

# The Fourth Edition of the Best Practices Handbook for Solar Resource Data for Solar Energy Applications

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## Abstract

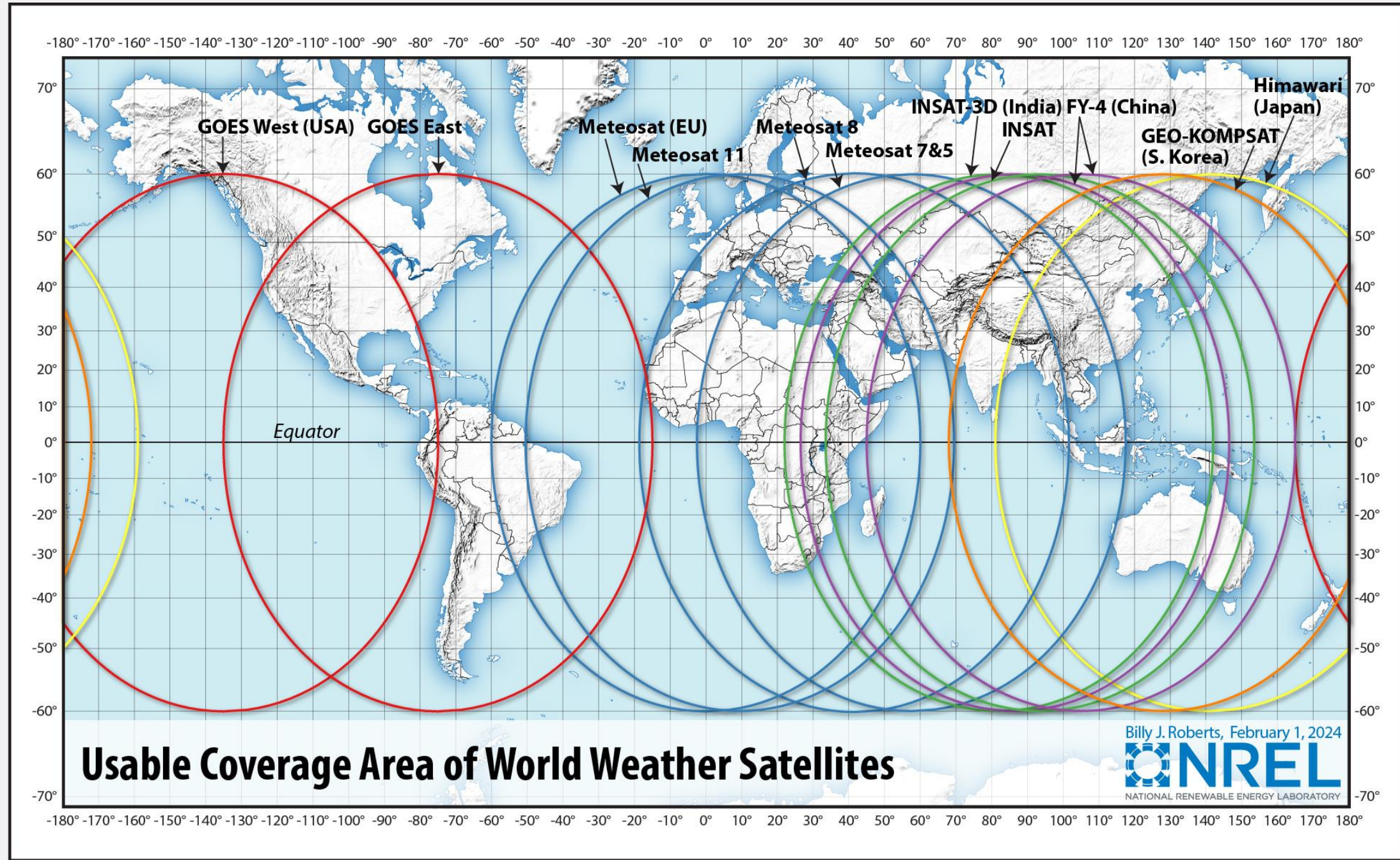
- To inform stakeholders of the latest research in solar resource assessment, the National Renewable Energy Laboratory (NREL), in collaboration with the International Energy Agency (IEA) Photovoltaic Power Systems Programme (PVPS) Task 16 and the Solar Power and Chemical Energy Systems (SolarPACES) technology programs, published the fourth edition of the *Best Practices Handbook for the Collection and Use of Solar Resource Data for Solar Energy Applications* in October 2024.
- This update includes 12 chapters with contributions from 52 authors from 15 countries. It summarizes the techniques used to measure, model, and forecast the solar resource using radiometers, weather satellites, and numerical weather models.
- This poster presents the key features of the two chapters related to Modeling Solar Radiation and Applying Data to Solar Energy Projects.

