National Aeronautics and Space Administration

NASA POWER: Providing Present and Future Climate Services Based on NASA Data for the Energy, Agricultural, and Sustainable Buildings Communities

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

RETScreen Team at CanmetENERGY, Varennes

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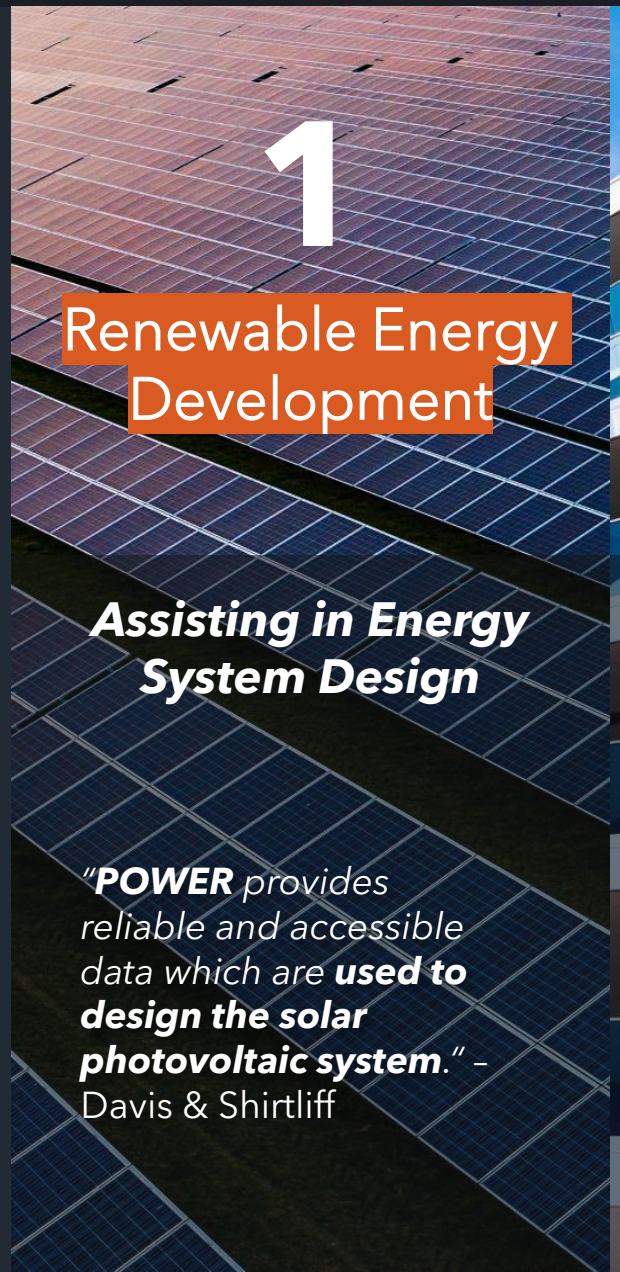
The Prediction Of Worldwide Energy Resources Project

Research to Action: NASA POWER improves the capability to integrate NASA Earth Observations & model data into decision processes related to energy, buildings & agriculture.

Benefit Sector Relationships: Long-term partnerships, collaborations & user interaction within targeted benefit sectors provides critical feedback on needs.

Accessibility of Validated Parameters: Processing & validating key user parameters, then developing IT infrastructure to provide information according to user requirements.



1 Renewable Energy Development

Assisting in Energy System Design

*"**POWER** provides reliable and accessible data which are **used to design the solar photovoltaic system**."* – Davis & Shirtliff

2 Building Energy Efficiency & Sustainability

Informing Building Energy Efficiency

*"The **NASA datasets we use are critical to our energy analysis** since they are used as major variables that predict our energy use."* - 3M Company

3 Agroclimatology Applications.

Enhancing Food Security

*POWER's customized, community-specific parameters used in **DSSAT** model helped in the "**Nitrogen fertilizer intervention response analysis** in Ethiopia maize".*

Introduction

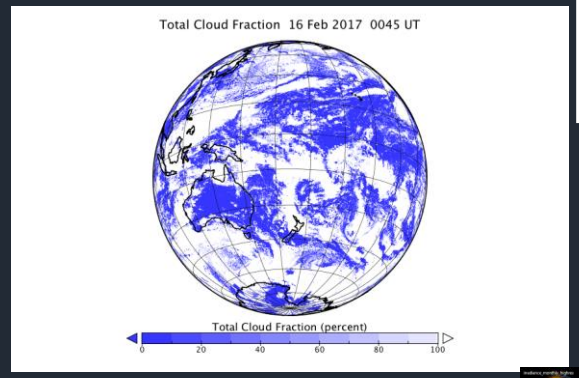
Definition of climate services from *A Federal Framework and Action Plan for Climate Services*: "scientifically-based, usable information and products that enhance knowledge and understanding about the impacts of climate change on potential decisions and actions"

- **Existing NASA POWER data services for past and current climate**
- **New services to support decision-making for our users.**

Where do POWER's Data Parameters Originate?

