



## Question & Answer Session Part 3

Please type your questions in the Question Box. We will try our best to answer all your questions. If we don't, feel free to email The POWER Project ([larc-power-project@mail.nasa.gov](mailto:larc-power-project@mail.nasa.gov)), Paul Stackhouse ([paul.w.stackhouse@nasa.gov](mailto:paul.w.stackhouse@nasa.gov)), or Bradley Macpherson ([bradley.macpherson@nasa.gov](mailto:bradley.macpherson@nasa.gov)).

Question 1: When it comes to wind energy, where wind data of a certain hub height is necessary under different landscapes, how do we extrapolate or estimate wind parameters from the Earth related data (above say 200 m above the surface)? Similarly, shade effects of solar?

Answer 1: Directly from MERRA-2, POWER provides spatially averaged wind fields for the entire gridded area at 50, 10 and 2 m. For wind at arbitrary levels between 10 and 300 m, POWER has implemented a parameterization that uses a surface roughness exponent based on surface type, the requested elevation, and the winds at 50 and 10 meters to calculate the wind speed.

Chandler, William S., C.H. Whitlock, P.W. Stackhouse, Jr., 2005: [Determining Wind Resources as a Function of Surface Roughness and Height from NASA Global Assimilation Analysis](#). Proceedings of the International Solar Energy Society 2005 Solar World Congress, August 6-12, Orlando, Florida

Also see the code below:

```
def WSC(data, elevation, alpha):
    """
    This is the equation to compute on the fly wind speed corrected.

    - data: a dataframe with wind speed at ten meters (WS10M) and wind speed at fifty meters (WS50M) in meters a second (required)
    - elevation_User: User defined elevation in Meters (required)
    - alpha: the surface roughness (required)
    """
    WSC = (data["WS10M"] * np.power((elevation / data["WS50M"]), alpha))
    WSC.name = "WSC"
    WSC.attrs['units'] = "m/s"

    return WSC
```

Due to the spatial resolution of the POWER data, it is not possible to treat the shading of solar irradiance due to large scale features like mountains or small scale features like vegetation or buildings.



Question 2: So the radiance is the energy per second per surface then? (W being a Joule per second, right?)

Answer 2: Watt is Joule per second, so irradiance is the power per surface area which can be expressed in the units  $Wm^{-2}$ .

Question 3: Is it feasible to have RE-Nuclear (Renewable Energy) as a combination that acts as a safety firewall around the nuclear? This RE may be a solar array.

Answer 3: This question is beyond our level of expertise, but the POWER data products could be used to assess whether the solar resource is large enough in particular areas to act as a supplemental energy source. However, that question would require an energy assessment and energy grid integration analysis.

Question 4: Wind park sites can cross routes of migrant birds which are seasonal. Routes could have minor variations over time. Can these two aspects be studied from earth observations in the attempts of correct siting of wind turbines?

Answer 4: Potentially; the POWER wind products are provided at a relatively coarse spatial resolution ( $0.5^{\circ} \times 0.625^{\circ}$  lat/lon). These products have accuracy sufficient for a first-cut analysis for site suitability but it is recommended to use surface site data or high resolution modeling in later stages of analysis. The wind information is available at various time scales so the seasonal dependence of the winds in a region are provided at different temporal levels.

Question 5: Is the international satellite cloud climatology project network only in the USA or Globally?

Answer 5: It is a global data set. All the data products that POWER uses as input and the data parameters provided are global including the ocean regions.

The ISCCP data products are freely accessible to the public through NOAA's web site at: <https://www.ncdc.noaa.gov/isccp>.

Question 6: Can the user upload their own dataset and use the functionalities/capabilities of the POWER API on their own data?

Answer 6: No, currently POWER only supports the download of data products. But, POWER does provide parameterizations and equations to allow users to expand upon



or use our processes, available in the methodology section of the POWER web site:

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

Question 7: Do greenhouse gases in the atmosphere impact the climate parameters recorded by satellite sensors?

Answer 7: Yes, because greenhouse gases absorb and emit thermal infrared energy which will affect how much energy at those wavelengths are observed by the satellite. There is also some CO<sub>2</sub> absorption of solar irradiance. The most important gas in this respect is the water vapor itself. Water vapor does absorb solar irradiance at the longer wavelengths (beyond the visible wavelengths) and thus reduces the broadband solar irradiance and various satellite channels at sensitive to wavelengths.

We do provide information on the thermal infrared radiative fluxes (wavelengths from 4 to 100+ micrometers) incident to the Earth's surface. This information is used for energy efficiency analysis related to cooling of building structures, especially at night. Water vapor is the most important gas, but the radiative effect of CO<sub>2</sub> gets enhanced because small changes in temperature caused by CO<sub>2</sub> changes provide the capability of the air to hold more water vapor. Global long-term changes in the amount of CO<sub>2</sub> (from surface measurements) and spatial hourly estimates of water vapor are part of the computation of the solar and thermal infrared irradiances.

Question 8: Hello, will these data be always free of charge to use?

Answer 8: Yes, that is the plan for the foreseeable future.

