PV Systems Modelling with Python

IEEE PVSC54, New Orleans

Andrea Quattrone (DNV), Rajiv Daxini (NLR)

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Agenda

- 9:00-9:05: Arrive, get settled, wifi
- 9:05-9:20: Introduction
- 9:20-10:00: Part 1, Q&A
- 10:00-10:30: Start Part 2,
- 10:30-11:00: Break
- 11:00-11:30: Finish Part 2
- 11:30-12:00: Share results, Q&A

Wifi name: …

Wifi password: …

Objectives

- By the end of this tutorial, you will be able to:
  - Download irradiance data and sun position for a specific location.
  - Determine the orientation of a single-axis tracker system.
  - Calculate Plane of Array irradiance.
  - Estimate the power output of a PV system.

Introduction

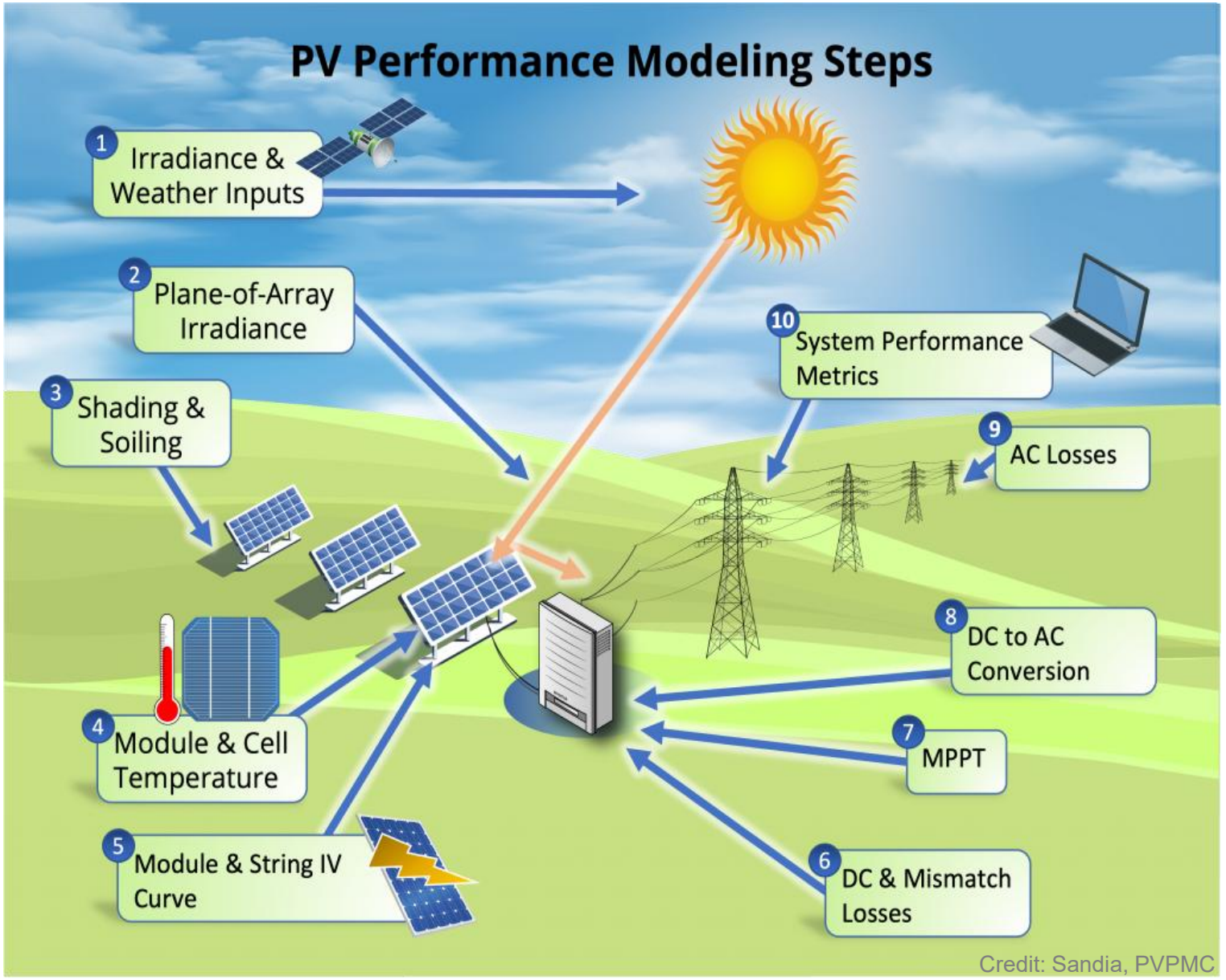
- What is pvlib
- PVPMC steps
- pvlib functions
- Irradiance transposition
- Irradiance sources
- What is a TMY?

