SOLAR SPECTRUM

Newsletter of the Resource Assessment Division

Volume 14, Issue 1 – March 2001 **of the American Solar Energy Society®**

NASA/SAIC PROJECT: CLIMATIC DATA SETS FOR ARCHITECTURAL APPLICATIONS

by Roberta DiPasquale

The first year of a two-year project, *Climatic Data Sets for Architectural Applications*, was funded through the NASA Langley Creativity and Innovation Fund. The focus of this architectural project, which is an extension of the Surface meteorology and Solar Energy Project, is the development of a prototype satellite-derived data set for architectural design programs specializing in energy-efficient design.

Frank Lloyd Wright was our country's first sustainable architect who oriented his buildings with the sun, and incorporated daylighting and passive heating techniques. He referred to his design style as organic architecture. Today we would call it sustainable. Approximately five percent of the architects registered with the American Institute of Architects' (AIA) are listed as practicing sustainable design. Architect William McDonough, the first recipient of the Presidential Award for Sustainable Development and Interiors' 1999 Designer of the Year, noted that global warming and toxic waste can be designed out of existence by adopting nature's regenerative principles. These principles include designs that are energy efficient, possibly energy generating, and have a benign impact on the environment. They form the basis of sustainable building design and are embraced by the AIA Committee on the Environment.

In the U.S. alone, buildings account for 62% of electricity use and 36% of total energy consumption. U.S. Buildings also account for 37% of ozone depletion potential and 30% of greenhouse gas emissions.

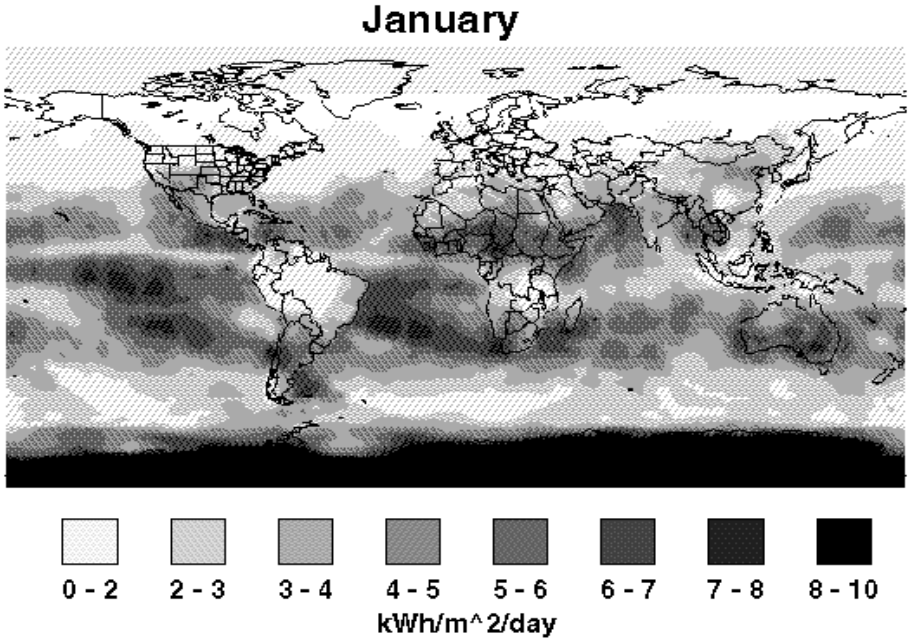

Fig. 1. *SatSMet/Perez Global Estimates for January 1986.*

An international DOE scientist (Dr. Douglas Balcomb) recently announced that industry now has the capability to design and construct buildings that use 50% less energy at no increase in construction cost if accurate environmental data are available. Therefore, environmental data (various temperature, solar radiation, illumination, winds, cloud cover, and humidity parameters) become the cornerstone of the design process. By inputting environmental data into modern building design programs, computer simulations are generated which perform en-

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Inside This Issue

Solar Spectrum is the newsletter from the Resource Assessment Division of the American Solar Energy Society and is published on a semi-annual basis. The purpose of this newsletter is to inform division members of events in the resource assessment field and activities of the division and its members.

Success of the newsletter depends on your contributions.

You are encouraged to send comments, letters, or short articles to the Editor:

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I would like to thank Daryl Myers and Roberta DiPasquale for their contributions to this newsletter.

Deadline for contributions to the next newsletter is February 1, 2001.