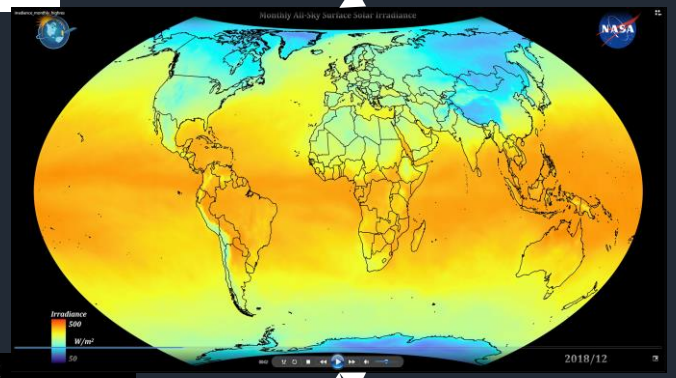
Surface Solar and Thermal IR Irradiance

SRB (1984-2000)

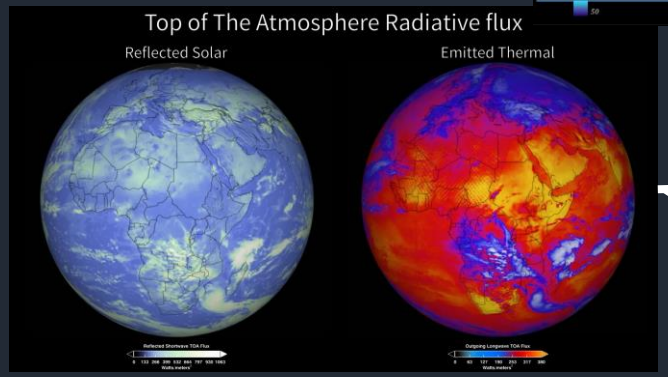


Atmosphere, clouds, aerosol, and surface inputs data

LaRC RT algorithm



CERES (2001-present)



Full RT model (adjusted to TOA)

Atmosphere, clouds, aerosol, and surface inputs data

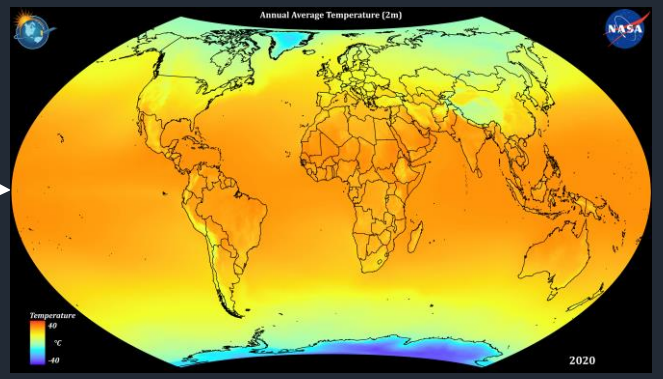
Surface Meteorological Parameters

Model (GCM)

Observations: satellite, in situ, airborne

Assimilation (4DVar)

MERRA2 Atmospheric Reanalysis Output



Daily Precipitation GPM IMERG
(10 km, daily; 2000 - present)

"...scientifically-based..."

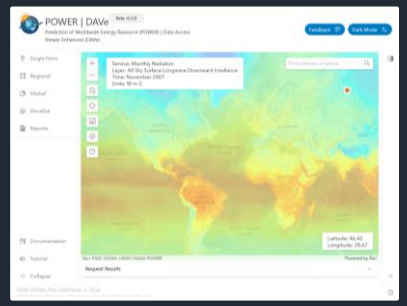
Enhancing Accessibility & Imagery

"...usable information and products..."

Application Programming Interface (API)

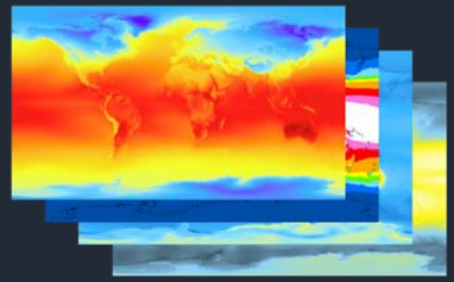
The API allows for direct integration into external applications and custom user scripts.

Data Access Viewer Enhanced (DAVe)



This application is a web-based data access service that provides a simple user interface built for mobile and desktop use.

Geospatial Services



This service allows users to efficiently interact with the POWER data in Geographic Information System (GIS) applications (included in the Esri® Living Atlas of the World).

Amazon Web Services

POWER AWS services are near real time (NRT), as soon as source data becomes available from our source data providers:

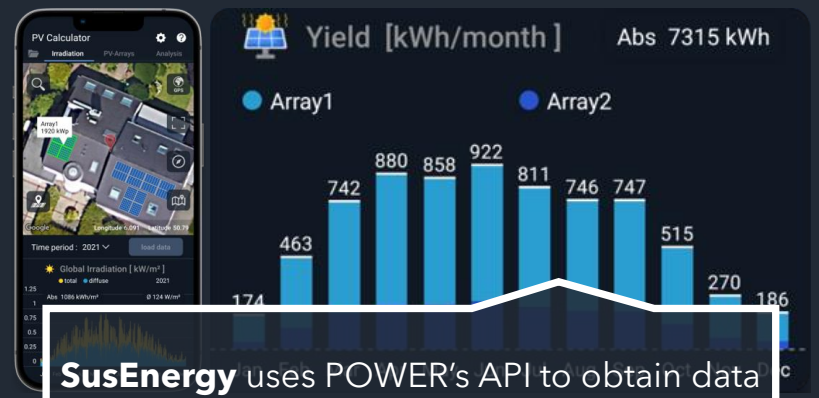
- Meteorological: ~2-3 days
- Solar ~5-7 days

