652
27.05	-28.65	7.228	6.782	5.956	4.927	4.273	3.741	4.205	4.933	6.143	6.757	7.458	7.652
27.10	-28.65	7.200	6.755	5.924	4.955	4.272	3.730	4.204	4.934	6.139	6.722	7.473	7.619
27.15	-28.65	7.200	6.755	5.924	4.955	4.272	3.730	4.204	4.934	6.139	6.722	7.473	7.619
27.20	-28.65	7.212	6.823	5.918	4.959	4.262	3.734	4.209	4.940	6.132	6.722	7.482	7.624
27.25	-28.65	7.217	6.824	5.913	4.952	4.261	3.731	4.208	4.941	6.138	6.725	7.484	7.644
27.30	-28.65	7.217	6.824	5.913	4.952	4.261	3.731	4.208	4.941	6.138	6.725	7.484	7.644
27.35	-28.65	7.265	6.851	5.913	4.965	4.254	3.727	4.208	4.940	6.132	6.680	7.469	7.598
27.40	-28.65	7.265	6.851	5.913	4.965	4.254	3.727	4.208	4.940	6.132	6.680	7.469	7.598
27.45	-28.65	7.190	6.849	5.859	4.914	4.257	3.719	4.207	4.946	6.118	6.661	7.416	7.559
27.50	-28.65	7.114	6.755	5.782	4.897	4.238	3.719	4.188	4.933	6.108	6.630	7.356	7.511
27.55	-28.65	7.112	6.755	5.782	4.897	4.232	3.719	4.188	4.931	6.108	6.630	7.356	7.511

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.60	-28.65	6.921	6.630	5.710	4.831	4.227	3.722	4.178	4.913	6.089	6.550	7.274	7.333
27.65	-28.65	7.058	6.679	5.724	4.862	4.233	3.721	4.178	4.924	6.104	6.561	7.292	7.365
27.70	-28.65	7.025	6.658	5.727	4.840	4.214	3.720	4.185	4.920	6.091	6.520	7.291	7.364
27.75	-28.65	7.063	6.716	5.771	4.862	4.229	3.729	4.190	4.935	6.098	6.548	7.295	7.427
27.80	-28.65	7.063	6.716	5.770	4.862	4.228	3.725	4.190	4.935	6.098	6.548	7.295	7.427
27.85	-28.65	6.998	6.680	5.737	4.859	4.136	3.633	4.082	4.878	6.025	6.515	7.253	7.391
27.90	-28.65	7.015	6.728	5.792	4.891	4.223	3.728	4.185	4.928	6.084	6.530	7.303	7.433
27.95	-28.65	6.855	6.574	5.684	4.812	4.173	3.710	4.171	4.894	6.017	6.431	7.177	7.346
28.00	-28.65	6.741	6.489	5.598	4.749	4.140	3.689	4.149	4.877	6.007	6.366	7.054	7.210
28.05	-28.65	6.687	6.439	5.508	4.724	4.148	3.689	4.149	4.835	5.924	6.275	6.995	7.154
28.10	-28.65	6.928	6.679	5.715	4.874	4.218	3.753	4.208	4.934	6.065	6.453	7.094	7.289
28.15	-28.65	6.943	6.679	5.717	4.873	4.212	3.755	4.212	4.930	6.065	6.469	7.143	7.331
28.20	-28.65	6.850	6.632	5.741	4.902	4.242	3.734	4.202	4.908	5.978	6.393	7.092	7.310
28.25	-28.65	6.837	6.641	5.742	4.921	4.240	3.743	4.207	4.913	6.012	6.419	7.106	7.311
28.30	-28.65	6.820	6.641	5.729	4.895	4.240	3.744	4.207	4.909	6.000	6.405	7.096	7.308
28.35	-28.65	6.851	6.644	5.749	4.934	4.221	3.741	4.172	4.875	5.999	6.390	7.086	7.341
28.40	-28.65	6.849	6.649	5.758	4.942	4.228	3.742	4.191	4.880	5.999	6.391	7.107	7.352
28.45	-28.65	6.647	6.483	5.660	4.838	4.174	3.715	4.155	4.775	5.846	6.253	7.010	7.168
28.50	-28.65	6.204	5.947	5.171	4.183	3.009	2.214	2.731	4.067	5.484	5.903	6.582	6.728
28.55	-28.65	6.204	5.899	5.181	4.331	3.657	3.329	3.758	4.328	5.553	5.897	6.562	6.700
28.60	-28.65	6.066	5.776	5.004	4.246	3.604	3.287	3.749	4.278	5.539	5.827	6.488	6.597
28.65	-28.65	6.154	6.063	5.253	4.550	4.012	3.491	4.095	4.643	5.765	5.911	6.538	6.703
28.70	-28.65	5.661	5.487	4.774	4.354	4.023	3.567	4.135	4.662	5.609	5.706	6.371	6.372
28.75	-28.65	5.688	5.517	4.739	4.198	3.724	3.358	3.672	4.294	5.421	5.598	6.294	6.356
28.80	-28.65	5.712	5.604	4.854	4.324	3.995	3.623	3.992	4.532	5.542	5.699	6.350	6.429
28.85	-28.65	6.240	6.149	5.379	4.743	4.242	3.699	4.169	4.796	5.689	5.910	6.722	6.817
28.90	-28.65	6.273	6.181	5.390	4.776	4.252	3.797	4.185	4.834	5.764	5.919	6.736	6.855
28.95	-28.65	6.020	6.000	5.302	4.705	4.256	3.795	4.175	4.799	5.589	5.685	6.516	6.556
29.00	-28.65	6.324	6.284	5.553	4.870	4.276	3.817	4.202	4.881	5.742	5.858	6.646	6.736
29.05	-28.65	6.324	6.287	5.557	4.870	4.278	3.817	4.204	4.881	5.742	5.858	6.657	6.746
29.10	-28.65	6.444	6.394	5.623	4.885	4.301	3.816	4.198	4.880	5.739	5.856	6.654	6.819
29.15	-28.65	6.444	6.394	5.623	4.884	4.303	3.816	4.200	4.880	5.739	5.856	6.654	6.819
29.20	-28.65	6.517	6.455	5.612	4.878	4.298	3.809	4.197	4.883	5.709	5.828	6.609	6.828
29.25	-28.65	6.523	6.501	5.622	4.894	4.292	3.809	4.191	4.878	5.703	5.839	6.594	6.844
29.30	-28.65	6.522	6.499	5.622	4.891	4.281	3.809	4.191	4.873	5.703	5.838	6.594	6.844
29.35	-28.65	6.563	6.587	5.665	4.908	4.278	3.794	4.161	4.851	5.660	5.761	6.556	6.933
29.40	-28.65	6.563	6.587	5.665	4.908	4.278	3.794	4.162	4.852	5.660	5.761	6.556	6.933
29.45	-28.65	6.525	6.569	5.693	4.873	4.247	3.702	4.067	4.832	5.613	5.742	6.516	6.891
29.50	-28.65	6.501	6.515	5.633	4.801	4.230	3.790	4.114	4.782	5.570	5.700	6.402	6.866
27.05	-28.70	7.193	6.743	5.926	4.939	4.264	3.739	4.182	4.908	6.097	6.734	7.493	7.684
27.10	-28.70	6.840	6.654	5.954	4.865	4.234	3.717	4.230	4.921	6.198	6.383	7.344	7.782
27.15	-28.70	7.223	6.763	5.930	4.936	4.258	3.727	4.187	4.912	6.101	6.733	7.473	7.653
27.25	-28.70	7.119	6.769	5.871	4.894	4.228	3.712	4.184	4.896	6.086	6.657	7.387	7.542
27.30	-28.70	6.769	6.666	5.890	4.803	4.196	3.691	4.230	4.895	6.188	6.291	7.234	7.644
27.35	-28.70	7.174	6.758	5.861	4.910	4.226	3.706	4.189	4.897	6.096	6.659	7.401	7.537
27.45	-28.70	7.130	6.771	5.840	4.884	4.237	3.708	4.193	4.908	6.078	6.623	7.423	7.556
27.50	-28.70	6.750	6.678	5.832	4.796	4.194	3.686	4.240	4.896	6.168	6.223	7.295	7.674
27.55	-28.70	7.122	6.741	5.788	4.883	4.210	3.703	4.163	4.906	6.067	6.617	7.396	7.559
27.65	-28.70	7.163	6.724	5.765	4.896	4.206	3.704	4.171	4.912	6.114	6.626	7.369	7.558

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.70	-28.70	6.679	6.601	5.733	4.743	4.189	3.672	4.229	4.898	6.167	6.205	7.228	7.583
27.75	-28.70	7.071	6.674	5.708	4.857	4.196	3.705	4.154	4.914	6.071	6.520	7.322	7.414
27.85	-28.70	6.974	6.632	5.742	4.842	4.208	3.696	4.159	4.896	6.032	6.480	7.256	7.372
27.90	-28.70	6.544	6.575	5.768	4.747	4.190	3.666	4.231	4.888	6.130	6.116	7.164	7.490
27.95	-28.70	6.901	6.602	5.674	4.807	4.198	3.695	4.158	4.876	5.977	6.423	7.165	7.306
28.05	-28.70	6.849	6.531	5.682	4.661	4.037	3.416	3.908	4.748	5.901	6.427	7.130	7.265
28.10	-28.70	6.519	6.597	5.819	4.790	4.193	3.705	4.214	4.868	6.117	6.140	7.066	7.462
28.15	-28.70	6.963	6.704	5.780	4.897	4.230	3.727	4.185	4.902	6.027	6.490	7.192	7.347
28.25	-28.70	6.973	6.782	5.797	4.904	4.228	3.675	4.126	4.819	5.968	6.464	7.177	7.420
28.30	-28.70	6.557	6.696	5.844	4.834	4.196	3.709	4.224	4.833	5.950	6.140	7.125	7.497
28.35	-28.70	6.911	6.764	5.821	4.954	4.238	3.730	4.179	4.848	5.959	6.401	7.133	7.380
28.45	-28.70	6.751	6.589	5.696	4.853	4.164	3.689	4.148	4.754	5.853	6.274	6.985	7.216
28.50	-28.70	5.767	5.849	5.243	4.383	3.798	3.335	4.011	4.509	5.853	5.542	6.540	6.818
28.55	-28.70	6.240	6.017	5.170	4.306	3.137	2.356	2.904	4.232	5.612	5.922	6.623	6.769
28.65	-28.70	6.361	6.106	5.257	4.548	3.922	3.457	3.969	4.589	5.703	5.974	6.658	6.755
28.70	-28.70	5.776	5.741	5.129	4.338	3.727	3.178	4.007	4.386	6.012	5.778	6.764	6.977
28.75	-28.70	6.080	5.747	5.056	4.318	3.799	3.202	3.837	4.297	5.721	6.023	6.721	6.645
28.85	-28.70	5.437	5.268	4.603	4.227	3.924	3.512	4.042	4.600	5.434	5.440	6.025	5.953
28.90	-28.70	5.069	4.957	4.464	3.801	3.597	3.240	3.703	4.268	5.341	4.846	5.791	5.929
28.95	-28.70	5.350	5.353	4.687	4.300	4.037	3.672	4.086	4.674	5.366	5.296	5.984	5.959
29.05	-28.70	5.714	5.743	5.086	4.577	4.155	3.747	4.161	4.771	5.533	5.465	6.176	6.234
29.10	-28.70	5.728	5.861	5.325	4.450	4.092	3.408	3.921	4.662	5.565	5.213	6.269	6.541
29.15	-28.70	6.116	6.116	5.400	4.732	4.223	3.779	4.174	4.821	5.612	5.639	6.420	6.535
29.25	-28.70	6.488	6.472	5.611	4.856	4.275	3.788	4.188	4.853	5.706	5.788	6.579	6.812
29.30	-28.70	6.196	6.297	5.660	4.749	4.336	3.753	4.275	4.841	5.762	5.413	6.485	6.870
29.35	-28.70	6.467	6.490	5.591	4.856	4.252	3.776	4.150	4.831	5.634	5.746	6.488	6.808
29.45	-28.70	6.499	6.502	5.590	4.847	4.247	3.783	4.133	4.838	5.583	5.730	6.422	6.811
29.50	-28.70	6.242	6.405	5.669	4.755	4.313	3.740	4.233	4.793	5.593	5.346	6.363	6.883
27.00	-28.75	7.205	6.753	5.972	4.958	4.263	3.728	4.175	4.903	6.084	6.736	7.505	7.688
27.05	-28.75	7.205	6.753	5.971	4.958	4.263	3.728	4.175	4.903	6.084	6.734	7.505	7.688
27.10	-28.75	7.236	6.773	5.940	4.939	4.251	3.719	4.182	4.899	6.097	6.727	7.484	7.659
27.15	-28.75	7.236	6.773	5.940	4.940	4.251	3.719	4.182	4.899	6.097	6.727	7.484	7.659
27.20	-28.75	7.156	6.790	5.885	4.903	4.230	3.699	4.172	4.885	6.084	6.658	7.422	7.577
27.25	-28.75	7.138	6.770	5.865	4.884	4.216	3.694	4.163	4.877	6.080	6.652	7.418	7.586
27.30	-28.75	7.138	6.764	5.849	4.884	4.206	3.684	4.153	4.877	6.080	6.648	7.386	7.572
27.35	-28.75	7.103	6.708	5.815	4.854	4.214	3.687	4.163	4.875	6.071	6.609	7.401	7.518
27.40	-28.75	7.103	6.709	5.814	4.854	4.204	3.678	4.145	4.876	6.071	6.608	7.401	7.518
27.45	-28.75	7.120	6.672	5.774	4.842	4.212	3.685	4.163	4.882	6.072	6.586	7.345	7.482
27.50	-28.75	7.179	6.706	5.780	4.865	4.214	3.711	4.157	4.903	6.075	6.603	7.340	7.557
27.55	-28.75	7.179	6.706	5.780	4.865	4.214	3.711	4.157	4.903	6.075	6.603	7.340	7.557
27.60	-28.75	7.174	6.733	5.806	4.891	4.203	3.704	4.158	4.908	6.085	6.628	7.371	7.566
27.65	-28.75	7.174	6.732	5.806	4.891	4.206	3.713	4.163	4.907	6.085	6.628	7.371	7.566
27.70	-28.75	7.106	6.651	5.689	4.856	4.189	3.690	4.151	4.906	6.088	6.571	7.316	7.470
27.75	-28.75	7.061	6.631	5.669	4.854	4.197	3.706	4.158	4.914	6.084	6.541	7.300	7.424
27.80	-28.75	7.060	6.625	5.657	4.834	4.179	3.700	4.133	4.877	6.084	6.538	7.294	7.424
27.85	-28.75	6.967	6.657	5.749	4.859	4.214	3.699	4.165	4.897	6.018	6.488	7.229	7.391
27.90	-28.75	6.967	6.657	5.751	4.859	4.213	3.701	4.165	4.897	6.018	6.492	7.242	7.391
27.95	-28.75	6.893	6.598	5.746	4.840	4.217	3.695	4.155	4.892	5.992	6.437	7.160	7.316
28.00	-28.75	6.908	6.614	5.757	4.871	4.213	3.700	4.170	4.898	5.993	6.480	7.173	7.347

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
28.05	-28.75	6.908	6.609	5.735	4.765	4.044	3.565	3.969	4.727	5.928	6.478	7.172	7.347
28.10	-28.75	6.944	6.743	5.814	4.895	4.215	3.704	4.161	4.836	5.977	6.470	7.176	7.362
28.15	-28.75	6.952	6.745	5.812	4.914	4.215	3.704	4.156	4.847	5.977	6.474	7.176	7.362
28.20	-28.75	6.978	6.730	5.789	4.945	4.218	3.688	4.157	4.849	5.960	6.462	7.157	7.374
28.25	-28.75	6.731	6.551	5.687	4.879	4.183	3.659	4.135	4.793	5.901	6.329	6.987	7.205
28.30	-28.75	6.734	6.551	5.688	4.879	4.185	3.659	4.146	4.791	5.901	6.330	6.987	7.205
28.35	-28.75	6.637	6.472	5.618	4.772	4.149	3.665	4.143	4.762	5.877	6.211	6.910	7.104
28.40	-28.75	6.633	6.449	5.608	4.751	4.137	3.665	4.123	4.719	5.861	6.208	6.884	7.090
28.45	-28.75	6.460	6.321	5.330	4.577	3.947	3.446	3.901	4.563	5.708	6.024	6.702	6.950
28.50	-28.75	6.311	6.137	5.266	4.539	4.000	3.475	4.028	4.642	5.755	5.985	6.693	6.827
28.55	-28.75	6.297	6.135	5.218	4.523	3.814	3.350	3.906	4.580	5.722	5.972	6.658	6.822
28.60	-28.75	6.290	6.065	5.180	4.480	3.859	3.344	3.947	4.535	5.706	5.931	6.612	6.751
28.65	-28.75	6.290	6.046	5.160	4.430	3.793	3.344	3.869	4.433	5.706	5.931	6.612	6.755
28.70	-28.75	6.212	5.964	5.125	4.442	3.841	3.196	3.825	4.409	5.745	6.055	6.808	6.735
28.75	-28.75	6.245	5.906	5.224	4.523	3.950	3.284	3.909	4.348	5.813	6.210	6.873	6.754
28.80	-28.75	6.234	5.846	5.166	4.510	3.889	3.202	3.822	4.351	5.763	6.180	6.838	6.752
28.85	-28.75	6.050	5.722	5.100	4.557	4.028	3.469	4.071	4.445	5.786	6.144	6.730	6.462
28.90	-28.75	5.703	5.279	4.518	4.134	3.652	3.118	3.595	3.967	4.730	5.252	6.209	6.109
28.95	-28.75	5.098	5.007	4.358	4.085	3.605	3.343	3.722	4.376	5.176	5.167	5.602	5.621
29.00	-28.75	5.545	5.555	4.906	4.435	4.070	3.719	4.120	4.680	5.467	5.370	5.979	6.065
29.05	-28.75	5.559	5.575	4.891	4.443	4.070	3.719	4.120	4.695	5.470	5.364	5.946	6.059
29.10	-28.75	5.926	5.973	5.201	4.501	3.854	3.369	3.755	4.572	5.294	5.471	6.211	6.343
29.15	-28.75	6.006	6.074	5.263	4.660	4.087	3.640	4.040	4.759	5.508	5.502	6.311	6.442
29.20	-28.75	6.327	6.371	5.524	4.817	4.253	3.793	4.190	4.851	5.678	5.731	6.557	6.736
29.25	-28.75	6.384	6.405	5.574	4.817	4.259	3.785	4.164	4.820	5.670	5.719	6.526	6.753
29.30	-28.75	6.383	6.407	5.579	4.825	4.255	3.785	4.177	4.835	5.670	5.718	6.537	6.753
29.35	-28.75	6.365	6.409	5.534	4.826	4.233	3.768	4.134	4.809	5.606	5.683	6.441	6.698
29.40	-28.75	6.365	6.409	5.536	4.829	4.240	3.768	4.146	4.812	5.606	5.684	6.445	6.698
29.45	-28.75	6.536	6.541	5.599	4.850	4.242	3.776	4.126	4.835	5.580	5.725	6.439	6.801
29.50	-28.75	6.540	6.541	5.554	4.803	4.225	3.770	4.104	4.791	5.498	5.664	6.419	6.780
27.00	-28.80	6.813	6.605	5.983	4.881	4.241	3.726	4.211	4.905	6.181	6.357	7.372	7.801
27.05	-28.80	7.205	6.753	5.972	4.958	4.263	3.728	4.174	4.903	6.084	6.736	7.505	7.688
27.15	-28.80	7.236	6.773	5.940	4.940	4.251	3.719	4.181	4.899	6.097	6.727	7.484	7.659
27.20	-28.80	6.803	6.674	5.906	4.822	4.202	3.682	4.219	4.890	6.174	6.277	7.273	7.693
27.25	-28.80	7.138	6.770	5.865	4.878	4.200	3.684	4.148	4.873	6.080	6.652	7.418	7.586
27.35	-28.80	7.103	6.709	5.809	4.854	4.199	3.678	4.134	4.876	6.071	6.606	7.395	7.518
27.40	-28.80	6.740	6.604	5.839	4.765	4.191	3.663	4.210	4.883	6.167	6.204	7.254	7.621
27.45	-28.80	7.120	6.671	5.774	4.842	4.211	3.693	4.162	4.881	6.072	6.586	7.345	7.482
27.55	-28.80	7.179	6.706	5.780	4.865	4.214	3.711	4.157	4.903	6.075	6.603	7.340	7.557
27.60	-28.80	6.757	6.696	5.849	4.785	4.201	3.685	4.228	4.899	6.190	6.259	7.296	7.694
27.65	-28.80	7.174	6.733	5.806	4.891	4.208	3.713	4.163	4.908	6.085	6.628	7.371	7.566
27.75	-28.80	7.061	6.631	5.669	4.854	4.193	3.700	4.156	4.914	6.084	6.540	7.300	7.424
27.80	-28.80	6.598	6.534	5.687	4.711	4.158	3.663	4.195	4.834	6.121	6.187	7.155	7.472
27.85	-28.80	6.967	6.657	5.751	4.859	4.214	3.701	4.165	4.897	6.018	6.492	7.242	7.391
27.95	-28.80	6.893	6.598	5.746	4.840	4.217	3.695	4.155	4.892	5.992	6.437	7.160	7.316
28.00	-28.80	6.325	6.425	5.548	4.593	3.897	3.359	3.872	4.696	5.897	6.008	6.885	7.206
28.05	-28.80	6.908	6.615	5.746	4.870	4.199	3.698	4.147	4.898	5.993	6.478	7.170	7.347
28.15	-28.80	6.934	6.712	5.746	4.868	4.076	3.609	4.054	4.772	5.934	6.458	7.106	7.317
28.20	-28.80	6.564	6.615	5.824	4.854	4.176	3.668	4.222	4.864	6.050	6.120	7.080	7.453

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
28.25	-28.80	6.715	6.551	5.688	4.874	4.184	3.660	4.146	4.787	5.901	6.317	6.935	7.158
28.35	-28.80	6.617	6.388	5.548	4.747	4.005	3.566	4.034	4.688	5.809	6.181	6.832	7.056
28.40	-28.80	6.183	6.297	5.631	4.695	4.095	3.654	4.223	4.772	5.958	5.853	6.841	7.183
28.45	-28.80	6.460	6.287	5.386	4.640	4.038	3.507	4.068	4.674	5.677	6.079	6.759	6.918
28.55	-28.80	6.173	6.051	5.206	4.439	3.868	3.475	3.988	4.509	5.693	5.914	6.647	6.766
28.60	-28.80	5.823	5.830	5.169	4.332	3.807	3.377	4.150	4.450	5.828	5.532	6.514	6.801
28.65	-28.80	6.313	6.099	5.240	4.516	3.925	3.458	4.039	4.571	5.783	6.007	6.751	6.811
28.75	-28.80	6.256	5.927	5.231	4.550	3.960	3.284	3.924	4.391	5.833	6.210	6.893	6.803
28.80	-28.80	5.820	5.641	5.179	4.393	3.906	3.281	4.175	4.432	6.022	5.853	6.791	7.015
28.85	-28.80	6.239	5.854	5.175	4.596	4.029	3.377	3.996	4.459	5.855	6.197	6.839	6.740
28.95	-28.80	4.850	4.531	3.961	3.247	2.827	2.478	2.674	3.188	4.102	4.483	4.909	5.102
29.00	-28.80	5.225	5.347	4.860	4.230	3.986	3.541	4.060	4.669	5.434	4.915	5.881	6.085
29.05	-28.80	5.559	5.566	4.857	4.415	4.042	3.614	4.004	4.695	5.440	5.364	5.946	6.058
29.15	-28.80	6.033	6.104	5.299	4.656	3.997	3.533	3.879	4.676	5.571	5.557	6.322	6.473
29.20	-28.80	6.030	6.215	5.547	4.721	4.306	3.752	4.256	4.830	5.728	5.379	6.465	6.801
29.25	-28.80	6.317	6.312	5.529	4.747	4.112	3.679	4.065	4.723	5.617	5.677	6.493	6.691
29.35	-28.80	6.364	6.407	5.536	4.829	4.240	3.768	4.146	4.812	5.606	5.681	6.444	6.698
29.40	-28.80	6.097	6.267	5.587	4.729	4.296	3.736	4.233	4.799	5.640	5.321	6.335	6.749
29.45	-28.80	6.536	6.541	5.597	4.850	4.235	3.776	4.117	4.835	5.580	5.725	6.435	6.801
27.00	-28.85	7.219	6.714	5.971	4.933	4.250	3.726	4.159	4.861	6.074	6.747	7.513	7.652
27.05	-28.85	7.219	6.714	5.971	4.933	4.250	3.726	4.159	4.861	6.074	6.747	7.512	7.652
27.10	-28.85	7.274	6.783	5.954	4.930	4.235	3.707	4.150	4.867	6.067	6.752	7.473	7.673
27.15	-28.85	7.274	6.783	5.954	4.930	4.235	3.707	4.150	4.867	6.067	6.752	7.473	7.673
27.20	-28.85	7.084	6.651	5.766	4.838	4.188	3.601	4.078	4.835	6.017	6.638	7.385	7.511
27.25	-28.85	7.058	6.604	5.735	4.827	4.195	3.676	4.132	4.848	6.037	6.582	7.316	7.458
27.30	-28.85	7.058	6.604	5.748	4.827	4.195	3.676	4.132	4.848	6.037	6.586	7.348	7.458
27.35	-28.85	7.106	6.633	5.762	4.819	4.176	3.660	4.137	4.842	6.034	6.585	7.352	7.530
27.40	-28.85	7.101	6.632	5.717	4.792	4.178	3.614	4.094	4.835	5.976	6.574	7.352	7.530
27.45	-28.85	7.189	6.699	5.814	4.843	4.189	3.683	4.149	4.876	6.073	6.597	7.391	7.590
27.50	-28.85	7.189	6.693	5.790	4.855	4.190	3.686	4.138	4.881	6.063	6.594	7.348	7.582
27.55	-28.85	7.189	6.693	5.790	4.855	4.190	3.686	4.138	4.881	6.063	6.593	7.348	7.582
27.60	-28.85	7.127	6.655	5.761	4.846	4.179	3.673	4.107	4.874	6.049	6.548	7.297	7.502
27.65	-28.85	7.127	6.655	5.765	4.847	4.192	3.679	4.132	4.874	6.049	6.551	7.299	7.502
27.70	-28.85	7.042	6.669	5.749	4.826	4.188	3.681	4.132	4.880	6.038	6.514	7.261	7.475
27.75	-28.85	7.009	6.643	5.756	4.858	4.186	3.671	4.131	4.889	6.047	6.503	7.235	7.464
27.80	-28.85	7.009	6.643	5.761	4.858	4.190	3.676	4.132	4.889	6.047	6.506	7.265	7.489
27.85	-28.85	6.935	6.592	5.793	4.842	4.193	3.688	4.116	4.818	5.944	6.446	7.198	7.366
27.90	-28.85	6.998	6.638	5.815	4.902	4.202	3.691	4.140	4.871	6.025	6.482	7.225	7.427
27.95	-28.85	7.030	6.683	5.713	4.734	3.776	3.368	3.776	4.574	5.819	6.428	7.181	7.402
28.00	-28.85	7.049	6.782	5.852	4.951	4.208	3.701	4.146	4.859	6.006	6.508	7.229	7.418
28.05	-28.85	7.049	6.782	5.851	4.952	4.208	3.701	4.146	4.860	6.006	6.508	7.229	7.418
28.10	-28.85	7.010	6.786	5.876	4.973	4.203	3.681	4.141	4.832	5.958	6.495	7.203	7.404
28.15	-28.85	7.011	6.788	5.876	4.976	4.211	3.681	4.140	4.836	5.958	6.497	7.202	7.404
28.20	-28.85	6.944	6.731	5.819	4.926	4.189	3.664	4.117	4.800	5.927	6.455	7.104	7.355
28.25	-28.85	6.699	6.519	5.640	4.782	4.113	3.615	4.106	4.740	5.844	6.276	6.936	7.121
28.30	-28.85	6.677	6.517	5.614	4.754	4.110	3.589	4.084	4.735	5.826	6.259	6.898	7.075
28.35	-28.85	6.480	6.306	5.495	4.521	3.935	3.501	3.972	4.561	5.712	6.098	6.804	6.990
28.40	-28.85	6.435	6.306	5.495	4.696	4.085	3.510	4.020	4.701	5.752	6.195	6.804	6.869
28.45	-28.85	6.002	5.801	5.052	4.301	3.745	3.309	3.820	4.307	5.391	5.645	6.368	6.400

