Use of MERRA-2 in the National Solar Radiation Database and Beyond

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• National Solar Radiation Database (NSRDB)
• Physical Solar Model (PSM) in the NSRDB
• Data sets required for the NSRDB
• Why MERRA-2 is used in the NSRDB?
• Use of NSRDB in general
• Use of NSRDB at NREL
• Wish list for future use.
The NSRDB seeks to advance our knowledge of solar radiation and its application for renewable energy and beyond.

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 (+ Typical Meteorological Year) of half-hourly data at a 4x4-km spatial resolution.

The NSRDB uses the physics-based model, the PSM.

https://nsrdb.nrel.gov
Physical Solar Model Framework
# Data Sets in the NSRDB

## Used in the PSM:

- **MERRA-2**
  - Atmospheric pressure
  - Surface albedo
  - Aerosols
    - Aerosol optical thickness
    - Single scattering albedo
    - Aerosol Angstrom parameter.
  - Total ozone
  - Precipitable water.
- **GOES (PATMOS-X retrievals)**
  - Cloud effective radius
  - Cloud optical depth
  - Cloud type.
- **Moderate Resolution Imaging Spectroradiometer/National Snow and Ice Data Center**
  - Surface albedo.

## Delivered to the Public:

- Global horizontal irradiance (GHI)
- Direct normal irradiance (DNI)
- Diffuse horizontal irradiance (DHI)
- Clear-sky GHI, DNI, and DHI
- Cloud type
- Dew point*
- Air temperature*
- Atmospheric pressure*
- Relative humidity*
- Solar zenith angle
- Precipitable water
- Wind direction*
- Wind speed.*

*Source: MERRA-2*
MERRA data were found to have lower root-mean-square error (RMSE) compared to CFSR* and NARR*.

*Climate Forecast System Reanalysis (CFSR)
*North American Regional Reanalysis (NARR)

Comparison with 216 stations for 2006–2012 period.
How Is the NSRDB Used?

The NSRDB and thus MERRA-2 are used by a variety of public and private organizations.

**Uses include**
- Solar energy prospecting
- Solar generator design
- Cancer research
- Education and general research
- Power system modeling and planning
- Microgrid and rural electrification
- Solar variability
- Climate change research
- Forecasting
- And more...

The NSRDB has become a heavily used data set in less than two years of deployment. Innovative small companies are significant users, leading to a reduction in barriers to solar development. More than $20 million in internal NREL research on grid integration, energy modeling, resource planning, and production cost modeling are facilitated by the NSRDB.
How Is the NSRDB Used at NREL?

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).
Our Wish List for MERRA-2 and Beyond

• Standardized or consensus methodology for spatial downscaling of the ~0.5-degree MERRA-2 data

• Increase in spatial resolution

• Addition of data sets:
  o Dew point
  o Relative humidity
  o Surface elevation information.
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