What is pvlib?

A python library for PV performance modeling

- Collection of tools
- community-driven
- free
- open-source
- well-documented

https://pvlib-python.readthedocs.io/en/stable/index.html


PV Performance Modeling Steps
1 Irradiance & Weather Inputs
2 Plane-of-Array Irradiance
3 Shading & Soiling
4 Module & Cell Temperature
5 Module & String IV Curve
6 DC & Mismatch Losses
7 MPPT
8 DC to AC Conversion
9 AC Losses
10 System Performance Metrics
Credit: Sandia, PVPMC

Reusable reference functions

- **pvlib.solarposition**
  - spa
  - ephemeris
  - hour_angle
- **pvlib.irradiance**
  - Transposition models
  - Decomposition models
- **pvlib.clearsky**
  - Ineichen
  - Simplified solis
- **pvlib.snow**
  - Marion model
  - Townsend

pvlib.bifacial
- infinite_sheds

pvlib.iam
- martin_ruiz
- martin_ruiz_diffuse
- marion_diffuse

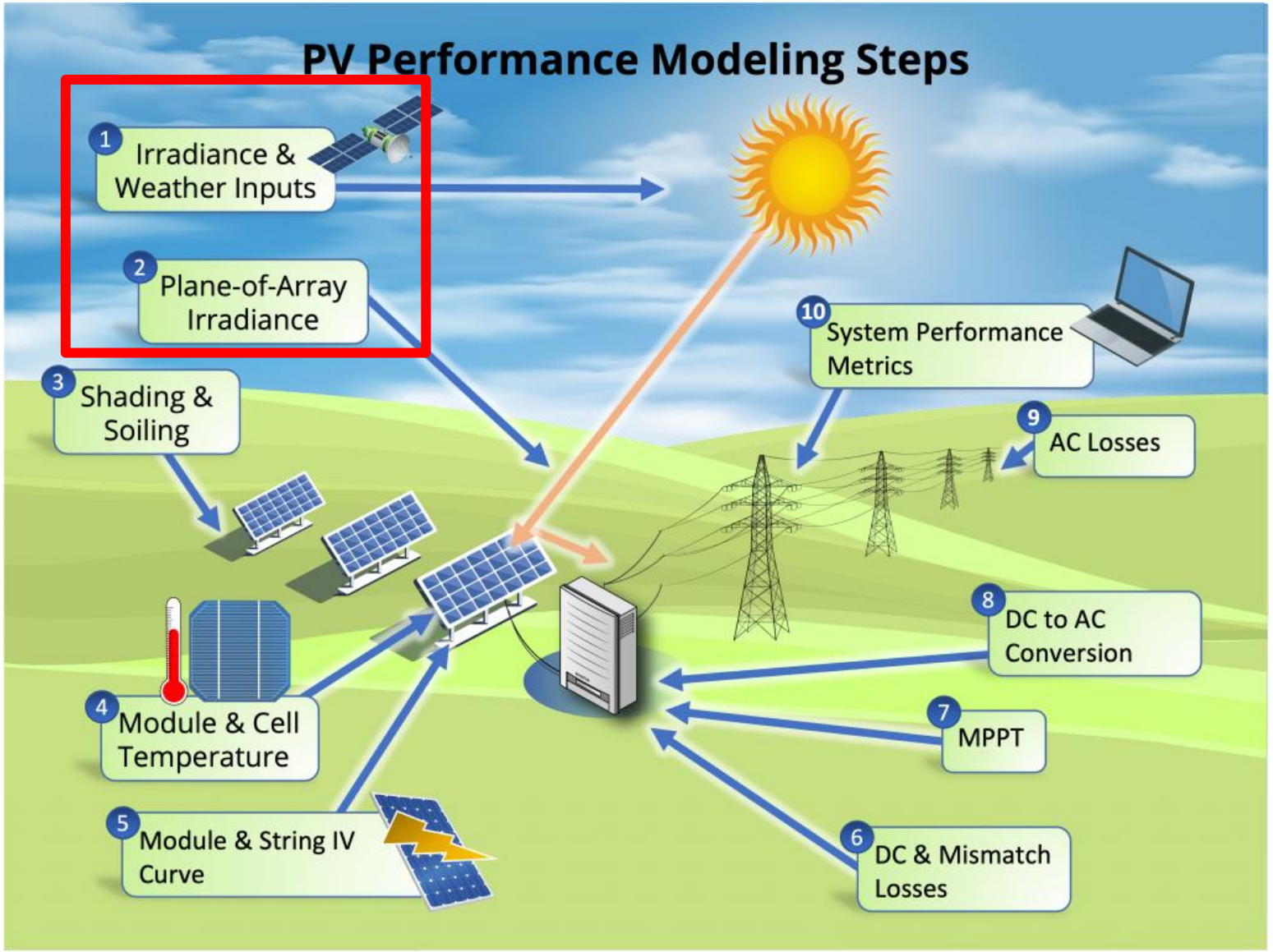
pvlib.temperature
- faiman
- fuentes
- ross
- noct_sam
- prilliman transient model