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
28.50	-28.85	6.442	6.234	5.322	4.602	3.987	3.564	4.045	4.621	5.761	6.069	6.731	6.814
28.55	-28.85	6.306	6.136	5.162	4.359	3.672	3.250	3.681	4.369	5.545	5.944	6.680	6.767
28.60	-28.85	6.388	6.127	5.260	4.558	3.969	3.540	4.050	4.612	5.755	6.107	6.790	6.836
28.65	-28.85	6.444	6.238	5.332	4.608	3.980	3.578	4.099	4.657	5.813	6.120	6.844	6.896
28.70	-28.85	6.276	6.046	5.273	4.543	3.744	3.221	3.797	4.346	5.734	6.128	6.859	6.894
28.75	-28.85	6.302	6.013	5.317	4.552	3.940	3.242	3.834	4.334	5.802	6.230	6.996	6.952
28.80	-28.85	6.300	6.013	5.324	4.558	3.940	3.222	3.820	4.334	5.810	6.234	7.006	6.952
28.85	-28.85	6.272	5.910	5.228	4.650	3.984	3.526	3.948	4.519	5.847	6.316	7.070	6.886
28.90	-28.85	6.265	5.941	5.271	4.726	4.120	3.651	4.133	4.646	5.924	6.357	7.089	6.899
28.95	-28.85	5.988	5.715	4.993	4.555	4.026	3.540	4.053	4.441	5.679	5.916	6.525	6.455
29.00	-28.85	5.549	5.266	4.529	4.054	3.610	3.224	3.584	3.966	5.224	5.458	5.907	5.925
29.05	-28.85	5.638	5.368	4.686	4.255	3.836	3.482	3.924	4.332	5.492	5.618	6.147	6.044
29.10	-28.85	5.397	5.446	4.745	4.292	4.012	3.659	4.048	4.582	5.317	5.234	5.904	5.955
29.15	-28.85	5.290	5.382	4.697	4.301	3.873	3.554	3.947	4.545	5.327	5.221	5.779	5.801
29.20	-28.85	5.830	5.904	5.088	4.395	3.975	3.433	3.852	4.523	5.305	5.368	6.039	6.183
29.25	-28.85	6.007	6.094	5.260	4.622	4.090	3.625	4.041	4.747	5.481	5.453	6.239	6.399
29.30	-28.85	6.007	6.094	5.272	4.622	4.086	3.625	4.018	4.747	5.481	5.445	6.219	6.399
29.35	-28.85	6.086	6.186	5.384	4.685	4.170	3.741	4.093	4.766	5.525	5.517	6.261	6.489
29.40	-28.85	6.085	6.184	5.380	4.688	4.170	3.741	4.093	4.774	5.525	5.516	6.255	6.489
29.45	-28.85	6.308	6.396	5.469	4.768	4.200	3.750	4.093	4.814	5.526	5.585	6.263	6.610
29.50	-28.85	6.362	6.453	5.510	4.769	4.193	3.741	4.088	4.803	5.527	5.610	6.281	6.643
27.05	-28.90	7.219	6.714	5.971	4.933	4.250	3.726	4.159	4.861	6.074	6.747	7.513	7.652
27.10	-28.90	6.923	6.671	5.961	4.861	4.222	3.696	4.190	4.876	6.167	6.403	7.358	7.796
27.15	-28.90	7.274	6.783	5.954	4.930	4.234	3.707	4.149	4.867	6.067	6.752	7.473	7.673
27.25	-28.90	7.058	6.603	5.748	4.827	4.191	3.676	4.132	4.847	6.037	6.586	7.348	7.458
27.30	-28.90	6.550	6.383	5.566	4.537	3.981	3.496	3.959	4.579	6.002	6.096	7.084	7.443
27.35	-28.90	7.091	6.632	5.762	4.816	4.178	3.668	4.139	4.841	6.034	6.572	7.305	7.485
27.45	-28.90	7.189	6.699	5.814	4.843	4.190	3.683	4.154	4.876	6.073	6.597	7.391	7.590
27.50	-28.90	6.783	6.605	5.805	4.749	4.164	3.656	4.197	4.881	6.164	6.197	7.237	7.716
27.55	-28.90	7.189	6.693	5.790	4.855	4.190	3.686	4.138	4.881	6.063	6.593	7.348	7.582
27.65	-28.90	7.123	6.653	5.765	4.847	4.192	3.678	4.132	4.874	6.049	6.548	7.299	7.502
27.70	-28.90	6.616	6.576	5.748	4.757	4.163	3.659	4.201	4.888	6.113	6.163	7.161	7.589
27.75	-28.90	7.009	6.643	5.761	4.858	4.188	3.671	4.132	4.889	6.047	6.506	7.265	7.489
27.85	-28.90	6.999	6.640	5.813	4.904	4.198	3.688	4.124	4.874	6.026	6.487	7.224	7.427
27.90	-28.90	6.578	6.556	5.825	4.808	4.176	3.653	4.203	4.876	6.110	6.143	7.129	7.541
27.95	-28.90	7.049	6.730	5.838	4.932	4.209	3.693	4.137	4.860	6.010	6.499	7.199	7.402
28.05	-28.90	7.049	6.782	5.851	4.951	4.208	3.701	4.146	4.860	6.006	6.507	7.229	7.418
28.10	-28.90	6.606	6.697	5.929	4.905	4.158	3.654	4.189	4.866	6.047	6.185	7.153	7.500
28.15	-28.90	7.012	6.788	5.876	4.976	4.208	3.680	4.140	4.835	5.958	6.497	7.202	7.404
28.25	-28.90	6.663	6.430	5.579	4.754	3.987	3.519	3.999	4.670	5.777	6.231	6.883	7.075
28.30	-28.90	6.222	6.311	5.683	4.706	4.051	3.590	4.177	4.753	5.943	5.906	6.818	7.103
28.35	-28.90	6.575	6.396	5.506	4.591	3.693	2.344	3.313	4.466	5.757	6.199	6.853	7.037
28.45	-28.90	6.109	5.892	5.000	4.310	3.682	3.222	3.718	4.344	5.536	5.798	6.462	6.515
28.50	-28.90	5.991	5.974	5.279	4.437	3.920	3.532	4.179	4.586	5.867	5.664	6.605	6.856
28.55	-28.90	6.394	6.192	5.271	4.499	3.711	3.348	3.777	4.492	5.657	5.992	6.716	6.768
28.65	-28.90	6.388	6.202	5.261	4.538	3.802	3.359	3.806	4.577	5.733	6.039	6.785	6.887
28.70	-28.90	5.877	5.854	5.259	4.446	3.789	3.183	4.038	4.436	5.948	5.807	6.710	7.038
28.75	-28.90	6.294	5.968	5.258	4.552	3.900	3.163	3.739	4.323	5.755	6.229	6.949	6.898
28.85	-28.90	6.282	5.941	5.271	4.735	4.124	3.651	4.133	4.654	5.924	6.367	7.089	6.915

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
28.90	-28.90	5.758	5.556	5.181	4.372	3.991	3.534	4.072	4.467	5.770	5.890	6.895	6.962
28.95	-28.90	5.965	5.714	4.962	4.513	3.981	3.444	3.950	4.418	5.657	5.898	6.467	6.403
29.05	-28.90	5.561	5.372	4.683	4.075	3.282	2.576	3.136	3.964	5.380	5.601	6.056	5.925
29.10	-28.90	4.980	5.106	4.615	3.975	3.839	3.254	3.964	4.388	5.141	4.752	5.752	5.816
29.15	-28.90	5.406	5.457	4.750	4.342	4.030	3.659	4.060	4.634	5.383	5.247	5.904	5.940
29.25	-28.90	6.037	6.107	5.299	4.650	4.174	3.750	4.127	4.752	5.548	5.498	6.239	6.425
29.30	-28.90	5.743	5.960	5.311	4.523	4.239	3.703	4.212	4.754	5.588	5.101	6.124	6.441
29.35	-28.90	6.058	6.159	5.319	4.624	4.029	3.619	3.933	4.709	5.457	5.456	6.220	6.460
29.45	-28.90	6.276	6.353	5.385	4.728	4.123	3.626	4.040	4.774	5.467	5.526	6.206	6.580
29.50	-28.90	6.074	6.356	5.528	4.655	4.280	3.688	4.188	4.787	5.544	5.232	6.185	6.738
27.00	-28.95	7.241	6.720	5.944	4.908	4.218	3.693	4.137	4.835	6.043	6.787	7.472	7.655
27.05	-28.95	7.241	6.720	5.943	4.908	4.218	3.693	4.137	4.835	6.043	6.787	7.472	7.655
27.10	-28.95	7.283	6.765	5.940	4.905	4.212	3.684	4.132	4.830	6.045	6.764	7.508	7.670
27.15	-28.95	7.283	6.765	5.940	4.905	4.212	3.684	4.132	4.830	6.045	6.764	7.508	7.670
27.20	-28.95	7.133	6.660	5.818	4.825	4.089	3.523	4.009	4.764	5.951	6.658	7.438	7.572
27.25	-28.95	7.113	6.645	5.799	4.881	4.163	3.660	4.118	4.821	6.037	6.654	7.445	7.560
27.30	-28.95	7.113	6.645	5.799	4.881	4.149	3.653	4.091	4.815	6.037	6.653	7.445	7.560
27.35	-28.95	7.101	6.605	5.743	4.821	4.183	3.664	4.137	4.837	6.039	6.600	7.423	7.512
27.40	-28.95	7.101	6.605	5.743	4.821	4.178	3.670	4.137	4.836	6.039	6.600	7.423	7.512
27.45	-28.95	7.125	6.686	5.764	4.835	4.159	3.672	4.114	4.846	6.050	6.603	7.408	7.534
27.50	-28.95	7.099	6.617	5.747	4.832	4.171	3.680	4.118	4.836	6.048	6.560	7.329	7.483
27.55	-28.95	7.099	6.617	5.747	4.832	4.171	3.680	4.117	4.836	6.048	6.560	7.329	7.483
27.60	-28.95	7.119	6.667	5.745	4.840	4.189	3.676	4.127	4.867	6.017	6.530	7.266	7.533
27.65	-28.95	7.119	6.667	5.744	4.840	4.188	3.675	4.127	4.867	6.017	6.530	7.265	7.533
27.70	-28.95	7.140	6.733	5.818	4.895	4.193	3.673	4.135	4.860	6.029	6.540	7.272	7.524
27.75	-28.95	7.154	6.748	5.833	4.908	4.193	3.660	4.109	4.828	6.018	6.523	7.276	7.529
27.80	-28.95	7.153	6.747	5.836	4.908	4.207	3.663	4.127	4.829	6.018	6.526	7.278	7.529
27.85	-28.95	7.096	6.739	5.836	4.910	4.195	3.661	4.121	4.828	6.005	6.506	7.235	7.480
27.90	-28.95	7.115	6.740	5.835	4.940	4.199	3.658	4.121	4.839	6.008	6.515	7.235	7.480
27.95	-28.95	7.087	6.737	5.839	4.921	4.200	3.667	4.104	4.816	5.967	6.505	7.223	7.447
28.00	-28.95	7.066	6.729	5.830	4.914	4.185	3.656	4.109	4.803	5.951	6.465	7.174	7.407
28.05	-28.95	7.064	6.727	5.826	4.880	4.178	3.657	4.111	4.791	5.942	6.459	7.174	7.407
28.10	-28.95	6.971	6.729	5.796	4.885	4.176	3.640	4.106	4.804	5.888	6.387	7.082	7.330
28.15	-28.95	6.971	6.727	5.796	4.886	4.170	3.640	4.106	4.802	5.887	6.387	7.082	7.330
28.20	-28.95	6.885	6.656	5.745	4.853	4.155	3.625	4.111	4.776	5.851	6.319	7.090	7.267
28.25	-28.95	6.661	6.451	5.574	4.702	3.974	3.480	3.958	4.667	5.782	6.197	6.928	7.085
28.30	-28.95	6.662	6.451	5.574	4.724	4.067	3.576	4.070	4.693	5.793	6.197	6.928	7.085
28.35	-28.95	6.297	6.049	5.253	4.504	3.952	3.492	4.019	4.593	5.725	5.982	6.671	6.771
28.40	-28.95	6.227	6.007	5.192	4.459	3.942	3.492	4.009	4.545	5.645	5.900	6.649	6.712
28.45	-28.95	5.884	5.474	4.751	4.080	3.567	3.202	3.677	4.171	5.117	5.727	6.270	6.365
28.50	-28.95	6.649	6.313	5.473	4.703	4.028	3.543	4.000	4.695	5.842	6.341	6.983	7.069
28.55	-28.95	6.625	6.298	5.437	4.627	3.929	3.510	3.928	4.571	5.807	6.268	6.883	7.062
28.60	-28.95	6.404	6.148	5.338	4.557	3.851	3.381	3.943	4.561	5.736	6.099	6.859	6.892
28.65	-28.95	6.298	6.035	5.151	4.293	3.484	3.044	3.449	4.163	5.502	5.869	6.666	6.761
28.70	-28.95	6.461	6.148	5.401	4.668	3.998	3.454	3.933	4.576	5.850	6.326	7.097	7.139
28.75	-28.95	6.359	6.087	5.383	4.661	3.901	3.385	3.874	4.507	5.802	6.363	7.048	7.030
28.80	-28.95	6.398	6.121	5.400	4.699	4.013	3.502	4.032	4.546	5.879	6.361	7.069	7.078
28.85	-28.95	6.317	6.023	5.354	4.692	4.069	3.600	4.095	4.606	5.905	6.391	7.124	7.062
28.90	-28.95	6.300	5.991	5.348	4.689	3.998	3.478	3.980	4.576	5.846	6.414	7.111	7.019

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
28.95	-28.95	6.286	6.030	5.272	4.720	4.074	3.682	4.133	4.611	5.836	6.182	6.854	6.733
29.00	-28.95	6.330	6.103	5.368	4.809	4.133	3.711	4.156	4.655	5.889	6.198	6.919	6.837
29.05	-28.95	6.312	6.100	5.312	4.731	3.969	3.605	4.029	4.557	5.848	6.179	6.922	6.837
29.10	-28.95	5.640	5.437	4.730	4.317	3.940	3.520	3.961	4.408	5.425	5.561	6.084	6.017
29.15	-28.95	5.576	5.350	4.627	4.078	3.496	3.107	3.464	4.028	5.185	5.382	5.987	5.910
29.20	-28.95	5.330	5.315	4.683	4.257	3.979	3.625	4.045	4.588	5.260	5.177	5.653	5.784
29.25	-28.95	5.501	5.498	4.856	4.358	4.020	3.642	4.035	4.642	5.339	5.238	5.770	5.913
29.30	-28.95	5.210	4.994	4.339	3.697	3.167	2.925	3.258	3.836	4.742	4.882	5.397	5.534
29.35	-28.95	5.297	5.308	4.715	4.247	3.975	3.527	3.917	4.578	5.198	5.065	5.593	5.735
29.40	-28.95	5.307	5.370	4.678	4.139	3.720	3.409	3.751	4.344	5.143	5.024	5.614	5.783
29.45	-28.95	5.856	6.000	5.240	4.573	4.116	3.688	4.047	4.693	5.400	5.347	5.982	6.253
29.50	-28.95	5.959	6.110	5.315	4.642	4.131	3.695	4.059	4.728	5.403	5.425	6.085	6.363
27.00	-29.00	6.801	6.523	5.905	4.771	4.186	3.667	4.151	4.833	6.153	6.424	7.310	7.764
27.05	-29.00	7.178	6.670	5.907	4.863	4.201	3.674	4.121	4.817	6.044	6.757	7.469	7.634
27.15	-29.00	7.231	6.722	5.885	4.863	4.182	3.660	4.119	4.813	6.029	6.736	7.480	7.644
27.20	-29.00	6.710	6.553	5.802	4.760	4.137	3.642	4.163	4.824	6.140	6.283	7.309	7.671
27.25	-29.00	7.072	6.624	5.777	4.848	4.143	3.647	4.102	4.809	6.019	6.649	7.434	7.543
27.35	-29.00	7.084	6.589	5.714	4.814	4.156	3.662	4.124	4.832	6.034	6.603	7.425	7.487
27.40	-29.00	6.644	6.411	5.712	4.702	4.136	3.625	4.160	4.840	6.122	6.196	7.278	7.586
27.45	-29.00	7.134	6.661	5.759	4.834	4.179	3.667	4.139	4.853	6.040	6.629	7.414	7.530
27.55	-29.00	7.129	6.679	5.756	4.850	4.167	3.676	4.115	4.844	6.030	6.612	7.375	7.516
27.60	-29.00	6.681	6.526	5.764	4.750	4.166	3.644	4.187	4.842	6.089	6.180	7.167	7.618
27.65	-29.00	7.125	6.672	5.744	4.839	4.180	3.672	4.122	4.844	6.018	6.536	7.281	7.501
27.75	-29.00	7.205	6.749	5.876	4.913	4.205	3.660	4.121	4.828	6.003	6.550	7.301	7.539
27.80	-29.00	6.770	6.622	5.872	4.828	4.169	3.613	4.166	4.813	6.087	6.194	7.186	7.628
27.85	-29.00	7.126	6.789	5.878	4.917	4.183	3.663	4.083	4.790	5.974	6.513	7.270	7.554
27.95	-29.00	7.062	6.758	5.861	4.936	4.187	3.658	4.101	4.799	5.966	6.503	7.252	7.490
28.00	-29.00	6.560	6.591	5.831	4.777	4.072	3.516	4.063	4.772	6.004	6.047	7.061	7.424
28.05	-29.00	6.994	6.706	5.785	4.885	4.160	3.638	4.093	4.775	5.908	6.427	7.141	7.375
28.15	-29.00	6.838	6.506	5.633	4.793	3.999	3.533	3.983	4.687	5.809	6.314	6.978	7.185
28.20	-29.00	6.222	6.274	5.573	4.581	4.021	3.543	4.159	4.723	5.933	5.835	6.829	7.088
28.25	-29.00	6.495	6.251	5.348	4.562	3.917	3.438	3.951	4.608	5.707	6.052	6.764	6.870
28.35	-29.00	6.030	5.765	4.792	4.097	3.497	2.913	3.467	4.281	5.476	5.708	6.292	6.306
28.40	-29.00	5.583	5.489	4.793	4.020	3.557	3.034	3.783	4.293	5.663	5.307	6.152	6.260
28.45	-29.00	6.780	6.472	5.517	4.729	4.081	3.554	4.014	4.739	5.877	6.401	7.043	7.097
28.55	-29.00	6.614	6.316	5.245	4.342	3.670	3.248	3.614	4.188	5.560	6.123	6.709	6.951
28.60	-29.00	6.143	5.902	5.289	4.404	3.846	3.368	4.135	4.564	5.907	5.840	6.755	7.123
28.65	-29.00	6.305	5.823	5.100	4.202	3.484	3.141	3.621	4.155	5.487	5.936	6.620	6.769
28.75	-29.00	6.487	6.149	5.468	4.745	4.041	3.596	4.071	4.655	5.913	6.404	7.141	7.122
28.80	-29.00	6.105	5.871	5.404	4.579	3.975	3.396	4.082	4.649	5.952	5.997	7.045	7.373
28.85	-29.00	6.343	6.069	5.417	4.747	4.067	3.604	4.100	4.598	5.925	6.417	7.109	7.058
28.95	-29.00	6.314	6.019	5.330	4.735	4.095	3.725	4.155	4.651	5.845	6.180	6.901	6.790
29.00	-29.00	6.059	5.899	5.325	4.648	4.098	3.677	4.258	4.731	6.024	5.724	6.818	7.008
29.05	-29.00	6.334	6.016	5.313	4.620	3.976	3.476	3.979	4.453	5.667	6.109	6.797	6.679
29.15	-29.00	6.336	6.098	5.326	4.700	4.095	3.567	4.018	4.547	5.777	6.059	6.754	6.719
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652

Improved Solar Database for Lesotho

Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652

Improved Solar Database for Lesotho

Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.20	-29.00	5.251	4.986	4.510	3.875	3.733	3.341	3.947	4.221	5.297	4.946	5.602	5.652
29.25	-29.00	5.341	5.070	4.448	4.043	3.816	3.516	3.919	4.381	5.256	5.296	5.639	5.648
29.35	-29.00	4.943	4.991	4.451	4.027	3.851	3.555	3.956	4.506	5.093	4.798	5.223	5.349
29.40	-29.00	4.539	4.715	4.390	3.788	3.958	3.481	4.058	4.461	5.130	4.323	5.035	5.279
29.45	-29.00	5.711	5.863	5.151	4.526	4.071	3.667	4.035	4.686	5.333	5.236	5.840	6.065
27.00	-29.05	7.164	6.669	5.907	4.848	4.197	3.674	4.121	4.810	6.044	6.744	7.423	7.590
27.05	-29.05	7.178	6.670	5.904	4.863	4.201	3.674	4.121	4.817	6.044	6.753	7.469	7.634
27.10	-29.05	7.231	6.722	5.885	4.863	4.182	3.660	4.119	4.813	6.029	6.736	7.480	7.645
27.15	-29.05	7.231	6.722	5.885	4.863	4.182	3.660	4.119	4.813	6.029	6.736	7.480	7.644
27.20	-29.05	7.110	6.677	5.816	4.860	4.169	3.657	4.116	4.805	6.025	6.657	7.447	7.574
27.25	-29.05	7.072	6.624	5.777	4.848	4.142	3.643	4.102	4.809	6.019	6.649	7.434	7.544
27.30	-29.05	7.058	6.623	5.776	4.821	4.138	3.647	4.102	4.801	6.014	6.640	7.434	7.543
27.35	-29.05	7.021	6.471	5.571	4.647	3.983	3.516	3.920	4.562	5.920	6.494	7.238	7.369
27.40	-29.05	7.021	6.533	5.614	4.752	4.142	3.652	4.097	4.772	5.937	6.494	7.351	7.421
27.45	-29.05	7.134	6.661	5.758	4.834	4.178	3.667	4.138	4.853	6.040	6.629	7.414	7.530
27.50	-29.05	7.129	6.679	5.756	4.850	4.167	3.676	4.115	4.844	6.030	6.611	7.375	7.516
27.55	-29.05	7.129	6.679	5.756	4.850	4.167	3.676	4.114	4.844	6.030	6.612	7.375	7.516
27.60	-29.05	7.125	6.672	5.744	4.839	4.180	3.673	4.122	4.844	6.018	6.536	7.281	7.501
27.65	-29.05	7.125	6.672	5.744	4.839	4.180	3.672	4.122	4.845	6.018	6.536	7.281	7.501
27.70	-29.05	7.228	6.734	5.840	4.912	4.204	3.666	4.124	4.833	6.010	6.549	7.278	7.533
27.75	-29.05	7.205	6.750	5.876	4.913	4.205	3.660	4.121	4.828	6.003	6.550	7.301	7.539
27.80	-29.05	7.205	6.750	5.875	4.913	4.205	3.660	4.121	4.828	6.003	6.550	7.301	7.539
27.85	-29.05	7.116	6.788	5.886	4.910	4.197	3.666	4.106	4.802	5.973	6.509	7.277	7.554
27.90	-29.05	7.126	6.789	5.886	4.930	4.203	3.666	4.106	4.813	5.974	6.515	7.277	7.554
27.95	-29.05	7.021	6.714	5.772	4.841	4.015	3.526	3.904	4.689	5.878	6.402	7.179	7.431
28.00	-29.05	6.972	6.640	5.727	4.732	4.021	3.545	3.989	4.628	5.832	6.381	7.088	7.326
28.05	-29.05	6.973	6.705	5.772	4.851	4.155	3.638	4.093	4.764	5.893	6.412	7.122	7.375
28.10	-29.05	6.838	6.579	5.620	4.742	4.121	3.625	4.064	4.705	5.767	6.313	7.006	7.212
28.15	-29.05	6.809	6.503	5.621	4.791	4.047	3.532	3.963	4.695	5.809	6.307	6.952	7.150
28.20	-29.05	6.663	6.462	5.555	4.716	4.072	3.576	4.082	4.715	5.806	6.174	6.893	7.051
28.25	-29.05	6.449	6.246	5.381	4.515	3.962	3.408	4.023	4.594	5.666	6.042	6.790	6.862
28.30	-29.05	6.515	6.291	5.406	4.597	4.004	3.532	4.054	4.654	5.765	6.069	6.815	6.916
28.35	-29.05	6.149	5.830	4.942	4.245	3.688	3.216	3.815	4.385	5.591	5.824	6.452	6.466
28.40	-29.05	6.009	5.754	4.935	4.226	3.689	3.216	3.819	4.375	5.591	5.824	6.439	6.371
28.45	-29.05	6.757	6.434	5.529	4.684	4.027	3.522	4.039	4.690	5.825	6.325	7.050	7.094
28.50	-29.05	6.756	6.429	5.486	4.730	3.961	3.540	3.959	4.717	5.845	6.336	6.934	7.084
28.55	-29.05	6.777	6.496	5.596	4.743	4.081	3.667	4.117	4.743	5.924	6.406	7.063	7.112
28.60	-29.05	6.294	6.034	5.303	4.447	3.755	3.357	3.863	4.387	5.644	6.015	6.787	6.772
28.65	-29.05	6.499	6.172	5.379	4.561	3.912	3.448	3.982	4.545	5.795	6.161	6.864	7.003
28.70	-29.05	6.458	6.153	5.414	4.638	3.988	3.534	4.005	4.556	5.769	6.319	7.055	7.078

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
28.75	-29.05	6.458	6.129	5.389	4.685	3.905	3.475	3.906	4.591	5.841	6.318	7.055	7.101
28.80	-29.05	6.503	6.162	5.476	4.712	4.043	3.596	4.087	4.653	5.907	6.403	7.164	7.149
28.85	-29.05	6.348	6.072	5.417	4.747	4.077	3.604	4.100	4.601	5.925	6.418	7.109	7.058
28.90	-29.05	6.347	6.070	5.410	4.735	4.065	3.604	4.085	4.580	5.925	6.417	7.094	7.058
28.95	-29.05	6.308	5.990	5.287	4.585	3.786	3.333	3.729	4.470	5.636	6.097	6.838	6.703
29.00	-29.05	6.354	6.060	5.328	4.573	3.969	3.615	4.044	4.514	5.791	6.120	6.855	6.778
29.05	-29.05	6.353	6.108	5.322	4.661	3.913	3.240	3.782	4.509	5.859	6.162	6.866	6.820
29.10	-29.05	6.361	6.083	5.341	4.674	4.088	3.660	4.092	4.508	5.769	6.074	6.747	6.717
29.15	-29.05	6.362	6.101	5.348	4.732	4.090	3.539	4.060	4.536	5.795	6.080	6.763	6.729
29.20	-29.05	5.504	5.289	4.634	4.146	3.708	3.316	3.791	4.343	5.296	5.428	5.834	5.796
29.25	-29.05	5.106	4.735	4.179	3.815	3.567	3.161	3.659	4.222	4.932	5.084	5.389	5.444
29.30	-29.05	5.202	4.907	4.192	3.638	3.269	2.827	3.236	3.985	5.000	5.162	5.431	5.460
29.35	-29.05	4.925	4.969	4.419	3.988	3.815	3.470	3.956	4.477	5.027	4.783	5.183	5.296
29.40	-29.05	4.914	4.967	4.448	4.034	3.862	3.555	3.956	4.492	5.067	4.805	5.213	5.327
29.45	-29.05	5.711	5.863	5.151	4.530	4.081	3.667	4.035	4.698	5.333	5.236	5.836	6.041
29.50	-29.05	5.801	5.985	5.217	4.567	4.094	3.684	4.017	4.666	5.349	5.334	5.929	6.196
27.05	-29.10	7.233	6.681	5.927	4.873	4.181	3.666	4.101	4.818	6.059	6.797	7.556	7.724
27.10	-29.10	6.910	6.595	5.897	4.741	4.165	3.637	4.138	4.821	6.130	6.421	7.388	7.850
27.15	-29.10	7.248	6.732	5.893	4.851	4.179	3.647	4.104	4.810	6.039	6.767	7.539	7.709
27.25	-29.10	7.222	6.676	5.856	4.858	4.156	3.646	4.107	4.810	6.039	6.716	7.521	7.659
27.30	-29.10	6.834	6.505	5.868	4.746	4.115	3.616	4.150	4.820	6.136	6.323	7.349	7.794
27.35	-29.10	6.992	6.538	5.694	4.835	4.148	3.646	4.109	4.824	6.029	6.637	7.398	7.479
27.45	-29.10	7.056	6.631	5.711	4.832	4.033	3.572	4.011	4.787	6.016	6.613	7.411	7.546
27.50	-29.10	6.710	6.492	5.744	4.765	4.139	3.645	4.157	4.820	6.093	6.201	7.207	7.664
27.55	-29.10	7.131	6.641	5.747	4.855	4.157	3.668	4.092	4.821	6.005	6.559	7.332	7.527
27.65	-29.10	7.231	6.706	5.836	4.890	4.170	3.652	4.095	4.809	5.997	6.543	7.332	7.545
27.70	-29.10	6.775	6.577	5.899	4.849	4.143	3.615	4.161	4.781	6.049	6.167	7.188	7.547
27.75	-29.10	7.223	6.755	5.880	4.926	4.183	3.644	4.092	4.788	5.951	6.516	7.280	7.507
27.85	-29.10	7.150	6.717	5.860	4.898	4.146	3.621	4.075	4.763	5.907	6.454	7.228	7.482
27.90	-29.10	6.716	6.575	5.879	4.840	4.108	3.591	4.149	4.768	6.016	6.097	7.149	7.539
27.95	-29.10	7.071	6.735	5.835	4.858	4.149	3.610	4.065	4.749	5.892	6.433	7.162	7.439
28.05	-29.10	7.014	6.671	5.799	4.811	4.119	3.613	4.049	4.704	5.816	6.353	7.071	7.304
28.10	-29.10	6.393	6.402	5.694	4.625	3.999	3.532	4.127	4.722	5.915	5.875	6.868	7.243
28.15	-29.10	6.852	6.557	5.662	4.742	4.058	3.577	4.026	4.689	5.801	6.272	6.953	7.162
28.25	-29.10	6.345	5.993	4.995	4.154	3.400	2.733	3.290	4.128	5.435	5.835	6.520	6.573
28.30	-29.10	5.687	5.506	4.641	3.613	2.978	2.692	3.316	3.723	5.212	5.284	6.194	6.334
28.35	-29.10	6.589	6.211	5.329	4.595	3.862	3.367	3.906	4.509	5.801	6.316	6.968	6.960
28.45	-29.10	6.718	6.251	5.451	4.617	3.817	3.449	3.827	4.519	5.833	6.417	7.036	7.071
28.50	-29.10	6.409	6.163	5.498	4.567	4.055	3.541	4.153	4.689	5.964	5.984	6.957	7.305
28.55	-29.10	6.579	6.294	5.342	4.546	3.684	3.302	3.714	4.458	5.725	6.212	6.803	6.908
28.65	-29.10	6.662	6.416	5.562	4.760	4.110	3.591	4.051	4.726	5.916	6.425	7.090	7.169
28.70	-29.10	6.231	6.084	5.432	4.507	3.916	3.352	3.998	4.583	5.921	5.994	7.022	7.285
28.75	-29.10	6.384	6.163	5.403	4.505	3.905	3.386	3.904	4.467	5.810	6.276	7.057	7.006
28.85	-29.10	6.608	6.306	5.533	4.723	3.740	3.266	3.637	4.636	5.990	6.508	7.143	7.109
28.90	-29.10	6.148	5.995	5.419	4.502	3.937	3.366	4.010	4.619	5.847	6.034	6.877	7.183
28.95	-29.10	6.575	6.416	5.611	4.771	3.870	3.249	3.701	4.562	5.879	6.354	7.001	7.025
29.05	-29.10	6.527	6.398	5.575	4.853	4.177	3.640	4.140	4.690	5.848	6.246	6.971	6.982
29.10	-29.10	6.026	5.655	5.141	4.333	3.670	3.284	3.822	4.265	5.602	5.616	6.498	6.829
29.15	-29.10	6.528	6.271	5.510	4.816	4.119	3.674	4.107	4.624	5.819	6.222	6.855	6.936