Frank Vignola

Resource Assessment Division Officers & Board Members

Gary Vliet, Chair
Bob Cable, Vice Chair
David Renné, Secretary

Ray Bahm	June 2001
Mark Beaubien	June 2002
Doug Balcomb	June 2002
John Dunlop	June 2002
Dan Greenberg	June 2001
Bill Marion	June 2001
Rob Nelson	June 2001
Richard Perez	June 2002

Upcoming Events

Forum 2001
April 21-25, 2001
Solar Energy:
The Power to Choose

Washington, DC
Information: ASES
2400 Central, G-1
Boulder, CO 80301
Tel 303-443-3130
Fax 303-443-3212
Email: ases@ases.org
http://www.solarenergyforum.org

Presented By: American Institute of Architects—Committee on the Environment; American Society of Mechanical Engineers—Solar Energy Division; American Solar Energy Society; American Society of Heating Refrigerating and Air-Conditioning Engineers; Interstate Renewable Energy Council; Maryland DC Virginia Solar Energy Industries Association; National Association of Home Builders; Potomac Region Solar Energy Association; Society of Building Science Educators; Solar Energy Industries Association; Sustainable Buildings Industry Council; Utility PhotoVoltaics Group

RAD Division Nominees

Roberta DiPasquale of NASA Langley/SAIC Surface Solar Energy Project was elected RAD Vice Chair and David Rennè of NREL is was elected Secretary. Congratulations!

Four RAD members were elected to the board. Jim Augustyn of Augustyn and Company, Bill Marion of the National Renewable Energy Laboratory, Lorin L. Vant-Hull of the Unversity of Houston, and Robe Nelson of Heliakos. The RAD division again has a strong board.

The new officers and board members take their position in April at the annual meeting. Bob Cable, current Vice Chair, will also become Chair as is stipulated in the bylaws.

Thanks should be given to Gary Vliet who has served as chair and to Ray Bahm and Dan Greenberg for the service to the division for the past two years.

Email Addresses for Resource Assessment Division Members

In order to open communications between RAD division members, the following members circulated their Email address at the RAD division annual meeting. If you are not on this list and would like to add your name to the list, contact Solar Spectrum's editor and your Email address will be added to the list and published in the next newsletter.

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Cecile Warner	cecile@nrel.nrel.gov

Resource Assessment Activities at FORUM 2001

The annual meeting of the Resource Assessment Division and several sessions are scheduled for FORUM 2001.

The annual meeting of the RAD division is scheduled for Sunday **April 22**, 2001 from 4:30 to 6:00 pm. This is a chance to learn about resource assessment activities and to share your interests. This meeting will give us a change to develop a resource assessment agenda that we can present to our congressional representatives while we are in Washington, D.C.

On Monday **April 23** from 10:30 am to noon, a forum called **"Solar Radiation: Instrumentation Data Forms and Databases"** will be held. This is a teaching session for those wishing to be up-dated on solar radiation measurements and data sources. The topics for the planned session are:

a) Solar radiation measurement instrumentation, Frank Vignola

b) Data forms and available databases, (hard copy and web based) - David Renné

c) Satellite Measurements/Data. (applications, resolution and accuracy) - Richard Perez

The intent is to have three persons each make about a 30 minute presentation.

This is geared for a mixed audience of newcomers as well as those somewhat familiar with the technology (but not necessarily experts, i.e. this is not intended to be research oriented).

Also on Monday April 23 from 4:00 pm to 5:30 pm is the first solar resource assessment technical session called **Advancements in Radiometer Measurements.**

Four papers will be presented.

- D.R. Myers, T.L. Stoffel, I. Reda, S. Wilcox, *NREL*, Recent Progress in Reducing the Uncertainty in and Improving Pyranometer Calibrations.
- S. Wilcox, *NREL*, Improving Global Solar Radiation Measurements Using Zenith Angle Dependent Calibration Factors.
- S. Wilcox, *NREL*, Using Irradiance to Determine the Need for Radiometer Calibrations.
- I. Tyukhov and D.S. Strebkov, *VIESH*, I.N. Govor, D.F. Sedyh, A.M. Borisov, *VNIIFTRI*, Monitoring of the Solar Earth Energy Relationships.

