



HAL
open science

Uncertainty Estimation in Hourly Photovoltaic AC Power with a Focus on Solar Plane-Of-Array Irradiance

Alexandre Mathieu, Martin Thebault, Gilles Fraisse, Simon Thebault, Simon Boddaert, Leon Gaillard

► **To cite this version:**

Alexandre Mathieu, Martin Thebault, Gilles Fraisse, Simon Thebault, Simon Boddaert, et al.. Uncertainty Estimation in Hourly Photovoltaic AC Power with a Focus on Solar Plane-Of-Array Irradiance. 2024 European PVPMC Workshop, Aug 2024, Copenhagen, Denmark. . hal-04793278

HAL Id: hal-04793278

<https://cnrs.hal.science/hal-04793278v1>

Submitted on 20 Nov 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

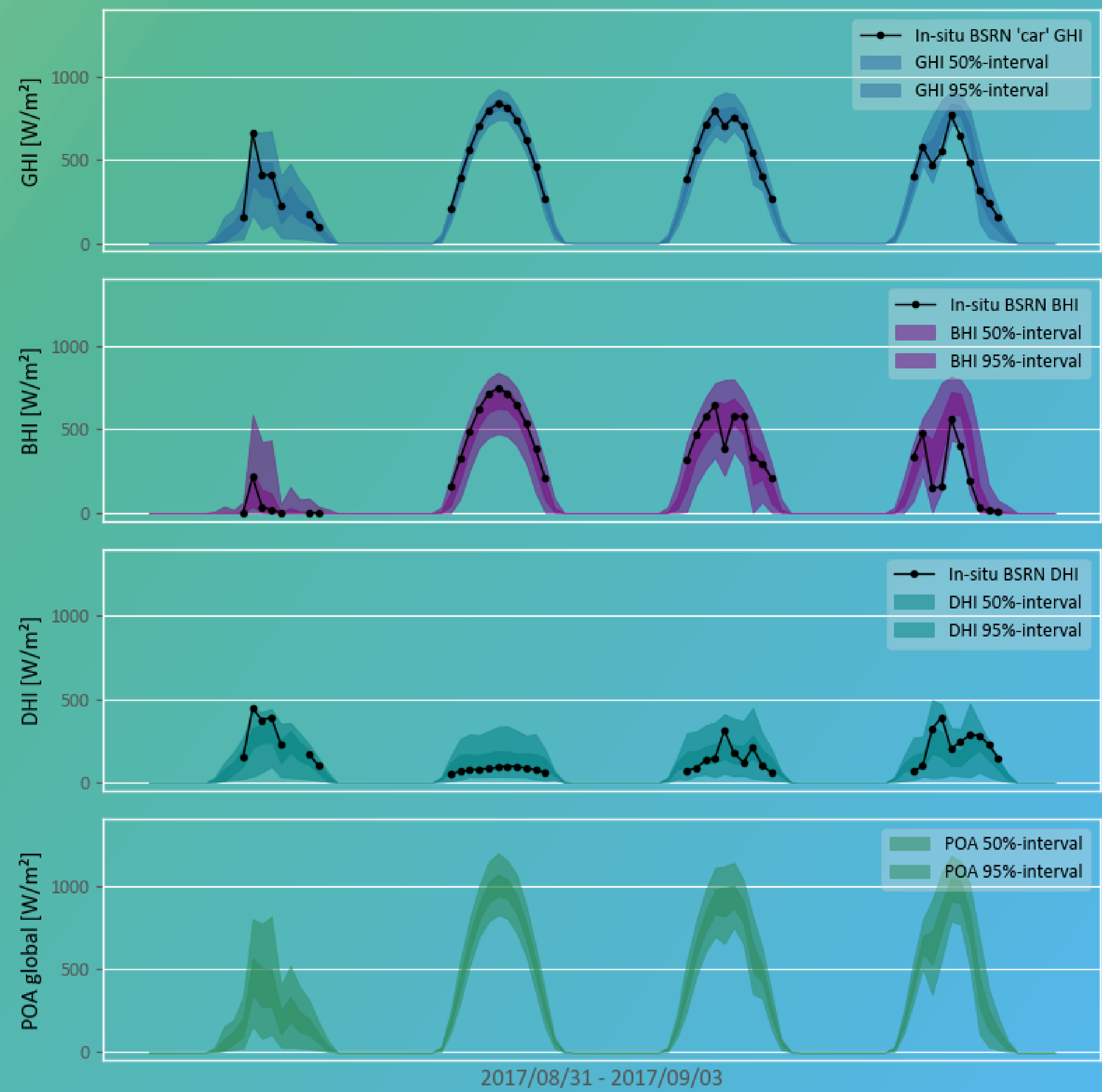
Uncertainty Estimation in Hourly Photovoltaic AC Power