## Highlights of the Best Practices Handbook

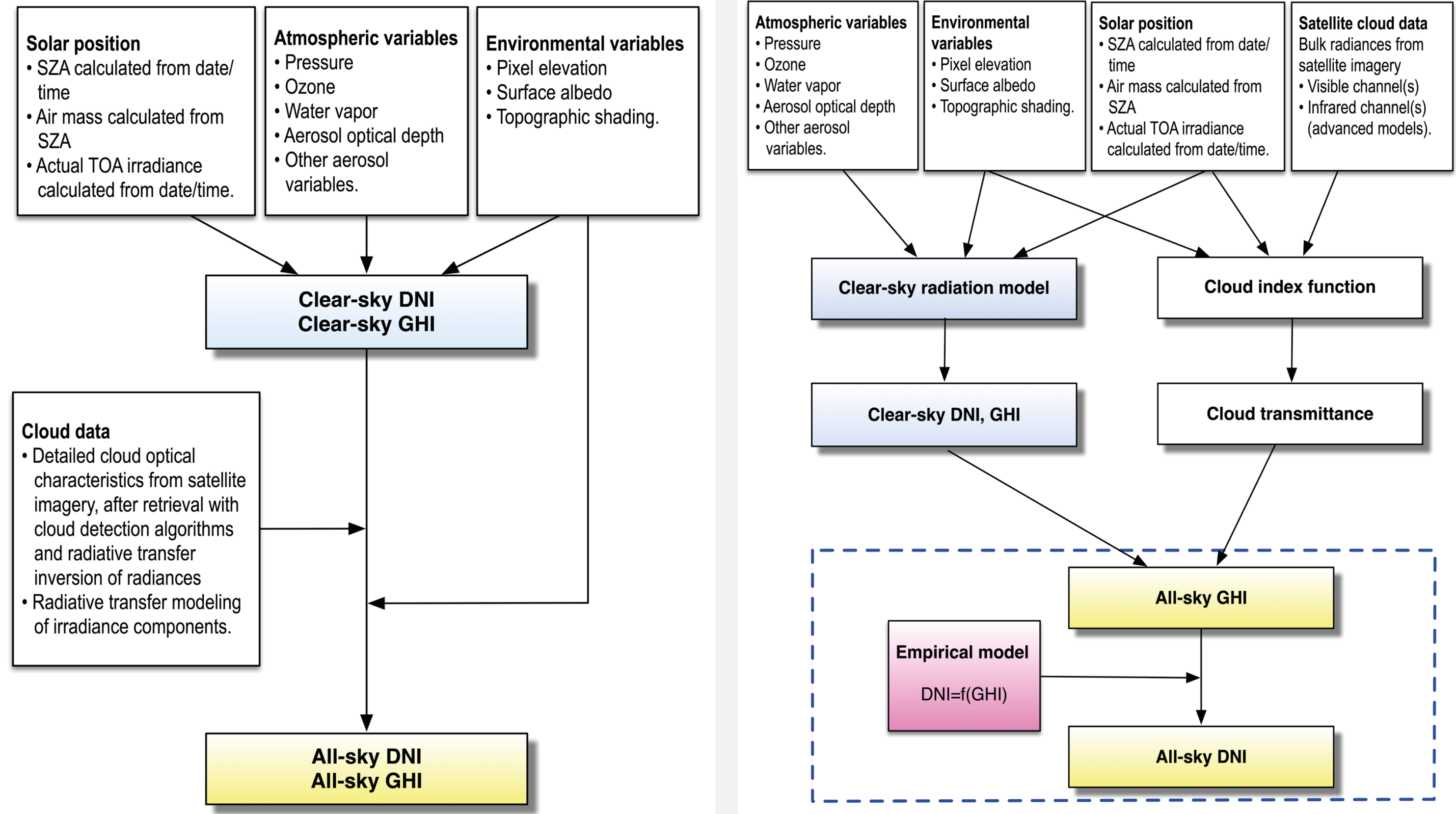
### Modeling Solar Radiation: Current Practices

