Enhancing the NASA Prediction Of Worldwide Energy Resource Web Data Delivery System with Geographic Information System (GIS) Capabilities

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The Description of the Prediction of Worldwide Energy Resource (POWER) Project

Renewable energy technologies are changing the face of the world's energy market. Currently, these technologies are being incorporated within existing structures to increase energy efficiency. Crucial to the success of the emerging renewable market is the availability of accurate, global solar radiation, and meteorology data. This poster traces the history of the development of an effort to distribute data parameters from NASA's research for use in the energy sector applications spanning from renewable energy to energy efficiency. These data may be useful to several renewable energy sectors: solar and wind power generation, agricultural crop modeling, and sustainable buildings .

NASA Applied Sciences projects support the application of NASA sponsored remote sensing and modeling analysis for specific societal applications, which includes renewable energy as one of many socio-economic themes. The NASA project, **Prediction of Worldwide Energy Resource (POWER)**, encompasses the development of several web based applications designed to support users requiring data for renewable energy, architectural and agricultural uses.

As part of these capabilities, the Surface meteorology and Solar Energy (SSE) web site was included in a broader vision to expand partnerships and provide more possibilities for use of the NASA data products for energy. SSE has been incorporated into the POWER project.
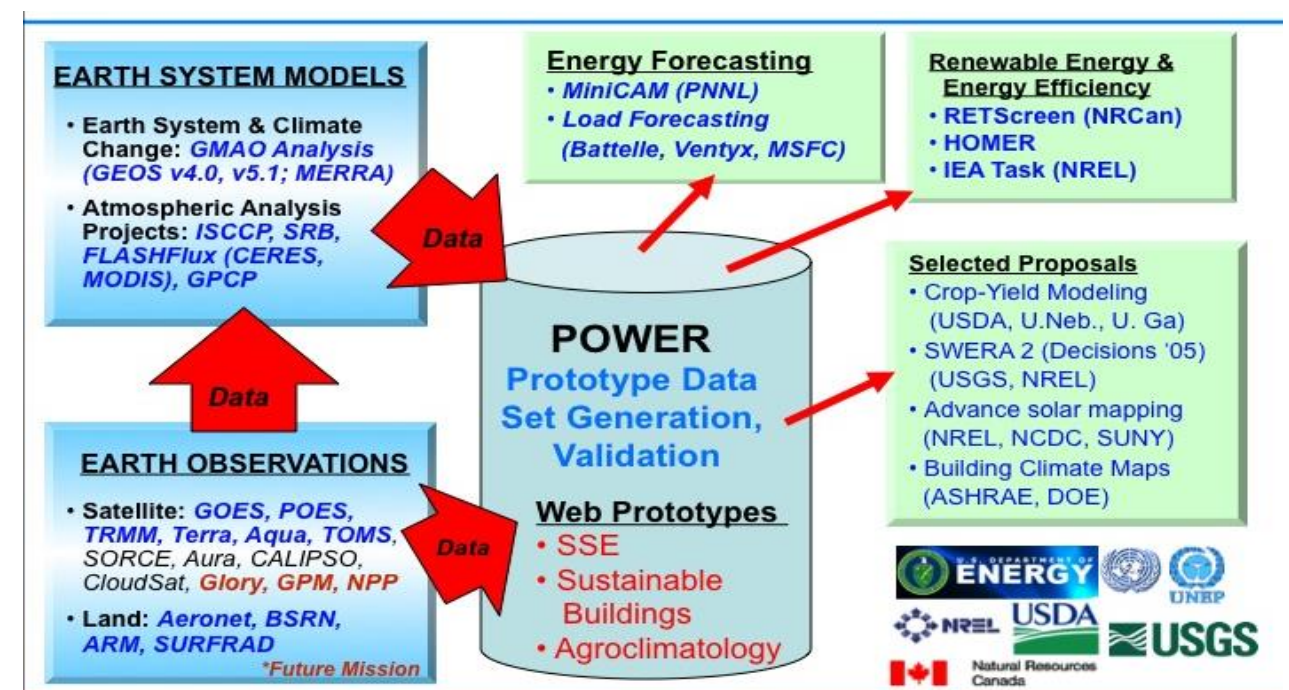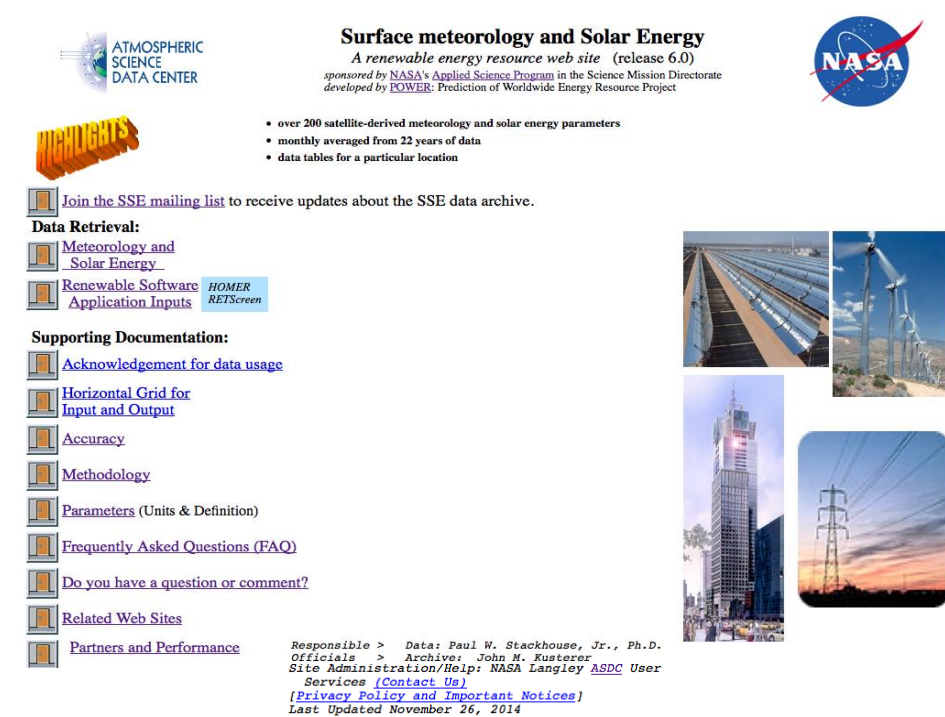
Under POWER, SSE was expanded to include more parameters, now over 200, spanning 22 years. The parameters were increased spatially to 1° x 1° and temporally to daily averages. POWER increased the variety of methods for users to download data. These products were made available from NASA research projects such as the GMAO, GEWEX SRB, and CERES. SSE will soon upgrade to 30 years of ½° x ½° using GMAO MERRA data.