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
29.25	-29.10	6.331	5.972	5.275	4.361	3.566	2.850	3.307	4.020	5.527	5.950	6.688	6.762
29.30	-29.10	5.973	5.608	5.208	4.481	3.854	3.372	3.977	4.289	5.805	5.587	6.588	6.968
29.35	-29.10	4.989	4.814	4.265	3.587	2.993	2.509	2.807	3.650	4.745	4.798	5.052	5.263
29.45	-29.10	5.480	5.559	4.861	4.350	3.986	3.583	3.970	4.594	5.158	5.031	5.507	5.795
29.50	-29.10	5.313	5.561	4.995	4.228	4.098	3.557	4.088	4.562	5.233	4.678	5.526	5.861
27.00	-29.15	7.233	6.681	5.927	4.873	4.181	3.666	4.101	4.818	6.059	6.797	7.556	7.724
27.05	-29.15	7.233	6.681	5.927	4.873	4.181	3.666	4.101	4.818	6.059	6.797	7.556	7.724
27.10	-29.15	7.248	6.733	5.893	4.851	4.179	3.647	4.104	4.810	6.039	6.767	7.540	7.710
27.15	-29.15	7.244	6.732	5.893	4.841	4.175	3.647	4.104	4.805	6.039	6.764	7.539	7.710
27.20	-29.15	7.256	6.710	5.863	4.869	4.163	3.658	4.117	4.815	6.042	6.747	7.553	7.681
27.25	-29.15	7.222	6.676	5.856	4.858	4.156	3.646	4.107	4.810	6.039	6.716	7.521	7.659
27.30	-29.15	7.210	6.675	5.856	4.854	4.152	3.646	4.107	4.807	6.039	6.707	7.521	7.659
27.35	-29.15	6.992	6.537	5.693	4.835	4.146	3.637	4.103	4.825	6.029	6.636	7.398	7.479
27.40	-29.15	6.977	6.537	5.687	4.808	4.147	3.646	4.108	4.817	6.020	6.624	7.394	7.479
27.45	-29.15	7.073	6.632	5.718	4.859	4.157	3.653	4.105	4.831	6.025	6.622	7.384	7.549
27.50	-29.15	7.131	6.641	5.746	4.854	4.156	3.668	4.092	4.821	6.005	6.559	7.333	7.527
27.55	-29.15	7.131	6.641	5.746	4.854	4.152	3.663	4.088	4.821	6.005	6.558	7.332	7.527
27.60	-29.15	7.231	6.706	5.838	4.890	4.167	3.652	4.090	4.809	5.997	6.547	7.333	7.545
27.65	-29.15	7.231	6.704	5.838	4.876	4.168	3.655	4.098	4.801	5.997	6.545	7.333	7.545
27.70	-29.15	7.228	6.739	5.853	4.916	4.165	3.647	4.072	4.775	5.962	6.518	7.263	7.493
27.75	-29.15	7.223	6.755	5.880	4.926	4.183	3.644	4.092	4.788	5.951	6.516	7.280	7.507
27.80	-29.15	7.223	6.755	5.880	4.926	4.182	3.644	4.092	4.788	5.951	6.516	7.280	7.507
27.85	-29.15	7.150	6.718	5.860	4.898	4.145	3.620	4.075	4.763	5.907	6.454	7.228	7.482
27.90	-29.15	7.150	6.718	5.860	4.898	4.146	3.620	4.075	4.763	5.907	6.454	7.228	7.482
27.95	-29.15	7.029	6.688	5.746	4.782	3.992	3.495	3.892	4.619	5.817	6.349	7.058	7.380
28.00	-29.15	6.952	6.622	5.752	4.823	4.012	3.521	3.969	4.680	5.799	6.276	7.048	7.292
28.05	-29.15	7.014	6.712	5.811	4.857	4.127	3.613	4.056	4.757	5.863	6.355	7.101	7.341
28.10	-29.15	6.784	6.465	5.613	4.622	3.924	3.484	3.925	4.536	5.747	6.202	6.934	7.162
28.15	-29.15	6.869	6.557	5.640	4.745	4.004	3.356	3.914	4.698	5.790	6.279	6.988	7.211
28.20	-29.15	6.217	5.932	5.053	4.339	3.789	3.267	3.881	4.416	5.652	5.831	6.447	6.521
28.25	-29.15	6.244	5.993	5.044	4.227	3.656	3.026	3.563	4.306	5.530	5.791	6.494	6.463
28.30	-29.15	6.381	6.037	5.159	4.236	3.336	2.881	3.311	4.130	5.572	5.934	6.559	6.598
28.35	-29.15	6.534	6.130	5.329	4.515	3.686	3.155	3.659	4.381	5.776	6.258	6.968	6.960
28.40	-29.15	6.613	6.224	5.389	4.646	4.005	3.455	4.011	4.585	5.848	6.337	7.025	7.011
28.45	-29.15	6.743	6.310	5.540	4.645	3.794	3.192	3.653	4.560	5.939	6.475	7.094	7.143
28.50	-29.15	6.643	6.294	5.483	4.698	4.007	3.536	3.974	4.635	5.862	6.234	6.988	7.102
28.55	-29.15	6.732	6.392	5.526	4.724	4.072	3.574	4.051	4.705	5.917	6.354	7.057	7.157
28.60	-29.15	6.618	6.389	5.440	4.616	3.738	3.166	3.582	4.507	5.784	6.335	7.010	7.126
28.65	-29.15	6.662	6.428	5.562	4.722	3.966	3.345	3.830	4.651	5.912	6.425	7.113	7.192
28.70	-29.15	6.598	6.353	5.487	4.680	3.804	3.355	3.782	4.543	5.886	6.409	7.146	7.140
28.75	-29.15	6.543	6.287	5.473	4.692	4.058	3.560	4.045	4.592	5.906	6.418	7.119	7.104
28.80	-29.15	6.543	6.270	5.473	4.674	4.058	3.560	4.045	4.579	5.874	6.418	7.118	7.082
28.85	-29.15	6.592	6.290	5.595	4.800	4.169	3.693	4.117	4.787	5.994	6.528	7.187	7.124
28.90	-29.15	6.557	6.220	5.532	4.719	4.021	3.648	4.052	4.693	5.963	6.451	7.143	7.109
28.95	-29.15	6.608	6.416	5.580	4.810	4.045	3.616	3.992	4.642	5.879	6.339	7.001	7.045
29.00	-29.15	6.460	6.200	5.332	4.427	3.776	3.342	3.661	4.192	5.385	6.047	6.657	6.780
29.05	-29.15	6.403	6.306	5.300	4.665	3.750	3.378	3.755	4.444	5.663	6.118	6.712	6.762
29.10	-29.15	6.449	6.145	5.366	4.618	3.838	3.292	3.735	4.415	5.546	6.061	6.740	6.792
29.15	-29.15	6.501	6.271	5.506	4.811	4.117	3.674	4.099	4.610	5.819	6.201	6.789	6.877

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
29.20	-29.15	6.316	6.000	5.243	4.491	3.649	3.215	3.541	4.176	5.430	5.898	6.620	6.710
29.25	-29.15	6.337	5.894	5.247	4.605	3.918	3.423	3.849	4.287	5.565	5.986	6.637	6.739
29.30	-29.15	6.365	6.004	5.317	4.646	4.029	3.524	3.956	4.350	5.640	6.014	6.691	6.798
29.35	-29.15	4.989	4.827	4.319	3.925	3.603	3.317	3.685	4.330	4.992	4.804	5.069	5.286
29.40	-29.15	4.971	4.824	4.311	3.954	3.748	3.346	3.877	4.440	4.976	4.813	5.086	5.258
29.45	-29.15	5.456	5.483	4.811	4.311	3.883	3.482	3.850	4.527	5.104	5.006	5.474	5.761
29.50	-29.15	5.615	5.734	4.993	4.441	4.013	3.613	3.994	4.609	5.195	5.124	5.644	5.928
27.00	-29.20	6.932	6.480	5.933	4.785	4.144	3.633	4.100	4.831	6.136	6.474	7.475	8.007
27.05	-29.20	7.329	6.692	5.913	4.865	4.161	3.653	4.090	4.821	6.050	6.819	7.622	7.829
27.15	-29.20	7.290	6.735	5.885	4.836	4.148	3.644	4.083	4.803	6.020	6.771	7.557	7.752
27.20	-29.20	6.882	6.537	5.843	4.729	4.116	3.602	4.122	4.808	6.104	6.380	7.396	7.803
27.25	-29.20	7.248	6.666	5.832	4.849	4.133	3.631	4.088	4.780	5.997	6.705	7.511	7.648
27.35	-29.20	7.126	6.552	5.723	4.811	4.129	3.582	4.051	4.796	5.994	6.664	7.405	7.507
27.40	-29.20	6.713	6.380	5.722	4.739	4.109	3.605	4.123	4.820	6.093	6.297	7.279	7.672
27.45	-29.20	7.105	6.601	5.747	4.836	4.109	3.629	4.074	4.808	6.008	6.587	7.399	7.528
27.55	-29.20	7.217	6.682	5.821	4.901	4.124	3.632	4.064	4.785	5.982	6.551	7.350	7.532
27.60	-29.20	6.815	6.561	5.890	4.849	4.107	3.609	4.138	4.760	6.069	6.138	7.212	7.608
27.65	-29.20	7.229	6.702	5.832	4.874	3.923	3.408	3.888	4.683	5.948	6.502	7.275	7.509
27.75	-29.20	7.103	6.665	5.817	4.882	4.123	3.604	4.062	4.755	5.921	6.485	7.227	7.446
27.80	-29.20	6.696	6.503	5.852	4.811	4.080	3.574	4.135	4.755	6.036	6.102	7.117	7.504
27.85	-29.20	6.891	6.513	5.700	4.758	4.063	3.555	3.993	4.679	5.847	6.309	7.061	7.265
27.95	-29.20	6.519	6.156	5.278	4.341	3.668	3.168	3.618	4.391	5.578	5.953	6.737	6.890
28.00	-29.20	5.962	5.799	5.205	4.123	3.699	3.151	3.812	4.374	5.762	5.521	6.464	6.692
28.05	-29.20	6.306	5.956	5.171	4.245	3.655	3.124	3.755	4.334	5.407	5.850	6.516	6.594
28.15	-29.20	6.337	5.955	5.086	4.264	3.730	3.268	3.734	4.292	5.492	5.959	6.535	6.603
28.20	-29.20	6.004	5.858	4.934	3.976	2.587	0.939	1.939	3.880	5.422	5.556	6.371	6.608
28.25	-29.20	6.860	6.455	5.568	4.725	4.014	3.540	4.004	4.677	5.887	6.444	7.166	7.272
28.35	-29.20	6.787	6.353	5.560	4.732	4.032	3.548	3.966	4.658	5.879	6.538	7.205	7.261
28.40	-29.20	6.454	6.122	5.547	4.630	4.130	3.616	4.185	4.727	6.000	6.239	7.098	7.405
28.45	-29.20	6.846	6.388	5.624	4.847	4.136	3.673	4.098	4.795	5.993	6.523	7.196	7.310
28.55	-29.20	6.673	6.290	5.527	4.633	3.833	3.271	3.737	4.557	5.628	6.371	7.064	7.138
28.60	-29.20	6.386	6.077	5.509	4.551	3.912	3.445	4.076	4.621	5.926	5.959	7.020	7.230
28.65	-29.20	6.644	6.276	5.505	4.728	3.942	3.510	3.970	4.638	5.821	6.349	7.044	7.083
28.75	-29.20	6.722	6.416	5.665	4.878	4.205	3.758	4.164	4.812	6.033	6.627	7.297	7.311
28.80	-29.20	6.294	6.066	5.545	4.563	3.858	3.307	3.761	4.643	5.814	6.144	7.053	7.356
28.85	-29.20	6.775	6.497	5.754	4.872	4.193	3.744	4.171	4.802	5.963	6.550	7.236	7.248
28.95	-29.20	6.551	6.423	5.506	4.699	3.915	3.372	3.767	4.589	5.741	6.192	6.786	6.911
29.00	-29.20	6.479	6.371	5.628	4.696	3.971	3.314	3.939	4.590	5.881	6.006	6.927	7.420
29.05	-29.20	6.598	6.458	5.659	4.831	4.052	3.632	4.050	4.644	5.856	6.353	7.000	7.080
29.15	-29.20	6.515	6.355	5.479	4.669	3.876	3.308	3.683	4.427	5.594	6.135	6.676	6.902
29.20	-29.20	6.042	5.783	5.254	4.423	3.848	3.192	3.733	4.305	5.655	5.608	6.658	6.997
29.25	-29.20	6.352	5.949	5.330	4.684	3.930	3.539	3.915	4.388	5.607	6.199	6.736	6.861
29.35	-29.20	6.135	5.758	5.140	4.596	4.029	3.605	3.959	4.372	5.561	6.058	6.595	6.650
29.40	-29.20	5.780	5.340	5.052	4.393	4.028	3.562	4.090	4.362	5.741	5.609	6.375	6.695
29.45	-29.20	5.280	5.214	4.602	4.057	3.752	3.141	3.713	4.357	4.988	4.958	5.310	5.578
27.00	-29.25	7.306	6.705	5.908	4.855	4.148	3.640	4.076	4.805	6.044	6.794	7.615	7.793
27.05	-29.25	7.306	6.705	5.908	4.855	4.148	3.640	4.076	4.805	6.044	6.794	7.615	7.793
27.10	-29.25	7.281	6.713	5.873	4.835	4.140	3.632	4.073	4.794	6.013	6.736	7.535	7.738
27.15	-29.25	7.281	6.713	5.873	4.835	4.143	3.631	4.073	4.795	6.013	6.736	7.535	7.738

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.20	-29.25	7.177	6.622	5.811	4.782	4.127	3.611	4.058	4.773	5.980	6.643	7.491	7.629
27.25	-29.25	7.198	6.617	5.797	4.811	4.123	3.624	4.073	4.785	5.976	6.637	7.509	7.595
27.30	-29.25	7.198	6.617	5.797	4.811	4.123	3.624	4.073	4.785	5.976	6.637	7.509	7.595
27.35	-29.25	7.135	6.570	5.757	4.826	4.123	3.617	4.080	4.790	5.994	6.627	7.424	7.551
27.40	-29.25	7.135	6.570	5.757	4.826	4.122	3.609	4.079	4.790	5.994	6.627	7.424	7.551
27.45	-29.25	7.155	6.633	5.783	4.858	4.116	3.610	4.063	4.776	5.982	6.554	7.362	7.548
27.50	-29.25	7.157	6.630	5.755	4.843	3.980	3.406	3.823	4.723	5.955	6.551	7.306	7.485
27.55	-29.25	7.178	6.659	5.808	4.890	4.112	3.627	4.054	4.777	5.985	6.566	7.357	7.535
27.60	-29.25	7.241	6.680	5.835	4.848	4.079	3.483	3.988	4.707	5.910	6.537	7.271	7.549
27.65	-29.25	7.241	6.698	5.850	4.906	4.139	3.620	4.060	4.763	5.962	6.544	7.301	7.554
27.70	-29.25	7.140	6.675	5.829	4.893	4.129	3.603	4.047	4.762	5.936	6.526	7.279	7.504
27.75	-29.25	7.073	6.619	5.810	4.867	4.108	3.592	4.036	4.751	5.920	6.494	7.241	7.470
27.80	-29.25	7.054	6.619	5.812	4.867	4.118	3.595	4.044	4.752	5.920	6.497	7.244	7.470
27.85	-29.25	6.807	6.472	5.701	4.775	4.056	3.549	3.995	4.689	5.836	6.335	7.067	7.249
27.90	-29.25	6.868	6.518	5.714	4.776	4.058	3.549	4.012	4.692	5.836	6.337	7.095	7.306
27.95	-29.25	6.646	6.240	5.390	4.485	3.904	3.420	3.904	4.543	5.718	6.059	6.789	6.935
28.00	-29.25	6.680	6.202	5.380	4.418	3.845	3.367	3.841	4.426	5.691	6.133	6.820	6.926
28.05	-29.25	6.497	6.019	5.274	4.342	3.816	3.330	3.751	4.318	5.550	6.064	6.684	6.761
28.10	-29.25	6.617	6.212	5.307	4.449	3.777	3.213	3.639	4.509	5.691	6.202	6.876	6.950
28.15	-29.25	6.740	6.305	5.407	4.615	3.941	3.427	3.880	4.629	5.822	6.334	6.993	7.089
28.20	-29.25	6.703	6.298	5.480	4.643	3.914	3.419	3.840	4.639	5.843	6.399	7.085	7.171
28.25	-29.25	6.730	6.362	5.471	4.629	3.887	3.366	3.864	4.569	5.857	6.421	7.157	7.261
28.30	-29.25	6.585	6.012	5.242	4.372	3.603	3.226	3.646	4.295	5.605	6.231	6.916	7.020
28.35	-29.25	6.749	6.316	5.555	4.761	4.033	3.456	3.969	4.684	5.922	6.543	7.151	7.280
28.40	-29.25	6.903	6.431	5.625	4.830	4.034	3.460	3.969	4.762	6.004	6.565	7.237	7.380
28.45	-29.25	6.922	6.440	5.673	4.846	4.122	3.546	4.090	4.778	6.014	6.579	7.262	7.399
28.50	-29.25	6.892	6.511	5.706	4.867	4.138	3.678	4.114	4.806	5.937	6.510	7.226	7.381
28.55	-29.25	6.908	6.469	5.693	4.844	4.080	3.551	4.038	4.762	5.870	6.508	7.230	7.367
28.60	-29.25	6.835	6.428	5.648	4.828	4.057	3.576	4.005	4.727	5.906	6.475	7.168	7.281
28.65	-29.25	6.835	6.464	5.679	4.834	4.146	3.609	4.073	4.780	5.940	6.475	7.194	7.303
28.70	-29.25	6.865	6.478	5.686	4.844	4.131	3.640	4.142	4.793	5.943	6.608	7.268	7.359
28.75	-29.25	6.812	6.492	5.682	4.860	4.091	3.614	4.009	4.833	5.976	6.551	7.260	7.358
28.80	-29.25	6.834	6.519	5.743	4.894	4.150	3.614	4.084	4.845	6.056	6.636	7.301	7.398
28.85	-29.25	6.885	6.647	5.729	4.727	3.862	3.364	3.752	4.581	5.867	6.442	7.154	7.287
28.90	-29.25	6.861	6.647	5.716	4.773	3.972	3.364	3.778	4.642	5.903	6.440	7.103	7.242
28.95	-29.25	6.762	6.602	5.702	4.871	4.026	3.481	4.024	4.665	5.846	6.358	7.082	7.210
29.00	-29.25	6.696	6.458	5.638	4.757	3.837	3.324	3.669	4.528	5.626	6.311	6.964	7.086
29.05	-29.25	6.814	6.599	5.758	4.956	4.188	3.721	4.143	4.732	5.908	6.449	7.087	7.238
29.10	-29.25	6.747	6.432	5.653	4.884	4.171	3.619	3.986	4.643	5.770	6.280	6.941	7.163
29.15	-29.25	6.600	6.252	5.427	4.673	3.725	3.338	3.724	4.372	5.522	6.169	6.731	6.964
29.20	-29.25	6.347	6.087	5.325	4.545	3.591	3.193	3.504	4.125	5.416	5.882	6.731	6.835
29.25	-29.25	6.563	6.265	5.515	4.797	3.970	3.580	3.963	4.497	5.729	6.319	6.890	7.052
29.30	-29.25	6.561	6.239	5.552	4.823	4.114	3.687	4.065	4.542	5.720	6.341	6.920	7.030
29.35	-29.25	6.189	5.857	5.168	4.462	3.784	3.385	3.796	4.265	5.452	6.022	6.602	6.688
29.40	-29.25	6.195	5.876	5.234	4.513	3.882	3.489	3.811	4.307	5.506	6.040	6.551	6.663
29.45	-29.25	4.916	4.805	4.281	3.954	3.723	3.423	3.919	4.436	4.997	4.868	5.063	5.296
29.50	-29.25	5.135	5.094	4.536	4.098	3.845	3.506	3.920	4.479	5.099	4.971	5.253	5.476
27.05	-29.30	7.306	6.705	5.908	4.855	4.148	3.640	4.076	4.805	6.044	6.794	7.615	7.793
27.10	-29.30	6.867	6.533	5.881	4.737	4.107	3.609	4.086	4.814	6.102	6.388	7.375	7.894

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.15	-29.30	7.281	6.713	5.873	4.835	4.143	3.631	4.073	4.795	6.013	6.736	7.535	7.738
27.25	-29.30	7.198	6.617	5.797	4.811	4.122	3.624	4.073	4.785	5.976	6.636	7.509	7.595
27.30	-29.30	6.790	6.449	5.762	4.709	4.085	3.595	4.107	4.794	6.081	6.257	7.338	7.731
27.35	-29.30	7.135	6.570	5.757	4.825	4.112	3.609	4.074	4.789	5.994	6.626	7.424	7.551
27.45	-29.30	7.155	6.633	5.782	4.858	4.109	3.605	4.057	4.776	5.982	6.554	7.362	7.548
27.50	-29.30	6.749	6.512	5.812	4.798	4.086	3.603	4.118	4.798	6.074	6.205	7.232	7.665
27.55	-29.30	7.157	6.658	5.809	4.886	4.112	3.627	4.054	4.774	5.985	6.552	7.306	7.485
27.65	-29.30	7.244	6.700	5.850	4.906	4.134	3.620	4.060	4.761	5.962	6.544	7.301	7.554
27.70	-29.30	6.737	6.523	5.857	4.833	4.082	3.574	4.100	4.774	6.055	6.140	7.184	7.601
27.75	-29.30	7.053	6.619	5.813	4.847	4.113	3.595	4.044	4.743	5.919	6.481	7.231	7.423
27.85	-29.30	6.864	6.518	5.714	4.766	4.060	3.549	4.012	4.686	5.836	6.334	7.095	7.306
27.90	-29.30	6.434	6.307	5.744	4.641	3.888	3.428	3.961	4.632	5.927	5.931	6.968	7.400
27.95	-29.30	6.590	6.113	5.273	4.352	3.774	3.336	3.802	4.390	5.572	6.003	6.709	6.840
28.05	-29.30	6.701	6.247	5.370	4.411	3.590	3.087	3.447	4.341	5.675	6.080	6.841	6.956
28.10	-29.30	6.265	5.995	5.324	4.316	3.797	3.332	3.878	4.364	5.775	5.847	6.793	7.180
28.15	-29.30	6.740	6.305	5.420	4.615	4.000	3.516	3.985	4.648	5.828	6.335	7.011	7.137
28.25	-29.30	6.732	6.362	5.517	4.671	4.011	3.535	3.986	4.650	5.907	6.427	7.168	7.267
28.30	-29.30	6.255	6.075	5.371	4.494	3.773	3.271	3.880	4.555	5.891	5.969	6.949	7.318
28.35	-29.30	6.830	6.325	5.510	4.639	3.956	3.354	3.906	4.542	5.829	6.461	7.075	7.259
28.45	-29.30	6.900	6.336	5.613	4.797	4.021	3.577	3.987	4.705	5.915	6.556	7.201	7.299
28.50	-29.30	6.615	6.309	5.746	4.800	4.112	3.553	4.095	4.850	6.073	6.161	7.151	7.561
28.55	-29.30	6.916	6.510	5.716	4.904	4.138	3.678	4.102	4.818	5.953	6.528	7.232	7.410
28.65	-29.30	6.835	6.464	5.714	4.835	4.136	3.677	4.115	4.779	5.959	6.475	7.216	7.313
28.70	-29.30	6.567	6.254	5.720	4.726	4.212	3.719	4.223	4.842	6.112	6.280	7.168	7.587
28.75	-29.30	6.834	6.527	5.695	4.776	3.964	3.264	3.718	4.718	6.020	6.617	7.255	7.348
28.85	-29.30	6.843	6.616	5.702	4.851	4.067	3.591	3.976	4.676	5.888	6.382	7.047	7.241
28.90	-29.30	6.560	6.455	5.766	4.801	4.054	3.585	4.098	4.727	6.000	6.092	7.022	7.330
28.95	-29.30	6.727	6.570	5.722	4.905	4.156	3.590	4.111	4.739	5.846	6.350	7.062	7.167
29.05	-29.30	6.796	6.599	5.763	4.963	4.196	3.721	4.148	4.751	5.908	6.451	7.094	7.217
29.10	-29.30	6.530	6.353	5.721	4.865	4.213	3.656	4.198	4.732	5.930	5.992	6.960	7.438
29.15	-29.30	6.757	6.543	5.697	4.896	4.178	3.695	4.113	4.678	5.846	6.326	6.949	7.163
29.25	-29.30	6.561	6.238	5.499	4.749	3.834	3.459	3.798	4.430	5.700	6.269	6.885	7.030
29.30	-29.30	6.292	6.036	5.502	4.654	3.953	3.412	3.995	4.469	5.837	5.938	6.850	7.278
29.35	-29.30	6.194	5.857	5.249	4.540	4.003	3.601	3.954	4.348	5.504	5.997	6.515	6.666
29.45	-29.30	4.801	4.618	4.064	3.716	3.346	2.852	3.278	3.999	4.329	4.570	4.807	5.116
29.50	-29.30	4.756	4.749	4.417	3.774	3.707	3.093	3.795	4.282	4.991	4.376	5.018	5.334
27.00	-29.35	7.303	6.683	5.887	4.874	4.123	3.620	4.058	4.790	6.054	6.785	7.620	7.775
27.05	-29.35	7.303	6.683	5.887	4.872	4.119	3.620	4.058	4.788	6.054	6.785	7.619	7.775
27.10	-29.35	7.288	6.700	5.860	4.826	4.111	3.613	4.031	4.728	6.008	6.706	7.552	7.733
27.15	-29.35	7.288	6.699	5.870	4.857	4.124	3.614	4.056	4.785	6.018	6.710	7.562	7.733
27.20	-29.35	7.252	6.632	5.831	4.845	4.115	3.612	4.047	4.775	5.996	6.664	7.501	7.672
27.25	-29.35	7.153	6.577	5.751	4.852	4.114	3.599	4.049	4.783	5.992	6.637	7.440	7.579
27.30	-29.35	7.153	6.577	5.751	4.852	4.100	3.599	4.025	4.781	5.992	6.637	7.440	7.579
27.35	-29.35	7.145	6.588	5.747	4.860	4.093	3.577	4.042	4.756	5.967	6.587	7.399	7.562
27.40	-29.35	7.146	6.589	5.747	4.862	4.097	3.577	4.042	4.759	5.967	6.588	7.398	7.562
27.45	-29.35	7.191	6.667	5.829	4.874	4.116	3.601	4.050	4.763	5.982	6.568	7.411	7.594
27.50	-29.35	7.210	6.672	5.844	4.864	4.097	3.601	4.010	4.720	5.965	6.572	7.358	7.576
27.55	-29.35	7.210	6.671	5.855	4.862	4.047	3.520	3.942	4.736	5.960	6.572	7.358	7.576
27.60	-29.35	7.223	6.683	5.864	4.866	4.111	3.585	4.011	4.700	5.943	6.591	7.313	7.581

