

# Integration of GOES Data for Solar Resource Assessment of the Contiguous United States

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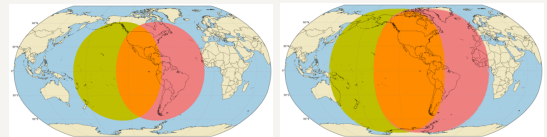


## Overview

- The National Solar Radiation Database (NSRDB), produced by the National Laboratory of the Rockies (NLR), provides high-resolution solar resource data for the contiguous United States (CONUS) using Geostationary Operational Environmental Satellite (GOES) East and West observations.
- This study evaluates the integration of multi-satellite data within the GOES-East/West overlap regions, where conventional longitude-based selection methods often produce an artificial boundary seam.
- An advanced blending algorithm is developed to improve NSRDB accuracy and creates a spatially continuous dataset.

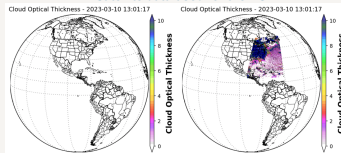
## GOES data for the NSRDB

The NSRDB data are available from 1998 to 2024. Data for 2025 will become available by September, 2026.



The spatial coverage of GOES satellites .

### Satellite data used for the NSRDB.

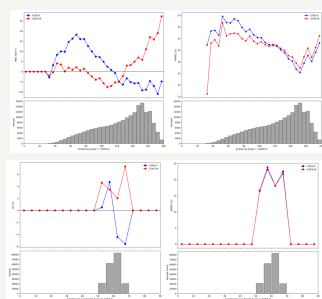


Sample data for cloud optical thickness from GOES-West and GOES-East.

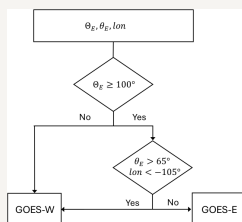
- Prior to 2019, GOES-West and GOES-East failed to capture portions of the Northeastern and Northwestern United States, respectively.
- The availability of cloud property retrievals are different.
- Multiple satellites are required to achieve complete spatial coverage.

## A new blending model

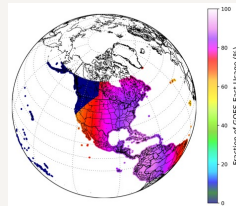
A fixed longitude-based partition at  $105^\circ$  W is used to merge geostationary satellite observations. Although computationally straightforward, this hard split introduces a discontinuity in the treatment of satellite observations across the domain.



Bias dependence on the scattering angle and SVZA.



A flowchart of the new blending model.

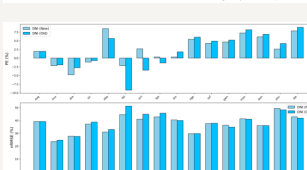
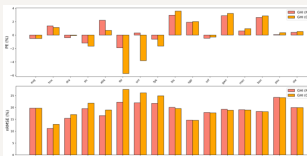


The fraction of GOES-East usage in the new blending model.

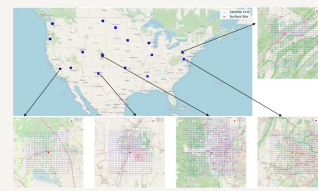
- The scattering geometry associated with GOES observations is a dominant factor affecting the bias in GHI.
- In backward-scattering conditions for GOES-East, GOES-East retrievals generally show smaller biases.
- In the forward-scattering directions, minor uncertainties in viewing geometry, radiometric calibration, or model assumptions can lead to substantial biases in retrieved cloud properties.
- Following the identified dependence of bias, a new blending algorithm is developed using scattering angle, SVZA, and longitude.
- The new blending algorithm provides a dynamically optimized integration of the two satellite datasets

## Evaluation

To evaluate the new blending model, we selected 17 surface sites from several radiation networks including SURFRAD, SOLRAD, UO, the U.S. Department of Energy ARM, and NLR that are distributed across the United States to ensure representative coverage of different climatic and solar regimes. Given the improved radiometric calibration and retrieval algorithm of the latest GOES data, we use data from 2023 as the basis for developing a new satellite blending algorithm.



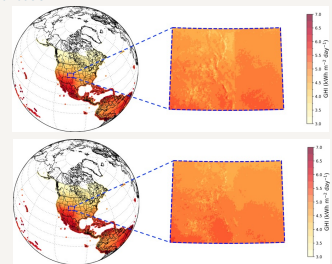
The PE and nRMSE of GHI and DNI for the old and new blending models.



The surface sites used in the validation.

The developed model is independently applied to the 2017 dataset, which represents an earlier generation of GOES observations with larger inter-satellite inconsistency.

The new blending approach leads to a systematic reduction in bias, with the most substantial improvements observed in the Mountain and Midwestern regions.



Mean GHI in 2017 using the old (upper) and new (lower) blending models.

In terms of annual mean GHI, the artificial boundary seam present in the current NSRDB is effectively eliminated by the new blending approach. This improvement reflects a gradual shift in satellite data usage, avoiding abrupt changes tied to fixed geographic boundaries .

## Conclusions

We identified a strong bias dependence on light scattering geometry, with substantially lower errors under backward-scattering conditions. This physical relationship provides a robust basis for improving satellite data integration. Following the analysis, we developed a new blending algorithm that adaptively selects satellite observations based on scattering angle and viewing geometry.