



The NASA POWER Global Solar Insolation and Meteorological Parameter Cloud-based Web Services

The Prediction Of Worldwide Energy Resources (POWER) Project, a NASA Applied Sciences Project

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What is POWER?

The **Prediction Of Worldwide Energy Resources (POWER)**¹

Project aims to improve the capability for integrating environmental data from NASA Earth Observations (EO), regarding surface solar irradiance and related parameters, into decision making processes regarding energy and agriculture

As a NASA Applied Sciences project, **POWER** creates application ready datasets and improves the accessibility and usage of EO data supporting community research in **three focus areas**



1

Renewable Energy Development

Assisting in Energy System Design

POWER's Renewable Energy Web Data Services provide access to parameters specifically tailored to inform the design of solar and wind powered renewable energy systems

2

Building Energy Efficiency & Sustainability

Informing Building Energy Efficiency

POWER's Sustainable Buildings Web Data Services provide industry-friendly parameters for the buildings community in customized formats for input to building decision support tools.

3

Agroclimatology Applications

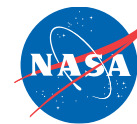
Enhancing Food Security

POWER's Agroclimatology Web Data Services are designed to provide web-based access to industry-friendly parameters formatted for input to crop models contained within agricultural decision support tools.

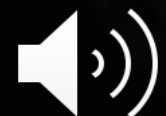




POWER Is 100% Driven by USER NEEDS

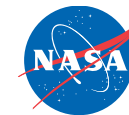


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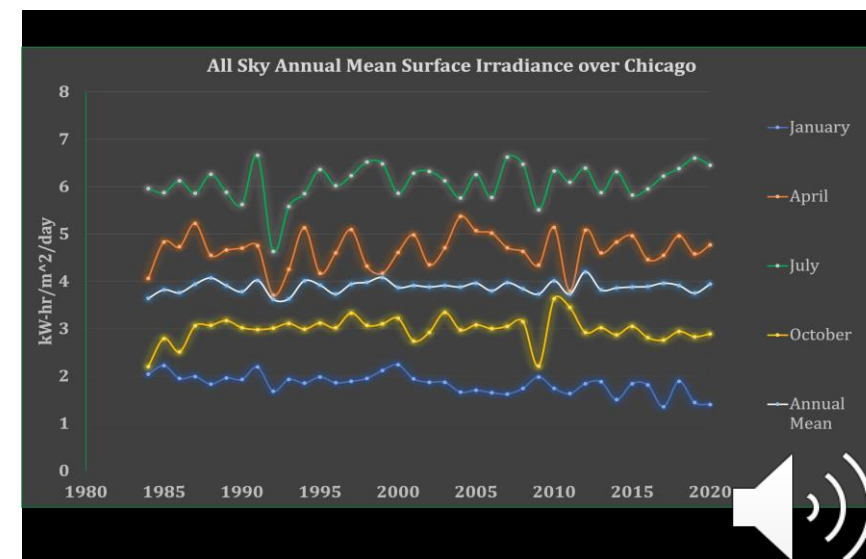
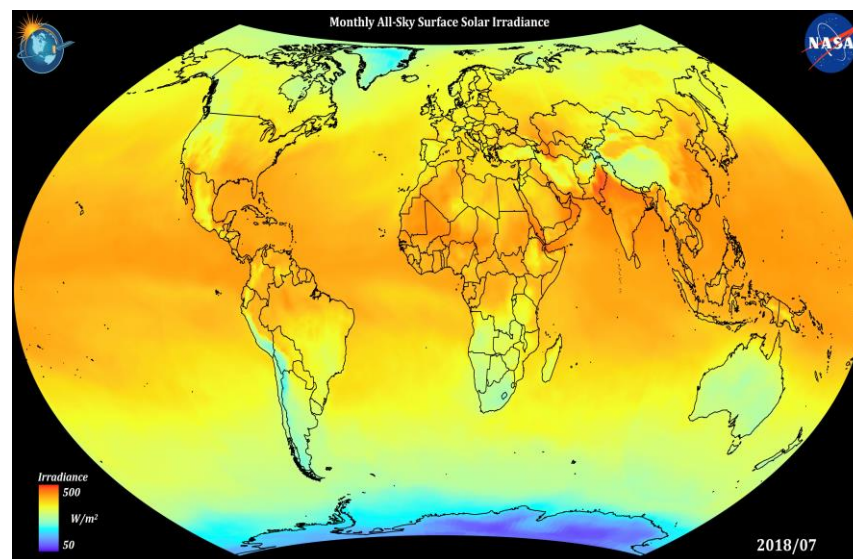
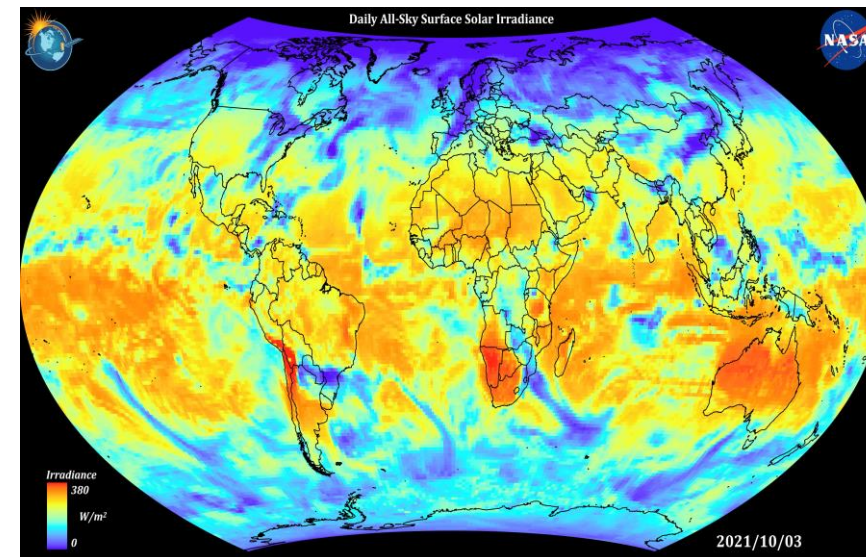
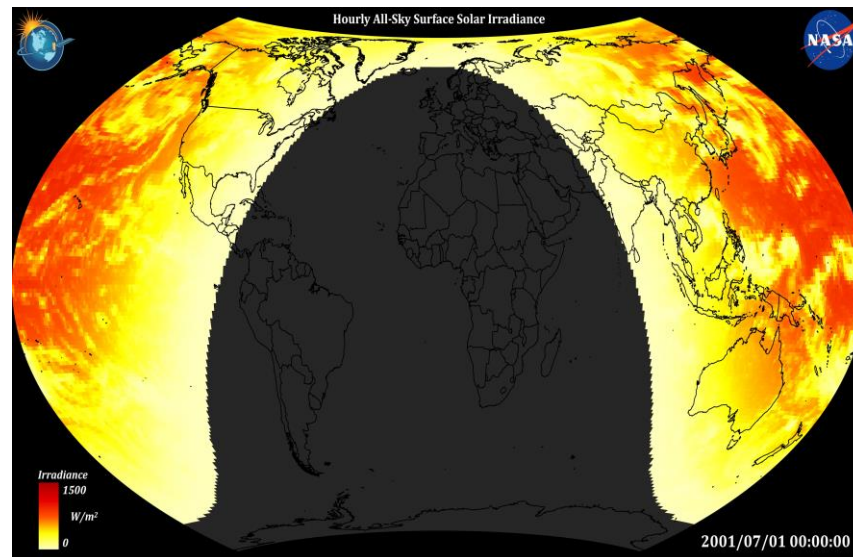




Data Products | Global Surface Solar Radiation

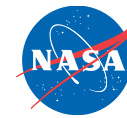


- Hourly since 2001
- Daily, monthly back to Jan 1984
- Latency within 3-4 days (solar a longer)





Data Source | Global Surface Solar Radiation

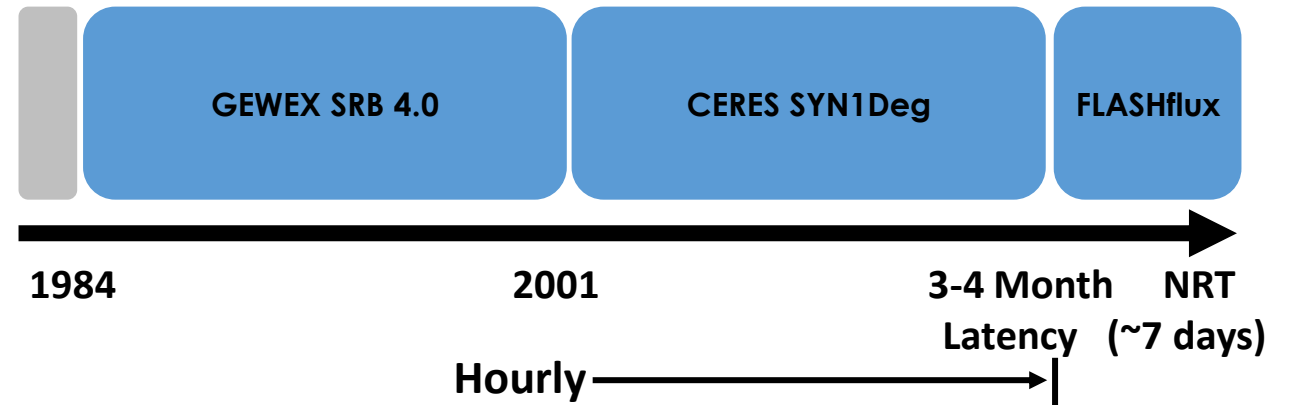


Source	Temporal Span		Temporal Average		Description
	Start	End	Input	Output	
GEWEX SRB 4.0	Jan 1, 1984	Dec. 31, 2000	Daily	Daily, Monthly, Annual, Multi-year	Satellite analysis from global cloud imagers (from geosynchronous and polar orbiters satellites) using radiative transfer lookup tables
CERES SYN1Deg (Ed 4A)	Jan 1, 2001	End of SYN1Deg (current)	Hourly	Hourly, Daily, Monthly, Annual, Multi-year	Satellite analysis from CERES convolved with MODIS for scene and TOA fluxes, then uses radiative transfer with additional input from geosynchronous satellites and other inputs to produce surface fluxes
CERES FLASHFlux	End of SYN1deg (current)	Near Real Time	Daily	Daily, Monthly, Annual, Multi-year	Satellite analysis of CERES (reflected solar) and MODIS (cloud imager) measurements (on Terra and Aqua satellites) providing daily averaged estimates of radiative fluxes within 5-6 days of real-time.