On Tuesday April 24 from 2:00 pm to 3:30 pm will be another solar resource assessment technical session called **Analysis of Solar Resource Data.**

- R, Perez, M. Kmiecik *ASRC*, R. George, *NREL*, A. Zelenka, *MeteoSuisse*, D. Renné, *NREL*, Determination of the Effective Accuracy of Satellite-Derived Global, Direct and Diffuse Irradiance in the Central United States.
- F. Vignola, *University of Oregon*, Variability of Solar Radiation over Short Time Intervals.
- R. DiPasquale, *Science Applications International Corp., et al Company* and RW. Stackhouse, Jr., *NASA Langley Research Center*, Comparison of Measured Direct Normal Radiation to Estimates Modeled from Satellite Data.
- R. George, P. Gray-Hann, *NREL*, NREL North American Solar Radiation Atlas.
- D. Brown, W.S. Chandler, *Science Applications International Corp.*, Overview of a Satellite-Derived Global Climatological Data Set for Solar and Wind Energy Resource Assessment

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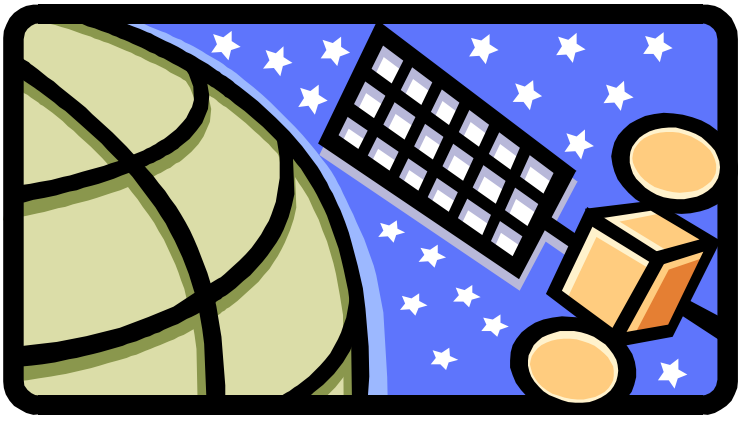
On Wednesday, April 25 from 8:30 am to 10:00 am there is another technical session called **Climate and Solar Resource Data Sets.**

- D. Renné, *NREL*, Has Climate Change Affected Solar Energy Resources?
- C.H. Whitlock, *Science Applications International Corporation, et al*, Global Solar Energy Anomalies during El Niño and La Niña Years.
- R. Perez, J.A. Bonaventura-Sparagna, M. Kmieeik, *ARSC*, D. Ronne, R. George, *NREL*, Cloud Cover Reporting Bias at Major Airports.
- M. Ibáñez, *Universitat de Lleida*, S.A. YJein, W.A. Beckman, *University of Wisconsin*, A New Generalized Frequency Distribution for the Daily Clearness Index.
- K. Olson, *SoL Energy* E. Woods, *Sunnywood Design*, Development of NASA Langley's Solar Energy Satellite Data Set for Solar Energy Systems Design.

There are many other excellent presentations at this conference. So far approximately 2000 people have registered.

UNEP's Resource Assessment Project Moves Forward

by David Renné National Renewable Energy Laboratory



In early November 2000, the GEF (Global Environment Facility) Council conditionally approved the United Nations Environment Programme's (UNEP's) Solar and Wind Energy Resource Assessment (SWERA) project for full funding. Once final approval is secured the GEF will allocate to UNEP over $6M in support of SWERA's 3-year activities. These funds will go to support the SWERA agencies and the participating countries for developing and disseminating the resource data over the next three years. The SWERA agencies that have been developing the project over the past year and a half include NREL, SUNY/Albany, the UNEP/GRID in Sioux Falls, SD, Riso National Laboratory, DLR in Germany, Teri in New Delhi, India, and INPE in Sao Jose dos Campos, Brazil.

The SWERA project is designed to develop high quality solar and wind energy resource assessment data and maps for countries that have endorsed the project, and to disseminate these data through the UNEP GRID (Geographic Resource Information Database). The data will be incorporated into Geographic Information Systems software packages and tools in formats that will allow energy planners and project developers to have a much more complete picture of the renewable energy resources in their country, and the potential for developing those resources.

