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Texas Solar Radiation DataBase (TSRDB) by Gary C. Vliet

Introduction

A state-wide network of solar radiation monitoring stations was established in Texas in 1996-97 and data have been obtained from the 15 station network since that time. The network consists of 10 Ascension rotating shadowband pyranometers (RSP's) and 5 Eppley instruments with Sci-Tec trackers. These instruments are located at the sites indicated by the 'circle' and 'square' symbols in Figure 1 (Page 4). The Ascension RSP stations are located at: Abilene, Big Spring, Calallen, Del Rio, Laredo, Menard, Overton, Pecos, Presidio, and Sanderson and the data are in 15 minute intervals. The Eppley/Sci-Tec stations are located at: Austin, Canvon, Clear Lake, Edinburg and El Paso, and the data are in 5 minute intervals. The 10 Ascension/RSP stations (Class 2) measure global and diffuse and cal-

culate the direct normal, while the Epply/Sci-Tec stations (Class 1) measure global, diffuse and direct normal. Each of the 15 sites is phone linked to the Solar Energy Laboratory at the University of Texas at Austin, and the data are downloaded to the laboratory's computers on a daily basis. The solar radiation data acquired under this project is designated the Texas Solar Radiation DataBase (TSRDB), and a TSRDB web site has been developed for dissemination of this data. This approximate 4 years of TSRDB data along with the 17 Texas sites in the National Solar Radiation DataBase (NSRDB) provide fairly good coverage of the state. The NSRDB Texas sites are shown in Figure 2 (Page 5). The Austin station was established in 1985 so that data is now of approximately 16 years duration. The entire TSRDB data set consists of measured data and is about 4 years of

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NREL Developing Plans to Update the 1961-1990 NSRDB

by NREL's Solar Resource Assessment Team

NREL's solar resource assessment team will continue to focus its efforts in FY02 on developing high quality national and international solar data sets, performing analyses on solar data to support a variety of industry and government initiatives, and disseminating these data through improved web-based geospatools.

Of particular importance this coming year will be the beginning of the process to update the 1961-1990 National Solar Radiation Data Base (NSRDB) to include the decade of 1991-2000. There is evidence that there

may be a long term trend toward decreasing solar insolation in many locations around the world, as reported by Dr. Dave RennÈ at the Solar Forum 2001 in Washington, DC. The Intergovernmental Panel on Climate Change's (IPCC's) Third Assessment Report has also noted that there appears to be an increasing trend in cloud cover over many parts of the world, which could be attributed to a warmer and moister climate now than in the earlier part of the century. There is also a general consensus by industry and investors that they should be using

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SOLAR 2002 Sunrise on the Reliable Energy Economy June 15-19, 2002 in Reno, Nevada Technical paper abstract submittal deadline: November 1st

NREL Developing Plans to Update the 1961-1990 NSRDB

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only the most recent data for sizing solar system

and evaluating their performance. Given these points, we believe that such an update is necessary.

However, this effort poses a unique challenge for us. During the 1990s, the U.S. National Weather Service modernized and streamlined the way it had been collecting observations at airport stations around the country with the Automated Surface Observation Station (ASOS). ASOS has essentially removed the need to conduct human observations, which had been the practice for the past century, at these stations. Because of the limited number of actual solar monitoring stations in the U.S., the 1961-1990 NSRDB made extensive use of the much larger network of airport stations that maintained human observations. These observations included estimates of the fraction of sky cover at various levels, as well as the amount of cloud cover that was opaque to direct The METeorologicalsunlight. STATistical (METSTAT) model was then developed to convert these observations to hourly estimates of direct normal, diffuse, and global horizontal radiation at each

station for the entire period.

ASOS, however, uses quite a different approach for providing cloud cover observations. The approach is based on an instrument known as a ceilometer: a zenith-looking device that uses a low-powered laser beam to determine the height of cloud bases immediately above the instrument. The process for producing a cloud fraction observation each hour is to track the readings from the ceilometer for the thirtyminute period prior to the observation, and then use an algorithm to convert the measured cloud base heights (when detected by the instrument) to cloud fraction. We have found in preliminary studies that the different approaches results in changes in cloud fraction values between the periods when human observations were made and the current ASOS observations. Furthermore, an observation on opaque cloud cover, which was an important input to the METSTAT, is no longer available with ASOS.