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.65	-29.35	7.222	6.681	5.865	4.892	4.125	3.585	4.032	4.753	5.943	6.589	7.313	7.581
27.70	-29.35	7.011	6.475	5.713	4.808	4.040	3.474	3.897	4.694	5.846	6.415	7.127	7.361
27.75	-29.35	6.942	6.440	5.645	4.750	3.902	3.451	3.878	4.595	5.797	6.315	7.035	7.268
27.80	-29.35	6.960	6.520	5.703	4.780	4.043	3.540	3.980	4.668	5.858	6.350	7.107	7.321
27.85	-29.35	6.814	6.349	5.512	4.591	3.940	3.458	3.927	4.559	5.781	6.225	6.955	7.092
27.90	-29.35	6.487	6.072	5.334	4.325	3.582	3.224	3.648	4.228	5.408	5.902	6.782	6.799
27.95	-29.35	6.769	6.311	5.514	4.566	3.786	3.101	3.732	4.477	5.813	6.272	7.015	7.128
28.00	-29.35	6.883	6.311	5.563	4.607	3.833	3.336	3.819	4.558	5.785	6.451	7.150	7.276
28.05	-29.35	6.861	6.275	5.545	4.621	3.923	3.292	3.777	4.575	5.819	6.435	7.123	7.223
28.10	-29.35	6.852	6.391	5.555	4.651	3.905	3.437	3.839	4.513	5.828	6.404	7.086	7.249
28.15	-29.35	6.872	6.347	5.611	4.670	3.927	3.370	3.864	4.582	5.841	6.442	7.165	7.255
28.20	-29.35	6.657	6.295	5.475	4.684	3.972	3.488	3.970	4.606	5.859	6.351	7.011	7.089
28.25	-29.35	6.708	6.307	5.470	4.700	3.980	3.471	3.962	4.604	5.852	6.389	7.104	7.186
28.30	-29.35	6.708	6.309	5.461	4.693	3.972	3.471	3.945	4.596	5.852	6.387	7.094	7.186
28.35	-29.35	6.729	6.304	5.491	4.751	4.031	3.600	4.027	4.715	5.952	6.493	7.187	7.237
28.40	-29.35	6.646	6.255	5.475	4.685	3.932	3.472	3.901	4.658	5.868	6.461	7.097	7.121
28.45	-29.35	6.758	6.321	5.507	4.770	4.038	3.642	4.072	4.764	5.980	6.487	7.188	7.273
28.50	-29.35	6.768	6.318	5.554	4.729	3.811	3.430	3.811	4.591	5.916	6.429	7.180	7.304
28.55	-29.35	6.675	6.256	5.535	4.652	3.917	3.318	3.775	4.652	5.903	6.394	7.188	7.295
28.60	-29.35	6.894	6.415	5.723	4.933	4.181	3.718	4.136	4.831	6.018	6.575	7.313	7.402
28.65	-29.35	6.887	6.412	5.716	4.900	4.184	3.680	4.117	4.835	6.001	6.560	7.313	7.402
28.70	-29.35	6.824	6.420	5.635	4.867	4.095	3.602	4.039	4.763	5.956	6.530	7.197	7.321
28.75	-29.35	6.852	6.508	5.746	4.875	4.194	3.599	4.139	4.827	5.992	6.558	7.277	7.377
28.80	-29.35	6.870	6.544	5.750	4.865	4.217	3.711	4.145	4.819	6.053	6.588	7.271	7.412
28.85	-29.35	6.645	6.333	5.527	4.724	3.935	3.504	3.958	4.516	5.709	6.184	6.869	7.023
28.90	-29.35	6.645	6.336	5.527	4.596	3.843	3.268	3.685	4.435	5.695	6.153	6.869	7.022
28.95	-29.35	6.511	6.338	5.399	4.558	3.807	3.292	3.701	4.443	5.615	6.068	6.664	6.852
29.00	-29.35	6.605	6.286	5.448	4.684	3.979	3.540	3.936	4.491	5.752	6.227	6.881	7.068
29.05	-29.35	6.644	6.351	5.539	4.757	4.106	3.664	4.113	4.649	5.813	6.297	7.005	7.140
29.10	-29.35	6.530	6.210	5.435	4.724	3.922	3.519	3.955	4.494	5.720	6.186	6.840	7.025
29.15	-29.35	6.485	6.179	5.423	4.613	3.888	3.377	3.903	4.381	5.617	6.149	6.786	6.944
29.20	-29.35	6.418	6.067	5.353	4.634	3.978	3.479	3.943	4.485	5.648	6.120	6.723	6.920
29.25	-29.35	6.482	6.135	5.385	4.629	3.936	3.467	3.835	4.385	5.658	6.196	6.825	6.955
29.30	-29.35	6.464	6.142	5.349	4.646	3.909	3.408	3.829	4.404	5.666	6.183	6.821	6.955
29.35	-29.35	5.842	5.647	5.031	4.468	3.988	3.602	3.942	4.327	5.478	5.819	6.293	6.403
29.40	-29.35	5.817	5.648	5.017	4.370	3.837	3.237	3.722	4.226	5.457	5.798	6.297	6.424
29.45	-29.35	5.452	5.370	4.817	4.345	3.879	3.517	3.889	4.524	5.269	5.294	5.643	5.790
29.50	-29.35	5.574	5.495	4.942	4.326	3.951	3.558	3.945	4.421	5.161	5.241	5.614	5.781
27.00	-29.40	6.961	6.459	5.906	4.798	4.097	3.596	4.077	4.807	6.142	6.435	7.459	7.964
27.05	-29.40	7.303	6.683	5.887	4.874	4.122	3.620	4.057	4.790	6.054	6.785	7.619	7.775
27.15	-29.40	7.288	6.700	5.869	4.857	4.115	3.613	4.043	4.785	6.018	6.710	7.562	7.733
27.20	-29.40	6.853	6.481	5.827	4.747	4.056	3.573	4.046	4.782	6.068	6.305	7.319	7.856
27.25	-29.40	7.153	6.577	5.751	4.852	4.114	3.599	4.051	4.784	5.992	6.637	7.440	7.579
27.35	-29.40	7.146	6.589	5.747	4.862	4.098	3.577	4.042	4.759	5.967	6.588	7.399	7.562
27.40	-29.40	6.717	6.440	5.757	4.775	4.040	3.542	4.074	4.774	6.045	6.246	7.191	7.715
27.45	-29.40	7.192	6.668	5.829	4.874	4.113	3.601	4.050	4.763	5.982	6.571	7.411	7.594
27.55	-29.40	7.210	6.672	5.855	4.884	4.112	3.601	4.032	4.759	5.965	6.574	7.358	7.576
27.60	-29.40	6.798	6.554	5.884	4.825	4.096	3.550	4.089	4.772	6.041	6.232	7.227	7.683
27.65	-29.40	7.222	6.681	5.865	4.887	4.119	3.585	4.028	4.749	5.943	6.589	7.313	7.581

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.75	-29.40	6.964	6.521	5.703	4.780	4.043	3.540	3.980	4.668	5.859	6.352	7.107	7.321
27.80	-29.40	6.555	6.360	5.738	4.693	3.980	3.505	4.046	4.683	5.985	5.974	6.969	7.353
27.85	-29.40	6.748	6.257	5.422	4.415	3.806	3.372	3.823	4.435	5.676	6.094	6.944	7.071
27.95	-29.40	6.748	6.309	5.507	4.603	3.929	3.426	3.907	4.600	5.813	6.256	6.993	7.124
28.00	-29.40	6.355	5.911	5.447	4.355	3.736	3.135	3.872	4.440	5.705	5.972	6.897	7.153
28.05	-29.40	6.871	6.338	5.591	4.719	4.040	3.552	3.991	4.684	5.883	6.452	7.149	7.269
28.15	-29.40	6.852	6.396	5.636	4.707	4.050	3.455	4.006	4.648	5.861	6.486	7.139	7.196
28.20	-29.40	6.202	6.020	5.380	4.508	3.761	3.296	3.899	4.511	5.885	5.906	6.894	7.149
28.25	-29.40	6.708	6.309	5.470	4.700	3.984	3.471	3.962	4.605	5.852	6.389	7.104	7.186
28.35	-29.40	6.704	6.301	5.493	4.716	4.033	3.600	4.043	4.702	5.947	6.475	7.187	7.212
28.40	-29.40	6.333	6.082	5.460	4.603	4.036	3.553	4.148	4.718	6.056	6.137	7.044	7.325
28.45	-29.40	6.728	6.282	5.463	4.679	3.903	3.514	3.900	4.602	5.896	6.448	7.173	7.256
28.55	-29.40	6.742	6.306	5.465	4.769	3.961	3.530	3.960	4.740	5.896	6.408	7.132	7.243
28.60	-29.40	6.581	6.152	5.673	4.740	4.067	3.547	4.027	4.733	6.018	6.136	7.186	7.510
28.65	-29.40	6.894	6.413	5.727	4.913	4.184	3.718	4.152	4.835	6.016	6.576	7.313	7.402
28.75	-29.40	6.867	6.508	5.699	4.734	4.067	3.328	3.964	4.636	5.915	6.538	7.277	7.377
28.80	-29.40	6.588	6.342	5.678	4.650	3.938	3.294	3.821	4.634	6.026	6.198	7.188	7.585
28.85	-29.40	6.668	6.415	5.597	4.758	4.072	3.606	4.070	4.593	5.786	6.213	6.934	7.082
28.95	-29.40	6.548	6.294	5.472	4.577	3.727	3.255	3.605	4.392	5.527	6.084	6.836	6.975
29.00	-29.40	6.301	6.096	5.364	4.591	4.134	3.624	4.182	4.620	5.822	5.826	6.838	7.265
29.05	-29.40	6.509	6.214	5.422	4.594	3.799	3.278	3.682	4.444	5.542	6.196	6.881	6.979
29.15	-29.40	6.545	6.317	5.468	4.736	3.922	3.519	3.955	4.507	5.764	6.203	6.903	7.086
29.20	-29.40	6.116	5.817	5.320	4.512	4.027	3.433	4.078	4.492	5.791	5.755	6.763	7.120
29.25	-29.40	6.448	6.113	5.399	4.693	4.070	3.631	4.019	4.448	5.714	6.204	6.813	6.917
29.35	-29.40	5.844	5.651	5.036	4.480	3.992	3.602	3.942	4.334	5.478	5.819	6.307	6.431
29.40	-29.40	5.533	5.434	4.915	4.128	3.873	3.190	3.723	4.280	5.552	5.387	6.249	6.594
29.45	-29.40	5.396	5.306	4.735	4.175	3.620	3.272	3.569	4.242	5.101	5.170	5.621	5.718
27.00	-29.45	7.215	6.684	5.860	4.843	4.098	3.605	4.036	4.783	6.025	6.742	7.583	7.786
27.05	-29.45	7.215	6.683	5.859	4.843	4.098	3.605	4.035	4.783	6.025	6.742	7.583	7.786
27.10	-29.45	7.246	6.666	5.881	4.843	4.089	3.597	4.035	4.780	5.994	6.698	7.543	7.746
27.15	-29.45	7.247	6.666	5.881	4.843	4.089	3.602	4.035	4.780	5.994	6.698	7.543	7.746
27.20	-29.45	7.249	6.634	5.854	4.855	4.108	3.599	4.031	4.764	5.980	6.684	7.522	7.721
27.25	-29.45	7.262	6.657	5.836	4.853	4.090	3.576	4.028	4.743	5.989	6.667	7.501	7.663
27.30	-29.45	7.262	6.639	5.822	4.829	4.073	3.570	4.004	4.684	5.981	6.663	7.466	7.653
27.35	-29.45	7.305	6.733	5.866	4.912	4.113	3.577	4.034	4.730	5.975	6.673	7.472	7.664
27.40	-29.45	7.287	6.723	5.858	4.885	4.110	3.579	4.034	4.723	5.971	6.657	7.411	7.611
27.45	-29.45	7.203	6.644	5.837	4.850	4.103	3.556	4.013	4.708	5.945	6.554	7.356	7.573
27.50	-29.45	7.232	6.648	5.833	4.877	4.095	3.570	4.006	4.719	5.949	6.539	7.279	7.561
27.55	-29.45	7.231	6.646	5.835	4.875	4.098	3.573	4.013	4.717	5.949	6.542	7.283	7.561
27.60	-29.45	7.181	6.657	5.814	4.844	4.065	3.540	3.989	4.698	5.886	6.447	7.209	7.493
27.65	-29.45	7.181	6.657	5.814	4.844	4.065	3.540	3.989	4.698	5.886	6.447	7.209	7.492
27.70	-29.45	7.027	6.471	5.678	4.742	4.011	3.505	3.942	4.640	5.846	6.372	7.078	7.339
27.75	-29.45	6.979	6.437	5.609	4.678	3.978	3.478	3.913	4.604	5.819	6.347	7.050	7.315
27.80	-29.45	6.848	6.124	5.355	4.374	3.596	2.862	3.392	4.240	5.576	6.206	6.807	7.071
27.85	-29.45	6.882	6.227	5.460	4.575	3.970	3.485	3.930	4.570	5.743	6.355	6.966	7.147
27.90	-29.45	6.840	6.166	5.417	4.411	3.696	3.120	3.693	4.387	5.573	6.267	6.895	7.014
27.95	-29.45	6.820	6.277	5.457	4.603	3.887	3.367	3.874	4.537	5.819	6.328	7.068	7.187
28.00	-29.45	6.789	6.223	5.486	4.634	4.010	3.520	3.971	4.619	5.864	6.402	7.090	7.222
28.05	-29.45	6.731	6.202	5.464	4.622	3.927	3.397	3.884	4.617	5.816	6.356	7.083	7.162

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
28.10	-29.45	6.874	6.358	5.628	4.729	4.058	3.602	4.034	4.739	5.913	6.509	7.201	7.284
28.15	-29.45	6.888	6.358	5.650	4.744	4.060	3.602	4.037	4.739	5.927	6.522	7.256	7.341
28.20	-29.45	6.745	6.311	5.595	4.585	3.821	3.243	3.672	4.545	5.777	6.400	7.155	7.298
28.25	-29.45	6.855	6.402	5.656	4.703	3.782	3.231	3.698	4.543	5.919	6.570	7.251	7.370
28.30	-29.45	6.801	6.390	5.656	4.807	4.079	3.619	4.053	4.701	5.951	6.573	7.251	7.331
28.35	-29.45	6.580	6.213	5.429	4.668	3.858	3.446	3.927	4.552	5.846	6.331	7.056	7.122
28.40	-29.45	6.604	6.289	5.428	4.689	3.936	3.446	3.925	4.608	5.867	6.375	7.064	7.122
28.45	-29.45	6.512	6.143	5.350	4.546	3.818	3.173	3.827	4.394	5.789	6.277	7.058	7.053
28.50	-29.45	6.660	6.221	5.464	4.809	4.100	3.679	4.083	4.778	6.002	6.483	7.196	7.244
28.55	-29.45	6.661	6.224	5.470	4.816	4.111	3.679	4.099	4.787	6.002	6.486	7.205	7.244
28.60	-29.45	6.800	6.306	5.560	4.724	4.003	3.462	3.942	4.590	5.926	6.514	7.222	7.254
28.65	-29.45	6.774	6.291	5.553	4.826	4.134	3.668	4.113	4.808	6.003	6.513	7.179	7.236
28.70	-29.45	6.878	6.468	5.758	4.963	4.201	3.719	4.158	4.836	6.033	6.500	7.248	7.355
28.75	-29.45	6.853	6.509	5.757	4.934	4.175	3.712	4.125	4.807	6.016	6.482	7.208	7.277
28.80	-29.45	6.832	6.502	5.749	4.905	4.164	3.712	4.125	4.772	6.016	6.465	7.193	7.277
28.85	-29.45	6.737	6.443	5.635	4.768	3.884	3.434	3.894	4.566	5.786	6.252	6.961	7.085
28.90	-29.45	6.704	6.408	5.610	4.722	3.937	3.434	3.950	4.522	5.699	6.221	6.945	7.041
28.95	-29.45	6.643	6.347	5.589	4.732	3.890	3.388	3.883	4.488	5.790	6.202	6.925	7.052
29.00	-29.45	6.473	6.206	5.438	4.649	3.850	3.263	3.687	4.370	5.726	6.147	6.840	6.935
29.05	-29.45	6.487	6.208	5.475	4.665	3.898	3.263	3.815	4.355	5.754	6.161	6.850	6.935
29.10	-29.45	6.296	5.864	5.228	4.521	3.808	3.273	3.723	4.196	5.579	5.993	6.631	6.715
29.15	-29.45	6.149	5.859	5.220	4.416	3.805	3.219	3.691	4.135	5.572	5.896	6.602	6.522
29.20	-29.45	6.219	5.890	5.211	4.573	3.953	3.369	3.773	4.168	5.584	6.046	6.641	6.737
29.25	-29.45	5.796	5.522	4.951	4.425	3.957	3.446	3.863	4.217	5.432	5.846	6.310	6.331
29.30	-29.45	5.798	5.523	4.912	4.396	3.849	3.345	3.723	4.195	5.391	5.809	6.312	6.374
29.35	-29.45	5.532	5.409	4.902	4.459	3.999	3.629	4.021	4.566	5.315	5.334	5.732	5.768
29.40	-29.45	5.451	5.326	4.789	4.200	3.508	2.906	3.383	4.115	5.084	5.214	5.668	5.676
29.45	-29.45	5.636	5.598	4.996	4.459	4.000	3.614	3.976	4.526	5.235	5.214	5.681	5.812
29.50	-29.45	6.035	5.884	5.223	4.501	3.875	3.264	3.804	4.436	5.234	5.357	5.885	6.077
27.05	-29.50	7.231	6.695	5.871	4.844	4.091	3.601	4.029	4.780	6.017	6.732	7.575	7.794
27.10	-29.50	6.919	6.486	5.869	4.756	4.050	3.565	4.051	4.802	6.075	6.364	7.396	7.971
27.15	-29.50	7.259	6.662	5.868	4.842	4.088	3.601	4.035	4.779	6.001	6.705	7.549	7.757
27.25	-29.50	7.300	6.658	5.882	4.879	4.086	3.576	3.999	4.735	5.990	6.689	7.513	7.696
27.30	-29.50	6.910	6.521	5.917	4.806	4.058	3.541	4.042	4.760	6.060	6.342	7.385	7.915
27.35	-29.50	7.288	6.723	5.874	4.889	4.095	3.556	3.999	4.702	5.945	6.625	7.436	7.632
27.45	-29.50	7.318	6.691	5.877	4.864	4.088	3.546	4.000	4.708	5.955	6.577	7.366	7.649
27.50	-29.50	6.982	6.550	5.909	4.806	4.036	3.495	4.029	4.722	6.001	6.149	7.176	7.705
27.55	-29.50	7.298	6.690	5.861	4.873	4.081	3.530	3.967	4.698	5.915	6.549	7.304	7.604
27.65	-29.50	7.039	6.554	5.710	4.734	4.002	3.470	3.931	4.613	5.829	6.332	7.081	7.363
27.70	-29.50	6.700	6.338	5.633	4.598	3.938	3.450	4.005	4.646	5.968	5.986	7.020	7.438
27.75	-29.50	6.887	6.351	5.538	4.495	3.850	3.249	3.733	4.481	5.736	6.256	7.024	7.287
27.85	-29.50	6.557	6.034	5.322	4.136	3.599	3.215	3.603	4.198	5.425	5.999	6.813	7.063
27.90	-29.50	6.546	6.194	5.553	4.478	3.810	3.304	3.781	4.570	5.911	6.012	6.957	7.429
27.95	-29.50	6.783	6.297	5.538	4.620	3.902	3.387	3.869	4.508	5.820	6.336	7.000	7.172
28.05	-29.50	6.850	6.330	5.554	4.642	3.831	3.348	3.762	4.542	5.785	6.387	7.134	7.262
28.10	-29.50	6.330	5.995	5.549	4.394	3.897	3.298	3.847	4.600	5.939	5.979	7.035	7.388
28.15	-29.50	6.838	6.338	5.629	4.753	4.049	3.554	3.986	4.737	5.934	6.512	7.229	7.335
28.25	-29.50	6.851	6.407	5.600	4.759	4.030	3.592	4.030	4.669	5.926	6.505	7.215	7.305
28.30	-29.50	6.486	6.192	5.528	4.644	3.955	3.326	3.964	4.664	5.950	6.128	7.054	7.384

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
28.35	-29.50	6.629	6.273	5.450	4.602	3.800	3.420	3.838	4.528	5.799	6.313	7.019	7.108
28.45	-29.50	6.492	6.115	5.396	4.625	3.908	3.360	3.925	4.519	5.818	6.310	7.058	7.080
28.50	-29.50	6.216	5.903	5.400	4.612	4.053	3.596	4.135	4.696	6.051	6.068	6.924	7.335
28.55	-29.50	6.558	6.204	5.431	4.729	4.042	3.637	4.047	4.707	5.974	6.418	7.141	7.204
28.65	-29.50	6.713	6.304	5.555	4.788	4.125	3.579	4.013	4.741	5.918	6.490	7.177	7.242
28.70	-29.50	6.515	6.172	5.594	4.667	3.876	3.263	3.772	4.616	5.780	6.031	7.010	7.302
28.75	-29.50	6.701	6.429	5.680	4.889	4.141	3.700	4.110	4.737	5.941	6.450	7.076	7.121
28.85	-29.50	6.803	6.484	5.700	4.874	4.135	3.665	4.093	4.702	5.879	6.337	7.011	7.153
28.90	-29.50	6.506	6.255	5.625	4.766	4.138	3.634	4.157	4.736	5.951	5.955	6.948	7.214
28.95	-29.50	6.779	6.437	5.667	4.824	4.098	3.638	4.069	4.602	5.797	6.278	6.978	7.117
29.05	-29.50	6.761	6.445	5.649	4.837	4.075	3.610	4.028	4.579	5.822	6.306	6.964	7.094
29.10	-29.50	6.139	5.860	5.430	4.615	4.065	3.543	4.030	4.487	5.897	5.892	6.831	7.161
29.15	-29.50	6.388	6.074	5.467	4.734	4.056	3.489	3.926	4.414	5.760	6.271	6.859	6.946
29.25	-29.50	5.664	5.450	4.858	4.427	3.984	3.524	3.897	4.357	5.435	5.798	6.190	6.189
29.30	-29.50	5.414	5.241	4.857	4.299	4.028	3.482	4.032	4.452	5.606	5.422	6.208	6.453
29.35	-29.50	5.400	5.181	4.736	4.213	3.576	3.144	3.600	4.354	5.177	5.262	5.613	5.612
29.45	-29.50	5.690	5.641	5.062	4.343	3.864	3.504	3.875	4.404	5.149	5.144	5.657	5.837
29.50	-29.50	5.577	5.670	5.117	4.405	3.945	3.422	3.929	4.444	5.261	4.866	5.747	5.929
27.00	-29.55	7.228	6.694	5.871	4.838	4.087	3.592	4.029	4.776	6.017	6.730	7.575	7.794
27.05	-29.55	7.231	6.695	5.871	4.843	4.091	3.601	4.029	4.780	6.017	6.732	7.575	7.794
27.10	-29.55	7.259	6.663	5.867	4.842	4.087	3.594	4.035	4.779	6.001	6.706	7.549	7.757
27.15	-29.55	7.259	6.663	5.867	4.842	4.084	3.594	4.030	4.779	6.001	6.706	7.549	7.757
27.20	-29.55	7.287	6.636	5.887	4.873	4.110	3.591	4.023	4.751	5.982	6.695	7.529	7.726
27.25	-29.55	7.300	6.658	5.885	4.880	4.091	3.576	4.007	4.736	5.990	6.689	7.517	7.696
27.30	-29.55	7.300	6.658	5.888	4.880	4.102	3.580	4.022	4.736	5.990	6.693	7.518	7.696
27.35	-29.55	7.308	6.725	5.872	4.899	4.090	3.553	3.988	4.708	5.945	6.625	7.436	7.640
27.40	-29.55	7.308	6.725	5.874	4.899	4.098	3.556	3.999	4.708	5.945	6.628	7.436	7.640
27.45	-29.55	7.315	6.691	5.877	4.854	4.088	3.546	3.999	4.704	5.954	6.574	7.366	7.649
27.50	-29.55	7.298	6.688	5.862	4.873	4.076	3.530	3.967	4.696	5.915	6.550	7.304	7.604
27.55	-29.55	7.286	6.680	5.805	4.844	4.077	3.530	3.968	4.689	5.902	6.533	7.285	7.604
27.60	-29.55	7.041	6.555	5.709	4.731	3.994	3.468	3.926	4.611	5.829	6.331	7.081	7.363
27.65	-29.55	7.010	6.554	5.699	4.721	3.985	3.468	3.912	4.594	5.829	6.323	7.049	7.296
27.70	-29.55	7.062	6.533	5.635	4.691	3.953	3.413	3.833	4.645	5.841	6.394	7.135	7.347
27.75	-29.55	7.002	6.446	5.589	4.588	3.813	3.169	3.616	4.497	5.810	6.359	7.080	7.341
27.80	-29.55	7.007	6.446	5.596	4.676	3.977	3.464	3.919	4.613	5.832	6.368	7.080	7.341
27.85	-29.55	6.965	6.415	5.592	4.666	4.004	3.519	3.940	4.614	5.856	6.417	7.119	7.378
27.90	-29.55	6.940	6.337	5.544	4.671	3.887	3.433	3.865	4.595	5.804	6.393	7.082	7.323
27.95	-29.55	6.863	6.342	5.551	4.629	3.914	3.387	3.886	4.537	5.820	6.350	7.086	7.288
28.00	-29.55	6.887	6.374	5.561	4.666	3.980	3.436	3.893	4.599	5.848	6.409	7.161	7.313
28.05	-29.55	6.850	6.296	5.440	4.479	3.824	3.268	3.684	4.362	5.686	6.326	7.014	7.262
28.10	-29.55	6.779	6.246	5.511	4.581	3.892	3.474	3.844	4.501	5.796	6.415	7.067	7.242
28.15	-29.55	6.755	6.288	5.564	4.619	3.874	3.384	3.743	4.566	5.831	6.469	7.180	7.230
28.20	-29.55	6.928	6.500	5.695	4.815	4.025	3.498	3.910	4.708	5.921	6.538	7.260	7.334
28.25	-29.55	6.878	6.441	5.620	4.726	3.756	3.141	3.683	4.520	5.937	6.525	7.244	7.322
28.30	-29.55	6.777	6.336	5.558	4.671	3.903	3.499	3.942	4.583	5.880	6.434	7.183	7.263
28.35	-29.55	6.657	6.314	5.487	4.690	3.857	3.420	3.887	4.595	5.883	6.334	7.046	7.170
28.40	-29.55	6.667	6.314	5.472	4.683	3.813	3.448	3.899	4.580	5.861	6.330	7.046	7.170
28.45	-29.55	6.534	6.114	5.353	4.640	3.809	3.388	3.854	4.502	5.841	6.326	7.020	7.074
28.50	-29.55	6.525	6.161	5.412	4.716	3.975	3.508	3.971	4.672	5.898	6.397	7.121	7.149

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
28.55	-29.55	6.504	6.161	5.388	4.717	3.954	3.508	3.937	4.672	5.898	6.339	7.121	7.102
28.60	-29.55	6.725	6.189	5.491	4.644	3.841	3.283	3.783	4.558	5.751	6.423	7.064	7.115
28.65	-29.55	6.761	6.343	5.583	4.837	4.132	3.681	4.115	4.791	6.009	6.495	7.194	7.246
28.70	-29.55	6.903	6.485	5.702	4.956	4.159	3.603	4.020	4.813	6.016	6.504	7.222	7.358
28.75	-29.55	6.835	6.504	5.657	4.829	4.018	3.572	3.945	4.604	5.895	6.391	7.050	7.202
28.80	-29.55	6.851	6.540	5.692	4.895	4.148	3.700	4.121	4.750	5.940	6.450	7.073	7.188
28.85	-29.55	6.628	6.332	5.595	4.643	3.848	3.280	3.916	4.464	5.608	6.236	6.812	6.926
28.90	-29.55	6.774	6.480	5.698	4.836	4.127	3.665	4.099	4.687	5.874	6.320	7.002	7.147
28.95	-29.55	6.773	6.468	5.667	4.852	4.096	3.638	4.069	4.611	5.856	6.292	6.978	7.080
29.00	-29.55	6.731	6.442	5.651	4.831	4.073	3.610	4.038	4.573	5.822	6.293	6.967	7.088
29.05	-29.55	6.714	6.369	5.552	4.675	3.939	3.490	3.871	4.364	5.702	6.229	6.843	7.025
29.10	-29.55	6.358	5.955	5.394	4.634	3.922	3.505	3.844	4.302	5.634	6.178	6.792	6.882
29.15	-29.55	6.383	6.046	5.390	4.721	4.013	3.489	3.934	4.414	5.711	6.199	6.793	6.946
29.20	-29.55	6.248	5.904	5.256	4.558	3.789	3.175	3.586	4.122	5.615	6.087	6.717	6.784
29.25	-29.55	5.685	5.450	4.889	4.425	3.977	3.479	3.846	4.347	5.445	5.815	6.220	6.248
29.30	-29.55	5.640	5.416	4.810	4.413	3.965	3.479	3.835	4.326	5.418	5.797	6.148	6.161
29.35	-29.55	5.400	5.269	4.749	4.296	3.962	3.458	3.966	4.517	5.218	5.251	5.627	5.612
29.40	-29.55	5.433	5.286	4.799	4.346	3.972	3.601	4.010	4.539	5.291	5.306	5.655	5.668
29.45	-29.55	5.802	5.714	5.119	4.510	3.962	3.494	3.939	4.523	5.181	5.236	5.733	5.892
29.50	-29.55	5.880	5.800	5.163	4.546	3.966	3.490	3.870	4.548	5.249	5.299	5.772	5.963
27.00	-29.60	6.959	6.499	5.925	4.772	4.021	3.525	4.022	4.788	6.042	6.409	7.385	8.079
27.05	-29.60	7.299	6.698	5.915	4.851	4.084	3.563	4.022	4.762	5.987	6.729	7.552	7.837
27.15	-29.60	7.297	6.670	5.885	4.862	4.077	3.557	4.008	4.731	5.956	6.682	7.543	7.784
27.20	-29.60	6.973	6.587	5.922	4.780	4.050	3.520	4.039	4.751	6.074	6.333	7.360	7.979
27.25	-29.60	7.333	6.796	5.933	4.891	4.102	3.553	4.011	4.731	5.998	6.711	7.530	7.780
27.35	-29.60	7.280	6.724	5.912	4.863	4.083	3.547	3.987	4.661	5.895	6.539	7.446	7.637
27.40	-29.60	7.013	6.610	5.971	4.825	4.053	3.517	4.056	4.723	6.061	6.252	7.331	7.853
27.45	-29.60	7.315	6.746	5.871	4.850	4.073	3.525	3.972	4.688	5.920	6.570	7.400	7.619
27.55	-29.60	7.222	6.688	5.822	4.809	4.050	3.508	3.950	4.664	5.887	6.519	7.292	7.533
27.65	-29.60	7.182	6.640	5.726	4.728	3.935	3.433	3.870	4.583	5.850	6.537	7.233	7.534
27.75	-29.60	6.961	6.452	5.613	4.642	3.834	3.357	3.754	4.528	5.759	6.347	7.160	7.414
27.85	-29.60	6.744	6.182	5.391	4.430	3.541	2.986	3.349	4.249	5.479	6.076	6.880	7.176
27.95	-29.60	6.616	6.192	5.342	4.484	3.738	3.179	3.697	4.427	5.679	6.128	6.858	7.038
28.05	-29.60	6.724	6.230	5.395	4.479	3.741	3.249	3.670	4.383	5.731	6.225	6.960	7.154
28.15	-29.60	6.717	6.210	5.342	4.431	3.607	3.205	3.508	4.275	5.603	6.336	7.001	7.195
28.25	-29.60	6.686	6.313	5.368	4.582	3.819	3.387	3.802	4.407	5.776	6.222	7.059	7.144
28.35	-29.60	6.552	6.112	5.371	4.559	3.858	3.461	3.876	4.485	5.782	6.193	6.983	7.103
28.45	-29.60	6.502	6.137	5.394	4.651	3.948	3.513	3.973	4.531	5.857	6.292	7.014	7.123
28.55	-29.60	6.467	6.122	5.398	4.679	3.949	3.430	3.987	4.565	5.849	6.315	7.031	7.081
28.65	-29.60	6.481	6.069	5.270	4.664	3.939	3.541	3.960	4.645	5.955	6.340	6.958	7.036
28.75	-29.60	6.838	6.435	5.655	4.746	4.018	3.584	3.940	4.541	5.879	6.368	6.977	7.178
28.85	-29.60	6.769	6.348	5.620	4.311	3.183	2.434	3.023	4.129	5.552	6.260	6.921	7.083
28.95	-29.60	6.476	6.074	5.343	4.491	3.815	3.214	3.663	4.323	5.597	6.027	6.723	6.876
29.05	-29.60	6.400	6.077	5.369	4.643	3.888	3.388	3.814	4.401	5.608	6.006	6.699	6.857
29.15	-29.60	6.101	5.810	5.142	4.538	3.868	3.434	3.761	4.312	5.567	5.896	6.453	6.620
29.25	-29.60	5.457	5.337	4.761	4.402	3.979	3.493	3.875	4.442	5.341	5.509	5.792	5.836
29.35	-29.60	5.503	5.388	4.910	4.364	3.881	3.362	3.802	4.482	5.267	5.273	5.619	5.672
29.45	-29.60	5.846	5.706	5.127	4.433	3.875	3.456	3.799	4.413	5.121	5.237	5.692	5.900
27.00	-29.65	7.299	6.698	5.915	4.851	4.085	3.563	4.022	4.762	5.987	6.729	7.552	7.837

