

# OVERVIEW OF A SATELLITE-DERIVED GLOBAL CLIMATOLOGICAL DATA SET FOR SOLAR AND WIND ENERGY RESOURCE ASSESSMENT

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## ABSTRACT

The focus of a Surface meteorology and Solar Energy (SSE) commercial outreach project of NASA's Earth Science Enterprise Program (ESE) Office is to distribute, via the Internet, a global climatological data set of radiation and meteorology parameters useful for resource assessment in the renewable energy industry. Release 3 of the SSE web site <http://eosweb.larc.nasa.gov/sse/>, now contains over 100 parameters which can be accessed in tabular or graphical format which the user defines. A user accessing the site can select from these parameters and produce an image displaying the data on the globe, or they can define their own region to display the data. This release of the SSE data set contains more accurate estimates of resource parameters in comparison to previous releases.

The SSE data set is being utilized as a standalone data source and as a data link to RETScreen® - a renewable energy project analysis software tool developed by Natural Resources Canada to evaluate the annual energy production, costs, and financial viability of renewable energy technology projects. The success of the SSE data set and web site is attributed to interactions with the renewable energy industry in an effort to provide scientific data that is meaningful to the industry and organized in a useful manner. The intent of this paper is to provide an overview of the SSE web site and to present, for audience review at FORUM 2001, additional parameters that are not currently available on the web site as possible candidates for insertion into the web site at a future date.

## 1. INTRODUCTION

The renewable energy industry is changing the face of the energy market all over the world. The technologies being

used vary from the simple solar cooker, to the more complex photovoltaic and wind energy systems. However, to make these technologies viable in an area is the need for information. Is the area prone to too many cloudy days in a particular month? What is the typical wind speed for the area during a given month? Questions like these need climatological solar and meteorological data to help industry professionals make informed decisions about the applications they are designing.

In October 2000 the third release of the SSE data set and web site was made public. The SSE project continues to provide the renewable energy industry an added resource to aide in designing applications. The data set has improved resolution and accuracy. It contains 35 additional parameters, including temperature, wind, and relative humidity. With these additions the SSE commercial outreach project designed the site to be easy to access with more intuitive methods to locate the desired area and data of interest.

## 2. BACKGROUND

The SSE data was calculated from International Satellite Cloud Climatology Project (ISCCP) D-1 data and NASA Goddard Earth Observing System Version 1 (GEOS-1) meteorology. In 1996 the SSE commercial outreach project released its first data set providing global coverage on a low-resolution 2.5-degree equal-area grid system. This initial release provided the renewable energy industry with 57 parameters. At that time it was a 4-year climatology spanning March 1985 through December 1988. The web site provided access to data by 9 pre-selected regions over the globe, or through latitude/longitude location values that the user entered.

Through continuing collaborations and discussions with industry and government users the SSE data set has grown to over 100 parameters provided on a higher resolution 1-degree grid system, and is a 10-year climatology spanning June 1983 through July 1993. The web site gives the user control in defining their own area of interest on a globe and the ability to view the data on a map or in tabular form.

### 3. ACCURACY OF RELEASE 3 DATA SET

Estimates of uncertainty for SSE insolation values for near average El Nino and La Nina years over the same time period can be found in Table 1. The SSE data was compared with quality ground site measurement data provided by the World Radiation Data Center (WRDC). The WRDC data set contains historical ground site measurement data. The National Renewable Energy Laboratory (NREL) distributes the WRDC insolation data for 1195 ground sites for the period from 1964 through 1993 on the following web site (<http://wrdc-mgo.nrel.gov/>).

When more than one station was located in a grid cell, the ground measurement values were averaged for comparison to the SSE data. Not all ground stations were operating every year. Following usual industry standards, estimated uncertainty is assumed as the Root-Mean-Square (RMS) difference when large sample sizes exist and statistical correlation has been performed. Bias is included in the RMS values.

It is generally considered that measured data are more accurate than satellite-derived values. The SSE data set should not be used to take the place of quality ground measurement data. Measurement uncertainties are not precisely known for the WRDC ground measurement data set, therefore SSE differences from ground measurements are considered as estimates of uncertainty.

TABLE 1: SSE ESTIMATED UNCERTAINTIES

Near-Average Years	WRDC Interior Regions	WRDC Coastal Zones
1983-2nd Half	11.7%	12.9%
1984	13.8%	13.1%
1985	13.5%	12.5%
1986	13.1%	13.7%
1990	15.5%	15.4%
El Nino Years		
1987	14.5%	14.6%
1991	17.0%	15.3%
1992	15.4%	13.7%
1993-1st Half	14.9%	15.4%
La Nina Years		
1988	14.8%	13.8%
1989	14.9%	13.9%

### 4. DESCRIPTION OF RELEASE 3 WEB SITE

Release 3 of the SSE web site was made public in October 2000. This release features more than 100 parameters, improved accuracy, and a user-friendly method of locating and viewing data.

#### 4.1 Locating and Viewing Data

By selecting the Meteorology and Solar Energy link on the main page of the SSE web site the user is given an option of whether they want to view data tables of a location, or a plot of a parameter the user chooses.