Further complicating the issue is the situation at the larger airports, where some of the hourly ASOS observations are "augmented" by human observations. As reported by Dr. Richard Perez, SUNY/

Albany, and colleagues at the Solar Forum 2001 in Washington, DC, this results in a significant bias at these larger stations when compared with simultaneous observations made only by ASOS at nearby smaller airports. This bias is most noticeable under clear-sky conditions, where we suspect that human observers may observe clouds that were not detected in the narrow view of the ceilometer. and thus report a higher cloud fraction than was reported at the smaller stations. In fact, there is evidence from the Dr. Perez study, based on a comparison of surface observations with satellite data, that these augmented values would actually result in a poorer estimate of solar resources than just by using the ASOS observations alone!

All of these studies lead us to believe that it is still very important to update the NSRDB taking into account new observation schemes so that we can maintain a continuous, long-term database of value to industry and planners. However, new techniques must be adopted for the observations made in the latter half of the 1990s to make that decade consistent with earlier decades.

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NREL Developing Plans to Update the 1961-1990 NSRDB

(Continued from page 2)

One approach we will take will be to use the high-resolution satellite-derived data for the U.S. that is being produced at SUNY/Albany for NREL. An archive of these data begins at about the same period of time that ASOS was implemented. We will examine ways in which these data can be used in place of ASOS data, and related back to the period of time when human observations were being made. Where solar radiation measurements are available, these will be incorporated into the update and will be a critical tool for validating the change in observation and data modeling methods for the latter 1990s.

We are always interested in the views of others on this topic, both on the importance of maintaining an updated database, and in methodologies for performing the updates. We welcome your comments, and encourage you to forward them to david_renne@nrel.gov.

Division Meeting Minutes

by Dave Renne

22 April 2001 Washington, DC



In attendance: Jim Augustyn, Robert Cable, Roberta DiPasquale, Daryl Myers, Rob Nelson, Richard Perez, Dave Renné, Lorin Vant Hull, Frank Vignola, Gary Vliet.

The meeting was called to order by the Division Chair, Gary Vliet, at 4:45, 22 April 2001, prior to the start of Forum 2001.

New officers were introduced:

- Robert Cable, incoming Chairman
- Roberta DiPasquale, newly-elected vice-Chair
- Dave Renné, newly-elected Secretary

New RAD Board Members were introduced: Jim Augustyn, Bill Marion, Lorin Vant Hull, Rob Nelson.

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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 increase awareness of the 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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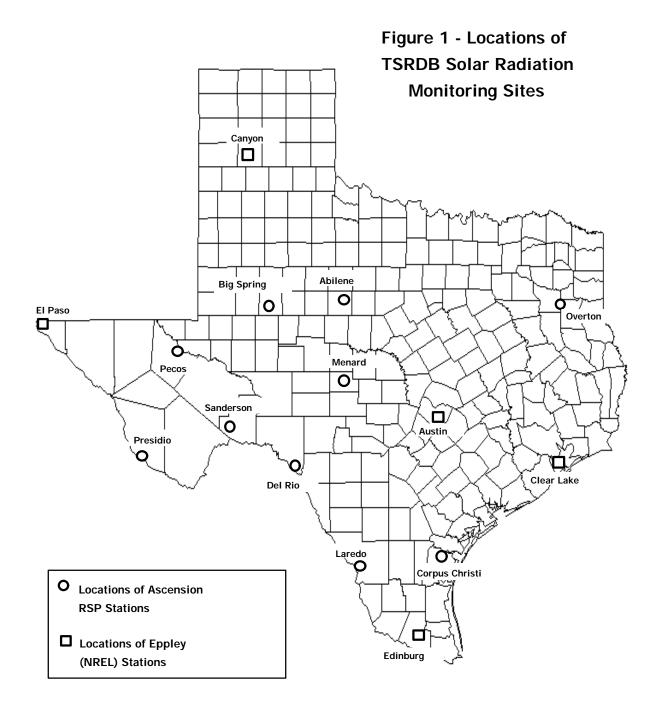
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I would like to thank Gary Vliet and Dave Renne for their contributions to this newsletter.