with a Focus on Solar Plane-Of-Array Irradiance

Alexandre MATHIEU^{1,2,3}, Martin THEBAULT², Gilles FRAISSE², Simon THEBAULT³, Simon BODDAERT³, Leon GAILLARD¹

1. Heliocity, FRANCE
2. LOCIE, Université Savoie Mont Blanc, CNRS UMR5271, FRANCE
3. CSTB, FRANCE

Email: alexandre.mathieu@cstb.fr

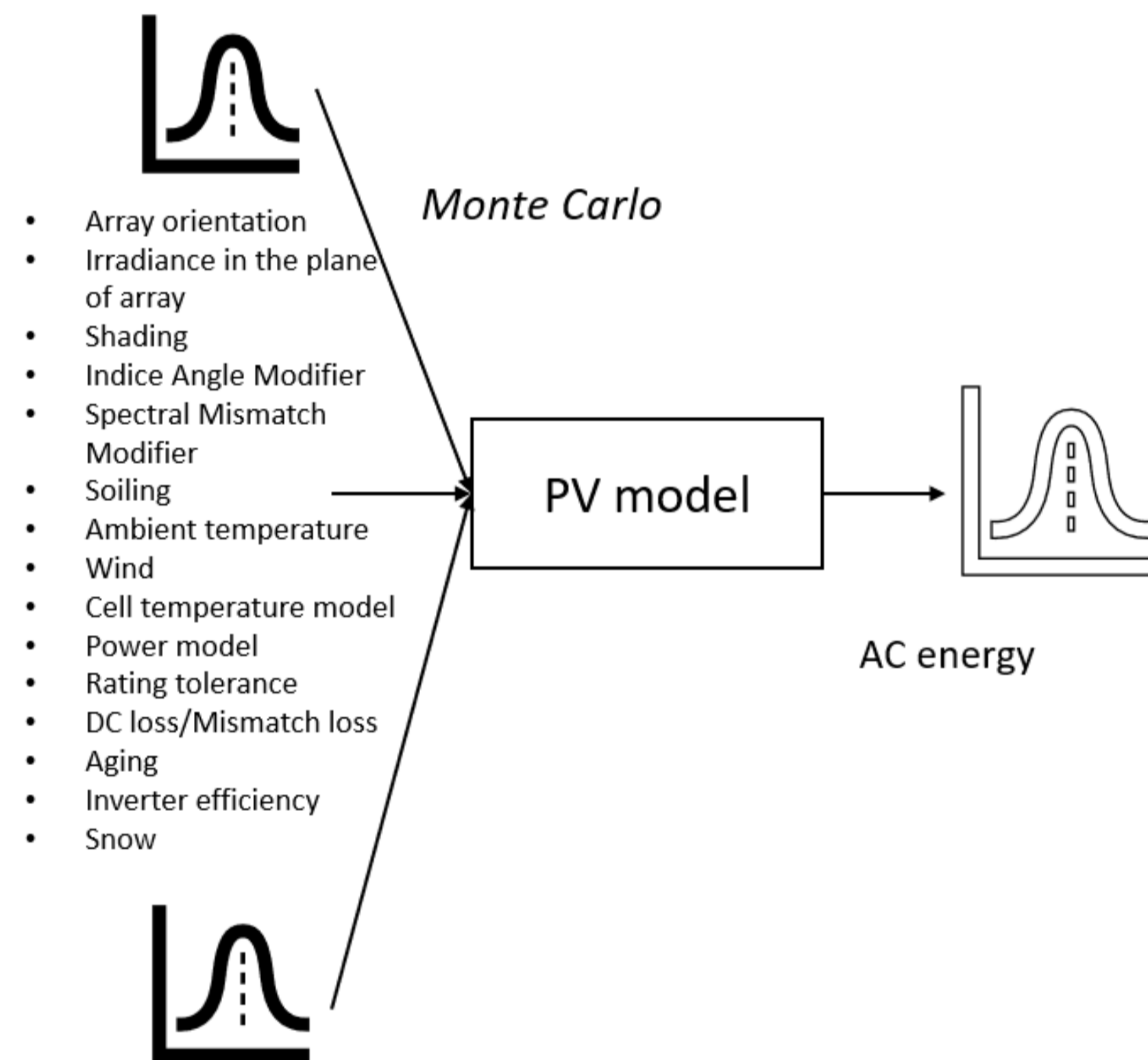


Background

Objectives:

Establishment of a methodology to estimate PV performance uncertainties

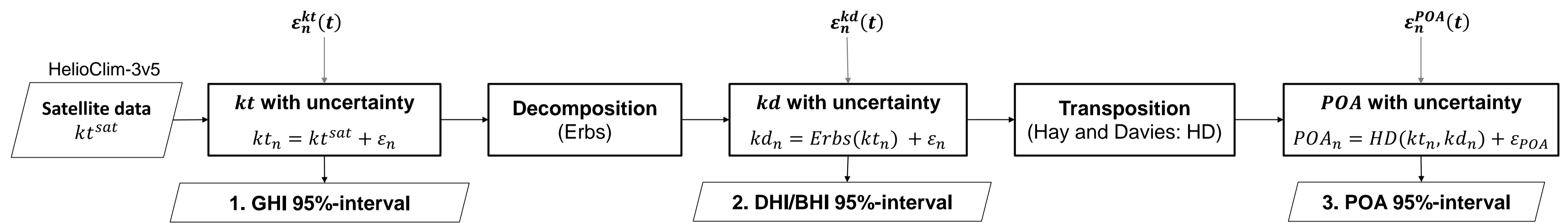
POA irradiance = major source of uncertainty*