POWER Community: Impactful Projects

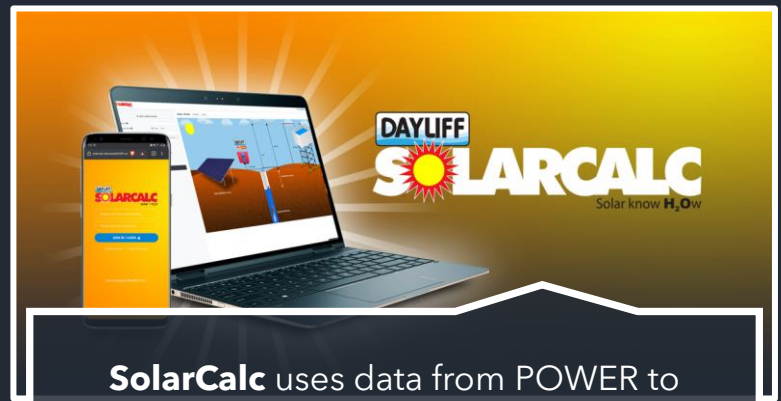
Natural Resources Canada's **RETScreen®** uses POWER climatological averages to calculate **feasibility & performance** related to energy efficiency, heating/cooling & power generation. **800k users**!

POWER data supports the **Decision Support System for Agrotechnology Transfer** tool, used for modeling crop yield prediction & **assessing the impact of climate change** on global food security.

SIL's **Solar Insolation Lookup Tool** predicts **power output from a solar panel** anywhere in the world using hourly data from POWER.



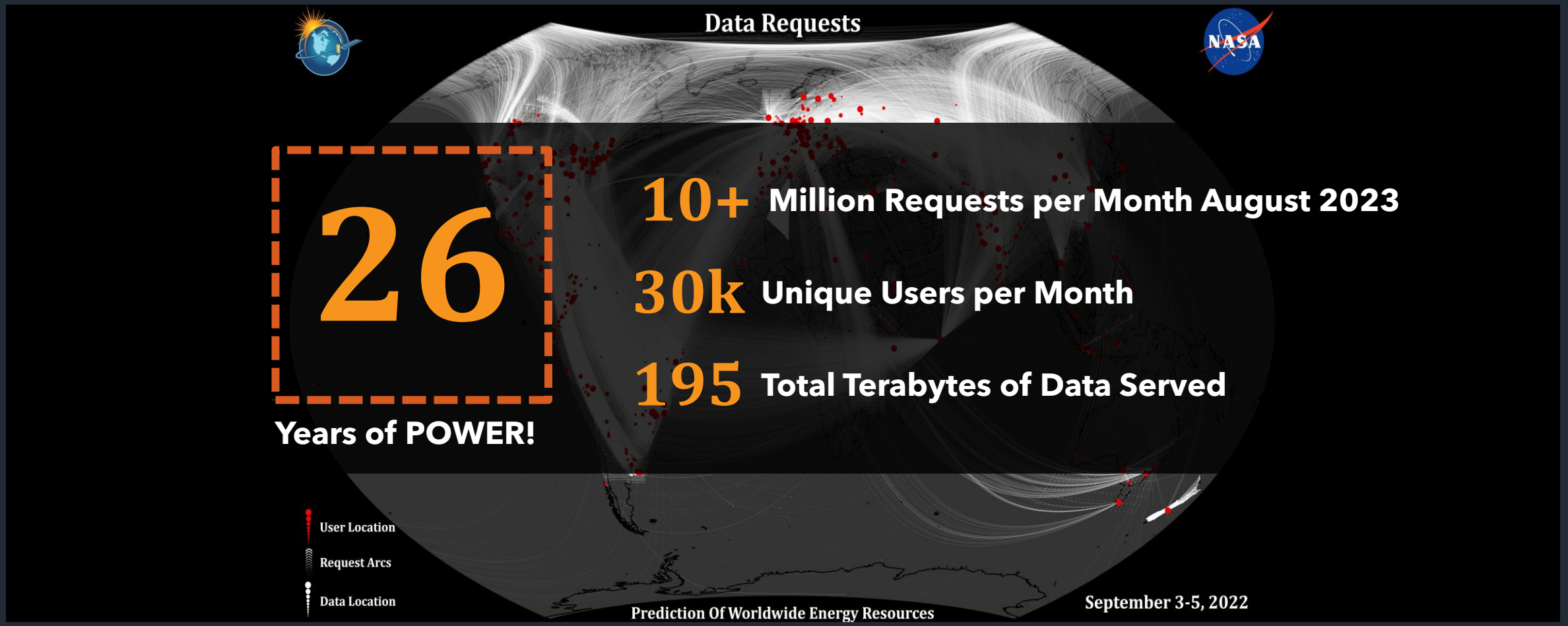
SusEnergy uses POWER's API to obtain data to feed into their app for **site-specific design** of photovoltaic & wind energy systems.



SolarCalc uses data from POWER to compute how many solar panels (including arrangement) are needed to power different types of **solar-powered water pumps**.