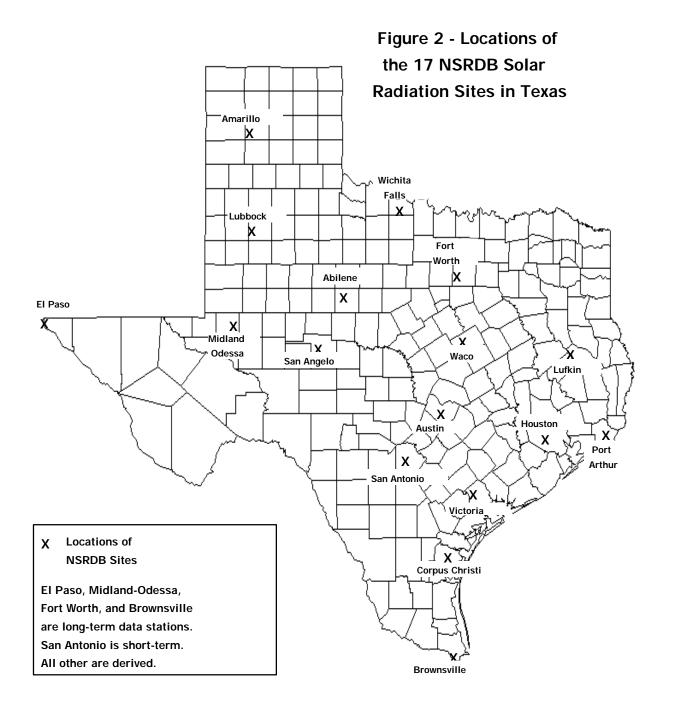
Resource Assessment Division Officers

Bob Cable, Chair Roberta DiPasquale, Vice-Chair David Renne, Secretary

Texas Solar Radiation DataBase (TSRDB)



Texas Solar Radiation DataBase (TSRDB)



Texas Solar Radiation DataBase (TSRDB)

(Continued from page 1)

duration, while the NSRDB data set is long term but has only 4 sites with measured data.

Solar Radiation Data

Both the global horizontal and direct normal data generally increase with distance from the coast, and also from east to west, as is expected and generally consistent with the NSRDB data.

For any location, both forms exhibit higher levels in summer than winter, as is expected.

A comparison of the solar data in the TSRDB and NSRDB data sets has been made for common locations or nearby locations in the two sets. This is done by month for the global and direct normal components and the percent differences are TSRDB-NSRDB normalized to TSRDB. The paired locations are:

Abilene – Abilene
Austin – Austin
Big Spring – Midland
Canyon – Amarillo
Calallen – Corpus Christi

Edinburg – Brownsville
El Paso – El Paso
Menard – San Angelo
Overton – Lufkin
Pecos – Midland

Clear Lake – Houston

For the pair listed the first location refers to the TSRDB site and the second location to the NSRDB site. In some cases the two are coincident and for others they are 'nearby'. There were no nearby sites in the NSRDB for comparisons with the Del Rio, Laredo, Presidio or Sanderson, data.

