Impact of the 2017 Solar Eclipse on the Smart Grid

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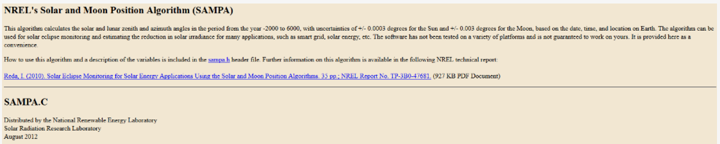
Abstract

With the increasing interest in using solar energy as a major contributor to the use of renewable generation, and with the focus on using smart grids to optimize the use of electrical energy based on demand and resources from different locations, the need arises to know the moon's position in the sky with respect to the sun. When a solar eclipse occurs, the moon disk might totally or partially shade the sun disk, which can affect the irradiance level from the sun disk, consequently affecting a resource on the electric grid. The moon's position can then provide smart grid users with information about how potential total or partial solar eclipses might affect different locations on the grid so that other resources on the grid can be directed to where they might be needed when such phenomena occurs. At least five solar eclipses occur yearly at different locations on Earth, they can last 3 hours or more depending on the location, and they can affect smart grid users. On August 21, 2017, a partial and full solar eclipse occurred in many locations in the United States, including at the National Renewable Energy Laboratory in Golden, Colorado. Solar irradiance measurements during the eclipse were compared to the data generated by a model for validation at eight locations.

Method

Using the solar and moon position algorithm (SAMPA) : https://midcdmz.nrel.gov/sampa/



NREL's Solar and Moon Position Algorithm (SAMPA)

This algorithm calculates the solar and lunar zenith and azimuth angles in the period from the year -2000 to 6000, with uncertainties of +/- 0.0003 degrees for the Sun and +/- 0.003 degrees for the Moon, based on the date, time, and location on Earth. The algorithm can be used for solar eclipse monitoring and estimating the reduction in solar irradiance for many applications, such as smart grid, solar energy, etc. The software has not been tested on a variety of platforms and is not guaranteed to work on yours. It is provided here as a convenience.

How to use this algorithm and a description of the variables is included in the sampa.h header file. Further information on this algorithm is available in the following NREL technical report:

Reda, I. (2010). Solar Eclipse Monitoring for Solar Energy Applications Using the Solar and Moon Position Algorithms. 35 pp.; NREL Report No. TP-3B0-47681. (927 KB PDF Document)

SAMPA.C

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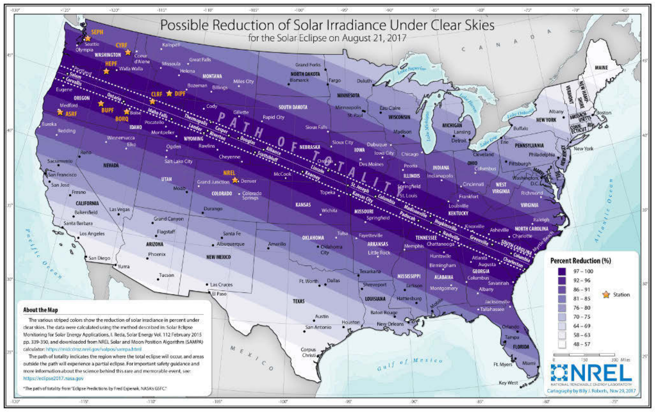
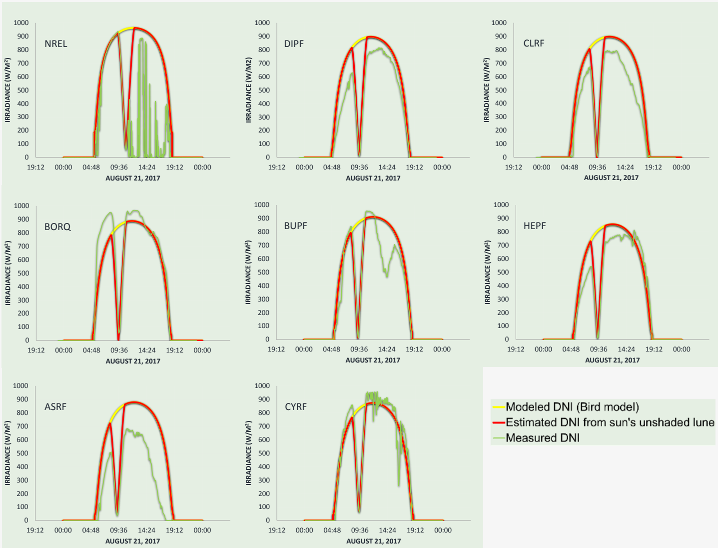


Results



Station	Code	City	State	Latitude	Longitude
DIPF	DIPF	Dillon	MT	45.21	-112.64
CYRF	CYRF	Cheney	WA	47.49	-117.59
CLRF	CLRF	Challis	ID	44.44	-114.13
BUPF	BUPF	Burns	OR	43.52	-119.02
BORQ	BORQ	Boise	ID	43.62	-116.21
ASRF	ASRF	Ashland	OR	42.19	-122.70
BERQ	BERQ	Bend	OR	43.97	-121.34
SEPH	SEPH	Seattle	WA	47.69	-122.26
HEPF	HEPF	Hermiston	OR	45.82	-119.28
NREL -SRRL	NREL	Golden	CO	39.74	-105.18

Conclusion:

- Estimated direct normal irradiance (DNI) using SAMPA showed good agreement with the measured data set during the solar eclipse.
- Because of wildfire, the measured DNI were lower in the Oregon, Washington, and Idaho locations than the estimated/modeled DNI data set.
- The temporal resolution of the measured versus estimated/modeled data set is not the same.

References

- National Aeronautics and Space Administration. 2017. "NASA Eclipse Web Site." https://eclipse.gsfc.nasa.gov/eclipse.html.
- Wilcox, S., A. Habte, B. Roberts, T. Stoffel, M. Kutchenreiter, and M. Sengupta. 2017. *Clear-Sky Probability for the August 21, 2017, Total Solar Eclipse Using the NREL National Solar Radiation Database* (Technical Report NREL/TP-5D00-68885). Golden, CO: National Renewable Energy Laboratory.
- Reda, I. 2010. *Solar Eclipse Monitoring for Solar Energy Applications Using the Solar and Moon Position Algorithms* (Technical Report NREL/TP-3B0-47681). Golden, CO: National Renewable Energy Laboratory.
- Reda, I. 2015. "Solar Eclipse Monitoring for Solar Energy Applications." *Solar Energy* 112 (February): 339–350.

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