- Satellite-based solar energy estimates have been developed over the years and are still being actively improved as next-generation meteorological satellites are deployed.
- Merging satellite estimates and ground observations have become important as the solar energy modeling world responds to the need for unbiased estimates of higher accuracy.
- The chapter provides a brief overview of solar radiation modeling methods, specifically emphasizing satellite-based models.
- Since the 1980s, the technologies of operational meteorological satellites and models to estimate surface radiation from these satellites have improved in resolution and accuracy.
- With the launch of the Geostationary Operational Environmental Satellite (GOES)-R series, Meteosat Third Generation (MTG\_I1), the FengYun (FY)4 series, Himawari-9, and GEO-KOMPSAT-2A (GK-2A) geostationary satellites, the world is now covered at temporal resolutions of 15 minutes or better and spatial resolutions of  $\approx 1$  km, except at high latitudes ( $< -60^\circ\text{N}$  /  $> 60^\circ\text{N}$ ).

**Figure 1.** Location of the current geostationary satellites providing coverage around the globe. *Image by Billy Roberts, NREL*



- The following flowcharts show the two main types of satellite-based models: (left) physical models and (right) semiempirical models.

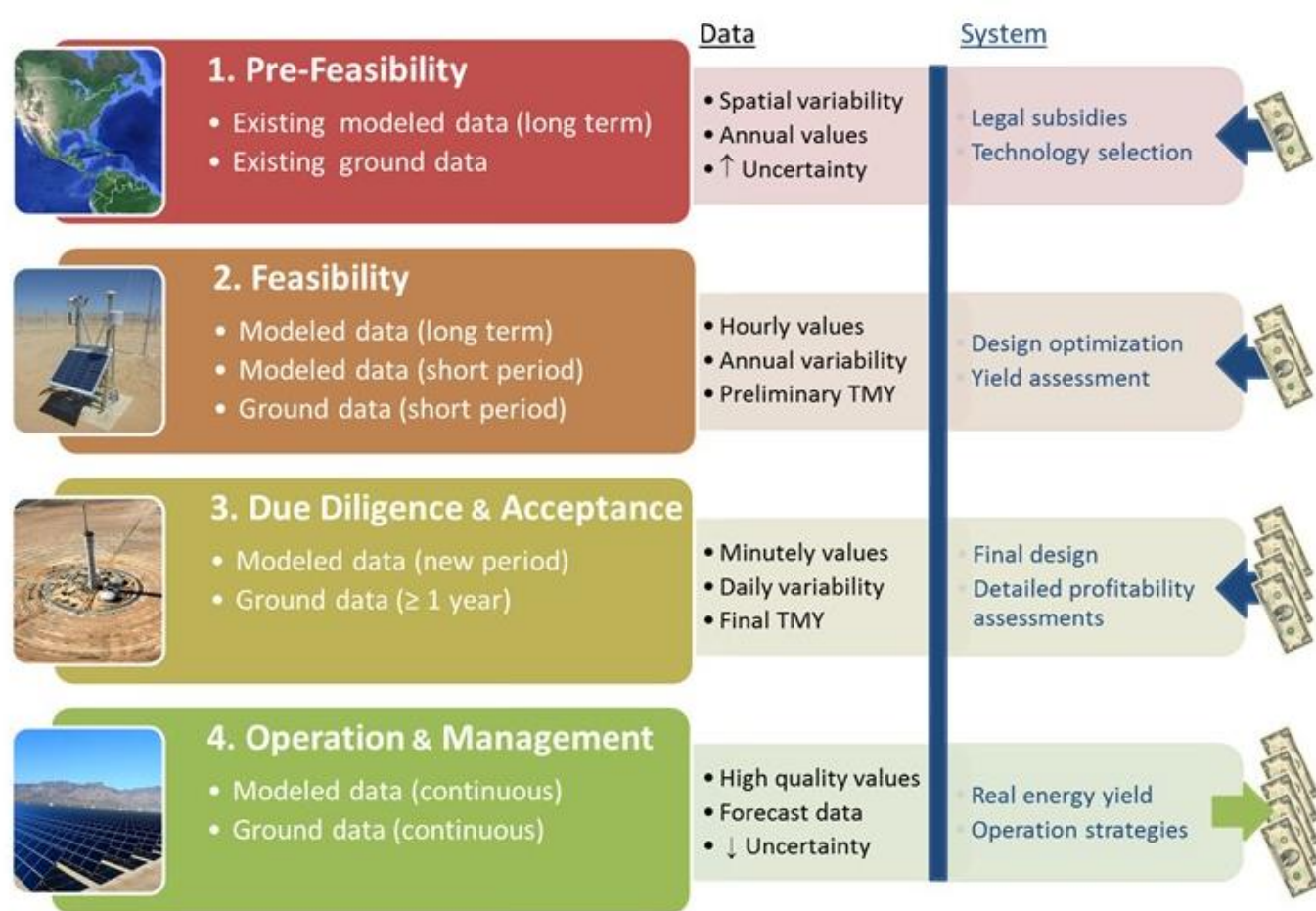


- For any specific project, the precise needs for solar resource data depend on the project's characteristics and how it is financed.
- In this context, size matters a lot. A small project of a few dozen kilowatts is usually designed with only an appropriate typical meteorological year (TMY) file or long-term monthly solar radiation estimates that can be obtained freely or commercially.

**Figure 2.** (Left) Schematic flowchart describing the different modeling parts of physical satellite models (SAZ: solar zenith angle; TOA: top of atmosphere). *Image by C. Gueymard*

**Figure 3.** (Right) Schematic flowchart describing the different modeling parts of semiempirical satellite models (SAZ: solar zenith angle; TOA: top of atmosphere). *Image by C. Gueymard*

**Figure 5.** Solar resource data at typical stages of a solar power project



- Continuous monitoring of the incident irradiance is rarely required during the life of the project.
- In sharp contrast, a large utility-scale solar power project typically requires several years of high-quality modeled data and at least 1 year of on-site measured data or satellite-derived data during the final stages of the project execution (Figure 5).

