NASA POWER: A Global Agroclimatology Solar Insolation and Meteorological Parameter Data Base: Meteorological Evaluation and User Application Updates

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Introduction

NASA's Prediction of Worldwide Energy Resource (POWER) project facilitates the use of NASA Earth Science data holdings within the agricultural, energy, and architectural industries. POWER packages solar and meteorological data at various temporal levels from several NASA mission and research modeling programs in user friendly web services through graphical interface menus and API endpoints. (https://power.larc.nasa.gov).

POWER Release 10 became available at the beginning of 2025, featuring full cloud-based datastores, updated and new parameter options, and website data application updates. Solar irradiance data has been updated with the latest release from Clouds and the Earth's Radiant Energy System (CERES) SYN1Deg Edition 4.2. Surface meteorological parameters are obtained from the NASA Modern Era Retrospective-analysis for Research and Applications (MERRA-2) data products. While most are taken from the MERRA-2 data set (~50 km), an alternate precipitation source from Integrated Multi-satellitE Retrievals for Global Precipitation Measurement (IMERG v7b) is available and included in this evaluation (~10 km).

We present here examples of the upgrades to the website and user interfaces, along with recent evaluations of the POWER meteorological data through comparisons with global surface site measurements. We will also showcase POWER data applications from the user base.

Data Sources - Meteorological

MERRA-2
- NASA's GMAO MERRA-2 reanalysis data set provides most meteorological parameters hosted by POWER.
- Original spatial resolution is 1/2° latitude x 5/8° longitude and the current POWER version retains this resolution.
- Available daily from 1 January 1981, hourly from 1 January 2001.

IMERG
- NASA's IMERG is an alternative precipitation data set for POWER users.
- Finer spatial resolution than MERRA-2 at 1/10° x 1/10°.
- Available daily from 1 January 2001.

NOAA GSOD/ISD, for the validation presented here
- Surface site observations are from the NOAA National Centers for Environmental Information (NCEI).
- Hourly surface observations are available through the Integrated Surface Database (ISD).
- Daily observations are from the Global Summary Of the Day (GSOD).

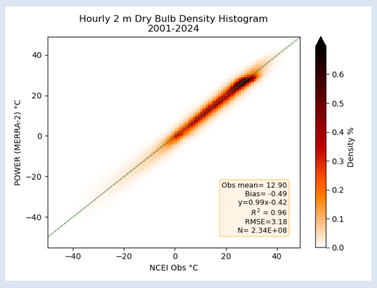
Surface Site Validation Statistics Summary

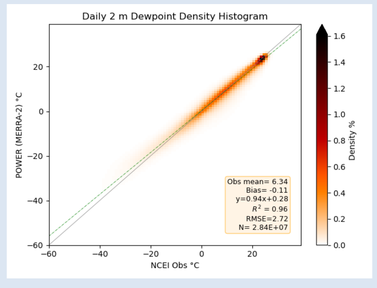
Hourly validation for 1 January 2001 through 31 December 2024

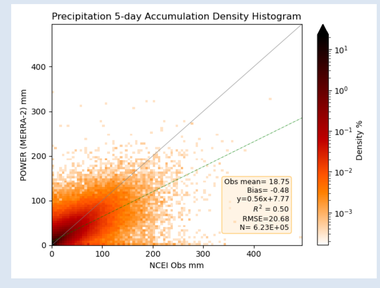
Field	Site Mean	Bias	RMS	R^2	Num (millions)
Temp. 2 m (C)	12.90	-0.49	3.18	0.96	234
Dewpoint (C)	6.36	0.04	3.45	0.93	205
Wet Bulb T. (C)	9.95	-0.07	2.46	0.96	76.3
Adjusted Surface Pressure (hPa)	982.83	0.26	2.11	1.00	155
Wind Speed 10 m (ms^{-1})	3.58	0.51	2.47	0.42	221
Relative Humidity (%)	68.81	3.20	15.64	0.62	209
Precipitation (mm)	0.14	2.44	9.81	0.00	55.0