"…enhance knowledge and understanding about the impacts of climate change on potential decisions and actions"

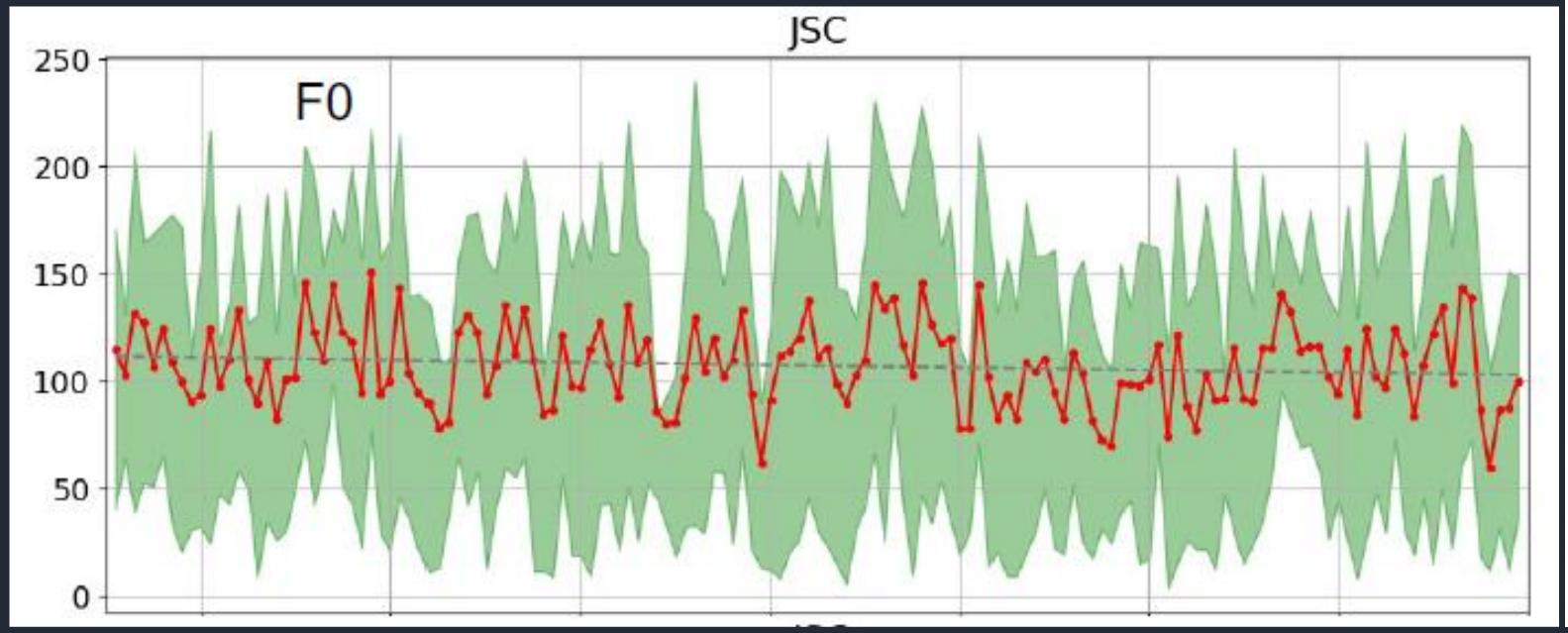
2023 POWER's Global Impact

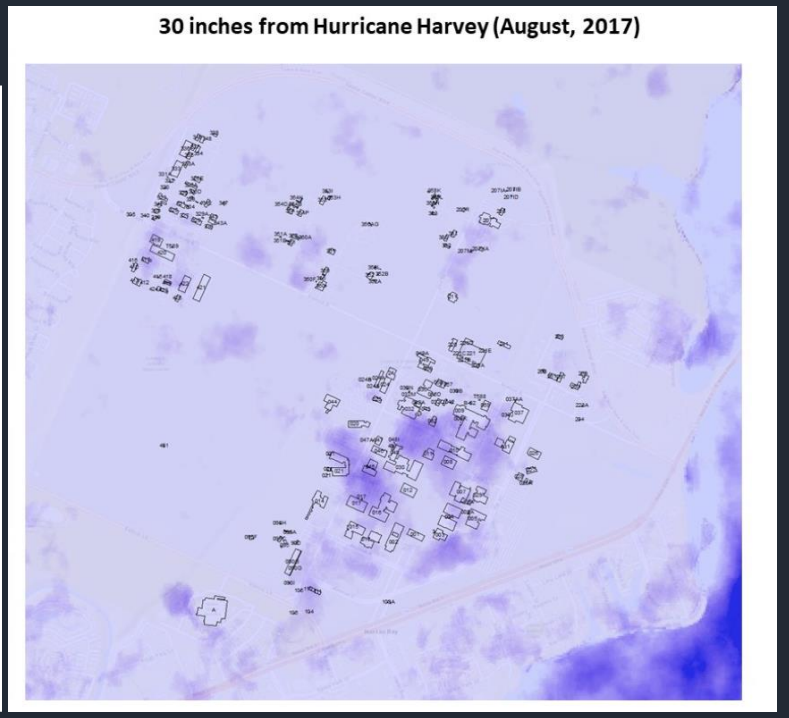


NASA POWER Projected Climate Services

Climate Adaptation Science Investigators Workgroup (CASI2)

- **Purpose:** To provide **usable projected climate information for decision-makers** within NASA's Office of Strategic Infrastructure (OSI) concerning potential **future meteorological conditions and risks relevant to NASA facilities**.
- **Subgroups**: Energy, Extreme Events, Sea Level Rise and Coastal Flooding, Water Budget, and Wildfires
- **Energy**: Quantify potential changes in total annual and monthly heating and cooling degree days, associated changes in the ASHRAE® thermal zones, and other parameters relevant to building energy systems.