A number of different types of data will be made available to SWERA. For solar these include the low-resolution, global solar data developed through NASA's Surface Solar Energy program, medium resolution climatological solar data developed using NREL's Climatological Solar Radiation model, and high resolution site/time specific data using techniques developed at SUNY/Albany and DLR. These high-resolution techniques make use of data collected by geostationary weather satellites, such as GOES, Meteosat, and the INSAT. INPE's high-resolution solar mapping methodologies will also be applied to South America. For wind, the high-resolution (1-km) wind resource mapping techniques developed at NREL will be the primary tool, with support for specific areas using Riso's wind mapping techniques. Wind mapping methods under development at Brazil's wind energy center will also be applied in that country. Locations where multiple techniques are being applied will allow for cross-model intercomparison studies by the SWERA team.

An important aspect of SWERA is to have all these data incorporated into a standard GIS framework. NREL is taking the lead in this area, and will also be developing GIS tools that allow users to perform a variety of analytical tasks to help in data interpretation and in understanding project development potential.

Countries that have currently endorsed the project, and for which the high-resolution wind and solar mapping methodologies will be applied, include Guatemala, Honduras, Nicaragua, El Salvador, Cuba, Brazil, Algeria, Ghana, Kenya, Ethiopia, China, Nepal, Bangladesh, and Sri Lanka. The medium resolution solar mapping will be conducted for four large regions around the world that encompass all of these countries.

Earlier in the project development phase it had been understood that India would also endorse SWERA. However, recently India officially decided to withdraw from the project. Ethiopia, whose endorsement came too late for the GEF Council review, will likely be invited to replace India. The UNEP and GEF believe that, once the initial countries have obtained the high quality data and tools for their regions, other countries will seek funding support to join in future SWERA activities. The UNEP is considering several mechanisms by which the project can continue with additional countries and new funding sources, once the current three-year program has been initiated. The vision of the entire SWERA

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Real Time PV Performance and Solar Radiation Data Available on the Web

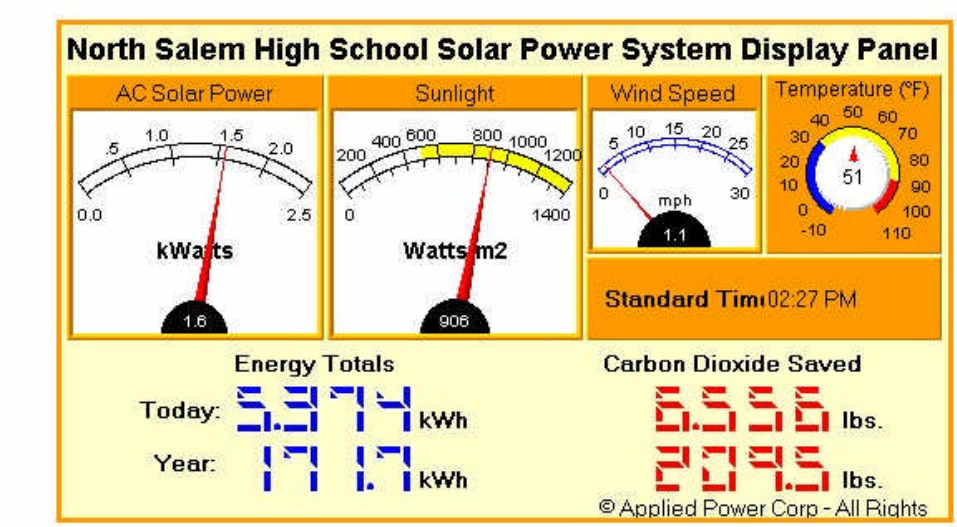

Fig. 1. Applet for the North Salem High School photovoltaic power system during a sunny period. The data was taken on March 2, 2001 at 2:27 pm PST.

One can now view real time solar radiation on the web at selected sites around the country. Ascension Technology, now part of Applied Power Corporation, developed a real time display that shows solar radiation data and the electrical output of PV arrays. A list of sites with this capability can be found at http://www.ascensiontech.com/rtdinfo/rtdpage.html.

An example of the information available is shown in the above applet for North Salem High School. Note the meters showing AC 'solar 'power out of the array and the incident sunlight. Also shown are meters for wind speed and ambient temperature.

A useful feature of the display is that one can click on the temperature or the wind speed and the units will change from ºF to Celsius. For wind speed the units are changed from miles per hour to meters per second. This is a good way to get students to think about units.

Also shown on the applet is the total electricity produced up to the current time during the day and the total amount of electricity produced over the year to date.

On the bottom right of the figure, the electricity produced is translated into the amount of carbon dioxide saved (or not produced). In this example, 1 kWh of electricity produced the photovoltaics prevent the addition of 1.2 lbs of carbon dioxide being dumped into the atmosphere by burning coal to produce the equivalent amount of electricity.