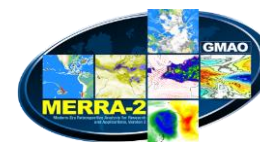
Production System:

- Daily solar data products from 1984 provided through 7 days of real-time at 1 Deg resolution
- SRB to CERES SYN1Deg, to FLASHFlux
- Hourly from 2001 through 3-4 months of observation

Production Data Timeline



SURFACE RADIATION BUDGET

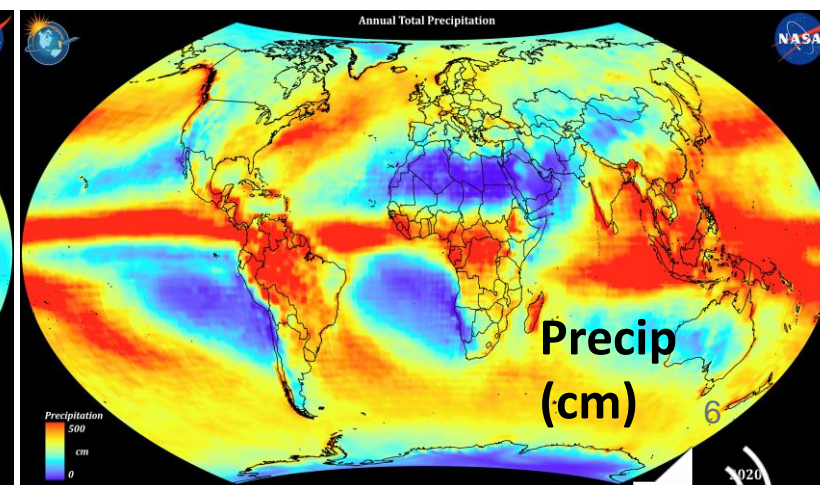
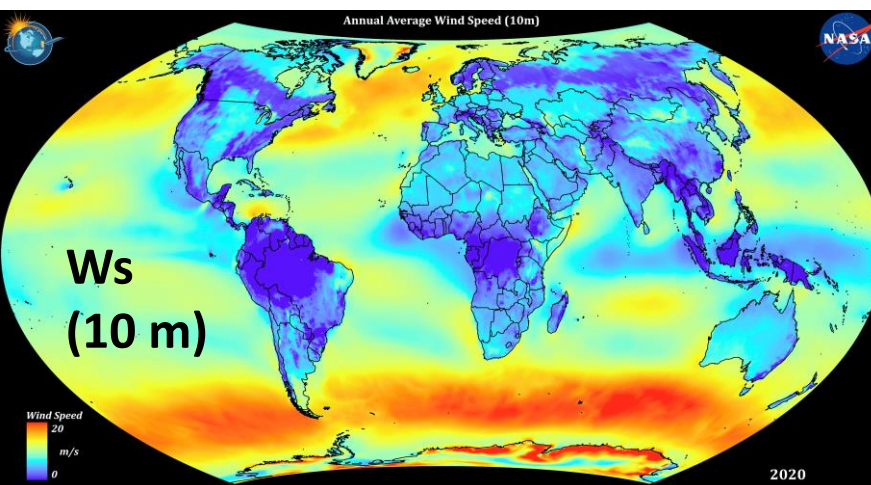
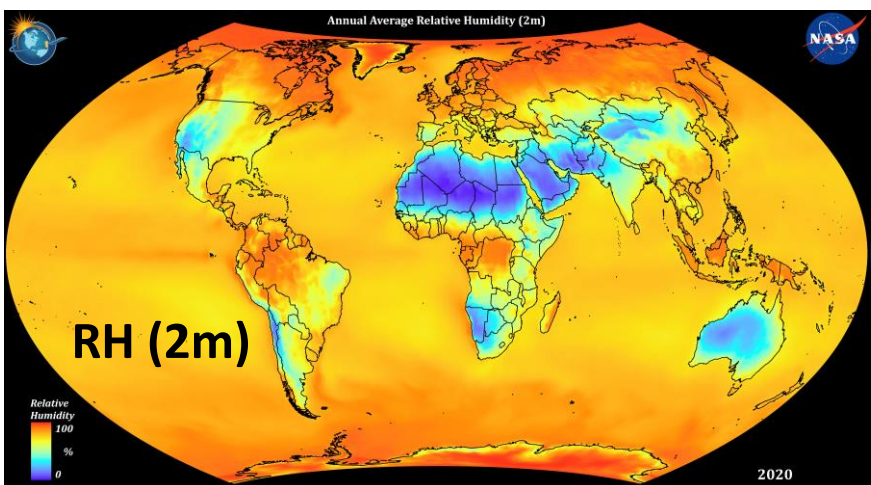
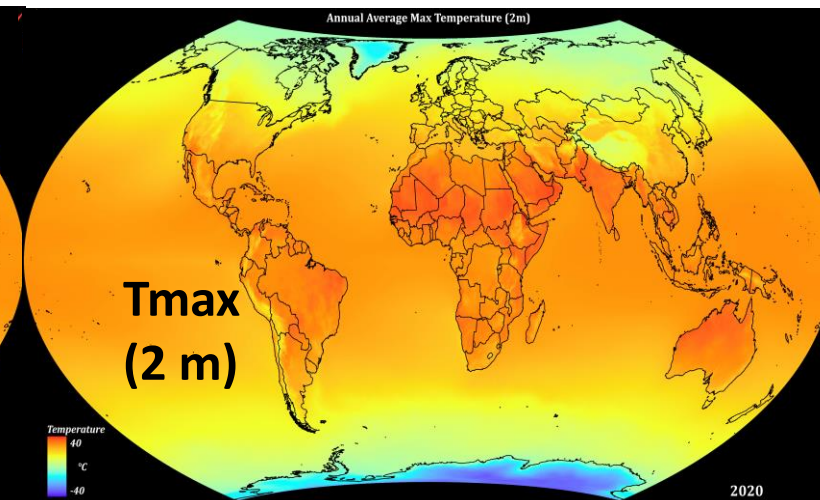
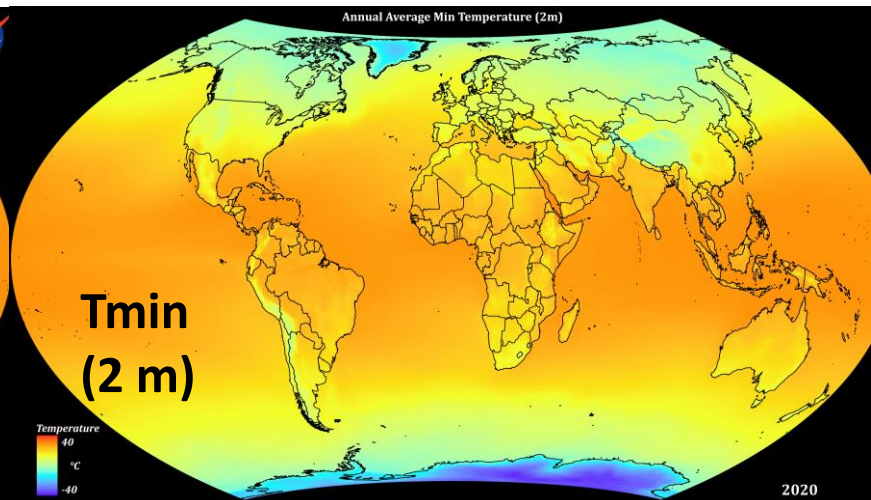
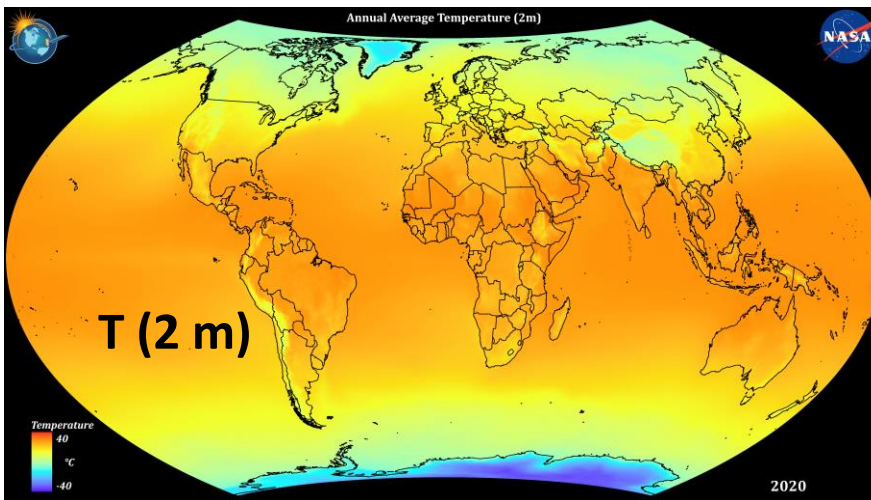




Data Products | Global Surface Meteorology

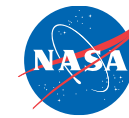


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Data Source | Global Surface Meteorology

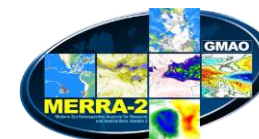
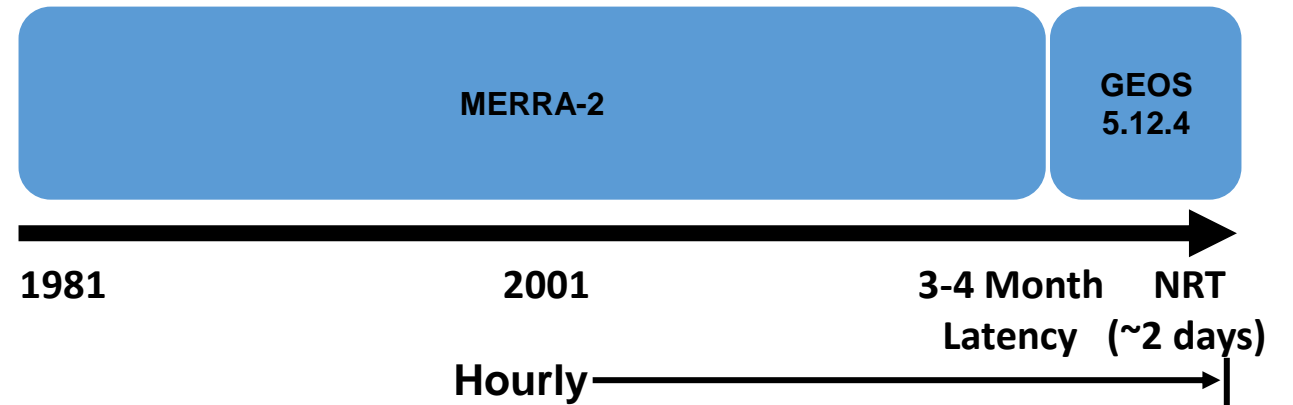


Source	Temporal Span		Temporal Average		Description
	Start	End	Input	Output	
MERRA-2	Jan. 1, 1981	End of MERRA-2 (current)	Hourly	Hourly, Daily, Monthly, Annual, Multi-year	Atmospheric reanalysis with assimilated observations (1-2 months behind real time)
GMAO FP-IT (GEOS 5.12.4)	End of MERRA-2	Near Real Time	Hourly	Hourly, Daily, Monthly, Annual, Multi-year	Atmospheric reanalysis with assimilated observations with less assimilated observations, available within 2 days of real-time
IMERG	Jan 1, 2001	Near Real Time	Daily	Daily	The Multi-satellite Retrievals for GPM (IMERG) algorithm provides estimates of precipitation in UTC time at 10 km resolution, available within 2 days of real-time.