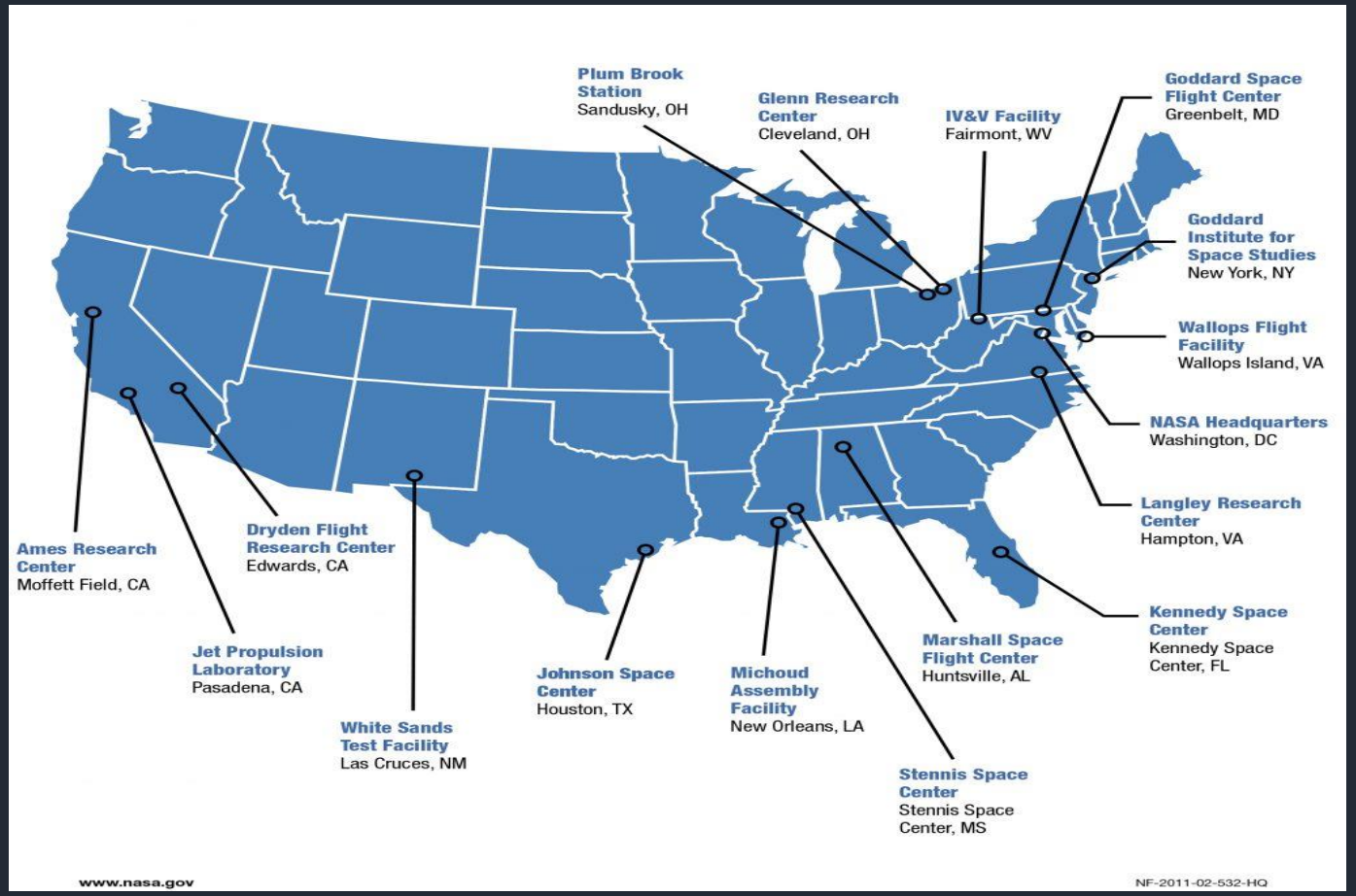


NASA POWER Projected Climate Services

Using NASA Earth Exchange (NEX) down-scaled projections from 22 CMIP6 climate models on a 25 km grid

- 9 meteorological/radiation parameters from 2015-2100
- 3 emissions scenarios
- Projection parameters provided at 14 NASA center locations

NEX Parameters
Mean Surface Air Temperature
Maximum Surface Air Temperature
Minimum Surface Air Temperature
Specific Humidity
Relative Humidity
Surface Downwelling Shortwave Flux
Surface Downwelling Longwave Flux
Daily Precipitation Rate
Surface Wind Speed (10-meter)