pvlib.ivtools
- fit_sde_sandia
- fit_pvsyst_sandia
- fit_desoto_sandia

pvlib.soiling
- Kimber model
- Humboldt State model

pvlib.tracking
- slope-aware backtracking

pvlib.inverter
- fit_sandia
- sandia_multi
- pvwatts_multi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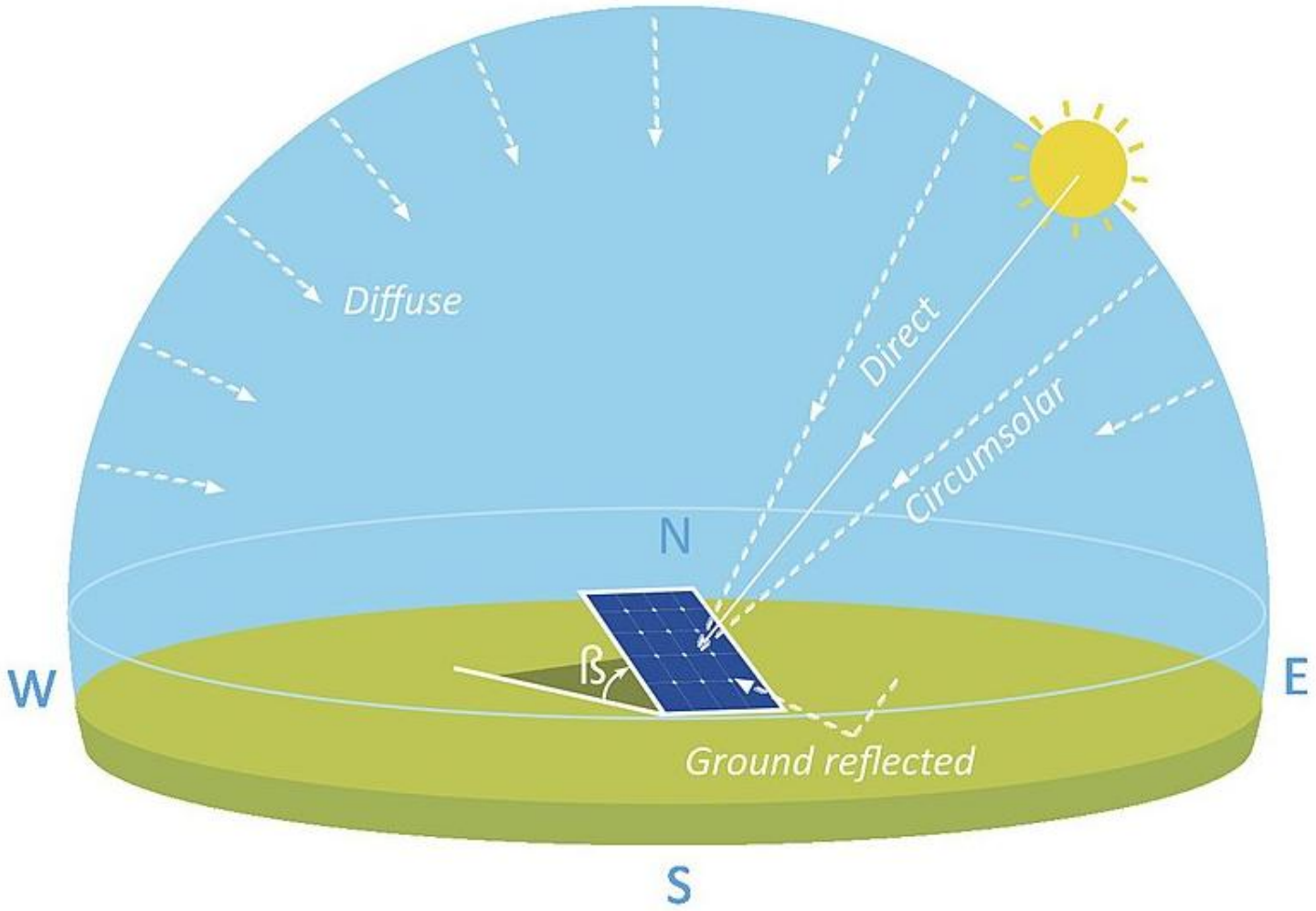