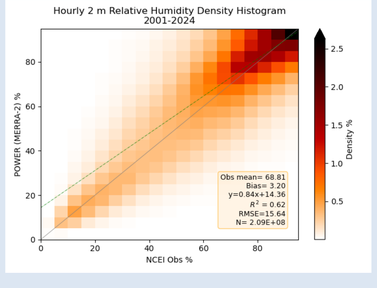
Daily validation for 1 January 1981 through 31 December 2023

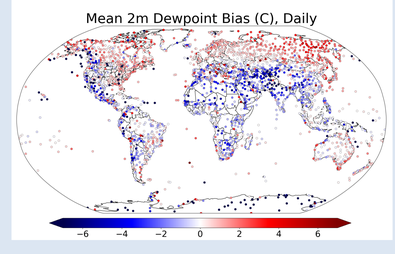
Field	Site Mean	Bias	RMS	R^2	Num (millions)
Temp. 2 m (C)	12.65	-0.68	2.40	0.98	29.1
Max Temp. 2 m (C)	17.71	-1.28	3.12	0.97	29.1
Min Temp. 2 m (C)	7.60	0.33	3.16	0.96	29.2
Dewpoint (C)	6.34	-0.11	2.72	0.96	28.4
Adjusted Surface Pressure (hPa)	963.43	-0.05	2.67	1.00	16.9
Wind Speed 10 m (ms^{-1})	3.34	0.60	1.69	0.56	27.7
Max Wind Speed 10 m (ms^{-1})	6.04	-0.28	2.49	0.44	28.3
Relative Humidity (%)	67.6	3.56	12.95	0.66	28.5
Precipitation (mm)	0.97	0.94	3.70	0.37	38.3







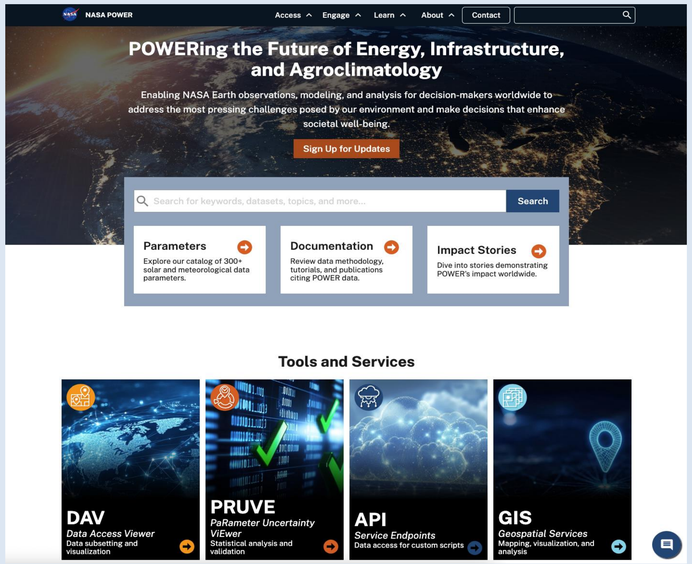




Key Takeaways
- Daily and hourly validation statistics of bias, RMS and std. dev. are comparable for 2 m temperature, dewpoint and mean 10 m wind speed.
- Temperature parameters and surface pressure are within 5% absolute bias.
- Wind speed and precipitation are not represented as well as temperature due to the variability in space and time.
- Surface pressure for validation is adjusted for difference in MERRA-2 grid box elevation and surface site elevation.
- Daily correlations are higher than hourly for similar parameters.
- Smaller MERRA-2 daily 2 m temperature than observed; daily max is under-predicted, daily min is slightly over-predicted.

New POWER Website

POWER's redesigned website features easy access to data tools and services, an improved search function, improved Parameter Dictionary with search, web contact form, and scalability to mobile devices.



Scan the QR code to explore the NASA POWER website

Getting Data from POWER

APIs
The Application Programming Interface (API) delivers Analysis Ready Data (ARD) for inputs to decision support tools, modeling and forecasting packages, and as inputs to scientific research.