Given the electrical power output of the array in kW and the incident solar radiation in Watts/m^2, it is possible to estimate the actual performance (or efficiency) of the array. Of course one needs to know the size of the array to make such calculations.

The array in Salem produces 1.6 kWatt of AC power when the solar radiation is 906 watts/m^2. A good exercise would be to have students estimate the efficiency of the solar cell array given that the array covers 125 ft^2.

UNEP's Resource Assessment Project Moves Forward

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technical team is for a global high-resolution solar and wind atlas to evolve.

The version of the SWERA project document that was approved by the GEF Council in November can be found on the http://GEFWEB.ORG web site by selecting: Documents, Council Documents, November 2000, Work Programme, Projects. The SWERA document is available for downloading under Climate Change.

NREL Establishes New Center for Distributed Power

Changing Electricity Market Demands Greater Flexibility, New Solutions

Golden, Colo., Jan. 8, 2001 - The nation's straining electrical generation system can be enhanced by moving away from an historic reliance on "mega" power plants and toward a network of dispersed, smaller-scale generation facilities.

That concept, known as "distributed power," will be advanced by a newly established research center at the U.S. Department of Energy's National Renewable Energy Laboratory (NREL).

The Distributed Energy Resources Center at NREL will conduct research and provide information needed to efficiently develop additional power supplies from relatively small, decentralized generating units, ideally operated at or near the commercial and residential sites they serve. This involves both interconnectivity systems that enable electricity produced by a variety of sources to flow onto the grid and specialized technologies for producing the new power itself.

Electrical generation technologies that are well suited for the emerging distributed power market include small natural gas turbines, as well as those that tap into renewable energy sources such as the sun, wind and biomass.

"Coming up with ways to get these various planned generating units to connect up safely, reliably and economically onto the existing electric power grid will be a formidable undertaking," said Stan Bull, NREL Associate Director for Science and Technology.

"When you add the challenges presented by the pressure for rapid deployment of state-of-the-art generation technologies, the need for the Distributed Energy Resources Center becomes readily apparent."

Bull will serve as acting director while a national search is conducted for a permanent center director. The center, with a budget of approximately $10 million for fiscal year 2001, is organized around three units: Resource and Environmental Evaluation, Distributed Power Systems Integration, and Hydrogen and Natural Gas Systems.

Resource and Environmental Evaluation will develop methods for analyzing environmental impacts and site requirements for locating distributed power systems. This will include mapping pertinent regions for their sun, wind or biomass production potential, as well as for wildlife and other environmental considerations. NREL's Tom Stoffel was named the center's acting manager for Resource and Environmental Evaluation.

Tom Stoffel, acting director of Resource and Environmental Evaluation

To support the Distributed Power Systems Integration mission, NREL has planned a new facility to test methods and equipment for interconnecting distributed power systems. The facility will be located at an existing laboratory site, 18200 State Highway 128, between Golden and Boulder.

A primary role of the testing facility will be to help develop universal standards to assure the performance and safety of distributed power equipment. That effort is critical because different electrical generation technologies produce power with widely varying characteristics. The data produced by the center will be used by standards-writing bodies to develop consensus test standards and by independent organizations to formally certify distributed power equipment.

Dick DeBlasio, who led NREL's earlier work on distributed power, has been named the new center's manager of Distributed Power System Integration.

Hydrogen and Natural Gas Systems will combine existing research at NREL into what are two of the most promising areas of distributed power generation: fuel cells and microturbines. Much of the currently planned growth in electrical generation capacity will come from advanced microturbines powered by natural gas, and many experts believe fuel cells that produce electricity from hydrogen have unlimited potential in the years ahead.

NREL's Jim Ohi will manage Hydrogen and Natural Gas Systems for the center.

This month NREL is sponsoring a conference in Washington, D.C. at which key issues surrounding distributed power will be examined. The U.S. Department of Energy Distributed Power Program Review and Planning Meeting, Jan. 15 through 19, will identify priorities for future work, including the development of interconnection standards for distributed power. To learn more, visit DOE's Distributed Power Program Web site.

For more information on that meeting, contact Megan Maguire at NREL, 303-275-4321.

NASA/SAIC PROJECT: CLIMATIC DATA SETS FOR ARCHITECTURAL APPLICATIONS

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ergy/cost trade-off studies.