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.05	-29.65	7.148	6.613	5.685	4.678	3.788	3.268	3.682	4.565	5.800	6.588	7.302	7.587
27.10	-29.65	7.303	6.671	5.885	4.865	4.081	3.557	4.008	4.733	5.956	6.684	7.544	7.784
27.15	-29.65	7.303	6.671	5.885	4.865	4.081	3.557	4.008	4.733	5.956	6.684	7.543	7.784
27.20	-29.65	7.318	6.748	5.904	4.877	4.095	3.554	4.014	4.729	5.992	6.685	7.532	7.777
27.25	-29.65	7.333	6.796	5.933	4.891	4.102	3.553	4.010	4.731	5.998	6.711	7.530	7.780
27.30	-29.65	7.333	6.796	5.933	4.891	4.102	3.552	4.010	4.731	5.998	6.711	7.530	7.780
27.35	-29.65	7.342	6.777	5.923	4.891	4.084	3.547	4.001	4.712	5.982	6.614	7.481	7.709
27.40	-29.65	7.346	6.764	5.912	4.894	4.083	3.547	3.987	4.708	5.981	6.616	7.446	7.650
27.45	-29.65	7.314	6.744	5.871	4.850	4.070	3.525	3.972	4.686	5.920	6.569	7.400	7.619
27.50	-29.65	7.222	6.689	5.822	4.809	4.051	3.508	3.950	4.664	5.888	6.519	7.292	7.533
27.55	-29.65	7.068	6.596	5.607	4.625	3.764	3.217	3.607	4.471	5.712	6.375	7.044	7.287
27.60	-29.65	7.205	6.647	5.770	4.783	4.048	3.516	3.939	4.646	5.874	6.550	7.258	7.568
27.65	-29.65	7.205	6.694	5.775	4.815	4.049	3.516	3.939	4.689	5.898	6.550	7.278	7.591
27.70	-29.65	7.092	6.573	5.717	4.798	4.034	3.511	3.958	4.711	5.896	6.504	7.232	7.523
27.75	-29.65	7.004	6.504	5.707	4.750	3.995	3.481	3.941	4.656	5.845	6.412	7.190	7.469
27.80	-29.65	6.790	6.307	5.479	4.513	3.627	3.110	3.493	4.419	5.530	6.172	7.026	7.240
27.85	-29.65	6.744	6.279	5.520	4.641	3.891	3.309	3.839	4.521	5.709	6.173	6.973	7.176
27.90	-29.65	6.779	6.326	5.563	4.667	3.956	3.393	3.870	4.563	5.783	6.222	6.945	7.185
27.95	-29.65	6.577	6.055	5.291	4.398	3.673	3.179	3.681	4.324	5.582	6.077	6.774	6.967
28.00	-29.65	6.733	6.276	5.477	4.594	3.886	3.285	3.771	4.560	5.818	6.290	6.990	7.185
28.05	-29.65	6.637	6.092	5.326	4.361	3.479	3.012	3.374	4.255	5.504	6.144	6.830	7.094
28.10	-29.65	6.737	6.248	5.426	4.584	3.765	3.376	3.717	4.466	5.812	6.380	7.001	7.237
28.15	-29.65	6.742	6.298	5.469	4.648	3.883	3.467	3.818	4.577	5.831	6.391	7.088	7.277
28.20	-29.65	6.816	6.361	5.615	4.747	4.024	3.585	4.003	4.669	5.858	6.435	7.119	7.205
28.25	-29.65	6.597	6.232	5.196	4.230	3.357	2.851	3.221	4.159	5.507	6.142	6.810	6.943
28.30	-29.65	6.686	6.253	5.412	4.709	3.953	3.417	3.860	4.570	5.799	6.268	7.002	7.087
28.35	-29.65	6.677	6.244	5.448	4.750	4.008	3.503	3.952	4.631	5.874	6.330	7.069	7.180
28.40	-29.65	6.632	6.204	5.417	4.667	3.853	3.112	3.751	4.497	5.799	6.245	7.021	7.129
28.45	-29.65	6.530	6.142	5.414	4.724	3.959	3.513	3.989	4.588	5.890	6.314	7.034	7.139
28.50	-29.65	6.489	6.158	5.401	4.694	3.990	3.534	4.009	4.605	5.916	6.325	7.046	7.122
28.55	-29.65	6.364	6.050	5.325	4.484	3.570	3.231	3.655	4.317	5.768	6.215	6.989	7.068
28.60	-29.65	6.481	6.069	5.273	4.664	4.018	3.541	3.960	4.691	5.955	6.342	6.969	7.036
28.65	-29.65	6.458	5.993	5.231	4.500	3.695	3.249	3.603	4.471	5.811	6.276	6.890	7.020
28.70	-29.65	6.789	6.341	5.609	4.833	4.140	3.697	4.104	4.741	5.991	6.439	7.106	7.207
28.75	-29.65	6.759	6.360	5.675	4.744	4.011	3.608	3.991	4.586	5.874	6.373	7.038	7.144
28.80	-29.65	6.913	6.513	5.751	4.936	4.160	3.710	4.116	4.785	5.983	6.468	7.123	7.253
28.85	-29.65	6.784	6.459	5.709	4.878	4.106	3.638	4.075	4.698	5.846	6.312	6.986	7.145
28.90	-29.65	6.576	6.299	5.399	4.609	3.890	3.293	3.714	4.501	5.590	6.070	6.691	6.825
28.95	-29.65	6.476	6.074	5.344	4.686	3.883	3.444	3.876	4.447	5.632	6.027	6.723	6.876
29.00	-29.65	6.447	6.098	5.315	4.579	3.682	3.178	3.576	4.278	5.637	6.005	6.707	6.897
29.05	-29.65	6.400	6.077	5.338	4.628	3.842	3.388	3.774	4.370	5.608	5.955	6.685	6.829
29.10	-29.65	6.123	5.834	5.203	4.544	3.992	3.544	3.914	4.342	5.617	5.950	6.500	6.641
29.15	-29.65	6.130	5.844	5.209	4.581	4.004	3.544	3.915	4.356	5.625	5.960	6.514	6.652
29.20	-29.65	5.968	5.735	5.150	4.572	4.028	3.580	3.895	4.314	5.542	5.902	6.349	6.484
29.25	-29.65	5.458	5.251	4.731	4.310	3.645	3.141	3.570	4.232	5.254	5.491	5.787	5.836
29.30	-29.65	5.400	5.237	4.748	4.253	3.724	3.382	3.710	4.259	5.285	5.454	5.795	5.836
29.35	-29.65	5.322	5.096	4.661	3.972	3.544	3.230	3.607	4.072	5.020	5.069	5.442	5.509
29.40	-29.65	5.480	5.397	4.910	4.393	3.967	3.576	3.974	4.508	5.270	5.273	5.619	5.667
29.45	-29.65	5.865	5.732	5.177	4.481	3.896	3.468	3.836	4.477	5.171	5.277	5.692	5.906

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
29.50	-29.65	5.928	5.806	5.202	4.520	3.996	3.555	3.932	4.495	5.181	5.331	5.778	5.984
27.05	-29.70	7.316	6.730	5.886	4.824	4.056	3.547	4.005	4.724	5.963	6.723	7.533	7.816
27.10	-29.70	7.071	6.572	5.905	4.774	4.016	3.525	4.003	4.737	6.058	6.368	7.425	8.034
27.15	-29.70	7.354	6.754	5.907	4.858	4.074	3.550	4.004	4.713	5.982	6.706	7.589	7.835
27.25	-29.70	7.362	6.815	5.883	4.869	3.975	3.458	3.907	4.639	5.935	6.678	7.475	7.751
27.30	-29.70	7.074	6.632	5.947	4.822	4.019	3.499	4.022	4.708	6.067	6.368	7.370	7.948
27.35	-29.70	7.320	6.723	5.869	4.827	4.052	3.494	3.914	4.671	5.940	6.610	7.454	7.726
27.45	-29.70	7.288	6.754	5.856	4.823	4.076	3.527	3.964	4.685	5.931	6.574	7.435	7.644
27.50	-29.70	6.871	6.531	5.827	4.680	3.959	3.434	3.978	4.636	5.997	6.138	7.176	7.622
27.55	-29.70	7.161	6.685	5.777	4.746	4.018	3.484	3.931	4.641	5.877	6.485	7.302	7.538
27.65	-29.70	7.111	6.592	5.685	4.710	3.874	3.273	3.696	4.625	5.805	6.486	7.215	7.499
27.70	-29.70	6.661	6.358	5.738	4.664	3.918	3.426	3.955	4.619	5.949	5.998	7.015	7.584
27.75	-29.70	6.705	6.296	5.491	4.559	3.802	3.252	3.812	4.459	5.683	6.144	6.875	7.191
27.85	-29.70	6.385	5.937	5.153	4.336	3.512	3.063	3.545	4.287	5.584	5.889	6.638	6.874
27.90	-29.70	5.972	5.618	5.155	4.104	3.495	3.035	3.715	4.228	5.725	5.425	6.471	6.825
27.95	-29.70	6.694	6.204	5.478	4.644	3.941	3.443	3.858	4.542	5.824	6.382	7.096	7.269
28.05	-29.70	6.661	6.191	5.436	4.638	3.821	3.364	3.736	4.540	5.796	6.370	7.140	7.221
28.10	-29.70	6.396	5.969	5.498	4.457	3.650	3.088	3.581	4.487	6.021	6.137	7.044	7.480
28.15	-29.70	6.719	6.248	5.539	4.760	4.045	3.601	4.005	4.736	5.999	6.538	7.256	7.335
28.25	-29.70	6.648	6.198	5.264	4.289	3.291	2.364	2.971	4.109	5.255	6.076	6.755	7.082
28.30	-29.70	6.560	6.158	5.638	4.623	3.856	3.391	3.883	4.553	5.898	5.977	7.070	7.419
28.35	-29.70	6.754	6.399	5.492	4.679	3.860	3.412	3.825	4.477	5.814	6.285	7.005	7.233
28.45	-29.70	6.578	6.222	5.311	4.472	3.530	3.203	3.599	4.224	5.624	6.221	6.969	7.166
28.50	-29.70	6.252	5.924	5.371	4.527	3.855	3.411	4.011	4.495	5.910	5.811	6.772	7.268
28.55	-29.70	6.552	6.229	5.414	4.639	3.907	3.387	3.866	4.456	5.810	6.226	6.965	7.156
28.65	-29.70	6.401	5.993	5.328	4.645	4.015	3.609	4.003	4.644	5.928	6.334	6.991	7.041
28.70	-29.70	6.576	6.263	5.607	4.756	4.055	3.506	4.058	4.773	6.029	6.014	7.060	7.283
28.75	-29.70	6.924	6.538	5.708	4.884	4.025	3.551	3.969	4.671	5.923	6.419	7.104	7.218
28.85	-29.70	6.745	6.351	5.534	4.676	3.795	3.403	3.760	4.428	5.668	6.133	6.843	7.010
28.90	-29.70	6.330	5.881	5.337	4.503	3.948	3.261	3.800	4.563	5.745	5.668	6.604	6.910
28.95	-29.70	6.374	6.034	5.291	4.549	3.951	3.440	3.836	4.346	5.596	5.959	6.643	6.838
29.05	-29.70	6.358	5.955	5.331	4.581	3.967	3.418	3.771	4.361	5.635	6.025	6.634	6.843
29.10	-29.70	5.253	5.166	4.803	4.188	3.972	3.439	3.989	4.388	5.511	5.302	6.040	6.245
29.15	-29.70	5.610	5.420	4.871	4.391	3.946	3.528	3.881	4.355	5.439	5.706	6.116	6.187
29.25	-29.70	5.710	5.642	4.844	3.985	3.029	2.419	2.693	3.728	4.880	5.212	5.702	5.919
29.30	-29.70	5.341	5.499	5.044	4.247	3.925	3.420	3.955	4.414	5.388	4.917	5.773	5.973
29.35	-29.70	5.888	5.803	5.164	4.575	3.935	3.482	3.874	4.511	5.247	5.297	5.847	5.953
29.45	-29.70	6.020	5.857	5.230	4.563	3.961	3.555	3.937	4.522	5.194	5.330	5.817	6.040
29.50	-29.70	5.732	5.719	5.256	4.449	4.053	3.461	4.005	4.506	5.246	4.931	5.747	5.986
27.00	-29.75	7.298	6.732	5.846	4.811	4.042	3.538	3.998	4.695	5.943	6.652	7.511	7.786
27.05	-29.75	7.298	6.732	5.846	4.809	4.039	3.538	3.998	4.693	5.943	6.652	7.511	7.786
27.10	-29.75	7.341	6.760	5.898	4.840	4.048	3.531	3.970	4.674	5.951	6.684	7.581	7.840
27.15	-29.75	7.342	6.760	5.899	4.851	4.063	3.537	3.992	4.698	5.951	6.684	7.581	7.840
27.20	-29.75	7.324	6.760	5.884	4.828	4.047	3.516	3.964	4.676	5.944	6.655	7.486	7.759
27.25	-29.75	7.380	6.817	5.909	4.864	4.064	3.522	3.977	4.686	5.965	6.669	7.512	7.800
27.30	-29.75	7.380	6.817	5.909	4.864	4.064	3.522	3.977	4.686	5.965	6.669	7.512	7.800
27.35	-29.75	7.270	6.673	5.821	4.771	4.037	3.497	3.933	4.601	5.875	6.591	7.375	7.635
27.40	-29.75	7.115	6.574	5.584	4.639	3.692	3.215	3.636	4.409	5.701	6.451	7.158	7.425
27.45	-29.75	7.274	6.729	5.800	4.767	4.051	3.440	3.873	4.664	5.934	6.594	7.443	7.668

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.50	-29.75	7.107	6.601	5.709	4.693	3.976	3.458	3.894	4.590	5.858	6.463	7.253	7.506
27.55	-29.75	7.031	6.508	5.654	4.620	3.868	3.379	3.827	4.512	5.798	6.382	7.195	7.450
27.60	-29.75	7.101	6.561	5.722	4.758	4.039	3.499	3.940	4.691	5.887	6.498	7.315	7.563
27.65	-29.75	7.035	6.412	5.648	4.543	3.901	3.230	3.696	4.505	5.724	6.435	7.222	7.505
27.70	-29.75	6.519	6.095	5.175	4.214	3.446	2.997	3.360	3.993	5.403	5.825	6.661	6.925
27.75	-29.75	6.466	6.045	5.220	4.205	3.237	2.399	2.891	4.028	5.532	5.856	6.690	6.902
27.80	-29.75	6.505	6.095	5.258	4.420	3.731	3.174	3.697	4.382	5.627	5.926	6.666	6.910
27.85	-29.75	6.630	6.206	5.473	4.547	3.870	3.291	3.800	4.463	5.676	6.132	6.980	7.171
27.90	-29.75	6.688	6.253	5.492	4.578	3.878	3.360	3.819	4.505	5.759	6.216	6.987	7.207
27.95	-29.75	6.778	6.265	5.554	4.699	4.008	3.509	3.916	4.601	5.896	6.534	7.242	7.357
28.00	-29.75	6.752	6.266	5.545	4.712	3.994	3.512	3.932	4.635	5.914	6.518	7.262	7.333
28.05	-29.75	6.752	6.266	5.546	4.708	3.966	3.425	3.838	4.633	5.913	6.519	7.262	7.333
28.10	-29.75	6.651	6.234	5.550	4.697	4.015	3.563	3.942	4.649	5.882	6.435	7.251	7.312
28.15	-29.75	6.729	6.285	5.569	4.754	4.021	3.563	3.952	4.699	5.968	6.524	7.271	7.372
28.20	-29.75	6.840	6.413	5.613	4.645	3.701	3.163	3.532	4.503	5.906	6.407	7.169	7.283
28.25	-29.75	6.772	6.353	5.526	4.605	3.902	3.433	3.805	4.465	5.718	6.264	7.021	7.234
28.30	-29.75	6.850	6.401	5.642	4.758	3.842	3.118	3.645	4.540	5.893	6.372	7.142	7.292
28.35	-29.75	6.415	6.032	5.178	4.413	3.487	3.151	3.561	4.219	5.472	6.029	6.674	6.795
28.40	-29.75	6.639	6.253	5.471	4.671	3.908	3.460	3.922	4.541	5.806	6.209	6.963	7.112
28.45	-29.75	6.368	6.000	5.302	4.501	3.867	3.411	3.831	4.405	5.652	6.090	6.856	6.922
28.50	-29.75	6.302	5.994	5.250	4.487	3.851	3.348	3.740	4.411	5.678	6.073	6.764	6.922
28.55	-29.75	6.320	5.919	5.243	4.375	3.697	3.083	3.642	4.266	5.547	6.079	6.744	6.823
28.60	-29.75	6.411	5.992	5.322	4.491	3.761	3.150	3.535	4.473	5.824	6.276	6.874	6.979
28.65	-29.75	6.437	5.989	5.369	4.517	3.639	3.129	3.552	4.404	5.825	6.296	6.937	7.008
28.70	-29.75	6.641	6.301	5.504	4.702	3.951	3.532	3.899	4.596	5.900	6.319	6.956	7.069
28.75	-29.75	6.826	6.441	5.703	4.870	4.135	3.670	4.066	4.701	5.911	6.452	7.112	7.151
28.80	-29.75	6.834	6.367	5.645	4.846	3.995	3.569	3.968	4.654	5.898	6.387	7.070	7.134
28.85	-29.75	6.775	6.309	5.497	4.537	3.651	3.056	3.565	4.284	5.592	6.154	6.875	7.065
28.90	-29.75	6.620	6.309	5.534	4.617	3.933	3.339	3.770	4.466	5.664	6.085	6.864	7.037
28.95	-29.75	6.291	5.979	5.210	4.535	3.746	3.139	3.515	4.310	5.557	6.003	6.622	6.860
29.00	-29.75	6.308	5.954	5.293	4.644	4.022	3.588	3.888	4.450	5.669	6.072	6.654	6.829
29.05	-29.75	6.277	5.931	5.218	4.602	3.960	3.491	3.787	4.420	5.623	6.049	6.578	6.763
29.10	-29.75	5.648	5.474	4.930	4.469	3.969	3.601	3.956	4.502	5.414	5.658	6.036	6.085
29.15	-29.75	5.574	5.389	4.877	4.338	3.704	3.243	3.538	4.313	5.187	5.474	5.945	6.000
29.20	-29.75	5.602	5.504	4.926	4.346	3.847	3.471	3.837	4.358	5.254	5.297	5.706	5.778
29.25	-29.75	5.813	5.742	5.091	4.472	3.913	3.470	3.872	4.502	5.260	5.371	5.825	5.952
29.30	-29.75	5.813	5.745	5.098	4.487	3.978	3.577	3.977	4.522	5.303	5.371	5.828	5.952
29.35	-29.75	5.992	5.835	5.167	4.382	3.741	3.235	3.723	4.212	5.133	5.328	5.866	6.065
29.40	-29.75	6.020	5.929	5.268	4.592	4.002	3.547	3.976	4.525	5.235	5.394	5.914	6.105
29.45	-29.75	6.002	5.877	5.250	4.546	3.948	3.482	3.887	4.507	5.171	5.317	5.841	6.046
29.50	-29.75	5.954	5.849	5.230	4.559	3.964	3.521	3.900	4.493	5.149	5.287	5.777	5.990
27.05	-29.80	7.298	6.732	5.846	4.811	4.041	3.538	3.998	4.695	5.943	6.652	7.511	7.786
27.15	-29.80	7.341	6.759	5.899	4.846	4.060	3.536	3.991	4.694	5.951	6.684	7.581	7.840
27.25	-29.80	7.380	6.817	5.909	4.864	4.064	3.522	3.977	4.686	5.965	6.669	7.512	7.800
27.35	-29.80	7.270	6.721	5.835	4.821	4.052	3.499	3.953	4.655	5.925	6.594	7.412	7.679
27.45	-29.80	7.133	6.633	5.723	4.611	3.936	3.251	3.708	4.544	5.841	6.476	7.379	7.613
27.55	-29.80	6.895	6.267	5.455	4.341	3.603	3.173	3.596	4.218	5.581	6.231	6.996	7.253
27.65	-29.80	7.103	6.561	5.712	4.747	4.028	3.497	3.918	4.662	5.887	6.499	7.282	7.541
27.75	-29.80	6.505	6.095	5.297	4.437	3.731	3.249	3.767	4.383	5.651	5.923	6.640	6.910

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.85	-29.80	6.688	6.253	5.459	4.570	3.878	3.282	3.746	4.505	5.735	6.219	6.953	7.195
27.95	-29.80	6.757	6.280	5.493	4.693	3.987	3.422	3.819	4.630	5.882	6.517	7.237	7.371
28.05	-29.80	6.745	6.264	5.546	4.682	3.993	3.512	3.936	4.624	5.909	6.514	7.262	7.333
28.15	-29.80	6.729	6.282	5.568	4.711	3.844	3.349	3.800	4.600	5.968	6.524	7.280	7.372
28.25	-29.80	6.772	6.353	5.571	4.661	3.909	3.453	3.842	4.476	5.774	6.271	7.100	7.232
28.35	-29.80	6.446	6.091	5.338	4.427	3.580	3.102	3.517	4.309	5.501	6.074	6.759	6.870
28.45	-29.80	6.342	5.958	5.192	4.433	3.739	3.237	3.632	4.274	5.610	6.052	6.701	6.859
28.55	-29.80	6.334	5.942	5.248	4.471	3.702	3.230	3.592	4.387	5.642	6.104	6.784	6.898
28.65	-29.80	6.437	5.996	5.382	4.621	4.036	3.608	4.003	4.625	5.840	6.296	6.937	7.032
28.75	-29.80	6.826	6.441	5.703	4.895	4.132	3.670	4.066	4.736	5.971	6.453	7.112	7.151
28.85	-29.80	6.797	6.383	5.645	4.803	4.074	3.623	4.028	4.587	5.729	6.234	6.920	7.092
28.95	-29.80	6.102	5.674	4.988	4.398	3.689	3.228	3.559	4.237	5.328	5.859	6.394	6.580
29.05	-29.80	6.308	5.951	5.293	4.644	4.012	3.588	3.891	4.446	5.669	6.070	6.654	6.829
29.15	-29.80	5.574	5.360	4.764	4.230	3.601	3.243	3.519	4.099	5.187	5.474	5.855	5.994
29.25	-29.80	5.813	5.745	5.095	4.502	3.983	3.577	3.977	4.527	5.303	5.371	5.818	5.951
29.35	-29.80	6.020	5.929	5.267	4.592	4.002	3.547	3.972	4.522	5.235	5.395	5.914	6.105
29.45	-29.80	6.017	5.877	5.267	4.582	3.961	3.535	3.935	4.529	5.182	5.330	5.850	6.055
27.00	-29.85	7.313	6.714	5.842	4.804	4.043	3.525	3.967	4.683	5.953	6.647	7.553	7.767
27.05	-29.85	7.313	6.714	5.831	4.799	4.028	3.518	3.942	4.675	5.953	6.642	7.544	7.767
27.10	-29.85	7.294	6.702	5.803	4.769	4.025	3.507	3.964	4.666	5.924	6.618	7.519	7.728
27.15	-29.85	7.276	6.702	5.782	4.755	4.023	3.471	3.936	4.665	5.910	6.603	7.505	7.714
27.20	-29.85	7.339	6.769	5.882	4.793	3.958	3.423	3.865	4.639	5.925	6.672	7.552	7.811
27.25	-29.85	7.224	6.635	5.810	4.636	3.932	3.421	3.870	4.555	5.850	6.572	7.477	7.744
27.30	-29.85	7.298	6.722	5.809	4.778	4.048	3.495	3.955	4.675	5.890	6.655	7.475	7.744
27.35	-29.85	7.216	6.607	5.783	4.796	3.943	3.389	3.779	4.611	5.892	6.623	7.396	7.587
27.40	-29.85	7.347	6.771	5.900	4.852	4.055	3.438	3.884	4.690	5.969	6.718	7.582	7.832
27.45	-29.85	7.198	6.630	5.748	4.739	4.052	3.488	3.927	4.636	5.812	6.517	7.401	7.627
27.50	-29.85	7.060	6.322	5.560	4.488	3.631	3.199	3.587	4.299	5.589	6.341	7.096	7.432
27.55	-29.85	7.209	6.628	5.837	4.769	4.030	3.486	3.925	4.657	5.866	6.524	7.377	7.691
27.60	-29.85	7.004	6.423	5.708	4.667	3.858	3.358	3.795	4.502	5.747	6.366	7.179	7.478
27.65	-29.85	7.051	6.516	5.767	4.750	3.987	3.438	3.898	4.609	5.806	6.416	7.238	7.538
27.70	-29.85	6.655	6.220	5.381	4.462	3.736	3.214	3.722	4.289	5.593	6.011	6.775	7.105
27.75	-29.85	6.613	6.237	5.454	4.430	3.691	3.177	3.675	4.292	5.619	6.047	6.849	7.176
27.80	-29.85	6.767	6.333	5.503	4.529	3.678	3.176	3.656	4.337	5.670	6.119	6.903	7.253
27.85	-29.85	6.896	6.423	5.663	4.779	4.000	3.491	3.903	4.670	5.869	6.492	7.269	7.539
27.90	-29.85	6.872	6.373	5.638	4.723	3.848	3.369	3.739	4.601	5.785	6.486	7.241	7.510
27.95	-29.85	6.729	6.256	5.584	4.729	4.000	3.494	3.908	4.652	5.906	6.501	7.280	7.416
28.00	-29.85	6.674	6.239	5.502	4.613	3.901	3.432	3.776	4.483	5.877	6.412	7.197	7.355
28.05	-29.85	6.752	6.240	5.587	4.703	4.048	3.517	3.937	4.653	5.893	6.530	7.269	7.370
28.10	-29.85	6.757	6.291	5.565	4.706	3.995	3.516	3.932	4.640	5.912	6.373	7.179	7.330
28.15	-29.85	6.780	6.264	5.553	4.690	3.991	3.516	3.917	4.601	5.873	6.378	7.150	7.305
28.20	-29.85	6.831	6.412	5.654	4.746	3.876	3.387	3.798	4.622	5.955	6.405	7.187	7.356
28.25	-29.85	6.883	6.448	5.650	4.828	4.085	3.539	3.937	4.705	5.882	6.385	7.140	7.345
28.30	-29.85	6.771	6.321	5.477	4.093	3.066	2.160	2.709	3.748	5.512	6.234	7.047	7.286
28.35	-29.85	6.748	6.340	5.581	4.594	3.753	3.096	3.666	4.360	5.751	6.232	7.018	7.245
28.40	-29.85	6.760	6.343	5.675	4.763	3.962	3.422	3.887	4.615	5.766	6.299	7.106	7.245
28.45	-29.85	6.584	6.283	5.525	4.600	3.882	3.420	3.764	4.429	5.781	6.252	7.005	7.171
28.50	-29.85	6.554	6.284	5.577	4.701	3.973	3.515	3.912	4.568	5.841	6.290	7.019	7.127
28.55	-29.85	6.563	6.286	5.577	4.685	3.977	3.463	3.871	4.566	5.836	6.294	7.019	7.127