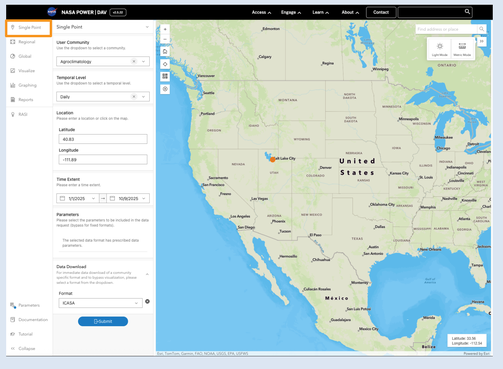
Data Access Viewer (DAV)
This application is a web-based user interface to enable no-code access to community-specific POWER data, providing subsetting capabilities for desktop and mobile use.

Amazon Web Services
The POWER AWS allows users to directly access the POWER ARD. The data is near real time (NRT), as soon as source data becomes available from POWER's source data providers.

Data Output Formats
ICASA, CSV, JSON, ASCII, GeoJSON, NETCDF, and Reports: Climate Design Condition, Annual Wind Rose

DAV: Data Access Viewer

Web-based user interface to enable easy access to community-specific POWER data, providing subsetting capabilities: https://power.larc.nasa.gov/data-access-viewer/



POWER data is readily available for agricultural modeling in DSSAT format (ICASA). From the DAV Single Point App, select "Agroclimatology" for the User Community, "Daily" as the Temporal Level, then enter site-specific coordinates (or point and click on map). Modify the "Time Extent" as needed and finally, under the "Data Download" dropdown menu, select "ICASA." There is no need to select the parameters for the ICASA format, as they will automatically be generated. *Note: The format can be requested directly as part of an API call. For more information, visit our website for instructions and tutorials: https://power.larc.nasa.gov/docs/tutorials/api-getting-started/*

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SWEATHER DATA: NASA

! T2M     Temperature at 2 Meters (C)
! TMIN    Temperature at 2 Meters Minimum (C)
! TMAX    Temperature at 2 Meters Maximum (C)
! TDEW    Dew/Frost Point at 2 Meters (C)
! RHUM    Relative Humidity at 2 Meters (%)
! RAIN    Precipitation Corrected (mm/day)
! WIND    Wind Speed at 2 Meters (m/s)
! SRAD    All Sky Surface Shortwave Downward Irradiance (MJ/m^2/day)
! Mean elevation for source NASA/POWER data tile (0.5 x 0.625 grid cell) = 1744.09m

@ INSI    WTHLAT  WTHLONG   WELEV    TAV  AMP  REFHT  WNDHT
  NASA   40.832 -111.891 1744.09   5.9 30.9      2      2

@  DATE     T2M    TMIN    TMAX    TDEW    RHUM     RAIN    WIND    SRAD
 2025001    -4.8   -12.0     0.3    -7.3    83.4     6.7     1.5     3.9
 2025002    -0.6    -4.0     1.4    -2.5    88.0     5.4     1.0     7.3
 2025003     1.1    -1.6     3.8    -2.5    77.2     0.1     1.8     6.8
 2025004    -2.4    -5.9     1.5    -4.1    89.5     9.1     2.1     5.1
 2025005    -2.9    -5.3     0.5    -4.8    88.4     1.8     1.0     6.9
 2025006    -2.6    -7.6     0.9    -4.0    92.0     1.2     0.9     6.6
 2025007    -8.4   -14.3    -0.3   -10.7    87.5     0.1     1.6     9.8
 2025008    -8.4   -16.0    -1.3   -13.4    67.8     0.0     1.2     9.4
 2025009    -8.2   -13.9    -0.7   -10.8    84.8     0.0     1.2    10.3
 2025010    -6.1   -12.0     0.1    -9.3    80.2     1.2     1.3     9.0
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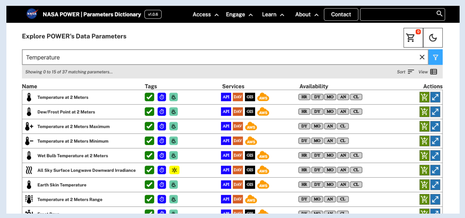
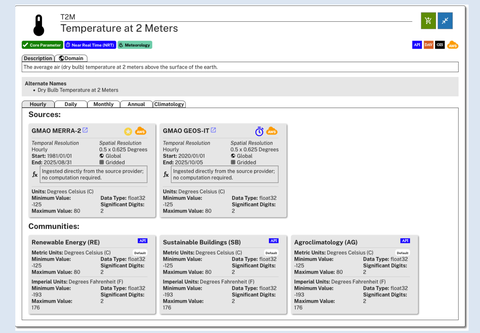
New Web Tools

