NASA GLOBAL METEOROLOGY AND SOLAR ENERGY DATA USED IN DESIGN SOFTWARE

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ABSTRACT

The Surface meteorology and Solar Energy (SSE) project delivers NASA satellite-derived data useful to the renewable energy industry. The SSE web site is continuously revised to fit the needs of its users. Direct use of the data by renewable energy assessment and design software has been implemented. One goal of the SSE project is to provide data for additional software tools that are in use or under development today.

The SSE web site location is <http://eosweb.larc.nasa.gov/sse/>. All of the web documents are delivered on the fly. There are applications to view data in tabular and graphical outputs. Supporting documentation includes geometry, accuracy, methodology, parameter units and definitions, frequently asked questions, related web sites, comments and questions mailing list, and usage statistics.

1. SSE DATA SET

The SSE data set is a continuous 10-year global climatology (July, 1983 - June, 1993) of satellite-derived insolation and meteorology data on a one-degree latitude by one-degree longitude grid (Whitlock, et al, 2000). The data source is the International Satellite Cloud Climatology Project (ISCCP) C-1 data and the NASA Goddard Earth Observing System Version 1 (GEOS-1) meteorology. There are parameters for sizing and pointing solar panels, solar thermal applications, cloud information, temperature, humidity, and wind (Figure 1) parameters.

Local climatological data from ground measurement stations are a useful asset for renewable energy projects. The global coverage of the SSE data set fills the gap for remote locations lacking ground measurement data. Most ground measurement stations are located near populated regions that may have natural or urban influence on the local climate. The SSE data set, averaged over a one-degree latitude by one-degree longitude grid, can augment ground measurement data affected by microclimates. The SSE data are considered accurate for preliminary feasibility studies of renewable energy projects.

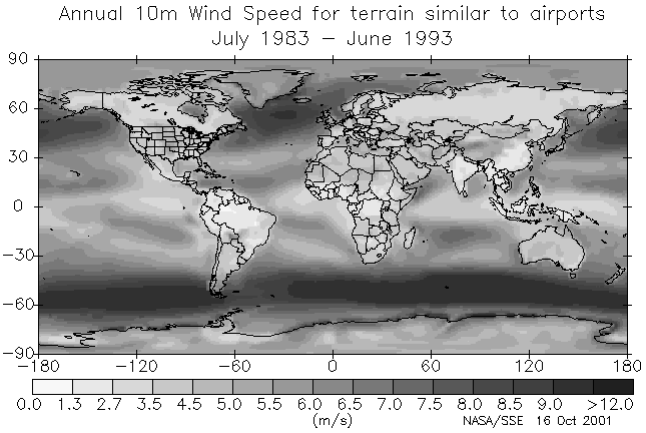

Fig. 1: Annual 10m Wind Speed for terrain similar to airports.

2. SSE WEB SITE HISTORY

The first release of the SSE data set became available via the Internet in 1997. The SSE data was presented in a scientific style using static documents and graphics.

Release 2 of the SSE web site (1999) was revised to speak the language of the renewable energy industry. Several industry partners were enlisted to advise about useful

parameters and simplify the presentation. The SSE web site was redesigned, allowing users to select just the parameter data tables and definitions of interest to them. Additional data types were calculated on the fly from parameters in the database. An application to plot the average daily global radiation data for 1195 ground sites from the 30-year World Radiation Data Centre data set was added. The first application designed to provide data directly to a renewable energy assessment tool like RETScreen® International (RETScreen) was developed (see section 4).

Dynamic data mapping and graphical location selection were introduced in Release 3 of the SSE data set and web site (2000). The underlying database was redesigned to store data for global maps and expanded data tables. This redesign allowed users the freedom of displaying global maps of monthly averaged parameters or zooming in on any region as small as six by six degrees of latitude and longitude. It also allowed the selection of one to more than 100 parameters to view in tables. After choosing a location and parameters the user is presented with 10-year averaged data for all months.