POWER Overview

- **Objectives:** Improve the Nation's and Global public private capability for integrating environmental data from NASA research to support increased renewable energy development, energy efficiency and agricultural modeling.
- **Goals:** Through partnerships, derive/validate/provide parameters relevant to industry needs, link to decision support, and transition capabilities when possible.
- **Website: http://power.larc.nasa.gov**
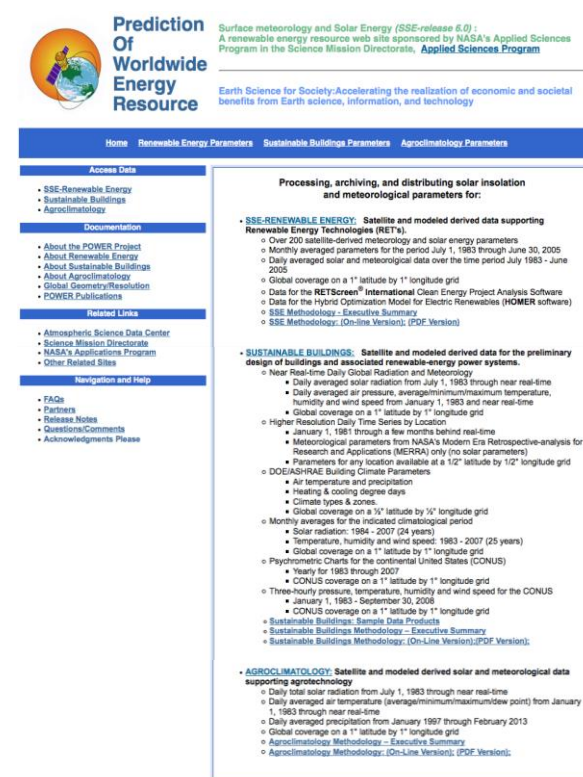
- 22 years of data
- Updated solar algorithms
- Improved validation and documentation
- Lat/Lon and regional data access
- Time series
- Direction connection to two renewable energy decision support tools: RETScreen and HOMER
- > 70,000 users, 40 million hits resulting in 25 million downloads since inception in 1997

POWER/SSE partnerships and collaboration have resulted in continuing improvements to the web site and formats. The most important of those was the initialization with RETScreen International now of National Resources Canada. RETScreen provided important validation for SSE and the impetus to add new parameters including surface meteorological parameters required for renewable energy data products.

EARTH SYSTEM MODELS
- **Earth System & Climate Change:** *GMAO Analysis (GEOS v4.0, v5.1; MERRA)*
- **Atmospheric Analysis Projects:** *ISCCP, SRB, FLASHFlux (CERES, MODIS), GPCP*

EARTH OBSERVATIONS
- **Satellite:** GOES, POES, TRMM, Terra, Aqua, TOMS, SORCE, Aura, CALIPSO, CloudSat, Glory, GPM, NPP
- **Land:** Aeronet, BSRN, ARM, SURFRAD
Future Mission

POWER
Prototype Data Set Generation, Validation

Web Prototypes
- SSE
- Sustainable Buildings
- Agroclimatology

Energy Forecasting
- *MiniCAM (PNNL)*
- *Load Forecasting (Battelle, Ventyx, MSFC)*

Renewable Energy & Energy Efficiency
- RETScreen (NRCan)
- HOMER
- IEA Task (NREL)

Selected Proposals
- Crop-Yield Modeling (USDA, U.Neb., U. Ga)
- SWERA 2 (Decisions '05) (USGS, NREL)
- Advance solar mapping (NREL, NCDC, SUNY)
- Building Climate Maps (ASHRAE, DOE)

A schematic showing NASA research data sources being mapped for applied science uses in renewable energy, architectural and agricultural areas.