Production System:

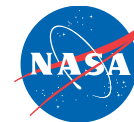
- Daily surface meteorology data products from 1981 provided through 3 days of real-time
- MERRA-2 to GEOS 5.12.4
- Data is at ~half degree spatial resolution

Production Data Timeline

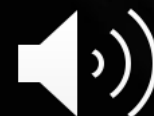


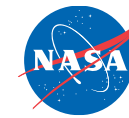


POWER Provides Trusted Latest Version Of Datasets



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How Is Data Parameter Quality Determined ?



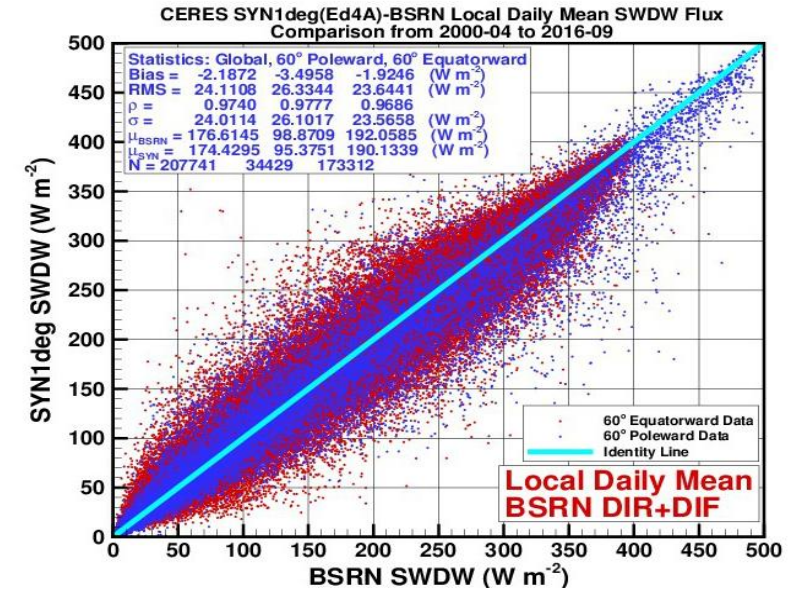
POWER uses surface measurements to characterize data product uncertainty



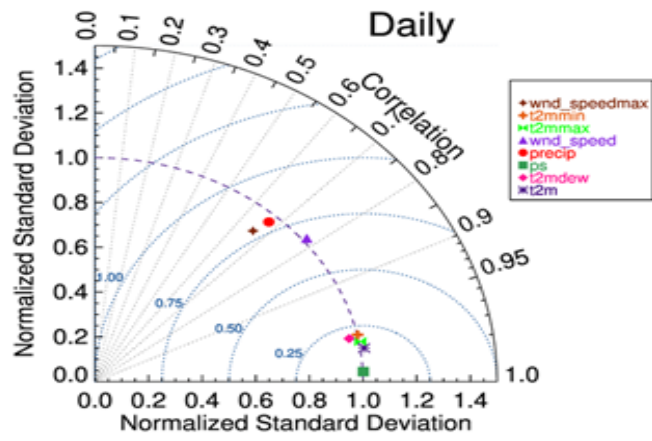
Validation at various temporal scales (up to hourly) and assessments for value-added products as observations available



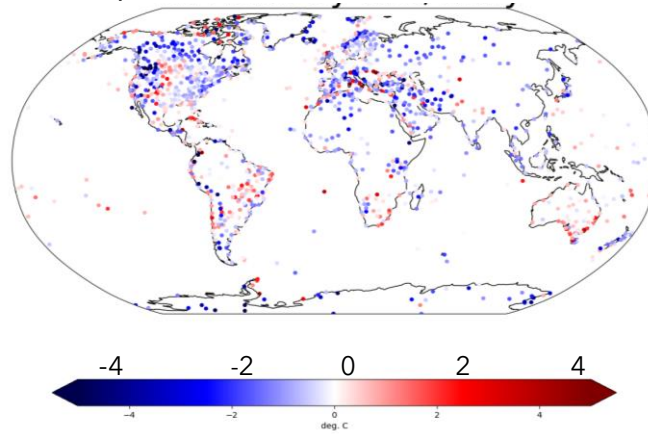
See "Methodology Documentation" pages for more information and statistics



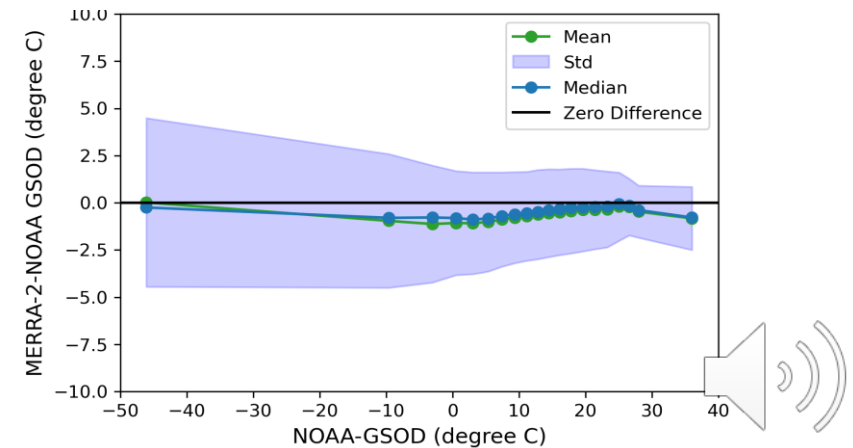
Merra-2 Daily Mean fields



2m Daily Temperature: Bias Comparison from 1981 - 2020

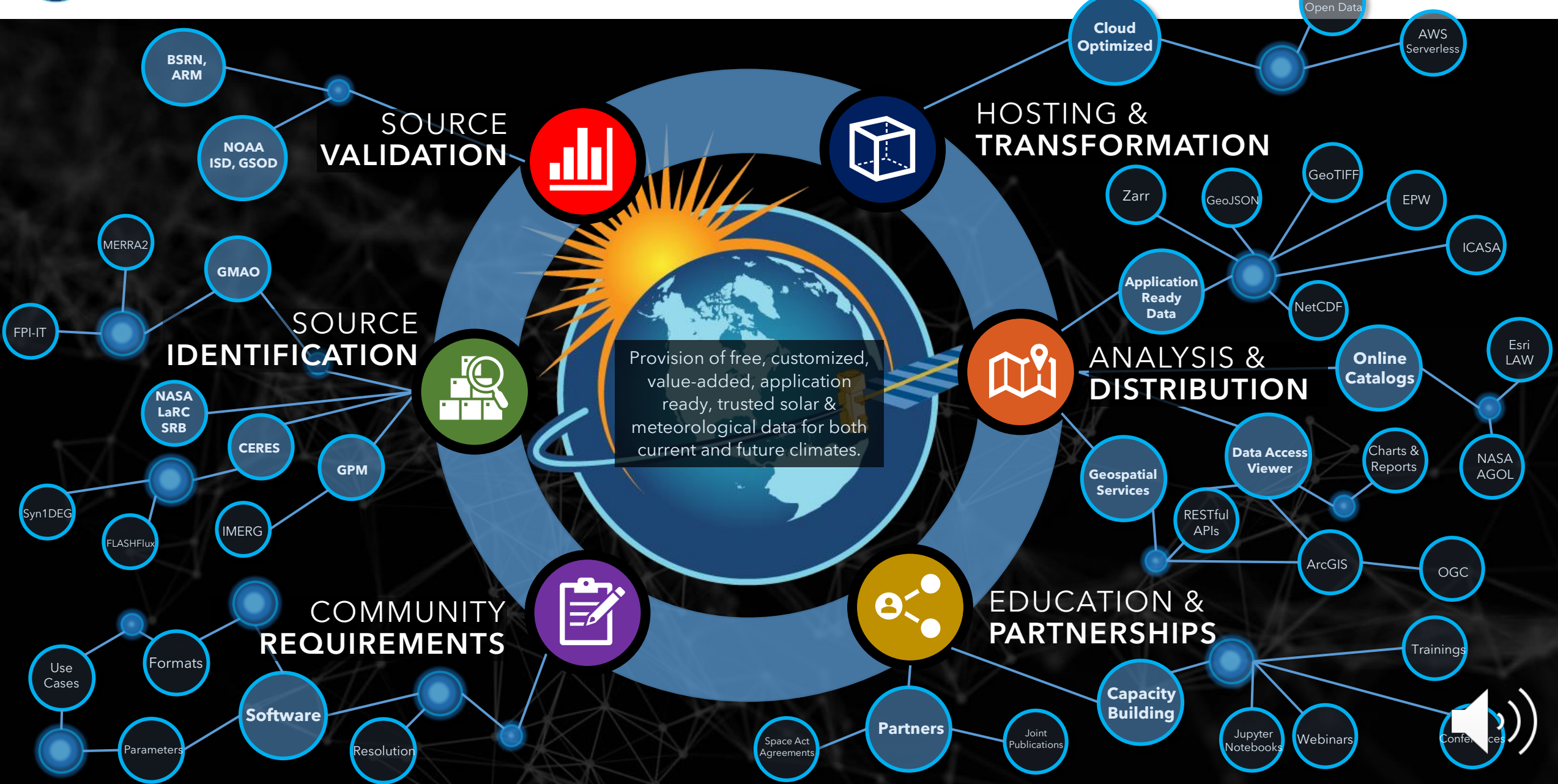


2m Daily Temperature Differences



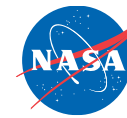


Beyond Data Needs | Accessibility





POWER Services for Data access



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Different users require different ways to access the same data

POWER Hourly API v2.3.5 OAS3
<https://power.larc.nasa.gov/api/temporal/hourly/openapi.json>

The API allows hourly data requests of POWER Analysis Ready Data (ARD).

