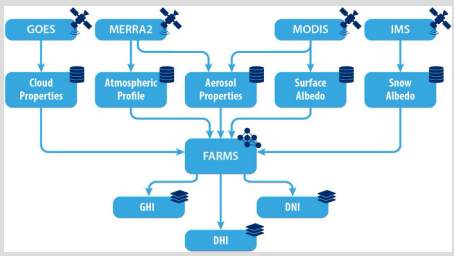
Recent Improvements in the National Solar Radiation Database (NSRDB)

Manajit Sengupta, Aron Habte, Yu Xie, Grant Buster, Mike Bannister, Michael Rossol, Paul Edwards, Galen Maclaurin, Evan Rosenlieb, Jaemo Yang, Haiku Sky, and Billy Roberts

Abstract

- The National Solar Radiation Database (NSRDB) has significantly evolved since the first release of the point source database in 1992.
- The NSRDB has been widely used by the solar energy industry to provide long-term time-series solar resource data for various project phases.
- The NSRDB represents the state of the art in the satellite-based estimation of solar resource information and uses a unique physics-based modeling approach that allows improvements in accuracy with the deployment of the next-generation geostationary satellites.
- The historical NSRDB data are available from 1998 to the present with a 1-year lag and are processed on a nominal 4x4-km grid spacing at a 30-min frequency. Beginning in 2018, the NSRDB has additional data sets available at a 2x2-km, 5-min resolution available for the continental United States, Hawaii, Mexico, and the Caribbean Islands and at a 2x2-km, 10-min resolution for North and South America from +60 to -60 degrees latitude.
- This poster demonstrates (1) the improved spatiotemporal resolution; (2) on-demand services and their applications; (3) future improvements, such as a new direct normal irradiance (DNI) model and new methods to gap-fill missing data using physics-guided machine learning; (4) data quality; and (5) data dissemination.

Physical Solar Model (PSM)