Credit: Paula Marengo

Irradiance data sources

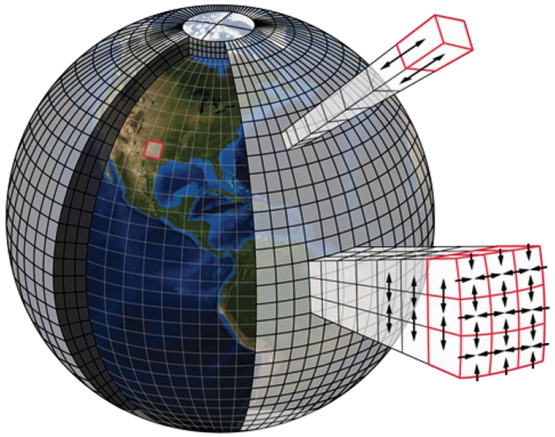
Ground-based

Credit: Hukseflux.com

Satellite-derived

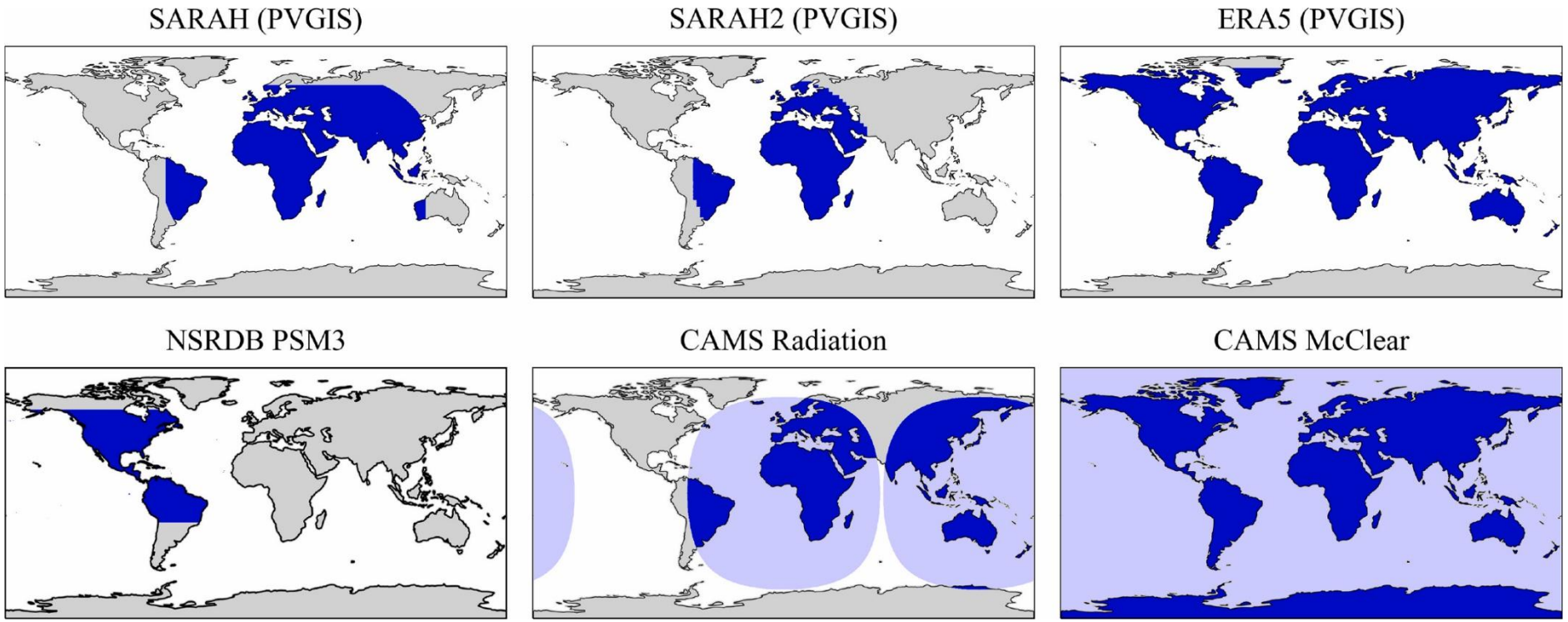
Credit: NASA

Weather models



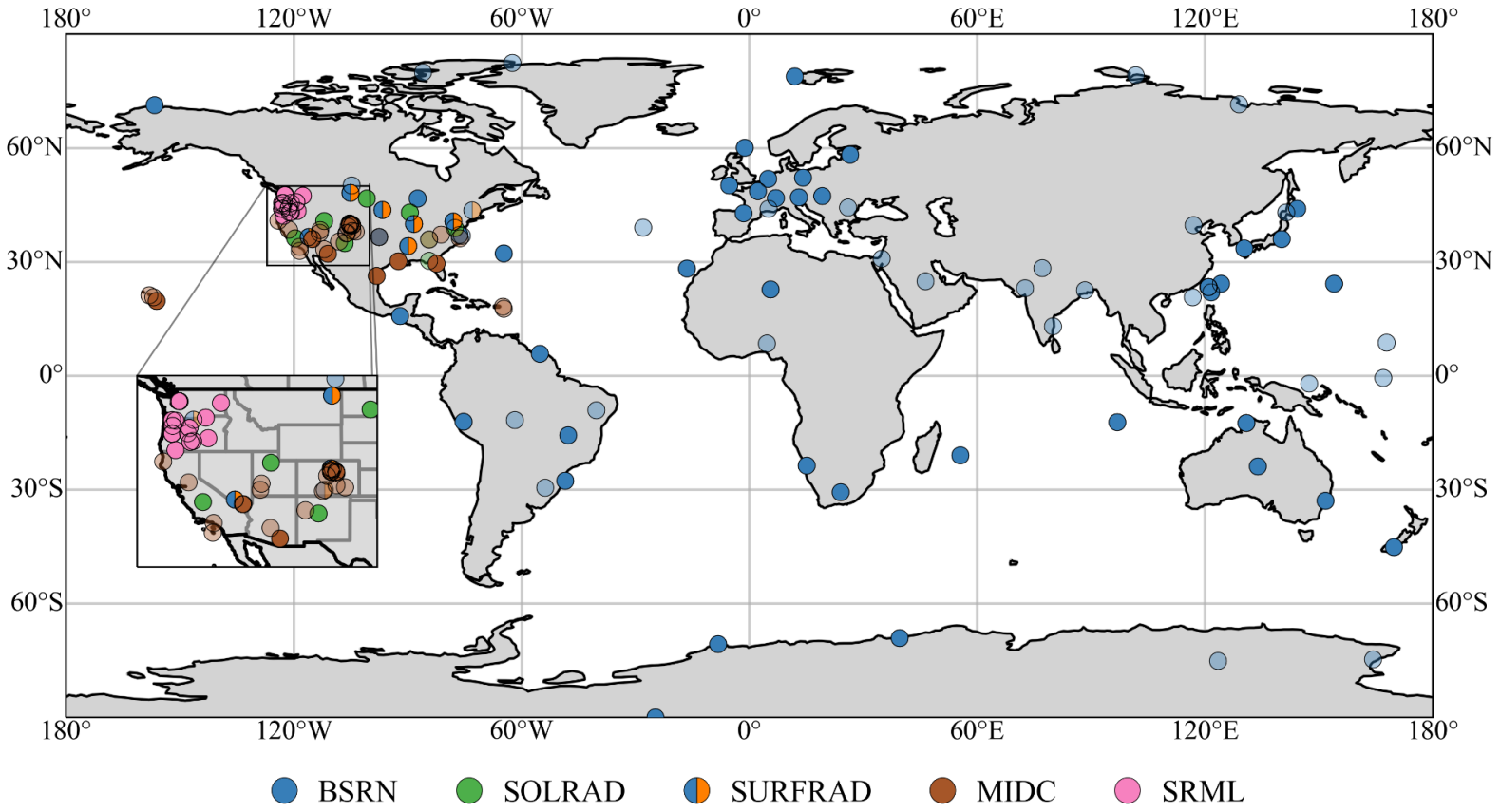
Credit: Francis Giraldo

pvlib iotools – modelled datasets