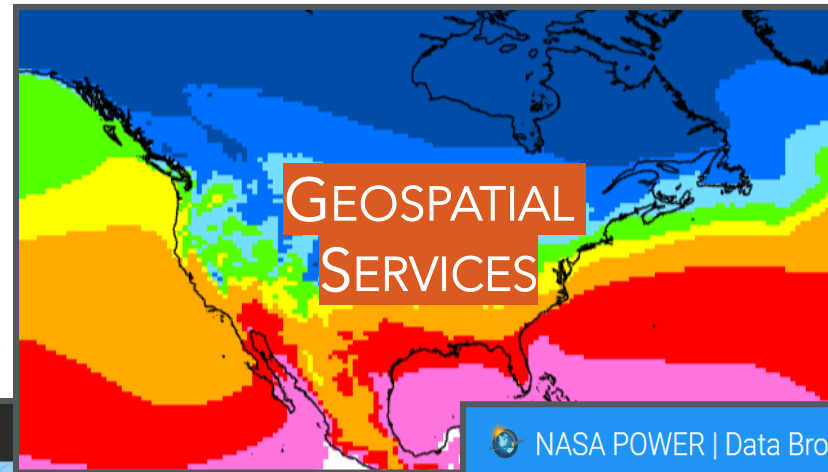
Data Requests More documentation: <https://power.larc.nasa.gov/docs/services/api/temporal/hourly/>

Configuration Settings

Schemas

APIInformation {
 version* string
 title: Version
 name* string
 title: Name
}

APIs



GEOSPATIAL
SERVICES

POWER | Dave beta v0.3
 Prediction of Worldwide Energy Resource (POWER) | Data Access Viewer Enhanced (DAVE)

temperature at 2 meters
 T2M

Temperature at 2 Meters Maximum Average
 T2M_max_avg

Temperature at 2 Meters Minimum Average
 T2M_min_avg

DewPoint at 2 Meters
 T2M_dp

Wet Bulb Temperature at 2 Meters
 T2M_wb

Earth Skin Temperature
 TS

Eastward Wind at 10 Meters
 U10M

Eastward Wind at 50 Meters
 U50M

Northward Wind at 10 Meters
 V10M

Northward Wind at 50 Meters
 V50M

Wind Direction at 10 Meters
 WD10M

Wind Direction at 50 Meters
 WD50M

Wind Speed at 10 Meters
 WS10M

Service: Annual Meteorology
 Layer: Wind Speed at 10 Meters
 Time: 2006
 Units: m/s

1991 1990 2000 2010 2020
 id: 42.42
 rade: -144.02

DATA ACCESS
VIEWER

NASA POWER | Data Browse

Folder Hide folders? 24

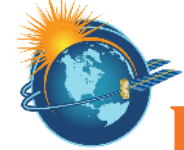
Show entries

Object	Timestamp	Size
power_901_annual_meteorology_utc.zarr/		
power_901_annual_radiation_utc.zarr/		
power_901_constants.zarr/		
power_901_daily_meteorology_lst.zarr/		

AMAZON WEB
SERVICES

Creating **trusted, value-added, easy-to-use Application Ready Data & Services**

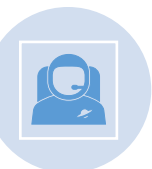




POWER Products & Services | RESTful APIs & Geospatial Services



POWER is currently providing image services for annual radiation, annual meteorology, monthly radiation, and monthly meteorology, and climatologies



The services can be accessed via the [NASA eGIS Portal for ArcGIS POWER Group](#), [NASA ArcGIS Online POWER Group](#), and the [Esri® Living Atlas of the World](#) (submitted on 11/30/2021).

Jupyter Notebooks User Tutorials & Documentation

The collage displays various POWER data services and user interfaces:

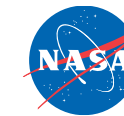
- RESTful API Response:** A JSON object showing a feature with geometry and coordinates:


```
{
    "type": "Feature",
    "geometry": {
      "type": "Point",
      "coordinates": [
        -92.2331,
        42.19,
        280.82
      ]
    },
    "properties": {
      "parameter": "ALLSKY_SFC_SNDWN"
    }
  }
```
- Jupyter Notebook:** A screenshot of a Jupyter Notebook titled "NASA POWER | Docs" showing "API Data Requests" and "Multi-Point Download with Python". The code includes:


```
1 # Import the requests module
2 # Parameters: 2.0 Publication: 2021/09/07 Source: NASA POWER (https://power.larc.nasa.gov)
3 # Units: "kWh/m2/day"
4 # Note: To be successful at the service to request data from multiple data points from the POWER API,
5 # you must use the "locations" parameter.
6 # Report on: data_requests
7 # Locations: [{"lon": -92.2331, "lat": 42.19}
8 ]
```
- ArcGIS Online Services:** Several map services are shown, including:
 - POWER Monthly Meteorology:** Provides global monthly meteorology data from 1981 to 2020. Created: Nov 30, 2021. Updated: Nov 30, 2021. View Count: 17.
 - POWER Monthly Radiation:** Provides global monthly radiation data from 1984 to 2020. Created: Nov 30, 2021. Updated: Nov 30, 2021. View Count: 17.
 - POWER Annual Meteorology:** Provides global annual meteorology data from 1981 to 2020. Created: Nov 30, 2021. Updated: Nov 30, 2021. View Count: 17.
 - POWER Annual Radiation:** Provides global annual radiation data from 1984 to 2020. Created: Nov 30, 2021. Updated: Nov 30, 2021. View Count: 76.
- Native Resolution Data:** A section showing high-resolution data visualizations.
- Living Atlas of the World:** Four map services are listed:
 - Thermal Moisture Building ...** by bmacpher_NASA. Created: Mar 26, 2020. Updated: Sep 14, 2020. View Count: 171.
 - Four Year Rolling Building ...** by bmacpher_NASA. Created: Mar 17, 2020. Updated: Sep 14, 2020. View Count: 261.
 - POWER: Evaluating Data U...** by bmacpher_NASA. Created: Jun 3, 2020. Updated: Feb 24, 2022. View Count: 722.
 - POWER Monthly Radiation** by NASA ArcGIS Online. Created: Nov 30, 2021. Updated: Dec 7, 2021. View Count: 255.



Analytic Data Services | Reports



Building Climatic Design Conditions

POWER Climatic Design Conditions (MERRA-2 and SRB/CERES)

Latitude: 29.6106 Longitude: -82.2603 Elevation: 28.3 StdPres: 14.68 Time Period: 2014 - 2019 Note: 0.5 x 0.5 Degree Gridded Data

Annual Heating and Humidification Design Conditions											
Colest Month	Heating DB	Humidification DP/MCDB and HR	99.6%	99%	DP	HR	99%	MCDB	WS	MCDB	WS
1	-0.2	1.8	-5.6	0.0	0.0	-3.2	0.0	2.7	2.7	0.4%	1%
Annual Cooling, Dehumidification, and Enthapy Design Conditions											
Hottest Month	Cooling DB/MCWB	1%	2%	Evaporation WB/MCDB	1%	2%	MCWS/PCWD to	0.4%	DB	99.6%	DB
7	12.5	35.8	34.7	33.6	28.4	28.1	27.8	0.4%	29.6	0.4%	29.6

Extreme Annual Design Conditions

Extreme Annual WS	Mean	Standard deviation	n=5 years	n=10 years	n=20 years	n=50 years
1%	6.0	5.2	5%	4.5	DB	WB
	-3.6	37.4	1.8	1.6	-4.9	38.6
	-5.4	29.2	2.9	0.4	-7.5	29.5
					-9.2	29.7
					-10.8	29.9
					-12.9	30.1

Monthly Climatic Design Conditions

	Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
DBAvg	21.2	11.5	15.3	17.3	21.3	25.1	27.1	27.9	25.6	22.3	17.2	15.6	
DBStd	0.7	2.2	3.0	1.8	1.3	1.1	0.9	0.8	0.4	0.8	1.4	2.1	
HDD10.0	59	40	8	2	0	0	0	0	0	0	3	6	
HDD18.3	535	204	95	63	8	0	0	0	0	0	61	95	
CDD10.0	4302	100	168	240	350	475	524	563	555	495	397	235	
CDD18.3	1747	7	20	45	109	218	275	306	298	246	148	44	
CDH23.3													
CDH26.7													

Wind

WSAvg	2.3	2.7	2.6	2.6	2.3	2.0	1.7	1.9	2.1	2.6	2.4	2.5
PrecAvg	811	53	44	45	41	45	86	77	145	173	38	31
PrecMax	1383	125	94	146	99	108	202	156	268	394	92	80
PrecMin	3	3	2	1	2	1	3	5	3	1	2	5
PrecStd	637	49	39	53	41	40	76	68	123	155	37	27

Monthly Design Dry Bulb and Mean Coincident Wet Bulb Temperatures

	0.4%	2%	5%	10%
DB	15.2	18.2	19.3	22.9
MCWB	11.2	16.0	15.2	18.4
DB	15.0	18.1	19.2	22.9
MCWB	11.0	15.9	15.2	18.4
DB	14.4	18.1	19.2	22.9
MCWB	10.7	15.8	15.1	18.3
DB	13.6	17.9	19.2	22.8
MCWB	10.1	15.7	15.0	18.1

Monthly Design Wet Bulb and Mean Coincident Dry Bulb Temperatures

	0.4%	2%	5%	10%
WB	11.2	16.0	15.2	18.4
MCDB	15.2	18.2	19.3	22.9
WB	11.0	15.9	15.2	18.3
MCDB	15.0	18.1	19.3	22.8
WB	10.7	15.8	15.1	18.0
MCDB	14.4	18.1	19.2	22.6
WB	10.1	15.6	14.9	17.5
MCDB	13.6	18.0	19.2	22.4