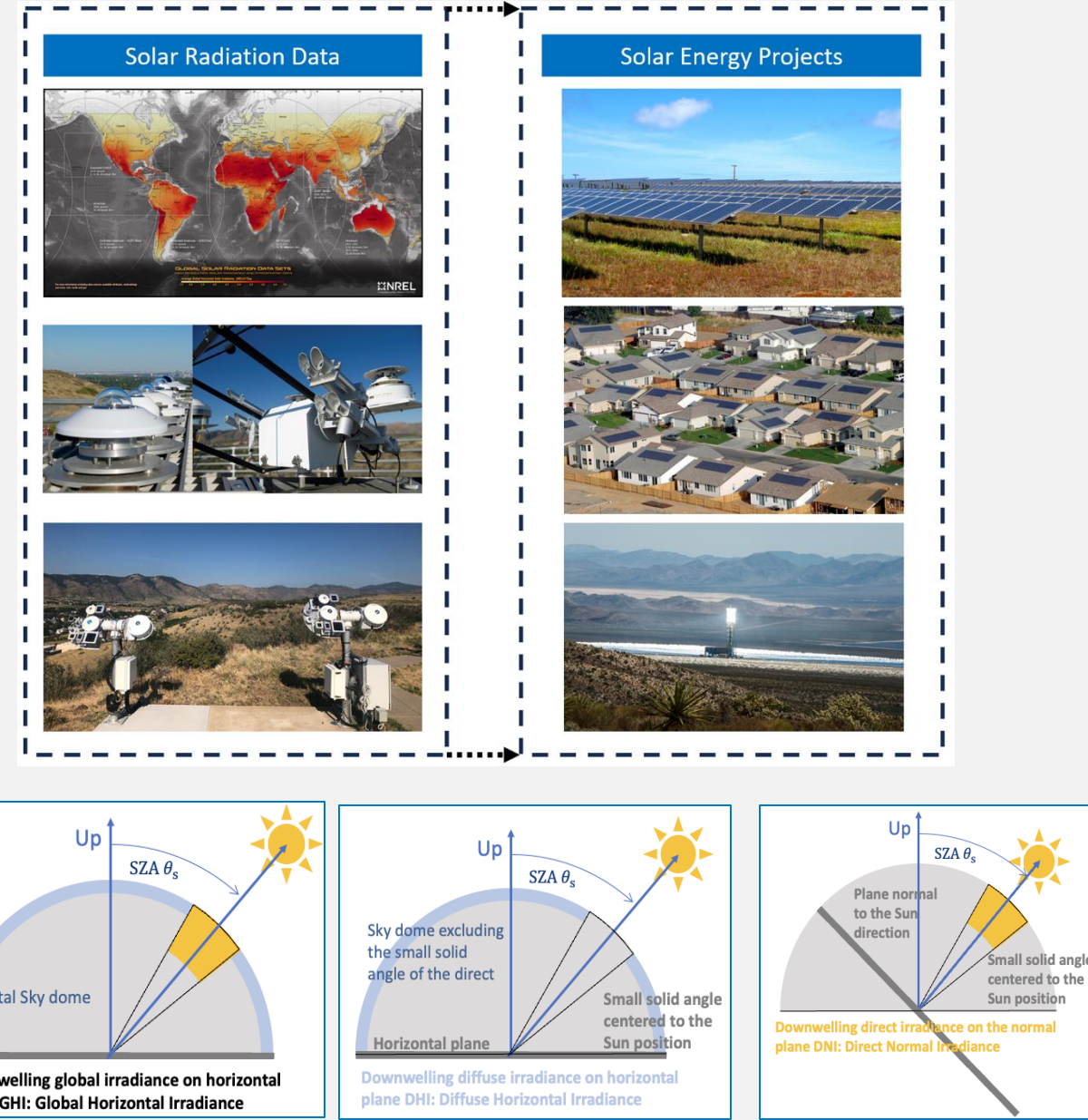


**Figure 4.** Example solar radiation data and application to solar energy projects

**Table 1.** Solar Irradiance Needs for Different Stages and Sizes of a Hypothetical Project

| Phase |                                | System Size                                                                                                                                           |                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                            |
|-------|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|       |                                | Small                                                                                                                                                 | Medium                                                                                                                                                                                                                                           | Large                                                                                                                                                                                                                                                                                      |
| Phase | 1. Prefeasibility and planning | <ul style="list-style-type: none"><li>Long-term averages</li><li>Monthly data</li><li>Solar cadastres/ maps</li><li>Simple shading analysis</li></ul> | <ul style="list-style-type: none"><li>TMY</li><li>Hourly data</li><li>Shading analysis</li></ul>                                                                                                                                                 | <ul style="list-style-type: none"><li>Long-term satellite data</li><li>Hourly data</li></ul>                                                                                                                                                                                               |