To accomplish this, surface radiation projects from the GEWEX Surface Radiation Budget (SRB) project and CERES FLASHFlux project provide radiation data. Surface meteorological parameters are from the NASA Goddard Modeling and Analysis Office (GMAO) Goddard Earth Observing System (GEOS) atmospheric reanalysis (GEOS-4, GEOS-5 FP-IT and MERRA). The current spatial resolution is 1°x1°. See figures to the right.
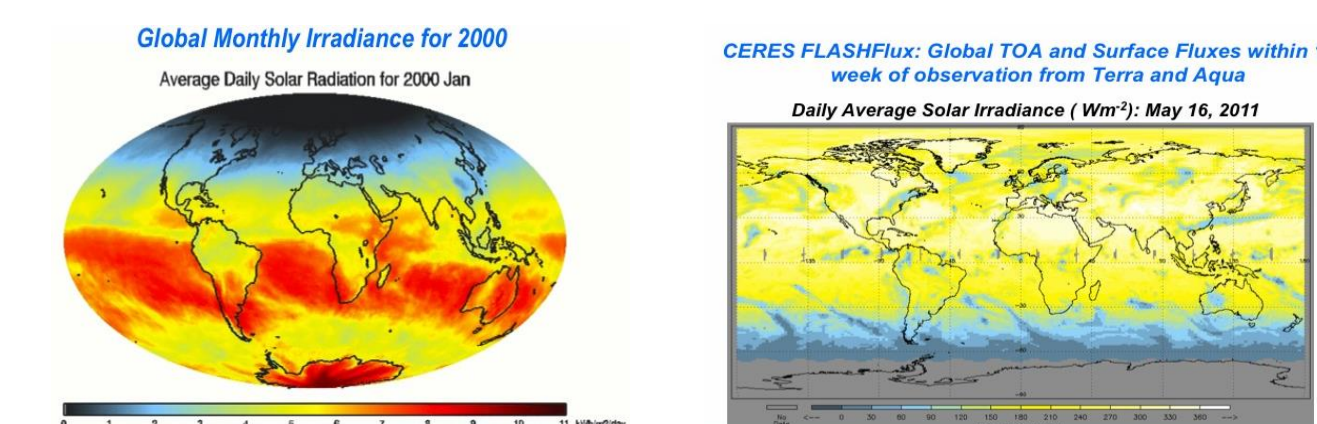
Near Future Changes

The POWER/SSE are currently undergoing major updates that include the production and validation of data products to the new spatial resolution of ½ x ½ degree and the expansion of the data set to a full 