Mean Daily Temperature Range

	5% DB	5% WB
MDBR	11.5	11.8
MCDBR	12.5	12.3
WB	12.1	12.1
MCWB	9.5	9.0
WB	8.4	8.4
MCWB	10.2	11.6
WB	10.7	10.7

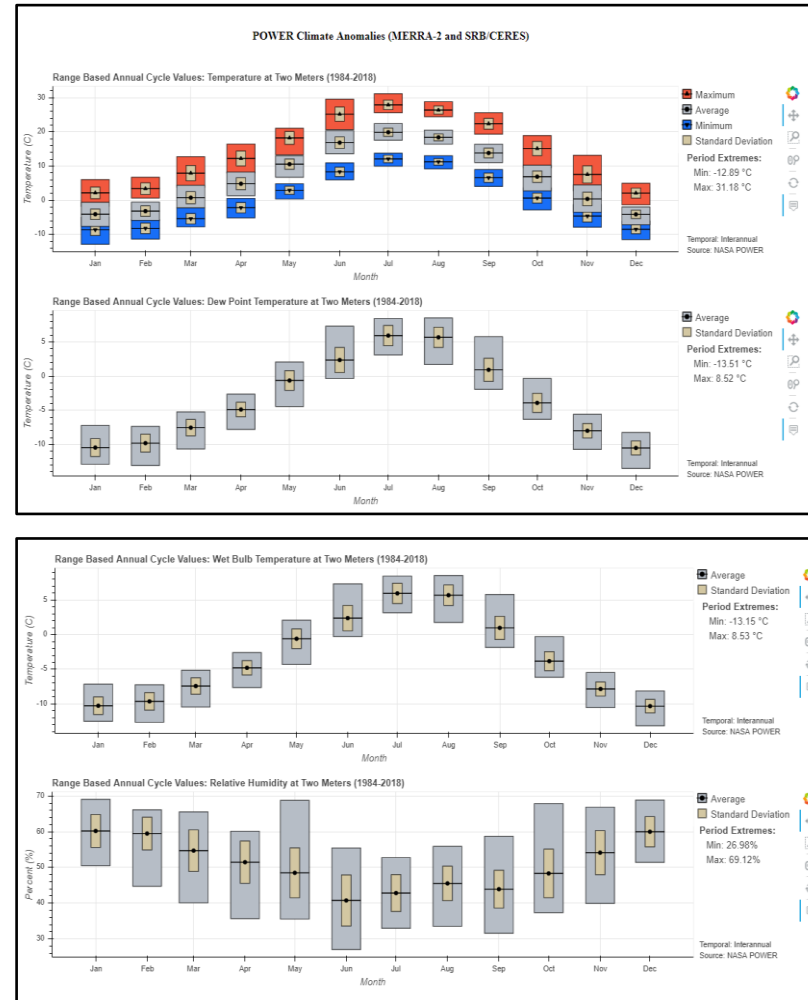
Clear Sky Solar Irradiance

	taub	taud	Ebn,noon	Edn,noon
RadAvg	3.2	3.94	5.02	5.97
RadStd	1.12	1.42	1.53	1.64
	1.6	1.72	1.65	1.44
	1.44	1.44	0.99	1.05
	0.94			

All-Sky Solar Radiation

	RadAvg	RadStd
	3.2	1.12
	3.94	1.42
	5.02	1.53
	5.97	1.64
	6.45	1.6
	5.84	1.72
	5.43	1.65
	5.38	1.44
	4.79	1.44
	4.48	0.99
	3.53	1.05
	2.95	0.94

Climate Variability and Anomalies Report



Windrose Report Table by NREL Classes

-BEGIN HEADER-

NASA/POWER Wind Rose MERRA2/GEOS 5.12.4 (FP-IT) 0.5 x 0.5 Degree Daily Averaged Data

Dates (month/day/year): 01/01/1984 through 12/31/2018

Single Point Total

Location: Latitude 38.9531 Longitude -77.828

Elevation from MERRA-2: Average for 1/2x1/2 degree lat/lon region = 83.32 meters Site = na

Value for missing model data; cannot be computed or out of model availability range: -999

Parameter(s):

WR18M Wind Rose at 10 meters (percent)

CLASS_1: 0-1.5 m/s

CLASS_2: 1.5-3.0 m/s

CLASS_3: 3.0-4.5 m/s

CLASS_4: 4.5-6.0 m/s

CLASS_5: 6.0-7.5 m/s

CLASS_6: 7.5-9.0 m/s

CLASS_7: 9.0-10.5 m/s

CLASS_8: 10.5-12.0 m/s

CLASS_9: 12.0-13.5 m/s

CLASS_10: 13.5-15.0 m/s

WR58M Wind Rose at 58 meters (percent)

CLASS_1: 0-1.5 m/s

CLASS_2: 1.5-3.0 m/s

CLASS_3: 3.0-4.5 m/s

CLASS_4: 4.5-6.0 m/s

CLASS_5: 6.0-7.5 m/s

CLASS_6: 7.5-9.0 m/s

CLASS_7: 9.0-10.5 m/s

CLASS_8: 10.5-12.0 m/s

CLASS_9: 12.0-13.5 m/s

CLASS_10: 13.5-15.0 m/s

WD_PCT Wind Direction Percent (percent)

WD_AVG Wind Direction Average Wind Speed (m/s)

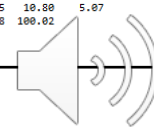
This consists of 16 22.5 degree swaths; the center point being defined. (degrees)

CLASS The NREL wind Classifications with enhanced low-end wind levels that have different cutoffs for 10m and 58m Heights.

PARAMETER DIRECTION CLASS_1 CLASS_2 CLASS_3 CLASS_4 CLASS_5 CLASS_6 CLASS_7 CLASS_8 CLASS_9 CLASS_10 WD_PCT WD_AVG

-END HEADER-

WR18M	090.0	1.59	4.03	1.60	0.33	0.16	0.03	0.05	0.02	0.03	0.00	7.83	2.50
WR18M	022.5	1.73	3.86	0.94	0.10	0.00	0.02	0.00	0.01	0.00	0.00	6.66	2.15
WR18M	045.0	1.42	4.07	1.27	0.09	0.02	0.01	0.00	0.00	0.00	0.00	6.87	2.28
WR18M	067.5	1.53	4.69	2.89	0.41	0.10	0.04	0.02	0.01	0.00	0.00	9.68	2.64
WR18M	090.0	1.44	3.77	1.69	0.16	0.06	0.02	0.01	0.01	0.00	0.00	7.15	2.42
WR18M	112.5	1.33	2.56	0.77	0.09	0.03	0.01	0.01	0.00	0.00	0.00	4.80	2.15
WR18M	135.0	1.01	1.71	0.41	0.11	0.00	0.01	0.00	0.00	0.00	0.00	3.25	2.06
WR18M	157.5	1.15	1.76	0.39	0.03	0.00	0.00	0.01	0.01	0.01	0.00	3.36	1.95
WR18M	180.0	1.00	1.64	0.51	0.09	0.02	0.02	0.02	0.00	0.00	0.00	3.29	2.14
WR18M	202.5	1.06	2.07	0.63	0.09	0.02	0.02	0.01	0.00	0.01	0.00	3.91	2.18
WR18M	225.0	1.17	1.99	0.79	0.09	0.08	0.02	0.02	0.02	0.02	0.04	4.22	2.31
WR18M	247.5	1.19	1.94	0.80	0.13	0.03	0.02	0.02	0.02	0.03	0.00	4.18	2.33
WR18M	270.0	1.13	2.64	1.34	0.13	0.00	0.04	0.03	0.02	0.02	0.00	5.42	2.40
WR18M	292.5	1.23	3.30	2.03	0.41	0.23	0.09	0.08	0.03	0.09	0.00	7.49	2.82
WR18M	315.0	1.60	3.56	3.49	0.95	0.48	0.24	0.26	0.21	0.25	0.02	11.05	3.28
WR18M	337.5	1.51	4.01	3.13	1.02	0.45	0.27	0.17	0.10	0.20	0.01	10.86	3.14
WR18M	ALL	21.09	47.60	22.68	4.23	1.76	0.86	0.71	0.46	0.68	0.03	100.02	0.00
WR58M	090.0	0.63	1.85	3.79	0.59	0.41	0.16	0.23	0.15	0.13	0.01	7.95	4.12
WR58M	022.5	0.46	1.73	3.75	0.53	0.16	0.11	0.03	0.02	0.01	0.00	6.80	3.77
WR58M	045.0	0.54	1.63	4.06	0.65	0.21	0.09	0.07	0.02	0.01	0.00	7.27	3.87
WR58M	067.5	0.41	1.66	5.24	1.18	0.61	0.34	0.23	0.13	0.13	0.00	9.93	4.51
WR58M	090.0	0.52	1.48	3.81	0.56	0.20	0.15	0.09	0.06	0.04	0.00	6.90	4.00
WR58M	112.5	0.37	1.45	2.44	0.24	0.06	0.05	0.04	0.05	0.02	0.00	4.72	3.57
WR58M	135.0	0.39	1.08	1.45	0.13	0.07	0.06	0.02	0.00	0.00	0.00	3.21	3.33
WR58M	157.5	0.47	1.15	3.44	0.06	0.04	0.01	0.01	0.01	0.03	0.00	3.24	3.10
WR58M	180.0	0.46	1.09	1.49	0.15	0.07	0.02	0.02	0.01	0.02	0.00	3.32	3.24
WR58M	202.5	0.43	1.18	1.81	0.17	0.10	0.04	0.02	0.01	0.03	0.01	3.80	3.49
WR58M	225.0	0.47	1.31	2.01	0.17	0.12	0.07	0.02	0.05	0.05	0.01	4.28	3.57
WR58M	247.5	0.42	1.20	1.83	0.27	0.12	0.05	0.02	0.02	0.07	0.00	4.01	3.64
WR58M	270.0	0.55	1.31	2.63	0.45	0.16	0.07	0.05	0.10	0.04	0.01	5.37	3.87
WR58M	292.5	0.58	1.35	3.39	0.74	0.35	0.31	0.22	0.15	0.24	0.02	7.38	4.52
WR58M	315.0	0.62	1.53	4.21	1.30	0.86	0.62	0.56	0.58	0.70	0.07	11.04	5.23
WR58M	337.5	0.54	1.71	4.32	1.06	0.81	0.58	0.53	0.61	0.59	0.05	10.80	5.07
WR58M	ALL	7.86	22.74	47.67	8.25	4.35	2.73	2.15	2.00	2.11	0.18	100.02	0.00



Natural Resources Canada's RETScreen® Clean Energy Management Software Platform

Renewable Energy Development

World's leading clean energy decision making software for benchmark, feasibility, performance, and portfolio analysis related to energy efficiency, heating and cooling, power generation and cogeneration, with 732,000+ registered users.