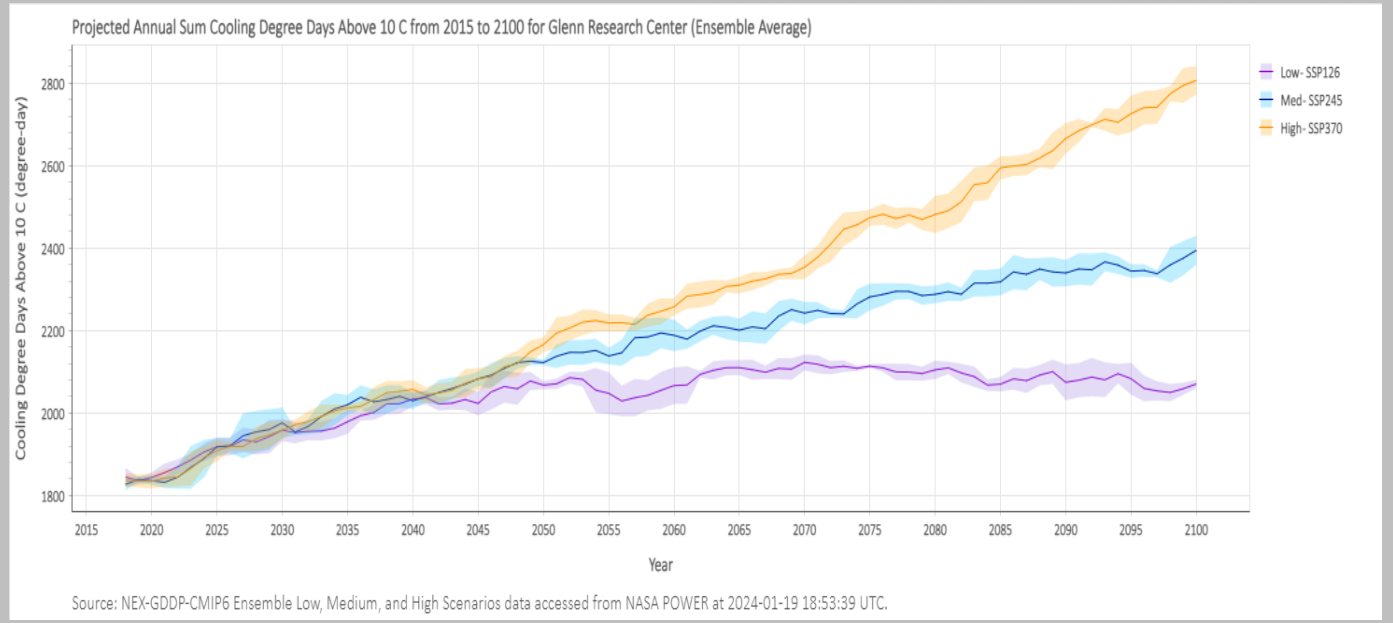
Emissions Scenarios	Description
Low (SSP1_26)	Sustainability – Taking the Green Road
Medium (SSP2_45)	Middle of the Road
High (SSP3_70)	Regional Rivalry - A Rocky Road

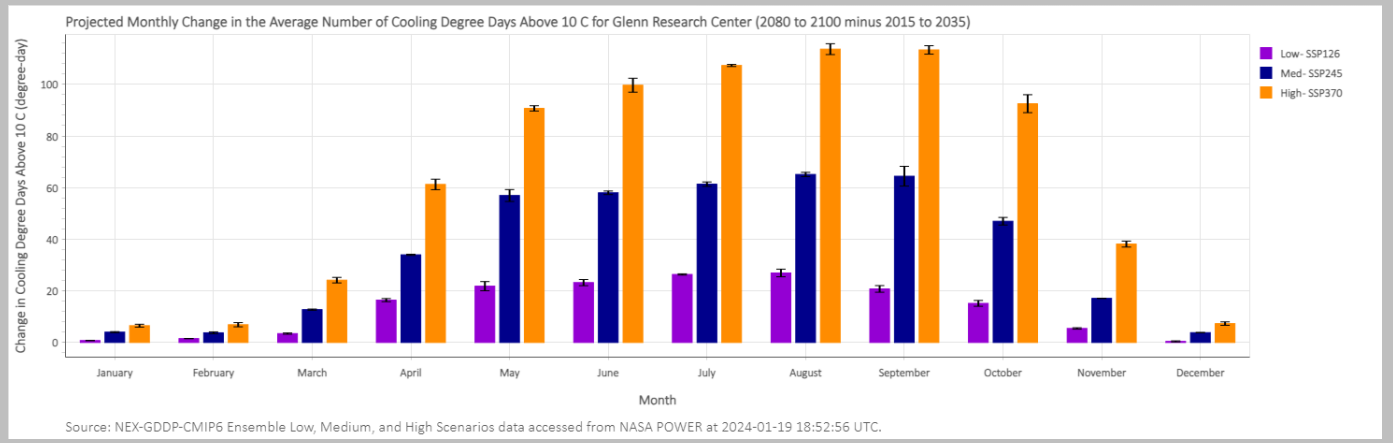
NASA POWER Projected Climate Services

Projected parameter products

- **Time series for 9 meteorological variables plus heating and cooling degree days at 14 NASA centers**
- **Analysis of monthly changes in heating and cooling degree days**
- ASHRAE® defined thermal zones from 3 future emissions scenarios