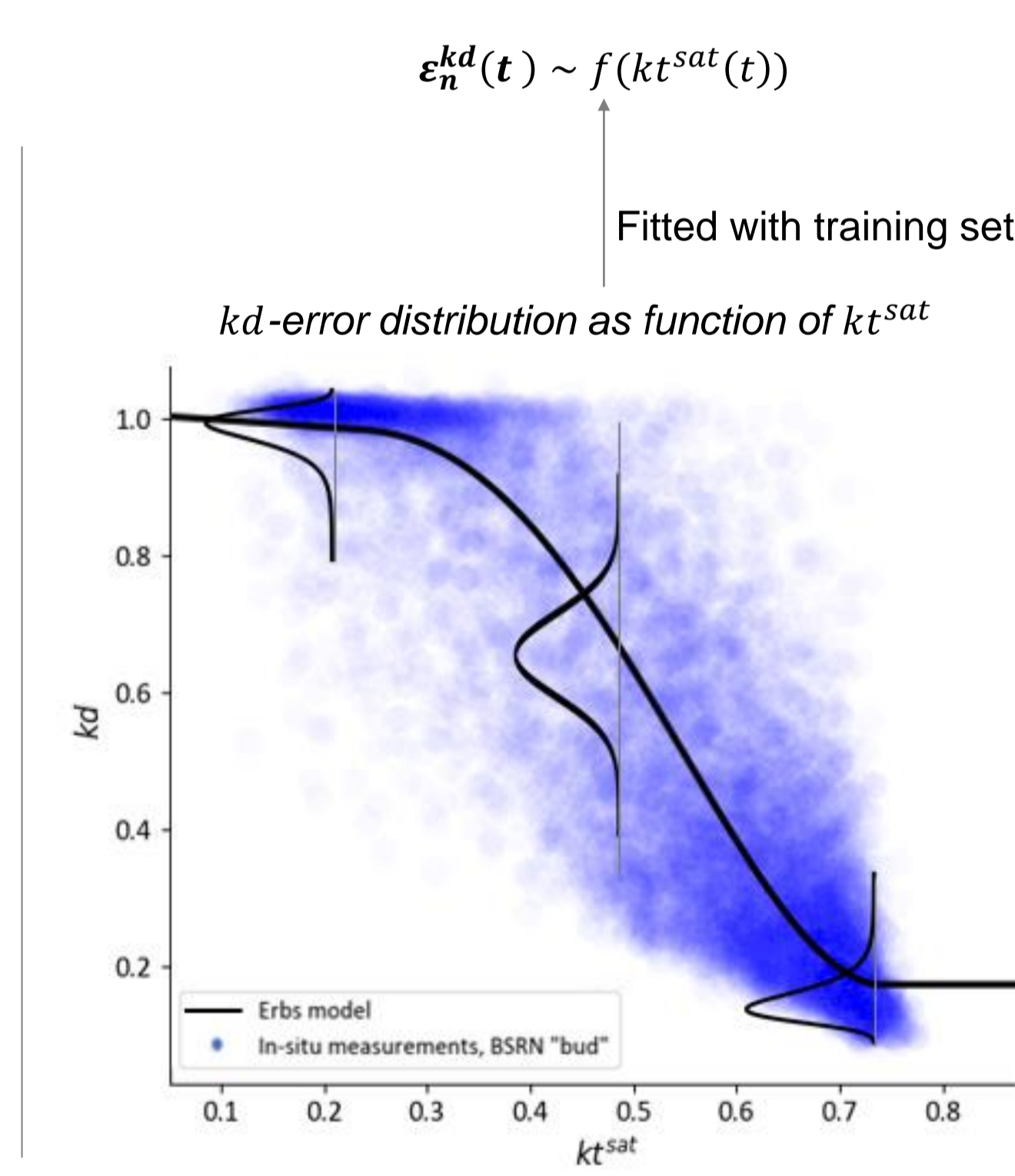
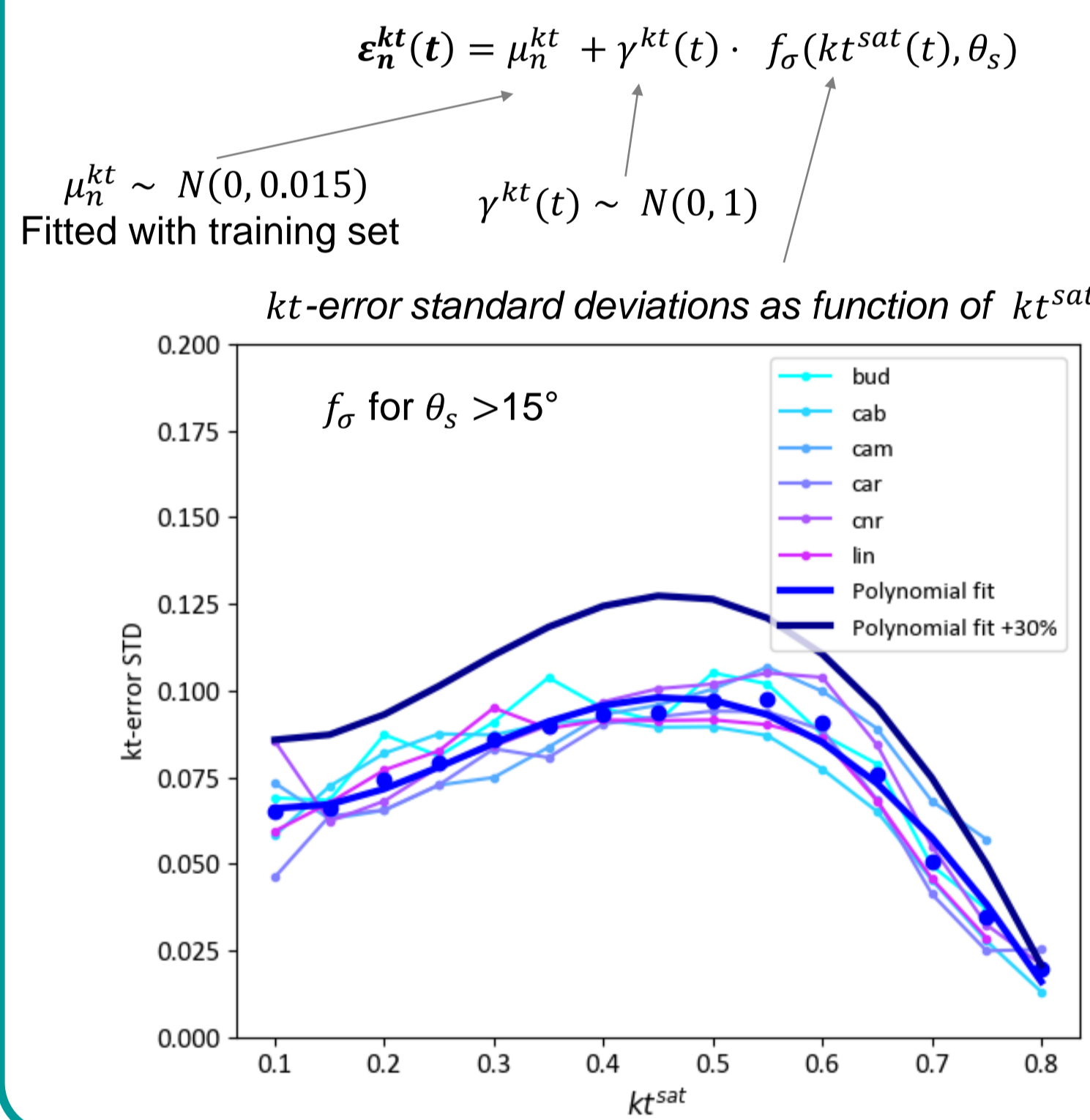
*D. Thevenard, S. Pelland, Solar Energy 2013, 91, 432-445. / D. Moser et al. Technical Risks in PV Projects. Solar Bankability Project 2017.