30 years. As part of this transition, data parameters from the Modern Era Retrospective-analysis for Research and Applications (MERRA) are now being used for the main data source for surface meteorological data parameters. This shows validation results for these efforts together with more recent applications.

Also, the web site is undergoing a complete transformation to allow users to obtain data sets and parameters utilizing an ArcGIS platform. Users will be able to obtain customized data sets and parameters in a variety of formats including GIS compatible formats.

Workflow of New Project to Enhance SSE with GIS Functionality
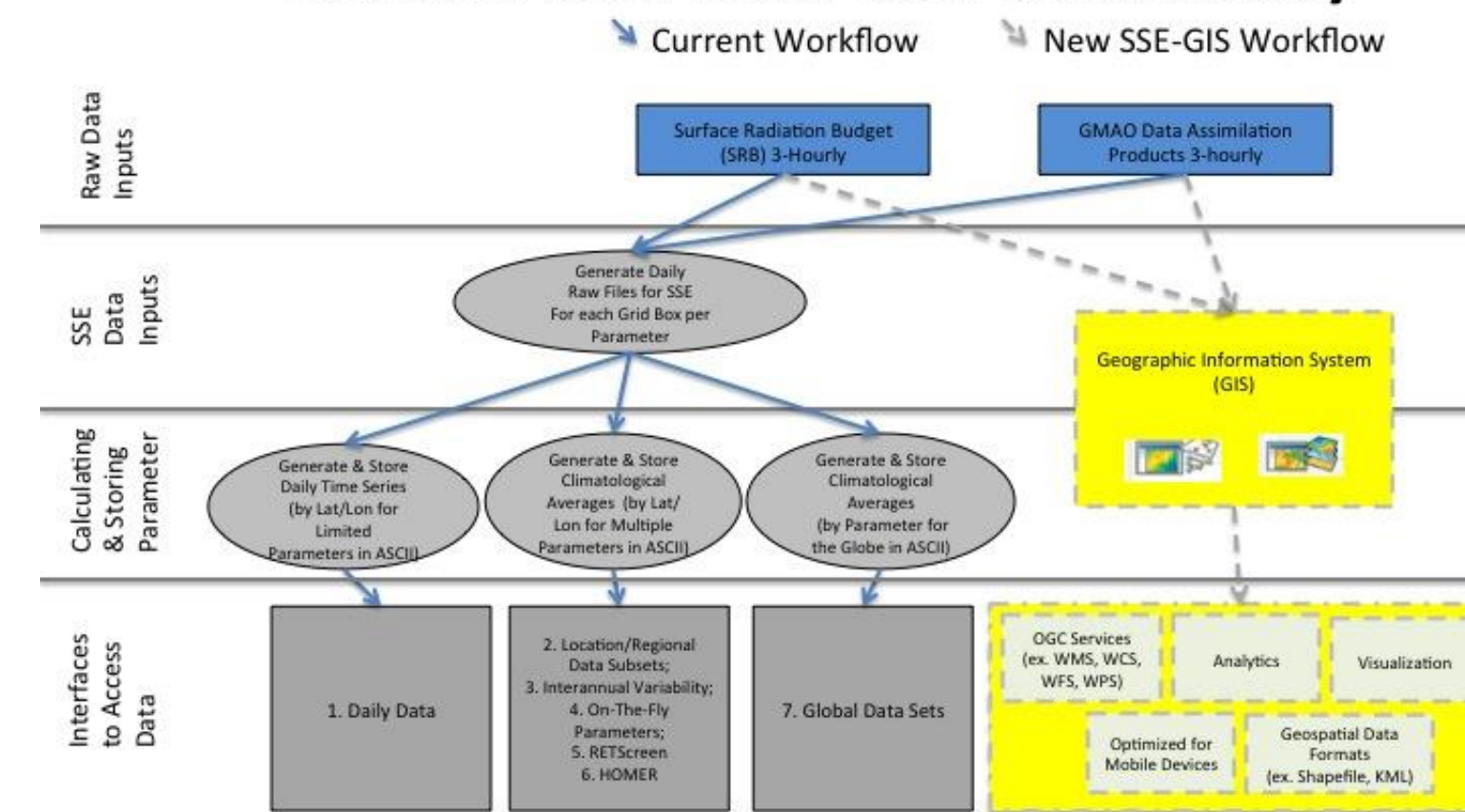

