Overview of New Capabilities in the NSRDB

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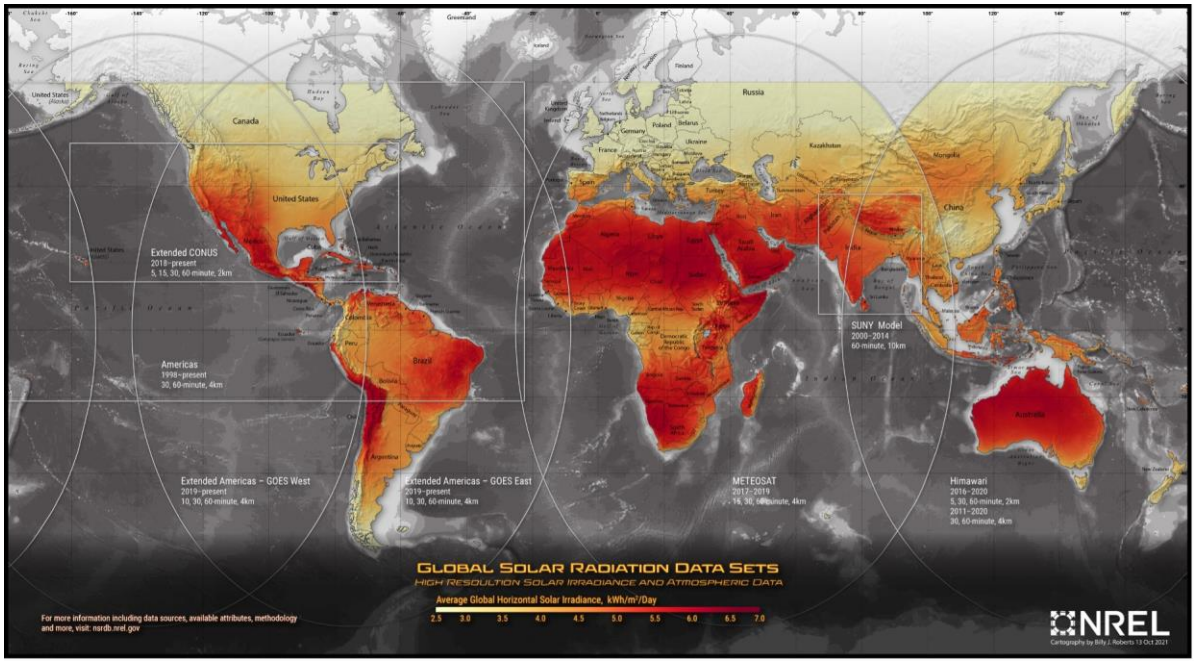
The National Solar Radiation Database (NSRDB) provides solar resource data across the globe at a high temporal and spatial resolution (Fig. 1). This data is primarily used in solar energy modeling. The NSRDB is updated annually for the United States and North, Central and South America and the data is currently available from 1998-2021. The NSRDB uses a physical approach to satellite-based solar modeling. The underlying Physical Solar Model (PSM) involves modeling cloud-properties using satellite remote sensing and subsequently computing solar radiation using radiative transfer models. The retrieved cloud properties include cloud-mask, cloud-type (i.e. water and ice clouds) cloud optical depth and cloud droplet size. The radiative transfer models require additional input parameters such as aerosol optical properties (AOD), preciptable water vapor, surface albedo, temperature and pressure to accurately model solar radiation. While cloud properties are obtained directly from the geostationary satellites other inputs are obtained from additional source such as the National Aeronautical and Space Administration (NASA) Modern Era Retrospective Analysis for Research and Applications version 2 (MERRA2), the Interactive Multisensor Snow and Ice Mapping System (IMS) model data from the U.S. National Ice Center and NASA's polar orbiting satellites such as the Moderate Resolution Imaging Spectroradiometer (MODIS) instruments on the Aqua and Terra Platform.

In 2022 the NSRDB was updated using the latest version of the underlying Physical Solar Model (PSM). This update includes improved surface albedo and gap-filling of cloud properties. The inclusion of these updates reduced the uncertainty in the data compared to previous versions of the NSRDB. The Himawari and Meteosat Indian Ocean Data Coverage(IODC) satellites were added to the Geostationary Operational Environmental Satellite (GOES) and made our coverage global. While standard data from the GOES continues to be served at an hourly 4km x 4km resolution, full resolution data has also been made available to the user. The NSRDB now contains over 200Tb of data with nearly 40Tb being added annually. The user is provided significant flexibility for downloading data depending on the amount of data required. Emphasis has been placed on the distribution of the datasets and data can be downloaded using either the web-interface, an Application Programming Interface or directly from the cloud using Amazon Web Services. Services such as spectral data use on-demand computation and delivery.

Evaluation of the NSRDB was conducted for 18 stations and the the Mean Bias Error (MBE), Mean Absolute Error (MAE) and Root Mean Square Error (RMSE) were computed for both GHI and DNI. The evaluation was conducted for the 1998-2021 period. As the NSRDB provides a cloud mask the evaluation can be separated into clear and cloudy periods. Generally, the MBE lies within plus or minus ±5% for GHI and ±20% for DNI. The RMSE is less than 30% for GHI and 35% for DNI. This presentation will provide users with the latest information about the NSRDB as well as plans for future development and updates.



1. Sengupta, M., Y. Xie, A. Lopez, A. Habte, G. Maclaurin, and J. Shelby. 2018. “The National Solar Radiation Data Base (NSRDB).” Renew. Sustain. Energy Rev., 89: 51–60. https://doi.org/10.1016/j.rser.2018.03.003.
2. A. Heidinger, M. Foster, A. Walther, X. Zhao, 2014. The pathfinder atmospheres-extended AVHRR climate dataset, Bull Am Meteorol Soc, 95, pp. 909-922
3. Yu Xie, Manajit Sengupta, Jimy Dudhia. 2016. "Fast All-Sky Radiation Model for Solar applications (FARMS): Algorithm and Performance Evaluation." Solar Energy, Vol. 135, 435-445.
4. Xie, Y., M. Sengupta, 2019, A Fast All-sky Radiation Model for Solar applications with Narrowband Irradiances on Tilted surfaces (FARMS-NIT): Part I. The clear-sky model, Solar Energy, 174, 691-702. https://doi.org/10.1016/j.solener.2018.09.056.
5. Xie, Y., M. Sengupta, Wang, C., 2019, A Fast All-sky Radiation Model for Solar applications with Narrowband Irradiances on Tilted surfaces (FARMS-NIT): Part II. The cloudy-sky model, Solar Energy, 188, 799-812. https://doi.org/10.1016/j.solener.2019.06.058.
6. Xie, Y., Sengupta, M., Liu, Y., Long, H., Min, Q., Liu, W., Habte, A., 2020. A physics-based DNI model assessing all-sky circumsolar radiation. iScience 22, https://doi.org/10.1016/j.isci.2020.100893. Habte, A., M. Sengupta, C.A. Gueymard, R. Narasappa, O. Rosseler, D.M. Burns, (2019), Estimating Ultraviolet Radiation from Global Horizontal Irradiance, IEEE J. Photovolt., 9, 1, 139-146. https://doi.org/10.1109/JPHOTOV.2018.2871780.
7. Buster, G. Bannister, M., Habte, A., Hettinger, D., Maclaurin, G., Rossol, M., Sengupta, M. and Xie, Y., 2022. Physics-guided machine learning for improved accuracy of the National Solar Radiation Database, Solar Energy, Volume 232, 483-492, https://doi.org/10.1016/j.solener.2022.01.004.