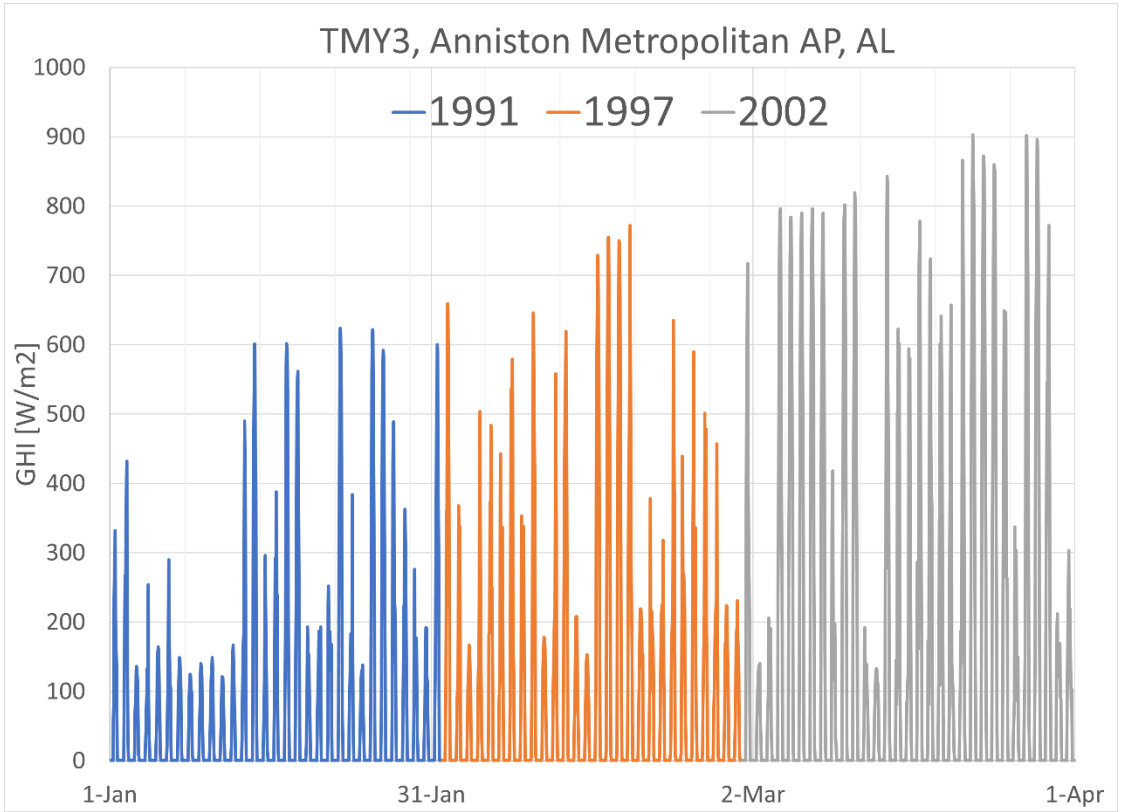
https://doi.org/10.1016/j.solener.2023.112092

pvlib iotools – ground stations



Why do we use Typical Meteorological Year (TMY)?

- What even is a TMY? **It's a Frankenstein's monster!**
  - January is from one year, February from another, *etc.*



Let’s start modelling!

https://pv-tutorials.github.io/

GitHub.com/PV-Tutorials

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Wi-Fi name: …

Wi-Fi password: …

Thank you!

Andrea.Quattrone@dnv.com
Rajiv.Daxini@nlr.gov

www.dnv.com

DNV

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