SSE-GIS Internet and Mobile GIS Tools
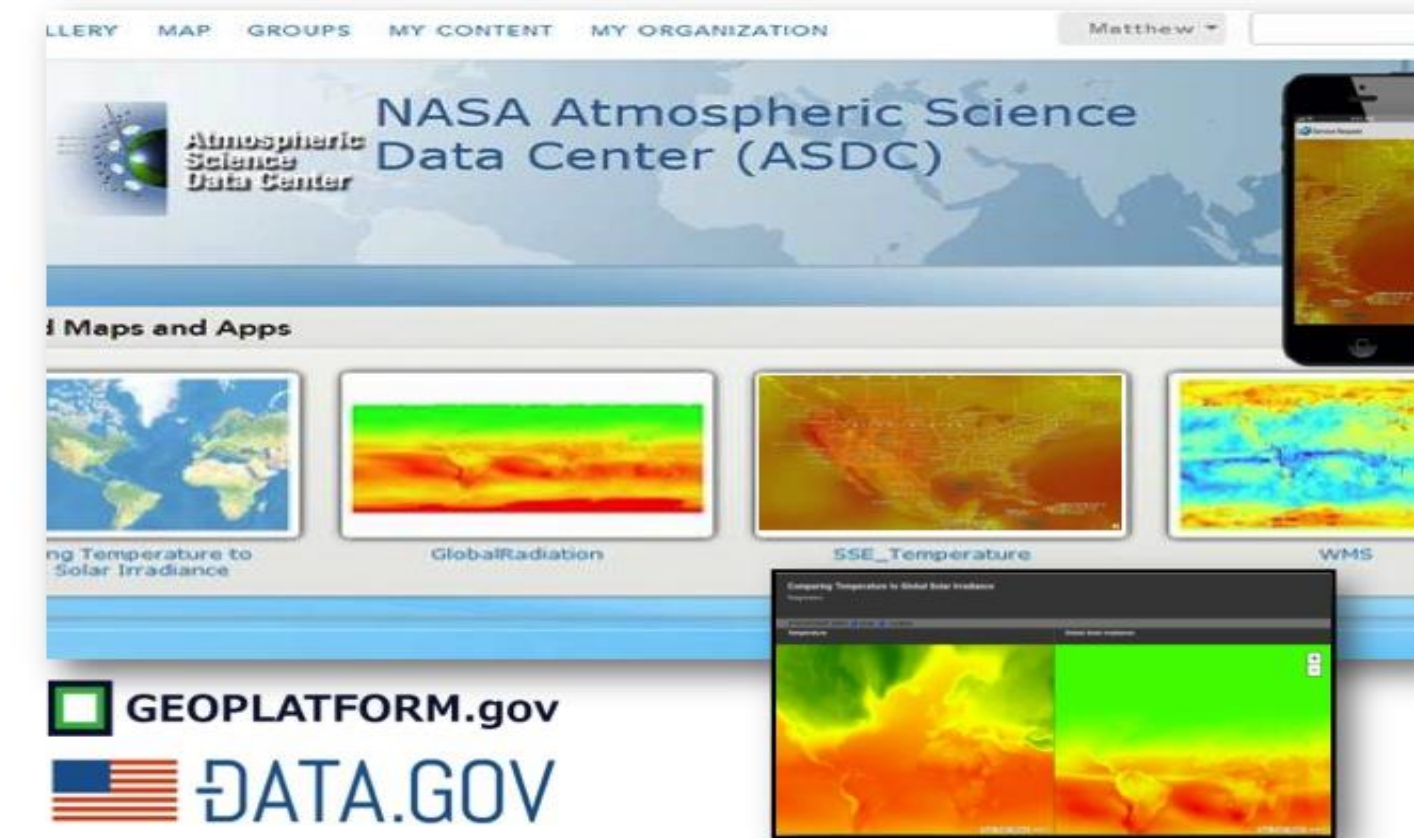
New GIS Applications on the POWER web site