POWER provides global data as climatological averages that are embedded in the software and near-real time data obtained via a direct connection to POWER.

12.2	25.1	32.1%	0.0	3.15
12.6	23.4	26.2%	0.0	2.33
12.3	23.1	48.4%	6.6	2.52
9.4	16.1	72.8%	3.2	2.91
5.7	20.7	54.1%	0.0	2.96



Renewable Energy Development

Wicked Joe Organic Coffees

"The benefits of solar, in our view, go far beyond the financial considerations or return on investment. While some regions may have 'more optimal' conditions for solar, we believe that any place where the sun shines is a good place for solar."

-Bob Garver, Wicked Joe Founder

Wicked Joe Coffee utilized RETScreen™ and POWER data to determine that a glazed solar wall would result in 40% more heat savings of approximately \$10,000 per year.



POWER Data Access Viewer Prediction Of Worldwide Energy Resource Eari World Geocoder

22 Year Climatology Average
Value: 3.88 (kWh/m²/day)
See bottom left of screen for coordinates
Zoom to

POWER Layer List

1. Choose a Parameter
 - Insolation on Horizontal Surface
 - Minimum Insolation on Horizontal Surface
 - Maximum Insolation on Horizontal Surface
 - Direct Normal Radiation

Month: Annual
Opacity: 90%
Clear Parameter Map Grid Layer Swipe

Left-Click on map for data set values by location.

High : 10
Low : 0
Units: (kWh/m²/day)

POWER Single Point Data Access

NASA Prediction of Worldwide Energy Resource (POWER)
Higher Resolution Daily Time Series 1/2 x 1/2 degree
Climatology Resource for SSE-Renewable Energy

Output Files
[GeoJSON](#) [ASCII](#)

Latitude: 43.8472 Longitude: -69.9236
Time Extent:
22 Year Solar Climatological Averages (Jul 1983 - Jun 2005)
30 Year Meteorology Climatological Averages (Jan 1984 - Dec 2013)
Elevation: 27.77 meters

Parameter Charts
All Sky Insolation Incident on a Horizontal Surface

Line chart showing insolation (kWh/m²/day) by month. The x-axis lists months from January to December. The y-axis ranges from 0 to 6. The curve shows a seasonal peak in June/July and a minimum in December.

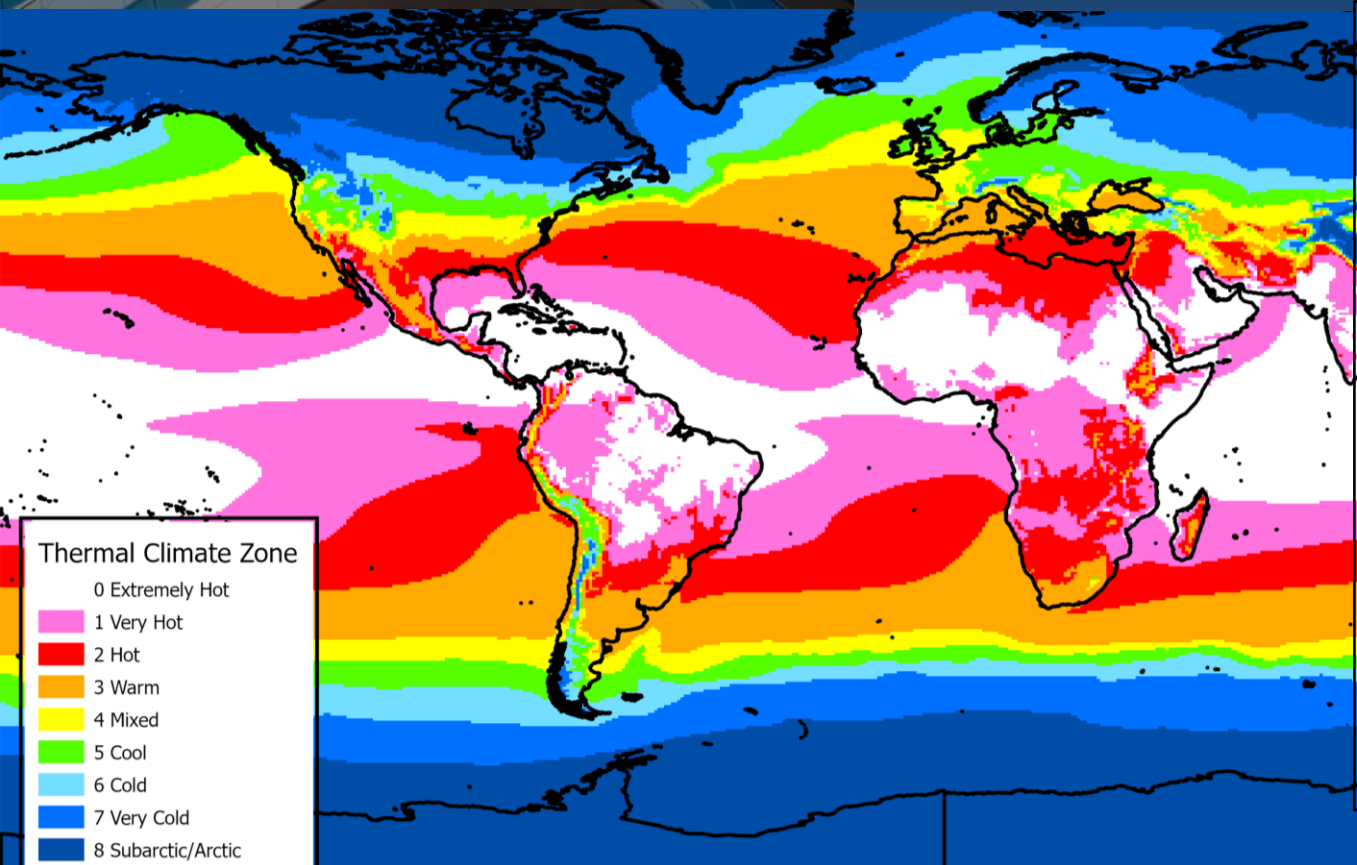
Data Availability
Jan 1984 - Dec 2013 (Meteorology)
Jul 1983 - Jun 2005 (Solar)
*Missing data and/or no data periods are not plotted.

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

Building Energy Efficiency & Sustainability

The POWER project is working with ASHRAE professional association to make their Climatic Design Conditions reports available to the public with POWER data globally.

Using MERRA-2, POWER creates Global ASHRAE Building Climate Zone maps, as well as "rolling" climate zones from 4-year means to illustrate the changes in time from 1984 through 2021.



Thermal Climate Zone

- 0 Extremely Hot
- 1 Very Hot
- 2 Hot
- 3 Warm
- 4 Mixed
- 5 Cool
- 6 Cold
- 7 Very Cold
- 8 Subarctic/Arctic

Building Climatic Design Conditions

POWER Climatic Design Conditions (MERRA-2 and SRB/CERES)

Latitude: 29.6106 Longitude: -82.2603 Elevation: 28.3 StdPres: 14.68 Time Period: 2014 - 2019 Note: 0.5 x 0.5 Degree Gridded Data

Annual Heating and Humidification Design Conditions											
Coldest Month	Heating DB	Humidification DP/MCDB and HR	99.6%	99%	DP	HR	MCDB	DP	HR	MCDB	WS
1	-0.2	1.8	-5.6	0.0	-3.2	0.0	2.7	2.7	2.7	2.7	2.7

Annual Cooling, Dehumidification, and Entropy Design Conditions											
Hottest Month	DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	PCWD
7	12.5	35.8	34.7	33.6	28.4	28.1	27.8	27.8	27.8	27.8	27.8

Extreme Annual Design Conditions											
Extreme Annual WS	1%	2.5%	5%	DB	Min	Max	Standard deviation	Min	Max	Min	Max
6.0	5.2	4.5	4.5	DB	-5.4	37.4	1.8	1.6	-4.9	38.6	-6.0

Monthly Climatic Design Conditions												
Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
DBAvg	21.2	11.5	15.3	17.3	21.3	25.1	27.1	27.9	26.0	22.3	17.2	15.6

Wind													
WSAvg	2.3	2.7	2.6	2.6	2.6	2.3	2.0	1.7	1.9	2.1	2.6	2.4	2.5
PrecMax	811	53	44	45	41	45	86	77	145	173	38	44	31

Precipitation													
PrecMax	1383	125	94	146	99	108	202	156	268	394	92	101	80
PrecMin	3	3	2	3	2	1	3	5	1	2	2	2	3

Monthly Design Dry Bulb and Mean Coincident Wet Bulb Temperatures													
0.4%	DB	15.2	18.2	19.3	22.9	26.8	28.1	29.4	28.1	27.1	24.3	20.2	19.1
2%	DB	11.2	16.0	15.2	18.4	19.4	23.0	23.8	24.2	23.4	20.1	17.7	16.3

Monthly Design Wet Bulb and Mean Coincident Dry Bulb Temperatures													
0.4%	WB	11.2	16.0	15.2	18.4	19.4	23.0	23.8	24.2	23.4	20.1	17.7	16.3
2%	WB <td>11.0</td> <td>15.9</td> <td>15.2</td> <td>18.3</td> <td>19.3</td> <td>23.0</td> <td>23.8</td> <td>24.2</td> <td>23.4</td> <td>20.0</td> <td>17.4</td> <td>16.0</td>	11.0	15.9	15.2	18.3	19.3	23.0	23.8	24.2	23.4	20.0	17.4	16.0

Mean Daily Temperature Range													
5% DB	MCDBR	11.5	11.8	12.5	12.3	12.1	9.5	9.0	8.4	8.4	10.2	11.6	10.7
5% WB	MCWBR	15.2	16.2	19.3	22.9	26.7	28.1	29.3	28.1	27.1	24.3	20.1	19.1

Clear Sky Solar Irradiance												
RadAvg	3.2	3.94	5.02	5.97	6.45	5.84	5.43	5.38	4.79	4.48	3.53	2.95
RadStd	1.12	1.42	1.53	1.64	1.6	1.72	1.65	1.44	1.44	0.99	1.05	0.94



ANSI/ASHRAE Standard 169-2021
(Supersedes ANSI/ASHRAE Standard 169-2020)
Includes ANSI/ASHRAE addenda listed in Appendix C

Climatic Data for Building Design Standards

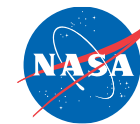
Maintenance by a Standing Standard Project Committee (SSPC) for which the Standards are published. Procedures for regular publication of addenda or revisions, including procedures for requests for change to any part of the Standard. Instructions for how to submit a website (<https://www.ashrae.org/continuous-maintenance>).