One of the key scientific parameters required by the sustainable building design industry is the Direct-beam Normal Radiation (DNR) of the sun. Ground measurements of DNR throughout the world are limited. However, satellite data can be used to calculate global estimates of DNR by applying industry-accepted conversion models. The development of global DNR estimates has been the primary focus of work to date. Two conversion models - Perez and Page – are being investigated for estimating DNR using the output of the Pinker/Laszlo Shortwave Algorithm (a physical model) and the newly developed Langley Parameterized Shortwave Algorithm (LPSA). The Perez and Page conversion models consist of linear equations derived statistically from multi-climatic ground measurement data sets. Fig. 1 is a global plot of DNR calculated from the Perez model for January 1986. This year can be considered a near average year with only a slight influence of El-Nino weather fluctuations. Fig. 2 shows a DNR comparison of NREL TMY (average year) with estimates from the Perez model for January 1986. The plots are in fairly good agreement although two different methods and supporting data sets were employed to derive DNR. Ongoing investigations will involve comparisons of model calculated DNR to ground measurements of DNR to determine the most accurate model for the development of this satellite-derived architectural data set.

NOAA-11

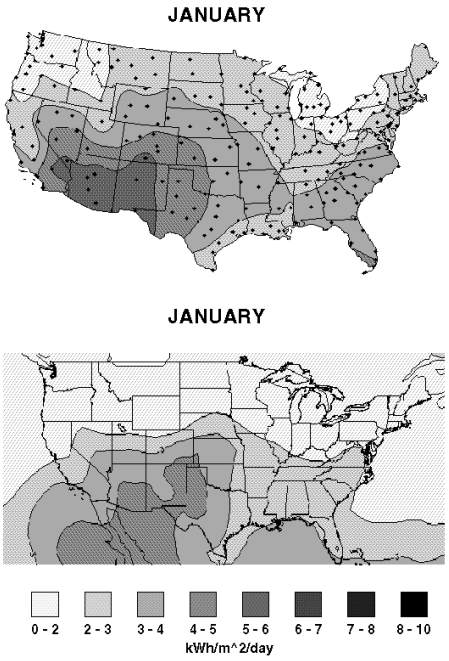

Fig. 2. *Comparison of TMY Measured and SatSMet/Perez Estimates of DNR for January.*
Top: NREL/TMY
Bottom: SatSMet/Perez

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In This Issue... *UNEP's Resource Assessment Project Moves Forward*

More Accurate Diffuse Measurements

Eppley Black and White pyranometers shine in measurements of diffuse irradiance. It is difficult to obtain accurate diffuse measurements because the instrument must be shade from the direct sunlight at all times. Shadowbands do this well, but they also block out some diffuse radiation from the rest of the sky. To eliminate this problem automatic trackers with shade disks are needed to block out only the direct sunlight.

Accurate diffuse measurements are now being obtained with automatic trackers with shade disks. With the improved diffuse measurements comparisons can be made to modeled predictions. On clear days, the average diffuse irradiance is ~100 W/m^2 or less. Therefore small systematic errors that aren't apparent in global measurements can significantly affect the new diffuse measurements.

During the nighttime it is well known that the Eppley PSP re-radiates to the night sky and this results in small negative readings over the nighttime. It turns out that this also occurs during the day and this results in a 10 to 20% systematic error in the diffuse reading on clear days.

Climate modelers have been concerned about the measured diffuse data because the values were lower than the values calculated from complex models. This systematic error helps account for some of this discrepancy.

It turns out that old black and white pyranometers, long maligned because of their azimuthal variation, have a much smaller re-radiation problem and are excellent for diffuse measurements. While the black and white wedges do re-radiate to the night sky, they both re-radiate about the same amount. The re-radiation difference is on the order of 1-2 W/m^2 instead of the 10-20 W/m^2 observed with the WMO first class thermopile radiometers (Ibrahim Reda—NREL).

When a black and white pyranometer is mounted on a tracker, the same orientation is preserved between the sun and the black and white wedges. This means that the variation in the responsivity with azimuthal angle disappears. When a Schenk pyranometer (similar to the Eppley B&W pyranometer) was mounted on a tracker to calibrate the instrument, its calibration characteristics over the day compared very will with an Eppley PSP. While this is a very limited comparison, it does show that the black and white pyranometers would make excellent instruments for diffuse measurements when mounted on an automatic tracker.

Schenk Star type pyranometer