Methodology

Uncertainties are estimated at **each step** of the modeling chain to generate the **Plane-Of-Array (POA) irradiance at a hourly granularity with Monte Carlo simulations.**



Clearness index $kt = \frac{GHI}{G_{ext}}$
Diffuse ratio $kd = \frac{DHI}{GHI}$
 G_{ext} : extraterrestrial irradiance on a horizontal plane



- Mean bias: $\mu_n^{POA} \sim N(0, 1.5\%)*$
- « Standard Deviation » (σ_n^{POA}) uniformly picked within [5%; 9%]*

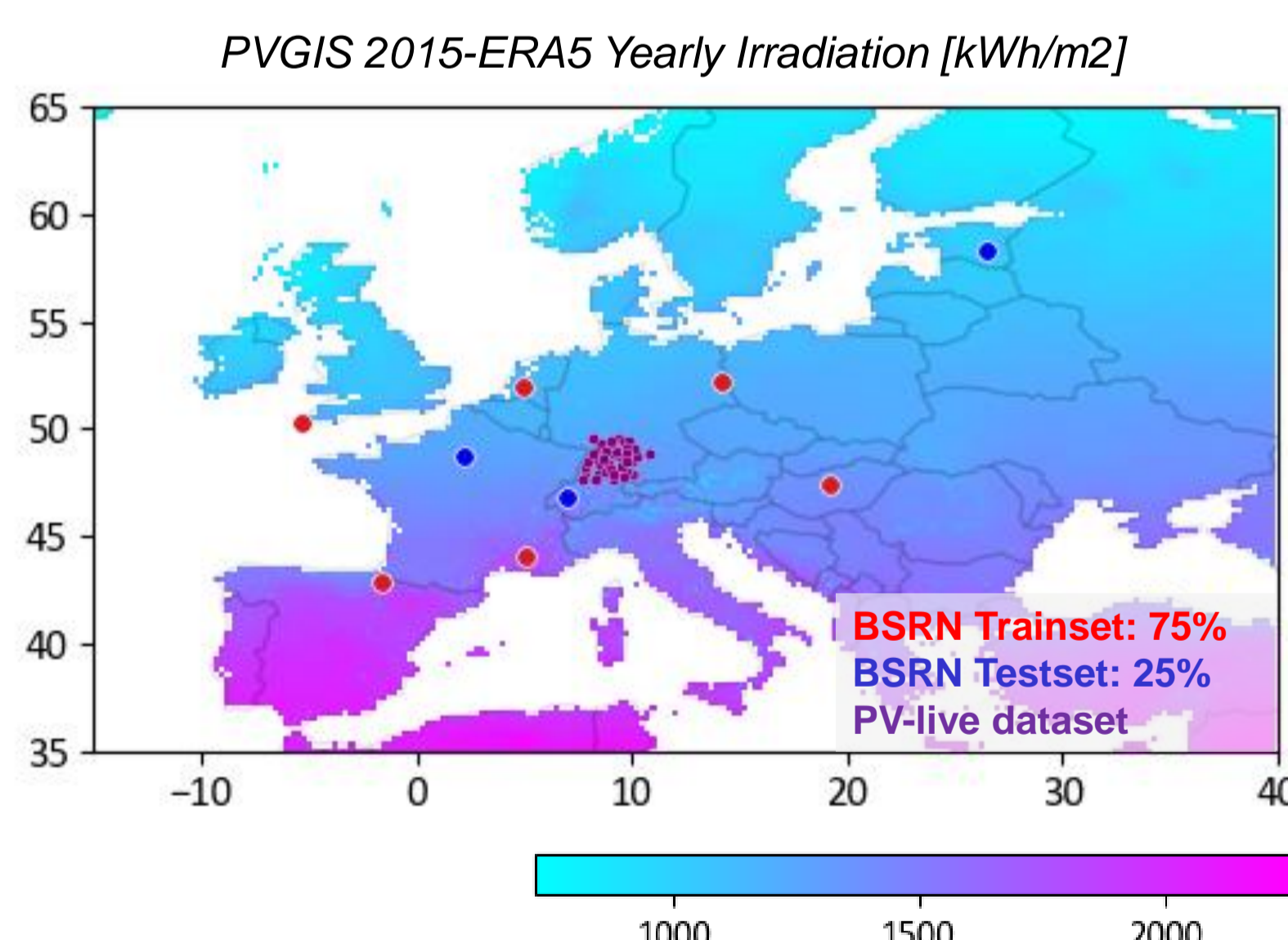
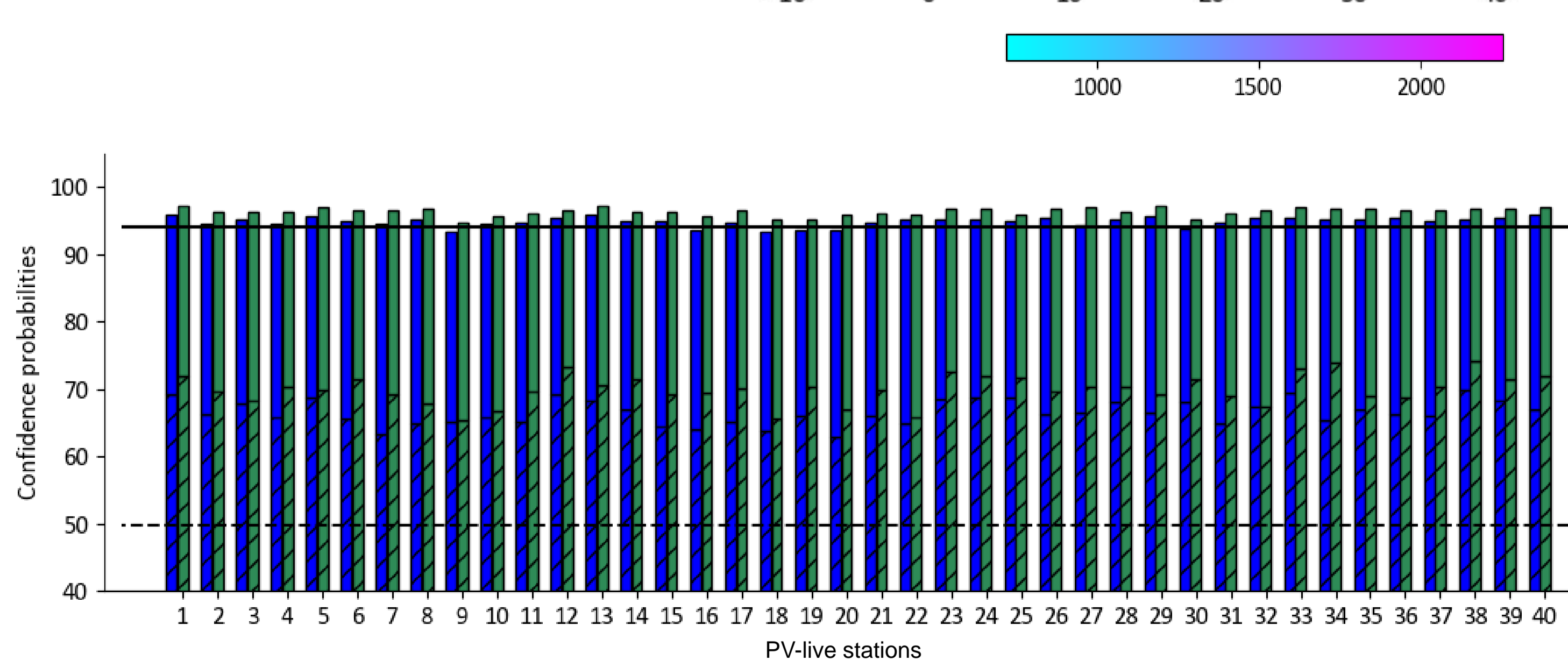
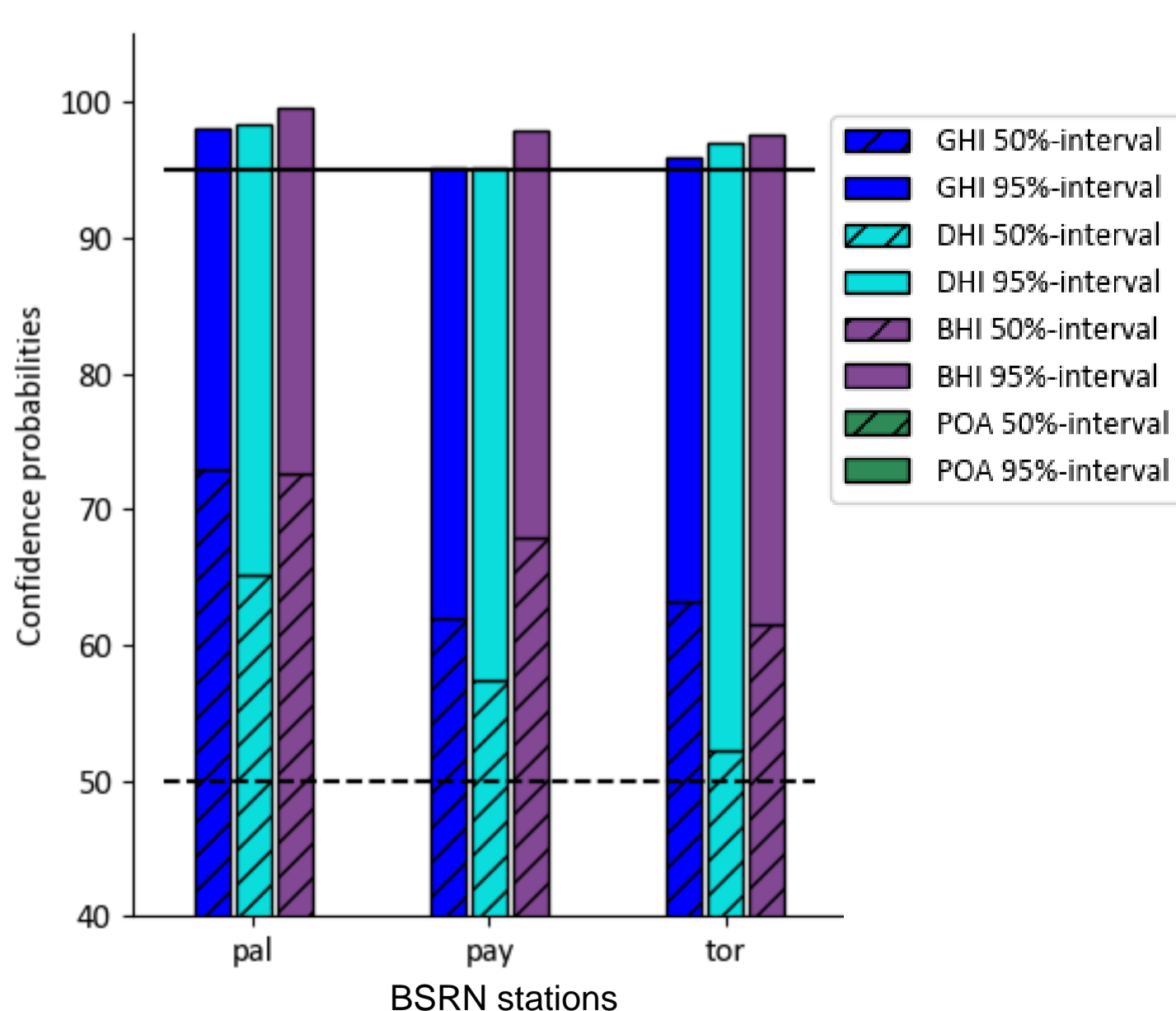
*Identified intervals from the literature

