AI TO PREDICT SOLAR SPECTRA FROM BASIC METEOROLOGICAL PARAMETERS

AUTHORS

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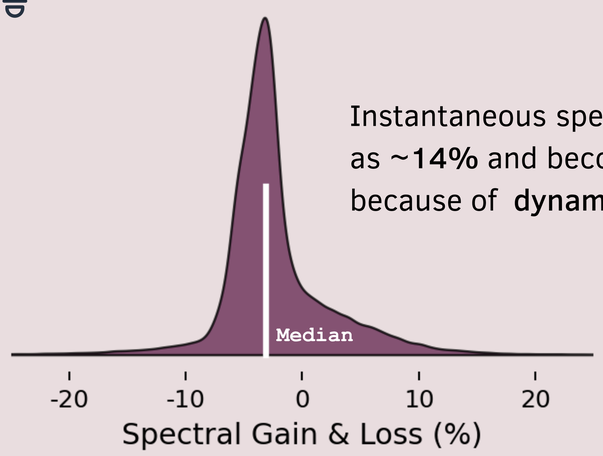
AFFILIATIONS

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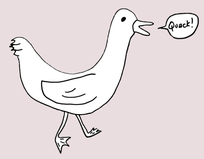
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MOTIVATION



Instantaneous spectral effects can be as large as ~**14%** and become economically important because of **dynamic electricity pricing**



SPECTRAL EFFECT CORRECTION

Conventional approach:

$$\mathbf{f}_{spectrum} \times IPOA(DNI,\ DHI) = IPOA(\mathbf{f}_{spectrum} \times DNI, \mathbf{f}_{spectrum} \times DHI)$$

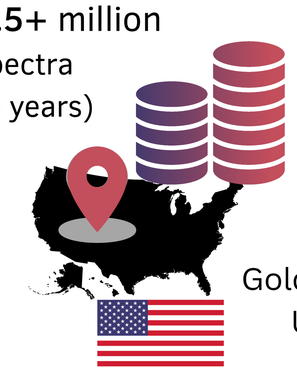
A global spectral correction **is rarely valid**; it varies with Plane of array (POA).

Predicting DNI & DHI spectra enables **independent correction of broadband irradiance components,** eliminating POA dependence.

AI SPECTRA MODELLING: Promising for dynamic skies where physical models struggle

AI PREDICTION

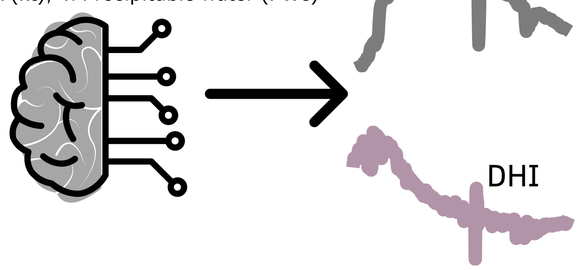
1.5+ million spectra (6 years)



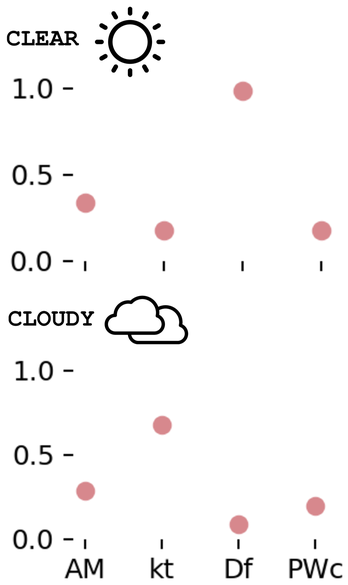
Golden, CO
USA

AI model

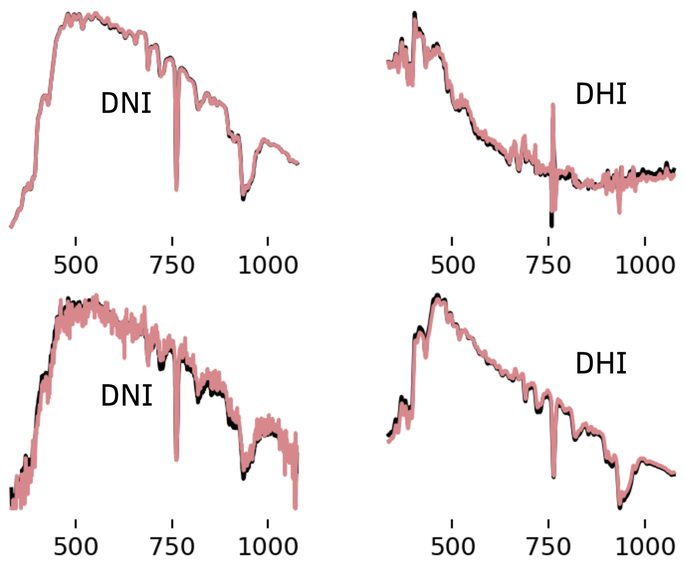
Predictors:
1. Absolute Air Mass (**AM**), **2.** Diffuse Fraction (**Df**)
3. Clearness index (**kt**), **4.** Precipitable water (**PWc**)



Source: Andreas, A.; Stoffel, T.; (1981). NRI Report *No. DA-5500-56488*

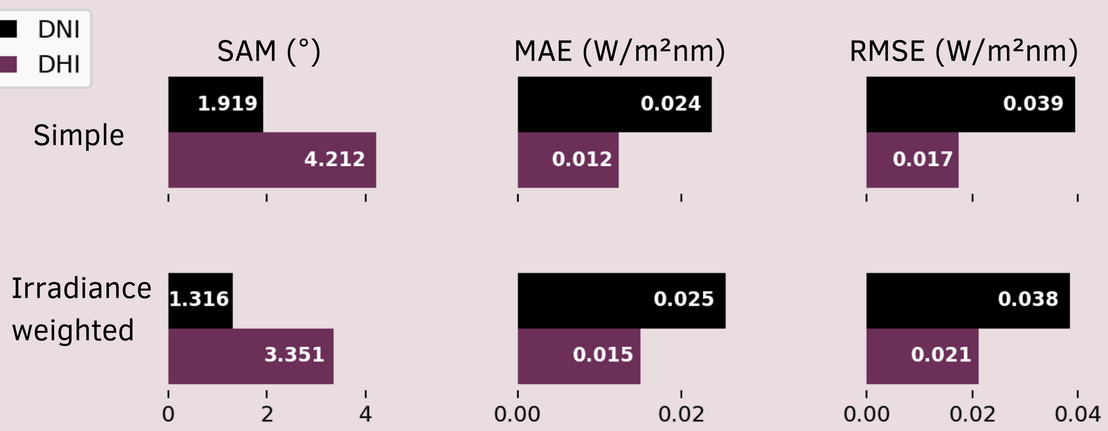


Scaled inputs



Normalized spectra: **Real** and **Predicted**

MODEL ASSESSMENT



SAM: Spectral Angel Mapper, MAE: Mean Absolute Error, RMSE: Root Mean Square Error

SUMMARY

- Our AI model predicts sun spectra under **clear** and **cloudy** conditions
- The Spectral Angle Mapper shows a high spectral similarity between model and experiment for the direct and diffuse spectra, with only 1.9° and 4.2° respectively.
- The model allows for predicting the POA-independent spectral mismatch factors of PV technologies.
- Moreover, it can predict the fraction of photosynthetically active radiation.

ACKNOWLEDGMENTS

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2024 GHI spectra from NREL | mono-Si (HJT)