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
28.60	-29.85	6.781	6.400	5.565	4.719	3.954	3.534	3.875	4.496	5.902	6.372	6.959	7.093
28.65	-29.85	6.668	6.155	5.287	4.152	3.238	2.685	2.885	3.946	5.405	6.291	6.829	7.014
28.70	-29.85	6.837	6.506	5.655	4.690	3.791	3.026	3.639	4.428	5.848	6.412	7.042	7.203
28.75	-29.85	6.844	6.514	5.674	4.816	4.048	3.617	3.989	4.621	5.848	6.340	7.013	7.183
28.80	-29.85	6.789	6.402	5.597	4.722	3.903	3.517	3.882	4.520	5.777	6.278	6.928	7.117
28.85	-29.85	6.452	6.041	5.155	4.237	3.527	3.121	3.383	3.899	5.281	5.737	6.436	6.741
28.90	-29.85	6.580	6.191	5.407	4.569	3.877	3.467	3.796	4.358	5.571	5.965	6.684	6.897
28.95	-29.85	6.101	5.782	5.165	4.398	3.888	3.531	3.835	4.405	5.555	5.833	6.412	6.568
29.00	-29.85	6.220	5.861	5.250	4.541	3.873	3.512	3.829	4.396	5.591	5.977	6.505	6.612
29.05	-29.85	6.308	5.954	5.304	4.607	4.013	3.612	3.934	4.499	5.655	6.034	6.503	6.586
29.10	-29.85	6.015	5.756	5.153	4.437	3.798	3.186	3.612	4.327	5.420	5.669	6.127	6.274
29.15	-29.85	6.027	5.758	5.147	4.521	3.973	3.515	3.903	4.401	5.408	5.683	6.123	6.274
29.20	-29.85	5.768	5.678	5.082	4.486	3.953	3.563	3.954	4.498	5.276	5.334	5.789	5.882
29.25	-29.85	5.870	5.805	5.145	4.519	3.977	3.552	3.948	4.498	5.233	5.337	5.849	5.980
29.30	-29.85	5.870	5.805	5.145	4.519	3.974	3.552	3.948	4.497	5.233	5.337	5.849	5.980
29.35	-29.85	6.020	5.940	5.243	4.541	3.931	3.435	3.820	4.471	5.186	5.384	5.888	6.124
29.40	-29.85	6.036	5.944	5.283	4.566	3.984	3.530	3.923	4.475	5.217	5.396	5.908	6.153
29.45	-29.85	5.930	5.833	5.237	4.497	3.949	3.498	3.900	4.431	5.122	5.259	5.763	6.007
29.50	-29.85	5.955	5.849	5.242	4.507	3.946	3.495	3.879	4.417	5.074	5.191	5.683	5.913
27.05	-29.90	7.313	6.714	5.842	4.804	4.043	3.524	3.967	4.683	5.953	6.647	7.553	7.767
27.10	-29.90	6.945	6.507	5.839	4.679	3.970	3.483	3.984	4.700	6.006	6.307	7.326	7.897
27.15	-29.90	7.297	6.703	5.803	4.780	4.028	3.507	3.964	4.672	5.924	6.619	7.519	7.728
27.25	-29.90	7.316	6.728	5.854	4.796	4.034	3.493	3.932	4.669	5.934	6.664	7.524	7.800
27.30	-29.90	6.794	6.355	5.539	4.451	3.454	3.003	3.460	4.387	5.630	6.019	7.170	7.675
27.35	-29.90	7.362	6.772	5.898	4.842	4.041	3.389	3.906	4.653	5.958	6.729	7.582	7.832
27.45	-29.90	7.244	6.655	5.825	4.745	4.048	3.488	3.927	4.636	5.832	6.600	7.401	7.680
27.50	-29.90	6.867	6.424	5.792	4.657	3.969	3.441	3.952	4.672	5.947	6.164	7.222	7.821
27.55	-29.90	7.215	6.628	5.835	4.772	4.015	3.485	3.904	4.647	5.868	6.528	7.377	7.691
27.65	-29.90	7.027	6.480	5.709	4.726	3.916	3.358	3.806	4.569	5.758	6.400	7.179	7.478
27.70	-29.90	6.276	6.016	5.444	4.372	3.566	3.167	3.830	4.283	5.743	5.580	6.660	7.107
27.75	-29.90	6.613	6.237	5.454	4.541	3.741	3.177	3.675	4.375	5.635	6.106	6.849	7.149
27.85	-29.90	6.892	6.420	5.638	4.746	3.823	3.285	3.750	4.592	5.847	6.479	7.250	7.539
27.90	-29.90	6.382	5.918	5.341	4.162	3.521	3.081	3.479	4.063	5.411	5.826	6.759	7.383
27.95	-29.90	6.724	6.256	5.564	4.696	3.997	3.494	3.906	4.643	5.897	6.490	7.280	7.416
28.05	-29.90	6.758	6.290	5.597	4.755	4.051	3.558	3.937	4.706	5.963	6.531	7.294	7.422
28.10	-29.90	6.407	5.965	5.469	4.502	3.828	3.394	3.884	4.514	5.966	5.959	6.971	7.454
28.15	-29.90	6.780	6.294	5.563	4.730	4.000	3.516	3.930	4.650	5.914	6.378	7.178	7.330
28.25	-29.90	6.908	6.484	5.688	4.660	3.666	3.129	3.534	4.393	5.873	6.402	7.188	7.407
28.30	-29.90	6.614	6.290	5.705	4.792	4.071	3.493	4.011	4.726	6.025	5.973	7.088	7.530
28.35	-29.90	6.778	6.379	5.691	4.776	4.023	3.541	3.956	4.618	5.842	6.314	7.049	7.238
28.45	-29.90	6.479	6.103	5.349	4.346	3.586	2.844	3.425	4.183	5.543	6.182	6.825	6.951
28.50	-29.90	6.211	5.942	5.491	4.433	3.815	3.331	3.841	4.386	5.757	5.831	6.778	7.185
28.55	-29.90	6.411	6.177	5.510	4.555	3.837	3.360	3.790	4.426	5.757	6.168	6.955	7.062
28.65	-29.90	6.623	6.193	5.284	4.458	3.536	3.194	3.505	4.198	5.559	6.217	6.695	6.931
28.70	-29.90	6.555	6.350	5.655	4.724	4.045	3.561	4.069	4.732	6.024	6.024	6.939	7.317
28.75	-29.90	6.784	6.403	5.606	4.722	3.909	3.517	3.893	4.514	5.777	6.280	6.951	7.120
28.85	-29.90	6.540	6.125	5.297	4.389	3.713	3.121	3.560	4.166	5.327	5.881	6.601	6.855
28.90	-29.90	6.252	5.981	5.387	4.353	3.606	3.196	3.613	4.316	5.639	5.617	6.593	6.967
28.95	-29.90	6.213	5.862	5.221	4.499	3.904	3.513	3.782	4.339	5.580	5.948	6.527	6.631

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
29.05	-29.90	6.332	5.971	5.323	4.658	4.013	3.612	3.934	4.539	5.678	6.045	6.578	6.675
29.10	-29.90	5.683	5.540	5.128	4.380	3.988	3.359	3.990	4.479	5.504	5.282	5.956	6.383
29.15	-29.90	6.028	5.760	5.153	4.548	3.979	3.515	3.912	4.437	5.427	5.684	6.127	6.274
29.25	-29.90	5.852	5.779	5.085	4.283	3.563	3.049	3.535	4.198	5.122	5.322	5.814	5.948
29.30	-29.90	5.564	5.595	5.128	4.400	4.026	3.479	4.015	4.472	5.309	4.874	5.693	5.927
29.35	-29.90	6.036	5.948	5.289	4.576	3.988	3.530	3.929	4.498	5.217	5.397	5.918	6.153
29.45	-29.90	5.903	5.761	5.187	4.414	3.793	3.067	3.605	4.324	5.073	5.227	5.728	5.973
29.50	-29.90	5.648	5.748	5.304	4.396	4.040	3.435	3.971	4.428	5.093	4.812	5.644	5.848
27.00	-29.95	7.309	6.711	5.853	4.803	4.017	3.490	3.922	4.665	5.911	6.650	7.502	7.738
27.05	-29.95	7.309	6.712	5.870	4.809	4.036	3.496	3.947	4.671	5.911	6.653	7.545	7.753
27.10	-29.95	7.312	6.726	5.884	4.789	4.029	3.498	3.930	4.675	5.934	6.642	7.536	7.777
27.15	-29.95	7.312	6.726	5.890	4.790	4.044	3.502	3.953	4.677	5.934	6.647	7.571	7.777
27.20	-29.95	7.354	6.724	5.860	4.790	4.047	3.489	3.945	4.684	5.926	6.652	7.525	7.769
27.25	-29.95	7.385	6.761	5.888	4.805	4.045	3.516	3.945	4.667	5.961	6.697	7.577	7.818
27.30	-29.95	7.385	6.759	5.895	4.815	4.045	3.516	3.945	4.684	5.961	6.701	7.577	7.818
27.35	-29.95	7.433	6.759	5.927	4.889	4.087	3.501	3.955	4.699	5.949	6.739	7.587	7.866
27.40	-29.95	7.432	6.758	5.928	4.888	4.085	3.502	3.957	4.698	5.949	6.739	7.586	7.865
27.45	-29.95	7.220	6.627	5.807	4.794	3.992	3.425	3.857	4.638	5.861	6.510	7.377	7.651
27.50	-29.95	7.070	6.515	5.752	4.729	3.930	3.420	3.866	4.573	5.781	6.391	7.214	7.510
27.55	-29.95	7.074	6.515	5.749	4.738	3.930	3.420	3.862	4.579	5.781	6.392	7.214	7.510
27.60	-29.95	6.684	6.205	5.449	4.445	3.730	3.257	3.762	4.384	5.614	6.016	6.848	7.129
27.65	-29.95	6.601	6.156	5.412	4.378	3.589	3.145	3.590	4.291	5.531	5.994	6.760	7.005
27.70	-29.95	6.773	6.280	5.497	4.543	3.888	3.379	3.806	4.489	5.685	6.191	7.007	7.348
27.75	-29.95	6.837	6.323	5.552	4.582	3.788	3.299	3.670	4.500	5.710	6.340	7.114	7.418
27.80	-29.95	6.814	6.331	5.569	4.618	3.931	3.320	3.828	4.554	5.761	6.326	7.088	7.389
27.85	-29.95	6.837	6.298	5.561	4.687	3.893	3.410	3.746	4.609	5.826	6.420	7.245	7.456
27.90	-29.95	6.826	6.296	5.550	4.671	3.887	3.410	3.746	4.634	5.815	6.403	7.243	7.456
27.95	-29.95	6.895	6.392	5.668	4.803	3.957	3.421	3.783	4.706	5.896	6.468	7.337	7.544
28.00	-29.95	6.954	6.481	5.752	4.864	4.088	3.561	3.952	4.702	5.990	6.544	7.323	7.587
28.05	-29.95	6.875	6.423	5.586	4.687	3.868	3.117	3.624	4.563	5.866	6.435	7.204	7.532
28.10	-29.95	6.886	6.430	5.718	4.821	4.021	3.482	3.877	4.668	5.885	6.397	7.242	7.476
28.15	-29.95	6.861	6.387	5.685	4.786	4.067	3.451	3.959	4.656	5.824	6.368	7.215	7.418
28.20	-29.95	7.005	6.544	5.768	4.742	3.546	2.439	3.145	4.419	5.909	6.499	7.260	7.513
28.25	-29.95	7.040	6.611	5.871	4.936	4.088	3.590	3.976	4.687	5.935	6.483	7.253	7.497
28.30	-29.95	6.868	6.444	5.601	4.737	3.857	3.264	3.638	4.553	5.715	6.326	6.975	7.219
28.35	-29.95	7.032	6.663	5.891	4.921	4.092	3.604	3.978	4.668	5.847	6.437	7.220	7.510
28.40	-29.95	7.006	6.619	5.900	4.874	3.821	3.122	3.625	4.537	5.801	6.407	7.198	7.458
28.45	-29.95	6.700	6.342	5.617	4.731	3.995	3.510	3.865	4.582	5.723	6.227	6.926	7.156
28.50	-29.95	6.658	6.292	5.585	4.721	4.043	3.542	3.880	4.583	5.742	6.208	6.892	7.075
28.55	-29.95	6.697	6.312	5.549	4.430	3.420	2.900	3.161	4.204	5.617	6.144	6.892	7.114
28.60	-29.95	6.698	6.312	5.474	4.591	3.672	3.253	3.551	4.403	5.613	6.252	6.877	7.132
28.65	-29.95	6.672	6.307	5.496	4.717	3.962	3.417	3.832	4.622	5.778	6.272	6.915	7.072
28.70	-29.95	6.737	6.448	5.579	4.577	3.761	3.239	3.617	4.416	5.647	6.156	6.931	7.185
28.75	-29.95	6.844	6.583	5.682	4.787	4.033	3.606	3.969	4.598	5.790	6.217	6.904	7.154
28.80	-29.95	6.852	6.478	5.618	4.759	3.904	3.508	3.875	4.523	5.728	6.200	6.922	7.200
28.85	-29.95	6.531	6.152	5.346	4.493	3.632	3.163	3.450	4.278	5.516	5.946	6.588	6.859
28.90	-29.95	6.533	6.136	5.386	4.522	3.767	3.163	3.515	4.415	5.536	5.953	6.594	6.845
28.95	-29.95	6.448	6.170	5.427	4.651	3.978	3.458	3.874	4.483	5.535	5.952	6.484	6.712
29.00	-29.95	6.356	6.130	5.394	4.644	4.016	3.569	3.931	4.491	5.561	5.872	6.348	6.585

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
29.05	-29.95	6.383	6.132	5.397	4.670	4.029	3.569	3.938	4.524	5.561	5.892	6.389	6.635
29.10	-29.95	6.346	6.113	5.357	4.658	4.029	3.565	3.972	4.543	5.482	5.729	6.278	6.517
29.15	-29.95	6.371	6.115	5.359	4.658	4.027	3.565	3.973	4.545	5.482	5.733	6.281	6.527
29.20	-29.95	6.262	6.068	5.329	4.591	3.990	3.539	3.942	4.447	5.282	5.572	6.124	6.358
29.25	-29.95	6.291	6.107	5.291	4.510	3.875	3.423	3.785	4.325	5.254	5.540	6.108	6.389
29.30	-29.95	6.324	6.140	5.364	4.608	3.999	3.535	3.934	4.480	5.305	5.596	6.180	6.422
29.35	-29.95	6.201	6.089	5.327	4.590	3.958	3.519	3.914	4.475	5.208	5.474	6.056	6.298
29.40	-29.95	6.184	6.087	5.324	4.556	3.951	3.519	3.915	4.462	5.199	5.461	6.035	6.281
29.45	-29.95	5.947	5.853	5.266	4.487	3.913	3.464	3.847	4.379	5.063	5.213	5.720	5.968
29.50	-29.95	5.773	5.751	5.128	4.467	3.911	3.441	3.820	4.373	4.957	5.097	5.473	5.723
27.05	-30.00	7.326	6.694	5.804	4.791	3.937	3.411	3.831	4.605	5.881	6.669	7.525	7.785
27.15	-30.00	7.311	6.757	5.854	4.792	4.011	3.480	3.926	4.636	5.932	6.674	7.595	7.824
27.25	-30.00	7.366	6.700	5.843	4.788	4.008	3.490	3.920	4.630	5.981	6.697	7.569	7.838
27.35	-30.00	7.356	6.782	5.928	4.840	4.035	3.465	3.923	4.638	5.949	6.681	7.532	7.832
27.45	-30.00	7.219	6.668	5.801	4.728	3.859	3.221	3.678	4.512	5.799	6.463	7.363	7.686
27.55	-30.00	7.084	6.549	5.769	4.733	3.910	3.405	3.830	4.525	5.730	6.393	7.220	7.580
27.65	-30.00	6.504	6.033	5.232	4.284	3.517	3.084	3.541	4.110	5.447	5.862	6.596	6.935
27.75	-30.00	6.866	6.352	5.551	4.549	3.574	2.891	3.283	4.354	5.699	6.419	7.195	7.505
27.85	-30.00	7.038	6.556	5.770	4.858	4.061	3.538	3.886	4.707	5.950	6.626	7.413	7.688
27.95	-30.00	7.022	6.622	5.788	4.874	3.932	3.417	3.744	4.637	5.858	6.521	7.401	7.651
28.05	-30.00	7.101	6.606	5.775	4.902	4.078	3.546	3.914	4.644	5.919	6.542	7.339	7.627
28.15	-30.00	7.081	6.679	5.870	4.967	4.091	3.555	3.922	4.677	5.937	6.546	7.307	7.640
28.25	-30.00	7.068	6.717	5.886	4.958	4.083	3.556	3.941	4.659	5.865	6.473	7.235	7.479
28.35	-30.00	7.077	6.621	5.865	4.857	3.942	3.499	3.840	4.518	5.770	6.379	7.224	7.521
28.45	-30.00	6.840	6.508	5.581	4.686	3.784	3.294	3.628	4.430	5.643	6.217	6.900	7.147
28.55	-30.00	6.971	6.507	5.711	4.531	2.845	1.580	2.344	4.052	5.694	6.348	7.116	7.334
28.65	-30.00	7.010	6.653	5.770	4.866	3.898	3.406	3.851	4.567	5.860	6.414	7.186	7.382
28.75	-30.00	6.946	6.594	5.697	4.826	4.028	3.595	3.959	4.582	5.747	6.245	7.010	7.235
28.85	-30.00	6.537	6.265	5.463	4.701	3.956	3.486	3.831	4.490	5.613	5.930	6.581	6.769
28.95	-30.00	6.479	6.187	5.426	4.669	3.884	3.468	3.791	4.449	5.525	5.873	6.531	6.718
29.05	-30.00	6.434	6.162	5.401	4.652	3.884	3.456	3.788	4.486	5.494	5.835	6.456	6.618
29.15	-30.00	6.538	6.275	5.436	4.665	4.012	3.496	3.912	4.533	5.481	5.803	6.434	6.643
29.25	-30.00	6.558	6.300	5.471	4.659	3.984	3.520	3.893	4.436	5.353	5.724	6.352	6.646
29.35	-30.00	6.289	6.128	5.346	4.602	3.935	3.501	3.861	4.434	5.215	5.486	6.127	6.395
29.45	-30.00	5.793	5.732	5.130	4.445	3.909	3.446	3.830	4.354	4.960	5.093	5.560	5.742
27.00	-30.05	7.347	6.740	5.856	4.814	4.009	3.480	3.913	4.634	5.935	6.682	7.582	7.842
27.05	-30.05	7.347	6.740	5.857	4.814	4.011	3.479	3.912	4.635	5.935	6.683	7.582	7.842
27.10	-30.05	7.311	6.759	5.854	4.795	4.014	3.480	3.926	4.637	5.932	6.677	7.595	7.824
27.15	-30.05	7.311	6.759	5.854	4.795	4.014	3.480	3.926	4.638	5.932	6.677	7.595	7.824
27.20	-30.05	7.367	6.739	5.871	4.801	4.012	3.481	3.922	4.650	5.951	6.673	7.587	7.836
27.25	-30.05	7.367	6.707	5.861	4.793	4.020	3.492	3.942	4.657	5.980	6.702	7.603	7.838
27.30	-30.05	7.294	6.651	5.818	4.745	4.008	3.490	3.920	4.610	5.894	6.605	7.562	7.756
27.35	-30.05	7.356	6.782	5.927	4.840	4.037	3.465	3.924	4.638	5.949	6.681	7.532	7.832
27.40	-30.05	7.356	6.782	5.928	4.840	4.037	3.465	3.925	4.638	5.949	6.681	7.532	7.832
27.45	-30.05	7.219	6.668	5.818	4.778	3.964	3.419	3.867	4.562	5.830	6.467	7.370	7.686
27.50	-30.05	7.093	6.550	5.770	4.736	3.911	3.405	3.830	4.526	5.730	6.393	7.220	7.580
27.55	-30.05	7.086	6.549	5.756	4.710	3.910	3.352	3.782	4.519	5.716	6.387	7.220	7.580
27.60	-30.05	6.528	6.065	5.290	4.314	3.515	2.964	3.441	4.138	5.506	5.890	6.683	6.996
27.65	-30.05	6.525	6.063	5.285	4.269	3.488	2.799	3.372	4.088	5.490	5.888	6.683	6.996

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.70	-30.05	6.814	6.349	5.546	4.671	3.941	3.435	3.793	4.536	5.754	6.360	7.164	7.501
27.75	-30.05	6.874	6.387	5.603	4.573	3.724	3.227	3.557	4.350	5.752	6.442	7.209	7.529
27.80	-30.05	6.643	6.124	5.419	4.462	3.600	3.008	3.397	4.339	5.446	6.327	7.005	7.226
27.85	-30.05	6.979	6.512	5.761	4.810	3.933	3.415	3.734	4.670	5.869	6.610	7.392	7.620
27.90	-30.05	6.869	6.430	5.513	4.671	3.929	3.452	3.794	4.585	5.842	6.476	7.153	7.414
27.95	-30.05	7.056	6.656	5.780	4.901	4.036	3.455	3.815	4.682	5.910	6.572	7.369	7.654
28.00	-30.05	7.038	6.644	5.829	4.888	4.078	3.483	3.914	4.639	5.898	6.542	7.384	7.629
28.05	-30.05	7.064	6.647	5.772	4.849	3.939	3.423	3.754	4.552	5.882	6.465	7.363	7.629
28.10	-30.05	7.081	6.680	5.879	4.972	4.071	3.466	3.831	4.673	5.937	6.548	7.331	7.640
28.15	-30.05	7.081	6.680	5.879	4.977	4.098	3.555	3.931	4.685	5.937	6.549	7.331	7.640
28.20	-30.05	7.064	6.692	5.884	4.978	4.096	3.573	3.953	4.702	5.925	6.525	7.332	7.592
28.25	-30.05	7.068	6.700	5.845	4.898	4.069	3.556	3.928	4.603	5.851	6.461	7.214	7.477
28.30	-30.05	7.037	6.589	5.808	4.898	4.069	3.477	3.829	4.585	5.791	6.400	7.214	7.438
28.35	-30.05	7.129	6.730	5.927	4.958	4.082	3.590	3.948	4.629	5.836	6.435	7.272	7.584
28.40	-30.05	7.103	6.643	5.865	4.921	3.981	3.499	3.853	4.566	5.770	6.401	7.224	7.521
28.45	-30.05	7.006	6.615	5.832	4.895	4.068	3.620	3.968	4.636	5.827	6.362	7.154	7.407
28.50	-30.05	6.998	6.576	5.814	4.840	3.985	3.507	3.852	4.608	5.815	6.415	7.149	7.385
28.55	-30.05	6.955	6.557	5.812	4.840	4.076	3.631	3.977	4.613	5.777	6.415	7.062	7.296
28.60	-30.05	7.010	6.618	5.761	4.801	3.936	3.503	3.812	4.498	5.820	6.414	7.166	7.351
28.65	-30.05	7.005	6.651	5.779	4.880	4.053	3.623	3.971	4.624	5.862	6.409	7.188	7.382
28.70	-30.05	6.841	6.511	5.654	4.632	3.906	3.337	3.710	4.442	5.686	6.178	6.979	7.202
28.75	-30.05	6.917	6.566	5.621	4.738	3.887	3.280	3.677	4.480	5.703	6.224	6.941	7.174
28.80	-30.05	6.947	6.595	5.697	4.833	4.037	3.595	3.959	4.587	5.747	6.244	7.010	7.235
28.85	-30.05	6.453	6.149	5.380	4.442	3.753	3.367	3.682	4.180	5.508	5.802	6.481	6.734
28.90	-30.05	6.537	6.273	5.459	4.705	3.962	3.486	3.837	4.503	5.619	5.929	6.569	6.769
28.95	-30.05	6.469	6.191	5.464	4.632	3.791	3.115	3.655	4.371	5.522	5.876	6.523	6.691
29.00	-30.05	6.472	6.194	5.441	4.699	4.011	3.572	3.934	4.538	5.551	5.904	6.461	6.645
29.05	-30.05	6.446	6.185	5.377	4.612	3.867	3.474	3.832	4.416	5.496	5.885	6.416	6.600
29.10	-30.05	6.525	6.247	5.442	4.662	4.017	3.548	3.951	4.506	5.437	5.787	6.429	6.617
29.15	-30.05	6.564	6.277	5.460	4.695	4.004	3.451	3.864	4.541	5.496	5.818	6.445	6.653
29.20	-30.05	6.533	6.239	5.441	4.583	3.785	3.326	3.666	4.342	5.308	5.705	6.339	6.605
29.25	-30.05	6.558	6.302	5.475	4.666	3.980	3.520	3.893	4.451	5.353	5.725	6.364	6.646
29.30	-30.05	6.558	6.286	5.471	4.642	3.981	3.520	3.893	4.420	5.336	5.724	6.350	6.635
29.35	-30.05	6.260	6.103	5.337	4.566	3.919	3.393	3.842	4.405	5.169	5.477	6.119	6.366
29.40	-30.05	6.289	6.129	5.348	4.602	3.947	3.501	3.868	4.437	5.215	5.487	6.131	6.395
29.45	-30.05	5.787	5.732	5.105	4.437	3.847	3.343	3.762	4.353	4.936	5.065	5.564	5.749
29.50	-30.05	5.752	5.738	5.100	4.404	3.770	3.346	3.732	4.300	4.949	5.056	5.471	5.662
27.05	-30.10	7.281	6.652	5.827	4.786	3.989	3.463	3.900	4.618	5.939	6.656	7.566	7.795
27.10	-30.10	6.983	6.457	5.918	4.704	3.936	3.443	3.919	4.696	5.972	6.294	7.352	7.983
27.15	-30.10	7.306	6.695	5.857	4.798	3.982	3.461	3.893	4.627	5.917	6.644	7.561	7.848
27.25	-30.10	7.315	6.612	5.847	4.754	3.974	3.450	3.887	4.622	5.925	6.606	7.540	7.782
27.30	-30.10	7.008	6.329	5.908	4.650	3.937	3.416	3.908	4.689	5.980	6.244	7.329	7.878
27.35	-30.10	7.362	6.723	5.874	4.784	3.976	3.417	3.867	4.597	5.891	6.562	7.500	7.824
27.45	-30.10	7.249	6.705	5.823	4.744	3.937	3.380	3.845	4.556	5.819	6.417	7.388	7.703
27.50	-30.10	6.877	6.390	5.766	4.586	3.796	3.280	3.799	4.557	5.818	5.994	7.093	7.661
27.55	-30.10	7.044	6.528	5.714	4.628	3.777	3.289	3.716	4.410	5.653	6.266	7.144	7.501
27.65	-30.10	6.434	6.091	5.303	4.331	3.463	3.017	3.409	4.107	5.430	5.807	6.755	6.770
27.70	-30.10	6.595	6.082	5.692	4.574	3.917	3.397	3.919	4.668	5.951	6.110	7.117	7.726
27.75	-30.10	6.869	6.348	5.584	4.660	3.945	3.437	3.810	4.546	5.850	6.442	7.230	7.484

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.85	-30.10	7.064	6.519	5.745	4.636	3.773	3.031	3.494	4.421	5.850	6.508	7.290	7.516
27.90	-30.10	6.708	6.212	5.820	4.716	3.916	3.321	3.854	4.674	5.943	6.128	7.153	7.629
27.95	-30.10	7.019	6.610	5.785	4.805	3.969	3.419	3.810	4.532	5.848	6.403	7.175	7.507
28.05	-30.10	7.068	6.640	5.793	4.828	4.035	3.468	3.857	4.590	5.866	6.444	7.294	7.609
28.10	-30.10	6.773	6.301	5.729	4.557	3.659	3.150	3.621	4.374	5.845	6.140	7.094	7.665
28.15	-30.10	7.055	6.574	5.754	4.817	3.931	3.397	3.793	4.544	5.823	6.473	7.244	7.526
28.25	-30.10	6.913	6.515	5.735	4.773	3.986	3.427	3.825	4.516	5.786	6.385	7.206	7.486
28.30	-30.10	6.460	6.120	5.575	4.425	3.449	2.990	3.436	4.277	5.659	5.931	7.002	7.476
28.35	-30.10	6.461	6.044	5.371	4.461	3.817	3.193	3.546	4.352	5.566	5.919	6.773	6.943
28.45	-30.10	6.443	6.086	5.410	4.529	3.850	3.420	3.735	4.411	5.617	5.945	6.754	6.845
28.50	-30.10	6.054	5.782	5.231	4.112	3.486	2.839	3.241	4.172	5.519	5.477	6.241	6.648
28.55	-30.10	6.411	6.133	5.401	4.592	3.847	3.349	3.725	4.471	5.575	5.864	6.637	6.723
28.65	-30.10	6.495	6.242	5.497	4.566	3.881	3.245	3.633	4.411	5.617	5.907	6.739	6.933
28.70	-30.10	6.371	6.250	5.634	4.648	4.078	3.405	3.971	4.617	5.806	5.709	6.511	7.066
28.75	-30.10	6.687	6.467	5.632	4.696	3.891	3.428	3.745	4.424	5.682	6.024	6.800	7.000
28.85	-30.10	6.651	6.402	5.577	4.679	3.738	3.101	3.517	4.384	5.583	5.974	6.700	6.905
28.90	-30.10	6.339	6.216	5.592	4.633	4.068	3.501	4.035	4.582	5.716	5.658	6.408	6.995
28.95	-30.10	6.512	6.272	5.386	4.440	3.730	3.156	3.535	4.231	5.436	5.821	6.507	6.749
29.05	-30.10	6.668	6.416	5.559	4.697	3.941	3.426	3.833	4.496	5.545	5.978	6.603	6.890
29.10	-30.10	6.453	6.380	5.653	4.686	4.059	3.438	4.021	4.559	5.629	5.633	6.435	7.095
29.15	-30.10	6.749	6.515	5.590	4.746	4.007	3.526	3.913	4.487	5.518	5.966	6.622	6.979
29.25	-30.10	6.683	6.407	5.517	4.713	3.986	3.515	3.900	4.451	5.427	5.874	6.497	6.881
29.30	-30.10	6.358	6.240	5.575	4.620	4.009	3.429	3.999	4.497	5.504	5.513	6.312	7.000
29.35	-30.10	6.531	6.258	5.381	4.577	3.802	3.274	3.613	4.342	5.282	5.665	6.299	6.676
29.45	-30.10	5.590	5.540	4.951	4.387	3.872	3.426	3.787	4.305	4.939	5.057	5.410	5.610
29.50	-30.10	5.181	5.312	4.957	4.252	3.911	3.355	3.883	4.317	4.860	4.591	5.157	5.333
27.00	-30.15	7.281	6.652	5.827	4.786	3.987	3.461	3.900	4.618	5.939	6.657	7.566	7.795
27.05	-30.15	7.281	6.652	5.827	4.786	3.989	3.462	3.900	4.618	5.939	6.657	7.566	7.795
27.10	-30.15	7.306	6.695	5.857	4.798	3.982	3.462	3.894	4.626	5.917	6.644	7.561	7.849
27.15	-30.15	7.306	6.695	5.857	4.798	3.981	3.461	3.893	4.627	5.917	6.644	7.561	7.849
27.20	-30.15	7.330	6.635	5.852	4.768	3.970	3.458	3.891	4.623	5.941	6.616	7.566	7.819
27.25	-30.15	7.315	6.612	5.847	4.754	3.973	3.450	3.887	4.622	5.925	6.606	7.540	7.782
27.30	-30.15	7.182	6.516	5.792	4.728	3.891	3.374	3.802	4.578	5.869	6.588	7.479	7.723
27.35	-30.15	7.362	6.724	5.873	4.784	3.970	3.416	3.859	4.597	5.891	6.562	7.500	7.824
27.40	-30.15	7.362	6.723	5.871	4.784	3.976	3.417	3.867	4.597	5.891	6.559	7.500	7.824
27.45	-30.15	7.245	6.705	5.823	4.744	3.935	3.380	3.845	4.556	5.819	6.417	7.388	7.703
27.50	-30.15	7.150	6.623	5.773	4.681	3.907	3.364	3.819	4.513	5.703	6.329	7.241	7.614
27.55	-30.15	7.104	6.569	5.763	4.654	3.894	3.363	3.802	4.464	5.664	6.311	7.205	7.541
27.60	-30.15	6.880	6.383	5.496	4.542	3.787	3.205	3.616	4.342	5.667	6.195	7.037	7.335
27.65	-30.15	6.880	6.424	5.535	4.547	3.826	3.276	3.714	4.376	5.699	6.192	7.003	7.322
27.70	-30.15	6.900	6.362	5.621	4.510	3.527	2.299	3.129	4.287	5.792	6.448	7.261	7.576
27.75	-30.15	6.896	6.357	5.612	4.702	3.950	3.437	3.810	4.584	5.862	6.459	7.270	7.503
27.80	-30.15	6.896	6.357	5.616	4.711	3.962	3.437	3.827	4.601	5.862	6.463	7.272	7.503
27.85	-30.15	6.958	6.341	5.549	4.583	3.618	3.112	3.399	4.367	5.592	6.367	7.160	7.411
27.90	-30.15	6.550	5.999	5.089	3.870	1.805	0.837	1.195	3.310	5.261	6.059	6.602	6.849
27.95	-30.15	7.019	6.610	5.795	4.802	3.979	3.419	3.826	4.535	5.848	6.406	7.200	7.507
28.00	-30.15	7.062	6.639	5.796	4.806	4.042	3.393	3.825	4.602	5.861	6.442	7.315	7.609
28.05	-30.15	6.992	6.529	5.692	4.749	3.902	3.263	3.631	4.542	5.745	6.419	7.219	7.532
28.10	-30.15	7.055	6.642	5.820	4.830	4.049	3.482	3.886	4.602	5.884	6.486	7.310	7.578

