Evolution of NREL's National Solar Radiation Database (NSRDB)

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Abstract

- The National Solar Radiation Database (NSRDB) is a widely accessed public database of solar irradiance and weather parameters for use in solar energy projects.
- The NSRDB underpins a large range of activities that take place within the U.S. Department of Energy Solar Energy Technologies Office by providing easy access to high-quality, foundational data essential for innovative product development and downstream modeling.
- The NSRDB data are currently available for the contiguous United States, Central America, and South Asia covering a 4-km x 4-km half-hourly spatial and temporal resolution, respectively, from 1998–2017.
- This poster demonstrates (1) the evolution of the NSRDB from sparse data to a high-resolution data set, (2) on-demand services and their applications, (3) summary products, such as a typical meteorological year (TMY) data set, and (4) wider user availability through cloud services.

Recent Improvements

- Hourly aerosol optical depth (AOD) (1998–2017) from Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2)
- Snow-free surface albedo from MODIS (2001–2015) (MCD43GF CMG Gap-Filled Snow-Free Products from the University of Massachusetts, Boston)
- Snow cover from Integrated Multisensor Snow and Ice Mapping System (IMS) daily snow cover product (National Snow and Ice Data Center)
- Geostationary Operational Environmental Satellite system-East (GOES-East) time shift applied to cloud properties instead of solar radiation
- Ancillary data (precipitable water vapor, pressure, humidity, wind speed, etc.) from MERRA-2.

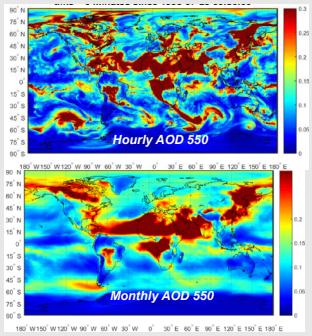

Fig. 4. Hourly AOD for one-time stamp in July 1998 (top) versus monthly AOD for July 1998 (bottom)

Background

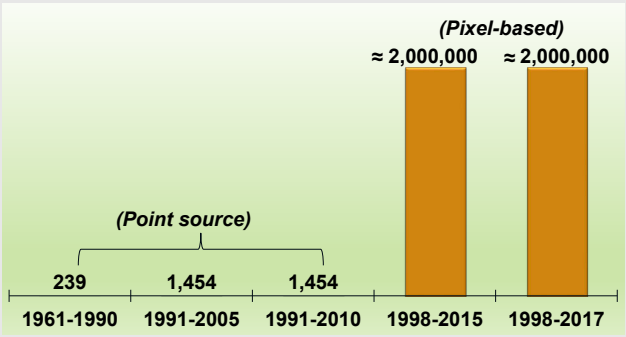

Fig. 1. Evolution of NSRDB from sparse to seamless high-resolution data set

- 1961–1990: 239 modeled stations with 56 partial measurement stations (DOE, NOAA, 1994)
- 1990–2005: 1,454 modeled locations (DOE, SUNY-A, NOAA, 2007)
- 1990–2010: 1,454 modeled locations (DOE, CPR, 2012)
- **1998–2015: Satellite-based, gridded, 4-km x 4-km, half-hourly [DOE, NOAA, UW, SCS 2016]—NSRDB Version 2**
- **1998–2017: Satellite-based, gridded, 4-km x 4-km, half-hourly [DOE, NOAA, UW, SCS 2018]—NSRDB Version 3**

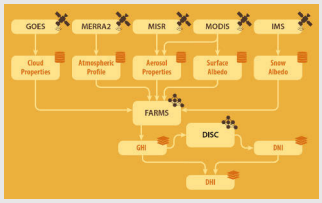

Fig. 2. Physical solar model (PSM v3) flowchart

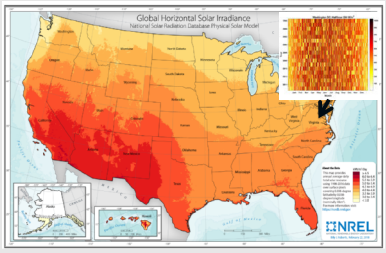

Fig. 3. NSRDB v3 data set

On-demand Spectral and TMY Data

- New capability to provide spectral plane of array (POA) on demand for any fixed-tilt or single-axis tracking orientation
- POA irradiances are efficiently computed for 2002 wavelength bands (0.28–4.0 mm) from the radiances.
- Spectral radiances are computed by using a lookup table of cloud transmittance and solving the radiative transfer equation.
- POA irradiance is computed by integrating radiances over inclined surfaces.
- TMY product is also available.
- Multiple summary products are available with current data sets.

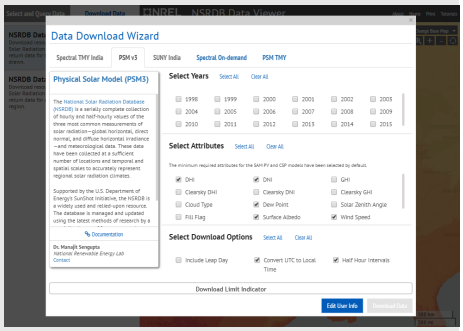

Fig. 5. On-demand and summary products

Validation

The NSRDB Version 3 demonstrates a significant reduction in hourly uncertainty estimations compared to Version 2, as shown in Figure 7. These improvements are clearly noticeable for all locations, especially Desert Rock, Nevada, where the uncertainty was reduced to approximately 12% in NSRDB Version 3 from approximately 18% in NSRDB Version 2.

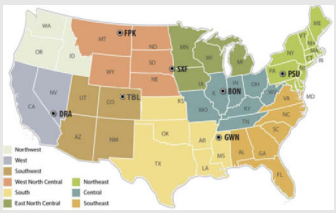

Fig. 6. Ground measurement stations used for the evaluation

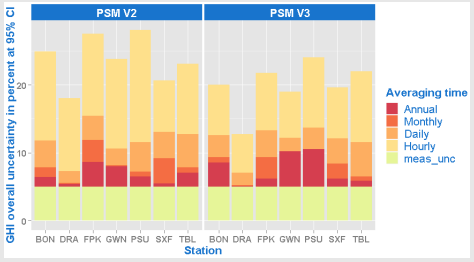

Fig. 7. Data uncertainty comparison between version 2 and 3

Conclusions and Future Work

- The historical NSRDB started with sparse point-source ground locations and now evolved to a seamless data set that is based on PSM Version3 and runs on high-resolution GOES satellite information.
- A fast spectral POA model was built, validated, and implemented to provide on-demand spectral radiation from the NSRDB.
- NSRDB Version 3 results showed improvement compared to NSRDB Version 2.

References

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2. Y. Xie, M. Sengupta, and J. Dudhia, "A Fast All-Sky Radiation Model for Solar Applications (FARMS): Algorithm and Performance Evaluation," *Solar Energy* 135 (2016): 435–445.
3. A. Habte, M. Sengupta, and ***References***
4. A. Lopez, *Evaluation of the National Solar Radiation Database (NSRDB): 1998–2015* (NREL/TP-5D00-67722) (Golden, CO: National Renewable Energy Laboratory, 2017).

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