M. Dubois et al., International Journal of Photoenergy 2021 / C. A. Gueymard, Solar Energy 2009 / R. Mubarak et al. Energies 2017 / M. Lave et al., IEEE Journal of Photovoltaics 2015

Validation

The methodology is validated through 3 steps:

1. Trained on 6 BSRN stations
2. Tested on 3 other BSRN stations for GHI/BHI/DHI
3. Tested on 40 PV-live stations for POA-global (25° south)



Conclusion

This study addresses AC-energy **uncertainties** with a focus on POA-irradiance at an **hourly** granularity within **Europe**.

Using **Monte Carlo** techniques, the developed methodology enables to generate 95% confidence intervals for:

- Global Horizontal Irradiance
- Beam Horizontal Irradiance
- Diffuse Horizontal Irradiance
- Plane-Of-Array (POA) irradiance.

Paper in progress

"Uncertainty Estimation of the Hourly Plane-Of-Array Irradiance from Satellite Data: An European Case Study"

The authors of the article would like to thank the ANRT funding as well as the co-financing between Heliocity and CSTB for the project "Methodology development to guarantee building photovoltaic systems' performance including failure modelling". This work has been supported by the French National Research Agency, through the Investments for Future Program (ref. ANR-18-EURE-0016 – Solar Academy).