**Solecito: A Software Library for the Detailed Simulation of Photovoltaic Arrays**

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Context

• (2012) Branch of Matlab-PVLIB
  ~ Irregular Terrain & Trackers (CPV)
  ~ Mismatch (string-layout)
  ~ Sub-hourly time-steps

• (2016) Start-Up
  ~ Digital Twins
  ~ Parametric studies (shading)

• (2019) HyForPV
  ~ Performance Optimization
  ~ Consolidation & Validation
  ~ Data assimilation
Overview
Part 1/3
Grid-based, sub-cell resolution shading
Fully anisotropic transposition
Fully anisotropic diffuse shading
Fully anisotropic diffuse shading

CDM43 vs ISO+CS (RMS*)

Cocoa, Florida
28° N, 80° W, 12 m ASL

Eugene, Oregon
44° N, 123° W, 145 m ASL
Terrain
Terrain
Meteorological Data

- Dedicated class
  - YAML sensor config.
  - Meta-Data
    - Location
    - Summarization
  - Non destructive flags
  - Uncertainty

- ID: Analog_GTIAvg
  type: GTI
  model: Si-V-10TC
  info: Ref. cell at platform
  location: [9.189, 48.694, 423.3]
  mount:
    - tilt: 25.0
    - azimuth: 17.3 S2E
    - type: 0a
  zero_offset: 5.0
  calibration: 5.0
  temp_response: 0.1
  azimuth_response: 0.0
  cosine_response: 60.0
  tilt_response: 0.0
  fIAM: []
Meteorological Data

- Quality Control (CIE, BSRN, clear-sky, uncertainty, ...)
- Detection of common issues (units, time offset & summarization, ...)

true lag = 1, detected lag = 1, $P_0 = 41\%$, $P_B = 59\%$
Meteorological Data

- Gap filling of ancillary variables (MSSA)
- Completion with MERRA / CAMS / defaults
Part 2/3

Simulated Irradiance

Weather Data
- Ambient Temperature
- Wind Speed
  - [Pressure, TPW, ...]

Electrical Layout

Electrical Simulation
- Bypass Diode Model
- Electrical Cell Model
- IV Curve Calculation
- Temperature Cell Model
- Circuit Solver
- Inverter Model

Ohmic Losses

Simulated Power

Legend:
- Layout Specifications
- Input Weather Data
- Component Models
- Irradiance Calculation
- Electrical Simulation
- Important Departure from State-of-the-Art
Electrical Layout
• Ported & Optimized
  - ODM* (PVsyst+)
  - MDPWL approximation
  - Series-parallel adition
Part 3/3

Simulated Power

Validation & Visualization

Dynamic QC

Data Assimilation

Monitoring Data

Irradiance Forecasts

Power Nowcasting & Forecasting

Postprocessing

Electrical Simulation

Postprocessing

Important Departure from State-of-the-Art
Recursive Bayesian Estimation Framework for Data Assimilation

- Probabilistic separation models
- Probabilistic forecasts
- Sensor measurements
- Probabilistic transposition models
- Sensor uncertainty models

Posterior informs next prior

Data-assimilated probabilistic step-ahead forecast
Probabilistic measurement model
Data-assimilated probabilistic now-cast

Optimal State Estimate!
Recursive Bayesian Estimation Framework for Data Assimilation

Prior
\[ P(x_i \mid Y_{i-1}) = P(x_i) \]

Likelihood
\[ P(y_i \mid x_i, y_i = GTI\{90'\}) \]

Posterior
\[ P(x_i \mid Y_i) \]
Example of RBE correction

Original

2D-is + Mattei et al. + LR

Measured $P_{ac}$ [kW/kWp]

Simple model $P_{ac}$ [kW/kWp]

nRMSE = 59.0 W/kWp
nMBE = -2.7 W/kWp
nMAD = 26.9 W/kWp

RBE - prior on $kn \cdot kd$, GHI + RSI + GTI $30^\circ$

2D-is + Mattei et al. + LR

Measured $P_{ac}$ [kW/kWp]

Simple model $P_{ac}$ [kW/kWp]

nRMSE = 40.5 W/kWp
nMBE = -0.2 W/kWp
nMAD = 23.1 W/kWp
https://github.com/martinherrerias/solecito

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