|       | 2. Feasibility                 |                                                                                                                                                       |                                                                                                                                                                                                                                                  | <ul style="list-style-type: none"><li>Satellite data</li><li>Time series (&gt; 10 years)</li><li>Ground measurements (&gt;1 year)</li><li>Shading analysis</li><li>Further site- and technology-specific meteorological parameters (e.g., albedo, soiling)</li></ul>                       |
|       | 3. Due diligence and finance   |                                                                                                                                                       | <ul style="list-style-type: none"><li>Satellite data</li><li>Time series (&gt;10 years)</li><li>Minutely data</li><li>Shading analysis</li><li>Further site- and technology-specific meteorological parameters (e.g., albedo, soiling)</li></ul> | <ul style="list-style-type: none"><li>Satellite data</li><li>Time series (&gt;10 years)</li><li>Ground measurements (&gt; 1 year)</li><li>Minutely data</li><li>Shading analysis</li><li>Further site- and technology-specific meteorological parameters (e.g., albedo, soiling)</li></ul> |
|       | 4. Operations and maintenance  | <ul style="list-style-type: none"><li>Simple (inverter) monitoring</li></ul>                                                                          | <ul style="list-style-type: none"><li>Local measurements</li><li>Forecasts</li></ul>                                                                                                                                                             | <ul style="list-style-type: none"><li>Local measurements</li><li>Forecasts</li></ul>                                                                                                                                                                                                       |