Table 1 (Page 8) summarizes the results of these comparisons for the eleven locations. In assessing these comparisons, one observes in general that:

- There is reasonably good agreement between the global horizontal values for the two data sets. While the individual monthly differences range from –18.3% (Edinburg/Nov.) to +12.5% (Pecos/Sept.), the annual averages varied only from –8.8% (Austin) to 8.7% (Pecos). Overall, the TSRDB global horizontal data is about 1-2% lower than that in the NSRDB, thus the global horizontal data can be considered fairly reliable.
- (2) There are considerably larger differences in the direct normal values for the two data sets, with the NSRDB values on average being lower. The monthly values ranged from –21% Menard/June) to +49% (Edinburg/Jan.). The average annual difference for the 11 locations compared is about +9%, with Austin being the only location where the NSRDB direct normal data exceeded the TSRDB data.
- (3) The greatest deviations in the direct normal data between the two sets are for coastal locations in the winter. For the three coastal locations compared: Clear Lake/Houston, Calallen/Corpus Christi and Edinburg/Brownsville, the average difference for the months of December and January is +41%. Thus, the NSRDB set severely underestimates the direct normal solar radiation for those coastal locations in the winter. There is certainly a strong solar gradient near the coast and the three sets of locations compared are not identical sites. That Edinburg is about 50 miles inland from Brownsville, and Calallen is a few miles inland from Corpus Christi might partly explain the difference. However, Clear Lake is about 20 miles closer to the coast than Houston and a similar difference is observed, so the distance between sites compared does not explain the differences observed. Thus, differences in direct normal radiation near the coast between the two sets of data are felt to be real.
- (4) The TSRDB Pecos data appear to exhibit significantly higher solar radiation than does the NSRDB (Midland), particularly in the case of direct normal solar radiation. This could suggest that the Trans-Pecos region in west Texas exhibits significantly higher solar radiation than generally accepted. Midland and Pecos are only about 100 miles apart and it is not expected that this distance in west Texas would explain the difference in the comparison.

Texas Solar Radiation DataBase (TSRDB)

(Continued from page 6)

In making these comparisons, a number of differences in the TSRDB and NSRDB data sets are to be noted:

- The NSRDB is a long-term data set, while TSRDB is a 3.5 to 4.5 year data set.
- Most of sites in the NSRDB have modeled data, while all of the sites in the TSRDB have measured data.
- c. Some unusual climate/weather features occurred during the TSRDB data period, El Nino and the fires in Central America. El Nino could be a major factor in the comparison. The Central American fires resulted in considerable smoke extending into south and central Texas during May/June of 1998.

Solar Radiation Data Web Site

A Web site for the Texas Solar Radiation Data-Base (TSRDB) has been established to make the solar radiation data available to the public. The web site address is:

http://www.me.utexas.edu/~solarlab/tsrdb.html

The web site includes solar radiation data for the 15 sites in the TSRDB, summary data for the Texas stations in the NSRDB, and links to other related web sites.

Detailed Report

A recent detailed reporting on the project is available in: "Development of Baseline Solar Radiation data for Texas", University of Texas at Austin, Final Report to the Texas State Energy Conservation Office, May 2001.

Sponsors

The primary sponsor of this work has been the Texas State Energy Conservation Office (SECO). NREL loaned the five Eppley-Sci-Tec stations to the project.

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E-mail Addresses for Division Members



This list is provided to open communications between RAD division members. If you would like to be added to this list, please contact the editor of the Solar Spectrum.

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Table 1: Texas Solar Radiation DataBase (TSRDB)