Question 9: We have been hearing about sun and earth energy evaluations mostly to be used on solar panels and wind power energy. Is there anyone working on thermal difference energy within water masses (oceans, large lakes) and how to harness it?

Answer 9: We don't currently have data products related to thermoelectric energy. This would require finer resolution data on water temperature and mass, of which we don't currently have access. Data for tidal energy has the same limitations at this time.

Question 10: With regard to Power data, could you elaborate further possible applications of GIS dataset?

Answer 10: Yes, currently POWER provides image and feature services connected to the data. You can pull that into QGIS or Arc. Our goal is to have image services related to long term temporal periods.



Question 11: What are the parameters through which we measure solar irradiance data quality? Can you elaborate?

Answer 11: We compare our estimates of surface solar irradiance (“All Sky Insolation Incident on a Horizontal Surface“) to surface measurements and provide a statistical overview of the agreement. Highly calibrated measurements from the globally distributed Baseline Surface Radiation Network (BSRN) are used to determine quality. Our methodology documentation gives a more thorough description.

Question 12: Are there any attempts to make this data available via Google Earth Engine or as plugins on QGIS?

Answer 12: Currently there is no plan but we are working to make the POWER data products available in AWS as part of a Space Act Agreement to provide Earth Observation Data for Sustainability. This should make it more accessible to other platforms. Time series is available without a plugin in GeoJSON format therefore an import into QGIS and ArcGIS is possible. We are open to any system to make the POWER data more accessible.

Question 13: What are the possible reasons for the deviation between the recorded data and the estimated data?

Answer 13: This depends on which measurements in which you are referring. Solar irradiance from POWER represents an area of  $1^{\circ} \times 1^{\circ}$  lat/lon (approximately 100 km) while the surface measurements are point measurements. Differences on the monthly or longer time scales are most likely due to systematic biases in the various inputs to the flux algorithms, such as water vapor and/or aerosol optical properties. Cloud processes statistically vary but inaccuracies in cloud representation of certain clouds can occur. If there are persistent cloud features within a  $1^{\circ} \times 1^{\circ}$  area, such as near coasts or mountain regions, biases can occur when comparing point locations to the entire region. At shorter time scales, cloud configurations are more likely to result in noise that tends to average out with temporal averaging. Some regions with brighter surfaces, such as over deserts or snow/ice covered surfaces, have more difficulty in detecting thin clouds.

For the meteorological fields, differences between measurements and observations are similar to solar differences due to the comparison of the point measurements to a gridded average quantity ( $0.5^{\circ} \times 0.625^{\circ}$ ). Additionally, elevation differences and local



features (e.g., smaller bodies of water like lakes and rivers) can cause biases relative to the regional average for temperatures, humidities, etc.

Question 14: How do you effectively filter through cloud data while scanning for Smoke from fire zones using EO? As in, how do you know to spot Smoke and smoke drift and not get that data muddled with filtered out cloud data?

Answer 14: Smoke is an issue in cloud detection. Cloud detection algorithms can mistake thick smoke for clouds. This can lead to inaccuracies in the estimate of the solar irradiance because the smoke particles are more obse. Utilizing different spectral bands from satellite observations can aid in discerning between smoke and cloud. If smoke is identified, an estimate of the amount of solar radiation is computed. Smoke particles absorb more of the incoming solar radiation.

Question 15: Is there any data related on interaction of radiations impacting atm from space or outside Earth?

Answer 15: We only consider the visible through the thermal IR wavelengths. We assume the amount of energy within the system comes from the sun or emitted from the atmosphere and earth.

Question 16: Is GEOJson data format a unique data format or is it somewhat similar to gdb, shp, xml format?

Answer 16: GeoJSON is a unique data format that has been around for ~15 years. We follow the [GeoJSON Standard \(RFC7946\)](#) standard. It has metadata related to the geographic location and includes the POWER data as a time series.

Question 17: GeoJSON is a unique data format. In that case how will ArcGIS recognize it?

Answer 17: The GeoJSON format is recognized natively by the ArcGIS software.

Question 18: GES DISC does not have the option of country selection in the area selection variables. Why is that?

Answer 18: To get an accurate answer, you should submit a question to them but we believe that NASA's subsetting capability at Earth Data Search and other tools is still latitudinally and longitudinally based and doesn't provide for polygon or shapefile searches at this time.



Question 19: Is it possible to make measurements of solar irradiation during a solar storm event? Are these events recorded on a timeline?

