The National Solar Radiation Database (NSRDB): A Brief Overview

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I. Background Information on the NSRDB

The National Renewable Energy Laboratory (NREL) has been developing, updating, and disseminating the modeled National Solar Radiation Database (NSRDB) during the last three decades.

- NSRDB 1961–1990 ➔ 239 modeled stations with 56 partial measurement stations [DOE, NOAA, 1994]
- NSRDB 1991–2005 ➔ 1,454 modeled locations [DOE, SUNY-A, NOAA, 2007]
- NSRDB 1991–2010 ➔ 1,454 modeled locations [DOE, CPR, 2012]
- NSRDB 1998–2015 ➔ Satellite-based, gridded, 4 km x 4 km, half-hourly [DOE, NOAA, UW, SCS 2016].
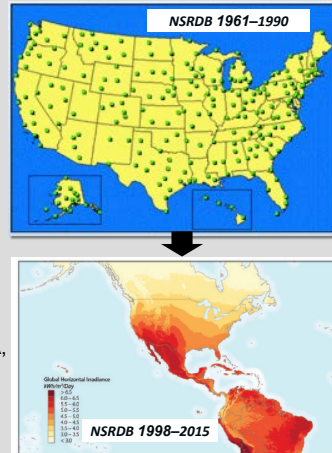

Figure 1. Spatial and temporal improvement of NSRDB.

II. Method (NSRDB: 1998–2015)

The NSRDB uses the physics-based model (**PSM**), which was developed using:
- Adapted PATMOS-X model for cloud identification and properties
- REST-2 model for clear-sky conditions
- NREL's Fast All-sky Radiation Model for Solar Applications (FARMS) for cloudy-sky Global Horizontal Irradiance (GHI) solar irradiance calculations
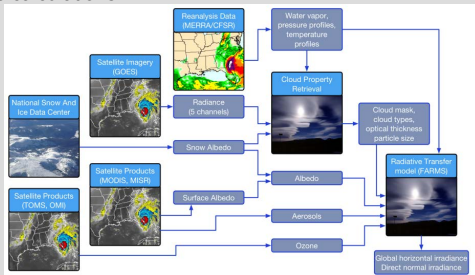- NREL's DISC model for cloudy-sky Direct Normal Irradiance (DNI) solar irradiance calculations.

Figure 2. Physical Solar Model (PSM) Framework

The meteorological data set associated with the NSRDB data was derived from the National Aeronautics and Space Administration (NASA) Modern Era-Retrospective Analysis (MERRA) data sets.

III. Validation

The accuracy of the NSRDB-PSM was assessed using high-quality ground measurement stations. The temporal and spatial evaluation was performed by comparing the NSRDB data to concurrent ground-based measurements.
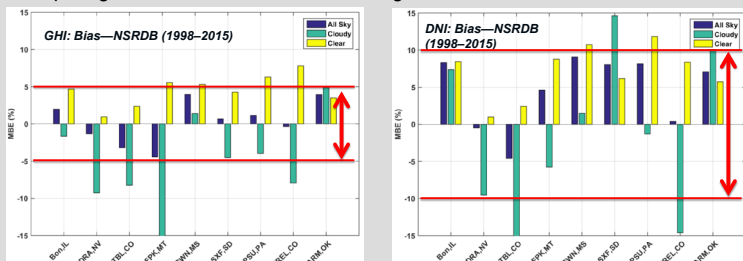

Figure 3. Percentage bias - comparison results for both GHI (left) and DNI (right) between the NSRDB and ground-measured data for nine locations

IV. Applications of NSRDB (1998–2015)—PSM

Large analysis and vision studies use a variety of models that use the NSRDB:

- Grid-planning modeling (ReEDS, RPM)
- Grid operations modeling (PLEXOS)
- Distributed Generation Market Demand modeling (dGen)
- Techno-economic assessment (reV)
- Performance and financial modeling (SAM).

Figure 6. Application of NSRDB to some of the NREL studies

V. Dissemination

Data are available from 1998–2015 at a half-hourly temporal resolution and a 4-km by 4-km spatial resolution. The spatial coverage extends from Southern Canada to parts of Brazil (longitude: -25° E to -175° W, latitude: -20° S to 60° N).

- Automated download of resource data and SAM simulation
- Point or area download option
- Globus data download
  - Details: https://nsrdb.nrel.gov/api-instructions.

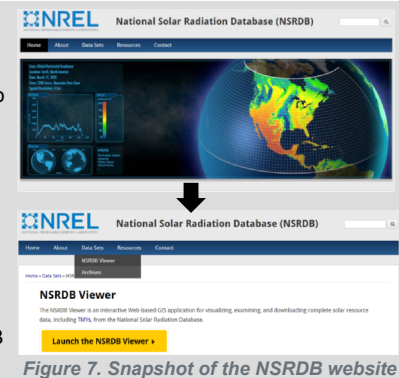Gridded TMY: Developed using the NSRDB (1998–2015).

Figure 7. Snapshot of the NSRDB website

VI. Future Work

Improved inputs:
- Meteorological variables from NASA's MERRA-2
- Inclusion of hourly or daily MERRA-2 aerosols
- Improved surface albedo time series to reflect land use changes.

Improved modeling:
- Improved identification of high albedo surfaces (sand and snow)
- Spectral data sets in the plane of array
- Improved cloud retrievals from GOES-15
- Aerosol retrieval from GOES-15.

VII. Conclusions

- The NSRDB provides a serially complete database of solar irradiance *and meteorological* information across the United States and in a growing number of international locations.
- The NSRDB provides 18 years of half-hourly data at a 4x4-km spatial resolution.
- A gridded Typical Meteorological Year (TMY) is also available.

VIII. References and Contacts

1. Xie, Y., M. Sengupta, and J. Dudhia. 2016. "A Fast All-Sky Radiation Model for Solar Applications (FARMS): Algorithm and Performance Evaluation." *Solar Energy* 135: 435–445.
2. Habte, A., M. Sengupta, and A. Lopez, A. 2017. *Evaluation of the National Solar Radiation Database (NSRDB): 1998-2015* (Technical Report NREL/TP-5D00-67722). Golden, CO: National Renewable Energy Laboratory.
3. Sengupta, M., A. Habte, P. Gotseff, A. Weekley, A. Lopez, M. Anderberg, C. Molling, and A. Heidinger. 2014. "Physics-Based GOES Product for Use in NREL's National Solar Radiation Database: Preprint" (NREL/CP-5D00-62776). Paper presented at the European Photovoltaic Solar Energy Conference and Exhibition, Amsterdam, The Netherlands, Sept. 22–26, 2014.
4. Sengupta, M., A. Habte, P. Gotseff, A. Weekley, A. Lopez, C. Molling, and A. Heidinger. 2014. "Physics-Based GOES Satellite Product for Use in NREL's National Solar Radiation Database: Preprint" (NREL/CP-5D00-62237). Presented at Solar 2014, San Francisco, California, July 6–10, 2014.

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