TSRDB	NSRDB	TSRD	Color					£ 1								۸۰
ISKUB	NOKUB	B B	Solar				N	Month								An- nual
Loca-	Location	Years	Data	1	2	3	4	5	6	7	8	9	10	11	12	
tion				% Diff	% Diff	% Diff	% Diff	%	% Diff	% Diff	% Diff	% Diff	% Diff	% Diff	% Diff	%
				,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Diff	, , , , , , , , , , , , , , , ,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	, , , , , , , ,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	, , , , , , , ,	,, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Diff
Abilene	Abilono	2.5	GHI	1.0	F 0	F 0	F 2	2.2	0.1	3.3	0.5	4.4	10 E	1.6	0.5	1 1
Abliene	Abilene	3.5	DNI	-1.9 9.8	5.8 23.8	-5.9 4.4	5.3 18.4	3.2	-9.1 -11.2	3.3 17.1	-0.5 8.7	4.1 21.3	-10.5 -5.1	-1.6 13.9	-9.5 6.2	-1.4 9.7
<u> </u>			DINI	9.6	23.0	4.4	10.4	9.6	-11.2	17.1	0.7	21.3	-5.1	13.9	0.2	9.7
Austin	Austin	14	GHI	-14.4	-14.3	-10.1	-4.8	-9.1	-6.1	-1.7	-2.0	-3.2	-8.8	-14.4	-16.5	-8.8
			DNI	-6.1	-14.1	-8.4	1.7	-15.2	-11.0	-3.2	-2.4	0.0	-7.1	-12.3	-8.4	-7.2
Big Spring	Midland	4	GHI	-3.7	-4.2	-4.7	-3.2	0.6	-2.4	5.5	-2.7	3.3	-0.9	-1.6	2.5	-1.0
			DNI	2.1	5.2	5.5	7.9	7.6	1.7	21.5	7.9	18.2	12.2	11.7	17.5	9.9
			Divi	2.1			7.0	7.0		21.0	7.0	10.2	12.2			0.0
Canyon	Amarillo	3.5	GHI	-3.3	2.2	-5.8	-3.7	6.0	-3.5	2.4	1.8	1.5	-7.1	5.4	0.7	-0.3
			DNI	-5.9	9.7	-0.4	1.3	16.0	0.0	11.9	8.1	10.9	-7.3	19.2	7.0	5.9
Calallen	•	3	GHI	11.9	8.6	-12.3	0.0	9.5	4.1	3.0	-2.8	-3.1	-11.1	-6.7	12.1	1.1
	Christi		DNI	42.3	25.4	-20.2	14.5	18.4	15.4	12.1	10.3	14.3	-5.0	-4.5	47.4	14.2
Clear	Houston	3.5	GHI	4.4	0.7	-1.6	2.3	0.0	-2.0	5.7	2.3	0.1	-10.1	-2.6	6.2	0.5
Lake			DNI	18.6	11.1	4.9	15.9	-2.2	-0.1	25.0	15.5	13.3	-4.1	6.0	45.8	12.5
			5141	10.0		1.0	10.0			20.0	10.0	10.0	••••	0.0	10.0	12.0
Edin- burg	Brownsville	3.5	GHI	10.9	10.1	-4.9	-2.6	-0.7	-1.9	-1.2	-2.7	-4.4	-12.2	-18.3	2.1	-2.2
			DNI	49.2	28.5	4.5	6.4	5.8	1.9	7.6	11.2	10.8	6.0	-12.9	41.5	12.4
			DINI	49.2	20.0	4.5	0.4	5.6	1.9	7.0	11.2	10.0	-0.0	-12.9	41.5	12.4
El Paso	El Paso	3.5	GHI	7.6	1.8	-0.9	0.4	-1.8	-3.8	-3.0	1.0	1.6	-4.3	2.0	-2.9	-0.2
			DNI	25.0	6.9	4.1	7.4	2.6	1.2	4.4	10.9	12.3	6.4	17.2	4.6	8.6
Menard	San Angelo	4	GHI	-9.4	-11.3	-11.7	-5.3	-8.5	-12.9	-1.2	-4.8	1.6	-14.0	-4.6	-2.9	-7.1
			DNI	4.9	-3.7	-7.7	7.1	-7.8	-21.3	3.6	0.1	18.7	-12.6	4.3	8.7	-0.5
Overton	Lufkin	4	GHI	-11.8		-13.5	-2.2		-8.6	0.0	-3.3			-18.2	-6.3	-7.5
			DNI	7.9	18.6	-3.9	18.4	-3.2	-12.0	19.6	11.9	12.9	-6.2	-7.2	22.4	6.6
Pecos	Midland	4	GHI	16.0	9.0	11.3	8.4	7.2	0.9	4.2	6.5	12.5	5.4	11.1	12.1	8.7
1 6000	iviiuiaiiu	+	DNI	33.1	25.0	28.3	26.8	19.4	8.5	18.3	24.4	36.0	19.2	27.5	27.4	24.5
Ava Di	ff for all local	tions	GHI	0.6	0.5	-5.5	-0.5	0.0	-4.1	1.5	-0.7	0.9	-7.9	-4.5	-0.2	-1.6
7.100.0			DNI	16.4	12.4	1.0	11.4	4.6			9.7	15.3	-1.4		20.0	8.8
Percent differences are (TSPDR NSPDR)/TSPDR GUI global horizontal radiation											0.0					