Products available at https://power.larc.nasa.gov/beta/data-access-viewer/

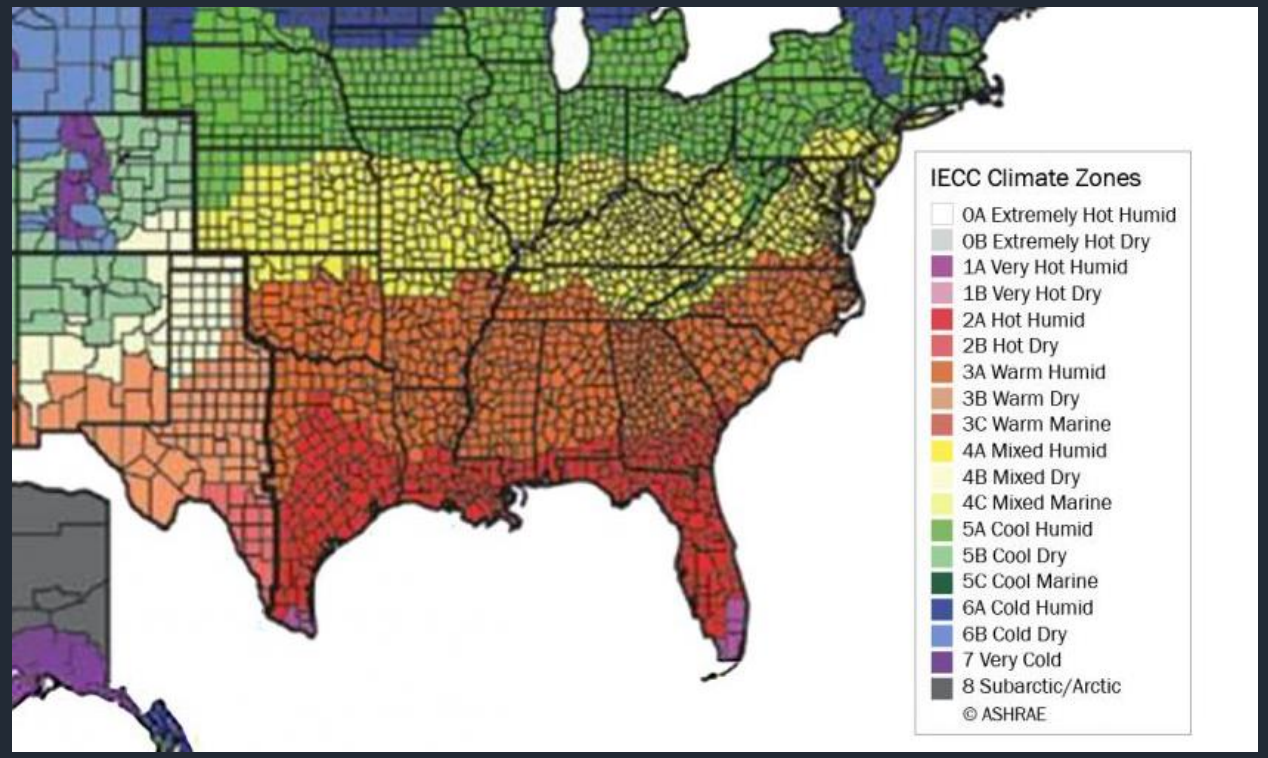


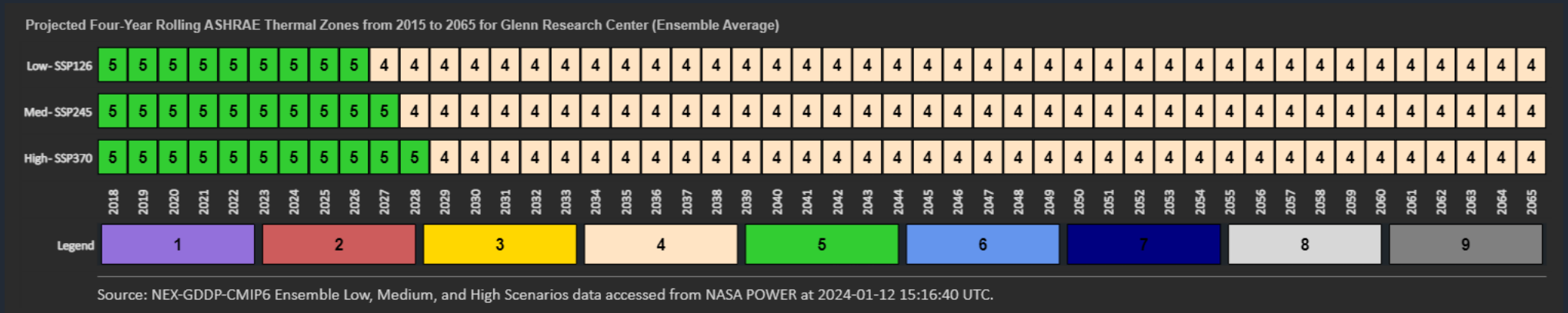


NASA POWER Projected Climate Services

Projected parameter products

- Time series for 9 meteorological variables plus heating and cooling degree days at 14 NASA centers
- Analysis of monthly changes in heating and cooling degree days
- **ASHRAE® defined thermal zones from 3 future emissions scenarios** (based upon annual HDD/CDD and precipitation thresholds)