A recent focus has been to process, formulate and geospatially enable current data to formats consistent with **Esri** and **openGIS** tools useful for decision support systems. Functions are in development to improve upon the current site capabilities to produce data products on the fly, extending these beyond the single location to regional and global scales. A major expected significance on the inclusion of GIS with POWER will be the development of **Open Geospatial Consortium (OGC) compliant web services (WMS, WCS, WFS, and WPS) and Esri ArcGIS Image Services.** This will provide additional data accessibility options and geoprocessing tools for the renewable energy and agricultural application users. This will restore graphical functionality to the POWER web applications, allowing users to view and produce images of their desired parameters in relation to a larger geographical scale as well as in relationship to other GIS displayed parameters. Leveraging the suite of Esri ArcGIS tools and open source products provides an open computing platform for maps and geographic information, making it easy to create and share POWER data as useful and geospatially intelligent maps.

This sample plot was produced on a test web server where the ArcGIS tools are being developed.

Capabilities
- High quality viewing (Desktop/Mobile) and printing
- Data Extraction/Subsetting
- Simultaneous Dataset Visualization (Swiping)
- Temporal Visualization
- Custom Color Ramps
- Pixel/Attribute Value Identification at Selected Location
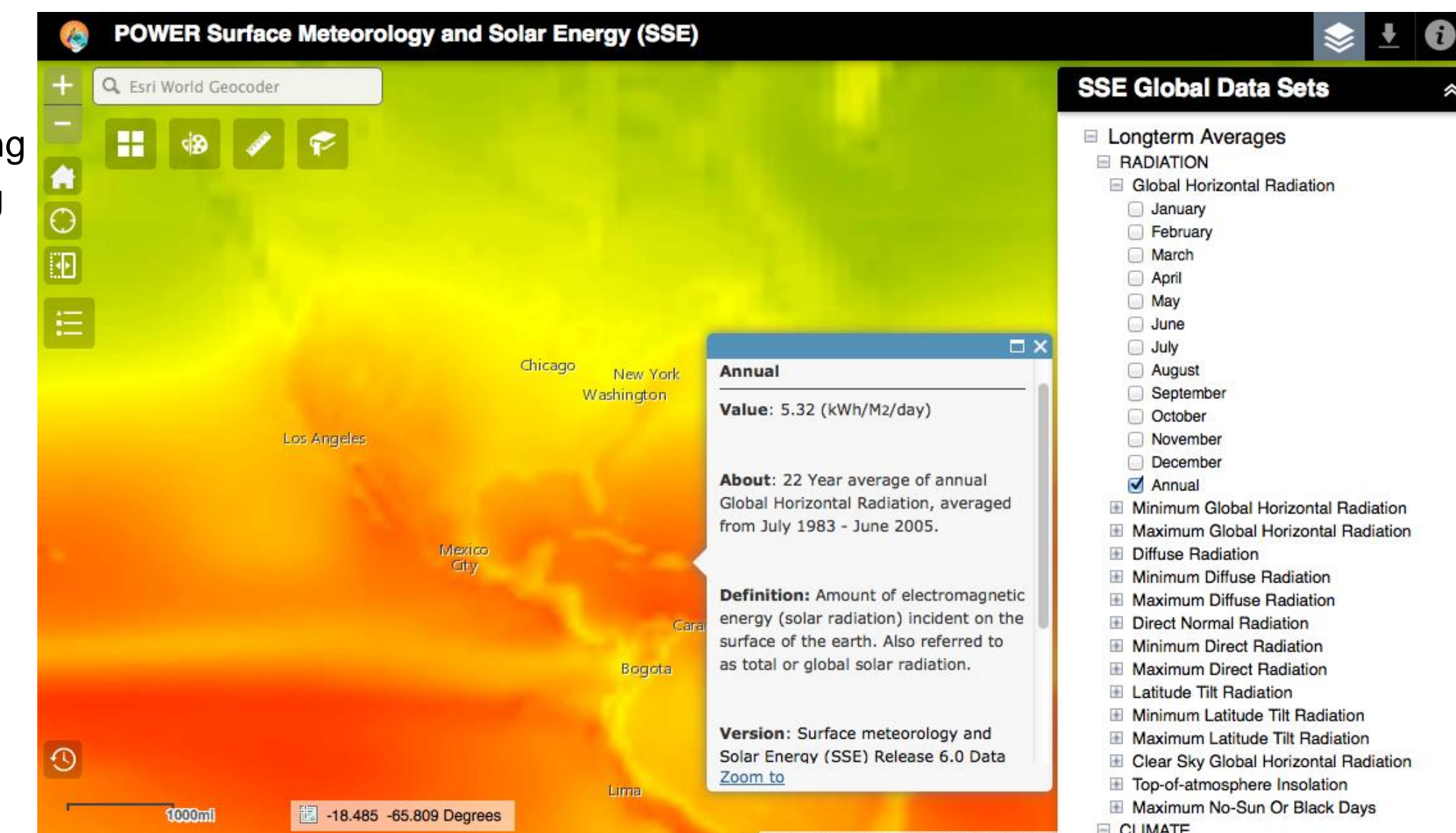
Summary and Conclusions

This poster summarizes POWER project efforts to distribute data parameters from NASA's research for use in the energy and agricultural sector applications spanning from renewable energy to energy efficiency. The following conclusions are made:
- NASA data sets are very valuable in the energy sector, particularly the renewable energy sector where accurate environmental information is needed to assess new or existing renewable energy projects.
- Long-term (greater than 10 years) partnerships with entities like NREL and RETScreen International have greatly enhanced the value and usage of these data products.
- Additional value is obtained through the periodic upgrade of the data products as research advances.
- Major updates are underway including adding GIS tools for data set manipulation and visualization.

Acknowledgements

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