Percent differences are (TSRDB-NSRDB)/TSRDB GHI – global horizontal radiation DNI – direct normal radiation

Division Meeting Minutes

(Continued from page 3)

It was noted that Forum 2001 includes 4 RAD-related activities:

- Monday 10:30 12:00: Solar Radiation; a tutorial session on Instruments, Data Forms, and Databases (presented by Vignola, Renné, and Perez);
- Monday 4:00 5:30: Advances in Radiometer Measurements (4 papers);
- Tuesday 2:00 3:30: Analysis of Solar Resource Data (5 papers); and
- Wednesday 8:30 10:00: Climate and Solar Data Sets (5 papers)

It was noted that the program was incorrect on this last session, and needs to be corrected.

Dave Renné gave a report on the ASES policy on the election of officers for the Divisions.

Dave Renné then reported on an ASES task force set up to assess the ASES Board structure. Extensive discussion followed. Individual RAD members proposed Board structure modifications, such as having representatives from only 3-4 Divisions but expanding Chapter representation to 3-4 as well. It was also suggested that the Board increase the number of members overall. The general consensus was that the Board should probably have a greater chapter/state representation, but that ASES should not lose its balanced emphasis on technical issues. There was also discussion that the RAD should broaden its activities to include technology education.

There was a brief discussion by those present on their activities:

- Frank Vignola (U of OR): He will be hosting a
 workshop for utilities in October on how to use
 solar data. He is developing an improved web site.
 He is working with Richard Perez on satellitederived solar resource data for the Pacific Northwest
- Richard Perez (SUNY/Albany): He is looking at load matching data, and is working on a one-step method for generating direct normal data from satellite images.
- Roberta DiPasquale (NASA): She reports that Charlie Whitlock is developing a scheme to adjust reanalysis wind data for local conditions in order to develop a wind resource product for RET-Screen.

- Daryl Myers (NREL): He is developing a reference spectrum for ASTM.
- Jim Augustyn: He is revising the DQMS software for NREL; conducting direct normal solar measurements in Spain for siting trough plants.
- Dave Renné (NREL): He and colleagues are developing solar resource data in Spain for the Concentrating Solar Power program.
- Gary Vliet (U of TX): there is a lull in funding; he needs to work on the web site.
- Bob Cable (KJC Inc.): Bob and KJC received good press recently in a San Francisco Chronicle article.

Frank Vignola was applauded for the Solar Spectrum newsletter editorship. Roberta DiPasquale has agreed to assume the editorship of Solar Spectrum.

Reno/ASES Program (2002): Both a Forum and a paper session on the Atmospheric Radiation Measurement (ARM) Program, with a focus on climate modeling and instrumentation, was decided. Renné, DiPasquale, Perez, and Vignola agreed to solicit speakers and papers for each.

For the Forum 2002 technical review of abstracts: Vliet will do the travel review, and DiPasquale and Cable will do the mail review.

A RAD nominating committee consisting of Vliet, Renné, Vignola, and Perez was appointed. There was agreement by Vignola to be nominated for vice Chair, and by Augustyn to be nominated for Secretary. Potential RAD Board member nominees are Renné, Perez, and Vliet.

Concern was expressed among the attendees on having all Division meetings occur at the same time on the Sunday prior to the conference. Many did not attend this meeting because of conflicts with other meetings.

Gary Vliet then adjourned the meeting at 6:00 PM.

Submitted by Dave Renné, Secretary. 16 September, 2001.

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<u>In this Issue</u> Texas Solar Radiation DataBase & NREL to Update the NSRDB