3. SSE WEB SITE TODAY

<http://eosweb.larc.nasa.gov/sse/>

Release 4 of the SSE data set and web site (2002) has grown to provide more than 150 parameters and has made accessing the data more straightforward. Four new applications have been included (Figure 2). SolarSizer (see section 5) is the first photovoltaic system design software to import data directly from its own SSE web site application.

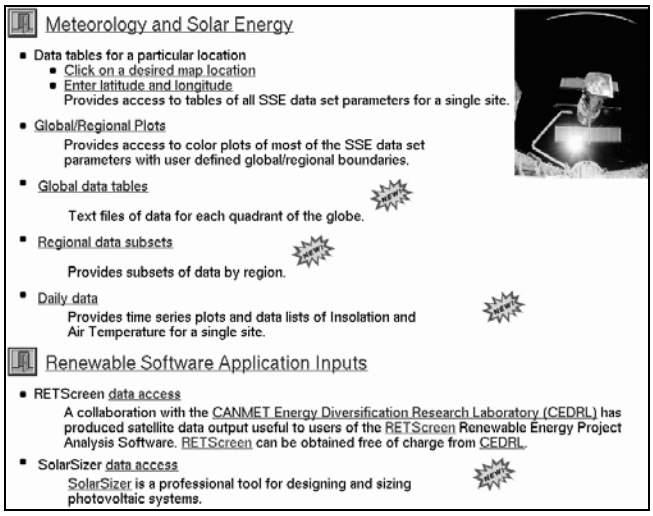

Fig. 2: SSE web site snapshot showing new applications.

The specialized applications for RETScreen and SolarSizer allow quick insertion of SSE data. They rely on the standard SSE database and provide navigation to the full suite of information on the SSE web site.

New ideas have come from user comments and requests. Efforts to continually refine the global resource assessment data are ongoing.

4. RENEWABLE ENERGY PROJECT ANALYSIS

Within a year following the implementation of web based access to the SSE data set we were approached by the developers of RETScreen, a renewable energy project analysis software tool developed by Natural Resources Canada's CANMET Energy Diversification Research Laboratory (Leng, et al, 2002). Collaboration ensued, resulting in an SSE web application designed to meet the specific needs of RETScreen. Cooling and heating design temperatures, heating degree days and average summer daily temperature range are a few of the new parameters calculated and presented in a format that may easily be inserted into RETScreen (Table 1). Each model requires one to six of these parameters.

TABLE 1: RETSCREEN MODELS AND SSE PARAMETERS

RETScreen Models	**SSE daily, monthly and/or annual average values**
Wind Energy Small Hydro Photovoltaics Solar Air Heating Biomass Heating Solar Water Heating Passive Solar Heating Ground-Source Heat Pumps	Horizontal solar radiation Wind speed Atmospheric pressure Relative humidity Ambient temperature Heating degree-days Heating design temperature Cooling design temperature Summer daily temperature range Frost days Earth (skin) temperature Annual earth (skin) temperature amplitude

RETScreen offers two options for inserting insolation and weather data into the RETScreen models. Data from the RETScreen weather database may be pasted into the RETScreen models with the press of a button. Drop down menus provide a selection of more than 1,000 locations of ground monitoring stations worldwide. This is useful if the project is located near one of those stations.

The second option is to use NASA satellite-derived data. This is useful if the project is located away from any

ground monitoring stations. RETScreen menus (Figure 3) and worksheets offer multiple paths to the SSE data.

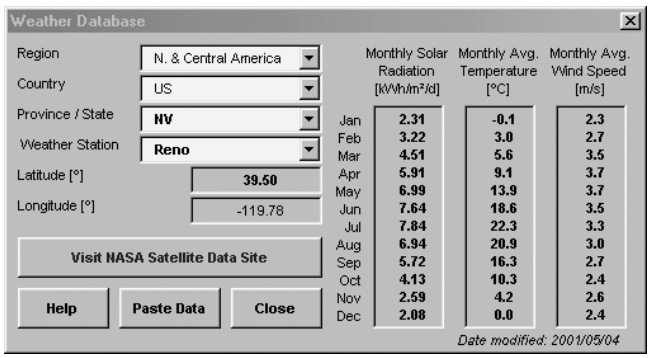

Fig. 3: One of several options for inserting data into RETScreen Models.