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
28.15	-30.15	7.055	6.642	5.816	4.817	4.049	3.482	3.886	4.602	5.883	6.476	7.244	7.526
28.20	-30.15	6.811	6.409	5.672	4.585	3.571	2.420	3.102	4.257	5.527	6.334	7.115	7.352
28.25	-30.15	6.913	6.479	5.724	4.715	3.890	3.238	3.678	4.460	5.735	6.384	7.204	7.453
28.30	-30.15	6.797	6.404	5.669	4.603	3.852	3.238	3.667	4.378	5.701	6.290	7.166	7.418
28.35	-30.15	6.422	6.050	5.362	4.573	3.911	3.377	3.825	4.442	5.576	5.869	6.720	6.898
28.40	-30.15	6.353	5.935	5.176	4.215	3.583	3.127	3.389	3.967	5.285	5.713	6.536	6.832
28.45	-30.15	6.353	5.869	5.202	4.384	3.584	3.226	3.548	4.244	5.425	5.822	6.556	6.674
28.50	-30.15	6.471	6.189	5.477	4.649	4.012	3.562	3.901	4.521	5.691	5.914	6.681	6.813
28.55	-30.15	6.471	6.194	5.480	4.647	4.009	3.562	3.901	4.519	5.689	5.915	6.700	6.813
28.60	-30.15	6.593	6.287	5.510	4.637	3.899	3.445	3.769	4.350	5.654	5.954	6.695	6.938
28.65	-30.15	6.612	6.334	5.567	4.719	4.003	3.396	3.868	4.517	5.711	6.012	6.745	6.933
28.70	-30.15	6.701	6.464	5.598	4.734	3.880	3.334	3.663	4.493	5.680	6.041	6.814	7.009
28.75	-30.15	6.657	6.431	5.538	4.689	3.904	3.333	3.719	4.486	5.591	5.944	6.678	6.882
28.80	-30.15	6.712	6.467	5.638	4.744	4.023	3.547	3.904	4.526	5.681	6.039	6.804	7.007
28.85	-30.15	6.695	6.437	5.592	4.781	4.015	3.576	3.935	4.560	5.642	5.995	6.702	6.946
28.90	-30.15	6.695	6.427	5.587	4.773	4.016	3.576	3.935	4.550	5.642	5.995	6.709	6.946
28.95	-30.15	6.535	6.280	5.494	4.529	3.730	3.134	3.542	4.310	5.493	5.826	6.508	6.806
29.00	-30.15	6.668	6.414	5.561	4.740	4.011	3.540	3.907	4.536	5.584	5.978	6.587	6.884
29.05	-30.15	6.668	6.417	5.567	4.740	4.015	3.540	3.912	4.536	5.584	5.978	6.602	6.890
29.10	-30.15	6.749	6.505	5.585	4.723	4.006	3.526	3.911	4.454	5.508	5.966	6.607	6.979
29.15	-30.15	6.749	6.515	5.591	4.746	4.010	3.526	3.918	4.487	5.518	5.967	6.623	6.979
29.20	-30.15	6.689	6.424	5.526	4.718	3.989	3.524	3.902	4.462	5.438	5.879	6.508	6.884
29.25	-30.15	6.683	6.407	5.517	4.713	3.988	3.515	3.900	4.451	5.427	5.873	6.498	6.881
29.30	-30.15	6.682	6.403	5.517	4.686	3.979	3.515	3.900	4.438	5.426	5.866	6.497	6.881
29.35	-30.15	6.510	6.238	5.394	4.603	3.899	3.368	3.793	4.361	5.269	5.664	6.287	6.645
29.40	-30.15	6.543	6.260	5.404	4.633	3.941	3.474	3.843	4.387	5.315	5.683	6.287	6.674
29.45	-30.15	5.590	5.534	4.951	4.386	3.870	3.426	3.787	4.304	4.937	5.057	5.410	5.612
29.50	-30.15	5.538	5.520	4.909	4.269	3.614	2.948	3.446	4.182	4.875	4.976	5.320	5.536
27.05	-30.20	7.230	6.570	5.758	4.733	3.920	3.428	3.853	4.584	5.924	6.597	7.528	7.763
27.15	-30.20	7.274	6.673	5.837	4.779	3.946	3.437	3.857	4.599	5.928	6.603	7.561	7.834
27.25	-30.20	7.330	6.623	5.812	4.745	3.952	3.423	3.854	4.612	5.932	6.586	7.556	7.802
27.35	-30.20	7.407	6.680	5.858	4.772	3.954	3.405	3.862	4.579	5.886	6.542	7.539	7.829
27.45	-30.20	7.410	6.773	5.890	4.775	3.942	3.286	3.832	4.544	5.871	6.529	7.564	7.875
27.55	-30.20	7.159	6.571	5.707	4.663	3.863	3.263	3.690	4.475	5.686	6.338	7.230	7.621
27.65	-30.20	6.913	6.380	5.624	4.501	3.744	3.248	3.670	4.324	5.675	6.243	7.144	7.455
27.75	-30.20	7.174	6.583	5.775	4.621	3.706	3.295	3.689	4.388	5.618	6.528	7.324	7.593
27.85	-30.20	7.218	6.677	5.842	4.847	3.930	3.350	3.739	4.549	5.781	6.455	7.297	7.658
27.95	-30.20	7.163	6.699	5.841	4.813	3.989	3.324	3.761	4.528	5.802	6.427	7.328	7.652
28.05	-30.20	7.114	6.669	5.826	4.773	4.000	3.400	3.822	4.542	5.825	6.410	7.304	7.644
28.15	-30.20	7.001	6.543	5.757	4.760	3.936	3.311	3.762	4.459	5.810	6.375	7.179	7.480
28.25	-30.20	6.472	6.209	5.482	4.623	3.945	3.441	3.796	4.447	5.704	5.997	6.766	7.024
28.35	-30.20	6.385	6.088	5.434	4.656	3.990	3.567	3.861	4.580	5.709	5.978	6.704	6.853
28.45	-30.20	6.568	6.214	5.476	4.616	3.825	3.456	3.783	4.478	5.656	5.951	6.715	6.921
28.55	-30.20	6.705	6.428	5.600	4.714	3.970	3.542	3.863	4.554	5.700	6.002	6.821	7.058
28.65	-30.20	6.697	6.430	5.590	4.611	3.856	3.232	3.628	4.435	5.605	5.942	6.826	7.092
28.75	-30.20	6.983	6.686	5.773	4.830	4.010	3.546	3.914	4.548	5.712	6.192	6.976	7.287
28.85	-30.20	6.848	6.535	5.674	4.749	4.008	3.541	3.883	4.496	5.603	6.090	6.801	7.111
28.95	-30.20	6.805	6.499	5.611	4.754	3.967	3.541	3.882	4.515	5.580	6.019	6.715	7.020
29.05	-30.20	6.844	6.536	5.604	4.760	3.944	3.530	3.866	4.493	5.573	6.002	6.702	7.042

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
29.15	-30.20	6.842	6.568	5.613	4.742	3.978	3.517	3.875	4.474	5.511	5.981	6.633	7.008
29.25	-30.20	6.807	6.538	5.595	4.719	3.980	3.501	3.867	4.436	5.460	5.954	6.573	6.912
29.35	-30.20	6.615	6.394	5.499	4.637	3.952	3.486	3.840	4.397	5.342	5.758	6.325	6.698
29.45	-30.20	5.877	5.828	5.131	4.446	3.860	3.411	3.761	4.286	5.016	5.245	5.643	5.915
27.00	-30.25	7.208	6.543	5.739	4.694	3.898	3.408	3.823	4.558	5.927	6.586	7.472	7.737
27.05	-30.25	7.208	6.543	5.757	4.703	3.913	3.411	3.844	4.575	5.927	6.592	7.498	7.737
27.10	-30.25	7.304	6.680	5.859	4.771	3.951	3.437	3.867	4.612	5.939	6.626	7.585	7.852
27.15	-30.25	7.304	6.681	5.858	4.771	3.945	3.435	3.859	4.612	5.939	6.623	7.585	7.852
27.20	-30.25	7.306	6.621	5.832	4.740	3.948	3.422	3.853	4.611	5.919	6.591	7.596	7.833
27.25	-30.25	7.310	6.592	5.799	4.734	3.934	3.427	3.835	4.603	5.922	6.594	7.575	7.807
27.30	-30.25	7.310	6.592	5.806	4.741	3.945	3.427	3.850	4.610	5.922	6.594	7.575	7.807
27.35	-30.25	7.431	6.702	5.842	4.779	3.936	3.413	3.854	4.579	5.869	6.553	7.557	7.843
27.40	-30.25	7.408	6.682	5.788	4.702	3.763	3.140	3.600	4.488	5.829	6.541	7.496	7.782
27.45	-30.25	7.427	6.814	5.919	4.806	3.892	3.339	3.757	4.565	5.871	6.531	7.575	7.874
27.50	-30.25	7.370	6.766	5.904	4.788	3.952	3.400	3.818	4.571	5.790	6.493	7.451	7.834
27.55	-30.25	7.346	6.766	5.883	4.763	3.951	3.400	3.818	4.565	5.787	6.477	7.420	7.809
27.60	-30.25	7.199	6.672	5.834	4.779	3.960	3.399	3.806	4.566	5.826	6.499	7.383	7.737
27.65	-30.25	6.947	6.518	5.658	4.537	3.825	3.324	3.704	4.386	5.647	6.245	7.051	7.388
27.70	-30.25	7.094	6.549	5.751	4.676	3.841	3.327	3.669	4.457	5.796	6.536	7.417	7.674
27.75	-30.25	7.229	6.760	5.879	4.780	3.888	3.312	3.693	4.535	5.753	6.583	7.402	7.769
27.80	-30.25	7.188	6.717	5.780	4.754	3.841	3.312	3.678	4.456	5.761	6.510	7.333	7.713
27.85	-30.25	7.210	6.747	5.869	4.838	3.955	3.407	3.807	4.525	5.820	6.468	7.354	7.714
27.90	-30.25	7.147	6.702	5.847	4.792	3.894	3.289	3.740	4.481	5.733	6.452	7.325	7.643
27.95	-30.25	6.990	6.459	5.627	4.656	3.804	3.236	3.667	4.379	5.707	6.298	7.129	7.480
28.00	-30.25	6.993	6.501	5.680	4.660	3.937	3.335	3.776	4.492	5.779	6.300	7.181	7.475
28.05	-30.25	6.504	6.156	5.203	4.179	3.546	2.767	3.265	4.103	5.310	5.882	6.837	7.072
28.10	-30.25	6.936	6.489	5.711	4.671	3.872	3.262	3.701	4.386	5.765	6.319	7.196	7.517
28.15	-30.25	6.912	6.488	5.720	4.654	3.815	3.188	3.613	4.346	5.765	6.321	7.224	7.530
28.20	-30.25	6.692	6.280	5.552	4.554	3.739	3.191	3.525	4.254	5.688	6.134	6.973	7.287
28.25	-30.25	6.163	5.869	5.283	4.458	3.851	3.415	3.691	4.338	5.573	5.836	6.571	6.758
28.30	-30.25	6.201	5.982	5.353	4.582	3.994	3.528	3.852	4.563	5.655	5.910	6.656	6.821
28.35	-30.25	6.459	6.160	5.437	4.381	3.375	2.257	2.961	4.113	5.667	5.993	6.711	6.865
28.40	-30.25	6.459	6.172	5.443	4.640	3.938	3.544	3.849	4.544	5.718	5.992	6.731	6.876
28.45	-30.25	6.654	6.309	5.553	4.688	3.937	3.542	3.868	4.528	5.658	6.006	6.802	7.012
28.50	-30.25	6.708	6.382	5.562	4.682	3.886	3.462	3.784	4.473	5.647	6.007	6.851	7.079
28.55	-30.25	6.711	6.403	5.592	4.741	3.968	3.550	3.884	4.550	5.689	6.022	6.872	7.089
28.60	-30.25	6.856	6.549	5.701	4.788	3.985	3.540	3.908	4.548	5.690	6.094	6.879	7.161
28.65	-30.25	6.856	6.549	5.701	4.788	3.981	3.540	3.905	4.547	5.690	6.094	6.879	7.161
28.70	-30.25	6.952	6.648	5.746	4.814	3.994	3.540	3.912	4.551	5.714	6.177	6.958	7.257
28.75	-30.25	7.027	6.701	5.783	4.833	4.011	3.535	3.907	4.562	5.686	6.210	7.007	7.309
28.80	-30.25	7.027	6.701	5.783	4.824	4.004	3.535	3.907	4.556	5.686	6.210	7.007	7.309
28.85	-30.25	6.905	6.564	5.707	4.776	3.988	3.535	3.881	4.520	5.631	6.112	6.855	7.148
28.90	-30.25	6.904	6.564	5.707	4.778	3.994	3.535	3.886	4.522	5.631	6.115	6.855	7.148
28.95	-30.25	6.861	6.541	5.655	4.753	3.955	3.523	3.859	4.484	5.569	6.076	6.762	7.078
29.00	-30.25	6.852	6.538	5.642	4.742	3.946	3.520	3.838	4.457	5.536	6.046	6.746	7.042
29.05	-30.25	6.852	6.518	5.628	4.700	3.823	3.405	3.691	4.407	5.503	6.046	6.733	7.041
29.10	-30.25	6.836	6.552	5.604	4.724	3.947	3.506	3.846	4.443	5.504	6.014	6.635	7.023
29.15	-30.25	6.837	6.541	5.596	4.695	3.893	3.392	3.782	4.415	5.467	6.014	6.630	7.023
29.20	-30.25	6.785	6.528	5.598	4.719	3.974	3.500	3.855	4.407	5.492	6.081	6.665	6.984

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
29.25	-30.25	6.776	6.534	5.600	4.699	3.970	3.496	3.853	4.421	5.460	6.015	6.640	6.961
29.30	-30.25	6.776	6.533	5.600	4.699	3.970	3.496	3.853	4.421	5.460	6.015	6.640	6.961
29.35	-30.25	6.457	6.288	5.437	4.605	3.928	3.475	3.824	4.417	5.258	5.659	6.236	6.551
29.40	-30.25	6.422	6.216	5.359	4.465	3.817	3.196	3.692	4.238	5.167	5.601	6.153	6.506
29.45	-30.25	6.303	6.147	5.341	4.543	3.885	3.427	3.764	4.328	5.185	5.512	6.041	6.362
29.50	-30.25	5.331	5.369	4.839	4.333	3.805	3.355	3.726	4.263	4.840	4.933	5.205	5.424
27.05	-30.30	7.186	6.530	5.705	4.681	3.836	3.340	3.765	4.536	5.897	6.578	7.440	7.677
27.10	-30.30	6.985	6.380	5.902	4.638	3.899	3.393	3.886	4.674	6.002	6.286	7.406	7.955
27.15	-30.30	7.304	6.681	5.859	4.771	3.951	3.437	3.867	4.612	5.939	6.626	7.585	7.852
27.25	-30.30	7.307	6.590	5.809	4.735	3.946	3.427	3.856	4.606	5.922	6.596	7.575	7.807
27.30	-30.30	6.951	6.310	5.855	4.612	3.906	3.376	3.885	4.667	5.985	6.271	7.359	7.886
27.35	-30.30	7.408	6.701	5.844	4.778	3.941	3.414	3.860	4.579	5.869	6.547	7.557	7.808
27.45	-30.30	7.436	6.816	5.919	4.827	3.973	3.413	3.836	4.597	5.876	6.535	7.575	7.874
27.50	-30.30	7.100	6.531	5.947	4.709	3.903	3.380	3.880	4.635	5.885	6.197	7.420	7.952
27.55	-30.30	7.346	6.766	5.885	4.763	3.956	3.400	3.824	4.565	5.778	6.479	7.414	7.786
27.65	-30.30	7.200	6.672	5.834	4.779	3.960	3.399	3.806	4.566	5.826	6.499	7.383	7.737
27.70	-30.30	6.886	6.291	5.872	4.659	3.946	3.385	3.889	4.625	5.892	6.222	7.310	7.855
27.75	-30.30	7.256	6.785	5.906	4.836	3.981	3.377	3.796	4.584	5.831	6.609	7.459	7.782
27.85	-30.30	7.184	6.747	5.825	4.812	3.948	3.328	3.729	4.518	5.796	6.453	7.289	7.646
27.90	-30.30	6.819	6.462	5.906	4.722	3.822	3.254	3.828	4.525	5.803	6.148	7.204	7.704
27.95	-30.30	6.784	6.248	5.306	4.210	3.528	2.971	3.313	3.930	5.226	6.021	6.743	7.168
28.05	-30.30	6.964	6.472	5.597	4.589	3.800	3.226	3.610	4.363	5.701	6.229	7.136	7.480
28.10	-30.30	6.607	6.179	5.714	4.572	3.781	3.244	3.855	4.415	5.837	6.017	7.082	7.656
28.15	-30.30	6.848	6.446	5.690	4.641	3.875	3.262	3.701	4.362	5.684	6.213	7.178	7.465
28.25	-30.30	6.220	5.982	5.363	4.577	3.930	3.415	3.754	4.527	5.641	5.924	6.696	6.845
28.30	-30.30	5.869	5.635	5.340	4.316	3.611	2.996	3.549	4.349	5.681	5.612	6.444	6.976
28.35	-30.30	6.459	6.172	5.437	4.629	3.815	3.422	3.701	4.466	5.718	5.993	6.717	6.876
28.45	-30.30	6.655	6.336	5.561	4.718	3.942	3.542	3.873	4.568	5.706	6.007	6.822	7.016
28.50	-30.30	6.404	6.160	5.617	4.648	4.002	3.460	3.983	4.568	5.825	5.713	6.611	7.227
28.55	-30.30	6.711	6.402	5.592	4.741	3.968	3.550	3.887	4.550	5.689	6.022	6.872	7.089
28.65	-30.30	6.856	6.549	5.701	4.788	3.984	3.540	3.906	4.548	5.690	6.093	6.879	7.161
28.70	-30.30	6.586	6.426	5.774	4.714	4.048	3.460	4.020	4.596	5.831	5.876	6.735	7.382
28.75	-30.30	7.027	6.701	5.783	4.833	4.011	3.535	3.907	4.562	5.686	6.210	7.007	7.309
28.85	-30.30	6.905	6.566	5.707	4.778	3.994	3.535	3.886	4.522	5.631	6.115	6.855	7.148
28.90	-30.30	6.562	6.316	5.675	4.629	4.008	3.340	3.968	4.524	5.689	5.805	6.633	7.248
28.95	-30.30	6.861	6.541	5.659	4.753	3.950	3.523	3.852	4.483	5.569	6.078	6.764	7.078
29.05	-30.30	6.852	6.538	5.642	4.742	3.947	3.520	3.841	4.457	5.536	6.046	6.750	7.042
29.10	-30.30	6.586	6.415	5.645	4.668	4.026	3.416	3.971	4.504	5.611	5.715	6.457	7.173
29.15	-30.30	6.837	6.555	5.604	4.734	3.958	3.506	3.852	4.449	5.504	6.015	6.635	7.023
29.25	-30.30	6.776	6.532	5.600	4.699	3.971	3.496	3.854	4.421	5.460	6.015	6.640	6.961
29.30	-30.30	6.488	6.402	5.676	4.608	4.016	3.417	3.969	4.460	5.602	5.710	6.479	7.077
29.35	-30.30	6.457	6.288	5.438	4.605	3.932	3.475	3.830	4.418	5.259	5.659	6.230	6.551
29.45	-30.30	6.303	6.147	5.343	4.555	3.895	3.427	3.769	4.336	5.185	5.513	6.043	6.362
29.50	-30.30	5.003	5.183	4.856	4.165	3.754	3.182	3.724	4.197	4.753	4.556	5.052	5.229
27.00	-30.35	7.427	6.713	5.916	4.816	3.956	3.433	3.855	4.617	5.952	6.681	7.685	7.920
27.05	-30.35	7.426	6.711	5.916	4.817	3.956	3.431	3.854	4.617	5.952	6.680	7.685	7.920
27.10	-30.35	7.335	6.640	5.803	4.761	3.818	3.356	3.757	4.538	5.864	6.641	7.593	7.873
27.15	-30.35	7.354	6.642	5.852	4.785	3.924	3.428	3.846	4.597	5.916	6.651	7.601	7.873
27.20	-30.35	7.279	6.554	5.763	4.742	3.899	3.390	3.818	4.559	5.846	6.531	7.520	7.800

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.25	-30.35	7.281	6.532	5.745	4.735	3.901	3.399	3.814	4.552	5.835	6.499	7.526	7.749
27.30	-30.35	7.281	6.532	5.747	4.739	3.911	3.399	3.834	4.562	5.835	6.501	7.526	7.749
27.35	-30.35	7.282	6.544	5.780	4.741	3.875	3.367	3.786	4.498	5.785	6.430	7.377	7.705
27.40	-30.35	7.176	6.527	5.769	4.724	3.872	3.367	3.786	4.507	5.784	6.415	7.316	7.566
27.45	-30.35	7.331	6.664	5.853	4.798	3.924	3.375	3.825	4.557	5.834	6.460	7.465	7.786
27.50	-30.35	7.353	6.701	5.893	4.807	3.917	3.366	3.792	4.533	5.789	6.458	7.431	7.778
27.55	-30.35	7.338	6.699	5.870	4.779	3.904	3.292	3.706	4.511	5.772	6.441	7.427	7.778
27.60	-30.35	7.403	6.783	5.953	4.813	3.959	3.401	3.793	4.527	5.810	6.564	7.461	7.837
27.65	-30.35	7.393	6.789	5.966	4.815	3.962	3.356	3.793	4.521	5.807	6.567	7.498	7.854
27.70	-30.35	7.371	6.794	5.930	4.822	3.953	3.396	3.813	4.557	5.829	6.622	7.479	7.857
27.75	-30.35	7.090	6.537	5.633	4.650	3.790	3.194	3.686	4.384	5.616	6.271	7.005	7.377
27.80	-30.35	6.950	6.443	5.593	4.440	3.452	2.960	3.297	4.098	5.442	6.137	7.070	7.402
27.85	-30.35	7.236	6.662	5.823	4.742	3.908	3.337	3.795	4.500	5.789	6.391	7.242	7.680
27.90	-30.35	7.003	6.403	5.471	4.239	3.502	2.917	3.280	3.952	5.293	6.084	6.840	7.394
27.95	-30.35	7.098	6.621	5.756	4.715	3.878	3.228	3.668	4.437	5.751	6.343	7.163	7.506
28.00	-30.35	6.958	6.455	5.627	4.635	3.806	3.179	3.637	4.340	5.733	6.246	7.085	7.408
28.05	-30.35	6.958	6.430	5.613	4.585	3.798	3.160	3.626	4.297	5.667	6.246	7.087	7.421
28.10	-30.35	6.655	6.198	5.407	4.465	3.682	3.140	3.506	4.226	5.655	6.172	7.000	7.217
28.15	-30.35	6.610	6.209	5.465	4.542	3.800	3.214	3.590	4.321	5.716	6.163	7.036	7.222
28.20	-30.35	6.282	5.922	5.336	4.516	3.725	3.189	3.471	4.334	5.682	6.038	6.810	6.964
28.25	-30.35	6.082	5.768	5.191	4.534	3.850	3.318	3.731	4.533	5.683	5.921	6.617	6.680
28.30	-30.35	6.050	5.737	5.209	4.544	3.926	3.524	3.839	4.526	5.704	5.927	6.596	6.634
28.35	-30.35	6.373	6.083	5.383	4.596	3.882	3.513	3.837	4.556	5.672	5.945	6.682	6.841
28.40	-30.35	6.328	6.011	5.330	4.437	3.674	3.091	3.464	4.393	5.592	5.893	6.640	6.802
28.45	-30.35	6.677	6.354	5.595	4.717	3.921	3.532	3.857	4.540	5.683	6.003	6.847	7.057
28.50	-30.35	6.757	6.433	5.640	4.736	3.933	3.530	3.861	4.536	5.711	6.043	6.878	7.147
28.55	-30.35	6.757	6.433	5.645	4.741	3.938	3.530	3.867	4.542	5.711	6.045	6.883	7.147
28.60	-30.35	6.917	6.562	5.725	4.757	3.956	3.506	3.873	4.496	5.679	6.161	6.918	7.256
28.65	-30.35	6.877	6.520	5.635	4.697	3.832	3.389	3.726	4.430	5.614	6.087	6.817	7.212
28.70	-30.35	6.756	6.485	5.688	4.713	3.957	3.486	3.856	4.461	5.646	6.107	6.858	7.168
28.75	-30.35	6.598	6.291	5.527	4.558	3.812	3.402	3.740	4.343	5.516	5.969	6.661	6.968
28.80	-30.35	6.612	6.298	5.578	4.644	3.939	3.490	3.825	4.429	5.524	5.987	6.662	6.944
28.85	-30.35	6.603	6.333	5.588	4.674	3.946	3.503	3.849	4.484	5.554	5.964	6.702	6.967
28.90	-30.35	6.603	6.333	5.589	4.674	3.946	3.503	3.849	4.484	5.554	5.965	6.702	6.967
28.95	-30.35	6.665	6.338	5.573	4.646	3.927	3.498	3.829	4.456	5.489	5.900	6.652	6.931
29.00	-30.35	6.641	6.340	5.568	4.641	3.928	3.484	3.822	4.443	5.465	5.879	6.633	6.909
29.05	-30.35	6.641	6.340	5.568	4.641	3.928	3.484	3.822	4.443	5.465	5.879	6.633	6.909
29.10	-30.35	6.700	6.458	5.598	4.705	3.929	3.476	3.840	4.437	5.482	5.968	6.657	6.955
29.15	-30.35	6.700	6.458	5.598	4.705	3.928	3.476	3.840	4.437	5.482	5.968	6.656	6.955
29.20	-30.35	6.658	6.469	5.580	4.698	3.937	3.461	3.840	4.395	5.475	5.944	6.575	6.934
29.25	-30.35	6.454	6.279	5.453	4.582	3.909	3.440	3.814	4.341	5.345	5.764	6.364	6.700
29.30	-30.35	6.462	6.283	5.461	4.618	3.916	3.440	3.813	4.353	5.355	5.775	6.364	6.700
29.35	-30.35	6.056	5.898	5.244	4.474	3.888	3.413	3.773	4.352	5.154	5.493	5.976	6.199
29.40	-30.35	6.056	5.896	5.242	4.460	3.888	3.413	3.773	4.332	5.144	5.493	5.978	6.199
29.45	-30.35	6.209	6.097	5.294	4.520	3.885	3.374	3.728	4.284	5.126	5.482	5.989	6.286
29.50	-30.35	5.665	5.628	4.951	4.369	3.724	3.251	3.604	4.176	4.904	5.111	5.515	5.722
27.05	-30.40	7.427	6.713	5.916	4.817	3.958	3.433	3.854	4.618	5.952	6.681	7.685	7.920
27.15	-30.40	7.354	6.642	5.855	4.785	3.931	3.430	3.848	4.597	5.916	6.657	7.601	7.873
27.25	-30.40	7.174	6.467	5.728	4.701	3.901	3.399	3.814	4.512	5.768	6.483	7.479	7.663