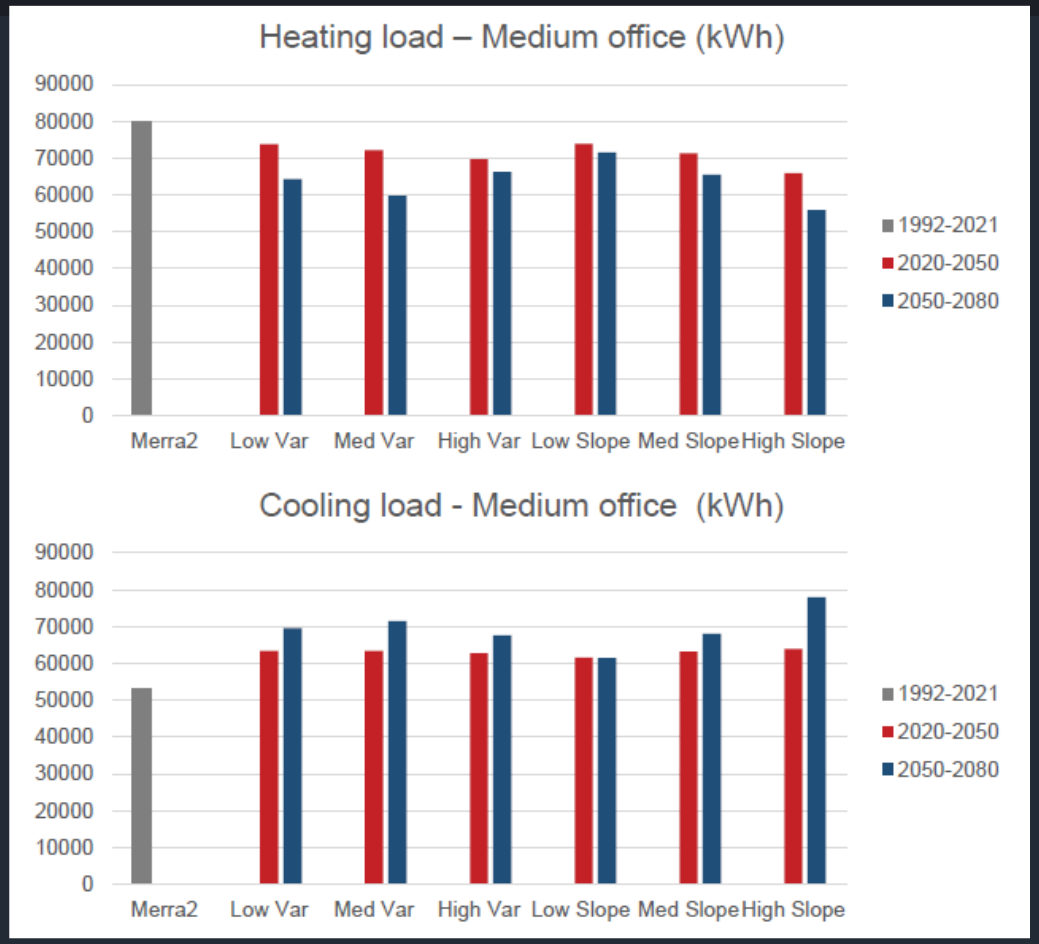
Center	Thermal Zone Change?	Thermal Zone Change	When in High Emissions Scenario?	When in Medium Emissions Scenario?	When in Low Emissions Scenario?
Glenn	Yes	5-->4	After 2030	After 2030	After 2030
Johnson	Yes	2-->1	After 2045	After 2091	No change
Langley	Yes	3-->2	After 2060	No change	No change
Goddard	Yes	4 ->2	After 2028 (to 3) After 2085 (to 2)	After 2028 (to 3)	After 2028 (to 3)

Use of products: Estimate the change in the thermal climate zone

NASA POWER Projected Climate Services

Collaboration with RETScreen®

- Estimation of energy use for heating and cooling in buildings at NASA centers for different types of buildings (archetypical)
  - Including estimation of greenhouse gas emissions to provide power



Energy Use (Langley Example)

	2050 - 2080	
	Heating (kWh)	Cooling (kWh)
Merra 2	-	-
Low Var	64,362	69,571
Med Var	59,806	71,569
High Var	66,258	67,609
Low Slope	71,537	61,503
Med Slope	65,471	68,064
High Slope	55,891	77,925

Emissions

GHG emission (tCO2) – Med Var			
Electricity grid factor	92-21	20-50	50-80
Actual - 39,53 gC02/kWh	**23.7**	22.7	20.9
Projected - 20,01 gC02/kWh	19.1	**17.9**	15.9

Future plans

What's next?

- Expand spatial coverage of data products (regional/global)
- Integrate real-world NASA buildings into RETScreen® analysis
- Provide projected climate services for communities around NASA centers

Summary

NASA POWER currently provides data products to the renewable energy, sustainable buildings, and agroclimatology communities.

We are working to provide projected climate services to support these same communities and decision-making within NASA's Office of Strategic Infrastructure, to broader communities and ultimately to the world.

The team loves to hear feedback on POWER's data & applications. You can reach out to the POWER team direct via our email: larc-power-project@mail.nasa.gov

Products available at https://power.larc.nasa.gov/beta/data-access-viewer/