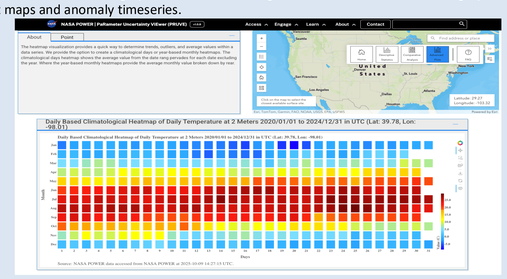
Enhanced Parameter Search and Explorer
The Parameter Dictionary allows for general keyword searches. Returns available data acquisition methods and temporal availability.



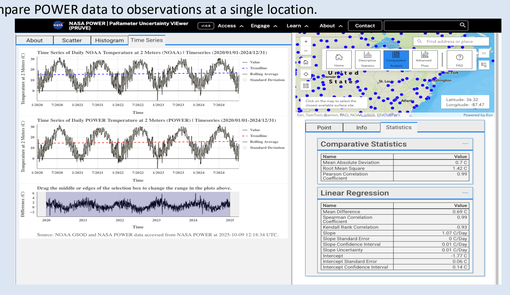
Expandable results for detailed information of availability by method, time averaging, and community.



PRUVE: PaRameter Uncertainty ViEwer
Generate numerical and graphical statistics for single locations and view advanced graphics like heat maps and anomaly timeseries.



Compare POWER data to observations at a single location.



Future Enhancements

- **Higher Spatial Resolution Data Sets**: POWER is evaluating data sets such as MERRA 21-C and HydroSCS.
- **Specialized Parameters**: Soil moisture from Soil Moisture Active Passive (SMAP) and lake and reservoir level data from Global Water Measurements (GWM).
- **New Web Apps:** A Regional Insights Tool will provide users with accessible summary statistics for custom geographic polygons such as political or natural boundaries. This can be for a single POWER parameter or more nuanced spatial patterns.

Tell Your Story!

Do you use POWER data? Let us know how NASA POWER data impacts your work by visiting our website (scan the QR code) and hitting the "Contact" button at the top or emailing us at larc-power-project@mail.nasa.gov.

Real World Impact

Regrow Ag, a U.S. company that monitors 1.4 billion acres of agricultural land worldwide, uses POWER weather data to feed into its software platform, allowing farmers and companies across the agriculture value chain to make informed and strategic decisions on best methods to use and care for farmland. The principal software engineer at Regrow Ag said NASA POWER's accessible data has ensured Regrow Ag pulls in the most accurate datasets available, which builds trust from the farmers its serves.

NASA POWER's climate data enables precise simulation of crop yields across diverse regions and timeframes. The integration of POWER data enhances model scalability, allowing for adaptation to different scenarios, and facilitates continuous updates throughout the growing season, improving accuracy and supporting more effective decision-making. By leveraging POWER's data, Yieldata developed digital tools that are valuable for stakeholders such as: financial and insurance companies (for risk assessment under varying climate conditions) and farmers and agriculture suppliers (to optimize crop management strategies).