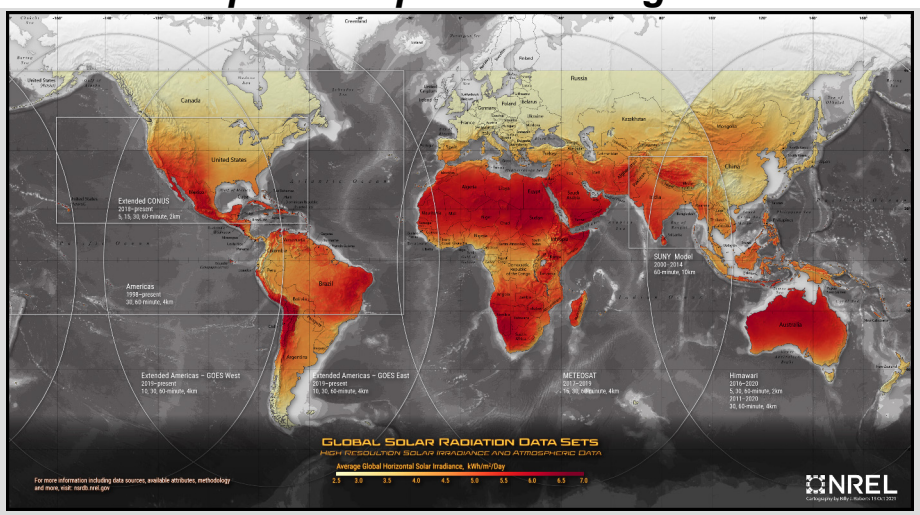
Data sources

Model inputs

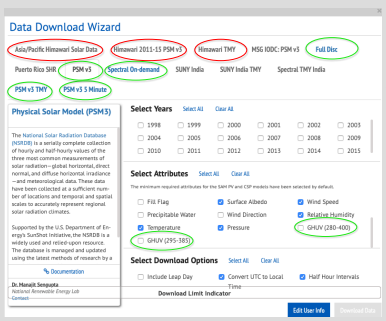
Radiative transfer model

Solar irradiance time-series variables

Spatiotemporal Coverage



Recent Additions

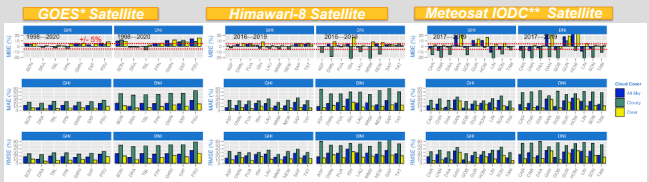


Updated products to contain 2022 data

New products released in 2021

https://maps.nrel.gov/nsrdb-viewer

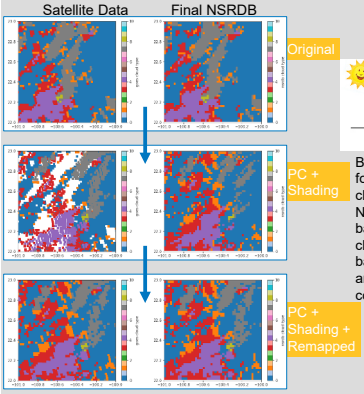
Validation



*Geostationary Operational Environmental Satellites
**Indian Ocean Data Coverage

Updates in Fiscal Year (FY) 2022

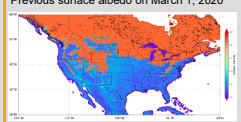
Parallax-Correction, Shading, and Remapping



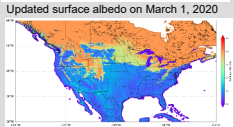
Better algorithm for projecting clouds onto the NSRDB grid based on the cloud-geometry-based parallax and shading corrections.

Albedo Adjustment

Previous surface albedo on March 1, 2020



Updated surface albedo on March 1, 2020



$$\alpha = \begin{cases} 0.8 \text{ when } T < 268K \\ 0.65 + 0.03(273 - T) \text{ when } 268K < T < 273K \\ 0.65 \text{ when } T = 273K \end{cases}$$

Ross and Walsh (1987) suggested a parameterization that decreases the albedo linearly with temperature when it approaches the freezing point. The snow/ice albedo is updated according to Ross and Walsh (1987).

Ross, Becky, and John E. Walsh. 1987. "A comparison of Simulated and Observed Fluctuations in Summertime Arctic Surface Albedo." *Journal of Geophysical Research* 92: 13115–13125.

Version Logs

Version	Effective Date	Data Years*	Notes
3.2.1	1/12/2021	2021	Implemented an algorithm to re-map the parallax and shading corrected cloud coordinates to the nominal GOES coordinate system. This fixes the issue of PC cloud coordinates conflicting with clear-sky coordinates. This also fixes the strange pattern that was found in the long-term means generated from PC data.
3.2.2	2/25/2022	1998-2022	Implemented a model for snowy albedo as a function of temperature from MERRA2 based on the paper "A comparison of simulated and observed fluctuations in summertime Arctic surface albedo" by Becky Ross and John E. Walsh.

Data Dissemination

The data sets can be accessed:

- By point location or small area downloaded through the NSRDB Data Viewer (https://maps.nrel.gov/nsrdb-viewer/)
- By application programming interface to access larger quantities of data through automated approaches (https://nsrdb.nrel.gov/data-sets/api-instructions.html)
- Through the Highly Scalable Data Service (HSDS) hosted on Amazon Web Services (https://github.com/NREL/hsds-examples/blob/master/notebooks/03_NSRDB_introduction.ipynb).

Updates in FY 2023–FY 2024

- Implement **FARMS–DNI model** (https://www.sciencedirect.com/science/article/pii/S2589004220300778).
- Implement machine learning/artificial intelligence-based derivation of cloud identification.
- Investigate the availability of aerosol data sets from GOES-16 and GOES-17 satellites.
- Custom typical meteorological year in the plane of array.
- High-resolution cloud properties (500 m) to get cloud fraction and improved cloud optical depth.
- A 50-year projected solar radiation data set going out to 2070 from regional climate models.

References

- Manajit Sengupta, Yu Xie, Anthony Lopez, Aron Habte, Galen Maclaurin, and James Shelby. 2018. "The National Solar Radiation Database (NSRDB)." *Renewable and Sustainable Energy Reviews* 89: 51–60. SSN 1364-0321. https://doi.org/10.1016/j.rser.2018.03.003.
- Yue Xie, Manajit Sengupta, and Jimy Dudhia. 2016. "A Fast All-Sky Radiation Model for Solar Applications (FARMS): Algorithm and Performance Evaluation." *Solar Energy* 135: 435–445.

This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Solar Energy Technologies Office. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

Solar Power International 2022
Anaheim, CA
September 19–22, 2022
NREL/PO-5000-83375