Standard may be purchased from the ASHRAE website (www.ashrae.org) or from ASHRAE, 1801 Alexander Bell Drive, Peachtree Corners, GA 30092. E-mail: orders@ashrae.org. Fax: 770-396-5991. Toll free 1-800-527-4773 (for orders in US and Canada). For more information, visit www.ashrae.org.

2236



Includes Web-based access to climatic data, design conditions, figures, and tables. (Requires Adobe Acrobat® and Microsoft Excel®)

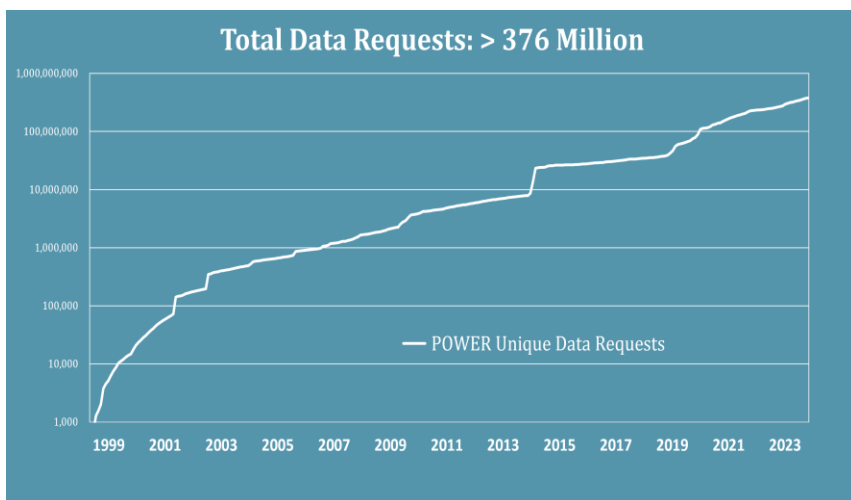
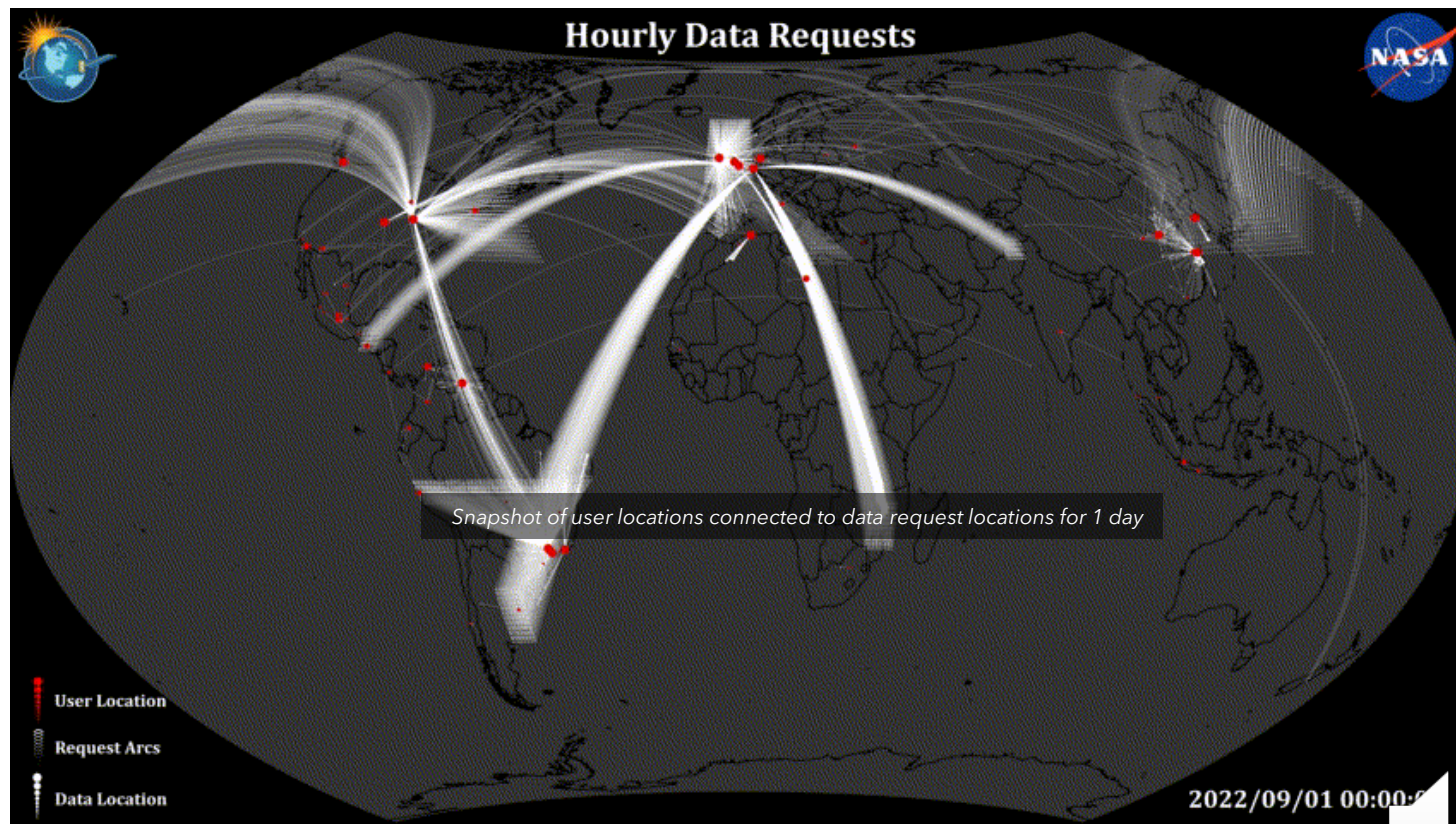


POWER Users | Impact of Modern Technology Adoption

POWER fulfills
7+ million data requests
for over
30,000 unique users
per month

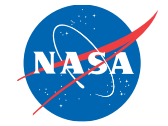
Before Geospatial Services	
1999/06/01 to 2018/05/01	
Requests	35,988,533
Data Volume	3,612 GB
<small>The data volume is available from 6/01/2019</small>	

After Geospatial Services	
2018/05/01 to Present	
Requests	340,264,728
Data Volume	110.46 TB
Unique Users	734,389

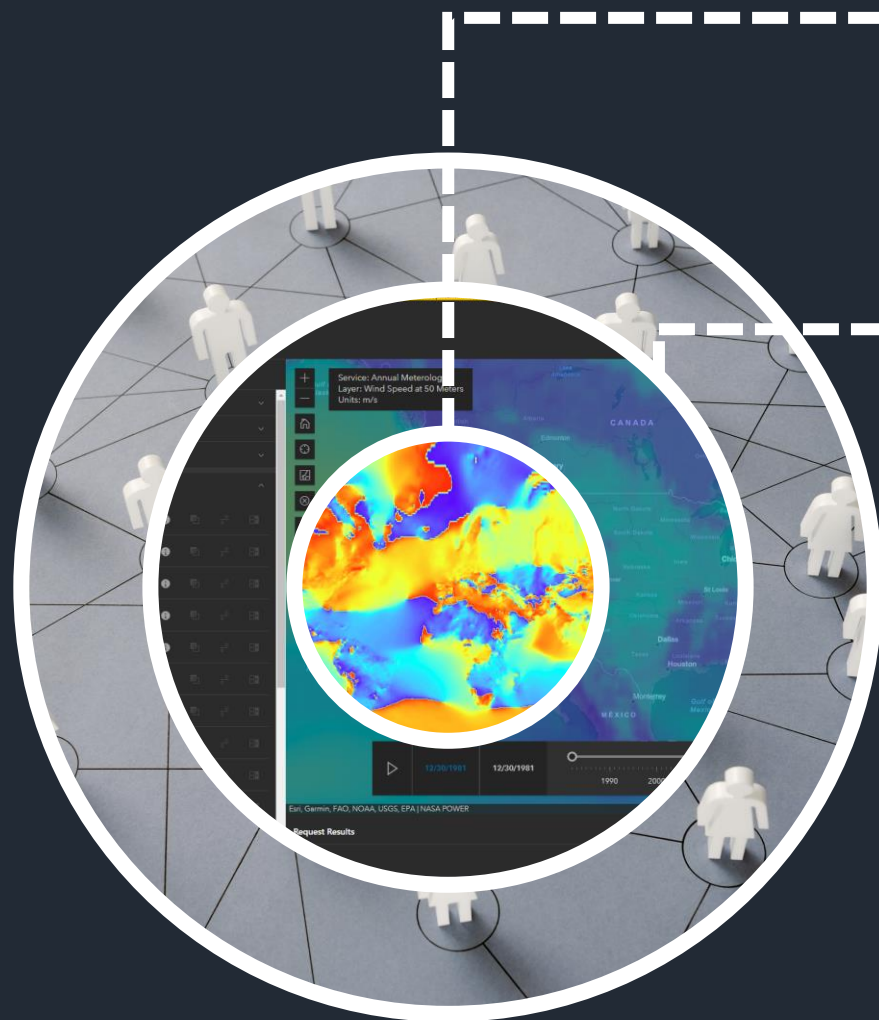




Roadmap | **POWER's Future Plans**



EARTH SCIENCE
APPLIED SCIENCES



New & Improved Datasets from Providers (including predictive data!)