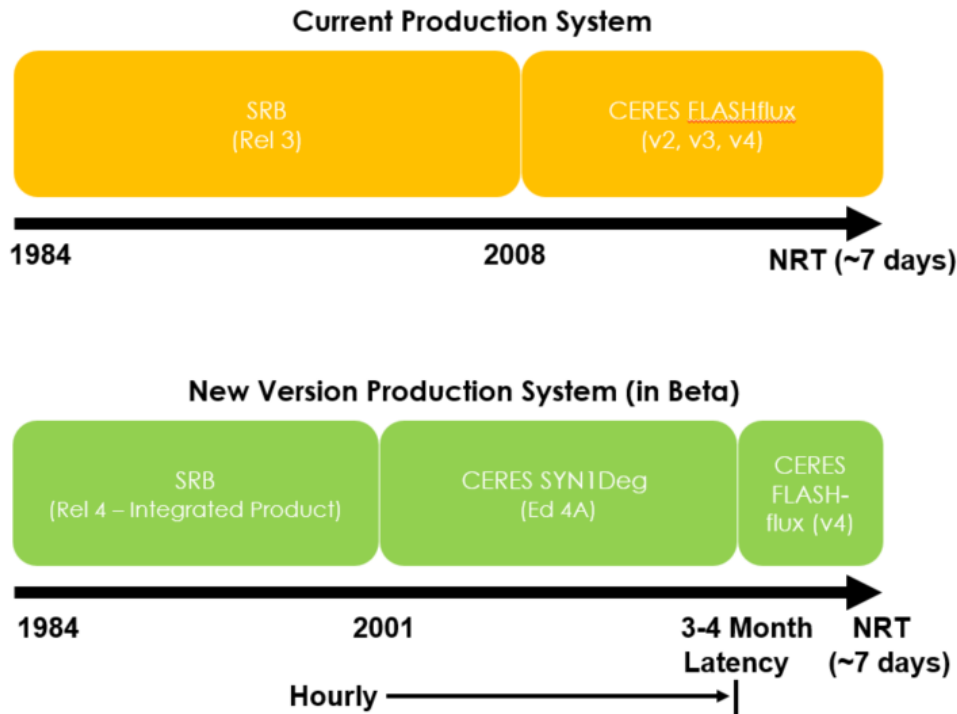
Answer 19: The total solar irradiance that we use as input to our calculations is only slightly sensitive to solar storm activity. We used SORCE and now use TSIS measurements (<https://lasp.colorado.edu/home/sorce/>) (<https://lasp.colorado.edu/home/missions-projects/quick-facts-tsis/>), which are provided on a daily basis, so the effect of solar storms on the TSI is captured. However, the largest effects of solar storms are seen in the wavelengths outside of those we use for surface solar irradiance calculations, particularly at very short wavelengths like UV.

Question 20: Do Photosynthetic active radiation (PAR) data exist in POWER data archive? If not, what other parameters related to PAR exist?

Answer 20: Yes! This is a parameter that is carried in both the GEWEX SRB and CERES data sets. The upcoming POWER version (now in beta) contains an estimate of the PAR irradiance that is orderable through the Data Access Viewer (DAV) and API.

Question 21: How do you select the suitable solar radiation out of the different products available on Power (GEWEX AND CERES)?

Answer 21: This depends upon your specific application. If you need hourly data time series, then you would specify a data request to begin in January 2001 using the new version which is currently still in beta (<https://power.larc.nasa.gov/beta>). For long-term averages and time series of daily, monthly or annual averages, the time requested will determine which source you receive.



Question 22: Is there any information for shade analysis for solar system design?

Answer 22: There is no information on shading currently (mountain ranges, complex terrain). Trees and buildings at local levels would be impossible to resolve at the resolution of the POWER data.

Question 23: The data from The POWER Project can only be analyzed at a given point or can you define regions of interest?

Answer 23: We are optimized for point data but one can design a script, with help by using our tutorials (<https://power.larc.nasa.gov/beta/docs/tutorials/>), to repeatedly request adjacent points to do this. Additionally, the Data Access Viewer has a small regional data request and will have a global capability in the beta version.

Question 24: Does POWER have applications for e.g. developing climate change adaptation scenarios?

Answer 24: This is on our list for future improvements. Within 1-2 years we should develop this. Please provide feedback in the survey to help us better refine these scenarios.



Question 25: How do you cite this data in your research reference?

Answer 25: From the POWER web site here is one recommendation on how to cite:

When POWER data products are used in a publication, we request the following acknowledgment be included:

"These data were obtained from the NASA Langley Research Center (LaRC) POWER Project funded through the NASA Earth Science/Applied Science Program."

The POWER Project kindly requests a reference, web link and/or a reprint of any published papers or reports or a brief description of other uses (e.g., posters, oral presentations, etc.) of data products that we have distributed. This will help us determine the use of data that we distribute, which is helpful in optimizing product development. It also helps us to assess our value to the community. Please contact us at POWER Project Team for additional information on sending reference material.

Question 26: For a water disposal project, is it possible to use solar radiation data for evaporation? What kind of data do I need?

Answer 26: Yes, but you also need information on temperature and water vapor in that area. A POWER data user developed an app for evapotranspiration, which might be adaptable for a general evaporation usage:

Maldonado, W., T. T. B. Valeriano, and G. de Souza Rolim, 2019: EVAPO: A smartphone application to estimate potential evapotranspiration using cloud gridded meteorological data from NASA-POWER system. *Computers and Electronics in Agriculture*, 156, 187–192, <https://doi.org/10.1016/j.compag.2018.10.032>.

The MERRA-2 products have evaporative flux data and we may be able to add that to POWER in the future.