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
27.35	-30.40	7.281	6.558	5.791	4.749	3.872	3.367	3.786	4.512	5.785	6.430	7.397	7.712
27.45	-30.40	7.356	6.637	5.836	4.760	3.915	3.374	3.806	4.511	5.807	6.459	7.423	7.742
27.55	-30.40	7.353	6.701	5.893	4.806	3.916	3.366	3.793	4.533	5.789	6.457	7.431	7.778
27.65	-30.40	7.402	6.789	5.968	4.841	3.973	3.401	3.810	4.571	5.810	6.567	7.498	7.854
27.75	-30.40	7.177	6.602	5.708	4.609	3.684	3.121	3.499	4.296	5.645	6.343	7.198	7.648
27.85	-30.40	7.004	6.472	5.666	4.521	3.534	2.991	3.340	4.256	5.480	6.246	7.075	7.434
27.95	-30.40	7.122	6.621	5.786	4.742	3.894	3.303	3.737	4.444	5.772	6.350	7.213	7.576
28.05	-30.40	6.463	6.111	5.139	4.148	3.434	2.922	3.342	3.959	5.248	5.812	6.602	6.803
28.15	-30.40	6.626	6.123	5.357	4.348	3.465	2.889	3.181	4.113	5.489	6.103	6.924	7.141
28.25	-30.40	6.082	5.768	5.218	4.548	3.929	3.524	3.852	4.554	5.704	5.925	6.617	6.680
28.35	-30.40	6.335	6.049	5.378	4.563	3.879	3.513	3.831	4.519	5.598	5.870	6.645	6.796
28.45	-30.40	6.677	6.344	5.586	4.675	3.912	3.508	3.831	4.491	5.676	5.999	6.827	7.057
28.55	-30.40	6.757	6.433	5.645	4.741	3.939	3.530	3.869	4.542	5.711	6.045	6.883	7.147
28.65	-30.40	6.917	6.565	5.729	4.772	3.965	3.506	3.882	4.529	5.679	6.163	6.921	7.256
28.75	-30.40	6.604	6.323	5.559	4.634	3.850	3.402	3.730	4.387	5.543	5.975	6.680	6.968
28.85	-30.40	6.603	6.333	5.589	4.674	3.943	3.503	3.842	4.484	5.554	5.965	6.702	6.967
28.95	-30.40	6.665	6.338	5.573	4.646	3.927	3.498	3.829	4.456	5.489	5.900	6.652	6.931
29.05	-30.40	6.603	6.311	5.547	4.600	3.826	3.369	3.787	4.407	5.404	5.810	6.615	6.872
29.15	-30.40	6.700	6.458	5.598	4.705	3.928	3.476	3.840	4.437	5.482	5.968	6.656	6.955
29.25	-30.40	6.438	6.204	5.400	4.444	3.636	3.129	3.486	4.173	5.263	5.745	6.323	6.653
29.35	-30.40	6.003	5.867	5.200	4.399	3.765	3.316	3.642	4.305	5.099	5.426	5.960	6.146
29.45	-30.40	6.197	6.094	5.293	4.508	3.875	3.374	3.728	4.273	5.126	5.476	5.988	6.287
27.00	-30.45	7.441	6.711	5.889	4.773	3.912	3.397	3.828	4.594	5.912	6.694	7.683	7.924
27.05	-30.45	7.441	6.712	5.892	4.774	3.918	3.399	3.831	4.594	5.912	6.699	7.683	7.924
27.10	-30.45	7.392	6.657	5.814	4.753	3.890	3.366	3.807	4.552	5.840	6.592	7.571	7.801
27.15	-30.45	7.392	6.657	5.814	4.753	3.890	3.366	3.807	4.552	5.840	6.592	7.571	7.801
27.20	-30.45	7.398	6.672	5.808	4.756	3.888	3.368	3.793	4.547	5.807	6.520	7.518	7.819
27.25	-30.45	7.166	6.514	5.634	4.558	3.683	3.086	3.484	4.379	5.645	6.317	7.351	7.580
27.30	-30.45	7.337	6.612	5.782	4.731	3.878	3.350	3.780	4.511	5.786	6.463	7.469	7.733
27.35	-30.45	7.294	6.646	5.775	4.736	3.853	3.253	3.701	4.494	5.739	6.417	7.364	7.661
27.40	-30.45	7.294	6.600	5.766	4.736	3.773	3.254	3.700	4.427	5.710	6.378	7.364	7.661
27.45	-30.45	7.054	6.412	5.612	4.568	3.812	3.277	3.724	4.407	5.645	6.210	7.232	7.488
27.50	-30.45	6.996	6.415	5.691	4.518	3.747	3.147	3.608	4.374	5.667	6.202	7.161	7.567
27.55	-30.45	7.165	6.511	5.745	4.664	3.861	3.316	3.733	4.496	5.744	6.342	7.297	7.632
27.60	-30.45	7.261	6.642	5.858	4.745	3.895	3.340	3.729	4.489	5.757	6.426	7.338	7.691
27.65	-30.45	7.236	6.642	5.801	4.719	3.891	3.267	3.670	4.481	5.727	6.412	7.277	7.625
27.70	-30.45	7.090	6.503	5.696	4.623	3.825	3.286	3.715	4.429	5.725	6.312	7.208	7.526
27.75	-30.45	6.778	6.212	5.365	4.385	3.590	3.088	3.543	4.273	5.611	6.063	6.916	7.222
27.80	-30.45	6.805	6.212	5.407	4.385	3.673	3.141	3.577	4.305	5.636	6.076	6.966	7.304
27.85	-30.45	6.567	5.945	5.061	3.808	2.725	2.153	2.529	3.595	5.201	5.767	6.664	7.130
27.90	-30.45	6.527	6.030	5.302	4.294	3.575	2.880	3.403	4.119	5.529	5.963	6.817	7.127
27.95	-30.45	6.887	6.284	5.531	4.537	3.860	3.297	3.732	4.426	5.780	6.269	7.124	7.389
28.00	-30.45	6.931	6.350	5.592	4.565	3.774	3.251	3.666	4.383	5.741	6.287	7.146	7.466
28.05	-30.45	6.955	6.453	5.671	4.602	3.655	2.849	3.425	4.391	5.797	6.328	7.232	7.535
28.10	-30.45	6.591	6.145	5.538	4.573	3.866	3.305	3.702	4.365	5.698	6.116	6.969	7.218
28.15	-30.45	6.591	6.143	5.536	4.573	3.867	3.305	3.698	4.367	5.698	6.115	6.969	7.218
28.20	-30.45	6.053	5.732	5.186	4.455	3.822	3.387	3.678	4.462	5.584	5.829	6.484	6.636
28.25	-30.45	6.207	5.849	5.168	4.343	3.513	3.048	3.367	4.306	5.481	5.869	6.492	6.668
28.30	-30.45	6.090	5.789	5.085	4.017	2.631	1.701	2.161	3.849	5.297	5.831	6.541	6.621

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
28.35	-30.45	6.440	6.083	5.430	4.578	3.867	3.490	3.823	4.531	5.625	5.939	6.664	6.824
28.40	-30.45	6.291	5.963	5.372	4.551	3.884	3.485	3.849	4.518	5.660	5.822	6.634	6.748
28.45	-30.45	6.639	6.297	5.517	4.597	3.759	3.373	3.697	4.476	5.541	5.982	6.759	6.955
28.50	-30.45	6.715	6.380	5.618	4.654	3.899	3.488	3.848	4.518	5.631	6.007	6.793	7.032
28.55	-30.45	6.714	6.378	5.618	4.630	3.898	3.488	3.845	4.510	5.627	6.002	6.793	7.032
28.60	-30.45	7.022	6.661	5.769	4.755	3.924	3.486	3.830	4.504	5.663	6.190	6.977	7.346
28.65	-30.45	7.022	6.662	5.779	4.768	3.935	3.486	3.837	4.520	5.663	6.192	6.987	7.346
28.70	-30.45	6.504	6.293	5.548	4.664	3.899	3.446	3.805	4.412	5.488	5.896	6.608	6.852
28.75	-30.45	6.269	6.073	5.411	4.588	3.897	3.437	3.791	4.368	5.443	5.814	6.448	6.675
28.80	-30.45	6.288	6.073	5.409	4.596	3.898	3.437	3.782	4.374	5.443	5.829	6.447	6.675
28.85	-30.45	6.250	6.034	5.397	4.517	3.876	3.439	3.776	4.325	5.347	5.777	6.387	6.577
28.90	-30.45	6.193	5.961	5.336	4.472	3.750	3.355	3.684	4.270	5.329	5.709	6.357	6.531
28.95	-30.45	6.346	6.150	5.462	4.557	3.878	3.420	3.759	4.380	5.356	5.718	6.395	6.616
29.00	-30.45	6.422	6.197	5.487	4.603	3.882	3.458	3.784	4.415	5.406	5.732	6.448	6.695
29.05	-30.45	6.421	6.197	5.488	4.601	3.882	3.458	3.784	4.414	5.406	5.732	6.448	6.695
29.10	-30.45	6.490	6.243	5.490	4.615	3.904	3.438	3.801	4.408	5.369	5.765	6.413	6.654
29.15	-30.45	6.491	6.246	5.490	4.615	3.907	3.438	3.799	4.409	5.369	5.765	6.413	6.654
29.20	-30.45	6.510	6.294	5.462	4.622	3.898	3.419	3.799	4.395	5.358	5.788	6.339	6.676
29.25	-30.45	6.473	6.248	5.443	4.619	3.904	3.434	3.795	4.370	5.310	5.723	6.266	6.595
29.30	-30.45	6.473	6.248	5.442	4.624	3.903	3.434	3.795	4.383	5.310	5.723	6.252	6.589
29.35	-30.45	6.414	6.176	5.407	4.548	3.886	3.364	3.713	4.344	5.231	5.717	6.155	6.502
29.40	-30.45	6.435	6.179	5.417	4.575	3.888	3.397	3.757	4.351	5.244	5.731	6.168	6.520
29.45	-30.45	6.376	6.180	5.311	4.438	3.730	3.275	3.576	4.177	5.113	5.569	6.103	6.502
29.50	-30.45	6.275	6.091	5.284	4.480	3.814	3.350	3.683	4.277	5.085	5.484	5.956	6.325
27.05	-30.50	7.474	6.790	5.928	4.788	3.894	3.378	3.809	4.552	5.852	6.654	7.637	7.884
27.10	-30.50	7.090	6.446	5.857	4.637	3.751	3.261	3.747	4.558	5.827	6.284	7.375	7.953
27.15	-30.50	7.447	6.733	5.855	4.761	3.879	3.367	3.799	4.537	5.852	6.618	7.592	7.862
27.25	-30.50	7.389	6.634	5.799	4.677	3.852	3.331	3.754	4.444	5.712	6.488	7.436	7.748
27.30	-30.50	6.979	6.408	5.823	4.561	3.623	3.125	3.600	4.465	5.720	6.056	7.192	7.714
27.35	-30.50	7.322	6.674	5.785	4.691	3.767	3.117	3.581	4.410	5.715	6.414	7.403	7.734
27.45	-30.50	7.195	6.570	5.710	4.654	3.823	3.207	3.676	4.441	5.708	6.313	7.271	7.557
27.50	-30.50	6.863	6.114	5.755	4.486	3.801	3.279	3.788	4.502	5.791	5.992	7.152	7.718
27.55	-30.50	7.113	6.446	5.647	4.604	3.767	3.168	3.623	4.461	5.680	6.302	7.307	7.551
27.65	-30.50	7.193	6.520	5.786	4.693	3.885	3.316	3.731	4.459	5.767	6.407	7.333	7.680
27.70	-30.50	6.637	6.220	5.701	4.374	3.679	3.052	3.574	4.303	5.661	5.792	6.993	7.461
27.75	-30.50	6.977	6.416	5.510	4.144	3.012	2.329	2.698	3.853	5.374	6.219	7.141	7.448
27.85	-30.50	6.408	5.868	5.099	4.161	3.372	2.742	3.237	3.965	5.489	5.776	6.641	6.903
27.90	-30.50	5.973	5.486	5.062	3.888	3.135	2.658	3.369	3.920	5.612	5.379	6.388	6.933
27.95	-30.50	6.607	6.059	5.297	4.389	3.732	3.151	3.577	4.282	5.623	6.032	6.947	7.195
28.05	-30.50	6.575	6.072	5.366	4.329	3.509	2.989	3.524	4.204	5.463	6.031	6.965	7.108
28.10	-30.50	6.067	5.618	5.336	4.245	3.700	3.152	3.766	4.326	5.692	5.800	6.738	7.247
28.15	-30.50	6.417	5.993	5.340	4.408	3.672	3.131	3.523	4.215	5.597	6.040	6.843	7.051
28.25	-30.50	6.266	5.958	5.282	4.345	3.394	2.810	3.135	4.267	5.533	5.904	6.586	6.745
28.30	-30.50	5.920	5.685	5.299	4.393	3.881	3.381	3.912	4.551	5.743	5.637	6.386	6.937
28.35	-30.50	6.582	6.209	5.495	4.565	3.856	3.479	3.824	4.494	5.543	5.974	6.731	6.948
28.45	-30.50	6.665	6.341	5.572	4.638	3.866	3.474	3.829	4.509	5.599	5.989	6.849	7.072
28.50	-30.50	6.294	6.039	5.582	4.493	3.809	3.309	3.836	4.468	5.655	5.676	6.556	7.188
28.55	-30.50	6.673	6.337	5.589	4.643	3.879	3.467	3.829	4.505	5.591	5.993	6.799	7.055
28.65	-30.50	6.937	6.571	5.727	4.669	3.923	3.473	3.817	4.445	5.560	6.113	6.934	7.238

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
28.70	-30.50	6.231	6.071	5.467	4.331	3.560	2.955	3.368	4.123	5.329	5.546	6.291	6.771
28.75	-30.50	6.318	6.118	5.381	4.326	3.360	2.641	3.097	3.911	5.293	5.727	6.346	6.640
28.85	-30.50	6.153	6.054	5.362	4.534	3.799	3.320	3.683	4.284	5.271	5.649	6.276	6.400
28.90	-30.50	5.909	5.878	5.435	4.474	3.919	3.345	3.875	4.423	5.423	5.465	6.131	6.479
28.95	-30.50	6.170	6.015	5.362	4.577	3.872	3.437	3.775	4.385	5.319	5.611	6.195	6.330
29.05	-30.50	6.245	6.082	5.385	4.604	3.867	3.423	3.760	4.386	5.301	5.606	6.177	6.362
29.10	-30.50	6.189	5.977	5.519	4.524	3.931	3.321	3.874	4.392	5.409	5.466	6.139	6.723
29.15	-30.50	6.430	6.160	5.432	4.597	3.873	3.378	3.764	4.352	5.336	5.703	6.302	6.600
29.25	-30.50	6.515	6.238	5.489	4.628	3.879	3.426	3.767	4.391	5.294	5.698	6.256	6.580
29.30	-30.50	6.221	6.076	5.560	4.534	3.944	3.332	3.847	4.378	5.352	5.424	6.116	6.666
29.35	-30.50	6.543	6.216	5.469	4.599	3.881	3.401	3.745	4.361	5.248	5.724	6.231	6.579
29.45	-30.50	6.462	6.221	5.401	4.538	3.843	3.367	3.689	4.295	5.161	5.669	6.154	6.582
29.50	-30.50	6.126	6.052	5.407	4.430	3.846	3.228	3.772	4.305	5.113	5.346	5.974	6.550
27.05	-30.55	7.412	6.722	5.849	4.729	3.737	3.254	3.630	4.479	5.764	6.565	7.629	7.851
27.15	-30.55	7.397	6.662	5.822	4.700	3.823	3.245	3.743	4.484	5.756	6.582	7.547	7.775
27.25	-30.55	7.389	6.688	5.818	4.740	3.866	3.332	3.772	4.501	5.792	6.493	7.478	7.771
27.35	-30.55	7.347	6.676	5.840	4.741	3.852	3.302	3.765	4.486	5.757	6.432	7.427	7.736
27.45	-30.55	7.214	6.570	5.749	4.637	3.808	3.095	3.650	4.406	5.719	6.321	7.332	7.619
27.55	-30.55	7.213	6.504	5.748	4.670	3.885	3.332	3.756	4.485	5.784	6.398	7.379	7.673
27.65	-30.55	7.121	6.474	5.728	4.646	3.745	3.202	3.580	4.425	5.688	6.313	7.329	7.602
27.75	-30.55	6.856	6.416	5.605	4.508	3.700	3.182	3.626	4.279	5.651	6.130	7.111	7.448
27.85	-30.55	6.442	5.914	5.141	4.197	3.278	2.356	3.013	3.971	5.540	5.852	6.696	6.907
27.95	-30.55	6.661	6.087	5.343	4.420	3.732	3.151	3.577	4.294	5.704	6.117	6.953	7.225
28.05	-30.55	6.664	6.146	5.361	4.454	3.641	3.063	3.500	4.315	5.625	6.131	7.017	7.199
28.15	-30.55	6.396	6.003	5.383	4.410	3.730	3.131	3.517	4.233	5.590	6.055	6.881	7.065
28.25	-30.55	6.277	5.936	5.255	4.377	3.603	3.179	3.490	4.368	5.555	5.897	6.587	6.747
28.35	-30.55	6.587	6.243	5.499	4.588	3.816	3.361	3.744	4.501	5.615	5.976	6.748	6.988
28.45	-30.55	6.665	6.341	5.569	4.636	3.865	3.474	3.837	4.512	5.599	5.988	6.846	7.072
28.55	-30.55	6.652	6.304	5.539	4.615	3.796	3.380	3.745	4.457	5.548	5.980	6.758	7.009
28.65	-30.55	6.935	6.597	5.737	4.704	3.926	3.473	3.826	4.480	5.628	6.114	6.955	7.240
28.75	-30.55	6.354	6.178	5.467	4.635	3.889	3.443	3.780	4.369	5.406	5.796	6.449	6.681
28.85	-30.55	6.213	6.085	5.398	4.577	3.871	3.432	3.770	4.320	5.325	5.712	6.315	6.480
28.95	-30.55	6.132	5.987	5.354	4.533	3.867	3.437	3.767	4.349	5.258	5.601	6.185	6.297
29.05	-30.55	6.224	6.078	5.387	4.593	3.862	3.423	3.766	4.379	5.301	5.603	6.191	6.336
29.15	-30.55	6.430	6.162	5.432	4.623	3.873	3.411	3.765	4.385	5.345	5.703	6.306	6.600
29.25	-30.55	6.515	6.238	5.489	4.628	3.885	3.426	3.771	4.391	5.294	5.698	6.256	6.580
29.35	-30.55	6.543	6.217	5.469	4.584	3.826	3.315	3.651	4.338	5.248	5.724	6.231	6.579
29.45	-30.55	6.440	6.224	5.406	4.547	3.837	3.367	3.694	4.316	5.160	5.656	6.165	6.560
27.05	-30.60	7.426	6.788	5.889	4.770	3.846	3.295	3.705	4.513	5.839	6.688	7.639	7.932
27.15	-30.60	7.486	6.797	5.926	4.791	3.870	3.351	3.777	4.511	5.845	6.662	7.610	7.915
27.25	-30.60	7.230	6.523	5.675	4.587	3.730	3.225	3.676	4.398	5.703	6.323	7.322	7.604
27.35	-30.60	7.184	6.502	5.657	4.574	3.726	3.209	3.660	4.401	5.700	6.264	7.231	7.552
27.45	-30.60	6.889	6.216	5.403	4.372	3.574	3.023	3.522	4.294	5.577	6.033	7.070	7.258
27.55	-30.60	7.055	6.371	5.618	4.533	3.771	3.210	3.667	4.446	5.738	6.289	7.258	7.492
27.65	-30.60	6.917	6.278	5.582	4.504	3.722	3.184	3.630	4.365	5.695	6.243	7.073	7.282
27.75	-30.60	7.038	6.379	5.624	4.521	3.560	2.956	3.381	4.263	5.679	6.279	7.181	7.481
27.85	-30.60	6.722	6.146	5.236	3.656	2.371	1.621	2.032	3.211	5.191	6.060	6.970	7.197
27.95	-30.60	6.757	6.219	5.520	4.533	3.807	3.237	3.569	4.309	5.809	6.323	7.208	7.430
28.05	-30.60	6.673	6.107	5.448	4.488	3.751	3.221	3.534	4.248	5.727	6.258	7.106	7.285

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
28.15	-30.60	6.114	5.747	5.221	4.443	3.670	3.165	3.461	4.209	5.552	5.889	6.623	6.709
28.25	-30.60	6.090	5.781	5.153	4.267	3.422	2.989	3.358	4.230	5.388	5.777	6.485	6.550
28.35	-30.60	6.330	6.022	5.354	4.507	3.823	3.456	3.812	4.471	5.513	5.810	6.640	6.732
28.45	-30.60	6.626	6.225	5.517	4.570	3.841	3.409	3.744	4.463	5.521	5.938	6.745	6.958
28.55	-30.60	6.659	6.284	5.541	4.574	3.740	3.329	3.635	4.411	5.480	5.958	6.763	7.033
28.65	-30.60	6.540	6.258	5.494	4.533	3.734	3.336	3.629	4.276	5.431	5.856	6.704	6.932
28.75	-30.60	6.412	6.190	5.487	4.629	3.874	3.455	3.761	4.372	5.377	5.773	6.396	6.620
28.85	-30.60	6.202	6.080	5.386	4.417	3.568	3.066	3.406	4.141	5.097	5.524	6.205	6.359
28.95	-30.60	6.279	6.046	5.376	4.495	3.730	3.341	3.657	4.244	5.243	5.660	6.225	6.328
29.05	-30.60	6.317	6.190	5.447	4.624	3.860	3.413	3.745	4.351	5.290	5.688	6.277	6.421
29.15	-30.60	6.269	6.048	5.387	4.582	3.834	3.358	3.714	4.305	5.246	5.610	6.182	6.407
29.25	-30.60	6.293	6.019	5.358	4.554	3.858	3.364	3.723	4.317	5.165	5.590	6.097	6.399
29.35	-30.60	6.428	6.178	5.473	4.593	3.846	3.364	3.703	4.315	5.194	5.655	6.219	6.499
29.45	-30.60	6.212	6.021	5.354	4.518	3.811	3.331	3.679	4.262	5.066	5.475	5.905	6.242
27.05	-30.65	7.426	6.788	5.889	4.778	3.872	3.364	3.792	4.518	5.839	6.689	7.639	7.932
27.15	-30.65	7.462	6.796	5.881	4.768	3.758	3.284	3.700	4.454	5.806	6.645	7.602	7.909
27.25	-30.65	7.150	6.431	5.534	4.446	3.550	3.044	3.435	4.174	5.615	6.218	7.127	7.515
27.35	-30.65	7.078	6.471	5.588	4.530	3.722	3.209	3.660	4.348	5.674	6.244	7.131	7.405
27.45	-30.65	6.942	6.187	5.360	4.265	3.439	2.886	3.329	4.212	5.513	6.068	7.051	7.278
27.55	-30.65	7.046	6.369	5.615	4.528	3.758	3.210	3.651	4.443	5.738	6.281	7.256	7.492
27.65	-30.65	6.973	6.278	5.541	4.467	3.722	3.184	3.630	4.348	5.610	6.215	7.123	7.325
27.75	-30.65	6.982	6.420	5.614	4.568	3.800	3.129	3.666	4.367	5.658	6.228	7.160	7.404
27.85	-30.65	6.814	6.278	5.440	4.429	3.604	2.859	3.344	4.055	5.685	6.180	7.063	7.330
27.95	-30.65	6.757	6.200	5.519	4.467	3.679	3.131	3.430	4.201	5.788	6.323	7.183	7.419
28.05	-30.65	6.641	6.127	5.442	4.498	3.751	3.221	3.534	4.275	5.771	6.238	7.115	7.245
28.15	-30.65	5.983	5.655	5.116	4.363	3.619	3.093	3.383	4.117	5.518	5.884	6.601	6.757
28.25	-30.65	6.113	5.812	5.209	4.439	3.797	3.432	3.785	4.480	5.519	5.821	6.506	6.592
28.35	-30.65	6.330	6.022	5.353	4.507	3.819	3.456	3.803	4.471	5.513	5.809	6.640	6.732
28.45	-30.65	6.608	6.213	5.466	4.433	3.623	3.161	3.503	4.315	5.468	5.924	6.711	6.958
28.55	-30.65	6.638	6.300	5.473	4.432	3.683	3.143	3.472	4.311	5.437	5.940	6.734	6.988
28.65	-30.65	6.583	6.296	5.531	4.612	3.862	3.447	3.777	4.390	5.498	5.902	6.724	6.972
28.75	-30.65	6.412	6.190	5.486	4.613	3.812	3.367	3.671	4.353	5.378	5.774	6.389	6.620
28.85	-30.65	6.332	6.178	5.428	4.547	3.757	3.335	3.648	4.251	5.278	5.706	6.279	6.474
28.95	-30.65	6.306	6.146	5.439	4.607	3.862	3.427	3.746	4.379	5.303	5.690	6.280	6.398
29.05	-30.65	6.300	6.193	5.454	4.637	3.869	3.413	3.753	4.378	5.290	5.691	6.291	6.421
29.15	-30.65	6.269	6.060	5.392	4.582	3.827	3.358	3.714	4.299	5.246	5.610	6.190	6.407
29.25	-30.65	6.288	6.062	5.330	4.547	3.782	3.282	3.642	4.297	5.148	5.542	6.054	6.409
29.35	-30.65	6.294	6.073	5.340	4.382	3.477	3.066	3.393	4.049	4.998	5.541	6.141	6.382
29.45	-30.65	6.100	5.914	5.281	4.340	3.639	3.061	3.548	4.099	4.870	5.415	5.837	6.133
27.05	-30.70	7.517	6.893	5.955	4.781	3.886	3.360	3.787	4.514	5.863	6.706	7.701	8.047
27.15	-30.70	7.476	6.833	5.919	4.771	3.849	3.338	3.770	4.501	5.823	6.666	7.632	7.993
27.25	-30.70	7.288	6.687	5.764	4.654	3.695	3.103	3.600	4.406	5.711	6.491	7.447	7.781
27.35	-30.70	7.078	6.405	5.631	4.449	3.635	3.157	3.580	4.296	5.681	6.324	7.319	7.633
27.45	-30.70	7.031	6.428	5.679	4.492	3.520	2.345	3.109	4.392	5.814	6.451	7.406	7.716
27.55	-30.70	6.971	6.402	5.628	4.553	3.860	3.357	3.732	4.481	5.817	6.471	7.292	7.625
27.65	-30.70	7.002	6.402	5.622	4.447	3.575	2.952	3.321	4.348	5.737	6.392	7.321	7.630
27.75	-30.70	7.082	6.410	5.615	4.478	3.626	2.979	3.474	4.287	5.627	6.309	7.173	7.543
27.85	-30.70	6.760	6.044	5.280	4.063	2.930	2.519	2.778	3.649	5.114	5.938	6.811	7.221
27.95	-30.70	6.903	6.299	5.613	4.621	3.861	3.343	3.700	4.442	5.778	6.369	7.237	7.463

Improved Solar Database for Lesotho													
Lon	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
28.05	-30.70	6.816	6.229	5.579	4.602	3.825	3.309	3.672	4.365	5.745	6.305	7.154	7.363
28.15	-30.70	6.134	5.747	5.257	4.399	3.503	2.930	3.275	4.140	5.497	5.903	6.664	6.730
28.25	-30.70	6.088	5.785	5.203	4.413	3.765	3.421	3.756	4.411	5.441	5.725	6.396	6.461
28.35	-30.70	6.258	5.958	5.323	4.497	3.764	3.413	3.750	4.424	5.447	5.748	6.456	6.567
28.45	-30.70	6.261	5.958	5.381	4.495	3.738	3.303	3.676	4.370	5.367	5.775	6.469	6.579
28.55	-30.70	6.437	6.139	5.466	4.531	3.718	3.311	3.622	4.322	5.359	5.763	6.506	6.671
28.65	-30.70	6.331	6.110	5.439	4.540	3.803	3.398	3.712	4.306	5.363	5.679	6.381	6.493
28.75	-30.70	6.119	5.903	5.301	4.506	3.798	3.402	3.705	4.282	5.300	5.627	6.207	6.305
28.85	-30.70	6.222	6.041	5.373	4.528	3.807	3.399	3.723	4.302	5.271	5.626	6.165	6.332
28.85	-30.70	6.222	6.041	5.373	4.528	3.807	3.399	3.723	4.302	5.271	5.626	6.165	6.332
28.95	-30.70	6.305	6.144	5.390	4.540	3.724	3.318	3.664	4.310	5.252	5.613	6.174	6.381
29.05	-30.70	6.376	6.223	5.461	4.592	3.825	3.378	3.717	4.330	5.278	5.658	6.244	6.467
29.15	-30.70	6.361	6.190	5.469	4.583	3.805	3.347	3.702	4.294	5.252	5.646	6.243	6.453
29.25	-30.70	6.118	5.942	5.269	4.506	3.754	3.279	3.625	4.261	5.083	5.477	5.936	6.184
29.35	-30.70	6.365	6.155	5.452	4.568	3.843	3.350	3.681	4.277	5.147	5.616	6.143	6.420
29.45	-30.70	5.890	5.731	5.147	4.432	3.771	3.317	3.660	4.217	4.928	5.276	5.605	5.874
27.05	-30.75	7.580	6.906	5.984	4.804	3.869	3.332	3.781	4.511	5.850	6.721	7.725	8.096
27.15	-30.75	7.471	6.844	5.921	4.741	3.826	3.306	3.750	4.470	5.799	6.617	7.610	7.968
27.25	-30.75	7.245	6.653	5.820	4.649	3.772	3.167	3.653	4.403	5.694	6.545	7.508	7.788
27.35	-30.75	7.185	6.530	5.715	4.569	3.756	3.221	3.662	4.396	5.723	6.419	7.425	7.717
27.45	-30.75	7.155	6.535	5.764	4.632	3.776	3.270	3.669	4.456	5.825	6.565	7.529	7.822
27.55	-30.75	7.063	6.452	5.738	4.578	3.857	3.287	3.669	4.490	5.814	6.573	7.459	7.771
27.65	-30.75	7.026	6.409	5.631	4.541	3.734	3.230	3.580	4.424	5.662	6.397	7.340	7.581
27.75	-30.75	7.060	6.454	5.676	4.612	3.800	3.300	3.691	4.421	5.722	6.311	7.257	7.563
27.85	-30.75	7.105	6.459	5.713	4.662	3.880	3.361	3.735	4.460	5.734	6.382	7.300	7.643
27.95	-30.75	6.930	6.275	5.640	4.532	3.753	3.174	3.611	4.301	5.627	6.293	7.167	7.436
28.05	-30.75	6.755	6.145	5.507	4.393	3.457	2.998	3.339	4.114	5.565	6.212	7.084	7.296
28.15	-30.75	5.980	5.571	5.176	4.369	3.710	3.179	3.496	4.254	5.433	5.776	6.468	6.576
28.25	-30.75	6.026	5.738	5.199	4.329	3.538	3.198	3.532	4.282	5.346	5.604	6.322	6.360
28.35	-30.75	6.215	5.889	5.321	4.470	3.746	3.397	3.721	4.381	5.402	5.684	6.436	6.581
28.45	-30.75	6.022	5.770	5.180	4.402	3.617	3.210	3.588	4.260	5.223	5.561	6.203	6.302
28.55	-30.75	6.184	5.932	5.278	4.352	3.455	2.970	3.252	4.137	5.243	5.596	6.297	6.433
28.65	-30.75	6.179	5.950	5.267	4.357	3.658	3.327	3.634	4.206	5.180	5.535	6.123	6.255
28.75	-30.75	5.911	5.743	5.168	4.450	3.767	3.360	3.669	4.222	5.202	5.486	5.980	6.052
28.85	-30.75	5.981	5.814	5.183	4.414	3.659	3.263	3.549	4.220	5.148	5.445	5.979	6.076
28.95	-30.75	6.263	6.073	5.388	4.524	3.802	3.384	3.727	4.306	5.226	5.569	6.131	6.293
29.05	-30.75	6.316	6.174	5.416	4.566	3.804	3.366	3.719	4.340	5.247	5.595	6.188	6.399
29.15	-30.75	6.262	6.113	5.375	4.431	3.471	3.049	3.385	4.091	5.162	5.593	6.156	6.373
29.25	-30.75	6.086	5.904	5.299	4.507	3.677	3.252	3.563	4.225	5.075	5.465	5.893	6.120
29.35	-30.75	5.957	5.847	5.234	4.443	3.772	3.301	3.634	4.169	4.996	5.334	5.754	6.025
29.45	-30.75	5.857	5.710	5.133	4.422	3.755	3.303	3.642	4.195	4.899	5.248	5.571	5.848