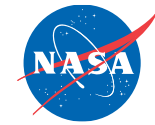
Enhanced Data Production Technologies

Increased User Community Engagement & Communication
(e.g. Validation Tool PRUVE)





Roadmap | Climate Data Services



EARTH SCIENCE
APPLIED SCIENCES

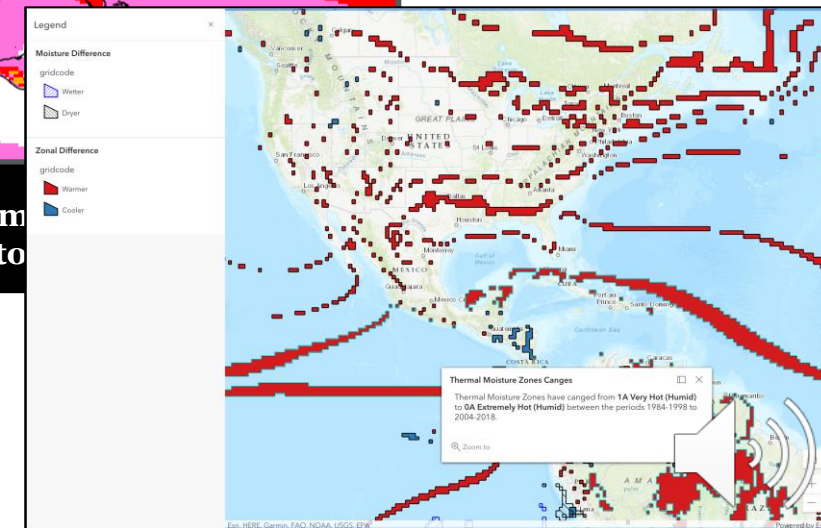
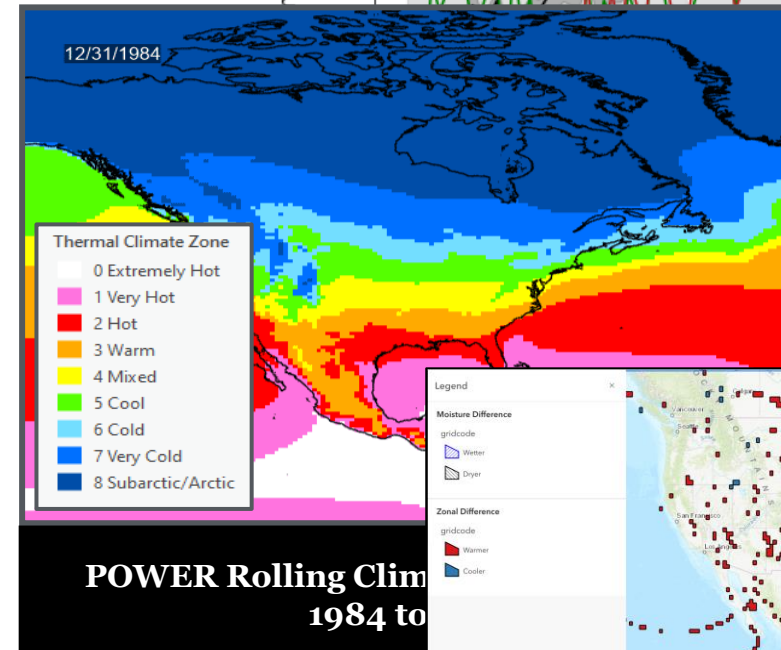
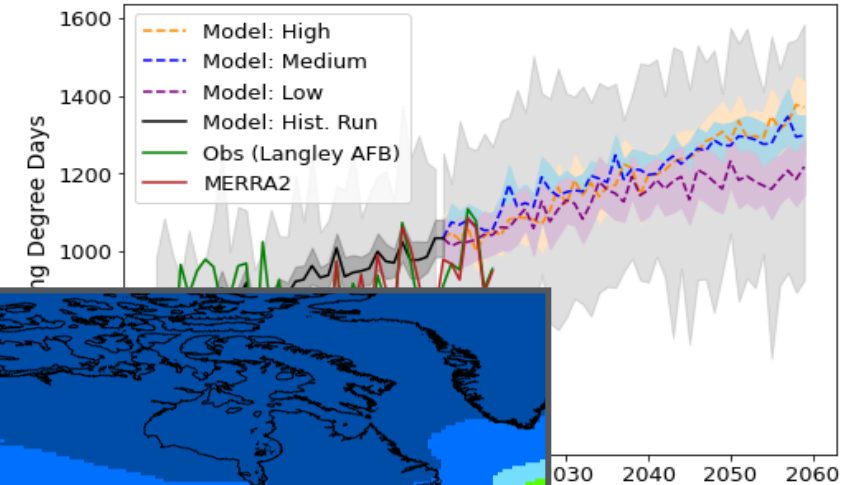
NASA-wide project to assess building system sustainability for operations, maintenance and planning according to Federal regulations

Assess and utilize NASA Earth Exchange (NEX) Global Downscaled Data Product from CMIP6 model data products:

- 22 of 26 models utilized; runs out to 2100
- 3 SSPs processed
- 60°S-90°N, all longitudes; downscaled to 20 km; daily temporal resolution
- 9 parameters including: T, Tmin, Tmax, RH (q), Wind Speed, Precip, SWdown, Lwdown

22 Member Ensemble for each SSP processed to assess CCD/HDD at each center

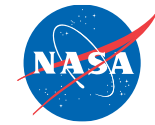
Cooling Degree Days: Yearly Sum Across Models and Obs
Langley Research Center



**POWER Rolling Climate
1984 to**



Roadmap | Online Data Validation Tool (PRUVE)



EARTH SCIENCE
APPLIED SCIENCES

Currently working on a new web-application called **PaRameTer Uncertainty ViEwer (PRUVE)**

Provides Ability to assess the uncertainties of the data products for a region and time period of interest

Key Features:

- Single feature service provides the underlying uncertainty statistics
- No-coding access
- Prototype to include ~3,000 surface sites
- Dynamic data visualization available for each site
- Creates maps, plots, and conducts spatial analysis on the fly
- Automatically displays referenced statistical content
- Integrated image service as a backdrop

The screenshots illustrate the PRUVE tool's capabilities in data visualization and statistical analysis. The top panel shows a map-based interface for selecting a specific station (Station 3452) and viewing its associated statistical metrics and a regression plot. The middle panel displays a comparison of two data series (Surface Site vs. T2M Surface) using histograms and normal distribution fits. The bottom panel shows a regional heatmap with an area aggregation tool that provides summary statistics for a selected geographic region.





Connect with POWER & Learn More



Explore POWER's docs & learning resources!

- ➔ [Esri® ArcGIS StoryMap](#)
- ➔ [POWER Services Dashboard](#)
 - ➔ [API Landing Pages](#)
 - ➔ [Methodology Docs](#)



<https://power.larc.nasa.gov/>

Submit your user stories & POWER-featured publications!

- ➔ The team keeps a list of presentations, papers, & projects that have used POWER Data.



[Energy Webinars](#)

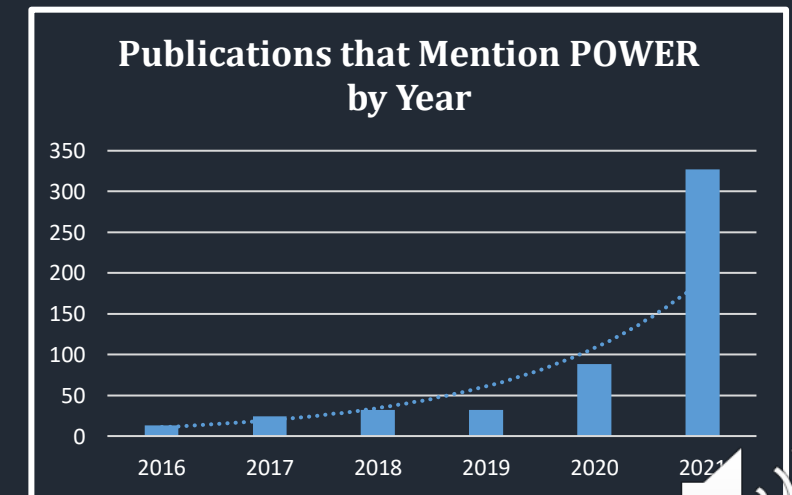
ARSET Webinars

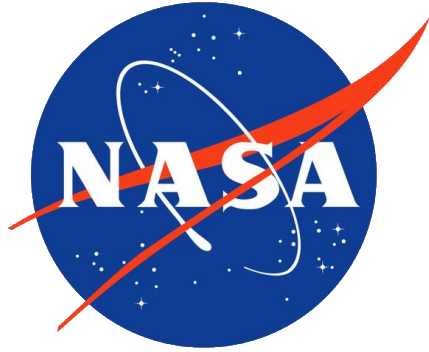


Reach out to POWER directly!

larc-power-project@mail.nasa.gov

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Thank you!

Email: larc-power-project@mail.nasa.gov

Website: <https://power.larc.nasa.gov>

Principal Investigators: Dr. Paul W. Stackhouse, Jr. & Dr. Falguni Patadia – National Aeronautics and Space Administration (NASA)

Co-Investigators:

- Bradley Macpherson, Madison Broddle, Christopher Higham, Claire Baldacci, & A. Jason Barnett – Booz Allen Hamilton (BAH)
- Taiping Zhang, Colleen Mikovitz, Bradley Hegyi, & Neha Khadka – Science Systems and Applications, Inc. (SSAI)

<https://www.earthdata.nasa.gov/learn/articles/power-overview>

EARTHDATA
OPEN ACCESS FOR OPEN SCIENCE

Earthdata / Learn / Articles / The POWER of Earth Science Data

The POWER of Earth Science Data

NASA Earth science data help ensure global coverage for the Prediction of Worldwide Energy Resources (POWER) Project.

POWER | DAV
Prediction of Worldwide Energy Resource (POWER) | Data Access Viewer Enhanced (DAV)

Visualize Data Layer

- Monthly Radiation
- Monthly Meteorology
- Annual Radiation
- All Sky Insolation Clearness Index
- All Sky Surface Longwave Downward Irradiance
- All Sky Surface Longwave Upward Irradiance
- All Sky Surface Total SW
- All Sky Surface Shortwave Diffuse Irradiance
- All Sky Surface Shortwave Downward Direct Normal Irradiance

Request Details

- 41.8, -93.15
- 301.38 Meters
- 2021-10-31 to 2021-11-29
- Response: 1.63 s
- POWER Daily API v2.4.3

Clear Sky Surface Shortwave Downward Irradiance

History of All Sky Surface Shortwave Downward Direct Normal Irradiance (000001 to 20211031)

Examples of the tools and charting resources available through the enhanced POWER DAV. A video from the 2022 POWER Global Community Summit²³ provides a demonstration of the enhanced DAV. Credit: NASA POWER.

Trade names and trademarks are used in this presentation for identification only. Their usage does not constitute an official endorsement, either expressed or implied, by the National Aeronautics and Space Administration.