To view a data table for a location the user can either submit their desired latitude/longitude values, or if they do not know the latitude and longitude they can use a clickable globe to zoom in on their area of interest. Once the area has been chosen the user can then select the parameter(s) that they would like to view in tabular form. An example of an SSE data table is shown in Table 2.

TABLE 2: SSE DATA TABLE EXAMPLE

Insolation (kWh/m <sup>2</sup> /day)												
Lat 0 Lon 0	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10 Year Average	5.04	5.74	5.43	4.91	5.28	5.31	5.39	5.49	5.64	5.60	5.67	5.37

By Choosing the Global/Regional Plots link the user is shown a map of the globe. By using a mouse the user can define two corners of a rectangular region to produce an area of the globe they would like to view. Scrolling down the window the user can select a month and a parameter. The smallest region can be 6 by 6 degrees. Clicking the submit button produces the plot of the desired region and parameter. An example is shown in Figure 1.

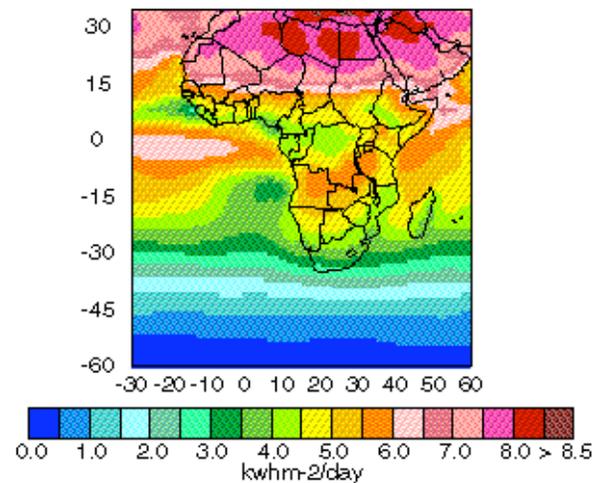


Fig. 1: Monthly Average Insolation for July 1986.

By using their browser the user can then generate an image of their plot.

#### 4.2 SSE Success

Since its public release in 1996 the SSE web site has had increased usage, as can be seen in Figure 2.

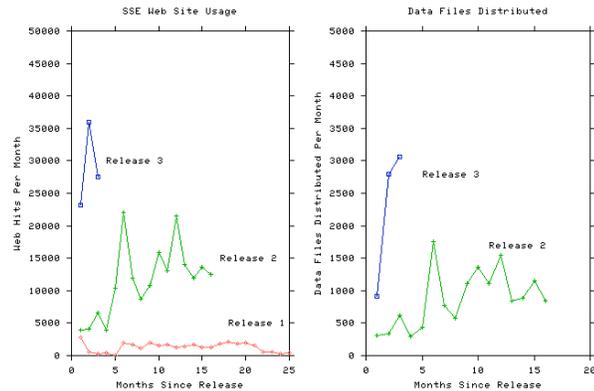


Fig. 2: Web site statistics since 1996.

During the 16-month period that the release 2 web site was online a total of 1991 users registered to download data from the site. Users included people from The World Bank, BP Amoco, and Siemens Solar Industries, among many other individuals from government and university settings.

When release 3 was made available in October 2000 it was expected to have wider appeal within the energy industry as well as to educational institutions because of the additional parameters and advanced user-designed graphics capability. So far, web site statistics has shown this expectation.

#### 5. THE FUTURE OF SSE

The SSE data has been limited to a 10-year data period. Requests have been made for more recent data at higher spatial resolution. Data from such projects as the Global Energy and Water Cycle Experiment, Clouds and Earth's Radiant Energy System, and Goddard Earth Observing System Version 3 should be applied to commercial applications as soon as possible.

The needs of industries such as architecture can be met with an improved data set. In the U.S., buildings account for 62% of electricity use, 36% of total energy consumption, 37% of ozone depletion, and 30% of greenhouse gas emissions. The architectural industry has shown it is possible to design new buildings that require 50% less energy for the same construction costs. To help architects meet lower energy design parameters, the SSE is working

to provide this industry with the necessary global solar and meteorology data.

There are other fields/industries that may benefit from NASA ESE surface solar and meteorology data, such as Environment and Human Health, Hydrology, Precision Agriculture, and Urban Climatology. Preliminary contacts indicate each area has good possibilities for future ESE applications.

The SSE data set and web site were created to be a resource for the renewable energy industry. The future and continued success of the SSE project depends on collaborations and discussions with industry professionals. It is encouraged that anyone with information or experience in the fields and areas discussed in this paper provide feedback to inform the SSE what information could be useful.

#### 6. CONCLUSION

The SSE commercial outreach project of the NASA ESE program continues its mission to provide quality satellite-derived climatological solar and meteorology data. In October 2000 the third release of the SSE data set and web site was made public. In response to user-requests the number of parameters available in the data set was increased giving the renewable energy industry more information to aide in application design and assessment. The web site was made easier to navigate to give the user more control in viewing and accessing data.

With continued interaction with industry professionals the SSE commercial outreach project will continue to provide the renewable energy industry with a convenient and free repository of quality solar and meteorology data.

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