RETScreen is a series of Microsoft® Excel workbooks and worksheets. A user must have an Internet connection and browser to find the appropriate data on the SSE web site. Although the data tables are presented in horizontal rows by parameter type (Figure 4), simple clipboard cut and paste methods allow replacement of the RETScreen worksheet entries.

NASA Surface meteorology and Solar Energy Data Set
RETScreen Data
Latitude 39.54 / Longitude –119.82 was chosen.

RETScreen Model(s) chosen:
Solar Air Heating

Average Daily Radiation on Horizontal Surface (kWh/m²/day)

Lat 39.54 Lon –119.82	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10 Year Average	2.31	3.28	4.34	5.81	6.62	7.34	7.64	6.61	5.87	3.89	2.50	2.02

Average Temperature (° C)

Lat 39.54 Lon –119.82	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
10 Year Average	0.05	1.53	4.28	7.92	11.6	17.8	23.0	22.6	17.2	11.3	3.25	–0.42	10.0
El Nino Year (1987)	–1.28	0.15	3.01	10.1	13.2	19.6	20.5	23.2	19.3	14.5	3.62	–1.77	10.3
La Nina Year (1988)	–0.28	2.18	3.77	7.98	10.9	18.6	25.3	24.0	18.2	15.1	2.77	–1.08	10.6

Average Wind Speed (m/s)

Lat 39.54 Lon –119.82	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average
10 Year Average	3.32	3.43	3.39	3.25	3.38	3.37	3.22	3.11	3.27	3.22	3.41	3.43	3.31
El Nino Year (1987)	3.48	3.29	3.57	3.26	2.90	3.16	3.39	3.03	2.92	2.71	3.22	3.94	3.23
La Nina Year (1988)	3.45	3.03	3.34	3.35	3.69	3.36	3.10	2.89	3.48	2.93	3.59	3.60	3.31

Fig. 4: The SSE web site data for a RETScreen Model.

5. PHOTOVOLTAIC SYSTEM DESIGN

Concurrently, several potential users suggested additional useful parameters and web site content. Among them were Solar Energy International and the Center for Renewable Energy and Sustainable Technology (CREST). The developers of SolarSizer, CREST's professional tool for designing and sizing photovoltaic systems, wished to design new modules that could directly use the SSE data set (Olson and Woods, 2001). We co-developed applications on the SSE web site and in SolarSizer. The latest version of SolarSizer ingests time series and monthly averaged insolation data from the SSE web site when those data types are required.

6. FUTURE

RETScreen and SolarSizer have become integral SSE web site applications. The SSE project group wishes to partner with more developers of renewable energy design tools that are in use or under development today. Any smart building, wind power and solar energy software that would benefit from NASA's satellite-derived data are welcome additions to the SSE suite of web applications.

7. REFERENCES

(1) Leng, Gregory J., A. Monarque, R. Alward, N. Meloche and A. Richard, Canada's Renewable Energy Capacity Building Program & Retscreen® International, Proceedings of the World Renewable Energy Congress VII, 2002

(2) Olson, Ken and E. L. Woods, Development of NASA Langley's Solar Energy Satellite Data Set For Solar Energy Systems Design, Proceedings of the FORUM 2001 Solar Energy: The Power To Choose Conference, American Solar Energy Society, 2001

(3) Whitlock, Charles H., D. E. Brown, W. S. Chandler, R. C. DiPasquale, N. Meloche, G. J. Leng, S. K. Gupta, A. C. Wilber, N. A. Ritchey, A. B. Carlson, D. P. Kratz, and P. W. Stackhouse, Release 3 NASA Surface Meteorology and Solar Energy Data Set For Renewable Energy Industry Use, Proceedings of Rise and Shine 2000, The 26th Annual Conference of the Solar Energy Society of Canada Inc. and Solar Nova Scotia, 2000